Your Name _____ Score _____

Group Members _____ _____ _____ Minutes _____

Standard 4
Key Idea 1

Performance Indicator 1.1

Explain complex phenomena, such as tides, variations in day length, solar insolation, apparent motion of the planets, and annual traverse of the constellations.

Major Understanding:

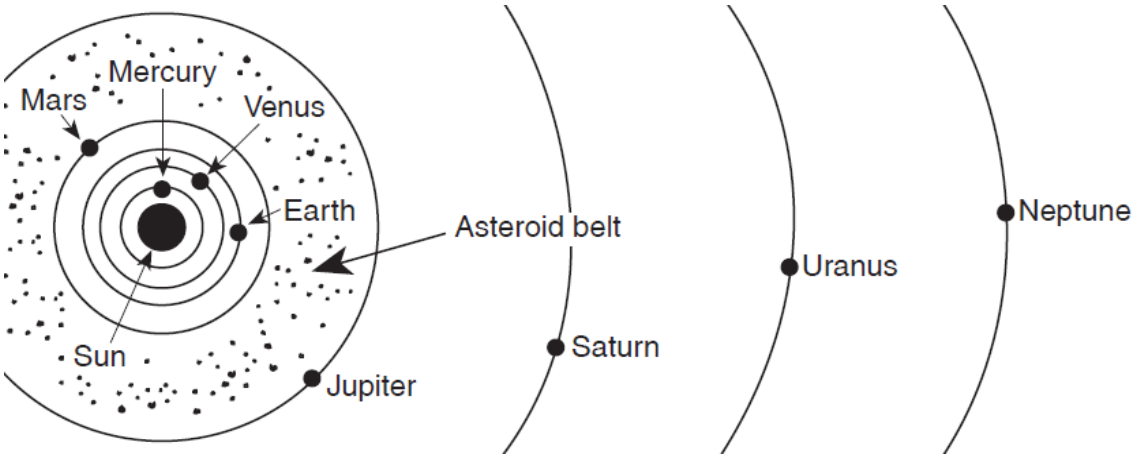
1.1a Most objects in the solar system are in regular and predictable motion.

- These motions explain such phenomena as the day, the year, seasons, phases of the moon, eclipses, and tides.
- Gravity influences the motions of celestial objects. The force of gravity between two objects in the universe depends on their masses and the distance between them.

1.1b Nine planets move around the Sun in nearly circular orbits.

- The orbit of each planet is an ellipse with the Sun located at one of the foci.
- Earth is orbited by one moon and many artificial satellites.

1.1i Approximately 70 percent of Earth's surface is covered by a relatively thin layer of water, which responds to the gravitational attraction of the moon and the Sun with a daily cycle of high and low tides.



Mini Lesson 1: The Solar System

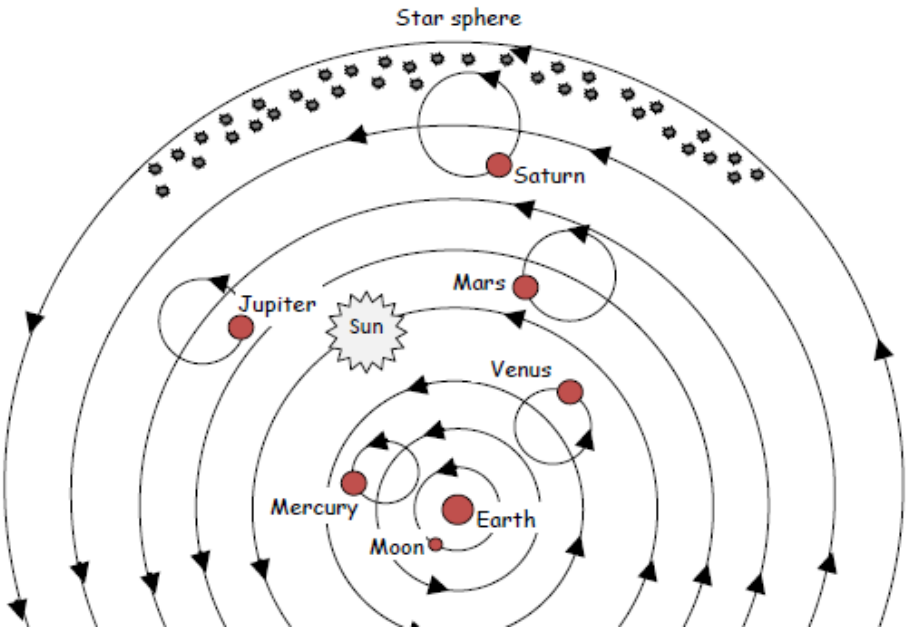
Diagrams Not drawn to scale

Geocentric Model: Earth Centered

Earth was stationary with the Sun, Moon and planets revolving around it

Explains
- night and day
- revolution of the Moon

Did not easily explain movement of the inner and outer planets or seasons

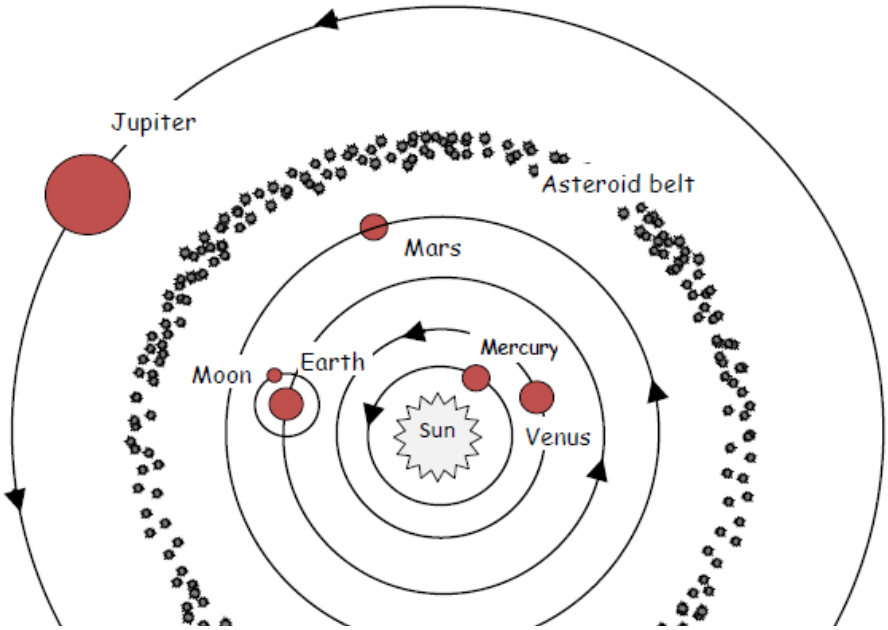


Heliocentric Model: Sun Centered

Sun is in the center of the solar system

Explains
- night and day
- revolution of the Moon
- Seasons
- Motion of all celestial objects

This is the model we use today



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Need to know:

1. What does geocentric mean? _____
2. What does heliocentric mean? _____
3. What did the geocentric model not explain easily? _____

   _____

4. What does the heliocentric model explain that the geocentric model did not explain at all?

   _____

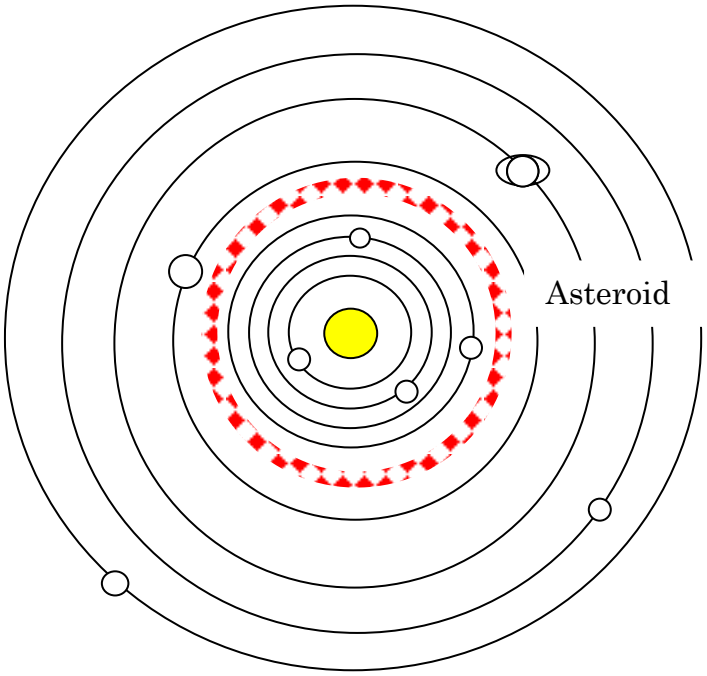
Picture this

The solar system is consists of 8 planets, that revolve around the Sun in slightly elliptical orbits. When the planet is at perihelion (closest) to the Sun, the greater the gravitational attraction and the *faster* it moves in its orbit. Earth is actually closest to the Sun in January. When a planet is at aphelion (farthest) from the Sun, the slower it moves in its orbit.

The four planets closest to the Sun are most dense and are primarily composed of silicate rocks. They are known as the "rocky planets" and are called the terrestrial planets.

There is an asteroid belt is located just outside the orbit of Mars. It contains thousands of asteroids that also revolve around the Sun.

Jovian planets are the farthest four planets from the Sun and are known as gas giants because they have a very low density and much larger.



1. Where are the terrestrial planets located in reference to the Sun? _____
2. Where is the asteroid belt located? _____
3. Compare the density of terrestrial planets with the density of Jovian planets.

   _____

4. Compare the size of terrestrial planets with the size of Jovian planets.

   _____

5. Planets travel faster in their orbits when they are [closer to / farther from] the Sun.

   Explain your reasoning. _____

"Solar System Data" Earth Science Reference Tables page 15

1. Using a yellow color pencil, shade in the entire row labeled Sun.

   a. What is the diameter of the Sun? _____ km

   b. Does the Sun rotate? _____

   c. If yes, how long does it take for one complete rotation of the Sun? _____

   d. The column labeled "Mass" compares the Sun and planets mass to that of Earth. How many times more massive is the Sun compared to Earth? _____

   e. What is the density of the Sun? _____ g/cm^3

2. Using a light green color pencil, shade in the entire row labeled Earth's Moon.

   a. How far is Earth's Moon from Earth? _____ million km

   b. How long does it take the Moon for one revolution around Earth to occur? _____

   c. How long does it take the Moon for one period of rotation ? _____

   d. What is true about the Moon's rotation and period of revolution? _____

   e. What is the mass of the Moon compared to Earth's mass? _____

3. Looking at the column labeled "Mean Distance for Sun" . . .

   a. What planet in our solar system is closest to the Sun? _____

   b. What is the distance from the Sun to the closest planet? _____ million km

   c. What planet in our solar system is farthest from the Sun? _____

   d. What is the distance from the Sun to the farthest planet? _____ million km

   e. State the relationship between "Mean Distance from the Sun" and "Period of Revolution".

   _____

   _____

4. Looking at the column labeled "Equatorial Diameter" . . .

   a. What is the name of the largest planet in our solar system? _____

   b. What is the name of the smallest planet in our solar system? _____

   c. Name the planet that is very close to the same size as Earth. _____

   d. Name the planet that is about half the same size of Earth. _____

   e. Name the planet that is about ten times the size of Earth. _____

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5. Looking at the two columns labeled "Period of Revolution" and "Period of Rotation" . . .

   a. Which planet has a period of revolution shorter than its period of rotation? _____

   b. Which planet has a period of rotation close to that of Earth? _____

   c. How long does it take for Neptune to make one complete revolution around the Sun? _____

   d. Which planet takes about twice the time as Earth to revolve around the Sun? _____

   e. Which planet has the shortest period of rotation? _____

6. Looking at the column labeled "Density" . . .

   a. What is the density of Earth? _____ g/cm^3

   b. What two planets have a density similar to Earth's? _____ & _____

   c. Which planet has a density less than the density of water? _____

   d. Which two planets have the same density? _____ & _____

   e. What is the density of the Moon? _____ g/cm^3

Regents Questions:

____1. Which object orbits Earth in both the Earth centered (geocentric) and Sun-centered (heliocentric) models of our solar system?
(1) the Moon (2) the Sun (3) Venus (4) *Polaris*

____2. Compared to the terrestrial planets, the Jovian planets have
(1) smaller diameters (3) slower rates of rotation
(2) greater average densities (4) longer periods of revolution

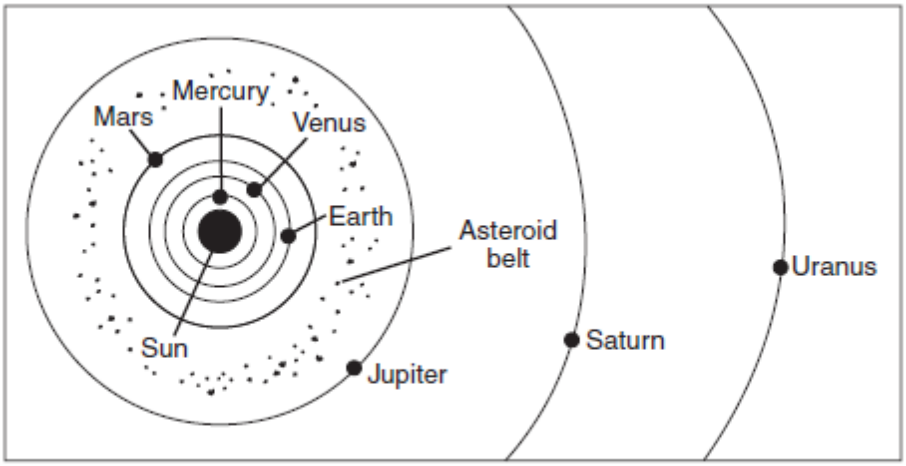
____3. A major belt of asteroids is located between Mars and Jupiter. What is the approximate average distance between the Sun and this major asteroid belt?
(1) 110 million kilometers (3) 390 million kilometers
(2) 220 million kilometers (4) 850 million kilometers

____4. Scientists believe that a large asteroid struck Earth approximately 65 million years ago. It is often theorized that this event contributed to the
(1) end of the last ice age (3) evolution of the first birds
(2) breaking up of the supercontinent Pangea (4) extinction of the dinosaurs

____5. There is evidence that an asteroid or a comet crashed into the Gulf of Mexico at the end of the Mesozoic Era. Consequences of this impact event may explain the
(1) extinction of many kinds of marine animals, including trilobites
(2) extinction of ammonoids and dinosaurs
(3) appearance of the earliest birds and mammals
(4) appearance of great coal-forming forests and Insects

____6. The Foucault pendulum provides evidence of Earth's
(1) revolution around the Sun in a geocentric solar system
(2) revolution around the Sun in a heliocentric solar system
(3) rotation on its axis in a geocentric solar system
(4) rotation on its axis in a heliocentric solar system

____7. Base your answer on the diagram below which shows a portion of the solar system.



(Not drawn to scale)

What is the average distance, in millions of kilometers, from the Sun to the asteroid belt?
(1) 129 (2) 189 (3) 503 (4) 857

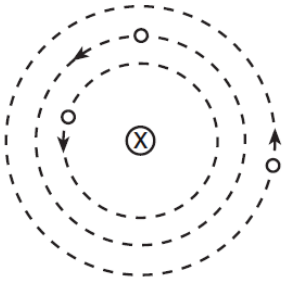
____8. The diagram below represents a simple geocentric model. Which object is represented by the letter *X*?

(1) Earth

(2) Sun

(3) Moon

(4) *Polaris*



(Not drawn to scale)

____9. Compared to the average density of the terrestrial planets (Mercury, Venus, Earth, and Mars), the average density of the Jovian planets (Jupiter, Saturn, Uranus, and Neptune) is
(1) less (2) greater (3) the same

____10. Terrestrial planets move more rapidly in their orbits than the Jovian planets because terrestrial planets are
(1) rotating on a tilted axis
(2) more dense
(3) more massive
(4) closer to the Sun

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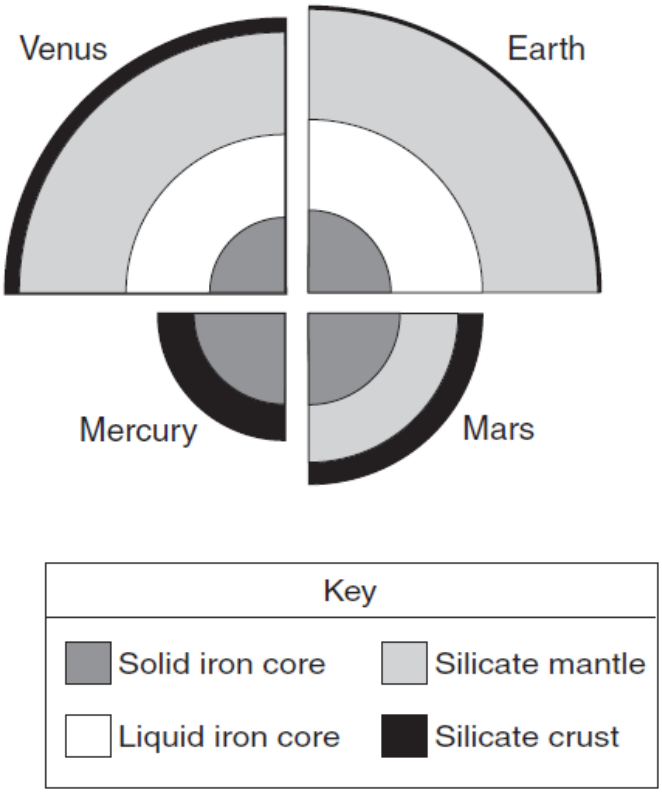
____11. Compared to the Jovian planets in our solar system, Earth is
(1) less dense and closer to the Sun
(2) less dense and farther from the Sun
(3) more dense and closer to the Sun
(4) more dense and farther from the Sun

____12. Compared to the terrestrial planets, the Jovian planets are
(1) smaller and have lower densities
(2) smaller and have greater densities
(3) larger and have lower densities
(4) larger and have greater densities

Base your answers to questions 13 through 15 on the diagram below, which shows the inferred internal structure of the four terrestrial planets, drawn to scale.



13. How are the crusts of Mars, Mercury, Venus, and Earth similar in composition? _____

_____

14. Identify the *two* planets that would allow an *S*-wave from a crustal quake to be transmitted through the core to the opposite side of the planet. _____

_____

15. Explain why the densities of these terrestrial planets are greater than the densities of the Jovian planets. _____

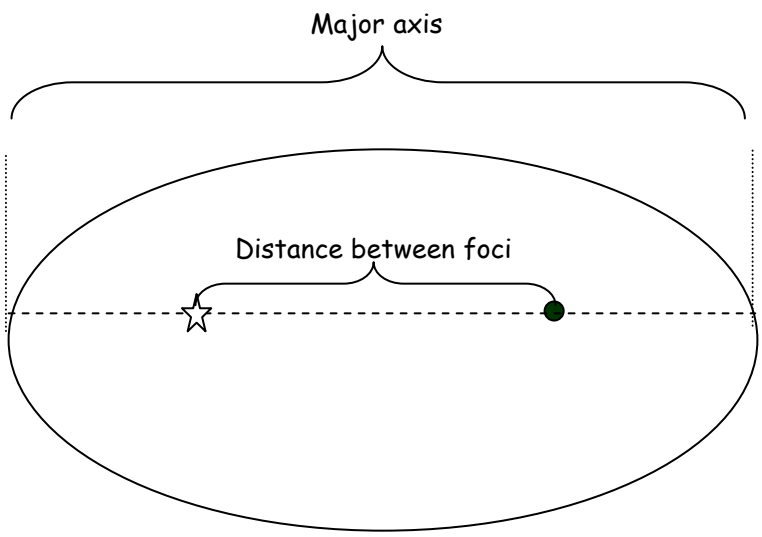
_____

Introduction:

The orbits of the planets in our solar system are slightly elliptical (oval) with the Sun at one focus. Eccentricity is how elliptical an orbit is. In order to determine the eccentricity of an orbit you need to know the distance between foci and the length of the major axis. The more round an orbit is, the lower the number. A circle, for example, has an eccentricity of zero. The formula for eccentricity can be found on the front page of the Earth Science Reference Tables.

Materials
- ✓ pencil
- ✓ 2 push pins
- ✓ 25 cm piece of string
- ✓ cardboard
- ✓ calculator
- ✓ metric ruler

Objective:
- To draw ellipses and determine eccentricity

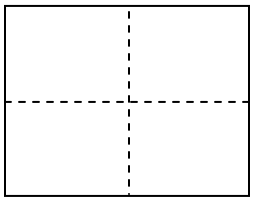


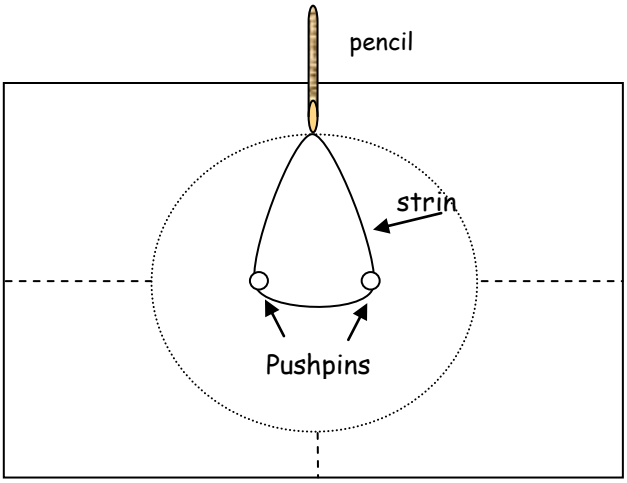
Write the formula for eccentricity below.

Using the ruler on the front of the Earth Science Reference Tables measure the <u>distance between foci</u> and the <u>length of the major axis</u>.

Procedure:

1. Cut a piece of string about 25 cm in length and tie the ends together to forms a loop.
2. Take a white sheet of plain paper and fold it lengthwise. Unfold the paper and now fold it the other way.





3. Place the sheet of paper on a piece of cardboard.
4. Place one pushpin 1 cm on each side of the center where the fold is. This means you will have two pushpins on your paper and they will be 2 cm apart.
5. Loop the string around the pushpins. Using an orange color pencil draw the ellipse by placing the pencil inside the loop as shown below. Label this ellipse #1

6. Measure the distance between the foci and the length of the major axis and determine eccentricity of this ellipse to the nearest thousandth.

	Distance between foci	_____
Ellipse # 1	Distance of major axis	_____
	Eccentricity =	_____

---

7. Place each pushpins 1 cm away from the previous spot, away from the center.
8. Loop the string around the pushpins. Using a blue color pencil, draw the ellipse by placing the pencil inside the loop. Label this ellipse #2.
9. Measure the distance between the foci and the length of the major axis and determine eccentricity of this ellipse to the nearest thousandth.

	Distance between foci	_____
Ellipse # 2	Distance of major axis	_____
	Eccentricity =	_____

---

10. Place each pushpins 1 cm away from the previous spot, away from the center.
11. Loop the string around the pushpins. Using a green color pencil, draw the ellipse by placing the pencil inside the loop. Label this ellipse #3.
12. Measure the distance between the foci and the length of the major axis and determine eccentricity of this ellipse to the nearest thousandth.

	Distance between foci	_____
Ellipse # 3	Distance of major axis	_____
	Eccentricity =	_____

---

13. Place each pushpins 1 cm away from the previous spot, away from the center.
14. Loop the string around the pushpins. Using a purple color pencil draw the ellipse by placing the pencil inside the loop. Label this ellipse #4.
15. Measure the distance between the foci and the length of the major axis and determine eccentricity of this ellipse to the nearest thousandth.

	Distance between foci	_____
Ellipse # 4	Distance of major axis	_____
	Eccentricity =	_____

✓ **Check Point**

1. Which change takes place in the eccentricity of the ellipses (shape) when you increase the distance between the foci? _____
2. How does the numerical value of "e" change as the shape of the ellipse becomes more oval?

_____

3. Where is the sun located on a diagram of Earth's orbit? _____
4. What geometric shape does ellipse #1 appear to be? _____
5. What is the eccentricity of ellipse # 1? _____
6. What is the eccentricity of Earth? _____
7. Compare the eccentricity of the Earth's orbit with ellipse # 1. _____

_____

8. Using the Earth Science Reference Tables, list the planets in order of increasing eccentricity of their orbits:

Least eccentric: _____

_____

_____

_____

_____

_____

_____

Most eccentric: _____

9. Referring to the "Solar System Data" chart in your Earth Science Reference Tables, the planets are listed in order by their distance from the sun. Is there a relationship between the eccentricity of its orbit and the distance a planet is from the sun? _____
10. Describe the true shape of Earth's orbit. _____

_____

11. Earth's revolutionary speed changes as it travels in orbit around the Sun. When is Earth's orbital speed the greatest? (hint – pg 3) _____
12. What month is Earth closest to the Sun? _____

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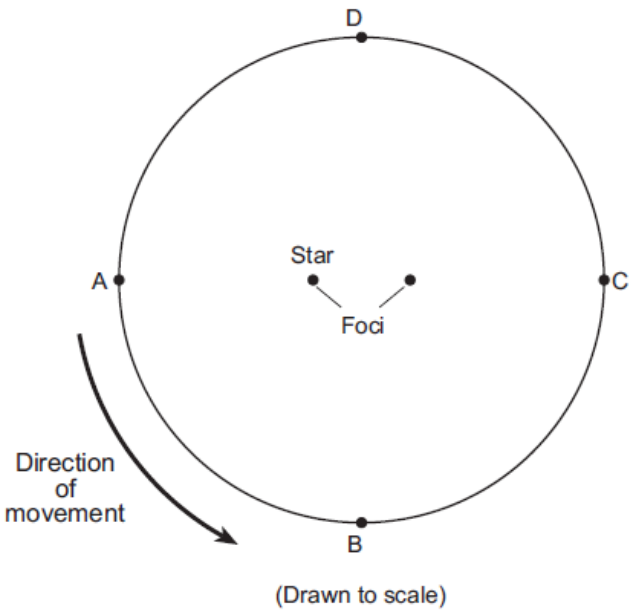
Regents Questions:

Base your answers to questions 1 through 3 on the diagram below, which represents the elliptical orbit of a planet traveling around a star. Points *A, B, C,* and *D* are four positions of this planet in its orbit.



_____1. The calculated eccentricity of this orbit is approximately
(1) 0.1 (3) 0.3
(2) 0.2 (4) 0.4

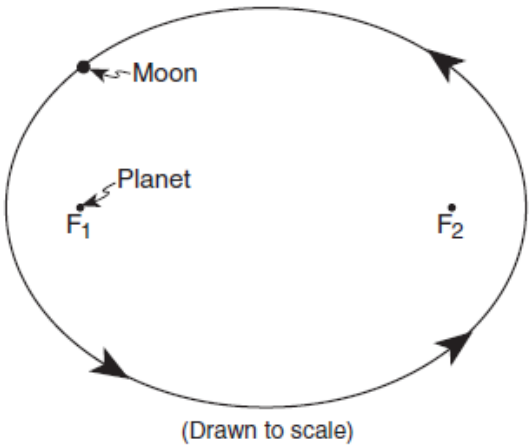
_____2. The gravitational attraction between the star and the planet will be greatest at position
(1) *A* (2) B (3) *C* (4) *D*

_____3. As the planet revolves in orbit from position *A* to position *D*, the orbital velocity will
(1) continually decrease
(2) continually increase
(3) decrease, then increase
(4) increase, then decrease

_____4. Which planet has an orbit with an eccentricity most similar to the eccentricity of the Moon's orbit around Earth?
(1) Earth (2) Jupiter (3) Pluto (4) Saturn

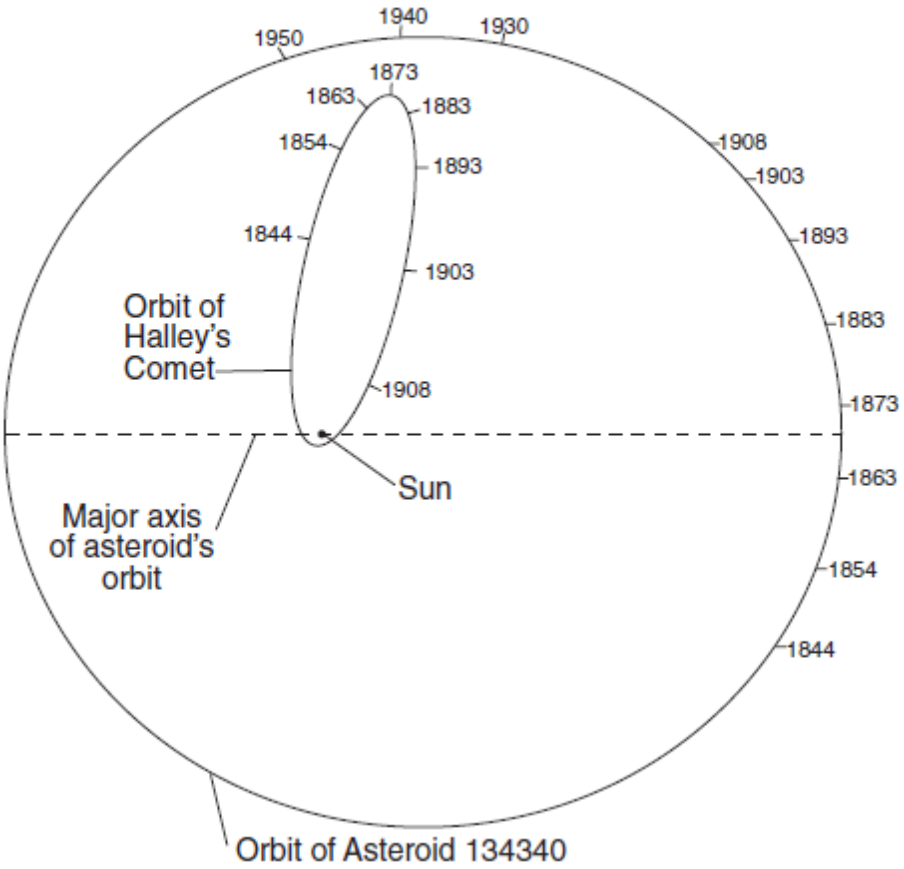
_____5. The diagram to the right represents the elliptical orbit of a moon revolving around a planet. The foci of this orbit are the points labeled *F*1 and *F*2.

What is the approximate eccentricity of this elliptical orbit?
(1) 0.3 (3) 0.7
(2) 0.5 (4) 1.4



_____6. Which planet has an orbital eccentricity most like the orbital eccentricity of the Moon?
(1) Venus (2) Saturn (3) Mars (4) Mercury

Base your answers to questions 7 through 9 on the diagram below. The diagram shows the positions of Halley's Comet and Asteroid 134340 at various times in their orbits. Specific orbital positions are shown for certain years.



7. The eccentricity of the asteroid's orbit is 0.250. On the orbital diagram *above* , mark the position of the second focus of the asteroid's orbit by placing an **X** on the major axis at the proper location.

8. Which was traveling faster, (Halley's Comet or the asteroid), between the years 1903 and 1908? State *one* reason for your choice. _____

_____

9. Explain why Halley's Comet is considered to be part of our solar system. _____

_____

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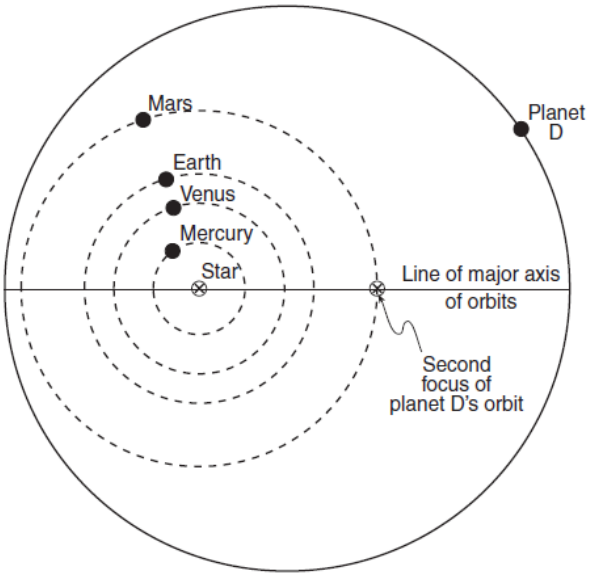
Base your answers to questions 10 and 11 on the diagram to the right, which shows the orbit of planet *D* around the star *Upsilon Andromedae.*

The dashed lines show where the paths of the first four planets of our solar system would be located if they were going around *Upsilon Andromedae* instead of the Sun.

All distances are drawn to scale.



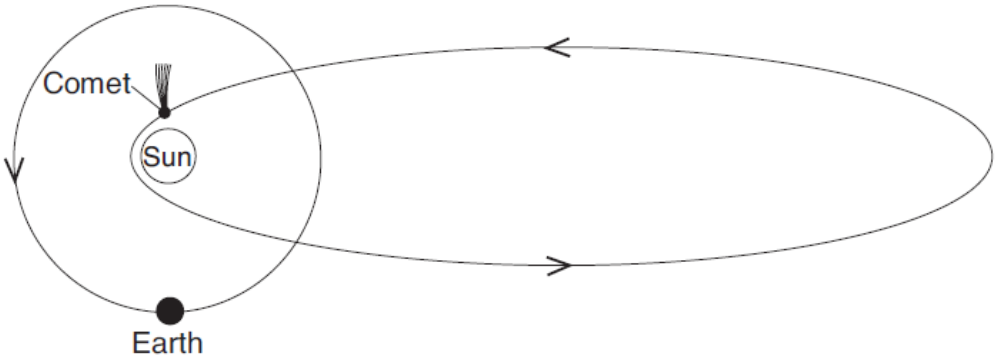
10. Describe the eccentricity of planet *D*'s orbit relative to the eccentricities of the orbits of the planets shown in our solar system.

_____

11. Describe the changes in gravitational force between planet *D* and the star *Upsilon Andromedae* during one complete orbit around the star. Be sure to describe where the force is greatest and where the force is least.

_____

Base your answers to questions 12 and 13 on the diagram below, which shows Earth's orbit and the orbit of a comet within our solar system.



(Not drawn to scale)

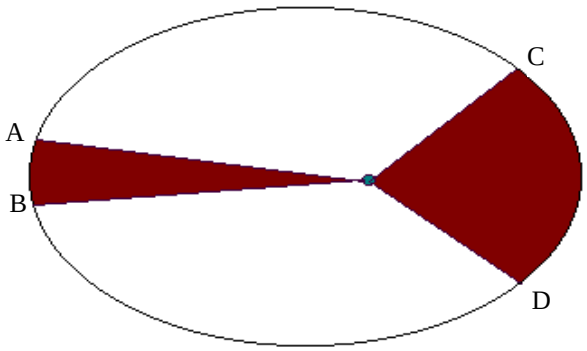
12. Explain how this comet's orbit illustrates the heliocentric model of our solar system.

_____

13. Explain why the time required for one revolution of the comet is more than the time required for one revolution of Earth. _____

Mini Lesson 2: Gravity, Planet Velocities, and Area

Gravity is an invisible force of attraction. It depends on mass and distance. The larger the mass the greater the gravitational attraction. The closer objects are to each the greater the attraction. The speed of a planet depends on its distance from the star. In an elliptical orbit planets will move faster when it is closer to the star it orbits. The line joining the star and planet sweeps out equal areas in equal intervals of time. In the diagram below, the shaded area between A, B and the star is the same as the shaded area between C, D and the star.



Regents Questions:

Base your answers to questions 1 and 2 on the data table below, which provides information about four of Jupiter's moons.

Data Table

Moons of Jupiter	Density (g/cm^3)	Diameter (km)	Distance from Jupiter (km)
Io	3.5	3630	421,600
Europa	3.0	3138	670,900
Ganymede	1.9	5262	1,070,000
Callisto	1.9	4800	1,883,000

1. Identify the planet in our solar system that is closest in diameter to Callisto. _____

2. In 1610, Galileo was the first person to observe, with the aid of a telescope, these four moons orbiting Jupiter. Explain why Galileo's observation of this motion did *not* support the geocentric model of our solar system. _____

_____

_____

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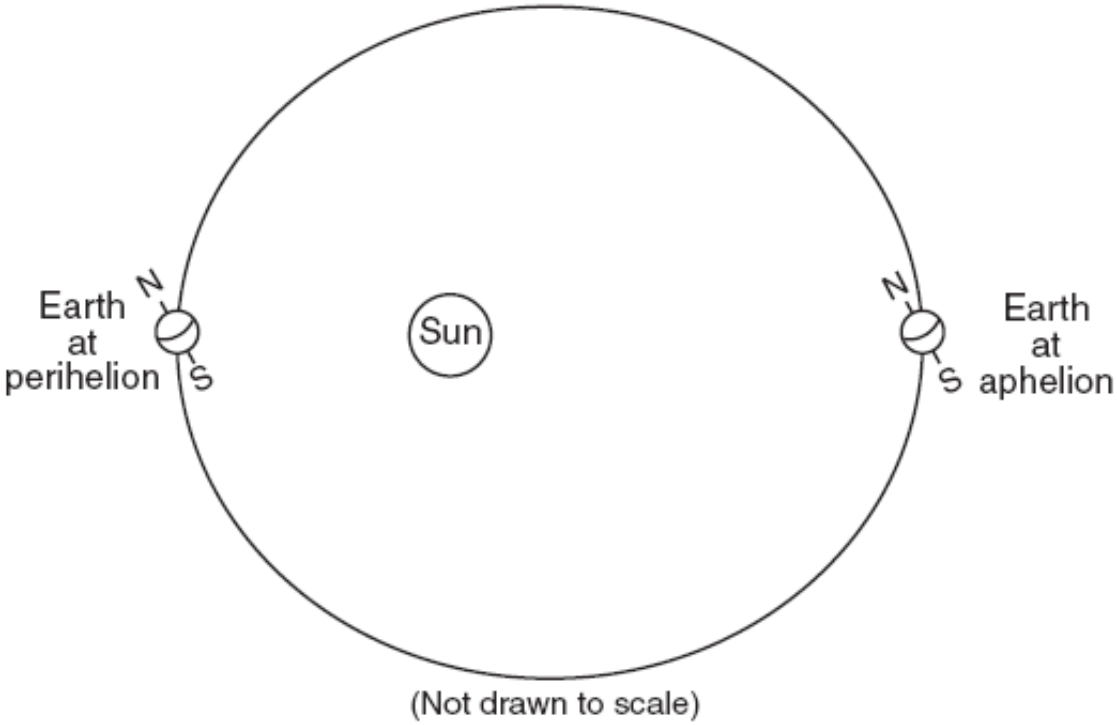
Base your answers to questions 3 through 6 on the diagram below, which represents an exaggerated model of Earth's orbital shape. Earth is closest to the Sun at one time of year (perihelion) and farthest from the Sun at another time of year (aphelion).



3. State the actual geometric shape of Earth's orbit. _____

4. Identify the season in the Northern Hemisphere when Earth is at perihelion.

_____

5. Describe the change that takes place in the apparent size of the Sun, as viewed from Earth, as Earth moves from perihelion to aphelion.

_____

6. State the relationship between Earth's distance from the Sun and Earth's orbital velocity.

_____

_____

_____

Base your answers to questions 6 through 8 on the data table below, which shows the average distance from the Sun, the average surface temperature, and the average orbital velocity for each planet in our solar system.

Data Table

Planet	Average Distance from Sun (millions of km)	Average Surface Temperature (°C)	Average Orbital Velocity (km/sec)
Mercury	58	167	47.9
Venus	108	457	35.0
Earth	150	14	29.8
Mars	228	-55	24.1
Jupiter	778	-153	13.1
Saturn	1427	-185	9.7
Uranus	2869	-214	6.8
Neptune	4496	-225	5.4

6. State the relationship between the average distance from the Sun and the average surface temperature of the Jovian planets. _____

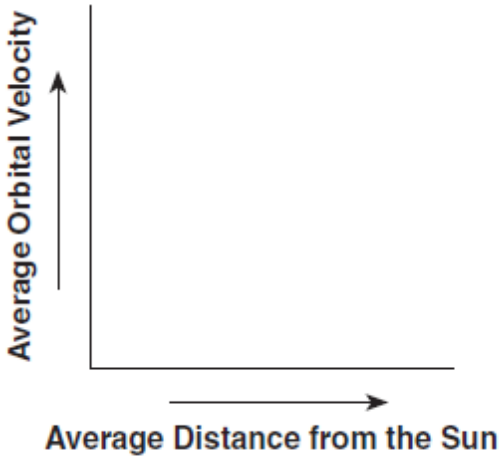
_____

7. Venus has an atmosphere composed mostly of carbon dioxide. Mercury has almost no atmosphere. Explain how the presence of the carbon dioxide in Venus' atmosphere causes the average surface temperature on Venus to be higher than the average surface temperature on Mercury.

_____

_____

8. On the graph below, draw a line to indicate the general relationship between a planet's average distance from the Sun and its average orbital velocity.



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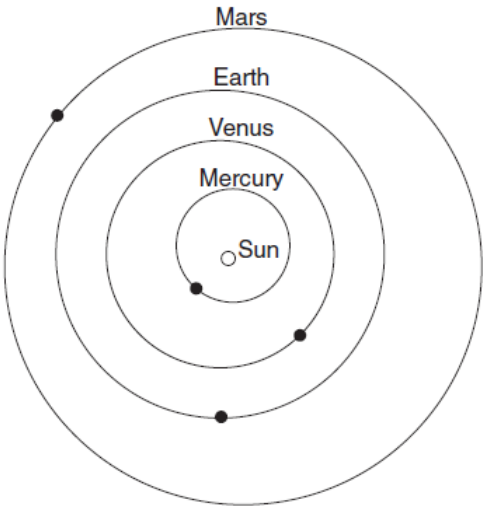
Base your answers to questions 9 through 13 on the two diagrams in your answer booklet. Diagram I shows the orbits of the four inner planets. Black dots in diagram I show the positions in the orbits where each planet is closest to the Sun. Diagram II shows the orbits of the six planets that are farthest from the Sun. The distance scale in diagram II is different than the distance scale in diagram I.

9. On diagram I *to the right,* place the letter **W** on Mars' orbit to represent the position of Mars where the Sun's gravitational force on Mars would be *weakest*.

Diagram I



(Not drawn to scale)

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10. On diagram II *to the right,* circle the names of the *two* largest Jovian planets.

11. Pluto's orbital speed is usually slower than Neptune's orbital speed. Based on diagram II, explain why Pluto's orbital speed is sometimes faster than Neptune's orbital speed.

_____

_____

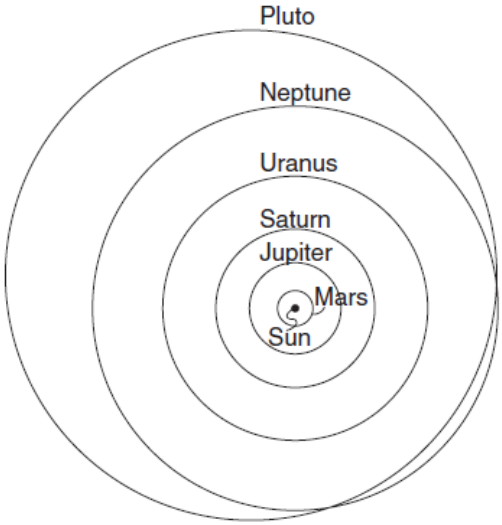
_____

_____

_____

_____

Diagram II



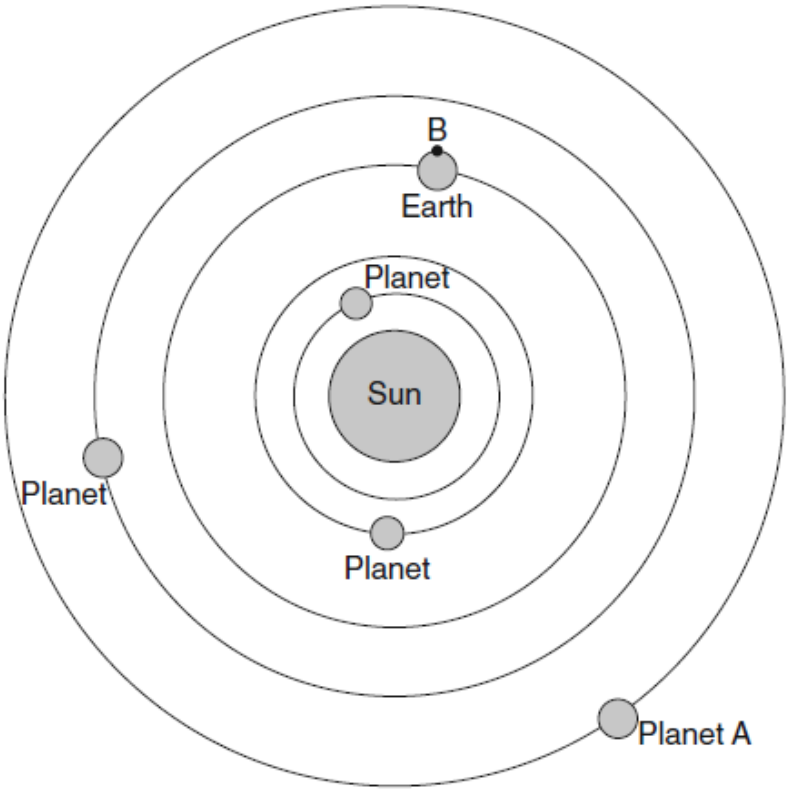
(Not drawn to scale)

11. How long does it take the planet Uranus to complete one orbit around the Sun? Units must be included in your answer. _____

12. Describe how the orbits of each of the nine planets are similar in shape.

_____

Base your answers to questions 13 through 16 on the diagram below, which shows the heliocentric model of a part of our solar system. The planets closest to the Sun are shown. Point *B* is a location on Earth's equator.



(Not drawn to scale)

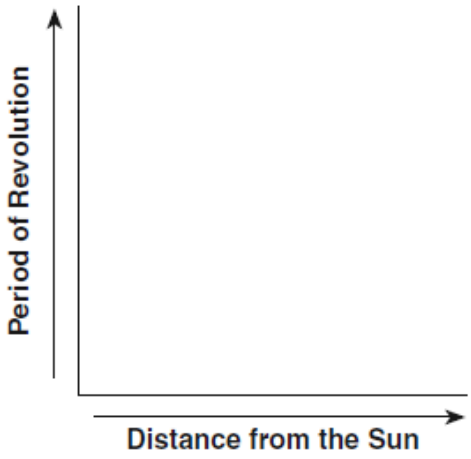
13. State the name of planet *A*. _____

14. Explain why location *B* experiences both day and night in a 24 hour period.

_____

15. Identify *one* feature of the geocentric model of our solar system that differs from the heliocentric model shown. _____

16. On the graph *to the right*, draw a line to show the general relationship between a planet's distance from the Sun and the planet's period of revolution.



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Materials
- ✓ Color pencils

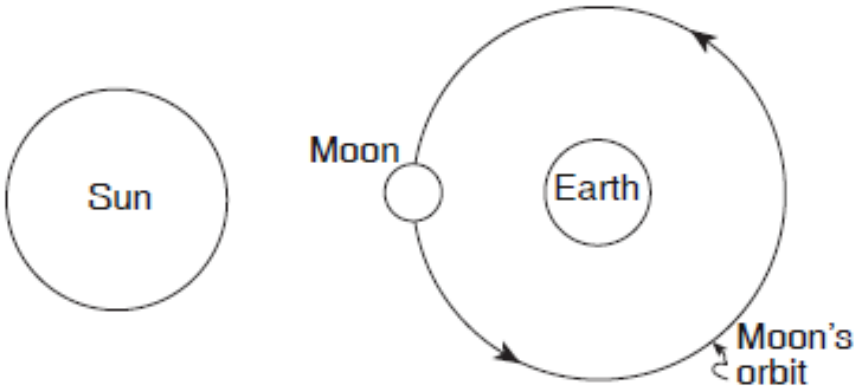
Introduction:

A satellite is any celestial object moving in an orbit around another celestial object. Earth is a satellite of the Sun and the Moon is a natural satellite of Earth. The apparent shape of the Moon depends on the changing positions of the Sun, Earth and Moon.

It takes 27.3 days for one revolution of the Moon around Earth, however it takes 29 $\frac{1}{2}$ days for the Moon to go through all of its phases. As the Moon moves around Earth in its revolution, Earth also is revolving around the Sun. This is why it takes a little over two additional days for the illuminated portion of the Moon to complete its cycle. Generally speaking it takes approximately one month.

Objective:

- To draw the phases of the moon



Need to know:

1. What is a satellite? _____

   _____

2. Earth is a satellite of the _____
3. What is the name of Earth's satellite? _____
4. How long does it take for the moon to complete one revolution around Earth? _____
5. How long does it take for the moon to complete a full cycle of its phases? _____
6. Why does it take just over 2 additional days for the moon to complete its phases?

   _____

   _____

7. Approximately how long does it take for one complete cycle of the Moons phases? _____

Procedure:

The diagram on page 21 represents the Moon orbiting Earth as viewed from space above the North Pole. The Moon is shown at eight different positions in its orbit.

1. Using a green color pencil, draw one arrow counter clockwise **between** each phase (eight total) on the diagram to show the direction of the Moons orbit. The arrow between phase 1 and 2 has been done for you (trace that arrow in green).

2. Using an orange color pencil draw an arrow from Earth to each of the Moons locations. This illustrates the portion of the Moon that is visible from Earth. The arrow for location 1 has been done for you (trace that arrow in orange).

3. Using a blue color pencil, draw a line through each moon phase around its orbit, as shown in the diagram. Trace the line that has already been drawn for you blue.

4. **Drawing the phases of the moon:**
   shade in the corresponding phases on the diagram with those in the chart provided.

   - Location 1 is called a "New Moon". Look where the arrow from Earth is pointing to the Moon. You will notice that the entire side of the Moon facing Earth is dark. Shade in the entire circle in the chart.

   - Location 2 is called a "Waxing Crescent". Shade in the portion of circle 2 on page 21 that illustrates what part of the Moon is not illuminated. Be careful to show that the left side of the circle that is shaded is larger than the right side. The right side is a crescent shaped.

   - Location 3 is called a "First Quarter". Shade in the portion of circle 3 on page 21 that illustrates what part of the Moon is not illuminated.

   - Location 4 is called a "Waxing Gibbous ". Shade in the portion of circle 4 on page 21 that illustrates what part of the Moon is not illuminated.

   - Location 5 is called a "Full Moon ". Shade in the portion of circle 5 on page 21 that illustrates what part of the Moon is not illuminated.

   - Location 6 is called a "Waning Gibbous ". Shade in the portion of circle 6 on page 21 that illustrates what part of the Moon is not illuminated.

   - Location 7 is called a "Last Quarter". Shade in the portion of circle 7 on page 21 that illustrates what part of the Moon is not illuminated.

   - Location 8 is called a "Waning Crescent ". Shade in the portion of circle 8 on page 21 that illustrates what part of the Moon is not illuminated.

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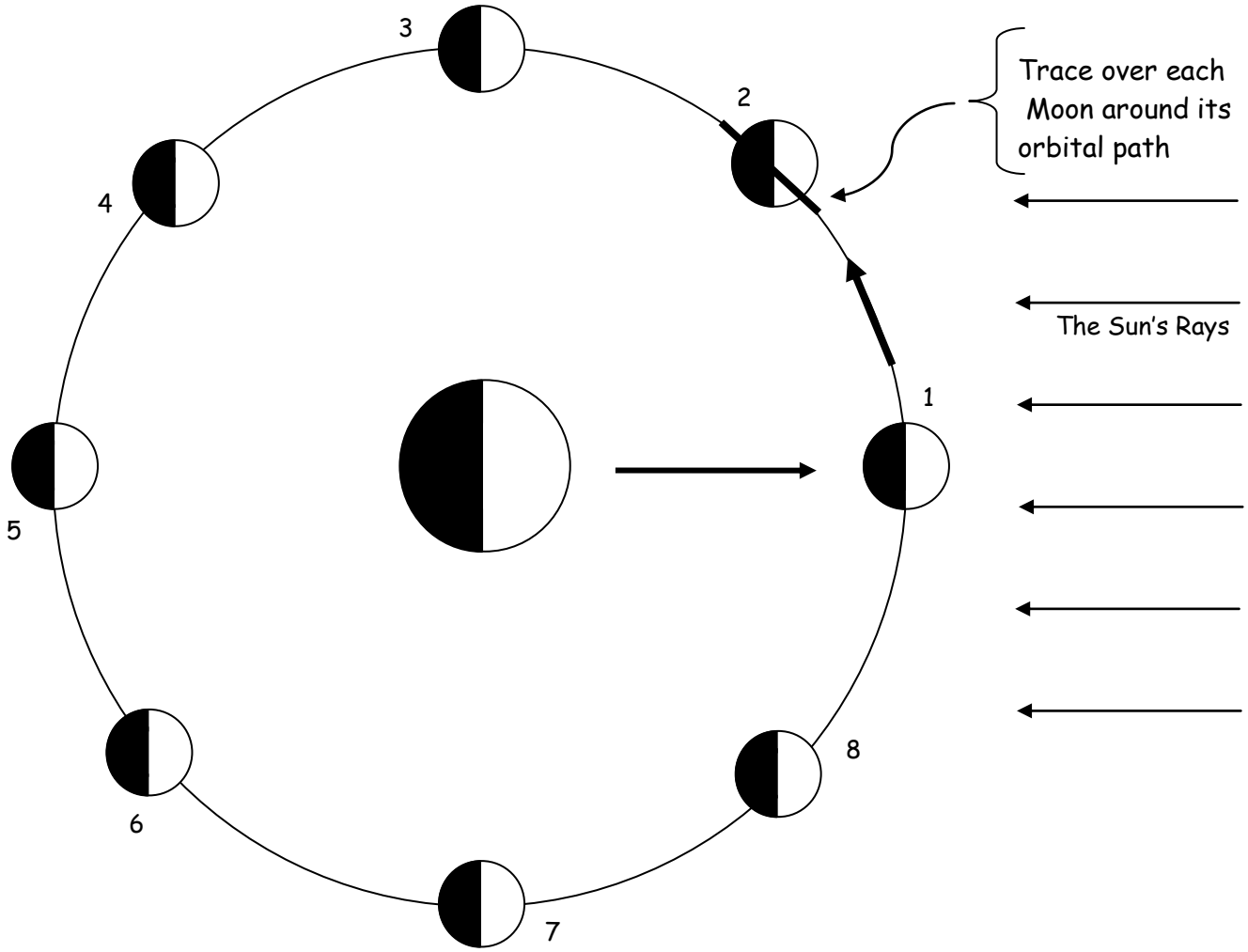
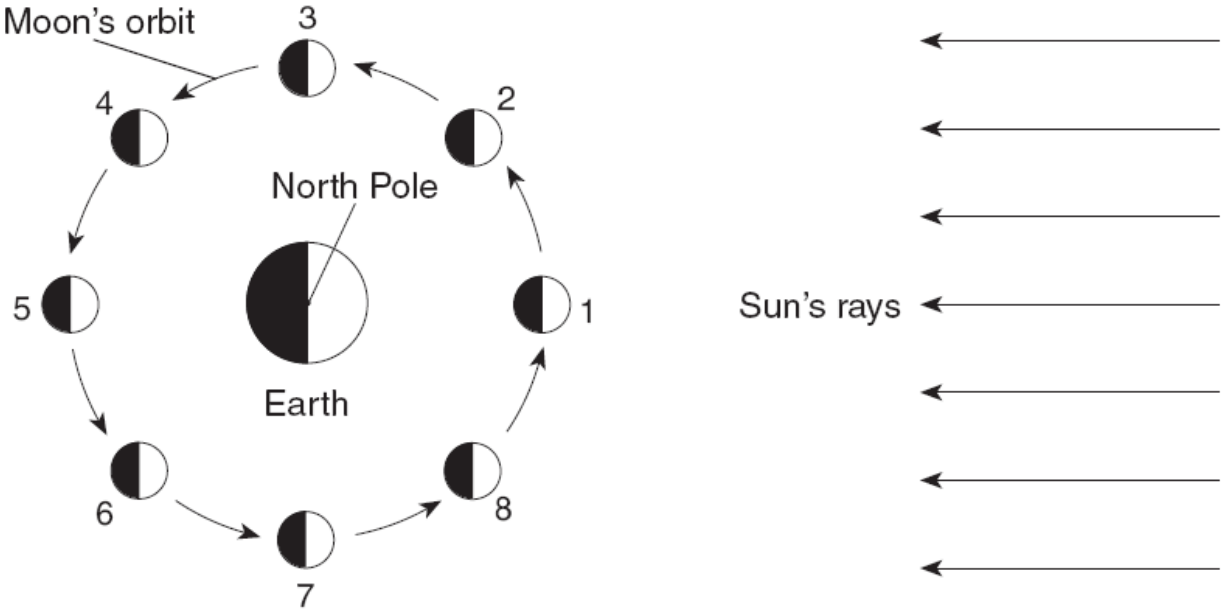


Moon Phase	Name	Moon Phase	Name
1		5	
2		6	
3		7	
4		8	

Regents Questions

Base your answers to questions 1 through 5 on the diagram below, which represents the Moon orbiting Earth as viewed from space above the North Pole. The Moon is shown at eight different positions in its orbit.



(Not drawn to scale)

Key	
☐	Lighted, visible part of the Moon
■	Dark, invisible part of the Moon

____1. The approximate time required for the Moon to move from position 3 to position 7 is
(1) 1 hour (2) 3 months (3) 2 weeks (4) 4 days

____2. As the Moon changes location from position 2 to position 6, the visible portion of the Moon as observed from Earth
(1) decreases, only
(2) increases, only
(3) decreases, then increases
(4) increases, then decreases

____3. When the Moon is in position 2, which phase would be visible to an observer in New York State?


(1)


(2)


(3)


(4)

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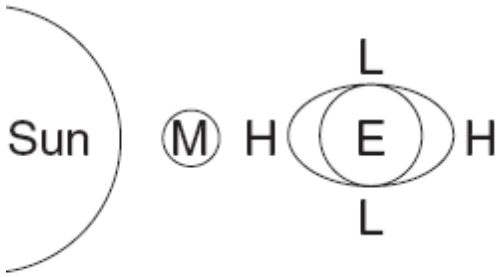
Mini Lesson 3: Tides & Eclipses

Tides are the rising and falling of the ocean surface. The gravitational pull between the changing positions of the Moon and Sun relative to Earth causes the different heights of the ocean water. Close to two high tides and two low tides occur each day. Four times each month there are special types of tides, where the height of the water is at its highest or lowest. These are described in the section below.

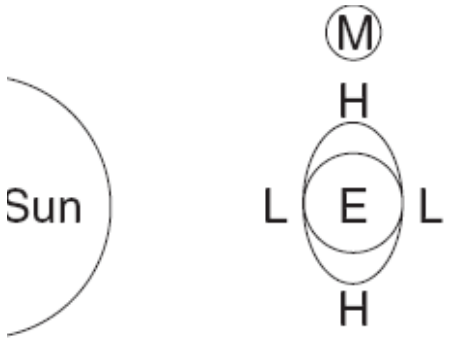
Key	
E = Earth	H = High tide
M = Moon	L = Low tide

Spring Tide



This occurs when the Moon and Earth are aligned in a straight line with the sun. It has the greatest change from high tide to low tide. It is the highest of the high tide and lowest of the low. This occurs twice a month when the moon is in the New Moon and Full Moon phases.

Neap Tide



This occurs when the Moon and Earth are positioned in a right angle with the sun. It has the smallest change from high tide to low tide. It is the highest of the low tide and lowest of the high. This occurs twice a month when the moon is in the First Quarter and Third Quarter Moon phases.

Need to know:

1. What are tides? _____
2. What causes the change in tides? _____

_____

3. What does the change in gravitation attraction depend on? _____

_____

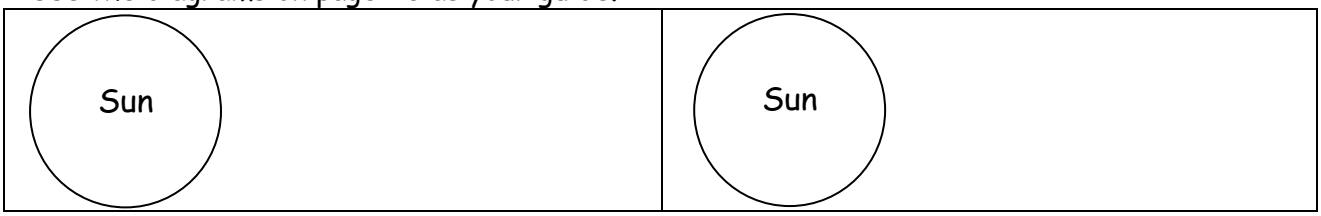
4. What two phases of the Moon result in a Spring Tide? _____

   and _____

5. Describe the size of the high and low tides during a Spring Tide _____

   _____

6. In the two boxes below, draw the position of the Moon and Earth during a Spring Tide.
   Use the diagrams on page 20 as your guide.



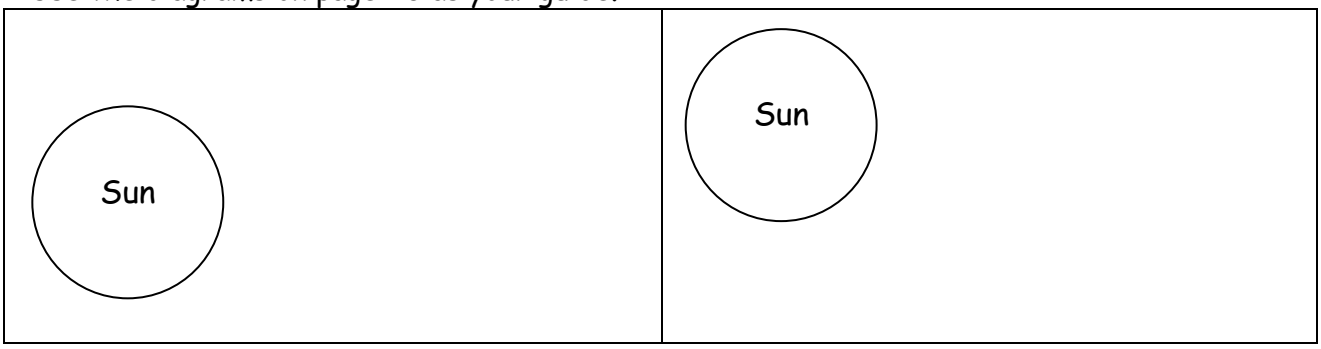
7. What two phases of the Moon result in a Neap Tide? _____

   and _____

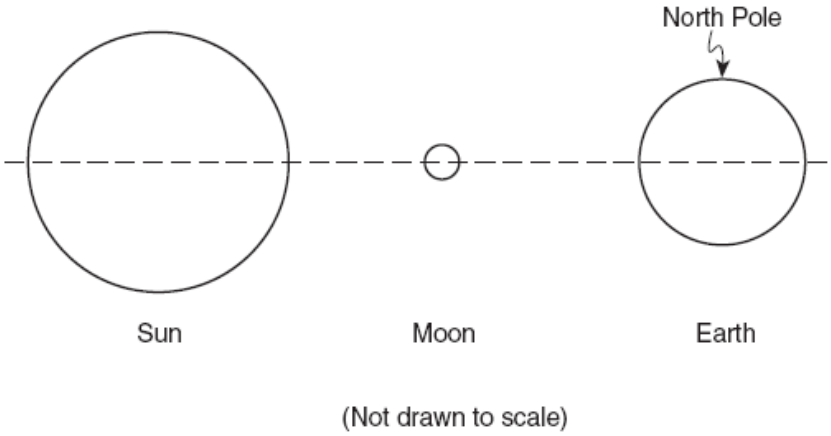
8. Describe the size of the high and low tides during a Neap Tide _____

   _____

9. In the two boxes below, draw the position of the Moon and Earth during a Neap Tide.
   Use the diagrams on page 20 as your guide.



The diagram to the right shows the Sun, the Moon, and Earth in line with one another in space. On the diagram, draw *two* dots (•) on the surface of Earth to indicate the locations where the highest ocean tides are most likely occurring.



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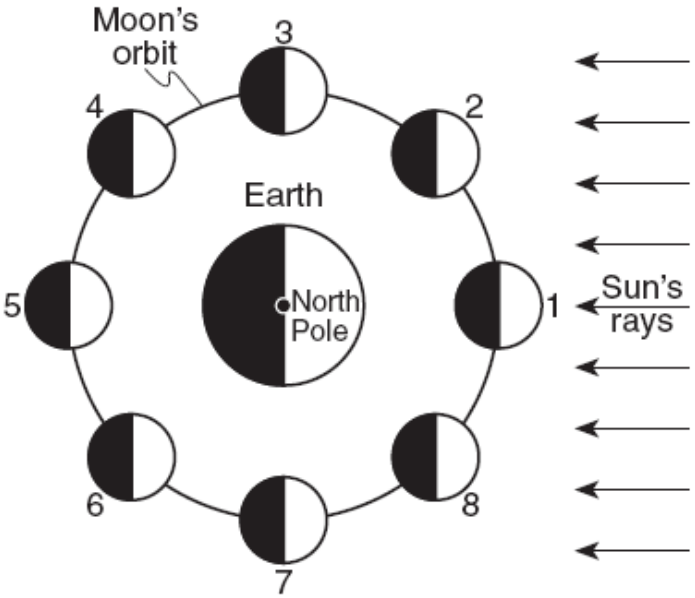
Regents questions:

____1. Which motion causes the Moon to show phases when viewed from Earth?
(1) rotation of Earth (3) rotation of the Sun
(2) revolution of Earth (4) revolution of the Moon

____2. Which device when placed on the Moon would provide evidence of Moon rotation?
(1) Foucault pendulum (2) thermometer (3) seismograph (4) wind vane

---

____3. The diagram below shows the Moon orbiting Earth, as viewed from space above Earth's North Pole. The Moon is shown at eight positions in its orbit.

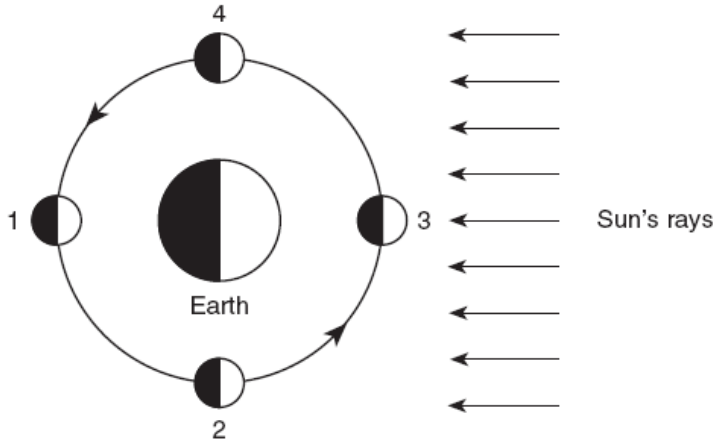


(Not drawn to scale)

Spring ocean tides occur when the difference in height between high tide and low tide is greatest. At which two positions of the Moon will spring tides occur on Earth?
(1) 1 and 5 (2) 3 and 7 (3) 2 and 6 (4) 4 and 8

____4. The diagram below represents the Sun's rays striking Earth and the Moon. Numbers 1 through 4 represent positions of the Moon in its orbit around Earth.

The highest tides on Earth occur when the Moon is in positions
(1) 1 and 3 (3) 3 and 2
(2) 2 and 4 (4) 4 and 1



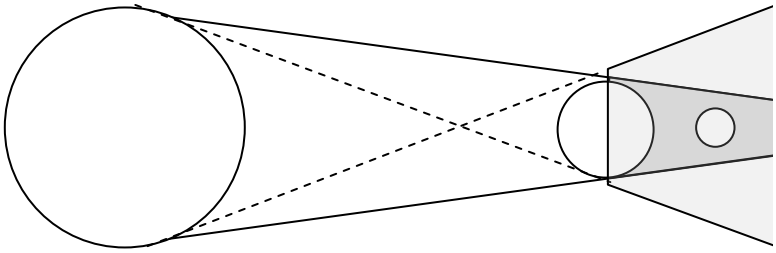
(Not drawn to scale)

Picture this:

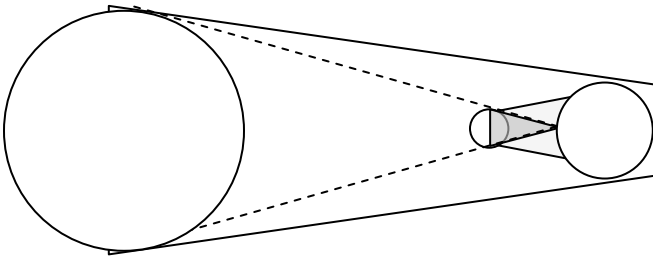
Eclipses do not occur every time there is a Full or New moon because the plane of orbit of the Moon is at a 5°tilt to that of Earth's orbital plane.
The Moon, Sun and Earth have to be aligned perfectly for them to occur.

Eclipses

A Lunar Eclipse occurs when the moon moves into Earth's shadow. The moon first moves in a lighter shadow called a penumbra. Eventually it moves into the darkest part of the shadow called the umbra. It lasts until the Moon moves out of Earth's shadow. Earth's shadow is so large a lunar eclipse can last for more than an hour. The phase of the moon is Full Moon.



A Solar Eclipse occurs when the Moon's shadow moves over Earth's surface. It occurs only where the "point" of the shadow hits Earth's surface. The phase of the moon is New Moon.



Regents Questions

____1. Which description of change is most closely associated with ocean tides and moon phases?
(1) cyclic and predictable (3) noncyclic and predictable
(2) cyclic and unpredictable (4) noncyclic and unpredictable

____2. The cyclic rise and fall of ocean tides on Earth is primarily caused by Earth's rotation and the
(1) temperature differences in ocean currents
(2) revolution of Earth around the Sun
(3) direction of Earth's planetary winds
(4) gravitational attraction of the Moon and the Sun

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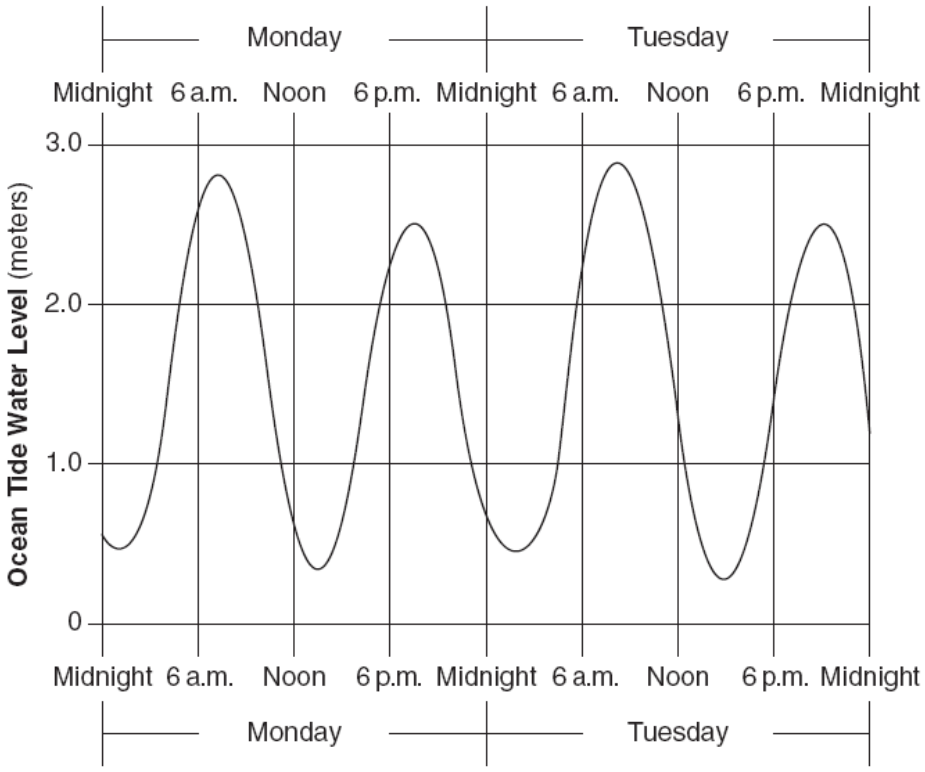
Base your answers to questions 3through 5 on the graph below, which shows the water levels of ocean tides measured in Boston, Massachusetts, for a 2-day period.

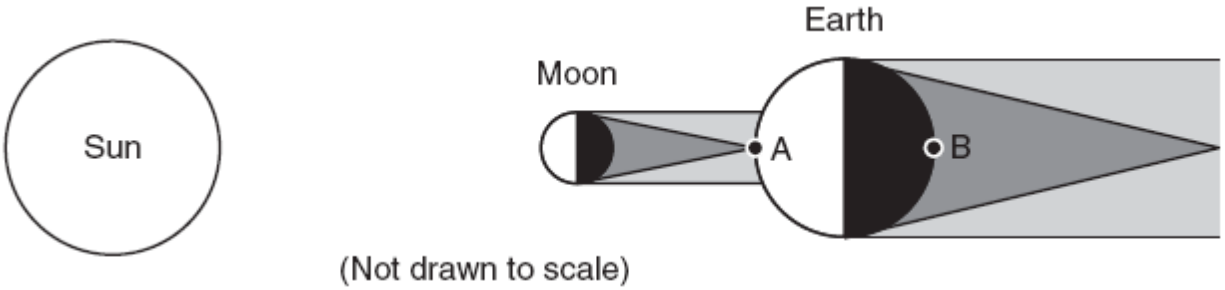


____3. The graph shows that high tides at Boston occur approximately every
(1) 3.5 hours (2) 6.0 hours (3) 12.5 hours (4) 16.0 hours

____4. If the trends shown by the graph continue, which statement best describes the next low tide at Boston that is expected to occur on Wednesday?
(1) It will occur about 3 a.m. with a 0.4-meter water level.
(2) It will occur about 6 a.m. with a 0.6-meter water level.
(3) It will occur about 9 p.m. with a 2.6-meter water level.
(4) It will occur about 10 p.m. with a 2.8-meter water level.

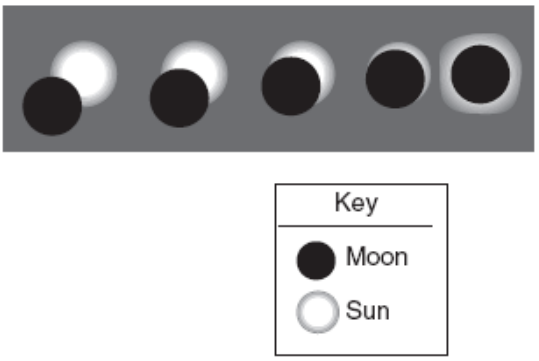
____5. The gravitational pull of the Moon has the greatest influence on the water levels of Earth's ocean tides. If the distance between the Moon and Earth were to *decrease* steadily for the week following the time shown on the graph, which water level changes would be expected to occur?
(1) High tides would get higher and low tides would get lower.
(2) High tides would get lower and low tides would get higher.
(3) Both high tides and low tides would get higher.
(4) Both high tides and low tides would get lower.

The diagram below shows the relative positions of the Sun, the Moon, and Earth when an eclipse was observed from Earth. Positions *A* and *B* are locations on Earth's surface.



____6. Which statement correctly describes the type of eclipse that was occurring and the position on Earth where this eclipse was observed?
(1) A lunar eclipse was observed from position *A*.
(2) A lunar eclipse was observed from position *B*.
(3) A solar eclipse was observed from position *A*.
(4) A solar eclipse was observed from position *B*.

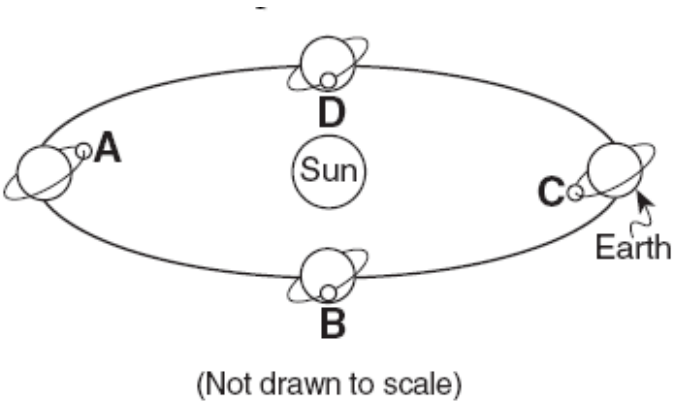
____7. What is represented by the diagram to the right?



(1) changing phases of the Sun
(2) changing phases of the Moon
(3) stages in an eclipse of the Sun
(4) stages in an eclipse of the Moon

____8. The diagram to the right shows Earth's orbit around the Sun and different positions of the Moon as it travels around Earth. Letters *A* through *D* represent four different positions of the Moon.

An eclipse of the Moon is most likely to occur when the Moon is at position
(1) *A* (2) B (3) *C* (4) D



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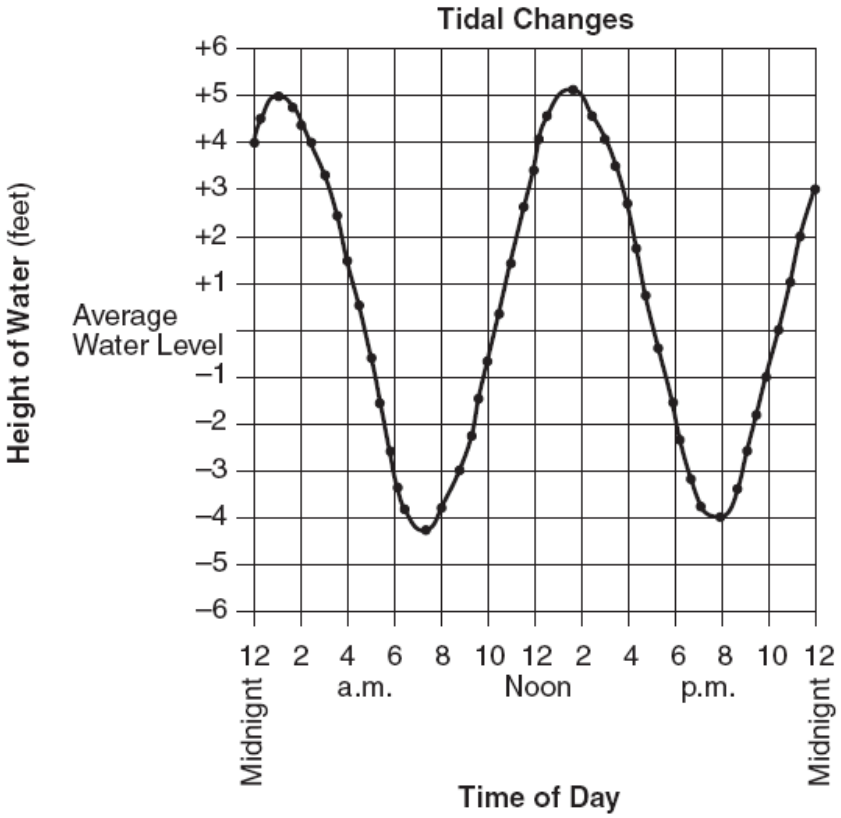
Base your answers to questions 9 and 10 on the graph below. The graph shows the recorded change in water level (ocean tides) at a coastal city in the northeastern United States during 1 day.



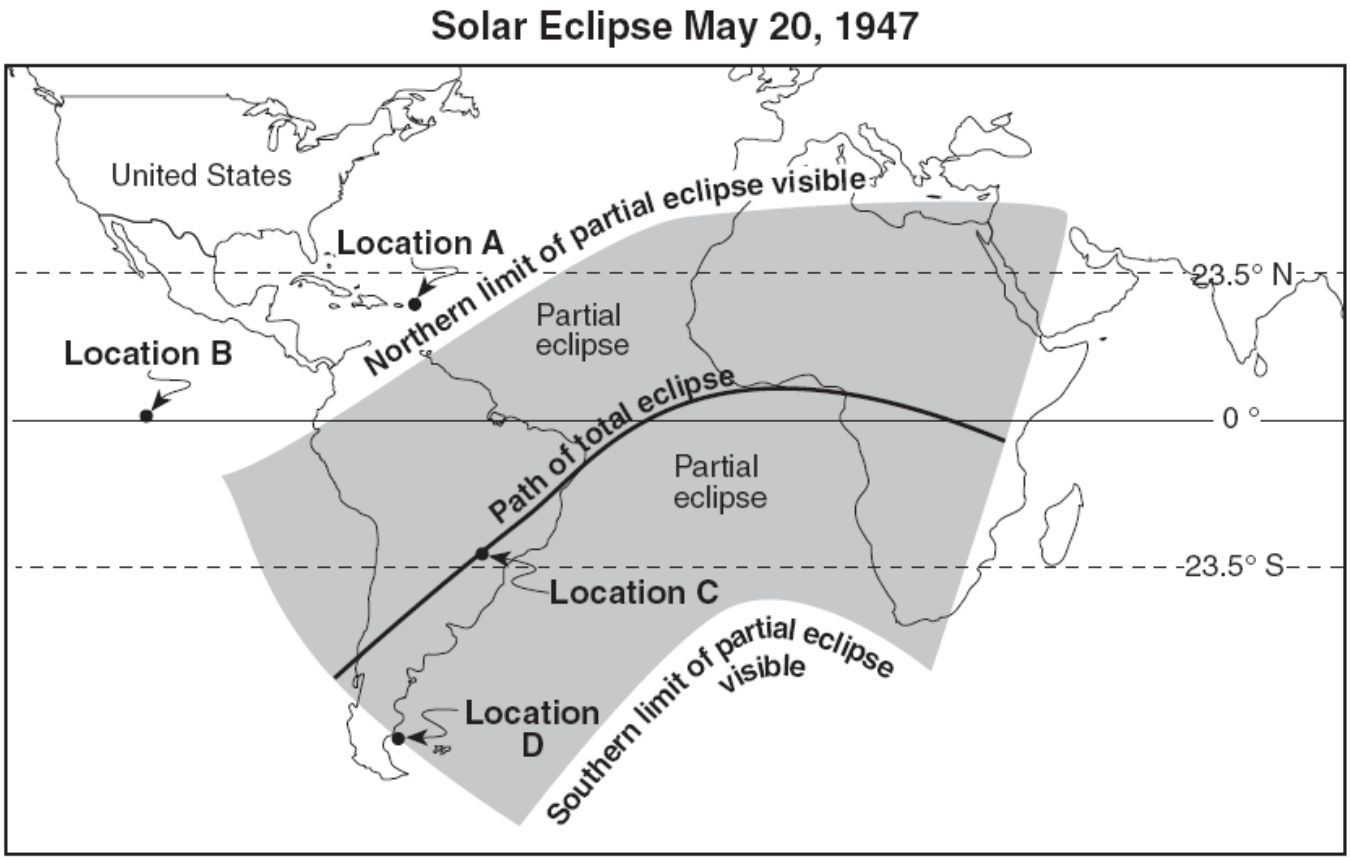
____9. Which inference about tides is best made from this graph?
(1) The hourly rate of tidal change is always the same.
(2) The rate of tidal change is greatest at high tide.
(3) The tidal change is a random event.
(4) The tidal change is cyclic.

____10. According to the pattern shown on the graph, the next high tide will occur on the following day at approximately
(1) 12:30 a.m. (2) 3:15 a.m. (3) 2:00 a.m. (4) 4:00 a.m.

____11. Ocean tides are best described as
(1) unpredictable and cyclic
(2) predictable and cyclic
(3) unpredictable and noncyclic
(4) predictable and noncyclic

.

Base your answers to questions 12 through 13 on the world map below, which shows regions of Earth where a solar eclipse was visible on May 20, 1947. Locations *A*, *B*, *C*, and *D* are on Earth's surface.



____12. At which location could an observer have viewed this total solar eclipse if the skies were clear?
(1) *A* (2) *B* (3) *C* (4) *D*

____13. Which statement best describes the visibility of this eclipse from locations in New York State?
(1) A total eclipse was visible all day.
(2) A total eclipse was visible only from noon until sunset.
3) A partial eclipse was visible only from noon until sunset.
(4) Neither a partial nor a total eclipse was visible.

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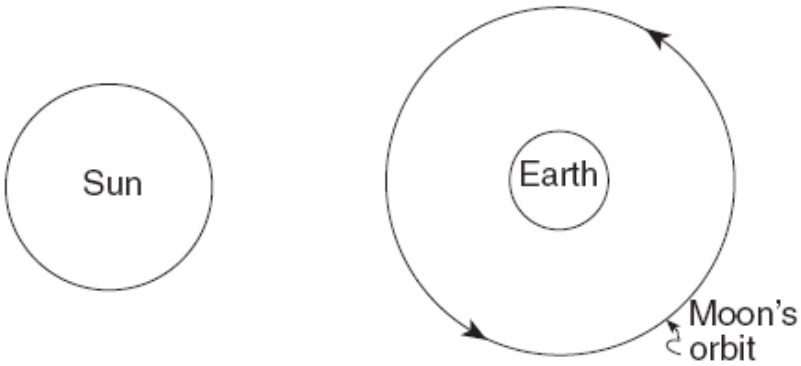
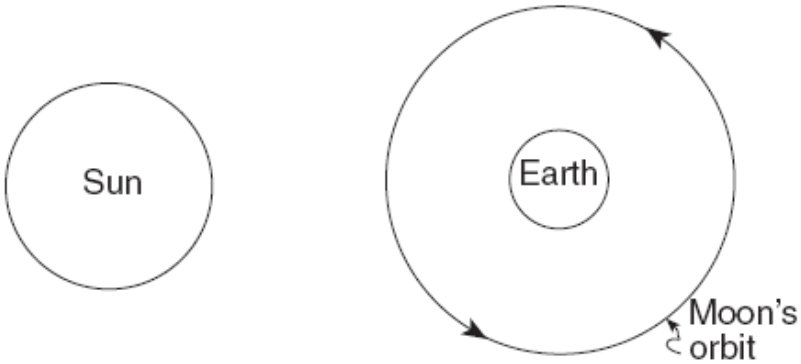
14. On the diagram provided *below,* draw a circle of approximately this size ◯ to represent the Moon's position in its orbit when a solar eclipse is viewed from Earth.



(Not drawn to scale)

What moon phase is it when a solar eclipse occurs? _____

15. On the diagram provided *below,* draw a circle of approximately this size ◯ to represent the Moon's position in its orbit when a lunar eclipse is viewed from Earth.



(Not drawn to scale)

What moon phase is it when a lunar eclipse occurs? _____

16. Approximately how many complete revolutions does the Moon make around Earth each month? _____

17. Explain why solar eclipses do not occur every time the Moon revolves around Earth

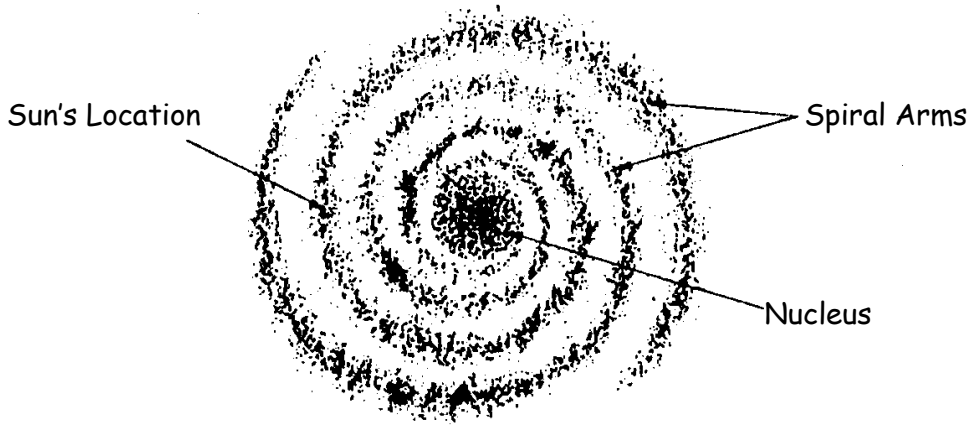
_____

_____

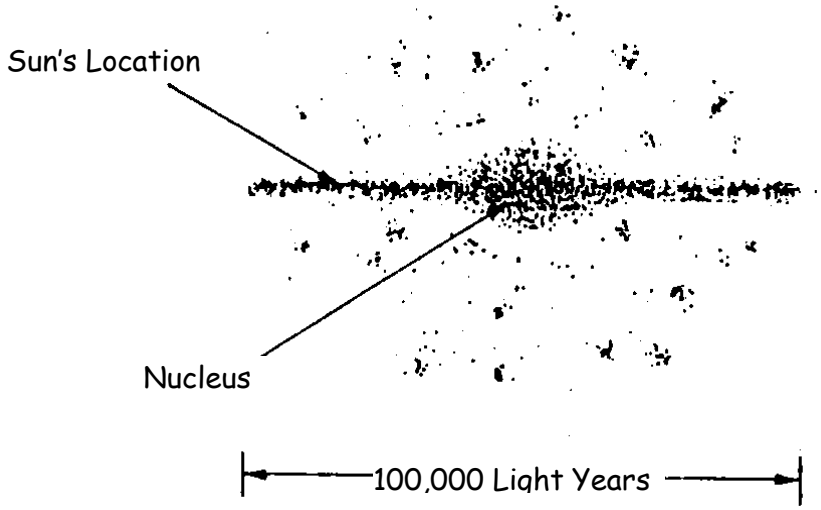
Mini Lesson 4: Galaxy

A galaxy is a huge system that includes billions of stars, planets, moons and all other space matter that is held together by gravitational attraction. Our solar system is located in a spiral galaxy, the Milky Way. It is located in one of the spiral arms.

Top View



Side View



Need to know:

1. What is a galaxy made up of ? _____

   _____

2. What is the name of our galaxy? _____
3. What kind of a galaxy do we live in? _____
4. Where is our solar system located within the galaxy? _____

   _____

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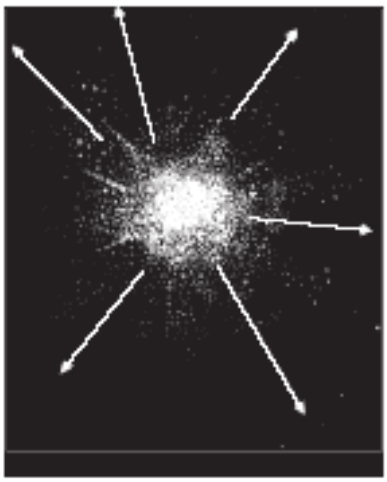
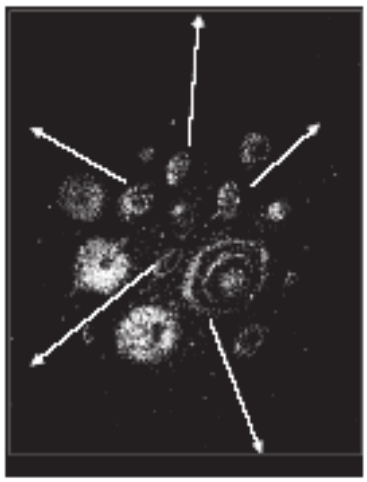
Mini Lesson 5: Universe

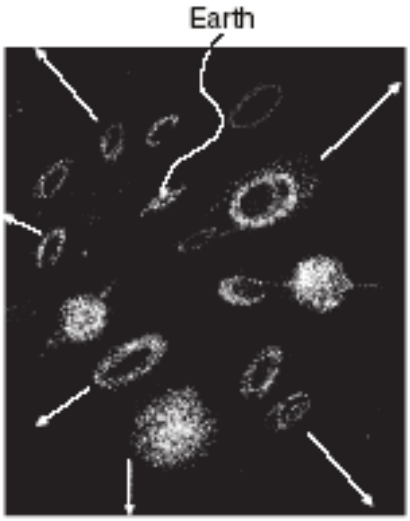
The Universe includes everything that exists from the smallest object to the largest Galaxies. It is believed that about 15 billion years ago a massive explosion took place and started the formation of the universe. This is called the Big Bang Theory. Radioactive aftermath of the initial explosion (background radiation) and the red shift of galaxies along with the fact that the universe is still expanding in every direction is evidence that supports this theory. The diagram below illustrates three stages of a current theory of the formation of the universe.



Stage 1
A ball of hydrogen exploded.



Stage 2
A huge hydrogen cloud moved outward with cloud parts condensing to form galaxies.



Stage 3
The galaxies continue to move outward.

Need to know:

1. How old is the universe? _____
2. What is the name of the theory that explains the origin of the universe?

   _____

3. List three pieces of evidence that supports this theory.

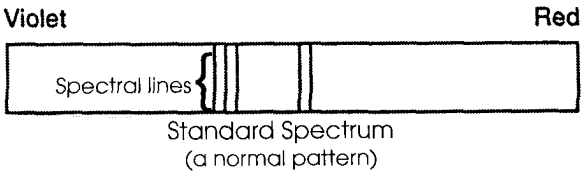
   _____

   _____

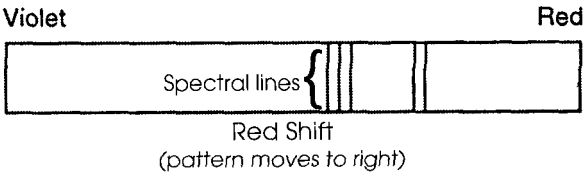
   _____

Spectral lines :

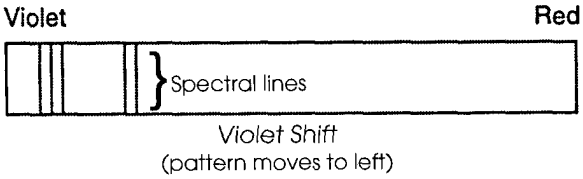
The separation of different colors based on wavelengths.



Red shift: objects moving away
- The farther away an object moves the more the wavelength is stretched out.



Blue shift: objects moving towards us
- The closer object moves the more the wavelength is decreased



Regents questions

____1. A major piece of scientific evidence supporting this theory is the fact that wavelengths of light from galaxies moving away from Earth in stage 3 are observed to be
(1) shorter than normal (a red shift)
(2) shorter than normal (a blue shift)
(3) longer than normal (a red shift)
(4) longer than normal (a blue shift)

____2. In a Doppler red shift, the observed wavelengths of light from distant celestial objects appear closer to the red end of the spectrum than light from similar nearby celestial objects. The explanation for the red shift is that the universe is presently
(1) contracting, only
(2) expanding, only
(3) remaining constant in size
(4) alternating between contracting and expanding

____3. Large craters found on Earth support the hypothesis that impact events have caused
(1) a decrease in the number of earthquakes and an increase in sea level
(2) an increase in solar radiation and a decrease in Earth radiation
(3) the red shift of light from distant stars and the blue shift of light from nearby stars
(4) mass extinctions of life-forms and global climate changes

____4. The red shift of visible light waves that is observed by astronomers on Earth is used to determine the
(1) sizes of nearby galaxies
(2) relative motions of distant galaxies
(3) densities of the planets
(4) rotation periods of the planets

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____5. What does a red shift in light from distant celestial objects indicate to a scientist on Earth?
(1) The gravitational force on Earth changes.
(2) The universe appears to be expanding.
(3) The Jovian planets are aligned with the Sun.
(4) Galaxies are becoming more numerous.

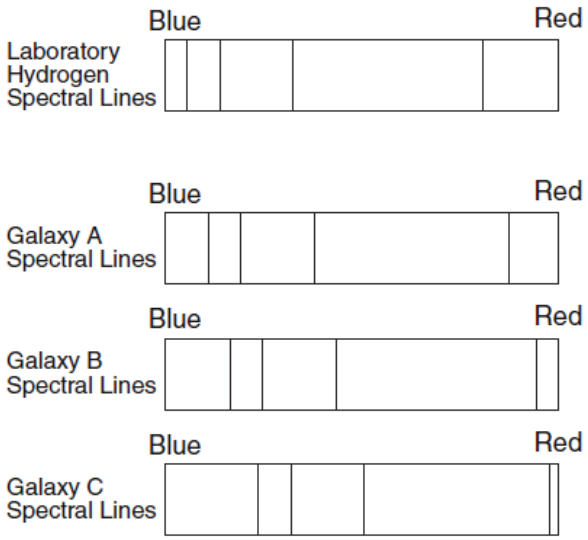
____6. Evidence that the universe is expanding is best provided by the
(1) red shift in the light from distant galaxies
(2) change in the swing direction of a Foucault pendulum on Earth
(3) parallelism of Earth's axis in orbit
(4) spiral shape of the Milky Way Galaxy

____7. The theory that the universe is expanding is supported by the
(1) blue shift of light from distant galaxies
(2) red shift of light from distant galaxies
(3) nuclear fusion occurring in the Sun
(4) radioactive decay occurring in the Sun

____8. When viewed from Earth, the light from very distant galaxies shows a red shift. This is evidence that these distant galaxies are
(1) revolving around the Sun (3) moving away from Earth
(2) revolving around the Milky Way (4) moving toward Earth

____9. Based on the red-shift data on galaxies, most astronomers infer that the universe is currently
(1) expanding (2) contracting (3) moving randomly (4) fixed and stationary

In the diagram to the right, the spectral lines of hydrogen gas from three galaxies, *A, B,* and *C,* are compared to the spectral lines of hydrogen gas observed in a laboratory.



____10. What is the best inference that can be made concerning the movement of galaxies *A, B,* and *C*?
(1) Galaxy *A* is moving away from Earth, but galaxies *B* and *C* are moving toward Earth.
(2) Galaxy *B* is moving away from Earth, but galaxies *A* and *C* are moving toward Earth.
(3) Galaxies *A, B,* and *C* are all moving toward Earth.
(4) Galaxies *A, B,* and *C* are all moving away from Earth.

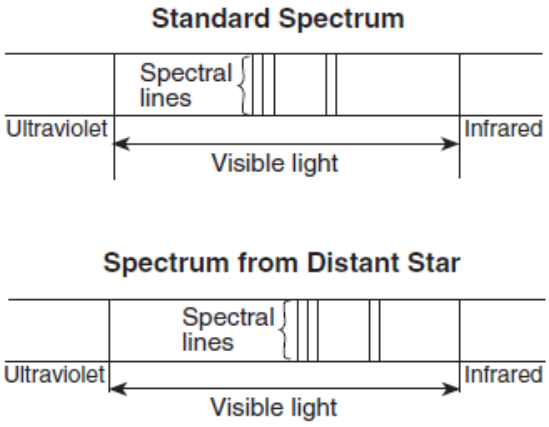
_____11. The diagram below shows a standard spectrum compared to a spectrum produced from a distant star. Which conclusion can be made by comparing the standard spectrum to the spectrum produced from this distant star?

(1) The star's spectral lines have shifted toward the ultraviolet end of the spectrum and the star is moving toward Earth.

(2) The star's spectral lines have shifted toward the ultraviolet end of the spectrum and the star is moving away from Earth.

(3) The star's spectral lines have shifted toward the infrared end of the spectrum and the star is moving toward Earth.

(4) The star's spectral lines have shifted toward the infrared end of the spectrum and the star is moving away from Earth.



_____12. Astronomers viewing light from distant galaxies observe a shift of spectral lines toward the red end of the visible spectrum. This shift provides evidence that

(1) orbital velocities of stars are decreasing

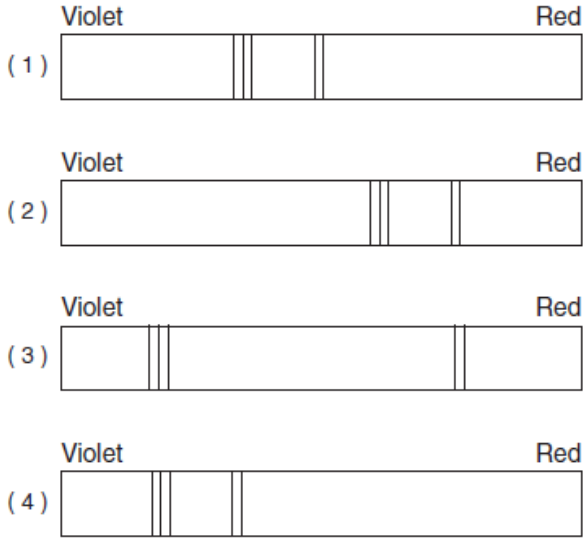
(2) Earth's atmosphere is warming

(3) the Sun is cooling

(4) the universe is expanding

_____13. The diagram below shows the spectral lines for an element.

Which diagram best represents the spectral lines of this element when its light is observed coming from a star that is moving away from Earth?



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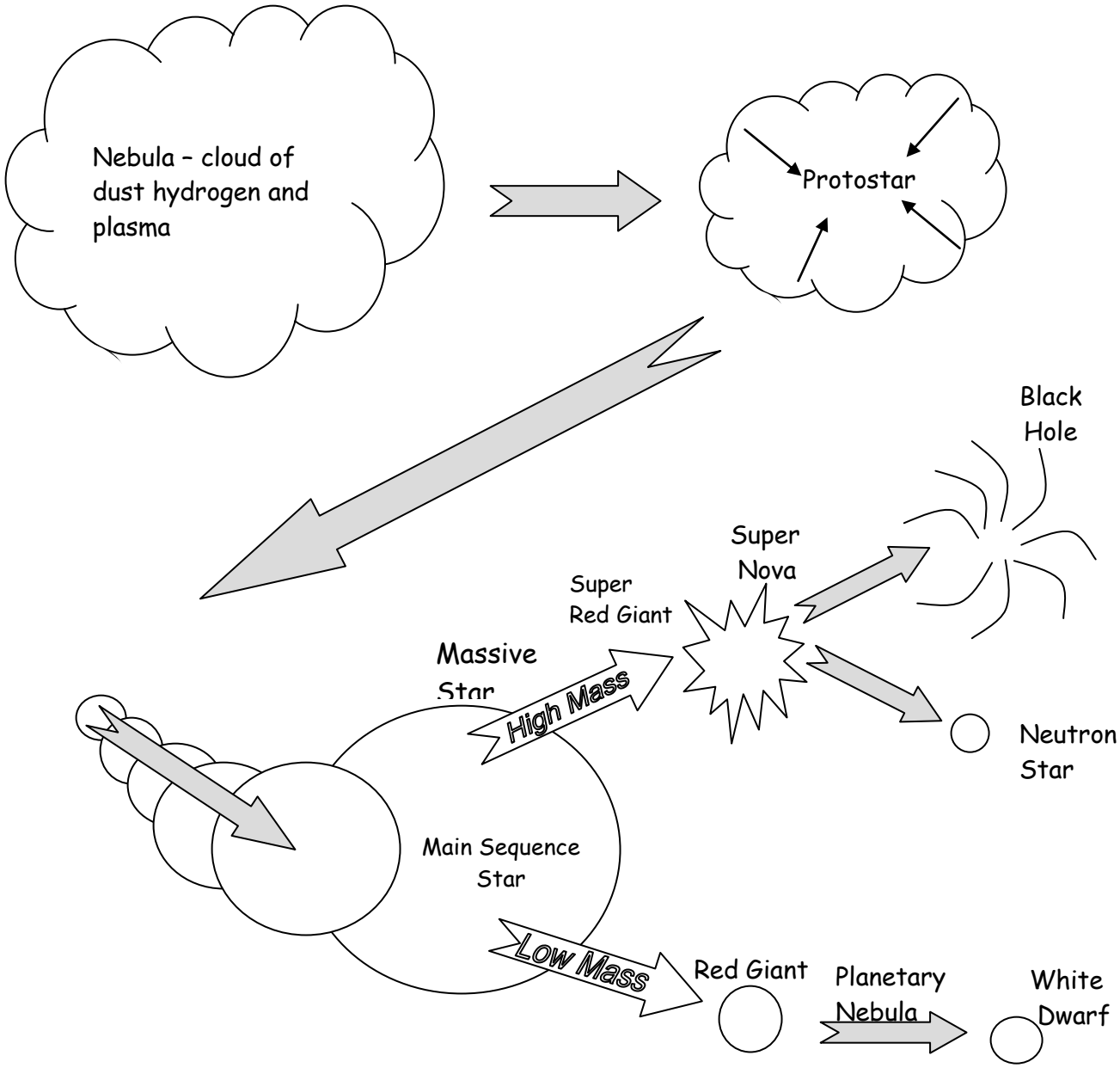
Mini Lesson 6: Stars

Stars start out is a nebula which is a massive cloud of dust, hydrogen and plasma.
Due to gravitational attraction the cloud collapses and temperature increases significantly, nuclear fusion is taking place where hydrogen is becoming helium. A protostar forms. Stars become either main sequence or massive.
Stars differ from each other in mass, weight, size, temperature and brightness. Our Sun is an average size star located in the main sequence. Classification of stars is based on temperature and brightness. Luminosity is relative to the sun.



- Einar Hertzsprung and Henry Russell developed a graph called the H-R Diagram. It compares the spectral class color and temperature of a star against their luminosity.

1. Within what area on the diagram is the Sun located? _____
2. Name the star that has a similar temperature and luminosity as the Sun

   _____
3. What does Polaris and the Sun have in common? _____
4. What is the name of the hottest star located on the Diagram? _____
5. What is the name of the brightest star located on the Diagram? _____
6. Name two Red Dwarf _____ and _____
7. Name a White Dwarf _____
8. What is the approximate temperature of Rigel? _____ °K

Extra Astronomical Information

Sunspots are areas on the Sun's surface that has lower temperatures than the rest of the Sun. They appear to be dark spots because they are cooler. They can cause disruption of air line communication, GPS signals, and problems with cell phones.

Speed of light is 299,792,458 meters per second. A light year is the distance light can travel in one year. When you see the light of distance stars you are gazing at the past because it takes millions of year to reach Earth. The star may not even be there anymore.

A meteor is a streak of light in the sky that occurs when a meteoroid enters Earth's atmosphere. Many people believe them to be shooting stars, however stars are so far away they cannot move that quickly across the night sky. A meteorite is a meteor that reaches Earth's surface.

Comets are huge balls of ice that revolve around the Sun. When they are close to the Sun they exhibit a tail.

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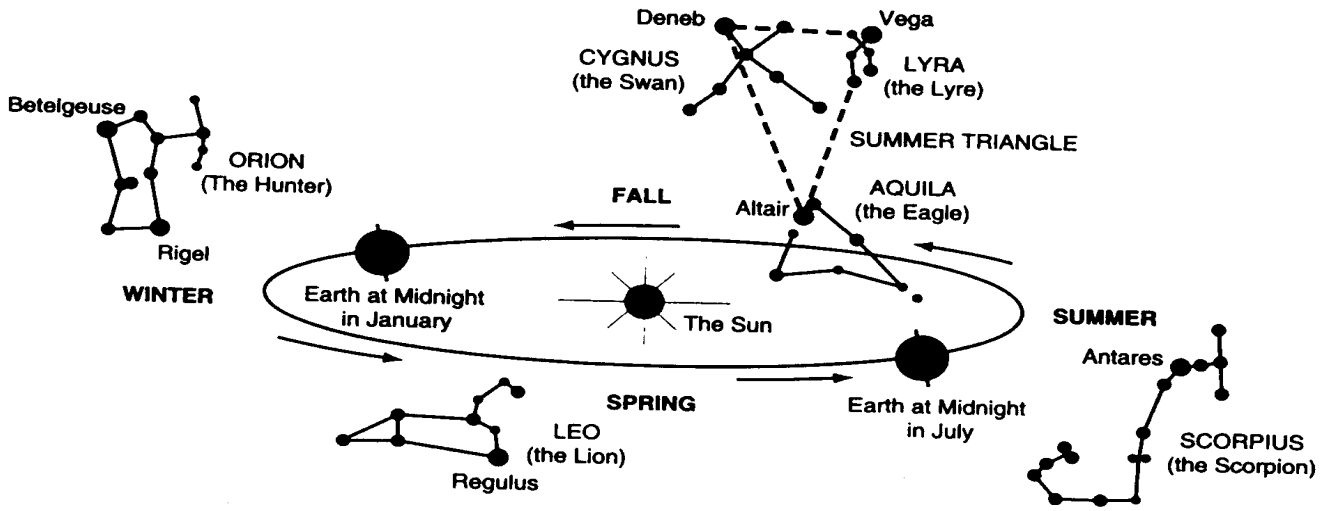
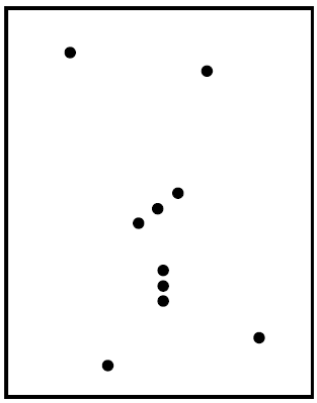
Constellations

Constellations are random patterns of stars in the night sky. Different constellations are visible at different times of the year The big dipper is always visible in the northern sky in New York State evidence of revolution.



____ 1. The diagram to the right represents the major stars of the constellation Orion, as viewed by an observer in New York State.



Which statement best explains why Orion can be observed from New York State on December 21 but not on June 21?
(1) Orion has an eccentric orbit around Earth.
(2) Orion has an eccentric orbit around the Sun.
(3) Earth revolves around the Sun.
(4) Earth rotates on its axis.

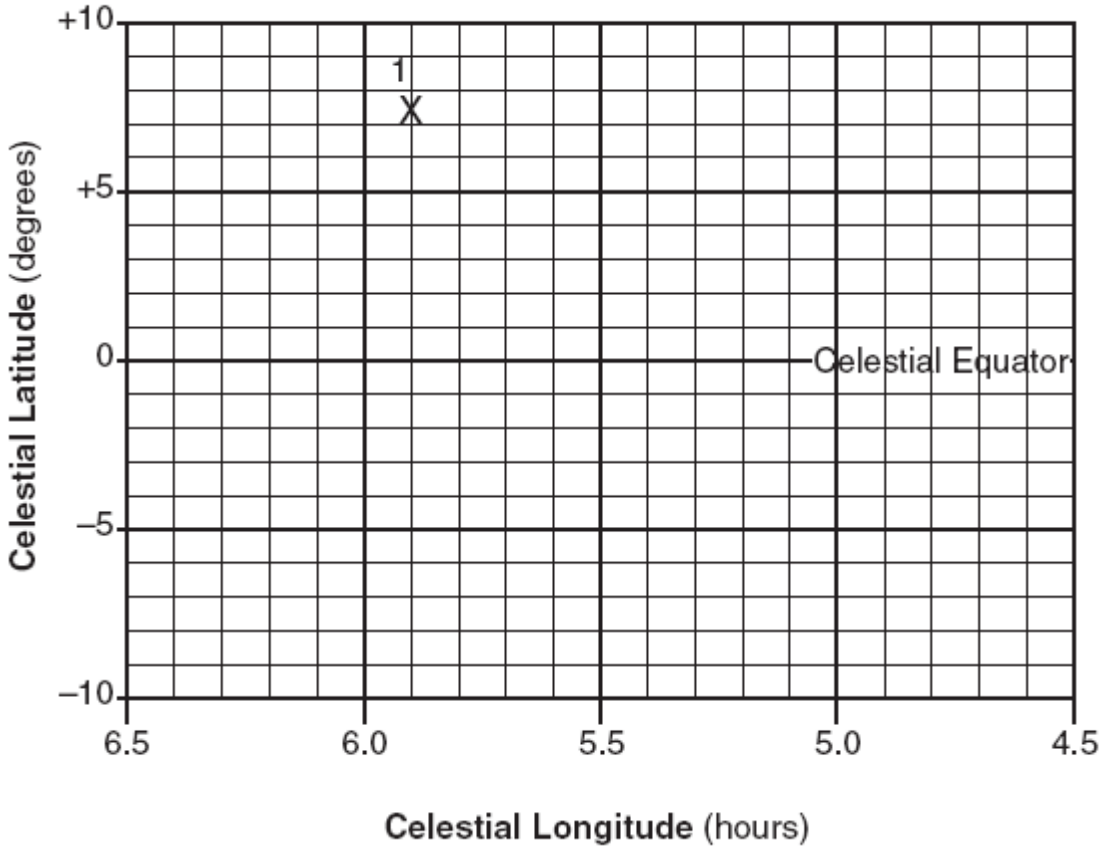
____ 2. Which event is a direct result of Earth's revolution?
(1) the apparent deflection of winds
(2) the changing of the Moon phases
(3) the seasonal changes in constellations viewed in the night sky
(4) the daily rising and setting of the Sun

____ 3. In New York State, the constellation Pisces can be seen in the night sky between the middle of summer and the middle of winter. The constellation Scorpio can be seen in the night sky between early spring and early fall. The reason these two constellations can be viewed only at these times is a direct result of Earth's
(1) spin on its axis
(2) axis having a 23.5° tilt
(3) movement around the Sun
(4) distance from the Sun

Base your answers to questions 4 through 7 on your knowledge of Earth science and on the table below, which lists the seven brightest stars, numbered 1 through 7, in the constellation Orion. This constellation can be seen in the winter sky by an observer in New York State. The table shows the celestial coordinates for the seven numbered stars of Orion.

Locations of the Seven Brightest Stars I Orion		
Star Number	Celestial Longitude (measured in hours)	Celestial Latitude (measured in degrees)
1	5.9	+7.4
2	5.4	+6.3
3	5.2	-8.2
4	5.8	-9.7
5	5.7	-1.9
6	5.6	-1.2
7	5.5	-0.3

4. On the grid provided below, graph the data shown in the table by following the steps below.
   a Mark with an **X**, the position of *each* of the seven stars. Write the number of the plotted star beside each **X**. The first star has been plotted for you.
   b Show the apparent shape of Orion by connecting the **X**s in the following order:
   5 – 1 – 2 – 7 – 3 – 4 – 5 – 6 – 7



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5. Star 1 plotted on the grid is the star *Betelgeuse*. Star 3 plotted on the grid is the star *Rigel*. How do the temperature and luminosity of *Betelgeuse* compare to the temperature and luminosity of *Rigel* ? _____

6. The seven stars of the constellation Orion that were plotted are located within our galaxy. Name the galaxy in which the plotted stars of Orion are located. _____

7. State one reason why an observer in New York State can never observe the constellation Orion at midnight during July but can observe the constellation Orion at midnight during January.

_____

Base your answers to questions 8 through 10 on Diagram 1 and Diagram 2 *below,* which show some constellations in the night sky viewed by a group of students. Diagram 1 below shows the positions of the constellations at 9:00 p.m. Diagram 2 *below* shows their positions two hours later.

Diagram 1 — 9:00 p.m.

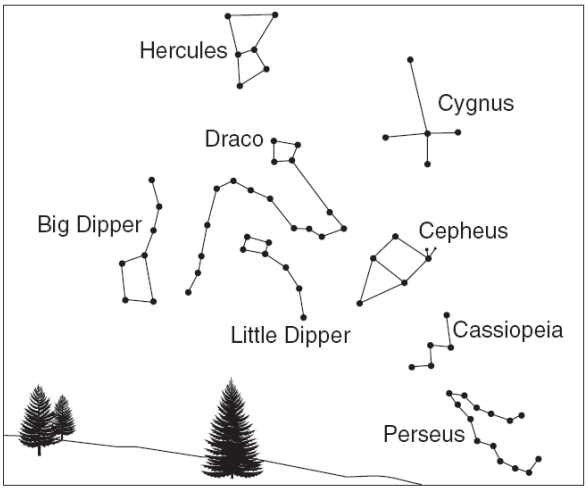
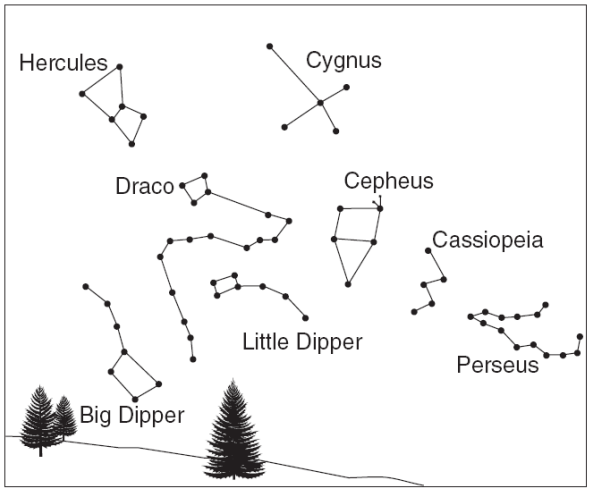


Diagram 2 — 11:00 p.m.



8. On both diagrams, extend an arrow through the "pointer stars on the Big Dipper to locate *Polaris.* Then circle *Polaris* on each diagram.

9. In which compass direction were the students facing? _____

10. Describe the apparent direction of movement of the constellations Hercules and Perseus during the two hours between student observations.

_____

____ 11. Which statement provides evidence that Earth revolves around the Sun?
(1) Winds at different latitudes are curved different amounts by the Coriolis effect.
(2) Different star constellations are visible from Earth at different seasons of the year.
(3) The Sun follows an apparent arc across the sky during the day.
(4) The stars appear to circle Earth during the night.

____ 12. In October, observers in New York State looking due south at the night sky would see a different group of constellations than they had seen in March. What is the best explanation for this change in the night sky?
(1) Constellations revolve around Earth.
(2) Constellations revolve around the Sun.
(3) The Sun revolves around the center of our galaxy.
(4) Earth revolves around the Sun.

Base your answers to questions 13 through 15 on the passage below and on your knowledge of Earth science.

Great Balls of Fire

The Earth's predicted near-miss with asteroid XF11 in the year 2028 has once again focused attention on the fear that a large asteroid or comet hitting our planet could trigger a global catastrophe. To back this up, every article and television program about XF11 boldly asserted that the dinosaur extinction was caused by a giant asteroid impacting into the Earth 65 million years ago. This has typically been accompanied by a picture of frightened dinosaurs looking skyward at a huge flaming meteorite streaking across the horizon. This scenario is so widely accepted that few commentators bother to question it any more. There is, however, much evidence to suggest that an asteroid may not have hit the Earth 65 million years ago and that, even if it did, it did not cause the mass extinction of life attributed to it. There is also the possibility that dinosaurs may not have been around to witness it!

by Paul Chambers
http://www.forteantimes.com/articles/111_asteroid.shtml (6/98)

13. If an asteroid struck Earth 65 million years ago, what surface feature was most likely created by this asteroid impact? _____

14. Identify *one* geologic process occurring on Earth that could have hidden or even destroyed this inferred impact feature. _____

15. Explain how an asteroid impact may have been able to cause a worldwide mass extinction of dinosaurs. _____

_____

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