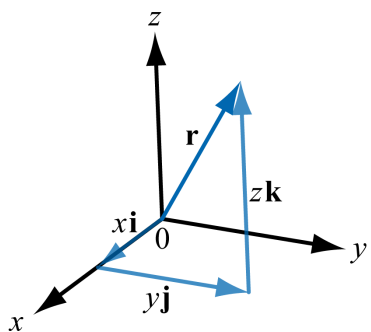# **Vectors** (for AP Physics C)

Vector means

a spatial relationship between an arrowhead and an arrow tail.

Symbols and features

Symbol: $\vec{r}$

Length (magnitude): $|\vec{r}|$

Direction (for example, for a vector confined to the xy plane, one could use the angle θ counter-clockwise from the $+x$ axis).
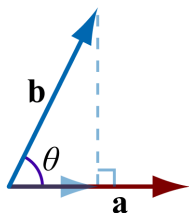
Component expression

$$\vec{r} = x\hat{i} + y\hat{j} + z\hat{k}$$

$$\vec{a} = a_x\hat{i} + a_y\hat{j} + a_z\hat{k}$$

Dot product means

Light rays perpendicular to $\vec{a}$ are partially blocked by $\vec{b}$. Multiply the length of the shadow of $\vec{b}$ by the length of $\vec{a}$.
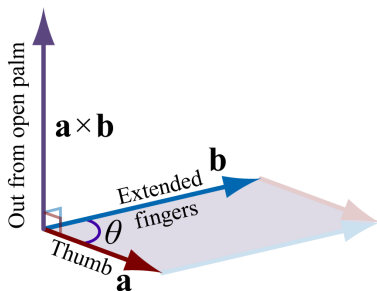
Mathematical definition

$$\vec{a} \cdot \vec{b} := |\vec{a}||\vec{b}| \cos\theta$$

Computing formula

$$\left(a_x\hat{i} + a_y\hat{j} + a_z\hat{k}\right) \cdot \left(b_x\hat{i} + b_y\hat{j} + b_z\hat{k}\right)$$
$$= a_x b_x + a_y b_y + a_z b_z$$

Cross product means

Construct a vector perpendicular to both $\vec{a}$ and $\vec{b}$ using the **RHR**. The magnitude of the vector equals the area of the parallelogram spanned by $\vec{a}$ and $\vec{b}$.

Mathematical definition

$$\vec{a} \times \vec{b} := |\vec{a}||\vec{b}| \sin\theta \, \vec{u}_{\vec{a}\times\vec{b}}$$

Computing formula

$$\vec{a} \times \vec{b} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ a_x & a_y & a_z \\ b_x & b_y & b_z \end{vmatrix}$$