Equipotential surfaces are surfaces or regions where V is a constant. V is electric potential.

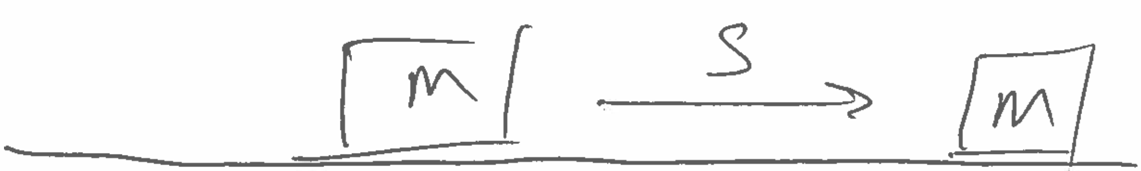
Conductors are equipotentials.

Since V is a constant, what is work required to move a charge along an equipotential?

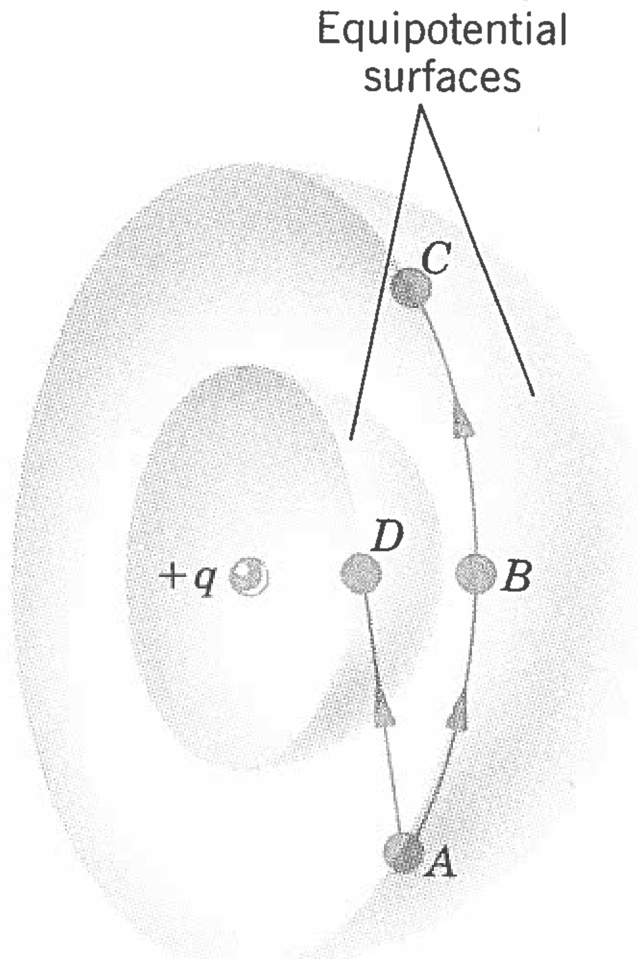
$$W = Q \Delta V = Q (V_f - V_o)$$

equipotential $\Rightarrow$ $V_f = V_o$

$$W = Q (V - V) = 0$$



$$W_{grav} = 0$$



Copyright © John Wiley & Sons, Inc.

FIGURE 19.8

$$W_{A\to B} = W_{B\to C} = 0$$

$$W_{A\to B} = Q(V_B - V_A) = Q(0) = 0$$

$$W_{A\to D} = Q(V_D - V_A)$$

Assume $Q > 0$ $W_{A\to D} > 0$

Assume $Q < 0$ $W_{A\to D} < 0$

Equipotentials and Electric field lines

Equipotentials and field lines make 90° angles between them.

E field lines start on + charges
⇒ Higher potentials

and end on − charges
⇒ lower potentials

Copyright ©John Wiley & Sons, Inc.

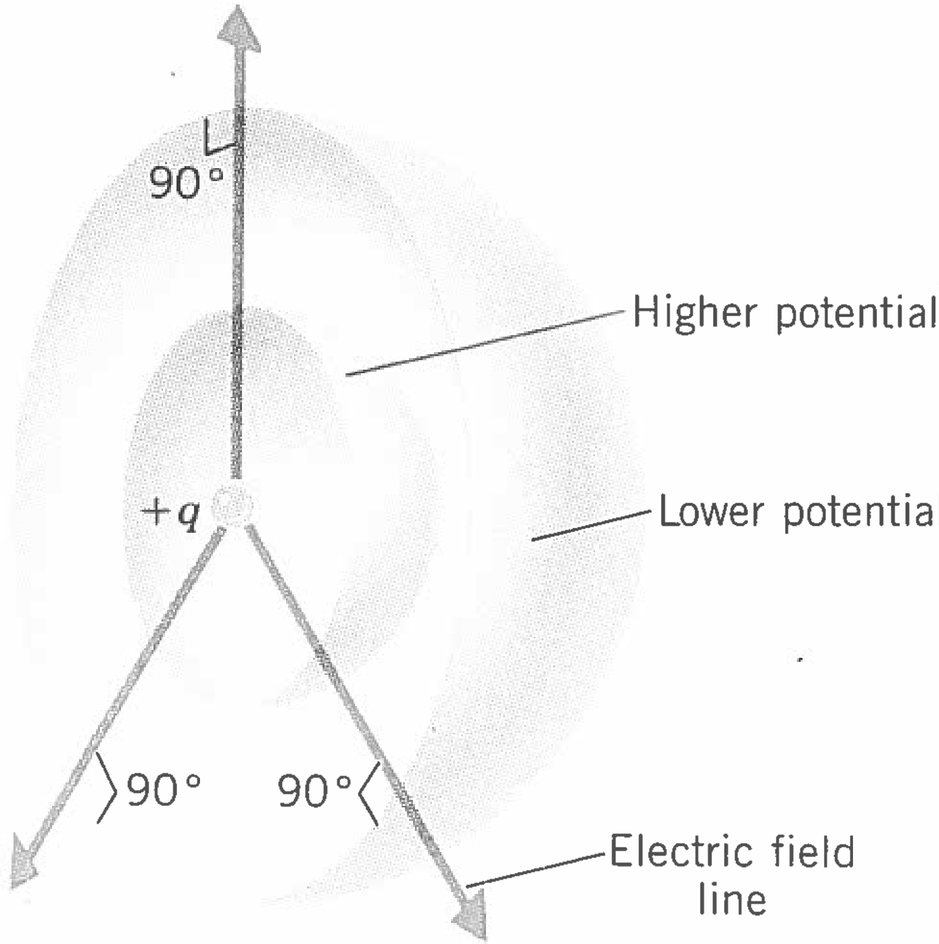
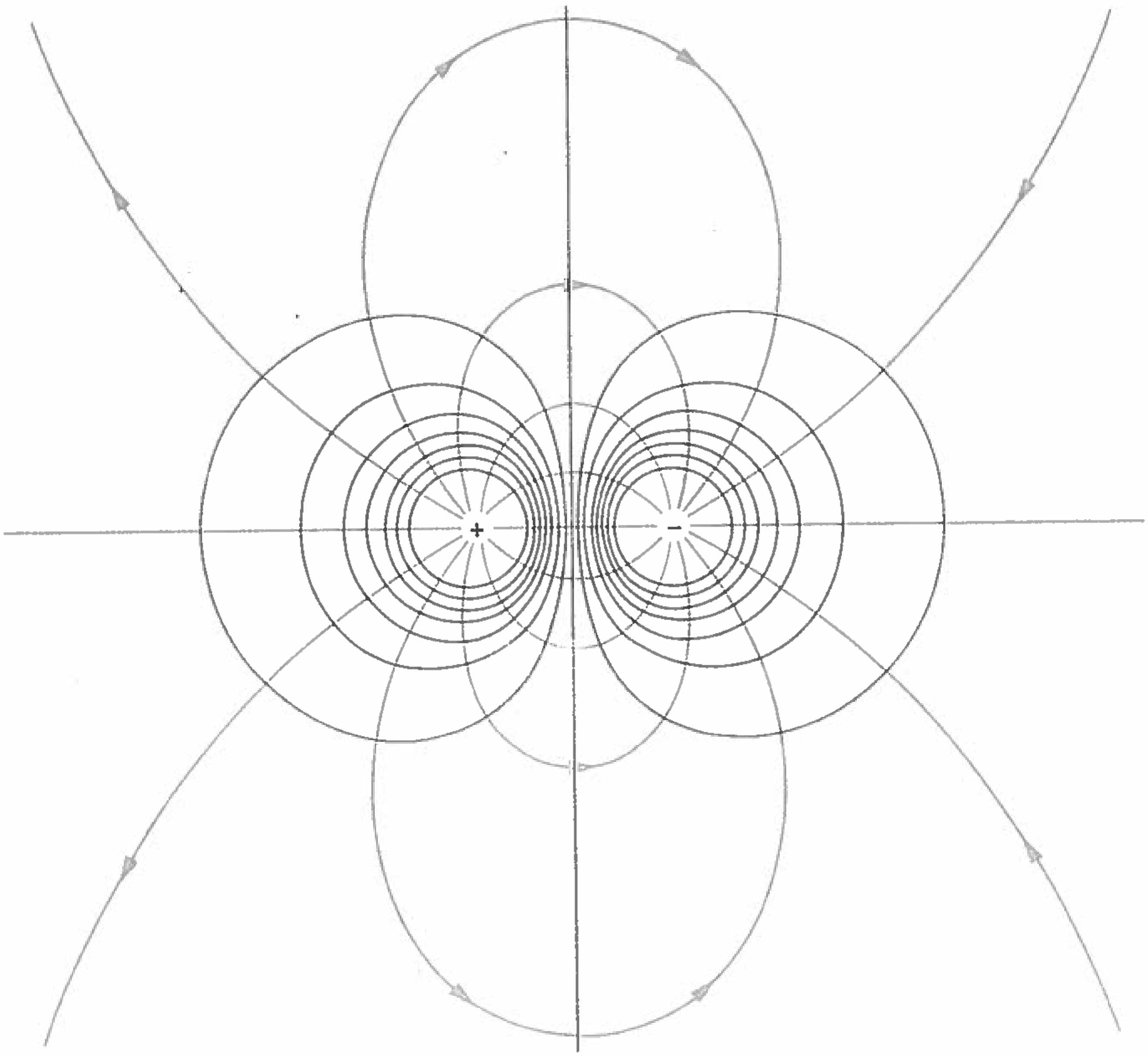
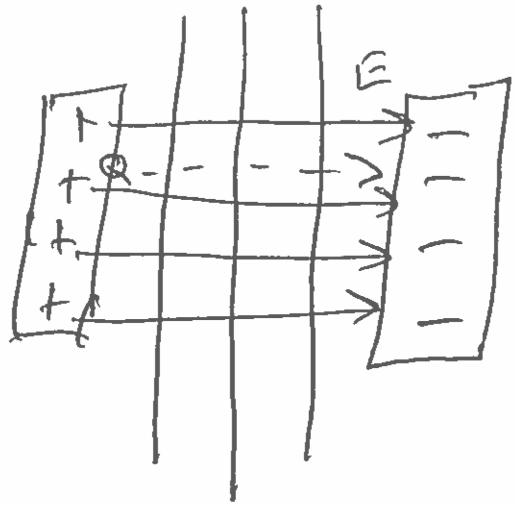


FIGURE 19.9



Parallel Plate Capacitor



equi → V

$$\vec{F}_{on Q} = QE$$

$$W = -F\Delta S = -QE\Delta S = Q\Delta V$$

$$E = \frac{-\Delta V}{\Delta S}$$ = Gradient of potential

$$E = -\frac{\Delta V}{\Delta S}$$

Units of $\vec{E}$

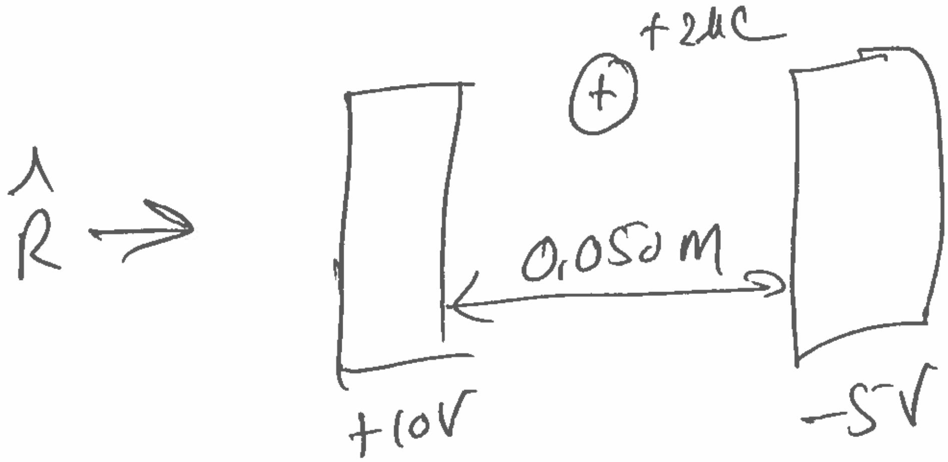
$N/C \quad V/m$

$$V = \frac{J}{C} = \frac{Nm}{C}$$

$$V/m = N/C$$

Electric field is the negative spatial gradient of the electric potential field.

What force would a $+2.0\,\mu C$ charge feel in between two parallel plates one at a potential $+10V$, the other at a potential $-5V$. The plates are spaced $0.050\,m$ apart?



$$\vec{F} = q\vec{E}$$

$$\vec{E} = -\frac{\Delta V}{\Delta s}$$

$$\vec{F} = -q\frac{\Delta V}{\Delta s}$$

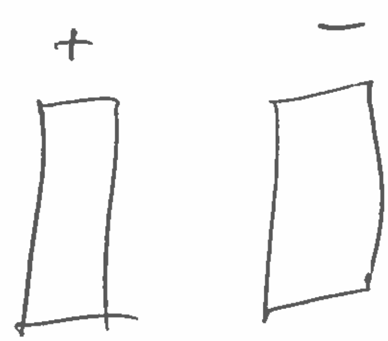
$$\vec{F} = -\frac{(2\times10^{-6}\,c)(-5V-10V)}{0.050\,m}\hat{R}$$

$$= \frac{(2\times10^{-6}\,c)(-(-15V))}{0.050\,m}\hat{R} = \boxed{6.0\times10^{-4}\,N\,\hat{R}}$$

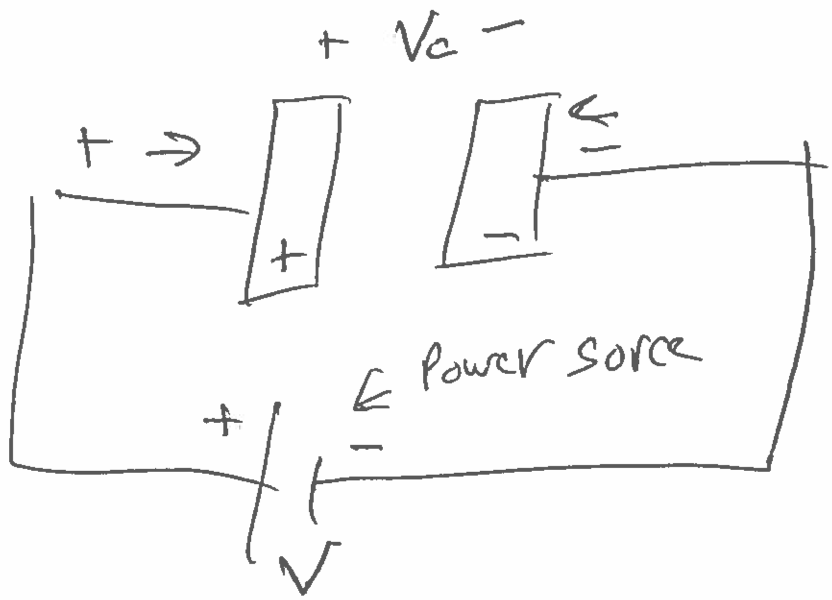
What is a capacitor?

A capacitor is an electrical component that stores charge on conductors (plates) in addition storing charge is similar to storing energy in an electric field.

Later you will find the primary role of a capacitor in a circuit is to maintain constant voltage.



Parallel plate capacitor



Charges travel to capacitor as long as $V_c < V_{source}$

When $V_C = V_{source}$ $\Rightarrow$ No more charge is added

If $V_C > V_{source}$ $\Rightarrow$ Charges leave the capacitor

Capacitance

$$Q = C\,V$$ C is the capacitance

C is the proportionality constant between Q and V.

$$C = \frac{Q}{V} = \frac{10\,\mu C}{10\,V} = 10\,\mu F$$

Unit of capacitance is the Farad

$$1\,F = \frac{1\,C}{V} = \frac{1\,C}{J/C} = \frac{C^2}{J} = \frac{C^2 s^2}{kg\,m^2}$$

20 μC on a 5 mF capacitor

What is V across the plates?

$$Q = CV$$

$$V = \frac{Q}{C} = \frac{20\,\mu C}{5\,mF} = \frac{20 \times 10^{-3}\,mC}{5\,mF}$$

$$V = 4 \times 10^{-3}\,V = \boxed{4\,mV}$$

$$\frac{C}{F} = \frac{C}{\frac{C}{V}} = \frac{1}{\frac{1}{V}} = V$$