

Preparation to the Young Physicists' Tournaments' 2021

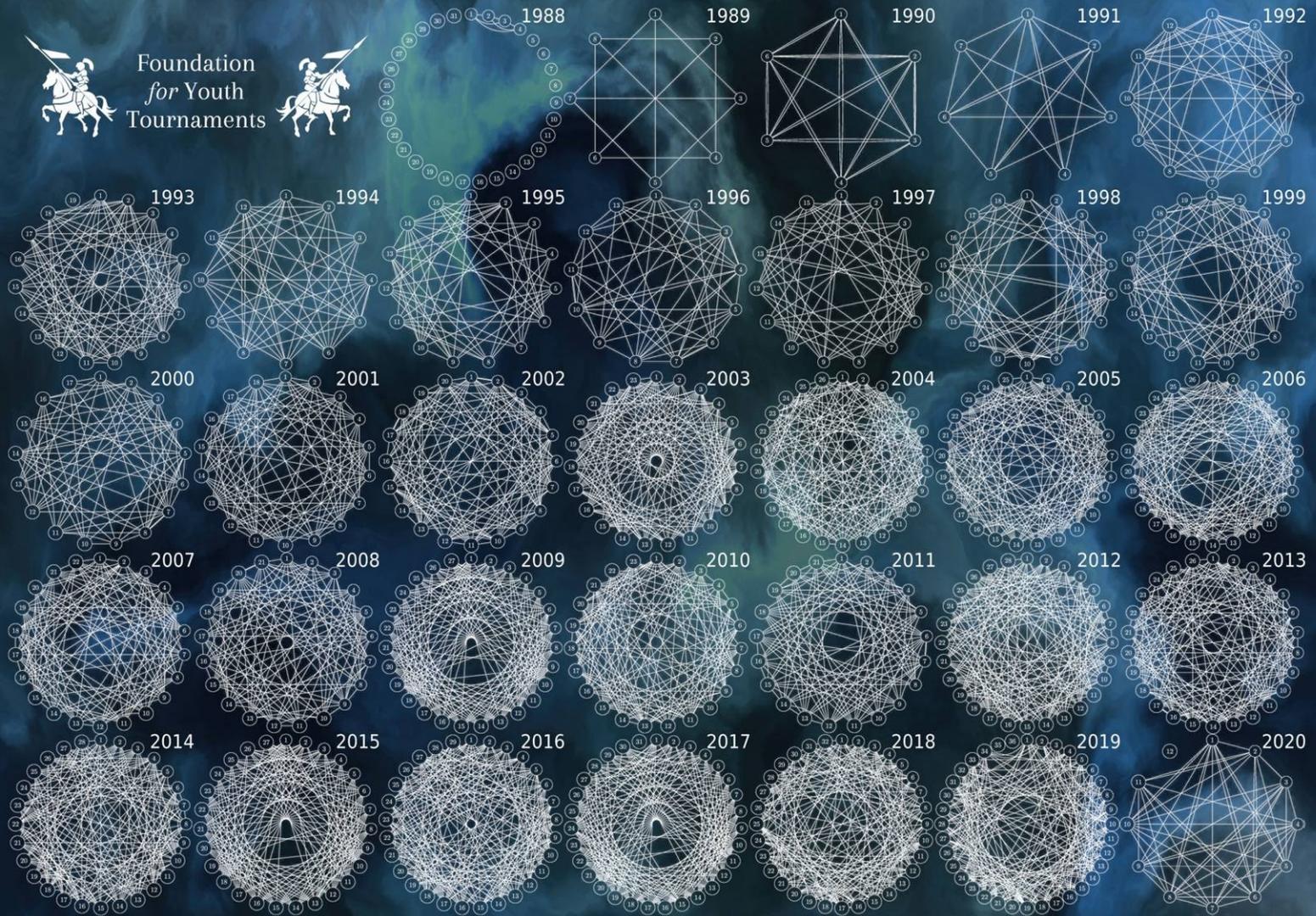
Ilya Martchenko^{1*} and Nikita Chernikov²

¹Foundation for Youth Tournaments; ²Novosibirsk State University





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for Youth
Tournaments



PHYSIK

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Is the novel research limited and discouraged by the existing common knowledge and the ongoing work of competing groups? :-)

Röhler: Informativtheorie in der Optik

75 Jahre Abteilung für optische Messtechniken 1893 - 1968

3.2.6
36

MODERN OPTICS

VOLUME 1
A
GUIDE
TO
OPTICAL
SYSTEM
DESIGN

Systems
and
Transforms
with
Applications
in
Optics

PAPOULIS

How to tackle the IYPT problems?



- How to structure a report?
- What level is competitive?
- How to set the goals, fix the priorities, and set the direction of the work?
- How were people resolving particular issues in the past?
- Look through the historical solutions in the Archive
- an opportunity for goal-oriented critical learning
- examples, not guidelines
- those solutions were good, but yours should be better!





Problem No. 1 “Invent yourself”

Design a boat that moves only due to the periodical mechanical movements of its internal parts and which only interacts with the environment (air, water) through its stiff hull. Optimise the parameters of your boat for maximum speed.

Background reading

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Problem No. 2 “Circling magnets”

Button magnets with different diameters are attached to each end of a cylindrical battery. When placed on an aluminium foil the object starts to circle. Investigate how the motion depends on relevant parameters.

Background reading

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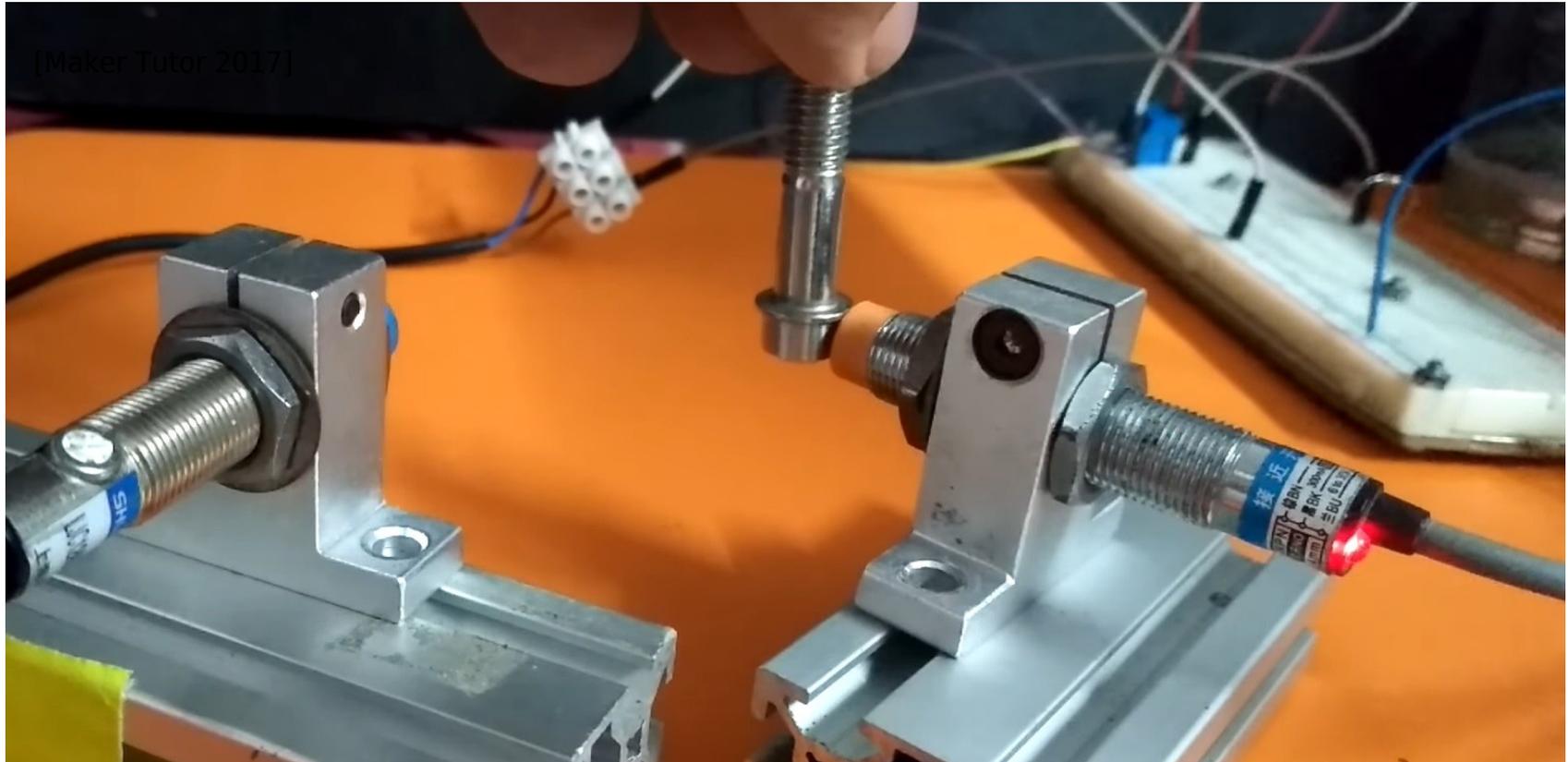
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-



Problem No. 3 “Proximity sensor”

A simple passive inductive sensor can detect ferromagnetic objects moving through its magnetic field. Construct such a passive sensor and investigate its characteristics such as sensing range.

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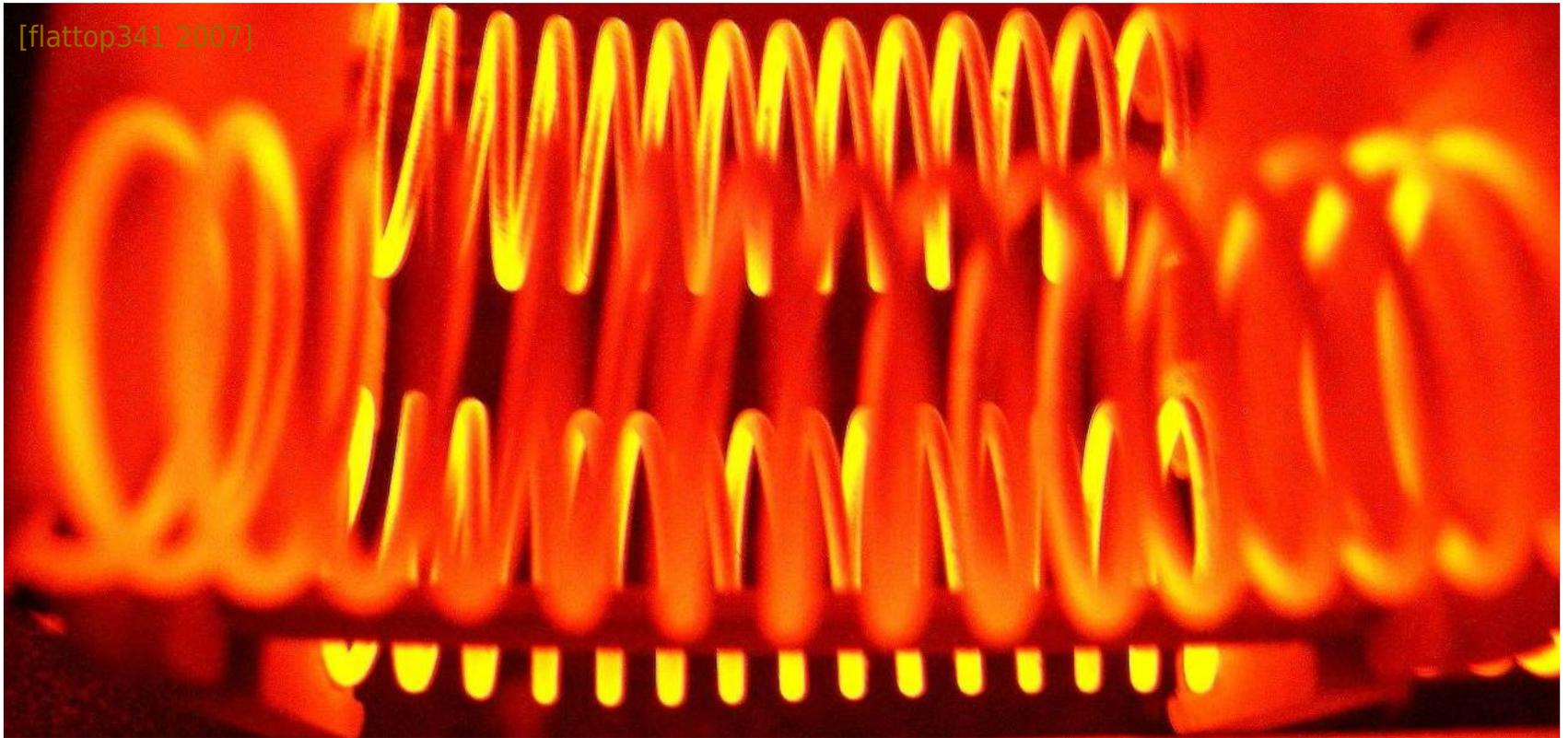
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[flattop341 2007]



Problem No. 4 “Wind speed”

Let an electric current flow through a coil. When cold air flows over the coil, the coil's temperature will decrease. Investigate how the temperature drop depends on the wind speed. What is the accuracy of this method of measuring the wind speed?

Background reading

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<http://seniorphysics.com/physics/se.html>



Problem No. 5 “Synchronised candles”

Oscillatory flames can be observed when several candles burn next to each other. Two such oscillators can couple with each other, resulting in in-phase or anti-phase synchronisation (depending on the distance between the sets of candles). Explain and investigate this phenomenon.

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Prob. No. 6 “Irreversible Cartesian diver”

A simple Cartesian diver (e.g. an inverted test tube partially filled with water) is placed in a long vertical tube filled with water. Increasing the pressure in the tube forces the Cartesian diver to sink. When it reaches a certain depth, it never returns to the surface even if the pressure is changed back to its initial value. Investigate this phenomenon and how it depends on relevant parameters.

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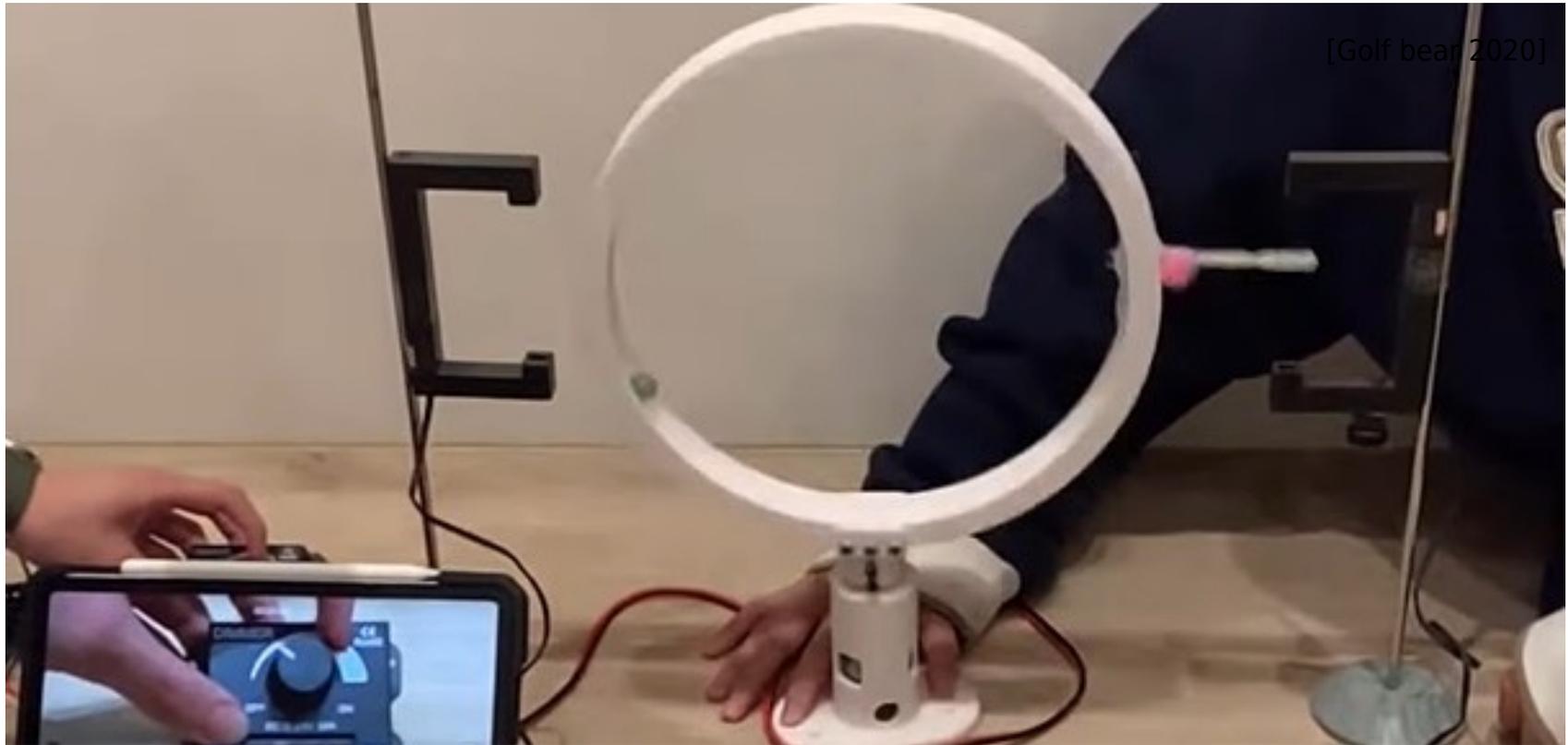
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Problem No. 7 “Bead dynamics”

A circular hoop rotates about a vertical diameter. A small bead is allowed to roll in a groove on the inside of the hoop. Investigate the relevant parameters affecting the dynamics of the bead.

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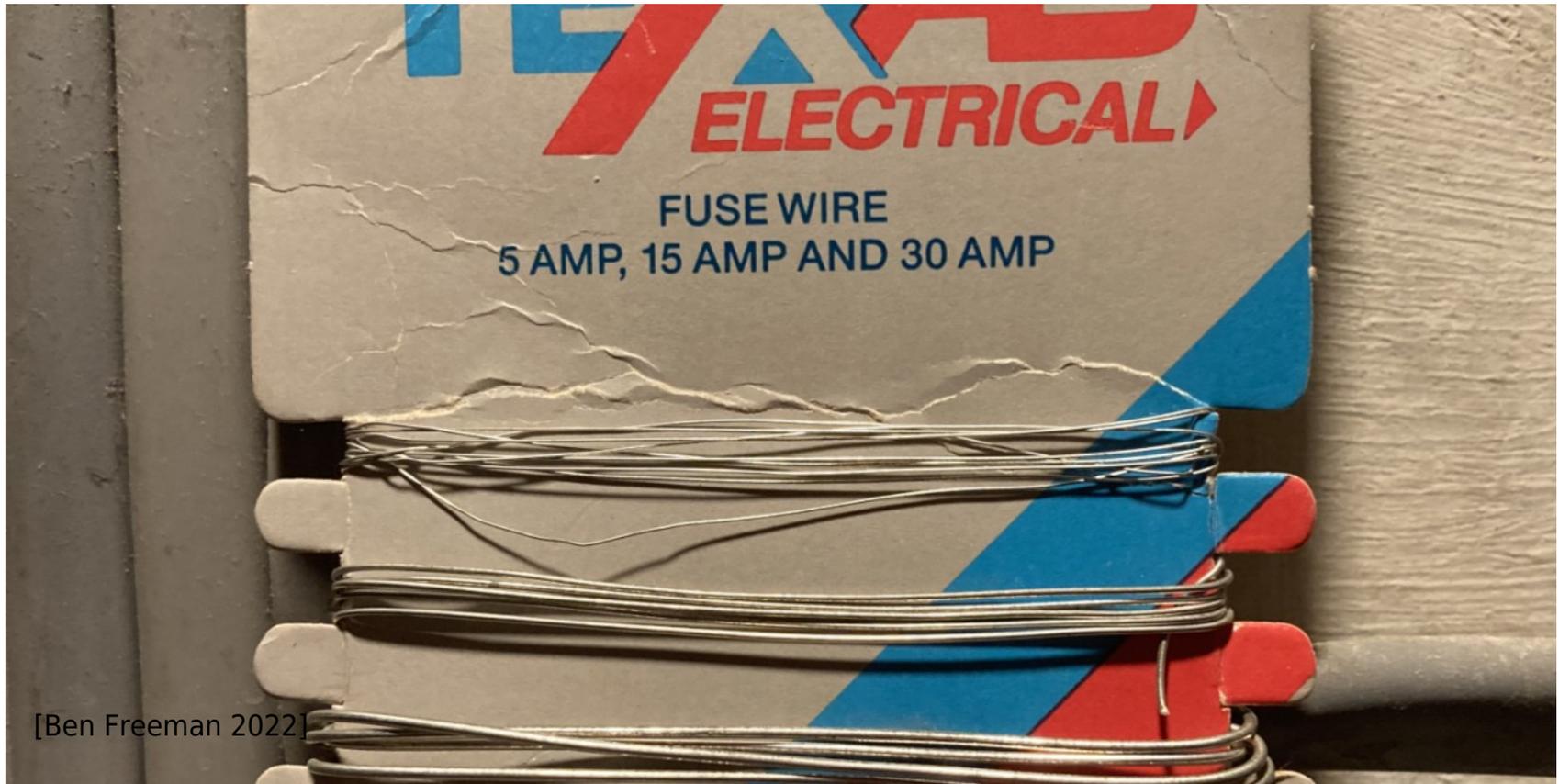
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[Ben Freeman 2022]

Problem No. 8 “Fuses”

A short length of wire can act as an electrical fuse. Determine how various parameters affect the time taken for the fuse to 'blow'.

Background reading

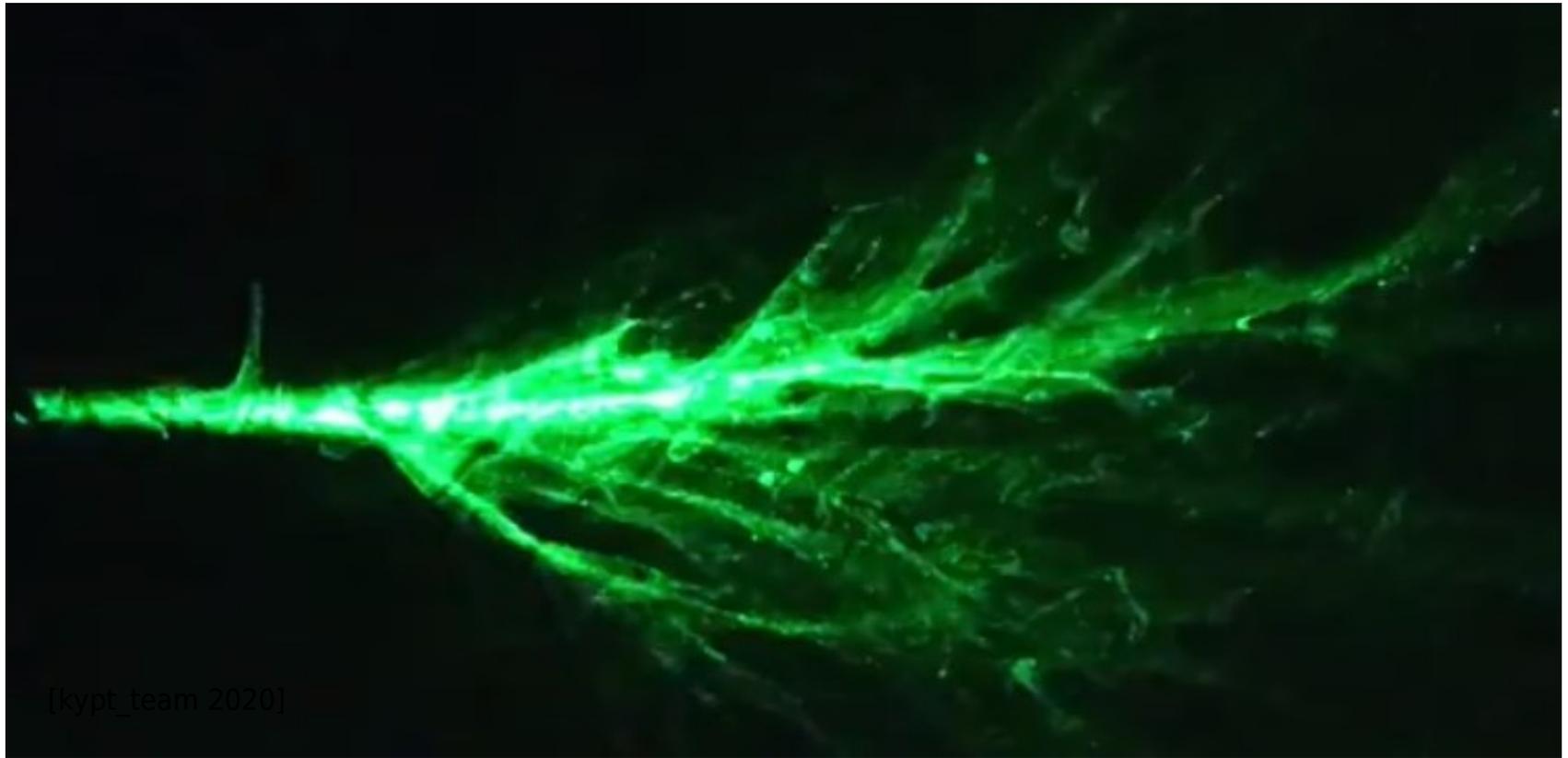
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Problem No. 9 “Light whiskers”

When a laser beam enters a soap film at a small angle, a rapidly changing pattern of thin, branching light tracks may appear inside the film. Explain and investigate this phenomenon.

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Problem No. 10 “Spin drift”

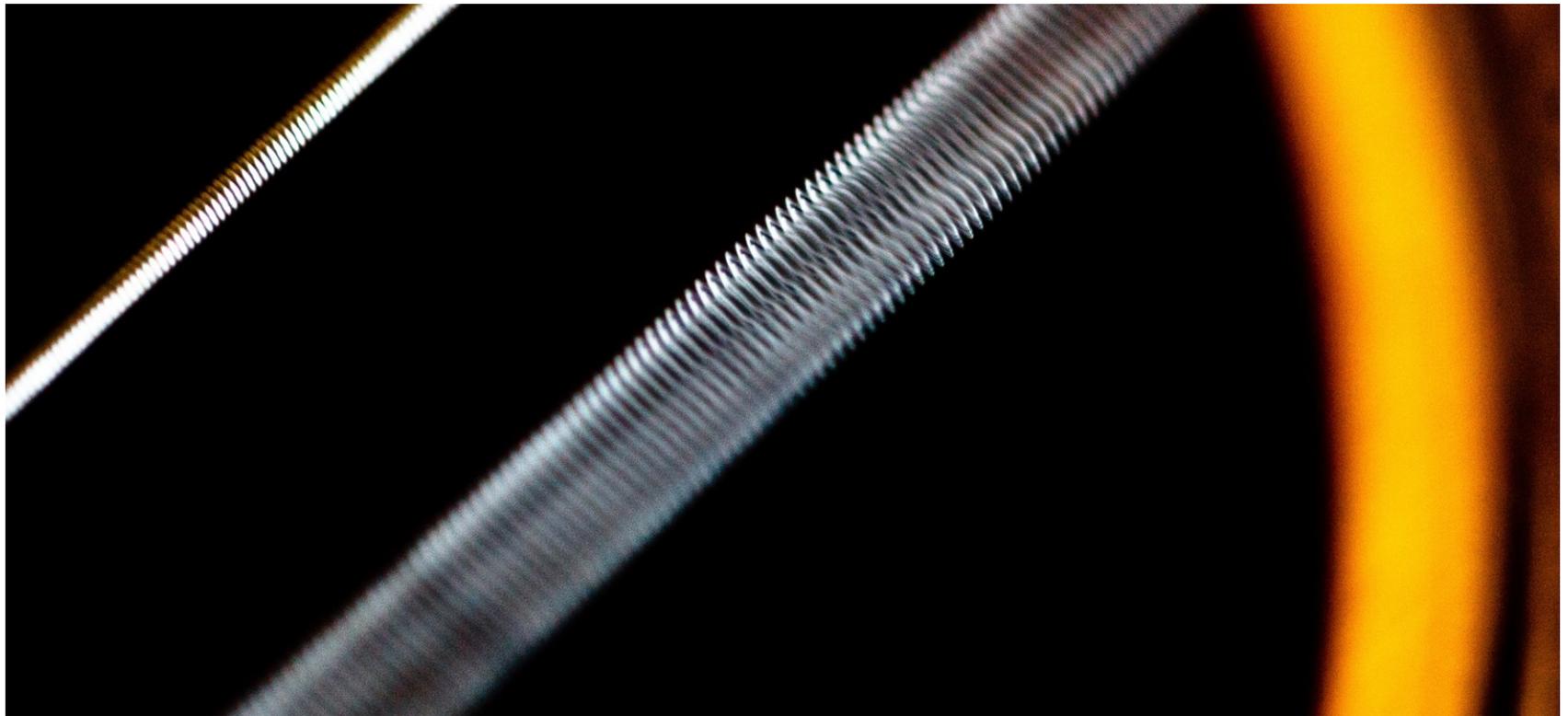
When a ring is set to roll in a parabolic bowl, interesting motion patterns may arise. Investigate this phenomenon.

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Problem No. 11 “Guitar string”

A periodic force is applied to a steel guitar string using an electromagnet. Investigate the motion of the guitar string around its resonance frequency.

Background reading

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[xofunkox-scientific experiments 2020]



Problem No. 12 “Wilberforce pendulum”

A Wilberforce pendulum consists of a mass hanging from a vertically oriented helical spring. The mass can both move up and down on the spring and rotate about its vertical axis. Investigate the behaviour of such a pendulum and how it depends on relevant parameters.

Background reading

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Problem No. 13 “Sponge”

A sponge will soak up water at a rate and in a quantity determined by various parameters. Investigate how effective a sponge is at drying a wet surface.

Background reading

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[Tom Wicker 2010]



Problem No. 14 “Dynamic hydrophobicity”

When a drop of liquid impacts on a horizontally moving surface, the droplet may be reflected or not, depending on the speed of the surface. Investigate the interaction between a moving surface and a liquid drop.

Background reading

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- Bouncing Water Droplet Falling onto Super-Hydrophobic Surface (youtube, Mizzou Engineering, 29.10.2009), https://youtu.be/riXp_Q-fDv8
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Background reading

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Problem No. 15 “Rebounding capsule”

A spherical ball dropped onto a hard surface will never rebound to the release height, even if it has an initial spin. A capsule-shaped object (i.e. Tic Tac mint) on the other hand may exceed the initial height. Investigate this phenomenon.

Background reading

- Rebounding capsule (youtube, HAO CHEN YANG, 28.04.2021), <https://youtu.be/gnPy2J1yxvY>
- IYPT 2021 №15 Rebounding Capsule (Отскок капсулы) (youtube, ЭЙНШТЕЙН, 27.07.2020), <https://youtu.be/FsAFYhUvTt4>
- Crazy tic tac bounce!?! | EVERYDAY MYSTERIES (youtube, Physics Girl, 03.05.2018), <https://youtu.be/x4ySPDvebes>
- Football Science: Bouncing Tic Tac (youtube, Liz Heinecke, The Kitchen Pantry Scientist, 02.02.2018), <https://youtu.be/DeW09x2fQtY>
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- R. Bharadwaj, C. Smith, and B. C. Hancock. The coefficient of restitution of some pharmaceutical tablets/compacts. Int. J. Pharmaceutics 402, 1-2, 50-56 (2010)
- R. Cross. The fall and bounce of pencils and other elongated objects. Am. J. Phys. 74, 1, 26-30 (2006)
- Tic Tac Bounce AKA Inventing a New Flavor of Energy Storage (kellyoshea.blog, 2015/08/31), <https://kellyoshea.blog/2015/08/31/tic-tac-bounce/>



Problem No. 16 “Ultrasonic pump”

A capillary immersed in an ultrasonic bath works like a pump that can lift water to a considerable height. Explain and investigate this phenomenon.

Background reading

- Ultrasonic Syringe Pump (youtube, Ultrasonic Liquid Processing - CHEERSONIC, 03.11.2020), <https://youtu.be/P5rukmlI2Zs>
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- I. Tzanakis, W. W. Xu, D. G. Eskin, P. D. Lee, and N. Kotsovinos. In situ observation and analysis of ultrasonic capillary effect in molten aluminium. *Ultrasonics Sonochemistry* 27, 72-80 (2015)
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Problem No. 17 “Hand helicopter”

A simple hand helicopter can be made by attaching rotor blades to one end of a vertical stick. The helicopter moves upwards when the stick is twisted at a high enough speed and then let go. Investigate how the relevant parameters affect the lift-off and the maximum height.

Background reading

- How to make Paper cup Helicopter | Rubber band powered flying plane | easy Paper toy (youtube, siddharth creations, 02.04.2022), <https://youtu.be/68p4YCz7Ga4>
- IYPT 2021 №17 Hand Helicopter (tech wonder) (youtube, ЭйНШтейн, 12.04.2021), <https://youtu.be/PJrM8EkqJQo>
- Physics Hand Helicopter (youtube, Frank Feng, 26.03.2021), <https://youtu.be/Y94YD4JsnBU>
- Making a Hand Powered Helicopter (youtube, Wood By Wright ASMR, 13.12.2018), <https://youtu.be/-cnycgx0SZg>
- How To Make a Helicopter - Hand Helicopter (youtube, Andry Scholar, 08.08.2018), <https://youtu.be/eaZGsbQZts8>
- How To make a mini hand Helicopter (youtube, LUCKY CREATION, 18.12.2017), <https://youtu.be/A9t0OJSNFk4>
- Flying Stick Helicopter (youtube, Spark Something, 05.05.2017), <https://youtu.be/8jrTQZBqi8o>
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- 10C10.20 - Propeller on a Stick - Hand Helicopter (physics.uiowa.edu), <https://instructional-resources.physics.uiowa.edu/demos/10c1020-propeller-stick-hand-helicopter>
- Investigating the lift force of a toy helicopter (sphsdevilphysics.weebly.com), http://sphsdevilphysics.weebly.com/uploads/5/0/7/1/5071691/example02_en.pdf
- Propeller Thrust (grc.nasa.gov), <https://www1.grc.nasa.gov/beginners-guide-to-aeronautics/propeller-thrust/>

The ultimate response to all "What for?"-questions:

**" If we knew what we were doing,
it wouldn't be called research! "**

Albert Einstein

John Blocher



Important information

- The basic goal of this Kit is **not** in providing students with a start-to-finish manual or in limiting their creativity, but **in encouraging** them to
 - regard their work critically,
 - look deeper,
 - have a better background knowledge,
 - be skeptical in embedding their projects into the standards of professional research,
 - and, as of a first priority, be attentive in not “re-inventing the wheel”
 - An early exposure to the culture of **scientific citations**, and developing a **responsible attitude toward making own work truly novel and original**, is assumed to be a helpful learning experience in developing necessary standards and attitudes
 - Good examples are known when the Kit has been used as a **concise supporting material** for jurors and the external community; the benefits were in having the common knowledge structured and better visible
 - Even if linked from iypt.org, this file is **not** an official, binding release of the IYPT, and should under no circumstances be considered as a collection of authoritative “musts” or “instructions” for whatever competition
 - All suggestions, feedback, and criticism about the Kit are warmly appreciated
-

Habits and customs

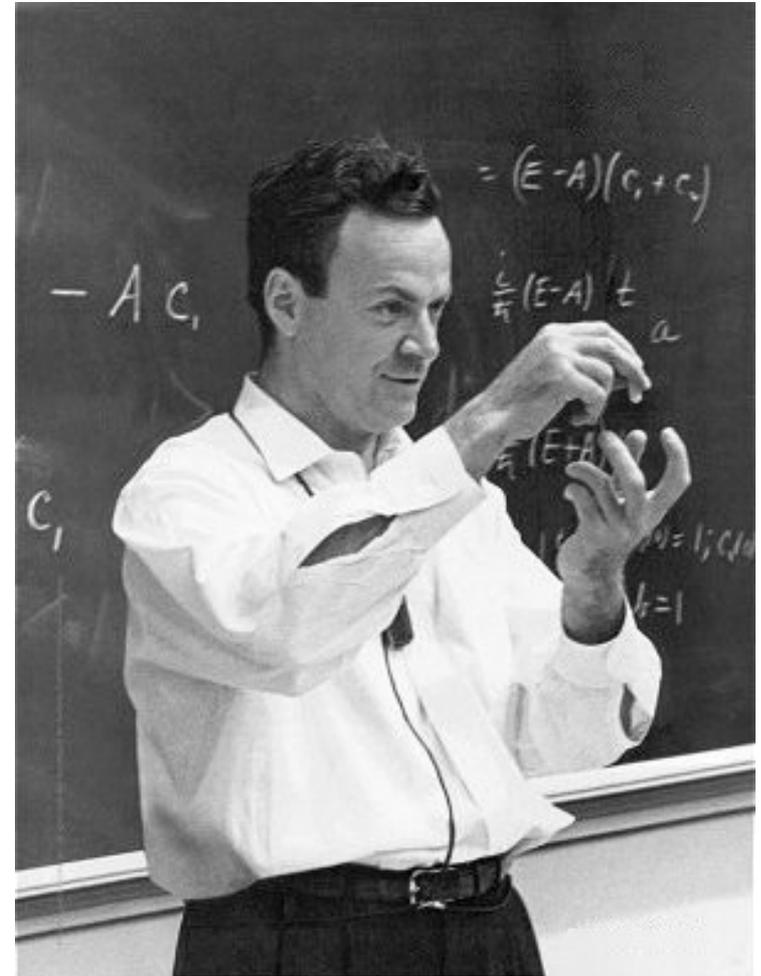
- Originality and independence of your work is always considered as of a first priority
 - There is no “correct answer” to any of the IYPT problems
 - Having a deep background knowledge about earlier work is a must
 - Taking ideas without citing is a serious misconduct
 - Critically distinguishing between personal contribution and common knowledge is likely to be appreciated
 - Reading more in a non-native language may be very helpful
 - Local libraries and institutions can always help in getting access to paid articles in journals, books, and databases
 - The IYPT is not about reinventing the wheel, or innovating, creating, discovering, and being able to contrast own work with earlier knowledge and the achievements of others?
 - Is IYPT all about competing, or about developing professional personal standards?
-

Requirements for a successful IYPT report

- Novel research, not a survey or a compilation of known facts
 - Balance between experimental investigation and theoretical analysis
 - Comprehensible, logical and interesting presentation, not a detailed description of everything-you-have-performed-and-thought-about
 - Clear understanding of the validity of your experiments, and how exactly you analyzed the obtained data
 - Clear understanding of what physical model is used, and why it is considered appropriate
 - Clear understanding of what your theory relies upon, and in what limits it may be applied
 - Comparison of your theory with your experiments
 - Clear conclusions and clear answers to the raised questions, especially those in the task
 - Clear understanding of what is your novel contribution, in comparison to previous studies
 - Solid knowledge of relevant physics
 - Proofread nice-looking slides
 - An unexpected trick, such as a demonstration *in situ*, will always be a plus
-

Feynman: to be self-confident?

- “I’ve very often made mistakes in my physics by thinking the theory isn’t as good as it really is, thinking that there are lots of complications that are going to spoil it
- — an attitude that anything can happen, in spite of what you’re pretty sure should happen.”



Call for cooperation

- If you are interested in the idea behind the Kit — to structure the existing knowledge about the physics behind the problems and to encourage students to contrast their personal contribution from the existing knowledge — **your cooperation is welcome**
 - If more contributors join the work on the Kit for 2021, or plan bringing together the Kit for 2022, **good editions may be completed earlier**
 - It would be of benefit for everybody,
 - **students and team leaders**, who would have an early reference (providing a first impetus to the work) and a strong warning that IYPT is all about appropriate, novel research, and not about “re-inventing the wheel”
 - **jurors**, who would have a brief, informal supporting material, possibly making them more skeptical and objective about the presentations
 - **the audience outside the IYPT**, who benefits from the structured references in e.g. physics popularization activities and physics teaching
 - **the IYPT**, as a community and a center of competence, that generates vibrant, state-of-the-art research problems, widely used in other activities and at other events
 - and also **the author (-s)** of the Kit, who could rapidly acquire a competence for the future activities and have a great learning experience
-



Preparation to 34th IYPT' 2021: references, questions and advices

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Ilya Martchenko ^{1*} and Nikita Chernikov ²

¹ Foundation for Youth Tournaments

² Novosibirsk State University

July 22, 2020...December 26, 2023

* <http://kit.ilyam.org>