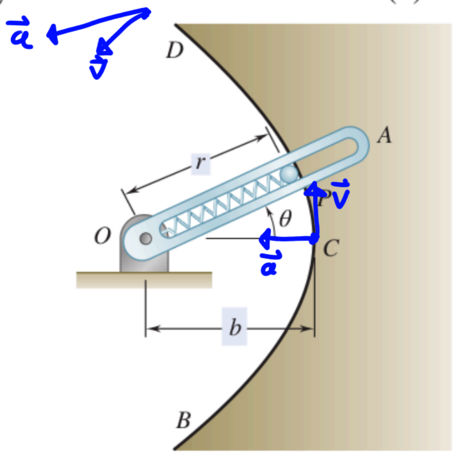
As rod OA rotates, pin P moves along the parabola BCD. Knowing that the equation of this parabola is $r = 2b/(1 + \cos\theta)$ and that $\theta = kt$, determine the velocity and acceleration of P when (*a*) $\theta = 0$, (*b*) $\theta = 90°$.



$\theta = kt \qquad \frac{d\theta}{dt} = k \qquad \frac{d^2\theta}{dt^2} = 0$

$r = \frac{2b}{1+\cos\theta}$

$r = \frac{2b}{1+\cos kt} \qquad \frac{dr}{dt} = \frac{2bk\sin kt}{(1+\cos kt)^2}$

$\frac{d^2r}{dt^2} = 2b\left(\frac{k^2\cos kt}{(1+\cos kt)^2} + \frac{2k^2\sin^2 kt}{(1+\cos kt)^3}\right)$

$\theta = 0 \qquad kt = 0$

$r = \frac{2b}{1+\cos 0} = \frac{2b}{1+1} = b$

$\frac{dr}{dt} = \frac{2bk\sin 0}{(1+\cos 0)^2} = 0$

$\frac{d^2r}{dt^2} = 2b\left(\frac{k^2\cos 0}{(1+\cos 0)^2} + \cancel{\frac{2k^2\sin^2 0}{(1+\cos 0)^3}}\right) \to 0$

$= 2b\frac{k^2}{(1+1)^2} = \frac{2bk^2}{4} = \frac{bk^2}{2}$

$\vec{v} = \frac{dr}{dt}\vec{e}_r + r\frac{d\theta}{dt}\vec{e}_\theta$

$= 0\vec{e}_r + bk\vec{e}_t = bk\vec{e}_\theta$

$\vec{a} = \left(\frac{d^2r}{dt^2} - r\left(\frac{d\theta}{dt}\right)^2\right)\vec{e}_r + \left(r\frac{d^2\theta}{dt^2} + 2\frac{dr}{dt}\frac{d\theta}{dt}\right)\vec{e}_\theta$

$= \left(\frac{bk^2}{2} - bk^2\right)\vec{e}_r + (b0 + 2\cdot 0\cdot k)\vec{e}_\theta$

$= -\frac{bk^2}{2}\vec{e}_r$

$\theta = 90° \qquad kt = 90°$

$r = \frac{2b}{1+\cos 90°} = \frac{2b}{1} = 2b$

$\frac{dr}{dt} = \frac{2bk\sin 90°}{(1+\cos 90°)^2} = 2bk$

$\frac{d^2r}{dt} = 2b\left(\cancel{\frac{k^2\cos 90°}{(1+\cos 90°)^2}} + \frac{2k^2\sin^2 90°}{(1+\cos 90°)^3}\right) \to 0$

$= 2b\frac{2k^2}{1} = 4bk^2$

$\vec{v} = \frac{dr}{dt}\vec{e}_r + r\frac{d\theta}{dt}\vec{e}_\theta$

$= 2bk\vec{e}_r + 2bk\vec{e}_\theta$

$\vec{a} = \left(\frac{d^2r}{dt^2} - r\left(\frac{d\theta}{dt}\right)^2\right)\vec{e}_r + \left(r\frac{d^2\theta}{dt^2} + 2\frac{dr}{dt}\frac{d\theta}{dt}\right)\vec{e}_\theta$

$= (4bk^2 - 2bk^2)\vec{e}_r + (2b\cdot 0 + 2\cdot 2bk\,k)\vec{e}_\theta$

$= 2bk^2\vec{e}_r + 4bk^2\vec{e}_\theta$