17. $\rho$ ranges from 0 to 3, putting us inside a sphere of radius 3 centered at the origin. $\theta$ ranges from 0 to $\pi/2$, putting us above or below the first quadrant in the $xy$-plane. Finally, $\phi$ ranges from 0 to $\pi/6$, putting us inside a cone (and sphere) measuring 30 degrees down from the $z$-axis. Note that we only get the portion in the first octant. See the back of the book for a graph. (It’s a quarter of a snow cone.)

18. Since $\rho$ ranges from 1 to 2, we are inside a spherical shell with inner radius 1 and outer radius 2. Taking $\phi$ from $\pi/2$ to $\pi$ puts us below the $xy$-plane, and taking $\theta$ from 0 to $2\pi$ gives us the entire shell below the $xy$-plane. We get

$$
\int_{0}^{2\pi} \int_{\pi/2}^{\pi} \int_{1}^{2} \rho^2 \sin \phi \, d\rho \, d\phi \, d\theta = \frac{14}{3} \pi.
$$

20. In this one, $\rho$ ranges from 1 to 2, $\theta$ from $\pi/2$ to $2\pi$, and $\phi$ from 0 to $\pi/2$. We have

$$
\int_{0}^{\pi/2} \int_{\pi/2}^{2\pi} \int_{1}^{2} f(\rho \sin \phi \cos \theta, \rho \sin \phi \sin \theta, \rho \cos \phi) \rho^2 \sin \phi \, d\rho \, d\phi \, d\theta.
$$

21. $\int_{0}^{2\pi} \int_{0}^{\pi} \int_{0}^{5} (\rho^4) \rho^2 \sin \phi \, d\rho \, d\phi \, d\theta = \frac{4(5^7)}{7} \pi.$

23. $\int_{0}^{\pi/2} \int_{0}^{\pi/2} \int_{0}^{2} (\rho \cos \phi) \rho^2 \sin \phi \, d\rho \, d\phi \, d\theta = \frac{15}{16} \pi.$

29. The sphere in question sits on the origin and has a radius of 2: $\rho = 4 \cos \phi$ implies that $\rho^2 = 4 \rho \cos \phi$, or $x^2 + y^2 + z^2 = 4z$, so $x^2 + y^2 + (z - 2)^2 = 4$. We get

$$
\int_{0}^{2\pi} \int_{0}^{\pi/3} \int_{0}^{4 \cos \phi} \rho^2 \sin \phi \, d\rho \, d\phi \, d\theta = 10\pi.
$$

35. This looks spherical to me. The given cone can be written as $\phi = \pi/4$. The volume is

$$
\int_{0}^{2\pi} \int_{0}^{\pi/4} \int_{0}^{1} \rho^2 \sin \phi \, d\rho \, d\phi \, d\theta = \frac{2 - \sqrt{2}}{3} \pi.
$$

By symmetry, the centroid will lie on the $z$-axis, so we only need to compute

$$
\bar{z} = \frac{M_{xy}}{m} = \int_{0}^{2\pi} \int_{0}^{\pi/4} \int_{0}^{1} (\rho \cos \phi) \rho^2 \sin \phi \, d\rho \, d\phi \, d\theta
\int_{0}^{2\pi} \int_{0}^{\pi/4} \int_{0}^{1} \rho^2 \sin \phi \, d\rho \, d\phi \, d\theta = \frac{3}{8(\sqrt{2} - 2)}.
$$

36. Go spherical!

$$
\int_{0}^{\pi/6} \int_{0}^{\pi} \int_{0}^{a} \rho^2 \sin \phi \, d\rho \, d\phi \, d\theta = \frac{\pi a^3}{9}.
$$