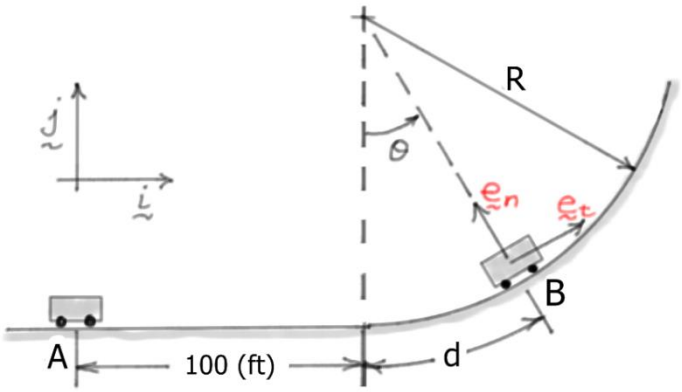
ME 2580 Example #8: (2D Motion, Normal & Tangential Components)

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

car starts from rest at $A\ (s = 0)$

car accelerates at a rate of

$\dot{v} = a_t = 0.2s$ (ft/s^2) from A to B



Find: $\underset{\sim}{v}_B$ and $\underset{\sim}{a}_B$ in ft/s and ft/s^2 using ***normal*** and ***tangential*** components.

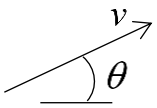
Solution:

Velocity:

$$\boxed{\frac{dv}{dt} = v\frac{dv}{ds} = 0.2s} \Rightarrow \boxed{\int v\,dv = \int 0.2s\,ds} \Rightarrow \boxed{\tfrac{1}{2}v^2 = 0.1s^2 + D} \quad \left(v = 0 \ @ \ s = 0 \Rightarrow \boxed{D = 0}\right)$$

$$\boxed{v(s) = \sqrt{0.2s^2} = \sqrt{0.2}\ s} \quad (0 \le s \le 112) \Rightarrow \boxed{v_B = \left(v(s)\right)_{s=112} \approx 50.0879 \approx 50.1\ \text{(ft/s)}}$$

$$\Rightarrow \boxed{\underset{\sim}{v}_B = 50.1\,\underset{\sim}{e}_t\ \text{(ft/s)}}$$



Acceleration:

$$\boxed{a_t = \left(0.2\,s\right)_{s=112} = 22.4\ \text{(ft/s}^2\text{)}} \qquad \boxed{a_n = \frac{v^2}{\rho} = \frac{\left(0.2s^2\right)_{s=112}}{200} = 12.544 \approx 12.5\ \text{(ft/s}^2\text{)}}$$

$$\boxed{\underset{\sim}{a}_B = 22.4\,\underset{\sim}{e}_t + 12.5\,\underset{\sim}{e}_n\ \text{(ft/s}^2\text{)}} \Rightarrow \boxed{|\underset{\sim}{a}_B| = \sqrt{a_t^2 + a_n^2} \approx 25.6732 \approx 25.7\ \text{(ft/s}^2\text{)}}$$