Directions: Show your work, organize, and write clearly.

1. Let \( F(x, y) = (2y, x^2) \) be a vector field.
   Let \( C \) be the directed line segment from point \( A(2, 0) \) to point \( B(1, 1) \).
   Then evaluate the line integral \( \int_C F \cdot dr \). answer: \( \frac{4}{3} \)

2. Let \( F(x, y) = (3y, 4x) \) be a vector field.
   Let \( C \) be the path around the region bounded by the graphs of \( y = x^2 \) and \( y = \sqrt{x} \).
   Assume the curve \( C \) is traversed in the counter-clockwise direction.
   Apply Green’s Theorem in evaluating the line integral \( \int_C F \cdot dr \). answer: \( \frac{1}{3} \)

3. Let \( F(x, y) = (2x + 4y, 4x + 8y) \) be a vector field.
   Let \( C \) be a directed line segment that is parametrized by \( r(t) = (2t, t) \), \( 0 \leq t \leq 1 \).
   Apply the Fundamental Theorem for Line Integrals in evaluating the line integral \( \int_C F \cdot dr \). answer: 16

4. Let \( F(x, y) = \left( \frac{1}{y}e^{x/y}, -\left( \frac{x}{y^2}e^{x/y} + \pi \sin(\pi y) \right) \right) \) be a vector field.
   Let \( C \) be a line segment that is parametrized by \( r(t) = (t, -2t + 3) \), \( 0 \leq t \leq 1 \).
   Apply the Fundamental Theorem for Line Integrals in evaluating the line integral \( \int_C F \cdot dr \). answer: \( e - 1 \)

5. Convert the point \( (x, y, z) = (-\frac{3}{2}, \sqrt{3}, -1) \) in Cartesian coordinates to spherical coordinates.
   answer: \( (\rho, \theta, \phi) = (2, \frac{5\pi}{6}, \frac{2\pi}{3}) \)

6. Convert the point \( (\rho, \theta, \phi) = (2, \frac{2\pi}{3}, \frac{5\pi}{6}) \) in spherical coordinates to Cartesian coordinates.
   answer: \( (x, y, z) = (-\frac{1}{2}, \frac{\sqrt{3}}{2}, -\sqrt{3}) \)

7. Let \( F(x, y) = (xy, x) \) be a vector field.
   Let \( C \) be the directed line segment from point \( A(\frac{1}{2}, -\frac{1}{2}) \) to point \( B(1, 0) \).
   Then evaluate the line integral \( \int_C F \cdot dr \). answer: \( \frac{7}{38} \)

8. The point \( P(-\sqrt{6}, \sqrt{6}, -2) \) is given in cartesian coordinates.
   Express the point \( P \) in spherical coordinates \( (\rho, \theta, \phi) \).
   answer: \( (\rho, \theta, \phi) = (4, \frac{3\pi}{4}, \frac{2\pi}{3}) \)

9. Determine the critical points of \( f(x, y) = x^3 - 27x - y^2 + 2y \).
   answer: \((-3, 1), (3, 1)\)

10. Let \( F(x, y) = (8xy, 6x^2) \) be a vector field.
    Let \( C \) be a triangular path in the \( xy \)-plane from the origin to point \( (1, 2) \) to point \( (0, 2) \) and to the origin.
    Apply Green’s Theorem in evaluating the line integral \( \int_C F \cdot dr \). answer: \( \frac{4}{3} \)

11. Let \( F(x, y) = (ye^{xy} - 2\pi \sin(\pi x), xe^{xy}) \) be a vector field.
    Let \( C \) be a line segment that is parametrized by \( r(t) = (\frac{1}{6}, 3(t - 1)) \), \( 1 \leq t \leq 2 \).
    Apply the Fundamental Theorem for Line Integrals in evaluating the line integral \( \int_C F \cdot dr \). answer: \( e - \sqrt{3} \)

12. Evaluate \( \int \int_R \sqrt{x^2 + y^2 + z^2} \) where \( R \) is the solid enclosed by the surface \( x^2 + y^2 + z^2 = 2 \). answer: \( 4\pi \)

13. Evaluate \( \int \int_R z \) where \( R \) is the solid that is enclosed by the surfaces \( z = \sqrt{x^2 + y^2} \) and \( x^2 + y^2 + z^2 = 8 \)
    answer: \( 8\pi \)

14. Evaluate \( \int \int_R x \) where \( R \) is the solid that is enclosed by the surfaces \( z = \sqrt{3x^2 + 3y^2} \) and \( x^2 + y^2 + z^2 = 36 \).
    answer: \( 0 \)

15. Homework exercises in Section 1.4, #1-4, 45-49

16. Evaluate \( \int \int_R y \) where \( R \) is the solid in the first octant that is enclosed by the surfaces \( z = \sqrt{3x^2 + 3y^2} \) and \( x^2 + y^2 + z^2 = 36 \).
    answer: \( \frac{54\pi - 81\sqrt{3}}{2} \)