

Elementary Dynamics Example #6: (2D Motion, Normal & Tangential Components)

Given: $R = 200$ (ft), $d = 12$ (ft)

at B : $v = 35$ (mph); $\dot{v} = 15$ (ft/s 2)

Find: v_B and a_B in ft/s and ft/s 2 using **normal** and **tangential** components.

Solution:

Velocity:

$$v = \left[35 \frac{\text{mi}}{\text{hr}} \right] \left[\frac{1 \text{ hr}}{3600 \text{ sec}} \right] \left[\frac{5280 \text{ ft}}{1 \text{ mi}} \right] \approx 51.3 \text{ (ft/s)} \Rightarrow \boxed{v_B = 51.3 e_t \text{ (ft/s)}}$$



Acceleration:

$$a_t = \dot{v} = 15 \text{ (ft/s}^2\text{)} \quad a_n = \frac{v^2}{R} = \frac{51.3^2}{200} \approx 13.1756 \approx 13.2 \text{ (ft/s}^2\text{)}$$

$$a_B = 15 e_t + 13.2 e_n \text{ (ft/s}^2\text{)} \Rightarrow |a_B| = \sqrt{a_t^2 + a_n^2} \approx 19.9649 \approx 20.0 \text{ (ft/s}^2\text{)}$$

Aside: Since the motion at B is **circular**,

$$d = R\theta \Rightarrow v = \dot{d} = R\dot{\theta} \Rightarrow \boxed{\dot{\theta} = v/R \approx 0.257 \text{ (rad/s)}}$$

$$a_t = \dot{v} = \ddot{d} = R\ddot{\theta} \Rightarrow \boxed{\ddot{\theta} = \dot{v}/R \approx 0.075 \text{ (rad/s}^2\text{)}}$$