

- A. Let $\mathbf{G} = \langle y^2z, \sin(xy), x^2 + y^2 \rangle$ and let $f(x, y, z)$ be a function satisfying $\nabla f = \langle e^{-x^2}, \sin(y), z^3 \rangle$. Calculate $\frac{\partial}{\partial x}(f(\mathbf{G}))$.
- B. Compute the area of the region where $1 \leq xy^2 \leq 2$ and $1 \leq x^2y^3 \leq 2$. Hint: use a change of coordinates.
- C. Let C be the semicircle $(x - 2)^2 + (y - 3)^2 = 4$, $y \geq 3$ (oriented counterclockwise), and let $\mathbf{F} = \langle 2x + y^2, 2xy + 3x \rangle$. Compute $\int_C \mathbf{F} \cdot d\mathbf{r}$. Hint: compute part of it directly and the rest using the Fundamental Theorem of Line integrals.
- D. Find the center of mass of the hemispherical shell $z = \sqrt{1 - x^2 - y^2}$ assuming it has mass density function $1 - z$.
- E. Compute the flux of $\mathbf{F} = \langle y^2z, x - ye^z, e^z + z \rangle$ through the hemisphere $x^2 + y^2 + z^2 = 4$, $z \geq 0$. Hint: use the divergence theorem to relate this to the flux through a different surface.
- F. A particle moves along the intersection of the surfaces $x^2 + y^2 + z^2 = 2$ and $z = x^2 - y^2$. Suppose that $\langle x(0), y(0), z(0) \rangle = \langle 1, 1, 0 \rangle$ and $x'(0) = 1$. Find $y'(0)$ and $z'(0)$.
- G. Parameterize the surface obtained by rotating the plane curve $y = x^2 + 1$, $0 \leq x \leq 2$ around the x -axis. Use the parameterization to find the tangent plane at $(1, 1, \sqrt{3})$.
- H. The plane $x + y + 2z = 2$ intersects the paraboloid $z = x^2 + y^2$ in an ellipse. Find the points on the ellipse nearest to and farthest from the origin.

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