NEWTON'S LAWS OF MOTION

First Law | An object moving with constant velocity will move at the same velocity forever if no net forces act on it.

second law | An object of mass (m) has an acceleration ($\vec{a}$) equal to the net force vector ($\sum \vec{F}$) divided by the mass.

$$\boxed{\vec{a} = \frac{\sum \vec{F}}{m} \quad \text{or} \quad \sum \vec{F} = m\vec{a}}$$

$[F] \equiv N = kg\,\frac{m}{s^2}$ units

where ; $\sum_{i=1}^{N} \vec{F}_i = \vec{F}_1 + \vec{F}_2 + \vec{F}_3 + \cdots + \vec{F}_N$

Remember how to add (sum) vectors

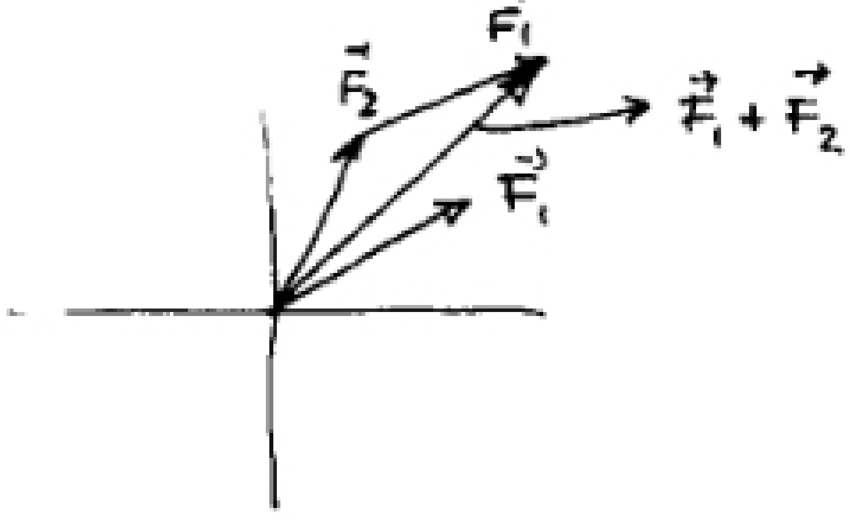
i) by components ;

$$\sum \vec{F} = \sum F_x \,\hat{x} + \sum F_y \,\hat{y} + \sum F_z \,\hat{z} \quad \left[\sum_{i=1}^{N} F_{x_i} = F_{x_1} + F_{x_2} + \cdots + \right]$$

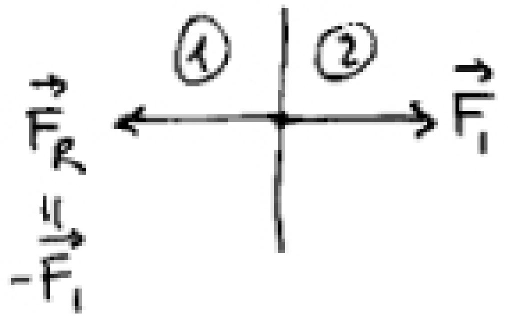
so, in the same way we can study the acceleration by its components :

$$a_x = \frac{\sum F_x}{m} \;,\; a_y = \frac{\sum F_y}{m} \;,\; a_z = \frac{\sum F_z}{m}$$

ii) geometrically :



third law For every force that acts on an object there is a reaction force that is equal in magnitude and opposite in direction.

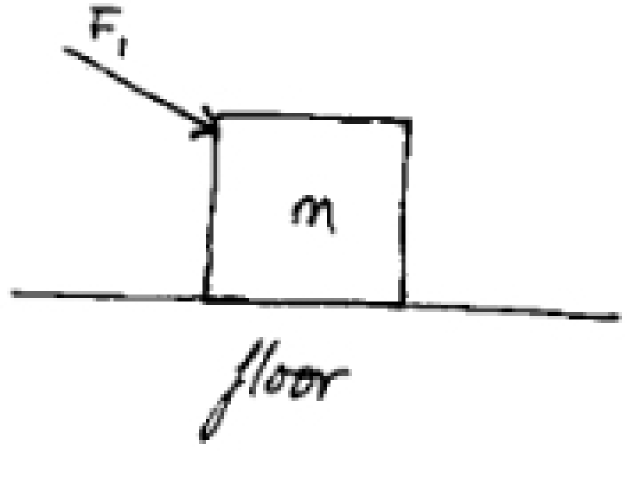


FREE-BODY DIAGRAMS

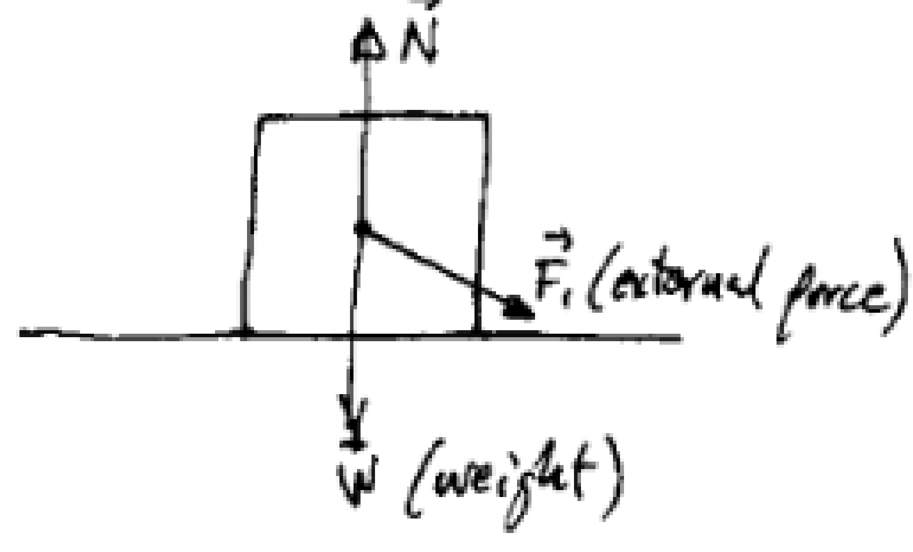
For non-rotational motion, all the forces acting on an object can be taken to act on a point. This point usually corresponds to the center of mass of the object.

i) <u>First step</u>: Figure out each and every external force acting on an object, taking into account direction and magnitude.

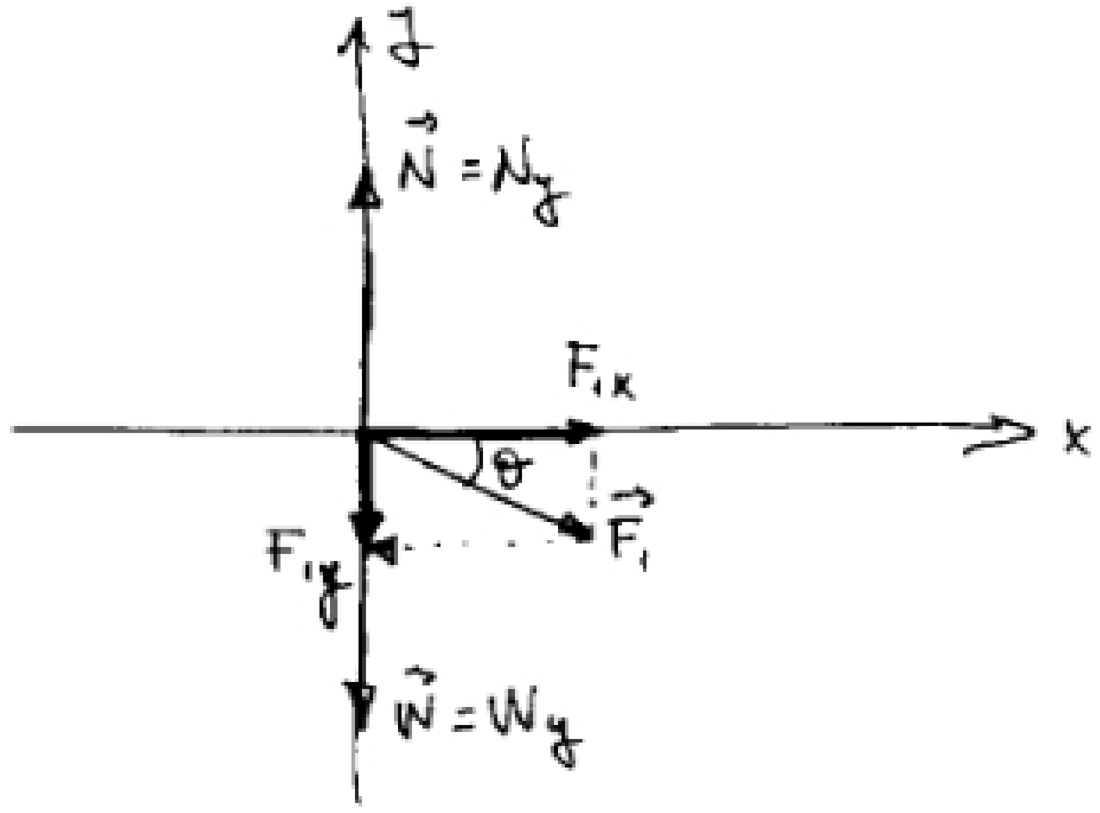
For example:



Forces acting on the object:



ii) Second step: Project each force on the coordinate system axes. For this, an appropriate coordinate system should be chosen.



iii) Third step: Work out the resulting net force on each of the axes (x, y).

on the x-axis: $\sum F_x = F_{1x}$

on the y-axis: $\sum F_y = N_y - F_{1y} - W_y$

where: $F_x = F_1 \cos\theta$
$F_y = -F_1 \sin\theta$

iv) Fourth step: Apply the equations of motion seen in the previous chapter by using the acceleration generated by the net forces.

$$a_x = \sum \frac{F_x}{m} = F_{1x}/m$$
$$a_y = \sum \frac{F_y}{m} = (N_y - F_{1y} - W_y)/m$$