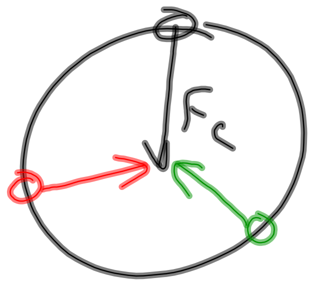
centripetal force

"center-seeking"

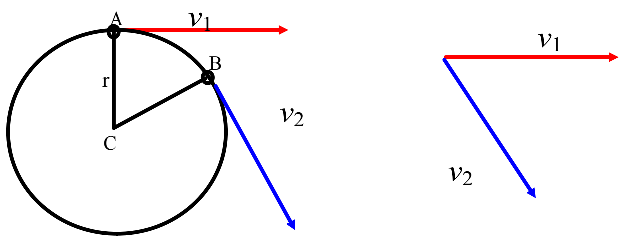


$F_c = ma_c$

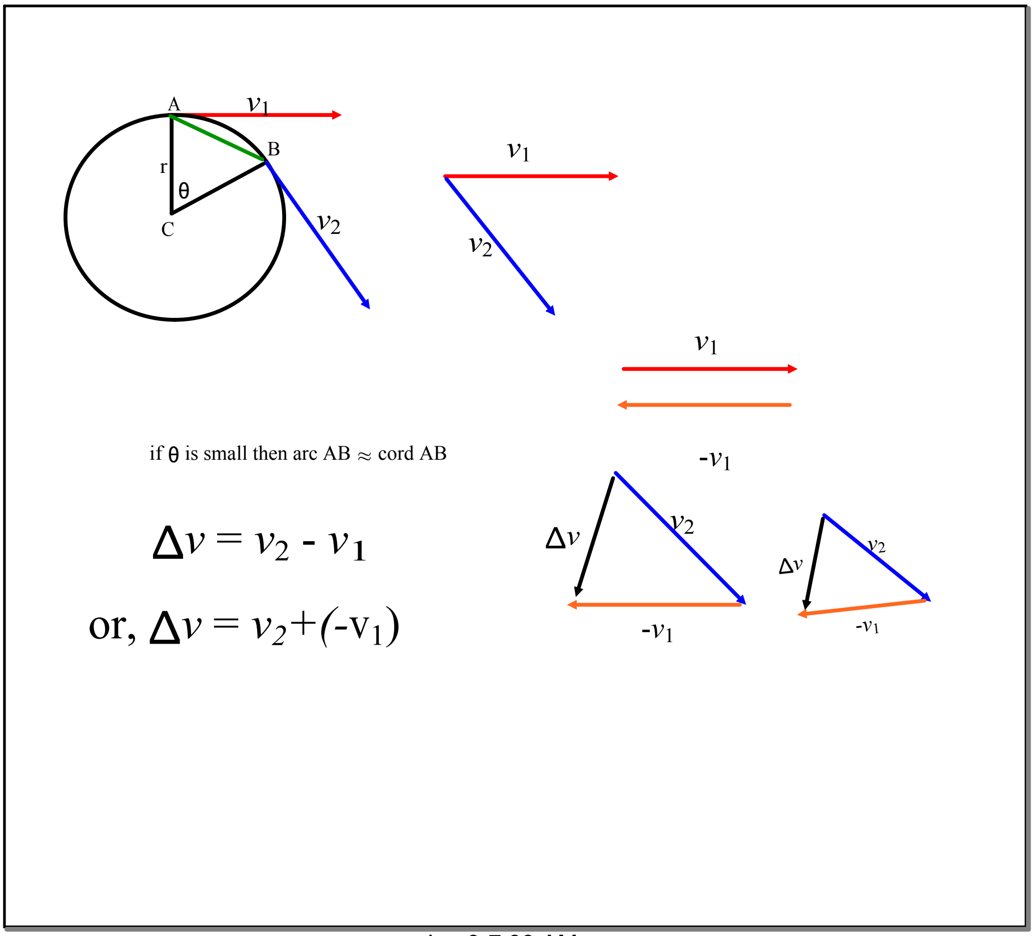
$a_c = v^2/r$

Jan 3-7:51 AM

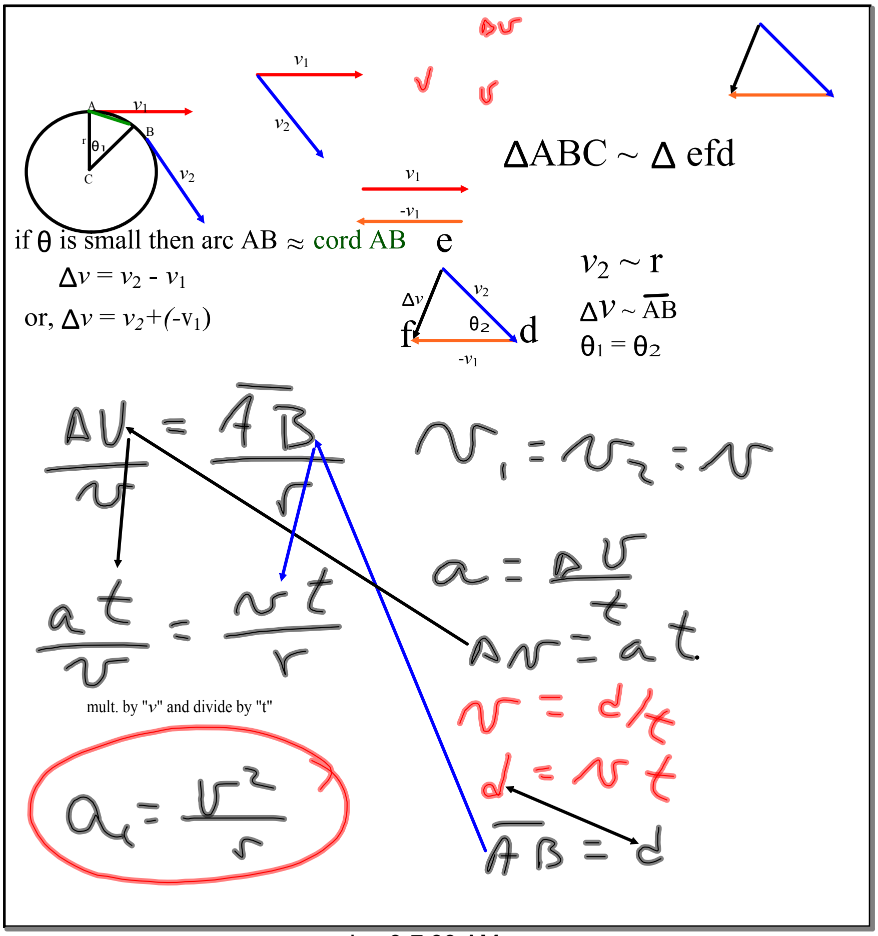
$a = \Delta v/t$



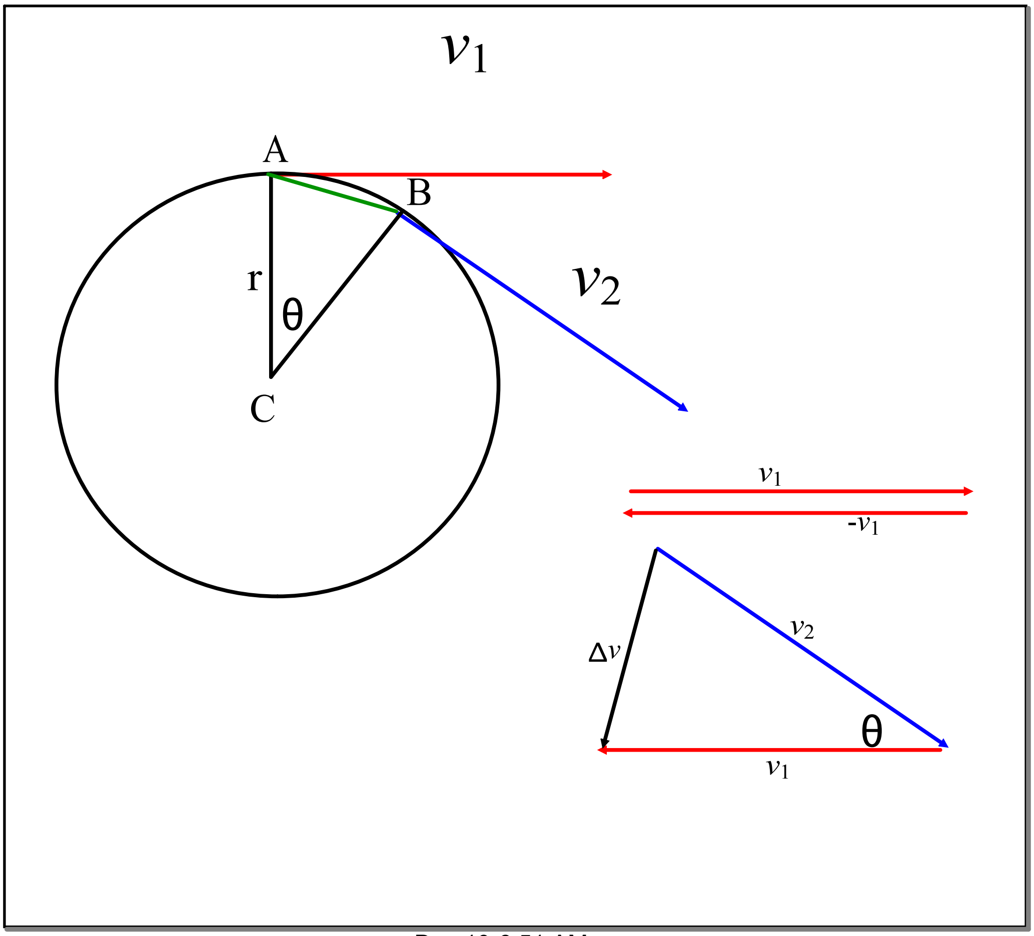
Jan 3-7:32 AM



Jan 3-7:33 AM



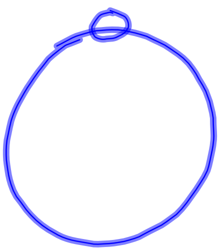
Jan 3-7:33 AM



Dec 10-6:51 AM

① $v = \frac{d}{t} = \frac{C}{t} = \left(\frac{2\pi r}{T}\right)$

Period
time/event



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

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

Dec 4-10:35 AM

T = period

time/event

$T = 1\,s$

$$v = \frac{d}{t} = \frac{C}{t} = \frac{2\pi r}{T}$$

$$v = \frac{2\pi(1.0\,m)}{1\,s}$$

$$v = 6.28\,m/s$$

$$a_c = \frac{v^2}{r} = \frac{(6.28\,m/s)^2}{1.0\,m}$$

$$a_c = 39\,m/s^2$$

30 g stopper

$$F_c = m a_c$$

$$F_c = .03\,kg(39\,m/s^2)$$

$$F_c = 1.2\,N$$

Jan 3-8:17 AM

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

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

$$F_c = m a_c$$

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

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

Jan 3-8:23 AM

Revolutions to m/s

Car idles:

v = 600. rpm's
r = 1.00 m

$$\frac{600.\ \text{rev}}{\text{min.}}\left[\frac{2\pi r(\text{m})}{\text{rev}}\right]\frac{(1\text{min})}{60\ \text{s}}$$

v = 62.8 m/s

Jan 2-10:38 AM

$T = 1/f$ f = frequency = events per time
rev/s

T = period = time per event
s/rev

note that frequency and period are reciprocals of each other

$\therefore\ T = 1/f$ or $f = 1/T$

$v = 2\pi r/T$ $\therefore\ v = 2\pi r f$

Nov 29-9:46 AM

Revolutions to m/s

Car idles:

v = 600. rpm's

f = 10 rev/s

$v = 2\pi r f$

r = 1.00 m

$$\frac{600.\ \text{rev}}{\text{min.}}\left[\frac{2\pi r(\text{m})}{\text{rev}}\right]\left(\frac{1\text{min}}{60\ \text{s}}\right)$$

v = 62.8 m/s

Nov 29-10:08 AM

f = 600 rpm's

↳ 10 rev/s ∴ T = .1 s

f = frequency = events/time = rev/s

T = period = time/event = s/rev

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

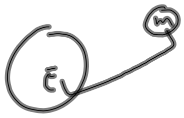
$v = \frac{2\pi r}{T}$ or $v = 2\pi r f$

Nov 29-11:03 AM

$r_e = 6.38\times10^6\,m$

moon is $60\,r_e$

r_{om} $3.8\times10^8\,m$
orbital radius of moon



$a_c = \frac{4\pi^2 r}{T^2} = \frac{4\pi^2(3.8\times10^8\,m)}{(2.4\times10^6\,s)^2}$

$T_m = 27.3\,da$ $a_c = .0026\,m/s^2$

$\hookrightarrow 2.4\times10^6\,s$

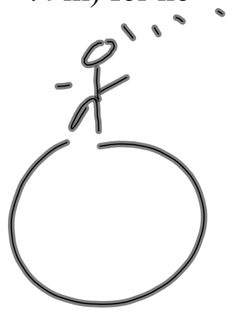
$F_c = ma_c$

$F_c = 7.2\times10^{22}\,kg\,(.0026\,m/s^2)$

$F_c = 1.9\times10^{20}\,N$

Jan 2-11:06 AM

Mr. G goes *bonkers* and runs in a tight circle (r = .4 m) for no apparent reason. He's slow, so it takes him 2 seconds to go around once. What centripetal force does the floor apply to him?



$T = 2\,s$

$r = .4\,m$

$m = 93\,kg$

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

$F_c = \frac{93\,kg\,(4)\pi^2(.4\,m)}{(2\,s)^2}$

$F_c = 367\,N$

Jan 2-11:15 AM

Circular Motion — external axis - not part of object
object revolves

Rotational Motion — internal axis - part of object
object rotates about axis (pivot)

Obeys 1st Law

wants to maintain a constant velocity (straight line/constant speed-inertia)

wants to to rotate in a constant plane at a constant speed - rotational inertia

2nd Law

$F_c = ma_c$

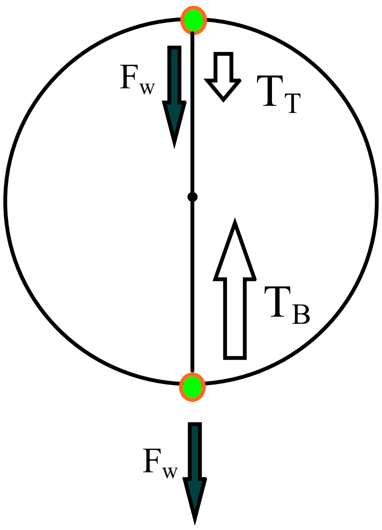
a centripetal force is necessary for an object to circle(accelerate) - circling is accelerating because object is changing direction. It takes a force to change the direction of an object

$\tau = I\alpha$

a torque is required to rotate an object. a torque (τ) is needed to cause an object of inertia (I) to accelerate (α)

Jan 2-10:15 AM

Vertical Circle



Bottom of Circle

V_{max} at bottom

$\Sigma F = ma$ ... $ma = mv^2/r = F_c$

$T_B + F_w = F_c$

$T_B + F_w = mv^2/r$

$T_B = mv^2/r - (F_w)$

or, $F_c = T_B + F_w$

Oct 22-6:54 AM

A 100. g stopper has a velocity of 12 m/s at the bottom of a 1.0 m vertical circle. What is the tension on the string?

$m = 100.$ g
$v = 12$ m/s
$r = 1.0$ m
$T_B = ?$

Oct 22-7:08 AM

A 100. g stopper has a velocity of 12 m/s at the bottom of a 1.0 m vertical circle. What is the tension on the string?

$m = 100.$ g
$v = 12$ m/s
$r = 1.0$ m
$T_B = ?$

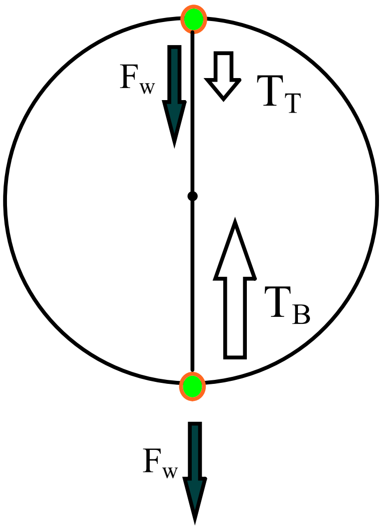
$T_B = mv^2/r - mg$

$T_B = [.100\text{kg}(12\text{m/s})^2]/1.0\text{ m} - [.100\text{ kg}(-9.8\text{ m/s}^2)]$

$T_B = 15.4$ N

Oct 22-7:11 AM

Vertical Circle



Top of Circle

V_{min} at top and $T_T = 0$

and $F_w = F_c$

$\Sigma F = ma = mv^2/r$

$T_T + F_w = mv^2/r$

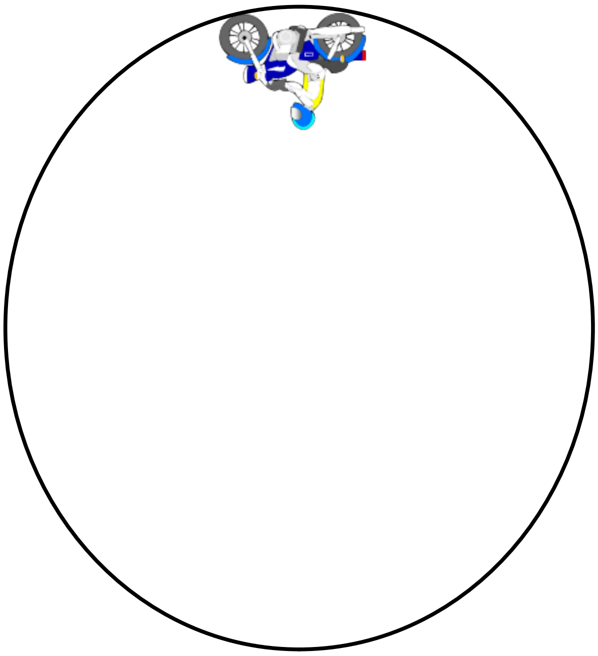
$T_T + mg = mv^2/r$

$T_T = 0 \therefore mg = mv^2/r$

and, $v^2 = rg$

Oct 22-7:14 AM

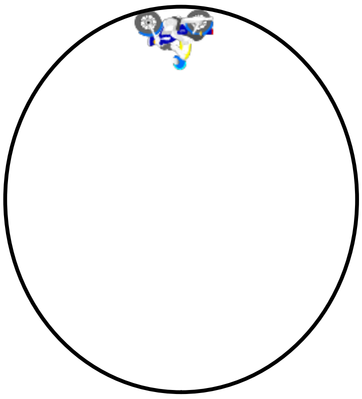
What is the minimum velocity of a circus cycle doing vertical loop in a 14 m loop? The cycle and rider has a combined mass of 275 kg.



$r = 14$ m
$m = 275$ kg
v_{min}

Oct 22-7:36 AM

What is the minimum velocity of a circus cycle doing vertical loop in a 14 m loop? The cycle and rider has a combined mass of 275 kg.



$v^2 = rg$

$v = \sqrt{rg}$

$v = \sqrt{14m(9.8m/s^2)}$

$v = 12$ m/s

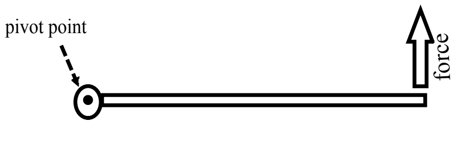
r = 14 m
m = 275 kg
v_{min}

Rotational Motion

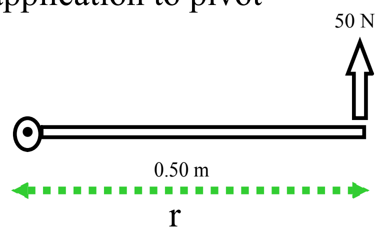
a rigid rotating object: a mass that rotates about its own axis (pivot point)

Torque (τ) required to change rotation

$\tau = Fr$ F = force applied
r = torque (lever) arm ($\perp$distance from point of force application to pivot



object will rotate counterclockwise (cc)



$\tau = Fr$
$\tau = 50$ N x 0.50 m = 25 mN

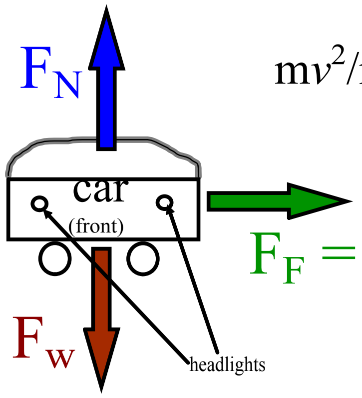
Cornering on the Horizontal

$F_c = F_f \quad \therefore\ mv_2/r = \mu Fn$

on horizontal, $F_N = F_w = mg$

$mv^2/r = \mu mg$

or, $\mu = v^2/rg$



$F_F = F_c$

Oct 26-7:23 AM

Note, F_N is resultant!!!

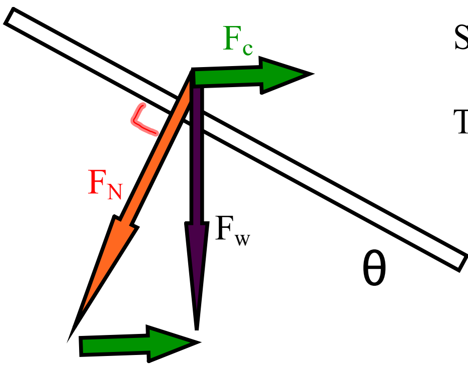
$\cos\theta = F_w/F_N$ and $\sin\theta = Fc/F_N$

$\therefore\ F_N = F_w/\cos\theta = mg/\cos\theta$ and $F_N = F_c/\sin\theta = mv^2/(r\sin\theta)$

$\therefore\ mg/\cos\theta = mv^2/r\sin\theta$

$\sin\theta / \cos\theta = mv^2/rmg$

$\tan\theta = v^2/rg$



F_N supplies F_c for circular motion, no F_F is needed

*Note that F_c is directed toward the center of curvature (the circle) and is perpendicular to F_w $\therefore$ F_w does **not** produce F_c, but F_c comes from F_N*

Oct 26-7:34 AM

Little Ronnie has a mass of 60. kg and can just hold a 110 kg mass hanging from a rope without it sliding through his hands. Little Ronnie decides to use his massive strength to swing from the ceiling of the gym with a rope that is 5.0 m long. What maximum velocity can Little Ronnie hit the bottom his swing at? How high up could he swing from? What angle would that be?

Oct 27-7:35 AM

Little Ronnie has a mass of 60. kg and can just hold a 110 kg mass hanging from a rope without it sliding through his hands. Little Ronnie decides to use his massive strength to swing from the ceiling of the gym with a rope that is 5.0 m long. What maximum velocity can Little Ronnie hit the bottom his swing at? How high up could he swing from? What angle would that be?

$m = 60.\ kg$

$F_w = -588\ N$

$T = 110\ kg(9.8\ m/s^2) = 1078\ N$

$F_c = T + F_w$

$mv^2/r = T + F_w$

$v = \sqrt{[(T + F_w)r]/m}$

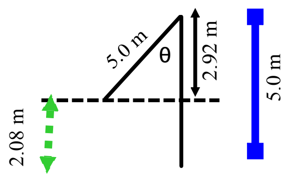
$v = \sqrt{[((1078\ N + (-588\ N))5.0\ m]/60\ kg}$

$v = 6.39\ m/s$

$v_2^2 = v_1^2 + 2ad$

$d = (v_2^2 - v_1^2)/2a$

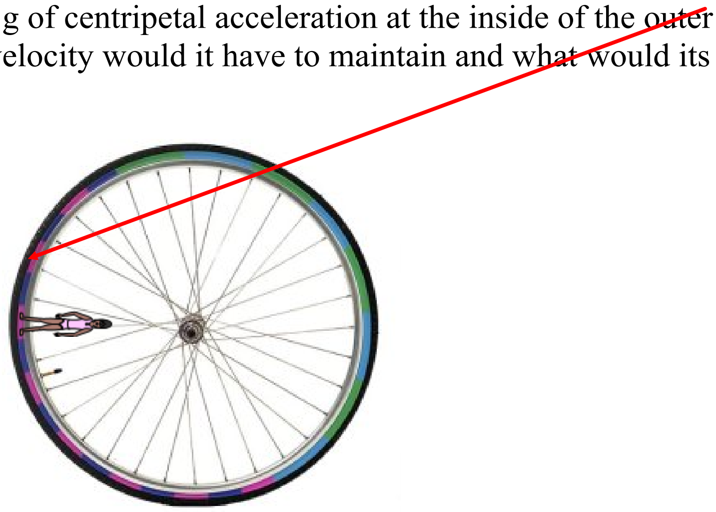
$d = (6.39\ m/s)^2/2(9.8\ m/s^2) = 2.08\ m$



$\cos\theta = 2.92\ m/5.0\ m = 54.3^0$

Oct 27-7:35 AM

NASA developed plans for a space station that would be a lot like a bike tire. It would have to be about 1.2 km in diameter and maintain 1g of centripetal acceleration at the inside of the outer rim. What velocity would it have to maintain and what would its period be?



Oct 27-7:35 AM

NASA developed plans for a space station that would be a lot like a bike tire. It would have to be about 1.2 km in diameter and maintain 1g of centripetal acceleration at the inside of the outer rim. What velocity would it have to maintain and what would its period be?

dia = 1200 m

r = 600 m

$a = 1g = 9.8\ m/s^2$

v = ?

T = ?

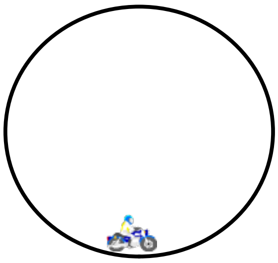
$a = v^2/r$

$v = \sqrt{ar} = \sqrt{9.8\ m/s^2(600\ m)} = 77\ m/s$

$v = 2\pi r/T \quad T = 2\pi r/v = 6.28(600\ m)/77\ m/s = 48.9\ s$

Oct 27-7:35 AM

A motor bike stunt rider wants to do his vertical circle trick and has determined his bike (an him) can only withstand 3g's of acceleration safely. If he wants to do his trick at 60. mph how big will the circular track be? What will his effective weight be at the bottom of the run?



Oct 27-7:37 AM

A motor bike stunt rider wants to do his vertical circle trick and has determined his bike (an him) can only withstand 3g's of acceleration safely. If he wants to do his trick at 60. mph how big will the circular track be? What will his effective weight be at the bottom of the run if his mass is 70. kg?

a = 3g's = 29.4 m/s^2
v = 60. mph
27 m/s
m = 70 kg
F_w = -686 N
r = ?

$a = v^2/r$

$r = v^2/a = (27 m/s)^2/29.4 m/s^2 = 24.8 m$

$\Sigma F = F_c + F_w = ma_c + mg$
$\Sigma F = 70 kg(29.4 m/s^2 + 9.8 m/s^2) = 2744 N$

Oct 27-7:37 AM

What angle exit ramp is needed for a 1200 kg car to circle without needing friction. The radius of the ramp is 75 m and your traveling 55 mph.

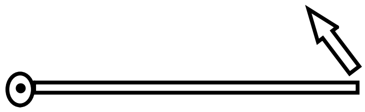
Oct 26-7:46 AM

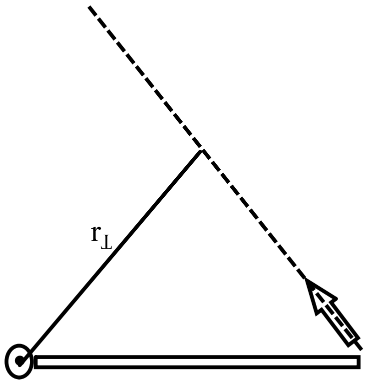
What angle exit ramp is needed for a 1200 kg car to circle without needing friction. The radius of the ramp is 75 m and your traveling 55 mph.

$\tan \Theta = v^2/rg$

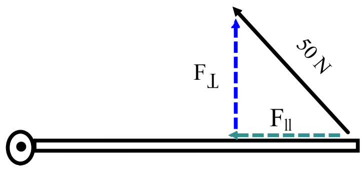
Oct 26-7:49 AM

When force or lever arm are not perpendicular to each other you have to make one of them (either one) perpendicular





make lever are perpendicular
extend direction of force and draw a radius perpendicular to that direction



make force are perpendicular
draw force vector to scale and break down in to parallel and perpendicular components

Jan 3-10:21 AM