**1.** The triple integral

$$\int_{-3}^{3}\int_{0}^{\sqrt{9-x^2}}\int_{0}^{\sqrt{x^2+y^2}} 8(x^2+y^2)dzdydx$$

when converted to cylindrical coordinates becomes ...

*Proof.* Our bounds give us the following inequalities:

$$-3 \le x \le 3, \qquad 0 \le y \le \sqrt{9-x^2}, \qquad 0 \le z \le \sqrt{x^2+y^2}.$$

In cylindrical coordinates, $r^2 = x^2+y^2$, so $0 \le z \le \sqrt{r^2} = r$. In the $xy$-plane, $-3 \le x \le 3$ and $0 \le y \le \sqrt{9-x^2}$ tell us that the projection of our region is bounded by the upper semi-circle of radius 3. Hence, $0 \le r \le 3$ and $0 \le \theta \le \pi$. So, our integral becomes

$$\int_0^{\pi}\int_0^3\int_0^r 8(r^2)rdzdrd\theta = \int_0^{\pi}\int_0^3\int_0^r 8r^3dzdrd\theta,$$

where the additional factor of $r$ in the integrand is from our coordinate change. Therefore, the correct option is $B$. □

**2.** Which of the following integrals represents the volume of the solid in the first octant that is bounded on the side by the surface $x^2+y^2=4$ and on top by the surface $x^2+y^2+z=4$?

*Proof.* Since our solid is restricted to the first octant, then $x \ge 0, y \ge 0$, and $z \ge 0$. From our top bound, we have that $z = 4-x^2-y^2$, so $0 \le z \le 4-x^2-y^2$. In the $xy$-plane, our solid is bound by $x^2+y^2=4$, i.e., the circle of radius 2. Since we are restricted to the first octant, then we have a semi-circle with radius 2, so $0 \le y \le \sqrt{4-x^2}$ and $0 \le x \le 2$ sufficiently describes the region. Thus, the integral is

$$\int_0^2\int_0^{\sqrt{4-x^2}}\int_0^{4-x^2-y^2} dzdydx,$$

where we integrate over 1 as we want to recover the volume of the solid. Thus, the correct answer is $C$. □