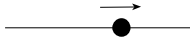
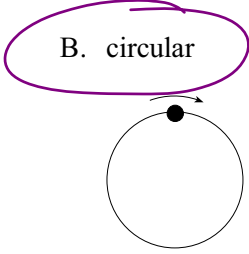


1. An object travels along a path at constant speed. There is a constant net force acting on the object that remains perpendicular to the direction of the motion. Describe the path of the object.

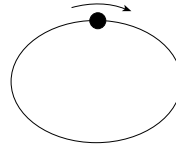
A. linear



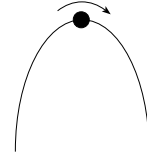
B. circular



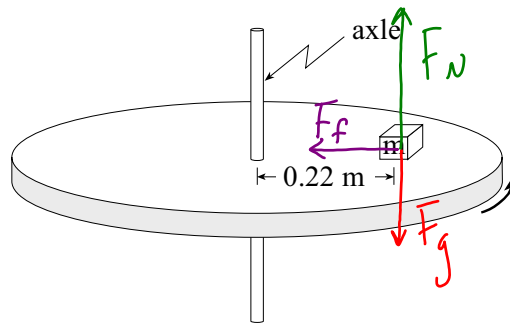
C. elliptical



D. parabolic



2. An object of mass  $m$  is on a horizontal rotating platform. The mass is located 0.22 m from the axle and makes one revolution every 0.74 s.



$$F_c = F_f$$

$$\frac{m4\pi^2 r}{T^2} = F_f$$

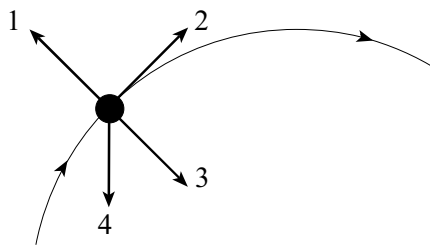
$$m = \sqrt{\frac{F_f T^2}{4\pi^2 r}} = \sqrt{\frac{(13\text{N})(0.74\text{s})^2}{4\pi^2(0.22\text{m})}}$$

$$= 0.82 \text{ kg}$$

The friction force needed to keep the mass from sliding is 13 N. What is the object's mass?

- A. 0.82 kg
- B. 1.3 kg
- C. 2.7 kg
- D. 5.2 kg

3. An object moves at a constant speed along a circular path as shown.



Which vector best represents the centripetal acceleration of the object at this point?

- A. 1
- B. 2
- C. 3
- D. 4

4. A child is riding on a merry-go-round which is rotating at a constant rate. Which of the following describes the child's speed, velocity, and magnitude of acceleration?

	SPEED	VELOCITY	MAGNITUDE OF ACCELERATION
A.	constant	constant	constant
<b>B.</b>	constant	changing	constant
C.	changing	constant	changing
D.	changing	changing	changing

5. A 0.055 kg puck is attached to a 0.150 kg mass M by a cord that passes through a hole in a frictionless table, as shown. The puck travels in a circular path of radius 0.25 m.

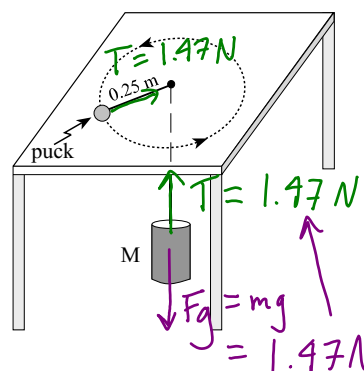
What is the speed of the puck?

- A. 0.61 m/s  
 B. 0.95 m/s  
 C. 1.6 m/s  
**D. 2.6 m/s**

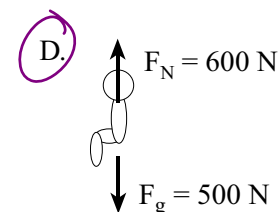
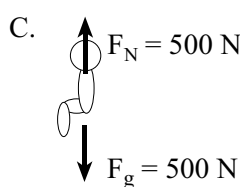
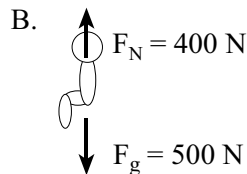
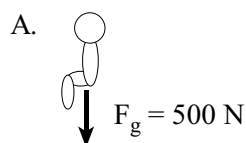
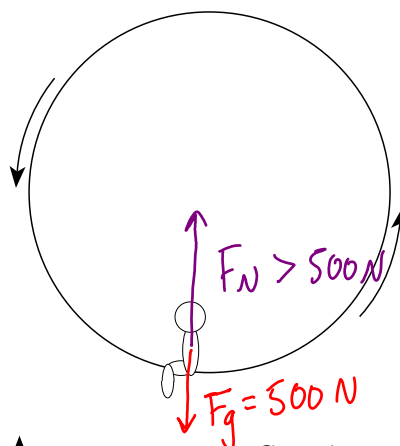
$$F_c = T = \frac{mv^2}{r}$$

$$v = \sqrt{\frac{Tr}{m}} = \sqrt{\frac{(1.47 \text{ N})(0.25 \text{ m})}{0.055 \text{ kg}}}$$

$$= 2.58 \text{ m/s}$$



6. A 500 N child travels in a circular path on a ferris wheel. Which free body diagram best shows the forces which could act on the child as she passes the lowest point?



7. A car travels at a uniform speed through a level circular curve in the road. Which of the following correctly describes the magnitude of the acceleration, velocity and force acting on the car?

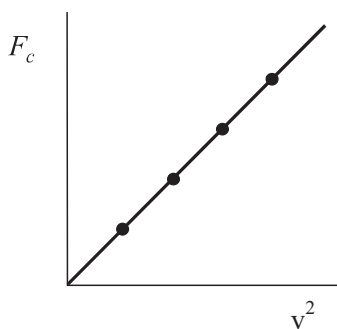
	MAGNITUDE OF ACCELERATION	MAGNITUDE OF VELOCITY	MAGNITUDE OF FORCE
A.	constant	constant	constant
B.	constant	changing	changing
C.	constant	changing	constant
D.	changing	changing	changing

8. A student plots a graph of centripetal force  $F_c$  versus the square of velocity  $v^2$  for an object in uniform circular motion.

$$F_c = \frac{m v^2}{r}$$

$$y = mx + b$$

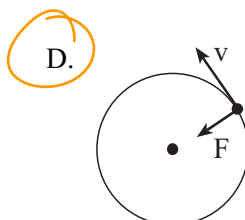
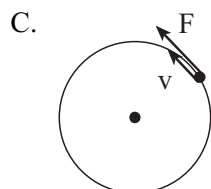
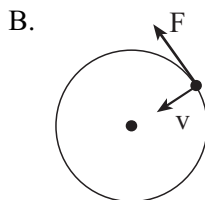
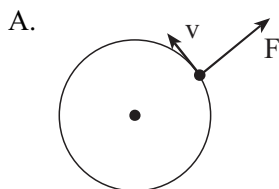
Slope =  $\frac{m}{r}$



What is the slope of this graph?

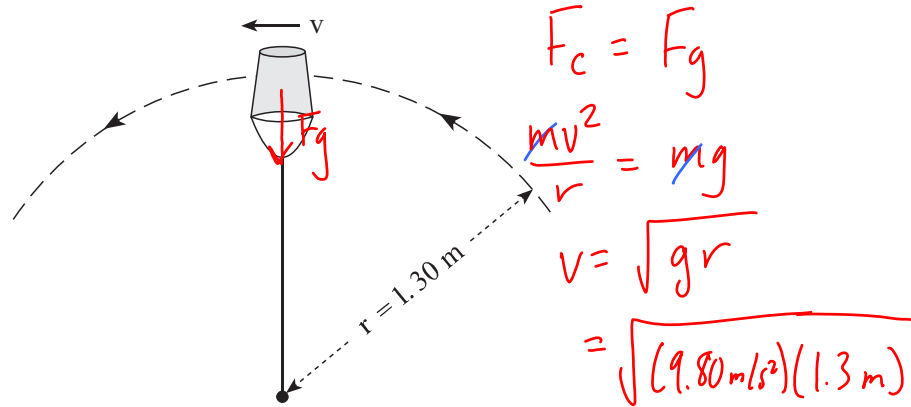
- A.  $\frac{m}{r}$       B.  $\frac{r}{m}$       C.  $\frac{4\pi^2 r}{T^2}$       D.  $\frac{T^2}{4\pi^2 r}$

9. Which of the following diagrams shows the instantaneous velocity  $v$  and centripetal force  $F$  for an object in uniform circular motion.



10. An object travels with a constant speed in a circular path. The net force on the object is
- A. zero.
  - B. towards the centre.
  - C. away from the centre.
  - D. tangent to the object's path.

11. A physics student swings a 5.0 kg pail of water in a vertical circle of radius 1.3 m.

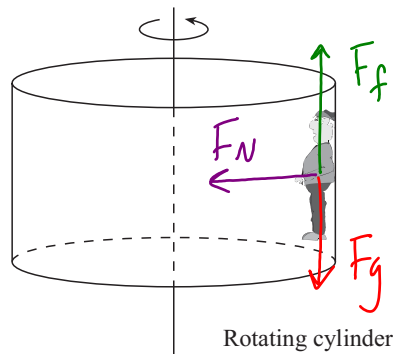


What is the minimum speed,  $v$ , at the top of the circle if the water is not to spill from the pail?

- A. 3.6 m/s
- B. 6.1 m/s
- C. 8.0 m/s
- D. 9.8 m/s

$$= 3.6 \text{ m/s}$$

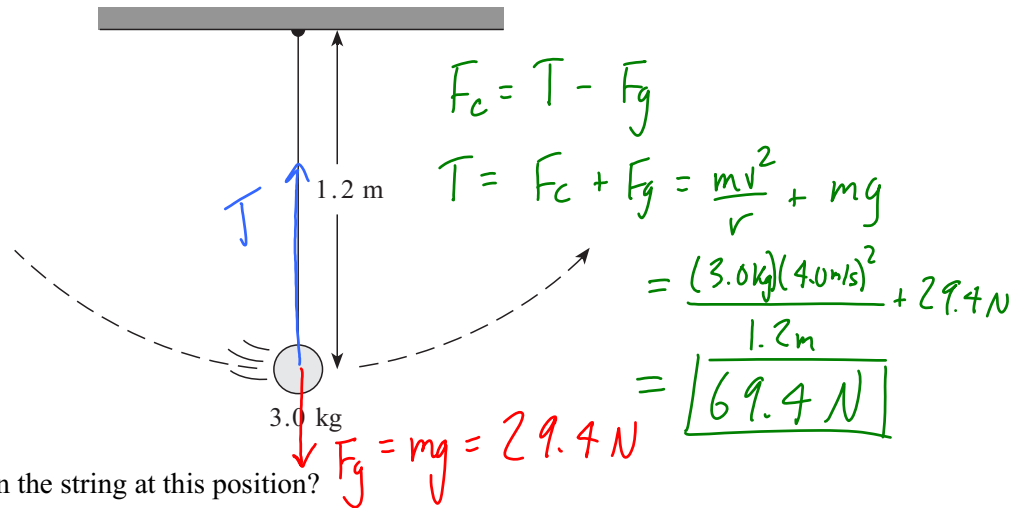
12. In a popular amusement park ride, a large cylinder is set in rotation. The floor then drops away leaving the riders suspended against the wall in a vertical position as shown.



Which of the following is the correct free-body diagram for the person at the position shown?

- A.
- B.
- C.
- D.

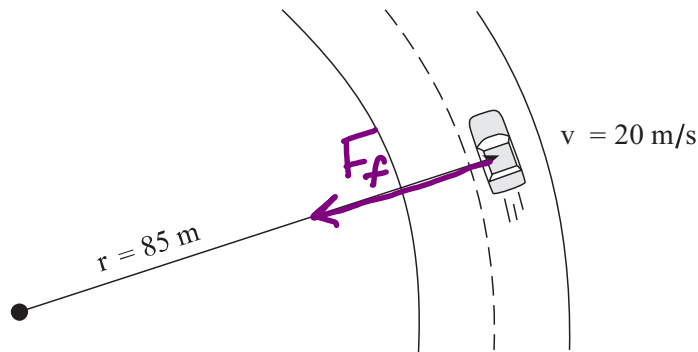
13. A 1.2 m long pendulum reaches a speed of 4.0 m/s at the bottom of its swing.



What is the tension in the string at this position?

- A. 11 N
- B. 29 N
- C. 40 N
- D. 69 N**

14. A 1200 kg car rounds a flat circular section of road at 20 m/s as shown in the diagram.



The coefficient of friction between the car tires and the road surface is 0.65. What minimum friction force is required for the car to follow this curve?

- A.  $3.7 \times 10^3$  N
- B.  $5.6 \times 10^3$  N**
- C.  $7.6 \times 10^3$  N
- D.  $1.2 \times 10^4$  N

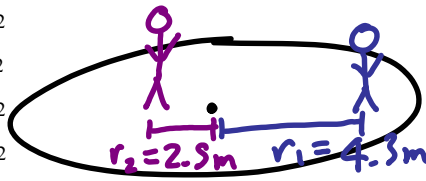
$$F_c = F_f = \frac{mv^2}{r}$$

$$= \frac{(1200\text{kg})(20\text{m/s})^2}{(85\text{m})}$$

$$= 5647\text{N}$$

15. A person is on a horizontal rotating platform at a distance of 4.3 m from its centre. This person experiences a centripetal acceleration of  $5.6 \text{ m/s}^2$ . What centripetal acceleration is experienced by another person who is at a distance of 2.5 m from the centre of the platform?

- A.  $2.3 \text{ m/s}^2$   
 B.  $3.3 \text{ m/s}^2$   
 C.  $5.6 \text{ m/s}^2$   
 D.  $9.6 \text{ m/s}^2$



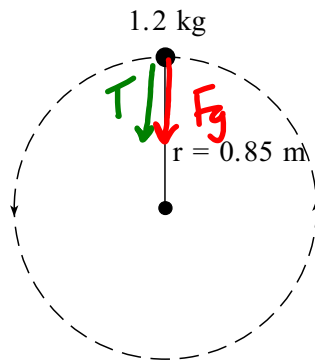
$$a_{c1} = \frac{4\pi^2 r}{T^2}$$

$$T = \sqrt{\frac{4\pi^2 r}{a_c}} = 5.50 \text{ s}$$

$$a_{c2} = \frac{4\pi^2 r}{T^2} = \frac{4\pi^2 (2.5)}{(5.50)^2} = 3.26 \text{ m/s}^2$$

On same platform  $\therefore T_1 = T_2$

16. A 1.2 kg mass on the end of a string is rotated in a vertical circle of radius 0.85 m.



$$F_c = T + F_g$$

$$T = F_c - F_g = \frac{mv^2}{r} - mg = 6.5 \text{ N}$$

If the speed of the mass at the top of the circle is 3.6 m/s, what is the tension in the string at this location?

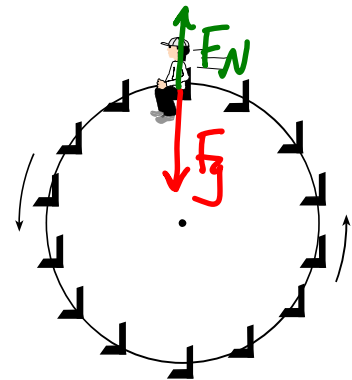
- A. 6.5 N  
 B. 12 N  
 C. 18 N  
 D. 30 N

17. Hans, whose mass is 50 kg, rides on a ferris wheel in a circular path at constant speed. When he is at the top of the wheel, the seat exerts an upward force of 420 N on Hans.

What is the centripetal force on Hans at the top of the wheel?

- A. 70 N  
 B. 420 N  
 C. 490 N  
 D. 910 N

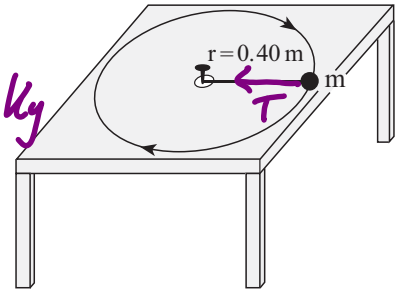
$$F_c = F_g - F_N = (50 \times 9.80) - 420 = 70 \text{ N}$$



18. An object is attached to a string that can withstand a maximum tension force of 6.3 N. The object travels in a circular path of radius 0.40 m with a period of 2.1 s.

$$F_c = T = 6.3 \text{ N}$$

$$F_c = \frac{m4\pi^2r}{T^2} \quad m = \frac{F_c T^2}{4\pi^2 r} = 1.76 \text{ kg}$$

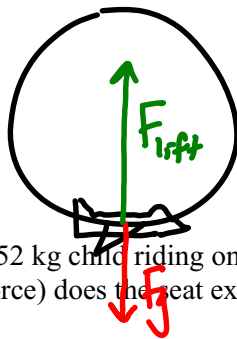


What is the maximum mass of the object?

- A. 0.57 kg
- B. 0.64 kg
- C. 1.8 kg
- D. 3.6 kg

19. A 65 kg pilot in a stunt plane performs a vertical loop with a 700 m radius. The plane reaches a speed of 210 m/s at the bottom of the loop. What is the upward force on the pilot at the bottom of the loop?

- A. 640 N
- B. 3 500 N
- C. 4 100 N
- D. 4 700 N

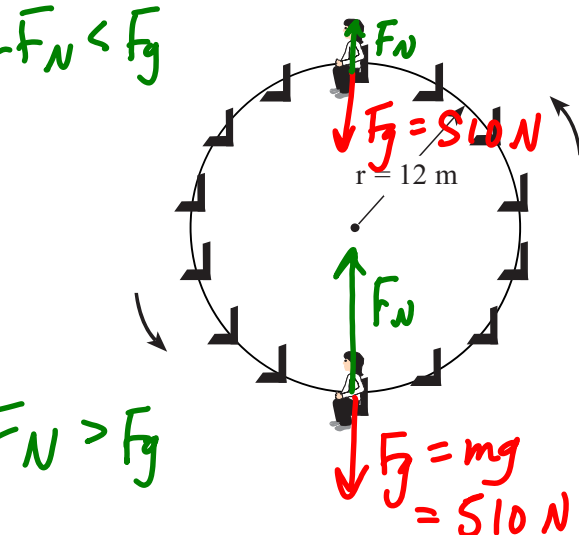


$$F_c = F_{lift} - F_g$$

$$F_{lift} = F_c + F_g = \frac{mv^2}{r} + mg = 4732 \text{ N}$$

20. The diagram shows a 52 kg child riding on a Ferris wheel of radius 12 m and period 18 s. What force (normal force) does the seat exert on the child at the top and bottom of the ride?

	TOP	BOTTOM
A.	76 N	76 N
<input checked="" type="radio"/> B.	430 N	590 N
C.	510 N	510 N
<del>D.</del>	590 N	430 N

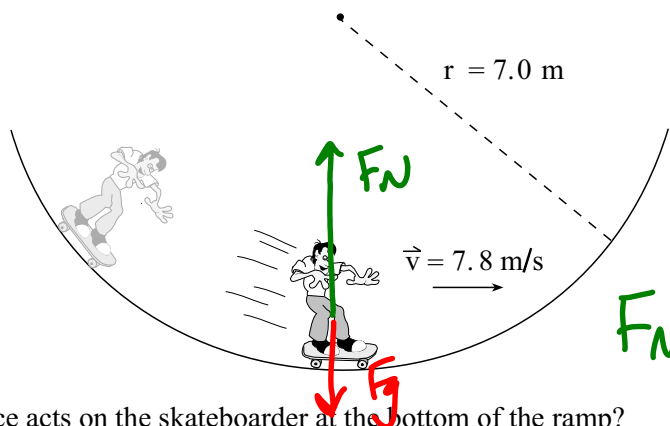


21. A 1200 kg car is travelling at 25 m/s on a horizontal surface in a circular path of radius 85 m. What is the net force acting on this car?

- A. 0 N  
 B.  $8.8 \times 10^3$  N  
 C.  $1.2 \times 10^4$  N  
 D.  $3.8 \times 10^5$  N

$$F_c = \frac{mv^2}{r} = \frac{(1200\text{kg})(25\text{m/s})^2}{85\text{m}} = 8.8 \times 10^3 \text{ N}$$

22. A 61 kg skateboarder is moving down a ramp with a 7.0 m radius of curvature. At the bottom of this ramp he reaches a speed of 7.8 m/s.



$$\begin{aligned} F_c &= F_N - F_g \\ F_N &= F_c + F_g \\ &= \frac{mv^2}{r} + mg \\ &= 530\text{N} + 598\text{N} \\ &= 1.1 \times 10^3 \text{ N} \end{aligned}$$

What upward force acts on the skateboarder at the bottom of the ramp?

- A.  $7.0 \times 10^1$  N  
 B.  $5.3 \times 10^2$  N  
 C.  $6.0 \times 10^2$  N  
 D.  $1.1 \times 10^3$  N

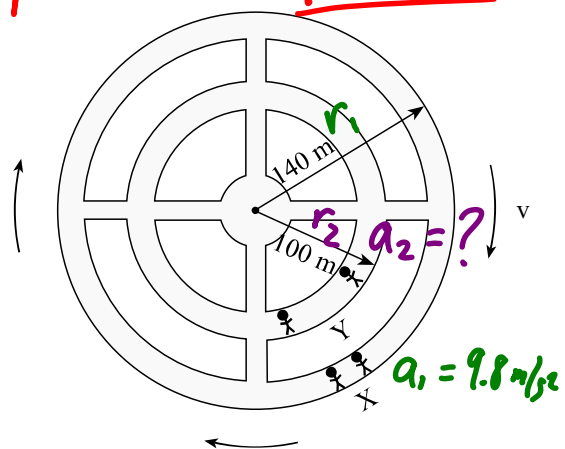
23. A space station has an outer radius of 140 m. The station rotates so that the occupants at X at the outer wall experience an acceleration of  $9.8 \text{ m/s}^2$ . What acceleration will the occupants at Y experience at the 100 m radius?

Same space station  $\therefore T_1 = T_2$

A.  $7.0 \text{ m/s}^2$   
 B.  $8.3 \text{ m/s}^2$   
 C.  $9.8 \text{ m/s}^2$   
 D.  $14 \text{ m/s}^2$

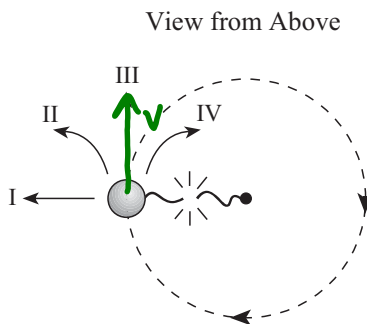
$$\begin{aligned} a_{c1} &= \frac{4\pi^2 r_1}{T^2} \\ T &= \sqrt{\frac{4\pi^2 r_1}{a_c}} = \sqrt{\frac{4\pi^2 (140)}{9.8}} \\ &= 23.74\text{s} \end{aligned}$$

$$a_{c2} = \frac{4\pi^2 r}{T^2} = \frac{4\pi^2 (100)}{(23.74)^2} = 7.0 \text{ m/s}^2$$





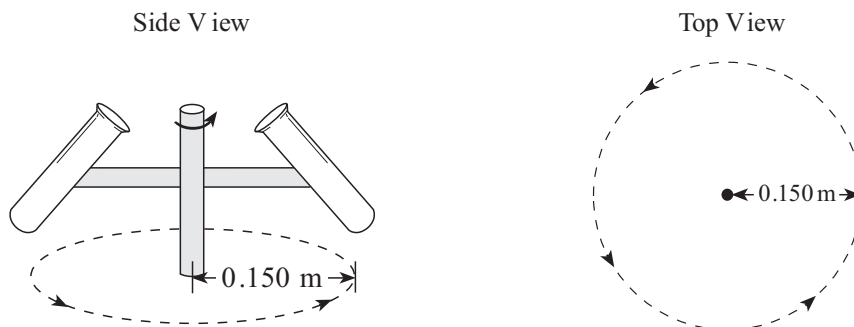
24. A ball attached to a string is swung in a horizontal circle.



Which path will the ball follow at the instant the string breaks?

- A. I
- B. II
- C. III
- D. IV

25. A test tube rotates in a centrifuge with a period of  $1.20 \times 10^{-3}$  s. The bottom of the test tube travels in a circular path of radius 0.150 m.

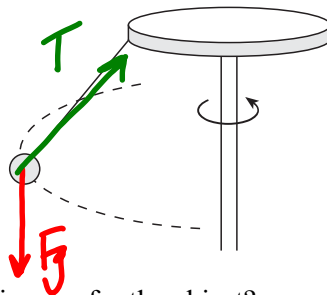


What is the centripetal force exerted on a  $2.00 \times 10^{-8}$  kg amoeba at the bottom of the tube?

- A.  $9.86 \times 10^{-5}$  N
- B.  $2.08 \times 10^{-3}$  N
- C.  $8.22 \times 10^{-2}$  N
- D.  $4.11 \times 10^6$  N

$$F_c = \frac{m 4\pi^2 r}{T^2} = 0.082 \text{ N}$$

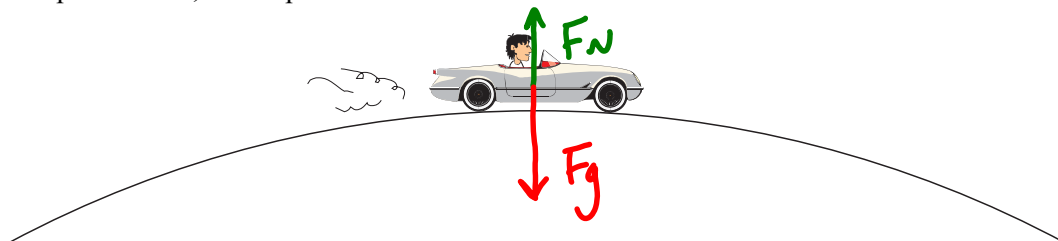
26. An object attached to a rotating table is moving in a circular path with a constant speed.



Which is the correct free body diagram for the object?

- A. B. C. D.

27. A 65 kg student is in a car travelling at 25 m/s on a hill of radius 110 m. When the car is at the top of the hill, what upward force does the seat exert on the student?



$$F_c = F_g - F_N \quad F_N = F_g - F_c$$

$$= mg - \frac{mv^2}{r}$$

$$= 637\text{N} - 369\text{N}$$

$$= 267\text{N}$$

- A. 270 N  
B. 370 N  
C. 640 N  
D. 910 N

28. A 1200 kg car can travel without slipping at a maximum speed of 28 m/s in a circular path of radius 70 m on a dry horizontal surface. When it rains, the coefficient of friction is reduced to one half its original value. What is the maximum speed under this wet condition?

- A. 7.0 m/s  
B. 14 m/s  
C. 20 m/s  
D. 28 m/s

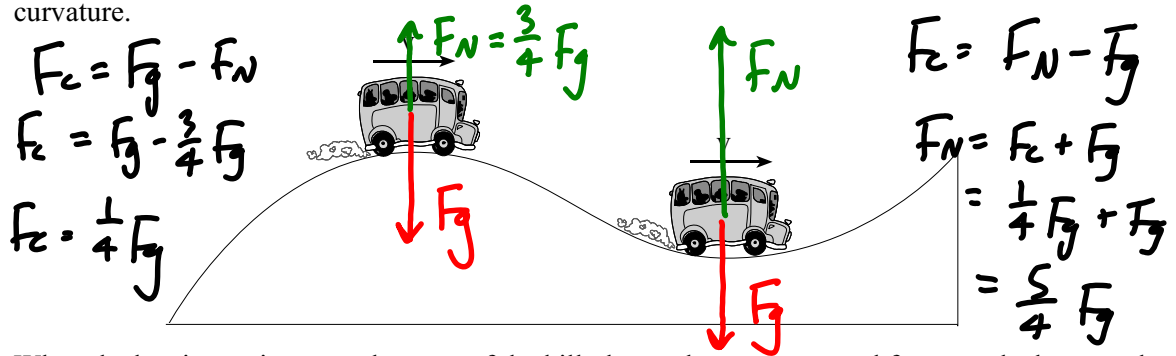
$$F_c = F_f \quad \therefore v^2 \propto \mu$$

$$\frac{mv^2}{r} = \mu mg \quad \therefore v \propto \sqrt{\mu}$$

$$\therefore v \text{ is reduced by } \sqrt{2}$$

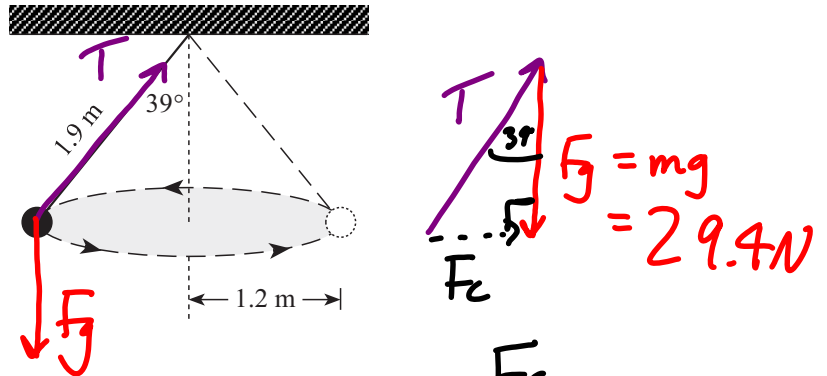
$$v = 19.8 \text{ m/s}$$

29. A bus of weight  $F_g$  is moving at a constant speed over a hill and dip that have the same radius of curvature.



When the bus is passing over the crest of the hill, the road exerts a normal force on the bus equal to three quarters of the bus's weight ( $\frac{3}{4} F_g$ ). What is the normal force the road exerts on the bus when the bus is passing through the bottom of the dip?

- A.  $\frac{1}{4} F_g$
- B.  $\frac{3}{4} F_g$
- C.  $\frac{5}{4} F_g$
- D.  $\frac{7}{4} F_g$
30. The diagram shows an object of mass 3.0 kg travelling in a circular path of radius 1.2 m while suspended by a piece of string of length 1.9 m. What is the centripetal force on the mass?



- A. 19 N
- B. 23 N
- C. 24 N
- D. 29 N

$$\tan 39^\circ = \frac{F_c}{F_g}$$

$$F_c = F_g \tan 39^\circ = 23.8 N$$