Circular Motion

1 Introduction to circular motion

For an object to be going in a circle a force is needed to accelerate the object. This is because in a circle an object is constantly changing velocity, even if it isn't changing speed.
Centripetal force is not an extra force, it is just the name for a resultant force.
For an object to be deflected towards the centre, there needs to be a force acting towards the centre.

1.1 Definitions

Quantity	Symbol	Unit	Definition
Period	T	Seconds,s	The time taken for an object to complete one revolution
Frequency	f	Hertz,hz	The number of revolutions per second
Angular velocity	ω	rads^{-1}	The rate of change in angle(the angle covered per second)

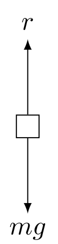
1.2 Formula not on formula book

$$\omega = \frac{\Delta \theta}{\Delta t}$$

$$a = \frac{\Delta V}{\Delta t}$$

Don't forget application of $F = ma$ with the equations for force

2 Circular motion for going over a hump



For an object going over a hump the force of the weight is in the opposite direction to the reaction force.
The object will leave the ground if $mg > r$.

2.1 Calculations

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

Calculating the speed at which the car will leave the ground (R=0)

$$mg = \frac{mv_0^2}{r} \qquad V_0 = \sqrt{gr}$$

Once the car has left the ground, use SUVAT equations rather than circular motion.

3 Roundabouts

On a roundabout the centripetal force is provided by friction.

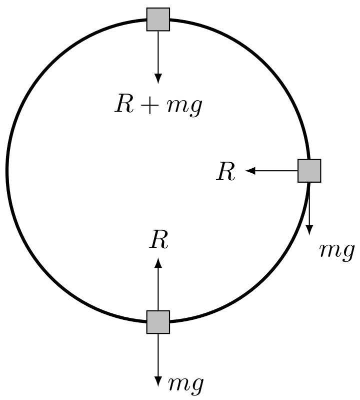
$$F_r = \frac{mv_0^2}{r}$$

To avoid slipping, the centripetal force must be less than the maximum possible for the car and road surface.
Example question *The maximum possible force of friction between a car and the road is 800N, given a mass of 1000kg and a radius of 5m, what is the maximum speed the car can go without slipping*

4 Banked motion

N is the reaction force
$n\sin\theta = \frac{mv^2}{r}$ - Force towards the centre of notion is equal to the centripetal force
$N\cos\theta = mg$ - The force vertically downwards is equal to the weight
$\tan\theta = \frac{v^2}{rg}$ - Combining the equations
$v^2 = gr\tan\theta$ - Re-write

5 Forces in a circle



Top: Centripetal force $= R + W$
Side: Centripetal force $= R$
Bottom: Centripetal force $= R - W$
At the top of the loop r=0
$v = \sqrt{gr}$