**Math 241 Homework 1: §12.1, 12.2**

1. Describe the geometric shapes given by the following sets of equations.
   (a) $x = 4$, $y = 1$
   (b) $x^2 + y^2 + (z-2)^2 = 3$
   (c) $x^2 + y^2 + z^2 = 4$, $z \geq 1$
2. Calculate the distance between the points $P$ and $Q$.
   (a) $P = (0, 1, 0)$, $Q = (2, 3, 4)$
   (b) $P = (1, 1, 1)$, $Q = (-2, -1, 3)$
   (c) $P = (4567, 1280, 4)$, $Q = (4567, 1280, 2)$
3. Find the center and radius of the sphere whose equation is given by $4x^2 + 4y^2 + 4z^2 - 4x + 8y + 16z - 13 = 0$.
4. Does the equation $x^2 + y^2 + z^2 - 4x + 2y + 4z + 9 = 0$ describe a sphere? If not, what does it describe?
5. Write a set of inequalities to describe the solid cube in the first octant whose sides have length 6.
6. Find the distance between the point $(3, 4, 5)$ and the $x$-axis.
7. Find the distance between the point $(2, -1, 1)$ and the $y$-axis.
8. Find the vector $\overrightarrow{PQ}$ and its magnitude $|\overrightarrow{PQ}|$ for the following pairs of points.
   (a) $P = (1, 2, 3)$, $Q = (4, 5, 6)$
   (b) $P = (0, 1, 1)$, $Q = (2, 1, 0)$
   (c) $P = (-1, 0, 3)$, $Q = (1, 0, 2)$
9. In the previous problem, which of the three vectors are equal to each other?
10. Find a vector going in the opposite direction as the vector $\langle 2, -2, 5 \rangle$.
11. Find a vector of length 3 that goes in the opposite direction as the vector $\langle 8, -1, -4 \rangle$.
12. Find a unit vector in the direction of the vector $\langle 2, -1, 3 \rangle$.
13. If $\mathbf{u} = \langle 2, 3 \rangle$ and $\mathbf{v} = \langle -1, 2 \rangle$, calculate the following.
    (a) $\mathbf{u} + \mathbf{v}$
    (b) $3\mathbf{u}$
    (c) $2\mathbf{u} - 3\mathbf{v}$
14. Find the midpoint of the line segment $\overline{PQ}$ where $P = (-1, 2, -3)$ and $Q = (1, 3, 5)$.