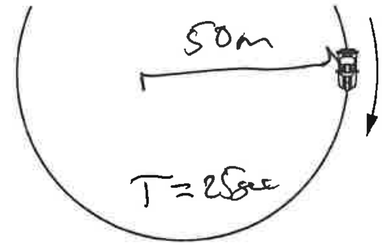
Force your name on the paper Key

AP Physics C: 4.6 Centripetal Force

1. The car above has a mass of 450-kg and is traveling around a track with a radius of 50-m, the car takes 25 seconds to travel all the way around the circular track.



a. Calculate the centripetal force of the car. *(ans: 1419.78 N)*

$$V=\frac{2\pi r}{T}=\frac{2\pi(50)}{25}=12.56\,m/s$$

$$F_c=ma_c=\frac{mv^2}{r}=\frac{(450)(12.56)^2}{50}=1419.78N$$

b. The car would begin to slide to the outside of the circle if there wasn't friction. Calculate what the friction coefficient would need to be for the car to drive in a circle. *(ans: 0.32)*

$$F_c=F_f$$

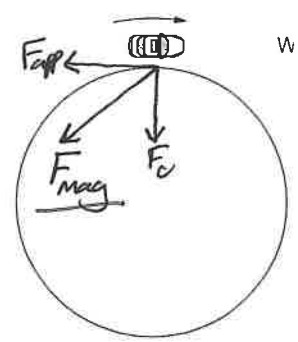
$$\frac{mv^2}{r}=\mu F_N$$

$$1419.78=\mu mg$$

$$1419.78=\mu(450)(9.8)$$

$$\mu=\frac{1419.78}{450(9.8)}=.32$$

2. A car is traveling clockwise around a circular racetrack of radius 1440 meters. When the car is at the point shown on the diagram, it has a speed of 36m/s and is slowing down with an acceleration of 1.2 m/s^2,



a. Calculate the magnitude of the centripetal Force acting on the car above, if the car's mass is 500 kg. *(ans: 750 N)*

$$F_c=ma_c=\frac{mv^2}{r}=\frac{(500)(36)^2}{1440}=450N$$

$$ma=1.2\,m/s^2(500)=600N$$

$$F_{mag}=\sqrt{450^2+600^2}=750N$$

b. ~~The car would begin to slide to the outside of the circle if there wasn't friction. Calculate what the friction coefficient would need to be for the car to drive in a circle. (ans: 0.09)~~

Draw the direction of the magnitude of forces calculated above on the digram.

3. A car of mass M is traveling in a flat circular path of radius R. If the car completes one revolution around the circle every T seconds, calculate the friction coefficient the car and the floor must have to keep the car on the road.

$$F_c=f$$

$$\frac{mv^2}{R}=\mu mg$$

$$\frac{v^2}{R}=\mu g$$

$$\frac{v^2}{Rg}=\mu$$

$$\frac{\left(\frac{2\pi R}{T}\right)^2}{Rg}=\mu$$

$$\mu=\frac{\left(\frac{4\pi^2R^2}{T^2}\right)}{\left(\frac{Rg}{1}\right)}=\frac{4\pi^2R^2}{T^2Rg}$$

$$\boxed{\mu=\frac{4\pi^2R}{T^2g}}$$

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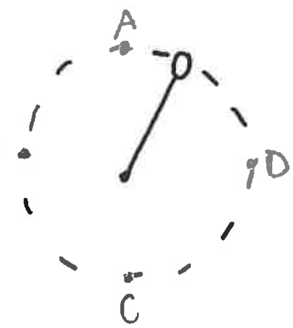
4. A 2-kg ball is being swung around in a circle vertically with a radius of 2.3 meters. If the person swings the ball too slowly the ball will droop down at the top (point A) so it's not a perfect circle.



a. Calculate the velocity the person spinning the ball must maintain in order for the ball not to droop at point A? *(ans: 4.7 m/s)* $v = \sqrt{9.8(2.3)} = \boxed{4.7\,m/s}$

$F_c = mg - T$ ← $T \to 0$ because if it loses its shape there is no tension

$F_c = mg \to ma_c = mg \to a_c = g \to \frac{v^2}{r} = g \to v = \sqrt{gr}$

b. If the ball had triple the mass how fast must the ball be spun not to droop at point A?

No because mass cancels and is not part of the equation.

c. If the radius of the circle was increased to double the size, how must the velocity of the ball change in order to maintain the perfect circle?

_X_ must increase ____can decrease ____stay the same

Explain your reasoning.

Since $v = \sqrt{gr}$ if r becomes larger then v must also. If r doubled in size the v would increase by $\sqrt{2}$.

4. A car of mass M is driving over a hill with a radius R. When the car reaches the top of the circular hill the car barely lifts off the hill so it becomes airborne.

a. Calculate the minimum speed the car must achieve to go airborne.

$F_c = mg - F_N$ ($F_N \to 0$ Not touching the floor.)

$ma_c = mg$

$M\left(\frac{v^2}{R}\right) = Mg \to \frac{v^2}{R} = g$, $v^2 = gR \to \boxed{v = \sqrt{gR}}$

b. If you double the mass to 2M, how would that change the speed the car must achieve?

No, the mass cancels out.

c. If we quadrupled the radius of the hill, calculate the new speed of the car.

$v_{New} = \sqrt{g4R} = \sqrt{4} \cdot \sqrt{gR} = 2\sqrt{gR}$

the velocity must double to lift off the ground.