Show your work for full credit
You may have an 8.5 x 11 sheet of notes, a scientific or graphing calculator, and scratch paper

1. (25 pts with 5 pts for each part) The figure below shows a spherical shell with uniform volume charge density $\rho=2$ µC/m^3. The inner radius $a = 20$ cm, and outer radius $b = 2.5a$. what is the magnitude of the electric field (in N/C) at the following radial distances? (a) $r = a/4$. (b) $r=a$. (c) $r = 2a$. (d) $r = b$. (e) $r = 2b$.
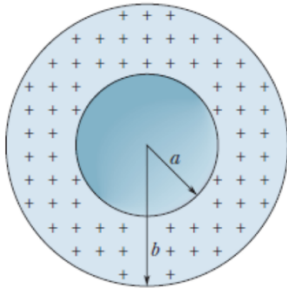

2. (15 pts) Write down the electric flux through each surface from S_1 to S_6 whose cross-section is shown below.
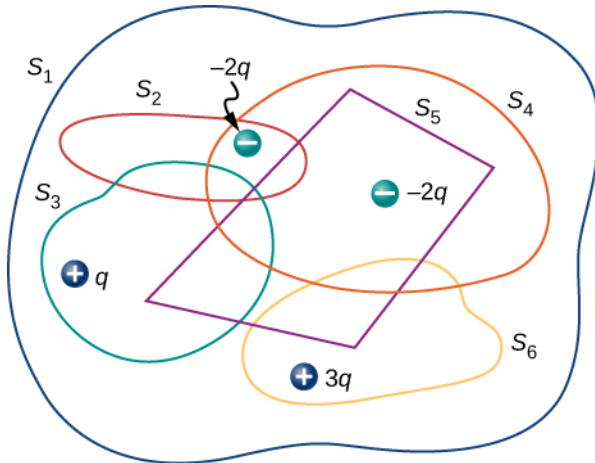
3. (20 pts) A positive charge Q is distributed uniformly throughout an insulating sphere of radius R, centered at the origin. A second charged particle with a positive charge Q is placed at $x = 3R$ on the x axis. Find the magnitude of the electric field at (a) $x = R/3$ on the x axis, (b) $x = 5R$ on the x axis. (Hint: calculate the electrical field from the sphere and point charge. Then apply the superposition principle)

4. (20 pts) Four-point charges are fixed at four corners of a square with side 1 m shown in figure below. What is the magnitude and direction of the force on the charge placed at the center of the square?

5.0 μC　　　　　　4.0 μC

2.0 μC

1.0 m

1.0 m

−4.0 μC　　　5.0 μC
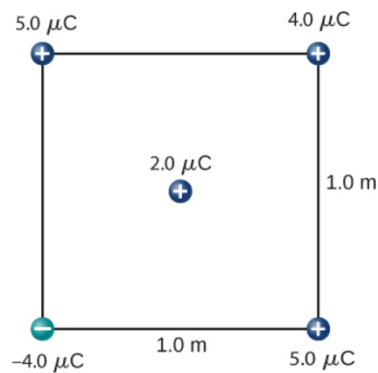
5. (20 pts) Charge is distributed throughout a very long cylindrical volume of radius R such that the charge density increase with the distance r from the central axis of the cylinder according to $\rho = \alpha * r$, where α is a constant. Calculate the electric field of this charge distribution for (a) $r \leq R$ and (b) $r \geq R$.