1. Let $R$ be the region bounded by the graphs of $y = 9 - x^2$, $y = 5$, and $x = 0$ in the 1st quadrant.
   a. Sketch, label, and shade the region. (2 points)
   
   b. Set up (DO NOT EVALUATE OR SIMPLIFY.) the integral that gives the volume when the region is revolved around the y-axis. State the method that you use. (7 points)
   
   c. Set up (DO NOT EVALUATE OR SIMPLIFY.) the integral that gives the volume when the region is revolved around the x-axis. State the method you use. (7 points)
   
   d. Set up (DO NOT EVALUATE OR SIMPLIFY.) the integral that gives the volume when the region is revolved around the line $x = 3$. State the method that you use. (7 points)
2. A car travels along a winding mountain road that follows the shape of the graph of 

\[ f(x) = x^3 - 3x^2 + x + 3 \]

on the interval \([-1,1]\).

a. Set up the integral that will calculate the distance traveled by the car. (7 points)

b. Assuming the coordinate units are miles, use your calculator to approximate (to 3 decimal places) the distance traveled by the car. State your answer in the form of a sentence. (3 points)

3. The graph of \( y = \sin \left( \frac{x}{2} \right) \) on \([0,2\pi]\) is revolved about the x-axis to form a football. Set up (DO NOT EVALUATE OR SIMPLIFY.) the integral that gives the surface area of the football. (10 points)
4. A curve C is defined by the parametric equations \( x = t^3 - 3t^2 \) and \( y = t^3 - 3t \).

a. Use your calculator to sketch the curve on the interval \(-3 \leq t \leq 3\). Indicate direction and label the endpoints, \((t, x, y)\), in exact values. (4 points)

b. Analytically (without the use of your calculator) find \( \frac{dy}{dx} \). Show all work. (7 points)

c. Analytically (without using your calculator) find all points, \((t, x, y)\) in exact values, on the curve where the tangent line is horizontal. Show your work. (7 points)

d. Analytically (without using your calculator) find all points, \((t, x, y)\) in exact values, on the curve where the tangent line is vertical. Show your work. (7 points)
5. For the polar curve $r = 3\cos(3\theta)$ on the interval $0 \leq \theta \leq \pi$
   a. Sketch the curve. (3 pts)

   b. Find and label the polar coordinates, $(r, \theta)$, of all intercepts in exact values. Show your work. (7 pts)

   c. Set up (DO NOT EVALUATE OR SIMPLIFY.) the integral that gives the area enclosed by one loop of the curve. (7 pts)
6. For the polar curves $r_1 = 4 \sin \theta$ and $r_2 = 2(1 + \sin \theta)$
   a. Sketch and label $r_1$ and $r_2$. Shade the interior region that is inside $r_2$ and outside $r_1$. (3 points)

   ![Diagram]

   b. Set up (DO NOT EVALUATE OR SIMPLIFY.) the integral that gives the area inside $r_2$ and outside $r_1$. (7 points)

7. The linear density in a rod 8m long is $12 \sqrt{x + 1}$ kg/m, where $x$ is measured in meters from one end of the rod. Approximate, to three decimal places, the average density of the rod. State your answer in the form of a sentence. (10 pts)