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D-1 (H)
Paper - II

Capacitance of a parallel plate capacitor.

* Capacitance : capacitance of a conductor is defined as the ratio of charge on it to its potential. i.e $C = \frac{Q}{V}$

If $V = 1$, $C = Q$

The unit of capacitance is a Farad. thus it may be also defined as the quantity of charge required to raise the potential of a conductor through unity.

Capacitance of a parallel plate Capacitor :-

A parallel plate capacitor consists of two plate placed parallel to one another separated by a small distance containing air or some other dielectric medium. One of the plate is earthed and a charge is given to the other as shown in fig. Let A be the area of each plate, $+\sigma$ the surface density of charge on the plate A and $-\sigma$ the induced

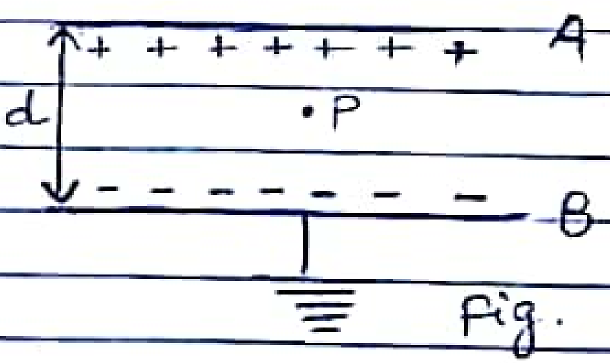

Fig.

on the plate B, d the distance between the plates, then

Electric field near a charged conducting plate in air $= \frac{\sigma}{2\epsilon_0}$

$\therefore$ Force experienced by a unit positive charge at a point P (i) due to a upper plate $= \frac{\sigma}{2\epsilon_0}$

(ii) due to the lower plate $B = \frac{\sigma}{2\epsilon_0}$

The two forces act in the same direction i.e downward.

$\therefore$ Resultant force on a unit +ve charge at P

$$= \frac{\sigma}{2\epsilon_0} + \frac{\sigma}{2\epsilon_0} = \frac{\sigma}{\epsilon_0}$$

Hence the work done in moving a unit positive charge from plate B to a plate A against the electric forces

$$= \frac{\sigma}{\epsilon_0} d$$

because the field between the two plates is uniform and is in a direction ⊥ to the plates.

$\therefore$ Potential difference between the two plates $V_a - V_b = \frac{\sigma}{\epsilon_0} d$

charge on the plate A, $Q = A\sigma$

$\therefore$ Capacitance $= \frac{Q}{V_a - V_b} = \frac{A\sigma}{\frac{\sigma}{\epsilon_0} d} = \frac{\epsilon_0 A}{d}$