1. Determine the value of each definite integral, based on the graph of the function $f$ which appears below:

(a) $\int_{-2}^{2} f(x) \, dx$  
(b) $\int_{4}^{0} f(x) \, dx$

2. Write down and evaluate the definite integral equal to

$$\lim_{n \to \infty} \sum_{k=1}^{n} \sqrt{x_k} \Delta x$$

where $x_k$ are evaluation points equally spaced throughout $4 \leq x \leq 16$.

3. Calculate the average value of $f(x) = 60e^{-0.02x}$ when $0 \leq x \leq 50$. 
4. Calculate the derivative of

(a) \( f(x) = e^{-3x} \sin \pi x \) \hspace{1cm} (b) \( G(x) = \ln \left( x + \sqrt{x^2 + 1} \right) \)

5. Calculate the value of each limit:

(a) \( \lim_{x \to 0} \frac{\arcsin 2x}{x} \) \hspace{1cm} (b) \( G(x) = \lim_{n \to \infty} n \ln \left( 1 + \frac{4}{n} \right) \)
6. Evaluate each of the following integrals:

(a) \[ \int \frac{\ln 3x}{x} \, dx \]

(b) \[ \int (3t + 2)e^{-4t} \, dt \]

(c) \[ \int \frac{12}{x(x - 1)(x + 1)} \, dx \]
7. Evaluate the integral \( \int \sqrt{25 - 4x^2} \, dx \)

If you use a trig substitution, you may need \( \cos^2 \theta = \frac{1 + \cos 2\theta}{2} \) and \( \sin 2\theta = 2 \sin \theta \cos \theta \).

8. Solve the differential equation

\[
\frac{dP}{dt} = -0.05P \quad \text{and} \quad P(0) = 200
\]

Then find the value of \( t \) at which \( P(t) = 25 \).
9. Consider the region bounded by the curve $y = 2^x$, the lines $x + y = 3$ and $y = 1$.

Set up integrals for (but don’t evaluate)

(a) the area of the region.

(b) the $x$ and $y$ coordinates of the region’s center of mass (assuming constant density)

(c) the volume of the solid of revolution obtained by rotating the region around the vertical line $x = 8$.

(d) the perimeter of the region.
10. Convert the polar equation
\[ r = 8 \sin \theta \]
to an equation using rectangular coordinates \( x \) and \( y \).

11. Find parametric equations for downward motion along the parabola \( x = y^2 \).

12. Consider the polar region to the right of the line \( r = 3 \sec \theta \) and inside the circle \( r = 4 \cos \theta \).

(a) sketch the region

(b) set up a definite integral using polar coordinates for the area of this region. (no need to evaluate the integral)
13. Consider the set of parametric equations

\[
\begin{cases}
  x = t^3 + 3t^2 \\
  y = t^3 - 300t
\end{cases}
\]

(a) Horizontal tangent lines to the path of motion occur at which values of \( t \)?

(b) Vertical tangent lines to the path of motion occur at which values of \( t \)?

(c) Sketch the path by analyzing the sign of the derivatives of \( x \) and \( y \).