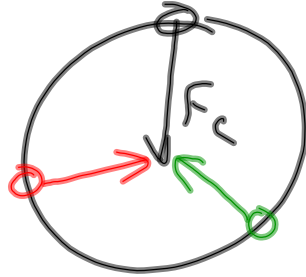


centripetal force

"center-seeking"

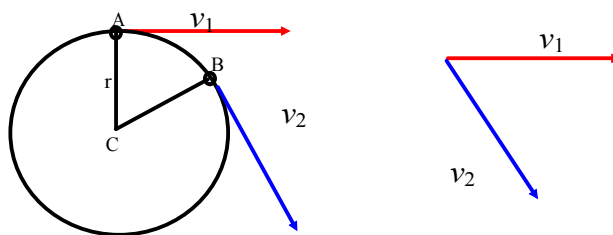


$$F_c = ma_c$$

$$a_c = v^2/r$$

Jan 3-7:51 AM

$$a = \Delta v/t$$



Jan 3-7:32 AM

if θ is small then arc $AB \approx$ cord AB

$$\Delta v = v_2 - v_1$$

OR, $\Delta v = v_2 + (-v_1)$

Jan 3-7:33 AM

if θ is small then arc $AB \approx$ cord AB

$$\Delta v = v_2 - v_1$$

OR, $\Delta v = v_2 + (-v_1)$

$\Delta ABC \sim \Delta efd$

$v_2 \sim r$
 $\Delta v \sim \overline{AB}$
 $\theta_1 = \theta_2$

$v_1 = v_2 = v$

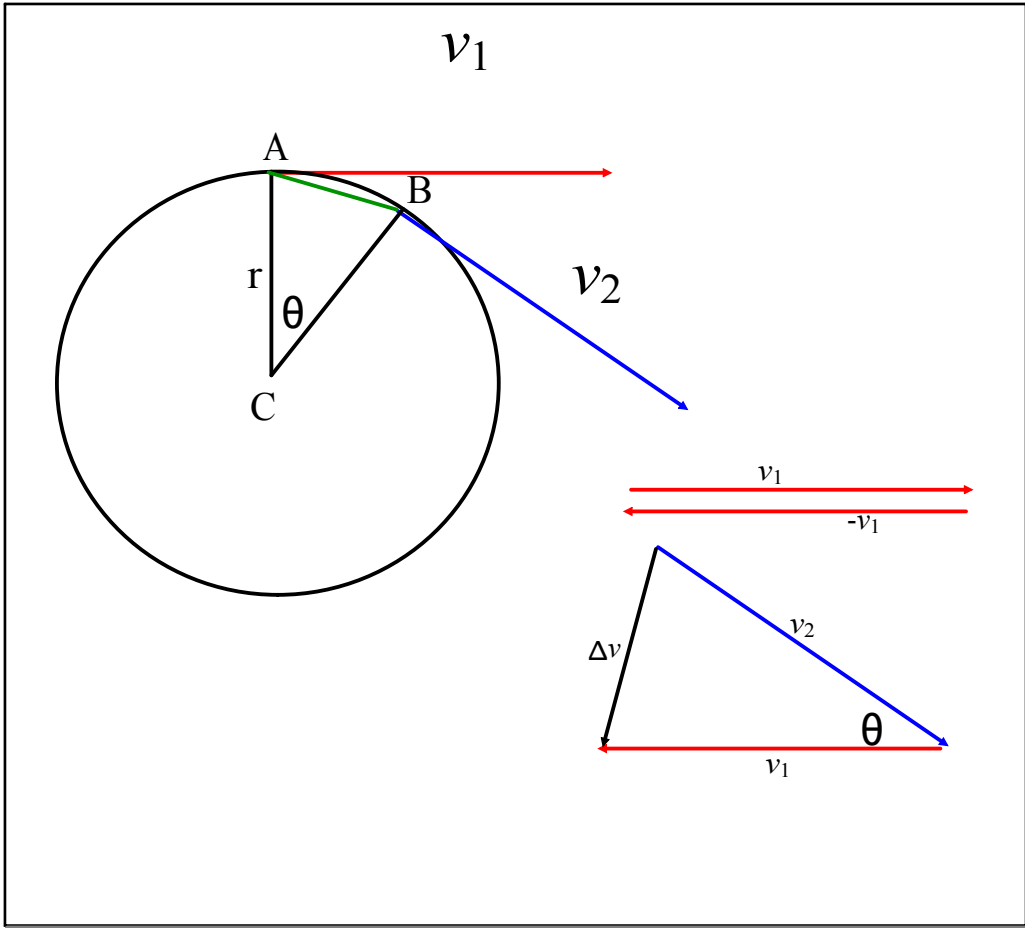
$a = \frac{\Delta v}{t}$
 $\Delta v = a t$
 $v = d/t$
 $d = v t$
 $\overline{AB} = d$

$\frac{\Delta v}{v} = \frac{\overline{AB}}{r}$

mult. by "v" and divide by "t"

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

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

$T = \text{period}$
 time/event



$T = 1 \text{ s}$

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

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

$$v = 6.28 \text{ m/s}$$

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

$$a_c = 39 \text{ m/s}^2$$

30 g stopper

$$F_c = ma_c$$

$$F_c = 0.03 \text{ kg}(39 \text{ m/s}^2)$$

$$F_c = 1.2 \text{ N}$$

Jan 3-8:17 AM

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

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

$$F_c = ma_c$$

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

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

Jan 3-8:23 AM

Revolutions to m/s

Car idles:

$$v = 600. \text{ rpm's}$$

$$r = 1.00 \text{ m}$$

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

$$v = 62.8 \text{ m/s}$$

Jan 2-10:38 AM

$$T = 1/f \quad f = \text{frequency} = \frac{\text{events per time}}{\text{rev/s}}$$

$$T = \text{period} = \frac{\text{time per event}}{\text{s/rev}}$$

note that frequency and period are reciprocals of each other

$$\therefore T = 1/f \quad \text{or} \quad f = 1/T$$

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

Nov 29-9:46 AM

Revolutions to m/s

Car idles:

$$v = 600. \text{ rpm's}$$

$$f = 10 \text{ rev/s}$$

$$v = 2\pi r f$$

$$r = 1.00 \text{ m}$$

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

$$v = 62.8 \text{ m/s}$$

Nov 29-10:08 AM

$$f = 600 \text{ rpm's}$$

$\rightarrow 10 \text{ rev/s} \therefore T = 0.1 \text{ s}$

$$f = \text{frequency} = \frac{\text{events}}{\text{time}} = \frac{\text{rev}}{\text{s}}$$

$$T = \text{period} = \frac{\text{time}}{\text{event}} = \frac{\text{s}}{\text{rev}}$$

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

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

Nov 29-11:03 AM

$$r_c = 4.38 \times 10^8 \text{ m}$$

moon is 60 r_c

$$r_{\text{om}} = 3.84 \times 10^8 \text{ m}$$

orbital radius of moon



$$a_c = \frac{4\pi^2 r}{T^2} = \frac{4\pi^2 (3.84 \times 10^8 \text{ m})}{(2.4 \times 10^6 \text{ s})^2}$$

$$T_m = 27.3 \text{ da} \quad a_c = .0026 \text{ m/s}^2$$

$$\rightarrow 2.4 \times 10^6$$

$$F_c = m a_c$$

$$F_c = 7.2 \times 10^{22} \text{ kg} (.0026 \text{ m/s}^2)$$

$$F_c = 1.9 \times 10^{20} \text{ N}$$

Jan 2-11:06 AM

Mr. G goes *bonkers* and runs in a tight circle ($r = .4 \text{ m}$) 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?

$$T = 2 \text{ s}$$

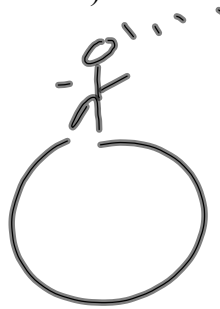
$$r = .4 \text{ m}$$

$$m = 93 \text{ kg}$$

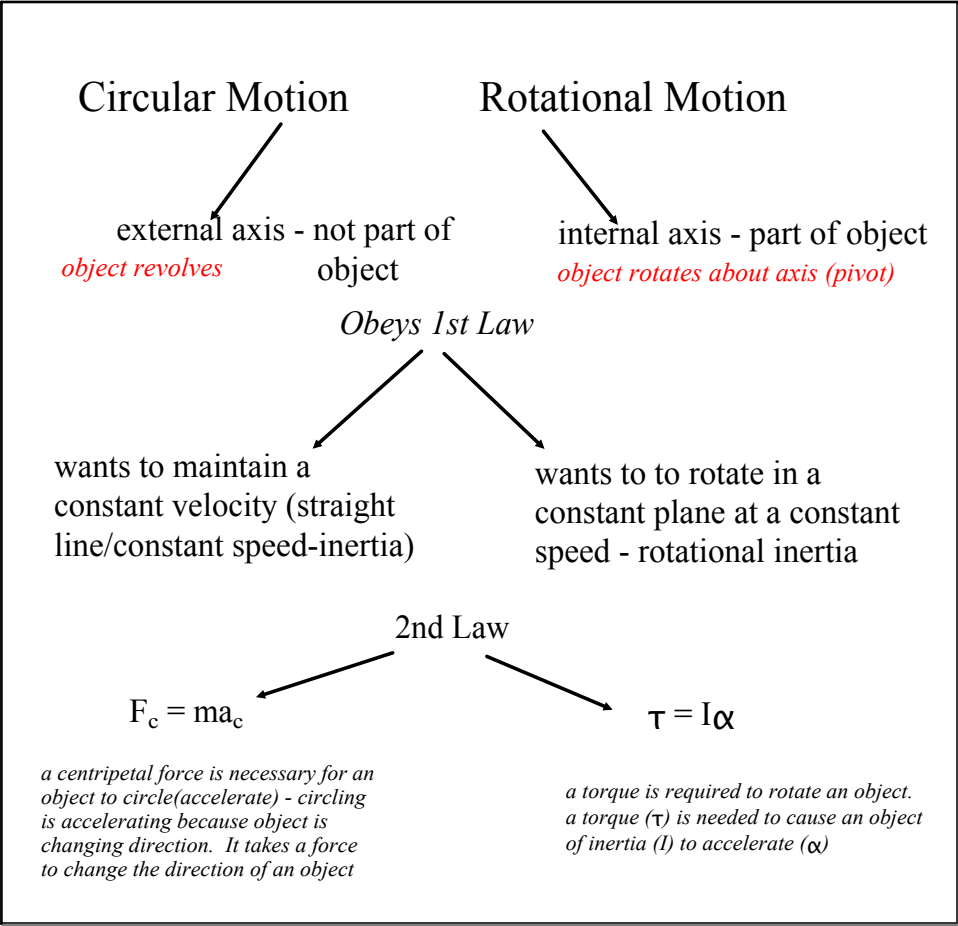
$$F_c = \frac{m 4\pi^2 r}{T^2}$$

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

$$F_c = 367 \text{ N}$$



Jan 2-11:15 AM



Jan 2-10:15 AM

Vertical Circle

Bottom of Circle

V_{max} at bottom

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

$T_B + F_w = F_c$

$T_B + F_w = mv^2/r$

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

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?

$m = 100. \text{ g}$
 $v = 12 \text{ m/s}$
 $r = 1.0 \text{ m}$
 $T_B = ?$



Oct 22-7:08 AM

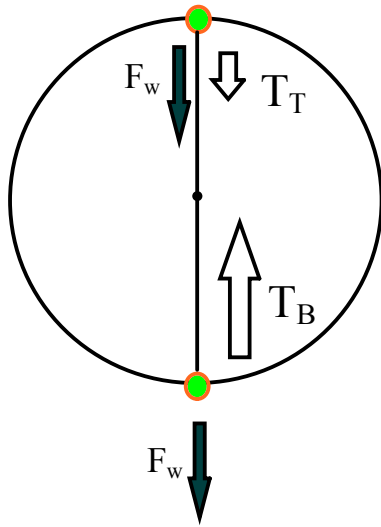
A 100. g stopper has a velocity of 12 m/s at the bottom of a 1.0 m vertical circle. What is the tension on the string?

$T_B = mv^2/r - mg$
 $m = 100. \text{ g}$
 $v = 12 \text{ m/s}$
 $r = 1.0 \text{ m}$
 $T_B = ?$
 $T_B = [.100\text{kg}(12\text{m/s})^2]/1.0 \text{ m} - [.100 \text{ kg}(-9.8 \text{ m/s}^2)]$
 $T_B = 15.4 \text{ N}$



Oct 22-7:11 AM

Vertical Circle



Top of Circle

v_{\min} at top and $T_T = 0$

and $F_w = F_c$

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

$$T_T + F_w = mv^2/r$$

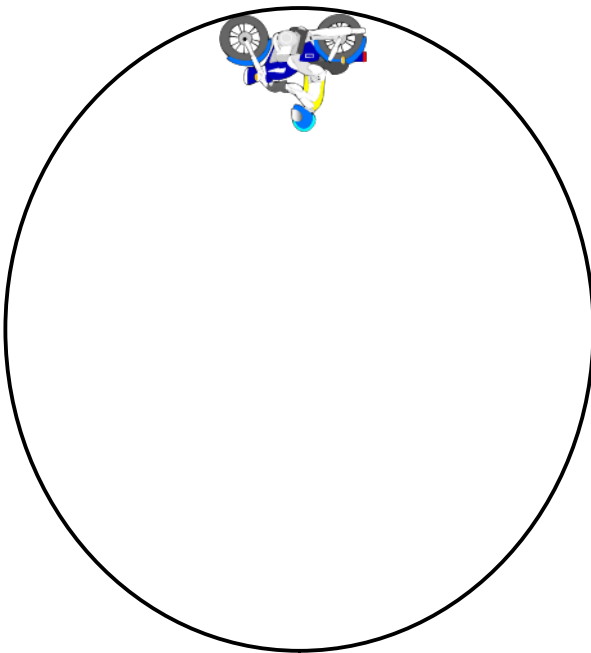
$$T_T + mg = mv^2/r$$

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

$$\text{and, } v^2 = rg$$

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.



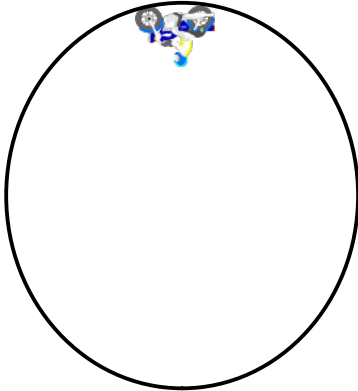
$$r = 14 \text{ m}$$

$$m = 275 \text{ kg}$$

$$v_{\min}$$

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.



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

$$v^2 = rg$$

$$v = \sqrt{rg}$$

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

$$v = 12 \text{ m/s}$$

Oct 22-7:39 AM

Rotational Motion

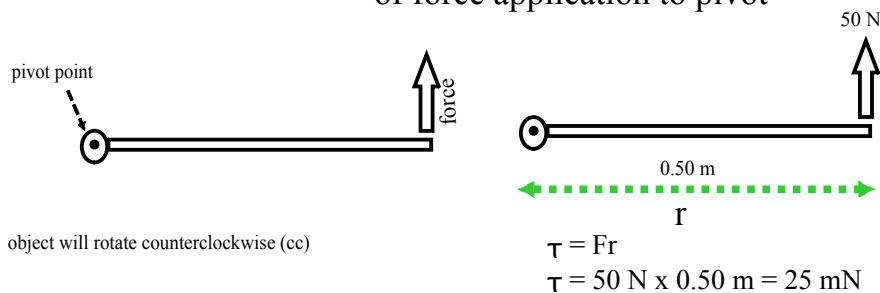
a rigid rotating object: a mass that rotates about its own axis (pivot point)

Torque (τ) required to change rotation

$$\tau = Fr$$

$F =$ force applied

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

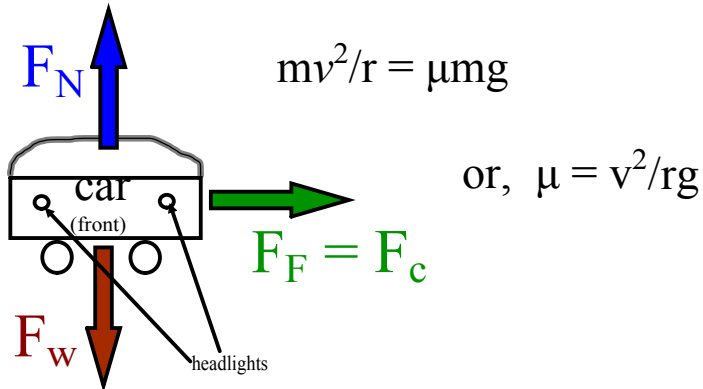


Jan 3-8:20 AM

Cornering on the Horizontal

$$F_c = F_f \quad \therefore mv^2/r = \mu F_n$$

on horizontal, $F_N = F_w = mg$



Oct 26-7:23 AM

Note, F_N is resultant!!!

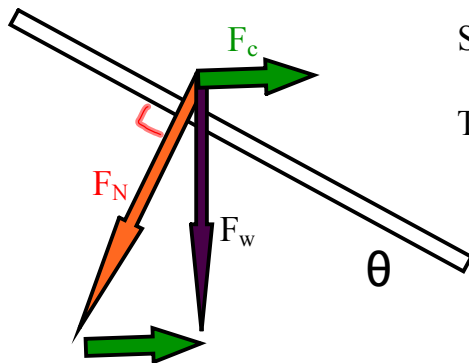
$$\cos \theta = F_w/F_N \quad \text{and} \quad \sin \theta = F_c/F_N$$

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

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

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

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



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?

$$m = 60. \text{ kg}$$

What angle would that be?

$$F_w = -588 \text{ N}$$

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

$$F_c = T + F_w$$

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

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

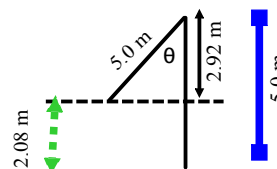
$$mv^2/r = T + F_w$$

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

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

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

$$v = 6.39 \text{ m/s}$$



$$\cos \theta = 2.92 \text{ m} / 5.0 \text{ m} = 54.3^\circ$$

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?

$$\text{dia} = 1200 \text{ m}$$

$$r = 600 \text{ m}$$

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

$$v = ?$$

$$T = ?$$

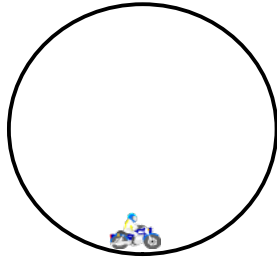
$$a = v^2/r$$

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

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

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?

$$a = 3g's = 29.4 \text{ m/s}^2$$

$$v = 60. \text{ mph}$$

$$27 \text{ m/s}$$

$$m = 70 \text{ kg}$$

$$F_w = -686 \text{ N}$$

$$r = ?$$

$$a = v^2/r$$

$$r = v^2/a = (27\text{m/s})^2/29.4 \text{ m/s}^2 = 24.8 \text{ m}$$

$$\Sigma F = F_c + F_w = ma_c + mg$$

$$\Sigma F = 70 \text{ kg}(29.4 \text{ m/s}^2 + 9.8 \text{ m/s}^2) = 2744 \text{ N}$$

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.

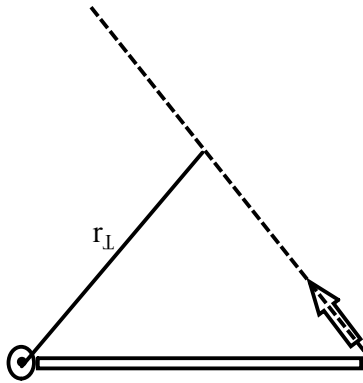
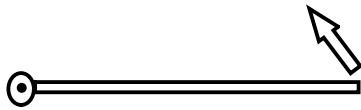
Oct 26-7:46 AM

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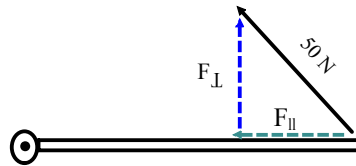
$$\tan \Theta = v^2/rg$$

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