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Q3.
A. Any 2.
ii)

$$x = 3t^3 - 18t^2 + 26t + 8.$$

$$\therefore v = \frac{dx}{dt} = 9t^2 - 36t + 26.$$

$$a = \frac{dv}{dt} = 18t - 36.$$

(i) when velocity is zero,

$$v = 9t^2 - 36t + 26 = 0.$$

$$t = \frac{36 \pm \sqrt{36^2 - 4 \times 9 \times 26}}{2 \times 9}$$

$$\therefore t_1 = 3.054s \quad or \quad t_2 = 0.946s.$$

$$\boxed{\therefore \text{At time } t_1 = 3.054s \text{ and } t_2 = 0.946s, \text{ the velocity is zero}}$$

(ii) acceleration is zero, $\therefore a = 18t - 36 = 0 \quad \therefore t = 2sec.$

at $t = 2s$,

$$x = 3 \times 2^3 - 18 \times 2^2 + 26 \times 2 + 8.$$
$$= 24 - 72 + 52 + 8$$
$$x_2 = 12m$$

Total distance travelled when acceleration becomes zero,

$$s = \int_0^2 x.dt = \left[t^4 - 6t^3 + 13t^2 + 8t\right]_0^2$$

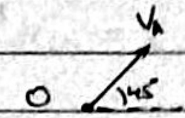
$$= (16 - 8 \times 6 + 13 \times 4 + 16) - 0$$
$$= 36m.$$

$$\therefore S_2 = 36m.$$

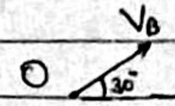
$\therefore$ The position and the total distance travelled when the acceleration becomes zero is $x_2 = 12m$ and $S_2 = 36m$, respectively.

Q3 A. iii)

→ Stone A is projected at an angle 45° from O.



Stone B is projected at an angle 30° from O.



for stone A,

In vertical direction, ($\uparrow$ +ve)

$u_y = V_A \sin 45^\circ$

for max height, $V_y = 0$.

$\therefore \; 0 = u_y + at \qquad \therefore u_y = gt. \qquad \therefore t = \dfrac{V_A \sin 45^\circ}{g}$

$$S = H_{max} = u_y t + \frac{1}{2}(-g)t^2 = \frac{(V_A \sin 45^\circ)^2}{g} - \frac{g}{2}\frac{(V_A \sin 45^\circ)^2}{g^2}$$

$$S_A = H_{max} = \frac{1}{2g}(V_A \sin 45^\circ)^2$$

Similarly for stone B,

$$S_B = H_{max} = \frac{1}{2g}(V_B \sin 30^\circ)^2$$

$S_A = S_B = H_{max}$ (Given)

$$\therefore V_A^2 (\sin 45)^2 = V_B^2 (\sin 30)^2$$

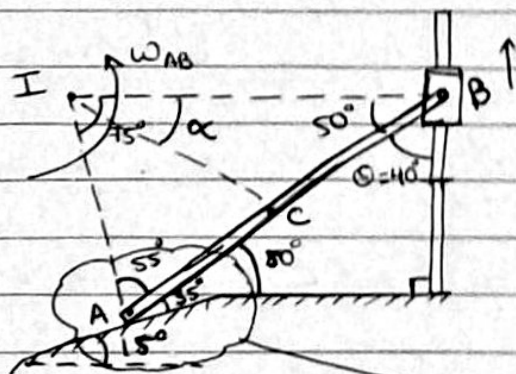
$$V_A^2 / 2 = V_B^2 / 4$$

$$\therefore \underline{V_B = \sqrt{2}\, V_A}$$

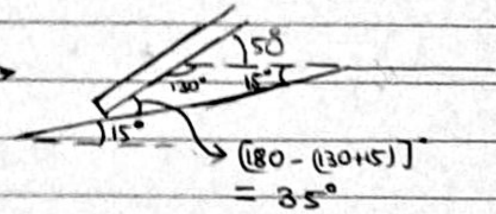
$$\boxed{\therefore \frac{V_A}{V_B} = \frac{1}{\sqrt{2}}}$$

Q 3.
B. Any one.
ii)
→

FBD:-



AB = 1.5m



Solution: In ΔIAB, using sine rule

$$\frac{AB}{\sin 75°} = \frac{IA}{\sin 50°} = \frac{IB}{\sin 55°}$$

$\therefore IA = 1.5 \times \sin 50° / \sin 75°$

$\therefore IA = 1.19 m$

$\therefore IB = 1.27 m$

Now, for Rod AB, at the given instant point I is the ICR

$V_B = IB \times \omega_{AB}$ $\quad \therefore \omega_{AB} = \frac{V_A}{IB} = \frac{2}{1.27} = 1.575$ rad/s (↺)

$\boxed{\therefore \omega_{AB} = 1.575 \text{ rad/s } (↺)}$

$V_A = IA \times \omega_{AB}$ $\quad \therefore V_A = 1.19 \times 1.575 = 2.23$ m/s.

$\boxed{\therefore V_A = 2.23 \text{ m/s } (15°)}$

Now, In ΔICB, $IC^2 = IB^2 + CB^2 - 2(IB)(CB)\cos 50°$.

$= (1.27)^2 + (0.75)^2 - 2 \times (1.27)(0.75) \times \cos 50°$

$IC^2 = 0.95$

$\therefore IC = 0.975 m.$

$\therefore \quad V_c = IC \times \omega_{AB} = 1.536.$

$\boxed{\therefore V_c = 1.536 m/s.}$

Conclusion:- i) The angular velocity $\underline{\omega_{AB} = 1.575 \text{ rad/s } (\circlearrowleft)}$

ii) The velocity of end A of the rod $\underline{V_A = 2.23 m/s \ (\angle 15°)}$

iii) The velocity of midpoint C of the rod AB $\underline{V_c = 1.536 m/s.}$

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