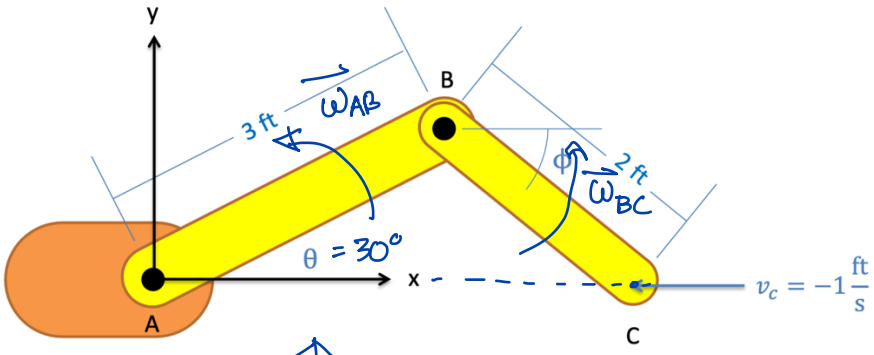
The robotic arm from the previous problem is in the configuration shown below. Assume that theta is currently 30 degrees and that point C currently lies along the x axis. If we want the end effector at C to travel 1 ft/s in the negative x direction, what should the angular velocities be at joints A and B?



Find $\vec{\omega}_{AB}$ & $\vec{\omega}_{BC}$

Known:

$\vec{v}_A = 0$

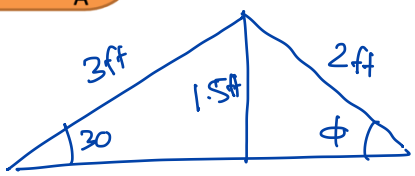
$\vec{v}_C = -1\ ft/s\ \hat{\imath}$

$\vec{r}_{B/A} = 3(\cos 30\hat{\imath} + \sin 30\hat{\jmath})\ ft$

Assume positive

$\vec{\omega}_{AB} = \omega_{AB}\hat{k}$

$\vec{\omega}_{BC} = \omega_{BC}\hat{k}$



$2\ ft \sin\phi = 1.5\ ft$

$\Rightarrow \phi = 48.6°$

$\vec{r}_{C/B} = 2(\cos 48.6\hat{\imath} - \sin 48.6\hat{\jmath})\ ft$

$\vec{v}_B = \cancel{\vec{v}_A}^{\,0} + \vec{\omega}_{AB} \times \vec{r}_{B/A}$

$\vec{v}_C = \vec{v}_B + \vec{\omega}_{BC} \times \vec{r}_{C/B}$

$= \vec{\omega}_{AB} \times \vec{r}_{B/A} + \vec{\omega}_{BC} \times \vec{r}_{C/B}$

$-1\ ft/s\,\hat{\imath} = \omega_{AB}\hat{k} \times (3\cos 30\hat{\imath} + 3\sin 30\hat{\jmath})\ ft + \omega_{BC}\hat{k} \times (2\cos 48.6\hat{\imath} - 2\sin 48.6\hat{\jmath})\ ft$

from $\hat{\jmath}$: $-3\,\omega_{AB}\cos 30 = 2\,\omega_{BC}\cos 48.6$

$\Rightarrow \omega_{AB} = \dfrac{-2\cos 48.6}{3\cos 30}\,\omega_{BC} = -0.51\,\omega_{BC}$