

# 8 Study Guide

Use with Chapter 8.

## Universal Gravitation

### Vocabulary Review

Write the term that correctly completes each statement. Use each term once.

black hole	inertial mass	law of universal gravitation
centripetal acceleration	inverse square law	Newton's universal gravitational constant
gravitational field	Kepler's laws of planetary motion	period
gravitational mass		

- \_\_\_\_\_ The behavior of every planet and satellite is described by \_\_\_\_\_.
- \_\_\_\_\_ The \_\_\_\_\_ states that the gravitational force between two objects depends directly on the product of their masses and inversely on the square of the distance between the centers of the masses.
- \_\_\_\_\_ The \_\_\_\_\_ of an object is  $\frac{F_{net}}{a}$ , where  $F_{net}$  is the net force exerted on an object and  $a$  is its acceleration.
- \_\_\_\_\_ The \_\_\_\_\_ of an object is defined as  $\frac{r^2 F_{grav}}{Gm}$  where  $F_{grav}$  is the gravitational force exerted on an object by another object of mass  $m$  at a distance  $r$ , and  $G$  is a universal constant.
- \_\_\_\_\_ The \_\_\_\_\_ is a property of the region surrounding an object, is due to the object's mass, and interacts with other objects, resulting in a force of attraction.
- \_\_\_\_\_ A massive and dense object in which light leaving the object is totally bent back to the object, resulting in no light escaping is a(n) \_\_\_\_\_.
- \_\_\_\_\_ The time needed to repeat one complete cycle of motion is a(n) \_\_\_\_\_.
- \_\_\_\_\_ The direction of \_\_\_\_\_ is toward the center of motion.
- \_\_\_\_\_ A relationship in which one variable is inversely proportional to the square of another variable is the basis of a(n) \_\_\_\_\_.
- \_\_\_\_\_ \_\_\_\_\_ is the same number for any two masses anywhere.

## Section 8.1: Motions in the Heavens and on Earth

In your textbook, read about observed motion and Kepler's laws.

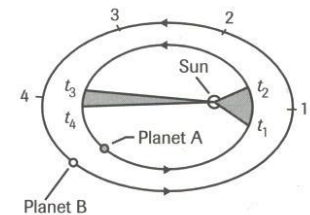
For each statement below, write true or rewrite the italicized part to make the statement true.

- Tycho Brahe believed that Earth was the center of the universe.  
\_\_\_\_\_
- Johannes Kepler believed *the sun* was the center of the universe.  
\_\_\_\_\_
- From studying Brahe's astronomical data, Kepler developed three *physical* laws of planetary motion.  
\_\_\_\_\_
- Kepler's first law states that the paths of the planets are *ellipses*.  
\_\_\_\_\_
- In the first law, *the planet* is located at one focus of the planet's orbit.  
\_\_\_\_\_
- The second law states that an imaginary line extending from the sun to the planet sweeps out equal *distances* in equal times.  
\_\_\_\_\_
- The third law states that the *product* of the squares of the periods of any two planets revolving about the sun is equal to the cube of the ratio of their average distances from the sun.  
\_\_\_\_\_
- Kepler's *first, second, and third* laws apply to each planet, moon, or satellite individually.  
\_\_\_\_\_

In your textbook, read about Kepler's laws.

Refer to the diagram to answer the following questions.

- The shaded portions of planet A's orbit represent areas swept out by an imaginary line from the sun between times  $t_1$  and  $t_2$  and between times  $t_3$  and  $t_4$ . If the time intervals  $t_2 - t_1$  and  $t_4 - t_3$  are equal, what statement can be made about the two shaded areas?  
\_\_\_\_\_  
\_\_\_\_\_



10. At which of the indicated points in planet B's orbit is its speed the greatest?

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11. Io, one of Jupiter's moons, has a period of 1.8 days. What information would you need to apply Kepler's third law to determine how far Io is from the center of Jupiter?

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In your textbook, read about observed motion and universal gravitation. For each term on the left, write the letter of the matching item.

- |   |            |
|---|------------|
| _____ 12. German mathematician who developed three laws of planetary motion   | a. Brahe   |
| _____ 13. Danish astronomer who recorded the exact positions of the planets and stars for over 20 years             | b. Galileo |
| _____ 14. English physicist who proposed that gravitational attraction keeps planets and satellites in their orbits | c. Kepler  |
| _____ 15. Italian scientist who discovered the moons of Jupiter   | d. Newton  |

In your textbook, read about universal gravitation.

Refer to the diagram and complete the table for the new values of distance and mass.

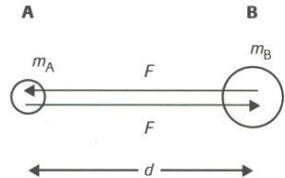


Table 1			
Distance	Mass A	Mass B	Force
16. $d$	$m_A$	$2m_B$	
17. $d$	$2m_A$	$m_B$	
18. $d$	$2m_A$	$2m_B$	
19. $2d$	$m_A$	$m_B$	
20. $d/2$	$m_A$	$m_B$	

Read about universal gravitation and weighing the earth.

Answer the following questions, using complete sentences.

21. What apparatus did Cavendish use to find a value for Newton's universal gravitational constant?

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22. How did Cavendish get an experimental value for gravitational force,  $F$ , to use in Newton's law of gravitational force?

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23. The gravitational force between two 1.00-kg masses whose centers are 1.00 m apart is defined as  $6.67 \times 10^{-11}$  N. Show that the value of Newton's universal gravitational constant is  $6.67 \times 10^{-11} \text{ N}\cdot\text{m}^2/\text{kg}^2$ .

## Section 8.2: Using the Law of Universal Gravitation

In your textbook, read about the motion of planets and satellites.

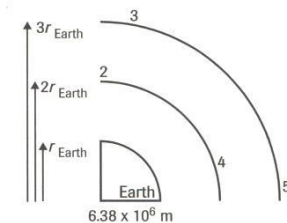
Write the term that correctly completes each statement.

- If a cannonball is fired horizontally from a cannon high atop a mountain, its
- (1) \_\_\_\_\_ has both horizontal and vertical components. During the first second of its flight, the cannonball falls (2) \_\_\_\_\_. If fired at the right horizontal velocity, the cannonball will fall 4.9 m at a point where Earth's surface has curved 4.9 m from the (3) \_\_\_\_\_. Thus, the cannonball is at the same (4) \_\_\_\_\_ above Earth as it was initially. The curvature of the cannonball's path will continue to just match the (5) \_\_\_\_\_ of Earth. As a result, the cannonball is said to be in (6) \_\_\_\_\_. A horizontal speed of 8 km/s will keep the cannonball at the same altitude, and it will circle Earth as an artificial (7) \_\_\_\_\_.

In your textbook, read about the gravitational field.

Refer to the diagram on the right to answer the following questions.

8. Draw the vector representing the direction and magnitude of the gravitational field at each of the points 1–5. Indicate the scale you used. Label each gravitational field vector with its magnitude.
9. What is the weight of a 10.0-kg mass located at point 4?



In your textbook, read about two kinds of masses.

For each term on the left, write the letter of the matching item.

- |   |                                     |
|---|-------------------------------------|
| _____ 10. definition of inertial mass                                     | a. resistance to acceleration       |
| _____ 11. definition of gravitational mass                                | b. principle of equivalence         |
| _____ 12. property of inertial mass                                       | c. $\frac{F_{\text{net}}}{a}$       |
| _____ 13. property of gravitational mass                                  | d. attraction toward other masses   |
| _____ 14. hypothesis that inertial and gravitational masses are identical | e. $\frac{r^2 F_{\text{grav}}}{Gm}$ |

In your textbook, read about Einstein's theory of gravity.  
*Circle the letter of the choice that best completes each statement.*

15. The effect of gravity can be explained by the \_\_\_\_\_.  
a. equivalence principle  
b. gravitational field  
c. general theory of relativity  
d. inertial field
16. The origin of gravity is proposed in \_\_\_\_\_.  
a. the law of universal gravitation  
b. the gravitational field  
c. the general theory of relativity  
d. the inertial field
17. According to Einstein, gravity is \_\_\_\_\_.  
a. an effect of space  
b. a force  
c. a property of mass  
d. energy
18. The mass of an object causes the space around it to become \_\_\_\_\_.  
a. more dense  
b. less dense  
c. heated  
d. curved
19. Objects \_\_\_\_\_ because they follow the shape of the space surrounding a massive object.  
a. are repulsed  
b. become visible  
c. lose mass  
d. undergo accelerations
20. The effect of mass on space \_\_\_\_\_.  
a. accounts for the deflection of light by massive objects  
b. explains the existence of black holes  
c. models gravitational attraction  
d. all of these