

$$W = F_x \Delta x + F_y \Delta y + F_z \Delta z$$

$$= \vec{F} \cdot \vec{\Delta r} \quad \text{dot product}$$

$\Delta \vec{r} = \Delta x \hat{x} + \Delta y \hat{y} + \Delta z \hat{z}$

$$\vec{A} \cdot \vec{B} = A_x B_x + A_y B_y + A_z B_z$$

e.g.  $\langle 3, 1, 5 \rangle \cdot \langle -2, 0, 1 \rangle$

$$= 3 \cdot -2 + 1 \cdot 0 + 5 \cdot 1$$

$$= -6 + 0 + 5$$

$$= -1$$

$$3\hat{x} \cdot (2\hat{x} - \hat{y})$$

$$= 3\hat{x} \cdot 2\hat{x} - 3\hat{x} \cdot \hat{y}$$

$$= 6\hat{x} \cdot \hat{x} - 3\hat{x} \cdot \hat{y}$$

$$= 6 - 0 = 6$$

$\hat{x} \cdot \hat{x} = 1$   
 $\hat{x} \cdot \hat{y} = 0$

$$\vec{A} \cdot \vec{B} = |\vec{A}| |\vec{B}| \cos \theta$$



e.g.  $3\hat{x} \cdot (2\hat{x} - \hat{y}) = 6$

$$= |3\hat{x}| |2\hat{x} - \hat{y}| \cos \theta$$

$$6 = 3\sqrt{5} \cos \theta$$

$$\theta = \cos^{-1} \frac{6}{3\sqrt{5}} = 27^\circ$$

$$\theta = 0^\circ \quad \vec{A} \cdot \vec{B} = |\vec{A}| |\vec{B}| \cos 0 = AB \quad \rightarrow$$

$$\theta = 180^\circ \quad \vec{A} \cdot \vec{B} = AB \cos 180^\circ = -AB \quad \leftarrow$$

$$\theta = 90^\circ \quad \vec{A} \cdot \vec{B} = AB \cos 90^\circ = 0 \quad \uparrow \downarrow$$

if  $0^\circ < \theta < 90^\circ$ ,  $\cos \theta > 0$

$$\vec{A} \cdot \vec{B} > 0$$



same-ish direction

$90^\circ < \theta < 180^\circ$ ,  $\cos \theta < 0$

$$\vec{A} \cdot \vec{B} < 0$$



opposite-ish direction

$$W = \vec{F} \cdot \Delta \vec{r}$$

work done by gravity

$F \downarrow \quad \Delta \vec{r} \swarrow \quad \theta < 90^\circ$

$$W > 0$$

$F \rightarrow \quad \Delta \vec{r} \swarrow$

$$W < 0$$



$$KE = \frac{1}{2} m v^2$$

$$PE_g = mg \Delta y$$

$$PE_s = \frac{1}{2} k (\Delta L)^2$$

$$E_f = E_i + W$$

$$2a) 1.2 \text{ m/s}$$

$$2b) 37 \text{ cm}$$