$= 4.9 \{2t-5\}$

$\text{or } (2t-5) = \frac{196}{4.9} = 4$

$\therefore t = 9/2 = 4.5 \text{ sec}$

Substitute $t = 4.5$ sec in equation (ii)

$h = 4.9(t-3)^2$

$= 4.9(4.5-3)^2$

$= 11.025 \text{ m}$ (Ans)

$\therefore$ Height of the building is 11.025 m

Case (4) : Acceleration is a function of Distance

1) Acceleration of a body starting from rest is given by the relationship

$$a = 15 - 2s$$

where a is the acceleration in m/s^2 ; s is the distance travelled in m. Determine

(i) Velocity of body it has travelled 4m

(ii) Distance travelled when the body is again at rest

Given:

$$a = 15 - 2s$$

$$a = v \cdot \frac{dv}{ds} = 15 - 2s$$

$$v \cdot dv = (15 - 2s)\, ds$$

On integrating,

$$\frac{v^2}{2} = 15s - \frac{2s^2}{2} + c$$

$$= 15s - s^2 + c$$

To find c

Body starts from rest

$$t = 0;\ v = 0;\ s = 0$$

$$\boxed{c = 0}$$

$$\frac{v^2}{2} = 15s - s^2$$

$$v^2 = 30s - 2s^2 \quad \text{— (1)}$$

when $s = 4$ in (1)

$$v_4^2 = 30(4) - 2(4)^2$$

$$v_4 = \sqrt{30(4) - (2 \times 4^2)}$$

$$= 9.38 \text{ m/s}$$

(ii) Distance travelled when the body is again at rest

$v = 0$

Sub $v = 0$ in (1)

$$0 = 30s - 2s^2$$

$$30s = 2s^2$$

$$s = 15\text{m}$$

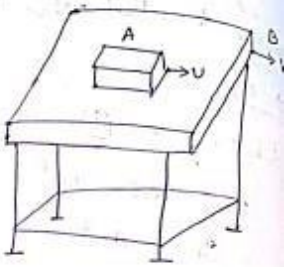
Relative Motion

A Particle is said to be in motion if it changes its position with respect to the surrounding taken as fixed, this type of motion is known as individual motion of body.

V_A → Rate of change of distance between O to A

$= \frac{dx}{dt}$

$a = \frac{d^2x}{dt^2}$



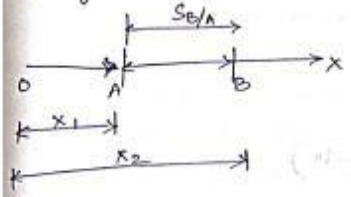
→ If the block is moving at velocity 'u' & at the same time is also pushed in the same direction at velocity 'v'.

Both are moving in different velocities, Now the velocity of block can be determined related to the velocity of table & this velocity is known as "relative velocity" & this motion is said to be "relative motion"

Relative velocity of A wrt B

$V_{A/B} = V_A - V_B = (u-v)$ m/s

① Relative Velocity of two particles moving in Straight lone



Relative velocity of B wrt A

$V_{B/A} = V_B - V_A$

- here both A & B are moving in same direction. If the particle A moves in the opposite direction, then the -ve sign has to be used for V_A. Hence for our convienience, right hand side velocity is taken +ve & left hand side is taken as -ve.

② Car A travels at a Speed of 30m/s & car B ~~from~~ travels at a Speed of 20m/s in the same direction Determine

(i) Velocity of car A relative to car B

(ii) Velocity of car B relative to car A

Let car A & B travels in same direction say towards right.

Velocity of car A = 30m/s

Velocity of car B = 20m/s

Velocity of car A relative to car B

$$V_{A/B} = V_A - V_B$$

$$= 30 - 20$$

$$= 10 \text{ m/s} \ (\rightarrow +ve)$$

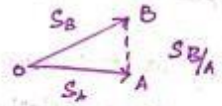
(ii) Velocity of Car B relative to Car A

$$V_{B/A} = V_B - V_A$$
$$= 20 - 30$$
$$= -10 \text{ m/s}$$
$$= 10 \text{ m/s} (\leftarrow -ve)$$

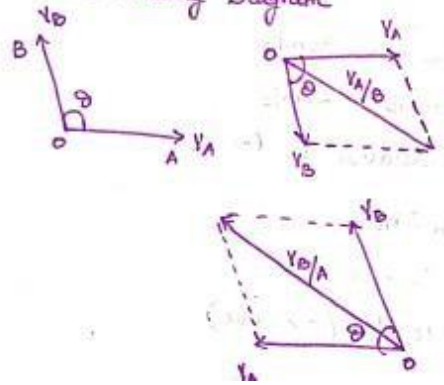
(2) Relative Velocity of a particle from relative velocity Diagram.

*. Relative velocity of the particles moving in a plane.

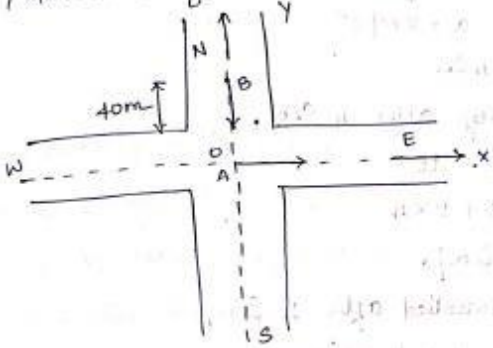
$$S_{B/A} = S_B - S_A$$
$$V_{B/A} = V_B - V_A$$
$$a_{B/A} = a_B - a_A$$



Relative Velocity Diagram



1) A Motor A is travelling from west to east at a constant speed of 18 kmph. When the motor A cross north - south road as shown in figure; a lorry B starts from rest, 40m north of the intersection & moves with a constant acceleration of $2 m/s^2$. Determine the position, velocity & acceleration of lorry relative to motor A, 4 seconds after observation.



Soln

The reference axes OX (towards East) & OY (towards North) are shown in the figure. First of all, let us analyse the motion of motor & lorry at 4 Sec, after the observations are made

* Motor A

Initial velocity $u = 18$ km/hr

$= \frac{18 \times 1000}{3600}$

$= 5 m/s$

Acceleration $a = 0$ [$\because$ travelling at constant speed]

$\therefore$ Distance travelled after 4 Sec = Constant x time
Speed

$= 5 \times 4$

$= 20m$

(ie) after 4 Sec, motor A is at 20m from the origin 'O' along x axis.

* Leray B :

Initial velocity $u = 0$ (∵ Starts from rest)

acceleration $a = 2 m/s^2$

time $t = 4$ Sec

∴ Final velocity after 4 Sec,

$v = u + at$

$= 0 + 2 \times 4$

$= 8 m/s$

∴ Distance travelled after 4 Sec,

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

$= 0 + \left[\frac{1}{2} + 2 \times 4^2\right]$

$= 16m$

Position of the Leray after 4 Sec is

$(40 - 16) = 24m$ from the origin along y axis.

The Position of motor & Leray after 4 seconds are shown in figure (a)