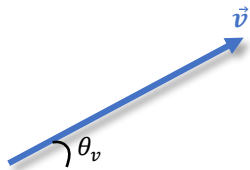


CONCEPT: ACCELERATION IN 2D

- 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



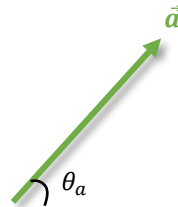
$$|\vec{v}| = \frac{\Delta r}{\Delta t} = \sqrt{v_x^2 + v_y^2}$$

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

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

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

Acceleration



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

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

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

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

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 $a = 340 \text{ m/s}^2$. 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

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

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