PS#20: More integrals!!!

Nueva Multivariable Calculus

1. Find the volume of the region whose top is given by the function e^x, and whose bottom is a triangle with corners at $(0,0)$, $(0,1)$, and $(1,1)$.

2. Consider the function:

$$f : \mathbb{R}^2 \to \mathbb{R}^1$$

$$f(x,y) = \frac{1}{\sqrt{x^2+y^2}}$$

   What does this look like? What's the total volume underneath this shape, above a disc (circle) with radius 1?

   Don't just come up with some sort of gross rectangular integral for this and punt it to Wolfram Alpha or Sage—this is something you can actually figure out yourselves, WITHOUT needing to debase yourselves before an algorithm! Here's a giant hint: the shape whose volume we want to find has a circular base—what coordinate system does that bring to mind?

3. Brrr! It's pretty chilly up here in the high latitudes! Despite that, the rare **arctic rose** is growing in abundance at your Alaskan outpost. Its small flowers—just [REDACTED] inches in diameter!—are described by the equation:

$$r = \cos 4\theta$$

   What do the flowers look like? Make a graph. You're a biologist, and of course you're interested in how these flowers grow so well despite the cold, and of course you know that heat loss/gain is basically proportional to surface area—what's the surface area of these flowers? (Also, what's the diameter of the flowers?)