1. Suppose that a bug is crawling on a flat plate along the circle $x = \sin t, y = \cos t$, while the temperature of the plate is given by $T = x^2e^y - 2xy$. Find $dT/dt$ at $t = \pi/4$ by the chain rule.

2. Consider function
   
   $$f(x, y) = 48xy - 32x^3 - 24y^2$$

   (a) At $P(1, 1)$, what is the gradient of $f$?
   (b) Find the directional derivative of $f$ at $P$ along $A = i + 2j$.
   (c) Along which direction, the value of function $f(x, y)$ decreases the fastest at $P$?
   (d) What is the level curve of $f(x, y)$ at $P$? Find the equation of the tangent line to the level curve of $f(x, y)$ at $P$.

3. Consider function
   
   $$f(x, y) = 4xy - x^2y - xy^2$$

   (a) Find all the local maxima, local maxima and saddle points of the function.
   (b) Find the absolute maxima and minima of $f(x, y)$ on the closed triangular region bounded by the $x$-axis, $y$-axis and $x + y = 6$.

4. Use the method of Lagrange multipliers to find extreme values of $f(x, y) = 5xy$ on the ellipse $4x^2 + y^2 = 4$.

5. Consider the integral
   
   $$\int_0^\pi \int_0^x x \sin ydydx.$$

   Over which region is this integral calculated?
   (A) A rectangle with vertices $(0, 0), (0, \pi), (\pi, 0)$ and $(\pi, \pi)$;
   (B) A triangle with vertices $(0, 0), (0, \pi)$ and $(\pi, 0)$;
   (C) A triangle with vertices $(0, 0), (0, \pi)$ and $(\pi, \pi)$;
   (D) A triangle with vertices $(0, 0), (\pi, 0)$ and $(\pi, \pi)$.

6. Still consider the integral
   
   $$\int_0^\pi \int_0^x x \sin ydydx.$$

   If we first integrate with respect to $x$, then which is the correct form?
   (A) $\int_0^\pi \int_0^y x \sin ydydx$, (B) $\int_0^\pi \int_0^y x \sin ydydx$, (C) $\int_0^\pi \int_0^y x \sin ydydx$, (D) $\int_0^\pi \int_0^y x \sin ydydx$

7. Find the volume of the region in the first octant between the cylinder $z = y^2$ and the $xy$-plane that is bounded by the planes $x = 0$, $x = 1$, $y = 0$ and $y = 1$. 
8. Calculate the integral:
\[ \iint_D \frac{y}{1 + x^2} \, dA \]

where \( D \) is the bounded by \( y = \sqrt{x} \), \( y = 0 \) and \( x = 1 \).

9. Calculate the iterated integral by first reversing the order of integration.
\[ \int_0^1 \int_x^1 \cos(y^2) \, dy \, dx \]

10. Find the volume of the tetrahedron in the first octant bounded by the three coordinate planes, and the plane \( 3x + 4y + 5z = 60 \).

11. Find the volume under the paraboloid \( z = x^2 + y^2 \) above the triangle enclosed by the lines \( y = x \), \( x = 0 \) and \( x + y = 2 \) in the \( xy \) plane.