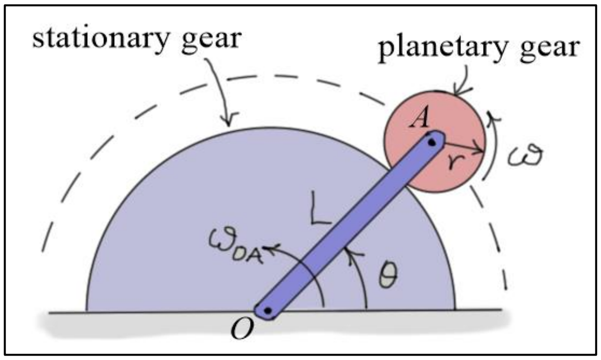
Elementary Dynamics Example #33: (Rigid Body Kinematics – Instantaneous Centers)



Given: L, r, ω_{OA} (ω_{OA} is the angular rate of bar OA)

planetary gear rolls without slipping on the stationary gear

Find: ω, the angular rate of the planetary gear

Solution:

Link OA rotates about point O, so the velocity of A is along the dashed circular path with magnitude

$v_A = L\omega_{OA}$ (motion up and to the left for $\omega_{OA} > 0$)

The instantaneous center of the planetary gear is at the contact point with the stationary gear. So, as the planetary gear rolls on the surface of the stationary gear, the velocity of A, the center of the gear, can be written as

$v_A = r\,\omega$ (motion is up and to the left for $\omega > 0$)

Equating the two velocities and solving for ω gives

$\boxed{\omega = \left(\frac{L}{r}\right)\omega_{OA}}$ (both angular rates are counterclockwise (CCW))

Note:

When using the concept of instantaneous centers of zero velocity, the analyst must determine the directions (or signs) of the resulting motions because this is a scalar method. Compare this method to the concept of relative velocity which is a vector method. When using the concept of relative velocity, the directions (or signs) of the motions were found by solving the scalar equations associated with the relative velocity equation.