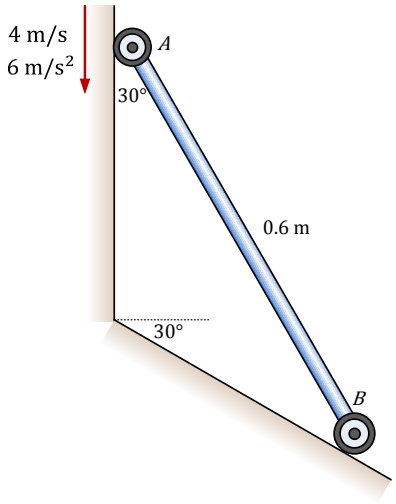
Question 10.10.



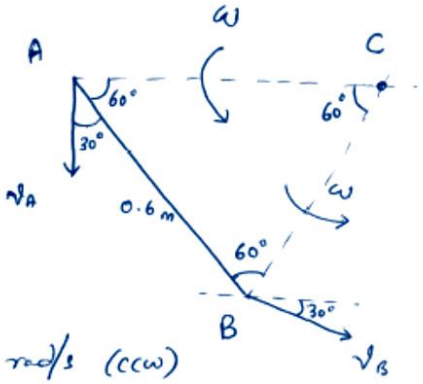
At a given instant the roller A on the bar has the velocity and acceleration shown. Determine the velocity and acceleration of the roller B, and the bar's angular velocity and angular acceleration at this instant.

Solution

Velocity analysis :-

Determine instant centre (C) for AB

Since it is an equilateral triangle.



$\overline{AC} = \overline{AB} = \overline{BC} = 0.6\ m$

$\omega = \dfrac{v_A}{\overline{AC}}$

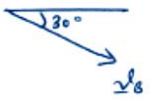
$\omega = \dfrac{4}{0.6} = 6.667\ rad/s\ (ccw)$

ANSWER

Also,

$v_B = \omega BC$

$v_B = (6.667)(0.6) = 4\ m/s$



ANSWER

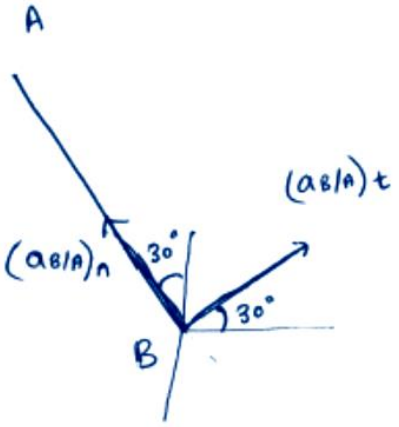
Acceleration analysis :-

Key equation → $\underline{a}_B = \underline{a}_A + \underline{a}_{B/A}$ — (1)

$\underline{a}_A = -6\,j\ m/s^2$ (given).

$\underline{a}_B = a_B \cos 30^\circ i - a_B \sin 30^\circ j$

$\underline{a}_{B/A} = (\underline{a}_{B/A})_n + (a_{B/A})_t$.



$(a_{B/A})_n = \omega_{AB}^2 \, \overline{AB}$

$= (6.667)^2 (0.6)$

$= 26.667 \ m/s^2$.

$(\underline{a}_{B/A})_n = -26.667 \sin 30^\circ \underline{i} + 26.667 \cos 30^\circ \underline{j}$

$(\underline{a}_{B/A})_n = -13.33 \underline{i} + 23.1 \underline{j}$

$(\underline{a}_{B/A})_t = \alpha_{AB} \overline{AB} = 0.6 \alpha_{AB}$.

$(\underline{a}_{B/A})_t = 0.6 \alpha_{AB} \cos 30^\circ \underline{i} + 0.6 \alpha_{AB} \sin 30^\circ \underline{j}$

$(\underline{a}_{B/A})_t = 0.52 \alpha_{AB} \underline{i} + 0.3 \alpha_{AB} \underline{j}$

Group the i terms in (1).

$a_B \cos 30^\circ = -13.33 + 0.52 \alpha_{AB}$ —— (2)

Group the j terms in (1)

$-a_B \sin 30^\circ = -6 + 23.1 + 0.3 \alpha_{AB}$ —— (3)

Solving (2) and (3) simultaneously

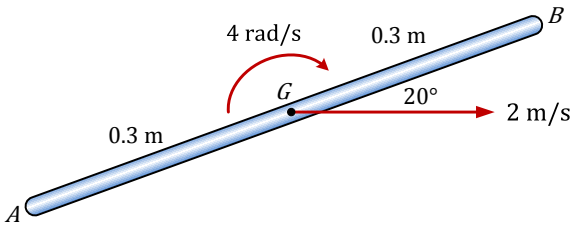
$\alpha_{AB} = -15.667 \ rad/s^2$ (CCW) ANSWER

$a_B = 24.8 \ m/s^2$

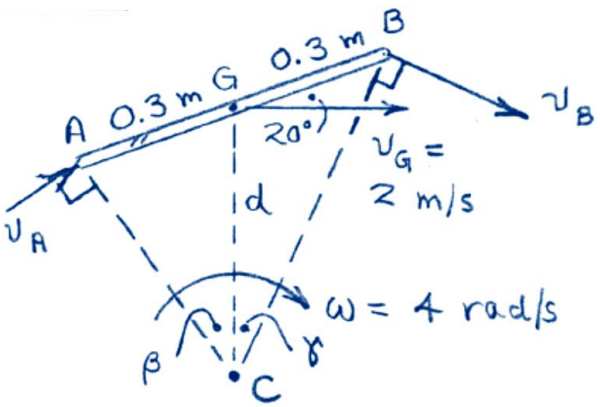
ANSWER

Question 10.11.

The slender bar is moving in general plane motion with the indicated linear and angular properties. Locate the instantaneous centre of zero velocity and determine the velocities of point A and B.



Solution



$$\begin{cases} v_G = d\omega \\ 2 = d(4) \\ d = 0.5 \text{ m} \\ \text{(below G)} \end{cases}$$

$$\overline{AC}^2 = 0.3^2 + 0.5^2 - 2(0.3)(0.5)\cos 70^\circ$$

$$\overline{AC} = 0.487 \text{ m}$$

$$\frac{\sin\beta}{0.3} = \frac{\sin 70^\circ}{0.487}, \quad \beta = 35.4^\circ$$

$$v_A = \overline{AC}\,\omega = 0.487(4) = 1.949 \text{ m/s} \quad \angle 35.4^\circ$$

$$\overline{BC}^2 = 0.3^2 + 0.5^2 - 2(0.3)(0.5)\cos 110^\circ$$

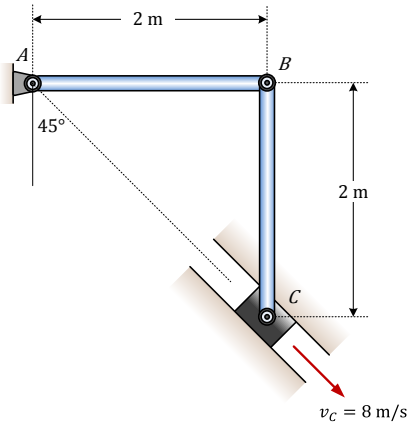
$$\overline{BC} = 0.665 \text{ m}$$

$$\frac{\sin\gamma}{0.3} = \frac{\sin 110^\circ}{0.665}, \quad \gamma = 25.1^\circ$$

$$v_B = \overline{BC}\,\omega = 0.665(4) = 2.66 \text{ m/s} \quad \angle 25.1^\circ$$

Question 10.12.

The slider block C moves at 8 m/s down the inclined groove. Determine the angular velocities of links AB and BC at the instant shown.



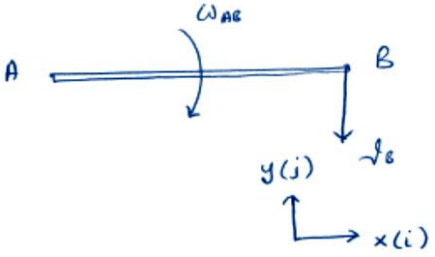
Solution

Consider link AB :-

$\underline{v}_B = \underline{v}_A + \underline{v}_{B/A}$

$\underline{v}_B = \underline{v}_{B/A} = \omega_{AB} \times \overline{AB}$

$\underline{v}_B = -2\,\omega_{AB}\,\underline{j}$



Consider link BC :-

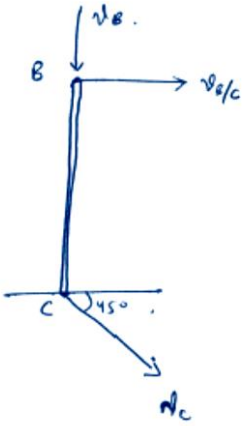
$\underline{v}_B = \underline{v}_C + \underline{v}_{B/C}$ — (1)

where

$\underline{v}_B = -2\,\omega_{AB}\,\underline{j}$

$\underline{v}_C = 8\cos 45^\circ\,\underline{i} - 8\sin 45^\circ\,\underline{j}$

$\underline{v}_C = 5.657\,\underline{i} - 5.657\,\underline{j}$



and

$\underline{v}_{B/C} = v_{B/C}\,\underline{i}$ ($\perp$ to BC).

Group the j terms together in (1).

$-2\,\omega_{AB} = -5.657$

$\omega_{AB} = 2.83$ rad/s (CW) ANSWER

Group the i terms together in (1).

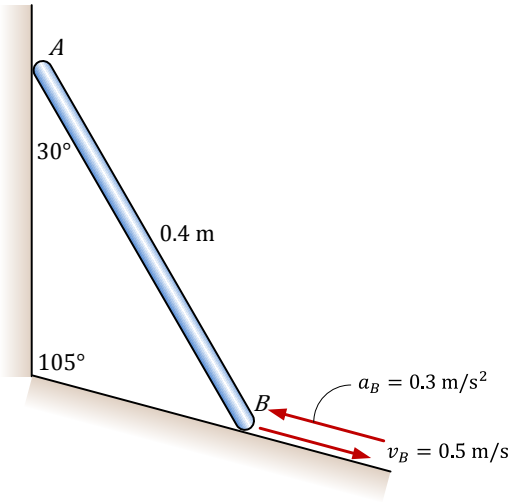
$0 = 5.657 + v_{B/C} \longrightarrow v_{B/C} = -5.657$ m/s

Therefore.

$\omega_{BC} = \dfrac{v_{B/C}}{\overline{BC}} = -2.83$ rad/s (CW) ANSWER

Question 10.13.

The ends of the 0.4 m slender bar remain in contact with their respective contact surfaces. End B has a velocity $v_B = 0.5\ \text{m/s}$ and an acceleration of $a_B = 0.3\ \text{m/s}^2$ in the directions shown. Determine the angular acceleration of the bar and the acceleration of end A.



Solution

The solution to this problem is very much similar to problem 10.10