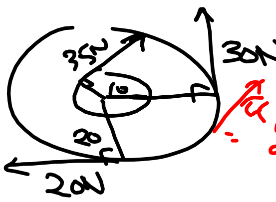
6.

$\tau_f = 0.40\ N\cdot m$



$$\sum\tau = \sum\tau_{cw} - \sum\tau_{ccw} \pm \tau_f$$

$$= 20N\cdot 0.20m + 35N\cdot 0.10m - 30N\cdot 0.20m \pm \tau_f$$

$$= 1.5\ N\cdot m - 0.40\ N\cdot m$$

$$= 1.1\ N\cdot m$$

τ_f is acting in the CCW direction (opposing motion)

Uniform Circular Motion

Textbook Ch. 11.2

Learning Objectives:
- Students will be able to explain the forces involved in uniform circular motion, demonstrated through free body diagrams and written/verbal explanation.
- Students will analyze, predict and explain circular motion demonstrated through problem solving and experiment.
- Students will demonstrate an understanding of the relationship between period and frequency of an object in circular motion and use this understanding in experiment and problem solving.

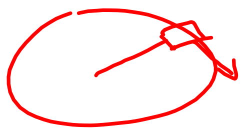
Circular Motion

For an object going in a circle

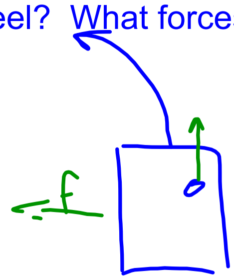
A) what is the direction of the velocity?

B) what is the direction of the force acting on the object?

C) is there an acceleration? And if so, what is the direction of the acceleration of the object?



If you are that object what do you feel? What forces do you experience?



Centripetal vs. Centrifugal Force

Center seeking center fearing

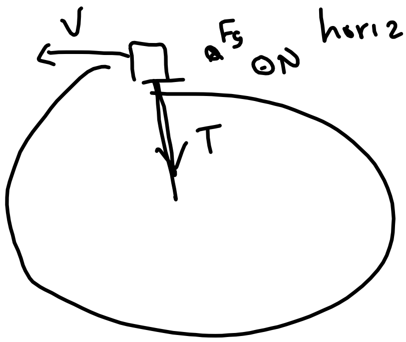
To travel in a circular path requires a net centripetal force.

horizontal circle

$\Sigma \vec{F} = \vec{T} = \vec{F}_c$

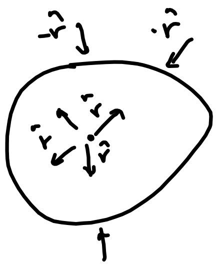
↑

centripetal force.

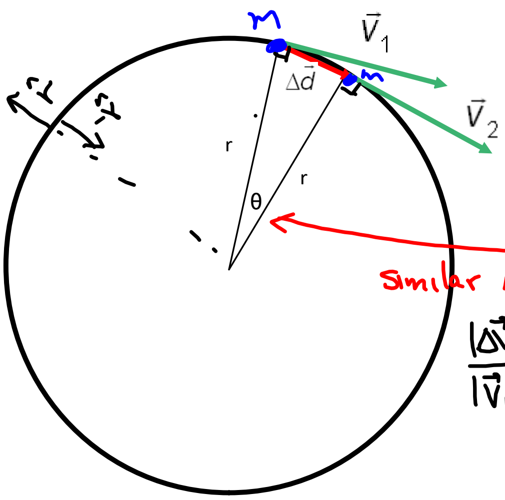


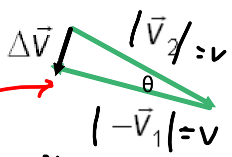
the Centripetal Force = net force causing an object to move in a circular path.

(directed inward toward the center of the circle $-\hat{r}$ direction)



Derivation of Centripetal Acceleration Equation





Similar Δ's

$$|\vec{v}_1| = |\vec{v}_2| = v$$

$$\vec{a} = \frac{\Delta\vec{v}}{t} = \frac{\vec{v}_2 - \vec{v}_1}{t}$$

$$\vec{a} = \frac{d\vec{v}}{dt}$$

$$\frac{|\Delta\vec{v}|}{|\vec{v}_1|} = \frac{|\Delta\vec{d}|}{r} \Rightarrow \frac{\Delta v}{v} = \frac{\Delta d}{r}$$

$$\Delta v = \frac{v\,\Delta d}{r}$$

$$a = \frac{\frac{v\,\Delta d}{r}}{t} = \frac{v}{r}\cdot\frac{\Delta d}{t}\Big)\, v$$

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

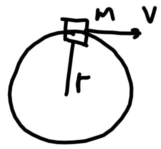
$$\vec{a}_c = -\frac{v^2}{r}\hat{r}$$

Centripetal Force

$$\Sigma F = F_c = m a_c = \frac{mv^2}{r}$$

$$\Sigma \vec{F} = \vec{F}_c = -\frac{mv^2}{r}\hat{r}$$

apply at any point in time



the time to complete one revolution is called the period, T.

So $v = \frac{2\pi r}{T}$

So $a_c = \frac{v^2}{r} = \frac{\left(\frac{2\pi r}{T}\right)^2}{r} = \frac{\frac{4\pi^2 r^2}{T^2}}{r}$

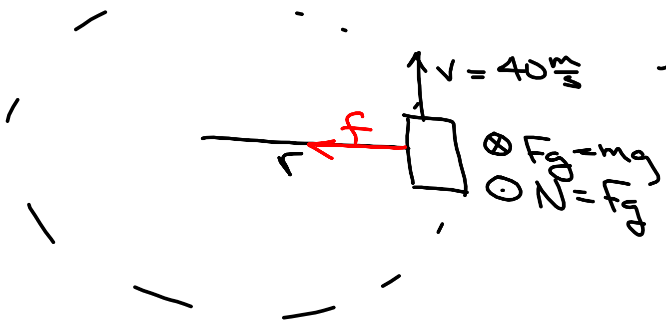
$$\boxed{a_c = \frac{4\pi^2 r}{T^2}}$$

$$F_c = \frac{m\,4\pi^2 r}{T^2} \longleftarrow$$

uniform circular motion only (or as average F_c, a_c)

Example

A car (m=1000 kg) takes a turn at 40 m/s. If the coefficient of friction between the road and the tires is 0.90, what is the minimum radius the car can take?



$\mu = 0.90$

$$\Sigma F = f = F_c = \frac{mv^2}{r}$$

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

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

$$\mu \cancel{m} g = \frac{\cancel{m} v^2}{r}$$

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

$$= \frac{(40\ \frac{m}{s})^2}{(0.90)(9.8)}$$

$$= \underline{181\text{m}}$$

Homework: Sheet #1-5