

## Elementary Dynamics Example #8: (2D Motion, Normal & Tangential Components)

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

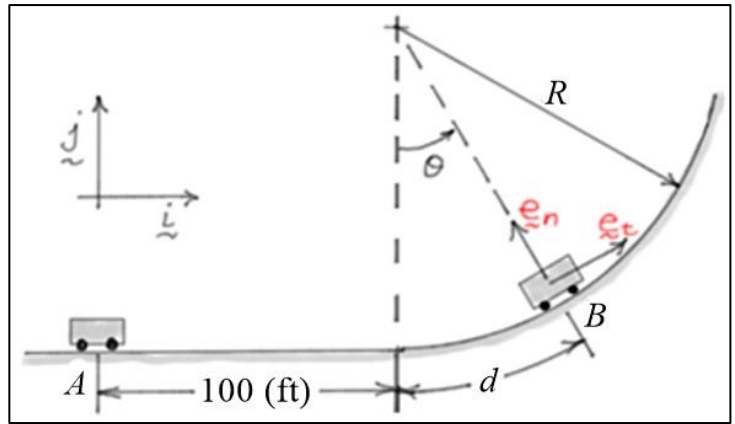
car starts from rest at A ( $s = 0$ )

car accelerates at a rate of

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

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

**Solution:**



**Velocity:**

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

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

$$\Rightarrow \boxed{v_B = 50.1 e_t \text{ (ft/s)}}$$

**Acceleration:**

$$a_t = (0.2s)_{s=112} = 22.4 \text{ (ft/s}^2\text{)}$$

$$a_n = \frac{v^2}{\rho} = \frac{(0.2s^2)_{s=112}}{200} = 12.544 \approx 12.5 \text{ (ft/s}^2\text{)}$$

$$\boxed{a_B = 22.4 e_t + 12.5 e_n \text{ (ft/s}^2\text{)}} \Rightarrow \boxed{|a_B| = \sqrt{a_t^2 + a_n^2} \approx 25.6732 \approx 25.7 \text{ (ft/s}^2\text{)}}$$