

# THE MOON & ITS MANY PHASES



## Before you Read

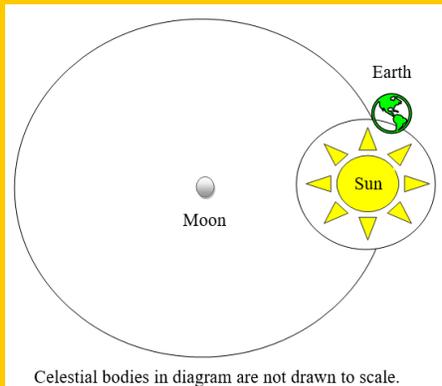
- 1 What force causes a Moon to orbit a planet?
- 2 How does the position of the Sun, Moon, and Earth determine the Moon phases?
- 3 Why do we refer to the Moon phases as the lunar cycle?

## Reading Passage

Moons can be defined as celestial bodies that orbit other celestial bodies. Planets are often the bodies that most moons orbit. Moons orbit planets due to a force called gravity. Gravity is a force that pulls objects with different masses together. Most planets have a greater mass than moons, so this causes a Moon to be pulled in by a planet. Some planets, like Mercury and Venus, have no Moons, while other planets like Jupiter have several! Earth has one Moon. Our Moon is involved in phenomena such as eclipses, tides, light reflection, and most interestingly the Moon phases!

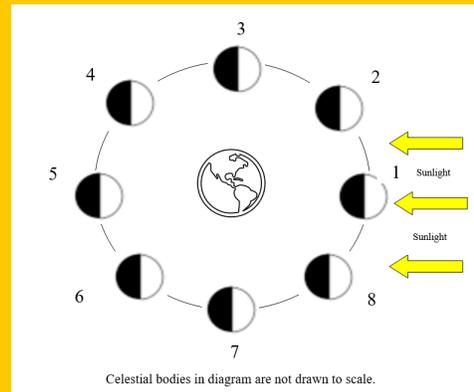
The Moon phases or lunar cycle is caused by the relative position of the Sun, Moon, and Earth. In our solar system, the Sun is at the center, the Earth orbits the Sun, and the Moon orbits the Earth. As the Moon orbits the Earth, we are able to see portions of its shape based on how much of the sunlit portion of the Moon is able to be seen on Earth at that time. The lunar cycle takes about a month, or 29.5 days. The lunar cycle begins when the Moon appears completely dark (New Moon) and gradually increases its illumination, this is known as waxing. Once the moon is completely illuminated (Full Moon) the moon's illumination gradually decreases, this is known as waning. The phases in between a New and Full Moon include waxing or waning crescent, quarter, and gibbous. These are determined by what percentage of the Moon we can see. The next time you're outside at night, take a look to determine the Moon's phase!

## Activity #1



**Directions:** Above is an incorrect diagram of the position of the Sun, Moon, and Earth. In the space provided, draw a correct diagram of their positions.

## Activity #2



**Directions:** Correctly label each of the Moon's phases, using the diagram above.

- 1 \_\_\_\_\_
- 2 \_\_\_\_\_
- 3 \_\_\_\_\_
- 4 \_\_\_\_\_
- 5 \_\_\_\_\_
- 6 \_\_\_\_\_
- 7 \_\_\_\_\_
- 8 \_\_\_\_\_

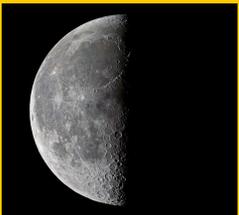
# THE MOON & ITS MANY PHASES

## Activity #3

**Directions:** As you know, some Moon phases look very similar. Observe the pictures below, identify the moon phases shown, and explain how you know.



- Name of the Moon phase:
- How do you know?



- Name of the Moon phase:
- How do you know?



- Name of the Moon phase:
- How do you know?

## Activity #4

**Directions:** Using the materials listed below, create a model of all the Moon phases. Be sure to include representations of the Sun and Earth in your model!

### Materials:

- Chocolate cream filled cookies
- Plastic utensil
- Paper plate
- Colored pencils/crayons/markers

**Once you have completed your model, answer the questions below. You may need to use a separate sheet of paper.**

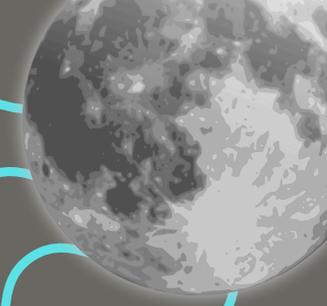
1. What do you notice about the phases of the Moon in your diagram as you go from a New Moon to a Full Moon?
2. How did you illustrate a waxing versus a waning Moon phase? Why did you choose to model it in this way?
3. How does the position of the Sun and Earth affect the arrangement of the Moon phases in your model?

## Extension Activity

**Directions:** Use the Aloha Telescope and your observations of the Moon to answer the following questions.

- What phase of the Moon is currently being displayed using the telescope? How do you know? Describe what characteristics of the Moon support your answer.
- How might your view of certain lunar surface features change depending on the phase of the Moon?
- How might different Moon phases impact your view of other celestial bodies, such as stars or planets?
- What telescope settings may need to be adjusted during certain Moon phases in order to have the best view?

# CRATERS, RILLES, MARIA...OH MY!



1 What surface features exist on Earth's Moon?

2 How does the surface of the Moon compare to the surface of the Earth?

3 What is lunar regolith and how does it differ from Earth's soil?

## Reading Passage

Have you ever looked up at the Moon at night and wondered what it might look like if you travelled there? The easiest way to describe the Moon is to compare it to the Earth.

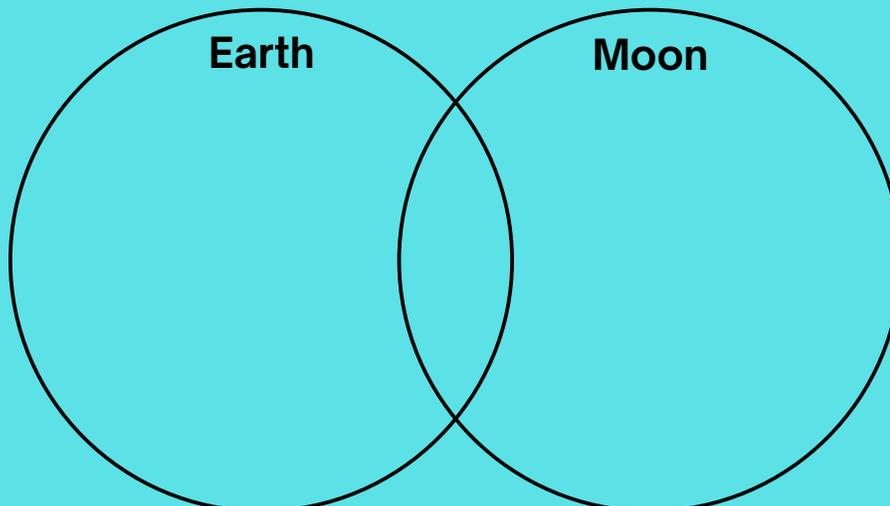
In terms of size, the Moon is much smaller than the Earth. The Earth's larger mass pulls the Moon into an orbit due to its greater gravitation. The Moon also differs from the Earth in its atmosphere. The Earth's atmosphere has several layers that protect Earth from risk factors such as UV radiation and space debris. However, the Moon is not so fortunate. It has no atmosphere, which allows all of its gases to escape into space. This is one reason why the Moon is so cold because it lacks insulation. The Moon's cold climate also allows for some water in the form of ice to exist. However, this ice is pretty sparse across its surface. One area in which the Earth and the Moon are similar is their interior. Like the Earth, the Moon's interior is also composed of a crust, mantle, and core. This is supported by seismic activity on both celestial bodies (NASA, n.d.).

The geography of the Moon also greatly varies in comparison to the Earth. It has many unique surface features, such as craters, rilles, highlands, and maria. Craters are created when another object strikes the Moon and leaves a dent-like formation. Highlands and maria are patches of rock on the Moon that vary in their appearance from Earth. Highlands appear as lighter surfaces and have the oldest rocks. In contrast, maria appear as darker regions. Maria have the youngest rocks that were produced by lava flows. Lastly, rilles are slender structures that are located within maria (NASA, n.d.).

Another component of the Moon that is of interest to scientists is its regolith. Regolith can most simply be defined as lunar soil. On Earth, soil contains various elements including rock fragments, organic matter, and water. Regolith is primarily composed of rock fragments that come from meteoroids. As a result, regolith is composed of rock and mineral fragments, volcanic glasses, and mineral and glass mixtures called agglutinates (NASA, 2019). It is important to be familiar with the surface of the Moon in order to better understand how it contrasts to the celestial body it orbits, Earth.

## Activity #1

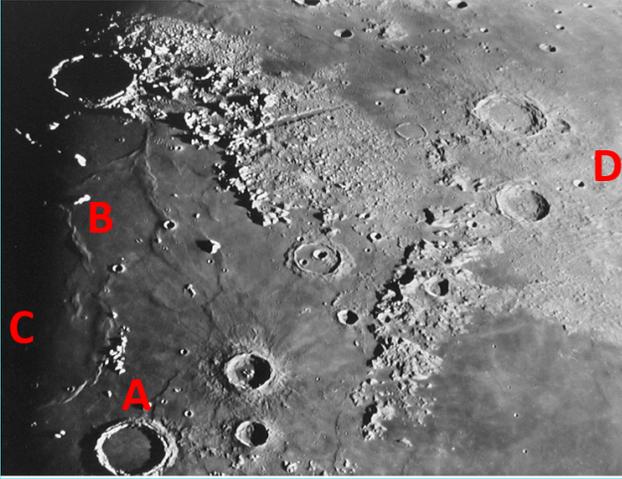
**Directions:** Using the provided Venn diagram, compare the features of the Moon and Earth. Consider their **size, atmosphere, water content, and interior.**



# CRATERS, RILLES, MARIA...OH MY!

## Activity #2

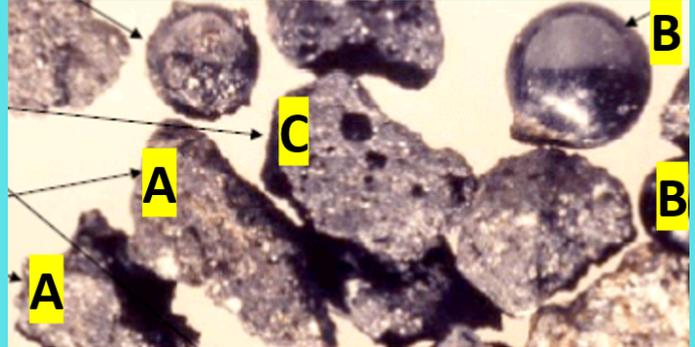
**Directions:** Observe the picture below and identify each of the lunar surface features.



- A \_\_\_\_\_
- B \_\_\_\_\_
- C \_\_\_\_\_
- D \_\_\_\_\_

## Activity #3

**Directions:** Observe the picture below and identify each of the components of regolith by drawing a line.



*Fraction of lunar soil photograph taken by Larry Taylor.*

- A                      Rock fragment
- B                      Agglutinate
- C                      Volcanic glass

## Activity #4

**Directions:** Mix the materials below to simulate the composition of lunar regolith. Discuss how regolith differs from soil on Earth in terms of composition and origin.

### Materials:

- Sand
- Rock fragments
- Gravel

**Once you have completed your simulation, answer the questions below. You may need to use a separate sheet of paper.**

1. What are the main components of regolith on the Moon and how do they differ from those found in soil on Earth?
2. Why is regolith generally more uniform in composition compared to the varied types of soil found on Earth?
3. How does the absence of organic matter in regolith affect its composition compared to soil on Earth?

# CRATERS, RILLES, MARIA...OH MY!

## Extension Activity

**Directions:** Use the Aloha Telescope and your observations of the Moon to complete the table and answer the following questions.

Feature	Description	Number observed on Telescope	Location on Moon (Choose one and identify coordinates if known, otherwise describe nearby landmarks)	Sketch/Drawing (Choose one and draw)
<i>Craters</i>				
<i>Rilles</i>				
<i>Highlands</i>				
<i>Maria</i>				

- What feature did you observe the most on the Moon's surface through the telescope? Why do you think this is?
- Compare the sizes of different craters you observe. What might determine the size of a crater?
- How would you describe the texture of the Moon's regolith as seen through the telescope?
- What adjustments did you have to make to the telescope to get a clearer view of the Moon's surface? How does the magnification of the telescope affect what you can see on the Moon?

# CRATERS, RILLES, MARIA...OH MY!

## References

NASA. (n.d.). Moon facts. NASA Science. <https://science.nasa.gov/moon/facts/>

National Aeronautics and Space Administration (NASA). (2019). The lunar regolith: A potential resource for in-situ resource utilization (ISRU). NASA. [https://www.nasa.gov/wp-content/uploads/2019/04/05\\_1\\_snoble\\_thelunarregolith.pdf](https://www.nasa.gov/wp-content/uploads/2019/04/05_1_snoble_thelunarregolith.pdf)

Taylor, Larry. (n.d.). Photograph of a large size fraction of a lunar soil [Photograph]. [https://www.nasa.gov/wp-content/uploads/2019/04/05\\_1\\_snoble\\_thelunarregolith.pdf](https://www.nasa.gov/wp-content/uploads/2019/04/05_1_snoble_thelunarregolith.pdf)

# EARTH & ITS PLANETARY NEIGHBORS



## Before you Read

- 1 How does distance from the Sun affect a planet's conditions?
- 2 What factors influence whether a planet can sustain life?
- 3 Will other planet's be able to support life in the future?

## Reading Passage

As you look high into the sky you might start to wonder, is Earth all alone in space? The answer to that is question is no! Along with the Moon and other celestial objects, the Earth has 7 other planetary neighbors in our solar system. Each of these planets orbits our central star, the Sun due to its immense gravitational pull.

All 8 planets can be classified as either terrestrial or a gas giant. The terrestrial planets are Mercury, Venus, Earth, and Mars. They are often nicknamed the "inner" planets because they are closest to the sun and relatively close to each other. They are also small in size. Mercury is the smallest planet in our solar system. Terrestrial planets also have rocky cores and solid surfaces with lots of craters and plains. The gas giant planets include Jupiter, Saturn, Uranus, and Neptune. These planets are farther away from the Sun and each other. This is why they are sometimes called the "outer" planets. The gas giant planets are very different from Earth and the other terrestrial planets. To start, they are much larger in size. Jupiter is the largest planet in our solar system. They also have liquid or gaseous surfaces. Lastly, all the gas giants also have rings systems, with Saturn being the most popular!

Another quality that can differentiate the planets are their number of Moons! On Earth, we only have one Moon. However, several of Earth's planetary neighbors have many Moons. The number of Moons that a planet has is largely due to the strength of its gravitational pull. The larger a celestial body is the stronger its gravitational pull and the more and larger objects it can pull into its orbit. This is why smaller planets, such as Mercury and Venus have no Moons. In contrast, larger planets like Jupiter and Saturn have close to 100 Moons each!

At this time, Earth is the only planet that can support human life. To support life, a planet must have an ideal temperature and atmosphere, as well as water and energy sources. Mercury and Venus' close distance to the Sun makes their surface too hot, while the large distance between the Sun and the gas giant planets makes them too cold for humans to live. There is also the issue of planets' hazardous atmospheres, like Venus, that are primarily made up of chemicals like Carbon Dioxide. Water is also essential to humans. Although Mars does have some water on its surface, it is not enough to support all humans. These factors and many others prevent humans from packing their bags and moving to other planets. However, as we learn more about other planets and technology advances, there is always hope for the future that Earth may not always be our only home.

## Activity #1

**Directions:** Below is a chart with information about each of the planets in our solar system. Use it to answer the following questions.

	<u>MERCURY</u>	<u>VENUS</u>	<u>EARTH</u>	<u>MOON</u>	<u>MARS</u>	<u>JUPITER</u>	<u>SATURN</u>	<u>URANUS</u>	<u>NEPTUNE</u>
<u>Mass</u> ( $10^{24}$ kg)	0.330	4.87	5.97	0.073	0.642	1898	568	86.8	102
<u>Diameter</u> (km)	4879	12,104	12,756	3475	6792	142,984	120,536	51,118	49,528
<u>Density</u> (kg/m <sup>3</sup> )	5429	5243	5514	3340	3934	1326	687	1270	1638
<u>Gravity</u> (m/s <sup>2</sup> )	3.7	8.9	9.8	1.6	3.7	23.1	9.0	8.7	11.0

1. Which planet has the greatest mass?
2. Which planet has the smallest mass?
3. How many Earth's could fit inside of Uranus?
4. According to the table, Mercury has the smallest gravitational pull. Why do you think this is?
5. According to the table, Saturn has a diameter of 120, 536 km but the smallest density. Why do you think this is?

NASA Planetary Fact Sheet - Metric by Dr. David R. Williams.

# EARTH & ITS PLANETARY NEIGHBORS

## Activity #2

**Directions:** Record each planet's order from the Sun and what surface features it has as a result of its location.

*All pictures shown below are NASA images.*



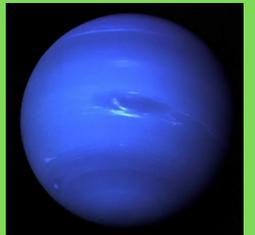
*Venus*

- Distance from the Sun:
- Surface features:



*Earth*

- Distance from the Sun:
- Surface features:



*Neptune*

- Distance from the Sun:
- Surface features:

## Activity #3

**Directions:** Recall the characteristics of the planets listed below and use them to complete the table.

Planet Name	Can it currently support life?	Explain your answer.
<i>Mercury</i>		
<i>Earth</i>		
<i>Jupiter</i>		
<i>Uranus</i>		

## Activity #4

**Directions:** For this activity, you will create and illustrate your own planet and answer the questions below. You are free to give your planet whatever characteristics you would like as long as they make sense within our solar system...

- How far away (in kilometers) is your planet from the Sun?
- Describe the size of your planet in relation to the other planets in the solar system.
- What surface features does your planet have due to its location?
- Does your planet currently have the ability to support life?
- Do you believe your planet will be able to support life in the future? Why or why not?

**Draw a picture of your planet!!!**

Planet Name: \_\_\_\_\_

# EARTH & ITS PLANETARY NEIGHBORS

## Extension Activity

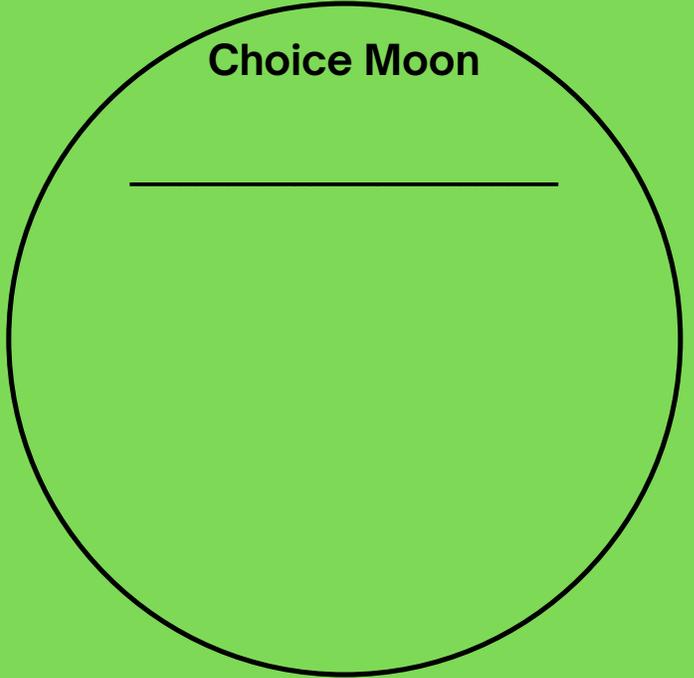
**Directions:** Observe the surface of Earth's Moon using the Aloha telescope. Then, conduct your own research on the surface of the Moon of a planet of your choice. Once you are done, illustrate the surface of each Moon and answer the questions below.

**Earth's Moon**



**Choice Moon**

\_\_\_\_\_



- What surface features appear the most on each Moon?
- How does the surface of each Moon compare to the other (Think about their maria, highlands, craters)?
- What materials likely make up the surface of each Moon?
- Which Moon has a surface that is more accessible to robotic or human exploration? Explain your answer.
- Could either Moon support life in the future? Explain your answer.

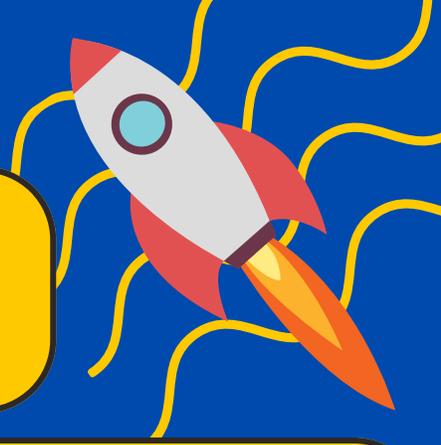
# EARTH & ITS PLANETARY NEIGHBORS

## References

NASA. (n.d.). Planet sizes and locations in our solar system. NASA Science. Retrieved July 10, 2024, from <https://science.nasa.gov/solar-system/planet-sizes-and-locations-in-our-solar-system/>

National Aeronautics and Space Administration. (n.d.). Planetary fact sheet - metric. NASA Space Science Data Coordinated Archive. [https://www.nasa.gov/wp-content/uploads/2019/04/05\\_1\\_snoble\\_thelunarregolith.pdf](https://www.nasa.gov/wp-content/uploads/2019/04/05_1_snoble_thelunarregolith.pdf)

# TO THE MOON & BEYOND!



## Before you Read

- 1 When was NASA's first trip to the Moon? What did they discover?
- 2 How many times have humans been to the Moon?
- 3 Why has NASA not travelled back to the Moon recently?

## Reading Passage

Have you ever wondered what it must be like to walk on the Moon? You are not the only one! For centuries, astronomers gazed into the darkness and wondered what the Moon and other celestial bodies must look like past the scope of a telescope. In 1958, the National Aeronautics and Space Administration (NASA) was formed to help satisfy humans' desire to explore the Moon and beyond in space. One of NASA's first human expeditions was to the Moon!

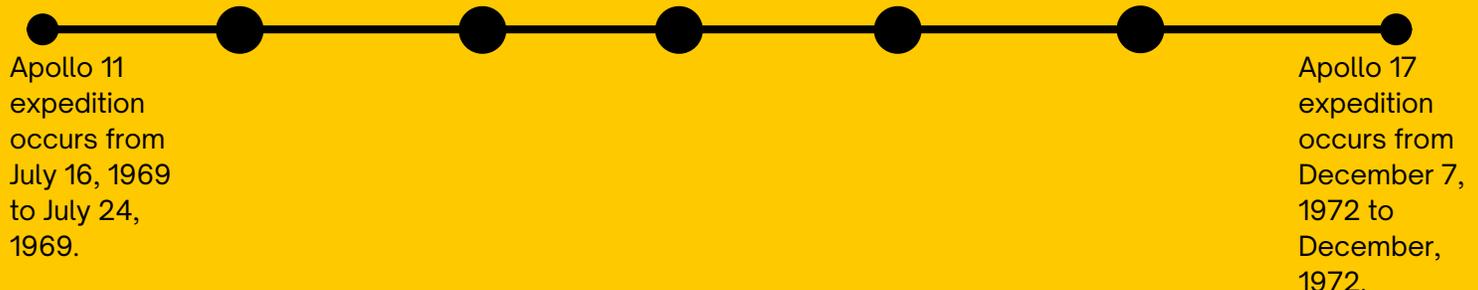
In 1969, NASA launched the Apollo 11 expedition. Once the spaceflight landed, astronauts Neil Armstrong and Edwin Aldrin became the first men to walk on the Moon. The astronauts first few steps on the Moon revealed that its surface was indeed solid. This might sound obvious as many predicted this. However, Armstrong and Aldrin were the first to be able to confirm this hypothesis. As they explored the Moon, they were able to collect samples of lunar dust and rocks. Some of the rocks they found on this mission included breccia, basalt, agglutinate, and anorthosite. Breccia is an angular rock composed of gravel fragments. Basalt and agglutinate are both igneous rocks that form from volcanoes. Anorthosite is also an igneous rock that is coarse textured and made up of mostly feldspar. These samples were important for other scientists who would later study them to draw more conclusions about the Moon.

Following the Apollo 11, NASA conducted 6 more trips back to the Moon. The Apollo 12 resulted in a more accurate lunar landing. Apollo 13 resulted in a small explosion, however everyone survived. During Apollo 14, astronauts were able to land in lunar Maria. Apollo 15 was the first mission in which a land rover was used on the Moon. Finally, lunar highlands were explored further during the Apollo 16 expedition. The final Apollo 17 mission occurred in 1972 (Encyclopaedia Britannica, n.d.). NASA has not been back to the Moon for a variety of reasons including money, technological limitations, and a priority on other space missions. This raises the question of "Will astronauts ever explore the Moon again?"

Lucky for you, the answer is yes! NASA has announced that they plan to conduct three other expeditions called Artemis II, III, and IV to the Moon in 2025, 2026, and 2028. The goal for these expeditions is to explore different areas of the Moon including its South Pole and Gateway Space Station and collect more data. They also plan to test out safety procedures to better prepare for other space expeditions (NASA, 2023). This leaves us back at home with the hope that we will soon learn more about the Moon and hopefully get to explore other celestial bodies in the future!

## Activity #1

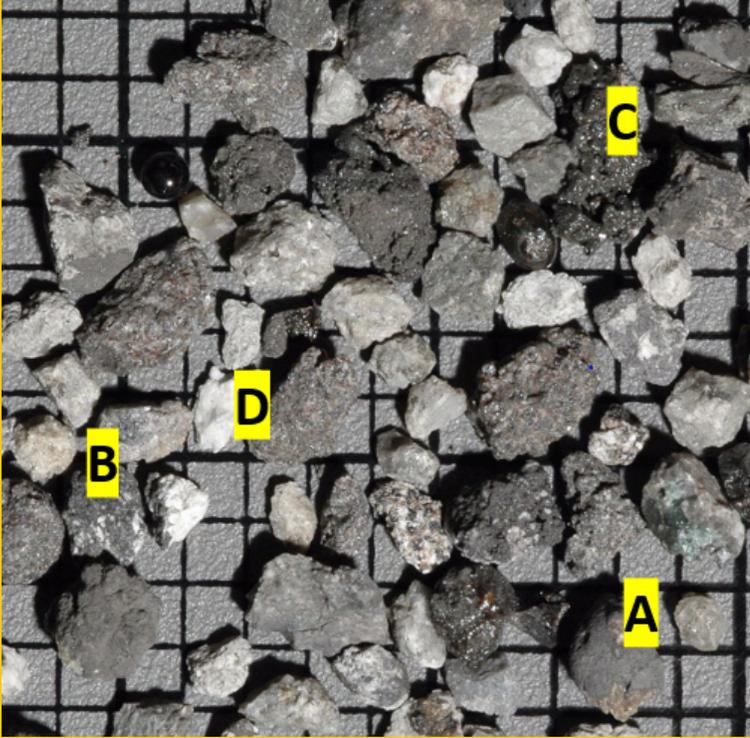
**Directions:** Complete the timeline of NASA's Apollo expeditions to the Moon, using the information you learned in the reading passage.



# TO THE MOON & BEYOND!

## Activity #2

**Directions:** Below is a sample lunar sample given to you by NASA scientists. Identify each rock sample by drawing a line from the letter to the correct rock type.



Apollo 11 sample photograph by Randy Korotev (Washington University).

- |   |             |
|---|-------------|
| A | Breccia     |
| B | Basalt      |
| C | Agglutinate |
| D | Anorthosite |

## Activity #3

**Directions:** Pretend you are Neil Armstrong or Edwin Aldrin. Write a journal entry about your experience on the Moon.

**Your response should be at least 6 sentences.** Be sure to answer the following questions in your entry:

- *What did the surface of the Moon look and feel like?*
- *What did you discover there?*
- *Do you want to return to the Moon in the future? Why or why not?*

**Dear Journal,**

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# TO THE MOON & BEYOND!

## Activity #4

**Directions:** For this activity, you will create a shoebox diorama of the surface of the Moon! Follow the directions below.

**Materials (optional unless indicated as required):**

- Shoebox or small box (Required)
- Colored paper paper
- Play dough
- Small rocks, pebbles, or sand
- Coloring utensils

**Must represent and label in diorama:**

- Moon's surface
- At least 3 types of lunar rocks
- Lunar dust
- Craters
- Rilles

As you complete your diorama, consider the questions below!

**What does the Moon's surface look like?**

- Is it solid?
- What color is it?
- What is its texture?

**What do the rocks on the Moon look like?**

- Are they large or small?

**Are there craters and rilles?**

- How many?
- Are they big and/or small?

## Extension Activity

**Directions:** Pretend you are an astronaut preparing for a expedition back to the Moon! Use the Aloha telescope to complete the chart below.

<b>Landing Site</b> <i>(Describe the area/any nearby landmarks)</i>	<b>Explanation</b> <i>(Why is this an ideal site for landing?)</i>	<b>Potential Hazards</b> <i>(Are there any safety precautions needed for this site?)</i>
<b>Landing Site #1</b>		
<b>Landing Site #2</b>		
<b>Landing Site #3</b>		

# TO THE MOON & BEYOND!

## References

Encyclopaedia Britannica. (n.d.). Timeline of the Apollo space missions. <https://www.britannica.com/story/timeline-of-the-apollo-space-missions>

NASA. (2023, January 17). NASA shares progress toward early Artemis Moon missions with crew. <https://www.nasa.gov/news-release/nasa-shares-progress-toward-early-artemis-moon-missions-with-crew/#:~:text=NASA%20will%20now%20target%20September,remains%20on%20track%20for%202028>

Washington University in St. Louis. (n.d.). Some photos of Apollo samples. <https://sites.wustl.edu/meteoritesite/items/some-photos-of-apollo-samples/>