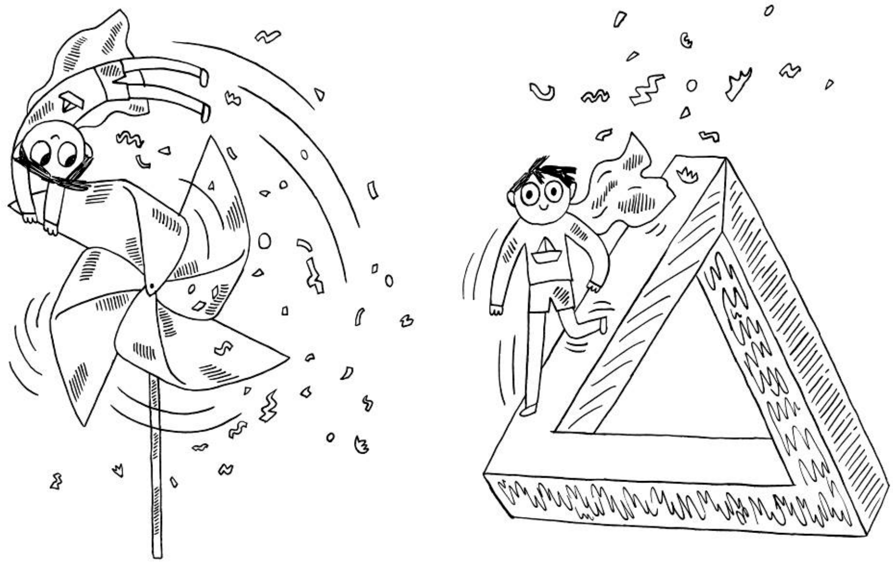
Paper Science



Manual

Věra Pejčochová

Editors: Jitka Houfková, Věra Koudelková
Illustrations: Nikola Hoření
Technical drawing: Karel Michal Houfek
Photos: Jitka Houfková, Věra Koudelková

Forward

If the goal of your teaching is for students to discover, play, ask questions, create, develop their creativity, be active, learn to understand more about the world around them, and if the shining eyes of children are something that should not be missing in any classroom, then you have the right publication in your hands.

Paper Science by Věra Pajčochová, which brings together years of her teaching experience and builds on what is most valuable in Elixir, sharing and enthusiasm, can become a useful and inspirational guide to your teaching across many science topics.

I am very happy that Elixir for Schools is privileged to create another space for sharing in the Czech Republic and beyond through the support of this publication.

I wish Paper Science will be able to reach as many teachers as possible and that there will be many teachers and children with shining eyes after reading it.

Petra Prošková
Director of Elixir for Schools

Introduction

The play is a joy. Learning at play is joyful learning.
A. Comenius

I have been collecting and making interesting functional and creative toys and puzzles since childhood. I became even more interested in them as a physics and mathematics teacher. In physics toys I saw the positive aspect that they bring a physics law or a phenomenon closer in a friendly way and show that physics is everywhere. They help with experimentation, allow you to follow a phenomenon to the end, quickly repeat it again, and better describe the phenomenon or regularity based on your observations. This then makes it easier to provoke thinking and stimulate discussion. In addition, toys on their own making contribute to the development of technical creativity and various manual skills in kids.

Paper toys are an inexpensive aid for experimental activities. Over four decades, I have collected many patterns and templates, which have been gradually modified based on my experience working with children at school and in extracurricular after school activities (Association of Little Débrouillards, science and technology clubs at the House of Children and Youth, science and technology events for the general public in the Czech Republic and international events). The need for some special thematic events has also contributed to the development of new ideas and toys.

The toy templates were first drawn with pencil, marker, ruler and compass. Later, with the help of younger friends and pupils, they were converted into digital form.

Many of the templates were adapted in cooperation with physics teacher Krystyna Raczkowska-Tomczak from Opole, Poland. A big thank you also goes to Jitka Houfková and Věra Koudelková, without whose active cooperation and help the Paper Science collection would not have been created in its current form. Of course, the collection could not have been published without the specific support of Elixir for Schools and the personal commitment of its director Petra Prošková. The illustrations by Nikola Hoření have given the collection a special character. From a technical point of view, the careful redrawing of the templates into digital format by Karel Michal Houfek was also important.

The Paper Science collection is intended not only for teachers and children, but also for their parents. I hope it will bring them a lot of joy from creative activities and learning about the world around us.

Věra Pejčochová

Content

Everything´s flying

Part 1: Paper helicopters

How do paper whirlpools work:

Although we call them paper helicopters the following toys are in reality whirligigs. A whirlgig is unique in its way of flight. It is held in the air by rotating blades that are not actively spun by the power unit, but are spun by the air flow.

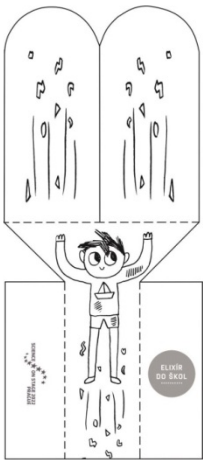
We launch our paper helicopters from a height. They fall to the ground because of the force of gravity. There's a resistance of air against this motion. This drag force pushes on the angled parts of the vortices (like propellers) and makes the vortices spin. The vortex performs a motion composed of a sliding and a rotating motion.

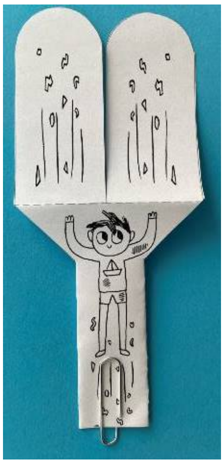
Paper helicopter with a picture

Materials, equipment and implementation: template no. 1, thick printing paper (160 g), paper clips, scissors

How to make:

- Print the template or draw it on thick paper.
- Then cut along the solid lines and bend along the dashed lines.
- Create the body of the swirl by folding the outermost rectangles over the middle rectangle and secure it with a paper clip, which also serves as a weight.
- Fold the top ears propellers to one side each.
- Grasp the helicopter by the propellers (they should be at an acute angle) and release it from the height. The vortex falls down and rotates.
- We can increase the load, i.e. the number of paper clips, and observe the changes in movement. (At a certain number of paper clips, the whirligig stops rotating and falls down in free fall.)
- If we change the bend of the propeller-ears, the whirligig rotates to the other side.





Paper helicopter from a rectangle

Materials, equipment and implementation: template no. 2, office paper (80 g), triangle ruler with a line, pencil, compass, scissors, paper clip

How to make:

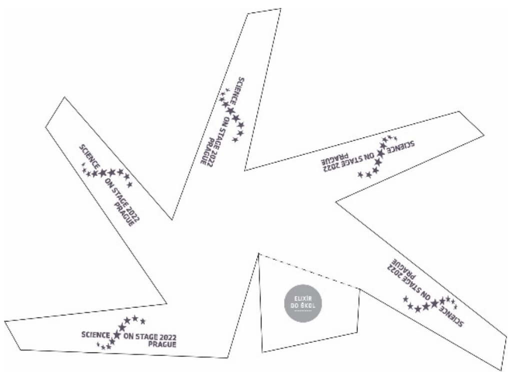
- Draw a 12.5 cm rectangle and a 3 cm rectangle on office paper.
- Divide the rectangle into 3 small rectangles 1 cm wide and mark the lengths as shown in the picture with a solid line. (You can also use a rectangular template.)
- Cut out the rectangle and cut its inside along the dashed lines.
- Take the rectangle by the right and left corners, put them together and join them with a paper clip.
- This creates a swirl. (The top is slanted ⊠ 2 propellers, the paperclip is at the bottom).
- Release the vortex freely from as high as possible. It falls down and rotates.

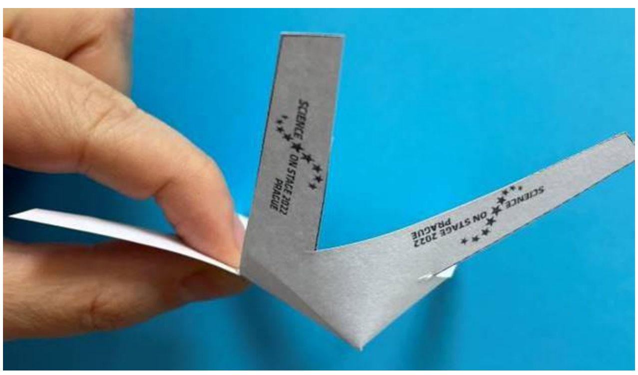
Paper helicopter like a snowflake

Materials, equipment and implementation: template no. 4, office paper (80 g), glue, scissors

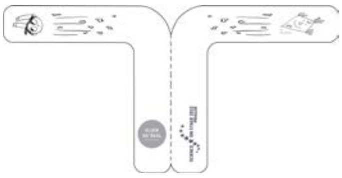
How to make:

- Copy or redraw the template on the office paper (80 g) and cut it out.
- Paint the marked area with glue and glue the template into a cone.
  Drop the pinwheel from the top (tip down). The snowflake falls and rotates.





Part 2: Flying toys



Boomerang

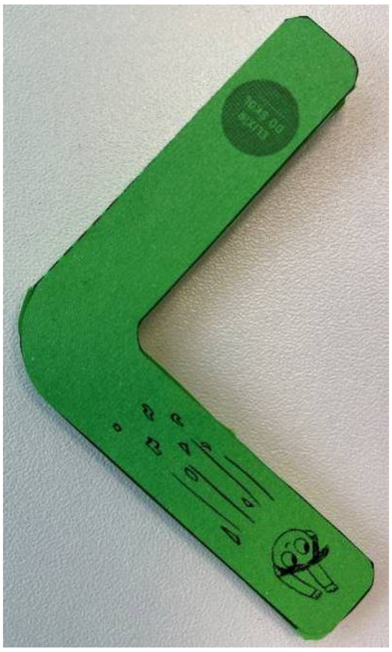
Materials, equipment and implementation: template no. 3, thick printing paper (160 g), glue, scissors

How to make:

- Cut out the template.
- Paint both halves of the template with glue and glue them together. Let dry well.
- Then bend both parts of the boomerang over your finger into an arch (like a wing shape).
- Place the finished boomerang on the back of your hand and strike the protruding end sharply with a pencil (or your finger) in a horizontal direction.
- The boomerang flies out and comes back in an arc.

How does the boomerang work:

When set in motion, the boomerang not only moves forward by inertia in a gradual motion, but also rotates. Therefore, a force is generated that brings it back. The gravitational force pulls the cross towards the Earth, but the shape of the cross and the boomerang causes a greater resistive force of air to act in the opposite direction of motion. In a classic boomerang, the shape of the wing also helps the buoyancy. The flight path of both the boomerang and the cross is therefore quite large.

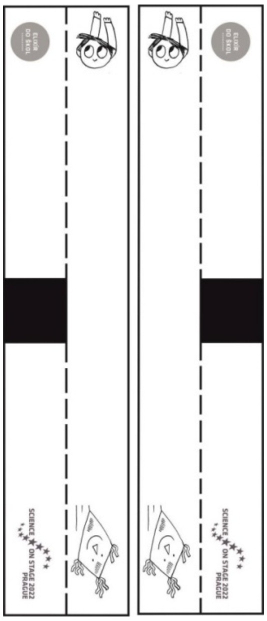


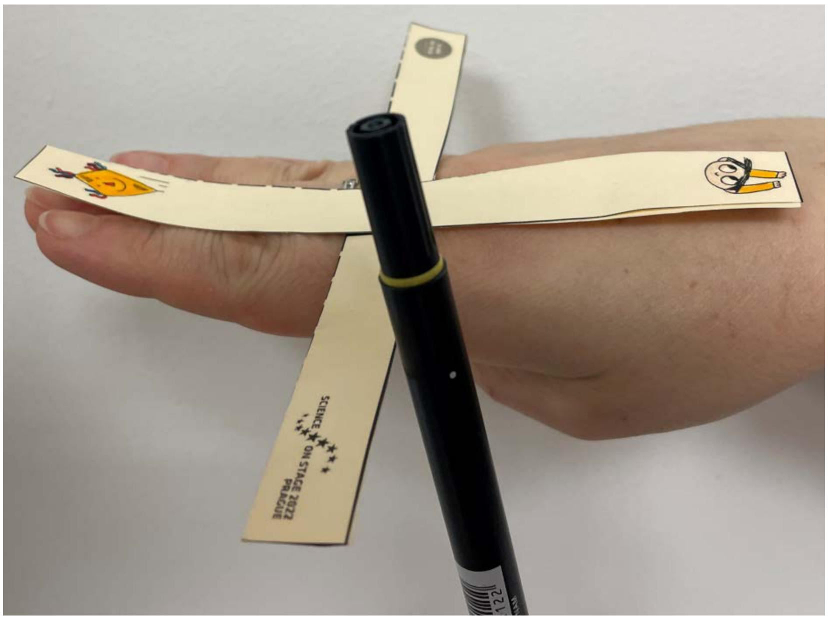
Flying cross

Materials, equipment and implementation: template no. 5, thick printing paper (160 g), glue, scissors

How to make:

- Cut out both rectangular parts of the template.
- Fold each rectangle in half at the dotted line and glue together.
- Then glue the two resulting strips together as marked in a cross.
- Place the finished cross on the back of your hand and strike one overhanging end sharply with a pencil or finger in a horizontal direction.
- The cross flies out and comes back in an arc.





Flying saucer

Materials, equipment and implementation: template no. 6, thick printing paper (160 g), scissors, hat elastic, glue, (compass (drawing tool), pencil, ruler)

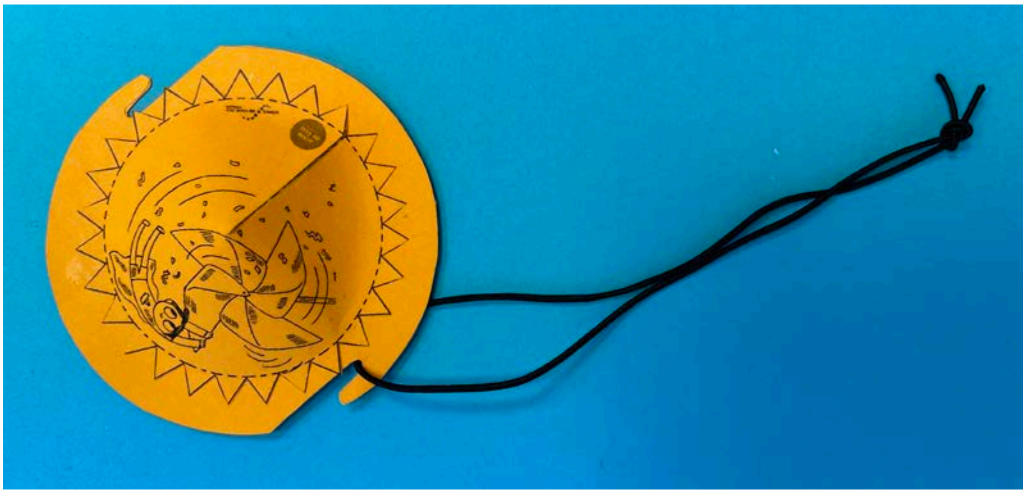
How to make:

- Cut out the circular template (base) roughly and glue it on additional thick printing paper (160 g). Then cut out exactly.
- Cut out the cab template and glue it into the shape of a cone.
- Bend the triangles that are around the bottom of the cab, paint them with glue and use them to glue the cabin to the double base of the flying saucer. Let everything dry well.
- Launch the saucer with a rubber band (preferably hat band).

How does the flying saucer work:

Set the flying saucer in motion with the rubber band. This gives the saucer a lot of movement energy, both rotational and linear. When the rubber band is fired, the saucer is moved forward by the force of the band and keeps moving because of its inertia. The rotation aids its stability. At the same time, the force of gravity pulls the flying saucer towards the Earth but the shape of the saucer leads to enough upwards force from the air to hold up the saucer, aided by the rotation which keeps the saucer level. The flight path of the saucer is quite large.

Safety warning: When shooting flying saucers, it is necessary to ensure that the target area is empty.



I can turn, I can roll, I can climb

Rotating wheel

Materials, equipment and implementation: template no. 7, thick printing paper (160 g), scissors, cut off knife or small scissors, small and large drawing pin (thumbtack), bracelet knitting ribbon

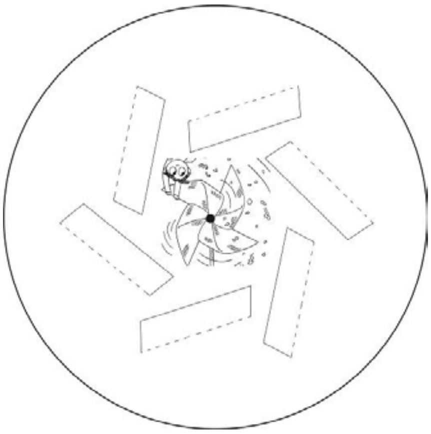
How to make:

- Cut out the circular template.
- Cut the solid lines on the drawn parallelogram wings with scissors or cut off knife.
- Fold the wings diagonally upwards.
- Using a small drawing pin, pierce the circle in the middle (marked dot).
- Insert a large drawing pin into the centre of the circular template from the bottom, and slide a small piece of ribbon onto the tip of the drawing pin.
- Place the circle on the table and blow into its centre (slowly at first, then more). The wheel spins.

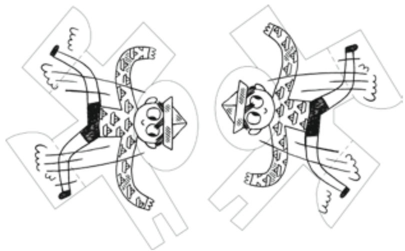
How it works:

The wheel is spun by the compressive force of the airflow acting on its bent wings. The wheel spins quickly because there is a thin layer of air underneath it (the paper wheel lies on the head of the drawing pin) and the drawing pin is smooth, reducing the frictional force between the pad and the wheel.

The spin time is influenced not only by the spin method but also by the size of the drawing pin. If a large drawing pin is used, it spins longer (flywheel).



Unconventional pinwheel



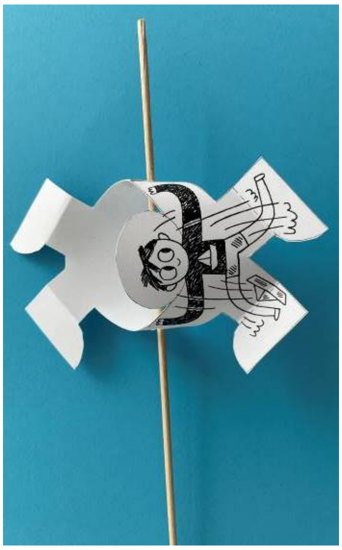
Materials, equipment and implementation: template no. 8, thick printing paper (160 g), skewers, scissors, glue

How to make:

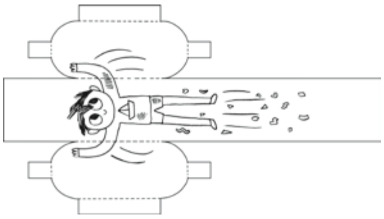
- Cut out the figures.
- Bend the hands of the figures into an arc and glue them together as follows – glue the hand with the hole of the first figure to the hand without the hole of the second figure, the hand without the hole of the first figure to the hand with the hole of the second figure. (The head of the first figure is above the legs of the second figure, the head of the second figure is above the legs of the first figure (slightly offset). An "oval" is formed.
- Thread a skewer through the holes created in the hands. Bend the heads and legs of the figures a little. (This creates the blades of the pinwheel.)
- Blow the wheel to make it spin. It is recommended to start blowing on the legs.

How it works:

As you blow, the current of air exerts a compressive force on the bent heads and legs, which are actually the blades of the pinwheel, and sets the whole pinwheel in motion.



Frolicking bean



Materials, equipment and implementation: template no. 9, thick printing paper (160 g), scissors, marble ball (clay, better steel ball from a bearing or fishing egg), pencil, paper glue, crayons, board

How to make:

- Print the template on cardboard or draw it. Adjust the size of the template according to the size of the marble ball.
- (Color the template.)
- Following the dotted lines, bend some parts and glue them into the shape as shown.
- Before gluing the last part, put the marble ball inside.
- Wait for the glue to dry, than put the bean on a tilted plane and see what acrobatics pieces the bean can do.

How it works:

The box is much lighter than the ball. Therefore, the ball will move at a greater speed on the inclined plane. As the position of the ball in the box changes, the position of the center of gravity of the box-ball system changes, so that the center of gravity is above the support surface (the rounded part). The box will "stand up" and at the same time move out of its stable position by inertia. The ball brings the box back to the inclined plane, starts to move again and the action repeats...

Obedient rappeller

Materials, equipment and implementation: template no. 10, thick printing paper (160 g), markers, string, 2 pieces of straw, glue stick, scissors

How to make:

- Draw a rappeller on the cardboard or cut out the template.
- Cut about 50 cm of string.
- Cut two equal pieces of straw about 3 cm long.
- Stick them on the back of the picture – one behind the other with slightly reversed sticky tape.
- Thread the string through both straws.
- Grab the ends of the string by both ends and pull the string vertically. The rappeller is on top.
- Keeping the string taut, the spider hangs in one place.
- If the string is loosened, the rappeller slides down the string.
- If we are skilful, by quickly alternating the loosening and tightening of the string we can achieve the illusion of the rappeller descending down the thread.

How it works:

When the string is taut, it scrubs around the slanted ends of the straws. The frictional force between the string and the straw is applied. This force counteracts the downward movement of the rappeller (by equally the downward force of its weight) and the rappeller stands still. If the string is loosened, the frictional force is reduced and the rappeller moves downwards because its weight exceeds the opposing frictional force.

Climber

Materials, equipment and implementation: template no. 11, thick printing paper (160 g), markers, string, straw, beads, duct tape, scissors

How to make:

- Draw a climber on cardboard, colour and cut out or cut out and colour the template.
- Cut about 1 m of string or thick thread.
- Cut two equal pieces of straw, about 3-4 cm long
- Turn the climber bottom side up and glue the two pieces of straw about halfway up the body using duct tape.
- Push the string through one straw upwards and then through the other straw downwards. A bend is created at the top.
- Tie beads or make loops on both ends of the string.
- Hang the string in the middle on a window or door handle.
- To make the climber climb, pull down on one side releasing the other, then pull down on that other side releasing the first side...and continue alternating.
- Once the climber has climbed up to the doorknob, release both ends of the string. The climber will slowly slide back down to the beginning of its journey.

How it works:

Each time the string is pulled in one straw, the string tightens and the friction holds it against the straw. Friction is created because the string is pushing against the inside of the straw. The other side is slack and the toy rotates sliding up the loose string. When this side is then tightened the string grips again, the toy rotates in the opposite direction, and thus begins its climb.

As soon as the strings are released, they stop pushing against the straws, so the friction is less and the climber slides down. And we can climb again.

If we turn the climber inside out, we can see how this process works.

Acrobats

Acrobatic parrot

Materials, equipment and implementation: template no. 12, thick printing paper (160 g), scissors, glue, paper clips, crayons, markers

How to make:

- Print the template on the thick printing paper or draw and cut it out. (You can colour the parrot.)
- If you stand this parrot with its foot on your finger, it will fall off.
- But just put a paper clip on the tail and the parrot sits on the finger and won't fall off. (It is best to hang a few paper clips on a chain).



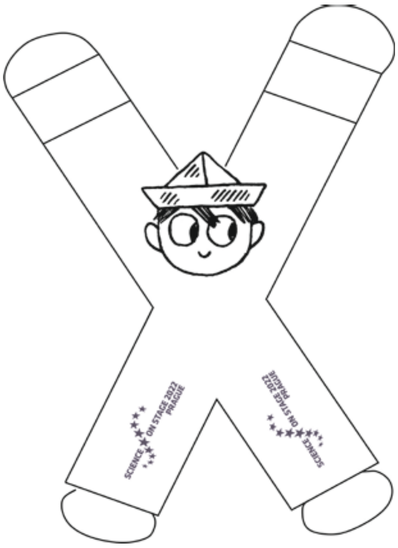
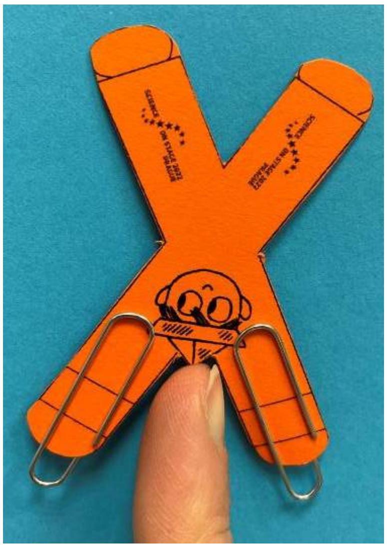
Acrobatics figure

Materials, equipment and implementation: template no. 13, thick printing paper (160 g), pencil, crayons, scissors, 2 paper clips (or more)

How to make:

- Print or trace the acrobat template on the thick printing paper and cut out. (Paint the figure with crayons).
- Put the figure on a finger, skewer or scissors, it will fall off.

- Put one paper clip on each hand of the figure. Balance the figure on its head on a finger or skewer, as shown The figure holds on and does not fall off.
- If the paperclip is pushed all the way in, the figure will lie in a stable position.
- If the paper clip is only a little bit in, the figure will be upright.
- If more paper clips are added, for example by "hanging", the position of the figure will be even more stable.

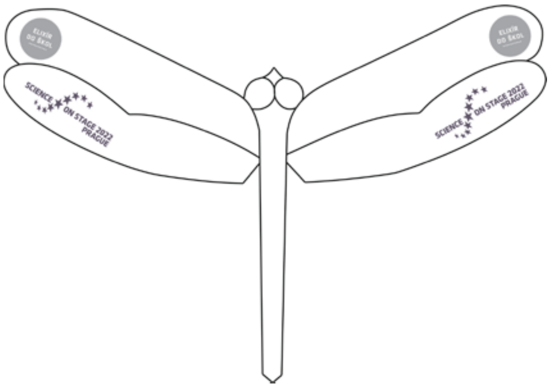
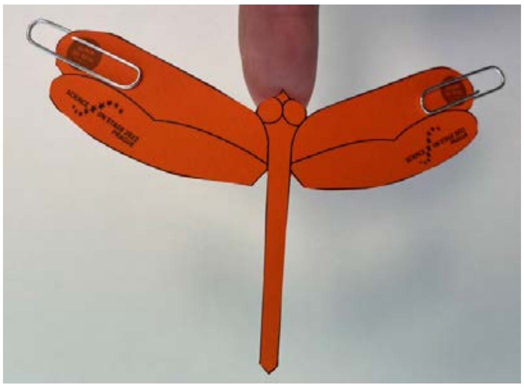



Acrobatics dragonfly

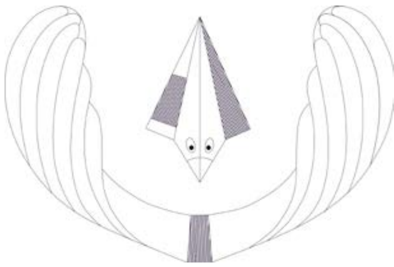
Materials, equipment and implementation: template no. 14, thick printing paper (160 g), scissors, paper clips, (pliers, tensioners), crayons, markers

How to make:

- Print the template on the thick printing paper or draw and cut it out. (You can colour the dragonfly.)
- If you put the dragonfly on our finger, it will fall off.
- However, just put 1 snap on each side of the dragonfly's wings in the marked place, the dragonfly will rest on the finger and will not fall. (You can also use a stylus to pierce the marked spot and bend the sharp tip with pliers on the other side.)

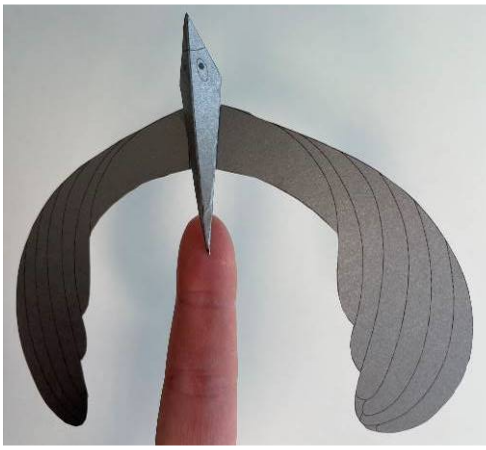
Balancing bird



Materials, equipment and implementation: template no. 15, thick printing paper (160 g), glue, scissors, crayons, markers, string (thread), needle

How to make:

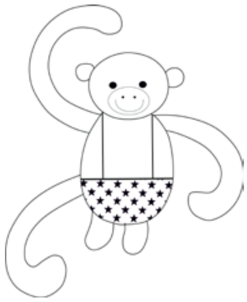
- Print both parts of the template on the thick printing paper and cut out.
- Fold the 1st part of the template along the 3 marked lines and glue the body spatially.
- Join the body to the wings at the marked point. Leave to dry well.
- Rest the end of the tail on your finger. The bird does not fall and stays horizontal.
- You can also hang the bird on a thread. Just take a needle with thread on it, make a larger knot at the bottom end of the thread and thread the needle and thread through the end of the tail. If you hold the thread at the top, the bird floats horizontally.



How do acrobatic bodies work:

The stability of the acrobat depends on the position of the centre of gravity. The lower the centre of gravity, the more stable the position. The position of the centre of gravity in turn depends on the distribution of material in the body. If we add a weight - paper clips - to a lower part of the object (for example the arms of the acrobatic figure), the center of gravity shifts down to the level of paper clips and under the support point. The acrobatic figure will be in a stable position.
A parrot without weight has its centre of gravity above the foot, i.e. above the support point.
If we put a weight (paper clips) on its tail, the centre of gravity will move behind the weight to below the support point.
A paper dragonfly with no extra weights has its centre of gravity above the support point.
If we put a weight on the wings (turnbuckles), the centre of gravity moves behind the weight to below the support point. The dragonfly will not fall, it is in a stable position.
We don't have to add weight to the bird. The shape and size of the wings cause the bird's centre of gravity to be below the tail, i.e. below the support point. Therefore, after gluing together the bird will be in a stable position.
We call these positions where the position of the centre of mass causes the object to return to its balanced position when given a slight displacement, "stable equilibrium".

Lever with monkeys



Materials, equipment and implementation: template no. 15, thick printing paper (160 g), markers, pipe cleaners or furry wire or a skewer, thread, scissors, string, ruler, permanent marker

How to make:

- Divide the hairy wire into 4 equal parts (mark with permanent marker).
- Tie a string loop in the middle of the wire to hang the trapeze.
- Print the monkey templates several times (at least 4 times) on a thick printing paper.
- Hang one monkey on one end. Then add a second one to the middle of the other arm. The trapeze will not hang horizontally.
- Add another monkey to the tail of the other one. The trapeze will be horizontal.
- Then try hanging all the monkeys at different points on the trapeze.

How it works:

The trapeze acts as the swing (lever) and the string in the middle as the central point at which it swings (axis of rotation).
When we place a monkey on one end, the end of the trapeze swings a lot. When the monkey hangs in the middle of the arm, the trapeze will tilt just a little.
As we hang the other monkey on the tail of one monkey, more force will be applied to the trapeze, and the trapeze will swing more than when one monkey was hanging there.
Thus, the rotation of the trapeze (lever) depends on the force applied and the distance of the hanging point from the central point (axis of rotation).

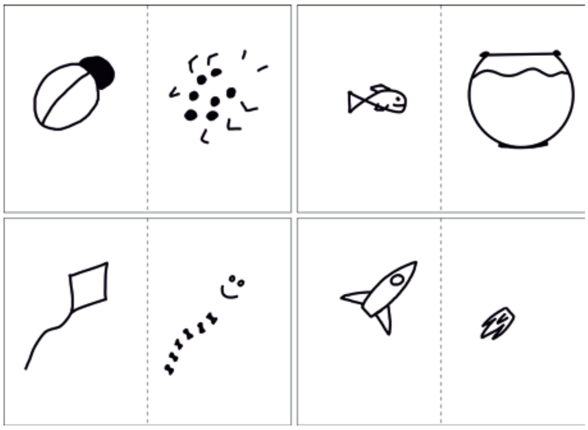
Living Pictures

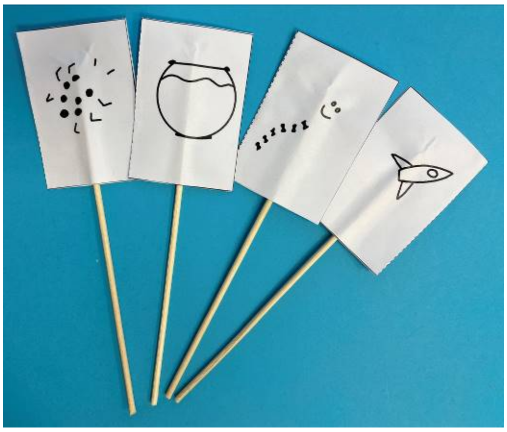
Thaumatropes

Materials, equipment and implementation: template no. 17, thick white printing paper (160 g), scissors, glue, skewers

How to make:

- Cut and fold the rectangular template with the pictures along the marked line.
- Paint both halves of the rectangle with glue.
- Insert a piece of skewer in the middle of the picture so that one end is sticking out.
- Then glue the two parts together. Let them dry well.
- Then rotate the skewer between your hands at a suitable speed. It looks to us like the lady bug has got its dots, the kite its tail, the fish is in the aquarium, and the rocket has ignited its jets.





Kinetoscope

Materials, equipment and implementation: template no. 18, thick white printing paper (160 g), scissors, glue, cork stopper, larger thimble, mirror, (black paint or black paper, bead)

How to make:

- Cut out the template (we can also glue them with black paper or drawing, which we paint with black paint).
- Pierce the centre of the template with a thimble, enlarge the hole with a circular motion and then pin the thimble into the cork plug. (The circular template must rotate freely around the tip of the tensioner).
- Turn the disc pictures against the mirror, rotate it and look into the mirror through the slits. It appears to us that the athlete is running, the butterfly is flying …)

How do the animated pictures work:

In experiments with moving pictures (both thaumatrope and kinetoscope), we take advantage of the fact that vision has a certain "inertia". We call this retention of vision. With fast-moving images we are unable to distinguish one from the other sharply and they merge into a moving image.

Two pictures in one

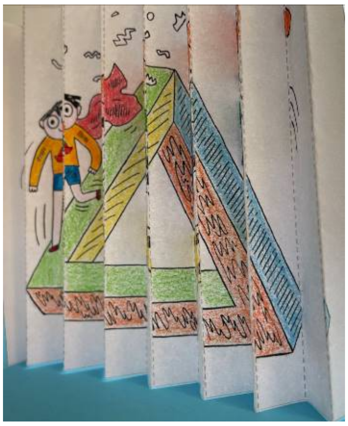
Materials, equipment and implementation: template no. 19, office paper (80 g), scissors, crayons, (2 postcards, glue, paper)

How to make:

- Copy the template, cut it out and colour it.
- Then we fold the template according to the indicated lines into the shape of an accordion.
- Spread the accordion out a little and look at it alternately from left and right.
- In one view we see the Little Paper Elf coming down the magic triangle, in the other the Little Paper Elf wrapped in paper.

How it works:

The pictures of the Little Paper Elf in two different surroundings are divided into narrow rectangles, which alternate in the new picture. When the picture is folded into an accordion shape, the rectangles with the pictures of the Little Paper Elf coming down the magic triangle are seen from one side, the picture of the Little Paper Elf wrapped in paper from the other. The light spreads in a straight line, we cannot see around the corner.



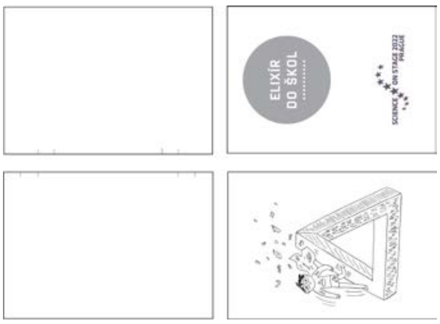
Puzzles

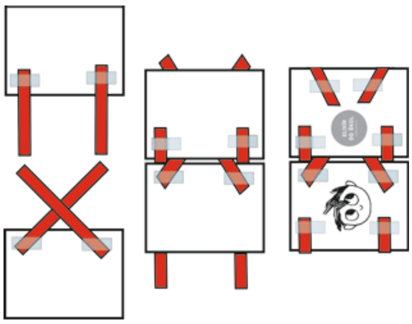
Magic folders

Materials, equipment and implementation: template no. 20, thick printing paper (160 g), ribbon, scissors, ruler, pencil, paper glue

How to make:

- Cut out 4 rectangular templates.
- Take 2 rectangles. Glue the ribbons onto the boards as shown in the pictures. Then the horizontal and crosswise ribbons are always glued with one end on the left side and the other end on the right side.
- Cover the sides of the rectangles where the ends of the ribbons are glued with paper so that no one can see how we have led the ribbons.
- Then lay the note or painted card loosely in the boards. Close the boards, discreetly flip them over and open the other side. The banknote is under the crossed ribbons.
- Close the boards again and open them on the other side. The banknote appears under the horizontal ribbons.
- ...repeat.





How it works:

The magic plates have an interesting design. The way the ribbons are glued allows the boards to be opened from both sides. The banknote is in place, only the position of the ribbons changes.

Astronaut rocket puzzle

Materials, equipment and implementation: template no. 21, thick printing paper (160 g), large and small scissors (cut off knife)

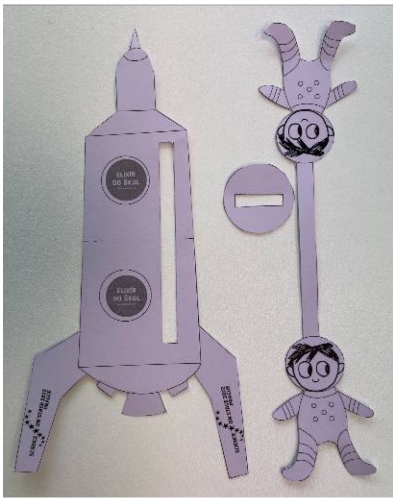
How to make:

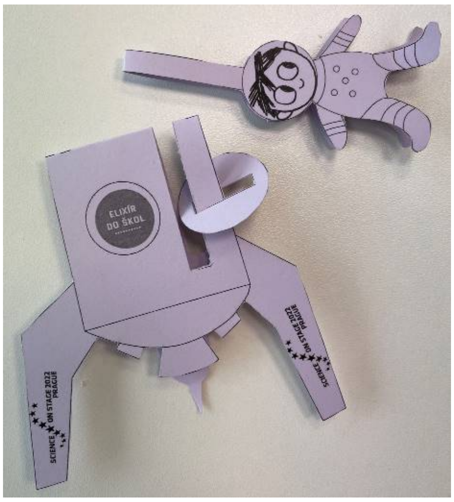
- Copy the template on the thick paper and cut out all 3 parts.
- Cut out the rectangular holes in the circle and in the rocket with small scissors or cut off knife.

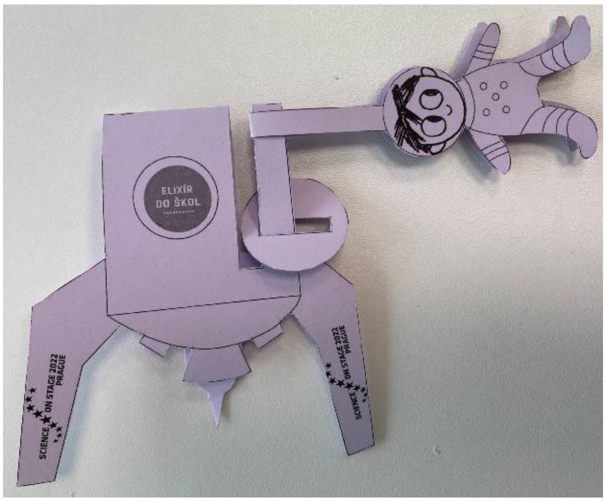
Task 1: Attach the astronaut to the rocket.

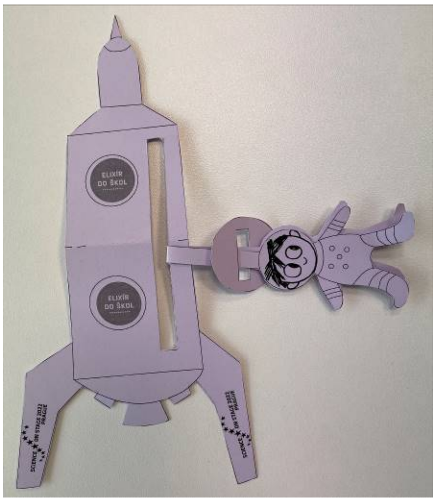
Task 2: Then detach the astronaut from the rocket.

Solution:

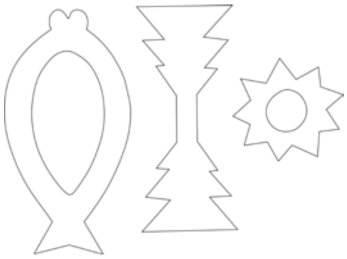








Christmas puzzle



Materials, equipment and implementation: template no. 22, white thick printing paper (160 g) or coloured (blue, green and yellow) thick printing papers (160 g), pencil, scissors

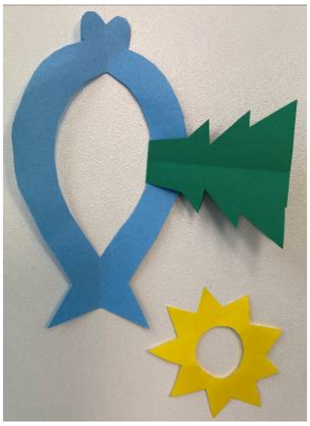
How to make:

- Print the templates on thick printing paper or trace on the corresponding papers and cut out.

Task: Attach the tree to the fish and secure it with the star.

Solution:

- Fold the tree so that the two parts are on top of each other and string it onto one part of the fish.
- Carefully fold the fish in half (so that the fold is not visible).
- Then pull the star over the tail, body and mouth of the fish.
- Straighten the fish. On one side of the fish, a tree is strung with a star.
- You can write a Christmas or New Year's card on the fish. You get a Christmas/New Year card puzzle. The task is to release the tree and star from the fish, then string it back on.....
- The whole set can also be used as a name tag for the Christmas holiday table (the tree will be a stand).

Three rabbits and only 3 ears

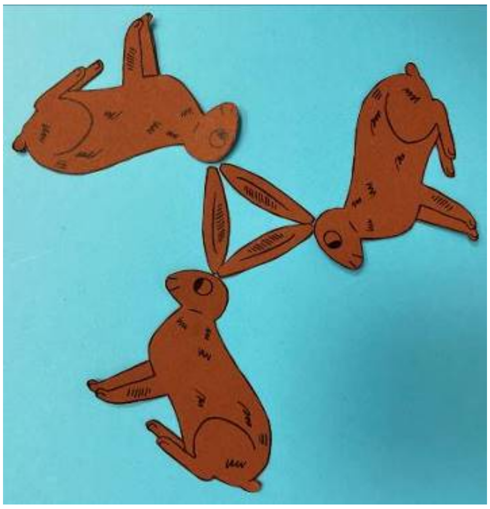
Materials, equipment and implementation: template no. 23, thick printing paper (160 g), scissors, pencil

How to make:

- Print the template on cardboard or draw the rabbit template 3 times and the ear template 3 times.
- Cut out everything.

Task: Arrange the 3 rabbits and 3 ears so that each rabbit has 2 ears.

Solution:



Mathematical puzzles

The cube without gluing

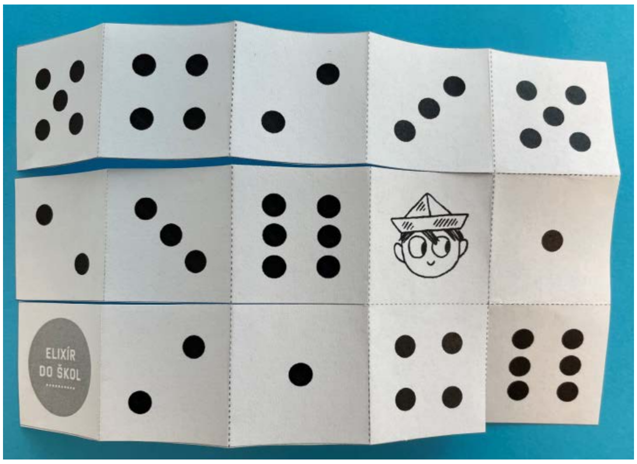
Materials, equipment and implementation: template no. 24, office or coloured copier paper, scissors

How to make:

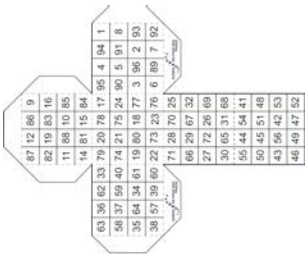
- Copy and cut out the template.
- Cut along solid lines, fold along dashed lines (pictures and dots are on the outside).

Task: Use this unconventional grid to make a cube that will hold together without gluing.

Hint: The sum of the dots on the opposite sides must be always 7 like on a dice.



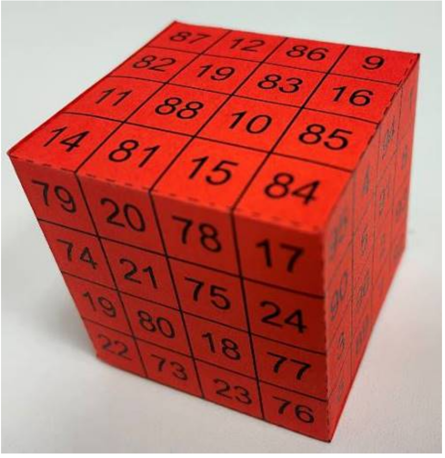
Magic cube



Materials, equipment and implementation: template no. 25, thick printing paper (160 g), scissors, ruler

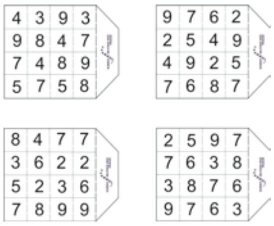
How to make:

- Copy the template of the cube – net onto the thick printing paper and cut out.
- Trace the dotted lines with the reverse side of the scissors along the ruler and bend.
- Glue the net into a cube.



You got a magic cube. The numbers from 1 to 96 are written on the cube and no number is repeated. The sum in each column, in each row, and on each diagonal equals 194. Check it out.

Mathematical columns



Materials, equipment and implementation: template no. 26, thick printing paper (160 g) ⊠ four different colours, scissors, glue, ruler

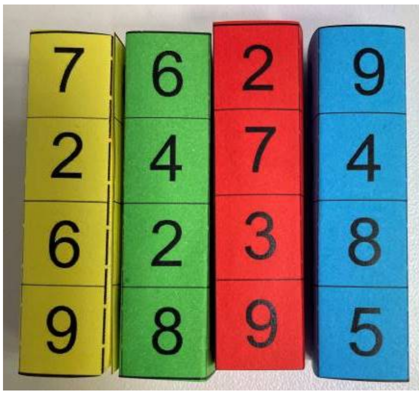
How to make:

- Copy the 4 column templates onto the 4 differently coloured thick printing papers and cut out.
- Trace the dotted lines with the reverse side of the scissors along the ruler and fold.
- Paint the bookmark with glue and glue the square bars of numbers (columns) together.
- Place the bars next to each other. You will get 4 rows of 4-digit numbers.

Task: Sum all four four-digit numbers as quickly as possible

Let's try this out on adding numbers:

7 629
2 474
6 238
9 895
26 236



How? Always look at the 3rd row (four-digit number combinations):

7 629
2 474
6 238
9 895

In our case we have the number 6 2 3 8. Subtract 2 from the last digit to get 6 2 3 6. The result must have 5 digits. So we put the 2 we subtracted in front. So we get the result: 2 6 2 3 6. And that's the correct result.

Remark:

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

This math magic works with 3 or 2 rods, 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

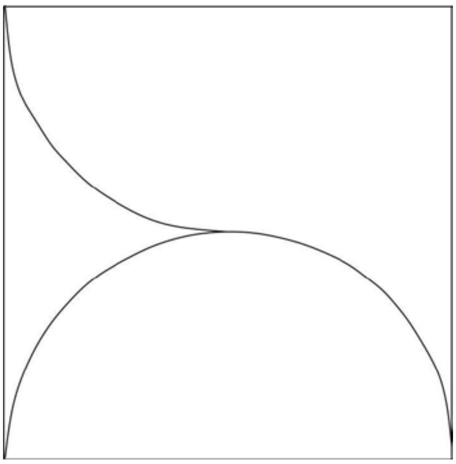
A square or a vase?

Materials, equipment and implementation: template no. 27, thick printing paper (160 g), scissors, pencil, ruler

How to make:

- Copy the template on the thick printing paper or draw as follows:
  - Draw a square with a side of 10 cm.
  - Find the centres of the two opposite sides of the square.
  - Draw a semicircle from one of the centres.
  - Draw a quarter circle from the other centre.
  - Divide the square into 3 parts.
- Cut out the square and cut it into these 3 parts.

Task: Use these 3 parts to make a pitcher-shaped vase.



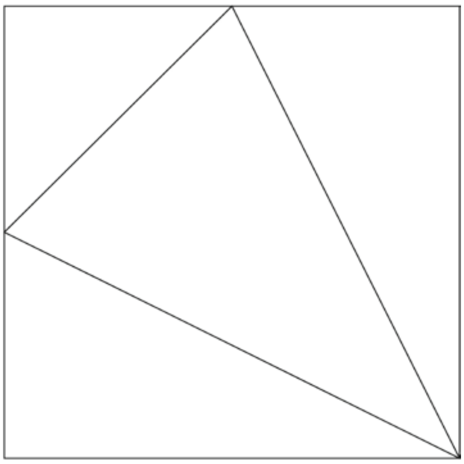
A square from triangles

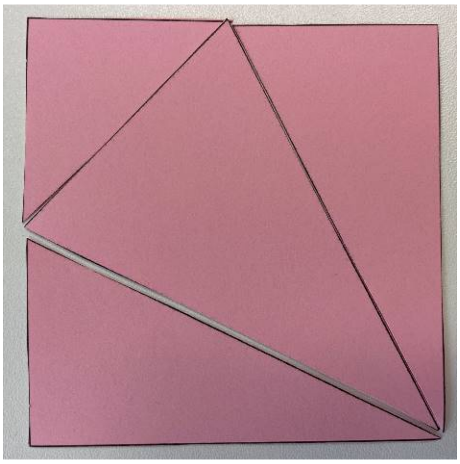
Materials, equipment and implementation: template no. 28, thick printing paper (160 g), scissors, pencil, ruler

How to make:

- Copy the template on the thick printing paper or draw as follows:
    - Draw an ABCD square with a side of 10 cm.
    - Find the centres of sides AD and CD – points E, F.
    - Draw the lines EF, FB, BE
- Cut out the square and cut it along the drawn lines. We get 4 triangles.

Task: Make a square out of these 4 triangles.





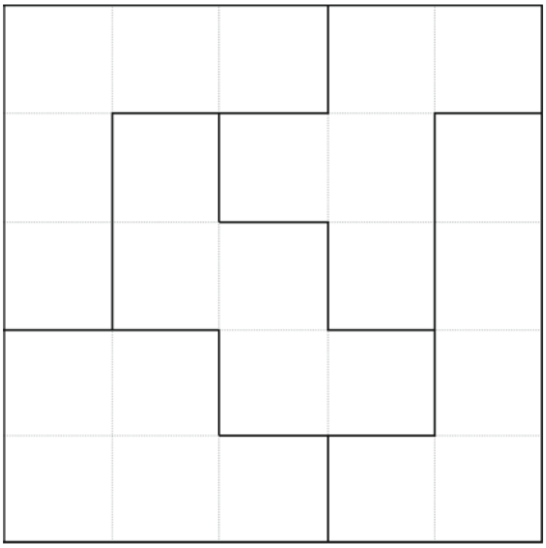
Cutted square

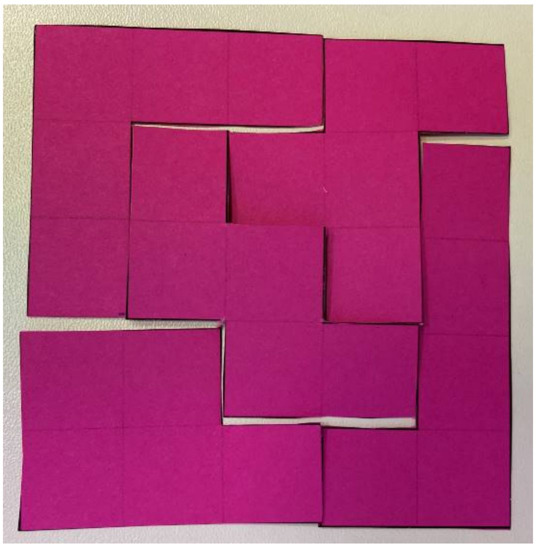
Materials, equipment and implementation: template no. 29, thick printing paper (160 g), scissors, pencil, ruler

How to make:

- Copy the template on the thick printing paper or draw as follows:
    - Draw a square with a side of 10 cm.
    - Draw a 1 cm square grid with a thin line.
    - Using a thick line, divide the square into 5 different parts according to the pattern.
- Cut out the square and cut it along the thick lines.

Task: Make a square out of these 5 parts.



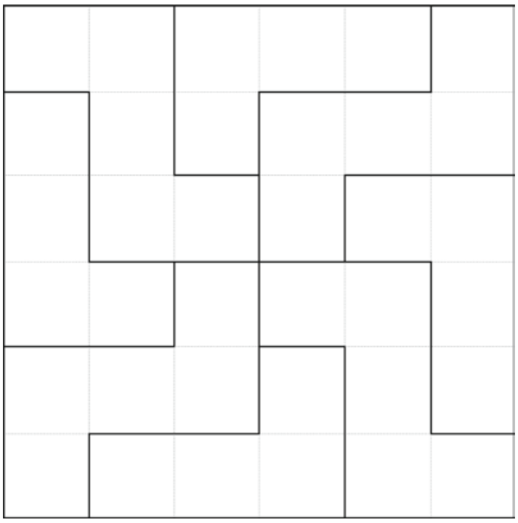


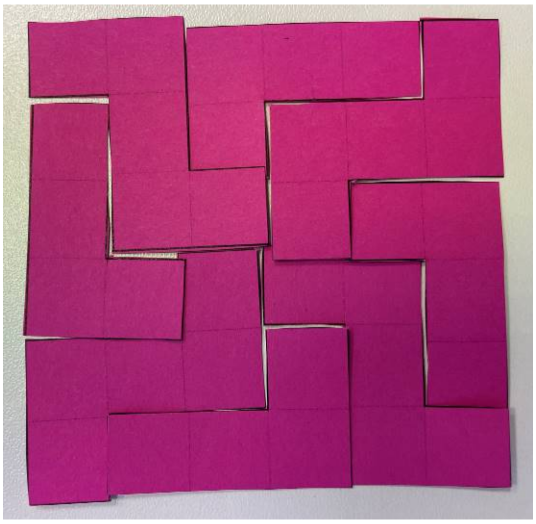
A square from 4 Z and 4 L

Materials, equipment and implementation: template no. 30, thick printing paper (160 g), scissors, pencil, ruler

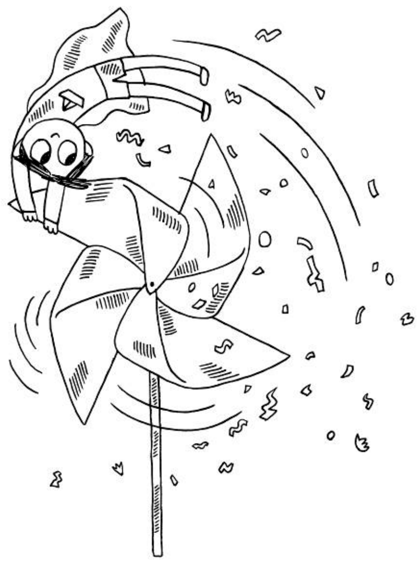
- Copy the template on the thick printing paper or draw as follows:
    - Draw a square with a side of 10 cm.
    - Draw a 1 cm square grid with a thin line.
    - Using a thick line, divide the square into 8 different parts according to the pattern (4 W and 4 L).
- Cut out the square and cut it into these 8 parts.

Task: Make a square out of these 8 parts.





Paper Science



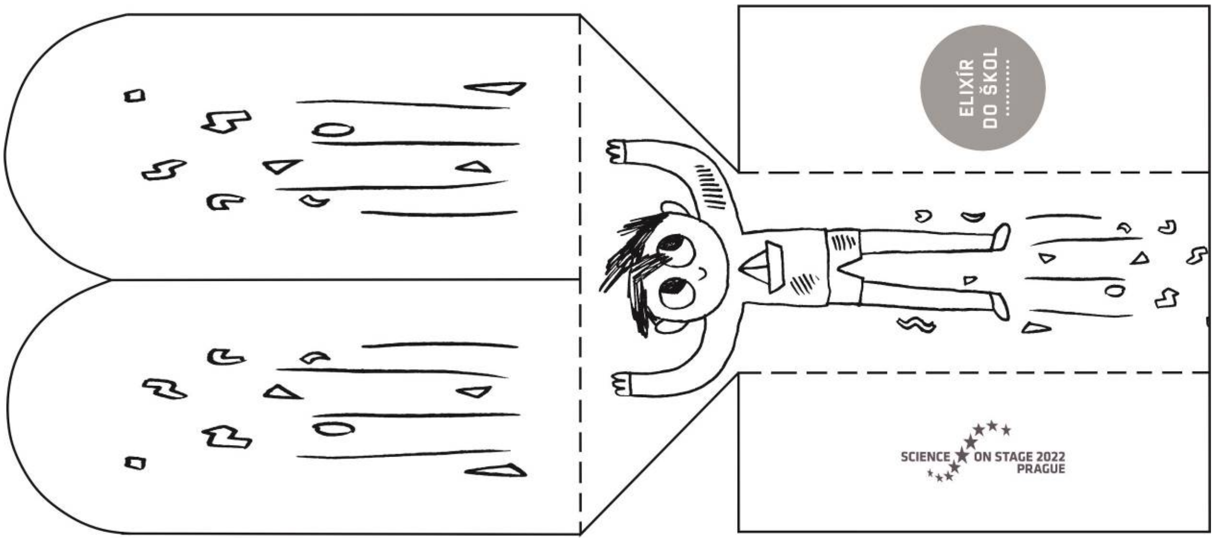
Templates

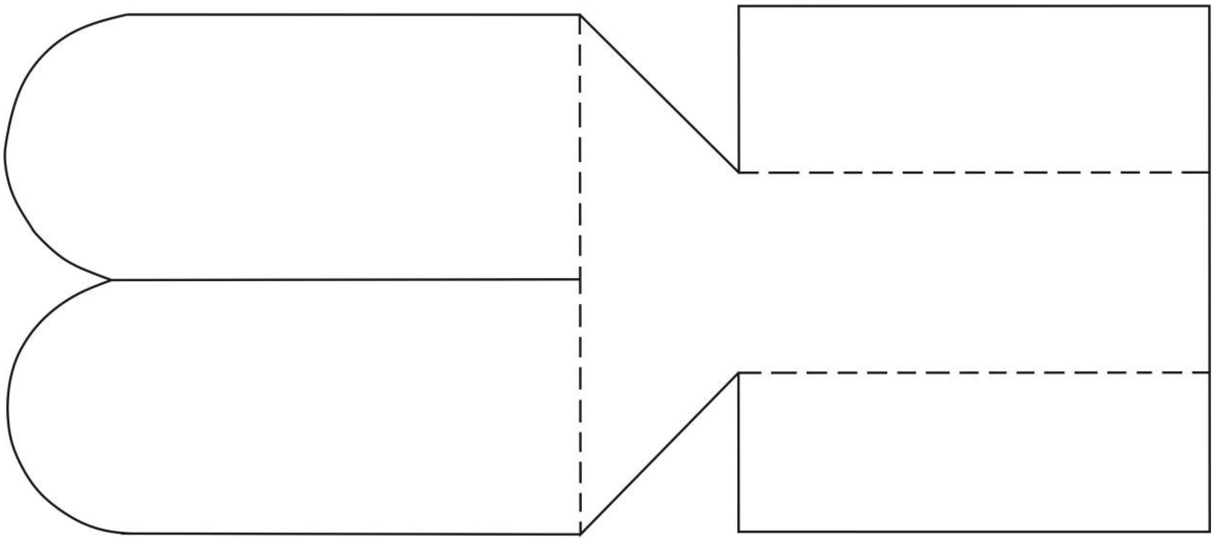
Věra Pejčochová

Editors: Jitka Houfková, Věra Koudelková
Illustrations: Nikola Hoření
Technical drawing: Karel Michal Houfek

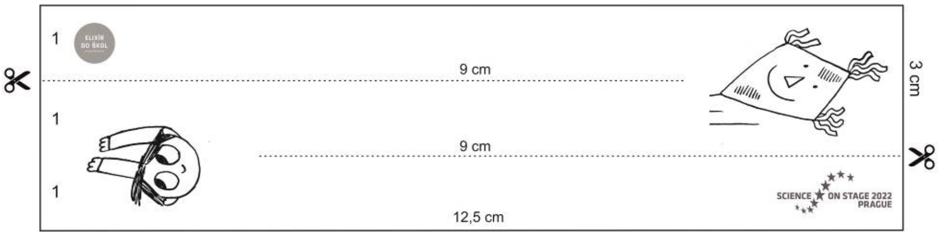
Everything´s flying

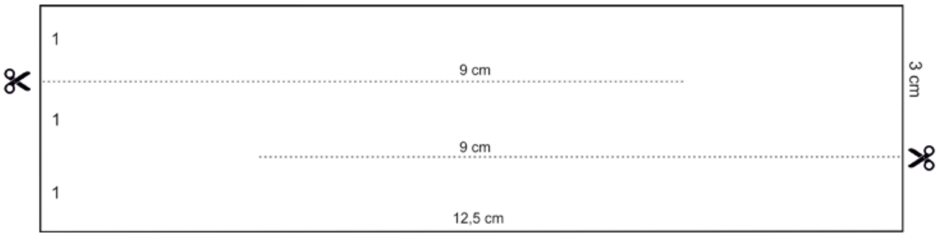
Template 1: Paper helicopter with a picture



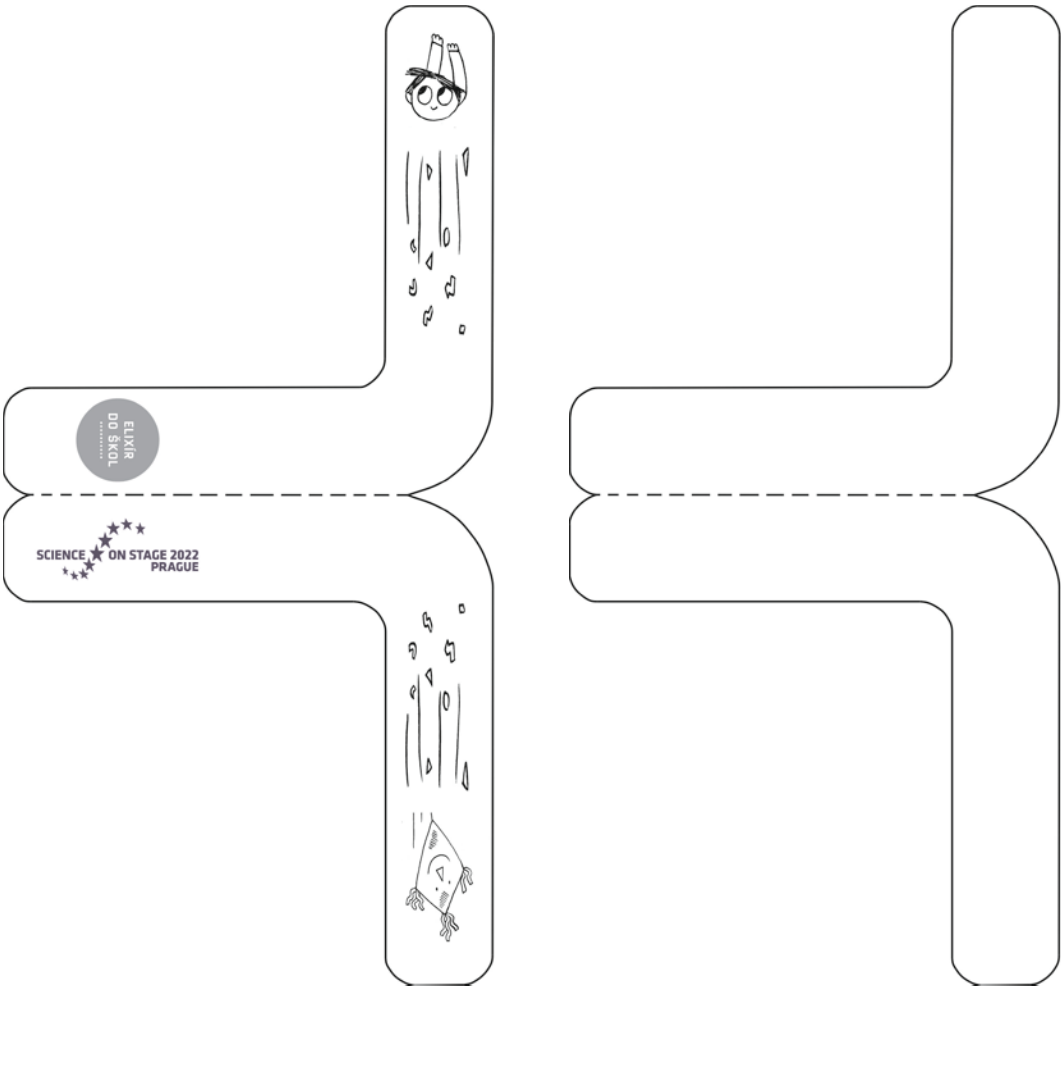


Template 2: Paper helicopter from a rectangle

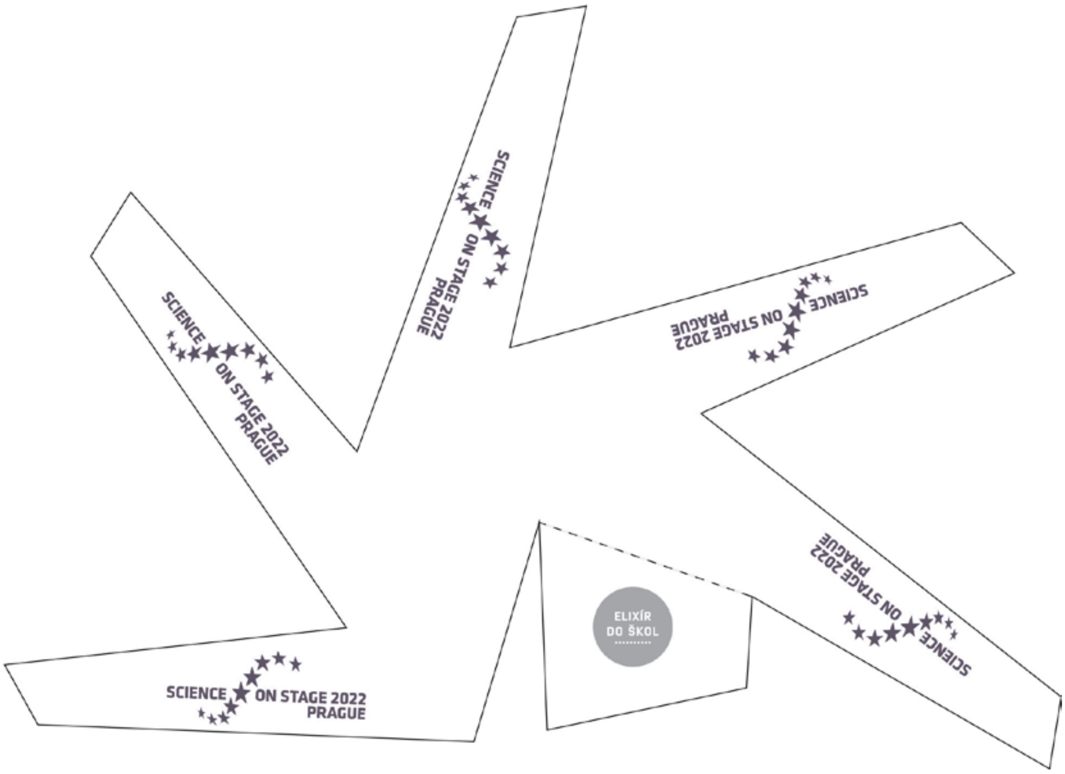


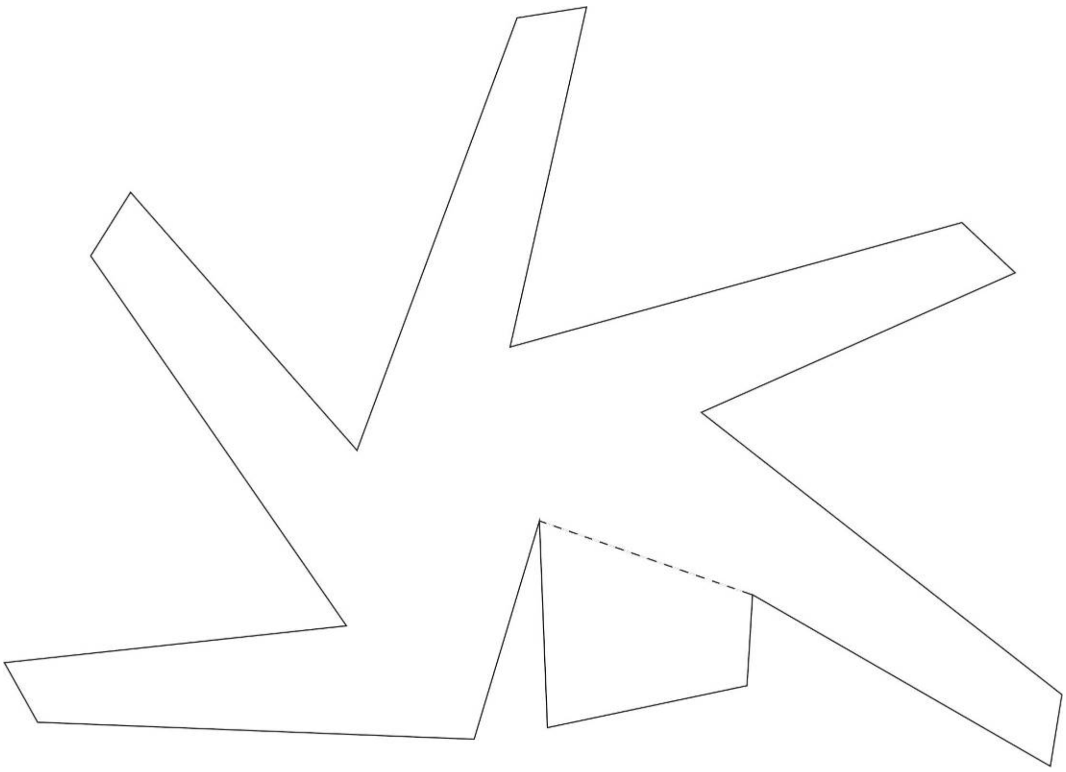


Template 3: Boomerang

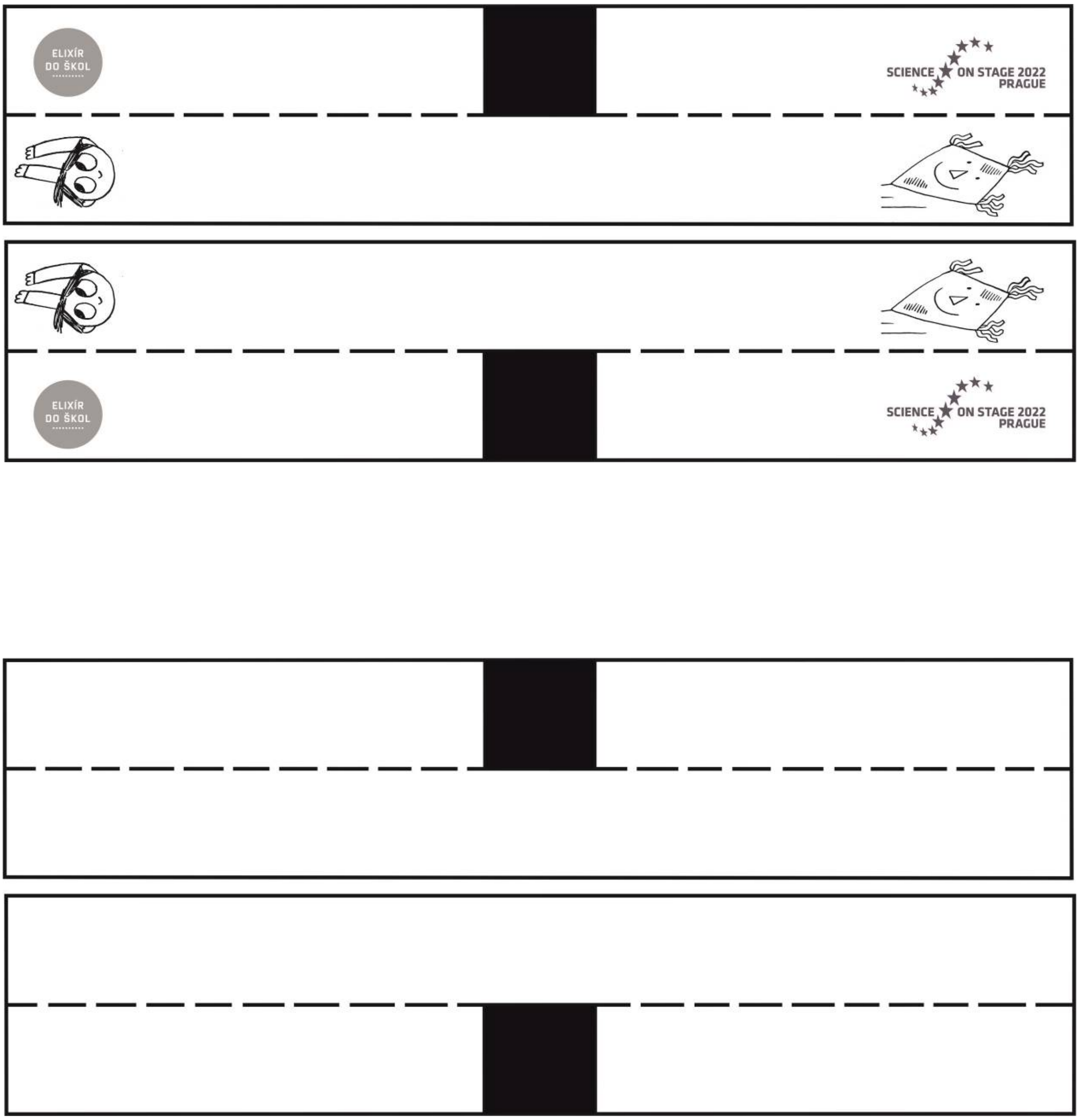


Template 4: Paper helicopter like a snowflake

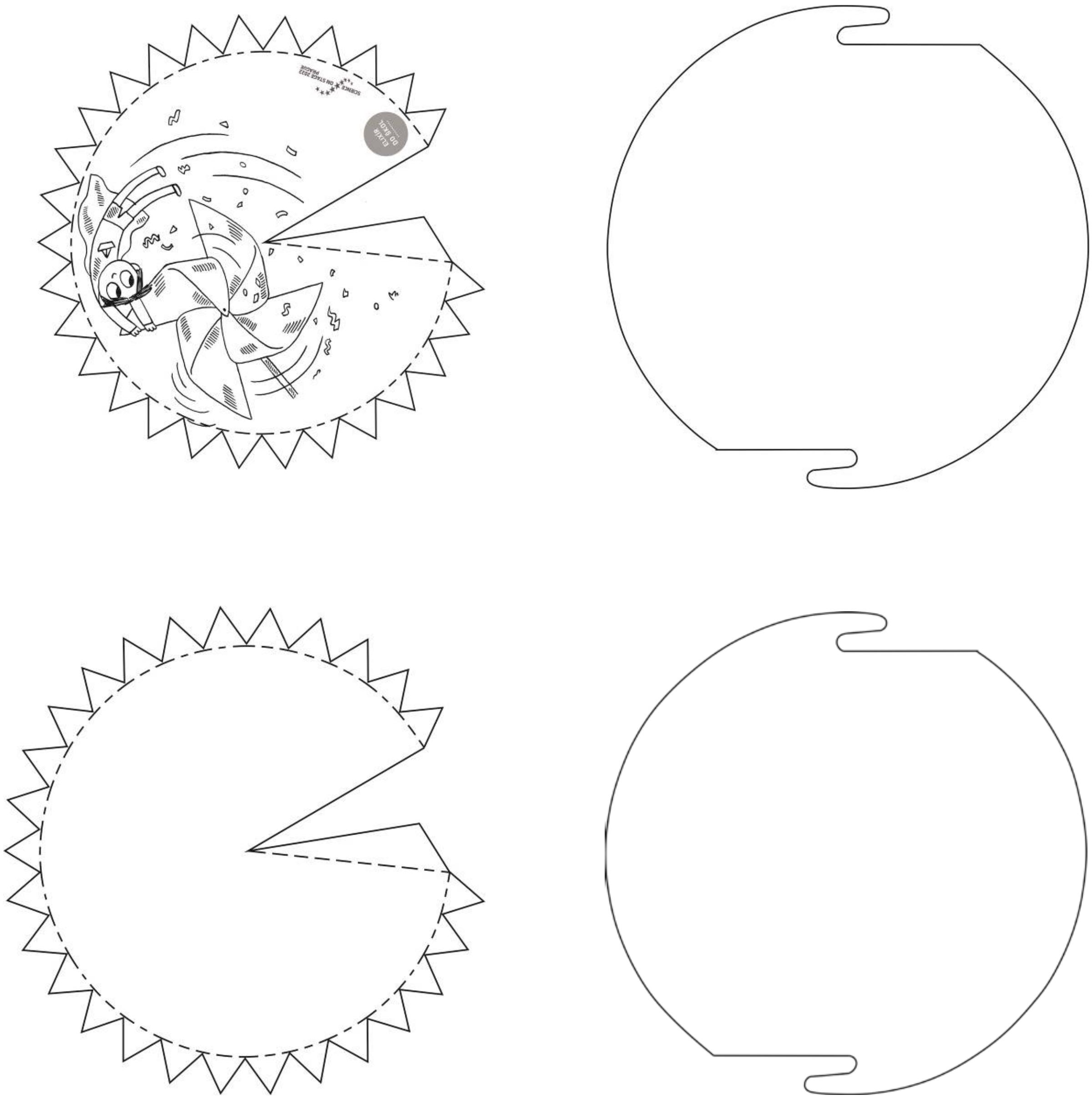




Template 5: Flying cross

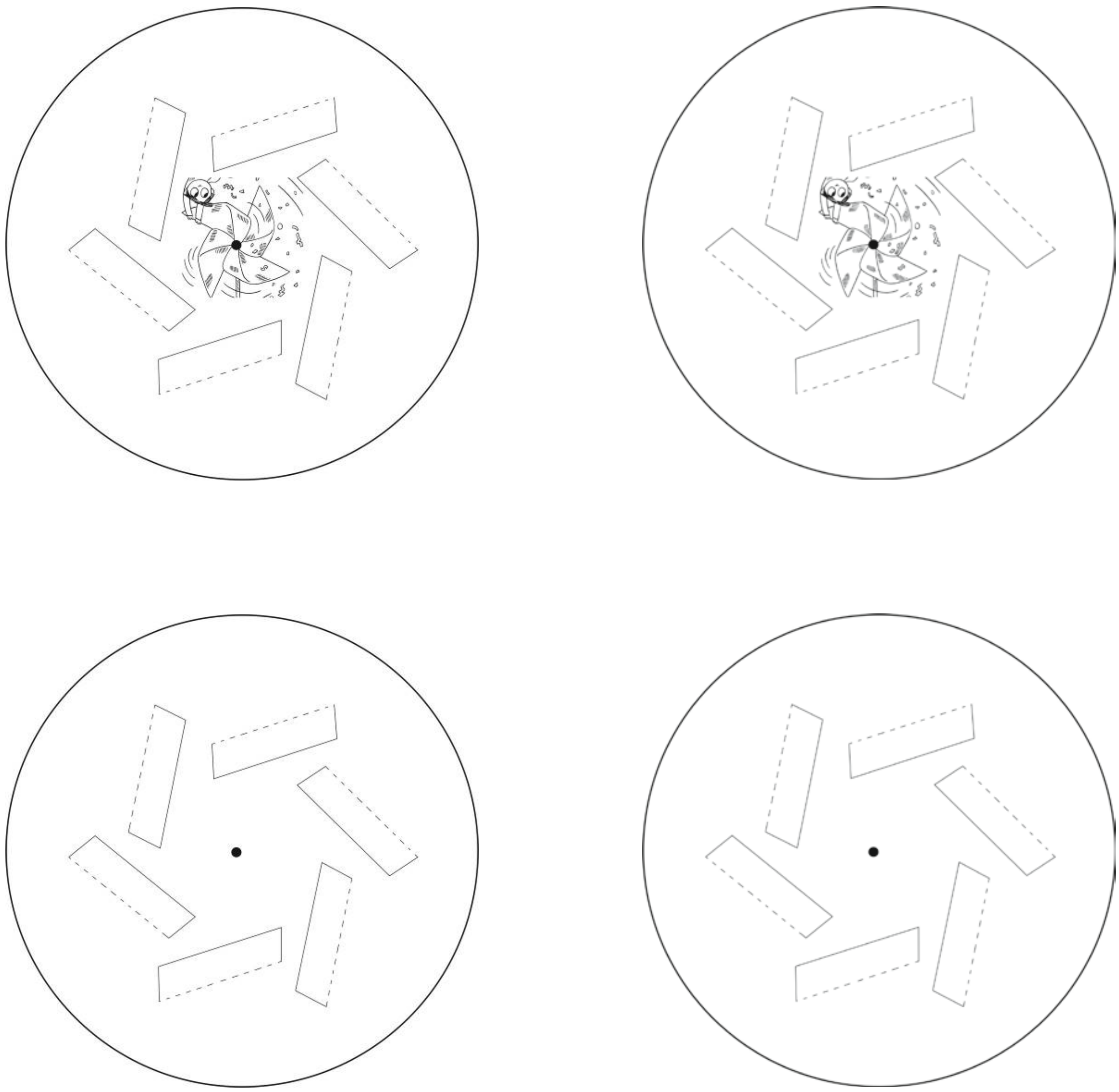


Template 6: Flying saucer

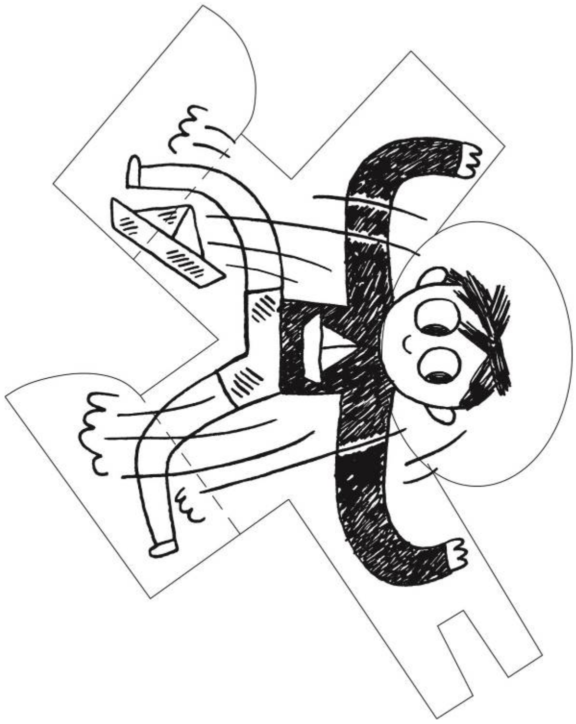


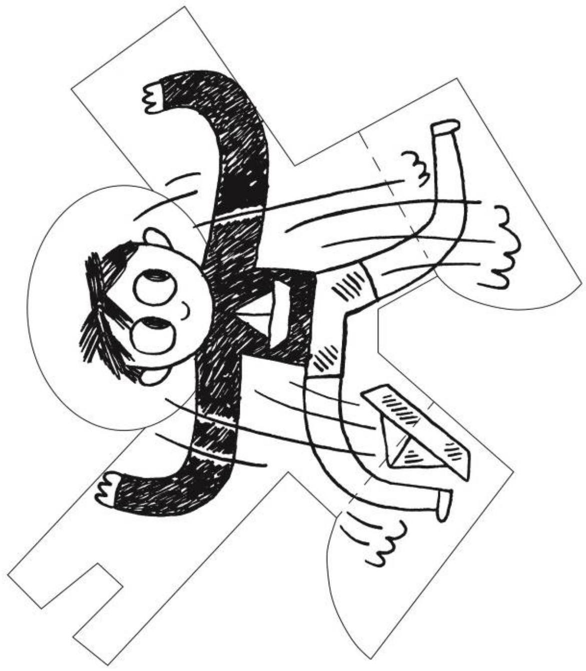
I can turn, I can roll,
I can climb

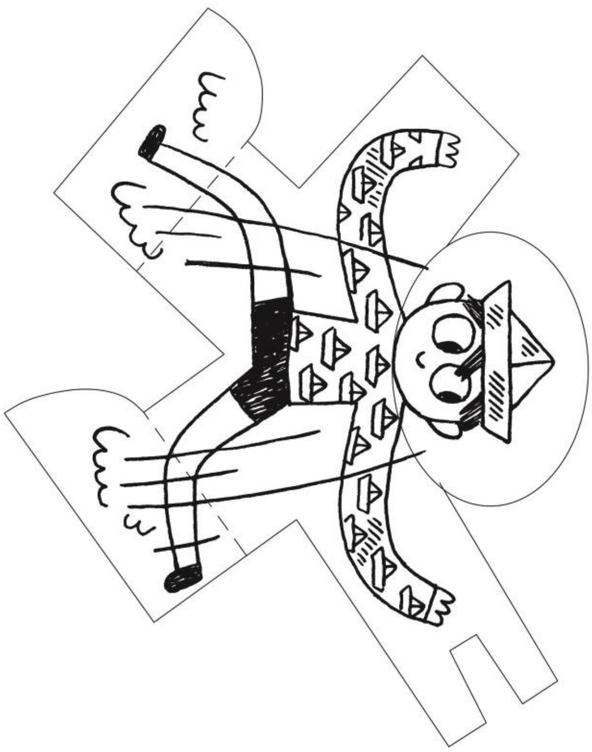
Template 7: Rotating wheel

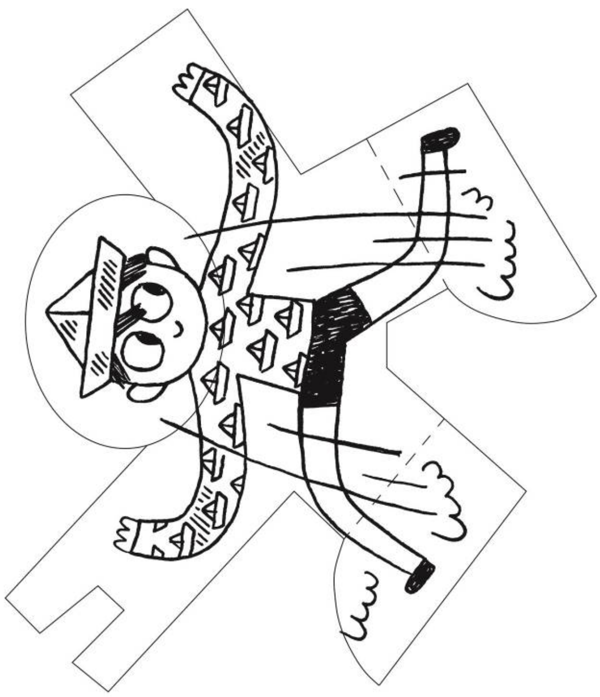


Template 8: Unconventional pinwheel

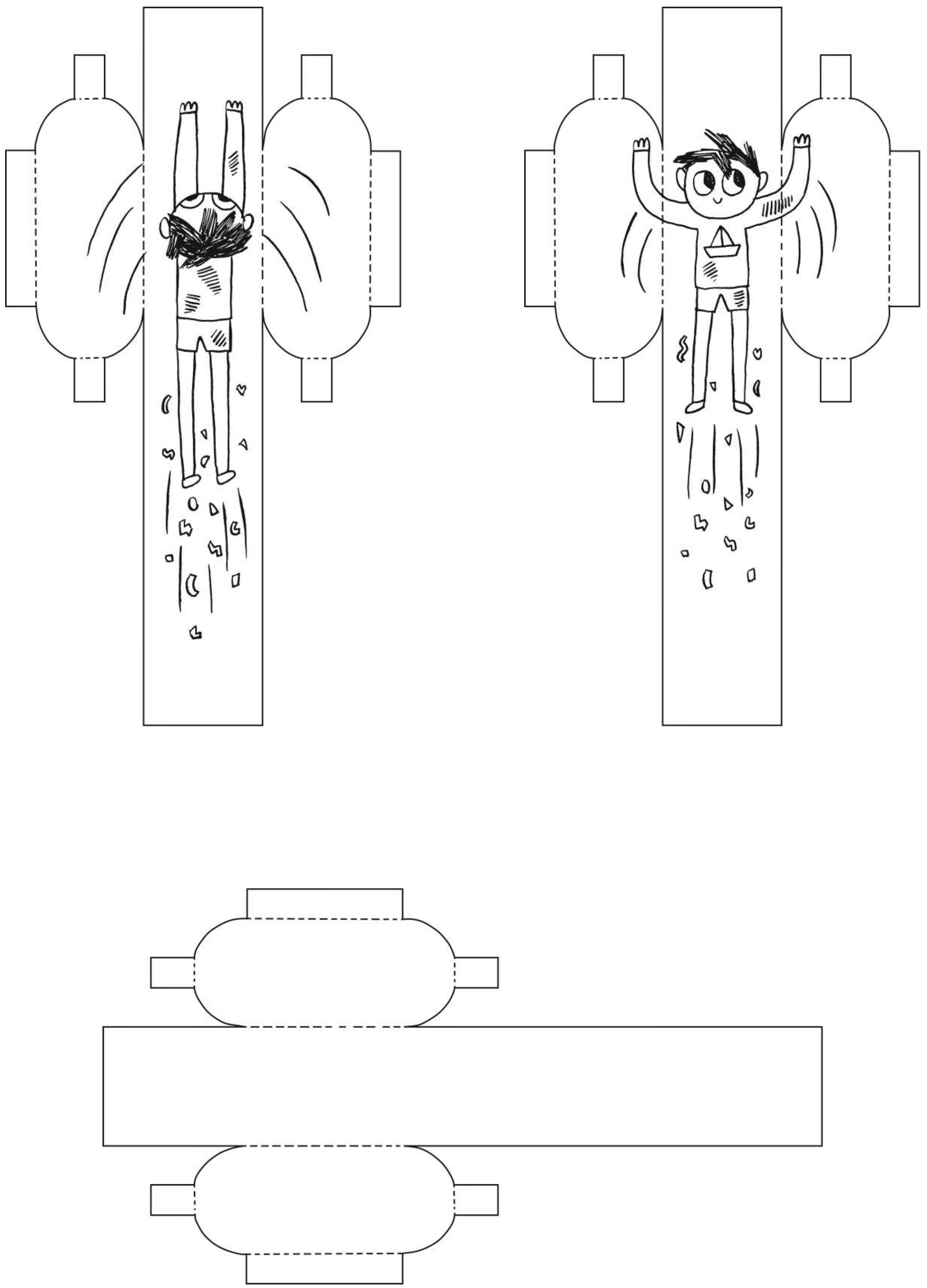






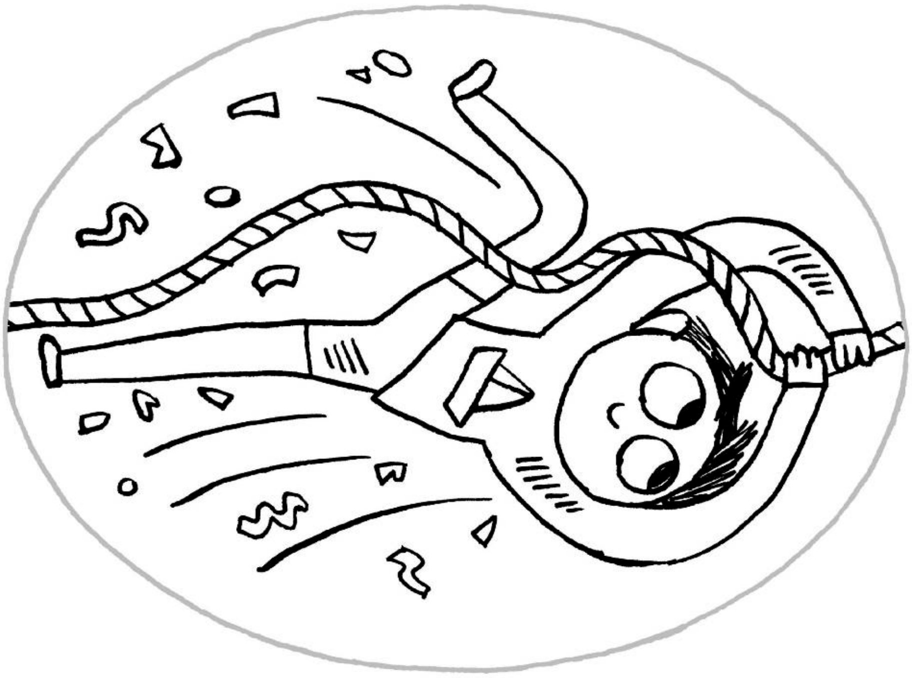


Template 9: Frolicking frog

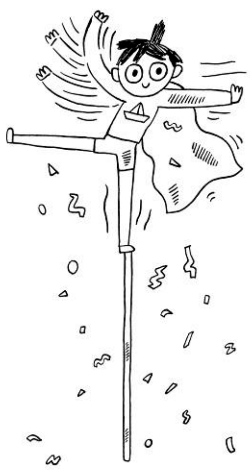


Template 10: Obedient spider

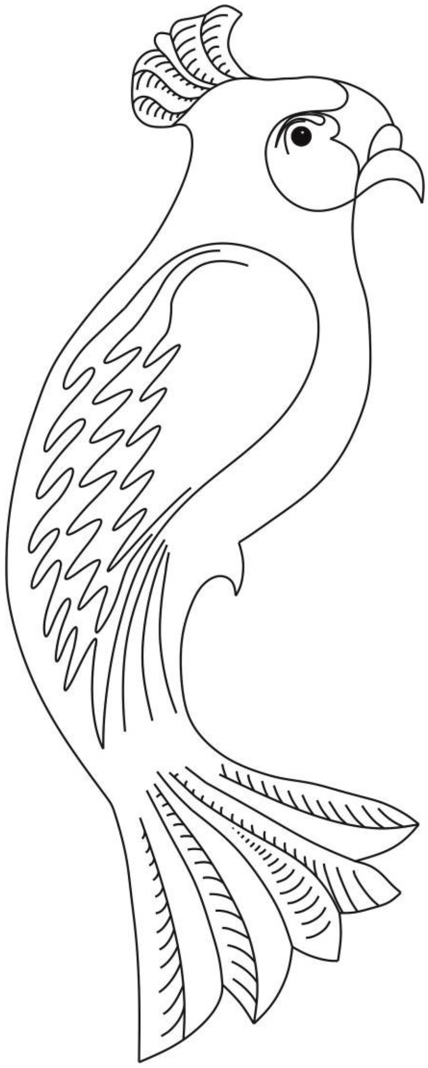
Template 11: Climber

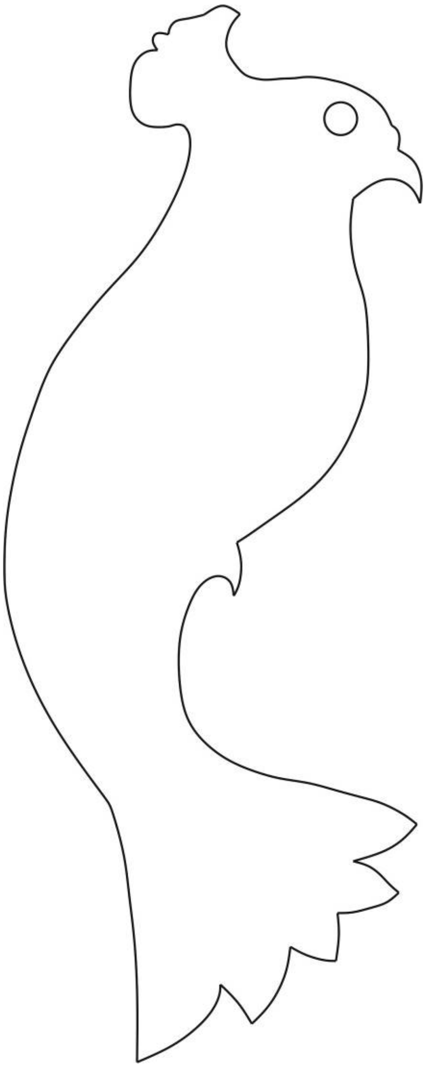


Acrobats

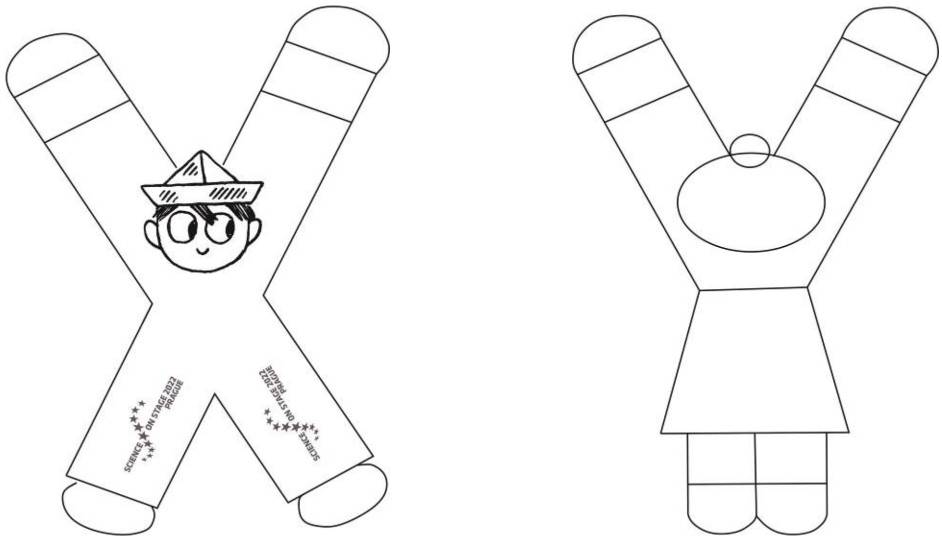


Templates 12: Acrobatic parrot

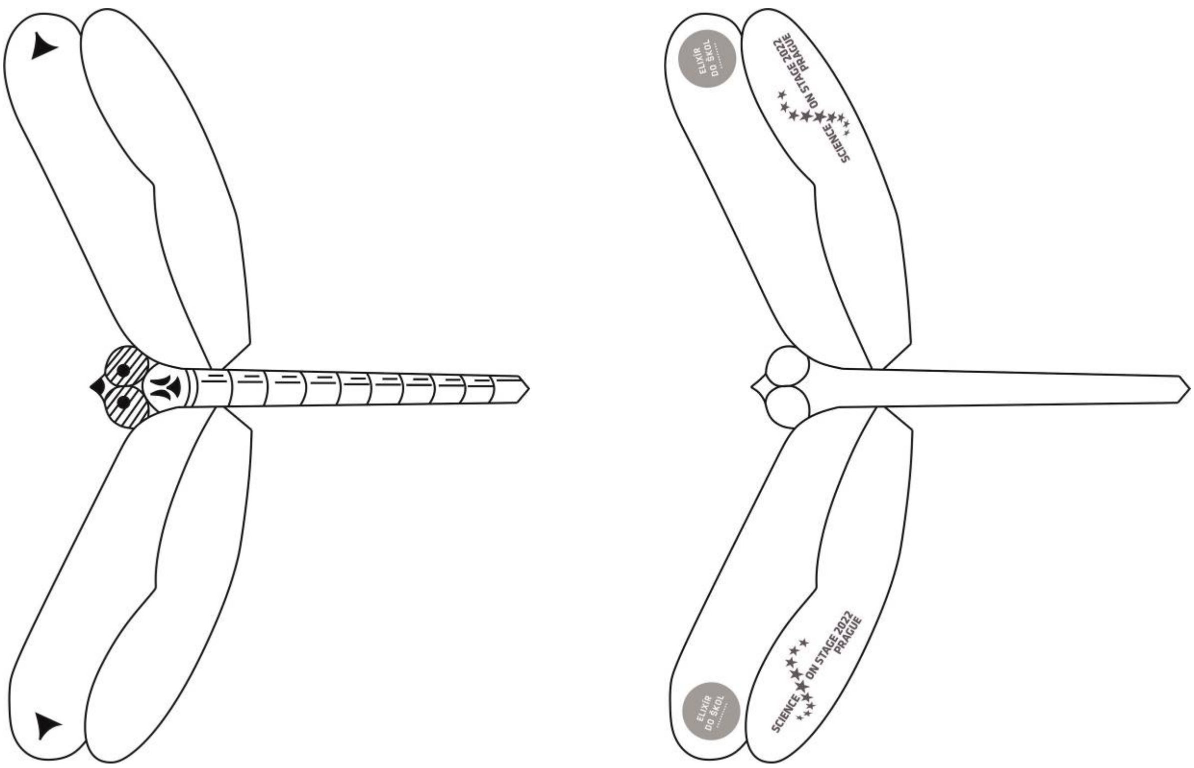




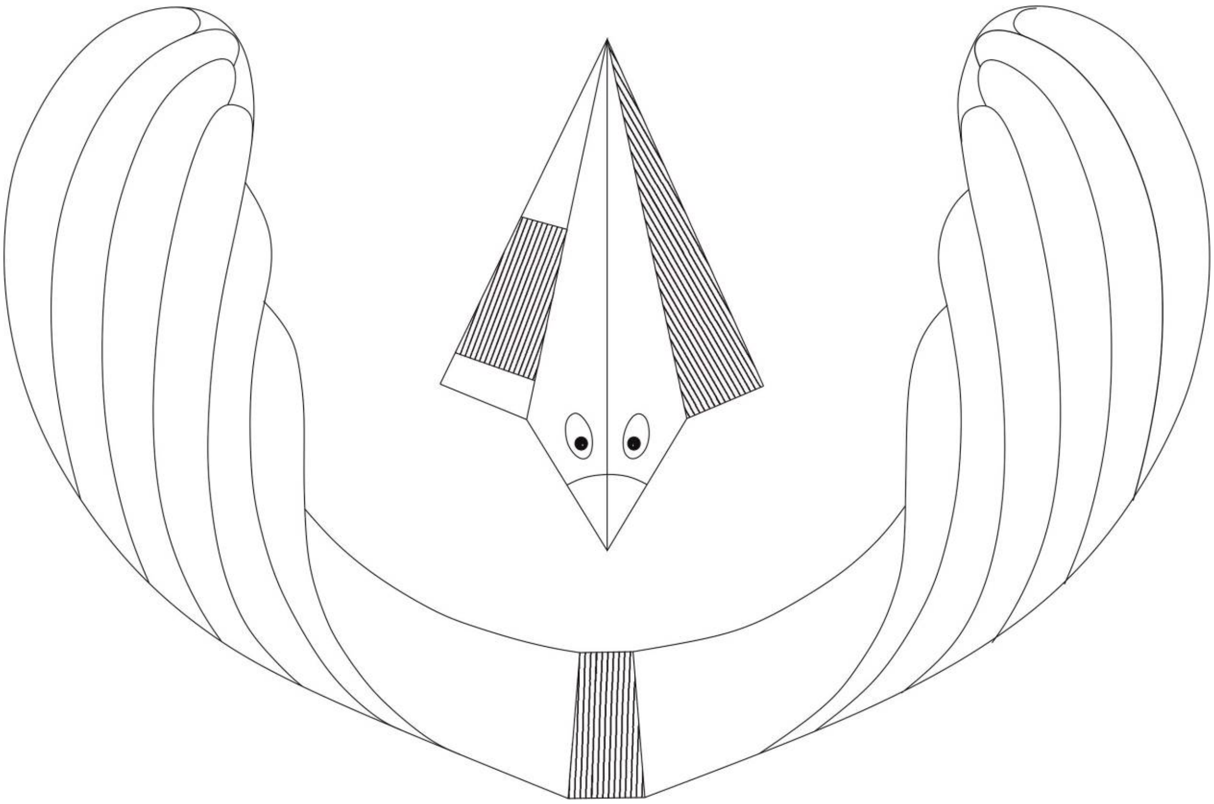
Template 13: Acrobatic figure

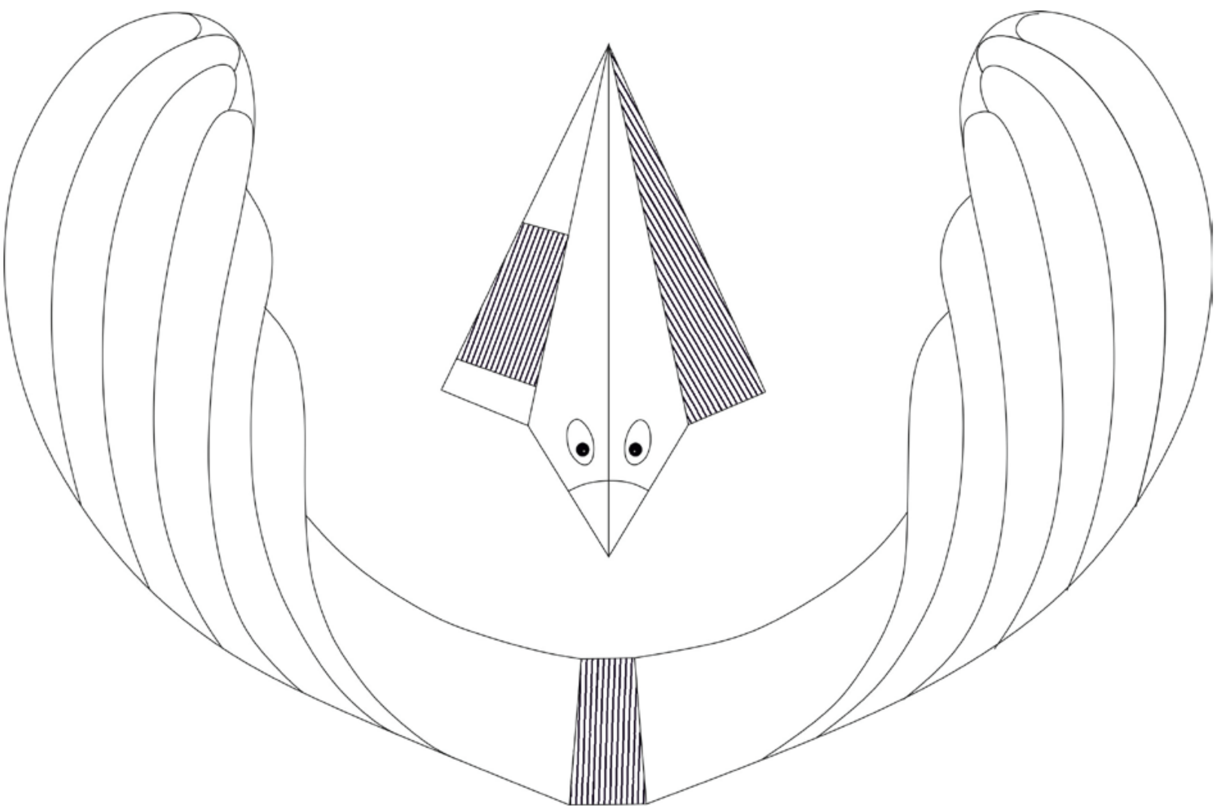


Template 14: Acrobatic dragonfly

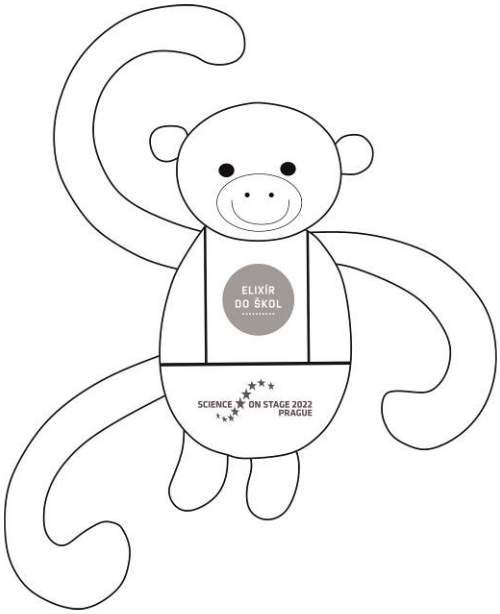


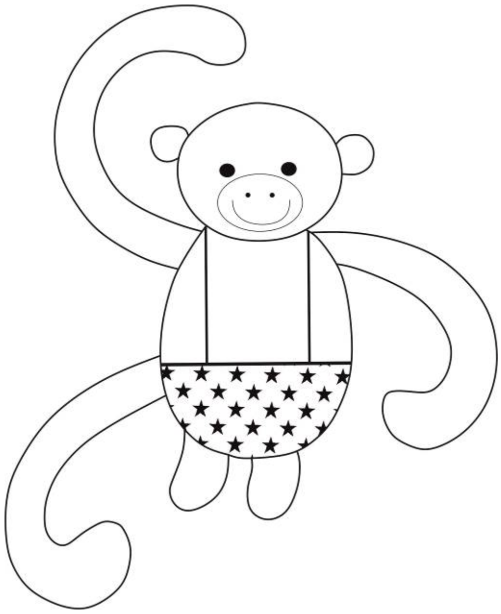
Template 15: Balancing bird

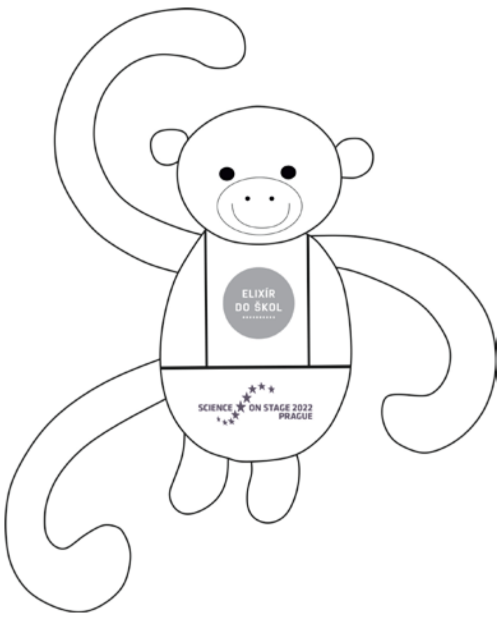


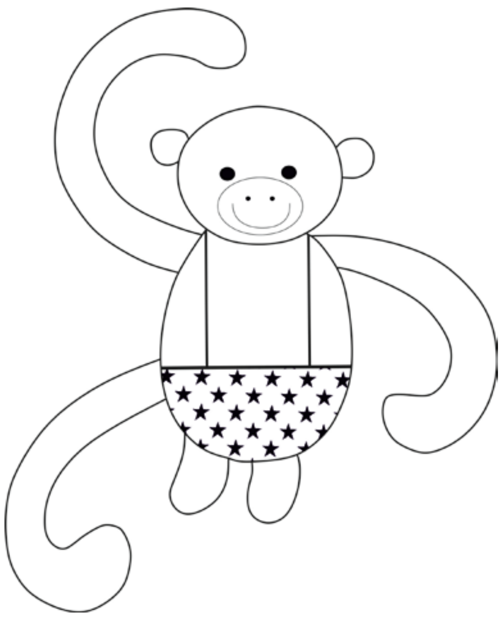


Template 16: Lever with monkeys

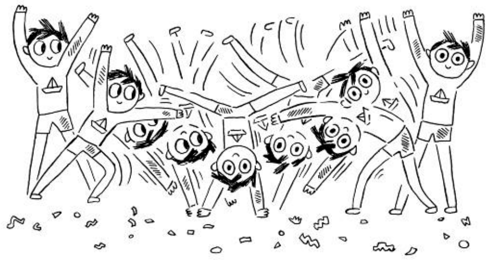




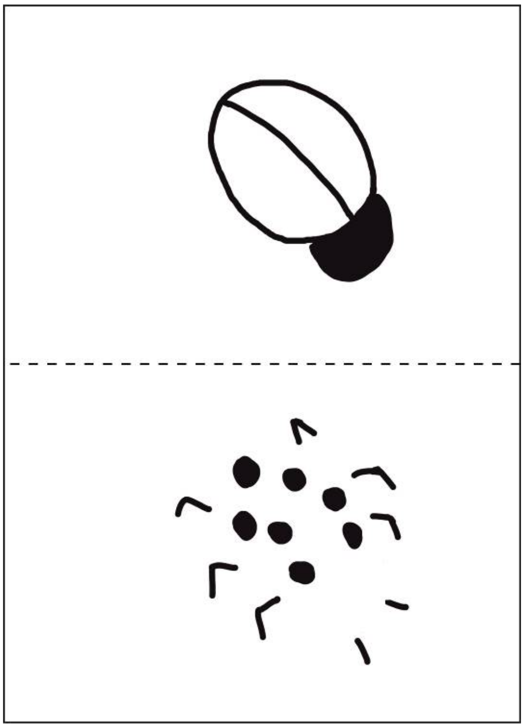


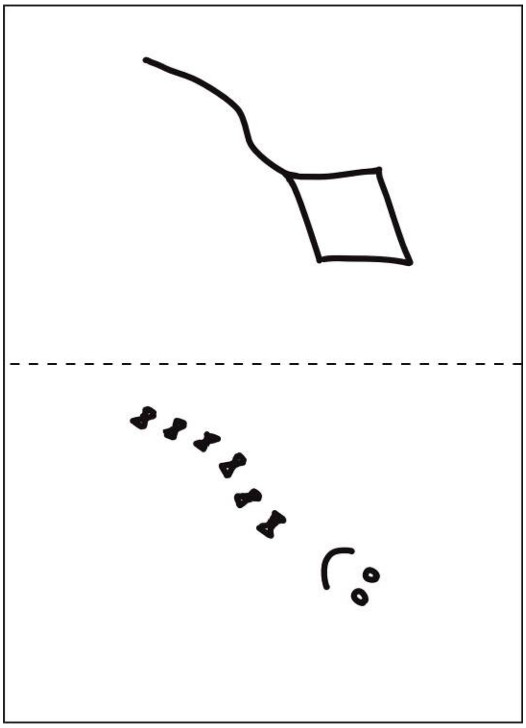


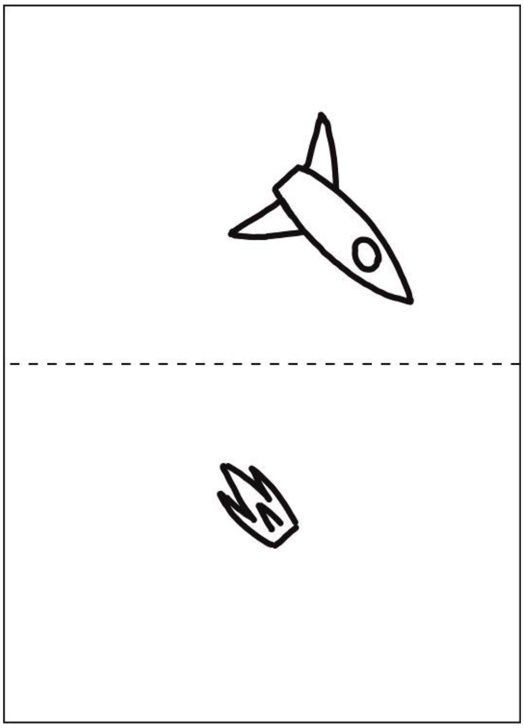
Living Pictures

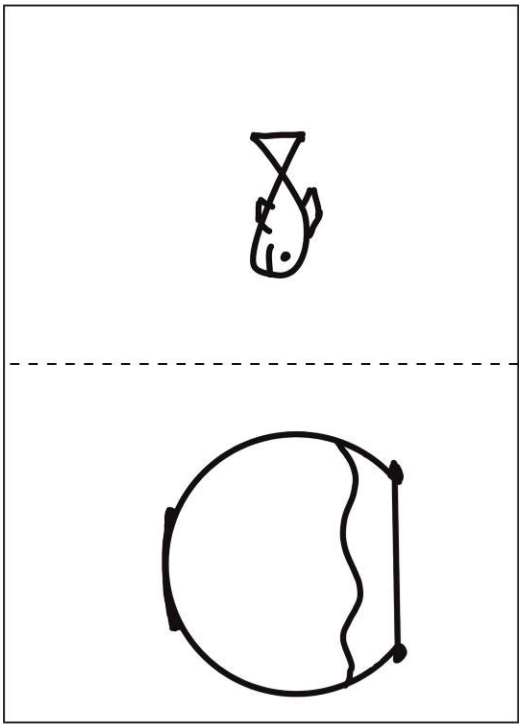


Template 17: Thaumatropes

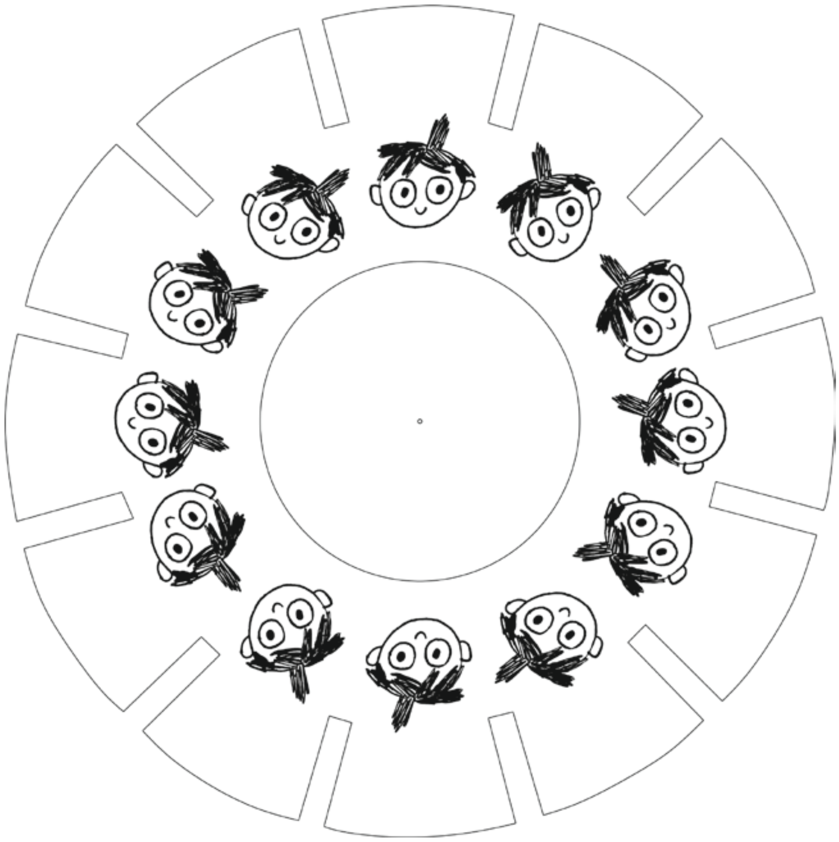


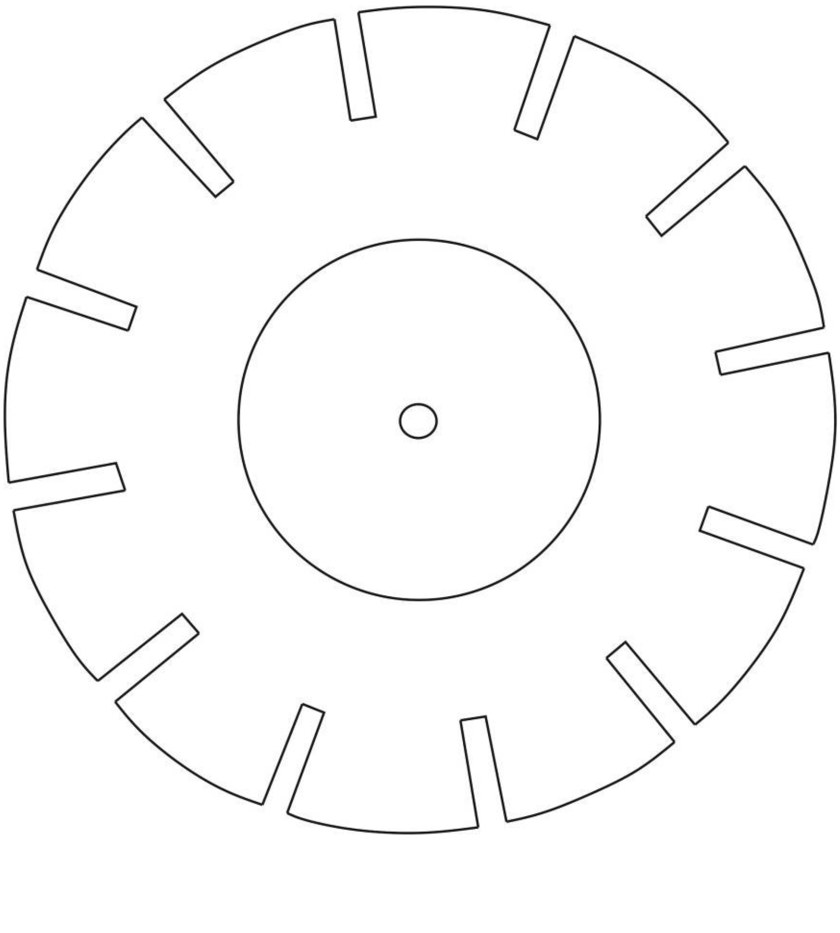




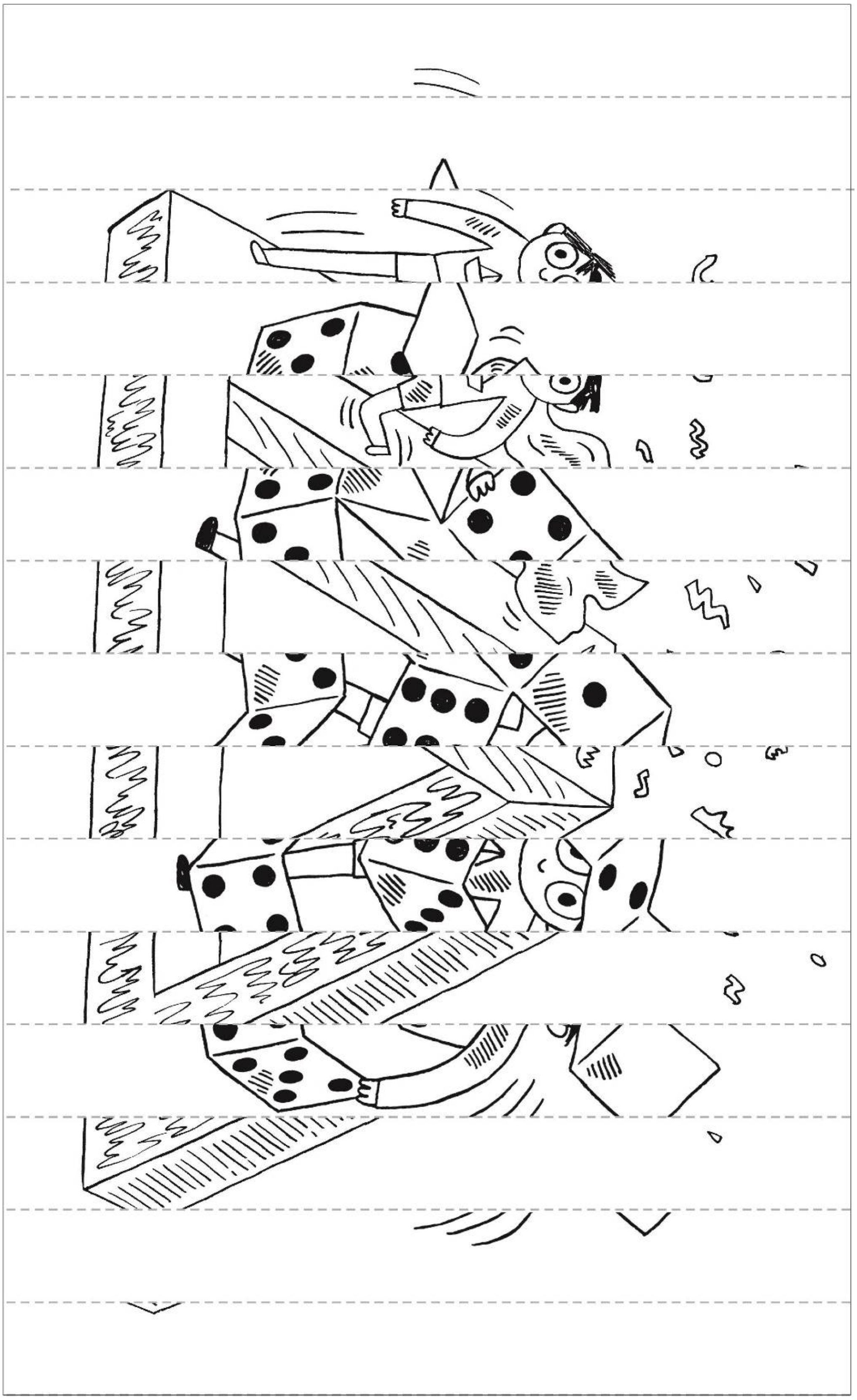


Template 18: Kinetoscope





Template 19: Two pictures in one



Puzzles

Template 20: Magic Folders

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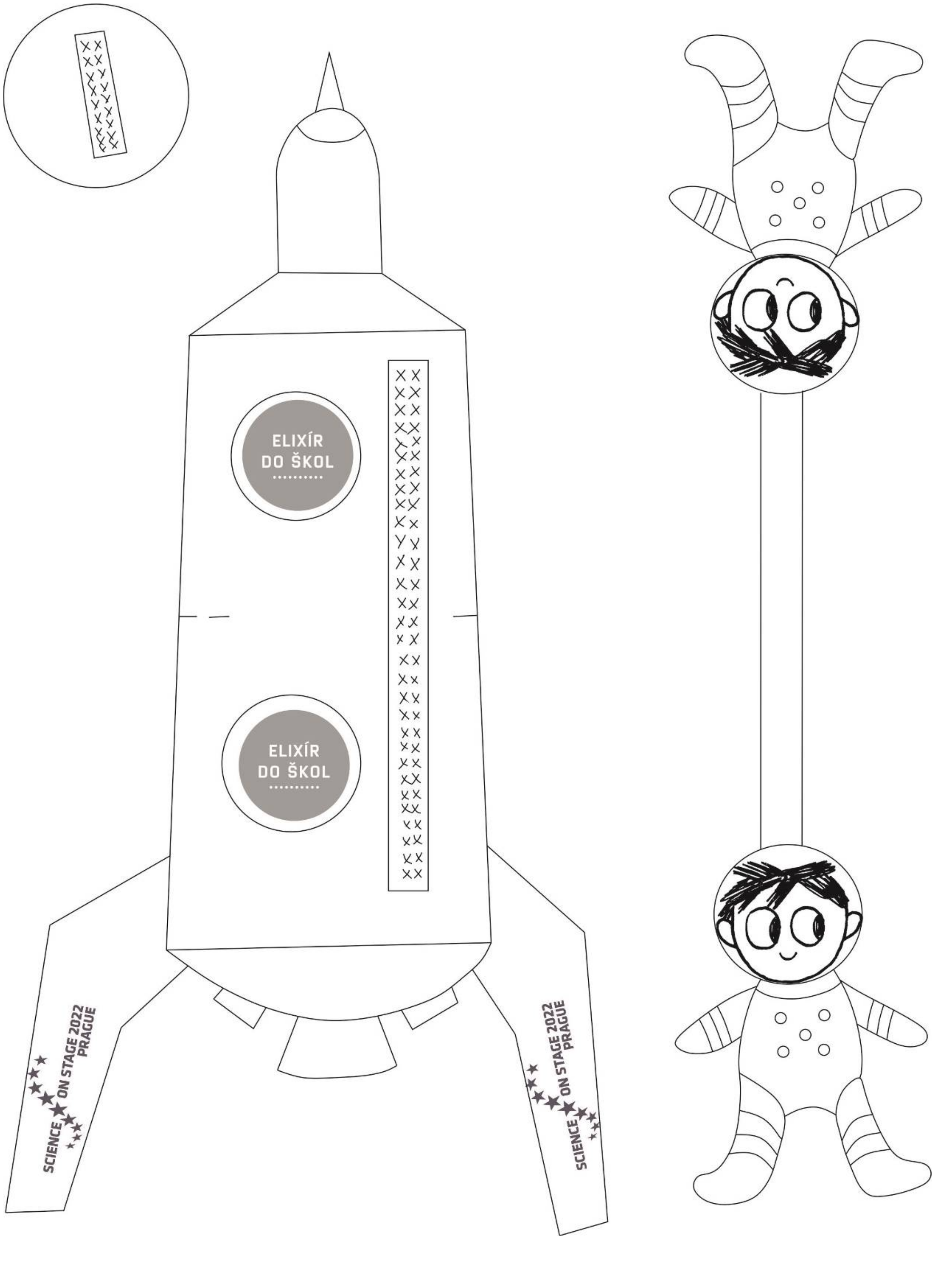
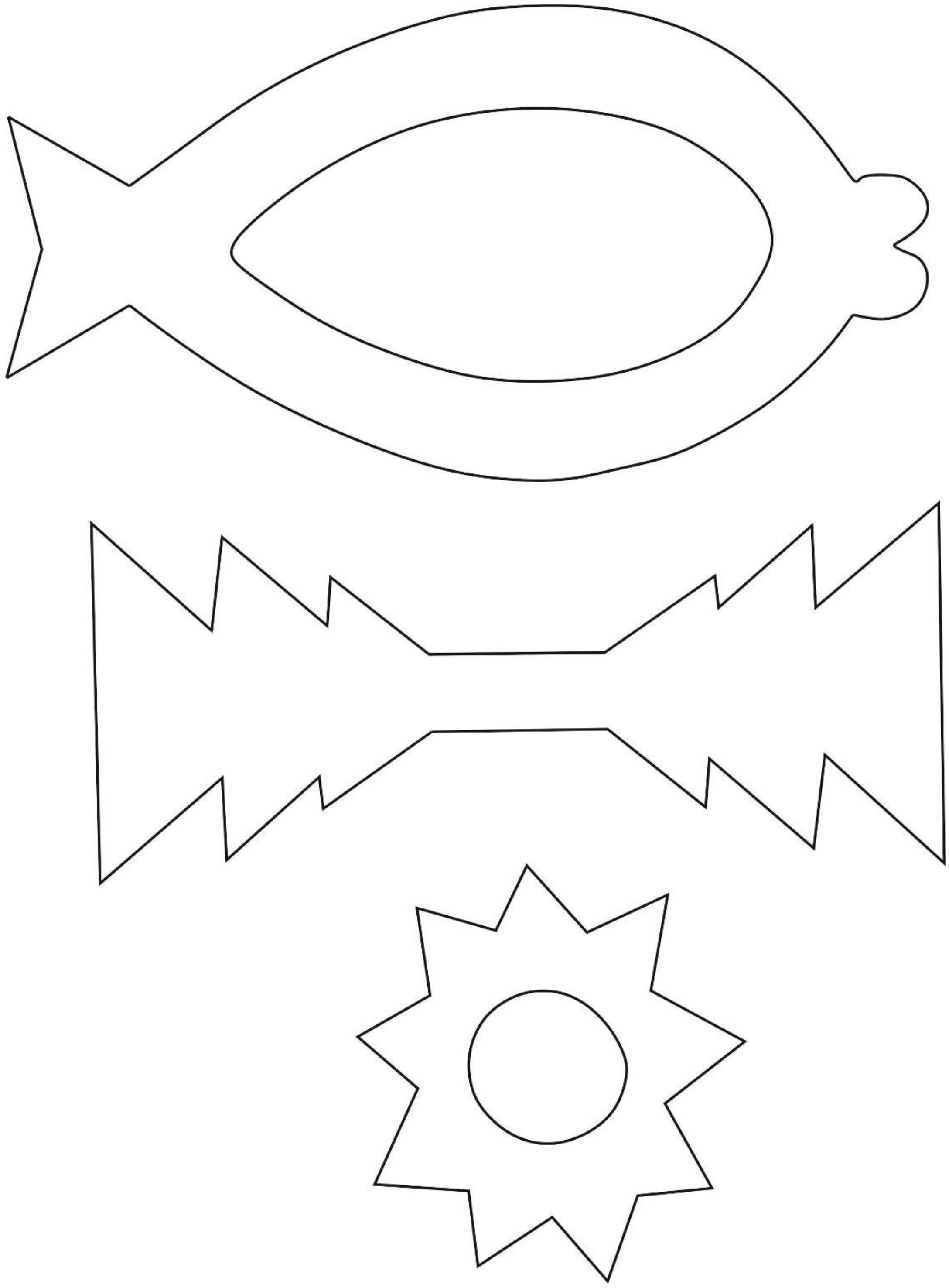
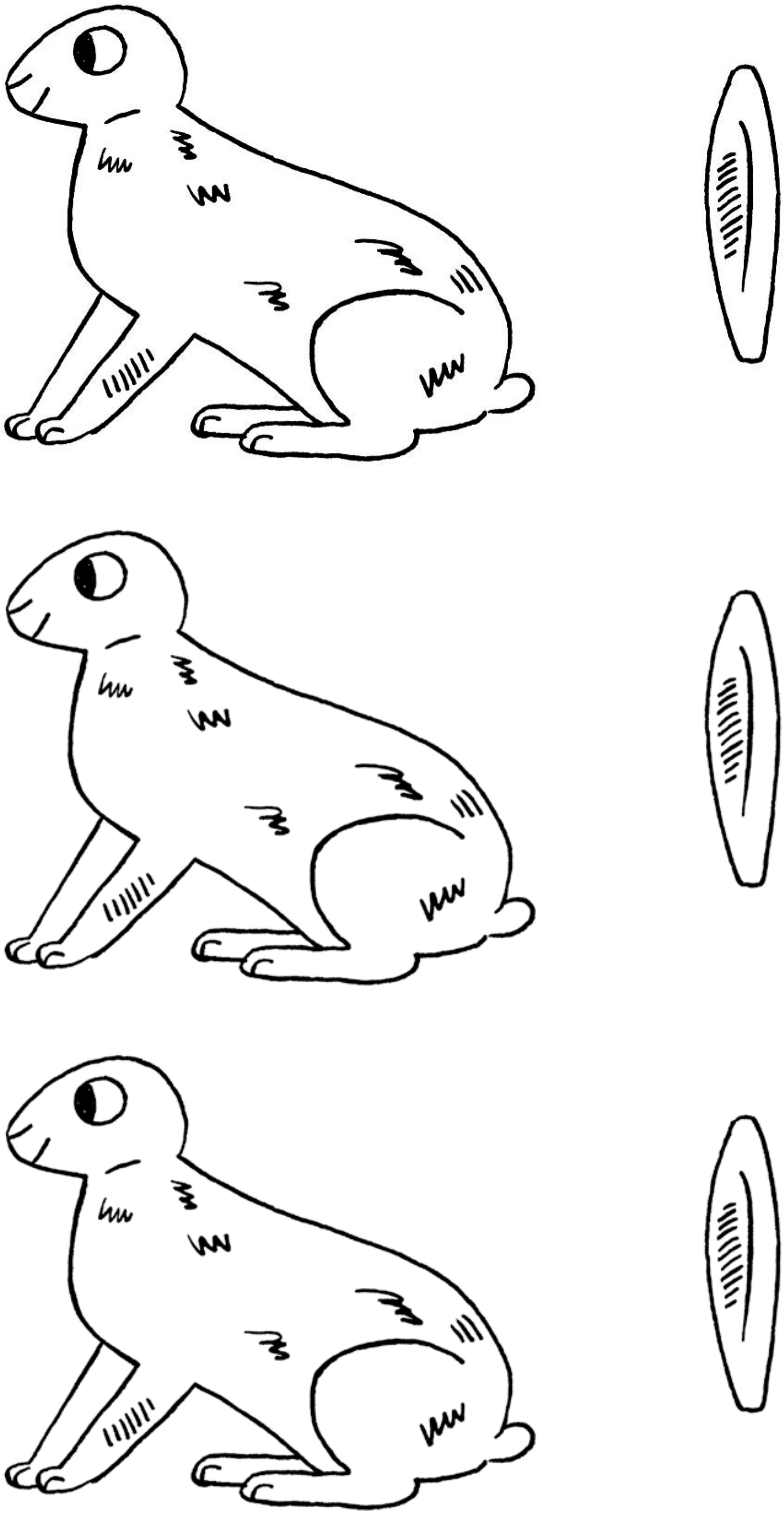
Template 21: Astronaut rocket puzzle



Template 22: Christmas puzzle

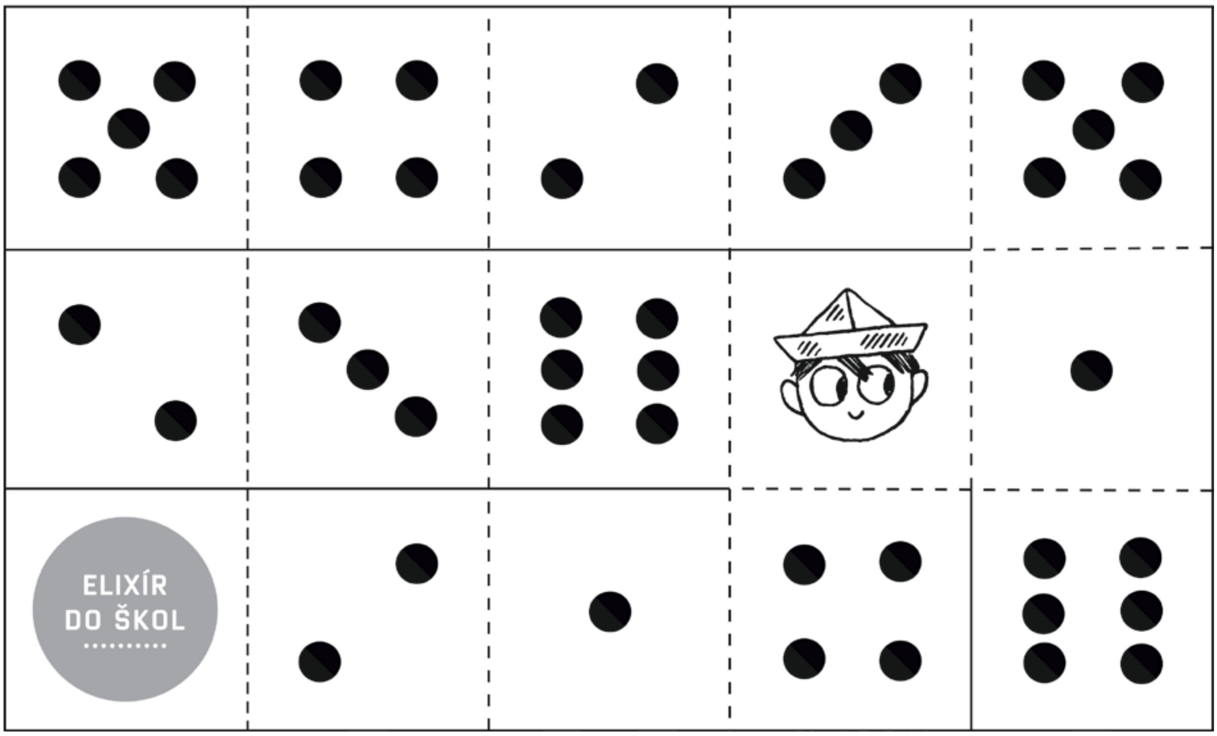


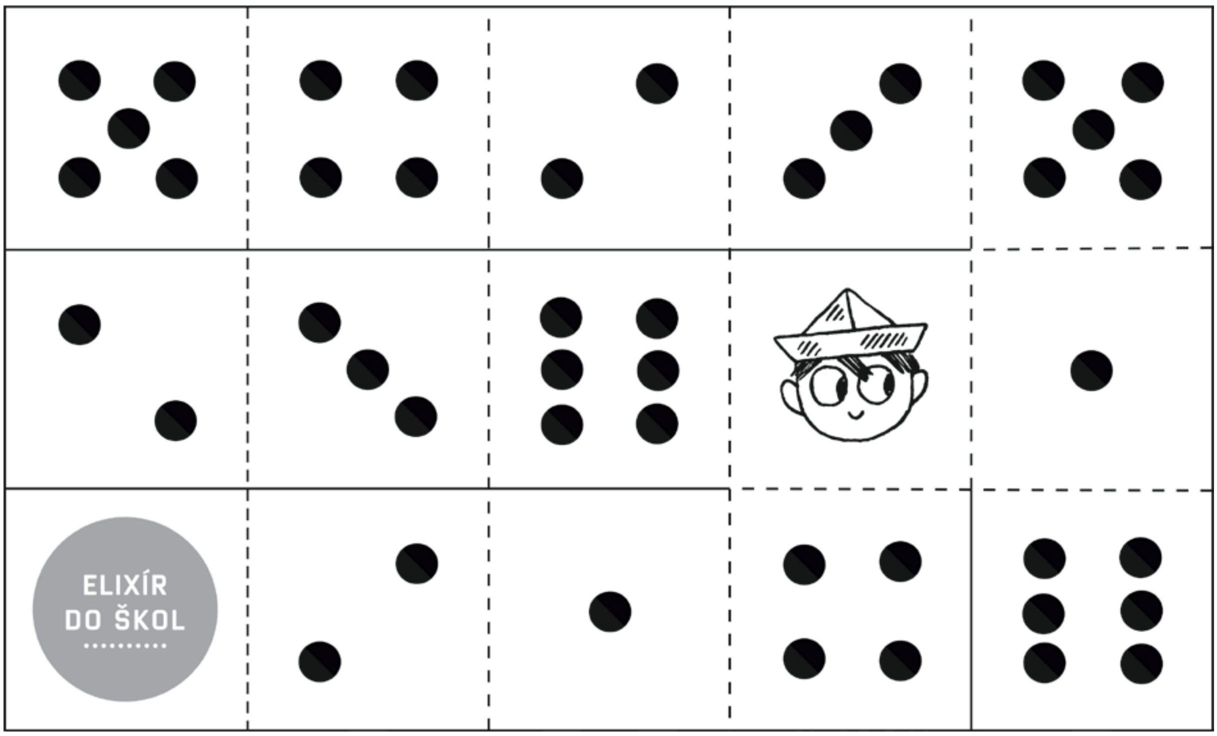
Template 23: Three rabbits and only three ears



Mathematical puzzles

Template 24: The cube without gluing





Template 25: Magic cube

				87	12	86	9				
				82	19	83	16				
				11	88	10	85				
				14	81	15	84				
63	36	62	33	79	20	78	17	95	4	94	1
58	37	59	40	74	21	75	24	90	5	91	8
35	64	34	61	19	80	18	77	3	96	2	93
38	57	39	60	22	73	23	76	6	89	7	92
				71	28	70	25				
				66	29	67	32				
				27	72	26	69				
				30	65	31	68				
				55	44	54	41				
				50	45	51	48				
				43	56	42	53				
				46	49	47	52				

Template 26: Mathematical columns

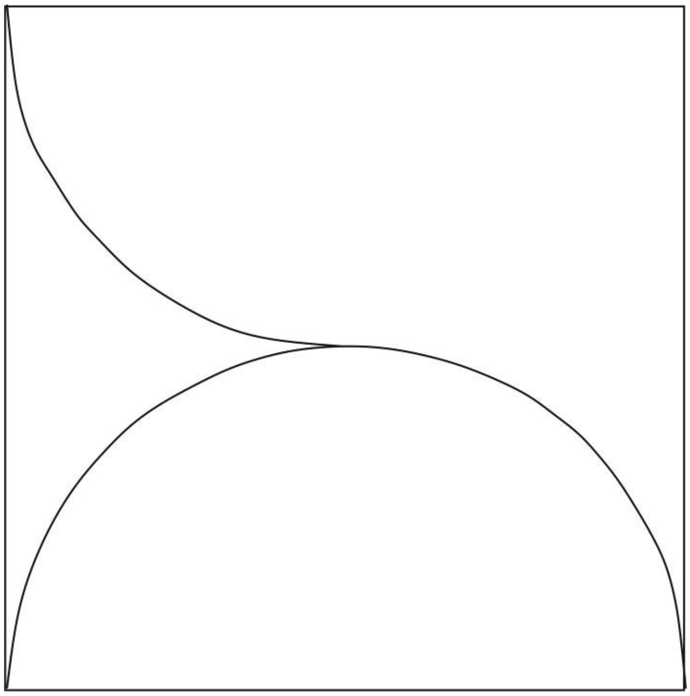
4	3	9	3
9	8	4	7
7	4	8	9
5	7	5	8

9	7	6	2
2	5	4	9
4	9	2	5
7	6	8	7

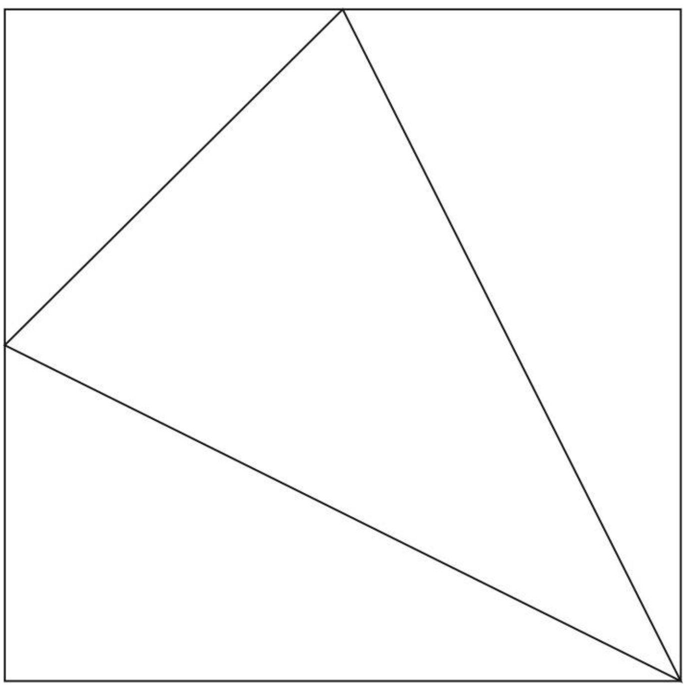
8	4	7	7
3	6	2	2
5	2	3	6
7	8	9	9

2	5	9	7
7	6	3	8
3	8	7	6
9	7	6	3

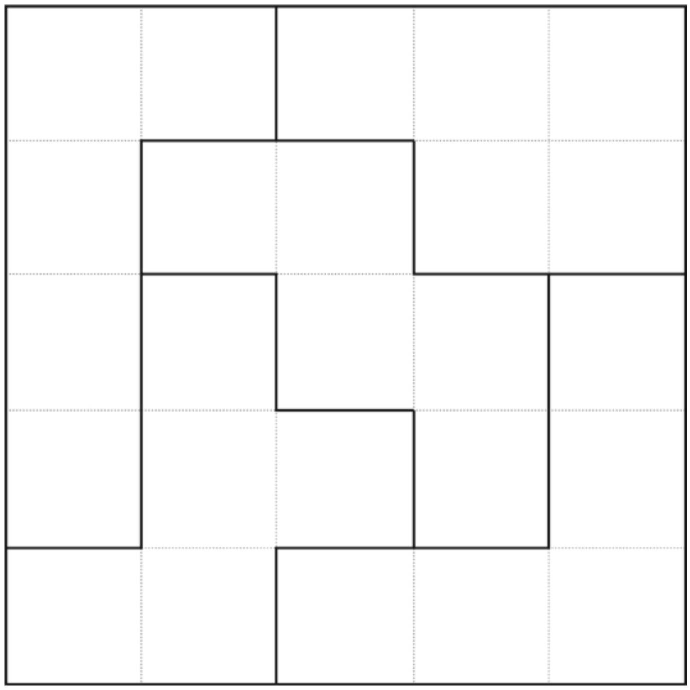
Template 27: A square or a vase?



Template 28: A square from triangles



Template 29: Cutted square



Template 30: A square from 4 Z and 4 L