# ANGLES BETWEEN VECTORS

(1-7) Let $\vec{u} = 2\hat{i} + 3\hat{j} + 4\hat{k}$, $\vec{v} = \hat{i} - 5\hat{j} + \hat{k}$, and $\vec{w} = -3\hat{i} - 2\hat{j} - 8\hat{k}$. Find the angles between the following vectors. Give your answers in degrees rounded, if necessary, to the nearest tenth of a degree.

1. $\vec{u}$ and $\vec{v}$

2. $\vec{u}$ and $\vec{w}$

3. $\vec{v}$ and $\vec{w}$

4. $\vec{v}$ and $2\vec{w}$

5. $\vec{v}$ and $\vec{v}$

6. $\vec{w}$ and $-\vec{w}$

7. $(\vec{u} + \vec{w})$ and $(\vec{u} - \vec{w})$

8. Let $\vec{v} = a\hat{i} + b\hat{j} + c\hat{k}$ be a nonzero vector, and let $\alpha$, $\beta$, and $\gamma$ be the angles between $\vec{v}$ and the unit vectors $\hat{i}$, $\hat{j}$, and $\hat{k}$, respectively. Show that $\cos^2\alpha + \cos^2\beta + \cos^2\gamma = 1$. (NOTE: The angles $\alpha$, $\beta$, and $\gamma$ are called the *direction angles* of $\vec{v}$, and $\cos\alpha$, $\cos\beta$, and $\cos\gamma$ are called the *direction cosines*.)