DISCOVERING SCIENCE

There is a famous ancient Greek myth that asks, "What goes on four legs in the morning, two at noon, and on three when evening comes?"

Answer: Human beings, who crawl as babies, then walk as adults, then use a cane in old age

Science is a way of thinking. It's sometimes called "organized common sense", but that isn't quite right. Many times a new scientific idea seems to contradict common sense. After all, what's a more common-sense notion than the idea that the Earth is flat? It's obvious -- just look around you! But we now know the Earth is a sphere. Science is actually a form of organized curiosity.

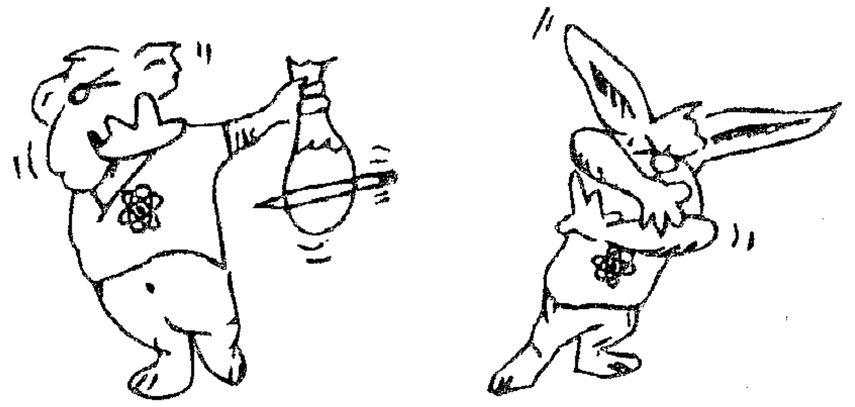
Pi is an interesting number. Most books give its value as about 3.14, or perhaps 3.1416. But, in reality, pi seems to go on forever. In 1983, two computer workers in Japan divided pi out to 8,388,608 decimal places. It hasn't shown a repeating pattern yet.

Draw a square on a piece of paper. Pretend the square is one surface of a cube. How many edges (not surfaces) of the cube are hidden?

Answer: Eight

Bet you can't fold a sheet of paper -- any paper -- in half more than nine times! The way the layers of paper included in a fold increases is called a "geometrical progression". On the first fold, you have two layers of paper; on the second, four. The third fold creates eight layers. By the time you get to the seventh fold, you already have 128 layers. It's like trying to fold a book!

Fill a plastic bag 2/3 full with water. Hold the bag tightly closed at the top. Stick a sharp pencil straight through the bag and leave it there.

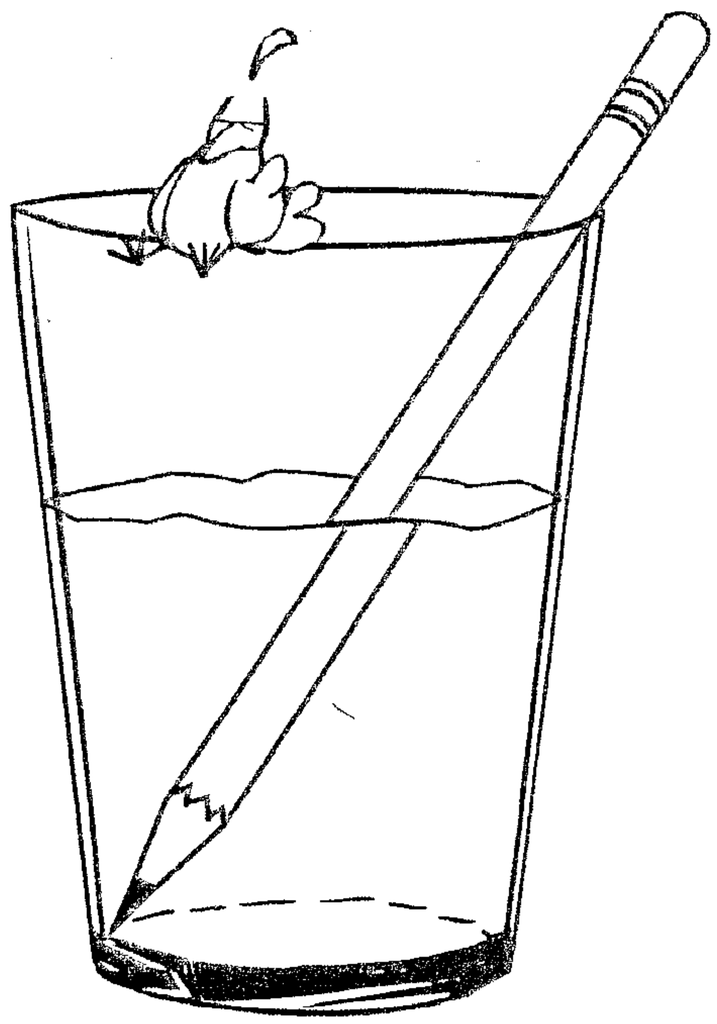


Not a single drop of water will leak out! Why? The polyethylene film molecules pull together to form a seal around whatever is puncturing the film.

BROKEN PENCIL

Bears are more scientific than you think. They are able to sweep fish out of the water even though the fish aren't where they appear to be. What do bears know?

QUICKIES



MATERIALS: Drinking glass; water; pencil.

DOING IT:

1. Fill a drinking glass about 2/3 full with water.

2. Put a pencil in the glass (at a slant, not straight up and down).

3. Look at the pencil at, above, and below the water line. What do you see? Why?

Light travels through the air in what appears to be a straight line. But light bends when it moves from one medium to another, like from air into water.

Even though water is clear, looking through it changes the way you see things. Light travels more slowly through water than through air. The bending of light is called "refraction".

When you put a pencil in a glass of water, the pencil appears to bend at the water line. You see the pencil in the first place because light bounces off it to your eyes. The light from the end of the pencil in the air goes to your eyes from a different direction than the light from the end of the pencil that's underwater. Light bends (refracts) as it leaves the water and enters the air. So, the pencil underwater isn't really bent; the pencil isn't where it appears to be. The bent light fools your eyes and creates an optical illusion. Note that the pencil also looks bigger underwater. The curved surface of the glass and the water in it act as a convex lens.

Topics: Light; Atmosphere.

Mirages occur because of refraction. A mirage appears when there's a clear sky and little wind. As the sun heats up the ground, the air closest to the ground is warmer than the air above it. Light passing through the boundary between the warmer and colder air is bent and you see things that aren't really there -- like a pool of water on a highway that's actually an image of the sky.

You see the sun several minutes before it actually rises above the horizon in the morning. You also see the sun for a few minutes after it has gone below the horizon in the evening. This is because the Earth's atmosphere refracts light, making objects like the sun appear higher in the sky.

INVISIBLE GLASS

You look into a container filled with liquid and there's nothing inside. But when you stick your hand into the liquid, you pull out a drinking glass!

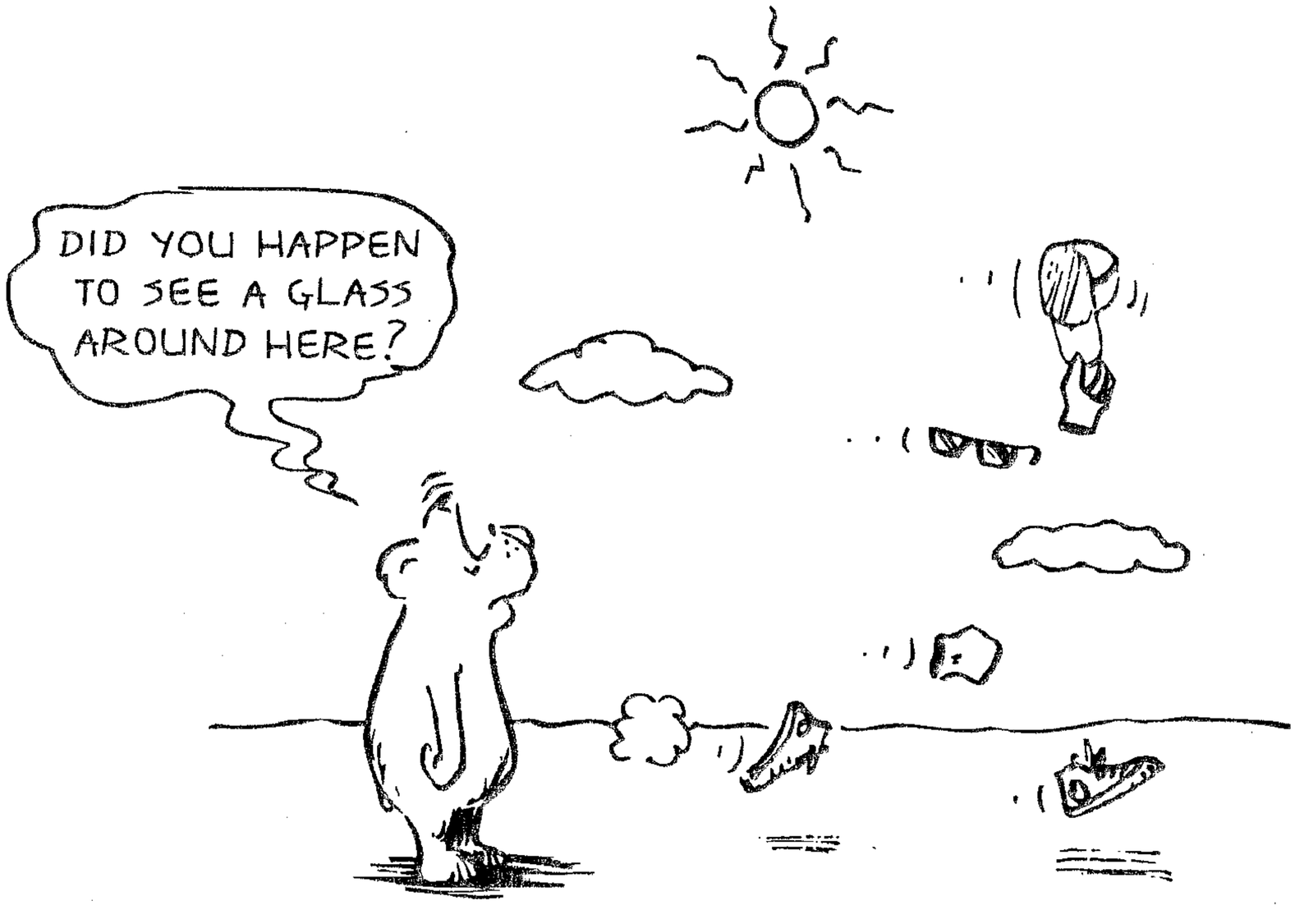
MATERIALS: Large glass container or jar; small drinking glass; water; cooking oil; paper towels.

DOING IT:

1. Put the drinking glass inside the larger glass container. Fill the container with water. Look at the container from different angles. Do you see the drinking glass?

2. Spill out the water and wipe out the drinking glass and container.

3. Put the drinking glass inside the larger glass container. Fill the container with cooking oil. Look at the container from different angles. Do you see the drinking glass?



Some fish have built-in bifocal lenses in their eyes. The top part of their eye is for seeing in air, the bottom half is for seeing underwater. People can't see well underwater because our eyes are made for seeing in air.

As light passes from one medium to another (e.g. water to air, glass to air), the light is bent (refracted) at the boundary between the two mediums. This happens because light travels through different mediums at different speeds. Light moves through petroleum products (including cooking oil) at about the same speed as it does through glass. Therefore, as light passes between glass and oil it doesn't bend at the boundaries, leaving the boundaries invisible.

Topics: Light.

At The Speed Of Light

How long does it take light to reach the Earth from the sun? Do a few simple light-year calculations and then time it for yourself.

MATERIALS: Paper; pencil; kitchen timer. Optional -- calculator.

DOING IT:

1. Light travels at a speed of about 300,000 kilometres in one second. Calculate the distance light travels in one minute: 300,000 km x 60 (there are 60 seconds in one minute) = A km.

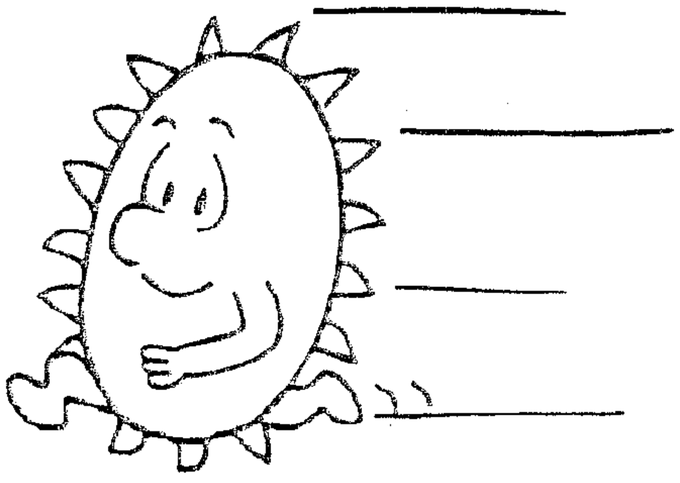
2. Calculate the distance light travels in one hour: A km (answer from above) x 60 (there are 60 minutes in one hour) = B km.

3. Calculate the distance light travels in one day: B km (answer from above) x 24 (there are 24 hours in one day) = C km.

4. Calculate the distance light travels in one year: C km (answer from above) x 365 (there are 365 days in one year) = D km. The answer, D km, is one light-year.

5. Now calculate the time it takes for light to reach Earth from the sun. The sun is approximately 150,000,000 km away from the Earth. 150,000,000 km divided by 300,000 km/sec gives you the time in seconds. Divide the time in seconds by 60 to get the number of minutes it takes light to travel from the sun to the Earth.

6. Time light as it travels from the sun to the Earth. Count down: "Three . . . two . . . one . . . some light is on its way!" As you end the count, set a kitchen timer to the correct number of minutes (calculated above). When the timer goes off, you'll know the light has reached the Earth.



If you sent a message into space, how would you know someone was listening? How would you recognize a reply? Astronomers are aiming radio telescopes at all parts of the universe. So far, they believe they have picked up radio waves from natural sources only. Radio waves travel at the speed of light (300,000 km/sec). Even at that speed, it would take years for a message to travel the distance between Earth and its closest stars. Can you imagine saying "hello" -- and then waiting 100 years for an answer?

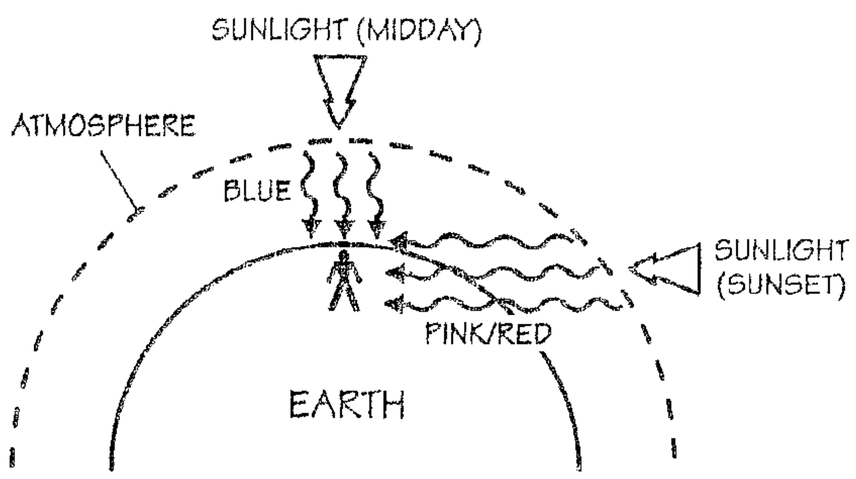
Our atmosphere is largely heated from below, by the Earth itself. The sun's radiant energy is first absorbed by Earth's water, rocks, and soil, and changed into heat. These warmed substances then heat the layer of air closest to Earth's surface through "infrared radiation" (radiant heat). The temperature of the atmosphere is warmer closer to Earth than farther away because of this heating process. Also, air closer to Earth -- which is denser, dustier, and moister than air in upper layers -- is able to absorb more of the sun's radiation, as well as more of the infrared radiation from the Earth.

Distances in space are so large that they are measured in "light-years". One light-year is the distance light travels through space in one year. How far is that? Light travels at almost 300,000 km/sec. That's about 9.5 trillion km in a year. It takes light only 8 minutes and 20 seconds to travel the millions of kilometres between the Earth and the sun.

Topics: Light; Numbers; Measurement.

SKY BLUE

Why does the sky look blue from Earth? In photographs taken from the moon, why does space look black? Use milk and water to find out.



MATERIALS: Large, clear drinking glass or jar; water; milk; spoon; black construction paper; large, bright flashlight.

DOING IT:

1. Do this activity in a dark area (e.g. a closet).

2. Fill a glass or jar 3/4 full with water. Prop up a sheet of black paper behind the glass.

3. Shine a flashlight down into the water or through the side of the glass. Does the water look clear? Can you see the black paper easily through the water? This is like looking into space from the surface of the moon.

4. While you're shining the flashlight into the water, stir milk into the water a small spoonful at a time. Do you see a faint blue in the glass? Can you still see the black paper? Does the blue eventually change to pink/red? Move the flashlight around and shine light through the glass from all angles. How is this like Earth's sky?

QUICKIES

The Earth's atmosphere is filled with all sorts of microscopic particles (e.g. gas molecules, dust, soot, pollen, bits of rock, salt from the oceans, as well as particles added by humans through car exhaust and smoke from factories). When sunlight hits these particles, the light is scattered. Visible, white light from the sun is made up of all the colours of the rainbow. As the light hits and bounces off particles, different colours become visible. Colours with short wavelengths (i.e. blue/violet) are scattered differently than colours with longer wavelengths (i.e. red). When the sun is directly overhead (i.e. midday), blue light is scattered most and so the sky looks blue. When the sun is lower on the horizon (i.e. sunrise, sunset), the sky is tinted pink/red. The angled light must travel through more of the atmosphere and blue light is scattered so much that it doesn't reach your eye; only red light is left to reach the Earth. The moon doesn't have an atmosphere. There are no floating particles and light isn't scattered. If you looked into space from the surface of the moon, you would have a clear view of the blackness of never-ending space. Different atmospheres make a sky look different. For example, if you looked up from Mars, the atmosphere would make the Martian sky look pink.

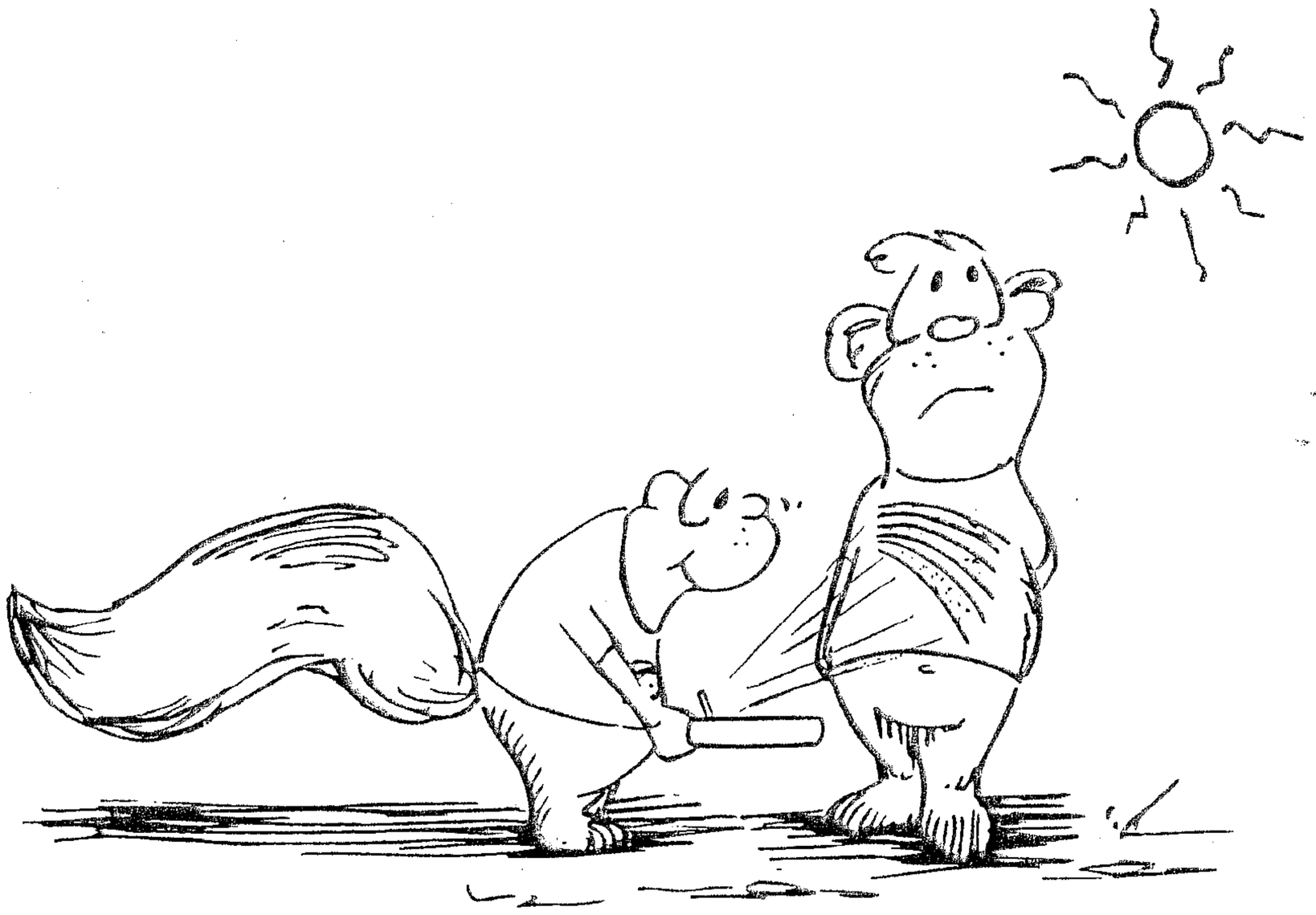
In this activity, the clear water represents the way space looks from the moon. When you stir milk into the water, you create an "atmosphere". The light is scattered and you can see faint colours. The more milk you add, the "thicker" the atmosphere, representing angled light having to travel through more of Earth's atmosphere. The colours you see move from one end of the colour spectrum (the blues) to the other end of the spectrum (pinks/reds).

Topics: Light; Atmosphere.

The Earth's atmosphere not only scatters light; it also refracts (bends) light. One result is that most heavenly bodies appear to be a bit higher in the sky than they actually are. The closer a body is to the horizon, the greater the effect. For example, you see the sun several minutes before it actually rises above the horizon in the morning. The bending of light rays also helps to make the sunset colourful. After the sun has gone below the horizon, sunlight still spills over the horizon. The light rays are bent in differing amounts and separate into bands of colour, like light being bent by a prism.

COLOURS OF THE RAINBOW

The light around you is made up of many colours. Use a prism to break the light into a mini-rainbow, and then make your own prism.



MATERIALS: Prism; flashlight or slide projector; white wall or white sheet of paper; mirror; pan of water; sunlight.

DOING IT:

1. Shine a beam of light on a white surface.

2. Put a prism in the path of the beam of light. What do you see? Which colour seems to bend the most as light passes through the prism? Which colour bends the least?

3. Place a pan of water in direct sunlight.

4. Place a mirror in the pan. Most of the mirror should be underwater. **Never look at the sun or its reflection in a mirror because you can permanently damage your eyes.** Tilt the mirror so that reflected sunlight falls on a white surface. The water should be still. What do you see on the white surface?

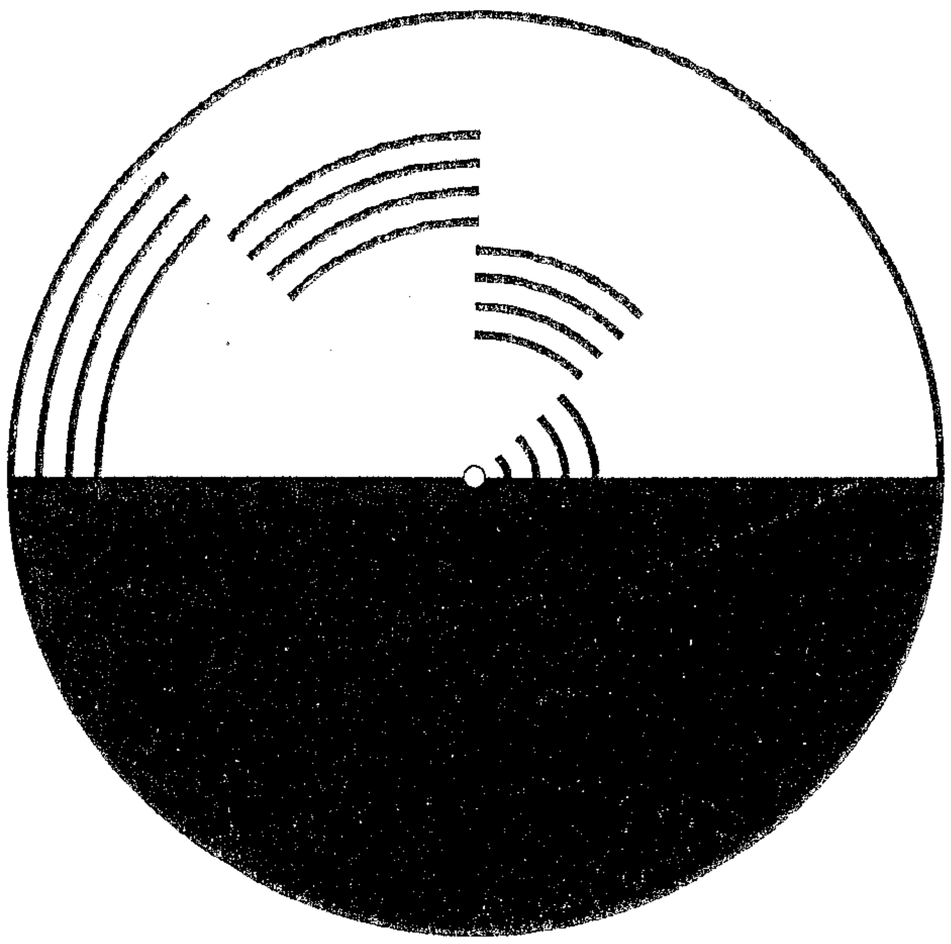
"Photons" are particles of energy that make up light. Visible, white light is made up of the colours of the rainbow: red, orange, yellow, green, blue, indigo, and violet (an easy way to remember these: ROY G. BIV). Each colour of light is made up of photons that carry a particular quantity of energy. For example, red-light photons each carry less energy than photons of blue light. Each colour also has its own wavelength. Violet has the shortest wavelength and red has the longest. A "prism" breaks visible, white light into a "spectrum", an arrangement of light separated according to wavelength, frequency, and energy. Light is bent (refracted) as it passes through the glass that makes up the prism. The prism bends different wavelengths of light to a different degree; violet is bent the most and red the least, with the rest of the colours in between. In a homemade prism, light rays are bent as they pass through the water. When conditions are right, water droplets in the air can act as a prism to separate the colours in sunlight -- that's when you get a rainbow. Sometimes you can see rainbows in fine sprays of water, like from a lawn sprinkler.

Topics: Light; Atmosphere.

MAKE TIME

Colour Disc

How do you change a black-and-white disc into a coloured disc? All you have to do is give it a little spin!



MAKE TIME

MATERIALS: Photocopy of disc illustrated (or draw a disc using a compass and black marker); glue; stiff cardboard; scissors; paper clip.

DOING IT:

1. Glue a photocopy of the disc illustrated on a piece of cardboard. Cut away the excess cardboard around the disc.

2. Make a small hole in the centre of the disc.

3. Bend up the outside end of a paper clip (so that you have a long, straight piece above the rest of the paper clip).

4. Hold the paper clip between your thumb and index finger so that the straight part sticks up. Slip the disc onto the straight part; the disc should rest on your thumb and index finger.

5. Spin the disc. What colours do you see? What happens to the colours when you spin the disc in the opposite direction?

How you see colour depends on two things: what's actually in front of you, and what your eyes perceive to be in front of you. Colour results from the ability of your eyes to distinguish between the different wavelengths or frequencies of light. The apparent colour of an object depends on the wavelength of light that it reflects. In white light, an opaque object that reflects all wavelengths looks white; an opaque object that absorbs all wavelengths looks black. When your eye receives repeated flashes of white light, your brain interprets the flashes as colour. That's why the black-and-white disc looks like it has coloured circles on it when the disc spins.

Topics: Light; Senses.

Colour depends on light. Colour isn't part of an object the way, for example, shape is. In a dark closet, an apple is still round, but it isn't red. It has no colour. If, while in the closet, you shine a bright blue light on the apple, it looks black. If you hold the apple in daylight, then it looks red.

The colour red attracts attention. That's why red is used for stop signs, danger signals, and brake lights. Its stimulating effect makes it a favourite colour for advertising and displays. Some scientific studies have shown that red in bedrooms can cause restlessness and insomnia.

Reflection

Write a reflection about what you have learned from doing these activities. Use complete sentences.