

Forces, Newton's 1st , 2nd & 3rd Laws.

**GRADE 9 advance
PHYSICS
2018\2019**



Name:_____.

Grade 9 advance ()

Force & newton's laws

A force can cause:

change in state of motion of an object (acceleration).

change in shape of an object (deformation).

FORCE  **ACCELERATION**

The force has symbol of **F** and SI unit of Newton **N**

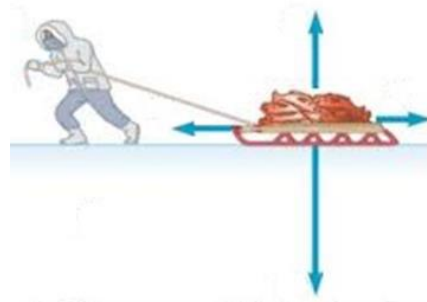
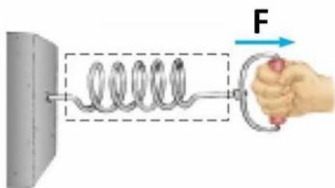
The force is **vector** quantity; i.e. has magnitude and direction.

Forces can be divided into two main **types**:

1. Contact Forces
2. Field Forces

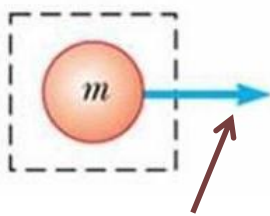
Contact Forces:

Contact Forces: forces that are exerted **by touching** the object. It is either push or pull.



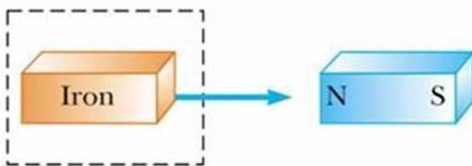
Field Force

Field Forces: forces that are exerted **without touching** the object.

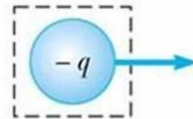


Gravity force

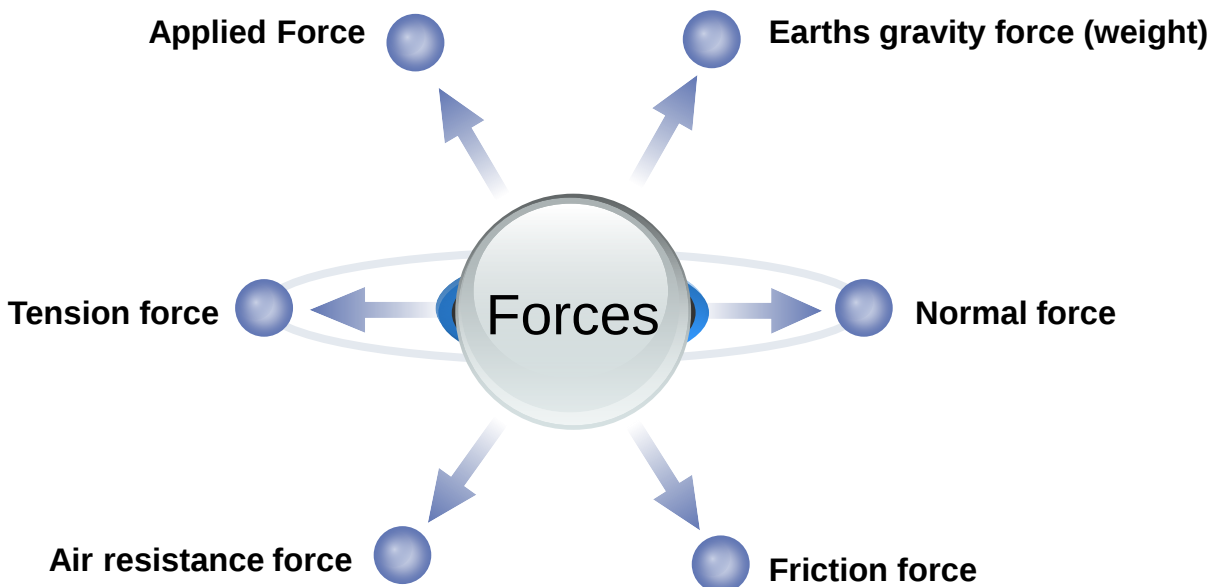
same as the Earth's gravity and the Sun's gravity



Electrical force



Magnetic force

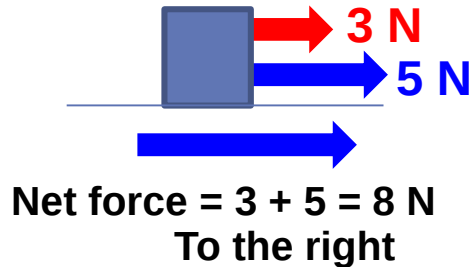


Net Force

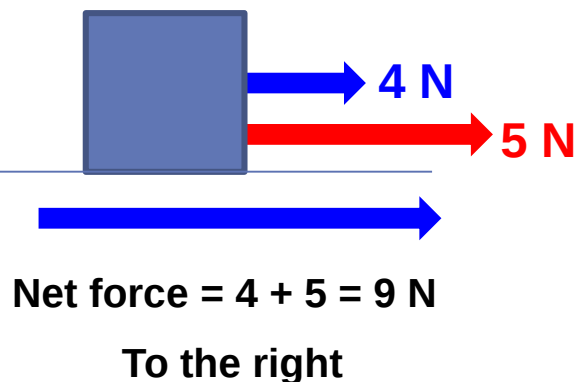
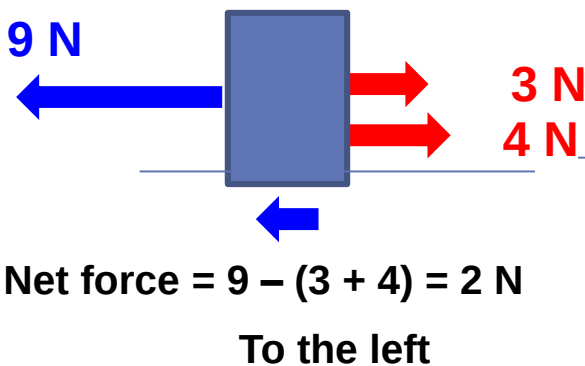
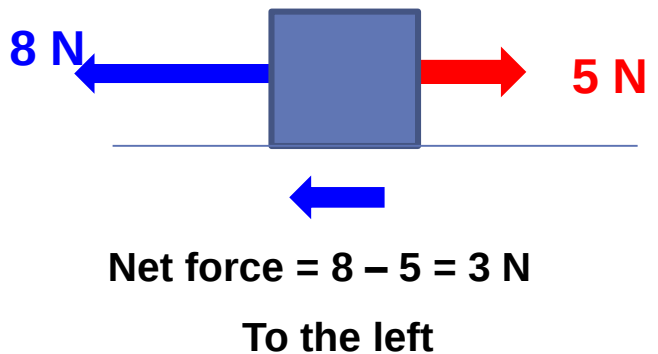
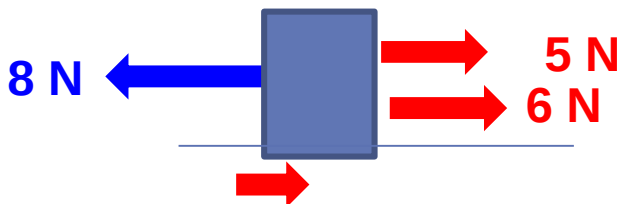
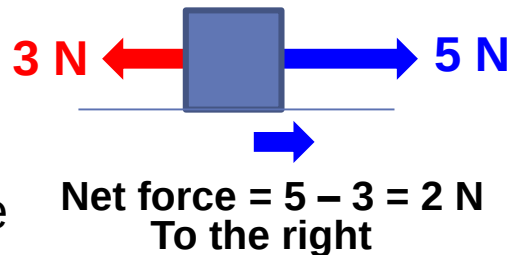
Net Force (resultant force): is the combination of two or more forces acting on one object.

Symbol of net force is F_{net} or ΣF .

When two forces are in the **same** direction
net force is their **addition**.
direction is same as them



When two forces are in the **opposite** direction
net force is their **difference**.
direction is same as greater force



Balanced Forces

when the **net force on an object is zero**, then the **object**:

is at rest **Or** **is moving with constant velocity.**

And in both cases the object is said to be in **equilibrium**.



Inertia

Inertia:

is the tendency of an object to resist changes in velocity.

So;



an object at **rest** tends to **stay at rest** unless a net force moves it.

an object moving with **constant velocity** tends to **stay** like that unless a net force changes it.



Newton's First
Law is called
Law of Inertia.

Newton's First Law(Law of inertia)

States that: An object at rest remains at rest and an object in motion continues in constant velocity (straight line at constant speed), unless it experiences a net external force acting on it.

According to Newton's 1st Law:

when the net force acting on an object is **zero**,

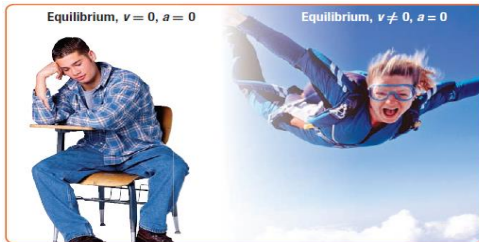
then the object is at **rest** (velocity is zero)

or is moving with **constant velocity** (uniform motion).



Equilibrium

States that: An object at rest remains at rest and an object in motion continues in constant velocity (straight line at constant speed), unless it experiences a net external force acting on it.



when the net force on an object is **zero**, the object is said to be in **equilibrium**. $F_{net} = 0$.

Newton's First Law

Why the coin (in the picture) falls in the cup when the paper is pushed hard?



The coin and paper were at rest.

The pushing force acted on the paper and moved it.

The coin stayed at rest because of its **inertia** and fell down because of gravity.

Newton's First Law

Why wearing seatbelt is important to save lives?



Passengers in a car have the **same velocity** of the car.

When the car is stopped suddenly by a force (wall or brakes), the passengers keep moving with the same velocity because of their **inertia**.

If the passengers were wearing their seatbelts, the seatbelts will exert force to stop them when the car stops.

Newton's 2nd Law

States that: The acceleration of an object is **directly** proportional to the net **force** and **inversely** proportional to the **mass** of the object.

From Newton's second law we can say:

- If the **force** increases, **acceleration increases**.
- If the **mass** increases, **acceleration decreases**.

$$a = \frac{\sum F}{m}$$

Newton's second law can be expressed mathematically by the formula:

$$\sum F = F_{net} = ma$$

m: mass

SI unit: kg

a: acceleration

SI unit: m/s²

F: force

SI unit: N

$$N \equiv \text{kg.m/s}^2$$

Newton's 2nd Law

Uniform Motion

no net force on object

no acceleration

velocity is constant or zero

described by 1st law

$$F = 0$$

$$a = 0$$

$$v = 0 \text{ or } v = \text{const.}$$

equilibrium
uniform motion

Non Uniform Motion

there is net force on object

there is acceleration

velocity is changing

described by 2nd law

$$F = ma$$

$$a \neq 0$$

$$v: \text{changing}$$

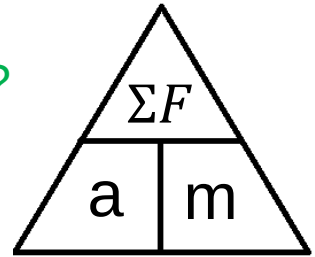
Newton's 2nd Law

EX 1 :

If the mass of a plane is 2000 Kg and the net force on it is 16000 N, what is the plane's acceleration?

Data: $m = 2000 \text{ kg}$ $F_{\text{net}} = 16000 \text{ N}$ $a = ?$

$$a = \frac{F_{\text{net}}}{m} = \frac{16000}{2000} = 8 \text{ m/s}^2$$



EX 2 :

What is the net force on a car with a mass of 800 kg if its acceleration is 2 m/s^2 ?

Data: $m = 800 \text{ kg}$ $a = 2 \text{ m/s}^2$ $F_{\text{net}} = ?$

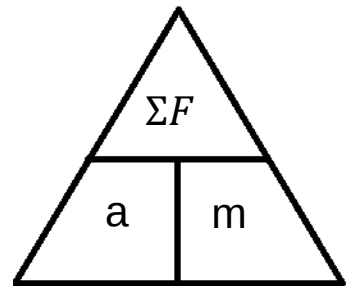
$$F_{\text{net}} = ma = 800 \times 2 = 1600 \text{ N}$$

EX 3 :

A wagon is being pulled by a horse. What is the wagon's mass if the net force on the wagon is 500 N and it has an acceleration of 2 m/s^2 ?

Data: $F_{\text{net}} = 500 \text{ N}$ $a = 2 \text{ m/s}^2$ $m = ?$

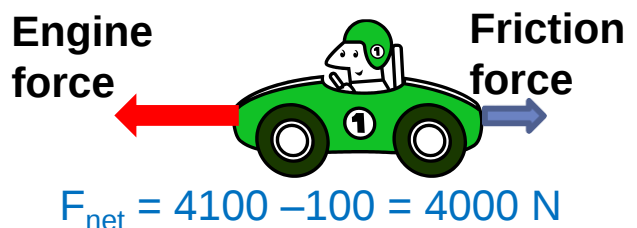
$$m = \frac{F_{\text{net}}}{a} = \frac{500}{2} = 250 \text{ kg}$$



EX 4 :

the engine force is 4100 N and friction force is 100 N. If the car's mass is 1000 kg, find the car's acceleration.

$$a = \frac{F_{\text{net}}}{m} = \frac{4000}{1000} = 4 \text{ m/s}^2$$



Newton's 2nd Law

EX 5 :

A 1000-kg car accelerates from 10 m/s to 26 m/s in 8 s.
Calculate the net force acted on the car during that time.

Data: $m = 1000$;

$v_i = 10$;

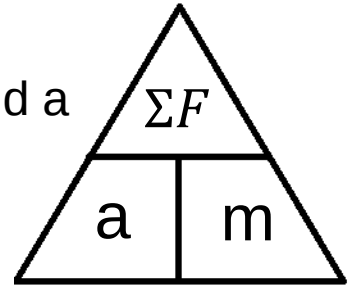
$v_f = 26$;

$t = 8$;

$F_{\text{net}} = ?$

$$F_{\text{net}} = ma$$

we need to find a



$$a = \frac{v_f - v_i}{\Delta t} = \frac{26 - 10}{8} = 2 \text{ m/s}^2$$

$$F_{\text{net}} = ma = 1000 \times 2 = 2000 \text{ N}$$

EX 6 :

A 3000-kg truck is at rest. If a net force of 6000 N exerted on the truck for 10 s, what will be the trucks speed after the 10 s?

Data: $m = 3000$;

$v_i = 0$ (at rest) ;

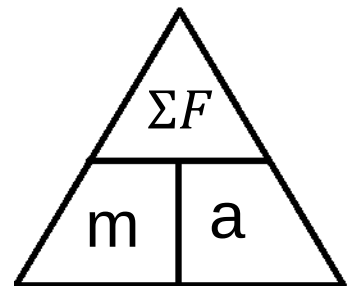
$F_{\text{net}} = 6000$;

$t = 10$;

$v_f = ?$

$$\Sigma F = ma$$

we need to find a



$$a = \frac{F_{\text{net}}}{m} = \frac{6000}{3000} = 2 \text{ m/s}^2$$

$$a = \frac{v_f - v_i}{\Delta t} \Rightarrow v_f = v_i + a \Delta t = 0 + 2 \times 10 = 20 \text{ m/s}$$

Force & Acceleration

When a net **force** acts on object, one of the following happens:

Object **deformed** (change in shape)

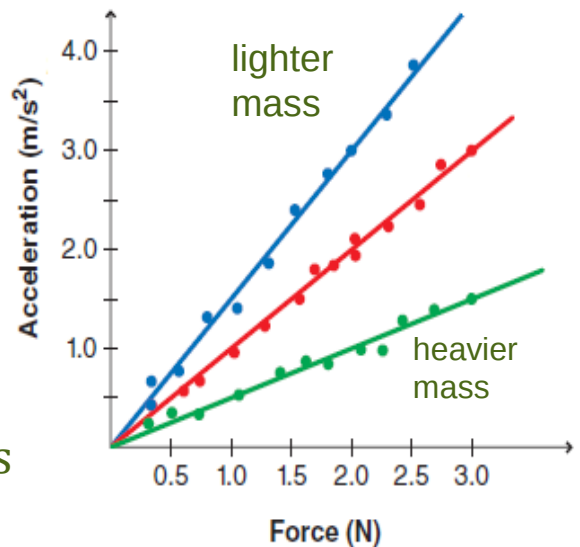
Object **accelerated** (change in motion)

Object **balanced** (its in equilibrium)

The relation between force and acceleration is **linear** (direct proportional).

$$y = mx + a \quad m: \text{slope}$$

$$a = \frac{1}{m}F + 0 \Rightarrow a = \frac{F}{m} \quad m: \text{mass}$$



questions:

Q1: If the mass of a plane is 500 Kg and the net force on it is 1200 N, what is the plane's acceleration?

Q2: What is the net force on a car with a mass of 600 kg if its acceleration is 3 m/s²?

Q3: A 2000-kg truck is at rest. If a net force of 4000 N exerted on the truck for 10 s, what will be the truck's speed after the 10 s?