(1)

Sol. Total time of journey = 2 hrs

Total distance = 16 km [upstream + downstream]

$\therefore V_{boat} = \frac{\text{Total distance}}{\text{Total time}} = \frac{16}{2} = 8$ kmph

when boat is going upstream, the effective speed $V_{upstream} = V_{boat} - V_{water} = 8-4 = 4$ kmph

$T_{upstream} = \frac{\text{Distance}}{V_{upstream}} = \frac{8}{4} = 2$ hrs

$V_{downstream} = V_{boat} + V_{water} = 8+4 = 12$ kmph

$T_{downstream} = \frac{\text{Distance}}{V_{downstream}} = \frac{8}{12} = \frac{2}{3}$ hrs.

$\therefore$ Total time $= T_{upstream} + T_{downstream} = 2\text{ hr} + \frac{2}{3}\text{ hrs}$

$\simeq 2$ hrs 40 min → B

(2)

Given $V_{water} = 2 \text{ kmph} = 2 \times \frac{5}{18} = \frac{10}{18} = \frac{5}{9}$ m/s

$V_{boat} = 8 \text{ kmph} = 8 \times \frac{5}{18} = \frac{20}{9}$ m/s

Time to cross the river can be $= \frac{d}{v} = \frac{400}{\frac{20}{9}} = 180$ sec.

Drift $= x = u_w \times t = \frac{5}{9} \times 180 = \underline{100\text{m}}$ → D

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(3)

$V_{river} = 5\, kmph = 5 \times \frac{5}{18}\, m/s = \frac{25}{18}\, m/s$

width $\Rightarrow d = 200\, m.$

time to cross river = 25 sec.

$time = \frac{d}{V_{Boat}} \Rightarrow V_{Boat} = \frac{200}{t} = \frac{200}{25}$

$\Rightarrow V_{Boat} = 8\, m/s$

If River flow is not there

$\therefore$ Time taken to cross river $= \frac{d}{V_{Boat}}$

$= \frac{200}{8} = 25\, sec \rightarrow C$

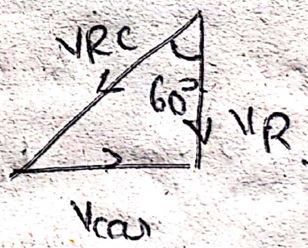
(4)

$V_{Rain} = 4\, kmph \qquad V_{M} = 2\, kmph$

$V_{RM} = \sqrt{V_R^2 + V_m^2} = \sqrt{4^2 + 2^2} = 2\sqrt{5}\, kmph \rightarrow B$

(5)

$V_{car} = 20\, m/s$



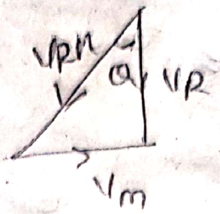
From fig

$\tan 60° = \frac{V_{car}}{V_{Rain}} \Rightarrow$

$\Rightarrow V_{Rain} = \frac{V_{car}}{\tan 60°} = \frac{20}{\sqrt{3}} = 11.55\, m/s \rightarrow B$

(6)

$V_{RM} = 2 V_M$



From fig $\tan\theta = \frac{V_M}{V_R}$

or $\sin\theta = \frac{V_M}{V_{RM}} = \frac{V_M}{2V_M} = \frac{1}{2} \Rightarrow \theta = 30^\circ \rightarrow A$

(7)

$T_{upstream} = 4\text{ hrs}$ $T_{downstream} = 2\text{ hrs}$

$\Rightarrow \frac{d}{V_{boat} - V_w} = 4 \rightarrow (1)$; $\frac{d}{V_{boat} + V_{water}} = 2\text{ hr} \rightarrow (2)$

where 'd' is distance travelled by the boat

$$\frac{(1)}{(2)} = \frac{\frac{\cancel{d}}{V_{Boat} - V_w}}{\frac{\cancel{d}}{V_{Boat} + V_w}} = \frac{\cancel{4}^{\,2}}{\cancel{2}}$$

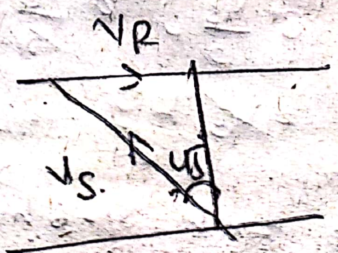
$\Rightarrow \frac{V_B + V_w}{V_B - V_w} = 2 \Rightarrow V_B + V_w = 2V_B - 2V_w$

$\Rightarrow V_B = 3V_w$

$\Rightarrow \frac{V_B}{V_w} = \frac{3}{1} \rightarrow B$

(8)

From given data



From fig $\sin 45^\circ = \frac{V_R}{V_S}$

$\Rightarrow \frac{1}{\sqrt{2}} = \frac{V_R}{V_S}$

$\Rightarrow V_S : V_R = \sqrt{2} : 1 \rightarrow B$

$V_R \rightarrow$ velocity of river

(9)

V_B Given $V_B = 10$ kmph.

$V_{River} = 4$ kmph.

Breadth $d = 80$ km.

we know drift $= \frac{d}{V_{Boat}} \times V_{river}$

$\Rightarrow \frac{80}{10} \times 4 = 32$ km $\rightarrow$ D

(10)

Given Time for upstream $T_U = 12$ hrs

Time for downstream $T_d = 8$ hrs.

let

$V_B \rightarrow$ velocity of boat ; $V_R \rightarrow$ velocity of river.

$d = T_U (V_B - V_R)$ $\rightarrow$ (1) also $d = T_{down} [V_B + V_R]$ $\rightarrow$ (2)

$\Rightarrow T_U (V_B - V_R] = T_d (V_B + V_R]$

$\Rightarrow \cancel{12}^{3} (V_B - V_R] = \cancel{8}_{2} [V_B + V_R]$

$\Rightarrow 3V_B - 3V_R = 2V_B + 2V_R \Rightarrow V_B = 5V_R$.

also distance travelled by boat $d = V_B t$

from (2) so $T_d (V_B + V_R] = 5V_R t$

$\Rightarrow 8 [\cancel{5V_R + V_R}\ V_B + \frac{V_B}{5}] = \cancel{5} \frac{V_B}{\cancel{5}} \times t$

$\Rightarrow 8 \times \frac{6 \cancel{V_B}}{5} = \cancel{V_B}\, t$

$\Rightarrow \frac{48}{5} = t \Rightarrow t = 9.6$ hrs $\rightarrow$ B

(14)

Given

$$V_b = n V_\omega$$

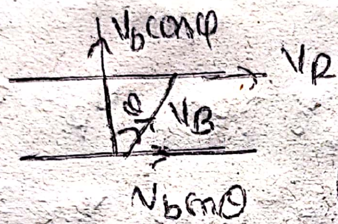
Velocity of boat w.r.t. ground

$$V_{bg} = \sqrt{V_b^2 - V_\omega^2} = \sqrt{(nV_\omega)^2 - V_\omega^2}$$

$$V_{Bg} = V_\omega \sqrt{n^2 - 1}$$

If $n > 1$; $V_{bg} > 0$, so boat can cross the river along shortest path.

Let θ be the angle between boat and shortest path



$V_b \cos\theta = n V_\omega \cos\theta$

Parallel component $= V_\omega - V_b \sin\theta$

$\Rightarrow V_\omega - n V_\omega \sin\theta$

If $\theta > 0$

$\Rightarrow V_\omega (1 - n \sin\theta)$

If $n = 1$; $V_{\parallel} \neq 0$, so boat can not cross river without drifting

If $n \neq 0$ $V_\perp \neq 0$, so Boat can not cross the river. $n < 1$.

(16)

$$\text{drift} = V_R \times \frac{d}{V_B} = \cancel{V_R \times d}$$

(a) $d = 1000\,m$; $V_R = 2\,m/s$; $V_b = 4\,m/s \Rightarrow \text{drift} = 2 \times \frac{1000}{4} = 500\,m$

(b) $d = 500\,m$; $V_r = 1\,m/s$; $V_b = 6\,m/s \Rightarrow \text{drift} = 1 \times \frac{500}{6} = 83.3\,m$

(c) $d = 1000\,m$; $V_r = 6\,m/s$; $V_b = 6\,m/s \Rightarrow \text{drift} = 6 \times \frac{1000}{6} = 1000\,m$

I Task

(1)

$V_{Bw} = 10$ m/min ; velocity of river $V_{Rw} = 4$ m/min

width of the river $d = 500$ m

Time taken to cross the river in shortest time

$$t = \frac{d}{V_B} = \frac{d}{\sqrt{V_{Bw}^2 - V_{Rw}^2}}$$

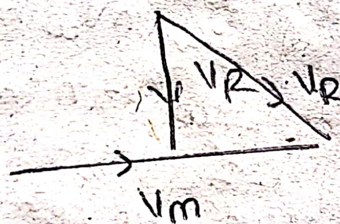
$$= \frac{500}{\sqrt{10^2 - 4^2}} = \frac{500}{\sqrt{84}} \simeq 50 \text{ min}$$

→ B

(2)

Given velocity of rain $V_R = 3$ m/s

velocity of wind $V_w = 3$ m/s



Relative velocity of rain w.r.t wind $= \sqrt{V_R^2 + V_w^2} = \sqrt{3^2 + 3^2} = 3\sqrt{2}$ m/s

→ D

(3)

Given velocity of river $V_R = 3$ m/s

width of river $d = 300$ m

velocity of swimmer $V_{m} = 2$ m/s

Time taken to cross the river $= \frac{d}{V_{mR}} = \frac{300}{\cancel{\beta}}$

$$= \frac{300}{2} = 150 \text{ sec} \rightarrow B$$

(4)

Given velocity of swimmer $V_m = 4$ kmph

$= \frac{4000}{60}$ m/min

width $d = 1$ km

velocity of river $V_R = 3$ kmph

Time taken to cross the river $= \frac{d}{V_m} = \frac{1}{4}$

$\Rightarrow \frac{1000}{4000} \times 60 = 15$ min $\rightarrow$ B

(5)

Given velocity of river $V_r = 3$ m/s

velocity of boat or man $V_m = 2$ m/s

width $d = 300$ m.

drift $= d \pm V_R t$

$= 3 \times \frac{300}{2}^{150} = 450$ m $\rightarrow$ C

(6)

Given velocity of man $V_m = 10$ kmph.

velocity of river $V_R = 5$ kmph.

Velocity of man with respect to river

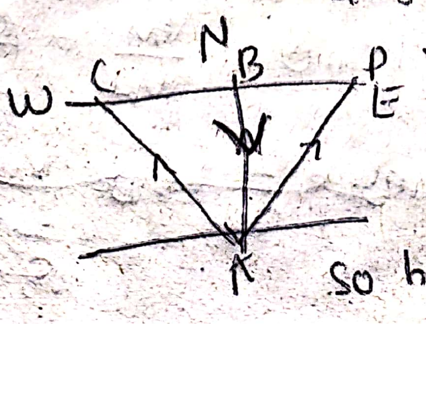
$V_{mR} = \sqrt{V_m^2 + V_R^2} = \sqrt{10^2 + 5^2} = 5\sqrt{2}$ kmph

$\rightarrow$ C

(7)

Given velocity of river $\rightarrow V_R = 4$ kmph.

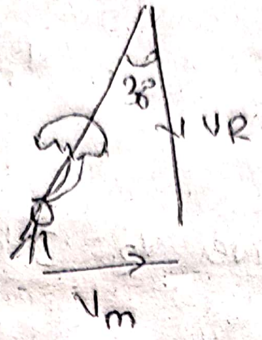
velocity of man $\rightarrow V_m = 8$ kmph.



The man has to swim along AB to cross the river in shortest time

So he should swim along South

(8)



From fig $\tan\theta = \frac{V_m}{V_R}$

$\Rightarrow \tan 30^\circ = \frac{V_M}{V_R}$

$\Rightarrow \frac{1}{\sqrt{3}} = \frac{V_m}{V_R}$

$\Rightarrow \frac{V_R}{V_m} = \frac{\sqrt{3}}{1} \rightarrow A$

(9) Given

velocity of A $= V_A = 16\hat{j}$ kmph.

velocity of B $= V_B = 12(-\hat{i})$ kmph

After some time velocity of B

$V_B' = 15$ NE of V_A

velocity of A relative to B

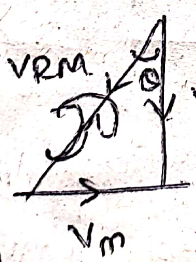
$\vec{V}_{AB} = \vec{V}_A - \vec{V}_B = 16\hat{j} - (-12\hat{i}) = 16\hat{j} + 12\hat{i}$

$|\vec{V}_{AB}| = \sqrt{12^2 + 16^2} = \sqrt{400} = 20$ kmph $\rightarrow B$

(10)

Given velocity of rain $= 1.5$ velocity of man

$V_{RM} = \frac{3}{2} V_M$.



he should hold the umbrella in a direction opposite to Relative velocity of rain w.r.t man

From fig $\tan\theta = \frac{V_M}{V_R} =$

$V_{RM}^2 = V_R^2 + V_m^2$

$\Rightarrow \frac{9}{4} V_m^2 = V_R^2 + V_m^2 \Rightarrow V_R^2 = \frac{5}{4} V_m^2 \Rightarrow V_R = \frac{\sqrt{5}}{2} V_M$

$$\tan\theta = \frac{v_M}{\frac{\sqrt{5}}{2} v_m} = \frac{2}{\sqrt{5}} \rightarrow A$$

(13)

(a) Given $u = 2v \Rightarrow \sin\theta = \frac{v}{u} = \frac{v}{2v} = \frac{1}{2}$

$\theta = 30^\circ$

(b) $u = 1.414v \Rightarrow \sin\theta = \frac{v}{u} = \frac{v}{\sqrt{2}v} = \frac{1}{\sqrt{2}}$

$= \sqrt{2}v$

$\theta = 45^\circ$

(c) $u = v \Rightarrow \sin\theta = \frac{v}{u} = \frac{u}{u} = 1 \Rightarrow \theta = 90^\circ$

θ a angle made by the boat with flow

(14)

Given

$v_B = 5$ kmph ; width $d = 1$ km

Time to cross along shortest path $= t = 15$ min

$= \frac{1}{4}$ hrs

$$\Rightarrow t = \frac{d}{\sqrt{v_B^2 - v_R^2}} \Rightarrow \frac{1}{4} = \frac{1}{\sqrt{5^2 - v_R^2}}$$

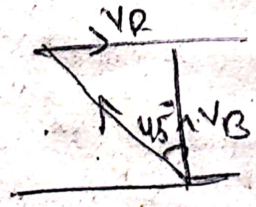
$$\Rightarrow \sqrt{5^2 - v_R^2} = 4 \Rightarrow 5^2 - v_R^2 = 4^2$$

$$\Rightarrow v_R^2 = 5^2 - 4^2 \Rightarrow v_R = 3 \text{ kmph}$$

$\rightarrow A$

(15)

Given velocity of water $v_w = v$.



$\sin\theta = \frac{v_R}{v_B}$ Here $v_B \rightarrow$ velocity of boat.

$$\Rightarrow \sin 45^\circ = \frac{v}{v_B}$$

$$\Rightarrow \frac{1}{\sqrt{2}} = \frac{v}{v_B} \Rightarrow v_B = \sqrt{2}v$$

(16) Given $V_{BW} = 2\hat{i} + 3\hat{j}$ m/s

$V_W = 3\hat{i} + 2\hat{j}$ m/s

$V_{BW} = V_{BG} - V_{WG}$

$\Rightarrow 2\hat{i} + 3\hat{j} = V_{BG} - 3\hat{i} - 2\hat{j}$

$\Rightarrow V_{BG} = 5\hat{i} + 5\hat{j}$ m/s

<u>~~WS45~~</u> ~~Motion in G~~

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