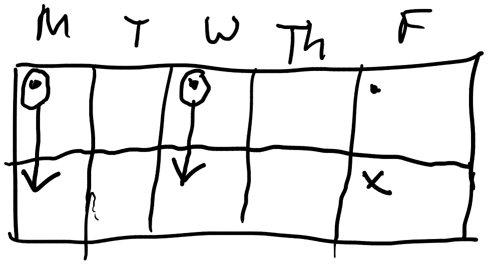
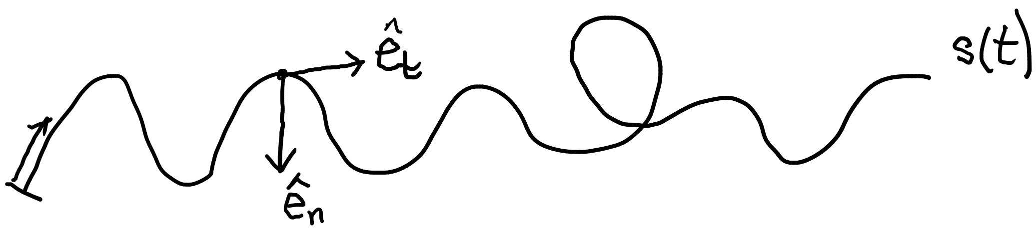
# Tangential & Normal Basis Cont'd



TRUE OR FALSE?




1) The velocity of a moving particle is always tangent to the path. (along $\hat{e}_t$)

A TRUE

B FALSE

$\vec{v} = v\,\hat{e}_t$

2) The acceleration of a moving particle is always normal to $\hat{e}_t$

A TRUE

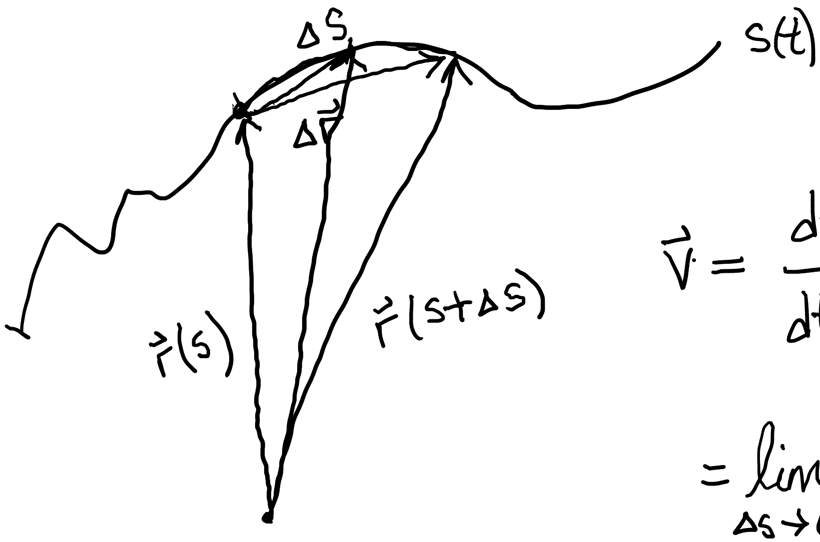
B FALSE

3) The acceleration of a particle moving with constant speed is always normal to $\hat{e}_t$

A TRUE

B FALSE

4) In classical dynamics, the acceleration can point towards the inside of a curve, but never the outside. A-TRUE B-FALSE




$s$ = arc length, total distance covered

$$\vec{v} = \frac{d\vec{r}}{dt} = \frac{d\vec{r}}{ds}\,\frac{ds}{dt}$$

$$= \underbrace{\lim_{\Delta s \to 0}\left(\frac{\Delta\vec{r}}{\Delta s}\right)}_{\text{vector} = \hat{e}_t}\,\dot{s}$$

scalar, a.k.a speed

as $\Delta s \to 0$:

1) $\Delta\vec{r}$ becomes tangent to path
2) $|\Delta\vec{r}|/\Delta s \to 1$

$$\vec{v} = \dot{s}\,\hat{e}_t$$

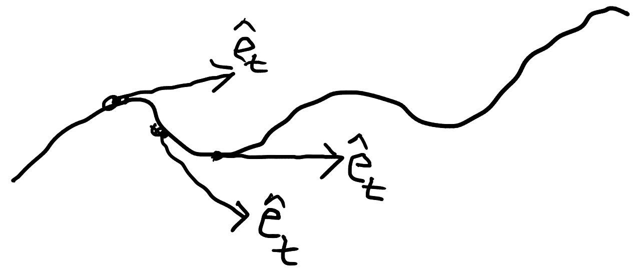
mag

direction

$$\hat{e}_t = \frac{\vec{v}}{|v|} = \hat{v}$$

What about $\vec{a}$?

$$\vec{a} = \frac{d\vec{v}}{dt} = \frac{d}{dt}\left(\dot{s} e_t\right)$$




$$= \ddot{s}\hat{e}_t + \dot{s}\left(\frac{d\hat{e}_t}{dt}\right)$$

$$= \ddot{s}\hat{e}_t + \dot{s}\frac{d\hat{e}_t}{ds}\left(\frac{ds}{dt}\right)$$

$$= \ddot{s}\hat{e}_t + (\dot{s})^2\left(\frac{d\hat{e}_t}{ds}\right)$$

vector:

direction? $\hat{e}_n$

magnitude? $\kappa$ (Kappa, curvature)

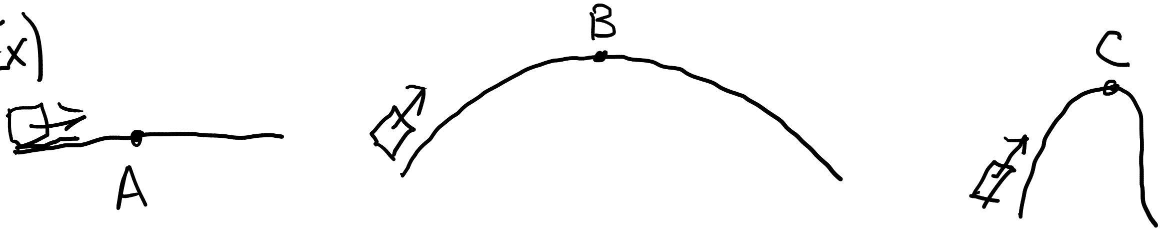
$$= \ddot{s}\hat{e}_t + (\dot{s})^2 \kappa \hat{e}_n$$

changing speed

changing direction

$$\frac{d\hat{e}_t}{ds} = \kappa \hat{e}_n$$

Ex)

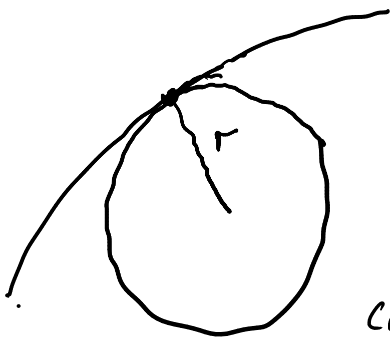



pt C has highest curvature

$$\vec{a} = \ddot{s}\hat{e}_t + \underline{\underbrace{(\dot{s})^2 \kappa}\hat{e}_n}$$

$$\kappa_C > \kappa_B > \kappa_A$$

$$|a_c| > |a_B| > |a_a|$$




$$\kappa = \frac{1}{r}$$

curvature

"radius of curvature"