Name _____ **Period** _____

Circular Motion and Universal Gravitation
STUDY GUIDE

Vocabulary: *Define the following terms.* SEE NOTES FOR DEFINITONS.

1. uniform circular motion
2. radius
3. circumference
4. tangent line
5. period
6. centripetal acceleration
7. centripetal force
8. Law of Universal Gravitation

Concept Questions: *Answer the following questions.*

9. Where do the acceleration and the force of an object in uniform circular motion always point?
   Both the force and acceleration are directed toward the center of the circle.
10. You are whirling a ball around tied to a string in a horizontal circle. Describe the motion of the ball if the string suddenly broke.
    The ball would fly off tangent to the circular path then follow a parabolic trajectory to the ground.
11. You are whirling a ball around tied to a string in a horizontal circle. What would happen to the tension in the string if the mass was tripled?
    If the mass is tripled, the tension of the string would also triple.
12. You are whirling a ball around tied to a string in a horizontal circle. What would happen to the tension in the string if you whirled the ball faster?
    If the ball moves faster, the tension will increase.
13. When a car rounds a corner on the road, what provides the centripetal force?
    When a car rounds a corner on the road, friction provides the centripetal force.
14. What causes you to slide to the left when riding in a bus and it suddenly turns to the right?
    Inertia (Newton's 1^{st} Law) explains why you slide to the left when the bus suddenly to the right.
15. On a merry-go-round, where would you have the greatest speed, near the center of the platform or near the edge?
    You have the greatest speed near the edge of the platform because there is a greater distance to cover.

Problem Solving: *Solve the following problems paying attention to significant figures and units.*

16. A car rounds a curve with a radius of 45.0 m at a speed of 22.0 m/s. What is the centripetal acceleration of the car?

$$a_c = 10.8 \text{ m/s}^2$$

17. A 0.50 kg stopper is tied to the end of a 0.80 m long string and is swung in a horizontal circle with a velocity of 3.5 m/s. Find the centripetal acceleration and the centripetal force.

$$a_c = 15 \text{ m/s}^2 \text{ and } F_c = 7.5 \text{ N}$$

18. What is the force of gravity between two objects that both have a mass of 2.0 kg and are 4.0 meters apart?

$$F_g = 1.7 \times 10^{-11} \text{ N}$$

COMPLETE THE BACK OF THIS SHEET

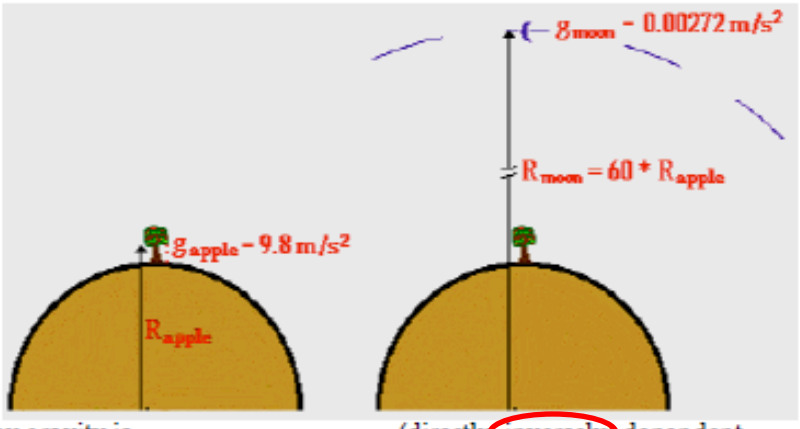
The Inverse Square Law of Universal Gravitation

Read from **Lesson 3** of the **Circular and Satellite Motion** chapter at **The Physics Classroom**:

http://www.physicsclassroom.com/Class/circles/u6l3b.html
http://www.physicsclassroom.com/Class/circles/u6l3c.html

MOP Connection: Circular Motion and Gravitation: sublevels 6 and 7

1. Isaac Newton compared the acceleration of a falling apple to the acceleration of the *falling* moon. In his comparison, he proved that the moon accelerates at a rate that is 1/3600-th of the apple's rate; he also showed that the separation distance (center to center) between the moon and the Earth was 60 times the separation distance between the apple and the Earth. This is evidence that the acceleration caused by gravity is _____ (directly, inversely) dependent upon the _____ (square, square root, cube, cubed root, etc.) of the separation distance.



Use Newton's gravitational law in a conceptual manner in order to fill in the following blanks.

2. Two objects gravitationally attract with a force of 18 N. If the distance between the two objects' centers is doubled, then the new force of attraction is __4.5__ N.

3. Two objects gravitationally attract with a force of 18 N. If the distance between the two objects' centers is tripled, then the new force of attraction is __2__ N.

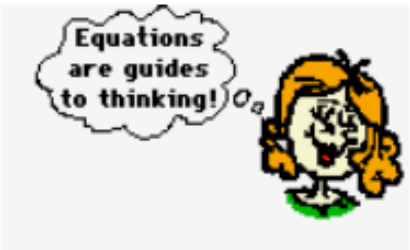
4. Two objects gravitationally attract with a force of 18 N. If the distance between the two objects' centers is halved, then the new force of attraction is __72__ N.

5. Two objects gravitationally attract with a force of 18 N. If the distance between the two objects' centers is decreased by a factor of three, then the new force of attraction is __162__ N.

6. Two objects gravitationally attract with a force of 18 N. If the distance between their centers is decreased by a factor of four, then the new force of attraction is __288__ N.

7. Two objects gravitationally attract with a force of 18 N. If the **mass** of one of the objects is doubled and the **distance** between their centers is doubled, then the new force of attraction is __9__ N.

8. Two objects gravitationally attract with a force of 18 N. If the **masses** of both of the objects are doubled and the **distance** between their centers is doubled, then the new force of attraction is __18__ N.



9. Two objects gravitationally attract with a force of 18 N. If the **masses** of both of the objects are tripled and the **distance** between the two objects' centers is doubled, then the new force of attraction is __40.5__ N.