Homework #4 (100 points) - Show all work on the following problems:
(Grading rubric: Solid attempt = 50% credit, Correct approach but errors = 75% credit, Correct original solution = 100% credit, Copy of online solutions = 0% credit)

Problem 1 (20 points):
a. Find the electric potential a distance of z above the center of a flat circular disc of radius R that carries a uniform surface charge density σ, using direct integration over the charge density.

b. Compute the z-component of the electric field from your answer to (a), and verify that you recover the solution from Problem 5 on HW #2.

Problem 2 (20 points):
a. Use Gauss's law to compute the electric field inside and outside of a long hollow cylindrical tube that carries a uniform surface charge density σ.

b. Verify that the change in electric field between the inside and the outside of the tube agrees with Eq. 2.33

Problem 3 (20 points): Consider four charges arranged in a square with sides of length a. If the upper left and lower right charges are $-q$ and the upper right and lower left are $+q$, compute the total work needed to assemble this configuration.

Problem 4 (20 points): Find the electrostatic energy stored in a solid sphere of radius R with a uniform volume charge density ρ, and thus a total charge $Q = \frac{4}{3}\pi R^3 \rho$ (same as Problems 2&5 on HW #3). Express your answers in terms of Q, not ρ.

a. First, use Eq. 2.43, with the potential you solved for last week.

b. Next, use Eq. 2.45.

Problem 5 (20 points): Consider a metal sphere of radius R carrying charge Q, surrounded by a thin concentric spherical metal shell with inner radius a and outer radius b, carrying no net charge.

a. Find the surface charge density σ at r = R, r = a, and r = b.

b. Find the electric potential at the center of the sphere, with respect to infinity.