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Electric potential, potential difference, electric potential due to a point charge

CLASS-XII

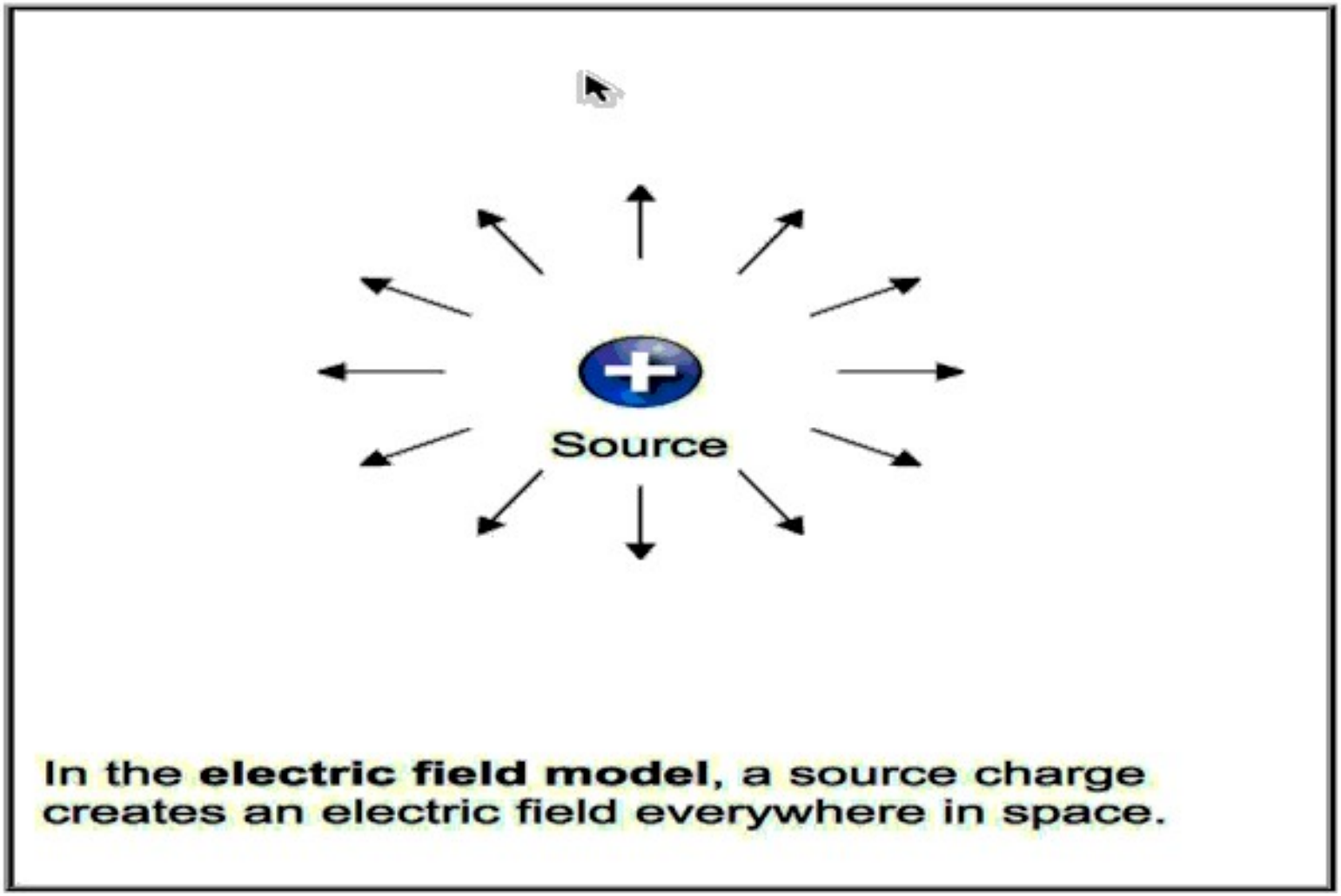
SUBJECT : PHYSICS
CHAPTER NUMBER: 02
CHAPTER NAME : ELECTROSTATIC POTENTIAL AND CAPACITANCE

LEARNING OUTCOME

- Understand the concept of potential and potential difference.
- Explain the direction of flow of charge between two bodies in contact.
- Understand the amount of work done by an external force in carrying a unit +ve charge (test charge) from one point to other along any path (Identify the attraction or repulsion of charged objects.
- Explain potential due to a system of charges.
- Identify that at every point in a charged object's electric field, the object sets up an electric potential V, which is a scalar quantity that can be positive or negative depending on the sign of the object's charge.

INTRODUCTION

What do you understand by scalar and vector field?



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ELECTROSTATIC POTENTIAL

Electric field can also be represented in terms of a scalar quantity called Electrostatic Potential

Electric Potential represents:-

(i) The idea of potential energy possessed by a unit charge at that point.

(ii) The degree of Electrification of a body.

(iii) The direction of flow of charge between two bodies in contact.

Note :

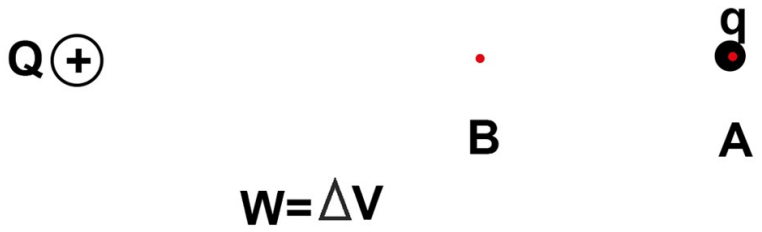
The actual value of potential energy is not physically significant, it is only the difference of potential i.e significant.

ELECTROSTATIC POTENTIAL DIFFERENCE

The amount of work done by an external force in carrying a unit +ve charge (test charge) from one point to other along any path (without acceleration)

mathematically

$$V_B - V_A = \frac{W_{AB}}{q_0}$$



The work done by an electrostatic electric field in moving a charge is usually conservative

POINTS TO REMEMBER

1. $(W_{A\to B})_{\text{electric force}} = q_0(V_A - V_B)$
2. $(W_{A\to B})_{elec} + (W_{A\to B})_{external} = (K)_B - (K)_A$
3. $(W_{A\to B})_{ext} = (K_B - K_A) + q_0(V_B - V_A)$

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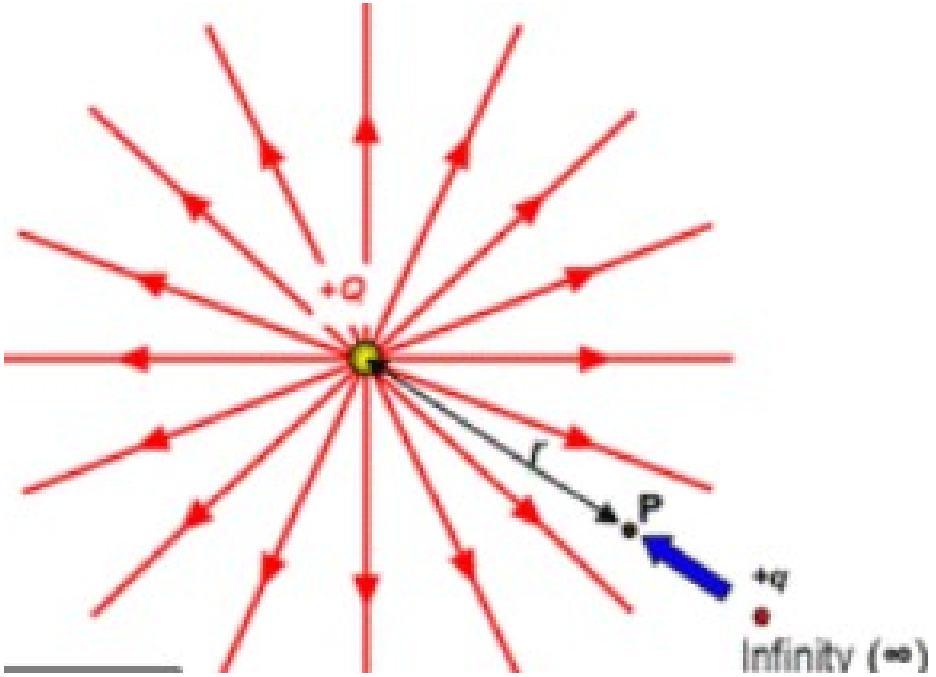
ELECTROSTATIC POTENTIAL AT A POINT

$$V_P = \frac{W_{\infty P}}{q_o}$$



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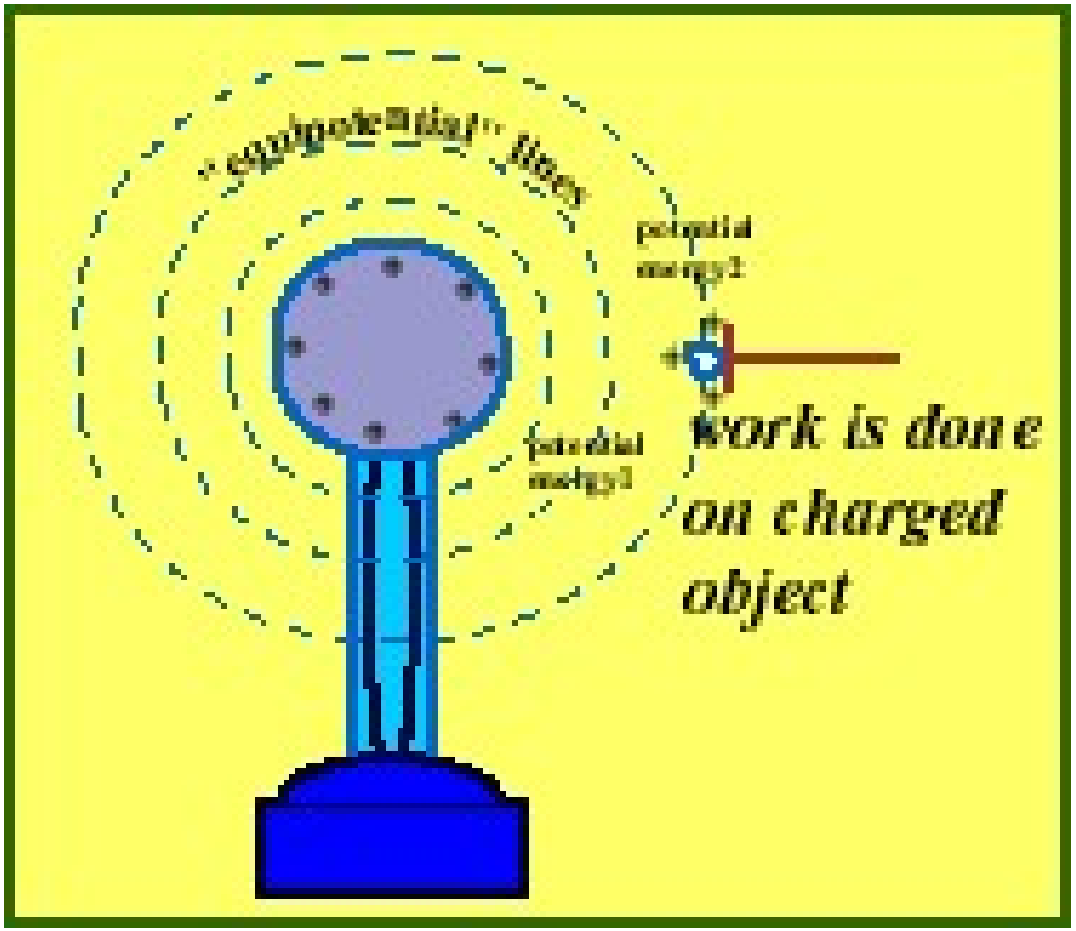
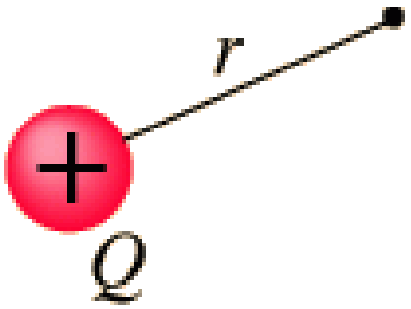
POTENTIAL DUE TO A POINT CHARGE:

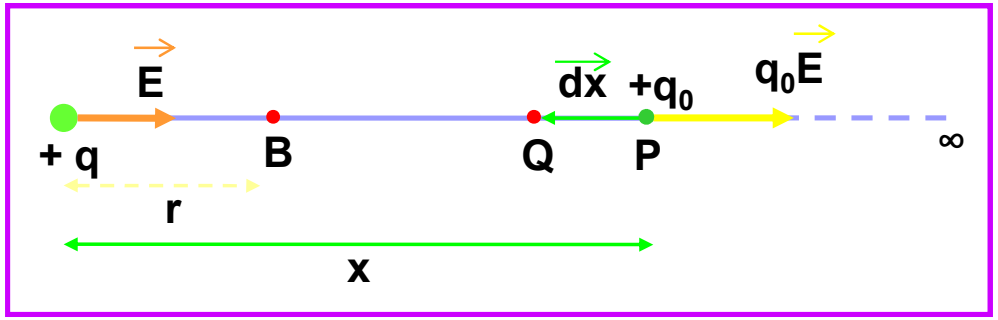


$$V = \frac{kQ}{r} = \frac{Q}{4\pi\varepsilon_0 r}$$



Electric Potential due to a Single Point Charge:

$$V = \frac{q}{4\pi\varepsilon_0 r}$$

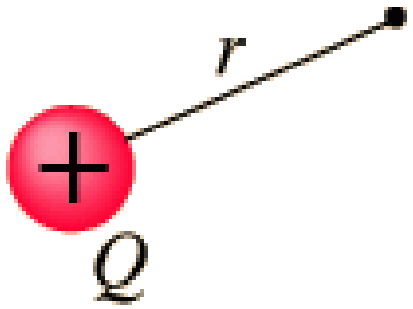


POTENTIAL DUE TO A POINT CHARGE:

By Definition ; $V = \frac{W}{q_0} = \frac{KQ}{r}$

$$V = \frac{Q}{4\pi \in_0 r}$$

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



GRAPH

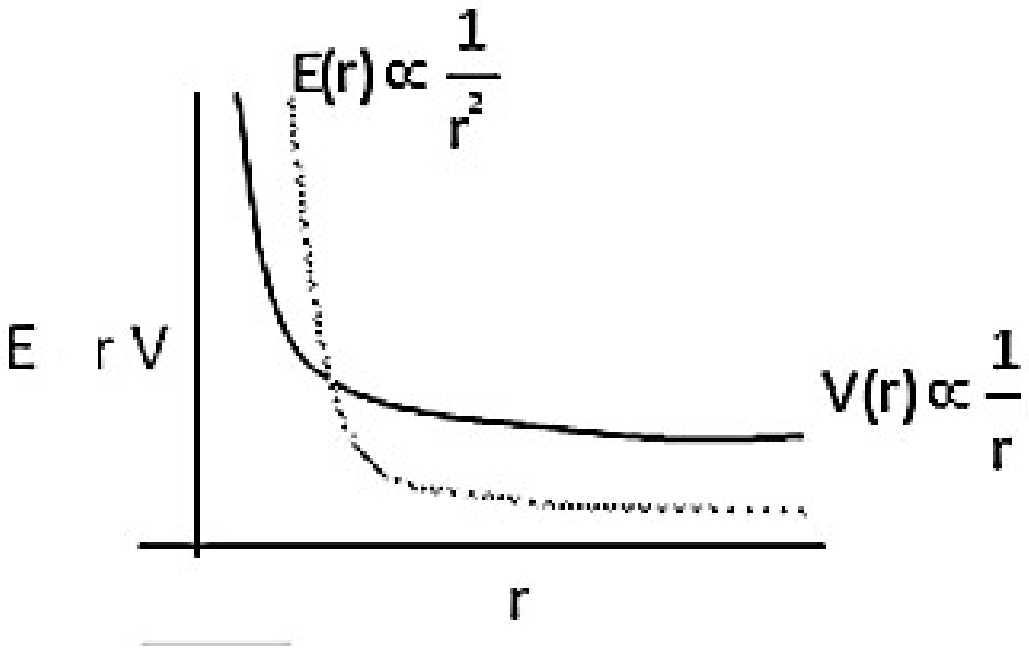
For the variation of V and E with r due to a point charge

Fig shows the variation of electrostatic potentia

with distance i.e $V \propto \frac{1}{r}$:

and also the variation of the electrostatic fiel

with distance i.e $E \propto \frac{1}{r^2}$



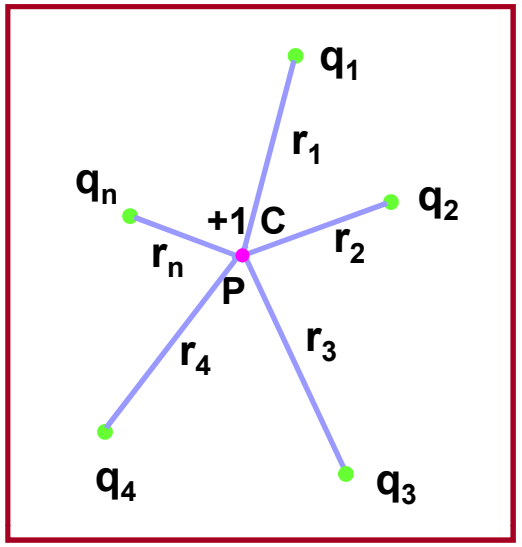
Electric Potential due to a Group of Point Charges:

$$V_P = V_1 + V_2 + V_3 + V_4 + \ldots\ldots\ldots\ldots + V_n$$

$$V = \frac{1}{4\pi\varepsilon_0} \sum_{i=1}^{n} \frac{q_i}{r_i}$$

$$V = \frac{1}{4\pi\varepsilon_0} \sum_{i=1}^{n} \frac{q_i}{|\vec{r} - \vec{r_i}|}$$

(in terms of position vector)



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NCERT NUMERICAL

a) Calculate the potential at a point 'P' due to a charge of $4 \times 10^{-7} C$ located 9cm away

b) Hence obtain the work done in bringing a charge of $2 \times 10^{-9} C$ from infinity to the point 'P'. Does the answer depend on the path along which the charge is brought?

NCERT NUMERICAL

And the isolated small spherical body is given a charge ‘q’ in air. What will be it’s potential

(i) in air ?

(ii) in a medium of a dielectric constant ($\in_r$)?

NCERT NUMERICAL

A charge of 1mC is displaced from point A of potential 25V to another point B of potential 5V.

(i) Find the work done by the electrostatic force on the charge for displacement $A \rightarrow B$.

(ii) If K.E. of the particle increases by 2mJ during displacement from $A \rightarrow B$, then calculate the work done by external force on the charge.

(iii) What would be the work done by the external force on the charge during the motion, if K.E of the charged particle remains constant?

NCERT NUMERICAL

Electric field intensity and electric potential at a point due to a point charge are 10 N/C aid 100 V respectively.

(a) What is the magnitude of the charge?

(b) What is the distance of the point form the charge?

THANKING YOU

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