# Homework VII-VIII

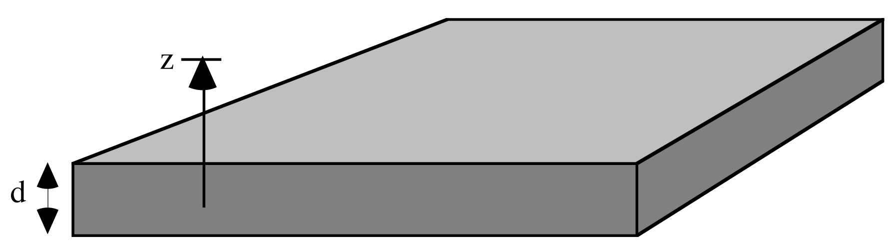
## Unit VII-Fields

1. Use Gauss's law to find the electric field as a function of distance from an infinite plane charged such that a unit area has a total charge of σ (in other words, 1 $m^2$ of surface area would contain σ Coulombs--σ is usually called a surface charge density, charge per unit area). Sketch your result. Does this look like what you saw with the E-field program?

2. A sphere of radius 0.1 m has a total charge of 0.001 C distributed on the surface (i.e. the inside of the sphere is uncharged). Use Gauss's law to find the electric field as a function of distance r from the center of the sphere for r > R. How does this compare to the field for a point charge of 0.001 C?

3. Two concentric spherical shells have equal but opposite charges on their surfaces: $10^{-5}$ C on the inner shell of radius 0.02 m and $-10^{-5}$ C on the outer shell of radius 0.04 m. Use Gauss's law to calculate the electric field as a function of distance from the center (r), and draw a graph of this function E(r).

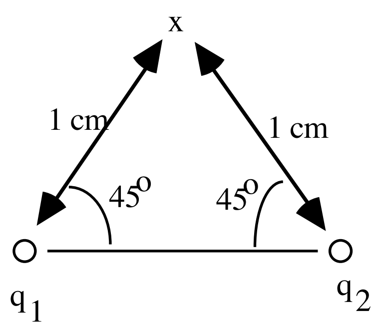
4. A large plate of thickness d has a uniform charge density throughout of $\rho=10^{-2}$ C/$m^3$, as shown in the figure. Use Gauss's law to calculate the electric field outside the plate as well as inside the plate, as a function of the distance z from the center of the plate. It may help you to note that by symmetry, the electric field right in the center of the plate (z = 0) must be zero.



5. Calculate the electric field at the point x shown below, equally distant from charge 1 and charge 2 in the following cases:

a. The two charges each have a value of $+10^{-5}$ C.
b. Charge 1 has a value of $+10^{-5}$ C and charge 2 has a value of $-10^{-5}$ C.

Make sure to add the electric fields as vectors, and report the final direction of the field.




**Unit VIII-Potential and Energy**

6. You discovered that the power lost in current flowing through a resistor was VI. Combine this with Ohm's Law (V = IR) to find expressions for power in terms of
a) V and R only
b) I and R only.

7. We have some power supplies that can supply current as large as 500 mA, and voltage up to 30 V. What is the resistance of the resistor that, when connected across the power supply, will give the most power? What is that power? This process of matching a resistance (a subset of a more general property called impedance) is called impedance matching between your load and your supply.

8. You discovered that the energy stored in a capacitor was equal to 1/2 QV. Combine this with the definition of capacitance C = Q/V to find expressions for energy stored in terms of
a) Q and C only
b) C and V only.

9. How much charge was stored in our green capacitors (C = 0.5 F) charged to their maximum value of 5 V? How much energy was stored? If this was converted entirely to mechanical potential energy, how high could this raise a 1 kg (about 2 lb, or the weight of a quart of water)?