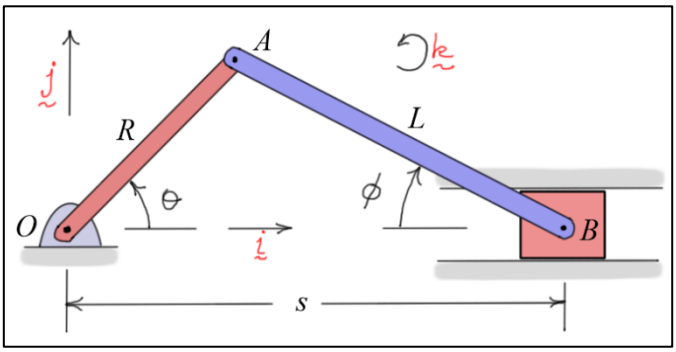
Elementary Dynamics Example #34: (Rigid Body Kinematics – Instantaneous Centers)

Given: $R = 3$ (in), $L = 6$ (in), $\theta = 30$ (deg)

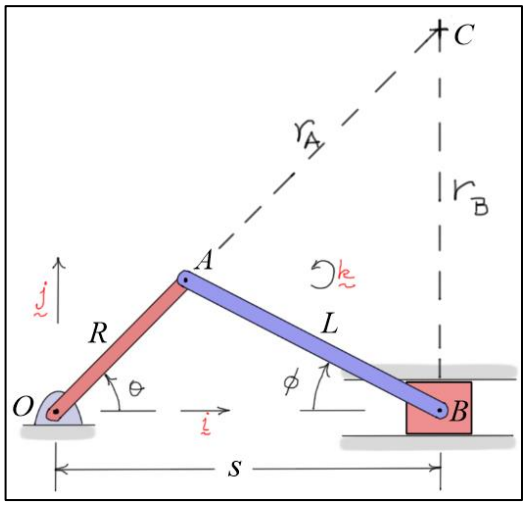
$\omega_{OA} = \dot{\theta} = 100$ (rpm) (CCW)

Find: ω_{AB}, $v_B = \dot{s}$



Solution:

To find the instantaneous center (IC) for the connecting link *AB* construct a line perpendicular to the velocity of *A*, and construct a second line perpendicular to the velocity of *B*. The intersection of these two lines is the IC of *AB* and is shown as point *C* on the diagram.



Using the triangle *OAB*, write

$$R\sin(\theta) = L\sin(\phi)$$

$$\Rightarrow \boxed{\phi = \sin^{-1}\left(\left(\frac{R}{L}\right)\sin(\theta)\right) = 14.4775 \text{ (deg)}}$$

and

$$\boxed{s = R\cos(\theta) + L\cos(\phi) = 8.40755 \text{ (in)}}$$

Using the right-triangle OBC, write

$$\left(R + r_A\right)\cos(\theta) = s \quad \Rightarrow \boxed{r_A = \left(\frac{s}{\cos(\theta)}\right) - R = 6.7082 \text{ (in)}}$$

$$\frac{r_B}{s} = \tan(\theta) \quad \Rightarrow \boxed{r_B = s\tan(\theta) = 4.8541 \text{ (in)}}$$

Velocity Analysis:

$$\left.\begin{array}{l} v_A = R\,\omega_{OA} = r_A\,\omega_{AB} \\ \Rightarrow \boxed{\omega_{AB} = \left(\frac{R}{r_A}\right)\omega_{OA} = 4.68321 \approx 4.68 \text{ (r/s) (CW)}} \end{array}\right\} \Rightarrow \boxed{\underset{\sim}{\omega}_{AB} = -4.68\,\underset{\sim}{k} \text{ (r/s)}}$$

$$\boxed{v_B = r_B\,\omega_{AB} = 22.7328 \approx 22.7 \text{ (in/s) to the left}} \quad \boxed{\underset{\sim}{v}_B \approx -22.7\,\underset{\sim}{i} \text{ (in/s)} \approx -1.89\,\underset{\sim}{i} \text{ (ft/s)}}$$

Note:

As noted in the previous example, the analyst must determine the directions (or signs) of the calculated motions.