


# Newton's Laws



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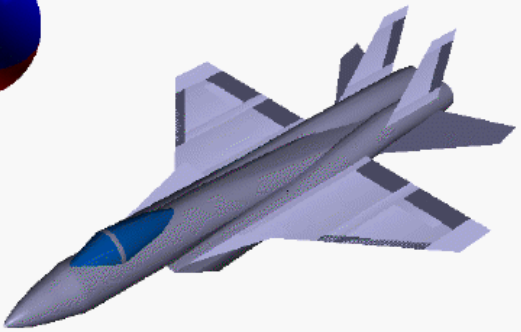

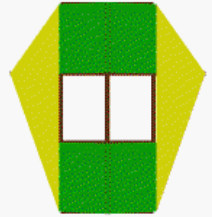
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## Newton's First Law

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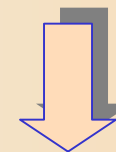
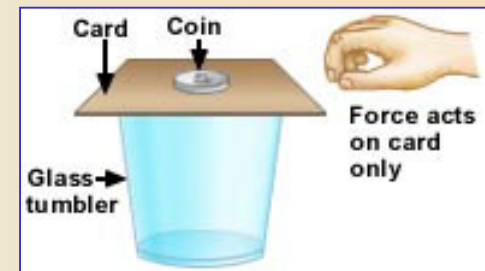
"Every object persists in its state of rest or uniform motion in a straight line unless it is compelled to change that state by forces impressed on it."

<http://www.grc.nasa.gov/WWW/K-12/airplane/newton1g.html>

## Newton's First Law: Law of inertia

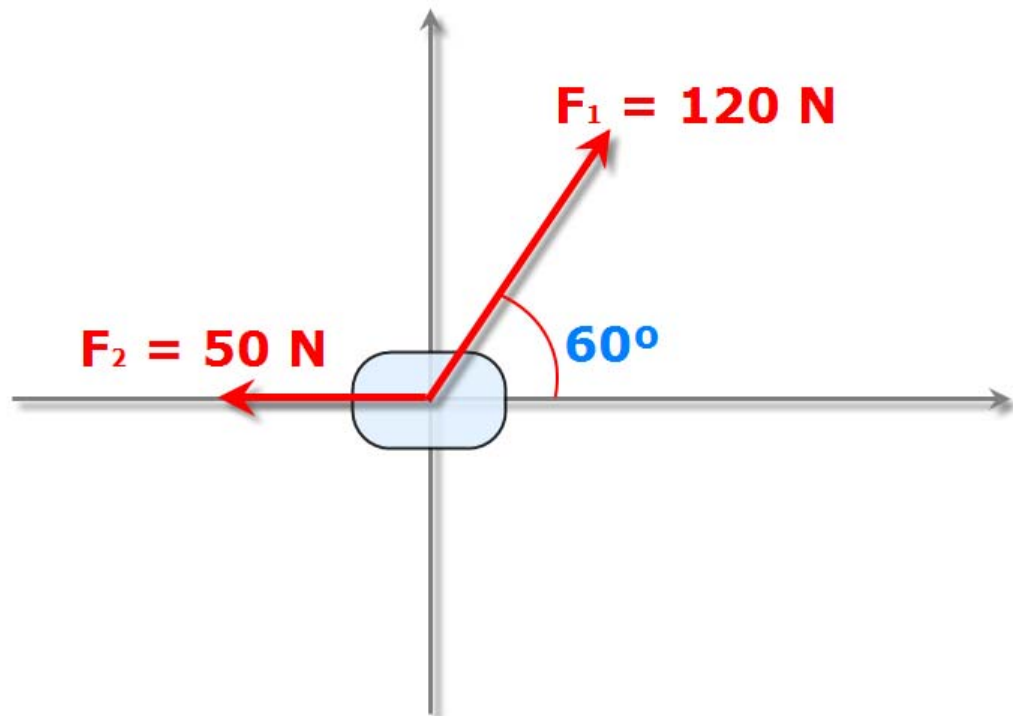
Every object continues in a state of rest, or of motion in a straight line at constant speed, unless forces are applied upon it.



[http://home.att.net/~cat4a/images/newton\\_first\\_law2.jpg](http://home.att.net/~cat4a/images/newton_first_law2.jpg)

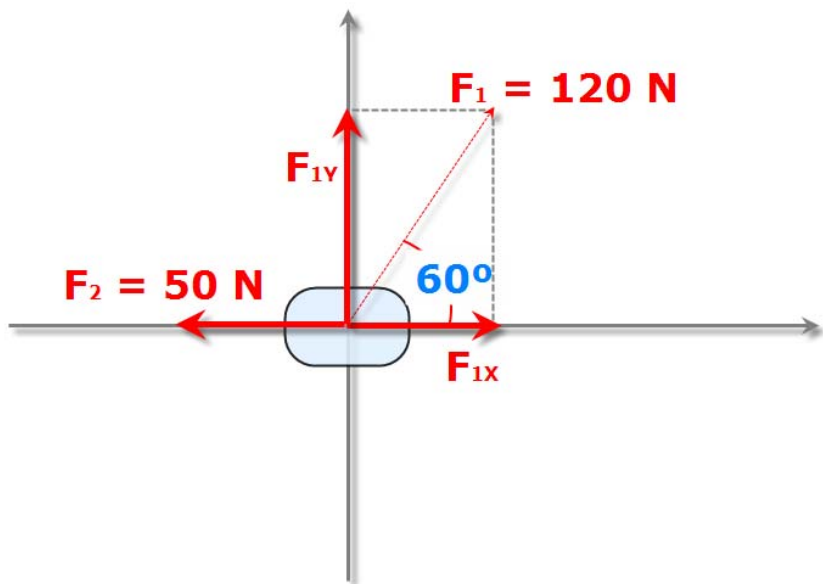
$$\vec{F}_{\text{net}} = 0 \rightarrow \vec{a} = 0 \rightarrow \vec{v} = \text{const} \rightarrow \begin{cases} \text{magnitude const.} \Leftrightarrow |\vec{v}| = \text{const} \\ \text{direction const} \Leftrightarrow \alpha = \text{const} \end{cases}$$

# Newton's Laws



Calculate the force needed ( $F_3$ ) to cancel out the effects of those two forces present in the picture

## Newton's Laws



Calculate the force needed ( $F_3$ ) to cancel out the effects of those two forces present in the picture

The net force is 0:

$$\vec{F}_1 + \vec{F}_2 + \vec{F}_3 = 0$$

The components and expressions of the forces are:

$$F_{1x} = 120\text{ N} * \cos 60^\circ = 60\text{ N}$$

$$F_{1y} = 120\text{ N} * \sin 60^\circ = 103.9\text{ N}$$

$$\vec{F}_1 = 60\text{ N } \vec{i} + 103.9\text{ N } \vec{j} \text{ (N)}$$

$$\vec{F}_2 = -50\text{ N } \vec{i} \text{ (N)}$$

By substituting those values, we get  $F_3$ :

$$\vec{F}_1 + \vec{F}_2 + \vec{F}_3 = 0$$

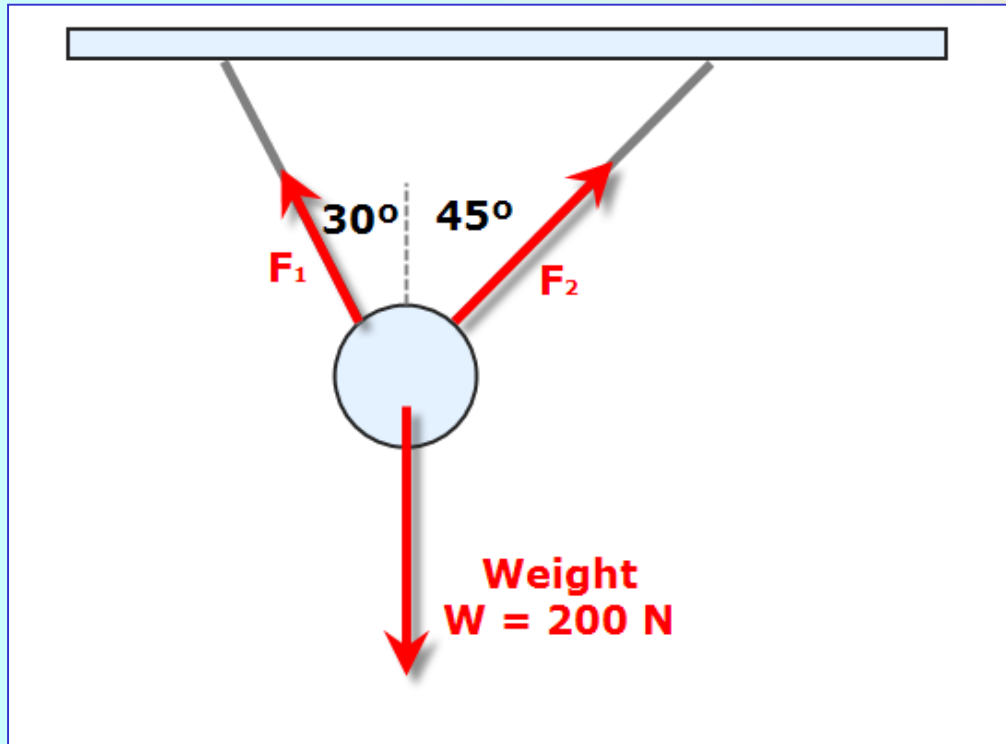
$$(60\text{ N } \vec{i} + 103.9\text{ N } \vec{j}) - 50\text{ N } \vec{i} + \vec{F}_3 = 0$$

$$\vec{F}_3 = -10\text{ N } \vec{i} - 103.9\text{ N } \vec{j} \text{ (N)}$$

$$|\vec{F}_3| = \sqrt{(-10)^2 + (-103.9)^2} = 104.4\text{ N}$$

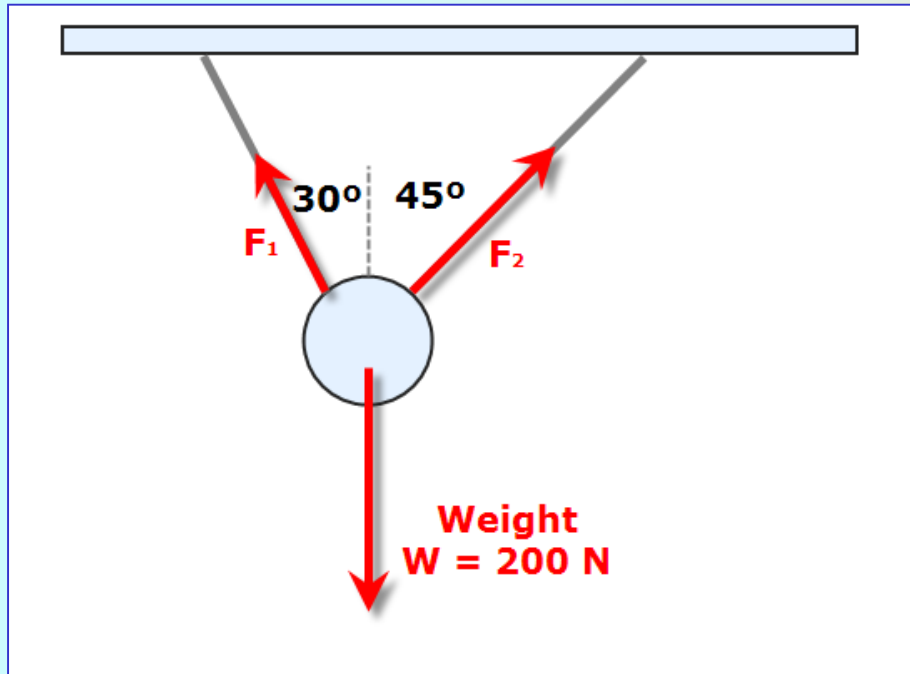
$$\alpha = \tan^{-1} \frac{103.9}{10} = 180^\circ + 85^\circ = 265^\circ$$

# Newton's Laws



Calculate the expressions of the forces  $F_1$  and  $F_2$

# Newton's Laws



$$F_{1x} = F_1 \cdot \sin 30^\circ = 0.5 F_1$$

$$F_{1y} = F_1 \cdot \cos 30^\circ = 0.87 F_1$$

$$F_{2x} = F_{2y} = F_2 \cdot \frac{\sqrt{2}}{2} = 0.7 F_2$$

2. The expressions of the forces are:

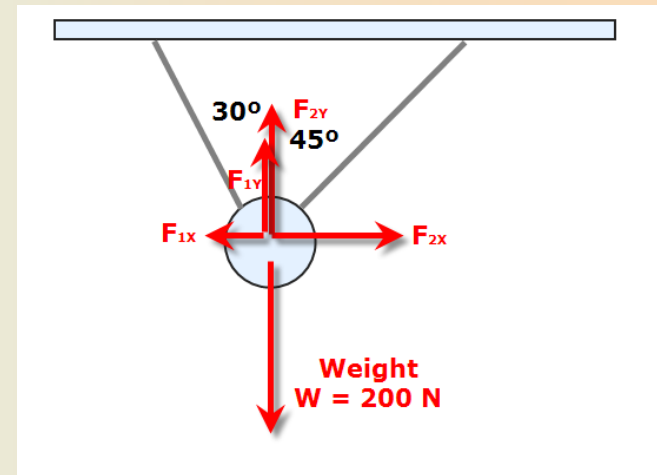
$$\vec{F}_1 = -0.5 F_1 \vec{i} + 0.87 F_1 \vec{j} \text{ (N)}$$

$$\vec{F}_2 = 0.7 F_2 \vec{i} + 0.7 F_2 \vec{j} \text{ (N)}$$

$$\vec{W} = -200 \vec{j} \text{ (N)}$$

Calculate the expressions of the forces  $F_1$  and  $F_2$

1. Firstly, let's calculate the components of the forces:

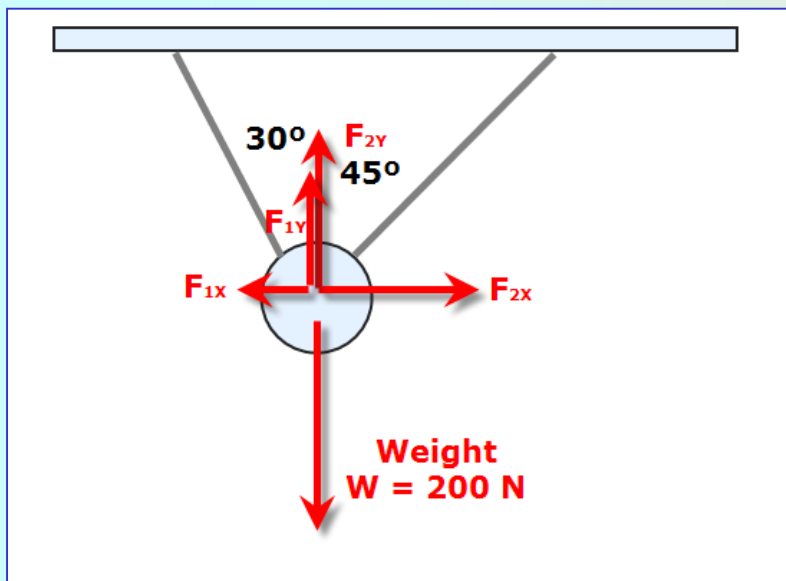


3. Then we apply the principle that the sum of all forces (that is, the net force) is 0

$$\vec{F}_1 + \vec{F}_2 + \vec{W} = 0$$

$$(-0.5 F_1 \vec{i} + 0.87 F_1 \vec{j}) + (0.7 F_2 \vec{i} + 0.7 F_2 \vec{j}) - 200 \vec{j} = 0$$

# Newton's Laws



Calculate the expressions of the forces  $F_1$  and  $F_2$

4. If we separate components, we have a system of two equations

$$\begin{cases} -0.5 F_1 + 0.7 F_2 = 0 \\ 0.87 F_1 + 0.7 F_2 - 200 = 0 \end{cases}$$

5. We solve the system

$$F_1 = \frac{0.7 F_2}{0.5} = 1.4 * F_2$$

$$0.87 * 1.4 * F_2 + 0.7 F_2 - 200 = 0$$

$$F_2 = \frac{200}{1.918} = 104.3\text{ N}; F_1 = 146\text{ N}$$