EXPERIMINTA
ScienceCenter FrankfurtRheinMain

The Small MINT Researchers

A journey with younger children through the EXPERIMINTA

Mathematics

Informatics

Natural Sciences

Technology

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FOREWORD

Children are explorers by nature. With their curiosity and open-mindedness they always question and like get to the bottom of things. They are on the road as little researchers in everyday life so to speak, they are in awe, they think and try. Scientific phenomena, objects and experiments reinforce children's curiosity and stimulate them again and again to ask new questions. Having something to explore, unravel or resolve can be an impressive experience for everyone. What you learn in this way you will not easily forget.

EXPERIMINTA with its experimental stations aims to promote the curiosity and joy of discovery and bring children closer to the world of science.

The experiments selected for younger children:

Ten experiments were selected for the tour. "Small MINT researchers" can handle the experiments by themselves; the scientific background can then be understood in its basics.

Most phenomena are known to children from their daily lives. To help parents, teachers and education professionals to get easier access to the stations, didactic materials have been developed to serve both the preparation and the follow-up of the exhibition visit. There is a reference to each of the stations on the site, photos of the exhibits and explanatory sketches as well as a brief description and an explanation of the scientific background.

In addition – if feasible - you can find suggestions for reconstruct an experiment or suggestions for observing a phenomenon in everyday life. The materials needed are inexpensive and easy to obtain.[1]

Tour suggestions: „The small MINT researchers"

The suggested tour experiments are marked with a symbol, the „wise owl". The children can then follow the owl and so find „their" stations themselves. There is no compulsory order for the tour, it only presents these as a guide and should enable children to make further discoveries.

Of course there is no need to include all experiment stations in the tour. One can concentrate on some stations, e.g. the exhibits in two to three rooms and look at them more thoroughly and precisely.

We would like to point out another important subject regarding groups: Very often there are two stations close to each other so that groups can be divided and hence the children can deal more intensively with a station.

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1 This tour was inspired by the materials Phänomenta Lüdenscheid.

HOVER MIRROR

Ground floor, left hand side

Description

On the opposite wall (next to the window) there is a very high and narrow mirror. At right angles to it - on the freestanding wall - another big mirror is located.

Position yourself on the narrow side of the wall so that you can see only the right half of your body in the mirror opposite. With careful positioning you can see your complete body. If you raise your right leg, for example, you can see in the mirror your other leg lifts also. It looks as though you are floating.

Explanation

This seemingly complete figure is composed of two different reflections of the same uncovered half of the body. In the opposite mirror you see the right half of your body. This is now also left mirrored - in the mirror located on the wall. So you see the right half of your body twice - once to the right and once mirrored to the left. You think you see your complete body, but in reality you only see the right half of it. This can be tested simply, for example, by placing a handkerchief on your right shoe.

Promotion

This station was sponsored by the company Glasbau Hahn in Frankfurt a.M.

Suggestion

Mirror symmetric figures can be produced by the „blob technique". Fold a sheet of paper in half, with small drawings or blobs on one side of the paper using water colors and fold the blank side onto the painted side.

This creates fantastic pictures that can be interpreted in many different ways.

GIANT KALEIDOSCOPE

Ground floor, left hand side

Description

A very large triangle box is lined with mirrors. Position yourself on the inside of this giant kaleidoscope so you can see yourself from all sides in many mirrors.

Explanation

Inside the triangle box are three mirrored walls. Each mirror creates a mirror image as known from an ordinary wall mirror. By aligning the mirrors at 60 degrees mirror images are created of each other from different perspectives.

These are repeated by reflection again and again. So we are infinitely 'mirrored', sometimes directly, sometimes from behind, sometimes obliquely from the front, sometimes obliquely from behind. Due to the never-ending reflections you have the impression that you stand in an infinitely structured triangular space.

And you can see not only yourself but also the mirror edges of the triangular box – an infinite number of times.

Promotion

This station was provided by the Physics Club in Frankfurt.

Inspiration, please see next page

Suggestion

To tinker a small kaleidoscope is quite difficult for younger children. A somewhat simpler version is based on the use of Toblerone boxes. The triangular shape, which is important for the kaleidoscope, is already provided by this package .[2]

You will need:

• an empty Toblerone box and the inner tube of a kitchen roll.

• reflective foil (or thick, smooth coated aluminum foil)

• 'cling film'

• greaseproof paper (parchment paper)

• a strip of thin cardboard

• glass beads or glass stones

• material for decoration, for example, string or wool, coloured paper, etc.

• adhesive tape, scissors, glue

1. Cut the edge of the Toblerone box, remove the top and bottom and glue the foil securely onto the cardboard. Then fold it back into a Toblerone box and glue the box with tape.

2. Put the Toblerone box in the kitchen roll inner tube (or toilet roll inner tube) and adjust the length. Then you clamp cling film over one of the box openings and fix it with adhesive tape.

3. Now extend the tube a little by sticking a very narrow strip of cardboard. Then gently put coloured beads into it.

4. The greaseproof paper is stretched and glued over the end. For the other end, cut a peephole into a piece of cardboard and seal the opening with it.

Finally, decorate the kaleidoscope in your own way!

2 see: www.wagraini.at / fileadmin / user_upload / bilder_wagraini / spiel_spass / Kaleidoskop_Bastelanleitung.pdf

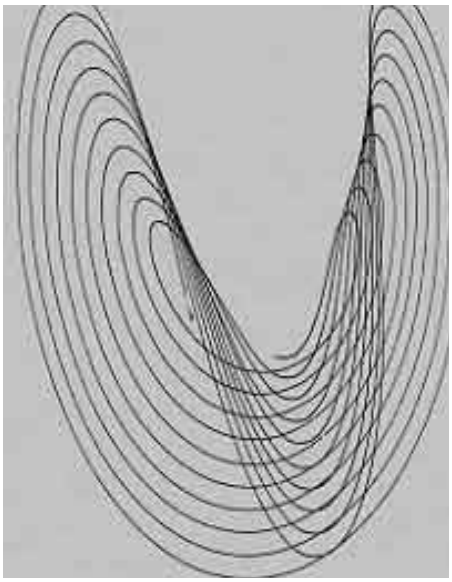
PENDULUM TABLE

Ground floor, left hand side

Description

A metal plate is attached to a special suspension and can undergo a particular type of oscillating movement in two directions.

A pen is fixed to the plate. The pen can be lowered to touch the paper in order to draw. By setting the plate to oscillate curves and loops are drawn that become closer and closer.



Explanation

The special suspension makes the plate go in circular movements. Since the pen is stationary and the paper is fixed on the plate, the movement of the plate is printed on the paper over time. We call such shapes Lissajous figures.

The curves are getting smaller with time because the vibrations of the plate gradually subside. The type of deflection and the time delays of the oscillations can be determined. Due to this it always comes back to the other oscillation images.

Promotion

This station was funded by the Foundation airport Frankfurt/Main for the region.

GIANT SPOON

Ground floor, right hand side

Description

A giant spoon is set free and can be seen from both sides. If one is a little further away from the hollow side of the spoon , one sees oneself decreased in height and upside down. If one is very close to the hollow side, one sees oneself back up the right way. On the reverse side one sees one's upright mirror image but rather distorted.

Explanation

The giant spoon has a hollow side (concave mirror) and a bulging side (convex mirror). A concave mirror has a focal point like a convex lens, the distance between the focal point and the mirror is called focal length.

When the subject is located within the focal length of the concave mirror an upright, enlarged picture is seen.

If the object is beyond the focal length then a reduced, inverted image (left picture) is produced.

On the reverse of the spoon one sees oneself upright but decreased (right picture).

Promotion

This station was promoted by the company WMF Wuerttembergische metal goods factory AG, Geislingen/Steige.

Suggestion

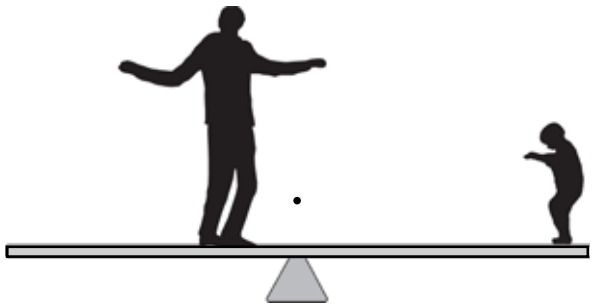
In everyday life we see convex mirrors that produce enlarged visual fields. These are used, for example, on the road to increase safety for traffic at T-junctions.

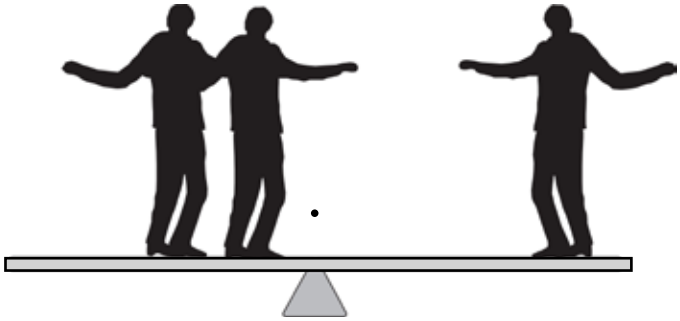
SEESAW

1st Floor, right hand side

Description

If the seesaw isn't touching the ground anymore it is horizontal (like scales) and is in the so-called equilibrium. The seesaw is in equilibrium, for example, when people having same weight are standing at the same distance from the center of the seesaw.





The seesaw might be also in equilibrium in cases where people do not have the same weight.

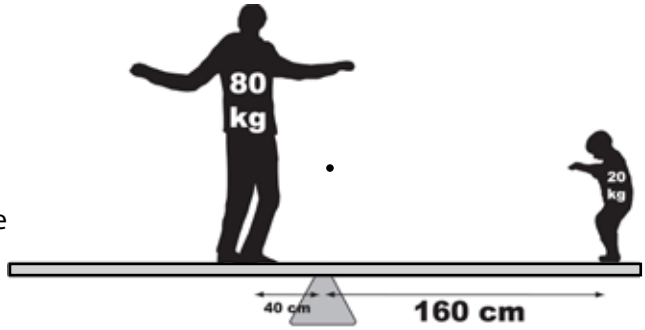
The heavier person must be nearer to the center than the lighter one.

The seesaw can also be in equilibrium when one person is on the right side and two are on the left. In this case the individual must be further away from the pivot point of the seesaw than the other two.

Explanation

The seesaw is a lever where the lever principles apply. For the case illustrated this means simplified: If the man is four times heavier than the child, the child must be located four times as far from the center of the seesaw in order to bring the lever into balance.

In other words: the result of multiplying the weight of the person and the distance from the center of the seesaw must be equal on both sides of the seesaw .



Suggestion

In playgrounds you can often find seesaws where the above mentioned lever principles also apply. Here, children can try out how to handle the weight distribution on both sides of the seesaw to balance successfully.

PULLEY SEAT

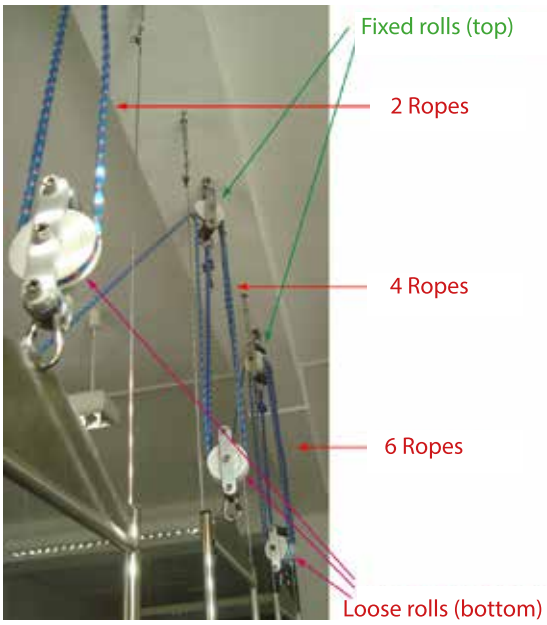
1st Floor, right hand side

Description

Three pulley seats (white, red and black) are mounted side by side on ropes, available via the rollers run. Sitting on either of the seats you can pull yourself up using the ropes. The easiest way to pull yourself up is sitting on the white seat, the hardest is the black one.

Explanation

The ropes run via pulleys. The greater the number of the ropes between the pulleys the less force has to exerted to lift one's own weight. The white seat is supported by six ropes. Each rope will bear one-sixth of the load. At one rope is pulled. Therefore one must only use one-sixth of the power which would be necessary without the pulleys.



The red seat is supported by four ropes (one quarter of the force must be applied) and the black seat by two (half the force must be applied).

On the other hand, it is observed that with less effort required more rope must be pulled through; for the white seat six times more, four times more for the red and twice as much for the black seat.

Here the *golden rule of mechanics* is applied: What you can save by force, must be compensated by a longer distance. One can find a very clear model of the pulley technique in a demonstration box („tackle box") on the wall next to the pulley seats.

Promotion

This station was funded by the Foundation airport Frankfurt/Main for the region.

Suggestion

Even in ancient times the force reduction was known by applying the laws of leverage. There are many examples of pulleys available over the centuries. Today, children can observe the pulley technique quite well on cranes, for example, on construction sites. For example, cranes can be built with kits from Lego and Fischer technique.

SHADOW THEATER

1st Floor, left hand side

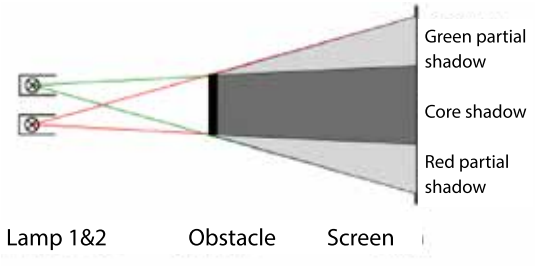
Description

Four lamps (blue, red, green, yellow) are fixed behind a big screen. You can move back and forth behind the screen.

The screen appears white where the light from all the lamps strike. If a person stands between the lamp and the screen, a portion of the light is covered - so (coloured). shadows arise

Explanation

Shadows are created when the light from a light source meets an opaque body. Since the light is absorbed or reflected, it doesn't get in the space behind the body. This space is called shadow space. If the shadow space is bounded by a screen, you can see the silhouette of the body on the screen. If you increase the distance of the shadow-casting object to the projection area, then the shadow enlarges. Conversely, when getting closer to the screen, the shadow gets smaller (but not less than the body itself).



A point source of light produces sharp shadow edges. Multiple light sources form part shadows, which overlap to produce darker core shadows.

In our shadow theater, there are different coloured light sources. The partial shadows are coloured, mixed colours are created partly and by movements between the light sources and the screen fantastic, coloured effects are created. The coloured shadows occur when only a part of the lamps are covered. The light from the uncovered light sources can still be seen and overlap to produce a mixed colour.

A more detailed description of the mixed colours can be found at the entrance to shadow theatre.

Inspiration, please see next page

Suggestion

Playing with peoples shadows

You need a bed sheet, clothes-pegs, tight rope and a light source (for example, a flexible table or bedside lamp). Fix the sheet between the viewer and light source, for example on a rope stretched across the room. The players operate behind this bed sheet - dancing, running, jumping, lifting heavy things, shadow boxing etc. even acting small scenes or a stage play. With coloured transparent paper held up to the light source, the shadows are also seen in colour.

Shadow plays with the overhead projector

If an overhead projector is available, then this is excellent for small shadow plays. The „shadow guessing" is recommended for the introduction to this technique. Various smaller items like keys, comb, pencil, dice, etc. can be laid on the surface of the projector and must be guessed on the basis of their shadows. Even small scenes can be „performed" on the surface of the projector.

Figures and scenes can be made from newspaper or black construction paper that are either torn (relatively rough, undifferentiated contours) or cut out (relatively distinct, differentiated contours) and placed on the surface. Through the combination of characters, scenery and props scenes can be created quite easily and scene changes can be made quickly.

BALL IN THE AIR FLOW

1st Floor, left hand side

Description

A ball floats in a slanting upward air current. The position of the ball and its movements can be influenced with your hands, just by approaching the ball from different sides, without touching it.

By moving the fan the air flow changes and therefore also the movement of the ball changes.

Explanation

When the air flows vertically from the bottom, it impacts on the ball in such a way that about the same amount of air is flowing on all sides of the ball. The gravitational force of the ball is balanced by the air pressure under the ball.

One might think that the air flow can only carry the ball if it is exactly perpendicular from below. Why does the ball remain in the air stream even if the air hits it diagonally? As the air flow hits of the ball at an angle it drops slightly initially.

Then more air flows above the ball than below. However, this air does not flow just above the ball, but „sticks“ slightly to it by passing around it. This „sticking“ also acts on the ball and thereby counteracts the upper air flow. But this works only when the ball is light enough and the upper air flow does not dominate.

Promotion

This station was sponsored by the company Procter & Gamble , Schwalbach am Taunus.

Suggestion

This experiment can be imitated easily. All you need is a hairdryer instead of the fan and a ping pong ball instead of a water polo ball. The hairdryer is set on cold, holding it upright and the ball in the air flow. When you turn on the hairdryer you can really hit the ball and make it dance!

Note: If the hairdryer is set hot the ball can get deformed.

GIANT SOAP SKIN

2nd Floor, left hand side

Description

A large plastic ring located in a round tub filled with soapy water can be pulled to the top using a rope. With this you are wrapped in a beautiful soap skin.

First, the soap film has the shape of a tube but soon it gets an ever narrower „waist" until it finally touches the visitor and bursts. Often, several attempts are necessary.

Explanation

Water consists of molecules that attract each other. This cohesive force is called surface tension (see the water boatman which can flit back and forth on the surface of water).

With the addition of soap, the soap skin becomes more elastic. With a water-soap mixture you can produce soap films easily. Resilient surfaces (such as here, the soap film) try to take on a surface area as small as possible. The result is a so-called minimal surface. The giant soap skin takes the approximate form of an hourglass. Above and below the soap skin remains circular and in the middle it reforms by itself according to the principle of minimal surface.

Promotion

This station was funded by the Katinka Platzhoff Foundation in Hanau.

Suggestion

Big soap bubbles are particularly interesting. They are easy to make by yourself. Bend a piece of wire (e.g. wire coat hanger) into a wire frame with a handle. Keep the self produced soapy water in a shallow dish in which the wire frame can be immersed. Then you pull the wire frame from the liquid with a swing.

Here are two recipes from many for producing the soap bubbles liquid:

First recipe
0.75 liters of distillated water
1/4 liter washing-up liquid
1 tablespoon glycerin (Pharmacy)
70 grams of icing sugar
In this recipe, dissolve the powdered sugar in the distillated water and then stir in the washing-up liquid and glycerin. The mixture should be allowed to stand for one night.

Second recipe
250 ml of water
3 teaspoons washing-up liquid
3 teaspoons of cooking oil
4 teaspoons of sugar

Mix all ingredients well.
- Done!

PARALLEL MIRRORS LOOK TO INFINITY

Staircase in the entrance area

Description

Large mirrors are located in the stairwell of EXPERIMINTA on the right and left, respectively (arranged in parallel). If a person steps in between these two mirrors their mirror image is infinitely reflected.

For a good view, you should go up and down the stairs.

Explanation

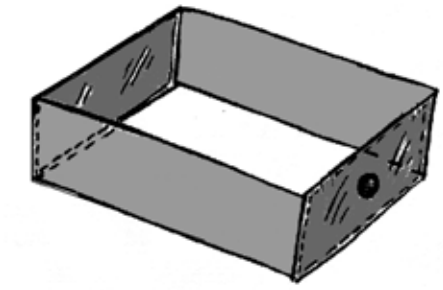
First, the mirror image of the person appears then follows the image of the mirror image, then the image of the image of the mirror image. This goes on and on so you can not see how many images are created. It's as if the space is infinitely deep and the number of people mirrored is hardly countable. The mirror images are always smaller in relation to the distance behind the mirrors. Things that are far away appear small. Additionally, in a reflection the light needs to pass the upper layer of the mirror twice.
This leads to a loss of light intensity, so that the images are getting dimmer.

Promotion

This station was sponsored by the company Glasbau Hahn in Frankfurt am Main.

Suggestion

The „look to infinity" can be simply seen with multi-part mirror cabinets – that one often encounters in bathrooms - or seen in mirrors located opposite each other. But it can also be easily produced:



You need a cardboard shoe box or larger, 2 mirror tiles, adhesive tape, small items such as toy animals, dolls etc.

With adhesive tape fix the mirror tiles in the box (without lid) on two opposite sides and align them as parallel as possible. Set the small objects between the two mirrors.

View one of the mirrors as directly as possible to get the impression of the room with a wonderful multiplication of the items. The effect is even more interesting when you have a hole in the middle of one of the mirror tiles and also in the cardboard. You can gently scrape the back coating of the mirror tile to the desired hole size.

SPONSORS OF THE EXPERIMENTAL STATIONS

Experimental station	See page	Sponsor
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The sponsors in alphabetic order

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