Physics

FRICTION, GRAVITY AND ENERGY

Recommended for Grades 6-8

Physics is an area of science that is all about motion and the rules that explain how things move. This set of experiments will cover just a few small pieces of the science of physics – friction, gravity, and energy.

- **Friction is a force that resists motion.** Friction is created when two objects rub against each other like wheels rolling on the road.
- **Gravity is the force that exists between two objects that have mass** (or take up space), like two planets or a person and the Earth. Gravity is the force that holds us onto the Earth so we don't float off into space, and gravity is the force that keeps the moon in orbit around the Earth.
- What is energy**? Energy is the ability to do work or cause change.** Energy is literally what makes the world and everything in it go. While energy is found in many forms and places, there are only two types: kinetic and potential**.**

Kinetic energy is defined as the "energy associated with motion." A train racing down the track, a car speeding down the road, and a rock falling downhill all have kinetic energy. When talking about kinetic energy, remember that the weight of an object and how fast an object is moving control how much kinetic energy it has.

Wikipedia defines potential energy as "the energy stored in a physical system." For example, a spring can be stretched and held, or a weight can be lifted up and suspended. The spring and the weight both have the potential, or opportunity, to do work. This means a rock on the edge of a cliff has gravitational potential energy because it can fall, while a wind-up toy has elastic potential energy once you wind it up because it can unwind. We will be investigating the potential energy caused by the force of gravity.

Thank you to the WIN Chapter at Oak Ridge National Lab, Tennessee

for lesson plan development.

HERE ARE THE ACTIVITIES WE'LL DO AS WE INVESTIGATE AIR PRESSURE:

ROLL IT: How Do Surfaces Affect Friction?

DROP IT: Gravity and Friction at Work in Three Parts

BOUNCE IT: Gravitational Potential Energy

RACE IT: Energy at Work

THINGS YOU WILL NEED:

1. A large rubber band and a paper clip
2. Two pieces of paper
3. A rubber ball and a ping pong ball
4. One balloon race car kit
5. Clay
6. Colored pencils
7. Scissors
8. Ruler
9. A few hardback books or food boxes (e.g. cake mix)

Roll It!

Friction is a force caused by two objects rubbing together. Let's see how different surfaces and wheels (or rollers) affect friction. What surfaces (smooth or rough) will require less force? Why?

YOU WILL NEED:

- 2 large books or heavy boxed food (like cake mix)
- An index card
- Rubber band, large enough to go around the book or box
- Paper Clip
- 10 pencils or markers
- Ruler

WHAT TO DO:

1) Stack the books or boxes on a piece of carpet or a towel on a flat surface.
2) Wrap a rubber band around the bottom item.
3) Attach the paper clip to the rubber band so you can use the paper clip to pull the rubber band.
4) Set down the ruler next to the stack or put a piece of tape or some other mark on the surface so you can measure how far the rubber band stretches.
5) Move the stack of items by pulling on the paper clip. Keep your pulling motion level with the items.
6) Measure how far the rubber band stretches using the ruler.
7) Record your measurement in a table.
8) Place the 10 pencils or markers under the stack of books.
9) Move the books by pulling the paper clip level with the books.
10) Measure how far the rubber band stretches.
11) Record your results in a table.
12) Repeat steps 1-11 using a smooth surface. Compare your results.

WHAT HAPPENED:

Did the rubber band stretch more with or without the rollers? Why? Friction is a force that tries to stop motion. The flat surface of the book slides across the rough carpet or the smooth table and the round pencils roll across. Things that roll, like the pens, cause less friction between them and the table than between the flat book and the table. What would happen with more or fewer rollers? Try it!

Drop It!

Part 1 - Friction

Friction is another force that affects falling objects. When an object falls, the air around it pushes on it and slows it down. This is a type of friction called wind resistance. In a vacuum (a place with no air, like outer space), a piece of paper will fall straight to the ground. In air, it will flutter and float to the ground. What difference do you think the shape of an object makes on how it falls?

YOU WILL NEED:

- Blob of modeling clay
- Two pieces of paper that are the same size
- A ruler

WHAT TO DO:

1) Take the two flat pieces of paper and hold them over your head. Drop them to the floor.
2) Which took longer to fall? Did they both fall straight down? Record your observations.
3) Take one piece of paper and wad it up into a tight ball. You may want to wad it up a few times so that it will be a nice tight ball.
4) Hold your paper ball and the flat piece of paper over your head and drop it to the floor.
5) Which took longer to fall? Did they both fall straight down? Record your observations.
6) Keep your flat paper and your paper ball for part two!

WHAT HAPPENED:

Why doesn't a flat piece of paper fall at the same speed as the paper ball? It would if it wasn't for a type of friction called air resistance. The flat paper catches a lot of air during its fall, which slows it down. The flat paper will fall slower because it has more surface area for the air resistance to work on. This means that the flat piece of paper is slowed down by more friction than the wadded-up ball of paper.

Drop It!

Part 2 - Gravity

Gravity is the force between two objects due to their mass or size. Gravity keeps us "stuck" to the Earth and is the force that makes things fall by pulling them down to Earth. Aristotle, a famous Greek philosopher and part-time scientist who lived from 384 to 322 BC, believed that the heavier something is, the faster it will fall to Earth. Do you believe this? Let's find out!

YOU WILL NEED:

- Blob of modeling clay
- Two pieces of paper that are the same size
- A ruler

WHAT TO DO:

1) Hold the clay in your hands for a minute, and then divide the clay into 3 equal pieces. Roll them into equal sized balls.
2) Hold two of the small clay balls about 2 feet from the ground. Drop them at the same time onto a hard surface and see if they fall at the same speed. Record your observations. Did they fall at the same speed?
3) Combine two of the three balls to make one larger ball. This one should be twice the weight of the remaining small ball.
4) Hold the large ball and the remaining small ball about 2 feet from the ground. Drop them at the same time. Record your observations.
5) Take the wadded-up paper ball from Part 1. Wad it up again into a tight ball.
6) Hold your paper ball and the small clay ball over your head and drop them to the floor. Which took longer to fall? Record your observations.

WHAT HAPPENED:

Look at your finished table. Was Aristotle right? Do the different sized clay balls reach the ground at the same time? If not, which one reaches the ground first? What about the paper ball and the clay ball? Aristotle had a lot of great ideas, but this time he was wrong! Galileo, an Italian physicist who lived from 1564 to 1642, showed that all things of roughly the same shape fall at the same rate no matter how much they weigh. The two balls, although different in weight, fall at the same speed.

Drop It!

Part 3 – Kinetic Energy

There is yet another piece of the physics puzzle to explore with this experiment – the kinetic energy of a falling object. You may have already noticed that the clay balls from Part 2 changed shape when you dropped them. This happens because the kinetic energy the ball has when falling has to go somewhere when the ball can't fall any more. The kinetic energy is used up by making the ball flatten out when it hits the ground. This change in shape is called "deformation."

YOU WILL NEED:

- Blob of modeling clay
- Two pieces of paper that are the same size
- A ruler

WHAT TO DO:

1) Hold the 2 clay balls from Part 2 in your hands for a minute and then roll them back into balls.
2) Look at each ball carefully to make sure it is as round as you can make it. No flat spots!
3) Hold the two balls about 2 feet above a hard surface. Drop them at the same time onto a hard surface and see what happens. It would be best to have one person drop the clay balls and one person watch them.
4) Do the balls bounce? Do they change shape? Measure the width or diameter of any flat spots using your ruler. Record your observations.
5) Reshape both clay balls and repeat dropping the balls from different heights. Record your observations. Reshape the balls after each drop.

Bounce It!

Gravitational Potential Energy:
Measuring How Height Affects Potential Energy

In this experiment you get to bounce balls around and observe the effects of gravitational potential energy (GPE). GPE depends on the height of an object. If an object is positioned in a way that allows the force of gravity to set the object in motion, then the object has GPE. Amusement park "sky coaster" rides are an excellent example of GPE. Thrill seekers are strapped into a swing harness and raised three stories or more into the air. While perched precariously in pre-launch position, the riders have GPE. The moment they pull the "ripcord," they swing free, and the potential energy becomes kinetic energy. We've seen how clay balls squish or deform when they are dropped from a height in the Drop It! experiment. The energy in the clay balls is used up when they are squished. Now you will drop two different balls that aren't as squishy and count how many times they bounce when dropped from different heights. The different balls in this experiment do deform, but not enough to use up all the energy, as the energy is put into bouncing.

YOU WILL NEED:

- A ping pong ball and a rubber ball

WHAT TO DO:

1) Stand on a hard floor (wood, linoleum, tile, concrete, but NOT carpet). Hold your first ball about 12 inches (1 foot) above the floor.
2) Let the ball go and count how many times it bounces before it stops. (You may have to repeat this step several times if the ball tends to bounce off…).
3) Now hold the ball at about 2 feet. Let it go and count how many times it bounces. Record your answer.
4) Repeat this for 3 feet and 4 feet and record your answers. Repeat steps 1-4 using the ping pong ball. Look at your recorded results.

WHAT HAPPENED:

Squeeze each ball in your hand. Which ball is easier to deform or squish? Which ball bounced more, the one that was easier to squish or the other one? What do you notice about how high it was and how many times it bounced? The higher the ball is, the more potential energy it has, so you will see more bounces as the ball falls farther.

Roll It!

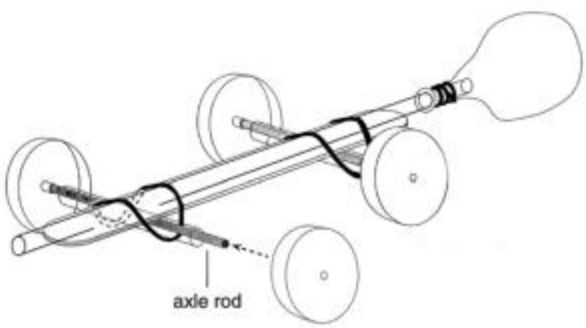
Here is a fun way to watch energy change from potential to kinetic. This is not an experiment, but a project. You (and an adult helper) will build your own balloon powered car. The air you blow into the balloon becomes the energy that makes the car go.

YOU WILL NEED:

- 1 balloon
- 4 plastic wheels
- 2 long straws
- 2 short straws
- 2 tongue depressors
- 3 rubber bands (2 large and 1 small)
- Scissors

WHAT TO DO:

We've given you some instructions for building a car. You can follow these or try out your own ideas. Several of the steps are hard to explain with words, so make sure to keep looking at the picture for help.



1) Cut one of the long straws into 2 pieces that are each about 1.3 cm (1/2 inch) shorter than each axle straw.
2) Insert an axle into each straw piece.
3) Push plastic wheels onto both ends of the axle/straw assemblies. This is hard to do, so you may need some help.
4) Take one of your wheel assemblies and put one wheel through a rubber band.
5) Place a tongue depressor on top of the wheel assembly.

6) Pull the rubber band over the tongue depressor and go over the other wheel. The rubber band will be loose, so you will have to either twist the rubber band several times or wrap it around the end of the tongue depressor. Don't make it too tight, just tight enough to hold things together. The wrapping is not shown in the picture.
7) Take the other wheel assembly and put one wheel through another rubber band.
8) Put the wheel assembly on the other end of the tongue depressor.
9) Just like in step 8, take this rubber band and pull the loose end of the rubber band over the tongue depressor and go over the other wheel on the wheel assembly.
10) Adjust the wheel assemblies and the tongue depressor so that the tongue depressor is centered between the wheels on each axle and that the tongue depressor sticks out about 2.5 cm (1 inch) at each end. Again, check the picture for help. Set this aside for a minute.
11) Insert about 2 cm (0.75 inch) of the straw into the neck of a balloon.
12) Secure the balloon in place by looping a rubber band around the neck of the balloon several times. This will be your "engine."
13) Now get the rest of your car and slide the long straw along the top of the tongue depressor and underneath the rubber bands. Each end of the straw should stick out beyond the length of the tongue depressor.
14) To "energize" the balloon car, blow into the free end of the straw until the balloon is the desired size. Place a finger over the open end of the straw to keep the air (or potential energy) from escaping.
15) Place the car on a smooth surface like a wood floor or tile floor and let it go! The air is released from the balloon, the potential energy becomes kinetic energy, and the car moves.
16) You can experiment with your car by changing how much air you blow into the balloon or adding more weight to it by taping coins on the tongue depressor. Then see if the extra air or extra weight makes a difference in how it far or fast it moves.