





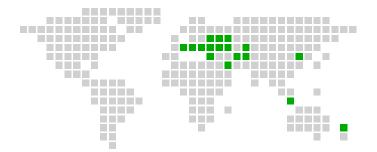
#### Preparation to the Young Physicists' Tournaments' 2019

Ilya Martchenko, 1\* Hossein Salari, 2Łukasz Gładczuk, 3 and Klim Sladkov 4

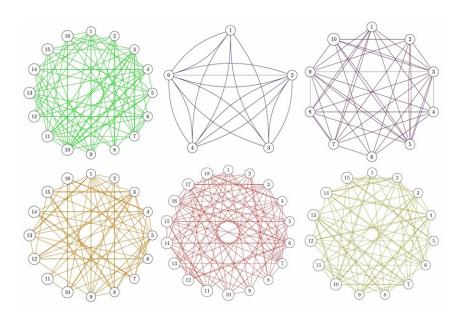
<sup>1</sup> Foundation for Youth Tournaments; <sup>2</sup> Institute for Research in Fundamental Sciences; <sup>3</sup> University of Oxford; <sup>4</sup> Moscow State University

#### Welcome to the 7th IYNT 2019 in Minsk

- The International Young Naturalists' Tournament, IYNT, is a whole new competition with breathtaking problems, state-of-the-art grading standards, and an impressive momentum
- The IYNT bridges gaps between natural sciences and is focused on participants aged 12 through 16
- The IYNT has so far attracted 80 teams from 17 different countries from Switzerland in the West to China in the East and from Russia in the North to New Zealand in the South; has given 8157 grades in 375 stages; and has awarded 48 medals
- Do not hesitate and pre-register today



http://iynt.org





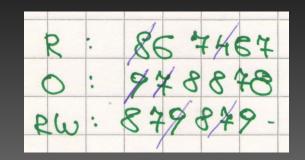
### Call for cooperation

- 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 and plan bringing together the Kit for 2020, 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-ofthe-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



# In search for missing results

- Have you attended an IYPT marked in red and preserved Physics Fight results, e.g. by keeping printed rankings?
- Have you attended an IYPT marked in orange or red, and recorded grades from a Fight, e.g. by writing them down?



Thank you for helping us locate the missing results of past IYPTs



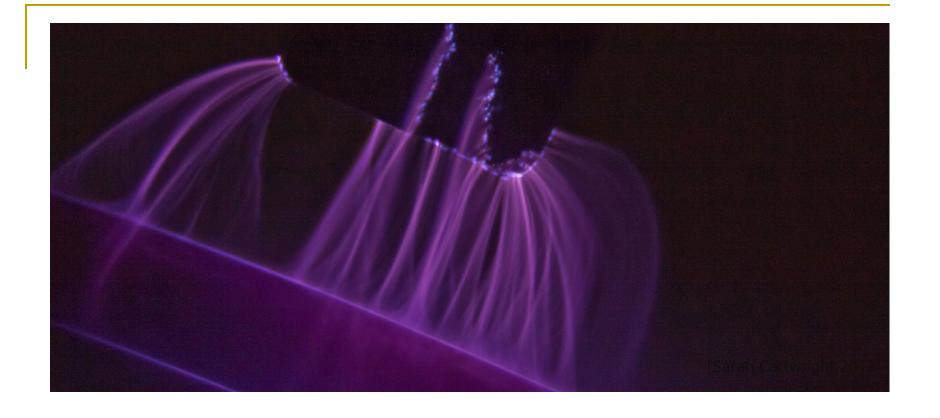
# How to tackle the IYPT problems?



- 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"

Build a simple motor whose propulsion is based on corona discharge. Investigate how the rotor's motion depends on relevant parameters and optimize your design for maximum speed at a fixed input voltage.

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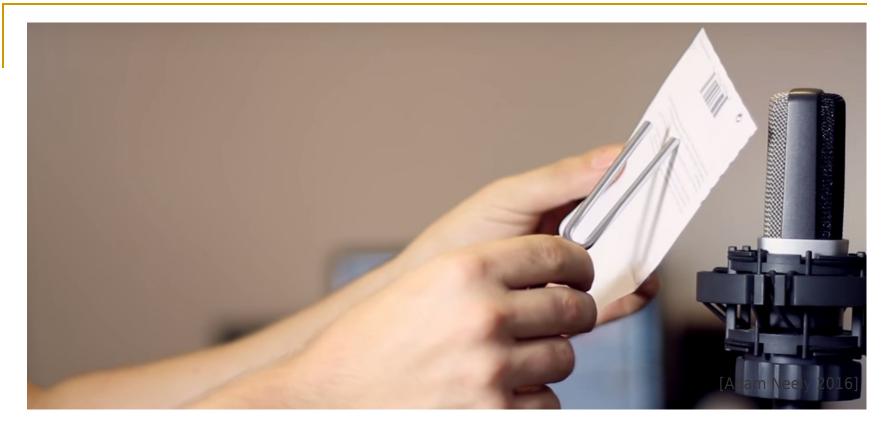
#### Problem No. 2 "Aerosol"

When water flows through a small aperture, an aerosol may be formed. Investigate the parameters that determine whether an aerosol is formed rather than a jet for example. What are the properties of the aerosol?

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- IYPT 2019 Problem 2 Aerosol Demonstration (youtube, Canadian Young Physicists' Tournament, Dec 14, 2018), https://youtu.be/MEhP5PnlZbo
- How to Make Simple Air Paint Spray Gun Homemade (youtube, Creative Life, Oct 15, 2017), https://youtu.be/buLrAZBPETI
- How Spray Bottle Works (youtube, Shashank Singh, Jul 1, 2017), https://youtu.be/MpYLx2odltM
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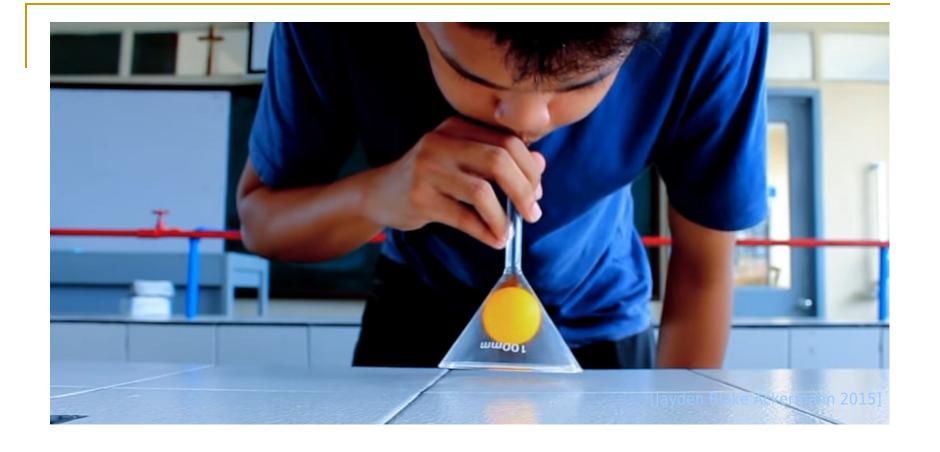


#### Problem No. 3 "Undertone sound"

Allow a tuning fork or another simple oscillator to vibrate against a sheet of paper with a weak contact between them. The frequency of the resulting sound can have a lower frequency than the tuning fork's fundamental frequency. Investigate this phenomenon.

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- The Tuning Fork Mystery: unexpected vibrations (youtube, standupmaths, Mar 23, 2018), https://youtu.be/NVUCf8mB1Wg
- Tuning Fork Demo (youtube, Skyline IB Physics Demo Videos, Jun 9, 2017), https://youtu.be/UDymhyyxy14
- SUBHARMONIC Music (Anomalous Low Frequency Vibration) (youtube, Adam Neely, Sep 19, 2016), https://youtu.be/o4jgPdGrZYI



#### Problem No. 4 "Funnel and ball"

A light ball (e.g. ping-pong ball) can be picked up with a funnel by blowing air through it. Explain the phenomenon and investigate the relevant parameters.

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- EXPERIMENT #4 Levitate a Sphere (nasa.gov), https://www.nasa.gov/sites/default/files/atoms/files/bernoullisprinciple 5-8-02-09-17-508.pdf
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- Ball and Funnel™ (youtube, Stephen Schuler, Sep 10, 2017), https://youtu.be/kTjgvyBVfy0
- Ping-pong ball in Filter Funnel Bernoulli's Principle (youtube, My Fun Physics World, Aug 10, 2017), https://youtu.be/ZDPqkHwUCss
- Funnel & ping pong ball (youtube, Paul Rutherford, PhD, Feb 13, 2017), https://youtu.be/K80xbb82sMQ
- Get Your Science On: Benoulli Ball (youtube, Little Shop of Physics, Apr 8, 2016), https://youtu.be/SuiCTXEE1BQ
- Bernoulli's Principle: Ping-pong Ball and Funnel (youtube, Jayden Blake Ackermann, Nov 18, 2015), https://youtu.be/1TQL1ju3RoQ
- Bernoulli principle.mpg (youtube, peter s p Lim, Dec 23, 2011), https://youtu.be/n7U0H05Kduw
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# Problem No. 5 "Filling up a bottle"

When a vertical water jet enters a bottle, sound may be produced, and, as the bottle is filled up, the properties of the sound may change. Investigate how relevant parameters of the system such as speed and dimensions of the jet, size and shape of the bottle or water temperature affect the sound.

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- What will happen to the pitch of the sound when the level of water in the bottle increases gradually? (quora.com, 2018), https://www.quora.com/What-will-happen-to-the-pitch-of-thesound-when-the-level-of-water-in-the-bottle-increases-gradually

- Why the sound of filling water into a bottle rise in its frequency? (physics.stackexchange.com, 2017), https://physics.stackexchange.com/questions/357512/why-the-sound-of-filling-water-into-a-bottle-rise-in-its-frequency
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#### Problem No. 6 "Hurricane balls"

Two steel balls that are joined together can be spun at incredibly high frequency by first spinning them by hand and then blowing on them through a tube, e.g. a drinking straw. Explain and investigate this phenomenon.

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- Hurricane Balls in Slow Motion (youtube, dprljackson, Feb 26, 2017), https://youtu.be/QhpZ1M67vng
- Now they can fly: Hurricane Balls (youtube, Latheman's crazy machines, May 7, 2016), https://youtu.be/cgPekwKK7JM
- Hurricane Balls in 4K | Shanks FX | PBS Digital Studios (youtube, Shanks FX, Mar 28, 2016), https://youtu.be/JRou-3oh7h0
- Remaking History: Dancing Spheres (youtube, Make:, Apr 28, 2015), https://youtu.be/c9aNkLoqNoE
- How To Make Hurricane Balls (youtube, Peter Brown, Dec 31, 2014), https://youtu.be/rFZrwMPNVvk
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#### Problem No. 7 "Loud voices"

A simple cone-shaped or horn-shaped object can be used to optimise the transfer of the human voice to a remote listener. Investigate how the resulting acoustic output depends on relevant parameters such as the shape, size, and material of the cone.

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- How a horn amplifies sound (hint: Impedance matching) (youtube, Applied Science, Jan 11, 2015), https://youtu.be/vcSc16tnVqk
- Working of a megaphone | Sound | Physics (youtube, KClassScienceChannel, Jan 20, 2014), https://youtu.be/Ptp-a6MfBYk
- Mocc Horn Voice Demo 18 Tones (youtube, APS Traders, Oct 19, 2013), https://youtu.be/dqaEkw-Y9ao
- Testing the theory you DO need an exponential Horn! (youtube, EMGColonel, May 8, 2013), https://youtu.be/TVdrjm1BVP0



#### Problem No. 8 "Sci-Fi sound"

Tapping a helical spring can make a sound like a "laser shot" in a science-fiction movie. Investigate and explain this phenomenon.

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- How to create laser sounds with a slinky spring (youtube, Lasec Education, Oct 26, 2016), https://youtu.be/CpZkNWBmKNM
- How To Make Laser Sound Effects (youtube, PoundSound, Jul 6, 2015), https://youtu.be/XACHZbgcH5M
- How To Make Epic Laser Space Battle Sound Effects With A Slinky Spring (youtube, wonderstruckwow, Jan 30, 2016), https://youtu.be/g2Sa0dRmHgA

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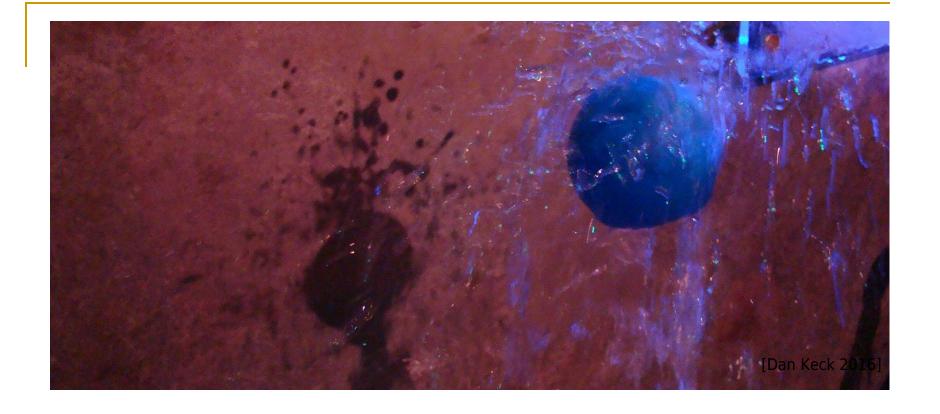


# Problem No. 9 "Soy sauce optics"

Using a laser beam passing through a thin layer (about 200  $\mu$ m) of soy sauce the thermal lens effect can be observed. Investigate this phenomenon.

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## Problem No. 10 "Suspended water wheel"

Carefully place a light object, such as a Styrofoam disk, near the edge of a water jet aiming upwards. Under certain conditions, the object will start to spin while being suspended. Investigate this phenomenon and its stability to external perturbations.

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# Problem No. 11 "Flat self-assembly"

Put a number of identical hard regular-shaped particles in a flat layer on top of a vibrating plate. Depending on the number of particles per unit area, they may or may not form an ordered crystal-like structure. Investigate the phenomenon.

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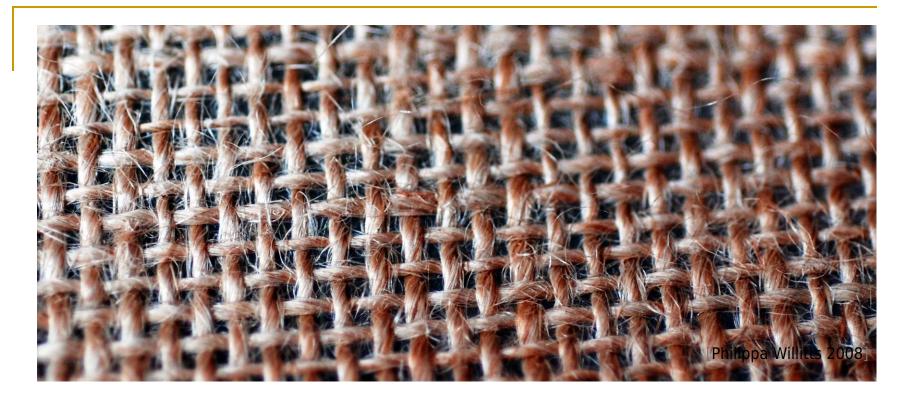


## Problem No. 12 "Gyroscope teslameter"

A spinning gyroscope made from a conducting, but nonferromagnetic material slows down when placed in a magnetic field. Investigate how the deceleration depends on relevant parameters.

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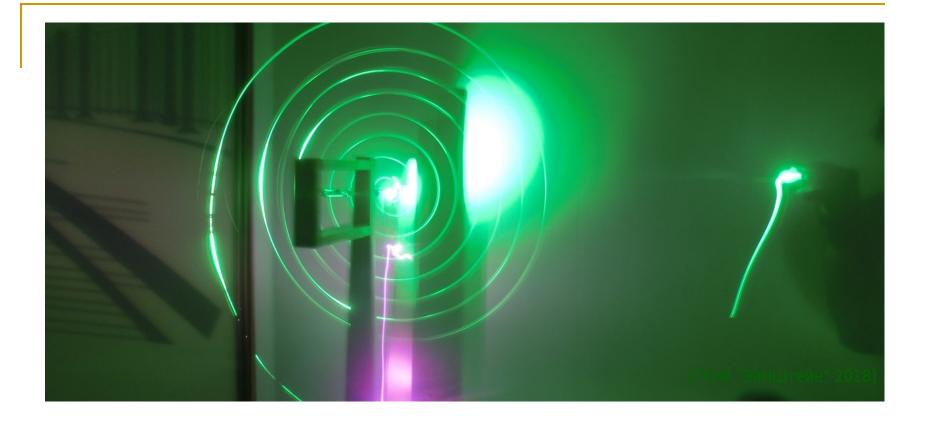


## Problem No. 13 "Moiré thread counter"

When a pattern of closely spaced non-intersecting lines (with transparent gaps in between) is overlaid on a piece of woven fabric, characteristic moiré fringes may be observed. Design an overlay that allows you to measure the thread count of the fabric. Determine the accuracy for simple fabrics (e.g. linen) and investigate if the method is reliable for more complex fabrics (e.g. denim or Oxford cloth).

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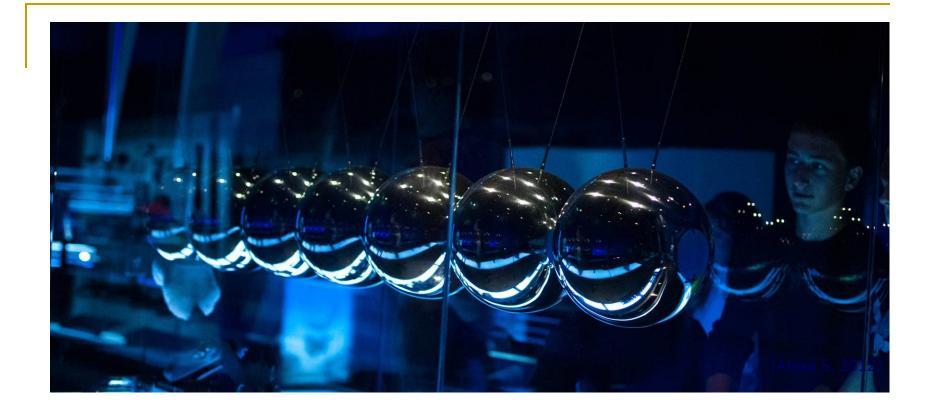
# Problem No. 14 "Looping pendulum"

Connect two loads, one heavy and one light, with a string over a horizontal rod and lift up the heavy load by pulling down the light one. Release the light load and it will sweep around the rod, keeping the heavy load from falling to the ground. Investigate this phenomenon.

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## Problem No. 15 "Newton's cradle"

The oscillations of a Newton's cradle will gradually decay until the spheres come to rest. Investigate how the rate of decay of a Newton's cradle depends on relevant parameters such as the number, material, and alignment of the spheres.

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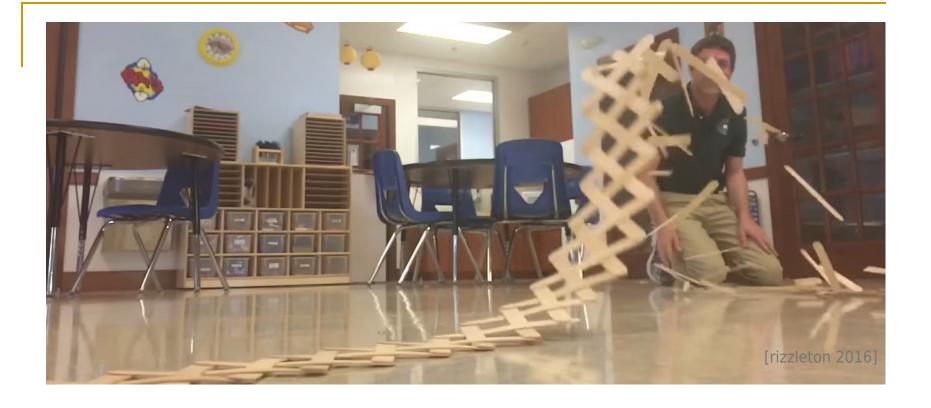
# Problem No. 16 "Sinking bubbles"

When a container of liquid (e.g. water) oscillates vertically, it is possible that bubbles in the liquid move downwards instead of rising. Investigate this phenomenon.

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## Problem No. 17 "Popsicle chain reaction"

Wooden popsicle sticks can be joined together by slightly bending each of them so that they interlock in a so-called "cobra weave" chain. When such a chain has one of its ends released, the sticks rapidly dislodge, and a wave front travels along the chain. Investigate the phenomenon.

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## Find all the differences you can!





IYPT 1989, Team Netherlands IYPT 2016, Team United Kingdom

## 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
- Serious conclusions will be drawn, up to discontinuing the project in its current form, if systematic
  misuse of the Kit is detected, such as explicit failure of citing properly, replacing own research with a
  compilation, or interpreting the Kit itself as a binding "user guide"
- All suggestions, feedback, and criticism about the Kit are warmly appreciated :-)

## Habits and customs

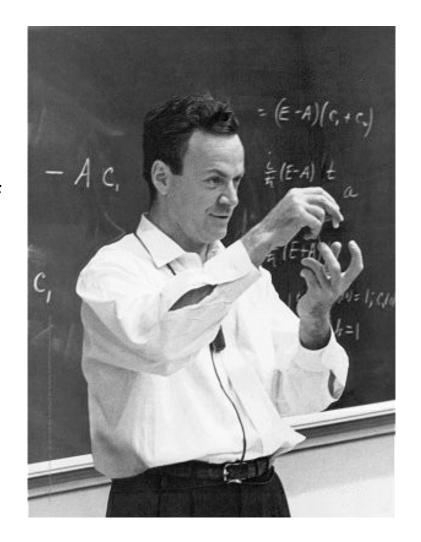
- Originality and independence of your work is always considered as of a first priority
- There is no "correct answer" to any of the IYPT problems
- Having a deep background knowledge about earlier work is a must
- Taking ideas without citing is a serious misconduct
- Critically distinguishing between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





### International Young Naturalists' Tournament

Pro

Pre-register a team!

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## About the IYNT

Check the breathtaking problems!



#### Introduction

The IYNT is an inclusive educational network and a prestigious international competition. The IYNT is focused on student participants aged 12 through 16, the

### Short links

**PROBLEMS 2019** 

**IYNT REGULATIONS** 

PRE-REGISTRATION 2019

#### What is a Naturalist?



In their <u>Treatise on Natural</u>

<u>Philosophy</u> (1867), Lord Kelvin and
Tait give the definitions of matter



# Preparation to 32nd IYPT' 2019: references, questions and advices

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