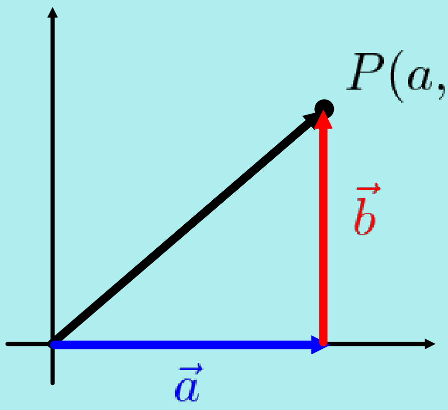
Recall: A vector can be expressed in terms of its <u>components</u>, either in component form, or in terms of the basis vectors.



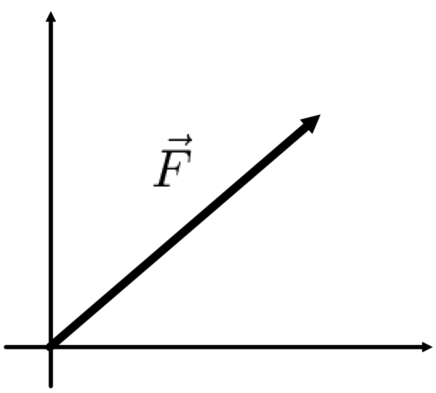
$$\vec{OP} = (a, b)$$
$$\vec{OP} = a\vec{i} + b\vec{j}$$

May 1-8:19 PM

Unit 6 - Applications of Vectors

May 4/2018

<u>Vectors as Forces</u>



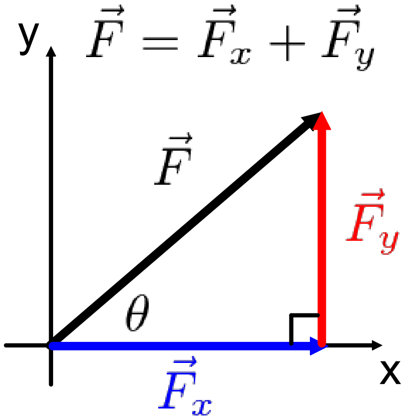
A force is a push or pull interaction on an object.

A force has both magnitude (the strength of the interaction) and direction, so it is a vector quantity.

Examples: pushing on a box, pulling on a rope, gravity pulling you to the ground, magnets repelling or attracting each other

May 6-9:54 PM

$$\vec{F} = \vec{F}_x + \vec{F}_y$$



Like other vectors, it is often useful to consider a force in terms of vector components.

If the components are not provided, they can be determined using right-angle trigonometry (SohCahToa).

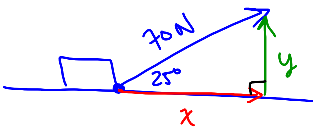
The geometry and location of the angle matters. In this case, the angle is with respect to the +x-axis.

$$\left|\vec{F}_x\right| = \left|\vec{F}\cos\theta\right| \qquad \left|\vec{F}_y\right| = \left|\vec{F}\sin\theta\right|$$

May 6-9:54 PM

Ex.1 A child is pulled on a toboggan. A force of 70 N (Newtons) is exerted along the rope, which makes an angle of 25° with the horizontal.

Determine the vertical and horizontal components of the force.



$\cos 25° = \frac{x}{70}$

$x = 70 \cos 25°$

$x \doteq 63.4$

$y = 70 \sin 25°$

$\doteq 29.6$

$\therefore$ the horizontal force is 63.4 N

Vertical force is 29.6N

OR

$\vec{F} \doteq 63.4\text{N}\,\vec{i} + 29.6\text{N}\,\vec{j}$

OR

$\vec{F} \doteq (63.4\text{ N}, 29.6\text{N})$

May 7-1:06 PM

Definitions:

1. Resultant (Net) Force: The vector sum of all forces acting upon an object.

$$\vec{F}_R = \vec{F}_{net} = \vec{F}_1 + \vec{F}_2 + \ldots$$

2. Equilibrium: The sum of all forces is zero (i.e., the zero vector).

$$\vec{F}_R = \vec{F}_{net} = \vec{0}$$

3. Equilibrant Force: The force required to oppose the resultant force and produce a state of equilibrium.

$$\vec{F}_{eq} = -\vec{F}_R$$

May 6-9:54 PM

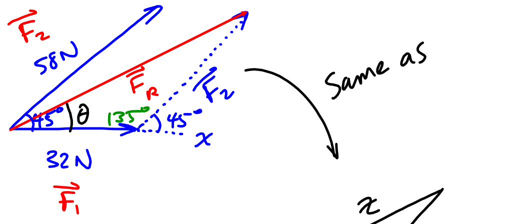
Assigned Work

p.362 # 3, 5, 6, 8, 10, 11, 12, 16, 17

for more worked examples, see dedicated video

May 7-1:15 PM

Ex.2 Two forces of 32 N and 58 N are acting at an angle of 45° to each other. Determine the resultant force.



$\vec{F}_R = \vec{F}_1 + \vec{F}_2$

$z^2 = 32^2 + 58^2 - 2(32)(58)\cos 135°$

$z \doteq 83.7$ keep more decimals!

$\frac{\sin\theta}{58} \doteq \frac{\sin 135°}{83.7}$

$\sin\theta =$ ____

$\theta \doteq 29°$ or ~~____~~

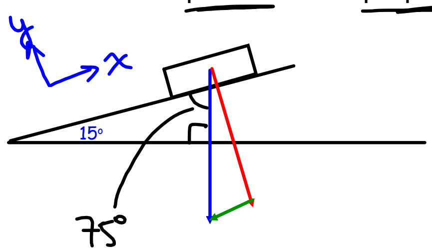
S A
T C

$\therefore \vec{F}_R = 83.7\,N$ [29° above x-axis]

May 7-1:17 PM

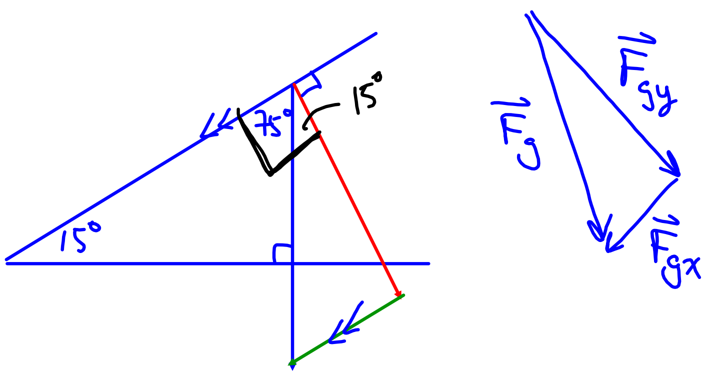
The x- and y-axes can be chosen for convenience when determining vector components.

Ex.3 A 20 kg trunk is resting on a ramp inclined at 15°
Calculate the components of the force of gravity on the trunk that are parallel to and perpendicular to the ramp.



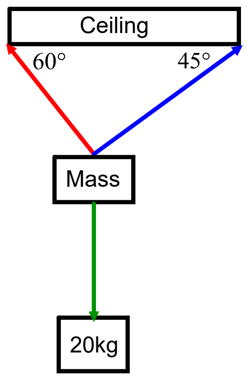
$$\left|\vec{F}_{\text{gravity}}\right| = mg$$

$$g = 9.8N/kg$$



May 7-1:23 PM

Ex.4 A mass of 20kg is suspended from a ceiling by two lengths of rope that make angles of 60 ∘ and 45∘ with the ceiling. Determine the tension in each of the ropes.

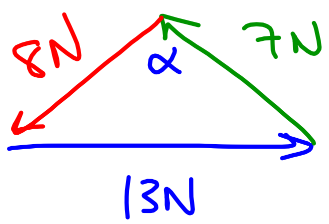


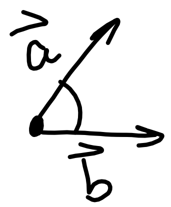
Apr 25-2:26 PM

Assigned Work

p.362 # 3, 5, 6, 8, 10, 11, 12, 16, 17

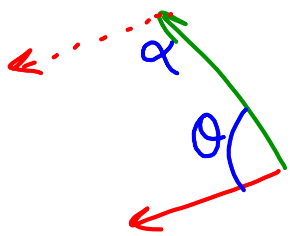
11.





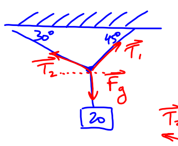
① cosine law for α

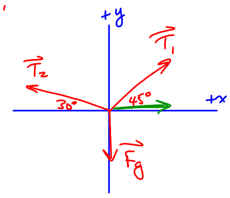
② $\theta = 180° - \alpha$



May 7-1:15 PM

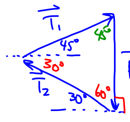
16.



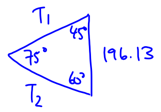


$\vec{T}_1 + \vec{T}_2 + \vec{F}_g = \vec{0}$

① make triangle



$\vec{F}_g = m\vec{g}$



$|\vec{F}_g| \doteq 20(9.8)$
$\doteq 196.13$

$\frac{T_1}{\sin 60°} = \frac{T_2}{\sin 45°} = \frac{196.13}{\sin 75°}$

T_1 T_2

or vector components:

$\vec{T}_1 + \vec{T}_2 + \vec{F}_g = \vec{0}$

x-dir

$\vec{T}_{1x} + \vec{T}_{2x} + \vec{F}_{gx} = \vec{0}$

$+T_1 \cos 45° - T_2 \cos 30° + 0 = 0$

① $T_1 \cos 45° = T_2 \cos 30°$

y-dir

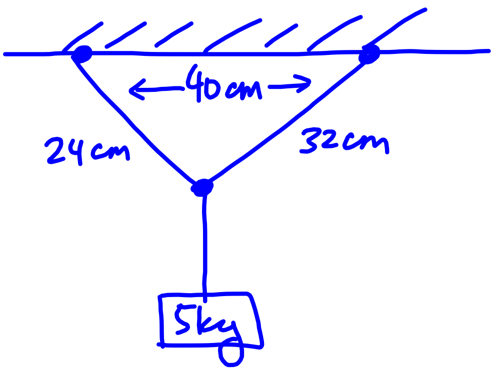
$\vec{T}_{1y} + \vec{T}_{2y} + \vec{F}_{gy} = \vec{0}$

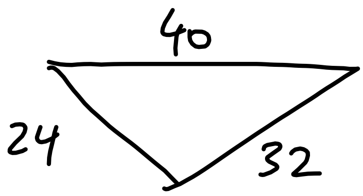
② $T_1 \sin 45° + T_2 \sin 30° - 196.13 = 0$

2 eq, 2 unknowns, solve.

May 8-2:02 PM

17.





Same as 16, but angles of strings unknown.

$\Rightarrow$ cosine law

May 8-2:18 PM