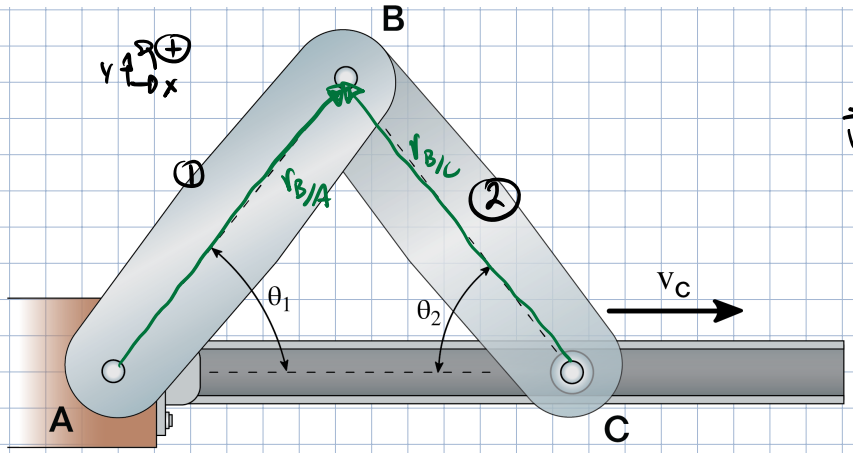
Two linkages AB and BC are pinned together. Linkage AB is pinned at A meanwhile linkage BC can only slide horizontally at C. If $V_C = 1\ m/s$, what is the relative velocity of B with respect to C ($V_{B/C}$)? Assume the linkages are of equal length $l = 1m$ and at an angle of $\theta = 30\ deg$ with the horizontal.



$\vec{V}_C = 1\ m/s\ \hat{i}$

① $\vec{V}_B = \vec{\omega}_{AB} \times \vec{r}_{B/A} = |\vec{\omega}_{AB}|(-\hat{k}) \times (1\cos 30^\circ \hat{i} + 1\sin 30^\circ \hat{j})$

$= |\vec{\omega}_{AB}|(\sin 30^\circ \hat{i} - \cos 30^\circ \hat{j})$

② $\vec{V}_B = \vec{V}_C + \vec{\omega}_{BC} \times \vec{r}_{B/C} = (1\ m/s\ \hat{i}) + |\vec{\omega}_{BC}|(\hat{k}) \times (-1\cos 30^\circ \hat{i} + 1\sin 30^\circ \hat{j})$

$= (1\hat{i}) + |\vec{\omega}_{BC}|(-\sin 30^\circ \hat{i} - \cos 30^\circ \hat{j})$

① $\vec{V}_B$ − ② $\vec{V}_B$ ⇒ $|\vec{\omega}_{AB}| \sin 30^\circ \hat{i} = -|\vec{\omega}_{BC}| \sin 30^\circ \hat{i} + 1\hat{i}$

$-|\vec{\omega}_{AB}| \cos 30^\circ \hat{j} = -|\vec{\omega}_{BC}| \cos 30^\circ \hat{j}$

∴ $|\vec{\omega}_{AB}| = |\vec{\omega}_{BC}|$

∴ $\vec{\omega}_{AB} = -\vec{\omega}_{BC}$

∴ $|\vec{\omega}_{AB}| = \frac{1}{2\sin 30^\circ} = 1\ rad/s$

$$\vec{\omega}_{AB} = -\vec{\omega}_{BC} = -1 \text{ rad/s}\ \hat{k}$$

$$\vec{v}_B = \vec{\omega}_{AB} \times \vec{r}_{B/A} = |\vec{\omega}_{AB}|\ (-\hat{k}) \times (1\cos 30^\circ \hat{i} + 1 \sin 30^\circ \hat{j}) = |\vec{\omega}_{AB}|\ (\sin 30^\circ \hat{j} - \cos 30^\circ \hat{i})$$

($|\vec{\omega}_{AB}|$: 1 rad/s)

$$\vec{v}_{B/C} = \vec{v}_B - \vec{v}_C = (1 \text{ rad/s})(\sin 30^\circ \hat{j} - \cos 30^\circ \hat{i}) - (1 \text{ m/s}\ \hat{i})$$

$$\boxed{\vec{v}_{B/C} = -0.5\hat{i} - 0.866\hat{j} \text{ m/s}}$$