I. (8 pts.) Evaluate $\int_0^6 \int_0^y x \ dy \ dx$.

Answer: 36

2. (12 pts.) Sketch the region of integration in the integral in (1) and write an equivalent double integral with the order of integration reversed. Evaluate your new integral.

\[
\int_0^6 \int_x^6 x \ dy \ dx = 36
\]

3. (14 pts.) Change the Cartesian integral into an equivalent polar integral. Then evaluate the polar integral.

\[
\int_{\frac{\pi}{4}}^{\frac{\pi}{2}} \int_0^{\frac{6}{\sqrt{2} \sin \theta}} r^2 \cos \theta \ dr \ d\theta
\]

II. (12 pts.) Set up only a double integral to find the area of a thin plate occupying the smaller region cut from the ellipse $x^2 + 4y^2 = 12$ and the parabola $x = 4y^2$.

\[
\int_{-1}^{\sqrt{12-4y^2}} 1 \ dx \ dy
\]

III. (14 pts.) Set up only triple integrals to find the y coordinate of the center of mass of the solid of density $x + y$ bounded by $z = 0$, $z = 2 - x$, and $x^2 + 4y^2 = 4$.

\[
\bar{y} = \frac{\int_{-1}^{1} \int_{\sqrt{4-4y^2}}^{\sqrt{12-4y^2}} \int_0^{2-x} y(x + y) \ dz \ dx \ dy}{\int_{-1}^{1} \int_{\sqrt{4-4y^2}}^{\sqrt{12-4y^2}} \int_0^{2-x} (x + y) \ dz \ dx \ dy}
\]
1. (20 pts.) Set up an integral in cylindrical coordinates to find the volume of the solid bounded by the planes \( z = 1 \) and \( z = 2 \) and the cone \( x^2 + y^2 - z^2 = 0 \). Evaluate your integral.

\[
\int_{0}^{2\pi} \int_{1}^{2} \int_{0}^{r} r \, dr \, dz \, d\theta \quad \text{or} \quad \int_{0}^{2\pi} \int_{1}^{2} \int_{0}^{r} r \, dz \, dr \, d\theta = \frac{7\pi}{3}
\]

2. (20 pts.) For the same solid, set up an integral in spherical coordinates and then evaluate it.

\[
\int_{0}^{2\pi} \int_{\frac{\pi}{4}}^{\frac{\pi}{2}} \int_{0}^{\frac{2}{\cos \phi}} \rho^2 \sin \phi \, d\rho \, d\phi \, d\theta = \frac{7\pi}{3}
\]