Fragments of Playing with Science at Novolíšeňská

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The paper focuses on a demonstration of scientific and technical activities at the Novolíšeňská primary school with specific examples, instructions for experiments, and on physical models and toys.

ŠOK (School Scientific Club)

Vědohraní ("Playing with Science") is not only the name of a traditional interactive scientific events organized by Novolíšeňská Elementary School, but in this contribution it is seen as playing with science and playing scientist.

Physical and scientific events at Novolíšeňská Elementary School are organized under the patronage of ŠOK (school scientific club). In addition to regular meetings in the form of creative workshops with different thematic focus and rehearsals of physics shows, the School Scientific Club organizes mostly traditional scientific events, e.g. School Full of Spells (for all kindergartens from Líšeň), Vědohraní (prepared by lower-secondary students for all primary school pupils). Pupils also participate in various events organized by other institutions, for example Researchers' Night at FCH VUT (exhibition Playing with Optics), Celebration of the first anniversary of Vida Science Centre (physical show of "The Wizard of the land of AKIZYF"), Heureka teachers visit (physical show, magical creative workshop, refreshment with physics and chemistry and exhibition of magnetic toys).

Earth Day

This year, for the first time, we organized Earth Day at the school as a comprehensive event for all lower-secondary students. A project Incredible Nature was prepared for 6th grade (protected areas around Brno, caves, speleology, environmental games, making geodes, creative competition "Flying Egg"). For the seventh grade, a project Plastics Island (plastics and their recycling, plastics and heat, bioplastics, production of bioplastic, an exhibition of products from PET bottles, making and firing rockets from PET bottles) was prepared. Programme was prepared for 8^{th} and 9^{th} grade pupils at FCH VUT Brno, with which our school signed an agreement on cooperation.

Following are the instructions on activities that the pupils liked. They can be used in teaching physics and include concrete examples of interdisciplinary relationships with science and chemistry.

Making Geodes */particle structure of substances, crystallization/*

Geode is rock body with a cavity in the middle. The cavity is, along its circumference, filled with small or large crystals facing inwards the cavity (quartz crystals, zeolites, ...).

The basis for the creation of geodes were escaping gas bubbles that remained in the cooling rocks.

Equipment:

raw eggs, bitter salt (magnesium sulphate – $MgSO_4$), food colouring (preferably liquid), knife, brush or cotton swab, Hercules (or any liquid paper) glue, pot for boiling water, bowls

Procedure:

Crack the eggs in half (we can use knife to help), empty and wash them and let them dry. Spread glue on the inner side of the shells, using a brush or cotton swab. Dust it with selected salt and let it dry well (for example overnight). Pour water into the pot and heat it until it boils and then start adding the selected salt. Continue adding the salt until it stops dissolving. Allow the salt solution to cool. We have created a supersaturated solution. Once the solution is cooled down enough that we are able to put our hand in it, place the prepared egg shells into it. It is possible to add food colouring. Let the crystals grow. Recommendation – 3 weeks. Then remove the shells with crystals from the solution and let them dry. We can use a magnifying glass to inspect the crystals.

Explanation:

A supersaturated solution is needed to form bitter salt crystals. The supersaturated solution is a solution with more atoms of solid substance in water than is normal. Such a solution can be made at home in such a way that we first warm it up and then cool down. The crystals begin to form if the supersaturated solution contains a "core" atom or molecule, around which other atoms of the solution concentrate. In our case, the crystals grow on the basis of salt, which we poured on the glue.

Safety:

The adult should crack the egg and boil the water.

We always wash our hands after working with raw eggs.

Other topics and comments:

Magnesium sulphate heptahydrate has proven to be a good choice – it was given to us as a sponsorship gift of one mother – a pharmacist.

We can also use potassium alum – $KAl(SO_4)_2$ to make the geode. We can buy both salts in a technical drugstore or on the Internet. Bitter salt (large crystals) can be obtained as a fertilizer in a drugstore. We can also buy it at the pharmacy (smaller crystals).

Geodes can be made with salt or sugar. We can then compare the crystal shapes of different salts.

We can grow crystal on other objects as well.

Making Bioplastic

/chemistry, ecology, thermal physics, substance properties/

Most plastics are made from crude oil. In this experiment we will make plastic from plant materials.

Equipment:

corn starch, vegetable oil, vinegar, food colouring, dropper, tablespoon, plate, plastic resealable bag, microwave oven, kitchen mittens

Procedure – 1 dose:

Pour 2 tablespoons of corn starch into a cup, add 2 tablespoons of water and stir. Use a dropper to add 6 drops of vegetable oil, 6 drops of vinegar and 2 drops of food colouring, which you have previously dissolved in water. Stir. Pour the mixture into a bag and close it (not completely). Place the bag on a plate and heat it in the microwave oven for about 30 seconds. Remove the plate from the microwave. Before you open it, let the bag cool down a bit.

Explanation:

The basic raw material for the production of bioplastics is plant biomass (e.g. corn, crops, potatoes, sugar beet, sugar cane, soy, tobacco) and natural raw materials such as cellulose and lignite. Bioplastic is made from the starch of these plants. In order for the starch to be converted into a substance with properties corresponding to plastics made from crude oil, it is necessary to expose it to high temperatures and to obtain glucose from it by means of isolation. Lactic acid and later polylactic acid ("PLA") is obtained from glucose by fermentation.

Safety:

Beware of burns!

Crash test – "Flying egg" competition – competition for 3-4 member teams

/mechanics, gravitational force/

Task:

Do you think that an egg can fly? It can, but it needs your help. Each group will receive a set of materials and tools. You have to use them to make a special "device" for the egg. You will drop the egg from the second floor and it cannot crack when it hits the ground. You must consider all the facts that can help the flight and the storage of the egg (soft impact, slowing down the flight, …).

Basic rules:

Each group will receive a starting pack of 1,000 points. For these points the teams can purchase materials:

Old paper, size A4	100 points
Playdough piece	50 points
Inflatable baloon	300 points
HDPE bag	50 points
1 m string	50 points
Sellotape piece	50 points
1 paper clip	10 points
Straw	20 points
Skewer	10 points

Material can be purchased throughout the activity.

Each team must make a flying machine; the egg must not be released freely. The device must be built in a specified time - approx. 45 min.

Each team gives a name to its flying machine.

The egg is "released" from the window on the 2nd floor on a small yard.

Rating:

is the following is evaluated:

name of the flying device	+ (0 to 30)
aesthetics of the model	+ (0 to 100)
flight elegance	+ (0 to 100)
egg breaking	- (0 - 100) *these points are deducted*

Final evaluation = name + aesthetics + elegance of flight - egg breaking + balance of points from the starting package

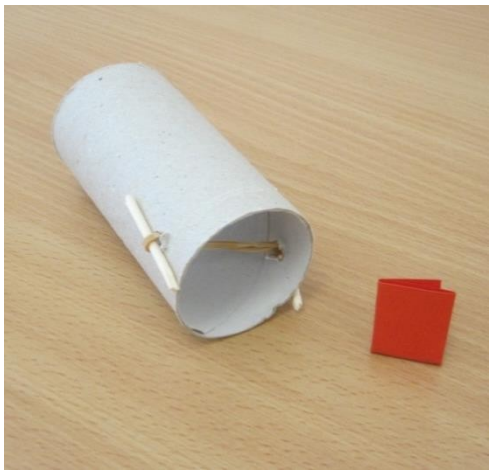
Vědohraní (Playing with Science)

Vědohraní is a traditional interactive science and technology event prepared by lower-secondary students and teachers for all primary pupils of the of elementary school. This year with the motto "Into the World of Fairy tales and Fantasy". Pupils from 1st – 3rd grades visited the Paper Kingdom (physical performance, game rooms with experiments and functional toys from paper, creative workshops). Pupils in the 4th and 5th grade took part in "Space Expedition to Planet XYZ". They went through the demanding preparation of cosmonauts (tasks for observation, logical thinking, spatial imagination, work with information and examining some manual skills). They made and fired water rockets from PET bottles or a landing module – a flying saucer, they surveyed the unknown planet on which they landed.

Toilet roll shooter

(example from the workshop in the Paper Kingdom)

/mechanics, potential and kinetic energy and their transformation/



Equipment:

toilet paper roll, rubber band, hook,

2 small pieces of skewer, small scissors, a piece of paper

Procedure:

Using the scissors, make two holes in a roll of toilet paper (about 1 - 1,5 cm from the edge). Use the hook to thread the rubber band through both holes and secure it with a piece of skewer on each side so that it doesn't slip.

The bullet for this shooter is made from thin paper (the rest of the drawing). Fold the small rectangle in half (or three times), and then fold it into a "v" shape.

Take the shooter in one hand, turn it so that the rubber band faces you. Hook the v-shaped bullet around the rubber band and use it to pull the rubber band towards you. Then let go. The bullet flies through the roll, out of it and reaches a relatively long distance.

Explanation:

If we stretch the rubber band, we perform work. This will be stored as potential energy of the elasticity of the rubber band. After we release the rubber band, the potential energy transforms to kinetic energy which is passed to the paper bullet.

Semi-precious stones (geological survey of the planet)

/thermal physics, plastics and substance properties/

Equipment:

HDPE bags of different colours, aluminium foil, knife, oven

Procedure:

By crimping the HDPE bags, we create a core and tightly wrap bags of other colours around it. We wrap everything in aluminium foil and put it in the oven that is switched on at full capacity. Bake for about 15 - 20 minutes depending on the type of the oven and the size of the foil balls. Use pliers or mittens to carefully remove the ball onto a cutting board, let it cool down a bit, remove the foil and cut in half with a sharp knife.

Explanation:

Heated plastics deform and shrink.

Snugglea amphibia (exploration of the planet's fauna)

/electrification of bodies, el. charge, el. polarization, electric force, buoyancy force and floating/

Equipment:

HDPE bags, thin string (thread), scissors, straw, larger bottle (plastic or glass)

Method:

Cut the bag. Cut out a square and a circle from the resulting rectangle. Put the straw into the centre of the circle and create a small head around it. Use the string to make a head and a neck. Using a straw, inflate the head a little, quickly pull the straw out and "twist the neck" so that the air does not escape. Then we wrap and tie the string well. Cut the remaining annular part around the head to form tentacles. We can draw eyes on the head with a permanent marker or stick plastic googly eyes with Chemoprene glue.

a) Rub the resulting "octopus" against hair, clothing or fur and then place it against the wall. The octopus stays on the wall for several hours.

b) You can put the octopus in a bottle of water. It floats and its head is above the water level and its tentacles are in the water. If we turn the bottle upside down, the octopus floats to the surface again.

Explanation:

a) By friction, the octopus gains electric charge. It is drawn to the wall that is not electrified (el. polarization), and because it is lightweight, it sticks to it (electrical power is greater than gravity).

b) When we put it in water, it always floats on top, because its average density is less than the density of water. If we have enough patience, we can add a small amount of water through a straw into the octopus's head to achieve that it always floats just below the water level.

Earth-like animals (exploration of planet's fauna)

The principle of this game is to identify a correct animal when a part of the animal name was substituted by a different, yet similar, word. For example: baconster is hamster. From a translator's point of view, the translation of these Czech words is a tough nut to crack. However, I was able to come up with some ideas that may or may not be used in this game. I'm sure that a native English speaker will be able to prepare fun words to play this game.

Butterhover (butterfly), dontone (donkey), rabpiece(rabbit), friarey(monkey), pencilguin (penguin), fromad (toad), …

Magnetic matter (geological survey of the planet)

/magnets, ferromagnetic substances/

Equipment:

Herkules (or any liquid paper) glue, very fine iron fillings, borax, water, neodymium magnet, 2 bowls, wooden stick as a stirrer, (food colouring)

Procedure:

Dissolve 100 ml of Hercules in 100 ml of water. Dissolve 20 ml of borax in 100 ml of hot water. Mix both solutions with a stirrer, then work with your hands. We work for some time until a chemical reaction occurs. We can add food colouring. Put some slime in a second bowl and add the iron filings (about 2 to 3 tablespoons). The resulting mass must not be too dense.

If we place a powerful neodymium magnet next to the slime, the slime is attracted to the magnet it begins to wrap the magnet.

Explanation:

The mass contains small particles of ferromagnetic iron, so it is attracted to the neodymium magnet.

Note:

The material cannot be stored for a long time because the iron fillings get rusty.

Electrically conductive matter (geological survey of the planet)

a) Making electrically conductive dough

Equipment:

230 ml of water, 160 g of flour, 160 g of salt, 2 heaping tablespoons of tartar (potassium hydrogen tartrate), 1 tablespoon of vegetable oil, food colouring, small pot, wooden spoon, tablespoon, cutting board, cooker

Procedure:

Put water and salt into a pot, heat it until it boils and the majority of the salts dissolves. Lower the heat of the cooker and add the other ingredients, stirring continuously until a dough is formed. Take the pot off the heater and place the dough on the cutting board that is covered by a thin layer of flour. Knead the dough until it reaches a desired density. You can add colour.

Store the dough in an airtight jar or plastic bag. However, water condenses in the plastic bag. Then just knead the dough after taking it out of the bag and it will be like "new". The dough lasts for several weeks.

b) Making electrically non-conductive dough

Equipment:

1 ½ cup of flour, ½ cup of sugar, 3 tablespoons of vegetable oil,

½ cup of distilled water, bowl, wooden spoon, cutting board

Procedure:

Mix sugar and flour in a bowl (leave about ½ of a cup to add at the end). Add the oil and gradually add water using the spoon. Prepare a smooth dough. You can add water or flour as needed.

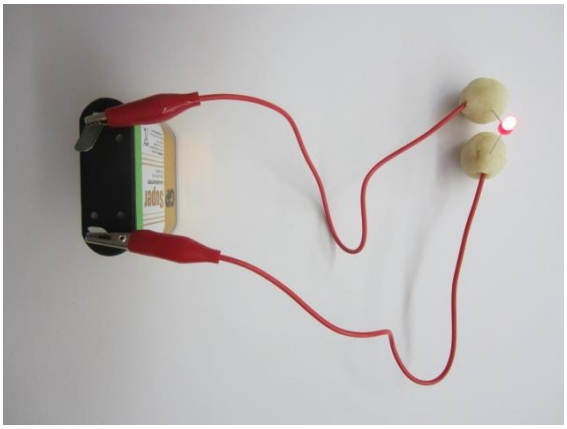
You don't have to make this dough. It is not needed for most experiments. However, you will need it if you want to make some "electric figurines".

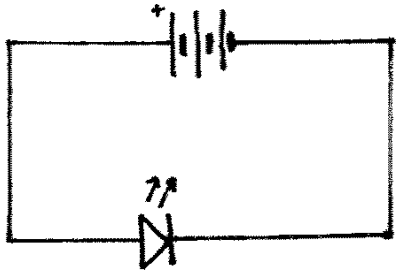
c) Assembly of electrical circuits

Other equipment:

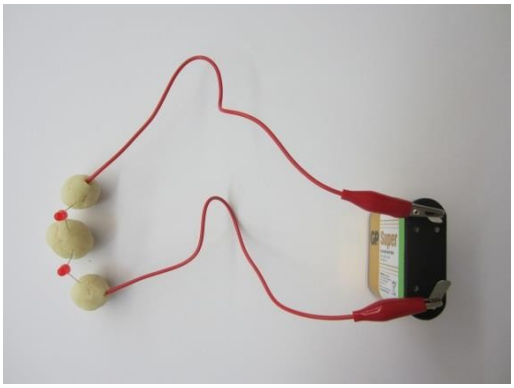
wires, 4.5 V and 9 V batteries, various LED diodes, buzzer, motor, ..., knife, wooden or cardboard mat

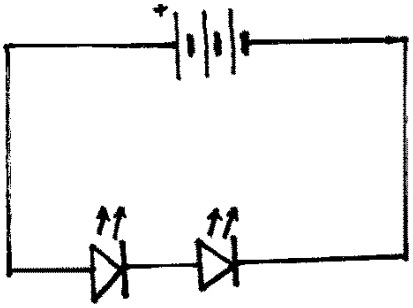
1. Simple el. circuit with 1 LED



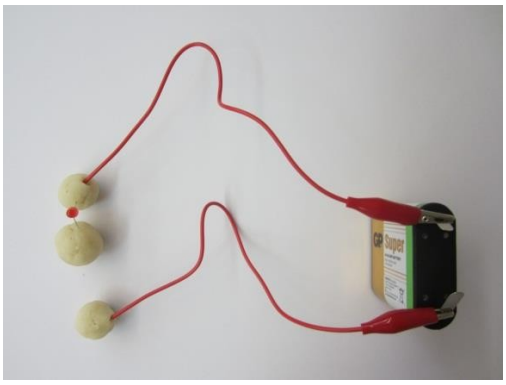


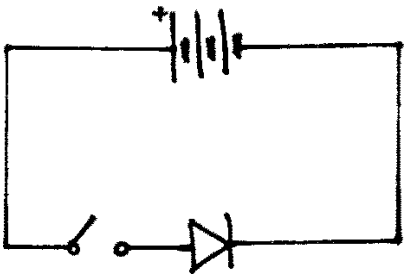
2. Serial wiring of 2 LEDs



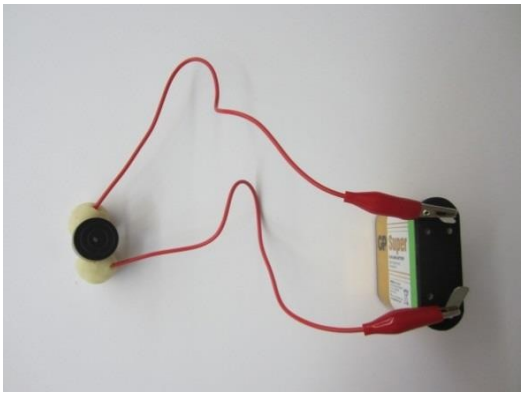


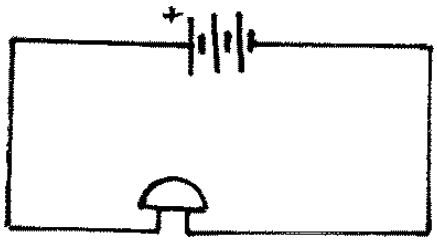
3. El. circuit with LED and open switch



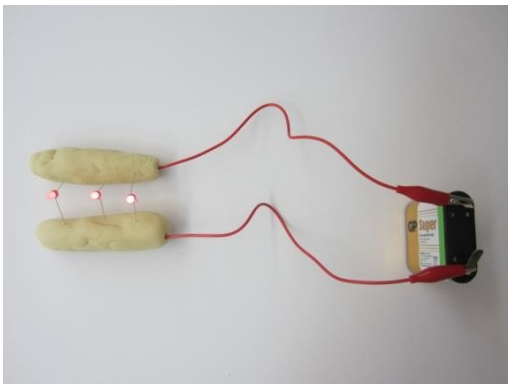


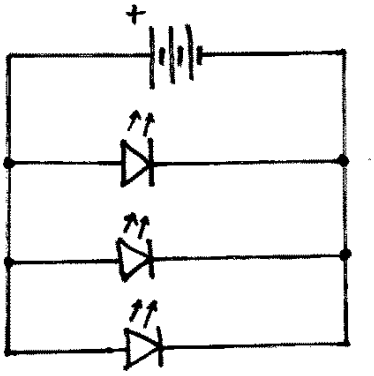
4. El. circuit with buzzer (bell)



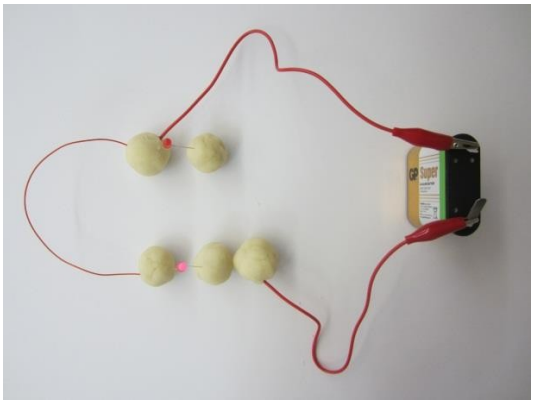


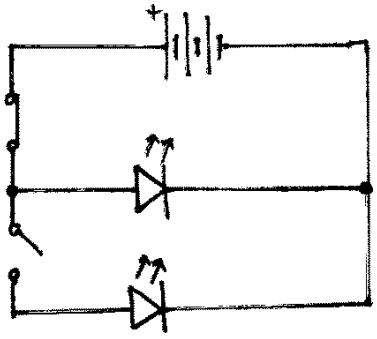
5. Parallel wiring of 3 LEDs



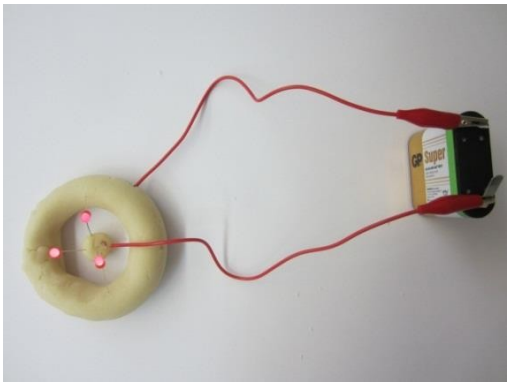


6. Parallel wiring of 2 LEDs with open switch

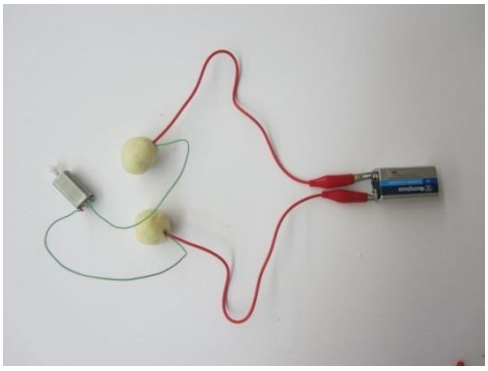




7. Parallel wiring of 3 LEDs differently



8. Wiring with electric motor



You and the students can come up with other wiring schemes. If you use the non-conductive dough, you can create, for example, animal figurines and connect diodes, a buzzer etc.

6 boards (cards) with numbers (unknown objects on the planet)

A set of 6 number cards was found on the planet XYZ. It was investigated. The following was found:

There are numbers from 1 to 63 on the cards.

All cards have the same amount of numbers - 32,

The 1st number on each card is the power of the number 2

$1 = 2^0$ $2 = 2^1$ $4 = 2^2$

$8 = 2^3$ $16 = 2^4$ $32 = 2^5$

Each number from 1 to 63 can be written as the only sum of the numbers listed in the 1st place on the cards.

1 = 1	2 = 2	3 = 1+2
4 = 4	5 = 1+4	6 = 2+4
7 = 1+2+4	8 = 8	9 = 1+8
10 = 2+8	11 = 1+2+8	12 = 4+8
13 = 1+4+8	14 = 2+4+8	15 = 1+2+4+8

…….

30 = 2+4+8+16 …… 51 = 1+2+16+32 ……. 63 = 1+2+4+8+16+32

Cards are also formed according to these sums. The number is indicated on all cards, its first number being the summand of this sum.

How can we use the cards?

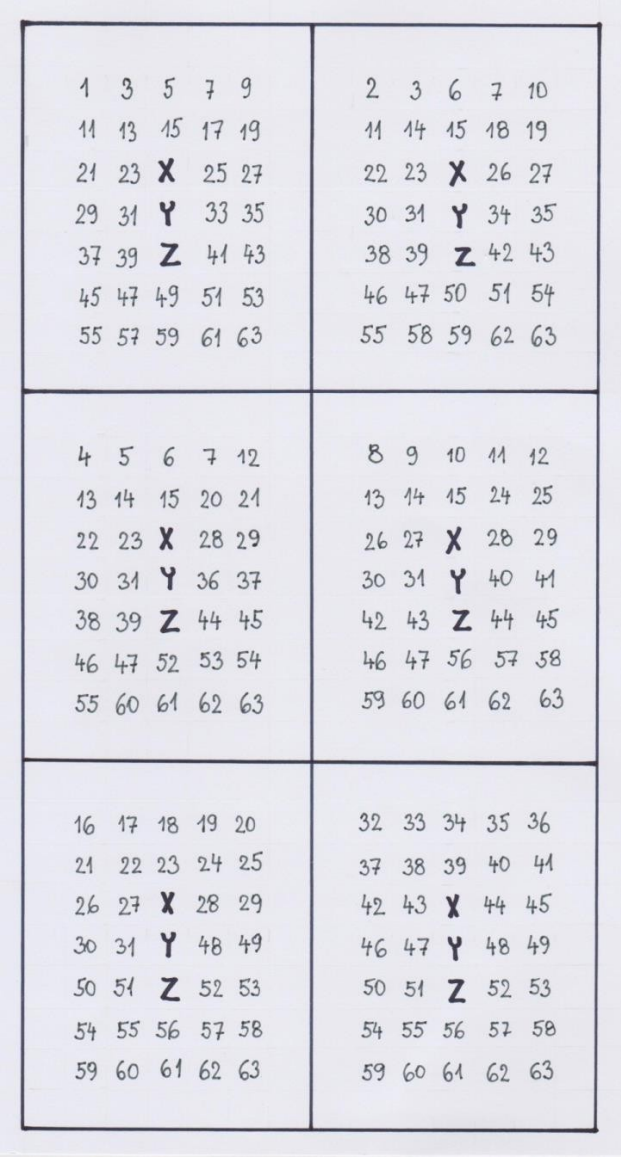
With these cards you can guess any number from 1 to 63 that a friend has on his or her mind.

Give the cards to a friend with a challenge to think of a number from 1 to 63. Without saying the number, he or she returns you all the cards on which the imagined number is written.

You then quickly determine the imaginary number by adding the first numbers on the returned cards.

Try it.

Template:



1	3	5	7	9
11	13	15	17	19
21	23	X	25	27
29	31	Y	33	35
37	39	Z	41	43
45	47	49	51	53
55	57	59	61	63

2	3	6	7	10
11	14	15	18	19
22	23	X	26	27
30	31	Y	34	35
38	39	Z	42	43
46	47	50	51	54
55	58	59	62	63

4	5	6	7	12
13	14	15	20	21
22	23	X	28	29
30	31	Y	36	37
38	39	Z	44	45
46	47	52	53	54
55	60	61	62	63

8	9	10	11	12
13	14	15	24	25
26	27	X	28	29
30	31	Y	40	41
42	43	Z	44	45
46	47	56	57	58
59	60	61	62	63

16	17	18	19	20
21	22	23	24	25
26	27	X	28	29
30	31	Y	48	49
50	51	Z	52	53
54	55	56	57	58
59	60	61	62	63

32	33	34	35	36
37	38	39	40	41
42	43	X	44	45
46	47	Y	48	49
50	51	Z	52	53
54	55	56	57	58
59	60	61	62	63

Mathemagical addition columns

On the planet, 4 columns were found with 4 numbers on each of the 4 walls of each column. During their examination it was found that 4 four-digit numbers on the walls of the columns can be added up very quickly.

You can make their copies.

Equipment:

4 templates (see appendix), scissors, glue

Procedure:

Cut out 4 templates, preferably in 4 diferent colours, and bend according to the dashed lines. Cover the dotted fold with glue and glue the bars with numbers of the cylinder. Place the bars next to each other. We always get 4 rows of four-digit numbers.

With our numbers obtained from the columns, we can quickly determine the sum of all 4 rows with numbers below each other.

We try it out on the numbers:

7629

2474

6238

9895

2 6236

How do we use it?

→ always look at the third row (four-digit combination of numbers)

E.g. 7 6 2 9

2 4 7 4

6 2 3 8

9 8 9 5

→ in our case we have the number 6 2 3 8

→ we subtract 2 from the last digit, so we get 6 2 3 6

→ The result must have 5 digits. So we put the number 2, which we subtracted, to the front. So we get the result:

2 6 2 3 6

And that is the right result.

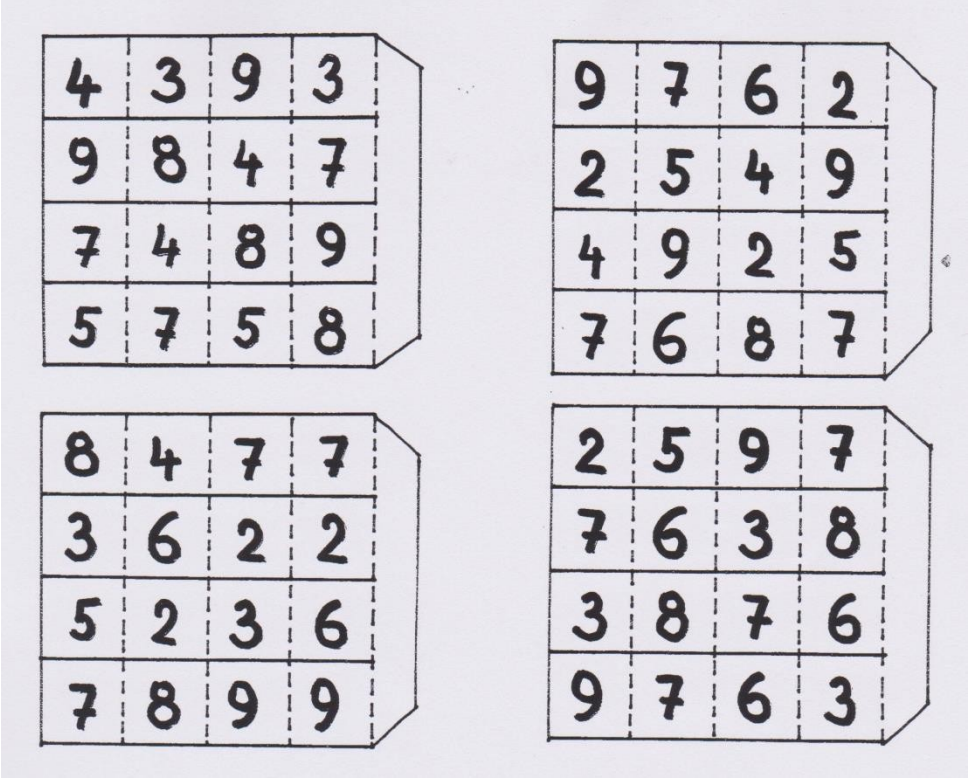
Note:

By turning the bars, we can change combinations of numbers. We always determine their sum in the same way according to the number in the 3rd row. Subtract 2 from the last number and add this two before the number.

This mathematical magic works well with 3 or 2 bars, even with one. The procedure is the same.

E.g.	629	76	6
	474	24	4
	238	62	2
	895	98	8
	2 236	260	20

Template:



Literature

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