1. Find a parameterization $f$ and corresponding region $R$ for the helicoid shown. Note the helicoid wraps around the $z$-axis three times, and the points on the outer helix boundary are 2 units from the $z$-axis; finally, the bottom is 1 unit below the $x$ axis and the top is 2 units above it.

2. Recall one way to parameterize the unit sphere is

$$f(s, t) = (\cos(s) \cos(t), \cos(s) \sin(t), \sin(s)),$$

for $(s, t)$ in the rectangle $R = [-\pi/2, \pi/2] \times [0, 2\pi]$.

Find a subset $A$ of $R$ such that the parameterization $f$ restricted to $A$ yields the part of the sphere shaded in below. The lines connecting the poles are called meridians, or lines of longitude. They are 9 degrees apart on this figure. The bold meridian passes through $(1, 0, 0)$. Also shown is the “equator”, which is the unit circle in the $xy$ plane. The lines running parallel to it are called “parallels”, or lines of latitude. On this figure they are 6 degrees apart. Give your answer in terms of radians.

3. Consider the surface $M$ having the parameterization given by $f(s, t) = (s^2, t^3, s + t)$ over the region in the $st$ plane bounded by $s = 1$, $s = 2$ and the curves $t = s^2$ and $t = 6 - s$. Set up the double integral (with appropriate limits on the integrals) which represents the surface area of $M$. Simplify the integrand as much as possible.

4. Let $M$ be as in (3). Let $g(x, y, z) = y + xz$. Set up the integral $\int \int_M g \, d\sigma$; simplify the integrand as much as possible.