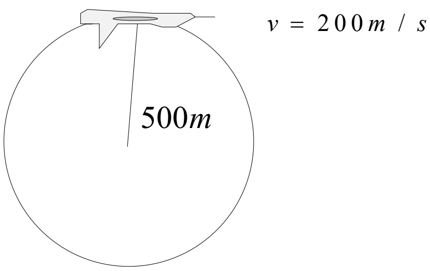
Centripetal Force is one of those concepts in physics that causes so much metal distress because centripetal force doesn't really exist.... well doesn't exist in a traditional sense. **Centripetal force** is a result of **centripetal acceleration**. The **force** that **causes** centripetal acceleration is **net resultant** of other forces such as friction, air pressure or tension. **Centripetal force** is a "**net**" force. Therefore all forces in a system must **add** up to equal the **centripetal force** or just $\vec{F}_c$.

I.e.
A 2000kg plane flying at a constant velocity of 200m/s hits the top of an acrobatic loop of radius 500m. a) find the centripetal acceleration. b) the centripetal force.



a)

$$a_c = \frac{v^2}{R} = \frac{(200)^2}{500} = 80m/s^2$$

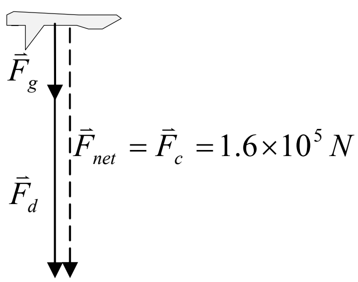
b)

$$\vec{F}_c = m\vec{a}_c = (2000)(80) = 1.6 \times 10^5 N[down]$$

Therefore the net force is 1.6 x10^{5}N down. Since the **centripetal force** is a net force, something must be causing this force.

$$\vec{F}_g = mg = 2000(9.8) = 1.96 \times 10^4 N$$

$$\vec{F}_d = ???$$

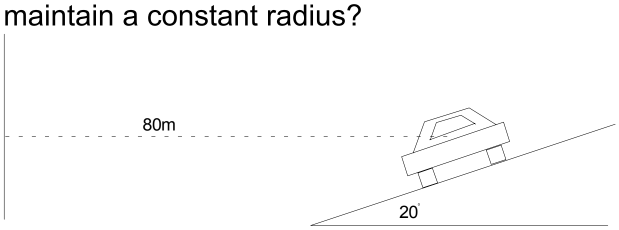


$$\vec{F}_{net} = \vec{F}_d + \vec{F}_g$$
$$-F_c = -F_d - F_g$$
$$F_c = F_d + F_g$$
$$F_d = F_c - F_g = 1.6 \times 10^5 - 1.96 \times 10^4 = 1.4 \times 10^5 N$$

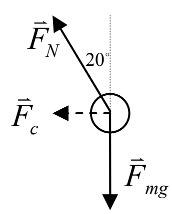
The question is, what produces the downward force? Answer.... air pressure. You could not do this in outer space because there is no atmosphere to push against. Note: **all forces add up to the net force or centripetal force**.

<u>An other Example</u>

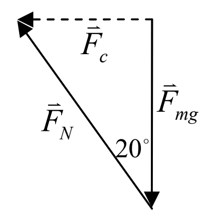
A 1000kg car travels around a frictionless banked curve at a radius of 80m. What speed is required to maintain a constant radius?



Remember, $\vec{F}_c$ is $\vec{F}_{net}$. The free body diagram looks like this.



Using vector addition we know that $\vec{F}_c = \vec{F}_N + \vec{F}_{mg}$ therefore.



The easiest way to get $\vec{F}_c$ is just to you the laws of Trig.

$$\tan\theta = \frac{opp}{adj}$$

$$\tan 20^\circ = \frac{\vec{F}_c}{\vec{F}_{mg}}$$

$$\begin{aligned}\vec{F}_c &= \vec{F}_{mg}\tan 20^\circ \\ &= mg\tan 20^\circ \\ &= 1000(9.8)\tan 20^\circ \\ &= 3.57\times 10^3\,N\end{aligned}$$

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

$$\vec{F}_c = m\frac{v^2}{R}$$

$$v^2 = \frac{R\vec{F}_c}{m}$$

$$v = \sqrt{\frac{80\left(3.57\times 10^3\right)}{1000}}$$

$$v = 17m/s$$

The thing to remember is that $\vec{F}_c$ comes from "real" forces. In this question, $\vec{F}_c$ is equal to component of $\vec{F}_N$ in the horizontal direction. The vertical component of $\vec{F}_N$ exists merely to oppose to $\vec{F}_{mg}$ to prevent the car from moving up or down in the vertical direction.