

Chapter 23: Electric Potential

Date: _____

23-1 Potential Difference

- Comparison to gravitational potential energy:

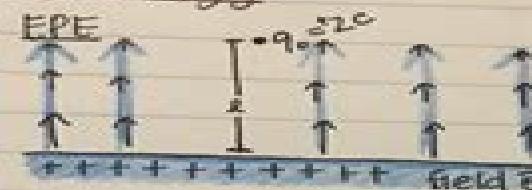
GPE

$$PE_g = m \cdot g \cdot h$$

$$= F_g \cdot h$$

$W = F \cdot d = F_g \cdot h$ equal and opposite

$$\therefore W = PE_g$$



$$E = \frac{F}{C} = \text{Force/charge}$$

$$W = F \cdot d$$

$$= E \cdot q \cdot d = PE_e$$

$$\therefore W = PE_e$$

- Deriving the equation:

$$\textcircled{1} \quad dU = -\vec{F} \cdot d\vec{r} \quad \text{change in PE for a conservative force } F \text{ undergoing } d\vec{r}$$

$$\textcircled{2} \quad \vec{F} = q_0 \vec{E} \quad \text{force exerted by electrostatic field } \vec{E} \text{ on pt charge } q.$$

$$\textcircled{3} \quad dU = -q_0 \vec{E} \cdot d\vec{r} \quad \text{resulting change in electric potential energy}$$

$$\textcircled{4} \quad dV = \frac{dU}{q_0} = -\vec{E} \cdot d\vec{r} \quad \text{potential difference} \rightarrow \text{potential energy change per unit charge}$$

For a finite displacement from point $a \rightarrow b$

$$\Delta V = V_b - V_a = \frac{ab}{q_0} = - \int_a^b \vec{E} \cdot d\vec{r} \quad \text{This is } -\frac{W}{q}$$

scalar function unlike \vec{E}

- Function V is called the electric potential / potential

- $U = q_0 V$ relation between potential energy and potential

- V is continuous at any point not occupied by a point or line of charge.

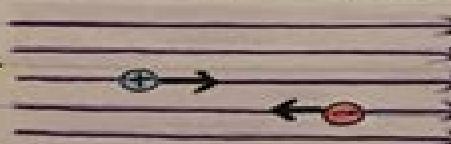
- Units

$$\text{Electric Potential} = \left[\frac{\text{Potential energy}}{\text{unit charge}} \right] = \left[\frac{J}{C} \right] = V \quad \text{or Volts/Voltage} \rightarrow 1 \text{ V} = 1.60 \times 10^{-19} \text{ C} \cdot \text{V} \text{ or J}$$

$$\text{Electric Field} = \left[\frac{N}{C} \right] = \left[\frac{V}{m} \right] \quad \text{either } \frac{\text{force}}{\text{unit charge}} \text{ or } \frac{\text{change in potential}}{\text{distance}}$$

- Potential and Electric Fields

High
 V



Low
 V

- \vec{E} points in a direction where V decreases
- positive charge accelerates in direction of \vec{E} : decreasing V
- negative charge accelerates in direction opposite of \vec{E} : increasing V

If released from rest, KE increases and PE decreases.

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