1. Let $\boldsymbol{a} = \langle 3, 1\rangle$ and $\boldsymbol{b} = \langle -2, 2\rangle$.

   (a) Make a reasonably large and accurate sketch of these vectors, then guess (estimate) the angle (in degrees) between the vectors.

   (b) Use the dot product to calculate the angle between the vectors to the nearest tenth of a degree. How good was your estimate?

2. Find (to the nearest degree) the angle between vectors $\boldsymbol{a} = \langle 1, -2, 2\rangle$ and $\boldsymbol{b} = \langle -1, 4, 8\rangle$.

3. If $\boldsymbol{a}$ and $\boldsymbol{b}$ are two non-zero vectors, what is the geometric relationship between the vectors if $\boldsymbol{a} \cdot \boldsymbol{b} = 0$?

4. The "direction angles" of a non-zero vector $\boldsymbol{a} = \langle a_1, a_2, a_3\rangle$ are the angles α, β, and γ that it makes with the vectors $\hat{\boldsymbol{\imath}}$, $\hat{\boldsymbol{\jmath}}$ and $\hat{\mathbf{k}}$, respectively. The "direction cosines" of the vector are the cosines of these angles.

   (a) Find expressions for the direction cosines of the vector $\boldsymbol{a} = \langle a_1, a_2, a_3\rangle$.

   (b) How do these expressions relate to the components of the unit vector in the direction of vector $\boldsymbol{a}$?

   (c) Find the direction cosines of the vector $\boldsymbol{a} = \langle 2, 6, 3\rangle$.

   (d) Find the direction angles (to the nearest degree) of the vector $\boldsymbol{a} = \langle 2, 6, 3\rangle$.