3.3 FBDs in 2-D

Perform Launch-Lab on pg 119... discuss

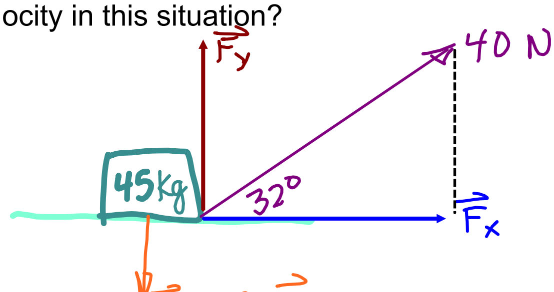
Since force is a vector, we need to use x-components and y-components to calculate $\vec{F}_{net}$ when dealing with forces in two dimensions. In other words, we will have an $\vec{F}_{net}$ equation for the x and y directions. In the end, we will need trigonometry to calculate the resulting $\vec{F}_{net}$.

ex. A person pulls a toboggan on horizontal snow. The rope attached to the sled forms an angle of 32° with the ground. If the person pulls with a force of 40 N and the sled (including passenger) has a mass of 45 kg,

a) how fast does the system accelerate? assume $\vec{F}_{friction} = 0$

b) Why isn't the sled lifted off the snow?

c) What would be the force of friction in order to maintain a constant velocity in this situation?



x - component

$\cos 32° = \frac{\vec{F}_x}{40 N}$

$\vec{F}_x = 40 \cos 32°$

$\vec{F}_x = 33.92$ N

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

$\vec{a} = \frac{\vec{F}_x}{m} = \frac{33.92}{45}$

$\vec{a} = 0.75\ m/s^2$

or $0.8\ m/s^2$ with S.F.

b) $\vec{F}_g = m\vec{a}$

$= (45\ kg)(9.8\ m/s^2)$

$\vec{F}_g = 441$ N

$\vec{F}_y = 40 \sin 32°$

$= 21.20$ N

$\vec{F}_{net_y} = -441\ N + 21.2\ N$

$= -419.8$ N

Since $\vec{F}_{net_y}$ is still acting downward we do not have liftoff

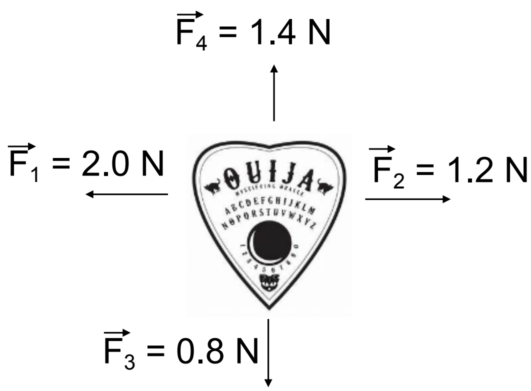
c) if v_x = constant, $F_{net_x} = 0$

F_f ← [box] → $F_x = 33.92$ N

$\therefore F_f = F_x = 33.92$ N

https://www.thoughtco.com/is-the-ouija-board-dangerous-2593140

ex. Ouija boards were invented in 1890 but became popular during world war one as a way for people to communicate with the deceased. A "planchette" is move around a board by multiple people with the goal of spelling out the answers to their questions. Four people push on the planchette (0.2 kg) with the following forces. Find the net force and acceleration vectors. Assume that up and right are positive.



x-dir.

$\vec{F}_{net_x} = \vec{F}_2 + \vec{F}_1$

$= 1.2\text{N} - 2.0\text{N}$ ← leftward acting

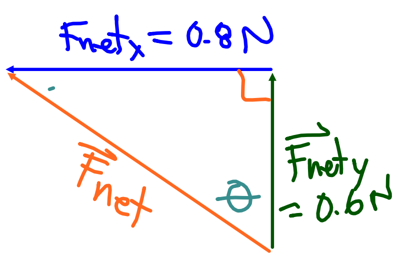
$= -0.8\text{ N}$

y-dir

$\vec{F}_{net_y} = \vec{F}_3 + \vec{F}_4$

$= -0.8\text{N} + 1.4\text{N}$

$= 0.6\text{N}$



use pythagoras to get magnitude

$\vec{F}_{net}^2 = F_{net_x}^2 + F_{net_y}^2$

$= (0.8)^2 + (0.6)^2$

$\sqrt{\vec{F}_{net}^2} = \sqrt{1}$

$\boxed{|\vec{F}_{net}| = 1\text{ N}}$

$\tan\theta = \frac{0.8}{0.6}$

$\theta = \tan^{-1}\left(\frac{.8}{.6}\right)$

$\theta = 53.13°$

$\therefore \vec{F}_{net} = 1\text{N [up } 53° \text{ left]}$

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

$\vec{a} = \frac{1\text{N}}{0.2\text{kg}} = 5\text{ m/s}^2 \text{ [up } 53° \text{ left]}$

practice: photocopy #44, 46, 47