Answer the following problems and simplify your answers.

1. (22 pts) Let $\mathcal{R}$ be the region bounded by the curves $y = x^2 - 2x$ and $y = 2x$.

   (a) Sketch and shade the region $\mathcal{R}$, labeling the axes, intersection points, and curves.

   (b) Set up, **but do not evaluate**, an integral with respect to x to find the volume of the solid generated when $\mathcal{R}$ is revolved about the line $x = -1$.

   (c) Set up, **but do not evaluate**, an integral with respect to x to find the volume of the solid generated when $\mathcal{R}$ is revolved about the line $y = 8$.

2. (18 pts) Consider the curve $y = \ln(\cos(x))$ on the interval $0 \le x \le \pi/4$.

   (a) Set up, **but do not evaluate**, an integral to find the arc length of this curve. **Fully simplify** ds.

   (b) The curve is rotated about the x-axis to generate a surface. Set up, **but do not evaluate**, an integral to find the surface area.

3. (24 pts) Assuming a uniform density ρ, find the centroid of the region under the curve $y = \cos(x)$ and above the x-axis with $0 \le x \le \pi/2$.

4. (12 pts) A 10 m long chain with a mass of 50 kg hangs vertically from a crane. How much work is required to lift the entire chain to the top? (Use 10 m/s^2 as the acceleration due to gravity).

5.