Mississippi State University
Department of Physics and Astronomy
PH 2223 Lab

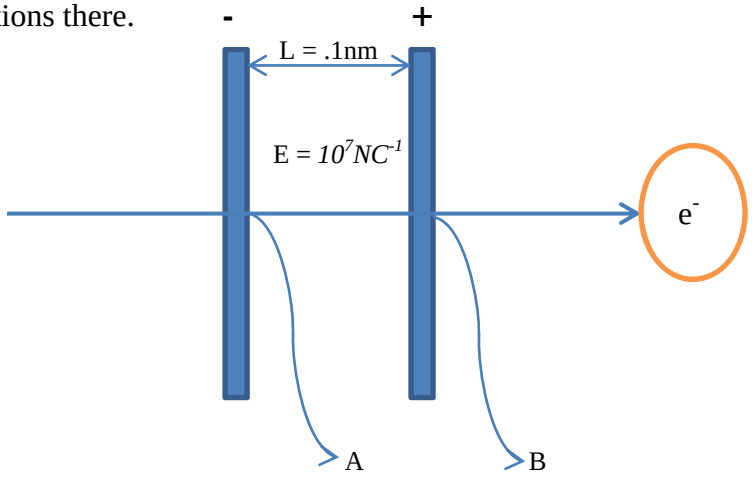
Electric Field Deflection of Electrons

Why is the apparatus that we will be investigating called Cathode Ray Tube? (and not Anode Ray Tube?) What do you think an Anode Ray Tube will do? To answer that, understand what the Cathode Ray Tube does by reading about it in the Lab Manual and read the Wikipedia Article on CRT at http://en.wikipedia.org/wiki/Cathode_ray_tube

Familiarize yourself with the *Equations 21.3* (P.722; Sears and Zemansky's University Physics, Ed.12) using which you can calculate the acceleration of an electron if you are given the electric field (*E*), charge on an electron ($e = 1.60217646 \times 10^{-19}\ C$) and mass of an electron ($m_e = 9.10938188 \times 10^{-31}\ kg$) because you know Newton's II Law from Physics I which helps you to find out the acceleration of a particle given the force acting on the particle. In our case, *Equations 21.3* helps us find the force on an electron (so you know the acceleration on it given the Electric Field *E*). What is the acceleration of an electron if it is placed in an electric field of $E = 10^{7} NC^{-1}$. Note the units of electric field. Express those units in terms of Joules (*J*).

An important task before we continue our journey of exploration, look at the lab manual and understand the derivations there.

Fig. 1



The figure above shows 2 plates with equal and opposite charges on them. Suppose I leave an electron at point 'A', what would be its velocity at point 'B'? What would happen if I were to somehow take the electron that arrives at point 'B' with a velocity and leave it at point 'A'. So this time around the electron has some initial velocity to begin with and this initial velocity is the velocity at which the electron arrived at point 'B' the first time. What would be the velocity of the electron if I repeated this process 10,000 times? Now that you know the velocity of the particle after repeating this activity 10,000 times, what is its energy? So this energy in particle physics is a large amount of energy! This is precisely how large particle accelerators known as LINACs work. Now you can build your own LHC, can't you?!

Challenge

Can you calculate the approximate energy of the electrons in your CRT when they hit the screen? Compute the velocity too in the process. How will you modify the CRT if it were to accelerate positively charged particles?