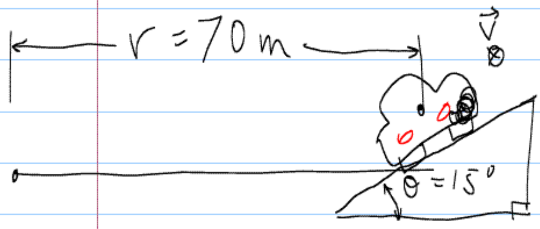
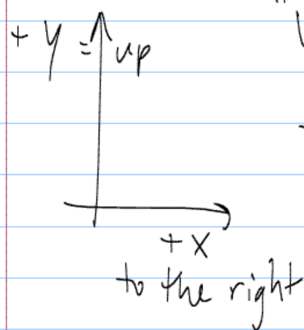
PHY131H1F Centre-screen notes
Wednesday Oct. 24, 2012

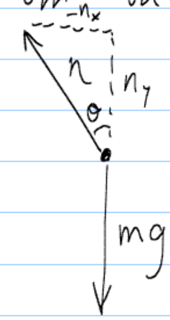


Find speed.

"without friction"
→ assume frictionless!!



f.b.d. of car, as seen from back:



$\sin\theta = \frac{-n_x}{n}$

$n_x = -n\sin\theta$

$n_y = n\cos\theta$

	x	y
$\vec{n}$	$-n\sin\theta$	$n\cos\theta$
$m\vec{g}$	0	$-mg$
$\vec{F}_{Net}$	$(F_{Net})_x = -n\sin\theta$	$(F_{Net})_y = n\cos\theta - mg$

Is the car in equilibrium? No!

$a = a_c = \frac{v^2}{r}$, toward the centre of circular path.
→ to the left.

$$a_x = -\frac{v^2}{r}$$

$$a_y = 0$$

$$(F_{Net})_x = m a_x = -m\frac{v^2}{r} = -n\sin\theta$$

$$(F_{Net})_y = 0 = n\cos\theta - mg$$

n unknown..

m unknown...

Let's eliminate n, solve for v, hope that m's cancel.

Use y-eq to solve for n:

$$n = \frac{mg}{\cos\theta}$$

Plug into x-eq:

$$-\frac{m v^2}{r} = -\frac{mg}{\cos\theta}\sin\theta$$

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

Note:
$\frac{\sin\theta}{\cos\theta} = \tan\theta$

$$v = \sqrt{gr\tan\theta} = \sqrt{9.8(70)\tan 15°}$$
$$= 13.6 \text{ m/s}$$
$$\boxed{v_0 = 14 \text{ m/s}} \leftarrow \text{2 sig figs}$$

"Orbit" is when your centripetal acceleration is equal to gravity.

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

$$v_{orbit} = \sqrt{gr}$$

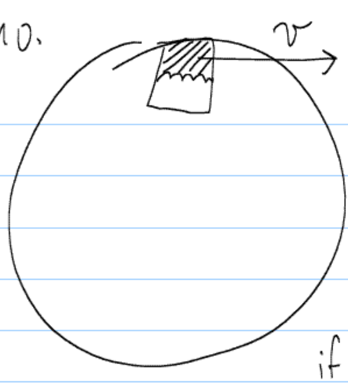
$r = 6.4\times10^6$ m = radius of Earth.

$$= \sqrt{9.8(6.4\times10^6)}$$

neglecting air resistance → $\boxed{v_{orbit} = 8000 \text{ m/s}}$

→ around the world in 80 minutes!

Demo.



At the top of the circle the cup is accelerating DOWN.

Let's estimate v...

if $r \simeq 0.7$ m

T = period $\approx$ 1 sec.

Assume uniform circular motion for this rough estimate → $v \approx \frac{2\pi r}{T} = \frac{2\pi(0.7\text{ m})}{1\text{ s.}} \simeq 4$ m/s

$$a_c = \frac{v^2}{r} = \frac{4^2}{0.7} = 23 \text{ m/s}^2$$

f.b.d. of water:

$\downarrow a = 23 \text{ m/s}^2$

is $F_g = mg$ enough

to keep water on circular path ?, No!

Need an extra downward force

normal force from cup.