HW #3 Due Feb 4 at 9 am

READING: This week we will be working on Ch. 17, a very important chapter. We will skip section 17-6. Sections 17-7 to 17-9 will be covered very briefly, but you should still read these sections carefully. Section 17-11 will be covered as part of lab the following week.

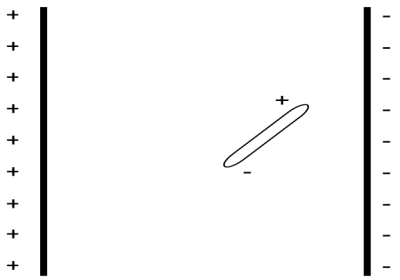
Please hand in this HW in two parts. Part I: Ch 17. Questions and Additional Problems,
Part II: Ch. 17. Problems

QUESTIONS: Ch. 17 #6, 11, 13

PROBLEMS: Ch. 17 #6, 10, 16, 21, 39, 65 (For 65, assume the field is uniform and that it ends abruptly at the ends of the plates.)

ADDITIONAL PROBLEMS:

1) A grass seed is sitting between two parallel plates, floating on some mineral oil. The long axis of the seed is at a 45º angle with respect to the plates. The plates are connected to a Wimhurst machine, creating a + charge on the left plate and a - charge on the right plate. The potential difference between the plates is 5600 V, and the plates are 8 cm apart.



a) Assuming that the grass seed has no effect on the field, what is the electric field between the plates, (magnitude and direction)? Assume the field is uniform.
b) Imagine that the grass seed is a simple dipole with charges of + and - 3.7 nC at each end. What is the force on each end of the grass seed due to the electric field (magnitude and direction)?
c) Is the net force on the grass seed to the left, to the right, or zero? Explain.
d) There is a net torque on the grass seed tending to turn it. Based on the charges shown in the diagram, will this torque turn it clockwise, or anticlockwise?
e) The grass seed will rotate until the net torque is zero. When the net torque is zero, what will be the final orientation of the grass seed relative to the plates?

2) Air is normally an insulator, however you have seen in class that it can become a conductor (arcing of Van deGraff generator and Wimhurst machines). Dry air will conduct if the electric field is greater than about 3×10^6 V/m.

a) With the Van deGraff generator it is possible to produce an arc from the main sphere to a secondary sphere at ground when the spheres are separated by about 20 cm. Assume that the field between the spheres is approximately uniform. What must be the potential difference between the spheres to cause an arc to jump across a gap of 20 cm?
b) When I walk down the stairs of the science building using the railing, I invariably get a shock at the bottom of the stairs when I touch the metal support for the railing. Suppose that the arc from my finger to the metal of the railing occurs when they are 1 mm apart, and assume a uniform field. What is the potential difference between me and the metal railing?
c) During a typical lightning storm, the potential difference between a cloud and the earth is 75,000,000 V and the bottom of the cloud is 1.5 km above the earth. What is the magnitude of the electric field between the earth and the cloud (assumed uniform)? According to the information given at the beginning of this problem, one would not expect a lightning strike to occur, and yet it does. Can you explain why?

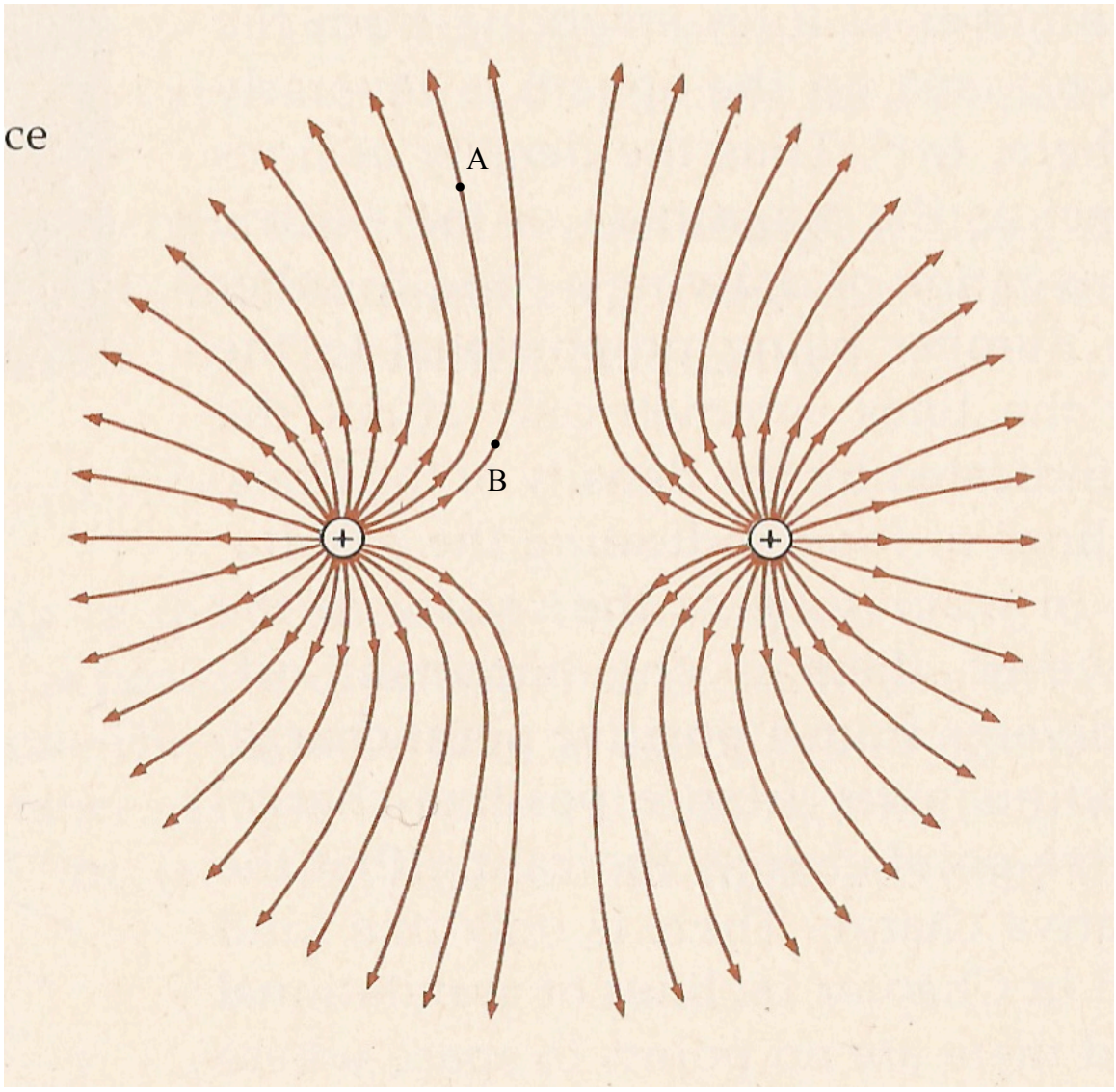
3) In the aCORN experiment (Professor Jones collaborator), a proton produced in the radioactive decay of a neutron has a velocity of 3.9×10^5 m/s, up. The proton finds itself in a uniform electric field pointed downward, that has a magnitude of 6900 V/m. Use Conservation of Energy to answer the following two parts.

a) How far does the proton travel before coming to rest?
b) After coming to rest, the proton (still in the field) reverses direction and travels 43 cm before hitting the negative plate of the apparatus. What is its velocity when it hits the plate?

4) A 47 pF capacitor is charged to a voltage of 15 V. The plates of the capacitor each have an area of 7.18 cm^2, and the plates are separated by paper with a dielectric constant of 3.7.

a) How much charge is on each plate?
b) How much energy is stored in the capacitor?
c) What is the distance between the plates, in mm?

5) Draw in an equipotential line that goes through point A on the diagram on the next page. Draw in another equipotential line that goes through point B.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