EXPERIMENT MANUAL

GNITION / SERIES

PHYSICS FORCE & PRESSURE

& KOSMOS THAMES

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Contents

- > 7 balloons
- > 3 die-cut cardboard sheets
- > 1 balloon clamp
- > clay > 1 blue string
- > 1 measuring cup with lid > 1 syringe
- > 1 plastic bag
- > 4 tubes

You will also need: effervescent tablets, two empty half-liter plastic drink bottles (16 ounce bottles, soft plastic material), flat box or box lid, tape, glue, water, bowl, two chairs, books

Safety notes

CAUTION! Not suitable for children under 3 years of age. There is a risk of suffocation due to small parts that can be swallowed or inhaled. There is a risk of strangulation if long pieces of cord are wrapped around the neck.

CAUTION! Children under 8 years of age can choke on uninflated or popped balloons. Adult supervision is required. Keep uninflated balloons away from children. Remove popped balloons immediately. Use a pump for inflating balloons. The balloons are made of natural latex. Clean all utensils after use and rinse them with water. Save the packaging and instructions, as they contain important information.

Dear Researchers.

Air – what is it, really? We rarely think about this invisible something, even when we are constantly breathing it in and out. And yet, air has astonishing properties. Moving air is capable of displaying impressive force. If the wind is blowing too strongly, you can hardly resist it. A storm can break trees as if they were matches. This seemingly unremarkable thing is really quite remarkable – such as when you pump it into your bicycle tires and it bears your entire weight without complaint. As you perform the experiments here, you will learn about all sorts of other things that air can do as well.

Before each experiment, ask an adult to read the instructions with you and accompany you in the experiment. The materials you will need in addition to the materials supplied in the kit are listed below the contents list. And now, have fun experimenting!

Is air nothing?

EXPERIMENT 1

YOU WILL NEED: Measuring cup, balloon, bowl with water

- 1. Immerse your measuring cup in the water with its open end pointed down. It won't fill up. The water will rise just a few millimeters into it. Tip it a little as you continue to hold it under the water. Bubbles of air will rise to the surface.
- 2. Partially inflate a balloon. Hold the opening closed and immerse the balloon in the water. With your other hand, lower the measuring cup into the water at an angle. Hold the water-filled cup over the mouth of the balloon. If you release the balloon's opening, the air will bubble out and collect in the cup, where it will even push out some of the water.

WHY 🥑 In the first step of the experiment, the cup wasn't really empty at all. In fact, it was filled with air, which prevented the water from flowing into it. In the second step, you actually transferred air from the balloon into the measuring cup. So air is clearly a substance much like other substances, except that it is unusually thin and light. The general term for substances like this is gases.

Impossible to inflate?

EXPERIMENT 2

YOU WILL NEED:

- > 2 balloons
- 2 empty half-liter drink bottles made of soft plastic material (16 ounce plastic bottles), sewing needle

Air is elastic. What about water? EXPERIMENT 3

YOU WILL NEED:

> Syringe, measuring cup, water

- 1. Pull the plunger out of the syringe. This will fill the syringe with air. Then fill the measuring cup with water, dip the tip of the syringe in the water, and push the plunger in. You will only need a little force to push the air out in the form of lots of little bubbles.
- 2. Fill the syringe with air again. Hold your thumb tightly over the opening. Try to push in the plunger. You will only be able to push it in a little, and then when you let go it will spring back.
- 3. Fill the syringe as full as possible with water. Press your finger over the opening and try to push in the plunger. The plunger barely moves!

WHY GAir can be compressed easily. Take away the pressure, and it expands again. Scientists describe this by saying that "air is elastic." You are probably familiar with the elasticity of air from inflated balls and bike tires, in which it cushions impacts. Water, however, cannot be compressed.

- 1. Push the balloon into the bottle until just the neck is sticking out, and then blow up the balloon. The balloon will inflate until it seals off the neck of the bottle. Then you can't inflate it any more — unless you know the next trick
- 2. Have an adult make a tiny hole in the other bottle with a needle. In this bottle, you will be able to fully inflate the balloon.



WHY C

Even though the air is invisible, it still fills up the bottle. Instead of simply being pushed away by the balloon, it puts up resistance. It isn't until you give it a way to escape (a small hole in the bottle, for example) that you can nflate the balloon.

Careful! Don't

aet wet!





Make your own water fountain!

EXPERIMENT 4

Tip! It's best to perform this experiment outside or over a sink!

YOU WILL NEED:

> Tube, clay, empty half-liter bottle made of soft plastic material (16 ounce plastic bottle), water

- 1. Fill the bottle halfway with water. Form a thick ring of clay around the tube, and push the clay ring into the neck of the bottle. Be sure that there is no gap at all remaining between the tube and the bottle, and that the tube extends into the water.
- 2. Now blow hard into the tube, holding the ring of clay tightly so it doesn't fly out.
- 3. Pull your face away quickly. Water will briefly shoot up through the straw.

3

WHY 🐓 By blowing, you compressed the air inside the bottle. When you stopped blowing, the air expanded again and exerted force on the water. It pushed the water out of the way. But because water isn't elastic, it had to find some space for itself, which it did by rising up the tube.



EXPERIMENT 5

YOU WILL NEED:

- > Balloon, balloon clamp, blue string, tube, rocket (die-cut cardboard sheet), tape, 2 chairs
- 1. Inflate the balloon and seal the neck shut with the clamp.

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- 2. Assemble the rocket and tape the balloon to it.
- 3. Thread the string through the tube.

- 4. Stretch the string between two chairs.
- 5. Tape the balloon rocket to the tube
- 6. Now you can release the clamp and let your rocket go!





WHY 😯 The air flows out with plenty of force, propelling the balloon and the rocket in the opposite direction. This **recoil** is something that space rockets use as well, except instead of air they expel large quantities of hot combustion gases through their nozzles.

Force of air

EXPERIMENT 6

YOU WILL NEED: > Plastic bag, tube, blue string, several books

1. Push the tube into the mouth of the bag, and tie the opening of the bag shut.

2. Place the bag on the table and stack several books on top of it. Then blow hard into the tube. The bag will expand and lift up the books. But watch out: the books will take off pretty quickly!

> WHY Compressed air can carry heavy loads. You know about that from your bicycle tires. The air in the tires of a truck can even carry the truck and its cargo, totaling several thousands of pounds.

Magic balloon

EXPERIMENT 8

YOU WILL NEED:

> Balloon, funnel (die-cut cardboard sheet), 2 effervescent tablets, water, glue, empty half-liter plastic bottle (16 ounce bottle)

1. Separate the cardboard funnel from the die-cut cardboard sheet. Roll it up and glue it together. Let the glue dry thoroughly.

2. Crumble two effervescent tablets and pour the powder through the funnel into the balloon.



Balloons under pressure

EXPERIMENT 7

YOU WILL NEED:

- > 6 ballons, shallow cardboard box or box lid, various heavy loads (such as books)
- 1. First blow up all six balloons and tie their openings closed. Then stick as many balloons under the box as possible. The edges of the box should keep the balloons from shooting off to the side.
- 2. Carefully stack a load, such as heavy books, onto the box. The box will hold them without any problem. Do you think it might even be able to carry your weight if you sit on it carefully?

WHY Compressed air can hold an astonishing amount of weight. You may be familiar with that fact from air mattresses, which can hold up the weight of a sleeping person with nothing but air.



Airbag test

EXPERIMENT 9

YOU WILL NEED:

> Syringe, measuring cup, lid, launch pad (die-cut cardboard sheet), water, effervescent tablet

Tip! Perform this experiment outside in the yard, because it gets really messy! Be careful to stand far enough way so that you don't get hit in the face by the lid!

- 1. Find the launch pad on the die-cut sheet and place it on the ground. Draw 20 ml of water into the syringe and add the water to the measuring cup. Place an entire effervescent tablet in the water and quickly put the lid on the measuring cup.
- 2. Working very quickly, set the cup on the launch pad and step back. After just a few seconds, the lid will fly off with a bang.

WHY S The carbon dioxide gas released in the cup makes the pressure rise so much that it blows the lid off.

2

A car's **airbag** also contains a gas generator that ignites electronically during an accident. With a loud bang, the generator instantly creates large quantities of gas to inflate the bag in a fraction of a second. This protects the passengers from being struck by hard areas of the car's interior, which could lead to dangerous head and chest injuries. Then, the gas quickly escapes again.

WHAT ARE THE COMPONENTS OF THE AIR THAT YOU BREATHE?

Air is a mixture of various gases. Nitrogen (78%), oxygen (21%), and argon (0.9%) form the

largest components. Carbon dioxide and other gases only make a tiny contribution.

HOW LONG HAVE **AIRBAGS EXISTED?**

Airbags have existed since the 1970s, but it wasn't until the 80s and early 90s that they became standard equipment in many cars.



3. Fill the bottle halfway with water and fit the balloon over the bottle's neck. Lift the balloon so the effervescent powder trickles into the bottle. Hold the balloon tight around the bottle's neck as you do this!

Caution! After the expen iment is over, you should throw the balloon away!

WHY 🕜 The balloon will inflate as if by magic! But what's filling the balloon isn't ordinary air. It's another gas called **carbon dioxide**. That's the same gas that gives soda drinks their fizz. The effervescent tablet releases this gas when it combines with









