

Read 5.4-5.6

H.W #4 solutions on
class web page

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chapter 5

Circular motion; Gravitation

Uniform circular motion:
motion of an object traveling
at a constant instantaneous
speed on a circular path

$\vec{v}$ is changing direction $\rightarrow$
acceleration

centripetal acceleration (radial)

$$a_R = \frac{v^2}{r} \quad (a_c)$$

Few more Definitions

PERIOD (T): TIME to make 1 complete revolution

Frequency: number of revolutions
(f) in a given time

Frequency and period are related

$$T = 1/f \quad f = \frac{1}{T}$$

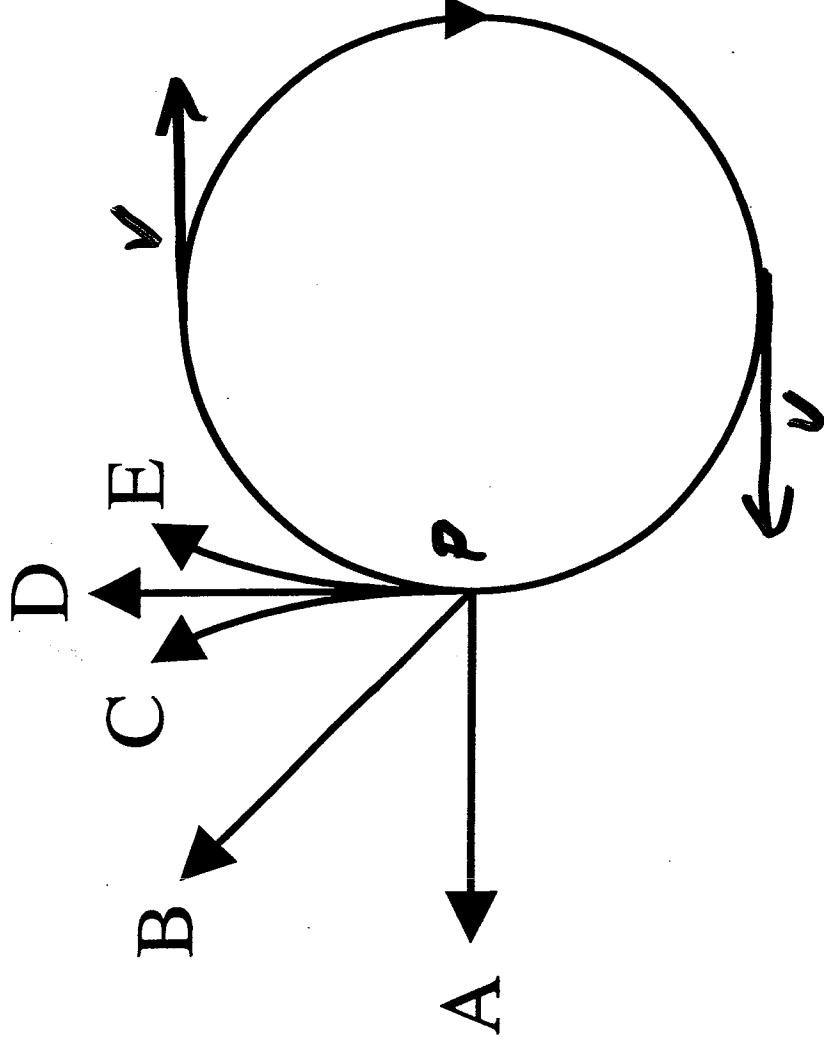
ex) if it takes 4s for a complete revolution, what is T and f ?

$$T = 4s \quad f = \frac{1}{4s} \quad (\text{Hz})$$

Hertz ($\frac{1}{s}$)

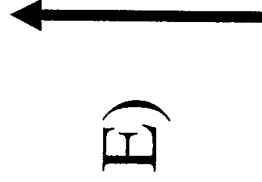
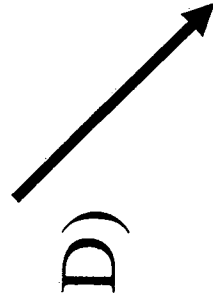
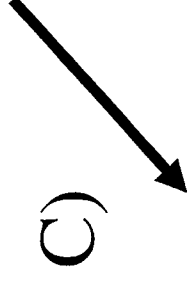
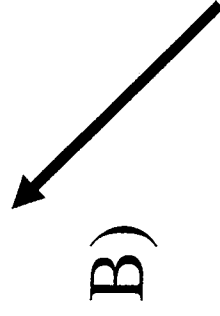
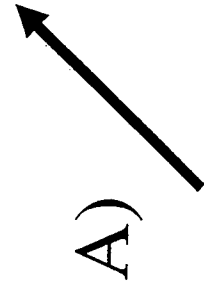
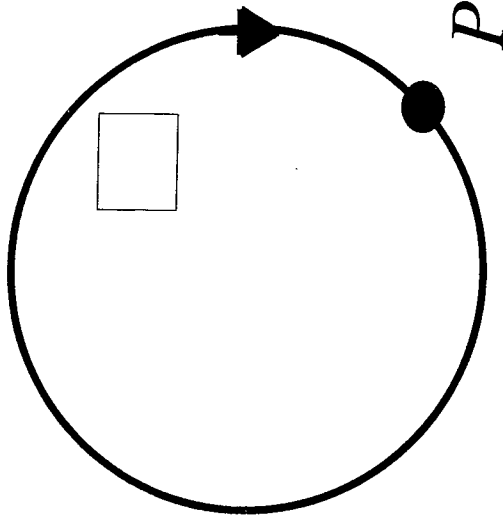
Interactive Question

A girl attaches a rock to a string which she then swings clockwise in a horizontal circle. The string breaks at point P on the sketch which shows a view from above. What path will the rock follow?



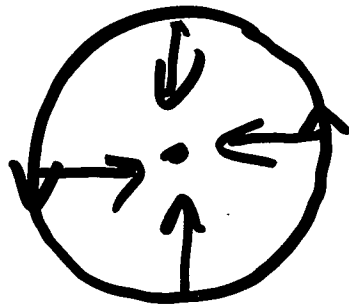
Interactive Question

A rock is twirled on a string at a constant speed in a clockwise direction as shown. The direction of its acceleration at point P is



$$a_R = \frac{v^2}{r} \quad \text{magnitude}$$

$\vec{a}$ is a vector so need a direction



what direction
is
acceleration?

always toward center

Note a_R not constant
magnitude constant
direction changing

Newton's 2nd Law

$$\Sigma F = m a_R = \frac{m v^2}{R}$$

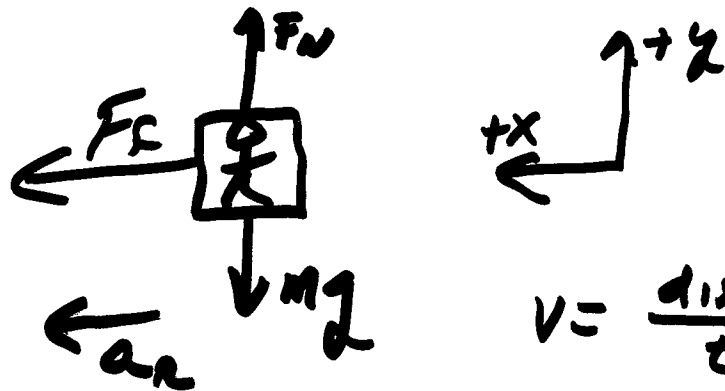
It is not a new force. It is
the net sum of all forces in
radial direction



Tensions

Friction

ex) merry-go-round has a radius of 11m. It rotates at a rate of 1 revolution every 8.2s. If $\mu_s = 0.7$ can you stand at edge without sliding?



$$y: F_N - mg = 0 \quad F_N = mg$$

$$v = \frac{\text{distance}}{\text{time}}$$

$$v = \frac{2\pi r}{T} \quad \checkmark$$

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

$$v = 2\pi r f \quad \checkmark$$

$$ma_c = \frac{mv^2}{r} = \frac{m(2\pi r f)^2}{r} = m4\pi^2 f^2$$

$$a_c = 4\pi^2 (11\text{m}) \left(\frac{1\text{ rev}}{8.2\text{s}} \right)^2 = \underline{\underline{6.5 \text{ m/s}^2}}$$

max frictional force

$$\mu_s F_N = \mu_s mg$$

$$a_{c_{\text{max}}} = (0.7) 9.8 \text{ m/s}^2$$

yes

$$a_{c_{\text{max}}} = 6.9 \text{ m/s}^2$$

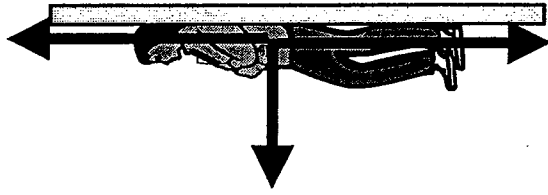
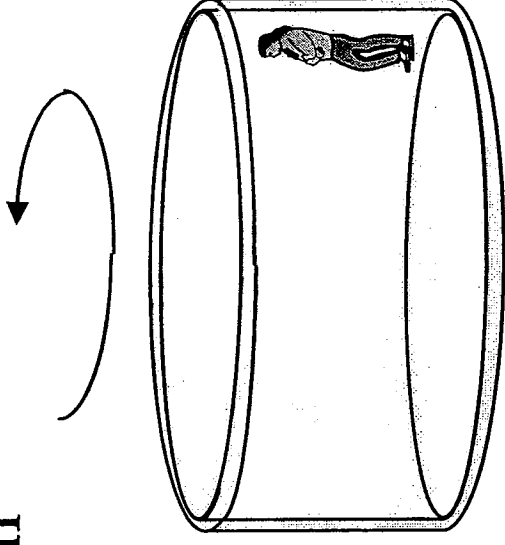
Interactive Question

You and a friend are riding on a merry-go-round. You are sitting on a horse that is twice as far from the center of the merry-go-round as your friend. How does your centripetal acceleration relate to that of your friend's?

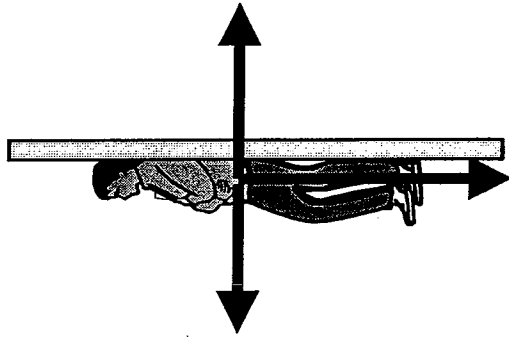
- A) It is one-fourth as much
- B) It is one-half as much
- C) It is the same
- D) It is twice as much
- E) It is four times as much

Interactive Question

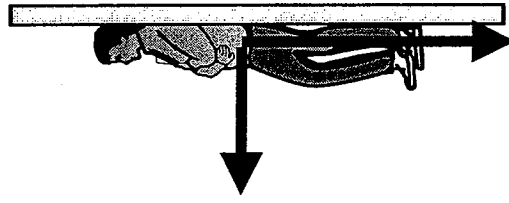
A rider in an amusement park ride, the “barrel of fun” finds herself stuck with her back to the wall. Which diagram correctly shows the forces acting on her?



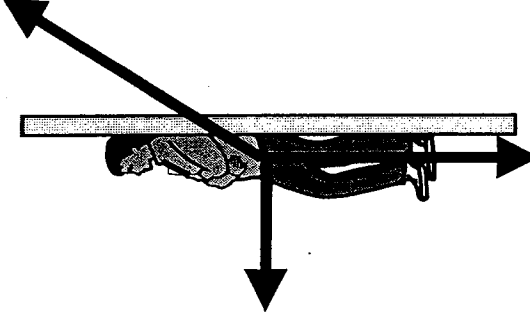
A)



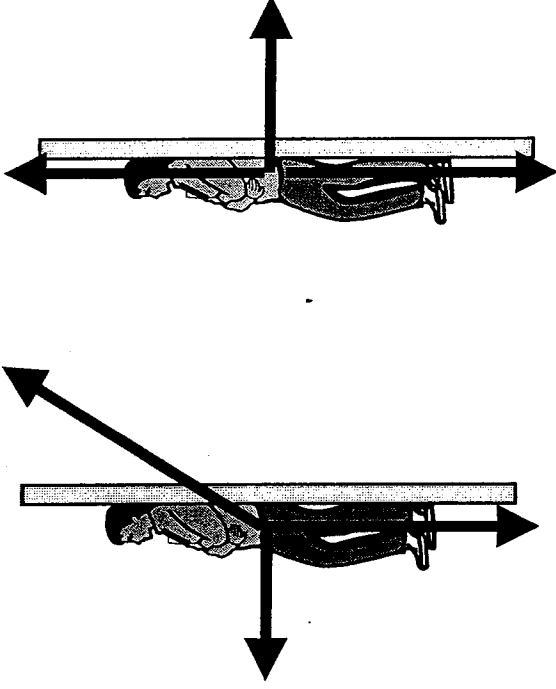
B)



C)

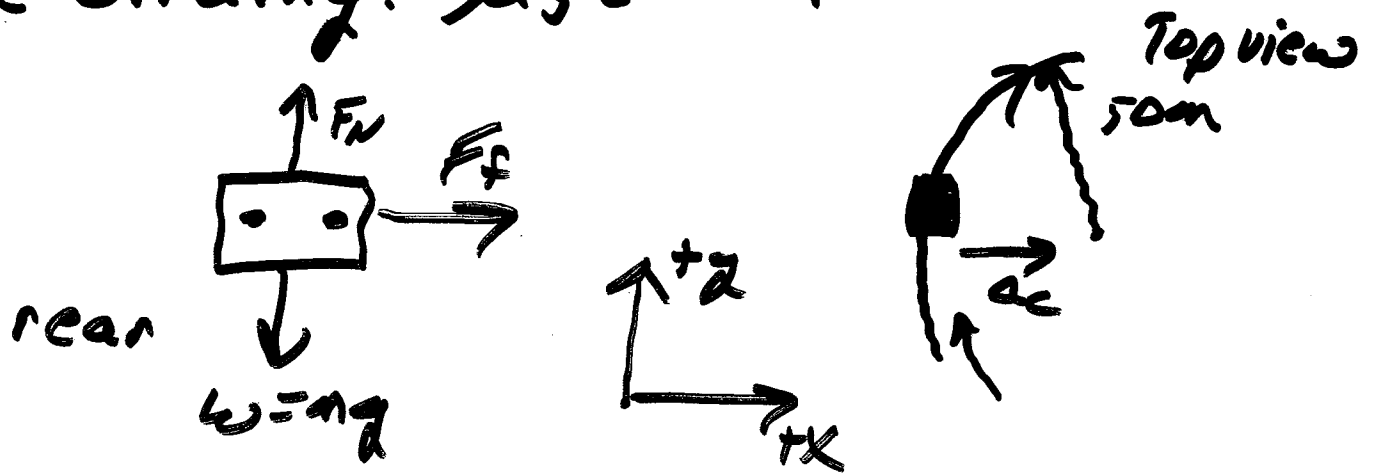


D)



E)

Ex) A car turns a corner on a road of radius 50.0 m. Find max speed car can negotiate turn without sliding. $\mu_s = 0.9$



$$y: F_N - mg = 0$$

$$x: F_f = ma_c = \frac{mv^2}{r}$$

$$F_f = \mu_s F_N = \mu_s mg$$

$$\frac{mv^2}{r} = \mu_s mg \Rightarrow v = \sqrt{\mu_s g r}$$

$$= \sqrt{(0.9)(9.8 \text{ m/s}^2)(50.0 \text{ m})}$$

$$= 21 \text{ m/s}$$

Interactive Question

A 1500 kg car travels at a constant speed of 22 m/s around a circular track which has a radius of 80 m. Which statement is true concerning this car?

- A) The velocity of the car is changing.
- B) The car is characterized by constant velocity.
- C) The car is characterized by constant acceleration.
- D) The car has a velocity vector that points along the radius of the circle.
- E) More than one of the above is true.