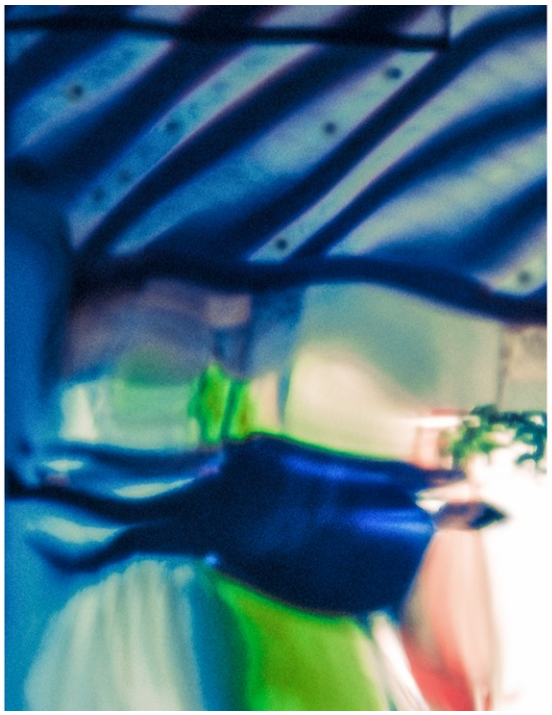

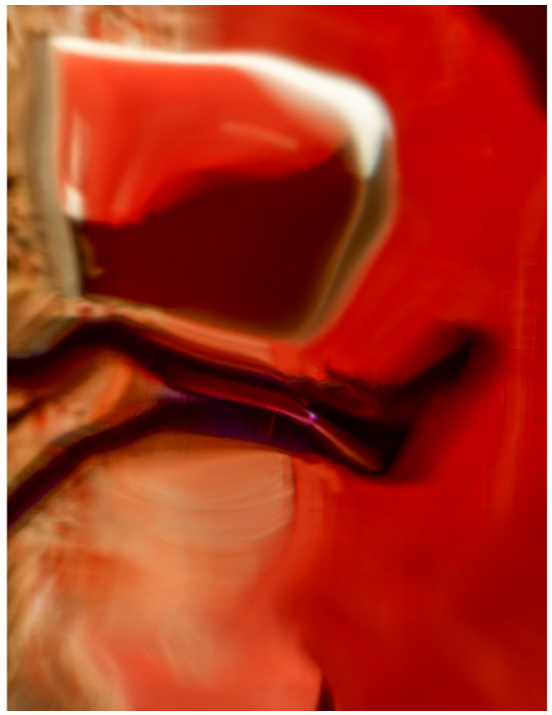

Preparation to the Young Physicists' Tournaments' 2024

Ilya Martchenko, Foundation for Youth Tournaments


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

Invitation 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 2024, or plan bringing together the Kit for 2025, 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 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 may generate original, state-of-the-art research problems, widely used in other activities and at other events
  - and also the authors of the Kit, who could rapidly acquire a competence for the future activities and have a great learning experience

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

[Fabian Reus 2015]

Problem No. 1 “Invent yourself”

Take a box (e.g. a matchbox), filled with identical objects (e.g. matches, balls, …). Find a method to determine the number of objects in the box solely by the sound produced while shaking the box. How does the accuracy depend on the properties of the objects, the box, and the packing density?

Background reading

- How accuratley can you determine the number of matchsticks in a matchbox from the sound it makes when you shake it? (physics.stackexchange.com, 2023), https://physics.stackexchange.com/questions/759575/how-accuratley-can-you-determine-the-number-of-matchsticks-in-a-matchbox-from-th
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Problem No. 2 “Droplet microscope”

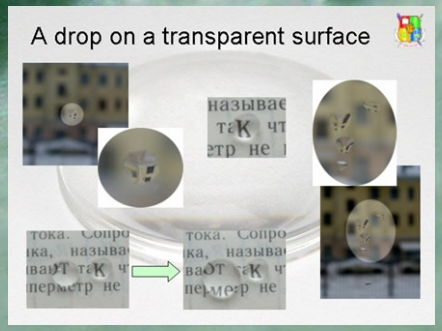
By looking through a single water droplet placed on a glass surface, one can observe that the droplet acts as an imaging system. Investigate the magnification and resolution of such a lens.

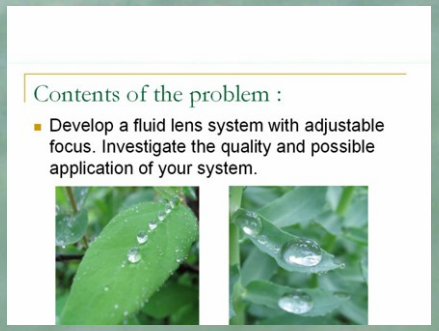
IYPT history

Problem No. 12 “Fluid lens” (IYPT 2007)

Develop a fluid lens system with adjustable focus. Investigate the quality and possible applications of your system.

Reported 5 times, rejected 2 times at IYPT 2007





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- One drop of water turns an iPhone into a Microscope - Day of Curiosity #17 (youtube, Jeremy Pedersen, 30.03.2022), https://youtu.be/aYQsxB2p4KI
- Make a FREE Microscope! (DIY With a Water Drop Lens) (youtube, Squint Science, 28.07.2020), https://youtu.be/cnKCbW75dIk

Background reading

- Laser Microscope Made With a Drop of Water (youtube, The Action Lab, 11.07.2021), https://youtu.be/bYEuo3j2Ly0
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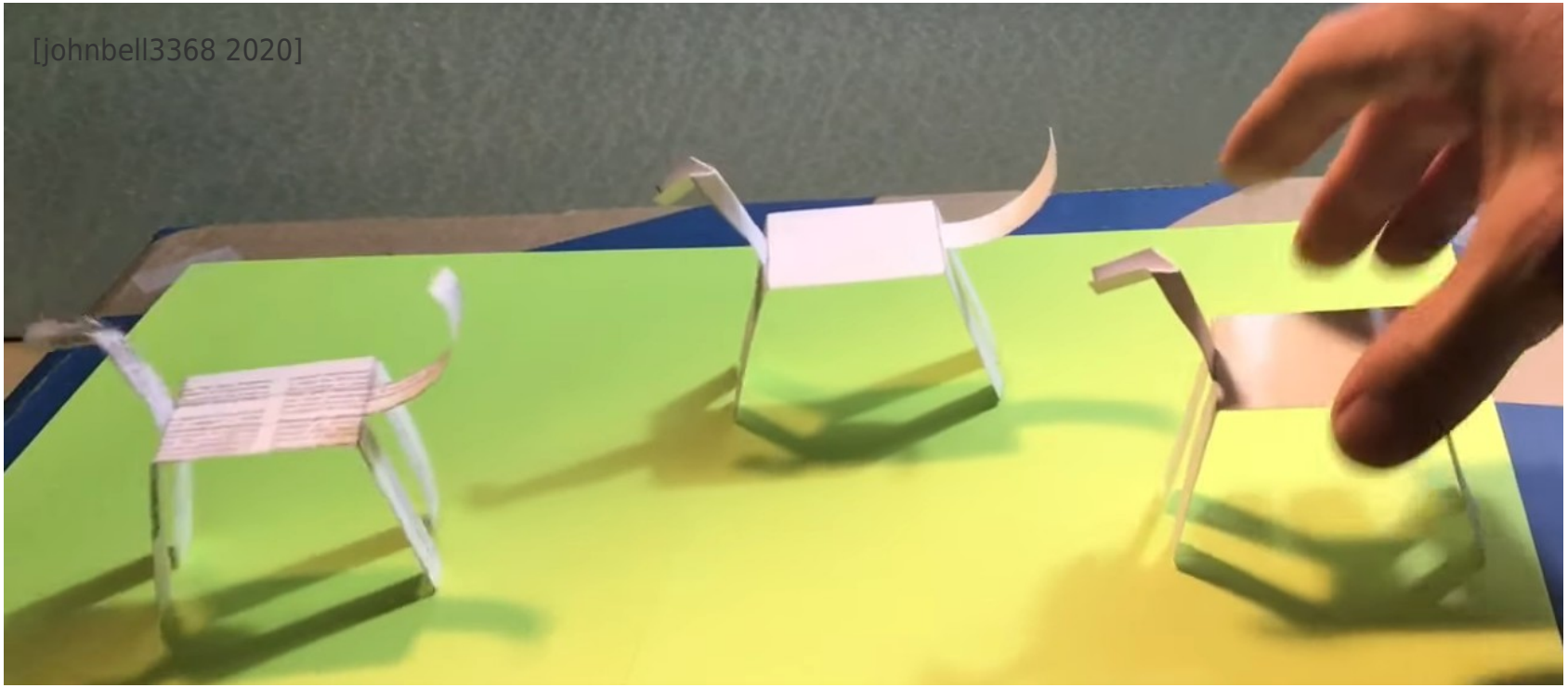


Problem No. 3 “Rigid ramp walker”

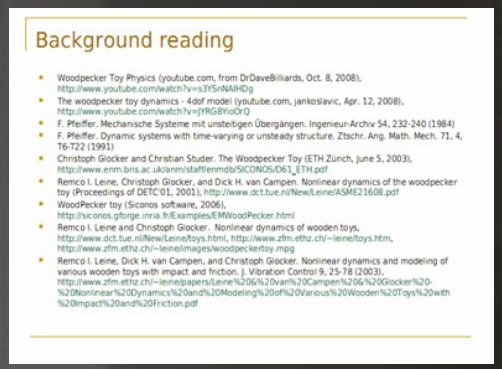
Construct a rigid ramp walker with four legs (e.g. in the form of a ladder). The construction may begin to ‘walk’ down a rough ramp. Investigate how the geometry of the walker and relevant parameters affect its terminal velocity of walking.

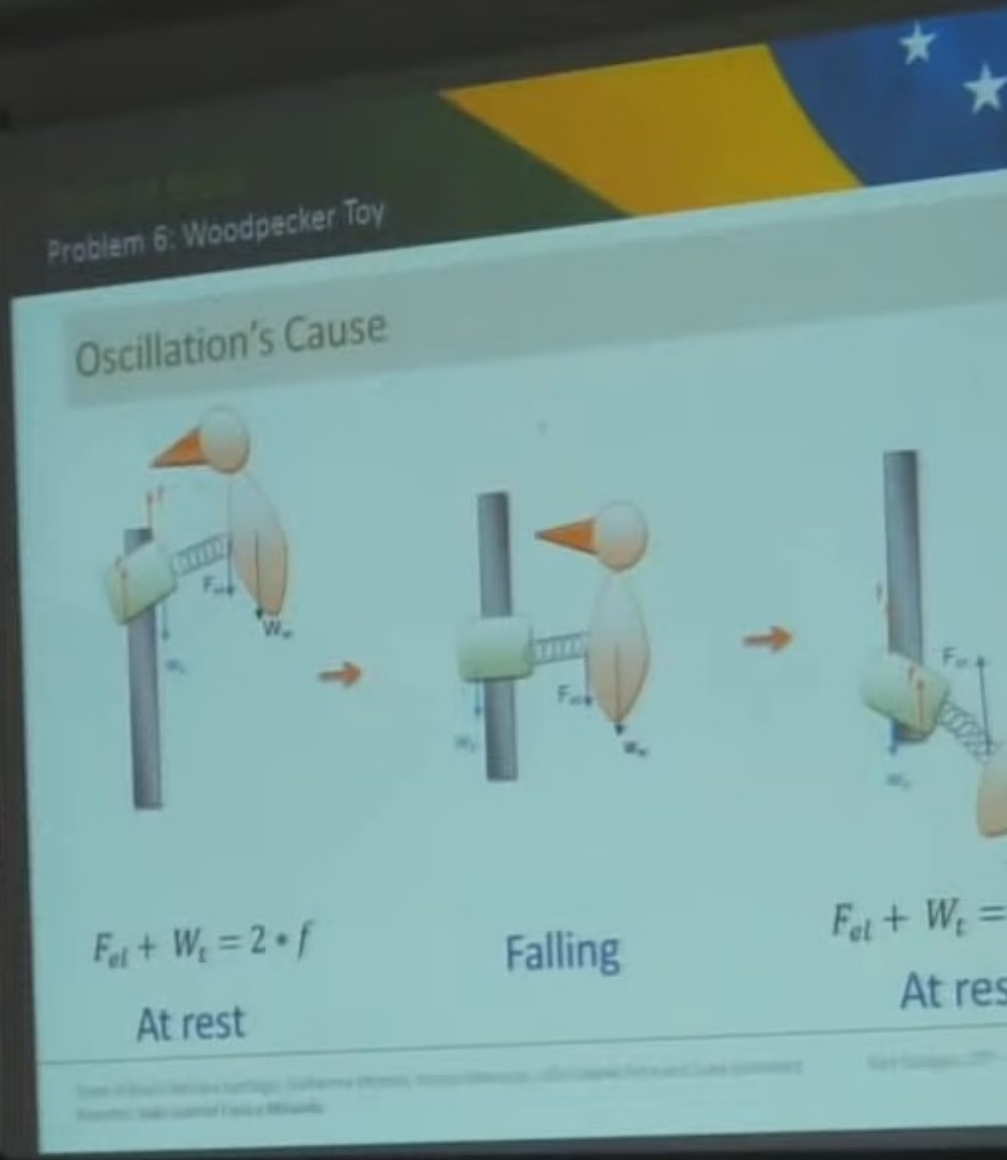
IYPT history

Problem No. 6. “Woodpecker toy” (IYPT 2012)

A woodpecker toy (see picture) exhibits an oscillatory motion. Investigate and explain the motion of the toy.

Reported 10 times, rejected 5 times at IYPT 2012





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- Walking Horses Made of Paper - J Bell (youtube, John Bell, 29.03.2020), https://youtu.be/zxxZXrgUq1c
- The Walking Horse │ Physics Toy │ Gravity Powered Walking Toy (youtube, The Amaze Lab, 16.04.2020), https://youtu.be/GmSa9-UIyhk
- Cardboard ramp walkers..... easy build (youtube, Bruce Yeany, 01.06.2020), https://youtu.be/kx-1RuBoSqs
- Easy to Make Cardboard Ramp Walker (youtube, Ludic Science, 28.07.2020), https://youtu.be/DjwI-A6S4qs
- Science Lab: DIY Ramp Walker Toys (youtube, Charlotte County Community Services, 05.10.2020), https://youtu.be/GHG8PLyJv38

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- Make a Dinosaur Ramp Walker (youtube, OntarioScienceCentre, 27.11.2020), https://youtu.be/aLv9ypg70wk
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- Toy Physics - Part 3: Waddling Duck (youtube, DrDaveBilliards, 09.10.2008), https://youtu.be/huOoqu6O-Yo
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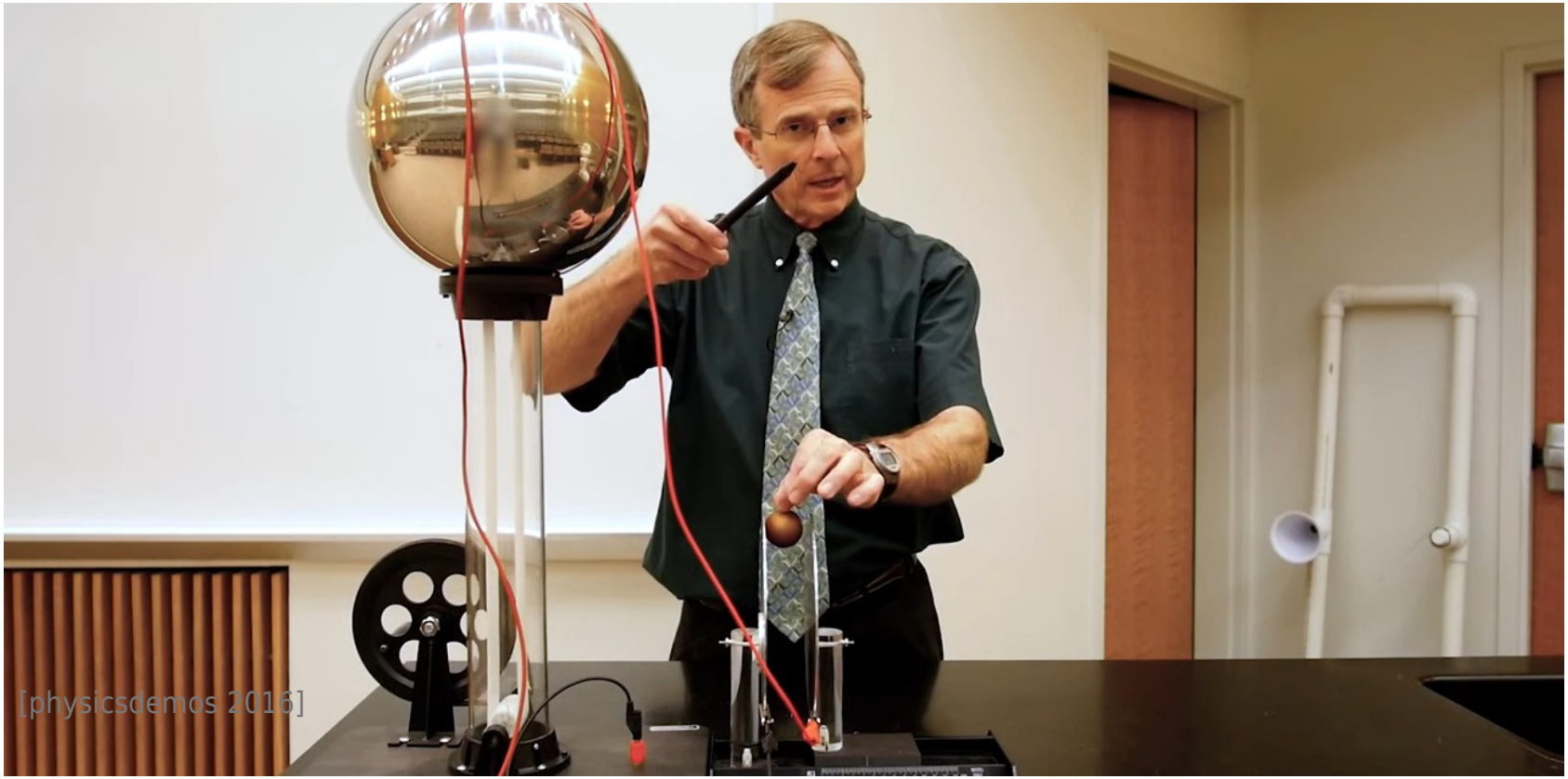


Problem No. 4 “Charge meter”

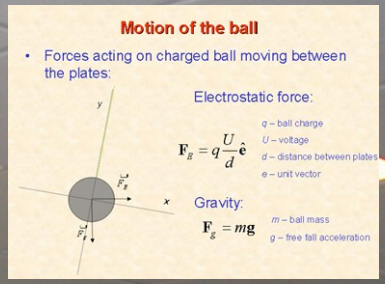
A lightweight ball is suspended from a thread in the area between two charged plates. If the ball is also charged it will be deflected to one side at a certain angle. What is the accuracy of such a device for measuring the amount of charge on the ball? Optimise your device to measure the smallest possible charge on the ball.

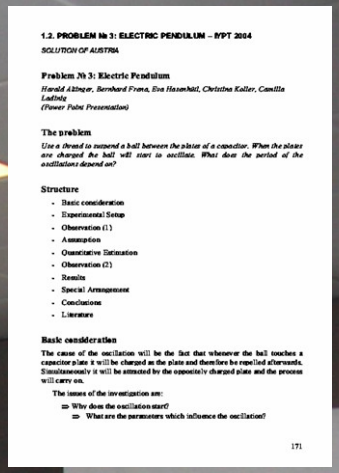
IYPT history

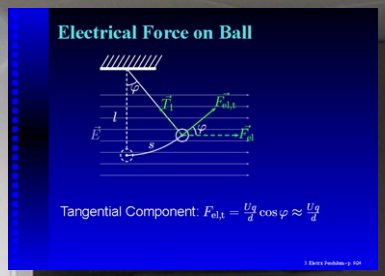
Problem No. 3 “Electric pendulum” (IYPT 2004)

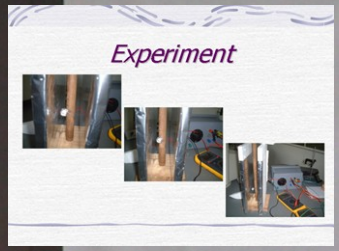
Use a thread to suspend a suitable ball between the plates of a capacitor. When the plates are charged the ball will start to oscillate. What does the period of the oscillations depend on?

Reported 7 times, rejected 3 times at IYPT 2004









Background reading

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Problem No. 5 “Ping pong rocket”

A ping pong ball is placed in a container of water. When the container is dropped, the ping pong ball will get launched to a great height. What maximum height can you reach with up to 2 liters of water?

Background reading

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- Ping Pong Blast Off (youtube, Dr. Pi's STEAM LAB, 14.12.2020), https://youtu.be/74SZjPQ4Dg0

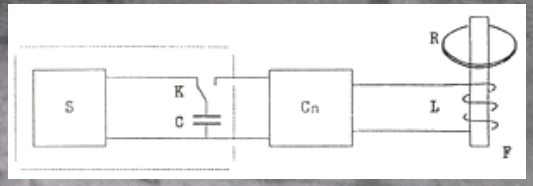
Problem No. 6 “Non-contact resistance”

The responses of a LRC circuit driven by an AC source can be changed by inserting either a non-magnetic metal rod or a ferromagnetic rod into the inductor coil. How can we obtain the magnetic and electric properties of the inserted rod from the circuit’s responses?

IYPT history

Problems Nos. 9-10 “Gun” (IYPT 1993)

The picture shows an electromagnetic gun circuit. It can launch metal rings.
(S, C, K) is a power supply consisting of
S, a source of constant voltage in the range 10—300 V,
C, a capacitor with C=1000 μF,
K, a switch;
L is an induction coil;
F is a ferromagnetic core;
R is a metal ring projectile with mass from 1 to 100 g.
C_n is a converter (some device that converts the energy passing from the capacitor to inductance L in a way you need.) This element does not contain energy sources. It may be completely absent from your gun.
You are to construct, make and demonstrate the electromagnetic gun. It is worth mentioning that the demonstration of your gun will take place with the power supply (elements S, C and K) presented by the Organizing Committee of the YPT. Develop two variants of the gun:
9. A long-range gun is to be constructed to shoot a ring to a maximum altitude. The control parameter is the quantity $H=kh/U^2$, where k=10000 V^2, h is the height of the projectile, U is the voltage to which the capacitor is charged.
10. A gun-lift is to be constructed to achieve the maximum work of lifting a weight (ring). The control parameter is $W=mgh$, where m is the mass of the ring, g=10 m/s^2.



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- Simulation of the Thomson Ring Experiment (Max Bigelmayr), http://www.bigel-labs.de/3.Physik/Thomson/web

Problem No. 7 “Giant sounding plate”

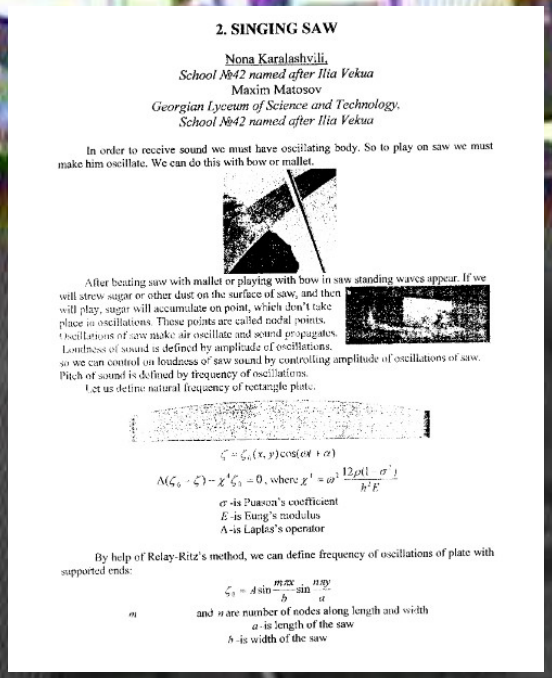
When a large, thin and flexible plate (e.g. plastic, metal or plexiglass) is bent, it may produce a loud and unusual howling sound. Explain and investigate this phenomenon.

IYPT history

Problem No. 2 “Singing saw” (IYPT 2001)

Some people can play music on a handsaw. How do they get different pitches? Give a quantitative description of the phenomenon.

Reported 7 times, rejected 2 times at IYPT 2001



2. SINGING SAW

Nona Karalashvili,
School №42 named after Ilia Vekua
Maxim Matosov
Georgian Lyceum of Science and Technology,
School №42 named after Ilia Vekua

In order to receive sound we must have oscillating body. So to play on saw we must make him oscillate. We can do this with bow or mallet.

After beating saw with mallet or playing with bow in saw standing waves appear. If we will strew sugar or other dust on the surface of saw, and then will play, sugar will accumulate on point, which don't take place in oscillations. These points are called nodal points. Oscillations of saw make air oscillate and sound propagates. Loudness of sound is defined by amplitude of oscillations, so we can control on loudness of saw sound by controlling amplitude of oscillations of saw. Pitch of sound is defined by frequency of oscillations.

Let us define natural frequency of rectangle plate.

$$\zeta = \zeta_0(x, y)\cos(\omega t + \alpha)$$

$$\Delta(\zeta_0 - \zeta) - \chi^4\zeta_0 = 0, \text{ where } \chi^4 = \omega^2 \frac{12\rho(1-\sigma^2)}{h^2 E}$$

σ -is Puasson's coefficient
E -is Eurig's modulus
Δ -is Laplas's operator

By help of Relay-Ritz's method, we can define frequency of oscillations of plate with supported ends:

$$\zeta_0 = A\sin\frac{m\pi x}{b}\sin\frac{n\pi y}{a}$$

m and n are number of nodes along length and width
a -is length of the saw
b -is width of the saw

Background reading

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- S. Shankar, P. Bryde, and L. Mahadevan. Geometric control of topological dynamics in a singing saw. PNAS 119, 17, e2117241119 (2022)
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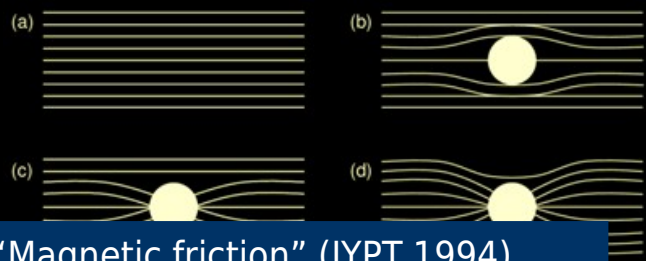
- R. Worland. The musical saw: Musical acoustics of trapped vibrational modes in a curved blade. J. Acoust. Soc. Am. 145, 1750–1750 (2019)
- The unique mathematical physics of the singing saw (Amit Malewar, techexplorist.com, Apr 23, 2022), https://www.techexplorist.com/unique-mathematical-physics-singing-saw/
- Musical Saw / Scie Musicale : Gounod, Ave Maria par Grégoire Blanc (youtube, Grégoire Blanc, 15.12.2014), https://youtu.be/i5KiodkF2m4
- N. H. Fletcher and T. D. Rossing. The physics of musical instruments (New York, Springer-Verlag, 1991)
- Lord Rayleigh. The Theory of Sound. (London, Macmillan, 1877, Courier Dover Publications, 1945), http://books.google.com/books?id=v4NSAlsTwnQC

Prob. No. 8 “Another magnetic levitation”

Place a large disk-shaped magnet on a non-magnetic conductive plate. When a smaller magnet is moved under the plate, the magnet on top may levitate under certain conditions. Investigate the levitation and the possible motion of the magnet on top.

IYPT history



Problem No. 1 “Invent it yourself” (IYPT 1992)

“Magnetic suspension” may be used in high speed trains of the future. Design and make an experimental model of such a suspension.

Reported 1 times, rejected 1 times at IYPT 1992

Problem No. 3 “Magnetism” (IYPT 1994)

A cylindrical permanent magnet falling inside a copper tube is found to move at an almost constant velocity, the slower the thicker and the walls of the tube. Use this fact to formulate a problem (See also 14).

Reported 3 times, rejected 3 times at IYPT 1994

Problem No. 16 “Magnetic brakes” (IYPT 2014)

When a strong magnet falls down a non-ferromagnetic metal tube, it will experience a retarding force. Investigate the phenomenon.

Reported 15 times, rejected 2 times at IYPT 2014

Problem No. 14 “Magnetic friction” (IYPT 1994)

To investigate the phenomenon described in the problem 3 we suggest to create the device containing the following elements:
a copper plate (or a set of plates) 0.3 to 15 mm thick. The length and the width of the plate may be chosen according to one’s convenience, but they should be large enough to avoid the effect of the boundaries;
a cylindrical electromagnet with a flat butt-end;
a device providing free motion of the flat butt-end of the electric magnet over the horizontal surface of the copper plate. It is very important that the gap between the magnet and the plate is small as possible and constant everywhere;
the push providing the uniform motion of the magnet at a given velocity over the plate surface.
Introduce the following notation: T — the push (and the force of magnetic friction), v — the velocity of the magnet, h — the thickness of the plate. Investigate and determine experimentally the dependence of T on h at v=const for several values of v.

Reported 0 times, rejected 0 times at IYPT 1994

Background reading

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- M. Bonvalot, P. Courtois, P. Gillon, and R. Tournier. Magnetic levitation stabilized by eddy currents. J. Magnetism and Magnetic Materials 151, 1-2, 283-289 (1995)
- A. Schilling. The physics of diamagnetic levitation (2021), arXiv:2101.02160 [physics.ed-ph]
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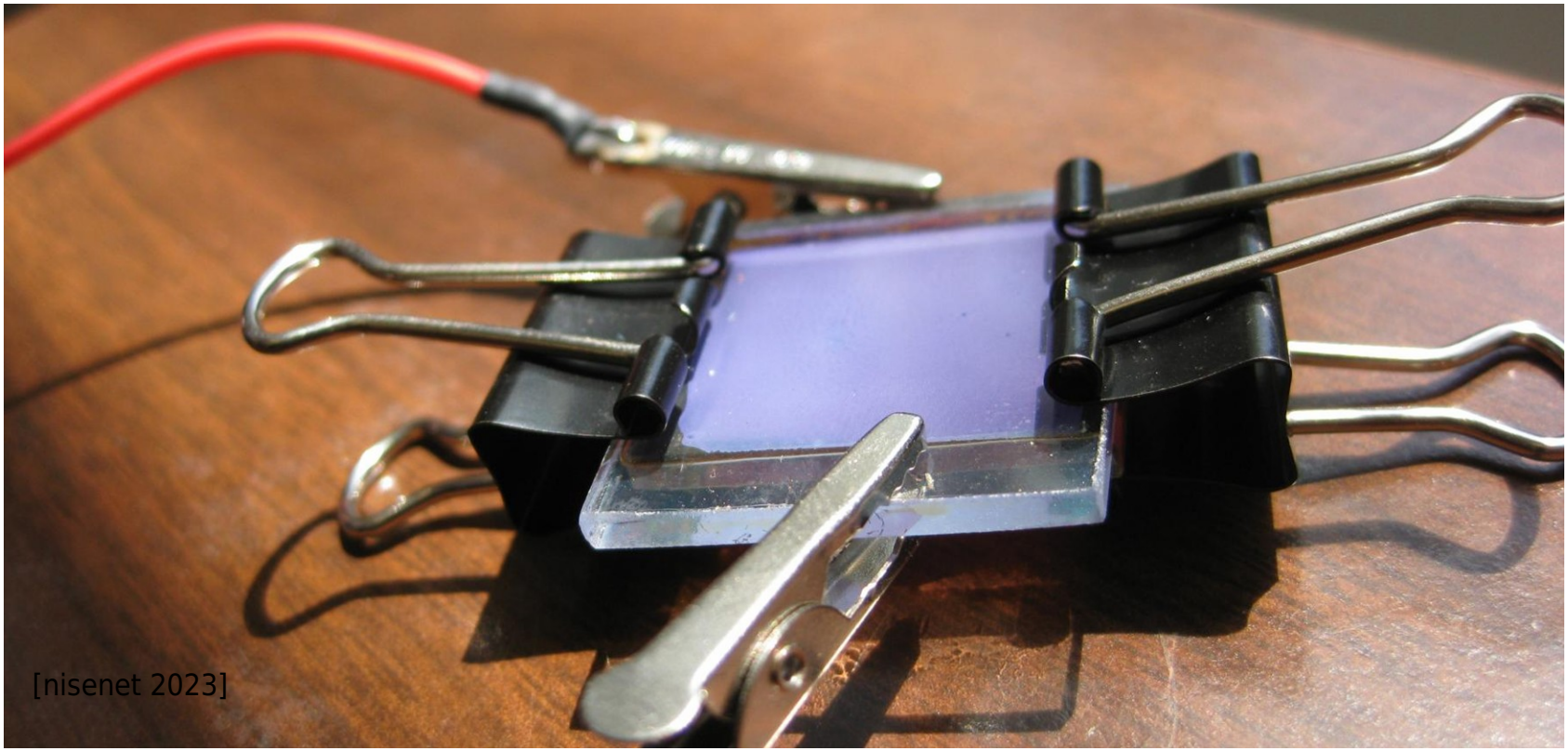
- Eddy Current Levitation (youtube, Chris's Workbench, 28.08.2017), https://youtu.be/A7BScXvM8w0
- Stable eddy current induction levitation of aluminum disk (youtube, davekni, 18.02.2018), https://youtu.be/AHED5xSnnM8
- Copper's Surprising Reaction to Strong Magnets | Force Field Motion Dampening (youtube, NightHawkInLight, 26.01.2018), https://youtu.be/sENgdSF8ppA
- Eddy Currents, Magnetic Braking and Lenz's Law (youtube, Fiona Meade, 21.06.2011), http://youtu.be/otu-KV3iH_I
- Wikipedia: Faraday's law of induction, https://en.wikipedia.org/wiki/Faraday%27s_law_of_induction
- Wikipedia: Lenz's law, https://en.wikipedia.org/wiki/Lenz%27s_law
- C. Elbuken, E. Shameli, and M. B. Khamesee. Modeling and analysis of eddy-current damping for high-precision magnetic levitation. IEEE Trans. on Magnetics 43, 1, 26-32 (2007), https://celbuken.unam.bilkent.edu.tr/wp-content/uploads/2017/01/2-Elbuken07-IEEE-magnetics-eddy-current.pdf



Problem No. 9 “Juicy solar cell”

A functional solar cell can be created using conducting glass slides, iodine, juice (eg. blackberry) and titanium dioxide. This type of cell is called a Grätzel cell. Make such a cell and investigate the necessary parameters to obtain maximum efficiency.

Background reading

- Make a Grätzel cell (edu.rsc.org), https://edu.rsc.org/resources/make-a-grtaand776zel-cell/1290.article
- How to Build & Use a Dye-Sensitized Solar Cell (DSSC) + a Discussion on Energy & Efficiency (instructables.com), https://www.instructables.com/How-to-Build-Use-A-Dye-Sensitized-Solar-Cell-DS/
- Constructing a Dye Sensitized Solar Cell (youtube, Neal Abrams, 09.10.2009), https://youtu.be/17SsOKEN5dE
- Wikipedia: Dye-sensitized solar cell, https://en.wikipedia.org/wiki/Dye-sensitized_solar_cell

Problem No. 10 “Magnetic gear”

Take several identical fidget spinners and attach neodymium magnets to their ends. If you place them side by side on a plane and rotate one of them, the remaining ones start to rotate only due to the magnetic field. Investigate and explain the phenomenon.

Background reading

- Wikipedia: Magnetic gear, https://en.wikipedia.org/wiki/Magnetic_gear
- Magnetic Gears (youtube, K&J Magnetics, 03.08.2021), https://youtu.be/HBgjueoZ58Q
- Magnetic Gears (kjmagnetics.com), https://www.kjmagnetics.com/blog.asp?p=magnetic-gear
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- "Free Energy" Magnetic Fidget Spinner Motor Real? (youtube, electronicsNmore, 22.07.2017), https://youtu.be/BSdSDfOWbNs
- A. Ya. Krasil'nikov and A. Ya. Krasil'nikov. Calculation of the shear force of highly coercive permanent magnets in magnetic systems With consideration of affiliation to a certain group based on residual induction. Chem. Petroleum Engineering 44, 7-8, 362-365 (2008)
- E. P. Furlani. Permanent magnet and electromechanical devices (Academic Press, San Diego, 2001)

Background reading

- W. Lorimer and A. Hartman. Magnetization pattern for increased coupling in magnetic clutches. IEEE Trans. Magnetics 33, 5 (1997)
- A. Ya. Krasil'nikov and A. A. Krasil'nikov. Torque determination for a cylindrical magnetic clutch. Rus. Engineering Res. 29, 6, 544–547 (2009)
- Demonstration of Magnetic Gear (youtube, Mau Hing CHAN, 20.04.2022), https://youtu.be/INcGbOcSqEg

Problem No. 11 “Pumping straw”

A simple water pump can be made using a straw shaped into a triangle and cut open at the vertices. When such a triangle is partially immersed in water with one of its vertices and rotated around its vertical axis, water may flow up through the straw. Investigate how the geometry and other relevant parameters affect the pumping speed.

Background reading

- Pumping Straw - a centrifugal pump (thenakedscientists.com, 19 April 2009), https://www.thenakedscientists.com/get-naked/experiments/pumping-straw-centrifugal-pump
- How to make a Water pump with a Straw - dArtofScience (youtube, d'Art of Science, 12.12.2014), https://youtu.be/yf1tSFXhnjw
- Wikipedia: Centrifugal pump, https://en.wikipedia.org/wiki/Centrifugal_pump
- STEM Toy: Centrifugal Sprinkler (Yamiuo, instructables.com), https://www.instructables.com/STEM-Toy-Centrifugal-Sprinkler/
- Straw Sprinkler (youtube, Ayushi Verma, 18.10.2021), https://youtu.be/q7dslGdqYL0
- Centrifugal Straw Sprinkler Experiment - How to make a sprinkler with a straw (youtube, Kids Fun Science, 22.05.2017), https://youtu.be/IapoJBslMGo
- The drinking straw pump (E. Inglis-Arkell, gizmodo.com, Sep 16, 2011), https://gizmodo.com/the-drinking-straw-pump-5840539
- Centrifugal sprinkler (Sprinkler Straw) experiment (robolab.in), https://www.robolab.in/centrifugal-sprinkler-sprinkler-straw-experiment/
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Problem No. 12 “The soap spiral”

Lower a compressed slinky into a soap solution, pull it out and straighten it. A soap film is formed between the turns of the slinky. If you break the integrity of the film, the front of the film will begin to move. Explain this phenomenon and investigate the movement of the front of the soap film.

Background reading

- Wikipedia: Minimal surface, https://en.wikipedia.org/wiki/Minimal_surface
- Wikipedia: Young-Laplace_equation, https://en.wikipedia.org/wiki/Young%E2%80%93Laplace_equation
- Wikipedia: Plateau's problem, https://en.wikipedia.org/wiki/Plateau%27s_problem
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- F. J. Almgren Jr. and J. E. Taylor. The geometry of soap films and soap bubbles. Scientific American 235, 1, 82–93 (July 1976)
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- L. Giomi and L. Mahadevan. Minimal surfaces bounded by elastic lines. Proc. Royal Soc. A 468, 1851-1864 (2012)
- Playing with bubbles and slinky toy - so much fun for kids and adults too! (youtube, Bubbly Heaven, 26.11.2022), https://youtu.be/5o6mIXcOmqs
- Blowing bubbles with a slinky toy (Little Party Heaven, Dec 12, 2022), https://www.bubblyheaven.co.uk/2022/12/12/blowing-bubbles-slinky-toy/
- Amazing slinky bubble skills..... #kieronthemighty #shorts #shortswithcamilla #slinky #slinkytricks (youtube, Kieron the Mighty, 25.08.2022), https://youtu.be/VBoLo8gBpsg
- The chemistry (and a little physics) of soap bubbles (David A. Katz, chymist.com), http://www.chymist.com/soap%20bubbles%20part%203.pdf
- R. A. Young. Longitudinal standing waves on a vertically suspended slinky. Am. J. Phys. 61, 353-360 (1993)

Background reading

- W. J. Cunningham. The physics of the tumbling spring. Am. J. Phys. 15, 348-352 (1947)
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- A. G. Cook. Tough soap films and bubbles. J. Chem. Educ. 15, 161 (1938)
- A. L. Kuehner. Long lived soap bubbles. J. Chem. Educ. 35, 337 (1958)
- C. L. Stong. How to blow soap bubbles that last for months or even years. Sci. Amer. 220 (5), 128 (1969)
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- V. Casteletto, I. Cantat, D. Sarker, R. Bausch, D. Bonn, and J. Meunier. Stability of soap films: Hysteresis and nucleation of black films. Phys. Rev. Lett, 90, 048302 (2003)
- F. Brasz. Soap Films: Statics and Dynamics (Princeton, 2010), http://www.princeton.edu/~stonelab/Teaching/FredBraszFinalPaper.pdf
- A. S. C. Lawrence. Stability in soap films. Nature, 125, 970-971 (1930)

Problem No. 13 “Shooting rubber band”

A rubber band may fly a longer distance if it is non-uniformly stretched when shot, giving it spin. Optimise the distance that a rubber band with spin can reach.

Background reading

- A. T. Oratis and J. C. Bird. Shooting rubber bands: Two self-similar retractions for a stretched elastic wedge. Phys. Rev. Lett. 122, 014102 (2019)
- A. T. Oratis. Shooting rubber bands: dynamic buckling in unconstrained elastic ribbons (Boston University Theses & Dissertations, 2016), https://open.bu.edu/handle/2144/17073
- P. Mason. Finite elastic wave propagation in rubber. Proc. Royal Soc. A 272, 1350, 315-330 (1963)
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- R. Vermorel, N. Vandenberghe, and E. Villermaux. Rubber band recoil. Proc. Royal Soc. A 463, 641-658 (2006)
- How to shoot a rubber band twice as fast, twice as far, and much more accurately (Mark Frauenfelder, boingboing.net, Nov 10, 2016), https://boingboing.net/2016/11/10/how-to-shoot-a-rubber-band-twi.html
- You've Probably Been Shooting Rubber Bands Wrong (youtube, Scam Nation, 10.11.2016), https://youtu.be/fa3vvClBtWg
- How to Shoot Rubber Bands (youtube, GIAN MAN SUPER, 16.06.2021), https://youtu.be/N6QCKvqPMYE
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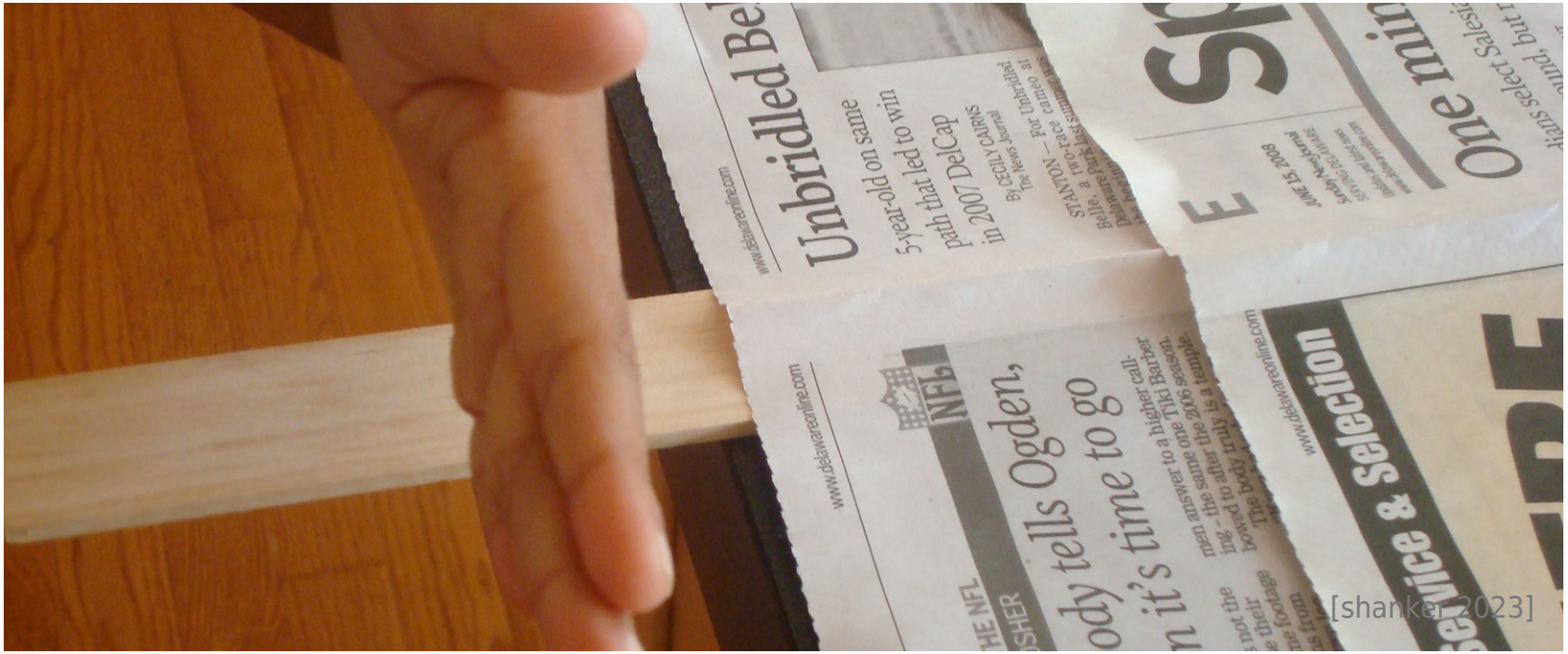

[shanker 2023]

Problem No. 14 “Ruler trick”

Place a ruler on the edge of a table, and throw a ball at its free end. The ruler will fall. However, if you cover a part of the ruler with a piece of paper and repeat the throw, then the ruler will remain on the table while the ball will bounce off it. Explain this phenomenon, and investigate the relevant parameters.

Background reading

- H. G. Riveros. Popular explanations of physical phenomena: Broken ruler, oxygen in the air and water attracted by electric charges. Eur. J. Phys. Educ. 3, 2, 52-57 (2012), http://eu-journal.org/index.php/EJPE/article/view/111/110, https://files.eric.ed.gov/fulltext/EJ1052002.pdf
- D. Ivanov and S. Nikolov. Is it simple to explain simple experiments? The 'heavy newspaper' stick break. Phys. Educ. 55, 1, 015014 (2020)
- J. Leeming. The Real Book of Science Experiments (New York, Garden City, 1954)
- D. Herbert. Mr. Wizard's Science Secrets (New York, Hawthorn, 1965)
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- Atmospheric pressure: Very heavy newspaper (youtube, SciencesFunFunFun, 14.12.2008), https://youtu.be/ywJBZlS81c4
- How Does The Ruler Trick Work? (youtube, The Action Lab, 23.02.2022), https://youtu.be/VI8C52ueO6c
- Air Pressure Breaks a Ruler (youtube, George Mehler, 18.04.2012), https://youtu.be/UvMmfacVA24
- Break a Ruler With Atmospheric Pressure! (youtube, TAMU Physics & Astronomy, 29.06.2022), https://youtu.be/0pJlTzz5pDw
- slow motion ruler broken by newspaper and atmospheric pressure a science with bobert video short (youtube, science with bobert, 19.02.2023), https://youtu.be/T9pRYfa9syk

Background reading

- Heavy paper (youtube, The Experiment Archive, 03.03.2022), https://youtu.be/LYsMInZ7lzI
- Break a Ruler Using Newspaper and Atmospheric Pressure (education.com), https://www.education.com/science-fair/article/pressure-news-pretty-heavy/
- Is that sheet of newspaper really that heavy? (Vijay K. Shanker), https://www.eecis.udel.edu/~vijay/BLAST/air_pressure/newspaper_ruler.html
- Heavy paper (experimentarchive.com), https://www.experimentarchive.com/experiments/heavy-paper/
- Suction Science: How to Break a Ruler Using Air Pressure (Mack Levine, education.com, Jan 9, 2014), https://www.scientificamerican.com/article/bring-science-home-air-pressure-ruler/
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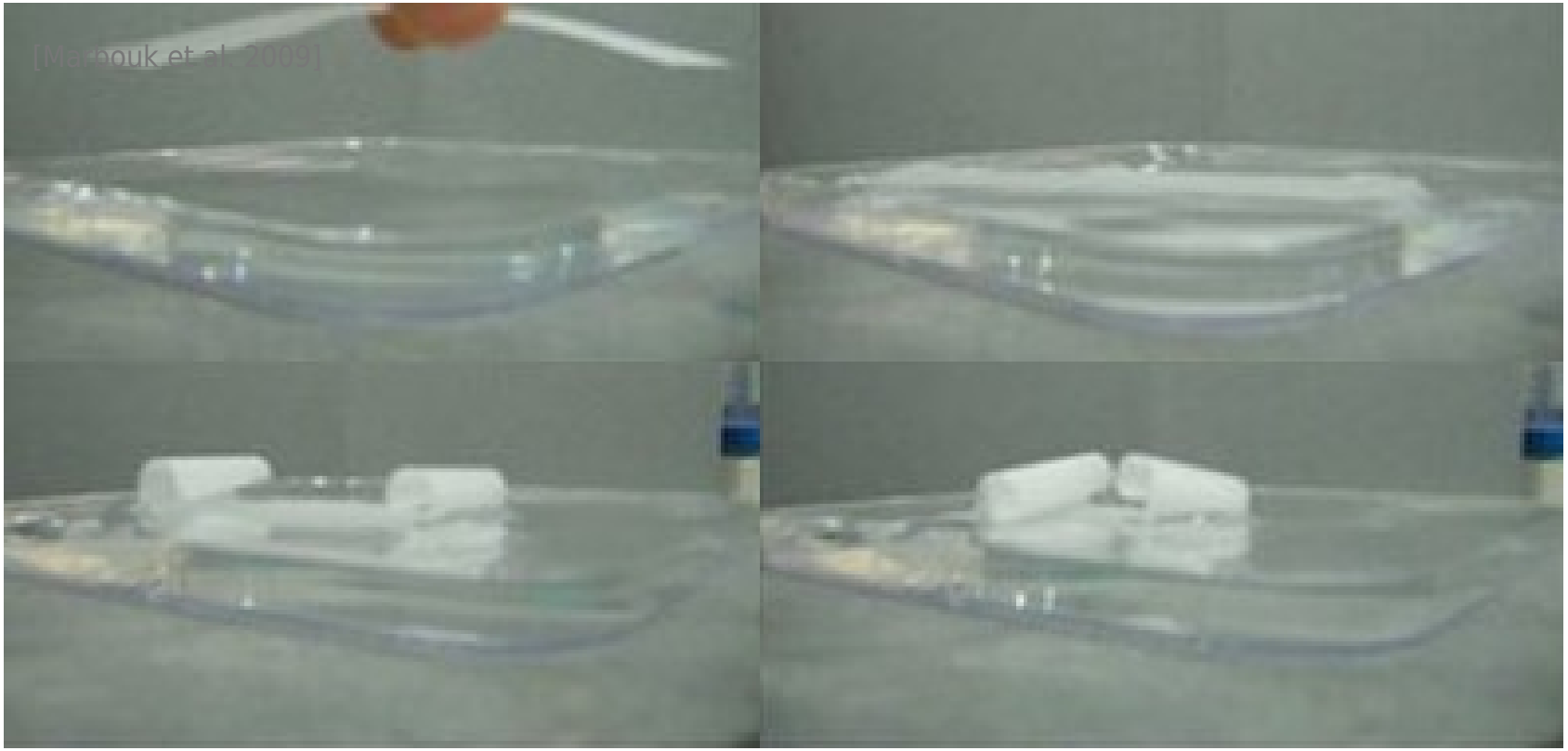
- In this issue: the power of atmospheric pressure (Backyard chemistry, rsc.org), https://www.rsc.org/images/IC0511-atmospheric-pressure_tcm18-233508.pdf



Problem No. 15 “Wet scroll”

Gently place a piece of tracing paper on the surface of water. It rapidly curls into a scroll and then slowly uncurls. Explain and investigate this phenomenon.

Background reading

- E. Reyssat and L. Mahadevan. How wet paper curls. EPL, 93, 5, 54001 (2011), https://softmath.seas.harvard.edu/wp-content/uploads/2019/10/2011-05.pdf
- E. Mabrouk, D. Cuvelier, F. Brochard-Wyart, P. Nassoy, and M.-H. Li. Bursting of sensitive polymersomes induced by curling. PNAS 106, 18, 7294-7298 (2009)
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- M. Lindner. Factors affecting the hygroexpansion of paper. J. Materials Sci. 53, 1, 1-26 (2018)

Problem No. 16 “Cushion catapult”

Place an object on a large air cushion and drop several other objects in such a way that the first object is catapulted away. Investigate how the exit velocity depends on relevant parameters.

Background reading

- Blob Jumping Catapults People into the Sky Like Angry Birds (DNews, seeker.com, 7/22/2011), https://www.seeker.com/blob-jumping-catapults-people-into-the-sky-like-angry-birds-1765324542.html
- Blobbing Projectiles (Casey Morrissey, Physics in our everyday lives, September 10, 2012), https://caseymorrissey.wordpress.com/2012/09/10/blobbing-projectiles/
- Conservation of energy: Practice (physics.info), https://physics.info/energy-conservation/practice.shtml
- So, this is called Blobbing! (fyphysica.tumblr.com), https://fyphysica.tumblr.com/post/143675036136/so-this-is-called-blobbing-potential-energy-of
- physics of blobbing (Grace Lee, prezi.com, Dec 13 2013), https://prezi.com/jjkjofg6hnuq/physics-of-blobbing/
- World Record Blob Jump (Rhett Allain, wired.com, Aug. 1, 2011), https://www.wired.com/2011/08/world-record-blob-jump/
- Launch into Fun with the WaterBlob (The Original Water Blob, 2023), http://thewaterblob.com/
- Best Blob Jumps Compilation (youtube, Poor Judgement, 07.03.2017), https://youtu.be/BfU8SZ41rJ0
- Blob Jump Official Guinness World Record (youtube, Paintballfarm, 01.07.2011), https://youtu.be/n8BX6v9k9CU
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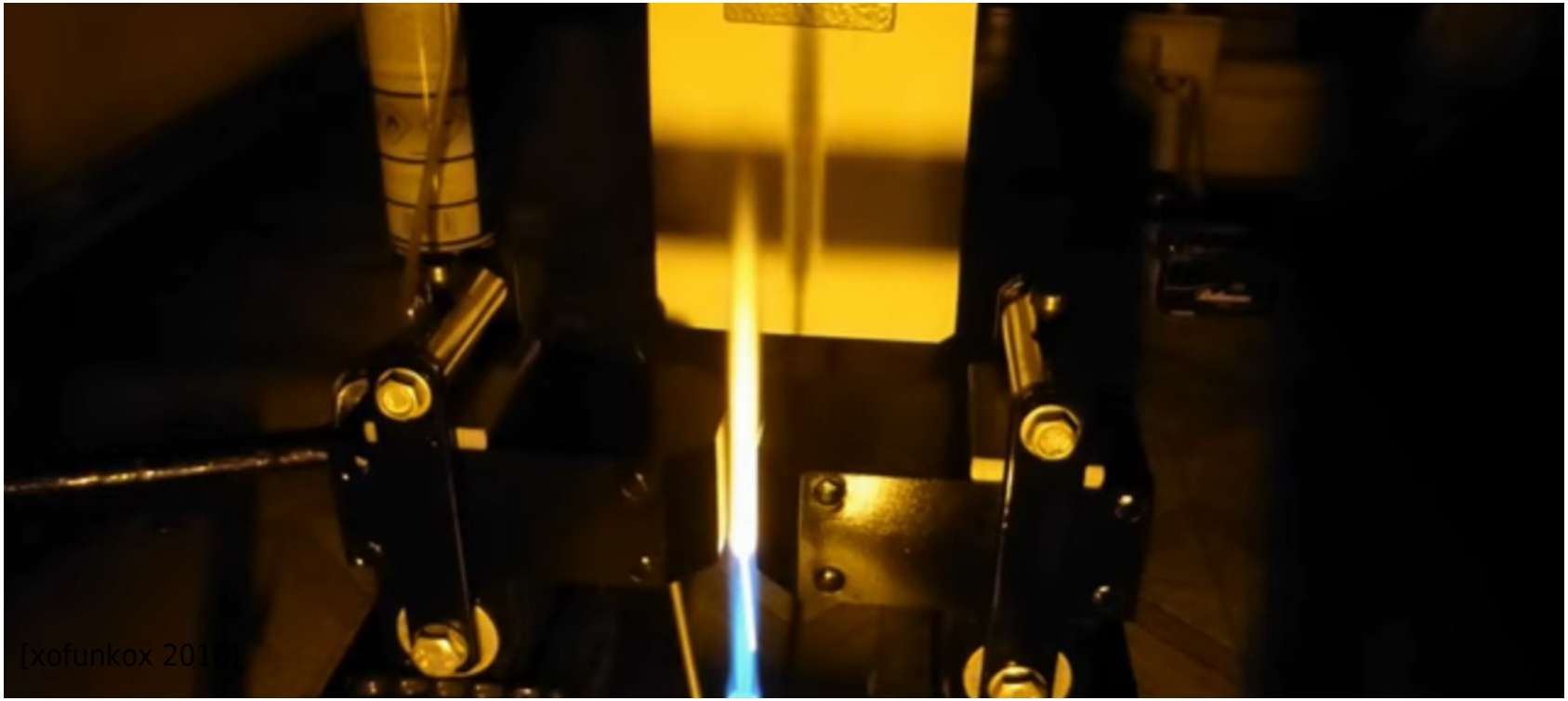
Background reading

- Blobbing | AREA 47 - Tirol (youtube, AREA 47 - Tirol, 24.03.2016), https://youtu.be/QVh_sEaWqco
- Blob Jump Official Guinness World Record (youtube, Paintballfarm, 01.07.2011), https://youtu.be/n8BX6v9k9CU
- G. Tural. Amazing physics: Learning about work, energy and projectile motion in a historical context. Phys. Educ. 48, 3, 336 (2013)



Problem No. 17 “Quantum light dimmer”

If you put a flame with table salt added in front of a vapour sodium lamp, the flame casts a shadow. The shadow can become lighter, if the flame is put into a strong magnetic field. Investigate and explain the phenomenon.

Background reading

- Zeeman Effect - Control light with magnetic fields (youtube, Applied Science, 25.06.2018), https://youtu.be/OzkcB1lkgGU
- Candle flame is repelled by magnets (and Zeeman follow-up) (youtube, Applied Science, 16.07.2018), https://youtu.be/JV4Fk3VNZqs
- Zeeman Effect, Effekt (youtube, xofunkox-scientific experiments, 09.06.2018), https://youtu.be/iyBjPiRlxzg
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- M. Faraday. On the diamagnetic conditions of flame and gases. Phil. Magazine and J. of Science 3, 31, 210, 401-421 (1847)
- Be a fire bender with the power of magnets (Dan Maloney, hackaday, July 23, 2018), https://hackaday.com/2018/07/23/be-a-fire-bender-with-the-power-of-magnets/
- Wikipedia: Zeeman effect, https://en.wikipedia.org/wiki/Zeeman_effect
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Find all the differences you can!

IYPT 1989, Team Netherlands

IYPT 2016, Team United Kingdom

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

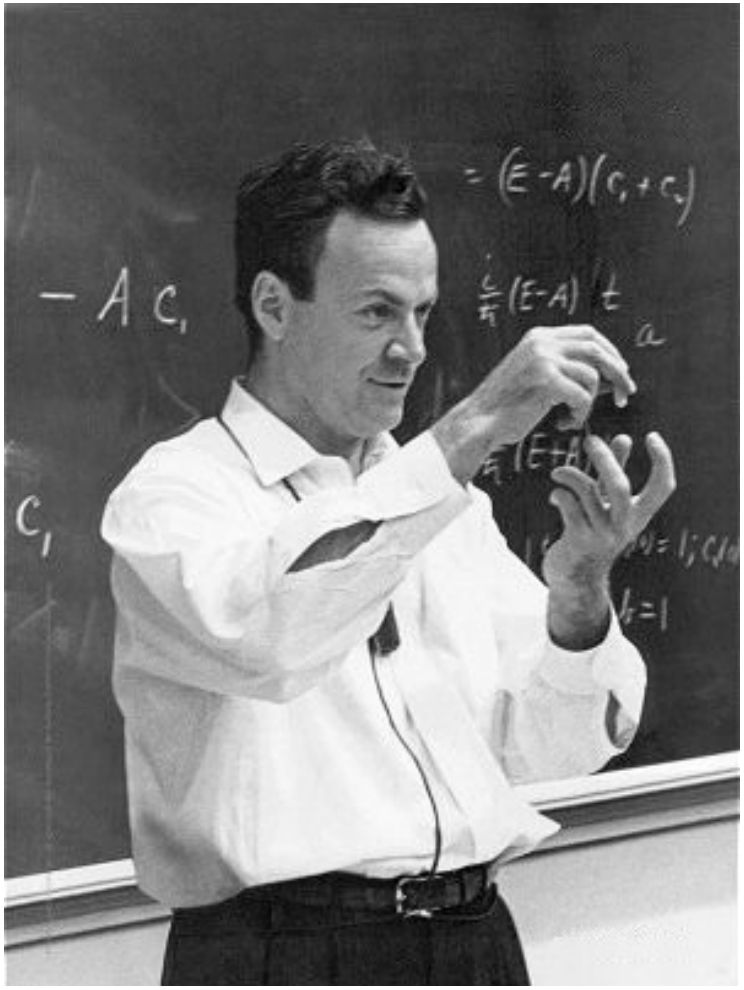
- Originality and independence of your work is always considered as of a first priority
- There is no “correct answer” to any of the IYPT problems
- Having a deep background knowledge about earlier work is a must
- Taking ideas without citing is a serious misconduct
- Critically distinguishing between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

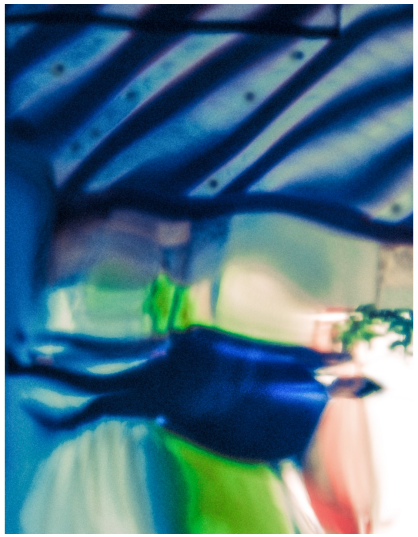
- Novel research, not a survey or a compilation of known facts
- Balance between experimental investigation and theoretical analysis
- Comprehensible, logical and interesting presentation, not a detailed description of everything-you-have-performed-and-thought-about
- Clear understanding of the validity 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)



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Preparation to 37th IYPT' 2024: references, questions and advices

Ilya Martchenko [1]

[1] Foundation for Youth Tournaments

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