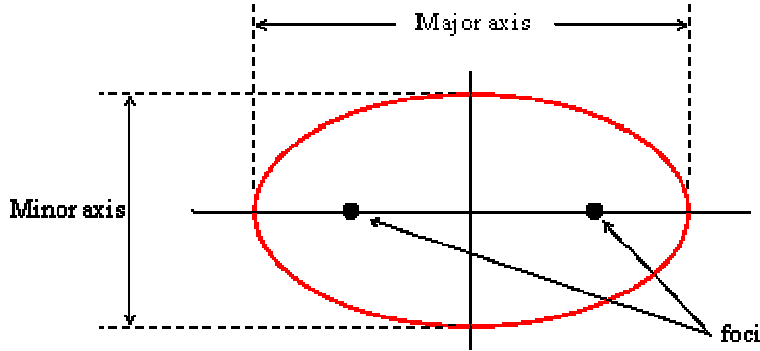


**AIM 2: What are the geometry of orbits and the force of gravity?**

**HW**

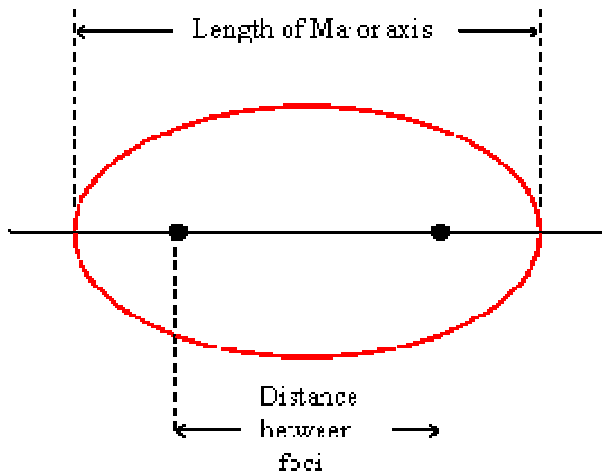
- Read “The Geometry of Orbits” p231&232
- Read “The Force of Gravity” p232&233

An orbit is an ellipse. An ellipse is defined by two fixed points called foci (singular: focus) that lie on either side of the center of the major axis.



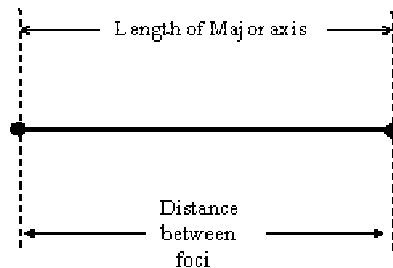
The shape of an ellipse is defined as its eccentricity. See reference table for equation.

$$\text{eccentricity} = \frac{\text{distance between the foci}}{\text{length of the major axis}}$$



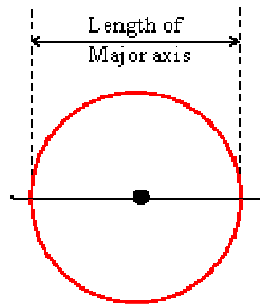
At one extreme, when the length of major axis is equal to the distance between foci, eccentricity is 1 and the ellipse is a line.

Ex: Eccentricity =  $\frac{3}{3} = 1$

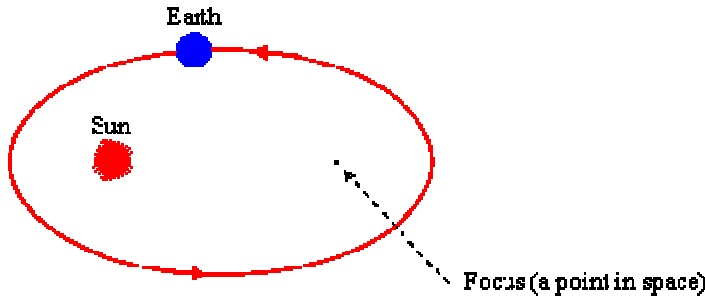


At the other extreme, when the distance between foci is zero, eccentricity is 0 and the ellipse is a circle.

Ex: Eccentricity =  $0/3 = 0$



Earth orbits (moves along an elliptical path) around the Sun which is located at one of the foci. The Earth is called a satellite and the Sun its primary.



Gravity is a force of attraction between objects.

- Gravity is the force that holds the planets and other objects in the solar system in their orbits.
- Gravity increases when distance between the two object decreases and when the product of the masses increases.

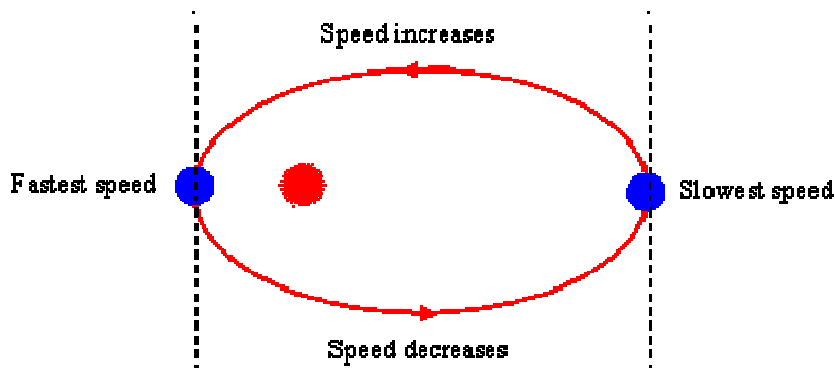
$$\text{Gravity} = \frac{(m_1 m_2)}{d^2}$$

$m_1$  = mass of object 1

$m_2$  = mass of object 2

$d$  = distance between the two objects

A satellite moves faster when it is near its primary and slower when it is farther away.



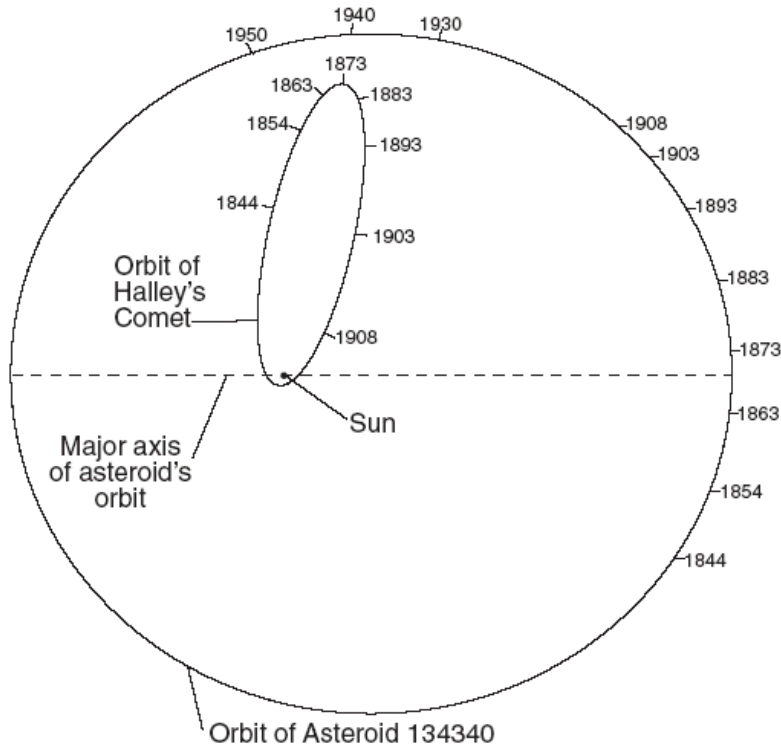
**TEST YOUR UNDERSTANDING**

8/07

4 Approximately how many degrees per day does Earth revolve in its orbit around the Sun? (1)  $1^\circ$  (2)  $13^\circ$  (3)  $15^\circ$  (4)  $23.5^\circ$

Base your answers to questions 65 through 67 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.

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



66 Determine which was traveling faster, Halley's Comet or the asteroid, between the years 1903 and 1908. State *one* reason for your choice.

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

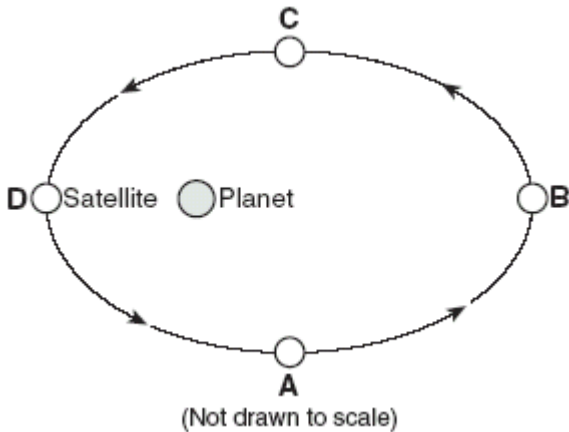
1/07

3 What is the main reason that the gravitational attraction between Earth and the Moon changes each day?

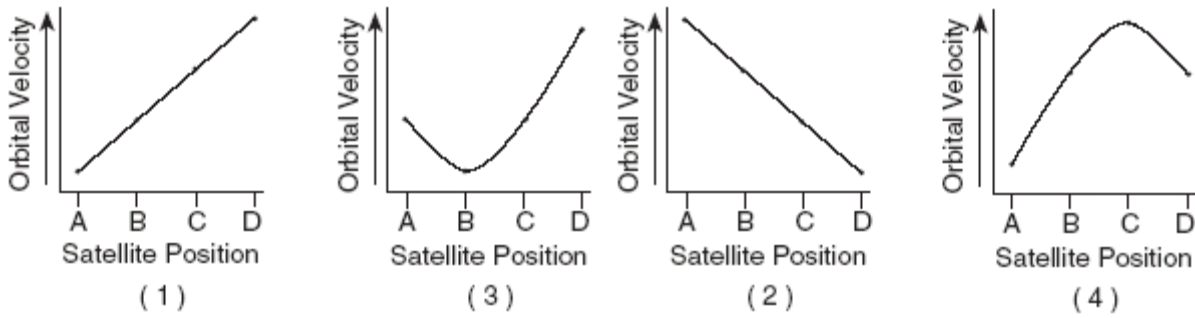
- (1) Earth's axis is tilted at  $23.5^\circ$ .
- (2) Earth's rotational speed varies with the seasons.
- (3) The Moon has an elliptical orbit.
- (4) The Moon has a spherical shape.

1/06

5 The diagram below shows a satellite in four different positions as it revolves around a planet.

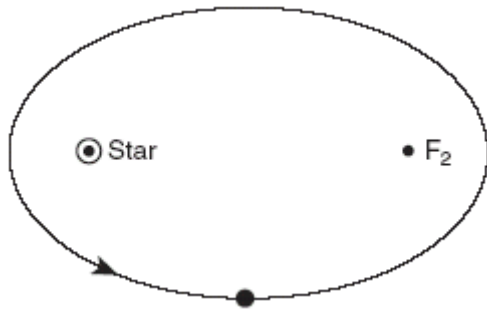


Which graph best represents the changes in this satellite's orbital velocity as it revolves around the planet?



8/06

3 The diagram below shows the elliptical orbit of a planet revolving around a star. The star and  $F_2$  are the foci of this ellipse.



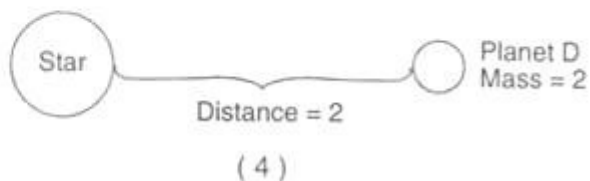
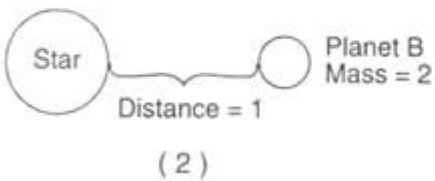
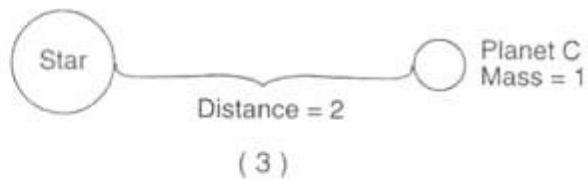
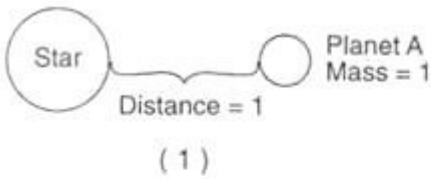
What is the approximate eccentricity of this ellipse? (1) 0.22 (2) 0.47 (3) 0.68 (4) 1.47

6/04

4 Which planet has an orbital eccentricity most like the orbital eccentricity of the Moon?

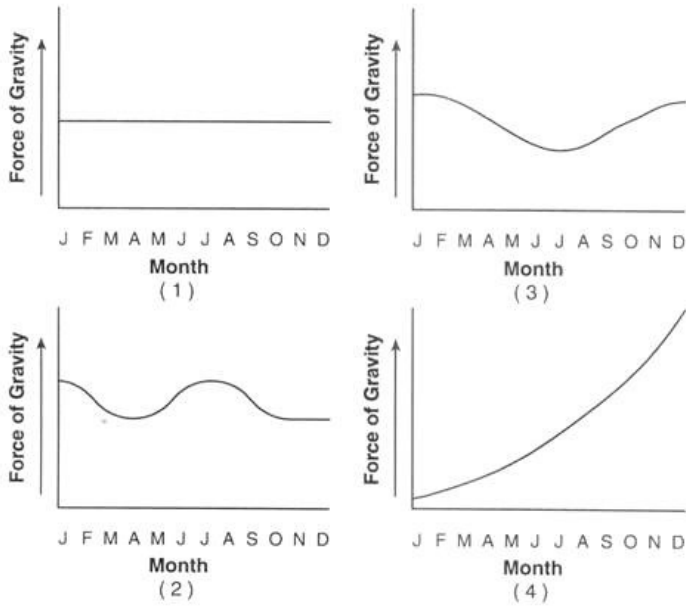
- (1) Pluto (2) Saturn (3) Mars (4) Mercury

18 In each diagram below, the mass of the star is the same. In which diagram is the force of gravity greatest between the star and the planet shown?



1/04

1 Which graph best represents the force of gravity between Earth and the Sun during one revolution of Earth around the Sun?

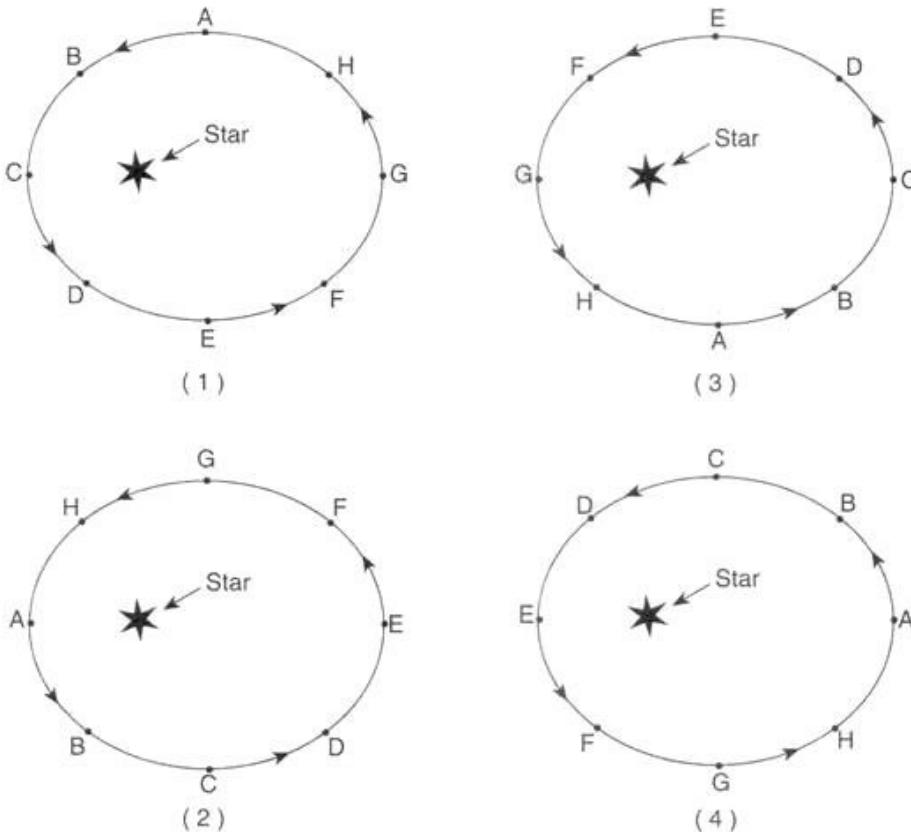


8/03

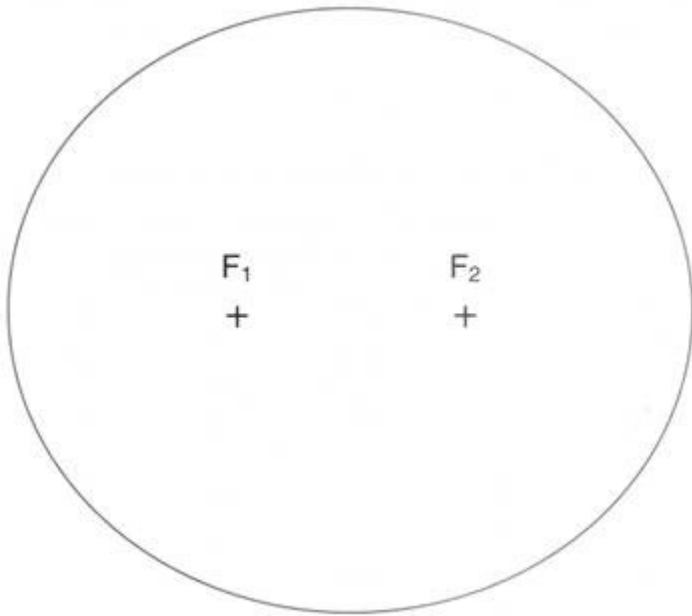
36 The table below shows gravitational data for a planet traveling in an elliptical orbit around a star. The table shows the relative gravitational force between the star and this planet at eight positions in the orbit (letters A through H). Higher numbers indicate stronger gravitational attraction.

Planet's Position in the Orbit	A	B	C	D	E	F	G	H
Relative Gravitational Force Between Star and Planet	52	42	25	12	10	12	25	42

Which diagram best represents the positions of the planet in its orbit that would produce the gravitational forces shown in the data table?



6/03 Base your answers to questions 67 and 68 on the diagram of the ellipse below.



67 Calculate the eccentricity of the ellipse to the nearest thousandth.

68 State how the eccentricity of the given ellipse compares to the eccentricity of the orbit of Mars.

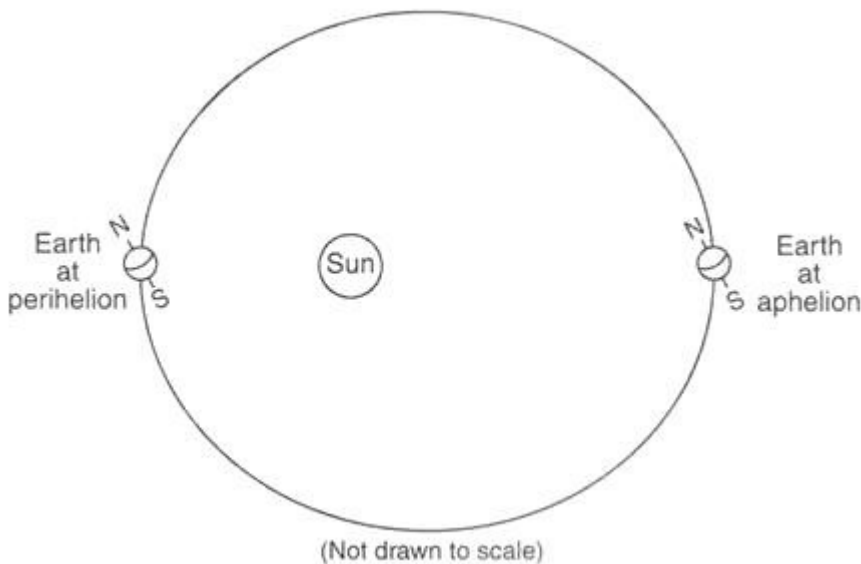
1/03

2. Earth's orbital velocity is slowest on July 5 because

- (1) the Moon is closest to Earth
- (2) Earth's distance from the Sun is greatest
- (3) Earth, the Moon, and the Sun are located along a straight line in space
- (4) the highest maximum temperatures occur in the Northern Hemisphere

8/02

Base your answers to questions 63 through 66 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).



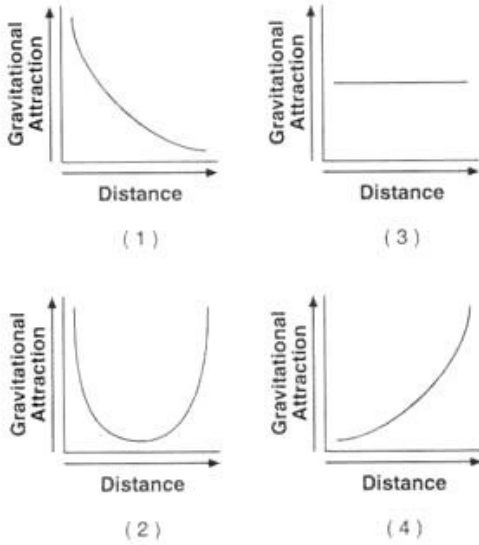
63 State the actual geometric shape of Earth's orbit.

64 identify the season in the Northern Hemisphere when Earth is at perihelion.

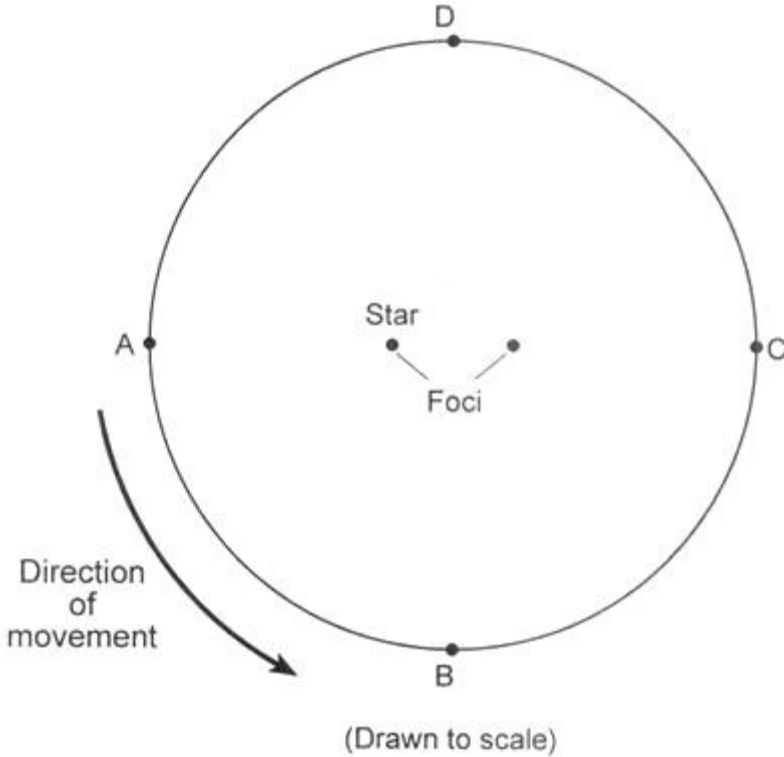
65 Describe the change that takes place in the apparent size of the Sun, as viewed from Earth, as Earth moves from perihelion to aphelion.

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

3 Which graph best represents the change in gravitational attraction between the Sun and a comet as the distance between them increases?



6/02  
Base your answers to questions 36 through 38 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.



- 36 The calculated eccentricity of this orbit is approximately (1) 0.1 (2) 0.2 (3) 0.3 (4) 0.4  
 37 The gravitational attraction between the star and the planet will be greatest at position (1) A (2) B (3) C (4) D  
 38 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

8/01  
6 Which object is located at one foci of the elliptical orbit of Mars? (1) the Sun (2) Betelgeuse (3) Earth (4) Jupiter