# AP Physics 1   Circular Motion and Gravitation Practice Test

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

1) A 250-kg motorcycle goes around an unbanked turn of radius 13.7 m at a steady 96.5 km/h. What is the magnitude of the net force on the motorcycle?
   A) 4.31×10^4 N   B) 2.95×10^3 N   C) 1.31×10^4 N   D) 719 N

2) A particularly scary roller coaster contains a loop-the-loop in which the car and rider are completely upside down. If the radius of the loop is 13.2 m, with what minimum speed must the car traverse the loop so that the rider does not fall out while upside down at the top? Assume the rider is not strapped to the car.
   A) 14.9 m/s   B) 11.4 m/s   C) 12.5 m/s   D) 10.1 m/s

3) A satellite of mass M takes time T to orbit a planet. If the satellite had twice as much mass, the time for it to orbit the planet at the same altitude would be
   A) $T/2$.   B) $4T$.   C) T.   D) $2T$.

4) The banking angle in a turn on the Olympic bobsled track is not constant, but increases upward from the horizontal. Coming around a turn, the bobsled team will intentionally "climb the wall," then go lower coming out of the turn. Why do they do this?
   A) to prevent the bobsled from turning over
   B) to take the turn at a faster speed
   C) to increase the g-force on them
   D) to give the team better control, because they are able to see ahead of the turn

5) Two small balls, A and B, attract each other gravitationally with a force of magnitude F. If we now double both masses and the separation of the balls, what will now be the magnitude of the attractive force on each one?
   A) $4F$ B) F C) $F/4$ D) $16F$

6) What is the distance from the center of the Moon to the point between Earth and the Moon where the gravitational pulls of Earth and Moon are equal? The mass of Earth is 5.97×10^{24} kg, the mass of the Moon is 7.35×10^{22} kg, the center-to-center distance between Earth and the Moon is 3.84×10^8 m, and $G = 6.67 \times 10^{-11}$ N $\cdot$ m^2/kg^2.
   A) 3.84×10^7 m   B) 4.69×10^6 m   C) 3.45×10^8 m   D) 3.83×10^6 m

7) Let the orbital radius of a planet be R and let the orbital period of the planet be T. What quantity is constant for *all* planets orbiting the sun, assuming circular orbits?
   A) T^2/R^3 B) T^2/R C) T/R^2 D) T^3/R^2

8) A 20-g bead is attached to a light 120 cm-long string as shown in the figure. If the angle α is measured to be 18°, what is the speed of the mass?

α

120 cm
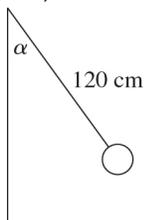
   A) 1.3 m/s   B) 3.8 m/s   C) 0.55 m/s   D) 1.1 m/s

9) The captain of a spaceship orbiting planet X discovers that to remain in orbit at 410 kmfrom the planet's center, she needs to maintain a speed of 68 m/s. What is the mass of planet X? ($G = 6.67 \times 10^{-11}$ N · m^2/kg^2)
   A) 4.2×10^{14} kg
   B) 4.2×10^{17} kg
   C) 2.8×10^{16} kg
   D) 2.8×10^{19} kg

10) If you stood on a planet having a mass four times that of Earth's mass, and a radius two times that of Earth's radius, you would weigh
   A) four times more than you do on Earth.
   B) two times less than you do on Earth.
   C) two times more than you do on Earth.
   D) the same as you do on Earth.

11) A 1000–kg car is slowly picking up speed as it goes around a horizontal unbanked curve whose radius is 100 m. The coefficient of static friction between the tires and the road is 0.35. At what speed will the car begin to skid sideways?
   A) 24 m/s
   B) 19 m/s
   C) 35 m/s
   D) 34 m/s

12) One way that future space stations may create artificial gravity is by rotating the station. Consider a cylindrical space station 380 m in diameter that is rotating about its longitudinal axis. Astronauts walk on the inside surface of the space station. How long will it take for each rotation of the cylinder if it is to provide "normal" gravity for the astronauts?
   A) 28 s
   B) 39 s
   C) 6.2 s
   D) 4.4 s

13) A girl attaches a rock to a string, which she then swings counter–clockwise in a horizontal circle. The string breaks at point P in the figure, which shows a bird's-eye view (as seen from above). Which path (A–E) will the rock follow?
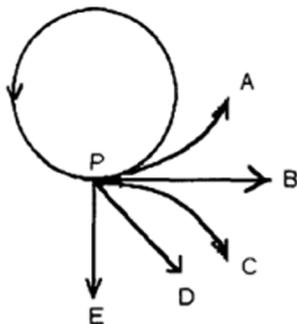

   A) Path A
   B) Path B
   C) Path C
   D) Path D
   E) Path E

14) An piece of space debris is released from rest at an altitude that is two earth radii from the center of the earth. Compared to its weight on Earth, the weight of this debris is
   A) one–third of its weight on the surface of the earth.
   B) zero.
   C) one–quarter of its weight on the surface of the earth.
   D) the same as on the surface of the earth.

15) Two small objects, with masses m and M, are originally a distance r apart, and the magnitude of the gravitational force on each one is F. The masses are changed to $2m$ and $2M$, and the distance is changed to $4r$. What is the magnitude of the new gravitational force?
   A) $4F$
   B) $F/4$
   C) $F/16$
   D) $16F$

16) Two children, Ahmed and Jacques, ride on a merry–go–round. Ahmed is at a greater distance from the axis of rotation than Jacques. Which of the following are true statements?
  A) Jacques has a smaller angular speed than Ahmed.
  B) Jacques has a greater angular speed than Ahmed.
  C) Ahmed has a greater tangential speed than Jacques.
  D) Jacques and Ahmed have the same tangential speed.

17) When a car goes around a banked circular curve at the proper speed speed for the banking angle, what force cause it to follow the circular path?
  A) the friction force from the road
  B) gravity
  C) the normal force from the road
  D) No force causes the car to do this because the car is traveling at constant speed and therefore has no acceleration.

18) A 20–g bead is attached to a light 120–cm–long string as shown in the figure. This bead moves in a horizontal circle with a constant speed of 1.5 m/s. What is the tension in the string if the angle α is measured to be 25°?

α

120 cm
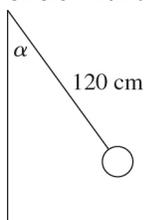
  A) 0.22 N   B) 0.089 N   C) 0.46 N   D) 0.041 N

19) Suppose NASA wants a satellite to revolve around Earth 5 times a day. What should be the radius of its orbit if we neglect the presence of the Moon? ($G = 6.67 \times 10^{-11}$ N $\cdot$ m^2/kg^2, $M_{earth} = 5.97 \times 10^{24}$ kg)
  A) 7.22×10^7 m   B) 0.69×10^7 m   C) 2.11×10^7 m   D) 1.44×10^7 m

20) When a spacecraft is launched from the earth toward the sun, at what distance from the earth will the gravitational forces due to the sun and the earth cancel?
  Earth's mass is 5.97×10^{24} kg, the sun's mass is 1.99×10^{30} kg, and the Earth–sun distance is 1.5×10^{11} m.
  A) 1.3×10^{10} m   B) 1.3×10^8 m   C) 2.6×10^{10} m   D) 2.6×10^8 m

21) When a car goes around a circular curve on a horizontal road at constant speed, what force causes it to follow the circular path?
  A) gravity
  B) the friction force from the road
  C) the normal force from the road
  D) No force causes the car to do this because the car is traveling at constant speed and therefore has no acceleration.

22) A satellite is in orbit around the earth. Which one feels the greater force?
  A) Earth and the satellite feel exactly the same force.
  B) the satellite because the earth is so much more massive
  C) the earth because the satellite has so little mass
  D) It depends on the distance of the satellite from Earth.

23) Suppose NASA wants a satellite to revolve around Earth 6 times a day. What should be the radius of its orbit if we neglect the presence of the Moon? ($G = 6.67 \times 10^{-11}$ N $\cdot$ m^2/kg^2, $M_{earth} = 5.97 \times 10^{24}$ kg)

    A) 7.67×10^7 m   B) 1.28×10^7 m   C) 2.11×10^7 m   D) 0.78×10^7 m

24) In a carnival ride, passengers stand with their backs against the wall of a cylinder. The cylinder is set into rotation and the floor is lowered away from the passengers, but they remain stuck against the wall of the cylinder. For a cylinder with a 2.0–m radius, what is the minimum speed that the passengers can have so they do not fall if the coefficient of static friction between the passengers and the wall is 0.25?

    A) 8.9 m/s   B) 2.3 m/s   C) 3.0 m/s   D) 4.9 m/s

25) Two horizontal curves on a bobsled run are banked at the same angle, but one has twice the radius of the other. The safe speed (for which no friction is needed to stay on the run) for the smaller radius curve is v. What is the safe speed on the larger–radius curve?

   A) $v/2$ B) $v / \sqrt{2}$ C) $2v$ D) $v\sqrt{2}$

FIGURE 7–5
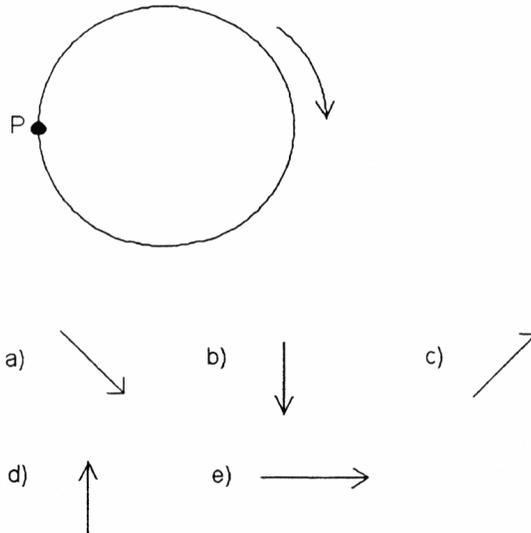
26) The record playing on the turntable of your stereo is rotating clockwise (as seen from above in Fig. 7–5). After turning it off, your turntable is slowing down, but hasn't stopped yet. The direction of the acceleration of point P (at the left) is

    A) graph a.   B) graph b.   C) graph c.   D) graph d.   E) graph e.

27) A satellite having orbital speed V orbits a planet of mass M. If the planet had half as much mass, the orbital speed of the satellite at the same distance from the center would be

    A) $V/\sqrt{2}$.   B) $V/2$.   C) $V\sqrt{2}$.   D) $2V$.

28) You are making a circular turn in your car on a horizontal road when you hit a big patch of ice, causing the force of friction between the tires and the road to become zero. While the car is on the ice, it

    A) continues to follow a circular path, but with a radius larger than the original radius.
    B) moves along a straight–line path toward the center of the circle.
    C) moves along a straight–line path in its original direction.
    D) moves along a straight–line path away from the center of the circle.

29) The earth has radius R. A satellite of mass 100 kg is in orbit at an altitude of $3R$ above the earth's surface. What is the satellite's weight at the altitude of its orbit?
   A) 9000 N   B) 16,000 N   C) 110 N   D) 61 N

30) A car goes around a circular curve on a horizontal road at constant speed. What is the direction of the friction force on the car due to the road?
   A) perpendicular to the curve outward
   B) tangent to the curve in the forward direction
   C) tangent to the curve opposite to the direction of the car's motion
   D) perpendicular to the curve inward

FIGURE 5–2
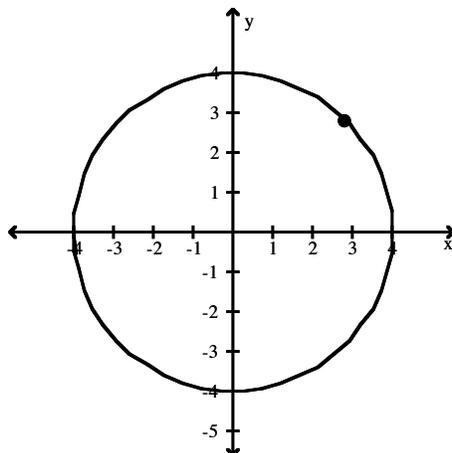
31) Fig. 5–2 indicates the current position of an object traveling at constant speed clockwise around the circle. Which arrow best represent the direction the object would travel if the centripetal force was suddenly reduced to zero?

A)   B)   C)   D)   E)
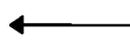
32) A 0.50–kg toy is attached to the end of a 1.0–m very light string. The toy is whirled in a horizontal circular path on a frictionless tabletop. If the maximum tension that the string can withstand without breaking is 350 N. What is the maximum speed the mass can have without breaking the string?
   A) 13 m/s   B) 19 m/s   C) 700 m/s   D) 26 m/s

33) Two children are riding on a merry–go–round. Child A is at a greater distance from the axis of rotation than child B. Which child has the larger angular displacement?
   A) Child A
   B) Child B
   C) They have the same zero angular displacement.
   D) They have the same non–zero angular displacement.

34) A highway curve of radius 100 m, banked at an angle of 45°, may be negotiated without friction at a speed of
   A) 44 m/s.   B) 22 m/s.   C) 67 m/s.   D) 31 m/s.

35) A 1000–kg car is moving at 30 m/s around a horizontal unbanked curve whose diameter is 0.20 km. What is the magnitude of the friction force required to keep the car from sliding?

    A) 9000 N   B) 3000 N   C) 9800 N   D) 900 N

1) C
2) B
3) C
4) B
5) B
6) A
7) A
8) D
9) D
10) D
11) B
12) A
13) B
14) C
15) B
16) C
17) C
18) A
19) D
20) D
21) B
22) A
23) B
24) A
25) D
26) A
27) A
28) C
29) D
30) D
31) C
32) D
33) D
34) D
35) A