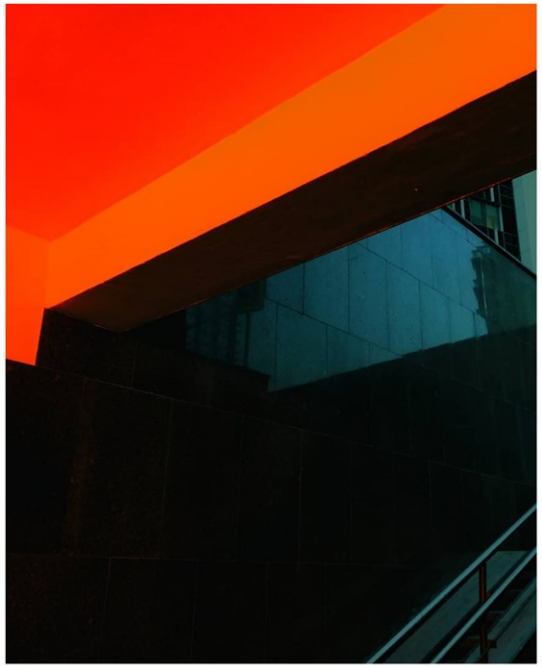
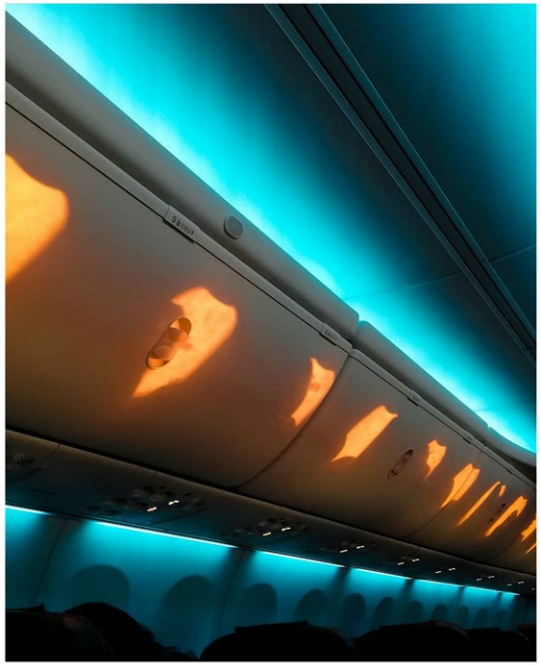
Enhanced edition // December 25, 2023





Preparation to the Young Physicists' Tournaments' 2020

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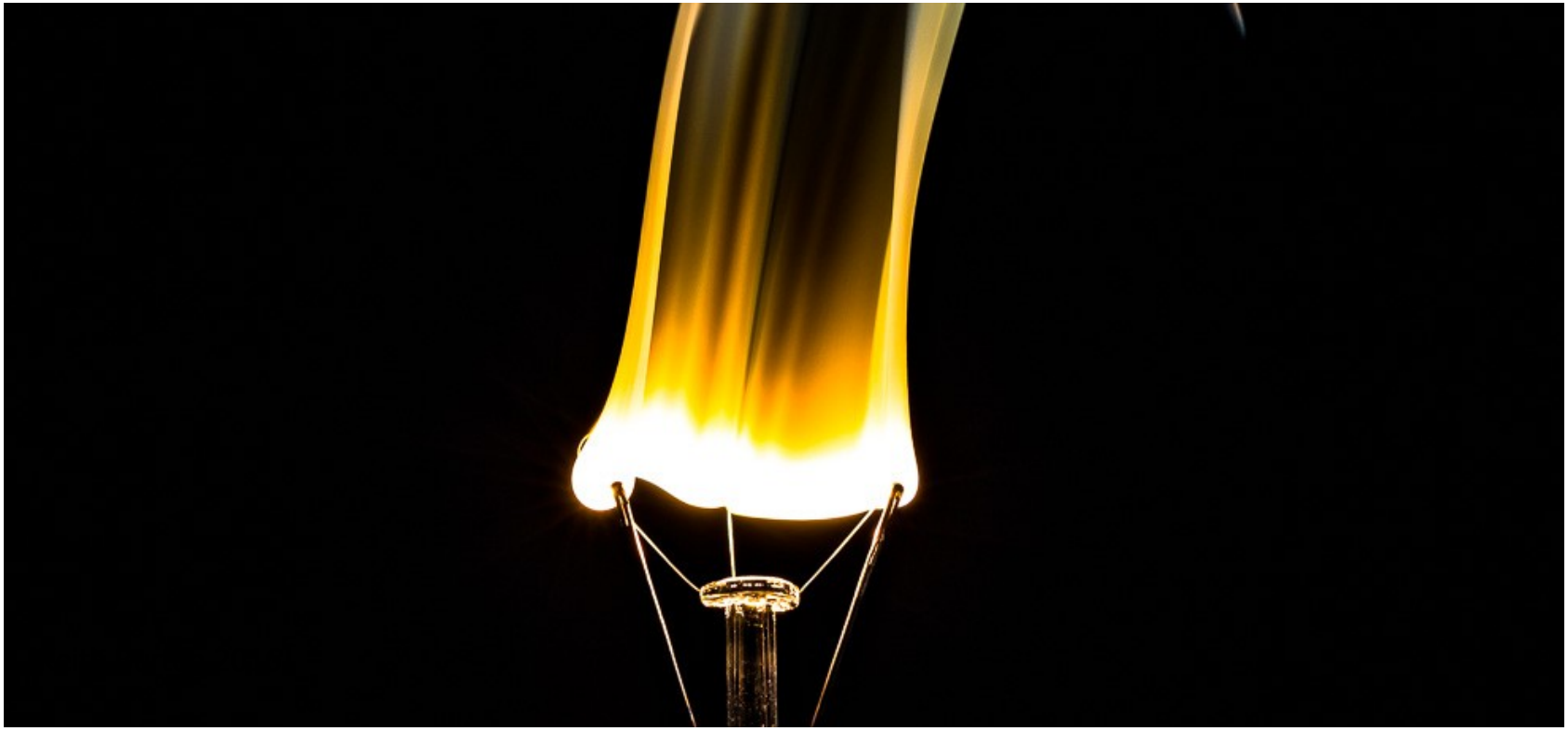
Is the novel research limited and discouraged by the existing common knowledge and the ongoing work of competing groups? :-)

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!

iypt archive mc^2 hv



Problem No. 1 “Invent yourself”

Design an instrument for measuring current using its heating effect. What are the accuracy, precision and limits of the method?

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Problem No. 2 “Inconspicuous bottle”

Put a lit candle behind a bottle. If you blow on the bottle from the opposite side, the candle may go out, as if the bottle was not there at all. Explain the phenomenon.

Background reading

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- Эффект Коанда ● 1 (youtube, GetAClass - Физика в опытах и экспериментах, 20.05.2021), https://youtu.be/te5ziZcnU_w
- IYPT 2020 Problem 2 Inconspicuous Bottle Demonstration (youtube, Canadian Young Physicists' Tournament, 13.01.2020), https://youtu.be/7-BkCzjy-Uk
- How to Blow out a Candle behind a Bottle | Kids Science (youtube, TheDadLab, 15.11.2018), https://youtu.be/fxIrwaOzWWo
- Blowing Out a Candle Behind a Cylinder (youtube, JSME FED, 02.02.2018), https://youtu.be/JB9BG2KmUzI
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Problem No. 3 “Swinging sound tube”

A Sound Tube is a toy, consisting of a corrugated plastic tube, that you can spin around to produce sounds. Study the characteristics of the sounds produced by such toys, and how they are affected by the relevant parameters.

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- How To Change The Pitch Of The Whirly Tube (youtube, The Tone-Deaf Music Teacher, 28.02.2017), https://youtu.be/30xhHihfnEw
- Plastic Singing Tube Sound Tube Sound Pipe Sound Hose (youtube, GrandadIsAnOldMan, 11.02.2017), https://youtu.be/aNekSNX56E0
- Whirly Tube (youtube, Graham Elementary Music, 21.01.2016), https://youtu.be/eCOZxzO3FvE
- Hello - Walk off the Earth (Ft. KRNFX) (youtube, Walk off the Earth, 06.01.2016), https://youtu.be/t-Z2BDDogCI
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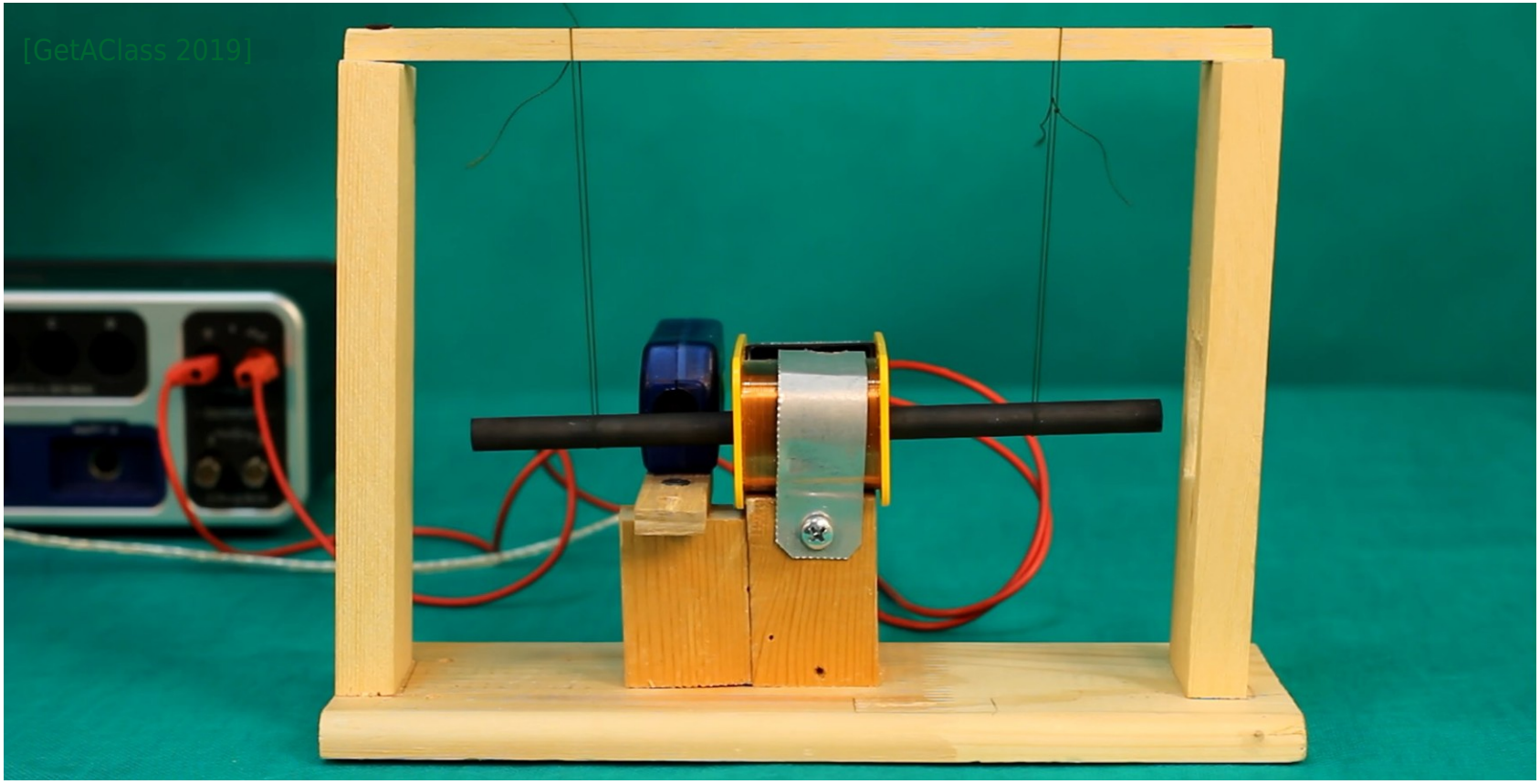

Problem No. 4 “Singing ferrite”

Insert a ferrite rod into a coil fed from a signal generator. At some frequencies the rod begins to produce a sound. Investigate the phenomenon.

Background reading

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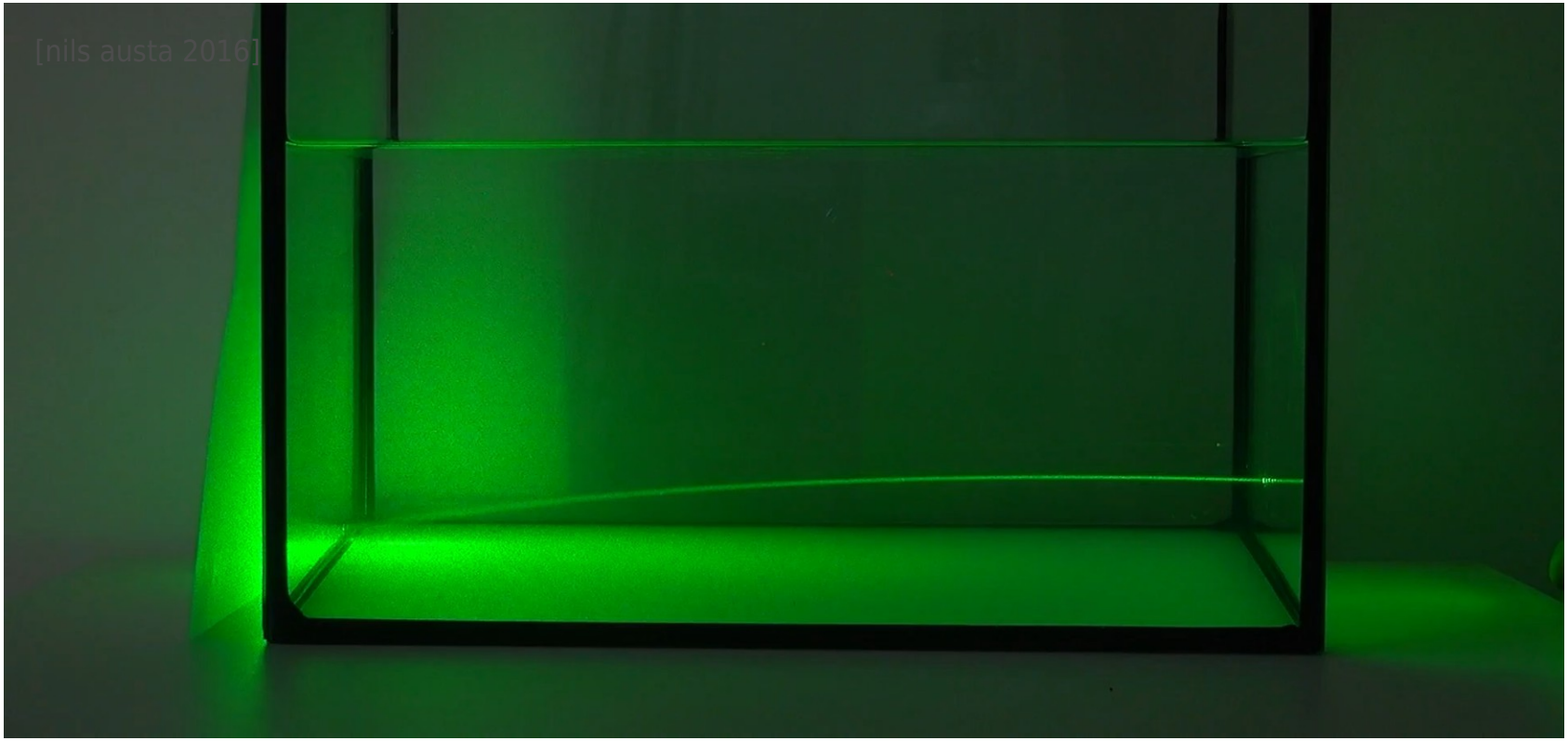

Problem No. 5 “Sweet mirage”

Fata Morgana is the name given to a particular form of mirage. A similar effect can be produced by shining a laser through a fluid with a refractive index gradient. Investigate the phenomenon.

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- Bending Light with a Sugar Gradient (youtube, SFU Physics, 26.03.2020), https://youtu.be/sft3QYZjNCU
- IYPT 2020 Problem 5 Sweet Mirage Demonstration (youtube, Canadian Young Physicists' Tournament, 29.09.2019), https://youtu.be/GMOWKZh4kS0
- Argon Laser Refraction in Sugar Water in RamZland!□ (youtube, RamZland, 21.02.2017), https://youtu.be/x--6b3qlm5o
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Problem No. 6 “Saxon bowl”

A bowl with a hole in its base will sink when placed in water. The Saxons used this device for timing purposes. Investigate the parameters that determine the time of sinking.

Background reading

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- International Young Physicists : saxon bowl (youtube, WASUTHA Janonsoong, 28.02.2020), https://youtu.be/xWTSq1yVf50
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- Saxon Bowl IYPT 2020 - analytical solution from ilinblog (Саксонская миска) (Ivan Ilin, 25-07-2019), http://ilinblog.ru/article.php?id_article=58
- How is Bernoulli's equation related to saxon bowls? (odysseyinheights, physicsforums.com, Mar 18, 2016), https://www.physicsforums.com/threads/how-is-bernoullis-equation-related-to-saxon-bowls.862660/
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Problem No. 7 “Balls on a string”

Put a string through a ball with a hole in it such that the ball can move freely along the string. Attach another ball to one end of the string. When you move the free end periodically, you can observe complex movements of the two balls. Investigate the phenomenon.

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- IYPT 2020 Problem 7 Ball on a String Demonstration (youtube, Canadian Young Physicists' Tournament, 15.09.2019), https://youtu.be/J_qSH3plftg
- Astrojax Trick Tutorial: Vertical Orbit (youtube, US ASTROJAX, 06.12.2013), https://youtu.be/VmGJiIHqn6E
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Problem No. 8 “Soap membrane filter”

A heavy particle may fall through a horizontal soap film without rupturing it. However, a light particle may not penetrate the film and may remain on its surface. Investigate the properties of such a membrane filter.

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- Self-Healing Soap Films (Nicole Sharp, fyfluiddynamics.com, November 23, 2012), https://fyfluiddynamics.com/2012/11/some-soap-films-are-capable-of-self-healing-after/

Background reading

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Problem No. 9 “Magnetic levitation”

Under certain circumstances, the "flea" of a magnetic stirrer can rise up and levitate stably in a viscous fluid during stirring. Investigate the origins of the dynamic stabilization of the "flea" and how it depends on the relevant parameters.

Background reading

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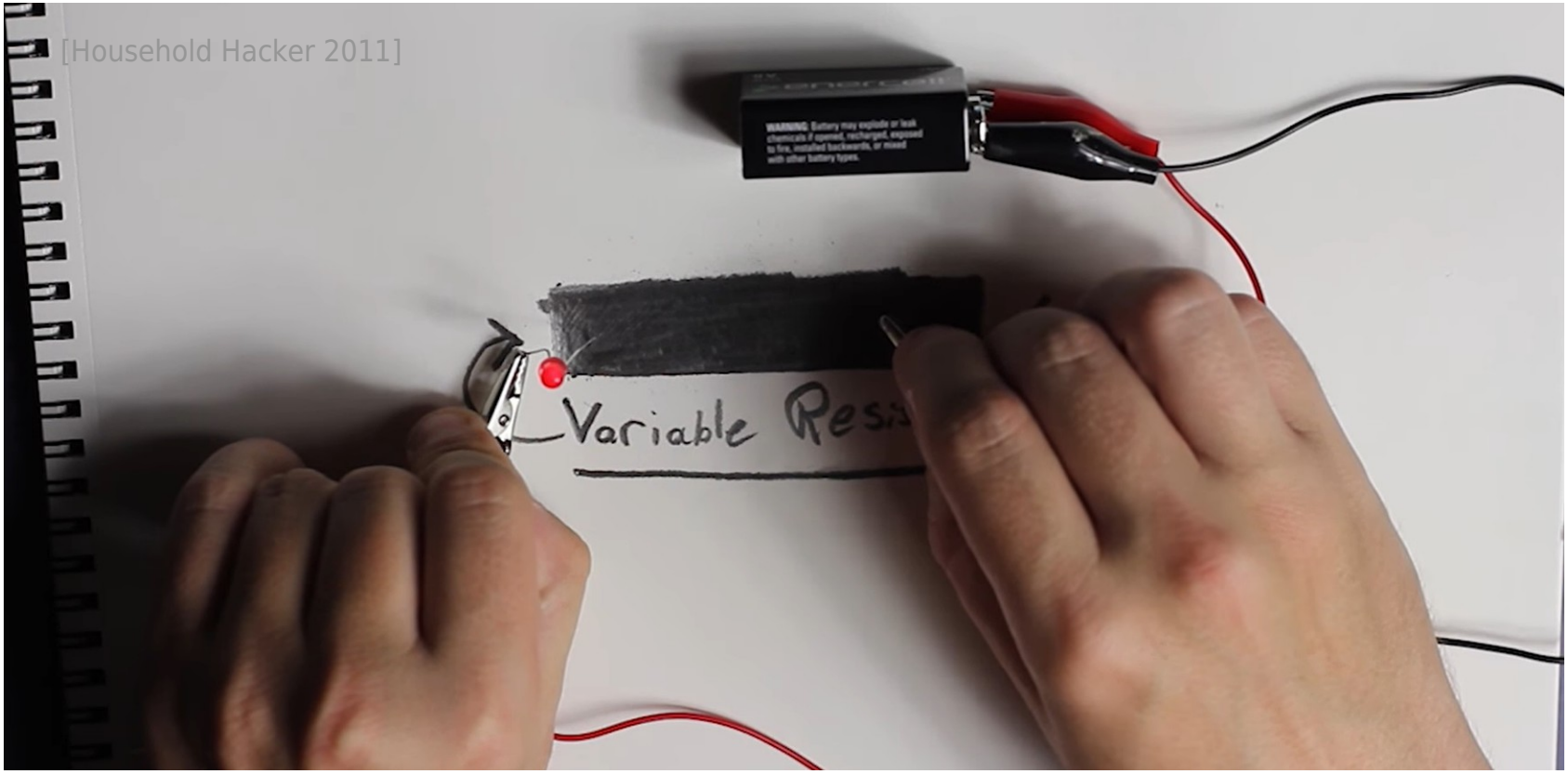

Problem No. 10 “Conducting lines”

A line drawn with a pencil on paper can be electrically conducting. Investigate the characteristics of the conducting line.

Background reading

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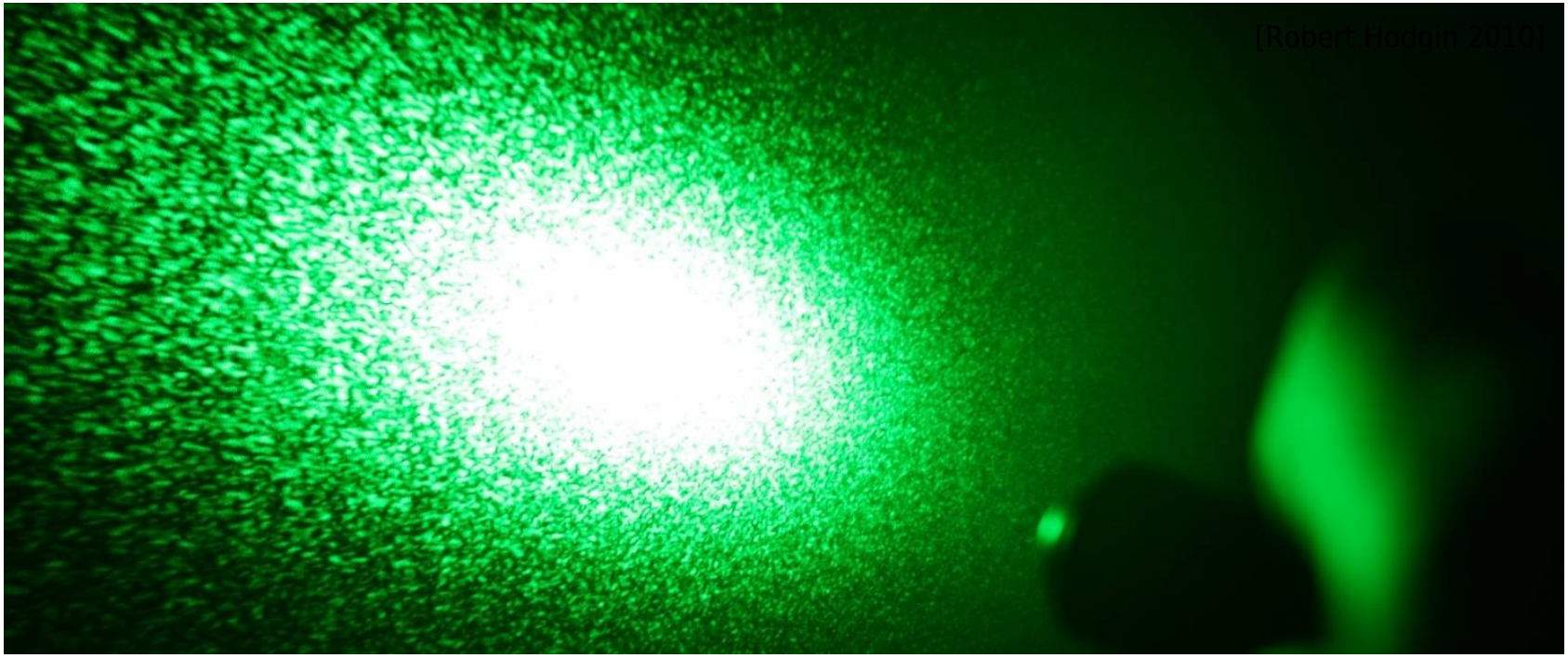

Problem No. 11 “Drifting speckles”

Shine a laser beam onto a dark surface. A granular pattern can be seen inside the spot. When the pattern is observed by a camera or the eye, that is moving slowly, the pattern seems to drift relative to the surface. Explain the phenomenon and investigate how the drift depends on relevant parameters.

Background reading

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Problem No. 12 “Polygon vortex”

A stationary cylindrical vessel containing a rotating plate near the bottom surface is partially filled with liquid. Under certain conditions, the shape of the liquid surface becomes polygon-like. Explain this phenomenon and investigate the dependence on the relevant parameters.

Background reading

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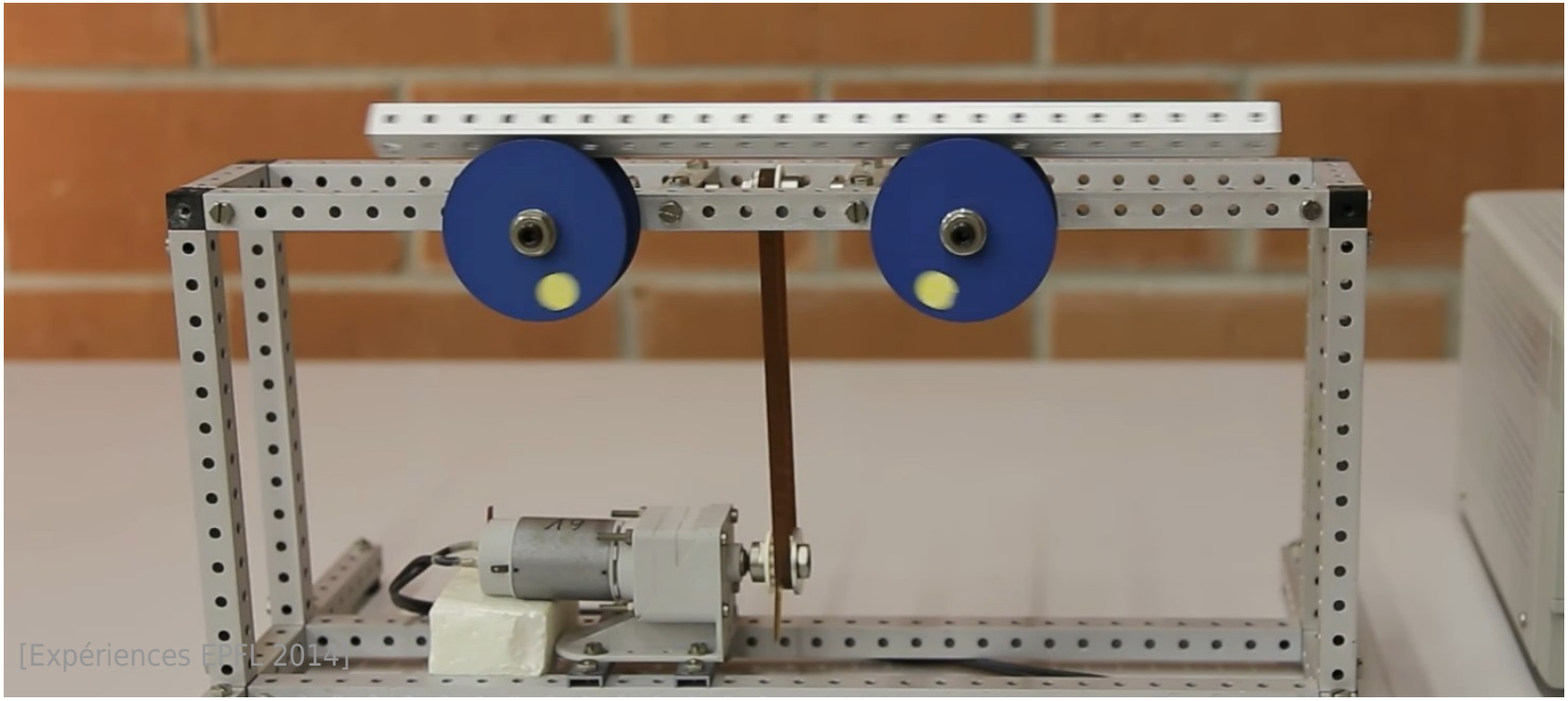

Problem No. 13 “Friction oscillator”

A massive object is placed onto two identical parallel horizontal cylinders. The two cylinders each rotate with the same angular velocity, but in opposite directions. Investigate how the motion of the object on the cylinders depends on the relevant parameters.

Background reading

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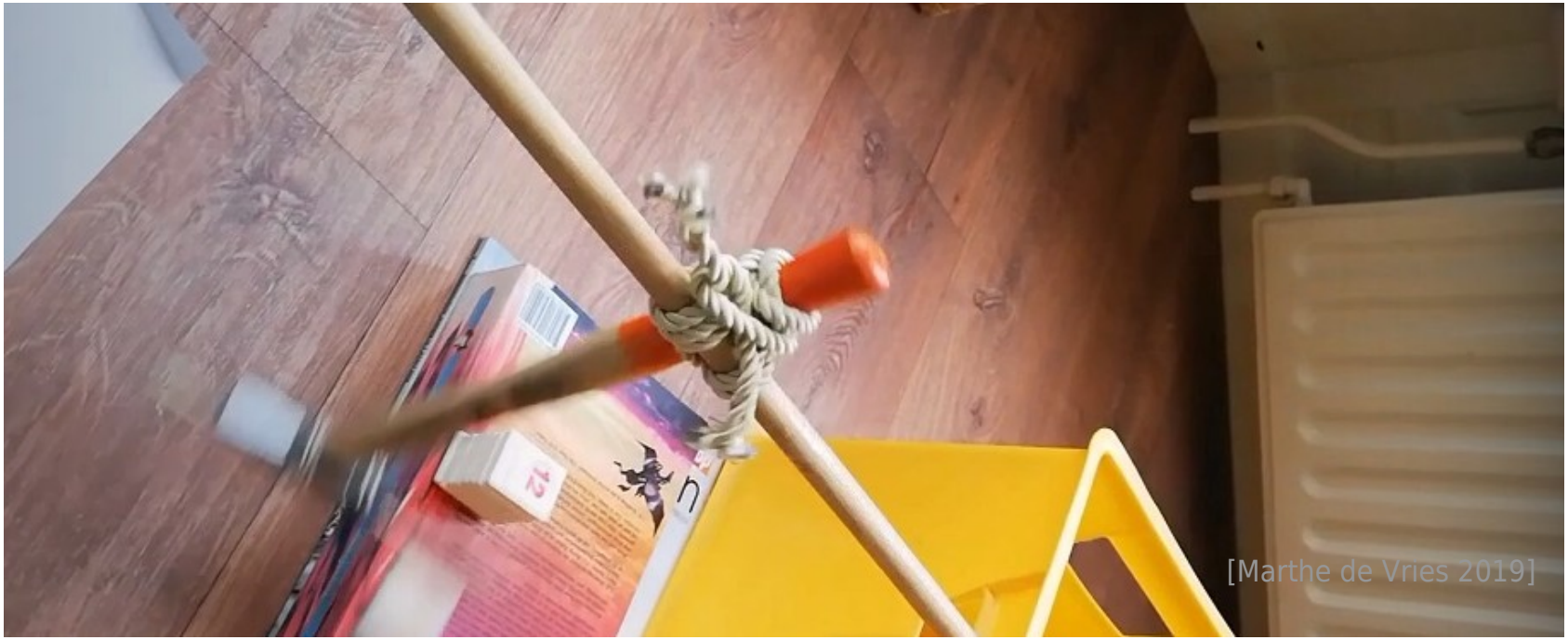

Problem No. 14 “Falling tower”

Identical discs are stacked one on top of another to form a freestanding tower. The bottom disc can be removed by applying a sudden horizontal force such that the rest of the tower will drop down onto the surface and the tower remains standing. Investigate the phenomenon and determine the conditions that allow the tower to remain standing.

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Problem No. 15 “Pepper pot”

If you take a salt or pepper pot and just shake it, the contents will pour out relatively slowly. However, if an object is rubbed along the bottom of the pot, then the rate of pouring can increase dramatically. Explain this phenomenon and investigate how the rate depends on the relevant parameters.

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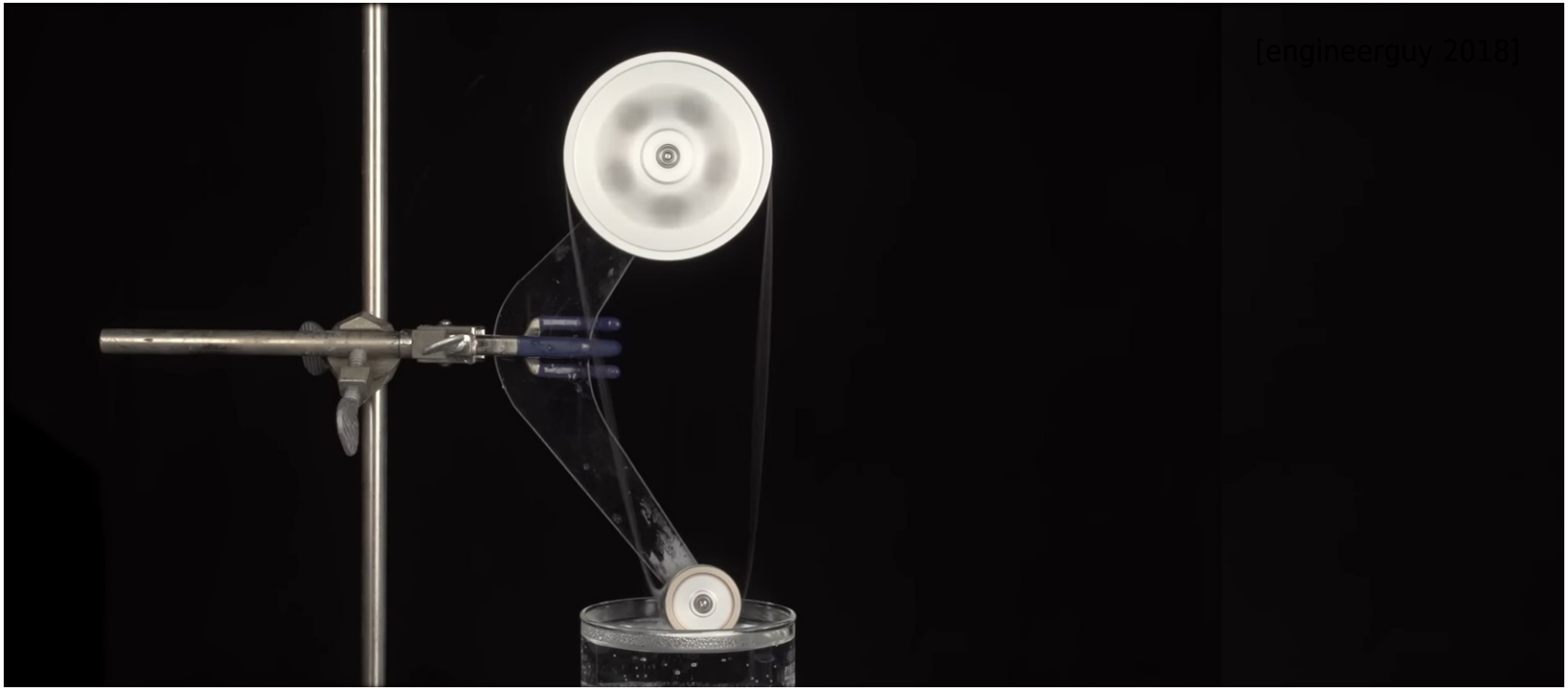

Problem No. 16 “Nitinol engine”

Place a nitinol wire loop around two pulleys with their axes located at some distance from each other. If one of the pulleys movable along string is immersed into hot water, the wire tends to straighten, causing a rotation of the pulleys. Investigate the properties of such an engine.

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Problem No. 17 “Playing card”

A standard playing card can travel a very long distance provided that spin is imparted as it is thrown. Investigate the parameters that affect the distance and the trajectory.

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

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

Albert Einstein

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

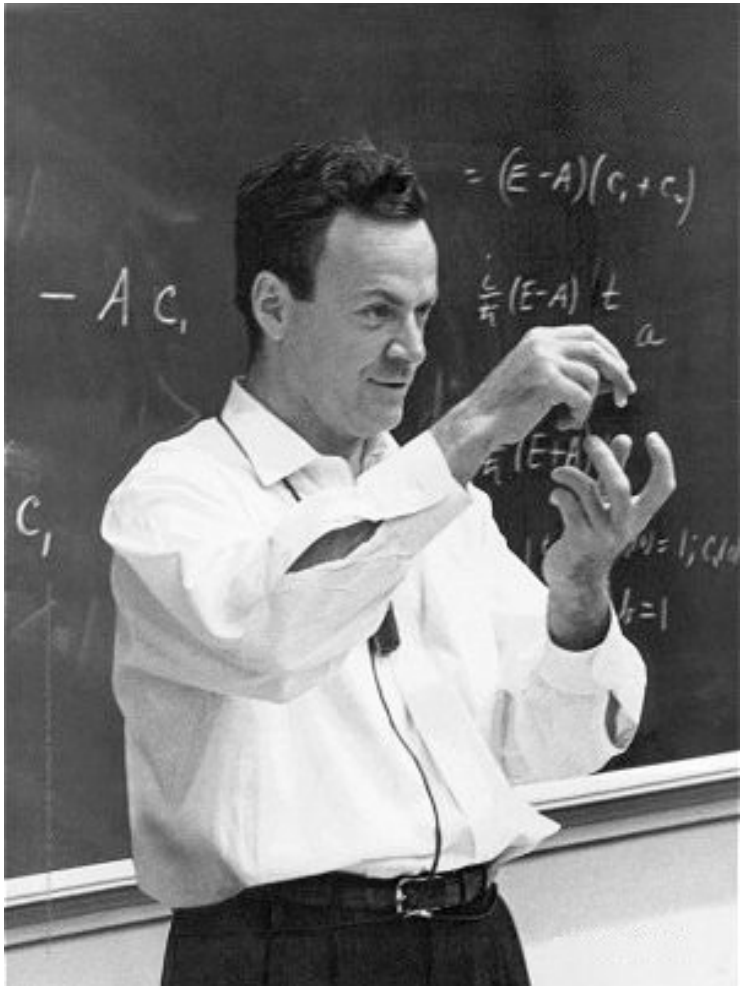
- Originality and independence of your work is always considered as of a first priority
- There is no “correct answer” to any of the IYPT problems
- Having a deep background knowledge about earlier work is a must
- Taking ideas without citing is a serious misconduct
- Critically distinguishing between 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?

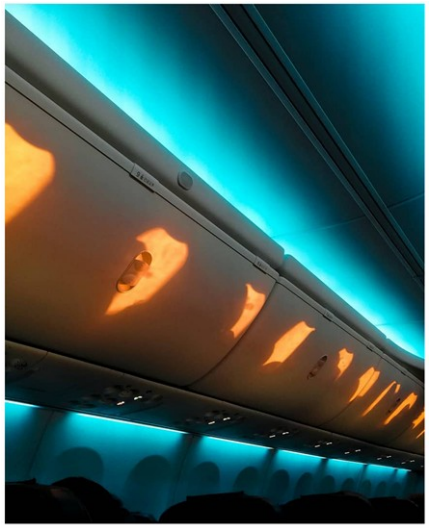
- “I’ve very often made mistakes in my physics by thinking the theory isn’t as good as it really is, thinking that there are lots of complications that are going to spoil it
- — an attitude that anything can happen, in spite of what you’re pretty sure should happen.”



R.P. Feynman. Surely You’re Joking, Mr. Feynman (Norton, New York, NY, 1985)

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 2020, or plan bringing together the Kit for 2021, 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 33rd IYPT' 2020: references, questions and advices

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July 14, 2019...December 25, 2023

* http://kit.ilyam.org