EXPERIMENT MANUAL

# SPACE EXPLORATION


THAMES & KOSMOS

**WARNING** — Science Education Set. This set contains chemicals and/or parts that may be harmful if misused. Read cautions on individual containers and in manual carefully. Not to be used by children except under adult supervision.

# WARNING!

- Individual parts in this kit may have sharp points, corners, or edges. Do not injure yourself!
- Not suitable for children under 3 years. There is a danger of suffocation due to small parts, small balls, and balloons that may be swallowed or inhaled.
- Save the packaging and instructions, as they contain important information.

## WARNING: CHOKING HAZARD

Children under 8 years can choke or suffocate on uninflated or broken balloons. Adult supervision required. Keep uninflated balloons from children. Discard broken balloons at once. Not for children under 3 years. Use an air pump to inflate the balloon. Made of natural rubber latex.

## Rules for safe experimentation

- Carefully prepare your workplace for the experiments. Be sure that you have enough room and get everything ready that you might need.
- Carry out the experiments calmly and carefully, and follow the instructions precisely.
- Read the instructions before use, follow them, and keep them ready for reference.
- Never shine your flashlight directly into your eyes or the eyes of another person.
- For experiments that are to be performed in a darkened room, be sure to clear away any tripping hazards first.
- Keep young children and pets away from the experiments.
- Store the experiment kit out of the reach of young children.
- Save the packaging and instructions, as they contain important information.
- We reserve the right to make technical changes.

# Dear Parents,

The sun, moon, and stars have intrigued humankind for thousands of years. This experiment kit turns humans' celestial fascination into a series of hands-on experiments for children, in order to teach them a basic knowledge of astronomy and space exploration. This kit invites them to explore exciting questions such as why the moon appears to change shape, how a rocket works, and why solar eclipses occur. In this experiential way, your child can increase and deepen his or her academic understanding of this topic.

The experiments in this kit are designed to be very easily understood, so that your child should have no trouble following them. Depending on your child's age and knowledge of these topics, however, it is recommended that you choose appropriate experiments when starting out. In the event that your child is not able to understand or do something properly, please lend them your assistance. Talk through questions with them, and help them execute the experiments. For example, your child may need help in gluing parts together.

The kit contains all of the specialized parts essential to the experiments. For some experiments, your child will need additional materials that are commonly found in the household, such as glue. For each experiment, there is a list showing exactly what parts are needed. The materials that are not included in the kit are listed in italics after those that are included.

Generally, the moon and stars can only be observed in the dark. Make it possible for your child to observe the sky from a location that is as dark as possible, without strong extraneous light. Please accompany them on any stargazing outings.

Please note that some of the parts in the kit are quite small. Due to these swallowable small parts, the kit should be kept out of the reach of young children, as well as pets. In some experiments, additional safety tips should be followed. These are clearly emphasized and marked. Please be sure that your child follows these safety tips.

We wish you and your child an exciting journey of discovery into the world of astronomy and hope you have a lot of fun with this experiment kit.

## What's in your experiment kit:


## **Checklist:** Find – Inspect – Check off

| ✔ | No. | Description | Qty. | Item No. |
|---|---|---|---|---|
| ☐ | 1 | Graduated beaker | 2 | 061150 |
| ☐ | 2 | Drinking straw | 3 | 000414 |
| ☐ | 3 | Ocular lens | 1 | 701378 |
| ☐ | 4 | Field lens | 1 | 701780 |
| ☐ | 5 | Objective lens | 1 | 701379 |
| ☐ | 6 | Polystyrene foam ball | 1 | 000172 |
| ☐ | 7 | Paper ball | 1 | 701383 |
| ☐ | 8 | Wooden skewer | 2 | 020042 |
| ☐ | 9 | Two-pronged fastener | 1 | 020039 |
| ☐ | 10 | Modeling clay | 1 | 000588 |
| ☐ | 11 | Bag of balloons | 1 | 701392 |
| ☐ | 12 | Rocket | 1 | 701450 |
| ☐ | 13 | Launch pad for rocket | 1 | 701451 |
| ☐ | 14 | Rubber band | 2 | 700420 |
| ☐ | 15 | Die-cut cardboard sheet I, panels 1 and 2 (thick cardboard) | 1 | 704464 |
| ☐ | 16 | Die-cut cardboard sheet II, panels 1 to 5 (thin cardboard) | 1 | 704463 |
| ☐ | 17 | Constellation sheet | 1 | 704465 |
| ☐ | 18 | Moon flip-book sheet | 1 | 704466 |

### Additional things you will need:

*Scissors, adhesive tape, glue, nylon string or sewing thread, tear-proof string, effervescent tablets/powder, or baking powder, 2 large paper clips, ruler, flashlight, measuring tape, thumbtacks, felt-tip markers, pencil, yellow crayon, permanent marker, paper, compass for drawing circles, flour, black paper, aluminum foil, blow-dryer, heat-resistant mat, compass for determining direction (optional)*

Any materials not contained in the kit are marked in *italic script* in the "You will need" boxes.

→ Before doing anything else, please check all the parts against the list to make sure that nothing is missing.

→ If you are missing any parts, please contact Thames & Kosmos customer service.

CONTENTS



**CHECK IT OUT**

You will find supplemental information on pages 10, 15, 19, 30, 43, 47, and 48.

# 3, 2, 1...Blast Off! Rockets

The study of the sun, moon, solar system, and stars has made incredible progress as a result of space travel. With the aid of satellites, huge space telescopes, and rockets, we have made a lot of exciting discoveries in space, but there are still many things left to learn. Who knows, perhaps you may be one of the scientists who explores outer space one day! On the pages that follow, you will find out what propels rockets.


NASA's Delta II rocket blasts off.
Photo: NASA/Sandra Joseph and Rafael Hernandez

EXPERIMENT 1

# Air balloon rocket

## YOU WILL NEED

- → oblong balloon
- → drinking straw
- → balloon clip from die-cut cardboard sheet (I)
- → *strong, thin string with a smooth surface (dental floss or nylon string)*
- → *scissors*
- → *adhesive tape*

## HERE'S HOW

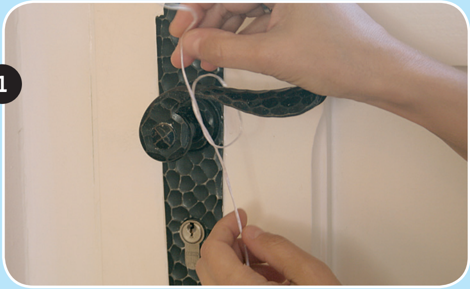
1. Detach the balloon clip from the die-cut sheet. Cut a piece of string at least 3 meters (10 feet) long. Tie one end to a doorknob.

2. Pull the free end of the string through the drinking straw, as shown in picture 2.

3. Blow the balloon up and secure the end using the balloon clip. It's easier if someone helps.

4. Hold the balloon against the drinking straw, with the balloon clip facing toward you, and attach the straw to the balloon using a couple of strips of adhesive tape.

1



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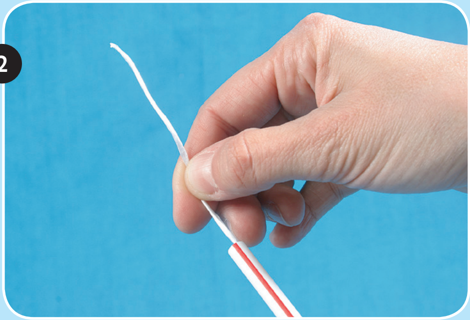

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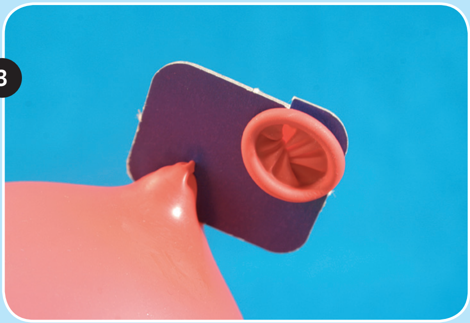

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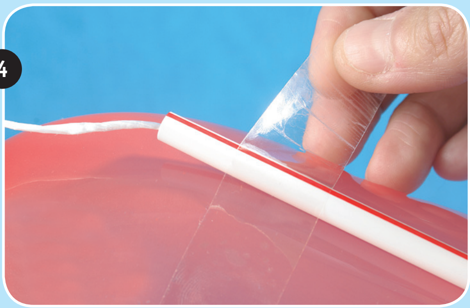
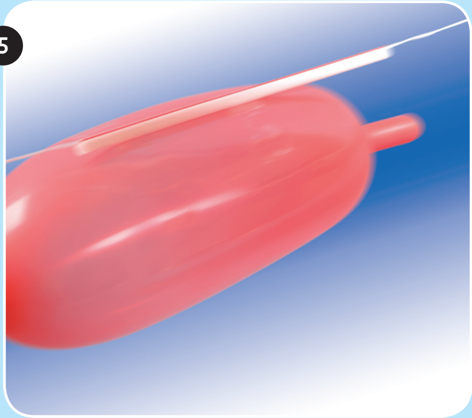


EXPERIMENT 1

# Air balloon rocket



## HERE'S HOW IT CONTINUES

5. Holding the string, walk away from the door until the string is taught. Hold the string so it runs diagonally upward from your hand to the doorknob, allowing the balloon to rest against your hand. Detach the clip from the balloon, but hold the mouth of the balloon closed. When you're ready, let go of the balloon, and watch it travel up the string like a rocket!

### → WHAT'S HAPPENING?

The balloon contains compressed air that presses against the skin of the balloon in all directions. As soon as you let the opening go, the air flows out of the opening at high speed as it decompresses. This causes the air balloon rocket to travel up the string. This type of propulsion is based on the recoil principle, or Newton's law of reciprocal actions. This law states that every force produces an equal counterforce that always acts in the opposite direction.

If, for example, you roll one marble toward another with a lot of force, when they collide, both marbles move — the one that is impacted rolls forward, whereas the one that impacts rolls backward. If you press your hand against the wall, the wall presses back with the same force. After all, if no counterforce came into play, then you could push the wall over with the force of your hand!

In your air balloon rocket, the exiting air acts as a downward force, and the counterforce pushes the rocket upward.

The amount of force with which the exiting air propels your rocket depends on how much air is compressed in the balloon. You can test this out yourself. Launch your rocket several times, filling up the balloon with a different amount of air each time. You can also try making the rocket fly more or less steeply by holding the string at different angles.

You will notice that the amount of air in the balloon and the string's angle of inclination have an influence on the speed and range of your balloon rocket.

EXPERIMENT 2

# Pressurized air rocket

## YOU WILL NEED

→ red rocket
→ drinking straw


1

## HERE'S HOW

1. Insert the end of the straw into the opening on the bottom of the rocket. Make sure that the rocket's flight path is clear of people and breakable objects. Do not aim the rocket at anyone, especially not near anyone's eyes or faces, and make sure that rocket will not land on a hard surface.

2. Hold the straw at a diagonal angle, with the rocket pointing upward, and blow hard into the open end of the straw.

### → WHAT'S HAPPENING?

The rocket lifts off and flies away in a high arc because you abruptly increased the air pressure in the rocket as you blew into the straw. The air pushes the rocket off the straw and up into the air. When an object is propelled by an external force, it is called a projectile. Another example of a projectile is a cannonball fired from a cannon. The exploding powder in the barrel of the cannon creates pressure, making the cannonball fly out. Your pressurized air rocket is not a true rocket, but a projectile, because the force that propels it comes from outside. Rockets are only considered true rockets when they are propelled according to the recoil principle.

EXPERIMENT 3

# Chemically propelled rocket

## YOU WILL NEED

→ rocket
→ launch pad
→ graduated beaker
→ *effervescent tablets (vitamin C, antacid, or similar tablets), baking powder, or effervescent powder*
→ *water*

1

## HERE'S HOW

It is best to perform this experiment in an open, outdoor space where water and the remains of the effervescent substance cannot do any damage, and your rocket has plenty of room to fly. Ask an adult to assist you!

1. Place the launch pad on a large, soft, level surface like a lawn, for example, so that the rocket doesn't break during landing.

2. If you are using effervescent tablets, break them up and place several pieces into the opening on the bottom of the rocket. If you are using effervescent powder or baking powder, put one tablespoon into the rocket.


2

**Safety Tip:** Never hold the rocket when it is launching! Never bend over the rocket when it is ready to launch, and always maintain plenty of distance during its flight. If the rocket does not launch, do not pick it up. Only an adult should separate the rocket from the launching pad, because it could still be under pressure. Keep young children and pets away. After launching, pour out the liquid, and do not drink it! Clean the rocket thoroughly after each launch.

**Note:** You can launch your rocket with effervescent tablets, effervescent power, or baking powder.

EXPERIMENT 3

# Chemically propelled rocket

## HERE'S HOW IT CONTINUES

3. Fill the launch pad (propellant chamber) up to the brim with water. As quickly as possible, firmly attach the rocket to the launch pad, and take two steps back. Make sure that no one is in the launch area, flight path, or landing area of your rocket. Initiate the countdown, and soon your rocket will lift off! It is propelled into the air under the high pressure.

### → WHAT'S HAPPENING?

After a very short time, the rocket begins its ascent. It is propelled by the gas carbon dioxide, also known as $CO_2$. This nontoxic gas is also responsible for the little bubbles in sparkling water and soft drinks.

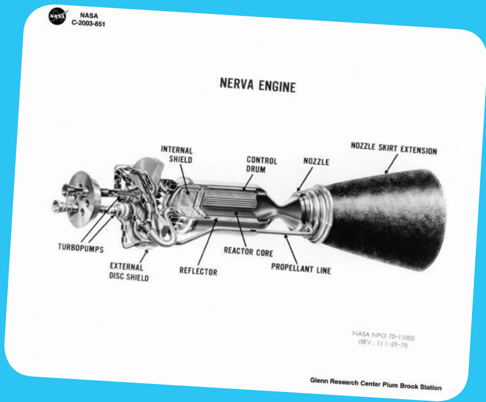
When you attach the rocket to the launch pad, the effervescent tablet, effervescent powder, or baking powder falls into the propellant chamber and mixes with the water, creating a violent chemical reaction. The tablet or powder contains sodium bicarbonate and citric acid — just look at the ingredient list on the packaging! These two substances react with each other in water and form the gas carbon dioxide ($CO_2$), which creates a lot of pressure in the launch pad. The pressure shoots the rocket into the air like a champagne bottle shoots off its cork.

Baking powder — which also causes cakes to rise during baking — contains a weak acid. Like effervescent tablets and powder, it does not react in a dry state. When it mixes with water, carbon dioxide ($CO_2$) is formed.

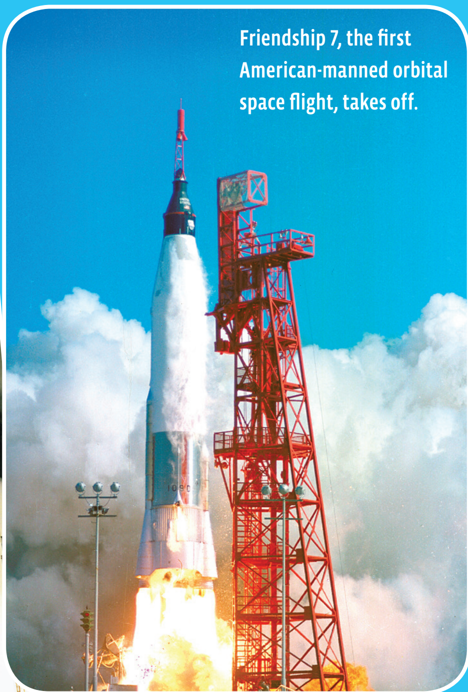
CHECK IT OUT

# Combustible Gases in Space

Space rockets are propelled by the recoil principle. These rockets don't push themselves away from Earth or the air in the atmosphere; they fly according to the recoil principle. This is why rockets are also able to fly in the airless vacuum of space. However, space rockets aren't propelled by air, like in our experiments, but rather with exhaust gases that are created by burning propellants. The exhaust gases exit from the bottom of the rocket and form a kind of cushion that produces the necessary counterforce to push the rocket forward.

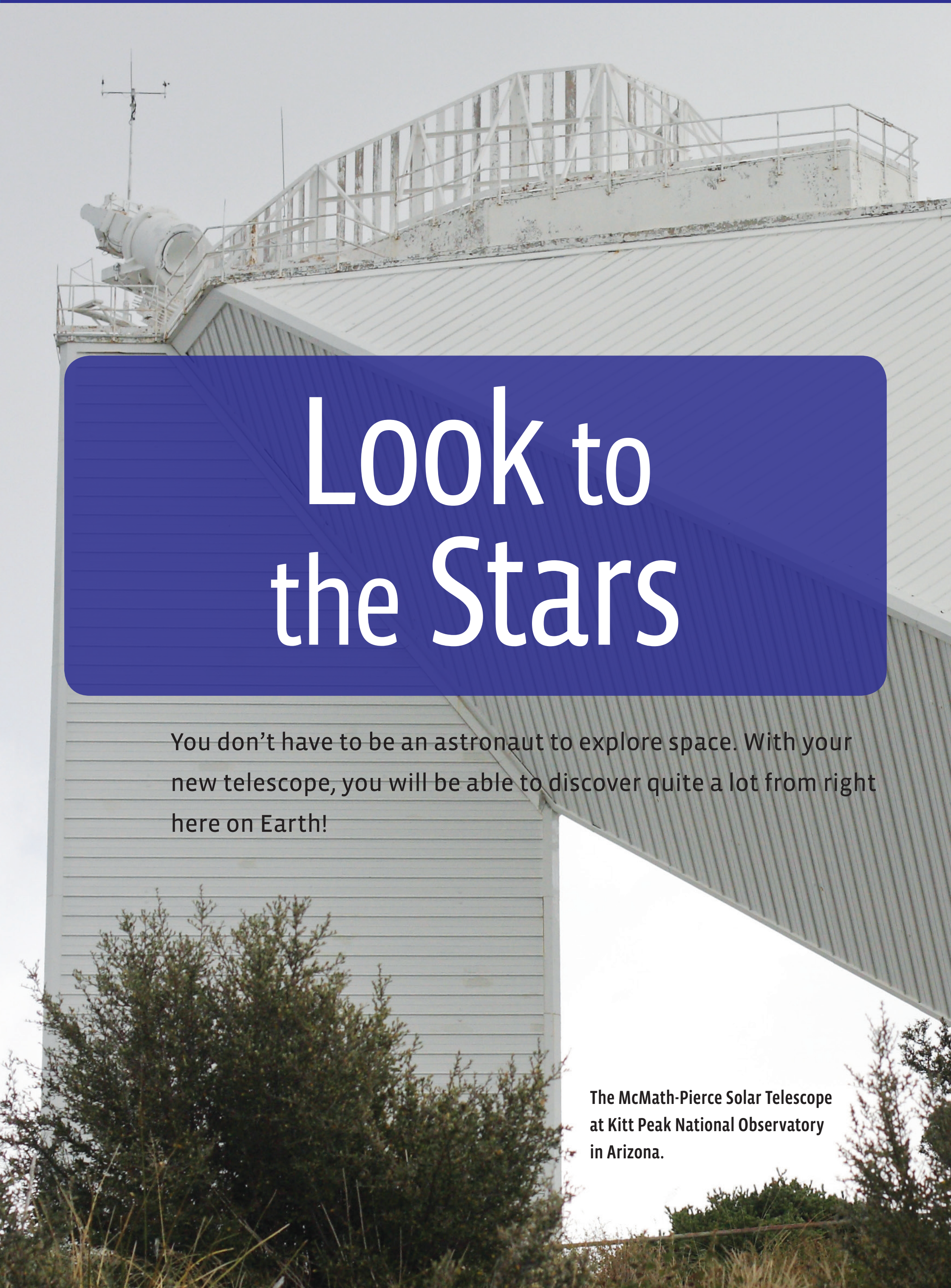



↑ This diagram shows a rocket engine from 1970. Liquid hydrogen shot out of the nozzle to produce thrust.



Friendship 7, the first American-manned orbital space flight, takes off.

← Titan IVB/Centaur, carrying the Cassini orbiter and the Huygens probe, lifts off for its seven-year odyssey.



# Look to the Stars

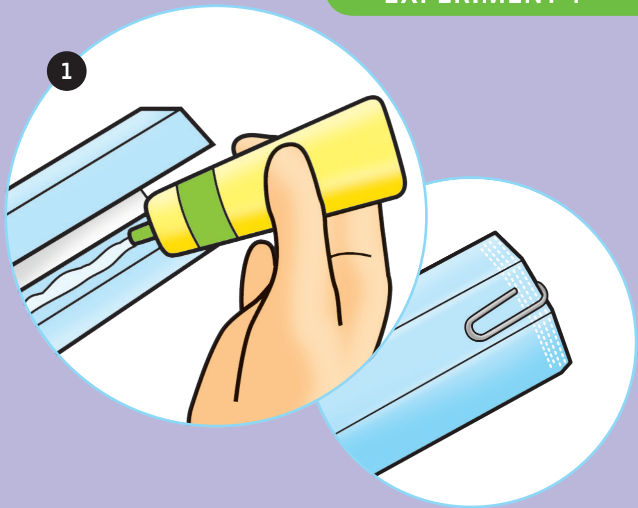
You don't have to be an astronaut to explore space. With your new telescope, you will be able to discover quite a lot from right here on Earth!

**The McMath-Pierce Solar Telescope at Kitt Peak National Observatory in Arizona.**

# Build a telescope

## YOU WILL NEED

→ 2 tubular parts (objective tube and ocular tube) from die-cut cardboard sheets (II—1 and 3)
→ 3 lens holders from die-cut sheets (II—2 and 4)
→ 3 lenses
→ *glue or adhesive tape*
→ *2 large paper clips*
→ *long ruler*

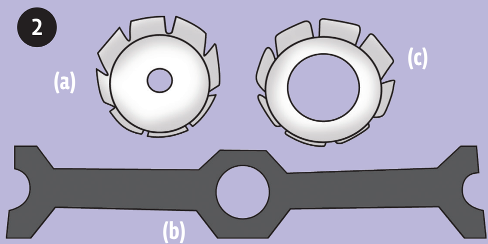


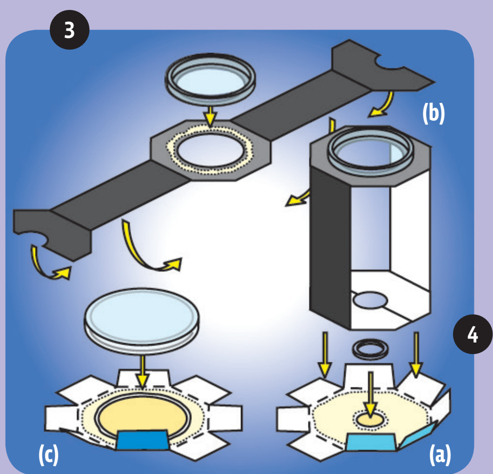

## HERE'S HOW

1. Detach the parts from the die-cut sheets. Fold the objective and ocular tubes along the specified lines, and glue the overlapping flaps together, as in picture 1. Use a paper clip to hold the glued flaps together while drying. You may also want to use a ruler to press the glued flaps together.

2. Fold the three lens holders along the specified lines, and pair each lens with its holder. The smallest lens, the ocular lens, will go into the light blue ocular lens holder (a); the medium lens, the field lens, will go into the long field lens holder (b); and the largest lens, the objective lens, will go into the dark blue objective lens holder (c).

3. Apply glue around the opening of each lens holder. Make sure you apply glue to the unprinted sides of the ocular and objective lens holders. Affix the objective lens to its holder with its curved side facing down. Affix the ocular and field lenses to their holders with their curved sides facing up.




**Safety Tip:** CAUTION! Never look at the sun, either with your naked eye or with the telescope. It can blind you. Never place the optical lenses in direct sunlight either. It is a fire hazard.

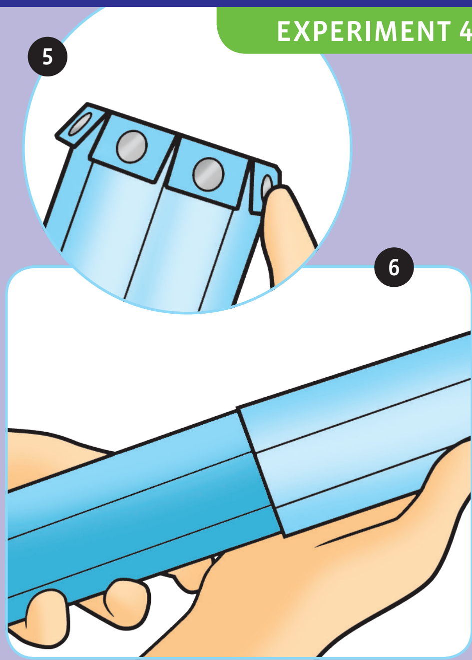
EXPERIMENT 4

# Build a telescope

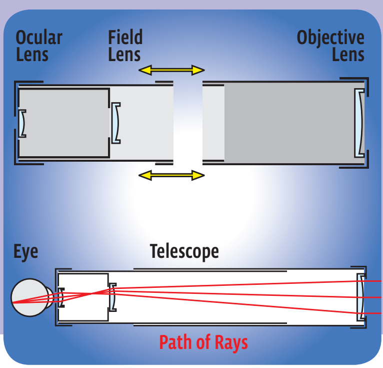
4. Glue the bottom of the long field lens holder to the unprinted side of the light blue ocular lens holder.

5. Push the long holder with the field and ocular lenses into the narrower ocular lens tube, field lens first, and glue the flaps of the ocular lens holder to the outside of the tube. Position the objective lens holder at the end of the wider objective lens tube, and glue the holder flaps to the outside of the tube.

6. Slide the open end of the narrower tube into the open end of the wider tube.




To use the telescope, look through the small ocular lens. By carefully moving the tubes, you can bring images into focus. Practice focusing in daylight. To keep the telescope as still as possible, you can place it on a forked branch, fence, chair, or tripod. When you look through the telescope, you may be surprised to see that everything is upside down. That is typical of a Kepler telescope. When observing the night sky, this doesn't matter, because the sky doesn't have an up or down side.




## → WHAT'S HAPPENING?

Your telescope has a magnification of about ten times. This is why things that are far away appear closer and clearer. You can see craters on the moon much better with the telescope than with the naked eye.

Your telescope contains three lenses. The large one in the front, the objective lens, bundles the weak light from the stars together into its focal point. An intermediate image is first formed here, but it cannot yet be seen with the small ocular lens, which magnifies the image. First, the field lens, an illuminating lens, guides the light from the intermediate image onto the ocular lens. So what you see through the ocular lens is actually an enlargement of the image that is caught by the objective lens!

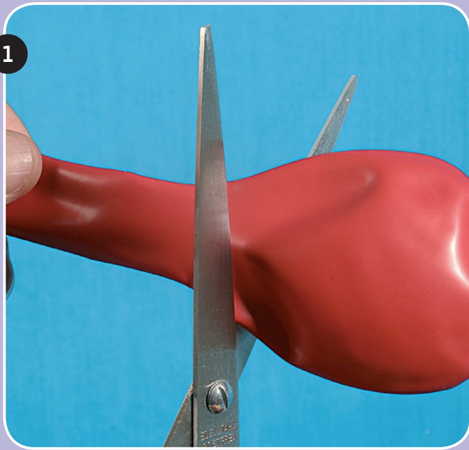
EXPERIMENT 5

# Stargazing light

## YOU WILL NEED

→ red balloon
→ rubber band
→ *flashlight*
→ *scissors*

1



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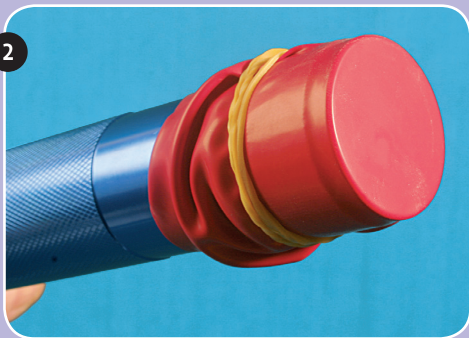


## HERE'S HOW

To study the sky in the dark and take notes without straining your eyes, you can use of this observational flashlight.

1. Cut off the open end of the balloon, as shown in picture 1, and discard it.

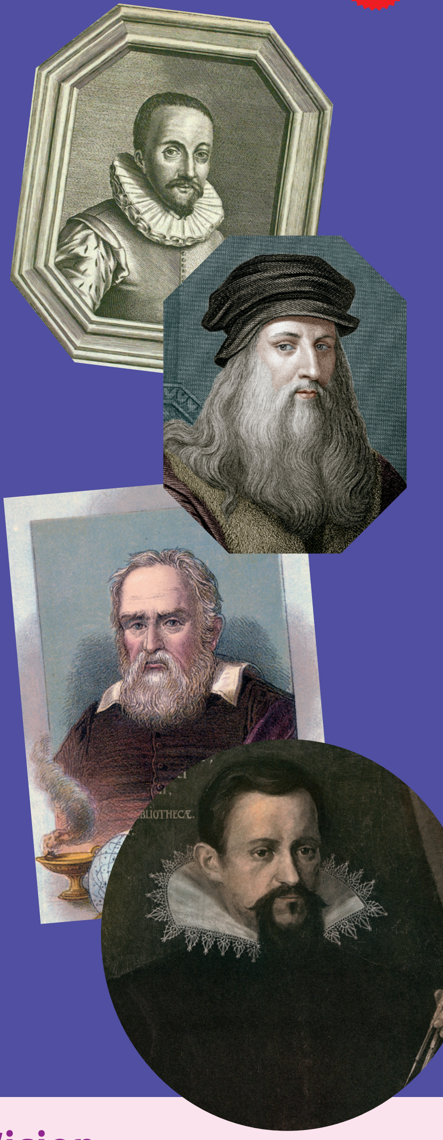
2. Pull the balloon over the top of the flashlight so that the light source is completely covered. Wrap the rubber band around the balloon and flashlight to hold the balloon in place. If you are using a large flashlight, you may also wish to use some adhesive tape to secure the balloon. Have an adult help you with this.

## → WHAT'S HAPPENING?

When you go back and forth between light and dark, your eyes have to adjust after each transition. Using a red light instead of a bright white light to read or take notes in the dark makes the adjustment easier, so you don't strain your eyes.

CHECK IT OUT

# WHO INVENTED THE TELESCOPE?

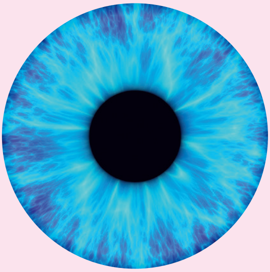



Sometimes, it's not clear who invented something first. For a long time, the eyeglass maker **Hans (Jan) Lippershey**, who worked in the Netherlands, was considered the inventor of the telescope. As the story goes, he held several eyeglasses in front of one another and accidentally discovered that they magnified things in the distance.

We know now, however, that **Leonardo da Vinci**, the Italian Renaissance genius, experimented with lenses about a hundred years earlier than Lippershey, and built a small, weakly magnifying telescope.

In 1609, **Galileo Galilei** pointed his own telescope toward the sky — and discovered astounding things: that the moon, which was hitherto thought of as a smooth ball, displayed craters and mountains; that several moons orbited the planet Jupiter; and that the Milky Way was made up of countless stars.

The astronomer **Johannes Kepler** published an important optics textbook in 1611, in which he explained how a telescope works and proposed a better way of constructing a telescope than the techniques of his predecessors. His astronomical telescope turned everything upside down, but in astronomy that doesn't really matter.



## Visual Purple for Vision

Small cells in your eyes called rods are responsible for making it possible for you to see at night in black and white. In order to work well, they need a pigment called **rhodopsin**, or **visual purple**. Without it, you could hardly see anything at night. When we go into the dark, visual purple forms and our eyes grow accustomed to the darkness. When we go back into the light, the pigment dissipates.

# Our Solar System

You probably know that the Earth revolves around the sun. Earth is a planet. Planets are celestial bodies that travel around a sun on a fixed orbit. But Earth isn't the only planet that orbits our sun. Seven other planets also follow orbits around our sun: Mercury, Venus, Mars, Jupiter, Saturn, Uranus, and Neptune. Together with Earth, they make up our solar system.

A montage of photographs of planets taken by NASA's Voyager mission

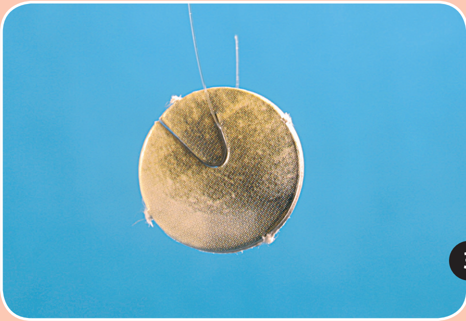
EXPERIMENT 6

# Solar system mobile

## YOU WILL NEED

- → 8 planets and 9 labeled mobile tags from the die-cut cardboard sheet (I—1 and 2)
- → yellow balloon
- → *scissors*
- → *string or yarn*
- → *fishing line or sewing thread*
- → *measuring tape*
- → *2 thumbtacks*

1

3

## HERE'S HOW

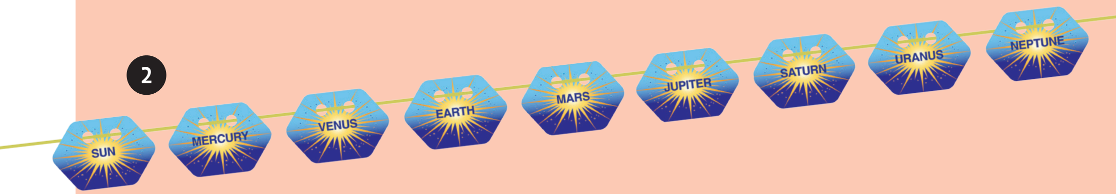
The planets in our solar system each have their own orbit at a fixed distance from the sun. This solar system mobile will show their order.

1. Cut a piece of string or yarn at least 3 meters (10 feet) long. Detach the mobile tags with the planet names from the die-cut sheet. Thread the string through the holes in the tags in the order shown below.

2. Leave about 20 centimeters (8 inches) of space between each name tag and at either end of the string, so you can hang up the mobile later.

3. Cut nine pieces of fishing line or sewing thread, each about 40 centimeters (16 inches) long. Starting with Mercury, detach the planets from the die-cut sheet one at a time, in the order of the labeled tags, and insert the end of one piece of fishing line or thread into the slit on the planet. Only detach and work with one planet at a time so they don't get mixed up.

2




Sun Mercury Venus Earth Mars Jupiter Saturn Uranus Neptune

EXPERIMENT 6

# Solar system mobile

## HERE'S HOW IT CONTINUES

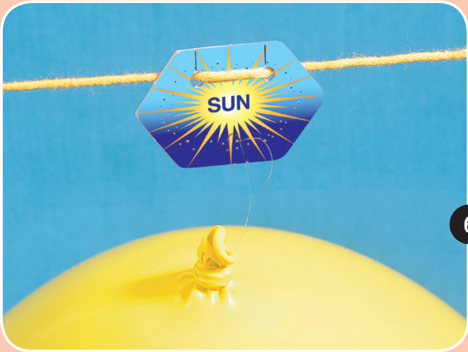
4. Insert the other end of the fishing line or thread into the slit on the planet's labeled tag.

5. One by one, attach all the planets to their tags. Make sure the planets are not hitting one another by pulling the ends of the fishing line or thread further through the slits to adjust their length.

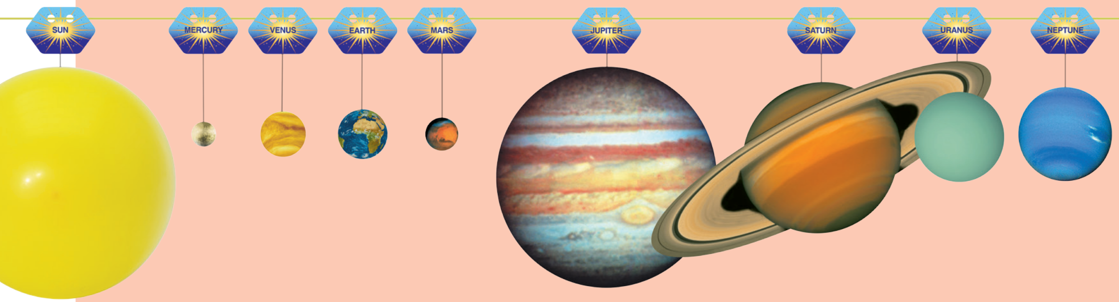
6. Blow up the round yellow balloon and knot the end. Tie the last piece of fishing line or thread to the knotted end, and insert the other end of the line into the slit on the sun tag.

7. Hang up your mobile. It's best to attach the mobile with thumbtacks to adjacent walls. Make sure you ask permission before you put thumbtacks into the walls, and ask for help from an adult to hang your mobile.

4


6

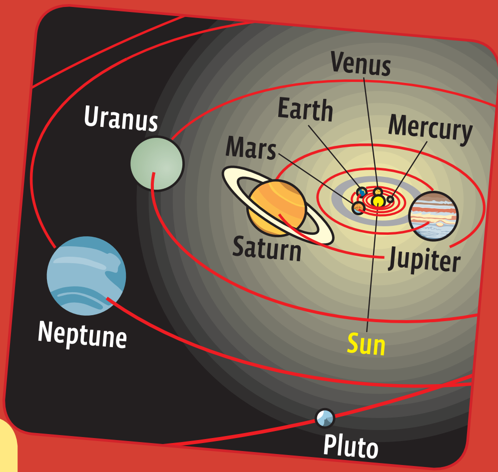


CHECK IT OUT

# SOLAR SYSTEM FACTS

Our solar system is made up of the sun, eight planets, and a lot of other stuff, like dwarf planets — very small planets — and moons. A moon is a celestial body that orbits around a planet. There are hundreds of moons in our solar system.

Our solar system is not the only one in the universe. The universe contains billions of other suns. All of the stars that you see in the sky are actually suns. Perhaps there is even a planet somewhere that looks just like Earth!




## A More Accurate Model

Distances in space are unimaginably large, even the distance between planets in our solar system. To get an impression of how large these distances are, line up with eight of your friends along a very long sidewalk. Have each person hold one of the planets or the sun from your mobile. The person with the sun starts the line. Have each person holding a planet take the corresponding number of steps away from the person with the sun: Mercury, 6; Venus, 11; Earth, 15; Mars, 23; Jupiter, 78, Saturn, 140; Uranus, 287; and Neptune, 450. Now you can see how far apart the planets really are!

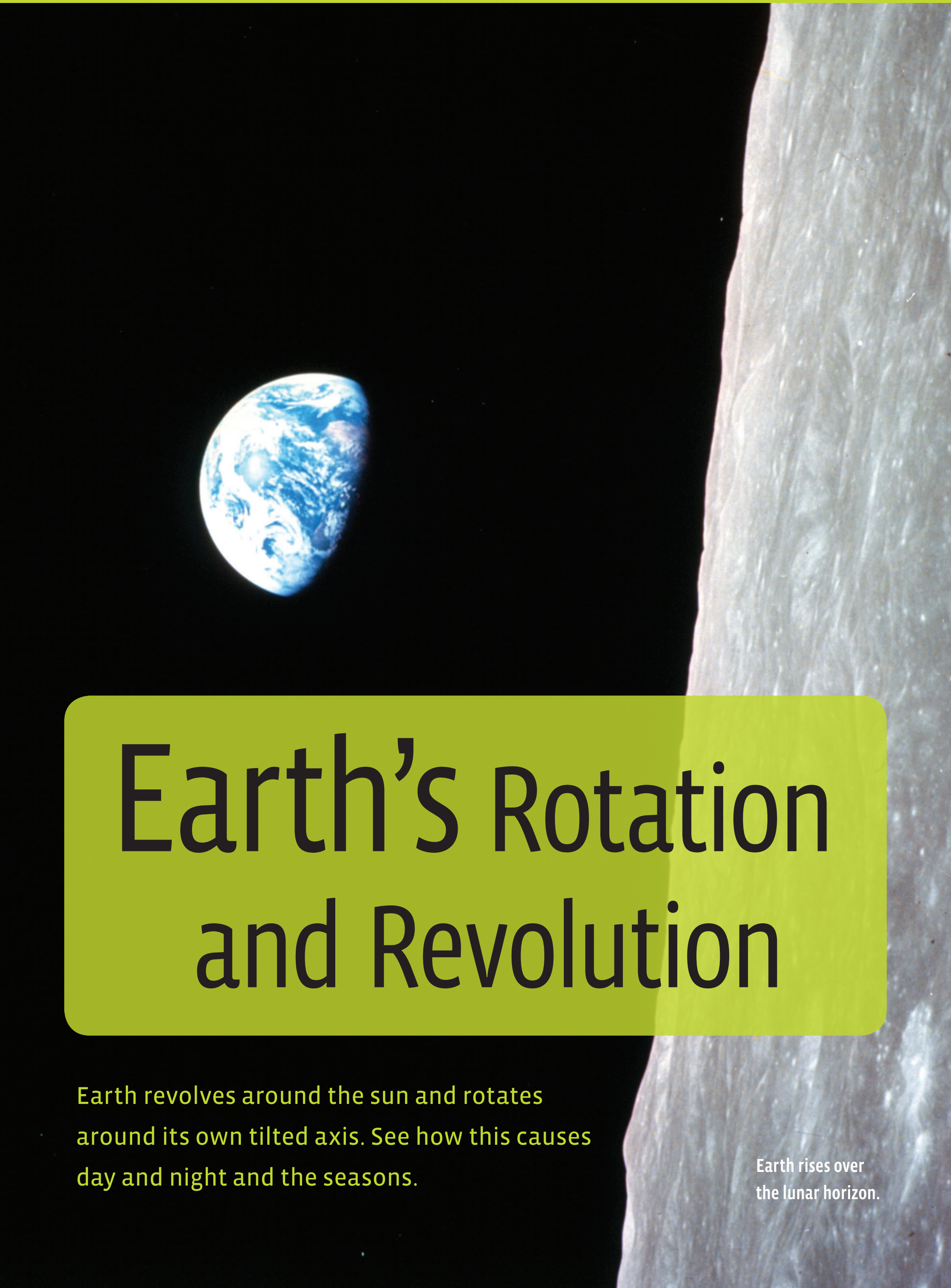
## AND THEN THERE WERE EIGHT...

Until recently, Pluto was considered the ninth planet in our solar system. In the fall of 2006, however, a group of scientists at a worldwide conference decided that Pluto is really a dwarf planet. Other dwarf planets include Ceres and Eris. Pluto is so far from Earth that it would take 16 years to travel there by spaceship!

## Important Solar System Data

| NAME | DIAMETER (IN MILES) | DISTANCE FROM THE SUN (IN MILLIONS OF MILES) | ORBITAL PERIOD: DURATION OF A YEAR (IN EARTH TIME) | ROTATIONAL PERIOD: DURATION OF A DAY (IN EARTH TIME) | NUMBER OF MOONS |
|---|---|---|---|---|---|
| SUN | 864,900 | | | | |
| MERCURY | 3,032 | 36 | 88 DAYS | 59 DAYS | 0 |
| VENUS | 7,521 | 67 | 225 DAYS | 243 DAYS | 0 |
| EARTH | 7,926 | 93 | 365 DAYS | 23 HRS. 56 MIN. | 1 |
| MARS | 4,221 | 142 | 687 DAYS | 24 HRS. 37 MIN. | 2 |
| JUPITER | 88,846 | 484 | 12 YEARS | 9 HRS. 55 MIN. | 63 |
| SATURN | 74,897 | 891 | 29 YEARS | 10 HRS. 34 MIN. | 62 |
| URANUS | 31,763 | 1,785 | 84 YEARS | 17 HRS. 14 MIN. | 27 |
| NEPTUNE | 30,775 | 2,793 | 164 YEARS | 16 HRS. 6 MIN. | 13 |

All figures are approximate. This is a constantly evolving field, and it's impossible to perfectly measure these diameters and distances with today's technology. Even the number of moons changes as new moons are discovered.



# Earth's Rotation and Revolution

Earth revolves around the sun and rotates around its own tilted axis. See how this causes day and night and the seasons.

Earth rises over the lunar horizon.

EXPERIMENT 7

# Day and night

## YOU WILL NEED

→ polystyrene ball
→ wooden skewer
→ modeling clay
→ *flashlight*
→ *colored felt-tip markers*

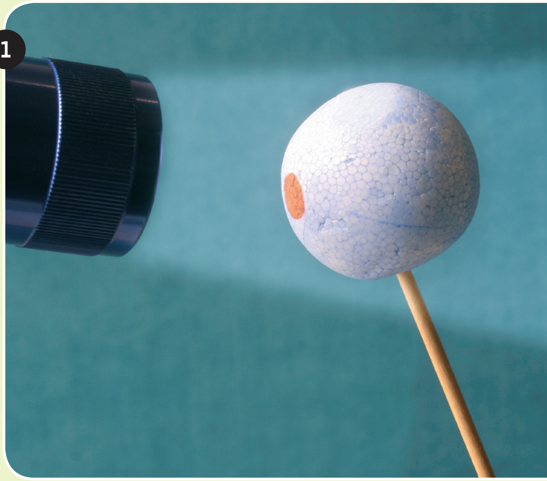
## HERE'S HOW

When you get out of school, children in other parts of the world are going to bed or just getting up. You can see why it's daytime where you are and nighttime where they are using your very own Earth model.

1. Draw a clearly visible dot on the polystyrene ball. If you want to, you can also color the ball to look like Earth. Stick the sharp tip of the wooden skewer through the bottom of the ball to act as Earth's axis. Using the modeling clay, form a stand, and stick the blunt end of the skewer into the stand at a slight angle. Turn out the lights, and then turn on the flashlight so the dot you drew is illuminated.

2. The flashlight represents the sun, and the dot represents the place on Earth where you are. Now, slowly rotate, or turn, the ball on its axis.
   What happens to your dot?

1



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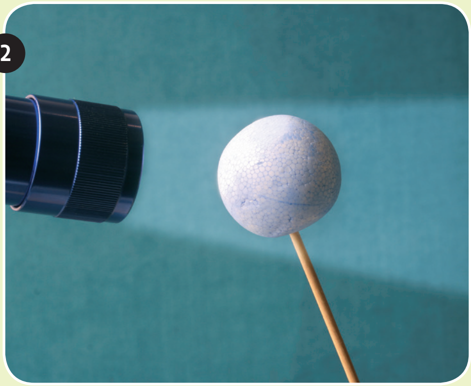


### → WHAT'S HAPPENING?

The light only reaches the side of the ball that faces the flashlight, while the other side remains dark. The same thing happens on Earth. The sun only shines on one side of the planet at a time. As the Earth rotates on its axis, the sun shines on different parts of the world, making it daytime in some parts of the world while it's nighttime in others.

EXPERIMENT 8

# The seasons

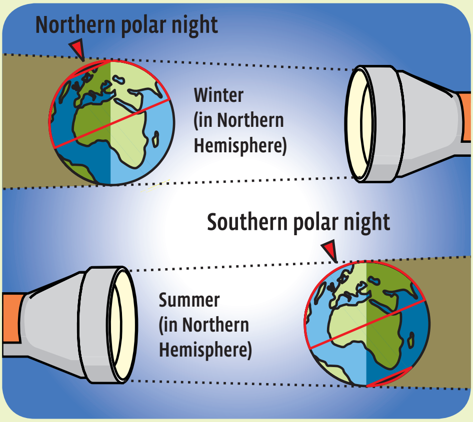
## YOU WILL NEED

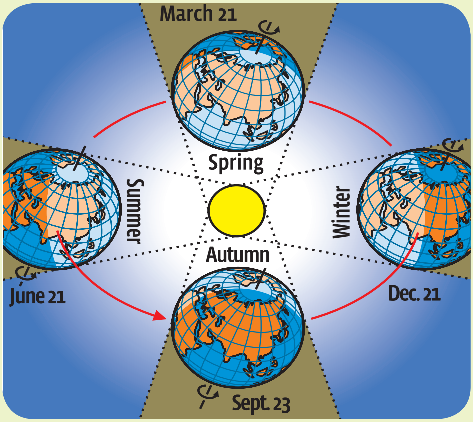
→ polystyrene ball
→ wooden skewer
→ modeling clay
→ *flashlight*
→ *colored felt-tip markers*

## HERE'S HOW

Earth takes 24 hours — one day and one night — to rotate one full rotation on its own axis. However, to travel once around the sun, Earth takes a whole year. Earth remains tilted on its axis as it travels around the sun. You can see how this affects the seasons in this experiment.

1. Set up the polystyrene ball with the clay and the skewer as described in the previous experiment. Turn out the lights and turn on the flashlight so it is pointing at the ball. Holding the flashlight level, circle the ball with the flashlight, observing what happens at the top and bottom of the ball, where the poles would be on Earth.



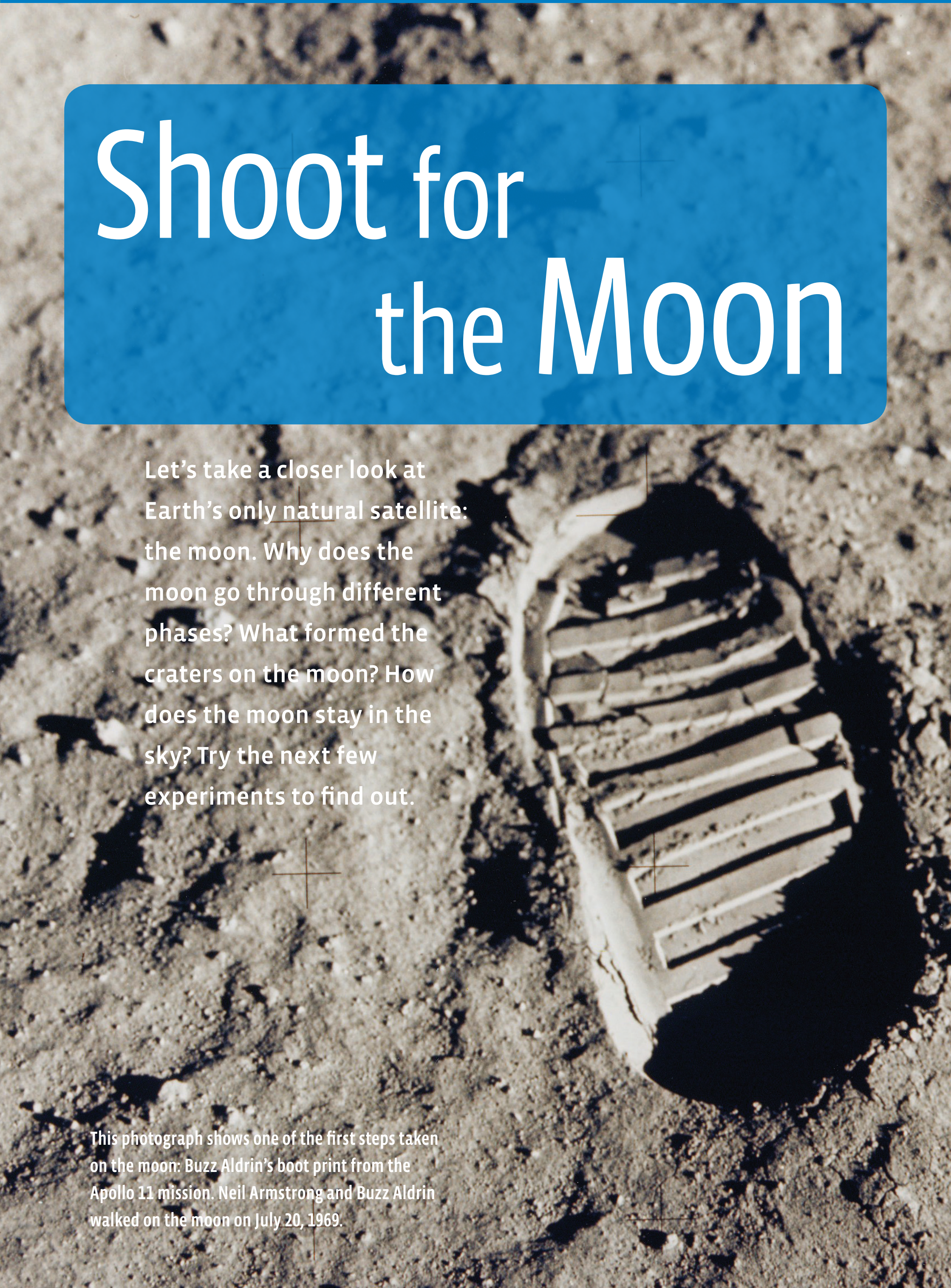




### → WHAT'S HAPPENING?

Over the course of a year — a complete orbit around the sun — sometimes the top half of the Earth, the Northern Hemisphere, is tilted toward the sun, and sometimes the bottom half, the Southern Hemisphere, is. The hemisphere tilted toward the sun warms up more than the hemisphere that tilted away. In the warmer hemisphere it's summer, while it's winter in the colder hemisphere.

### What is polar day and night?

As you circled the ball with the flashlight, you may have noticed that the top of the ball, where the North Pole would be on Earth, is illuminated for half the circle and dark for the other half. On Earth, this phenomenon is called polar day and polar night. Because of the tilt of Earth's axis, for half the year, in the summer, the pole is illuminated all the time (polar day), and half the year, in the winter, it's dark all the time (polar night). The same phenomenon occurs at both poles; when it's polar day at the North Pole, it's polar night at the South Pole, and vice versa.



# Shoot for the Moon

**Let's take a closer look at Earth's only natural satellite: the moon. Why does the moon go through different phases? What formed the craters on the moon? How does the moon stay in the sky? Try the next few experiments to find out.**

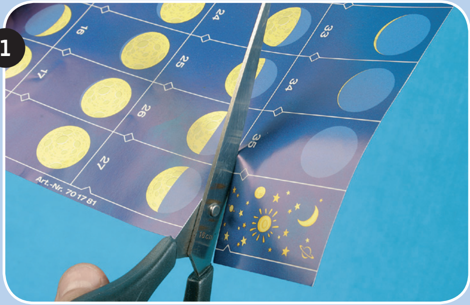
This photograph shows one of the first steps taken on the moon: Buzz Aldrin's boot print from the Apollo 11 mission. Neil Armstrong and Buzz Aldrin walked on the moon on July 20, 1969.

EXPERIMENT 9

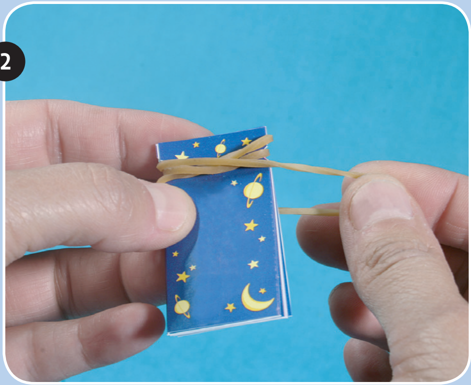
# The phases of the moon, part I

## YOU WILL NEED

→ moon flip-book sheet
→ rubber band
→ *scissors*




1



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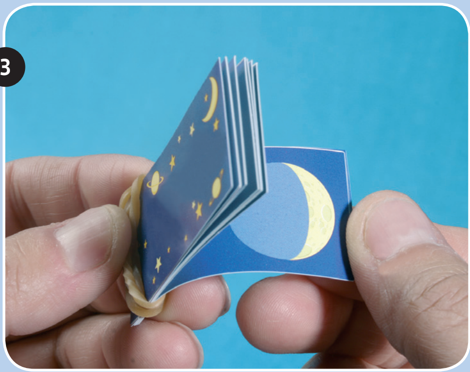


3

## HERE'S HOW

With your moon phase flip book, you can see all the phases of the moon — a 28-day cycle — in just a few seconds.

1. Cut out the moon flip book pages with the scissors. Make sure that you also cut out the small diamond-shaped notches at the top and bottom of each card.

2. Place the numbered cards in a stack in the correct sequence. The card with the stars printed on it should be on the top. Then take the rubber band and secure it around the cards at the notches. The rubber band holds the cards together.

## → WHAT'S HAPPENING?

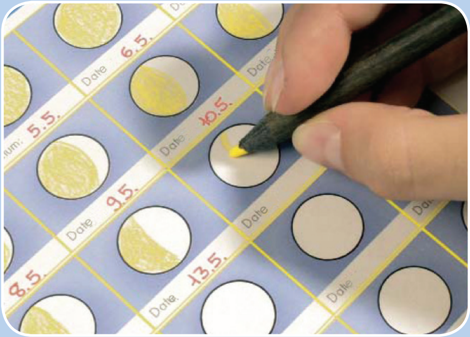
Hold the flip book in your left hand and flip through the cards with the thumb of your right hand. You will see the phases of the moon speed by in fast motion — a month passes with the flip of your thumb!

EXPERIMENT 9

# The phases of the moon, part II

## YOU WILL NEED

→ moon phase calendar on the next page
→ *stargazing flashlight*
→ *yellow marker*




## HERE'S HOW

You can observe the phases of the moon in the night sky. A moon phase calendar will help you to record your observations.

1. Observe the moon in the night sky. Take a good look at its shape, and then draw the shape with a yellow marker in the circle of the first box, using the stargazing flashlight that you made in Experiment 5 to help you see your work in the dark without straining your eyes. Write the date under the box. If it's cloudy and you can't see the moon, or the moon rises too late to be observed, have an adult help you look up the moon's shape for that day in the newspaper or online. Repeat this every evening for 28 days.

### → WHAT'S HAPPENING?

Once you have recorded your moon observations for each day, your moon calendar will show all of the phases of the moon. One of the phases you will observe is the new moon, when none or only a tiny crescent of the moon is illuminated. As the days progress, the lit part of the moon grows bigger, through the waxing crescent and gibbous phases. Waxing means "increasing in size." Then comes a full moon. After that, the lit part of the moon becomes smaller, through the waning gibbous and crescent phases, until it reaches the new moon phase again. Waning means "decreasing in size."

EXPERIMENT 9

# Moon phase calendar

| | | | |
|---|---|---|---|
| Date: | Date: | Date: | Date: |
| Date: | Date: | Date: | Date: |
| Date: | Date: | Date: | Date: |
| Date: | Date: | Date: | Date: |
| Date: | Date: | Date: | Date: |
| Date: | Date: | Date: | Date: |
| Date: | Date: | Date: | Date: |

EXPERIMENT 10

# The moon's path

## YOU WILL NEED

→ paper ball
→ moon holder from die-cut cardboard sheet (I—2)
→ *string or sewing thread*
→ *scissors*

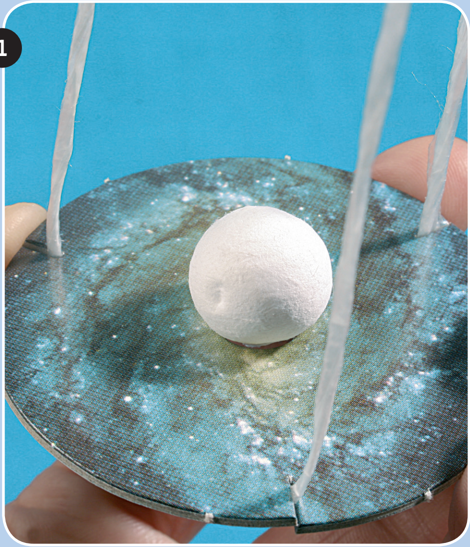
## HERE'S HOW

You can make a moon sling to find out why the moon orbits Earth, instead of flying off into space or crashing into our planet.

1. Cut three pieces of string approximately 40 centimeters (16 inches) long, and make a knot at one end of each string. Detach the moon holder from the die-cut cardboard sheet and insert the strings to the slits. Then tie the free ends of the strings together.

2. Place the paper ball, representing the moon, in the center of the holder, and swing the holder by the strings in a circular motion perpendicular to the ground. The moon stays put in the center of the disc! It neither flies off into the air nor falls to the ground.

1



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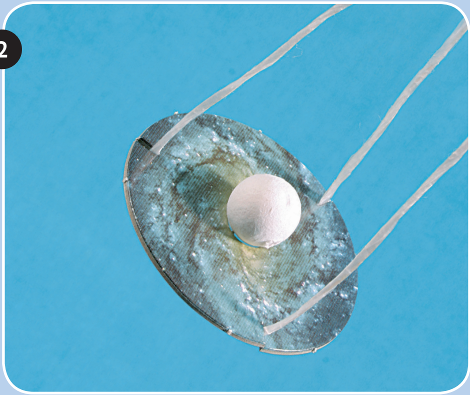


## → WHAT'S HAPPENING?

Two forces hold the moon in its orbit around Earth: attractive force (gravitation) and centrifugal force. Attractive force draws the moon toward Earth, and centrifugal force keeps the moon spinning around Earth. Both forces act simultaneously, in balance, to keep the moon in orbit. If the moon were not revolving around Earth due to centrifugal force, the moon would crash into Earth due to the attractive force. If attractive force didn't draw the moon toward Earth, keeping its speed in check, centrifugal force would fling the moon into space. Since both forces are balanced, it stays in its orbit, the same way these forces keep the ball balanced on the holder.

EXPERIMENT 11

# The man in the moon

## YOU WILL NEED

→ telescope
→ *stargazing flashlight*
→ *paper and pencil*
→ *compass (optional)*

## HERE'S HOW

You've probably heard of the man in the moon, but why do so many people see a face when they look at the moon? Learn why in this experiment.

1. Observe the full moon with the naked eye, and then with the telescope you made in Experiment 4.

2. You will notice that the moon is not a uniform gray disc, but rather, that it consists of various gray surfaces and craters, or recesses, in the surface.

3. Illuminate your paper with the stargazing flashlight you made in Experiment 5. Use the compass to draw a large circle on the paper, or draw one freehand, and try to draw a simple map of the moon that shows these darker gray surfaces and craters.
   Do you see features on this map that remind you of a face?

If you don't see the man in the moon, don't worry, not everyone sees a face in the shadowy surface of the moon. For example, the Chinese often see the image of a rabbit in the moon, and in South Africa, they describe a woman who is carrying firewood. Let your imagination run wild, and discover your own images in the moon!

## → WHAT'S HAPPENING?

The Greek philosopher Plutarch (circa A.D. 50–120) long ago described the features of the "face" in the moon. He believed that the moon was formed and shaped similarly to Earth. In his book *On the Face of the Moon's Orb*, he wrote, "The face in the moon consists of recesses and indentations, of chasms and ravines." Long after he wrote these words, Plutarch was proven right: the "face" is not a face at all, but geographical features of the moon's surface.

EXPERIMENT 12

# Moon craters

## YOU WILL NEED

→ polystyrene foam parts tray from this experiment kit
→ modeling clay
→ *flour*

## HERE'S HOW

While looking at the moon through your telescope in the previous experiment, you saw that the lunar landscapes consist of elevations and craters. With this experiment, you will learn how craters are formed.

1. First, find a place where spilled flour will not cause any harm or make a mess that cannot be cleaned up. Take the polystyrene foam parts tray out of your experiment kit and empty it out. Fill the large, round indentation on the underside of the polystyrene tray with flour, and spread it out to make a smooth, level surface.

2. Make balls of different sizes with the clay. These are your meteoroids. Drop the balls from as high as possible onto the smooth flour surface. Craters are formed where your clay meteoroids land.

**Safety Tip:** Caution! Throw the flour away in the trash after the experiment. Wash the polystyrene tray and allow it to dry.

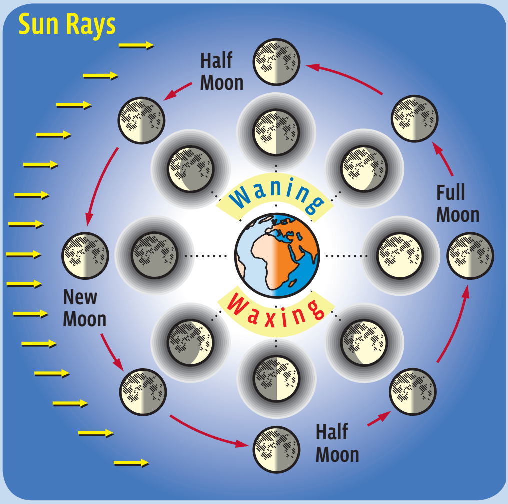
1

2

### → WHAT'S HAPPENING?

Some craters on the moon are more than a billion years old, while others were formed only 100 million years ago. They were created by meteoroids and asteroids, or chunks of rock from space, hitting the moon. During the early history of the solar system, these rocks rained down regularly on the moons and planets.

Earth has been hit by meteoroids and asteroids many times, but our planet has an atmosphere — a kind of protective shell — in which the meteoroids burned up. When a large impact did occur, the crater was quickly covered up by wind and weather. The Chesapeake Bay in Virginia and Beaverhead Crater in Idaho are examples of impact craters. There is no atmosphere on the moon, however, and no erosion (the work of wind and weather), so craters on the moon remain unchanged for millions of years.




# The Moon's Path

Just as Earth revolves around the sun, the moon revolves around Earth. The moon also rotates around its own axis as it revolves around Earth. The moon is in **synchronous rotation** with Earth, meaning that it rotates about one full turn for each revolution around Earth. Because of this, the same side of the moon always faces Earth, with only small variations. The moon needs a little less than a calendar month, 28 days, to rotate once on its own axis and to revolve once around Earth. The word "month" originally meant "moon" or "lunation." Long ago, the passing of time was marked by noting the revolutions of the moon.

At night, the shape of the moon appears to change because of the amount of the moon that is illuminated by the sun's rays in space. If the moon is between Earth and the sun, it appears barely visible, because the side of the moon facing us does not have any sunlight hitting it — the sun is shining entirely on the side facing away from us. This is called a **new moon**. Exactly 14 days later, the moon is fully illuminated by the sun and can be seen from Earth in its entirety. This is a **full moon**. In the times between new and full phases, the moon is only partially visible in the night sky, in its **crescent** or **gibbous** phases.

CHECK IT OUT

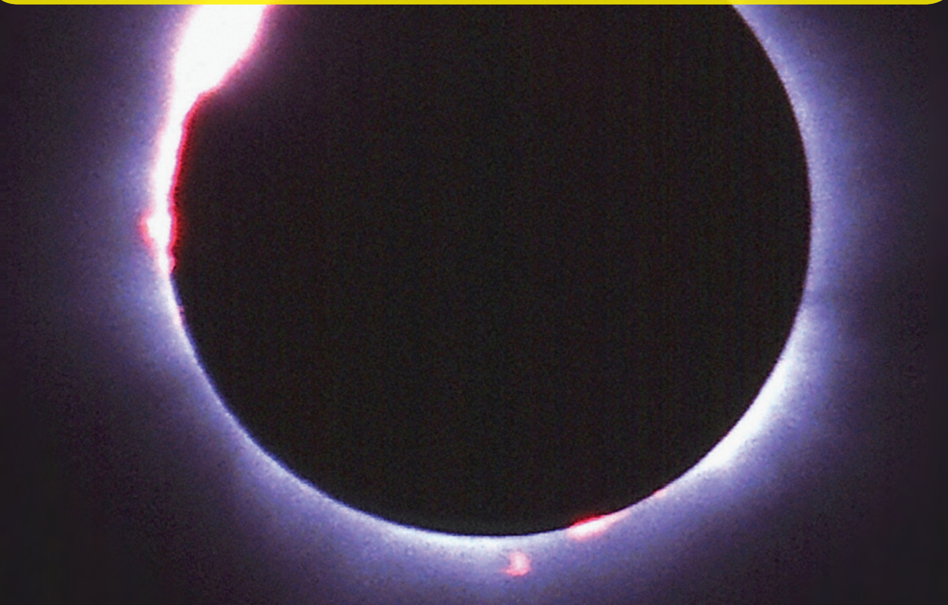
## SEAS ON THE MOON?

In earlier times, when people looked at the moon, they thought the large, dark areas on its surface were seas. They gave the seas names like "Sea of Tranquility" and "Ocean of Storms". We now know these *maria*, Latin for "seas", are large areas covered with basalt, a kind of volcanic rock, which makes them look darker than the rest of the moon.

## Thrown Out of Orbit

Earth and the other planets are kept in their orbits by the attractive and centrifugal forces you learned about in Experiment 11. Comets, which also revolve around the sun, can be thrown out of their orbits from an imbalance of these forces, and then they sometimes crash into the sun or a planet.

# Lunar and Solar Eclipses



Have you ever witnessed an eclipse? An eclipse happens when either the moon disappears into Earth's shadow, or the moon comes between us and the sun. Both of these astronomical events are rather rare, but we can do some experiments to recreate them!

# Lunar eclipse

## YOU WILL NEED

→ polystyrene ball
→ paper ball
→ 2 wooden skewers
→ modeling clay
→ *flashlight*

## HERE'S HOW

Once in while, the moon suddenly appears to go completely dark. These events, called lunar eclipses, used to scare a lot of people. Now we know why they occur.

1. Stick a wooden skewer into the polystyrene ball, representing the Earth, and one into the paper ball, representing the moon. Form two stands out of modeling clay, and stick the blunt ends of the skewers into the clay stands so the skewers are standing straight up. Position the stands so the balls line up as pictured below.

2. Turn out the lights, and turn on the flashlight, which represents the sun. Hold the flashlight level with the two balls, as pictured below. When the sun, Earth, and moon line up this way, the moon is entirely in the Earth's shadow. The Earth blocks the sun's light from reaching the moon, making the moon completely dark.

### → WHAT'S HAPPENING?

The moon doesn't create light of its own the way the sun and other stars do. The moon reflects light from the sun, like a mirror. If Earth moves between the sun and the moon, sunlight can't reach the moon, causing the moon to go dark until it moves out of Earth's shadow again. If the moon is completely within Earth's shadow, it is called a total lunar eclipse. Now reposition the moon in the experiment so it is only partially in the Earth's shadow. This incomplete eclipse is called a partial lunar eclipse. On the next page, you will find out why lunar eclipses are so rare.

EXPERIMENT 14

# Solar eclipse

## YOU WILL NEED

→ polystyrene ball
→ paper ball
→ 2 wooden skewers
→ modeling clay
→ *flashlight*

## HERE'S HOW

In our solar system, everything literally revolves around the sun. The sun's light and heat are vital to the survival of people, animals, and plants on Earth. But the sun can appear to go dark, just like the moon, when there is a solar eclipse.

1. Prepare this experiment as described in step 1 of the previous experiment, but position the stands so they line up as pictured below. Then follow the instructions for step 2 of the previous experiment, but shine the light on the ball representing the moon instead of the ball representing the Earth, as pictured below. When the sun, moon, and Earth align this way, the moon casts a shadow on the Earth.

## → WHAT'S HAPPENING?

In a solar eclipse, a phenomenon similar to a lunar eclipse occurs. The moon moves between the sun and the Earth, and wherever the moon's shadow falls on the Earth, like in the experiment, the sun appears to go dark. If the sun is completely covered, it is called a total solar eclipse. However, if only a portion of the sun is covered by the moon, it is called a partial solar eclipse.

Both lunar and solar eclipses are rare. Even though the moon passes between the sun and Earth once every month, the moon's orbit is not perfectly aligned with Earth's orbit around the sun, so the three celestial bodies are staggered in space when they pass each other. However, every once in a while, the orbits line up in a way that either the sun or moon is blocked from view on Earth, creating an eclipse.

The sun gives Earth the energy that all life we know of needs to survive and thrive. Every day, huge amounts of energy are transferred from the sun to our planet in the form of light and heat. In this chapter, you can experiment with these gifts from the sun.

# The Mighty Sun

EXPERIMENT 15

# Sundial

## YOU WILL NEED

→ sundial from die-cut cardboard sheet (II—4)
→ wooden skewer
→ modeling clay
→ *glue*
→ *pencil*
→ *ruler*
→ *compass (optional)*

## HERE'S HOW

The ancient Egyptians measured time using the sun 7,000 years ago! You can build your own timepiece in the form of a sundial too.

1. Detach the sundial disc from the die-cut sheet. Using your pencil, make a mark 5 centimeters (2 inches) from the blunt end of the wooden skewer.

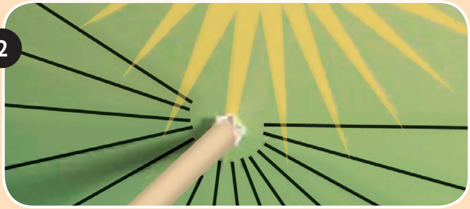
2. Stick the skewer through the middle of the disc from the back side, and push it through up to the mark. The skewer will cast a shadow to tell you what time it is when you are done.

3. Set the blunt end of the skewer into a lump of modeling clay.

4. Place the sundial in a sunny place. The tip of the skewer must point north. Determine the direction using a compass, or ask an adult for help.

1

2



3

4

## → WHAT'S HAPPENING?

Earth rotates once on its axis every 24 hours, so one hour is one twenty-fourth of a rotation. Since Earth rotates at a constant rate, the shadow that the skewer casts on the ground also travels at a constant rate. When the sun is at its highest, it casts the shortest shadow. Depending on where you are and what time of year it is, the sun's highest point occurs at different times. In the United States, this is usually between noon and 2 p.m. If you want your sundial to be precise, it needs to be pointed directly north. Use the North Star for reference.

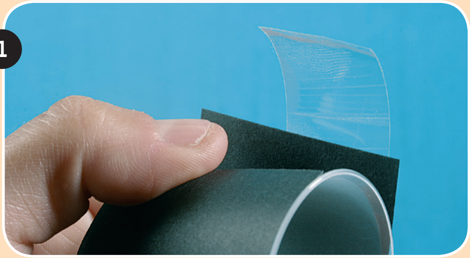
EXPERIMENT 16

# Solar collector

## YOU WILL NEED

→ 2 graduated beakers
→ *cold water*
→ *a piece of black paper, like construction paper*
→ *adhesive tape*

1



2

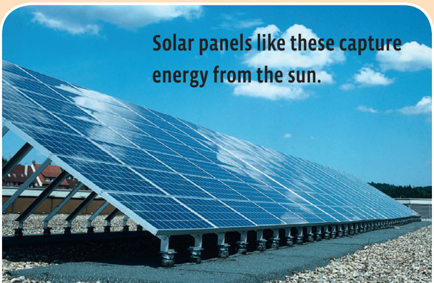
## HERE'S HOW

The sun is one of our most important sources of energy. The energy from the sun is called renewable because it does not consume any raw materials, such as oil or coal. Using solar panels, the energy of the sun can be harnessed to heat up water.

1. Cut out a strip of black paper measuring about 4 by 12.5 centimeters (1.5 by 5 inches). Wrap the strip around one of the graduated beakers, and affix it in place with adhesive tape.

2. Pour equal amounts of water into both beakers. Place the beakers in the sun.

3. After about 15 minutes, test the temperature of the water in each beaker with your fingers. Several factors affect the temperature of the water. The time needed to heat the water depends on the strength of the sun and the amount of water you pour into the beakers.



Solar panels like these capture energy from the sun.

## → WHAT'S HAPPENING?

The water in the black beaker heated up more than the water in the clear beaker. Depending on the season, the weather, the amount of water, and the time the beakers sat in the sun, the water in the black beaker might even be hot.

Dark surfaces can absorb the energy of the sun's rays better than light or transparent surfaces. Dark surfaces do not reflect as much light as light or white surfaces. Transparent surfaces allow light to pass through them. Water in the black beaker heats up more quickly because the dark surface of the beaker absorbs more of the sun's light energy.

Solar collector panels are becoming more and more common on rooftops. Inside these solar panels, water flows through tubes. The sun's rays hit the black solar panels and heat up the water inside the tubes, storing the sun's energy as heat.

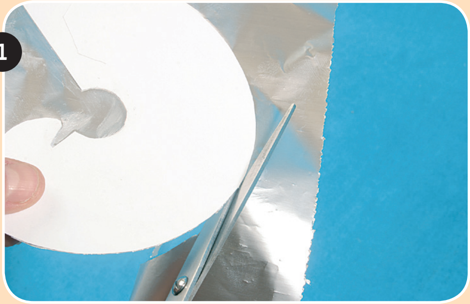
EXPERIMENT 17

# Finger parabolic mirror

## YOU WILL NEED

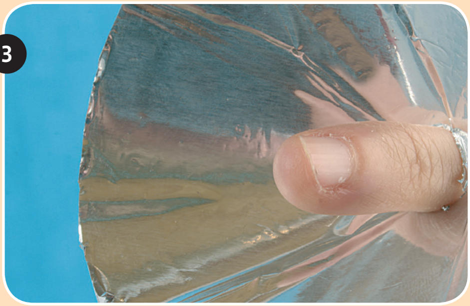
→ parabolic mirror form from die-cut sheet (II—2)
→ *piece of aluminum foil*
→ *scissors*
→ *glue stick*
→ *adhesive tape*

1



2

3



## HERE'S HOW

Although you may not know what a parabolic shape is, you have probably seen one before. Satellite dishes are parabolic shapes. Parabolic shapes can be used to collect not only radio waves, but also light and heat from the sun!

1. Detach the parabolic mirror form from the die-cut sheet. Cut out a square piece of aluminum foil a bit larger than the die-cut form. Spread glue on the parabolic mirror form, and carefully adhere it to the foil by laying the glue-covered side of the cardboard form onto the foil, and running your finger over the back of the cardboard form to ensure adhesion. Let the glue dry. Use the scissors to trim off the excess foil around the edge of the form.

2. Bring the open edges of the form together, bending it into a funnel shape, with the foil on the inside. Affix the edges together with adhesive tape.

3. Push your index finger through the hole in the middle of the funnel, at the focal point, where the most heat will be generated. Hold the finger with the mirror up to the sun, and do the same with a finger from the other hand. The finger with the parabolic mirror gets warm much faster than the finger with no mirror!

## → WHAT'S HAPPENING?

The shiny inside of the funnel focuses the sun's rays onto a central point, where your finger is, warming it. If a parabolic mirror is very large, it can produce enough heat at its focal point to cook with!

This photograph shows a swarm of stars called M80, one of the densest known star clusters in our galaxy.

# To the Stars

Do you know how many stars are shining in night sky above us? No one knows the exact answer to this question. The stars we can see from Earth make up only a tiny part of the universe. But we know that, like our own sun, the stars we see in the night sky are made up of glowing hot gasses. Perhaps some of these stars even have inhabited planets like Earth orbiting around them!

EXPERIMENT 18

# Star map

## YOU WILL NEED

→ star map holder and star disc from the die-cut cardboard sheets (II—4 and 5)
→ two-pronged fastener
→ *stargazing flashlight*
→ *glue*

## HERE'S HOW

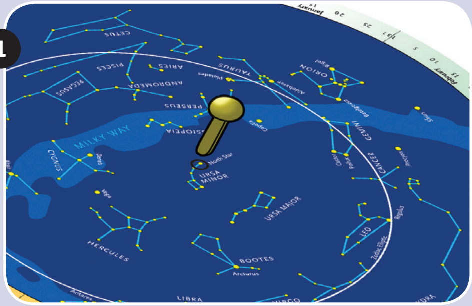
1. Detach the star map parts from the die-cut sheet. Fold the star map holder along the indicated lines. Align the holes in the star disc and holder, and insert the two-pronged fastener through the holes, bending the prongs apart in the back.

2. Fold the holder together, and glue the side tabs together.

3. Rotate the star disc counterclockwise until the lines for the current date and time lay over one another.

To learn how to use the star map, continue reading on the next page.

1

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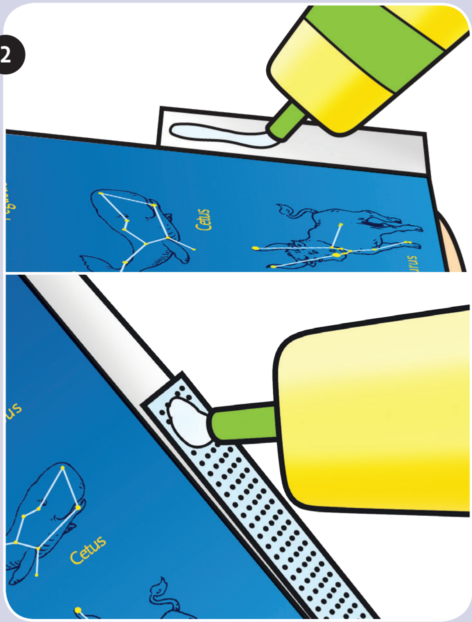


EXPERIMENT 18

# Star map

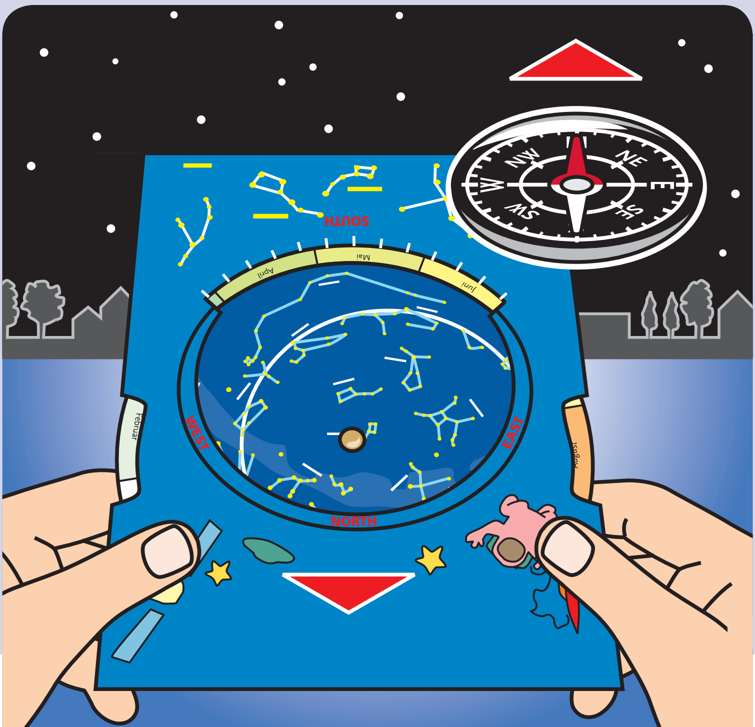
## HERE'S HOW IT CONTINUES

4. To use the star map, hold it so when you look toward the north to observe the northern sky, the northern horizon on the star map is on the lower edge. The map will look upside down to you, as in the illustration below. Use a compass or ask an adult to help you find which direction is north.

5. Try to align the map with the sky, using the map to help you find especially bright stars in the sky. Use the stargazing flashlight you made in Experiment 5 to help you see the star map in the dark. Learn to recognize the constellations, the North Star, and the Milky Way. Follow the change in the starry sky over the course of the year. Write down special observations. You will notice that different stars are visible in the sky during different seasons.

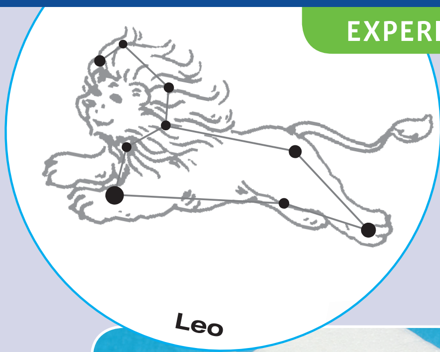
### → WHAT'S HAPPENING?

Earth is constantly in motion, changing its position relative to the sun and the other stars in the sky. The sun and other stars move too, but the change is so small from our perspective that we can't really see it. You can better understand the movement of Earth using your star map. When using the map, it appears as if Earth is stationary and the sky moves, but really, the stars in the sky are stationary, and Earth rotates!



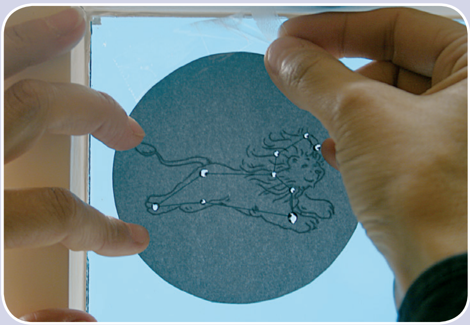
EXPERIMENT 19

# Constellations




## YOU WILL NEED

→ constellation cards
→ star map
→ wooden skewer
→ polystyrene parts tray
→ *scissors*
→ *adhesive tape*
→ *flashlight*



## HERE'S HOW

A constellation is a group of stars that shines brightly and is easy to recognize in the sky. If you connect the stars with imaginary lines, pictures emerge, such as a bear or a swan. The constellation cards will help you find these pictures in the sky.

1. Cut out the six constellation circles from the sheet along the cutting lines.

2. Empty out the polystyrene parts tray and flip it over. Place a constellation circle into the circular depression in the tray so that you can see the picture. Poke the wooden skewer through each of the black dots, representing stars, in the picture. Make a small hole for small stars and a larger hole for large stars. Repeat this process with all of the constellation circles.

3. Using adhesive tape, attach the constellation circles to a window pane, with the dark side facing inside. Sunlight shines through the holes and makes them look like real constellations.

## → WHAT'S HAPPENING?

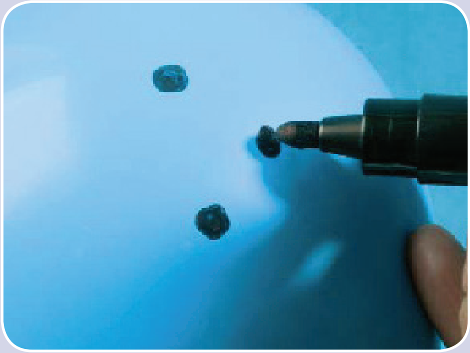
The constellations pictured on the circles are six of the most well known: the Big Dipper (Ursa Major), the Little Dipper (Ursa Minor), Orion, Cassiopeia, Gemini, and Leo. With the help of your star map, you can locate these constellations in the night sky. If you look at the shapes of the constellations on the circles often enough, eventually you will be able to find the constellations in the sky without the map!

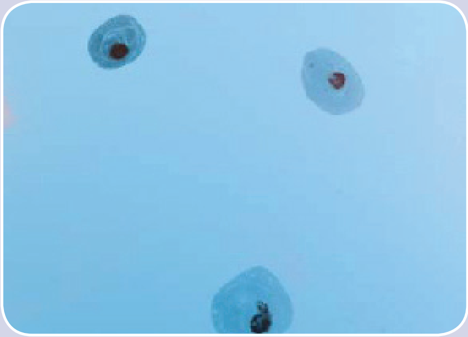
EXPERIMENT 20

# The expanding universe

## YOU WILL NEED

→ blue balloon
→ balloon clip
→ *permanent marker*





## HERE'S HOW

Scientists think the universe is constantly expanding, and that it has been ever since the universe began in the Big Bang. This experiment will help you visualize the expanding universe.

1. Blow up the balloon until it's the size of an orange, and then hold it closed with the balloon clip. Now draw several dots on the balloon with a permanent marker. These dots represent the stars of the Milky Way galaxy.

2. Detach the balloon clip, and continue to blow up the balloon very slowly. Observe the dots you drew.

## → WHAT'S HAPPENING?

The balloon represents the universe. As you inflate the balloon, it expands, or stretches out, making the dots drift apart. As the universe expands, the stars of the Milky Way and other galaxies drift apart as well.

# The Milky Way

The Milky Way was given its name because astronomers thought this light strip in the night sky looked like a milky fog. Now we know the Milky Way is a gigantic galaxy composed of countless individual stars and planets, including Earth!

In the summer, you can easily find the Milky Way in the night sky. The bright, light-colored strip of several hundred billion stars can be seen with the naked eye.

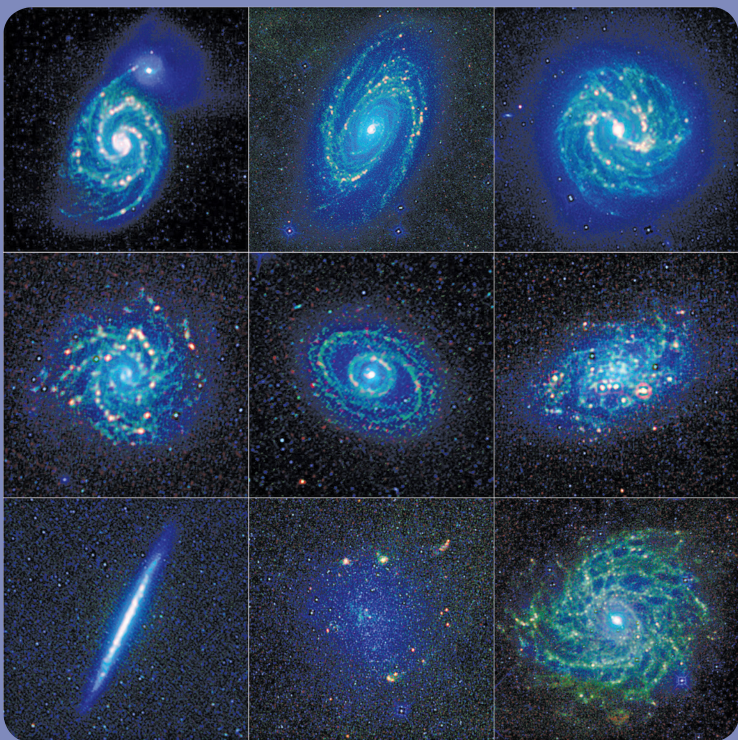
## 100 BILLION MILKY WAYS

When seen from the outside, the Milky Way is a large spiral galaxy rotating around a central point. Our sun is located in an arm of this spiral. According to the latest estimate, there are about 100 billion galaxies in the universe. They are floating like islands through the universe.

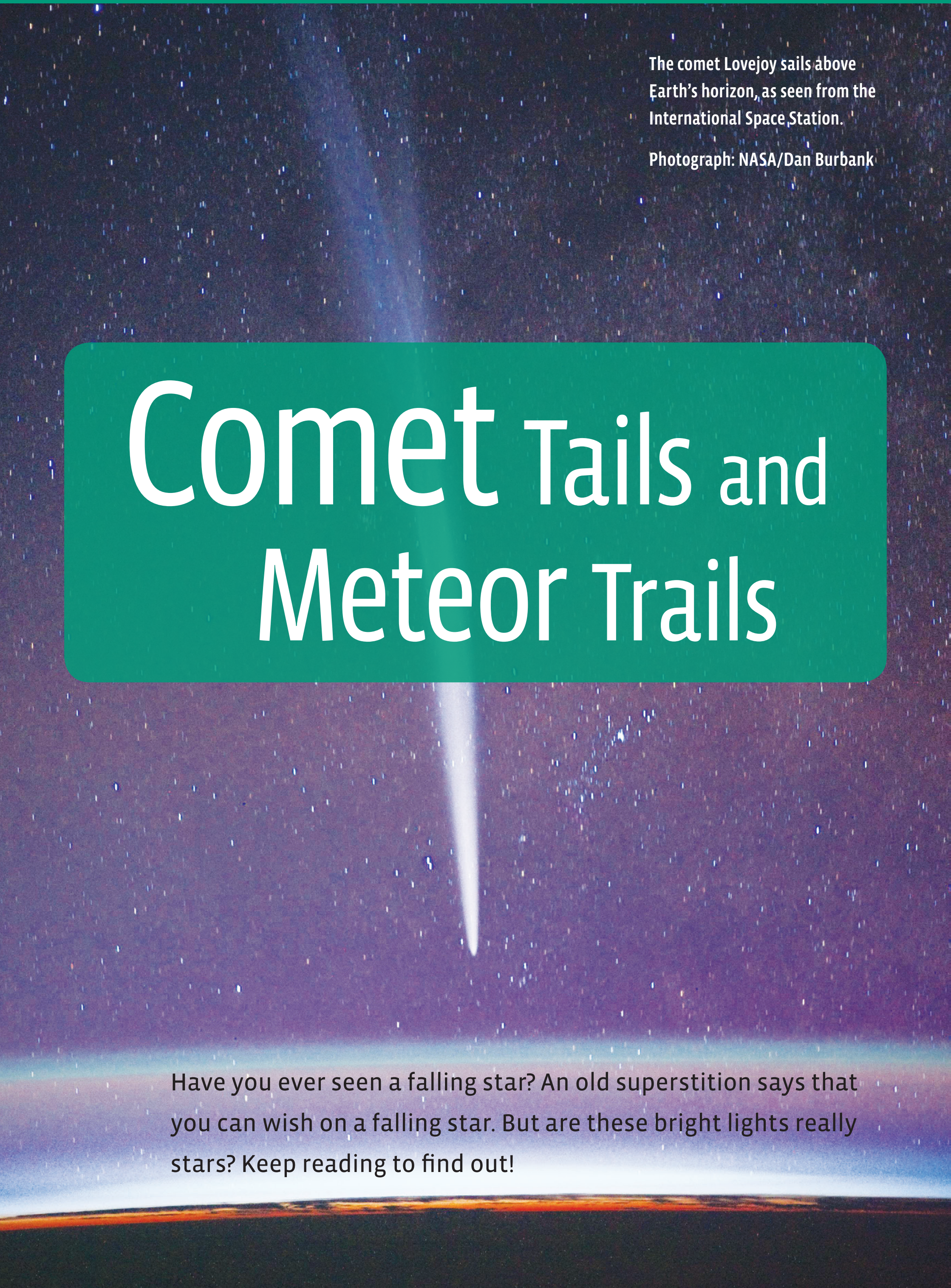
CHECK IT OUT

### Artificial Starry Sky

In a planetarium, images of constellations are projected onto a special dome-shaped screen. You can see constellations, planets, the Milky Way, black holes, and more up close, as well as how these celestial bodies interact, while astronomy experts explain what you're seeing.



Nine colorful galaxies of different shapes



The comet Lovejoy sails above Earth's horizon, as seen from the International Space Station.

Photograph: NASA/Dan Burbank

# Comet Tails and Meteor Trails

Have you ever seen a falling star? An old superstition says that you can wish on a falling star. But are these bright lights really stars? Keep reading to find out!

EXPERIMENT 21

# Falling stars

## YOU WILL NEED

→ telescope
→ star map
→ *stargazing flashlight*

## → WHAT'S HAPPENING?

Earth is surrounded by several meteorite swarms, which are made up of innumerable tiny meteorites. These are mostly remains of vaporized comets. Earth regularly passes through these debris trails. While the majority of the meteorites pass by, some of them burn up in Earth's atmosphere. We see the burning meteorites as meteors, or shooting stars.

## HERE'S HOW

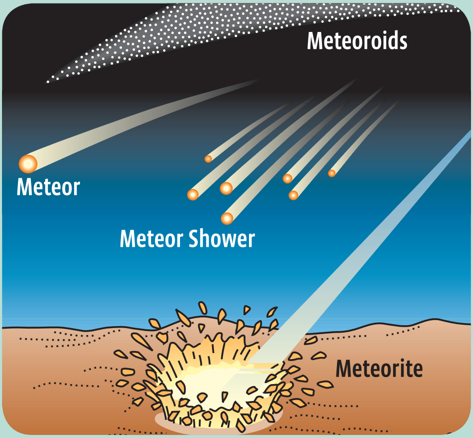
Shooting stars are tiny meteoroids with diameters of about one centimeter (half an inch). They are the remains of comets or fragments of asteroids, jettisoned rocks from the moon or other planets. These meteoroids collide with Earth's atmosphere and burn up because of the friction, forming shooting stars, or meteors.

1. Take a look at the falling star calendar below. On the nights listed, your chances of seeing falling stars are good. Try to see if you can "catch" some!

**Falling Star Calendar**

A particularly high number of falling stars are visible on the following dates. The dates are approximate.

| Dates | Meteor rate |
|---|---|
| January 3–4 | 120 per hour |
| April 21–22 | 15 per hour |
| May 4–5 | 60 per hour |
| July 28–29 | 20 per hour |
| August 12–13 | 100 per hour |
| October 21–22 | 20 per hour |
| November 16–17 | 20 per hour |
| December 13–14 | 120 per hour |



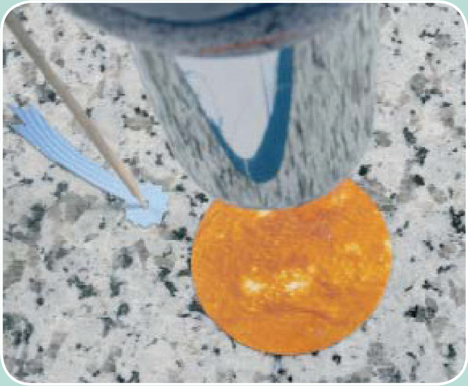

**A Meteor by Any Other Name**

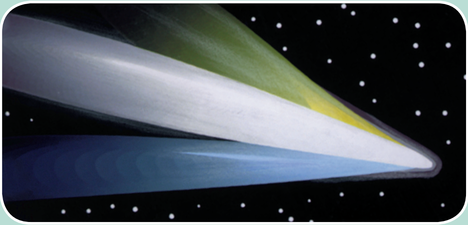
A meteoroid is small rock or boulder in outer space. An asteroid is similar to a meteroid, but larger. A meteor is what we see when a meteoroid or an asteroid enters Earth's atmosphere. A meteorite is what we call a meteoroid that has landed on Earth, if it survives the impact.

# Comet tails

## YOU WILL NEED

→ comet and sun parts from the die-cut cardboard sheet (II—2 and 5)
→ wooden skewer
→ *hair dryer*
→ *smooth, heat-resistant surface, such as a kitchen counter top or tiled floor*





## HERE'S HOW

Comets are often pictured with tails. How are comet tails formed?

1. Detach the comet and sun from the die-cut sheet. Using adhesive tape, affix the sun to a smooth, heat-resistant surface. Place the comet near the sun, and the tip of the wooden skewer through the hole in the comet.

2. Have an assistant hold the hair dryer so the nozzle is directly above the sun, and turn it on. The stream of air should push the comet tail away from the sun. Move the comet around the sun, and observe what happens to the comet tail.

A comet is a bulky ball made of ice and stone. Comets are often referred to as "dirty snowballs." Comets originate at the outer edge of the solar system. They are remnants from the origin of the solar system. Some comets revolve around the sun on fixed orbits, and others approach the sun unpredictably.

## → WHAT'S HAPPENING?

Your comet's tail always points away from the sun because a steady stream of air from the hair dryer pushes the comet's tail away.

The tail of a real comet is created when the comet nears the sun. Small particles are constantly released from the sun. These particles bombard the comet. When the particles strike the comet, gas is emitted. The radiation from the sun makes this gas glow. This is how the comet's tail is formed.

The comet's tail always moves away from the sun, just like in the experiment. The air from the hair dryer represents the stream of particles from the sun. When a comet travels away from the sun, its tail flies ahead of it!

CHECK IT OUT

Here are several terms that come up frequently when discussing space travel and astronomy. The explanations will help you to understand the terms better.

**Atmosphere:** This not only refers to the sphere of air around the Earth, but also to the gas covering around other planets, too. The moon has no atmosphere, Venus has a very thick one, and Mars has a very thin one.

**Astronaut:** In the Western world, space travelers are called astronauts. In Russia, they are called cosmonauts.

**Astronomy:** This term comes from the Greek words *astro*, meaning "star," and *nomos*, meaning "law." Astronomy is the science of the stars. It studies the characteristics of celestial bodies, material, and space radiation. In addition, it studies the origin and structure of the universe.

**Countdown:** This is an audible, backward counting off of the last few seconds before a rocket lifts off. The countdown can start at any number, but ends, "3, 2, 1, lift off!"

**Cosmos:** This Greek word means "world," and it can be used as another term for the universe. It is also a part of the name of the publisher of this kit, but spelled differently (Kosmos).

**Speed of Light:** Albert Einstein, a famous scientist, discovered that nothing can travel faster than the speed of light. In one second, light can travel 7.5 times around the Earth. At about 300,000 kilometers a second (186,000 miles a second), light travels over a billion kilometers an hour (670 million miles an hour).

**Light Year:** This is the distance that light travels in one year: 9.46 trillion kilometers or 5.88 trillion miles. A light year, therefore, is not a unit of time, but rather one of distance.

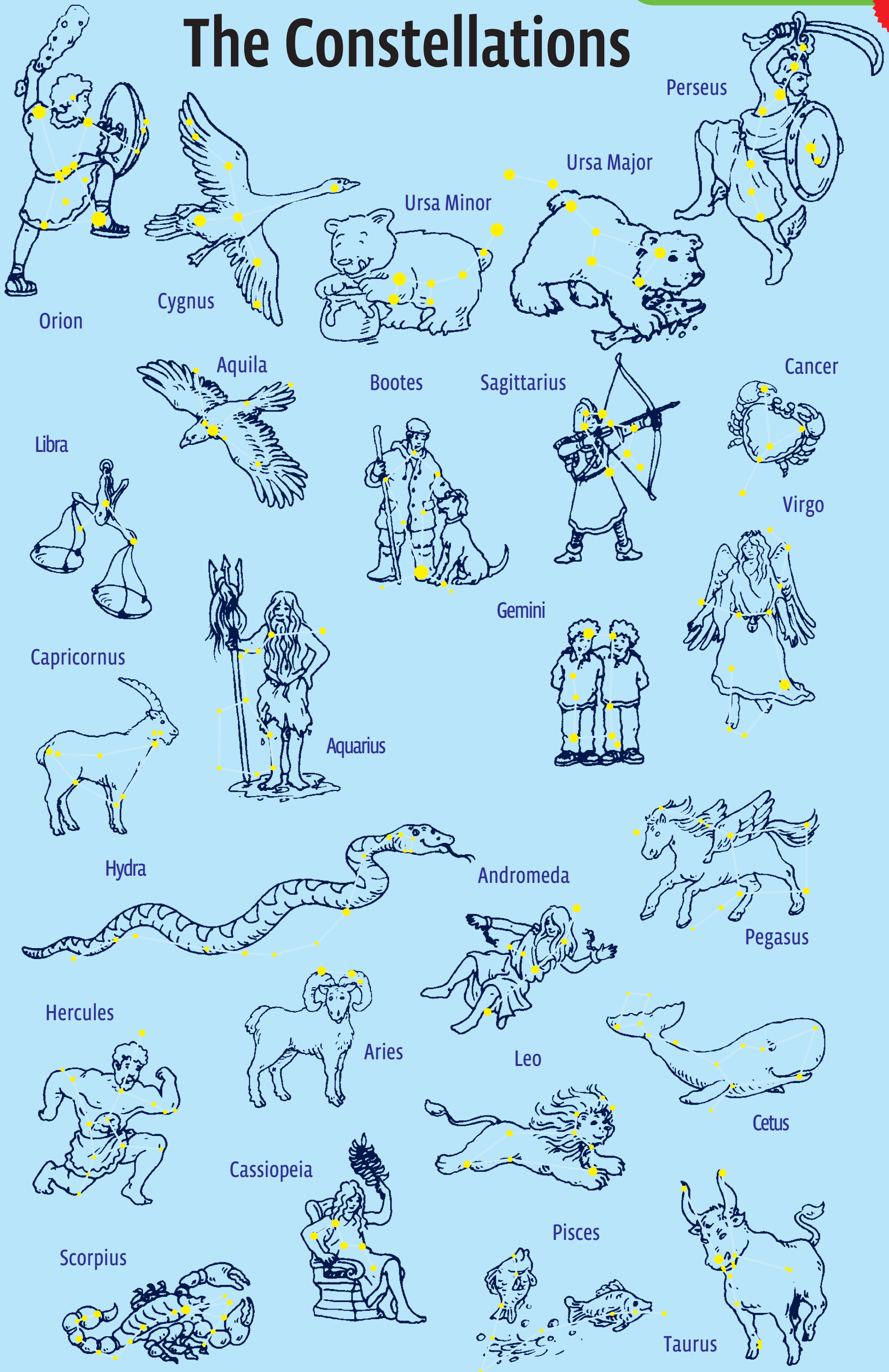
**Orbit:** This is what we call the path of an object around Earth or another planet. A satellite or spaceship that is circling around Earth is in orbit, and is also referred to as an orbiter.

**Black Hole:** This is what astronomers call the remains of a burned-out star that has collapsed in on itself, generating immense gravitational force. Like a giant magnet, a black hole attracts the material in its surroundings. It even pulls in light! This is why black holes got their name — because they do not emit any light. It is assumed that there is a black hole at the center of many galaxies, including our Milky Way.

**Big Bang:** This is how scientists refer to the beginning of our universe. It is theorized that the universe originated in a massive, rapid expansion from a single point of nearly infinite energy density that led to the creation of everything in the universe. According to today's estimates, the Big Bang occurred over 13 billion years ago.

CHECK IT OUT

# The Constellations



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Concept: Dr. Bernd Flessner
Revised by: Yara Hackstein
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Product development: Monika Schall
Layout: Fine tuning, Michaela Schelk, Stuttgart
Typesetting and design: Medien Kommunikation, Unna
Graphics: Bluguy Grafik Design, Munich; Medien Kommunikation, Unna

Photos: Medien Kommunikation, Unna, except p. 1: pro-studios, Michael Flaig, Stuttgart; Title photo, packaging, and instructions: www.digitalstock.de; Illustrations: Wolfgang Lang; Title graphics: Rayhle Design, Claus Rayhle, Stuttgart; Spreads: Illustrations of constellations: Peter Nieländer; Moon image: Werth-Design
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Editing: Ted McGuire; Additional Graphics and Layout: Dan Freitas

Distributed in North America by Thames & Kosmos, LLC. Providence, RI 02903
Phone: 800-587-2872; Email: support@thamesandkosmos.com

Printed in Germany / Imprimé en Allemagne