Show all work, including mental steps, in a clearly organized way that speaks for itself. Use proper mathematical notation, identifying expressions by their proper symbols (introducing them if necessary) and using equal signs when appropriate. [Box] Final short answers requested.

\[ \int_{0}^{2} \int_{-\sqrt{4-x^2}}^{\sqrt{4-x^2}} x \, dy \, dx \]

\( a) \) Make a labeled diagram illustrating the region of integration.

\( b) \) Re-express the double integral by converting to polar coordinates and evaluate the new double integral.

\( y = \pm \sqrt{4-x^2} \) \( \quad \) circle of radius 2

\( x^2 + y^2 = 4 \) \( \quad \) from lower half circle to upper half circle

\( r = 2 \) \( \quad \) between \( x = 0 \) and \( x = 2 \)

\( y = -\sqrt{4-x^2} \)

\( y = \sqrt{4-x^2} \)

\( x^2 y^2 = 4 \) \( (r = 3) \)

\( 0 \leq r \leq 2 \), \( -\frac{\pi}{2} \leq \theta \leq \frac{\pi}{2} \)

\[ \int_{-\frac{\pi}{2}}^{\frac{\pi}{2}} \int_{0}^{2} r^2 \cos^3 \theta \, dr \, d\theta \]

\[ = \int_{-\frac{\pi}{2}}^{\frac{\pi}{2}} \left[ \frac{r^4}{2} \cos^3 \theta \right]_{r=0}^{r=2} \, d\theta \]

\[ = \int_{-\frac{\pi}{2}}^{\frac{\pi}{2}} \frac{2^4}{2} \cos^3 \theta \, d\theta \]

\[ = \frac{2^3}{3} \cos \theta \bigg|_{-\frac{\pi}{2}}^{\frac{\pi}{2}} \]

\[ = \frac{8}{3} \cdot 1 = \frac{8}{3} \]

\[ \therefore \text{Result} = \frac{16}{3} \]