1. Find the angle between the vectors $< 1, 2, 3 >$ and $< 0, -1, 2 >$.

2. State whether each of the following statements is true, false, or nonsense. If the statement is false, try to correct it. Assume all vectors are in $\mathbf{R}^3$ unless otherwise stated. Lower case letters such as r, t denote real scalars.

a. $\vec{a} \cdot \vec{b} = \vec{b} \cdot \vec{a}$
b. $(\vec{a} \cdot \vec{b}) \cdot \vec{c} = \vec{a} \cdot (\vec{b} \cdot \vec{c})$
c. $\vec{a} \cdot \vec{a} = \mid \vec{a} \mid$
d. The vectors $\vec{a}$ and $\vec{b}$ are orthogonal if and only if $\vec{a} \cdot \vec{b} = \vec{0}$
e. If $\vec{a}, \vec{b}, \vec{c} \in \mathbf{R}^2$, and $\vec{a} \neq \vec{0}$, $\vec{b} \neq \vec{0}$, then we can always find $r, s \in \mathbf{R}$ such that $\vec{c} = r\vec{a} + s\vec{b}$.

3. Use vectors to find the angle between the diagonal of a cube and one of its edges.

4. Find three vectors that are perpendicular to the vector $< 1, 3, 2 >$.

5a. Use the scalar product to find an equation of the cone whose vertex is at the origin and that passes through the circle $\{(x, y, 1) \mid x^2 + y^2 = 9\}$.
b. Use the scalar product to find an equation of the cone whose vertex is at the origin, whose vertex half-angle is $60°$, and whose axis of symmetry is in the direction of the vector $< 1, 3, -2 >$.

6. Let $\mathbf{a}$ and $\mathbf{b}$ be two non-parallel vectors. If $\mathbf{c} = \mid \mathbf{a} \mid \mathbf{b} + \mid \mathbf{b} \mid \mathbf{a}$, prove that $\mathbf{c}$ bisects the angle between $\mathbf{a}$ and $\mathbf{b}$.

7. Let O be a point in $\mathcal{R}^2$ and for any point Q, let $\mathbf{q}$ denote the vector $\vec{OQ}$. Let A and B be two fixed points and let S be a (variable) third point such that

$$(\mathbf{s} - \mathbf{a}) \cdot (\mathbf{s} - \mathbf{b}) = 0. \qquad (*)$$

Describe algebraically and geometrically the set of all points S in $\mathcal{R}^2$ satisfying (*). What if the the points O, A, B, and S are in $\mathcal{R}^3$?

8. Prove that if two pairs of opposite edges of a tetrahedron are perpendicular, then the remaining pair of opposite edges are perpendicular.

9. (*Review*) In ΔABC let M be the midpoint of $\overline{AB}$ and let G be the point on $\overline{CM}$ such that $CG : GM = 1 : 3$.
a. Find possible masses to put at the vertices of the triangle so that G is the center of mass of the system with point masses at the vertices.
b. Let N denote the point of intersection of the line through A and G with $\overline{BC}$. Find the ratios $CN : NB$ and $AG : GN$.
c. Let (XYZ) denote the area of ΔXYZ. Determine the ratios $(AGB)/(ABC)$, $(AGC)/(ABC)$, and $(BGC)/(ABC)$.