 Name:____

Problem 1 (20 points). Let three points be given by $P = (2, 1, 5)$, $Q = (-1, 3, 4)$, and $R = (3, 0, 6)$.

(a). Find an equation of the plane which contains P, Q, and R.

(b). Find the area of the triangle PQR.

Problem 2 (20 points). Consider the plane P given by the equation $x - y + 3z = 1$, and the line L given by $(x, y, z) = (1, 1, 0) + t(3, -1, -1)$, $t \in \mathbb{R}$.

(a). Find the angle between the plane P and the line L.

(b). Find an equation of a parallel plane P' such that the line segment given by the part of L which lies between the two planes P and P' has length $3\sqrt{11}$.

Problem 3 (20 points). Classify and sketch the surface given by the equation $4y^2+z^2-x-16y-4z+20=0$.

Problem 4 (20 points).

(a). Write the equations $z = \sqrt{x^2 + y^2}$ and $x^2 + y^2 + z^2 = z$ in spherical coordinates.

(b). Describe in words and sketch the two surfaces given by the equations.

Problem 5 (20 points). Let $r : [0, \infty) \to \mathbb{R}^3$ be given as $r(t) = (\frac{4}{3}t^{3/2}, 2t, \frac{1}{2}t^2)$.

(a). Find the length of the resulting curve from the point $(0, 0, 0)$ to $(\frac{32}{3}, 8, 8)$.

(b). Find the curvature of the resulting curve at the point $(\frac{4}{3}, 2, \frac{1}{2})$.

Problem 6 (Extra Credit - 10 points, no partial credit). Suppose that $r : \mathbb{R} \to \mathbb{R}^3$ defines a smooth curve which is parameterized with respect to arc length. Show that $r'(t)$ and $r''(t)$ are always perpendicular. Find an example where this is false if r is not parameterized with respect to arc length.