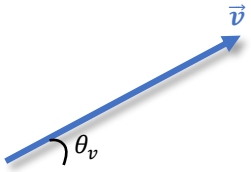
CONCEPT: ACCELERATION IN 2D

- Remember! Acceleration (in 1D & 2D) causes a *change* in _____ (***magnitude*** and/or ***direction***).
  - Just like velocity, there are two sets of equations to calculate acceleration and its components:

Velocity



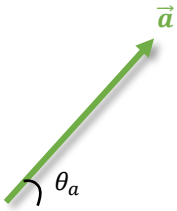
$|\boldsymbol{v}| = \frac{\Delta \boldsymbol{r}}{\Delta \boldsymbol{t}} = \sqrt{v_x^2 + v_y^2}$

$\theta_v = \tan^{-1}\left(\left|\frac{v_y}{v_x}\right|\right)$

$v_x = \frac{\Delta x}{\Delta t} = v\cos\theta$

$v_y = \frac{\Delta y}{\Delta t} = v\sin\theta$

Acceleration



$|\boldsymbol{a}| = \frac{\Delta \boldsymbol{v}}{\Delta \boldsymbol{t}} = \sqrt{\quad}$

$\theta_a = \tan^{-1}\left(\left|\frac{\quad}{\quad}\right|\right)$

$a_x = \frac{\quad}{\Delta t} = \_\_\_\cos\theta$

$a_y = \frac{\quad}{\Delta t} = \_\_\_\sin\theta$

EXAMPLE: A toy car is initially moving 20m/s in the +x-axis. 10 seconds later, the car is moving 67 m/s at 26.5° above the x-axis. **a)** Calculate the x & y components of the car's acceleration. **b)** Calculate the magnitude & direction of the car's acceleration over the 10s.

PROBLEM: A football at rest is kicked by a football kicker. The ball is in contact with the kicker's foot for 0.050s, during which it experiences an acceleration $a = 340$ m/s^2. The ball is launched at an angle of 40° above the ground (x-axis). Calculate the horizontal and vertical components of the launch velocity.

A) 13 m/s horizontal; 10.9 m/s vertical
B) 130 m/s horizontal; 109 m/s vertical
C) 10.9 m/s horizontal; 13 m/s vertical
D) 17 m/s horizontal; 17 m/s vertical

2D Acceleration Vector

$$|\vec{a}| = \frac{\Delta v}{\Delta t} = \sqrt{a_x^2 + a_y^2} \qquad \overrightarrow{a_x} = \frac{\Delta v_x}{\Delta t} = a \cos\theta$$

$$\theta_a = \tan^{-1}\left(\frac{|a_y|}{|a_x|}\right) \qquad \overrightarrow{a_y} = \frac{\Delta v_y}{\Delta t} = a \sin\theta$$