

## SUMMARY OF THE SCALAR PRODUCT $\underline{a} \cdot \underline{b}$

By definition  $\underline{a} \cdot \underline{b} = |\underline{a}| |\underline{b}| \cos \theta$   
the answer is a scalar

### EXAMPLE

If  $\underline{a}$  is  $\begin{pmatrix} 1 \\ 3 \\ -4 \end{pmatrix}$  and  $\underline{b}$  is  $\begin{pmatrix} 6 \\ 0 \\ 1 \end{pmatrix}$

$$\begin{aligned} \text{then } \underline{a} \cdot \underline{b} &= 1 \times 6 + 3 \times 0 + (-4) \times 1 \\ &= 2 \end{aligned}$$

### APPLICATIONS

1. To find the angle between two vectors

$$\begin{aligned} \cos \theta &= \frac{\underline{a} \cdot \underline{b}}{|\underline{a}| |\underline{b}|} \\ &= \frac{2}{\sqrt{1^2 + 3^2 + 4^2} \sqrt{6^2 + 1^2}} \\ &= \frac{2}{\sqrt{26} \sqrt{37}} \end{aligned}$$

$$\theta = 86^\circ \text{ (to nearest degree)}$$

2. Perpendicular vectors

If  $\underline{a}$  and  $\underline{b}$  are perpendicular  
 $\underline{a} \cdot \underline{b} = 0$

$$\text{since } \cos 90^\circ = 0$$