10.2: Space Coordinates and Vectors in Space

A. The **three-dimensional coordinate system** is constructed by passing a z-axis perpendicular to the x and y axes at the origin. Taken as pairs the axes determine three coordinate planes: **the xy-plane, the xz-plane, and the yz-plane**. These coordinate planes separate three-space into 8 octants.

B. A point in space is determined by **ordered triples (x, y, z)** where x, y, and z are as follows.

x = directed distance from the yz-plane to P
y = directed distance from the xy-plane to P
z = directed distance from the xy-plane to P

* We will use a right-handed system in class, not a left-handed system.

C. Many of the formulas established for the two-dimensions system can be extended to 3 dimensions.

Distance between to point: $d = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2 + (z_2 - z_1)^2}$

A **sphere** centered at (x_0,y_0,z_0) and radius r can be found using the distance formula. The standard equation of a sphere is:

$$(x_2 - x_1)^2 + (y_2 - y_1)^2 + (z_2 - z_1)^2 = r^2$$

The **midpoint of a line segment** with endpoints (x_1,y_1,z_1) and (x_2,y_2,z_2) has coordinates

$$\left(\frac{x_1 + x_2}{2}, \frac{y_1 + y_2}{2}, \frac{z_1 + z_2}{2}\right)$$

D. Using unit vectors $\mathbf{i} = \langle 1,0,0 \rangle$, $\mathbf{j} = \langle 0,1,0 \rangle$, $\mathbf{k} = \langle 0,0,1 \rangle$ the standard unit vector notation for v is

$$\mathbf{v} = v_1\mathbf{i} + v_2\mathbf{j} + v_3\mathbf{k}$$

E. Vectors in Space: See page 729