Motion of Charged Particles in Electric Fields Assignment   NAME_____

1.
   Grev the electric bandit pushes a positive electric charge against the field lines between two oppositely charged plates. The potential difference between the plates is 100 V, and the distance between the plates is 1.22 m.
   a) What is the magnitude of the electric field strength at any point in the field (away from the edges)?

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   b) If the charge is 1.1 C, calculate the amount of work (in joules) done by Grev.

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   c) Convert the answer to (b) into electron volts.

                                                                                                      /1
   d) In part a you probably used the expression $E = \dfrac{\Delta V}{d}$. Derive this expression.

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2.
   Compare and explain the difference and similarity between the motion of a charged particle in a uniform electric field and the motion of a projectile.

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3.
   An electron enters a uniform electric field produced by applying a potential difference of 150 V between two oppositely charged parallel plates in a vacuum. The plates are separated by a distance $d = 0.050$ m and are of length $L = 0.100$ m. The initial velocity of the electron is 1.0×10^7 ms^{-1} parallel and near to the negatively charged plate, and it leaves the field without hitting the positive plate.
   Ignore the effect of gravity.
   a) Calculate the time the electron spends between the plates.   /2
   b) Calculate the acceleration of the electron due to the electric field between the plates.   /3
   c) Calculate the deflection of the electron (displacement parallel to the field lines).   /3
   d) Determine the velocity of the electron as it leaves the field.   /4

4.
   a) Given the expressions $F = Eq$ and $E = \dfrac{\Delta V}{d}$, show that the potential difference required to levitate a particle (i.e. so the force of the field cancels out the weight of the object) of charge q and mass m between two plates a distance d apart can be given by the expression $\Delta V = \dfrac{gmd}{q}$.   /2

   b) Hence calculate the potential difference that would be required to levitate an electron between two oppositely charged plates, assuming the electron has no initial velocity and the plates are 9.5cm apart. Acceleration due to gravity is 9.8 ms^{-2}.   /2

   c) State which plate (top or bottom) will be positively charged.   /1

5.
   a) Explain why there is no electric field inside the dees of a cyclotron.   /1
   b) Draw a labelled diagram of a cyclotron   /2
   c) Describe how an ion is accelerated by repeatedly crossing between the dees.

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   d) If a cyclotron has a potential difference between the dees of 1000V and the potential alternates at 10MHz, calculate how much energy is imparted to a proton in 4.0×10^{-6} s. Give your answer both in joules and in electron volts.   /4

                                                                                    TOTAL   /35