The 53rd International Physics Olympiad
Tokyo, Japan (July 10-17, 2023)

Final Report of IPhO2023

The 53rd International Physics Olympiad (IPhO2023)
Tokyo, Japan (July 10-17, 2023)

January,17, 2024

The IPhO2023 Organizing Committee
and
The IPhO2023 Association

Foreword

This is the final report of the 53rd International Physics Olympiad (IPhO2023) held from July 10th(Mon) to 17th(Mon) 2023 at the National Olympics Memorial Youth Center in Tokyo, Japan.

IPhO2023 was the first on-site execution of IPhO in four years since the outbreak of COVID-19 pandemic in 2020. It was the utmost pleasure for us, the organizers, to have been able to welcome the delegations from around the world and to provide a face-to-face communication environment. We hope that each one of the contestants brought home happy memory that will further motivate his/her pursuit of future career. At the same time, we hope that we were able to add a new page to the long successful history of the International Physics Olympiad and has contributed something to the promotion of science education in the countries/regions that participated in IPhO2023.

We would like to express our sincere gratitude to MEXT and Co-Organizers and Supporters listed in this report for their generous support and contributions that made IPhO2023 possible.

KOBAYASHI Makoto
Chair, Organizing Committee of the 53rd International Physics Olympiad (IPhO2023)
Honorary Professor Emeritus, High Energy Accelerator Research Organization (KEK)
2008 Nobel Laureate in Physics

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** drafted by IYE Yasuhiro*
*** drafted by HAYANO Ryugo*

1. Executive Summary

The 53rd International Physics Olympiad (IPhO2023), Tokyo, Japan

[Date] July 10th to 17th, 2023

[Venues] The National Olympics Memorial Youth Center (NYC)
Kamizono-cho, Yoyogi, Shibuya-ku, Tokyo
Nippon Seinenkan Hotel (NSH)
Kasumigaoka-cho, Shinjuku-ku, Tokyo
The Institute for Industrial Science (IIS), The University of Tokyo
Komaba, Meguro-ku, Tokyo

[Attendance]

Participating Countries and Regions

Regular Participation	80
Team of Individuals	1
Observer Countries	2
Guest Team	1

Participants (Figures in parentheses are number of females.)

Contestants (Students)

Regular Contestants	388 (43)
Guest Students	4 (1)
Sub Total	392 (44)

Adult Participants

Leaders	155 (13)
Observers	96 (19)
Guests	17 (9)
Sub Total	268 (41)

Total number of participants 660 (85)

[Awards]

Medals and Honorable Mentions

	number	cumulative	ratio
Gold medals	37	37	9.5%
Silver medals	74	111	28.6%
Bronze medals	103	204	52.6%
Honorable Mentions	54	258	66.5%
Regular Contestants	388		100%

Special Prizes

Absolute Winner	1
Best Performance in the Experimental Examination	1
Best Performance in the Theoretical Examination	2

Diversity Commendation (given to teams) 4 teams

[Organizing Side]

Organizers

The Organizing Committee of the International Physics Olympiad 2023
and
The International Physics Olympiad 2023 Association
with the support of the Ministry of Education, Culture, Sports, Science and Technology (MEXT), Japan

Co-Organizers

Academic Societies	4
Government Affiliated Organizations	5
Universities	6

Number of Persons Involved

A. Organizing Committee		
A-1 Organizing Committee Members	36	
B. Academic Committee		
B-1 Academic Committee Members	19	[4 of which are included in A-1]
B-2 IT Technical Staff	5	
B-3 Moderators (assistant profs, postdocs)	23	
B-4 Markers (graduate students)	23	
B-5 Invigilation	70	[21 of which overlap with C-3]
B-6 Exam printing, Answer scanning	20	
B-7 Answer numerical input (Excel sheet)	27	
Subtotal	187	[minus 25 for the grand total]
C. Executive Committee		
C-1 Executive Committee Members	4	[3 of which are included in A-1]
C-2 Student Leaders (events, newsletters)	14	
C-3 Student Supporters (team attend)	142	
C-4 Exam Partition Designers	2	
C-5 Photographers	2	
C-6 Nurses	2	
Subtotal	165	[minus 3 for the grand total]
D. IPhO2023 Association (Secretariat)		
D-1 Administrative Staff	8	
Grand Total	369	

*Personnel and temporary staff of the official travel agency (Tobu Top-Tours) are not included in this count.

**Of the 369 persons counted above, about 20 persons, including the chairs of the committees, the head of the subcommittees, the exam preparers, the staff of the secretariat and the auditors, made long-term (more than 5 years) commitment from the early planning stage. Additional 30 persons joined the organizing body for the last two to one years for the actual planning of the programs, including cultural events, excursions etc. The rest were recruited to various roles for the operation of IPhO2023 during its period.

[Supporters]

Special Supporters	
Diamond Supporter Companies	8
Sapphire Supporter Companies	18
Ruby Supporter Companies	22
Supporters	
Supporting Members (companies and groups)	13
Supporting Members (individuals)	18
Donors (companies and groups)	63
Donors (individuals)	112

[Web sites]

https://international-physics-olympiad2023-tokyo.jp/ International page in English

https://international-physics-olympiad2023.jp/ Domestic page in Japanese

2. Chronology --- Long and Winding Road to IPhO2023

2.1 Pre-History (before 2015)

The International Physics Olympiad (IPhO) first held in Warsaw (Poland) in 1967, has developed to a world-wide competition of young talents in the field of physics. IPhO has been held every year (with a few exceptions) by host countries taking turns. In the long history of IPhO, Japan joined the IPhO community relatively recently. Japan sent its first delegation to IPhO2006 in Singapore and participated regularly ever since. An organization by the name of "the Committee of Japan Physics Olympiad (JPhO)" is the body responsible for domestic selection and dispatch of the representative contestants to each year's IPhO.

The IPhO Statutes and Regulations state that "each country should, within five years of entry, declare its intention to host a future Olympiad". The JPhO delegation leaders to IPhO2009 in Mexico conveyed Japan's intention to take the responsibility of hosting IPhO but no earlier than a decade from then, possibly around 2023, to the President of IPhO at that time. Soon after, JPhO was approached by the IPhO President for the possibility of hosting IPhO in 2022, and accepted the request. Thus, the preliminary setting for an IPhO in Japan was set with the target year 2022, and Japan became listed as prospective host country in the timeline on an unofficial webpage of Physics Olympiad.

2.2 Early Planning Period (2015 to 2019)

The substantive activity as a future host country began in 2015 with KOBAYASHI Makoto's acceptance of chairmanship. On May, 2016, the kick-off meeting of the IPhO2022 Organizing Committee was held by the core members. Three committees --- the Executive Committee (chaired by IYE Yasuhiro), the Academic Committee (chaired by HAYANO Ryugo) and the Fund-raising Committee (chaired by SAKAKI Hiroyuki) --- were formed. In consideration of potential conflict of interests, it was determined from the outset that the organizing body of IPhO2022 should be appropriately demarcated from JPhO which was the organization conducting domestic selection and dispatch of the contestants, especially with regard to the exam problems creation.

The Initial tasks of the IPhO2022 Organizing Committee included the followings:

(1) To communicate with the Ministry of Education Culture Sports Science and Technology (MEXT), and the Japan Science and Technology Agency (JST -- a funding agency under the jurisdiction of MEXT) for the governmental support of hosting IPhO2022.
(2) To communicate with physics-related academic societies, including the Physical Society of Japan, the Japan Society for Applied Physics, and the Physics Education Society of Japan.
(3) To contact with the Tokyo University of Science for installation of the IPhO2022 Secretariat office within the campus.
(4) To conduct survey of facilities which are both suitable as the venue of IPhO in Tokyo and are affordable.
(5) To estimate the overall cost of hosting an IPhO and make up plans for fund raising.
(6) To recruit sufficient number of able physicists who are willing to work together anonymously to create and brush up the exam problems.

We contacted the Human Resources Policy Division, the Science and Technology Policy Bureau of MEXT early on, so that the MEXT will officially endorse the invitation of IPhO to Japan when the appropriate time comes. We were told that the subsidy from MEXT would be at most the amount equal to the funds collected by the organizing body. The total cost of hosting an IPhO in Tokyo was roughly estimated as 400 million JPY (depending largely on the accommodation cost and on the extent of outsourcing logistics), by reference to the publicly disclosed account settlements of other Science Olympiads of comparable size (biology, chemistry *etc.*) held recently in Japan. This meant that we would have to secure about 200 million JPY as self-help revenue. The total amount of participation fees paid by the delegations from various countries/regions was estimated to be about 50 million JPY. Thus, the fund-raising target was set at 150 million JPY, which seemed quite a challenge in view of the somewhat recessing economy in Japan at that time.

In regard to the selection of IPhO venue within the Tokyo metropolitan area, the National Olympics Memorial Youth Center (NYC) seemed to be the only practical choice, so that we placed a tentative reservation for the period of July 10-18, 2022. (The official reservation had to wait until one year prior to the actual event.)

Three physics-related academic societies, the Physical Society of Japan, the Japan Society for Applied Physics, and the Physics Education Society of Japan, agreed to be co-organizers. Later, the Biophysical Society of Japan joined.

In April 2018, a General Incorporated Association entitled “International Physics Olympiad 2022 Association (IPhO2022 Association)” was established with KOBAYASHI Makoto as the president, and he and IYE Yasuhiro assuming the positions of representative director for legal registration. This Association was the implementation body of IPhO2022 and the recipient of the government subsidy. The office of the IPhO2022 Association was set up within the premise of the Tokyo University of Science, which agreed to be one of the co-organizers of IPhO2022. SUZUKI Akifumi, a former MEXT officer, was recruited for the administrative office head. Thus, the IPhO2022 Association took its initial shape.

Neither HAYANO nor IYE had prior experience of attending IPhOs. HAYANO paid visit to IPhO2016 in Switzerland/Lichtenstein, and IYE attended IPhO2017 in Indonesia and IPhO2019 in Israel to get familiarized with the International Board Meeting and other matters relevant to running an IPhO.

The Academic Committee of IPhO2022 chaired by HAYANO Ryugo made an early start. He managed to recruit physics professors and formed two subcommittees for experimental and theoretical problems. They held regular meetings, initially starting with review of the exam problems of the past IPhOs. The members and activities of the Academic Committee were kept undisclosed until the completion of the real examination. The detailed account of the Academic Committee’s activity is given by HAYANO, in Chapter 3 of this report.

2.3 Outbreak of COVID-19 and Postponement of IPhO2020 (2020)

Things completely changed in early 2020 when COVID-19 pandemic started to spread like a wildfire all over the world. IPhO2020 scheduled to be held in Lithuania that year was forced to be postponed to the next year. We were approached by the IPhO President and were asked if the IPhO2022 in Japan could be shifted to 2023. Given the unprecedented circumstances, we agreed, after consulting with MEXT, on the rescheduling. Accordingly, the Association was renamed IPhO2023 Association, and other relevant changes were made.

In July 2021, with the global situation of COVID-19 aggravated, the Lithuanian organizers had no other choice but to hold IPhO2021 on-line, for the first time in the IPhO history. The Lithuanian organizers requested each participating country to appoint invigilators who were *not* the members of the dispatching organization (in the case of Japan, JPhO, mentioned earlier). In response, HAYANO and IYE served as invigilators of the exam executed on-line. This offered us a good opportunity for us to recognize various issues with regard to on-line style competition, thus get prepared with an unwanted turn of event that similar situations occur in 2023. While we wanted to make IPhO2023 an on-site face-to-face event by all means, we also had to keep in mind an alternative scenario of on-line execution of IPhO2023. The necessity of such “two-way planning” was very stressful throughout the preparation of IPhO2023. We did not consider an option of so-called “hybrid style” implementation, because that would make it extremely difficult to secure equal conditions and fairness in the contest.

2.4 Period of Accelerated Preparations (2021 to March 2023)

2.4.1 Fund-raising campaign

In 2021 and 2022, we accelerated our fund-raising effort. Three categories of “Special Supporters” titles (Diamond, Sapphire and Ruby) were installed according to the level of contributions. Calls for donations from individuals, groups and companies, irrespective of the amount of money, were continued. In retrospect, we were fortunate to be able to achieve more or less the initially set fund-raising target of 150 million JPY by March 2023.

2.4.2 Logistics and social event planning

In 2021, about two years before the actual IPhO2023 event, we selected Tobu Top Tours company as the official travel agency of IPhO2023, after an appropriate process of bidding. Tobu Top Tours formed a special team for IPhO2023 and handled various aspects of logistics in close collaboration with the IPhO2023 Secretariat. The work included reservation of rooms in the NYC and the Nippon Seinenkan Hotel (NSH), assistance of visa applications, arrangement for airport pickup and transportation during IPhO2023, and many others.

As for the planning of social events such as excursions, cultural experience sessions, we wanted to incorporate senses and preferences of youngsters as much as possible. For this purpose, we recruited students of Tokyo University of Foreign Studies and International Christian University and appointed them as Student Support Leaders. They formed a team with YAMASHITA Minoru, Head of the Event Planning Subcommittee. Over the last one and half years, the team held regular meetings and put forward ideas for cultural experience events, which were materialized in the style of “en-nichi” (festival held at temples or shrines on designated religious days) with many stalls providing foods and games and “bon-odori” (group dance at summer festival). As for the excursions, they actually took the trouble of visiting each of the candidate destinations and checked all the relevant issues, including trip route and time, where to visit and take lunch *etc*. In this way, they made plans of four half-day courses and four full-day excursion courses, and they produced brochures which are reproduced in the Appendix 2. Each team of students could choose 2 half-day excursion courses out of 4 for Wednesday and Friday and 2 full-day excursion courses out of 4 for Saturday and Sunday. The adult participants (leaders, observers and guests) were offered 2 half-day excursions in the time slots when students engaged themselves in the exams on Tuesday and Thursday.

2.4.3 Design and production of experimental kits

The Academic Committee narrowed down the candidates of exam problems by spring of 2022. The big issue was to design and materialize the experimental apparatuses. The Academic Committee approached a few companies capable of producing them. Going through the calling for bids, Shimadzu Rika company was selected. Shimazu Rika and the Organizing Committee entered into a contract for the production of the experimental kits with an appropriate non-disclosure agreement. A few rounds of trial production and operation check were made before proceeding to the final production of 500 sets.

Here, it is worthwhile to put on a record, a specific problem we encountered in connection with the possibility of remote execution of the exam. If the exam were to be conducted remotely, the experimental kits would have to be shiped to the participating countries in advance. Time and trouble of custom clearance in different countries were well anticipated. What came to our attention in later stage was the RoHS (Restriction of Hazardous Substances) Directive in European countries. It turned out that the experimental kits being developed contained some materials such as lead-containing solder, brass with trace amount of cadmium, and metal parts surface-plated with hexavalent chromium, which may not comply with the RoHS regulations in EU, although they are perfectly okay within Japan. After discussions with Shimadzu Rika Company, the specs of the relevant parts were changed (with extra costs) just to be on the safe side, and the parts in question were replaced by those made of materials complying with RoHS. Although this measure turned out to be unnecessary because the contest was held on-site, this should be put as a note for future IPhOs.

2.4.4 Preparation for exam environment

Two gymnastic halls in the Sports Building of NYC were chosen as the venue of examination. Based on the number of Pre-Registration Forms, we estimated the maximum number of contestants could be as large as 450. Planning of the layout of booths for individual contestants was made by HAYANO, Chair of the Academic Committee. In addition to those two halls, a few additional rooms were reserved as extra venue of examination, in consideration of possibilities such that some of the contestants should be separated (*e.g.* due to COVID-19 infection), or would require special treatment (*e.g.* for medical reason *etc.*).

The design and layout of booths to be set up in the gymnastic halls of NYC were planned by HAYANO with a great help of FUKUSHIMA Katsuya's group at Tokyo City University specializing in architectural design. With due considerations of ecology, the partitions were made with cardboards and were designed to be easy to assemble and dismantle and be apt for re-usage and recycling. After IPhO2023, some sets of the used cardboard partitions were donated to Tokyo City University as a stock for potential use at emergency evacuation sites in an event of natural disaster *etc.*

2.4.5 Scientific calculators

Another important issue was scientific calculators to be used by the contestants. In the past IPhOs, it was customary to allow the contestants to use their own calculators provided they meet the regulations. This made it necessary to check the spec of the models, and to clear the memories of the calculators prior to the exam. In IPhO2023, CASIO COMPUTER Co. Ltd. offered to provide a suitable model of scientific calculator. Making all the contestants use the same model of calculator has a lot of advantages in terms of equality of exam conditions. On the other hand, making all of them appropriately familiarized with the model prior to the exams was the challenge. Fortunately, CASIO offered a web-based emulator program that allowed prospective users to get used to the usage of the model. We provided the access codes to the emulator program to each participating teams so that the contestants could get used to the usage of the calculator. In addition, we installed a special practice session on the first day of IPhO2023. Despite our concerns, it turned out that young students are so quick to get used to a new gadget. No complaints were heard about the uniform use of the calculator provided by the organizer. We were impressed to find that young students were "digital native" so that they were able to make use of the newly provided gadget effortlessly (perhaps without even reading the manual) in a short period of time.

In this connection, it is our opinion that the part of the Regulations to Section 5 of the Statutes relevant to calculators should be reconsidered: The Regulations state that "Contestants may bring into the examination drawing instruments and approved calculators". However, if, as practiced in IPhO2023, official calculators are provided to all contestants and fairness is ensured by pre-training opportunity *etc*., then the provision "permission to bring one's own calculator" should be unnecessary. The Regulations also state that "A calculator shall be an approved calculator if it is not a graphical calculator, its display has no more than three lines, and if its user memory is completely cleared immediately prior to each examination." This part of the Regulations seems outdated, given that new models of calculators are continually introduced in the market.

2.4.6 Logo, conference goods, medals and trophies

The logo of IPhO2023 was designed by Ms NAKANURA Maiko.

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2023 TOKYO JAPAN

The "I" of the IPhO2023 logo is an exclamation mark representing excitement of doing physics.
The "P" is a question mark symbolizing intellectual curiosity which is a driving force of research.
The "h" may be seen as the Planck constant, one of the fundamental constants of physics (admittedly a strained interpretation).
The "O" is designed as a light bulb, a classic symbol of an "Eureka" moment

The IPhO2023 goods were (1)T-shirt, (2)cap, (3)bag, and (4)thermos bottle. Students were given all four items, while the leaders and observers were given a T-shirt and a bag.

IPhO2023 T-shirts

IPhO2023 Caps

IPho2023 Bag

Thermos bottle

The design of medals to be awarded to the contestants who marked high scores carried the image of Mt. Fuji. Mount Fuji is an undisputed symbol of Japan, and has been an inexhaustible spring of artistic inspiration. The medals of IPhO2023 adopt one of the most famous images of Mt. Fuji taken from a series of masterwork wood prints “Fugaku Sanju-rokkei (36 views of Mount Fuji)” by KATSUSHIKA Hokusai (1760-1849), renowned artist of Edo era, days of TOKUGAWA Shogunate lasted from mid 17th century to mid 19th century.

Wood print work “Gaifu-Kaisei (fine breezy day)”, also known as “Aka-Fuji (red Fuji)” by KATSUSHIKA Hokusai.

In the Statutes of IPhO, it is stipulated that gold, silver, bronze medals and honorable mentions are to be awarded to the contestants according to their exam achievements and that on top of these regular awards, the host organization can award special prizes to the contestants who rank highest in the experimental exam, highest in the theoretical exam, and highest in the total score. Following the practice of past IPhOs, we prepared trophies for these top performers. To our surprise, two contestants tied at the full mark in the theoretical exam. Given this unanticipated outcome, we hurriedly produced an additional piece of trophy and sent it to one of the two students about two weeks after the closing of IPhO2023.

2.4.7 Promotion of gender diversity

It had been adopted at the IBM of IPhO2022 (Switzerland, on-line) that a statement “Each country is encouraged to promote gender diversity within its team” be added to the Regulations to the Sec. 3 of the IPhO Statutes. In some of the past IPhOs, a special prize was awarded to the female best performer. We deliberated on this issue and sought opinions of various people (men and women, senior and young) about the idea of “best female performer prize”. Although opinions varied among seniors, young female students unanimously opposed the idea. Their shared opinion was that such a prize would be insulting to female contestants who would like to compete on the same ground regardless of gender. After taking account of various opinions, we decided not to award a “best female performer prize” in IPhO2023. Instead, we decided to give “Diversity Commendation” to those teams representing well-balanced gender mixture and achieving respectable results in the contest.

In connection with the gender issue, we comment that we made the gender entry of the Team Registration as three choices consisting of “male”, “female”, and “decline to identify” in consideration of transgender persons. It turned out no one chose the third option this time, but this would be something to be paid attention in organizing future IPhOs.

2.5 Count-Down Months (Jan to July 2023)

2.5.1 First circular and pre-registration

In late 2022, IPhO Secretary STANLEY provided us the list of leaders of countries/regions which participated in at least one of the previous three IPhOs -- IPhO2019 (Israel), IPhO2021 (Lithuania, on-line) and IPhO2022 (Switzerland, on-line) with their e-mail addresses. We sent an e-mail of pre-announcement on Jan. 17, which was also intended as communication test.

On Jan. 24, we sent out the First Circular and simultaneously opened the Pre-Registration site in which a Pre-Registration Form was to be filled out by a principal contact person of the prospective participating country/region, so that we can collect tentative numbers of participants.

In addition to the countries/regions with the record of participation in the past, we were approached by some twenty individuals. Half of them were high school students who wanted to participate without knowing the rules of IPhO. We let them know that one has to go through the domestic selection and advised to check the relevant system in their respective countries/regions. The other half were physics teachers or professors who wanted to send a team to IPhO for the first time. We referred to the IPhO Statutes and explained them that it is a general practice that a country/region first entering IPhO should do so as an observer country/region and has to pay the prescribed participation fee. After many exchanges of e-mails, many of them dropped their idea or simply disappeared from communication. The countries eventually participated either as observer country or guest team were those listed in Sec. 5.1.

2.5.2 On-site or on-line: COVID-19 and other risks

Due to the COVID-19 pandemic, the 2020 competition was canceled, and both IPhO2021 (Lithuania) and IPhO2022 (Switzerland) were forced to be held remotely. We, the organizers of IPhO2023 had to prepare for IPhO2023 in two ways. Namely, while we wanted to realize IPhO2023 as an on-site face-to-face event, we had to consider the option of on-line implementation in parallel until a fairly late stage of preparation

Learning from the experience of exam invigilation for the remote implementation of IPhO2021 (Lithuania), we knew that some countries could take a long time for customs clearance, so a final decision on the implementation format (on-site or on-line) had to be made by the end of March at the latest. Fortunately, the situation had calmed down considerably by early spring, so we decided to go ahead with on-site implementation of IPhO2023 at the Organizing Committee Meeting on March 24, and immediately notified the participating countries/regions by e-mails.

Starting from May 8th, Japanese government re-classified COVID-19 from Class 2 to Class 5, deregulating various infection prevention measures. Accordingly, we decided to leave mask wearing and other infection prevention measures to individual discretion during IPhO2023. On the other hand, considering a possibility of infection development during IPhO2023, we included the following clause in the Commitment Form to be signed by all participants:

> *I commit myself to cooperate with the IPhO2023 organizer for a safe execution of the event. I obey the Japanese laws and the usage rules of the National Olympics Memorial Youth Center. I follow directions of the IPhO2023 organizer with regards to the COVID-19 infection prevention and emergency safety measures against natural disasters such as earthquake.*

Preparations were made to stock masks, disinfectants, thermometers, antigen test kits, *etc.* at the competition headquarters in case infections spread during the competition period.

In the process of preparation for IPhO2023, we had identified the following risks and potential incidents in addition to COVID-19 that should be kept in mind: (a) Natural disasters such as earthquakes and typhoons, (b) Illness, injury, involvement into crimes or accidents, and disappearance of participants, (c) Troubles between participants due to international tensions. Fortunately, no troubles so serious to hinder a safe operation of IPhO2023 occurred.

2.5.3 Second circular and team registration

The Second Circular was distributed on April 14, 2023 and the website for the team registration was opened. The Google form for the team registration was quite large in volume, because we had to collect all the relevant data including passport photocopies, face photos, agreement forms, commitment forms, *etc*. Some teams whose internet environments were less than ideal experienced difficulty in uploading the large volume of data. We had to handle those cases individually.

The deadline for the team registration was set at May 15. However, many countries/regions could not meet this deadline because they did not finalize their domestic selection. Many Asian countries waited the outcome of the Asian Physics Olympiad held in late May. Such delay in finalizing the membership of the teams rippled to the delay in visa acquisition process and in finalizing the travel plan as stated below.

2.5.4 Assistance of visa acquisition

Depending on their nationalities, some participants were required to get visas for entry to Japan. In the First Circular, we recommended the leaders of such teams that include members in need of visas to act well in advance for a visa application referring to the website of the Ministry of Foreign Affairs, Japan https://www.mofa.go.jp/j_info/visit/visa/index.html. We offered that the Organizer would provide invitation letters to assist with the visa application upon request and registration of relevant information.

However, some countries/regions could not take actions for visa application either because the selection of the representative contestants was not finalized until June as mentioned above, or, simply the necessity of visas slipped their mind. Administrative procedures of visa issue differed from one embassy of Japan to another. Late filing of visa application by some of the participating teams caused a lot of paper works in tight schedule for the Organizer.

2.5.5 Recruitment of student supporters

We started recruitment of student supporters (part-time workers) who would help the operation of IPhO2023 in various aspects; (a)attending the students during their stay and excursions, (b)assisting implementation of the examinations, and (c)assisting implementation of cultural and scientific experience events. The recruitment was extended to the Tokyo University of Foreign Studies (TUFS), The International Christian University (ICU), Tokyo University of Science (TUS), Tokyo City University (TCU) and Sophia University. The applicants were interviewed and were assigned the tasks according to their skills and availability during the IPhO2023 period. Some of the former IPhO contestants, now university students, also joined the supporting team.

In addition to the student supporters, we recruited cultural clubs of university students which would show their performance as entertainment at the Opening and Closing Ceremonies and cultural events. A few clubs took up the task: the wadaiko (Japanese drum) club of International Christian University, the Karate

(Japanese martial arts) club of ICU, the Koto (Japanese harp) club of Sophia University, and the Sado (tea ceremony) club of Tokyo University of Foreign Studies.

2.5.6 Dry run of exam execution

On May 13th (Sat.), the Academic Committee carried out a dry run of the examination execution. All 46 markers were assembled and asked to try solving the actual exam problems in the morning, (They had signed the non-disclosure agreement.) Then, in the afternoon, they were trained to grade those answer sheets. This dry run was quite meaningful in digging up potential problems of the marking process and gaining consensus on the scoring criteria.

It Is stipulated In the IPhO Regulations that the host organization should set an opportunity for an advance visit by the IPhO President. We thought this dry run was a suitable opportunity for President RAWAT to pay a pre-visit. Fortunately, he was able to accept our invitation and inspected the dry run. He got a briefing from the Academic Committee Chair HAYANO, and put his hand on the experimental kits, and inspected the facilities of the venue of IPhO2023. President RAWAT expressed his satisfaction about the preparation status of IPhO2023 both in terms of the contest implementation and all aspects of logistics.

2.6 IPhO2023 Period (July 8 to 18, 2023)

2.6.1 Last-minute rehearsal of exam execution

On July 8th and 9th, the installation of the exam environment and the last-minute rehearsal of exam execution were carried out. The rehearsal included, (a)printing of the numerous pages of the exam problems, the answer sheets, and the work sheets, (b)distributing, collecting and sorting of the exam sheets, (c)transportation of the answer sheets and work sheets from the NYC to the marking center at the Institute for Industrial Science (IIS) in Komaba II Campus of the University of Tokyo, and (d)scanning and conversion to PDF of those answer sheets and work sheets.

At NSH where the International Board Meeting was to be conducted, high capacity internet line was installed by the special IT team on the 9th, the day before the first IBM.

2.6.2 Arrival and registration of delegations

We asked each delegation to enter the flight schedule in the Team Registration Form. However, because many airlines had reduced the number of flights on account of COVID-19 pandemic, quite a few teams apparently experienced difficulty in finding appropriate flights and could not fix their travel schedule until the last minutes, which in turn caused difficulty on our side to make arrangement of airport pick-up service and accommodation for the night of their arrival to Japan. We prepared a new Google Form to be filled out by those teams as soon as their flight schedule were fixed.

Still, the majority of the participating teams entered Japan either at the Narita International Airport or Tokyo International Airport (Haneda) on July 8th or 9th, were picked up by our travel agency and transported to the venue of IPhO2023 by chartered buses.

Upon arrival to the NYC, each team was received at the registration desk, where the students were greeted by a student supporter who was to escort them during IPhO2023. After picking up the IPhO2023 goods and handbook, students were then led to a drop-off desk where they were asked to hand over their personal computers, smartphones, and any other electronic devices with communication function, including bluetooth headphones *etc*. Those devices were returned to them after the completion of the theoretical exam on July 13th (Thu).

A get-together party was held in the evening of 9th (Sun) at the reception hall of the International Exchange Building of NYC. After the get-together party, the adult participants (leaders, observers and guests) were transported to the NSH.

2.6.3 Opening of IPhO2023

The Opening Ceremony started at 10:00 on 10th (Mon) with the Opening Address by KOBAYASHI Makoto, Chair of the Organization Committee. The Minister of Education, Culture, Sports, Science and Technology (MEXT), NAGAOKA Keiko, gave a welcome address. In connection to the attendance of the Minister, we had been instructed by the MEXT to make the number of attendants in the auditorium minimal for the security reasons. Accordingly, we decided to accommodate only the students in the main auditorium and the adult participants were seated in a separate room where video coverage of the opening ceremony was shown on a screen. Some voices of complaint were heard from adult participants, but we were not allowed to reveal the reason for admission restriction, either. The Minister left the venue after her address, and then each team of students were called to the stage.

After the formal part of the ceremony, “wadaiko (Japanese drum)” play by students of International Christian University and “karate (Japanese martial arts)” demonstration by students of Sophia University were performed on the stage.

Right after the Opening Ceremony, the leaders and observers were transported to NSH where the first International Board Meeting was to be held from 14:00.

This summer of 2023, the International Mathematical Olympiad (IMO2023) was also held in Japan (Makuhari, Chiba) with the period of July 3rd to 12th partially overlapping with that of IPhO2023. We were aware that among the IPhO2023 contestants, several students also participated in IMO2023 where the exams were to be completed by 9th (Sun). We instructed those students to come to the IPhO2023 venue and drop off their communication devices at the latest by 14:00 on 10th (Mon), which was the time the IBM started and the experimental exam problems were disclosed to the team leaders and observers. Some of those students wanted to attend the closing ceremony of IMO2023 on 12th (Wed), but we did not give them permission to go out the NYC since it was the day between the experimental and the theoretical exams.

There was an incident that two students of a certain team missed their flight connection and arrived at Narita Airport in the evening of 10th (Mon) when the first IBM session was already in progress. Since these students had failed to hand over their communication devices by the designated time (14:00, the starting time of the first IBM), we thought they should be disqualified as regular contestants but be only accepted as guest contestants. However, there were no clearcut statements in Statutes and Regulations. Although we eventually agreed to treat them as regular contestants following suggestions by IPhO President and Secretary, we felt that the rule should be clarified for such cases.

2.6.4 COVID-19 situation during IPhO2023

The first half of the IPhO2023 period went by without any serious incidents. But in the second half, some team leaders developed symptoms of fever and tested positive for COVID-19. Antigen tests were administered for roommates and close contacts. It turned out that the test kits stocked in advance were not sufficiently sensitive, so we visited nearby pharmacies to purchase more test kits. Roommates who also tested positive remained in isolation, while those testing negative were moved to other rooms, isolating only the infected individuals. Meals were delivered by hotel staff. The management of NSH was very cooperative and flexible, securing alternative rooms on short notice. In total, 5 team leaders tested positive. Attitudes toward COVID varied by countries and individuals. In one case, we had to argue with an infected individual who strongly complained about being isolated in his hotel rooms (despite that he had signed the Commitment Form mentioned in 2.5.4).

Around this time, moderation sessions were scheduled, in which team leaders from each country/region and Academic Committee members get together to discuss their respective marking results. In order to conduct the moderation safely under the above situation, the number of participants was limited to 2 per country/region. All the participants of the moderation session were required to have been proved negative by antigen test and to wear masks throughout the session. Some 200 antigen test kits needed for this purpose were hurriedly collected by visiting several pharmacies in the neighborhood of Nippon Seinenkan Hotel (NSH).

Toward the end of the competition, infections also began appearing among students staying at the NYC. With appropriate nursing care and medication, their symptoms did not go serious, and all teams were able to depart on schedule.

2.6.5 Other issues and their counter-measures

The Handbook distributed to the participants included explanations of evacuation procedures in case of earthquake/fire, and contact information in case of illness/injury, as countermeasures for natural disasters and illnesses/accidents among participants.

Two nurses were stationed full-time during the competition period at the National Olympic Memorial Youth Center (NYC). It was anticipated that some students might get sick after long travels and with mental pressure for the contest. In the first half of the competition period, two students complained of disconfort, but recovered after consultation by the nurses, drug prescription and rest in their rooms. They were tested COVID negative.

With intense heat expected and actually continuing throughout the competition period, heat stroke countermeasures included preparing ample mineral water, salt candies for electrolyte replenishment, cooling towels, etc., and urging students to stay hydrated through nursing staff and student supporters.

Care was taken to accommodate participants with medical conditions, disabilities, dietary restrictions (allergies, halal, kosher, vegetarian, etc.). The Team Registration Form included entry for notifying such special requirements. Several dozen participants, both students and team leaders, required halal meals. While basic accommodations were made in the dining hall, dissatisfaction was heard about the small variety of halal menus. In particular, some restaurants could only provide vegetarian menus to halal diners, forcing participants wanting to eat non-pork/non-alcohol meals to compromise.

Having heard of cases of visiting foreigners disappearing after entering Japan for international events, invitation letters for visa applications were issued only after confirming the applicant's affiliation, status, passport copy, *etc.*, with extra care taken for applications from countries with no prior participation record.

As for Russia and Belarus, we notified the contact persons at the time of Second Circular that "While we cannot invite the delegation as a national team, a team of individual contestants can be accepted". As a consequence, Belarus chose not to participate in IPhO2023 and Russia took the option of sending a team of individuals. The Russian students were grouped as "Oly Team" and the accompanying adults were categorized as observers without the right to vote at the IBM. The opportunity of moderation was guaranteed.

Every participant was urged to pledge "no political activities or statements during the competition period" by submitting a signed Commitment Form. As we took extra care of the Russian students throughout IPhO2023, no particular troubles occurred, to the best of our knowledge.

Most of the contestants were minors requiring appropriate protection. Some countries seemed remiss in their escort duties, allowing subsets of students to travel separately on different schedules without escorts. There was a case that two students of a certain delegation missed the flight connection and traveled by themselves to Narita Airport and had to be picked up upon their late arrival.

A student supporter was assigned to each team. Many of the student supporters were able to communicate with the contestants in language of their country/region. Their roles were to assist with the stay and to guide excursions. Contestants were instructed to act under the student supporters' escort, but some were spotted going out of the NYC on their own after dark. In a case that a contestant wished to go out of NYC, for example with a relative living in Tokyo, we granted it on condition that the person taking out the student to submit a pledge document detailing the purpose and the time to be back at NYC.

2.6.6 Time table for students

IPhO2023 Student Program

	Time	Activity	Place
July 9 Sunday	13:00-17:00	Registration	
	17:00-19:00	Get Together	*Reception Hall*, International Exchange Bldg. 1F
July 10 Monday	7:15-8:00	Breakfast	*Cafeteria Fuji*, Central Bldg. 2F
	10:00-12:00	Opening Ceremony	*Large Hall*, Arts Bldg. 1F
	12:30-13:30	Lunch	*Cafeteria Fuji*, Central Bldg. 2F
	14:00-14:45	Briefing on Calculators Used for Examination	*Large Hall*, Arts Bldg. 1F
	15:00-18:00	Free Time	
	18:00-19:00	Dinner	*Cafeteria Fuji*, Central Bldg. 2F
July 11 Tuesday	7:15-8:00	Breakfast	*Cafeteria Fuji*, Central Bldg. 2F
	8:30	Enter the Examination Room	Athletic Bldg. 1F & B1F
	9:00-14:00	Examination (Experiment)	
	14:30-15:30	Lunch (light meal)	
	16:00-19:00	Cultural/Scientific Experience Events	Cultural events: *Reception Hall & Oka Tei*, Scientific events: *International Conference Room*, International Exchange Bldg. 1F
	18:00-19:00	Dinner	*Cafeteria Fuji*, Central Bldg. 2F
July 12 Wednesday	7:15-8:00	Breakfast	*Cafeteria Fuji*, Central Bldg. 2F
	9:00-14:00	Half-day Tokyo Excursion 1	
	16:00-19:00	Cultural/Scientific Experience Events	Cultural events: *Reception Hall & Oka Tei*, Scientific events: *International Conference Room*, International Exchange Bldg. 1F
	18:00-19:00	Dinner	*Cafeteria Fuji*, Central Bldg. 2F
July 13 Thursday	7:15-8:00	Breakfast	*Cafeteria Fuji*, Central Bldg. 2F
	8:30	Enter the Examination Room	Athletic Bldg. 1F & B1F
	9:00-14:00	Examination (Theory)	
	14:30-15:30	Lunch (light meal)	
	16:00-19:00	Cultural/Scientific Experience Events	Cultural events: *Reception Hall & Oka Tei*, Scientific events: *International Conference Room*, International Exchange Bldg. 1F
	18:00-19:00	Dinner	*Cafeteria Fuji*, Central Bldg. 2F
July 14 Friday	7:15-8:00	Breakfast	*Cafeteria Fuji*, Central Bldg. 2F
	9:00-14:00	Half-day Tokyo Excursion 2	
	16:00-17:40	Special Lectures	*Large Hall*, Arts Bldg. 1F
	18:00-19:30	Dinner Party	*Reception Hall*, International Exchange Bldg. 1F
July 15 Saturday	7:15-8:00	Breakfast	*Cafeteria Fuji*, Central Bldg. 2F
	8:00-19:00	Full-day Kanto Excursion 1	

July 16 Sunday	7:15-8:00	Breakfast	*Cafeteria Fuji*, Central Bldg. 2F
	8:00-19:00	Full-day Kanto Excursion 2	

July 17 Monday	7:15-8:00	Breakfast	*Cafeteria Fuji*, Central Bldg. 2F
	9:30-12:00	Closing Ceremony	*Large Hall*, Arts Bldg. 1F
	12:20-13:30	Farewell Lunch	*Reception Hall*, International Exchange Bldg. 1F
		Departures	

2.6.7 Time table for leaders and observers

IPhO2023 Team Leader & Observer Program

Black: Nippon Seinenkan Hotel
Blue: National Olympics Memorial Youth Center

	Time	Activity	Place
July 9 Sunday	13:00-17:00	Registration	
	17:00-19:00	Get Together	*Reception Hall*, International Exchange Bldg. 1F

July 10 Monday	7:00-8:00	Breakfast	The dining room on the 9th floor
	10:00-12:00	Opening Ceremony	*Large Hall*, Arts Bldg. 1F
	12:30-14:30	Lunch	The dining room on the 9th floor
	14:30-18:30	Board meeting (Exp. Exam)	Rm. Yellow (for leaders) Rm. Blue (for observers)
	18:30-20:00	Dinner	The dining room on the 9th floor
	20:00-23:00	Board meeting (Exp. Exam) (Cont.)	Rm. Yellow (for leaders) Rm. Blue (for observers)

July 11 Tuesday	7:00-8:00	Breakfast	The dining room on the 9th floor
	9:00-15:00	Half-day Tokyo Excursion 1	
	18:00-19:30	Dinner	The dining room on the 9th floor

July 12 Wednesday	7:00-8:00	Breakfast	The dining room on the 9th floor
	9:00-12:30	Board meeting (Theory exam)	Rm. Yellow (for leaders) Rm. Blue (for observers)
	12:30-14:00	Lunch	The dining room on the 9th floor
	14:00-18:00	Board meeting (Theory exam) (Cont.)	Rm. Yellow (for leaders) Rm. Blue (for observers)
	18:00-19:30	Dinner	The dining room on the 9th floor
	19:30-23:00	Board meeting (Theory exam) (Cont.)	Rm. Yellow (for leaders) Rm. Blue (for observers)

July 13 Thursday	7:00-8:00	Breakfast	The dining room on the 9th floor
	9:00-15:00	Half-day Tokyo Excursion 2	
	18:00-19:30	Dinner	The dining room on the 9th floor

July 14 Friday	7:00-8:00	Breakfast	The dining room on the 9th floor
	12:00-13:30	Lunch	The dining room on the 9th floor
	16:00-17:40	Special Lectures	*Large Hall*, Arts Bldg. 1F
	18:00-19:30	Dinner Party	*Reception Hall*, International Exchange Bldg. 1F

July 15 Saturday	7:00-8:00	Breakfast	The dining room on the 9th floor
	12:00-13:30	Lunch	The dining room on the 9th floor
	14:00-15:00	Board meeting (medal threshold)	Rm. Yellow (for leaders) Rm. Blue (for observers)
	18:00-19:30	Dinner	The dining room on the 9th floor

July 16 Sunday	7:00-8:00	Breakfast	The dining room on the 9th floor
	9:00-12:15	Moderation	Rooms on the 8th floor
	12:15-13:30	Lunch	The dining room on the 9th floor
	13:30-16:45	Moderation (Cont.)	Rooms on the 8th floor
	18:00-19:30	Dinner	The dining room on the 9th floor
	20:00-23:00	Final Board Meeting	Rm. Yellow (for leaders) Rm. Blue (for observers)

July 17 Monday	7:00-8:00	Breakfast	The dining room on the 9th floor
	9:30-12:00	Closing Ceremony	*Large Hall*, Arts Bldg. 1F
	12:20-13:30	Farewell Lunch	*Reception Hall*, International Exchange Bldg. 1F
		Departures	

2.6.8 Ceremony programs

Opening Ceremony July 10 (Mon)

Opening Address
KOBAYASHI Makoto (Chair, Organizing Committee of IPhO2023)
Congratulatory Address
NAGAOKA Keiko, Minister of Education, Culture, Sports, Science, and Technology
Contestants Introduction
Each team of contestants called onto the stage
Address
RAWAT Rajdeep (President, IPhO Secretariat)

Welcome Events (Stage Performances)
Wadaiko (Japanese drum) International Christian University Wadaiko Club
Karate demonstration Sophia University Karate Club

Special Lectures July 14 (Fri)

[Lecture 1] *"Neutrinos – key particles for the understanding of the smallest particles and the largest Universe –"*
KAJITA Takaaki, Distinguished University Professor, The University of Tokyo, 2015 Nobel Laureate in Physics
[Lecture 2] *"Don't waste your gifted talents"*
AMANO Hiroshi, Professor, Nagoya University, 2014 Nobel Laureate in Physics
Moderator: YOKOYAMA Hiromi
Professor, Kavli Institute for the Physics and Mathematics of the Universe. The University of Tokyo

Closing Ceremony July 17 (Mon)

Opening address
KOBAYASHI Makoto (Chair, Organizing Committee of IPhO2023)
Report on the Implementation of Examination
HAYANO Ryugo (Chair, Academic Committee of IPhO2023)
Announcements
IYE Yasuhiro (Chair, Executive Committee of IPhO2023)

Presentation of Diversity Commendation
Presenter: YOKOYAMA Hiromi
Medal Ceremony, Special Awards
Medal Presenters: RAWAT Rajdeep, STANKEY Paul, SAKAIKI Hiroyuki
AMANO Hiroshi, KAJITA Takaaki, KOBAYASHI Makoto
Greeting from the Next Host Country
SHIRZAD Ahmad (Chair, Organizer of IPhO2024 in Iran)
Closing Remark
RAWAT Rajdeep (President, IPhO Secretariat)

Farewell Events (Stage Performances)

Koto (Japanese horizontal harp) Music	Sophia University Koto Club
Daikagura (Japanese traditional street performance)	Daikagura Kyokugei Kyoukai

2.6.9 Closing of IPhO2023

In the Closing Ceremony, the Academic Committee Chair HAYANO made a presentation explaining the exam problems and the distribution of contestants' scores. Special awards "Diversity Commendation" were given to four teams which exhibited both healthy gender diversity and respectable contest results.

That was followed by the announcement of the winners of Honorary Mentions, Bronze Medals, Silver Medals and Gold Medals. Bronze medals were presented by the IPhO President RAWAT Rajdeep, the IPhO Secretary STANLEY Paul and the Fundraising Committee Chair SAKAKI Hiroyuki. Silver medals by the Organization Committee Vice-Chairs AMANO Hiroshi and KAJITA Takaaki, and Gold medals by the Organization Committee Chair KOBAYASHI Makoto. Finally, the Best Performers in the experimental exam and the theoretical exam, and the Absolute Winner were announced and given the respective trophies. It turned out that two contestants tied at full marks in the theoretical exam. An additional piece of trophy was made and sent to the one of them after IPhO2023.

After the presentation of medals and prizes, Iranian Leader SHIRZAD Ahmad made an invitation address of IPhO2024 in Isfahan. The official part of the Closing Ceremony was concluded by a closing speech by the IPhO President RAWAT. After that, "koto (Japanese horizontal harp)" music played by a student club of ICU and "daikagura (juggling performance)" by professional street performers entertained the audience. After the Closing Ceremony, a farewell lunch party was held.

The representatives of the individual teams were urged to visit the IPhO2023 headquarters to pick up such documents as "Certificate of Participation", "Certificate of Medals (or Honorable Mention)". Delegations were sent off and transported to the airports as necessary to catch their return flights.

2.7 Post-Event Works

2.7.1 Experimental kits

After the experimental exam, the experimental kits used by the contestants were repacked by the staff and student supporters. We gave one set of the used kit to each of the participating country/region for free. For those teams or individuals who wanted more than one set, we sold brand new kits at a price of 80,000JPY/set which was an actual cost. Prior to IPhO2023, we had planned to sell used kits at a reduced price. However, the condition of the experimental kits after use differed significantly from one to another, and we did not have time or manpower to confirm their operation. Therefore, we decided to give them for free with the following priority order. Those teams who had signed up to buy used kits at the time of team registration were awarded the first priority. Those teams who bought brand new kits were given the same number of used kits for free. The remaining kits were distributed to the other teams by lottery. Thus, we sold 20.5* sets of brand new kits and gave away about 200 sets of used kits to the participating countries/regions. (*One set of the experimental kits consisted of two boxes of apparatuses corresponding to the two experimental exam tasks.)

The remaining kits were distributed to some 100 “Super Science High Schools (SSH)” which are high schools designated by MEXT for special science education, to be used for their physics education.

2.7.2 Questionnaire survey

A week after the closing of IPhO2023, we conducted an on-line questionnaire survey to the participants of their impression, evaluation and other opinions about IPhO2023. Two kinds of Questionnaire Form (Google form), one for the students and the other for the leaders and observers, were prepared and sent to the leaders and observers of all participating teams. Since we did not collect the e-mail addresses of students, we asked the leaders to forward to their students the letter requesting cooperation to the survey. By the end of August, we got response from 79 students and 76 adults. The questionnaire answers are summarized in Chapter 7 “Feedbacks from the Participants”.

3. Preparation and Implementation of IPhO2023 Examination

3.1 Composition of the Academic Committee

As indicated in **Figure 1** the organization of the IPhO2023 includes the Academic Committee highlighted in yellow. Enclosed by the dotted orange line is the team primarily responsible for the development of the exam problems. Following the Organizing Committee's inaugural meeting in May 2016, the Academic Committee initiated its activities. The identities of the committee members were kept confidential, with the exception of the Chair, up until after the conclusion of IPhO2023, when the full membership was revealed.

The committee consisted of eight members from the theoretical subcommittee, six from the experimental subcommittee, and one individual assigned to handle English translations and proofreading. The Invigilation Subcommittee was in charge of overseeing 70 invigilators, whereas the Chair of the Marking Subcommittee was responsible for managing the recruitment and coordination of 46 markers.

It was important to delineate that the Committee of Japan Physics Olympiad (JPhO), responsible for the national selection and training of contestants for each year' IPhO, operated autonomously from the Academic Committee. A strict information barrier was maintained between the two organizations from the start.

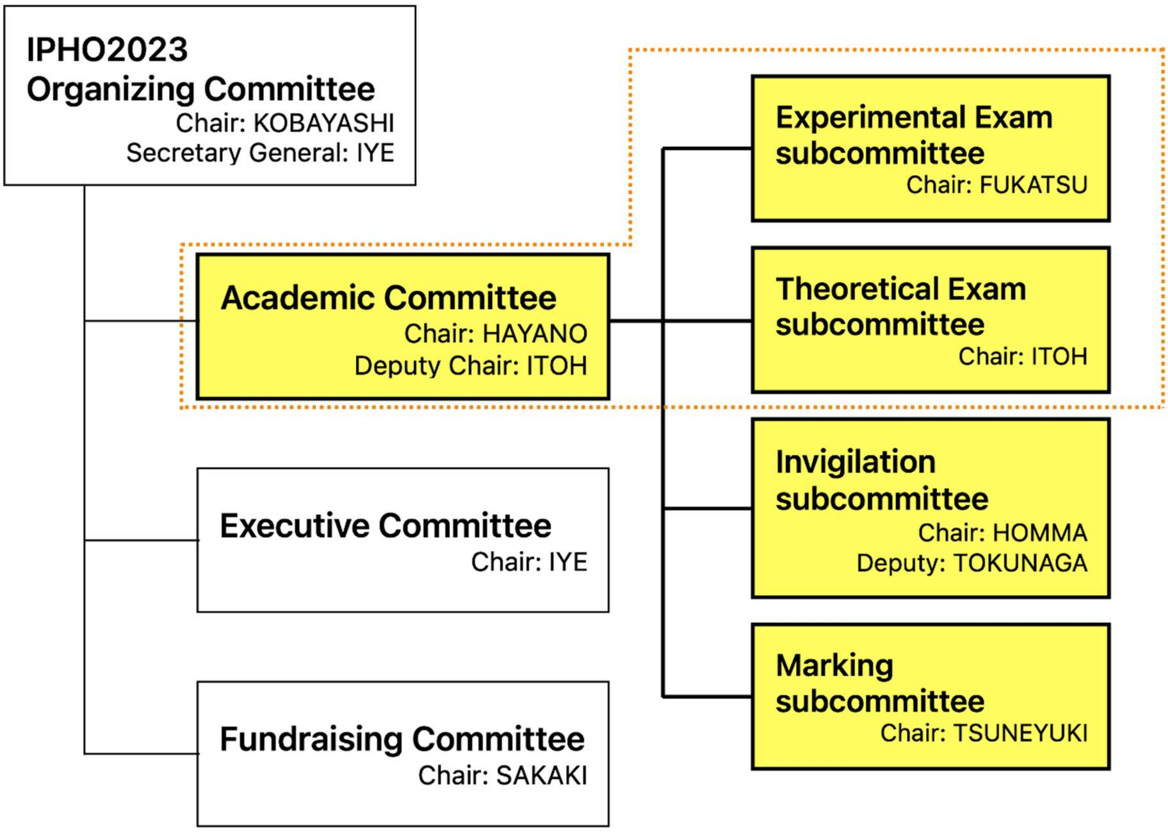


Figure 1 Composition of the IPhO2023 Academic Committee

3.2 Academic Timelines

Table 1 shows the timeline of the activities related to the Academic Committee from its establishment during the preparatory phase of IPhO2023. **Table 2** shows the schedule for students, leaders, Academic

Committee members and markers during IPhO2023.

Table 1 Major timeline for Academic Committee until IPhO2023

May	2016	Steering Committee, Academic Committee, Fundraising Committee established.
July	2016	HAYANO attended IPhO2016 as an observer. Started recruiting Academic Committee members.
Sept	2016	Started researching past IPhO problems.
July	2017	Steering Committee chair (IYE) attended IPhO2017 as an observer.
March	2018	Completed the report on analysis of past IPhO problems.
April	2018	Started brainstorming for problem ideas (initial focus on experimental problems).
July	2018	Sent an Academic Committee member as an observer to IPhO2018.
July	2019	IYE attended IPhO2019 as an observer.
Feb	2020	COVID-19 → We switched to online meetings via Zoom.
May	2020	IPhO2020 (Lithuania) postponed to 2021, IPhO in Japan postponed from 2022 to 2023.
Oct	2020	Selected and contracted with manufacturers for mass production of experimental equipment.
Nov	2020	Started discussions with Tokyo City University about design of exam booths.
July	2021	HAYANO and IYE served as Invigilators for IPhO2021 (online, hosted by Lithuania).
March	2022	Separated theory and experiment sections of the Academic Committee.
June	2022	Evaluated the theory problems (the 5 final candidates) by 3 monitors.
Aug	2022	Evaluated the experiment problems (the 3 final candidates) by 3 monitors.
Sept	2022	Selected 3 theory problems (1 backup) and 2 experiment problems. Started translating the problems into English. Began preparing model answers and marking schemes.
Jan	2023	Signed a contract with the OlyExams Association.
March	2023	The IPhO2023 Organizing Committee decided to hold IPhO2023 in a face- to-face format.
April	2023	Started recruiting marker teams.
May13	2023	Conducted a mock exam and marking practice on the day of the IPhO President's visit.
June	2023	Registration of leaders and students.
July 1	2023	IBM rehearsal.
July 9	2023	Rehearsal for conducting the exam.

Table 2 IPhO2023 schedule

	Students	Leaders	Academic Committee	Markers
July 10	Opening Ceremony			
		IBM: Discussion of exp. Exam questions		
July 11		Translation		
			Printing of problems	
	Exp. Exam	Excursion	Administer the exam	
			Scanning of answer sheets	
July 12	Excursion	IBM: Discussion of theory exam questions		Exp. Exam marking
July 13		Translation		
			Printing of problems	
	Theory Exam	Excursion	Administer the exam	
			Scanning of answer sheets	
July 14	Excursion	Marking		Theory exam marking

July 15	Excursion		Score disclosure	
		IBM: determine medal thresholds		
July 16	Excursion	Moderation		
		IBM: determine medalists		
July 17	Closing Ceremony			

3.3 Making of IPhO2023 Exam Problems

3.3.1 Preparatory phase

In the midsummer of July 2016, we commenced our strategic journey towards the International Physics Olympiad, with the Academic Committee Chair HAYANO, who notably had no prior IPhO experience, attending IPhO2016. His participation was aimed at gaining a deep understanding of the competition's operations. This proactive step marked the beginning of an informed series of engagements with the IPhO events.

In the following years, our engagement with the competition deepened. The Executive Committee Chair and Secretary General IYE represented our commitment by attending both IPhO2017 and IPhO2019. Another Academic Committee member attended IPhO2018, further enriching our collective understanding of the event. The experience was further expanded when HAYANO and IYE served as invigilators for the 2021 online IPhO hosted by Lithuania, providing us with vital insights into the management of the Olympiad in a virtual format.

Initiating regular meetings of Academic Committee from September 2016, we set out to scrutinize the past exam problems, starting with those for IPhO2006 up to the most recent ones. These discussions, which continued until the spring of 2018, focused on assessing the alignment of the problems with the IPhO syllabus and the overall difficulty and quality. This thorough analysis was critical for cultivating a consensus among committee members regarding the nature of problems befitting the Olympiad's standards.

By April 2018, the evolution of our preparation entered into a constructive phase, concentrating on the development of experimental exam questions. Acknowledging the urgency of manufacturing 500 sets of experimental kits, the team prioritized the development of experimental apparatuses. Prototypes were meticulously crafted and evaluated within the team. For security purposes, we resorted to the use of password-protected Slack channels for communication, while avoiding email correspondences to guard against information breaches.

As we advanced, our meetings, held approximately every two months, became more comprehensive, encompassing discussions around both theoretical and experimental problems. However, the unforeseeable advent of COVID-19 in spring 2020 forced us to adapt swiftly, transitioning to virtual meetings via Zoom. This change represented our flexibility and commitment to ensuring our preparatory efforts were not derailed by the pandemic.

The implications of the pandemic also led to a rearrangement of the anticipated IPhO schedule. In May 2020, the IPhO Board made the difficult decision to postpone the IPhO2020 in Lithuania to the following year. As a ripple effect, the IPhO we were set to host in Japan was subsequently moved from 2022 to 2023. This rescheduling demanded from us not just patience but also a recalibration of our plans and strategies to stay on course for the forthcoming Olympiad.

3.3.2 Quality control of exam questions

In March 2022, we streamlined our examination preparation process by dividing the Subcommittee into two specialized groups: the Theory Subcommittee, comprising 8 members, and the Experiment Subcommittee, including 6 members. At the division's inception, the theoretical and experimental problem pools consisted of five and four candidates, respectively, with three experimental problems being advanced to the stage of prototyping for mass production. Collaborative joint meetings were subsequently organized to ensure synergy and coordination between both subcommittees.

A pivotal moment in quality assurance was on June 26, 2022, when we conducted a rigorous monitoring test of the theoretical problems. For this critical evaluation, three former IPhO students, of whom one was a gold medal laureate, undertook the challenge of solving five sets of candidate problems, each containing three questions, within a five-hour time frame.

Parallel to this, an evaluation of the experimental problems was executed on August 7, 2022. The monitors, during a similar five-hour window, were tasked with resolving three candidate problems, each composed of two questions.

In the aftermath of these comprehensive tests, and with the reassurance that there was no content overlap with the IPhO2022 problems, the month of August 2022 saw the Academic Committee members cast their votes to select the final problems: three theory problems and a single backup problem, alongside two experiment problems. It is worth noting that all preparatory steps were conducted using the Japanese language.

3.3.3 Mass production of experimental equipment

Identifying a manufacturing partner that could ensure the bulk production of 500 experimental equipment kits within financial bounds was a critical milestone achieved in October 2020 with Shimadzu Rika, a Shimadzu Corporation subsidiary experienced in crafting physics educational tools. The partnership commenced with the mutual agreement on confidentiality.

Until March 2023, the status of the competition's format—whether it would be held remotely or in-person—remained uncertain, prompting considerations for the ease of equipment shipping. The equipment had to be designed for safe transportation, potentially across borders, and adhering to regulatory standards such as the Restriction of Hazardous Substances (RoHS).

This period of contingency planning concluded when the Organizing Committee confirmed the on-site execution of IPhO2023 in March 2023.

Prototyping and cost assessment of three experimental devices were completed by August 2022, leading to the selection of two final designs geared towards mass production: a device based on the Kibble balance concept and another for measuring sample thickness using birefringence. We then proceeded with the mass production phase.

Innovation was integral in the development phase. The Kibble balance apparatus incorporated a 3D-printed oscillator, which efficiently provided a lightweight and low-cost solution. For the birefringence experiments, the prototyping phase initially used expensive commercial optical components. However, post-prototyping, we identified cost-effective manufacturing methods using cardboard and synthetic wood that maintained optical precision, significantly reducing production costs.

3.3.4 Recruiting the markers

IPhO2023 deployed an innovative marking system, diverging from the conventional method where individual teams would grade each problem. Historically, assembling 80-90 markers to address the papers from participants across 80 nations was a commonplace practice. Yet, IPhO2023 coincided with the summer term at universities in Japan, which posed a significant challenge in sourcing an adequate number of markers.

Consequently, we adopted a more streamlined approach where each team, comprising a pair of markers, was responsible for assessing all submissions (two experiments and three theories) from 3-4 specific countries. This restructuring led to a formation of 20+ such teams. While this new model placed a higher workload on the markers, given that it required engagement on both experimental and theoretical grading days, it offered improved manageability and quality control measures, ensuring consistent application of the marking criteria as all markers were centralized in one location.

Moderation also changed, with leaders and markers at each table reviewing all problems together for 1 hour and 40 minutes, which simplified the schedule.

For the staffing needs, we onboarded 23 postdoctoral researchers alongside 23 graduate students—among whom were former IPhO contestants—from the University of Tokyo's Graduate School of Physics. This (23 instead of 20 teams) was a precautionary measure in anticipation of potential absenteeism due to COVID-19, which, fortunately, did not materialize. These individuals made up the 23 marking teams.

3.3.5 Rehearsals

At the onset of 2023, we entered into a partnership with the OlyExams Association, embracing the use of ExamTools for managing the myriad aspects of examination administration—from handling source files for problems, translation, and printing, to the scanning of answers sheets and overseeing the IBM.

A notable assembly was on May 13, in conjunction with the visit from the IPhO President. That day, the 46 markers convened; each was allocated a problem to solve in the morning session. Subsequently, the Academic Committee members elucidated on the marking schemes in the afternoon, and the marking teams engaged in a hands-on marking exercise with the answer sheets from the morning's mock exam. The feedback and variability observed during this marking session were crucial in refining the marking schemes.

Further, on July 1, we conducted an IBM rehearsal, which was well-attended by members of the Academic Committee, the technical support staff, and the secretariat. The team from OlyExams provided a demonstration of how to operate the IBM via ExamTools, supplemented by a practical session for the attendees. Additionally, we executed a test stream of the IBM session using Zoom and undertook a comprehensive assessment of the network environment and its throughput capabilities.

On the eve of the opening ceremony, July 9, a final rehearsal encompassed all personnel, including part-time staff, which simulated the complete examination procedure. This drill covered all procedural elements such as the printing and transport of exam booklets, distribution at the test site, execution of the examination, responding to students' requirements, collecting answer sheets, and their precise scanning, thereby ensuring a smooth operation on the day of the actual exam.

3.4 Other Preparatory Tasks

Executing the exams involved significant preparation beyond problem creation, with the Academic Committee Chair overseeing several key tasks:

3.4.1 Choosing the venues

The National Olympics Memorial Youth Center (NYC), initially chosen for student housing and the exam venue, posed significant challenges. Necessary were accommodations for leaders/observers completely separated from students, a location for the board meeting, a marking area, and a secure, high-bandwidth internet environment. Given these constraints, a reassessment led to the following decisions by January 2022:

- NYC would house students, provide exam facilities, and serve as IPhO2023 headquarters.
- The Nippon Seinenkan Hotel (NSH) would accommodate leaders/observers and hold board meetings.
- The University of Tokyo Institute of Industrial Science (IIS) campus would facilitate marking and large volume printing/scanning.

With these venues located within a 2 km radius from the NYC (**Figure 2**), logistical continuity for secure exam material transport was established.

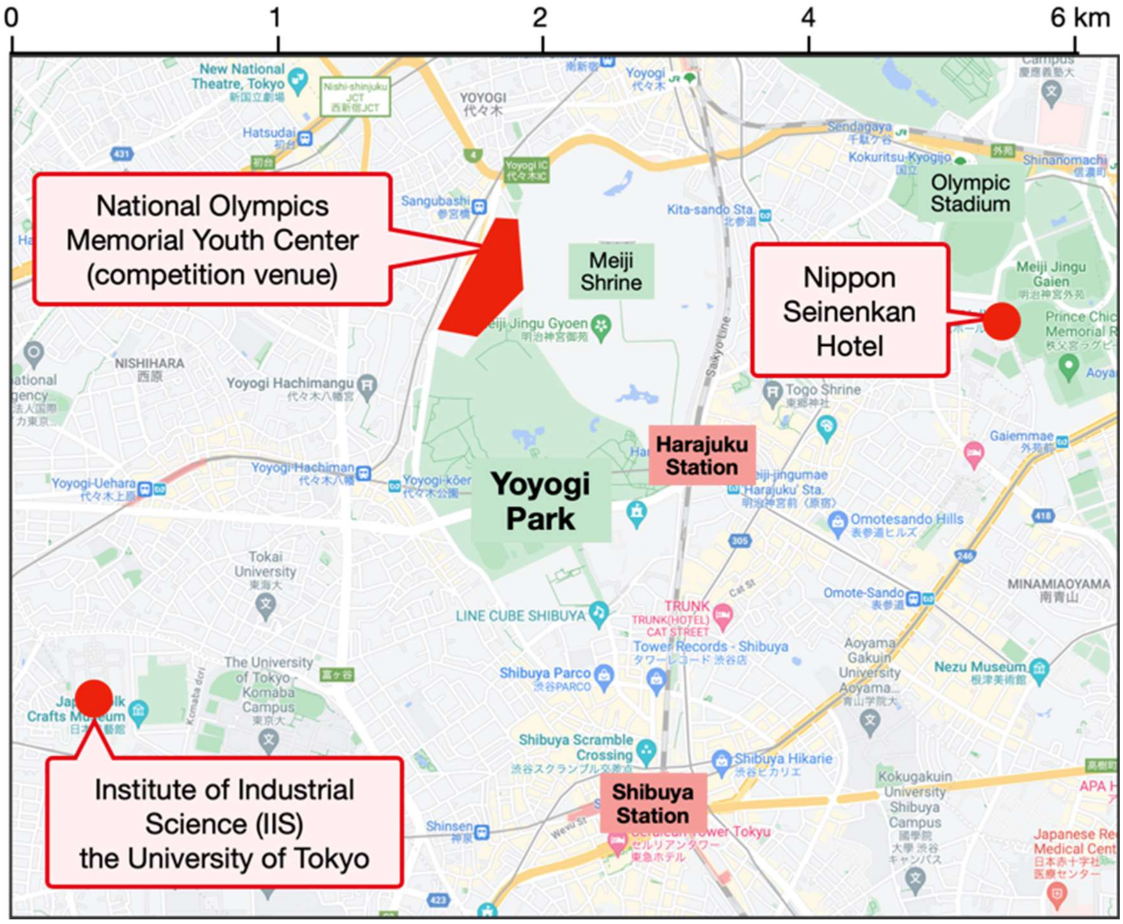


Figure 2 Locations of IPhO2023 venues

3.4.2 Exam booths

The Cooperation with Tokyo City University's Department of Architecture led to exam booth designs, initiating in November 2020 and culminating in mass production by April 2023. The final design included:

- Assembly-style booths for 450 participants across two gymnasiums in NYC, devoid of electrical wiring (this means that all exam equipment must be battery operated).
- Use of existing gym lighting, supplemented by booth white walls, to ensure desk illumination.
- Desks sized 150-180cm by 60-80cm, determining the limit for exam apparatus sizes.
- Aisle clearances for safety and invigilation.

After prototyping, a white-walled, 1.6m height booth model was chosen. Necessary accessories such as "Water, Toilet, Help" flags and procedural guidelines were developed for the booth setup at NYC by July 7.

Additionally, surveillance systems were installed in the exam halls and auxiliary printing facilities were established adjacent to the exam hall 1 (**Figure 3** and **Figure 4**).

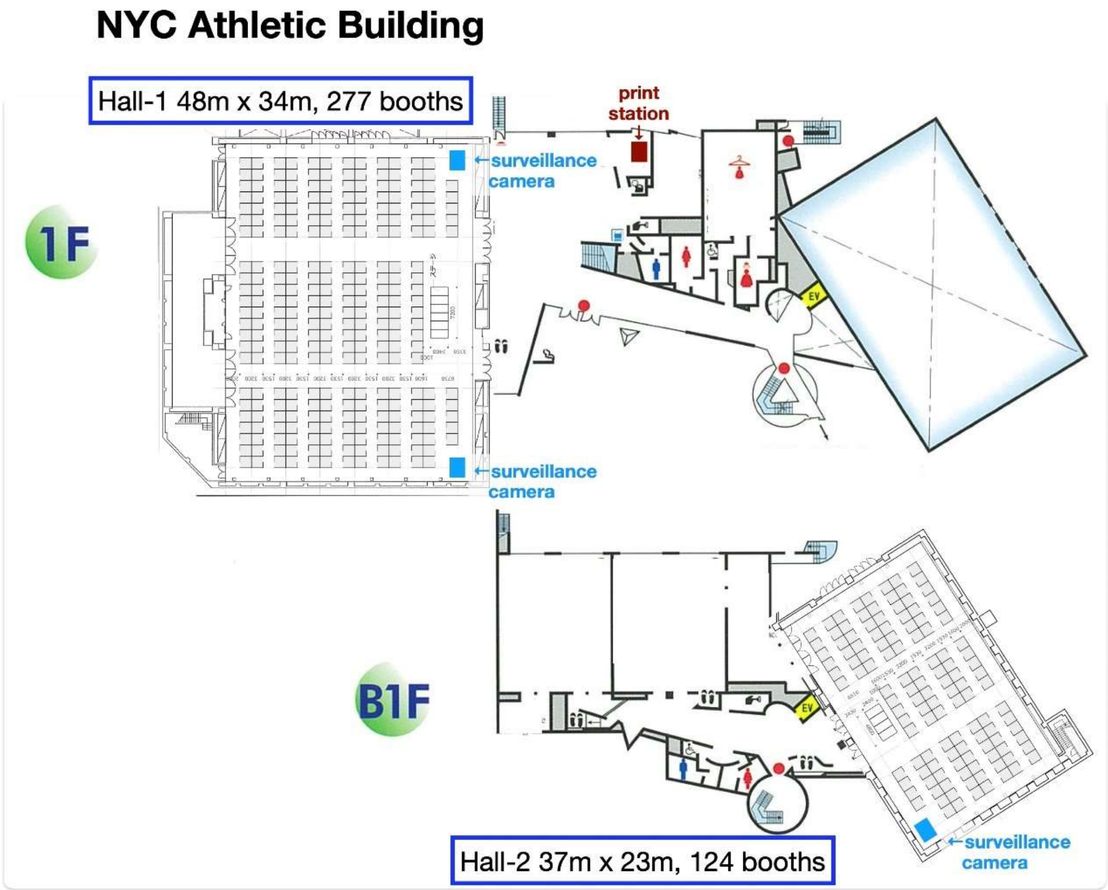


Figure 3 Exam venue floor layout

Figure 4 Booths closeup

3.4.3 Student codes and booth codes

Once registrations were completed, we allocated student codes and booth codes for participants. The structure of assigning codes was as follows:

- **Student Codes**: These codes comprised a three-letter country code, followed by an 'S' for "student," and a serial number. For example, "JPN-S-1" represents the first student from Japan.
- **Booth Codes**: Each exam booth was designated by its location, with codes indicating the Row (A through V) and the Column (1 through 27), such as "Q-14."

Using a random number table, we matched exam booth codes with student codes. **Figure 5** displays the layout for Exam Room 1 on July 11, set for the experimental exam, including specified booth rows and columns. For the theory exam on July 13, we used a different set of randomized numbers to generate a new seating chart.

Each student's nametag exhibited both their student code and their booth code — these identifiers were also displayed on exam booths to direct students to their respective seats. Furthermore, student and booth codes were printed on the exams' envelopes, visible through a window, allowing invigilators to ensure that each envelope reached the correct booth (**Figure 5**).

For added security and organization, QR codes were printed on all answer sheets and worksheets (illustrated in **Figure 6**). These codes were instrumental in ExamTools' feature of sorting scanned images into dedicated folders for each participant and question as soon as they were scanned.

Examination Room 1 : Experiment (July 11)

	01	02	03	04	05	06	07		11	12	13	14	15	16	17	18	19		21	22	23	24	25	26	27	
A	CHN-S-4	BRA-S-1	LVA-S-1	GBR-S-3	HKG-S-1	JPN-S-3	THA-S-2	A	SUR-S-1	THA-S-5	USA-S-4	PRT-S-1	ITA-S-3	SVN-S-4	MAC-S-2	ROU-S-5	PRT-S-4	A	SGP-S-2	SVK-S-4	CAN-S-4	KEN-S-1	KAZ-S-2	SYR-S-5	DNK-S-1	A
B	ESP-S-3	SYR-S-2	MDA-S-1	SAU-S-4	IRN-S-5	CHE-S-3	ZAF-S-5	B	PAK-S-4	USA-S-2	CZE-S-3	DNK-S-5	TWN-S-2	MEX-S-5	CAN-S-1	COL-S-1	DEU-S-5	B	KAZ-S-5	POL-S-5	HRV-S-4	CHE-S-4	CYP-S-3	LUX-S-1	JPN-S-5	B
C	SVK-S-3	GEO-S-5	LUX-S-2	SRB-S-3	CYP-S-2	FIN-S-3	OLY-S-1	C	MNG-S-2	COL-S-5	LVA-S-4	BIH-S-3	ARM-S-2	KOR-S-4	DNK-S-2	DEU-S-3	GBR-S-1	C	SRB-S-4	FRA-S-1	TWN-S-4	IRN-S-3	LTU-S-3	TWN-S-5	SGP-S-3	C
D	LVA-S-5	HUN-S-4	NLD-S-3	BGR-S-3	ZAF-S-1	GRC-S-5	IDN-S-4	D	SAU-S-2	CYP-S-1	AZE-S-5	BIH-S-5	ESP-S-1	PRT-S-5	ITA-S-4	BIH-S-2	UZB-S-2	D	BRA-S-5	EST-S-4	ARE-S-2	CHN-S-2	LUX-S-5	BEL-S-3	XKX-S-2	D
E	MEX-S-1	GEO-S-4	SWE-S-4	UKR-S-5	ISR-S-5	CHE-S-2	LTU-S-2	E	ITA-S-2	GRC-S-1	ARE-S-5	EST-S-3	CHN-S-3	ROU-S-4	UKR-S-4	MNE-S-4	IDN-S-1	E	PHL-S-1	TUR-S-1	SRB-S-5	PRT-S-3	XKX-S-1	SGP-S-1	KOR-S-5	E
F	NOR-S-5	SVN-S-2	KHM-S-5	MNE-S-2	IND-S-1	SLV-S-2	USA-S-5	F	LVA-S-3	ITA-S-5	FIN-S-5	AUT-S-1	NLD-S-1	JPN-S-2	FRA-S-3	IRN-S-2	SUR-S-3	F	NPL-S-3	SWE-S-1	KGZ-S-5	HRV-S-3	MKD-S-4	LTU-S-5	CHE-S-1	F
G	OLY-S-2	TKM-S-3	COL-S-2	HKG-S-2	KHM-S-3	GEO-S-2	MYS-S-4	G	KHM-S-4	MEX-S-2	UZB-S-1	SGP-S-5	BEL-S-5	BOL-S-2	KGZ-S-3	AUS-S-3	FIN-S-4	G	IDN-S-2	MKD-S-3	UZB-S-3	TUR-S-4	~~TK[illegible]S-1~~	ROU-S-1	KEN-S-5	G
H	COL-S-3	POL-S-3	DEU-S-1	GEO-S-3	NOR-S-1	MDA-S-4	TUR-S-3	H	SVN-S-1	KEN-S-4	SUR-S-2	BGR-S-2	AZE-S-2	CAN-S-2	SYR-S-4	TJK-S-4	GBR-S-4	H	EST-S-5	BRA-S-4	CAN-S-3	AUS-S-2	TJK-S-2	MNE-S-3	MYS-S-2	H
I	VNM-S-4	KGZ-S-2	CZE-S-1	ISL-S-3	SVN-S-5	BOL-S-3	ARM-S-3	I	MNG-S-5	ARM-S-1	ROU-S-3	AUS-S-5	VNM-S-5	HRV-S-5	KAZ-S-4	ISR-S-3	HUN-S-2	I	MDA-S-2	~~HN[illegible]S-1~~	MDA-S-3	ISR-S-1	SWE-S-2	THA-S-3	TKM-S-4	I
J	IND-S-5	ISL-S-2	MAC-S-1	QAT-S-5	HRV-S-2	KEN-S-2	MAC-S-4	J	TUR-S-5	QAT-S-4	BGD-S-3	EST-S-1	TUR-S-2	MKD-S-2	PHL-S-3	BEL-S-1	MEX-S-3	J	MDA-S-5	FIN-S-1	ARE-S-3	SGP-S-4	ISL-S-1	HKG-S-4	IRN-S-4	J
K	BIH-S-4	OLY-S-5	ZAF-S-4	BGD-S-2	AUT-S-5	ITA-S-1	XKX-S-3	K	CZE-S-4	BOL-S-4	SAU-S-3	PAK-S-3	BGD-S-5	TKM-S-2	BEL-S-4	BOL-S-1	KHM-S-1	K	FRA-S-5	CZE-S-5	NOR-S-3	BRA-S-3	DEU-S-2	SYR-S-1	MKD-S-1	K
L	PAK-S-5	IND-S-2	ARE-S-1	LTU-S-1	HUN-S-5	MNG-S-1	UKR-S-1	L										L	HKG-S-5	TJK-S-3	TJK-S-5	JPN-S-1	NOR-S-4	LTU-S-4	ESP-S-2	L
M			ISR-S-2	PAK-S-1	IDN-S-3	AZE-S-1	NPL-S-4	M										M	DNK-S-4	CZE-S-2	UZB-S-4	CHN-S-5	MYS-S-3			M
	1	2	3	4	5	6	7		11	12	13	14	15	16	17	18	19		21	22	23	24	25	26	27	

Figure 5 Exam Room 1 Booth Layout for the Experimental Exam

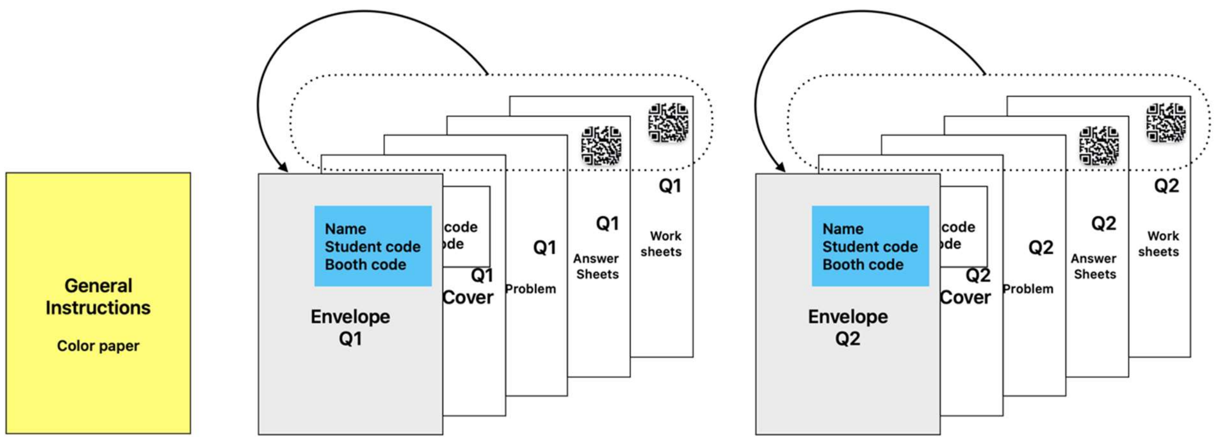


Figure 6 Student & Booth codes used in the exam problem packages

3.4.4 Exam tools

Our engagement with OlyExams for the use of their ExamTools commenced in the spring of 2021. Several Science Olympiads, across various disciplines, have utilized ExamTools since its introduction at IPhO2016. The platform managed an array of tasks — from handling exam question source files, overseeing translations and printing, to scanning and facilitating IBMs.

The ExamTools were operated and maintained by the OlyExams team based in Switzerland, with the system hosted on a cloud server in France. Approximately 2.5 months prior to IPhO2023, the Academic Committee began uploading the question source files and reviewing the output PDFs generated by the system.

Our communication with the OlyExams team was primarily conducted via Slack, supplemented with Zoom meetings as necessary. Although there was an option for the OlyExams team to provide on-site support in Japan, the effectiveness of remote assistance negated the need for their physical presence during the Olympiad.

Throughout IPhO2023, the OlyExams team delivered round-the-clock support in two shifts. A four-person team provided first-level network and ExamTools technical support to leaders engaged in the IBM. An individual was also dedicated to overseeing the technical aspects of the print servers located in the Bulk Print Center.

3.4.5 Designing the IT infrastructure

For IPhO, the meticulous design of the network, printers, and other facets of IT infrastructure was crucial, alongside comprehensive staff training and rigorous pre-event testing. The following components were of particular significance:

- **Network Configuration at the IBM Venue**
- **Strategic Printer/Scanner Placement**
- **Secure Video/Audio Streaming Capabilities**

Each element is elaborated upon in the subsequent sections.

IBM venue setup

Ensuring the stable operation of ExamTools from the setup phase through the conclusion of IPhO2023 was paramount. Specifically, leaders and observers required stress-free access, with sufficient bandwidth, to ExamTools for the translation of exam questions via the venue's Wi-Fi. Achieving this level of service was challenging from a network design standpoint.

We secured the entire 8th floor of the NSH for the IBM (**Figure 7**). The allocation of rooms on this floor was as follows:

- **Room Yellow** (250 m²): Served as the central hub for approximately 160 leaders, academic committee members, and support staff.
- **Room Blue** (140 m²): Designated for observers as Room Yellow could not accommodate everyone.
- **Room Green** (70 m²): Utilized for the experimental equipment showcase on the IBM's first day and as the organizing committee's operational area on subsequent days. At the entrance, a high-speed printer was placed for use by leaders and observers.
- **Room Orange** (40 m²): Operated as the academic committee's workroom, outfitted with high-speed printers (one operational and one backup) and a PC print server.

To accommodate nearly 300 individuals connecting to Wi-Fi over a 500 m² space, we installed two 1Gbps optical lines, in addition to the hotel's existing line. We ensured traffic balancing and redundancy by contracting these lines from different providers. The Wi-Fi mesh setup comprised multiple Yamaha WLX413 units, capable of supporting 500 PC connections each, which met the high demand anticipated for IPhO2023's IBM (**Figure 7**). Additionally, PCs for print servers and three high-speed printers (including one ready on standby) were deployed.

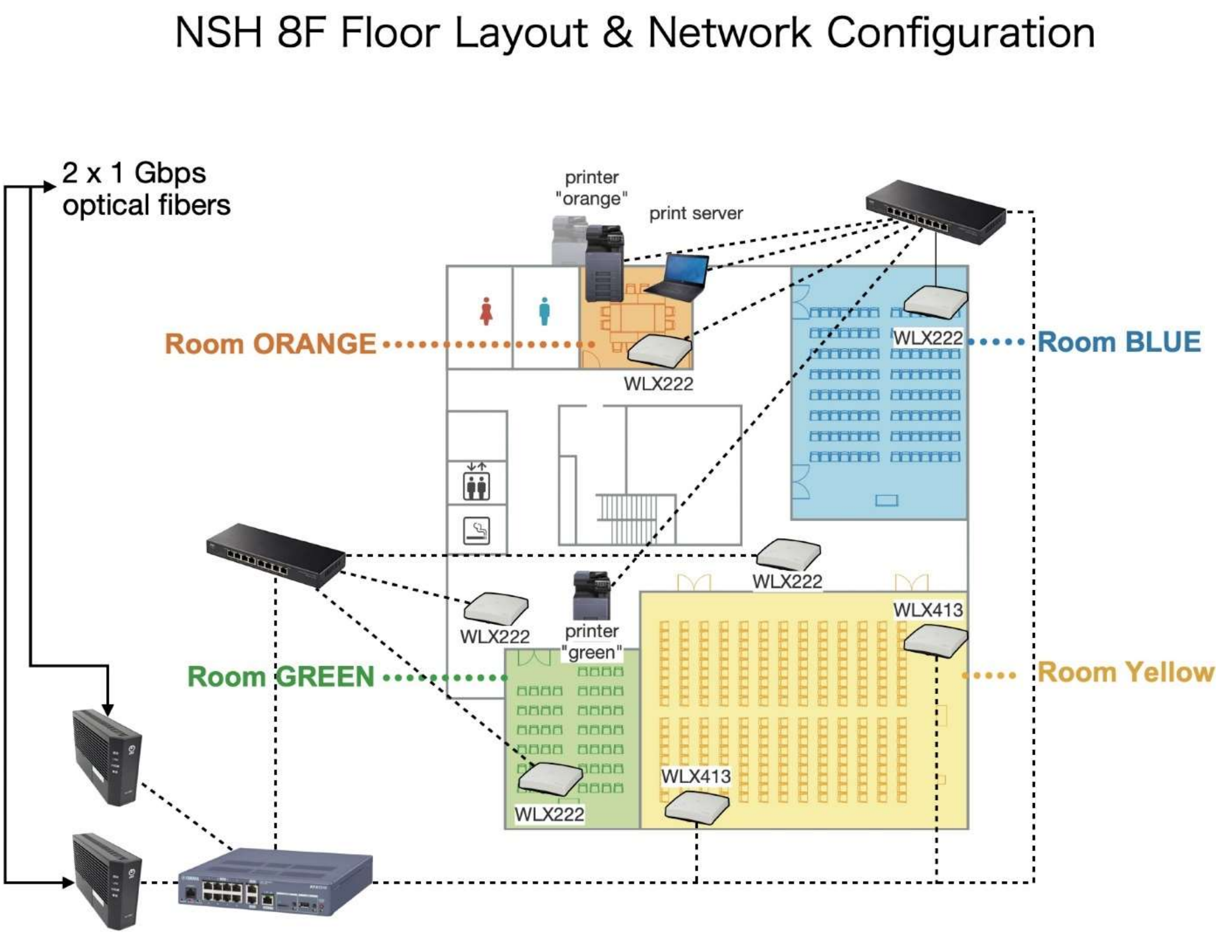


Figure 7　Floor layout and network configuration of NSH 8F (IBM venue)

Printers/scanners

Figure 8 outlines the distribution of printers across the three IPhO2023 venues. We standardized the printer model for consistency and efficiency, opting for the Kyocera TASKalfa 5054ci (printing speed of 50 pages/minute, scanning speed of 130 pages/minute), a smaller Kyocera ECOSYS P5026cdw printer was situated adjacent to Hall-1 for supplementary worksheet printing needs.

At the NSH venue, printers were made available for the Academic Committee's exclusive use (print queue “Orange”) and for self-service by team leaders and observers (print queue “Green”). The Bulk Print Center at Tokyo University's Institute of Industrial Science (IIS) encompassed a print server PC running Ubuntu and a quintet of Kyocera TASKalfa 5054ci printers, all integrated into the campus network.

The setup and software installation for the Bulk Print Center’s server PC was handled remotely from Switzerland by the OlyExams team. Extensive testing, including a mock exam and marking session conducted on May 13th, helped us gauge the printers' throughput. These trials, coupled with projections of the printed sheet volume and the event's time constraints, prompted the decision to utilize five printers for efficient operation (instead of four, as was initially planned).

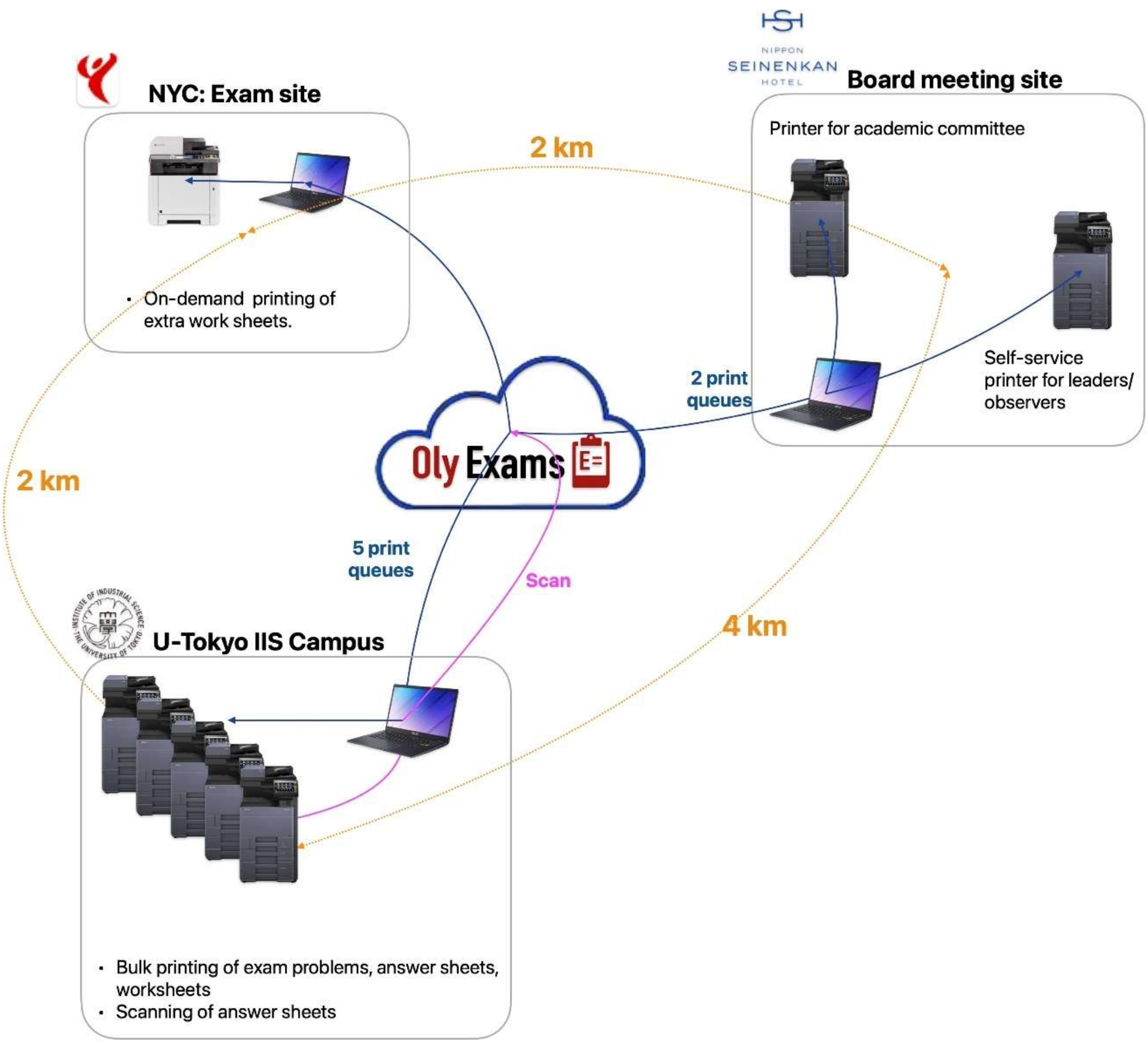


Figure 8 Printer configuration

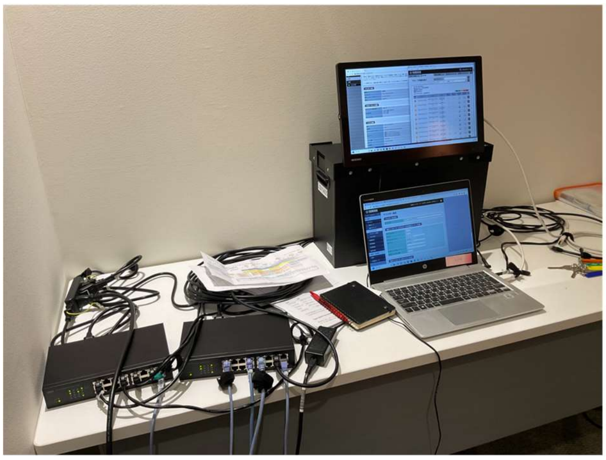
Enhancing Connectivity Through Zoom at IPhO2023

During IPhO 2023, Zoom functioned as a crucial communication bridge connecting various locations. The IBM session, conducted in Room Yellow, was seamlessly relayed to Room Blue, which served as the observer's space, Room Orange, reserved for the Academic Committee members, and the OlyExams team based in Switzerland. Access to Zoom was securely gated, requiring authentication through the email addresses registered for IPhO2023. Notably, access from outside Japan was restricted to prevent unauthorized entry, with a sole exception granted to the OlyExams team for operational purposes.

In instances where local support teams, stationed in room Yellow, found themselves unable to resolve certain issues, such as difficulties encountered in the translation of problem texts, they were afforded the ability to seek immediate assistance from the OlyExams team. This support utilized a dual-channel approach, involving both Slack and Zoom.

Moreover, Zoom was deftly integrated with the IIS print center, the grading site, and the NYC exam site, enabling real-time monitoring and status updates across these crucial nodes. This integration proved instrumental in streamlining coordination and ensuring the smooth running of the event.

The IT operational framework is illustrated in **Figure 9**. It highlights the constant surveillance of the Wi-Fi traffic and fiber optic loads at NSH (depicted in the left panel of the figure). During the IBM sessions, the technical operators were tasked with managing microphones, controlling a remote video camera, and distributing the feeds to Zoom, ensuring the event's technological aspects ran smoothly (right).



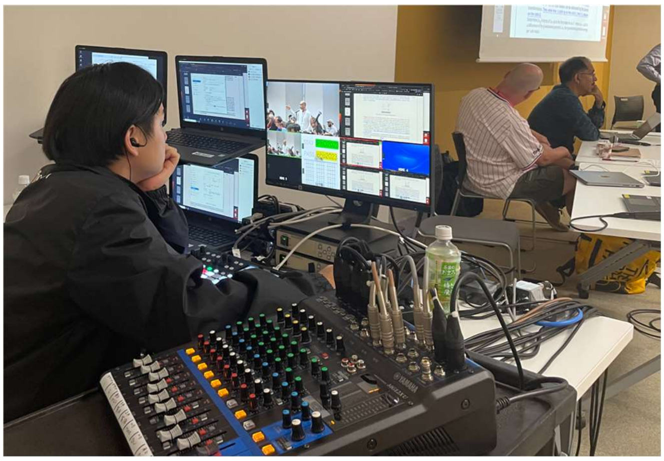


Figure 9 (left) Constant monitoring of the Wi-Fi traffic load at NSH.
(right) An audio-visual operator at the IBM site.

3.5 International Board Meeting (IBM)

According to IPhO regulations, up to two leaders from each country may participate in IBM. Although observers were welcome to attend the meeting to translate the test questions and to grade the answer sheets of their national contestants, they did not possess voting rights. This gathering was held at the NSH, which also served as the residence for the leaders. The event saw 81 official participating countries joined by one observer country, with attendance totaling 156 leaders and 97 observers

3.5.1 Discussion and decision of exam questions

On the afternoon of July 10th, the Board convened to finalize the examination questions. The Academic Committee presented two questions, and the setup needed for the exam was demonstrated. An instructional video detailing the assembly of this equipment was also shown.

Shortly after the IBM began, concerns were raised about the length of the examination questions. The Academic Committee was aware of the IPhO regulation that "the text of the theoretical and experimental examinations shall not exceed 12,000 characters each, including spaces and excluding the cover sheet and answer sheets". They had been careful to ensure that the number of characters for each question did not exceed this limit. The committee was also aware of past instances where IPhO questions had exceeded 12,000 characters. However, during the IBM it became clear that the wording of the rules had been interpreted in the past to mean that the 12,000 character limit was intended to apply to the total character count of all questions combined, for both theoretical and experimental papers. This deviation from the Committee's understanding was further highlighted by the fact that the IPhO President's visit in May had not served to clarify this interpretation. When the issue was raised at the beginning of the IBM, there was an immediate need to address the situation. It became imperative to quickly revise and condense the examination text on the spot to conform to the practiced and historical interpretation of the 12,000 character limit.

Responding swiftly, the Academic Committee condensed the text, and the final version of the two questions in English was approved at 1:00 following a vote. Translations were completed by 4:30.

On July 11, the day before the second IBM meeting where the theory problems were to be reviewed, efforts were made to reduce the number of characters in the theory questions. In many cases the introductory part had to be removed and/or some problems had to be taken out.

At 8:00 a.m. on July 12, the shortened versions were distributed. Moderated by the Theory Subcommittee Chair ITOH, the discussions proceeded without hindrance, culminating in the official English versions of the three questions being voted on and approved at 22:00. The translation process was completed around 3:00.

3.5.2 Marking and medal thresholds

After each examination, answer sheets and worksheets were returned to leaders at the NSH by 8:00. the following day. At the same time, scanned documents were uploaded onto ExamTools. The leaders of each delegation graded their students' answers based on these materials.

Scores from the organizers were shared with each team via ExamTools on July 15th, prior to the IBM where medal thresholds were established. The Chair and Vice-Chair of the Academic Committee had exchanged views with the "Three-Person Committee" (as defined in Regulations to §7 of Statutes) on grading, in particular how to award partial marks and how to deal with errors in answers that carry over to later questions. The Chair then confirmed that they would follow the "Three-Person Committee's" suggestions.

The day before the moderation was scheduled, quarantine measures were implemented due to COVID-19 infection cases among a few leaders and observers that had occurred at the NSH. HAYANO addressed this issue at the International Physics Olympiad Board Meeting (IBM) on July 15th, stating that participation in the moderation session scheduled on the following day would be restricted to two representatives from each delegation. Furthermore, it was mandated that attendants (both markers and leaders) test negative in antigen tests and wear masks during the event. Antigen tests for more than 200 participants of the moderation (*i.e.* 46 markers, 160 leaders (or observers, if the leader turns out to be positive) and 20 members of the Academic Committee) had to be finished before 9 a.m. To meet this need, a sufficient quantity of antigen test kits which would give the result quickly, had to be collected in a hurry and were purchased in the middle of the night of the previous day at several local pharmacies by the Executive Committee. Fortunately, almost all attendants were confirmed negative before the deadline for the start of the moderation.

For countries/regions whose leaders tested positive for antigen, it was decided to conduct the moderation via ZOOM. The moderation for the team of individuals was set in a separate room at the NSH after they were confirmed to be antigen negative.

3.5.3 Moderation

The moderation took place on July 16th, spanning from 9:00 to 16:45 in two separate rooms of the NSH, Yellow and Blue. Here, pairs of markers were seated across from pairs of country leaders at each of the 23 tables provided. Each country/region was allocated a total time of 100 minutes for discussion, split across two morning sessions and two afternoon sessions.

Leaders would naturally negotiate with moderators with the goal of raising the scores of students who may be a little closer to earning a better medal. However, if there were a large number of cases where moderation raised scores, it could lead to medal inflation. Therefore, the Academic Committee had instructed the markers to carefully read not only the answer sheets, but also the worksheets, and to add points in favor of the students to the extent that it is not unreasonable in light of the scoring criteria. They were then instructed to increase the score during the moderation session only in cases where marking errors were obvious.

Most moderation proceeded without problems. However, some leaders continued to negotiate beyond the allotted 100-minute window for the solution to a particular problem for a particular student. In such cases, the "Three-Person Committee" on site intervened. In some cases, when consensus could not be reached, the committee took the average of the moderator's and leader's arguments and awarded points in 0.05 increments. This procedure is vaguely noted in Marking Rules 4.5 in the IPhO's regulations, but is not explicitly stated, but it was an unavoidable measure since moderation could not be prolonged indefinitely.

3.5.4 Medal decision

The final board meeting of the competition was held on July 16th at 20:00. The agenda related to the operation of the IPhO was discussed, and it was decided that the next competition would be held in Iran. The medal winners were then announced, with 37 gold medals, 74 silver medals, 103 bronze medals, and 54 honorable mentions awarded out of the 393 participating contestants. Additionally, four countries (Cyprus, France, Iceland, and Ukraine) were commended for their diversity in participants and excellent results. The closing ceremony, where the winners received their medals and prizes, took place on the 17th at NYC.

3.6 Conducting Exams

This section details the logistics, i.e. activities behind the scenes, of conducting exams and their marking on schedule, which was a rase against time.

3.6.1 Printing works at IIS venue

The final draft of the experimental exam was completed just after midnight on July 10th during the IBM, causing subsequent delays in the translation of the questions. The translations were not completed until 5:00, creating a logistical challenge to meet the 6:30 deadline for the printing team to ship the exam materials to the NYC venue. The English version of the exam was 65 pages, including General Instructions (1 page), Experiment 1 (22 pages total: Cover 1, Questions 9, Answer Sheets 12, Worksheets 10), and Experiment 2 (32 pages total: Cover 1, Questions 12, Answer Sheets 9, Worksheets 10). The translated versions varied in length, with some exceeding the page count of the English version. In addition, some countries provided their students with both the English original and the translated versions, resulting in an estimated total of approximately 40,000 printed pages.

For the Theory Exam, the final draft of the English version was completed efficiently, with all teams completing their translations by approximately 3:00. Printing began just before midnight on July 12th, and delivery to the NYC venue was completed by 6:00. The English version of the Theory Exam consisted of 73 pages, including General Instructions (2 pages), Theory 1 (26 pages: Cover 1, Questions 6, Answer Sheets 4, Worksheets 15), Theory 2 (23 pages: Cover 1, Questions 5, Answer Sheets 2, Worksheets 15), and Theory 3 (20 pages: Cover 1, Questions 4, Answer Sheets 2, Worksheets 15). The estimated total number of printed pages was approximately 45,000.

3.6.2 Test administration work at NYC venue

The experiment exam was administered on July 11 from 9:00 to 14:00. The envelopes containing questions, answer sheets and worksheets were delivered from IIS to the NYC venue, and the invigilators distributed them to the booths. Students entered the exam booths at 8:30. Although they were informed in advance that they were not allowed to bring their personal belongings, many students disobeyed the ban and were forced to leave them at the entrance of the exam halls. Because it is difficult to individually check whether a wristwatch has communication capabilities, students who are wearing a wristwatch were instructed to remove it and place it outside the booth.

Figure 10 (left) shows Help, Water and Toilet flags placed at the entrance of the exam booth, and **Figure 10 (right)** shows stationery (a ballpoint pen, a mechanical pencil, refills, an eraser, and a ruler), an official calculator, a radio-controlled clock, a bag of snacks, and a water bottle provided by the organizers for the students.

Figure 10 (Left) “Help”, “Water”, “Toilet” flags placed at the entrance of the exam booth. (Right) Stationery, snacks, and water provided by the organizers for the students.

When the exam started at 9:00, some students asked for help because they found some sheets missing, or they noticed that the booth numbers did not match the names displayed (this had been a problem during registration by the participating countries).

Several students short-circuited the power supply without fully reading the instructions in the question text and blew the power supply fuse in Experiment 1. This could be considered a failure of question 1. However, we decided to help them; Shimazu-Rika personnel involved in the production of the equipment were on standby at the test site in case this happened, and responded by replacing the power supply.

Otherwise, there were no major problems that affected the administration of the exam.

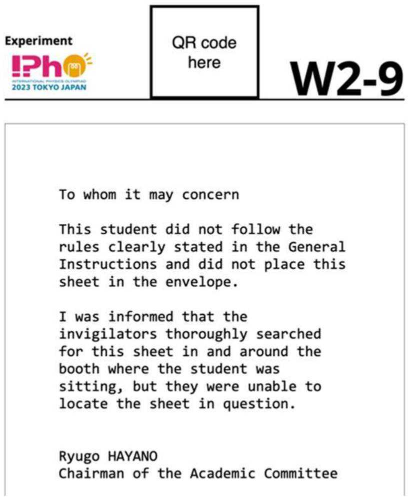
The exam ended at 14:00. The students were instructed to sort all the sheets (problems, answer sheets and worksheets) and put them in the envelopes. After forbidding the students to take anything on their desks, the exam questions and answers were collected and after confirming that everything had been collected, they were sent to the IIS venue before 15:00.

The venue was then cleaned and prepared for the theoretical exam on the 13th. The experimental setups were repackaged and transported from NYC to NSH for distribution to the leaders.

The theory exam was similarly conducted on July 13 from 9:00 to 14:00. During the exam, some students attempted to take the exam questions and answer sheets out of the venue despite the ban. The invigilators made every effort to find such cases and retrieve the removed papers. But there were still dozens of pages that could not be retrieved and resulted in “missing” errors when the answer sheets were scanned. In such cases, we printed a new page with a QR code, as shown in **Figure 11**, inserted it to the respective place of the answer sheets, and informed the markers that the page could not be retrieved.

Some other students complained about incomprehensible exam questions, which they believed to be translation errors made by their leaders. When such a student requested the official English version to check the meaning of the question, we took steps to inform the student that the English version would only be distributed if the leader specified that both the translated version and the official English version be printed. Since there were a significant number of requests for the English version, it may be better to distribute the official English version to all students in future IPhOs to make the test administration smoother. However, this will increase the number of printed copies of the questions and thus the workload for the printing team.

The exam ended at 14:00 and the envelopes were collected and sent to the IIS site at 15:00. Students were allowed to take all items on the desks with them.



Experiment

IPhO 2023 TOKYO JAPAN

QR code here

W2-9

To whom it may concern

This student did not follow the rules clearly stated in the General Instructions and did not place this sheet in the envelope.

I was informed that the invigilators thoroughly searched for this sheet in and around the booth where the student was sitting, but they were unable to locate the sheet in question.

Ryugo HAYANO
Chairman of the Academic Committee

Figure 11 How missing page(s) were handled.

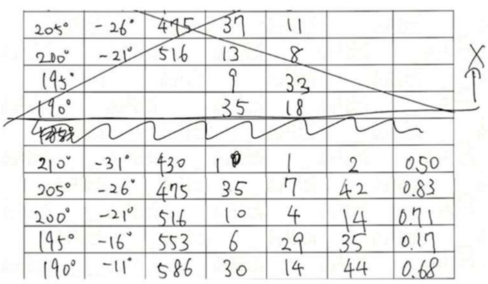
3.6.3 Scanning and copying work at IIS venue

After the experiment exam, the envelopes arrived at IIS from NYC shortly after 15:00. And were scanned by a 10-person scanning team. Members of the Academic Committee checked the scanned data for correct storage in the ExamTools folder. However, some worksheets could not be found despite considerable efforts to locate them (presumably students had taken them home), and in these cases a "missing page" was inserted with the Academic Committee Chair's signature.

After scanning, the team printed two copies of the answer sheets+worksheets from ExamTools, one for the scoring team and the other for the leaders. The total number of pages printed was estimated to be approximately 35,000.

The original answer sheets were given to the 27 part-time helpers. They read the handwritten numbers in the table and the students' experimental results, as illustrated in **Figure 12**, and typed them into the designated Excel sheet.

A macro on the Excel sheet sorted those numbers in order (often out of order, since the students tended to measure back and forth), compared the results to the marking criteria, and color-coded them to indicate whether they were within the range considered correct. On July 12th, the markers first looked at the Excel table for scoring, and then checked the original handwritten number table if there was any doubt. This greatly sped up the marking process.



205°	-26°	475	37	11		
200°	-21°	516	13	8		
195°			9	33		
190°			35	18		
210°	-31°	430	1	1	2	0.50
205°	-26°	475	35	7	42	0.83
200°	-21°	516	10	4	14	0.71
195°	-16°	553	6	29	35	0.17
190°	-11°	586	30	14	44	0.68

Figure 12 (left) A typical handwritten table from an Experimental Exam answer sheet. (right) converting the handwritten tables to Excel sheets

The scanning/printing of the theory exam answer sheets/worksheets was done in a similar manner, except that the theory exam did not require Excel spreadsheet entry. The printing (copying) consisted of 53 pages of answer sheets and worksheets, and the total number of printed/copied pages was estimated to be approximately 43,000.

3.6.4 Marking

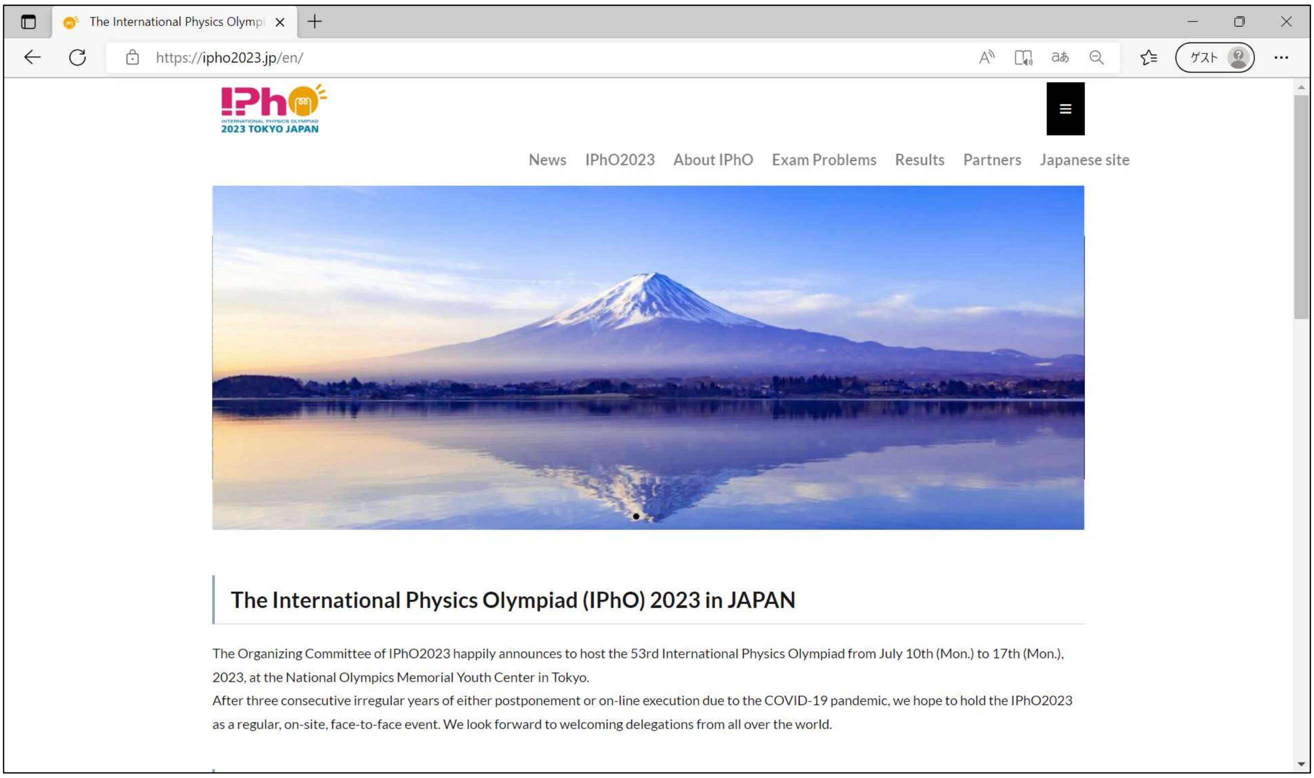
Marking sessions began at the IIS the day after each exam. To facilitate the process, a member of the Academic Committee was present to provide a detailed explanation of the marking protocol and to answer any questions that arose. Following a regimented procedure, each answer sheet was marked independently by a pair of markers from the respective teams. To clearly distinguish the entries, the first marker used a red pencil to indicate areas warranting partial credit and to record the preliminary score, while the subsequent marker used a blue pencil. After completing their individual evaluations, the markers met to reconcile any discrepancies in scoring and discussed until a consensus was reached. Only then did the markers sign off on the answer sheets. These final grades were then entered into ExamTools. Marking took place on July 12 and 14, from 9:00 a.m. until late in the evening. The task was diligently completed by the end of the day.

On July 15, all marked documents were transported to NSH, the designated moderation site.

4. IPhO2023 Website, Circulars and Registration Forms

4.1 IPhO2023 Website

The Japanese webpage of IPhO2022 (as planned at the time) was opened in 2019 for the purpose of public relation and fundraising. The international (English) webpage of IPhO2023 was officially opened in the autumn of 2022 and has been enriched progressively.



The pull-down menus of the IPhO2023 webpage was organized as follows:

- NEWS
- IPhO2023
  - NEWSLETTERS [IPhO2023 newsletters]
  - GALLERY [photos and movies of IPhO2023]
  - FIRST CIRCULAR [pdf]
  - SECOND CIRCULAR [pdf]
  - THIRD CIRCULAR [pdf]
  - ORGANIZER [Organizing Committee members, Co-Organizers]
  - ABOUT IPhO [linked to the IPhO Secretariat webpage https://www.ipho-new.org/]
- PARTNERS [Supporters of IPhO2023]
- INFORMATION
  - CONTEST [IPhO2023 exam questions and model answers]
    - Results (medals, honorary mentions, special prizes)
    - Experimental Exam
    - Theoretical Exam
- COMMUNICATION
  - IPhO2023 Pre-Registration [Google form for pre-registration]
  - Request of Invitation Letter for Visa Application [Google form for invitation letter request]
  - IPhO2023 Team Registration [Google form for team registration]
  - INQUIRY BOX
  - FAQ

**After IPhO2023, the original IPhO2023 webpage at the URL ipho2023.jp/en/ suffered from DDoS attack, so that the webpage was relocated to international-physics-olympiad2023-tokyo.jp/*

4.2 Pre-Announcement (Jan. 17, 2023)

On January 17, 2023, the following pre-announcement e-mail was sent to the countries/regions which participated in at least one of the last three IPhOs --- IPhO2019 (Israel), IPhO2021 (Lithuania, online) and IPhO2022 (Switzerland, online). The e-mail addresses of the leaders of the previous years' delegation were taken from a list provided to us from the IPhO Headquarter. This was intended to establish the contact channel for subsequent communication with each of the prospective participating countries/regions.

To Leaders of Countries/Regions interested in participating in IPhO2023 [sent via bcc]

I am IYE Yasuhiro, Secretary General of the Organizing Committee of IPhO2023.
This e-mail is a pre-announcement of IPhO203 in July this year. It is also intended as communication test with the leaders of countries/regions for future communications on IPhO2023. The First Circular of IPhO2023 will be issued in about a week and will be e-mailed to each of you. The webpage of IPhO2023 ipho2023.jp/en will be updated in due course.

If you are handing over the leadership of your country/region to someone else this year, please forward this e-mail to the new leader, and let me know his/her name and e-mail address.

Thank you for your cooperation.

Yours sincerely

Prof. IYE Yasuhiro, Secretary General, the Organizing Committee of IPhO2023

4.3 First Circular and Pre-Registration

4.3.1 First circular

The First Circular, which is reproduced on the following pages, was sent to the contact persons of prospective participating countries/regions on January 24, 2023. At the same time the Pre-Registration site was opened. The representatives of those countries/regions interested in participating were asked to fill out the Pre-Registration Form.

Here, it may be worthwhile to drop a note on the web-based forms used for IPhO2023: It was anticipated that we would have to collect a large volume of data, at the time of full registration, including not only text data but also different types of data such as face photos, passport photocopies, signed documents etc. There are many kinds of web-based forms available free or at a reasonable cost. We tried a few of them. They did not differ much in terms of function. The crucial points were;

- Secure data transfer and storage
- Capacity to handle a large volume of data
- Accessibility from different countries/regions
- Easy, intuitive operation for those who would fill out the form

Not knowing well about the accessibility from different regions of world, I (IYE) tentatively chose Google form, made a beta version of Pre-Registration Form, and asked a few friends living abroad to give a try. Confirmed positive, at least partially, the Pre-Registration Form was put into practice. Fortunately, there seemed no problems even in countries/regions where access to internet was reputed to be strictly controlled. Encouraged by this clearance of the first stage, I moved on to prepare the full registration form, *i.e.* Team Registration Form. Here the variety of the data files and total amount of data to be collected were the major challenge.

IPhO 2023 – First Circular

January 2023

Dear Colleagues,

We have the honor of hosting the 53rd International Physics Olympiad (IPhO) 2023 based on the decision made at the International Board Meeting during IPhO2022 held online in July 2022. IPhO2023 will take place from July 10th (Mon) to July 17th (Mon), 2023 in Tokyo, Japan. We would like to invite you to participate in IPhO2023. Towards this important event, we are happy to share with you the logistic information that will help you to plan your trip.

Program: A tentative timetable of IPhO2023 is given at the end of this document to facilitate your travel plan.

Delegations: Each participating country/region may send a delegation, normally consisting of five students (contestants) and two accompanying persons (delegation leaders) at most. The contestants shall be students of general or technical secondary schools. Students who have finished their school examinations in the year of the competition can be members of the team as long as they have not commenced their university studies. The age of the contestants should not exceed twenty years on June 30th, 2023. The delegation leaders must be specialists in physics or physics education, capable of solving the problems of the competition. Each of them should be able to communicate in English. In addition to the delegations, teams may be accompanied by observers and guests. Observers may attend all Olympiad meetings, including the meetings of the International Board. However, they may not vote or take part in the discussions. Guests do not attend the meetings of the International Board.
The promotion of gender diversity within each participating team is encouraged. Section 3 of the IPhO Statutes and the associated Regulations should be referred to for more details.

Hospitality: The organizer will provide and cover meals, accommodation, excursions and various entertainments during the Olympiad official period (10 days) starting July 9th (Sun) and ending July 18th (Tue), 2023.

Transportation. Ground transportation will be provided for the official events. Transportation service includes pick-up and drop-off of delegations* either at Tokyo International Airport (Haneda Airport) or Narita International Airport.

* Applicable to arrivals on 8th(Sat), 9th(Sun) and early morning of 10th (Mon). Note that the Opening Ceremony starts at 10:00 on 10th(Mon). To utilize the airport pick-up service, you have to include the flight number and arrival time in the Full Registration Form. As for departures, airport transportation will be provided on 17th(Mon) and 18th(Tue). Trips from and to the airport on other days have to be self-covered. Individual arrival or departure on a different schedule than the group travel of the delegation will not be taken care of by the Organizer.

Accommodation: All students shall be staying in the dormitory within the campus of the National Olympics Memorial Youth Center, the venue of IPhO2023. Each room is single

Leaders, observers and guests will be staying at the Nippon Seinenkan Hotel. The hotel rooms are based on two people per room. If single occupancy is preferred, a surcharge has to be incurred per night.

Travel Insurance: Each delegation is advised to take out an appropriate travel insurance policy. Although the organizer signs up for a contingency insurance policy to cover accidents during IPhO2023, the policy does not cover personal medical insurance.

IPhO2023 Website: The official website of IPhO2023 is https://www.ipho2023.jp/en/.

Pre-Registration: The website for pre-registration is ready. We request the representative leader of each participating team to fill out the Pre-Registration Form at his/her earliest convenience, but no later than 15th March 2023.
This is for us to know which countries/regions are interested in participating IPhO2023, and to collect relevant information for subsequent communication with the prospective participating teams. Submission of this Pre-Registration Form implies neither your formal commitment to IPhO2023, nor a formal invitation of your team to IPhO2023 by the Organizer.
The Second Circular and a Full Registration site will be available in April 2023.

Visa: Visa application may be required depending on the traveler's origin. In case a visa is required, we recommend you to prepare well in advance for a visa application. Please check for the latest information on visa issue at the following website of the Ministry of Foreign Affairs, Japan.
https://www.mofa.go.jp/j_info/visit/visa/index.html
The Organizing Committee, upon request and registration, can provide invitation letters to assist with the visa application.

COVID-19: It is difficult at this moment to predict the status of the COVID-19 pandemic in Japan and worldwide in July 2023. The Organizing Committee will collect and post relevant information, while striving to prepare for the safe execution of IPhO2023. The Japanese border measures concerning COVID-19, as of Jan. 2023, can be found on the following webpage of the Ministry of Health, Labour and Welfare, Japan.
https://www.mhlw.go.jp/stf/covid-19/bordercontrol.html

Participation Fee: Participation fees are set as follows:

Students: 70,000 JPY per person
Leaders: 70,000 JPY per person
Observers: 250,000 JPY per person
Guests: 250,000 JPY per person
Surcharge for single room occupancy* at the Nippon Seinenkan Hotel:
12,000 JPY per night per person

* Applicable only to leaders, observers and guests staying at the Nippon Seinenkan Hotel. All student rooms in the National Olympics Memorial Youth Center are single occupancy with shared bathrooms.

Payment of the participation fees should be made by bank transfer. Details of the payment method will be given in the Second Circular.

Communications: Should you have any questions, please do not hesitate to contact us at the e-mail address given below.

IPhO2023 Secretariat: e-mail address: secretariat@ipho2023.jp

We look forward to your participation, and hope that you enjoy your stay in Tokyo.

Yours sincerely,

Prof. KOBAYASHI Makoto: Chair,
Prof. IYE Yasuhiro: Secretary General
The Organizing Committee of IPhO2023

Time Table of IPhO2023 (tentative)

		Contestants(Students)	Leaders and Observers
July 9th (Sun)		Arrival of Delegations	Arrival of Delegations
	PM	Registration	Registration
		Get Together	Get Together
July 10th (Mon)	AM	Registration	Registration
		Opening Ceremony	Opening Ceremony
	PM	Cultural Experience Event	Board Meeting
July 11th (Tue)	AM	Exam (Experiment)	Excursion
	PM	Cultural/Scientific Experience Event	
July 12th (Wed)	AM	Excursion	Board Meeting
	PM	Cultural/Scientific Experience Event	Board Meeting
July 13th (Thr)	AM	Exam (Theory)	Excursion
	PM	Cultural/Scientific Experience Event	Cultural/Scientific Experience Event
July 14th (Fri)	AM	Excursion	
	PM	Special Lecture	Special Lecture
		Dinner Party	Dinner Party
July 15th (Sat)	AM	Excursion	Board Meeting
	PM	Excursion	Moderation
July 16th (Sun)	AM	Excursion	Moderation
	PM	Excursion	Board Meeting
July 17th (Mon)	AM	Closing Ceremony	Closing Ceremony
	PM	Farewell Lunch	Farewell Lunch
		Departure of Delegations	Departure of Delegations
July 18th (Tue)		Departure of Delegations	Departure of Delegations

4.3.2 IPhO2023 Pre-Registration Form

Upon distribution of the First Circular on Jan, 23, 2023, the following Pre-Registration site offering the following Pre-Registration Form was made open.

IPhO2023 Pre-Registration Form

Please fill out this Pre-Registration Form to express your interest in participating the 53rd International Physics Olympiad (IPhO2023) to be held from 10th (Mon) to 17th (Mon), July 2023 in Tokyo, Japan. We appreciate the representative leader of each country to fill out this form at his/her earliest convenience, but no later than 15th March 2023.

There are 5 Sections including this one. It is expected that a person representing the dispatching organization is filling out this form, and he/she will be the principal contact person for subsequent communication.

You can correct your data entry, if necessary, after submission.

This is for us to know which countries/regions are interested in participating IPhO2023, and to collect relevant information for subsequent communication with the prospective participating teams. Submission of this Pre-Registration Form implies neither your formal commitment to IPhO2023, nor a formal invitation of your team to IPhO2023 by the Organizer. A Second Circular and a Full Registration site will be available in April 2023.

* 必須の質問です

1。 メールアドレス *

2。 YOUR COUNTRY/REGION (e.g. Japan) *

PRINCIPAL CONTACT PERSON

Please give the name, title, affiliation, e-mail address of the principal contact person.

3。 NAME (FAMILY NAME, Given name) *
(e.g. EINSTEIN, Albert)

4。 TITLE *

1つだけマークしてください。

- Professor
- Dr.
- Mr.
- Ms.
- Other

5。 AFFILIATION *

6。 POSTAL ADDRESS *

7。 E-MAIL ADDRESS *

8。 ADDITIONAL E-MAIL ADDRESS (if any)

YOUR TEAM

Please give the numbers of students (contestants), leaders, observers, and guests. (Tentative numbers suffice at this point.

9。 PARTICIPATION TO IPHO2023 *

当てはまるものをすべて選択してください。

- Regular Participation
- Participation as Observer Country/Region
- Participation as a Group of Individuals
- Participation as a Guest Team

10。 NUMBER OF STUDENTS (CONTESTANTS)

1つだけマークしてください。

- 0
- 1
- 2
- 3
- 4
- 5

11。 NUMBER OF LEADERS

1つだけマークしてください。

- 0
- 1
- 2

12。 NUMBER OF OBSERVERS

1つだけマークしてください。

- 0
- 1
- 2
- 3
- 4
- 5

13。 NUMER OF GUESTS

1つだけマークしてください。

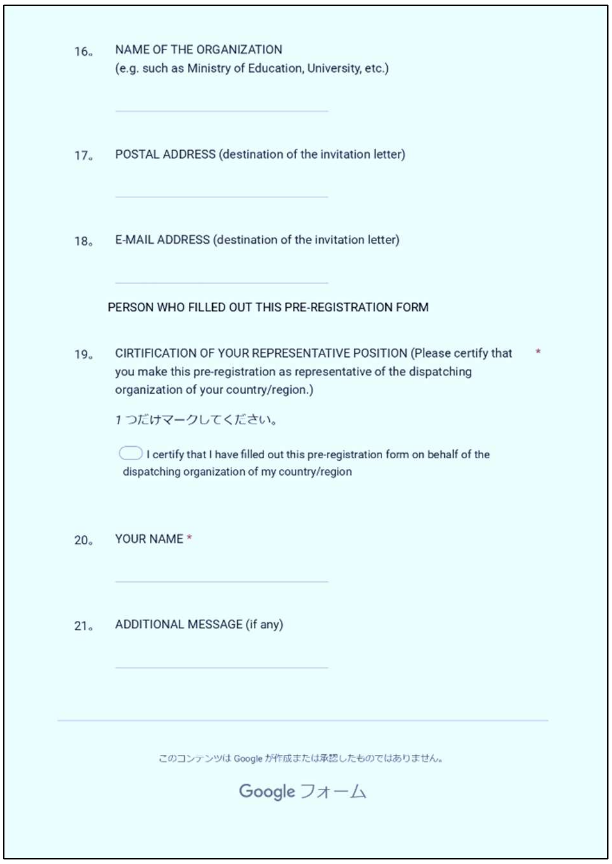
- 0
- 1
- 2
- 3
- 4
- 5

NEED FOR AN OFFICIAL INVITATION LETTER?

If you need an official invitation letter issued by the IPhO2023 Organizer, please fill out the followings.

14。 ADDRESSEE OF THE INVITATION LETTER (e.g. such as, President of the Dispatching Organization, or Minister of Education)

15。 TITLE (e.g. Minister, Director, President, etc.)



16。 NAME OF THE ORGANIZATION
(e.g. such as Ministry of Education, University, etc.)

17。 POSTAL ADDRESS (destination of the invitation letter)

18。 E-MAIL ADDRESS (destination of the invitation letter)

PERSON WHO FILLED OUT THIS PRE-REGISTRATION FORM

19。 CIRTIFICATION OF YOUR REPRESENTATIVE POSITION (Please certify that you make this pre-registration as representative of the dispatching organization of your country/region.) *

1 つだけマークしてください。

I certify that I have filled out this pre-registration form on behalf of the dispatching organization of my country/region

20。 YOUR NAME *

21。 ADDITIONAL MESSAGE (if any)

このコンテンツは Google が作成または承認したものではありません。

Google フォーム

Note that the sentences written in Japanese here are automatically shown in the language selected by the individual browser.

4.4 Second Circular and Team Registration

4.4.1 Second circular

The Second Circular was sent to the contact persons of respective countries/regions and uploaded to the IPhO2023 website on April 14, 2023.

IPhO2023
Second Circular and Call for Registration

April 2023

Dear Colleagues,

The 53rd International Physics Olympiad (IPhO2023) will be held from July 10 (Mon) to 17 (Mon), 2023 in Tokyo, Japan. We are experiencing the pleasure of receiving pre-registration from about 90 countries/regions. Given the relatively calmed down situation of COVID-19 in Japan and elsewhere, we are happy to announce that IPhO2023 will be held as an on-site face-to-face event for the first time in four years.

IPhO2023 Website: The official website of IPhO2023 is https://www.ipho2023.jp/en/.

Pre-Registration Status

The following 83 countries/regions have made pre-registration to IPhO2023:

Armenia	Australia	Austria,	Azerbaijan	Bangladesh
Belgium	Bolivia	Bosnia and Herzegovina		Brazil
Bulgaria	Cambodia	Canada	China	Czech
Colombia	Croatia	Cyprus	Denmark	Egypt
El Salvador	Estonia	Finland	France	Georgia
Germany	Greece	Hong Kong	Hungary	Iceland
India	Indonesia	Iran	Israel	Italy
Japan	Kazakhstan	Korea	Kosovo	Kuwait
Kyrgyzstan	Latvia	Lithuania	Luxembourg	Macao
Macedonia	Malaysia	Mexico	Moldova	Mongolia
Montenegro	Nepal	Netherlands	Nigeria	Norway
Pakistan	Philippines	Poland	Portugal	Puerto Rico
Qatar	Romania	Saudi Arabia	Serbia	Singapore
Slovakia	Slovenia	South Africa	Spain	Suriname
Sweden	Switzerland	Syria	Taiwan	Tajikistan
Thailand	Turkey	Turkmenistan	Ukraine	United Arab Emirates
United Kingdom	United States of America		Uzbekistan	Vietnam

The following 8 countries have expressed their intention to join IPhO2023 as observer country or guest team:

Brunei	Ecuador	Ghana	Honduras	Kenya
Oman	Peru	Tunisia		

Team Registration Site: The Team Registration (Full Registration) site now open can be reached from the IPhO2023 website ipho2023.jp/en via the pull-down menu under COMMUNICATION. The password for access to the Registration form is sent to the contact person of each team (usually the first leader). Please complete registration at your earliest convenience, but no later than May 15 (Mon). We cannot take responsibility for any disadvantage or inconvenience due to delay in the team registration.

The Team Registration Form is somewhat lengthy, as we need to collect detailed information on each of the participants. We appreciate your cooperation and patience in filling out the Form. After you submit the Form, you will get an acknowledging e-mail. You can change the data entries after submission, if necessary.

Prior to get started on the Team Registration Form, the following files for each participant have to be prepared and be made ready for uploading.

- Photographic portrait: clear face photo to appear on the name tag and the IPhO2023 booklet --- jpg or gif file no heavier than 1MB.
- Pronunciation of full name: audio mp3 file no heavier than 1MB.
- Photocopy of the photo page of the passport – jpg or gif or pdf file no heavier than 1MB.
- Signed “Photography Consent Form” --- pdf file no heavier than 1MB.
- Signed “Commitment Form” — pdf file no heavier than 1MB

The “Photography Consent Form” and the “Commitment Form” can be downloaded from the IPhO2023 webpage. Those for students and those for leaders/observers are different. They should be read carefully, and be signed and scanned to make pdf files to be uploaded upon registration.

Participation Fee: Participation fees are set as follows:

Students: 70,000 JPY per person
(Students of a “Guest Team”: 150,000 JPY per person)
Leaders: 70,000 JPY per person
Observers: 250,000 JPY per person
Guests: 250,000 JPY per person
Surcharge for single room occupancy* at the Nippon Seinenkan Hotel:
12,000 JPY per night per person

* Applicable only to leaders, observers and guests staying at the Nippon Seinenkan Hotel. All student rooms in the National Olympics Memorial Youth Center are single occupancy with shared bathrooms.

Payment of the participation fees should be made by bank transfer to the following account by June 16 (Fri). Remittance should be made so that the total amount of participation fees for your team is deposited in our bank account. Namely, the remittance charge should be paid by the sender.

Beneficiary: International Physics Olympiad 2023 IPhO2023
Bank: MUFG BANK, LTD
KAGURAZAKA BRANCH
3-7, Kagurazaka, Shinjuku-ku, Tokyo, 162-0825, Japan
Account Number: 052-0970796
SWIFT Code: BOTKJPJTXXX

If you have difficulty with bank transfer, contact us prior to the above-mentioned deadline so that we can discuss on the payment method.
If you are unable to make bank transfer despite all your efforts, we accept payment in cash at the registration desk of IPhO2023. You have to bring the exact total amount of the participation fees of your team in JPY.

Cancellation or any other schedule changes must be notified to the IPhO2023 organizer by June 30 (Fri). Cancellation after this date will not be refundable.

Hospitality: In accord with the tradition of IPhO, we extend our hospitality. We will provide and cover accommodation of the registered participants during the Olympiad official period (10 days) beginning in the evening of July 9 (Sun) and ending in the morning of July 18 (Tue) 2023.

Service of meals starts with a get-together party in the evening of July 9 (Sun) and ends with a farewell lunch on July 17(Mon).
Excursions and entertainments during IPhO2023 will be covered by the organizer.

Transportation. Ground transportation will be provided for the official events. Transportation service includes pick-up and drop-off of delegations* either at Tokyo International Airport (Haneda Airport) or Narita International Airport.

* Applicable to arrivals on 8 (Sat), 9 (Sun) and early morning of 10 (Mon). Note that the Opening Ceremony starts at 10:00 on 10 (Mon). Arrival in the morning of the same day is not advisable, considering the time for immigration procedures and transportation from the airport. To utilize the airport pick-up service, you have to include the flight number and arrival time in the Team Registration Form. As for departures, airport transportation will be provided on 17 (Mon) and 18 (Tue).
Trips from and to the airport on other days have to be self-covered. Individual arrival or departure on a different schedule than the group travel of the delegation will not be taken care of by the Organizer.

Accommodation: All students shall be staying in the dormitory within the campus of the National Olympics Memorial Youth Center, the venue of IPhO2023. Each room is single occupancy. Several rooms constitute a unit with a shared bathroom.
Leaders, observers and guests will be staying at the Nippon Seinenkan Hotel. The hotel rooms are based on two people per room. If single occupancy is preferred, a surcharge per night has to be paid.

Travel Insurance: Each delegation is advised to take out an appropriate travel insurance policy. Although the organizer signs up for a contingency insurance policy to cover accidents during IPhO2023, the policy does not cover personal medical insurance.

Visa: Visa application may be required depending on the traveler’s origin. In case a visa is required, we recommend you to prepare well in advance for a visa application. Please check for the latest information on visa issue at the following website of the Ministry of Foreign Affairs, Japan.
https://www.mofa.go.jp/j_info/visit/visa/index.html
The Organizing Committee, upon request and registration, can provide invitation letters to assist with the visa application. Visit the “Request for Letter of Invitation to IPhO2023” page via the pull-down menu under CORRESPONDENCE menu, and fill out the Form.

COVID-19: It is difficult at this moment to predict the status of the COVID-19 pandemic in Japan and worldwide in July 2023. The Organizing Committee will collect and post relevant information, while striving to prepare for the safe execution of IPhO2023. The Japanese border measures concerning COVID-19, as of April 2023, can be found on the following webpage of the Ministry of Health, Labour and Welfare, Japan.
https://www.mhlw.go.jp/stf/covid-19/bordercontrol.html

Exam Tools: We are using the OlyExam Tool, first introduced in IPhO2016, for discussions, voting, translating, marking and managing exams. Access to the OlyExam system will be via a WiFi network. Leaders and observers are advised to bring their own personal computers which they are used to. Make sure to bring your international power adaptor. Limited number of rental computers will be available for those teams experiencing troubles with their computers. Please be reminded that the electrical power outlet in Japan is “type A” supplying 100V a.c. at 50Hz (in the eastern part of Japan including Tokyo).

Calculators: All contestants will use CASIO fx-82cw calculator to be provided by the organizer. CASIO company provides a web-based emulator of the calculator with which students can practice the usage of the calculator in advance. The access code will be sent to the contact person (usually the first team leader) of the country/region after he/she has completed the Team Registration.

Distribution of Experimental Kits: To each participating country/region, we will present one set of the experimental kit used in the exam. If you want more, you can purchase either brand new kits at a price of 80,000 JPY/set which is an actual cost, or used kits at a much reduced price. The exact price of used kits cannot be predetermined because it should depend on their condition after use. The number of sets that can be purchased is subject to the availability.

Excursions:
<For Students>
Half-day excursions within the city of Tokyo will take place on July 12 (Wed) and July 14 (Fri).

A1. Yokohama
A2. Asakusa and Ueno
A3. Odaiba

One-day excursions in Kanto (greater metropolitan) area will take place on July 15 (Sat.) and July 16 (Sun.).

B1. Hakone
B2. Tsukuba
B3. Nikko
B4. Kamakura

Description of the excursion courses can be found in the Excursion Guide attached to the Second Circular.
Note that the choices of excursion courses should be made on a team base. Namely, all students of a team must go together with an attending student supporter. There should be no going off on one's own. The organizer will arrange the schedule of excursions so as to meet the choices as much as possible.

<For Leaders and Observers>
Half-day excursions within the city of Tokyo for leaders and observers will take place on July 11 (Tue) and on July 13 (Thur), while students are sitting for the exams. The destination will be "Asakusa and Ueno" and "Odaiba and Fukagawa".
Communications: Should you have any questions, please do not hesitate to contact us via the INQUIRY FORM activated from the pull-down menu under the COMMUNICATION item in the menu-bar.

We look forward to meeting you in Tokyo in July.

The Organizing Committee of IPhO2023

4.4.2 Photography consent form and commitment form

Photography consent forms and commitment forms to be signed by the students (contestants), and those for the escorting adult participants (leaders and observers).

IPhO2023 – Photography Consent Form (Student)

Student:

Full Name ________________________________

Postal address ____

Country/Region ____________________

During my participation in the 53rd International Physics Olympiad (IPhO2023) taking place in July 2023, I understand that my picture and/or voice may be recorded by any means of photography, audio/video recording, etc.

I am aware and agree that those recordings might be used to promote the IPhO2023 (internet, newspapers, radio, television, social media, etc.) and/or for administrative purposes including but not limited to fraud prevention. No material will be used outside the scope of IPhO2023.

I hereby grant the IPhO2023 organizer the right to use the mentioned pictures and audio/video records for public relations strictly related to the IPhO2023 and renounce any interest derived from the use of that material, such as royalties, proceeds or other benefits.

By signing this form below, I agree to the aforementioned rules. If I disagree, I send an e-mail to secretariat@ipho2023.jp by June 30th, 2023 with the title "IPhO2023 photography consent [Country]", to explicitly state where the consent is not given.

Date ____________________________

Signature ____________________________

*If the above signer is underage under the law of the country, legally responsible person:

Full Name in print ____________________

Signature ____________________________

IPhO2023 – Commitment Form (Student)

As a proud IPhO2023 contestant,

☐ I certify that I am aware of the rules of IPhO contest, in particular that all devices with communication function (cellphones, connected watches, etc.) have to be deposited with the organizer until the completion of experimental and theoretical examinations.

☐ I commit myself to work on the examinations with full integrity, not to cheat or attempt to during the examinations, and not to get in touch with any external contact during or before the examinations.

☐ I understand that any case of cheating (or attempt) might lead to my disqualification from IPhO2023 and that any case of cheating (or attempt) might lead to the elimination of my entire team.

☐ I respect the spirit and ideals stated in the IPhO Statutes. I cooperate with the IPhO2023 organizer to maintain a friendly atmosphere throughout the IPhO2023. I refrain from any political messages or actions.

[Excerpt from the Section 2 of the IPhO Statutes]
The competition is conducted in the friendly atmosphere designed to promote future collaborations and to encourage the formation of friendship in the scientific community. Therefore all possible political tensions between the participants should not be reflected in any activity during the competition. Any political activity directed against any individuals or countries is strictly prohibited.

☐ I commit myself to cooperate with the IPhO2023 organizer for a safe execution of the event. I obey the Japanese laws* and the usage rules of the National Olympics Memorial Youth Center. I follow directions of the IPhO2023 organizer with regards to the COVID-19 infection prevention and emergency safety measures against natural disasters such as earthquake.

**Be advised of Japanese laws and regulations: Drag control is extremely strict. Alcohol and/or tobacco are prohibited under 20, although the adult age is 18.*

Date ______________________________

Full Name in print ________________________ Signature ______________________________

IPhO2023 – Photography Consent Form (Leader/Observer)

Participant (leader/observer):

Full Name ________________________________

Postal address ____

Country/Region ____________________

During my participation in the 53rd International Physics Olympiad (IPhO2023) taking place in July 2023, I understand that my picture and/or voice may be recorded by any means of photography, audio/video recording, etc.

I am aware and agree that those recordings might be used to promote the IPhO2023 (internet, newspapers, radio, television, social media, etc.) and/or for administrative purposes including but not limited to fraud prevention. No material will be used outside the scope of IPhO2023.

I hereby grant the IPhO2023 organizer the right to use the mentioned pictures and audio/video records for public relations strictly related to the IPhO2023 and renounce any interest derived from the use of that material, such as royalties, proceeds or other benefits.

By signing this form below, I agree to the aforementioned rules. If I disagree, I send an e-mail to secretariat@ipho2023.jp by June 30th, 2023 with the title "IPhO2023 photography consent [Country]", to explicitly state where the consent is not given.

Date ______________________________

Signature

____

IPhO2023 – Commitment Form (Leader/Observer)

As a IPhO2023 participant (leader/observer),

☐ I cooperate with the IPhO2023 organizer for a fair execution of the contest. In particular, in translating the exam problems, I exercise my meticulous attention to exclude any kinds of hints that are not present in the original problem description.

☐ I understand that any case of misconduct (or attempt) might lead to the elimination of my entire team from IPhO2023.

☐ I respect the spirit and ideals stated in the IPhO Statutes. I cooperate with the IPhO2023 organizer to maintain a friendly atmosphere throughout the IPhO2023. I refrain from any political messages or actions.

[Excerpt from the Section 2 of the IPhO Statutes]
The competition is conducted in the friendly atmosphere designed to promote future collaborations and to encourage the formation of friendship in the scientific community. Therefore all possible political tensions between the participants should not be reflected in any activity during the competition. Any political activity directed against any individuals or countries is strictly prohibited.

☐ I understand that the above-mentioned “prohibition of political activity directed against any individuals or countries” does not preclude sound and constructive discussions on the proposed amendments to the IPhO Statutes and Regulations, to be put on the agenda in the final session of the International Board Meeting (IBM) in IPhO2023.

☐ I commit myself to cooperate with the IPhO2023 organizer for a safe execution of the event. I obey the Japanese laws* and the usage rules of the National Olympics Memorial Youth Center. I follow directions of the IPhO2023 organizer with regards to the COVID-19 infection prevention and emergency safety measures against natural disasters such as earthquake.

**Be aware of Japanese laws and regulations: Drag control is extremely strict. Alcohol and/or tobacco are prohibited under 20, although the adult age is 18.*

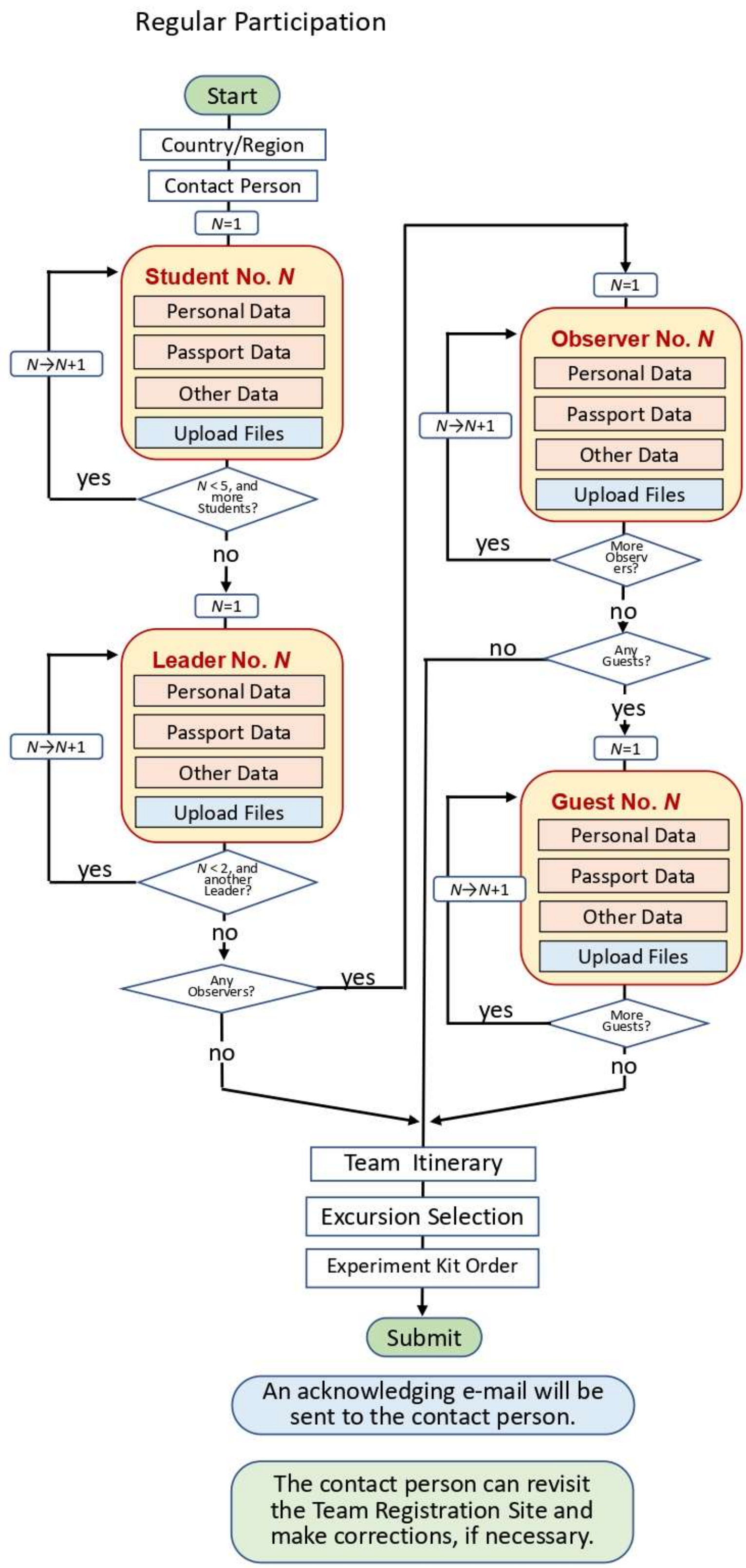
Date ______________________________

Full Name in print ______________________________

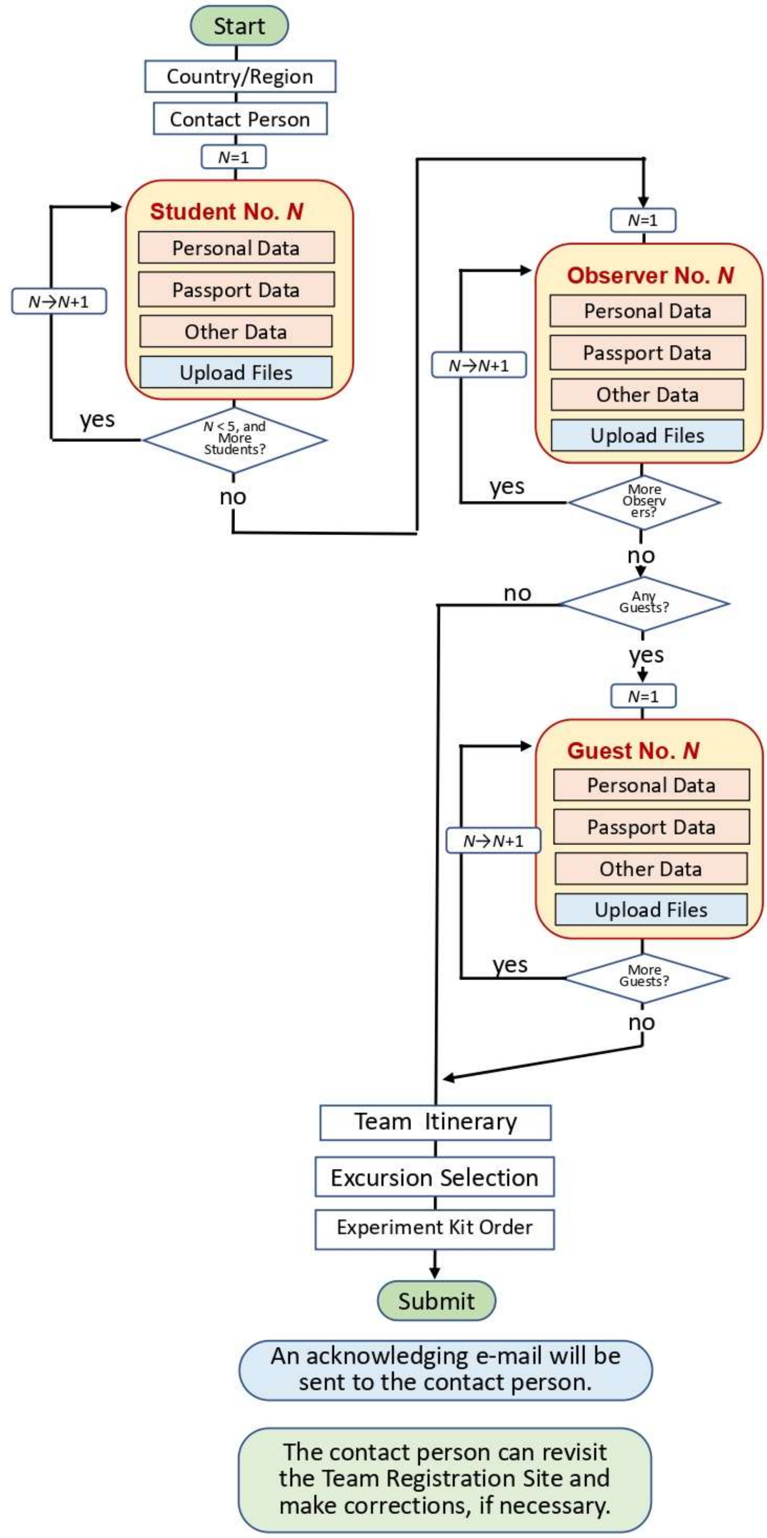
Signature ______________________________

4.4.3 Flow chart of the team registration form

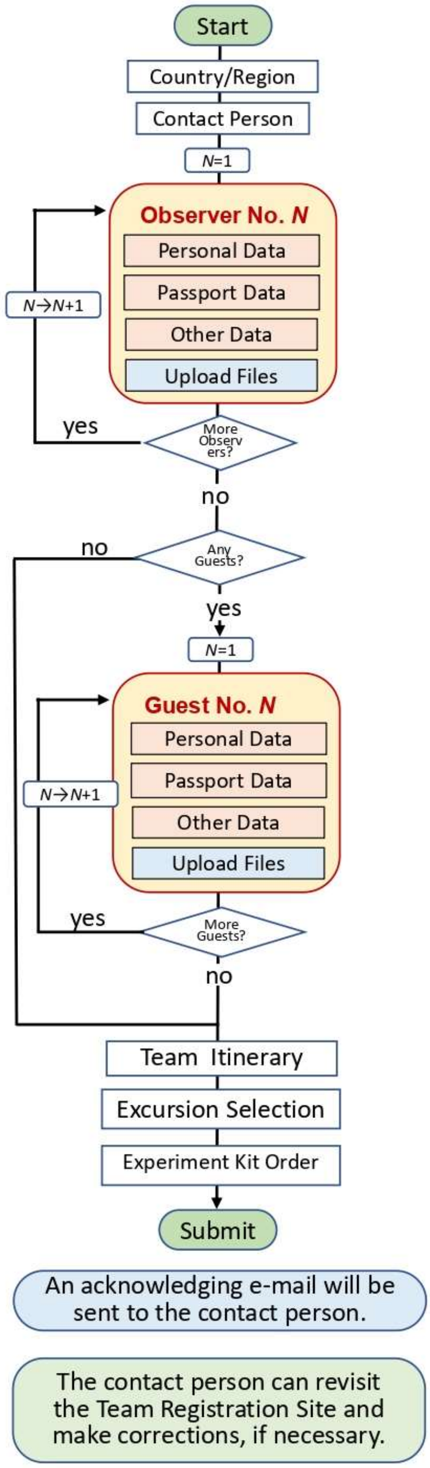
The followings are the flow charts of the Team Registration Form for different categories of participating teams.



Participation as a Group of Individuals
or
Participation as a Guest Team



Participation as an Observer Country



4.4.4 Team registration form

Shown below are some pages ofis the Team Registration Form which the contact person of each participating delegation was requested to fill out by May 15.

IPhO2023 Team Registration Form

This form should be filled out by the primary contact person (usually the Leader No.1) of each participating country/region. The person has to collect from each member of his/her team all the relevant data, photo and audio files and signed consent forms. For the details of this form, please refer to "Instruction for Preparation of Team Registration Form".

* 必須の質問です

1。 メールアドレス *

2。 Country/Region *

3。 Your Name *

4。 Your E-mail Address (for confirmation) *

5。 Participation Category *

1 つだけマークしてください。

- Regular Participation as a National Team [students+leaders(+observers+guests)]　　質問 6 にスキップします
- Participation as an Observer Country/Region [observers(+guests)]　質問 276 にスキップします
- Participation as a Group of Individuals [students+observers]　質問 116 にスキップします
- Participation as a Guest Team [students+observers(+guests)]　質問 116 にスキップします

STUDENT NO.1 (Regular Participation)

Provide personal information on Student No.1.

6。 Family Name

7。 Given Name(s)

8。 Gender

1 つだけマークしてください。

- Male
- Female
- Decline to identify

9。 <Photographic Portrait>
Face photo to appear on the name tag and the booklet) Upload a clear image file no heavier than 1MB.
Make the file name "Family Name-photo.jpg" or "Family Name-photo.gif".

送信済みファイル:

10。 <Pronunciation of Full Name>
Upload an audio file recording a pronounciation of this person's full name.
The file name should be "Family Name-pronounce.wav" or "Family Name-pronounce.mp3".

送信済みファイル:

11。 Name of the School (*e.g.*, Tokyo High School)

12。 Location of the School (Name of the City)

13。 School Year (grade/total school years)
(e.g. 3/3, 11/12 etc.)

************** PASSPORT INFORMATION *****************

14。 Full Name as it appears on the passport

15。 Birth Date (DD/MM/YYYY) (*e.g.*, 15/03/2006)

16。 Passport Number

17。 Issuing Country

18。 Date of Expiration (DD/MM/YYYY)) (*e.g.*, 25/10/2025)

19。 <Photocopy of the Passport Photo Page> Upload a clear image file (.jpg, .gif or pdf.) no heavier than 1MB.
Make the file name "Family Name-passport.jpg", "----.gif". or "---.pdf".

送信済みファイル:

***** FOR A PLEASANT STAY AND DEVELOPMENT OF FRIENDSHIP *******

20。 Native Language and Familiar Languages (e.g. Japanese, English, Spanish)

21。 <Self Introduction Key Words>
Provide a few key words (200 characters or less in total), describing your special skills, hobbies, and interests (e.g. playing music, athletic sports, favorite things) This information will appear on your name tag and in your profile in the IPhO 2023 Workbook to be handed at the Registration Desk, and should be helpful for "icebreaking", i.e. starting conversations with participants from other countries/regions.

22。 T-Shirt Size (We may not be able to meet your request,)

1 つだけマークしてください。

- S
- M
- L
- XL
- XXL

23。 Special Dietary Requirements (*e.g.*, halal, kosher, vegitalian, food allergies)

24。 Special Medical Requirements (*e.g.*, wheel chair, everyday medication)

************** CONSENT FORMS **************
<Photography Consent Form>
Read the "IPhO2023 Photography Consent Form (student)" and append your signature. Scan the signed form to make a pdf file titled "Family name-photo consent.pdf" (*e.g.*, Einstein-photoconsent.pdf) and upload it. If the student is considerd underage by his/her country's law, an additional signature by his/her guardian is required.

<Commitment Form>
Read the "IPhO2023 Commitment Form (student)" and append your signature. Scan the signed form to make a pdf file titled "Family name-commitment.pdf" (*e.g.*, Einstein-commitment.pdf) and upload it.

25。 Upload a Signed Photography Consent Form (student)
File name should be "Family name-photoconcent.pdf"

送信済みファイル:

26。 Upload a Signed Commitment Form (student).
File name should be "Family name-commitment.pdf"

送信済みファイル:

27。 NEXT ENTRY

1 つだけマークしてください。

- Proceed to STUDENT No.2 質問 28 にスキップします
- That's all for the Students. Proceed to LEADER No.1 質問 226 にスキップします

STUDENT NO.2 (Regular Participation)

Provide personal information on Student No.2.

28。 Family Name

29。 Given Name(s)

LEADER NO.1

Provide personal information on Leader No.1.

226。 Family Name

227。 Given Name(s)

228。 Title

1 つだけマークしてください。

- Prof.
- Dr.
- Mr.
- Ms.
- Mx.
- no prefix

229。 Gender

1 つだけマークしてください。

- Male
- Female
- Decline to identify

230。 E-mail Address

231。 Affiliation (*e.g.*, University of Tokyo)

232。 Position (*e.g.*, Professor)

233。 Photographic Portrait to appear on the name tag and the booklet) Upload a clear image file no heavier than 1MB.
Make the file name "Family Name-photo.jpg" or "Family Name-photo.gif".

送信済みファイル:

234。 <Pronunciation of Your Name>
Upload an audio file recording a pronounciation of this person's full name.
The file name should be "Family Name-pronounce.wav" or "Family Name-pronounce.mp3".

送信済みファイル:

********** PASSPORT INFORMATION **************

235。 Full Name as it appears on the passport

236。 Birth Date (DD/MM/YYYY)

237。 Passport Number

238。 Issuing Country

239。 Date of Expiration (DD/MM/YYYY)

240。 <Photocopy of the Passport Photo Page> Upload a clear image file (.jpg, .gif or pdf.) no heavier than 1MB.
Make the file name "Family Name-passport.jpg", "---.gif". or "---.pdf".

送信済みファイル:

******** ROOM SHARE IN THE NIHON SEINENKAN HOTEL *********

241。 Check-in and Check-out Dates (*e.g.*, from July 9 to July 18)

242。 Room Assignment at the Nihon Seinenkan Hotel

1 つだけマークしてください。

- Twin Occupancy (with no extra charge)
- Single Occupancy (with an extra charge)
- Another hotel of my choice

243。 Room Share (if you select "Twin Occupancy" in the previous question, give the name of your room mate. If you leave it to the Organizer, write "anyone".

244。 Additional notes on the accomodation, if any.

245。 Special Dietary Requirements (*e.g.*, halal, kosher, vegitalian, food allergies)

246。 Special Medical Requirements (*e.g.*, wheel chair, everyday medication)

247。 T-Shirt Size (We may not be able to meet your request,)

1 つだけマークしてください。

- M
- L
- XL

************* CONSENT FORM ****************
<Photography Consent Form>
Read the "IPhO2023 Photography Consent Form (leader, observer)" and append your signature. Scan the signed form to make a pdf file titled "Family name-photo consent.pdf" (*e.g.*, Einstein-photoconsent.pdf) and upload it.

<Commitment Form>
Read the "IPhO2023 Commitment Form (leader, observer)" and append your signature. Scan the signed form to make a pdf file titled "Family name-commitment.pdf" (*e.g.*, Einstein-commitment.pdf) and upload it.

248。 Upload a Signed Photography Consent Form (leader, observer)

送信済みファイル:

249。 Upload a Signed Commitment Form (leader, observer)

送信済みファイル:

250。 NEXT ENTRY

1 つだけマークしてください。

- Proceed to LEADER No.2 質問 *251* にスキップします
- That's all for the Leaders. Proceed to OBSERVER No.1 質問 *276* にスキップします
- That's all for the Leaders. Proceed to GUEST No.1 質問 *401* にスキップします
- That's all for the Team. Proceed to the next item. 質問 *491* にスキップします

LEADER NO.2

Provide personal information on Leader No.2.

274。 Upload a Signed Commitment Form (leader, observer)

送信済みファイル:

275。 NEXT ENTRY

1 つだけマークしてください。

- Proceed to OBSERVER No.1 質問 *276* にスキップします
- Proceed to GUEST No.1 質問 *401* にスキップします
- That's all for the Team. Proceed to the next item. 質問 *491* にスキップします

OBSERVER NO.1

Provide personal information on Observer No.1.

276。 Family Name

277。 Given Name(s)

278。 Title

1 つだけマークしてください。

- Prof.
- Dr.
- Mr.
- Ms.
- Mx.
- no prefix

279。 Gender

1 つだけマークしてください。

- Male
- Female
- Decline to identify

280。 E-mail Address

281。 Affiliation (*e.g.,* University of Tokyo)

282。 Position (*e.g.,* Professor)

283。 Photographic Portrait to appear on the name tag and the booklet) Upload a clear image file no heavier than 1MB.
Make the file name "Family Name-photo.jpg" or "Family Name-photo.gif".

送信済みファイル:

284。 <Pronunciation of Your Name>
Upload an audio file recording a pronounciation of this person's full name.
The file name should be "Family Name-pronounce.wav" or "Family Name-pronounce.mp3".

送信済みファイル:

********** PASSPORT INFORMATION **************

285。 Full Name as it appears on the passport

286。 Birth Date (DD/MM/YYYY)

287。 Passport Number

288。 Issuing Country

289。 Date of Expiration (DD/MM/YYYY)

290。 <Photocopy of the Passport Photo Page> Upload a clear image file (.jpg, .gif or pdf.) no heavier than 1MB.
Make the file name "Family Name-passport.jpg", "----.gif". or "---.pdf".

送信済みファイル:

******** ROOM SHARE IN THE NIHON SEINENKAN HOTEL *********

291。 Check-in and Check-out Dates (*e.g.,* from July 9 to July 18)

292。 Room Assignment at the Nihon Seinenkan Hotel

1 つだけマークしてください。

- Twin Occupancy (with no extra charge)
- Single Occupancy (with an extra charge)
- Another hotel of my choice

293。 Room Share (if you select "Twin Occupancy" in the previous question, give the name of your room mate. If you leave it to the Organizer, write "anyone".

294。 Additional notes on the accomodation, if any.

295。 Special Dietary Requirements (*e.g.,* halal, kosher, vegitalian, food allergies)

296。 Special Medical Requirements (*e.g.,* wheel chair, everyday medication)

297。 T-Shirt Size (We may not be able to meet your request,)

1 つだけマークしてください。

- M
- L
- XL

************* CONSENT FORMS ****************
<Photography Consent Form>
Read the "IPhO2023 Photography Consent Form (leader, observer)" and append your signature. Scan the signed form to make a pdf file titled "Family name-photo consent.pdf" (*e.g.*, Einstein-photoconsent.pdf) and upload it.

<Commitment Form>
Read the "IPhO2023 Commitment Form (leader, observer)" and append your signature. Scan the signed form to make a pdf file titled "Family name-commitment.pdf" (*e.g.*, Einstein-commitment.pdf) and upload it.

298。 Upload a Signed Photography Consent Form (leader, observer)

送信済みファイル:

299。 Upload a Signed Commitment Form (leader, observer)

送信済みファイル:

300。 NEXT ENTRY

1 つだけマークしてください。

- Proceed to OBSERVER No.2 　質問 *301* にスキップします
- That's all for Observers. Proceed to GUEST No.1
  質問 *401* にスキップします
- That's all for the Team. Proceed to the next item.
  質問 *491* にスキップします

************* CONSENT FORMS ****************
<Photography Consent Form>
Read the "IPhO2023 Photography Consent Form (leader, observer)" and append your signature. Scan the signed form to make a pdf file titled "Family name-photo consent.pdf" (*e.g.*, Einstein-photoconsent.pdf) and upload it.

Read the "IPhO2023 Commitment Form (leder, observer)" and append your signature. Scan the signed form to make a pdf file titled "Family name-commitment.pdf" (*e.g.*, Einstein-commitment.pdf) and upload it.

398。 Upload a Signed Photography Consent Form (leader, observer)

送信済みファイル:

399。 Upload a Signed Commitment Form (leader, observer)

送信済みファイル:

400。 NEXT ENTRY

1 つだけマークしてください。

- That's all for the Observers. Proceed to GUEST No.1. 質問 *401* にスキップします
- That's all for the Team. Proceed to the next item. 質問 *491* にスキップします

GUEST NO.1

Provide personal information on Guest No.1.

401。 Family Name

402。 Given Name(s)

403。 Title

1 つだけマークしてください。

- Prof.
- Dr.
- Mr.
- Ms.
- Mx.
- no prefix

404。 Gender

1 つだけマークしてください。

- Male
- Female
- Decline to identify

405。 E-mail Address

********** PASSPORT INFORMATION **************

406。 Full Name as it appears on the passport

407。 Birth Date (DD/MM/YYYY)

408。 Passport Number

409。 Issuing Country

410。 Date of Expiration (DD/MM/YYYY)

411。 <Photocopy of the Passport Photo Page> Upload a clear image file (.jpg, .gif or pdf.) no heavier than 1MB.
Make the file name "Family Name-passport.jpg", "----.gif". or "---.pdf".

送信済みファイル:

******** ACCOMODATION ETC. *********

412。 Check-in and Check-out Dates (*e.g.*, from July 9 to July 18)

413。 Room Assignment at the Nihon Seinenkan Hotel

1 つだけマークしてください。

- Twin Occupancy (with no extra charge)
- Single Occupancy (with an extra charge)
- Another hotel of my choice

414。 Room Share (if you select "Twin Occupancy" in the previous question, give the name of your room mate. If you leave it to the Organizer, write "anyone".

415。 Additional notes on the accomodation, if any.

416。 Special Dietary Requirements (*e.g.*, halal, kosher, vegitalian, food allergies)

417。 Special Medical Requirements (*e.g.*, wheel chair, everyday medication)

418。 NEXT ENTRY

1 つだけマークしてください。

- Proceed to GUEST No.2 質問 *419* にスキップします
- That's all for the Team. Proceed to the next item. 質問 *491* にスキップします

GUEST NO.2

Provide personal information on Guest No.2.

419。 Family Name

487。 Additional notes on the accomodation, if any.

488。 Special Dietary Requirements *e.g.,* halal, kosher, vegitalian, food allergies)

489。 Special Medical Requirements (*e.g.,* wheel chair, everyday medication)

490。

1 つだけマークしてください。

- That's all for the Team. Proceed to the next item.
  質問 *491* にスキップします

ITINERARY OF YOUR TEAM

Give the port of entry/departure and the flight information of your team. (Group travel iteneraty)

491。 Port of Entry in Japan

1 つだけマークしてください。

- Narita International Airport
- Tokyo International Airport (Haneda)
- Other (Our team will reach the IPhO2023 venue by ourselves.)

492。 Arrival Date, Flight Number, and Arrival Time (in the 24-hour time format) (*e.g.,* July 9, JL746, 14:55)

493。 Port of Departure from Japan

1 つだけマークしてください。

- Narita International Airport
- Tokyo International Airport (Haneda)
- Other (Our team will reach the departing airport by ourselves.)

494。 Departure Date, Flight Number, Departure Time (in the 24-hour time format) (*e.g.,* July 18, JL741, 9:30)

STUDENT EXCURSIONS

Half-day excursions within the city of Tokyo will take place on July 12 (Wed.) and July 14 (Fri.). One-day excursions in Kanto (greater metropolitan) area will take place on July 15 (Sat.) and July 16 (Sun.). Description of the excursion courses are given as suppleemenary documents to the Second Circular.
Choice of excursion courses should be made on the team base. All the members of a team must go together with an attending student supporter. There should be no going off on one's own.
The organizer will arrange the schedule of excursions so as to meet the choices as much as possible.

495。 The First Choice of Half-Day Excursion (within the city of Tokyo) .

1 つだけマークしてください。

- A1. Yokoyama
- A2. Asakusa and Ueno
- A3. Odaiba
- will not participate

496。 The Second Choice of Half-Day Excursion (within the city of Tokyo).

1 つだけマークしてください。

- A1. Yokohama
- A2. Asakusa and Ueno
- A3. Odaiba
- will not participate

497。 The First Choice of One-Day Excursion (in Kanto (greater metropolitan) area).

1 つだけマークしてください。

- B1. Hakone
- B2. Tsukuba
- B3. Nikko
- B4. Kamakura
- will not participate

498。 The Second Choice of One-Day Excursion (in Kanto (greater metropolitan) area).

1 つだけマークしてください。

- B1. Hakone
- B2. Tsukuba
- B3. Nikko
- B4. Kamakura
- will not participate

PURCHASE OF EXPERIMENTAL KITS

To each participating country/region we will give away one set of the experimental kit (used in the exam) free of charge, if you would like to take it home. If you want more, you can purchase brand new kits at a price of 80,000 JPY/set which is an actual cost, or used kits at a much reduced price. The exact price of the used kits cannot be predetermined because it should depend on their condition after use. The number of sets that can be purchased is subject to the availability.

499。 Number of brand new experimetnal kits you wish to purchase (80,000 JPY per set):

1 つだけマークしてください。

- 0
- 1
- 2
- 3

500。 Number of used experimental kits you wish to purchase (price to be determined):

1つだけマークしてください。

- 0
- 1
- 2
- 3

4.5 Third Circular

The Third Circular was distributed on June 30.

IPhO2023 Third Circular

June 30, 2023

Dear Colleagues,

The 53rd International Physics Olympiad (IPhO2023) to be held from July 10 (Mon) to 17 (Mon), 2023 in Tokyo, Japan is only 10 days away. We trust your team members are busy in preparation for participation in IPhO2023. Here we give you a few last minutes announcements and some tips for travel to Tokyo.

IPhO2023 Website: The official website of IPhO2023 is https://www.ipho2023.jp/en/.

Participating Countries and Regions

We expect the following teams enter the IPhO2023 contest:

Armenia	Australia	Austria,	Azerbaijan	Bangladesh
Belgium	Bolivia	Bosnia and Herzegovina		Brazil
Bulgaria	Cambodia	Canada	China	Colombia
Croatia	Cyprus	Czech	Denmark	El Salvador
Estonia	Finland	France	Georgia	Germany
Greece	Hong Kong	Hungary	Iceland	India
Indonesia	Iran	Israel	Italy	Japan
Kazakhstan	Korea	Kosovo	Kyrgyzstan	Latvia
Lithuania	Luxembourg	Macao	Macedonia	Malaysia
Mexico	Moldova	Mongolia	Montenegro	Nepal
Netherlands	Nigeria	Norway	Pakistan	Philippines
Poland	Portugal	Puerto Rico	Qatar	Romania
Saudi Arabia	Serbia	Singapore	Slovakia	Slovenia
South Africa	Spain	Suriname	Sweden	Switzerland
Syria	Taiwan	Tajikistan	Thailand	Turkey
Turkmenistan	Ukraine	United Arab Emirates		United Kingdom
United States	Uzbekistan	Vietnam	Oly team of Individuals	

The followings are guest teams and observer countries:

Honduras	Kenya	Kuwait	Oman	Tunisia

[IMPORTANT] Visit Japan Web

To facilitate the procedures at the Immigration Control and Custom, please visit the "Visit Japan Web" and make registration prior to your trip to Japan.
https://www.digital.go.jp/en/services/visit_japan_web-en/

[IMPORTANT] Travel insurance

Each delegation is advised to take out an appropriate travel insurance policy. Although the organizer signs up for a contingency insurance policy to cover accidents during IPhO2023, the policy does not cover personal medical insurance.

Travel and Airport Pickup

Many teams have notified us of their travel itinerary. If you have yet to do so, please fill out the "Notification of Team Itinerary Form" from https://forms.gle/Qfha5QYbUheVbg419 at your earliest convenience. We arrange for transportation between the airport (either Haneda or Narita) and the venue of IPhO2023.

For those who travel by themselves, the address and access information are given below.

<The National Olympics Memorial Youth Center>

3-1, Yoyogi Kamizono-cho, Shibuya-ku, Tokyo 151-0052
Accessc Guide: https://nyc.niye.go.jp/wp/en/access-train/

<Nippon Seinenkan Hotel>
4-1 Kasumigaoka-machi, Shinjuku-ku, Tokyo 160-0013, Japan
Access Guide: https://nippon-seinenkan.or.jp/en/access.php

Registration Desk at the National Olympics Memorial Youth Center
The charted bus from the airport brings all team members to the NYC, where you are to complete registration, get your nametag, a IPhO2023 handbook, and a set of IPhO2023 goods (a cap, a T-shirt, a bag). For the students an insulated water bottle will be provided.
Students (contestants) have to deposit all their electronic devices with communication capability, mobile phones, personal computers, tablets, smart watches. Failure to comply with this rule may result in disqualification of the entire team. Those electronic devices will be handed back after completion of the theory exam on Thursday.
Those teams who have chosen to pay the participation fee in cash can do so here. We may ask you about the difference between the invoice and the amount of remittance.
There will be a Get Together from 17:00 on July 9 where light meal and beverage will be served. After the Get Together, the adult participants will be transported to the Nippon Seinenka Hotel by chartered buses.

Stay at the National Olympics Memorial Youth Center (Students)
All students are accommodated in Building A of the National Olympics Memorial Youth Center (NYC), the venue of IPhO2023. Each room is single occupancy. Several rooms constitute a unit with a shared bathroom.
There are no supply of amenities in the NYC except shampoo and soap in the bathroom. Do bring your own towels, tooth brushes, tooth paste, etc.
Because the NYC is surrounded by greens, you may be annoyed by mosquitos and other insects. You may want to bring insect repellant and anti-itch ointment, although the organizer also prepares some.
There are coin-operated washing machines and dryers. You may want to bring detergent you are familiar with, although you can buy detergent in the shop.
A nurse station will be set up within the NYC for emergency medical response. Standard stock medication and medical treatment will be provided, but oral medicine will not be prescribed. Therefore, those who suffer from chronic ailment and/or carry risk of disease should make sure to bring their own medication. In this connection, be warned that the control of narcotic drug is extremely strict in Japan.

Stay at the Nippon Seinenkan Hotel (Adult Participants)
Adult participants (leaders, observers and guests) will stay at the Nippon Seinenkan Hotel unless arranged otherwise by themselves. We do our best to meet your request for room assignment, but depending on the availability, we may ask you for some adjustments, Standard hotel amenity supplies such as towels, toothbrushes, razors will be provided. Any extra payments, such as room service, laundry, contents of refrigerator, charged to your room has to be paid individually upon check-out.

[IMPORTANT] Extra Nights Stay
We have found that significant number of teams need accommodation for nights before July 9 and/or those after Jul 17. To meet such needs, we have secured rooms in the NYC, arrange the accommodation as follows:
<Early Arrivals>
Those teams who comes to Japan on July 8 (or July 7) will be accommodated in the NYC. On July 9, the adult participants move to the Nippon Seinenkan Hotel.
<Late Departures>
We ask all adult participants to check out the Nippon Seinenkan Hotel in the morning of July 17 (Mon) and go to the Closing Ceremony at the NYC. Those who stay for the night of July 17 (and possibly for the night of July 18 also) will be accommodated in the NYC. Any adjustment of room charges (*i.e.* surcharges

for single occupancy) associated with this arrangement will be settled at the Registration Desk. We apologize for inconvenience and appreciate your kind understanding.

As stated in the preceding page, there are no supply of amenities in the NYC, except shampoo and soap in the bathroom. So bring your own towels, tooth brushes, tooth paste, etc, if you are going to stay some nights in the NYC. .

Miscellaneous

There is no dress code in IPhO2023. Tokyo in mid July is generally hot and humid. The daytime temperature can be anywhere between 30 to 35 Celsius. The rainy season may or may not be over by mid July, so there is a chance of occasional rain.

Some may feel freezing in some of the air-conditioned rooms. It is advisable to bring something to wear in order to adjust to the room temperature.

Bring a pair of comfortable shoes for excursions and other activities. Those who suffer motion sickness should bring an appropriate medication, especially for the one-day excursions with long bus ride.

You are recommended to bring a folding umbrella or a compact rain wear in preparation of occasional rain

The electricity in Japan is 100 volts and 50 Hz (in Tokyo area). The power plug sockets are type A. Make sure to bring a suitable power adapter.

Tap water in Japan is safe to drink. Coin-operated beverage vender machines are everywhere.

COVID-19

Since May, the COVID-19 has been down-categorized as common infectious disease. Accordingly, there is no special border measures concerning COVID-19. Infection prevention measures such as wearing of a mask are left to the individual personal discretion.
Still, we have to exercise due precaution to prevent infections. The organizer will prepare antibody test kits in stock for quick check. If you notice changes in your physical condition, do notify the staff of IPhO2023 organizer and visit nurse station.

International Board Meeting

The International Board Meetings will be held in the meeting rooms on the 8^{th} floor of the Nippon Seinenkan Hotel. The main meeting room (Room Yellow) is for leaders only. Observers can watch the monitor screen in another meeting room (Room Blue), or on-line broadcast from the hotel rooms. In the latter case, the TV set in the hotel room can be used as external display for your PC. If you want to utilize it, bring an HDMI cable.
The OlyExams Tool will be used for discussions, voting, translating, marking and managing exams. We trust the leaders are already familiarized with the operation of the OlyExams Tool by doing the trial work of translating the General Instructions.
Access to the OlyExams system will be via a WiFi network. Leaders and observers are expected to bring their own personal computers. Make sure to bring your international power adaptor. The power outlet in the meeting room is 100 volts and the power plug socket is type A.

Calculators

All contestants will use CASIO fx-82cw calculator to be provided by the organizer. CASIO company provides a web-based emulator of the calculator with which students can practice the usage of the calculator in advance. The access codes have been sent to the leaders of the participating countries/regions. We trust the contestants had chance to practice the usage. In the afternoon of July 10 (Mon), there will be a session where usage of the CASIO calculator fx-82cw will be explained, and students can give hands-on practices.

Distribution of Experimental Kits

To each participating country/region, we will present one set of the experimental kit used in the exam. If you want more, you can purchase either brand new kits at a price of 80,000 JPY/set which is an actual cost, or used kits at a much reduced price. The exact price of used kits cannot be predetermined because it should depend on their condition after use. The number of sets that can be purchased is subject to the availability.

Excursions

<For Students>

Half-day excursions within the city of Tokyo will take place on July 12 (Wed) and July 14 (Fri).

A1. Yokohama
A2. Asakusa and Ueno
A3. Odaiba

One-day excursions in Kanto (greater metropolitan) area will take place on July 15 (Sat.) and July 16 (Sun.).

B1. Hakone
B2. Tsukuba
B3. Nikko
B4. Kamakura

Description of the excursion courses can be found in the Excursion Guide attached to the Second Circular. Note that the choices of excursion courses should be made on a team base. Namely, all students of a team must go together with an attending student supporter. There should be no going off on one’s own.

<For Adult Participants>

Half-day excursions within the city of Tokyo for leaders, observers and guests will take place on July 11 (Tue) and on July 13 (Thu), while students are sitting for the exams. The destination will be “Asakusa and Ueno” and “Odaiba and Toyosu (fish market)“.

Safe trip to Japan. We look forward to welcoming you in Tokyo.

The Organizing Committee of IPhO2023

Time Table for Contestants (Students)

	Time	Activity	Place
July 9 (Sun)	13:00-17:00	Registration	International Exchange Bldg. 1F
	17:00-18:30	Get Together	
July 10 (Mon)	7:15-8:00	Breakfast	Cafeteria Fuji, Central Bldg. 2F
	10:00-12:00	Opening Ceremony	Large Hall, Arts Bldg. 1F
	12:30-13:30	Lunch	Cafeteria Fuji, Central Bldg. 2F
	14:00-14:45	Briefing on Calculators	Large Hall, Arts Bldg. 1F
	15:00-18:00	Free Time	
	18:00-19:00	Dinner	Cafeteria Fuji, Central Bldg. 2F
July 11 (Tue)	7:15-8:00	Breakfast	Cafeteria Fuji, Central Bldg. 2F
	8:30	Meet at the Exam Room	Athletic Bldg. 1F & B1F
	9:00-14:00	Exam (Experiment)	
	14:30-15:30	Lunch (light meal)	
		Cultural/Scientific Events	International Exchange Bldg. 1F
July 12 (Wed)	7:15-8:00	Breakfast	Cafeteria Fuji, Central Bldg. 2F
	9:00-14:00	Excursion 1	Half-day in Tokyo city
	16:00-19:00	Cultural/Scientific Events	International Exchange Bldg. 1F
	18:00-19:00	Dinner	Cafeteria Fuji, Central Bldg. 2F
July 13 (Thu)	7:15-8:00	Breakfast	Cafeteria Fuji, Central Bldg. 2F
	8:30	Meet at the Exam Room	Athletic Bldg. 1F & B1F
	9:00-14:00	Exam (Theory)	
	14:30-15:30	Lunch (light meal)	
	16:00-19:00	Cultural/Scientific Events	International Exchange Bldg. 1F
	18:00-19:00	Dinner	Cafeteria Fuji, Central Bldg. 2F
July 14 (Fri)	7:15-8:00	Breakfast	Cafeteria Fuji, Central Bldg. 2F
	9:00-14:00	Excursion 2	Half-day in Tokyo city
	16:00-17:40	Special Lectures	Large Hall, Arts Bldg. 1F
	18:00-19:30	Dinner Party	International Exchange Bldg. 1F
July 15 (Sat)	7:15-8:00	Breakfast	Cafeteria Fuji, Central Bldg. 2F
	8:00-19:00	Kanto Excursion 1	Full-day in Kanto area
July 16 (Sun)	7:15-8:00	Breakfast	Cafeteria Fuji, Central Bldg. 2F
	8:00-19:00	Kanto Excursion 2	Full-day in Kanto area
July 17 (Mon)	7:15-8:00	Breakfast	Cafeteria Fuji, Central Bldg. 2F
	9:30-12:00	Closing Ceremony	Large Hall, Arts Bldg. 1F
	12:20-13:30	Farewell Lunch	International Exchange Bldg. 1F
	Departure		

Time Table for Leaders and Observers

	Time	Activity	Place
July 9 (Sun)	13:00-17:00	Registration	International Exchange Bldg. 1F
	17:00-19:00	Get Together	
July 10 (Mon)	7:00-8:00	Breakfast	Dining room (9F)
	10:00-12:00	Opening Ceremony	Large Hall, Arts Bldg. 1F
	12:30-14:30	Lunch	Dining room (9F)
	14:30-18:30	Board meeting (Experiment)	Meeting rooms (8F)
	18:30-20:00	Dinner	Dining room (9F)
	20:00-23:00	Board meeting (Experiment)	Meeting rooms (8F)
July 11 (Tue)	7:00-8:00	Breakfast	Dining room (9F)
	9:00-15:00	Excursion 1	Half day in Tokyo city
	18:00-19:30	Dinner	Dining room (9F)
July 12 (Wed)	7:00-8:00	Breakfast	Dining room (9F)
	9:00-12:30	Board meeting (Theory)	Meeting rooms (8F)
	12:30-14:00	Lunch	Dining room (9F)
	14:00-18:00	Board meeting (Theory)	Meeting rooms (8F)
	18:00-19:30	Dinner	Dining room (9F)
	19:30-23:00	Board meeting (Theory)	Meeting rooms (8F)
July 13 (Thu)	7:00-8:00	Breakfast	Dining room (9F)
	9:00-15:00	Excursion 2	Half-day in Tokyo city
	18:00-19:30	Dinner	Dining room (9F)
July 14 (Fri)	7:00-8:00	Breakfast	Dining room (9F)
	12:00-13:30	Lunch	Dining room (9F)
	16:00-17:40	Special Lectures	Large Hall, Arts Bldg. 1F
	18:00-19:30	Dinner Party	International Exchange Bldg.
July 15 (Sat)	7:00-8:00	Breakfast	Dining room (9F)
	12:00-13:30	Lunch	Dining room (9F)
	14:00-15:00	Board meeting (medal threshold)	Meeting rooms (8F)
	18:00-19:30	Dinner	Dining room (9F)
July16 (Sun)	7:00-8:00	Breakfast	Dining room (9F)
	9:00-12:15	Moderation	Meeting rooms (8F)
	12:15-13:30	Lunch	Dining room (9F)
	13:30-16:45	Moderation	Meeting rooms (8F)
	18:00-19:30	Dinner	Dining room (9F)
	20:00-23:00	Final Board Meeting	Meeting rooms (8F)
July 17 (Mon)	7:00-8:00	Breakfast	Dining room (9F)
	9:30-12:00	Closing Ceremony	Large Hall, Arts Bldg. 1F
	12:20-13:30	Farewell Lunch	International Exchange Bldg.
	Departures		

*Event places highlighted in **orange** are in the National Olympics Memorials Youth Center. Others are in the Nippon Seinenkan Hotel.

4.6 Request form of invitation letter for visa application

We issued upon request a letter of invitation to IPhO2023 to those who needed visa to enter Japan. The following is the Google form for the request of invitation letter.

Request for a Letter of Invitation to IPhO2023 (for visa application to Japan)

To Leader of a delegation that includes individuals who need visa for entry into Japan:
Please fill out this form for each individual (student, leader, observer, guest) of your team who needs visa for entry to Japan, so that we can collect necessary data to issue an invitation letter which can used for visa application.
Upon submission of this form, an acknowledging e-mail will be sent to the address below. You can edit the entries after submission.

* 必須の質問です

1。 メールアドレス *

2。 Country/Region *

3。 Individual participating in IPhO2023 as *

1 つだけマークしてください。

- Contestant (Student)
- Leader
- Observer
- Guest

4。 Family Name of the Individual *

5。 Given Name(s) of the Individual *

6。 Prefix *

1 つだけマークしてください。

- Mr.
- Ms.
- Mx.

7。 Nationality *

8。 Date of Birth *

例: 2019 年 1 月 7 日

9。 Passport Number *

10。 Issuing Country *

11。 Date of Expiration *

例: 2019 年 1 月 7 日

12。 Home Address

13。 E-mail Address of the individual

14。 Affiliation (School, University, etc.) *

15。 Position in the Affiliation (student, teacher, professor, etc.) *

16。 Address of the Affiliation

17。 Photocopy of the picture page of passport (pdf, jpg, or gif file no heavier than 1MB). *
Make the file name "Family name-passport.pdf" (or jpg, or gif).

送信済みファイル:

18。 Embacy or consulate to which visa application will be submitted.

19。 Specific request, if any.

このコンテンツは Google が作成または承認したものではありません。

5. IPhO2023 Contest Results

5.1 Participating Countries and Regions

Regular Participation (80)

Armenia	Australia	Austria,	Azerbaijan	Bangladesh
Belgium	Bolivia	Bosnia and Herzegovina		Brazil
Bulgaria	Cambodia	Canada	China	Colombia
Croatia	Cyprus	Czech	Denmark	El Salvador
Estonia	Finland	France	Georgia	Germany
Greece	Hong Kong	Hungary	Iceland	India
Indonesia	Iran	Israel	Italy	Japan
Kazakhstan	Korea	Kosovo	Kyrgyzstan	Latvia
Lithuania	Luxembourg	Macao	Macedonia	Malaysia
Mexico	Moldova	Mongolia	Montenegro	Nepal
Netherlands	Norway	Pakistan	Philippines	Poland
Portugal	Puerto Rico	Qatar	Romania	Saudi Arabia
Serbia	Singapore	Slovakia	Slovenia	South Africa
Spain	Suriname	Sweden	Switzerland	Syria
Taiwan	Tajikistan	Thailand	Turkey	Turkmenistan
Ukraine	United Arab Emirates		United Kingdom	
United States	Uzbekistan	Vietnam		

Team of Individuals (1)

Oly Team

Guest Team (1)

Kenya

Observer Countries (2)

Kuwait　Oman

5.2 Participants (contestants, leaders, observers and guests)

*Figures in parentheses are number of females.

Contestants (Students)	
Regular Contestants	388 (43)
Guest Students	4 (1)
Sub Total	392 (44)
Adult Participants	
Leaders	155 (13)
Observers	96 (19)
Guests	17 (9)
Sub Total	268 (41)
Grand Total	660 (85)

5.3 Contest Results and Awards

5.3.1 Medals and honorable mentions

— Gold Medals —

Last Name	First Name	Country/Region	Exp.	Theory	Total	Medal
YU	Bowen	China	15.6	29.6	45.2	Gold
DING	Zhuoli	China	15	29.8	44.8	Gold
TIAN	Xiangchen	China	14.9	29.9	44.8	Gold
ZHAO	Hanhong	China	14.1	30	44.1	Gold
FAN	Collin	United States	16	26.2	42.2	Gold
JIANG	Daibing	China	12.3	29.7	42	Gold
MOMOIU	Alexandru	Romania	13.2	28	41.2	Gold
LEE	Junsuh	Korea	11.9	29.1	41	Gold
HAN	Jongyoon	Korea	11.1	29.9	41	Gold
BOBKOV	Viacheslav	OLY team	13.7	27.1	40.8	Gold
CHANG	Ya-Cheng	Taiwan	13.4	27.4	40.8	Gold
LEE	Hyunchae	Korea	10.3	29.9	40.2	Gold
KIM	Evan	nited States	10.8	29.3	40.1	Gold
YEVTUSHENKO	Feodor	United States	10.1	30	40.1	Gold
OROS	Vlad-Stefan	Romania	11.9	27.7	39.6	Gold
SHI	Zian	United States	11.1	28.4	39.5	Gold
NOH	Ian	Korea	10.4	28.8	39.2	Gold
SUH	Kyumin	Korea	11	28.1	39.1	Gold
BURTSEV	Roman	OLY team	13.9	25.2	39.1	Gold
BACIAK	Filip	Poland	10.9	27	37.9	Gold
DRAGOMIR	Andrei-Darius	Romania	10.3	27.5	37.8	Gold
CHANG	Cheng-Kuang	Taiwan	14.2	23.3	37.5	Gold
NGUYEN	Tuan Phong	Vietnam	9.3	28.2	37.5	Gold
DOLIA	Vsevolod	OLY team	10.2	27.2	37.4	Gold
BORAD	Mehul	India	11.1	25.5	36.6	Gold
TANAKA	Yuki	Japan	10.3	26.3	36.6	Gold
PHADETSUWANNUKUN	Nutdech	Thailand	11.5	25.1	36.6	Gold
ADITYA		India	8	28.5	36.5	Gold
IMAMURA	Kotaro	Japan	10.8	25.5	36.3	Gold
WANG	Zhao-Guo	Taiwan	11.4	24.9	36.3	Gold
LAM	Chung Wang	Hong Kong	11.9	24.3	36.2	Gold
ANDOLŠEK	Peter	Slovenia	14.4	21.8	36.2	Gold
ERSHOV	Aleksandr	OLY team	8.5	27.4	35.9	Gold
VO	Hoang Hai	Vietnam	8.4	27.5	35.9	Gold
POTAPOV	Egor	OLY team	12	23.8	35.8	Gold
SHAH	Dhruv	India	8.9	26.8	35.7	Gold
AKDAĞ	Emir	Turkey	7.6	28	35.6	Gold

— Silver Medals —

Last Name	First Name	Country/Region	Exp.	Theory	Total	Medal
HSU	Zi-Siang	Taiwan	8.05	27.5	35.55	Silver
RAM	Ido	Israel	8.3	27	35.3	Silver
CHEN	Peng-Wei	Taiwan	8.2	26.7	34.9	Silver
PITEBAY	Yersultan	Kazakhstan	9.1	25.7	34.8	Silver
IWASHITA	Koki	Japan	8.6	26.1	34.7	Silver
LIU	Lincoln	Hong Kong	9.5	24.9	34.4	Silver
CHEN	Shuoyan	United States	7.2	27.2	34.4	Silver
TUDOSE	Rares Felix	Romania	7.6	26.6	34.2	Silver
GOYAL	Raghav	India	8.1	26	34.1	Silver
DI GRAZIA	Guglielmo	Italy	9.7	23.5	33.2	Silver
KITA	Shunsuke	Japan	4.2	28.8	33	Silver
JINDAL	Shanay	Singapore	8.9	23.9	32.8	Silver
MYLET	Alexander	United Kingdom	10.5	22	32.5	Silver
BISSIMBI	Doszhan	Kazakhstan	8	24.4	32.4	Silver
KEDIA	Rhythm	India	4.2	28.1	32.3	Silver
MOOSAVI	Mohammad	Iran	8.8	23.5	32.3	Silver
NURSAGATOV	Margulan	Kazakhstan	9.5	22.6	32.1	Silver
ZHU	Coy	United Kingdom	9.5	22.5	32	Silver
HUI	Pok Shing	Hong Kong	9.6	22.3	31.9	Silver

TAN	Pin Che	Singapore	8.4	23.4	31.8	Silver
ZAZUBYK	Diana	Ukraine	6.4	25.4	31.8	Silver
GULATI	Ojas	United Kingdom	6.9	24.8	31.7	Silver
NGUYEN	Tuan Duong	Vietnam	5.8	25.8	31.6	Silver
WEINMAN	Matan	Israel	7.6	23.7	31.3	Silver
SHIRINBAYAN	Mahdi	Iran	7.1	24	31.1	Silver
KAHU	Kristjan-Eerik	Estonia	7.8	22.8	30.6	Silver
KWOK	Ching Yeung	Hong Kong	9.8	20.7	30.5	Silver
MAROŃ	Andrzej Franciszek	Poland	9.4	21.1	30.5	Silver
WALACH	Doron	Israel	8.1	22.2	30.3	Silver
YERKEBAYEV	Alisher	Kazakhstan	6.8	23.5	30.3	Silver
KARAN	Val	Croatia	5.3	24.9	30.2	Silver
HE	Jingyang, James	Singapore	8.3	21.8	30.1	Silver
LIPIEC	Michał Piotr	Poland	8.5	21.4	29.9	Silver
UGULAVA	Irakli	Georgia	8	21.8	29.8	Silver
SUN	Yu Chieh	Singapore	5.4	24.3	29.7	Silver
KARPIEJCZYK	Stanisław Marcin	Poland	9	20.3	29.3	Silver
ARÉVALO AGUIRRE	Sebastián Andrés	El Salvador	7.5	21.7	29.2	Silver
LI	Yichen	Singapore	8.6	20.2	28.8	Silver
DOS SANTOS SILVA	Paulo Henrique	Brazil	4.5	24.1	28.6	Silver
BABELIS	Tomas	Lithuania	10.8	17.7	28.5	Silver
GAYDUKOV	Alexander	Slovenia	9.1	19.2	28.3	Silver
MIRICA	Ioan-Alexandru	Romania	4.2	24	28.2	Silver
HIGASHIGAWA	Leon	Japan	8.2	19.9	28.1	Silver
NITZAN	Omri	Israel	7.8	20.2	28	Silver
JOSHI	Douglas	Australia	6.9	21	27.9	Silver
CHAN	Kelvin	Australia	8.5	19.1	27.6	Silver
LE	Viet Hoang Anh	Vietnam	5.2	22.2	27.4	Silver
GHANBARI	Ali	Iran	3.6	23.6	27.2	Silver
ROSIAR	Samuel	Czech	6.3	20.7	27	Silver
CHANKASAMSAT	Thanassorn	Thailand	2.7	24.3	27	Silver
UN	Chong Un	Macao	6	20.9	26.9	Silver
FUNATA	Fansen Candra	Indonesia	7.5	19.3	26.8	Silver
FATHI	Sina	Iran	4.4	22.3	26.7	Silver
DE ANDRADE PORFÍRIO	Murilo	Brazil	9.7	16.8	26.5	Silver
VORONA	Victor	Moldova	7.1	18.9	26	Silver
DŽAVORONOK	Adam	Slovakia	6.3	19.7	26	Silver
PATTARAPON	Punlertrapee	Thailand	5.7	20.3	26	Silver
DERE	Kaan	Turkey	5.9	20.1	26	Silver
FAUCHEU	Hannah	France	7.7	18.2	25.9	Silver
OTGOCHULUU	Anirchuluu	Mongolia	7.5	18.4	25.9	Silver
NÜSKE	Anton	Germany	9.3	16.4	25.7	Silver
ROUAN	Mathurin	France	5.1	20.6	25.7	Silver
SADIKHZADA	Sadig	Azerbaijan	5.5	20.1	25.6	Silver
TCHOTASHVILI	Dachi	Georgia	8.6	17	25.6	Silver
WALD	Inbar	Israel	4.2	21.4	25.6	Silver
LBATH	Mounir	France	6.1	19.3	25.4	Silver
STORBACKA	Melvin	Sweden	10.9	14.4	25.3	Silver
GONZALEZ FILIPOV	Daniel	Switzerland	8.1	17.1	25.2	Silver
CHANDRA	Savero Lukianto	Indonesia	4.7	20.5	25.2	Silver
ONG	Zhi Zheng	Malaysia	10.4	14.8	25.2	Silver
RYD	Emil	Sweden	6.6	18.6	25.2	Silver
KARAPETYAN	Hovsep	Armenia	7	17.9	25.2	Silver
İŞKESEN	Mehmet Anıl	Turkey	8.3	16.9	25.2	Silver
TRABZON	Ahmet Bahadır	Turkey	5.7	19.5	25.2	Silver

— Bronze Medals —

Last Name	First Name	Country/Region	Exp.	Theory	Total	Medal
WONG	Connor Tianzheng	Canada	7.3	17.7	25	Bronze
TEKRIWAL	Aditya	United Kingdom	10	14.9	24.9	Bronze
CHANG	Kia Yau	Malaysia	7.1	17.6	24.7	Bronze
PHAN	The Manh	Vietnam	7.9	16.6	24.5	Bronze
SULTANOV	Javohir	Uzbekistan	5.4	18.9	24.3	Bronze

GEORGIEVSKI	Majkl	Macedonia	7.3	16.9	24.2	Bronze
CHUA	Harold Scott	Philippines	5.1	19.1	24.2	Bronze
ISHTIAK	Golam	Bulgaria	6.4	17.6	24	Bronze
LUKIANIKHIN	Viktor	Ukraine	4.5	19.5	24	Bronze
ECKSTÄDT	Oliver	Germany	6.8	16.9	23.7	Bronze
LEINONEN	Eppu	Finland	5.5	18.1	23.6	Bronze
LI	Zander	Canada	8	15.5	23.5	Bronze
PERKOVIĆ	Borna	Croatia	5.9	17.6	23.5	Bronze
SODSRI	Nopparuj	Thailand	4.5	18.6	23.1	Bronze
ISMOLDAYEV	Margulan	Bulgaria	5.7	17.3	23	Bronze
ZHANG	Wenhe	Canada	4.5	18.5	23	Bronze
AMBROŽIČ	Žan	Slovenia	11.9	11	22.9	Bronze
TVALAVADZE	Luka	Georgia	5.4	17.2	22.6	Bronze
ROHNER	Moritz	Luxembourg	9.6	12.9	22.5	Bronze
KREJAN	Samo	Slovenia	8.8	13.7	22.5	Bronze
JELESIJEVIĆ	Tadija	Serbia	4.3	18.1	22.4	Bronze
CHEN	Liam	Australia	7.9	14.3	22.2	Bronze
JAVORA	Lukáš	Czech	3.2	19	22.2	Bronze
SCHOMERUS	Arved	Denmark	6.1	16.1	22.2	Bronze
FEY	Dávid	Hungary	5.2	17	22.2	Bronze
HIP	Vuk	Serbia	2.8	19.4	22.2	Bronze
MOLNÁR-SZABÓ	Vilmos	Hungary	6.9	15.2	22.1	Bronze
SKIPPER	Timothy David	Spain	5.5	16.5	22	Bronze
GANBOLD	Azjargal	Mongolia	4.1	17.8	21.9	Bronze
BRVAR	Miha	Slovenia	9.1	12.8	21.9	Bronze
SERRANO CAPATINA	Adrian	Switzerland	8.9	12.9	21.8	Bronze
BARSEGHYAN	Areg	Armenia	5.2	16.4	21.6	Bronze
MANJAVIDZE	Andria	Georgia	5	16.5	21.5	Bronze
WONG	Jian Bin	Malaysia	7.9	13.6	21.5	Bronze
YOVCHEV	Yovo	Bulgaria	6.1	15.2	21.3	Bronze
ABRAR	MD Fahim	Bangladesh	3.6	17.6	21.2	Bronze
TAVARES VITORIANO	Lucas	Brazil	3.9	17.1	21	Bronze
TSUTSUI	Kodai	Switzerland	6	15	21	Bronze
KAMIŃSKI	Mateusz	Poland	6.4	14.6	21	Bronze
DIMITROV	Rumen Lyubomirov	Bulgaria	5	15.9	20.9	Bronze
FEYZ	Shayan	Iran	3.1	17.7	20.8	Bronze
NURTAYEV	Dair	Kazakhstan	5	15.8	20.8	Bronze
STOJANOVSKI	Jan	Macedonia	5.7	15	20.7	Bronze
KÖHLER	Luise	Germany	7.2	13.4	20.6	Bronze
PAABO	Ralf Robert	Estonia	7.1	13.5	20.6	Bronze
ÜNVER	Arda	Turkey	4.5	16	20.5	Bronze
POSPIECH	Luke	Germany	9.2	11.1	20.3	Bronze
ISMAIL	Muhammad Arif Khalfani	Indonesia	4.1	16.1	20.2	Bronze
SUVOROV	Petro	Ukraine	5	15.2	20.2	Bronze
GURBAZAR	Batbayar	Mongolia	2.7	17.4	20.1	Bronze
ARAKELYAN	Maria	Armenia	2.2	17.7	19.9	Bronze
SHAO	Eric Yuang	Canada	5.2	14.6	19.8	Bronze
KONDRACHUK	Yaroslav	Ukraine	4.9	14.7	19.6	Bronze
AGHAYAN	Arsen	Armenia	3.7	15.8	19.5	Bronze
VOGEL	Christian	Germany	5.4	14.1	19.5	Bronze
BOHDAN	Maryna	Ukraine	3.1	16.3	19.4	Bronze
TODOROVIĆ	Sava	Serbia	4.1	15.2	19.3	Bronze
ABDULKARIM	Murad	Azerbaijan	5.5	13.7	19.2	Bronze
BENCZ	Benedek	Hungary	3.6	15.5	19.1	Bronze
MOLNÁR	Barnabás	Hungary	6.5	12.3	18.8	Bronze
RUSU	Paisie	Moldova	6.5	12.3	18.8	Bronze
GECHEV	Bayan	Bulgaria	4.3	14.4	18.7	Bronze
KWOK	Tsz Yin	Hong Kong	4.1	14.6	18.7	Bronze
ABBASOV	Nijat	Azerbaijan	2.3	16.3	18.6	Bronze
MATHE	Julian	Belgium	3.6	15	18.6	Bronze
RISTIĆ	Tadej	Serbia	3.9	14.7	18.6	Bronze
MIDŽIĆ	Dženan	Bosnia and Herzegovina	4.2	14.3	18.5	Bronze
CHU	Wai In	Macao	8.5	10	18.5	Bronze
PÕLDMAA	Saskia	Estonia	5.9	12.5	18.4	Bronze
JONGMAN-RIOS	Mali	United Kingdom	7.3	11.1	18.4	Bronze

REUTIN	Ilya	Latvia	6.5	11.9	18.4	Bronze
KOTZAMPASIS	Odysseas	Greece	6.1	12.2	18.3	Bronze
COSENTINO	Giulio	Italy	5.4	12.9	18.3	Bronze
DUBROVSKIS	Stanislavs	Latvia	6.9	11.4	18.3	Bronze
QADAH	Hussain Jamal H	Saudi Arabia	2.3	16	18.3	Bronze
NIKOLAOU	Charalampos	Greece	3.4	14.8	18.2	Bronze
PETROSYAN	Vyacheslav	Armenia	2.5	15.5	18	Bronze
FARES MENHEM	Hugo	Brazil	5.1	12.9	18	Bronze
LECLERC	Adeline	France	4.7	13.3	18	Bronze
VUKOVIĆ	Viktor	Croatia	5.5	12.5	18	Bronze
BUDAI	Csanád Gyula	Hungary	5.9	12.1	18	Bronze
IONAȘ	Vadim	Moldova	2.9	15.1	18	Bronze
ARMESTO MÉNDEZ	Irene	Spain	7.2	10.7	17.9	Bronze
JEMELJANOV	Aleksei	Estonia	3.5	14.4	17.9	Bronze
ARCHABOONYASEK	Thongchai	Thailand	6.2	11.7	17.9	Bronze
OGNYANOV	Michail	Belgium	4.4	13.4	17.8	Bronze
STEPANYAN	Robert	Netherlands	6.8	11	17.8	Bronze
AZIM	Ughur	Azerbaijan	5.5	12.2	17.7	Bronze
HEGEDIĆ	Ivan	Croatia	3.4	14.3	17.7	Bronze
ABDELRAHIM	Youssof	Qatar	5.2	12.5	17.7	Bronze
RAZBADAUSKAS	Tomas	Lithuania	4.9	12.7	17.6	Bronze
ALSHAKHS	Mazen Zaid A	Saudi Arabia	6.4	11.2	17.6	Bronze
PAROJČIĆ	Đorđe	Serbia	4.1	13.5	17.6	Bronze
NUMANOVIĆ	Muhamed	Bosnia and Herzegovina	7.6	9.9	17.5	Bronze
AUGUSTO DE PAULA	Jônatas	Brazil	5	12.5	17.5	Bronze
CARPENTER	Ruben Mason	Spain	2	15.5	17.5	Bronze
FRÉCHETTE	Louis	France	6.1	11.4	17.5	Bronze
KALINAUSKAS	Paulius	Lithuania	4.5	13	17.5	Bronze
KELLIJS	Lukass	Latvia	5.7	11.8	17.5	Bronze
TONNER	Benjamin Patrick	Austria	4.8	12.6	17.4	Bronze
BÁLEK	David	Czech	8.1	9.3	17.4	Bronze
GIURI	Andrea	Italy	4.8	12.6	17.4	Bronze
WONG	Ka Wa	Macao	4.6	12.8	17.4	Bronze

— Honorable Mentions —

Last Name	First Name	Country/Region	Exp.	Theory	Total	Medal
VIRŠILAS	Jokūbas	Lithuania	8.1	9.2	17.3	HM
GIL-GARCÍA	Javier	Mexico	4.8	12.5	17.3	HM
RAMADHAN	Ahmad Nafi	Indonesia	3.1	14.1	17.2	HM
PALMGREN	Alvin	Sweden	7.8	9.4	17.2	HM
MILLINGTON	Vincent	Canada	7.4	9.7	17.1	HM
AMARFII	Ștefan	Moldova	4.2	12.9	17.1	HM
KHAIRO ALSENDI	Rose Abdulqadir I	Saudi Arabia	3.5	13.6	17.1	HM
MURPHY	Alastair	Australia	5.6	11.4	17	HM
PROVAZNÍK	Pavel	Czech	5.4	11.6	17	HM
SALIMOV	Husanjon	Tajikistan	4.7	12.3	17	HM
FIALA	Mikuláš	Czech	5.8	11.1	16.9	HM
NAJA	Muh. Zaidan	Indonesia	6.3	10.6	16.9	HM
DORADEA MELÉNDEZ	Miguel Isaias	El Salvador	4	12.9	16.9	HM
MRUG	Eduard	Slovakia	4.9	11.9	16.8	HM
HE	Susan	Australia	5.5	11.2	16.7	HM
GERALDES	João	Portugal	4	12.5	16.5	HM
VIRTANEN	Oskari	Finland	5.2	11.2	16.4	HM
VAN HERBRUGGEN	Cas	Belgium	5.5	10.8	16.3	HM
ALAM	KM Meshkat Bin	Bangladesh	2.7	13.6	16.3	HM
LUVSAN	Dulguun	Mongolia	6.7	9.6	16.3	HM
SABIT	Ahmed Saad	Bangladesh	4.9	11.3	16.2	HM
RISTOLAINEN	Eero	Finland	6.5	9.6	16.1	HM
MUSUMECI	Matteo	Italy	3.1	13	16.1	HM
MILANOV	Vladimir	Bulgaria	4	11.8	15.8	HM
ZIGO	Matej	Slovakia	7.9	7.9	15.8	HM
MAYYA	Anas	Syria	3.4	12.4	15.8	HM
GRAUR	Darius	Moldova	3.1	12.4	15.5	HM

DE HAAS	Stan	Netherlands	6.4	9	15.4	HM
ISMAYILOV	Murad	Azerbaijan	2.9	12.4	15.3	HM
OSTOJIĆ	Miodrag	Bosnia and Herzegovina	3.1	12.1	15.2	HM
RASMUSSEN	Benjamin Olander	Denmark	6.8	8.4	15.2	HM
PINTO	Ivan	Portugal	5.3	9.9	15.2	HM
GUIMARÃES MELLO	Matheus	Luxembourg	6.4	8.5	14.9	HM
GELEV	Matej	Macedonia	4.2	10.7	14.9	HM
GAGNIDZE	Bidzina	Georgia	3.4	11.4	14.8	HM
PONTECORVO	Bruno	Switzerland	5.1	9.3	14.4	HM
WITSCHEL	Ludvig Steen	Denmark	4.4	9.8	14.2	HM
ZADOROŽNAJA	Olita Anastasija	Latvia	5.5	8.7	14.2	HM
EMIRZAS	Sotirios	Greece	5.7	8.4	14.1	HM
KOMOČAR	Lorena	Croatia	4.4	9.7	14.1	HM
AIROUD	Mahmoud	Syria	1.3	12.8	14.1	HM
KUBRICKÝ	Tomáš	Slovakia	4.5	9.5	14	HM
EMILIJA	Nikolovska	Macedonia	4.8	9.1	13.9	HM
ALTAMASH	Huzaifa	Pakistan	3.8	10.1	13.9	HM
JACOB	Benjamin	Philippines	3.1	10.8	13.9	HM
KRISTMANNSSON	Jakob Lars	Iceland	5.3	8.5	13.8	HM
OZOLIŅŠ	Toms	Latvia	6.3	7.5	13.8	HM
LEI	Chi Kun	Macao	6.4	7.4	13.8	HM
SHAH	Aayan	Nepal	5.9	7.9	13.8	HM
TURDUKEEV	Atai	Kyrgyzstan	4.7	9	13.7	HM
ASMATULLAH	Muhammad Bilal	Pakistan	2.2	11.5	13.7	HM
VALAMAT-ZADE	Matin	Tajikistan	4.1	9.4	13.5	HM
VASQUEZ GARCIA	Juan Esteban	Colombia	5.2	8.2	13.4	HM
GHULOMZODA	Huseini	Tajikistan	2	11.4	13.4	HM

5.3.2 Special Prizes

Absolute Winner
YU, Bowen (China)
Best Performance in Experimental Examination
FAN, Collin (United States)
Best Performance in Theoretical Examination
YEVTUSHENKO, Feodor (United States)
ZHAO, Hanhong (China)

5.3.3 Diversity commendation

A statement “Each country is encouraged to promote gender diversity within its team.” has been added to the Regulations to the Statutes of IPhO. To promote this action, the IPhO2023 organizer has awarded “Diversity Commendation” to the following four teams which represented well balanced gender mixture and exhibited good team performance in the contest.

Cyprus France Iceland Ukraine

IPhO
INTERNATIONAL PHYSICS OLYMPIAD
2023 TOKYO JAPAN

Diversity Commendation

This is to express our praise to the

Ukraine Team in IPhO2023

which embodied significant gender diversity and showed respectable performance in the contest of the 53rd International Physics Olympiad held July 10 to 17, 2023, in Tokyo, Japan.

KOBAYASHI Makoto
Chair
The Organizing Committee of IPhO2023

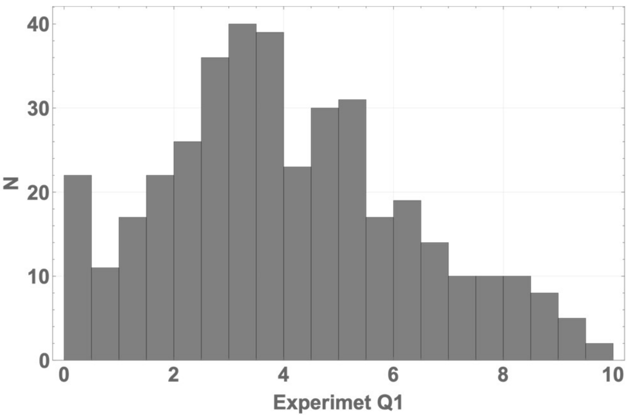
IYE Yasuhiro
Chair
The Executive Committee
and
Secretary General
The Organizing Committee of IPhO2023

5.3.4 Statistics of the contest results (score distribution)

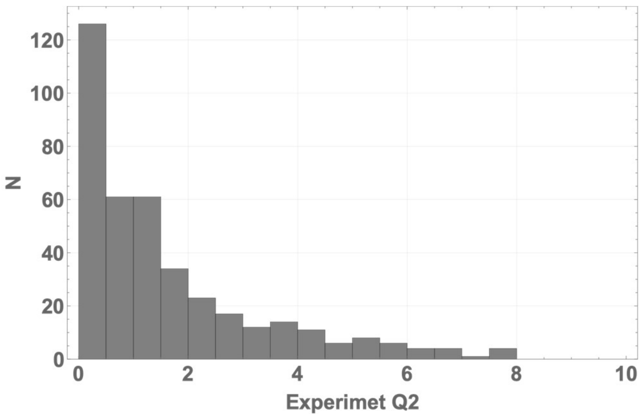
[Experimental exam (full mark = 10 X 2 = 20)]

Distributions of scores for Questions 1 and 2 of the experimental exam.

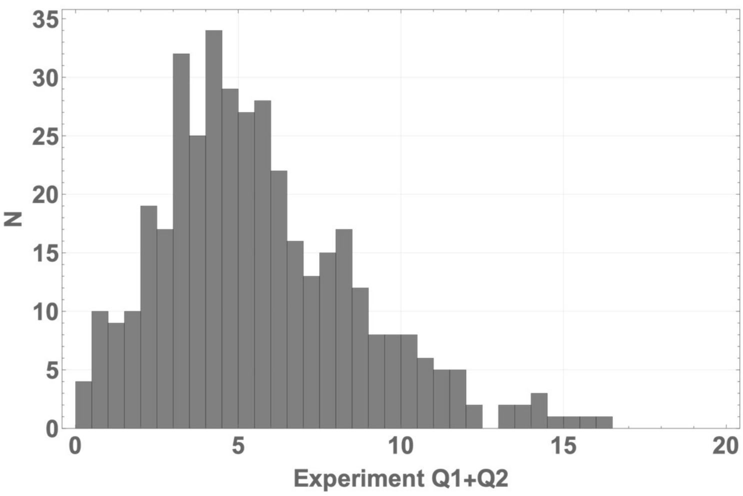
Experiment Q1



Experiment Q2



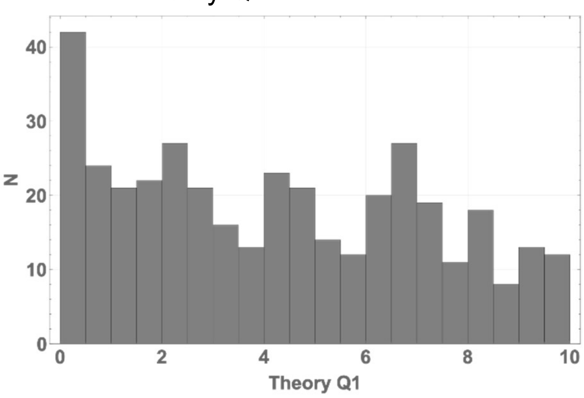
Distribution of the total score (Q1+Q2) of the experimental exam.



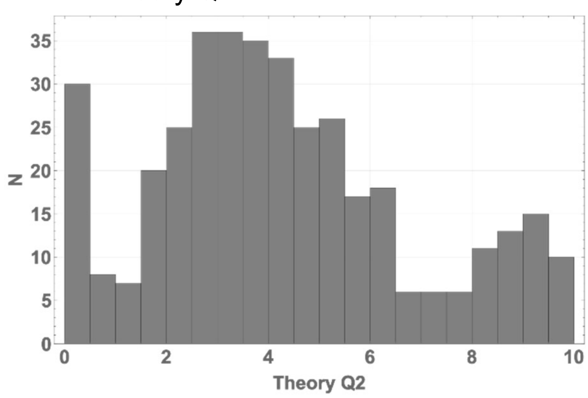
[Theoretical exam (full mark = 10 X 3 = 30)]

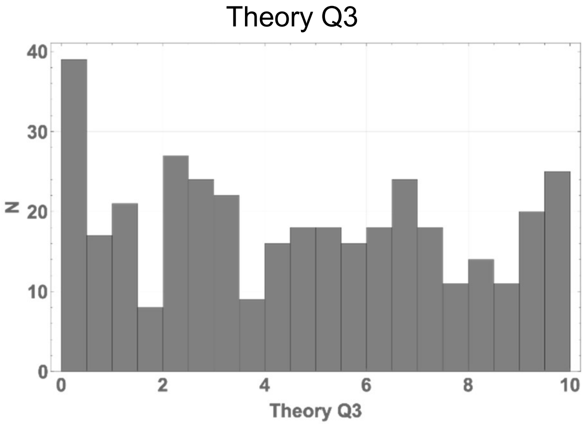
Distributions of scores for Questions 1, 2 and 3 of the theoretical exam.

Theory Q1

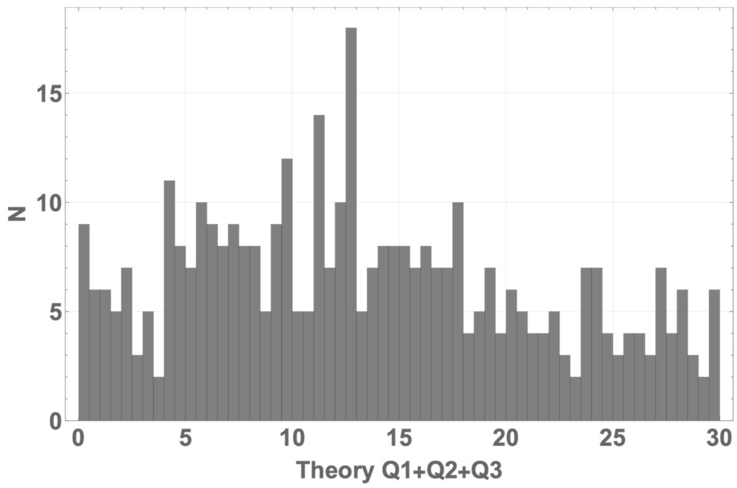


Theory Q2



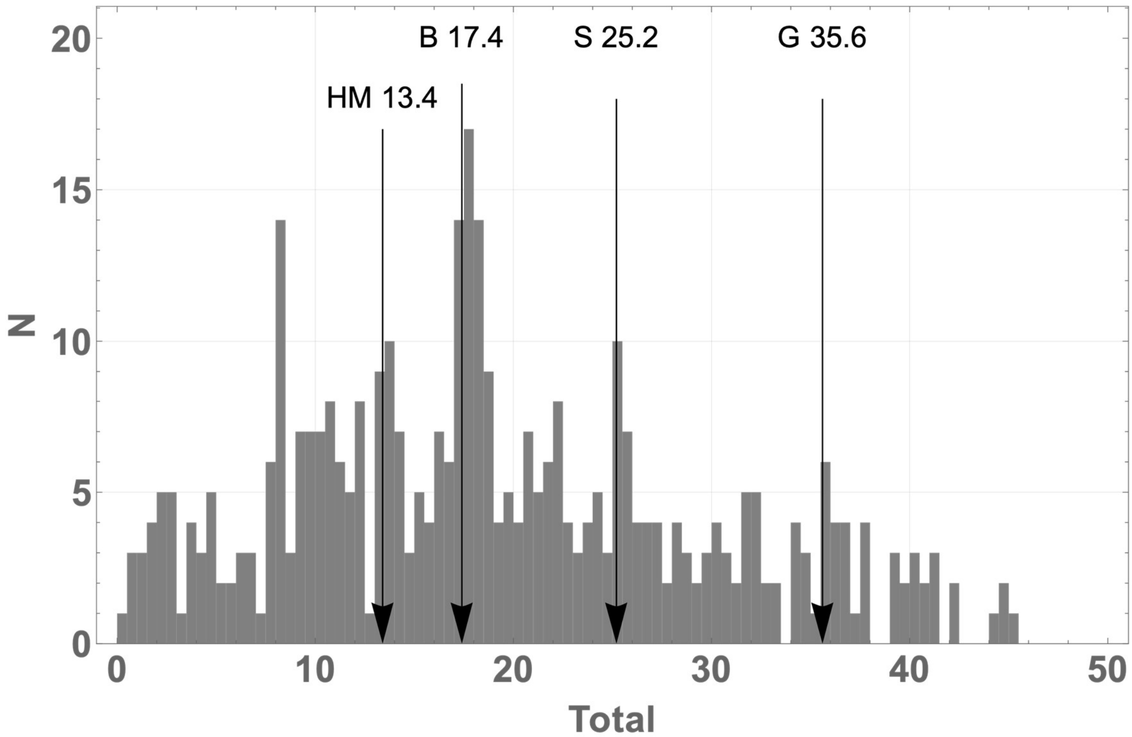


Distribution of the total score (Q1+Q2+Q3) of the theoretical exam.



[Total Score (full mark = 50)]

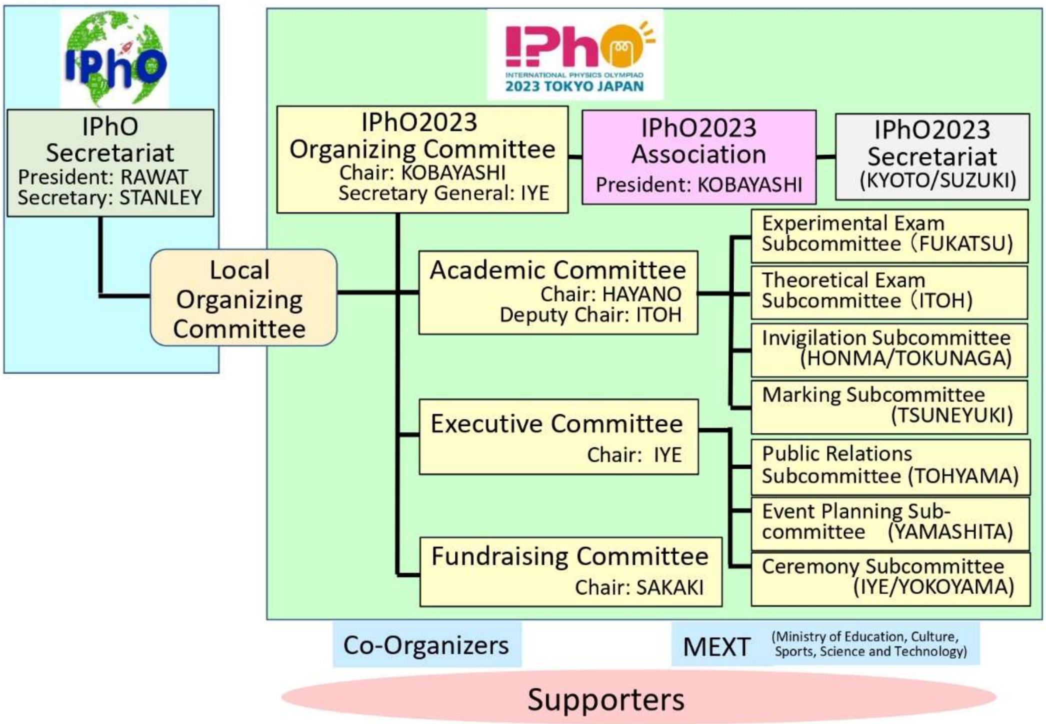
Distribution of the total (experimental and theoretical exams) score and medal thresholds.



6. Organization and Logistics of IPhO2023

6.1 Organization of IPhO2023

6.1.1 Organization chart



Article of Incorporation of the IPhO2023 Association*

The objectives of the IPhO2023 Association are (1)to promote awareness of physics and physics education and (2)to contribute to physics education reform in elementary/ secondary education stage and to human resource development in physics area, through hosting of the International Physics Olympiad 2023 in Japan (IPhO2023)

In order to accomplish the above objectives, the IPhO2023 Association undertakes following activities.

(1) Planning and implementation of IPhO2023

(2) Communication and collaboration with the IPhO Secretariat as well as relevant domestic organizations

(3) Preparation for IPhO2023, including exam creation, venue setup, and public relations

(4) Fund-raising for IPhO2023

(5) Other necessary activities for smooth implementation of IPhO2023

*English translation of the Articles of Incorporation (the original in Japanese)

The IPhO2023 Association was established in 2018 in accordance with the “Act on General Incorporated Associations and General Incorporated Foundations” issued by the Japanese government.

Address: Secretariat of the IPhO2023 Association
c/o Tokyo University of Science, 1-3 Kagurazaka, Shinjuku-ku, Tokyo 162-8601, Japan

6.1.2 IPhO2023 Local organizing committee

KOBAYASHI Makoto

Chair, Organizing Committee
President,
IPhO2023 Association

AMANO Hiroshi

Vice Chair,
Organizing Committee

KAJITA Takaaki

Vice Chair,
Organizing Committee

IYE Yasuhiro
Secretary-General,
Organizing Committee
Chair, Executive Committee
Board Member,
IPhO2023 Association

HAYANO Ryugo
Chair, Academic Committee
Member,
Organizing Committee
Board Member,
IPhO2023 Association

SAKAKI Hiroyuki
Chair, Fundraising Committee
Member,
Organizing Committee
Board Member,
IPhO2023 Association

RAWAT Rajdeep Singh

President,
IPhO Secretariat

STANLEY Paul

Secretary,
IPhO Secretariat

6.1.3 Organizing committee and board members

KOBAYASHI Makoto

Chair, Organizing Committee
President,
IPhO2023 Association

AMANO Hiroshi

Vice Chair,
Organizing Committee

KAJITA Takaaki

Vice Chair,
Organizing Committee

IYE Yasuhiro
Secretary-General,
Organizing Committee
Chair, Executive Committee
Board Member,
IPhO2023 Association

HAYANO Ryugo
Chair, Academic Committee
Member,
Organizing Committee
Board Member,
IPhO2023 Association

SAKAKI Hiroyuki
Chair, Fundraising Committee
Member,
Organizing Committee
Board Member,
IPhO2023 Association

DEGUCHI Yukichi

Member,
Organizing Committee

FUJII Teruo

Member,
Organizing Committee

FUJIWARA Makoto

Member,
Organizing Committee

FURUKAWA Kazu

Member,
Organizing Committee

GONOKAMI Makoto

Member,
Organizing Committee

HASEGAWA Mariko

Member,
Organizing Committee

HAYASHI Kayoko

Member,
Organizing Committee

HIRAMOTO Toshiro

Member,
Organizing Committee

HOMMA Yoshikazu

Member,
Organizing Committee
Board Member,
IPhO2023 Association

ISHIKAWA Masatoshi

Member,
Organizing Committee

ITOH Kimitaka

Member,
Organizing Committee

IWAKIRI Shoichiro

Member,
Organizing Committee

KITAHARA Kazuo

Member,
Organizing Committee

KYOTO Michihisa

Board Member,
IPhO2023 Association

MATSUMOTO Yoichiro

Member,
Organizing Committee

MIKI Chitoshi

Member,
Organizing Committee

MIYAJIMA Kazuo

Member,
Organizing Committee

NAKAMOTO Akira

Member,
Organizing Committee

NAKAMURA Michiharu

Member,
Organizing Committee

NITTA Hideo

Member,
Organizing Committee

NOJI Hiroyuki

Member,
Organizing Committee

SHINODA Kenichi

Member,
Organizing Committee

TAJIMA Setsuko

Member,
Organizing Committee

TERUMICHI Yoshiaki

Member,
Organizing Committee

TOHYAMA Takami

Member,
Organizing Committee
Board Member,
IPhO2023 Association

TOKUNAGA Eiji

Member,
Organizing Committee
Board Member,
IPhO2023 Association

YOKOYAMA Hiromi

Member,
Organizing Committee
Board Member,
IPhO2023 Association

YUKI Akio

Member,
Organizing Committee

ARIYAMA Masataka

Auditor,
IPhO2023 Association

TANIMOTO Shigeru

Auditor and Former Director,
IPhO2023 Association

6.1.4 Academic Committee

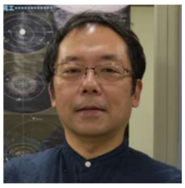
HAYANO Ryugo
Chair, Academic Committee of IPhO2023
Professor Emeritus, The University of Tokyo

ITOH Kimitaka
Vice Chair, Academic Committee of IPhO2023
Head, Theoretical Exam Subcommittee
Advisor to the Chancellor, Chubu University

ARAFUNE Jiro
Member, Theoretical Exam Subcommittee
Professor Emeritus, The University of Tokyo

FUKUSHIMA Kenji
Member, Theoretical Exam Subcommittee
Professor, Department of Physics, Graduate School of Science, The University of Tokyo

KATO Takeo
Member, Theoretical Exam Subcommittee
Associate Professor, The Institute for Solid State Physics,
The University of Tokyo



KISHINE Junichiro
Member, Theoretical Exam Subcommittee
Professor, The Open University of Japan

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Professor, College of Science and Engineering,
Department of Physical Sciences, Ritsumeikan University

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YASUDA Masami
Member, Theoretical Exam Subcommittee
Group Leader, Time Standards Group,
National Institute of Advanced Industrial Science and Technology

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National Metrology Institute of Japan,
National Institute of Advanced Industrial Science and Technology

SAKEMI Yasuhiro
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Member, Experimental Exam Subcommittee
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Chuo University

HOMMA Yoshikazu
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Director, Organization for Innovation and Social Collaboration,
Tokyo University of Science

TSUNEYUKI Shinji
Head, Marking Subcommittee
Professor, Department of Physics,
Graduate School of Science, The University of Tokyo

6.1.5 Executive committee

IYE Yasuhiro
Chair, Executive Committee of IPhO2023
Head, Ceremony Subcommittee
Chancellor, Chubu University
Professor Emeritus, The University of Tokyo

TOHYAMA Takami
Member,
Organizing Committee
Board Member,
IPhO2023 Association

YAMASHITA Minoru
Head, Event Planning Subcommittee
Associate Professor, Institute for Solid State Physics,
The University of Tokyo

YOKOYAMA Hiromi

Member,
Organizing Committee
Board Member,
IPhO2023 Association

6.1.6 Event planning subcommittee (Excursion/cultural event team)

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Event Planning Subcommitee
Excursion/Cultural Event Team

HAN Ruisi

Student staff leader,
Excursion/Cultural Event Team

KATABE Ai

Student staff leader,
Excursion/Cultural Event Team

OGURA Chiyori

Student staff leader,
Excursion/Cultural Event Team

OOKA Aki

Student staff leader,
Excursion/Cultural Event Team
and Newsletter Team

KUSUNO Sakura

Student staff leader,
Excursion/Cultural Event Team

SHINODA Erika

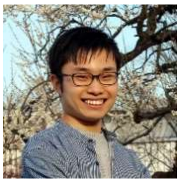
Student staff leader,
Excursion/Cultural Event Team
and Newsletter Team

TSUKIJI Natsumi

Student staff leader,
Excursion/Cultural Event Team

YAMADA Rino

Student staff leader,
Excursion/Cultural Event Team



YATSU Rikuo

Student staff leader,
Excursion/Cultural Event Team

BLOCK Ashley Miyuki

Student staff,
Excursion/Cultural Event Team

6.1.7 Public relations subcommittee (Newsletter team)

TOHYAMA Takami

Head,
Public Relations Subcommittee
Newsletter Team

ONO Yoshimasa A.

Member
Newsletter Team

ANDO Karin

Student staff,
Newsletter Team

JOKA Natsumi

Student staff,
Newsletter Team

KIMPARA Michiru

Student staff,
Newsletter Team

SASAKI Yasutaka

Student staff,
Newsletter Team

6.1.8 Official Photographers

SHIMIZU Takeshi

Photographer

OONO Aiko

Photographer

6.2 Co-Organizers and Supporters

IPhO2023 was organized under the auspices of the Ministry of Education, Culture, Sports, Science and Technology (MEXT) Japan.

Ministry of Education, Culture, Sports, Science and Technology (MEXT)

IPhO2023 was supported by the following co-organizers and special supporters, together with many other individuals and organizations:

6.2.1 Co-organizers

The Physical Society of Japan

Japan Society of Applied Physics

The Physics Education Society of Japan

The Biophysical Society of Japan

Japan Science and Technology Agency (JST)

National Institution for Youth Education (NIYE)

National Museum of Nature and Science

Japan Arts Council

Tokyo National Museum

The University of Tokyo

Tokyo University of Science

Tokyo City University

Tokyo University of Foreign Studies

International Christian University

Sophia University

6.2.2 Special supporters

Special supporters are companies and foundations that offered generous support to IPhO2023.

Some of the special supporters preferred to be anonymous. Although their names or logos are not shown here, they are included in the number of supporters.

Diamond Supporters

Benesse Holdings, Inc.	CASIO COMPUTER CO. LTD.	Daikin Industries, Ltd.
Fujikin Co., Ltd.	NICHIA CORPORATION	Tokyo Electron Limited
Toray Industries, Inc.		

Sapphire Supporters

BUFFALO INC.	Hamamatsu Photonics K.K.	HIROSE ELECTRIC CO., LTD
HORIBA, Ltd.	Honda Motor Co., Ltd.	Masason Foundation
Murata Manufacturing Co., Ltd.	NGK INSULATORS, LTD.	Nikon Corporation

Rigaku Corporation.

RIKEN KEIKI Co., Ltd.

SCREEN Semiconductor Solutions Co., Ltd.

Shimadzu Corporation

TOPPAN INC.

Toyota Motor Corporation

Toyota Physical and Chemical Research Institute

ULVAC, Inc.

The University of Tokyo Edge Capital Partners Co., Ltd.

Ruby Supporters

AGC Inc.

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Mitsubishi Electric Corporation

MUFG Bank, Ltd.

Sankei Giken Kogyo Co., Ltd.

Takagi Co., Ltd.

Toshiba Corporation

Western Digital Corporation

YASKAWA Electric Corporation

6.2.3 Supporters and donors

Special Supporters*		
	Diamond Supporter Companies	8
	Sapphire Supporter Companies	18
	Ruby Supporter Companies	22
Supporters		
	Supporting Members (companies and groups)	13
	Supporting Members (individuals)	18
	Donors (companies and groups)	63
	Donors (individuals)	112

*Because some of the special supporters preferred to be anonymous, these numbers do not necessarily coincide with the numbers of company logos shown above.

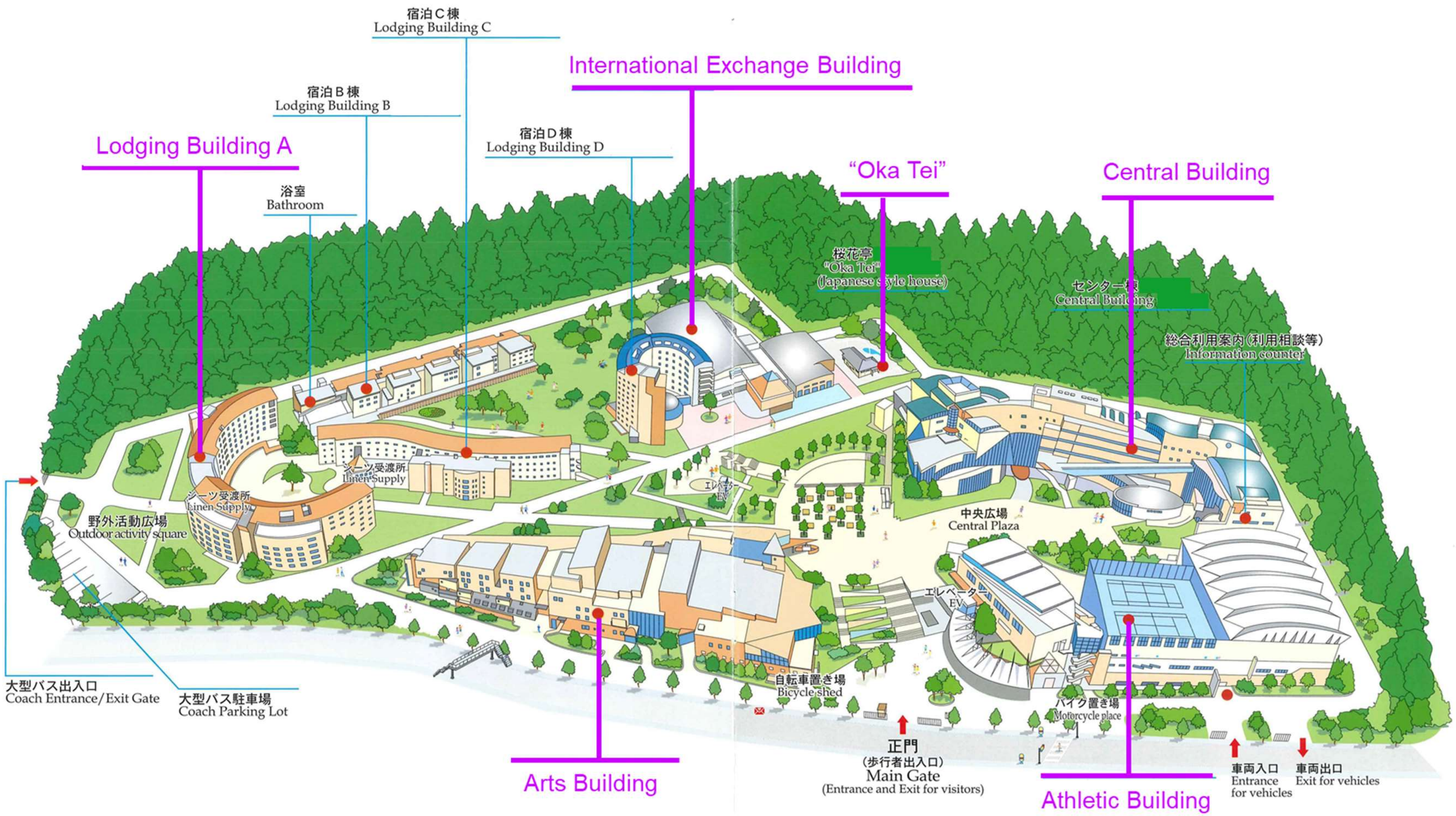
6.3 Logistics of IPhO2023

6.3.1 Venue of IPhO2023

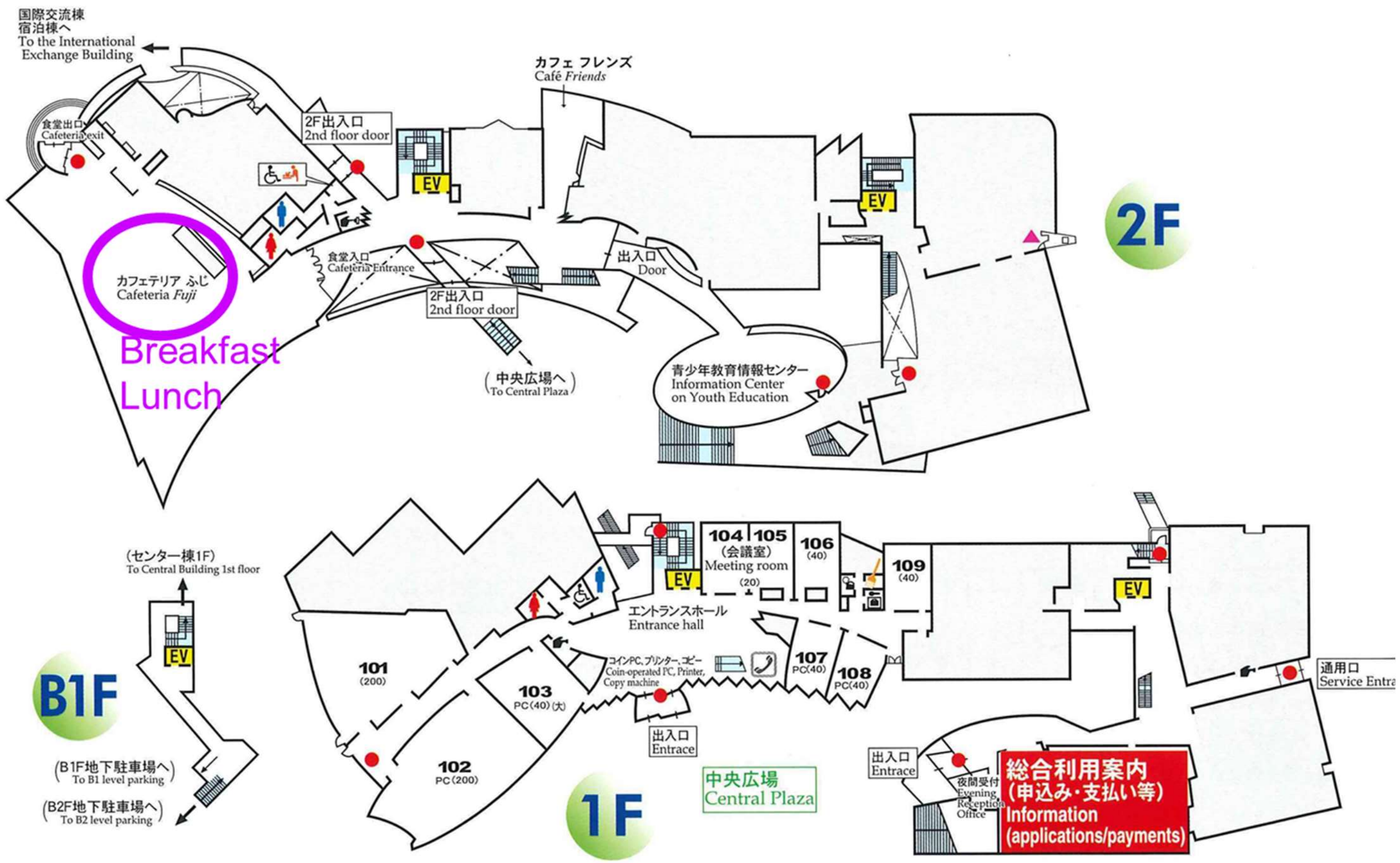
The National Olympics Memorial Youth Center (NYC)

The National Olympics Memorial Youth Center (NYC)

View of NYC



宿泊C棟
Lodging Building C
International Exchange Building
宿泊B棟
Lodging Building B
宿泊D棟
Lodging Building D
Lodging Building A
浴室
Bathroom
"Oka Tei"
Central Building
桜花亭
"Oka Tei"
(Japanese style house)
センター棟
Central Building
総合利用案内（利用相談等）
Information counter
シーツ受渡所
Linen Supply
シーツ受渡所
Linen Supply
野外活動広場
Outdoor activity square
中央広場
Central Plaza
エレベーター
EV
自転車置き場
Bicycle shed
バイク置き場
Motorcycle place
大型バス出入口
Coach Entrance/Exit Gate
大型バス駐車場
Coach Parking Lot
Arts Building
正門
（歩行者出入口）
Main Gate
(Entrance and Exit for visitors)
Athletic Building
車両入口
Entrance for vehicles
車両出口
Exit for vehicles



各平面図の共通記号一覧　List of common signs for each floor plan

● 印は非常口 Indicates emergency exit.

▲ 印は避難器具 Indicates evacuation equipment.

EV エレベーター Elevator

PCは持ち込みパソコンの利用が可能 Electric outlets for PC's brought in

ロッカー Locker

給湯室 Facilities for hot water

喫煙コーナー Smoking area

談話コーナー Lounge

自販機コーナー Vending machine corner

おむつ交換所 Diaper changing section

男・女トイレ Lavatory

多目的トイレ Multipurpose Lavatory

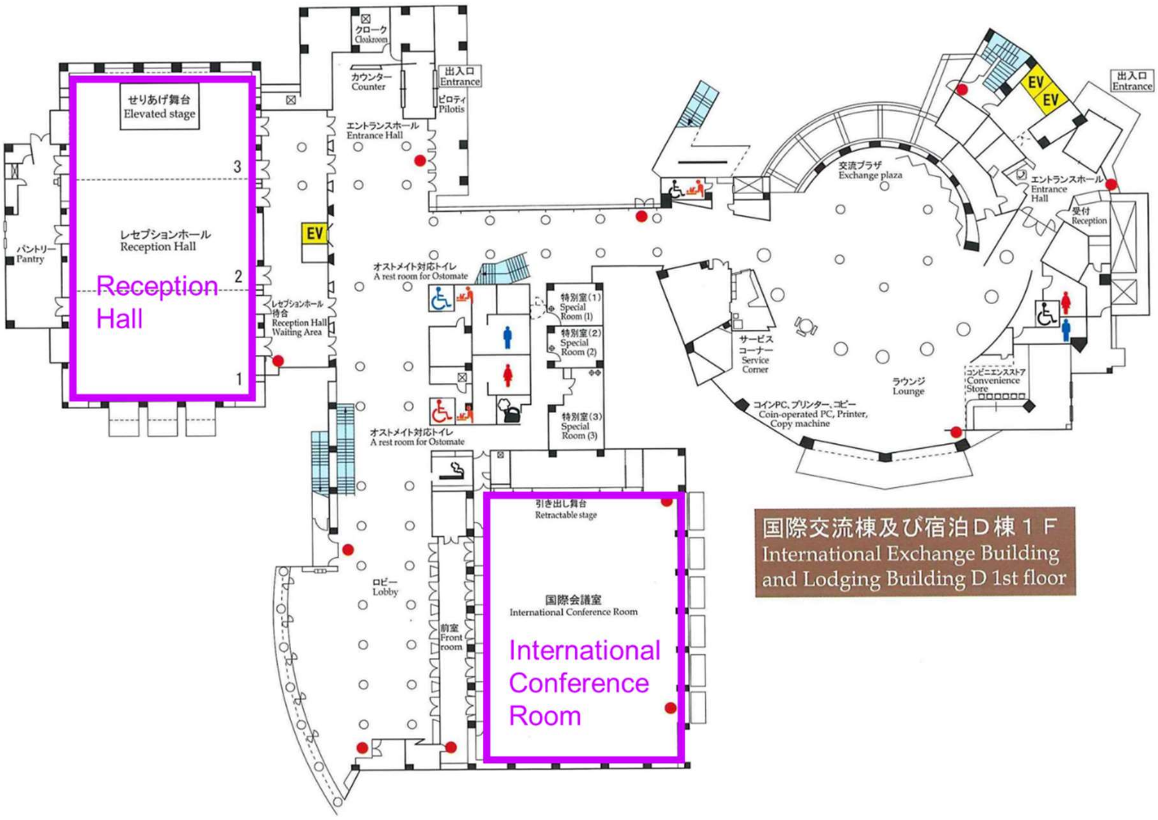
シャワー Shower

更衣室 Changing Room

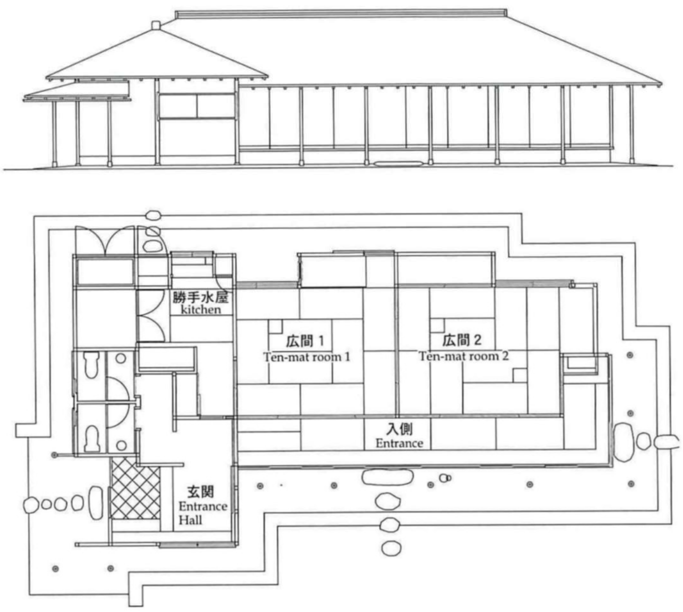
清掃用具庫 Cleaning equipment storage

公衆電話 Publice teiephone

給水機 Water dosing machine

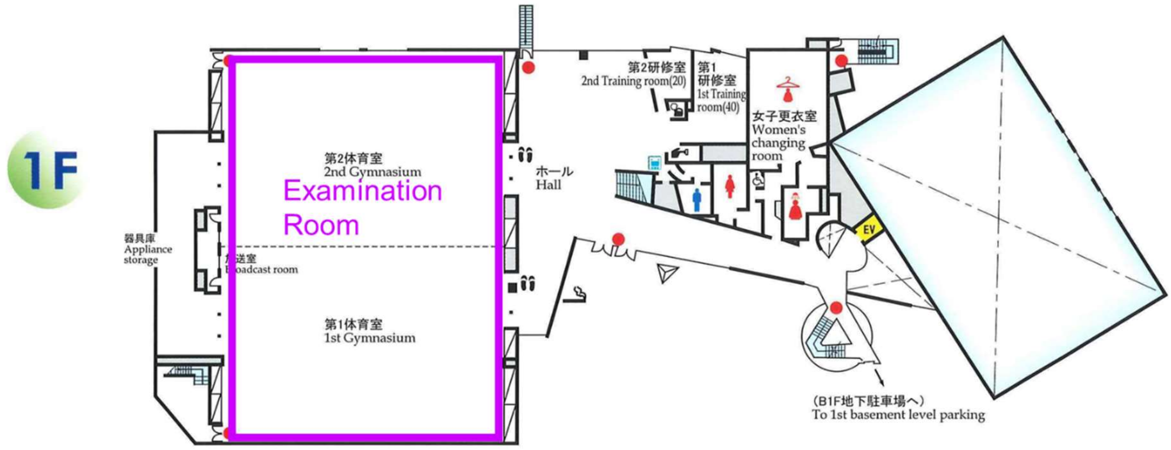


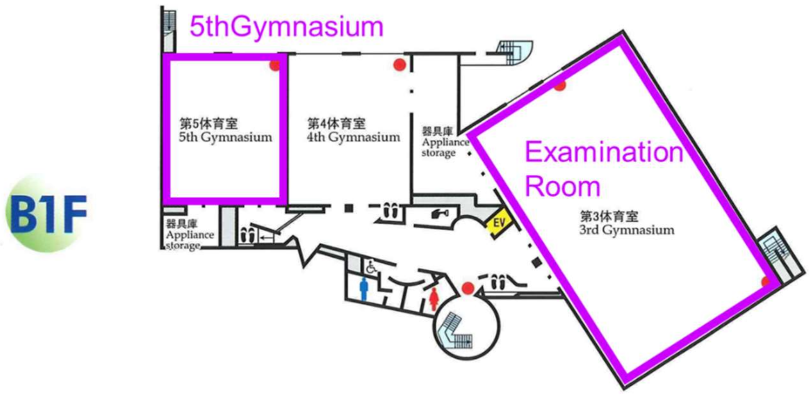
国際交流棟及び宿泊Ｄ棟１Ｆ
International Exchange Building and Lodging Building D 1st floor



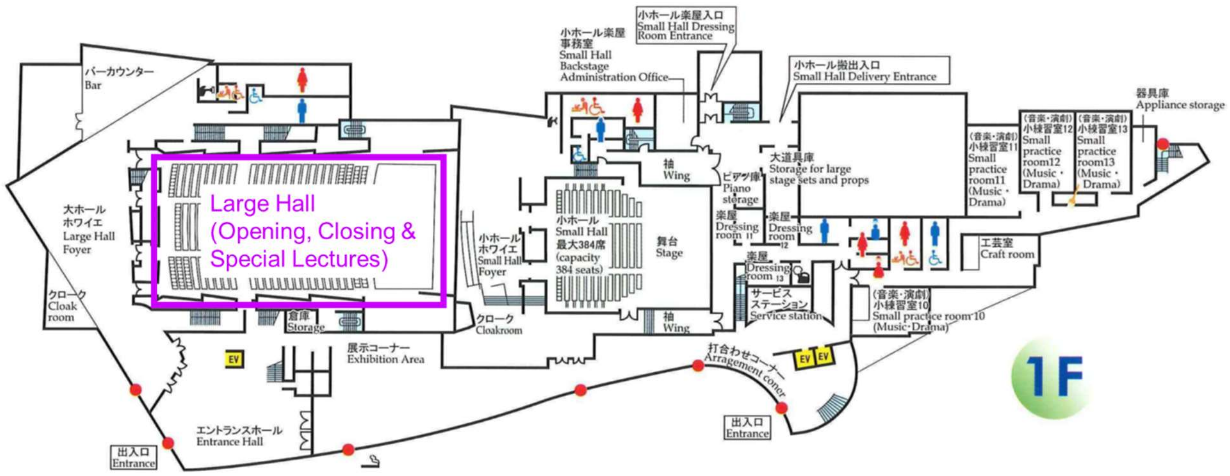
桜花亭
Oka Tei (Japanese-style house)

Athletic Building

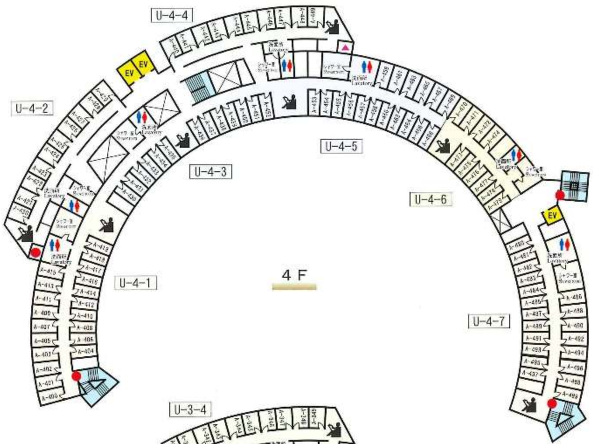


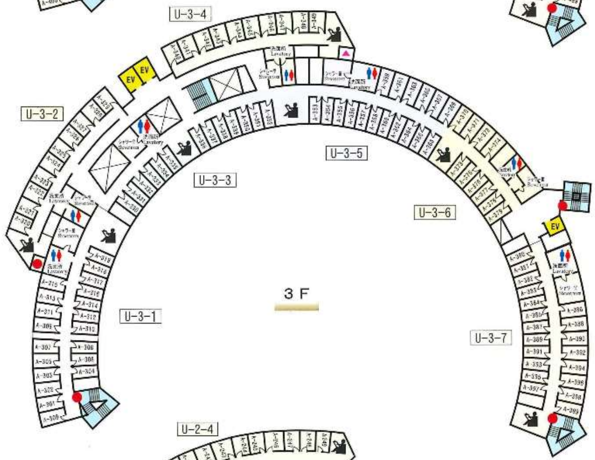


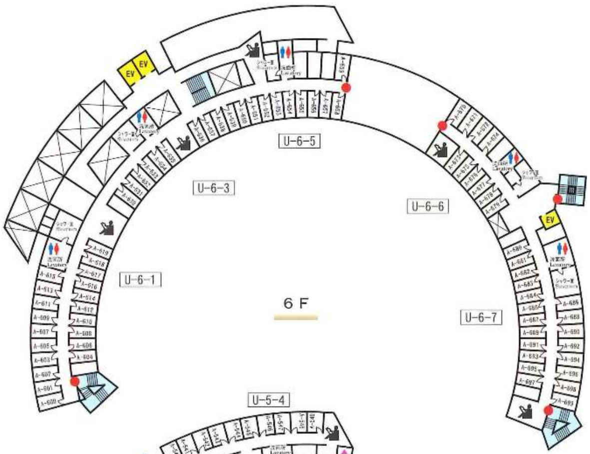
Arts Building

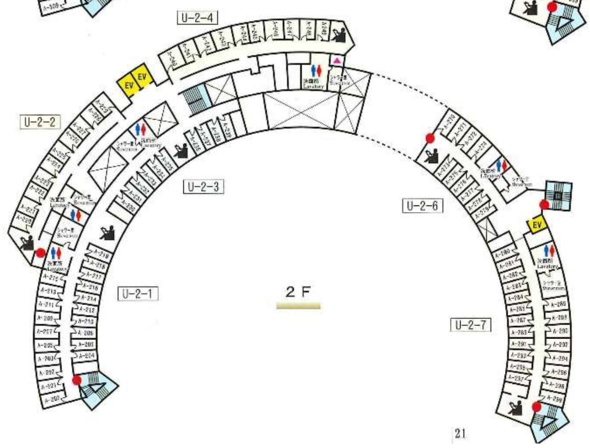


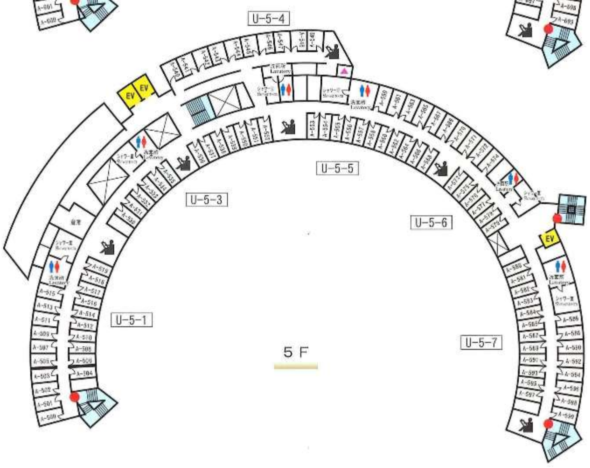
Building A - Accommodation –











6.3.2 Social activities – Excursions

<u>Half-day Tokyo Excursion</u>: A-1, A-2, and A-3

A-1: Yokohama


Yokohama Chinatown


Cosmo World

Highlights

Yokohama is a famous harbor city with an international seaport that was opened in the Edo period. Yokohama has been vigorously acquiring new cultures and information from foreign countries and introducing first-time-ever things to Japan from foods to a wide range of cultures, which entitles Yokohama as the birthplace of Japan’s modern culture. This Yokohama course offers a tour of the history, culture, tourist places, and local activities of the Yokohama area.

What can you do?

Schedule: NYC (National Olympic Memorial Youth Center) →(bus)→ Yokohama (free time) →(bus)→NYC
You can visit a variety of popular sightseeing spots in Yokohama.
Here is the example below ↓

- Yokohama Chinatown
    - You can grab delicious Chinese foods!
- Cosmo World
    - Compact but varied amusement park famous for the Ferris wheel!
- Yokohama Landmark Tower
    - Sushi, Studio Ghibli, Weekly Shonen Jump…everything is there!
- Harbor View Park
    - You can enjoy the perfect ocean view!
- Yokohama Red Brick Warehouse
    - You can enjoy shopping at a historical warehouse!
- Cup noodle Museum
    - Let’s make your original cup noodle!

A-2: Asakusa & Ueno

Senso-ji

National Museum of Nature and Science

Tokyo National Museum

Highlights

Asakusa is the central “shitamachi” (downtown) in Tokyo. Asakusa is a town known for traditional performing arts such as Kabuki. There still retains the old downtown atmosphere in Nakamise, one of the most famous streets in Japan. The second town you will visit is Ueno, famous for its many cultural facilities. Since Ueno Park opened as the first national park in Japan in 1876, Ueno has developed into a cultural city with many museums. In this course, you will explore the Japanese history!

What can you do?

Schedule: NYC → Asakusa (free time including lunch) → Ueno (one museum) → NYC

*For the Ueno area, you will choose either the National Museum of Nature and Science or the Tokyo National Museum to visit. Below are some spots in this course.

- Nakamise (old shopping street famous since the Edo period (1603-1867), 89 shops, 250-m long)
    - You will have Japanese foods and souvenirs (fees for buying souvenirs are not included) while walking along Nakamise.
- Beautiful and famous scenery in the Asakusa area
    - You can take pictures of some famous spots: Tokyo Skytree and Kaminari-mon.
- National Museum of Nature and Science
    - You can learn about the history of the Earth and Japan with various exhibitions. (e.g. fossils of dinosaurs).
- Tokyo National Museum
    - You can see various works of art from Asia, with a focus on Japanese art.

A-3: Odaiba

JOYPOLIS

National Museum of Emerging Science and Innovation

Highlights

Odaiba is a large landfill island in Tokyo Bay, famous for being the most modern active seaside place. There are vast parks, large commerce facilities, sightseeing spots, etc. Its history goes back to the Edo period (1603-1867). When Commodore Perry visited Japan's shores in 1853, the Edo government decided to strengthen coastal defenses and started to build Odaiba. Until today, Odaiba has developed as a commercial and leisure area. In this excursion course, you will enjoy the modern city and the cutting edge of science!

What can you do?

Schedule: NYC → Odaiba (JOYPOLIS / Miraikan) → NYC

*In this course, you will choose either JOYPOLIS (A-3a) or the National Museum of Emerging Science and Innovation ("Miraikan", A-3b) to visit.

Below are the main spots in this course.

- JOYPOLIS (an indoor amusement park using the latest technology)
    - You can enjoy thrilling rides and activities.
    - You will experience exciting lights, sounds, and physical motions.
- National Museum of Emerging Science and Innovation ("Miraikan")
    - You will experience today's technological progress, including space exploration and life science.

Full-day Kanto Excursion: B-1, B-2, B-3, and B-4

B-1: Hakone

Hakone shrine

Black egg

Pirate ship ride

Highlights

Hakone is a mountainous area that has long been known as an important transportation hub since the Kamakura period (1185-1333). Hakone has been famous for hot springs since the Edo period (1603-1868), and still, many tourists visit Hakone for the sake of healing. One of the specialties in Hakone is the black egg. Sulfur from the hot springs turns the egg's color black. In this course, you can fully enjoy the nature of Hakone. We hope you can see Mt. Fuji from the ropeway!

What can you do?

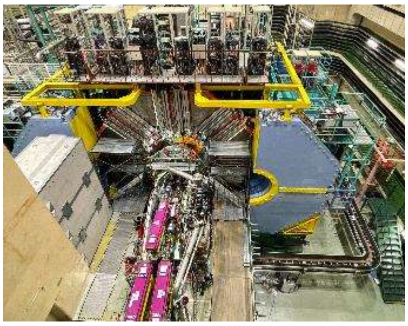
Schedule: NYC → Owakudani → Hakone En → Pirate ship ride → Hakone shrine →NYC

- Hakone Shrine
    - Famous shrine with the historical Torii gate.
- Owakudani
    - You can eat famous black-boiled eggs.
    - You may need to pay attention to the smell of sulfur wafting from the hot springs!
- Near the Ashinoko Lake

You can ride
    - Pirate ship
    - Ropeway

B-2: Tsukuba

KEK



KEK

Ropeway to Mt. Tsukuba

Highlights

Tsukuba is widely known as a “Science City” of Japan located in the suburban area to the North of Tokyo. Various institutions such as Japan Aerospace Exploration Agency (JAXA) and the Geospatial Information Authority of Japan (GSI) as well as the University of Tsukuba develop the latest academic research with people gathered from all over the world. In this Tsukuba course, you have an opportunity to experience the fundamental technologies from High Energy Accelerator Research Organization (KEK), which will be followed by relaxing in nature on the top of Mt. Tsukuba. You can get to the top by using a ropeway and cable car. From the peak, the vast view of the Kanto area can be seen.

What can you do?

Schedule: NYC → KEK → Mount Tsukuba → NYC

- ★ Two-hour lab. tour of High Energy Accelerator Research Organization (KEK)
  - Operate the largest particle physics laboratory in Japan
- ★ Lunch at KEK
- ★ Hike in Mount Tsukuba
  - Ride on a cable car and ropeway.
  - Panorama view of Tsukuba and Tokyo
  - Shrine at the bottom of the mountain

B-3: Nikko

Kegon Fall

Theater in the Edo Wonderland

Yomeimon in the Nikko Toshogu

Highlights

Nikko's history as a religious place can go back to 766. Since then, not only majestic buildings but also beautiful paintings or sculptures in temples and shrines have fascinated people for a long time. Also, Nikko has been known to be an ideal place for leisure. Between Meiji (1868-1912) and the early Showa era, many foreign embassies built their villas in Nikko. If you join this course, you can relax in nature and visit famous shrines constructed in Nikko. You can experience "live" Edo culture, too.

What can you do?

Schedule: NYC → Kegon falls → Nikko Toshogu → Nikko Edo-mura (Edo Wonderland) →NYC

- Nikko Toshogu (World Heritage)
    - You can see traditional majestic architecture.
- Kegon fall
    - You can feel nature and relax.
- Edo Wonderland
    - You can enjoy "live" Edo culture.

B-4: Kamakura

Hachimangu Shrine

Kotokuin Temple

Hokokuji Temple

Highlights

Kamakura is a coastal town in Kanagawa Prefecture, less than an hour away from the south of Tokyo by train. The town became the political center of Japan when Minamoto Yoritomo chose it as the seat for his new military government in the late 12th century. Today, Kamakura is a small city but a very popular tourist destination. Sometimes called the Kyoto of Eastern Japan, Kamakura offers numerous temples, shrines, and other historical monuments. In addition, beautiful Kamakura's sand beaches attract large crowds during the summer.

What can you do?

☆In this course, we don't prepare a fixed route. You can choose where to visit according to your preferences.

- Hachimangu Shrine (National Important Cultural Property)
    - You can enjoy the atmosphere of a historic shrine.
- Kotokuin Temple
    - You can see the Great Buddha, which is a symbol of Kamakura.
- Hokokuji Temple
    - You can enjoy a bamboo forest and matcha tea.
- Yuigahama beach
    - You can get in the sea and may take photogenic pictures.

6.3.3 Social activities -- Japanese cultural experience

July 11 - 13, 4:00 pm – 7:00 pm

✧ ***Aikidō* (Japanese Martial Art) experience (July 11th and 13th) @ 5th Gymnasium**

Aikidō（合気道）is a sport trying to control your opponents by utilizing their attacks. Through practical exercises, you will learn how to defend yourself in case of an attack. Maximum of 20 participants for a 30-minutes session. Come to Reception Hall for registration.

✧ ***Sadō* (Japanese Tea Ceremony) experience (July 11th and 13th) @ Oka Tei**

In *Sadō*（茶道）experience, you will experience a tea ceremony and its preparation along with authentic Japanese sweets and powdered green tea. Maximum of 15 participants for a 30-minute session. Come to Reception Hall for registration.

✧ ***Shodō* (Japanese style calligraphy) experience (July 11th and 13th) @ Lounge area near the International Conference Hall**

Shodō（書道） is one of the traditional arts in which one expresses oneself with letters using a brush and sumi ink. In this experience event, you will have the opportunity to use a brush correctly to write letters on Japanese paper.

✧ ***En'nichi* festival: July 12th @ Reception Hall**

En'nichi（縁日）is a traditional Japanese summer festival. In addition to playing old-style games (target shooting, etc.) and enjoying small snacks, you will experience *Bon Odori* dancing around a "*yagura*" tower.

✧ **Making your own "*watoji*" notebooks (July 11th-13th) and "*uchiwa*" fans (July 12th).**

Make your notebook using traditional Japanese paper. Making an *uchiwa* (Japanese fan) with a picture of your design will also be a good memory of IPhO2023 Tokyo.

✧ **Japanese traditional games (July 11th and 13th)**

You will enjoy traditional games such as *kendama*, *koma*-rolling, origami making, etc.

6.3.4 Social Activities --- Science and technology experience corner

July 11 - 13, 4:00 pm – 7:00 pm
at International Conference Room, International Exchange Bldg. 1F

The Science and Technology Experience Corner offers opportunities for hands-on experience with cutting-edge technologies and/or amusing games based on scientific principles. The exhibition corners are furnished by volunteering companies who also contributed to IPhO2023 as special supporters.

✧ CASIO COMPUTER CO., LTD.
Brighten your summer with curiosity!
✧ Fujikin Incorporated
Integrated Gas System Competition
✧ Masason Foundation
Experience the world created by young talents of various nationalities and specialties
✧ NGK Insulators, Ltd.
NGK SCIENCE SITE
✧ Nikon Corporation
See physical phenomena for yourself!
✧ Rigaku Corporation
Material analysis experience using portable and desktop analyzers
✧ SHIMADZU CORPORATION
Analyze the caffeine content of commercial beverages!
✧ Tokyo Electron Limited
Semiconductor Manufacturing Technology Experience Corner
✧ ULVAC, Inc.
Hands-on vacuum experiment show

6.4 IPhO2023 Handbook

CONTENTS page

6.5 IPhO2023 Newsletters

Newsletters were published everyday during the IPhO2023 period. The title “Butsuri” meaning “Physics” in Japanese were written in different typeface of Kanji (Chinese characters), Hirakata (cursive form of Japanese syllabary), and Katakana (square form of Japanese syllabary)


Thursday, July 13th 2023
Issue 5
ぶつり
- BUTSURI -
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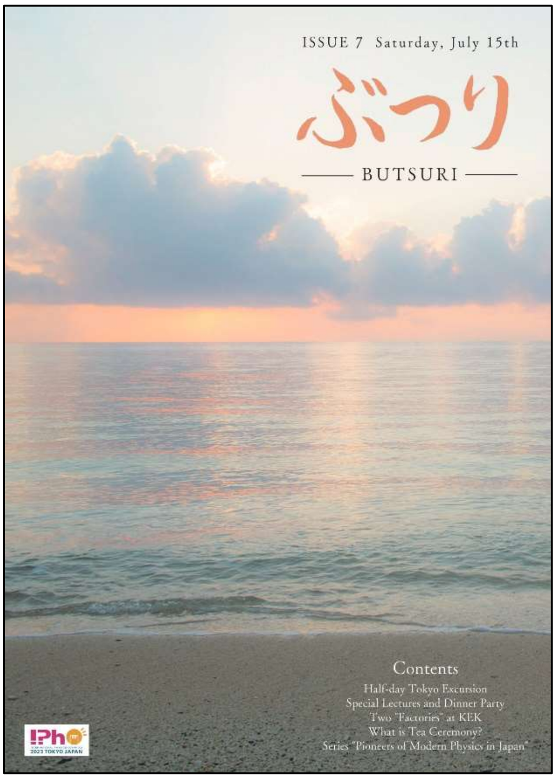
· Half-day Tokyo Excursion
· Cultural and Scientific Experience Events
· History of Tokyo
· Little Tales about Japan
· What is Game Center?
· Becoming a Leader in Promoting Diversity
IPhO
2023 TOKYO JAPAN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Series "Pioneers of Modern Physics in Japan"
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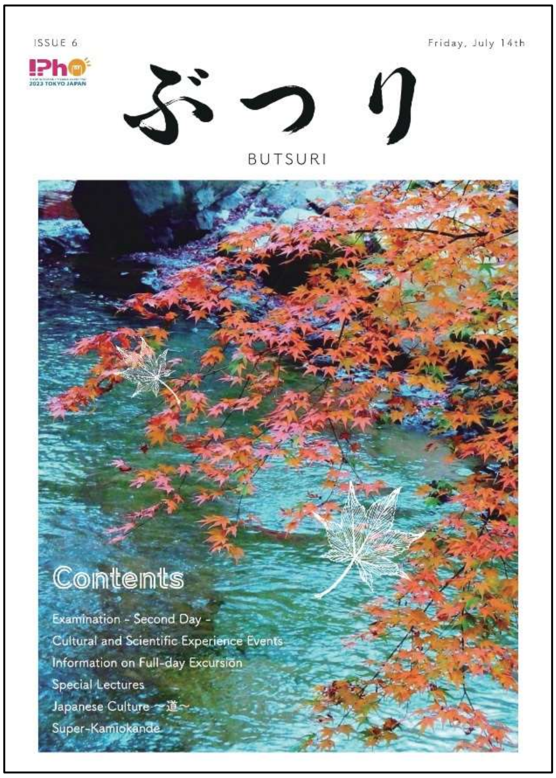
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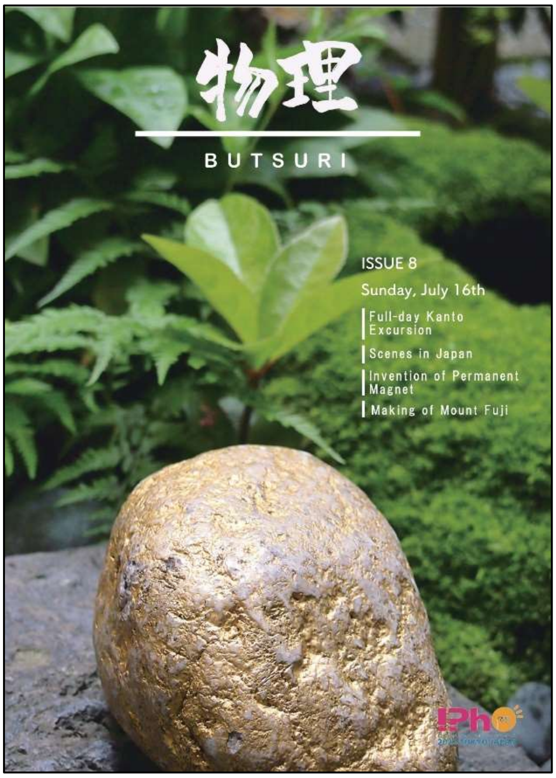
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Making of Mount Fuji
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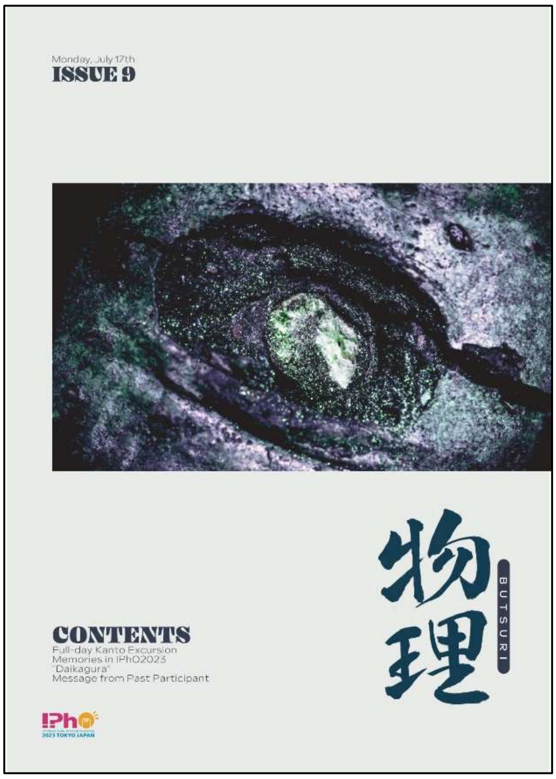
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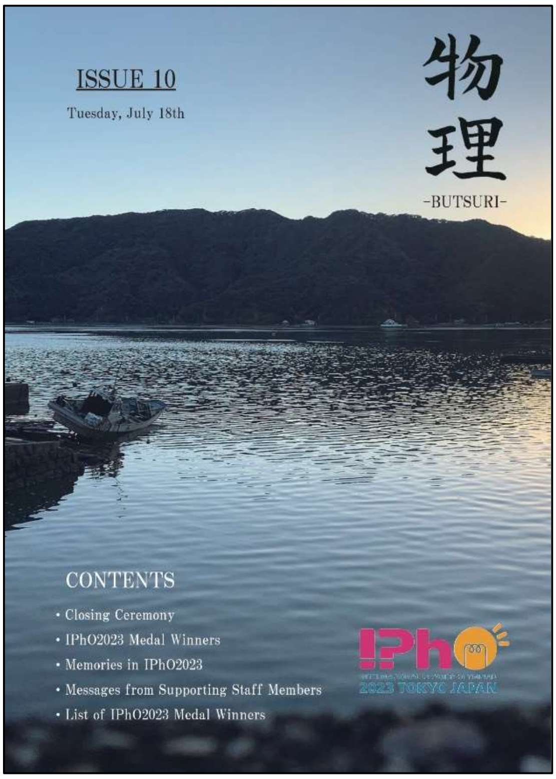
"Daikagura"
Message from Past Participant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2023 TOKYO JAPAN

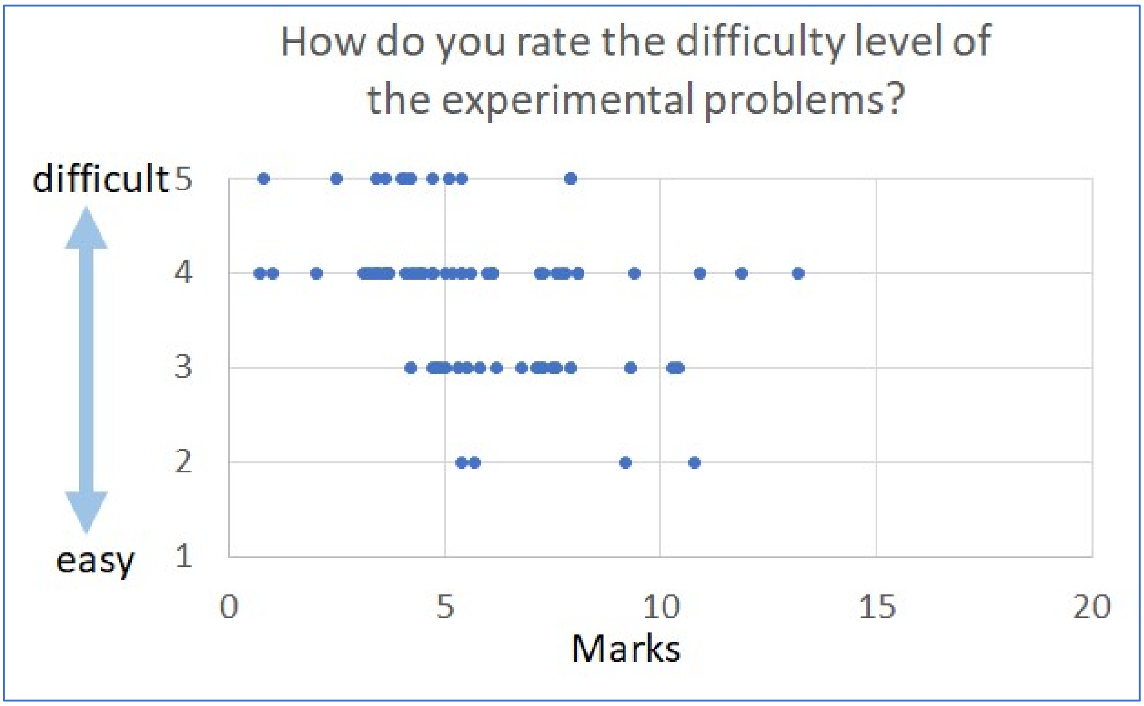
7. Feedback from Participants

We have sent questionnaire to the contestants (students), leaders and observers after the IPhO2023. About 80 contestants and 80 adult participants responded.

7.1 Feedback from Contestants on the Implementation of Examination

7.1.1 On the experimental exam

Correlation between the subjective rating of the difficulty level of the experimental exam by individual contestants and theiru actual score.



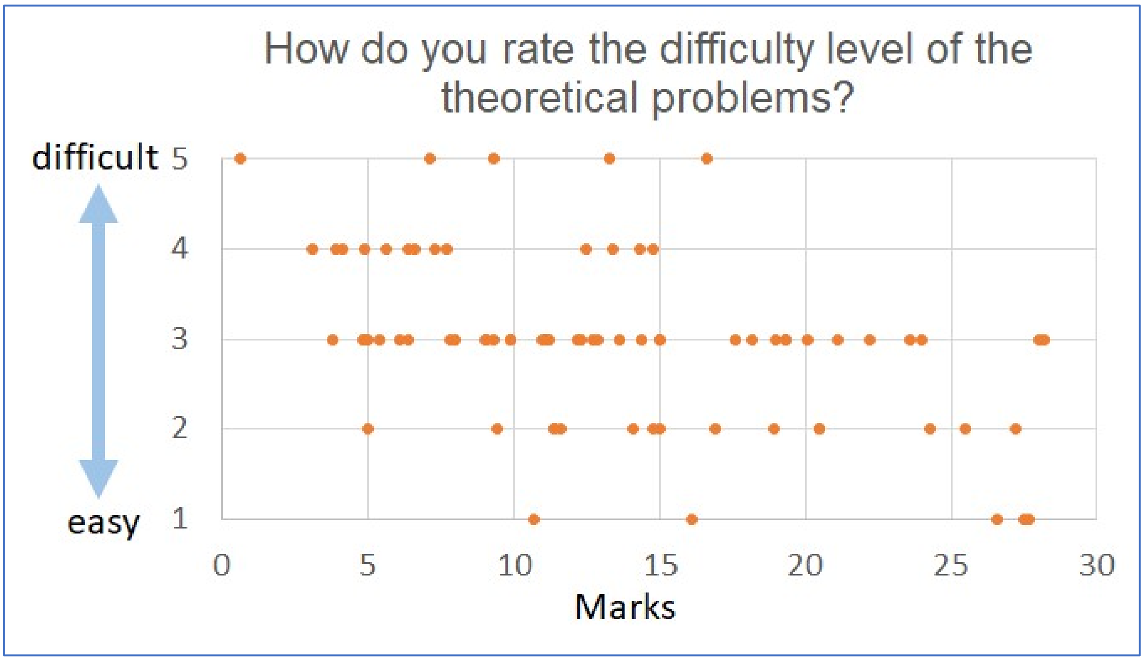
[Comments by contestants on the experimental problems]

- I found that setting up the experiments were particularly time consuming, not leaving so much time to actually complete the experiment. The experiments themselves were interesting.
- Experiment 2 was very delicate and sensitive to initial imprecisions in the setup. I did not manage to get around to E1.
- Although problems required time to assemble, I really enjoyed all of experimental test
- It was really long to set up and it wasn't really easy so we would have time to do both experiments really good
- Conceptually and theoretically the problems were of a normal IPhO difficulty. However, the setup for the experiments was difficult and time-consuming which didn't help to score as much as we have studied for the olympiad.
- I found the experimental problems very interesting. Even though the process of assembling the kit was more time-consuming than I had thought, I really enjoyed them.
- There was not enough space. Second table would be preferred for optics. Hole instead of crease in the optics aparature would be also great.
- easy technically, but big time pressure
- The second experiment required little thinking. One had to do very precise measurements which were hard to achieve with the given tools. I really did not like it.
- Too much setup
- The main difficulty I came across was managing my time during the exam. The experimental kit was incredible and very fun to setup. But it also took a very long time before being able to make our first measurements so I couldn't get to explore the questions as far as I would have hoped...
- It's very cool to assemble the kit
- It was awesome to assemble everything ourselves, and it demanded a lot of mastery and precision. The only problem is working on optics, light and diffraction without being able to be in the dark, that made things a lot more complicated than they should have been. I noted that we were very guided on what protocol to follow, maybe it would be a good thing to also test the candidates on their ability to create a smart protocol because it is also a crucial part of experimental physics.

- It was great being able to set up everything on my own, however I lacked time
- Way too much text so i missed important things. I heard there was a misunderstanding with the number of characters in the statutes
- Second one was extremely difficult.
- The time was too limited!
- Took too long to set up and it was hard because we had to be very precise
- A lot of strict steps, but no creativity
- fun experiment problems overall, question 2 is kinda hard to assemble
- It takes a lot of time to set up E2
- setups were so nice but the optic rails where not effective and setting up was difficult in second experiment. although i wish i had more time to do the experiments, for my own pleasure:)
- Long rather than difficult
- fun experiment problems overall, question 2 is kinda hard to assemble
- It takes a lot of time to set up E2
- setups were so nice but the optic rails were not effective and setting up was difficult in second experiment. although i wish i had more time to do the experiments, for my own pleasure:)
- Long rather than difficult
- FUN BUT CHALLENGING TO SETUP.
- E2 too delicate, better if sturdier.
- Preperation took way too long, the questions were quite easy, but the time required to get to the questions was too long
- The experimental problems both took quite a long time to set up, which meant that you had to be doing an experiment for quite a while before being able to get points.
- There was a lot things to do. Also experimental sets were too complex
- The first experiment was very simple to understand and gather data, however, the second experiment was very time-consuming, and sometimes hard to understand.
- Assembly of E-2 (optical problem) was especially finicky and time-consuming.
- A bit lenghty(the instructions were very clear, but it took a lot of time to assemble the experiment and make the measurements)
- The problems were really interesting, but the setup and the calibration of the equipment took too long.
- Quite simple phenomena represented in some really ingenious experiments. The experiments were really well explained.
- the experimental apparatuses were far too complicated and took too long to set up. the problems were not conceptually difficult, but they were nearly impossible to finish because of the aforementioned issue.
- Should have turned off the lights in the exam hall for Q2
- The questions themselves were not that difficult but it was difficult to do everything because of lack of time.
- Very interesting problems! But they were a little bit too difficult for me - I felt that I didn't understand anything...
- I thought they were very fun! Though it seemed that many people complained that it took a long time to get started.
- The experimental problems were really interesting, because of its difficulty level
- The experiments itself weren't that hard, but it took quite a long time to build them. In my opinion, a bit too long.
- Experimental problems were really interesting. I liked both of the questions
- Setup took too long, instructions unclear for how many data points to take for problem 2
- I still don't understand why there was values like 11.3, 11.4 mm,.. while minimum division is 1 mm. Problems were so good, it didn't take all of the time to assemble the setup. They were a bit difficult
- Very exciting and terrible
- Very solid problems. Loved the oscillations one, although I didn't have time to do the interesting parts of the birefringence one.
- I liked the problem with the oscillator very much, it was a nice and easy electronic setup but still the theory behind it was hard.

7.1.2 On the theoretical exam

Correlation between the subjective rating of the difficulty level of the thoretical exam by individual contestants and their actual score.

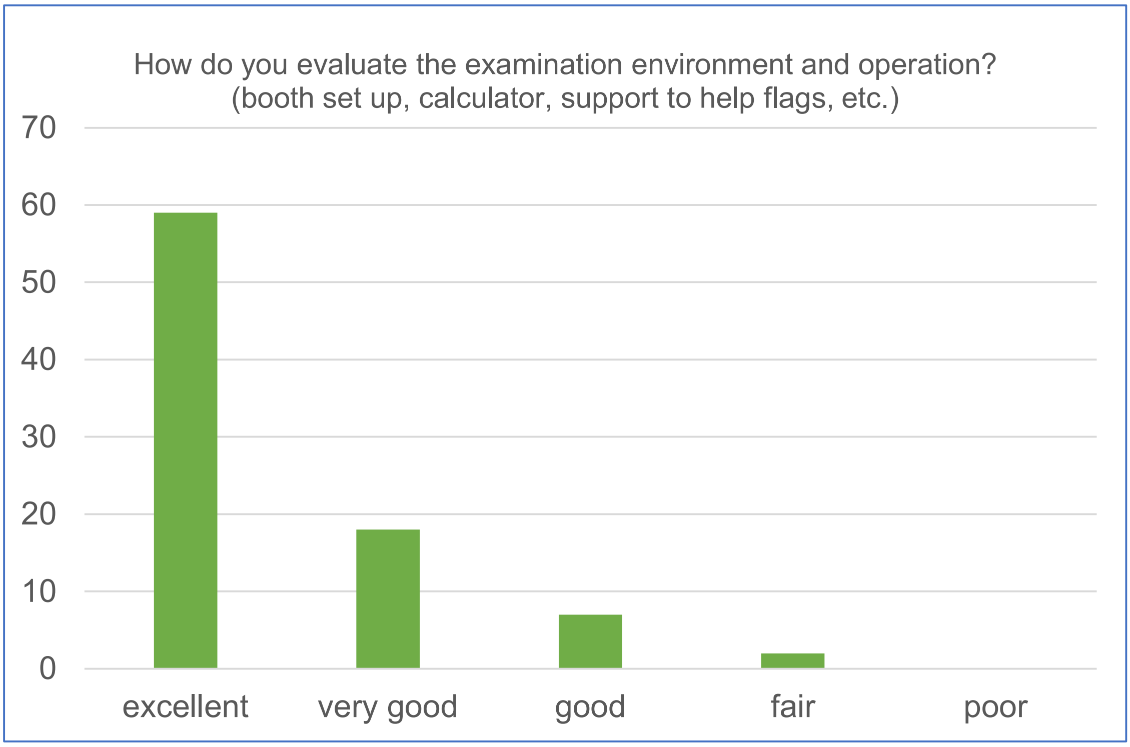


[Comments by Students on the theoretical problems]

- I found that the theoretical problems were easier than most ipho problems, but the problems themselves were quite interesting applications of theory.
- I thought that very interesting topics were chosen, especially connecting the Brownian motion to Nikon's stand at the scientific events.
- It was fine
- Very interesting problems!!
- The theoretical problems were very clear and challenging. I loved them.
- The tasks weren't hard but tedious. It wasn't about thinking, but about repetitive use of math.
- very hand-holdy, do this, calculate this, but the calculations weren't easiest
- Mostly fine.
- T3 felt easier than the rest
- It was fine.
- Very mathematical
- They were gorgeous, all in very different ways. It was just the right amount of mathematics, and I believe it is a complicated thing to balance. We were able to see 3 very different things in very satisfying ways, to get a full grasp at them, thank you so much. I have small issues with them, first question of Q3 about the bounce of a water droplet, we are given k such that Cinetic energy is equal to k times the potential energy loss, (0,06) and with k the problem is trivial. The only real physical difficulty is to find k, so it is hard to see the point of the question. In the last question of Q1, part E, there is an indication to use Newton's second law, when really we should be using energy, and it is what the official correction does, it was a mistaking indication. Otherwise, everything was amazing. Maybe I wish there were a few less guided questions, where we could be more autonomous. I am aware that it is complicated because it leads to tedious and subjective moderation with team leaders afterwards, and most of the questions should be guided, but maybe I would be nice to have one or two more opened questions (like Fermi's questions), which are really relevant for testing physicists.
- Quite mathematical, as most of it didn't really need a brilliant physical idea and then you could solve in an elegant way. I'd like to have more of this
- There should be less questions focusing only on mathematical tasks and more focusing on creative thinking and physics intuition.
- Good concept, but not hard math

- was not as hard as i thought, but still relatively challenging
- standard. completely ok.
- The stated problems have been already seen as similar tasks previously, a lot of math was applied instead of neat physics problems. The physics knowledge actually was not test, instead, long mathematical tasks without much of the physical insight.
- i liked the theoretical problems
- The marking schemes were too focused on the mathematical part, and did not focus on the physics, but rather punished mathematical mistakes.
- I think that the first two problems were too much about math than actual physics, and some people, like me, might be frightened just by looking at the problem.
- Too heavy on math, especially the Brownian motion problems.
- Seemed a bit too short and too easy. The last problem(water tensions) was especially short
- The questions were relatively easy, but exemplified interesting phenomena and principles.
- While the problems were quite easy to solve, I really enjoyed the concepts presented in the problems.
- the problems were too short and easy to effectively identify the level of the contestants
- Very good - there were both problems I could solve and problems I couldn't.
- Theoretical problems were quite easy
- Theoretical problems were fun to solve. I liked mostly theoretical problems
- nice to have some more variety in problems set like electricity (felt quite mechanics oriented)
- Interesting problems
- I found no drawbacks in theoretical problems
- I want cry again huhu
- Problems were pretty thought-provoking. They don't seem to be that diverse though (mostly mechanics).
- I liked the problems, especially the first part of the neutron star problem about stability, although it was a quite easy part the calculations are cool to do (I always like formulas that look hard but are not and have a physical meaning).

7.1.3 On the exam environment and operation



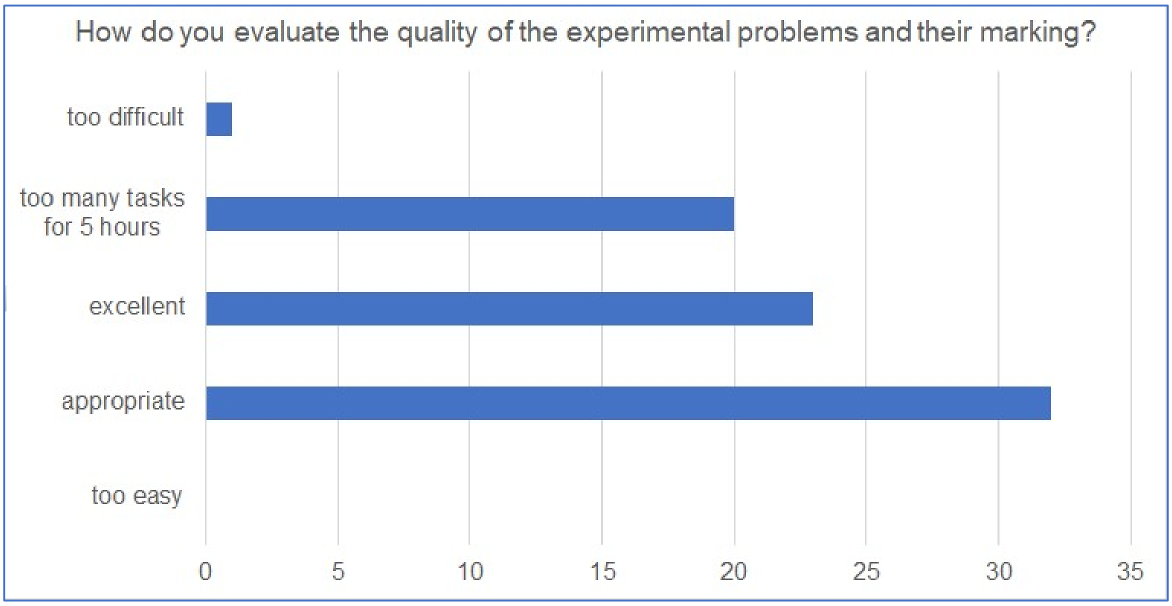
【Comments by Students on the Examination Environment and Operation】

- Very comfortable air and temperature compared to outside, nice tables with enough space
- Examination environment and operation were greatly arranged. Places in which we solved problems have been perfectly done. Examination operation was well organized. For me it was the best examination environment.
- Hard to coordinate 2 experiments on the table provided.

- Everything worked perfectly.
- Very square
- I loved jelly like drink
- It would have been nice to have people who know what we're doing there to help because when other competitors' equipment just wasn't working the people helping thought it was supposed to be the way and this seriously impacted his performance.
- apart from the excessively many steps necessary to assembly the experiments, everything went well
- Everyone in my room are so niceeeee
- very nice calculators! i'm glad we got them home, together with the clocks
- The environment and operation were excellent. The effort and organization was noticed.
- the functionality of the calculator was very limited
- Add numbers to the rulers
- On the first day the examination hall was too hot.
- "The snacks during the exams were amazing :)
- maybe make it clearer before the competition that we won't be able to bring any food during the exam (I took a lot of snacks with me to Japan that I couldn't use) and that all connected device have to be handed out for a period 4 days."
- I had difficulties to understand the announcement
- Everything was so well organized, it was amazing. A shame that the announcer in green room on the experimental test day spoke terrible English, it was impossible to comprehend.
- The tables were too low, or at least the frames underneath the table surface were too low for me. I was completely unable to have my legs underneath the table, my knees hit the metal frame. As a result I could only sit leaning forward a lot which was quite uncomfortable.
- The setup was very well prepared and everything was explained very clear
- The table wasn't high enough for my legs to fit under.
- Everything was perfectly setup. Wonderful!
- chair height was about 5 cm shorter than my legs length
- a bit of confusion with the rooms (I was at first sent to the wrong room), but everything else was great
- Everything was really timely and well prepared.
- It was very good, hard to cheat for anyone but still you had enough space and snacks so you could do the tests in a comfortable way.
- It was very good except for the air conditioning. The room would get hot and it was difficult to concentrate at some points.

7.2 Feedback from the Leaders and Observers on the Implementation of Examination

7.2.1 On the experimental exam

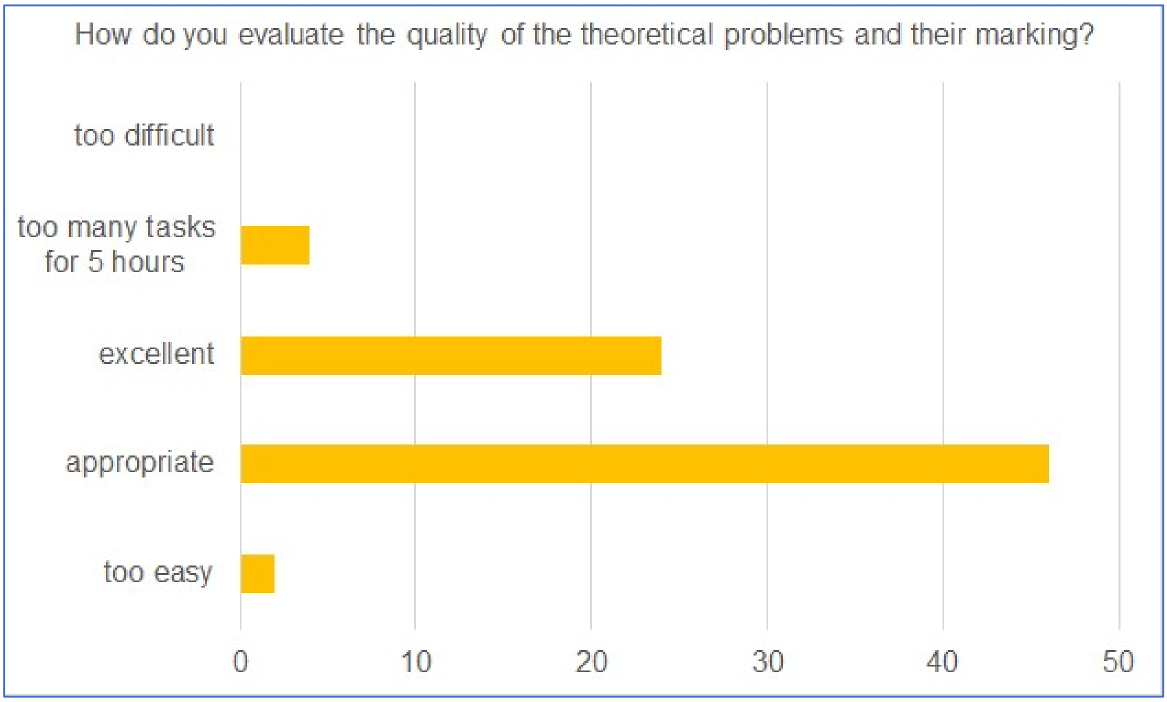


【Comments by Leaders and Observers on the experimental problems】

- Too long description, too much text
- I am happy with the experimental problems. I was glad to see that they requite some assembly and setup skills, which is not always the case. On the negative side, I was surprised that the same markers checked both experiment and theory. It is never done like this.
- Very good and challenging problems
- interesting, well done
- The setup part took a substantial part of the time allocated - though admittedly the instructions were clear. Yet this way of distributing the time for the experiment, handicapped the students who were not too much familiar with the working of the instruments provided.
- The experimental problems were very interesting and beautiful.
- The tasks were interesting, however, the text of the tasks was too long. We should follow the rules and not exceed 12000 characters.
- Great questions and ingenious apparatus. Would have preferred a shorter question statement.
- Excellent problems
- The problems were interesting with the theory behind them not overly difficult, and they focused on experimental skills (which is good), even though the setup of the equipment took quite some time. The marking was also on point.
- very good
- E2 is well designed, and the use of wooden parts for optomechanical mounts splendidly reflects Japanese craftmanship. E1 is also robust. I like how E1 requires a little bit of assembly as well.
- The optical set up was well built and had a Muji vibe to it!
- A bit too long for student to finish all in 5 hours.
- The problems are exciting when it asks students to perform operations to set up the experiment. However, the number of tasks needs much more time than 5 hours.
- It took to much time for students to assemble both experimental kits. One of the experimental tasks should have been assembled and ready to be used.
- Excellent problems, but a bit too long for 5 hours. Perhaps having the experiments partly set up would have helped students.
- Maybe it was good to give some marks to the student who could build the setup of the experiment even he did not make any measurements, because building the setup itself was not easy especially in E2.
- long
- There was too much text for the students to process. I would've preferred shorter problems and less instructions on what the students needed to do to conduct the experiment.
- Experimental questions were very good.

- Too much composition of delicate parts prior to measurements
- The experiments were interesting but they required a lot of time to carry out. To mount and tune the setup of the second experiment was not a easy job.
- Problems were very well designed. What makes these problems different from typical IPhO problems is that the assembling and tuning of the apparatus had an important part to play, and if not done carefully, a lot of points would be lost on the tasks due to the results being not accurate enough. This is definitely a useful lesson for the contestants as in real physics experiments, design and assembly of the apparatus are crucial. Overall, there was a lot of work to do (assembly and executing all the tasks). Due to this, our students managed only to start the second experiment. While it would have made sense to reduce the volume of technically easier tasks so that more students would have been able to reach the more demanding tasks, longer problems have their own merits (e.g. using the apparatus to a fuller degree).
- Q2: It was desirable to clearly indicate that wavelength increments should be measured at 5 nm or less where necessary.
- The moderating processes were stuck by unreasonable principles. In our case, three international referees had already agreed with the correctness of our students' answers, but still had to force the moderator of Taiwan team to make a small reasonable change. The marking scheme is too simplified and discourages the students' learning.
- The procedures for the experimental problems might be too long.
- I also consider the problems themselves and their preparation excellent.
- Very good practicals. Maybe too many detailed instructions making it difficult to complete in the time available. Would be better if the final section of each question could involve some creativity or insight rather than just the process of taking and analysing results, however, this is difficult to achieve. The apparatus was very good.
- A student who build the experiment correctly without measurements (running out of time) get zero, the same mark as a student who don't touch the experiment !
- They were very well designed. The Kibble balance actual.
- Especially two experiments with many settings gave problems in time.
- To do all the experiments was very time-consuming.
- Both needed a lot of time before doing the actual experiment (for points). One such an experiment should be fine. Not two. The (average) score on the second experiment supports this.
- The experiments are well designed. It is great to require students to carefully assemble the equipment.
- For the experimental problems maybe some less structuring of the problems could be better. Less direct instructions how to measure something.
- Experimental Problems were too long.
- "Nice and well-prepared experiments, thank you! I also liked the idea that students should have assembled their setup themselves and some points were given for validation that the setup worked correctly.
- Some issues:
- During the exam one our student had to spend additional time dealing with not-working power supply (it had to be replaced twice!). It is good that organizers had spare ones available (good practice for future organizers), but more thorough inspection is needed prior exams.
- (Noticed only during the marking) How to measure oscillation amplitude in Exp 1 D2 part with precision of 0.1 mm?"
- Problem 2 required a careful setup. Since the problems description were too long it took too much time to translate.
- I haven't solved the experiments step by step myself, but the quality of the kits seemed very nice.
- Fine experiments, the first one is important for students - new definitions in SI
- Great problems, but a little too much to do for the students.

7.2.2 On the theoretical exam

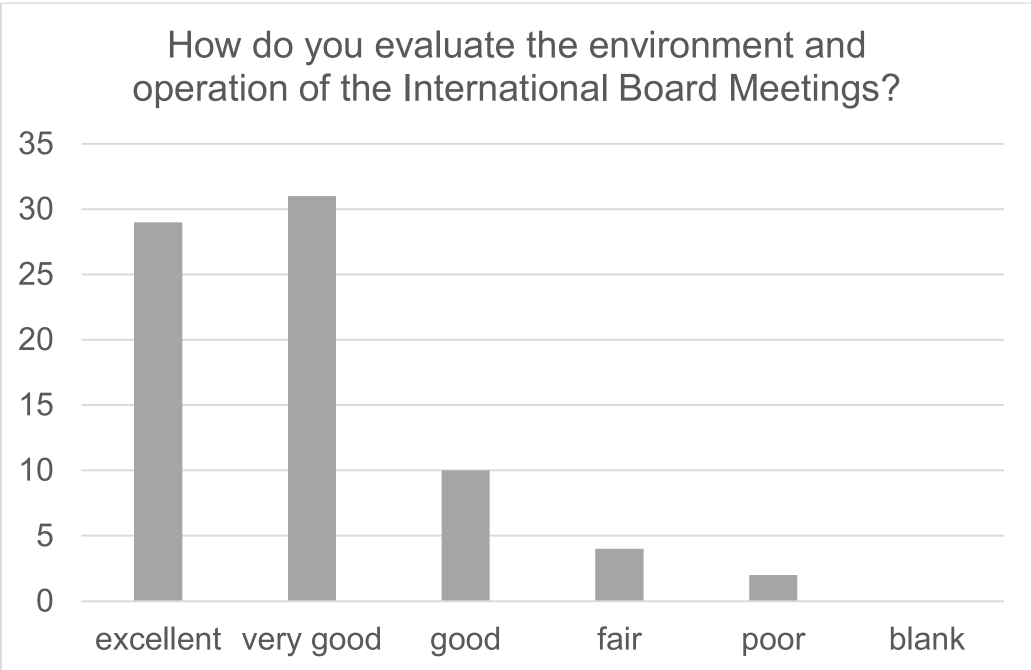


【Comments by Learders and Observers on the theoretical problems】

- Also too much text, they should be well shorter
- Interesting exam. Also, good to see reference to Japanese nature. On the negative side, I was surprised that the same markers checked both experiment and theory. It is never done like this.
- Good problems
- The theoretical problems were interesting and addressed a series of practical applications, the tasks were well structured and clearly formulated.
- The tasks were appropriate, however, the text of the tasks was too long. We should follow the rules and not exceed 12000 characters.
- Great ideas in the questions, but too many subparts telling the students what to do
- The problems were quite interesting and accessible to the students in my opinion. A good variety of different areas of physics was implemented throughout the three problems. The marking was also very good and all issues with the marking were satisfactorily resolved during the moderations.
- very good
- Well balanced and span full contents of syllabus.
- I thought the contexts were well thought of, making links to the host country.
- It is good and interesting problems, but need more challenging.
- Excellent problems and a good level of difficulty
- Good subjects
- suitable
- I think the problems were of appropriate difficulty, but there was too much text and instructions. This made each individual problem just a little bit easier and shifted the focus of the exam on reading comprehension and efficient text processing.
- Very nice questions, I appreciate that two of them dealt with problems of modern physics.
- Too many characters used for introducing the problems
- All three problems dealt with fascinating physical phenomena which bring students to the forefront of modern physics. For instance, the dynamics of water droplets on superhydrophobic materials is a topic actively studied by modern fluid dynamics. That's why I enjoyed the problems very much. The problems were reasonably challenging; to get full marks, one had to have a solid understanding of the topics at hand, and to be able to execute mathematical calculations fast and without mistakes. What I missed myself a little was that there were no tasks which were conceptually very difficult. But regardless of that, the eventual distribution of the theory scores was very nice. This means that the overall difficulty of the problem set was very appropriate.
- Too much hint in the problems

- The problems are appropriate, but the marking scheme is unreasonably rigid.
- Very nicely put problems, in my opinion, albeit rather mathematical.
- The problems were fairly standard. If you could work through the maths, you could get through the problems in the time available. They were appropriate for the syllabus. However, it would be better to try and include a section at the end requiring insight and a deep understanding of the physics, rather than just maths. This is difficult to achieve.
- A lot of math. Not a lot of 'conceptual' questions.
- "The order of questions could be reconsidered, unless you intentionally arranged so.
- In Q1, Part E seems to be somewhat ad hoc addition and might have given a little confusion."
- Due to serious shortening of the problems just one day before the disscussion the problems might be much worse, but somehow they appeared nice at the end. The problem 2 should probably not be shortened. Marking scheme for all the problems should be more detailed and some better evaluation and notion of the propagating errors should take place. Students displayed correct reasoning but using some wrong numbers they got at previous tasks no points were given even if they displayed the full comprehantion of the physics in particular task. This is remark also for experimental problems (about more detailed marking scheme and propagating errors). It was good that we got the marking scheme immediatelly, but maybe the possibility to adapt the marking scheme after the competition, when you see which common mistakes were done by the students and which alternative ways of reasoning they took, should be appropriate.
- Theoretical Problems were very good.
- Markers were too strict regarding foolish arithmetical mistakes made by students (like 1/3+1=7/3) that change only numerical value of the final answer, regardless of the correct solution method.
- Since the problems description were too long it took too much time to translate.
- Very nice problems, some sentences have been a bit wordy, but I think that was already realized that it might be good for future years to have some native english person that reads the exams in advance. Also the marking was very similar to our own, and the moderations seemed to be fair.

7.2.3 On the International Board Meeting: environment and operation



【Comment by Leaders and Observers on the environment and operation of the International Board Meetings】

- It would have been greater if all delegation members (leaders, observers) could have been together
- Everything work very well, excellent support. Except for the absence of tea!
- I feel like the org was oftentimes not agressive enough. I personally missed some of the critical votings - that while sitting in the room. More should be done to focus the crowd, because everyone is busy. The org did not approach teams to understand their comments. Often refused remarks were marked as "withdrawn" - while the leaders did not actually withdraw them.

- Nice event
- I appreciated the very good organization and punctuality for each board meeting, as well as the constructive discussions within the board.
- It was very good that there were always drinks and snacks during the translation time.
- Procedure seemed somewhat inefficient. For example, question writers would often scroll through changes in a long PDF document, without sharing the PDF file itself, making it hard to see globally what was changed. Sometimes question writers would read through every comment when it would have been more efficient to group similar ones together, or quickly skim over very minor ones.
- The overall atmosphere was pleasant and the organization was on point. It was my first time as a leader in the Olympiad and I thoroughly enjoyed the Board Meetings.
- very good
- Our seats were right on the exit, and people kept walking through our seating
- It was a good move to use Zoom for Obsevers to tune in.
- Both lectures were really interesting and inspiring young talented students. I would like to thank both Japanese Nobel laureates as well as IPhO 2023 organizers.
- At times, discussions felt unneeded and that the question writer should just make the decision rather than put small edits to a vote. But the operation of the meetings improved a lot from the experiment to the theory.
- no proplem
- Some of the problem discussions could've been better organised. I feel like we didn't make use of the full potential of the OlyExams tool when it came to voting. There should be a clear procedure on how we deal with the problem discussion because oftentimes we as leaders didn't quite know what was going on and were afraid that the issues were raised would get lost. Perhaps the IPhO Secretariat should chair the board meetings? Also it would be quite useful if there was more time to read the problems and give feedback plus another 30 mins or so after feedback is submitted to vote on feedback; this would make it easier for the host to decide which issues are important.
- very well prepared and controlled (esp Paul) discussions on change of IPhO regulations
- Thank you very much for your hard work well done!
- The meetings were well conducted. Thank you. For the future we have yet to find a perfect solution to manage the discussions on the tasks.
- Facilities were good, printing efficient, WiFi was good. The meetings were well run. However, communication was sometimes lacking, especially regarding timings and schedules. Communication was very succinct but needs to be repeated more often!
- nice
- It would have been better if the leaders and observers had been together (but I understand it is not easy to find a large enough meeting room).
- There is room for improvement. I believe that feedback on the exam questions should be semi-anonymous. Displaying the name of the country does not add any substance (physics) to the comments. On the contrary, it may allow implicit biases to creep into the evaluation. It may also encourage an unhealthy competition to provide more edits. However, the authorship of edits should be accessible to the organizers to prevent any abuse of the system.
- Good spirit, but updated/final versions came with an annoying delay.
- Voting (also during translation) remains strange. Some leaders are present but do not vote.
- good
- It was better if leaders and observers were in the same room.
- Some technical difficulties while voting, and sometimes it seemd helpfull that Paul guided that discussion a little bit. Maybe with a different person leading the discussion (from the japan organisation team) some discussions would have been a bit faster or less confusing. But from what I retain it was more smooth towards the end of the week (I was most of the time in the observers room, not strictly following all discussions).
- Sometimes difficult to follow the meeting from the observer room, but apart from that everything went well. And the meeting was very good and efficiently lead!

7.3 On the Cultural and Social Events

7.3.1 Special lectures by Nobel laureates

【Comments by Students on the Special Lectures by Prof. Kajita and Prof. Amano】

- The lectures were amazing, It wasn't the conventional boring physics presentation, Prof. Kajita and Prof. Amano, really did a great job, also I think that anybody not related to physics could understand them presentation.
- We really liked whole presentation and we are very honoured to listen to nobel lauterates
- Really great
- Their lectures were awesome. It was honor that we heard lectures by two Nobel Laureates in Physics. I sincerely thank Professor Takaaki Kajita and Professor Hiroshi Amano for things that they taught us
- very interesting and enjoyable
- Very interesting, really enjoyed them
- The lectures were interesting and helped me make decisions for my future.
- Prof. Kajita's lecture was very exhaustive on the topic of neutrions. We learned a lot from his talk and his comments and questions. Prof. Amano's lecture sent some very valuable messages about finding passion in your work and never giving up.
- I enjoyed both of them and I liked that their styles were so different. While the first lecture exposed a short glimpse into neutrino research, the second lecture was more relaxed and inspiring for achieving high goals in life.
- I thought that the lectures added perspective to the Olympiad, especially its competitive aspect.
- Quite awesome and cool
- Inspirational
- Interesting and well-organized
- Very enlightening
- Hmmmm, He is wonderful, amazing, handsome
- Very good and inspiring! Hope to view it again online(hopefully it is available on the website later)!
- Interesting and informative
- It would be nice to have the slides or at least the recordings of the lectures.
- I learned a lot from the special lectures, which were very enjoyable and educational
- the neutrino lecture was boring and the blue LED lecture was funny (in a good way)
- I found the lectures very interesting, and it was an honour to listen to them!
- Nice, thank you again!!
- Interesting
- Interesting
- interesting materials and fun
- interesting materials and fun
- Very interesting
- Very interesting
- oth lectures were interesting and they complemented each other very well.
- They were great, I really enjoyed them
- Thank you for these very instructive lectures.
- The first one was really good
- Grateful for the lectures
- It was an honor to have them talk to us about there research and research life, truly inspiring. The issue was that they struggled a little with English, so it was hard to understand, and they read a lot what was written on their PowerPoints, which you shouldn't do.
- I suspect most of the student were expecting more details about the research and more rigorous explanations
- The first lecture was good and I was pleasantly surprised by the second one. I found it actually very useful for my future career.
- An awesome mix between science and life advice.
- Both were interesting. I would even spend more time here.
- Were extremely inspiring and fun! Amazing!
- I can't really emphasize enough, how stunning and valuable those lectures were.
- Inspiring lectures
- detailed. a bit fast at some points and a bit slow and some other points.
- Amaizing! Deep insights, personal angle, interesting topics!

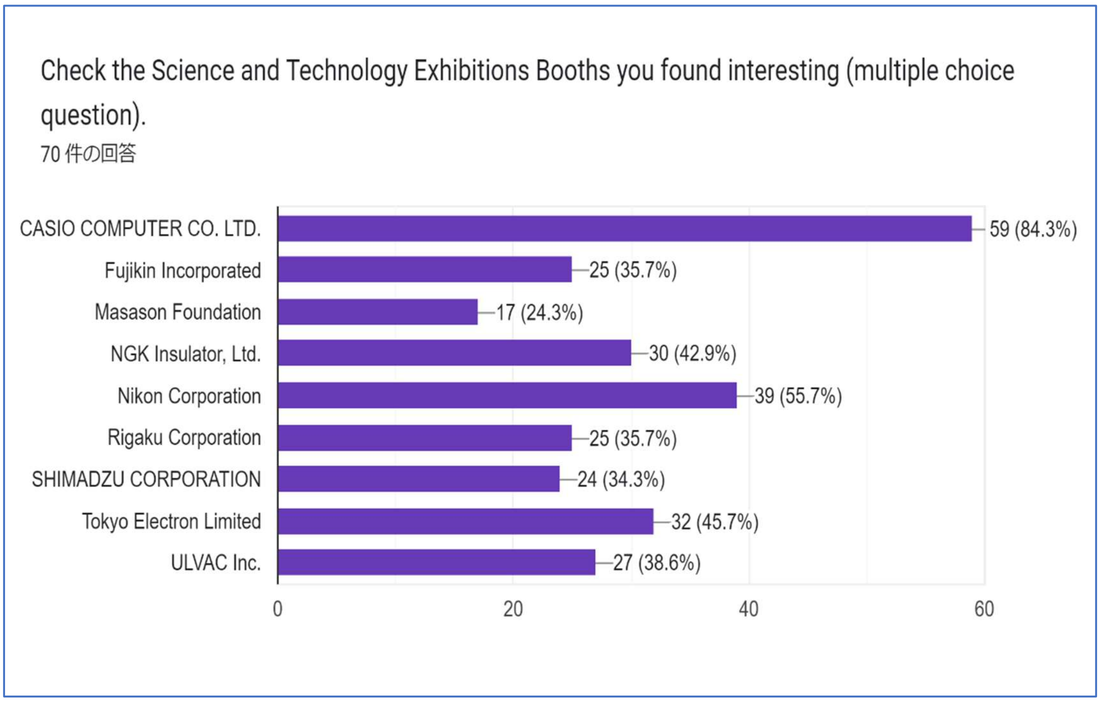
- Loved them! It was really interesting to hear about their research/how they progressed from high schoolers/undergraduates just like us to being extraordinary.
- They were both very nice! The neutrino one actually thought me things I didn't know before without overusing my brain (After the tests I wanted to give my brain some rest), while the other was an interesting life.
- Really enjoyable, straight to the point lecture that left me with a thought.

【Comments by Leaders and Observers on the Special Lectures by Prof. Kajita and Prof. Amano】

- Excellent and the right balance of inspiration and level of physics detail. Were they recorded and can they be put on Youtube for other students?
- Very interesting talks, in particular the one by Prof. Amano
- Totally loved; Super inspirational and important. The best I have seen on any of the IPhOs. These are true heroes.
- Great experience
- did not attend
- Very nice.
- "The special lectures by Prof. Kajita and Prof. Amano represented a very special and unique moment in my life.
- Thank you for this extraordinary opportunity to attend the captivating lectures of the two Nobel laureates and to discuss with Prof. Kajita.
- Both very interesting each in its own style and content.
- Very good, and inspiring for our students!
- It was my honor to attend lectures from Nobel laureate.
- It was truly an honor attending the lectures and I believe both the students and the leaders/observers found them equally interesting. The lectures were also not overly technical in nature, which I very much appreciated - the professors focused more on their life paths and stories as well as some advice for the audience, which made for a very pleasant experience.
- very good
- Excellent speakers! Excellent lectures!
- Kajita sensei's neutrino lecture is useful and informative, while Amano sensei's is inspiring and more personal. I think students may enjoy's neutrino topics more, but as an adult I like the story of the birth of blue LED and the struggle of a scholar.
- Very interesting and different from previous Olympiads
- Very interesting and intriguing
- Excellent. Very inspiring and motivating lectures. Students need to hear that science means hard working.
- Excellent
- Very impressive and useful lectures.
- excellent
- A spectacular event!
- I really enjoyed the lectures! I also believe the lectures were very useful for the students for planning their career.
- Excellent
- They were very useful lectures for the students.
- The lectures are great and inspiring. The speakers in the small hall was broken, and the online video was disconnected from time to time.
- Excellent
- Especially the lecture by Prof. Amano was heartwarming and inspiring as it was not a normal lecture but rather a story of a professional life.
- The lectures were great but the quality of the video feed was surprisingly poor for such a venue which distracted from the lecture for leaders in the small lecture theatre.
- Very nice
- they were nice to hear
- Nice combination.
- Very interesting and encouraging especially for students
- good

- ➢ Very well prepared lectures, paying attention to the audience, I am sure every student was able to understand and grasp the meanings. Extraordinary event that we were able to meet 3 Nobel prize laureates, who were not disappearing immediately after the lectures:)
- ➢ Those lectures were very interesting for leaders, observers and specially for students.
- ➢ I loved it!
- ➢ Unfortunately I have been late and couldn't join.
- ➢ Great!
- ➢ Good

7.3.2 Science and technology exhibitions

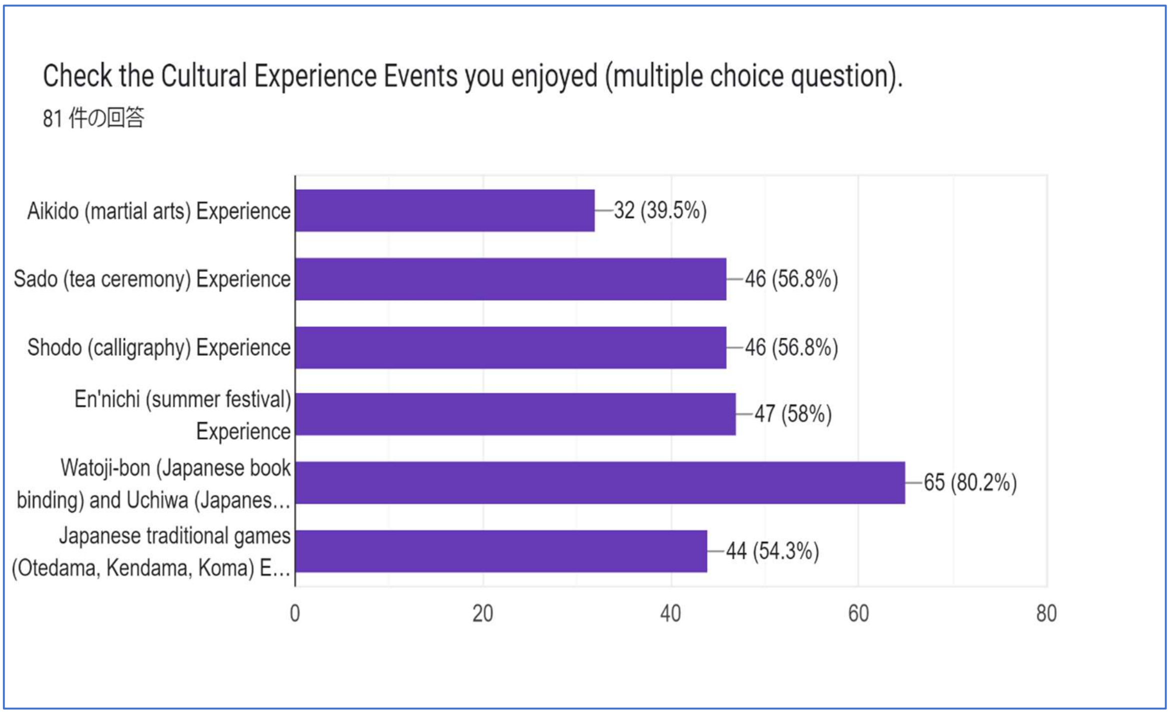


【Comments by Students on the Science and Technology Experience Events】

- They were interesting events. The things that they showed and taught us were so awesome that I want to go there again
- Besides the CASIO booth, the events I found most interesting were building the Da Vinci bridge and the test for caffeine in everyday drinks, but I can't remember the names of the entities that provided these experiences.
- The expositions were really interesting, and I loved the fact that all booths gave us free souvenirs, which made the experience even more memorable
- Nikon was the highlight.
- Thank you for letting me play rush E at the casino piano booth
- Interesting, inspirational, cool gifts
- I love ittt
- engaging experience
- i dont like science during my free time
- Good
- fun
- I only had time to see the booths I checked above and all were very interesting!
- I didn't see most of them, so in the multiple choice questions I can't fairly answer.
- They were a bit like the companies were trying to recruit you, what wasn't very pleasant, but it was ok.
- It was not interesting at all.
- Camera booth with milk crowns was really cool, but can't remember the company
- Insightful, really loved NGK sweets and the bridge building booth
- excellent. one of my best moments in this journey.

- Good for general schools, but not technical enaught for a physics olympiad
- It is a very nice way to let the sponsors promote themselves without giving boring speeches.

7.3.3. Cultural experience events

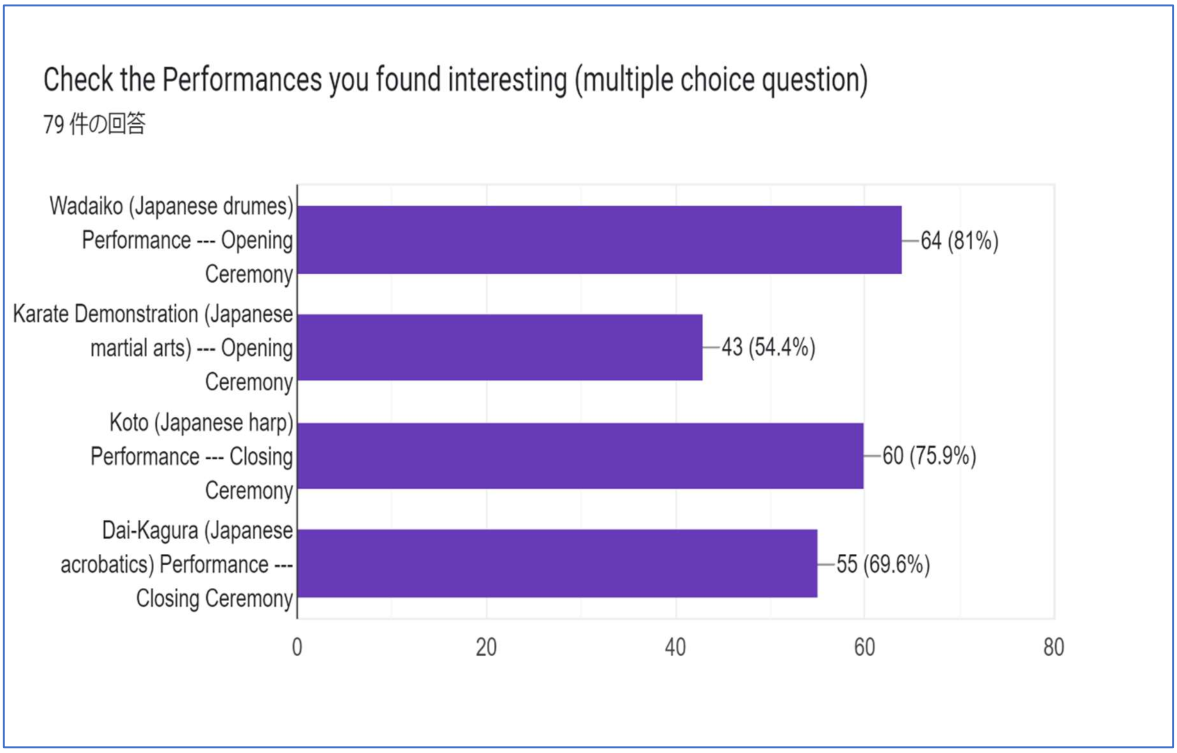


【Comments by Students on the Cultural Experience Events】

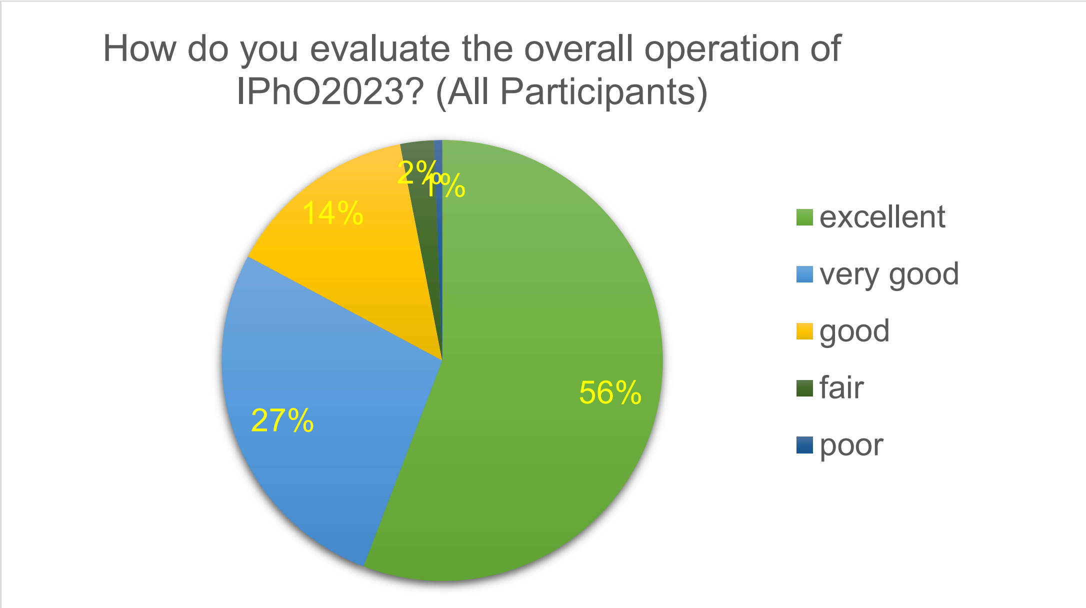
- Each of them was so enjoyable. It was one of the best experiences in my life. I really want to try them again
- Great, perhaps more planning to ensure everyone can have an equal chance to do certain activities as some people were at shodo for a long time and some of our team only were given time for 1 before they were asked to leave
- Really enjoyed trying to learn to play with Koma. There is a certain beauty to knowing you suck at a game that is a pastime for primary schoolchildren. The staff was really nice and really helpful!
- The events were fun and a great way to bring back souvenirs from Japan.
- Everything was perfect.
- It was so beautifully organized and it was a great opportunity to experience various aspects of the Japanese culture. All of them were so exciting, I LOVED IT.
- Based YMCA
- Well orgonised
- I did not have time to attend all the events, but I appreciated all of them
- the new act, amazing experience
- good and fun
- very cool
- I found the cultural experience events interesting, and it was exciting to be able to experience a taste of Japanese culture.
- Really fun
- fun
- I think there should be some instructions in Japanese traditional game
- I loved that we were able to get a taste of traditional Japanese culture
- Thank you all for organizing these events!
- I really enjoyed the Shodo Experience. All cultural events were very interesting
- Some of my best memories from the trip are from the summer festival. In general the Cultural Events were so much fun, we were so lucky to have them organized for us.
- I unfortunately didn't participate in the tea ceremony but I'm sure it would have been enjoyable.

- I was really nice events, we
- Everything was awesome!
- Amazing
- I loved ennichi the most. Everything else was perfect too!!
- i missed much of them. tea party was excellent.
- We had the posibility to experience stuff, that most turists don't get to experience. A lot of different stuff, and the free will to pick and choose made it one of the hightlights
- I liked them very much, it is important that not only science but also culture is respected in concern with decisions in life (like (not) building a star observatory on top of a holy mountain), so culture should definitely be represented on an event like IPhO as well.
- I really enjoyed them all. It gave a great opportunity to experience Japanese culture as well as creating lovely memories with my friends.
-

7.3.4 Stage performances



7.4 On the Overall Operation and Hospitality



【Comments by Students on hospitality of IPhO2023 (accommodation, food, student supporters, etc.】

- It was a bit of problem for us halal students because we were often put in the same place as vegetarians because we can eat every meat except pork
- I loved the hospitality of all staff of IPhO2023, the food was very different to our main country both in terms of flavour and quantity, but it gave a sense of the Japanese culture, which was pretty cool.
- food was disgusting (especially the tasteless rice), hospitality couldn't be better, everything else was fine
- The accommodation was nice. I liked place where I lived. It was comfortable. Foods were so delicious. Each of student supporters were great, nice and kind, especially our student supporters. Every excursion that we went was so fun and exciting. I thank all IPhO 2023 organizers and people that helped in this olympiad from the bottom of my heart
- student supporters were fantastic and very friendly. More variety of fruit and veg for meals.
- The hospitality in general was great. The food could have been more suited to non asian contestants. Student supporters were excellent, but they had difficulty communicating in english.
- "The food was good, and I was never hungry during the IPhO.
- Our student supporter was very nice, and I don't think our experience would have been as fun without her. By helping us deal with all the details of navigating Tokyo and it's metro, Seiko made our stay in japan flawless. Besides being a very interesting person herself, having someone who could explain to you the customs of a foreign culture was invaluable (things that most people take for granted in japan, like leaving chopsticks in rice being disrespectful). I am really grateful for all her help!"
- Food was very strange sometimes (especially for Europeans), but nevertheless a unique experience. Accommodation in single-occupancy rooms was good offering privacy, but the queue for the shared showers was long. Amazing toilets by the way downstairs in international exchange building.
- Accommodation was bad, food at fuji cafeteria was terrible. Our student supporter was really sweet and helpful.
- The Wi-Fi provided was quite poor, the showers were stuck at 40ºC water and our student supporter barely spoke English. The food was good.
- We loved our student supporter, she was really nice and pleasant to talk to.
- The food was really good for cafeteria food, the accommodation was also good but my experience in Japan was so good also due to our student supporter, who was great! She brought us to so many great restaurants and her general vibe was so nice. She made the experience incredible
- Ja!
- "Accommodation was fine but without wifi connection
- Halal food didn't have great variety
- Student supporter is 11/10"
- My name is registered wrongly :(

- It should have been hosted in a hotel
- The food could have been better — for the first few days there weren't seperate vegetarian options so the vegetarian competitors had only rice. The accommodation was good and our student supporter was amazing :)
- I would have preferred for the accommodation to be at a more comfortable location (i.e. a hotel), but I enjoyed that we had air conditioning in our rooms. The volunteers were also great!
- Sending my gratefulness to Ami
- Excellent! The buffet-style food served is awesome and tasty. The student supporters are friendly and help a lot.
- The food was delicious. The supporter did a really good job and was fun.
- one of the things i loved the most at the olympiad! and lots of love for our amazing supporter!
- Excellent organization, generous, and willing to help in everything they could. The timetable and the guides were selected in such a way that we could enjoy the olympiad, have cultural experiences, and have time to visit Japan. My only complaint is two things. On one hand, the early dinner schedule you couldn't control anyways), and the poor design of the backpacks (even a child knows that the logo must be big, bold, and in the middle of the backpack, it is common sense). The
- it would be cool to have more quality meals outside of the canteen
- The student leaders were very hospitable and helpful, and I appreciate having them there to lead us around and teach us a bit about Japan!
- The accommodation and the food we were served there was bad. Old, tiny rooms, dirty bathrooms and terrible food. Ik the budget is always tight but please, if you can, change the accommodation the next time
- Good
- Good
- showed great hospitality, NYC was a good site to held IPhO. The rooms, however, weren't that great, but it's still manageable
- showed great hospitality, NYC was a good site to held IPhO. The rooms, however, weren't that great, but it's still manageable
- The accommodation and food were subpar, but the student supporters i met were really nice people.
- Food was rather poor quality
- "Accommodation: very good, private room + lots of social areas
- Food: good but not enough food during ""light lunch""
- Student supporters: our guide (Chihiro) was truly amazing and all supporters that I met were friendly and helpful"
- Our student supporter was great, he was always really nice and helped us with everything we needed.
- I wanted to thank all organizers and people involved in the competition. It was a truly unforgettable experience for me! Every step of the organization was very neat and precise which let me enjoy this week even more. Again a great thank you to you all!
- Maybe the portions of food were too small but it was overall a great experience!!
- The guides were exceptional, taking care for us
- Our student supporter spoke our language (French) and it changed everything for us, it was amazing.
- A bit more varied food was welcome
- The cafeteria definitely could have been better
- Both the accommodation and the food In cafeteria Fuji weren't great. The food was kinda bland and the accommodation was small and the facilities (showers etc.) lackluster. The showers only being available from 17:00-23:30 were quite a nuisance for example.
- It would be better if accommodation was in some hotel instead, with better service. Combining vegetarian food with halal food was too bad, the only thing we ate is rice, we aren't used to eat vegan food.
- Extremely bad accommodation and food
- Everything was good. Our guide was amazing.
- "Our toilet wasn't working :(
- Otherwise"
- It was all amazing, extremely well organized!
- Accommodation was bad, and meals were good
- Very poor accommodation and food, but good enough, I suppose. Student supporter was incredibly helpful!
- Food was good! But having to make our bed was very new to me
- "i will miss you so much. sorry for being late most of the time:_)
- i learn many thing from you society. i think its so rare to have a chance to have a trip to japan, especially for me. so thanks a lot from anyone who have a hand in this event. ありがとうございます."

- Accommodation good, it had ac, but some of the restrooms were closed. Food was sub par, the food we had on the excursions was leagues better. Our student supporter(s) were really enjoyable people that we got to know.
- Our student supporter was amazing! The housing/food seemed pretty standard.
- Anything was really good, except for the food in the Fuji cafetaria, which I didn't like so much; on excursions and after the closing ceremony we went eating in restaurants and it was the best food I've ever eaten! Going to a Japanese restaurant (or for that matter, any restaurant) in Belgium will always be a disappointment since it will be very hard for them to beat the Udong we ate with our guide, Amika, in a very small restaurant where only locals came.
- "I really liked the aspect of having all the events concentrated at the same place, the NYC. By that way, it created more opportunities for us to communicate and make friends with students from other countries. We had a better experience than staying in hotel, and I hope that the next IPhOs will be held the same way.
- We really loved our first student supporter. She had a nice personality that we enjoyed every second being with her. Going on excursions with her made the experience much more enjoyable and memorable in my opinion. It was very sad that they had to change our student supporter due to the student working hour law. And it was hard to getting along with our new student supporter as she stayed silent most of the time."
- Everything perfect, at least 9.5/10 rate

【Comments by Leaders and Observers on the Overall Operation of IPhO2023】

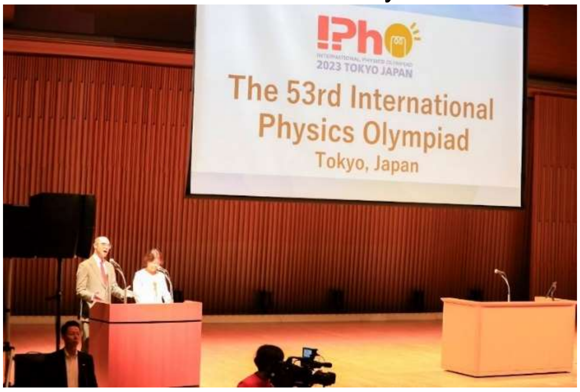
- I participated as a leader in many editions of IPhO, but IPhO2023 impressed me in a very special way, through absolutely everything. IPhO2023 has been a complete success!
- "For the most part the organisation was very good.
- The fact that during the opening and closing ceremonies, there was no adequate room for all attending participants was something new for me, although the first IPhO I participated in dates back to 1998.
- I would complain also on the airport pickups. You guys made us wait to take several teams at once. We didn't do this to you...
- Check in system at hotel. Waiting for a long time.
- Also, I believe that students awarded honourable mentions should also be invited on the stage of the closing ceremony and receive a congratulations round af applause, as is customary.
- Other than that, local organisers, along with the members of the IPhO secretariat performed in a way most useful for the best outcome of this years contest."
- Only problem: ensure there is sufficient seating for leaders and students to sit together. The audio and video quality in the small hall were very poor.
- Everything went smoothly and was well-coordinated.
- hotel check in should be earlier at leader arrival
- Most of the events are well prepared. A little disappointed during the opening ceremony where leaders were separated from the students due to the hall capacity
- Generally well-run and I enjoyed the whole stay there. Thank you so much!
- A very well organised IPhO - thank you.
- good
- Almost everything was fine. The only thing I did not understand was the participation of the Russian team using the name "Oly team of individuals", under the leadership of four observers. In my opinion the Russian team should not have been allowed to participate.
- late opening of rooms on arrival day, inconvenient for exhausted travelers
- This was definitely one of the best IPhO-s.
- Except for the residence of the leaders on the last day at the National Olympic Youth Centre. So unorganized and poor planning
- Thank you for organising IPhO 2023. it was a wonderful event.
- Everything ran on time in a professional manner
- The retransmission of the opening ceremony to the separate room for the leaders and observers did not function very well (butI understand it could be difficult to obtain a room big enough for 700 persons).
- The organisation was okay and we appreciate the effort in helping us with sleeping places before and after the olympiad!
- Opening and closing: housing small. Not fun to look at a screen. A livestream for parents at home could be nice!
- We did not like the coordination of transportation to the airport at the end of the Olympics, as the buses were limited and not available at suitable times for the delegations' trips.

- Sincerely appreciate the effort by the organizer, especially on their prompt and appropriate responses to unforeseen issues. Well done.
- I was happy to see that mixed gender teams were awarded for their good overall results!
- It was better to stay in original hotel until last day, leaving hotel before closing ceremony and displacement to art hall building with our luggage was very hard.
- Punctuality in holding meetings and programs was excellent
- "Overall very smooth organisation!
- Almost everything is acceptable except for the last day to spend one night at the National Olympic Youth Centre before departing back home. The schedule is so unorganized for the check in time . No one knows what is going on. The schedule was announced to be 2 pm and kept postponing over and over again.... until late in the evening around 18:00. This should be organized better than this. I should say it is quite unorganized . This was my first experience in Japan in last 20 years that never happened before. Usually, the Japanese way to organize is precise with a flawless plan.
- One point that was a bit unlucky is that the observers had to be seperated from the leaders during the problem discussion/translation. In the Swiss team we have been in total 5 leaders, so it was no problem to arrange that we could work in teams of 2 and 3, often we even mixed with the austrian team. But it was a bit said to see that some other observers had to work isolated from their team.
- From our Leader-1 I got the feedback that she really appreciated that she could follow all the discussions live in the main room. This showed to me that this is indeed of importance, and it would have been nice if it would have been possible for observers and leaders to be in the main room. But of course I understand that the space is limited... Same applies to the opening ceremony, where the sound and image have been rather bad quality... But the closing ceremony was really nice (there I could join in the main hall)
- Typical Japanese, this match our perception of Japan

8 IPhO2023 in Photos
8.1 Opening Ceremony

Secretary General IYE explaining the flow of ceremony.

Masters of ceremony.



Opening Address by the Organizing Committee Chair KOBAYASHI Makoto

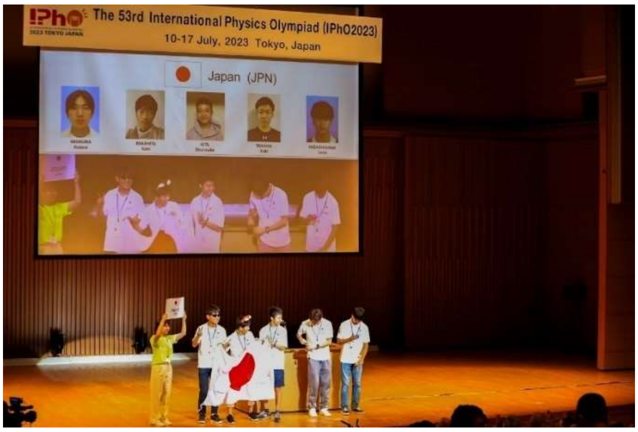
Minister of MEXT NAGAOKA Keiko

IPhO President RAWAT Rajdeep


The 53rd International Physics Olympiad (IPhO2023)
10-17 July, 2023 Tokyo, Japan
Armenia (ARM)


The 53rd International Physics Olympiad (IPhO2023)
10-17 July, 2023 Tokyo, Japan
Austria (AUT)


The 53rd International Physics Olympiad (IPhO2023)
10-17 July, 2023 Tokyo, Japan
Brazil (BRA)


The 53rd International Physics Olympiad (IPhO2023)
10-17 July, 2023 Tokyo, Japan
Japan (JPN)

8.2 Setting up the exam venue

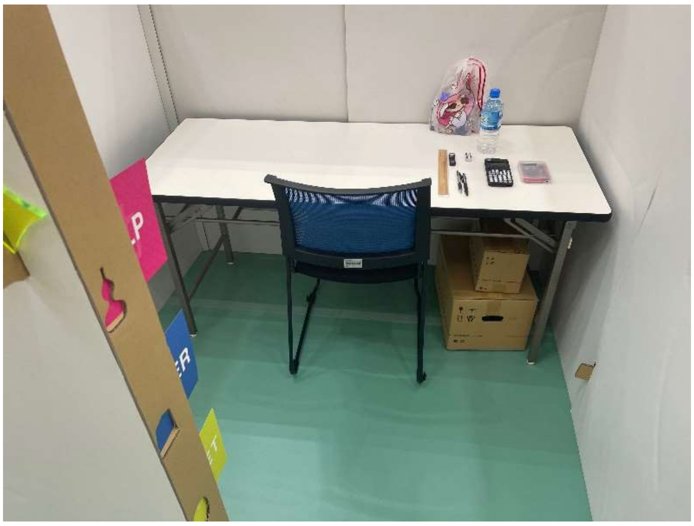
The exam booths were set up in two gyms in the Athletic Building of NYC.





Exam compartments were designed by FUKUSHIMA’s group at Tokyo City University.
Partitions were made of cardboard, and could be assembled and dismantled without special tools.
They can be re-used as partitions of emergency evacuation sites in an event of natural disasters etc.

Compartment

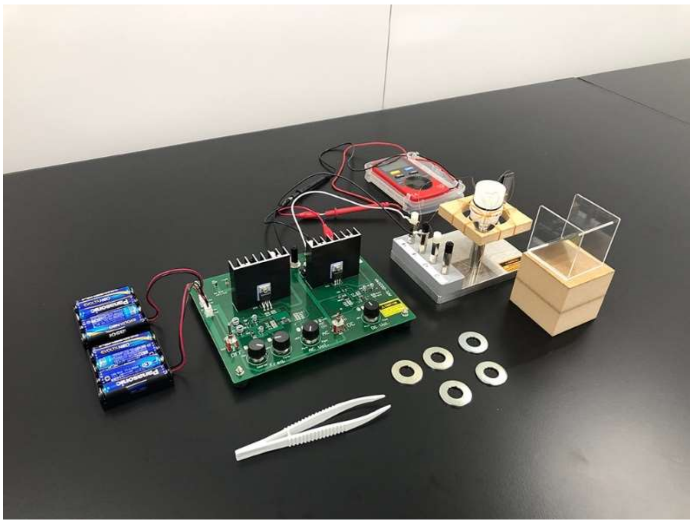


Desk

Stationaries

Sign flags.

Experimental kits



8.3 International board meeting

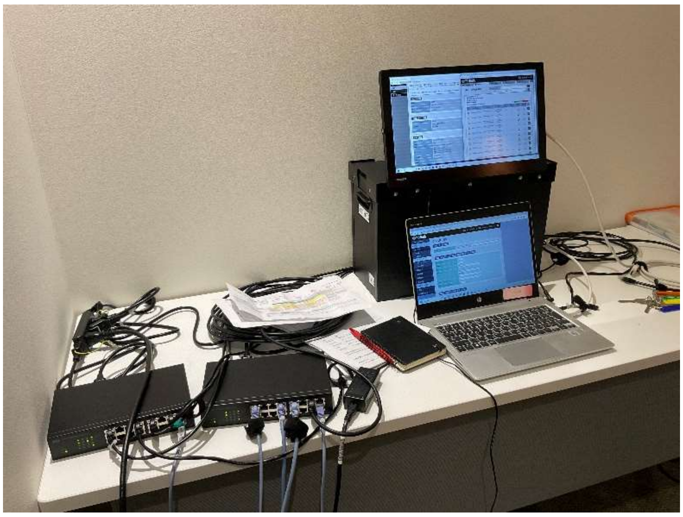
International Board Meetings were held in NSH where leaders and observers of participating countries/regions were accommodated.

Presentation of the exam problems

Inspection of the experimental kits.

IT technical team in preparation of IT environment for the International Board Meetings.

Pigeon boxes for printout delivery.

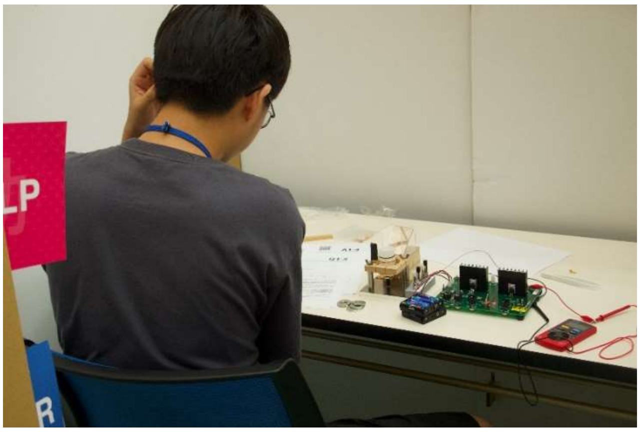


Coffee and midnight snacks.

Display of the status of translation submission

8.4 Examination

Monitoring camera



Checking of the answer sheets etc.

Contestants relieved from pressure of exams.

8.5 Excursions (half day, metropolitan area)

8.6 Cultural events

















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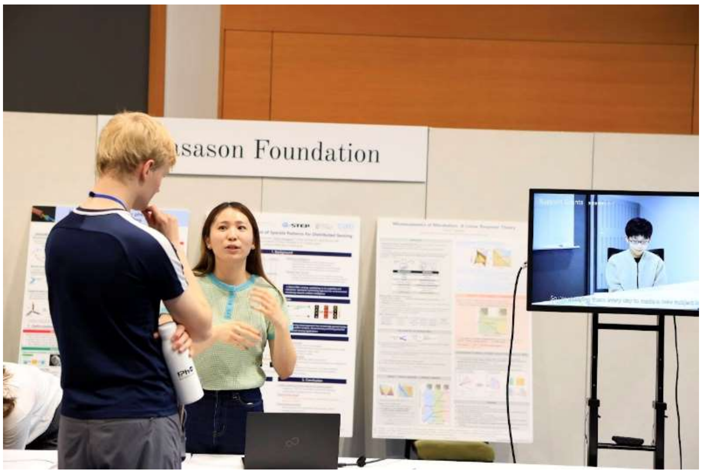
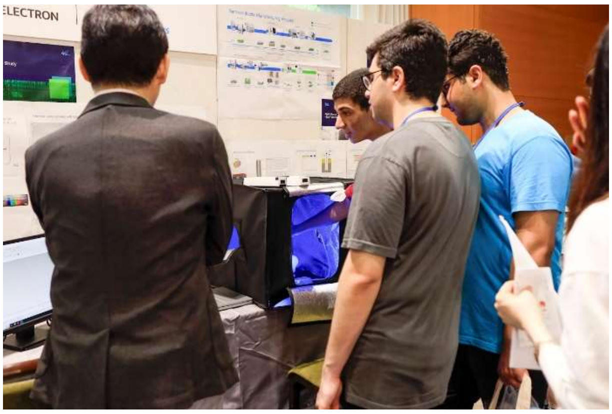
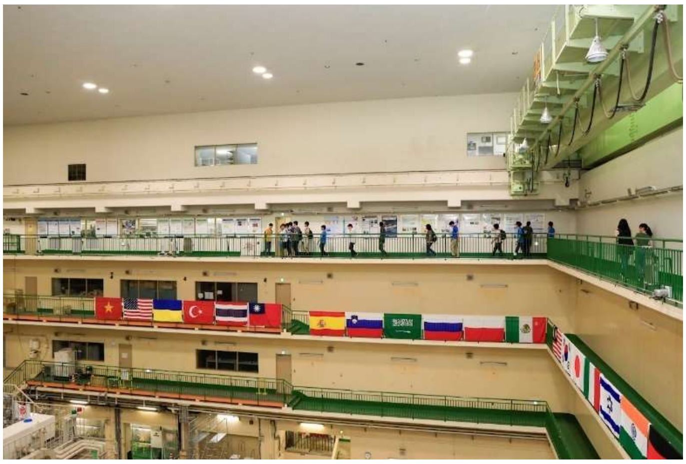
SMART BALL

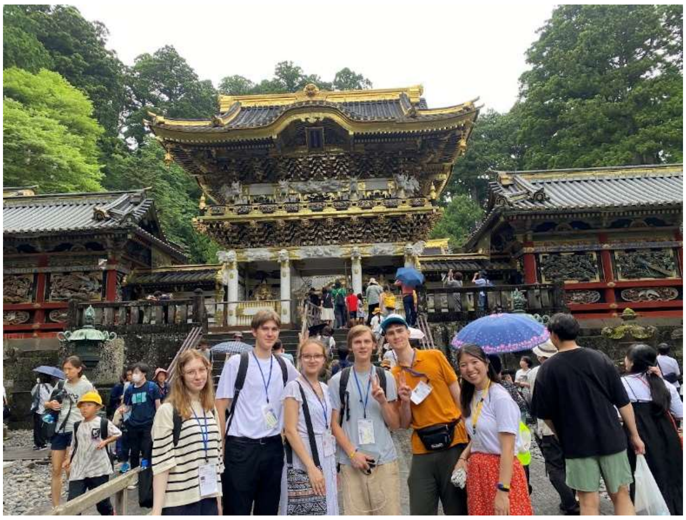
8.7 Science and technology experience corner





8.8 Excursions (full day, Kanto area)










8.9 Special lectures by Nobel laureates

KAJITA Takaaki

AMANO Hiroshi

8.10 Final International Board Meeting

8.11 Closing Ceremony

KOBAYASHI Makoto, Organizing Committee Chair giving an opening address.

HAYANO Ryugo, Academic Committee Chair explaining the exam problems and marking results.

IYE Yasuhiro, Executive Committee Chair introducing the team of student support leaders

YOKOYAMA Hiromi presenting special “Diversity Commendation” to the teams with gender diversity.

Medal presentation

Bronze medals presented by RAWAT Radjeep, STANLEY Paul and SAKAKI Hiroyuki

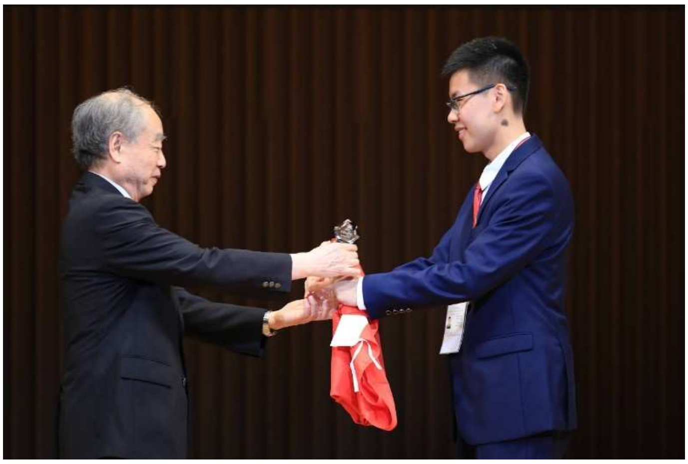
Silver medals presented by AMANO Hiroshi and KAJITA Takaaki.

Gold medals presented by KOBAYASHI Makoto.

Special awards, Best Performance in Experimental and Theoretical Exams, and The Absolute Winner.

Best performances in experimental and theoretical exams.

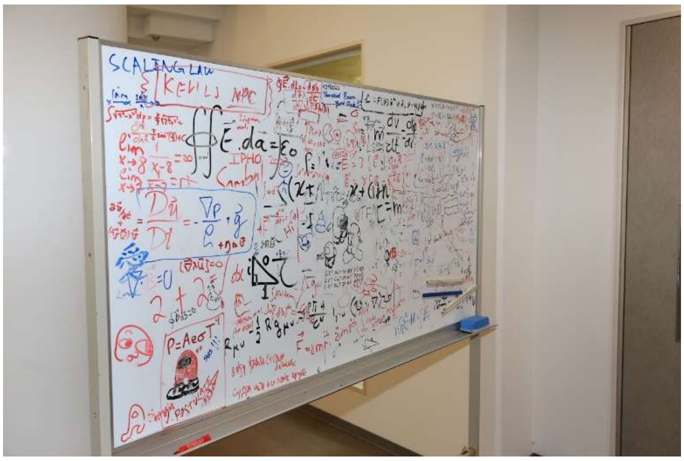
The Absolute winner.



Invitation to IPhO2024 by the Iranian leader SHIRZAD

Closing Address by the IPhO President RAWAT

8.12 Farewell Lunch



Afterword

As the title of Chap. 2 “Long and Winding Road to IPhO2023” conveys, it was a long and laborious enterprise to host an International Physics Olympiad. Since the official kick-off of the Organizing Committee on May, 2016, the core members tackled seemingly endless list of tasks. The hardest part of the tasks was that we had to make up a plan without clear prospect for the financial basis. As stated in Sec. 2.4.1, we were supposed to fundraise about 150 million JPY to meet the estimated total cost. The economic situation in Japan was not favorable and the outbreak of COVID-19 caused further damage. Fortunately, we were able to secure support from numerous companies and individuals who understand the importance of IPhO event, so that we could host IPhO2023 with not so luxurious but decent accommodations and hospitalities. We are pleased to receive mostly positive evaluations by the participants from all over the world.

Although the overall operation of IPhO2023 went relatively smoothly, there were a few incidents that might have derailed the plan. Firstly, COVID infection cases took place both in the NYC and the NSH during the final few days. The moderation sessions were conducted with those who proved negative in the antigen test. Luckily, the infection did not spread, so that we were able to complete the IPhO2023 programs and see off the delegations to their return trip. Had the infection cases occurred in the earlier part of IPhO2023, the whole schedule would have been severely scrambled.

Secondly, as we uploaded movies and photos on the IPhO2023 website, access increased. Our server was forced to shut down on account of DDoS attack. Had it occurred during the most crucial periods of team registration and/or in early July when last minute correspondences were made with team leaders, the operation might have been paralyzed.

In any event, we are happy to be able to complete the mission of hosting IPhO2023 with a lot of help from people involved with the contest and entertainment and with financial support from the Co-Organizers and Supporters. We thank the participants from around the world for joining IPhO2023 and make it successful. Echoing the title of Chap.2 “Long and winding road to IPhO2023”, our personal recollection of IPhO2023 is “All is well that ends.”

Appendix 1

Exam Questions and Model Answers

Experimental Examination

General Instructions

Failure to comply with any of the following conditions may result in disqualification.

The exam is worth a total of 20 points and lasts five hours.

When to start and finish up the examination and when 15 minutes remain before the end of the examination will be indicated by your Invigilator.

Do not open the envelopes nor boxes until instructed to do so.

The following items are provided for your use on the table: (1) a ballpoint pen, (2) a mechanical pencil, (3) a plastic eraser, (4) a scale ruler, (5) a scientific calculator, and (6) a digital table clock.

During the exam:

- Use the ballpoint pen provided. If you use the mechanical pencil to draft your notes, figures, tables and graphs, never fail to trace the outlines of the final version with the ballpoint pen.
- Use the dedicated sheets labeled **A** for your final answers. Fill in appropriate sections with your answers and necessary observations. Draw graphs as required. Cross out any unneeded answers.
- Blank working sheets labeled **W** are provided for drafting. Use the designated ones. Cross out any unneeded answers and rough work that do not need to be graded. Use only the front face of each sheet and keep the margin outside the border clean.
- Additional working sheets labeled **Z** are available upon request. Raise the "Help" flag and let the Invigilator know.
- Keep your answers concise and legible. Use equations, logical operators, symbols, and sketches that best convey your thoughts. Avoid being lengthy and wordy as the markers may not be multilingual.
- Uncertainty quantification is not required unless otherwise specified. On the other hand, you may decide how many data points or measurement runs are needed unless instructed otherwise.
- You will be video-recorded for fairness and security purposes. Do not leave your booth without permission. If you need a washroom break or any other assistance, raise the flag(s) marked "Toilet", "Water", or "Help".

At the end of the exam:

- Stop writing immediately when the end of the exam is announced.
- Put all the sheets in the windowed envelope for each question. Organize them faceup in the following order: cover sheet on top, question sheets (**Q**), answer sheets (**A**), working sheets (**W**), and additional working sheets (**Z**), if any. Arrange them according to their page numbers. In the final check, make sure that your ID, name, and seat number on the cover sheet are visible through the window. Leave only the General Instructions (yellow sheets stapled) on the table.
- You Invigilator will let you know when you can leave. Do not take anything with you. Time permitting, put everything back as it was. Your cooperation would be greatly appreciated.

Mass Measurement (10 points)

In this experimental problem, a measurement of mass is attempted. We further measure the mass utilizing the resonance characteristics of the harmonic oscillator.

Experimental setup

Below is the list of parts (Fig. 1). The number of the parts is given in [ ] if only there are two or more.

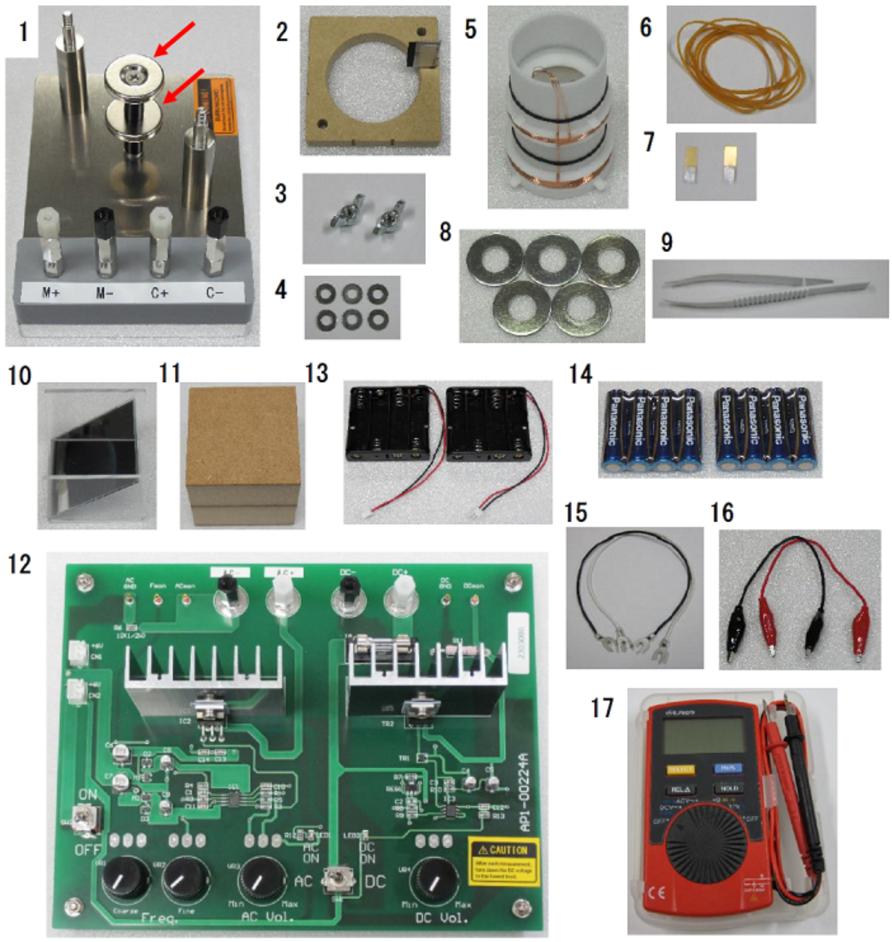


Figure 1: The experimental apparatus set.

1. Mounting base:

   Note: magnet unit on the base creates the height-independent uniform radial magnetic fields warranted near the center of the magnet pair to within ± 3 mm in height.

2. (Oscillator) support
3. Thumbscrews [2]:

   Note: Remove 2 and 3 from 1 in the as-received package for use.

4. Shim (washer) [6]

5. Cylindrical oscillator
6. Rubber bands [6]
7. Markers [2]
8. Weights [5]
9. Tweezers
10. Mirror
11. Riser block
12. Power supply (PS):

    DC or AC mode is toggled on.

    In the DC mode, it works as the constant-current source. Turn the knob labeled "DC Vol" to adjust the current. The magnitude of current is obtained from the voltage between "DCmon" and "DC GND" using the conversion factor 1.00 A/V.

    In the AC mode, it functions as the voltage source with a fixed amplitude. Turn the "AC Vol" to adjust the voltage. The AC current is obtained from the AC voltage between "ACmon" and "AC GND" using the conversion factor 0.106 A/V. The frequency (Freq.) is tunable by using the "Coarse" and "Fine" tuning knobs.
13. Battery holders [2]
14. Batteries [8]
15. U-shaped crimp terminal wires [2]
16. Alligator clip wires [2]
17. Digital multimeter (DMM):

    Turn the knob to select an appropriate measurement mode, "DCV", "ACV", and "Hz". Note that the displayed value of the AC voltage indicates the root mean square (RMS) value, i.e., the effective value.

Modeling the system

Figure 2 is a simplified model of the experimental setup. It is essentially a driven mass-on-spring oscillator.

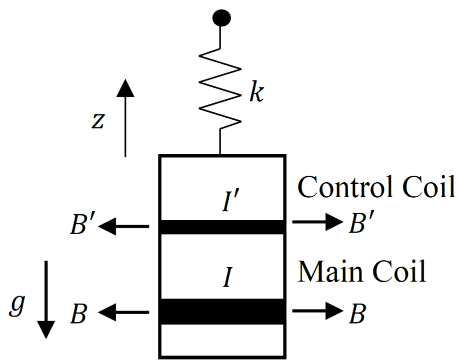


Figure 2: Harmonic oscillator model.

The relevant parameters are:

- M: mass of the (cylindrical) oscillator
- m: mass per weight
- N: the number of weights
- g: acceleration due to gravity
- k: effective spring constant pertaining to the vertical motion
- z: oscillator height (or displacement)
- z_{e}: oscillator height at which a force balance without gravitational and electromagnetic forces is established.
- $B(B')$: magnetic field applied to the main (control) coil
- $L(L')$: length of the conducting wire of the main (control) coil
- $I(I')$: current flowing through the main (control) coil
- α: positive coefficient of drag force

The equation of motion is given by

$$(M+Nm)\frac{\mathrm{d}^2 z}{\mathrm{d}t^2} = -(M+Nm)g - k(z-z_{\mathrm{e}}) + BLI + B'L'I' - \alpha\frac{\mathrm{d}z}{\mathrm{d}t}. \tag{1}$$

Installation of the oscillator

1. Remove the support from the mounting base. Wrap four rubber bands around it in a grid pattern (See Fig. 3(a)).
2. Insert the cylindrical oscillator from the scale side into the square opening amid the crossed rubber bands. Place the wire leads on the other side of the scale. (Fig. 3(b)).
3. The oscillator is designed to hang on the support with four rubber bands and eight little hooks (red circled in Fig. 3(c)). When properly implemented, one rubber band loop forms a truncated rhombus with two hooks above and below the support level in the side view.

   Note: In this experiment, we can assume that the effective force due to the rubber bands obeys Hooke's law.
4. Refix the support to the post diagonally with two thumbscrews. The scale has to stand upright on top, not on the side of the binding posts (Fig. 3(d)).
5. Stand the oscillator upright. Its axis must be aligned vertically and shared with the magnet unit.
6. The main coil should sit near the middle of the two magnets when at rest, which can be confirmed by the distance between the upper surface of the lower magnet and the lower surface of the oscillator being 3 to 5 mm (Fig. 3(e) red arrow). If it is low, put the shims between the binding posts and the support (Fig. 3(f) red arrows). If it is high, turn the post of the magnet to remove it and add the shim under the post (Fig. 3(f) yellow arrow).
7. Expose the sticky surface of the double-sided adhesive tape on the marker (Fig. 4(a)). Glue the marker to the tiny little floating shelf on the oscillator to measure the height (Fig. 4(b)).
8. Set the mirror on the riser block (Fig. 4(c)). Secure a clear vision of the marker from above through the mirror (Fig. 4(d) red circle).

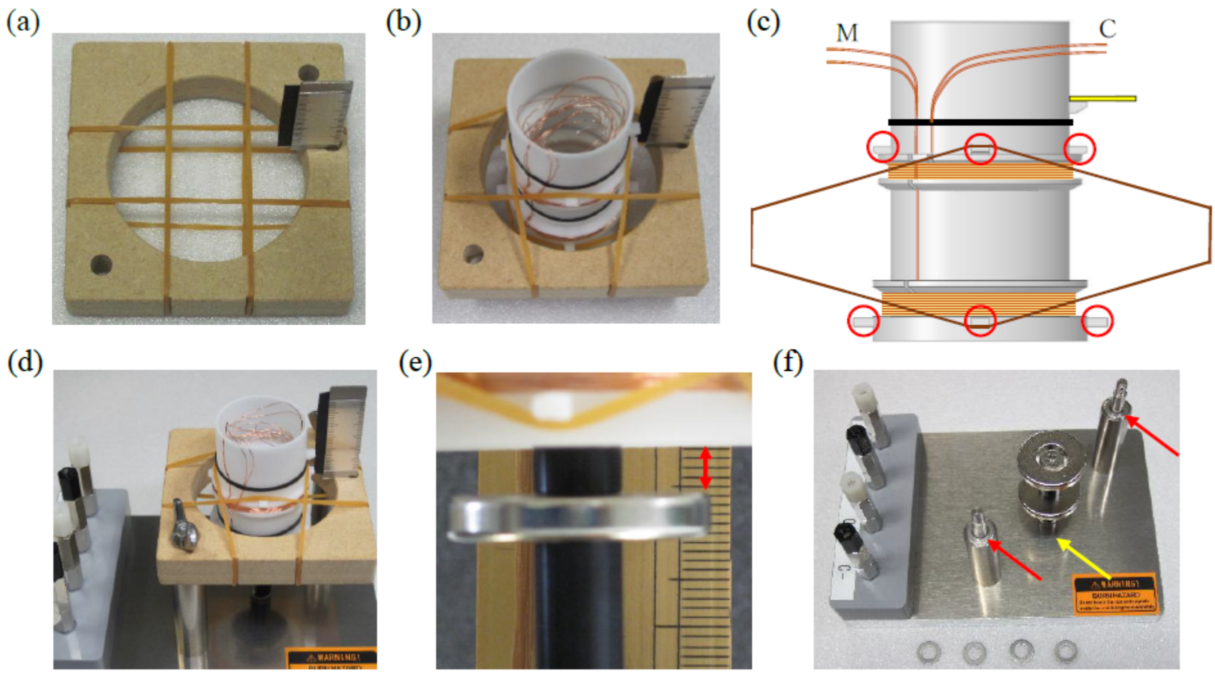


Figure 3: Installation of the oscillator.

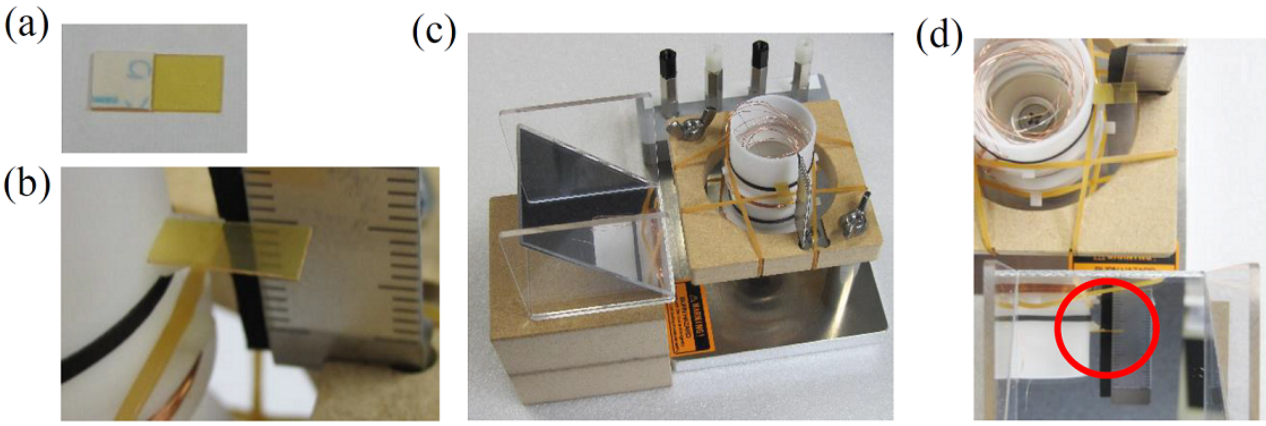


Figure 4: Installation of the marker and mirror.

Wiring

1. Locate and pull gently the correct pair of wires leading to the main (M) and control (C) coils (Fig. 3(c)) from inside the oscillator (Fig.3(b)). Check to see if the enamel has been stripped off from the loose ends.
2. Loosen the screw on the binding posts M+ and M- to allow for gaps. Use the lower gaps for the wiring (Fig. 5(a), (b)). The polarity check will follow soon.
3. Wire the binding posts labeled C+ and C- likewise. (Either polarity is acceptable.)

4. Place the batteries in the battery holders and secure connections with PS (CN1, CN2) (Fig. 5(c)).
5. Connect the binding posts M+ and M- to the DC output (DC+ and DC-) on PS using the U-shaped crimp terminal wires.
6. Toggle on DC and power up PS.
7. Turn the "DC Vol." knob to adjust the current. Check to see if the oscillator moves upward by 2 mm or higher. If downward, swap the wires for polarity reversal and try again.

Caution: Hot parts. Beware of coils and magnets. Put the DC output down to the minimum at the end of each step.

(a) (b) (c)

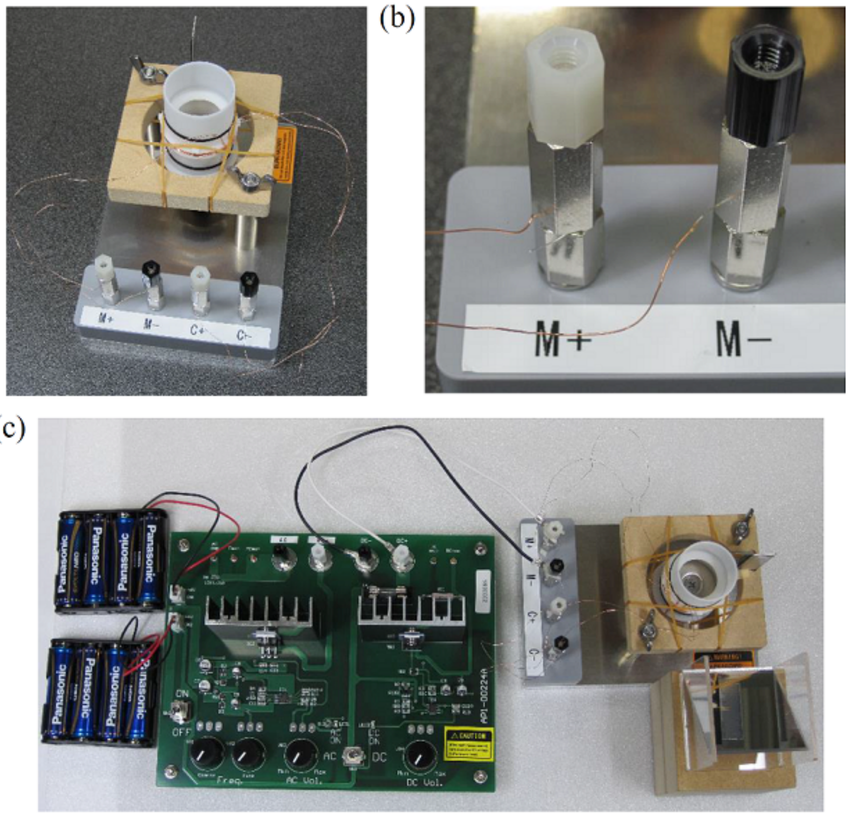


Figure 5: (a), (b) Binding posts wired, (c) The whole setup wired including PS and batteries.

Oscillator test

1. Connect the M+ and M- binding posts to the AC output (AC+ and AC-) with the crimp terminal wires.
2. Toggle on the AC and power up PS.
3. Turn the knob labeled "AC Vol." clockwise starting from the minimum up to a quarter turn. Tune the frequency with the "Coarse" control knob to start oscillation.
4. Adjust the AC output voltage and frequency to make the oscillation about $A = 3$ mm in amplitude (Fig.6). If the oscillation is unstable, adjust the oscillator settings as appropriate.
5. Disconnect M+ and M- and connect the C+ and C- binding posts to the AC output.

6. Power up PS to start oscillation again.

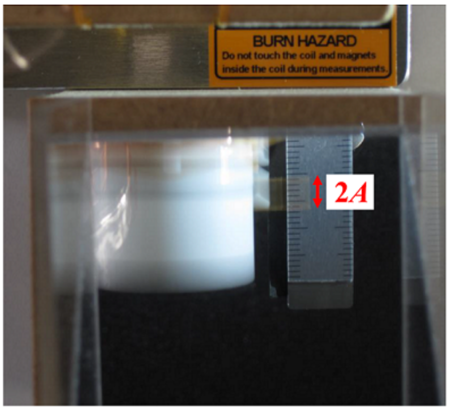


Figure 6: Oscillation behavior as seen through the mirror.

Part A. Hooke's law and electromagnetic forces (2.4 points)

A.1	Draw in the answer sheet the magnetic field lines created by the two identical disc-shaped magnets with their N poles facing each other.	0.4pt

A.2	Connect the M+ and M- posts to the DC output. Couple the DMM with the terminals for DC current readouts using the alligator clip wires (Fig. 7). Read the oscillator height z at null DC current without a weight, i.e., $N = 0$. Record it in **Table A.2**. Place a weight ($N = 1$) on a circular shelf hanging out from the inner wall of the cylinder and record the height z at which the oscillator comes to rest. What is the DC current I flowing through the main coil to bring the oscillator back to where it was without a weight? Repeat the measurements with increasing N up to 5 to fill in **Table A.2**.	0.6pt

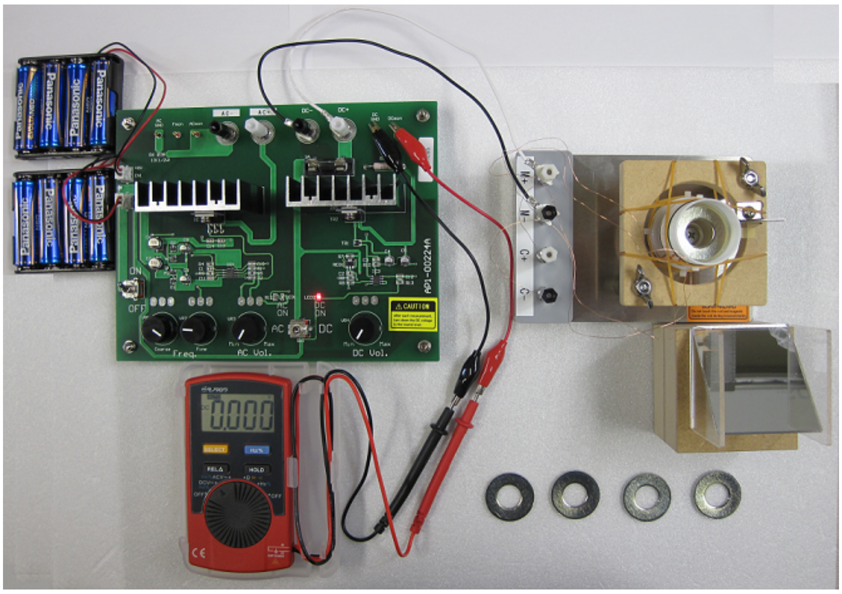


Figure 7: The test leads of the DMM connected. The oscillator with a weight on the right.

A.3	Draw a graph showing the relationship between the number of the weights N and the height z. Obtain the slope $a = \frac{\Delta z}{\Delta N}$ and its uncertainty from the graph.	0.7pt

A.4	Draw a graph showing the relationship between the number of weights N and the current I. Obtain the value of b defined as $b = \frac{I}{N}$ and its uncertainty from the graph.	0.7pt

Part B. Induced electromotive force (3.0 points)

B.1 Suppose that an AC current at frequency f is applied to the control coil without a weight. Given that the oscillator height varies sinusoidally with time **0.2pt**

$$z - z_0 = A\sin(2\pi f t) \tag{2}$$

where z_0 is the height for the force balance and A is the amplitude of the oscillation, write down the expression for the amplitude V of the induced electromotive force in the main coil.

B.2 Connect the C+ and C- posts to the AC output. Connect the DMM to the "Fmon" and "AC GND" to read the frequency. **0.5pt**

Adjust both the AC frequency and the output voltage to produce a steady oscillation of appropriate amplitude. Measure the frequency f_B and record it in the answer sheet.

Couple the DMM with the binding posts M+ and M-. With the frequency fixed, vary the output voltage and measure the oscillation amplitude A and the AC voltage $V'(V' = V/\sqrt{2})$ induced in the main coil. Fill in **Table B.2** as appropriate.

B.3	Draw a graph showing the relationship between the amplitude A and voltage V'. Obtain the value of c defined as $c = \frac{V'}{A}$ and its uncertainty from the graph.	0.7pt

B.4	Calculate BL and its uncertainty using the results of **B.3**.	0.4pt

B.5	Using the results of **A.3**, **A.4**, and **B.4**, calculate the values of m and k and quantify their uncertainties. Use the acceleration due to gravity, $g = 9.80$ m/s^2 where appropriate.	1.2pt

Part C. Mass-dependent resonant frequency (2.3 points)

For the following experiments use the main coil to drive the oscillator. Change connections accordingly.

C.1	Write down the expression for the resonant frequency f of the oscillator with N weights. Use the spring constant k' during motion, which is different than k.	0.2pt

C.2	Drive the oscillator by coupling AC power to the main coil. Measure the resonant frequency f, for different number of weights, $N = 0$ to 5, and write down the values in **Table C.2**. Avoid jumping weights.	0.5pt

C.3	Using the results of **C.2**, draw a graph to obtain $\frac{M}{k'}$ and $\frac{m}{k'}$. Write down the obtained values in the answer sheet. If you need to calculate any additional physical quantities, write them down in the blanks of **Table C.2**.	1.0pt

C.4	What is the value of $\frac{M}{m}$? Calculate M and k' using the results of **B.5**.	0.6pt

Part D. Resonance characteristics (2.3 points)

When a periodic force of amplitude F_{AC} and frequency f acts on the oscillator without a weight, the oscillation amplitude of A is well described by the following with resonance characteristics:

$$A(f) = \frac{F_{\text{AC}}}{8\pi^2 M f_0} \cdot \frac{1}{\sqrt{(f - f_0)^2 + (\Delta f)^2}}. \tag{3}$$

Here $\Delta f = \frac{\alpha}{4\pi M}$. This equation only holds in the frequency range where $|f - f_0| \ll f_0$ is relevant.

In this part, the resonance characteristics are used to obtain the mass of the oscillator, M, assuming that Eq. (3) is always valid.

D.1	Drive the oscillator by coupling AC power to the main coil. Adjust the frequency and output voltage to produce a resonance with appropriate amplitude. Record the AC voltage V'_{AC} between the “ACmon” and "AC GND" in the answer sheet. Using the results of **B.4** and the conversion factor 0.106 A/V, calculate the amplitude F_{AC} of the periodic electromagnetic force acting on the oscillator.	0.4pt

D.2	Record in **Table D.2** the amplitude A of the oscillation as the frequency f is varied. A constant amplitude F_{AC} of the applied force must be maintained throughout the measurement. Draw a graph showing the relationship between the frequency f and the amplitude A.	0.9pt

D.3	Using the results of **D.1** and **D.2**, obtain M.	1.0pt

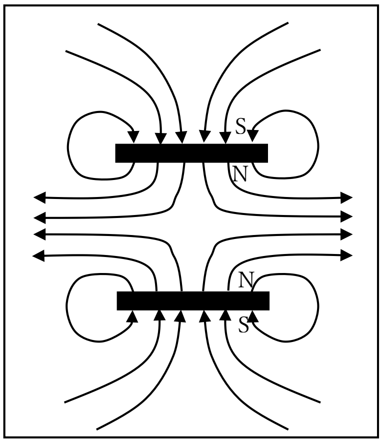
Mass Measurement (10 points)

Write down the numbers 0 to 9 in the following table:

0	1	2	3	4	5	6	7	8	9
0	1	2	3	4	5	6	7	8	9

Part A: Hooke's law and electromagnetic forces (2.4 points)

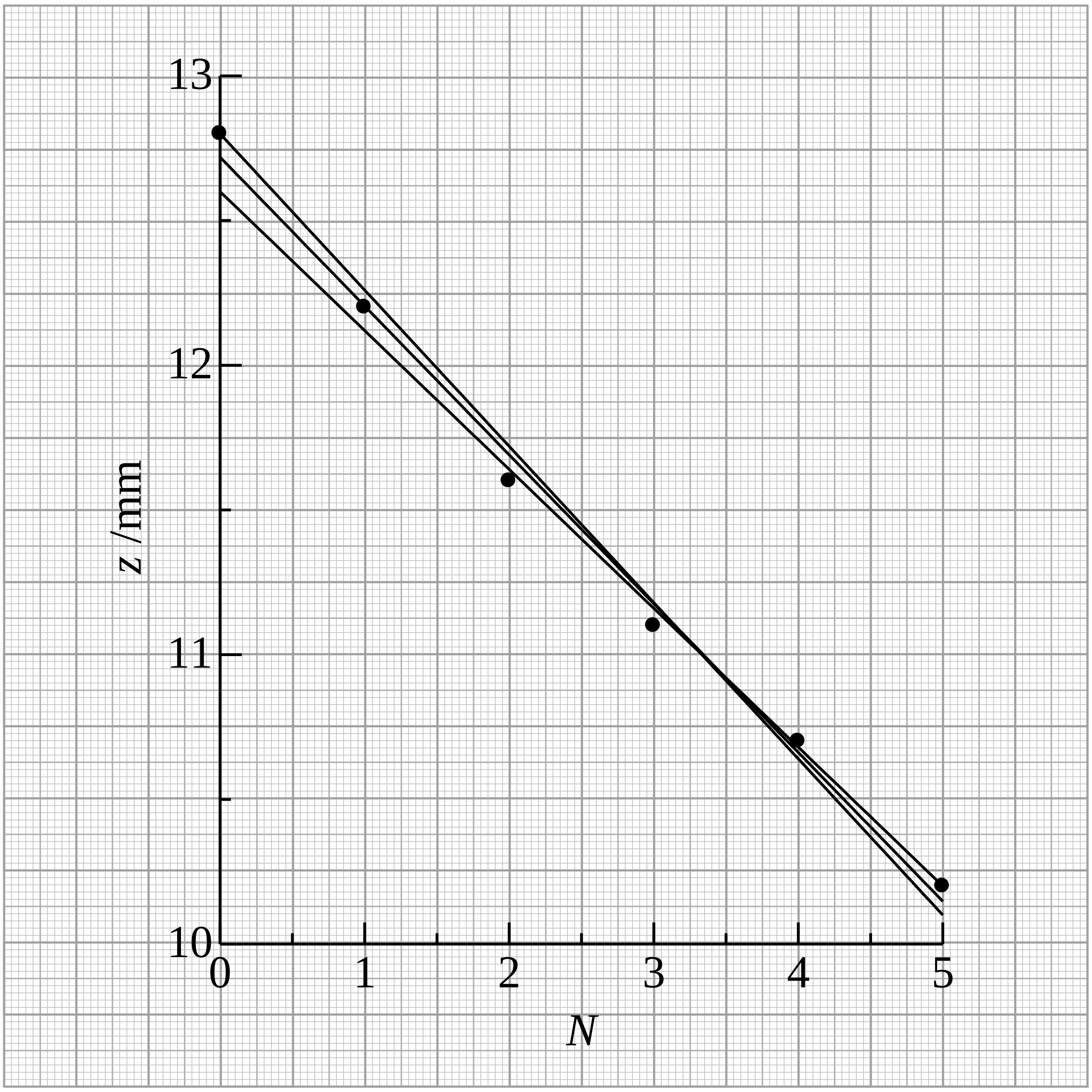
A.1 (0.4 pt)



A.2 (0.6 pt)

N	z /mm	I /A
0	12.8	0
1	12.2	0.103
2	11.6	0.213
3	11.1	0.323
4	10.7	0.423
5	10.2	0.524

A.3 (0.7 pt)



The slope and uncertainty are read from the lines plotted on the graph.

$$a = \frac{\Delta z}{\Delta N} = \frac{10.15 - 12.70}{5} = -0.51$$

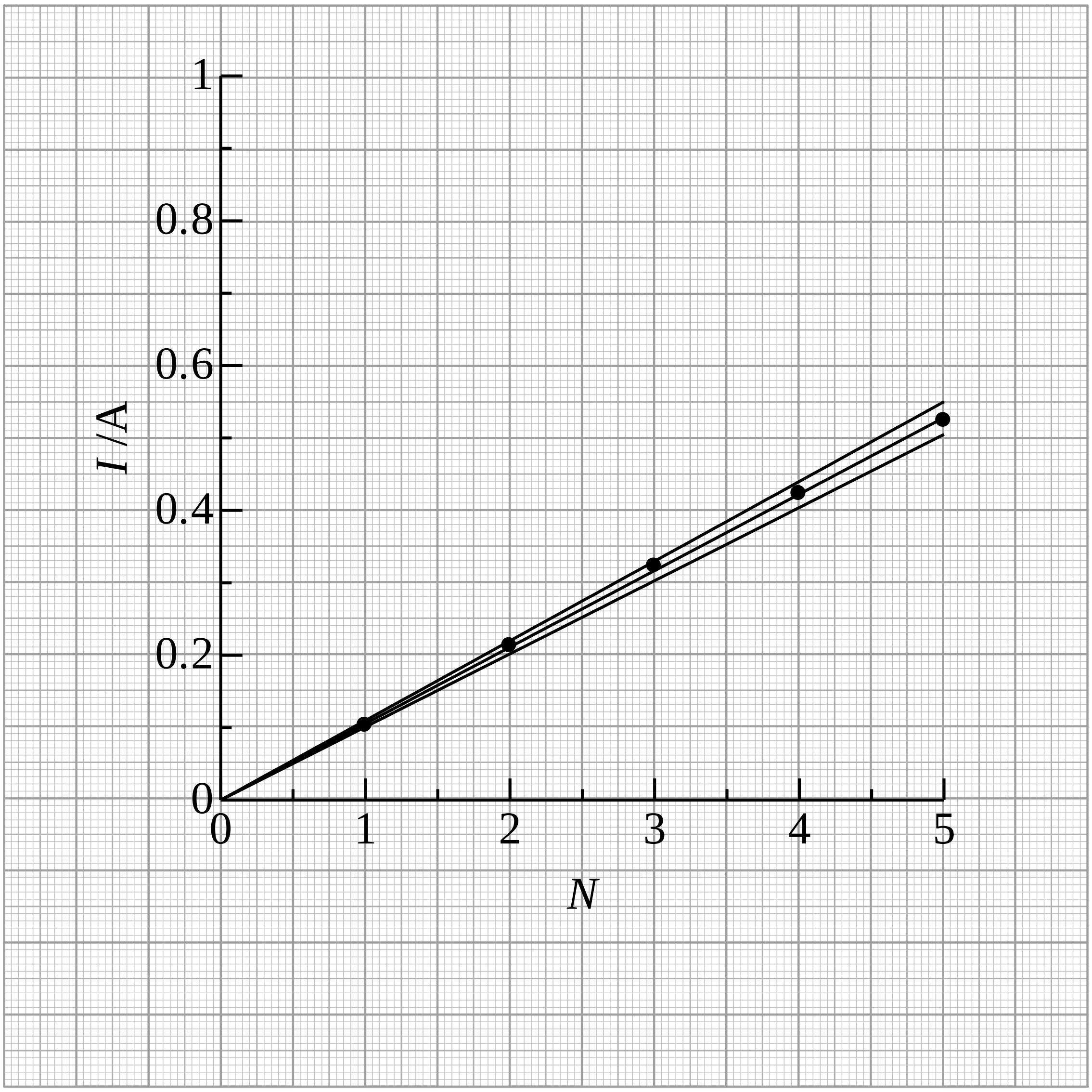
$$a_+ = \frac{10.20 - 12.60}{5} = -0.48$$

$$a_- = \frac{10.10 - 12.80}{5} = -0.54$$

$$\Delta a = \frac{-0.48 - (-0.54)}{2} = 0.03$$

$$a = -0.51 \pm 0.03 \text{ mm}$$

A.4 (0.7 pt)



The slope and uncertainty are read from the lines plotted on the graph.

$$b = \frac{I}{N} = \frac{0.53}{5} = 0.106$$

$$b_{+} = \frac{0.55}{5} = 0.110$$

$$b_{-} = \frac{0.505}{5} = 0.101$$

$$\Delta b = \frac{0.110 - 0.101}{2} = 0.005$$

$$b = \ 0.106 \pm 0.005 \text{ A}$$

Part B: Induced electromotive force (3.0 points)

B.1 (0.2 pt)

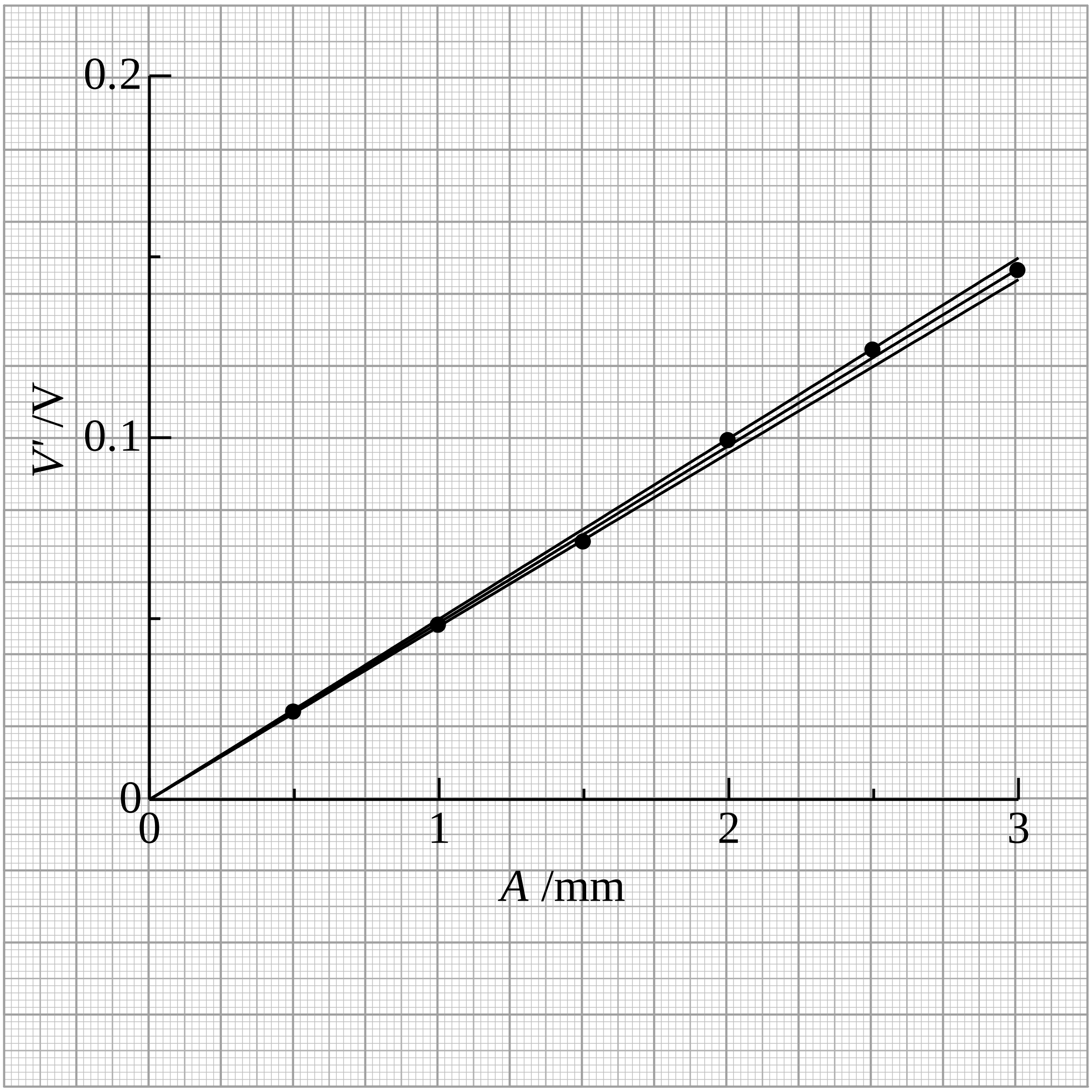
$V = 2\pi f ABL$

B.2 (0.5 pt)

$f_{\mathrm{B}} = 15.85\ \mathrm{Hz}$

A /mm	V' /V
0.5	0.024
1.0	0.048
1.5	0.071
2.0	0.099
2.5	0.124
3.0	0.146

B.3 (0.7 pt)



The slope and uncertainty are read from the lines plotted on the graph.

$$c = \frac{V'}{N} = \frac{0.147}{5} = 0.049$$

$$c_+ = \frac{0.150}{5} = 0.050$$

$$c_- = \frac{0.144}{5} = 0.048$$

$$\Delta c = \frac{0.050 - 0.048}{2} = 0.001$$

$$c = \ 0.049 \pm 0.001 \ \mathrm{V/mm}$$

B.4 (0.4 pt)

$$BL = \frac{V}{2\pi A f_\mathrm{B}} = \frac{\sqrt{2}V'}{2\pi A f_\mathrm{B}} = \frac{\sqrt{2}c}{2\pi f_\mathrm{B}} = \frac{\sqrt{2}\times 0.049}{2\pi \times 15.85} = 0.000696\ \mathrm{Vs/mm} = 0.696\ \mathrm{Vs/m}$$

$$\Delta(BL) = BL\cdot\frac{\Delta c}{c} = 0.696\times\frac{0.001}{0.049} = 0.014\ \mathrm{Vs/m}$$

$$BL = \ 0.696 \pm 0.014\ \mathrm{Vs/m}$$

B.5 (1.2 pt)

$$m = \frac{mg}{BL}\cdot\frac{BL}{g} = \frac{I}{N}\cdot\frac{V}{2\pi A f_\mathrm{B}}\cdot\frac{1}{g} = b\frac{\sqrt{2}c}{2\pi g f_\mathrm{B}} = 0.106\times\frac{\sqrt{2}\times 0.049}{2\pi\times 9.80\times 15.85} = 0.0075\ \mathrm{kg} = 7.5\ \mathrm{g}$$

The principle of the Kibble balance (watt balance)

Mechanical power: $Fv = Nmg\cdot 2\pi A f_\mathrm{B}$

Electrical power: VI

$$Fv = VI$$

$$\Delta m = m\cdot\sqrt{(\frac{\Delta b}{b})^2 + (\frac{\Delta c}{c})^2} = 0.4\ \mathrm{g}$$

$$m = \ 7.5 \pm 0.4\ \mathrm{g}$$

$$k = -\frac{mg}{a} = -\frac{7.5\times 9.80}{-0.51} = 144\ \mathrm{N/m}$$

$$\Delta k = k\cdot\sqrt{(\frac{\Delta a}{a})^2 + (\frac{\Delta m}{m})^2} = 11\ \mathrm{N/m}$$

$$k = \ 144 \pm 11\ \mathrm{N/m}$$

Part C: Mass dependence of resonant frequency (2.3 points)

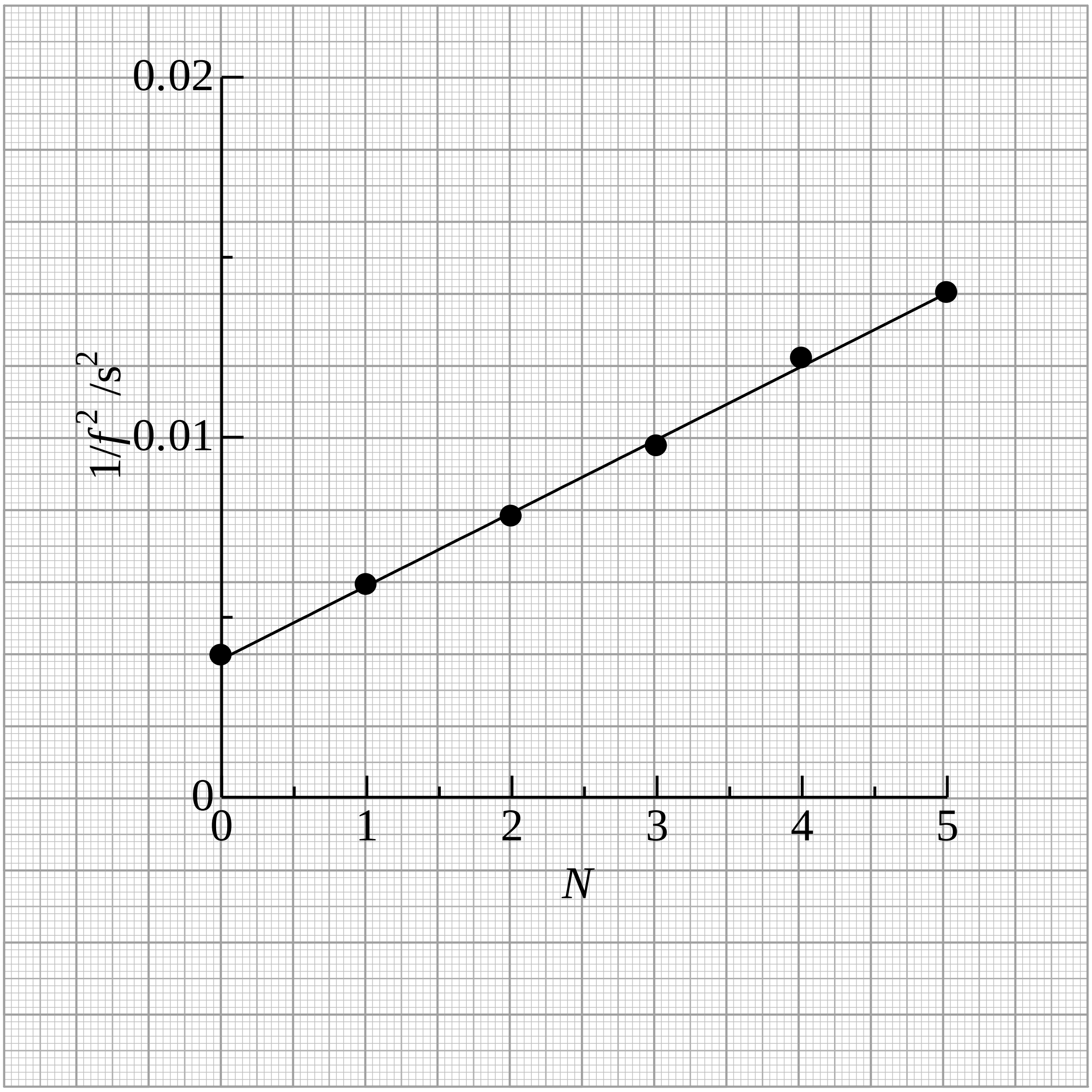
C.1 (0.2 pt)

$$f = \frac{1}{2\pi}\sqrt{\frac{k'}{M+Nm}}$$

C.2 (0.5 pt)

N	f /Hz	$1/f^2$ /s^2		
0	15.96	0.003926		
1	13.03	0.005390		
2	11.33	0.007790		
3	10.13	0.009745		
4	9.06	0.01218		
5	8.45	0.01401		

C.3 (1.0 pt)



The additional quantities $1/f^2$ are calculated in Table C.2. Then, $\frac{M}{k'}$ and $\frac{m}{k'}$ are obtained from the graph using the equation $\frac{1}{f^2} = (2\pi)^2(\frac{M}{k'} + \frac{m}{k'}N)$.

$$\frac{M}{k'} = \frac{0.0039}{(2\pi)^2} = 9.88 \times 10^{-5}\ \mathrm{s}^2$$

$$\frac{m}{k'} = \frac{(0.0140 - 0.0039)/5}{(2\pi)^2} = 5.12 \times 10^{-5}\ \mathrm{s}^2$$

C.4 (0.6 pt)

$$\frac{M}{m} = \frac{M/k'}{m/k'} = \frac{9.88}{5.12} = 1.93$$

$$\frac{M}{m} = 1.93$$

$$M = \frac{M}{m} \cdot m = 1.93 \times 0.0075 = 0.0145 \text{ kg}$$

$$M = 14.5 \text{ g}$$

$$k' = \frac{M}{M/k'} = \frac{0.0145}{9.88 \times 10^{-5}} = 147 \text{ N/m}$$

$$k' = 147 \text{ N/m}$$

Part D: Resonance characteristics (2.3 points)

D.1 (0.4 pt)

$$V'_{\mathrm{AC}} = 0.157\ \mathrm{V}$$

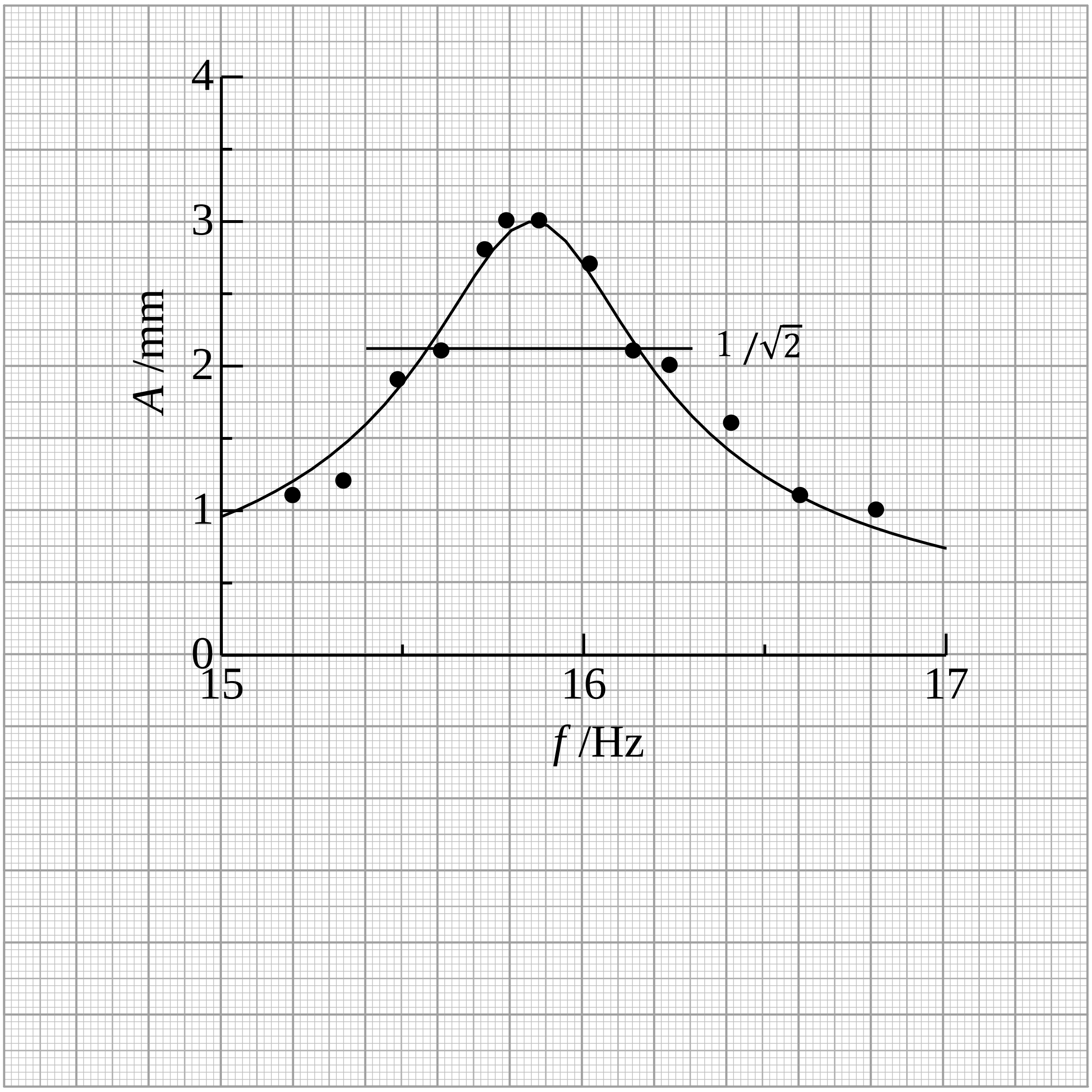
$$F_{\mathrm{AC}} = BLI_{\mathrm{AC}} = BL \times 0.106 \times \sqrt{2}V'_{\mathrm{AC}} = 0.696 \times 0.106 \times \sqrt{2} \times 0.157 = 0.0164\ \mathrm{N}$$

$$F_{\mathrm{AC}} = 0.0164\ \mathrm{N}$$

D.2 (0.9 pt)

f /Hz	A /mm	$(f-f_0)^2$ /Hz^2	$1/A^2$ /mm^{-2}
15.88	3.0	0.0064	0.111
15.79	3.0	0.0289	0.111
15.73	2.8	0.0529	0.128
15.61	2.1	0.1225	0.227
15.49	1.9	0.2209	0.277
15.34	1.2	0.3844	0.694
15.20	1.1	0.5776	0.826
16.02	2.7	0.0036	0.137
16.14	2.1	0.0324	0.227
16.24	2.0	0.0784	0.250
16.41	1.6	0.2025	0.391
16.60	1.1	0.4096	0.826
16.81	1.0	0.7225	1.000

D.2 (cont.)



D.3 (1.0 pt)

Reading from the graph D.2

$f_0 = 15.83\ \mathrm{Hz}$

$A(f_0) = 3.0\ \mathrm{mm}$

$$\Delta f = \frac{15.14 - 15.56}{2} = 0.29\ \mathrm{Hz}$$

Calculaton using Eq.(4)

$$M = \frac{F_{\mathrm{AC}}}{8\pi^2 f_0 \Delta f A(f_0)} = \frac{0.0164}{8\pi^2 \times 15.83 \times 0.29 \times 0.003} = 0.0151\ \mathrm{kg}$$

$$M = 15.1\ \mathrm{g}$$

An alternative way to find M

$(f - f_0)^2$ and $1/A^2$ are calculated in Table D.2 to use the linear relationship

$$\frac{1}{A^2} = \left(\frac{8\pi^2 M f_0}{F_{\mathrm{AC}}}\right)^2 \cdot [(f - f_0)^2 + (\Delta f)^2]\ .$$

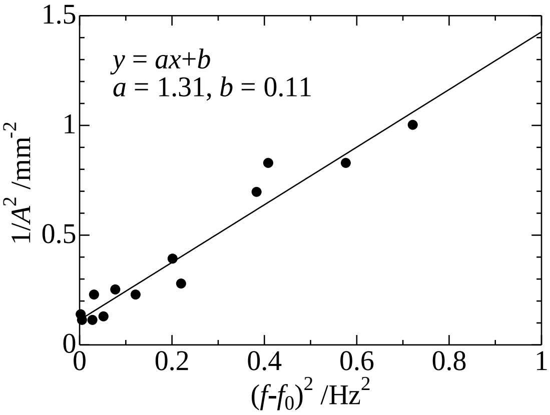
$f_0 = 15.96\ \mathrm{Hz}$ obtained in C.2 is used.

The slope is obtained from the graph of the additional quantities or the calculation

$$\left(\frac{8\pi^2 M f_0}{F_{\mathrm{AC}}}\right)^2 = 1.31\ \mathrm{mm}^{-2}\mathrm{Hz}^{-2} = 1.31 \times 10^6\ \mathrm{m}^{-2}\mathrm{Hz}^{-2}.$$

$$M = \sqrt{1.31 \times 10^6} \times \frac{F_{\mathrm{AC}}}{8\pi^2 f_0} = \sqrt{1.31 \times 10^6} \times \frac{0.0164}{8\pi^2 \times 15.96} = 0.0149\ \mathrm{kg}$$

$$M = 14.9\ \mathrm{g}$$



Thickness Measurements Using Birefringence (10 points)

Uncertainty analysis is not required throughout this question.

Birefringence is an optical property of a crystal that light propagates as two rays experiencing different refractive indices. When the orthogonal crystal axes x and y lie in the plane of the input face of a birefringent crystal (Fig. 1), the electric field $\boldsymbol{E}$ of linearly polarized light at normal incidence on the crystal is decomposed into two orthogonal components $\boldsymbol{E}_x$ and $\boldsymbol{E}_y$ accompanied by refractive indices n_o and n_e, respectively. For a crystal of thickness L, the phase shift of the x-polarized light Γ_x and that of the y-polarized light Γ_y as they pass through the crystal are respectively given by

$$\Gamma_x = \frac{2\pi}{\lambda} n_\mathrm{o} L, \tag{1}$$

$$\Gamma_y = \frac{2\pi}{\lambda} n_\mathrm{e} L, \tag{2}$$

where λ is the wavelength of light in vacuum.

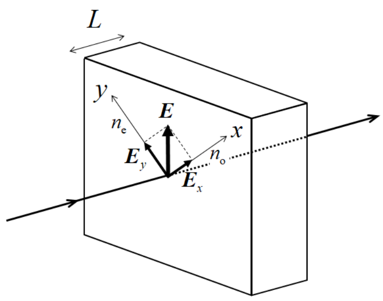


Figure 1: Vectorial decomposition of the electric field $\boldsymbol{E}$ of linearly polarized light at normal incidence on the surface of a birefringent crystal.

The phase difference Γ between the two rays is

$$\Gamma = \Gamma_y - \Gamma_x = \frac{2\pi}{\lambda} \Delta n L, \tag{3}$$

where

$$\Delta n = n_\mathrm{e} - n_\mathrm{o} \tag{4}$$

is the birefringence. Since the electric field of light is the vectorial sum of $\boldsymbol{E}_x$ and $\boldsymbol{E}_y$ with a phase difference Γ, the light after passing through the crystal has a polarization component perpendicular to the initial linear polarization of the incident light.

Let $I_\parallel$ and $I_\perp$ denote the intensities of the components of the light after passing through the crystal which are parallel and perpendicular to the direction of the linear polarization of the incident light, respectively. Hereafter the direction of the linear polarization of the incident light ($\boldsymbol{E}$ in Fig. 1) is 45° with respect to the x axis. Then the normalized intensity of the perpendicular component I_Norm is given by

$$I_\mathrm{Norm} = \frac{I_\perp}{I_\mathrm{Total}} = \sin^2 \frac{\Gamma}{2}, \tag{5}$$

where I_{Total} is the total transmitted light intensity, $I_{\parallel} + I_{\perp}$.

We can design an experiment such that I_{Norm} oscillates between 0 and 1 as we vary the wavelength of the incident light. Let λ_m $(m = 1, 2, 3, \cdots)$ be the wavelengths at which $I_{\text{Norm}} = 0$; then we find the phase difference Γ_m such that

$$\Gamma_m = \frac{2\pi}{\lambda_m} \Delta n(\lambda_m) L = 2\pi m. \tag{6}$$

This equation allows us to determine the crystal thickness L if multiple λ_m's can be measured for the known $\Delta n(\lambda_m)$.

In this experiment, you will determine the thickness of the quartz plate. Quartz is birefringent with its refractive indices n_{o} and n_{e} depending on the wavelength of light in vacuum as shown in Fig. 2.

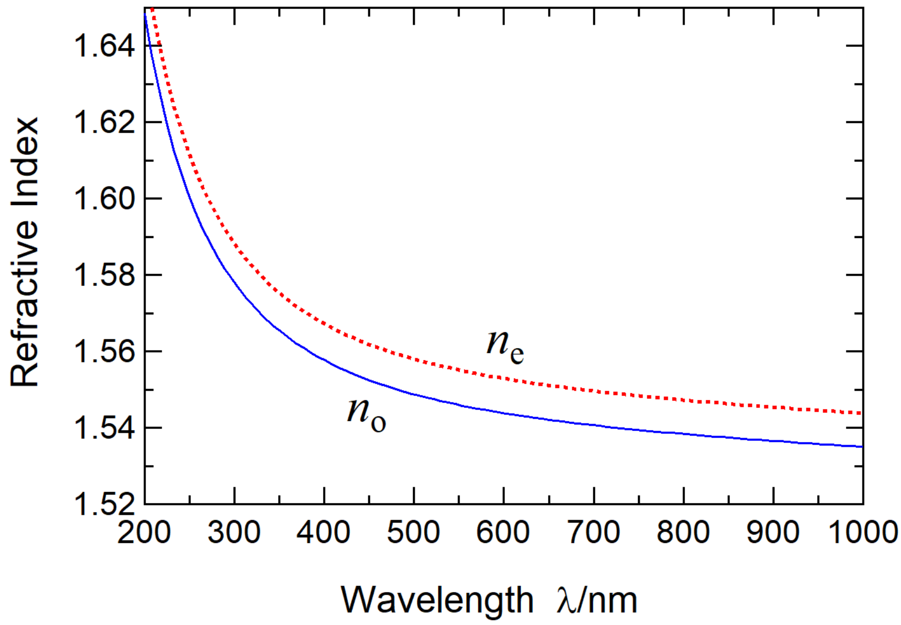
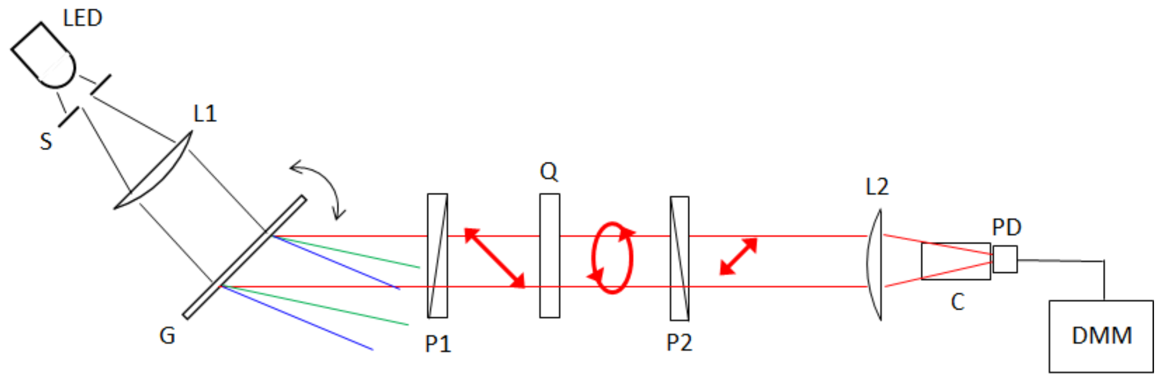


Figure 2: Wavelength dependence of the refractive indices n_{o} and n_{e} of quartz.

Figure 3 shows the thickness-measurement system. Shown in Figs. 4 and 5 are the optomechanical and photonic components and devices. A white light-emitting diode (LED) is used as the light source, which contains a blue LED and a phosphor. When light from the blue LED is irradiated onto the phosphor, white light is emitted with a continuous spectrum. Light from this white LED is dispersed, i.e., spectrally resolved, using the transmission diffraction grating **G**, and linearly polarized by the polarizer **P1**. Its direction of polarization ($\boldsymbol{E}$ in Fig. 1) is 45° off the x-axis of the quartz plate **Q**. The polarization component of light after passing through **Q**, i.e., parallel and perpendicular to the direction of polarization of **P1**, is selected by rotating the polarizer **P2**. The photodetector measures the light intensity.

(a)



(b)

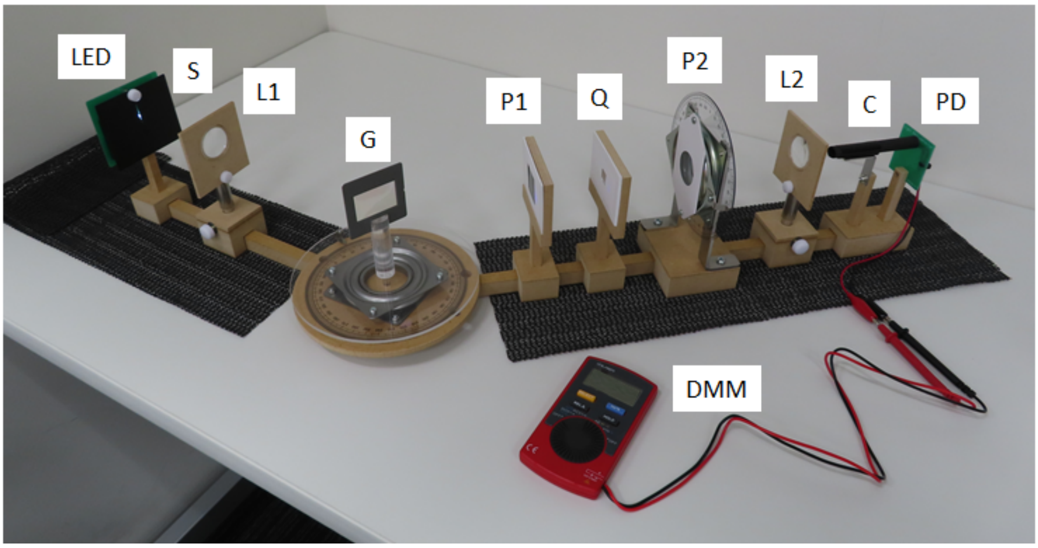


Figure 3: (a) Schematic and (b) photograph of thickness−measurement system. **LED**: white LED, **S**: slit, **L1**: collimating lens, **G**: transmission diffraction grating, **P1**: polarizer, **Q**: quartz plate, **P2**: polarizer, **L2**: focusing lens, **C**: light-shield cylinder, **PD**: photodetector, **DMM**: digital multimeter.

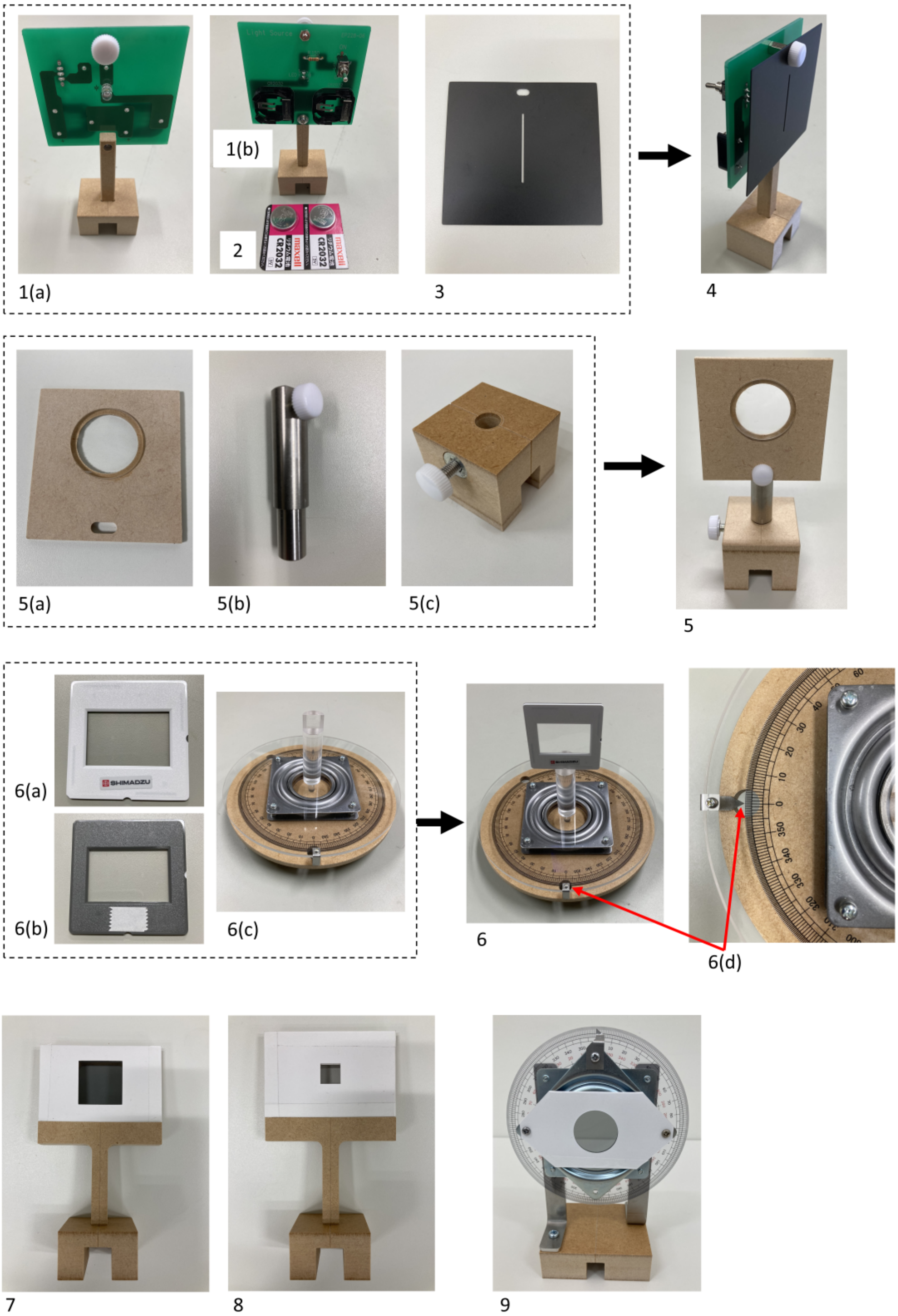


Figure 4: Components and devices: **1(a)**. white LED (front view); **1(b)**. white LED (rear view); **2**. batteries; **3**. slit (**S** in Fig. 3); **4**. LED with slit attached; **5**. lens (**L1**, **L2** in Fig. 3); **5(a)** mounted lens; **5(b)** lens post; **5(c)** post base; **6**. transmission diffraction grating (**6(a)** front; **6(b)** rear w/ adhesive tape) on **6(c)** rotation stage (**G** in Fig. 3); **6(d)** angle readout device on the rotation stage; **7**. polarizer (**P1** in Fig. 3); **8**. quartz plate (**Q** in Fig. 3); **9**. polarizer on rotation mount (**P2** in Fig. 3).

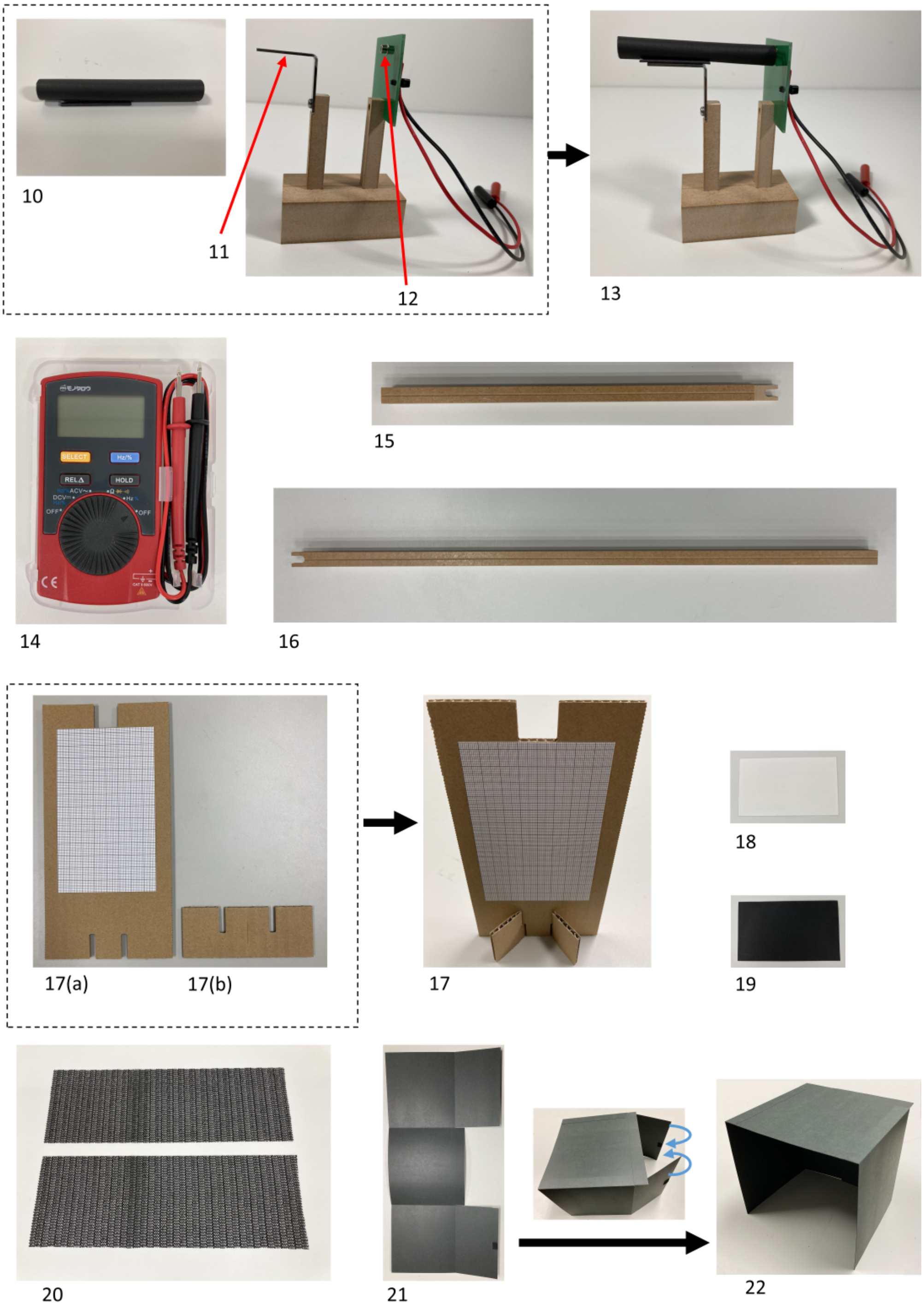


Figure 5: Components and devices (continued): **10**. light–shield cylinder with magnet (**C** in Fig. 3); **11**. cylinder mount; **12**. photodetector (**PD** in Fig. 3); **13**. photodetector with cylinder; **14**. digital multimeter (**DMM** in Fig. 3); **15**. short guide rail; **16**. long guide rail; **17**. scale assembly; **18**. white card; **19**. black card; **20**. anti-slip sheets; **21** & **22**. light-shield box (before assembly and as assembled).

Part A. Measurement System Setup (2.3 points)

The LED output is incident on the grating surface (Fig. 6). The rotation angle θ of **G** for normal incidence is defined as 0°. The counterclockwise and clockwise rotations are denoted by $+$ and $-$, respectively. The first-order diffraction angle α is defined as illustrated. Using the groove period (or slit separation) d of **G**, the wavelength λ is given in terms of θ as

$$\lambda = d\sin(\alpha-\theta) + d\sin\theta \tag{7}$$

$$= 2d\sin\frac{\alpha}{2}\cos\left(\frac{\alpha}{2}-\theta\right). \tag{8}$$

Hereafter use $d = 1.00$ µm and the fixed diffraction angle $\alpha = 40.0°$.

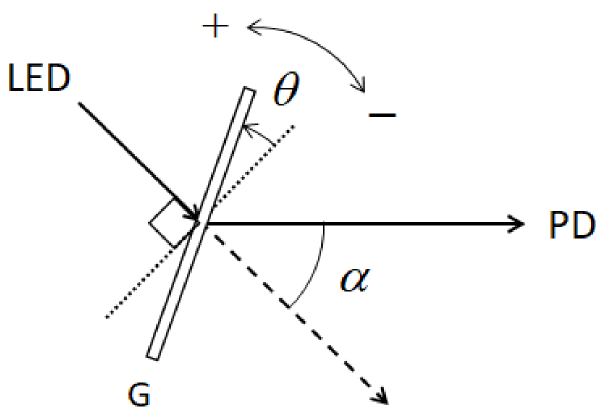


Figure 6: The rotation angle θ of the transmission diffraction grating **G** and the diffraction angle α.

A.1	Calculate the longest wavelength λ that can be measured and the associated θ.	0.3pt

A.2	Calculate the numeric values of θ for $\lambda = 440$ nm.	0.2pt

Setup procedures for the measurement system are as follows.

[1] Stand the scale assembly upright (**17** in Fig. 5) using the pedestal (**17(b)**).

[2] Set two batteries on the white LED module. The "+" sides must face toward you.

[3] Turn on the LED.

[4] Remove the screw on the front side of the LED module. Attach the slit to the LED module with the screw (**4** in Fig. 4). Using the scale assembly, adjust the slit position to make the transmitted white light flux brightest, and measure the height of the beam center at the exit of the slit (for the procedure [9]).

[5] Let the U-shaped open-slotted end of the long guide rail ride on that of the short one (Fig. 7(i)). Insert the rotation axle sticking out of the bottom face of the rotation stage into the "virtual through-hole" made by the guide rails (Fig. 7(ii)). Ensure free and smooth rotation of both arms about the axle referring to Fig. 7(iii). Make sure that the long guide rail will stay on the table $0° \leq \alpha \leq 40.0°$.

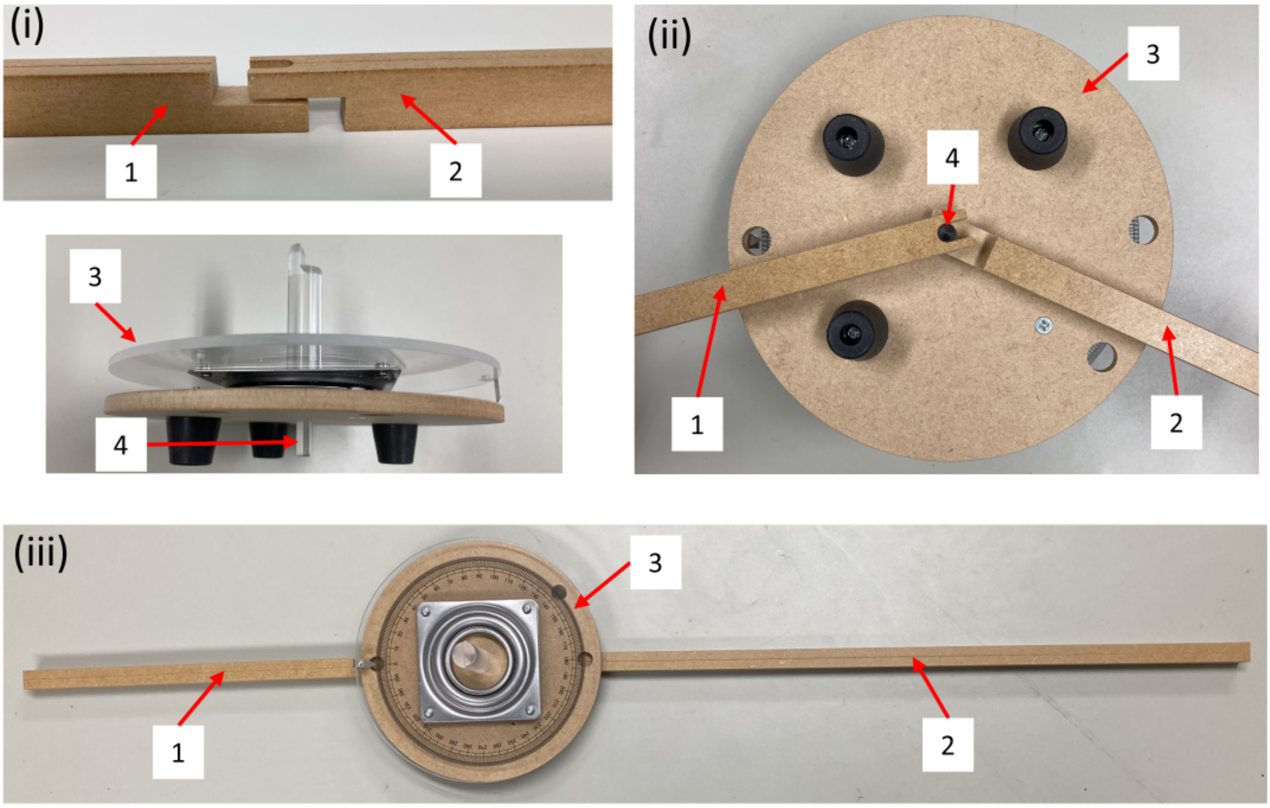


Figure 7: **(i)** U-shaped open-slotted end of the short guide rail under that of the long guide rail making a "virtual" through-hole. **(ii)** Into the virtual hole, insert the axle sticking out of the bottom face of the rotation stage. **(iii)** Top view of the rotation stage with guide rails that are free to rotate about the axle. **1**. short guide rail; **2**. long guide rail; **3**. rotation stage; **4**. axle of the rotation stage.

[6] Align the centerline of the short guide rail with 0° on the scale of the rotation stage, and keep it in that place. You may put an anti-slip sheet under the short guide rail.

[7] Assemble the lenses (**5** in Fig. 4).

[8] Place the white LED module with the slit and the lens (**L1** in Fig. 3) on the short guide rail. Adjust the distance between the slit and **L1** so that the light beam size after passing through **L1** remains almost constant, i.e., collimated, over the flight path.

[9] Using the scale assembly, measure the beam height after **L1**. Adjust the level of **L1** by loosening the setscrew of the post base and moving the post as necessary to keep the beam height almost the same as that right after the slit.

[10] Align the centerline of the long guide rail with 180° on the angle scale on the rotation stage.

[11] Tweak the horizontal position of the lens mount (**5(a)** in Fig. 4) by loosening the setscrew and moving it right or left. The beam center after **L1** should align with the center line of the long guide rail. You may put the scale assembly upside down over the long rail.

[12] Expose the second surface of the double-sided adhesive tape on the rear side of the transmission diffraction grating (**6(b)** in Fig. 4) and affix it to the axle top of the rotation stage (**6** in Fig. 4).

[13] Face the front side of the grating towards the light source, and rotate the stage so that the reflected light enters the slit, i.e., $\theta = 0°$ (normal incidence). Record the angle θ_{Stage} of the rotation stage. It will be used in B.1.

[14] Move the long guide rail around the axle so that $\alpha = 40.0°$ (Fig. 6). Once fixed, you may place another anti-slip sheet thereafter to prevent accidental misalignment.

[15] Place the lens (**L2** in Fig. 3) and the photodetector (**PD** in Fig. 3) with the cylinder mount on the long rail. To focus the diffracted light onto **PD**, adjust the distance between **PD** and **L2** along the long rail, and also the height of **L2**. The vertical beam diameter is thereby minimized. Check the beam diameter with the white card. In case it is too weak to recognize with the naked eye, use the light-shield box to cover **PD**.

[16] Set the light-shield cylinder to the mount (**13** in Fig. 5). The light shield minimizes the unwanted light to be detected.

[17] Connect **PD** to the DMM. The red (black) jump wire goes to red (black) terminal. Set the multimeter to the DC voltage measurement mode.

[18] Adjust the height of **L2** to maximize the DMM readings. Hereafter the intensity of light is identified with the voltage values on the DMM.

A.3	Rotate the rotation stage and find the angle θ and the corresponding wavelength λ_{Peak} at which the blue LED spectral density is maximized, assuming that $\alpha = 40.0°$. If your answer for λ_{Peak} is between 450 and 460 nm, your apparatus is properly aligned; write down $\alpha = 40.0°$ on the answer sheet and continue. Otherwise, you will have to find the true value of α. Without changing anything, including your original value for λ_{Peak}, find a corrected value for α which would make λ_{Peak} fall in the appropriate range. Record this α on the answer sheet and use it for the rest of the problem.	0.8pt

[19] Set the polarizers (**P1** and **P2** in Fig. 3) on the long guide rail.

A.4	Set the rotation stage to the $\theta = -15.0°$ position. Watch the readings on the DMM and find the angle $\varphi_{\perp}$ of the rotation mount of the polarizer **P2** such that its polarization direction is perpendicular to that of the light transmitted through the polarizer **P1**. From this result, find the angle $\varphi_{\parallel}$ of the rotation mount of the polarizer **P2** when its polarization direction is parallel to that of the polarizer **P1**.	0.3pt

A.5	Block the light through the slit by placing the black card in front of the slit. By doing so, you can evaluate the system background, i.e., the offset of the intensity from zero. We define the light intensities $I_{\text{Offset}\,\perp}$ and $I_{\text{Offset}\,\parallel}$ when the angles of the rotation mount of the polarizer **P2** are $\varphi_{\perp}$ and $\varphi_{\parallel}$, respectively. Measure the offsets $I_{\text{Offset}\,\perp}$ and $I_{\text{Offset}\,\parallel}$. Note that $I_{\text{Offset}\,\perp}$ and $I_{\text{Offset}\,\parallel}$ are due to light other than the light source. They should be eliminated by subtraction to determine the true contribution from the light source.	0.2pt

A.6	$I_{\perp}$ and $I_{\parallel}$ refer to the light intensities from the light source when the angles of the rotation mount of the polarizer **P2** are $\varphi_{\perp}$ and $\varphi_{\parallel}$, respectively. Measure the light intensities $I_{\perp}$ and $I_{\parallel}$ for $\theta = -15.0°$.	0.5pt

Part B. Measurement of transmitted light intensities (4.7 points)

Hereafter use the values of λ calculated using the corrected value of α in **A.3** as necessary.

B.1	Place the quartz plate between polarizers **P1** and **P2** and measure the transmitted light intensities $I_\perp$ and $I_\parallel$ at various angles θ. Your measurements should fully cover the wavelength range of 440 nm to 660 nm. Tabulate the following parameters: θ_{Stage} (angle readings of the rotation stage), $\theta,\ \lambda,\ I_\perp,\ I_\parallel,\ I_{\text{Total}} = I_\perp + I_\parallel,\ I_{\text{Norm}} = I_\perp / I_{\text{Total}}$. Note that when the value of θ_{Stage} increases, the value of θ decreases with the same value, and vice versa. You do not have to use every row of the provided table, but you should take enough data to obtain accurate results.	2.0pt

B.2	Plot the spectrum of the white LED, i.e., I_{Total}, versus wavelength on the graph.	1.0pt

B.3	Find the full width at half maximum $\Delta\lambda_{\text{FWHM}}$ of the spectrum of the blue LED built in the white LED. It is the width of a peak measured between those points which are at half the maximum amplitude	0.2pt

B.4	Plot the spectrum of I_{Norm} on the graph.	1.5pt

Part C. Analyses of Measured Results (3.0 points)

C.1	From the I_{Norm} graph, find all the wavelengths at which the intensities go through local minima. The associated order number m according to Eq. (6) must be given below the corresponding wavelength. To determine the birefringence Δn, use the values of n_{o} and n_{e} given in Table 1.	1.5pt

C.2	Obtain the sample thickness L.	1.5pt

Table 1: Refractive indices n_o and n_e of quartz (400–700 nm).

λ/nm	n_o	n_e	λ/nm	n_o	n_e	λ/nm	n_o	n_e
400	1.55769	1.56725	434	1.55394	1.56337	467	1.55107	1.56041
401	1.55756	1.56712	435	1.55384	1.56327	468	1.55099	1.56033
402	1.55744	1.56700	436	1.55374	1.56318	469	1.55091	1.56025
403	1.55732	1.56687	437	1.55365	1.56308	470	1.55084	1.56017
404	1.55720	1.56674	438	1.55355	1.56298	471	1.55076	1.56009
405	1.55707	1.56662	439	1.55346	1.56288	472	1.55068	1.56001
406	1.55695	1.56649	440	1.55337	1.56278	473	1.55061	1.55993
407	1.55684	1.56637	441	1.55327	1.56269	474	1.55054	1.55986
408	1.55672	1.56625	442	1.55318	1.56259	475	1.55046	1.55978
409	1.55660	1.56613	443	1.55309	1.56250	476	1.55039	1.55970
410	1.55648	1.56601	444	1.55300	1.56240	477	1.55031	1.55963
411	1.55637	1.56589	445	1.55291	1.56231	478	1.55024	1.55955
412	1.55625	1.56577	446	1.55282	1.56222	479	1.55017	1.55948
413	1.55614	1.56565	447	1.55273	1.56213	480	1.55010	1.55940
414	1.55603	1.56554	448	1.55264	1.56203	481	1.55003	1.55933
415	1.55592	1.56542	449	1.55255	1.56194	482	1.54995	1.55926
416	1.55580	1.56531	450	1.55247	1.56185	483	1.54988	1.55918
417	1.55569	1.56519	451	1.55238	1.56176	484	1.54981	1.55911
418	1.55558	1.56508	452	1.55229	1.56167	485	1.54974	1.55904
419	1.55548	1.56497	453	1.55221	1.56159	486	1.54967	1.55897
420	1.55537	1.56485	454	1.55212	1.56150	487	1.54961	1.55890
421	1.55526	1.56474	455	1.55204	1.56141	488	1.54954	1.55883
422	1.55515	1.56463	456	1.55195	1.56132	489	1.54947	1.55875
423	1.55505	1.56452	457	1.55187	1.56124	490	1.54940	1.55868
424	1.55494	1.56442	458	1.55179	1.56115	491	1.54933	1.55862
425	1.55484	1.56431	459	1.55171	1.56107	492	1.54927	1.55855
426	1.55474	1.56420	460	1.55162	1.56098	493	1.54920	1.55848
427	1.55463	1.56410	461	1.55154	1.56090	494	1.54913	1.55841
428	1.55453	1.56399	462	1.55146	1.56082	495	1.54907	1.55834
429	1.55443	1.56389	463	1.55138	1.56073	496	1.54900	1.55827
430	1.55433	1.56378	464	1.55130	1.56065	497	1.54894	1.55821
431	1.55423	1.56368	465	1.55122	1.56057	498	1.54887	1.55814
432	1.55413	1.56358	466	1.55115	1.56049	499	1.54881	1.55807
433	1.55403	1.56348						

λ/nm	n_o	n_e	λ/nm	n_o	n_e	λ/nm	n_o	n_e
500	1.54875	1.55801	534	1.54678	1.55597	567	1.54518	1.55432
501	1.54868	1.55794	535	1.54673	1.55592	568	1.54514	1.55427
502	1.54862	1.55788	536	1.54667	1.55587	569	1.54509	1.55423
503	1.54856	1.55781	537	1.54662	1.55581	570	1.54505	1.55418
504	1.54850	1.55775	538	1.54657	1.55576	571	1.54500	1.55414
505	1.54843	1.55768	539	1.54652	1.55570	572	1.54496	1.55409
506	1.54837	1.55762	540	1.54647	1.55565	573	1.54492	1.55405
507	1.54831	1.55756	541	1.54642	1.55560	574	1.54487	1.55400
508	1.54825	1.55749	542	1.54637	1.55555	575	1.54483	1.55396
509	1.54819	1.55743	543	1.54632	1.55549	576	1.54479	1.55391
510	1.54813	1.55737	544	1.54627	1.55544	577	1.54474	1.55387
511	1.54807	1.55731	545	1.54622	1.55539	578	1.54470	1.55383
512	1.54801	1.55725	546	1.54617	1.55534	579	1.54466	1.55378
513	1.54795	1.55718	547	1.54612	1.55529	580	1.54462	1.55374
514	1.54789	1.55712	548	1.54607	1.55524	581	1.54458	1.55370
515	1.54783	1.55706	549	1.54602	1.55519	582	1.54453	1.55365
516	1.54777	1.55700	550	1.54597	1.55514	583	1.54449	1.55361
517	1.54772	1.55694	551	1.54592	1.55509	584	1.54445	1.55357
518	1.54766	1.55688	552	1.54587	1.55504	585	1.54441	1.55352
519	1.54760	1.55682	553	1.54583	1.55499	586	1.54437	1.55348
520	1.54754	1.55676	554	1.54578	1.55494	587	1.54433	1.55344
521	1.54749	1.55671	555	1.54573	1.55489	588	1.54429	1.55340
522	1.54743	1.55665	556	1.54568	1.55484	589	1.54425	1.55336
523	1.54738	1.55659	557	1.54564	1.55479	590	1.54421	1.55331
524	1.54732	1.55653	558	1.54559	1.55474	591	1.54417	1.55327
525	1.54726	1.55648	559	1.54554	1.55470	592	1.54413	1.55323
526	1.54721	1.55642	560	1.54550	1.55465	593	1.54409	1.55319
527	1.54715	1.55636	561	1.54545	1.55460	594	1.54405	1.55315
528	1.54710	1.55631	562	1.54541	1.55455	595	1.54401	1.55311
529	1.54705	1.55625	563	1.54536	1.55451	596	1.54397	1.55307
530	1.54699	1.55619	564	1.54531	1.55446	597	1.54393	1.55303
531	1.54694	1.55614	565	1.54527	1.55441	598	1.54389	1.55299
532	1.54688	1.55608	566	1.54522	1.55437	599	1.54385	1.55295
533	1.54683	1.55603						

λ/nm	n_o	n_e	λ/nm	n_o	n_e	λ/nm	n_o	n_e
600	1.54382	1.55291	634	1.54260	1.55165	667	1.54157	1.55059
601	1.54378	1.55287	635	1.54257	1.55162	668	1.54154	1.55056
602	1.54374	1.55283	636	1.54254	1.55159	669	1.54151	1.55053
603	1.54370	1.55279	637	1.54250	1.55155	670	1.54148	1.55050
604	1.54366	1.55275	638	1.54247	1.55152	671	1.54145	1.55047
605	1.54363	1.55271	639	1.54244	1.55148	672	1.54143	1.55044
606	1.54359	1.55267	640	1.54241	1.55145	673	1.54140	1.55041
607	1.54355	1.55264	641	1.54237	1.55142	674	1.54137	1.55038
608	1.54351	1.55260	642	1.54234	1.55138	675	1.54134	1.55035
609	1.54348	1.55256	643	1.54231	1.55135	676	1.54131	1.55032
610	1.54344	1.55252	644	1.54228	1.55132	677	1.54128	1.55029
611	1.54340	1.55248	645	1.54224	1.55128	678	1.54125	1.55026
612	1.54337	1.55245	646	1.54221	1.55125	679	1.54123	1.55023
613	1.54333	1.55241	647	1.54218	1.55122	680	1.54120	1.55020
614	1.54330	1.55237	648	1.54215	1.55119	681	1.54117	1.55017
615	1.54326	1.55233	649	1.54212	1.55115	682	1.54114	1.55014
616	1.54322	1.55230	650	1.54209	1.55112	683	1.54111	1.55011
617	1.54319	1.55226	651	1.54206	1.55109	684	1.54109	1.55009
618	1.54315	1.55222	652	1.54202	1.55106	685	1.54106	1.55006
619	1.54312	1.55219	653	1.54199	1.55102	686	1.54103	1.55003
620	1.54308	1.55215	654	1.54196	1.55099	687	1.54100	1.55000
621	1.54305	1.55211	655	1.54193	1.55096	688	1.54098	1.54997
622	1.54301	1.55208	656	1.54190	1.55093	689	1.54095	1.54994
623	1.54298	1.55204	657	1.54187	1.55090	690	1.54092	1.54992
624	1.54294	1.55201	658	1.54184	1.55087	691	1.54090	1.54989
625	1.54291	1.55197	659	1.54181	1.55083	692	1.54087	1.54986
626	1.54287	1.55193	660	1.54178	1.55080	693	1.54084	1.54983
627	1.54284	1.55190	661	1.54175	1.55077	694	1.54081	1.54980
628	1.54280	1.55186	662	1.54172	1.55074	695	1.54079	1.54978
629	1.54277	1.55183	663	1.54169	1.55071	696	1.54076	1.54975
630	1.54274	1.55179	664	1.54166	1.55068	697	1.54073	1.54972
631	1.54270	1.55176	665	1.54163	1.55065	698	1.54071	1.54969
632	1.54267	1.55172	666	1.54160	1.55062	699	1.54068	1.54967
633	1.54264	1.55169				700	1.54066	1.54964

Thickness Measurements Using Birefringence (10 points)

Values in black (blue) are typical (acceptable).

Part A. Measurement System Setup (2.3 points)

A.1 (0.3 pt)

$\lambda = 684$ nm

$\theta = 20.0°$

A.2 (0.2 pt)

$\theta = -30.0°,\ 70.0°$

A.3 (0.8 pt)

$\theta = -28.0°$ $(-28.9° \leq \theta \leq -27.7°$ or $67.7° \leq \theta \leq 68.9°)$

$\lambda_{\text{Peak}} = 458$ nm
(450 nm $\leq \lambda_{\text{Peak}} \leq$ 460 nm; λ_{Peak} and θ must be consistent with Eq. (7) or (8).)

$\alpha = 40.0°$

A.4 (0.3 pt)

$\varphi_\perp = 90°$ $(85° \leq \varphi_\perp \leq 95°$ or $265° \leq \varphi_\perp \leq 275°)$

$\varphi_\parallel = 0°$ $(\varphi_\parallel = \varphi_\perp + 90°$ or $\varphi_\perp - 90°)$

A.5 (0.2 pt)

$I_{\text{Offset}\perp} = 0.005\ \text{V}$ $\quad (I_{\text{Offset}\perp} \leq 0.010\ \text{V})$

$I_{\text{Offset}\parallel} = 0.010\ \text{V}$ $\quad (I_{\text{Offset}\parallel} \leq 0.020\ \text{V})$

A.6 (0.5 pt)

$I_{\perp} = 0.001\ \text{V}$ $\quad (I_{\perp} \leq 0.003\ \text{V})$

$I_{\parallel} = 0.160\ \text{V}$ $\quad (I_{\parallel} \geq 0.100\ \text{V})$

Part B. Measurement of transmitted light intensities (4.7 points)

B.1 (2.0 pt)

θ_{Stage}/degree	θ/degree	λ/nm	$I_\perp$/mV	$I_\parallel$/mV	I_{Total}/mV	I_{Norm}
30.5	-31	430.5	13	26	39	0.333
30	-30.5	435.1	38	31	69	0.551
29.5	-30	439.7	83	27	110	0.755
29	-29.5	444.2	166	17	183	0.907
28.5	-29	448.8	244	21	265	0.921
28	-28.5	453.3	280	80	360	0.778
27.5	-28	457.7	267	159	426	0.627
27	-27.5	462.1	188	216	404	0.465
26.5	-27	466.5	73	223	296	0.247
26	-26.5	470.9	17	197	214	0.079
25.5	-26	475.2	12	162	174	0.069
25	-25.5	479.5	19	121	140	0.136
24.5	-25	483.7	34	71	105	0.324
24	-24.5	487.9	48	43	91	0.527
23.5	-24	492.1	61	22	83	0.735
23	-23.5	496.2	72	10	82	0.878
22.5	-23	500.3	83	4	87	0.954
22	-22.5	504.3	94	8	102	0.922
21.5	-22	508.3	97	19	116	0.836

B.1 (2.0 pt)

(Continued)

θ_{Stage}/degree	θ/degree	λ/nm	$I_{\perp}$/mV	$I_{\parallel}$/mV	I_{Total}/mV	I_{Norm}
21	-21.5	512.3	92	37	129	0.713
20.5	-21	516.3	77	68	145	0.531
20	-20.5	520.1	61	90	151	0.404
19.5	-20	524.0	35	130	165	0.212
19	-19.5	527.8	18	153	171	0.105
18.5	-19	531.6	8	166	174	0.046
18	-18.5	535.3	8	167	175	0.046
17.5	-18	539.0	14	158	172	0.081
17	-17.5	542.7	32	141	173	0.185
16.5	-17	546.3	47	127	174	0.270
16	-16.5	549.9	73	99	172	0.424
15.5	-16	553.4	93	76	169	0.550
15	-15.5	556.9	112	55	167	0.671
14.5	-15	560.3	130	34	164	0.793
14	-14.5	563.7	141	20	161	0.876
13.5	-14	567.1	147	10	157	0.936
13	-13.5	570.4	148	6	154	0.961
12.5	-13	573.7	146	6	152	0.961
12	-12.5	576.9	138	10	148	0.932

B.1 (2.0 pt)

(Continued)

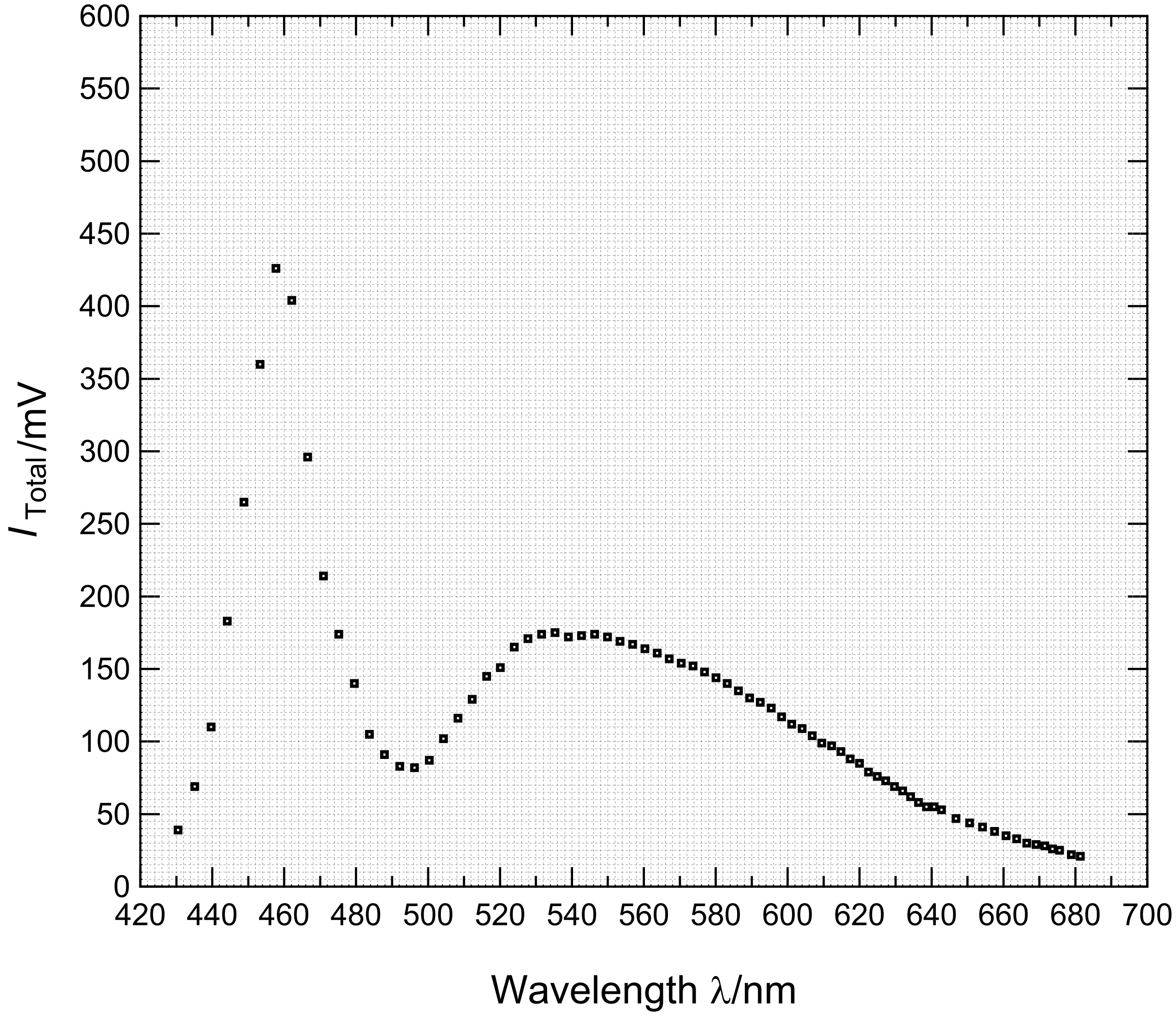
θ_{Stage}/degree	θ/degree	λ/nm	$I_\perp$/mV	$I_\parallel$/mV	I_{Total}/mV	I_{Norm}
11.5	-12	580.1	127	17	144	0.882
11	-11.5	583.2	114	26	140	0.814
10.5	-11	586.3	97	38	135	0.719
10	-10.5	589.4	80	50	130	0.615
9.5	-10	592.4	67	60	127	0.528
9	-9.5	595.4	54	69	123	0.439
8.5	-9	598.3	41	76	117	0.350
8	-8.5	601.1	31	81	112	0.277
7.5	-8	604.0	22	87	109	0.202
7	-7.5	606.8	15	89	104	0.144
6.5	-7	609.5	8	91	99	0.081
6	-6.5	612.2	6	91	97	0.062
5.5	-6	614.8	4	89	93	0.043
5	-5.5	617.4	3	85	88	0.034
4.5	-5	620.0	4	81	85	0.047
4	-4.5	622.5	5	74	79	0.063
3.5	-4	624.9	7	69	76	0.092
3	-3.5	627.3	10	63	73	0.137
2.5	-3	629.7	12	57	69	0.174

B.1 (2.0 pt)

(Continued)

θ_{Stage}/degree	θ/degree	λ/nm	$I_{\perp}$/mV	$I_{\parallel}$/mV	I_{Total}/mV	I_{Norm}
2	-2.5	632.0	15	51	66	0.227
1.5	-2	634.2	18	44	62	0.290
1	-1.5	636.4	21	37	58	0.362
0.5	-1	638.6	23	32	55	0.418
0	-0.5	640.7	25	30	55	0.455
-0.5	0	642.8	27	26	53	0.509
-1.5	1	646.8	29	18	47	0.617
-2.5	2	650.6	31	13	44	0.705
-3.5	3	654.2	32	9	41	0.780
-4.5	4	657.5	32	6	38	0.842
-5.5	5	660.7	31	4	35	0.886
-6.5	6	663.7	30	3	33	0.909
-7.5	7	666.5	28	2	30	0.933
-8.5	8	669.1	27	2	29	0.931
-9.5	9	671.5	26	2	28	0.929
-10.5	10	673.6	24	2	26	0.923
-11.5	11	675.6	23	2	25	0.920
-13.5	13	678.9	20	2	22	0.909
-15.5	15	681.4	18	3	21	0.857

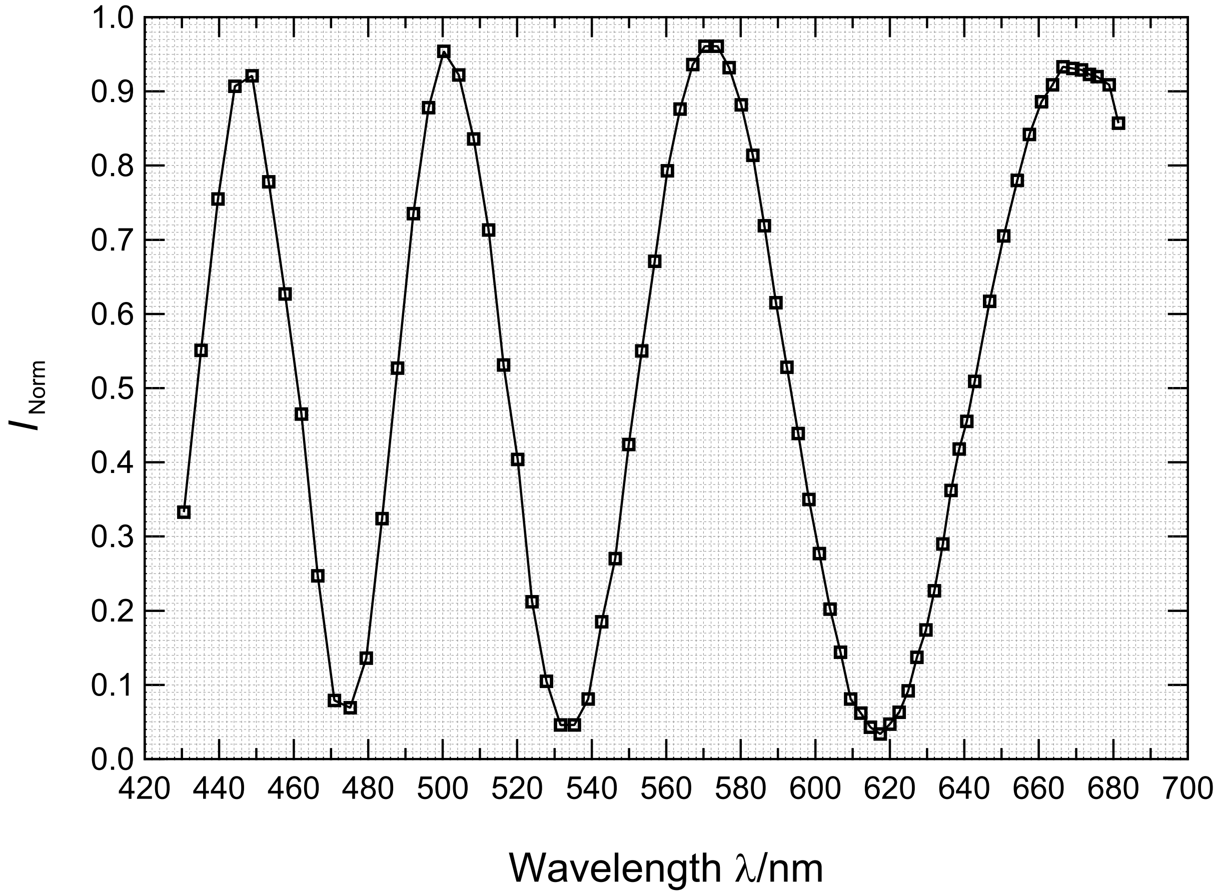
B.2 (1.0 pt)



B.3 (0.2 pt)

$\Delta\lambda_{\mathrm{FWHM}} = 25$ nm $\quad (\Delta\lambda_{\mathrm{FWHM}} \leq 40$ nm$)$

B.4 (1.5 pt)


1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
I_{Norm}
420 440 460 480 500 520 540 560 580 600 620 640 660 680 700
Wavelength λ/nm

Part C. Analyses of Measured Results (3.0 points)

C.1 (1.5 pt)

$\lambda = 473\ \text{nm},\ 534\ \text{nm},\ 617\ \text{nm}$

$(455\ \text{nm} < \lambda < 479\ \text{nm}, \quad 513\ \text{nm} < \lambda < 539\ \text{nm}, \quad 590\ \text{nm} < \lambda < 620\ \text{nm})$

$m = 8, \quad 7, \quad 6$

C.2 (1.5 pt)

$L = 407\ \mu\text{m} \quad (390\ \mu\text{m} < L < 410\ \mu\text{m})$

Theoretical Examination

General Instructions

Failure to comply with one or more of the following conditions may result in disqualification.

The exam is worth a total of 30 points and lasts five hours.

When to start and finish up the examination and when 15 minutes remain before the end of the examination will be indicated by your Invigilator.

Do not open the envelopes until instructed to do so.

The following items are provided for your use on the table: (1) a ballpoint pen, (2) a mechanical pencil, (3) a plastic eraser, (4) a scale ruler, (5) a scientific calculator, and (6) a digital table clock.

During the exam:

- Use the ballpoint pen provided. If you use the mechanical pencil to draft your notes, figures, tables, and graphs, never fail to trace the outlines of the final version with the ballpoint pen.
- Use the dedicated sheets labeled **A** for your final answers. Fill in appropriate sections with your answers and necessary observations. Draw graphs as required. Cross out any unneeded answers.
- Blank working sheets labeled **W** are provided for drafting. Use the designated ones. Cross out any unneeded answers and rough work that do not need to be graded. Use only the front face of each sheet and keep the margin outside the border clean.
- Additional working sheets labeled **Z** are available upon request. Raise the "Help" flag and let the Invigilator know.
- Keep your answers concise and legible. Use equations, logical operators, symbols, and sketches that best convey your thoughts. Avoid being lengthy and wordy as the markers may not be multilingual.
- Uncertainty quantification is not required unless otherwise specified.
- You will be video-recorded for fairness and security purposes. Do not leave your booth without permission. If you need a washroom break or any other assistance, raise the flag(s) marked "Toilet", "Water", or "Help".

At the end of the exam:

- Stop writing immediately when the end of the exam is announced.
- Put all the sheets in the windowed envelope for each question. Organize them faceup in the following order: cover sheet on top, question sheets (**Q**), answer sheets (**A**), working sheets (**W**), and additional working sheets (**Z**), if any. Arrange them according to their page numbers. In the final check, make sure that your ID, name, and seat number on the cover sheet are visible through the window. Leave only the General Instructions (yellow sheets stapled) on the table.
- Your Invigilator will let you know when you can leave. You may take the remaining items with you, for example, the ballpoint pen, the mechanical pencil, the plastic eraser, the scale ruler, the scientific calculator, the digital table clock, the bottle of drinking water, and snacks.

Physical Constants

Below is the list of physical constants you might use in your solution in addition to the quantities given in the body text.

Physical constant	Notation	Numerical value
Speed of light in vacuum	c	$299\,792\,458$ m/s
Vacuum permeability (magnetic constant)	μ_0	$1.256\,637\,062\,12(19) \times 10^{-6}$ N/A^2; [1 N/A^2 = 1 V·s/(A·m)]
Vacuum permittivity (electric constant)	ε_0	$8.854\,187\,8128(13) \times 10^{-12}$ F/m; [1 F/m = 1 A·s/(V·m)]
Elementary charge	e	$1.602\,176\,634 \times 10^{-19}$ C ; [1 C = 1 A·s]
Electron mass	m_e	$9.109\,383\,7015(28) \times 10^{-31}$ kg
Newtonian constant of gravitation	G	$6.674\,30(15) \times 10^{-11}$ m^3/(kg·s^2)
Avogadro constant	N_A	$6.022\,140\,76 \times 10^{23}$ mol^{-1}
Molar gas constant	R	$8.314\,462\,618\ldots$ J/(K·mol)
Boltzmann constant	k	$1.380\,649 \times 10^{-23}$ J/K
Stefan–Boltzmann constant	σ	$5.670\,374\,419\ldots \times 10^{-8}$ W/(m^2·K^4)
Planck constant	h	$6.626\,070\,15 \times 10^{-34}$ J·s
Reduced Planck constant	$\hbar = h/(2\pi)$	$1.054\,571\,817\ldots \times 10^{-34}$ J·s

Characterization of Soil Colloids (10 points)

Colloidal science is useful to characterize soil particles because many of them can be regarded as colloidal particles of micrometer size. For example, Brownian motion (random motion of colloidal particles) can be used to measure particle sizes.

Part A. Motions of colloidal particles (1.6 points)

We analyze the one-dimensional Brownian motion of a colloidal particle with mass M. The equation of motion for its velocity $v(t)$ reads:

$$M\dot{v} = -\gamma v(t) + F(t) + F_{\text{ext}}(t), \tag{1}$$

where γ is the friction coefficient, $F(t)$ is a force due to random collisions with water molecules, and $F_{\text{ext}}(t)$ is an external force. In Part A, we assume $F_{\text{ext}}(t) = 0$.

A.1	Consider that a water molecule collides with the particle at $t = t_0$, giving impulse I_0, and $F(t) = 0$ afterward. If $v(t) = 0$ before the collision, $v(t) = v_0 e^{-(t-t_0)/\tau}$ for $t > t_0$. Determine v_0 and τ, using I_0 and necessary parameters in Eq.(1).	0.8pt

In the following, you may use τ in your answers.

A.2	Actually, water molecules collide with the particle one after another. Suppose the ith collision gives the impulse I_i at time t_i and determine $v(t)$ on condition that $t > 0$ and $v(0) = 0$. Also give the inequality specifying the range of t_i that needs to be considered for a given t. In the answer sheet, it is not necessary to specify this range in the expression for $v(t)$.	0.8pt

Part B. Effective equation of motion (1.8 points)

Results so far imply that particle velocities $v(t)$ and $v(t')$ may be regarded as uncorrelated random quantities if $|t - t'| \gg \tau$. On this basis, we introduce a theoretical model to approximately describe the one-dimensional Brownian motion, where the velocity changes randomly at each time interval $\delta\ (\gg \tau)$, i.e.,

$$v(t) = v_n \quad (t_{n-1} < t \le t_n), \tag{2}$$

with $t_n = n\delta\ (n = 0, 1, 2, \cdots)$ and a random quantity v_n. It satisfies

$$\langle v_n \rangle = 0, \quad \langle v_n v_m \rangle = \begin{cases} C & (n = m), \\ 0 & (n \neq m), \end{cases} \tag{3}$$

with a parameter C depending on δ. Here $\langle X \rangle$ indicates the expectation value of X. That is, if you draw random numbers X infinite times, the mean will be $\langle X \rangle$.

Now we consider the particle displacement $\Delta x(t) = x(t) - x(0)$ for $t = N\delta$ with an integer N.

B.1	Determine $\langle \Delta x(t) \rangle$ and $\langle \Delta x(t)^2 \rangle$ using C, δ, and t.	1.0pt

B.2	The quantity $\langle \Delta x(t)^2 \rangle$ is called the mean square displacement (MSD). It is a characteristic observable of the Brownian motion, which corresponds to the limiting case $\delta \to 0$. From this, we can show $C \propto \delta^\alpha$ and $\langle \Delta x(t)^2 \rangle \propto t^\beta$. Determine the values of α and β.	0.8pt

Part C. Electrophoresis (2.7 points)

Here we discuss electrophoresis, i.e., transport of charged particles by an electric field. Suspension of colloidal particles with mass M and charge $Q\ (>0)$ is put in a narrow channel with a cross-section A (Fig.1(a)). We ignore the interaction between particles, effects of the wall, the fluid, the ions therein, and gravity.

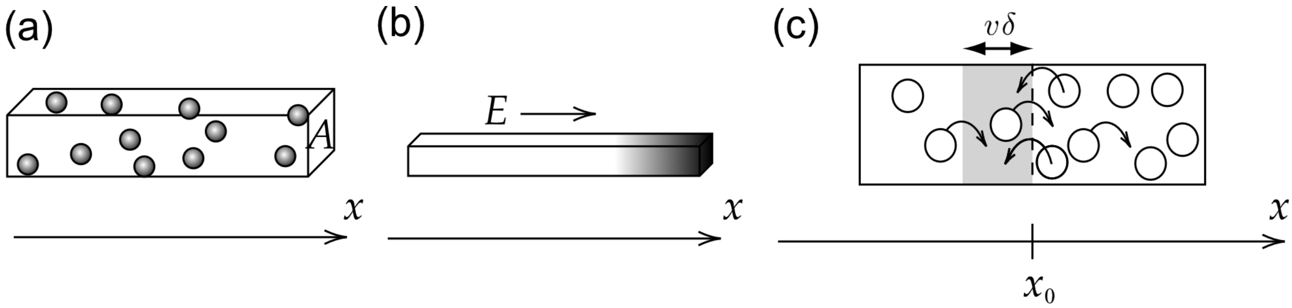


Fig.1: Setting for Part C.

By applying a uniform electric field E in the x-direction, particles are transported and their concentration $n(x)$ (particle number per unit volume) becomes non-uniform (Fig.1(b)). When E is removed, this non-uniformity gradually disappears. This is due to Brownian motion of particles. If $n(x)$ is not uniform, the numbers of right-going and left-going particles may differ (Fig.1(c)). This generates a particle flux $J_D(x)$, the mean number of particles flowing at x along the x-axis per unit cross-sectional area and unit time. This flux is known to satisfy

$$J_D(x) = -D\frac{dn}{dx}(x), \tag{4}$$

where D is called the diffusion coefficient.

Now let's assume, for simplicity, that half of the particles have velocity $+v$ and the other half have velocity $-v$. Let $N_+(x_0)$ be the number of particles with velocity $+v$ that cross x_0 from left to right per unit cross-sectional area and unit time. For particles with velocity $+v$ to cross x_0 in the time interval δ, they should be in the shaded region of Fig.1(c). Since δ is small, we have $n(x) \simeq n(x_0) + (x - x_0)\frac{dn}{dx}(x_0)$ in this region.

C.1	Express $N_+(x_0)$ using necessary quantities from $v,\ \delta,\ n(x_0)$, and $\frac{dn}{dx}(x_0)$.	0.5pt

We define $N_-(x_0)$ as the counterpart of $N_+(x_0)$ for the velocity $-v$. With this, we have $J_D(x_0) = \langle N_+(x_0) - N_-(x_0) \rangle$. According to Eq.(3), we have $\langle v^2 \rangle = C$.

C.2	Determine $J_D(x_0)$ using necessary quantities from $C, \delta, n(x_0)$, and $\frac{dn}{dx}(x_0)$. Using this and Eq.(4), express D in terms of C and δ, and $\langle \Delta x(t)^2 \rangle$ in terms of D and t.	0.7pt

Now we discuss the effect of osmotic pressure Π. It is given by $\Pi = \frac{n}{N_A}RT = nkT$ with the Avogadro constant N_A, the gas constant R, temperature T, and the Boltzmann constant $k = \frac{R}{N_A}$. Let us consider the non-uniform concentration formed under the electric field E (Fig.1(b)). Since $n(x)$ depends on x, so does $\Pi(x)$. Then the forces due to $\Pi(x)$ and $\Pi(x+\Delta x)$ must be balanced with the total force from the field E acting on the particles (Fig.2). Here we consider small Δx, so that $n(x)$ can be regarded as constant over this range, while $n(x+\Delta x) - n(x) \simeq \Delta x \frac{dn}{dx}(x)$.

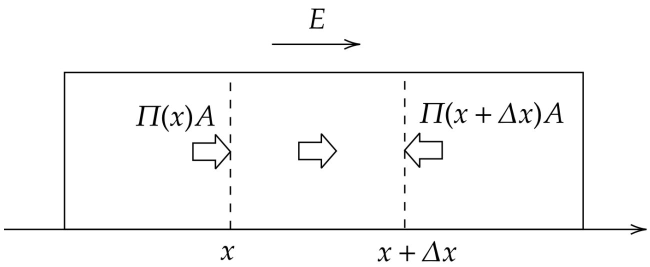


Fig.2: Force balance.

C.3	Express $\frac{dn}{dx}(x)$ using $n(x)$, T, Q, E, and k.	0.5pt

Let us discuss the balance of the flux now. Besides the flux $J_D(x)$ due to the Brownian motion, there is also a flux due to the electric field, $J_Q(x)$. It is given by

$$J_Q(x) = n(x)u, \tag{5}$$

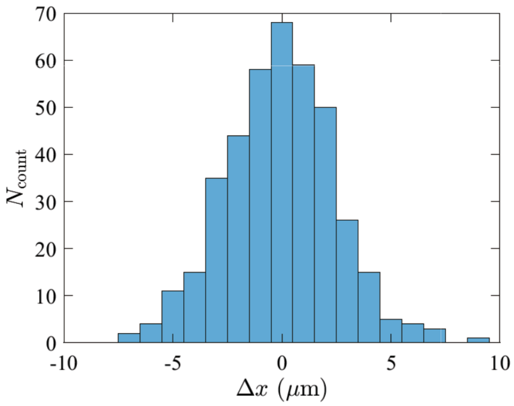
where u is the terminal velocity of particles driven by the field.

C.4	To determine u, we use Eq.(1) with $F_{\text{ext}}(t) = QE$. Since $v(t)$ is fluctuating, we consider $\langle v(t) \rangle$. Assuming $\langle v(0) \rangle = 0$ and using $\langle F(t) \rangle = 0$, evaluate $\langle v(t) \rangle$ and obtain $u = \lim_{t\to\infty} \langle v(t) \rangle$.	0.5pt

C.5	The flux balance reads $J_D(x) + J_Q(x) = 0$. Express the diffusion coefficient D in terms of k, γ, and T.	0.5pt

Part D. Mean square displacement (2.4 points)

Suppose we observed the Brownian motion of an isolated, spherical colloidal particle with radius $a = 5.0\ \mu$m in water. Figure 3 shows the histogram of displacements Δx measured in the x-direction at every interval $\Delta t = 60$ s. The friction coefficient is given by $\gamma = 6\pi a \eta$ with water viscosity $\eta = 8.9 \times 10^{-4}$ Pa · s and the temperature was $T = 25\ ^\circ$C.



Δx (μm)	-10	-9	-8	-7	-6	-5	-4
N_{count}	0	0	0	2	4	11	15

Δx (μm)	-3	-2	-1	0	1	2	3
N_{count}	35	44	58	68	59	50	26

Δx (μm)	4	5	6	7	8	9	10
N_{count}	15	5	4	3	0	1	0

Fig.3: Histogram of displacements.

D.1	Estimate the value of N_A without using the fact that it is the Avogadro constant, up to two significant digits from the data in Fig.3. The gas constant is $R = 8.31\,\text{J/K}\cdot\text{mol}$. Do not use the value of the Boltzmann constant k given in General Instructions. As for the Avogadro constant, you might obtain a value different from that in General Instructions.	1.0pt

Now we extend the model in Part B to describe the motion of a particle with charge Q under an electric field E. The particle velocity $v(t)$ considered in Eq.(2) should be replaced by $v(t) = u + v_n$ $(t_{n-1} < t \leq t_n)$ with v_n satisfying Eq. (3) and u being the terminal velocity considered in Eq.(5).

D.2	Express the MSD $\langle \Delta x(t)^2 \rangle$ in terms of u, D, and t. Obtain approximate power laws for small t and large t, as well as the characteristic time t_* where this change occurs. Draw a rough graph of MSD in a log-log plot, indicating the approximate location of t_*.	0.8pt

Next, we consider swimming microbes (Fig.4(a)), in one dimension for simplicity (Fig.4(b)). These are spherical particles with radius a. They swim at velocity either $+u_0$ or$-u_0$, the sign chosen randomly at every time interval δ_0 without correlation. The observed motion is a combination of displacements due to swimming and those due to the Brownian motion of a spherical particle.

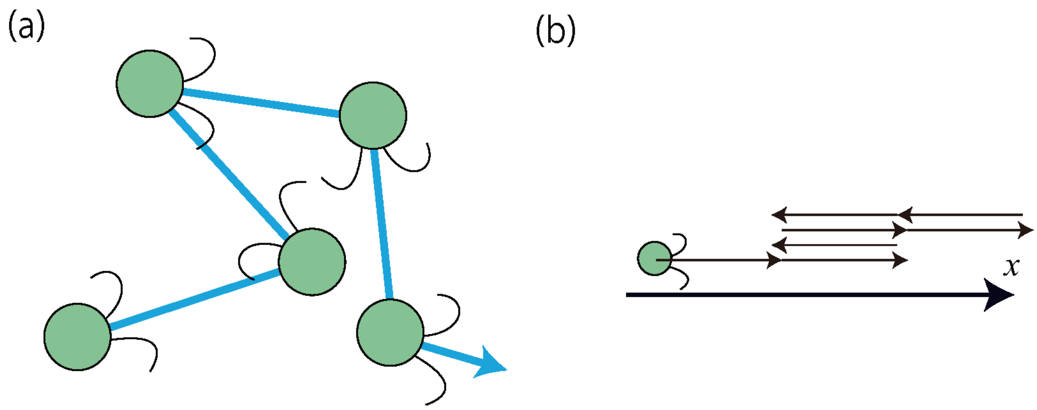


Fig.4: (a) Motion of microbes. (b) Its one-dimensional version.

D.3 Figure 5 displays the MSD $\langle \Delta x(t)^2 \rangle$ of those microbes, showing different power laws for small, large, and intermidiate t, as indicated by dashed lines. Obtain the power law for each time range and express it using necessary quantities from D, u_0, δ_0, and t. 0.6pt

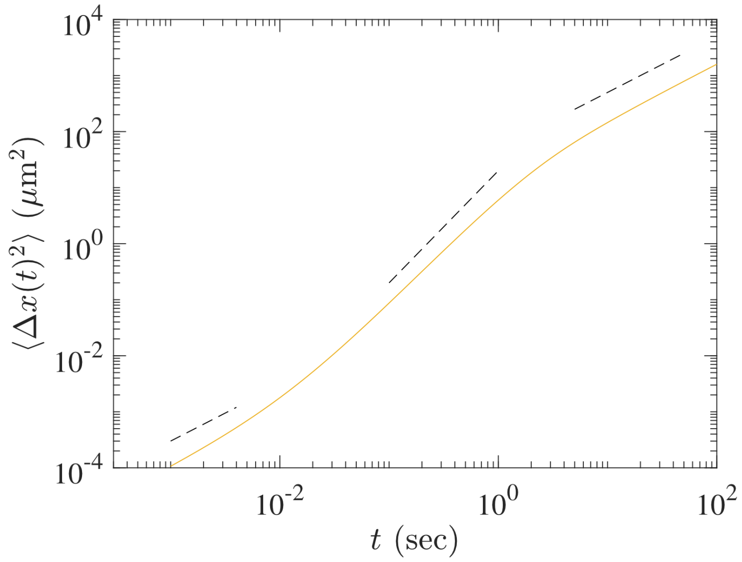


Fig.5: Mean square displacement of the microbes.

Part E. Water purification (1.5 points)

Here we discuss the purification of water including colloid-like soil particles, by adding electrolytes to coagulate them. Particles interact through van der Waals force and electrostatic force, the latter including effects of both surface charges and the surrounding layer of oppositely charged ions (such ions and their layer are called counter-ions and the electric double layer, respectively; see Fig.6(a)). As a result, the interaction potential for particle distance d (Fig.6(b)) is given by

$$U(d) = -\frac{A}{d} + \frac{B\epsilon(kT)^2}{q^2} e^{-d/\lambda}, \tag{6}$$

where A and B are positive constants, ϵ is the dielectric constant of water, and λ is the thickness of the electric double layer. Assuming that charges of ions are $\pm q$, we have

$$\lambda = \sqrt{\frac{\epsilon kT}{2N_A q^2 c}}, \tag{7}$$

where c is the molar concentration of ion.

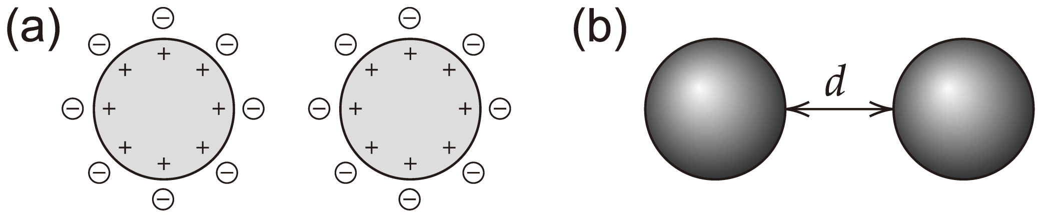


Fig.6: (a) Surface charges of colloidal particles and counter-ions. (b) Definition of the distance d.

E.1	Addition of sodium chloride (NaCl) to the suspension causes colloidal particles to coagulate. Determine the lowest concentration c of NaCl necessary for coagulation. It is sufficient to consider two particles without thermal fluctuations, i.e., $F(t) = 0$ in Eq.(1), and assume that the terminal velocity for the given potential force is reached instantaneously.	1.5pt

Neutron Stars (10 points)

We discuss the stability of large nuclei and estimate the mass of neutron stars theoretically and experimentally.

Part A. Mass and stability of nuclei (2.5 points)

The rest-energy of a nucleus $m(Z,N)c^2$ consisting of Z protons and N neutrons is smaller than the sum of rest-energies of protons and neutrons, hereafter called nucleons, by the binding energy $B(Z,N)$, where c is the speed of light in vacuum. Ignoring minor corrections, we can approximate the binding energy consisting of the volume term with a_V, the surface term with a_S, the Coulomb energy term with a_C, and the symmetry energy term with a_{sym} in the following way.

$$m(Z,N)c^2 = Am_N c^2 - B(Z,N), \qquad B(Z,N) = a_V A - a_S A^{2/3} - a_C \frac{Z^2}{A^{1/3}} - a_{\text{sym}} \frac{(N-Z)^2}{A}, \tag{1}$$

where $A = Z + N$ is the mass number and m_N is the nucleon mass. In the calculation, use $a_V \approx 15.8\ \text{MeV}$, $a_S \approx 17.8\ \text{MeV}$, $a_C \approx 0.711\ \text{MeV}$, and $a_{\text{sym}} \approx 23.7\ \text{MeV}$ (MeV = 10^6 electron volts).

A.1	Under the condition of $Z = N$, determine A for maximizing the binding energy per nucleon, B/A.	0.9pt

A.2	Under the condition of fixed A, the atomic number of the most stable nucleus Z^* is determined by maximizing $B(Z, A-Z)$. For $A = 197$, calculate Z^* using Eq. (1).	0.9pt

A.3 A nucleus having large A breaks up into lighter nuclei through fission in order to minimize the total rest-mass energy. For simplicity, we consider one of multiple ways to break a nucleus with (Z,N) into two equal nuclei, which occurs when the following energy relation holds, (0.7pt)

$$m(Z,N)c^2 > 2m(Z/2, N/2)c^2.$$

When this relation is written as

$$Z^2/A > C_{\text{fission}} \frac{a_S}{a_C},$$

obtain C_{fission} up to two significant digits.

Part B. Neutron star as a gigantic nucleus (1.5 points)

For large nuclei with a large enough mass number $A > A_c$ with a threshold A_c, these nuclei stay stable against nuclear fission because of the sufficiently large binding energy due to gravity.

B.1	We assume that $N = A$ and $Z = 0$ is realized for sufficiently large A and Eq. (1) continues to hold with the addition of the gravitational binding energy. The binding energy due to gravity is $$B_{\text{grav}} = \frac{3}{5}\frac{GM^2}{R},$$ where $M = m_N A$ and $R = R_0 A^{1/3}$ with $R_0 \simeq 1.1 \times 10^{-15}$ m $= 1.1$ fm are the mass and the radius of the nucleus, respectively. For $B_{\text{grav}} = a_{\text{grav}} A^{5/3}$, obtain a_{grav} in the MeV unit up to the first significant digit. Then, ignoring the surface term, estimate A_c up to the first significant digit. In the calculation, use $m_N c^2 \simeq 939\ \mathrm{MeV}$ and $G = \hbar c / M_P^2$ where $M_P c^2 \simeq 1.22 \times 10^{22}\ \mathrm{MeV}$ and $\hbar c \simeq 197\ \mathrm{MeV \cdot fm}$.	1.5pt

Part C. Neutron star in a binary system (6.0 points)

Some neutron stars are pulsars regularly emitting electromagnetic waves, which we call "light" for simplicity here, at a constant period. Neutron stars often make binary systems with a White Dwarf. Let us consider the star configuration shown in Fig. 1, where a light pulse from a neutron star **N** to the Earth **E** passes near a White Dwarf **W** of the binary system. Measuring these pulses influenced by the star's gravity leads to an accurate estimation of the mass of **W** as explained below, resulting in the estimation of the mass of **N**.

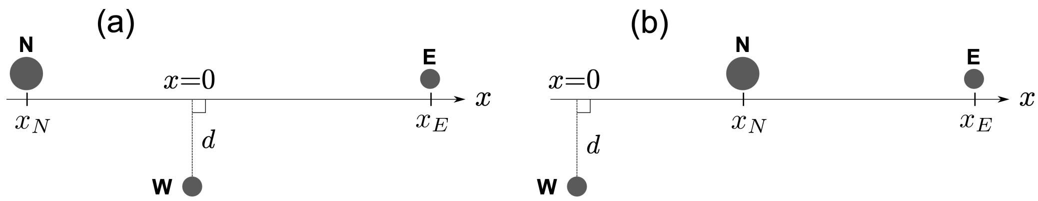
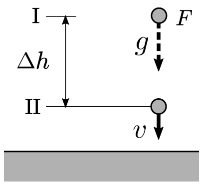


Fig. 1: Configurations with the x-axis along the line connecting **N** and **E**. (a) for $x_N < 0$ and (b) for $x_N > 0$.

C.1 As shown in the figure below, under the constant gravitational acceleration g we place two levels I and II with the height difference $\Delta h(>0)$. Set the identical clocks at I, II, and F, the free-falling system, denoted by clock-I, clock-II, and clock-F, respectively. 1.0pt



Set-up of the thought experiment.

We assume that an observer sits with clock-F, and initially F is placed at the same height as that of clock-I and its velocity is zero. Since the clocks are identical, they register equal time intervals, $\Delta\tau_F = \Delta\tau_{\mathrm{I}}$. Then, we let F fall freely, and work in the frame of F, which is considered to be inertial. In this frame, clock-II passes by clock-F with velocity v, so that the time dilation of clock-II can be determined by the Lorentz transformation. When time $\Delta\tau_{\mathrm{I}}$ elapses on clock-F, time $\Delta\tau_{\mathrm{II}}$ elapses on clock-II.
Determine $\Delta\tau_{\mathrm{II}}$ in terms of $\Delta\tau_{\mathrm{I}}$ up to the first order in $\Delta\phi/c^2$, where $\Delta\phi = g\Delta h$ is a difference of the gravitational potential, *i.e.*, the gravitational potential energy per unit mass.

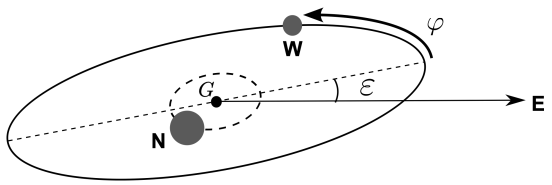
C.2 Under the gravitational potential ϕ, time delays change the effective speed of light, c_{eff}, observed at the infinity, though the local speed of light is c. When $\phi(r=\infty)=0$, c_{eff} can be given up to the first order in ϕ/c^2 as 1.8pt

$$c_{\text{eff}} \approx \left(1 + \frac{2\phi}{c^2}\right) c$$

including the effect of space distortion, which was not featured in **C.1**. We note that the light path can be approximated as a straight line.
As shown in Fig. 1 (a), we take the x-axis along the light path from the neutron star **N** to the Earth **E** and place $x=0$ at the point where the White Dwarf **W** is the closest to the light path. Let $x_N\,(<0)$ be the x-coordinate of **N**, $x_E\,(>0)$ be that of **E**, and d be the distance between **W** and the light path.
Estimate the changes of the arrival time Δt of the light from **N** to **E** caused by the White Dwarf with mass M_{WD} and evaluate the answer in a simple form disregarding higher order terms of the following small quantities: $d/|x_N| \ll 1$, $d/x_E \ll 1$, and $GM_{\text{WD}}/(c^2 d) \ll 1$. If necessary, use the following formula.

$$\int \frac{dx}{\sqrt{x^2+d^2}} = \frac{1}{2}\log\left(\frac{\sqrt{x^2+d^2}+x}{\sqrt{x^2+d^2}-x}\right) + C. \qquad (\log \text{ is the natural logarithm})$$

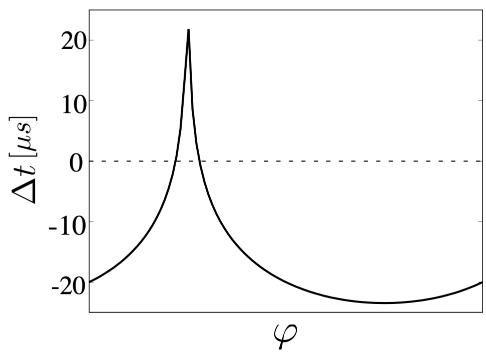
C.3 As shown below, in a binary star system **N** and **W** are assumed to be moving in circular orbits with zero eccentricity around the center of mass G on the orbit plane. Let ε be the orbital inclination angle measured from the orbit plane to the line directed toward **E** from G, and let L be the length between **N** and **W** and M_{WD} be the mass of the White Dwarf. In the following, we assume $\varepsilon \ll 1$. 1.8pt



Binary star system.

We observe light pulses from **N** on **E** far away from **N**. The light path to **E** varies with time depending on the configuration of **N** and **W.** The delay in the time interval of arriving pulses on **E** has the maximum value Δt_{max} for $x_N \simeq -L$ and the minimum value Δt_{min} for $x_N \simeq L$ (see Fig. 1 (b) for the configuration). Calculate $\Delta t_{\text{max}} - \Delta t_{\text{min}}$ in a simple form disregarding higher order terms of small quantities as done in **C.2**. We note that the delays due to gravity from stellar objects other than **W** are assumed to cancel out in $\Delta t_{\text{max}} - \Delta t_{\text{min}}$.

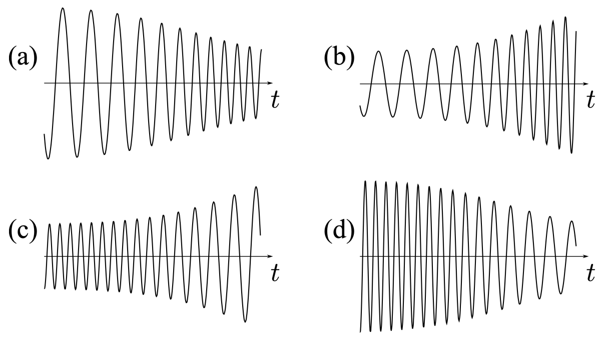
C.4 The below figure shows the observed time delays as a function of the orbital phase φ for the binary star system with $L \approx 6 \times 10^6\,\mathrm{km}$ and $\cos\varepsilon \approx 0.99989$. Estimate M_{WD} in terms of the solar mass $M_\odot$ and show the results for $M_{\text{WD}}/M_\odot$ up to the first significant digit. Here the approximate relation, $GM_\odot/c^3 \approx 5\,\mu\mathrm{s}$, can be used. 0.8pt



Observed time delays Δt as a function of the orbital phase φ (see the figure in **C.3**) to locate **N** and **W** on the orbits.

C.5 In the binary system of neutron stars, two stars release energy and angular momentum by emitting gravitational waves and eventually collide to merge. For simplicity, let us consider only a circular motion with the radius R and the angular velocity ω and then $\omega = \chi R^p$ holds with the constant χ depending on neither ω nor R if relativistic effects are ignored. Determine the value for p. 0.4pt

C.6 The amplitude of the emitted gravitational wave from the binary system in **C.5** is proportional to $R^2\omega^2$. Figure below qualitatively shows four different temporal profiles of the observed gravitational waves before the two-star collision. Select the most appropriate profile from (a) to (d). 0.2pt



Observed data profiles of gravitational waves.

Theory Problem 1: Characterization of Soil Colloids (10 points)

Part A. Analysis of motions of colloidal particles (1.6 points)

A.1 The relation between the impulse and the momentum change is given by $Mv_0 = I_0$. Therefore,

$$v_0 = \frac{I_0}{M}. \tag{S1.1}$$

For the situation considered here, the equation of motion reads

$$M\dot{v} = -\gamma v(t). \tag{S1.2}$$

Substituting the form of the solution given in the question sheet, $v(t) = v_0 e^{-(t-t_0)/\tau}$, we obtain

$$\tau = \frac{M}{\gamma}. \tag{S1.3}$$

A.1 0.8 pt

$$v_0 = \frac{I_0}{M}$$
$$\tau = \frac{M}{\gamma}$$

A.2 Thanks to the linearity of Eq. (S1.2), we can use the superposition principle, which tells us that $v(t)$ is given by the sum of solutions for single collision events that occur before time t. This immediately gives the solution as

$$v(t) = \sum_i \frac{I_i}{M} e^{-(t-t_i)/\tau}, \tag{S1.4}$$

where the sum is taken in the range of i that satisfies $0 < t_i < t$.

It is also not difficult to figure out this superposition principle, by considering the effect of a single collision as well as the velocity change between two consecutive collisions. From A.1, it is straightforward to show that the velocity right after the ith collision is given by

$$v(t_i) = v_0(t_i) + \frac{I_i}{M}, \tag{S1.5}$$

where $v_0(t_i)$ is the velocity right before the collision. Also, since there is no collision during $t_i < t < t_{i+1}$, we have

$$v(t) = \left(v_0(t_i) + \frac{I_i}{M}\right) e^{-(t-t_i)/\tau}. \tag{S1.6}$$

In particular,

$$v_0(t_{i+1}) = \left(v_0(t_i) + \frac{I_i}{M}\right) e^{-(t_{i+1}-t_i)/\tau}. \tag{S1.7}$$

Therefore, with $v_0(t_1) = 0$, we obtain

$$v_0(t_i) = \sum_{j=1}^{i-1} \frac{I_j}{M} e^{-(t_i-t_j)/\tau} \tag{S1.8}$$

and, for $t_i < t < t_{i+1}$,

$$v(t) = \sum_{j=1}^{i} \frac{I_j}{M} e^{-(t-t_j)/\tau}. \tag{S1.9}$$

This is equivalent to Eq. (S1.4).

A.2 0.8 pt

$v(t) = \sum_i \frac{I_i}{M} e^{-(t-t_i)/\tau}$

the inequality specifying the range of t_i that needs to be considered:

$0 < t_i < t$

Part B. Effective equation of motion (1.8 points)

B.1 From the definition of the model, we have

$$\Delta x(t) = \sum_{n=1}^{N} v_n \delta. \tag{S1.10}$$

Taking the average and using $\langle v_n \rangle = 0$, we obtain

$$\langle \Delta x(t) \rangle = 0. \tag{S1.11}$$

For the mean square displacement, computing the square of Eq. (S1.10) and taking the average, we obtain

$$\langle \Delta x(t)^2 \rangle = \sum_{m=1}^{N} \sum_{n=1}^{N} \langle v_m v_n \rangle \delta^2. \tag{S1.12}$$

Using $\langle v_m v_n \rangle = C$ for $n = m$ and 0 otherwise, we find

$$\langle \Delta x(t)^2 \rangle = \sum_{n=1}^{N} C\delta^2 = NC\delta^2. \tag{S1.13}$$

Since $N\delta = t$, we obtain

$$\langle \Delta x(t)^2 \rangle = C\delta t. \tag{S1.14}$$

B.1 1.0 pt

$\langle \Delta x(t) \rangle = 0$

$\langle \Delta x(t)^2 \rangle = C\delta t$

B.2 As described in the question sheet, the mean square displacement $\langle \Delta x(t)^2 \rangle$ is a characteristic observable of the Brownian motion, which of course takes a finite value for a given t. For the model considered here, we have Eq. (S1.14), but we need to consider the limit $\delta \to 0$ to describe the Brownian motion in this model. This requires that $C\delta$ remains finite, so that $C \propto \delta^{-1}$. It also follows that $\langle \Delta x(t)^2 \rangle \propto t$.

▷ Note: The continuous time limit $\delta \to 0$ of the present model corresponds to what is called the over-damped Langevin equation. This reads, in the absence of external force as considered here,

$$\gamma \frac{dx}{dt} = \xi(t) \tag{S1.15}$$

with a Gaussian noise $\xi(t)$ that satisfies

$$\langle \xi(t) \rangle = 0, \qquad \langle \xi(t)\xi(t') \rangle = 2D\delta(t-t') \tag{S1.16}$$

with the diffusion coefficient D. Here, $\delta(t)$ (not to confuse with δ in the problem) is called the delta function, which satisfies $\delta(t) = 0$ for $t \neq 0$ and $\delta(0) = \infty$ but $\int_a^b \delta(t)dt = 1$ for any $a < 0$ and $b > 0$.

B.2	0.8 pt
$\alpha = -1$	
$\beta = 1$	

Part C. Electrophoresis (2.7 points)

C.1 For particles with velocity v (> 0), only those in the range $x_0 - v\delta \leq x \leq x_0$ pass the position x_0 during a time interval δ. Therefore, the number of such particles per unit cross-sectional area and per unit time is given by

$$N_+(x_0) = \frac{1}{\delta}\int_{x_0 - v\delta}^{x_0} \frac{1}{2} n(x)dx \tag{S1.17}$$

Using the Taylor expansion $n(x) \simeq n(x_0) + (x - x_0)\frac{dn}{dx}(x_0)$ and integrating, we obtain

$$N_+(x_0) = \frac{1}{2}n(x_0)v - \frac{1}{4}\frac{dn}{dx}(x_0)v^2\delta. \tag{S1.18}$$

C.1	0.5 pt
$N_+(x_0) = \frac{1}{2}n(x_0)v - \frac{1}{4}\frac{dn}{dx}(x_0)v^2\delta$	

C.2 Let $N_-(x_0)$ be the counterpart of $N_+(x_0)$ for particles with velocity $-v$, then

$$N_-(x_0) = \frac{1}{2}n(x_0)v + \frac{1}{4}\frac{dn}{dx}(x_0)v^2\delta. \tag{S1.19}$$

With this equation, Eq. (S1.18), and $J_D(x_0) = \langle N_+(x_0) - N_-(x_0) \rangle$, we obtain

$$J_D(x_0) = -\frac{1}{2}\frac{dn}{dx}(x_0)\langle v^2 \rangle \delta = -\frac{1}{2}\frac{dn}{dx}(x_0)C\delta. \tag{S1.20}$$

Comparing this with Eq. (4) in the question sheet for $x = x_0$, $J_D(x_0) = -D\frac{dn}{dx}(x_0)$, we obtain

$$D = \frac{1}{2}C\delta. \tag{S1.21}$$

Plugging this into the result of B.1, we obtain

$$\langle \Delta x(t)^2 \rangle = 2Dt. \tag{S1.22}$$

C.2 0.7 pt

$$J_D(x_0) = -\frac{1}{2}\frac{dn}{dx}(x_0)C\delta$$

$$D = \frac{1}{2}C\delta$$

$$\langle \Delta x(t)^2 \rangle = 2Dt$$

C.3 The force balance sketched in Fig. 2 is expressed by the following equation:

$$\Pi(x)A + n(x)A\Delta xQE = \Pi(x+\Delta x)A. \tag{S1.23}$$

Using the van 't Hoff equation for the osmotic pressure, $\Pi(x) = n(x)kT$, and carrying out the Taylor expansion of $n(x+\Delta x)$, we obtain

$$\frac{dn}{dx} = \frac{n(x)}{kT}QE. \tag{S1.24}$$

C.3 0.5 pt

$$\frac{dn}{dx} = \frac{n(x)}{kT}QE$$

C.4 The equation of motion for $\langle v(t) \rangle$ is

$$M\frac{d\langle v(t)\rangle}{dt} = -\gamma\langle v(t)\rangle + QE. \tag{S1.25}$$

By solving this with the initial condition $\langle v(0)\rangle = 0$, we obtain

$$\langle v(t)\rangle = \frac{QE}{\gamma}(1 - e^{-t/\tau}). \tag{S1.26}$$

Therefore,

$$u = \lim_{t\to\infty}\langle v(t)\rangle = \frac{QE}{\gamma}. \tag{S1.27}$$

▷ Note: The student is expected to surmise that the solution to Eq. (S1.25) has a functional form analogous to that to Eq. (S1.2), whose solution is given in the question sheet.

C.4 0.5 pt

$$\langle v(t)\rangle = \frac{QE}{\gamma}(1 - e^{-t/\tau})$$

$$u = \frac{QE}{\gamma}$$

C.5 From the result of C.3 and Eq. (4) in the question sheet, we have

$$J_D(x) = -\frac{DQE}{kT}n(x). \tag{S1.28}$$

From the result of C.4 and Eq. (5) in the question sheet, we have

$$J_Q(x) = \frac{QE}{\gamma} n(x). \tag{S1.29}$$

Plugging these into the flux balance condition, $J_D(x) + J_Q(x) = 0$, we obtain

$$D = \frac{kT}{\gamma}. \tag{S1.30}$$

C.5	0.5 pt
$D = \dfrac{kT}{\gamma}$	

Part D. Mean square displacement (2.4 points)

D.1 Combining the results of C.2 and C.5, $k = R/N_A, \gamma = 6\pi a\eta$, we obtain the following equation that links the mean square displacement to N_A:

$$\langle \Delta x^2 \rangle = \frac{RT\Delta t}{3\pi a\eta N_A}. \tag{S1.31}$$

From the data given in the question sheet, the mean square displacement is estimated at $\langle \Delta x^2 \rangle = 6.34\ \mu\text{m}^2$. Plugging this and the values of the parameters given in the question sheet, we obtain

$$N_A = 5.6 \times 10^{23}\ \text{mol}^{-1}. \tag{S1.32}$$

▷ Note: In 1908, Jean Baptiste Perrin (1870-1942) carried out such an observation and obtained an estimate of N_A, which turned out to be consistent with the values known at that time by other approaches. This convinced the community of the fact that molecules and hence atoms do exist as constituents of matter. Perrin was awarded the Nobel Prize in Physics in 1926 for ``his work on the discontinuous structure of matter, and especially for his discovery of sedimentation equilibrium''. For more details, see, e.g., S. G. Brush, ``A History of Random Processes: I. Brownian Movement from Brown to Perrin'', Archive for History of Exact Sciences, volume **5**, pages 1–36 (1968).

▷ Note: On May 20, 2019, the definition of physical constants including the Avogadro constant N_A was changed. As a result, N_A is now defined by a fixed value, not to be determined through measurements.

D.1	1.0 pt
$N_A = 5.6 \times 10^{23}\ \text{mol}^{-1}$	

D.2 Using $\Delta x(t) = \sum_{n=1}^{N} (u + v_n)\delta$ and Eq. (3) in the question sheet, we obtain

$$\langle \Delta x^2 \rangle = (ut)^2 + 2Dt \tag{S1.33}$$

for general t. This can be rewritten as

$$\langle \Delta x^2 \rangle = u^2 t \left(t + \frac{2D}{u^2} \right) = u^2 t (t + t_*), \tag{S1.34}$$

with $t_* = 2D/u^2$. Therefore,

$$\langle \Delta x^2 \rangle \propto \begin{cases} t & \text{for } t \ll t_* \\ t^2 & \text{for } t \gg t_* \end{cases} \tag{S1.35}$$

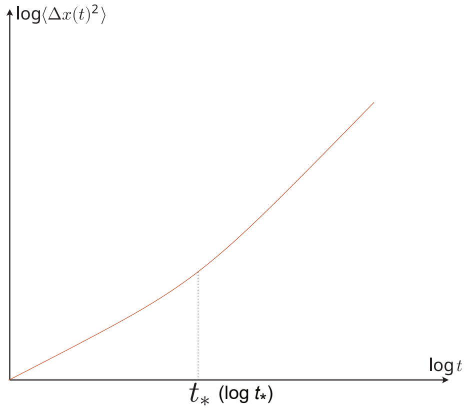
D.2 0.8 pt

$\langle \Delta x^2 \rangle = (ut)^2 + 2Dt$ for general t

$$\langle \Delta x^2 \rangle \propto \begin{cases} t & \text{for small } t \\ t^2 & \text{for large } t \end{cases}$$

$$t_* = \frac{2D}{u^2}$$

An example of the graph to answer:



D.1 Since the microbe does not change the swimming direction for $t \ll \delta_0$, we can use the result of D.2 just by replacing u by u_0. By contrast, for $t \gg \delta_0$, the motion of the microbe can be described by the model considered in PART B, though its parameter δ is not an artificial parameter anymore but is now a quantity that characterizes the microbe's motion, δ_0. The parameter C is given by $C = u_0^2$. Plugging this into Eq. (S1.14) and collecting all these results, we obtain

$$\langle \Delta x^2 \rangle = \begin{cases} 2Dt & \text{for } t \ll 2D/u_0^2 \\ u_0^2 t^2 & \text{for } 2D/u_0^2 \ll t \ll \delta_0 \\ u_0^2 \delta_0 t & \text{for } \delta_0 \ll t \end{cases} \tag{S1.36}$$

▷ Note: More precisely, one can show $\langle \Delta x^2 \rangle = (u_0^2 \delta_0 + 2D)t$ for $t \gg \delta_0$. However, in order for the intermediate regime to exist, we have $2D/u_0^2 \ll \delta_0$, from which it follows that $u_0^2 \delta_0 \gg 2D$ and the expression in Eq. (S1.36) is a good approximation.

▷ Note: The motion of the microbe described here is called the run-and-tumble motion, except that it is usually assumed that the microbe changes the swimming direction (``tumbling'') at random time intervals. Some bacteria including *Escherichia coli* is known to swim in this manner.

D.3 0.6 pt

$$\langle \Delta x^2 \rangle = \begin{cases} 2Dt & \text{for small } t \\ u_0^2 t^2 & \text{for intermediate } t \\ u_0^2 \delta_0 t & \text{for large } t \end{cases}$$

Part E. Water purification (1.5 points)

E.1 The interaction energy $U(d)$ has a barrier if c is small enough, but the barrier disappears if c exceeds a threshold. This threshold is the critical concentration to derive in this question. The condition for the barrier to disappear is given by

$$\min U'(d) = 0. \tag{S1.37}$$

This can be expressed by the following two equations:

$$U'(d) = \frac{A}{d^2} - \frac{B\epsilon(kT)^2}{q^2\lambda}e^{-d/\lambda} = 0, \tag{S1.38}$$

$$U''(d) = -\frac{2A}{d^3} + \frac{B\epsilon(kT)^2}{q^2\lambda^2}e^{-d/\lambda} = 0. \tag{S1.39}$$

Solving these, we obtain

$$d = 2\lambda = \sqrt{\frac{Aq^2\lambda}{B\epsilon(kT)^2}} \tag{S1.40}$$

and therefore

$$\lambda = \frac{e^2Aq^2}{4B\epsilon(kT)^2}. \tag{S1.41}$$

Plugging this into $c = \dfrac{\epsilon kT}{2N_Aq^2}\lambda^{-2}$, we obtain

$$c = \frac{8B^2\epsilon^3(kT)^5}{e^4N_AA^2q^6}. \tag{S1.42}$$

▷ Note: In the literature, it is also common to consider that the critical concentration is reached when the energy barrier becomes as low as the energy for $d \to \infty$, i.e., $\max U(d) = 0$, although this does not meet the requirements given in the question sheet. If this condition is used instead, we find $c = \frac{B^2\epsilon^3(kT)^5}{2e^2N_AA^2q^6}$. This differs from Eq. (S1.42) only by a factor $e^2/8 \approx 0.92$.

E.1 1.5 pt

$$c = \frac{8B^2\epsilon^3(kT)^5}{e^4N_AA^2q^6}$$

Theory Problem 2: Neutron Stars (10 points)

Part A. Mass and stability of nuclei (2.5 points)

A.1 The given binding energy is often called the Weizsäcker-Bethe mass formula, and the physical interpretation of the volume and the surface terms is based on the liquid drop model. The formula works quite well except for the shell effects. Find A to minimize the binding energy per mass number, i.e.,

$$\frac{B}{A} = a_V - a_S A^{-1/3} - \frac{a_C}{4} A^{2/3} \,. \tag{S2.1}$$

As long as A is small, the second term is dominantly increasing with increasing A, and it is eventually taken over by the third term which is decreasing. Therefore, the extremal corresponds to the maximum of B/A. One can explicitly carry out

$$\frac{d(B/A)}{dA} = 0 \tag{S2.2}$$

to find the following condition,

$$\frac{a_S}{3} A^{-4/3} - \frac{a_C}{6} A^{-1/3} = 0 \,. \tag{S2.3}$$

The solution is

$$A = \frac{2a_S}{a_C} \,. \tag{S2.4}$$

From the given numerical values, $A = 50$ (which must be an integer) is concluded.

▷ Note: In reality B/A has a maximum for A ranging from $^{56}\mathrm{Fe}$ to $^{62}\mathrm{Ni}$. The discrepancy from the answer in this problem is understood by the approximation of dropping the pairing energy and disregarding a mass difference between the proton and the neutron.

A.1	0.9 pt
$A = 50$	

A.2 Take the differentiation of $B(Z, A-Z)/A$ with respect to Z for a fixed A, which leads to

$$-2a_C \frac{Z^*}{A^{1/3}} - 4a_{\text{sym}} \frac{2Z^* - A}{A} = 0 \,. \tag{S2.5}$$

By solving this in terms of Z^*, one finds

$$Z^* = \frac{1}{1 + \dfrac{a_C}{4a_{\text{sym}}} A^{2/3}} \cdot \frac{A}{2} \,. \tag{S2.6}$$

From this expression one can understand that $Z^* \simeq N$ as long as A is small enough, while Z^* becomes far smaller than N for large A. It is obvious from the explicit form that the symmetry energy tends to favor $Z = N$ but the Coulomb interaction tends to favor $Z \to 0$, and the balance between these competing effects determines Z^*. Nuclei with too many neutrons (protons) would go through the β^- decay (the β^+ decay or the electron capture) toward the stable (Z, N).

A.2	0.9 pt
$Z^* = 79$	

A.3 Plugging the binding energy into the given inequality, one sees that the volume terms cancel due to volume conservation. Then, the condition involves only a_S and a_C which are related as

$$a_S\left[A^{2/3}-2\left(\frac{A}{2}\right)^{2/3}\right]+a_C\left[\frac{Z^2}{A^{1/3}}-2\frac{(Z/2)^2}{(A/2)^{1/3}}\right]>0\,. \tag{S2.7}$$

As guided in the problem, the above inequality becomes as simple as

$$\frac{Z^2}{A}>\frac{2^{1/3}-1}{1-2^{-2/3}}\cdot\frac{a_S}{a_C}\,. \tag{S2.8}$$

Therefore, the numerical coefficient turns out to be 0.7.

> ▷ Note: The physical interpretation of this result may need some explanations. Using the values of a_S and a_C, one finds that such a symmetric fission process is possible for $Z^2/A \gtrsim 18$. For example, lead (Pb) with $Z=82$ and $A=208$ is a stable element among several isotopes. Now, one can compute $82^2/208\approx 32$, which is larger than the threshold 18. The key to resolving this gap is the potential barrier from the deformation. When a heavy nucleus splits into two fragments, the shape and the surface should change from the stable configuration (which is not necessarily spherical due to interaction) and thus the surface energy increases. Although some heavy elements are energetically unstable, the lifetime necessary to overcome the potential barrier can be very large.

A.3 $C_{\text{fission}}=7.0\times10^{-1}$	0.7 pt

Part B. Neutron star as a gigantic nucleus (1.5 points)

B.1 The expression apart from the parametric dependence on A can be identified as

$$a_{\text{grav}}=\frac{3}{5}\frac{Gm_N^2}{R_0}\,, \tag{S2.9}$$

which is re-expressed in terms of M_P using the given relation to G, leading to

$$a_{\text{grav}}=\frac{3}{5}\frac{\hbar c\, m_N^2}{R_0 M_P^2}=\frac{3}{5}\cdot\frac{197\,\text{fm}\cdot\text{MeV}\times(939\,\text{MeV}/c^2)^2}{1.1\,\text{fm}\times(1.22\times10^{22}\,\text{MeV}/c^2)^2}\simeq 6.4\times10^{-37}\,\text{MeV}\,. \tag{S2.10}$$

Here, M_P is a quantity often called the Planck mass. The gravitational effect is extremely tiny as compared to the typical scale in nuclear physics and this scale difference is manifest for this expression of G with M_P in the MeV unit.

The stability is judged from the condition that the binding energy should be positive, i.e.,

$$B_{\text{total}}(A)=a_V A-a_{\text{sym}}A+a_{\text{grav}}A^{5/3}>0\,. \tag{S2.11}$$

This inequality can be translated into $A>A_c$ with A_c given by

$$A_c=\left(\frac{a_{\text{sym}}-a_V}{a_{\text{grav}}}\right)^{3/2}\simeq 4.4\times10^{55}\,. \tag{S2.12}$$

> ▷ Note: One may think that one neutron drip is a process with the least change in the surface area and thus the smallest barrier. This leads to a condition, $B_{\text{total}}(A)>B_{\text{total}}(A-1)$ or approximately $dB_{\text{total}}(A)/dA>0$, which is satisfied in a window with $B_{\text{total}}<0$. This condition, $dB_{\text{total}}/dA=0$, results in smaller A_c but it is nontrivial whether such an unstable initial state could be prepared in the nature. The neutron star is born in the Type-II (core-collapse) supernovae, and a baby star called the proto-neutron star is an energetic state at high temperature. Neutrinos bring heat out from the proto-neutron star

within the time scale of $\mathcal{O}(10)$ seconds. What is the possible smallest mass of the neutron star? This is not completely understood partly because the computer simulation of the supernovae is a big challenge even today. Although the neutron star mass can become much smaller than $M_\odot$ theoretically, the simulation and the observation favor the mass $\gtrsim 1.4M_\odot$.

B.1 1.5 pt

$$a_{\text{grav}} = 6 \times 10^{-37}\ \text{MeV}$$

$$A_c = 4 \times 10^{55}$$

Part C. Neutron star in a binary system (6.0 points)

C.1 From the energy conservation, the free-falling system earns the kinetic energy $\frac{1}{2}mv^2$ from the potential energy $mg\Delta h$, and the velocity takes

$$v^2 = 2g\Delta h = 2\Delta\phi\,. \tag{S2.13}$$

The time delay can be derived from the standard arguments. Suppose that Clock-II passes two infinitesimally separate points, z and $z+\Delta z$, in F at time t and $t+\Delta\tau_{\text{II}}$, then the time interval registered by Clock-II is

$$\Delta\tau_{\text{II}} = \frac{\gamma}{c}(c\Delta\tau_{\text{F}} - \beta\Delta z)\,, \tag{S2.14}$$

where the Lorentz transformation is used[1] with $\beta = v/c$ and $\gamma = 1/\sqrt{1-\beta^2}$. Because $\Delta z/\Delta\tau_{\text{F}} = v$ and $\Delta\tau_{\text{F}} = \Delta\tau_{\text{I}}$, the above expression is written as

$$\Delta\tau_{\text{II}} = \gamma(1-\beta^2)\Delta\tau_{\text{F}} = \sqrt{1-\beta^2}\,\Delta\tau_{\text{I}}\,. \tag{S2.15}$$

Using the expression of v^2, one finally arrives at

$$\Delta\tau_{\text{II}} = \sqrt{1 - 2\frac{\Delta\phi}{c^2}}\,\Delta\tau_{\text{I}} \simeq \left(1 - \frac{\Delta\phi}{c^2}\right)\Delta\tau_{\text{I}}\,. \tag{S2.16}$$

C.1 1.0 pt

$$\Delta\tau_{\text{II}} = \left(1 - \frac{\Delta\phi}{c^2}\right)\Delta\tau_{\text{I}}$$

C.2 In terms of the effective speed of light, the total time necessary for the light propagation from **N** to **E** is

$$t_{\text{E-N}} = \int_{x_N}^{x_E} \frac{dx}{c_{\text{eff}}(x)}\,. \tag{S2.17}$$

The denominator is expanded in terms of the gravitational potential and the leading-order correction is found to be

$$t_{\text{E-N}} \simeq \frac{1}{c}\int_{x_N}^{x_E} dx\left(1 + \frac{2GM_{\text{WD}}}{c^2\sqrt{x^2+d^2}}\right) = \frac{x_E - x_N}{c} + \Delta t\,, \tag{S2.18}$$

[1] Clock-F is in an inertial frame but Clock-II is not. Using Clock-II′ in another free-falling frame II′ as an inertial reference to Clock-II, the Lorentz transformation is validated for Clock-II′ seen from Clock-F.

where the time delay Δt is identified as

$$\Delta t = \frac{2GM_{\mathrm{WD}}}{c^3}\int_{x_N}^{x_E}\frac{dx}{\sqrt{x^2+d^2}} = \frac{GM_{\mathrm{WD}}}{c^3}\log\left(\frac{\sqrt{x^2+d^2}+x}{\sqrt{x^2+d^2}-x}\right)\Bigg|_{x=x_N}^{x=x_E}. \tag{S2.19}$$

Inside the logarithm, the following approximations are made:

$$\sqrt{x_N^2+d^2}+x_N \simeq \frac{d^2}{2|x_N|}, \qquad \sqrt{x_N^2+d^2}-x_N \simeq 2|x_N|, \tag{S2.20}$$

and

$$\sqrt{x_E^2+d^2}-x_E \simeq \frac{d^2}{2x_E}, \qquad \sqrt{x_E^2+d^2}+x_E \simeq 2x_E. \tag{S2.21}$$

Then, the simple form of approximated Δt is

$$\Delta t \simeq \frac{GM_{\mathrm{WD}}}{c^3}\log\left(\frac{2x_E\cdot 2|x_N|}{d^2/(2x_E)\cdot d^2/(2|x_N|)}\right) = \frac{2GM_{\mathrm{WD}}}{c^3}\log\left(\frac{4|x_N|x_E}{d^2}\right). \tag{S2.22}$$

C.2 1.8 pt

$$\Delta t = \frac{2GM_{\mathrm{WD}}}{c^3}\log\left(\frac{4|x_N|x_E}{d^2}\right)$$

C.3 Because $|x_N| = L\cos\varepsilon \simeq L$ and $d = L\sin\varepsilon \simeq L\varepsilon$ for Δt_{max}, the answer of C.2 gives

$$\Delta t_{\mathrm{max}} = \frac{2GM_{\mathrm{WD}}}{c^3}\log(4x_E/L\varepsilon^2) \tag{S2.23}$$

For Δt_{min} the sign of x_N is changed. Although the expression of Δt is intact, the approximation takes a different form as

$$\sqrt{x_N^2+d^2}+x_N \simeq 2x_N, \qquad \sqrt{x_N^2+d^2}-x_N \simeq \frac{d^2}{2x_N}. \tag{S2.24}$$

Then, the approximated form of Δt_{min} is

$$\Delta t_{\mathrm{min}} \simeq \frac{GM_{\mathrm{WD}}}{c^3}\log\left(\frac{2x_E\cdot d^2/(2x_N)}{d^2/(2x_E)\cdot 2x_N}\right) = \frac{2GM_{\mathrm{WD}}}{c^3}\log(x_E/L), \tag{S2.25}$$

where $x_N \simeq L$ is used in the last expression. In the difference, $\Delta t_{\mathrm{max}} - \Delta t_{\mathrm{min}}$, one sees that L and x_E disappear.

C.3 1.8 pt

$$\Delta t_{\mathrm{max}} - \Delta t_{\mathrm{min}} = \frac{2GM_{\mathrm{WD}}}{c^3}\log(4/\varepsilon^2)$$

C.4 Using the expansion, $\cos\varepsilon \simeq 1 - \frac{1}{2}\varepsilon^2$, one can evaluate

$$\varepsilon^2 \simeq 2\times(1-\cos\varepsilon) = 0.00022. \tag{S2.26}$$

From the graph the difference in time delays is roughly read out as

$$\Delta t_{\mathrm{max}} - \Delta t_{\mathrm{min}} \approx 50\,\mu\mathrm{s} \tag{S2.27}$$

From these numerical values, M_{WD} is solved as

$$M_{\mathrm{WD}} = M_\odot\left(\frac{2GM_\odot}{c^3}\right)^{-1}\frac{\Delta t_{\mathrm{max}}-\Delta t_{\mathrm{min}}}{\log(4/\varepsilon^2)} \simeq \frac{50\,\mu\mathrm{s}}{10\,\mu\mathrm{s}\ \log(4/0.00022)}M_\odot \simeq 0.5\,M_\odot. \tag{S2.28}$$

▷ Note: The data in this problem roughly correspond to PSR J1614-2230 [see P.B. Demorest *et al.*, Nature 467, 1080-1083 (2010)]. From the Shapiro delay measurement, the White Dwarf mass was estimated as $0.500 \pm 0.006 M_\odot$. With the Keplerian orbital parameters in the binary system, the neutron star mass was considered to be $1.97 \pm 0.04 M_\odot$, which was the heaviest neutron star at that time. Since then, several candidates for heavier neutron stars have been found.

C.4	0.8 pt
$M_{\mathrm{WD}}/M_\odot = 0.5$	

C.5 For the circular orbit with the radius R, the equation of motion is

$$mR\omega^2 = G\frac{mM}{R^2}\,, \tag{S2.29}$$

if M is sufficiently large. From this it is easy to see

$$R^3\omega^2 = GM = (\text{const.}) \tag{S2.30}$$

This is nothing but Kepler's third law and the relation holds for more general elliptical orbits around the center of mass.

C.5	0.4 pt
$p = -\frac{3}{2}$	

C.6 The sum of the kinetic energy and the potential energy is

$$E = \frac{1}{2}mR^2\omega^2 - G\frac{mM}{R}\,. \tag{S2.31}$$

From the equation of motion this is rewritten as

$$E = -\frac{1}{2}G\frac{mM}{R}\,. \tag{S2.32}$$

Therefore, when E decreases due to gravitational wave emission, R should decrease. Then, ω should increase. Since the amplitude is proportional to $R^2\omega^2 \propto R^{-1}$, it should increase. In summary, both the frequency and the amplitude should increase as time goes on, as illustrated in (b).

C.6	0.2 pt
The most appropriate profile is (b).	

Water and Objects (10 pt)

In this problem, we consider the phenomena caused by the interaction between water and objects, related to surface tension. Part A treats motion, while Parts B and C are regarding static situations.

If necessary, you can use the fact that if the function $y(x)$ satisfies the differential equation $y''(x) = ay(x)$ (a is a positive constant), then its general solution is $y(x) = Ae^{\sqrt{a}x} + Be^{-\sqrt{a}x}$, where A and B are arbitrary constants.

Part A. Merger of water drops (2.0 points)

As shown in Fig.1, we consider two stationary, spherical water drops on the surface of a super-hydrophobic material, i.e., very strong repulsive force exists between material and water.

Initially neighboring two identical spherical water drops are placed on the surface; then these two drops are merged after touching each other and form a larger spherical water drop, which suddenly jumps up.

A.1	The radius a of both water drops before the merger is $100\ \mu$m. The density of water ρ is 1.00×10^3 kg/m^3. The surface tension γ is 7.27×10^{-2} J/m^2. A portion k of the difference of the surface energy before and after the merger, ΔE, is transformed into the kinetic energy of the jumped water drop. Then, determine the initial jump-up velocity, v, of the merged water drop in two significant digits under the following assumptions: • $k = 0.06$ • Before and after merger, the total volume of water is conserved.	2.0pt

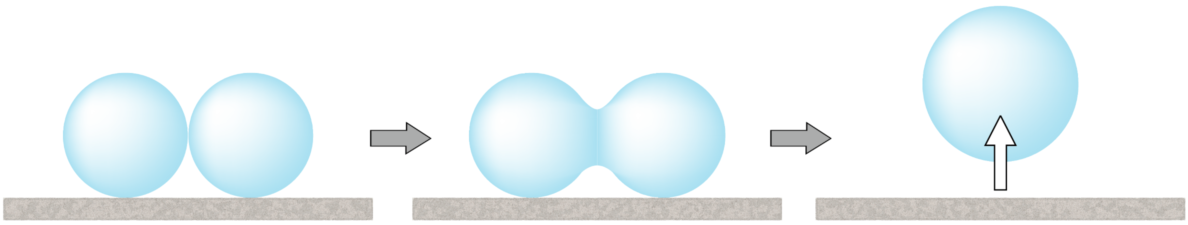


Fig. 1: Merger of two water drops and jump of the merged water drop.

Part B. A vertically placed board (4.5 points)

A flat board is immersed vertically in water. Figures 2(a) and 2(b) respectively show water surface forms for the hydrophilic (attractive) and hydrophobic board materials. We neglect the thickness of the board.

The board surface is on the yz plane, and the horizontal water surface far away from the board is on the xy plane with $z = 0$. The surface shape does not depend on the y-coordinate. Let $\theta(x)$ be the angle between the water surface and the horizontal plane at a point (x, z) on the water surface in the xz plane. Here $\theta(x)$ is measured with respect to the positive x axis and the counterclockwise rotation is taken as positive. Let $\theta(x)$ be θ_0 at the point of contact between the board and the water surface ($x = 0$). In the following, θ_0 is fixed by the properties of the board material.

Water density ρ is constant and water surface tension γ is uniform. The gravitational acceleration constant is given by g. The atmospheric pressure, P_0, is assumed to be always uniform. Let us determine the water surface form in the following steps. Note that the unit of surface tension is J/m^{2}as well as N/m.

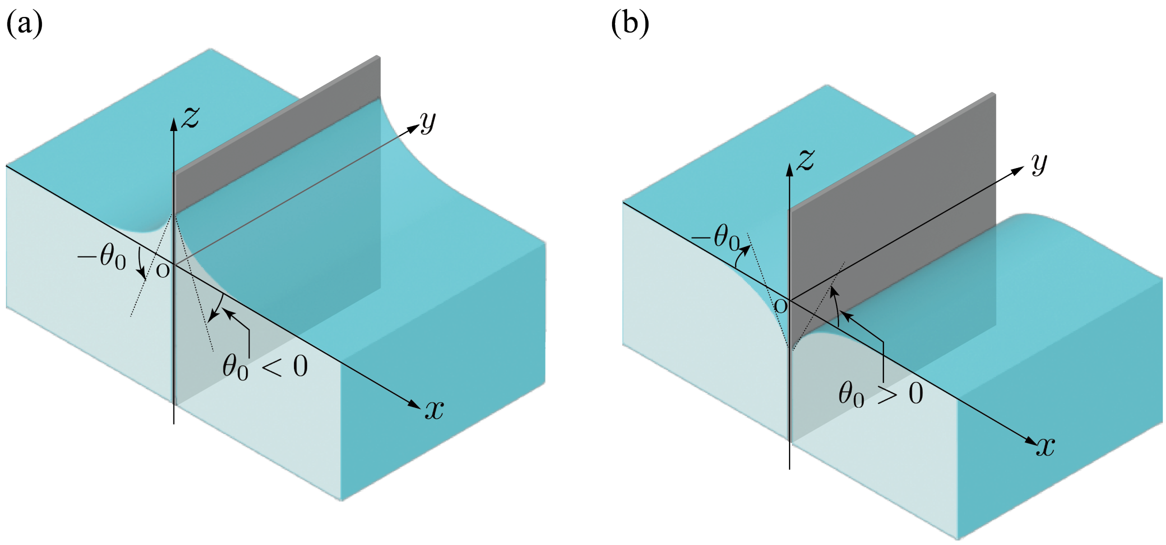


Fig. 2: Boards vertically immersed in the water. (a) hydrophilic board case; (b) hydrophobic board case.

B.1	We consider a hydrophilic board case, as shown in Fig.2(a). We note that the water pressure, P, satisfies the conditions $P < P_0$ for $z > 0$ and $P = P_0$ for $z = 0$. Then, express P at z in terms of ρ, g, z, and P_0.	0.6pt

B.2	We consider a water block whose cutout is shown as shaded in Fig.3(a). Its xz plane cross-section is shown in a hatched area in Fig.3(b). Let z_1 and z_2 respectively be the left and right edge coordinates of the boundary (water surface) between the water block and the air. Obtain a horizontal component (x component) of the net force per unit length along the y-axis, f_x, which is exerted on the water block due to the pressure, in terms of ρ, g, z_1, and z_2. Note that P_0 results in no net horizontal force on the water block.	0.8pt

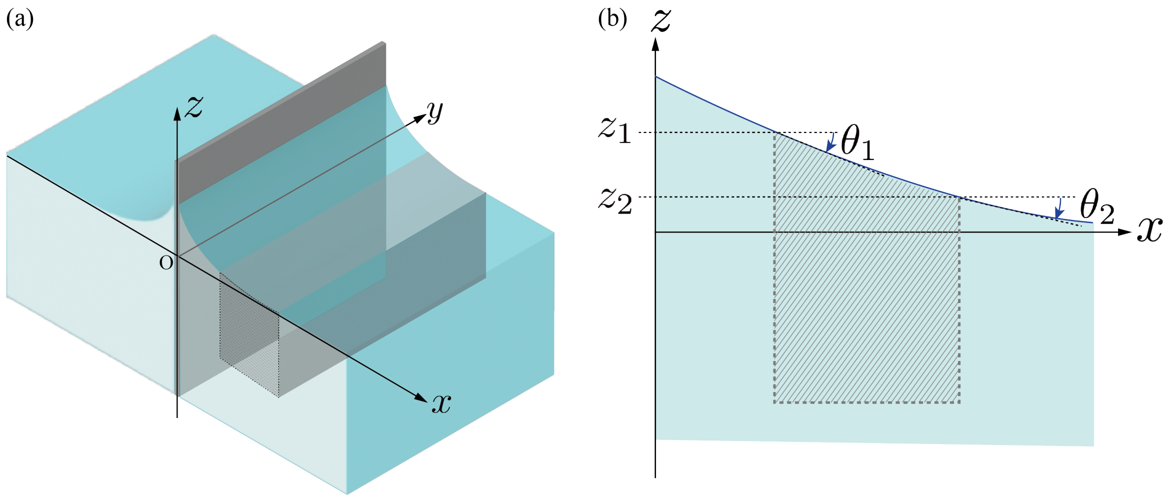


Fig. 3: Cutout form of water block on the water surface. (a) Bird's eye view and (b) cross-sectional view.

B.3	Surface tension acting on the water block is balanced with the force f_x discussed in B.2. We respectively define θ_1 and θ_2 as the angles between the water surface and the horizontal plane at the left and right edges. Express f_x in terms of γ, θ_1, and θ_2.	0.8pt

B.4 The following equation holds at an arbitrary point (x, z) on the water surface, 0.8pt

$$\frac{1}{2}\left(\frac{z}{\ell}\right)^a + \cos\theta(x) = \text{constant.} \tag{1}$$

Determine the exponent a and express the constant ℓ in terms of γ and ρ. Note that this equation holds regardless of hydrophilic or hydrophobic board materials.

B.5	In Eq. (1) in B.4, we assume that variation of the water surface is slow, i.e., $\lvert z'(x)\rvert \ll 1$, so that we can expand $\cos\theta(x)$ with respect to $z'(x)$ up to the second order. Then, differentiating the resultant equation with respect to x, we obtain the differential equation satisfied by $z(x)$. Solve this differential equation and determine $z(x)$ for $x \geq 0$ in terms of $\tan\theta_0$ and ℓ. Note that the vertical directions of Figs. 2 and 3 are exaggerated for better view and they do not satisfy the condition, $\lvert z'(x)\rvert \ll 1$.	1.5pt

Part C. Interaction between two rods (3.5 points)

The identical rods A and B made of the same material floating in parallel on the water surface are placed at the same distance away from the y-axis (Fig.4).

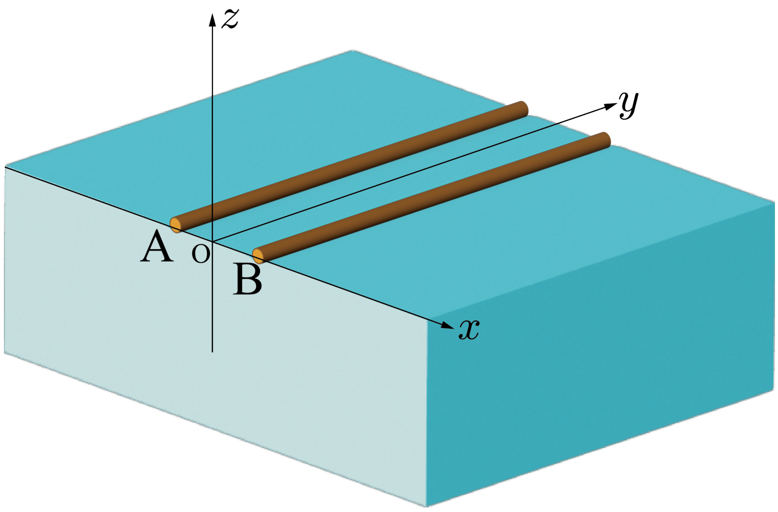


Fig. 4: Two rods A and B floating on the water surface.

C.1	At the contact points of the rod B and the water surface, we define the z-coordinates z_a and z_b, and the angles θ_a and θ_b, as shown in Fig.5. Determine the horizontal force component, F_x, on the rod B per unit length along the y-axis in terms of θ_a, θ_b, z_a, z_b, ρ, g, and γ.	1.0pt

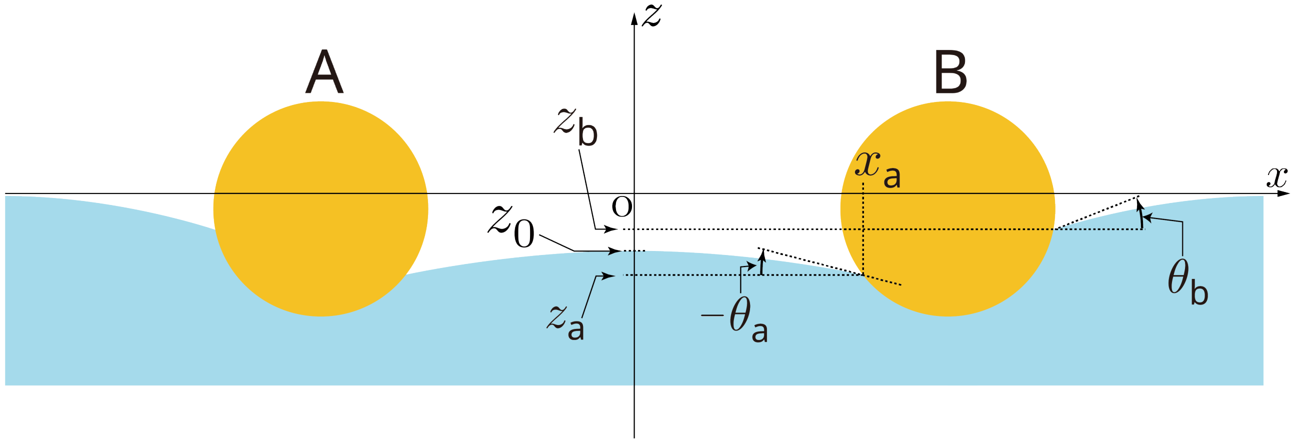


Fig. 5: Vertical cross-sectional view of two rods floating on the water surface.

C.2	We define the z-coordinate of the water surface, z_0, at the midpoint of two rods in the xz plane. Express the force F_x obtained in C.1 without using θ_a, θ_b, z_a, and z_b.	1.5pt

C.3	Let x_a be the x-coordinate of the contact point between the water surface and the left side of the rod B. Using the differential equation obtained in B.5, express the water level coordinate z_0 of the midpoint of these two rods A and B in terms of x_a and z_a. You can use the constant ℓ introduced in B.4.	1.0pt

Theory Problem 3: Water and Objects (10 points)

Part A. Merger of water drops (2.0 pt)

A.1 The surface energy per drop before the merger is

$$E = 4\pi a^2 \gamma. \tag{S3.1}$$

Therefore, the surface energy difference becomes

$$\Delta E = 4\pi \left(2 - 2^{2/3}\right) a^2 \gamma. \tag{S3.2}$$

The transfer of surface energy to kinetic energy is represented by

$$Mv^2/2 = k\Delta E, \tag{S3.3}$$

where $k = 0.06$ and $M = 4\pi a^3 \rho/3 \times 2 = 8\pi a^3 \rho/3$ is the mass of the drop after the merger. The numerical computation gives

$$v = \sqrt{\frac{2k\Delta E}{M}} = \sqrt{3\left(2 - 2^{2/3}\right)\frac{k\gamma}{\rho a}} = \sqrt{3\left(2 - 2^{2/3}\right) \times \frac{0.06 \times (7.27 \times 10^{-2})}{(1.0 \times 10^3) \times (100 \times 10^{-6})}} = 0.23\cancel{2}\ \mathrm{m/s}. \tag{S3.4}$$

▷ Note: We point out an interesting phenomenon related to this question. On a superhydrophobic surface, when small droplets merge, they release surface energy, causing the surface area to shrink. This energy release propels the merged droplet to jump up. This phenomenon mirrors the natural mechanism seen in cicadas. Cicadas' wings, which possess superhydrophobic surfaces, facilitate the removal of water droplets upon coalescence. This process serves as a natural self-cleaning system, converting surface energy to kinetic energy, as reported in the following paper: Wisdom *et. al.*, Proc. Natl. Acad. Sci. USA **110**, 7992–7997 (2013).

A.1	2.0 pt
$v = 0.23$ m/s	

Part B. A vertically placed board (4.5 pt)

B.1

Consider a vertical upright column-shaped water block as shown in the hatched area of Fig. S3-1. The vertical force balance with respect to this block per unit area leads to $P + \rho g z = P_0$.

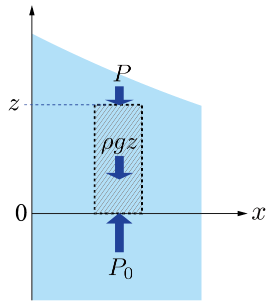


Fig. S3-1

B.1	0.6 pt
$P = P_0 - \rho g z$	

B.2

Because the atmospheric pressure P_0 exerts no net horizontal force on the water block, we have

$$f_x = \int_{z_2}^{z_1} (-\rho g z) dz = \frac{1}{2}\rho g \left(z_2^2 - z_1^2\right). \tag{S3.5}$$

This force acts in the leftward direction.

▷ Note: The reason why P_0 exerts no net horizontal force is understood as follows. Consider a small area (infinitesimally divided piece) near the surface, which is regarded as a right-angled triangle (see Fig. S3-2).

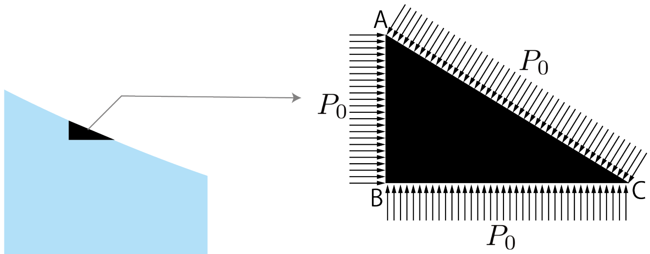


Fig. S3-2

The horizontal component of the combined force exerted on the right-angled triangle ABC per unit length along the y-axis by atmospheric pressure is

$$P_0 \times \overline{\mathrm{AB}} - P_0 \times \overline{\mathrm{AC}} \times \frac{\overline{\mathrm{AB}}}{\overline{\mathrm{AC}}} = 0$$

Integrating infinitesimal pieces over a finite domain yields a finite volume of water, while the net force remains zero.

B.2 0.8 pt

$$f_x = \frac{1}{2}\rho g \left(z_2^2 - z_1^2\right)$$

B.3

The horizontal component of the surface tension acting on the water block is $\gamma\cos\theta_2 - \gamma\cos\theta_1$. Thus, the horizontal force balance is expressed as

$$f_x + \gamma\cos\theta_2 - \gamma\cos\theta_1 = 0. \tag{S3.6}$$

B.3 0.8 pt

$$f_x = \gamma\cos\theta_1 - \gamma\cos\theta_2$$

B.4

From the results of B.2 and B.3, we have

$$\frac{1}{2}\rho g z_1^2 + \gamma\cos\theta_1 = \frac{1}{2}\rho g z_2^2 + \gamma\cos\theta_2. \tag{S3.7}$$

Since this equation holds at an arbitrary point (x, z) on the water surface, we conclude

$$\frac{1}{2}\rho g z^2 + \gamma\cos\theta = \text{constant}, \tag{S3.8}$$

which is written as

$$\frac{1}{2}\left(\frac{z}{\ell}\right)^a + \cos\theta(x) = \text{constant}, \tag{S3.9}$$

with $a = 2$ and $\ell = \sqrt{\frac{\gamma}{\rho g}}$.

▷ Note: The equaiton (S3.9) is a kind of conservation law. The constant ℓ is called the capillary length.

B.4 0.8 pt

$$a = 2, \quad \ell = \sqrt{\frac{\gamma}{\rho g}}$$

B.5 The derivative of the water surface coordinate z, denoted by z', is associated with the angle of inclination θ, given by the equation: $z' = \tan\theta$. This relation yields

$$\cos\theta = \frac{1}{\sqrt{1 + (z')^2}}, \tag{S3.10}$$

which leads to

$$\cos\theta \simeq 1 - \frac{1}{2}(z')^2. \tag{S3.11}$$

Plugging this into Eq. (S3.9), we obtain

$$\frac{z^2}{\ell^2} - z'^2 = \text{const.} \tag{S3.12}$$

Taking the derivative of both sides with respect to x, we have

$$z'' = \frac{z}{\ell^2}, \tag{S3.13}$$

which is the differential equation that determines the water surface form.

Its general solution is

$$z = Ae^{x/\ell} + Be^{-x/\ell}. \tag{S3.14}$$

The boundary condition, $z(\infty) = 0$, leads to $A = 0$.

The boundary condition, $z'(0) = \tan\theta_0$, leads to $B = -\ell\tan\theta_0$.

B.5 1.5 pt

$$z(x) = -\ell\tan\theta_0 e^{-x/\ell}$$

Part C. Interaction between two rods (3.5 pt)

C.1 The horizontal component of the force due to the pressure is

$$\int_{z_\mathrm{a}}^{z_\mathrm{b}} (\rho g z)\, dz = \frac{1}{2}\rho g\left(z_\mathrm{b}^2 - z_\mathrm{a}^2\right) \tag{S3.15}$$

Let z_bottom be the z-coordinate at the bottom of the rod. Then, we have

$$F_x = \int_{z_\mathrm{bottom}}^{z_\mathrm{a}} (-\rho g z) dz + \left(-\int_{z_\mathrm{bottom}}^{z_\mathrm{b}} (-\rho g z) dz\right) = \int_{z_\mathrm{a}}^{z_\mathrm{b}} (\rho g z) dz \tag{S3.16}$$

▷ Note: The fact that the contribution due to the pressure does not depend on the shape of the cross-section can be demonstrated as follows. The pressure at the point s on the contour C along the cross-sectional boundary is

$$-P\hat{n}ds = (-P_0 + \rho g z)\hat{n}ds. \tag{S3.17}$$

Let $\hat{x}$ be the unit vector pointing the positive x-direction and noting $\hat{x}\cdot\hat{n}ds = dz$ (see Fig. S3-3), we obtain its horizontal component as

$$-P\hat{n}\cdot\hat{x}ds = -P_0 dz + \rho g z dz. \tag{S3.18}$$

Integrating along the contour C.[1] We obtain

$$\int_{z_\mathrm{a}}^{z_\mathrm{b}} (\rho g z) dz = \frac{1}{2}\rho g\left(z_\mathrm{b}^2 - z_\mathrm{a}^2\right) \tag{S3.19}$$

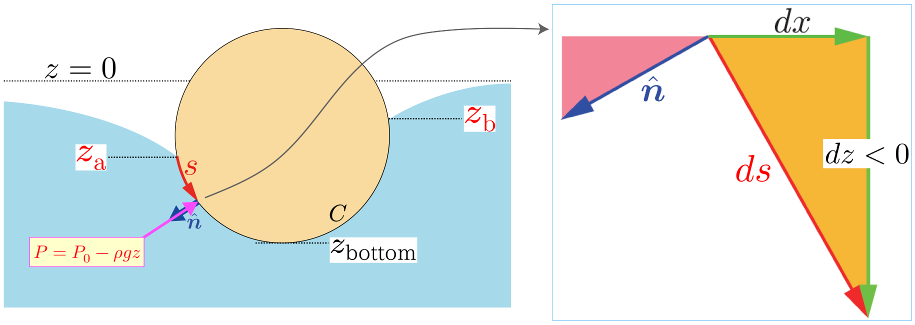


Fig. S3-3

C.1 1.0 pt

$$F_x = \frac{1}{2}\rho g\left(z_\mathrm{b}^2 - z_\mathrm{a}^2\right) + \gamma\left(\cos\theta_\mathrm{b} - \cos\theta_\mathrm{a}\right)$$

C.2 By applying the boundary conditions to Eq. (S3.8), we obtain

$$\underbrace{\frac{1}{2}\rho g z_\mathrm{a}^2 + \gamma\cos\theta_\mathrm{a}}_{x=x_\mathrm{a}} = \underbrace{\frac{1}{2}\rho g z_0^2 + \gamma}_{x=0} \tag{S3.20}$$

$$\underbrace{\frac{1}{2}\rho g z_\mathrm{b}^2 + \gamma\cos\theta_\mathrm{b}}_{x=x_\mathrm{b}} = \underbrace{\gamma}_{x\to\infty} \tag{S3.21}$$

Then, $F_x = -\dfrac{1}{2}\rho g z_0^2$ is obtained by subtracting (S3.20) from (S3.21).

▷ Note: The physical background of this problem is as follows. When a single rod is placed on the water surface, the shape of the water surface on both sides of the rod remains the same. In other words, the rod is placed in an environment that exhibits the left-right symmetry. Then, there is no force acting on the rod. On the other hand, when two rods are placed on the water surface, the left-right symmetry of the water surface is broken from the perspective of each rod. As a result, an attractive force is generated.

The displacement of the water surface at the midpoint between the two rods differs from that of a horizontal water surface. This deviation is represented by z_0. That is to say, z_0 plays the role of a symmetry-breaking parameter (see Fig. S3-4).

The fact that the attractive force between the two rods is determined solely by this parameter suggests that the symmetry breaking directly becomes the origin of the force. This corresponds to the fundamental principle in physics that relates symmetry breaking to force generation.

[1] This integral is symbolically written as $\oint_C (-P\hat{n}\cdot\hat{x}ds)$.

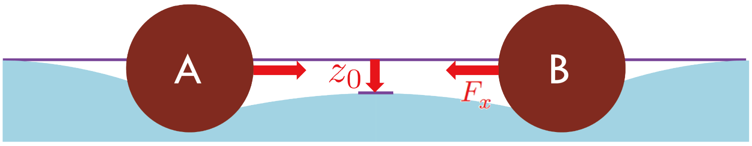


Fig. S3-4

C.2 1.5 pt

$$F_x = -\frac{1}{2}\rho g z_0^2$$

C.3 The general solution for the water surface height is given by the equation

$$z(x) = Ae^{x/\ell} + Be^{-x/\ell}. \tag{S3.22}$$

By considering the left-right symmetry, we find

$$A = B. \tag{S3.23}$$

Applying the boundary condition $z(0) = z_0$, we obtain

$$A + B = z_0. \tag{S3.24}$$

We thus have

$$A = z_0/2, \quad B = z_0/2. \tag{S3.25}$$

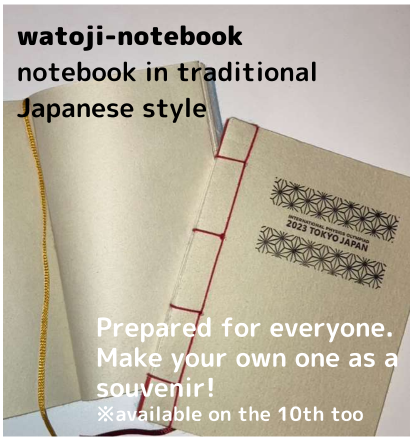
C.3 1.0 pt

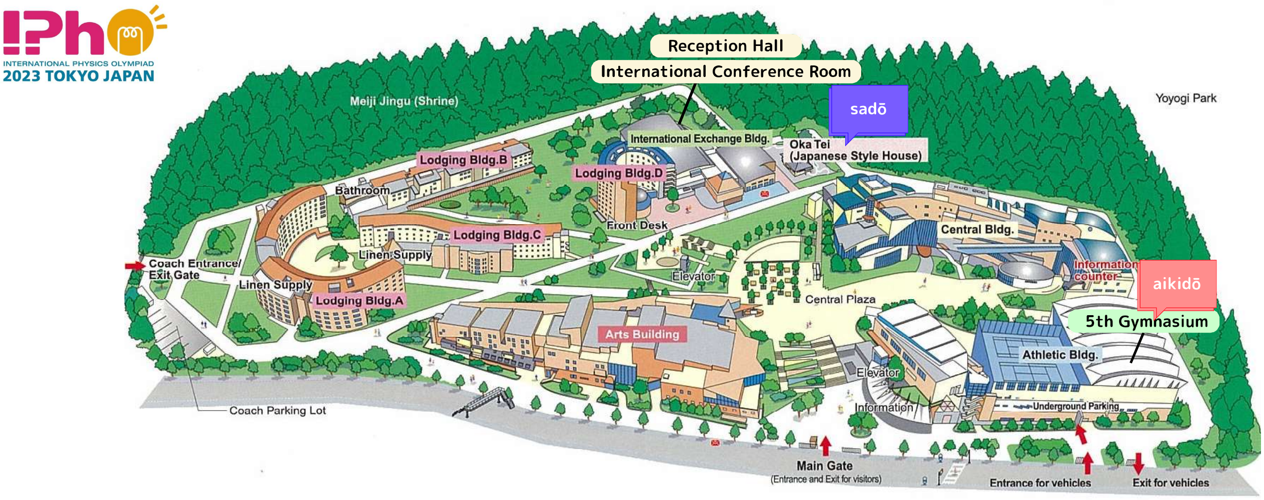
$$z_0 = \frac{2z_{\mathrm{a}}}{e^{x_{\mathrm{a}}/\ell} + e^{-x_{\mathrm{a}}/\ell}}$$

Appendix 2

Brochures of Cultural Events And Excursions

Event Timetable & Introduction





<u>11th & 13th 4-7 p.m.</u>

aikidō @5th Gymnasium

sadō @Ōka-Tei

Japanese traditional games, making a watoji-notebook, shodō @Reception Hall

Science Technology Corner by Japanese companies @International Conference Room

<u>12th 4-7 p.m.</u>

En'nichi Festival! @Reception Hall

stands of games & food, bon dance, making an uchiwa

Science Technology Corner by Japanese companies @International Conference Room

Schedule

9:15	Departure at National Olympics Memorial Youth Center
10:00	Arrival at Minato Mirai 21
	Free time♪
15:15	Departure at Minto Mirai 21
16:00	Arrival at National Olympics Memorial Youth Center


Yokohama Cosmo World


Yokohama Chinatown


Harbor View Park


Yokohama Red Brick Warehouse


CUPNOODLES MUSEUM


Yokohama Landmark Tower

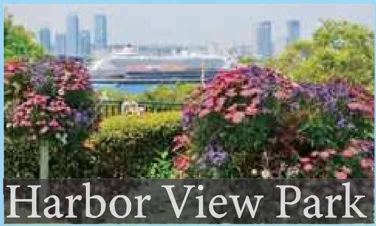
Memo

TRAVEL TO YOKOHAMA

2023. 07.12,14

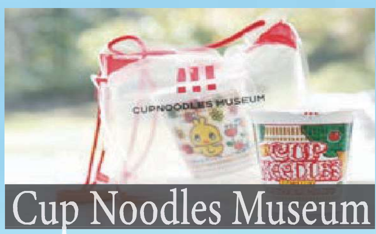
IPhO 2023 TOKYO JAPAN

HAVE A NICE TRIP



Harbor View Park

Opened in 1962 at the former site of the British soldier's barracks. The observation deck and benches facing the ocean offer a panoramic view of Yokohama port. A perfect place for viewing the Yokohama Bay.



Cup Noodles Museum

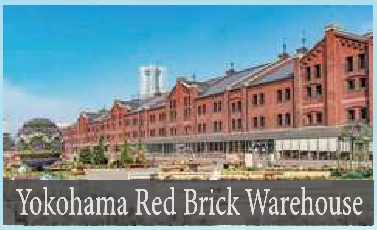
The Cup Noodles Museum is a fun and interactive museum that shows the history of instant ramen noodles using a combination of interesting exhibits and hands on workshops.

Chinatown

Largest China Town in Japan. A large number of Chinese stores and restaurants can be found in the narrow and colorful streets of Chinatown

Yokohama Landmark Tower

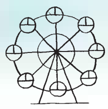
The Yokohama Landmark Tower is the second tallest building in Japan. There are shopping mall, restaurants and view point inside the building.



Yokohama Red Brick Warehouse

Yokohama Red Brick Warehouse (akarenga souko) was built in the early 20th century. There are many shops restaurants and bars in the two red brick building s which are also used for exhibitions.

Yokohama Cosmo World



Cosmo world is a compact but varied amusement park with enough entertainment for both kids and adults to spend an afternoon.

schedule

9:00 Depart for Yoyogi-koen Station
Take trains for Asakusa Station

Yoyogi-koen St.
▼ Chiyoda Line
Omotesando St.
▼ Ginza Line
Asakusa St.

10:00 Start free time around Senso-Ji

~ take lunch ~

11:30 Depart from Asakusa for Ueno

12:00 Start visiting museums (free tour)

Option1: National Museum of Nature and Science

Option2: Tokyo National Museum

15:00: Depart from Ueno Station

Ueno St.
▼ Ginza Line
Omotesando St.
▼ Chiyoda Line
Yoyogi-koen St.

16:00: Arrive at Olympics Center

memo

2023 TOKYO JAPAN

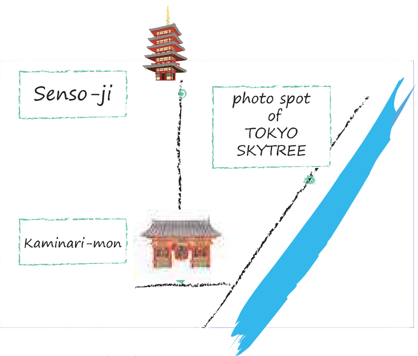
HAVE A NICE TRIP

ASAKUSA UENO

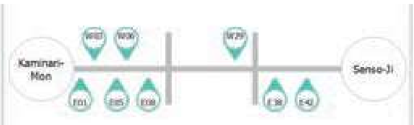
浅草&上野

2023. 07. 12, 14

ASAKUSA

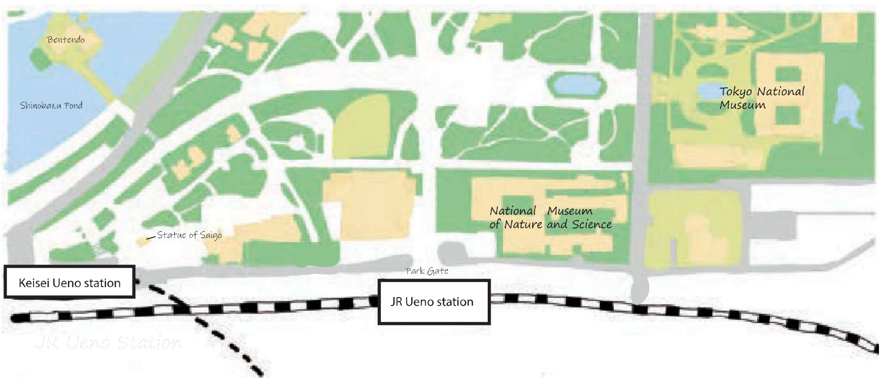


recomended shop



	name	main goods	credit cards
W03	本家 梅林堂	Ningyo-yaki	no
W06	浅草きびだんご あづま	millet dumpling	no
W29	[illegible]	fried buns	no
E01	[illegible]	souvenir	yes
E05	いなば	souvenir	yes
E08	モリタ	dried mochi	yes
E38	浅草ちょうちんもなか	bean-jam-filled wafers	no
E42	ハトのマークの木村家人形焼本舗	Ningyo-yaki	yes

UENO



National Museum of Nature and Science

The largest museum in Japan
You can learn about the history of the Earth and Japan with various exhibitions.
(eg. fossils of dinosaurs)

Tokyo National Museum

The museum exhibits cultural properties from various fields such as archaeology, arts, crafts, and historical materials from Japan and the Orient in five exhibition halls, with a total of approximately 3,000 items on display at any given time.

SCHEDULE MEMO

schedule

9:30
Depature from olympic center

10:00
Arrive at Odaiba

You can enjoy
amusument park
or
science museum

You take a lunch at Odaiba.

15:30
Deparure from meeting point

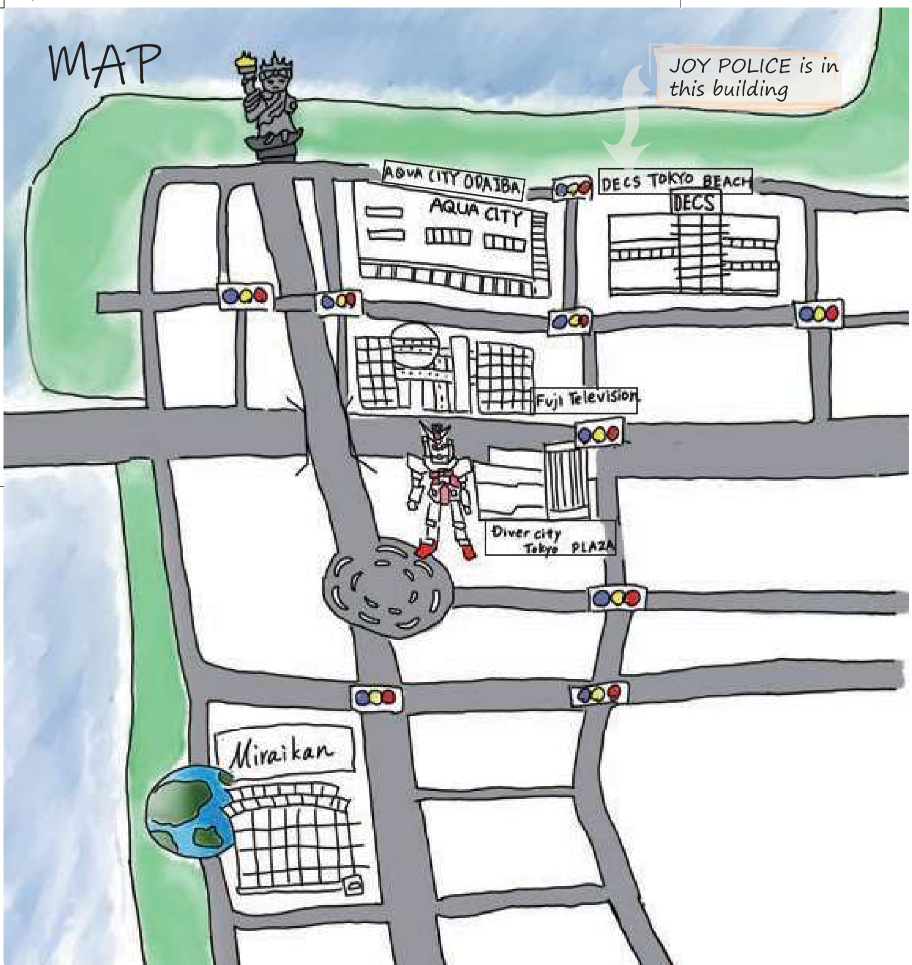
16:00
Arrive at olympic center

memo

HAVE A NICE TRIP

2023.07.12,14

ODAIBA



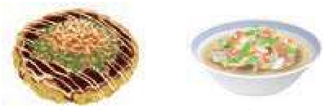
LUNCH GUIDE

lunch guide

☆AQUA CITY ODAIBA

・TOKYO RAMEN KOKUGIKAN MAI(5F)
A ramen park with 6 famous ramen restaurants from across Japan.

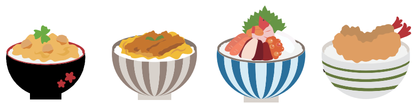
・ODAIBA Food Court(1F)
Chinese, humburger, Okonomiyaki, Chanpon



Okonomiyaki Chanpon

☆Diver city Tokyo PLAZA

・Tokyo Gourmet Stadium(2F)
A food court with 14 shops. You can enjoy various Japanese foods.



Oyako-don Katsu-don Kaisen-don Ten-don

☆DECS TOKYO BEACH

・Takoyaki Museum
Takoyaki entertainment where you can enjoy piping hot takoyaki (fried octopus balls)!

Takoyaki

Each of the facilities also has many cafes and restaurants!

Schedule

8:00	Depart Olympic Center
11:00	Arrive at Owakudani
11:30	Depart for lunch by ropeway
12:00	Lunch time
13:30	Leave for the Cruise
	Free time at Motohakone
15:45	Come back to the parking
17:45	Arrive at Olympic Center

Memo

Hakone

箱根

7.15(Sat)
7.16(Sun)

IPhO 2023 TOKYO JAPAN

Hakone Map

1 Owakudani

Black eggs ("Kurotamago") are local specialty that can only be found here. A must-try snack! These eggs are steamed after being carefully boiled in the heat of the spring waters, which gives it its characteristic pure-black shell. At GeoMuseum, you can enjoy various exhibitions on the structure of volcanoes and the history of Hakone.

2 Ropeway

During the ride you can look down at Lake Ashi and Hakone's great outdoors. Owakudani, a popular sightseeing spot, is accessible from the ropeway.

3 Hakone-en

We will have lunch at thePrince Hotel inside Hakone-en. It is located by the lake and you might be able to have some time to play in the field.

4 Cruise

This sightseeing ship navigates Ashinoko Lake like a pirate ship! At present there are 3 different design pirate ships! Don't miss prime spots with Mt. Fuji and the laketop torii gate of Hakone-jinja shrine both in the same view!

5 Hakone Shrine

The history of Hakone Shrine dates back to the year 757. Many samurai warlords worshipped at the shrine, making its name known throughout Japan. Travelers visiting Hakone also came to the shrine to pray for safety on their journeys. Even today, many visitors come to the shrine to learn about the history at the treasure house ("Homotsuden") and to see the red gate of peace ("Heiwa-no Trii") standing above Ashinoko Lake.

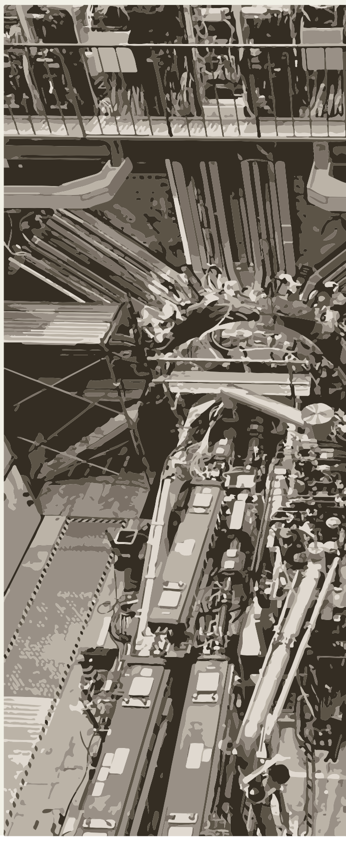
Schedule

- 9:00 Depart Olympic Center
- 10:30 Arrive at KEK
  Explore KEK and Lunch time
- 14:00 Depart KEK
- 14:30 Arrive at Mount Tsukuba
- 16:30 Leave Mount Tsukuba
- 18:00 Arrive at Olympic Center

Memo

Tsukuba

つくば

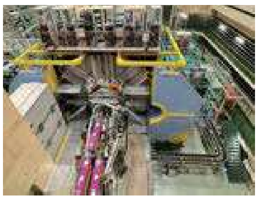


7.15(Sat)
7.16(Sun)

IPhO 2023 TOKYO JAPAN

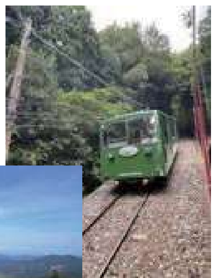
KEK High Energy Accelerator Research Organization

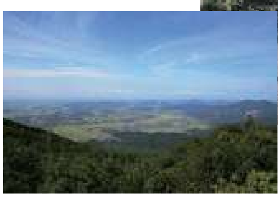
KEK is one of the world's leading accelerator science research laboratories, using high-energy particle beams and synchrotron light sources to probe the fundamental properties of matter. With state-of-the-art infrastructure, KEK is advancing our understanding of the universe that surrounds us, its mechanisms and their control.



Mount Tsukuba

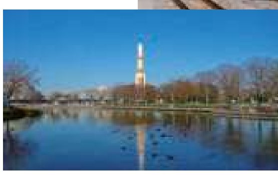
Mount Tsukuba is popular to climbers, cyclists, runners and for drives from its accessible location from Tokyo. There is the Tsukuba Shrine at the at the foot of the mountain where you can pray. We will be climbing up the Mount Tsukuba by cable car and will go down by ropeway. The steep of the cable car is astonishing, and the view from the peak is wonderful. You can see the second largest lake in Japan (Kasumigaura), skyscrapers of Tokyo and the mountain rages of Fuji and Hakone. Be sure to follow "Power Spots" (a Japanese coined word which means sacred places with good luck for money, health and advancement in life) are interspersed at various places on the mountain.





About Tsukuba

Tsukuba is widely known as a " Science City" of Japan located in the suburb area at the North of Tokyo. Various institutions such as Japan Aerospace Exploration Agency (JAXA) and the Geospatial Information Authority of Japan (GSI) as well as Tsukuba University develop the latest academic research with people gathered from all over the world. Even though Tsukuba is located outside Tokyo, it is easily acccessible by Tsukuba Express!



Schedule

- 8:00 Depart Olympic Center
- 10:00 Arrive at Kegon Waterfall
- 10:30 Depart for lunch
- 13:20 Leave for Edo Wonder-land
- 16:20 Leave Edo wonderland
- 19:00 Arrive at dinner place
- 21:00 Arrive at Olympic Center

Memo

Nikko

日光

7.15(Sat)
7.16(Sun)

Kegon Waterfall

Kegon Waterfall(華厳の滝) is one of Japan's three most beautiful falls, having the length of 100 meters. It is said that 3 tonns of water falls down per second on average. You can view the impressive waterfall with the Lake Chuzenji from the observation platform. The water source of the Lake Chuzenji comes from the Kegon Waterfall. In autumn season, you can enjoy the view with the coloured leaves.

Nikko Toshogu

Nikko (日光, Nikkō) is a town at the entrance to Nikko National Park, most famous for Toshogu, Japan's most lavishly decorated shrine and the mausoleum of Tokugawa Ieyasu. Ieyasu is the founder of the Tokugawa shogunate, which ruled Japan for over 250 years until 1868.

After the entrance, you will see very colourful and elaborative crarvings that decorate the storehouse. The most famous carvings are the three monkeys describing see no evil, speak no evil and hear no evil". Find your favourite carvings!

Edo Wonderland

Step back in time to 17th century Japan and explore the beauty, culture and interesting characters of the Edo Era. Enjoy delicious foods, fun activities and a variety of entertaining performances.

Explore the village freely and interact with the friendly locals, they love to chat and have their photo taken.
You can experience shuriken, Japanese archery, watch ninja theater, and enjoy the Edo vibes.

Some are available only in Japanese, so talk with the support staff and decide where to go.

Schedule

9:30
Depature from olympic center

11:00
Arrive at Kamakura

Enjoy the twon of Kamakura with your staff!

17:15
Come back to the parking

19:00
arrive at olympic center

Memo

Kamakura

鎌倉

7.15(Sat)
7.16(Sun)

IPhO 2023 TOKYO JAPAN

Use Green trains of Enoden railway (shown as the green line) for your transportation. The numbers on the green line indicate the time in minutes required between the stations.

How to enjoy town of Kamakura?

01. Decide where you want to enjoy the most. Kamakura/Beach/Enoshima.

- Kamakura...A lot of Japanese traditional places.
- Beach...Yuiga-Hama or Shichiriga-Hama are recommended.
- Enoshima...Can climb up to the mountain on foot or by elevator to see nice view.

02. Decide where to eat lunch. Komachi Dori has variety of restaurants, there are nice view lunch spots by the beach as well. Enoshima is famous for seafood and tendon(rice bowl with tempura).

Appendix 3

Newsletters
No.1 - 10

Sunday, July 9th 2023

BUTSURI 物理

Issue 1

Welcome to JAPAN!

CONTENTS

IPhO INTERNATIONAL PHYSICS OLYMPIAD 2023 TOKYO JAPAN

Welcome to IPhO 2023!

Message from IPhO President

Prof. RAWAT Rajdeep Singh

President, IPhO Head,
Natural Sciences and Science Education, National Institute of Education, Nanyang Technological University, Singapore

I extend my warmest greetings to the best young physics talents, shortlisted to represent their country after a rigorous selection procedure, and team leaders from about eighty countries of the world who have come back together for IPhO2023 once again in the original physical face-to-face format, after a gap of three years, in this wonderful land of rising sun, Japan, which is known for excellence in science, technology and innovation. As you gather from all corners of the globe, I am humbled by the immense talent and dedication each one of you brings to this global stage. The International Physics Olympiad represents the pinnacle of physics competitions, where the brightest young minds converge to test their mettle and push the boundaries of physics. Tokyo, a city renowned for its rich cultural heritage and technological innovation, is an ideal setting for this momentous event. From the bustling streets of Shibuya to the tranquil beauty of the Imperial Gardens, Tokyo offers a captivating blend of tradition and modernity that will undoubtedly inspire and invigorate your pursuit of knowledge in physics. Throughout the IPhO2023, you will have the opportunity to engage with fellow participants and local volunteers from diverse backgrounds, cultures, and perspectives. Embrace this unique opportunity to forge new friendships and foster a global network of scientific minds that will shape the future of physics. Remember that beyond the competition itself, this journey is about personal growth, learning, and enjoying diverse international exposure. Cherish every moment, relish the challenges, and savor the joy of looking at complex problems through the lens of physics. On behalf of the International Physics Olympiad community, I wish you all the best as you embark on this challenging yet incredible journey towards excellence in physics.

Message from Chairman of the Organizing Committee of IPhO2023

Dr. KOBAYASHI Makoto

Honorary Professor Emeritus, High Energy Accelerator Research Organization (KEK)
2008 Nobel Laureate in Physics

I am very happy to welcome you to the International Physics Olympiad (IPhO) 2023 in Japan. After three irregular years due to the spread of the COVID-19 infection, the normal style of the Physics Olympiad has come back. Now you can enjoy face-to-face communication. Human life is supported by the development of science and technology. In this development, physics plays an important part as a foundation of all fields of science. One of the missions of the Physics Olympiad is to enhance international contact in the field of school education in physics. It also aims to encourage the formation of friendships among young participants who will lead the future of our society. I hope you do your best in the competition and enjoy the various programs offered during your stay in Japan.

Cheers from Students!

NAKAMURA Hanako

My name is Hanako, and I’m a student support staff member. I'm a fourth-year student studying International Relations at International Christian University. While I have no knowledge of physics, I decided to become a support staff member for IPhO 2023 because I wanted to be a part of this wonderful opportunity where students from around the world get together in Tokyo, my hometown. I personally think Japan is a very interesting country with its rich history, vibrant culture, and of course, good food. I hope you enjoy your time in Japan. Feel free to reach out to the support staff any time if you have any questions or need any assistance. Remember to stay hydrated and good luck! :)

YATSU Rikuo

IPhO 2023 is ready to start! We spent one and a half years pursuing exciting and unforgettable IPhO 2023 for all participants. The reason why I’ve worked hard for the excursion planning is because I love traveling very much. So, I’m really excited to go on one-day trips with you and show you around famous sightseeing spots. In addition, your questions or comments will give me the opportunity to reflect on our familiar customs. I hope you’ll enjoy not only the events we prepare but also all the wonderful experiences in Japan. Good luck with your exam, too!

SASAKI Yasutaka

My name is Yasutaka Sasaki, a second-year student at the University of Tokyo. I am looking forward to interacting with you all and experiencing Japanese culture at this convention. Although I was not able to participate in IPhO 2020 due to the covid pandemic, I think that the experience of studying for IPhO has built up not only my basic academic ability, but also my attitude to challenge various fields such as biology and information science, too. I wish you all the best of luck and hope that you will gain something from this competition!

Han Ruisi

I’m Ruisi, the student staff leader for IPhO 2023. I came from China four years ago and am currently a junior student at International Christian University. I’m very interested in different cultures and communications, so I joined this big family to help every contestant to have a fantastic adventure in Japan. I really enjoyed the process to plan for the trip and culture events because while researching and field-working on the event contents, I could feel the charm of Japanese culture from various aspects. I hope everyone can enjoy our activities and have a wonderful time in Japan!

Why Butsuri?

As you may have noticed, the title of this newsletter is 物理 . It is written in kanji, i.e., in Chinese characters, and pronounced as BU-TSU-RI. It is the word that means PHYSICS in Japanese. People in countries that use kanji understand the meaning of each word (物 and 理); 物 means all things and 理 means reason or natural way. Therefore, 物理 , which combines the two characters, means "the natural way of all things". In fact, in China, 物理 has been used in this sense in the past. The word 物理 in today's sense of PHYSICS began to be used in Japanese school textbooks in 1872. After that, 物理 has also been used as a word to express PHYSICS in China. PHYSICS is derived from the Greek word for "NATURE". It is very interesting to see a similarity between "NATURE" and the word 物理 in kanji, which expresses "the natural way of all things''.

The Messages Behind...

-LOGO-

We hope you like the logo of IPhO2023. As you most likely have already recognized:

The “I” is an exclamation mark (!) representing the excitement of doing physics. The “P” is a question mark (?) symbolizing intellectual curiosity which is a driving force of research.The “h” may be seen as the Planck constant, one of the fundamental constants of physics (admittedly a strained interpretation). The “O” is designed as a light bulb, a classic symbol of a “Eureka” moment.

-MEDAL-

These medals to be awarded to the top-grade contestants carry the image of Mount Fuji, which is an undisputed symbol of Japan and has been an inexhaustible spring of artistic inspiration. Inscribed on these medals is one of the most famous images of Mt. Fuji taken from a series of masterwork wood prints (ukiyo-e) “Fugaku Sanjurokkei (Thirty-Six Views of Mount Fuji)” by Katsushika Hokusai (1760-1849), renowned artist of the Edo era.

Wood print work “Gaifu-Kaisei (fine breezy day)” , also known as “Aka-Fuji (red Fuji)” by Hokusai.

Some useful Japanese phrases!

Kon nichi wa!
Why don't you use Japanese, even if it is only one word, during your stay in Japan?
All Japanese people who hear you will respond with a smile

Good morning (morning!)

- O ha yo u go za i ma su(O ha yo!)
  おはようございます

Hello

- ko n ni chi wa
  こんにちは

Good evening

- ko n ba n wa
  こんばんは

Good night

- o ya su mi na sa i (O ya su mi)
  おやすみなさい

Good bye

- sa yo u na ra
  さようなら

See you soon

- ma ta ne
  またね

Thank you very much

- a ri ga to u go za i ma su
  ありがとうございます

Frank thank you

- do u mo
  どうも

Phrase used when asking something or passing by others(Excuse me)

- su mi ma se n
  すみません

Phrase of apology(I'm sorry)

- go me n na sa i
  ごめんなさい

(" go me n" for more frank way)

Phrase to begin a meal

- i ta da ki ma su
  いただきます

Phrase at the end of the meal

- go chi so u sa ma
  ごちそうさま

How much is this?

- ko re wa i ku ra de su ka
  これはいくらですか

Where is ***?

- *** wa do ko de su ka
  ***はどこですか

Yes/No

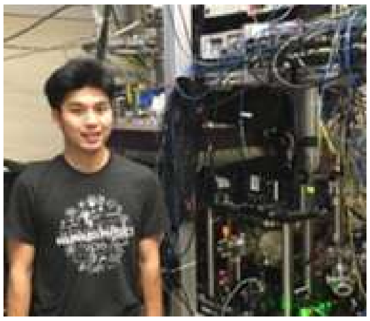
- ha i = Yes
  はい

- i i e = No
  いいえ

Remember some Japanese phrases and try using them for the staff!

"What I gained from the International Physics Olympiad."

Hiromitsu Sawaoka
Participants of IPhO2013 in Denmark



If I had to name the most inspiring week in my 24 years of life so far, it would definitely be the week of the 2013 International Physics Olympiad. Through this week, I gained a "treasure" that will be a great weapon for the rest of my life.

Little did I know there was such a great "treasure" in it until I competed in the Physics Olympiad. I had always genuinely loved physics, and I also admired the fact that my fellow high school seniors had also won medals at the Physics Olympiad. That made me study for the Physics Olympiad. My love of physics began in junior high school physics experiment classes. By carefully examining the results of my experiments, I discovered laws of physics that were not intended in those experiments. Since then, I have been captivated by physics, which seeks to discover the hidden nature of things through careful experimentation and observation. And through the Physics Challenge, I was able to hone that ability further. I felt a great sense of accomplishment when I was able to derive a surprisingly simple principle for a phenomenon even though it seemed impossible to explain at first glance by considering approximations or, in the case of an experimental problem, by taking data under various conditions.

In this way, I had already benefited greatly from physics before competing in the Olympics, but actually competing in the Olympics stimulated me to the extent that it completely overturned my approach to physics. Of course, I was not only stimulated by the exam itself, which lasted only 10 hours in total during the week (although the exam itself was fun), but also the international exchange we had during most of the remaining time was the "treasure". Since I was the most fluent English speaker in the Japanese delegation, I took on the role of "exchange committee chairperson" and took the lead in actively interacting with ″athletes″ from other countries during the excursions and other activities. During these interactions, I heard serious topics such as the prize amount of scholarships at universities in Indonesia depending on the color of the medals from the Physics Olympiad, and I had fun playing logic games with athletes from around the world. In the evenings, I joined members from other countries on the dance floor and experienced the spirit of "work hard, play hard" firsthand. Above all, it was a refreshing discovery that many students around the world are interested in physics as I am and that the world is full of people who have strengths that I do not have. The most important thing was that I gained the mindset that it would be a shame not to learn physics not only from self-study or teachers but also from so many fascinating people of my generation.

The Japanese athletes have a tradition of bringing a blank map of the world every year and asking the athletes they interacted with to color their countries on the map. By the end of the Physics Olympiad, more than 40 countries, half of which participated in our Games, had been colored. And this exchange has continued ever since, and today at Harvard, I continue to engage in friendly competition as a classmate with the athletes representing Turkey and Iceland at that time. And after entering an overseas university, I especially valued the discussions with students of my generation, and my understanding of physics improved dramatically. I cannot thank the Physics Olympiad enough for giving me a lifetime treasure.

【Brief Personal History】
Born in Osaka City, Osaka
Graduated from Osaka Seikouin High School in 2014
Graduated from the University of Toronto in 2018
Current: Ph.D. student, Department of Physics, Harvard University

“The Physics Olympiad has my back.”

Hiroto Takahashi
Participant of IPhO2015 in India

My first encounter with physics was an educational manga that I came across in junior high school. The characters elegantly unraveled a few simple rules to describe the movement of familiar objects through experiment and discussion. Having been a big fan of various kinds of puzzles such as jigsaw, Sudoku, and role-playing video games, I naturally got interested in physics which I sensed to be a sophisticated puzzle involving cooperation and fun discussion. While the physics course that started in school was enjoyable, I was not motivated enough to get deeply involved at that time. Getting good grades on school exams was enough to satisfy myself and little did I imagine I would get more pleasure by studying more deeply. Even though my school grades were good, I was not confident that I would be able to compete with 'truly smart people' in solving enigmatic physics questions. It was the Physics Olympiad that changed my mind and pushed me forward.

One of the things that impressed me a lot was the cover of the question booklet for the Japan Physics Olympiad. It read, "The problems may seem difficult to solve at first glance, but if you study them carefully, you will see that you can understand.” Many problems in the Physics Olympiad deal with unique and advanced subjects. For example, “Let’s try to estimate the surface temperature of the sun by modeling the fusion reaction” or “Let’s describe how light scattering by water droplets in the air creates a rainbow”. These questions appear to be so difficult that one may get tempted to throw them away. However, reading through the long problem text full of clues and thinking patiently for a few hours, I was often able to reach an answer. I found myself surprised and said, "Oh, did I really solve that?”. Even a phenomenon as elusive as the sun or a rainbow just shining in the distance can be solved by a very beginner physicist like my high school self, if one builds up a logic step by step based on certain assumptions and hints. I was shocked by how open-door physics was. The excitement of successfully understanding difficult phenomena gave me great joy and confidence, encouraging me to continue studying and attacking even more mysterious and profound phenomena.

In addition to the joy of physics itself, it was a great pleasure to expand my world by meeting many new people. During my first Japan Physics Olympiad, I had a chance to talk with the participants of the International Physics Olympiad of the previous year, who seemed like from another world. Directly getting advice from them greatly encouraged me. Though I got a nearly bottom place in the competition that year, I was determined to catch up as much as possible next year, eventually making it through to the International Physics Olympiad. There I was shocked to realize that the world was indeed very large— getting 4th out of 5 Japanese representatives placed me at about 200th out of all the global participants. On the other hand, I was able to make a lot of fun memories. I overcame the language barrier and quickly became friends with representatives from other countries, talking about various subjects from physics to each other's culture, dancing together, and playing card games. These experiences motivated me to go abroad again and to work with researchers from around the world.
I am currently based at the University of Oxford and also am affiliated with the Max Planck Institute in Germany. I am studying the physics of special types of magnets with interesting hidden structures inside. I have spent two years building up a large room-size apparatus that allows me to measure and elucidate the properties of these magnets, which are difficult to calculate or predict by theory alone. Compared to the time of the Physics Olympiad, the way I work on physics has changed, transitioning from scholastic “study” to academic research. However, the joy of understanding difficult phenomena through step-by-step logic and the pleasure of meeting new people remain the chief driving forces of my work.

【Brief Personal History】
Born in Tokyo
Graduated from Koishikawa Secondary Education School in 2016
Graduated from the Department of Physics, Faculty of Science, the University of Tokyo in 2020
Current: DPhil course in Condensed Matter Physics, University of Oxford. Student, Max Planck Graduate Center for Quantum Materials.

SCHEDULE

TODAY
Sunday, July 9th

32°C
24°C

Students, Leaders, & Observers

All day	Arrivals	NYC
13:00	Registration	NYC
17:00-19:00	Get Together and Dinner	NYC

TOMORROW
Monday, July 10th

34°C
25°C

Students

7:15-8:00	Breakfast	NYC
10:00-12:00	Opening Ceremony	NYC
12:30-13:30	Lunch	NYC
14:00-14:45	Briefing on Calculators	NYC
15:00-18:00	Free Time	NYC
18:00-19:00	Dinner	NYC

Leaders & Observers

7:00-8:00	Breakfast	NSH
10:00-12:00	Opening Ceremony	NYC
12:30-14:30	Lunch	NYC
14:30-18:30	Board Meeting	NYC
18:30-20:00	Dinner	NYC
20:00-23:00	Board Meeting	NYC

NYC: National Olympics Memorial Youth Center
NSH: Nippon Seinenkan Hotel

The Physical Society of Japan
Japan Society of Applied Physics
The Physics Education Society of Japan
The Biophysical Society of Japan
Japan Science and Technology Agency (JST)
National Institution for Youth Education (NIYE)
National Museum of Nature and Science
Japan Arts Council
Tokyo National Museum
The University of Tokyo
Tokyo University of Science
Tokyo City University
Tokyo University of Foreign Studies
International Christian University
Sophia University
IPhO 2023 TOKYO JAPAN

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"物理 BUTSURI" daily magazine
Editorial Committee Member:

TOHYAMA Takami, IYE Yasuhiro, OOKA Aki, SHINODA Erika, ANDO Karin, JOKA Natsumi, KIMPARA Michiru, SASAKI Yasutaka, ONO Yoshimasa (translator), OONO Aiko (photographer), SHIMIZU Takeshi (photographer)

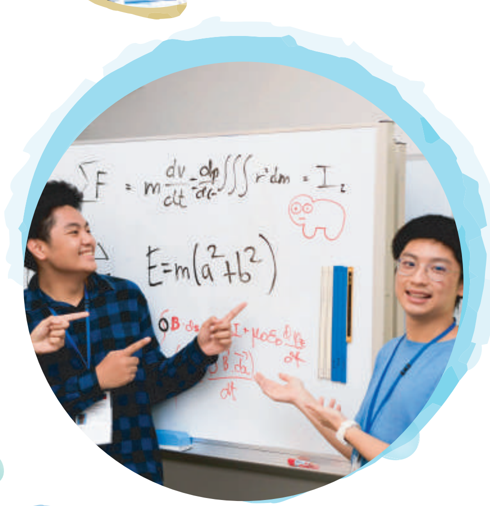
物理
— BUTSURI —

ISSUE 2

Monday,July 10th

Contents

Registration and Get-Together Party



Comments from Participants

USA: YEVTUSHENKO Feodor

It's really nice what I have seen so far; everything is so much better than in the United States. The vending machines are amazing, like several times cheaper. People are very very nice. The food is also better. This is actually my first time in all of Asia. It's pretty fun from what I have seen so far and I'm pretty thrilled that Japan is well organized.

France: FAUCHEU Hannah

It's my first time to come to IPhO and also to Japan. It's quite pretty. There are more trees and greens here than in Paris. And I quite like eating more rice and Asian food. Today's lunch was also good. I'm quite nervous because some teams are very very prepared compared to us. They had a one-month camp, while we had only a four-day camp and then a two-day camp. It's quite exciting to see many students from other countries. I am enjoying it for now.

South Africa: GIRARD NGUETSOP Serena Angele

I traveled for about 27 hours from South Africa. I've found that Japan is an exciting country and I like its nature and everything. The people are really nice. I'm definitely nervous about exams, but excited about the competition, because I think it is an interesting experience to have this kind of test. You need to use basic knowledge learned at school and then to look for methods for solving the problem in different ways from what you've learned.

China: JIANG, Daibing

It is my first time to come to Japan. I think it is a good country and people here are friendly. It is very good chance to get together with a lot of students from all over the world and I'm sure that we can communicate with each other a lot. I want to make a lot of friends. I'm really excited about competition but a little bit nervous. We have prepared for one month in the University, practiced some questions, and done a lot of experiments.

Slovenia: KREJAN Samo

It's my first time in Japan. I like here, the National Olympic Memorial Youth Center. I like its architecture and surroundings, especially trees. That's nice! But the weather is quite humid for me. I'm not used to that.
(About competition) I'm excited. It's first time for me to compete in international physics olympiad, though I've competed in european olympiad before. I'm here not only for the competition but also for meeting people from all over the world.

Brazil: TAVARES VITORIANO Lucas

Hello everyone! I'm from the other side of the world, so I'm looking forward to learning more about Japanese culture very different from ours. During the excursion, I'm interested in visiting Ghibli Studio and Cupnoodles Museum in Yokohama. I'm really excited for the competition. My favorite physics laws are Ampere's law and Maxwell's equations describing electromagnetism.

Kosovo: THAQI Era

All of us are definitely excited by the opportunity to solve experimental and theoretical problems at IPhO2023. It is amazing that I can expand my perspective and meet many other cultures and people, because physics enthusiasts from more than 80 countries are participating. Also I'm looking forward to getting to know participants and becoming friends!

Japanese Language

01 ひらがな (hiragana)

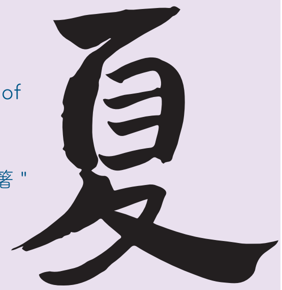
Hiragana are phonetic characters of the Japanese language with 46 letters by combining vowels "a, i, u, e, o" and consonants.

02 カタカナ (katakana)

Katakana are other phonetic characters with 46 characters and are mainly used for foreign words, foreign names, and scientific and technical terms.

03 漢字 (kanji)

Kanji are characters introduced from China to express meaning. There are thousands of kanji in the Japanese language. Kanji are more complex than hiragana and katakana, with a single kanji representing a word or concept. Some kanji have the same pronunciation but different meanings. For example, the pronunciation of "hashi" is " 橋 " (bridge), " 端 " (edge), and " 箸 " (chopsticks).



To read Japanese newspapers or books, you need to memorize hiragana, katakana, and kanji. To fully understand what is written, you need to know 2,500 kanji characters. Beginners in Japanese are advised to study katakana first, since many foreign-origin (loan) words are written in katakana. Also, many physics terms are written in katakana. For example, try reading " モーメント " using the table shown below. Here, " ー " means that the " モ " is pronounced with an extension. Have you figured out what モーメント is? How about " エレクトロニクス "?

Now, let's memorize katakana using the following table.

Katakana Table

ア	イ	ウ	エ	オ
a	i	u	e	o
カ	キ	ク	ケ	コ
ka	ki	ku	ke	ko
サ	シ	ス	セ	ソ
sa	si	su	se	so
タ	チ	ツ	テ	ト
ta	chi	tsu	te	to
ナ	ニ	ヌ	ネ	ノ
na	ni	nu	ne	no
ハ	ヒ	フ	ヘ	ホ
ha	hi	fu	he	ho
マ	ミ	ム	メ	モ
ma	mi	mu	me	mo
ヤ		ユ		ヨ
ya		yu		yo
ラ	リ	ル	レ	ロ
ra	ri	ru	re	ro
ワ		ヲ		ン
wa		wo		n

Answers: モーメント = moment, エレクトロニクス = electronics

Japanese Food

Japan has a rich food culture. The staple food is traditionally rice. Japanese rice is a short-grain variety, which is fluffy and sticky when cooked. For this reason, a lot of Japanese prefer a fluffy type of bread. Tea is an essential part of the Japanese diet. There are many kinds of tea, such as green tea, brown rice tea, oolong tea, and hojicha (toasted tea), and many types are sold in vending machines and stores.

Below are some typical foods that you should try during your stay in Japan.

01 Typical Japanese Dishes

Japanese dishes are characterized by a well-balanced diet with rice, fish, vegetables, tofu, miso, and soy sauce as the main ingredients. Typical Japanese dishes include sushi, tempura, oden, sukiyaki, and shabu-shabu.

02 Grilled Dish

Japanese grilled dishes include grilled fish, yakitori, and okonomiyaki. These dishes are often grilled on a teppan or charcoal grill and are delicious and savory. Teriyaki, which you may have heard of, is grilling fish or chicken while coating it with sauce made from soy

03 Noodles

Ramen is a Japanese adaptation of a Chinese noodle dish, featuring pork bone broth, chicken broth, seafood, soy sauce, or miso soup. Udon noodles are made by kneading wheat flour with water and have a thick, sticky texture. Soba is made by mixing wheat and buckwheat flour, and has a

04 Sweets

Wagashi is a traditional Japanese confectionery made with rice flour, azuki beans, sugar, and other ingredients. Typical wagashi include yokan, daifuku, and anmitsu.

The top three uniquely Japanese foods popular among young people in Japan are probably ramen, sushi, and curry rice (rice topped with curry). Why not try them during your stay in Japan?

Japan's two giants of theoretical physics

In the middle of the 20th century, Japan had two giants who achieved great results in the research of the theoretical physics of quantum physics. They were Hideki Yukawa (1907-1981) and Sin-Itiro Tomonaga (1906-1979). In 1949, Yukawa became the first Japanese to receive the Nobel Prize in Physics for his achievement in theoretically predicting the existence of mesons in 1935, which mediate strong interactions that bind protons and neutrons to each other inside the atomic nucleus. Therefore, an attractive potential between protons and neutrons has been named the Yukawa potential. On the other hand, in 1947 Tomonaga invented a renormalization theory to solve the difficulties of divergence in quantum electrodynamics and performed an accurate theoretical calculation of the so-called Lamb shift seen in the energy levels of hydrogen atoms. In 1965, Tomonaga received the Nobel Prize in Physics, jointly with Julian Schwinger and Richard Feynman. Tomonaga became the second Japanese to win the Nobel Prize. In particular, the Nobel Prize award to Yukawa was a feat that encouraged Japanese people just after the end of World War II. Together with the subsequent award of the Nobel Prize to Tomonaga, physics became a popular subject in Japan.

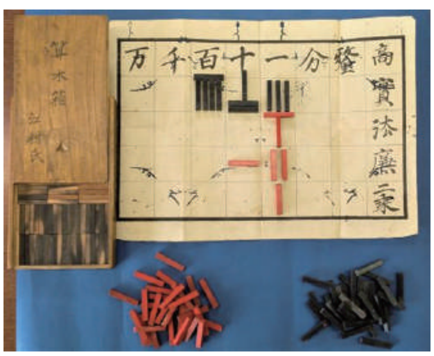
Photo taken at Kyoto University (1950). Hideki Yukawa and Sin-Itiro Tomonaga (2nd and 3rd from the left in the front row, respectively). Yoichiro Nambu (1st from the right in the back row: Nobel laureate in physics (2008)). Provided by Yukawa Institute for Theoretical Physics, Kyoto University.

Hideki Yukawa (left) and Sin-Itiro Tomonaga (right). Provided by Yukawa Institute for Theoretical Physics, Kyoto University.

Yukawa and Tomonaga were friends but good rivals. They went to the same junior high school, high school, and university (Department of Physics, Kyoto University), and were in the same grade after high school. They shared the same room in the laboratory at Kyoto University, where they worked as assistants after graduation. The two giants were completely different types of physicists: Yukawa emphasized intuition while Tomonaga was the logical type in pursuing his research. Yukawa moved to Osaka University located in the western part of Japan, while Tomonaga moved to the Institute of Physical and Chemical Research (RIKEN) located in the eastern part of Japan. Yukawa published his meson theory during his tenure at Osaka University. However, he did not produce any results immediately after his appointment, and Professor Hidetsugu Yagi, who had hired Yukawa, scolded him, saying, "I hired you instead of Tomonaga, so you have to work hard." The rival spirit in Yukawa must have been ignited. After winning the Nobel Prize, Yukawa founded the Institute for Theoretical Physics at Kyoto University. Tomonaga conducted research at the Tokyo University of Education (now the University of Tsukuba) after RIKEN and perfected the renormalization theory. There is no doubt that the fact that the two giants were separately located in the western and eastern parts of Japan led to the subsequent developments of physics in Japan.

WASAN 和算
---- *Japanese Mathematics* ----

Like many other cultural activities, Japanese mathematics owes much to China. Historically, an ancient Chinese math book, "Nine Chapters on Mathematical Art 九章算術" was a standard textbook. During the Edo period (1600-1868), the Tokugawa Shogunate maintained a policy of national isolation. In particular, for the first half of the Edo period up to the mid-18th century, Japanese intellectuals did not have access to the latest developments in Western science. In such situations, WASAN 和算 (Japanese mathematics) achieved unique independent development.
The most eminent Japanese mathematician of the period was SEKI Takakazu 関孝和 (1642-1708). SEKI was a contemporary of Isaac Newton and Gottfried Leibnitz. Up to him, the standard calculation technique called Tengenjutu 天元術 utilized sangi' s 算木 (red and black arithmetic sticks) and a sanban 算盤 (a sectioned board) as shown in the picture. SEKI developed a new method later called Tenzanjutsu 点竄術 , a calculation technique on paper for solutions of higher dimensional equations.
WASAN excelled at numerical calculations of algebra. For instance, TAKEBE Katahiro 建部賢弘 (1664-1739), the highest apprentice of SEKI, managed to calculate Pi down to the 41st digit after the decimal point, an accomplishment 15 years ahead of Leonhard Euler.
Although WASAN reached a highly impressive level of achievement, it did not develop into an organized academic system. Part of the reason may lie in the fact that WASAN was practiced in an exclusive master/apprentice relation system. Actually, many of the findings in WASAN were considered secret and protected within each school of mathematics. So, after the Meiji restoration, as Western mathematics was systematically introduced in the newly established universities, WASAN gradually faded out.



Sangi' s (red and black sticks) and a sanban (sectioned board) used for numerical calculations

The tradition of Japanese mathematics was not only among professionals. Indeed, the study of mathematics was very popular among all social classes. "Jinkoki" 塵劫記 , an arithmetic textbook written by YOSHIDA Mitsuyoshi 吉田光由 and published in 1627 continued to be a best-seller throughout the Edo period. Boys and girls learned reading, writing, and arithmetic in Terakoya 寺子屋 , a sort of private elementary school attached to temples. The high level of literacy in the Japanese population was certainly one of the key factors for the rapid modernization of Japan after the Meiji Restoration.

SCHEDULE

TODAY

Monday, July 10th

27℃
36℃

Students

7:15-8:00	Breakfast	NYC
10:00-12:00	Opening Ceremony	NYC
12:30-13:30	Lunch	NYC
14:00-14:45	Brriefing on Calculators	NYC
15:00-18:00	Free Time	
18:00-19:00	Dinner	NYC

Leaders&Observers

7:00-8:00	Breakfast	NSH
10:00-12:00	Opening Ceremony	NYC
12:30-14:30	Lunch	NSH
14:30-18:30	Board Meeting	NSH
18:00-20:00	Dinner	NSH
20:00-23:00	Board Meeting	NSH

TOMORROW

Tuesday, July 11th

27℃
36℃

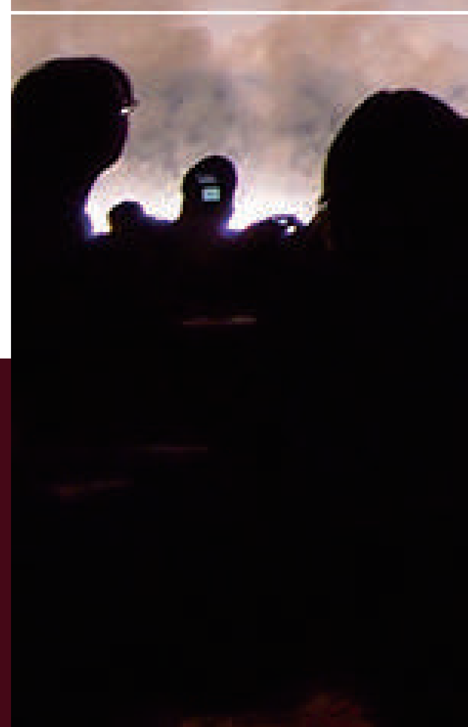
Students

7:15-8:00	Breakfast	NYC
8:30	Meet at the Exam Room	NYC
9:00-14:00	Exam(Experiment)	NYC
14:30-15:30	Lunch(light meal)	NYC
16:00-19:00	Cultural/Scientific Experience Events	NYC
18:00-19:00	Dinner	NYC

Leaders&Observer

7:00-8:00	Breakfast	NSH
9:00-15:00	Half-day Tokyo Excursion 1	
18:00-19:30	Dinner	NYC

NYC: National Olympics Memorial Youth Center
NSH: Nippon Seinenkan Hotel



The Physical Society of Japan
Japan Society of Applied Physics
The Physics Education Society of Japan
The Biophysical Society of Japan
Japan Science and Technology Agency (JST)
National Institution for Youth Education (NIYE)
National Museum of Nature and Science
Japan Arts Council
Tokyo National Museum
The University of Tokyo
Tokyo University of Science
Tokyo City University
Tokyo University of Foreign Studies
International Christian University
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ONO Yoshimasa (translator),
OONO Aiko (photographer),
SHIMIZU Takeshi (photographer)

BUTSURI

ISSUE 3

Tuesday, July 11th

CONTENTS

IPhO 2023 TOKYO JAPAN

Opening Ceremony of the 53rd International Physics Olympiad

The 53rd International Physics Olympiad (IPhO2023) opened with a bang! This is the first time in four years that the Games have been held face-to-face since IPhO2019 in Israel. Under a clear blue sky but intense heat, the 80 teams, as well as the Oly team of individuals, one guest team, and two observer countries, eagerly awaited the beginning of the opening ceremony. The opening ceremony began with a greeting by Prof. KOBAYASHI Makoto, Chair of the Organizing Committee of IPhO2023. After expressing a welcome to the face-to-face meeting and his gratitude for the support of the Japanese side, he emphasized the importance of science and technology in our daily life and encouraged the participants to know that advances in physics not only describe science but also have the potential to transform our perception of nature. Ms. NAGAOKA Keiko, Minister of Education, Culture, Sports, Science, and Technology gave a congratulatory address by mentioning that physics is the foundation for opening up new possibilities to address many of the problems facing our time and expressed her hope that contestants will use their skills to help lead a better world. The contestants then went up on the stage by country, holding their national flags and waving their hands to express their respective emotions and the joy of participating in the event. Finally, Prof. RAWAT Rajdeep Singh, President of the IPhO Secretariat, after welcoming all those involved in the opening ceremony for the first face-to-face meeting in four years, mentioned the deep relationship between science and cultures such as the Zen garden in the host country, Japan. He also sent us a message that the IPhO would be a useful opportunity for competition and the exchange of ideas and interaction with diverse people from various regions. The opening ceremony was followed by a Japanese drumming performance by International Christian University students a nd a karate performance by Sophia University students. The fascinating aspects of Japanese culture, such as the dynamic nature of stillness and movement, greatly impressed the participants. All in all, the opening ceremony was a great success.

Comments from Participants

Japan: IWASHITA Koki
I will do my best for IPhO2023. Though I am a little bit nervous, I would like to enjoy it and welcome everyone who have come to Japan. I have prepared well by solving problems that the committee members and professors provided to us and by studying hard also at home. I want to make friends with participants from different countries through international exchange.

Taiwan: CHANG Ya-Cheng
I have been to Japan when I was really really young. I am not really nervous today but I think I'll be a little bit more nervous tomorrow because the exam is coming close. My main purpose here is just to have fun and meet a lot of people who love physics. I hope I'm going to gain a lot of experience. All of us have prepared a lot for the competition.

Briefing on calculators to be used for examination

Making "Watoji" notebook

Board meeting

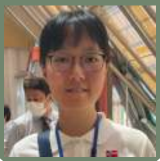
"Watoji" work done!

Indonesia: NAJA Muh. Zaidan

The opening ceremony was cool. It was interesting to learn about Japanese culture. I didn't know much before, but now I know about drum performance and karate. It was really cool. I liked it. I like Japanese culture, such as Pokemon, anime, drumming, and karate. I think it is a cool culture. Today, I'm going to the Pokemon Center, and I'm excited. I'm nervous about taking the exam tomorrow, but I have already prepared for a long time.

Norway: HE Zejia

I enjoyed the opening ceremony very much, especially the traditional performance I have never seen before. I also liked the occasion that a lot of contestants went up to the stage and had a chance to get to know each other. Since it is so hot outside today, we are not going out, but in the next few days, we definitely will. I don't know much about Japanese culture and hope to learn more this week.



Suriname: PURPERHART Nyuk-Shi

The opening ceremony was really fun. It was really energetic and nice. I really liked the drum performance, which was very very passionate. It looked fun when they were really hitting the drum. I had never seen that. The karate was also really good. It was really nice how you could see how strong the movements were. They made a lot of intimidating noises. Though I'm a little nervous about taking the exam tomorrow, I will try my best.

Qatar: AL-NAJJAR Khalid

The opening ceremony performance was great. I liked the second drum performance the most because it was the most fun and energetic. It has both music and dance aspects. It is very humid, but Qatar is also as humid as Japan all year.

Belgium: BARANI Kristina

The opening ceremony was very punctual. The speeches were very well written. The drum and karate performances were also very well executed. I really like the second drum dance. I did not know much about the drum, but the sound was very loud and coordinated. About tomorrow's competition, I hope the line for the breakfast will not be too long, so I will get to the test room on time. Also, I hope the experiment problems are not too challenging. We cross our fingers that everything will go well.

Serbia: TODOROVIĆ Sava

The opening ceremony was very well-organized, and actually it was the best-organized ceremony that I have ever been to. I really liked the performances, especially the acoustic drums. I think it shows the real Japanese culture. It was so nice. I feel excited to take the experiment exam tomorrow and I am wondering how well I will perform. I am so excited to see Tokyo. For me, it is the main part of this competition.

Cultural and Scientific Experience Events Today!

4 pm to 7 pm

Cultural Experience Corner at International Exchange Bldg. 1F

Today's Japanese cultural events include the following:

1


Aikidō (Japanese Martial Art)
at 5th Gymnasium

2

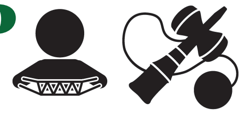

Sadō (Japanese Tea Ceremony)
at Oka Tei

3


Shodō (Japanese style calligraphy)
at the Lounge area
near the International Conference Hall

4


Making of your own "**watoji**" notebooks
at the Reception Hall

5


Japanese traditional games
at the Reception Hall.

"watoji" notebooks in traditional Japanese style will be memorial souvenirs!

Science and Technology Experience Corner at International Conference Room

The Science and Technology Experience Corner offers opportunities for hands-on experience with cutting-edge technologies and/or amusing games based on scientific principles.

Do NOT miss the Corner!

Semiconductor Manufacturing Technology Experience Corner
Tokyo Electron Limited

See physical phenomena for yourself!
Nikon Corporation

Material analysis experience using portable and desktop analyzers
Rigaku Corporation

Hands-on vacuum experiment show
ULVAC, Inc.

Brighten your summer with curiosity!
CASIO COMPUTER CO., LTD.

Integrated Gas System Competition
Fujikin Incorporated

Experience the world created by young talents of various nationalities and specialties
Masason Foundation
Masason Foundation

NGK SCIENCE SITE
NGK Insulators, Ltd.

Analyze the caffeine content of commercial beverages!
SHIMADZU CORPORATION

Symbols of Tokyo

If you ask what the symbol of Tokyo is, most people will probably say the Tokyo Skytree. Completed in 2012, the Tokyo Skytree is a 634-meter-high skyscraper radio tower located near Sensoji Temple in Asakusa. The Skytree has two observation decks, one 350 meters high and the other 450 meters high, offering panoramic views of the city of Tokyo and surrounding mountains including Mt. Fuji. We also recommend a visit to the shopping mall, restaurants, and entertainment facilities in the Tokyo Skytree.

Another symbol of Tokyo is the orange-colored Tokyo Tower, similar to the Eiffel Tower in Paris. Completed in 1958, the 333-meter-high radio tower was the tallest structure in Japan at the time.

Among famous shrines and temples in Tokyo, one should visit the Meiji Jingu Shrine established in 1920 to commemorate the virtue of Emperor Meiji and Empress Shoken who took the initiative to make a foundation of modernized Japan. Surrounded by a large forest, Meiji Jingu is a quiet place away from the hustle and bustle of the city, where visitors can enjoy the natural and mystical atmosphere.

Road approaching to Meiji shrine

Excursion for Leaders and Observers

Toyosu Course

- Meiji Shrine

  Tokyo round Trip by Bus

- Lunch
- National Science Museum

Asakusa Course

- Tokyo National Museum
- Lunch
- National Science Museum

Series "Pioneers of Modern Physics in Japan"

Hantaro Nagaoka (1865-1950)

Have you ever heard about the Saturn model of the atom? In the early 1900s, it was known that an atom seems to be a collection of positively charged and negatively charged particles. As a model to explain this, Hantaro Nagaoka, a professor of physics at the University of Tokyo, proposed in 1903 a Saturn-type atomic model with a positively charged nucleus in the center and negatively charged electrons orbiting around it in rings. The paper was published in the journal Philosophical Magazine (Phil. Mag.) in 1904. The paper was based on elaborate calculations inspired by Maxwell's work on the stability of Saturn's rings. Two months earlier, in the same magazine, British physicist J. J. Thomson, a prominent physicist at the time, proposed the plum pudding model: the atom was a sphere of uniform positive charge with negatively charged electrons scattered through it like plums in a pudding. In Nagaoka's model, an atom is assumed to have a heavy, highly charged nucleus at its center and thousands to tens of thousands of electrons revolving around it, which gives the atom a certain degree of stability. However, there was concern that the electrons would eventually emit electromagnetic waves, lose energy, and merge with the nucleus. For this reason, the number of citations of Nagaoka's paper was less than 1/10th of that of Thomson's paper. However, in 1911, Ernest Rutherford conducted an α-particle scattering experiment and presented an atomic model based on the experimental results. This model was similar to Nagaoka's Saturn model, in which electrons were revolving around the nucleus at the center. As is well known, the electrons revolving around the nucleus were explained by quantum mechanics through Bohr's atomic model published by Niels Bohr in 1913. Nagaoka's model did not ultimately survive, but it was a pioneering and original proposal at that time. Nagaoka was active not only in atomic models but also in magnetostriction and tsunami research. From 1893 to 1989, he studied in Germany under Ludwig Boltzmann. He then continued his research as a professor at the University of Tokyo and was involved in the establishment of the Institute of Physical and Chemical Research (RIKEN). He also became the first president of Osaka University. In 1937, he was awarded Japan's first Order of Culture.

SCHEDULE

TODAY
Tuesday, July 11th

27℃ 36℃

Students

7:15-8:00	Breakfast	NYC
8:30	Meet at the Exam Room	NYC
9:00-14:00	Exam (Experiment)	NYC
14:30-15:30	Lunch (light meal)	NYC
16:00-19:00	Cultural/Scientific Experience Events	NYC
18:00-19:00	Dinner	NYC

Leaders&Observers

7:00-8:00	Breakfast	NSH
9:00-15:00	Half-day Tokyo Excursion	
18:00-19:30	Dinner	NSH

NYC: National Olympics Memorial Youth Center
NSH: Nippon Seinenkan Hotel

TOMORROW
Wednesday, July 12th

27℃ 36℃

Students

7:15-8:00	Breakfast	NYC
9:00-16:00	Half-day Tokyo Excursion	
16:00-19:00	Cultral/Scientific Experience Events	NYC
18:00-19:00	Dinner	NYC

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18:00-19:30	Dinner	NSH
19:30-23:00	Board Meeting	NSH

The Physical Society of Japan
Japan Society of Applied Physics
The Physics Education Society of Japan
The Biophysical Society of Japan
Japan Science and Technology Agency (JST)
National Institution for Youth Education (NIYE)
National Museum of Nature and Science
Japan Arts Council
Tokyo National Museum
The University of Tokyo
Tokyo University of Science
Tokyo City University
Tokyo University of Foreign Studies
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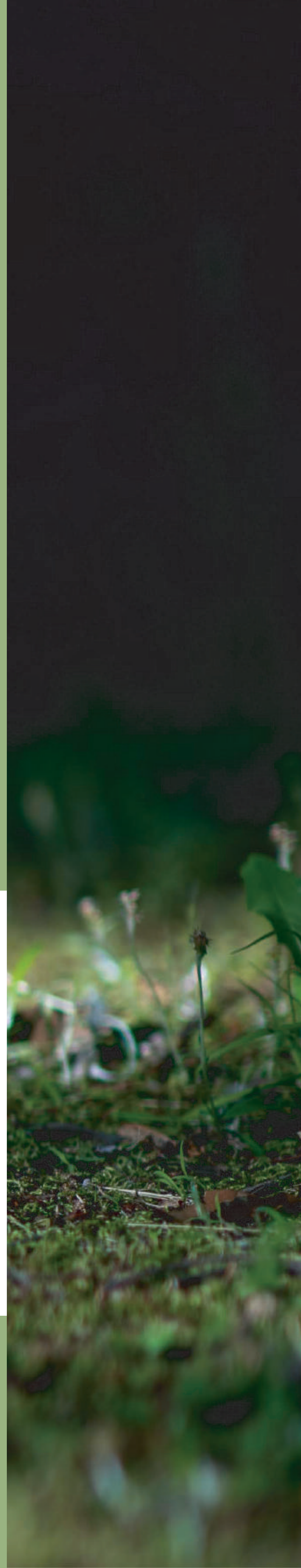

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— BUTSURI —

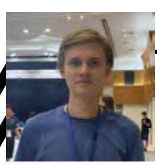
ISSUE 4

Wednesday, July 12th

CONTENTS

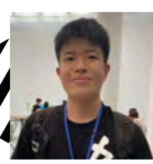
IPhO
INTERNATIONAL PHYSICS OLYMPIAD
2023 TOKYO JAPAN

Examination -First Day - ~ EXPERIMENT ~



Ukraine: KONDRACHUK Yaroslav

I think this experimental exam was really exciting and interesting. I really enjoyed it very much. It was a good experience for me, because it's really different from the exam of our national physics olympiad. I will probably enjoy the theoretical exam the day after tomorrow, but now I am not so optimistic.



Singapore: TAN Pin Che

Today's test was difficult and quite challenging with a lot of equipment involved. I think I am OK with my results in the end. I hope I will be able to get a good score with some prize at the end of the competition.

Cultural Experience Events










About the Japanese cultural experience event, we tried a little bit of string weaving, which turned out to be a lot of difficult to follow the video, but we got a bit of a way doing fun and trying something fun.

Denmark: RASMUSSEN Benjamin Olander

Japanese calligraphy writing is beautiful, fun and interesting and I love the way you guys write. It was very tough to master how to exactly keep the brush and stick, but I managed to do it.

India: GOYAL Raghav

I'm currently trying to experience a wood Japanese game called kendama. It consists of something like a hammer and a stringed wooden ball; you have to get the ball to land on the top of the hammer. It is really hard. I've never seen it before so it' s new to me.

Kenya: CAESAR Iman

Scientific Experience Events



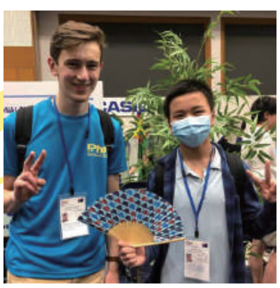







I saw a lot of very high-quality experiments here. I really enjoyed the piano experience. After I played the piano, I got to see what I played on the screen. That was very beautiful and interesting because I had never seen anything like that before. I liked it.

Georgia: UGULAVA Irakli



The CASIO's booth was really fun when I watched their performance. They tanked up a machine and threw the machine to the ground. It's interesting to see how they work in a factory. They have a lot to show us. I think it is really cool. They showed us how to apply theory and knowledge of the pressure to real-life things found in industries.

Australia: MURPHY Alastair & CHAN Kelvin

ASAKUSA

There is a large lantern at Kaminarimon, the entrance to Sensoji Temple. One of the most famous sightseeing spots in Asakusa, or rather Tokyo. It is 3.9 meters high, 3.3 meters wide, and weighs 700 kilograms. The paper used to make the lantern is about five times thicker than newspaper, making it very durable.

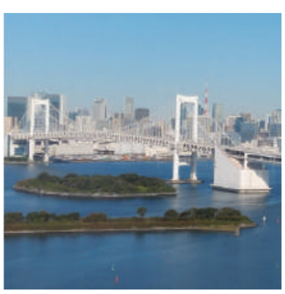
YOKOHAMAA

Since its opening in 1859, Yokohama has been Japan's leading international trading port, and was one of the first to introduce Western culture and industrial technology. The production and sale of ice cream, the installation of gas lamps, the opening of the railway, the telephone business, and the publication of newspapers... all of these are originated in Yokohama! Yokohama still keeps a lot of historical architecture that recalls the port's history. Furthermore, the

city offers state-of-the-art tourist facilities and the world's largest Chinatown!

ODAIBA

The name "Odaiba" came from the place for gun batteries when American black ships commanded by Perry appeared. Since the government built batteries in many places, Japan had many Odaibas in the past. This Odaiba has two statues as a commemoration of goodwill agreements between Japan and France. One is a replica of the Statue of Liberty built in



1998, leading to the Rainbow Bridge. The other is the Flame of Liberty donated by France in 2000.

Excurtion information

ATTENTION

- During the excursion you are not allowed to deviate from the pre-determined courses.
- You must follow the leader's directions during the excursion Don't leave your group; don't wander around alone

While staying at NYC (National Olympics Memorial Youth Center) you are not allowed to go out from NYC without permission; going out by yourselves can be subject to disqualification.

The Origin of Manga

Manga (and anime) may be one of the best-known Japanese (sub-) cultures. You may be wondering if we can trace the roots of manga art. One potent candidate is 鳥獣戯画絵巻 (Cho-Ju Giga Emaki --- Bird and Beast Caricature Picture Scroll) which was produced in the 12th to 13th century and has been passed down in Kozan-ji temple in Kyoto as a national treasure.

In one of the most famous scenes, a flog and a rabbit wrestle each other. Spectator flogs are applauding and laughing at seeing their peer manage to throw the rabbit down.

北斎漫画 (Hokusai manga)

In the early 19th century, KATSUSHIKA Hokusai, the artist who later created the famous "Red Fuji" (the image reproduced on the IPhO2023 medals), produced a series of books containing drawings of people of various occupations. They came to be known as 北斎漫画 (Hokusai manga) and continue to be a rich source of imagination for artists who want to capture human postures and body language.

鳥獣戯画絵巻 (Cho-Ju Giga Emaki)

Series "Pioneers of Modern Physics in Japan"

Kotaro Honda
(1870-1954)

Permanent magnets are indispensable materials in materials science. The performance of a magnet is determined by its residual magnetic flux density (the magnetic flux density remaining when the magnetic field strength is returned to zero) and coercive force (the magnetic field strength required to reduce the residual flux density to zero).

In 1917, Kotaro Honda, a professor at Tohoku University, and his collaborator Hiromu Takagi invented the world's highest-performance permanent magnet with a holding power three to four times greater than the strongest magnet of the time. The magnet was an iron alloy containing cobalt, tungsten, chromium, and carbon.

At that time, World War I broke out, making it difficult to import high-performance magnets, so it became necessary to develop a new permanent magnet in Japan, and research was conducted with the donation of research funds from the Sumitomo conglomerate. Therefore, the permanent magnet discovered was named KS steel after the initials of the donor, Kichizaemon Sumitomo. In 1933, Honda and his collaborators also discovered a new permanent magnet (new KS steel) (an alloy composed of cobalt, nickel, titanium, and iron) with the highest performance in the world.

As a student at the University of Tokyo, Honda studied the temperature variation of the magnetic susceptibility of metallic materials. He also studied abroad in Germany and England, where he measured the magnetic susceptibility of elements and left precise experimental results.

Honda was famous as a "demon for experiment" who devoted all his time to experiments. He became a professor of physics at Tohoku University in 1911, the first director of the Institute for Materials Research at Tohoku University in 1922, and president of Tohoku University from 1931 to 1940, laying the foundation for Tohoku University to become a center of materials science. In 1937, he was awarded Japan's first Order of Culture.

As can be seen from the discovery of KS steel, his contribution to the industry was significant, and he placed great importance on the utilization of the results of science in industry, as he said, "Where there is learning, technology grows; where there is technology, industry develops; the industry is the dojo for learning. "

SCHEDULE

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Wednesday, July 12th

27℃ 36℃

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Thursday, July 13th 2023

Issue 5

ぶつり

- BUTSURI -

Contents

Half-Day Tokyo Excurtion

United Kingdom: ZHU Coy

Asakusa was really cool, and the traditional architecture was amazing. In the shrine, I threw in 25 yen, and I made several wishes. I got a medium when I tried a fortune slip. Well, it was still very cool, and I will keep the sheet for a long time. Unfortunately, I didn't have much time to look at different shops, but I'm going to buy a Yukata later on this trip. In addition, I found the Ueno area really beautiful with lots of greenery.

United Arab Emirates: SOWJANNYA Sabari & PRAMOD Punnya

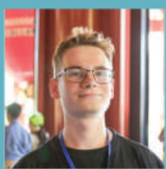
The metro was really good and clean. Also, it was very fast. Japanese people keep themselves well organized even on the escalator. They move to the left and leave the right side for people who like to walk up or down. They follow the line very patiently and they don't rush. Everyone is very honest and respectful.

Hong Kong: LAM Chung Wang

I think it is really awesome to be able to come to such a place. All you can sense here is really extraordinary because you feel that great sense of spirituality. It is also good to pray for good fortune, especially during such a hectic competition. I'm very lucky to be able to come here on my birthday. So overall I feel this is an amazing and special experience.

Poland: BACIAK Filip

I think we were all astonished at this Japanese temple. It was very nice because we had the occasion to learn more about Japanese culture. In Asakusa, there were a lot of shops, people, and tourists. Though a little bit crumpled, these shops gave us an opportunity to buy lots of souvenirs.



Spain: CARPENTER Ruben Mason

The metro was quite busy. We took the three different connections, and it was interesting to see it. Asakusa is very nice. You can really see the Japanese culture here. Spain is also quite hot but less humid than here, so here it is hotter. I am really excited to go to the Tokyo National Museum and see the Japanese arts and so on there.

Israel: RAM Ido

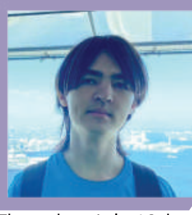
I really liked Yokohama because it has a cool view with a very big tower, fast elevators, and a nice view of the sea. I also was excited to go to the cup-noodle museum.

Kazakhstan: PITEBAY Yersultan

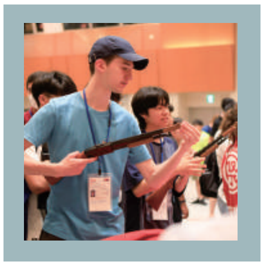
I really liked Yokohama because it has nice views and the ride on the Japanese roller coaster in the COSMO Park. I also liked the coral door, so all in all this excursion was very great.

Germany: POSPIECH Luke

Visiting Yokohama was at most fun. It was nice to see something so different from what I see usually in Germany and to find out how big Tokyo and Yokohama really are. Chinatown is also nice with a lot of people hustling and bustling on the street. Yokohama was as a whole a pretty nice city to visit.



Cultural and Scientific Experience Events





When I first went to En'nichi festival corner, I got some food using a food source ticket. Then my friends suggested that I should try a shooting game. So I did and succeeded in shooting a small Japanese snack, probably because I was lucky. It was really fun and I enjoyed it very much. Next time I will try to shoot chocolate bananas.

Canada:
SHAO Eric Yuan

I tried Japanese food here. I really like it very much though it tasted something new to me. Also, I like the stands where you can play Japanese dances. So, this is a really nice experience for me. In addition, I got the chance to experience Japanese culture. Since this is the first time to come to Japan, I really would like to learn more about Japan. I′ m definitely going to try what I haven′ t experienced yet.

Armenia:
ARAKELYAN Maria

History of Tokyo

Tokyo is currently home to approximately 14 million people, about 11% of Japan's population. Tokyo was once a small fishing village called Edo. In 1603, Ieyasu Tokugawa, as shogun, established the seat of the samurai government in Edo. Edo developed as a political center and by 1721 had a population of 1 million. Edo became the center of Japan, and the peaceful era known as the "Edo Period" continued for more than 200 years. In 1867, the Tokugawa shogun abdicated, and political power returned to the emperor in Kyoto. It was decided that Kyoto and Edo would share the functions of the capital, with Kyoto as the capital of the west and Edo as the capital of the east.
The name was changed from Edo to Tokyo (東京) according to the capital (京) of the east (東). The Emperor also moved to Tokyo in 1867.

After becoming the capital of Japan, Tokyo was severely damaged by the Great Kanto Earthquake in 1923 and the Great Tokyo Air Raid in 1945. However, each time it was rebuilt, and Japan entered a period of rapid economic growth, growing and developing into one of the world's l

Little stories about Japan

Japanese words used abroad

“Kawaii” may be the most used Japanese word overseas. If you don't know what it means, please ask the support staff.

First words when answering the phone

In English it is “Hello” , but in Japanese, it is “Moshi Moshi” . If you encounter someone Japanese on the phone, listen carefully. When the telephone was first introduced, the telephone operator would call out to the recipient, "Moshiagemasu, moshiagemasu" (I will tell you, I will tell you). Its abbreviated form "Moshi Moshi" came into use.

Do you stand on the right side or the left side of the escalator?

In Tokyo, people stand on the left side because someone may walk up on the right side. In Osaka, on the other hand, people stand on the right side. What is the case in Nagoya, located between Tokyo and Osaka? In Nagoya, the escalator in the subway has a sign that says, “Do not walk” . This means both sides for standing.

What is Game Center?

Japanese culture has many unique aspects, such as characters, beliefs, and values. Among various Japanese cultures, the game is popular among the young generation. In the 1970s, against the backdrop of rapid economic growth, electronic technologies such as computers and electronic music were fostered. These technologies are still the foundation of today's game and anime culture, such as Pokémon and NARUTO.

Let us introduce some equipment in Japanese game arcades where you can experience this kind of culture. First of all, the game shown below is called Taiko no Tatsujin. In this game, you beat the taiko drum with a bachi to the rhythm.

The game below is Mario Kart, a racing game featuring characters from Super Mario Bros.

The author is currently addicted to a washing machine-type game called Maimai (see photo below), in which you tap buttons to the rhythm. These games belong to a genre called "sound games," and when you are in a game center, you often encounter people with tremendous skills who can process information in a way that ordinary people cannot follow with their eyes.

Gacha machines shown below can also be used to obtain mascot characters and other items.

UFO Catcher is a game to get cute Pokémon goods by arm in the box shown below, but it is easier to lose money than in other games. The author spent 1,800 yen to get Mimikyu, a Pokémon character, with the help of a game center staff.

All in all, game arcades are attractive facilities where you can enjoy relatively healthy and unrealistic experiences for as little as 100 yen, but be careful not to get into them too much or spend too much money.

Becoming a Leader in Promoting Diversity

Prof. YOKOYAMA Hiromi

Kavli Institute for the Physics and Mathematics of the Universe,
The University of Tokyo

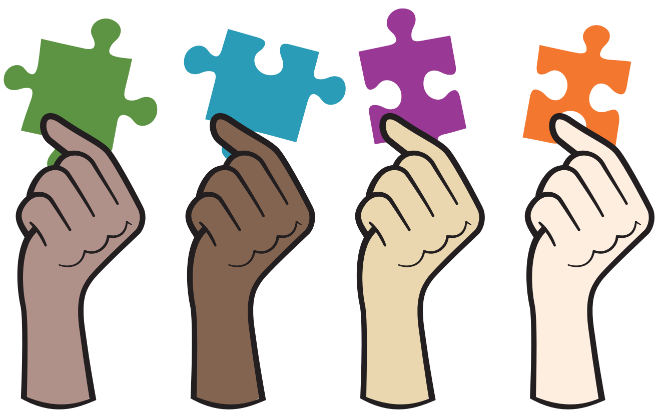
To all the participants in IPhO2023, I look forward to seeing each of you perform to the best of your abilities. Now, I have one question. Why are there so few women participants in the Physics Olympiad?

When I was in the eighth grade, I read a science magazine and developed a strong interest in physics, which can explain how the universe is formed. I was able to persuade my parents that I really wanted to study physics and was able to go on to higher education. However, in Japanese society, a false bias has taken root that physics and mathematics are male-oriented studies, and many female students have given up on higher education. Of course, the bias is not true! Many psychological and sociological data and studies are now available. The ability to study is not based on gender or ethnicity and it is an individual difference. There are many potentially highly capable minorities who do not get the chance or support to study physics.

I hope that all of you who are currently participating in IPhO2023 will play an active role in reforming these situations. While male students are the majority, let us reach out to those who belong to the minority, such as women, sexual minorities, and international students in your countries, and let us work together in friendly competition.

I am giving a seminar on diversity with Prof. Hitoshi Murayama, a Japanese physicist in the U.S. (Distinguished Professor at the University of California, Berkeley, and the University of Tokyo) for his graduate students. His experience of discrimination as an Asian was a great shock to him as a Japanese male student who thought he was in the majority. He is now a supporter of minorities and welcomes them into his laboratory. He is surrounded by many talented students.

IPhO2023 is not just a competition for your physics abilities, but also a place to help you become insightful leaders through international networking. We hope you will enjoy the interaction with other participants who are different from you.



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TOMORROW

Friday, July 14th

25℃ / 33℃

Students

7:15-8:00	Breakfast	NYC
9:00-15:30	Half-day Tokyo Excursion	
16:00-17:40	Special Lectures	NYC
18:00-19:30	Dinner Party	NYC

Leaders&Observers

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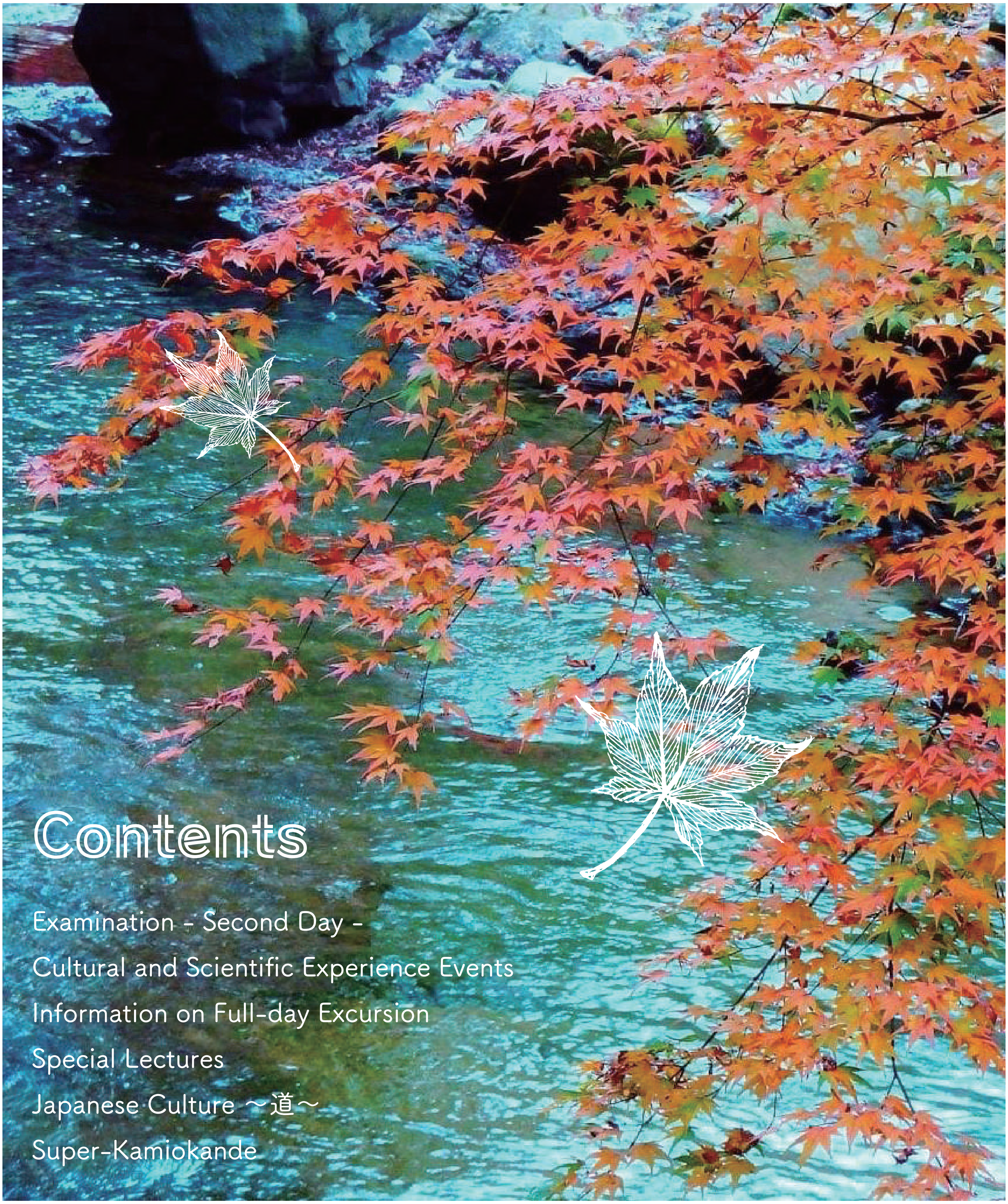
ISSUE 6

Friday, July 14th

IPhO INTERNATIONAL PHYSICS OLYMPIAD 2023 TOKYO JAPAN

ぶつり

BUTSURI

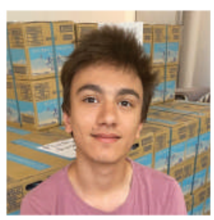


Contents

Examination - Second Day - ~THEORY~

Latvia:
OZOLINS Toms

The exam was harder than I expected, but at the same time, I managed to do something in all five hours. I think it was OK, but it could have been worse. I could have done better, but sadly, maybe my brain didn't work as I wanted. I did 80% or 90% out of my maximum capacity, but I'm happy about the exams. Today it was not as hot as before, so I don't think the weather affected my condition.



Slovakia:
HARMANSKY Adam

Today's theory problems were really surprizing to me. They were a lot more about math than about physics. But I liked the third problem on "Water and Object". I think the first one was OK but the second one was a little bit weird. Unfortunately, I don't think I did really well. However, the exams went well, the corrections to the tests were taken care of efficiently, and the test procedure was well-organized. It was funny to take the exams in the card-board booth, though.

Cultural & Scientific Experience Events

Austria：
LUN Pascal &
VOGRINCIC Neza

We tried calligraphy and had a lot of fun doing it. We find it so cool to use brushes but what we drew with a brush looked worse than the model drawing, We wrote our names and "physics (butsuri)" in Japanese. All in all drawing with brushes was very enjoyable. We also tried making "Watoji" notebooks, which we found very interesting as well. We used traditional Japanese paper which normally we don't choose. In addition, we enjoyed the Japanese tea ceremony. We felt the Japanese culture in it.

Tajikistan:
SALIMOV Husanjon

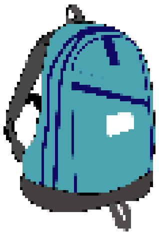
Japanese cultural experience booths were really good. I made a "watoji" notebook using some paper for myself. The process was really interesting and people at the booth helped me. I drew a picture on the notebook with the name of my country Tajikistan in Japanese letters and the logo of IPhO. In writing in Japanese, people at the booth helped me. It was really good. I learned a lot from this, like how to make my own notebook.

Portugal:
PINTO Ivan

I played with a spinning top, "Koma." Since we have a similar toy in Portugal, I have some experience. But it was very different from Portuguese's one: the Japanese tops are sharp, while the Portuguese tops are tall and round. I like playing with a koma. It's fun.

Nepal:
RAUT Manish

I tried calligraphy, which was fun and a great experience. I wanted to write my first name in Japanese characters, so I asked the attendant to help me out.
Unfortunately, my name was written as Manis, not the correct name Manish, probably because my pronunciation was not so good. However, it was not really difficult to write with brushes and I really like it.



Excursion Information

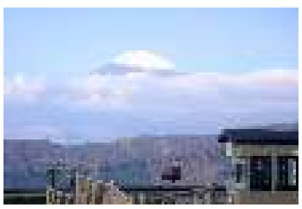
July 15th (Sat)

July 16th (Sun)

HAKONE

Courtyard of Building A at 7:45

"Hakone" means a box-shaped mountain: "Hako" means a box and "ne" means a root. It is the area around Mt. Hakone that straddles Kanagawa and Shizuoka prefectures. Weather permitting, from the ropeway, you can see Mt. Fuji, Japan's tallest mountain.



Also, Hakone has been famous as a hot spring resort.

NIKKO

Courtyard of Building A at 7:45

At Nikko Toshogu Shrine, you can find a lot of colorful sculptures. The most famous one is statue of the three wise monkeys. It represents the teaching of "See no evil, hear no evil, speak no evil." Also, you can see another famous sculpture of the sleeping cat designated as a national treasure.

KAMAKURA

Courtyard of Building A at 9:15

Kamakura is a historical city where the shogunate was established by samurai during the Kamakura period (1185-1333). Hence, you can enjoy its historical heritages and samurai culture, while being surrounded by rich nature.

You can also enjoy Enoshima Island, sightseeing spot.

TSUKUBA

Courtyard of Building A at 8:45

It is the largest academic city in Japan. At KEK (High Energy Accelerator Research Organization), the development of accelerator technology, such as super KEKB, is being carried out. Also, Mt. Tsukuba is a famous mountain. Weather permitting, you can enjoy the view of Lake Kasumigaura.

Special Lectures
by two Nobel Laureates in Physics

KAJITA Takaaki
President, Science Council of Japan
Distinguished University Professor
The University of Tokyo
2015 Nobel Laureate in Physics

Neutrinos
– key particles for the understanding of the smallest particles and the largest Universe –

Neutrinos are remarkably interesting particles. Neutrinos have three types, i.e., electron-neutrinos, muon-neutrinos, and tau-neutrinos. They have no electric charge and interact with matter very rarely. Because of the last nature, neutrinos can easily pass through even the Earth or the stars. One can study the interior of stars by detecting neutrinos from these stars, although the detection of neutrinos is difficult. Neutrinos have been assumed to be massless. However, if neutrinos have mass, they may change their type while propagating in a medium. For example, a muon neutrino may change to a tau-neutrino. These phenomena are called neutrino oscillations. Twenty-five years ago, neutrino oscillations were discovered, and therefore it was found that neutrinos have tiny mass. I will discuss the studies of neutrinos focusing on our experiments that have been carried out in Kamioka, Japan.

Message to students:

Physics is really a fascinating scientific field. Through collaborations of theoretical and experimental studies, we understand the smallest elementary particles and the largest Universe. However, our understanding of these smallest and largest scales is still incomplete. We believe that many more fundamental discoveries await us. Young students, join us on our journey to understand the smallest and the largest world.

Don’ t waste your gifted talents

Sometimes, I am asked by students or young researchers, “What are the most important characteristics of a scientist?” . I would answer, a scientist should have (1) a future vision, (2) enthusiasm, and (3) patience. Your future vision leads you to concentrate on reaching your goal, and enthusiasm is essential for you to be able to continue your effort until you have reached your goal. As for patience, if you are under some pressure, for example, when you have to obtain PhD degree as soon as possible, it is rather easy to do things that are not so meaningful to you but are merely convenient to quickly solve an urgent problem. You may feel relieved after solving a problem, but in such a case, you may not be satisfied with the results. It is difficult not to do so. However, during your effort, sometimes you should be patient and wait until you find the real route to your goal. You do not need to compromise.

AMANO Hiroshi
Professor, Nagoya University
2014 Nobel Laureate in Physics

Message to students:

I presume that you have done extremely well in physics so far. I think your achievements until today owe much to your gifted talents. After this Physics Olympics, however, your situation may change. You may attract the attention of many people, and you may feel you have to do something big. If you already have your future vision, this is not a problem for you. However, if you still do not have a clear image of your future, please listen to my talk. In this presentation, I would like to share my experiences with you. I hope this presentation gives you some hints for your future life.

Japansese Culture

道

DOU

What is “道” ?

The process of training to improve traditional techniques. To master a technique, one begins with “kata” (it means form), and beginners practice basic kata repeatedly without reason until their bodies learn them. The purpose of most "dou" is to grow as a person through training and to become a person of character. In Japan, there are many "dou" that have been handed down to people for hundreds of years.

① Kendo(剣道): Kendo is a sport in which players in kendo uniform face each other one-on-one and compete to win or lose by striking or thrusting a shinai (bamboo sword) at a predetermined spot. ② Sado(茶道): In Sado, the master prepares tea in the traditional Japanese style and serves it to guests, who then enjoy it while being entertained by the master.③ Kado(華道): Kado is the act of cutting seasonal trees, branches, and flowers and arranging them in vases to express and appreciate the beauty of their appearance and the preciousness of life. ④ Shodo(書道): Shodo (Japanese calligraphy) is a way of expressing oneself by writing letters on paper using a brush and ink and conveying one's thoughts through the letters and styles of writing. ⑤ Kyudo(弓道): Kyudo is a Japanese martial art that trains the body and mind through a series of movements that involve shooting an arrow with a Japanese bow and hitting a target.

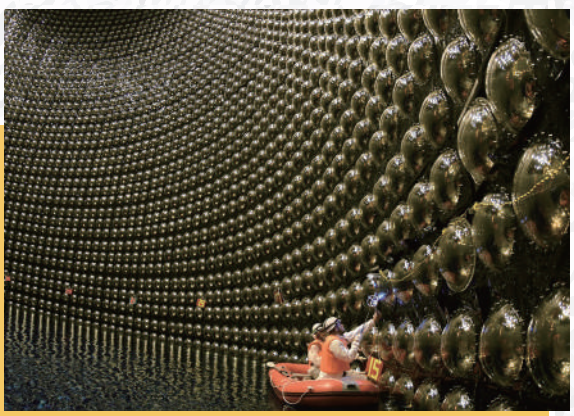
Super-Kamiokande

- Uncovering the nature of neutrinos and the mysteries of elementary particles and the universe -

Super-Kamiokande (SK) is the world's largest water Cherenkov observatory operated by the Institute for Cosmic Ray Research at the University of Tokyo, located 1,000 m underground in the former Kamioka Mine in Hida City, Gifu Prefecture, in the central part of Japan. The purpose of SK is to study elementary particle physics and astrophysics through neutrino detection and proton decay searches.

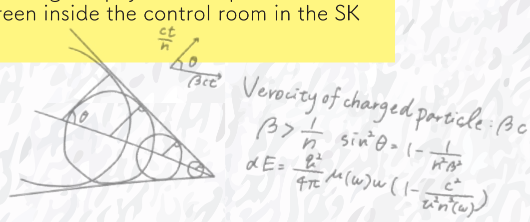
SK is a 50,000-ton cylindrical water Cherenkov detector, 40 m in height and 40 m in diameter, whose operations began in 1996. It is equipped with over 11,000 50-cm photomultiplier tubes (PMTs) to observe various elementary particle interactions in the detector. SK observes neutrinos produced both in the Sun (solar neutrinos) and by the interactions of cosmic rays in the atmosphere (atmospheric neutrinos). In 1998, SK observed a clear anisotropy in the zenith angle distribution in its atmospheric neutrino data, thereby establishing the existence of neutrino masses and mixing, a phenomenon known as "neutrino oscillations." For this result, the Nobel Prize in Physics was awarded to Prof. Takaaki Kajita in 2015. Furthermore, accurate measurements of the solar neutrino flux using neutrino electron scattering data in SK, in conjunction with the results from the SNO (The Sudbury Neutrino Observatory) experiments in Canada, led to the discovery of oscillations among neutrinos produced in the center of the Sun.

All materials in the universe are made of atoms, which consist of nuclei and electrons. Furthermore, the nucleus is a composite of protons and neutrons. It has been thought that protons are stable; however, Grand Unified Theory, which unifies strong, weak, and electromagnetic interactions, predicts protons will decay into lighter particles like mesons and leptons. To confirm this prediction, we ^{34}have been measuring proton lifetime using SK with 50,000 tons of pure water containing 7×10^{33} protons. (a huge number of protons!) Although SK has been running for more than 20 years, any evidence of proton decay has not been observed yet. From this result, the proton lifetime is estimated to be more than 1,034 years. Just as has been done until now, Super-Kamiokande will keep running towards a new horizon of the world of particle physics in the future as well.



Inside picture of Super-Kamiokande' s cylindrical water Cherenkov detector.

Researchers discussing the physics of experimental data shown on the screen inside the control room in the SK facility.



SCHEDULE

TODAY
Friday, July 14th

24 ℃
31 ℃

Students

7:15-8:00	Breakfast	NYC
9:00-15:00	Half-day Tokyo Excursion	
16:00-17:40	Special Lectures	NYC
18:00-19:30	Dinner Party	NYC

Leaders & Observers

7:00-8:00	Breakfast	NSH
12:00-13:30	Lunch	NSH
16:00-17:40	Special Lectures	NYC
18:00-19:30	Dinner Party	NYC

TOMORROW
Saturday, July 15th

26 ℃
34 ℃

Students

7:15-8:00	Breakfast	NYC
8:00-19:00	Full-day Kanto Excursion	

Leaders & Observers

7:00-8:00	Breakfast	NSH
12:00-13:30	Lunch	NSH
14:00-15:00	Board Meeting	NSH
18:00-19:30	Dinner	NSH

NYC: National Olympics Memorial Youth Center
NSH: Nippon Seinenkan Hotel

The Physical Society of Japan
Japan Society of Applied Physics
The Physics Education Society of Japan
The Biophysical Society of Japan
Japan Science and Technology Agency (JST)
National Institution for Youth Education (NIYE)
National Museum of Nature and Science
Japan Arts Council
Tokyo National Museum
The University of Tokyo
Tokyo University of Science
Tokyo City University
Tokyo University of Foreign Studies
International Christian University
Sophia University

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ISSUE 7 Saturday, July 15th

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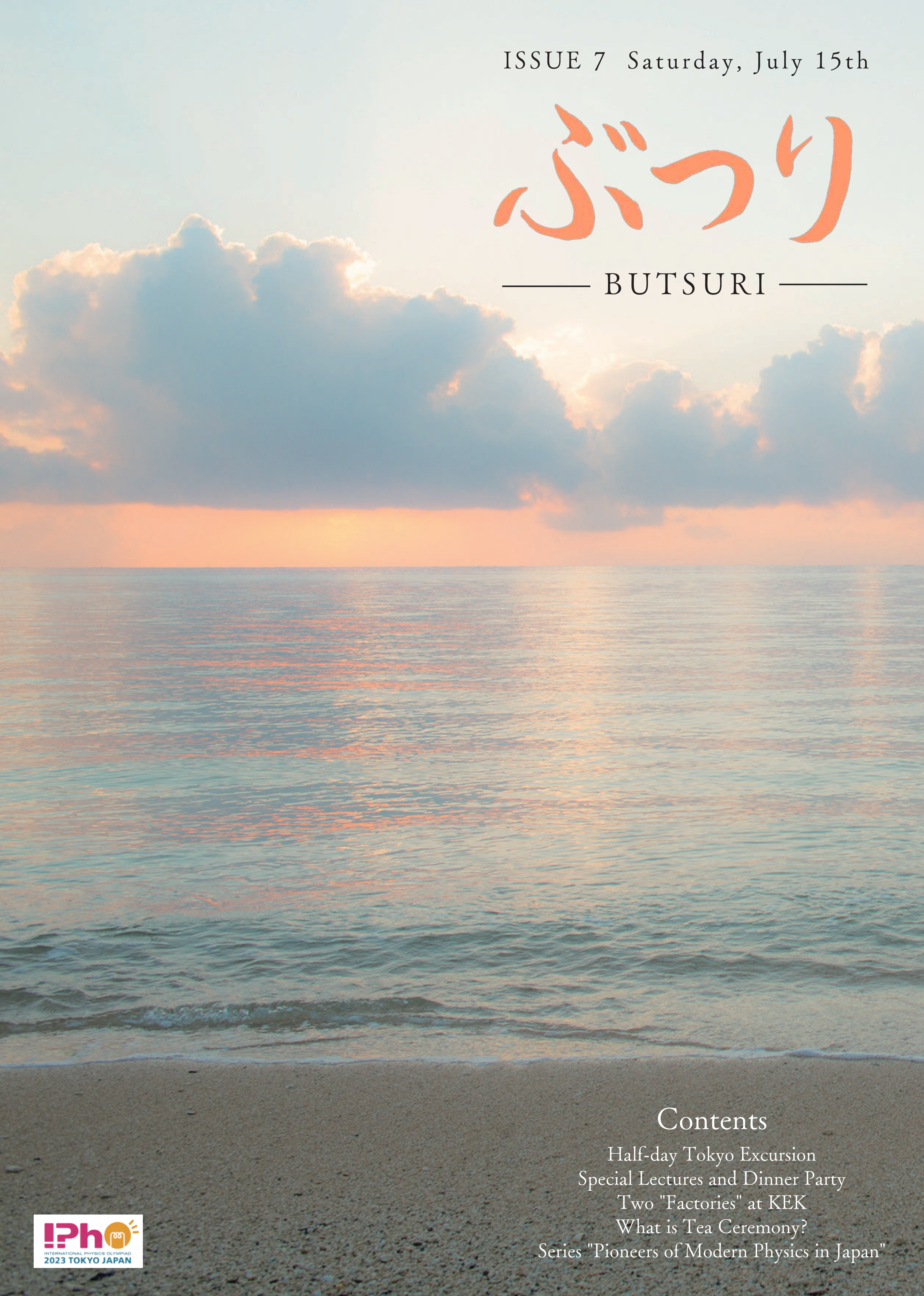
BUTSURI



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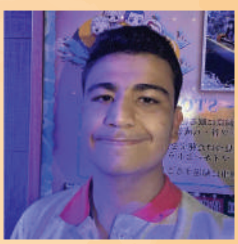
Half-day Tokyo Excursion



Iran: FAYZ Shayan

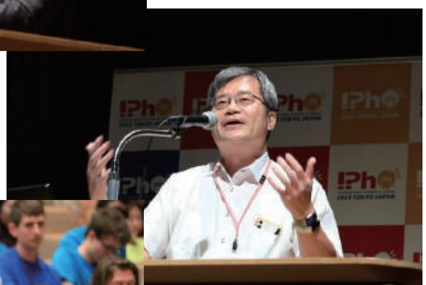
In Tokyo-joypolis, I had to wait very long before I got in, but the ride was really fun. If we could stay here much longer, it would be much better. I also found that Odaiba was a good place, but I thought the museum was not designed for us, but rather designed for kids much younger than us. In addition, the price of food is reasonably good. All in all this city was really nice.

Finland: LEINONEN Eppu

I found Yokohama pretty nice. We went to see the red brick warehouse buildings, which were very interesting to see here in Japan. They looked like a European style buildings. Also, we went to the cup-noodle museum to make our own cup needle, which I found very nice. Even though I think we were the oldest children there, it was fun. We were able to design anything there, so we had a lot of fun with physics designs.

Special Lectures

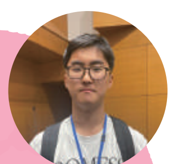
by two Nobel Laureates in Physics



On July 14, two Nobel laureates in physics, Dr. Takaaki Kajita and Dr. Hiroshi Amano, gave special lectures. Dr. Kajita spoke about the importance of finding new questions in pure science and examining them for a long time, which is expanding the horizon of knowledge. Dr. Amano talked about the fascination of research and deep tech, which allows researchers to pursue the interest of science and its contributions to people in a unique way. He further explained that you shouldn't waste your gifted talent and three things are necessary for researchers: Vision of the future, Enthusiasm, and Persistence. As a whole, the two lectures gave us cues about how researchers should approach science.

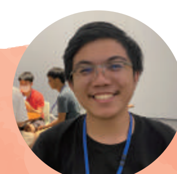
Italy: GIURI Andrea

Both lectures were really interesting. In the first lecture, Professor Kajita talked about neutrinos. It was very informative and listening to the process of neutrino experiments was fun. In the second lecture, Professor Amano talked about important choices for the future and the idea of doing actual university doctorate work based on his experience.



Mongolia: MUNKHBAATAR

The special lectures by two Japanese Nobel laureates were really interesting. The first one was the talk about scientific achievement. The second one was about gifted young talents and what they should do in the future. I would like to thank both of them as well as the Japanese physics society.



Philippines: JACOB Benjamin

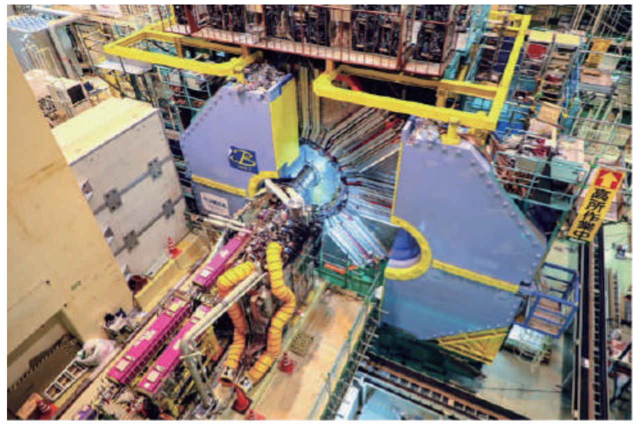
I found Professor Amano's talk really inspirational. Previously, I actually didn't think about what I was going to do in my life, but now I came to think it's about time to decide what I should do in the future. The lecture told me that I should keep on going with what I really believe in and what I want to do in my life.

Dinner Party photos

All the participants of IPhO2023, students, leaders, observers, and organizing staff, got together and enjoyed talking to each other while biting sushi, pizzas, sausages, etc. and drinking beverages and water.

Get-together photo

Two "Factories" at KEK Solving the Mysteries of the Universe, Matter, and Life



B Factory: Belle II particle measurement device of B Factory (Credit: KEK)

Photon Factory: Experimental Hall of Photon Factory (Credit: KEK)

High Energy Accelerator Research Organization (KEK) is a national research institute with large equipment called "accelerators". Located in Tsukuba City, Ibaraki Prefecture, about 50 km north of Tokyo, KEK conducts a variety of research on space, matter, and life. It has a staff of about 1,000, half of whom are scientists. The annual budget is approximately 35 billion yen. It is an important role of KEK to provide external researchers with opportunities to conduct experiments and produce results.

An accelerator may not sound familiar to you, but it is basically a device that increases the speed of electrically charged particles by giving them energy through the force of an electric field. The vacuum tubes once used in radios and televisions are also small accelerators. Familiar devices that generate X-rays for medical use or microwaves to heat food in a microwave oven are also low-energy accelerators. However, the accelerator at KEK is one of the most special accelerators in the world, with an exceptionally high energy level.

At KEK in Tsukuba City, electrons are accelerated to nearly the speed of light and used for two major experiments.

The first is an experiment in which electrons and their antiparticles called positrons (particles that have the same mass as electrons but opposite electric charges), are created and collide with each other. In this experiment, an accelerator is used to create a high-energy state like the one in which our universe was born. Although the theory by Dr. Makoto Kobayashi, who is chairman of the Organizing Committee of IPhO2023, and Dr. Toshihide Maskawa (both won the Nobel Prize in Physics in 2008), helps to explain what happened when the universe was born, many mysteries remain. This experiment aims to elucidate them. The accelerator is in a circular tunnel with a circumference of 3 km at a depth of 11 m underground. The measurement device that looks at the particles produced as a result of collisions between electrons and positrons is 8 meters high. The accelerator and the measurement device are designed to create and observe particles called B mesons, hence the name "B Factory."

There is another experiment that uses the intense light produced when the orbits of accelerated electrons are bent by a magnetic field. This light, known as synchrotron radiation, is more directional than medical X-rays, making it ideal for studying the structure of matter, and is being used in a variety of studies. Recently, the samples brought back by the asteroid probe "Hayabusa 2" were analyzed. The facility has 48 light outlets, called "beamlines" , which extract synchrotron radiation from the accelerator. Each is used for a unique experiment. The facility is nicknamed the "Photon Factory" because synchrotron radiation is made up of light particles (photons). Dr. Ada Yonath of Israel, who experimented here for nearly 10 years and discovered the structure of the ribosome, the protein factory of our cells, was also awarded the Nobel Prize in Chemistry in 2009.

You can see both "factories" during a visit to KEK.

What is Tea Ceremony?

What comes to mind when you hear the term "tea ceremony"? Some people may think of matcha (powdered green tea) since matcha-based drinks are popular not only in Japan but also around the world these days. Let us tell you about the charm of the tea ceremony, which is not limited to matcha green tea.

The tea ceremony is a traditional Japanese art form based on a series of ceremonies in which tea is prepared and served to guests. There are more than 500 schools of tea ceremony, the three most popular being Urasenke, Omotesenke, and Mushanokoji Senke. The details of each school differ in various ways, but here we will introduce the Urasenke school, which is the most populous.

When you are invited as a guest, the general flow of the ceremony is to taste sweets, drink tea, and admire the furnishings. Most of the sweets served at a tea ceremony are Japanese sweets. They are not only tasty but also visually gorgeous, so you can enjoy them with your eyes. Sweets that are appropriate for the season or based on the season are served, so it is enjoyable to take a moment to appreciate them before eating them. After the sweets, matcha is served. The host who serves the tea will make froth for the matcha using a special device. This gives the matcha a mellow flavor. After the tea is finished, there is time to admire the room. The calligraphy scrolls, seasonal flowers in the alcove, vases, bowls, etc. can be savored and appreciated for their beauty.

In this way, the tea ceremony is not only about enjoying tea but also a place where one can enjoy beautiful things and feel the spirit of hospitality and wabi-sabi.

Matcha and sweets

Tea ceremony

Have you heard of Sencha-do?

One of the tea ceremonies is sencha-do, which involves brewing sencha, gyokuro, and other teas. The following is a brief introduction to what sencha-do is all about, using the Kung-fu school as an example.

Sencha-do have been founded in the middle of the 17th century by Ryuichi Ogen, the founder of the Obaku sect, a branch of the Rinzai school of Zen Buddhism that originated in China and was introduced to Japan. It was developed under the patronage of powerful persons during the Edo period when tea became popular among the general public as a luxury item. Every year in May, the National Sencha-Do Convention is held at Obakuzan Mampukuji Temple in Uji, Kyoto, where various schools of sencha-do are served in different ways. It is an exciting learning opportunity for those who practice sencha-do.

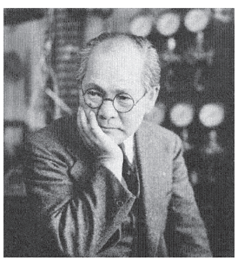
Examples of tea utensils in the Kaofu school

The following are some of the major differences between sencha-do and matcha-do. In sencha-do, a very large number of tea utensils are used, as shown in the picture below. This is in contrast to the matcha tea ceremony, which uses fewer tea utensils such as tea bowls and tea whisks. Also, while the same tea is served all year round in matcha, in the sencha tea ceremony, tea is served differently depending on the season or occasion. For example, in early spring, hojicha is served with cherry blossom petals, and in summer, when the temperature is high, gyokuro is served cold with ice. Why don't you enjoy not only matcha but also sencha?

Series "Pioneers of Modern Physics in Japan"

Torahiko Terada
(1878-1935)

Bragg's law is the law of diffraction and reflection of X-rays. When a material with a periodic structure such as a crystal is irradiated with X-rays of a certain wavelength, the X-rays scattered by the atoms constituting the material are enhanced and canceled out by the repetition of the crystal structure, a phenomenon used in the structural analysis of crystals. Stimulated by the X-ray diffraction of crystals by Max Theodor Felix von Laue, this law was discovered in 1913 by William Henry Bragg and William Lawrence Bragg, a father and son from England. There was a Japanese physicist also inspired by Laue's X-ray diffraction conducted his own X-ray diffraction experiments and independently discovered the present Bragg condition. This Japanese was Torahiko Terada. His other achievements include pioneering research in the field of geophysics, such as observations of tidal secondary oscillations, and in the statistical mechanical field dealing with the "physics of form," such as studies on forms of confetti horns and cracks. Besides being a physicist, Terada had a deep knowledge of literature and other matters and has left behind many essays that harmonize science and literature. In Japan, where there are many earthquakes and tsunamis, Terada left us with the famous saying, "Natural disasters come when you forget about them."



Yoshio Nishina
(1890-1951)

Yoshio Nishina was a physicist called "the father of modern physics in Japan". After graduating from the Department of Electrical Engineering at the University of Tokyo in 1918, Nishina studied physics as a graduate student at the University of Tokyo and at the same time as a research student at the Institute of Physical and Chemical Research (RIKEN). From 1921 to 1928, he studied abroad: in Cambridge, England; Göttingen, Germany; Copenhagen, Denmark; and Hamburg, Germany. While at these places, he conducted experimental and theoretical research with Ernest Rutherford, Niels Bohr, Isidore Rabi, and others. He was active in Europe during the early days of quantum mechanics. In 1928, together with Oscar Klein, he calculated the effective cross section of Compton scattering of X-rays based on Dirac's relativistic electron theory, leading to the famous Klein-Nishina formula. After returning to Japan, he joined Hantaro Nagaoka's laboratory at RIKEN. In 1931, he became a senior researcher at RIKEN and established the Nishina Laboratory. He started experimental and theoretical research on quantum theory, atomic nuclei, X-rays, and cosmic rays, which was unprecedented in Japan at that time. In experiments, he worked on the construction of a cyclotron. In theoretical research, he invited talented young theoretical researchers such as Sin-Itiro Tomonaga. The liberal academic culture that he acquired under Niels Bohr brought a free and active mental climate to Japan and raised Japanese particle physics to a world-class level. Nishina was called "Oyakata" (master) because of his personality. Since many physicists have come out of the laboratories hosted by Nishina, there are few researchers in particle physics in Japan who are not influenced by Nishina.

SCHEDULE

TODAY
Saturday, July 15th

27℃
33℃

Students

7:15-8:00	Breakfast	NYC
8:00-19:00	Full-day Kanto Excursion	

Leaders&Observers

7:00-8:00	Breakfast	NSH
12:00-13:30	Lunch	NSH
14:00-15:00	Board Meeting	NSH
18:00-19:30	Dinner	NSH

TOMORROW
Sunday, July 16th

27℃
36℃

Students

7:15-8:00	Breakfast	NYC
8:00-19:00	Full-day Kanto Excursion	

Leaders&Observers

7:00-8:00	Breakfast	NSH
9:00-12:00	Moderation	NSH
12:30-14:00	Lunch	NSH
14:00-18:00	Moderation	NSH
18:00-19:30	Dinner	NSH
19:30-23:00	Final Board Meeting	NSH

NYC: National Olympics Memorial Youth Center
NSH: Nippon Seinenkan Hotel

The Physical Society of Japan
Japan Society of Applied Physics
The Physics Education Society of Japan
The Biophysical Society of Japan
Japan Science and Technology Agency (JST)
National Institution for Youth Education (NIYE)
National Museum of Nature and Science
Japan Arts Council
Tokyo National Museum
The University of Tokyo
Tokyo University of Science
Tokyo City University
Tokyo University of Foreign Studies
International Christian University
Sophia University
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物理

BUTSURI

ISSUE 8

Sunday, July 16th

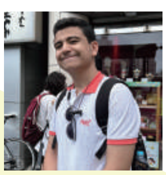
IPhO
INTERNATIONAL PHYSICS OLYMPIAD
2023 TOKYO JAPAN

Excursion -Kamakura-

Australia: CHAN Kelvin

Kamakura was really nice. First I visited a temple, which was really relaxing. The architecture was really beautiful as well. Then we went to eat Japanese traditional food, soba, and so on. All of them are really nice and delicious. I think I learned about Japanese culture and I really enjoy this experience.

Iran: FAYZ Shayan



It was a good day. We had a lot of choices in Kamakura. We went to a temple and took a lot of pictures. I think temples and shrines show Japan's cultures really well and it was a nice experience to learn about them. We ate sea food, like sashimi and fried fish. Fried fish was really nice.

Turkey: UNVER Arda

In Kamakura, I found it really interesting to see Japanese culture, which is so diverse and beautiful. Temples and shrines beautifully get along with nature and scenery. Visiting Kamakura was a wonderful experience for me. If I had a chance, I would like to come again.

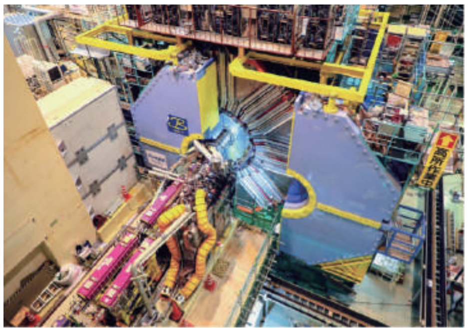
Excursion -Tsukuba-

Oly team of Individuals
ERSHOV Aleksandr

I really enjoyed the tour of KEK. At first, the staff just showed us some strange instruments with big mass. I thought it will be soon over so they showed them to us.

I was amazed to find out the largeness of KEK with its magnificent infrastructure. The memory of this visit will last forever.

KEK はカッコいいです！



Iceland
GUNNARSDOTTIR Ashali Asrun

At KEK it was totally cool listening and seeing how everything works. Especially, the particle accelerator was really amazing. I like it because it looks very cool.

Malaysia
MOHAMMAD Syakir FahmieE

Tsukuba City was very beautiful and reminded me of my hometown because both are full of greenery. That's why I was excited to see the green city environment.

Excursion -Nikko-

Pakistan: KHAN Aalia

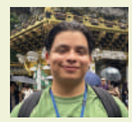
NIKKO IS BEAUTIFUL! It is a very beautiful place. I love the greenery here because the greenery and freshness are like coolness to my eyes. I′ m very happy that we actually came to Nikko. Nikko Toshogu, a Shinto shrine with historical architecture, was beautiful. I like this architecture very much. In Pakistan, we don′ t have many buildings like this, and I have never been to something like this. We saw the sculpture of a sleeping cat. All these things make us realize how versatile the cultures in the world are. This versatility amazed me the most during this IPhO competition.

Netherlands: WASSENAAR Steven

Nikko Toshogu was very interesting. It shows the culture of Japan very well, i.e., very old culture. I don't know how old it is, but it is still very beautiful. Old buildings here inspired us.

El Salvador: DORADEA MELÉNDEZ Miguel Isaias

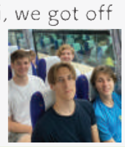
Nikko Toshogu was really nice. I liked the weather, even though it was raining then. Amazingly, this historical architectural building was old but preserved very well so I like that. I took several photos of the sculptures of the three wise monkeys indicating "see no evil, hear no evil, and speak no evil." They are really cool.



- Hakone-

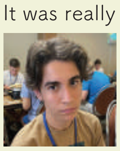
Lithuania: RAZBADAUSKAS Tomas, KALINAUSKAS Paulius, VIRSILAS Jokubas & BABELIS Tomas

This excursion to Hakone was lovely. We traveled four hours to Hakone but unfortunately, we couldn't see Mt. Fuji clearly. We hope to climb Mt. Fuji someday. But the food we ate was really cool, memorable, and unique. It was definitely real Japanese food and better than what we eat at the cafeteria "Fuji". In particular, we loved the dessert. At Owakudani, we got off the bus to walk. The wind tried to blow off our flag for a second, but we retrieved it. It was so much fun.



Montenegro: CUROVIC Vuk

We had pretty nice views of the Japanese countryside. It was certainly a scenic trip to Hakone. Unfortunately, it was kind of disappointing because of the fog; we could not ride the boat or the ropeway. But I'm just trying to see the positive side of everything. Probably it could have been a nice trip if it were not for this weather. Also, we saw Mt. Fuji from the bus while we were under the road edge. It was really big and monumental. You really kept seeing it and understanding the size of it.



Luxembourg: FOYSTER Barnaby Sharp

The trip to Hakone was really good. It was too bad that a part of the trip was canceled due to bad weather. The meal was really good and great. It definitely had lots of stuff that I recognized from my experience at other places in Japan. Fortunately, I was able to see Mt. Fuji from the bus window and I took its pictures. It looked really impressive and beautiful. It is definitely one of the largest mountains I have ever seen. This whole area was really beautiful and I like it very much.

Scenes in Japan

Cherry Blossom Viewing

Every spring, cherry blossom viewing is held throughout Japan. When the cherry blossoms are in full bloom, people gather with friends and family for a picnic in a park or along a riverside to view the beautiful blossoms.

Summer Festivals

In summer, festivals are held in many places. Festivals include processions of floats and portable shrines, many stalls with food stands, and fireworks displays at night. Bon dances are also held in a lot of places and people dance around a high wooden stage, as most of contestants may have experienced on the evening of July 12th.

Autumn Leaf Viewing

Autumn leaf viewing is held throughout Japan in the fall. This is called "Momijigari" , which means to enjoy strolling through the beautiful scenery of autumn leaves.

New Year's Day

New Year's Day is one of the most important events in Japan. Family members get together and eat traditional foods such as "osechi ryori" and "ozoni" , and go on "hatsumode" (New Year's visit to shrines).

High School Baseball Tournament at Koshien (甲子園)

Baseball is a popular sport in Japan. In spring and summer, the National High School Baseball Championship games are held at Koshien Stadium in Nishinomiya City, Hyogo Prefecture. The representative teams that have won the qualifying games in each region of the country participate in the tournament. "Koshien" (甲子園) means the pinnacle of high school baseball in Japan and attracts nationwide attention. Just like the International Physics Olympics, the games at Koshien are a once-in-a-lifetime experience for the players and generate a lot of emotion and drama.

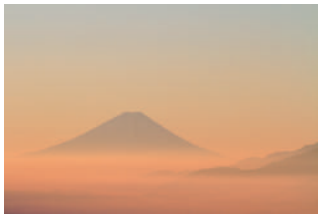
The invention of the sintered permanent magnet Nd-Fe-B

Have you ever held a neodymium magnet in your hand? A neodymium magnet is a permanent magnet made of Nd-Fe-B and is one of the magnetic materials indispensable to modern industry. Although such a neodymium magnet is one of the most important magnetic materials, it is not well known that a Japanese scientist and inventor, Masato Sagawa, is actually the developer of this magnet (note that John J. Croat was an independent developer at the same time). In this article, we trace the history of Sagawa's development of neodymium magnets.

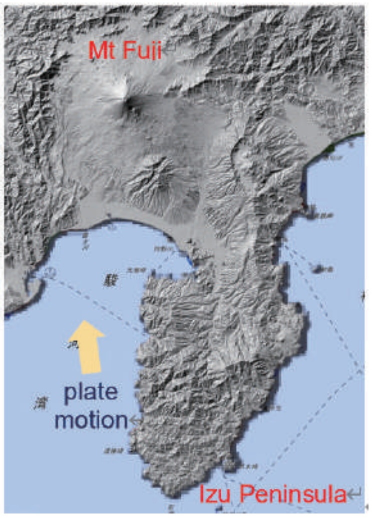
Sagawa had done basic research on the structure of solid surfaces before he joined Fujitsu Laboratories. However, when he joined the company, he was given a research project by his supervisor to improve the mechanical strength of Sm-Co magnets, which were the strongest permanent magnets at that time. In the course of his self-taught research on the Sm_2Co_{17} magnet, Sagawa began to wonder what caused the difference in magnetism between Fe and Co. Then, in a presentation by Masaaki Hamano from Institute for Materials Research, Tohoku University on January 31, 1978, he heard a report that the small Fe-Fe interatomic distance in R_2Fe_{17} (R: rare earth) crystals destabilizes the ferromagnetic state of the crystal. Sagawa then thought that he could expand the Fe-Fe interatomic distance by alloying carbon and boron, and he took up the challenge of searching for magnet materials based on R-Fe-X (X=C, B) compounds, an unknown and clear research subject. In 1981, Sagawa resigned from Fujitsu and joined Sumitomo Special Metals to devote himself to the development of magnets. Within several months after joining Sumitomo Special Metals in 1982, he developed the strongest sintered Nd-Fe-B magnet that could withstand practical use.

In both Kotaro Honda, who developed the KS magnet (see page 6 of ISSUE 4), and Masato Sagawa, who developed the neodymium magnet, we can see a spirit of persistence based on thorough experimentalism and the practice of Deeptech, which links the academic and industrial worlds.

Making of Mount Fuji



Mount Fuji
・Hight: 3776 m
・Location: on the border of Shizuoka and Yamanashi Prefectures
・Active volcano, last eruption in 1707
・World Heritage Site



You probably heard about how the Himalayas, the highest mountainous terrain on earth, were formed through geological forces. About 300 million years ago, landmass on the Earth formed a single supercontinent called Pangea. The piece which later became the Indian subcontinent was located in the southern hemisphere next to the African piece.

About 200 million years ago, the Pangea began to break apart. The Indian subcontinent drifted northward heading to the Eurasian continent. The Indian Plate submerged underneath the Eurasian Plate. This caused a gigantic lift of the landmass, resulting in the formation of the Himalayan range and the Tibetan plateau.

A similar geological event, albeit smaller in scale, was responsible for the formation of the landscape around Mt. Fuji. The landmass now constituting the Izu Peninsula used to be an island located far south in the Pacific Ocean. It was driven northward by the tectonic motion of the Philippine Sea Plate, and crashed onto mainland Japan, causing an uplift of the area creating an intriguing geological structure.

Along the direction of this plate motion, a train of volcanos called the Izu-Fuji Volcanic Zone is formed. The most recent large-scale eruption of Mt. Fuji (the Hoei eruption) occurred in 1707, which resulted in massive ash falls all over the Kanto Plain causing disastrous crop failure and subsequent tragic famine. Mt. Fuji has been dormant for the last 300 years, but may well become active again any time in the future.

Mount Fuji, offering us beautiful scenery (and disaster risk), is an artwork of subtle tectonic and volcanic action of the Earth.

SCHEDULE

TODAY
Sunday, July 16th

27℃ 36℃

Students

7:15-8:00	Breakfast	NYC
8:00-19:00	Full-day Kanto Excursion	

Leaders & Observers

7:00-8:00	Breakfast	NSH
9:00-12:15	Moderation	NSH
12:15-13:30	Lunch	NSH
13:30-16:45	Moderation	NSH
18:00-19:30	Dinner	NSH
20:00-23:00	Final Board Meeting	NSH

TOMORROW
Monday, July 17th

27℃ 37℃

Students

7:15-8:00	Breakfast	NYC
9:30-12:00	Closing Ceremony	NYC
12:20-13:30	Farewell Lunch	NYC
	Departures	

Leaders & Observers

7:00-8:00	Breakfast	NSH
9:30-12:00	Closing Ceremony	NYC
12:20-13:30	Farewell Lunch	NYC
	Departures	

NYC: National Olympics Memorial Youth Center
NSH: Nippon Seinenkan Hotel

The Physical Society of Japan
Japan Society of Applied Physics
The Physics Education Society of Japan
The Biophysical Society of Japan
Japan Science and Technology Agency (JST)
National Institution for Youth Education (NIYE)
National Museum of Nature and Science
Japan Arts Council
Tokyo National Museum
The University of Tokyo
Tokyo University of Science
Tokyo City University
Tokyo University of Foreign Studies
International Christian University
Sophia University
IPhO 2023 TOKYO JAPAN

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"物理 BUTSURI" daily magazine
Editorial Committee Member:

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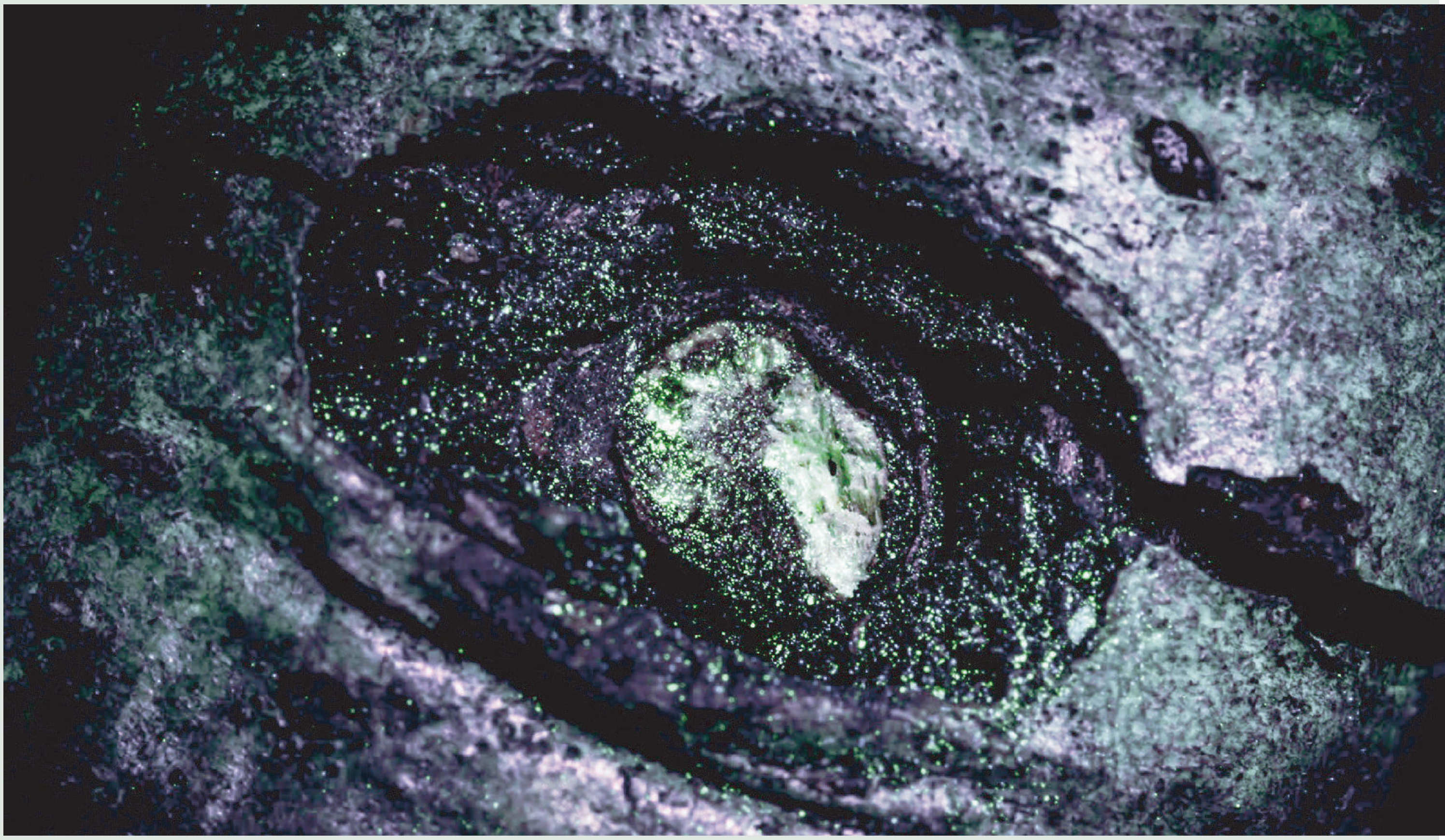
Monday, July 17th

ISSUE 9



物理

BUTSURI

CONTENTS

IPhO INTERNATIONAL PHYSICS OLYMPIAD 2023 TOKYO JAPAN

Nikko





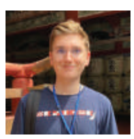







▶ Romania: MIRICA Ioan-Alexandru

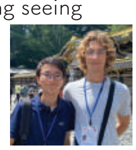
I liked here, Nikko. The bus ride to come here was pretty long, but everything was beautiful. In particular, the Toshogu Shrine was incredible. It was much better than what we saw in the photos. Luckily, I got the best luck of Omikuji here. In Asakusa I got the worst luck, but now I had the best luck, so I hope I'll get good results in the Olympiad competition.



▶ Switzerland: SERRANO CAPATINA Adrian & TSUTSUI Kodai

The bus ride was a bit long because of the heavy traffic, but Nikko was extremely beautiful, especially this stone torii gate. I also liked hearing the stories of carvings of the three wise monkeys which tells us how to live the perfect life. They were quite interesting.

I really liked the detailed decorations of the torii gate with the never-seen-before precision. It was really mind blowing seeing this level of precision remained for a long time, say a couple hundred years at least. It's quite a good experience for me.



▶ Bulgaria: DIMITROV Rumen Lyubomirov

The visit to Nikko was really great. I was looking forward to this excursion so that I could also see the Edo culture. My team members had the same idea. As I expected, this tour was really interesting and I saw what I wanted to see. In particular, the sculptures of the three wise monkeys of "see no evil, hear no evil, and speak no evil" were great. We took photos of the sculpture with our members doing the same poses as these monkeys. We really enjoyed them. The lunch was nice, though it was different from our country's food. The difference is always good and it was nice.

Excursion

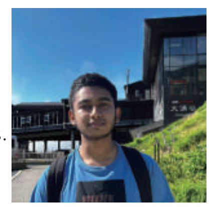
Hakone

Bosnia and Herzegovina: NUMANOVIC Muhamed

Hakone is a little bit away from Tokyo, but we enjoyed the ride to the destination. The feeling I had in Hakone was quite amazing. The most fascinating thing was the smell of the south pacific. Lunch was also good. I hope we would have a good view from the ropeway.

Bangladesh: ABRAR MD FAHIM

Today's excursion was great. First, we ate lunch at a famous restaurant, where the presentation on the Japanese dishes was really amazing. And then we went to Ohwakudani, where there are a lot of onsens. After this, we got on the ropeway. The environment was awesome and I loved it.



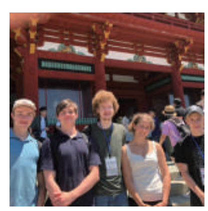
Kamakura

Netherlands: HANEMAAIJER Jesse

We first decided to go to the aquarium in Enoshima. There were some interesting fish, and some were very intriguing. Then we moved over to some shrines, using quite busy trains. At some point most of us were very hot, yet the shrines were very beautiful and comforting.

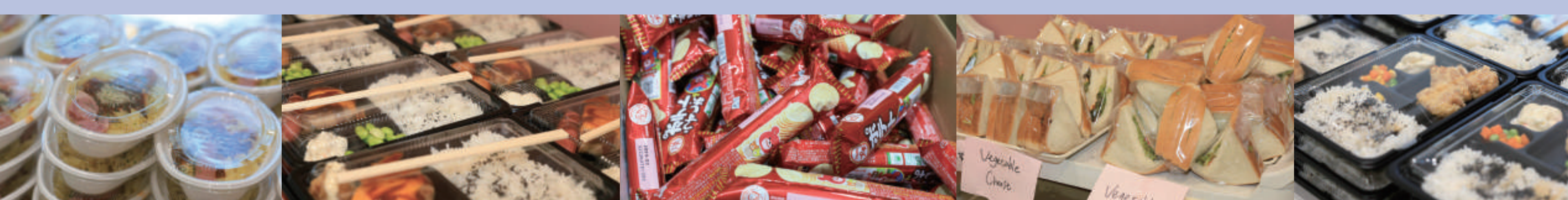
Estonia team

This shrine (Tsurugaoka Hachimangu) is really really big and the prettiest that I have ever seen. This shrine is very busy, but an actual traditional style is well in, which is nice. It was the first shrine I saw that had a SHIMENAWA. Its gradation is also very nice.



eating

Memories in IPhO2023



Cultural Experience

Memories in IPhO2023

Excursion

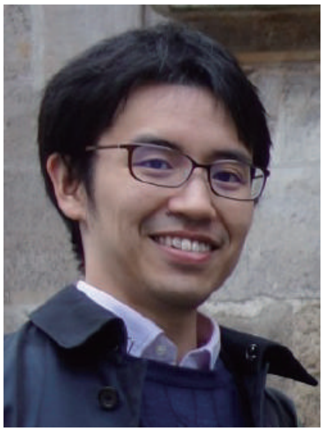
Daikagura

Traditional Japanese Performing Art

"Kyokugei"

Today's closing ceremony will feature a performance of Daikagura, a traditional Japanese performing art. Daikagura was originally a Shinto ritual art of the Edo period (1603-1867), in which Shinto priests of the Ise and Atsuta shrines in the central part of Japan performed lion dances and other performances as they traveled from place to place. Toward the end of the Edo period, Daikagura, which had previously been performed on the main street, began to be performed at vaudeville theaters called Yose. Today, it has become an indispensable entertainment at Yose.

Daikagura is composed of four arts: "Mai", "Kyokugei", "Wagei", and "Narimono":
"Mai" is a type of dancing and includes lion dances to drive away demons.
"Kyokugei" is acrobatics and includes throwing plectrums, balls, knives, and other objects, holding Japanese umbrellas on foreheads or chins, and spinning a gold ring or a square wooden box on top of the opened Japanese umbrella.
In "Wagei" meaning storytelling, performers parody Kabuki plays by exchanging comedic banter.
In "Narimono", musical instruments are played, such as flutes, drums, gongs, and others.



The Fun of Physics I Found from Outside Physics

Shuhei Yoshida
Participant of IPhO2008 in Vietnam
Born in Fukuyama City, Hiroshima
Graduated from Hiroshima University High School, Fukuyama in 2009
Graduated from the Department of Physics, Graduate School of Science, The University of Tokyo in 2018
Current: Researcher, NEC Visual Intelligence Research Labs

As far back as I can remember, I have always liked science. In my childhood, books on popular science were my favorite choice for my free time, and science museums in nearby cities were my favorite destination for weekend trips. I had a vague feeling of respect for "scientists" in the books who accomplished some cool stuff, just as many other children admired TV stars. After entering junior high school, my interest centered on mathematics and computer programming, which eventually led me to the final of the Japanese Olympiad in Informatics in my first year of senior high school. Unfortunately, I was not selected for the national team in the International Olympiad in Informatics. Still, around that time, I thought information science would be my future.

The Physics Challenge (the Japanese contest in physics) and IPhO totally changed the courses of my career. Many of the problems in the competitions involve subjects beyond the boundaries of physics taught in Japanese high schools. They presented how textbook knowledge and logic could help us understand physical phenomena that, for me, had only existed in books and science museum exhibits. That was a fascinating experience that ignited my enthusiasm for physics, which drove me over the next ten years until I eventually earned a Ph.D. in physics.

Now, my enthusiasm is pointing in another direction: machine learning and artificial intelligence. After obtaining the Ph.D., I joined a research group at NEC Corporation in Japan, where I have been studying machine learning and its application to image and video recognition. Researchers in this field try to develop new technologies that automatically understand complex data with computers. As I wrote above, I was into information science in high school. You might think I just have returned to what I used to like, but that is not the whole story. I am here because I studied physics. My experience in physics made me aware of some fascinating aspects of machine learning that I would not have found without my physics background. Conversely, there is also a fascination with physics that I noticed after I started machine learning.

In fact, there are many forms of connections between the two fields. For example, complex data may involve simple physical laws in its generation processes. If the laws behind them are uncovered, they can be incorporated into programs and significantly aid in understanding the data. In addition, various concepts from physics have been introduced into machine learning and used to understand existing algorithms and to develop new ones. Even after I left the field, I can see how powerful and universal the methods and concepts developed in physics are to model and understand complex systems. Behind this exchange of ideas is, of course, the exchange of people. Many researchers in machine learning have physics backgrounds; many colleagues in my current work have a physics degree. Occasionally, we communicate in the language of physics, which enables us to find new aspects of our machine-learning research.

Perhaps because machine learning is closely related to physics in the first place, I feel so familiar with physical ideas even after leaving physics. However, I believe that the style of physics itself, which is to scoop out meaningful information from complex situations and explore the principles behind it, is so powerful and universal that we can use it to solve problems in many other fields than just physics and machine learning. I hope that young people who were exposed to the fascination of physics through IPhO will use what they have gained from this experience and play an active role in their respective fields, whether it is physics, machine learning, or whatever.

SCHEDULE

TODAY
Monday, July 17th

27℃
37℃

Students

7:15-8:00	Breakfast	NYC
9:30-12:00	Closing Ceremony	NYC
12:20-13:30	Farewell Lunch	NYC
	Departures	

Leaders&Observers

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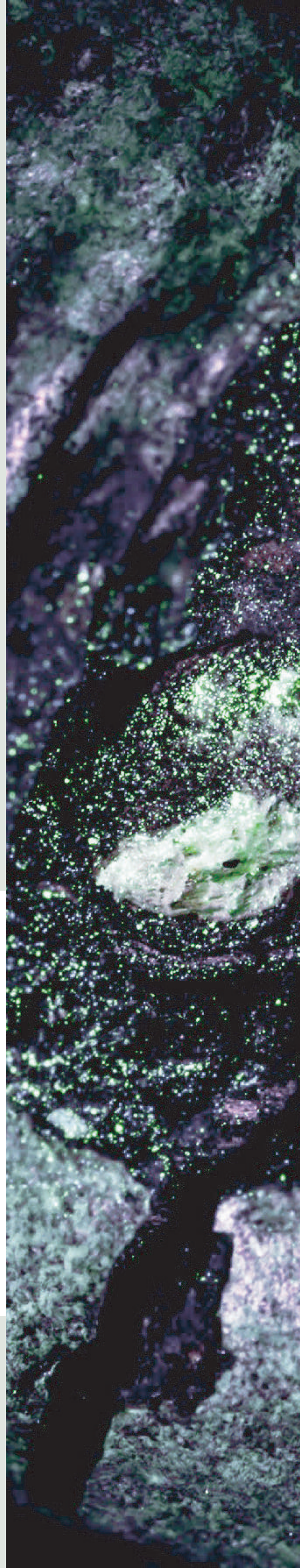
	Departures	

NYC: National Olympics Memorial Youth Center
NSH: Nippon Seinenkan Hotel

TOMORROW
Tuesday, July 18th

27℃
37℃

We wish you all
a safe return to your
countries!



The Physical Society of Japan
Japan Society of Applied Physics
The Physics Education Society of Japan
The Biophysical Society of Japan
Japan Science and Technology Agency (JST)
National Institution for Youth Education (NIYE)
National Museum of Nature and Science
Japan Arts Council
Tokyo National Museum
The University of Tokyo
Tokyo University of Science
Tokyo City University
Tokyo University of Foreign Studies
International Christian University
Sophia University

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OONO Aiko (photographer),
SHIMIZU Takeshi (photographer)

物理

-BUTSURI-

ISSUE 10

Tuesday, July 18th

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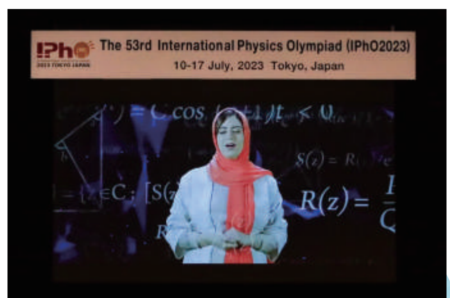
INTERNATIONAL PHYSICS OLYMPIAD
2023 TOKYO JAPAN

Closing Ceremony

The IPhO2023 came to a grand end with the awarding of glittering gold, silver, and bronze medals to many contestants. The closing ceremony was held with all the people concerned gathered in one place: contestants, leaders, observers, and IPhO2023 staff members. The ceremony opened up with the presentation showing a number of wonderful moments during the IPhO2023 through beautiful pictures.

The ceremony was followed by a speech by Prof. KOBAYASHI Makoto, Chair of the Organizing Committee, who emphasized the importance of the concept of physics. Then, Prof. HAYANO Ryugo, Chair of the Academic Committee, dressed in formal Japanese costumes, explained and showed scores of contestants, which exited the contestants. Next, the supporting staff leaders of the conference were introduced and received grand applause.

After the announcement of Commendation of Diversity, the award for promoting diversity, and the Honorable Mention winners, the Bronze Medal winners were announced. They went up to the stage to receive their medals. Then followed Silver and Gold Medal winners. All the winners stood under the spotlight on the stage decorated with glittering medals, each feeling a sense of honor. Finally, the best performance winners in the experimental exam and the theoretical exam, and the absolute winner were announced and awarded special trophies. (see page 2).



The ceremony was followed by a stylish presentation of the Invitation to IPhO2024 in Iran. Finally, Prof. RAWAT Rajdeep Singh, President of the IPhO Secretariat, gave the final remark. After the ceremony, Koto and Daikagura were performed as farewell events.

Congratulations to all participants of IPhO2023!

IPhO2023 Medal Winners

Special Prize

Commendation of Diversity

Gold Medals were awarded to 37 contestants, Silver Medals to 74 contestants, Bronze Medals to 103 contestants (names of winners up to here are listed on pages 5-6), and Honorable Mention to 54 contestants. Special prize for the absolute winner was awarded to **YU Bowen (China)**, Special prize for the best performance in the experimental exam was awarded to **FAN Collin (USA)**, and Special prize for the best performance in the theoretical exam was awarded to **YEVTUSHENKO Feodor (USA)** and **ZHAO Hanhong (China)**. Commendation of Diversity, an award for promoting diversity in the International Physics Olympiad, was awarded to four countries: **Cyprus**, **France**, **Iceland**, and **Ukraine**. Congratulations!

India: BORAD Mehul (Gold Medal)

I was kind of expecting that I was really close to a gold medal, so I was nervous. Now I am absolutely excited about actually receiving a gold medal. The experiment problems were really good and fun. About the excursion, especially the cruise ship and ropeway at Hakone, and the view from there were absolutely amazing. I love Japan!

Japan: TANAKA Yuki
and IMAMURA Kotaro (Gold Medal)

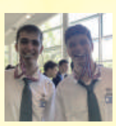
I'm very glad to receive a gold medal. It's like a dream come true. When I started studying physics, I didn't dream of coming this far, but frankly, I am really happy now. Experiment problems were very complicated, but theory problems were mostly straightforward dealing with mechanics. In the future, I would like to pursue physics by collaborating with friends, just as we did during this competition. In doing so, I want to clarify what I really want to do.

China: YU Bowen (Absolute Winner)

I was totally stunned when I heard my name mentioned as the absolute winner. This achievement is beyond my wildest imagination! I was so shocked that I nearly forgot to open my national flag when I walked onto the stage. It was such an impressive experience to shake hands and receive the trophy from the famous Nobel laureate in Physics, Prof. KOBAYASHI Makoto. Wonderful time in Japan these days will undoubtedly be a blooming flower flowing in the river of my memory.
Thank you, IPhO2023!

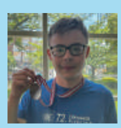
Israel: WALACH Doron
and NITZAN Omri (Silver Medal)

We were very excited! It was so fun. We were happy to receive the silver medals and to go up to the sage together. All our team members were also happy. It was a very nice and beautiful moment. We worked for this competition very hard and our endeaver paid off.



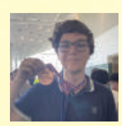
Poland: MARON Andrzej Franciszek (Silver Medal)

I feel really great. I thought that my best record was bronze, so getting a silver medal was very good for me. I have another year to study aiming for a gold medal at the next IPhO in Iran. I hope I will do well there.



Slovenia: BRVAR Miha (Bronze Medal)

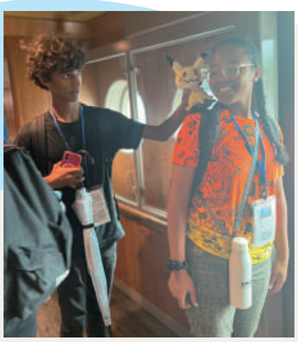
I'm very much satisfied with getting a bronze medal. I think I was pretty close to the silver but that's ok. I really liked our stay in Tokyo. I found all the excursions really exciting and fun. I saw a lot of new things and met new people. I am satisfied with everything and I think I can sleep well on the plane.



Memories in IPhO2023

- Farewell Lunch Photos -

- Excursion Photos -



Messages from Supporting Staff Members

ASAKA Momo (Greece)

I was assigned to Greece, a country I did not know much about. It was new and interesting for me to talk about Greece and Japan. Whenever I hear about Greece or see Greek yogurt somewhere in the future, I will remember their stories and it will warm my heart. It was a valuable experience that expanded my perspective.

KIMURA Rina (Suriname)

We had a lot of interaction during the excursions and the daily activities, which were a valuable cultural exchange experience. At first, it was hard to communicate fully due to cultural differences, but eventually we managed to spend meaningful time with each other with the help of verbal and body languages. I hope everyone enjoyed Tokyo.

ARIMOTO Hidemi (Austria)

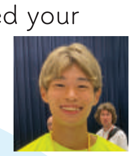
As a student supporter, the most crucial assignment for me was to make all participants feel welcomed and, if possible, at home. I truly feel that Team Austria was able to bond, and hope the friendship they established here with their peer participants from all over the world will continue to develop further.

YANO Ayaka (Italy)

As I spent a week with the Italian students, I've come to think they are very cheerful. It's a pity that we don't have enough time to see many places, but I'll do my best to support them during the rest of their stay so that they can bring back as many good memories as possible.

MURAYAMA Io (Latvia)

As a student supporter and a past IPhO participant, it was my pleasure welcoming you and having face-to-face interaction with you in Japan, my home country. I truly realized that IPhO is not only for competition but also for connection beyond boundaries. I hope you have enjoyed your stay in Tokyo.



KUSUMOTO Koki (China)

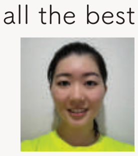
I'm very happy to participate as a student supporter in the IPhO2023. Having seen Japan from a different perspective, I deepened my understanding of my own country. Compared to the former online IPhO, which I participated in as a contestant two years ago, I realized how good it is to communicate with participants face-to-face. It was a valuable experience to get acquainted with those who love physics from all over the world.

AWANO Ryoya (Australia)

I participated in IPhO2021 and this time I was involved in IPhO2023 as a student supporter for Australia. While IPhO2021 was held online, IPhO2023 was held in face-to-face format. So I envied this year's participants, who enjoyed events and excursions, and had close interactions among them! I enjoyed the interaction with the Australian students, especially we enjoyed teaching each other about the cultures.

EGUCHI Saho (Turkey)

It was a pleasure to be a part of IPhO2023. I had a good time in an international yet very harmonious atmosphere with participants from all over the world. Also, their interests and curiosities gave me a new perspective on understanding Japan. I would like to express my gratitude to those who worked hard to make this competition a reality and wish the contestants all the best in their future studies.



List of IPhO2023 Medal Winners

Gold Medal

ADITYA (India)
AKDAĞ Emir (Turkey)
ANDOLŠEK Peter (Slovenia)
BACIAK Filip (Poland)
BOBKOV Viacheslav (Oly team)
BORAD Mehul (India)
BURTSEV Roman (Oly team)
CHANG Cheng-Kuang (Taiwan)
CHANG Ya-Cheng (Taiwan)
DING Zhuoli (China)
DOLIA Vsevolod (Oly team)
DRAGOMIR Andrei-Darius (Romania)
ERSHOV Aleksandr (Oly team)
FAN Collin (United States)
HAN Jongyoon (Korea)
IMAMURA Kotaro (Japan)
JIANG Daibing (China)
KIM Evan (United States)
LAM Chung Wang (Hong Kong)
LEE Hyunchae (Korea)
LEE Junsuh (Korea)
MOMOIU Alexandru (Romania)
NGUYEN Tuan Phong (Vietnam)
NOH Ian (Korea)
OROS Vlad-Stefan (Romania)
PHADETSUWANNUKUN Nutdech (Thailand)
POTAPOV Egor (Oly team)
SHAH Dhruv (India)
SHI Zian (United States)
SUH Kyumin (Korea)
TANAKA Yuki (Japan)
TIAN Xiangchen (China)
VO Hoang Hai (Vietnam)
WANG Zhao-Guo (Taiwan)
YEVTUSHENKO Feodor (United States)
YU Bowen (China)
ZHAO Hanhong (China)

Silver Medal

ARÉVALO AGUIRRE Sebastián Andrés (El Salvador)
BABELIS Tomas (Lithuania)
BISSIMBI Doszhan (Kazakhstan)
CHANDRA Savero Lukianto (Indonesia)
CHANKASAMSAT Thanassorn (Thailand)
CHAN Kelvin (Australia)
CHEN Peng-Wei (Taiwan)
CHEN Shuoyan (United States)
DE ANDRADE PORFÍRIO Murilo (Brazil)
DERE Kaan (Turkey)
DI GRAZIA Guglielmo (Italy)
DOS SANTOS SILVA Paulo Henrique (Brazil)
DŽAVORONOK Adam (Slovakia)
FATHI Sina (Iran)
FAUCHEU Hannah (France)
FUNATA Fansen Candra (Indonesia)
GAYDUKOV Alexander (Slovenia)
GHANBARI Ali (Iran)
GONZALEZ FILIPOV Daniel (Switzerland)
GOYAL Raghav (India)
GULATI Ojas (United Kingdom)
HE, Jingyang James (Singapore)
HIGASHIGAWA Leon (Japan)
HSU Zi-Siang (Taiwan)
HUI Pok Shing (Hong Kong)
İŞKESEN Mehmet Anıl (Turkey)
IWASHITA Koki (Japan)
JINDAL Shanay (Singapore)
JOSHI Douglas (Australia)
KAHU Kristjan-Eerik (Estonia)
KARAN Val (Croatia)
KARAPETYAN Hovsep (Armenia)
KARPIEJCZYK Stanisław Marcin (Poland)
KEDIA Rhythm (India)
KITA Shunsuke (Japan)
KWOK Ching Yeung (Hong Kong)
LBATH Mounir (France)
LE Viet Hoang Anh（Vietnam）
LI Yichen (Singapore)
LIPIEC Michał Piotr (Poland)
LIU Lincoln (Hong Kong)
MAROŃ Andrzej Franciszek (Poland)
MIRICA Ioan-Alexandru (Romania)
MOOSAVI Mohammad (Iran)
MYLET Alexander (United Kingdom)
NGUYEN Tuan Duong (Vietnam)
NITZAN Omri (Israel)
NURSAGATOV Margulan (Kazakhstan)
NÜSKE Anton (Germany)
ONG Zhi Zheng (Malaysia)
OTGOCHULUU Anirchuluu (Mongolia)
PATTARAPON Punlertrapee (Thailand)
PITEBAY Yersultan (Kazakhstan)
RAM Ido (Israel)
ROSIAR Samuel (Czech)
ROUAN Mathurin (France)
RYD Emil (Sweden)
SADIKHZADA Sadig (Azerbaijan)
SHIRINBAYAN Mahdi (Iran)
STORBACKA Melvin (Sweden)
SUN Yu Chieh (Singapore)
TAN Pin Che (Singapore)
TCHOTASHVILI Dachi (Georgia)
TRABZON Ahmet Bahadır (Turkey)
TUDOSE Rares Felix (Romania)
UGULAVA Irakli (Georgia)
UN Chong Un (Macao)
VORONA Victor (Moldova)
WALACH Doron (Israel)
WALD Inbar (Israel)
WEINMAN Matan (Israel)
YERKEBAYEV Alisher (Kazakhstan)
ZAZUBYK Diana (Ukraine)
ZHU Coy (United Kingdom)

Bronze Medal

ABBASOV Nijat (Azerbaijan)
ABDELRAHIM Youssof (Qatar)
ABDULKARIM Murad (Azerbaijan)
ABRAR M D Fahim (Bangladesh)
AGHAYAN Arsen (Armenia)
ALSHAKHS Mazen Zaid A (Saudi Arabia)
AMBROŽIČ Žan (Slovenia)
ARAKELYAN Maria (Armenia)
ARCHABOONYASEK Thongchai (Thailand)
ARMESTO MÉNDEZ Irene (Spain)
AUGUSTO DE PAULA Jônatas (Brazil)
AZIM Ughur (Azerbaijan)
BÁLEK David (Czech)
BARSEGHYAN Areg (Armenia)
BENCZ Benedek (Hungary)
BOHDAN Maryna (Ukraine)
BRVAR Miha (Slovenia)
BUDAI Csanád Gyula (Hungary)
CARPENTER Ruben Mason (Spain)
CHANG Kia Yau (Malaysia)
CHEN Liam (Australia)
CHU Wai In (Macao)
CHUA Harold Scott (Philippines)
COSENTINO Giulio (Italy)
DIMITROV Rumen Lyubomirov (Bulgaria)
DUBROVSKIS Stanislavs (Latvia)
ECKSTÄDT Oliver (Germany)
FARES MENHEM Hugo (Brazil)
FEY Dávid (Hungary)
FEYZ Shayan (Iran)
FRÉCHETTE Louis (France)
GANBOLD Azjargal (Mongolia)
GECHEV Bayan (Bulgaria)
GEORGIEVSKI Majkl (Macedonia)
GIURI Andrea (Italy)
GURBAZAR Batbayar (Mongolia)
HEGEDIĆ Ivan (Croatia)
HIP Vuk (Serbia)
IONAȘ Vadim (Moldova)
ISHTIAK Golam (Bangladesh)
ISMAIL Muhammad Arif Khalfani (Indonesia)
ISMOLDAYEV Margulan (Bulgaria)
JAVORA Lukáš (Czech)
JELESIJEVIĆ Tadija (Serbia)
JEMELJANOV Aleksei (Estonia)
JONGMAN-RIOS Mali (United Kingdom)
KALINAUSKAS Paulius (Lithuania)
KAMIŃSKI Mateusz (Poland)
KELLIJS Lukass (Latvia)
KÖHLER Luise (Germany)
KONDRACHUK Yaroslav (Ukraine)
KOTZAMPASIS Odysseas (Greece)
KREJAN Samo (Slovenia)
KWOK Tsz Yin (Hong Kong)
LECLERC Adeline (France)
LEINONEN Eppu (Finland)
LI Zander (Canada)
LUKIANIKHIN Viktor (Ukraine)
MANJAVIDZE Andria (Georgia)
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MIDŽIĆ Dženan (Bosnia and Herzegovina)
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PAROJČIĆ Đorđe (Serbia)
PERKOVIĆ Borna (Croatia)
PETROSYAN Vyacheslav (Armenia)
PHAN The Manh (Vietnam)
PÕLDMAA Saskia (Estonia)
POSPIECH Luke (Germany)
QADAH Hussain Jamal H (Saudi Arabia)
RAZBADAUSKAS Tomas (Lithuania)
REUTIN Ilya (Latvia)
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VOGEL Christian (Germany)
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WONG Connor Tianzheng (Canada)
WONG Jian Bin (Malaysia)
WONG Ka Wa (Macao)
YOVCHEV Yovo (Bulgaria)
ZHANG Wenhe (Canada)

Farewell Messages from Interviewers of IPhO2023 Newsletter Team

As a Newsletter Team, we interviewed many contestants from all over the world. We enjoyed talking with you and we were really impressed by your positive power. All the talks were very interesting; however, we could not include all of you in the newsletters due to space limitations.

The Physical Society of Japan
Japan Society of Applied Physics
The Physics Education Society of Japan
The Biophysical Society of Japan
Japan Science and Technology Agency (JST)
National Institution for Youth Education (NIYE)
National Museum of Nature and Science
Japan Arts Council
Tokyo National Museum
The University of Tokyo
Tokyo University of Science
Tokyo City University
Tokyo University of Foreign Studies
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