1. Set up, but do not evaluate, the following integrals.

(a) A double integral in polar coordinates which gives the area inside the cardioid \( r = 1 + \sin \theta \) in the right half of the plane (where \( x \)-values are positive)

\[
\int_{-\pi/2}^{\pi/2} \int_0^{1+\sin \theta} r \, dr \, d\theta
\]

(b) A triple integral which gives the volume between the cone \( x = \sqrt{4x^2 + 9y^2} \) and the plane \( x = 6 \)

\[
\int_{-2}^{2} \int_{-\sqrt{36 - 9y^2}/2}^{\sqrt{36 - 9y^2}/2} \int_{-\sqrt{4z^2 - 9y^2}/2}^{\sqrt{4z^2 - 9y^2}/2} 1 \, dx \, dz \, dy
\]

2. Suppose \( x \) and \( y \) are random variables with joint density function \( f \).

\[
f(x, y) = \begin{cases} 
3xy^2 & \text{if } 0 \leq x \leq 1, -1 \leq y \leq 1 \\
0 & \text{otherwise}
\end{cases}
\]

Find the probability that \( x \leq 1/2 \) and \( y \geq 0 \).

\[
P(x \leq 1/2, y \geq 0) = \int_0^{1/2} \int_0^1 3xy^2 \, dy \, dx
\]

\[
= \int_0^{1/2} xy^3 \Big|_{y=0}^{y=1} \, dx
\]

\[
= \int_0^{1/2} x \, dx
\]

\[
= \frac{1}{2} x^2 \Big|_{0}^{1/2} = \frac{1}{8}
\]

3. Evaluate the integral by converting it to polar coordinates.

\[
\int_{-2}^{0} \int_{0}^{\sqrt{4-y^2}} \cos(x^2 + y^2) \, dx \, dy
\]
Writing the integral in polar coordinates, we get

\[ \int_{-\pi/2}^{0} \int_{0}^{2} \cos(r^2) r \, dr \, d\theta. \]

To evaluate this, use \( u \)-substitution with \( u = r^2 \).

\[ \int_{-\pi/2}^{0} \frac{1}{2} \sin(r^2) \bigg|_{0}^{2} \, d\theta \]

\[ = \int_{-\pi/2}^{0} \frac{1}{2} \sin 4 \, d\theta \]

\[ = \frac{\pi}{4} \sin 4 \]