1. 13.1 (8 points) Describe and sketch the surface in $\mathbb{R}^3$ represented by the equation $x + y = 2$.

2. 13.2 (8 points) Find a unit vector that has the same direction as $\mathbf{a} = 8\mathbf{i} - \mathbf{j} + 4\mathbf{k}$.

3. 13.3 (8 points) Find the angle between the vectors $\mathbf{a} = <1, 2, 3>$ and $\mathbf{b} = <4, 0, -1>$.

4. 13.4 (8 points) Given $P(0, -2, 0), Q(4, 1, -2)$ and $R(5, 3, 1)$. (a) Find a vector orthogonal to the plane through the point $P, Q$ and $R$, and (b) find the area of triangle $\Delta PQR$.

5. 13.5 (8 points) Find a vector equation and parametric equations for the line through the point $(1, 0, 6)$ and perpendicular to the plane $x + 3y + z = 5$.

6. 13.5 (8 points) Find the angle between the planes $x + 4y - 3z = 1$ and $-3x + 6y + 7z = 0$.

7. 13.6 (8 points) Reduce the equation $x^2 - y^2 + z^2 - 4x - 2y - 2z + 4 = 0$ to one of the standard form and classify the surface.

8. 14.1 (8 points) Show that the curve with parametric equations $x = t\cos t, y = t\sin t, z = t$ lies on the cone $z^2 = x^2 + y^2$, and use this fact to help sketch the curve.

9. 14.2 (8 points) Find parametric equations for the tangent line to the curve $x = e^{-t}\cos t, y = e^{-t}\sin t, z = e^{-t}$ at the point $(1, 0, 1)$.

10. 14.3 (8 points) Find the length of the curve: $\mathbf{r}(t) = \mathbf{i} + t^2\mathbf{j} + t^3\mathbf{j}, 0 \leq t \leq 1$.

11. 14.3 (10 points) Given $\mathbf{r}(t) = <\sqrt{2}t, e^t, e^{-t}>$ (a) Find the unit tangent and unit normal vectors $\mathbf{T}(t)$ and $\mathbf{N}(t)$ (b) Find the curvature of the curve at $\mathbf{r}(t)$.

12. 14.4 (10 points) Find the velocity and position vectors of a particle that has acceleration $\mathbf{a}(t) = \mathbf{k}$ and the initial velocity $\mathbf{v}(0) = \mathbf{i} - \mathbf{j}$ and position $\mathbf{r}(0) = 0$. 