1. (a) Find a function \( f \) such that \( \mathbf{F} = \nabla f \) and (b) use part (a) to evaluate \( \int_C \mathbf{F} \cdot d\mathbf{r} \) along the given curve \( C \).

\[
\mathbf{F}(x, y, z) = 2xy^2z^2 \mathbf{i} + 2x^2yz^2 \mathbf{j} + 2x^2y^2z \mathbf{k},
\]

\[C : x = t^3, \quad y = t^2 + 1, \quad z = 2t + 1, \quad 0 \leq t \leq 1.\]

Ans. to (a): \( f = \)

Ans. to (b):
2. Evaluate the line integral
\[ \int_C y^2 \, dx + x^2 \, dy + xyz \, dz \]
where \( C : x = t^2, \ y = 3t, \ z = t^3, \ 0 \leq t \leq 1. \)

Ans.:
3. Evaluate

\[ \int \int \int_E (5x^2 + 5y^2 + 5z^2) \, dV, \]

where \( E \) is bounded by the \( yz \)-plane and the hemispheres \( x = -\sqrt{1 - y^2 - z^2} \) and \( x = -\sqrt{4 - y^2 - z^2} \).

Ans.: 3
4. Evaluate the triple integral
\[ \int \int \int_E 20yz \cos(x^5) \, dV \]
where
\[ E = \{(x, y, z) \mid 0 \leq x \leq 1, 0 \leq y \leq x, x \leq z \leq 2x\} \]

\textbf{Ans.:} 4
5. Find the Jacobian of the transformation from \((x, y, z)\)-space to \((u, v, w)\)-space.

\[
x = uv, \quad y = uw, \quad z = vw.
\]

Ans.:
6. Evaluate the integral
\[ \int \int_D 4e^{-2x^2-2y^2} \, dA , \]
where \( D \) is the region bounded by the semi-circle \( y = \sqrt{9-x^2} \) and the \( x \)-axis.

Ans.:
7. Sketch the region of integration and change the order of integration.

\[ \int_0^2 \int_{x}^{8} F(x, y) \, dy \, dx \]

Ans.: 

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8. Calculate the iterated integral

\[ \int_{1}^{2} \int_{0}^{1} (6x + 6y^2) \, dx \, dy \]

Ans.:
9. Use Lagrange multipliers to find the maximum and minimum values of \( f(x, y) = 4x + 6y \) subject to the constraint \( x^2 + y^2 = 13 \).

\[ \text{maximum value:} \]

\[ \text{minimum value:} \]
10. Find the local maximum and minimum values and saddle point(s) of the function \( f(x, y) = (1 + xy)(x + y) \)

local maximum value(s):

local minimum value(s):

saddle point(s):