1. Calculate
\[
\int_0^1 \int_0^{\sqrt{1-y^2}} (x^2 + y^2)^{2018} \, dx \, dy
\]

2. Find the volume of the region enclosed by the plane \( z = 4 \) and the surface \( z = (2x - y)^2 + (x + y - 1)^2 \) (hint: change of variables)

3. Suppose \( E \) is the region in space bounded by the surface
\[
z = 1 - y^2
\]
and the planes \( x + z = 1, x = 0, \text{ and } z = 0 \). (a) Set up (but do not evaluate) an iterated integral for the mass of a solid with shape \( E \) and density \( \rho(x, y, z) = xyz \) in the order \( dx \, dy \, dz \). (b) Set up (but do not evaluate) an integral for the same quantity but in the order \( dz \, dx \, dy \).

4. Find the volume of the part of the ball \( \rho \leq a \) that lies between the cones \( \phi = \pi/6 \) and \( \phi = \pi/3 \), where all regions are given in spherical coordinates.

5. Consider the force field \( \mathbf{F} = < x, x > \). Let \( C \) be the curve consisting of a straight line segment from \( P = (-1,0) \) to \( Q = (0,1) \) with unit speed, and then another from \( Q = (0,1) \) to \( R = (1,0) \) with unit speed. (a) Find the work done by \( \mathbf{F} \) on a particle moving along \( C \). (b) Find a curve connecting \( P \) and \( R \) along which the work done is zero.

6. Find the values of \( a \) and \( b \) for which the vector field
\[
\mathbf{F} = < axy^2 + x^2, x^2y + bx >,
\]
is conservative. For these \( a \) and \( b \), find a potential \( f \) such that \( \mathbf{F} = \nabla f \).

7. True or False:
(a) The line integral of a vector field \( \int_C \mathbf{F} \cdot d\mathbf{r} \) is independent of the direction of the curve \( C \) (i.e., does not change if the direction is reversed).
(b) If $F$ is a vector field such that $\int_C F \cdot dr = 0$ and $\int_C F \cdot n ds = 0$ for every simple closed curve $C$ in the plane, then $F$ must be constant.

(c) If $\int_C F \cdot dr = 0$ for every curve $C$ in the plane, then $F$ must be identically zero.

8. Consider the parameterized curves:

$$C_1 : r(t) = \langle t, \sin(3t) \rangle, \ t \in [0, \pi]$$

$$C_2 : r(t) = \langle \pi/2 + (\pi/2) \cos(t), (\pi/2) \sin(t) \rangle, \ t \in [0, \pi].$$

Let $C := C_1 + C_2$ (i.e., $C_1$ followed by $C_2$). (a) Draw a sketch of $C$. (b) Use Green’s theorem applied to an appropriate vector field to find the area enclosed by $C$. (c) Let $F = \langle x + y + \pi, x + y + 2 \pi \rangle$. What is the flux $\int_C F \cdot n ds$ of $F$ across $C$?