GIREP Seminar - Research-based proposals for improving physics teaching and learning – focus on laboratory work
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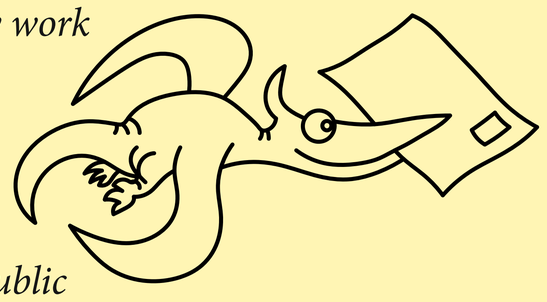
Experimental Problems at FYKOS

Karel Kolář, karel@fykos.cz, Faculty of Mathematics and Physics, Charles University in Prague, Czech Republic



FYKOS [1]

- The FYKOS uses English name „The Internet Physics Competition" or it could be translated as „The Physics Correspondence Competition".
- The organizers are university students (ISCED^{2011} 6, 7 & 8). They are mostly former participants of FYKOS and most of them study our faculty.
- The participants are high school students (mostly from „gymnasia" of CZ and SK, ISCED^{2011} 3). Most of them are also participants of the Physics Olympiad. However there are no other requirements other than to be a high school student (or younger) and be able to solve problems in Czech, Slovak or English language.

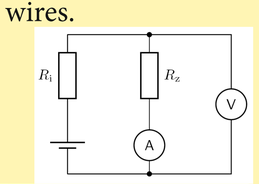
The FYKOS' Problems

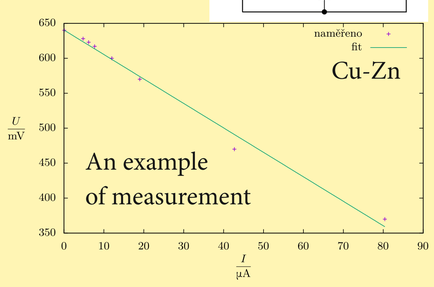
- The FYKOS has 6 series of 8 problems each school year. There are 5 kinds of problems. Participants have approximately one month for solving the problems and sending their solutions by post or mail. They can use the internet and other sources
  - "Easy" - the first two problems of every series should be not so difficult and even the younger participants should be able to solve them.
  - "Normal" - the problems 3, 4 and 5 are more complicated than the first two. Sometimes calculus or numerical simulations are needed.
  - "Problem" task - it is often some complicated task, open physics problem or problem requiring many approximations
  - Experimental task - the only problem in each series where we require experimental measurement.
  - "Serial" task - with each series there is a text with explanation of some physics on upper high school level. These texts are usually from one physics field. The task is directly connected to the text.
- Problem assignments can be found in English at [2]. Problem solutions are available only in Czech at [3], [4]. The solutions and text of „serial" are not currently translated because of low number of participants from outside of CZ and SK. However the problem assignments can be inspirational and equations in solutions should be readable even if you do not know Czech/Slovak.

28-I-Exp - charged potato [5]

- Assignment: Measure the load characteristic of a potato as a source of electric voltage with electrodes made from different metals.
- Equipment: voltmeter, ammeter, potato, resistors, electrodes and wires.

- This is a seamingly easy problem. There should be no problem in measuring of the voltage if the electrodes are from different metals and the potato is not completely dry. But the measuring of the electric current is not so easy - usual value of the current is in tens of microampers or lower.
- The second big problem is the fact that the potato is a very weak battery and the charge is relatively quickly decreasing. If you use kiloohm resistor as a load, you can see the rapid decrease of voltage. But the decrease is not completely permanent - you can „refresh" your battery by cleaning the electrodes or even by moving them inside the potato.

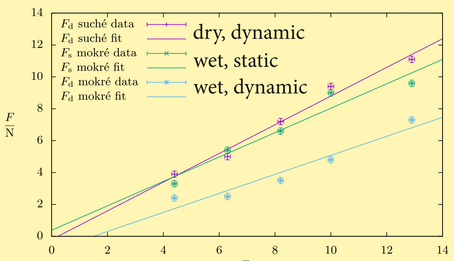




28-III-Exp - sneakers on water [6]

- Assignment: Measure the coefficient of static and dynamic friction between the sneaker (shoe) and a horizontal smooth surface, where the surface is dry and where it is wet. Compare the results and interpret them.
- Equipment: force meter, sneakers (shoes), smooth surface, water (+ weights)

- An easy experiment where very simple equipment can be used. It is enough to use dynamometer held in hand for measurument of static coefficient
- A bit tricky is to measure the dynamic coefficient of friction if you use only analog device - for greater precision is better to use some electronic device, but it is not necessary.
- Interesting could be that static friction is not so different on dry and wet surfaces, but the dynamic varies more depending on the surface.



A sneaker on linoleum

28-VI-Exp - alchemical [7]

- Assignment: *(shortened version)* CZ and SK participants received three thin wrapped pieces of metal. The task was to determine which metals they received. They could use even the destructive processes, but the sample was very small.
- Equipment: depends on creativity of a participant

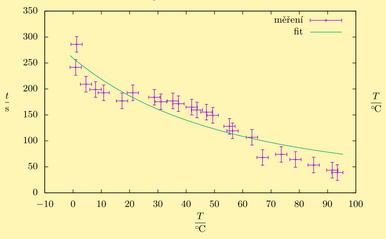
- The metal samples were very thin, actualy they were metals used for metal plating in art. The thickness of samples was not measureble by usual means - such as micrometer.
- Many participants used even chemical processes.
- This kind of problems - where participant can choose his/her own solution - are very interesting for correcting because they are often very creative.

29-II-Exp - Let's do some Fizzics! [8]

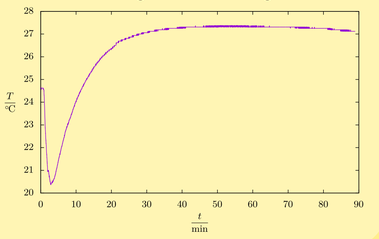
- Assignment: Buy any effervescent (i.e. fizzy) tablets and measure the time that takes for the tablet to fully dissolve in water as a function of temperature of this water. Discuss the possible causes and propose why is the relation the way it is.
- Equipment: water, watch, thermometer, fridge and water heater

- Some fizzy tablets are sold at every pharmacy and often in drugstores.
- It is common knowledge that the hotter the water is the quicker should the tablets dissolve - but what is the real dependence?
- Also interesting is the time dependence of temp. when dissolving the tablet.

Time for dissolving a tablet depending on the temperature



The time dependence of temperature when dissolving 5 tablets in a glass of water

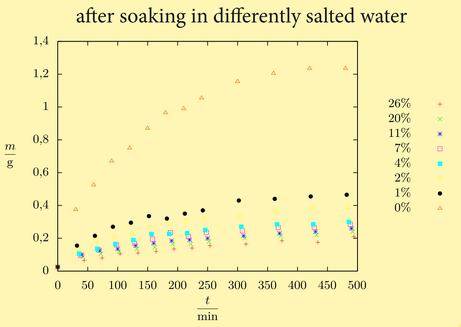


29-III-Exp - hydrogel [9]

- Assignment: Examine the dependence of a weight of a hydrogel ball on time of submersion in water and on concentration of salt dissolved in water.
  NOTE: We do not send the experimental material abroad, therefore the hydrogel you buy must be described in detail.
- Equipment: hydrogel, water, salt, weighing scale

- Inspiration for this problem is from the GIREP EPEC 2015.
- We sent to all (CZ and SK) participants the same hydrogel. There are many kinds of them (different colors and even chemical structure) - this way are the results comparable.
- The soaking of hydrogel is a phenomena connected also to osmotic pressure, so the higher the concentration of salt in the water, the lower the maximum weight (and size) of hydrogel.
- Soaking up of our hydrogel takes approx. 6 hours.

The time dependence of weight of hydrogel after soaking in differently salted water



29-VI-Exp - malicious coefficient of restitution [10]

- Assignment: If we drop a bouncing ball or any other elastic ball on an appropriate surface, it starts to bounce. During every hit on the surface some kinetic energy of the ball is dissipated (into heat, sound, etc.) and the ball doesn't return to its initial height. We define the coefficient of restitution as the ratio of the kinetic energy after and before the hit. Is there any dependence between the coefficient of restitution and the height which the ball fell from? Choose one suitable ball and one suitable surface (or several if you want) for which you determine the relation between the coefficient of restitution and the height of the fall.
- Equipment: bouncing ball, sound recorder and analyser (for example a notebook with Audacity or a smartphone with an app)

- This experiment is easy to perform. A bouncing ball makes sound when it hits the floor, so we can precisely measure the time between two hits.
- The harder part is to analyse data and determine whether for your ball and your initial height are more important the losses due to coefficient of restitution or due to air drag.

References

[1] FYKOS' web pages: http://fykos.org
[2] The problem assignments: http://fykos.org/problems
[3] The FYKOS' problem solutions: http://fykos.cz/zadani (only in Czech)
[4] The search among FYKOS' problem assignments http://fykos.cz/ulohy/vyhledavani (only in Czech)
[5] Erik Hendrych: The solution of FYKOS' problem 28-I-Exp http://fykos.cz/rocnik28/reseni/reseni1-6.pdf
[6] Erik Hendrych: The solution of FYKOS' problem 28-III-Exp http://fykos.cz/rocnik28/reseni/reseni3-6.pdf
[7] D. Kalasová et al.: The solution of FYKOS' problem 28-VI-Exp http://fykos.cz/rocnik28/reseni/reseni6-6.pdf
[8] Kristína Nešporová: The solution of FYKOS' problem 29-II-Exp http://fykos.cz/rocnik29/reseni/reseni2-6.pdf
[9] Michal Nožička: The solution of FYKOS' problem 29-III-Exp http://fykos.cz/rocnik29/reseni/reseni3-6.pdf
[10] Lubomír Grund: The solution of FYKOS' problem 29-VI-Exp http://fykos.cz/rocnik29/reseni/reseni6-6.pdf

Acknowledgments

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