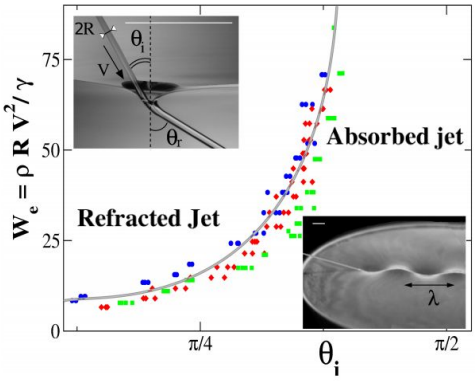
ID 2013-01
Received on September 9, 2011

Country	
Author's name	
e-mail	
Title of the problem	Jet and film
Suggested phrasing	A thin water jet is impacting on a soap film. Investigate how the jet interacts with the film as a function of relevant parameters.
Source (full citation of any paper, book or webpage used)	The phenomenon was very recently discovered by Christophe Raufaste et al. at the University of Nice. This proposed task was formulated during the Liquid Matter 2011 conference in Vienna, Austria. Geoffroy Kirstetter, Christophe Raufaste, and Franck Celestini. Jet impact on a soap film. arXiv:1203.0842v1 [cond-mat.soft] 5 Mar 2012, **http://arxiv.org/pdf/1203.0842.pdf**
Physical background of the problem	Depending on the incident angle and other parameters, the jet may either coalesce with the film, or penetrate it without bursting it. In the case of coalescence, the jet bends into a sinusoid-shape curve. In the case of penetration, the jet is physically refracted.  (Figure courtesy of Raufaste et al., used here **only** as an **internal** illustration.) The problem is recommended for the IYPT given the novelty and relevance of the phenomenon; a realistic possibility for the students to acquire new, state-of-the-art results; simplicity of conducting experiments at home; and possibility to interpret the data at various depth levels. Furthermore, the effect is believed to be very visual and though-provoking.
Expected contribution of students (theory / experiment / both)	both
Further explanations or comments	---

ID 2013-02
Received on November 27, 2011

Country	
Author's name	
e-mail	
Title of the problem	Freezing hot water
Suggested phrasing	Investigate the conditions for hot water freezing faster than cold water.
Source (full citation of any paper, book or webpage used)	http://math.ucr.edu/home/baez/physics/General/hot_water.html
Physical background of the problem	---
Expected contribution of students (theory / experiment / both)	---
Further explanations or comments	---

Decision: removed from the selection as too similar to a problem from the IYPT 2000

IYPT 2000, **15. Cooling water.** Two identical open glasses, filled with hot and warm water, respectively, begin to cool under normal room conditions. Is it possible that the glass filled with hot water will ever reach a lower temperature than the glass filled with warm water? Make an experiment to investigate this and explain the result.)

ID 2013-03
Received on January 20, 2012; in revised form on April 29, 2012

Country	
Author's name	
e-mail	
Title of the problem	Twisted Rope
Suggested phrasing	Consider a rope hold horizontally on its two ends. Twist one of its ends. At some point rope will form a helix or a loop. Investigate and explain the phenomenon.
Source (full citation of any paper, book or webpage used)	Once I read an interesting article on this topic, but I cannot find it at the time. Here are articles connected with this phenomenon: J. Michael T. Thompson "Single-molecule magnetic tweezer tests on DNA: bounds on topoisomerase relaxation" Proc. R. Soc. Lond. **464** (2008) 2811 A. Goriely M. Tabor "Nonlinear dynamics of filaments. IV Spontaneous looping of twisted elastic rods" Proc. R. Soc. Lond. **454** (1998) 3183
Physical background of the problem	When rope is twisted, energy due to internal strain is building up. At some point it is energetically preferable for rope to form a loop, than remain twisted. Problem involves basic continuum medium physics.
Expected contribution of students (theory / experiment / both)	Student should investigate, why initially straight horizontal twisted rope changes it shape. Student should answer questions: - What shapes can be obtained in this process. - On what parameters dose phenomenon depend: (length of rope, distance between ends of rope angle of twist, diameter of the rope, history of the rope) - Is there hysteretic in the system? It would be greater is student would achieve a phase diagram presenting what shapes can a rope obtain for given distance between ends of a rope and angle of twist. This phenomenon can be analyzed by looking on the total energy of the system. Such analysis, or similar, should be carried out, and conclusions should be carried out.
Further explanations or comments	This is a very common, and easy to observe phenomenon. However it is not easy to explain its cause.

ID 2013-04
Received on January 20, 2012; in revised form on April 29, 2012

Country	
Author's name	
e-mail	
Title of the problem	Magnetic pendulum
Suggested phrasing	Consider a pendulum with a magnet attached to its end. Place it over base containing magnets, and move it out of its equilibrium position. When is it possible to determine the final position of such pendulum?
Source (full citation of any paper, book or webpage used)	Here is a video well presenting this phenomenon: http://www.youtube.com/watch?v=Qe5Enm96MFQ
Physical background of the problem	Such pendulum exhibits chaotic behavior. Final position of the pendulum depends strongly on initial conditions, and in general one is not able to precisely predict pendulums motion and final position. However for some initial conditions (for example small displacement from equilibrium) one is able to predict final position.
Expected contribution of students (theory / experiment / both)	Solution of the problem would require knowledge of classical mechanics, magnetostatics, and little of electrodynamics. Mayor forces that act on the pendulum are gravitational and once from magnetic interaction. Dumping due to air friction and eddy currents also occurs. Students contribution that I would expects is: **Theoretical:** - Equations describing pendulums motion. - As those equations are hard to solve, a numerical simulation to solve them. - Chaotic systems are often investigated using methods such as: Lyapunov exponent, Poincaré map, Fourier analysis. This also allows comparing theory with experiment. **Experimental:** - Student should build such pendulum - Investigate how it behaves depending on initial conditions, mass of pendulum and its length, strength of the magnets, number of magnets and their position and orientation.
Further explanations or comments	Problem allows students to learn a lot about chaotic systems. Experimental setup is easy to build and no advance apparatus is required to perform measurements.

ID 2013-05
Received on January 20, 2012; in revised form on April 29, 2012

Country	
Author's name	
e-mail	
Title of the problem	Oscillating disk
Suggested phrasing	A massive horizontal disk is attached to a suspended helical spring. Investigate the motion of the disk after it is subjected to vertical oscillations.
Source (full citation of any paper, book or webpage used)	This device is called a "Wilberforce pendulum". Movie presenting the phenomenon can be found here: http://www.youtube.com/watch?v=S42lLTlnfZc
Physical background of the problem	When spring is extended, it also rotates a bit. If moment of inertia of suspended body is well selected, vertical oscillations may disappear and rotary oscillations will appear. After some time again rotary oscillations change into vertical oscillations and process repeats.
Expected contribution of students (theory / experiment / both)	Student should build and investigate mentioned device. He should experiment with springs of different parameters and use disks with different moment of inertia. For the theoretical part student is expected to explain why vertical oscillations change into rotary oscillations of the disk and other way.
Further explanations or comments	

ID 2013-06
Received on January 20, 2012; in revised form on April 29, 2012

Country	
Author's name	
e-mail	
Title of the problem	Leaky vessel
Suggested phrasing	If there is a hole near the base of the vessel, the liquid will flow out of it. How the flow rate depends on relevant parameters? Is it possible to construct a vessel such that the flow rate is the constant and independent on level of liquid inside the vessel?
Source (full citation of any paper, book or webpage used)	The task it self is my own idea. The part about constant flow rate independent on level of liquid inside the vessel is based on the simple construction I found is a book: Е.И.Бутиков, А.А.Быков, А.С.Кондратьев "ФИЗИКА В ЗАДАЧАХ" Л., Изд-во Ленингр. ун-та, 1974.
Physical background of the problem	In the problem one may find a lot of interesting phenomena know from hydrodynamics and hydrostatics. Such as how size of the hole limits flow rate, role of viscosity, or importance of hole's shape.
Expected contribution of students (theory / experiment / both)	The problem is an engineering task, which requires inventing and investigating device in which flow rate is the independent on level of liquid inside the vessel. This requires building many devices and determining which one is the best. Students should also look for the simplest way to achieve the goal. **Theory:** - Deciding which parameters determining the flow rate of the liquid? (viscosity, density, level of liquid, size and shape of the hole) - Theory can be based on known laws, such as Bernoulli's law, or in a more advanced model, Euler equation or Naviera-Stockes Equation. **Experiment:** - Building different devices and comparison. - Experimental investigation of considered parameters (viscosity, density, level of liquid, size and shape of the hole) - Developing a method for flow rate measurement - Farther improvement of best device.
Further explanations or comments	Problem allows students to learn about hydrodynamics. Students would be able to invent and experiment with the device they build.

Commentary: two very similar problems were suggested by other contributors for the IYPT 2007 and IYPT 2010, but not selected. This may suggest that the effect is of some interest for the community.

Proposed for the IYPT 2010: **Leaky can.** It has been suggested that the depth of liquid in a leaking can decreases exponentially, but this is at best an approximation, and under some circumstances, a very poor approximation. Investigate the problem.-

Proposed for the IYPT 2007: **A4**. How does the depth of fluid in a leaking vessel decrease with time? Investigate the phenomenon for a variety of fluids.

ID 2013-07
Received on January 20, 2012; in revised form on April 29, 2012

Country	
Author's name	
e-mail	
Title of the problem	Water resonance
Suggested phrasing	Horizontal tube partially is filled with water. Air above the water is excited to vibrations (for example using a laud speaker). At some frequencies unusual waves may form on water surface. Investigate the water behavior depending on excitement frequency and other relevant parameters.
Source (full citation of any paper, book or webpage used)	This phenomenon can be observed on exhibition in Copernicus Science Center in Warszaw.
Physical background of the problem	The phenomenon is connected with the device called Kundt's tube; here instead of grains one uses water.
Expected contribution of students (theory / experiment / both)	Student should investigate water pattern depending on the excitement frequency. He should build an experimental setup, perform experiments, and determine relevant parameters (frequency, fluid viscosity, density). For the theoretical part he should be familiar with Kundt's tube and waves on water.
Further explanations or comments	What is interesting about this phenomenon is that grains like to form heaps, but water cannot form heaps it rather likes to have a flat surface. Even though under air vibrations, in regions of lower air pressure water goes up.

Decision: removed from the selection as too similar to a recent problem from the IYPT 2004

IYPT 2004, **12. Kundt's Tube.** In a 'Kundt's Tube' type of experiment the standing waves produced can be made visible using a fine powder. A closer look at the experiment reveals that the regions of powder have a sub-structure. Investigate its nature.

ID 2013-08
Received on January 20, 2012; in revised form on April 29, 2012

Country	
Author's name	
e-mail	
Title of the problem	Window Frost
Suggested phrasing	Window frost is formed if a glass pane is exposed to very cold air on one side and moderately moist air on the other side. If a pane is not a good isolator, water vapor condenses on the glass forming patterns. Investigate shape of those patterns.
Source (full citation of any paper, book or webpage used)	Here are two photos of this phenomenon I found on the internet: **http://hoardedordinaries.wordpress.com/2010/01/30/feathered-ephemera/** http://www.flickr.com/photos/zelcam/103955555/in/gallery-andreas_helke-72157627163495075/
Physical background of the problem	
Expected contribution of students (theory / experiment / both)	Student should investigate the process of forming patterns by window frost. I would expect several experiments that would determine relevant parameters and repeatability of the process. I would expect a qualitative theory to describe why observed patters happen to have regular fractal like shapes.
Further explanations or comments	

ID 2013-09
Received on January 20, 2012; in revised form on April 29, 2012

Country	
Author's name	
e-mail	
Title of the problem	Clapping hands
Suggested phrasing	After a great performance it is nice to gratitude the performer by clapping. Investigate the sound of clapping. Is it possible to synthetically recover the applause of the crowd from a recording of single person clapping?
Source (full citation of any paper, book or webpage used)	My own idea
Physical background of the problem	When one claps, the sound is different from the sound of many people clapping. it is interesting, why and how this sound differs.
Expected contribution of students (theory / experiment / both)	I would expect students to develop a method to turn one persons clapping into a sound of the crowd clapping. This would require investigating what is clapping and its sound. This can be done by looking at spectrum of such sound. Student should answer what is different between one person clapping and a crowd clapping (delay between different person clapping, distances from different people, how important is the way person claps, how shape of room may affect the sound). Recording of crowd clapping and its analysis should be done. I would expect student to explain how sound is produced in general and it this case.
Further explanations or comments	Experiment is easy to perform, one just needs a microphone.

ID 2013-10
Received on April 4, 2012

Country

Author's name	
e-mail	
Title of the problem	Pendulum waves
Suggested phrasing	A determined number of pendulums are put side by side. The sizes of the pendulum's strings increase in the row. With a ruler (or rectangular piece of any material), all the pendulums are inclined together and released at the same time. Investigate the patterns that may be seen during the movement of the system and the relevant parameters for the phenomenon.
Source (full citation of any paper, book or webpage used)	http://www.youtube.com/watch?v=yVkdfJ9PkRQ
Physical background of the problem	The problem is based in the Simple Harmonic Oscillation. The periods of oscillation vary because of the different lengths of the strings, forming different images and patterns of waves that must be studied.
Expected contribution of students (theory / experiment / both)	Students are expected to see the cause of the phenomenon in the periods of oscillation that differ along the row because of the different lengths of the strings as a basic approach to the problem. Mathematical formulations for the patterns seem plausible, as clear waves are formed. For the experiments, a lot of parameters may be altered, including the rate in which the string's lengths change or even the maximum angle of inclination for which a Simple Harmonic Oscillation may be observed for the pendulums, being it a condition for the phenomenon existence. The images and waves formed MUST be evaluated experimentally.
Further explanations or comments	The problem, although based on simple concepts of high school physics, is challenging in the sense that the explored phenomenon may seem chaotic at the first look for some, as a lot of patterns are formed during the movement of the pendulums. Also, it can be solved with accessible material for the experiments.

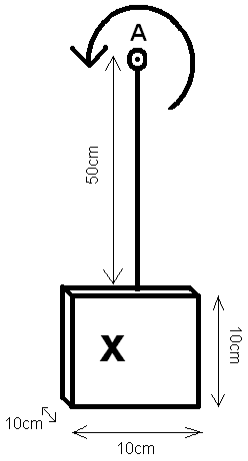
ID 2013-11
Received on April 5, 2012; in revised form on April 8, 2012

Country

Author's name

e-mail

Title of the problem	Swing
Suggested phrasing	The purpose is to construct a machine that could swing. It will be fixed in a **hermetic** box **X**. The whole construction is solid and can only rotate in the plane about the point **A**. Machine has to make it do one turn around the axis of rotation. The less time it requires the better. No installation outside the box (maybe except radio controller) is allowed.



Source (full citation of any paper, book or webpage used)	Own idea
Physical background of the problem	Angular momentum.
Expected contribution of students (theory / experiment / both)	Well, the machine. Those scores more, whose one will make a turnover sooner. The capacity of used motors should be bounded. The rest of the construction is uniform and is provided.
Further explanations or comments	The following solution is expected. The motor rotates a heavy flywheel in the bar's plane of rotation. Due to an angular momentum conservation law, it tends the bar to rotate otherwise. A number of periods (swings) should be required to surmount the gravity. The trickiest part, I suppose, is to invent this.

Decision: title changed to "Swing machine" to avoid overlapping with ID 2013-39

ID 2013-12
Received on April 5, 2012

Country

Author's name	
e-mail	
Title of the problem	Jet and waves
Suggested phrasing	When a slow and thin jet of water falls on a surface, a standing wave on the jet can be observed near the underlying surface. Explain the phenomenon and investigate the relevant parameters for the length of the wave.
Source (full citation of any paper, book or webpage used)	Self-observed fact.
Physical background of the problem	Surface tension, standing waves.
Expected contribution of students (theory / experiment / both)	A significant amount of experimental material (dependence on surface tension, cross-sectional area of a jet, speed of flowing liquid, viscosity, etc.). Explanation of the process. Theoretically obtained formula is also desirable.
Further explanations or comments	

Decision: removed from the selection as too similar to a problem from the IYPT 1998

IYPT 1998, **5. Water jet.** If a vertical water jet falls down onto a horizontal plate, standing waves will develop on the surface of the jet. Investigate the dependence of this phenomenon on different parameters.

ID 2013-13
Received on April 5, 2012

Country

Author's name	
e-mail	
Title of the problem	Jet and drops
Suggested phrasing	When a jet of water falls it can clearly be seen that the jet divides into distinct drops at a certain place. Explain the phenomenon and investigate the relevant parameters for the length of a connected jet
Source (full citation of any paper, book or webpage used)	Self-observed fact.
Physical background of the problem	Surface tension
Expected contribution of students (theory / experiment / both)	A significant amount of experimental material (dependence on surface tension, cross-section of a jet (its area and maybe its form), speed of flowing liquid, viscosity, etc.), a clear and secure method of measuring of the length of a jet. Theoretically obtained formula for it is also required.
Further explanations or comments	

Decision: removed from the selection as too similar to a problem from the IYPT 1997

IYPT 1997, **7. Water jet**. A water jet streaming vertically downwards from a tube is divided into drops at some distance from the tube. Choose the conditions under which the length of the unseparated jet is largest. What maximum length did you obtain?

ID 2013-14
Received on April 5, 2012

Country

Author's name	
e-mail	
Title of the problem	Tiny rainbow
Suggested phrasing	Place two objects in the way that you can see a narrow band of a bright light bounded by them. If these objects are placed at enough diverse distance from you and the band of light is narrow enough, it decomposes into a kind of a rainbow. Study and explain the phenomenon.
Source (full citation of any paper, book or webpage used)	Self-observed fact.
Physical background of the problem	Unfortunately, I'm not aware of it. It seems to be diffraction.
Expected contribution of students (theory / experiment / both)	I consider both of these aspects of this problem as quite tricky, so any promotion (either theoretical or experimental) should be scored.
Further explanations or comments	

ID 2013-15
Received on April 5, 2012

Country

Author's name

e-mail

Title of the problem	Fallen coin
Suggested phrasing	When a coin falls on the floor it usually starts to spin with a noise but calms down soon. Investigate the process and measure/calculate the dependence the rate and the whole time of a spinning on relevant parameters.
Source (full citation of any paper, book or webpage used)	Self-observed fact.
Physical background of the problem	Mainly angular momentum.
Expected contribution of students (theory / experiment / both)	Both.
Further explanations or comments	The first step may be the obtaining (by calculation of angular momentum) formula for the angular speed of the touching point: w^2=4g/h in case of regular movement, where h is the height of centre of the coin.

Decision: removed from the selection as too similar to a problem from the IYPT 2004

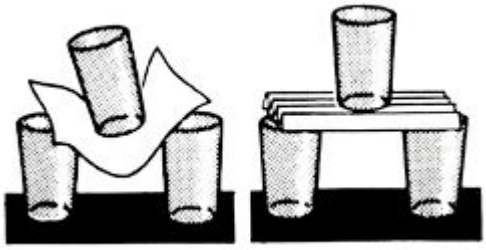
IYPT 2004, **7. Coin.** Stand a coin on its edge upon a horizontal surface. Gently spin the coin and investigate the resulting motion as it settles.

ID 2013-16
Received April 17, 2012

Country

Author's name	
e-mail	
Title of the problem	Shaking vessel
Suggested phrasing	Place and fix a vessel partially filled with water on a stiff vertical spring, which is fixed on the floor. Describe the motion of the vessel and its dependence on the amount of water in the vessel.
Source (full citation of any paper, book or webpage used)	Own invention, based on an unsuccessful "experiment" performed during cleaning a vivarium.
Physical background of the problem	Vessel with the spring form a nearly harmonic oscillator. The same holds for small amplitudes for the water in the vessel, however generally with different frequency and always shifted in phase. As such they would form a system of coupled oscillators. The water oscillator however cannot be always driven – it falls down easily into chaotic motion.
Expected contribution of students (theory / experiment / both)	The idea is to perform experiments and to see clear distinction between two kinds of behaviors – coupled oscillators and a spring oscillator strongly damped by the chaotic movement of water. Qualitative theoretical explanation shall be possible on the IYPT level, as well as quantitative for the coupled oscillator movement for all levels of the competition.
Further explanations or comments	

ID 2013-17
Received on April 18, 2012

Country	
Author's name	
e-mail	
Title of the problem	Paper bridge
Suggested phrasing	It is more difficult to bend a paper sheet, if it is folded "accordion style" or rolled into a tube. Using a single A4 sheet and only a small amount of glue, construct a bridge spanning a gap of 290 mm. Introduce parameters to describe the strength of your bridge, and maximize some or all of them.
Source (full citation of any paper, book or webpage used)	One of the suggested effects (see Figure) is a popular physics demonstration at an introductory level. A consistent quantitative description of the mechanical properties of such a bridge, however, is quite difficult and is beyond the level of popular physics books that often cite the effect. In the current wording the problem is left entirely open-ended to test different designs (tubes, paper truss bridges, corrugated sheets etc.) and thus many parameters to optimize.  (Image from http://www.klasika.edu.lv/new/VtorojKlass/Dosug/29b.gif and **not** to be used elsewhere.)
Physical background of the problem	The students are expected to develop good understanding of many concepts from mechanics (**http://en.wikipedia.org/wiki/Strength_of_materials**) and equally show a scientific approach to parametric optimization with various coupled and uncoupled physical parameters. The problem is considered ideal for the IYPT given a combination of visual and simplistic task with a good possibility for the students to acquire broad understanding in theoretical mechanics and material science.
Expected contribution of students (theory / experiment / both)	both
Further explanations or comments	---

ID 2013-18
Received on April 18, 2012

Country	
Author's name	
e-mail	
Title of the problem	Cloud chamber
Suggested phrasing	Research, develop, and evaluate a cloud chamber. What types of particles can you observe with your chamber? What properties of the particles can be determined with the chamber?
Source (full citation of any paper, book or webpage used)	**http://en.wikipedia.org/wiki/Cloud_chamber** http://www.youtube.com/watch?v=400xfGmSlqQ http://www.scienceinschool.org/2010/issue14/cloud
Physical background of the problem	The problem is expected to stimulate students learning introductory particle physics and equally enjoying with R&D of a fascinating and relatively easy-to-make instrument. The task is entirely feasible. Although many manuals and FAQs are available on home-made Wilson cloud chambers, many students may easily come up with an entirely novel design. This makes it realistic for some students to end up with a noteworthy popular physics publication (e.g. in Am. J. Phys.) These reasons suggest that the problem may be of a strong interest for the IYPT.
Expected contribution of students (theory / experiment / both)	both
Further explanations or comments	---

ID 2013-19
Received on April 21, 2012

Country

Author's name	
e-mail	
Title of the problem	Carbon Microphone
Suggested phrasing	For many years, a design of microphone has involved the use of carbon granules. Varying pressure on the granules produced by incident sound waves produces an electrical output signal. Investigate the components of such a device and determine its characteristics.
Source (full citation of any paper, book or webpage used)	The problem is of my own creation.
Physical background of the problem	Carbon granules conduct electricity. The granules are trapped between diaphragms that vibrate when sound waves are received. Greater pressure increases the conductivity of the granules and thus can produce an electrical signal.
Expected contribution of students (theory / experiment / both)	The students would be expected to obtain examples of carbon microphones and break them down into component parts. They should explore the electrical properties of the granules as a function of pressure etc. and the overall acoustic/mechanical/electrical properties of the device.
Further explanations or comments	Such microphones are very cheap and widely available

ID 2013-20
Received on April 21, 2012

Country

Author's name	
e-mail	
Title of the problem	Peltier Generator
Suggested phrasing	Peltier devices can be used to actively cool the CPU in a computer. The same devices can also be used to generate an electrical output as a result of a temperature difference. Construct and evaluate an electrical generator based on a single Peltier device. Could a scaled up version provide enough electricity to run your home?
Source (full citation of any paper, book or webpage used)	The problem is of my own creation.
Physical background of the problem	Although very inefficient, Peltier devices placed between hot and cold reservoirs can produce a few watts of electrical power output (i.e. the Seebeck effect).
Expected contribution of students (theory / experiment / both)	Students should research and explore the electrical and thermal characteristics of such a device. They should construct an electrical generator consisting of hot and cold reservoirs with a Peltier device sandwiched in between.
Further explanations or comments	Peltier devices are freely available and relatively cheap.

ID 2013-21
Received on April 21, 2012

Country

Author's name	
e-mail	
Title of the problem	YoYo Physics
Suggested phrasing	The YoYo has been entertaining adults and children for well over two thousand years. The motion of the Yoyo is controlled by gravity, and by applying and manipulating tensile forces in its string. Investigate the motion of a YoYo under various conditions.
Source (full citation of any paper, book or webpage used)	The problem is of my own creation.
Physical background of the problem	The YoYo consists of a fairly heavy spinning cylinder suspended on a length of string that sits in a deep groove around the axis of rotation. The YoYo is set in motion by 'throwing', while control is maintained via the attached string. Simple Yo-Yoing involves the unwinding and subsequent rewinding of the string, but many other tricks are possible. As a spinning system subject to externally applied forces, the YoYo provides many examples of rotational dynamics.
Expected contribution of students (theory / experiment / both)	Students should obtain and analyse the motion of a YoYo under normal play conditions. This means measuring forces in the string, rates of rotation etc. More complex situations may be explored e.g. gyroscopic effects.
Further explanations or comments	Simple YoYos are freely available all around the world, and could even be made. It is not expected that more complex YoYos involving mechanical clutches etc. should be investigated.

ID 2013-22
Received on April 24, 2012

Country	
Author's name	
e-mail	
Title of the problem	SUNFLOWER
Suggested phrasing	Explain how the spiral pattern of sunflower seeds, pineapple flakes and scales of pine cones arises. Perform an experiment to model its growth.
Source	1. Adler I. A model of contact pressure in phyllotaxis, *J. Theor. Biol*. **45** (1974) 1–79. 2. Rivier N., Occelli N., Pantaloni J., Lissowski A. Structure of Bénard convection cells, phyllotaxis and crystallography in cylindrical symmetry, *J. Physique* **45** (1984) 49–63. 3. Levitov L. S. Energetic approach to phyllotaxis, *Europhys. Lett.* **14** (1991) 533–539. 4. Douady S., Couder Y. Phyllotaxis as a physical self-organized growth process, *Phys. Rev. Lett.* **68** (1992) 2098–2101. 5. Adler I., Barabe D., Jean R. V. A history of the study of phyllotaxis, *Annals of botany* **80** (1997) 231–244. 6. Lee H. W., Levitov L. S. Universality in phyllotaxis: a mechanical theory, *Symmetry in plants* (Singapore, World Scientific, 1998) 619–653.
Physical background of the problem	Self-organized process. Energy and force approaches. Restructuring of dense packing during its growth.
Expected contribution of students	Theory and experiment.
Further explanations or comments	There are several levels of mathematical and physical theory in this problem: geometrical structure of dense packing and golden section, energetic approach to self-organized process of growth. Experiments are not easy but very interesting.

ID 2013-23
Received on April 27, 2012

Country

Author's name

e-mail

Title of the problem	Chain of coupled pendula
Suggested phrasing	Number (around 50) of equal pendula on stiff holds is equidistantly mounted on a horizontal axis in such a way that they can freely swing. Each two neighboring pendula are connected with a weak string. Determine the speed at which a small deflection propagates on such a chain. What is the speed of propagation of full 360° rotation of a pendulum (soliton)?
Source (full citation of any paper, book or webpage used)	Idea taken from the presentation of Thomas Filk, University of Freiburg on Quantum Malta 2012 conference (was used as a toy model for Quantum relativity models).
Physical background of the problem	The group speed of small waves **c** can be derived as a function of spring constant, length of the pendula, mass and gravitation acceleration. This can be also experimentally investigated. Soliton can be evoked by a quick turnaround of the first pendula in the row – it will start to propagate through the chain with a speed depending on the speed of the turnaround, but always smaller than **c**. Theoretical derivation is possible, but more complicated.
Expected contribution of students (theory / experiment / both)	Student should construct their own apparatus and me able to measure and theoretically derive the group speed of small waves. They should also observe the soliton and its propagation speed and the fact that it is smaller than **c**. On a more advanced level they might be able to derive a dependence between the speed of evoking the soliton and the speed (and width) of the soliton.
Further explanations or comments	I am happy to stick only on small waves on the chain if the soliton would seem to be more complicated. On the other hand other different stable solution, like the breathing solution, might be also introduced.

ID 2013-24
Received on April 28, 2012

Country

Author's name	
e-mail	
Title of the problem	"**Edison effect"** The thermo-electron emission was demonstrated by Edison using an electometer and a light bulb. How can the "thermo-emission current" be measured?
Suggested phrasing	
Source (full citation of any paper, book or webpage used)	
Physical background of the problem	
Expected contribution of students (theory / experiment / both)	
Further explanations or comments	

ID 2013-25
Received on April 28, 2012

Country

Author's name

e-mail

Title of the problem	"**Distortions"** When talking through a fire the sound is distorted. It is also distorted when it is recorded by microphone in a windy weather. Compare and analyze the differences between these two types of distortions.
Suggested phrasing	
Source (full citation of any paper, book or webpage used)	
Physical background of the problem	
Expected contribution of students (theory / experiment / both)	
Further explanations or comments	

ID 2013-26
Received on April 28, 2012

Country

Author's name

e-mail

Title of the problem	"**Platonic solids"** Compare experimentally the trajectory of the Platonic solids when rolling on a rough inclined surface. Investigate the outcomes for different tilts of the plane. What determines the mean-square perpendicular deviation of the trajectories of the bodies?
Suggested phrasing	
Source (full citation of any paper, book or webpage used)	
Physical background of the problem	
Expected contribution of students (theory / experiment / both)	
Further explanations or comments	

ID 2013-27
Received on April 28, 2012

Country

Author's name

e-mail

Title of the problem	"**Jumper"** It is known that boiled buckwheat "jumps" when it is warmed up on a frying pan. Why? What maximum height can be reached by the jump of a buckwheat seed?
Suggested phrasing	
Source (full citation of any paper, book or webpage used)	
Physical background of the problem	
Expected contribution of students (theory / experiment / both)	
Further explanations or comments	

ID 2013-28
Received on April 28, 2012

Country

Author's name	
e-mail	
Title of the problem	"**Fluid lens"** It is known that a droplet of water can act as a lens. What maximum focal power can be obtained by means of a droplet of distillated water?
Suggested phrasing	
Source (full citation of any paper, book or webpage used)	
Physical background of the problem	
Expected contribution of students (theory / experiment / both)	
Further explanations or comments	

Decision: removed from the selection as too similar to a problem from the IYPT 2007

IYPT 2007, 12. Fluid lens. Develop a fluid lens system with adjustable focus. Investigate the quality and possible applications of your system.

ID 2013-29
Received on April 28, 2012

Country

Author's name	
e-mail	
Title of the problem	"**Exploding droplet"** Investigate the maximum size of a free falling droplet depending on its maximal charge.
Suggested phrasing	
Source (full citation of any paper, book or webpage used)	
Physical background of the problem	
Expected contribution of students (theory / experiment / both)	
Further explanations or comments	

ID 2013-30
Received April 28, 2012

Country	
Author's name	
e-mail	
Title of the problem	Fire hose
Suggested phrasing	Look at a fire hose when a water-jet is coming out of its nozzles. In this situation if the fireman drops down the hose you will see the oscillation of hose. Find the effective parameters on the domain and period of this oscillation.
Source (full citation of any paper, book or webpage used)	NON Just looking in hose oscillating.
Physical background of the problem	Water jets and streams, Also Bernoulli Law of continue mechanic
Expected contribution of students (theory / experiment / both)	Both
Further explanations or comments	Water jet Water current Hose oscillation Water cause oscillation

ID 2013-31
Received on April 28, 2012

Country	
Author's name	
e-mail	
Title of the problem	Frog stone
Suggested phrasing	When a rotating stone hits the surface of water, it may jump several times. find the effective parameters in this phenomena and increase number of its jumping
Source (full citation of any paper, book or webpage used)	NON Children playing near rivers.
Physical background of the problem	Momentum. Newton moving low and effects
Expected contribution of students (theory / experiment / both)	Both
Further explanations or comments	

Decision: removed from the selection as too similar to a problem from the IYPT 2004

IYPT 2004, 8. Pebble skipping. It is possible to throw a flat pebble in such a way that it can bounce across a water surface. What conditions must be satisfied for this phenomenon to occur?

ID 2013-32
Received on April 29, 2012

Country	
Author's name	
e-mail	
Title of the problem	Helmholtz carousel
Suggested phrasing	Attach Christmas tree balls on a preferably frictionless mounting suspension (carousel) while the hole of each ball looks in a tangential direction to the rotation circle of the carousel. If you expose this setup to sound of a reasonable frequency with sufficient intensity, then the carousel starts to rotate. Explain this phenomenon and investigate the parameters leading to a maximum rotation frequency of the carousel.
Source (full citation of any paper, book or webpage used)	1. Einführung in die Akustik; Hans Borucki; BI-Wissenschaftsverlag; 3. Auflage 1989 2. Technische Akustik: Grundlagen Und Anwendungen; Reinhard Lerch, Gerhard Sessler, Dietrich Wolf; Springer; 2008 3. The reaction force on a Helmholtz resonator driven at high sound pressure amplitudes, Ricardo R. Boullosa and Felipe Orduna-Bustamante, Am. J. Phys. 60, 722 (1992)
Physical background of the problem	Helmholtz resonator
Expected contribution of students (theory / experiment / both)	Theory and experiments 
Further explanations or comments	---

ID 2013-33
Received on April 29, 2012

Country	
Author's name	
e-mail	
Title of the problem	The strange sound of a cup with a handle
Suggested phrasing	When a cup is hit by a spoon, one gets a different sound spectrum depending on the spoon and the handle position. Investigate and explain the different spectra.
Source (full citation of any paper, book or webpage used)	1. L. Mathelitsch, I. Verovnik, Akustische Phänomene S. 125ff Aulis Verlag Deubner 2. S. Heusler, E. Rehwald, Symmetrien in der Tasse, Vortrag auf DPG Frühjahrstagung in Mainz 3. A. P. French In Vino Veritas: A study of wineglass acuostics, Am. J. Phys. 51 (8) 1983
Physical background of the problem	Glass acoustic was often investigated and is quite clear. But the influence of the handle can be a very interesting problem (with different materials hit the cup at different locations of the cup)
Expected contribution of students (theory / experiment / both)	Theory and experiments The spectra of different cups can show common properties. Further investigations can be interesting e.g. stimulate the cup with a frequency generator.
Further explanations or comments	

ID 2013-34
Received on April 29, 2012

Country	
Author's name	
e-mail	
Title of the problem	Pulsating fountain
Suggested phrasing	Investigate the rising and falling process of a fluid jet, which is vertically upward directed.
Source (full citation of any paper, book or webpage used)	Chr. Clanet, "On large-amplitude pulsating fountains", J. Fluid Mech (1998), vol. 366, pp. 333-350
Physical background of the problem	Surface tension, fluid dynamics
Expected contribution of students (theory / experiment / both)	Theory and experiments especially with water. Experimentally the students have to construct fountains With very constant water flow. May be also other fluids show interesting effects.
Further explanations or comments	---

ID 2013-35
Received on April 29, 2012

Country	
Author's name	
e-mail	
Title of the problem	Water rise
Suggested phrasing	Fill a saucer up with water and place a candle in the middle of the water. Light the candle. Cover the candle with a clear beaker. Investigate and explain the phenomenon.
Source (full citation of any paper, book or webpage used)	Many different internet links to the candle experiments one can find (primary school to high school) e.g. http://www.wonderquest.com/candle-out.htm
Physical background of the problem	candle light,
Expected contribution of students (theory / experiment / both)	Theory to the chemical and physical matter and different experiments. At the end the students should give a reasonable explanation.
Further explanations or comments	---

ID 2013-36
Received on April 29, 2012

Country	
Author's name	
e-mail	
Title of the problem	Climbing droplets
Suggested phrasing	Liquid droplets can perform a self-propelled uphill motion when they are placed on a hot ratchetlike surface. Investigate and explain the phenomenon.
Source (full citation of any paper, book or webpage used)	H. Linke et al. "Self-Propelled Leidenfrost Droplets", Physical Review Letters, 96, April 2006
Physical background of the problem	Surface tension, Leidenfrost phenomenon, fluid and vapor
Expected contribution of students (theory / experiment / both)	Theory and experiments.
Further explanations or comments	---

ID 2013-37
Received on April 29, 2012

Country	
Author's name	
e-mail	
Title of the problem	Effervescent tablet
Suggested phrasing	An effervescent tablet dropped in water stays at the bottom of the glass at the beginning of the solution process. After some time the tablet rises to the top although the density of the tablet doesn't change. Examine the influence of relevant parameters and investigate the motion of the tablet.
Source (full citation of any paper, book or webpage used)	The problem is of our own creation
Physical background of the problem	….
Expected contribution of students (theory / experiment / both)	Theory and experiments ….
Further explanations or comments	….

ID 2013-38
Received on April 29, 2012

Country	
Author's name	
e-mail	
Title of the problem	Tumbling stick
Suggested phrasing	A cylindrical wooden stick lies on a horizontal surface. When you flip one end of the stick with your finger it starts to rotate about (or around) its mass centre. Under certain conditions the stick will rise up to a certain angle relative to the surface. Investigate the motion of the stick.
Source (full citation of any paper, book or webpage used)	The problem is of our own creation
Physical background of the problem	….
Expected contribution of students (theory / experiment / both)	Theory and experiments ….
Further explanations or comments	…

ID 2013-39
Received on April 29, 2012

Country	
Author's name	
e-mail	
Title of the problem	Water jet
Suggested phrasing	The shape of a water jet out of a watering can deviates from cylindrical form. Under certain conditions one can observe nodes in the jet where the eccentricity of the cross changes. Investigate the shape of the jet.
Source (full citation of any paper, book or webpage used)	The problem is of our own creation
Physical background of the problem	….
Expected contribution of students (theory / experiment / both)	Theory and experiments ….
Further explanations or comments	…

ID 2013-40
Received on April 29, 2012

Country	
Author's name	
e-mail	
Title of the problem	Flying chimney
Suggested phrasing	Light paper (e.g. from a tea bag) is formed into a cylinder with open front faces. The cylinder takes off, when one end is lit. Optimize the vertical velocity of the flying chimney.
Source (full citation of any paper, book or webpage used)	Similar problems are investgated in different reports of journals, e.g. "The flight of the humble tea bag" Physics Education, January 2004 pp 22
Physical background of the problem	….
Expected contribution of students (theory / experiment / both)	Theory and experiments ….
Further explanations or comments	…

Decision: merged with the proposal ID 2013-82. A merged wording may be considered.

ID 2013-41
Received on April 29, 2012

Country	
Author's name	
e-mail	
Title of the problem	Green flash
Suggested phrasing	When sun is at the horizon it turns red. Under specific conditions one may observe that very near the horizon sun turns green. Investigate and explain this phenomenon
Source (full citation of any paper, book or webpage used)	http://www.icstars.com/Mad/Astro/GreenFlash.html http://www.webexhibits.org/causesofcolor/13D.html
Physical background of the problem	The phenomenon is observed when sun is actually bellow the horizon. Light path is curved by the earth's atmosphere. Therefore the last ray of sun that one may observe is green.
Expected contribution of students (theory / experiment / both)	Student should explain what determines the color of the sun and how atmosphere curves the path of the light. Determine why last observed ray is green, under what conditions it can be observed and why is it hard to observe it. Several pictures presenting the phenomenon of green sun would be welcome.
Further explanations or comments	This phenomenon was use in the movie "Pirates of the Caribbean". There a green flash indicated that a soul came back from the dead.

ID 2013-42
Received on April 29, 2012

Country	
Author's name	
e-mail	
Title of the problem	Paper plane
Suggested phrasing	Using and A4 piece of paper and little amount of glue build the device that travels the longest distance thrown from height of 1.5m with maximal initial velocity of 2 m/s.
Source (full citation of any paper, book or webpage used)	This task is based on the IYPT 2011 Task Slow Descent, with additional horizontal velocity.
Physical background of the problem	There is a lot of aerodynamics involved. Task requires finding an optimum between lift and dragging force.
Expected contribution of students (theory / experiment / both)	Student is expected to build several paper planes (devices) and investigate their motion. He would encounter several problems such as: plain dose not fly or lift force is too big (instead of flying forward it flies upward). There will also be some problems with horizontal stability. When he learns to manage those problems, he will obtain a final device. This device can be father investigated and improved. As for theoretical investigation, student may determine importance and role of factors such as: lift force, drag force, air parameters, distribution of mass in the device. Finally he would be able to answer the question "why the plane flies after all?" for which answer is not easy.
Further explanations or comments	Every one played as a child with a paper plane, but how to build the best paper plane? This task will help to find answer to that question.

Decision: removed from the selection as too similar to a problem from the IYPT 1998 and the IYPT 2011

IYPT 1998, 1. Invent yourself. Construct an aeroplane from a sheet of paper (A4, 80 g/m^2). Make it fly as far and/or as long as possible. Explain why it was impossible to reach a greater distance or a longer time.

IYPT 2011, **15. Slow descent.** Design and make a device, using one sheet of A4 80 gram per m^2 paper that will take the longest possible time to fall to the ground through a vertical distance of 2.5 m. A small amount of glue may be used. Investigate the influence of the relevant parameters..

ID 2013-43
Received on April 29, 2012

Country	
Author's name	
e-mail	
Title of the problem	Pingpong ball
Suggested phrasing	When you let a ping-pong ball go, it bounces of the ground. Character of the collision changes when ball is filled with water. Investigate how character of the collision depends on amount of water inside the ball and other relevant parameters.
Source (full citation of any paper, book or webpage used)	My own idea.
Physical background of the problem	When two objects collide part of the kinetic energy is transformed into heat and vibration. Depending on the amount of transformed energy collision may be elastic, inelastic or ideally inelastic. The Character of the collision is described by coefficient of restitution (COR). As I conducted a simple experiment I found that for empty ball collision with the ground has high COR (it is almost ideally elastic), when ball is partially filled with water at some point ball barely bounces (low COR), but when ball if fully filled with water it again bounces similarly as the empty one did.
Expected contribution of students (theory / experiment / both)	Student should investigate qualitatively how dose coefficient of restitution depends on amount of water inside the ball. Explain way there is an elastic collision or inelastic collision, why for some amounts of water COR is higher and for some lower. What is the reason for energy dissipation in the system? Theoretical model explaining this phenomenon should be proposed if possible.
Further explanations or comments	Student who solves the problem will gain a great knowledge about collisions and waves.

ID 2013-44
Received on April 29, 2012

Country	
Author's name	
e-mail	
Title of the problem	Riding a bike
Suggested phrasing	It is relatively easy to stay stable on the bike when one rides on it, but it is much harder when bike is not moving. Why is that? Investigate and explain the phenomenon.
Source (full citation of any paper, book or webpage used)	My own idea.
Physical background of the problem	When one rides a bike, he makes slight movements with the handlebar; this motion opposes any tilt of the bike, but only when it is in motion. It is not possible to ride a bike (or it is much harder) which has rigidly attached handlebar to the rest of the bike.
Expected contribution of students (theory / experiment / both)	Student should explain why it is possible to ride a bike, and investigate how mentioned movement of handle bar effects bike's motion. He should also explain and investigate how one turns the handle bar in order to obtain stability on the bike. He should also investigate how other factors influence stability: mass distribution, speed, wheel size.
Further explanations or comments	It is a common mytht that bikes are stable due to a gyroscopic effect on the wheels; this is not true as careful investigation will show.

ID 2013-45
Received on April 29, 2012

Country	
Author's name	
e-mail	
Title of the problem	Running in the rain
Suggested phrasing	What is the optimal speed to run or walk during the rain in order to be as dry as possible?
Source (full citation of any paper, book or webpage used)	Herb Bailey, On running in the rain, College Math. J. 33 (2002) 88–92.
Physical background of the problem	Using only simple kinematics it was found that one should run or move with speed of the rain.
Expected contribution of students (theory / experiment / both)	First approach would require only requires simple kinematics. Results of such model are presented in cited article. However that article assumes strictly specified and constant atmospheric conditions. Student may expand that model by including a factor changing randomly (for example wind direction or speed may slightly change during the journey). Numerical simulations may also be helpful. Very interesting is experimental aspect of this problem. Student should develop a method of how to measure how wet is his/hers experimental setup. Student should also investigate the difference between real rain and one with controlled parameters.
Further explanations or comments	It would be nice to finally know the answer of should we walk or run in the rain ☺

ID 2013-46
Received on April 29, 2012

Country	
Author's name	
e-mail	
Title of the problem	Double bubble
Suggested phrasing	It is a common phenomenon that liquid encloses a gas forming a bubble. Can an opposite situation occur? Can a film of gas enclose a liquid? Explore the phenomenon.
Source (full citation of any paper, book or webpage used)	C.L. Strong, "The Amateur Scientist: Curious Bubbles in Which a Gas Encloses a Liquid Instead of the Other Way Around," Scientific American, vol. 230, no. 4, Apr. 1974, pp. 116-120.
Physical background of the problem	
Expected contribution of students (theory / experiment / both)	Student should explain nature of the phenomenon and determine under what condition it may occur. He should also build an experimental setup that allows creating such bubbles. I would expect student to explain, what is the role of parameters of fluid and gas such as: density, viscosity, surface tension. He should also discuss lifetime of created bubble.
Further explanations or comments	Myself, I first observed this phenomenon while preparing coffee. Droops of coffee, falling into the cup from the filter, floated on the surface (this bubble is called "Globule")

ID 2013-47
Received on April 29, 2012

Country	
Author's name	
e-mail	
Title of the problem	Water rocket
Suggested phrasing	Fill bottle of water partially with water and compressed air and place it vertically. When bottle is opened water will be pushed out and bottle will fly up. Achieve the highest altitude using a 1 litter bottle.
Source (full citation of any paper, book or webpage used)	Lately, this was an experiment presented during a lecture in physics I attended.
Physical background of the problem	High air pressure in the bottle throws water out giving a thrust to the bottle, and bottle flies into the air. It turns out that there is an optimal ration between amount of air and water in the bottle.
Expected contribution of students (theory / experiment / both)	Student investigating the problem should find optimal ratio between amount of air and water in the bottle. He should also discus other parameters such as shape of the nosle, viscosity of the fluid. For the theoretical part student should explain why bottle flies after all, this can be done from the momentum conservation.
Further explanations or comments	

ID 2013-48
Received on April 29, 2012

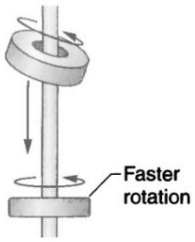
Country	
Author's name	
e-mail	
Title of the problem	Swing
Suggested phrasing	After some time kids learn to swing on the swing by them self. Explain and investigate the mechanism of swinging.
Source (full citation of any paper, book or webpage used)	My own idea
Physical background of the problem	The phenomenon behind swinging is a parametric resonance. At some point of the cycle one moves forward increasing CM (center of mass) position, at other point he move back decreasing CM position. One may compare this situation to a pendulum with periodical changing length.
Expected contribution of students (theory / experiment / both)	Student should investigate why one can swing a swing by him self. For theoretical part he should investigate what motion is needed to maintain swinging motion. Perhaps there is different way to achieve this goal, which one is the best? For the experimental part student is expected to swing on the swing and investigate his motion. He may also experimentally try different ways to swing on the swing and find the optimal one.
Further explanations or comments	This task allows students to investigate problem that is quite familiar to them. I guess most of kids have played on the swing.

ID 2013-49
Received on April 29, 2012

Country	
Author's name	
e-mail	
Title of the problem	Railgun
Suggested phrasing	A conducting bullet is placed on two conducting rails with potential difference between them. Rails are placed in external magnetic field. Current flows through the system and bullet is accelerated. Investigate the relevant parameters and maximize the efficiency of such a device.
Source (full citation of any paper, book or webpage used)	http://en.wikipedia.org/wiki/Railgun
Physical background of the problem	When current flows through a conductor in a magnetic field a Lorentz force acts on it. If conductor (for example a conducting bullet) is free to move it will be accelerated.
Expected contribution of students (theory / experiment / both)	I would expect student to build a device, investigate relevant parameters and determine what is limiting the speed of the bullet. For the theoretical part, one should find equations describing the system. Student may also write a simulation, and use it to optimize the efficiency.
Further explanations or comments	As high current and voltage are dangerous, if task is chosen, a limitation for used voltage should be specified. For example one should use a 100V capacitor too power the device.

ID 2013-50
Received on April 29, 2012

Country

Author's name	
e-mail	
Title of the problem	Falling ring
Suggested phrasing	Hold a wooden rod vertically with plastic ring at the top and then spin the ring – it will gradually move down the rod. Its rate of descent decreases and spin increases. Explane and investigate influence of different parameters on this penomenon.
Source (full citation of any paper, book or webpage used)	www.flyingcircusofphysics.com 
Physical background of the problem	At any given instant, the ring is at a slant, with part of its inner surface touching the rod. In the next instant, the point of touch has moved around the rod and also down it. The point of touch continues to spiral down the rod. As the ring descends, it converts potential energy into the kinetic energy for the spinning. The rate of descent is set by the pitch of the spiral, which is fixed by the slanted orientation of the ring. As the ring spins faster, it becomes more horizontal, and the pitch of the spiral and the rate of descent both decrease. If two rings are set spinning near the top of the rod, the higher ring might happen to catch up with the lower ring. When they touch, the higher ring bounces upward from the collision, spiraling upward.
Expected contribution of students (theory / experiment / both)	both
Further explanations or comments	

ID 2013-51
Received on April 29, 2012

Country

Author's name	
e-mail	
Title of the problem	Ionic engine
Suggested phrasing	Metal cone is pointing on metal net. Both are attached to a high voltage power source. When circuit is on, wind appears from the tip of cone to the net. Explain and investigate this phenomenon in case of different voltages, materials and other relevant parameters and calculate efficiency.
Source (full citation of any paper, book or webpage used)	My own observations
Physical background of the problem	At the tip of the cone is most dense electric field, which ionizes the ambient air, those ionized air molecules are repelled by cone surface and attracted by differently charged net. It produces continues air flow.
Expected contribution of students (theory / experiment / both)	both
Further explanations or comments	

ID 2013-52
Received on April 29, 2012

Country	
Author's name	
e-mail	
Title of the problem	Egg in the bottle
Suggested phrasing	Lit a piece of paper and put it inside a bottle. Then place a hard-boiled egg on the vessel and watch the egg being sucked into the bottle. Study the origin of this effect and determine the relevant parameters.
Source (full citation of any paper, book or webpage used)	Presentation of the phenomenon: http://www.youtube.com/watch?v=mpC5zlmtm-g Literature regarding the phenomenon in general: http://www.math.harvard.edu/~knill/pedagogy/waterexperiment/index.html , http://www.math.harvard.edu/~knill/pedagogy/waterexperiment/dhindsa.pdf , http://www.math.harvard.edu/~knill/pedagogy/waterexperiment/vera_rivera_nunez.pdf
Physical background of the problem	A source burning inside a bottle produces a pressure decrease. There seems to be a confusion whether the effect is mainly due to thermodynamic processes (and whether the air escapes the container due to larger temperature), or due to chemical processes occuring during combustion.
Expected contribution of students (theory / experiment / both)	• Theretical discussion of thermodynamics of heating a container (which isn't obvious, see for example http://ajp.aapt.org/resource/1/ajpias/v79/i1/p74_s1?isAuthorized=no) and how it applies to the problem • Theoretical predictions regarding the pressure change in the bottle • Experimental determination of the pressure inside the bottle with connection to other parameters (temperature, way of heating, number of sources etc)
Further explanations or comments	

ID 2013-53
Received on April 29, 2012

Country	
Author's name	
e-mail	
Title of the problem	Falling chain
Suggested phrasing	What is the force of interaction between a falling chain and a surfaces it touches. How does it depend on relevant parameters?
Source (full citation of any paper, book or webpage used)	E. Hamm et al, "The weight of a falling chain, revisited", Am. J. Phys 78(8), 2010 C. Wong et al, "Falling chains", Am. J. Phys. 74(6), 2006
Physical background of the problem	Although the motion of a falling chain is a standard textbook problem (e.g. weight of a chain falling on a scale, force exerted on a table if we attach one and to it and let the other end fall down), quoted articles (and many other) show that such treatment is seriously oversimplified.
Expected contribution of students (theory / experiment / both)	Build more realistic models of a falling chain and experimentally study its parameters, for example how the force exerted by it changes with time, how it depends on the elastic parameters of the chain etc
Further explanations or comments	

ID 2013-54
Received on April 29, 2012

Country	
Author’s name	
e-mail	
Title of the problem	Newton's cradle
Suggested phrasing	Newton's cradle is very often used to demonstrate the conservation of energy and momentum in a mechanical system. However, many different motions of the balls can exhibit the same momentum and energy. What additional parameters determine the outcome of the collisions of the balls?
Source (full citation of any paper, book or webpage used)	http://www.lhup.edu/~dsimanek/scenario/cradle.htm ; D R Lovett et al, “Collisions between elastic bodies: Newton's Cradle”, Eur. J. Phys 9 (1988); F. Hermann et al, “Simple explanation of a well-known collision experiment”, Am. J. Phys 49(8), 1981
Physical background of the problem	Collision mechanics, elasticity, dispersion
Expected contribution of students (theory / experiment / both)	There are plenty of experiments that can be performed to study the dependance of the outcome of an elastic collision on various parameters. I believe that the task could be about finding the minimum number of additional factors responsible for the collision and performing clever experiments to show that the suggested list is sufficient, but still every factor on it is relevant.
Further explanations or comments	

ID 2013-55
Received on April 29, 2012

Country	
Author's name	
e-mail	
Title of the problem	Helium speech
Suggested phrasing	After breathing helium, people speak in a recognizable and funny manner. Explain this phenomenon and study the parameters of the generated sound that change. Be sure to perform a safety research before conducting the experiment.
Source (full citation of any paper, book or webpage used)	Helium Speech: An Application of Standing Waves. The Physics Teacher -- April 2011 -- Volume 49, Issue 4, pp. 212
Physical background of the problem	Standing waves, sound waves
Expected contribution of students (theory / experiment / both)	• Students could research what parameters of the sound are relevant to the wave we perceive it. • Research into origins of sound-generation • Find out how to perform decent qualitative measurements of the way people speak • Finally study some more parameters of the effect, e.g. its time-dependance
Further explanations or comments	

ID 2013-56
Received April 29, 2012

Country

Author's name

e-mail

Title of the problem	Motion to Light
Suggested phrasing	Some plants move as the lightning condition changes, sometimes moving to face the light source to get more energy. Investigate this phenomenon and explain the movement mechanism.
Source	Own experiment.
Physical background of the problem	Probably (?) this could be explained thermodynamically, investigating the temperature and motion of water within the plant. Background: Thermal expansion, Conduction, Convection, Light Absorption, mechanics of materials, much more I can't predict!
Expected contribution of students	Both (Theory and Experiments)
Further explanations or comments	Attached File: "SABZE1.wmv" A time-lapse Movie I captured. Covering a time of about 2 hours and with a picture each 2 minutes. Subject is grown brown lentils (about 10 days old), They had been placed beside the window for some time, and I have suddenly rotated them, and it can be seen how they bend back to the light again. This problem also needs some biological research about the structure of these kinds of plants, however much more physics would be employed.

ID 2013-57
Received on April 30, 2012

Country

Author's name	
e-mail	
Title of the problem	Levitating ball
Suggested phrasing	A light ball (eg a ping pong ball) can be supported on an upward airstream. The airstream can be tilted yet still support the ball. Investigate the effect and optimize the system to produce the maximum angle of tilt of the airstream to produce a stable ball position.
Source (full citation of any paper, book or webpage used)	
Physical background of the problem	Fluid flow, pressure, Bernoulli effect, Koanda effect, surface drag, aerodynamics, force diagrams, balanced forces
Expected contribution of students (theory / experiment / both)	Both
Further explanations or comments	This stems from a well-known demonstration of the Bernoulli effect. To maximize the angle balls of different sizes, masses, surface properties etc will have to be investigated

ID 2013-58
Received on April 30, 2012

Country

Author's name	
e-mail	
Title of the problem	Singing saw
Suggested phrasing	When you cut an object with a hand saw - for example, if you saw through a piece of wood - the pitch of the sound that you hear changes as the cutting progresses. Investigate the situation and determine the relevant parameters which define the sound frequency?
Source (full citation of any paper, book or webpage used)	
Physical background of the problem	Sound wave formation, standing waves, resonance, Young modulus of materials, saw blade properties, dimensions of object being cut
Expected contribution of students (theory / experiment / both)	Both
Further explanations or comments	This is an everyday situation that anyone who has used a hand saw has experienced.

ID 2013-59
Received on April 30, 2012

Country

Author's name	
e-mail	
Title of the problem	Vertical spring
Suggested phrasing	A vertical helical spring is secured at its base with a mass attached to the top. The mass is moved to one side and released. Investigate the motion of the system.
Source (full citation of any paper, book or webpage used)	See the video to demonstrate the motion http://www.youtube.com/watch?v=B_SV10CvHnU&feature=youtu.be
Physical background of the problem	Mechanical oscillations, spring properties eg stiffness, rotational dynamics, mass, oscillation period.
Expected contribution of students (theory / experiment / both)	Both
Further explanations or comments	Following on from the "Woodpecker" problem of 2012 the motion of an object on a spring held vertically. Web video shows motion.

ID 2013-60
Received on April 30, 2012

Country	
Author's name	
e-mail	
Title of the problem	Spinning Coin
Suggested phrasing	Coin can spin on its side on a table for some time. Investigate the motion of the coin before it settles down. Determine how relevant parameters affect the spinning time and how to prolong it.
Source (full citation of any paper, book or webpage used)	1. The physics of a spinning coin. *http://physicsworld.com/cws/article/news/2000/apr/20/theĺ]physicsĺ]ofĺ]aĺ] spinningĺ]coin*.
Physical background of the problem	Probably we all once tried to play this little skill and tried to make the coin spins as long as possible. It's suitable for students to discuss this phenomenon from a scientific view. Serious research on the mechanical analysis is also extensive (on *Nature*, etc.).
Expected contribution of students (theory / experiment / both)	Actually setting the coin rotating for a sufficiently long time requires much skills and some interesting competitions are even held. Basically, students can attempt to establish a model as valid and complete as possible to describe the motion of the coin (by defining stages, considering the motion of mass center and rotation both, etc.). They are also expected to find out more interesting phenomena or types of spinning and the "best" skill to prolong the spinning time.
Further explanations or comments	In my opinion, the "spinning time" should include the stage after the spin along vertical axis stops before it settles down onto the table. The motion within this time period and the critical condition of the stage transition are worth investigated.

Decision: removed from the selection as too similar to a problem from the IYPT 2004

IYPT 2004, **7. Coin.** Stand a coin on its edge upon a horizontal surface. Gently spin the coin and investigate the resulting motion as it settles.

ID 2013-61
Received on April 30, 2012

Country

Author's name	
e-mail	
Title of the problem	Hearing Sound
Suggested phrasing	Coat one half of a jar's inside with a layer of soot and drill a hole in its cover. When light from a light bulb connected to ac hits the jar's black wall, a distinct sound can be heard. Explain and investigate the phenomenon.
Source (full citation of any paper, book or webpage used)	Euler M., Niemann K., "Hearing Light", The Physics Teacher, Vol. 38, pp 356ff
Physical background of the problem	Light is absorbed in the soot layer and its energy converted into heat. Since the intensity of light fluctuates, the air near the jar's surface periodically heats up and cools down, leading to pressure variations.
Expected contribution of students (theory / experiment / both)	Students should give a correct qualitative explanation of the phenomenon. They should set up a hypothesis for the relation between the various parameters (intensity and frequency of light, size and shape of jar) and the sound produced in the jar and investigate it experimentally.
Further explanations or comments	

ID 2013-62
Received on April 30, 2012

Country

Author's name	
e-mail	
Title of the problem	Hoops
Suggested phrasing	Make some hoops from an elastic material (e.g. strips of overhead transparencies). When you drop them vertically onto a hard surface, they rebound to a fraction of the initial height. Investigate how the rebound height depends on the relevant parameters.
Source (full citation of any paper, book or webpage used)	Yang E. Kim H.-Y., "Jumping Hoops", Am. J. Phys. 80, pp 19ff
Physical background of the problem	Conversion of different forms of energy (with dissipation). Elastic forces.
Expected contribution of students (theory / experiment / both)	Students should experimentally investigate the elastic properties ("spring constant") of the hoops and how they depend on various parameters. They might model the hoops motion including the relevant sources of dissipation.
Further explanations or comments	The jump of a hoop is similar to that of a rubber ball with the advantages that the properties can easily be adjusted and that the deformation is clearly visible.

ID 2013-63
Received on April 30, 2012

Country

Author's name	
e-mail	
Title of the problem	Dirty Microfiber Cloth
Suggested phrasing	Develop a procedure based on optical properties which allows to determine how dirty a microfiber cloth is.
Source (full citation of any paper, book or webpage used)	Inspired by a Swiss company working on a solution for this problem in the context of cleaning airplanes.
Physical background of the problem	Reflexion and absorption of light (possibly other optical effects)
Expected contribution of students (theory / experiment / both)	Students should define a standardised way of adding variable amounts of dirt/dust to the cloth. They should find a relation between the variation of an optical property and the degree of dirtiness. In the theoretical part they should explain how the optical properties of the fibers are affected by dirt/dust.
Further explanations or comments	

ID 2013-64
Received on April 30, 2012

Country

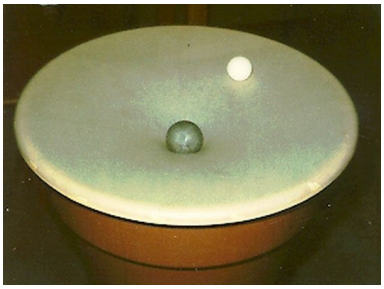
Author's name	
e-mail	
Title of the problem	Rotating disc
Suggested phrasing	A conducting disc (e.g. copper or aluminium) can freely rotate about its axis. When a magnet is rotated about the same axis and close to the disc, the disc starts rotating. Explain and investigate the disc's motion.
Source (full citation of any paper, book or webpage used)	Inspired by a demonstration experiment at our school
Physical background of the problem	Force on induced eddy currents accelerates the disc. An (idealised) stationary situation is reached once the disc's and magnet's speeds match, but because of friction the relative motion might not completely disappear.
Expected contribution of students (theory / experiment / both)	Students should give a correct explanation for the phenomenon. They should experimentally investigate the influence of relevant parameters (different magnets, distance between magnet an disc, speed, mass of disc, …) on the acceleration time, etc. The effect of at least one parameter should be explained with a theoretical model and qualitatively verified.
Further explanations or comments	

ID 2013-65
Received on April 30, 2012

Country

Author's name

e-mail

Title of the problem	Elastic space
Suggested phrasing	The dynamics and apparent interactions of massive balls rolling on a stretched horizontal membrane are often used to illustrate gravitation. Investigate the system further. Is it possible to define and measure the apparent "gravitational constant" in such a "world"?
Source (full citation of any paper, book or webpage used)	Inspired by a demonstration at Technorama Science Center in Winterthur and a related problem considered, but never selected for the IYPT 2008 https://wiki.brown.edu/confluence/display/physlecdemo/1L20.10+Gravitational+Well http://en.wikipedia.org/wiki/Gravity_well
Physical background of the problem	 (Figure courtesy of brown.edu, used here **only** as an **internal** illustration.) The two balls appear to experience an attractive force, while both can move only on an curved "2D" surface. If pushed aside, the lighter ball would start evolving around the heavier ball like a satellite around a planet. The instrumentation is extremely easy-to-made. Three or more balls would demonstrate complex and even more interesting behavior. The problem appears highly promising for the IYPT since it opens a plethora of opportunities for observations, measurements, interpretations, and serious analogies to complex models of gravitation (gravity wells in general relativity, shape of the rubber sheet vs field of a gravitational potential etc.) The participants are expected to develop understanding of idealized elastic membranes, "distorted" 2D or 3D spaces, interaction potentials, bases of field theory, complex dynamics, and draw analogies between systems of different nature that are governed by the similar mathematical laws.
Expected contribution of students (theory / experiment / both)	both
Further explanations or comments	

ID 2013-66
Received on April 30, 2012

Country

Author's name

e-mail

Title of the problem	Honey coils
Suggested phrasing	A thin downward flow of viscous liquid, such as honey, often turns itself into circular coils. Study and explain this phenomenon.
Source (full citation of any paper, book or webpage used)	http://www.youtube.com/watch?v=rEkuhC9eJlM http://ajp.aapt.org/resource/1/ajpias/v27/i2/p112_s1 http://ajp.aapt.org/resource/1/ajpias/v26/i4/p205_s1 http://www.annualreviews.org/doi/abs/10.1146/annurev-fluid-120710-101244 http://hal.archives-ouvertes.fr/docs/00/12/93/93/PDF/ribeetal_text.pdf http://rspa.royalsocietypublishing.org/content/460/2051/3223.full.pdf
Physical background of the problem	 (Figure courtesy of psidot, used here **only** as an **internal** illustration.) The coiling of viscous jets or rope-coil effect is proposed as a nearly ideal problem for the IYPT. Feasible and easily reproducible, it can be investigated and explained at different depth levels. The participants are expected to analyze the apparent hydrodynamic instability and the influence of such parameters as viscosity, surface tension and density on the stability and radii of the coils. The phenomenon is believed to be though-provoking and reflecting the sprit of "everyday life physics". Despite an existing number of past and recent publications, there are many unclear details about the phenomenon, and the participants have even a realistic opportunity to develop their projects beyond the state-of-the-art and come up with entirely novel results and make a good publication after the competition.
Expected contribution of students (theory / experiment / both)	both
Further explanations or comments	

ID 2013-67
Received on April 30, 2012

Country	
Author's name	
e-mail	
Title of the problem	Twinkling stars
Suggested phrasing	Watching the sky by night one sees twinkling stars and the planets which shine more steady. Test your hypothesis experimentally!
Source (full citation of any paper, book or web page used)	Question of my own.
Physical background of the problem	
Expected contribution of students (theory / experiment / both)	There seems to be still a debate going on if this of purely physiological origin or if factors as the angular resolution play a problem too.
Further explanations or comments	

ID 2013-68
Received on April 30, 2012

Country	
Author's name	
e-mail	
Title of the problem	Coloured Plastic
Suggested phrasing	Looking at a container or similar things made of plastic in bright sunlight, colours may be seen (see colours.jpg). Study and explain the phenomenon. Ascertain if one also sees the colours using an incandescent lamp as a light source.
Source (full citation of any paper, book or web page used)	Own observation.
Physical background of the problem	Preparing the plastic in a mould usually creates stress birefringence observable under crossed polarizers.
Expected contribution of students (theory / experiment / both)	The idea is to perform experiments to clarify why this colours can be seen without using polarнzers and give a theoretical explanation.
Further explanations or comments	Attached find the file colours.jpg. 

ID 2013-69
Received on April 30, 2012

Country	
Author's name	
e-mail	
Title of the problem	Chirping ribbons
Suggested phrasing	Investigate and compare the sounds produced by tightening rubber bands in contrast to those of e.g. tightened threads. Determine the relevant parameters which are responsible for the differences in the sounds produced.
Source (full citation of any paper, book or web page used)	Based on a problem found in: Jearl Walker, The flying circus of Physics, 2nd ed.; John Wiley & sons, 2007
Physical background of the problem	
Expected contribution of students (theory / experiment / both)	The idea is to make experiments which show the different behaviour of the frequencies produced by stretching the diverse materials and give a theoretical explanation.
Further explanations or comments	

ID 2013-70
Received on April 30, 2012

Country	
Author's name	
e-mail	
Title of the problem	Spy glass
Suggested phrasing	If you look in a one-way mirror (e.g. in cars or buildings), you just see your reflection. But by taking photos, under certain conditions, you can see the background through the mirror in the picture.
Source (full citation of any paper, book or web page used)	Own observation in venice.
Physical background of the problem	Polarization and Brewster's angle
Expected contribution of students (theory / experiment / both)	The idea is to perform experiments to see the effect and give a theoretical explanation.
Further explanations or comments	

ID 2013-71
Received on April 30, 2012

Country	
Author's name	
e-mail	
Title of the problem	the cello and the wolf
Suggested phrasing	Players of stringed instruments, especially those of cello and viola, often have to deal with a most annoying phenomenon: The so called **wolf tone**. It is a fast wobbling very unmusical sound that arises at a sharply defined frequency, characteristic for each single instrument. Investigate the phenomenon and combat the wolf!
Source (full citation of any paper, book or web page used)	Question of my own.
Physical background of the problem	The origin of the phenomenon seems to be an interference resulting in a beat from two overlapping resonances. (The phenomenon arises in cheap models too.) Usually it is dealt with by adding masses to the corpus or the strings or by pressing the instrument - this shifts the sound board resonances. I made two **sound files** of a wolf tone in one of my celli **freely available** too: http://dl.dropbox.com/u/74940793/wolf/audio/WolfGlissando.wav http://dl.dropbox.com/u/74940793/wolf/audio/Wolf.wav
Expected contribution of students (theory / experiment / both)	Investigating the origin of the phenomenon and dealing with interference and beat. If no instruments are available and no model can be built at least the sound files are available for interpretation and path the way for basic calculations and simulations. Nevertheless the author is sure that in nearly every city at least one cello or viola will be available. (Even _some_ violins show this behavior.)
Further explanations or comments	There are several papers on this subject, e.g..: On the mechanical theory of the vibrations of bowed strings and of musical instruments of the violin family, with experimental verification of the results C.V. RAMAN (!!) Indian Association for the Cultivation of Science 15 (1918!!) or The wolf in the cello IAN M. FIRTH AND J. MICHAEL BUCHANAN http://dx.doi.org/10.1121/1.1913343 or Computational modelling of string–body interaction for the violin family and simulation of wolf notes O. Inacioa,_, J. Antunesb, M.C.M. Wright http://dx.doi.org/10.1016/j.jsv.2007.07.079 or On the oscillations of the bowed string, F.G. FRIEDLANDER (!) Proceedings of the Cambridge Philosophical Society 49 (1953) 516–530. etc.

ID 2013-72
Received on April 30, 2012

Country	
Author's name	
e-mail	
Title of the problem	Straw Pop
Suggested phrasing	Take a drinking straw and hold each end between fingers to trap air inside. Wind the ends of the straw until the trapped air is pushed into the middle of the straw. A loud popping sound may be heard when the straw is flicked with a finger. Investigate the sound produced under various conditions.
Source (full citation of any paper, book or webpage used)	My own wording of the problem created after a friend showed the effect.
Physical background of the problem	Air is trapped and compressed creating a relatively high pressure difference between the inside and outside of the straw. The flick creates a shock.
Expected contribution of students (theory / experiment / both)	Easy to perform experimental work and sounds clearly depend upon the nature of the drinking straw used. A good theoretical understanding would be expected.
Further explanations or comments	I have since found videos of the effect on youtube

ID 2013-73
Received on April 30, 2012

Country	
Author's name	
e-mail	
Title of the problem	Ball scattering
Suggested phrasing	When a series of balls are rolled along parallel tracks towards an object they will be scattered in a pattern that will depend upon the shape of the object. Investigate how the scattered pattern allows the shape of the scattering object to be determined.
Source (full citation of any paper, book or webpage used)	My own wording of the problem created after seeing an online simulation of nuclear scattering with ball bearings at www.livephysics.com
Physical background of the problem	Basis of problem is simple reflection but complexity comes from linking patterns to size and shape of object
Expected contribution of students (theory / experiment / both)	Easy to perform experimental work and collect data. A good theoretical understanding would be expected.
Further explanations or comments	

ID 2013-74
Received on April 30, 2012

Country	
Author's name	
e-mail	
Title of the problem	Electrolycra
Suggested phrasing	Electrolycra is an example of a conductive fabric, where the fabric has metal plated onto the elastic fabric strands. The electrical resitance of the fabric varies as the electrolycra is placed under tension. Investigate the suitabilty of such a fabric as the basis of a pressure sensor.
Source (full citation of any paper, book or webpage used)	My own wording of the problem based upon being given a sample of electrolycra from www.mutr.co.uk (Product code: 234-309A) but lots of other suppliers.
Physical background of the problem	The resistance of a sample of the material will increase as the fabric is stretched before decreasing again.
Expected contribution of students (theory / experiment / both)	both
Further explanations or comments	The problem could be varied to look at the idea of clothing as shielding and link to faraday cages if preferred.

ID 2013-75
Received on May 1, 2012

Country	
Author's name	
e-mail	
Title of the problem	Song of the wind
Suggested phrasing	Sitting in a house during a storm, one can hear a song of the wind. How it is produced. Find the main parameters which determine such song.
Source (full citation of any paper, book or web page used)	
Physical background of the problem	
Expected contribution of students (theory / experiment / both)	
Further explanations or comments	

ID 2013-76
Received on May 1, 2012

Country	
Author's name	
e-mail	
Title of the problem	Lasso
Suggested phrasing	Lasso is used by various nations to catch animals. Explain mechanics of lasso moving and demonstrate it.
Source (full citation of any paper, book or web page used)	
Physical background of the problem	
Expected contribution of students (theory / experiment / both)	
Further explanations or comments	

ID 2013-77
Received on May 1, 2012

Country	
Author's name	
e-mail	
Title of the problem	Water lifting
Suggested phrasing	How water reach the top of high trees even during blossoming of leaves in spring.
Source (full citation of any paper, book or web page used)	
Physical background of the problem	
Expected contribution of students (theory / experiment / both)	
Further explanations or comments	

ID 2013-78
Received on May 1, 2012

Country	
Author's name	
e-mail	
Title of the problem	Spoon loving water
Suggested phrasing	Take a tea spoon and touch water jet from a faucet. You will feel attraction. Explain the fenomenon and find essential parameters.
Source (full citation of any paper, book or web page used)	
Physical background of the problem	
Expected contribution of students (theory / experiment / both)	
Further explanations or comments	

ID 2013-79
Received on May 1, 2012

Country

Author's name

e-mail

Title of the problem	Friction
Suggested phrasing	The commonly used model of the friction in high-school textbooks results in the friction force independent on the size of the contact area as well as on the velocity. Investigate the limitations of this model.
Source (full citation of any paper, book or webpage used)	Commonly asked question, only qualitative explanations found. See http://hyperphysics.phy-astr.gsu.edu/hbase/frict3.html#nor http://www.newton.dep.anl.gov/newton/askasci/1993/physics/PHY2.HTM as examples.
Physical background of the problem	The model mentioned is very simple (based on the surface roughness) and does not reflect all surface properties (e.g. intermolecular forces).
Expected contribution of students (theory / experiment / both)	Students should construct a device for friction force measurements. They should collect a larger amount of data sets for various materials. After the data collection, the analysis has to be done and suitable physical explanations are expected.
Further explanations or comments	It is commonly known that car stability depends on the size of the contact area between the tyre and the road. The explanation can be partly based on the sticky-tape model (IYPT problem 2010), what is a disadvantage of the proposed problem.

ID 2013-80
Received on May 2, 2012

Country

Author's name	
e-mail	
Title of the problem	Bouncing Spring
Suggested phrasing	Drop a compression spring vertically onto a horizontal surface so that it hits on one end. Investigate and explain the motion of the spring.
Source (full citation of any paper, book or webpage used)	
Physical background of the problem	
Expected contribution of students (theory / experiment / both)	
Further explanations or comments	

ID 2013-81
Received on May 2, 2012

Country

Author's name	
e-mail	
Title of the problem	Whistling sand
Suggested phrasing	Walking on dry sand may produce a distinct sound. Investigate the sound produced by a granular medium upon compression, and the role of relevant parameters.
Source (full citation of any paper, book or webpage used)	F. Nori, P. Sholtz, and M. Bretz "Booming Sands". *Scientific American* 277(3), 84 (September 1997). P. Sholtz, M. Bretz, and F. Nori "Sound-producing sand avalanches". *Contemporary Physics* 38(5), 329-342 (October 1997). K. Ridgeway and J. B. Scotton "Whistling sand beaches in the British Isles". *Sedimentology* 20 (2), 263–279 (1973). B. Andreotti "The Song of Dunes as a Wave-Particle Mode Locking". *Phys. Rev. Lett.* 93, 238001 (2004). S. Douady et al. "Song of the Dunes as a Self-Synchronized Instrument". *Phys. Rev. Lett.* 97, 018002 (2006). L. Bonneau, B. Andreotti and E. Clément "Surface elastic waves in granular media under gravity and their relation to booming avalanches". *Phys. Rev. E* 75, 016602 (2006). N.M. Vriend, L. Hunt, R.W. Clayton, C.E. Brennen, K.S. Brantley, and A. Ruiz-Angulo "Solving the mystery of booming sand dunes". *Geophysical Research Letters* 34, 2007GL030276 (2007). B. Andreotti, L. Bonneau and E. Clément "Comment on 'Solving the mystery of booming sand dunes'". *Geophys. Res. Lett.* 35, L08306 (2008).
Physical background of the problem	The phenomenon of singing or whistling sand has been largely investigated in the past, however, remains not entirely understood given the complexity of the interactions between individual grains of the sand. The distinct noise, somewhat similar to the noise of compressed dry snow, can be easily produced and investigated with home-made instrumentation. The problem is suggested as a promising task for the IYPT that can be addressed from various perspectives.
Expected contribution of students (theory / experiment / both)	both
Further explanations or comments	

ID 2013-82
Received on May 2, 2012

Country

Author's name

e-mail

Title of the problem	Teabag Rocket
Suggested phrasing	Cut the teabag's end, throw away contained tea leaves and straighten the material to form a cylinder (see the picture). Put the cylinder vertically to a nonflammable desk (could use an ordinary glass plate) and light the upside end with a lighter. The teabag will fly away vertically when almost burned. Explain the reasons of the phenomena and investigate the critical parameters (like size, density and flammability of the paper) that affect the lift-off occurrence and motion.
Source (full citation of any paper, book or webpage used)	Quite a well-known physics trick (I've seen this on the TV about 10 years ago), I used this video to take the screenshots : http://www.youtube.com/watch?v=TKF3OKxwM8g 
Physical background of the problem	It looks like the air is heated and convection occurs; when the mass of an unburned part and velocity of the convectional flow are in a certain relation the lift-off occurs,
Expected contribution of students (theory / experiment / both)	I expect that the teams prove the qualitative explanation (that is widely spread in the Internet) first and then concentrate on the critical parameters of the teabag (e.g. density/size/flammability of the paper) that influence the process (both lift-off and further motion). I'm pretty sure that these values should be in certain relation (allowed range) for the left-off to occur. I'd be happy to modify the wording to encourage students to study various range of paper and shapes.
Further explanations or comments	

Decision: merged with the proposal ID 2013-40. A merged wording may be considered.

ID 2013-83
Received on May 3, 2012

Country

Author's name	
e-mail	
Title of the problem	"Ball Bearing Motor"
Suggested phrasing	A device called "Ball Bearing Motor" uses electrical energy to create rotational motion. What parameters do the motor efficiency and the angular velocity of the rotation depend on?
Source (full citation of any paper, book or webpage used)	Inspired by problem, proposed in 2008. The device itself looks like this:  Two ball bearings with a conductive shaft placed through them (inside the vice). High current, low voltage DC power supply connected to outer rings. The shaft rotates. Further information available: http://en.wikipedia.org/wiki/Ball_bearing_motor http://www.youtube.com/watch?v=tHZbHMFWS2k http://www.youtube.com/watch?v=o0ktomInqp8 http://www.fdscience.org/uneko/bbmotor.htm
Physical background of the problem	The main point is origin of rotation. Some sources (as Wikipedia), point that the only source is thermal effect of current (no magnetic effects).
Expected contribution of students (theory / experiment / both)	Both. Theoretical approach needed to determine the main reasons of motion, but neither reliable prove nor efficiency assumptions can be done without working model and sufficient number of experiments.
Further explanations or comments	The problem is going to be quite challenging because of lack of information on unusual electric devices on the web and the controversy (thermal/magnetic) of the problem itself. Small voltages are safe for health, but using such a supply should be accurate do to high risk of short circuit.

ID 2013-84
Received on May 3, 2012

Country

Author's name

e-mail

Title of the problem	Collisions
Suggested phrasing	On a table, two slabs with the same thickness are put next to each other. One slab is made from hard materials, such as steel, and the other is made from soft materials, such as rubber. A pingpang ball falls onto the interface between the two slabs. Study the movement of the pingpang ball after the collision.
Source (full citation of any paper, book or webpage used)	
Physical background of the problem	
Expected contribution of students (theory / experiment / both)	
Further explanations or comments	

Decision: title suggested as "Collisions"

ID 2013-85
Received on May 3, 2012

Country

Author's name	
e-mail	
Title of the problem	Diffraction
Suggested phrasing	Cut a narrow slit on a metal sheet. Immerge the metal sheet into liquid, such as water. When pulling out the metal sheet, you can see a liquid film in the slit. Illuminate the slit with liquid film and study the diffraction pattern of the slit.
Source (full citation of any paper, book or webpage used)	
Physical background of the problem	
Expected contribution of students (theory / experiment / both)	
Further explanations or comments	

Decision: title suggested as "Diffraction"

ID 2013-86
Received on May 3, 2012

Country

Author's name	
e-mail	
Title of the problem	
Suggested phrasing	Put a pingpang ball into certain depth under the water surface and then release the ball. Study the condition under which the ball jumps over the water surface.
Source (full citation of any paper, book or webpage used)	
Physical background of the problem	
Expected contribution of students (theory / experiment / both)	
Further explanations or comments	

Decision: removed from the selection as too similar to a problem from the IYPT 1998

IYPT 1998, 2. Popping body. A body is submerged in water. After release it will pop out of the water. How does the height of the pop above the water surface depend on the initial conditions (depth and other parameters)?

ID 2013-87
Received on May 3, 2012

Country	
Author's name	
e-mail	
Title of the problem	Caviar
Suggested phrasing	When a solution of alginate is poured drop by drop in a calcium containing solution, soft spherical beads can be seen to form. Study the parameters that determine the texture of the beads. Can you suggest an optimal recipe to get the most tasty beads ?
Source (full citation of any paper, book or webpage used)	Well known experiment that can be found in "molecular cooking" books
Physical background of the problem	Physical chemistry of the alginate / calcium complexation reaction; diffusion; hydrodynamics
Expected contribution of students (theory / experiment / both)	Theory : understand the reaction that takes place, progress of the reaction front in the bead Experiment : study the influence of concentration, reaction time, presence of salts / colouring agents /alcohol, drop launching height, etc. Get a taste for physical chemistry and molecular cooking !
Further explanations or comments	

ID 2013-88
Received on May 3, 2012

Country	
Author's name	
e-mail	
Title of the problem	Cracking Ice
Suggested phrasing	When an ice cube is dipped in water, it may crack. Study the origin of this phenomenon and important parameters.
Source (full citation of any paper, book or webpage used)	My freezer
Physical background of the problem	Thermal expansion constraints ? Bubble expansion ?
Expected contribution of students (theory / experiment / both)	Theory : understand mechanical properties and failure of a material, Experiment : different bath temperatures, ice cube geometries, type of ice cubes, etc.
Further explanations or comments	

ID 2013-89
Received on May 3, 2012

Country	
Author's name	
e-mail	
Title of the problem	Whirly
Suggested phrasing	Study how sound is produced in a "whirly" tube (sound hose).
Source (full citation of any paper, book or webpage used)	A toy my nephew got. http://www.youtube.com/watch?v=CuGnsW0ysrA
Physical background of the problem	Acoustics ; air flow
Expected contribution of students (theory / experiment / both)	Understand various concepts : circular motion, acceleration, air flow, turbulence, resonating modes of a tube Experiments : mainly acoustics and playing around with custom pipes
Further explanations or comments	