What can air do? – Information for teachers

1 Information on the subject

Children gain new experiences with air and its properties almost every day from an early age, for example, when flying a kite, seeing objects flying through the air in windy or stormy weather, or just watching animals such as butterflies or birds in the garden. These and many other things would be impossible without air. Nevertheless, there is a widespread notion among children in particular that air is “nothing” because you cannot see it. The objective of the following experiments is to counter this false notion, convey to students what an amazing substance air is, and make them aware of the role air plays as the basis of life.
By allowing students to explore the properties of air experimentally, they can experience air with their own senses and thus perceive it consciously. They can compare the results of the experiments with their everyday experiences and evaluate them. The experiments also introduce children to a scientific method of working: they postulate ideas about the properties of air, which they then verify experimentally.
In this compilation of experiments, students will learn about five important properties of air:

Air takes up space.
Air consists of various small gas particles (atoms and molecules) that move freely and completely fill any space available. If the air particles are inside a container, they exert pressure on the walls of the container (see, for example, pressure in a balloon, tire pressure, but also air pressure).

Air acts as a brake.
If a body moves through the air, the air is pushed aside by the body. The body has to exert a force on the air to do this. The air in turn exerts a braking force on the body (principle of physics: force = opposite force). This force is called air resistance. The greater the surface and velocity of the body, for example, a parachute, the greater the air resistance is. Air resistance depends on the shape of the body. Other examples are: Holding your hand out the window of a moving car, airflow when riding a bike.

Air carries.
If we blow air vertically upward with a hair drier, we can make a table tennis ball hover on this airflow (caution: you should use the cold air setting; otherwise, the ball can melt). A horizontal airflow also possesses a lifting force. When air flows over a surface, for example, a kite or the wing of an airplane, if the surface is suitably shaped, the air flows faster over the top of the surface than it does underneath. These different air speeds result in different pressure situations above and below the surface. Low pressure prevails above and high pressure below. This pressure difference produces a force that lifts the surface. The faster the body moves through the airflow, the greater the lift is (which is why you have to run so fast with a kite to get it to lift off at all). Note: Modern parachutes reduce the rate of fall mainly through lift.

Air propels.
If a moving body meets another body (either at rest or in motion), it exerts an impact force on this body. This expresses itself in the fact that part (or all) of the velocity is transferred to the impacted body. Wind can also be considered a moving body, since wind is air in motion and air has mass. When the wind meets the blades of a pinwheel, it transfers some of its velocity to them. Since the blades are firmly attached to an axis, they do not fly away, but are set into rotary motion. (In the case described, the wind stream immediately pushes the blade away. In engineering, this is known

as a resistance force type turbine. With most modern propeller wind turbines, the wind flows over the propeller profiles and in this case the lift effect is the predominant force; see point 3).

Air transmits sound.
If, for example, a balloon bursts, the air contained in the balloon does not move toward the ear as "wind." Instead, the sudden rupture triggers a pressure wave. The bursting of a balloon generates a regular sequence of compressed and rarefied layers of air, in other words, wavelike fluctuations of the air pressure moving away from the source of the sound. In these sound waves, the air layers oscillate **longitudinally** in the form of periodic compression and rarefaction, i.e., directly in the direction of propagation.

The following experiments have been selected in order to better acquaint students with the physical properties of air mentioned above:

- Air takes up space: We pump up a bicycle tire
- Air acts as a brake: We make a parachute
- Air carries: We make a kite
- Air propels: We make and test a pinwheel
- Air transmits sound: Making a "drum skin"

2 Information about classroom work

The objectives of the experiments are first the examination of physical properties of air, and second the introduction to a scientific method of working through experiments and the documentation of observations.
Students should be given the opportunity in the classroom to carry out all experiments on their own or to work with a partner in order to "experience" the properties of air. Sufficient time should be scheduled for this.
In grade 1 and possibly 2, we recommended that teachers conduct the experiments together with the class or demonstrate them once to the class, as some of the instructions are quite complicated. Then, after the experiments with the self-made test objects have been carried out according to the teacher's instructions, the results can be collected and noted down in class.

2.1 Experiment 1: Air takes up space – We pump up a bicycle tire

The students pump up a bicycle tire. This illustrates the point that air is not "nothing."
Duration: about 5 minutes

2.2 Experiment 2: Air acts as a brake – We make a parachute

The students can make two different sized parachutes with the aid of the experimentation instructions. They then carry out flight tests with and without weights.
Duration: about 15 minutes to make, 20 minutes for the tests

2.3 Experiment 3: Air carries – We make a kite

The students make a kite from a pattern and fly it in the school yard. While doing so, they vary their running speed.
Duration: about 10 minutes to make, 10 minutes for the tests

2.4 Experiment 4: Air propels – We make a pinwheel

The students make a pinwheel from a pattern and test it in the wind in the school yard and by blowing.
Duration: about 10 minutes to make, 10 minutes for the tests

2.5 Experiment 5: Air transmits sounds – Making a "drum skin"

In this experiment, sound is generated by noises (shouting and tapping), which is transmitted through the air from the lower to the upper end of a tube. The grains of rice or sand on the covered tube start to bounce around.
Duration: about 10 minutes

2.6 List of materials per student (or per pair of students)

- 2 pieces of cloth (for example, 10 cm x 10 cm and 40 cm x 40 cm)
- 1 cardboard tube
- 3 drinking straws
- 2 household rubber bands
- 1 split pin (brass fastener)
- Grains of rice or sand
- Small weights (for example, action figure, toy, pencils, marbles, or similar.)
- 1 kite pattern
- 1 pinwheel pattern
- Modeling clay
- Adhesive tape
- String
- Paper or plastic wrap
- Scissors
- Hole punch
- 1 bicycle tire without air (should be several, but not one for every student)
- 1 air pump (see above)

3 Safety information

Observe the applicable safety guidelines for your school and discuss the **safety information** with your students in advance.

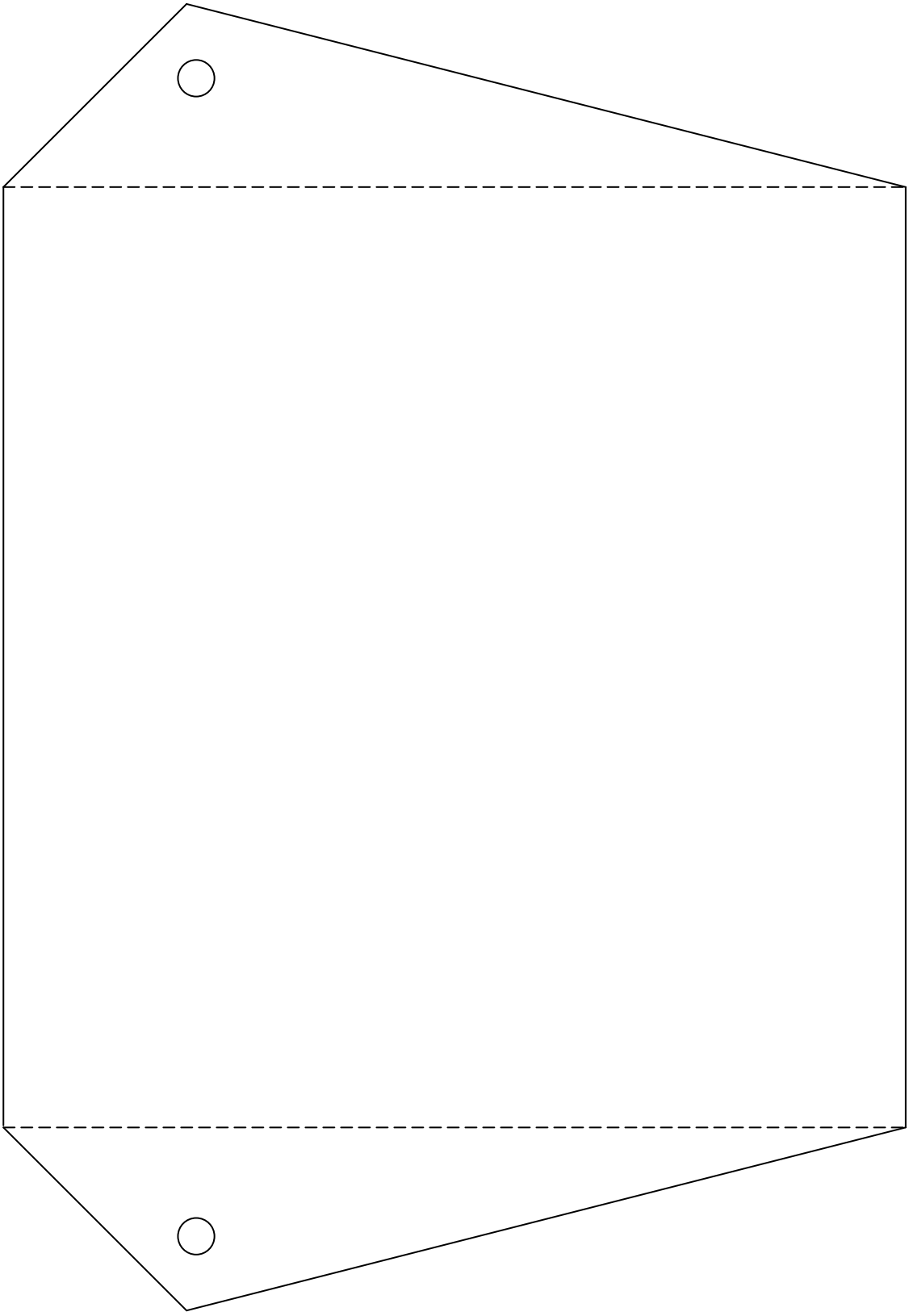
For experiment 1: Explain to the students how to use the air pump correctly and point out that they must not overfill the tire.

For experiment 2: Before conducting the experiment, the students should make sure that the flight path is free.

For experiments 2 – 4: Before the students conduct the experiments, make them aware of the risk of injury when using tools with points or sharp edges (for example, scissors) and warn them to be careful.

4 Patterns

4.1 Kite



4.2 Pinwheel