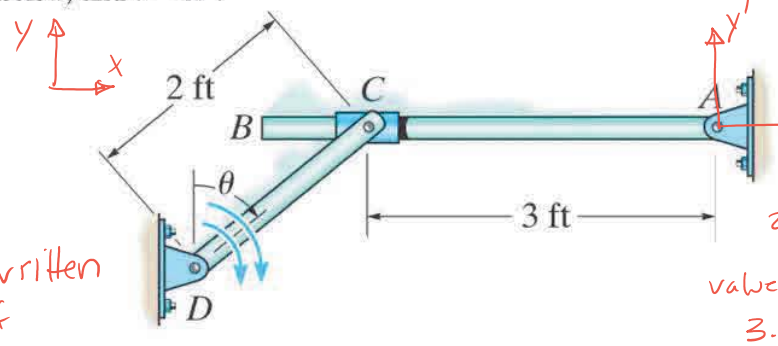
SA 1. [5 marks]

At the instant shown, collar C is sliding toward A along rod AB at 1.5 ft/s. The angular velocity of rod CD is 2 rad/s, with direction shown below, and $\theta = 45°$.



Rotating axes should be:
1. On the body experiencing the relative translation/$\vec{v}$/$\vec{a}$ (ie. AB)
2. Have origin at a pt. with some known values of $\vec{v}$ and/or $\vec{a}$ (ie. A)
3. Oriented to simplify vectors in the prob. (ie. an axis along shaft
4. A right-handed system

Reminder: All vectors must be written in terms of either x-y or x'-y' (this solution uses x-y)

a) (1 mark) Draw appropriate rotating x'-y' axes on the figure above and clearly indicate which body they are attached to.

b) (4 marks) Find the angular velocity of rod AB using rotating frame relative motion analysis.

Two equations for $\vec{v}_C$:

① $\vec{v}_C = \vec{\omega}_{CD} \times \vec{r}_{C/D}$

$\therefore \vec{v}_C = (-2\sqrt{2}\,\hat{j} + 2\sqrt{2}\,\hat{i})$ ft/s

$\vec{\omega}_{CD} = -2 \text{ rad/s}\,\hat{k}$

$\vec{r}_{CD} = \left(\frac{2}{\sqrt{2}}\hat{i} + \frac{2}{\sqrt{2}}\hat{j}\right)$ ft

② $\vec{v}_C = \vec{v}_A + \vec{\Omega}_{AB} \times \vec{r}_{C/A} + (\vec{v}_{C/A})_{x'y'z'}$

$\vec{v}_C = (0 - 3\Omega_{AB}\hat{j} + 1.5\hat{i})$ ft/s

$\vec{v}_A = 0$

$\vec{\Omega}_{AB} = \Omega_{AB}\,\hat{k}$

$\vec{r}_{C/A} = -3 \text{ ft}\,\hat{i}$

$(\vec{v}_{C/A})_{x'y'z'} = 1.5 \text{ ft/s}\,\hat{i}$

Equate ① + ②, examine components:

$\hat{j}$: $-2\sqrt{2} = -3\Omega_{AB}$

$\Rightarrow \Omega_{AB} = \frac{2\sqrt{2}}{3} \text{ rad/s} = 0.943 \text{ rad/s}$

$\vec{\Omega}_{AB} = 0.943 \frac{\text{rad}}{\text{s}}\,\hat{k}$