1. Find the mass of a piece of wire described by the curve $x^2 + y^2 = 1$ from $(1,0)$ to $(-1,0)$ if it has density function $\rho(x,y) = 3 + x + y$.

2. Evaluate the line integral $\int_C (3 + x + y)\, dy$ where C is as in problem 1.

3. Compute the work done by the vector field $\mathbf{F} = \begin{pmatrix} y \\ x \\ z \end{pmatrix}$ along the helix of radius 1 between the points $(1,0,0)$ and $(0,1,\pi/2)$.

4. Find the flux of the vector field $\mathbf{F} = \begin{pmatrix} 2x \\ 2y \\ 2z \end{pmatrix}$ over the union of the cylinder given by $x^2+y^2 = 9$, with $0 \le z \le 5$ and the plane $z = 5$ (so this is a cylinder with a cap on one end). Do this computation two ways: directly and using Green's theorem.

5. Find the surface area of the surface Σ, the paraboloid $z = 16 - x^2 - y^2$ where $z \ge 0$.

6. Let $f(x,y) = e^x + xy$ and $\mathbf{F} = \nabla f$. Calculate $\int_C \mathbf{F} \cdot d\mathbf{s}$ for each of the following curves:

   (a) C is the curve $y = x^2$ from $(0,0)$ to $(1,1)$.

   (b) C is the curve parametrized by $\gamma(t) = \begin{pmatrix} (\sin t)e^{\cos t^2 + \sqrt{t}} \\ \sin t + \cos t \end{pmatrix}$ with $0 \le t \le \pi$.

7. Let Σ be a disk of radius 6 centered around the z-axis in the plane $z = -4$ with an upward pointing normal. Find the flux of $\mathbf{F} = \begin{pmatrix} 2x^2y \\ x + y \\ z + 4 \end{pmatrix}$. Do this problem without doing any computations (though you may do the computation to check your answer).

8. Find the total charge over the spherical surface $x^2 + y^2 + z^2 = 4$ if the density of the charge is $\rho(x,y,z) = x^2 + y^2 + z^2$.