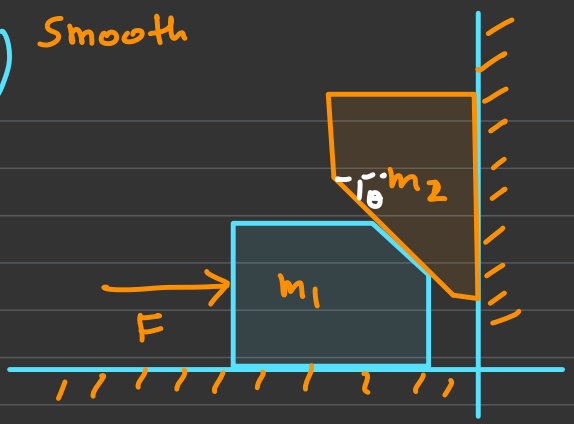
Introduction to Vector and Forces -4

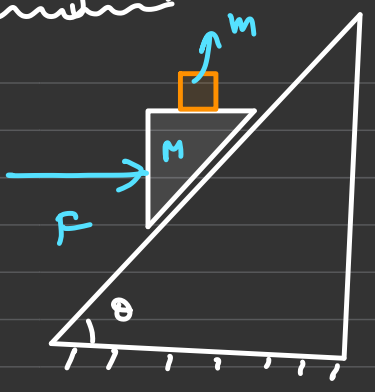
: Homework (Assignment) :

θ) Smooth



find F for which m_1 and m_2 both at equilibrium?

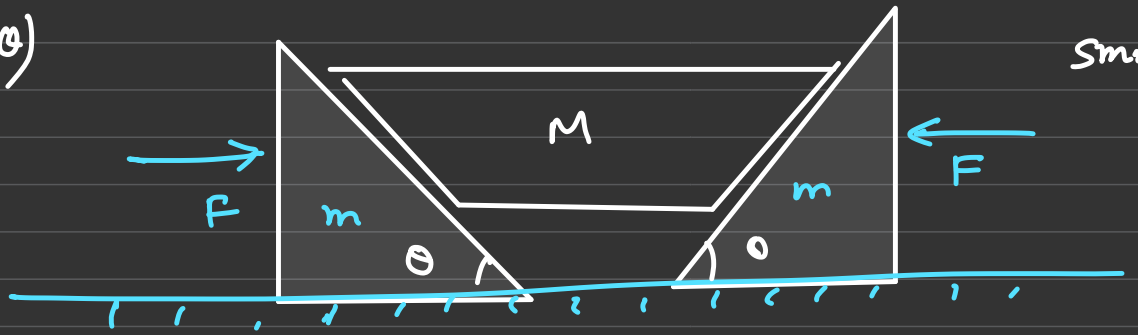
Smooth



find F for which m, M both at Equilibrium?

find F for which System is in eqb.

Q)

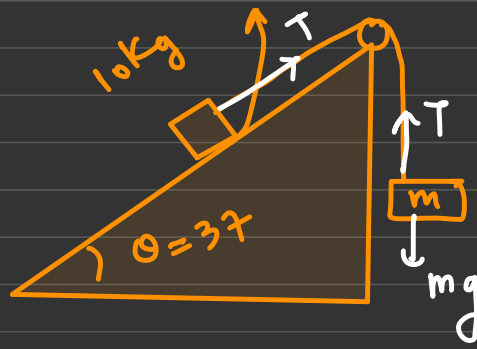


Smooth.

Advanced

$\mu_s = 0.3$

find m_{min} and m_{max} for which block is in equilibrium? for which



$\left\{ m_{min} \right.$

$\left. m_{max} \right\}$

$$F = T = mg\sin 37 + \mu_K mg\cos 37$$

$$= 10\times 16\times \frac{3}{5} + 0.3\times 10\times 16\times \frac{4}{5}$$

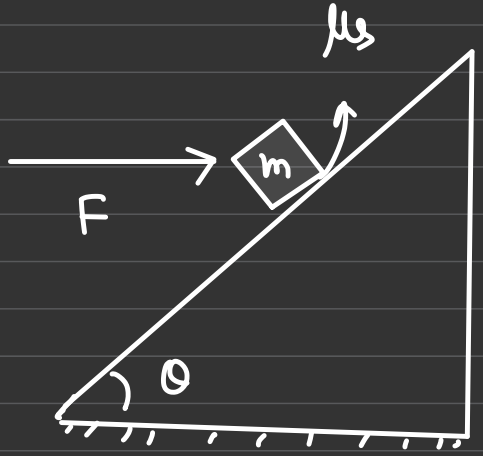
$$T_{max} = 60 + 24 = 84\ N = m_{max}\, g$$

$$T_{min} = 60 - 24 = 36\ N = m_{min}\, g$$

$$\left\{ \begin{array}{l} m_{max} = 8.4 \\ m_{min} = 3.6 \end{array} \right\} kg$$

Q) Homework

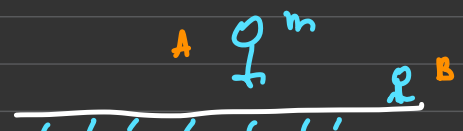
Find F_{max} and F_{min} to keep this block in equilibrium?



: Relative Velocity :

Velocity is always defined w.r.t some frame

velocity is not absolute



$\vec{V}_{m,g}$ = Velocity of man w.r.t ground

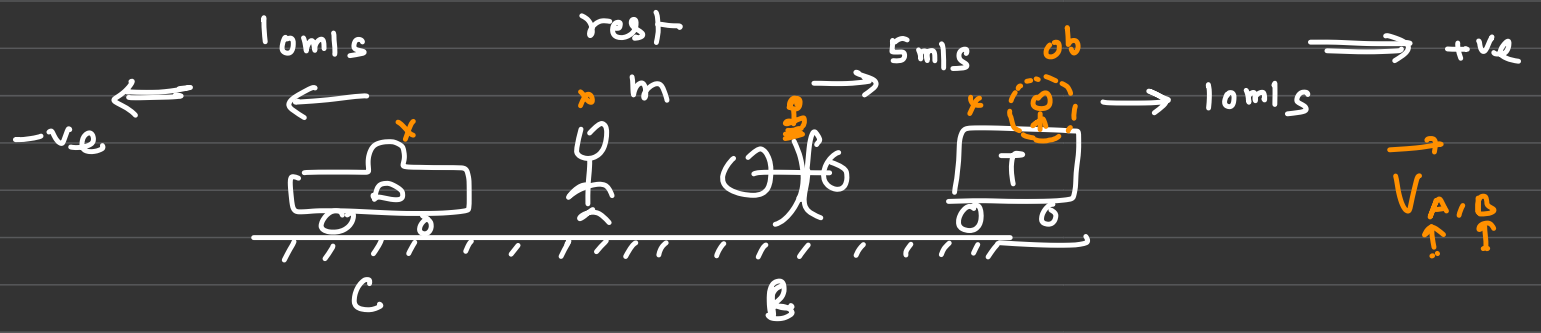
$\vec{V}_{A,B}$ $\{\vec{V}_A - \vec{V}_B\}$

Velocity of A w.r.t B

Velocity of A as seen by B

Velocity of A assuming B at rest

"1D Relative Velocity:" $\vec{V}_{AB} = \vec{V}_A - \vec{V}_B$



"Velocities given here is w.r.t ground"

find Velocity of truck w.r.t Car

$$\vec{V}_{T,C} = \vec{V}_T - \vec{V}_C$$
$$= +10 - (-10)$$
$$= +20 \text{ m/s}$$

$$\vec{V}_{CT} = -10\text{m/s} - (+10\text{m/s}) = -20\text{m/s}$$
$$= -20\text{ m/s}$$

Velocity of Car w.r.t truck is 20m/s Left

Velocity of car as seen by truck is 20 m/s left

Velocity of car assuming truck at rest is 20 m/s left

find

$\vec{V}_{C,B} = \vec{V}_C - \vec{V}_B = -10\,m/s - (+5\,m/s)$

$\vec{V}_{m,B} = 0 - (+5\,m/s) = -5\,m/s$

$\vec{V}_{T,B} = +(10\,m/s) - (+5\,m/s) = +5\,m/s$

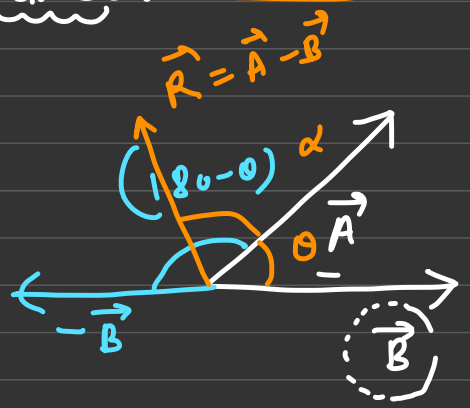
2D (Relative Velocity):

Vector Subtraction:

$$= \vec{A} - \vec{B} = \vec{A} + (-\vec{B})$$

Geometrical:

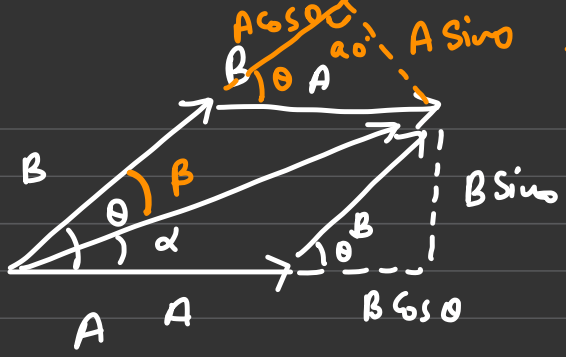
Aim: "$\vec{A} - \vec{B}$ Calculation"



"$|\vec{A} - \vec{B}| = \sqrt{A^2 + B^2 + 2AB\cos(180-\theta)}$"

$|\vec{A} + (-\vec{B})| = \sqrt{A^2 + B^2 - 2AB\cos\theta}$"

$$\tan\alpha = \frac{|\vec{B}|\sin(180-\theta)}{|\vec{A}| + |\vec{B}|\cos(180-\theta)}$$



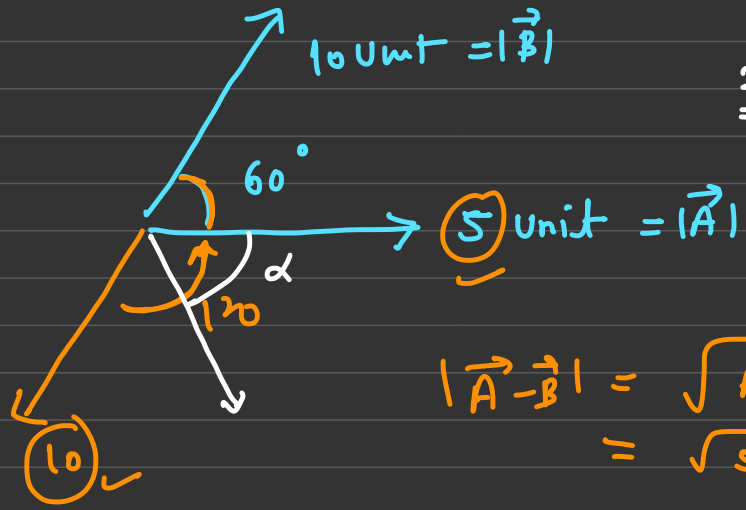
$\tan\beta = \frac{A\sin\theta}{B + A\cos\theta}$ w.r.t B

$\tan\alpha = \frac{B\sin\theta}{A + B(-\cos\theta)}$ w.r.t to A

Angle of

2D - plane

θ)



find $|\vec{A} - \vec{B}| =$

$|\vec{A} - \vec{B}| = \sqrt{A^2 + B^2 - 2AB\cos\theta}$

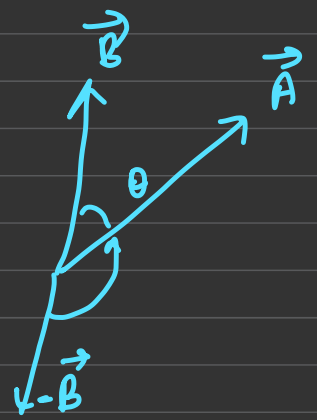
$= \sqrt{5^2 + 10^2 - 2 \times 5 \times 10 \times \cos 60}$

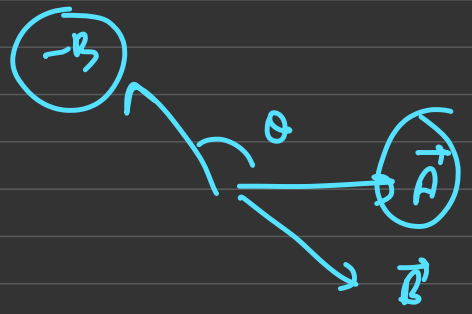
$|\vec{A} + (-\vec{B})| = \sqrt{(5)^2 + (10)^2 + 2 \times 5 \times 10 \times \cos 120}$

$= \sqrt{25 + 100 + 100(-1/2)}$

$$= \sqrt{25 + 100 - 50}$$

$$= \sqrt{75} \quad \underline{\underline{\text{Ans}}}$$





Relative Velocity of objects in 2D

1. River – Swimmer
2. Rain – man
3. Aeroplane – wind

"River Swimmer"

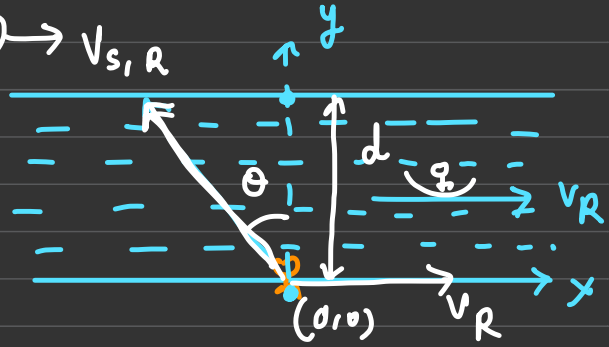
$$\vec{V}_{S,R} = \vec{V}_S - \vec{V}_R$$

$\vec{V}_{S,R}$ = # Velocity of Swimmer w.r.t River

" " " assuming river at rest.

V_S = Velocity of

(given) → $V_{S,R}$



$$\vec{V}_{SR} = \vec{V}_S - \vec{V}_R$$

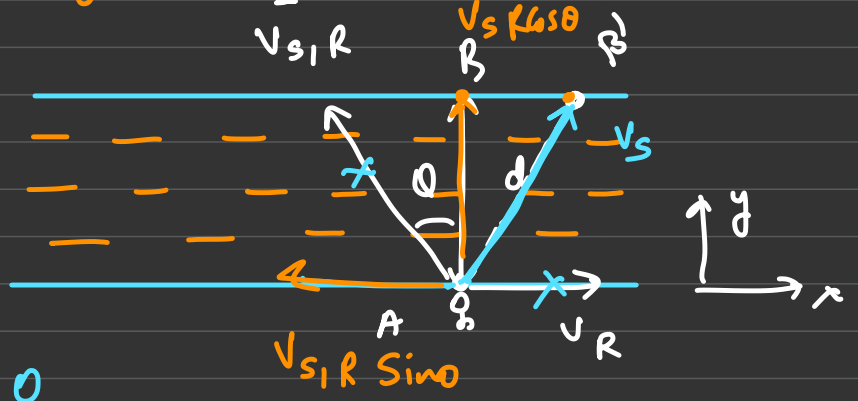
$$\vec{V}_S = \vec{V}_{SR} + \vec{V}_R$$

{ w.r.t ground

Swimmer w.r.t ground

V_R = " " "
River
w.r.t ground

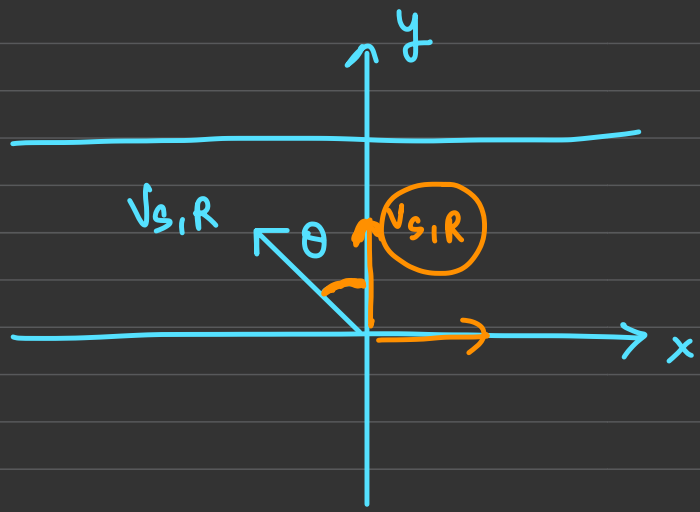
Case I: time taken by swimmer to cross the river for given θ and $V_{S,R}$ and d ?



if swimmer is at B1 then $V_R > V_{SR}\sin\theta$

$$t = \frac{d}{V_{s,R}\cos\theta}$$

$V_{s,R}$, V_R, = Constant



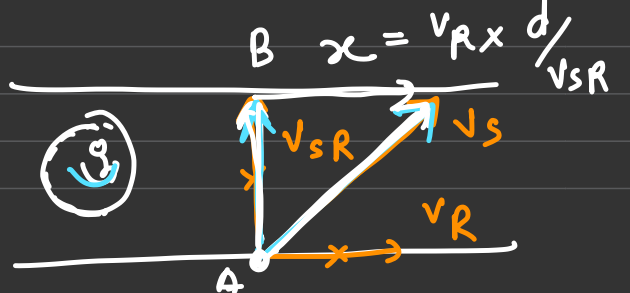
$$t = \frac{d}{V_{s,R}\cos\theta}$$

a) find θ for which time taken to cross the river is minimum?

$$\left\{ \begin{array}{l} \cos\theta = +1 \\ \theta = 0^\circ \end{array} \right.$$

if swimmer tries to swim $\perp$ to river's flow then he will take min time

$$t_{min} = \frac{d}{V_{SR}}$$



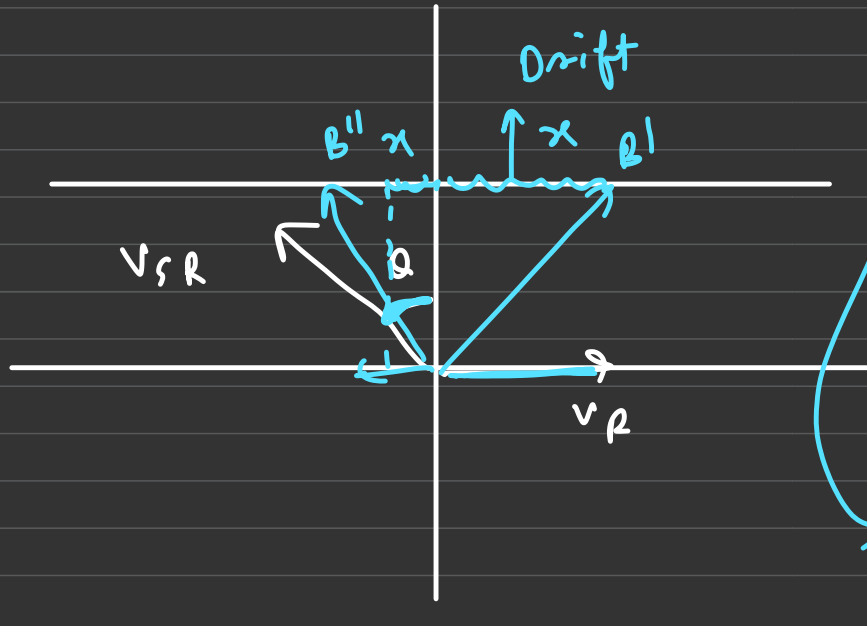
$$\vec{V_S} = \vec{V_{SR}} + \vec{V_R}$$

(4)

$$\vec{V}_{SR} = \vec{V}_S - \vec{V}_R$$

Distance covered by swimmer in min time to cross

$$\text{Distance} = \sqrt{d^2 + \left(\frac{V_R}{V_{SR}}\right)^2 d^2}$$



$V_R > V_{SR}\sin\theta \Rightarrow$

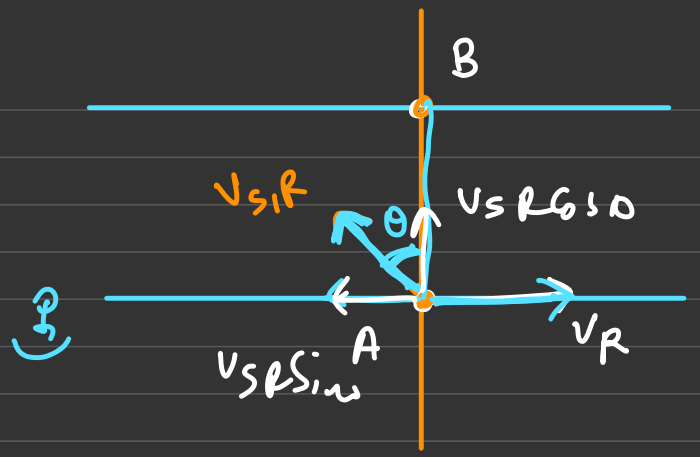
$V_R < V_{SR}\sin\theta$

$$x = (V_R - V_{SR}\sin\theta)\frac{d}{V_{SR}\cos\theta}$$

$$x = (V_{SR}\sin\theta - V_R)\times\frac{d}{V_{SR}\cos\theta}$$

#

Case II a)



"V_S, R, d"

V_R

if he start from A and reaches B then then min dis.

find direction of swimmer for which he crosses the river for minimum distance (ground)

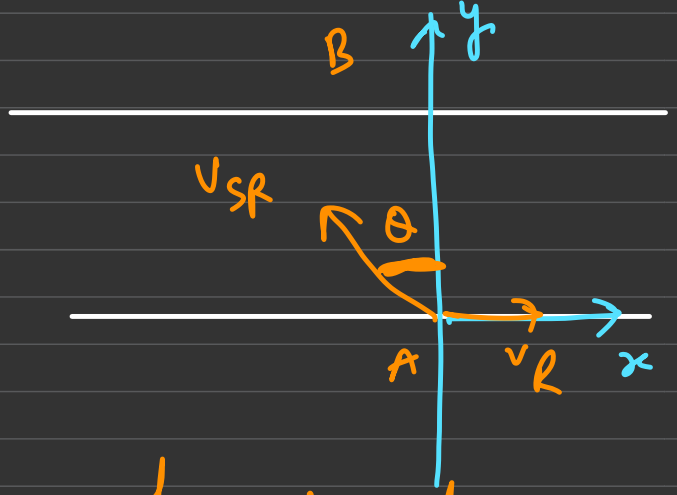
for min distance $V_R = V_{SR}\sin\theta$

$V_S = V_{SR}\cos\theta$ ↑ ans

$$\sin\theta = \frac{v_R}{v_{SR}} \quad v_R < v_{SR}$$

"If $v_R > v_{SR}$ then swimmer can never reach B"

a)



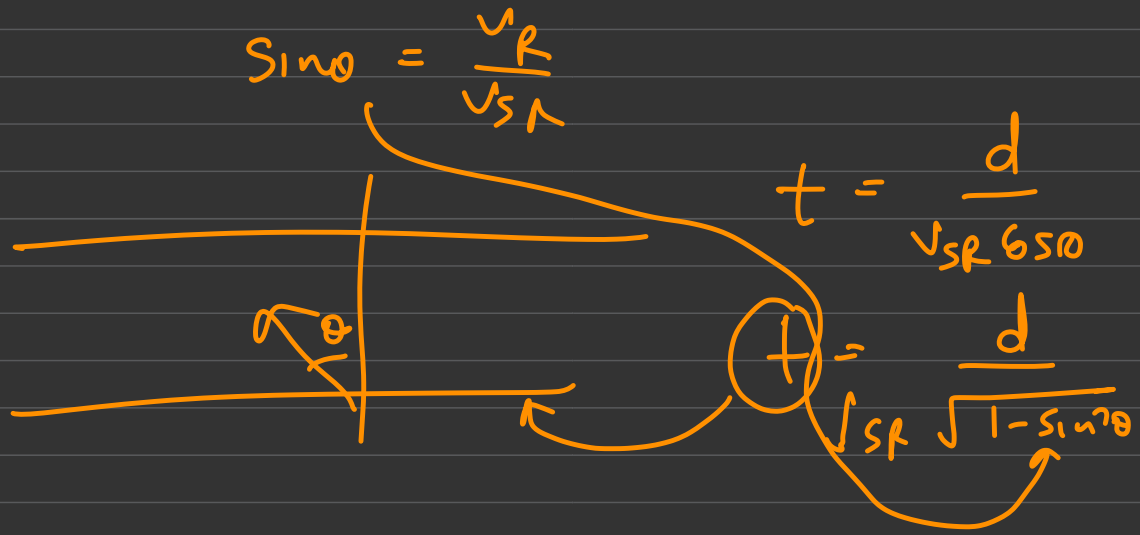
$v_R = 1\ km/hr$

$v_{SR} = 2\ km/hr$

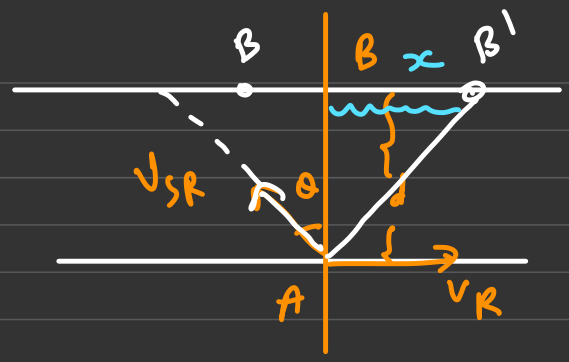
for min distance $= v_R = v_{SR}\sin\theta$

$$\sin\theta = \frac{1}{2} \Rightarrow \theta = 30^\circ$$

b) find time taken by swimmer to cross the river in min distance



Summery:



$\vec{V}_{SR} = \vec{V}_S - \vec{V}_R$

$\vec{V}_S = \vec{V}_{SR} + \vec{V}_R$

1) time for given θ and V_{SR} and V_R to cross river

$$t = \frac{d}{V_{SR}\cos\theta}$$

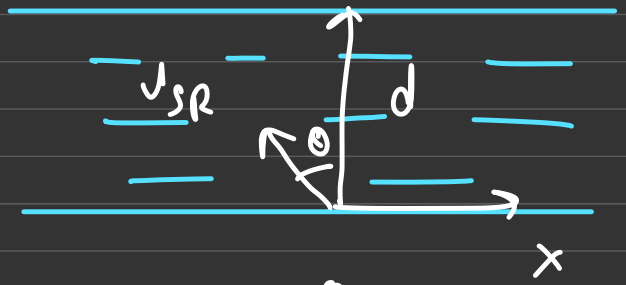
2) a) $V_R > V_{SR}\sin\theta$ (B')

$$x = (V_R - V_{SR}\sin\theta) \times \frac{d}{V_{SR}\cos\theta}$$

b) $V_R < V_{SR}\sin\theta$ (B)

$$x = \frac{(v_{SR}\sin\theta - v_R)}{v_{SR}\cos\theta}\, d$$

Case I: a) "find time for which Swimmer takes min time to cross river"



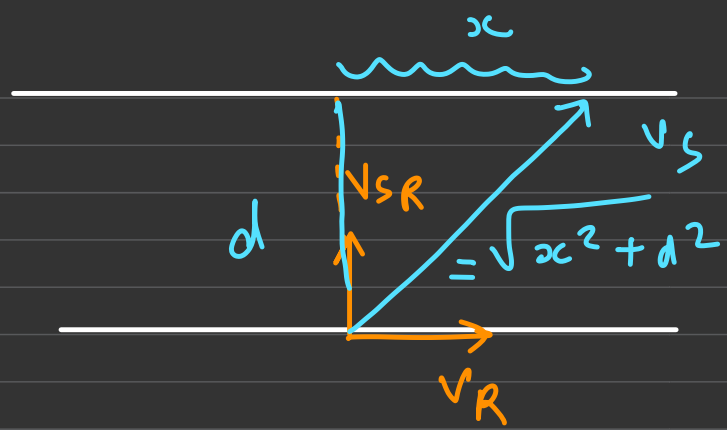
$$t = \frac{d}{v_{SR}\cos\theta}$$

$\cos\theta = 1 \Rightarrow \theta = 0$

$\theta = 0^\circ \Rightarrow$ ⊥ to river flow

$$t_{min} = \left(\frac{d}{v_{SR}}\right)$$

b)

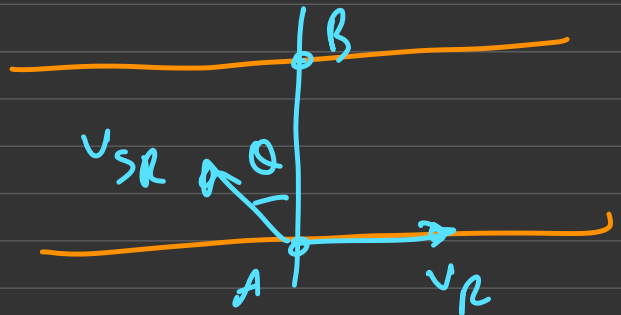


$$x = v_R \times \frac{d}{v_{SR}}$$

distance covered by swimmer to cross in min time

$$\text{distance} = \sqrt{d^2 + \frac{d^2 v_R^2}{v_{SR}^2}}$$

Case II: a) find θ for which distance covered is min.



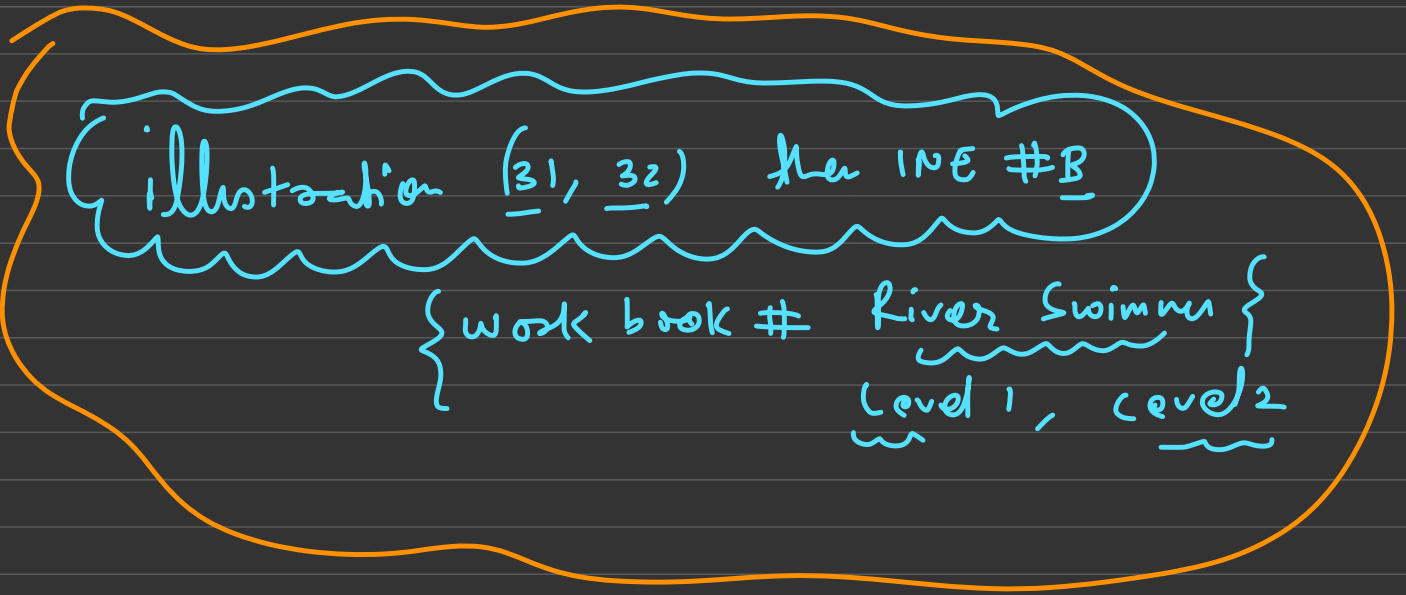
$$v_{SR} \sin\theta = v_R$$

$$\sin\theta = \frac{v_R}{v_{SR}}$$

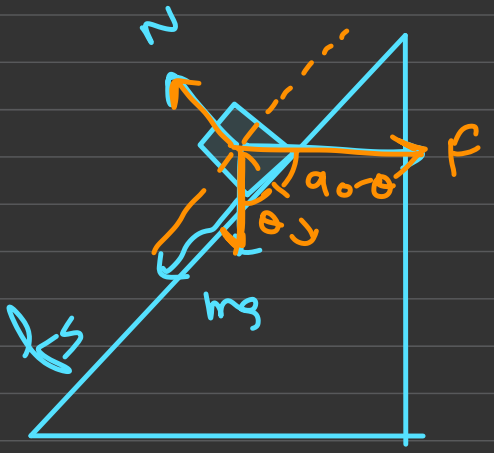
$v_R < v_{SR}$

for min distance

b) $t = \frac{d}{v_{s\,n\,60\,s0}}$



Homework Question



$$\begin{cases} F_{max}\cos\theta = mg\sin\theta + \mu_s N \\ N = mg\cos\theta + F_{max}\sin\theta \end{cases}$$

$$F_{max}\cos\theta = mg\sin\theta + \mu_s(mg\cos\theta + F_{max}\sin\theta)$$

$$F_{max}(\cos\theta - \mu_s\sin\theta) = mg\sin\theta + \mu_s mg\cos\theta$$

$$\Rightarrow \begin{cases} F_{max} = \dfrac{mg\sin\theta + \mu_s mg\cos\theta}{\cos\theta - \mu_s\sin\theta} \end{cases}$$

$$f_{min} = \frac{\mu \sin\omega - \sin\gamma \cos\omega}{\cos\omega + \mu \sin\omega}$$