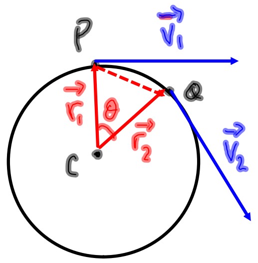
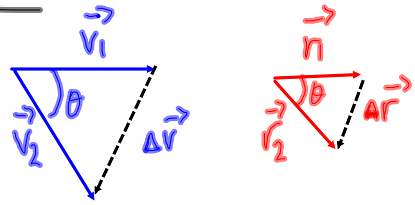
§11·2 Uniform Circular Motion





Using similar triangles

$|\Delta\vec{r}| = \Delta r \quad |\Delta\vec{v}| = \Delta v$

$|\vec{r}_1| = |\vec{r}_2| = r \quad |\vec{v}_1| = |\vec{v}_2| = v$

$$\frac{\Delta r}{r} = \frac{\Delta v}{v}$$

The distance actually travelled:

$$\Delta d = v\Delta t$$

But as $\Delta t \to 0$, $\Delta d \to \Delta r$

$$\frac{v\Delta t}{r} = \frac{\Delta v}{v}$$

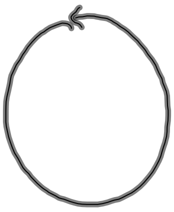
$$\frac{v^2}{r} = \frac{\Delta v}{\Delta t}$$

centre-seeking

Centripetal acceleration (magnitude only)

$$a_c = \frac{v^2}{r}$$

Dir ⇒ always to the centre of the curved path.



$\Delta d = 2\pi r$

$\Delta t = T$

$$v = \frac{\Delta d}{\Delta t}$$

$$v = \frac{2\pi r}{T}$$ ← tangential velocity

$$a_c = \frac{v^2}{r}$$

$$a_c = \frac{\left(\frac{2\pi r}{T}\right)^2}{r}$$

$$a_c = \frac{4\pi^2 r^2}{T^2 r}$$

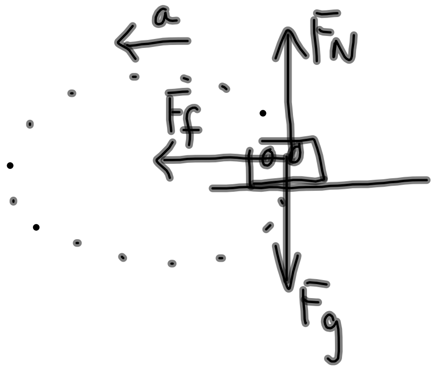
$$T = \frac{1}{f}$$

$$a_c = \frac{4\pi^2 r}{T^2} = 4\pi^2 r f^2$$

mp/555

* Centripetal force is the net force! It is the resultant of the other forces in your FBD.

Side-on



$m = 2135\,kg$

$\mu = 0.70$

$r = 52\,m$

$v = ??$

$$\vec{F}_{net} = m\vec{a}$$

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

$$\mu F_N = \frac{mv^2}{r}$$

$$\mu F_g = \frac{mv^2}{r}$$

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

$$v^2 = \mu g r$$

$$v = \sqrt{(0.70)(9.81\,m/s^2)(52\,m)}$$

$$\boxed{v \doteq 19\,m/s}$$

If the car travels less (or equal to) than 19 m/s, then the car can make the turn

If the car travels faster than 19 m/s, then the car cannot make the turn.

MP/557

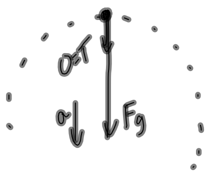
$m = 225g$

$r = 1.2m$

a) $V = ?$, $T = 0$ (Tension)

b) $T = ?$ (side + bottom)

a)



$\vec{F}_{net} = m\vec{a}$

$F_g = m\frac{v^2}{r}$

$mg = m\frac{v^2}{r}$

$v^2 = gr$

$V = \sqrt{(9.81m/s^2)(1.2m)}$

$V = 3.4\ m/s$

If you go 3.4m/s, T=0, If you got more than 3.4m/s, there will be tension →

If you go less than 3.4m/s, the yo-yo cannot complete the loop.

b) at the side:

$\vec{F}_{net} = m\vec{a}$

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

$T = \frac{(0.225kg)(3.4m/s)^2}{1.2m}$

$T = 2.2\ N$

at the bottom:

$F_g = (0.225kg)(9.81m/s^2) = 2.2N$

$\vec{F}_{net} = m\vec{a}$

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

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

$T - 2.2N = 2.2N$

* max tension at bottom → $T = 4.4N$
* minimum tension at top.

PP/559