1. Find the volume of the solid lying within the sphere $\rho = 4\cos\phi$ and below the cone $\phi = \pi/4$.

2. Use spherical coordinates to express the following sum of integrals as a single integral:

$$\int_{-2\sqrt{2}}^{0}\int_{0}^{\sqrt{8-x^2}}\int_{-\sqrt{8-x^2-y^2}}^{0} x\,dz\,dy\,dx + \int_{0}^{2}\int_{x}^{\sqrt{8-x^2}}\int_{-\sqrt{8-x^2-y^2}}^{0} x\,dz\,dy\,dx$$

3. Express the integral

$$\int_{-2}^{2}\int_{0}^{\sqrt{4-y^2}}\int_{0}^{x}(x^2+y^2)\,dz\,dx\,dy$$

in cylindrical coordinates (do not evaluate the integral).

4. Let $\mathbf{I}$ denote the integral $\int_0^1 \int_0^z \int_x^z ze^{-y^2}\, dy\, dx\, dz$.

   (a) Rewrite the integral in the order $dydzdx$.

   (b) Rewrite the integral in the order $dzdydx$.

   (c) Rewrite the integral in the order $dxdydz$.

5. [6 pts] Consider the triple integral

$$\int_0^2 \int_0^{2-y} \int_0^{\sqrt{8-2y^2}} f(x,y,z) dzdxdy$$

   Express the integral so that the order of integration is $dxdydz$.

Points earned: ______
out of a possible 6 points

6. [8 pts] If you take the circle $(y - \frac{1}{2})^2 + z^2 = \frac{1}{4}$ in the yz-plane and rotate it about the z-axis, the resulting surface is called a *torus*. Its equation in spherical coordinates is $\rho = \sin\phi$.

   The surface whose equation is $\rho = \cos\phi$ is a sphere.

   (a) Convert the equation of the sphere $\rho = \cos\phi$ to Cartesian coordinates (i.e. x, y, z coordinates) and identify its radius and center.

   (b) Integrate the function $\sigma(x, y, z) = \dfrac{1}{\sqrt{x^2 + y^2 + z^2}}$ over the solid region E that lies inside the sphere $\rho = \cos\phi$ and outside the torus $\rho = \sin\phi$.