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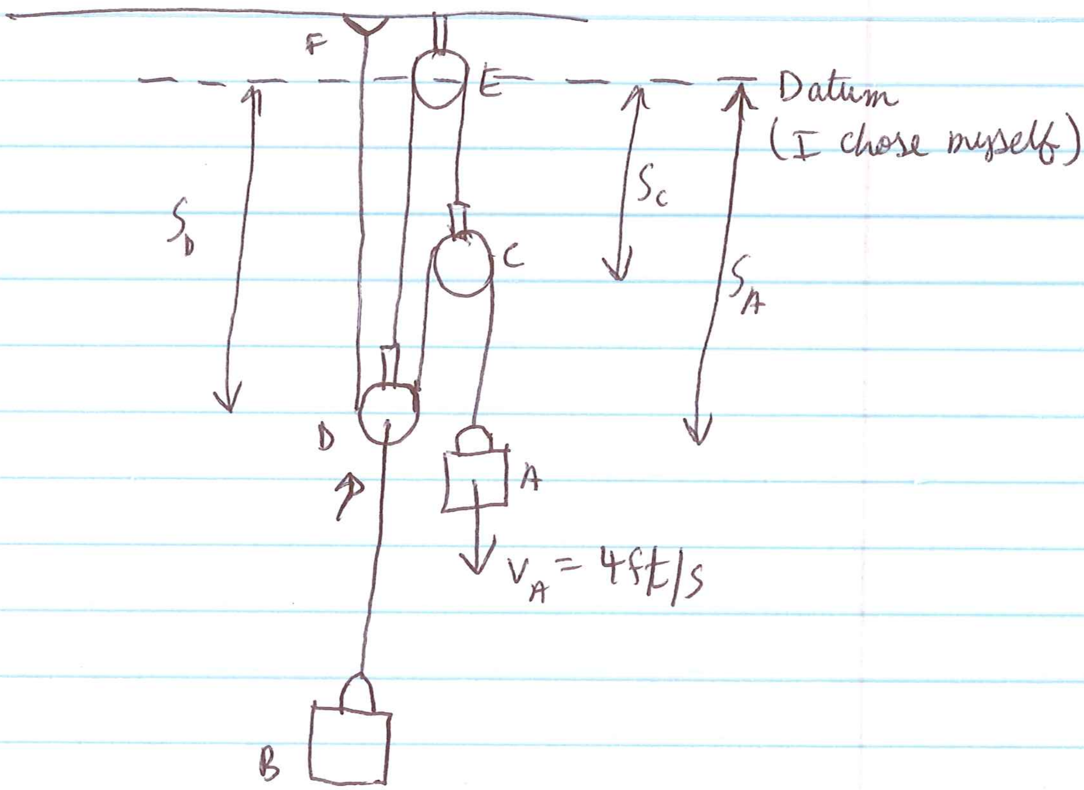

We have 2 ropes moving

$$l_1 = S_D + (S_D - S_c) + (S_A - S_c)$$
$$l_1 = 2S_D - 2S_C + S_A$$

$$l_2 = S_D + S_c$$

deffesentating

$$2V_D - 2V_c + V_A = 0$$

or $$2(V_D - V_c) + 4 = 0 \quad \text{—(1)}$$

$$V_D + V_c = 0 \quad \text{—(2)}$$

from (2)

$$V_D = -V_C \quad —(3)$$

(3) into (1)

$$2(-V_C - V_C) + 4 = 0$$

$$-4V_C = -4$$

$$V_C = 1 \text{ m/s}$$

$$V_D = -1 \text{ m/s}$$

will be velocity of cylinder B, going up.

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Let us resolve velocity of plane B into vertical and horizontal components. +y ↑ → +x

horizontal $(V_B)_x = 800 \cos 60 = 400 \leftarrow$

vertical $(V_B)_y = 800 \sin 60 = 692.82 \downarrow$

So analyse relative motion for each component

horizontal :

$V_{B/A} = V_B - V_A = -400 - 650 = -1050$ Km/h

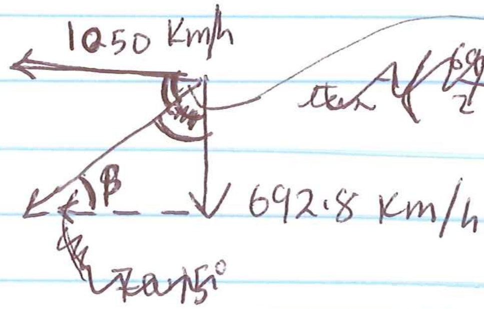
$= \cancel{-800\cos 60 + 650 - (-650)}$

$= 1050 \cancel{+250}$ Km/h

vertical :

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

$= -800 \sin 60 - 0 = -692.8$



$\tan^{-1}\left(\frac{692.8}{2}\right)$

$\tan^{-1}\left(\frac{250}{692.8}\right) = 19.84°$

$\beta = \tan^{-1}\left(\frac{692.8}{1050}\right) = 33.41°$

$|V_{B/A}| = \sqrt{1050^2 + 692.8^2} = 1257.96$ Km/h

So A would observe B coming towards it at 1257.96 Km/h at angle of 33.41°

Problems Based on Relative Motion

Q.11 A swimmer's speed in the direction of flow of river is $16kmh^{-1}$. Against the direction of flow of river, the swimmer's speed is $8kmh^{-1}$. Calculate the swimmer's speed in still water and the velocity of flow of the river.

Sol. Let v_s and v_r represent the velocities of swimmer and river respectively.

Now, $v_s + v_r = 16$

and $v_s - v_r = 8$ .....(1)

Adding, $2v_s = 16 + 8 = 24kmh^{-1}$

or $v_s = 12kmh^{-1}$

From Eq. (1) $12 + v_r = 16$

or $v_r = 4kmh^{-1}$

Q.12 A train 110m long is traveling at $60kmh^{-1}$. In what time it will cross a cyclist moving at $6kmh^{-1}$ (a) in the same direction, (b) in the opposite direction?

Sol. Velocity of train, $v_t = 60kmh^{-1}$;

Velocity of cyclist, $v_c = 6kmh^{-1}$

(a) Relative velocity of train w.r.t cyclist, $v_{tc} = (60 - 6)kmh^{-1}$

$$= 54kmh^{-1} = 54 \times \frac{5}{18}ms^{-1} = 15ms^{-1}$$

Now, $15 = \frac{100}{t}$ or $t = \frac{100}{15}s = 7.33s$

(b) Relative velocity of train w.r.t cyclist, $v_{tc} = (60 + 6)kmh^{-1} = 66kmh^{-1} = 66 \times \frac{5}{18}$

Now, $t = \frac{110 \times 18}{60 \times 5}s = 6s$

class

Q.13 A police van moving on a highway with a speed of $30kmh^{-1}$ fires a bullet at a thief's car speeding away in the same direction with a speed of $192kmh^{-1}$. If the muzzle speed of the bullet is $150kmh^{-1}$, with what speed does the bullet hit the thief's car?

Sol. Speed of police van,

$$v_p = 30kmh^{-1} = \frac{30 \times 1000}{3600}ms^{-1} = \frac{25}{3}ms^{-1}$$

Speed of thief's car,

$$v_t = 192kmh^{-1} = \frac{192 \times 1000}{3600}ms^{-1} = \frac{160}{3}ms^{-1}$$

Speed of bullet, v_b = speed of police van + speed with which bullet is actually fired

$$\therefore \quad v_b = \left(\frac{25}{3} + 150\right)ms^{-1} = \frac{475}{3}ms^{-1}$$

Relative velocity of bullet w.r.t. thief's car,

$$v_{bt} = v_b - v_t = \left(\frac{475}{3} - \frac{160}{3}\right)ms^{-1} = 105ms^{-1}$$

$vT = 18(v - 20)$

In direction B to A

$vT = 6(v + 20)$

On solving equation (1) and (2)

$V = 40kmh^{-1}$ and $t = 9min.$

Q.20 A jet air plane moving a the speed of $500kmh^{-1}$ ejects its products of combustion at the speed of $15000kmh^{-1}$ relative to it. Find the speed of the latter with respect to an observer on the ground.

Sol. $\therefore$ Velocity of jet plane $V_j = -500kmh^{-1}$

Velocity of product of combustion,

with respect to jet $= V_p = 1500kmh^{-1}$

Relative velocity of product of combustion w.r.t jet

= velocity of product - velocity of jet

$\therefore \quad 1500 = V - (-500)$

or $\quad V = 1500 - 500$

$= 1000kmhr^{-1}$