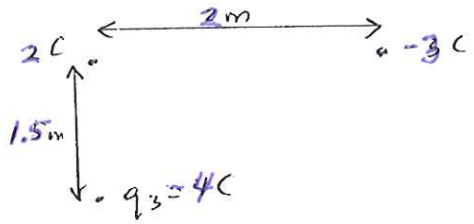
Assignment 8

1. Two equally charged 1 gram masses repel each other. The lower mass is held fixed.
   a) What is the charge on each mass for the Coulomb force to balance the gravitational force of the Earth on the upper mass?

   b) How many electrons does this charge represent?

2. Consider the three charges located at the positions below.



   c) Find the electric field on charge q_3.

   d) Find the force on q_3.

   e) What is the total potential energy of all the charges?

   f) What happens if the charges are free to move?

3. Two metal plates have a uniform charge density of 10 Coulombs/meter^2. The plates have dimensions of 0.6 x 0.6 meter^2 and are separated by 2 mm.
   a) Ignoring edge effects, the electric field (volts/meter) between the two plates is given by $E = 1.13 \times 10^{11} Q / A$ where Q is the charge in Coulombs on one plate and A is the area in meters^2. Evaluate the field.

   b) What is the voltage between the two plates?

   c) What is the charge stored on one plate?

   d) Capacitance is defined as the ratio of the charge on one plate to the voltage between the two plates. It has units of Coulomb/volt = farad. Evaluate it.

4. Consider two opposite charges. One is very heavy and may be assumed to be fixed while the other one has a mass m and orbits the second at a radius r and velocity v.
   a) Show that the relation between the orbital radius and the orbital period is given by Kepler's Law.

   b) If the radius is doubled what happens to the period?

5. 10^{10} electrons/sec travel down a wire having a circular cross section. The wire first has a diameter of 1 mm and then narrows to a diameter of 0.1 mm.
   a) What is the current in the wire?

   b) What is the current density in the first part of the wire?

   c) What is the current density in the second part of the wire?

6. A kettle draws 3 A of DC current when it is connected to a 10 V battery.
   a) What is the kettle resistance?

   b) What power is supplied to the kettle?

   c) If the kettle has 1 liter of water initially at a temperature of 20 C, how long will it take for the water to be heated to 90C?

7. a) Find the resistance of a gold cylinder having a diameter of 1 mm and a length of 100 meters.

   b) What is the radius of a copper cylinder having a length of 10 meters if it is to have the same resistance as the object in part a.

8. A laboratory only as 2 ohm resistors.
   a) Draw the circuit required to create a 3 ohm resistance

   b) Show that the total power dissipated in the above circuit is the same as when a single 3 ohm resistor is available.

9. Consider the Wheatstone bridge circuit shown below. Show that no current passes through R_5 if $R_1 / R_3 = R_2 / R_4$