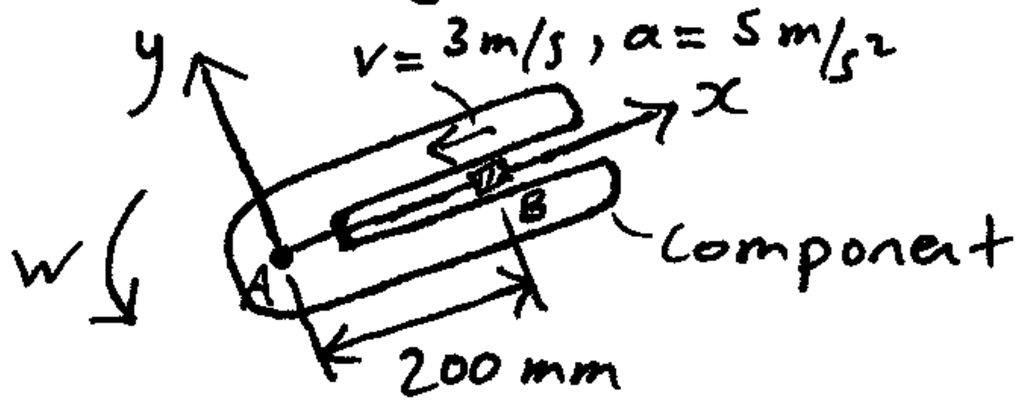
April 6, 2020

This is a 2D relative-motion analysis problem involving rotating axes (engineering mechanics).



A block B is moving along a slot at a velocity of 3 m/s relative to the slot and at an acceleration of 5 m/s² relative to the slot, in the direction shown. The componeat containing the slot is rotating about point A at a constant angular velocity of $w = 6$ rad/s. Determine the acceleration of the block B's at the instant shown.

Solution:

$$\vec{a}_B = \vec{a}_A + \vec{\alpha} \times \vec{r}_{B/A} + \vec{w} \times (\vec{w} \times \vec{r}_{B/A}) + 2\vec{w} \times (\vec{v}_{B/A})_{rel} + (\vec{a}_{B/A})_{rel} \quad (I)$$

$\vec{a}_A = 0$ (Fixed pivot point)

$\vec{\alpha} = 0$ (Since $\vec{w}$ is constant)

$\vec{w} = 6\hat{k}$ rad/s

$\vec{r}_{B/A} = 200\hat{i}$ mm $= 0.2\hat{i}$ m

$(\vec{v}_{B/A})_{rel} = -3\hat{i}$ m/s

$(\vec{a}_{B/A})_{rel} = -5\hat{i}$ m/s²

Substitute given quantities into equation (I):

$$\vec{a}_B = 0 + 0 + 6\hat{k} \times (6\hat{k} \times 0.2\hat{i}) + 2(6\hat{k}) \times (-3\hat{i})$$

$$-5\hat{i}$$

$$\vec{a}_B = 6\hat{k} \times (1.2\hat{j}) - 36\hat{j} - 5\hat{i}$$

$$\vec{a}_B = -7.2\hat{i} - 36\hat{j} - 5\hat{i}$$

$$\vec{a}_B = -12.2\hat{i} - 36\hat{j} \quad m/s^2$$