FORCE and Newton's laws:

Force is an action that can change motion.

Force is push or pull, which either changes or tends to change the state of rest or of uniform motion of a body.

OR:

It is the measure of interaction between two objects (pull or push).

-It may be a contact force or a field force:

*Contact forces result from physical contact between two objects.

*Field forces act between disconnected objects.

- ***Measured in Units of Newtons (N)***

(Kg.m/s^2= **N**)

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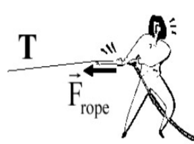
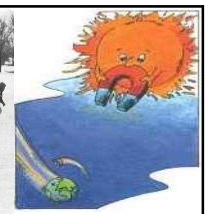
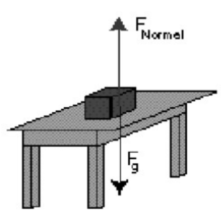
A-Particular forces:

1.Gravitational Force
2.Friction Force
3.Tension Force
4.Normal Force
5.Spring Force



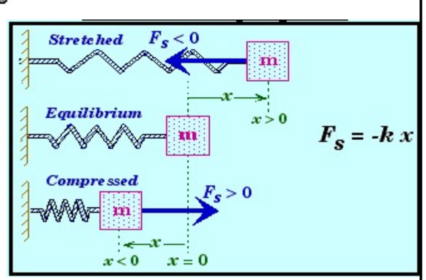




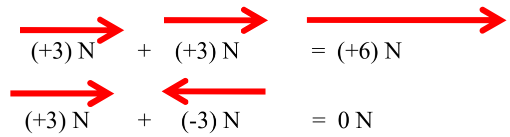
B-Net force: ***The resultant force*** acting on object.

*You must use the rules of vector addition to obtain the **net force** on an object

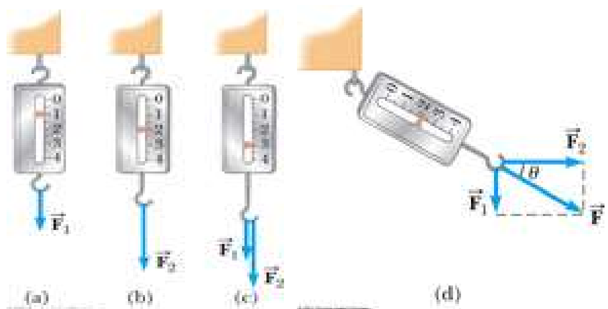
$$\vec{F}_{net} = \sum \vec{F} = \vec{F}_1 + \vec{F}_2 + \vec{F}_3 + ...$$



1. In one dimension, note direction using a + or – sign then add like scalar quantities (regular numbers with no direction associated with them)



2. In two or three dim. , the forces are add as vectors addition



$$|\vec{F}| = \sqrt{F_1^2 + F_2^2} = ? \quad N$$

$$\theta = \tan^{-1}\left(\frac{F_1}{F_2}\right) = ?^\circ$$

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Newton's Laws

First Law

<u>In the absence of a net external force</u>, a body at rest remains at rest and a body in motion continues in that state with a constant velocity.

If an object does not interact with other objects, it is possible to identify a reference frame in which the object has zero acceleration.

In simpler terms, we can say that when no force acts on an object, the acceleration of the object is zero. If nothing acts to change the object's motion, then its velocity does not change.

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2. Newton's Second Law

- The acceleration of an object is directly proportional to the net force acting on it, and inversely proportional to its mass.

$$\Sigma\vec{F} = m\vec{a}$$

$\vec{a}$ = *Acceleration of Motion*

m = *Mass*

$$F_{net,x} = ma_x \qquad F_{net,y} = ma_y$$

This means that the unit of force (N) is equivalent to 1kg m/s^2

1N≡1kg m/s^2

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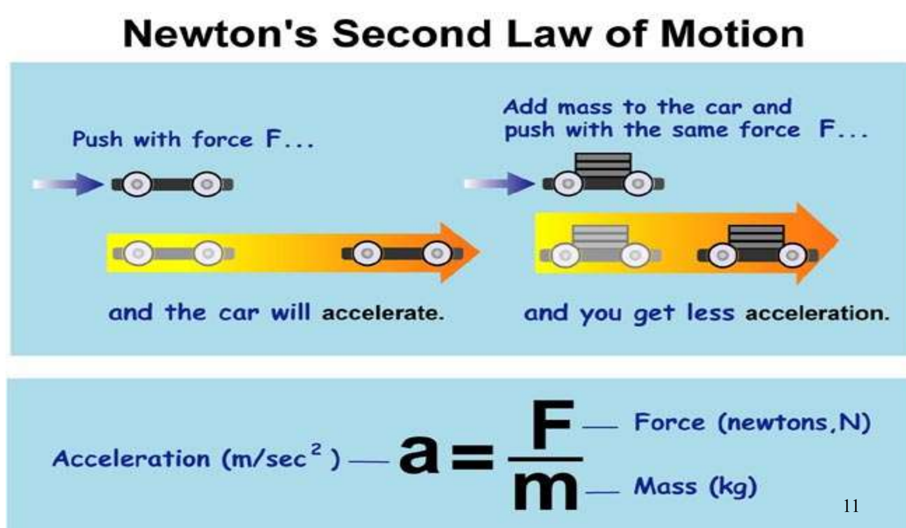
1. If you apply <u>more</u> force to an object, it accelerates at a higher rate.

2- If an object has more mass it accelerates at a lower rate because mass has inertia



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Three forms of the second law:

Use . . .	if you want to find . . .	and you know . . .
$a = \frac{F}{m}$	The acceleration (a)	The net force (F) and the mass (m)
$F = ma$	The net force (F)	The acceleration (a) and the mass (m)
$m = \frac{F}{a}$	The mass (m)	The acceleration (a) and the net force (F)

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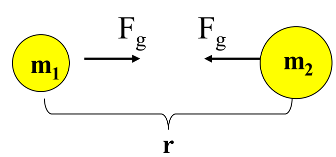
Newton's 2nd law and the gravitational force

- The attractive force exerted by the ***earth*** on an object is called the ***gravitational force.***
- The force between two objects of mass m_1 and m_2, a distance r apart is given by:

$$F_g = G\frac{m_1 m_2}{r^2}$$



- Where G is the universal gravitational constant

$$G=6.67x10^{-11}\ Nm^2/kg^2$$

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Equilibrium

1. The condition of zero acceleration is called equilibrium.
2. In equilibrium, all forces cancel out leaving zero net force.
3. Objects that are standing still are in equilibrium because their acceleration is zero.
4. Objects that are moving at constant speed and direction are also in equilibrium.
5. A static problem usually means there is no motion.

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Weight and mass

- We call the force acting on an object of mass 'm', the ***WEIGHT*** of the object.
- Thus the weight of an object is

WEIGHT

$$W = mg$$

Weight (N) — W; Mass (kg) — m; Strength of gravity (N/kg) — g

- and this is a ***FORCE***, with units Newtons (N).
- <u>Weight and mass are not the same</u>.
- An object's MASS (m) never changes, and is measured in kg. The object's WEIGHT (w) can change, if it is taken to a different planets, or to a different altitude on the earth.

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Relation Between Gravitation Force and Weight

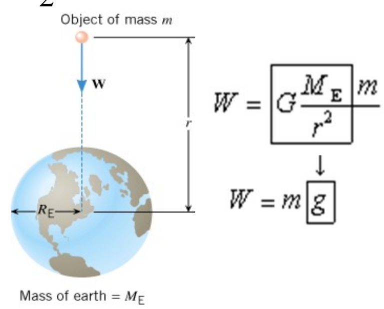
- Let us put the constants for the earth's mass and radius into the equation for the gravitational force
- We see that the quantity 'g', the ***acceleration due to gravity*** comes out of the equation
- On a planet with different $\boldsymbol{m_2}$ or $\boldsymbol{r}$, the acceleration due to gravity would be different

$$F_g = G\frac{m_1 m_2}{r^2}$$

$$= 6.67\times 10^{-11}\times\frac{5.9742\times 10^{24}}{(6.378\times 10^{6})^2}m_2$$

$$= 9.80\, m_2$$

$$= g m_2 = W \text{ (Weight)}$$



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