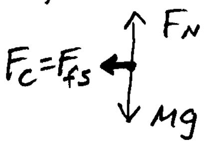
Centripetal Force

1) Car turning on flat road.

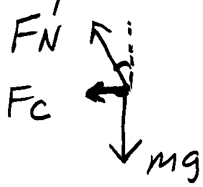


$F_N = mg$

$\Sigma F_x = \frac{mv^2}{r}$ $\quad$ $\mu_s F_N = \frac{mv^2}{r}$ $\quad$ $v^2 = \mu_s g r$

$F_{fs} = \frac{mv^2}{r}$ ↗ $\quad$ $\mu_s \cancel{m} g = \frac{\cancel{m} v^2}{r}$ ↗ $\quad$ $v = \sqrt{\mu_s g r}$

2) Car turning on banked track so there is no tendency to slide up or down the track. In this case, no friction is needed.



$F_N > mg$

$\Sigma F_y = 0$ $\quad$ $\Sigma F_x = \frac{mv^2}{r}$ $\quad$ $\tan\theta = \frac{v^2}{gr}$

$F_N \cos\theta - mg = 0$ $\quad$ $F_C = \frac{mv^2}{r}$ $\quad$ $v^2 = gr\tan\theta$

$F_N \cos\theta = mg$ $\quad$ $F_N \sin\theta = \frac{mv^2}{r}$ $\quad$ $v = \sqrt{gr\tan\theta}$

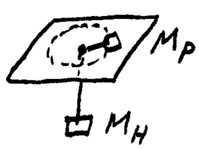
$F_N = \frac{mg}{\cos\theta}$ $\quad$ $\frac{\cancel{m}g}{\cos\theta}\sin\theta = \frac{\cancel{m}v^2}{r}$

F Is apparent weight.

3) Conical pendulum. Exactly the same as car on banked track, except F_N becomes F_T in string. θ is angle string makes with the vertical.

4) Plane banking while turning. Exactly the same as car on banked track and conical pendulum, except F_N is either the normal force on a passenger or it becomes F_L, the lift provided by the wing

5)



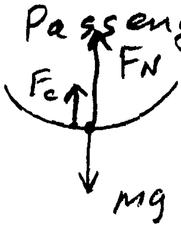
Puck rotating on frictionless table. Hanging mass provide F_c.

$M_H g = F_T$

$\Sigma F = \frac{M_P v^2}{r}$ $\quad$ $M_H g = \frac{M_P v^2}{r}$

$F_T = \frac{M_P v^2}{r}$ $\quad$ $v^2 = \frac{M_H g r}{M_P}$

6) Passenger in roller coaster going through a dip. Car, also.



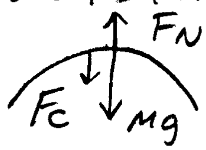
$\vec{F}_c = \vec{F}_N + m\vec{g}$ $\quad$ $F_N = \frac{mv^2}{r} + mg$

$F_c = F_N - mg$

$F_N = F_c + mg$ $\quad$ $F_N = m\left(\frac{v^2}{r} + g\right)$

F_N is apparent weight. Rider feels heavier because $F_N > mg$. This causes car and rider to go up.

7) Passenger in roller coaster going <u>over</u> the top of a hill.
Works for car, too.



$\vec{F}_c = \vec{mg} + \vec{F}_N$

$F_c = mg - F_N$

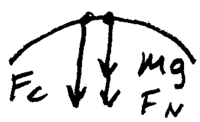
$F_N = mg - F_c$

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

$F_N = m\left(g - \frac{v^2}{r}\right)$

F_N is apparent weight, Rider feels lighter because $F_N < mg$.
This causes car and rider to go down.

8) Passenger in roller coaster going inside loop at the top.
Car is going fast enough so rider won't fall out.



Rider feels a bit lighter than mg in the diagram.

$\vec{F}_C = \vec{mg} + \vec{F}_N$

$F_c = mg + F_N$

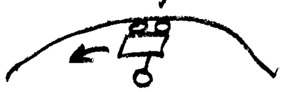
$F_N = F_c - mg$

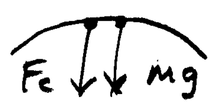
$F_N = \frac{mv^2}{r} - mg$

$F_N = m\left(\frac{v^2}{r} - g\right)$

F_N is apparent weight but rider feels his weight points up!

9) Passenger in roller coaster going inside loop at the top.
Car is going <u>just</u> fast enough so rider won't fall out.





$\vec{F}_c = \vec{F}_g$

$F_c = F_g$

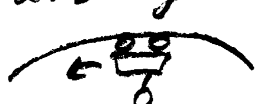
$\frac{mv^2}{r} = mg$

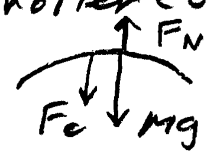
$v^2 = gr$

$v = \sqrt{gr}$

The normal force is zero! The weight <u>is</u> the F_c.

10) Passenger in roller coaster going inside loop at the top.





Car is going too slow. $mg > F_c$.
Rider will fall out without seat belt or bar, F_N pulls rider up

$F_c = mg - F_N$

$F_N = mg - F_c$

F_N is apparent weight. Rider feels his weight down but less than mg in this diagram.

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

$F_N = m\left(g - \frac{v^2}{r}\right)$

Rider wants to go in a parabola smaller than the track. Seat belt keeps him up.