

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

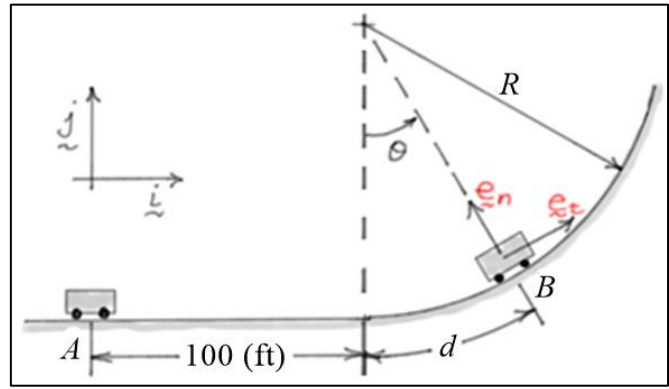
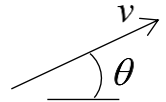
Given: $R = 200$ (ft), $d = 12$ (ft)
 at B : $v = 35$ (mph); $\dot{v} = 15$ (ft/s²)

Find: \underline{v}_B and \underline{a}_B in ft/s and ft/s² using
normal and **tangential** components.

Solution:

Velocity:

$$v = \left[35 \frac{\text{mi}}{\text{hr}} \right] \left[\frac{1 \text{ hr}}{3600 \text{ sec}} \right] \left[\frac{5280 \text{ ft}}{1 \text{ mi}} \right] \approx 51.3 \bar{3} \text{ (ft/s)} \Rightarrow \boxed{\underline{v}_B = 51.3 \underline{e}_t \text{ (ft/s)}}$$



Acceleration:

$$\boxed{a_t = \dot{v} = 15 \text{ (ft/s}^2\text{)}} \quad \boxed{a_n = \frac{v^2}{\rho} = \frac{51.3\bar{3}^2}{200} \approx 13.1756 \approx 13.2 \text{ (ft/s}^2\text{)}}$$

$$\boxed{\underline{a}_B = 15 \underline{e}_t + 13.2 \underline{e}_n \text{ (ft/s}^2\text{)}} \Rightarrow \boxed{|\underline{a}_B| = \sqrt{a_t^2 + a_n^2} \approx 19.9649 \approx 20.0 \text{ (ft/s}^2\text{)}}$$

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

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

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