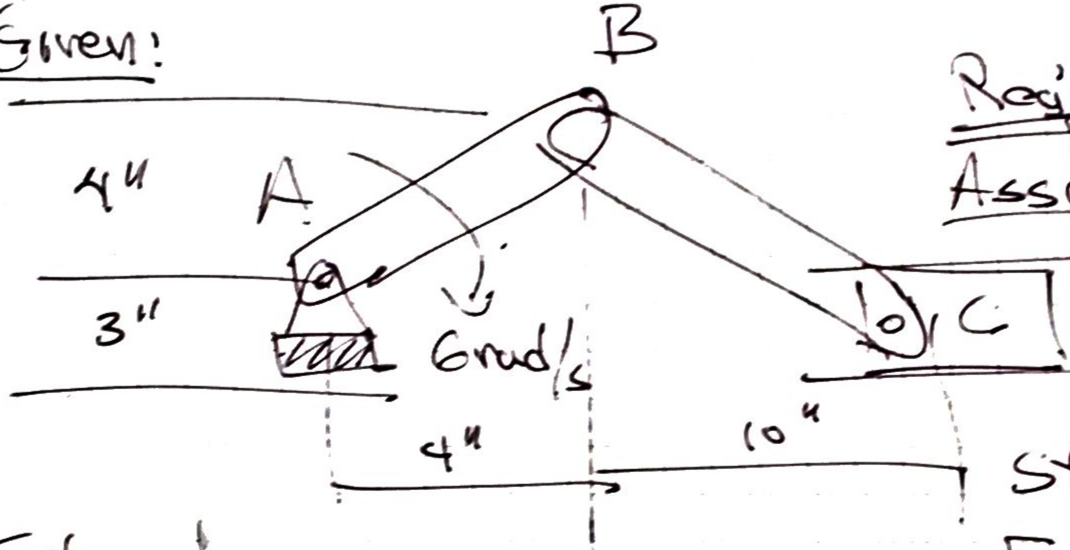
Bruce Emerson HW#/Sample ENGR212

Given:



Reqd $\bar{V}_c$

Assump – no friction
– no slop in joints
– rigid objects

Strategy: Relative motion
Find $V_{B/O}$ relative to A, the $V_{C/O}$ relative to B

Estimate

I expect $\omega_{BC} < 0$ from geometry

$r_{AB} \cong \sqrt{2}\,4'' \cong 6'' \Rightarrow V_B = 36''/s$ @ $45°$, x comp $\approx \frac{\sqrt{2}}{2} \cdot 36 \cong 26''/s$

Certainly don't expect c to move right any faster than that

V_c is pure x so $V_{c_y} = 0$

Soln:

$\bar{V}_{B/O} = \bar{V}_{A/O} + \bar{\omega} \times \bar{r}_{B/A}$ $\quad \bar{r}_{B/A} = 4''\hat{i} + 4''\hat{j}$

$V_{A/O} = 0$ $\quad \bar{\omega} = -6\,\frac{rad}{s}\,\hat{k}$ (into page)

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Soln cont

$$\bar{\omega} \times \bar{r}_{B/A} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 0 & 0 & -\omega \\ 4'' & 4'' & 0 \end{vmatrix}$$

$$\omega \times r_{B/A} = +4''\omega\hat{i} - \hat{j}(+4\omega)$$
$$= 4\omega\hat{i} - 4\omega\hat{j} = v_{B/O}$$

Step 2: $\bar{V}_{C/O} = \bar{V}_{B/O} + \bar{\omega}_{CB} \times \bar{r}_{C/B}$

$\bar{r}_{C/B} = 10''\hat{i} - 7''\hat{j}$

$\bar{\omega}_{CB} = \omega_{CB}\hat{k}$ (hard to know)

$$\bar{\omega}_{CB} \times \bar{r}_{C/B} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 0 & 0 & \omega_{CB} \\ 10'' & -7'' & 0 \end{vmatrix}$$

$$= 7\omega_{CB}\hat{i} - \hat{j}(-10''\omega_{CB})$$

$$= 7\omega_{CB}\hat{i} + 10\omega_{CB}\hat{j}$$

$$V_{C/O} = [4\omega\hat{i} - 4\omega\hat{j}] + [7\omega_{CB}\hat{i} + 10\omega_{CB}\hat{j}]$$

$$V_{C/O} = (4\omega + 7\omega_{CB})\hat{i} + (10\omega_{CB} - 4\omega)\hat{j}$$

$$10\omega_{CB} - 4\omega = 0$$

$$\Rightarrow \omega_{CB} = \frac{4''\omega}{10''} = .4(6\ \text{rad/s})$$

$$\boxed{\omega_{CB} = 2.4\ \text{rad/s}}$$

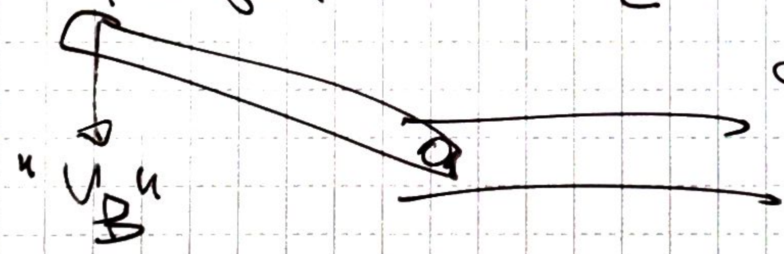
Soln: cont

$$\omega_{CB} = 2.4 \text{ rad/s}$$

$$\bar{v}_{C/O} = (4\omega + 7\omega_{CB})\,\hat{i} = \left(4''\left(6\tfrac{\text{rad}}{s}\right) + 7''\left(2.4 \text{ rad}/s\right)\right)\hat{i}$$

$$\bar{v}_{C/O} = 24''/s + 16.8''/s = \underline{40.8''/s}$$

Discussion: I'm a bit bothered because this is bigger than the x component of $\bar{v}_B$. After thinking about it I realize that even if v_B were only straight down v_C would still have an x component



due to the BC member extending down the slot. make sense (now) that it would be $v_C > 26''/s$