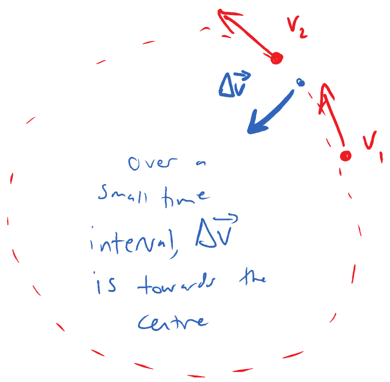
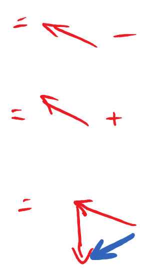
Year 12 Physics

Quick Quiz: Uniform Circular Motion

1. Using a vector subtraction, show that the change in the velocity and hence the acceleration, of an object over a very small time interval is directed towards the centre of the circle.



$\Delta\vec{v} = \vec{v}_2 - \vec{v}_1$

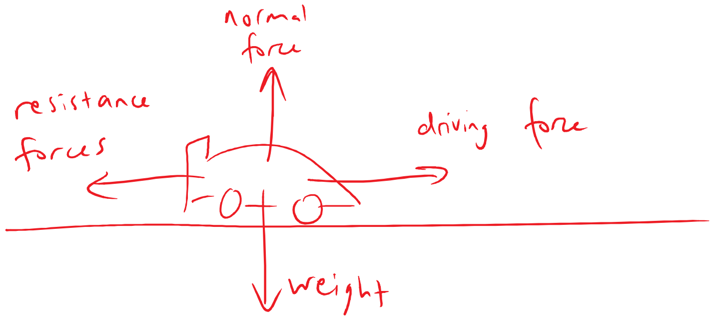


$\vec{a} = \dfrac{\Delta\vec{v}}{\Delta t}$

$\therefore$ $\vec{a}$ is in same direction as $\Delta\vec{v}$

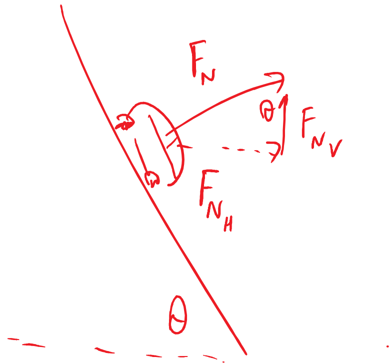
$\therefore$ towards centre

2. Draw a car below, side on. Label two vertical and two horizontal forces on the vehicle if it moving with constant velocity on a flat horizontal road.



3.

a. Derive the equation for a vehicle travelling around a banked curve with no reliance on friction.



$F_{N_V} = \text{weight} = mg$

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

$\therefore \tan\theta = \frac{F_{N_H}}{F_{N_V}} = \frac{m\frac{v^2}{r}}{mg} = \frac{v^2}{rg}$

b. A Porsche travels around a corner of radius 100 m. Elsewhere, a Mustang travels around a corner at half the speed of the Porsche. Both corners are banked to the same angle and both cars have no reliance on friction. Using proportionality, determine the radius of the corner the Mustang is travelling around.

$r_1 = 100 \qquad v_1 = v$

$r_2 = ? \qquad v_2 = \frac{1}{2}v$

$\tan\theta = \frac{v^2}{rg}$

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

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

g and $\tan\theta$ constant

$\therefore r \propto v^2$

$\therefore \frac{r_2}{r_1} = \frac{v_2^2}{v_1^2}$

$\therefore r_2 = \frac{v_2^2}{v_1^2} r_1$

$= \frac{(\frac{1}{2}v)^2}{v^2} \times 100$

$= \frac{\frac{1}{4}\cancel{v^2}}{\cancel{v^2}} \times 100$

$= 25 \text{ m}$