LEARNING

ELECTRIC FIELD INTENSITY

ELECTRIC FIELD

This is a region around which electric force is experienced. It can be mapped out by electrostatic lines of force. That is, an imaginary lie representing a line of force such as electric or magnetic field, such that the tangent to any point is the direction of the field vector at that point. Arrows on the lines of force show the direction of the field and each direction is always radially outward for a positive charge and otherwise for a negative charge. The lines of force are called “**Electric flux**”.

The force exerted on a charged body in an electric field depends on the charge of the body and on the intensity or strength of the field.

PROPERTIES OF ELECTRIC LINES OF FORCE.

1. They do not intersect with each other

2. They are continuous lines and they start from +ve to -ve charges

3. The tangent to the lines of force at every point gives the direction of the point

4. The magnitude of electric field is %alpha ti the number of lines

DEFINITION

The intensity, E of an electrostatic field at any point can be defined as force (F) per unit charge, which it exerts at that point.

The direction of the field is that of a force exerted on a +ve charge.

Mathematically,

E = F/q

F = Eq

q is the test charge.

If a charge q, is placed at the distance r from the test charge, then the force between the charges using coulomb’s law is

F = kqq\_1/r^2

At point P, the electric field is

E = F/q = kqq\_1/qr^2 = kq/r^2

The direction of the field is radially outward if the charge is positive, otherwise, it is radially inward

FLUX FROM A POINT CHARGE

Direction of lines of force do not remain constant

The intensity, E at a point can be represented by the number of lines per unit area through a surface perpendicular to the line of force at the point considered. The force through an area perpendicular to the lines of force is equal to the product of electric field strength and cross-sectional area, A

Flux = EA

Flux through an arc A, F=EA

Flux from a point charge

Electric Flux

It is the number of electric lines that possess through a surface per unit area

d rsub E = E.A

d rsub E = |E||A|cos %theta

where %theta is the angle between the electric force and the normal to the surface

E => Electric force

A => Surface Area

d rsub E => Electric flux

GAUSS’ LAW

The outward flux of electric field through any close surface is equal to the net enclosed charged divided by permitivity of free space E rsub o

d rsub E = E . A

sigma = q/A

Q= sigma times A

int {d rsub E} = Q/E = int from {s} {d rsub E}. dA =sigma times A/ E

where s is a any close surface

Q is the net charge enclosed with surface area

dA (with arrow) is the direction of the outward normal

1. An electron of charge 1.6 times 10^-19C is placed in a uniform electric field of 12000 intensity (N/C). Find the force on it, its acceleration and the time it takes to travel 2cm from rest.

M rsub e = 9.11 times 10^-31kg

F = Eq

F = ma

S = ut + ½ at^2

2. What is the electric field through a sphere of radius 4m that contains

a. 50uC b. -50uC

E rsub o = 8.85 times 10^-12

Formula: flux = Q/E rsub o

Answers: a 5.65 times 10^6 b. -5.65 times 10^6

3. Given that E=100N/C alpha (angle made with the horizontal) = 30, A = pi r^2 r = 2cm, calculate the flux in the figure

flux = EA cos theta

For this question, theta is 60. Angle made with the normal

nswer 0.25 pi Nm^2/C

4. Given a cuboid and a point charge of 30uC, calculate the flux in each face

Solution

flux = q/E rsub o

For each face, since there are six sides of a cuboid, we divide the total flux by the number of sides

flux = q/ 6 times {E rsub o}

Answer: 5.65 times 10^5

5. An electron is fixed between the plates of a parallel capacitor. Between the plates, a uniform electric field of magnitude 1000N/C is applied at initial velocity, v\_o of 10^7 m/s. Calculate the vertical deflection of the electron after it has travelled 10cm horizontally between the plates

a\_x = 0, v\_x = constant

a\_y = F/m = qE/m = 1.76 times 10^14

using x = ut+1/2at^2

x = ut (since a = 0)

0.1 = 10^7 times t

t = 10^-8

v\_y = u\_y + at

u\_y = 0

v = at

v\_y = 1.76 times 10^14 times 10^-8

v\_y = 1.76 times 10^6

y – y\_o = u\_yt+1/2a\_yt^2

delta y = ½ times 1.76 times 10^14 times (10^-8)^2

delta y = 8.8 times 10^13m

With a velocity of 9.10^6m/s an electron enters the homogeneous electric field of a parallel plate capacitor are 65mm long at a distance of 50mm apart. The pd between the plates is 150v

a. What is the acceleration of the electron in the y-direction

b. What is the time taken by the electron to travel from one end of the plate to the other end

c. How far from x-axis is the electron when it leaves the plate of the capacitor

d. What is velocity of the electron in the y-axis direction when it leaves the electric field

e. Determine the angle that the velocity makes with the x-axis when it leaves the electric field