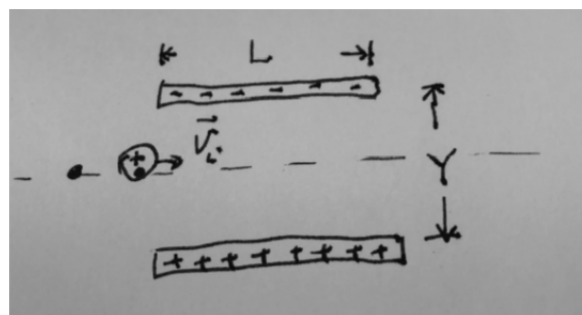


SN: _____, Name: _____

ABSOLUTELY NO CHEATING!
Problems (6 Problems, total 120%)
1. Motion of charged particle in an electric field: (20%)

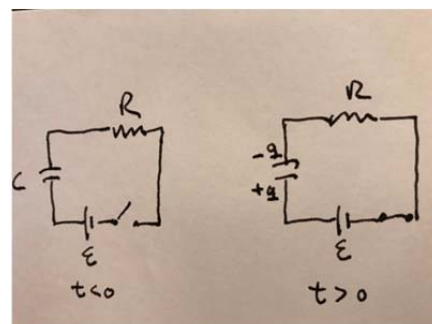
Suppose a charged particle with charge Q and mass m entering a uniform electric field region horizontally from $-x$ direction to the $+x$ direction with a constant velocity V_i . The field E is set up by a pair of large uniform parallel plates of length with L with opposite charges separated by a distance Y as shown in the figure to the right. If we wish this charge Q will hit the right end of the lower plate (in the figure) and it does not fly out this region, what will be the sign of the charge and the Electric field of this set up?



2. **Gauss's Law:** (20%) Use Gauss law to determine the electric field of spherical solid distribution. Assume the sphere has a radius R , what is the electric field at a distance r when (a) $r > R$, (b) $r < R$. (c) Plot the electric field as a function of distance r for each the above two cases.
3. **Magnetism:** (20%) In a hydrogen atom, an electron of charge Q , mass m , moving around the nucleus with an angular velocity ω , period T , and radius R , What is the electric current generated due to this electron moving in the atom? What is the magnetic momentum due to this motion?

4. **Single slit diffraction:** (20%) A parallel beam of blue light (wavelength 420 nm) is incident on a small aperture. After passing through the aperture, the beam is no longer parallel but diverges at 1° to the incident direction. What is the diameter of the aperture?
 Note: for small angle θ , $\sin\theta \cong \theta$. (15%)

5. **RC circuit:** (20%) Consider the figure to the right, in a simple RC circuit of a capacitor C , and resistor R that can be connected to a battery of electromotive \mathcal{E} in series to form a loop. (a) What is the current when the capacitor is not charged (i.e. at $t=0$)? (b) What is the current when the capacitor is completely charged? (c) Write down the general expression of the first order differential equation of this circuit.



6. **Maxwell equation:** (20%) Write down the Maxwell Equations and explain what the displacement current is? (20%) and why this term is needed.