TEACHERS FORUM®

QUESTION BANK

(SOLVED)

KERALA STATE

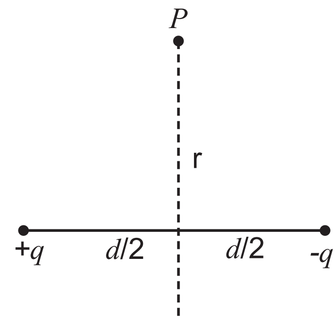
+2 PHYSICS

CONTENTS

1 ELECTRIC CHARGES AND FIELDS

PREVIOUS YEARS' QUESTIONS AND ANSWERS

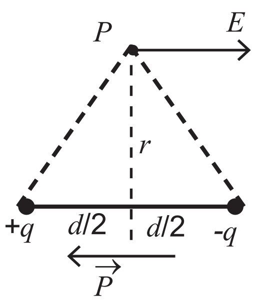
1. Two equal and opposite charges placed in air shown in figure: **(2018)**



(a) Redraw the figure and show the direction of dipole moment (P), direction of resultant electric field (E) at P.

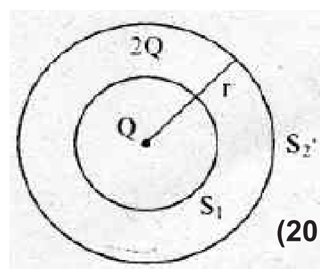
(b) Write an equation to find out the electric field at P.

Ans. (a)



(b) $E = \frac{1}{4\pi\varepsilon_0}\frac{P}{r^3}$ if d << r

2. Two spheres encloses charges as shown in figure:



(a) Derive an expression for electric field intensity at any point on the surfave S_2.

(b) What is the ratio of electric flux through S_1 and S_2? **(2018)**

Ans. (a) Electric field intensity, $E = \frac{1}{4\pi\varepsilon_0}\left(\frac{2Q}{r^2} + \frac{Q}{r^2}\right) = \frac{1}{4\pi\varepsilon_0}\frac{3Q}{r^2}$

(b) By Gauss's law, $\phi_1 = \frac{Q}{\varepsilon_0}$, $\phi_2 = \frac{3Q}{\varepsilon_0}$

$$\frac{\phi_1}{\phi_2} = \frac{1}{3}$$

3. (a) How many electrons constitute an electric charge of 16 μ C ? **(2017)**

(i) 10^{13} (ii) 10^{14} (iii) 10^{15} (iv) 10^{12}

(b) An electric dipole is a pair of equal and opposite point charges +q and -q separated by a distance r. Write an expression for its dipole moment.

(c)When an electric dipole is subjected to an uniform electric field, what will happen?

Ans. (a) (ii) 10^{14}

$$n = \frac{q}{e} = \frac{16 \times 10^{-6}}{1.6 \times 10^{-19}} = 10^{14}$$

(b) p = rq

(c) It will experience a torque and hence will rotate.

4. (a) How much greater is one micro coulomb compared to an elecronic charge ?

(i) 10^{13} times (ii) 10^{10} times (iii) 10^{11} times (iv) 10^{6} times **(2016)**

(b) A point charge of 2 μc is placed at the centre of a cubic Gaussian surface of side 0.5cm. What is the net flux through the surface? (Given $E_0 = 8.85 \times 10^{-12}$ $C^2/N/m^2$)

Ans. (a) $\frac{1\mu C}{e} = \frac{10^{-6}}{1.6 \times 10^{-19}} = 0.625 \times 10^{13}$.

So Ans. (i) 10^{13} times.

(b) By Gauss's theorem, the net flux passing through any closed surface

$$\phi = \frac{q}{\varepsilon_0} = \frac{2 \times 10^{-6}}{8.85 \times 10^{-12}} = 0.225 \times 10^{6} = 2.25 \times 10^{5} \times Nm^2/C$$

5. Gauss's theorem is useful in determining the electric field when the source distribution has symmetry.

(a) The electric field intensity at a distance 'r' from a uniformly charged infinite plane sheet of charge is

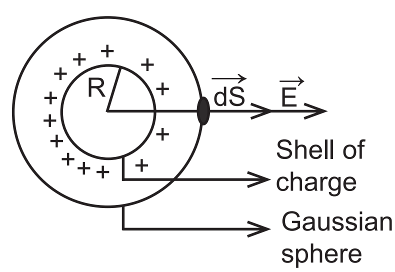
(i) Proportional to r (ii) Proportional to $\frac{1}{r}$ (iii) Proportional to r^2 (iv) Independent of r

(b) A thin spherical shell of radius 'R' is uniformly charged to a surface charge density σ. Using Gauss's theorem derive the expression for the electric field produced outside the shell. **(2016)**

Ans. (a) (iv) Independent of r

(b) Consider a shell of radius R and charge density σ. We have to find the electric field at a point distant r from the centre of this shell.

E.F. Outside the shell



The total Electric flux through the Gaussian sphere, $\oint \vec{E} \cdot \vec{dS}$

$$= \oint E ds \cos 0 \ (\because \vec{E} \parallel \vec{dS})$$

$$= \oint E ds$$

$$= E \oint dS = E \times 4\pi r^2$$

The charge enclosed by the Gaussian sphere, $q = A\sigma = 4\pi R^2 \sigma$

By Gauss's theorem, $\oint \vec{E} \cdot \vec{dS} = \frac{q}{\varepsilon_0}$

$$E \times 4\pi r^2 = \frac{4\pi R^2\sigma}{\varepsilon_0}$$

$$\Rightarrow E = \frac{R^2\sigma}{\varepsilon_0 r^2}$$

6. Electric field lines are a pictorial representation of electric field around charges.

(a) State Gauss's law in electrostatics

(b) Using this law derive an expression for the electric field intensity due to a uniformly charged spherical shell at a point

(i) Outside the shell (ii) Inside the shell

(c) Suppose you are in a cave deep within the earth. Are you safe from thunder and lightning? Why? **(2015)**

Ans. (a) Gauss's theorem state that "the total electric flux over a closed surface enclosing a charge is equal to $1/\varepsilon_0$ times the net charge enclosed."

Mathematically Gauss's theorem can be stated

$$\Phi = \frac{1}{\varepsilon_0} q$$

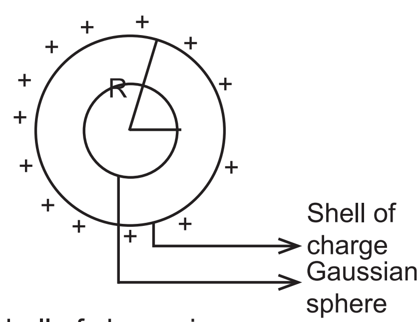
$$\Rightarrow \oint \vec{E} \cdot \vec{dS} = \frac{q}{\varepsilon_0}$$

(b) (i) Refer previous answer.

(ii) E.F.inside the shell

In this case the charge enclosed by the Gaussian sphere, q = 0

$\therefore$ Substituting in Gauss 's theorem we get,



$$E \times 4\pi r^2 = \frac{0}{\varepsilon_0}$$

$\Rightarrow$ E = 0. The electric field inside a sperical shell of charge is zero.

(c) Yes, It is due to electrostatic shielding.

7. According to Gauss' law the electric flux through a closed surface is equal to $\frac{q}{\varepsilon_0}$ where q and ε_0 have their usual meaning

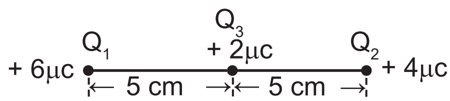
Why is it safe to be inside a bus than sheltered under a tree during lighting? **(2014)**

Ans. Due to electrostatic shielding no charge and electric field is present inside the conductor. So it is safer to be insider the bus than sheltered under a tree.

8. Conductors are materials which allow the passage of electricity through them

(a) When two conductors share their charges what happens to their total energy?

(b)3 charges Q_1, Q_2 and Q_3 are arranged as in figure. **(2014)**



(i) Find the force on the charge Q_3?

(ii) In which direction will this force act?

Ans. (a) Total energy remains the same.

(b) (i) $F_1 = \left(\frac{1}{4\pi\epsilon_0}\right)\left(\frac{Q_1 Q_3}{r^2}\right) = 43.2$ N

$F_2 = \left(\frac{1}{4\pi\epsilon_0}\right)\left(\frac{Q_2 Q_3}{r^2}\right) = 28.8$ N

Net force on $Q_3 = F_1 - F_2 = 43.2 - 28.8 = 14.4$ N towards Q_2

(ii) towards Q_2

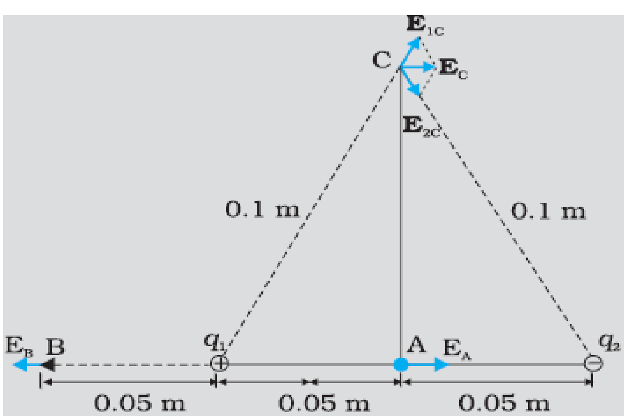
9. (A) All free charges are integral multiple of a basic unit charge e. Then quantization rule of electric charge implies **(2014)**

(a) Q = e (b) $Q = \frac{1}{e}$ (c) Q = ne (d) $Q = e^2$

(B) Match the following quantities in Column A with their units in Column B:

A	B
(i) Force	(a) Coulomb(C)
(ii) Charge	(b) N/C or V/m
(iii) Electric field	(c) Coulomb meter (Cm)
(iv) Dipole moment	(d) Newton(N)

(C) Electric field is an important way of characterising the electrical environment of a system of charges. Two point charges q_1 and q_2 of magnitude $+10^{-8}$C and -10^{-8}C respectively are placed 0.1 m apart. Calculate the electric fields at points A, B and C shown in the figure.



Ans. (a) Q = ne

(b)

A	B
(i) Force	(d) Newton(N)
(ii) Charge	(a) Coulomb(C)
(iii) Electric field	(b) N/C or V/m
(iv) Dipole moment	(c) Coulomb meter (Cm)

(c) At point A: Due to q_1, $E_1 = \frac{1}{4\pi\varepsilon_0} \times \frac{10^{-8}}{(0.05)^2} = 3.6 \times 10^4$ N/C -------- (1)

Due to q_2, $E_2 = \frac{1}{4\pi\varepsilon_0} \times \frac{10^{-8}}{(0.05)^2} = 3.6 \times 10^4$ N/C -------- (2)

Total electric field at A $= E_1 + E_2 = 7.2 \times 10^4$ N/C

At point B: Due to q_1, $E_1 = \frac{1}{4\pi\varepsilon_0} \times \frac{10^{-8}}{(0.05)^2} = 36000$ N/C

Due to q_2, $E_2 = \frac{1}{4\pi\varepsilon_0} \times \frac{10^{-8}}{(0.15)^2} = 4000$ N/C

Total electric field at B $= E_1 - E_2 = 32000$ N/C

At point C: $E_1 = E_2 = \frac{1}{4\pi\varepsilon_0} \times \frac{10^{-8}}{(0.1)^2} = 9 \times 10^3$ N/C

10. "Gauss's law is true for any closed surface, no matter what its shape or size" say the following statements are true or false.

(a) Gauss's law implies that the total electric flux through a closed surface is zero if no charge is enclosed by the surface.

(b) This law is useful for the calculation of electrostatic field when the system doesn't possess any symmetry.

(c) In a uniform electric field, we know that the dipole experiences no net force; but experiences a torque having a relation with P and E is given by _____, where the parameters P and E have their usual meaning. **(2014)**

Ans. (a) True (b) False (c) PE sin θ

11. The electric flux due to an electric field $\vec{E}$ through a surface $\vec{\Delta S}$ is given by $\vec{E} \cdot \vec{\Delta S}$.

(a)The SI unit of electric flux is

(i) $\frac{\text{Newton}}{\text{Coulomb}}$ (ii) Volt (iii) Volt x metre (iv) $\frac{\text{Volt}}{\text{Metre}}$

(b) Imagine that a charge 'Q' is situated at the centre of a hollow cube. What is the electric flux through one side of the cube? **(2014)**

Ans. (a) (iii) Volt x metre

(b) Total electric flux $\Phi = \frac{q}{\epsilon_0}$.

So flux through one side $= \frac{q}{6\epsilon_0}$

12. Gauss's law can be used to determine the electric field due to a charge distribution.

(a) Below are some statements about Gauss's law. Say whether they are true or false:

(i) Gauss's law is valid only for symmetrical charge distribution.

(ii) The electric field calculated by Gauss's law is the field due to charges inside the Gaussian surface.

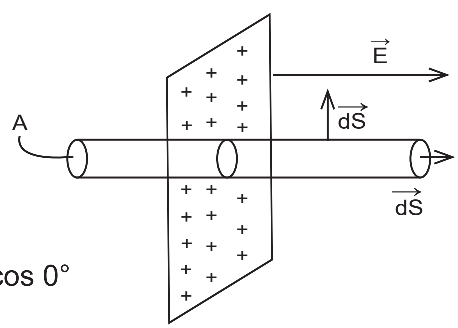
(b) Apply Gauss's law to find the electric field due to an infinitely long plane sheet of charge.

(c) "There can be no net charge in a region in which the electric field is uniform at all points". Do you agree with this statement? Justify your answer. **(2013)**

Ans. (a) (i) False (ii) False

(b) Consider an infinitely large plane sheet of charge density σ. To find electric field imagine a Gaussian cylinder of small area of cross section penetrating the sheet and extending to both sides equally.

The total electric flux through the Gaussian cylinder,



$$\oint_s \vec{E} \cdot \vec{dS} = \int_{\substack{\text{curved}\\ \text{surfaces}}} \vec{E} \cdot \vec{dS} + \int_{\substack{\text{end}\\ \text{faces}}} \vec{E} \cdot \vec{dS}$$

$$= \int_{\substack{\text{curved}\\ \text{surfaces}}} EdS \cos 90° + \int_{\substack{\text{end}\\ \text{faces}}} EdS \cos 0°$$

$$= E \int_{\substack{\text{end}\\ \text{faces}}} dS = E \times 2A$$

The charge enclosed by the Gaussian cylinder is $q = A\sigma$

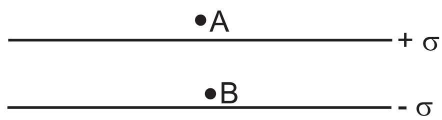
By Gauss's theorem, $\oint \vec{E} \cdot \vec{dS} = \frac{q}{\varepsilon_0}$

i.e., $E \times 2A = \frac{A\sigma}{\varepsilon_0} \qquad \Rightarrow E = \frac{\sigma}{2\varepsilon_0}$

(c) Yes, if the electric field is uniform the total flux entering the Gaussian surface will be equal to the total flux leaving the surface. i.e., $\oint \vec{E} \cdot \vec{dS} = 0$ or $q = 0$

13. (a) Name the physical quantity which has its unit joule.coulomb^{-1}. Is it a vector or a scalar? **(2012)**

(b) Two plane sheets of charge densities + σ and -σ are kept in air as shown in figure. What are the electric field intensities at points A and B?



Ans. (a) Electric potential /Potential Difference. It is a scalar.

(b) At the point A : zero ; At the point B : $\frac{\sigma}{\varepsilon_0}$

14. The idea of 'Electric field lines' is useful in pictorially mapping the electric field around charges. **(2012)**

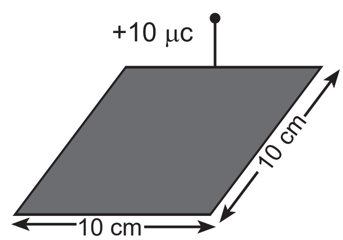
(a) Give any two properties of electric lines of force.

(b) State Gauss's theorem, in electrostatics.

(c)Using the theorem, derive an expression for electric field due to a uniformly charged spherical shell

(i) at a point outside the shell (ii) at a point inside the shell

(d) A point charge of +10 μc is at a distance of 5 cm directly above the centre of a square of side 10 cm as shown in figure. What is the electric flux through the square?



Ans. The properties of electric field lines are:

(i) Electric field lines start at positive charge and end at negative charge.

(ii) In a charge free region electric field lines have no break or they are continuous.

(iii) Two electric field lines never intersect each other.

(iv) In a uniform electric field, electric field lines are parallel.

(v) Electric field lines do not form closed loops.

(b) Gauss's theorem states that " the total electric flux over a closed surface enclosing a charge is equal to 1/ϵ_0 times the net charge enclosed."

Mathematically Gauss's theorem can be stated as $\phi = \frac{1}{\varepsilon_0} q$

$$\Rightarrow \oint \vec{E} \bullet \vec{ds} = \frac{q}{\varepsilon_0}$$

(c) **Refer Qn No: 6 (b)**

(d) Total flux through cube, $\phi = \frac{q}{\varepsilon_0} = \frac{10 \times 10^{-6}}{8.854 \times 10^{-12}} = 11.28 \times 10^5\ NC^{-1}m^2$

$\therefore$ Flux through each side $= \frac{1}{6}\phi = \frac{1}{6} \times 11.28 \times 10^5 = 1.88 \times 10^5\ NC^{-1}m^2$

15. Two equal and opposite charges +q and-q are separated by a small distance '2a'.

(a) Name this arrangement. (b) Define its moment. What is its direction?

(c) If the above system is placed in a spherical shell. What would be the net electric flux coming out of it?

(d) The above system of two charges is placed in an external electric field E, at an angle θ with it. Obtain relation for the torque acting on it. **(2011)**

Ans. (a) Electric dipole

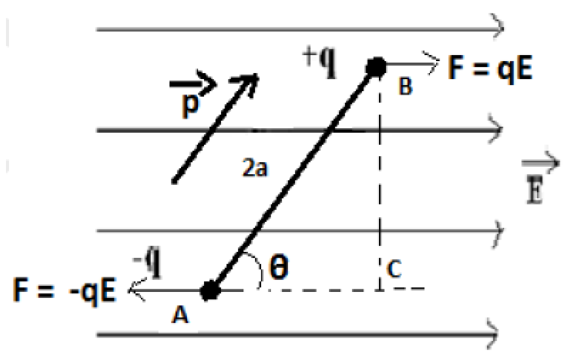
(b) Electric dipole moment is defined as the product of magnitude of one of the charges and length of the dipole.

Electric dipole moment $\vec{p}$ = q x 2a p

Electric dipole moment is a vector quantity.

(c) Zero

(d) Consider an electric dipole of dipole moment $\vec{p}$ = q x 2ap, placed in a uniform electric field.



Because of the two equal and opposite forces acting at the two ends of the dipole, a torque is experienced by the dipole. So the dipole will rotate till it becomes parallel to the electric field.

Torque, τ = Force x $\perp^r$ distance

$= qE \times BC = qE \times 2a \sin\theta = (q \times 2a) E\sin\theta = pE\sin\theta$

In vector form, $\vec{\tau} = \vec{p} \times \vec{E}$, The direction of this torque is given by right hand rule.

$\tau = pE\sin\theta$

16. A body of mass m is charged negatively. State whether the following statements are true or false. **(2011)**

(a) During charging, there is change in mass of body.

(b) The body can be charged to 2.5e where 'e' is the charge of an electron.

(c) While charging the body by induction new charges are created in it.

(d) The force between two charged objects is less when there is a medium between them (than in vacuum).

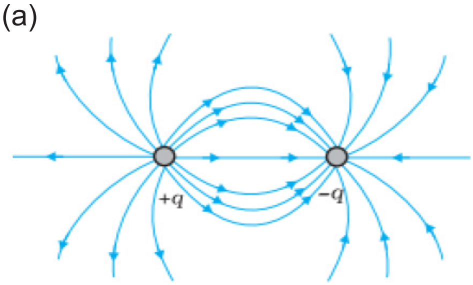
Ans. (a) True (b) False (c) False (d) True

17. Draw the electric field lines of force surrounding the charges if

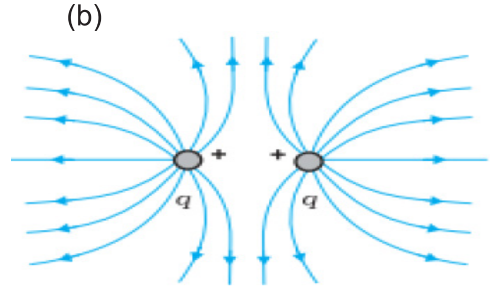
a) A +q charge and a –q charge are separated at a distance apart in air.

b) Two +q charges are placed at a distance apart in air. **(2011)**

Ans. (a)



(b)



Additional Questions and Answers

1. The value of charge on any object cannot be less than

(a) 4.8×10^{-19}C (b) 1C (c) 3.2×10^{-19}C (d) 1.6×0^{-19}C

Ans. (d) 1.6×10^{-19}C

As per charge quantisation, charge on any body is the integral multiple of fundamental charge e. $Q = \pm ne$. So Q cannot be less than $e = 1.6 \times 10^{-19}$C.

2. Derive an expression for work done rotating an electric dipole in a uniform electric field.

Ans. Work done = $\tau.d\theta$ ($\tau = PE\sin\theta$)

$$W = \int_{\theta_1}^{\theta_2} PE\sin\theta.d\theta = PE(\cos\theta_1 - \cos\theta_2)$$

3. There are two types of charges namely positive and negative.

(a) List any two basic properties of electric charge.

(b) Can a body have a charge of 0.8×10^{-19} C? Which basic property of electric charge is the reason for your answer?

(c) Name the basic property of electric charge that you can see in the equation

$Rn_{86} \rightarrow Po_{84} + He_2$.

Ans. (a) Quantization of electric charge, Conservation of electric charge.

(b) No. Quantization of electric charge (c) Conservation of electric charge.

4. In electrostatics, Electric charge is a feature of particles like protons, electrons etc that

decides the force of interaction among them

(a) Write the name of the law that is used to measure the above force of interaction.
(b) Express the above law in vector form.

(c) Two charged spheres when placed in air attract with a force F. Keeping the distance between the charges constant, the spheres are immersed in a liquid of relative permittivity K. Then the spheres will

(i) attract with a force KF (ii) repel with a force KF

(iii) attract with a force F/K (iv) repel with a force F/K

(d) Two small aluminum spheres are separated by 80 cm. How many electrons are to be transferred from one sphere to the other so that the they attract with a force of 10^4 N.

Ans. (a) Coulomb's law in electrostatics

(b) $\vec{F} = \frac{1}{4\pi\varepsilon_0} \times \frac{q_1 q_2}{r^2}\hat{r}$

(c) Attract with a force F/K

(d) If n electrons are transferred, charge on each sphere Q = ne

$$F = \frac{1}{4\pi\varepsilon_0} \times \frac{(ne)^2}{r^2}$$

$$n^2 = \frac{Fr^2}{9 \times 10^9 \times e^2} = \frac{10^4 \times 0.8^2}{9 \times 10^9 \times (1.6 \times 10^{-19})^2} = 2.77 \times 10^{31}$$

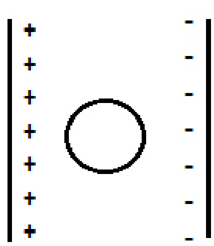
$$\Rightarrow n = 5.27 \times 10^{15}$$

5. Electric field is the region where an electric charge experiences a force and is visualized using the concept of electric field lines.
(a) What is the SI unit of intensity of electric field?

(b) "In a uniform electric field charges of different magnitude experience the same force". State whether this statement is true or false.

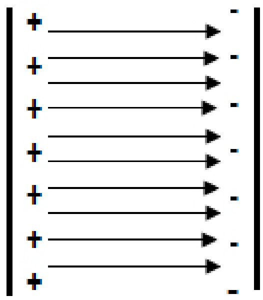
(c) Two identical metallic plates are charged with equal amount of charges as shown in the figure. Draw electric field lines representing the field between the plates.

(d) An uncharged metal hollow sphere is now placed between the plates as shown in the figure. Redraw the field lines

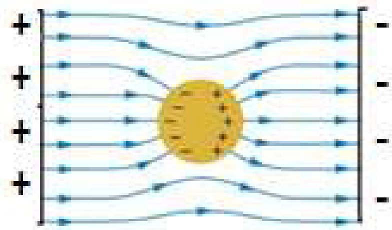


Ans. (a) NC^{-1} or Vm^{-1} (b) False

(c)



(d)



6. Intensity of electric field is a vector quantity.

(a) Define intensity of electric field at a point.

(b) Two small spheres A and B carrying charges 2 μC and 6μC respectively are separated by a fixed distance. Intensity of electric field at the location of B due to A is E. Intensity of electric field at the location of A due to B is

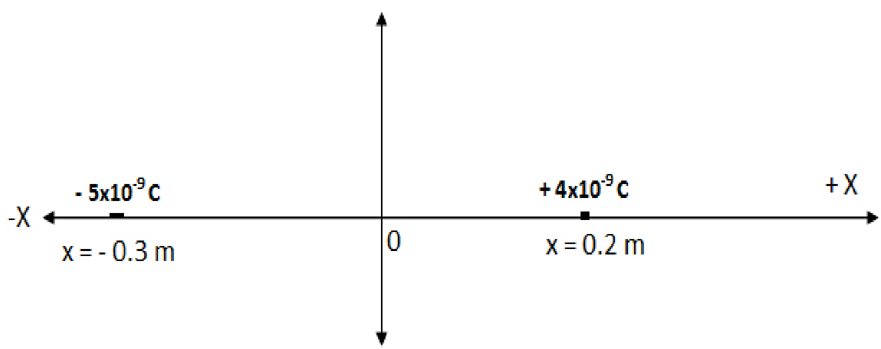
(i) E (ii) 3E (iii) 6E (iv) 12E

(c) Two point charges +4 nC and +5 nC are placed at x = 0.2 m and x = -0.3 m respectively along the x axis. Find the magnitude and direction of intensity of electric field at the origin.

Ans. (a) Intensity of electric field at point is the electrostatic force experienced by unit positive charge placed at that point.

(b) 3E

(c)



Intensity of electric field at the origin due to the negative charge

$$E_{(-)} = \frac{1}{4\pi\varepsilon_0} \times \frac{5 \times 10^{-9}}{0.3^2} = 500 \text{ N C}^{-1} \text{ along -ve } x \text{ axis}$$

Intensity of electric field at the origin due to the positive charge

$$E_{(+)} = 900 \text{ N C}^{-1} \text{ along -ve } x \text{ axis}$$

Net intensity of electric field at the origin

$$E = E_{(+)} + E_{(-)} = 500 + 900 = 1400 \text{ N C}^{-1} \text{ along -ve } x \text{ axis}$$

7. A pair of equal and opposite charges separated by a small vector distance forms an electric dipole.

(a) What is the direction of electric dipole moment?

(b) What is the angle between electric dipole moment and intensity of electric field due to the dipole at its

(i) axial point outside the dipole (ii) equatorial point?

(c) An electric dipole consisting of charges +20 μC and -20 μC separated by 2 mm is placed inside a cubical box of side 10 cm. What is the net electric flux passing through the box?

Ans. (a) From the negative to the positive charge along the dipole axis

(b) (i) zero (ii) 180^0

(c) Total charge of the dipole, q = 0

Flux passing through the box, $\phi = \frac{q}{\epsilon_0} \Rightarrow \phi = 0$

8. An electric dipole placed in an electric field experiences a torque.

(a) What is the net force acting on the dipole placed in a uniform electric field?

(b) Write the expression in vector form for the torque acting on an electric dipole when it is placed in a uniform electric field.

(c) When a dipole is placed in a uniform electric field the torque acting on it is found to be 0.707 times the maximum torque. Calculate the angle between the intensity of electric field and electric dipole moment and draw the orientation of the dipole in the electric field.

Ans. (a) Zero (b) $\vec{\tau} = \vec{p} \times \vec{E}$

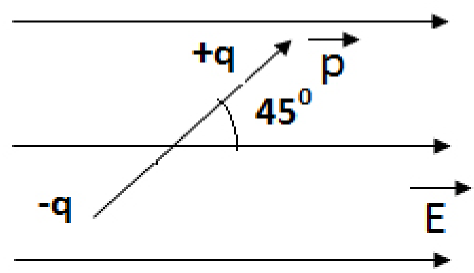
(c) Maximum torque $\tau_{max} = pE$

By the given condition $\tau = 0.707\tau_{max}$

$pE \sin\theta = 0.707\ pE$

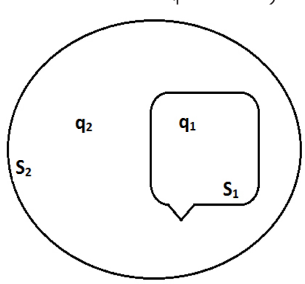
$\sin\theta = 0.707$

$\Rightarrow \theta = \sin^{-1}(0.707) = 45^0$



($\theta = 135^0$ is also will give the same torque)

9. Two closed surfaces S_1 and S_2 enclose two charges q_1 and q_2 as shown in the figure



(a) State the law in electrostatics that relates the electric flux passing through the surface with the charge enclosed.

(b) If q_1 = +6 μC and q_2 = - 4 μC find the ratio of the flux passing through surfaces S_1 and S_2

(c) Let the surface S_2 expands to double its area while S_1 remains as such. What will happen to the above ratio?

Ans. (a) The net flux of electric field passing through a closed surface is equal to $\frac{1}{\epsilon_0}$ times the charge enclosed by the surface.

(b) By Gauss' theorem flux passing through a surface $\phi = \frac{q}{\epsilon_0}$

Flux passing through S_1, $\phi_1 = \frac{6 \times 10^{-6}}{\epsilon_0}$ .... (1)

Flux passing through S_2, $\phi_2 = \frac{(6-4) \times 10^{-6}}{\epsilon_0}$ .... (2)

$(1) \div (2) \quad \frac{\phi_1}{\phi_2} = \frac{6}{2} = 3$

(c) Remains the same

10. Define Electric Flux. Write its SI unit.

Ans. Electric flux DΦ, through an area element $\overrightarrow{\Delta S}$, is defined by

$D\Phi = \vec{E}.\overrightarrow{\Delta S}$ = EDS cos θ, where θ is the angle between $\vec{E}$ and $\overrightarrow{\Delta S}$.

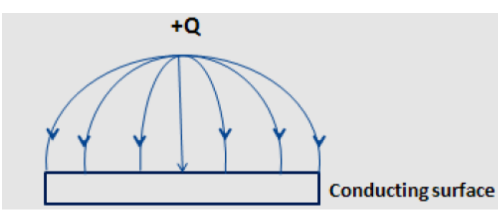
S.I unit of electric flux is $NC^{-1}m^2$.

11. How does the electric flux due to a point charge enclosed by a spherical Gaussian surface get affected when its radius is increased ?

Ans. Electric flux remains unaffected.

12. A point charge +Q is placed in the vicinity of a conducting surface. Trace the field lines between the charge and the conducting surface.

Ans.



13. An electric dipole is held in a uniform electric field.

(i) Show that the net force acting on it is zero.

(ii) The dipole is aligned parallel to the field. Find the work done in rotating it through the angle of 180°.

Ans. (i)

$$\vec{F}_1 = q\vec{E} \text{ and } \vec{F}_2 = -q\vec{E}$$

$$\vec{F}_{net} = \vec{F}_1 + \vec{F}_2$$

$$\therefore F_{net} = 0$$

(ii) $W = EP(\cos\theta_1 - \cos\theta_2)$

$W = 2EP$

14. (a) Define electric flux. Write its S.I. unit.

"Gauss's law in electrostatics is true for any closed surface, no matter what its shape or size is." Justify this statement with the help of a suitable example.

(b) Use Gauss's law to prove that the electric field inside a uniformly charged spherical shell is zero.

Ans. (a) Total number of electric lines of force passing perpendicular through a given surface.

Unit – newton m^2

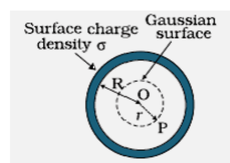
According to Gauss theorem, the electric flux through a closed surface depends only on the net charge enclosed by the surface and not upon the shape or size of the surface.

For any closed arbitrary slope of the surface enclosing a charge the outward flux is the same as that due to a spherical Gaussian surface enclosing the same charge.

Justification: This is due to the fact

(i) electric field is radial and (ii) the electric field $E \propto \frac{1}{R^2}$

(b) $\therefore$ According to Gauss theorem, $\int \vec{E} \cdot \vec{ds} = \frac{1}{\varepsilon_0} \cdot q = 0$



($\because$ charge inside the shell is zero.)

$\therefore E.dS = 0$, But $dS \neq 0$

$\therefore E = 0$

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