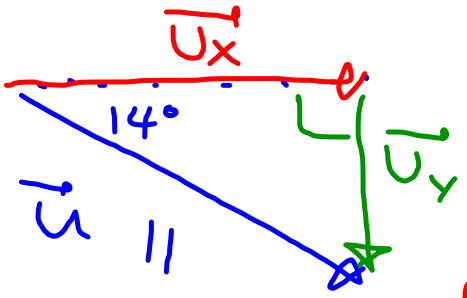
March 3, 2017

Warmup:

$\vec{u} = 11\,km\,[E\ 14°S]$

$\vec{v} = 18\,km\,[W\ 41°S]$

Find $\vec{u} + \vec{v}$



$$\cos 14 = \frac{\vec{u_x}}{11}$$

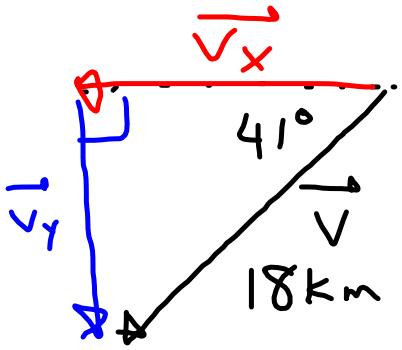
$$11 \cdot \cos 14 = \vec{u_x}$$

$$\vec{u_x} = 10.7\,km\,[E]$$

$$\sin 14^\circ = \frac{\vec{u_y}}{11}$$

$$\vec{u_y} = 11 \cdot \sin 14^\circ$$

$$\boxed{\vec{u_y} = 2.7\text{km}[S]}$$



$$\cos 41^\circ = \frac{\vec{V_x}}{18}$$

$$V_x = 18\cos 41^\circ$$

$$\boxed{\vec{V_x} = 13.6\text{km}[W]}$$

$$\sin 41 = \frac{\vec{V_y}}{18}$$

$$\vec{V_y} = 18 \cdot \sin 41^\circ$$

$$\boxed{\vec{V_y} = 11.8\text{km}[S]}$$

$$\vec{r} = \vec{u} + \vec{v}$$

$$\vec{r_x} = \vec{u_x} + \vec{v_x}$$

$$= 10.7\text{km}[E] + 13.6\text{km}[W]$$

$$= 2.9\text{km}[W]$$

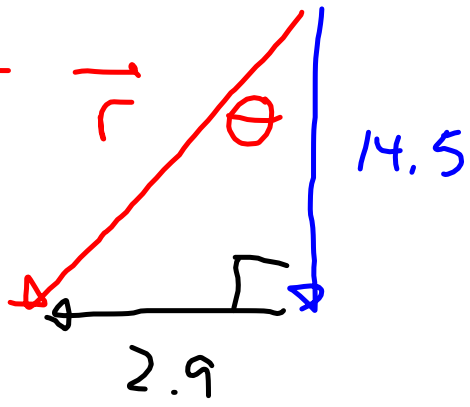
$$\vec{r_y} = \vec{u_y} + \vec{v_y}$$

$$= 2.7\,km[S] + 11.8\,km[S]$$

$$\boxed{\vec{r_y} = 14.5\,km[S]}$$

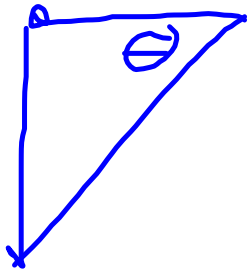
$$r^2 = 14.5^2 + 2.9^2$$

$$\boxed{|\vec{r}| = 14.7\,km}$$



$$\tan\theta = \frac{2.9}{14.5}$$

$$\theta = 11.3^\circ$$



$$\boxed{14.7\,km[S11.3^\circ W]}$$

Forces

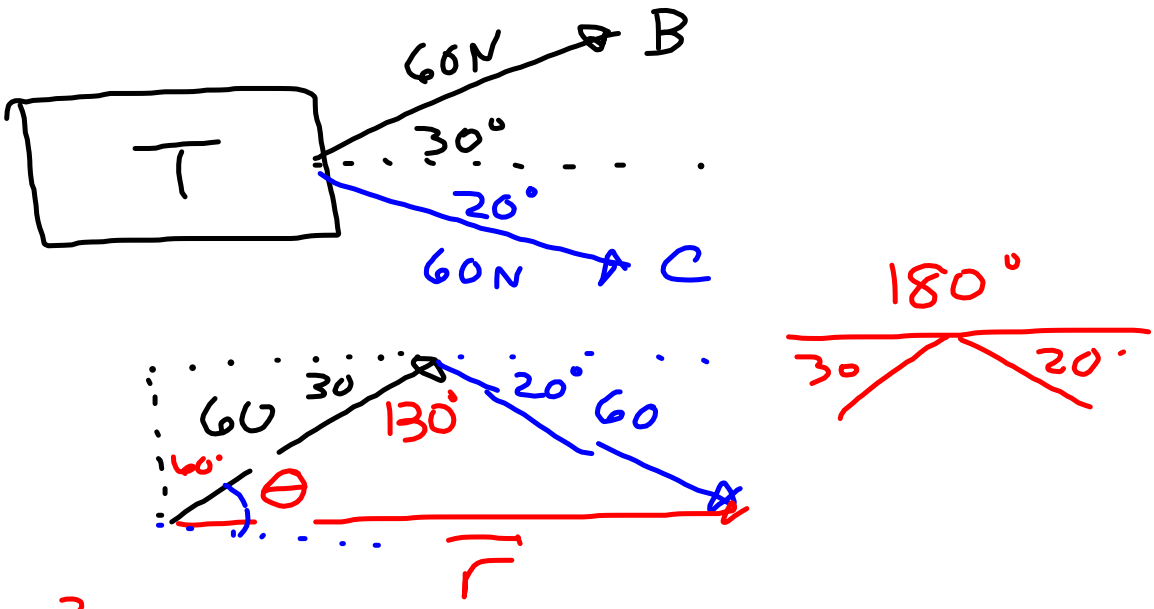
A force on any object causes an object to undergo acceleration.

Newton's First Law

An object will remain in a state of rest unless it is compelled to change by the action of an outside force.

Generally, several forces act on an object at once. The sum of all the forces is called the net force. Since forces are vectors, the single resultant force can be found by vector addition. If there is no acceleration, equilibrium $\vec{F}_{net} = \vec{0}$.

Ex. 1: Brad and Callin are pulling Theresa on a toboggan. Each is exerting a force of 60N. Brad pulls at an angle of 30° to the horizontal. Callin pulls at -20° to the horizontal. What is resultant force exerted on Theresa's toboggan?



$$|\vec{R}|^2 = 60^2 + 60^2 - 2(60)(60)\cos 130$$

$$\boxed{|\vec{R}| = 108.8}$$

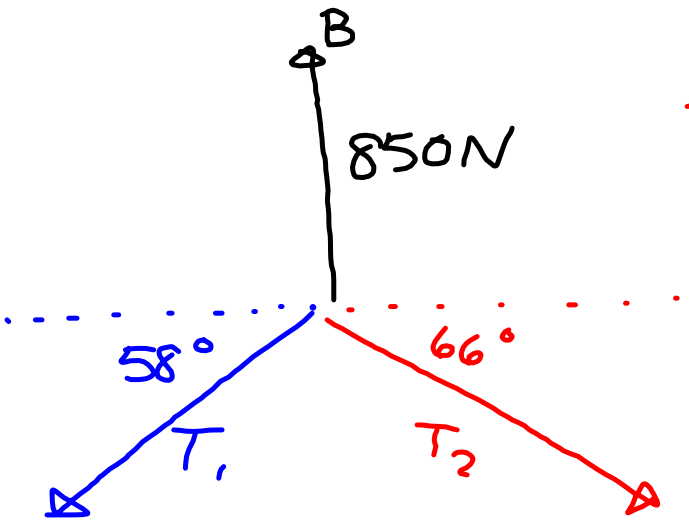
heading: $60^\circ + \theta$

$\therefore \vec{R} = 108.8\text{N}$ [85° from vert.)

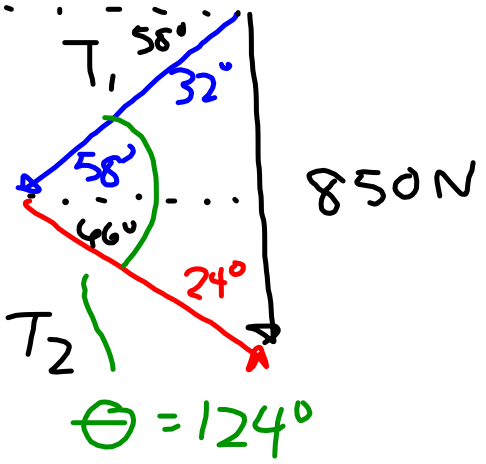
$$\frac{\sin\theta}{60} = \frac{\sin 130}{108.8}$$

$$\boxed{\theta = 25.0^\circ}$$

Ex. 2 : A large balloon is tethered to the top of a building by two guy wires attached 20m apart. If the buoyant force on the balloon is 85CN [up] and the two wires make angles of 58° and 66° with the horizontal, find the tension in each wire.



$T_1 + T_2 = 850$ [down]



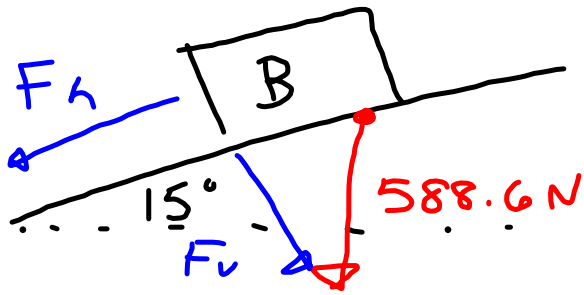
$\theta = 124°$

$$\frac{T_1}{\sin 24} = \frac{850}{\sin 124} \qquad \frac{T_2}{\sin 32} = \frac{850}{\sin 124}$$

$$T_1 = \frac{850 \cdot \sin 24}{\sin 124} \qquad T_2 = \frac{850 \cdot \sin 32}{\sin 124}$$

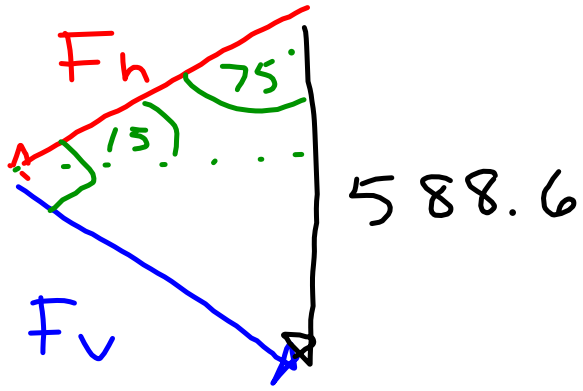
$$\boxed{T_1 = 417.0\,N} \qquad \boxed{T_2 = 543.3\,N}$$

Ex. 3 : A 60kg Brad is resting on a ramp inclined at an angle of 15°. Calculate the components of the force of gravity that are parallel and perpendicular to the ramp.



$$F_g = mg$$
$$= 60kg(9.81N/kg\,[down])$$
$$\boxed{F_g = 588.6N\,[down]}$$

$$F_g = F_h + F_v$$



$\sin 75° = \frac{F_v}{588.6}$ $\cos 75 = \frac{F_H}{588.6}$

$F_v = 588.6 \sin 75°$

$F_v =$