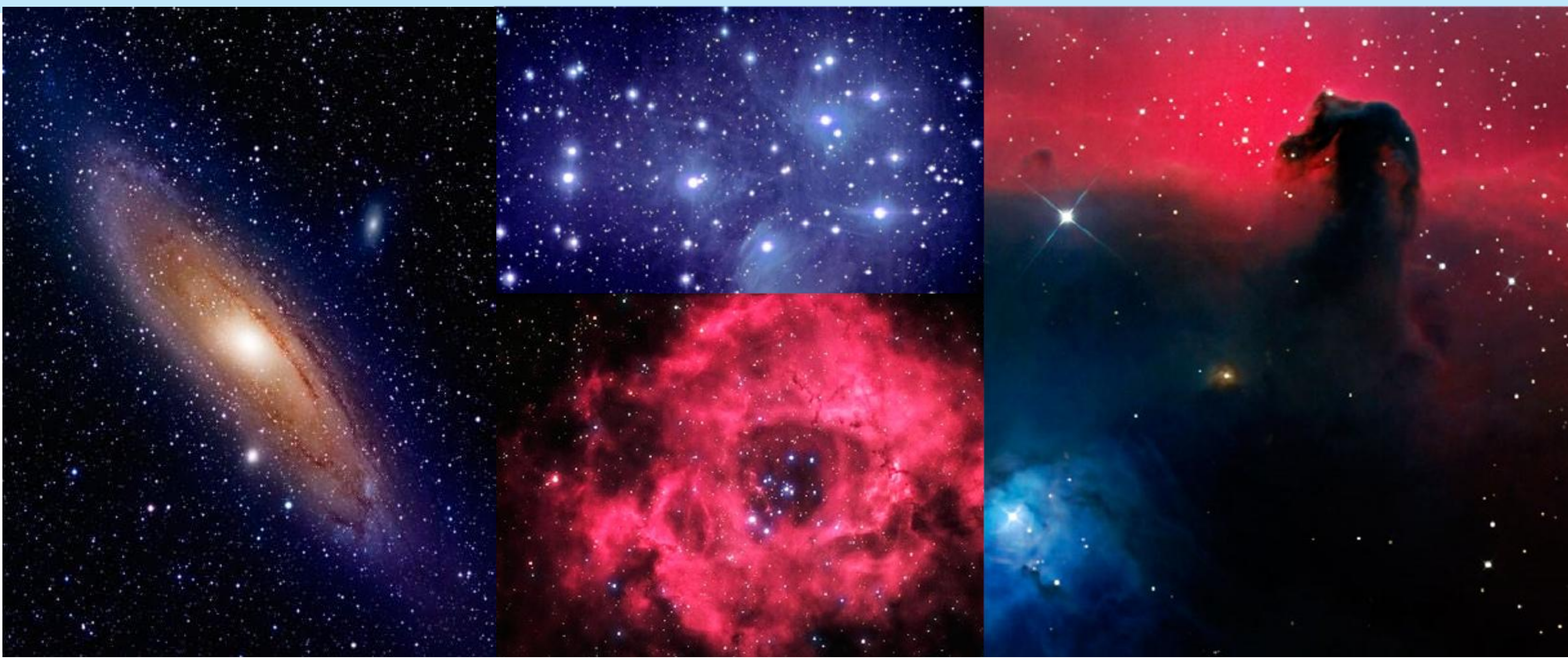
ASTRONOMY IN ACTION

Activities for after-school groups



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INTRODUCTION

This activity guide is intended for anyone working with preschool and elementary school students wishing to offer activities related to space and astronomy. As these subjects are generally popular with younger students, we have created this guide to share our expertise with you, the educators. We hope it will help you discover the fascinating world of astronomy with your students.

We have chosen and developed activities that are easy to complete in the classroom and other school spaces and that require little investment in materials and preparation time. The themes covered in this guide are the sky and constellations, the Earth-Moon-Sun system, the Solar System and the possibility of extraterrestrial life. We hope you will find these activities fun, educational, and inspiring as you bring them to your group of students. On top of our collection of 15 activities, you will find a glossary at the end of the guide with many useful definitions to aid in your delivery of these activities.

This guide was developed by astronomy education specialists from *Discover the Universe* and the *Planétarium Rio Tinto Alcan* in Montreal for the *Fédération des astronomes amateurs du Québec*. We would also like to thank the daycare educators at *École Tournesol* in Thetford Mines, *École du Grand-Fleuve* in Lévis, and *École Notre-Dame-du-Foyer* in Montreal for their helpful advice. Finally, we would like to thank the *Association des services de garde en milieu scolaire du Québec* for their collaboration.

	Preschool	Grades 1-2	Grades 3-4	Grades 5-6	Subject	Duration (min)	Page
1 - Design a Constellation	X	X			Sky and Constellations	30	5
2 - Make your own Star Finder			X	X	Sky and Constellations	30+	13
3 - Marshmallow Constellations			X	X	Sky and Constellations	20	18
4 - Head up, Head Down	X	X			Earth-Moon-Sun	30	23
5 - From the Earth to the Moon		X	X		Earth-Moon-Sun	15	28
6 - DIY Earth-Moon-Sun	X	X			Earth-Moon-Sun	30	33
7 - Measure the Solar System with Toilet Paper		X	X	X	Solar System	15	40
8 - What Solar System Object am I?			X	X	Solar System	20	46
9 - Planets with Modelling Clay			X	X	Solar System	20	51
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13 - My Very Own Alien!		X	X	X	Extraterrestrial Life	30+	66
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ACTIVITY 1

DESIGN A CONSTELLATION

Level:	Preparation:	Number of students:	Length:	Place:	Type of activity:
preschool, Grades 1-2	**easy**	**individual or small groups**	**30 min.**	**classroom**	**drawing, discussion, creation**

BRIEF DESCRIPTION

Students invent and draw a constellation from a map of the sky.

MATERIALS

- 1 map of the sky per person
- Images of the Big Dipper and Cassiopeia constellations

PREAMBLE

Constellations are patterns we've imagined in the sky. By linking the stars with lines in creative ways, humans have seen warriors, animals, and gods from various legends. Different cultures see different constellations. What would we see in the sky if constellations were created today? Which heroes or animals would we choose to immortalize in the sky? This activity lets children invent their own constellation and explain their design.

PREPARATION

Have the sky maps printed so that each child has a copy. Make sure you have a few extra copies in case of mistakes. You have two options; one with a sky with many stars, and one with fewer stars.

Print the images of the Big Dipper and Cassiopeia constellations.

Did you know that 3000 stars are visible in the sky over the countryside, but only a few dozen are visible from the city?

DID YOU KNOW... ?

STEPS

Explain to the students that constellations are drawings that humans have imagined in the sky. You can use the images of the Big Dipper and Cassiopeia to show them examples and share the mythology associated with them.

(See the "Information" section for more information on these two constellations).

Ask the children to create their own constellation.

We've outlined some options for guiding your students in their choice, if needed:

- Let the students be completely creative with the position of the stars;
- Ask the students to create a constellation linked to their hero or someone important to them;
- Ask the students to create a constellation and a related story, inspired by the stories behind today's 88 internationally recognized constellations.

Make sure they name their constellation. You can then ask everyone to describe their constellation in front of the group, or in smaller groups.

The Multicoloured Dragon.

INFORMATION

WHAT IS A CONSTELLATION?

Constellations are patterns we have imagined in the sky. They serve as reference points for way finding. They are not "real objects"; they are simply constructs of imagination. A very long time ago, humans had fun connecting the stars in the sky to create designs, and these are the same designs we still use today.

WHO INVENTED CONSTELLATIONS?

Many cultures have created their own constellations. The 88 internally recognized constellations are used today as the official system, deriving from ancient Greek mythology, as well as from European explorers of the 16th and 17th centuries.

WHY DON'T CONSTELLATIONS RESEMBLE THEIR NAMES?

Sometimes it's difficult to recognize those official designs in the stars. For many, it takes a lot of imagination! The light pollution created by our lights prevents us from seeing many of the stars that are less bright, which are sometimes necessary to help recognize constellations' inspiration. On the other hand, even without light pollution, we sometimes wonder how the ancient Greeks saw **all** these constellation patterns!

WHAT IS THE STORY OF THE BIG DIPPER IN GREEK MYTHOLOGY?

The Big Dipper was once known as Callisto, a woman of great beauty. She had a child with Zeus, the father of the gods. When Zeus' wife discovered that he had a child with another woman, she became enraged and turned Callisto into a bear. Many years later, Callisto's son Arcas had become a teenager and was hunting in the forest. When he was about to kill a bear, who was, in fact, his mother, Zeus intervened to protect Callisto and sent them both up into the sky. Thus, they became the Big Dipper and the Little Dipper (also known as Ursa [bear] Major and Minor).

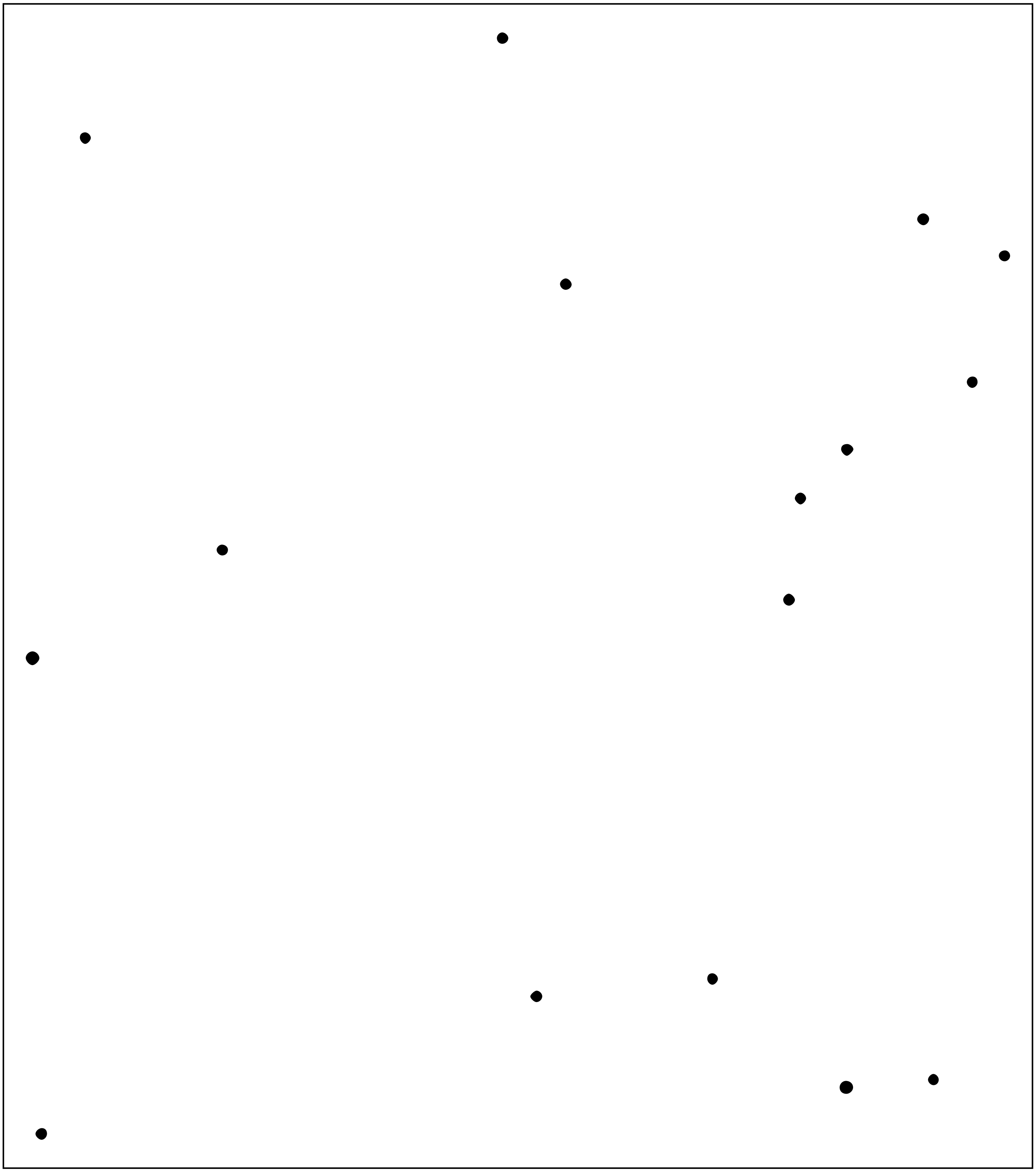
WHAT IS THE STORY OF CASSIOPEIA IN GREEK MYTHOLOGY?

Cassiopeia is a queen of Ethiopia, wife of King Cepheus and mother of the princess Andromeda. Cepheus and Andromeda are also constellations, and are visible near Cassiopeia in the sky. The story goes that Cassiopeia liked to boast of her beauty and that of her daughter. As punishment, she was condemned to circle the sky on her throne, spending half the year upside down —an undignified position for a queen!

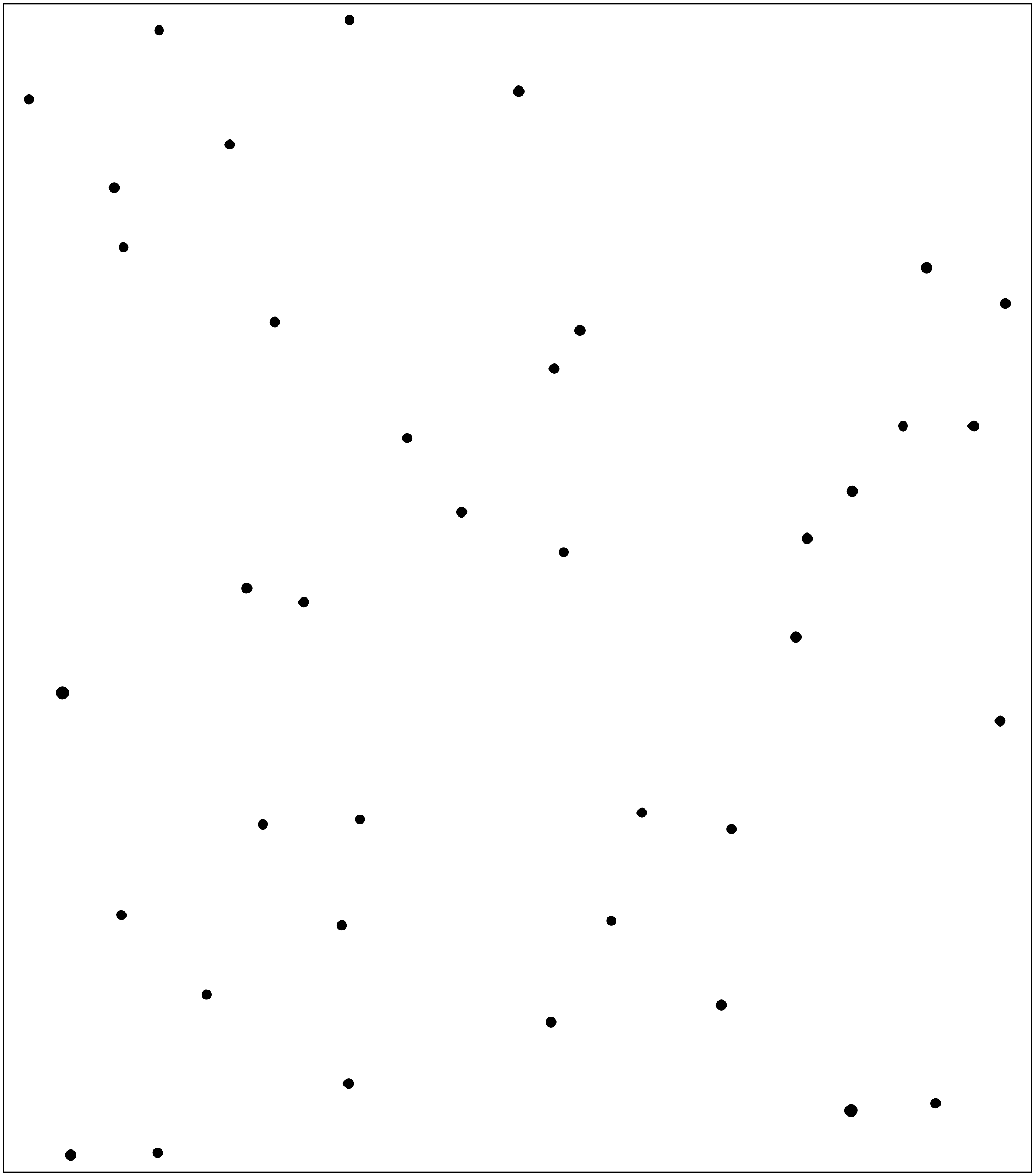
TO FIND OUT MORE

- *Cassiopeia*, *Wikipedia* page.
- *Andromeda*, *Wikipedia* page (to find out more about the Cassiopeia story).
- *Big Dipper*, *Wikipedia* page.
- *List of constellations*, *Wikipedia* page.

DESIGN A CONSTELLATION



DESIGN A CONSTELLATION



OFFICIAL CONSTELLATIONS

Don't show the students this sheet before doing the activity! Instead, let them be creative and invent their own constellations. This image is provided to show the constellation in this corner of the sky if children are curious after doing the activity. It is not really "the right answer."

BIG DIPPER

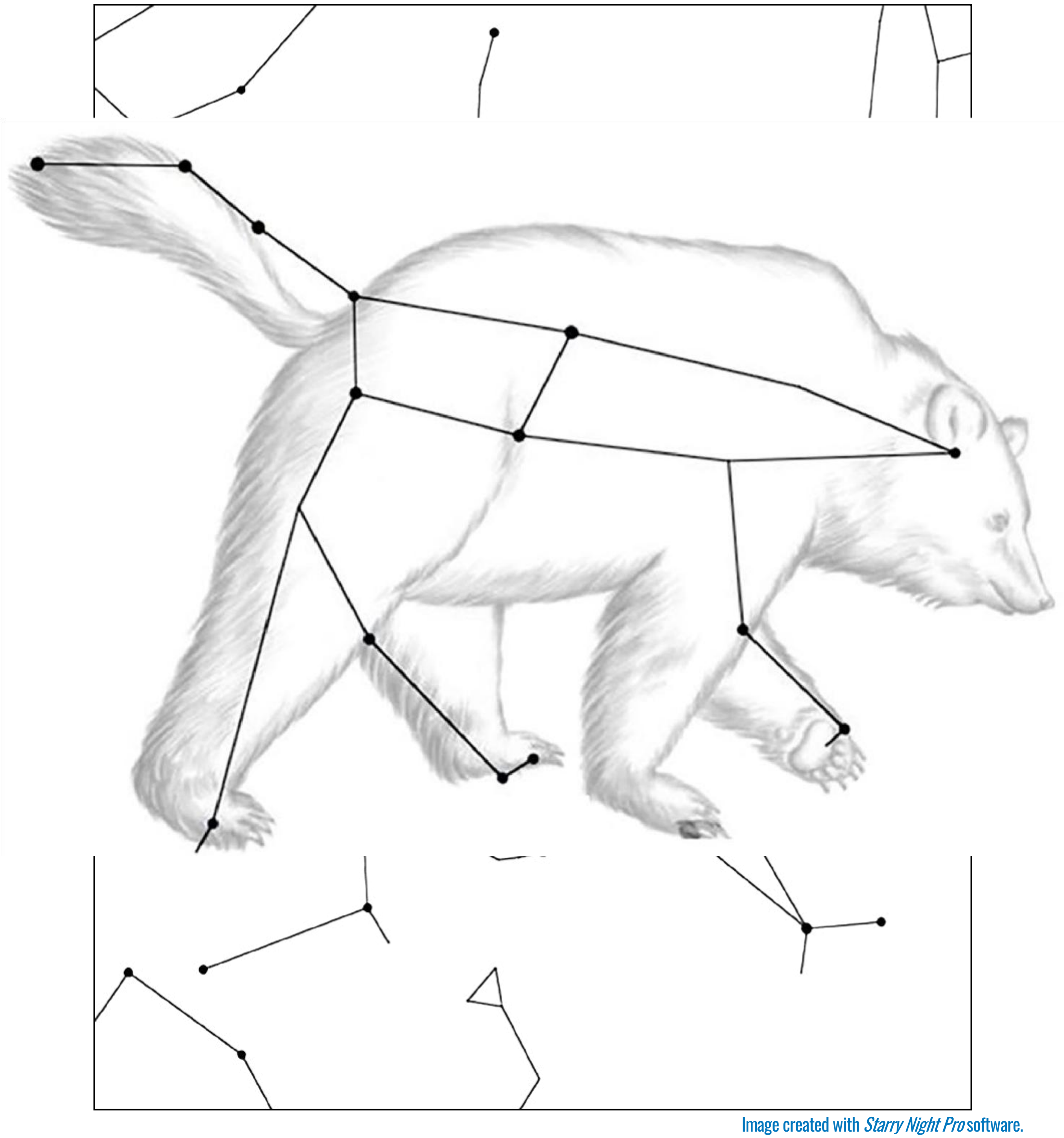


Image created with *Starry Night Pro* software.

Image created with *Starry Night Pro* software.

ACTIVITY 2

MAKE YOUR OWN STAR-FINDER

Level:	Preparation:	Number of students:	Length:	Place:	Type of activity:
Grades 3-6	**intermediate**	**individual**	**30 min. +**	**classroom**	**do-it-yourself, participatory activity**

BRIEF DESCRIPTION

Students cut out and assemble their own star-finder for use under the real sky. A star-finder is a map of the sky that allows us to identify the main stars and constellations visible at a given time.

MATERIALS

- Star-finders printed on cardstock (2 sheets for each student)
- Scissors

PREAMBLE

A star finder is very useful for identifying constellations. This cardboard version is a great initial introduction to star-finders. If you or your students are interested, laminated versions ($10-20) are available in most bookstores.

PREPARATION

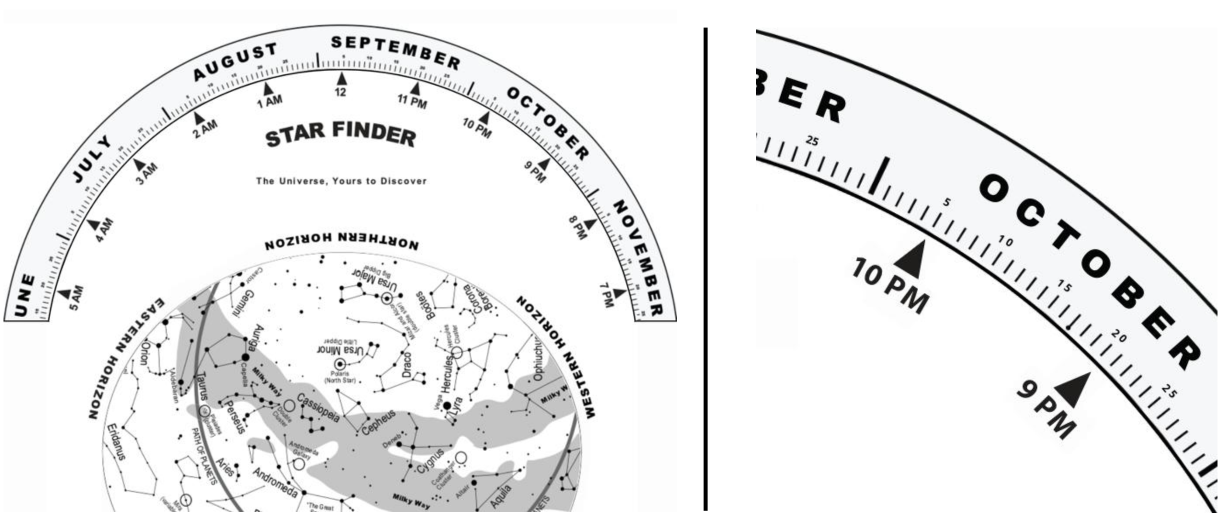
Before the activity, have the star-finders printed on 8 ½" x 11" cardboard sheets. Each student should have two sheets: the sky map and the time card. If you don't have cardboard sheets, you can print it on paper and have the children glue it onto soft cardboard, such as file folders. We encourage recycling old folders or boxes to reduce the need for new materials.

STEPS

Distribute the two sheets to each student and ask them to cut the pieces out by following the instructions on the star finder.

Show how to use the star-finder:

- Insert the sky chart into the holder to see the constellations in the oval hole.
- Line up the date and time you wish to observe the sky.
- The constellations visible in the hole represent the sky at that specific date and time.
  The circumference of the oval represents the horizon, while the centre of the oval represents the point directly above our heads, called the zenith.
- Turn the star finder so that the direction indicated at the bottom of the finder coincides with the direction in which you are looking.



Star-finder aligned to show the sky at 10 p.m. on October 5.

Here are some discussion ideas to have with your students:

- Which constellations will be visible in the North tonight? ...in the South?
- Name a bright star visible tonight in the East. In the West?
- Find a bright star in the Big Dipper constellation, or in Leo, or in Orion... The brighter the stars in the sky, the bigger the dot on the star finder.

In winter, the sun sets early, and so it is possible to stargaze earlier. Why not take this opportunity to take your group outside and practice using the star-finder under the full sky? The brightest constellations, such as the Big Dipper, Cassiopeia, and Orion, are visible even in the middle of a city.

Did you know that there are now applications for smartphones and tablet computers that simulate the real sky? *Stellarium*, *SkySafari*, and *StarWalk* are three interesting examples.

DID YOU KNOW...?

INFORMATION

The star-finder presented here is associated with the Royal Astronomical Society of Canada (RASC). You can find more information on how to use the star finder and its features on their website: rasc.ca/star-finder. Here are a few interesting facts found on the star-finder itself that are discussed in more detail on the website:

- The small circles represent interesting celestial objects observable with the naked eye or a small instrument (binoculars or telescope). These objects can be interesting stars, star clusters, galaxies, or nebulae. Find more information about these objects on the website rasc.ca/star-finder, as well as general definitions in the glossary at the end of this guide.
- The pale grey band across the sky represents the Milky Way, our galaxy. In this region of the sky, we find many more stars, which creates a whitish band. However, you need to be away from light pollution to observe it properly, i.e., away from major urban centres.
- The dark circle labelled Path of Planets represents the places where the planets might be visible. This is called the ecliptic. As planets are always in motion in the Solar System, they are not represented on the star-finder. If you see a bright star that's not on the star-finder but is close to this line, it's probably a planet!

Note that the star-finder does not take Daylight Saving Time into account. If Daylight Saving Time is in effect, subtract one hour from the time shown on your watch. For example, if you wish to observe the sky at 9 p.m. daylight saving time, set the star finder to 8 p.m.

SOURCE

This activity is based on the star-finder developed by the *Royal Astronomical Society of Canada* and the *Fédération des astronomes amateurs du Québec* (*Federation of amateur astronomers of Quebec*) for: rasc.ca/star-finder.

TO LEARN MORE

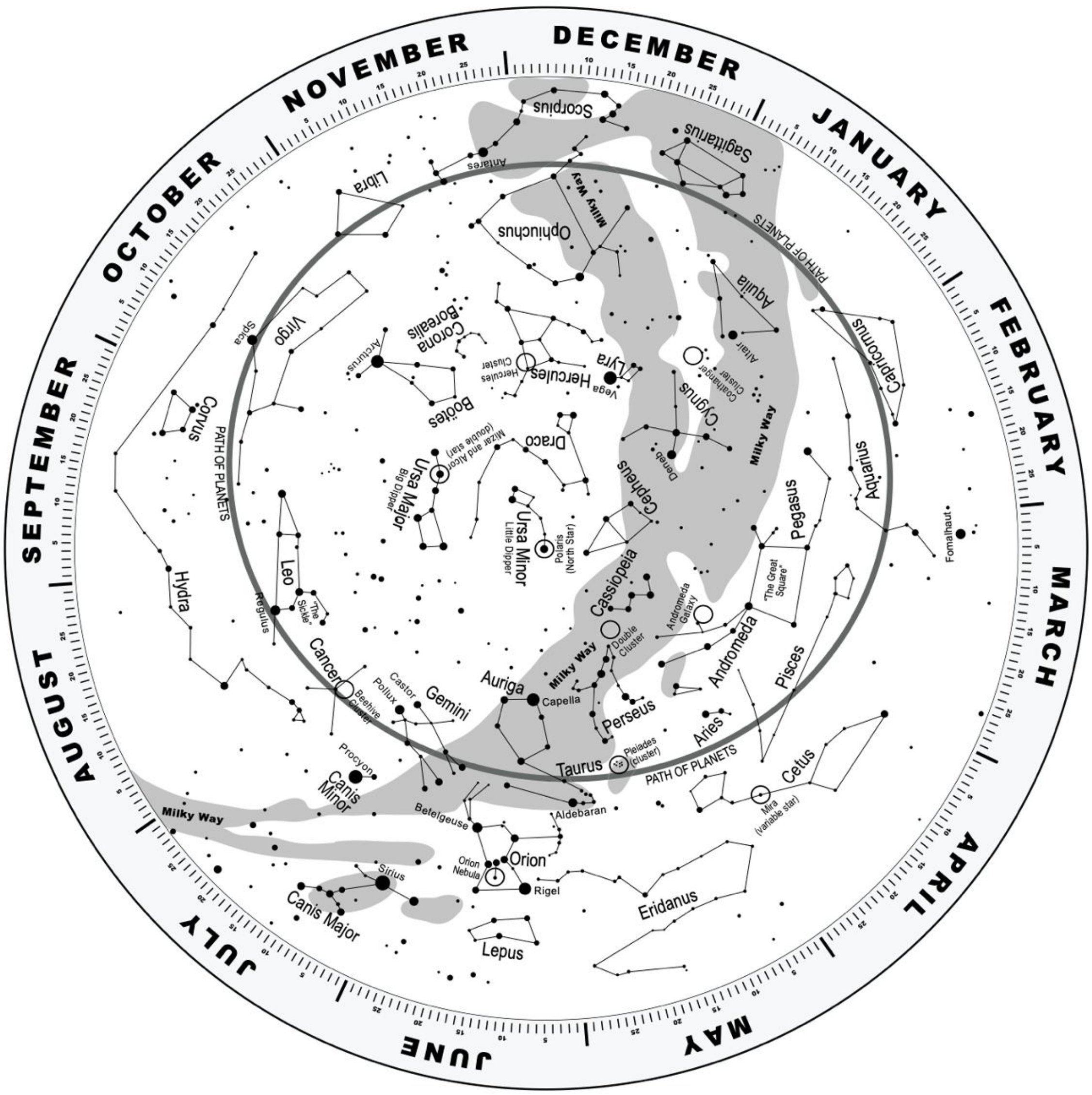
- *rasc.ca/star-finder*
- *How do star-finders work?* Canada under the Stars, from the Virtual Museum of Canada.
- *List of Constellations*, *Wikipedia* page.

Here is your star-finder to print!

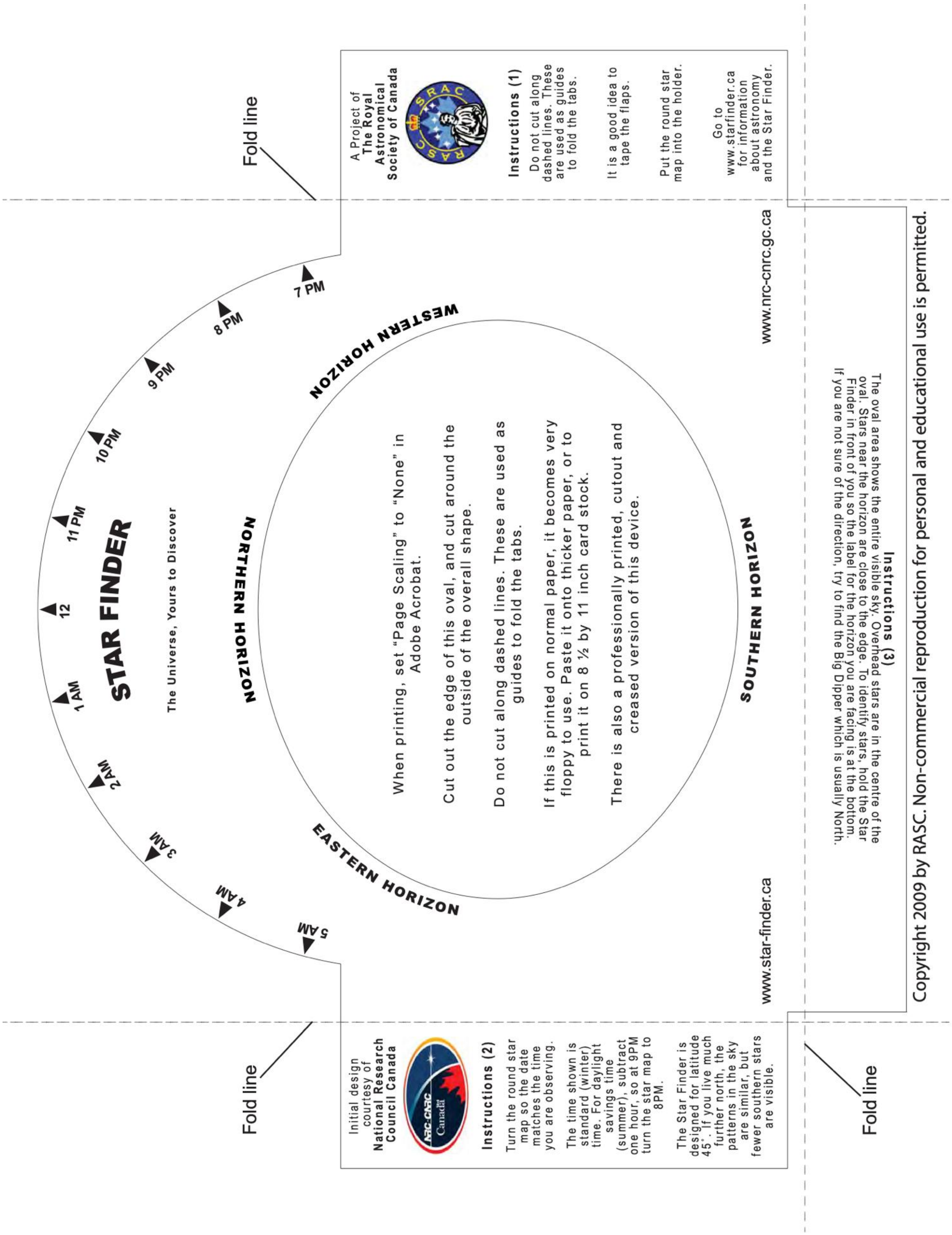
To print from Adobe Acrobat, select "None" in the Page Scaling.

Carefully cut out the circle.

This cutout slides into the holder once the flaps have been folded.



STAR-FINDERS (PART 2)



ACTIVITY 3

MARSHMALLOW CONSTELLATION

Level:	Preparation:	Number of students:	Length:	Place:	Type of activity:
Grades 3-6	**intermediate**	**individual or groups of 2-3**	**20 min.**	**classroom**	**do-it-yourself**

BRIEF DESCRIPTION

The students build a three-dimensional model of Cassiopeia using spaghetti and marshmallows.

MATERIALS

- spaghetti (minimum 5 per team)
- small marshmallows (minimum 5 per team)
- scissors
- modelling clay
- 1 sheet of cardboard per team (use cardboard from cereal boxes, shoe boxes, or any other box)
- rulers
- 1 sheet of Cassiopeia constellation with chart (last page of activity) per group

OPTIONAL

- images of the Big Dipper and Cassiopeia (see Activity 1—Design a constellation)

PREAMBLE

When we look at the stars, it appears as if the points of light are all at a set distance from us. In fact, we sometimes speak of the "celestial sphere," as if all the stars were glued to a giant sphere above our heads. But the sky is actually three-dimensional, and there are enormous distances between the stars. This activity allows you to explore a constellation in three dimensions.

PREPARATION

It might be a good idea to do Activity 2 with the star finder before this one, to familiarize the students with the sky and constellations, especially Cassiopeia.

STEPS

INTRODUCTION

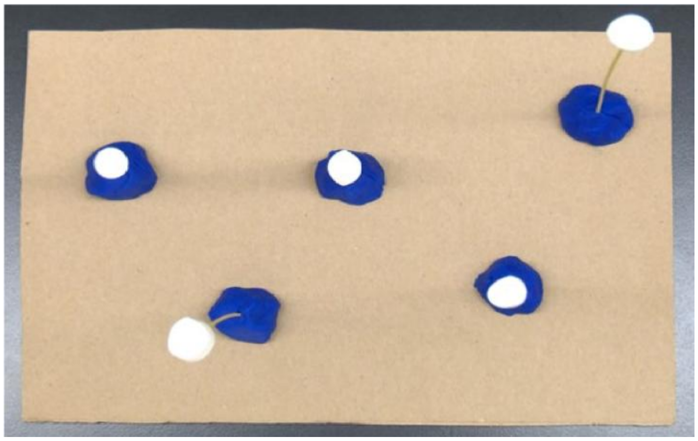
Start the activity with a discussion on the constellations. You can share images of the Big Dipper and Cassiopeia on her throne. Here are some questions and discussion points for the students
(see Information section for details):

- What is a constellation?
- Do you know any constellations? The Big Dipper is by far the most popular constellation. Cassiopeia is less well known, but remains one of the main constellations in the Canadian sky.
- The difference between what is easily seen (a saucepan for the Big Dipper) and the official constellation (a large bear as the Big Dipper). For Cassiopeia, the shape recognized in the sky is a "W", whereas this constellation represents a queen.
- Mythology (history) of the constellations, in particular Cassiopeia and the Big Dipper.

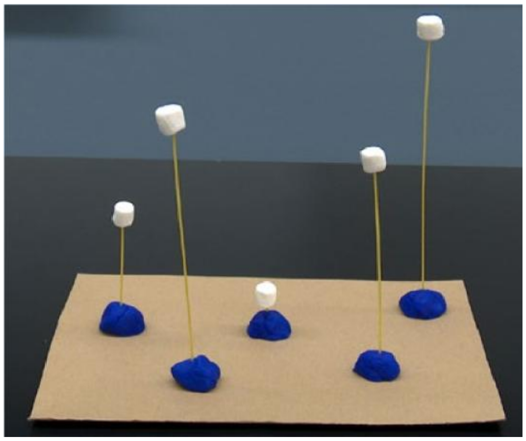
DO-IT-YOURSELF

On a sheet of cardboard, the students first place five pieces of modelling clay (about the size of a grape) to represent the stars forming the "W" of Cassiopeia. The clay is used to hold the spaghetti upright. For each star in the constellation, cut a spaghetti to the length indicated in the chart and insert it in the clay. Finally, attach a marshmallow to the end of the spaghetti to represent the star.

It's now easy to see the three-dimensional representation of the constellation. Seen from above, the stars (marshmallows) are indeed arranged in a "W" shape. From the side, however, the stars form a completely different pattern. If we could travel through space to the stars, they would form completely different patterns, and we wouldn't recognize any of the constellations visible from Earth.



View from above.
Photo Credit: Bertrand Nadeau.



View from the side.
Photo Credit: Bertrand Nadeau.

INFORMATION

Constellations are patterns formed from stars, and these can be very far apart.

In our model, the stars on the shortest spaghetti are the furthest from Earth, since we're looking at the model from above. Here's a table showing the true distances of the stars in the Cassiopeia constellation.

Star Name	Distance (light-years)	Length of spaghetti (cm)
Caph	55	23
Schedar	228	17
Navi	613	3
Ruchbah	99	21
Segin	412	10

One light-year is equivalent to around 10,000 billion kilometres, which is thousands of times the width of our Solar System. These stars are all extremely distant from us, but are still within our own galaxy, the Milky Way.

WHAT IS A CONSTELLATION?

Constellations are patterns we have imagined in the sky. They serve as a reference for way finding. They are not "real objects"; they are simply human constructs —imagined. A very long time ago, humans had fun connecting the stars in the sky to create designs, and many of these are the same designs we use today.

WHO INVENTED CONSTELLATIONS??

Many cultures have created their own constellations. The 88 internationally recognized constellations, currently used as the official system, come to us from ancient Greek mythology, as well as European explorers of the 16th and 17th centuries.

DID YOU KNOW...?

Did you know that it would take our fastest spacecraft nearly a million years to reach the nearest star in Cassiopeia?

WHY DONT THE CONSTELLATIONS LOOK LIKE THEIR NAMES?

It's true that it's sometimes difficult to recognize the official design in the stars. For many, it takes a lot of imagination! Light pollution caused by our city lights prevents us from seeing many of the stars that are less bright, which are sometimes necessary to recognize the official constellation designs. On the other hand, even without light pollution, we sometimes wonder how the ancient Greeks came up with the constellation patterns!

WHAT IS THE STORY OF CASSIOPEIA ACCORDING TO GREEK MYTHOLOGY?

Cassiopeia is a queen of Ethiopia, wife of King Cepheus and mother of princess Andromeda. Cepheus and Andromeda are also constellations, visible near Cassiopeia in the sky. The story goes that Cassiopeia liked to boast of her beauty and that of her daughter. As punishment, she was condemned to circle the sky on her throne, spending half the year upside down —an undignified position for a queen.

CAN YOU SEE CASSIOPEIA IN THE SKY?

From our latitudes in Canada, Cassiopeia is a circumpolar constellation, meaning it is visible every night of the year. It can be seen to the north. In summer, it appears as a "W" near the northern horizon, while in Winter, it appears as an "M" high in the sky. You can use the star-finder in Activity 2 to locate it.

WHAT IS THE STORY OF THE BIG DIPPER ACCORDING TO GREEK MYTHOLOGY?

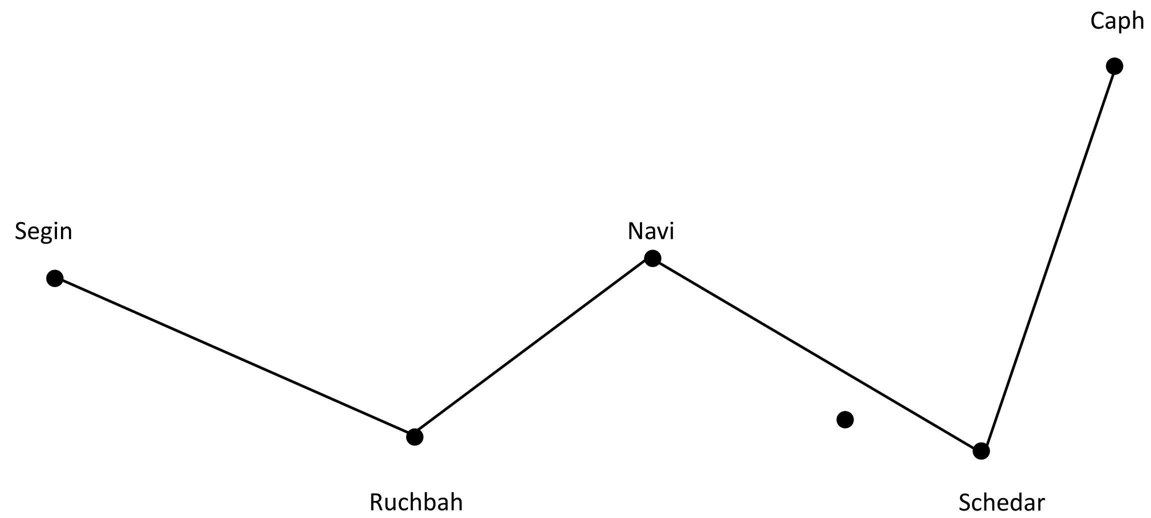
The Big Dipper was once Callisto, a woman of great beauty. She had a child with Zeus, father of the gods. When Zeus' wife discovered that he had a child with another woman, she became enraged and turned Callisto into a bear. Many years later, Callisto's son Arcas was hunting in the forest. When he was about to kill a bear, who was in fact his mother, Zeus intervened to protect Callisto and sent them both up into the sky. Thus, they became the Big Dipper and the Little Dipper.

SOURCE

This activity is inspired by *Marshmallow constellation*, an activity in Jim Wiese's book *Cosmic Science*, as well as the *Constellation shape* activity in the *Universe in a Box* guide from the international organization *Universe Awareness* (UNAWE).

TO LEARN MORE

- *Cassiopeia*, *Wikipedia* page.
- *Big Dipper*, *Wikipedia* page.
- *Andromeda*, *Wikipedia* page (to find out more about the Cassiopeia story).
- *List of constellations*, *Wikipedia* page.



Star	Length of the spaghetti (cm)
Caph	23
Schedar	17
Navi	3
Ruchbah	21
Segin	10

ACTIVITY 4

HEADS UP!

Level:	Preparation:	Number of students:	Length:	Place:	Type of activity:
preschool, Grades 1-2	**easy**	**big group**	**30 min.**	**classroom**	**participatory activity, discussion, colouring**

BRIEF DESCRIPTION

Students learn about gravity and our position on Earth. They learn that people on the other side of the Earth aren't "upside-down."

MATERIALS

- Earth and animal images printed on cardboard
- 20 Earth mosaic pieces
- colouring pencils
- scissors

PREAMBLE

Children often have difficulty visualizing the fact that we live on Earth, a spherical planet. If we place a globe with the North Pole up and imagine people standing on the Earth, those in Canada would be at an uncomfortable angle, while those in the Southern Hemisphere would be upside-down. In fact, children sometimes ask why people on the "bottom" of the Earth don't fall off.

This activity can help understand that our definition of up and down is relative to the centre of the Earth: regardless of where we are on the Earth, the direction "down" is always towards the centre of the Earth.

The image of the Earth we've provided is a photo taken from a satellite located 1.5 million kilometres from the Earth. It shows North America, Central America, and part of South America at bottom right. On the sheet, North is up.

PREPARATION

Print the images of the Earth and the animals on card stock and cut them out.

Print out the image of the mosaic piece so that you have enough for all the students; 20 mosaic pieces are enough to go around the Earth. If there are more or fewer than 20 children in a group, either group them in teams or have each student colour more than one piece.

STEPS

Start this activity by placing the polar bear at the North Pole and the penguin at the South Pole.

Make the characters speak the following dialogue:

Polar bear: "Hey there! How's it going with your head upside down? It must be really uncomfortable!"

Penguin: "Me? What do you mean, upside down? You're the one who's upside-down!"

While the penguin is answering, quickly turn the Earth so that the penguin is on top. You can continue the dialogue between the two animals and get the students to understand that neither of them is really upside-down — it's just a question of perspective.

Dialogue layout.
Photo Credit: Bertrand Nadeau.

Distribute the Earth mosaic pieces and ask each student to draw objects, animals, or people that they can find above and below the ground. For example, students might draw houses, trees, and mountains above the dotted line, while below it they might find earthworms, tunnels, or the subway. This drawing has two sections: a "top" and a "bottom".

Cut out and place the 20 mosaic pieces around the image of the Earth.

Earth mosaic.
Photo Credit: Bertrand Nadeau.

Ideas for discussion with the students:

- Where are "up" and "down" in your drawings now? No matter where the drawing is located around the Earth, the bottom is always towards the centre of the Earth.
- If a person in each of your drawings were to drop an object, in which direction would it fall? It would always be towards the centre of the Earth, what we call the "bottom" of the mosaic, no matter where we are on it.
- Why are objects and people attracted to the centre of the Earth? The force of gravity.

If you like, you can then display the mosaic and the Earth on a wall as a classroom decoration.

INFORMATION

It is sometimes difficult to visualize that we live on a spherical planet. At any given moment, we can only see a small part of the Earth —everything within our horizon. On this small scale, the Earth appears flat to us, and gravity seems to pull everything down: everything that goes up eventually comes down. Since this is our day-to-day experience, it's easy to assume that this applies to the whole planet, and that people "below" the Earth are also pulled downwards.

Gravity is what draws us to Earth. To be more precise, we can mention that gravity pulls us **towards the centre** of the Earth. So, whatever our position on Earth or any other planet, "down" is always defined as being towards the centre of it. People on the other side of the Earth don't fall off, and are also pulled towards the centre —that's their "bottom"!

When we look at the Earth as a whole, there are no highs and lows. The Earth can be placed with the Northern Hemisphere up or down, or even on its side. There's no right or wrong way to represent it. This principle also applies to space and all the other planets.

Did you know that there are over 7 billion human beings on Earth? If we wanted to count them all, at a rate of 1 per second, it would take us over 220 years!

DID YOU KNOW...?

SOURCE

This activity is inspired by an activity called *Up or Down* from the *Universe in a Box* guide from the international organization *Universe Awareness* (UNAWE).

TO LEARN MORE

- *Daily images of Earth from space*, from the Deep Space Climate Observatory satellite.
- *Andromeda*, *Wikipedia* page.

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Photo Credit: *NASA*.

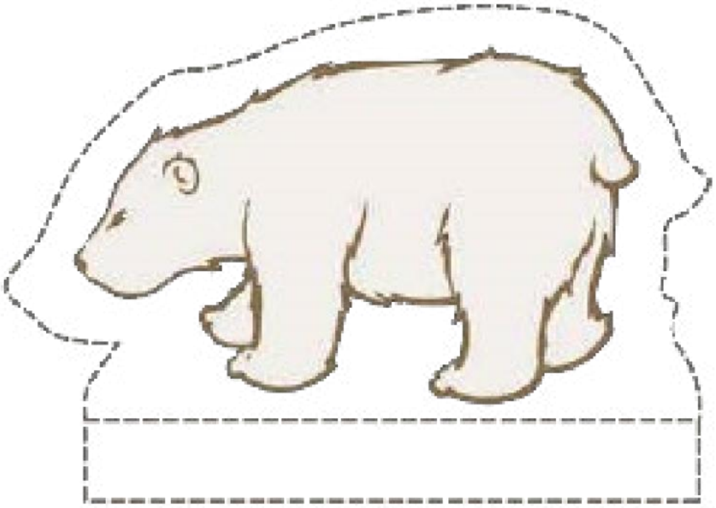
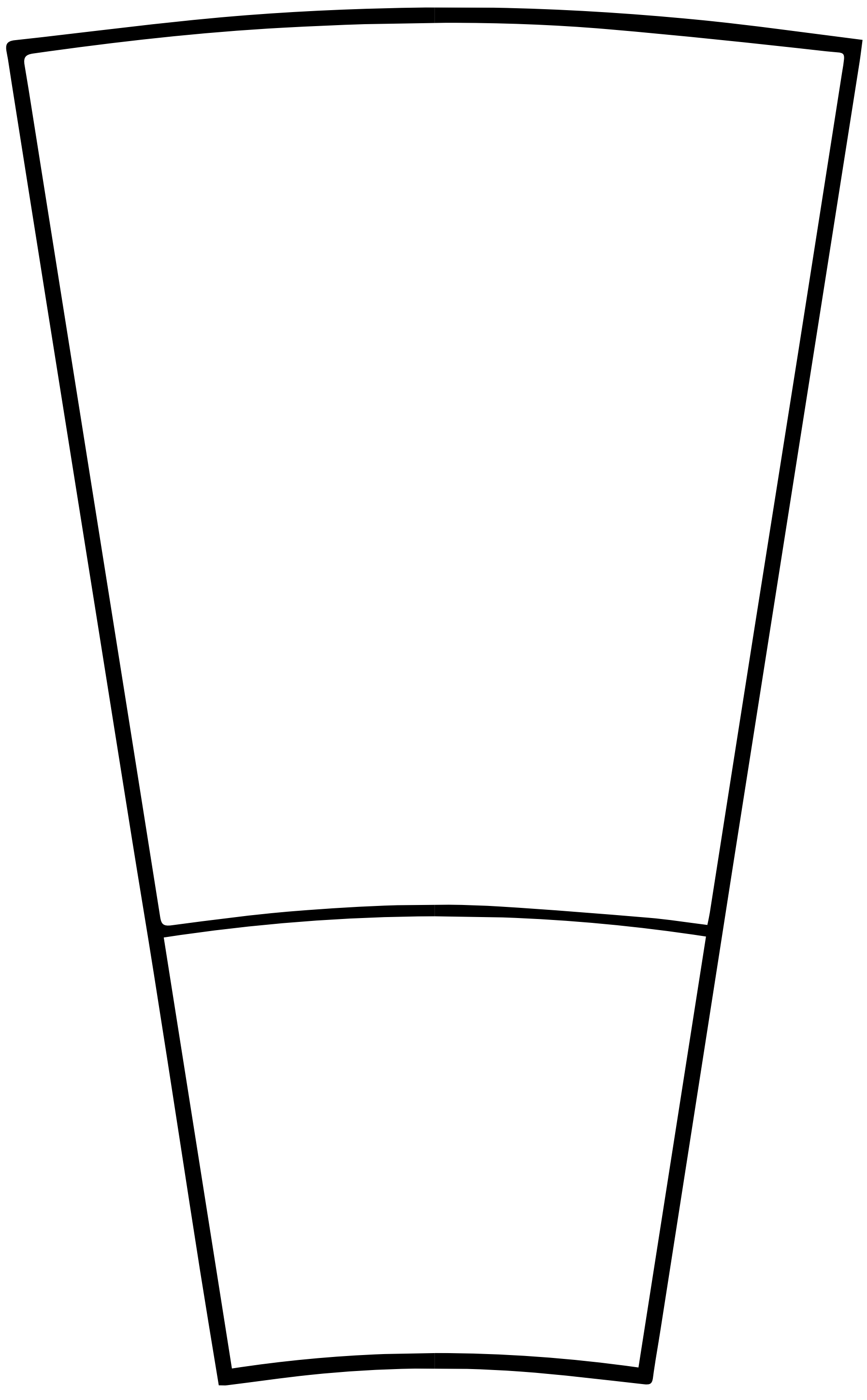


Photo Credit: *UNAWE* / C.Provot.

PIECE FOR THE EARTH MOSAIC



ACTIVITY 5

FROM THE EARTH TO THE MOON

Level:	Preparation:	Number of students:	Length:	Place:	Type of activity:
Grades 1-4	**intermediate**	**large group**	**15 min.**	**classroom, hall, outside**	**participation activity**

BRIEF DESCRIPTION

Students will discover the relative sizes of the Earth and Moon —and the distance between them—by making a scale model. They also learn about the concept of vast distance in space and the Earth's limited resources.

MATERIALS

- standard 30 cm-diametre globe
- approximately 8 cm-diametre ball
- measuring tape or 1-metre ruler
- small bottle for water
- measuring spoons
- satellite images to print and cut out

PREAMBLE

Students are likely already familiar with the Earth and Moon, having already seen images showing the two together —sometimes even showing the Moon orbiting the Earth. These images are rarely to scale, often giving the impression that the Moon is closer to the Earth than in reality. This activity helps us to better understand the distance between the two. We also include some interesting objects and distances in relation to the Earth, to make the concept of space clearer for students.

Finally, this activity will encourage reflection on the Earth and its resources. Although the Earth may seem quite big, especially for little ones, it's really a small planet in the scope of a vast universe. And our resources are limited, so taking care of our planet is important!

PREPARATION

Before undertaking this activity, be sure to find a correctly sized ball to represent the Moon. Some suggestions: a baseball or a Styrofoam ball for decoration, available in $1 stores. You can also use the image of the Moon provided with this activity.

In addition, it might be a good idea to put the amount of water on Earth (see Steps section) in a small bottle so that students can visualize the volume. The quantity, 19 ml, is roughly equivalent to one tablespoon plus one teaspoon.

Make sure you have a large enough room (9 metres long), or use a hallway or gymnasium.

STEPS

To begin, explain to the students that you will be making a scale model. To help them understand the concept of scale, you can use student's toys, such as small cars or animals. For example, you can hold up a small car or toy plane and discuss the fact that they are scale models, but (probably) not on the same scale as one another. You can then find two objects of the same scale to explain the difference.

EARTH-MOON

Show the students the globe and ball representing the Moon, and explain that these two objects are on the same scale. **The Moon is about 3.5 times smaller than the Earth**, which means it would be possible to fit 3.5 Moons into Earth's diameter. Are the students surprised that the Moon is so small next to the Earth?

Ask the students **how far from Earth would the Moon have to be to fit the model**. They may be surprised to learn that the Moon should be 9 metres away! You can use a one-metre ruler to measure this distance in the room, while a child holds the Moon at the other end. This model gives the correct impression of the distance between the Earth and the Moon. If they're surprised to see how far the Moon is from the Earth, you can add that on this scale, the Sun and planets would be kilometres from the globe! More precisely, you'd have to place the Sun 3.5 kms further away.

Did you know that travelling at 100 km/hr in space, it would take us more than four months to get to the Moon? Fortunately, space probes travel much faster than that!

DID YOU KNOW ?

AROUND THE EARTH

Let's take a closer look at the distance between the Earth and the Moon. Where, in between the two, are the astronauts on the International Space Station, or the satellites used for GPS? Where does space actually start as we climb to higher altitudes? Here's a table showing some of the distances that can be included in the model and discussed with students. These concepts are explained in greater detail in the *Information* section.

Object	Real distance from Earth	Distance from Earth in the model
Moon	385 000 km	9.06 m
Satellites for GPS	20 000 km	47 cm
International Space Station	400 km	0.9 cm
Limit of space	100 km	2.4 mm

ATMOSPHERE AND WATER

While there's plenty of air around and above us for us to breathe, our atmosphere is actually a very thin layer on a planetary scale. **If we want to see the atmosphere around the Earth to scale, it would be a sheet of paper!** So, it's easy to see how important it is not to pollute our air!

It's also possible to model the amount of water on Earth with our globe. **If we removed all the water from the oceans, rivers, lakes, and even glaciers from our model, the amount collected would be 19 millilitres.** Isn't that mindboggling? It's hard to imagine that this amount of water could fill all our oceans, but they are actually extremely shallow on the Earth's scale. On our globe, they would only be 0.2 mm deep.

Of all our water, only 0.007% is available freshwater. The other 99.993% is salt water from the oceans, ground and glacial freshwater. The amount of water available for supporting life on Earth is extremely limited: all the more reason to take care of our waters! To model this tiny quantity of water in our model, we'd have to take one drop of water and divide it fifty times.

The Earth and the Moon to scale, photographed by the Mars Odyssey space probe in 2001.
Credit: NASA / JPL / Arizona State University.

INFORMATION

It can be a challenge to understand the immense vastness of space. When we say that astronauts go into space, we imagine them far away from the Earth, when in reality they are typically so close to our planet that they can't see it as a complete sphere.

So, how do we define "space"? If we could climb a giant ladder up from the ground, when would we officially be in space? As a matter of fact, there is no obvious transition into space. The atmosphere doesn't suddenly end. It becomes thinner and thinner until we could no longer breathe. The sky would also get darker and darker the higher we climbed, since there is less air to diffuse the Sun's light. **With no clear delineation, scientists have created a definition: space begins at 100 km above the Earth.**

Beyond that, we can find satellites orbiting the Earth, including the International Space Station. These satellites have many functions: communications, weather forecasting, military use... In this activity, we talk about the International Space Station because as a home for astronauts, it's a particularly interesting satellite. We also mention GPS satellites, which are in a different orbit around the Earth. Most students are familiar with GPS, which is used for location. That signal comes from satellites located 20,000 km above the Earth. They are much further away than the International Space Station, at an altitude of 400 km.

TO LEARN MORE:

- The Earth Moon System, from *Let's Talk Science*.

Moon to scale (8.2 cm).

To be printed at actual size, without scaling in the print options.
Photo Credit: NASA.

Satellite GPS
(image not to scale with activity)
Photo Credit: Government of the United-States.

International Space Station
(image not to scale with activity)
Photo Credit: NASA.

ACTIVITY 6

DIY EARTH-MOON-SUN

Level:	Preparation:	Number of students:	Length:	Place:	Type of activity:
preschool, Grades 1-2	**easy**	**individual**	**30 min.**	**classroom**	**do-it-yourself**

BRIEF DESCRIPTION

Students build a simple model of the Earth, Moon, and Sun to demonstrate the Moon's orbit around the Earth, and the Earth's orbit around the Sun.

MATERIALS

- models printed on cardboard, 1 per student
- scissors
- paper fasteners (craft brads) 2 per student
- single hole punch
- rulers
- colouring pencils

OPTIONAL

- images of the Earth, the Moon, and the Sun

PREAMBLE

The Earth, Moon, and Sun are the celestial bodies are most familiar to students. However, it's not always easy to understand the connection between these three objects. This easy-to-make craft is an excellent way to familiarize yourself with the movements of the Moon and Earth.

PREPARATION

Print the models on 8 ½" x 11" sheets of white cardboard. For younger students, you can prepare the pieces in advance (cut out and punch holes).

Images of the Earth, Sun, and Moon can be printed or projected on a screen to start the discussion.

STEPS

Give each student their printed models and read out the instructions with them. They must **cut out all the individual pieces** needed for the model.

The students can then **punch the holes** with a hole-punch, or possibly push the fasteners through the paper (be cautious, you know your students best). A hole-punch may not be long enough to make the holes on the Earth and Sun. An adult's help may therefore be needed to make the holes using a scissor tip or other sharp object.

Ask the students to **assemble the four pieces**, making sure that the tabs connecting the Earth, Moon, and Sun are underneath the three celestial objects so as not to cover them. When the Moon goes around the Earth in the model, it's best if the Moon can pass over the tab connecting the Earth and the Sun.

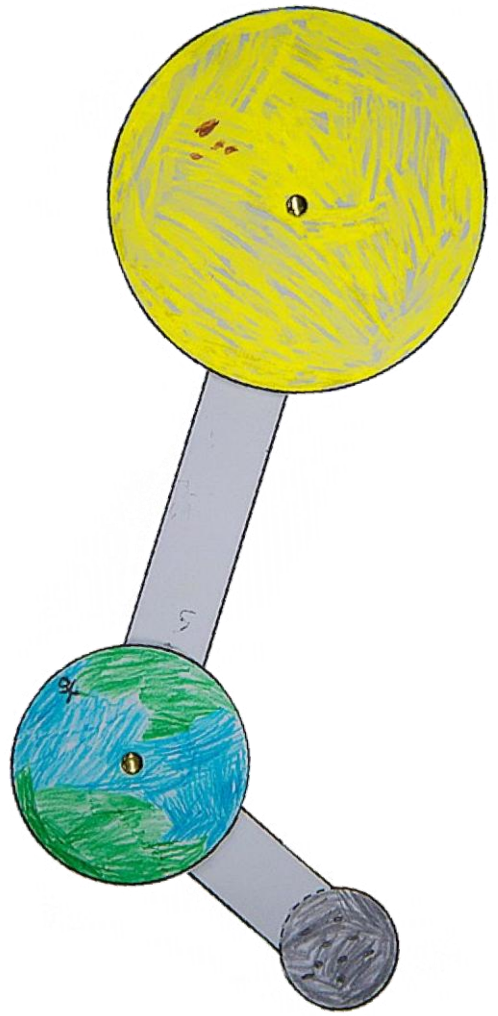
The students can **colour in the Earth, Moon, and Sun** before or after assembling them. Colouring can also be done during assembly if some students work faster than others.

Ask the children to make each piece move separately, discuss what they notice. Make sure the Sun remains fixed: it's the centre of our Solar System. The Earth must therefore revolve around the Sun, not the other way around!

It's also possible to discuss how these objects' movements represent different time scales here on Earth: days, months, years. See the *Information* section for more.

Questions for the students:

- What object does the Moon revolve around?
- Which object does the Earth revolve around?
- Does the Earth rotate around itself?
- Which side of the Earth is bright/illuminated?
- Why is it dark?
- How long does it take for the Earth to rotate around itself?
- How long does it take the Earth to revolve around the Sun?
- How long does it take for the Moon to revolve around the Earth?



DIY Earth-Moon-Sun assembled.
Photo Credit: Bertrand Nadeau.

INFORMATION

ROTATION OF THE EARTH

The Earth rotates on its axis over a period of 24 hours —this is the definition of a day. For the half of the Earth that is facing the Sun, it's daytime, while for the other side, it's night.

ORBIT OF THE MOON AROUND THE EARTH

The Moon orbits the Earth and completes one revolution in 27.3 days. This is approximately one month. In fact, the word *month* comes from the word *moon*. (Note: a revolution is when one object has completed its orbit around another object.)

THE REVOLUTION OF THE EARTH AROUND THE SUN

The Earth completes a revolution (orbits) around the Sun in 365.25 days: this is the definition of a year. That means that the Earth rotates on its axis 365 times in the time it takes to orbit the Sun once!

Note that the model created here is <u>not</u> to scale. (If we kept the Earth the same size as on the model, the Moon would be 2 cm wide and 2.5 meters away, while the Sun would be a 10-meter-diameter ball 1 km away! It's impossible to make a scale model like this with paper!)

SOURCE

This activity is inspired by a do-it-yourself project developed by *NASA*.

TO LEARN MORE

- *The Earth Moon System*, *Let's Talk Science* page.

Did you know that we always see the same side of the Moon? In fact, the Moon always shows the same face to the Earth. Only the astronauts who circumnavigated the Moon during the Apollo missions were able to see its hidden side.

DID YOU KNOW ?

PRINT AND CUT TEMPLATE

Cut out the shapes on the black lines.

Do not cut the dashed line.

Make holes on the small circles.

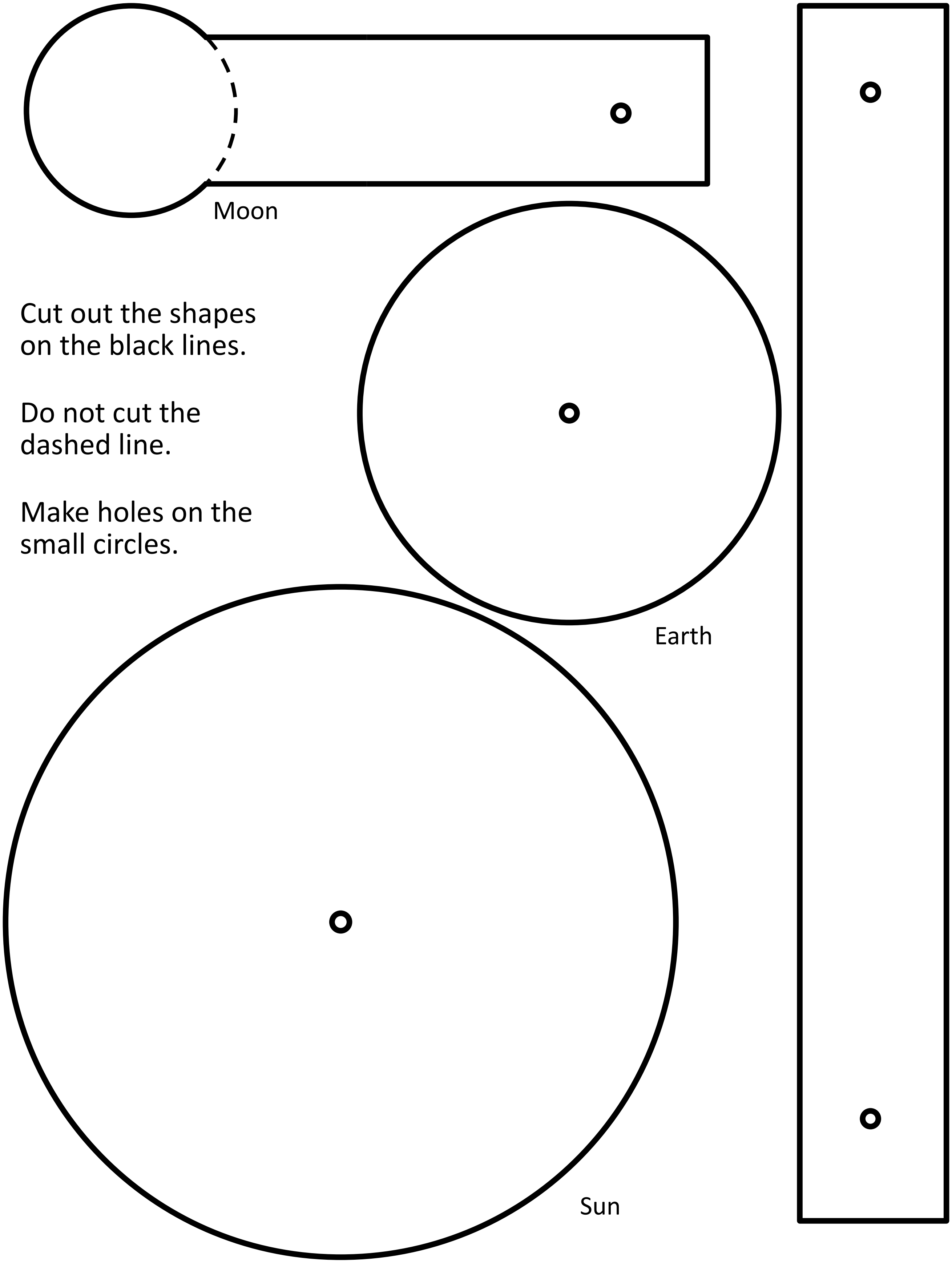


Photo Credit: NASA.

Photo Credit: NASA.

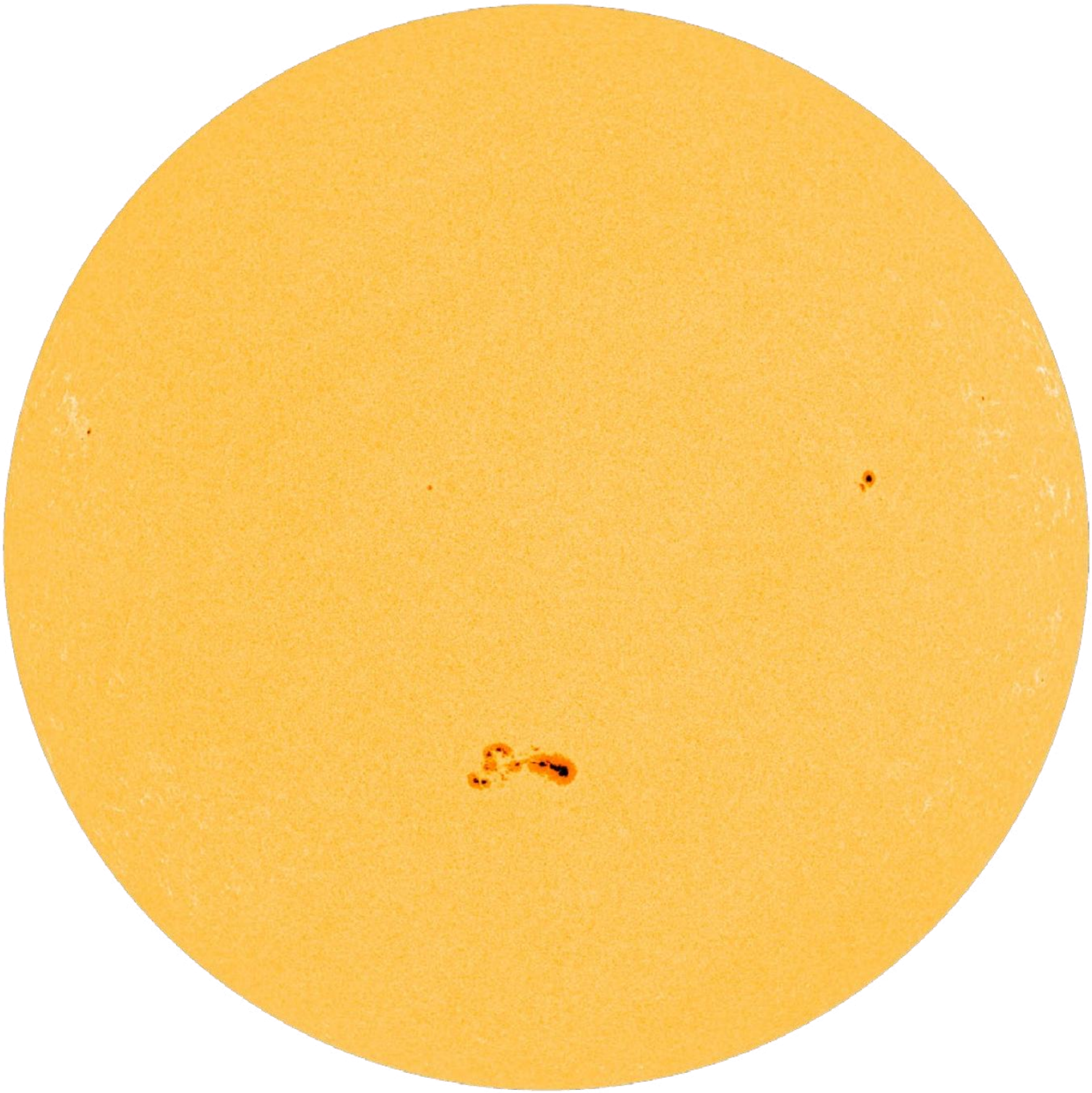


Photo Credit: NASA / SDO.

ACTIVITY 7

MEASURE THE SOLAR SYSTEM WITH TOILER PAPER

Level:	Preparation:	Number of students:	Length:	Place:	Type of activity:
Grades 1-6	**easy**	**groups of 10 students**	**15 min.**	**gymnasium or hallway**	**participation activity, discussion**

BRIEF DESCRIPTION

Students learn about the size of our Solar System and the distance between planets, using a toilet paper roll as a measuring instrument.

MATERIALS

- 1 roll of toilet paper per team (at least 250 sheets per roll)
- 1 set of planet cards per team

PREAMBLE

It is very difficult to visualize the size of the Solar System, since no single image can be made to-scale. If the *distances* are to-scale, the planets will be too small to see. If the *sizes* of the planets are to-scale, the distances between them will be far too great to fit into the image. This problem causes misrepresentations of the size of the Solar System. This activity helps you explore the enormous distances between the planets.

PREPARATION

Print and cut out the planet cards before starting the activity. Ideally, this activity should be done in groups of no more than 10 students; with larger groups, the students may get bored without a role to play.

This activity is based on a roll of toilet paper with 250 sheets, each 10.1 cm thick. This information is found on the packaging. **Make sure your roll has 250 sheets or more.**

STEPS

Place the Sun at a starting point. Unroll the toilet paper roll and count the number of squares as you go. At square number 3, place the Mercury card. At square number 5, place the Venus card. Continue unrolling the toilet paper and placing the planet cards on the squares indicated in the following chart. Each child should have their own planet card and keep count of the squares as the paper unrolls, making sure to place it at the right distance.

Table of values calculated for a roll of 250 sheets, approx. 10 cm wide.

Object	Distance (number of squares)
Mercury	3
Venus	5
Earth	7
Mars	10
Ceres (in the Asteroid Belt)	18
Jupiter	33
Saturn	61
Uranus	122
Neptune	191
Pluto (in the Kuiper Belt)	250

Possible discussions with the students:

- Are you surprised by our model? What surprised you most?
- How big do you think the objects would be if they were placed to scale in the model? See the Information section for the answer!

Eco-friendly tip: After the activity, roll up the paper as best you can and use it to repeat the activity with another group, for cleanup duty around the classroom.

Did you know that sunlight takes 8 minutes to reach Earth, 43 minutes to reach Jupiter, but about 5 hours to reach Pluto?

DID YOU KNOW...?

INFORMATION

This model shows the size of the Solar System and placement of the planets. In particular, it's striking how close together the objects of the inner Solar System (Mercury, Venus, Earth, Mars, and Ceres) are, while the objects of the outer Solar System (Jupiter, Saturn, Uranus, Neptune, and Pluto) are farther apart.

After the Sun, planets are the largest objects in a solar system. In this activity, we've also included two dwarf planets: Ceres and Pluto. Ceres lies within the asteroid belt and was long considered its largest asteroid before being reclassified as a dwarf planet in 2006. That same year, the International Astronomical Union updated the definitions of planets and dwarf planets, which led to Pluto being reclassified as well. Pluto is the largest known object in the Kuiper Belt —a distant region beyond Neptune that can be thought of as a second, far-flung asteroid belt.

This activity only models the distances between celestial objects, not the size of the objects themselves. The photos on the maps are not to scale. If we wanted to scale the objects, the Sun would be a sphere 6 mm in diameter, Jupiter, the largest planet, would be 0.6 mm and the Earth would be practically invisible!

SOURCE

This activity is inspired by *Toilet paper planets*, an activity in Jim Wiese's book *Cosmic Science*.

TO LEARN MORE

- *Solar System*, *Wikipedia* page.

SUN

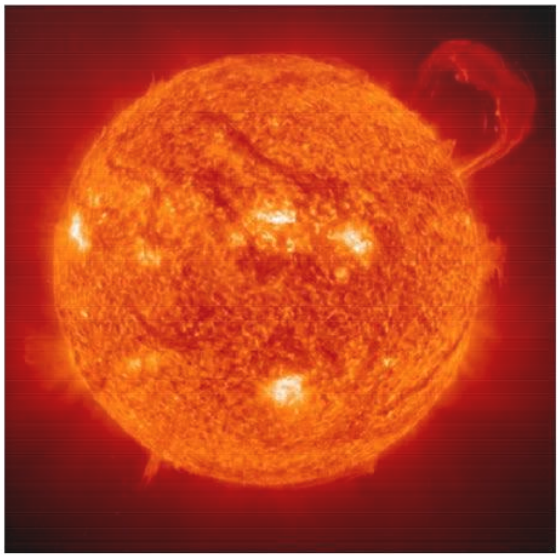


Image: *SOHO, NASA / ESA*

MERCURY

Image: *MESSENGER, NASA* / Johns Hopkins

VENUS

Image: *Mariner 10, NASA*

EARTH

Image: *NASA*

MARS

Image: *Hubble, NASA / ESA*

CERES (ASTEROID BELT)

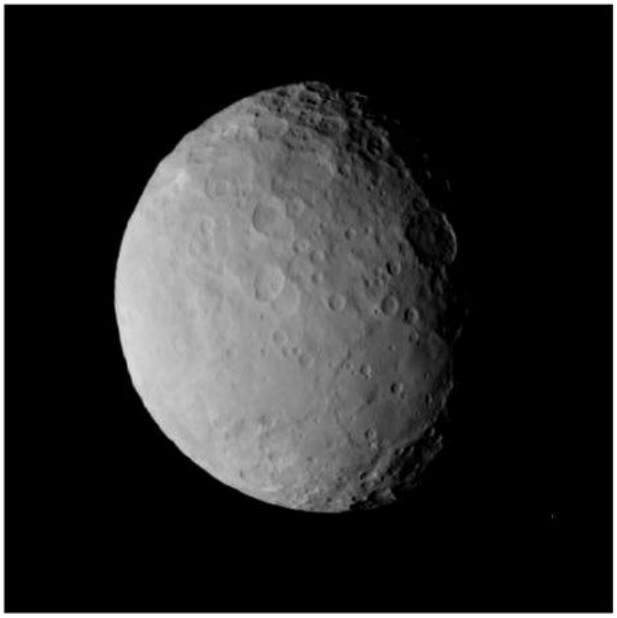


Image: *Dawn, NASA*, JPL-Caltech

JUPITER

Image: *Cassini, NASA / CICLOPS*

SATURN

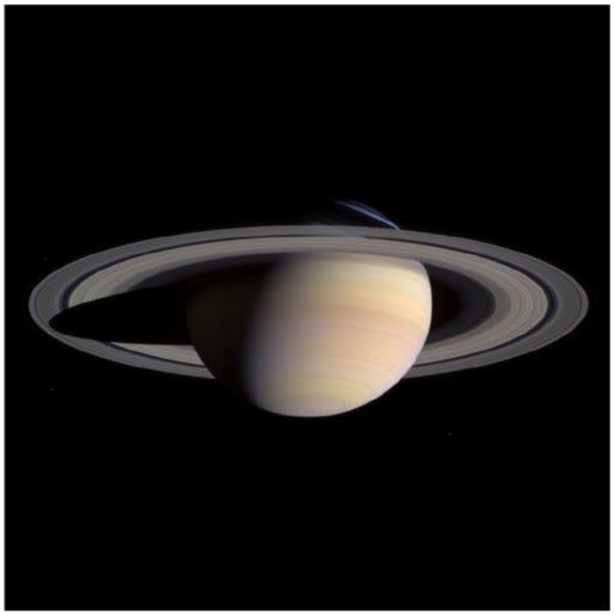


Image: Cassini, *NASA / JPL / Space Science Institute*

URANUS

Image: *NASA / JPL*

NEPTUNE

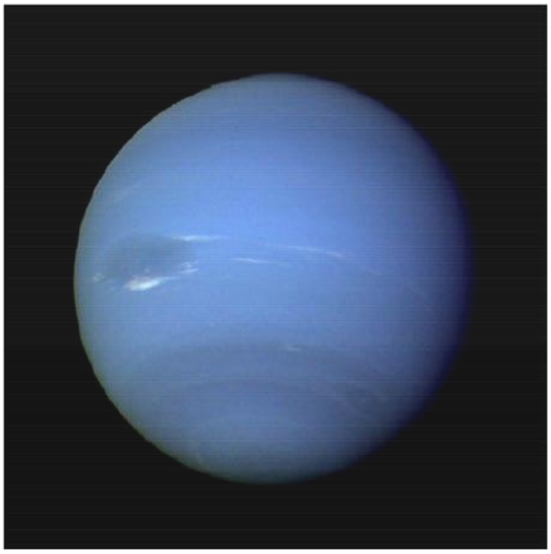


Image: *Voyager, NASA / JPL*

PLUTO (KUIPER BELT)

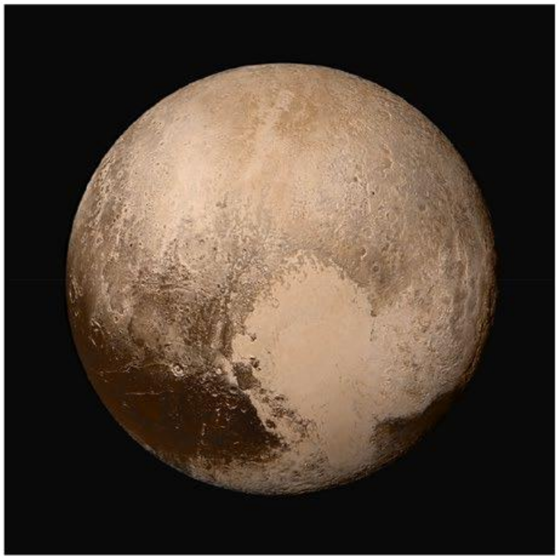


Image: *New Horizons, NASA / JHUAPL / SwRI*

ACTIVITY 8

WHAT SOLAR SYSTEM OBJECT AM I?

Level:	Preparation:	Number of students:	Length:	Place:	Type of activity:
Grades 3-6	easy	groups of 4 to 5	20 min.	classroom	game

BRIEF DESCRIPTION

Students guess which celestial body of the Solar System they are. They ask yes/no questions, and guess based on the information on the board.

MATERIALS

- Solar System information table (1 per team or per person)
- names of objects, printed and cut out
- Post-it notes or stickers (students will have their object on display on their foreheads)

PREAMBLE

Most people are familiar with the major planets and know that comets and asteroids exist. **However, the Solar System contains hundreds of interesting objects**, some of which are similar in size to the planets —such as some moons of Jupiter and Saturn. These worlds have fascinating histories and deserve to be better known. This game gives your students a chance to get to know some of these lesser-known objects in the Solar System.

PREPARATION

Print one object chart for each team. You may also choose to print individual copies for students so they can check off objects as they are eliminated.

Print and cut out the object names, preparing one complete set per group. Be sure each set contains more objects than there are students, so the game can't be easily solved by elimination..

STEPS

Divide students into groups of 4–5 and give each group an object chart. To assign each student an object without revealing it, have them place a folded piece of tape or a sticky note on their forehead. Then, give each student a card with the name of a celestial object and attach it to their forehead so that everyone else can see it, but they cannot..

Students take turns asking yes/no questions to figure out which object they are. Questions should be based on the information provided on the chart. For example, a student might ask, "Am I a planet?" or "Am I farther from the Sun than Earth?"

When a student thinks they know their object, they can ask, "Am I…?" If they are correct, their turn ends and the next student begins. Play continues until each student has guessed their object. Once everyone has had a turn, the game can be repeated with new objects.

Possible discussion questions:

- Had you heard of all these objects before? If not, which ones are new to you?
- Which objects did you find most interesting? Why?
- Were some objects easier or harder to guess? What made the difference?

Did you know that we now know of 8 planets, 5 dwarf planets, 173 moons, thousands of comets, and hundreds of thousands of asteroids in our Solar System.

DID YOU KNOW…?

INFORMATION

Many of the objects featured in this game may be unfamiliar to students. You can extend the activity by exploring some of these objects—or categories of objects—in more detail through additional research.

Below are interesting facts about each object that can be shared with students once they have correctly identified their own.

- **Sun**: I am so big; I could hold more than a million times the Earth in size and mass.
- **Venus**: My surface is hotter than a kitchen oven.
- **Jupiter**: I am bigger than all the other planets combined.
- **Neptune**: It takes me 165 years to circle the Sun.
- **Pluto**: I was visited in the summer of 2015 by the New Horizons probe. It was the first time humans saw what I look like.
- **Chury (67P/C-G)**: There is currently a small robot sleeping on my surface; its name is Philae.
- **Titan**: I have lakes of methane (natural gas) on my surface.
- **Ceres**: Discovered in 1801, I was first classified as a planet, then later as an asteroid. Today, I am considered a dwarf planet.
- **Vesta**: I have a giant crater on my surface. The impact that created it almost destroyed me completely.
- **Ida**: I look like a big potato full of craters.

See the glossary at the end of this guide for more information on the types of objects presented in this activity: star, planet, dwarf planet, moon, asteroid, and comet.

TO LEARN MORE

- *List of Solar System objects*, *Wikipedia* page.

Sun	Venus
Jupiter	Neptune
Pluto	Chury
Titan	Ceres
Vesta	Ida

TABLE OF OBJECTS

	Sun	Venus	Jupiter	Neptune	Pluto	Chury (67P/C-G)	Titan	Ceres	Vesta	Ida
I am a...	Star	Planet	Planet	Planet	Dwarf Planet	Comet	Moon	Dwarf Planet	Asteroid	Asteroid
I orbit around...	Centre of the galaxy	Sun	Sun	Sun	Sun	Sun	Saturn	Sun	Sun	Sun
Am I bigger than the Earth?	Yes	No	Yes	Yes	No	No	No	No	No	No
Am I bigger than the Moon?	Yes	Yes	Yes	Yes	No	No	Yes	No	No	No
Do I have an atmosphere?	Yes	Yes	Yes	Yes	Yes	No	Yes	No	No	No
Do I have moons?	No	No	Yes	Yes	Yes	No	No	No	No	Yes

Information:

An **atmosphere** is a layer of gases surrounding an object. On Earth, this layer is made mostly of nitrogen and oxygen—we call it "air," and it's what we breathe. Other objects also have atmospheres, but they are made of different gases that humans cannot breathe.

A **moon**, or natural satellite, is an object that orbits a planet, dwarf planet, or asteroid. Earth has one moon, called the Moon, but some objects have many. For example, Jupiter and Saturn each have more than ninety moons!

ACTIVITY 9

MAKE PLANETS WITH MODELLING DOUGH

Level:	Preparation:	Number of students:	Length:	Place:	Type of activity:
Grades 3-6	**intermediate**	**groups of 2 to 4**	**20 min.**	**classroom**	**participation activity, do-it-yourself**

BRIEF DESCRIPTION

Students discover the sizes of the planets by making a scale model using modelling dough.

MATERIALS

- 3 pounds (1.4 kg) of modelling dough per group *(see recipe on page 54)*
- plastic knives
- 1 instruction sheet per group
- placemats or wax paper to cover tables (if necessary)
- paper and pencil to identify planets

PREAMBLE

It is very rare to see images showing the sizes of planets to scale, and even if they are accurate, an image on paper does not give a good idea of three-dimensional sizes. This activity helps you understand the relative sizes of the planets by creating spheres for each of them.

PREPARATION

This activity requires 3lbs (1.4 kg) of dough per group. Using this full amount is important; otherwise, it won't be possible to create the smallest objects in the Solar System by the end of the activity.

If you are working with multiple groups, the cost can add up quickly. As an alternative, you can use the modelling dough recipe provided with this activity. Making the dough can even serve as a fun preliminary activity for students.

It's also a good idea to try the activity yourself beforehand. The results may surprise you!

STEPS

Begin the activity with a discussion on the size of the objects in our Solar System. Which is the largest planet? The smallest? Is the largest planet much larger than Earth? You can use the image of the not-to-scale planets so that students can see them, but without giving them the answers.

Give 3lbs of modelling dough to each group of 2–4 students, and explain that they are going to investigate the sizes of the planets using a scale model. To help them understand the principle of scale models, you can use children's toys, such as small cars or animals. For example, you can show them a toy car and a toy plane and discuss the fact that they are scale models, but (probably) not to the same scale. You can then find two objects of the same scale and explain the difference.

Ask the children to make paper labels for the 8 planets: Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, and Neptune. These labels can be used to identify the dough balls.

This activity can be done in two stages. First, ask students to create dough spheres representing the sizes of the planets based on their existing knowledge. Once they're finished, compare the models between groups and discuss the differences.

Then, have students reshape their dough into a single large ball. If you have enough dough, you may choose to keep their original models so they can compare their estimates with the actual sizes later on.

Hand out the instruction sheet so that students can complete the activity at their own pace. If you prefer, **you can also guide the group** by reading the instructions yourself.

At the end, come together as a class to discuss the results. Here are some questions you might ask:

- Are you surprised by the sizes of the planets? Why or why not?
- Do you think there are even smaller space objects? (*Yes, there are hundreds of objects even smaller than Mercury. These include dwarf planets such as Pluto, Eris, and Ceres, as well as moons, asteroids, and comets. For our scale model, the Moon would be practically invisible!)*

> Did you know that it would take 1750 pounds (794 kg) of modelling dough to create the Sun for our model? It would be a huge ball, 1 metre in diameter.

DID YOU KNOW...?

RECIPE FOR MODELLING DOUGH

This recipe makes 3 pounds of colourful modelling dough.

- 4 cups white flour
- 1 cup salt
- 2 cups boiling coloured water (food colouring can be added for colour)
- 4 tablespoons of vegetable oil
- 4 tablespoons of cream of tartar

In a large bowl, combine all dry ingredients (flour, salt, and cream of tartar). In a separate bowl, combine the liquid ingredients (water and oil) then pour over the dry ingredients. Mix well until a ball forms. If the mixture is too sticky, add a little flour. Remove from bowl and knead until smooth. Store in a plastic bag in the fridge until ready to use.

Over time, this modelling dough can become mouldy. If you plan to do this activity regularly, it may be easier to buy a good quantity of commercial modelling dough and store it.

INFORMATION

This activity compares the volumes of the planets. It's striking to see just how tiny the terrestrial planets are next to the giant planets.

The terrestrial planets are Mercury, Venus, Earth, and Mars. They are called terrestrial because they share Earth-like characteristics: they are relatively small, rocky, and have solid surfaces. These planets are also the closest to the Sun.

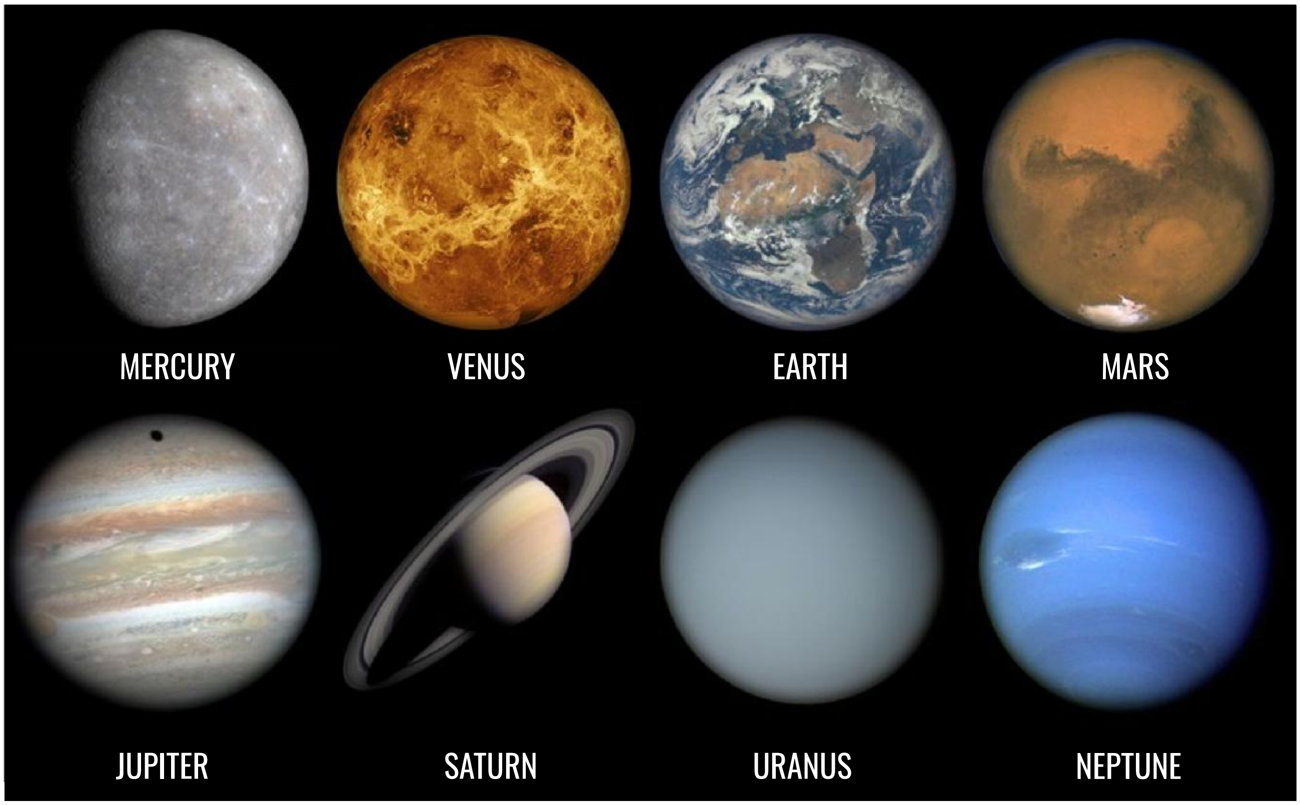
The giant planets—Jupiter, Saturn, Uranus, and Neptune—are much larger and are composed mostly of gas. They do not have solid surfaces like the terrestrial planets. All of them have ring systems (although only Saturn's rings are easily visible from Earth) and many moons. These planets are located much farther from the Sun, in the outer regions of the Solar System.

SOURCE

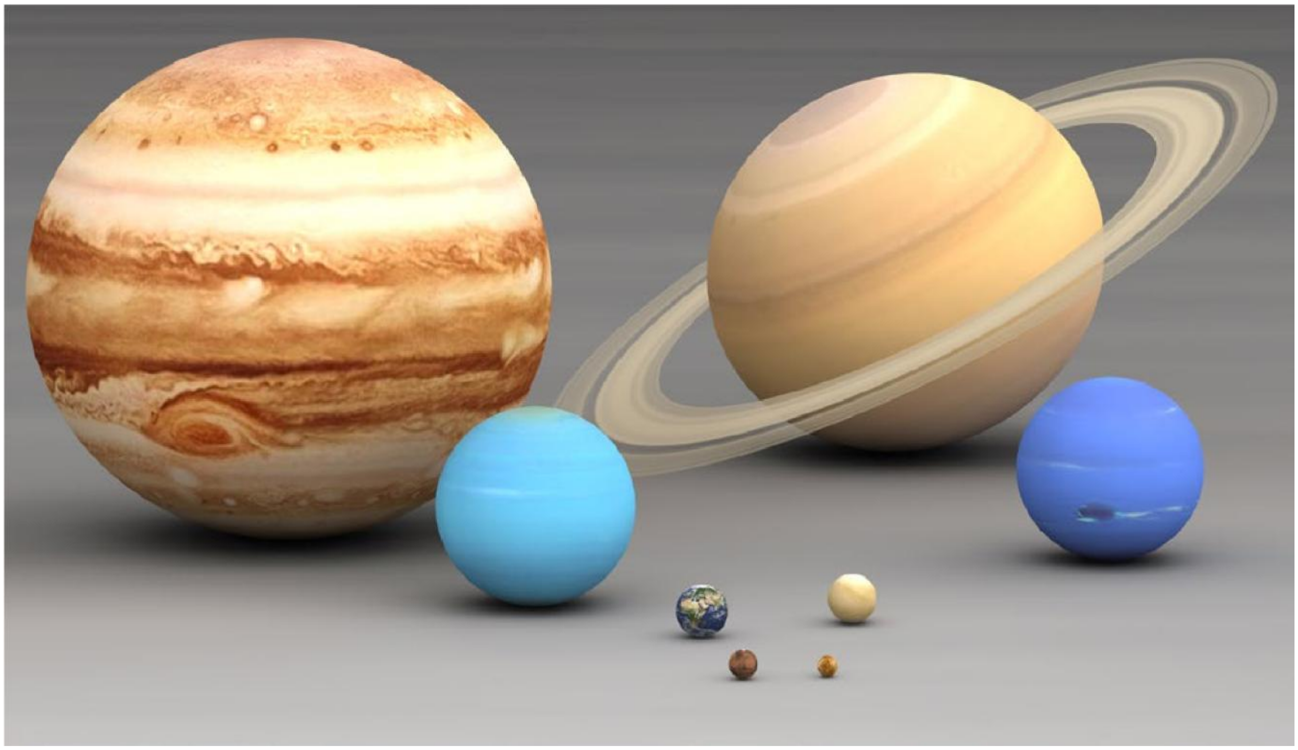
This activity is adapted from a *NASA* activity and the *Astronomical Society of the Pacific*'s activity *Worlds in comparison*.

PLANETS OF THE SOLAR SYSTEM

TO LEARN MORE: *Solar System*, *Wikipedia* page.



The planets of the Solar System. *Images not to scale.* Photo credit: *NASA.*



Planets to scale. Photo credit: Lsmpascal / *Wikimedia Commons.*

Start with a 3-pound ball of modelling dough. This volume represents all the planets combined.

To help you divide the dough, make a roll and cut it with a plastic knife.

1. **Divide the 3lbs ball into 10 equal parts, and then:**
   - Combine 6 of these parts together to make a new ball. This is the beginning of **Jupiter**.
   - Combine 3 other parts together and place this new ball on the **Saturn** label. More will be added later.

2. **Divide the remainder into 8 equal parts, and then:**
   - Combine 3 parts and add them to **Saturn**.
   - Combine 2 parts and form a ball. This is **Neptune**.
   - Combine 2 parts and form another ball. This is **Uranus**.

3. **Divide the remainder into 8 equal parts, and then:**
   - Combine 4 add them to **Saturn**.
   - Combine 2 and add them to **Uranus**.
   - Add one part to **Jupiter**.

4. **Divide the remainder into 10... Yes, it becomes a bit challenging!**
   - Combine 3 parts and form a ball to create the **Earth**.
   - Combine 2 parts and form a ball to create **Venus**.
   - Combine 4 parts and add them to **Neptune**.

5. **Divide the remainder into 5, and then:**
   - Combine 2 parts and add them to **Venus**.
   - Combine 2 parts to create **Mars**.
   - The remainder is **Mercury**.

Now that all the planet amounts have been distributed, form them into beautiful spheres and admire your Solar System!

ACTIVITY 10

MOVING ON OTHER WORLDS

Level:	Preparation:	Number of students:	Length:	Place:	Type of activity:
preschool, Grades 1-2	**easy**	**large group**	**5 min.**	**on the move**	**moving activity**

BRIEF DESCRIPTION

Students move around pretending to be on other planets in the Solar System, taking into account the gravitational pull on their surfaces.

MATERIALS

- none

PREAMBLE

You may have seen videos of astronauts on the Moon. They move by hopping because the lower gravity makes it easier to lift themselves off the ground. But what would gravity feel like on other planets? How would we move if gravity were much stronger than on Earth? This short activity lets students explore how gravity works on different worlds, and gets them moving for a few minutes in the process.

PREPARATION

None.

Did you know that some stars turn into black holes at the end of their lives? The Sun, however, is not massive enough to become a black hole.

DID YOU KNOW...?

STEPS

Introduce this activity by showing the astronauts from the **Apollo** missions who walked on the Moon. An Internet search for *astronauts*, *jumping*, and *moon* should yield some interesting videos.

Talk with students about how astronauts hop around on the Moon because its gravity is lower. They feel lighter and can jump much higher than on Earth; about six times lighter, in fact! Now, imagine a world where gravity is much stronger than on Earth. We would feel heavy and find it difficult to move. For example, if gravity were twice as strong, it would feel like carrying a friend on your shoulders —definitely not easy!

Ask the students to imagine themselves walking on different worlds in the Solar System, with the information in the following table, which lists the gravity on each world compared to the Earth.

World	Your weight
Earth	normal
Moon	6x lighter
Mars	3x lighter
Jupiter	2.5x heavier
Sun	28x heavier

Some worlds have weaker gravity than the Earth. This is true of the Moon and Mars, where we would be 6 times and 3 times lighter, respectively. On other worlds, we would feel much heavier. On Jupiter, it would be equivalent to carrying a friend (and a half) of the same weight on our shoulders. On the Sun, it would be equivalent to 27 friends —and that's on top of your own weight!

You can use this activity to get the students moving for a few minutes. It is also a great way to grab their attention and have fun at the same time! Moreover, you can add that on the Moon there's no air and therefore no sound —so, the students need to keep quiet when they are on the Moon!

Note: In reality, it would be impossible to stand on the surface of Jupiter and the Sun, since neither actually have a solid surface. Instead, they are gaseous worlds where the pressure would get higher and higher as we moved down towards the centre. And of course, the Sun would also be far too hot for us to even approach!

INFORMATION

Gravity is the force that keeps us anchored to the surface of the Earth, or any planet, and makes things fall back down. The strength of this force varies from one world to another, depending on its size and mass. Some small objects in the Solar System have such weak gravity —thousands of times weaker than Earth's—that you could actually jump right off them! This is true for Mars' moons, Deimos and Phobos. Imagine trying to keep track of your students on Phobos: one small hop, and they'd float away!

On the other end of the scale, some objects have extreme gravity. Neutron stars, the remnants of certain dead stars, have gravity hundreds of billions of times stronger than Earth's—enough to crush us instantly. And the strongest of all are black holes, where gravity is so intense that not even light can escape.

TO LEARN MORE

- *What Is Gravity?, NASA Science Space Place.*

ACTIVITY 11

RECALLING THE PLANETS

Level:	Preparation:	Number of students:	Length:	Place:	Type of activity:
Grades 1-4	**easy**	**individual or small groups**	**15 min.**	**classroom**	**creative activity**

BRIEF DESCRIPTION

Students create a mnemonic —a sentence where each word starts with the first letter of a planet—to help them remember the planets in order from the Sun.

MATERIALS

- Printable activity sheet (1 per person)

PREAMBLE

Most adults grew up learning that there were 9 planets in our Solar System. A phrase commonly used to remember the planets in order was "My Very Educated Mother Just Served Us Nine Pizzas". But in 2006, a new definition of "planet" was adopted, and Pluto was reclassified as a dwarf planet. That means the old mnemonic no longer works, and finding a new one becomes the students' mission in this activity.

PREPARATION

Print the activity sheet so that each student has one.

STEPS

Ask the students if they know the planets in the Solar System in order from the Sun. To help them remember, explain that it is handy to **invent sentences in which each word begins with the first letter of a planet**. This mnemonic device can also be used to help remember other tricky lists.

Hand out the activity sheets and let the students get creative! Then come back as a class to share ideas. Students could even vote for their favourite sentence.

This activity can be done individually or in groups of 2 or 3 students.

INFORMATION

Our Solar System comprises 8 planets, which are the largest objects orbiting the Sun.

Pluto's category change in 2006 is an event that has brought much confusion to those less familiar with astronomy. It's important to understand that **objects in our Solar System do not come with a label indicating whether they are planets, moons, asteroids, etc.** These categories were invented by scientists in order to group similar objects together.

Sometimes, new observations mean that we have to modify our classifications; **it's science evolving and adapting to new knowledge**. This was the case with Pluto, which is now classified as a dwarf planet. The reclassification of Pluto does not reflect a change to Pluto itself in any way —it's still part of the Solar System and continues to orbit the Sun unchanged.

Although Pluto is no longer classified as a planet, it remains just as fascinating and worth studying. In fact, the New Horizons probe flew past Pluto in July 2015, capturing stunning images of its surface, the first time we've been able to see this distant world up close.

Find out more about this mission on the *NASA* website: *https://science.nasa.gov/mission/new-horizons*

TO LEARN MORE

- *Planets & Dwarf Planets*, *NASA Science* Webpage.
- *Pluto*, *NASA Science* Webpage.

Did you know that, if there were a pool big enough the planet Saturn would be the only planet to float on water?

DID YOU KNOW...?

REMEMBERING THE PLANETS

To help you remember the planets in order from the Sun, invent a sentence with each word beginning with the first letter of each planet name. Let your imagination run wild and come up with a fun, creative sentence!

Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune

M ____________________

V ____________________

E ____________________

M ____________________

J ____________________

S ____________________

U ____________________

N ____________________

My sentence: ____

ACTIVITY 12

LANDING CONTEST

Level:	Preparation:	Number of students:	Length:	Place:	Type of activity:
Grades 3-6	**intermediate**	**groups of 2-4**	**60 min.**	**classroom, gym, outdoors**	**do-it-yourself, competitive, creative activity**

BRIEF DESCRIPTION

Students build a lander that allows an egg to fall from a minimum height of 2 metres without breaking.

MATERIALS

- materials for decorating the lander: pencils, glue, glitter...
- scissors
- adhesive tape
- fresh eggs, 1 per team
- plastic tablecloth or large garbage bag to protect the floor
- hoop or tape to mark out landing area

Note: you may want to boil the eggs to avoid making a mess, but sometimes messes are fun!

Eco-friendly tip: To build the lander, use materials that often end up in the recycling bin or garbage. Don't hesitate to ask parents to provide you with certain items in advance. Here are a few ideas:

- small plastic containers (yogurt, etc.)
- egg cartons
- straws
- wooden skewers
- string
- rubber bands
- balloons
- scrap paper or cardboard
- cotton or other stuffing material
  (ask the school secretary for stuffing material from delivered parcels) —limit quantities per team!

PREAMBLE

Imagine you need to send a probe to the planet Mars. After travelling hundreds of millions of kilometres, the probe must slow down to avoid crashing into the planet's surface. The probe can start to slow down using a parachute. However, this method can't be used on its own, as Mars' atmosphere is thinner than Earth's. The probe would still be travelling too fast on the ground! What other braking system could you use? How would you protect the probe from damage on landing?

Students will build a lander and then explore the influence of gravity and atmosphere in a safe landing, getting the students thinking about the technological challenges of such missions. The aim is to land an egg from a predetermined height without breaking it. This means slowing its fall and protecting it on impact with the ground.

PREPARATION

Make sure you have enough equipment for each group. You can allow groups to take what they want from the materials, or limit the quantities available to each. You can also provide each group with a bag or box containing all the materials they can use.

For the test, you can use different methods depending on your situation. The starting height can be two metres or more if you have access to a stepladder, the top of a staircase, or a 2nd-floor window. Make sure the whole thing is safe, and that any mess can be cleaned up easily if the eggs break.

STEPS

To broach the subject with students, share these videos demonstrating the challenges of landing on Mars.

- Challenges of Getting to Mars: Curiosity's Seven Minutes of Terror: *https://science.nasa.gov/resource/challenges-of-getting-to-mars-curiositys-seven-minutes-of-terror/*
- Landing of the Spirit and Opportunity probes in 2004: *https://www.youtube.com/watch?v=KyktvC7w7Js*

Discuss the challenges these missions represent, what they remember from the videos...

Explain to the students that today they'll be engineers, and that they'll also face a big challenge: building a system to land a fragile object without breaking it. Instead of landing a robot like on Mars, the students will have to land an egg! The challenge will be to see which groups can keep the egg intact, while landing as close as possible to the target.

Distribute the materials and set a time limit for building the lander (between 15 and 30 minutes). Groups can run tests without the egg during this period to optimize their landing systems.

For the test, **use a hoop or ribbon to mark out a landing zone.** Have the teams go one after the other, and check if the egg is broken once the lander is back on the ground. A cracked egg is considered a broken egg. Also note whether the lander has fallen inside the target. If you're looking for a competition and several groups successfully complete the challenge in the first round, you can repeat the challenge in a second round, with modifications such as starting higher or reducing the size of the target.

INFORMATION

The first missions to Mars took place in the 1960s. The first probes simply flew over the planet without stopping. Engineers then increased the level of difficulty by having probes orbit the planet to better study it. The most difficult challenge is when the probe has to land on the surface. Various types of landers have been tested over the years, including the famous inflatable balloons of the *Pathfinder*, *Spirit*, and *Opportunity* missions. **The Pathfinder mission, with its small robotic vehicle, took place in 1997 and was a huge success.** The same landing method was used for *Spirit* and *Opportunity* in 2004. Once again, these missions exceeded expectations. *Opportunity* was still moving around on the surface of Mars in 2018, fourteen years after its landing!

Inflatable balloons for the Mars *Pathfinder* mission. Image Credit: *NASA.*

Did you know that billions of years ago, there were lakes on the surface of Mars?

DID YOU KNOW...?

In 2011, *NASA* sent another rover to Mars: *Curiosity*. This was bigger than all the previous rovers, roughly the size of a small car. This size posed a problem for the inflatable balloon method, so instead, it was decided to use a crane to lower the rover gently to the surface. It was a challenge of engineering and creativity, and fortunately, it all worked out perfectly! *Curiosity* is still studying the surface of Mars today.

The *Curiosity* rover landing. Image Credit: *NASA.*

Unfortunately, not all missions have been so successful... Of all the missions sent to Mars by the USA, Russia, and Europe, around 65% have failed. A number of problems can arise during lift-off from Earth, during the journey, and especially on arrival to Mars. Occasionally, even human error during manufacturing or navigation of the probe can also cause a mission to fail.

Missions to other planets pose enormous technological challenges, and teams of engineers and scientists are constantly working to develop new methods. If your students don't manage to land an egg without breaking it, tell them to persevere, just like the engineers working on these space missions do!

SOURCE

This activity was inspired by the European Space Agency's activity *L'œuf-tronaute* and the *Club des Débrouillards* experiment.

TO LEARN MORE

- *Exploration of Mars*, *Wikipedia* page.

ACTIVITY 13

MY VERY OWN ALIEN!

Level:	Preparation:	Number of students:	Length:	Place:	Type of activity:
Grades 1-6	**intermediate**	**groups of 2-4**	**30 min. +**	**classroom**	**do-it-yourself, drawing, creative activity**

BRIEF DESCRIPTION

Students design an extraterrestrial (through a drawing or craft) and reflect on how its characteristics are adapted to the conditions of the planet where it lives.

MATERIALS

- colouring pencils
- paper

Eco-friendly tip: For DIY, use materials that often end up in the recycling bin or garbage. Don't hesitate to ask parents to provide certain items in advance. Here are a few ideas:

- plastic containers (yogurt, cottage cheese, shampoo, etc.)
- egg cartons
- styrofoam balls
- absorbent cotton
- scrap paper or cardboard
- scraps of fabric, such as old clothes (clean!)
- tissue paper
- pipe cleaners
- wooden skewers
- gouache
- glue/tape
- hot glue gun

PREAMBLE

Astronomers are always discovering new exoplanets, i.e. planets orbiting other stars (other than our Sun). Scientists are discovering that there are all kinds of planets, all with very different characteristics (atmosphere, mass, distance from their star, etc.). What might an alien living on these distant worlds be like?

In this activity, students can be imaginative as they create an extraterrestrial and think about the conditions needed to live on an imaginary planet. Depending on the time and resources you have available, you may decide to do this activity on paper, asking the students to draw their alien, or you may decide to make it into a craft.

PREPARATION

Assemble the materials you'll need for your DIY project.

STEPS

Explain that there are planets outside our solar system, and that some of them might be able to support life. What might aliens on those worlds look like? Ask them to imagine and create an alien and its world.

Point out that living species on Earth are often quite different from one another, depending on the environment in which they live. For example, a whale can be huge because it lives in water, where its weight is supported by the pressure of the water. We all feel lighter in water, and this phenomenon has allowed animals like whales to evolve to massive sizes in our oceans. On land, an animal that big would have difficulty moving. Another example is how animals living in polar zones have adapted to the cold. They all have thick fur or layers of fat to keep them warm.

DID YOU KNOW...?

Did you know that the first photo of an exoplanet was taken by a team of Quebec researchers at the University of Montreal?

Students can use one of the following four imaginary worlds as inspiration to create their alien. They can also invent their own planet.

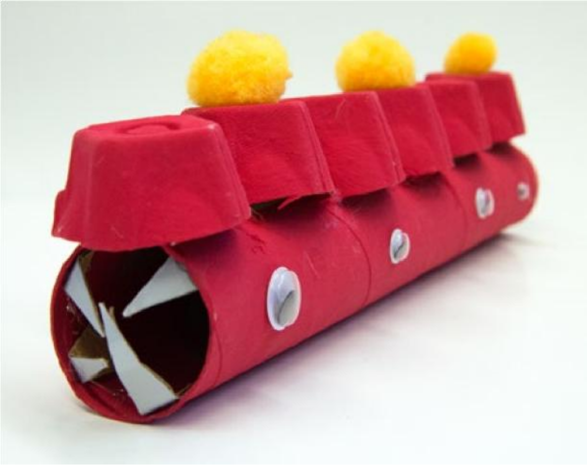
1. **Aklarok** is a small volcanic planet located close to its star, making it very hot. Because of its small size, gravity on its surface is 10 times weaker than on Earth, causing its inhabitants to be very tall and slim.
2. **Bilza** is a very cold, mountainous planet. Gravity on its surface is five times greater than on Earth and 80% of its surface is frozen. Its inhabitants are small and stocky.
3. **Chisk** is a planet about the size of Earth. An ocean covers its entire surface, so there are no continents. It orbits a small red star.

4. **Douxi** is a tropical planet with oceans and forested land. One side of the planet always faces its star, so it's always bright. The other side is constantly in the dark.

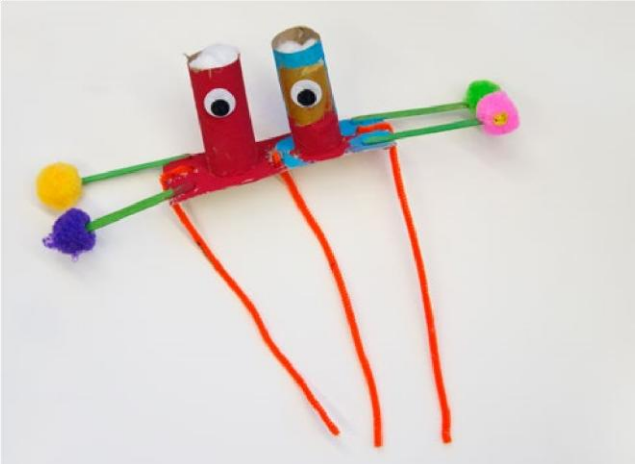
Here are **a few questions to guide the students**:

- How does your alien adapt to the conditions of the planet it lives on?
- How does it get around?
- How and what does it eat?
- Does it have the same senses as us (sight, hearing, smell, taste, and touch), or does it have sense that we don't have?
- How does it communicate?
- What is its name?

Once the students have a good idea of what their alien will look like, the creation can begin! For a quick activity, have the students draw their alien and its planet. For a longer activity, have them craft their alien using materials collected in advance. If you wish, you can then display their creations, making sure to include the alien's name and a short description.



Nidra lives on the planet Chisk. She filters water through her long body and captures the food she finds in it. The yellow parts are magnetic field detectors that help her to orient herself.
Image Credit: Bertrand Nadeau.



Fafalar is an inhabitant of the planet Aklarok. He is 22 meters tall, with two heads and three long, slender legs. He absorbs his food through his feet.
Image Credit: Bertrand Nadeau.

INFORMATION

Our Solar System has eight planets orbiting our star, the Sun. For a long time, nobody knew whether the other stars also had planets orbiting them. **The first exoplanet, a planet outside our Solar System, was discovered in 1995, and since then, more than 6,000 exoplanets have been catalogued.** The study of exoplanets is a very active area of astronomical research, and scientists are developing innovative methods to study these distant worlds.

These exoplanets are highly varied: some are very close to their star, with surface temperatures of several hundred degrees Celsius. Conversely, some are very far from their star and are frozen worlds. Some are also very small and have very low gravity, while others have a higher surface gravity than on Earth (see *Activity 10 Moving to Other Worlds* for more information on this subject).

We already know that there are gaseous planets, like Jupiter, without solid surfaces. If extraterrestrial creatures evolved on these worlds, they would most likely be very different from those on a planet with a solid surface like Earth. According to scientists, there could also be water planets.

Considering the variety of living species that have developed on Earth, it's easy to imagine that extraterrestrials could be entirely different from us.

DO ALIENS REALLY EXIST?

Nobody knows! There are billions of planets in our galaxy, many of which could have conditions similar to Earth. However, because they are extremely far away, it's a challenge for us to see what's on their surface. There is ongoing research to discover and to study exoplanets. There is one type of research that involves using radio telescopes in the hope of detecting a signal from an extraterrestrial civilization. While we do get signals from space, we've always been able to explain them as natural phenomenon, but this doesn't mean that extraterrestrials don't exist. Discovering the presence of life elsewhere in the Universe would be one of the greatest discoveries in human history.

Note: Since this activity was first published, we've launched a new resource in collaboration with other STEM organizations in Canada called *Exoplanets in the Classroom*, and we think you might find some information there helpful, especially if your students seem keen to learn more.

SOURCE

This activity is inspired by the *Fabrique ton extraterrestre* activity from the *Rio Tinto Alcan Planetarium* in Montreal, and the book *Il y a de la vie sur les exoplanètes* by Jean-Pierre Urbain.

TO LEARN MORE

- *Is There Life on Other Planets?*, *NASA Science* Webpage.

ACTIVITY 14

DECODE THE ALIEN MESSAGE

Level:	Preparation:	Number of students:	Length:	Place:	Type of activity:
Grades 3-6	**easy**	**individual**	**15 min.**	**classroom**	**riddle**

BRIEF DESCRIPTION

Students decode a message using the same code that scientists use to try and communicate with aliens.

MATERIALS

- sheet with the message (1 per person)
- pencil and eraser

PREAMBLE

One of humanity's biggest questions is whether we are alone in the Universe, or whether other civilizations exist on distant planets. Scientists scan the skies with radio antennas to detect possible extraterrestrial messages. They have also already sent messages that may one day be detected by other civilizations.

But how do we communicate with aliens, since they would not speak the same language as us? Scientists and philosophers believe that it would be interesting to use a system based on science and mathematics, since the laws of nature are the same everywhere in the Universe. So the first attempts at communication used a binary code, made up of 1s and 0s, to create messages. This same language is used in computers and other electronic devices.

In this activity, binary language has been used to create a secret message that the students will decode. Though, of course, it's not a real message from an extraterrestrial civilization!

PREPARATION

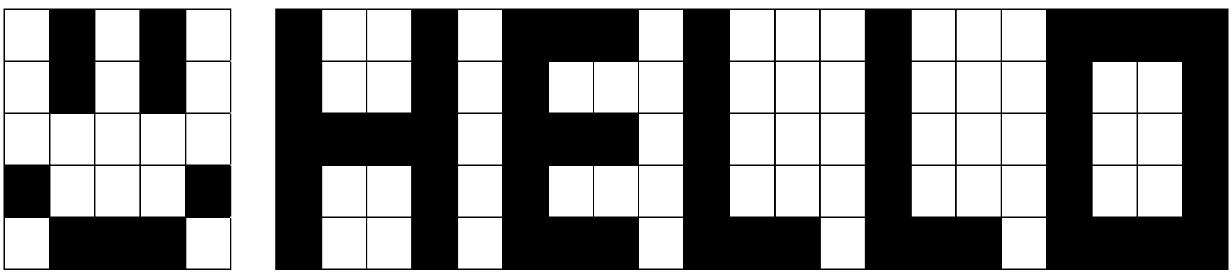
Print out more sheets than the number of students. If mistakes are made filling-in the grid, it may be easier to start all over again than to erase.

STEPS

The secret messages are a series of 0s and 1s, and each number corresponds to a cell in the grid, starting at the top left. The boxes associated with a 1 are to be coloured in, and the boxes associated with a 0 are to be left white.

Tip: In the easy message, each row of the grid has five squares. It may be useful to start by dividing the sequence of 0's and 1's into fives series of five to limit the risk of error when filling in the grid. You can do this by putting a line after each set of five digits in the sequence, or rewrite the sequence of 0's and 1's on five lines of five digits. You can then apply the same principle to the advanced level grid, but be careful to count the number of squares per row.

Here are the two decoded messages:



You can jump right into the activity since it's easy enough to decode the secret message. However, it's a good idea to take the opportunity to get your students thinking about the possibility of extraterrestrial life and the difficulties of communicating with such a civilization if it exists.

Here are some ideas for reflection and discussion, before or after decoding the message.

- Do you believe that aliens exist?
- How would we go about communicating with them? What language would we use?
- What problems did we encounter on Earth when two civilizations didn't speak the same language?
- Do you think aliens might understand a message written in binary code?

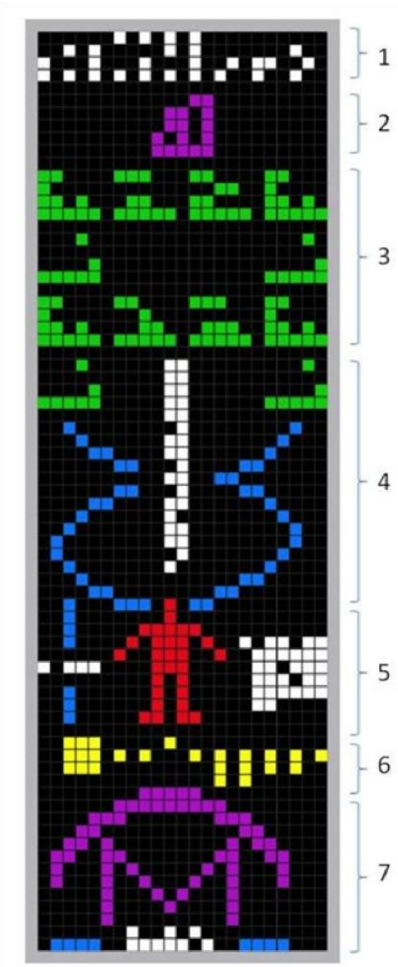
You could also have students create their own message in binary code, and let their parents or friends decipher it.

INFORMATION

This activity is inspired by a message that scientists sent into space in 1974. Commonly known as the Arecibo message, this radio message was sent from the Arecibo radio telescope in Puerto Rico. This is a giant radio antenna 300 metres in diameter.

This message consists of a sequence of 1679 binary numbers, i.e. 0's and 1's. Rearranging the sequence into a grid of 23 columns and 73 rows, the following drawing appears (colour has been added to the image to clearly see the different parts of the message).

It contains information about the Earth, humans, and life on Earth in general.



Message from Arecibo.
Image Credit: Arne Nordmann
/ *Wikimedia Commons*.

Here are the details of the different sections of the message:

1. Numbers from 1 to 10.

2. The atomic numbers of the five most common elements in living species on Earth: hydrogen, carbon, nitrogen, oxygen, and phosphorus.

3. Chemical formulas for nucleotides, the basic molecules in our DNA.

4. The DNA double helix.

5. A human with their height and the Earth's population at the time of the message (approx. 4 billion).

6. The Sun and the planets. The Earth is offset to highlight it.

7. The Arecibo radio telescope and its diameter.

This message was sent to the M13 star cluster, more than 20,000 light-years away. Travelling at the speed of light, this message would take over 20,000 years to reach its destination. If aliens living there receive the message, understand it and decide to respond, we'll receive our answer in more than 40,000 years!

DO ALIENS REALLY EXIST?

Nobody knows! There are billions of planets in our galaxy, many of which could have conditions similar to Earth. However, because they are extremely far away, it's a challenge for us to see what's on their surface. There is ongoing research to discover and to study exoplanets. There is one type of research that involves using radio telescopes in the hope of detecting a signal from an extraterrestrial civilization. While we do get signals from space, we've always been able to explain them as natural phenomenon, but this doesn't mean that extraterrestrials don't exist. Discovering the presence of life elsewhere in the Universe would be one of the greatest discoveries in human history.

HOW CAN WE COMMUNICATE WITH ALIENS?

In science-fiction movies, humans and aliens often end up understanding one another. Typically, the aliens even speak human languages! But in reality, communication with an extraterrestrial civilization would be very difficult, since we would have no common language and our cultures would be entirely different. That's why scientists believe that the best way to communicate would be through science and mathematics.

SOURCE

This activity is inspired by *Decode an extraterrestrial message* activity from the *Rio Tinto Alcan Planetarium* in Montreal.

TO FIND OUT MORE

- *Arecibo Message*, *Wikipedia* page.

Did you know that a light-year is the distance light travels in one year, or nearly ten thousand billion kilometers?

DID YOU KNOW...?

Decode your messages by colouring in the boxes corresponding to the number 1 (black) and leaving the boxes corresponding to the number 0 blank (white).

EASY LEVEL

0-1-0-1-0-0-1-0-1-0-0-0-0-0-1-0-0-0-1-0-1-1-1-0

Start here →

HARD LEVEL

1-0-0-1-0-1-1-1-0-1-0-0-0-1-0-0-0-1-1-1-1-1-0-0-1-0-1-0-0-0-1-0-0-0-1-0-0-0-1-0-0-1-1-1-
1-1-0-1-1-0-0-1-0-0-0-1-0-0-0-1-0-0-1-1-0-0-1-0-1-0-0-0-1-0-0-0-1-0-0-0-1-0-0-1-1-0-0-1-
0-1-1-1-0-1-1-1-0-1-1-1-0-1-1-1-1

ACTIVITY 15

WORD SEARCH

Find the words in the grid to discover the mystery word.

G	Y	E	R	E	T	I	P	U	J	T	E	M	O	C
M	X	H	T	R	A	E	M	I	L	K	Y	W	A	Y
C	A	T	E	N	A	L	P	F	R	A	W	D	S	M
R	L	I	N	B	L	A	C	K	H	O	L	E	T	A
A	A	N	E	B	U	L	A	S	S	P	A	C	E	R
T	G	I	E	N	U	T	P	E	N	O	A	O	R	S
E	S	R	E	V	I	N	U	R	B	L	S	U	O	R
R	S	N	R	U	T	A	S	E	E	A	T	R	I	E
R	V	A	U	R	O	R	A	C	A	R	R	A	D	P
C	O	N	S	T	E	L	L	A	T	I	O	N	R	P
R	T	M	E	T	E	O	R	Y	K	S	N	U	E	I
I	U	T	E	L	E	S	C	O	P	E	O	S	P	D
N	L	G	A	N	Y	M	E	D	E	T	M	T	I	G
G	P	O	Y	R	U	C	R	E	M	R	Y	A	U	I
S	A	I	E	P	O	I	S	S	A	C	Y	R	K	B

ASTEROID
ASTRONOMY
AURORA
BIG DIPPER
BLACK HOLE
CASSIOPEIA
CERES
COMET

CONSTELLATION
CRATER
DWARF PLANET
EARTH
GALAXY
GANYMEDE
JUPITER
KUIPER

MARS
MERCURY
METEOR
MILKY WAY
NEBULA
NEPTUNE
PLUTO
POLARIS

RINGS
SATURN
SKY
SPACE
STAR
TELESCOPE
UNIVERSE
URANUS

These twin 8-metre telescopes are located in Hawaii and Chile. They are Canada's largest telescopes.

_ _ _ _ _ _   _ _ _ _ _ _ _ _ _ _ _

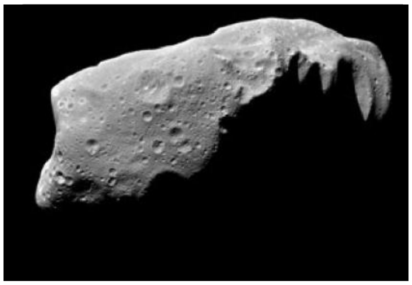
GLOSSARY

Here are a few useful definitions to help you understand the activities.

Globular Cluster. Credit: Rémi Lacasse.

Star Cluster: A star cluster is a grouping of stars in our galaxy. The stars in the cluster are really close together, having formed in the same region of space. Star clusters are beautiful objects, visible through binoculars or a telescope.

Light-year: A light-year is a unit of distance. It is the distance light travels in one year. It is equivalent to approximately 10,000 billion kilometres.



Ida Asteroid. Credit: *NASA*.

Asteroid: An asteroid is a small object orbiting the Sun. Its small mass means it has an irregular shape, rather than the spherical form of planets and dwarf planets. Most, but not all, asteroids are found in the asteroid belt between the orbits of Mars and Jupiter. Asteroids are composed of rocks and metals. It is estimated that there are millions of asteroids in the Solar System.

Comet Hale-Bopp.
Credit: Thomas Collin.

Comet: A comet is a small object orbiting the Sun. All comets are composed of ice, which turns to gas as they approach the Sun. This phenomenon causes long tails of dust and gas to form behind the comet. There are billions of comets in the Solar System.

Constellation: A constellation is a group of stars that forms a recognizable pattern in the night sky. These patterns were imagined by humans and are not real celestial objects. Today, we there are 88 internationally recognized constellations which we use as a reference system for finding way finding.

GLOSSARY (CONTINUED)

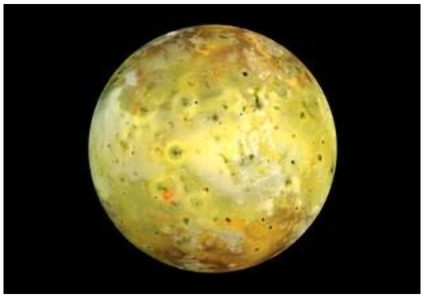
Stars in our galaxy.
Credit: *NASA / STScI / AURA*.

Star: A star is a giant ball of gas that emits a great deal of energy (light) thanks to nuclear fusion at its centre. The Sun is the only star in our Solar System, but it is one of 200 billion stars in our Milky Way galaxy.

Exoplanet: An exoplanet is a planet outside our Solar System. These planets orbit distant stars. Most of the stars we see at night have planets around them.

Spiral galaxy. Credit: Rémi Lacasse.

Galaxy: A galaxy is an immense grouping of stars. In addition to stars, galaxies contain nebulae, star clusters, and billions of other objects such as planets. There are many different types of galaxies, but the best known are spiral galaxies.



Io, moon of Jupiter. Credit: *NASA*.

Moon or Natural Satellite: A natural satellite is an object that orbits a planet. The Earth's natural satellite is called the Moon (with a capital M), while other moons are found around other planets. There are also moons around dwarf planets, such as Pluto, and around some asteroids. Note that some moons are larger than planets, and some even have atmospheres.

Orion Nebula.
Credit: Phillippe Moussette.

Nebula: A nebula is a cloud of gas and dust in space. Some nebulae are star-forming regions, while others are the remnants of a dead star. On camera, nebulae are stunning, colourful pockets of space. To the naked eye or with a small instrument, they simply appear as blurred specks in the sky.

Orbit: An orbit is the curved path that an object, like a planet, moon, or satellite, follows as it moves around another object in space, usually due to gravity. For example, the Moon orbits the Earth, while the Earth orbits the Sun.

Saturn. Credit: *NASA*.

Planet: A planet is an object orbiting a star, in our case the Sun. In addition, this object must be large enough (massive) to have a spherical shape, and it must not share its orbit with (many) other large objects. There are 8 planets in our solar system: Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, and Neptune.

Pluto. Credit: *NASA / JHUAPL / SwRI*.

Dwarf Planet: A dwarf planet is an object orbiting the Sun. Like a planet, this object must be large enough to have a spherical shape. However, it can share its orbit with other large objects. It is this latter criterion that has led Pluto to be considered a dwarf planet instead of a planet since 2006. In our solar system, there are currently five objects in this category (Pluto, Ceres, Eris, Haumea and Makemake), but more could be discovered.

Revolution: A revolution is the complete orbit of one object around another, i.e. a planet travelling all the way around the Sun. The Earth completes one revolution in one year —which is how we define a year.

Rotation: Movement of a celestial body that turns its own axis. For example, the Earth's rotation on its axis takes 24 hours —which is how we define a day.