

Rigid Body Kinematics II – Problem 2

At the instant shown the angular velocity of BC is 2 rad/second clockwise. Wheel A is a rolling no-slip wheel. Classify the motion of each rigid body in the figure, and determine the angular velocity of Wheel A. The radius of Wheel A is 1".

CLASSIFY MOTION

- BC - RRA
- AB - GPM
- WHEEL A - GPM

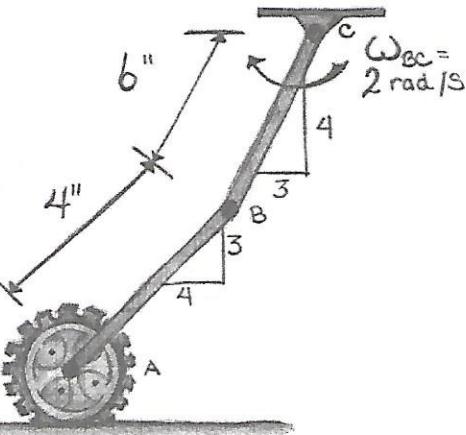
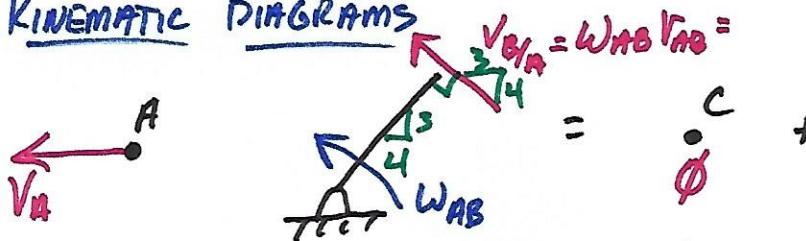
VELOCITY EQNS (CHOOSE PT "B")

$$\vec{V}_B = \vec{V}_A + \vec{V}_{B/A}$$

$$\vec{V}_B = \vec{V}_C + \vec{V}_{B/C}$$

COMBINING

$$\vec{V}_A + \vec{V}_{B/A} = \vec{V}_C + \vec{V}_{B/C}$$

KINEMATIC DIAGRAMS


$$\vec{V}_{B/A} = \omega_{AB} r_{AB} = \frac{3}{4} \cdot 2 \cdot 4 = 6 \text{ ips}$$

$$\vec{V}_{B/C} = \omega_{BC} r_{BC} = 2 \cdot 6 = 12 \text{ ips}$$

$$\leftarrow \sum x: V_A + \frac{3}{5} V_{B/A} = 0 + \frac{4}{5} V_{B/C}$$

$$\uparrow \sum y: 0 + \frac{4}{5} V_{B/A} = 0 + \frac{3}{5} V_{B/C}$$

$$\frac{4}{5} V_{B/A} = \frac{3}{5} (12) \Rightarrow V_{B/A} = 9 \text{ ips}$$

NO SLIP WHEEL

$$V_A = \omega_{wh} r_{wh} \Rightarrow$$

$$V_A = \frac{3}{5}(9) = \frac{4}{5}(12)$$

$$\underline{\underline{V_A = 4.2 \text{ ips}}}$$

$$4.2 = \omega_{wh} (1) \Rightarrow \underline{\underline{\omega_{wh} = 4.2 \text{ rps}}}$$

Rigid Body Kinematics II – Problem 2 ALTERNATE SOLUTION

At the instant shown the angular velocity of BC is 2 rad/second clockwise. Wheel A is a rolling no-slip wheel. Classify the motion of each rigid body in the figure, and determine the angular velocity of Wheel A. The radius of Wheel A is 1".

CLASSIFY MOTION

BC - RAFA

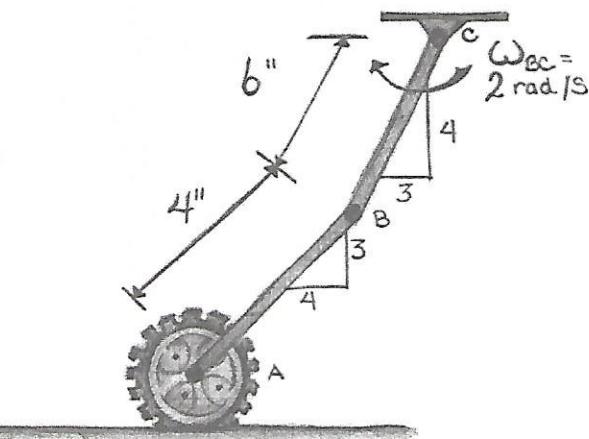
AB - GPM

WHEEL A - GPM

VELOCITY EQNS CHOOSE PT "A"

$$\vec{V}_A = \vec{V}_{pc} + \vec{V}_{A/pc}$$

$$\vec{V}_A = \vec{V}_B + \vec{V}_{A/B}$$

COMBINING


$$\vec{V}_{pc} + \vec{V}_{A/pc} = \vec{V}_B + \vec{V}_{A/B}$$

Point O: $\omega_{wh} = \omega_{wh}(1)$
 Point B: $\omega_{Bi} = 2 \text{ rps}$
 $v_B = \omega_{Bi} r_{Bi} = (2)(6) = 12$
 $v_{A/B} = 4\omega_{BA}$

$$\leftarrow \sum X \quad 0 + v_{A/pc} = \frac{4}{5}v_B + \frac{3}{5}v_{A/B}$$

$$\omega_{wh}(1) = \frac{4}{5}(12) + \frac{3}{5}(4\omega_{BA})$$

$$\uparrow \sum Y \quad 0 + 0 = \frac{3}{5}(12) + \frac{4}{5}(4\omega_{BA})$$

$$\omega_{BA} = -2.25 = 2.25 \text{ rps} \uparrow$$

$$\omega_{wh} = 4.2 \text{ rps} \uparrow$$

$$V_A = \omega_{wh}(1) = 4.2(1) = 4.2 \text{ in/s} \leftarrow$$