DAY: _____ DATE: _____

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Phy. Assignment

Potential Difference:

Moving a charge (q) from one point to another point in an electric field ($\vec{E}$) is called potential difference.

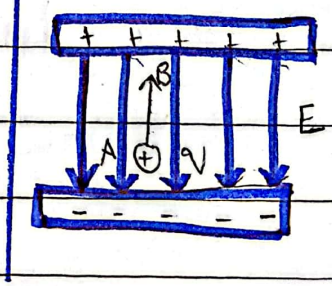
$$\Delta U = \frac{\Delta U}{q_0} \Rightarrow \Delta V = \frac{-qE.d}{q_0}$$

$$V_A - V_B = -qE.d/q_0$$

Potential Energy:

Work done by the electrostatic force against the field is called potential energy. Potential energy is -ive of the work done.

$$U = -W \quad , \quad U = -qE.d$$



Electric potential:

The amount of work done to move a unite tive

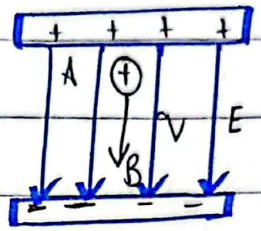
242863

DAY: DATE:

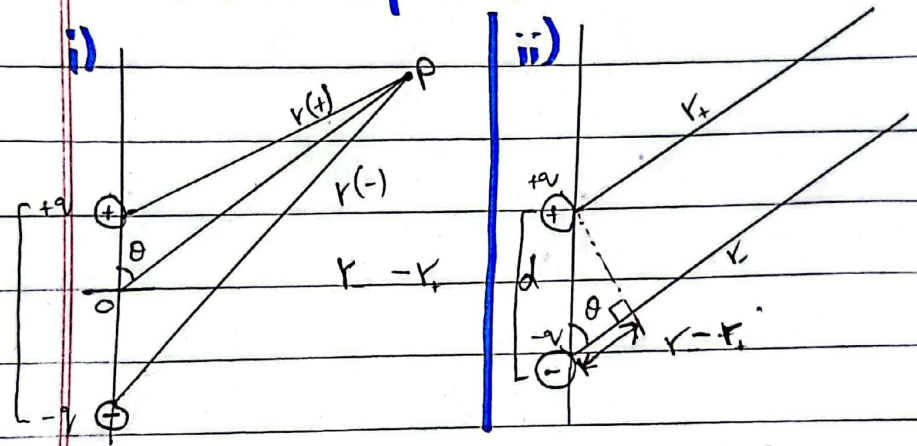
charge from one point another point in an electric field.

$W = F \cdot d$, $\therefore F = qE$

$W = qE \cdot d$



Electric potential due to an electric dipole:



In fig. i) Point P is a distance r from the mid-point O of a dipole. The line $\overline{OP}$ makes an angle of θ with dipole axis.

In fig. ii) If P is far from the dipole, the lines of length r_+ and r_- are approximately parallel to the line of length r. and the dashed back line is approx. perpendicular to the line of length r_-.

DAY: 242863 DATE:

Derivation:

To find electric potential due to dipole an arbitrary point P, use eq:

$$V = \sum_{i=1}^{2} V_i$$

At P, +ive charged particle (at distance r_+) sets up potential V_-. Then net potential is as follow:

$$V = \sum_{i=1}^{2} V_i = V_+ + V_-$$
$$= k\left(\frac{+q}{r_+} + \frac{-q}{r_-}\right)$$

Now, we will approximate the two lines to P as being parallel and their length difference as being parallel and their length difference as being the hypotenuse (d). Also that difference is so small that the product of length is (approxi) approximately r^2.

Thus,

$$r_- - r_+ = d\cos\theta \quad \text{and} \quad r_- r_+ = r^2$$

Putting values in above equation, we can approximate V to be:

$$V = \frac{q}{4\pi\varepsilon_0} \cdot \frac{d\cos\theta}{r^2}$$

242863

DAY: _____ DATE: _____

here, θ is the measured angle from the dipole axis.

Now, put $P = qd$

$$V = \frac{P}{4\pi\varepsilon_0} \cdot \frac{\cos\theta}{r^2} \Rightarrow \boxed{\frac{1}{4\pi\varepsilon_0} \cdot \frac{P\cos\theta}{r^2}}$$

Electric dipole

Here, ($P = qd$) is the magnitude of the electric dipole moment. The vector $\vec{P}$ is directed along the dipole axis from -ive to +ive charge. Thus, θ is measured from the direction of $\vec{P}$. We use the vector to report the orientation of electric dipde.