Physics REVIEW
Circular Motion and Gravitation

$$
a_{c}=\frac{v^{2}}{r} \quad F_{c}=\frac{m v^{2}}{r} \quad F_{g}=G \frac{m_{1} m_{2}}{r^{2}} \quad g=G \frac{m}{r^{2}} \quad \begin{aligned}
& \mathrm{G}=6.67 \cdot 10^{-11} \mathrm{Nm}^{2} / \mathrm{kg}^{2} \\
& \mathrm{~m}_{\mathrm{E}}=5.98 \cdot 10^{24} \mathrm{~kg} \\
& \mathrm{r}_{\mathrm{E}}=6.38 \cdot 10^{6} \mathrm{~m}
\end{aligned}
$$

## TRUE / FALSE

1. $\qquad$ The only reason riders on a tilting rotating platform of a carnival ride don't fall out is because they are strapped in.
2. When an object travels in a circle at constant speed, the acceleration of the object is zero.
3. ___ The gravitational force of Earth on an object does not depend upon the object's mass.
4. ___ Any force that causes an object to move in a circular path is called a centripetal force.
5. ___ The gravitational force on a ball decreases as the ball moves farther from Earth.

## MULTIPLE CHOICE

6. What term describes a change in the speed of an object in circular motion?
a. tangential speed
b. centrifugal acceleration
c. centripetal acceleration
d. centripetal force
7. When a car makes a sharp left turn, what causes the passengers to move toward the right side of the car?
a. centripetal acceleration
b. centripetal force
c. centrifugal force
d. inertia
8. Two small masses that are 10.0 cm apart attract each other with a force of 10.0 N . When they are 5.0 cm apart, these masses will attract each other with what force?
a. 5.0 N
b. 20.0 N
c. 2.5 N
d. 40.0 N
9. What is the centripetal force that holds planets in orbit?
a. inertia
b. gravitational force
c. planetary force
d. friction
10. The force that Earth exerts on the moon
a. is greater than the force the moon exerts on the Earth.
b. is less than the force the moon exerts on Earth.
c. is equal in magnitude to the force the moon exerts on Earth.
11. How does the gravitational force between two objects change if the distance between the objects doubles?
a. The force decreases by a factor of 4
b. The force decreases by a factor of 2
c. The force increases by a factor of 2
d. The force increases by a factor of 4
12. The gravitational force between two masses is 36 N . What is the gravitational force if the distance between them is tripled?
a. 4.0 N
b. 18 N
c. 9.0 N
d. 27 N
13. According to Newton's law of universal gravitation, the force of attraction between any two masses is directly proportional to the
a. velocity of the two masses
b. distance between the masses
c. product of the two masses
d. sum of the two masses
14. As the distance between two bodies increases, the force of attraction between the bodies
a. increases
b. decreases
c. remains the same
15. The centripetal force on an object in circular motion is
a. in the same direction as the tangential speed.
b. in the same direction as the centripetal acceleration.
c. in the direction opposite the tangential speed.
d. in the direction opposite the centripetal acceleration.

## CONCEPTUAL QUESTIONS

16. Discuss the following statement: "A satellite is continually in free fall."
17. Earth exerts a 1.0 N gravitational force on an apple. Does the apple accelerate toward Earth, or does Earth accelerate towards the apple? Explain your answer.
18. Why is centripetal force known as a net force? Give three different examples of objects in circular motion and the force(s) providing the centripetal force.
1) 
2) 
19. Assume two masses, $\mathbf{m}_{\mathbf{a}}$ and $\mathbf{m}_{\mathbf{b}}$, separated by a distance, $\mathbf{d}$, have a gravitational force, $\mathbf{F}$ acting between them. Fill in the values for gravitational force (in terms of multiples of F) when the masses and distance change according to the table.

| Distance | Mass A | Mass B | Force |
| :---: | :---: | :---: | :---: |
| d | $m_{a}$ | $2 m_{b}$ |  |
| $d$ | $2 m_{a}$ | $m_{b}$ |  |
| $d$ | $2 m_{a}$ | $2 m_{b}$ |  |
| $2 d$ | $m_{a}$ | $m_{b}$ |  |
| $d / 2$ | $m_{a}$ | $m_{b}$ |  |
| $d / 3$ | $3 m_{a}$ |  |  |

## CALCULATIONS

20. A car on a roller coaster loaded with passengers has a mass of 2000 kg . At the lowest point of the track, the radius of curvature of the track is 24 m and the roller car has a speed of $17 \mathrm{~m} / \mathrm{s}$. Find the centripetal acceleration of the roller coaster car at the lowest point on the track and the net force on the roller car at this point.
21. What is the speed of a 95 kg fullback who makes a turn on a football field and experiences a centripetal force of 637 N as he moves in a circle that has a radius of 12.0 m .
22. A 0.45 kg ball attached to the end of a 1.3 m cord and swung in a horizontal circle. What is the maximum speed the ball can go if the breaking tension of the string is 75 N .
23. Two trucks with equal mass are attracted to each other with a gravitational force of $6.7 \times 10^{-4} \mathrm{~N}$. The trucks are separated by a distance of 3.0 m . What is the mass of one of the trucks?
24. Two large spheres are suspended close to each other. Their centers are 2.2 m apart. One sphere weighs 920 N . The other sphere has a weight of 149 N . What is the gravitational force between them?
25. What is the force of gravity acting on a $2.00 \times 10^{3} \mathrm{~kg}$ spacecraft when it orbits at a distance equal to two Earth radii from the Earth's center?
26. What must be the speed of a satellite moving in a circular orbit about the Earth at an altitude of 3600 km ?
