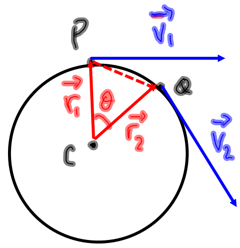
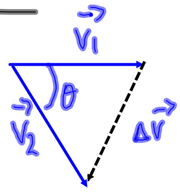
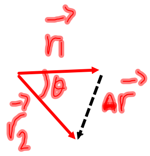
§11-2 Uniform Circular Motion







Using similar triangles

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

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

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

The distance actually travelled:

$\Delta d = v\Delta t$

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

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

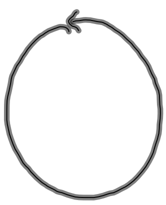
$$\frac{v^2}{r} = \frac{\Delta v}{\Delta t}$$

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

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

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

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

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

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

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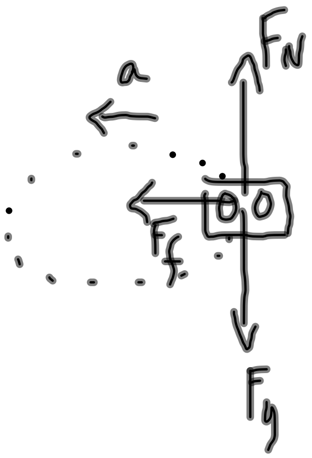
$m = 2135\,kg$

$r = 52\,m$

$\mu = 0.70$

$V_{max} = ?$

end view:



$\vec{F}_{net} = m\vec{a}$ ← centripetal force

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

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

$\mu \not{m} g = \not{m}\frac{v^2}{r}$

$v^2 = \mu g r$

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

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

The maximum speed that you can make the curved path. If you go faster, you will not be able to hold the curved path.

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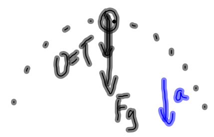
$m = 225g$

$r = 1.2m$

a) $v = ?$ (at top)
(just to make the loop)

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

a) At the top:

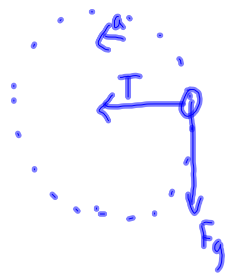


$$\vec{F}_{net} = m\vec{a}$$
$$F_g = m\frac{v^2}{r}$$
$$mg = m\frac{v^2}{r}$$
$$g = \frac{v^2}{r}$$
$$v^2 = gr$$
$$v^2 = (9.81 m/s^2)(1.2m)$$
$$\boxed{v = 3.4 m/s}$$

If you go slower, then you can't make the loop.
If you go faster the tension will increase.

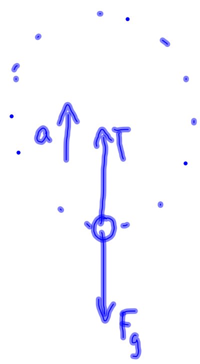
min speed to complete the loop. →

b) At the side:



$$\vec{F}_{net} = m\vec{a}$$
$$T = m\frac{v^2}{r}$$
$$T = \frac{(0.225kg)(3.4 m/s)^2}{1.2m}$$
$$\boxed{T = 2.2N}$$

At the bottom:



$$\vec{F}_{net} = m\vec{a}$$
$$T - F_g = m\frac{v^2}{r}$$
$$T - mg = m\frac{v^2}{r}$$
$$T = m\frac{v^2}{r} + mg$$
$$T = \frac{(0.225kg)(3.4)^2}{1.2} + (0.225)(9.81)$$
$$T = 2.2N + 2.2N$$
$$\boxed{T = 4.4N}$$

max tension at bottom
min at top →

Nov 25-9:59 AM