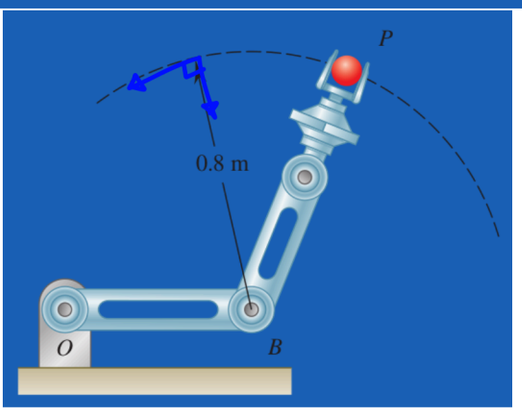
A robot arm moves so that P travels in a circle about point B, which is not moving. Knowing that P starts from rest, and its speed increases at a constant rate of 10 mm/s^2, determine (a) the magnitude of the acceleration when $t = 4$ s, (b) the time for the magnitude of the acceleration to be 80 mm/s^2.



$$\vec{a} = \frac{dv}{dt}\vec{e}_t + \frac{v^2}{r}\vec{e}_n \qquad \frac{dv}{dt} = 10\ \text{mm/s}^2$$

$$= 10\ \text{mm/s}^2\,\vec{e}_t + \frac{(40\ \text{mm/s})^2}{800\ \text{mm}}\vec{e}_n \qquad v = \cancel{v_0}^{\,0} + at$$

$$= 10\ \text{mm/s}^2\,\vec{e}_t + 2\ \text{mm/s}^2\,\vec{e}_n \qquad = 10\ \text{mm/s}^2\ 4\text{s} = 40\ \text{mm/s}$$

$$|\vec{a}| = \sqrt{10^2 + 2^2} = \boxed{10.2\ \text{mm/s}^2} \qquad r = 0.8\ \text{m}\left(\frac{1000\ \text{mm}}{1\ \text{m}}\right) = 800\ \text{mm}$$

$$\vec{a} = \frac{dv}{dt}\vec{e}_t + \frac{v^2}{r}\vec{e}_n$$

$$|\vec{a}| = \sqrt{\left(\frac{dv}{dt}\right)^2 + \left(\frac{v^2}{r}\right)^2}$$

$$80\ \text{mm/s}^2 = \sqrt{(10\ \text{mm/s}^2)^2 + \left(\frac{v^2}{800\ \text{mm}}\right)^2}$$

$$(80\ \text{mm/s}^2)^2 = (10\ \text{mm/s}^2)^2 + \left(\frac{v^2}{800\ \text{mm}}\right)^2$$

$$(80\ \text{mm/s}^2)^2 - (10\ \text{mm/s}^2)^2 = \left(\frac{v^2}{800\ \text{mm}}\right)^2$$

$$\sqrt{(80\ \text{mm/s}^2)^2 - (10\ \text{mm/s}^2)^2} = \frac{v^2}{800\ \text{mm}}$$

$$800\ \text{mm}\sqrt{(80\ \text{mm/s}^2)^2 - (10\ \text{mm/s}^2)^2} = v^2$$

$$\sqrt{800\ \text{mm}\sqrt{(80\ \text{mm/s}^2)^2 - (10\ \text{mm/s}^2)^2}} = v = 252\ \text{mm/s}$$

$$v = \cancel{v_0}^{\,0} + at \quad \Rightarrow \quad v = at$$

$$\frac{v}{a} = t \qquad \frac{252\ \text{mm/s}}{10\ \text{mm/s}^2} = \boxed{25.2\ \text{s}}$$