7.7.2 Electric Potential

videos

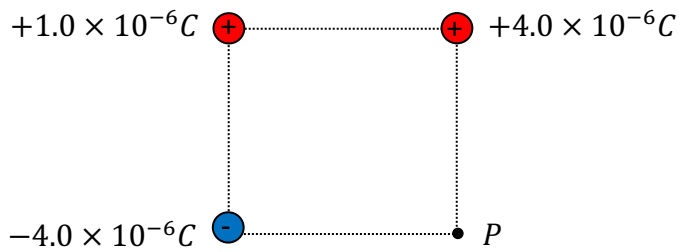
Electric potential (V) is the electric potential energy of a unit positive charge placed at a certain position in an electric field produced by a charge Q.

$$V = \frac{E_{pot}}{q} = \frac{1}{4\pi\varepsilon_0}\frac{Q}{r}$$

The potential energy of a charge q in this potential is given by:

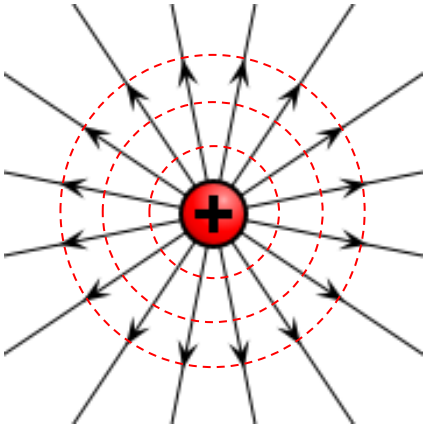
$$E_{pot} = qV$$

(1) Charges are placed at corners of a square with length of side = 0.030m. Work out the electric potential (V) at position P, in the following diagram:



(2) If a point charge of $-3.2 \times 10^{-6}C$ is placed at P, what electric potential energy will it have?

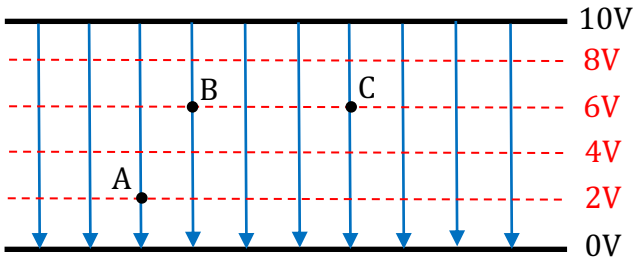
When we move from one location to another in an electric field the electric potential can change. The change in potential is called the potential difference.



In the diagram, left, we can see the field lines around a point positive charge. It is a radial field. The dotted lines are called lines of equipotential. When we move along an equipotential, the potential doesn't change.

(3) Why doesn't the potential change when moving along these lines? Hint – look at the equation for electric potential.

The following shows equipotential lines for a uniform electric field produced between two metal plates.



(4) How are equipotential lines aligned relative to field lines?

(5) What is the change of potential in going from position A to B?

(6) What is the change of potential in going from position C to B?

(7) What is the change of potential energy in moving an electron from A to C?

Graphical Methods

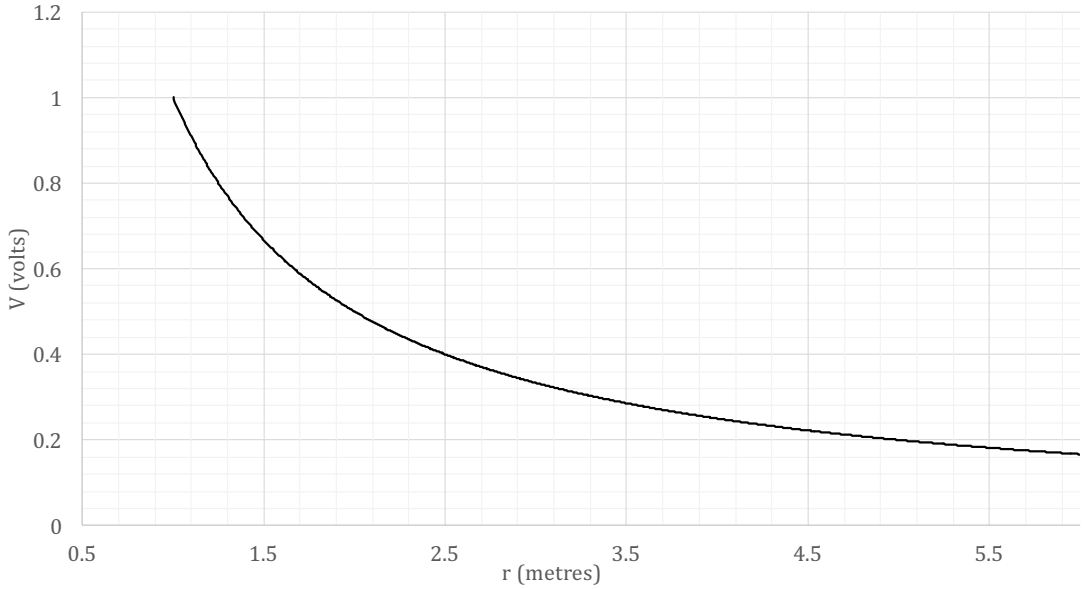
If we look at the formula for electric field E, and the electric potential V, we can see the mathematical relationship:

$$E = \frac{1}{4\pi\varepsilon_0}\frac{Q}{r^2}$$

$$V = \frac{1}{4\pi\varepsilon_0}\frac{Q}{r}$$

To get the electric field strength we need to differentiate V with respect to r (and add a negative sign). In other words, E is the –gradient of the V versus r graph.

Let's consider the graph of V versus r for a radial electric field.



The electric field strength can be obtained by taking the -gradient of the graph. We can do this by taking a tangent line to the curve and working out the gradient.

(8) Work out the gradient of the graph a r=2.5m. Hence, find the strength of the electric field (E) at this position.

(9) What are the units for electric field strength?

(10) Sketch a graph of V versus distance between two parallel plates.

(11) What can you tell about the electric field strength between parallel plates? How can you tell from your graph?