Vectors as Forces

What is force?

Force is a vector quantity with magnitude and direction. e.g. A force of 10N moving N30°E.

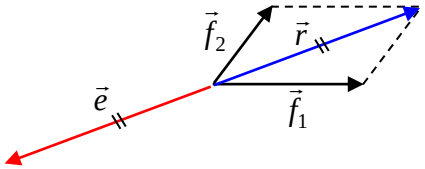
Resultant and Equilibrant Forces (by Parallelogram Law)

In the figure, sketch $\vec{r} = \overrightarrow{f_1} + \overrightarrow{f_2}$

$\vec{r}$ is the resultant vector of $\overrightarrow{f_1}$ and $\overrightarrow{f_2}$.

$\vec{e}$ is the equilibrant vector which is equal in magnitude to $\vec{r}$ but opposite in direction.

$$\vec{e} = -\vec{r} \quad |\vec{e}| = |\vec{r}|$$



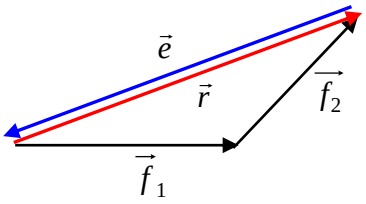
Resultant and Equilibrant Forces (by Triangular Law)

In the figure, sketch $\vec{r} = \overrightarrow{f_1} + \overrightarrow{f_2}$

$\vec{r} = \overrightarrow{f_1} + \overrightarrow{f_2}$

$\Rightarrow -\vec{e} = \overrightarrow{f_1} + \overrightarrow{f_2}$

$\Rightarrow \vec{0} = \overrightarrow{f_1} + \overrightarrow{f_2} + \vec{e}$



Example 1: Vectors as Forces (Resultant and Equilibrium Forces)

Find the magnitude and direction of the resultant and the equilibrant of the following systems of forces.
Force of 16 N and 10 N acting at an angle of 10° to each other.

Example 2: vectors as Forces

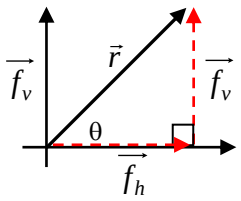
Two forces of equal magnitude act at 60° to each other. If their resultant has a magnitude of 30 N, find the magnitude of the equal forces.

Vectors as Forces

Resolution of a Force

A single force can be resolved into its vertical and horizontal components (magnitudes only).

$\left|\overrightarrow{f_v}\right| = \left|\vec{r}\right| \sin\theta \qquad \left|\overrightarrow{f_h}\right| = \left|\vec{r}\right| \cos\theta$



Example 3: Vertical and Horizontal components

Find the horizontal and vertical components of the following forces.

160 N acting at an angle of 71° to the horizontal

Example 4: Components of the force of gravity

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

Equilibrium by forces

To produce equilibrium by 3 forces, sum of <u>any</u> two forces ≥ the third force.

Example 5: Equilibrium

Which of the following sets of forces acting on an object could produce equilibrium?

a) 5 N, 2 N, 13 N

c) 13 N, 27 N, 14 N

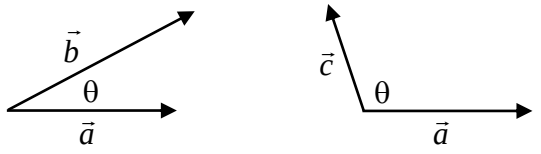
b) 7 N, 5 N, 5 N

d) 12 N, 26 N, 13 N

Vectors as Forces

Note:

Angles between 2 vectors are shown as follows: $0^\circ \le \theta \le 180^\circ$



Example 6: Equilibrium Applications

Three forces of 5 N, 7 N, and 8 N are applied to an object. If the object is in a state of equilibrium.

a) Show how the forces must be arranged.

b) Calculate the angle between the lines of action of the 5 N and 7 N forces.

Example 7: Forces Applications

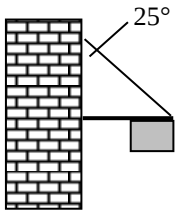
A mass of 10 kg is suspended from a ceiling by two cords that make angles of 30° and 45° with the ceiling. Find the tension in each of the cords.

Example 8: Forces Applications

An object of 15 kg is suspended by two cords of lengths 7 cm and 24 cm, and these two cords are 25 cm apart. Find the tension in each cord.

Example 9: Forces Applications

An advertising sign is supported by a horizontal steel brace extending at right angles from the side of a building, and by a wire attached to the building above the brace at an angle of 25°. If the force of gravity on the sign is 850 N, find the tension in the wire and the compression in the steel brace.



Homework: P. 362
#3,5,6,8,10-17