Circular Motion

Wednesday, January 13, 2010 12:44 PM

Period: the time required for one complete cycle of a repeated event <=
measured in units of seconds, variable T $= \frac{\text{seconds}}{\text{cycle}}$

Frequency: the number of complete cycles of a repeated event PER second
<=measured in units of Hertz (Hz), variable f $f = \frac{1}{T} = \frac{1}{\left(\frac{\text{seconds}}{\text{cycle}}\right)} = \frac{\text{cycle}}{\text{second}} = \text{Hz}.$

A dismembered cat head bobs up and down 17 times in 68 seconds, find its period and frequency.

$\text{Period} = T = \frac{\text{seconds}}{\text{cycle}} = \frac{68}{17} = 4.0\,\text{s}$

$\text{frequency} = f = \frac{1}{4} = .25\,\text{Hz}.$

Converting rpm to frequency: rpm (revolutions (cycles) per minute)
1800 rpm $1800\ \text{rpm} = \frac{1800}{60} = 30\,\text{Hz}.$

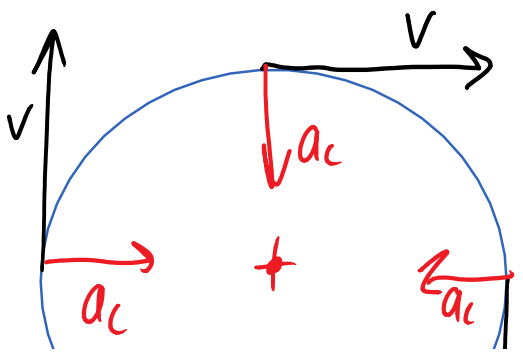
Uniform circular motion: motion in a circle at a constant speed

$d = vt \qquad v = \frac{d}{t} \qquad v = \frac{2\pi r}{T} = 2\pi r f$

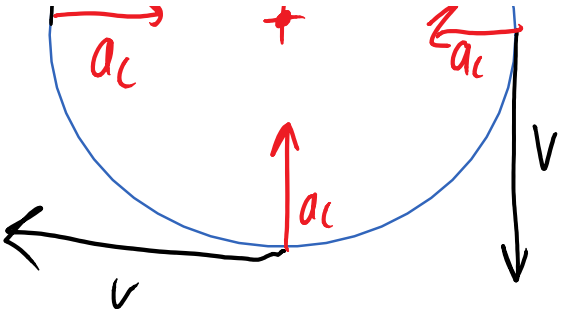
$a_c = \frac{v^2}{r} = \frac{(2\pi r f)^2}{r} = 4\pi^2 r f^2$

There is a net force directed toward the center of your circle (F_c) centripetal force
There is an acceleration in the direction of F_{net} (F_c) called the centripetal accel (a_c)
$F_{net} = ma$ then $F_c = ma_c$

The velocity is tangential to the circle
The accel and Fc are directed radially

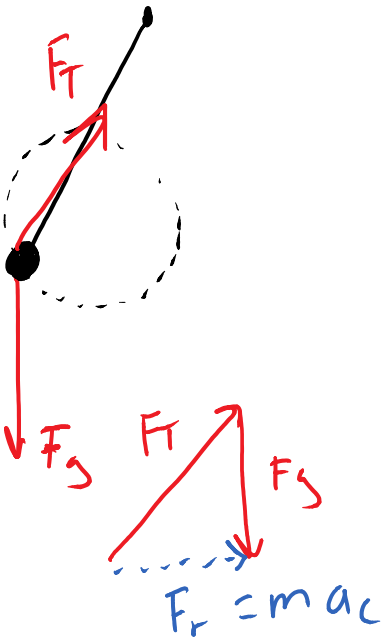


speed can be found using $v = \Delta d / \Delta t$

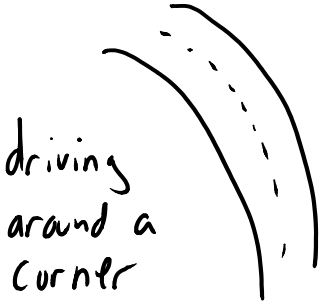


There are 3 types of circular motions

Conic Circles



Horizontal Circles

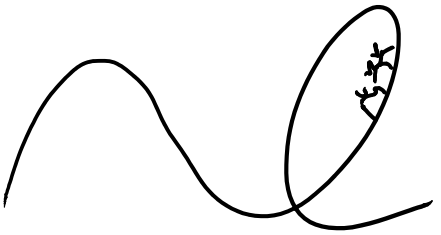


$\rightarrow F_c = F_f$

$m a_c = \mu m g$

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

Vertical Circles



roller coaster

Tomorrow

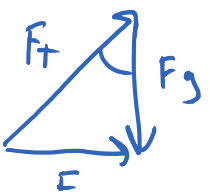
A cat of mass 5.0 kg is swung on a 2.0m long leash in radius 1.0 m.
Determine the velocity and frequency of the rotation!

$m = 5\,kg \quad l = 2\,m \quad r = 1$

$\sin\theta = \frac{1}{2}$

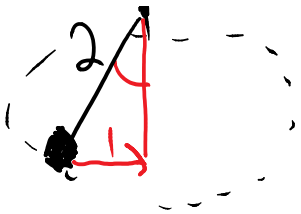
$\theta = 30°$

$F_g = mg = 49\,N$



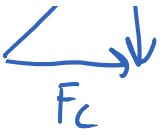
$\tan 30° = \frac{F_c}{F_g}$

$F_c = 28.3\,N$



$\theta = 30°$

$= 49N$



$F_c = 28.3N$

$= ma_c$

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

$28.3 = 5\left(\frac{v^2}{1}\right)$

$v = 2.38\ m/s$

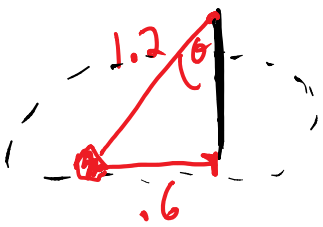
$a_c = 4\pi^2 r f^2$

$f = .38\ Hz.$

Conic Circles: these are horizontal circles caused when an object is swung in a CONE on a string

A cat of mass 5.0 kg is swung on a 1.2 m long leash through a fire in radius 0.60 m. Determine the Force of gravity, angle θ ,F_T, F_c, v, a_c and frequency

$m = 5.0kg \quad l = 1.2m \quad r = .60m$



$F_g = mg$

$= 49N$

$\sin\theta = \frac{opp}{hyp} = \frac{1}{2}$

$\theta = 30°$

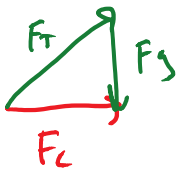
$\cos\theta = \frac{F_g}{F_T} = \frac{49}{F_T}$

$\frac{\sqrt{3}}{2} = \frac{49}{F_T}$

$F_T = 56.6N$

$\cos 30 = \frac{49}{F_T}$

$F_T = \frac{49}{\cos 30}$



$F_c = ma_c$

$\tan\theta = \frac{F_c}{F_g}$

$F_g \tan\theta = F_c$

$28.3N$

$28.3 = 5\,a_c$

$a_c = 5.66\ m/s^2$

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

$v = \sqrt{.6(5.66)}$

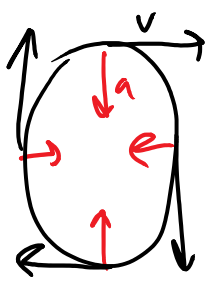
$= 1.84\ m/s$

$v = 2\pi r f$

$f = .49\ Hz.$

Circular motion in terms of frequency:

Horizontal circles on either a rotating disk or object travelling through a curve.



$F_c = F_f$

$m a_c = \mu m g$

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

$\mu g = 4\pi^2 r f^2$

A nickel of mass 1.0 g is placed on a record of radius 12 cm, if the record rotates at 30 rpm (revolutions per minute) what minimum coefficient of friction is necessary to prevent the coin from sliding off?

$m = 1.0\ g \quad r = 12\ cm \quad 30 = rpm \quad \mu = ?$

$30\ rpm = \frac{30\ cycles}{60\ seconds} = .5\ Hz. \rightarrow f$

$\mu g = 4\pi^2 r f^2$

$\mu = \frac{4\pi^2 (12 \times 10^{-2})(.5)^2}{9.8} = .12$

A lamborghini of mass 1000 kg travels through a corner of radius 50 m, at what maximum speed can it travel if the coefficient of friction is 0.85 between the tires and road?

$m = 1000\ kg \quad r = 50m \quad \mu = .85 \quad v = ?$

$F_c = F_f$

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

$v = \sqrt{\mu g r}$

$= \sqrt{.85(9.8)(50)}$