LECTURE NOTE ON ELECTRIC FIELD

BY

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TOPIC: ELECTRIC FIELD AND ITS STRENGTH

LEARNING OUTCOMES:

At the end of this lesson, the students should be able to

1. Define electric field strength;
2. State the properties of electric field lines;
3. Show that the unit of electric field intensity can be written as NC^{-1} or Vm^{-1}.

ELECTRIC FIELD

An electric field is describe to exist at a given point if a force having an electrical origin exerts its strength on a positive test charge that is placed at that point.

THE STRENGTH OF AN ELECTRIC FIELD OR ELECTRIC FIELD INTENSITY

The electric field intensity at any point within an electric field represents the strength of the field and may be defined as either

1. The force experienced by a unit positive charge placed at that point and whose direction of the force.
   $E = F/q_0$ (1.0)
   From equation (1.0), the unit of E is NC^{-1}.
   Also it can be shown that the dimension of E is $MLT^{-3}I^{-1}$

   OR
2. Equal to the lines of the force passing through a unit cross-section at that point. Suppose there is a charge Q, the number of lines of force produced is given as Q/E. If these lines fall normally on an area A surrounding the point then the electric field intensity at that point is

$$E = \frac{Q/\varepsilon}{A} = \frac{Q}{\varepsilon A}$$

Now, Q/A = D
Where D is the electric flux density.

Therefore,
$E = D/\varepsilon = D/\varepsilon_0\varepsilon_r$ in a medium.
$E = D/\varepsilon_0 \times 1$ in air
Where ε_r is the relative permittivity of the given medium and ε_0 is the permittivity of free space.
OR

3. Equal to the potential gradient at that point.
   E = -dv/dx (Vm^{-1})$E = -dv/dx$ (Vm^{-1})

ELECTRIC FIELD LINES

An electric field line is a concept used to visualize an electric field, it must be taken into account that the direction of fields varies from points, and hence field lines are usually curved.

PROPERTIES OF ELECTRIC FIELD LINES

1. They emanate from a positive charge and end up in a negative charge.
2. They repel one another side ways and therefore, they cannot cross one another.
3. The electric field lines is strong in a situation where the lines are close, weak where the lines are far apart and parallel and equally spaced where the field is uniform.
4. As one travels along a field line in the direction of the arrows, the electric potential decreases whereas as one travels against the direction of a field line, the electric potential increases.
5. They are in a state of tension and this cause them to shorten.
6. They cut equipotential surfaces at right angles. An equipotential surface is a surface where all the points on it have the same electric potential.

ASSIGNMENT

Show that the unit of electric field intensity can be written as NC^{-1} or Vm^{-1}.