Problem set for the home stage of IYNT – 2013

**1. Invent Yourself.** Suggest your own research problem for the Tournament and solve it.

2. The Bulb in the Glass. There is a popular way to force onions in a glass, filled with water (see figure). The bulb gives roots and leaves, and at the same time the volume of water in the glass decreases. What factors can influence the speed of water uptake? Test your hypothesis by experiment.

3. Magnetic Arrows. Place two suspended magnetic arrows close to each other. After a short time they will reach the equilibrium where the opposite poles are aligned together. Deflect one of the arrows by some small angle and release it. Both arrows will start oscillations. Investigate and explain the character of the coupled oscillations of the magnetic arrows.

4. Fresh and Salted Water. Electroconductivity of natural water depends on concentration of dissolved salts. The table below shows the conductivity of water samples taken from different natural sources.

1). Match the sample source with its conductivity

2). What might be the source of water with 13.2 µS/cm conductivity?

3). At the tournament you will be provided by a sample of water. Measure the electroconductivity of the new sample. Decide whether it is distilled water, tap water or mineral water.

Please, bring with you the equipment for the electroconductivity measurement.
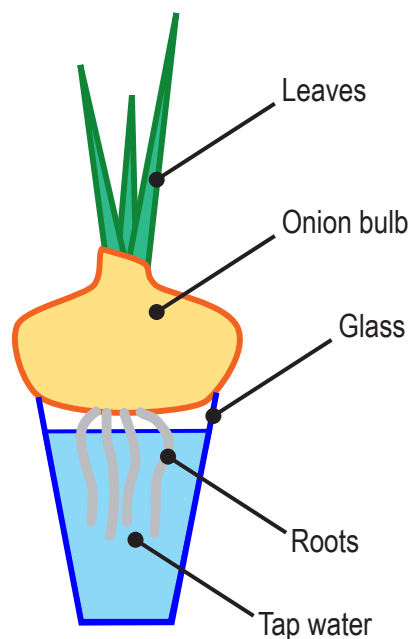
Source	Conductivity (µS/cm)
Black Sea	
Dead Sea	
Baltic Sea at Neva estuary	
Lake Baikal	
Moscow-river, upstream of Moscow City (in winter)	
Peat bog lake	
Moscow-river, downstream of Moscow City (in winter)	

Possible values of the electroconductivity, µS/cm: 10; 125; 420; 580; 4580; 45600; 228000.

5. A Compass and a Ruler. Two schoolboys – Alex and Boris – got a task to make a given segment (initial length L) n times longer. Alex is allowed to use a compass and a ruler. Boris is allowed to use a compass only while he is asked to plot only the end points of the final segment. Suggest some way (or a few ways) of solving the problem for both schoolboys.

Choose a solution Alex might use and let **A(n)** be a total number of lines drawn by the compass and the ruler in the solution for a segment of nL length. Choose a solution Boris might use and let **B(n)** be a total number of lines made by the compass for the points at nL length.

Find A(2), A(3), …, A(10) and make a bar diagram 1. Find B(2), B(3), …, B(10) and make a bar diagram 2. Determine which solution is the best calculating **A(n)/B(n)** for each case separately.

What reasonable assumptions about **A(n)** and **B(n)** behavior for all n can you make from the comparison of diagram 1 and diagram 2? For example, what can you tell about **A(n)/B(n)** behavior when **n** goes to infinity?

6. Nontypical Crystals. Crystals of substances have usually form typical shapes. For example, the sodium chloride crystals are cubes, and the crystals of alum are octahedrons. Is it possible to grow untypically shaped crystals, for example, cube alum (or as some other shape, but not octahedrons)? Explain your opinion and prove it experimentally. You can use your own examples of crystalline substances.

7. Fastidious Flour Moth. For several weeks Lucy as a tourist was enjoying a nice travel. At that time a flour moth (*Anagasta*) found a way to some food stocks in her kitchen. Coming back, Lucy found, that moth larvae appeared in porridge oat, in dry figs and ginger, in shelled sunflower seeds and hazelnuts. Flour moth paid less attention to dried plumes. Salt, sugar, roasted coffee grains, beans, cinnamon, cocoa powder, jam and peas remain intact. Explain the preferences of the flour moth. If possible, test in laboratory other 2–3 stocks as food for moth. **Avoid the infection of your own food stocks by any moth!**

8. A Good Battery. While in class, physics teacher has noticed that the TV remote control is not working properly. He was thinkig that its battery has died. At the end of the lesson he suggested that the schoolchildren do a scientific research to buy the best battery for the remote control device. That is how the competition ``Who buys the best battery'' has started. Carry out a similar research. Based on its results, suggest the best battery you can buy in the store.

9. Plant Fertilizers. You have got sodium hydrophosphate, barium dihydrophosphate, potassium phosphate, potassium dihydrophosphate, potassium nitrate, sodium chloride, copper(II) chloride, cobalt(II) nitrate, zink sulfate, aluminium sulfate. What substances could possibly be used to prepare soluble fertilizers for desert cacti (fam. Cactaceae) and moisture-loving spiderworts (*Tradescantia*)? What precautions should be taken not to cause harm to the plants?

10. The Land lease Contract. The chief of the tribe Chingachgook is settling a bargain with a cowboy Joe. The chief is about to turn over some of the Indian land to the cowboy, but only the land which Joe will be able to fence around with the help of four stakes and the same number of ropes tighten between each pair of stakes. The chief also has put forward the demand according to which the lengths of the ropes are to come to the quantities of
$(1 - 7t)$; $(14t + 5)$; $(7 - 6t)$ и $(5 - 3t)$, where t is a certain number.
What is the value of t at which Joe will be able to fence the largest area and what is the size of that area?

11. Flowering Chrysanthemums. *Chrysanthemum indicum* is a well-known autumn-flowering ornamental plant from India. Indira from Delhi sent a new large-flowered variety of chrysanthemum to her friends. Fatma planted those chrysanthemums in Istanbul, where they gave flowers on October 1st. Helen lives in Moscow, and Mary lives in Sydney (Australia). But their plants produced flowers at another date, rather than in Istanbul. Explain this phenomenon and calculate when Indira, Helen and Mary will see the flowering chrysanthemums, planted by themselves.

12. A Fireproof Handkerchief. This problem was suggested by the team of Moscow Suvorov Military School in the home stage of YNT-2012 and received the highest score from the Jury. Please watch the video (see link below). Carry out the similar experiments on your own and explain the results. **Make sure you follow the fire safety rules during the experiments! The presence of your teacher is required!**

**The problems are composed by
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Choob V. V., and Yunosov E. N.**

Edited by Choob V. V.

Problems for the 3rd IYNT 2015

Nach dem Spiel ist vor dem Spiel.
Sepp Herberger

1–3. Invent yourself
Formulate an open ended problem focused on a particular topic, and then solve this problem.

1. Invent yourself: Physics
Topic: precise weighting. Study the physical effects that influence precise weighting of solid objects with a mass of 10 to 100 g.

2. Invent yourself: Biology
Topic: microorganisms. Suggest an investigation of such cases that allow for a quantitative study and reproducible measurements.

3. Invent yourself: Chemistry
Topic: chemistry of potatoes. The 'life' of one potato tuber, from its growth in soil, to storage, and finally to human use such as boiling or production of chips, is a lengthy chain of chemical processes. Select and study one or several links of this chain.

4. Sunset
The visible Sun disk touches the horizon and after a particular time interval disappears behind the horizon. What is the duration of this time interval? Explain the optical phenomena observed during a sunset.

5. Falling ball
An electronic balance (1) is connected to a PC (5) in order to record the time dependence of the measured weight. A light frame (4) is mounted on a tall beaker (2) filled with water. The frame has a holder (3) allowing controlled release of a small ball such that it falls into the water. The beaker is placed on the balance as depicted in the Figure. Investigate how the readings of the balance reflect the different phases of the motion of the ball.
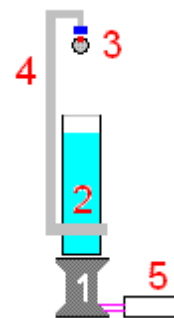
6. Disappearing ink
Suggest a chemical formulation for the ink that would disappear after used to write a text. What parameters determine the time when the text becomes invisible? Is it possible to process the paper in such a manner that the text appears again?

7. Pancakes
It is argued that pancakes can be so good looking that they ignite appetite by their appearance only. Suggest grounded scientific criteria to parameterize how appetizing the pancakes are.

8. Library
One person has decided to download all of the fiction existing in the English language and store it on a single USB stick. He expects to find or generate the respective text files, compress them, and then index them conveniently. Is this ambition realistic? Suggest a plan to approach this goal and solve a partial problem of this plan.

9. Distances in open space
How do astronomers measure distances between the planets of the Solar System, between the stars in our Galaxy, or between the galaxies? Determine the distance between the two space objects of your choice.

10. Ice hole
You have drilled two ice holes in a frozen lake on a frosty winter day. One ice hole is close to the shore, while the other ice hole is far from the shore. Surprisingly, the height difference between the ice surface and the liquid water is different for each hole. How can you explain this? How can one use this height difference to determine the local ice thickness?

11. Puzzle in a beaker
A researcher decided to measure the diffusion rate of ammonia in gelatin. He added some magnesium sulfate to the hot gelatin solution which set to a gel on cooling. He then poured some aqueous solution of ammonia onto the gel and left the beaker for two days. The researcher was surprised to discover white layers of precipitate in the beaker, as depicted in the Figure. Explain this phenomenon and determine what does the number of bands depends upon.

12. Structure of a hair
The hair of various animals may significantly differ in their structure. What are these differences and how can you explain them?

13. Shining orbs
Bright and rather unexpected white disks may appear in a photo taken with a flash in a dark room. Explain why such shining orbs appear in the photos.

14. Galton box
In the Galton box, a regular 2D lattice of obstacles disperses a thin flow of falling particles. When falling on the bottom of the box, the particles show a normal distribution. Use various types or particles and different arrangements of the obstacles to find the conditions when the distribution is no longer normal.

15. Fly
A fly can easily walk on a ceiling. How is this possible? Can one find such a ceiling that the fly would be unable to walk on?

16. Smoke ring cannon
Construct such a vortex ring cannon that would shoot with smoke rings on a distance sufficient to hit the chairperson of your Science Fight.

17. Starch monsters
A water suspension of starch is placed on a loudspeaker. Investigate and describe the resulting starch monsters.

Problems for the 4th IYNT 2016

"The first thing I want to say is thank you for letting me speak and thank you for not canceling my fellowship because I was younger than you might have expected. Often, I am younger than I might have expected, but this does not stop me from doing my work."
Reif Larsen, "The Selected Works of T.S. Spivet"

1. Invent Yourself: Air Traffic
Some web services, e.g. Flightradar24, aggregate and provide data on positions, altitudes, speeds, and other parameters of almost any commercial flight in the World. Suggest an investigation of an interesting scientific aspect of air traffic or flights using such data.

2. Invent Yourself: Weather Forecast
It is often argued that some of weather lore is true and has predictive value. Suggest a scientific test of two popular sayings forecasting respectively short-term and long-term weather trends.

3. Invent Yourself: Human Reaction Time
The time of human reaction to sound, light, and other stimuli is an interesting parameter. What does this time depend on? Propose an interesting experimental study that concerns the time of reaction.

4. Van der Graaf's Cat
A cat may crackle when petted. Parameterize and investigate the static electricity in cat's fur. How can one make this static discharge stronger or weaker?

5. Tempest in a Glass of Water
When water is poured into a glass, its dynamics is complex and intense. Even when the liquid surface settled down, it may take time before the water flow slows down and stops. Investigate this storm in a glass.

6. Dice
In many games, dice are thrown to obtain random results. How does the result of a die roll depend on its height above a table, if the die is released at zero initial speed?

7. Plants in Motion
Various plants can turn in response to the position of the sun or other light sources. Investigate this motion experimentally and theoretically.

8. Zipf's Law
Human language is described by unusual distributions. Take your favorite book and count how many times the most frequently appearing word (rank one) appears; the second most frequent word (rank two) appears, etc. Investigate and explain the dependence of the word count on its rank in the frequency table. Would it be the same for another book in the same or different language?

9. Cinder
In the Middle Ages, people used to wash the cloth in cinder. Study the effectiveness of cinder in washing clothes.

10. pH Indicator
The juice of many fruits or vegetable crops contains a natural pH indicator that changes colors according to the acidity or basicity of the solution. Investigate such pH indicator juices and their mixes. Propose the most precise and effective composition and compare its properties with those of common indicator paper.

11. Corrosiveness of Cola
It is often argued that cola is so corrosive that can be used to clean metal objects. Investigate this property of cola.

12. Ants and Food
Investigate what food attracts ants. Try different foods and introduce parameters to describe the reaction of ants.

13. Firelighting
Investigate various methods to start a fire by friction.

14. Effervescent Tablet
The rate of some chemical reactions may depend on surface area. Break effervescent tablets into smaller parts, or stir them into powder, to study how the dissolution rate depends on the surface area.

15. Mountain Peaks
What methods are used to determine the elevation of the World's highest mountains? Suggest your own experimental method and determine the height of a mountain or a hill of your choice.

16. Two Shovels
Sink two metal shovels deep into the soil outdoors, e.g. in a garden or in a field. Determine the dependence of the resistance between the two shovels on the distance between them in a sufficiently wide range, e.g. 0 to 25 meters.

17. Swadesh List
Many words in related languages (e.g. Kazakh and Turkish, or Croatian and Belarusian) can match or differ by a few sounds only. Study this similarity quantitatively for the language pairs of your choice. When did these languages separate from a common ancestor?

Problems for the 5th IYNT 2017

If I have seen further it is by standing on the shoulders of giants.
Isaac Newton

1. Invent Yourself: Good guesses
In 1906, Francis Galton observed a contest where 800 farmers guessed an animal's weight. To his surprise, the median of the guesses was within 0.8% of the true measured weight. What is the chance of obtaining such a good match by coincidence? Select an interesting and important parameter, measure it directly, and give a group of human observers the task to guess the value of the parameter. Discuss the results of your experiments.

2. Invent Yourself: Time-lapse videos
Propose a very slow physical, biological, or chemical phenomenon that can be studied and visualized using time-lapse photography. Produce and demonstrate such a video.

3. Invent Yourself: Curved mirrors
Suggest and demonstrate interesting experiments in which large concave mirrors can be used to heat up or cool down various objects.

4. Invent Yourself: Language barriers
Speakers of related but different languages or dialects can sometimes understand each other, without any prior intentional study. Propose an interesting study of such a mutual intelligibility. Investigate it experimentally for the pairs of dialects or languages of your choice. Introduce and determine quantitative parameters.

5. Invent Yourself: IYNT grades
An upwards of four thousand grades that Jurors have given in Science Fights of previous four IYNTs can reveal properties and hidden regularities of the IYNT grading. Suggest an interesting hypothesis that concerns the IYNT grades and test it with real data from previous IYNTs.

6. Apples
Why do apple slices turn brown after being cut? Investigate the speed of this process and test methods to prevent browning of apple slices.

7. Growing through asphalt
Can a little plant grow straight up through concrete or asphalt?

8. Tonic water in UV light
Tonic water glows brightly when exposed to an ultraviolet black light bulb. It is however easy to quench the glow of tonic water by adding salt. Investigate this effect. What other common substances glow under UV light and how can one influence their glow?

19. Salt production
Solar evaporation of seawater or salt mining are common methods to produce common salt ($NaCl$). Propose a method to extract salt from a natural source and determine both productive capacity of your method and purity of the product. Demonstrate an amount of salt produced by your method.

10. Rijke's tube
If air inside a vertical cylindrical tube open at both ends is heated, the tube produces sound. Study this effect.

11. Grow light
Investigate how different types of artificial lights affect plant growth. What is the role of light spectrum?

12. Milk
Develop simple methods allowing determination of some of the important properties of milk. Suggest an investigation requiring comparison of various milk samples.

13. Allometry
How do length and thickness of bones scale with overall size and weight of animal?

14. Routers and garden cress
In 2013, five young students claimed a sensational discovery that garden cress (*Lepidium sativum*) won't germinate when placed near two Wi-Fi routers. Reproduce their experiments under controlled conditions to support or dismiss their conclusions.

15. Water from the air
Design and construct a device allowing collection of water by condensing moisture from air. Determine if the water obtained with your device is suitable for drinking. What amount of water is possible to collect during one Science Fight?

16. Paper wrinkles
When a piece of paper dries after being wet, it can get wrinkled. Investigate and explain this phenomenon.

17. Tornado machine
Build a machine to produce an indoor air tornado. Investigate the properties and stability of the tornado. Is the machine portative enough to be demonstrated at a Science Fight room of the 5th IYNT?

Problems for the 6th IYNT 2018

Knowledge of certain principles easily compensates
for the lack of knowledge of certain facts.
Claude Adrien Helvétius

Main Problems for Science Fight 1

1. Buffon's needle
Draw a series of parallel equally spaced lines on a horizontal surface. Pick a bunch of sticks (e.g. matches or needles) slightly shorter or longer than the separation between the lines, and randomly drop them on the surface. It is claimed that the number of times the sticks cross the lines allows estimating the constant π to a high precision. What accuracy can you achieve?

2. All roads lead to Rome
Open a random Wikipedia article and click on the first link in the article. Keep clicking on the first link of each following article. It is argued that you will quickly end up on the page *Philosophy*. Investigate whether this is true. How can one describe such an observation?

3. Annoying foreground object
Look at a flat photograph. What methods allow you to tell which objects were closer and which were farther from the camera when the shot was taken? Design and create a photograph that violates the intuitive judgment of relative distances.

4. Making quark
Quark, cottage cheese, and similar varieties of white acid-set cheese can be produced from milk. Investigate this process experimentally and study the properties of the resulting product.

5. Collision
A highly elastic Super Ball collides with a rigid surface. How can one determine the collision time? Propose various techniques and compare the experimental results.

6. Eye color
In certain human populations, genetics allows predicting inheritance of eye color among family members. In other populations of the present day World, nearly everyone has the same eye color. What information is it possible to determine about the eye colors in both distant and close ancestors, descendants, and relatives of one living person?

Main Problems for Science Fight 2

7. Worms
Earthworms change the mechanical properties of soil and make the soil more porous. Investigate this process and introduce quantitative parameters.

8. Fair coin
In many cases, disputes are resolved with a coin toss. It is presumed that this procedure gives equal chances of winning to both sides. Investigate how the chances depend on the tossing mechanism and the coin properties.

9. Bottle tone
Take an empty bottle and blow air across its mouth to produce a sound. Now fill the bottle with some water and study how the sound changes.

10. Greenhouse
A hot object placed in the open air would gradually cool down. We can slow down this process by containing the object in a greenhouse. Compare different mechanisms of heat loss by the object and explain how the presence of a greenhouse affects them.

11. Fame
Some people in the modern World are considered 'famous' since they frequently appear in the news, TV, and social media. Suggest a quantitative parameter of such 'fame', and build lists of persons that are sorted according to this parameter.

12. Occulted stars
Investigate the optical effects that can occur when the Moon passes in front of a star.

Problems *Invent Yourself* for Science Fight 3

13. Invent Yourself: Blood pressure
Study the accuracy of various methods to measure blood pressure. Propose an interesting study involving blood pressure and pulse.

14. Invent Yourself: Dendrochronology
Annual growth rings of trees are often used to date important historical events or environmental conditions of the past. Suggest and perform an investigation using various tree rings samples.

15. Invent Yourself: Laser pointer
Suggest an interesting optical study involving a beam from a laser pointer.

16. Invent Yourself: Granular materials
Suggest a study involving properties and behavior of granular materials.

17. Invent Yourself: Chronophotographic gun
Étienne-Jules Marey pioneered the use of time resolved photography to study physiology of humans and animals, and in particular their postures and locomotion. Propose a quantitative study of important physiological functions or parameters that would require analysis of similarly taken videos.

Problems for the 7th IYNT 2019

*In the fields of observation chance favors
only the prepared mind.*
Pasteur

Main Problems for Science Fight 1

1. 2D foam
Soap foam enclosed between two glass sheets appears as a network of polygons. Such foams evolve with time, as individual bubbles move and coalesce, and the liquid drains out. Investigate the structure and evolution of 2D foams.

2. Mountains
What are the tallest mountains in the Solar System? Propose and analyze the theoretical models that can allow predicting the maximum altitudes of mountains on various celestial bodies.

3. Salty soils
Saline soils may affect plant growth. How do salts affect the growth and development of plants?

4. Sunflower spirals
Patterns of seeds in the head of a sunflower have a very specific geometric structure. How can one describe and explain such a structure? What other plants demonstrate similar geometric patterns in their leaves or seeds?

5. After the tempest
Take two beakers of water and use a spoon to stir water clockwise in one beaker and counterclockwise in the other beaker. Observe the beakers after a sufficiently long time when the water flow has slowed down. Is it possible to determine the original direction of water flow after 1 hour? 1 day? 1 week?

6. Soundproofing
It is sometimes necessary to reduce unwanted noise in a closed space. Test various methods to soundproof your room.

Main Problems for Science Fight 2

7. Burning glass
Propose and test various methods to start a fire with a magnifying glass.

8. Smells
Smells spread through the air, however it would take some time before a human nose is able to detect the smell. Study different aspects of odor diffusion and sensation of odor by humans.

9. Fading in sunlight
Printed pages fade in direct sunlight, especially if certain types of ink and paper are used. Propose quantitative parameters to study the prolonged exposure of ink and paper to sunlight.

10. Elastic bones
Chicken bones kept in acidic conditions for a few days become elastic. Perform such an experiment in controlled conditions and investigate what components of bones are responsible for their mechanical properties.

11. Yeast
Investigate the rate of the multiplication of yeast at different temperatures.

12. Moon
The apparent size of the Moon perceived by an observer depends on multiple factors. Investigate these factors and their role.

Problems *Invent Yourself* for Science Fight 3

13. Invent Yourself: Baking bread
Distinctly different types of bread are produced by varying methods of baking, proportions of ingredients, and types of flour. Suggest an experimental and theoretical study of how one or several bread varieties are baked.

14. Invent Yourself: Eye movements
Human eyes are in constant involuntary and voluntary motion when exposed to visual stimuli, such as scene viewing, reading or tracking a moving object. Use eye movement data to select and study an interesting psychological effect concerning perception of images and motion, in humans or in animals.

15. Invent Yourself: Fractals
Propose an interesting experimental and theoretical investigation involving fractal geometry.

16. Invent Yourself: Short-term memory
What is the capacity and duration of human short-term memory? Suggest an experimental study to evaluate short-term memory and factors that may have important influence.

17. Invent Yourself: Atmospheric electricity
Electric field is present in the atmosphere even in good weather. Suggest an interesting problem concerning atmospheric electricity.

Problems for the 8th IYNT 2020

Main Problems for Science Fight 1

1. Left-handed animals
Some animals have a preference for using one side of their body, similar to left-handed and right-handed humans. Perform experiments to obtain statistical data and investigate paw preferences of various animals.

2. Slow match
A cord in which the flame front propagates with a constant low speed has been important to ignite cannons. Produce such cords and investigate their burn rates and other properties.

3. Photography with iron salts
Mix 10 parts of ferrous oxalate (25% aqueous solution), 7 parts of concentrated ammonia solution, and 20 parts of saturated solution of oxalic acid to produce a photosensitive iron complex. Prepare separately a 25% solution of potassium ferricyanide. A sheet of paper saturated with a mix of these two solutions can be exposed to light and produce an image. What other iron salts are photosensitive? Produce photographs using various approaches and various iron salts, and investigate the role of relevant parameters.

4. Popping buoy
A light ball is held underwater and then released. The ball may sometimes pop above the water surface. Investigate this effect and the role of important parameters.

5. Disinfectants
Prepare sterile culture dishes and investigate the growth of door handle bacteria and other common microorganisms. Investigate how various disinfectants, such as antibacterial soap, affect the bacteria.

6. Piezo ignition
A common lighter uses piezoelectric crystals. Investigate the quantitative parameters describing the response of such crystals to pressure.

Main Problems for Science Fight 2

7. Caoutchouc
Milky latex is present not only in commercially cultivated rubber trees, but even in houseplants such as spurge or ficus. Produce natural rubber from plants of your choice and investigate the physical and chemical properties of the rubber.

8. Magnet and matchstick
A matchstick is not attracted to a magnet, however the head of a burned matchstick is attracted by a strong magnet. Investigate the reasons and the role of relevant parameters.

9. Venus flytrap
Investigate experimentally how Venus flytrap (*Dionaea muscipula*) catches and digests its prey.

10. Variable stars
Some variable stars, in particular Algol (β Persei), have sufficient magnitude to be observed with unaided eye or simple telescopes. Measure the light curve for such a star. What information can be obtained from the light curve?

11. Hydrogen release
A simple method to produce gaseous hydrogen is the reaction between metal aluminum and two salts in aqueous solution (e.g. copper sulphate and sodium chloride). Investigate how the reaction rate depends on the concentration of each salt and other relevant conditions. What salts react with aluminum to release hydrogen?

12. Onion cells
Investigate the effects of various salts on the structure of onion cells.

Problems *Invent Yourself* for Science Fight 3

13. Invent Yourself: Hearing
Each speaker can pronounce a vowel on several pitches, yet a listener is likely to recognize the phoneme (e.g. /o:/ or /u:/). Astonishing auditory illusions (e.g. *Yanny and Laurel*), so called *mondegreens*, and experiences of persons with poor hearing demonstrate nevertheless that listeners perceive sounds, words and phrases differently. Propose a problem concerning speech perception, mishearing, or physical differences between sounds of spoken language.

14. Invent Yourself: Chemical oscillators
Examples of oscillating chemical reactions are the Briggs-Rauscher reaction or the Belousov-Zhabotinsky reaction which result in periodic color changes. While some of such reactions are difficult to reproduce, there are multiple ways to produce a simpler and more reliable chemical oscillator. Propose a problem about an interesting and simple chemical oscillator.

15. Invent Yourself: Tasting food
Volunteers are given the task to judge the taste of food samples using a quantitative parameter. The results may depend on multiple factors (e.g. hunger or satiety, age of individuals, or temperature of food). Is it possible to detect statistically significant differences? Propose a study concerning the perception of taste.

16. Invent Yourself: Soap production
Vegetable and animal oils and fats are historically used to make soap. Investigate how physical and chemical properties of such soap depend on ingredients and recipes, and propose an interesting problem concerning soap-making from easily accessible ingredients.

17. Invent Yourself: Weight
The weight of a living organism is not constant. Propose an interesting study concerning short-term or long-term variations in the total body mass of a living organism.

Problems for the 9th IYNT 2021

Nature cannot be fooled.
Richard Feynman

Main Problems for Science Fight 1

1. Coin in a balloon
An inflated air balloon contains a coin and is gently moved to set the coin rolling around the inside of the balloon. Explain and investigate the buzzing sound produced in this experiment.

2. Liquid layers
Water and vegetable oil do not mix and form two layers in a beaker. It is possible to fill the beaker with many more layers of immiscible fluids. How many layers can you obtain? Investigate the motion of the interfaces if the beaker is disturbed or shaken.

3. The Purkinje shift
As light levels decrease, human eyes perceive relative brightness and contrast of various colors differently. Perform experiments in controlled conditions to investigate this effect.

4. Making butter
Investigate the methods to produce homemade butter from milk or cream. Investigate how properties of the butter depend on relevant parameters.

5. Lake water
A drop of water from a natural pond may contain bacteria, archaea, algae, fungi, protozoa, and other organisms. Perform observations to identify as many species of living organisms as possible. What are the chances that another drop contains a different selection of species?

6. Tall towers
A tower is built by stacking rectangular bricks on top of each other. Some people argue that the maximum height of the tower is limited by the human skill to place the bricks gently; others may say that the limiting factor is non-perfect shape of the bricks. Perform experiments to outline the factors that limit the maximum height of such a tower.

Main Problems for Science Fight 2

7. Electricity meters
Energy meters installed at your home have been measuring power usage for decades. Collect periodic readings for a sufficiently long period of time, e.g. last 20 years, and identify subtle or significant changes in energy using behavior at your home. When did your family switch from incandescent to fluorescent or LED bulbs? Is there a history of electric heating or air conditioning? Are there regular seasonal variations in power usage?

8. When dumplings rise
Frozen dumplings sink in water. However, they rise to the surface when cooked in boiling water. Are the dumplings ready once they float? Investigate this effect.

9. Salt and ice
Study the effectiveness of salt to melt ice cubes.

10. Blurred text
Printed text is well visible if covered with a piece of transparent film. As the film is lifted, the text becomes blurred and may gradually disappear. What parameters of the film are relevant? Investigate this phenomenon.

11. Oxygen from plants
Suggest an experimental method to measure how much oxygen is produced by a green plant.

12. Zinc layers
If a copper coin and small granules of zinc are immersed into a solution of zinc sulphate and then heated, a layer of zinc appears on the coin. What is the thickness of the zinc layer? What other metals can be covered with zinc in such an experiment? Investigate and explain the effect.

Problems *Invent Yourself* for Science Fight 3

13. Invent Yourself: Skin conductance
Conductance of human skin is often dependent on psychological condition and emotional stimulation. Suggest an interesting problem requiring experimental measurements of respective parameters.

14. Invent Yourself: Epidemiology
The human society has been profoundly affected by the COVID-19 pandemic. Propose a study involving analysis of available epidemiological data for the pandemic.

15. Invent Yourself: Hearing range
There is a considerable variation in the range of frequencies that can be heard by humans and other mammals. Suggest a problem to investigate the lowest and highest audible frequencies for specific species of societal groups.

16. Invent Yourself: Weak signals
Controlling signal-to-noise ratio is important in many measurements to distinguish a meaningful signal from statistical fluke. Propose a problem requiring experiments to detect very weak signals.

17. Invent Yourself: Standing waves
Formulate a problem about an interesting experiment where standing waves are observed.

Problems for the 10th IYNT 2022

The implications of this research are intriguing.
It may be that commissioned work will, in general,
be less creative than work that is done out of pure interest.
Teresa M. Amabile

Main Problems for Science Fight 1

1. Chocolate and speed of light
A visual method to measure the speed of light is to place a chocolate bar in a microwave oven until chocolate starts to melt and measure the distance between hotspots. Study this effect and investigate the accuracy of the method.

2. Rotary phones
If volunteers of different age groups are challenged to dial a number on a rotary phone, it may turn out that some age groups are unfamiliar with the old technology. Obtain statistical data in controlled conditions and discuss the results.

3. Matches on fire
When the outermost match in a regular array of matches is lit, the following matches ignite one by one. Investigate the parameters that determine the speed for such a fire wave.

4. Microscopic swimmers
Investigate experimentally and theoretically the locomotion of bacterial or eukaryotic cells that use natural flagella to move in a liquid.

5. Frosty patterns
Patterns similar to frost on a winter window are obtained if magnesium sulphate in solution is deposited on a glass surface. Investigate this effect.

6. Ship wakes
The wave pattern produced by a ship moving on the water is visually similar to a Mach cone and depends on various parameters. Investigate the effect.

Main Problems for Science Fight 2

7. Clicking fingers
Snapping one's fingers results in a loud popping sound. Investigate the nature and properties of this sound.

8. Seeing through pinholes
An opaque sheet with regularly arranged pinholes corrects myopia similar to corrective lenses. Explain this effect and introduce parameters to describe image perception by myopic humans with and without pinhole glasses.

9. Parosmia
Misperception of existing odors is a common post-COVID side effect that may persist for months. Collect data to study and characterize this dysfunction.

10. Rubber bands heat engine
All the spokes in a bicycle wheel are replaced by rubber bands. If the rubber bands on one side of the wheel are heated, the wheel starts to rotate. Investigate this effect.

11. Resistant plants
Some plants are tolerant of freezes but others can hardly survive low temperatures. Perform experiments to investigate what plants can survive freezing temperatures.

12. Colored fire
It is easy to colorize a flame using various chemicals. Identify the chemicals needed to get a specific color and investigate what color is obtained if a mix of two chemicals is used.

Problems *Invent Yourself* for Science Fight 3

13. Invent Yourself: Naming colors
A Munsell color chart can be used to survey volunteers about their perception of different colors. Suggest a problem related to color naming by humans and investigate the factors that influence how individuals categorize visible colors.

14. Invent Yourself: Wave optics
Formulate an open, though-provoking problem that concerns a phenomenon of wave optics.

15. Invent Yourself: Biological clock
Examples of timing processes in living organisms are plants opening their flowers at particular times of the day or sleep-wake cycles in humans. Propose a problem concerning rhythms and timing in the species of your choice.

16. Invent Yourself: Flying seeds
It is interesting to observe how maple seeds spin when falling to the ground, or how dandelion seeds fly away with the wind. Propose a problem about the flight of the seeds from a plant of your choice.

17. Invent Yourself: Principle of least effort
Propose an interesting experimental test of how a complex natural system chooses the path of least resistance in particular settings or situations.

Problems for the 11th IYNT 2023

To solve an interesting problem, start by
finding a problem that is interesting to you.
Eric S. Raymond

Main Problems for Science Fight 1

1. Chemical countdown
If solutions of potassium permanganate, oxalic acid and sulfuric acid are mixed, the mix discolors after a time interval. Is it possible to adjust the amounts of reagents so that the mix discolors after the time interval specified by your opponent at a Science Fight?

2. Knots
If a piece of rope is attached to the end of another rope with a knot, the knot may still fail to hold, break, or unravel under certain conditions. Investigate the factors affecting the knot strength.

3. Chirping sounds
Investigate experimentally and theoretically the chirping sound of crickets or grasshoppers. Does the sound depend on environmental factors? How to tell a cricket from a grasshopper by their sound?

4. Colorful lines
If a line is drawn on a rough surface with a piece of iron sulfide, the line has a different color than the mineral piece. Investigate this phenomenon. What other minerals show similar properties?

5. Dark side of the Moon
Determine experimentally and theoretically how dark is the side of the Moon facing away from the Sun. Does the illumination of this side depend on the lunar phase?

6. Buzzing ribbons
If the free end of a ribbon is placed near a vacuum cleaner hose pipe, the ribbon will flutter in the airflow and produce a loud buzzing sound. Explain this effect and investigate the parameters which affect the characteristics of this sound.

Main Problems for Science Fight 2

7. Stormglass
A stormglass is supposed to help judging the weather by observing the appearance of a sealed ampoule containing liquid and crystals of various shapes (one recipe is to dissolve potassium nitrate (2.5 g) and ammonium chloride (2.5 g) in distilled water (33 mL), dissolve camphor (10 g) in ethanol (40 mL), slightly heat and mix the two solutions together). Produce one or several stormglasses with various recipes and study their behavior in different weather conditions over sufficiently long time.

8. Shower head
A handheld shower head is hanging freely on a long hose. Turn the water on and observe the head deviating at a certain angle. What parameters does this angle depend on?

9. Flowers and ammonia
If exposed to ammonia, viola flowers wilt and discolor. How does ammonia affect colored flowers of other plant species? Investigate the chemical and biological processes occurring in this experiment.

10. Ferments
Investigate whether oxidizing ferments are present in apples, potatoes, onions and other fruits or vegetables. Which of them has the most active ferments? Analyze the effects of temperature on the action of the ferments.

11. Soot mirror
If an object is covered by soot (e.g. with a candle flame) and next submerged under water, it appears as if the object reflects light like a mirror. Explain and investigate this effect.

12. Jumps
A human can jump with straight legs, however so called squat jumps and countermovement jumps may be higher. Investigate the influence of starting postures and jumping techniques on the maximum height of the jump.

Problems *Invent Yourself* for Science Fight 3

13. Invent Yourself: Non-Newtonian fluids
There is a broad variety of fluids which do not necessarily have a constant viscosity. Suggest a problem concerning an interesting effect observed with a specific non-Newtonian fluid.

14. Invent Yourself: Proxy variables
It may be impossible to directly measure the number of attendees at a music festival or climate conditions millennia ago. However, these two variables may be determined indirectly from cellular connections or isotope composition of ice cores. Suggest a problem focused on reconstructing a variable of interest from an unusual proxy variable.

15. Invent Yourself: Genetics
Propose a problem to put a law of transmission of genetic traits to direct experimental test.

16. Invent Yourself: Boiling salt solutions
The boiling temperature of aqueous salt solutions is variable and may be higher than 100 ºC. Formulate a problem requiring theoretical and experimental studies with chemical compositions of your choice.

17. Invent Yourself: Elastic balls
Suggest a physics problem concerning an intriguing effect observed if one or several highly elastic balls collide (one against the other or with other surfaces.)