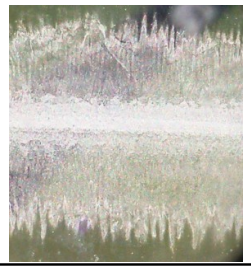
Short-list for IPT 2018

Not for spread except for voting. Please write your comments and proposals in the third column

We need your grades (they should **sum up to 100 points** or we will normalize them for you) and the **number of persons** who participated in the voting from your country.

The deadline for voting is **July 31th, 11:59 PM UTC** (send filled doc at problems@iptnet.info)

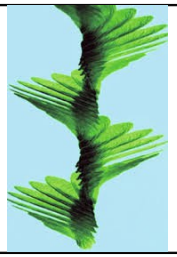
INTERNATIONAL PHYSICISTS' TOURNAMENT

№	Problem	Grade	Comments
1	**Origami launcher** Folded paper structures, such as the Miura-ori origami, can be programmed to exhibit a wide range of elastic properties depending on their crease and defect patterns. Using a single sheet of A4 paper, design an origami cannon to vertically launch a Ping-Pong ball using only a single, uncut sheet of A4 paper (80g/m^2). How is the height of the ball related to the folding pattern? Optimize your design to achieve the maximum height possible. http://www.latimes.com/science/sciencenow/la-sci-sn-miura-ori-engineered-origami-metamaterial-20140808-premiumvideo.html		
2	**Egg-White Pearls** Egg whites are separated from the yolk and put into a syringe. From the syringe the egg white is ejected into warm oil (roughly 70 degrees) while the tip is in motion. How does the size of the egg white pearls depend on the various parameters such as the temperature of the water, ejection and motion speed, or the nonNewtonian properties of egg whites? References; Molecular gastronomy food made by chefs such as Peter Gilmore https://youtu.be/-QliDP2fCRY A bit more detail in episode 23 of MasterChef Australia: The Professionals https://youtu.be/Xma9dBQu810 Strong relation with the Rayleigh-Plateau instability is expected. I think the specifics of the recipe might be required as it is not an easy phenomena to obtain. This can be found here; http://tenplay.com.au/channel-ten/masterchef/recipes/fragrant-poached-chicken-white-radish-sea-scallop-smoked-eggplant-cream-pea-blossoms		
3	**Chalk on the water** If you draw a line by chalk marker on the glass surface, covered with small layer of water, than line will blur i*n offshoot* distributed in lengthwise. What are statistical properties of this distribution? Does using colored marker influence on it? What and how parameters influence on quality of image?   		
4	**Relativity for dummies** Build the simplest device which can produce and measure particles with a Lorentz factor at least equal to 1.1. What is the maximum Lorentz factor such a device could reach?		

5	**Fluidic Calculator** When droplets of differing concentrations of food coloring (containing propylene glycol) are placed on a clear glass slide, the droplets move in beautiful and intricate patterns. Using this property a wide variety of autonomous fluidic machines can be produced. Implement diverse arithematic operations using this property, and optimize operation speed. http://www.nature.com/nature/journal/v519/n7544/full/nature14272.html http://stanford.edu/~manup/docs/Cira_DancingDroplets.pdf Droplet Dancing https://www.youtube.com/watch?v=K8Wx2PHIYGI https://www.youtube.com/watch?v=ZMsaH6SY4CY https://vimeo.com/121939679		
6	**Precious energy** How much mechanical energy can be obtained from a previously shaken bottle of beer? How does the answer change for champagne?		
7	**Macroscopic Flow** An array of mousetraps and ping-pong balls result in a chain reaction. From a macroscopic viewpoint there is a clear direction to the flow. Characterize the flow velocity as a function of relevant parameters, such as the initial positioning of the mousetraps and the elastic properties of the ping-pong balls. Also, does the flow undergo a transition from steady to turbulent flows? Characterize an effective Reynolds number for those same parameters. https://youtu.be/v7YQT6BCuAE		
8	**“Crowbaroffka”** By some legends in Syberia russians purify the liquid for cleaning windows and any other liquid containing alcohol to obtain pure alcohol. The purification technology is very simple: a crowbar is carried out to the frost and the liquid is poured on it and runs slowly along all the length of the crowbar. After some steps of such purifying the alcohol obtained can be used for drinking (even without water). Define the purification efficiency and find how the single purification efficiency depends on the important parameters?		
9	**Half-full bottle** Take a half-full bottle of water by the neck, and launch it in order to have a rotation of the bottle around an horizontal plane, in addition of a vertical motion. The displacement of the water in the bottle will imply a complex behavior. Is it possible to launch the bottle such that the rotational speed of the bottle around the horizontal axis will change of sign one or more times? You can consider other liquids than water. What are the influence of the relevant parameters?		
10	**Seracs** Under what conditions ice columns can be formed in highlands? What factors limit their size and lifetime? 		

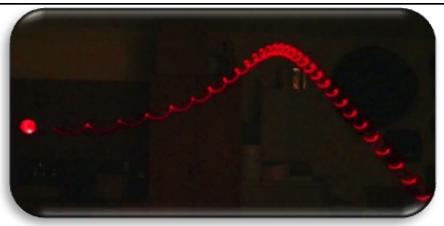
11	**Screaming balloon** If you put a hex nut in a balloon, it is possible to make it “scream” by giving a certain rotational movement to the balloon (see video: https://www.youtube.com/watch?v=zlAHSpLoejU). What are the important parameters of the sound produced?		
12	**Floating log** It is known, that a log floats down the river at a velocity different from the average velocity of the river's flow. Investigate the dependence of velocity on depth and width of the river, the flow velocity and the size of the log.		
13	**Drunken glass** Sometimes when we put a glass with its bottom up on a flat and wet table, it starts moving. How to obtain the maximal speed of moving?		
14	**Kitchen Geyser** If one throws salt into a slowly boiling pot of water, the water may popple and jump to a certain height. What does this height depend on? How much it is?		
15	**Soldiers** If a base with metal chips laying on it starts vibrating intensively, then the chips arrange vertically. Explain this phenomenon and find the required parameters for its appearance.		
16	**Dirty racing** Take a ball made of different materials (wood, metal, rubber), accelerate it to the particular velocity and let it roll on the flat sand surface. When the sand is wet the distance travelled by your ball until stopping will be different. Investigate how this distance depends on the sand wetness.		
17	**Runaway bubbles** Bubbles float in all directions when a jet of water pours from the tap into a container. Investigate the distribution of the distance from the jet to which the bubbles can escape dependent on the impact velocity of the jet with water and the depth of water tank. Will the situation qualitatively change in the waterfall? 		
18	**Candle Lighting trick:** It is possible to relight a candle that has just been blown by lighting the smoke that is created in the process : https://www.youtube.com/watch?v=C5eTn5d0cvg Indeed, the smoke contains vaporized wax, which is the substance that burns in the flame in the first place. What is the maximum distance (between the match and the candle) from which one can relight the candle ? How does it depend on important parameters (way of blowing the candle, chemical composition..) ?		
19	**Leaf fall** The carpet of leaves forms round the trees in the time of the leaf fall in autumn. How does the leaves concentration depends on the distance from the tree? What is the maximal distance the leaf can fall from the tree in the absence of wind? What trees have the maximal radius of the leaf carpet? 		

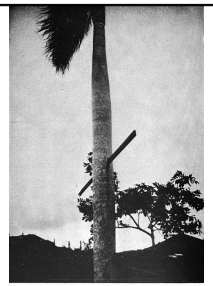
20	**Wavy paper** When one wets a paper sheet it may become wavy. Explain the phenomenon and investigate the parameters the wave size depends on.		
21	**Flat Fog** If you pour liquid nitrogen in a mug, you will notice that the mug starts to cast mist, and the mist's border is a clearly marked thin plane at a certain height from the mug. What does this height depend on and how? 		
22	**Levitating drops.** When a car moves with high speed in rain sometimes the drops on its side window walk up but not down. Explain the phenomenon a find the conditions for it to occur (size of the drops and car speed for example). What is the maximal speed of a drop elevation as function of the car speed?		
23	**Sparkler** Investigate burning process of a sparker. What's the maximal distance sparks can fly away? What factors determine the flame "diameter" (i.e. the sparks average travel distance)?		
24	**Divination for rail-track** The sound of approaching train, propagating in metals, reaches our ears early then train arrives. Is it possible to estimate the distance to train and speed of its movement using this phenomenon?		
25	**Soft rescuer** Why don't soap bubbles break when they fall on a soft carpet? At which conditions can this be observed?		
26	**Static Speaker** Build an audio-speaker without any moving part. Discuss the maximum bandwidth and power efficiency achieved with your design. Is it possible to modify your device to use it as a microphone?		
27	**A laborious musician** If while playing the recorder one blows too intense into the fipple then instead of the desired sound one obtains an overboost. Which is the minimum intensity of the blow at which the overboost is obtained? How does this intensity vary through different octaves?		
28	**Unrolling Tape** When unrolling a roll of adhesive tape a loud sound can be produced. Explain the physics of the sound emission and determine the parameters it depends on. Find ways to reduce the noise.		
29	**The crazy cylinder** Let us conduct the following experiment: let us fill the space between two parallel panels with liquid, and let us place between them a heavy (round) cylinder, its diameter being a little less than the distance between the panels. Let us pull it up by two threads placed on the edges of the cylinder so that its axe is horizontal. The cylinder will begin to hit the walls (there will appear autooscillations). Explain this phenomenon and estimate the frequency of the oscillations depending on the velocity of lifting of the cylinder and the parameters of the system.		

30	**Coffee break** Ground coffee is often sold in a sealed vacuum package hard enough for a person to stand on. What is the maximum weight that this package can support? Determine the key parameters that influence the physics of the phenomenon. Would you answer change for a pack of peanuts? 		
31	**How does the cheese roll in butter?** If a rigid ball is placed on an incline, which is situated in a high-viscosity liquid (it may be a steel ball in honey), the ball will “glide” with slippage without touching the incline. Explain this effect qualitative and quantitative.		
32	**Spilling soda can** https://www.youtube.com/watch?v=vD22eb7keSg What is the minimal number of tips you have to do on a shaken soda can to avoid it spilling? Devise a method to “calm” the soda can as quickly as possible.		
33	**Pull-pull, can't pull out** Fishing net is cast into the water. Investigate the dependence of the force necessary for pulling out the net on pulling velocity and the system parameters - size of the cell network, the node plexus types, the number of catch and algae. Find at what proportions between the catch and the net one can't pull the net out? Consider the extreme case when the net is a small piece of gauze. What will change in this case?		
34	**Half-life sparkles** Sparks caused by angle grinder tend to fly over a certain distance and then to split into several smaller sparks https://www.colourbox.com/preview/6421562-sparks-isolated-on-black-background.jpg https://youtu.be/GDpvHo75T-Q?t=98 What causes them to split? What is the condition for a split to occur? What influence the distance before the split?		
35	**The paper tube** Long paper strip is twisted to a tight tube and put vertically on the table. Why do it untwist by jerks? How does the jerks period depend on the paper parameters?		
36	Many people feel themselves disoriented in metro. You may observe that the compass needle behaves strangely when the metro vagon is accelerating. Explain the effect. Which parameters of vagon speed and orientation can be determined from such experiment. https://youtu.be/QigDuhCRcZg		
37	One can often find a maple samara far from any tree, carried by the wind. How the terminal speed of a samara does depend of the parameters? Is it more efficient than a parachute?  		
38	**Airlift pump** Propose and make an airlift pump of height 50 cm and power less than 50 Watts which will achieve the maximal number of water rotations in the system per hour. https://www.youtube.com/watch?v=I1uBybsdXHQ		

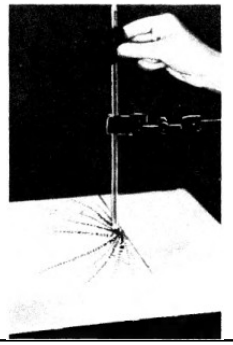
39	**Loud bicycle** Some cyclists attach to their bikes ratchets made of a clothespeg and plastic plate. When bike is moving the plate is beaten by wheel spokes and the sound is emitted. What volume can reach this sound? What does the volume depend on? Optimize the setup.		
40	When water is forced through a thin slit, the flow sometimes takes the shape of a helix. Describe the phenomenon and explain the dependance of the aspect ratio(s) of the helix on the parameters. https://twitter.com/PSE_ESPCI/status/738734718699601921		
41	A ball is leaning on a hard and flat surface under a perpendicular to the surface jet of water. On the video you can see that such a ball may start to oscillate. Investigate how the oscillations magnitude and period depend on the important parameters. https://youtu.be/yq_qSWZDHHk		
42	**Van Der Graaf's cat** Petting a cat may result in a static electricity being generated on its fur. What are the ultimate energetic parameters of a possible discharge spark under normal conditions? What fur properties and petting techniques improve generation? Can one start a fire with such spark? Please take necessary precautions while performing the experiments. Relevant links: https://www.youtube.com/watch?v=Th3GY5wgouA https://www.youtube.com/watch?v=N5_vLjtNGDI https://www.youtube.com/watch?v=Pp00xYc4hB4		
43	It is universally believed that fall of a pencil leads to the breakage of its graphite rod. How large is the probability of the breakage? How does this probability depend on the height of the fall and the length of the pencil? Propose an effective noninvasive technique to test whether the rod of a pencil is damaged.		
44	**Tea stripes** One can see stripes on tea surface when looking some time on the hot tea. Explain the phenomenon qualitatively and estimate the time of forming and the typical size of the stripes. What parameters do they depend on? (http://www.youtube.com/watch?v=H3ro3RiMnMs&feature=youtu.be). 		
45	**High-speed CD** If one spins a compact disk very fast then its surface starts to warp. However we can see (https://youtu.be/zs7x1Hu29Wc?t=406) that the warp rotates with a different speed than the point on the surface. How do these two rotational velocities relate to each other?		

46	**Ink tree:** When a drop of ink in dropped inside really still water, it first forms a ring of ink that then divides into smaller rings. The process repeats again and again and forms a tree-like structure of ink: https://www.youtube.com/watch?v=VPBdsIWyUZk This phenomenon can also be seen using a pipette and dropping a drop really close to the surface of still water. What is the maximum number of ring divisions that one can see, and how does it depend on important parameters?		
47	**Circle magnet** If you stack many small cylindrical magnets, the resulting stick of magnets will have some elasticity. Is it possible make it sufficently elastic to join both ends of the magnet stick? If yes, what is the minimal ratio of the radius of the resulting circle of magnets to the single magnet radius?		
48	**Rubber shot** Estimate the highest possible launch speed of a rubber band and investigate how do the relevant parameters influence on the result.		
49	**Planetary clock** Propose the most accurate clock that measures the time using the Earth rotation. If it is necessary assume that the clock should work for a Paris' latitude but with a correction factor it should work even on Venus.		
50	Shower curtains tend to blow inwards as the shower is running. Give a qualitative and quantitative explanation to this phenomenon and determine the curvature of the curtain as a function of relevant parameters. Ref.: https://en.wikipedia.org/wiki/Shower-curtain_effect		
51	**Two-wheel skateboard** Derive the conditions of stability for the two-wheel skateboard and test them experimentally. Additionally, explore the typical trajectories of the wheel traces. 		
52	With charged rods or balloons one can make a fine water jet bend, see https://www.youtube.com/watch?v=xZ69kHTCHUA. Explain the phenomenon. What is the smallest radius (curvature) of the water jet one can achieve? Are loops or helices possible?		
53	**Squeaky beads** When put on a hot plate, hydrogel beads bounce while emitting a high-pitched noise. Explain the physical origin of the sound and investigate the influence of the main parameters (size, concentration, temperature…) https://www.youtube.com/watch?v=9oQc-gAvUS4 		
54	What determines the speed and mass flow of a sand avalanche? https://www.youtube.com/watch?v=yfGD_kehIIE		

55	 **Cup flyers** A light-weight cylinder thrown horizontally with a high backspin, initially rises against gravity: https://www.youtube.com/watch?v=05zF0sBwHe8 Explain the trajectory and discuss the influence of the relevant parameters on the maximum height.		
56	**Sonic black hole** Surfing the Internet you can face lots of articles about black holes for sound. Try to create your own sound black hole. What represents the event horizon? Does the Hawking radiation exists for your black hole model? Which properties of black hole can not be represented?		
57	**String shooter** A closed loop of string fed between two high-speed rotating wheels seems to defy gravity. Explain the overall shape of the loop and investigate the propagation of waves on the string. https://www.youtube.com/watch?v=rffAjZPmkuU 		
58	**Hail** Design a setup to extract as much as possible information about the shape and dimensions of a metal container from the sound produced when dropping a small object into it (for example a pea).		
59	**Egg fight** There is an old game of egg-tapping: two players take a boiled egg each and hit collide them until one is broken. The player with an unbroken egg is the winner. Propose a method (or methods) to study and predict the winning egg among the given two. Assumptions: when collided the eggs are treated the same; you are not allowed to know the history of an egg preparation for the competition. Improve the prediction with invasive examination methods allowed Relevant link: https://en.wikipedia.org/wiki/Egg_tapping Picture: https://upload.wikimedia.org/wikipedia/commons/thumb/9/97/Eierkippen.jpg/220px-Eierkippen.jpg Note: the opponent is allowed to bring his eggs to the fight and test presenter's method if experimental demonstration is possible during the fight		
60	**The propelled boiling** Suggest the way to shorten the time of water boiling in a non-electric kettle (on the stove) with help of special appliances installed in the kettle that doesn't use any external energy sources (they may use for example the energy of thermal flow between the kettle bottom and environment or the mechanic energy of water flow in the kettle). What relative decrease in boiling time could you obtain with such appliances and how does it depends on the relevant parameters?		

61	**Pickle night light** If you pass current from a conventional household wall socket through the pickle it will glow. What is the physics behind the glow? Why does only half of the pickle glow when alternate current is applied? What is the longest pickle chain capable of glowing all elements simultaneously? What are the conditions for element wearing out and pickle replacement? What other vegetable are susceptible to the effect? Related video (more fun) https://youtu.be/aab8VjzuXyM?t=39 Alternative related video(more refined) https://www.youtube.com/watch?v=axbAvYK9Hcw Illustration (perhaps copyrighted) http://i.ytimg.com/vi/62urP2msq_M/maxresdefault.jpg		
62	While frying the egg whites in a frying pan, characteristic structures are formed. Try to build a mathematical model of the pattern and to investigate on what the number of branching's depends (see more https://www.aps.org/units/dfd/pressroom/gallery/2008/egg.cfm)		
63	**Sound thermometer** Device a method to know the temperature of a fluid by listenning to the sound emited when it's pourred into a cup. State the precision and the limits of your method as well as the important parameters of the fluid. https://www.youtube.com/watch?v=Ri_4dDvcZeM		
64	**Zombie ray** Everybody knows that modern television is zombiing people. On the photo there is shown an Ostankino TV-tower in Moscow. The photo is taken in winter with wide-angle lenses on a professional DSLR. Explain the black vertical ray emerging from the tower and find the most important parameters for it to occur. 		
65	We have all heard the singular sound that a suction cup emits when it is riped off its support. Study the dependance of this sound regarding the parameters that you consider the more important and propose a way to build a tool that can produce the notes of a standard music scale		
66	**Dangerous straw** After hurricanes there are observed trees that are pierced by regular boards. How can this happen? What in the maximum thickness of the tree that can be pierced by a board during the hurricane (on the photo is shown a pine board that is one inch thick)? 		

67	**Pringles stack ring** It is possible to build a Pringles Stack by simply placing each pringles on top of another. What are the physical parameters that allow the geometric pattern to be constructed? What is the largest stack ring that can be build? What is maximum weight you can put on top? Reference:https://www.youtube.com/watch?v=Sp47lvGR8Ek		
68	**The nervous pot** One may observe the pot with water on the electric cooker to begin trembling with high frequency. The water in the pot is still far from boiling. Explain the phenomenon. What does the frequency of oscillations depend on? (https://www.youtube.com/watch?v=zfTwLiBJPLk, http://www.youtube.com/watch?v=UtnlIIku8KM)		
69	**Bubble light** Sonoluminescence is the emission of short bursts of light from imploding bubbles in a liquid when excited by sound. Although the effect is known for decades there is no widely-accepted explanation. Construct a set-up to observe the phenomenon. Study the spectrum of emitted light. Can this effect be used to obtain coherent laser-like light emission?		
70	**Lighthouse in ice** At the times of winter storms, huge ice formations can grow on the walls of lighthouse. Estimate the maximal weight of such formation. What is its dependence upon the temperature regime and strength of the storm? What conditions are necessary for maximal weight of such growing ice? 		
71	**Yut** When making a choice or playing a game, we employ methods such as tossing a coin, rolling dice, or throwing a Yut stick. Yut sticks are roughly half-cylindrical in shape and as such it is much easier to bias the outcome of up vs. down than it is for a coin or dice. If the floor is soft, than the stick is likely to have a flat side up, as the round side has a larger surface. If the floor is hard and the stick is 'rolled', the stick is likely to have a round side up. How does this ability to bias the outcome influence the probability of victory against a player of random initial states?		
72	**“Can I cope a cigarette from you?”** It is known that experienced smokers can determine the number of matches in the box by the sound. What can be the precision of this number?		

73	**Balance** Stones which are taken by wind on ice of Baikal Lake can be found after some time staying on thin “stand”. Explain this phenomenon and estimate the curve of “stand”. (Photo by Olga Zima) 		
74	**Air conditioner** For the air conditioning in the house following setup is proposed. One pours cold water in the bottles and directs on them the air from a ventilator. How efficient is this setup? Propose your own equipment for air cooling with maximal efficiency based on this principle.		
75	**Shattering wave** Killer whales have a wonderful technique for breaking icebergs into smaller peaces by waves when hunting on seals hiding on pieces of ice. What is the maximal thickness of the iceberg that can be destroyed by such a trick? How does it depend on the important parameters (iceberg other dimensions and number of killer whales involved for example)? https://youtu.be/vwMynxeAuhQ?t=39m8s		
76	**An optimal candle** Can one increase the efficiency of a candle by varying its size and shape? What shape should it have such that when the wick has fully burnt out, all the wax has also completely burnt away?		
77	**Waves on paper.** Let us take a tube of glass with length about 0.5 m and diameter less than 1 cm. After some practicing you may obtain rather clean sound from it when with not too much pressure pass the cloth moistened in alcohol or toilet water from its middle to its end. An interesting experiment can be made with the help of such a tube. You may put a slice of foam rubber of several cm thickness on the table and a sheet of dense paper on it. Strew the paper evenly with small manganese or salt crystals. Take the tube in the middle and gently touch with its end the paper near its edge. If you are lucky, the crystals will form a beautiful picture of lines. What is the form of these lines? How does it depend on tube and paper size? 		
78	**Pulsar bar** Construct a mechanical model of a pulsar using a bar magnet. What frequency do you expect your device to radiate at? At what angles around the model do you expect the radiation to be detectable? Propose a contraption to detect this radiation.		
79	**Apples and Oranges** Under certain conditions plants can act as radio receivers https://www.youtube.com/watch?v=98s8xx1P-BI Will the quality of sound heard depend on the plant sort? Can plants transmit radio signals? What hypothetical plant could provide High Fidelity sound?		

80	**Resonating glasses.** When you take between two fingers two glasses of cylindrical form, they sometime emit in the shock a particular sound containing a sweep in frequency (see video). Investigate this phenomenon, and explain the frequencies of the emitted sound and on which parameters it depends. https://youtu.be/AIZkIfoQhIU		
81	**Enlaced shoelaces** When walking, sometimes the shoelace's knot fails. What are the parameters that affect the knot-bow fail? Is it possible to "improve" the shoelace knot so it does not fail? What will change if you accidentally got drenched your shoes under rain?		
82	**Small travelers** Some species of spiders are covering large distances in Autumn using their webs as a kind of kites to fly with the wind. Usually the spider climbs up on some high tree, waits until the appropriate wind conditions and then unleashes his web and the flight begins. Determine how does the travelled distance probability distribution depend on the important parameters (the wind conditions, the spider and web type and other). https://youtu.be/ai3gTAwssxQ https://youtu.be/vKPbxcK58aI 		

The IPT IOC is grateful to all the authors of the problems!

In case of any questions do not hesitate to contact the IPT Secretary Vladimir Vanovskiy

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The final list of 17 selected problems will appear in the beginning of August on our websites http://iptnet.info, http://2018.iptnet.info/