Linear Motion

- **Linear motion equations**

$v = u + at$

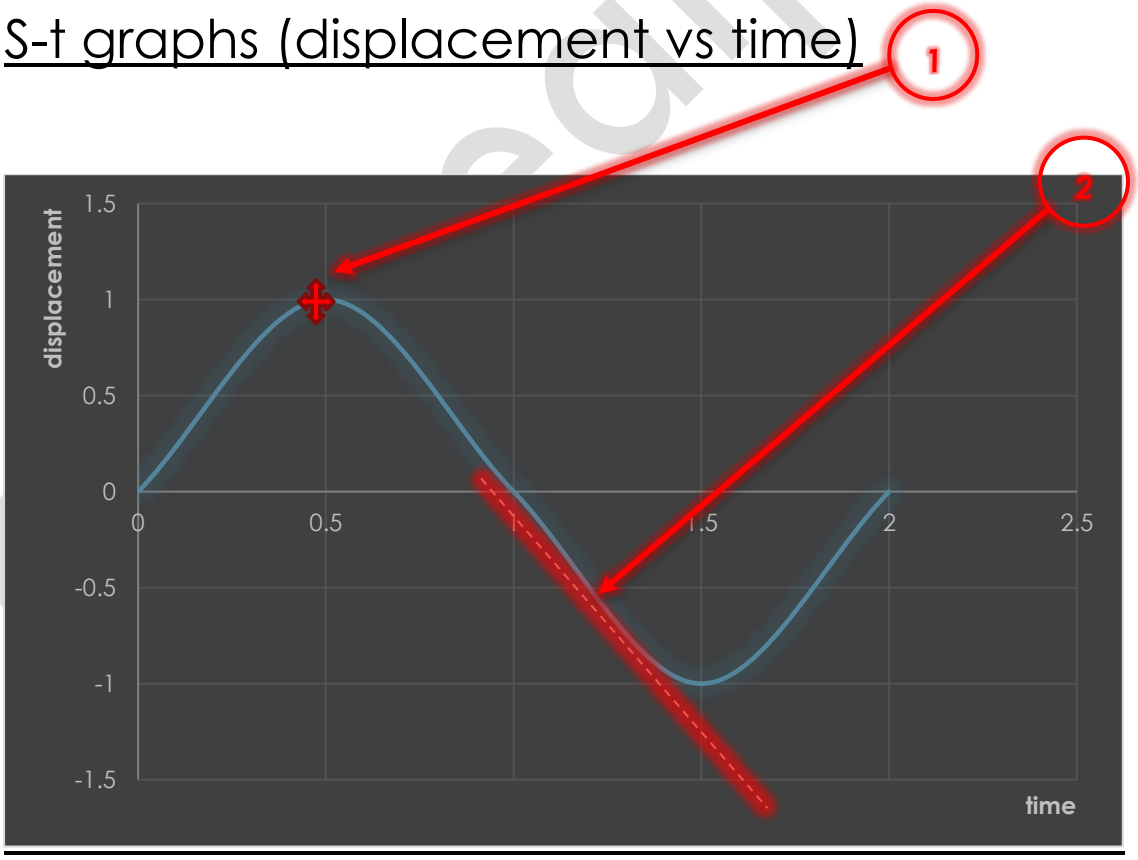
$S = ut + \frac{1}{2}at^2$

$S = \frac{1}{2}(u+v)t$

$v^2 = u^2 + 2aS$

- **Motion graphs**

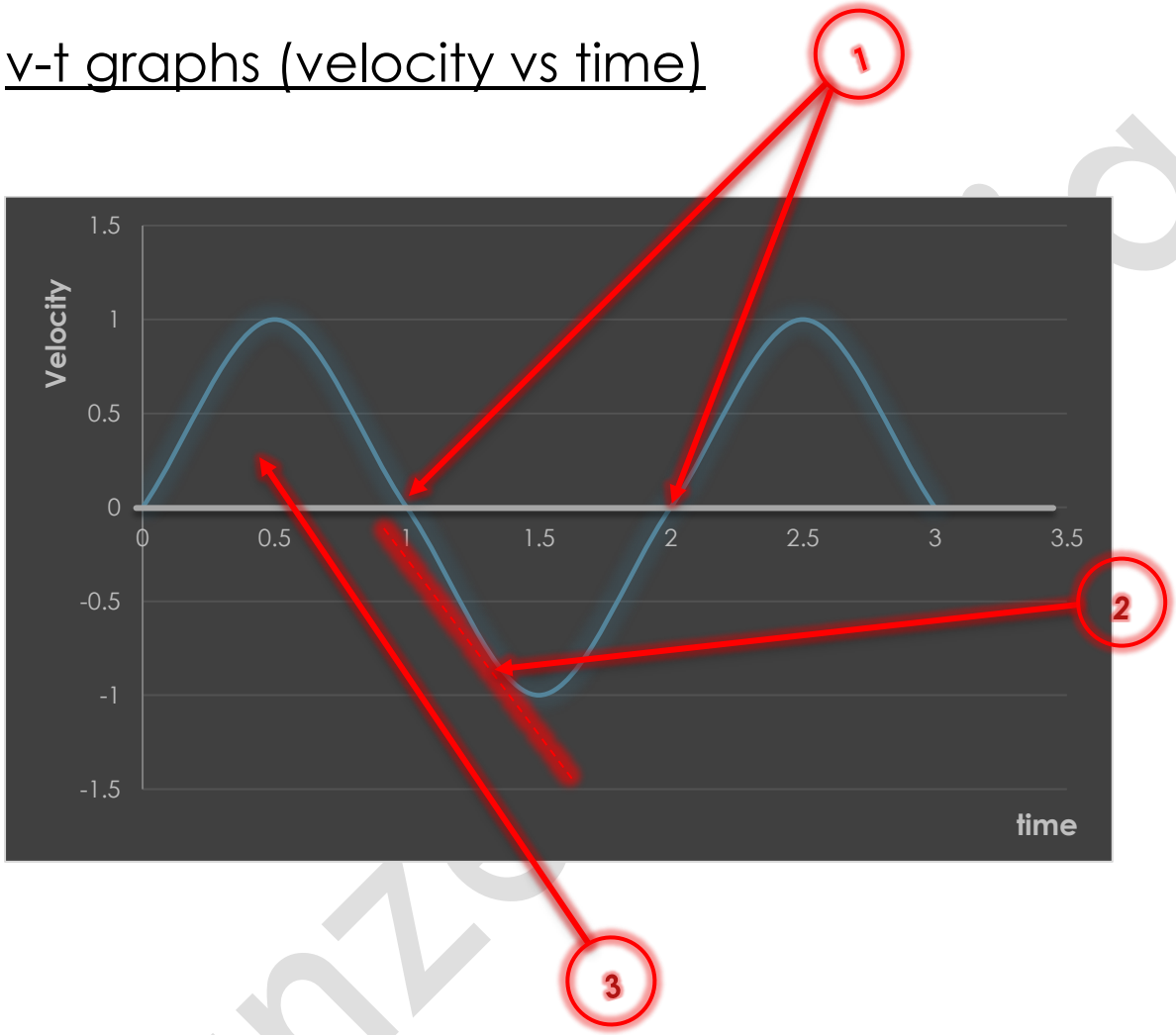
I. S-t graphs (displacement vs time)



1. This means a change in direction of the object. As the gradient goes to (-) .

2. From the gradient of the S-t graph…we can get the Velocity.

II. v-t graphs (velocity vs time)



1. When velocity changes from (+) to (-) or (-) to (+)
   object changes its direction.
2. From the gradient of the v-t graph…We can get the
   Acceleration.

3. From the Area of the graph, we can get the displacement of the object.

III. <u>a-t graphs (acceleration vs time)</u>

- Well…We don't have much to talk about them.
- From the Area of a-t graph, we can find the change of Velocity.

- **<u>Impulse</u>**

  Impulse = Force x time

  And also

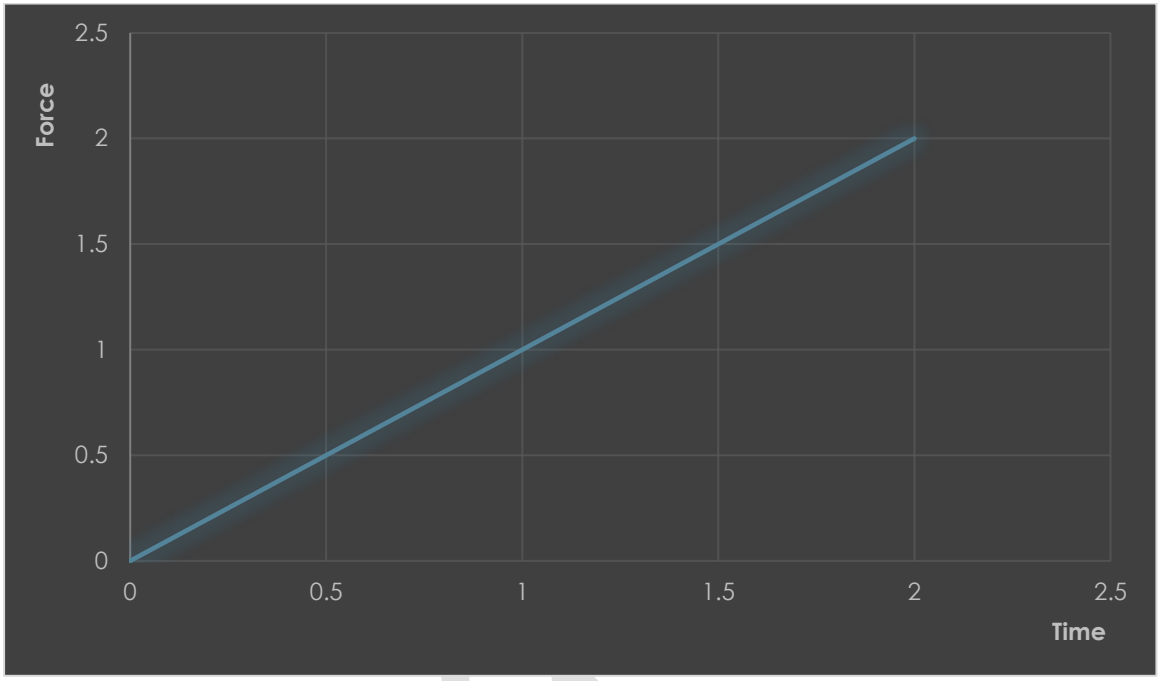
  Impulse = Change of Momentum

  $Ft = \Delta mv$

  - In questions you will need this combined equation most of the times other than a single equation.

- From the area of a F-t graph, you can get the value of impulse.

  Eg:



  Impulse = 1/2 x 2 x2

  = 2 Ns

- **<u>Newton Laws of Motion</u>**

  1. "Every object will remain at rest or in uniform motion in a straight line unless compelled to change its state by the action of an external force." **(Inertia)**

2. A force to be equal to change in momentum per change in time. **(Force)**

That means this,

$F = \frac{\Delta mv}{t}$ (Look at Impulse page too.)

$F = m \times \frac{v}{t}$; *but* $\frac{v}{t} = a$

$F = ma$

3. For every action in nature there is an equal and opposite reaction. **(Action and Reaction)**

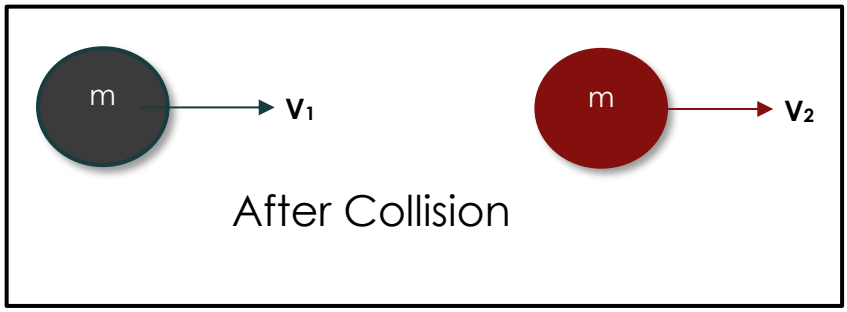
- **<u>Linear Momentum Conservation Principle</u>**
  - We get this formula from the 1st law of Newton.

$m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$

  - In questions we will have to use Newton's Experimental law too.

Relative velocity = -e (Relative velocity of Separation of Approach)

Eg:



According to L.M.C.P,

→ : $mu_1 + mu_2 = mv_1 + mv_2$

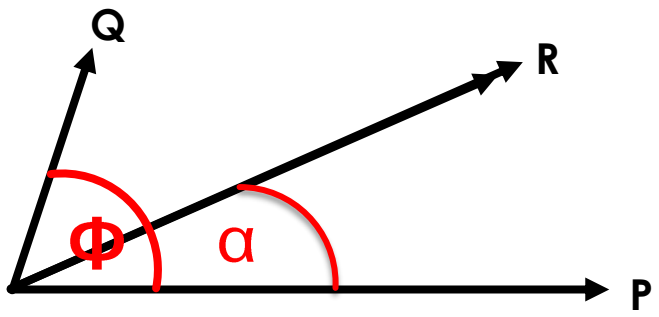
$u_1 + u_2 = v_1 + v_2$ --------***1***

According to N.E.L ,

→ : $v_2 - v_1 = -e\,(u_2 - u_1)$ --------**2**

➢By using **1** and **2** you can solve the mystery.

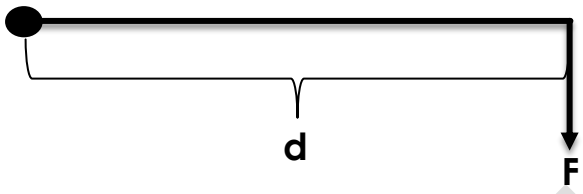
- **<u>Force Parallelogram Law</u>**



$$R^2 = P^2 + Q^2 + 2PQ.Cos\,\Phi$$

$$Tan\,\alpha = \frac{Q.Sin\Phi}{P + Q.Cos\Phi}$$

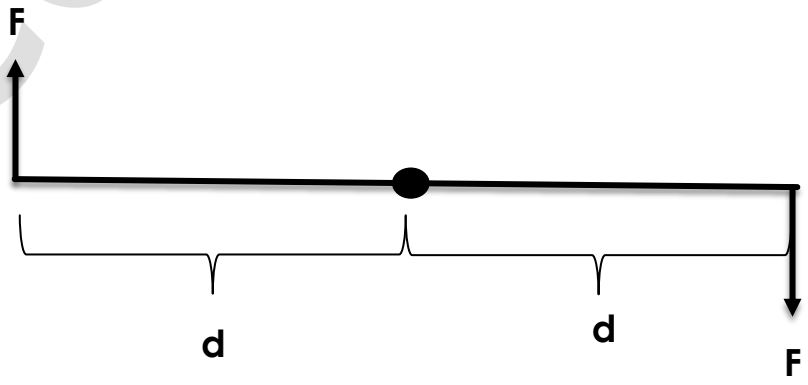
- **Torque**



Torque = Force x Distance

➢ *The distance should be perpendicular to the Force.*

- **Couple forces**



$\sum Torque$ = Force x Perpendicular distance between Forces

- **Work**

Work = Force x Displacement

  - Displacement should be the displacement that occurred to the direction of Force.

- **Power**

$$Power = \frac{Work}{Time}$$

P = W/t ; but W = Fs

$$P = \frac{Fs}{t}$$

$$P = F \times \frac{s}{t} \text{ ; but } \frac{s}{t} = v$$

$$P = Fv$$

- **Efficiency**

$$\text{Efficiency} = \frac{Output\ work}{Input\ work}$$