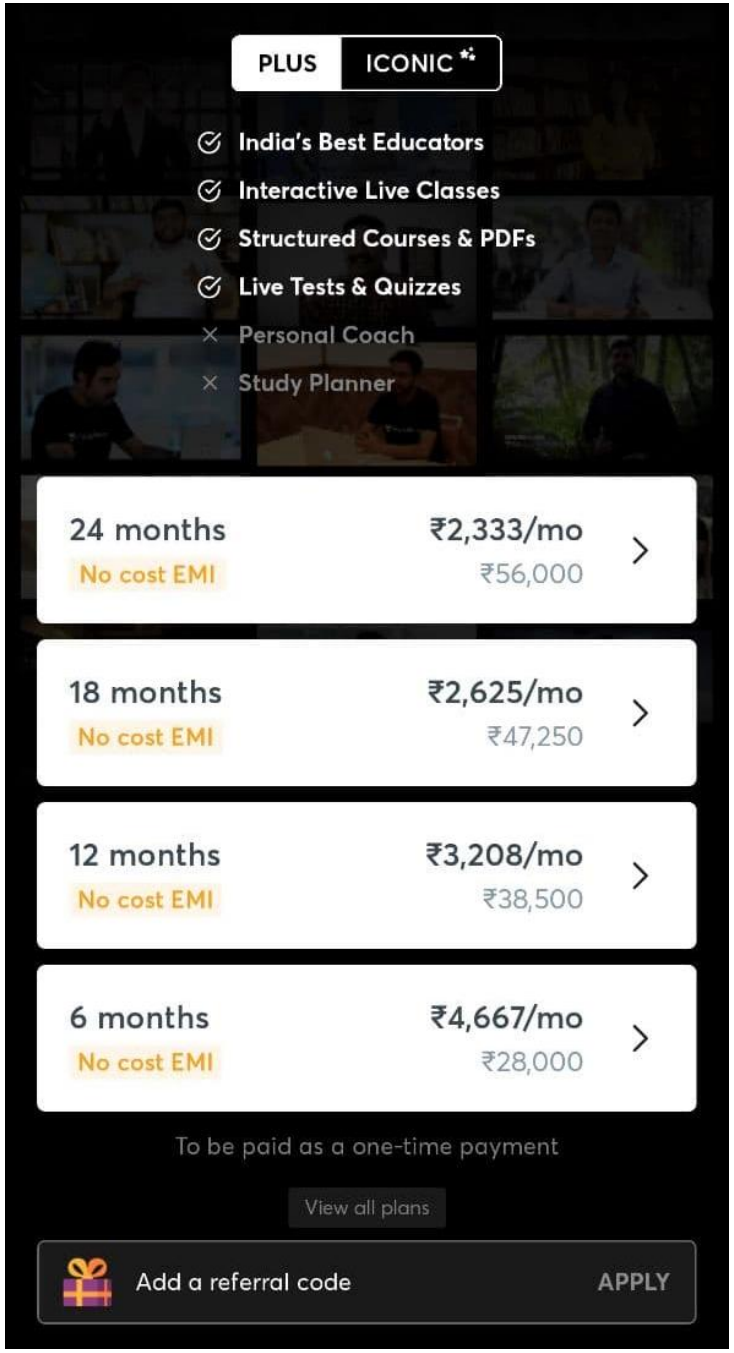
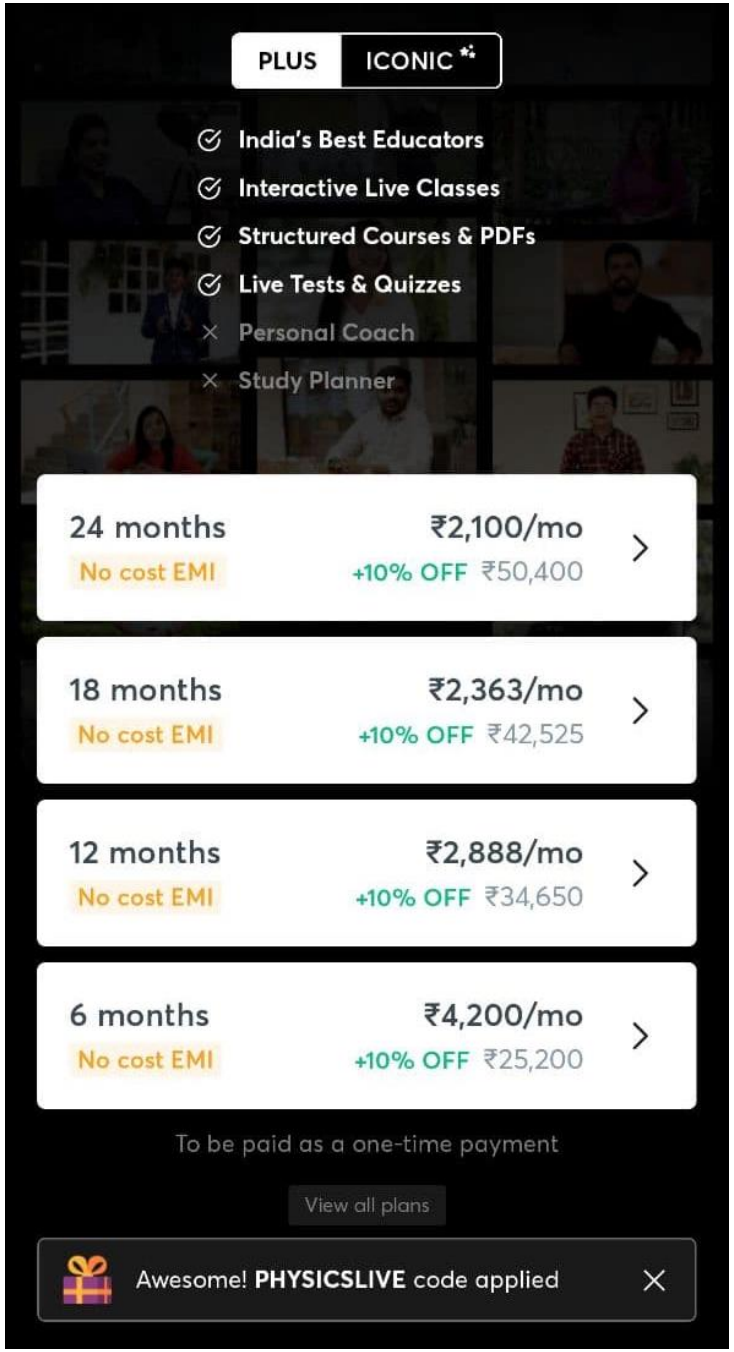
SIR PRATEEK JAIN

. Founder @ Physicsaholics
. Top Physics Faculty on Unacademy (IIT JEE & NEET)
. 8+ years of teaching experience in top institutes like FIITJEE (Delhi, Indore) , CP (KOTA) etc.
. Produced multiple Top ranks.
. Research work with HC Verma sir at IIT Kanpur
. Interviewed by International media.



PHYSICSLIVE

Use code PHYSICSLIVE to get 10% OFF on Unacademy PLUS.



For Video Solution of this DPP, Click on below link

Solution on Website:- https://physicsaholics.com/home/courseDetails/41

Solution on YouTube:- https://youtu.be/rFQzCJ3Kcsk

unacademy

Physics DPP

DPP-8 Relative motion (River-Boat problems)

By Physicsaholics Team

Q) A boat is moving with a velocity $3\hat{\imath} + 4\hat{\jmath}$ with respect to ground. The water in the river is moving with a velocity $-3\hat{\imath} - 4\hat{\jmath}$ with respect to ground. The relative velocity of the boat with respect to water is

(a) $8\hat{\jmath}$

(b) $-6\hat{\imath} - 8\hat{\jmath}$

(c) $6\hat{\imath} + 8\hat{\jmath}$

(d) $6\hat{\imath}$

Ans. c

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

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

$$\vec{V_{B/R}} = \vec{V_B} - \vec{V_R}$$

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

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

Q) A boat is sent across a river with a velocity of 8 km/hr (w.r.t. ground). If the resultant velocity of boat is 10 km/hr, then velocity of the river is:

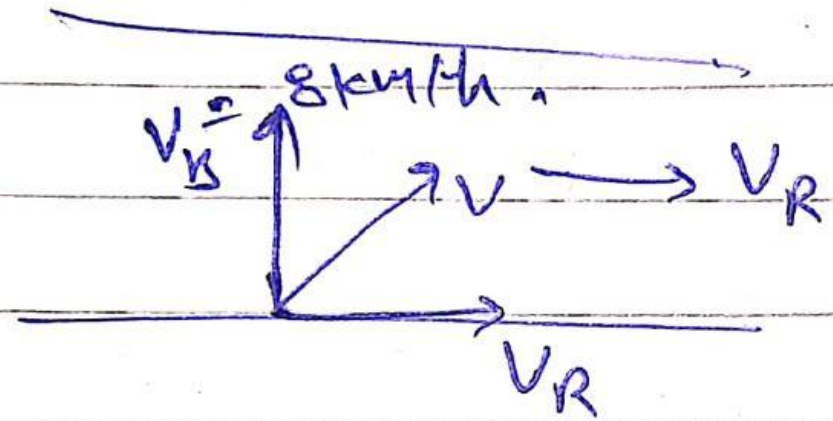
(a) 10 km/h

(b) 8 km/h

(c) 6 km/h

(d) 4 km/h

Ans. c



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

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

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

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

Q) A boat B is moving in upstream with velocity 3m/s with respect to ground. An observer standing on boat observes that a swimmer S is crossing the river perpendicular to the direction of motion of boat. If river flow velocity is 4 m/s and swimmer crosses the river of width 100m in 50 sec, then:

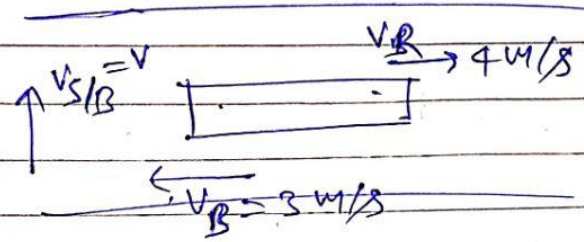
(a) Velocity of swimmer w.r.t. ground is $\sqrt{15}$ m/s

(b) Drift of swimmer along river will be zero

(c) Drift of swimmer along river will be 150 m

(d) Velocity of swimmer .w.r.t ground is 2m/s

Ans. c



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

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

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

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

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

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

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

time

$V = 2\,m/s$

$\boxed{\vec{V}_S = -3\hat{j} + 2\hat{j}}$ $\qquad V_S = \sqrt{3^2 + 2^2}$

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

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

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

Q) A river is flowing with velocity 2m/s. A boat is moving downstream. Velocity of boat in still water is 3m/s. A person standing on boat throws a ball vertically upwards w.r.t. himself with a velocity to 10m/s. At the topmost point the velocity of ball w.r.t. man standing on boat, w.r.t. river and w.r.t. ground respectively are:

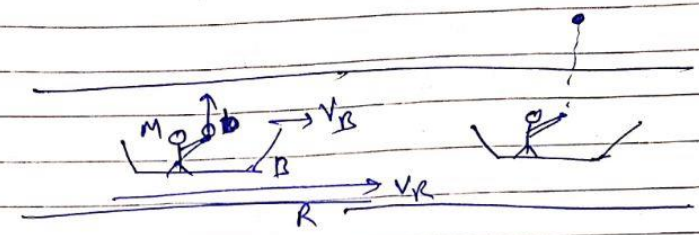
(a) 5, 3, 0 m/s

(b) 0, 3, 5 m/s

(c) 0, 5, 3 m/s

(d) None of these

Ans. b



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

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

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

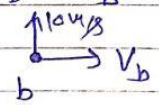
$V_B - 2 = 3$

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

↳ velocity of boat w.r.t. ground

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

~~at to~~ $V_b = V_B$



at topmost point velocity in vertical dir^n = 0

$\therefore$ $V_b \longrightarrow$ 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

Q) At a harbor, a boat is standing and wind is blowing at a speed of $\sqrt{2}$ m/s, due to which , the flag on the boat flutters along north-east. ow the boat enters in to river, which is flowing with a velocity of 2m/s due north. The boat starts with zero velocity relative to the river and its constant acceleration relative to the river is 0.2 m/s^2 due east. In which direction will the flag flutter at 10 seconds ?

(a) South-east

(b) South-west

(c) 30^0 south of west

(d) West

Ans. b

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

$V_R = 2$ m/s (N)

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

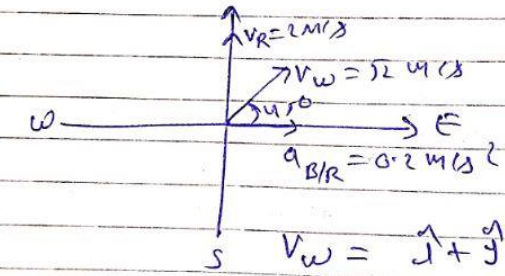
$u_B - V_R = -V_{B/R}$

$u_B = V_R = 2$ 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]



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

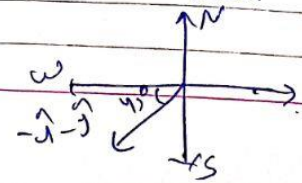
velocity of boat in 'E' at $t = 10$ sec

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

$(V_B)_{\text{in } E} = 2$ 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.

Q) A man crosses a river in a boat. If he cross the river in minimum time he takes 10 min with a drift 120m. If he crosses the river taking shortest path, he takes 12.5 min, find width of the river?

(a) 50 m

(b) 100 m

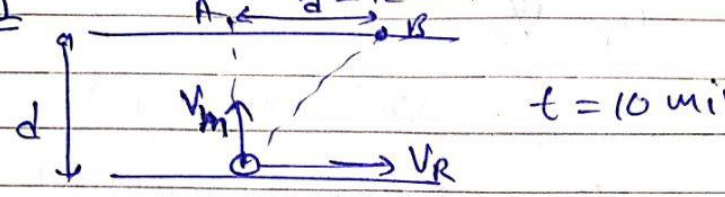
(c) 200 m

(d) 300 m

Ans. c

for min time,

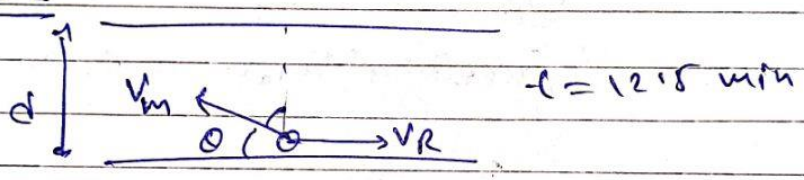
Case-1



$t = 10$ min

for min shortest distance,

Case-2



$t = 12.5$ min

from case-1 !

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

$$V_R = 0.2\ m/s$$

and

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

from case-2

for shortest path

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

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

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

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

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

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

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

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

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

$$V_m = 0.8$$

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

in eq^n (1)

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

$$d = V_m \times 600$$

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

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

Q) A boatman finds that he can save 6s in crossing a river by the quickest path than by the shortest path. If the velocity of the boat and the river be, respectively, 17 m/s and 8 m/s, find the river width:

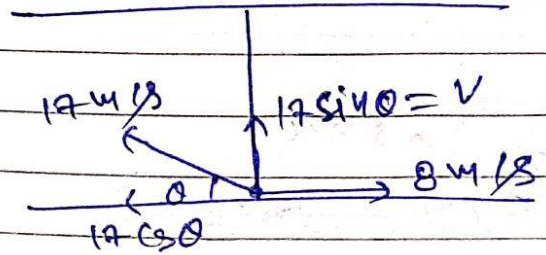
(a) 765 m

(b) 1000 m

(c) 556 m

(d) 816 m

Ans. a



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

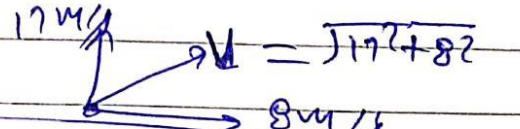
$$\cos\theta = \frac{8}{17} \Rightarrow \sin\theta = \frac{15}{17}$$

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

$v = 15$ m/s

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

For min. time;



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

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

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

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

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

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

Q) The width of river is 1 km. The velocity of boat is 5 km/hr. The boat covered the width of river with shortest will possible path in 15 min. Then the velocity of river stream is:

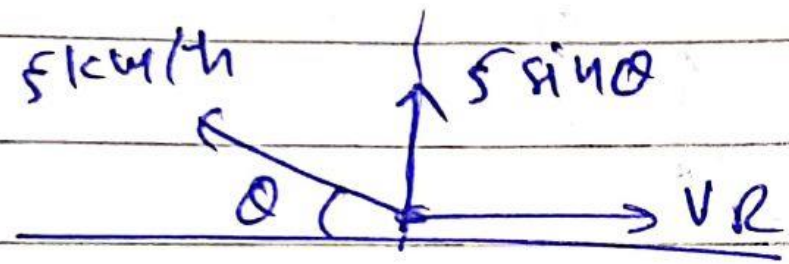
(a) 3 km/h

(b) 4 km/h

(c) $\sqrt{29}$ km/h

(d) $\sqrt{41}$ km/h

Ans. a



$$t = \frac{d}{5\sin\theta} \Rightarrow \frac{15}{60}\text{ hr} = \frac{1\text{ km}}{5\text{ km/h}\,\sin\theta}$$

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

$$V_R = 5\cos\theta$$

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

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

Q) The speed of a swimmer in still water is 20 m/s. The speed of river water of is 10 m/s and due east. If he is standing on the south bank and wishes to cross the river along the shortest path the angle at which he should make his stroke w.r.t. north is given by :-

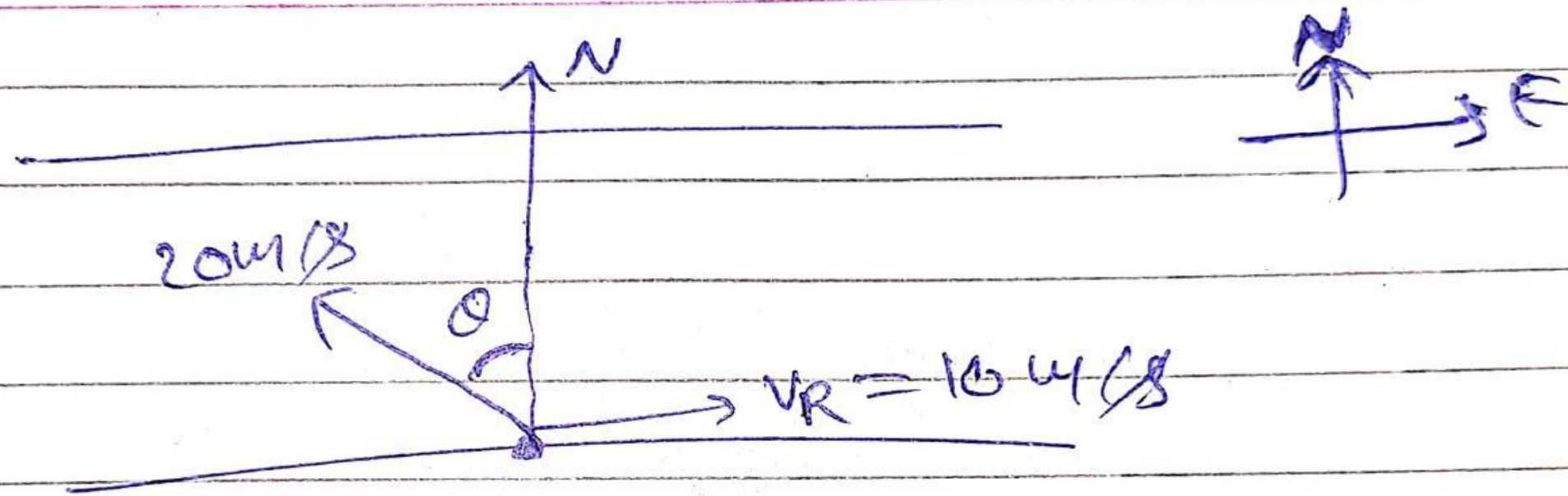
(a) 45^0 west

(b) 30^0 west

(c) 0^0

(d) 60^0 west

Ans. b



$$20 \sin\theta = 10$$

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

$$\boxed{\theta = 30^\circ}$$

Q) A man can swim in still water at 4m/s. River is flowing at 2m/s. The angle with downstream at which he should swim wo cross the river with minimum drift is:

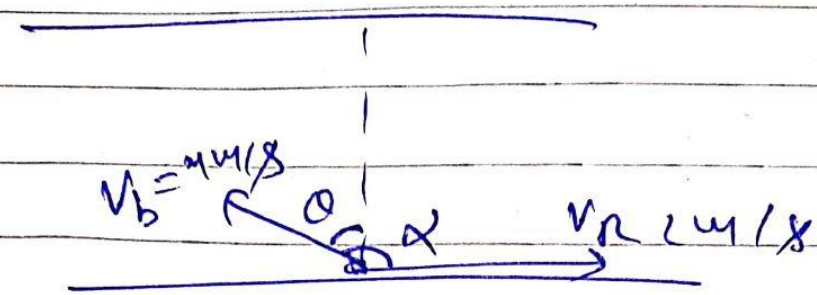
(a) 120^0

(b) 150^0

(c) 30^0

(d) 60^0

Ans. a



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.

For Video Solution of this DPP, Click on below link

Solution on Website:- https://physicsaholics.com/home/courseDetails/41

Solution on YouTube:- https://youtu.be/rFQzCJ3Kcsk

Chalo Niklo