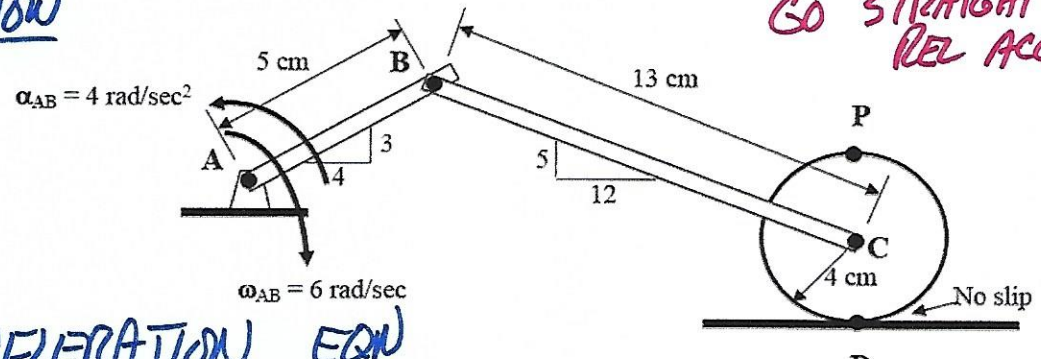
Rigid Body Kinematics III – Problem 4

The angular velocity of link AB is 6 rad/sec clockwise and its angular acceleration is 4 rad/sec^2 counterclockwise. Wheel D rolls without slipping on the horizontal plane. Determine the angular acceleration of the wheel and the acceleration of point P on the wheel. $\omega_{BC} = 2$ rps CCW and $\omega_{WH} = 7$ rps CW.

ALL ωs KNOWN GO STRAIGHT TO REL ACCEL

CLASSIFY MOTION

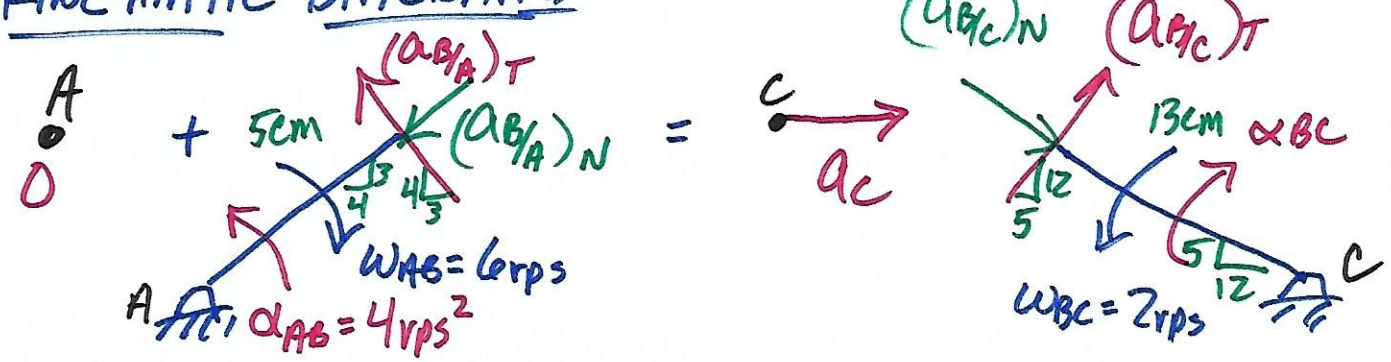
AB RAFA
BC GPM
WH GPM



RELATIVE ACCELERATION EQN

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

KINEMATIC DIAGRAMS



NOTES

$(a_{B/A})_T = \alpha_{AB} r_{AB} = 4(5) = 20$ $\quad (a_{B/C})_T = \alpha_{BC} r_{BC} = 13\alpha_{BC}$

$(a_{B/A})_N = \omega_{AB}^2 r_{AB} = 6^2(5) = 180$ $\quad (a_{B/C})_N = \omega_{BC}^2 r_{BC} = 2^2(13) = 52$

SCALAR EQNS

$$\rightarrow x \quad 0 - \tfrac{3}{5}(20) - \tfrac{4}{5}(180) = a_C + \tfrac{5}{13}(13\alpha_{BC}) + \tfrac{12}{13}(52)$$

$$\uparrow y \quad 0 + \tfrac{4}{5}(20) - \tfrac{3}{5}(180) = 0 + \tfrac{12}{13}(13\alpha_{BC}) - \tfrac{5}{13}(52)$$

Rigid Body Kinematics III – Problem 4 (Continued)

SOLVING $\alpha_{BC} = 6\ rps^2 \curvearrowleft$ $a_C = 174\ cm/s^2 \leftarrow$

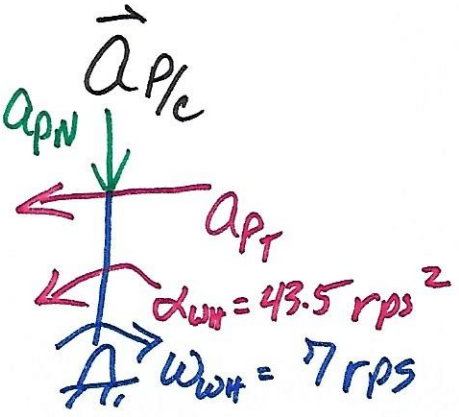
NO SLIP WHEEL

$a_C = \alpha_{WH} r_{WH}$ $\quad \alpha_{WH} = \dfrac{a_C}{r_{WH}} = \dfrac{174}{4} = 43.5\ rps^2 \curvearrowleft$

POINT P

REL ACCEL $\vec{a}_P = \vec{a}_C + \vec{a}_{P/C}$

$\vec{a}_P =$ C $\leftarrow 174\ cm/s^2$ $+$



NOTES $a_{P_T} = \alpha_{WH} r_{P/C} = 43.5(4)$

$a_{P_N} = \omega_{WH}^2 r_{P/C} = (7)^2(4)$

SCALAR EQNS

$\rightarrow x$ $\quad a_{P_x} = -174 - 43.5(4)$ $\quad a_{P_x} = 348\ cm/s^2 \leftarrow$

$\uparrow y$ $\quad a_{P_y} = 0 - (7)^2(4)$ $\quad a_{P_y} = 196\ cm/s^2 \downarrow$

$$\vec{a}_P = \{-348 \ -196\}\ cm/s^2$$