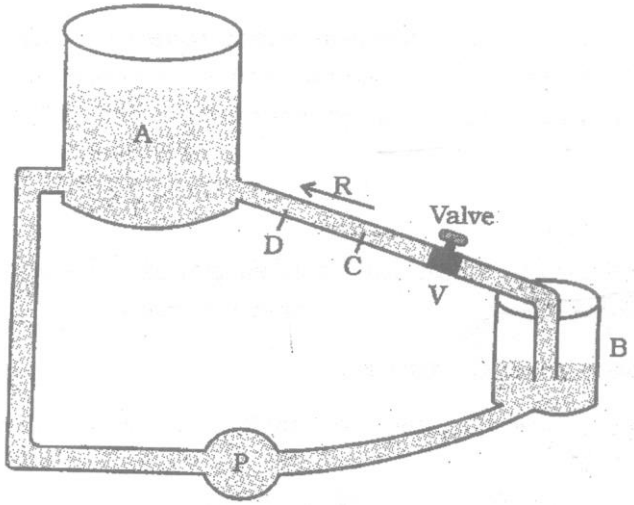
ELECTRICITY
Electric Potential

ELECTRIC FIELD AND ELECTRIC POTENTIAL:

The flow of electricity in a circuit can be regarded very mush similar to the flow of water in a pipe. The water pipe is analogous to the electric conductor, while the amount of water flowing through a given point per second corresponds to electric current. Figure below show how the pump (P) builds up and maintains pressure by lifting water from a tank (B) to the reservoir (A) through the pipe (R).
Note that along the pipe, different points are at different pressure. Water in the pipe flow from say, a point C to D only when the pressure at C is greater than that at D. Thus, when the value (V) is open, water start flowing into the reservoir.



Pump

In the same manner electrons will move along a wire only if there is a difference of electric pressure called potential difference along the conductor. This difference of potential produced by the cell or a battery, which acts like a water pump in the circuit.
The chemical action within the cell generates the difference in potential between the electrodes, which sets the electrons in motion and produces the current We define the electric potential difference between the two points, A and B, on a conductor carrying current, as the work done to move a unit charge from A to B. Potential difference (V) between the points A and B = work done (**W)**/charge (**Q**). The unit of potential is volt, named after a scientist Alessandra (1745 - 1827).
One volt is the potential difference when 1 joule of work is done to move a charge of 1C.

(a) Electric Field:

Electric field due to a given charge is defined as the space around the charge in which electrostatic force of attraction or repulsion due to charge can be experienced by any other charge. If a test charge experiences no force at a point, the electric field at that point must be zero.
Electric field intensity at any point is the strength of electric field at that point/ It is defined as the force experienced by unit positive charge placed at that point.

If $\vec{F}$ is the force acting on a test charge $+q_0$ at any point **r**, then electric field intensity at this point is given by

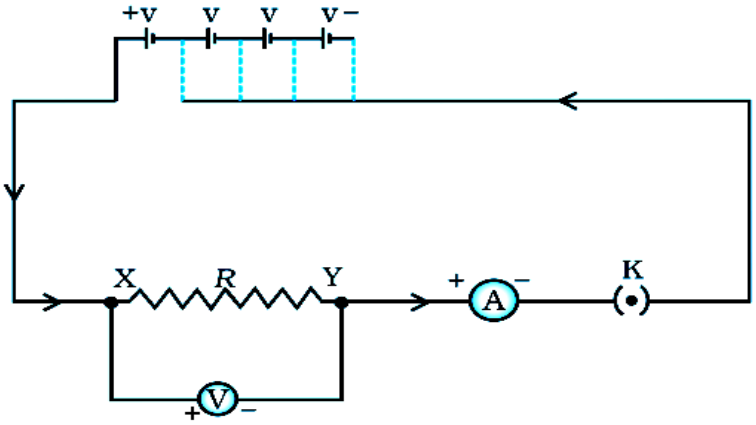
$$\vec{E}(r) = \frac{\vec{F}}{q_0}$$

Electric field is a vector quantity and its S.I. unit is Newton per coulomb or N/C.

(b) Electric Potential :

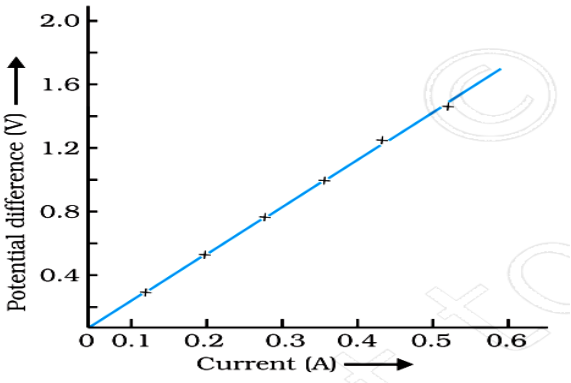
The electric potential at a point in an electric field is defined as the amount of work done in moving a unit +ve charge from infinity to that point, without acceleration or without a change in K.E., against the electric force due to the electric field.

$$V = \frac{W}{q}$$



Since work is measured in joule and charge in coulomb, therefore electric potential is measured in joule per coulomb (**J/C**). This unit occurs so often in our study of electricity, so it has been named as volt, in honour of the scientist Alessandra Volta (the inventor of the voltaic cell).

$$1\,\text{Volt} = \frac{1\,\text{joule}}{1\,\text{coulomb}}$$



Potential is a scalar quantity, therefore it is added algebraically. For a positively charged body potential is positive and for a negatively charged body potential is negative.

(c) Electric Potential Difference:

Consider a charge Q placed at a point P. Let A and B be two other point (B being closer to A) as shown

If a charge q is brought from infinity to A, a work W_A will be done.

The potential at A will then be, $V_A = \frac{W_A}{q}$

If charge q is brought from infinity to B, the work done will be W_B.

The potential at B will the be, $V_B = \frac{W_B}{q}$

The quantity V_B - V_A is called the potential difference between points A and B in the electric field of charge Q.

Mathematically we have,

$$V_B - V_A = \frac{W_B}{q} - \frac{W_A}{q}$$

Electric potential difference is also measured in volt.

Example:

How much work is done in moving a charge of 2 C across two points having a potential difference 12 V?

Solution:

The amount of charge Q, that flows between two points at potential difference V (= 12 V) is 2 C.

Thus, the amount of work W, done in moving the charge is

$$W = VQ = 12\ V \times 2\ C = 24\ J.$$