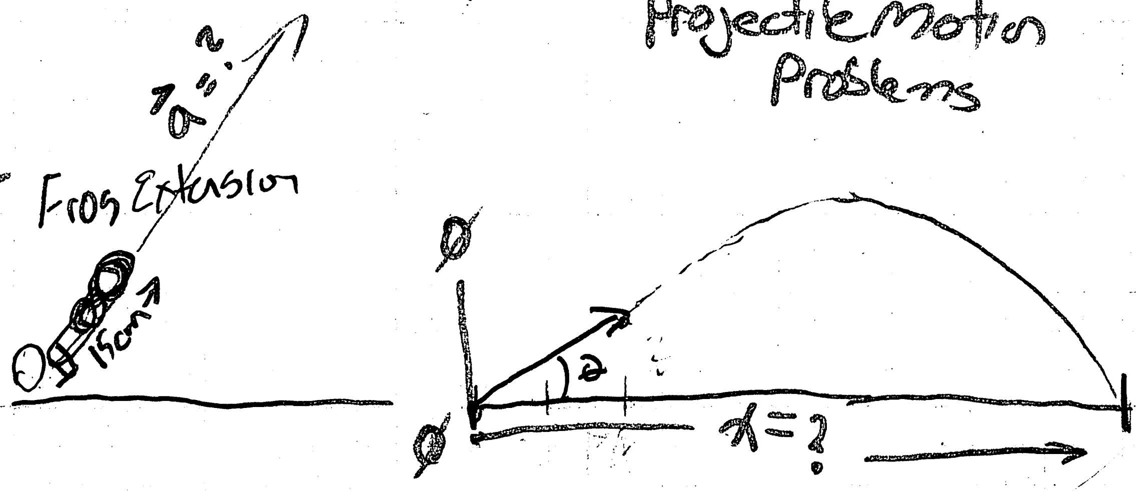
Steps for Solving Projectile Motion Problems

draw a picture 1)




List Variables 2) Find: acceleration during liftoff $= \vec{a}$ $\theta = 30°$

distance of Jump $= x$

Given: $\Delta t = 0.68$ sec

$\theta = 30°$

Discuss Approach 3) How to Approach? It's projectile motion, so split the problem into a x problem & a y problem

$\Delta x = x_f - x_i$

Let $x_i = \emptyset$

$x_f = \Delta x = x$

$\Delta y = y_f - y_i$

$y_f = y_i = 0$

Use Equations for Projectile motion 4)

$y_f = y_i + v_{yi}\Delta t - \frac{1}{2} g \Delta t^2$

$0 = 0 + v_{yi}(0.68) - \frac{1}{2} 9.81 (0.68)^2$

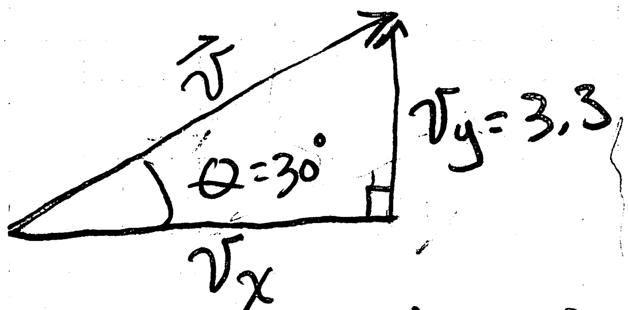
$0 = 0 + \underline{v_{yi}} \Delta t - \frac{9.81}{2} \Delta t^2$

$$\frac{v_{yi}\cancel{\Delta t}}{\cancel{\Delta t}} = \frac{9.81}{2}\frac{\Delta t^{\cancel{2}}}{\cancel{\Delta t}}$$

$$v_{yi} = 4.905\,\Delta t$$

$$v_{yi} = 4.905(0.68)$$

$$v_{yi} = 3.3\ m/s$$




$\sin\theta = opp/hyp$
$\cos\theta = adj/hyp$
$\tan\theta = opp/adj$

$$\sin\theta = \frac{opp}{hyp} = \frac{3.3}{\vec{v}}$$

$$\vec{v} = \frac{3.3}{\sin(30)} = \frac{3.3}{0.5} = 6.6\ m/s$$

<u>Right Triangle</u>

$$c^2 = a^2 + b^2$$

$$b = (c^2 - a^2)^{\frac{1}{2}}$$

$$v_x = (v^2 - v_y^2)^{\frac{1}{2}}$$

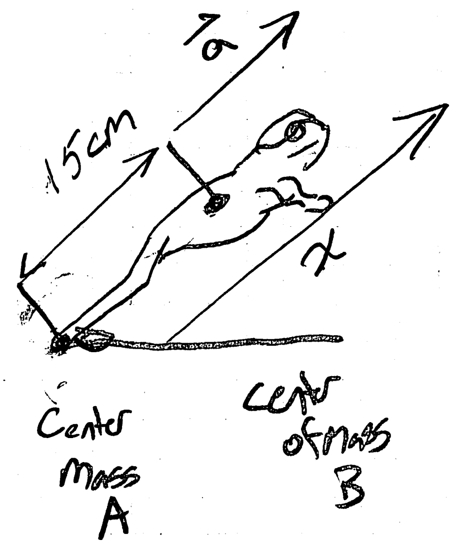
$$v_x = (6.6^2 - 3.3^2)^{\frac{1}{2}}$$

$$v_x = 5.72\ m/s$$

$$x = v_x \Delta t = 5.72\,\tfrac{m}{s} \cdot 0.68\,s$$

$$\underline{\underline{x = 3.9\,m}}$$

To find Acceleration




$v_i = \emptyset\ m/s$

$v_f = 6.6\ m/s$

$x = 0.15\ m$

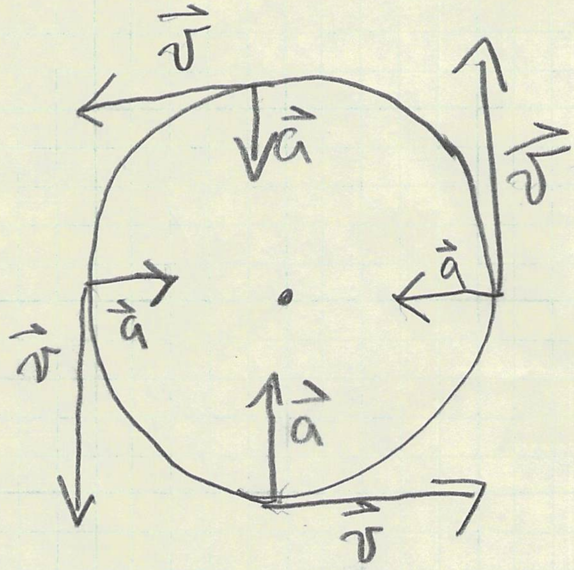
$$v_{xf}^2 = v_{xi}^2 + 2a\Delta x$$

$$6.6^2 = \emptyset + 2a(0.15)$$

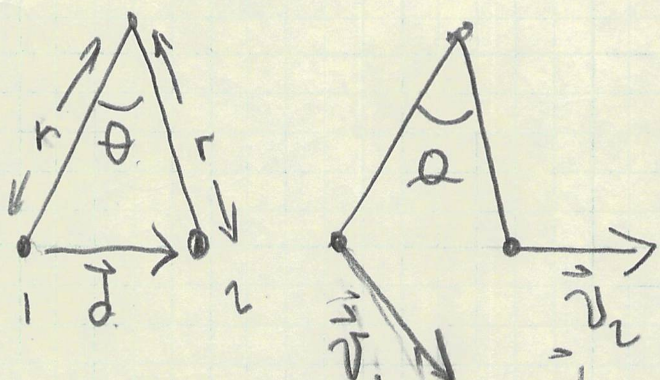
$$\frac{6.6^2}{0.3} = \vec{a}$$

$$\underline{\underline{145\,\frac{m}{sec^2} = \vec{a} \approx 150\,m/sec^2}}$$

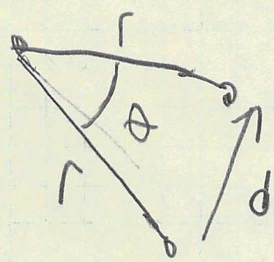
So, the frog lifting off @ $\theta = 30°$ and in the air for 0.68 sec (w/ 15 cm legs) has an initial acceleration of 150 $m/s^2$ and travels for 3.9 m before touching down.



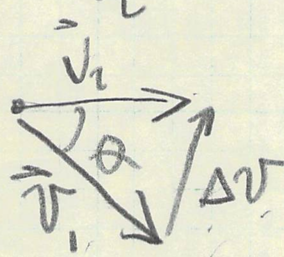

Objects @ constant Speed can also be accelerating ... if the path is circular i.e.g centripital motion




magnitude of Velocity is constant but direction changes




Same triangle but Rotated



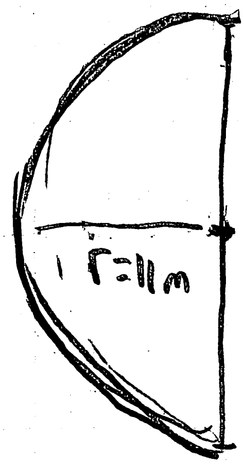

$$\frac{\Delta v}{v} = \frac{d}{r} = \frac{v \Delta t}{r}$$

rearranges to $\dfrac{\Delta v}{\Delta t} = \dfrac{v^2}{r}$

$a = \dfrac{v^2}{r}$, towards center of a circle

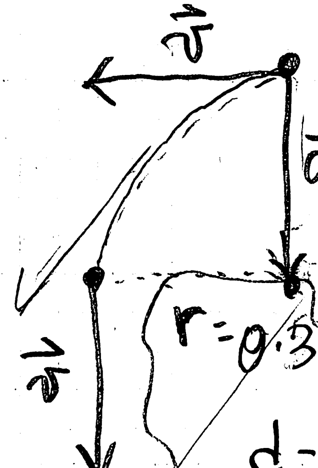
Speed skaters travel 500m in 45 sec

$$v_{ave} = \frac{500\ m}{45\ s} \approx 11\ m/s$$




What is the acceleration they experience through the turn?

$$\vec{a}_{centripital} = \frac{v^2}{r} = \frac{11^2}{11} \approx 11\ m/sec^2$$




how a sling works from above

What is the force of a 100g stone leaving sling with an accelertn of 7.6 m/s²

$d = rt$

$2\pi r = v\Delta t$

$\frac{1.9\ m}{0.5\ sec} = v = 3.8\ m/s \cdot \frac{1}{\Delta t} \approx 7.6\ m/s^2$

Newtons 1st An object in motion stays at the same velocity unless acted upon by an outside force
An object at rest stays at rest, unless acted upon by an outside force

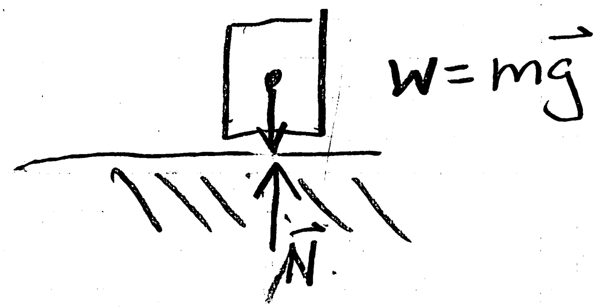
Newtons 2nd: acceleration is directly proportional to force and inversely proportional to mass

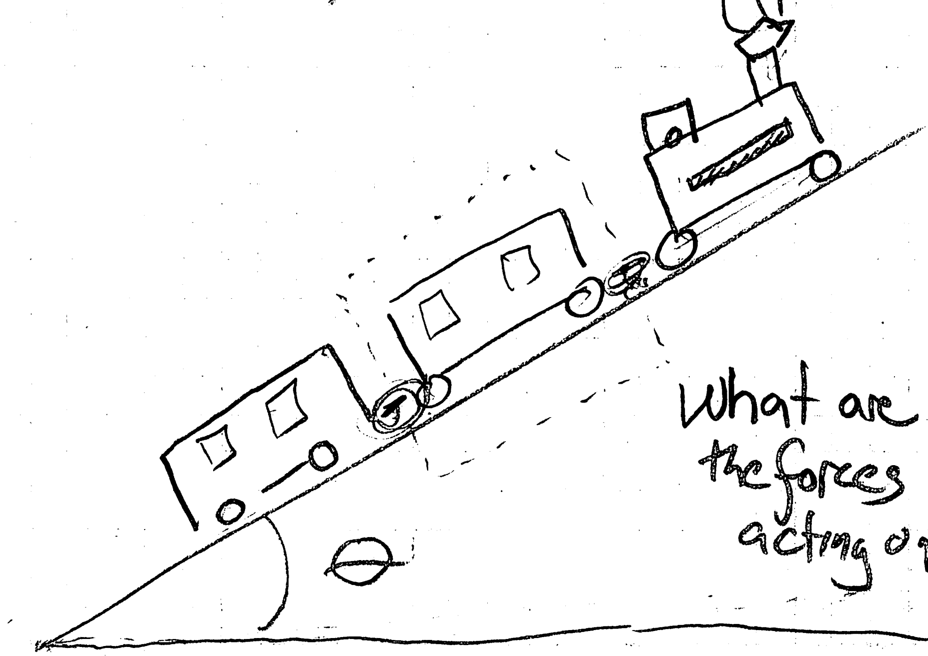
$$\vec{a} = \frac{\vec{F}}{m}$$

$$F_{rock} = m\vec{a}$$
$$= 0.1\,\text{Kg} \cdot 7.6\,\text{m/sec}^2$$
$$= 0.76\ \text{N}$$

So, we found out we calculated acceleration wrong...

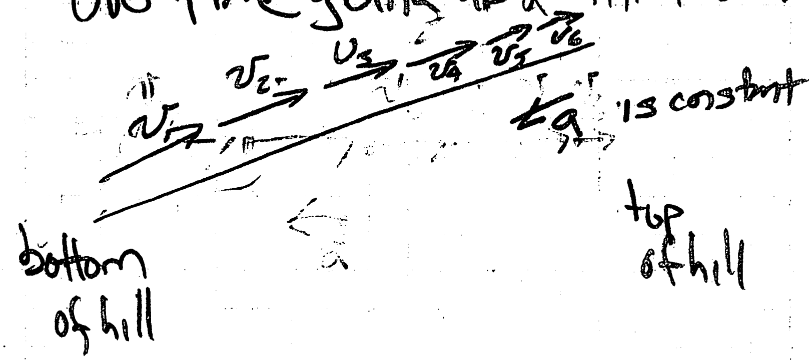
**Newtons 3rd:** Forces occur in action reaction pairs.




What are the forces acting on the car?

Over time going up a hill the train slows down



To find forces draw a free body diagram for

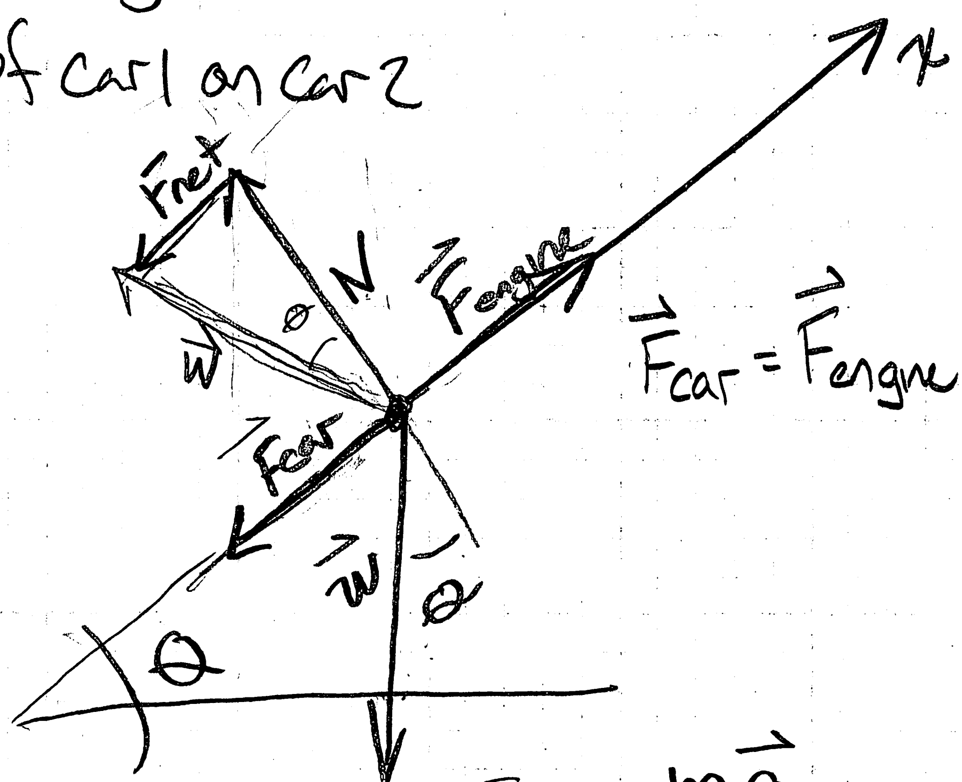
Weight; $\vec{W}$

Normal force; $\vec{N}$

friction force; small relative to the others

force of Engine on car1

force of car1 on car2

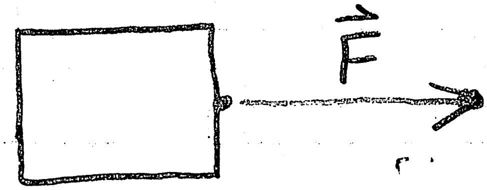



$\vec{F}_{car} = \vec{F}_{engine}$

$F_{net} = m\vec{a}$

# Find Mass of an unknown Block

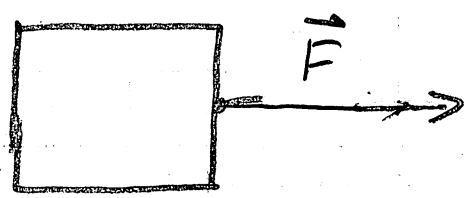
$F = m_1 a_1$




1kg

$\vec{a} = 3\,m/s^2$

$F = m_2 a_2$




? kg

$\vec{a} = 5\,m/s^2$

$$F_{const} = m_1 a_1 = m_2 a_2$$

$$1\,kg\,\frac{3m}{s^2} = ?\,kg\;5\,m/s^2$$

$$\frac{m}{1\,kg} = \frac{3\,\frac{m}{s^2}}{5\,m/s^2}$$

$$\underline{\underline{0.6\,kg = m}}$$