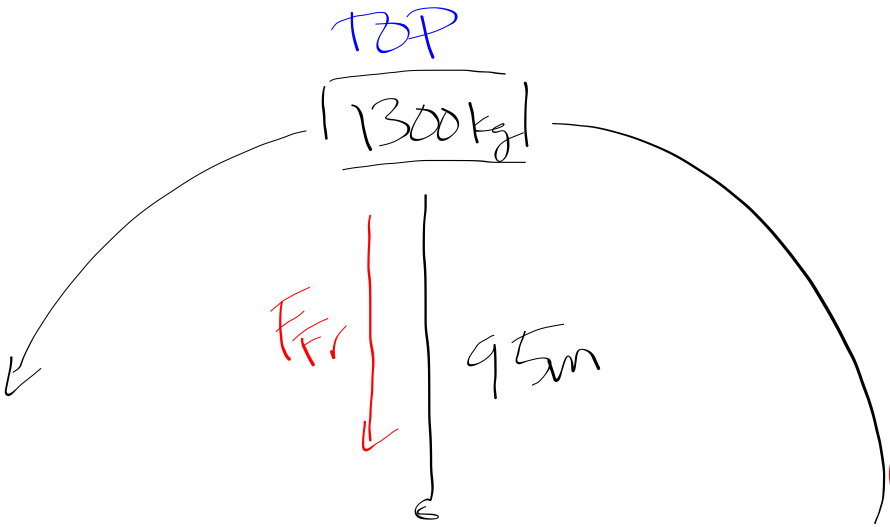
5. What is the maximum speed with which a 1300-kg car can round a turn of radius 95 m on a flat road if the coefficient of friction between tires and road is 0.55? Is this result independent of the mass of the car?



$\Sigma F = F_c$

YES

$$F_{Fr} = \frac{mv^2}{r}$$

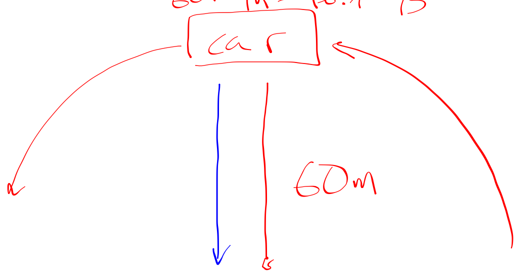
μF_N

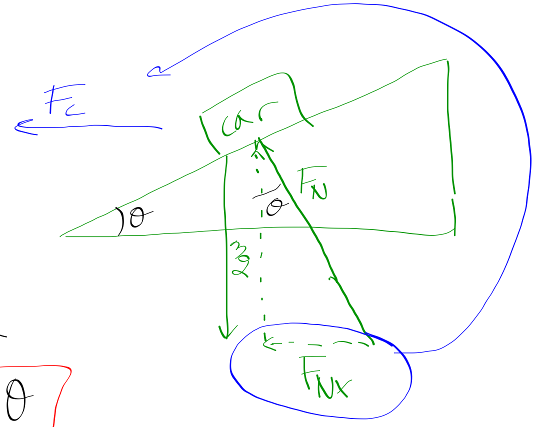
$$\mu \cancel{m} g = \frac{\cancel{m} v^2}{r}$$

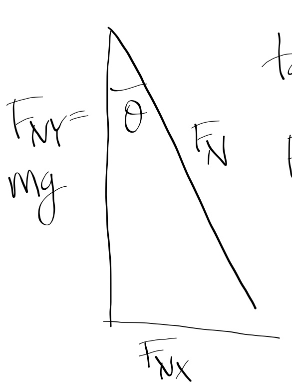
$$v = \sqrt{\mu \cdot g \cdot r}$$

16. What must a curve with a radius of 60.0 m be banked at (i.e. what is the banking angle) for a car traveling at 60 km/h? Remember, banked curves are designed so that for a given speed, NO fricition would be require to safely get around the corner. (Although not required, a more interesting, and difficult problem, would be to determine what the coefficient of static friction needs to be for a car not to skid when traveling at 90 km/h around this same curve, banked at the angle you determine in solving this problem).

$60\,km/h = 16.7\,m/s$







$$\tan\theta = \frac{F_{Nx}}{mg}$$

$$F_{Nx} = \boxed{mg\tan\theta}$$

$$\Sigma F = F_c$$

$$F_{Nx} = F_c$$

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

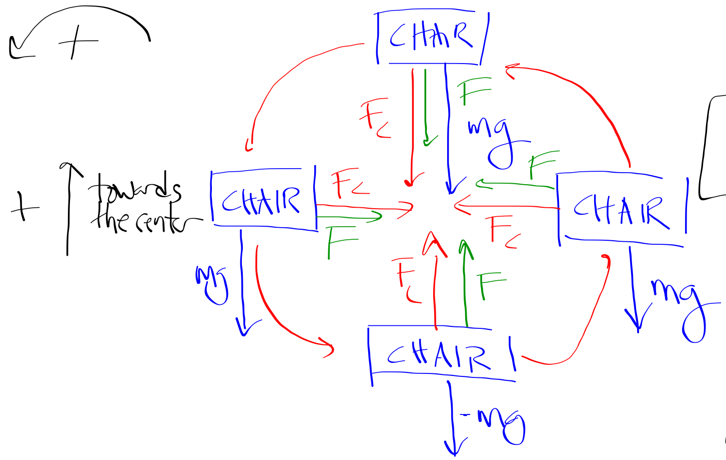
$$g\tan\theta = \frac{v^2}{r}$$

$$\theta = \tan^{-1}\frac{v^2}{r\cdot g}$$

$$= \tan^{-1}\left(\frac{16.7^2}{60\cdot 9.8}\right) = 25.4^\circ$$

Vertical Circular Motion:

To maintain a constant centripetal (towards the center!) force, we must account for the fact that the direction of the gravitational force is always the same. Therefore, whatever other forces that are providing the centripetal force must be constantly changing in both direction AND magnitude.



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

$\boxed{F} + mg = F_c$ (top)

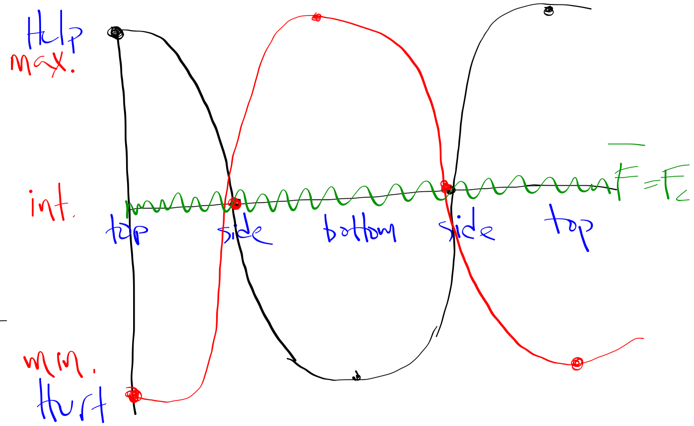
$\boxed{F} = F_c$ (sides)

$\boxed{F} + -mg = F_c$ (bottom)

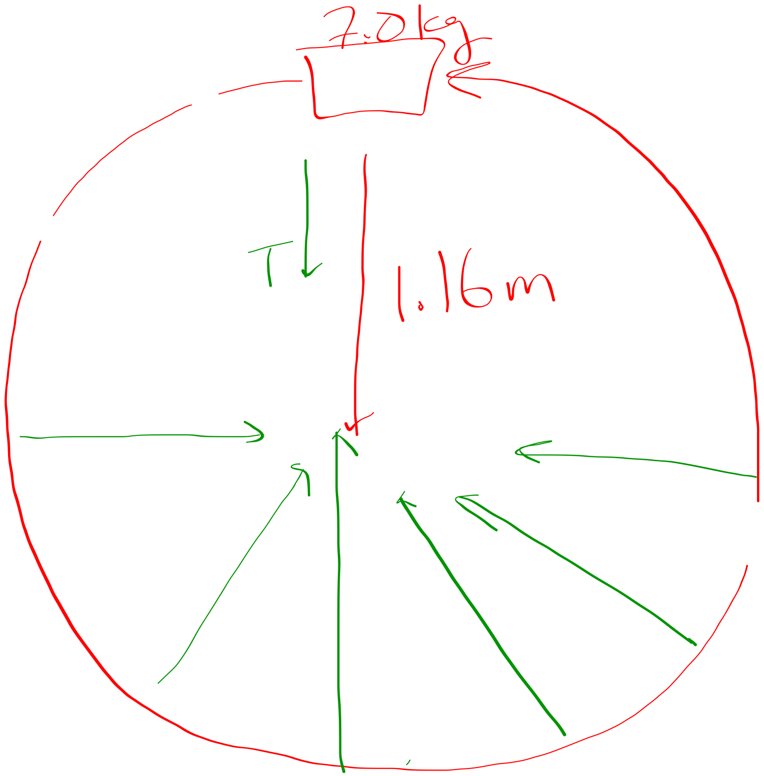
top: $F = F_c - mg$

sides: $F = F_c$

bottom: $F = F_c + mg$



EXAMPLE 1: A 7.0 kg mass at the end of a 116.0 cm string is spun in a vertical circle. The mass moves with a speed of 4.5 m/sec. What is the tension in the string when the mass is at the top of its travel? At the bottom?



top: $T + mg = F_c$

$$T = \frac{mv^2}{r} - mg$$

$$= \frac{7(4.5)^2}{1.16} - (7)(9.8)$$

$$= 53.6\ N$$

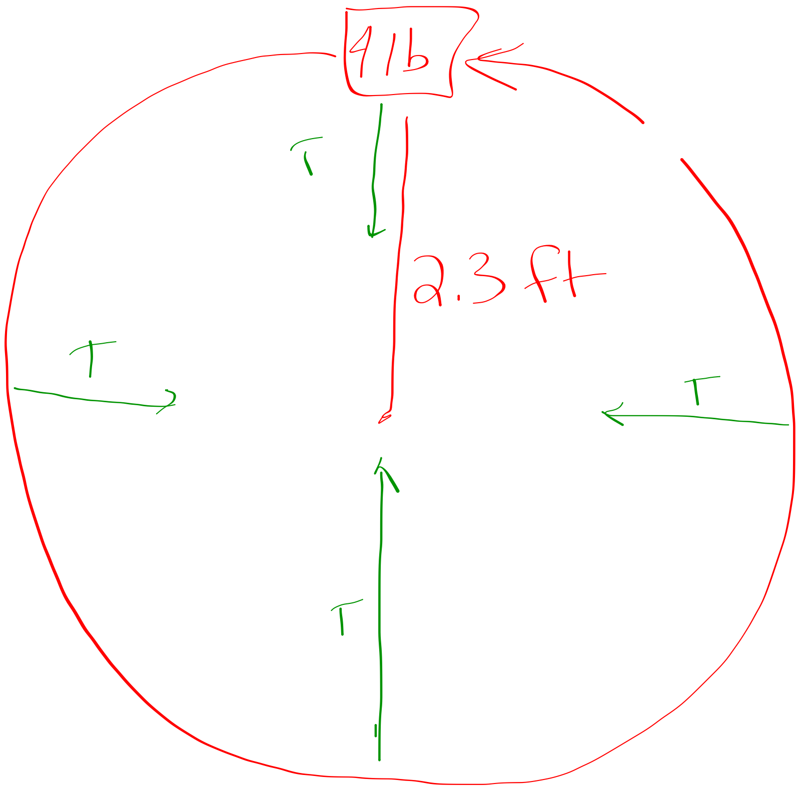
bottom: $T - mg = F_c$

$$T = \frac{mv^2}{r} + mg$$

$$= \frac{7(4.5)^2}{1.16} + (7)(9.8)$$

$$= 190.8\ N$$

EXAMPLE 2: A 4.0 lb object is swung in a vertical circle having a radius of 2.3 feet. At what speed will the string just begin to go slack? Where is the object along its circular path when the string first goes slack?



String is slack when T=0

(has to be @ top)

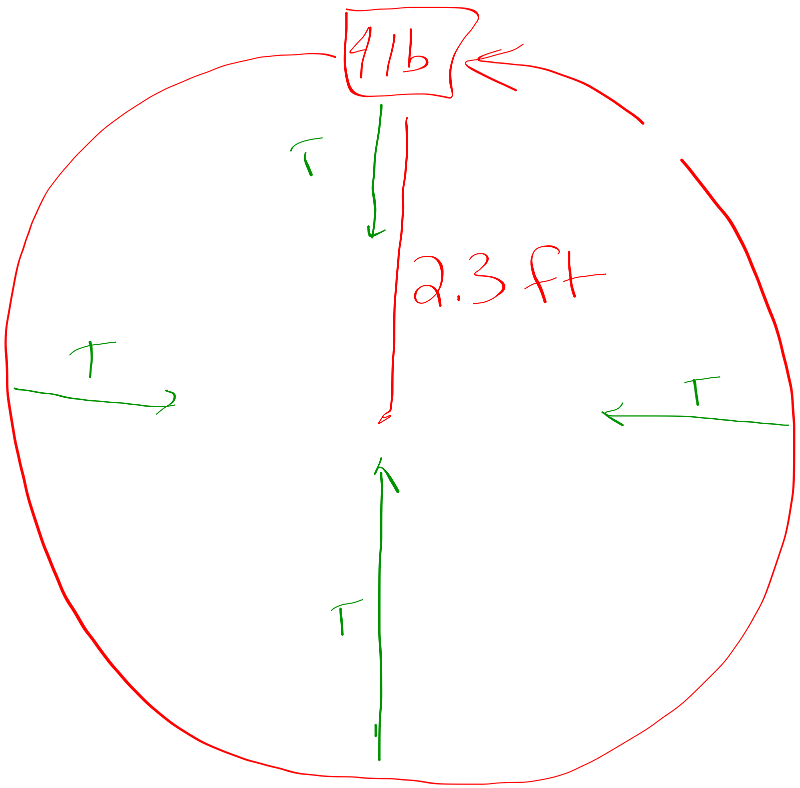
$$\cancel{T} + mg = \frac{mv^2}{r}$$

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

$$v = \sqrt{r \cdot g} = \sqrt{2.3 \cdot 32.2}$$

$$v = 8.6 \text{ ft/s}$$

EXAMPLE 3: For the previous problem, if the string breaks at 110.0 lbs, at what speed will the string break?



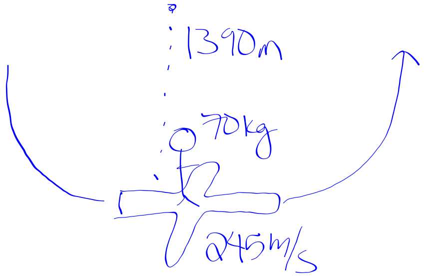
String will break when $T = 110$ (@ bottom)

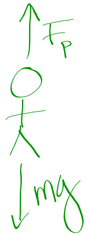
$$T - mg = F_c = \frac{mv^2}{r}$$

$$110\text{ lb} - 4\text{ lb} = \frac{(4/32.2)v^2}{2.3}$$

$$v = 44.3 \text{ ft/s}$$

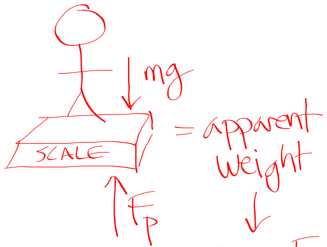
EXAMPLE 4: An airplane finds itself at the bottom of a circular dive having a radius of 1390 meters. The plane is traveling at 245 m/s.
a) What is the apparent weight of a 70-kg person when at the bottom of the dive?
b) How many g's does the person experience at this moment?





What is the Force exerted by the plane?

$$F_p - mg = F_c$$
$$F_p = mg + \frac{mv^2}{r}$$
$$= (70)(9.8) + \frac{(70)(245^2)}{1390}$$
$$\boxed{F_p = 3{,}708.8\,N}$$



$$mg + F_p = (70)(9.8) + 3708.8$$

a) $\boxed{\text{apparent weight} = 4394.8\ N}$

b) $1\,g = 9.8\ m/s^2$

$$a_c = \frac{v^2}{r} = \frac{245^2}{1390} = 43.2\ m/s^2$$
$$43.2\ m/s^2 = \boxed{4.4\,g}$$