In each of the following problems, show your work, and organize your work clearly, so as to maximize the opportunities for “partial credit”. For example, in all but one of the problems, it will be a good idea to make some sort of diagram showing the “element” $ds$, or $dS$, or $dF$, etc,

(16 pts) 1. Find the area enclosed by the cardioid which, in polar coordinates, is given by the equation $r = 1 + \sin \theta$. 
(16 pts) 2. Find the length of the curve $C$ parametrized by $x = \frac{1}{3} t^3$, $y = \frac{1}{2} t^2$. 
(16 pts) 3. Find the area of the surface obtained by revolving the graph of
\( y = \sin x \) around the \( x \)-axis, as \( x \) goes from 0 to \( \pi/2 \).
(16) 4. Find the centroid $C(x, y)$ for the upper half of the circle of radius 4 centered at the origin.

(5 pts) 5. Express the equation $r = 8 \sin \theta + 6 \cos \theta$ in the form \[
\frac{(x - h)^2}{a^2} + \frac{(y - k)^2}{b^2} = 1.
\]
6. A tank filled with water has an irregular-looking cross-section. It’s a triangle, as drawn. Find the force (due to the pressure of water on one end of the tank). (Density, and acceleration due to gravity, can be left as \( \rho \) and \( g \), respectively.)

\[ \text{slope} = -1 \quad \text{slope} \frac{1}{2} \]

depth 10m.
The parametric curve \( x = t^2, \ y = t^3 - 3t \) has a graph which is depicted below. It crosses the origin when \( t = 0 \) and when \( t = \pm \sqrt{3} \). Find the volume obtained by revolving the loop of the curve about the \( y \)-axis.

\[(3, 0)\]