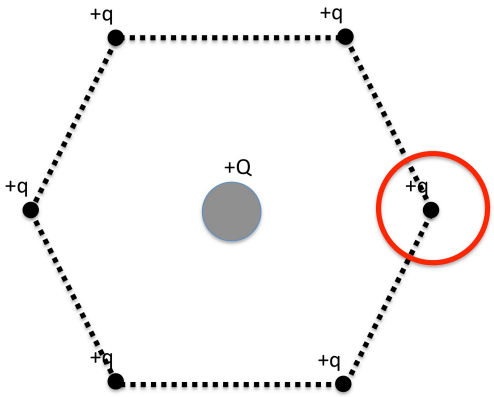
Final Exam

Name:

Problem 1



6 charges (+q) are held in a hexagonal arrangement by some plastic. Each side of the hexagon has length a.

(a) Calculate the net force (magnitude and direction) on the charge +Q at the center of hexagon

(b) Calculate the force (magnitude and direction) on the charge +Q if the charge indicated by a red circle is removed.

Problem 2

Consider a uniformly charged sphere of radius R. The charge density is given by ρ/m^3.

Calculate electric field (magnitude and direction) for
(a) r>R
(b) r<R

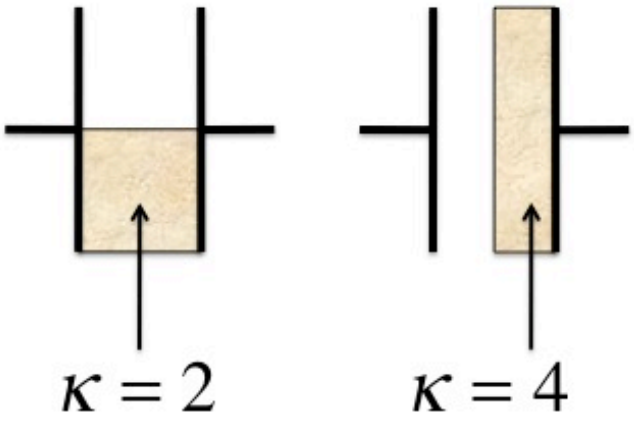
Calculate voltage (assuming V=0 at r=infinity) for
(a) r>R
(b) r<R

Problem 3

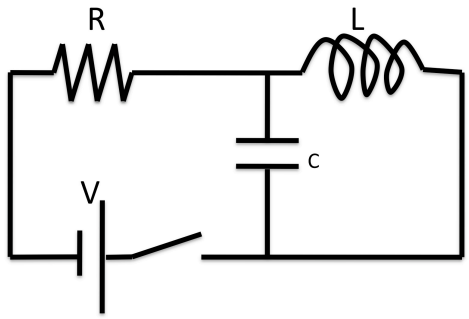
Calculate the capacitance of a spherical capacitor, which is composed of two spheres (one inside another), with inner radius a and outer radius b.

Problem 4

Parallel capacitors are half filled by dielectric materials as shown below. (a) calculate the capacitances in terms of ε_0, A, d. (b) Which capacitor has higher capacitance?



Problem 5



At t=0, the switch is closed.
(a) Calculate the current sourced by the battery at t=0
(b) Calculate the current sourced by the battery at t=infinity
(c) what is the voltage across the capacitor at t=infinity
(d) After a long time, the switch is released. Calculate the current through the capacitor as a function of time after the switch is released.

Problem 6

Consider a cylindrical wire with radius R with current I flowing through it. Calculate magnetic field for

(a) r>R

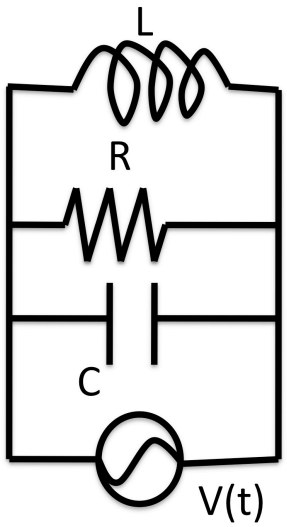
(b) r<R

assuming that current is uniformly distributed

Problem 7

Consider a coaxial cable as depicted below. Calculate the inductance per unit length for the cable if the inside wire has the diameter of a and the outside wire has a diameter of b.

Problem 8



Find the complex impedance for the parallel RLC circuit as shown. Assume that we have a voltage source for which we can adjust the angular frequency ω. $V(t)=V_{max}\cos(\omega t)$.

(a) Find the total complex impedance of the circuit
(b) Calculate I(ω).
(c) Find an expression for the phase ϕ.

(d) Given R=500 ohms, L= 1 henry, C=1.0μF and ω=100 rad/sec. Will the current lag or lead voltage and by how much?