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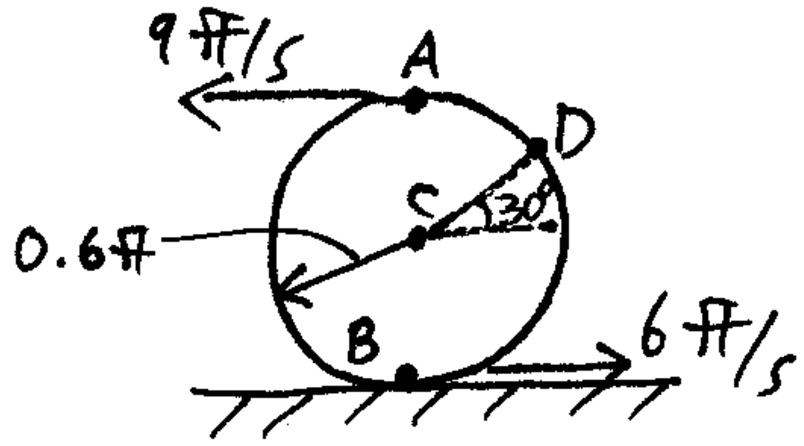
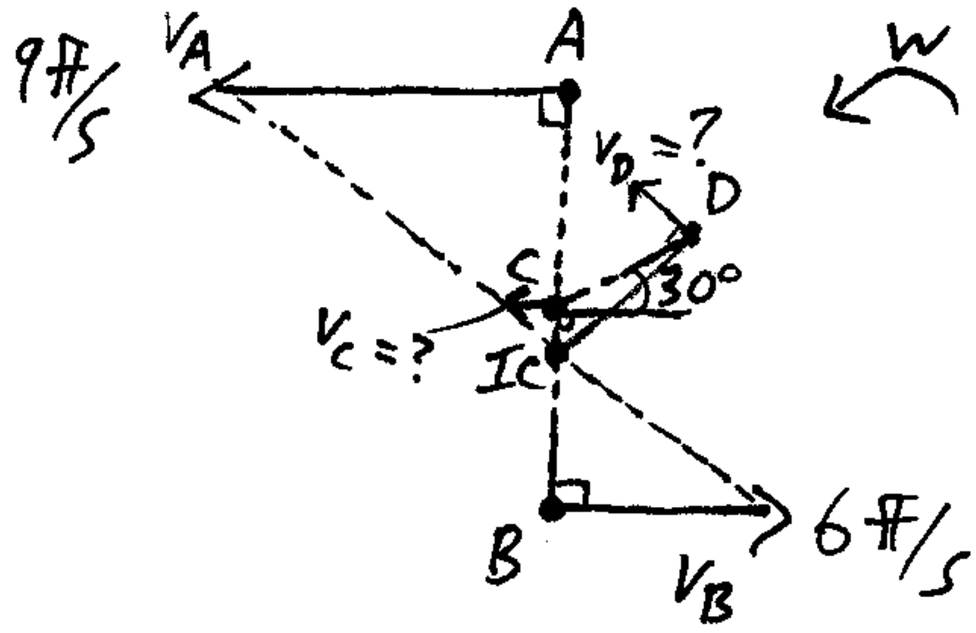
March 30, 2020

This is a problem involving instant center (engineering mechanics).



A wheel rolls with slipping on a surface, and as a result, the top and bottom of the wheel have a velocity of 9 ft/s and 6 ft/s, respectively. Determine the velocity of the center C and point D on the wheel.

Solution:



By similar triangles, $\frac{v_A}{0.6\,\text{ft} + r_{C/IC}} = \frac{v_B}{0.6\,\text{ft} - r_{C/IC}}$

Substitute known values and solve for $r_{C/IC}$:

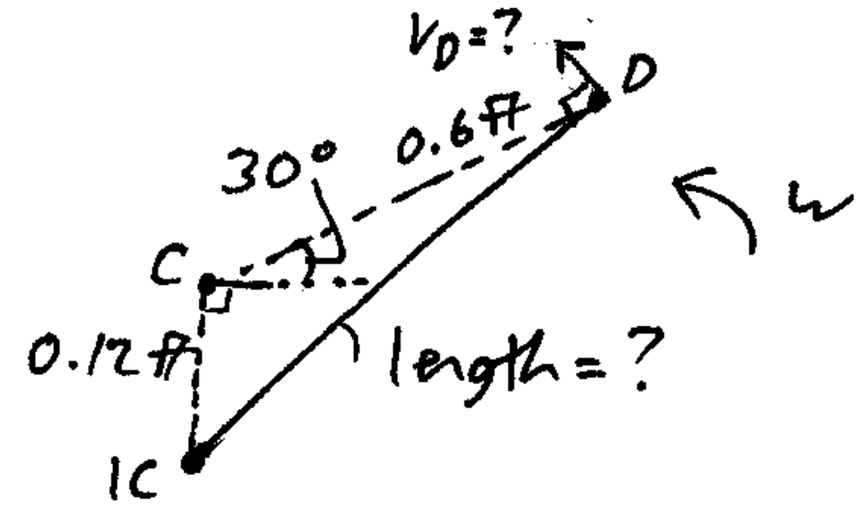
$$\frac{9\ \text{ft/s}}{0.6\,\text{ft} + r_{C/IC}} = \frac{6}{0.6\,\text{ft} - r_{C/IC}}, \quad r_{C/IC} = 0.12\ \text{ft}$$

$$w = \frac{9\ \text{ft/s}}{0.6\,\text{ft} + r_{C/IC}} = 12.5\ \text{rad/s}$$

$$v_c = \omega r_{c/ic} = (12.5\ rad/s)(0.12\ ft) = 1.5\ ft/s$$

(answer)

Next, Find the length between IC and point D



By the law of cosines:

$$(length)^2 = 0.12^2 + 0.6^2 - 2(0.12)(0.6)\cos(90° + 30°)$$

$$length = 0.668\ ft$$

Therefore, $v_D = (0.668)\omega = (0.668)(12.5) = 8.35\ ft/s$

(answer)