Unit 2

Projectile Motion
Circular Motion
Simple Harmonic Motion
Universal Gravitation

Uniform Circular Motion

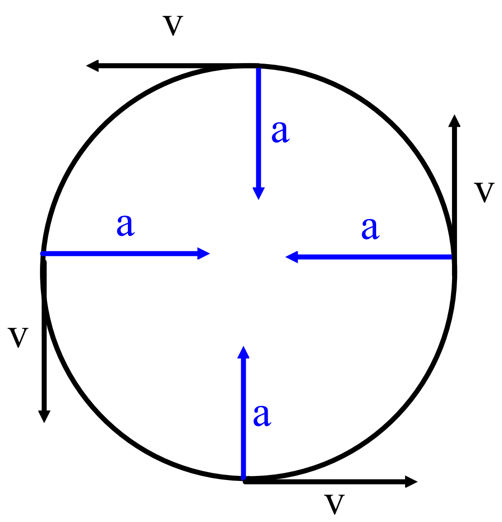
An object with uniform circular motion is an object that travels at constant speed in a circular path.

Although the object has the same speed at every point on the circular path, the direction of the object is constantly changing.

Because the direction of the object is continually changing, the object must be accelerating. The acceleration of an object travelling in a circular path is called centripetal acceleration.

Horizontal Circular Motion

Imagine you are looking down on a circular track with an object travelling counterclockwise.



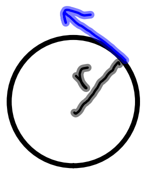
The object's speed is sometimes called the tangential speed - it is always drawn tangent to the circular path

Centripetal acceleration is always directed toward the center of the circular path.

centripetal -> center-seeking

Formulae for Horizontal Cir. Motion

$$v = \frac{d}{t}$$



Circumference = $2\pi r$

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

$v = 2\pi r f$

v -> speed (m/s)
r -> radius (m)
T -> period (s) (time for one revolution)

Remember: $T = \frac{1}{f}$

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

f = frequency (Hz)
the number of revolutions per second.

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

a_c -> centripetal acceleration (m/s^2)
v -> speed (m/s)
r -> radius (m)

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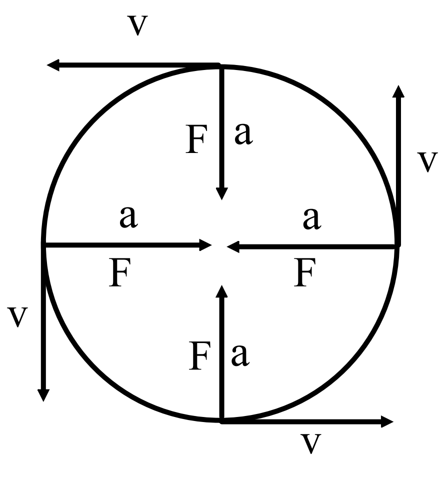
*Sometimes its kinda nice to have everything as a function of the radius and period (or frequency):

$$a = \frac{\left[\frac{(2\pi r)}{T}\right]^2}{r} = \frac{4\pi^2 r^2}{r T^2} = \boxed{\frac{4\pi^2 r}{T^2}}$$

$$\boxed{= 4\pi^2 r f^2}$$

Centripetal Force

Centripetal acceleration is due to a centripetal force. Centripetal force is the net force required to keep an object moving in a circular path. It may be a tension, force of friction, force of gravity or a combination of force components that point along the radial direction.



Centripetal force is always directed toward the center of the circular path.

Formulas

$F_{net} = ma$ $F_c = ma_c$

F_c -> centripetal force (N)
m -> mass (kg)
a_c -> centripetal accleration (m/s^2)

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

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

$F_c = m4\pi^2 r f^2$

Circular Motion Formulae

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

$$v = 2\pi r f$$

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

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

$$a_c = 4\pi^2 r f^2$$

$$F_c = m a_c$$

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

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

$$F_c = m 4\pi^2 r f^2$$

$v = \sqrt{rg\mu}$ (horizontal) unbanked

$v = \sqrt{rg\tan\theta}$ (banked)