1. Write down a triple integral in cylindrical coordinates that represents the volume of the solid inside the cone \( z = \sqrt{4x^2 + 4y^2} \) and below the sphere \( z = \sqrt{45 - x^2 - y^2} \).

Triple Integral in Cylindrical Coordinates:

\[
\int_0^{2\pi} \int_0^3 \int_{\sqrt{45-r^2}}^{\sqrt{4r^2}} r \, dz \, dr \, d\theta
\]

Solution: The cone and sphere intersect when 
\( \sqrt{4x^2 + 4y^2} = \sqrt{45 - x^2 - y^2} \) which after squaring and simplifying gives \( x^2 + y^2 = 9 \). So we are interested in points in the \( xy \)-plane which are inside the circle of radius 3 centered at the origin. In polar coordinates, we therefore want \( 0 \leq \theta < 2\pi \) and \( 0 \leq r \leq 3 \). The two equations \( z = \sqrt{4x^2 + 4y^2} \) and \( z = \sqrt{45 - x^2 - y^2} \) convert to \( z = \sqrt{4r^2} = 2r \) and \( z = \sqrt{45 - r^2} \). This gives the triple integral in cylindrical coordinates as shown.

2. Fill in the six boxes below to correctly complete interchanging the order of integration.

\[
\int_0^4 \int_0^{(12-3x)/4} \int_0^{(12-3x-4y)/2} f(x, y, z) \, dz \, dy \, dx
\]

\[
= \int_0^6 \int_0^{(6-z)/2} \int_0^{(12-4y-2z)/3} f(x, y, z) \, dx \, dy \, dz
\]

Solution: The picture to the right can be an optical illusion, so look at it correctly. The \( x \)-axis is numbered from 0 to 4 and is coming outward from the page. The plane on the right is given by \( z = (12 - 3x - 4y)/2 \) or equivalently by \( 3x + 4y + 2z = 12 \). This intersects the \( yz \)-plane (the plane \( x = 0 \)) at the line \( 4y + 2z = 12 \), simplifying to \( 2y + z = 6 \). Using this information as a guide produces the answers above.