1. Compute the length of the cycloid \( c(t) = (t - \sin t, 1 - \cos t), \ t \in [0, 2\pi] \).

[\textit{Hint: You will need the trigonometric identity} \( 1 - \cos(2\theta) = 2\sin^2 \theta \).]

2. Let \( F(x, y, z) = (xy^2, y + zx, zx^2) \). Find \( \text{div} \ F \), \( \text{curl} \ F \) and \( \text{div} \nabla F \).
3. A wire is parametrized by \( c(t) = (\cos t, \sin t, t), \ 0 \leq t \leq \frac{\pi}{2} \). Let its mass density at point \((x, y, z)\) be given by \( f(x, y, z) = xy \). Find the mass of the wire.

[Hint: You will need the trigonometric identity \( \sin(2\theta) = 2\sin \theta \cos \theta \).]

4. (Exercise 25, p.259) Let \( F : \mathbb{R}^3 \rightarrow \mathbb{R}^3 \) be a vector field. Which of the following expressions are meaningful, and which are nonsense? For those which are meaningful, decide whether the expression defines a scalar function or a vector field.

(a) \( \text{curl}(\text{grad} \ F) \)

(b) \( \text{grad}(\text{curl} \ F) \)

(c) \( \text{div}(\text{grad} \ F) \)

(d) \( \text{grad}(\text{div} \ F) \)

(e) \( \text{curl}(\text{div} \ F) \)

(f) \( \text{div}(\text{curl} \ F) \)
5. Find the work done by the force field \( F(x, y) = \langle x, 1 \rangle \) on a particle that moves along the cycloid in Problem 1.

6. Fill in the blanks

\[
\int_0^1 \int_x^1 \int_0^{y-x} f(x, y, z) \, dz \, dy \, dx = \int \int \int dxdydz
\]

Then sketch the region for the integral.
7. Find a parametrization for the curve C which is the intersection of
   (a) the cylinder \( y^2 + z^2 = 1 \) and the plane \( z = x \)
   
   (b) the cone \( z = \sqrt{x^2 + y^2} \) and the sphere \( x^2 + y^2 + z^2 = 2 \).

8. Compute the volume of the solid bounded by the planes \( x = 0, y = 0, z = 0 \), \( x + y = 0 \) and \( x = z - y - 1 \).