1. Evaluate \[ \int_{0}^{1} \int_{y}^{x} (x^2 + y^2) \, dy \, dx. \]

\[ \int_{0}^{1} \frac{1}{2} \left[ x^2 - y^2 \right] \, dx = \left[ \frac{x^3}{3} - \frac{y^2}{2} \right]_{0}^{1} = \frac{1}{3} - \frac{1}{2} = -\frac{1}{6} \]

2. Evaluate \[ \int_{0}^{1} \int_{0}^{\gamma} e^{x+y} \, dx \, dy. \]

\[ \int_{0}^{\gamma} e^{x+y} \, dx = e^{y} \left[ e^{x} \right]_{0}^{\gamma} = e^{y} (e^\gamma - 1) \]

\[ = e^{y} (e^\gamma - 1) \]

3. Evaluate \[ \int_{0}^{\gamma} e^{x+y} \, dx \, dy. \]

\[ \int_{0}^{\gamma} e^{x+y} \, dx = e^{y} \left[ e^{x} \right]_{0}^{\gamma} = e^{y} (e^\gamma - 1) \]

\[ = e^{y} (e^\gamma - 1) \]
3. Set up a double integral in polar coordinates and evaluate to find the area of the region in the first quadrant that lies between the circles \( x^2 + y^2 = a \) and \( x^2 + y^2 = b \).

\[
\int_{0}^{\pi/2} \int_{a}^{b} r \, dr \, d\theta
\]

4. Given \( f(x, y) \) by \( d \), set up an equivalent double integral(s) with the order of integration reversed. DO NOT EVALUATE THE INTEGRAL(S).
8. Set up a triple integral(s) to find the volume of the solid bounded by the paraboloid \( z = 4x^2 + 4y^2 \) and the plane \( z = k \). DO NOT EVALUATE THE INTEGRAL(S).

\[
\iiint_D \, dz \, dy \, dx
\]

6. Use triple integrals to find the mass \( M \), the center of mass \( \bar{z} \), and the moment about the x-axis \( M_{xy} \) of the solid bounded by \( x = 0 \), \( y = 0 \), \( z = 0 \), \( y = 1 - x \), and \( z = 1 - x^2 \). The density of the region is given by \( \delta(x, y, z) = x + 1 \). Set up all of your integrals in the order of integration you choose. DO NOT EVALUATE THE INTEGRALS.

\[
M = \iiint_D \delta(x, y, z) \, dz \, dy \, dx
\]

\[
M_{xy} = \iiint_D (1-x)(x^2 + y^2) \, dz \, dy \, dx
\]

\[
\bar{z} = \frac{M_{xy}}{M}
\]
7. Use the technique of Lagrange Multipliers to find the point on the plane $2x - y + z = 3$ that is closest to the point $(-4, 1, 3)$.

$\min \quad (x - 1)^2 + (y - 1)^2 + (z - 3)^2$ \quad (3)

subject to $y (x, y, z) = 2x - y + z = 3$ \quad (1)

$\nabla f = \lambda \nabla g$

$2(x-1) = \lambda \cdot 2 \Rightarrow x = 1 - \frac{\lambda}{2}$ \quad (5)

$2(y-1) = \lambda \cdot (-1) \Rightarrow y = \frac{2 - \lambda}{2} = 1 - \frac{\lambda}{2}$ \quad (6)

$2(z-3) = \lambda \cdot (1) \Rightarrow z = 3 + \frac{\lambda}{2}$

$2x - y + z - 3 = 0 \Rightarrow 2(\lambda - 1) - (1 - \frac{\lambda}{2}) + (3 + \frac{\lambda}{2}) - 3 = 0$

$2\lambda - 9 = 0 \Rightarrow \lambda = 3$

$x = 3 - \frac{\lambda}{2} = -1$

$y = 1 - \frac{\lambda}{2} = -1$

$z = 3 + \frac{\lambda}{2} = 9$

$(-1, -\frac{1}{2}, \frac{9}{2})$