University of California, Berkeley
Physics H7B, Spring 2007 (*Xiaosheng Huang*)

Midterm 2
Thursday, 4/19/2007
9:40-11:00 AM

1. (30 pts.) A point charge, Q, is placed between two semi-infinite conducting planes meeting at an angle of 60^0.

a) If the distance from the charge to one plane is a and to the other is b (figure 1(a)), locate all the image charges. Show that the electric potential produced by these image charges, with the appropriate signs and magnitudes, together with the charge Q satisfies the Laplace equation between the two planes and the boundary conditions on the planes.

b) If a=b, (i) calculate the electric potential, $\phi(x, y)$ everywhere between the two planes, except at the location of Q. (*Hint: Set up a coordinate system first with the origin at where the two conducting planes meet.*) (ii) Calculate the total electric force on Q. (iii) Calculate the electric field, $\boldsymbol{E}$, and the surface charge density, σ, at a point directly below Q on the horizontal plane, A.

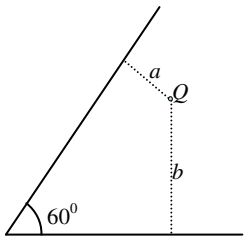


Figure 1 (a)

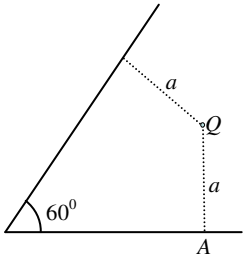
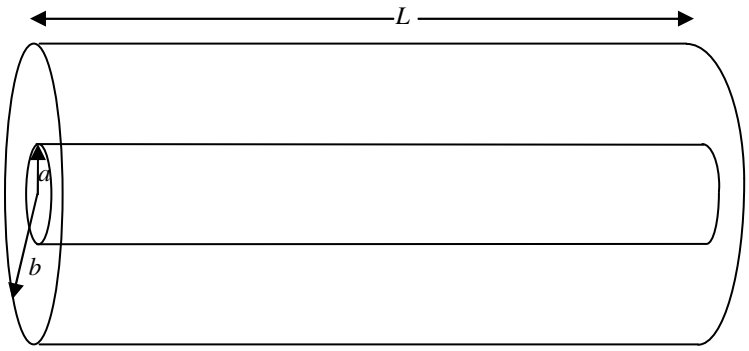


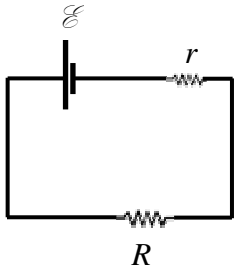
Figure 1 (b)

2) (50 pts.) Consider two concentric cylindrical conductors. The radius of the inner cylinder is a, and that of the outer cylinder is b. The length of both cylinders is L. $L \gg a$, b. The amount of charge on the outer cylinder is Q and, on the inner cylinder, $-Q$.



a) Find the electric field, $\boldsymbol{E}$, in the space between the two cylinders.
b) Find the capacitance.
c) Find the electric potential energy stored in this capacitor, using $U=1/2\ QV$.
d) Calculate the electric force between the two conductors as an external force slowly pushes the inner cylinder out.
e) Calculate the total electric potential energy by integrating the energy density of the electric field. Does it agree with part (b)?

3) (20 pts.) a) In the circuit below, the battery has EMF, $\mathscr{E}$, and internal resistance, r. If we connect this battery to a resistor with resistance, R, show that the power dissipation for R is the greatest when $R=r$.



b) Consider the circuit below. Treat the part of the circuit within the dashed line as a voltage source. Calculate its effective internal resistance and EMF. Using the result from part (a), find the value of R that will maximize the power dissipation for R.