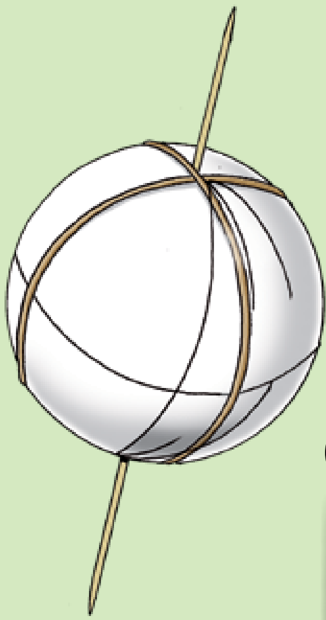
BONUS EXPERIMENTS

Weather & Climate Lab

THAMES & KOSMOS

EXPERIMENT 1

Day or night?



You will need

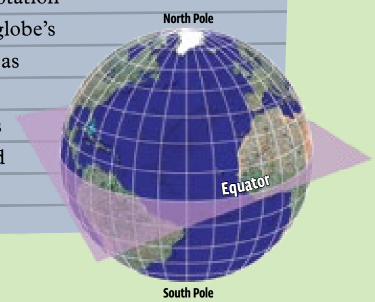
→ *Polystyrene foam ball*
→ *Polystyrene foam square*
→ *2 rubber bands*
→ *Wood or bamboo skewer*
→ *Markers (green and blue)*
→ *Pin*
→ *Flashlight or lamp*

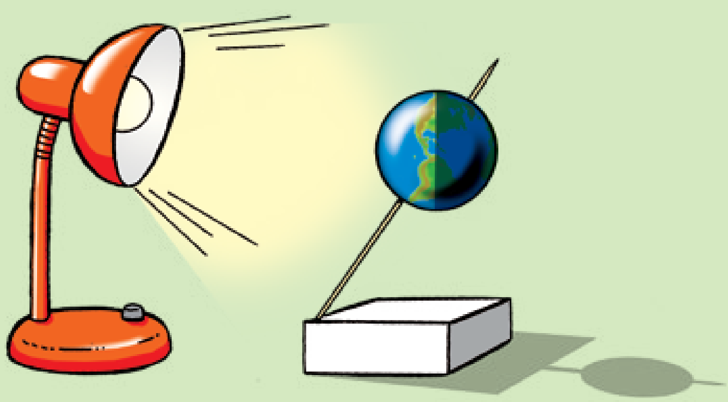
Here's how

1. Stretch two rubber bands over the sphere so that they are lying flat and are as centered as possible.
2. Insert a wooden skewer through the sphere at the points where the rubber bands cross. That is where your poles are, and the stick is the axis around which your Earth rotates. Use markers to decorate your globe to look like Earth.
3. Place the skewer in the polystyrene square so that it is at an angle. (Earth's axis is tilted approximately 23.5° from the plane of its orbit around the sun.)
4. Use the pin to mark a specific location on the globe, such as where you live. Set the globe in front of you on a table and point a bright flashlight or a desk lamp at it from the side. That will represent the sun.
5. You can see that half of the Earth, namely the half turned away from the sun, lies in shadow. It is night there, and on the other side it is day.

WHAT'S HAPPENING?

The Earth's axis of rotation is, of course, not really visible. It is an imaginary line around which the Earth rotates. In the model, it is represented by your wooden stick. In all heavenly bodies, the places where the axis of rotation emerges from the globe's surface are known as poles. On Earth, these are known as the North Pole and South Pole.





WHAT'S HAPPENING?

Earth turns once around its axis in a little under 24 hours. The side of the Earth turned toward the sun sees bright daylight, and the side turned away from the sun sleeps in the darkness of night. The rotation causes an ongoing change to take place, which we see as the sun going up or down. In fact, however, it is the Earth, not the sun, which is moving.

EXPERIMENT 2

Reason for the seasons

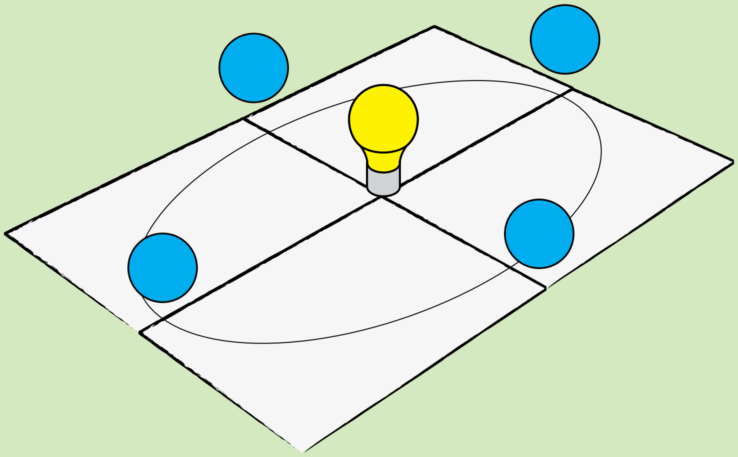
You will need

→ *Globe from Experiment 1*
→ *4 sheets of paper*
→ *Tape*
→ *Felt-tip marker*
→ *Lamp without shade*

Here's how

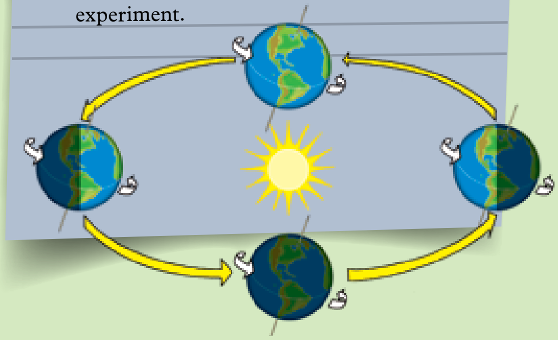
1. Tape four sheets of paper together as shown (or use one big piece). Draw an ellipse (an oval) as shown in the illustration here. Place a lamp in the center of the ellipse to act as the sun. Mark the position of the Earth in the various seasons around the ellipse. If you don't have a lamp without a shade, you can use a powerful flashlight if you always point the light at the model.
2. As you did in Experiment 1, use the pin to mark where you live. Guide the Earth slowly around the light following the ellipse you drew and, always keeping it at the same angle, place it at each of the four seasons' positions in turn. Observe the light and shadow above and below the equator as you turn the Earth around its axis of rotation.

   The Earth's axis of rotation is a little tilted. In the northern hemisphere, its upper end points toward the sun in the summer, and it points away from the sun in the winter.



WHAT'S HAPPENING?

One full revolution of the Earth around the sun on its elliptical path is what we experience as one year. Due to the tilt of the Earth's axis, different parts of the Earth are illuminated in different ways — both in terms of the length of the day and the angle at which the sun's rays hit the Earth. During our summer months, the northern hemisphere is tilted toward the sun. The sun's rays hit the Earth's surface there at a steeper angle than in the winter. That provides a given surface area with a lot of solar radiation and energy. The days are longer and the temperatures are warmer. In the winter, on the other hand, the sun's rays are flatter as they hit the Earth — we see the sun as being lower in the sky. The flatter rays supply less energy and warmth for a shorter time, and the temperatures stay colder. You can see these differences between summer and winter in the next experiment.

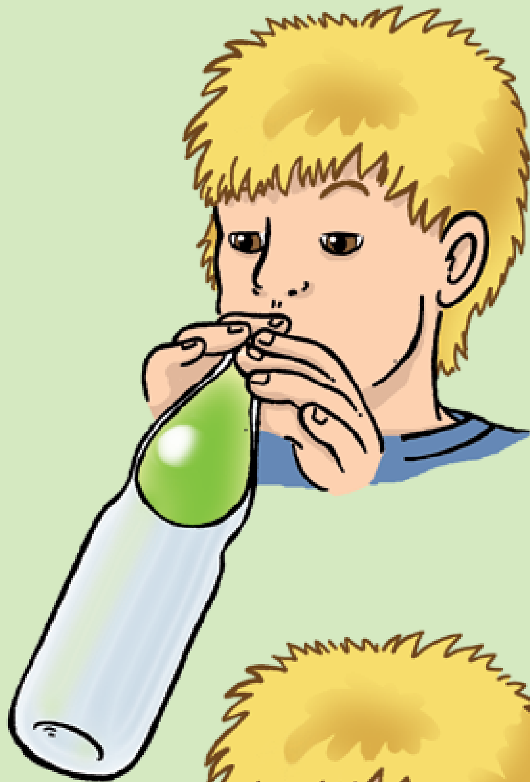


EXPERIMENT 3

Are you stronger than air?

You will need

→ *Balloon*
→ *Drinking straw*
→ *Empty plastic bottle*



Here's how

1. Insert the balloon into the neck of the bottle and try to inflate it inside the bottle.
   Can you do it?
2. Now place a straw along the side of the balloon inside the bottle as shown in the picture. Try to inflate the balloon inside the bottle.
   Can you do it this time?

WHAT'S HAPPENING?

The bottle is filled with air. As soon as your balloon grows to a size such that it seals the neck, the air can no longer escape. The air takes up all the space in the bottle and pushes so strongly against the balloon that you can't manage to inflate it against that pressure. You can only do it by using the trick of inserting the straw past the balloon into the bottle, so the air can escape and the balloon can expand.

EXPERIMENT 4

Make your own clouds

You will need

→ *Transparent plastic basin*
→ *Water*
→ *Tape*
→ *Insulated flask for hot/cold drinks*
→ *Flashlight*
→ *Towel or cloth*

Here's how

1. Place an empty, uncapped insulated flask in the freezer for one hour.
2. Fill the basin about halfway with warm water.
3. Take the flask from the freezer and immediately cover the opening with a towel or cloth. Quickly bring the flask over to the basin and tip the flask over the basin as if you were trying to pour water out of it. As you do this, the flask opening must be quite close to the surface of the water. Watch the surface of the water beneath the flask opening very closely!
What do you see?

WHAT'S HAPPENING?

The heavy cold air from the insulated flask pours onto the warm air above the basin and cools it. The air's capacity to absorb water decreases, some of the water contained in it condenses, and small clouds form. You can see these wisps of cloud particularly clearly in the beam of a flashlight coming from the side in a darkened room.

Rain clouds are likely to form when cold air masses slide under warm and humid ones and lift them up, and when damp ocean air gets pushed up and cooled by mountains and hills. But it also happens when damp air that is warmed during the day cools off at night. This is typical in tropical rainforests.

EXPERIMENT 5

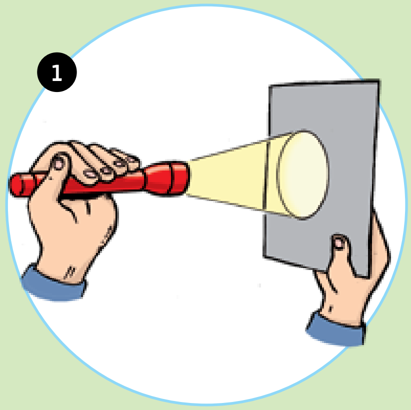
How the sun's rays strike Earth

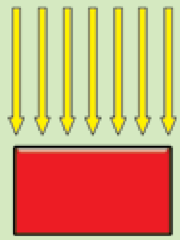
You will need

→ *Sheet of paper*
→ *Flashlight*

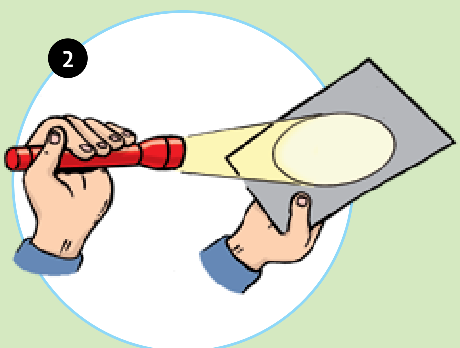
Here's how

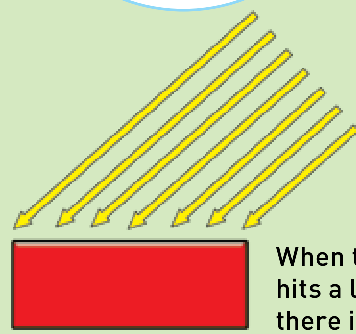
1. Hold the sheet of paper vertically and illuminate it from the front with the flashlight. The rays of light create a round circle on the paper. This works better in a dark room. Trace the circle.
2. Holding the flashlight in the same position, gradually tilt the paper backward. Watch how the patch of light changes on the paper's surface. Trace the oval.





When the sun is high, there is a lot of energy per unit of surface area.





When the sun is low, it hits a larger area, so there is less energy per unit of surface area.

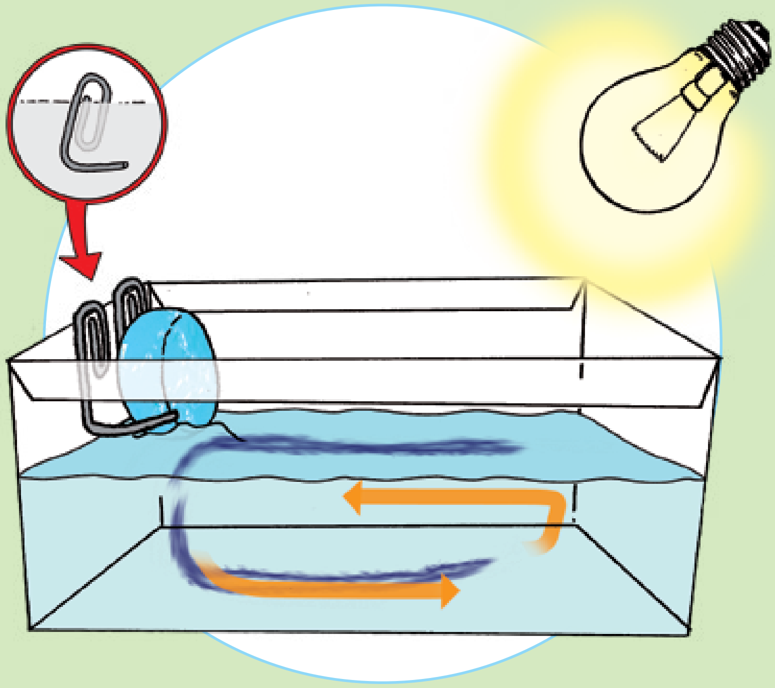
WHAT'S HAPPENING?

The greater the slant at which the flashlight's beam hits the paper, the larger the patch of light. The same amount of energy is therefore distributed across a larger surface area. This is the way it works with the sun's rays, too. If the sun is high, it supplies a lot of energy, warmth, and light per unit of surface area. If the rays are flat, the energy input for the same area is much less.

What determines the seasons is the tilt of the Earth's axis, and not (as many people believe) the distance from the sun. In the southern hemisphere, the seasons are exactly the opposite: Summertime in the northern hemisphere is wintertime there and vice versa.

EXPERIMENT 6

Ocean currants



You will need

→ *Transparent plastic basin*
→ *2 paper clips*
→ *2-3 empty tealight cups with ice*
→ *Food coloring*
→ *Large white shallow dish*
→ *Water*
→ *Lamp with incandescent bulb*

Here's how

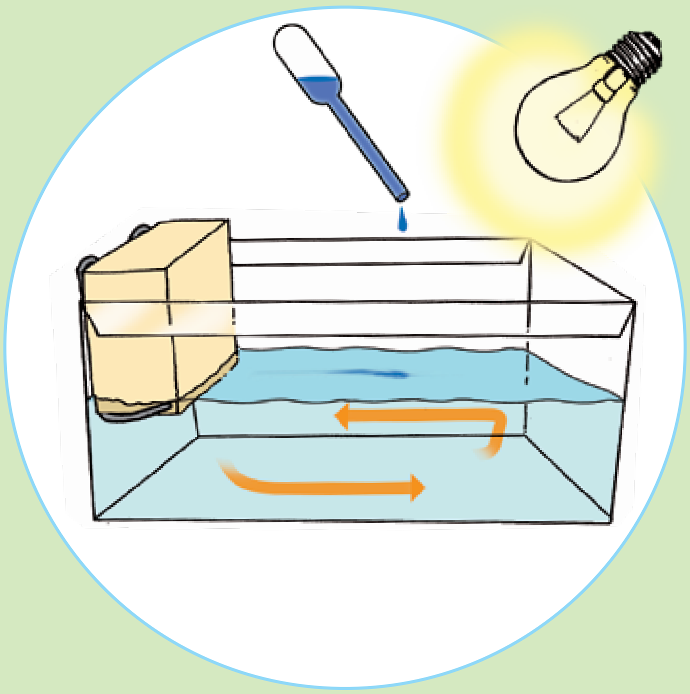
1. Make an ice cube holder by bending two paper clips as shown in the illustration, so a tealight cup fits onto it.
2. Fill several tealight cups with water and put them in the freezer. Take the experiment basin and place it in a large, white, shallow dish, such as a casserole dish, near a lamp.
3. Fill the basin a little over halfway with water. Point the desk lamp at the water at one end of the basin, from a distance of a few centimeters away. This will be your Gulf of Mexico. The lamp should never touch the water!
4. Hang your ice cube holder from the opposite narrow edge of the basin — this will be your northerly frozen sea — and set an ice cube into it (without the tealight cup). To remove the ice cube from the tealight cup, you will have to warm it briefly in your hands. Keep a second and third ice cube ready, because the ice melts quickly.
5. Add one or two small drops of food coloring to the surface of the water under the lamp. Some of it might sink to the bottom, but the rest will remain on the surface and move in streaks to the "north," toward the ice cube, along with the invisible portion of the current. There, the current starts to dive down in front of the ice, and then flow at a lower level back to the "equator," i.e. to the warmth. Before long, the ink will spread through the entire current and become thinner. After a few minutes, a clear border will form at mid-depth, above which the return current flows. This is something like what happens in the Gulf Stream. To see the cycle more clearly, put a few drops of food coloring into other areas of the basin as well. They will all move along the same path.

WHAT'S HAPPENING?

The water under the lamp is heated and flows near the surface toward the cooler water. Under the ice cube, it gets cooled off and sinks, and then flows back along the bottom. As long as the temperature difference is maintained, circulation will take place.

EXPERIMENT 7

Salt as an engine



You will need

- → *Transparent plastic basin*
- → *Paper clip ice holder*
- → *Sponge*
- → *Food coloring*
- → *Water*
- → *Ice*
- → *Table salt*

Here's how

1. Fill the basin from the previous experiment up to the paper clip ice holder with cold tap water.
2. Dissolve a heaping teaspoon of salt in half a glass of cold water. Dip the sponge into this salt solution, lift it out again and squeeze it out a little (not entirely), so it doesn't drip. Then place it on the ice holder so it barely touches the water.
3. Drip a few drops of food coloring in a few spots on the water's surface.

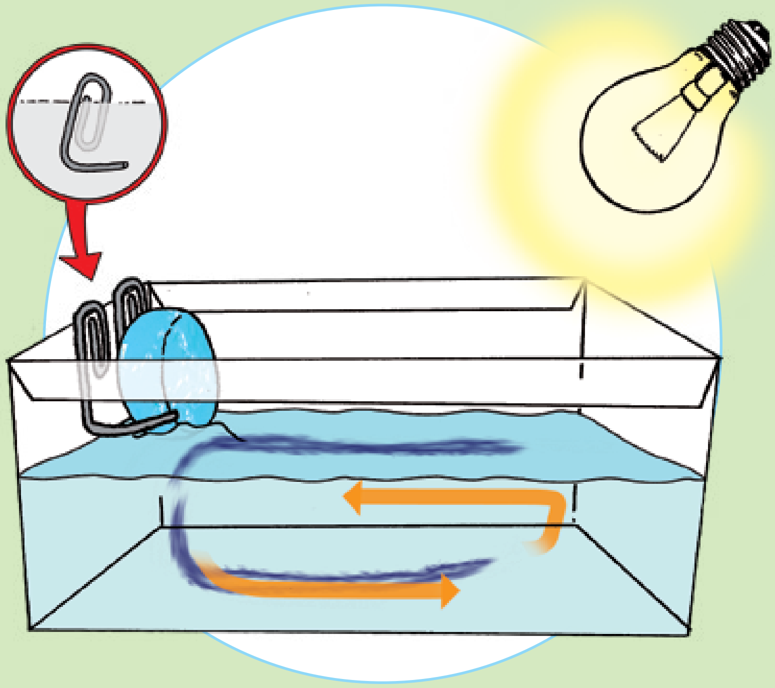
Do you see the paths that the threads of ink take?

WHAT'S HAPPENING?

The threads of ink flow toward the salt. Just as with temperature, a difference in salt concentration causes the water to strive to attain a balance.

The salt solution in the sponge tries to dilute itself, and pulls the fresh water toward it. Also, the salt water is heavier than the fresh water, so it sinks down beneath the sponge and moves along the basin bottom. If you look closely, you can see the salt water sinking down below the fresh water. This gives rise to a circular flow in the basin. This movement stops when the salt content has evened out.

EXPERIMENT 8



Ocean currants

You will need

- *Transparent plastic basin*
- *2 paper clips*
- *2-3 empty tealight cups with ice*
- *Food coloring*
- *Large white shallow dish*
- *Ice*
- *Lamp with incandescent bulb*

Here's how

1. Make an ice cube holder by bending two paper clips as shown in the illustration, so a tealight cup fits onto it.
2. Fill several tealight cups with water and put them in the freezer. Take the experiment basin and place it in a large, white, shallow dish, such as a casserole dish, near a lamp.
3. Fill the basin a little over halfway with water. Point the desk lamp at the water at one end of the basin, from a distance of a few centimeters away. This will be your Gulf of Mexico. The lamp should never touch the water!
4. Hang your ice cube holder from the opposite narrow edge of the basin — this will be your northerly frozen sea — and set an ice cube into it (without the tealight cup). To remove the ice cube from the tealight cup, you will have to warm it briefly in your hands. Keep a second and third ice cube ready, because the ice melts quickly.
5. Add one or two small drops of food coloring to the surface of the water under the lamp. Some of it might sink to the bottom, but the rest will remain on the surface and move in streaks to the "north," toward the ice cube, along with the invisible portion of the current. There, the current starts to dive down in front of the ice, and then flow at a lower level back to the "equator," i.e. to the warmth. Before long, the ink will spread through the entire current and become thinner. After a few minutes, a clear border will form at mid-depth, above which the return current flows. This is something like what happens in the Gulf Stream. To see the cycle more clearly, put a few drops of food coloring into other areas of the basin as well. They will all move along the same path.

WHAT'S HAPPENING?

The water under the lamp is heated and flows near the surface toward the cooler water. Under the ice cube, it gets cooled off and sinks, and then flows back along the bottom. As long as the temperature difference is maintained, circulation will take place.

EXPERIMENT 9

Sea level rise

You will need

→ *Transparent plastic basin*
→ *Bowl with flat bottom*
→ *Water*
→ *Ice cubes*
→ *Washable marker*

Here's how

1. Place the bowl upside down in the basin.
2. Fill the basin with water so it is about 1 inch from the top of the bowl. (The top of the bowl should not be covered with water.)
3. Mark the water level on the side of the basin with a marker.
4. Make a pile of ice cubes on top of the bowl.

What happens to the water level as the ice melts?

EXPERIMENT 10

Greenhouse effect

You will need

→ *2 transparent glass or plastic jars*
→ *2 glass thermometers*
→ *Plastic wrap*
→ *Rubber band*
→ *Notebook and pen or pencil*

Here's how

1. Place a thermometer in each jar.
2. Cover the top of one of the jars with plastic wrap and secure it using the rubber band.
3. Place both jars in direct sunlight.
4. Every few minutes, check the temperature of each thermometer and record it in a data table.

Which jar reached a higher temperature or where they the same?

WHAT'S HAPPENING?

These experiments model some of the causes and effects of global climate change.

In Earth's atmosphere, greenhouse gases — including water vapor, carbon dioxide, methane, nitrous oxide, and ozone — absorb energy from the sun's radiation, and insulate the planet, keeping it warm. Without the greenhouse effect, Earth would be too cold to support life as we know it. The plastic wrap on the jar models an atmosphere with a greenhouse effect. More of the sun's energy is trapped inside, so the jar warms up more.

In the past century, average temperatures on Earth have been going up because human-created industry (factories, cars, etc.) have released more carbon dioxide and other greenhouse gases into the atmosphere. These higher temperatures are causing the planet's ice caps to melt, which is resulting in rising seas.