Student Worksheet

This task is about the regular orbital motions of the planets around the sun and the moons around the planets.

You need to use a **ruler** and may use a **calculator** to complete this task.

Task

The solar system includes space materials that range from very small, dust-like and sand-sized particles to very immense asteroids and planets.

Most meteoroids burn up as they enter Earth's atmosphere causing little or no damage. However, asteroids, which are smaller than a planet but larger than meteoroids, can cause significant damage when they collide with Earth.

Some asteroids orbit the sun in a path that takes them near Earth. What keeps objects in the solar system in orbit around the sun?

Prompt 1

Part A.

Isaac Newton stated that two factors, **inertia** and **gravity**, combine to keep the planets in orbit around the sun. Recall that Newton's First Law of Motion is often stated as:

An object at rest stays at rest and an object in motion stays in motion with the same speed and in the same direction unless acted upon by an unbalanced force.

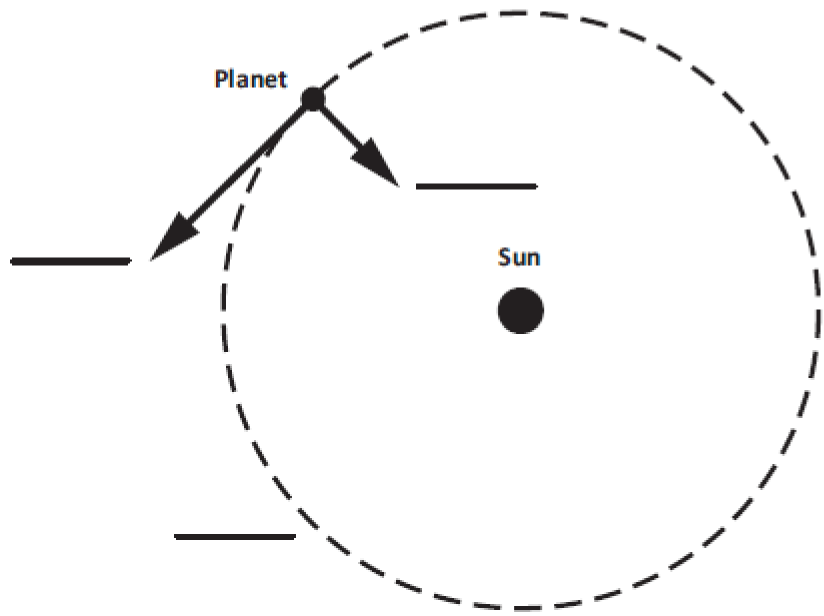
Write the corresponding letter for each of the labels below in the blank spaces in **Figure 1**.

A. Planet's motion without gravity

B. Actual orbit

C. Force of gravity

Figure 1. Planetary Orbit Around the Sun



Part B.

What would happen if the planet in **Figure 1** had no inertia?

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Prompt 2

Table 1 provides information about the planets in our solar system, including the dwarf planet Pluto.

Table 1. Planets in our Solar System

Planet	Distance traveled in one complete orbit of the Sun (in miles)	Amount of time for one complete orbit of the Sun (in Earth months)
Earth	584,000,000	12
Jupiter	3,037,000,000	142
Mars	888,000,000	23
Mercury	223,700,000	3
Neptune	17,562,300,000	1,979
Pluto	22,698,700,000	2,977
Saturn	5,565,900,000	354
Uranus	11,201,300,000	1,009
Venus	422,500,000	7

Part A.

Explain how **the distance traveled** by each planet when completing one orbit of the sun can be used to determine the order of the planets outward from the sun. Use data from **Table 1** to support your response.

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Part B.

Explain how **the amount of time** it takes for each planet to complete one orbit of the sun can be used to identify the inner planets from the outer planets. Use data from **Table 1** to support your response.

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Prompt 3

Distances in the solar system can be measured as Lunar distances, or LD. The distance from Earth to the moon is about 385,000 kilometers (km), which is the same as 1 LD.

A near-Earth object (NEO) is an asteroid or comet that passes close to Earth's orbit. In March of 2022, a NEO came within approximately 7 LDs to Earth.

Part A.

Use a ruler to draw and label a scale model in **Figure 2** that represents how close the NEO was to Earth. Use the scale of 1 LD equals one-half inch as shown in the key. In your model, be sure to show:

- Earth
- the moon
- the NEO

Be sure to complete the key.

Figure 2. Scale Model of Earth, Moon, NEO System

Key

Earth –

Moon –

NEO –

Scale: 1 LD = ½ inch

Part B.

Consider if the same scale model you used in **Figure 2**, which compares the distance between the objects in the Earth, moon, and NEO system, also needs to represent the diameter of each object drawn to scale. Table 2 shows the diameters of the Earth, moon, and NEO.

Table 2. Diameters of the Earth, Moon, and NEO

Object	Diameter (km)
Earth	12,742.00
Moon	3,474.00
NEO	0.02

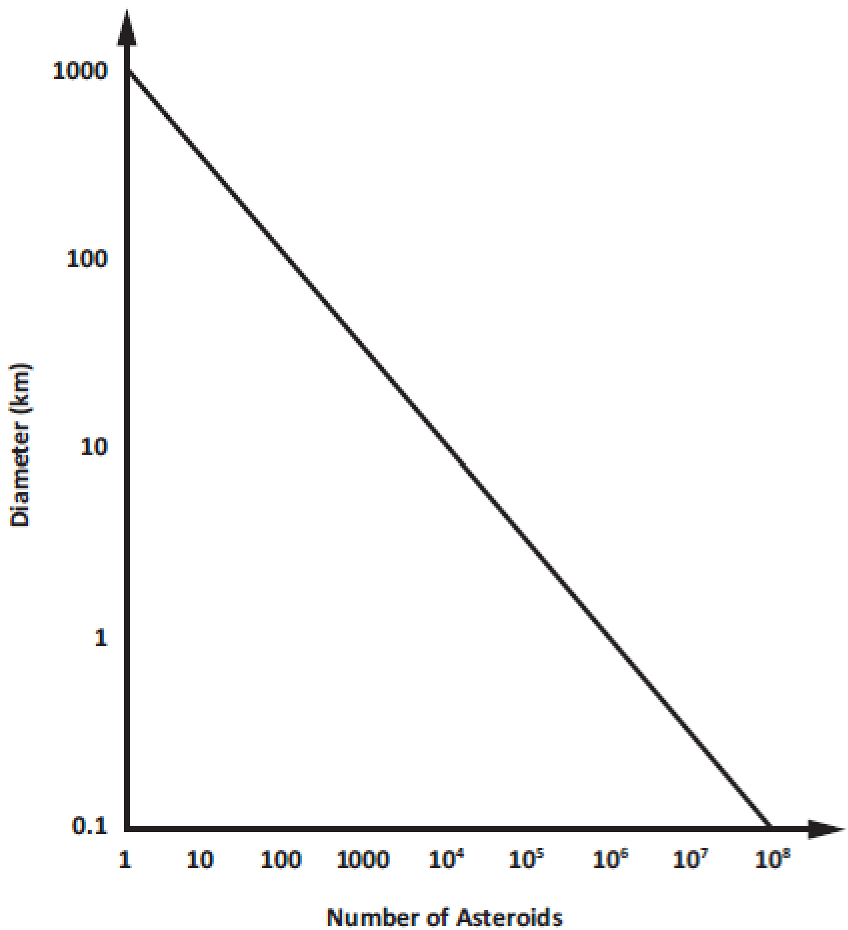
Why would it be challenging to represent **the diameter AND the distances** of the three objects accurately and to scale when looking at **Figure 2**? Remember, the distance between the moon and Earth is approximately 385,000 kilometers (km) or 1 LD.

Part C.

Asteroid impacts are relatively rare on Earth. However, NEOs of many different sizes can pose serious threats.

Figure 3 shows the diameter of asteroids versus the number of asteroids in our solar system.

Figure 3. Asteroid Diameter versus Number Identified in Earth's Solar System



Describe the relationship between asteroid diameters and the number of asteroids in Earth's solar system shown in **Figure 3**. Use information from **Figure 3** to support your response.

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Student Worksheet

This task is about the regular orbital motion of Earth around the sun.

You may use a **calculator** to complete this task.

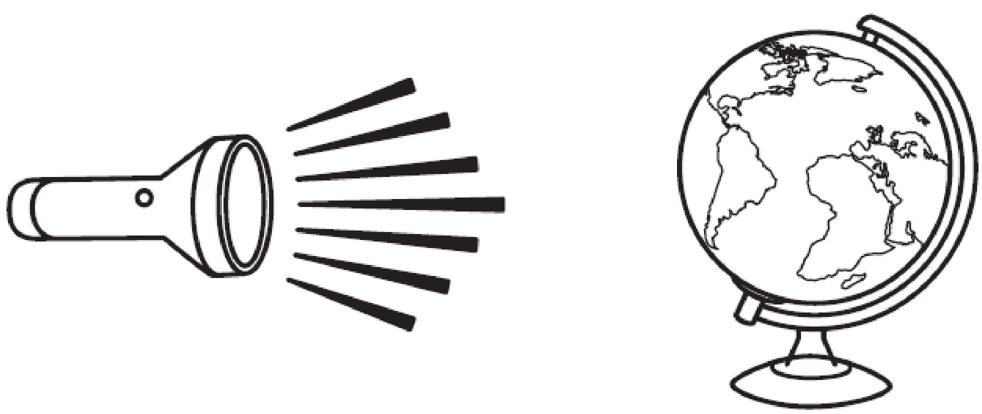
Task

Ancient astronomers studied the movement of the sun and the moon as they appeared to travel across the sky. They observed the patterns of the seasons, moon phases, and eclipses, just as we do today. What causes these age-old patterns in the sky?

Prompt 1

In Figure 1 below, the flashlight represents the sun. The globe represents Earth. Earth's axis is tilted at an angle of 23.5° away from vertical. The part of the globe that the flashlight is shining on represents daytime.

Figure 1. Earth-Sun System Model



Part A.

How could you use the model shown in **Figure 1** to represent a day **AND** to represent a year?

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Part B.

What two factors cause the cycle of the seasons?

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Part C.

According to **Figure 1**, which areas on Earth are consistently the coolest? Which areas are consistently the warmest? Why?

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Prompt 2

Sometimes the moon appears round. Other times, it appears as a thin sliver or crescent. The different appearances of the moon seen from Earth are called phases.

Part A.

Figure 2 shows Earth and the moon phases **as observed from Earth**. The sun is shining from the right. The Waxing crescent, New moon, and Waning gibbous are shown.

Use the letters A, B, C, D, and E to correctly sequence the moon phases in **Figure 2**.

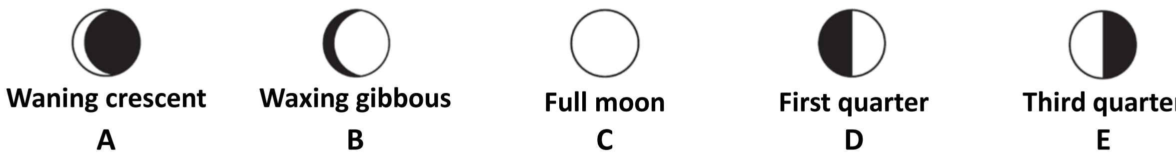
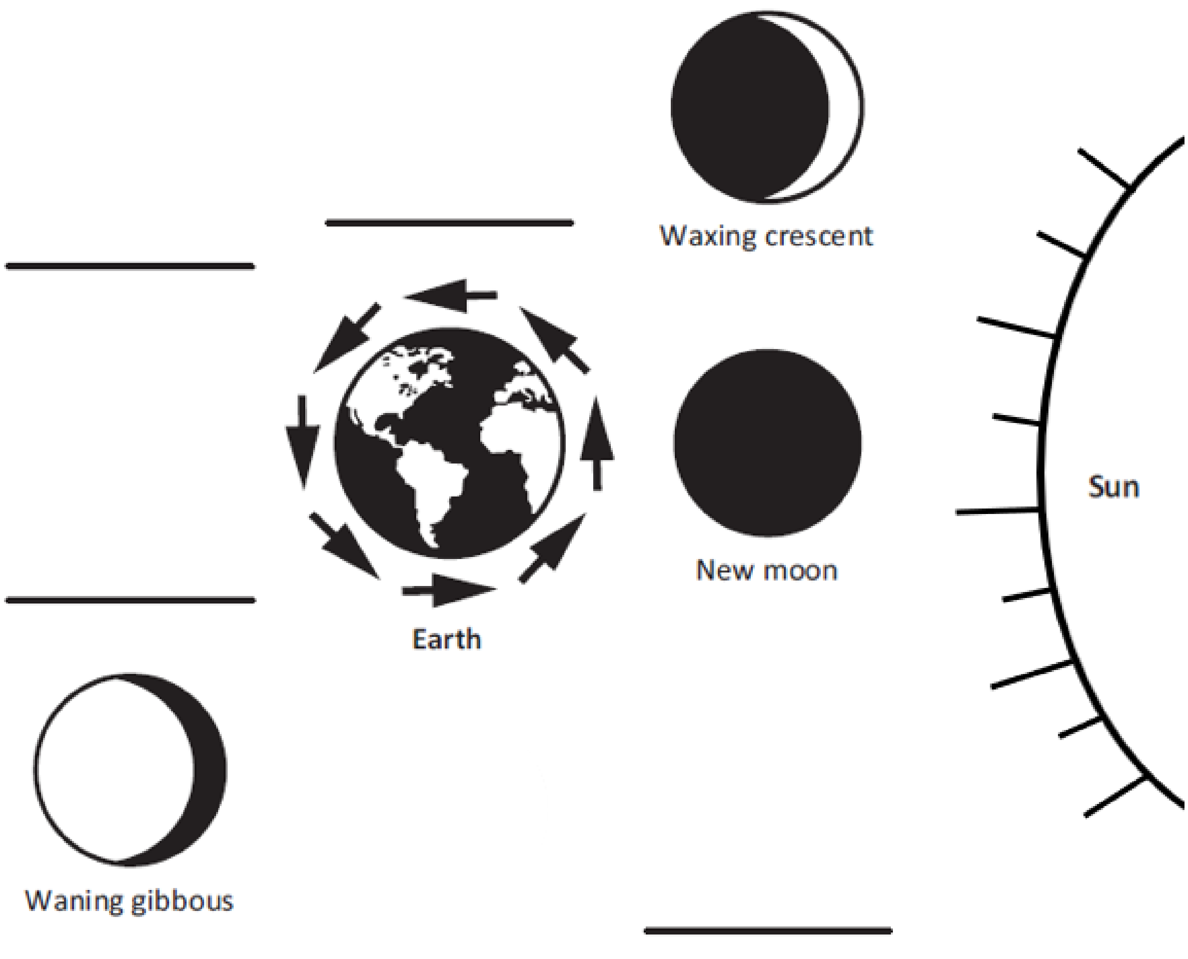


Figure 2. Moon Phases



Part B.

Why do the moon phases as observed from Earth change as the month progresses? Refer to **Figure 2** and the positions of the Earth, sun, and moon to support your response.

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Student Worksheet

This task is about the solar system.

You may use a **calculator** to complete this task.

Task

The Milky Way galaxy is just one of the billions of galaxies in the universe. It contains Earth and its solar system. The Milky Way galaxy has at least 100 billion stars. One of these stars is Earth’s sun.

The sun’s gravitational pull binds together the objects that compose our solar system. Each object in our solar system has its own gravitational pull defined by its density, size, mass, and distance from other celestial bodies.

Prompt 1

Part A.

If an object is dropped from 1,000 meters to the surface of the Earth, assuming there is no air resistance, the object would reach an ending velocity of 502 km/hr. On Earth’s moon, the same object dropped 1,000 meters above the surface of the moon would reach an ending velocity of 203 km/hr.

What must be true about the gravity of Earth compared to the gravity of the moon? Explain how the ending velocities support your statement.

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Part B.

Table 1 shows the approximate gravitational pull of some objects in our solar system.

Table 1. Gravitational Pull of Solar System Objects

Object	**Gravity (in m/s^2)**
Mercury	3.7
Venus	8.9
Earth	9.8
Mars	3.7
Jupiter	23.1
Saturn	9.0
Uranus	8.7
Neptune	11.0
Pluto	0.7

Use information from **Table 1** to complete the statements below.

Assume a person weighs 100 lbs. on Earth. On **Jupiter**, the same person would weigh ________________________________. **(Circle one.)**

more **the same** **less**

This is because____

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Assume a person weighs 100 lbs. on Earth. On **Mars**, the same person would weigh ________________________________. **(Circle one.)**

more **the same** **less**

This is because____

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Part C.

If you were to land a spacecraft on the surface of a planet, you would want to know your rate of descent.

Which object listed in **Table 1** would be **most likely** to land like a floating feather with a low rate of descent? Why?

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Prompt 2

Table 2 shows the density of each planet in our solar system.

Table 2. Density of Planets in our Solar System

Planet	Mercury	Mars	Uranus	Venus	Saturn	Earth	Neptune	Jupiter
Density (in kg/m^3)	5,429	3,934	1,270	5,243	687	5,514	1,638	1,326

Source: Planetary Fact Sheet (nasa.gov)

Part A.

Sort and list the rocky planets and the gaseous planets in **Chart 1** using the data in **Table 2**.

Chart 1. Rocky Planets versus Gaseous Planets

Rocky Planets	Gaseous Planets

Part B.

Explain your reasoning for sorting the planets as either Rocky Planets or Gaseous Planets. Include how you used data from **Table 2** to sort the planets.

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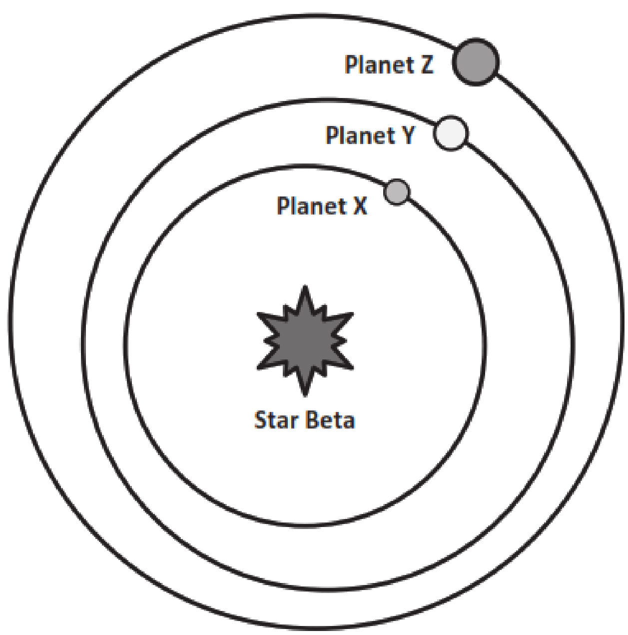
Prompt 3

Diagram 1 shows an imaginary, newly discovered planetary system around Star Beta. The orbital periods of the three planets are:

- Planet X – 75 Earth days
- Planet Y – 200 Earth days
- Planet Z – 300 Earth days

Diagram 1. Star Beta's System



Part A.

Is it ever possible for **Planet Z** to be closer to **Planet X** than to **Planet Y**? Circle **YES** or **NO**.

YES **NO**

Explain your answer by considering the planets' orbital periods **AND** by drawing the relative orbital positions of the planets on **Diagram 1**.

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Part B.

The following information relates to the Star Beta system in **Diagram 1**:

- **Planet X** is closest to Star Beta. **Planet X** has no atmosphere. During the day, the side facing Star Beta reaches temperatures of 500°C. At night, all the heat escapes into space. The temperature drops to −200°C.
- **Planet Y** has a thick atmosphere. All days on **Planet Y** are cloudy. The average daily temperature on this planet is 475°C.

Explain why Planet Y is hotter on average than Planet X, even though Planet Y is further from Star Beta. Use your knowledge of the characteristics of the planets in our solar system in your explanation.

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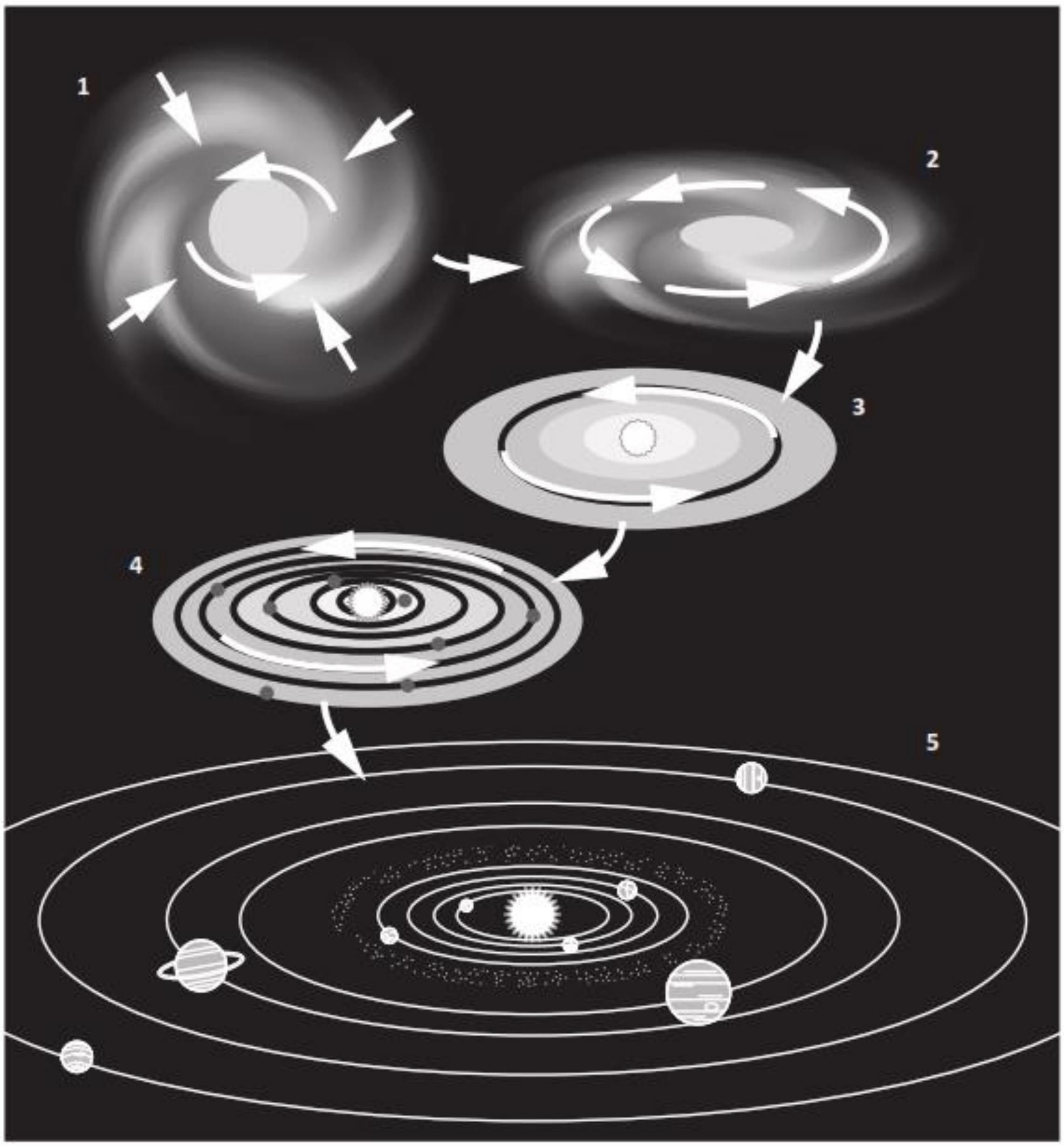
Prompt 4.

It is theorized that after the Big Bang, matter in the universe separated into galaxies such as the Milky Way Galaxy. Where Earth’s solar system is now, there was a cloud of gas and dust.

Figure 1 illustrates the sequence of events that led to the formation of Earth’s solar system.

Figure 1. Formation of Earth’s Solar System



Part A.

Use the numbers 1, 2, 3, 4, and 5 to correctly sequence the events in **Chart 2**. Use your understanding of the Big Bang theory and **Figure 1** to match the description of the events that formed Earth's solar system.

Chart 2. Sequence of Events in the Formation of Earth's Solar System

Sequence Number	Event
	The cloud contracted under its gravity and shrank to form a spinning disk.
	Small planetesimals collided and clumped together to form rocky planets. The gases spun out further from the sun and cooled to form the gaseous planets.
	Within the nebula, the matter in the disk of gas began to collect to form bigger clumps of matter due to gravity.
	Earth's sun formed in the center of a disk of gas. The remainder of the cloud formed a swirling disk called the solar nebula.
	The sun and all the planets of our solar system began as a giant cloud of gas and dust.

Part B.

Describe why the gaseous planets formed further from the sun.

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Part C.

What has become of the leftover debris in the solar system that never became planets?

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