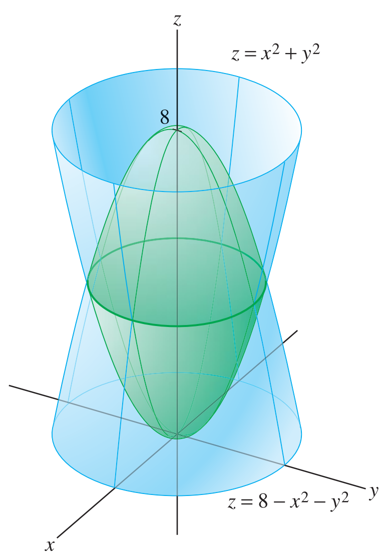
1. Let S be the solid region which is inside the sphere given by $x^2 + y^2 + z^2 = 4$ and above the plane where $z = 1$. Assume that x, y, and z are measured in meters. Suppose the density of the solid region S is given by $\delta(x, y, z) = \dfrac{1}{x^2 + y^2 + z^2}$ kg/m^3. Find the total mass of the solid region S.

2. Use spherical coordinates to find the volume of the solid that lies above the cone $z = \sqrt{x^2 + y^2}$ and below the sphere $x^2 + y^2 + z^2 = z$.

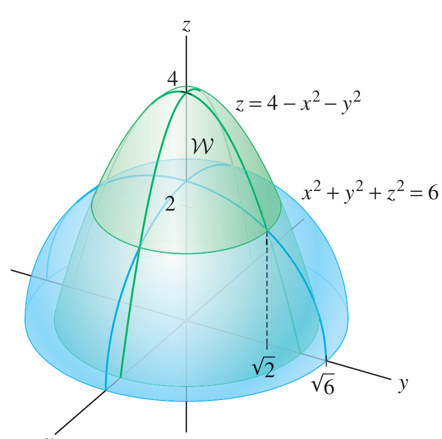
3. Let S be the solid region in the 1st octant (i.e., where $x \geq 0$, $y \geq 0$, and $z \geq 0$) in $\mathbb{R}^3$ which lies inside the (top) hemisphere where $x^2 + y^2 + z^2 = 4$ and $z \geq 0$ but lies outside the cylinder where $x^2 + y^2 = 1$, and bounded by the planes with equations $y = x$ and $y\sqrt{3} = x$. Compute the volume of the solid region S.

4. Let S be the solid region which is bounded by the half-cones where $z = \sqrt{x^2 + y^2}$ and $z\sqrt{3} = \sqrt{x^2 + y^2}$, and inside the cylinder where $x^2 + y^2 = 4$ and outside the cylinder where $x^2 + y^2 = 1$. Assume that x, y, and z are measured in meters. Suppose the density of the solid region S is given by $\delta(x, y, z) = \dfrac{1}{x^2 + y^2 + z^2}$ kg/m^3. Find the total mass of the solid region S.

5. Find the volume of the region in the following figure.



6. Let S be the solid region above the sphere $x^2 + y^2 + z^2 = 6$ and below the paraboloid $z = 4 - x^2 - y^2$.
   (a) Sketch the projection of S onto the xy-plane.
   (b) Compute the volume of the solid S.



7. Calculate the triple integral of $f(x, y, z)$ over the given region.

   (a) $f(x, y, z) = 1;\; x^2 + y^2 + z^2 \le 4z;\; z \ge \sqrt{x^2 + y^2}$

   (b) $f(x, y, z) = \sqrt{x^2 + y^2 + z^2};\; x^2 + y^2 + z^2 \le 2z$

8. Express the triple integral in cylindrical coordinates.

$$\int_0^2 \int_0^{\sqrt{2x - x^2}} \int_0^{\sqrt{x^2 + y^2}} f(x, y, z)\, dz\, dy\, dx$$