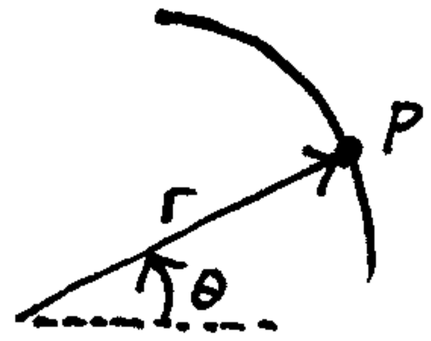
March 21, 2020

This is a curvilinear motion problem involving radial and transverse components (engineering mechanics).



For a short distance, a particle P travels along a path defined by $r = \frac{200}{\theta}$ m, where θ is in radians. If $\dot{\theta}$ is constant and equal to 0.3 rad/s, calculate the radial and transverse components of the velocity and acceleration of the particle when $\theta = \frac{5\pi}{4}$ radians.

Solution: Note that $\ddot{\theta} = 0$ since $\dot{\theta}$ is constant $\dot{\theta} = 0.3$ rad/s

$v_r = \dot{r} = -\frac{200}{\theta^2} \cdot \dot{\theta}$, at $\theta = \frac{5\pi}{4}$, $v_r = -3.9$ m/s (ans.)

$v_\theta = r\dot{\theta} = \frac{200}{\theta} \cdot \dot{\theta}$, at $\theta = \frac{5\pi}{4}$, $v_\theta = 15.3$ m/s (ans.)

$a_r = \ddot{r} - r\dot{\theta}^2 = \frac{400}{\theta^3} \cdot \dot{\theta}^2 - \frac{200}{\theta} \cdot \dot{\theta}^2$, at $\theta = \frac{5\pi}{4}$, (ans.) $a_r = -4.0$ m/s^2

$a_\theta = r\ddot{\theta} + 2\dot{r}\dot{\theta} = -\frac{400}{\theta^2} \cdot \dot{\theta}^2$, at $\theta = \frac{5\pi}{4}$, $a_\theta = -2.3$ m/s^2 (ans.)