1. If we are given $z = z(x, y)$ and $y = y(x)$ solve for $\frac{dz}{dx}$.

2. Use the equality below

$$\int_{-\infty}^{\infty} e^{-a(x+b)^2} dx = \int_{-\infty}^{\infty} e^{-ax^2} dx = \sqrt{\frac{\pi}{a}}$$

   to compute the following integral

$$\int_{-\infty}^{\infty} e^{-ax^2+bx} dx.$$

3. Suppose that $f(x, y) = \frac{\cos x}{\ln(y)}$. Prove the statement below and interpret it geometrically

$$\left(\frac{\partial}{\partial x}\left(\frac{\partial f}{\partial y}\right)_x\right)_y = \left(\frac{\partial}{\partial y}\left(\frac{\partial f}{\partial x}\right)_y\right)_x.$$

4. Set up integrals for the following values:

   (a) The **mass** of a three dimensional ball of radius R with density equal to the distance from its surface.

   (b) The **volume** of the earth with a latitude greater than 60 (e.g. within 30 degrees or $\frac{\pi}{6}$ radians of the north or south pole.) Assume the earth has radius r.

   (c) The **mass** of a cylinder with radius R and height H with density equal to the square root it's height. We haven't discussed cylindrical coordinates, but see if you can reason through it. (Hint: start with polar coordinates).

5. Suppose it is a very sunny day and the incidence of UV radiation on a beach is given by $U(x, y) = x^2 e^y - xy^3$. Naturally, you are enjoying your beach day by running in a circle at constant speed: $x(t) = \cos t$ and $y(t) = \sin t$. Find $\frac{dU}{dt}$ in two ways:

   (a) By the chain rule.

   (b) By finding U explicitly as a function of t and differentiating.

6. **challenge:** Integrate

$$\int e^x \cos x \, dx$$

7. **challenge:** Show that $\left(\frac{\partial x}{\partial y}\right)_z = -\left(\frac{\partial x}{\partial z}\right)_y \left(\frac{\partial z}{\partial y}\right)_x$. Assume that x, y, and z are interdependent variables, e.g., they are functions of each other. If it makes it easier to conceptualize, imagine there exists some function $f(x, y, z)$, though you won't need to invoke f. (Hint: consider the total derivative of dx and dy and substitute.)