Determine whether San Diego lies in the *southern* half of the northern hemisphere or the *northern* half of the northern hemisphere, as follows. The latitude of San Diego is 33 degrees north of the equator. Assume the earth is a sphere of radius 1, that is, the unit of distance used is earth radii (about 6366 kilometers).

1. Let $\mathbf{r}(u, v) = \left( \sqrt{1 - v^2} \cos u, \sqrt{1 - v^2} \sin u, v \right)$, $0 \leq u \leq 2\pi$, $0 \leq v \leq 1$. (This provides a parametrization for the entire northern hemisphere.)

   a. Show that the components of $\mathbf{r}(u, v)$ satisfy $x^2 + y^2 + z^2 = 1$.

   b. Find $|\mathbf{r}_u \times \mathbf{r}_v|$.

   c. Evaluate the area (in square earth radii) of the surface, $\int \int_D |\mathbf{r}_u \times \mathbf{r}_v| \, du \, dv$.

2.a. Repeat exercise #1c, but with $\mathbf{r}(u, v) = \left( \sqrt{1 - v^2} \cos u, \sqrt{1 - v^2} \sin u, v \right)$, $0 \leq u \leq 2\pi$, $0 \leq v \leq \sin 33^\circ$. (This represents the area of the portion of the northern hemisphere which lies south of San Diego.)

   b) What percentage of the northern hemisphere lies south of San Diego?