Electric Potential

To be able to explain what electric potential is and be able to calculate it
To know what the field strength is like in a uniform field and how it is linked to electric potential
To be able to sketch graphs of potential and field strength over distance from surface

Electric Potential, V

The electric potential at a point r from a point charge is defined as:

The work done per unit charge against the field to move a positive point charge from infinity to that point

The electric potential at a distance r from a charge Q is given by: $\boxed{V = \dfrac{Q}{4\pi\varepsilon_0 r}}$

The value will be positive when work is done against the field (when like charges are repelling).
The value will be negative when work is done by the field (when opposite charges attract).
In both cases the potential at infinity is zero. Electric potential is a scalar quantity.

Electric Potential is measured in Joules per Coulomb, J C^{-1}

Electric Potential Difference *(Also seen in GCSE Physics 2 and AS Unit 1)*

Electric potential is the work done per unit charge which can be written like this:

$$\boxed{V = \frac{W}{Q}}$$

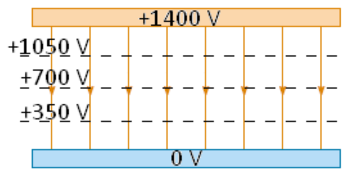
We came across this equation in the QVIRt lesson of Unit 1. We used it to define the potential difference as the energy given to each charge. From what we have just defined we can now update our definition of potential difference. *Potential difference is the difference in electric potential between two points in an electric field.*

The work done to move a charge from potential V_1 to potential V_2 is given by:

$\Delta W = Q(V_2 - V_1)$ which can be written as $\boxed{\Delta W = Q\Delta V}$

Uniform Fields

In a uniform field like that between two conducting plates the field strength is constant as we have already seen. Now that we understand electric potential we can use an equation for the field strength in a uniform field.



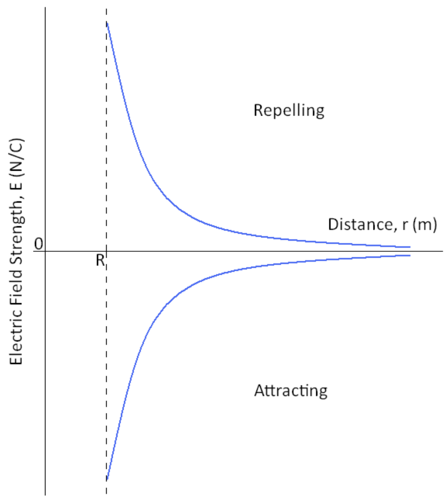
$\boxed{E = \dfrac{V}{d}}$ Where V is the potential difference between the plates and d is the separation of the plates.

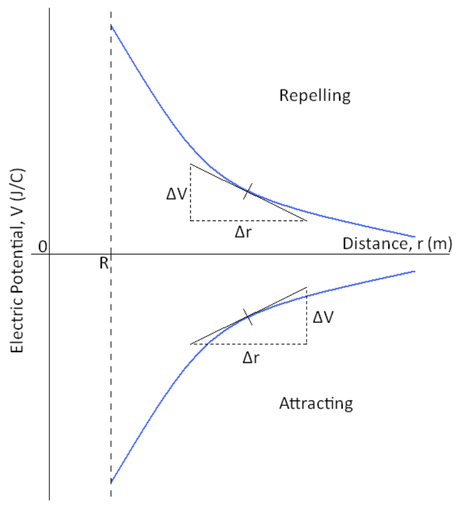
Electric Field Strength can be measured in Volts per metre, V m^{-1}

Graphs

Here are the graphs of how electric field strength and electric potential vary with distance from the centre of a charged sphere. In both cases R is the radius of the sphere.

The gradient of the electric potential graph gives us the electric field strength at that point. To find the gradient at a point on a curve we must draw a tangent to the line then calculate the gradient of the tangent:





$$gradient = \frac{\Delta y}{\Delta x} \rightarrow \boxed{E = \frac{\Delta V}{\Delta r}}$$

If we rearrange the equation we can see where we get the top equation for electric potential.

$E = \frac{\Delta V}{\Delta r}$ → $E\Delta r = \Delta V$ sub in the equation for E → $\frac{Q}{4\pi\varepsilon_0 r^2}\Delta r = \Delta V$ → $\frac{Q}{4\pi\varepsilon_0 r^2} r = V$ → $\frac{Q}{4\pi\varepsilon_0 r} = V$