An automobile travels to the right at a constant speed of 48 mi/h. If the diameter of a wheel is 22 in., determine the velocities of points *B*, *C*, *D*, and *E* on the rim of the wheel.

$V_A = 84.5\,i$ in/s

$\omega = -7.7K$ rad/s

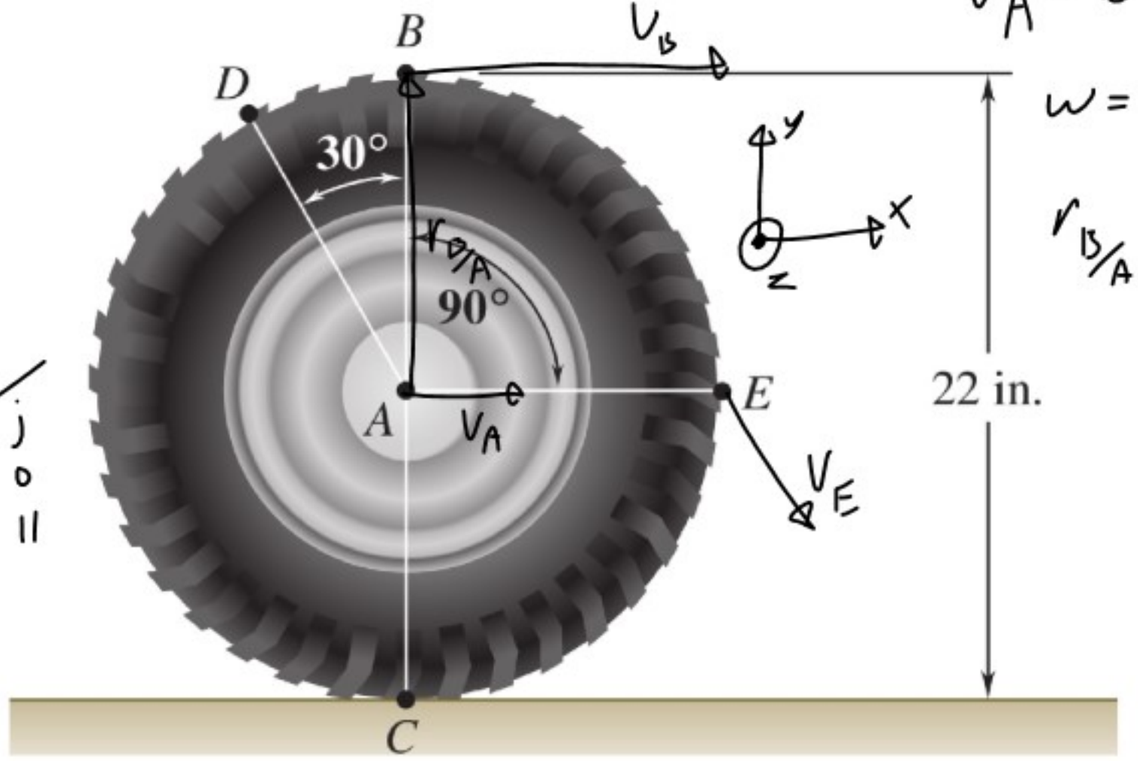
$r_{B/A} = 11\,j$ in

$V_B = V_A + V_{B/A}$

$= V_A + \omega \times r_{B/A}$

$= 84.5i + \begin{vmatrix} i & j & K \\ 0 & 0 & -7.7 \\ 0 & 11 & 0 \end{vmatrix}$ (i, j | 0 0 | 0 11)

$= 84.5i + 11 \cdot 77\,i = \boxed{1692\ \text{in/s}}$



$$V_C = V_A + V_{C/A} = V_A + \omega \times r_{C/A} \qquad r_{C/A} = -11j \text{ in}$$

$$= 845i + \begin{vmatrix} i & j & k \\ 0 & 0 & -77 \\ 0 & -11 & 0 \end{vmatrix} \begin{matrix} i & j \\ 0 & 0 \\ 0 & -11 \end{matrix} = 845i - 11.77i = -2i \text{ in/s} \approx 0$$

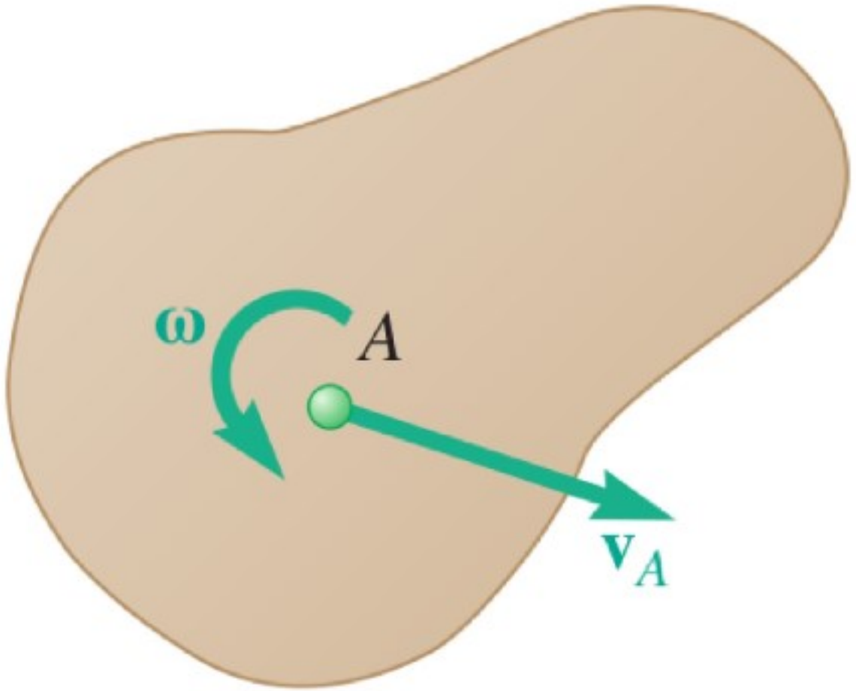
$$V_C = V_B + V_{C/B} = V_B + \omega \times r_{C/B} \qquad r_{C/B} = -22j \text{ in}$$

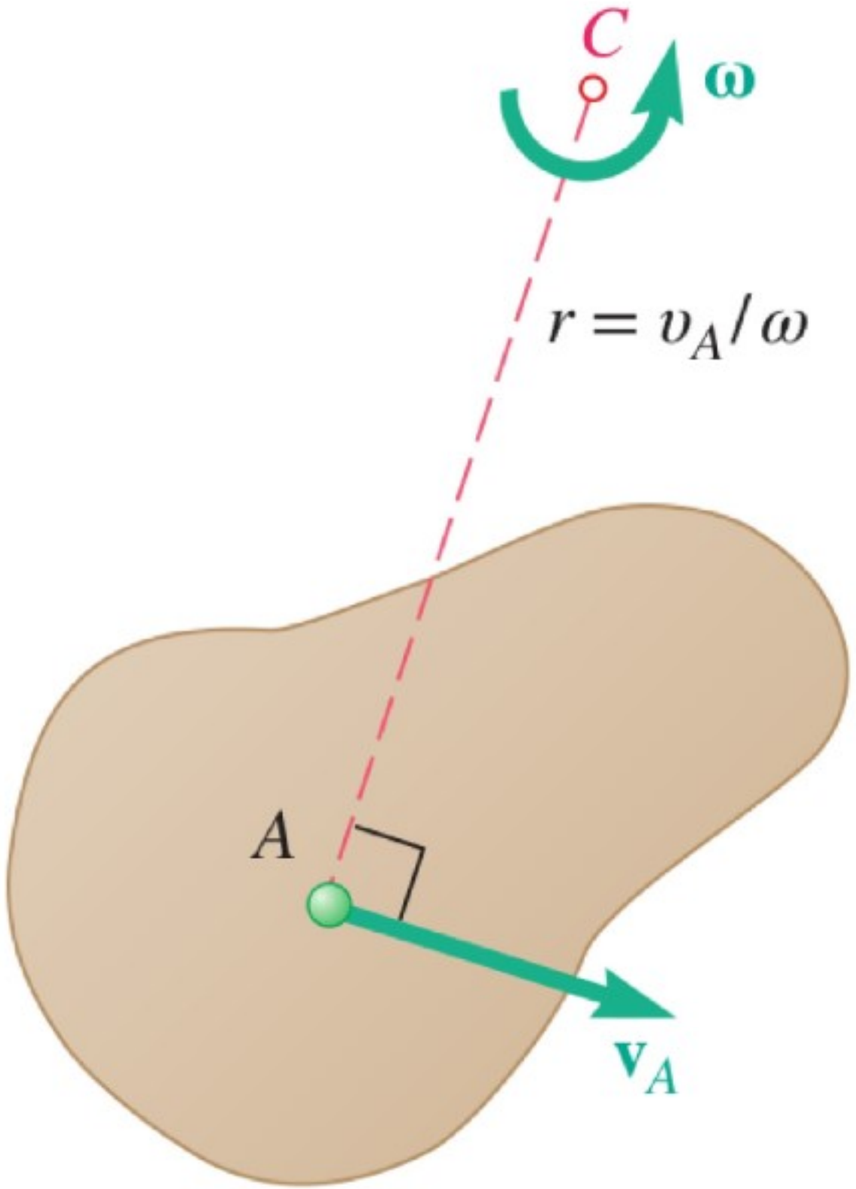
$$= 1692i + \begin{vmatrix} i & j & k \\ 0 & 0 & -77 \\ 0 & -22 & 0 \end{vmatrix} \begin{matrix} i & j \\ 0 & 0 \\ 0 & -22 \end{matrix} = 1692i - 22.77i = -2i \text{ in/s}$$

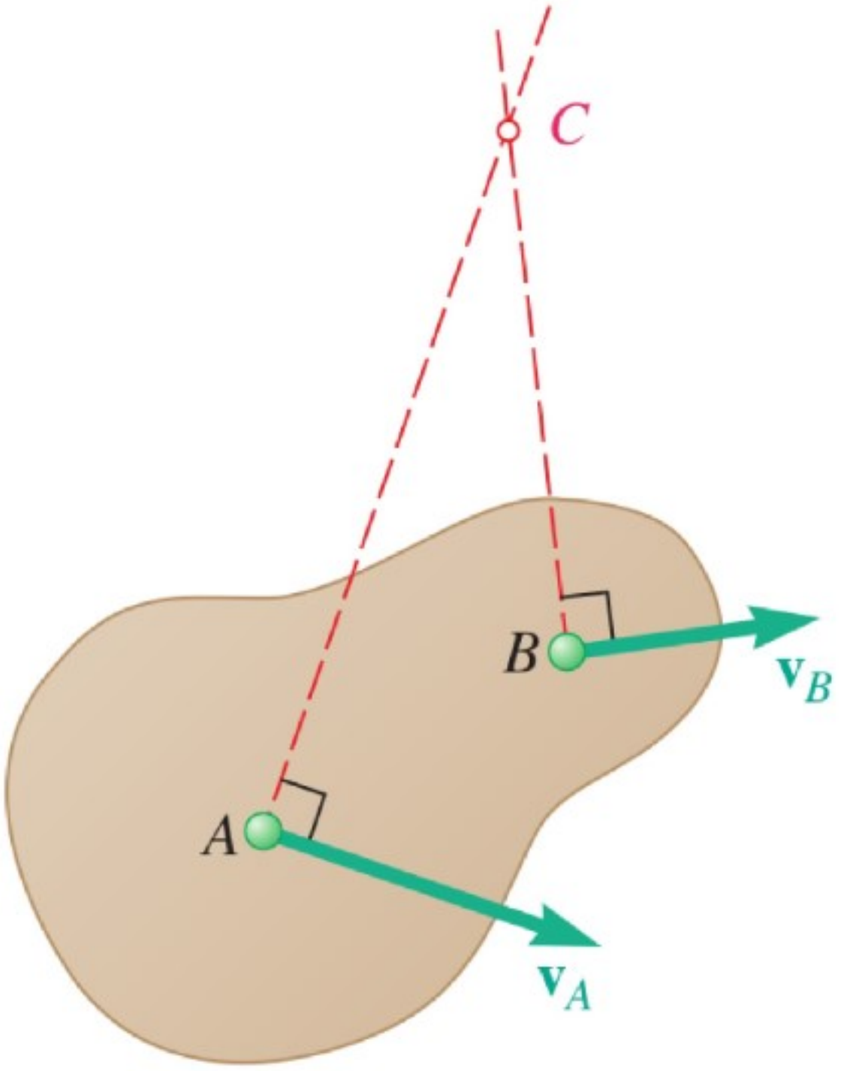
$$V_E = V_A + V_{E/A} = V_A + \omega \times r_{E/A} = 845i + \begin{vmatrix} i & j & k \\ 0 & 0 & -77 \\ 11 & 0 & 0 \end{vmatrix} \begin{matrix} i & j \\ 0 & 0 \\ 11 & 0 \end{matrix} = 845i - 11.77j$$

$$= 845i - 847j \text{ in/s} \qquad r_{E/A} = 11i \text{ in}$$

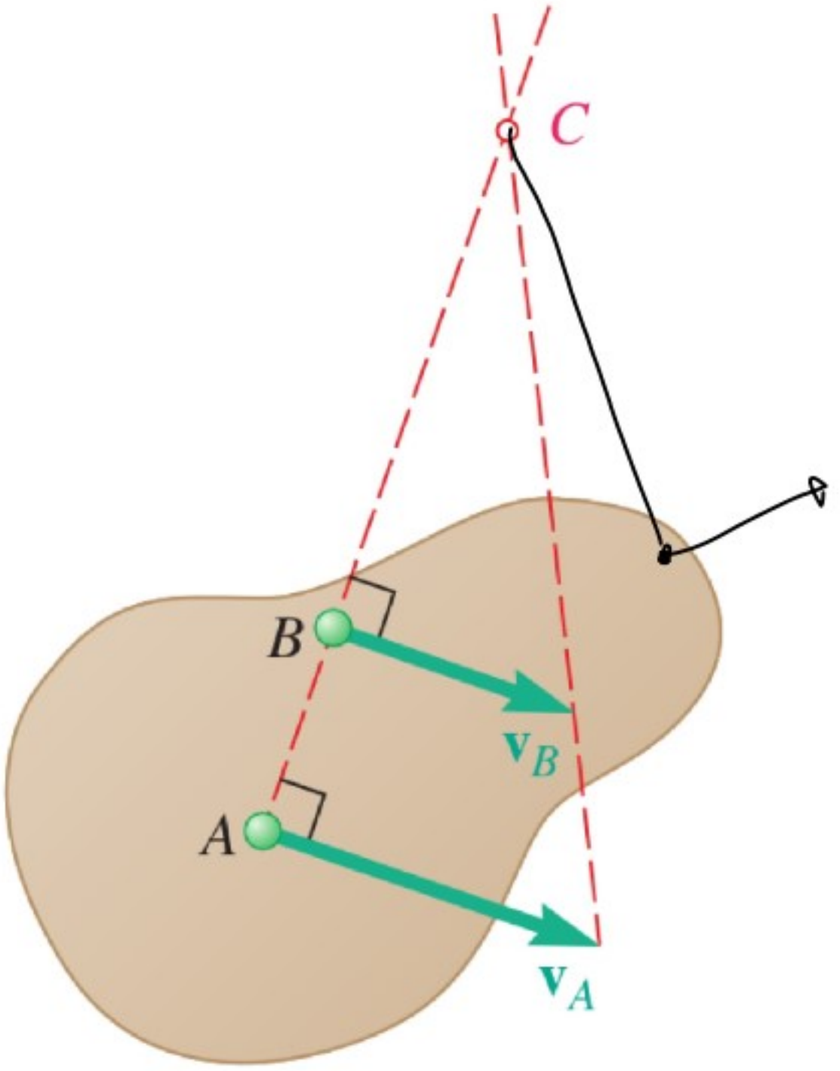
Instantaneous Center of Rotation



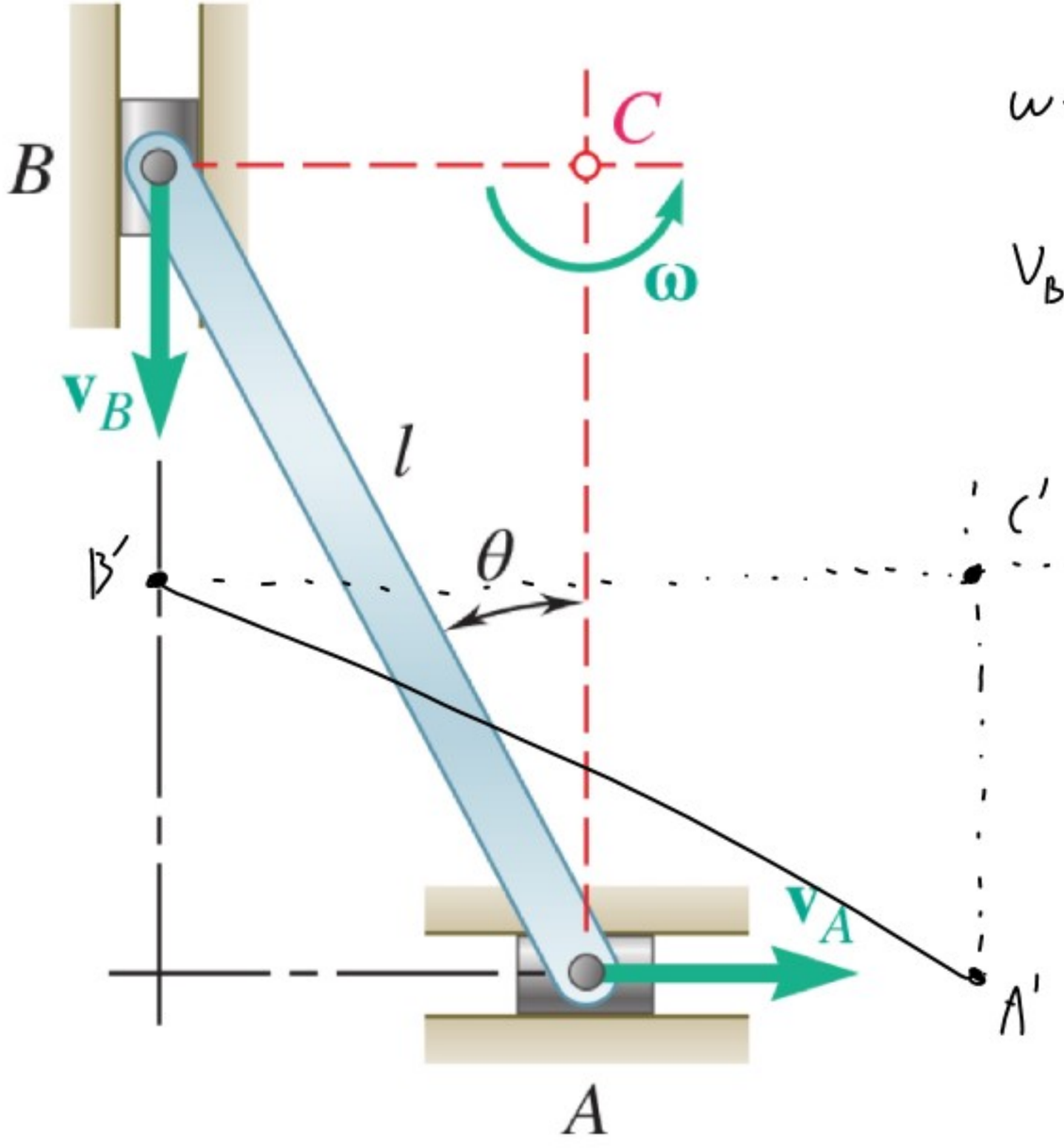




(a)

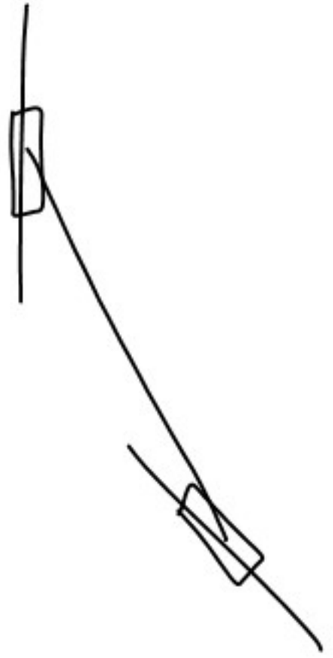


(b)

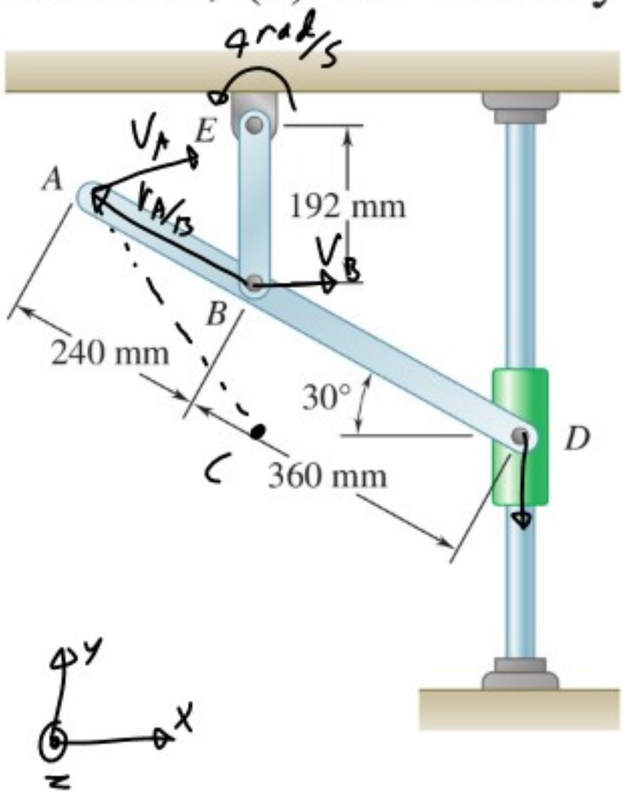


$$\omega = \frac{V_A}{AC} = \frac{V_A}{l\cos\theta}$$

$$V_B = (BC)\omega = l\sin\theta \; \frac{V_A}{l\cos\theta} = V_A \tan\theta$$



Knowing that at the instant shown the angular velocity of rod BE is 4 rad/s counterclockwise, determine (a) the angular velocity of rod AD, (b) the velocity of collar D, (c) the velocity of point A.



$$V_A = V_B + V_{A/B} = V_{13} + \omega \times r_{A/B}$$

$$= 768\,i + \begin{vmatrix} i & j & K \\ 0 & 0 & -4.27 \\ -203 & 120 & 0 \end{vmatrix} \begin{matrix} i & j \\ 0 & 0 \\ -203 & 120 \end{matrix}$$

$$= 768\,i + 4.27 \cdot 203\,j + 4.27 \cdot 120\,i$$

$$= 1280\,i + 888\,j \text{ mm/s}$$

$V_{13} = (BE)\omega$

$V_B = 192 \text{ mm} \cdot 4 \text{ rad/s} = 768 \text{ mm/s}$

$$\omega = \frac{V_B}{BC} = \frac{768 \text{ mm/s}}{360 \text{ mm} \sin 30} = 4.27 \text{ rad/s}$$

$V_D = (DC)\omega = 360 \text{ mm} \cos 30 \cdot 4.27 \text{ rad/s}$

$= 1330 \text{ mm/s}$

$r_{A/B} = -240\cos 30\,i + 240 \sin 30\,j$ mm

$= -203\,i + 120\,j$ mm

An overhead door is guided by wheels at A and B that roll in horizontal and vertical tracks. Knowing that when $\theta = 40°$ the velocity of wheel B is 1.5 ft/s upward, determine (a) the angular velocity of the door, (b) the velocity of end D of the door.