• No books allowed. You may use a scientific calculator and one $8\frac{1}{2} \times 11$ sheet of handwritten notes.

• Even if you have a calculator, give me exact answers.

• Do not share notes.

• In order to receive credit, you must show your work and explain your reasoning.

• Place a box around **YOUR FINAL ANSWER** to each question.

• If you need more room, use the backs of the pages and indicate to the grader where to find your work.

• Raise your hand if you have a question or need more paper.

Don’t open the test until everyone has a copy and the start of the test is announced.
1 (10 points) Consider the curve given by the equation in polar coordinates
\[ r = 1 + \sin \theta. \]
Find the equation of the tangent line to the curve at \( \theta = \pi/6 \).
(10 points total) Three points are given: $P(0, -1, 1)$, $Q(1, 2, 2)$, and $R(3, 1, 0)$.

(a) (5 points) Find the area of the triangle $PQR$.

(b) (5 points) Find the cosine of the angle of the triangle $PQR$ at the vertex $Q$. 
3 (10 points) Find an equation of the plane which contains the line

\[ \frac{x - 1}{2} = \frac{y + 2}{-3} = \frac{z - 3}{4} \]

and is perpendicular to the plane \( x + y - z = 0 \).
4 (10 points) Let $S$ be the surface defined as the set of points $P(x, y, z)$ such that the distance from $P$ to the plane $x = 2$ equals the distance from $P$ to the line $x = 1, z = 3$. Find an equation for $S$. Simplify the equation and determine what kind of surface this is.
5 (10 points total)
(a) (2 points) Identify the surface given by the equation $3x^2 = y^2 + z^2$ (sketch is not required).

(b) (8 points) Find a vector function $\vec{r}(t)$ that represents the curve of the intersection of the surfaces $3x^2 = y^2 + z^2$ and $y + 2x = 1$. 