1. Very often, we use vectors and points almost interchangeably. This is useful since we can add and dot vectors but not points, but can also lead to confusion if we lose track of which object we're working with. In the following problems, pay careful attention to when you're working with points and when you're working with vectors. Also, be careful with your vocabulary: the numbers that make up a point are called *coordinates*, while the numbers that make up a vector are called *components*.

   (a) Let O denote the origin. Is O a point or a vector?

   (b) Consider the point $N(1,2)$. Let $\vec{n} = \overrightarrow{ON}$. What are the components of $\vec{n}$? The vector $\vec{n}$ is called the *position vector for the point* N. In general, how can you take a point and produce its position vector?

   (c) Find an equation of the line L through the origin perpendicular to $\vec{n}$. Using your equation, find a point other than O that lies on your line.

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2. (a) Let P denote the plane $-x + 5y + 2z = 3$. Find a normal vector for P.

   (b) Find a point on the plane P.

   (c) What is the distance between P and the point $(1,1,1)$?

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3. (a) Find an equation for the plane P with normal vector $\vec{n} = \langle 2,3,1 \rangle$ and containing the point $(2,2,2)$.

   (b) Find an equation for a plane that contains the origin and meets the plane P at a right angle. How do you know your plane is perpendicular to P?

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4. A tetrahedron is a polyhedron with four triangular faces. In other words, it's a pyramid with a triangular base. It has four vertices (corners) and six edges. The edges don't necessarily have the same length. Suppose that on each face of a tetrahedron, we have a vector sticking out which is normal to the face and which has magnitude equal to the area of the face. Show that the sum of these four vectors is the zero vector.

   Hint: pick a vertex Q of the tetrahedron, and consider the three edges that are connected by this vertex. Think of those edges as vectors with tail end Q, and call them $\vec{\mathbf{u}}, \vec{\mathbf{v}}, \vec{\mathbf{w}}$. Can you express the other three edges of the tetrahedron in terms of $\vec{\mathbf{u}}, \vec{\mathbf{v}}, \vec{\mathbf{w}}$? Can you express the four vectors sticking out from each of the four faces in terms of $\vec{\mathbf{u}}, \vec{\mathbf{v}}, \vec{\mathbf{w}}$? What happens when you add up those four expressions?

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5. Vectors $\vec{a}$ and $\vec{b}$ lie in the xy-plane. Vector $\vec{a}$ has length 2 and makes an angle of $\frac{\pi}{6}$ with the positive x-axis, measured counterclockwise. Vector $\vec{b}$ has length 4 and makes an angle of $\frac{2\pi}{3}$ with the positive x-axis, also measured counterclockwise. Compute the following.

   (a) $\vec{a} \cdot \vec{b}$

   (b) $\left\|\vec{a} \times \vec{b}\right\|$

   (c) $\vec{a} \times \vec{b}$

   (d) $\vec{b} \times \vec{a}$

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6. Consider the points $A(1,1,-2)$, $B(2,0,-1)$, $C(-1,1,1)$, and $D(-2,2,0)$.

   (a) The figure $ABCD$ is a parallelogram. How would you show this?

   (b) Find the area of the parallelogram $ABCD$.

   (c) Find the area of the triangle ABC.