Name ______________________ Date ______________________

AP Physics

Period __________

AP Review # 20

Mrs. Nadworny

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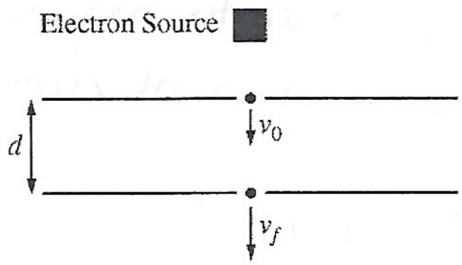


Note: Figure not drawn to scale.

4. (10 points - suggested time 20 minutes)

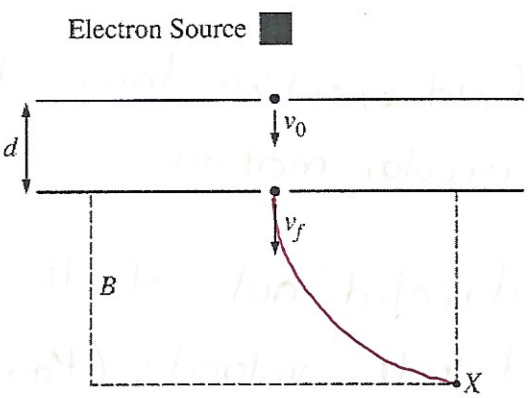
The apparatus shown in the figure above consists of two oppositely charged parallel conducting plates, each with area $A = 0.25\ \text{m}^2$, separated by a distance $d = 0.010\ \text{m}$. Each plate has a hole at its center through which electrons can pass. High velocity electrons produced by an electron source enter the top plate with speed $v_0 = 5.40 \times 10^6\ \text{m/s}$, take 1.49 ns to travel between the plates, and leave the bottom plate with speed $v_f = 8.02 \times 10^6\ \text{m/s}$.

(a) Which of the plates, top or bottom, is negatively charged? Support your answer with a reference to the direction of the electric field between the plates.

(b) Calculate the magnitude of the electric field between the plates.

(c) Calculate the magnitude of the charge on each plate.

(d) The electrons leave the bottom plate and enter the region inside the dashed box shown below, which contains a uniform magnetic field of magnitude B that is perpendicular to the page. The electrons then leave the magnetic field at point X.



(i) • circular
• leave opening + hit X
• (can start from arrowhead)

Note: Figure not drawn to scale.

i. On the figure above, sketch the path of the electrons from the bottom plate to point X. Explain why the path has the shape that you sketched.

ii. Indicate whether the magnetic field is directed into the page or out of the page. Briefly explain your choice.

a) The top plate is negatively charged. The electrons accelerate as they travel through the plates so they must be attracted to the bottom positive plate. The electric field points from positive to negative and electrons move opposite the direction of electric fields.

(1) top = -
(1) E field

b) $E = ?$ $a = \frac{F}{m}$ $a = \frac{\Delta v}{t}$ $F = Eq$

$\Sigma F = ma$

$F_e = ma$ (1) N2L (1) equate F

$Eq = m\left(\frac{\Delta v}{t}\right)$ (1) a

$E = \frac{m}{q}\left(\frac{\Delta v}{t}\right) = \frac{(9.11\times10^{-31}kg)(8.02\times10^{6}m/s - 5.40\times10^{6}m/s)}{(1.60\times10^{-19}C)(1.49\times10^{-9}s)}$

$= 10{,}000\ N/C$ (1) w/units

OR

$\Delta K = U_e$ (1) conserve

$\frac{1}{2}m(v_f^2 - v_i^2) = Vq$ (1) Ve

$U_e = qV$ $V = Ed$ (1)

$\frac{1}{2}m(v_f^2 - v_i^2) = Edq$

$E = \frac{m(v_f^2 - v_i^2)}{2dq}$

c) $E = \frac{Q}{\varepsilon_0 A}$

sub into eqn

$Q = E\varepsilon_0 A = (10{,}000\ N/C)(8.85\times10^{-12}\frac{C^2}{Nm^2})(.25\ m^2)$

$= 2.2\times10^{-8}C$

d) i) The magnetic field exerts a force ⊥ to the velocity which causes circular motion.
(1)

ii) The field is directed out of the page. When using the left hand rule, velocity (thumb) is down, force (palm) pushes right which aligns with magnetic field (fingers) directed out of the page

(1) must explain why