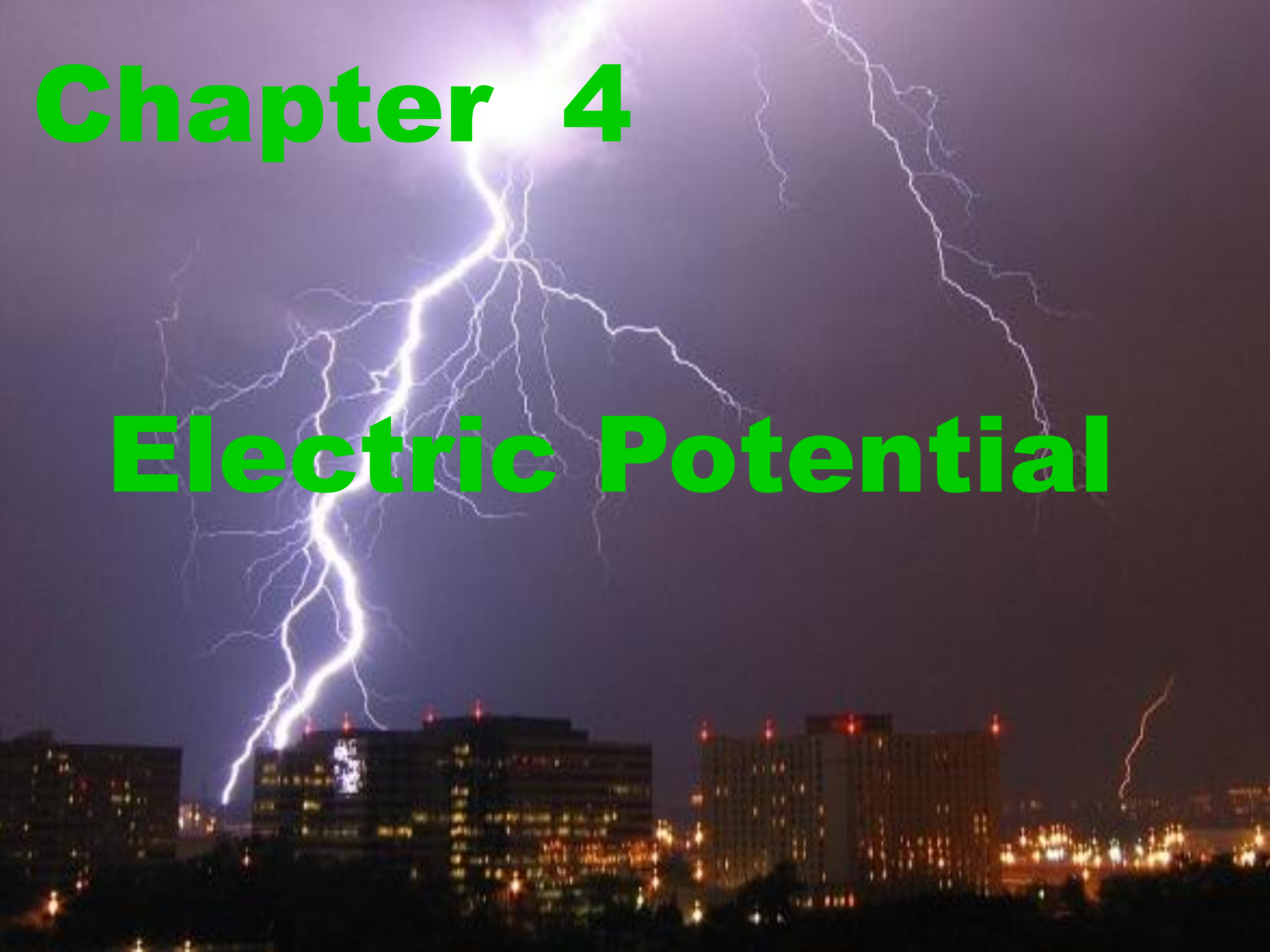
Chapter 4

Electric Potential



Intended Learning Outcomes of the lecture (ILOs):

When you have completed this section, the students will be able to:

- Define the electric potential difference
- Identify the electric Potential differences in a Uniform electric field and a Non-uniform electric field
- Understanding the Equipotential surfaces.

Chapter 4

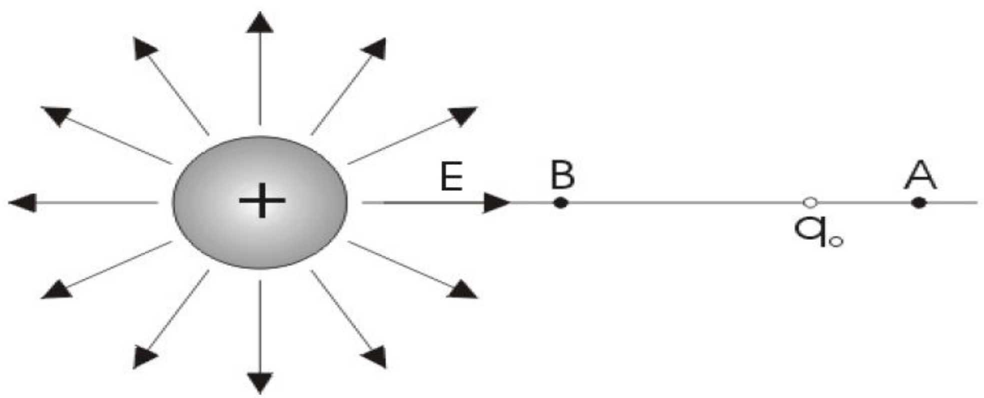
POTENTIAL DIFFERENCE

Definition of electric potential difference

potential difference between two points *A* and *B* as the work done by an external agent in moving a test charge q_o from *A* to *B* *i.e.*

$$V_B - V_A = \frac{WAB}{q_o}$$

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



S.I unit of electric potential difference joules/coulomb, or volts.

Chapter 4

Electric potential difference is scalar

The **potential difference** is independent **on the path** between *A* and *B*. Since the work (W_{AB}) done to move a test charge q_o from *A* to *B* is independent on the path,

Since the work may be **a) positive** $V_B > V_A$

b) negative $V_B < V_A$

c) zero $V_B = V_A$

You should remember that the work equals

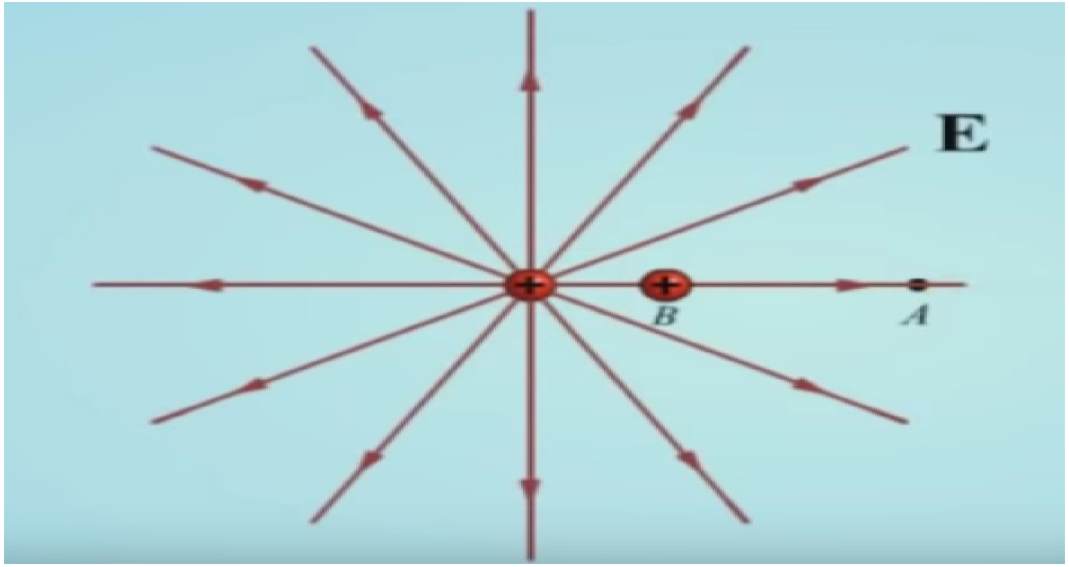
$$W = f_{ex} l = F_{ex} l \cos\theta$$

If $0 < \theta < 90$ — $\cos\theta$ is +ve and therefore the W is +ve

If $90 < \theta < 180$ — $\cos\theta$ is -ve and therefore the W is -ve

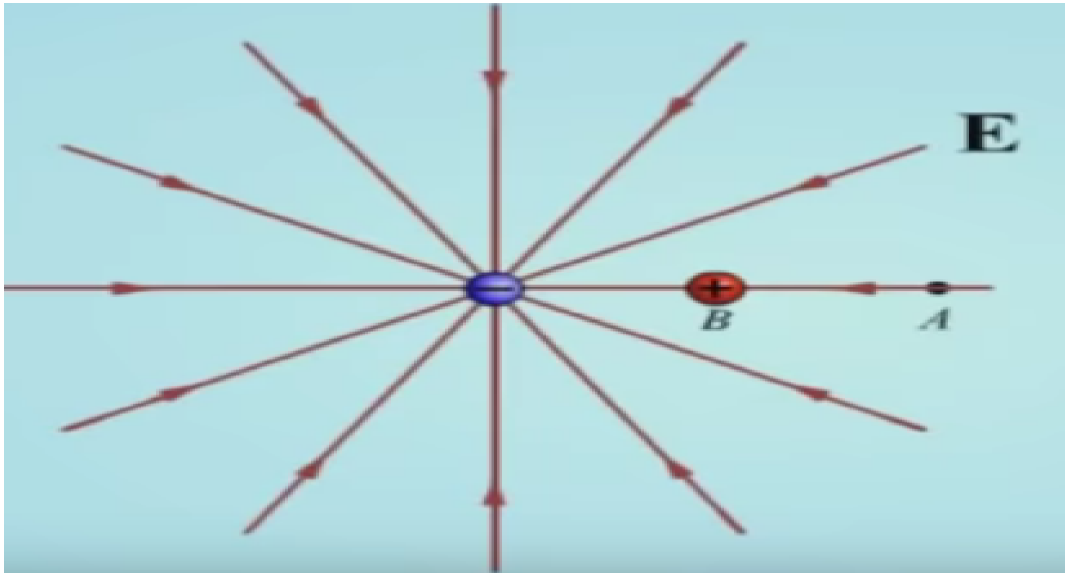
If $\theta = 90$ between F_{ex} and dl — therefore W is zero

POTENTIAL DIFFERENCE



$W > 0$

$V_B > V_A$



$W < 0$

$V_B < V_A$

Chapter 4

1- potential differences in a uniform electric field

the differential work ***dW*** done on a particle by a force during a displacement ***ds***

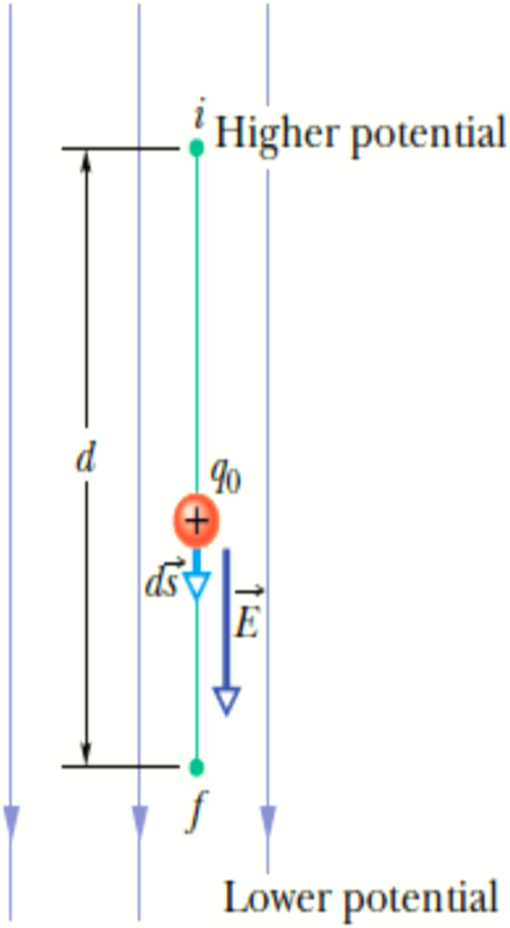
$$dW = \overrightarrow{F}.\overrightarrow{ds}$$

$$dW = q_o \overrightarrow{E}.\overrightarrow{ds}$$

The potential difference V_f -V_i is

$$V_f - V_i = \int_i^f \overrightarrow{E}.\overrightarrow{ds} = \int_i^f Eds\cos\theta$$

The angle between *E* and *ds* zero



$$V_f - V_i = -\int_i^f Eds = -E\int_i^f ds = Ed$$

$$\Delta V = Ed$$

Note that :

***E* has a new unit (V/m).**

Volte / *Meter* = Newton / Coulomb

2. Potential differences in a non-uniform electric field

$$dW = \overrightarrow{F}.\overrightarrow{ds}$$

$$dW = q_o \overrightarrow{E}.\overrightarrow{ds}$$

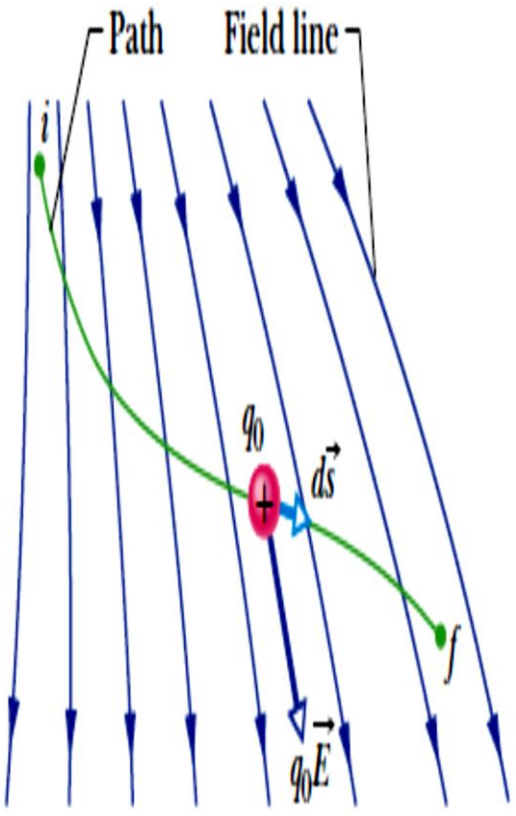
The potential difference V_f -V_i is

$$V_f - V_i = \int_i^f \overrightarrow{E}.\overrightarrow{ds}$$

If the point *i* is taken to infinity then *V*i = 0

the potential *V* at point *f* is

$$V_f = \int_\infty^f \overrightarrow{E}.\overrightarrow{ds}$$

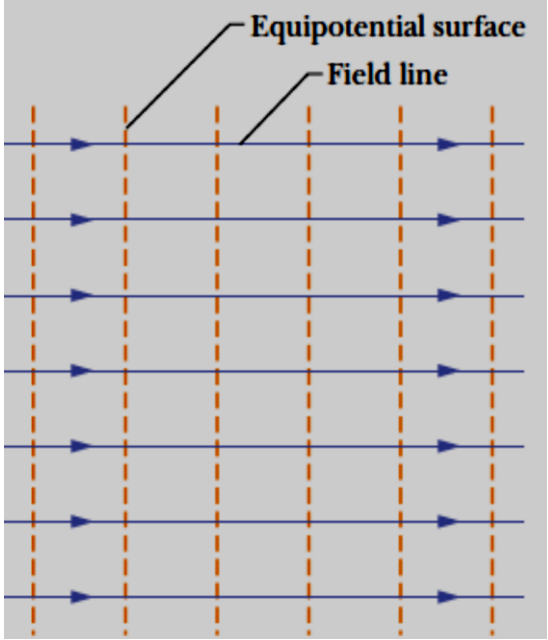


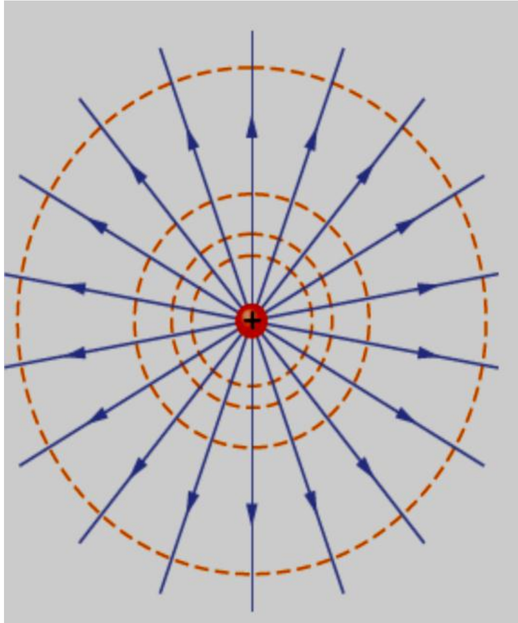
Chapter 4

Equipotential Surfaces

The equipotential surface is a surface such that the potential has the same value at all points on the surface. *i.e.* ***Vf -Vi = zero*** for any two points on one surface.

The work is required to move a test charge between any two points on an equipotential surface is zero.(Why)





$$W = q(V_f - V_i)$$

Where $(V_f - V_i)$ = **Zeo** $\therefore$ ***W= Zero***

Equipotential Surfaces

1. **The net electric force does no work as a charge moves on an equipotential surface.**
2. **The electric field created by any charge or group of charges is everywhere perpendicular to the associated equipotential surfaces.**
3. **The electric field points in the direction of decreasing potential.**


Thank
You