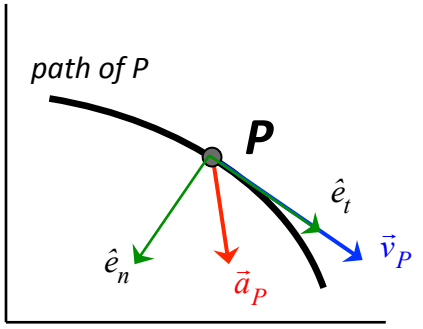
Summary: Particle Kinematics − Path Description

1. *PROBLEM*: Motion of a point described in path variables.
2. *FUNDAMENTAL EQUATIONS*:

$$\vec{v}_P = v_P \hat{e}_t = velocity\ of\ P$$

$$\vec{a}_P = \dot{v}_P \hat{e}_t + \frac{v_P^2}{\rho} \hat{e}_n = acceleration\ of\ P$$



where $\hat{e}_t$ and $\hat{e}_n$ are unit vectors tangent and (inwardly) normal to the path.

3. *OBSERVATIONS: In regard to the path description kinematics, we see*
   - Velocity is ALWAYS tangent to the path.
   - Acceleration, in general, has BOTH normal and tangential components.
   - Note that acceleration depends on three factors: speed v_P, rate of change of speed $\dot{v}_P$ and radius of curvature of the path ρ.
   - Rate of change of speed is the projection of acceleration onto the unit tangent vector: $\dot{v}_P = \vec{a}_P \bullet \hat{e}_t$
   - Rate of change of speed is NOT equal to the magnitude of acceleration:

$$\left|\vec{a}_P\right| = \sqrt{\dot{v}_P^2 + \left(v_P^2 / \rho\right)^2} \neq \left|\dot{v}_P\right|$$