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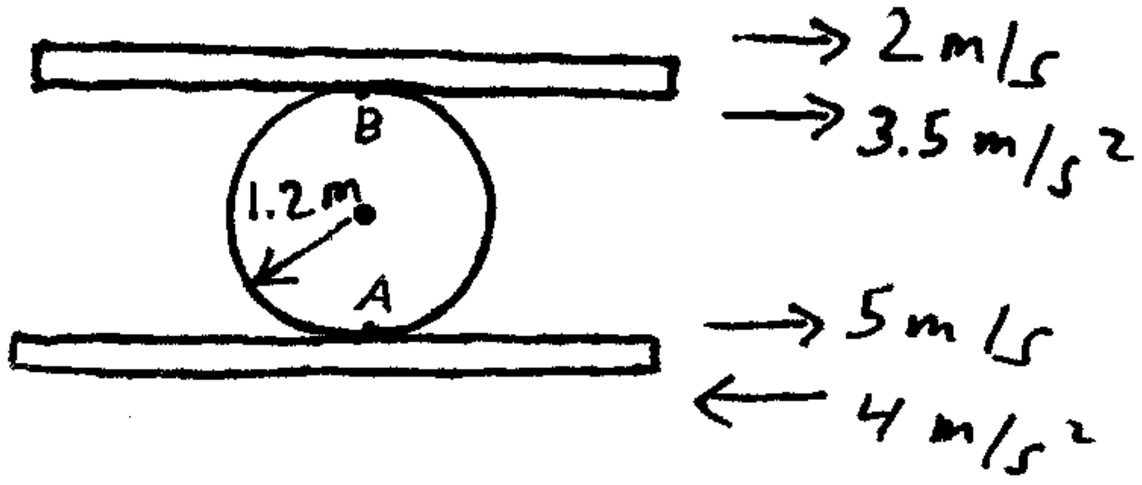
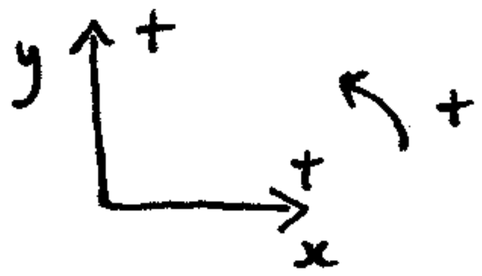
April 20, 2020

This is a 2D relative-motion problem involving acceleration (engineering mechanics).



At the instant shown, a cylinder is supported between two boards, and each board is moving with the velocity and acceleration shown. Determine the angular velocity and angular acceleration of the cylinder.

Solution:



coordinate frame

We must assume there is no slipping between the cylinder and boards.

First,

$$\left.\vec{v}_B = \vec{v}_A + \vec{w} \times \vec{r}_{B/A}\right\} \text{for cylinder}$$

Substitute known quantities:

$$2\hat{i} = 5\hat{i} + w\hat{k} \times 2.4\hat{j}$$

$$2\hat{i} = 5\hat{i} - 2.4w\hat{i}$$

$$\Rightarrow w = 1.25 \text{ rad/s} \curvearrowleft \quad \text{(answer)}$$

Next, $\vec{a}_B = \vec{a}_A + \vec{\alpha} \times \vec{r}_{B/A}$ ← For cylinder

Substitute known quantities:

$3.5\hat{i} = -4\hat{i} + \alpha\hat{k} \times 2.4\hat{j}$

$3.5\hat{i} = -4\hat{i} - 2.4\alpha\hat{i}$

$\Rightarrow \quad \alpha = -3.125 \text{ rad/s}^2$

(or 3.125 rad/s^2 ↷)

(answer)

← leave out the centripetal acceleration component, since only tangential component of acceleration of cylinder to be equated to board acceleration, at point of contact.