ELECTROSTATIC POTENTIAL AND CAPACITANCE

THE PARALLEL PLATE CAPACITOR

CAPACITOR:
A capacitor or condenser consists of two conductors separated by an insulator or dielectric.

(i) When uncharged conductor is brought near to a charged conductor, the charge on conductors remains same but its potential decreases resulting in the increase of capacitance.

(ii) In capacitor two conductors have equal but opposite charges.

(iii) The conductors are called the plates of the capacitor. The name of the capacitor depends on the shape of the capacitor.

(iv) Formulae related with capacitors:

$$Q = CV$$

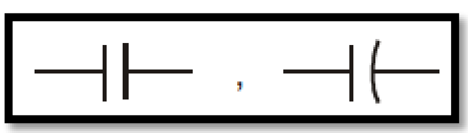
$$C = \frac{Q}{V} = \frac{Q_A}{V_A - V_B} = \frac{Q_B}{V_B - V_A}$$

Q = Charge of positive plate of capacitor.

V = Potential difference between positive and negative plates of capacitor

C = Capacitance of capacitor.

(v) The capacitor is represented as following



(vi) Based on shape and arrangement of capacitor plates there are various types of capacitors

(a) Parallel plate capacitor

(b) Spherical capacitor.

(c) Cylindrical capacitor

(viii) Capacitance of a capacitor depends on

(a) Area of plates.

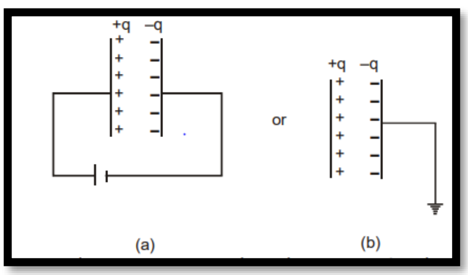
(b) Distance between the plates.

(c) Dielectric medium between the plates

Parallel Plate Capacitor

Two metallic parallel plates of any shape but of same size and separated by small distance constitute parallel plate capacitor. Suppose the area of each plate is A and the separation between the two plates is d. Also assume that the space between the plates contains vacuum.

We put a charge q on one plate and a charge ñq on the other. This can be done either by connecting one plate with the positive terminal and the other with negative plate of a battery (as shown in figure a) or by connecting one plate to the earth and by giving a charge +q to the other plate only. This charge will induce a charge ñ q on the earthed plate. The charges will appear on the facing surfaces. The charges density on each of these surfaces has a magnitude σ = q/



If the plates are large as compared to the separation between them, then the electric field between the plates (at point B) is uniform and perpendicular to the plates except for a small region near the edge. The magnitude of this uniform field E may be calculated by using the fact that both positive and negative plates produce the electric field in the same direction (from positive plate towards negative plate) of magnitude σ/2ε 0 and therefore, the net electric field between the plates will be.

$$E = \frac{\sigma}{2\varepsilon_0} + \frac{\sigma}{2\varepsilon_0} = \frac{\sigma}{\varepsilon_0}$$

Outside the plates (at point A and C) the field due to positive sheet of charge and negative sheet of charge are in opposite directions. Therefore, net field at these points is zero. The potential difference between the plates is,

$$V = E \bullet d = \left(\frac{\sigma}{\varepsilon_0}\right) d = \frac{qd}{A\varepsilon_0}$$

The capacitance of the parallel plate capacitor is.

$$C = \frac{q}{V} = \frac{A\varepsilon_0}{d} \text{ or } C = \frac{\varepsilon_0 A}{d}$$