YAKEEN NEET 2.0

2026

Motion in a Plane

PHYSICS | Lecture - 13

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Todays Goal

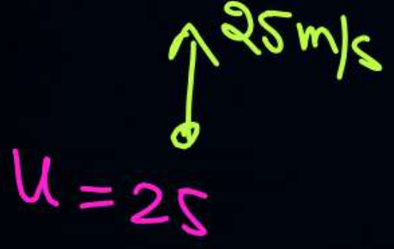
- River boat Problem

Q A juggler is playing with 6 ball, he throw the ball with regular interval of time of 1 sec.

$(n-1)t \equiv$

Sol $T = 5\ sec$

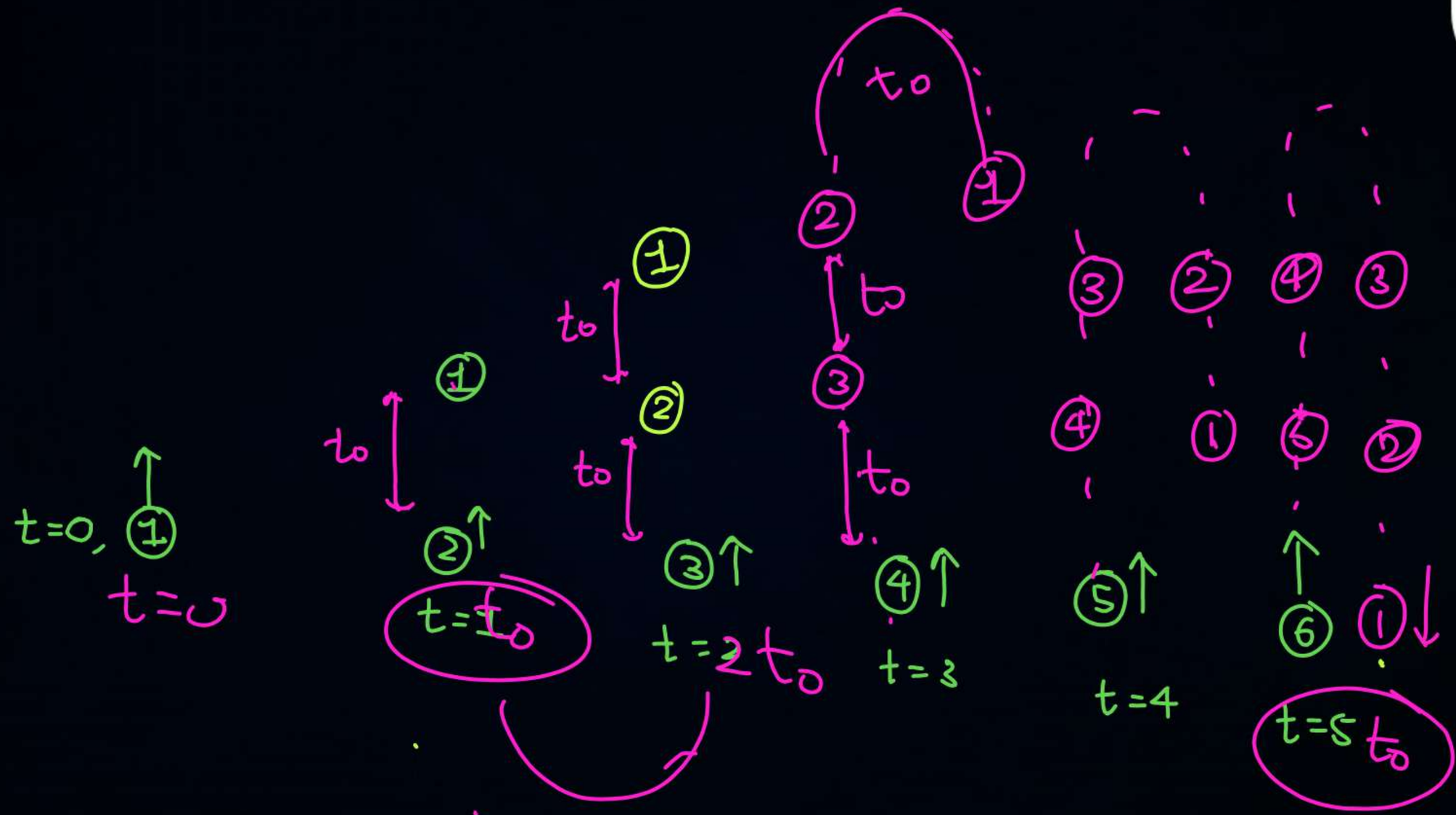
$T_{\text{upar}} = 2.5\ sec$



$h_{max} = \frac{(25)^2}{2 \times 10} =$ ✓

Sol

Sol

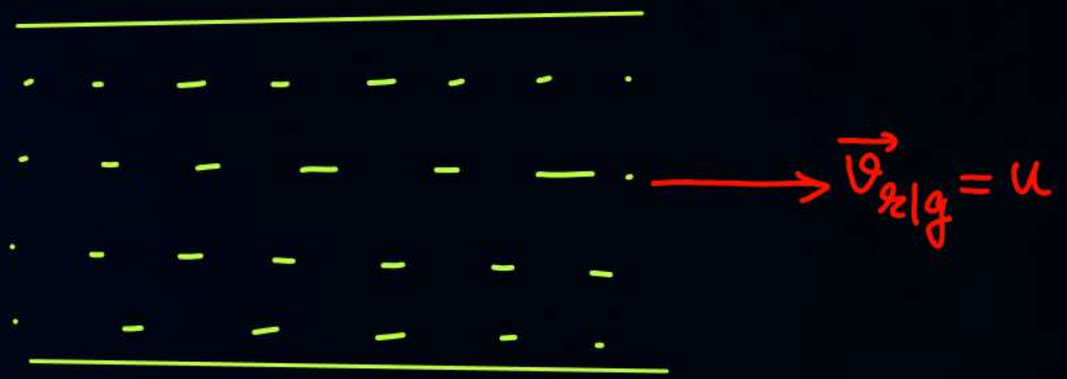


River boat Problem or River-man Problem

$\vec{v}_{r/g}$ = Velocity of river wrt ground $= u$

* $\vec{v}_{m/r}$ = Velocity of man wrt river
  = Velocity of man in still water.

* $\vec{v}_{m/g}$ = Velocity of man wrt ground.



$$\vec{v}_{m/r} = \vec{v}_m - \vec{v}_r$$

$$\boxed{\vec{v}_m = \vec{v}_{m/r} + \vec{v}_r}$$

Q

If a man can swim with velocity 15 m/s = v wrt river

$\longrightarrow u = 10\ m/s = \vec{v}_{river/ground}$

① Time taken by man from A $\longrightarrow$ B

$$t_{A\to B} = \frac{AB}{v+u} = \frac{100}{15+10}$$

$= 4$ sec.

(Downstream)

Vector से feel

$\vec{v}_m = \vec{v}_{m/r} + \vec{v}_r$

$= 15\hat{i} + 10\hat{i} = 25\hat{i}$

② If man return back from B to A

$$t_{B\to A} = \frac{AB}{v-u}$$

$$= \frac{100}{15-10} = 20 \text{sec.}$$

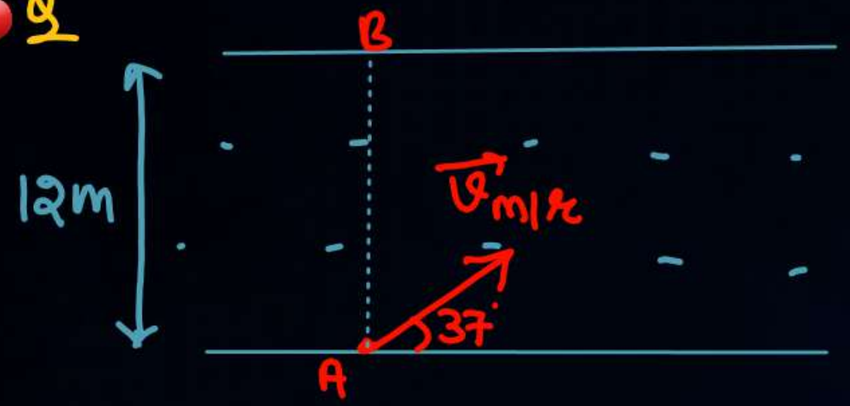
$\vec{v}_m = \vec{v}_{m/r} + \vec{v}_r = -15\hat{i} + 10\hat{i} = -5\hat{i}$

③ $T_{total} = t_{A\to B} + t_{B\to A} = 4 + 20 = 24$

④ Avg speed $= \frac{100+100}{24} = \frac{200}{24}$

⑤ Avg velocity $= 0$

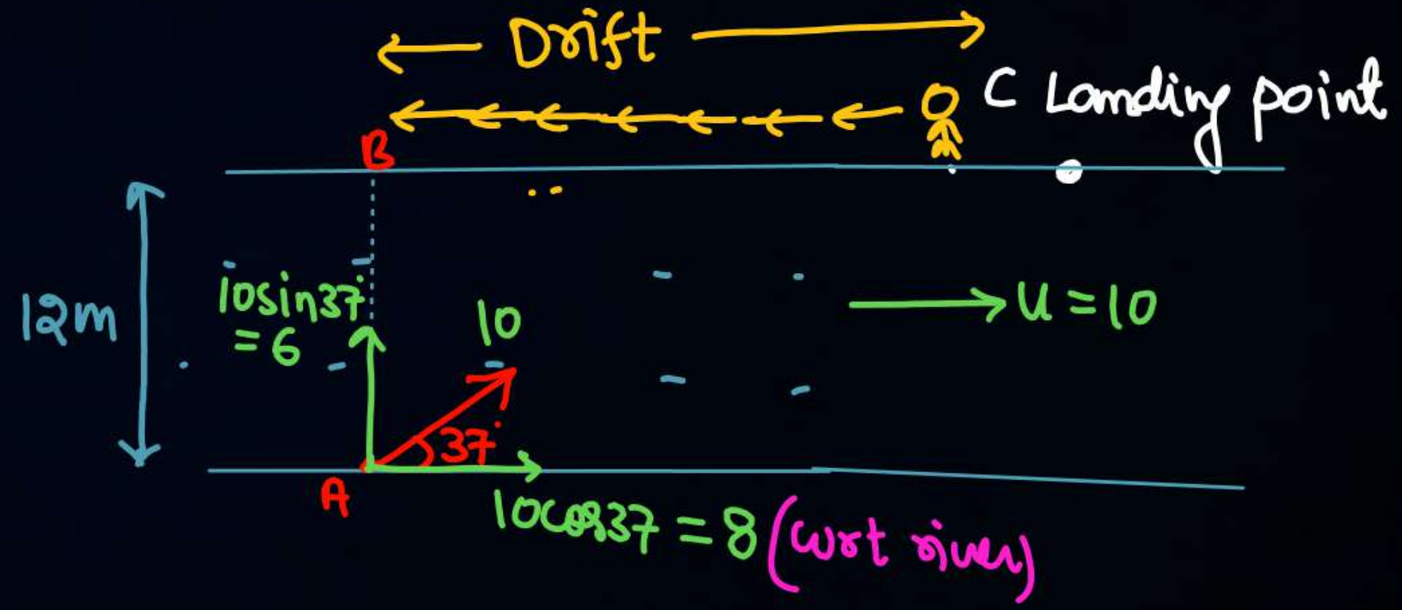
Q



$\vec{v}_{m/r} = 10\ m/s.$

$\longrightarrow \vec{v}_{r/g} = \vec{u} = 10\ m/s\ \hat{i}$

SSSQ $\quad \langle \vec{v} \rangle = \frac{12\hat{j}}{11}$



Sol" time taken by man to cross river $= \frac{12}{6} = 2$ sec

Drift $= BC = 2 \times 18 = 36$

(b) If man can walk on ground with 4m/s. then find time taken by man from A to B in above case

$t = t_{\text{पानी}} + t_{\text{जमीन}} = 2 + \frac{36}{4} = 11$ sec.

Q $\vec{v}_{r/g} = 4\ m/s. = u$

$\vec{v}_{m/r} = 10\ m/s. = V$

① time to cross the river.

$= 3$

② Drift = Distance of landing point from B = BC

$= 10 \times 3 = 30$

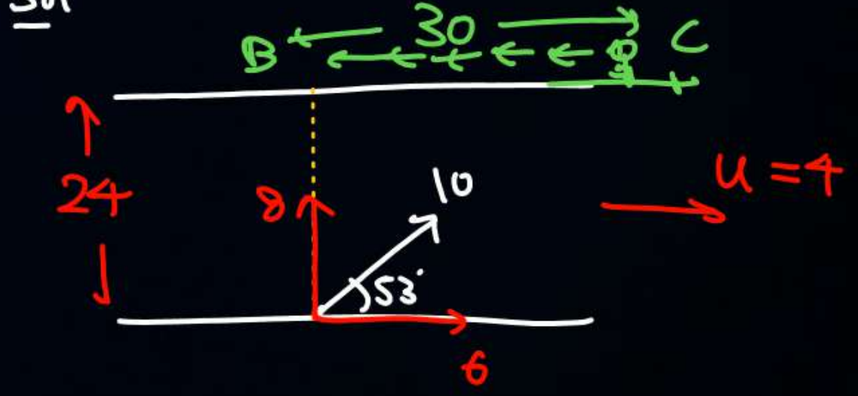
③ $\vec{v}_{m/g}$ (when swimming) $= 6\hat{i} + 8\hat{j} + 4\hat{i} = 10\hat{i} + 8\hat{j}$

④ If man can walk with speed 5 m/s on ground

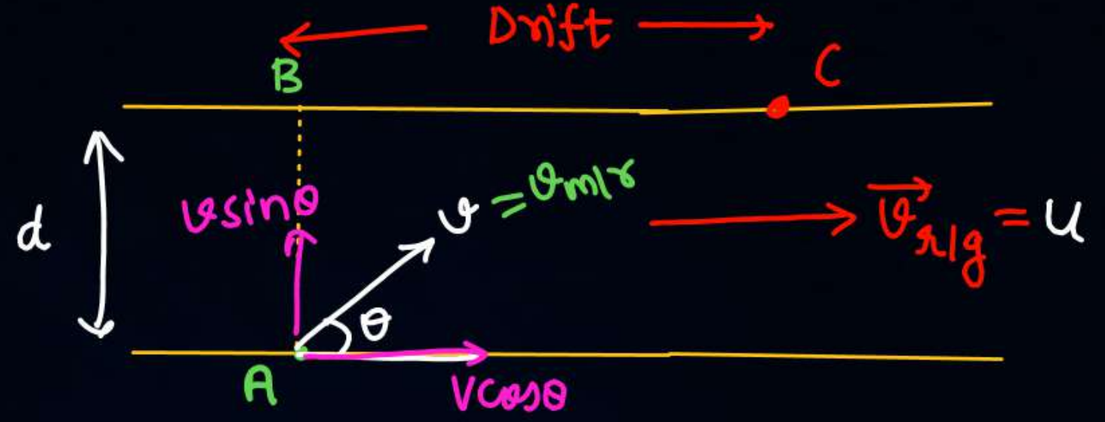
$t_{A \to B} = 3 + 6 = 9$

$\langle \vec{v} \rangle = \frac{24\hat{j}}{9}$

Sol^n



- $t = \frac{d}{v\sin\theta}$
- Drift $= (v\cos\theta + u)t$



$$t_{A\to C\to B} = t_{A\to B} + t_{B\to C} = t_{\text{पानी}} + t_{\text{जमीन}} = \frac{d}{v\sin\theta} + \frac{BC}{v_{\text{जमीन}}}$$

Q $\vec{v}_{r/g} = 4\ m/s. = u$

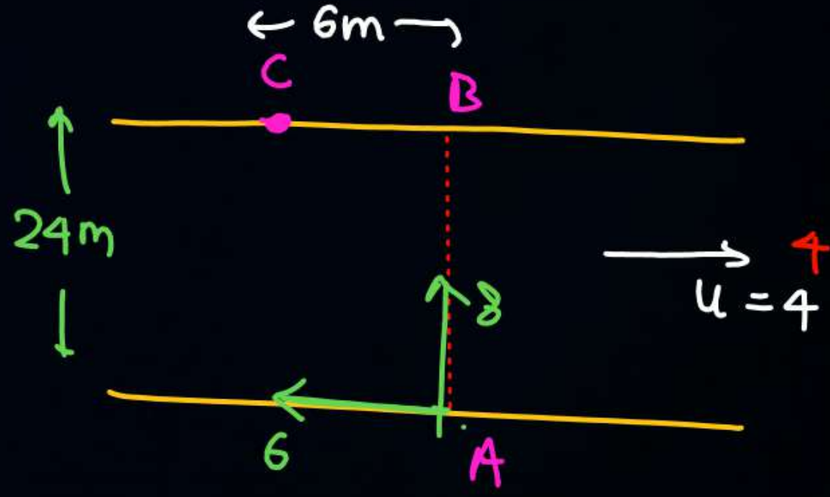
$\vec{v}_{m/r} = 10\ m/s. = v$

① time to cross the river.

$= 3$

② Drift = Distance of landing point from B = BC = 2X3

$= 6m$



③ $\vec{v}_{m/g}$ (when swimming) $= \vec{v}_{m/r} + \vec{u}_r = (-6\hat{i} + 8\hat{j}) + (4\hat{i})$

$= -2\hat{i} + 8\hat{j}$

④ If man can walk with speed 5 m/s on ground

$t_{A \to B} = 3 + \frac{6}{5}$

Q $\vec{v}_{r/g} = 4\ m/s. = u$

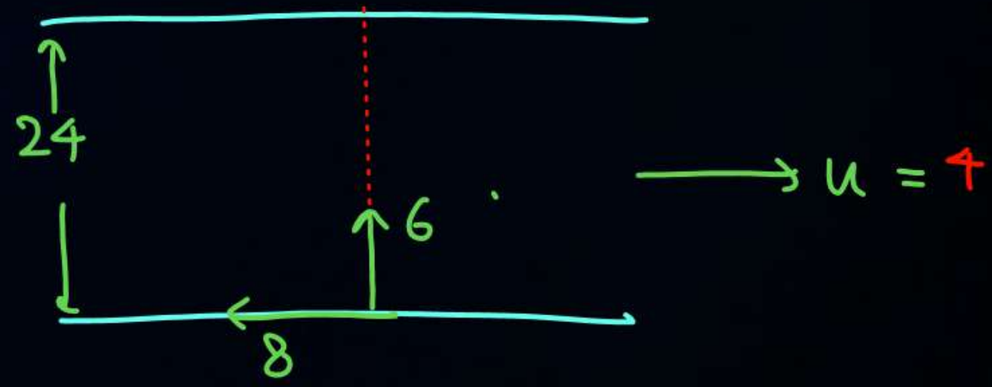
$\vec{v}_{m/r} = 10\ m/s. = v$

① time to cross the river.

$= 4$

② Drift = Distance of landing point from B $= 4 \times 4$

$= 16$



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Min distance (Crossing)

$\vec{v}_{m/r} = v$

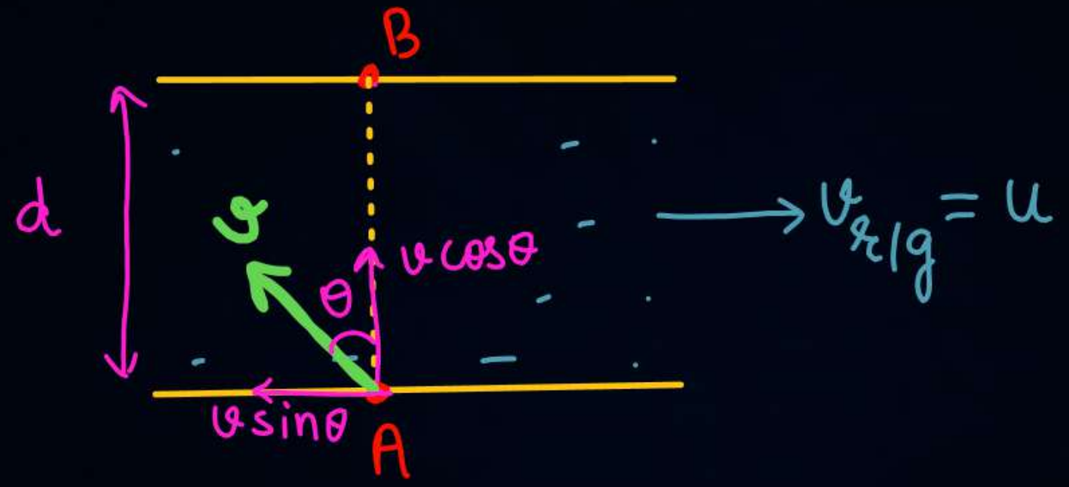
$t = \frac{d}{v\cos\theta}$

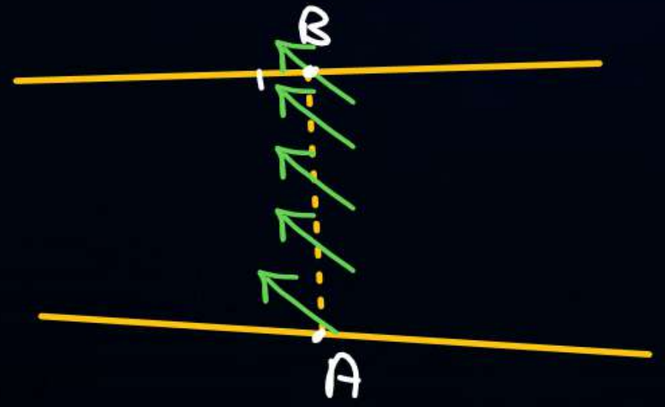
$v\sin\theta = u$

$\sin\theta = \frac{u}{V}$

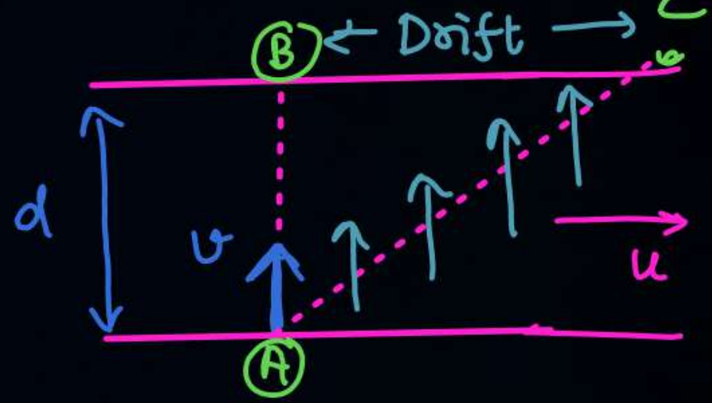
Drift = 0 SKC

$\sin\theta = \frac{\text{छोटी } V}{\text{बड़ी } v}$





Min time (River cross)



$t = \frac{d}{v} = t_{min}$

BC = drift = u·t

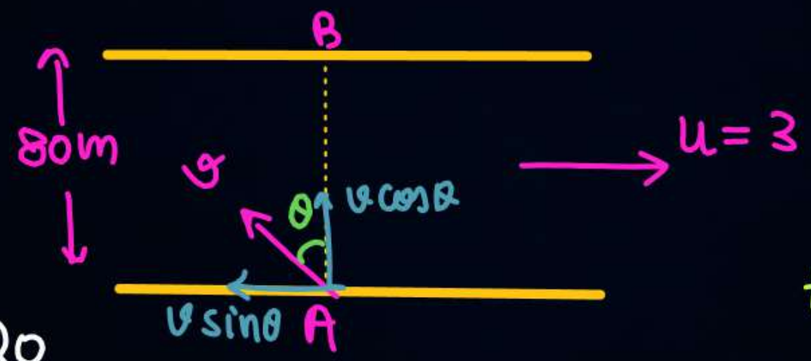
Q If river is flowing with speed 3m/s and a man can swim with velocity 5 m/s wrt to river. width of the river is 80m. Find

(1) In which dir^n man should swim so that he crosses the river in min distance

$v\sin\theta = u$

$5\sin\theta = 3$

$\boxed{\theta = 37^\circ}$



$t = \frac{80}{v\cos 37} = \frac{80}{5 \times \frac{4}{5}} = 20$

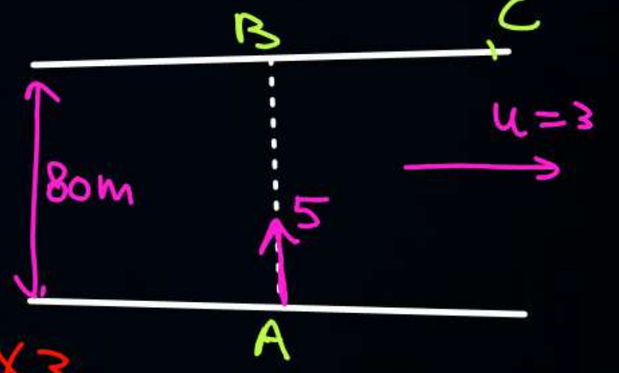
$\sin\theta = \frac{3}{5}$

** Silly

Angle with river flow $= 90 + 37$
$= 127^\circ$

(2) If he want to cross the river in min time. In which dir^n he should swim, find time, drift

Sol^n



$t = \frac{80}{5} = 16$

$BC = \text{Drift} = 16 \times 3$
$= \underline{48}$

(b) Repeat the above qus if

$u = 5$

$v = 10$

(a) For min distance $\sin\theta = \frac{5}{10} = \frac{1}{2}$

$\theta = 30^\circ$ with vertical

$\theta = 120^\circ$ (with river flow dir^n)

$$t = \frac{80}{10\cos 30}$$

(b)

$$t_{min} = \frac{80}{10} = 8$$

Drift $= 5 \times 8 = 40$

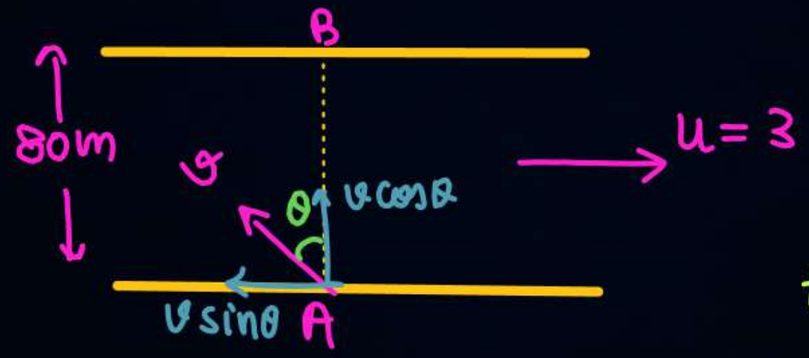
Q If river is flowing with speed 5 m/s and a man can swim with velocity 10 m/s wrt to river. width of the river is 80m. Find

① In which dir^n man should swim so that he crosses the river in min distance

$$\sin\theta = \frac{5}{10}$$

$$\theta = 30$$

$$t = \frac{80}{v\cos 30} = \checkmark$$



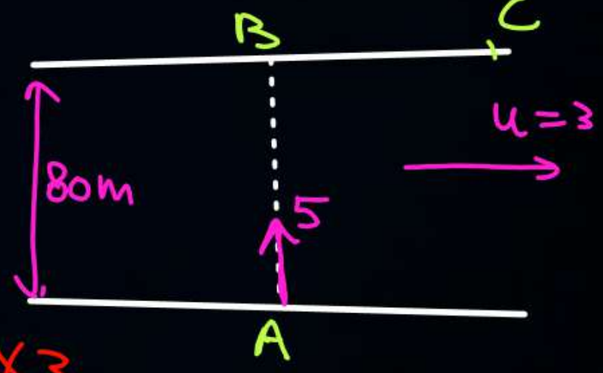
② If he want to cross the river in min time. In which dir^n he should swim, find time, drift

Sol^n

$$t = \frac{80}{5} = 16$$

BC = Drift = 16 × 3

= 48



42. A staircase contains three steps each 10 cm high and 20 cm wide (figure 3-E9). What should be the minimum horizontal velocity of a ball rolling off the uppermost plane so as to hit directly the lowest plane ?

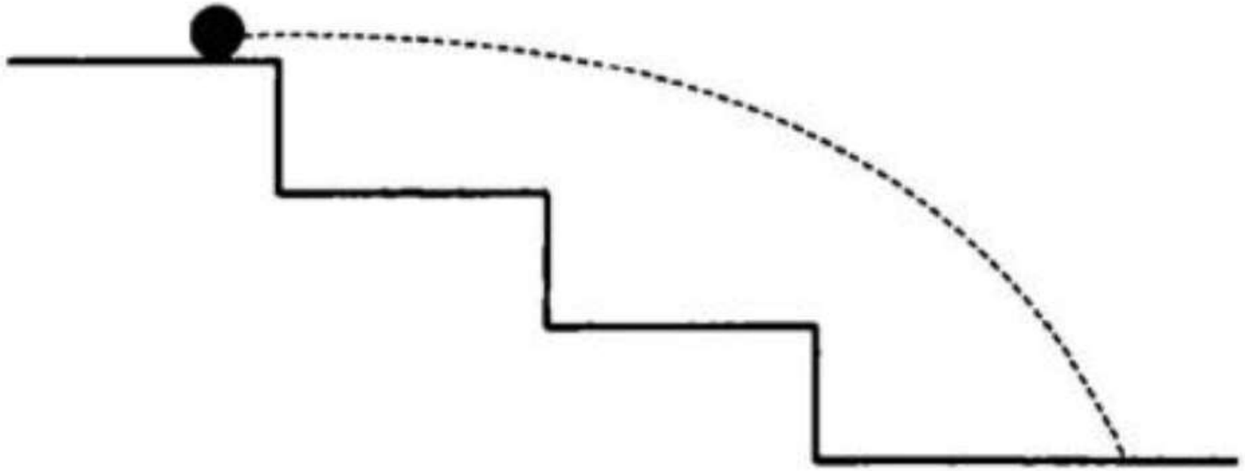
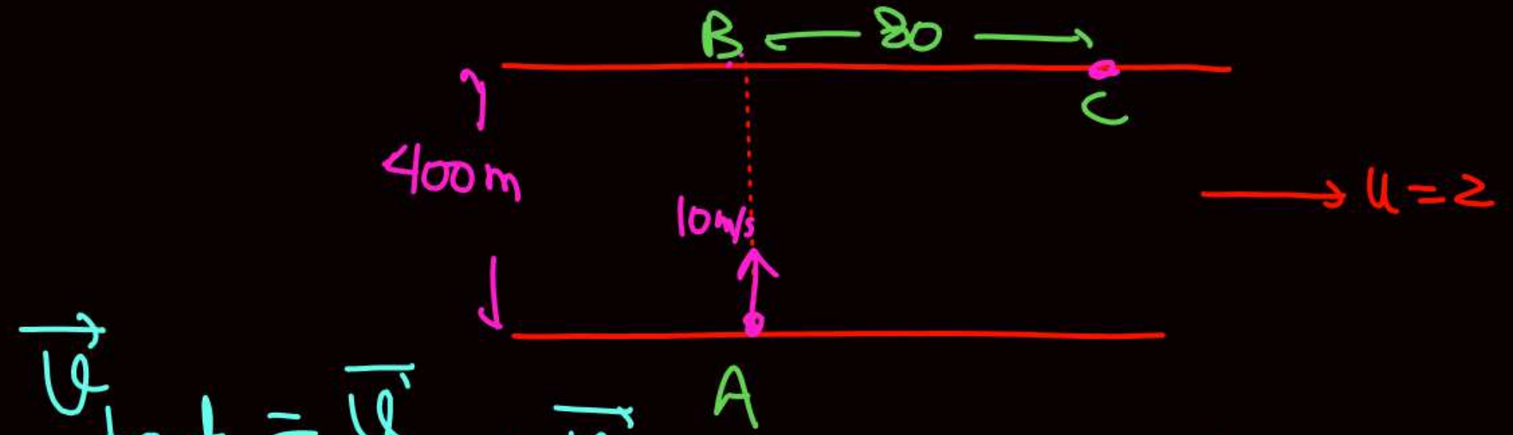


Figure 3-E9

46. A river 400 m wide is flowing at a rate of 2·0 m/s. A boat is sailing at a velocity of 10 m/s with respect to the water, in a direction perpendicular to the river. (a) Find the time taken by the boat to reach the opposite bank. (b) How far from the point directly opposite to the starting point does the boat reach the opposite bank ?

(b) $t = 40$



$\vec{v}_{boat} = \vec{v}_{b/r} + \vec{v}_r$

$= 10\hat{j} + 2\hat{i}$

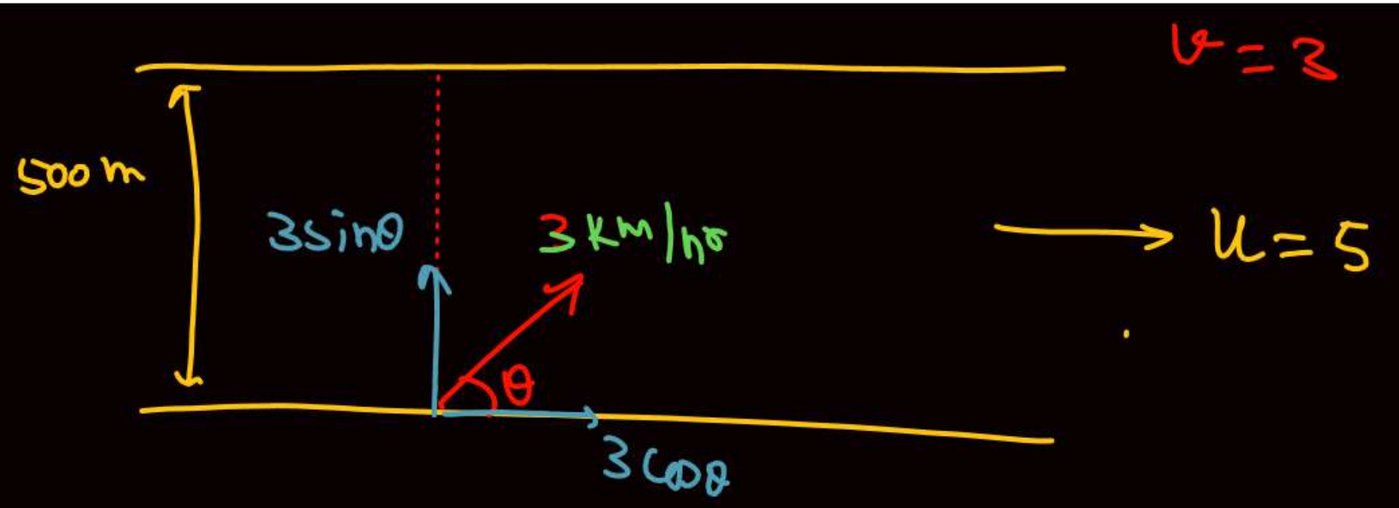
47. A swimmer wishes to cross a 500 m wide river flowing at 5 km/h. His speed with respect to water is 3 km/h.
(a) If he heads in a direction making an angle θ with the flow, find the time he takes to cross the river.
(b) Find the shortest possible time to cross the river.

$$t = \frac{500}{3\sin\theta \times \left(\frac{5}{18}\right)}$$

(b) $t_{\text{कम से कम}} = \frac{500}{3 \times 1 \times \frac{5}{18}}$

$(\sin\theta)_{max} = 1$

$\theta = 90^\circ$



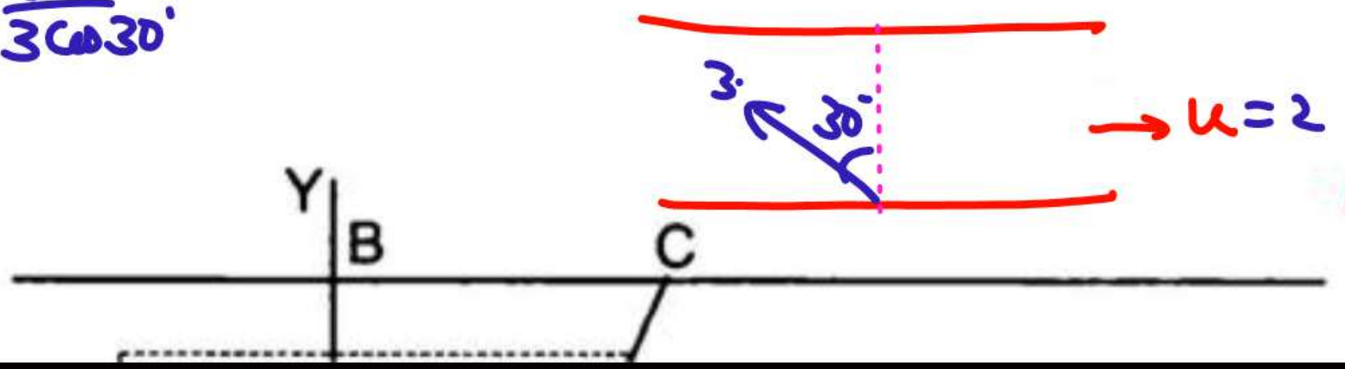
49. An aeroplane has to go from a point A to another point B, 500 km away due 30° east of north. A wind is blowing due north at a speed of 20 m/s. The air-speed of the plane is 150 m/s. (a) Find the direction in which the pilot should head the plane to reach the point B. (b) Find the time taken by the plane to go from A to B.

17. *A man can swim at a speed of* 3 km/h *in still water. He wants to cross a* 500 m *wide river flowing at* 2 km/h. *He keeps himself always at an angle of* 120° *with the river flow while swimming.*

(a) Find the time he takes to cross the river. (b) At what point on the opposite bank will he arrive ?

Hw

$t = \frac{500}{3\cos 30^\circ}$

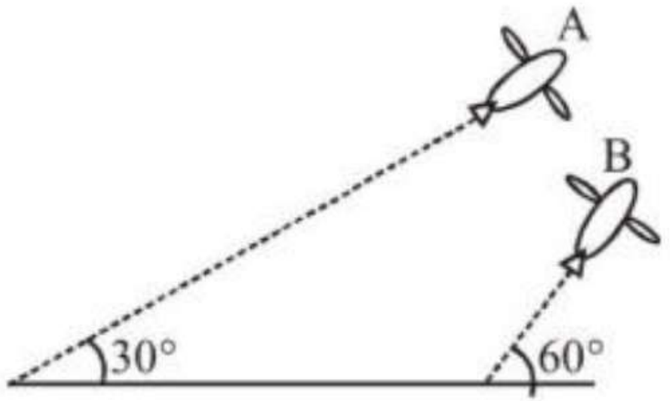


Ans $\frac{1}{3\sqrt{3}}$, $\frac{1}{6\sqrt{3}}$

3. Airplanes A and B are flying with constant velocity in the same vertical plane at angles 30° and 60° with respect to the horizontal respectively as shown in figure. The speed of A is $100\sqrt{3}$ ms^{-1}. At time $t = 0$ s, an observer in A finds B at a distance of 500 m. This observer sees B moving with a constant velocity perpendicular to the line of motion of A. If at $t = t_0$, A just escapes being hit by B, t_0 in seconds is

[JEE Advanced-2014]

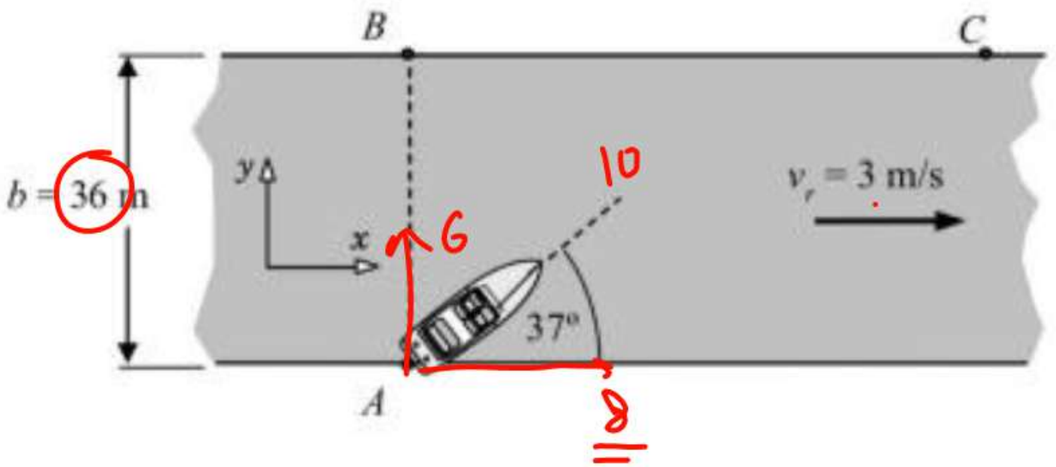
विमान A तथा विमान B नियत वेग से क्षैतिज से क्रमश: 30° तथा 60° का कोण बनाते हुए एक ही ऊर्ध्व तल में उड़ान भर रहे हैं। जैसा चित्र में दर्शाया गया है। विमान की A की गति $100\sqrt{3}$ ms^{-1} है। समय $t = 0$ s पर विमान A में एक प्रेक्षक के अनुसार B उससे 500 m की दूरी पर है। प्रेक्षक के अनुसार विमान B एक नियत वेग से A की गति की दिशा के लम्बवत दिशा में गतिमान है। यदि समय $t = t_0$ पर विमान A विमान B से टकराने से बाल-बाल बचता है, तब समय t_0 का सेकण्ड में मान है :



Ans. 5

28. Velocity of the boat with respect to river is 10 m/s. From point A it is steered in the direction shown to reach point C. Find the time of the trip and distance between B and C.

प्रदर्शित चित्र में नदी के सापेक्ष नाव का वेग 10 m/s है। बिन्दु C पर पहुंचने के लिये इसे बिन्दु A से प्रदर्शित दिशा में गति करायी जाती है। C तक पहुंचने में लगा समय तथा B व C के मध्य दूरी ज्ञात कीजिये।

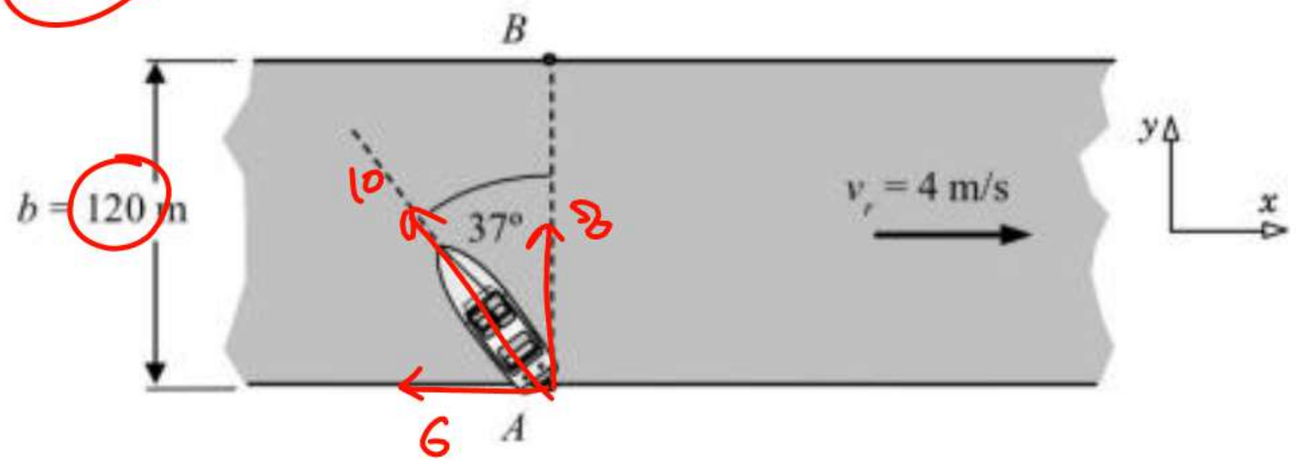


Ans. 6 s, 66 m

Velocity of the boat with respect to river is 10 m/s. From point A it is steered in the direction shown. Where will it reach on the opposite bank?

नदी के सापेक्ष नाव का वेग 10 m/s है। बिन्दु A से इसे प्रदर्शित दिशा में गति करायी जाती है। दूसरे किनारे पर यह कहाँ पहुंचेगी ?

15 X 2 = 30



Ans 30 (upstream)

27. Boat moves with velocity 5m/s on still water. It is steered perpendicular to the river current.

(a) Will it reach point B or somewhere else on the other bank?

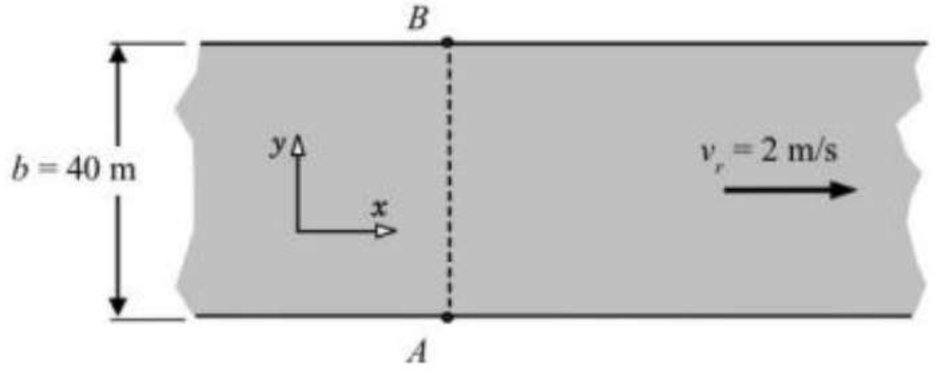
(b) How long will it take to cross the river?

(c) How far down stream, will it reach the other bank?

(d) Does it take minimum time in this way?

HW

8, 16m



एक नाव शांत जल में 5 m/s वेग से गति करती है, इसे नदी के प्रवाह के लम्बवत् खेया (steered) जाता है।

(a) यह दूसरे किनारे पर बिन्दु B पर पहुंचेगी अथवा अन्य कहीं ?

(b) नदी को पार करने में इसे कितना समय लगेगा ?

(c) यह धारा प्रवाह की दिशा में दूसरे किनारे पर प्रारिम्भक बिन्दु से कितनी दूर पहुंचेगी ?

(d) क्या इस पथ पर इसे न्यूनतम समय लगेगा ?

Ans. (a) Somewhere down stream (b) 8 s (c) 16 m (d) Yes

24. A man crosses a river by a boat. If he crosses the river in minimum time he takes 10 minutes with a drift 120 m. If he crosses the river taking shortest path, he takes 12.5 minutes. Assuming $v_{b/r} > v_r$, find

HW

(i) width of the river,

(ii) velocity of the boat with respect to water ($v_{b/r}$)

(iii) speed of the current (v_r)

एक आदमी नाव द्वारा नदी को पार करता है। यदि वह न्यूनतम समय में नदी को पार करना चाहता है तो उसे 120 m अपवहन के साथ 10 मिनिट लगते हैं। यदि वह सबसे छोटे पथ से नदी को पार करता है तो उसे 12.5 मिनिट लगते हैं। $v_{b/r} > v_r$ मानते हुए, ज्ञात कीजिए

(i) नदी की चौड़ाई (ii) पानी के सापेक्ष नाव का वेग ($v_{b/r}$) (iii) धारा की चाल (v_r)

Ans. 200 m, 20 m/min, 12 m/min

20. A person decided to walk on an escalator which is moving at constant rate (speed). When he moves at the rate 1 step/sec, then he reaches top in 20 steps. Next day he goes 2 steps / sec. and reaches top in 32 steps. If speed of escalator is n steps / sec. Find the value of n.

HW

एक व्यक्ति नियत दर (चाल) से गतिशील चलायमान सीढ़ी (escalator) पर पैदल चलने का निर्णय करता है। जब वह 1 सीढ़ी/सेकण्ड की दर से गति करता है तो वह 20 सीढ़ियां चढ़कर ऊपर पहुंच जाता है। अगले दिन वह 2 सीढ़ी/सेकण्ड चलता है तो वह 32 सीढ़ियां चढ़कर ऊपर पहुंच जाता है। यदि escalator की चाल n सीढ़ी / सेकण्ड हो तो n का मान ज्ञात कीजिए।

will Discuss next class

Ans. 3

Home work

- It's your Sunday (Revise full kinematics) ≡ Must needed for next article.
- DPP
- HCV ⟶ Page 53 ⇒ 40, 45, 46, 47, 48 & 49 (Unit का ध्यान रखें)
  Be careful.

THANK YOU