Electric Fields and Potential Difference

1. What is an electric field? Ans: A region in which a charge experiences a force
2. What is the source of an electric field? Ans: Charged particle.
3. In what direction do the electric field lines point? Ans: Positive to negative
4. Draw the radial electric field due to a negative charge. Ans: Pointing radially inwards to negative; see this website.
5. Draw the radial electric field due a positive charge. Ans: Pointing radially outwards away from positive; see this website.
6. Draw the field of the dipole below. Look up images in Google. See this website

7. Draw the uniform and parallel electric field due to the parallel plate conductors below. Ans: See this website

8. Suppose a potential difference 25.0 V exists between two parallel plate conductors. What do we mean by a *Potential Difference 25.0 V?* Your answer must include the words;
9. Energy, Coulomb and the number 25. Ans: This means 25 J of work must be done to move to move 1 Coulomb of positive charge from lower to upper potential.

An alpha particle is a Helium nucleus and as such it is made up of two neutrons and two protons. The mass of a proton and neutrons are about the same and equal to 1.7×10^{-27} kg each. The charge on a proton is 1.6×10^{-19} C.

In this example we use the following expressions.

a) The electric potential, V, at a point is given by $V = E_p/Q$ (p is for potential) and indicates the energy required to place a Coulomb of charge at that point. A Coulomb of charge will then have that energy stored as *electric potential energy.* These values are listed on the diagram below as 60 V, 45 V etc.

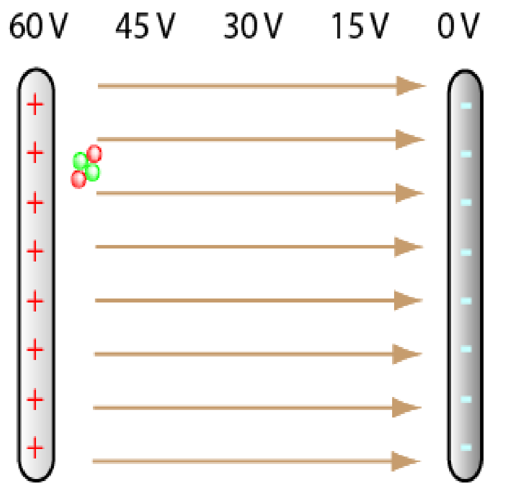
b) The potential energy of a charge, Q, at a point, V, in an electric field is therefore given by $E_p = VQ$.

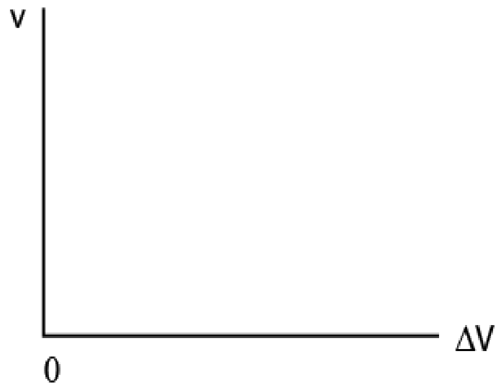
c) The potential energy lost or gained as a charge falls, (or is forced in the opposite direction), between two potentials, V_{Final} & $V_{Initial}$ is given by $E_p = \Delta VQ$, where $\Delta V = V_{Final} - V_{Initial}$.

d) E_P is also E_w the work done by the force during this displacement. So $E_p = \Delta VQ = Fd$, where d corresponds to the distance between the potentials.

e) The kinetic energy, Ek, gained when a charge of mass, m, and charge Q, 'falls' between two potentials is given by $E_p = \Delta VQ = 1/2mv^2$

10. An alpha particle is at a potential of 60.0 V in a uniform and parallel electric field as shown below.





In the uniform field the particle will experience the same force wherever it happens to be.

i) Calculate the potential energy of the alpha particle at the 60.0 V potential. See (b) above. Ans: 192×10^{-19} J

ii) Calculate the potential energy of the alpha particle at the 45.0 V potential. See (b). 144×10^{-19} J

iii) How much potential energy will the particle lose as it is pulled from the 60.0 V potential to the 45.0 V potential. See (c). 48×10^{-19} J

iv) Write down the work done by the field in pulling the charge from the 60.0 V potential the 45.0 V potential? See (c & d). 48×10^{-19} J

v) Calculate the speed of the particle as it passes the 45, 30, 15 and 0 V potentials and draw a graph of speed against change in potential as shown above. See (e). Ans (3.7, 5.3, 6.5 & 7.5) $\times 10^{4}$ ms^{-1} (Graph curves down ie $y = \sqrt{x}$)

vi) Suppose the distance from the 60.0 V potential to the 45.0 V potential is 0.10 m. Calculate the force on the charge due to the field. Ans: 480×10^{-9} N

vii) vii) Calculate the acceleration of the charge as it travels through the field. Ans: 70.5×10^{8} ms^{-2}

viii)

ix) Calculate the time taken for the charge to cover the 0.4 m? (eqns of motion).

Ans: 1.3 μs