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Surprising Science for Kids:

Force and Motion

KIT-535

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Welcome to
Surprising Science for Kids: Force and Motion
Grades 4-8

Your **Surprising Science for Kids: Force and Motion** kit includes almost everything you need to perform hands-on experiments and dynamic demonstrations related to Newton's Laws of Motion.

We believe the best way to learn about science is to have fun! The activities in this guide will ignite students' curiosity and make them eager to explore on their own.

Because we are working with objects flying through the air, you should ALWAYS wear your safety glasses when conducting the activities in this kit.

Included in this kit:

- 5 Hex Nuts
- 21 Rubber Bands
- Strip of Sandpaper
- 16 Craft Sticks
- 1 Bottle Cap (attached to a craft stick)
- 2 Hard Candies
- 1 Styrofoam Ball
- 1 Film Canister
- 1 Pipet
- 2 Alka Seltzer Tablets
- Goldenrod Paper
- 2 Rocket Patterns
- Safety Glasses
- 1 Rubber Ball
- 1 Dropper Popper
- 1 Ping Pong Ball
- Wire
- 1 Plastic Straw
- 1 Small Wiffle Ball
- Yoyo String
- 1 Centripetal Spinner

You will also need:

- Ruler
- Adhesive Tape
- Tape Measure or Yardstick
- 2 Sheets of White Paper
- Scissors
- Tissue
- Water

About Force and Motion

continued

In 1686, our friend, Sir Isaac Newton, gave us three Laws of Motion that are still used today! **Newton's First Law of Motion** states that an object at rest won't move (or stays at rest) until some force acts on it. And an object that is moving won't stop until some force acts on it.

Here's how it works.

The soccer ball was at rest until she kicked it.

Her foot applied the FORCE that put the ball into motion.

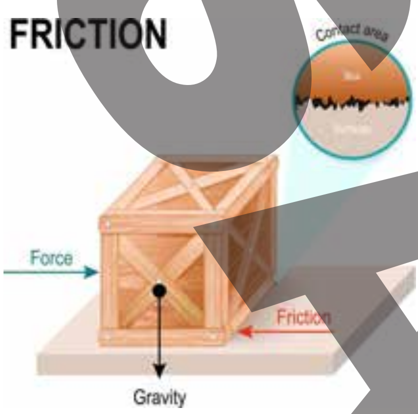
The soccer ball was in motion until it hit the net.

The net is the FORCE that stopped the soccer ball.

Newton's Second Law of Motion says the force (the push or pull) acting on an object is equal to the mass of an object (how much stuff is in the object) multiplied by its acceleration (how fast it's moving). This is often referred to by the equation **F=ma**. In this equation, **F** stands for force, **m** stands for mass and **a** stands for acceleration.

As an example, think about a baseball that you gently toss to a friend. Now think about that same baseball being thrown to your friend by a major league pitcher. Your friend should be sure to wear protective gear because that baseball has far more force when it's thrown faster.

Activity 1:
Aw, Nuts!



We mentioned earlier that friction is a force. If you press your hands together firmly and then quickly rub them back and forth for about 10 seconds, your hands will get hot. Try it!

FRICTION is the force that restricts movement between two objects that are touching. The rougher an object is, the more friction will be present. The smoother an object is, the less friction there is.

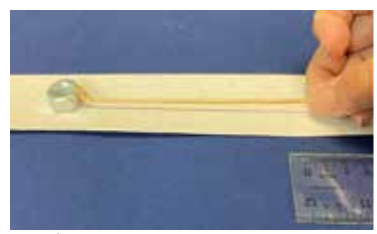
To counteract the effects of friction, we often add oil or wax to lubricate areas where things are in contact. This is especially true for things like door hinges, car engines, and the wheels on your roller skates.

Materials:

- 5 Hex Nuts
- Strip of Sandpaper
- Scissors (not included)
- Rubber Band
- Ruler (not included)
- Tape (not included)

Directions:

1. Cut your rubber band once so it looks more like a rubber string than a rubber band. Tie a hex nut to one end of your rubber string.



2. Tape the sandpaper strip onto a table or counter. Place the hex nut on the sandpaper strip so the hole of the nut is facing upward.
3. Extend the band so it is at its full length but does not put any force on the nut. Place your ruler at that point.

4. Very slowly, stretch the rubber band until the nut moves. On the data table on the next page, record the length of the stretched rubber band just before the nut moved.
5. Add a second nut by threading it on the rubber band and repeat the experiment. Record your results on the data table. Continue until you've used all five nuts.
6. As you increased the amount of weight your rubber band was pulling, what did you notice about how far it stretched?

7. Now repeat all the steps above, but instead of using sandpaper, use a smooth surface. Again, record your results on the data table on the next page.

Activity 2:
Build a Catapult

The Science:

POTENTIAL ENERGY is stored energy. It has the "potential" to be turned into **KINETIC ENERGY**, or the energy of motion. In this activity, we are going to talk about two types of potential energy. The first is gravitational. As you probably guessed, **gravitational potential energy** depends on gravity because of the object's height above the ground. The second is **elastic potential energy**. In this case, the energy is stored because of the object's ability to "spring" back into shape after it's been stretched or squeezed.

Because of gravity, all objects that are positioned above the ground have the potential to fall downward—just like Newton's apple. When the object falls, the potential energy is converted or changed to kinetic energy. Think of a roller coaster at the top of the highest hill. At that point, it has a lot of potential energy. As soon as it starts to roll downward, that potential energy is changed to kinetic energy.

With elastic potential energy, an object has the ability to change to kinetic energy by snapping back into its original shape after it has been stretched. Think of the elastic band we used in Activity 1. If you had let it go after it was stretched, it would have moved back toward the hex nuts. Other examples of items that can demonstrate elastic potential energy are diving boards, springs, bouncy balls, and even elastic waistbands!

As you learned, Newton's Second Law of Motion says that force equals the mass of an object times its acceleration (F=ma). In this activity, you're going to build your own working catapult. You'll discover for yourself what Newtown was talking about!

The History:

Catapults were used in ancient times during battle. Catapults could launch objects like stones, spears, or flaming projectiles at the enemy. As you can imagine, it took a great deal of force to launch large stones. As you can also imagine, those flying stones caused a lot of damage! The heavier the stones and the faster they flew, the more damage they caused to the enemy.

Materials:

- 16 Craft Sticks
- Bottle Cap (attached to a craft stick)
- Tape Measure (not included)
- 20 Rubber Bands
- 1 Styrofoam Ball
- Safety Glasses
- 2 Hard Candies
- 1 Tissue (not included)

Caution: Never shoot your catapult toward a person or animal.
Remember to wear your safety glasses at all times!

Activity 3:
Be a Rocket Scientist

continued

4. Next, the film canister should be taped to the cylinder with the open end extending far enough from the end of the cylinder so that no tape overlaps the canister's opening.

   NOTE: If any tape extends over the opening, the lid will not form a complete seal. Without a complete seal, sufficient pressure may not build, and the rocket may not launch.

5. Using the Film Canister Rocket Template, cut out the nose cone and fin shapes. The nose cone is made by cutting away the pie-shaped area and curling the paper so the edges of the missing pie piece begin to overlap, forming a cone shape. Apply tape to keep the cone together.

Fins add stability to your rocket and help it to fly straight.

6. Tape the nose cone to the end of the rocket opposite the film canister. Add tail fins to your rocket. Make sure not to apply tape to the open area of the canister.
7. Since this is an outside activity, bring your rocket, Alka Seltzer, water, pipet, and goldenrod paper outside.
8. Lay the goldenrod paper flat on the ground. Break one of the Alka Seltzer tablets into four equal pieces.
9. Put on your safety glasses.
10. Turn the rocket upside down, so the opening of the film canister is pointing upward. So as not to crush it, hold onto the solid film canister and not the paper cylinder.
11. Add one or two squirts of water into the canister, using your pipet.

What's happening?
Once the seltzer tablet is added to the water in the film canister, it will begin to fizz and give off carbon dioxide gas. This will continue for more than a minute or so, which gives you plenty of time to secure the cap to the film canister. Don't be nervous!

12. Add your seltzer piece to the canister. Calmly and securely place the cap on the canister, place your rocket, canister side down, on the goldenrod paper. Then just step back, and wait.

What's happening?
Inside the closed film canister, pressure continues to build from the gas being produced by the tablet. Once the lid can no longer hold the pressure, it separates from the canister. Since the lid is pushing against the ground, the rocket is propelled upward with a popping noise!

Activity 4:
Half a Ball?

You've already learned about two types of potential energy: gravitational and elastic. The higher an object is above the ground, the more gravitational potential energy it has. The more something is stretched out of shape, the more elastic potential energy it has.

You also know that kinetic energy is the energy of motion. If an object is moving, it has kinetic energy. The faster it's moving, the more kinetic energy it has.

In this next activity, you're going to use a combination of the two types of potential energies to get more kinetic energy!

Materials:

- Rubber Ball
- Dropper Popper
- Safety Glasses

In this lab, we'll be working with projectiles (objects thrown by force), so be sure to wear your safety glasses for all experiments!

Take a look at the rubber bouncy ball in your kit. Because it's made of rubber, it has the ability to store energy and then re-emit it. If you hold the ball out at arm's length and then release it, how high do you think it will bounce back up? Will it bounce back up to the height you dropped it? Will it bounce up higher? Will it bounce lower? Try it…

As long as no additional force is used (like throwing it down), it's impossible for the ball to bounce up to its original height, let alone bounce even higher than the point it was dropped. Here's a scientific rule for you. It's called the **Law of Conservation of Energy**. It says that energy cannot be created or destroyed. It can only change its form. This means that the amount of energy we have in the universe is always the same. It only seems like the energy is being lost, but it's not. It's just changing its form from one type of energy to another.

Hubble Space Telescope image
Credits: NASA, ESA and A. Riess (STScI/JHU)

Activity 6:
The Flying Straw Rocket

continued

6. Using a yardstick or tape measure and the data table below, drop your ball and straw from different heights and record how high your straw flew. Scientists conduct multiple tests to ensure their results are accurate. Test each drop height three times and then find the average (add the three heights together and then divide by three).

	Rocket Height			
Data	**1st drop**	**2nd drop**	**3rd drop**	**Average**
6"				
9"				
12"				
15"				
18"				
21"				
24"				
27"				
30"				
33"				
36"				

Activity 8:
The Centripetal Spinner

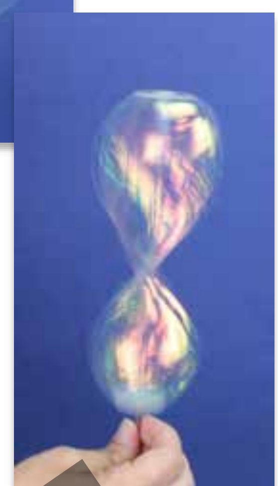
The Centripetal Spinner is a fun way to learn about science and the properties of matter and motion.

Materials:

- Centripetal Spinner

Hold your Centripetal Spinner so the handle is between your thumb and your index and middle fingers. Gently spin the handle and observe the Mylar bands.

You will notice that the top bands are permanently connected to the handle, while the bottom bands are connected to a disk that spins freely around the handle. When you spin the handle, the top bands immediately move along with it. However, because the bottom bands are not connected, they tend to continue moving in the direction they were originally moving (or if the bands weren't moving at all initially, they remain at rest). Yup, Newton's First L



If you switch directions suddenly, the top bands immediately follow, but the bottom bands continue traveling in the initial direction they were going, so they lag behind once the handle changes direction.

You will notice that the spinner will look like a figure 8 if you spin the spinner in one direction and then quickly switch directions. The bottom bands have difficult catching up.

As you continue to spin the handle you will notice the Mylar bands bulging outward. The faster you spin it, the more they bulge outward.

Think about yourself in a moving car or bus that's making a turn or even on an amusement park ride that's moving in a circle. Which way does your body want to move?

The same thing is happening with the bands of the spinner. **Inertia** is responsible for the bands moving outward and **centripetal force** is responsible for the bands moving in a circular motion.

The Centripetal Spinner has soooooo much science to teach. In addition to centripetal force, what are some other really neat things you can discover using it?

Tangled? Don't worry! Patiently work the bands over one another to untangle them. It's really a very durable science toy! Enjoy!