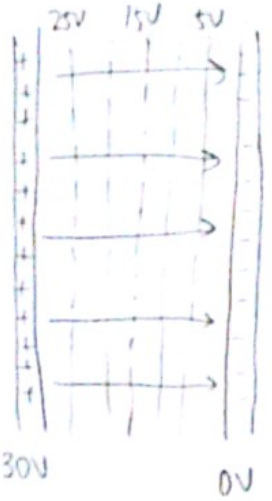
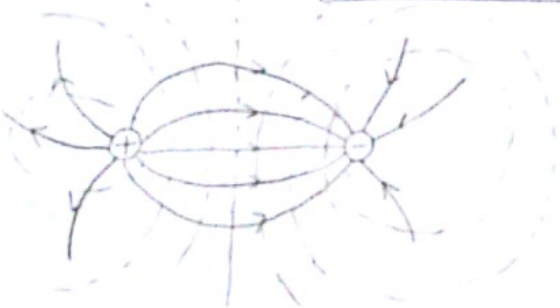
Electric Potential = potential energy per unit charge



Electric field lines point from higher to lower potential

★ All points on an equipotential surface are at the same potential
* An equipotential surface must be perpendicular to the electric field



Density of field lines ∝ electric field strength

---- equipotential lines
→ electric field lines

Electric Potential – Single Point Charge

$$V = k\frac{Q}{r} = \frac{1}{4\pi\epsilon_0}\frac{Q}{r} \qquad k = 9\times10^9\ N\cdot m^2/C^2 \qquad \epsilon_0 = 8.85\times10^{-12}\ C^2/N\cdot m^2$$

– Multiple Point Charge

$$V = V_1 + V_2 = k\frac{Q_1}{r_1} + k\frac{Q_2}{r_2}$$

Conservation of Energy

$$W = PE = q\Delta V \quad \text{if } \Delta V = 0,\ W = 0$$

$$V = -Ed$$

$$W = -qE\Delta d = \tfrac{1}{2}mv^2 \Rightarrow v = \sqrt{\frac{2qE\Delta d}{m}} = \sqrt{\frac{2Vq}{m}}$$

Potential Difference – 2 points

$$E = \frac{F}{q} \qquad V = \frac{PE}{q} \qquad V_{ba} = V_b - V_a = \frac{PE_b - PE_a}{q} = \frac{-W_{ba}}{q}$$

Ch 17
Section 5

III. ELECTRICITY AND MAGNETISM
A. Electrostatics
2. Electric field and electric potential (including point charges)
b) Students should understand the concept of electric potential, so they can:
(1) Determine the electric potential in the vicinity of one or more point charges.

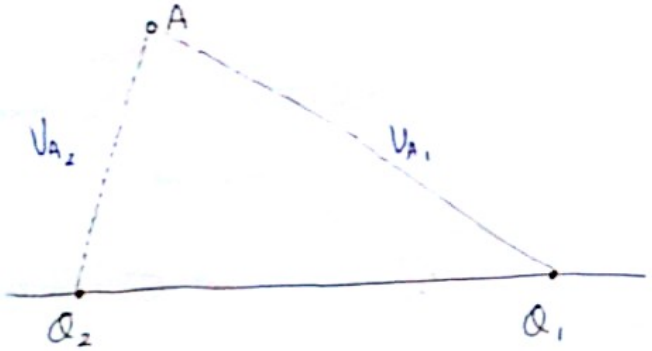
Electric potential (V) at a distance (r) from a single point charge (Q) :

$$V = k\frac{Q}{r} = \frac{1}{4\pi\varepsilon_0}\frac{Q}{r}$$

$k = 9 \cdot 10^9 \ (N \cdot m^2/C^2)$

$\varepsilon_0 = 8.85 \cdot 10^{-12} \ (C^2/N \cdot m^2)$

From a multiple point charges



$$V_A = V_{A_1} + V_{A_2}$$

$$= k\frac{Q_2}{r_{2A}} + k\frac{Q_1}{r_{1A}}$$

(* sign of V depends on Q)

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III. ELECTRICITY AND MAGNETISM
A. Electrostatics
2. Electric field and electric potential (including point charges)
b) Students should understand the concept of electric potential, so they can:
(2) Calculate the electrical work done on a charge or use conservation of energy to determine the speed of a charge that moves through a specified potential difference.

$W = \Delta PE$

$= q\Delta V$ $\quad \therefore$ if $\Delta V = 0$ (on equipotential fields)

$W = 0.$

$V = -Ed$

$W = -qE\Delta d$

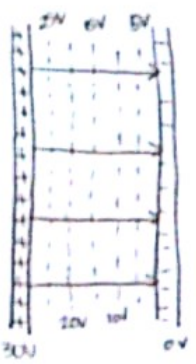
Conservation of energy

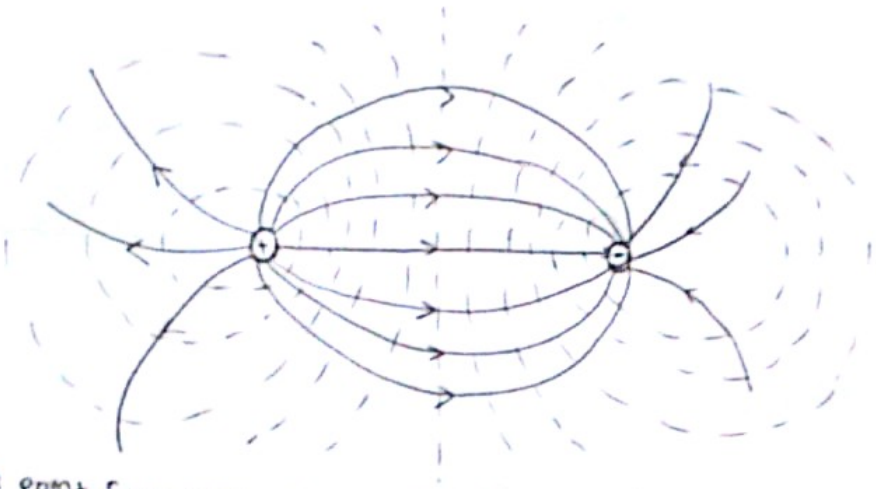
$-qE\Delta d = \frac{1}{2}mv^2$

$v = \sqrt{\frac{2qE\Delta d}{m}}$ or $\sqrt{\frac{2Vq}{m}}$

III. ELECTRICITY AND MAGNETISM
A. Electrostatics
2. Electric field and electric potential (including point charges)
b) Students should understand the concept of electric potential, so they can:
(3) Determine the direction and approximate magnitude of the electric field at various positions given a sketch of equipotentials.

- All points on an equipotential surface are at the same potential.
- An equipotential surface must be perpendicular to the electric field at any point.





Dashed: equipotential lines

Solid: electric field lines

Electric field lines point from higher to lower potential, and the potential on each equipotential line is indicated.

Take this diagram as an example.
- Less dense electric field lines ⇒ weaker electric field
- Direction of electric field is indicated by arrows
  - ⇒ into a -ve charge
  - ⇒ out of a +ve charge.

III. ELECTRICITY AND MAGNETISM

A. Electrostatics

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2. Electric field and electric potential (including point charges)

b) Students should understand the concept of electric potential, so they can:

(4) Calculate the potential difference between two points in a uniform electric field, and state which point is at the higher potential.

$\vec{E} = \frac{F}{q}$ → electric force (N)

↓ electric field (N/C, vector)

↘ charge at point (C)

$V_a = \frac{PE_a}{q}$ → "electric potential energy per unit charge"

↑ J → $\frac{kQq}{r}$

↓ (V) ↓ (C)

$V_{ba} = V_b - V_a = \frac{PE_b - PE_a}{q} = -\frac{W_{ba}}{q}$

↳ potential difference: the amount of work per unit charge required to move a particle from one point to another in an electric field

V_{ba} = work done (positive) required to move + ptle toward the field-generating +, which repels + ptles.

$\frac{}{q}$

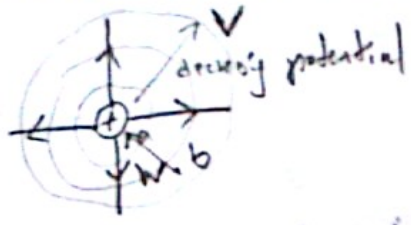
potential is higher at b, because (+)W is required to move (external) the + ptle from a to b.

Ch. 17
Sectn 1

III. ELECTRICITY AND MAGNETISM
A. Electrostatics
2. Electric field and electric potential (including point charges)
b) Students should understand the concept of electric potential, so they can.
(5) Calculate how much work is required to move a test charge from one location to another in the field of fixed point charges.

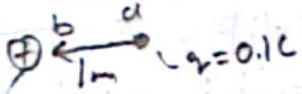
$V_a = \frac{PE_a}{q}$

$V_b - V_a = \frac{PE_b - PE_a}{q} = \frac{W}{q}$



Electric potential is the potential energy per unit charge.

example: $V_{ba} = 10V$



$W = ?$

$W = qV_{ba} = (0.1C)(10V)$
$= 1J$

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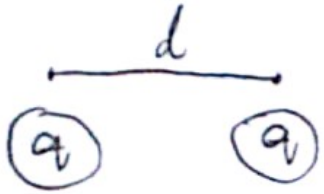
III. ELECTRICITY AND MAGNETISM
A. Electrostatics
2. Electric field and electric potential (including point charges)
b) Students should understand the concept of electric potential, so they can:
(6) Calculate the electrostatic potential energy of a system of two or more point charges, and calculate how much work is required to establish the charge system.



$PE = qV \qquad V = \frac{kQ}{r} \qquad PE = qEd$

$= \frac{kQq}{d}$

$W = -PE = \frac{-kQq}{d}$