Name

UNIT 5: CIRCULAR MOTION

Circular Motion Review Packet
Regents Physics

1. The centers of two 15.0-kilogram spheres are separated by 3.00 meters. The magnitude of the gravitational force between the two spheres is approximately
   1) 1.11 10^{-10} N
   2) 3.34 10^{-10} N
   3) 1.67 10^{-9} N
   4) 5.00 10^{-9} N

$F_g = G\frac{m_1 m_2}{r^2}$

$F_g = \frac{(6.67\times10^{-11}\ N\cdot m^2/kg^2)(15kg)(15kg)}{(3m)^2}$

2. Gravitational force F exists between point objects A and B separated by distance R. If the mass of A is doubled and distance R is tripled, what is the new gravitational force between A and B?
   1) $\frac{2F}{9}$
   2) $\frac{2F}{3}$
   3) $\frac{3F}{2}$
   4) $\frac{9F}{2}$

$F_g = \frac{G m_1 m_2}{r^2}$

$= \frac{(1)(2)(1)}{(3)^2} = \frac{2}{9}$

3. The gravitational force of attraction between two objects would be increased by
   1) doubling the mass of both objects, only
   2) doubling the distance between the objects, only
   3) doubling the mass of both objects and doubling the distance between the objects
   4) doubling the mass of one object and doubling the distance between the objects

$F_g = \frac{G m_1 m_2}{r^2}$

4. Compared to the mass of an object at the surface of the Earth, the mass of the object a distance of two Earth radii from the center of the Earth is
   1) the same
   2) twice as great
   3) one-half as great
   4) one-fourth as great

MASS DOES NOT CHANGE

5. The weight of a 2.0-kilogram mass on planet A is 40 Newtons. The acceleration due to gravity on planet A is closest to
   1) 20 m/s^2
   2) 2.0 m/s^2
   3) 80 m/s^2
   4) 40 m/s^2

$g = \frac{F_g}{m} = \frac{40N}{2kg}$

6. A satellite weighs 200 newtons on the surface of Earth. What is its weight at a distance of one Earth radius above the surface of Earth?
   1) 50 N
   2) 100 N
   3) 400 N
   4) 800 N

$r \rightarrow 2r$

$F_g = \frac{G m_1 m_2}{r^2} = \frac{(1)(1)(1)}{(2)^2} = \frac{1}{4}$

$200N\left(\frac{1}{4}\right) = 50N$

7. What is the magnitude of the gravitational force between an electron and a proton separated by a distance of 1.0 10^{-10} meter?
   1) 1.0 10^{-47} N
   2) 1.5 10^{-46} N
   3) 1.0 10^{-37} N
   4) 1.5 10^{-36} N

FIND ON REF. TABLES

$F_g = \frac{(6.67\times10^{-11})(1.67\times10^{-27})(9.31\times10^{-31})}{(1\times10^{-10})^2}$

8. An astronaut weighs 600 Newtons at the earth's surface. If he doubles his distance from the earth's center, his weight will be
   1) 100 N
   2) 150 N
   3) 300 N
   4) 400 N

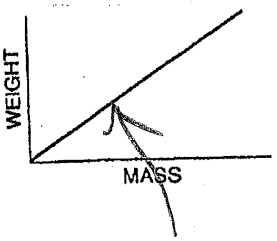
$F_g = \frac{G m_1 m_2}{r^2}$

$= \frac{(1)(1)(1)}{(2)^2} = 1/4$

9. A 3.0-kilogram mass weighs 15 Newtons at a given point in the Earth's gravitational field. What is the magnitude of the acceleration due to the gravity at this point?
   1) 45 m/s^2
   2) 9.8 m/s^2
   3) 5.0 m/s^2
   4) 0.20 m/s^2

$g = \frac{F_g}{m} = \frac{15N}{3kg} = 5\ m/s^2$

10. The graph at the right shows the relationship between weight and mass for a series of objects. The slope of this graph represents



   1) change of position
   2) normal force
   3) momentum
   4) acceleration due to gravity

$m = \frac{\Delta y}{\Delta x} = \frac{F_g}{m} = g$

11. The ratio of an object's weight to its mass is equal to the object's
   1) momentum
   2) inertia
   3) gravitational force
   4) gravitational acceleration

$g = \frac{F_g}{m}$

12. The magnitude of the acceleration due to gravity on the surface of planet A is twice as great as on the surface of planet B. What is the ratio of the weight of mass X on the surface of planet A to its weight on the surface of planet B?
   1) 1:2
   2) 2:1
   3) 1:4
   4) 4:1

$F_g = mg$

$F_g = (1)(2)$

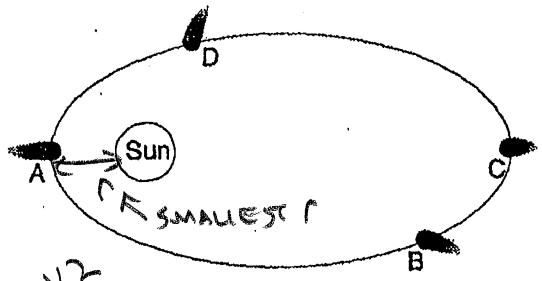
13. A 3.0-kilogram mass is traveling in a circle of 0.20-meter radius with a speed of 2.0 meters per second. What is its centripetal acceleration?
   1) 10. m/s^2
   2) 20. m/s^2
   3) 60. m/s^2
   4) 6.0 m/s^2

$a_c = \frac{v^2}{r} = \frac{(2m/s)^2}{0.2m}$

$a_c = \frac{v^2}{r} = \frac{(2)^2}{1} = 4x$

14. An object travels in a circular orbit. If the speed of the object is doubled, its centripetal acceleration will be
    1) halved
    2) doubled
    3) quartered
    4) quadrupled

15. The diagram below shows the elliptical orbit of a comet around the Sun

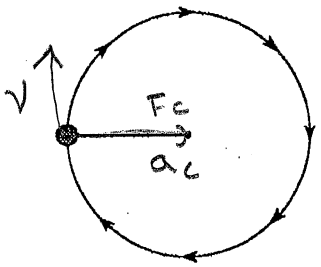


$\uparrow a_c = \frac{v^2}{r\downarrow}$

(not drawn to scale)

The magnitude of the centripetal acceleration of the comet is greatest at point
    1) A
    2) B
    3) C
    4) D

16. The diagram below represents a ball undergoing uniform circular motion as it travels clockwise on a string.



At the moment shown in the diagram, what are the correct directions of both the velocity and centripetal acceleration of the ball?
    1) v ↑ a →
    2) v → a ↑
    3) v ↓ a ←
    4) v → a ↓

17. A ball of mass M at the end of a string is swinging in a horizontal circular path of radius R at constant speed V. Which combination of changes would require the greatest increase in the centripetal force acting on the ball?
    1) doubling V and doubling R
    2) doubling V and halving R
    3) halving V and doubling R
    4) halving V and halving R

$F_c = \frac{mv^2}{r} = \frac{(1)(2)^2}{1/2} = 8x$

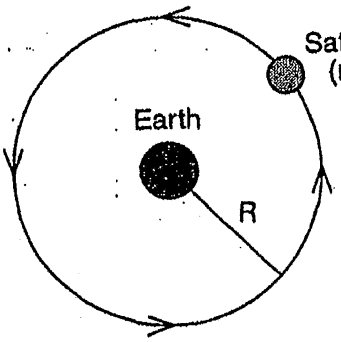
18. A motorcycle of mass 100 kilograms travels around a flat, circular track of radius 10 meters with a constant speed of 20 meters per second. What force is required to keep the motorcycle moving in a circular path at this speed
    1) 200 N
    2) 400 N
    3) 2000 N
    4) 4000 N

$F_c = \frac{mv^2}{r} = \frac{(100)(20)^2}{10}$

19. A motorcycle travels around a flat circular track. If the speed of the motorcycle is increased, the force required to keep it in the same circular path
    1) decreases
    2) increases
    3) remains the same

$\uparrow F_c = \frac{mv^2}{r} = \frac{(1)(\uparrow)^2}{(\uparrow)}$

20. The diagram below shows a satellite of mass m orbiting Earth in a circular path of radius R.



SOLVE FOR v

$F_c = \frac{mv^2}{r}$

$v = \sqrt{\frac{F_c r}{m}}$

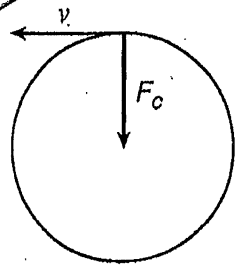
If centripetal force F_c is acting on the satellite, its speed is equal to
    1) $\sqrt{\frac{F_c R}{m}}$
    2) $\frac{F_c R}{m}$
    3) $\sqrt{\frac{F_c m}{R}}$
    4) $F_c m R$

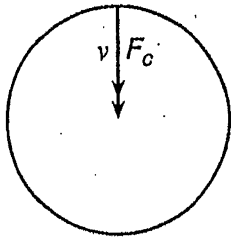
21. As the time taken for a car to make one lap around a circular track decreases, the centripetal acceleration of the car
    1) decreases
    2) increases
    3) remains the same

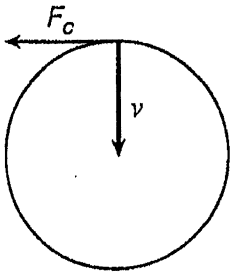
$\uparrow a_c = \frac{v^2}{r} \uparrow$

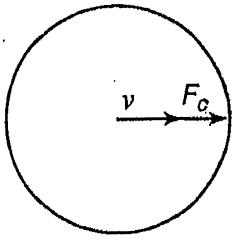
$\uparrow v = \frac{2\pi r}{T\downarrow}$

22. A 1.0 10^3-kilogram car travels at a constant speed of 20. meters per second around a horizontal circular track. Which diagram correctly represents the direction of the car's velocity (v) and the direction of the centripetal force (F_c) acting on the car at one particular moment?

1)


3)


2)


4)


26. The gravitational force of attraction between Earth and the Sun is 3.52×10^{22} newtons. Calculate the mass of the Sun. [Show all work, including the equation and substitution with units.]

FIND GIVENS ON REF. TABS.

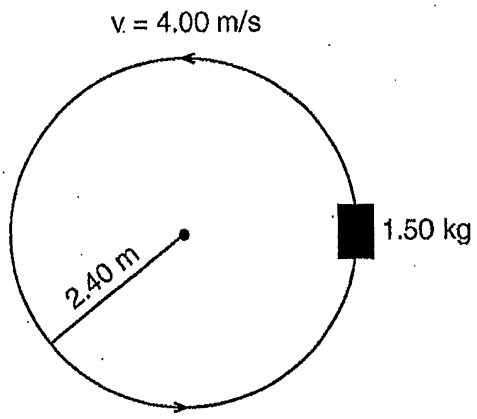
$M = 1.99 \times 10^{30}\ kg$

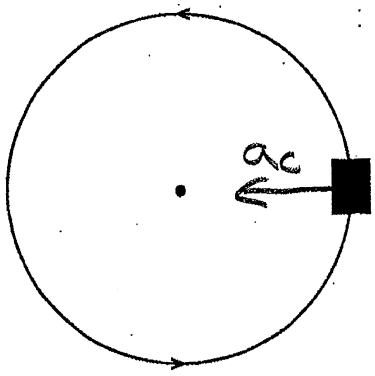
$F_c = \frac{G m_1 m_2}{r^2}$

$m_1 = \frac{F_c r^2}{G m_2} = \frac{(3.5 \times 10^{22}\ N)(1.5 \times 10^{11}\ m)^2}{(6.67 \times 10^{-11}\ \frac{N \cdot m^2}{kg})(5.98 \times 10^{24}\ kg)}$

Base your answers to questions **23** through **25** on the information and digram below.

A 1.50-kilogram cart travels in a horizontal circle of radius 2.40 meters at a constant speed of 4.00 meters per second.





23. Calculate the time required for the cart to make one complete revolution. [Show all work, including the equation and substitution with units.]

$v = \frac{2\pi r}{T} \rightarrow T = \frac{2\pi r}{v} = \frac{2(\pi)(3.14\ m)}{4\ m/s} = 3.75\ s$

24. Describe a change that would quadruple the magnitude of the centripetal force.

$F_c = \frac{mv^2}{r} = \frac{(1)(2)^2}{(1)}$ DOUBLE THE SPEED

25. On the blank circle above, draw an arrow to represent the direction of the acceleration of the cart in the position shown. Label the arrow *a*.

QUESTIONS ON BACK

26. By how much does the gravitational force change if you double the mass of both objects while halving the distance between them?

$$F_g = \frac{G m_1 m_2}{r^2} \Rightarrow \frac{(1)(2)(2)}{\left(\frac{1}{2}\right)} = \frac{4}{\left(\frac{1}{4}\right)} \rightarrow \boxed{16\times}$$

27. By how much does the centripetal force change if you ~~have~~ the speed while quadrupling the radius of an object in circular motion?

$$F_c = \frac{mv^2}{r} \Rightarrow \frac{1\,(1/2)^2}{4} \rightarrow \boxed{1/16\times}$$

28. Calculate the circular speed of an object that makes 20 rotations in 15.0 s around a circular path that has a radius of 0.750 m.

$$v = \frac{2\pi r}{T} = \frac{2\pi(0.750\,m)}{0.750\,s} = \boxed{6.28\,m/s}$$

$$T = \frac{15.0\,s}{20} = 0.750\,s$$

29. Calculate the centripetal force acting on a 15.0 kg object that has a circular speed of 7.00 m/s around a circular path with a radius of 1.50 m.

$$F_c = \frac{mv^2}{r} = \frac{(15.0\,kg)(7.00\,m/s)^2}{1.50\,m} = \boxed{490\,N}$$