

**February 16, 2024**  
**PVA EXPO PRAGUE**

# Guidebook



**Fyziklani2024**

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# Dear participants of Fyziklani 2024!

It is my pleasant duty to welcome you to the 18th edition of Fyziklani, which is hereby celebrating its symbolic adulthood. Just like last year, I am very delighted to see how much interest the competition is receiving – even the PVA EXPO PRAGUE premises are starting to become small for us ☺

Much like last year, I'd like to welcome hundreds of teams from dozens of countries around the world, which Fyziklani brought together to Prague. In addition to the heart of the event – the competition, we've prepared a rich week-long accompanying program for you, including lectures or a panel discussion with scientists who are among the top in their fields – but not only that. You can enjoy events like the Nations' Evening or excursions, which are not just about physics, and, for instance, a Party or a Buffet so we can all have a bit of fun.

During its adolescence, the competition has significantly outgrown its humble beginnings at CUNI MFF, but I dare say that the main essence remains the same – year after year, high school students (you!) gather to celebrate the beauty of physics, test their knowledge, but most importantly, enjoy an extraordinary experience that we are preparing for you throughout the entire year.

Therefore, a big thank you goes to all the organizers who have devoted countless hours of their time to the preparations and whose enthusiasm Fyziklani could not take place without. I also thank the partners, namely the CEZ Group, which, with its significant support, has become the general partner of the event. I also gladly mention the non-profit organization FABRIC, whose support, among other things, made possible the second year of the Fyziklani Scholarship program, enabling 15 teams from India, Brazil, Moldova, and many other countries to join us. Last but not least, I thank everyone else who supports Fyziklani directly or indirectly and, with small acts of kindness, helps its cause.

And finally, I thank you, the participants, for coming and helping to create the atmosphere of Fyziklani. I wish you a lot of fun and good luck at the competition, and hope that we will again enjoy the whole Fyziklani together!



A handwritten signature in black ink, appearing to read "David".

Vojtěch David  
Head organizer of Fyziklani

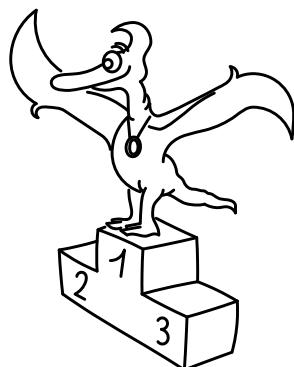
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# Game Schedule

<b>08:45 – 09:45</b>	<b>Team Arrival at PVA EXPO</b>
	Presence of Teams before the competition. Please arrive on time to speed up the process.
<b>10:00 – 10:25</b>	<b>Opening Ceremony</b>
	Explanation of the rules and course of competition. Initiation.
<b>10:30 – 13:30</b>	<b>Competition</b>
	Participants compete for 3 hours. During the competition, a program is prepared for the accompaniment.
<b>13:45 – 14:00</b>	<b>Presentation About FYKOS</b>
	Presentation about FYKOS during the break before announce- ment of results.
<b>14:00 – 14:45</b>	<b>Announcement of Results</b>
	Presentation of valuable prizes for the winning teams and awarding diplomas. The end of the contest.
<b>14:45 – 14:50</b>	<b>Joint Photo Shoot of the Winners</b>
	Ceremonial immortalization of the competition winners.

There will also be a lecture for teachers during the competition. More information can be found in the accompanying program section.



## Useful Contacts

Name	Role	Phone number
David Škrob	Communication With Teams on the Day of the Competition	+420 775 504 193
Veronika Hendrychová	Head of the Competition Registration	+420 732 383 025
Petr Kahan	Accompanying Program	+420 720 260 115
Denisa Zdvořilá	Accommodation	+420 722 018 074
Viačeslavas Šinkonis	Scholarship and Accommodation	+420 608 193 185
Vojtěch David	Head Organizer of Fyziklání	+420 730 973 923

For problems concerning arrival to the accommodation contact Denisa Zdvořilá, in case of delays or problems with travel on the day of the contest, contact David Škrob. In case of complications during the accompanying program, please contact Petr Kahan. Only call Vojtěch David in case of emergency.

You can also contact us by email at [fyziklani@fykos.org](mailto:fyziklani@fykos.org).

## Accommodation – Hotel Duo

Hotel Duo is a four star hotel. It is located near the metro station Střížkov. Besides 654 rooms, Hotel Duo also offers many high-quality services for leisure time and business affairs. The hotel address is **Teplická 492, 190 00, Prague, Czech Republic.**

## Check-In, Check-Out

You can **check-in from 15:00**. On the departure day, please leave your room, take all your belongings, and **check-out before 10:00**.

## Fees and Deposits

Please note that the participants of age 18 years or older will need to pay the city tax of approx. €2 (50 CZK) per night at the arrival to the hotel. All participants under the age of 18 will pay a refundable deposit of approx. €30 (750 CZK) on check-in.

## Venues and Maps

### PVA EXPO PRAGUE

Competition takes place at PVA EXPO PRAGUE at **Beranových 667, 199 00 Praha 9, Czech Republic**. The competition takes place in the Hall 1 and to enter, the (rear/side) Entrance Hall I must be used.

### Other Venues

The accompanying program of the competition will take place mainly at the following locations.

#### Campus Troja

V Holešovičkách 2/747, 180 00 Praha 8

The campus of CUNI MFF, which mostly houses the departments of the physics section. The program will take place in the modern IMPAKT Pavilion (lecture hall **N1**), located on a hill next to the road, and in the T Lecture Rooms (lecture halls **T1** and **T2**), located immediately next to the highest building in the area.

#### Campus Karlov

Ke Karlovu 2027, 121 16 Praha 2

The campus of CUNI MFF, which houses the Institute of Physics of CUNI and the Dean's Office. The program will take place in the "M" building (Ke Karlovu 2027/3, lecture halls **M1** and **M3**) and in the building of the Institute of Physics (Ke Karlovu 2027/5, lecture halls **F1** and **F2**).

#### Futurum Music Bar

Zborovská 7, 150 00 Praha 5

The venue of the Party after Fyziklani.

## Transportation

To get to the **competition venue**, take metro line C (red, goes from the Main Railway Station or the Florenc Bus Station in the Letňany direction) – get off at the **Letňany** (terminus). Then walk for about 5 minutes to get to **PVA EXPO building**. **To enter the hall you must approach from the side, see the map.**

From Hotel Duo, you can reach metro station Střížkov within a 5-minute walk. Then, metro line C (red) will get you both to Letňany, and to **Nádraží Holešovice**, from where you can get to **Campus Troja** (V Holešovičkách 2) within a 10-minute walk. Alternatively, you can take the bus 201 from stop Střížkov or Nádraží Holešovice to the stop Kuchyňka.

The best way to access **Campus Karlov** is by walk from metro station **I. P. Pavlova** (line C), or Karlovo náměstí (line B). The map shows recommended route from metro station I. P. Pavlova.

For transport to the Party from the Problem Analysis, you can take tram number 7 from the stop Albertov to the stop Zborovská.

## Recommended Apps

For easy orientation during Fyziklani, you can use Mapy.cz app, which enables users to download map of Prague that works even in offline mode.

Prague has a well-developed public transportation. To search connections, or to buy tickets with card, we recommend to use the official app PID Lítáčka.

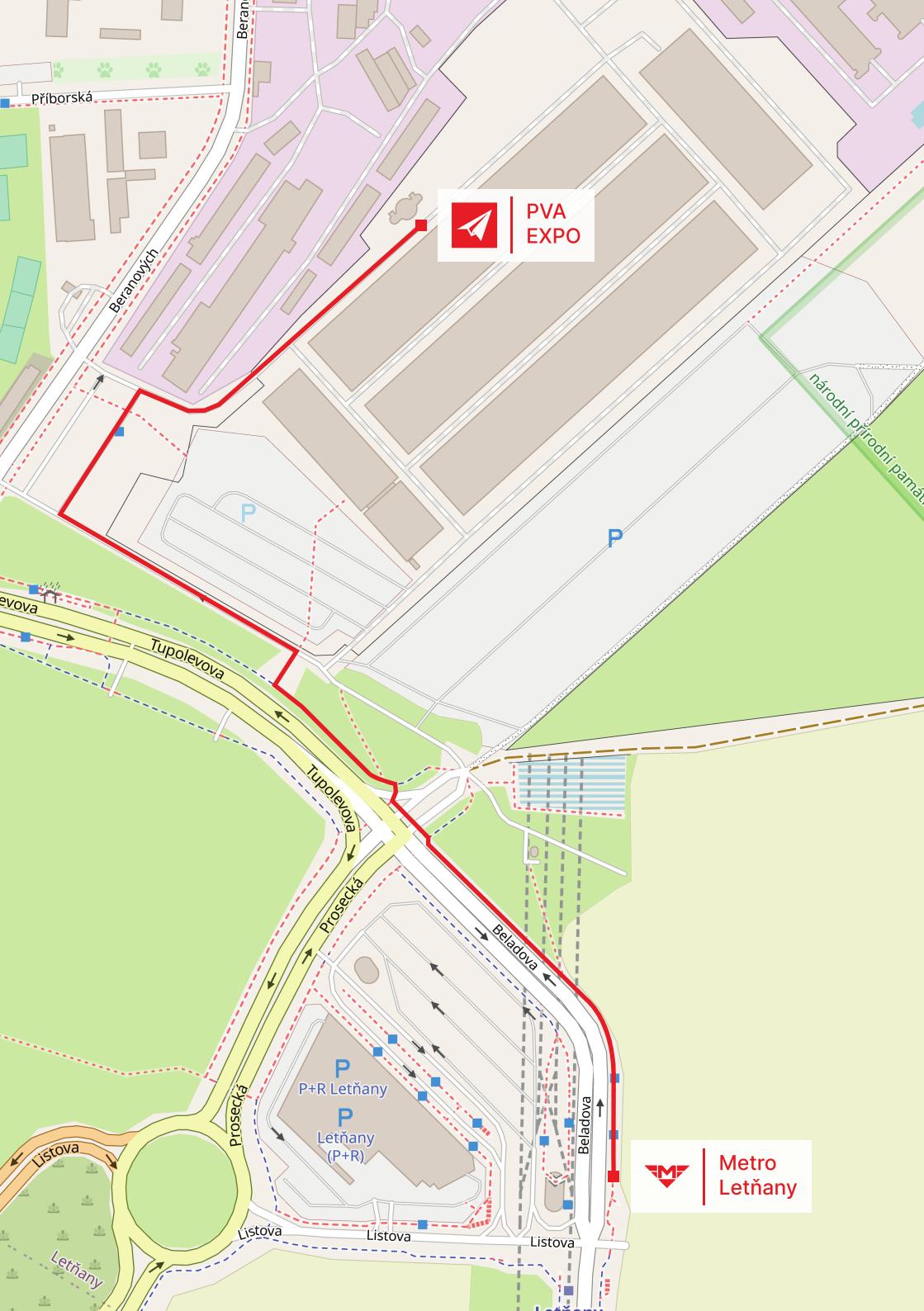
You can download both apps here (works for Android and iOS).

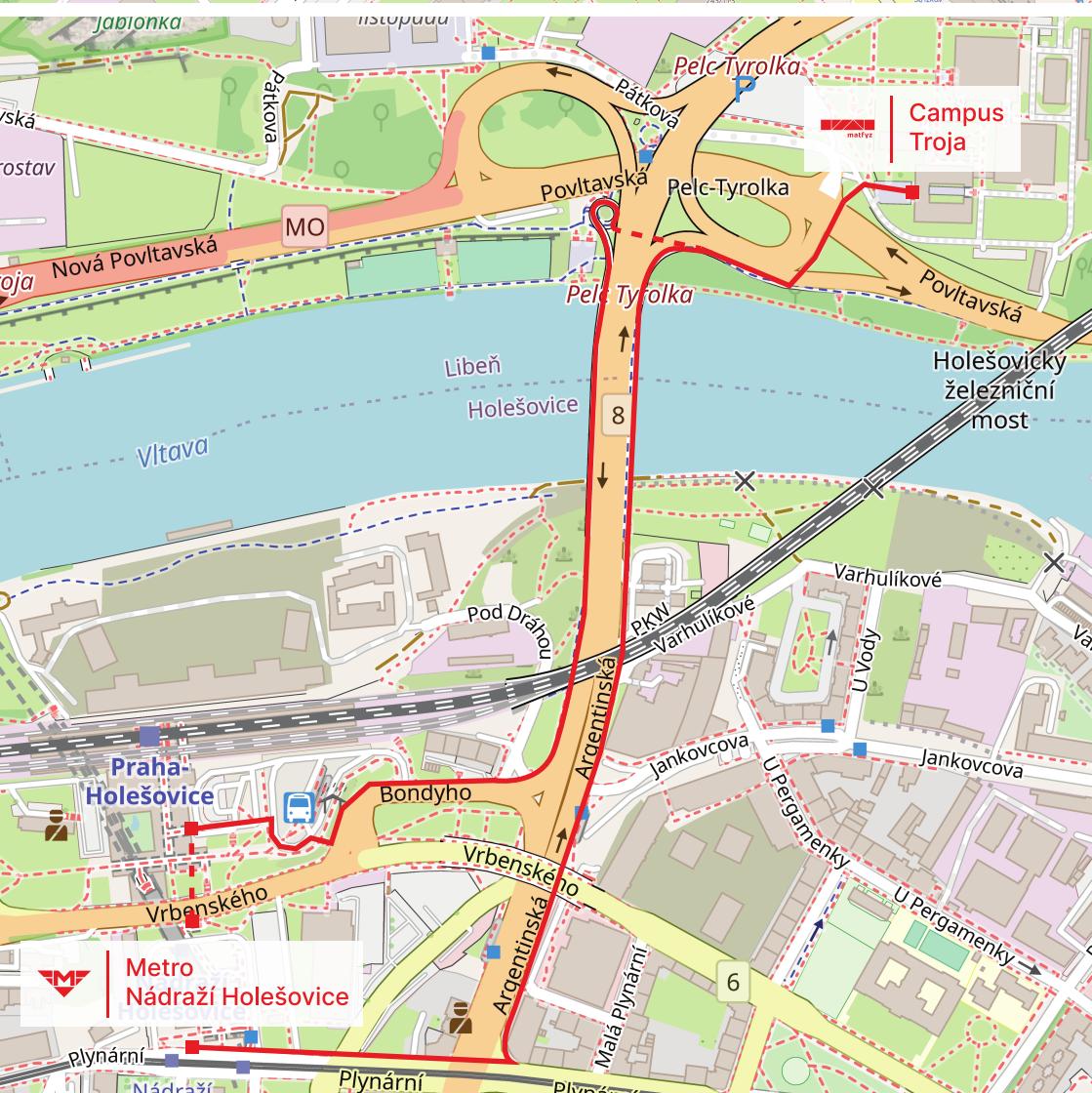
 M Mapy.cz app



 PID Lítáčka app

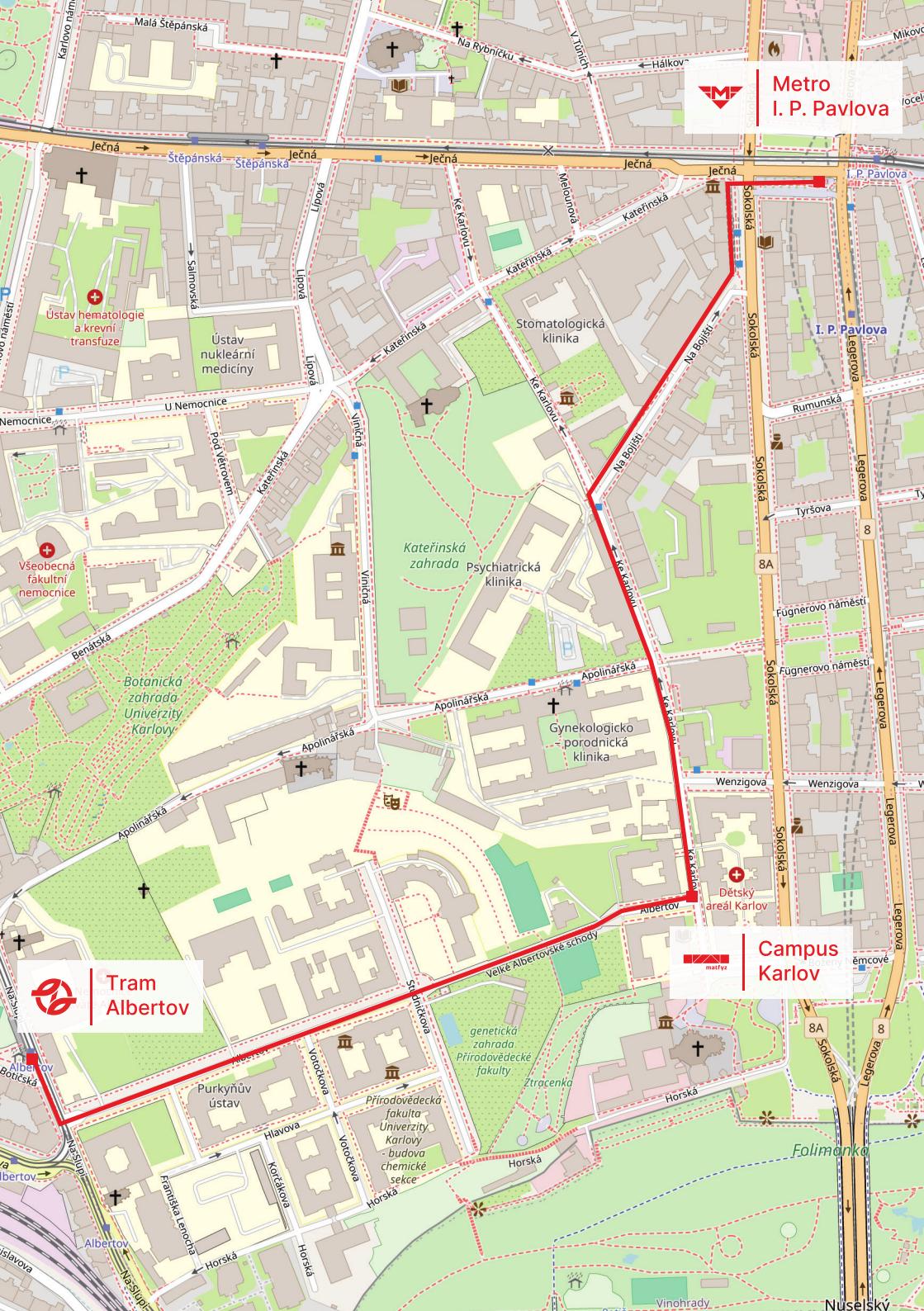








**Metro  
I. P. Pavlova**



**Tram  
Albertov**

**Campus  
Karlov**

# Accompanying Program

## Monday 12. 2.

**afternoon**

### **Arrival**

Participants will be able to check in at Hotel Duo.

**19:00 – 19:20**

### **Opening Ceremony and Welcome**

Ceremonial opening of the accompanying program

**19:30 – 21:00**

### **Icebreakers and Get-to-Know-You Games**

## Tuesday 13. 2.

**08:30 – 10:30**

### **Transport to iQLANDIA**

Bus transportation is provided for participants registered for the exhibition tour.

**11:00 – 16:00**

### **iQLANDIA**

Visit to the largest science centre in the Czech Republic

**19:00 – 21:00**

### **Evening Program**

Participants choose their own program from a range of interesting activities. Attendees are welcome to stay after the lecture and join in board game activities with others.

## Wednesday 14. 2.

**09:00 – 13:00**

### **Cultural / Educational Excursions**

Tour of Wallenstein Palace and Prague Castle, or Guided tour of Prague

**13:00 – 17:00**

### **Free Time**

Participants will have the opportunity to explore Prague themselves.

**17:00 – 18:00**

### **Nations' Evening Preparations**

The hall for the Nations' Evening will open and participants will have the opportunity to prepare their stands.

**18:00 – 22:00**

### **Nations' Evening**

Presentation of national foods, music, and culture

## Thursday 15. 2.

**09:00 – 16:00**

### **One Day with Physics**

Day full of excursions and lectures at CUNI MFF

**19:00 – 21:00**

### **Panel Discussion with Scientists**

Discussion with scientists about their work in physics

## **Friday 16. 2.**

**09:00 – 15:00**

### **Fyziklani**

The competition itself

**17:30 – 19:00**

### **Problem Analysis**

Presentation and analysis of the solutions to this year's problems from Fyziklani

**19:00 – 00:00**

### **Party**

Meet the other contestants at an evening party and celebrate Fyziklani.

## **Saturday 17. 2.**

**09:00 – 12:00**

### **Lectures**

Lectures from excellent Czech scientists and a guest speaker from the USA

**13:00 – 17:00**

### **Optional Program**

You may try the City Rally, visit a museum, or visit some other interesting places in Prague.

**19:00 – 22:00**

### **Buffet**

Ceremonial dinner with other contestants and the official closing of the accompanying program

## **Sunday 18. 2.**

**10:00 – arbit.**

### **City Rally**

Fun game will guide you through Prague and also keep your brain cells busy. The length of the game depends purely on how fast you are.

## **Monday**

### **Opening Ceremony, Icebreakers and Get-To-Know-You Games**

**Monday 19:00 – 21:00**

Ceremonial opening of the accompanying program followed by Icebreakers and Get-to-Know-You Games. The program will take place in hall Prague at Hotel Duo.

## **Tuesday**

### **Transport to iQLANDIA**

**Tuesday 8:30 – 10:30**

Bus transportation is provided for participants registered for the exhibition tour, please be ready at 8:05 in front of Hotel Duo.

## **iQLANDIA**

Tuesday 11:00 – 16:00

Visit to the largest science centre in the Czech Republic. Registered participants will also have the opportunity to enjoy a planetarium screening or a science show.

## **Evening Program**

Tuesday 19:00 – 21:00

Participants choose their own program from a range of interesting activities. Attendees are welcome to stay after the lecture and join in board game activities with others.

The program will take place in hall Prague at Hotel Duo.

## **Wednesday**

### **Tour of Wallenstein Palace and Prague Castle**

Wednesday 08:40 – 12:00 or 09:40 – 13:00

Guided tours of the seat of the Senate of the Parliament of the Czech Republic and the most important Czech castle – Prague's landmark, which is also the seat of the President of the Czech Republic.

For the first tour, arrive at the Malostranská metro stop at 8:40 a.m. at the latest, and for the second tour at 9:40 a.m. at the same place; meet at the metro exit. For transport from the hotel you may use the metro from Střížkov station with a change at Muzeum station. Do not carry excessive luggage, knives or any other dangerous objects.

### **Guided Tour of Prague**

Wednesday 10:00 – 13:00

Tour the historic center of one of the most beautiful cities in Europe. Meet in front of the Palladium shopping center on Náměstí republiky no later than 10:00 a.m. For transport, you can use the metro from Střížkov station with a change at Florenc station, and from there continue to Náměstí Republiky station.

### **Nations' Evening**

Wednesday 18:00 – 22:00

The Nations' Evening will be an opportunity for all foreign participants to get to know each other's cultures and learn something new about them. Each team will prepare a small introduction of their country, which may include food, clothing, songs, dances or other cultural enrichment.

The program will take place at Hotel Duo, in hall Prague. It will be open from 17:00, from when participants can prepare their stands.

# Thursday

## Lab tours – Campus Troja

Thursday 08:45 – 11:30

Please arrive no later than 8:45 a.m. at the Campus Troja to the "T" auditorium.



For more information visit

<https://fyziklani.org/schedule/detail#491>

## Lectures

The lectures will take place at Campus Troja.

### When Will Robots Start Taking Over at Matfyz? [EN] Thursday 13:00 – 14:15

**RNDr. Petr Čermák, Ph.D. – N1**

Recently, there's been a lot of buzz about which jobs might be taken over by robots in the future. Swiss researchers analyzed 1000 different professions and found that physicists ranked first in terms of being least likely to be replaced by automation. But is it really true? Is physics really safe from being automated by artificial intelligence? Let's dive into the world of physics together and explore where AI is already making an impact. Join me as we ponder the question: When will robots start taking over at Matfyz?

### Physics and Its Place in Economy [EN]

Thursday 14:30 – 15:45

**prof. RNDr. Filip Matějka, Ph.D. – N1**

We will talk about imperfect decision making of humans and about errors in choices that affect the economy. More specifically, we will mostly focus on the implications of noisy information and limited attention. It turns out that models of such behavior can be based on the concept of entropy, which is also widely used in physics.

## Evening Program

### Panel Discussion

Thursday 19:00 – 21:00

During the panel discussion, several scientists will share their personal experiences to give you an insight into life and work in science. Invitation to the discussion was accepted by

**prof. Ing. Pavel Hobza, DrSc., FRSC, dr.h.c.**

A distinguished Czech chemist recognized globally for his contributions to the field of non-covalent interactions. He currently holds a Distinguished Chair at the Institute of Organic Chemistry and Biochemistry of the Czech Academy of Sciences.

## **M.Phil Mark Nelson**

The Founder and Managing Director of Radiant Energy Group, having also worked as a consultant for the clean energy industry and environmental organizations worldwide. His analytical contributions have received coverage in reputable publications, including the New York Times, Wall Street Journal, and leading European papers.

## **doc. Ing. Vladimíra Petráková Ph.D.**

She is involved in imaging biomolecules using plasmonic nanoparticles and is a co-founder of Czexpats, a global network for Czech scientists.

## **Dr.rer.nat. Lukáš Palatinus**

He is engaged in electron crystallography, the determination of nanocrystal structure through electron scattering, and conducts his research at the Institute of Physics of the Czech Academy of Sciences.

## **Ing. Helena Reichlová Ph.D.**

She works on spintronics and magnonics with the aim of contributing to the development of new, sustainable information technology at the Institute of Physics of the CAS.

The discussion will be hosted by **Mgr. Daniel Dupkala**, a physicist, a graduate of CUNI MFF, and a long-time organizer of FYKOS who led Fyziklani from 2017 to 2022 and contributed significantly to its growth.

The discussion will take place in the lecture hall N1 and will be streamed into the lecture hall T1.

## **Friday**

### **Problem Analysis**

**Friday 17:30 – 19:00**

Presentation and analysis of the solutions to this year's problems from Fyziklani. It will take place at the Campus Karlov in lecture halls **F1** and **F2**.

### **Party**

**Friday 19:00 – 00:00**

Come and meet the other competitors and organizers after Fyziklani. The party will take place at **Zborovská 7, 150 00 Praha 5** in **Futurum Music Bar** and you can look forward to DJ Pavel Holý.

For transport from Problem Analysis, you can walk to the Albertov tram stop, from where you can take tram number 7 to the Zborovská tram stop.

# Saturday

## Lectures

The lectures will take place at Campus Troja

### First Block

Saturday 09:30 – 10:30

#### **Will Nuclear End the World – or Save It? [EN]**

**M.Phil Mark Nelson – N1**

Nuclear is the most powerful energy we have. But is it powerful for good or for ill? Let's take a hard look at one of the most controversial topics not just in Europe today but around the world with Mark Nelson of Radiant Energy Group. Come with your questions, concerns, and ideas, and no matter your view on nuclear, prepare to be challenged.

#### **Basics of Crystallography [CS]**

**prof. RNDr. Jiří Spousta Ph.D. – T1**

The technologies that surround us are largely based on the crystalline nature of the material. We will learn about the theoretical description of crystals, methods of solving the structure and practical applications of crystals around us. Can we already reliably predict new materials, their properties and uses?

This lecture is only available in Czech.

### Second Block

Saturday 10:50 – 11:50

#### **X-Ray Lasers for New Science [EN]**

**prof. Janos Hajdu – N1**

Ever wondered about the mechanics of lasers and what sets X-Ray lasers apart? Join this lecture for an insightful introduction to X-ray lasers, exploring distinctions from conventional lasers and free-electron lasers. The presentation will also present exciting new findings in the field.

#### **Crowd Madness: The Unexpected Behaviour of Multi-Star Systems [CS]**

**Mgr. Jan Ebr, Ph.D.; Ivana Ebrová, Ph.D.; Mgr. František Dinnbier, Ph.D. – T1**

The laws of gravity are simple. When two bodies attract each other, they start moving towards each other, and if they pass each other, they start orbiting each other in an ellipse – Kepler and Newton solved this problem for us. But as soon as two bodies are joined by even one other, the problem suddenly becomes so complicated that it no longer has a general solution. Predicting the behaviour of thousands or millions of stars all attracted to each other thus seems almost

impossible. In fact, in such systems – star clusters and galaxies – we find many interesting regularities. We'll explain some of them in simplified models and then use many-particle simulations to show how they play out in practice, or rather a good imitation of it.

This lecture is only available in Czech.

## **The Pursuit of Surpassing the Resolution Limits of Optical Microscopy: Peering into the Intricacies of Molecules Using Light [CS]**

**Ing. Tomáš Neuman, Ph.D. – T2**

Together, we will delve into the principles of optical microscopy and explore the inherent constraints on its resolution. By delving into physical techniques and innovative engineering, we will uncover ways to overcome the limits of conventional microscopes. Our journey will gradually lead us to the realm of super-resolution microscopy, where we will examine practical examples of its implementation. Conclusively, we will explore advanced microscopy techniques that enable us to peer inside individual organic dye molecules. Unveiling the quantum principles governing their imaging, we will unravel the insights that can be gleaned about these molecules using light.

This lecture is only available in Czech.

## **Optional Program**

If you want to experience Prague even more, we encourage you to tour the city and discover its hidden gems by yourself. We highly recommend the YouTube channel HONEST GUIDE (see for example <https://www.youtube.com/watch?v=fta6FjsqV2I>) which neatly showcases what to try (and what to avoid). You may, perhaps, also visit the following museums, each of which is unique in its own way.



### **National Museum**

**Václavské náměstí 68, Praha 1**

The largest museum in the Czech Republic with 25 expositions mostly related to history of Czech Republic. If you would like to know more about country hosting Fyziklani, you should definitely visit it.

The National Museum houses nearly 14 million items from the areas of natural history, history, arts, music and librarianship, thus offering something for everyone.

<https://www.nm.cz/en>

## **Visitor Centre of Czech National Bank**

Na Příkopě 28, Praha 1

An exciting place in the center of Prague where you can learn something about Czech currency and the basics of the economy. You can also get some free Czech crowns or simply stop inflation by riding a bike.

<https://nc.cnb.cz/pub/en/>

## **Franz Kafka Museum**

Cihelná 2b, Praha 1

The long-term exhibition offers a glimpse into the world of the famous Prague native Franz Kafka, one of the most important figures of 20th century world literature.

<https://kafkamuseum.cz/en/>

## **The Museum of Decorative Arts in Prague**

17. listopadu 2, Praha 1

A museum featuring interesting art-related exhibitions for everyone who wants to relax and ponder after the exhaustive week.

<https://www.upm.cz/en/>

## **Closing Ceremony of the Program**

### **Buffet**

Saturday 19:00 – 22:00

After Saturday's scientific program, you will have the opportunity to chat with all the participants who will stay in Prague until Sunday at the buffet. The reception will be held in the IMPAKT Pavilion in the Troja Campus. The buffet will also serve as a closing ceremony for the entire program.

## **Sunday**

### **City Rally**

Sunday 10:00 – arbitrary

The City Rally will take you through Prague. You will form small teams and together solve various tasks related to the streets of the capital city. It is not just an ordinary walk, you will have to engage your mind as well. The end of the game is not fixed, it depends on you.

The City Rally will be open all weekend at <https://game.online.fyziklani.org/>; you will receive login details by e-mail. You may look forward to several sets of challenges, so it's up to you whether you choose to explore Prague's viewpoints, islands or, perhaps, go follow a route called Astronomical Prague. The tasks can be found in the game system, where a new question will always

appear after successfully answering the previous one, until you reach the final destination.

If you are planning to go to the city game on Sunday, arrive before 10:00 at the Karlov Campus, where you will be able to store your luggage in the M3 lecture hall.

## Program for Teachers During the Competition

The program for teachers accompanying the participants will take place at PVA EXPO PRAGUE.

### **Scanning Probe Microscopy – A Window into the World of Molecules [CS/EN]**

**Mgr. Martin Švec, Ph.D.**

**Friday 10:30 – 11:30**

This lecture offers an introduction to the realm of scanning probe microscopy, with a focus on scanning tunneling microscopy and atomic force microscopy. Delve into the inner workings of these techniques and explore the unexpected possibilities they present for investigating the properties of molecules.

The lecture will only be held in Czech, the slides, however, will be in English.

## Patronage

Besides the main organizers and the partners, some important public figures significantly contributed and offered their patronage to the competition. We would like to thank them here.

The patronage of this year's event was taken over by **RNDr. Miloš Vystrčil**, President of the Senate of the Parliament of the Czech Republic, Czech politician and pedagogue. After graduating in mathematics-physics at the Faculty of Science of Masaryk University, he worked as a teacher at the Otokar Březina Grammar School, where he also served as deputy headmaster. In his rich political history, he served as the Governor of the Vysočina Region and as the Mayor of Telč. He is currently a Senator for District 52 – Jihlava and since 2020 the President of the Senate of the Parliament of the Czech Republic.

The competition is also under the patronage of **prof. Lenka Zdeborová**, a successful scientist dealing with statistical physics and its interdisciplinary applications. One of the focuses of her work is, among others, the study of the influence of phase transitions in computational problems on their time complexity. She has received many major scientific awards for her work. Last but not least, she also received the Neuron 2021 Award for Young Promising Scientists in Physics. Prof. Zdeborová decided to devote her financial prize through the Neuron Foundation to the development of talented students, thus supporting FYKOS, which she had previously participated in and also organized. This is the 3rd year that her contribution has supported Fyziklani.

Last but not least, the patronage was also taken over by the Councillor of the Capital City of Prague for Education, Sport and Leisure **Mgr. et Mgr. Antonín Klecanda, MBA**. He is a graduate of Masaryk University in Brno, Prague College of Psychosocial Studies and Jan Amos Komenský University in Prague. His responsibilities include the development of education and monitoring the quality of education in Prague.



Miloš Vystrčil



Antonín Klecanda



Lenka Zdeborová

# Organizers

**Vojtěch David** (Head Organizer of Fyziklani)  
Studies 3rd year of BSc. Mathematics at CUNI MFF.

**Martin Vaněk** (Head Organizer of FYKOS)  
Studies 1st year of MSc. Physics at CUNI MFF.

**Michal Červeňák** (IT, Management of Fyziklani)  
Works at the Academy of Sciences of the Czech Republic.

**Petr Kahan** (Head of Accompanying Program)  
Studies 2nd year of BSc. Solid State Engineering at FNSPE CTU.

**Kateřina Rosická** (Fyziklani Scholarship, Leadership of Fyziklani)  
Studies 2nd year of MSc. Surface and Plasma Physics at CUNI MFF.

**David Škrob** (Communication with Teams, Management of Team Registrations)  
Studies 1st year of BSc. Physics at CUNI MFF.

**Daniel Dupkala** (Consultant of Fyziklani)  
Graduated from MSc. Teaching physics and math at CUNI MFF. Works at Media Communications and PR Office of CUNI MFF.

**Radomír Mielec** (Fyziklani Scholarship)  
Studies 2nd year of BSc. Physics at CUNI MFF.

**Dávid Brodňanský** (Head of Translations, Partners of Fyziklani)  
Studies 2nd year of BSc. Physics – nanotechnologies at MUNI.

**Adam Krška** (IT, Typography, TeX)  
Studies 2nd year of BSc. Information Technology at FIT BUT.

**Jakub Dřevo** (Marketing, PR)  
Studies 3rd year of BSc. Physics at CUNI MFF.

**Tereza Hochmanová** (Marketing, PR)  
Studies 1st year of BSc. Physics at CUNI MFF.

**Veronika Hendrychová** (IT, Consultant of Fyziklani)  
Studies 1st year of Eng. Science de l'Informatique at Université de Rennes, France.

**Marek Milička** (Fyziklani IT)  
Studies 3rd year of BSc. Physics at CUNI MFF.

**Elena Chocholáková** (Consultant of Fyziklani)  
Studies 2nd year of BSc. Physics at CUNI MFF.

**Jaroslav Herman** (Physics Problems Administrator, Chief Editor)  
Studies 3rd year of BSc. Physics at CUNI MFF.

**Viačeslavas Šinkonis** (Accompanying Program)  
Studies 3rd year of BSc. Physics at CUNI MFF.

**Petr Sacher** (Partners of Fyziklani, Accompanying Program)  
Studies 3rd year of BSc. Physics at CUNI MFF.

**Tomáš Červeň** (Graphics)  
Studies 2nd year of MSc. Physics at CUNI MFF.

**Soňa Husáková** (Graphics)  
Studies 2nd year of BSc. Physics with a focus on Education at MUNI.

**Viktor Materna** (Finances)  
Studies 1st year of BSc. Informatics at CUNI MFF.

**Lukáš Létal** (Accompanying Program)  
Studies 1st year of BSc. Physics at CUNI MFF.

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# FYKOS

Fyziklani is organized by FYKOS – a group with the aim of inspiring and educating high-school students in physics and related fields. FYKOS is under the patronage of CUNI MFF and has a rich 37-year history of organizing educational events.

The keystone activity of FYKOS is a correspondence competition of the same name. It is open to all high-school students with an interest in physics. We publish eight new problems six times a year. Participants have about a month to solve these problems and submit their solutions, which we mark and send back with comments and helpful feedback.

The best contestants of FYKOS can attend week-long camps in spring and fall focused on physics education, including lectures or experiments, but also offer plenty of engaging games and leisure activities. Along with Fyziklani, FYKOS organizes an online version of the competition – Physics Brawl Online, which is held every year in late November – and also many other events, such as the Day with Experimental Physics.

You can learn more about the activities of FYKOS and how to take part in them at <https://fykos.org>.



## Faculty of Mathematics and Physics, Charles University

FYKOS and Fyziklani 2024 are under the auspices of the Faculty of Mathematics and Physics at Charles University (CUNI MFF). You can find more information at <https://mff.cuni.cz/en/>.

The Charles University, which in itself supported this year's Fyziklani as well through the program of one-time financial support of student organizations, is the oldest university in Central and Eastern Europe and it is the best-ranked university in said region (e.g. in the Academic Ranking of World Universities). It was founded in the year 1348 by Charles IV. The CUNI MFF was founded in 1952.



## The Ministry of Education, Youth and Sports of the Czech Republic

The Ministry of Education, Youth and Sports of the Czech Republic (MEYS) is one of the announcers of Fyziklani 2024. The competition is also listed in the list of competitions maintained by MEYS.

MEYS is responsible for public administration in education, for developing educational, youth and sport policies and international cooperation in these fields.



## General Partner

### CEZ Group

The vision of the CEZ Group is to bring innovations in the field of energy solutions and contribute to a higher quality of life. CEZ is one of the largest companies in the Czech Republic and one of the leading European energy groups in Western and Central Europe. In the Czech Republic, CEZ operates both nuclear power plants – Dukovany and Temelín.

The CEZ Group is committed to setting an example and achieving a sustainable, more environmentally friendly, and planet-friendly energy sector. For CEZ, greater diversity, closer collaboration with communities, and the most customer-friendly approach are priorities, offering them the best technological and energy-efficient solutions. One of the main strategic priorities of CEZ is to achieve climate neutrality by 2040.

The CEZ Group has a wide range of activities and projects, which also offer a wide range of job opportunities across various fields throughout the Czech Republic.

For more information, you can visit <https://kdejinde.jobs.cz/> or <https://www.cez.cz/en/home>.



# Support for Foreign Teams

## FABRIC

**FABRIC** FABRIC is a non-profit that organizes several events for students with analytical thinking who want to understand themselves and the world. One of these is the ESPR (European Summer Program on Rationality), an engaging and intensive workshop for mathematically gifted students. ESPR aims to help participants acquire rigorous quantitative, as well as other practical skills and techniques useful in many areas of life – from game theory and mathematical logic, through communication skills and the basics of rational thinking to cognitive science. ESPR is largely about improving thinking and reasoning, and its reflection in better practical decisions, whether for individuals or for society. After the camp ends, ESPR instructors further help their participants to develop or start and build their own projects, organize various meetings, etc.

The program usually takes place in the summer in England and is free for participants (with the possibility of reimbursement for travel and other expenses). Besides ESPR, the same group also co-organizes WARP, the winter version of this workshop, ASPR, a similar camp held in Asia, or PAIR (Program on AI and Reasoning), which also focuses more on the functioning and implications of artificial intelligence.

For more information, visit <https://fabric.camp>.

## Platinum Partners

### The Neuron Foundation



"Great teachers usually awaken passion for science in young people. They direct them to Olympiads and other competitions, where they can then develop their talents. This pattern is repeated regularly, as many laureates of the prestigious Neuron Prizes, which we award to top scientists for their research, confirm. Success in the High School Olympiad is often a stepping stone and the first clear impulse towards a scientific career. That's why it makes sense for us to support Fyziklani. We keep our fingers crossed for all high school students who enjoy physics, may this passion and enthusiasm last as long as possible. And we look forward to hearing from the Neuron Prize winner or laureate in Physics

one day about their success in the biggest physics competition in Europe!" – Monika Vondráková, Director of the Neuron Foundation.

The Neuron Foundation popularizes Czech science and inspires talented students to pursue scientific careers. It helps them to find their way in science, fulfills their scientific dreams, and sends them on internships at prestigious foreign universities and research institutions. It has long supported organizations that help students take their first scientific steps and find new opportunities.

Neuron started supporting Fyziklani thanks to the Neuron 2021 Prize winner, Lenka Zdeborová. The top scientist decided to donate her financial reward associated with the Neuron Prize to support the activities of FYKOS, which she once organized herself.

## Silver Partners

### Kalabria

Kalabria company was founded in 1911 and made its breakthrough by producing Calabria lemon juice from lemons imported from the Calabria region in South Italy – hence the name. Nowadays, it produces several kinds of lemonades and syrups in typical local flavors – in some cases innovated for the 21st century. The authentic taste of the lemonade is guaranteed by the use of the highest quality ingredients and experienced manufacturing processes. Kalabria company supported Fyziklani by gifting 1500 bottles of Karáskova limonáda, which were given to participants to stay hydrated.



**KARÁSKOVY  
LIMONÁDY  
A SIRUPY**

### Brilliant

Brilliant is the leading online learning platform renowned for its interactive and hands-on approach. Specializing in data science, math, and computer science, Brilliant offers a diverse array of courses designed to enhance problem-solving skills. Through customized lessons and engaging exercises, learners of all levels can deepen their understanding of complex subjects in STEM. With its user-friendly interface and emphasis on active learning, Brilliant empowers individuals to master challenging topics and boost their cognitive skills in as little as 15



minutes a day, making it a valuable resource for both students and professionals alike.

Brilliant has donated 20 annual premium licenses to the contest winners, as well as a 20% discount on an annual subscription to the first 200 people who sign up through the link <https://brilliant.org/Fyziklani/>.

## Casio (FAST ČR)

**CASIO.** Quality, design and functionality are key requirements in the development of calculators. In product development, Casio implements the brand mission of "Reliability and Durability" by uncompromisingly addressing all three basic requirements with the application of advanced technologies.

The company donated 15 scientific and 5 graphic calculators for the winners.

## Partners

### Prometheus



Prometheus, spol. s r. o. publishes textbooks, collections and other literature dealing with physics and mathematics. Their physics tables are known to everyone in the Czech Republic. Most of the books are intended for primary and secondary school students and their teachers, but they also offer titles dealing with history and important people contributing to mathematics and physics.

Prometheus has supplied book prizes for the winners.

### Humusoft



Humusoft s.r.o. is a Czech company that since its foundation has divided its efforts equally between the production and sale of instrumentation and software. It is the exclusive representative of the American company MathWorks, Inc. for the Czech Republic and Slovakia. HUMUSOFT s.r.o. also participates in the development of MATLAB® / Simulink® system superstructures. They provided 5 MATLAB® & SIMULINK® Student Suite licenses and other donations for the competition.

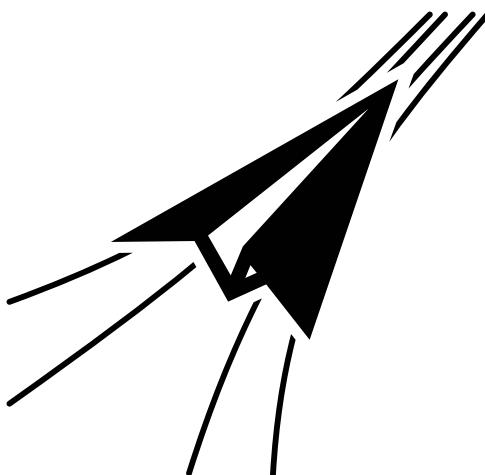
## **Hobžovy Strážnické brambůrky (Hobža's crisps)**

"We are not chips, we are crisps, crisps from Moravia!" – family company taking pride in quality and taste, making sure the crisps really taste the way they should. Hobza's brothers gave us 30 boxes of the crisps and they believe they will come in handy during the competition.



## **Escape Point**

"Intelligent entertainment" – an escape game that makes you think. Escape point provides eight unique games with adjustable difficulty, but beware, the clock is ticking. They donated 5 vouchers for a game of one's choice for the best teams.



## Brief Rules

- Fyziklani is a three-hour-long team competition taking place in Prague, Czech Republic.
- The competition is held for teams of up to 5 high-school students, who attend two different high schools at most.
- At any instance, every team should have 7 tasks accessible. Solutions of the tasks should be written on the paper that states the problem and delivered to the judges. In the case of a correct solution, the team earns points and gets a new task straight away. In case of an incorrect solution, the team gets the task back to correct their answer.
- Every problem solved on the first try is awarded 5 points, on the second try with 3 points, on the third try with 2 points and with 1 point otherwise.
- The only way to get a new problem is to solve another one correctly; you can't skip problems. In an exceptional case the judge can ask how the team found the solution.
- Solutions are accepted in standard form, i. e., with correct units. Fractions should be simplified. You should use constants like  $\pi$  and round the numbers correctly.
- It is allowed to use any written or printed materials. Electronic gadgets are strictly forbidden (except for calculators).

## Full Rules of Fyziklani

### Participation in the Competition

- To participate in the competition, pre-registration is required at <https://fyziklani.org/>.
- By registering for the competition, each team agrees to follow the Rules of Conduct and these Rules of Fyziklani and confirms they have made themselves acquainted with them.
- A team consists of 1–5 competitors.
- All team members must be high-school students, primary school students, or their respective equivalents.
- A team must consist of competitors belonging to at most two schools.

- Students of a single school can compete at most in four distinct teams. In the case of unfilled places or other similar conditions, the organizers reserve the right to make an exception to this rule.
- The name of a team cannot spread political or religious views, cannot be insulting, or be in any other way inappropriate. The head organizer has a right to change the name of such a team, censor it, or disqualify the team completely.
- By registering in the competition, the team members agree with publishing the results of their team in the form of basic information (your name, surname, category, school, and points) in the results list in both print and digital outputs.

## Designation into Categories

- Teams compete in three categories; to which they are placed based on the following algorithm.
- Each contestant is assigned a coefficient based on the expected year of high school graduation. A contestant who is in the final, i.e., graduating, year of secondary education at the time of the competition (specifically, a school corresponding to level 3 of the ISCED 2011 classification) is assigned a coefficient of 4. A contestant in the penultimate year is assigned a coefficient of 3, and so on. The lowest possible coefficient is 0 (this is assigned to pupils of primary schools and the corresponding years of multi-year grammar schools).
- The coefficient of a team is calculated as the arithmetic mean of the coefficients of individual competitors (they are added together and divided by the number of competitors).
- The team is assigned the lowest category whose conditions it satisfies:
  - category A: team coefficient  $\leq 4$ ,
  - category B: team coefficient  $\leq 3$  and maximum of two competitors have a coefficient of 4,
  - category C: team coefficient  $\leq 2$ , no member has a coefficient 4, and a maximum of two competitors have a coefficient of 3.
- A team can compete in category A even if its coefficient places it into a lower category if it chooses to do so during the registration.
- Organizers reserve the right to move a team back to the lower category, or conversely move a team to category A if the need arises. The team will be notified of such a change at least one day before the competition.

- All categories share the same set of problems.
- Each category of the competition has a separate results list.

## Arrival to the Competition

- Teams are required to arrive on time. Organizers reserve the right not to admit late-arriving teams to the competition.
- Teams are required to present themselves upon arrival and provide accurate information about their members (years, schools, etc.). Teams are obliged to point out any changes in their composition.
- Each team will receive an envelope with the first seven tasks. It is forbidden to open this envelope until the head organizer or an organizer designated by him has given clear instructions to do so.

## The Competition System and Awarding of Points

- The competition lasts 3 hours.
- At the beginning of the competition, each team receives 7 problems, which they try to solve.
- If the team thinks it has arrived at the correct solution to a problem, it sends one of the competitors to one of the examiners, who tells the member whether that solution is correct or incorrect. The designated member must present the paper with the problem with a solution clearly marked on the paper.
- The examiners may request a team to describe the steps used to solve the problem.
- The presenting member selects the correct examiner based on the label on the problem sheet. The proper selection algorithm will be explained before the start of the competition.
- If the solution is incorrect, the examiner marks this on the problem sheet, and the presenting member returns to the team and continues solving this problem.
- If the solution is correct, the examiner marks the problem sheet with the number of points obtained and forwards the presenting member to the distributor, from whom the presenting member receives a new problem sheet.

- The problems are awarded points based on the attempts needed to solve them in the following way: a single attempt – 5 points, two attempts – 3 points, three attempts – 2 points, and four or more attempts – 1 point.
- The team aims to receive as many points as possible.
- During the competition, the up-to-date results of all teams are posted. However, these will be hidden 20 minutes before the end of the competition.
- If a serious issue is discovered with a competition problem, organizers reserve the right to modify or eliminate it without compensation.
- During the competition, all competitors are allowed to communicate only with their team members or the organizers. Any interaction with teachers, other teams, etc. is strictly forbidden.
- Teams are permitted to use any literature in printed, paper form. It is forbidden to use the Internet during the competition. Furthermore, teams are permitted to use calculators and writing or drafting supplies. The calculator must not allow access to the Internet or any other form of communication (devices like mobile phones, tablets, laptops, smartwatches, and similar are strictly prohibited from being used as calculators).
- All supplies that the competitors use or have in their surroundings during the competition, can be requested to be disclosed to the organizers for control.

## Conclusion of the Competition and Announcement of Winners

- The end of the competition is clearly announced by the head organizer or an organizer designated by him.
- After the announcement of the end of the competition, no team is allowed to send a member to the examiners. If a presenting member was standing in a queue to an examiner when the end was announced, the member is allowed to stay there and their solution will be examined, but they are forbidden to use any writing supplies.
- In case the number of points obtained by teams is not sufficient to determine the winners or any other awarded positions, the order will be decided based on several criteria in the following order: higher average points awarded per submitted problem, a higher number of problems awarded 5 points, a higher number of problems awarded 3 points, a lower team coefficient, earlier date and time of team registration and a random draw.

## Breach of Rules

- In the case of a substantial suspicion of a breach of the Competition Rules or the Rules of Conduct, the head organizer has a right to perform special measures to confirm or rebut the suspicion and to prevent the continuation of disallowed conduct.
- If a team violates any of the Competition Rules or Rules of Conduct, the head organizer or a designated committee will determine the appropriate consequences for the team.
- In the case of a less serious breach of rules, the head organizer or a committee designated for this task by the head organizer can decide on the removal of a certain number of points from a team based on the severity of the breach.
- Organizers are allowed to disqualify a team that commits a severe breach of rules.
- In the case of an extremely severe breach of the Competition Rules or the Rules of Conduct, the Central Committee of the competition may decide to ban participation in the competition in the subsequent years or another punishment, to the competitors of the team and/or to any of the schools they come from. The organizer also reserves the right to share information about rule violations with the organizers of other competitions and activities organized or promoted by the CUNI MFF and with representatives of the competitors' schools.
- Extremely severe breaches of rules involve any intentional attempt to obtain the problems or their solutions before the competition, their publication, or disclosure to anybody outside their team. Any intentional attempts to impede the smooth running of the competition to the other participants or the organizers, or an attack on the competition server are also understood as extremely severe breaches of rules.

## Final Remarks

- Organizers reserve the right to make minor changes in the rules before the start of the competition.
- Resolution of any potential conflicts or issues not covered by these rules is decided by the head organizer or an organizer designated by him. The team will be informed of these decisions at the email addresses provided in the application form.

- If a team disagrees with a decision made by the head organizer, they have the right to appeal within 14 days of the decision being made. The Central Committee of the competition will process the appeal and decide within 40 days of the appeal being submitted.
- These rules were ratified by the Central Committee of the competition Fyziklani on September 19, 2023.
- These rules replace the previous version and come into effect on September 19, 2023.

You can find full Organizational Regulations of Fyziklani at:  
<https://fyziklani.org/rules/organizational-regulations>.



# List of Constants

## Fundamental Physics Constants

speed of light in vacuum	$c$	$2.998 \cdot 10^8 \text{ m}\cdot\text{s}^{-1}$
permittivity of free space	$\varepsilon_0$	$8.854 \cdot 10^{-12} \text{ F}\cdot\text{m}^{-1}$
permeability of free space	$\mu_0$	$1.257 \cdot 10^{-6} \text{ H}\cdot\text{m}^{-1}$
gravitational constant	$G$	$6.674 \cdot 10^{-11} \text{ m}^3\cdot\text{kg}^{-1}\cdot\text{s}^{-2}$
Planck constant	$h$	$6.626 \cdot 10^{-34} \text{ J}\cdot\text{s}$
reduced Planck constant	$\hbar$	$1.055 \cdot 10^{-34} \text{ J}\cdot\text{s}$
elementary charge	$e$	$1.602 \cdot 10^{-19} \text{ C}$
electron mass	$m_e$	$9.109 \cdot 10^{-31} \text{ kg}$
proton mass	$m_p$	$1.673 \cdot 10^{-27} \text{ kg}$
atomic mass unit	$u$	$1.661 \cdot 10^{-27} \text{ kg}$
Avogadro constant	$N_A$	$6.022 \cdot 10^{23} \text{ mol}^{-1}$
Boltzmann constant	$k_B$	$1.381 \cdot 10^{-23} \text{ J}\cdot\text{K}^{-1}$
molar gas constant	$R$	$8.314 \text{ J}\cdot\text{mol}^{-1}\cdot\text{K}^{-1}$
Stefan-Boltzmann constant	$\sigma$	$5.670 \cdot 10^{-8} \text{ W}\cdot\text{m}^{-2}\cdot\text{K}^{-4}$

## Astronomical Constants

mass of Earth	$M_{\oplus}$	$5.974 \cdot 10^{24} \text{ kg}$
mass of Sun	$M_{\odot}$	$1.989 \cdot 10^{30} \text{ kg}$
equatorial radius of Earth	$R_{\oplus}$	$6.378 \cdot 10^6 \text{ m}$
equatorial radius of Sun	$R_{\odot}$	$6.957 \cdot 10^8 \text{ m}$
astronomical unit	au	$149.6 \cdot 10^9 \text{ m}$

## Other Useful Constants

gravity of Earth	$g$	$9.81 \text{ m}\cdot\text{s}^{-2}$
normal pressure	$p_a$	$101.325 \text{ kPa}$
normal temperature	$t$	$20^\circ\text{C}$
air density <sup>1</sup>	$\rho$	$1.20 \text{ kg}\cdot\text{m}^{-3}$
molar mass of air	$M_{\text{air}}$	$28.96 \text{ g}\cdot\text{mol}^{-1}$
speed of sound in air <sup>1</sup>	$c_s$	$343 \text{ m}\cdot\text{s}^{-1}$
Zero-point of Celsius scale	$0^\circ\text{C}$	$273.15 \text{ K}$
density of mercury <sup>1</sup>	$\rho_{\text{Hg}}$	$13500 \text{ kg}\cdot\text{m}^{-3}$
heat capacity of mercury <sup>1</sup>	$c_{\text{Hg}}$	$140 \text{ J}\cdot\text{kg}^{-1}\cdot\text{K}^{-1}$

## Properties of Water<sup>1</sup>

specific latent heat of vaporization	$l_v$	$2.26 \cdot 10^6 \text{ J}\cdot\text{kg}^{-1}$
specific latent heat of fusion	$l_t$	$3.34 \cdot 10^5 \text{ J}\cdot\text{kg}^{-1}$
heat capacity	$c$	$4184 \text{ J}\cdot\text{kg}^{-1}\cdot\text{K}^{-1}$
molar mass	$M_{\text{H}_2\text{O}}$	$18.02 \text{ g}\cdot\text{mol}^{-1}$
index of refraction	$n$	$1.333$
density	$\rho$	$998 \text{ kg}\cdot\text{m}^{-3}$
dynamic viscosity	$\mu$	$1.005 \cdot 10^{-3} \text{ Pa}\cdot\text{s}$
surface tension	$\sigma$	$7.27 \cdot 10^{-2} \text{ N}\cdot\text{m}^{-1}$

<sup>1</sup>Under normal conditions.

Organized  
by



**FYKOS**



General  
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**CEZ GROUP**

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