1) Find the area of the portion of the plane $z = -x$ inside $x^2 + y^2 = 9$

2) Compute the following surface integral

$$\int\int_S x \, d\sigma$$

where $S$ is $\{(x, y, z) | y = x^2, 0 \leq x \leq 2, 0 \leq z \leq 3\}$.

3) Use the divergence theorem to compute the flux of $\vec{F} = x^2 \, \vec{i} + xz \, \vec{j} + 3z \, \vec{k}$ out of solid sphere $x^2 + y^2 + z^2 \leq 4$.

4) Let $\vec{F} = x \, \vec{i} + y \, \vec{j} + z \, \vec{k}$, and suppose that the surface $S$ bounds a region $V$ to which the divergence theorem applies. Calculate

$$\int\int_S \vec{F} \bullet \vec{n} \, d\sigma$$

where $\vec{n}$ is the outward pointing normal to $S$.

5) Let $f(x, y, z)$ be a function on a region $V$ such that

$$\frac{\partial^2 f}{\partial x^2} + \frac{\partial^2 f}{\partial y^2} + \frac{\partial^2 f}{\partial z^2} = 0$$

1. Calculate $\nabla \bullet (\nabla f)$ and $\nabla \bullet (f \nabla f)$ in terms of $f$ and $\nabla f$.
2. Compute the flux of $\nabla f$ for a surface $S$, bounding a region $V$, to which the divergence theorem applies.
3. Show that

$$\int\int_S (f \nabla f) \bullet \vec{n} \, d\sigma = \int\int\int_V ||\nabla f||^2 \, dV$$