The density of water is 1000 kg/m³ or 62.5 lb/ft³.

1. Find an equation in Cartesian coordinates for the curve described by the polar equation \( r = 3 \sin \theta \).

2. Find the area enclosed by one loop of the polar curve \( r = \cos(2\theta) \).

3. (a) Set up two different integrals—one integrated with respect to \( x \) and the other integrated with respect to \( y \)—to find the length of the curve \( y^2 = 4x, 0 \leq y \leq 2 \). You do not have to evaluate the integrals.

(b) For the same curve considered in part (a), set up two different integrals—one integrated with respect to \( x \) and the other integrated with respect to \( y \)—to find the area of the surface obtained by rotating the curve about the \( y \)-axis. Include a drawing that shows the differential surface area.

4. (a) For the curve given by parametric equations \( x = \sqrt{t}, y = 1 - t, t \geq 0 \), eliminate the parameter to find a Cartesian equation of the curve.

(b) Sketch the curve and indicate with an arrow the direction in which the curve is traced as the parameter increases.
5. For the curve given by the parametric equations $x = \cos t, y = e^t, 0 \leq t \leq \pi/2$:
(a) Sketch the curve and indicate with an arrow the direction in which the curve is traced as the parameter $t$ increases.

(b) Find the area bounded by the curve given above, $y = 1$ and $x = 0$.

6. Set up the integral and use your calculator to evaluate that integral for determining the perimeter of the ellipse $\frac{x^2}{4} + \frac{y^2}{9} = 1$.

7. Find the tangent line to the curve $x = t^3, y = 2t$ at the point $(x, y) = (1, 2)$.

8. Find the hydrostatic force on one end of a cylindrical drum with radius 3 ft. if the drum is submerged in water 10 ft deep.
(a) On the picture included below, draw an appropriate arbitrary approximating rectangle $R$ (differential element).
(b) Find the area the differential element $R$ and the force on the differential element $R$.
(c) Summing the forces over all of the approximating rectangles and letting $n \to \infty$, find an integral expression for the force acting on the end of the cylindrical drum.

9. Derive the formula for determining the length of a curve for a curve given in parametric form by $x = f(t), y = g(t), a \leq t \leq b$. Include a drawing on the plot of the curve given below that illustrates your derivation. (For your drawing assume that $t = a$ is associated with the origin and $t = b$ is associated with the point $(-2, 12)$.)
$x^2 + (y-3)^2 - 9 = 0$

water line

10 ft