Some answers will involve π, square roots, fractions, etc. Do not round off.

(1) (20 pts.) Let \( R \) be the region inside the circle \( r = 2 \sin \theta \) and outside the circle \( r = 1 \).

(a) Set up a double integral for the area of \( R \). Do not evaluate.

(b) If the density function is \( \rho = 1/r \), evaluate a double integral to find the mass of \( R \).

(c) Let \( S \) be the surface defined by \( z = 5 - x^2 - y^2 \). Set up a double integral for the surface area of the part of \( S \) that lies over \( R \). Do not evaluate.

(2) (10 pts.) Let \( S \) denote the plane \( x - y + z = 10 \). Find the surface area of the portion of \( S \) that lies above the given region \( R \).

(a) \( R \) is the rectangular region in the \( xy \)-plane with vertices \((0, 0), (0, 2), (3, 0), (3, 2)\).

(b) \( R \) is the circular region in the \( xy \)-plane inside the circle with polar equation \( r = 2 \cos \theta \).

(3) (20 pts.) Solve this integral by first reversing the order of integration.

\[
\int_0^1 \int_{2x}^1 \sin (y^2) \, dy \, dx
\]

(4) (20 pts.) Let \( E \) be the solid tetrahedron with vertices \((0,0,0), (1,1,0), (0,2,0), (0,2,2)\).

(a) Write \( \iiint_E \, dV \) as an iterated integral.

(b) Find the volume of \( E \) using any method. Specify the method used.

(c) If the density function is \( \rho = y + x \), evaluate a triple integral to find the mass of \( E \).

(5) (20 pts.) Let \( E \) denote the region inside the cylinder \( x^2 + y^2 = 1 \) and inside the sphere \( x^2 + y^2 + z^2 = 4 \). That is, \( E \) is defined by the inequalities \( x^2 + y^2 \leq 1 \) and \( x^2 + y^2 + z^2 \leq 4 \).

Write \( \iiint_E \, dV \) as an iterated integral using

(a) Cylindrical coordinates. Do not evaluate.

(b) Rectangular coordinates. Do not evaluate.

(6) (10 pts.) Let \( E \) be the region between the spheres \( x^2 + y^2 + z^2 = 1 \) and \( x^2 + y^2 + z^2 = 4 \) in the first octant. Evaluate \( \iiint_E \, z \, dV \).