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Problem 1: A cycloid is the curve traced out by a point P on the circumference of a circle as the circle rolls along a straight line. If a circle of radius r rolls along the positive x-axis, the parametric equation for this cycloid is given below.

$$\begin{cases} x = & r(t - \sin(t)) \\ y = & r(1 - \cos(t)) \end{cases}$$

(a) Find the length of one arch of the cycloid. [Hint: To evaluate the integral you may wish to use the identity $\sin^2(w) = \frac{1}{2}(1 - \cos(2w))$.]

(b) Set up, but DO NOT EVALUATE, the integral which calculates the area under one arch of the cycloid.

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Problem 2: (a) Graph the polar curve $r = \sin(\frac{\theta}{2})$.

(b) Find the formula for the slope of the line tangent to this polar curve. Your answer should be a function of θ.

(c) Find the equation of the line tangent to the polar curve when $\theta = \frac{3\pi}{4}$. Draw the graph of this line in your graph above.

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Problem 3: Graph the polar curves $r = \cos(2\theta)$ and $r = \frac{1}{2}$ and label the points of intersection.

Find the area inside the polar curve $r = \cos(2\theta)$ and outside the polar curve $r = \frac{1}{2}$.