Physicsaholics

DPP – 8 (Kinematics)

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Q 1. A boat moves relative to water with a velocity which is n times the river flow velocity
(a) If n < 1, boat cannot cross the river
(b) If n = 1, boat cannot cross the river without drifting
(c) If n > 1, boat can cross the river along shortest path
(d) Boat can cross the river whatever is the value of n (excluding zero value)

Q 2. A river is flowing east to west with velocity v. A man can swim with velocity v_0 in still water. He takes minimum time t_1 to cross the river. When he swims along shortest path, takes time t_2. The ratio of time $t_1 t_2$ is 1 : 2, then $\frac{v_o}{v}$ is equal to
(a) $\sqrt{3} : 2$ (b) 1 : 1 (c) $2 : \sqrt{3}$ (d) 2 : 1

Q 3. A boat which has a speed of 5 km/h in still water crosses a river of width 1 km along the shortest possible path in 15 min. The velocity of the river water in km/h is:
(a) 1 (b) 3 (c) 4 (d) $\sqrt{41}$

Q 4. River is flowing with a velocity $\vec{v}_R = 4\hat{\imath}$ m/s. A boat is moving with a velocity of $\vec{v}_{BR} = (-\hat{\imath} + 4\vec{j})$ m/s relative to river. The width of the river is 100 m along y-direction. Choose the correct alternative(s)
(a) The boatman will cross the river in 25 s
(b) Absolute velocity of boatman is $2\sqrt{5}$ m/s
(c) Drift of the boatman along the river current is 50 m
(d) The boatman can never cross the river.

Q 5. A man wants to cross a river 500 m wide. The rowing speed of the man relative to water is 3 km/hr and the river flows at the speed of 2 km/hr. If the man's walking speed on the shore is 5 km/hr, then in which direction should he start rowing in order to reach the directly opposite point on the other bank in the shortest time?
(a) At an angle $\sin^{-1}\left(\frac{3}{7}\right)$ with the river flow direction
(b) At an angle $90^o + \sin^{-1}\left(\frac{3}{7}\right)$ with the river flow direction
(c) At an angle $90^o - \sin^{-1}\left(\frac{3}{7}\right)$ with the river flow direction
(d) At an angle $90^0 - \cos^{-1}\left(\frac{3}{7}\right)$ with the river flow direction

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Q 6. A swimmer crosses a river of width d flowing at velocity v. While swimming, he keeps himself always at an angle of 120^o with the river flow and on reaching the other end he finds a drift of d/2 in the direction of flow of river. The speed of the swimmer with respect to the river is

(a) $(2-\sqrt{3})$ v (b) 2 $(2-\sqrt{3})$ v

(c) 4 $(2-\sqrt{3})$ v (d) $(2+\sqrt{3})$ v

Q 7. A motor boat is to reach at a point 30^0 upstream on the other side of a river flowing with velocity 5 m/s. Velocity of motor boat with respect to water is $5\sqrt{3}$ m/sec. The driver should steer the boat an angle:

(a) 30^0 w.r.t. the line of destination from starting point

(b) 60^0 w.r.t.. normal to the bank

(c) 120^0 w.r.t. stream direction

(d) None of these

Q 8. A man can swim at a speed of 5 km/h w.r.t. water. He wants to cross a 1.5 km wide river flowing at 3 km/h. He keeps himself always at an angle of 60^o with the flow direction while swimming. The time taken by him to cross the river will be

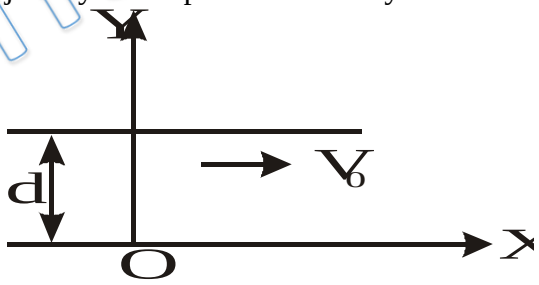
(a) 0.25 hr. (b) 0.35 hr. (c) 0.45 hr. (d) 0.55 hr.

Q 9. A swimmer wishes to cross a 1 km wide river flowing at 5 kmh^{-1}. His speed in still waters is 3 km/h. He has to reach directly opposite in minimum possible time. If he does not reach directly opposite by swimming, he has to walk that distance at 5 kmh^{-1}. Find the time taken

(a) 0.45 hr (b) 0.66 hr

(c) 1 hr (d) 1.5 hr

Q 10. A swimmer swims (with respect to water) perpendicular to the current with acceleration a = 2t (where t is time) starting from rest form the origin O at t = 0. Velocity of the river with respect to ground is given by 'V_0'. Width of the river is 'd'. The equation of trajectory of the path followed by the swimmer



(a) $y = \frac{x^3}{3V_0^3}$ (b) $y = \frac{x^2}{2V_0^2}$

(c) $y = \frac{x}{V_0}$ (d) $y = \sqrt{\frac{x}{V_0}}$

Q 11. Two swimmers start a race. One who reaches the point C first on the other bank wins the race. A makes his strokes in a direction of 37^0 to the river flow with velocity 5km/hr relative to water. B makes his strokes in a direction 127^0 to the river flow with same

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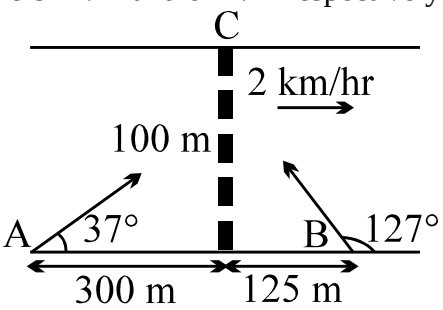
relative velocity. River is flowing with speed of 2km/hr and is 100m wide. speeds of A and B on the ground are 8km/hr and 6km/hr respectively.



(a) A will win the race
(b) B will win the race
(c) the time taken by A to reach the point C is 165 seconds
(d) the time taken by B to reach the point C is 150 seconds

Q 12. A man wishes to swim across a river 0.5 km wide. If he can swim at the rate of 2 km/h in still water and the river flows at the rate of 1 km/h. The angle (with respect to the flow of the river) along which he should swim so at to reach a point exactly opposite his starting point, should be-

(a) 60° (b) 120° (c) 145° (d) 90°

Q 13. A boat moves relative to water with a speed which is $\frac{1}{n}$ times the river flow speed. At what angle to the stream direction be boat move to minimize drifting (given n > 1) -

(a) $\frac{\pi}{2}$ (b) $\sin^{-1}\frac{1}{n}$ (c) $\frac{\pi}{2}+sin^{-1}\frac{1}{n}$ (d) $\frac{\pi}{2}+sin^{-1}(n)$

Q 14. Flow velocity of river of width d is given as u = $u_o r$, where u_o is constant and r is perpendicular distance from nearer bank. A swimmer heads perpendicular to direction of flow of river. Find his drift if his velocity in still water is v ?

(a) $\frac{u_o d^2}{4v}$ (b) $\frac{u_o d}{2}$ (c) $\frac{u_o^2 d^3}{3v^2}$ (d) $\frac{u_o^2 d^2}{2v}$

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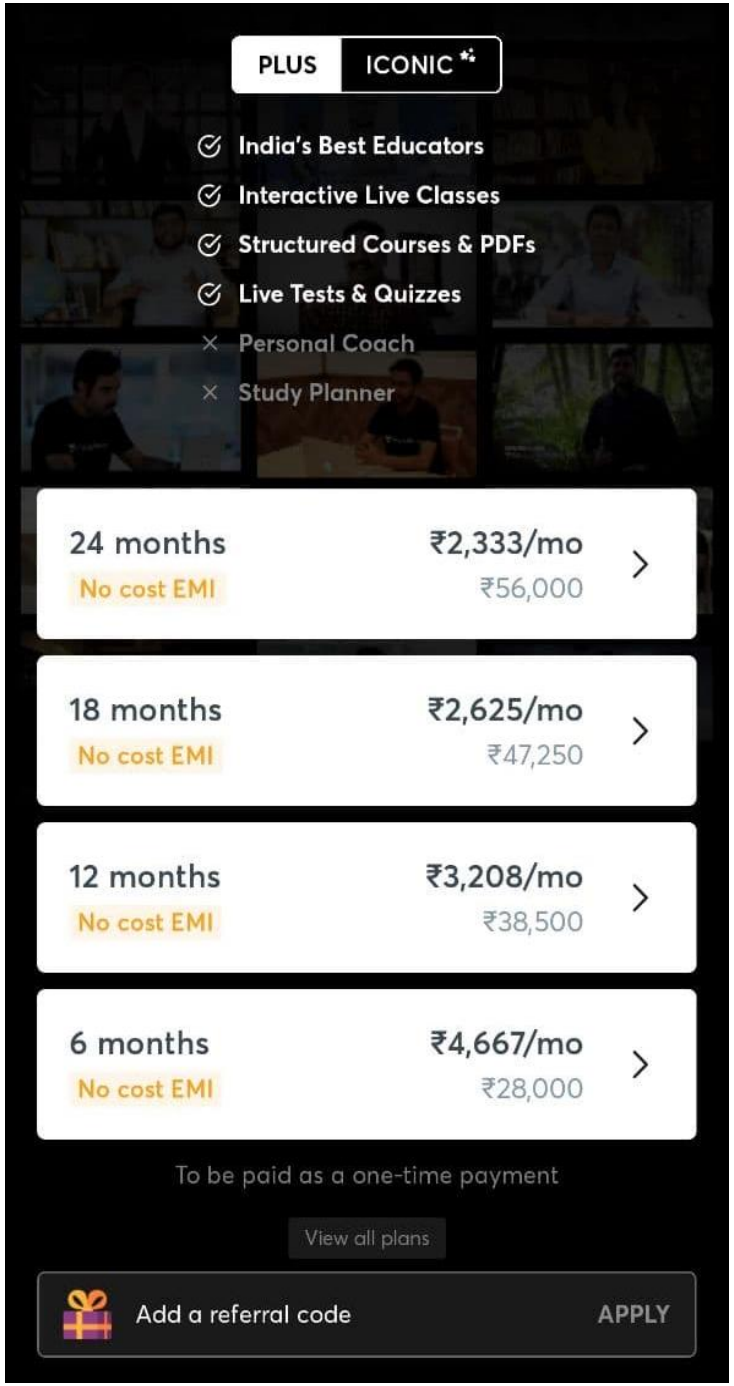
Answer Key

Q.1 b,c,d	**Q.2 c**	**Q.3 b**	**Q.4 a**	**Q.5 b**
Q.6 c	**Q.7 b**	**Q.8 b**	**Q.9 b**	**Q.10 a**
Q.11 b,c,d	**Q.12 b**	**Q.13 c**	**Q.14 a**	



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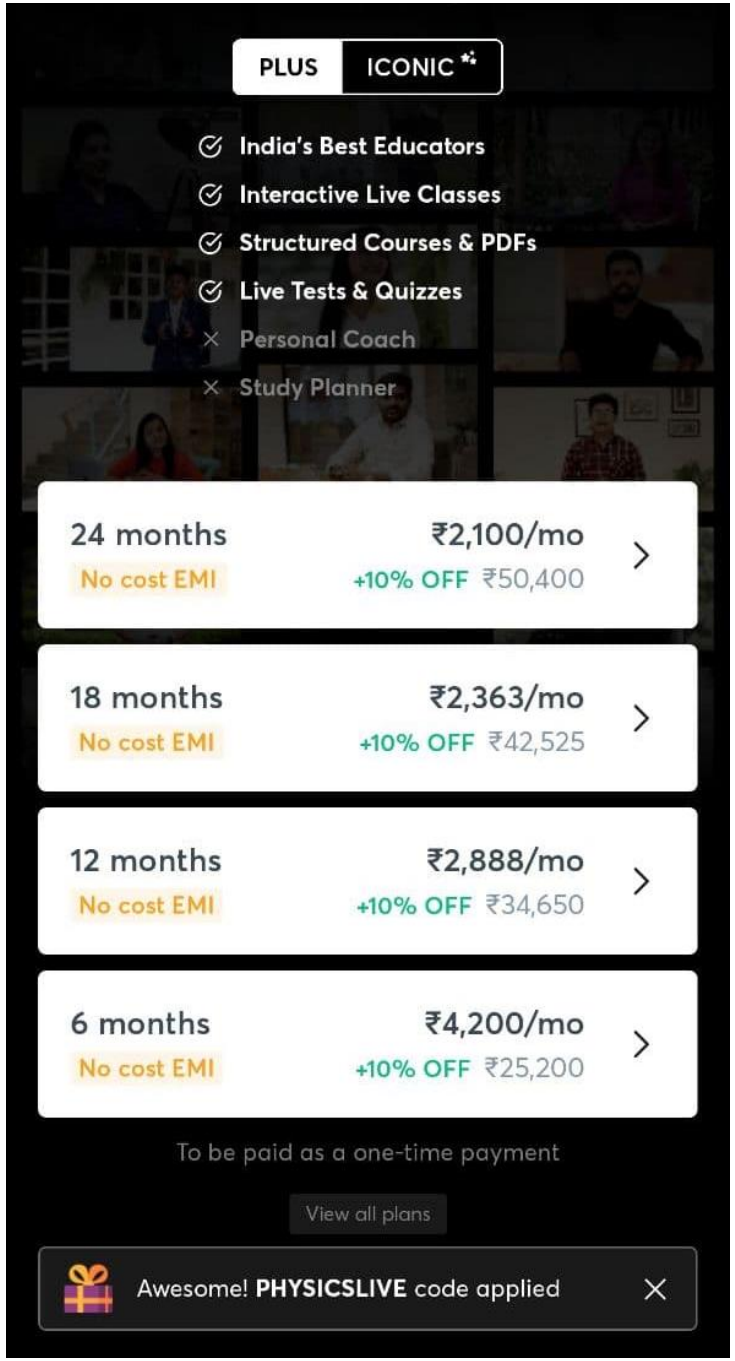

Written Solution

DPP-8 Relative motion (River-Boat problems)

By Physicsaholics Team

Solution.1

$$\vec{V}_B = 3\hat{i} + 4\hat{j}$$

$$\vec{V}_R = -3\hat{i} - 4\hat{j}$$

$$\vec{V}_{B/R} = \vec{V}_B - \vec{V}_R$$

$$= (3\hat{i} + 4\hat{j}) - (-3\hat{i} - 4\hat{j})$$

$$\boxed{\vec{V}_{B/R} = 6\hat{i} + 8\hat{j}}$$

Ans.c

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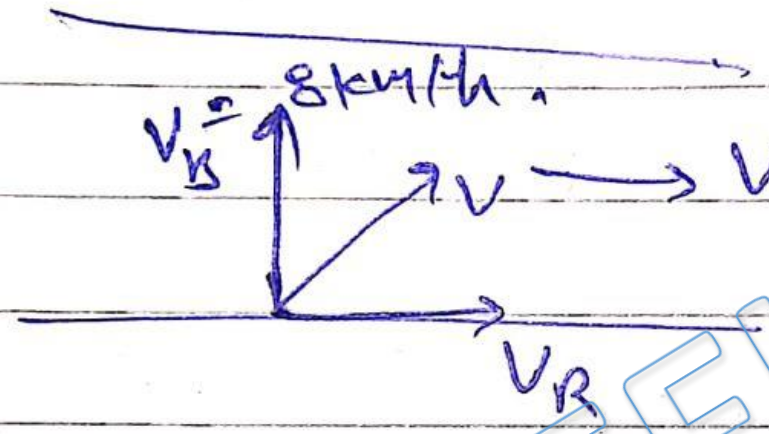
Solution.2



$$V = \sqrt{V_R^2 + V_B^2}$$

$$10 = \sqrt{V_R^2 + 8^2}$$

$$100 = V_R^2 + 8^2 \Rightarrow V_R^2 = 36$$

$$\boxed{V_R = 6 \text{ km/h}}$$

Ans.c

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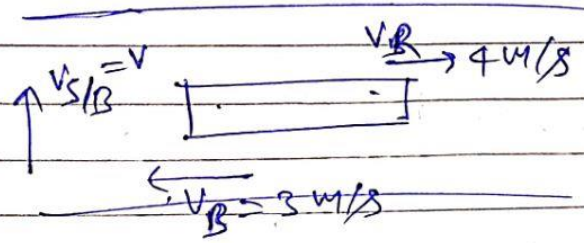
Solution.3



$\vec{V}_R = 4\,m/s = 4\hat{j}\ m/s$

$\vec{V}_B = -3\hat{j}\ m/s$

$\vec{V}_{B/R} = -7\,m/s\ \hat{j}$ $(V_{B/R} = 7\,m/s)$

$\vec{V}_{S/B} = V\hat{j} = \vec{V}_S - \vec{V}_B$

$V\hat{j} = \vec{V}_S - (-3\hat{j})$

$\Rightarrow \boxed{\vec{V}_S = -3\hat{j} + V\hat{j}}$

$\text{speed} = \frac{\text{dist.}}{\text{time}} \Rightarrow 50 = \frac{100}{\text{speed}} = \frac{100}{V}$

$V = 2\,m/s$

$\boxed{\vec{V}_S = -3\hat{j} + 2\hat{j}}$

$V_S = \sqrt{3^2 + 2^2}$

$\boxed{V_S = \sqrt{13}\ m/s}$

drift of swimmer $= V_R \cdot t = 3 \times 50$

$\boxed{\text{drift} = 150\ m.}$

Ans.c

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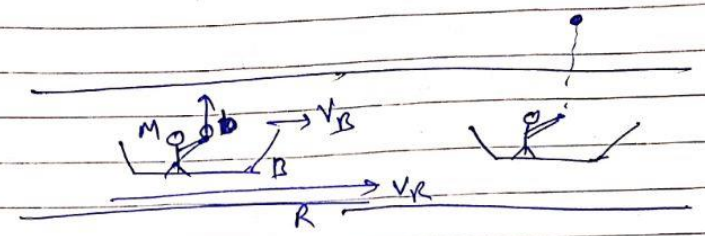
Solution.4



$V_{B/R} = 3\,m/s$ = Velo. of Boat w.r.t. River

$V_R = 2\,m/s$ = vel. of river w.r.t. ground

$V_B - V_R = V_{B/R}$ [$V_{B/R}$ = Vel. of boat w.r.t. River]

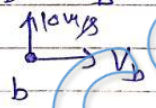
$V_B - 2 = 3$

$\boxed{V_B = 5\,m/s}$

↳ velocity of boat w.r.t. ground

V_b = vel. of ball w.r.t. ground.

$V_b = V_B$



at top most point velocity in vertical dir^n = 0

$\therefore$ $b \longrightarrow V_b$ $\quad V_{b\phi} = V_B$

w.r.t. ground

$V_b = V_B = 5\,m/s$

w.r.t. River = $V_{b/R} = V_b - V_R = 5 - 2 = 3\,m/s$

w.r.t. Boat = $V_{b/B} = V_b - V_B = 0\,m/s$

$\therefore$ 0 m/s, 3 m/s, 5 m/s

Ans.b

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Solution.5

$V_w = \sqrt{2}$ m/s (N-E)

$V_R = 2$ m/s (N)

$u_{B/R} = 0$ m/s

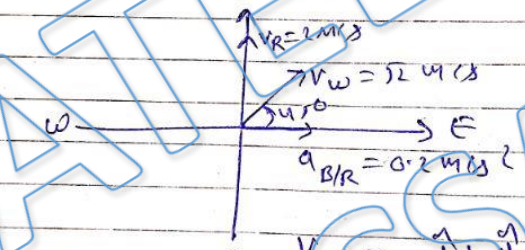
$u_B - V_R = V_{BR}$

$u_B = V_R = 2$ m/s (N)

$u_B = 2$ m/s (N) [initial velocity of boat w.r.t. ground]

$a_{B/R} = 0.2$ m/s^2 (E)

↳[acceleration of boat w.r.t. river]



$V_w = \hat{i} + \hat{j}$

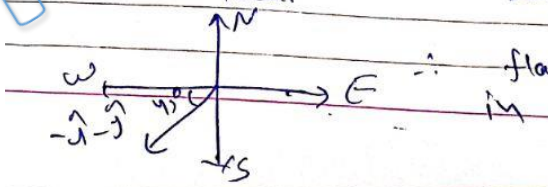
velocity of boat in $\hat{i}$ at $t = 10$ sec

$V = u + at = 0 + (0.2)10$

$(V_B)_{\text{in } \hat{i}} = 2$ m/s

$V_B = 2\hat{i} + 2\hat{j}$

$V_{w/Boat} = V_w - V_{boat} = -\hat{i} - \hat{j}$



∴ flag will flutter in S-W direction.

Ans.b

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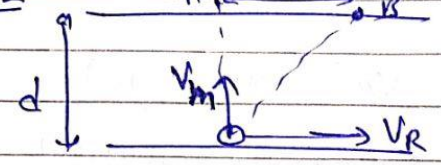
Solution.6

for min time,

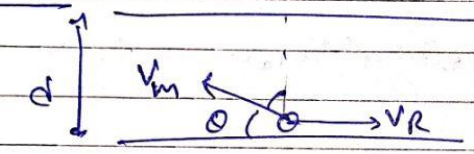
Case-1



$t = 10$ min

for min shortest distance.

Case-2



$t = 12.5$ min

from case-1 :

$$V_R = \frac{120}{10\,\text{min}} = 12\ \text{m/min}$$

$$V_R = 0.2\ \text{m/s}$$

and.

$$V_m = \frac{d}{t} = \frac{d}{10\,\text{min}} = \frac{d}{600\,\text{sec}} \quad \text{---(1)}$$

from case-2

for shortest path

$$V_R = V_m \cos\theta \quad \text{---(2)}$$

$$t = \frac{d}{V_m \sin\theta} \Rightarrow V_m \sin\theta = \frac{d}{12.5 \times 60} \quad \text{---(3)}$$

$$\frac{(3)}{(1)} \Rightarrow \frac{V_m \sin\theta}{V_m} = \frac{d/12.5 \times 60}{d/10 \times 60}$$

$$\sin\theta = \frac{10}{12.5} = \frac{100}{125} = \frac{20}{25} = \frac{4}{5}$$

$$\sin\theta = \frac{4}{5}$$

$$\therefore \cos\theta = \frac{3}{5}$$

Put $\cos\theta = \frac{3}{5}$ in eq^n (2)

$$V_R = V_m \left(\frac{3}{5}\right)$$

$$V_m = \frac{5}{3} V_R = \frac{5}{3} \times 0.2$$

$V_m = 0.8$ m/s

$$V_m = 1/3 \text{ or } 0.33\ \text{m/s}$$

in eq^n (1)

$$V_m = \frac{d}{600}$$

$$d = V_m \times 600$$

$$d = \frac{1}{3} \times 600$$

$$\boxed{d = 200\ \text{m}}$$

Ans.c

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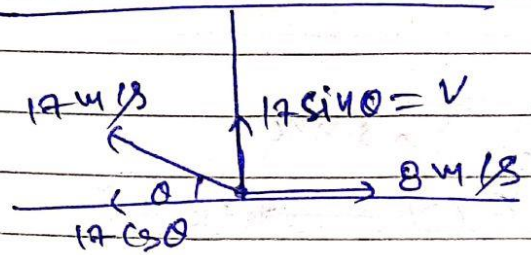
Solution.7



for shortest path; $8 = 17\cos\theta$

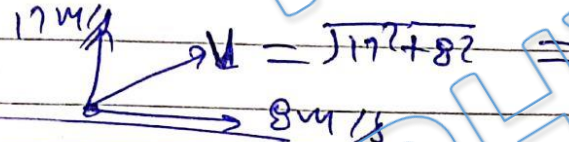
$$\cos\theta = \frac{8}{17} \Rightarrow \sin\theta = \frac{15}{17}$$

$$v = 17\sin\theta = 17 \times \frac{15}{17} = 15 \text{ m/s}$$

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

$$t_1 = \frac{d}{15} \text{ sec} \quad \text{—(1)}$$

For min. time;



$$t_2 = \frac{d}{17} \text{ sec} \quad \text{—(2)}$$

$$t_1 - t_2 = \frac{d}{15} - \frac{d}{17} = 6 \text{ sec}$$

$$\frac{17d - 15d}{15 \times 17} = 6$$

$$2d = 6 \times 15 \times 17$$

$$d = 3 \times 15 \times 17$$

$$d = 765 \text{ m}$$

Ans.a

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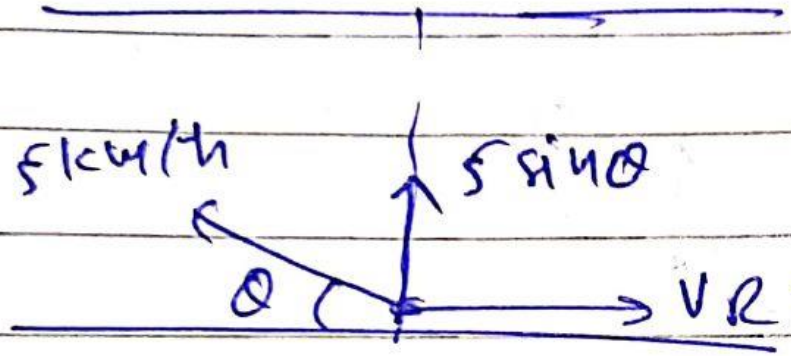
Solution.8



$$t = \frac{d}{5\sin\theta} \Rightarrow \frac{12}{60}\text{ hr} = \frac{1\text{ km}}{5\text{ km/h}\,\sin\theta}$$

$$\sin\theta = \frac{4}{5} \Rightarrow \cos\theta = \frac{3}{5}$$

$$v_R = 5\cos\theta$$

$$= 5 \times \frac{3}{5}$$

$$\boxed{v_R = 3\text{ km/h}}$$

Ans.a

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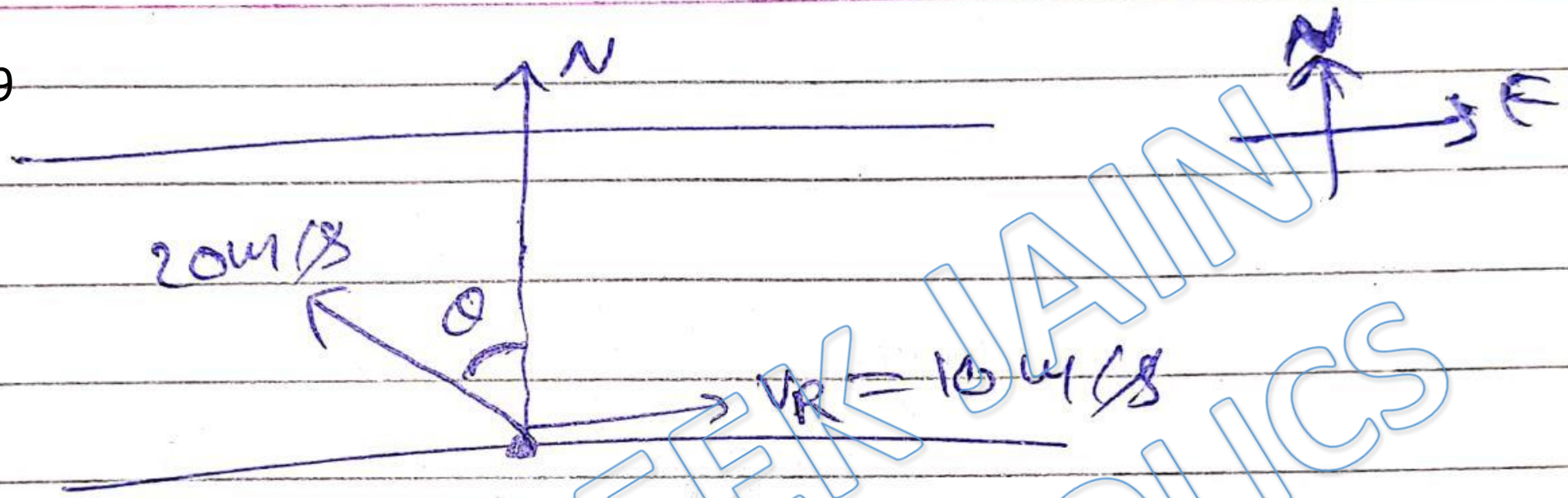
Solution.9



$20 \sin\theta = 10$

$\sin\theta = \frac{1}{2}$

$\theta = 30^\circ$

Ans.b

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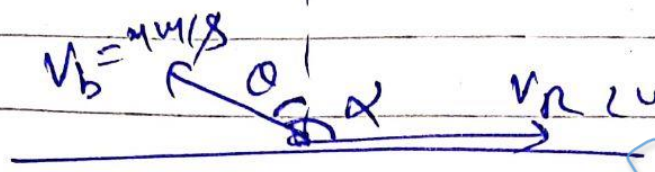
Solution.10



min drift = zero.

for zero drift.

$V_b \sin\theta = V_R$

$4 \sin\theta = 2$

$\sin\theta = \frac{1}{2}$

$\theta = 30°$

$\alpha = 90 + \theta$

$\boxed{\alpha = 120°}$ angle of V_b from ⊥ downstream.

Ans.a

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