Math 2440 – Spring 2017 **WS #4 – Planes in Space** Name: _____

Any plane in $\mathbb{R}^3$ may be written in the form $Ax + By + Cz = D$ for some real numbers A, B, C, D.

---

1. I'm thinking of a specific plane. [This is being read in Dr. Loft's voice, by the way.] Let's see if you can guess which one....

   (a) It contains the point $P = (1, 0, 4)$. If $Q = (x, y, z)$ is *any other* point on the plane, then the vector $\overrightarrow{PQ}$ is
   $$\overrightarrow{PQ} = \langle \quad , \quad , \quad \rangle$$

   (b) What is the relationship between our plane and the vector $\overrightarrow{PQ}$?

   (c) I happen to know that $\vec{n} = \langle -1, 5, 2 \rangle$ is orthogonal to this plane. What can you say about the relationship between the vectors $\vec{n}$ and $\overrightarrow{PQ}$?

   (d) Write this down as an equation and simplify it. Write it in the above form.

We say the plane $\vec{n}$ used above *is normal to* the vector $\vec{n}$. This vector is called a *normal vector*.

---

2. Determine the equation of the plane which is normal to the vector $\vec{n} = \langle 7, 10, -5 \rangle$ and contains the point $P = (-2, -3, 9)$.

3. Determine the equation of the plane which contains the points $P = (1, 3, 0), Q = (-1, -3, 4)$, and $R = (-1, -5, 0)$.

4. The next few exercises have you work with the plane $5x - 3y + z = 10$.

   (a) Let $\overrightarrow{v} = \langle 5, -3, 1 \rangle$. Where did I get this vector?

   (b) Locate two points P and Q in this plane. [Use trial and error here....]

   (c) Is $\overrightarrow{PQ}$ orthogonal to the vector $\overrightarrow{v} = \langle 5, -3, 1 \rangle$?

5. Locate a vector normal to the plane $-7x + y - 10z = 9$.

6. If two planes are parallel, what can you say about the vectors normal to these planes?

7. Are the planes $2x - 4y + z = 7$ and $x - 5y - z = 10$ parallel?

8. Are the planes $x + 2y - 4z = 9$ and $2x - 5y - 2z = 10$ parallel? Are they orthogonal?