MASS PHYSICS

Chapter 1

ELECTRIC CHARGES AND FIELDS

TOPIC 1 INTRODUCTION TO ELECTROSTATICS

Q.1 What is Electrostatics? Who discovered it?

A. The branch of physics , which deals with the study of charges at rest, the forces between static charges, fields and potentials due to these charges is called electrostatics.

It was discovered by Greek philosopher 'Thalus of Miletus'

Q.2 What are the various physical quantities which describes electrostatics ? write a brief note?

A. There are 5 major quantities in electrostatics :

1. F (forces between charges)

2. E (Electric field intensity)

3. ϕ (Electric field Flux)

4. V (Electric field potential)

5. C (Capacitance)

Note: this chapter deals with first 3 physical quantities (F, E & ϕ) while last 2 quantities (V & C) are in NCERT chapter 2

TOPIC-2 ELECTRIC CHARGE

Q.1 What is electric charge? Write a short note on its history [origin]?

A. According to William Gilbert, charge is something possessed by material objects that makes

It possible for them to exert electrical forces and to respond to electrical forces.

But : charge can be defined as:

History of charge:

1.Around 6OOBC In Greece Thalus of Miletus discovers that Amber rubbed with wool or silk attracts light objects

2.The name electricity is coined from the Greek word electron meaning Amber.

3.Static charge can be developed on a body or two by rubbing them with each other.

4.The positive and negative form of charges were given by Benjamin Franklin.

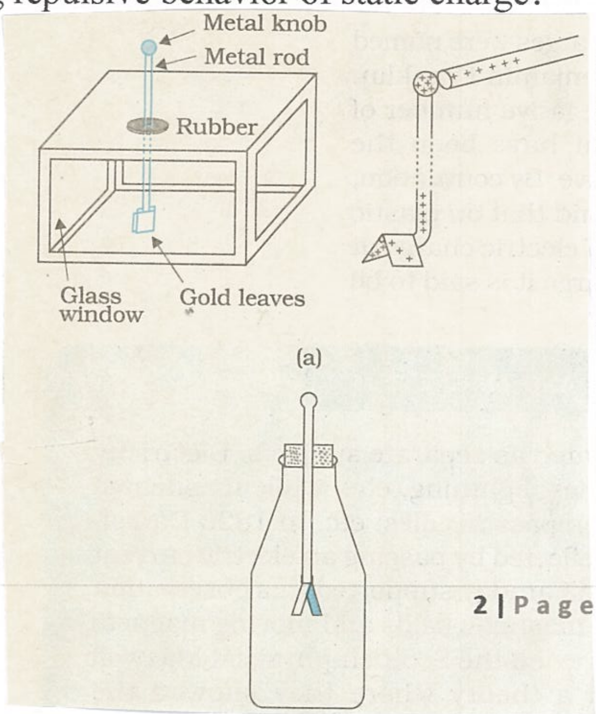
5. The bodies like glass, plastic rod, silk ,fur or pith balls suggested that on rubbing they get electrified, or they acquire an electric charge on rubbing.

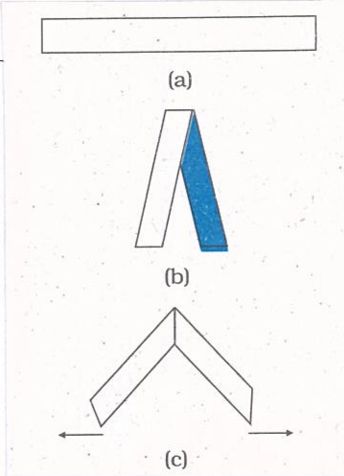
6. Various experiments shows that a) like charge repel & b) unlike charge attracts.

7.NOTE. the charges acquired after rubbing are lost when the charged bodies are brought in contact (when the body has no charge it is said to be neutral.

Q.2 ? Explain 2 experiments (electroscopes) for studying repulsive behavior of static charge?

A. The Gold Leaf electroscope (G.L.E) & Paper Strip Experiment.





Q.3 What are the five Important properties of electric charge ?

A. While studying charges we treat them as point charges and they posses five important properties:

1. Charge is additive in nature:

2. Conservation of charge:

3. Charge of a body is independent on its velocity:

4. Like charges repel and unlike charges attracts each other due to Coulombs force of electrostatics.

Special case:

5. QUANTISATION OF CHARGE :

Q.4 What are conductors and insulators, distinguish them on the basic of charge theory ?

Also explain the process of earthing or grounding ?

A.

Q.5 What are the two modes of transferring charge to a conducting body ?

A. Two modes of transferring charge are:

1. CONDUCTION:

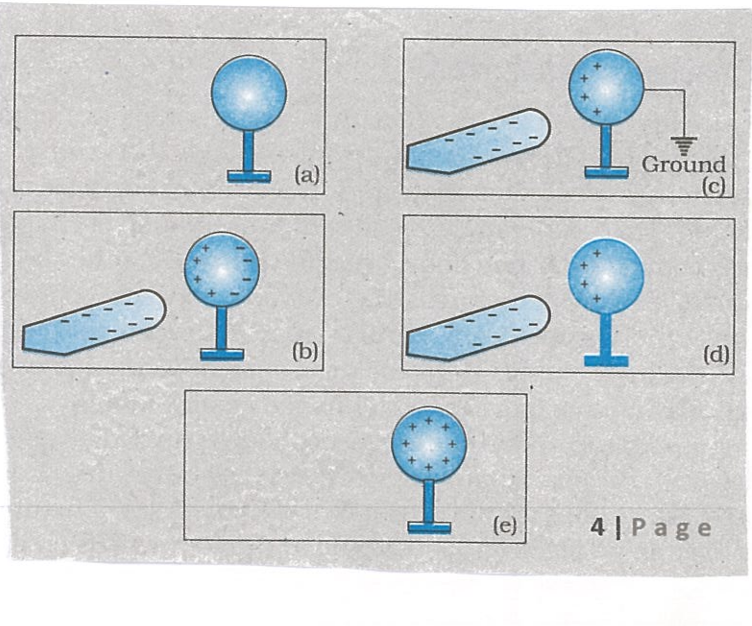
2. INDUCTION:

To understand them refer to following questions:

Q.6 How can you charge a metal sphere positively without touching it? N.C.E.R.T

A. This can be done by the means of induction and earthing in following steps:

Step 1.



Q.7 How to provide equal and opposite charge to identical metal spheres by the process of induction? N.C.E.R.T

A. Let us consider two metal spheres on insulated stand , to provide them charge by induction we must follow these steps:

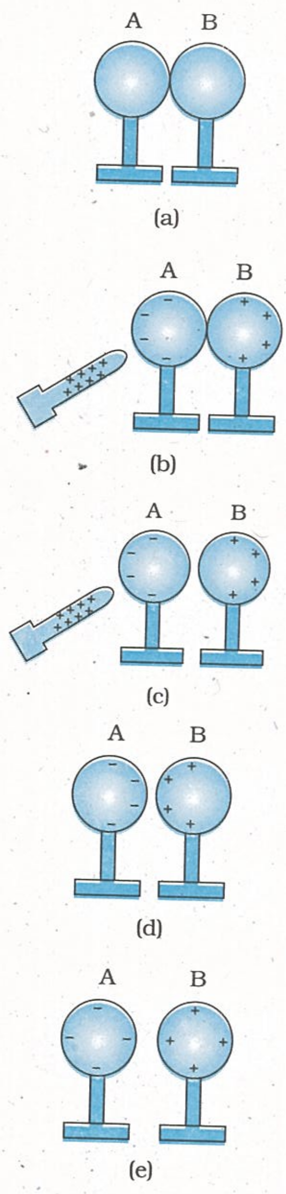


FIGURE 1.4 Charging by induction.

Important questions on charge:

Q.8 If 10^9 electrons move out of a body to another body every second, how much time is required to get a total charge of 1C on the other body? N.C.E.R.T

Q.9 How much positive and negative charge is there in a cup of water of mass 250gm ? N.C.E.R.T

Q.10 What is continuous charge distribution C.C.D , explain its various forms?

TOPIC 2: FORCES BETWEEN CHARGES [F]

Four form of coulombs law:

Q.1 Explain Coulombs law for force between charges in free space? (SCALAR form)

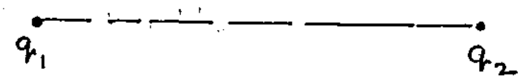
A.

Note: The value of force constant $K = 9 \times 10^9 \, Nm^2C^{-2}$ was given by Henry Cavandish by Inertial Method.

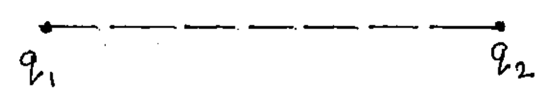
Q.2 Explain Coulombs law in vector form for two charge system?

A. In vector form we'll consider direction of force along with magnitude.

CASE 1. ATTRACTION:-

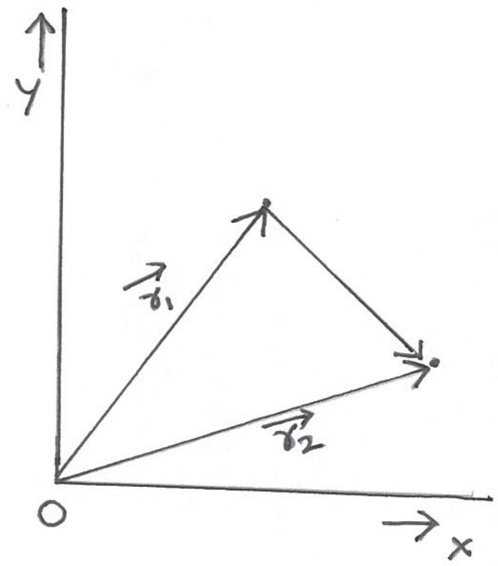


Case.2. REPULSION:-



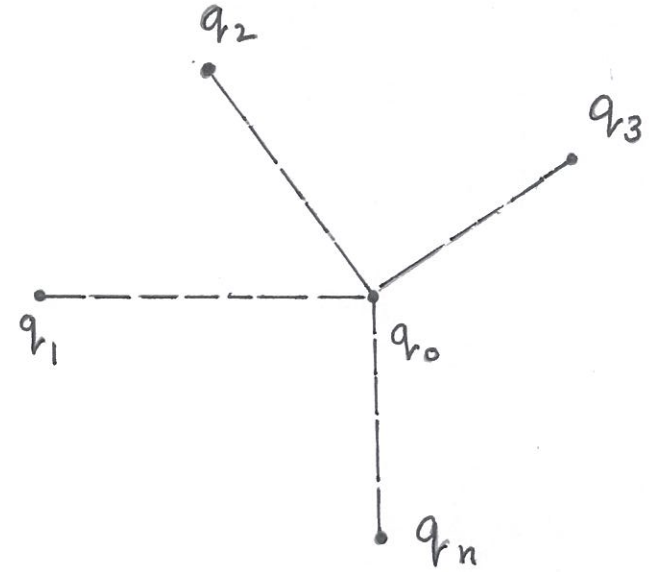
Q.3 Explain Coulombs law in position vector form?

A.



Q.4 Explain Coulombs law in superposition form ? or forces between multiple charges?

A.



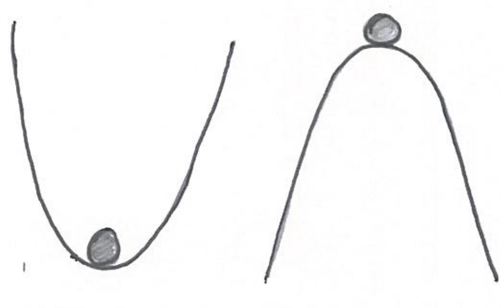
Q5. N.C.E.R.T

Example 1.4 Coulomb's law for electrostatic force between two point charges and Newton's law for gravitational force between two stationary point masses, both have inverse-square dependence on the distance between the charges/masses. (a) Compare the strength of these forces by determining the ratio of their magnitudes (i) for an electron and a proton and (ii) for two protons. (b) Estimate the accelerations of electron and proton due to the electrical force of their mutual attraction when they are 1 Å (= 10^{-10} m) apart? ($m_p = 1.67 \times 10^{-27}$ kg, $m_e = 9.11 \times 10^{-31}$ kg)

Solution

Q.6 What is equilibrium of charges ? Explain its two types?

A.



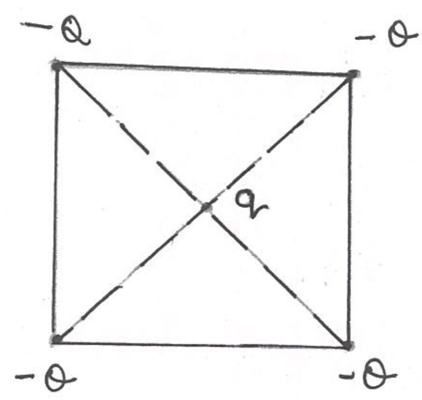
Q.7 A Charge q is placed at the centre of the line joining two equal two equal charges Q. Show that the system of three charges will be in equilibrium if q= -Q/4.

Ans. Q------r------q------r------Q

Q.8 Four charges equal to $-Q$ are placed at the four corners of a square and a charge q is at its centre. If the system is in equilibrium, the value of q is :-

a) $-\frac{Q}{4}(1+2\sqrt{2})$ c) $-\frac{Q}{2}(1+2\sqrt{2})$

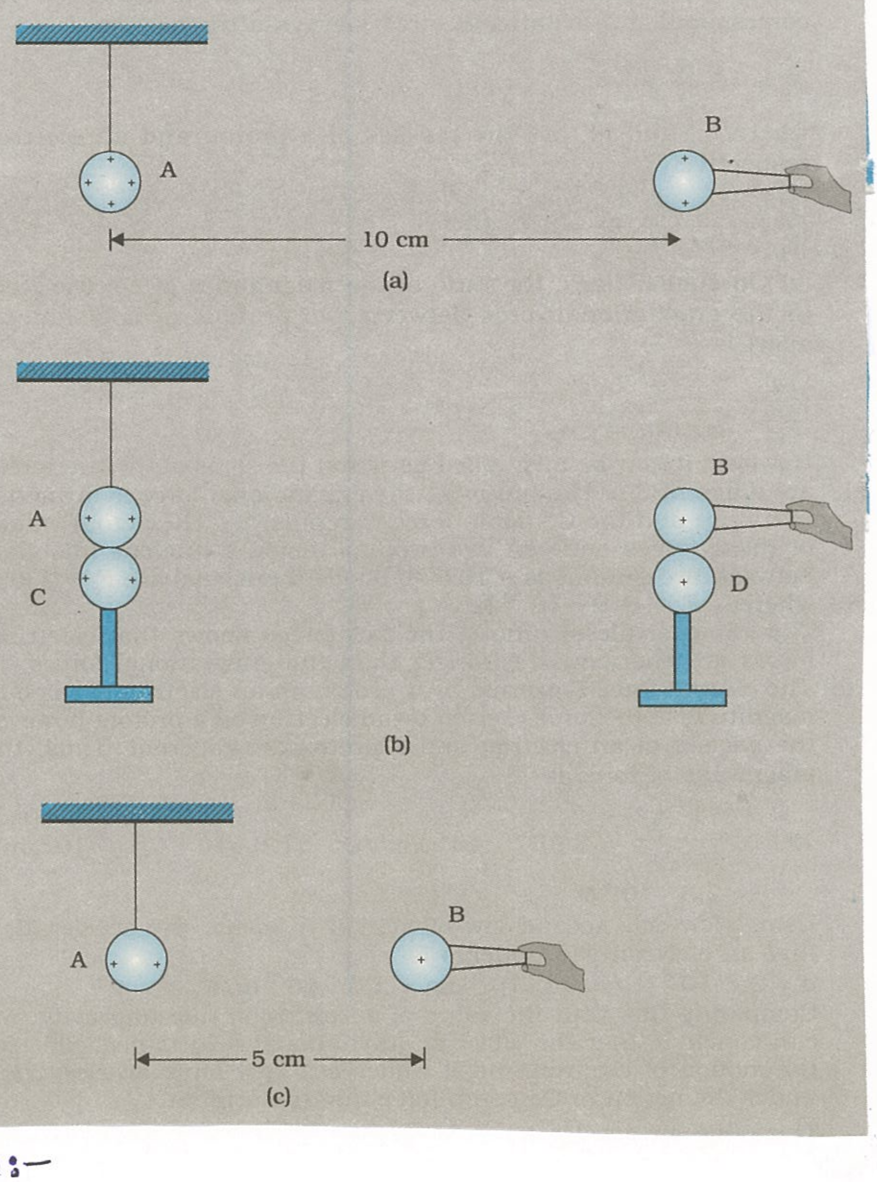
b) $+\frac{Q}{4}(1+2\sqrt{2})$ d) $+\frac{Q}{2}(1+2\sqrt{2})$



Ans.

Q.9 NCERT

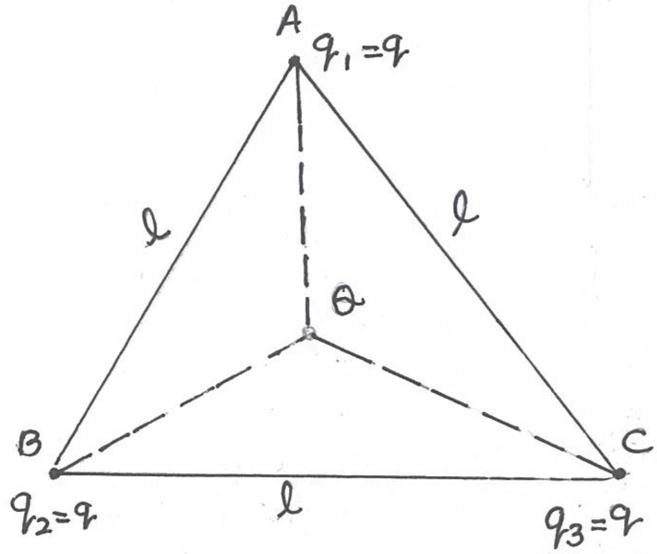
Example 1.5 A charged metallic sphere A is suspended by a nylon thread. Another charged metallic sphere B held by an insulating handle is brought close to A such that the distance between their centres is 10 cm, as shown in Fig. 1.7(a). The resulting repulsion of A is noted (for example, by shining a beam of light and measuring the deflection of its shadow on a screen). Spheres A and B are touched by uncharged spheres C and D respectively, as shown in Fig. 1.7(b). C and D are then removed and B is brought closer to A to a distance of 5.0 cm between their centres, as shown in Fig. 1.7(c). What is the expected repulsion of A on the basis of Coulomb's law? Spheres A and C and spheres B and D have identical sizes. Ignore the sizes of A and B in comparison to the separation between their centres.



Solution:–

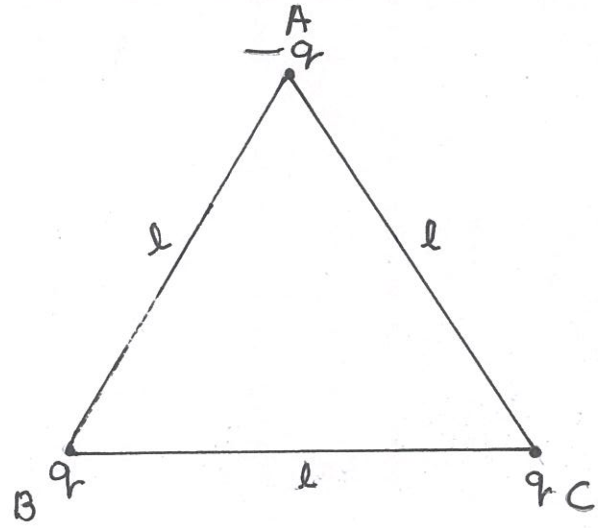
Q.10 NCERT Example 1.6 Consider three charges q_1, q_2, q_3 each equal to q at the vertices of an equilateral triangle of side *l*. What is the force on a charge Q (with the same sign as q) placed at the centroid of the triangle, as shown in fig below.

Sol.



Q.11 NCERT Example 1.7 Consider the charges q, q and –q placed at the vertices of an equilateral triangle , as shown in fig below. What is the force acting on each charge ?

Sol.



QUESTIONS FROM BOARD EXAMS

Q.12 **Very Short Answer Type Questions**

1. Which is bigger, a coulomb of charge or a charge on an electron?

Sol. A coulomb of charge is bigger than the charge on an electron.

2. What does $q_1 + q_2 = 0$ signify in electrostatics?

Sol. The charges q_1 and q_2 are equal and opposite.

3. Can a body has charge 1.5 e, where e is the electronic charge?

Sol. No, a body cannot has charge 1.5 e. It is because the physically existing charge is always an integral multiple of e, i.e. 1.6×10^{-19} C.

4. Consider three charged bodies A, B and C. If A and B repel each other and A attracts C, then what is nature of the force between B and C?

Sol. It is also attractive in nature.

5. What is the basic cause of quantisation of charge?

Sol. The basic cause of quantisation of charge is only the integral number of electrons which is transferred from one body to another, i.e. $\pm ne$.

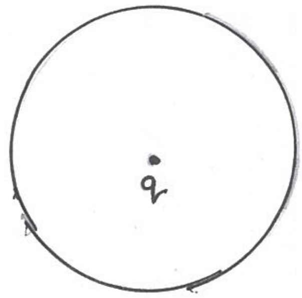
6. HOTS Quarks are the building blocks of nucleons and possess fractional electronic charge. Does this discovery violate the principle of quantisation of charge?

Sol. If the quarks are detected in any experiment with concrete practical evidence, then the minimum value of quantum of charge will be either $\frac{1}{3}e$ or $\frac{2}{3}e$. However, the law of quantisation will hold good.

TOPIC 3: ELECTRIC FIELD [E]

Q.1 What is electric field & electric field intensity E ?

A.



Q.2 Find Electric field due to system of charges?

A. Consider n charges arount a point A as shown in the diagram , according to superposition of coulombs law we can find net force on q_0 due to n charges around it as:

Q.3 Write various physical significances of electric field

Or

Write important points about electric field

Ans. a) Accelerated motion of charge q_1 produces electromagnetic waves which then propogate with the speed of light c and reaches q_2 and causes a force on $q_{2\,[\text{ proof in chapter 8 EM waves NCERT}]o}$ point known as intensity.

c) At equal distances from charge q the magnitude of its electric field is same however the direction may varies.

d) Unit test positive charge is the most convinient way to study field at various points denoted by $q_{o\,(qo\text{---}zero)}$

e) For a positive charge the electric field will be directed radially outwrds , on the other hand , if the charge is negative then electric field vecto points radially inwards, this is due to motion of unit test positive charge.

f) there are certain points in electrostatic configuration where net electric field is zero known as null points.

Q.4 What are electric field lines ? write their important properties , also explain their maping?

A. Definition:

Properties of electric field lines:

1. hypothetical property:

2. tangent:

3. No. of field lines:

4. Loop property:

5.Intersection property:

6. Perpendicular property:

<u>MAPING OF FIELD LINES:</u>

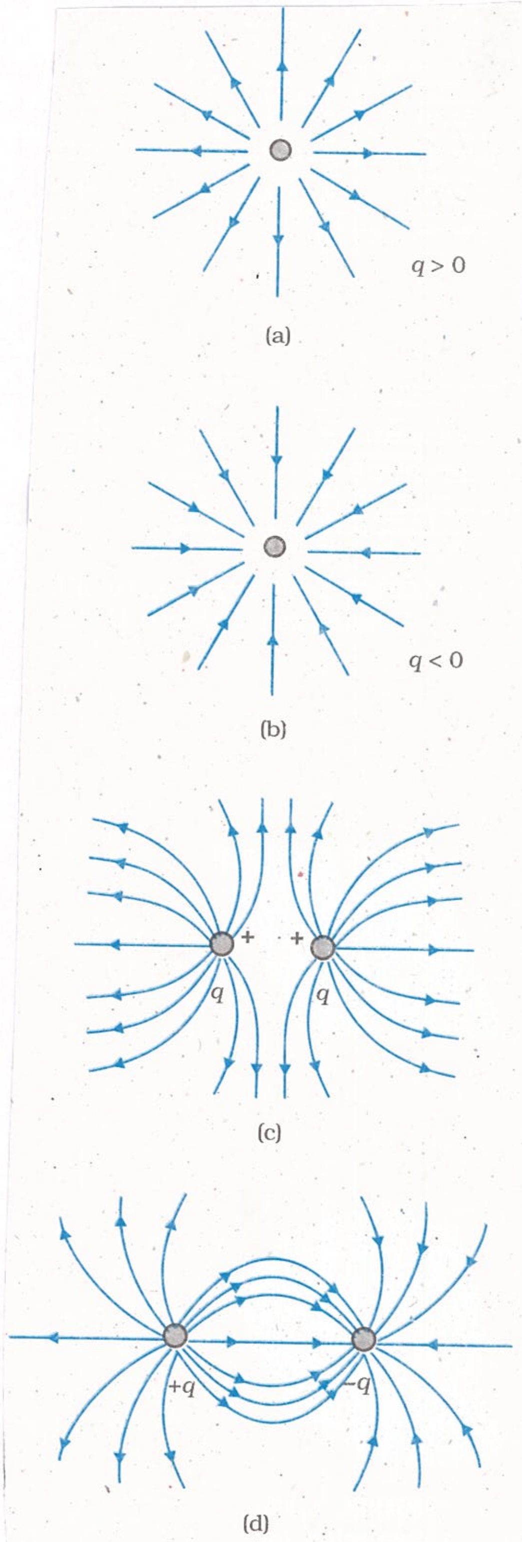
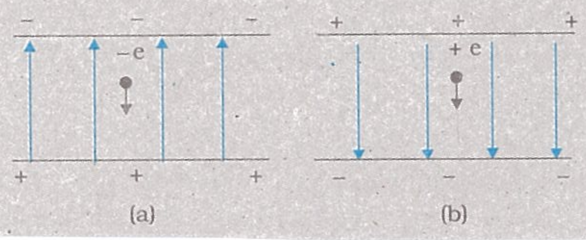


FIGURE 1.17 Field lines due to some simple charge configurations.

Q.5 NCERT

Example 1.8 An electron falls through a distance of 1.5 cm in a uniform electric field of magnitude 2.0×10^4 N C^{-1} [Fig. 1.13(a)]. The direction of the field is reversed keeping its magnitude unchanged and a proton falls through the same distance [Fig. 1.13(b)]. Compute the time of fall in each case. Contrast the situation with that of 'free fall under gravity'.



Solution:—

TOPIC 4: ELECTRIC DIPOLE

Q.1 What is electric dipole, give some examples ?

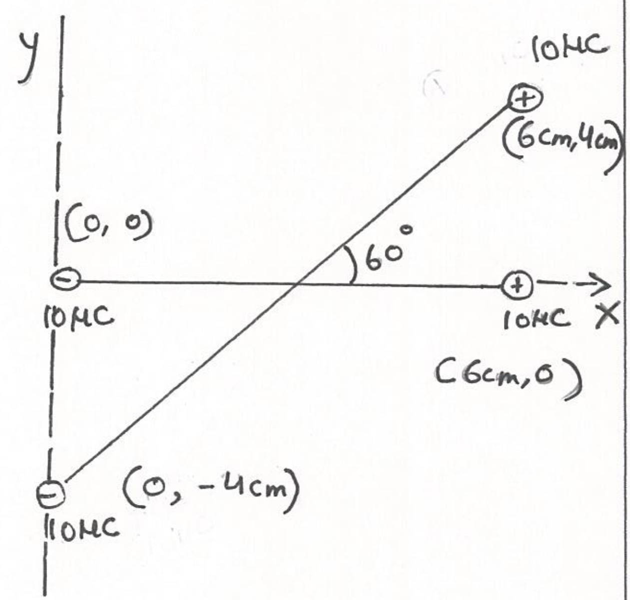
A.

Q.2 What is electric dipole moment P ?

A.

Q.3 Find net dipole moment of given electrostatic systems?

a)



Note: there are 4 important topics in electric dipole :

1. electric field on axial line of dipole

2.electric field on equatorial line of dipole

3. torque on dipole due to external electric field

4. potential energy stored in dipole when kept in external electric field

Q.4 Find electric field at a point on the axial line passing through electric dipole ?

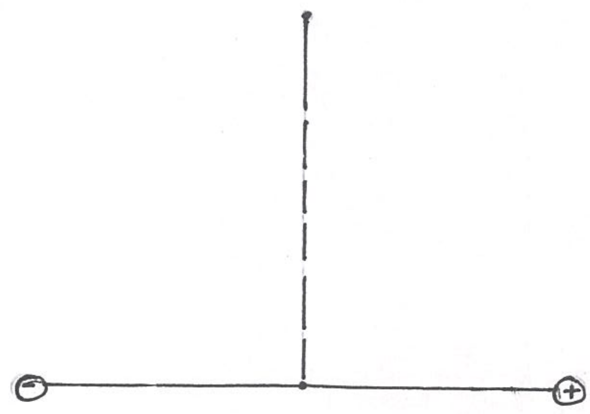
also explain the case of short dipole?

A. Consider an electric dipole having dipole moment p and a point A on its axial line , to find electric field intensity of this point we must place a test charge q_o on it as shown in the diagram below:

Q.5 Find electric field at a point on the equatorial line passing through electric dipole ?

also explain the case of short dipole?

A.Consider an electric dipole having dipole moment p and a point A on its equatorial line , to find electric field intensity of this point we must place a test charge q_o on it as shown in the diagram below:



Note: 1. For a short dipole $E_{axial} = -E_{equtorial}$

2. angle between E and P on axial line =0

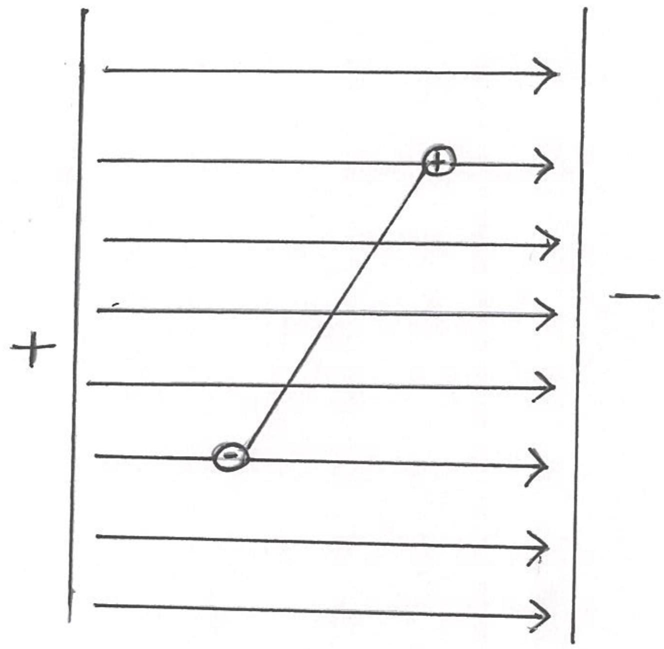
3. angle between E and P on equatorial line $=\pi$

Q.6 Explain the motion of dipole in a uniform electric field?

Or

Find the torque experienced by electric dipole inside external uniform electric field?

A. Consider an electric dipole placed by any angle inside external uniform electric field due to this field the dipole will experience two equal and opposite forces and these forces will result in a turning effect called torque as shown in diagram.



Special cases:

1. maximum torque:

2. minimum torque:

3. two types of equillibrium for dipole:

4. if the external field is non uniform :

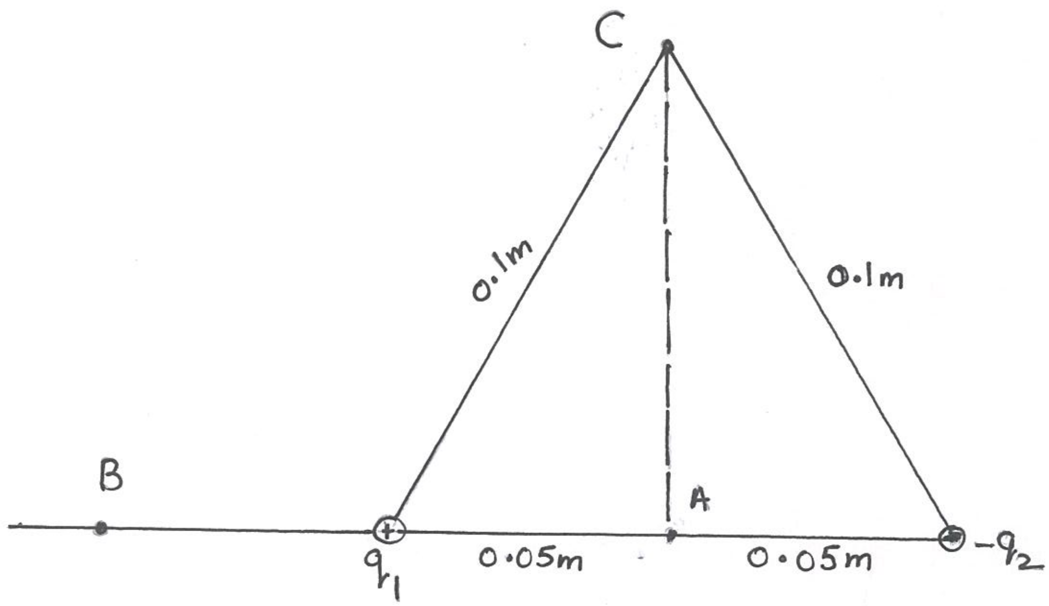
Q.7 Find the potential energy stored in a dipole when kept inside external uniform electric field?

A. The torque acting on dipole results in a work done to provide an angular motion from unstable state to stable state , this work done is equivalent to potential energy stored in dipole.

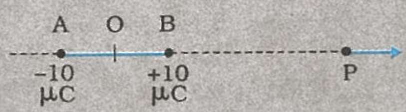
Small work done by the torque to turn the dipole:

Q.8 NCERT Example 1.9 Two charges q_1 & q_2 of magnitude $+10^{-8}$ C and -10^{-8} C respectively, are placed 0.1 m apart . Calculate the electric fields at point A,B and C shown in diagram below?

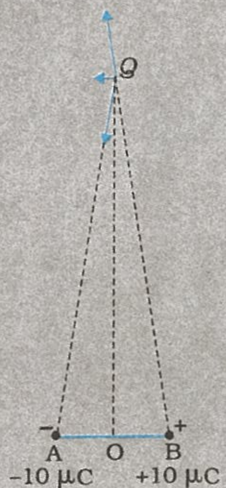
A.



Q.9 NCERT **Example 1.10** Two charges ±10 μC are placed 5.0 mm apart. Determine the electric field at (a) a point P on the axis of the dipole 15 cm away from its centre O on the side of the positive charge, as shown in Fig. 1.21(a), and (b) a point Q, 15 cm away from O on a line passing through O and normal to the axis of the dipole, as shown in Fig. 1.21(b).



(a)



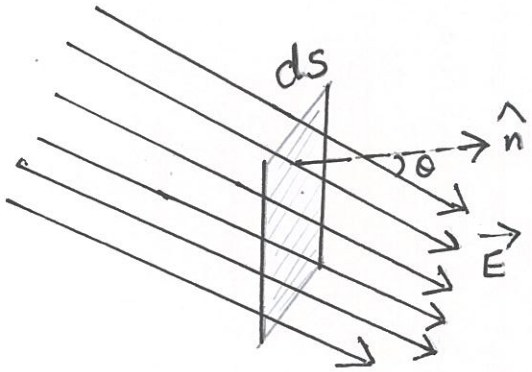
(b)

TOPIC-5 GAUSS'S LAW

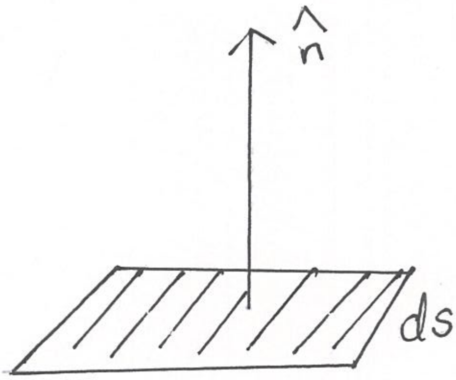
To understand Gauss's law we must understand electric flux and area vector first:

Q.1 What is electric flux? Write its unit and dimensional formula?

A.



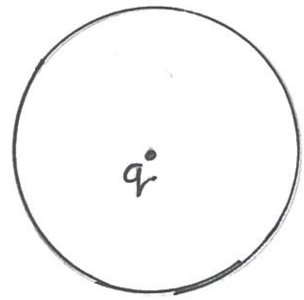
Q.2 What is area vector ? how it is helpful for determining electric flux?



Q.3 State and prove Gauss's law?

A. Statement:—

Proof:—



Important significances of Gauss's law:

1.Gauss's law is true for all closed surfaces, no matter what its shape and size.

2. The term q in Gauss's law is net charge enclosed, i.e outside charge q doesn't contribute in electric flux.

3.The surface of electric field we choose for Gauss's law is hypothetical surface called as GAUSSIAN SURFACE.

4. Gauss's law helps to find large electric fields due to large charge distribution. We'll study them in applications of Gauss's law.

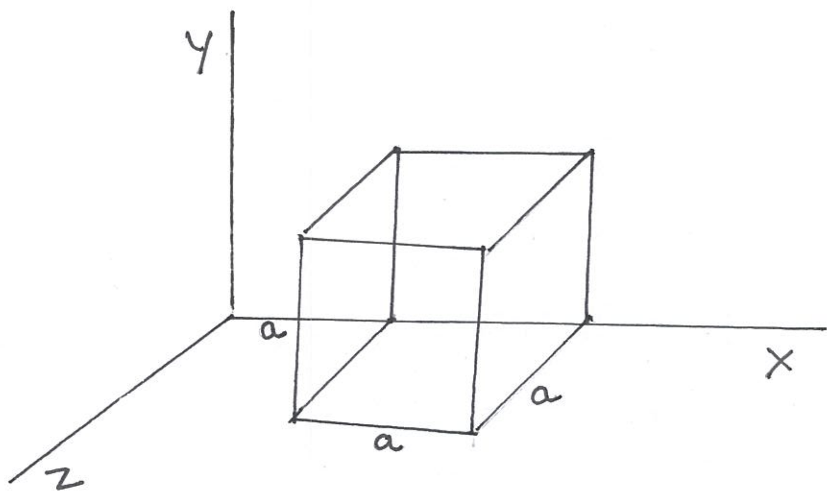
5. Coulombs law can be obtain by Gauss's law and vice –versa.. We'll practice this at end of chapter.

Q.4 NCERT Example 1.11 The electric field components in fig. below are $E_x=\alpha x^{1/2}$, $E_y=E_z=0$, in which $\alpha=800 N/C\ m^{1/2}$. Calculate :

a. the electric flux through the cube, and

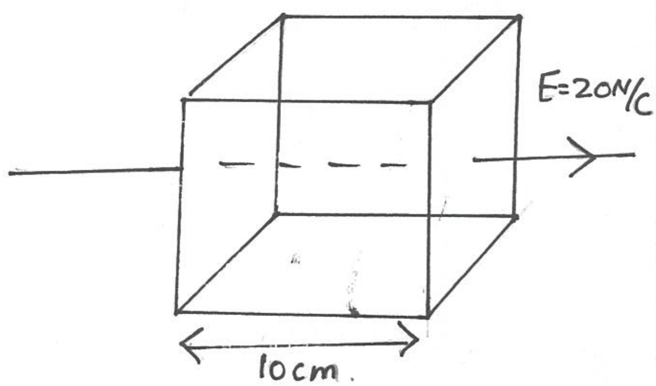
b. the charge within the cube. Assume that a=0.1m

Ans.

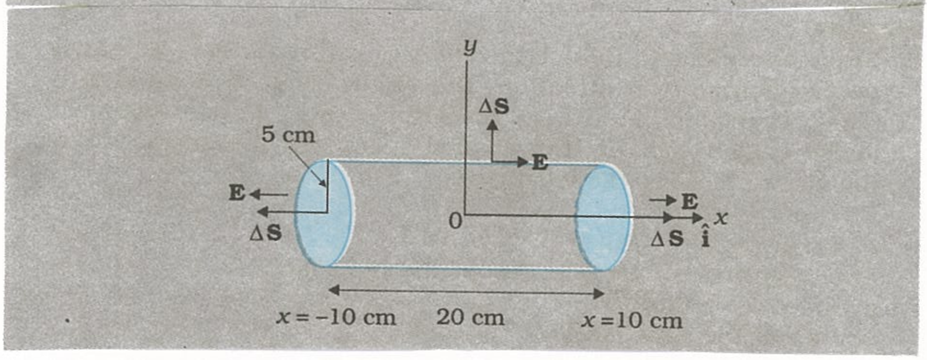


Q.5 Find electric flux associated with the cube having side 10cm subjected inside uniform electric field of 20N/C along x axis?

Ans.



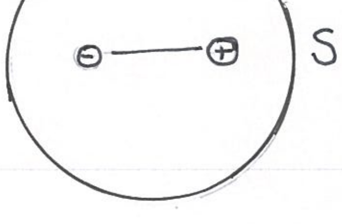
Q.6 NCERT **Example 1.12** An electric field is uniform, and in the positive x direction for positive x, and uniform with the same magnitude but in the negative x direction for negative x. It is given that $\mathbf{E} = 200\ \hat{\mathbf{i}}$ N/C for $x > 0$ and $\mathbf{E} = -200\ \hat{\mathbf{i}}$ N/C for $x < 0$. A right circular cylinder of length 20 cm and radius 5 cm has its centre at the origin and its axis along the x-axis so that one face is at $x = +10$ cm and the other is at $x = -10$ cm (Fig. 1.28). (a) What is the net outward flux through each flat face? (b) What is the flux through the side of the cylinder? (c) What is the net outward flux through the cylinder? (d) What is the net charge inside the cylinder?



Ans:

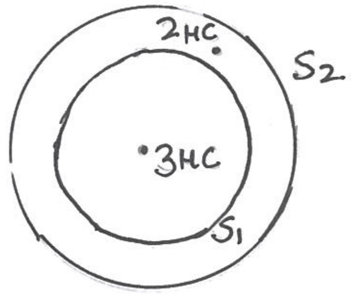
Q.7 Find the electric flux associated with a surface inside which an electric dipole is placed ?

A.



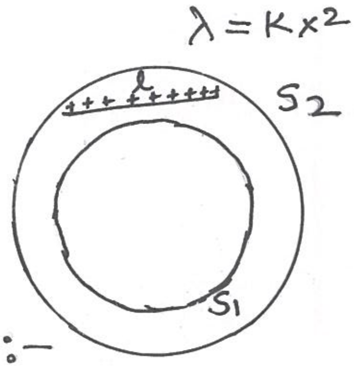
Q.8 Find the electric flux associated with S_1 and S_2 surfaces in following diagrams?

a)



Ans:-

b)

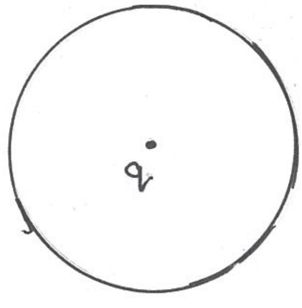


Ans:-

Q.9 Deduce Coulomb's law from Gauss's law

Or

Deduce Gauss's law from Coulomb's law



APPLICATIONS OF GAUSS'S LAW

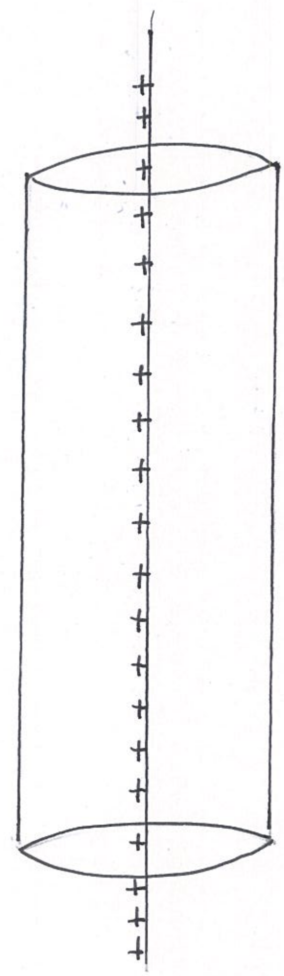
By using Gauss's law we can find electric field due to continuous charge distribution.

According to the shape and distribution of charge we have 4 Applications of Gauss's law

APPLICATION NO.1

Q. 10 Find electric field due to an infinitely long straight uniformly charged wire by using Gauss's law?

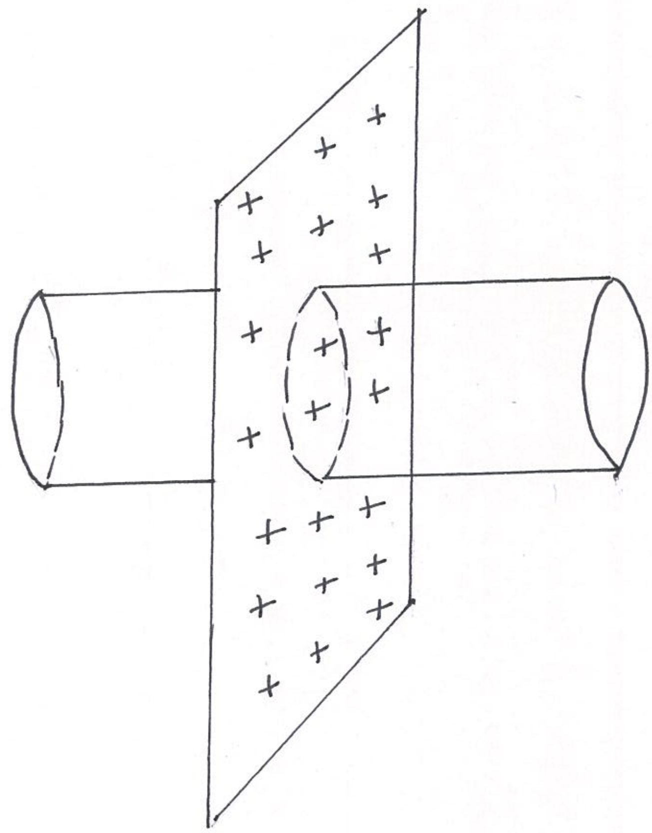
A.



APPLICATION NO.2

Q.11 Find Electric field due to a uniformly charged infinite plane sheet by using Gauss's law?

A.

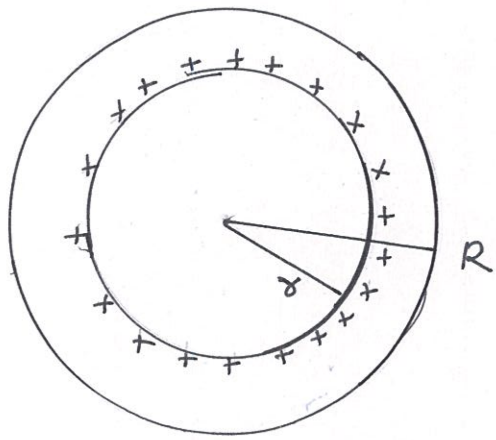


SPECIAL CASES :

APPLICATION NO.3

Q. 12 Find Electric field due to a uniformly charged thin spherical shell by using Gauss's law?

A.



SPECIAL CASES:

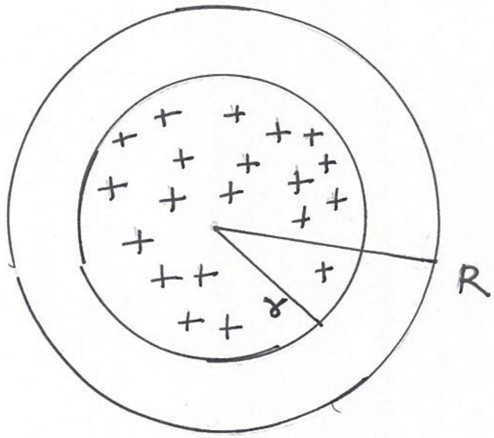
1. When Gaussian surface lies on the sphere

2. When Gaussian surface lies inside the sphere

APPLICATION NO. 4

Q.13 Find Electric field due to a uniformly charged dense spherical sphere by using Gauss's law?

A.



SPECIAL CASES:

1. When the Gaussian surface lie on the sphere

2. When the Gaussian surface lies inside the sphere

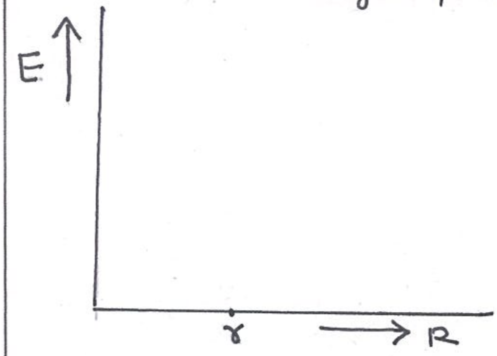
IMPORTANT QUESTION:

Q.14 Plot the graph showing the variations of electric field w.r.t distance R from the centre of:

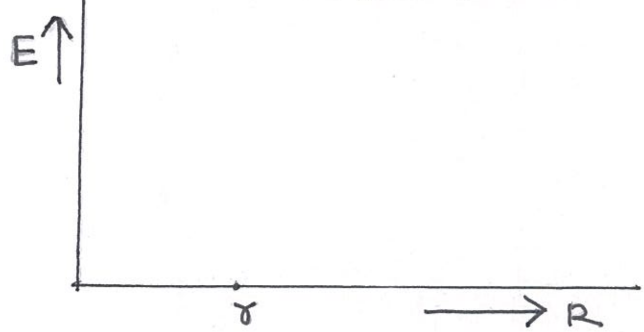
1. hollow charged sphere.

2. dense charged sphere.

A. 1. For hollow charged sphere



2. For dense charged sphere



Q.15 NCERT Example 1.13

Example 1.13 An early model for an atom considered it to have a positively charged point nucleus of charge Ze, surrounded by a uniform density of negative charge up to a radius R. The atom as a whole is neutral. For this model, what is the electric field at a distance r from the nucleus?

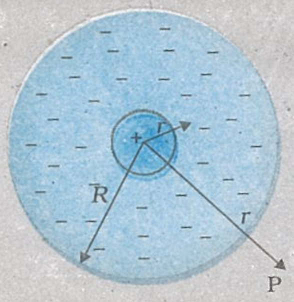


FIGURE 1.32

Solution:—

TOPIC-6
INTEXT QUESTIONS FROM NCERT

Q.1 What is the physical significance of dipole ?

A. In most molecules, the centres of positive charges and of negative charges* lie at the same place. Therefore, their dipole moment is zero. CO_2 and CH_4 are of this type of molecules. However, they develop a dipole moment when an electric field is applied. But in some molecules, the centres of negative charges and of positive charges do not coincide. Therefore they have a permanent electric dipole moment, even in the absence of an electric field. Such molecules are called polar molecules. Water molecules, H_2O, is an example of this type. Various materials give rise to interesting properties and important applications in the presence or absence of electric field.

This topic is in detail in chapter. 2.

Q.2 Explain unification of electricity and magnetism?

Ans. In olden days, electricity and magnetism were treated as separate subjects. Electricity dealt with charges on glass rods, cat's fur, batteries, lightning, etc., while magnetism described interactions of magnets, iron filings, compass needles, etc. In 1820 Danish scientist Oersted found that a compass needle is deflected by passing an electric current through a wire placed near the needle. Ampere and Faraday supported this observation by saying that electric charges in motion produce magnetic fields and moving magnets generate electricity. The unification was achieved when the Scottish physicist Maxwell and the Dutch physicist Lorentz put forward a theory where they showed the interdependence of these two subjects. This field is called *electromagnetism*.

Q.3 Explain dielectric constant K or relative permittivity ?

Ans. Force in air between 2 charges $F_0 = \frac{1}{4\pi\epsilon_0}\frac{q_1q_2}{r^2}$ —(i)

Force in medium between 2 charges $F_m = \frac{1}{4\pi\epsilon_m}\frac{q_1q_2}{r^2}$ —(ii)

dividing we'll obtain $\boxed{\frac{F_0}{F_m} = \frac{\epsilon_m}{\epsilon_0} = K \text{ or } \epsilon_r}$

Q.4 Two equal balls having equal positive charge q coulombs are suspended by two insulating strings of equal length. What would be the effect on the force when a plastic sheet is inserted between the two? (AI 2014)

Ans:- For insulator (Plastic) $K > 1$

$\therefore \epsilon_m > \epsilon_0$

as Force $\propto \frac{1}{\epsilon}$

$\Rightarrow$ Force between charges on Inserting plastic sheet will decrease.

IMPORTANT TOPICS WITH FORMULAS FOR NUMERICALS

TOPIC 1 FORCE [COULOMBS LAW]

1. $F = \frac{1}{4\pi\epsilon_0} \frac{q_1 q_2}{r^2}$

2. $\vec{F_{12}} = \frac{1}{4\pi\epsilon_0} \frac{q_1 q_2}{r_{12}^2} \hat{r}_{12}$ (attraction)

3. $\vec{F_{12}} = \frac{1}{4\pi\epsilon_0} \frac{q_1 q_2 (\vec{r_2} - \vec{r_1})}{|\vec{r_2} - \vec{r_1}|^3}$

4. $\vec{F_0} = \frac{q_0}{4\pi\epsilon_0} \sum \frac{q_i \hat{r}_{i0}}{r_{i0}^2}$

5. K = Force Constant $= \frac{1}{4\pi\epsilon_0}$
$= 9 \times 10^9 \ Nm^2C^{-2}$

ϵ_0 = absolute Permittivity of free space $= 8.85 \times 10^{-12}$

TOPIC-2 CHARGE AND CONTINUOUS CHARGE DISTRIBUTION

1. Charge $q = \pm ne$ (quantization]
2. L.C.D $\lambda = q/l$
3. S.C.D $\sigma = q/A$
4. V.C.D $\rho = q/V$
5. Dipole moment $\vec{P} = q(2a)$

TOPIC-3 FLUX AND GAUSS'S LAW

1 Area Vector $\vec{ds} = ds\,\hat{n}$

2. Electric flux (ϕ_E)
$\oint \vec{E}\cdot\vec{ds} = EA\cos\theta$

3. Gauss's Law:-
$\phi_E = \oint \vec{E}\cdot\vec{ds} = \frac{q}{\epsilon_0}$
q = net charge enclosed
Unit of ϕ = $NC^{-1}m^2$

TOPIC 4 ELECTRIC FIELD [E]

1. $\vec{E} = \frac{\vec{F}}{q_0} = \frac{q}{4\pi\epsilon_0 r}$ [Units. N/C]

2. $\vec{E_0} = \frac{1}{4\pi\epsilon_0} \sum \frac{q_i}{r_{i0}^2} \hat{r}_{i0}$

3. $\vec{E}_{axial} = \frac{2Pr}{4\pi\epsilon_0 (r^2 - a^2)^2} \hat{i}$

4. $\vec{E}_{equtorial} = \frac{P}{4\pi\epsilon_0 (r^2 + a^2)^{3/2}} (-\hat{i})$

5. $E = \frac{\tau}{P\sin\theta}$ [from $\tau = PE\sin\theta$]

6. $E = \left| \frac{U}{P\cos\theta} \right|$ [$U = -PE\cos\theta$]

Applications of Gauss's law:-

7. $E = \frac{\lambda}{2\pi\epsilon_0 r}$ [L.C.D]

8. $E = \frac{\sigma}{2\epsilon_0}$ [∞ charged sheet]

9. $E = \frac{\sigma r^2}{\epsilon_0 R^2}$ [hollow charged sphere]

10. $E = \frac{\rho r^3}{3\epsilon_0 R^2}$ [dense charged sphere]

11. Relation between V & E
$E = -\frac{dV}{dr}$

12. Relation between $\vec{E}$ & $\vec{B}$
$\frac{E}{B} = C$

MASS PHYSICS

Chapter wise Theoretical Important Questions in Physics for Class-XII

ELECTRIC CHARGES AND FIELDS

Electrostatics-

1. Derive an expression for the electric field at a point on the axial position of an electric dipole.
2. Derive an expression for the electric field at a point on the equatorial position of an electric dipole.

3. State Gauss theorem and apply it to find the electric field at a point due to

   (a) a line of charge
   (b) A plane sheet of charge
   (c) Two parallel sheets of charge
   (d) A Charged spherical conducting shell
   (e) A charged solid sphere

4. State Coulomb's law and express it in vector form. Derive it using Gauss theorem.
5. Derive an expression for the torque on an electric dipole in a uniform electric field.
6. Derive an expression for the work done in rotating an electric dipole in a uniform electric field
7. Derive an expression for the energy stored (Potential Energy) in a dipole in a uniform electric field.
8. What is meant by electric lines of force. Give their Important properties.
9. What is meant by electric flux? What are its units?
10. Explain charging by induction, how to provide positive charge to a sphere without touching it?
11. State and explain Coulombs law in vector form. Write unit of charge.
12. Explain what is meant by quantization of charge and conservation of charge ?

NCERT Question 1.1:
What is the force between two small charged spheres having charges of 2×10^{-7} C and 3×10^{-7} C placed 30 cm apart in air?

Answer

Repulsive force of magnitude 6×10^{-3} N Charge

on the first sphere, $q_1 = 2 \times 10^{-7}$ C

Charge on the second sphere, $q_2 = 3 \times 10^{-7}$ C

Distance between the spheres, $r = 30$ cm $= 0.3$ m

Electrostatic force between the spheres is given by the relation,

$$F = \frac{q_1 q_2}{4\pi \epsilon_0 r^2}$$

Where, ϵ_0 = Permittivity of free space

$$\frac{1}{4\pi \epsilon_0} = 9 \times 10^9 \text{ N m}^2 \text{C}^{-2}$$

$$F = \frac{9 \times 10^9 \times 2 \times 10^{-7} \times 3 \times 10^{-7}}{(0.3)^2} = 6 \times 10^{-3} \text{ N}$$

Hence, force between the two small charged spheres is 6×10^{-3} N. The charges are of same nature. Hence, force between them will be repulsive.

NCERT Question 1.2:

The electrostatic force on a small sphere of charge 0.4 μC due to another small sphere of charge − 0.8 μC in air is 0.2 N. (a) What is the distance between the two spheres? (b) What is the force on the second sphere due to the first?

Answer

NCERT Question 1.3:

Check that the ratio $ke^2/G\, m_e m_p$ is dimensionless. Look up a Table of Physical Constants and determine the value of this ratio. What does the ratio signify?

Answer

NCERT Question 1.4:

Explain the meaning of the statement 'electric charge of a body is quantised'.

Why can one ignore quantisation of electric charge when dealing with macroscopic i.e., large scale charges?

Answer

Electric charge of a body is quantized. This means that only integral (1, 2, …., n) number of electrons can be transferred from one body to the other. Charges are not transferred in fraction. Hence, a body possesses total charge only in integral multiples of electric charge.

In macroscopic or large scale charges, the charges used are huge as compared to the magnitude of electric charge. Hence, quantization of electric charge is of no use on macroscopic scale. Therefore, it is ignored and it is considered that electric charge is continuous.

NCERT Question 1.5:

When a glass rod is rubbed with a silk cloth, charges appear on both. A similar phenomenon is observed with many other pairs of bodies. Explain how this observation is consistent with the law of conservation of charge.

Answer

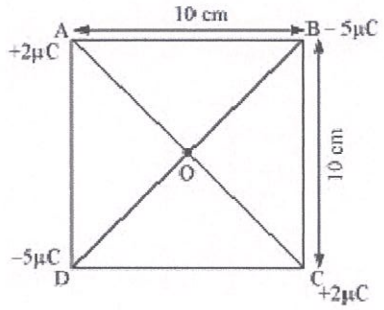
Rubbing produces charges of equal magnitude but of opposite nature on the two bodies because charges are created in pairs. This phenomenon of charging is called charging by friction. The net charge on the system of two rubbed bodies is zero. This is because equal amount of opposite charges annihilate each other. When a glass rod is rubbed with a silk cloth, opposite natured charges appear on both the bodies. This phenomenon is in consistence with the law of conservation of energy. A similar phenomenon is observed with many other pairs of bodies.

NCERT Question 1.6:

Four point charges $q_A = 2\ \mu C$, $q_B = -5\ \mu C$, $q_C = 2\ \mu C$, and $q_D = -5\ \mu C$ are located at the corners of a square ABCD of side 10 cm. What is the force on a charge of 1 μC placed at the centre of the square?

Answer

The given figure shows a square of side 10 cm with four charges placed at its corners. O is the centre of the square.



NCERT Question 1.7:

An electrostatic field line is a continuous curve. That is, a field line cannot have sudden breaks. Why not?

Explain why two field lines never cross each other at any point?

Answer

An electrostatic field line is a continuous curve because a charge experiences a continuous force when traced in an electrostatic field. The field line cannot have sudden breaks because the charge moves continuously and does not jump from one point to the other.

If two field lines cross each other at a point, then electric field intensity will show two directions at that point. This is not possible. Hence, two field lines never cross each other.

NCERT Question 1.8:

Two point charges $q_A = 3$ μC and $q_B = -3$ μC are located 20 cm apart in vacuum.

What is the electric field at the midpoint O of the line AB joining the two charges?

If a negative test charge of magnitude 1.5×10^{-9} C is placed at this point, what is the force experienced by the test charge?

Answer

NCERT Question 1.9:

A system has two charges $q_A = 2.5 \times 10^{-7}$ C and $q_B = -2.5 \times 10^{-7}$ C located at points A: (0, 0, − 15 cm) and B: (0, 0, + 15 cm), respectively. What are the total charge and electric dipole moment of the system?

Answer

NCERT Question 1.10:

An electric dipole with dipole moment 4×10^{-9} C m is aligned at 30° with the direction of a uniform electric field of magnitude 5×10^{4} N C^{-1}. Calculate the magnitude of the torque acting on the dipole.

Answer

NCERT Question 1.11:

A polythene piece rubbed with wool is found to have a negative charge of 3×10^{-7} C.

Estimate the number of electrons transferred (from which to which?)
Is there a transfer of mass from wool to polythene?

Answer

NCERT Question 1.12:

Two insulated charged copper spheres A and B have their centers separated by a distance of 50 cm. What is the mutual force of electrostatic repulsion if the charge on each is 6.5×10^{-7} C? The radii of A and B are negligible compared to the distance of separation.

What is the force of repulsion if each sphere is charged double the above amount, and the distance between them is halved?

Answer

NCERT Question 1.13:

Suppose the spheres A and B in Exercise 1.12 have identical sizes. A third sphere of the same size but uncharged is brought in contact with the first, then brought in contact with the second, and finally removed from both. What is the new force of repulsion between A and B?

Answer

Distance between the spheres, A and B, $r = 0.5$ m

Initially, the charge on each sphere, $q = 6.5 \times 10^{-7}$ C

When sphere A is touched with an uncharged sphere C, $\frac{q}{2}$ amount of charge from A will transfer to sphere C. Hence, charge on each of the spheres, A and C, is $\frac{q}{2}$.

When sphere C with charge $\frac{q}{2}$ is brought in contact with sphere B with charge q, total charges on the system will divide into two equal halves given as,

$$\frac{\frac{q}{2}+q}{2} = \frac{3q}{4}$$

Each sphere will each half. Hence, charge on each of the spheres, C and B, is $\frac{3q}{4}$.

Force of repulsion between sphere A having charge $\frac{q}{2}$ and sphere B having charge $\frac{3q}{4}$ =

$$\frac{\frac{q}{2}\times\frac{3q}{4}}{4\pi\epsilon_0 r^2} = \frac{3q^2}{8\times 4\pi\epsilon_0 r^2}$$

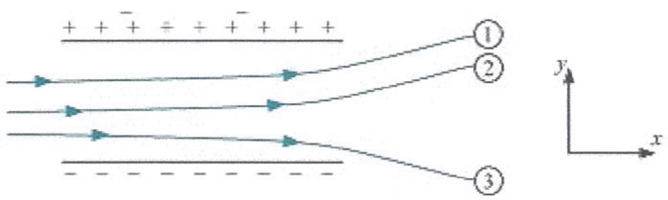
$$= 9\times10^9 \times \frac{3\times\left(6.5\times10^{-7}\right)^2}{8\times\left(0.5\right)^2}$$

$$= 5.703 \times 10^{-3} \text{ N}$$

Therefore, the force of attraction between the two spheres is 5.703×10^{-3} N.

NCERT Question 1.14:

Figure 1.33 shows tracks of three charged particles in a uniform electrostatic field. Give the signs of the three charges. Which particle has the highest charge to mass ratio?



Answer

NCERT Question 1.15:

Consider a uniform electric field $\mathbf{E} = 3 \times 10^3\ \hat{i}$ N/C. (a) What is the flux of this field through a square of 10 cm on a side whose plane is parallel to the *yz* plane? (b) What is the flux through the same square if the normal to its plane makes a 60° angle with the *x*-axis?

Answer

NCERT Question 1.16:

What is the net flux of the uniform electric field of Exercise 1.15 through a cube of side 20 cm oriented so that its faces are parallel to the coordinate planes?

Answer

All the faces of a cube are parallel to the coordinate axes. Therefore, the number of field lines entering the cube is equal to the number of field lines piercing out of the cube. As a result, net flux through the cube is zero.

NCERT Question 1.17:

Careful measurement of the electric field at the surface of a black box indicates that the net outward flux through the surface of the box is 8.0×10^3 N m^2/C. (a) What is the net charge inside the box? (b) If the net outward flux through the surface of the box were zero, could you conclude that there were no charges inside the box? Why or Why not?

Answer

Net outward flux through the surface of the box, $\Phi = 8.0 \times 10^3$ N m^2/C

For a body containing net charge q, flux is given by the relation,

$$\phi = \frac{q}{\epsilon_0}$$

ϵ_0 = Permittivity of free space

$= 8.854 \times 10^{-12} N^{-1}C^2$

$q = \epsilon_0 \Phi$

$= 8.854 \times 10^{-12} \times 8.0 \times 10^3$

$= 7.08 \times 10^{-8}$

$= 0.07$ μC

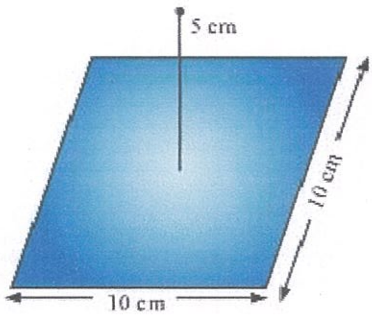
Therefore, the net charge inside the box is 0.07 μC.

No

Net flux piercing out through a body depends on the net charge contained in the body. If net flux is zero, then it can be inferred that net charge inside the body is zero.

NCERT Question 1.18:

A point charge +10 μC is a distance 5 cm directly above the centre of a square of side 10 cm, as shown in Fig. 1.34. What is the magnitude of the electric flux through the square? (*Hint:* Think of the square as one face of a cube with edge 10 cm.)



Answer

NCERT Question 1.19:

A point charge of 2.0 μC is at the centre of a cubic Gaussian surface 9.0 cm on edge. What is the net electric flux through the surface?

Answer

NCERT Question 1.20:

A point charge causes an electric flux of -1.0×10^3 Nm^2/C to pass through a spherical Gaussian surface of 10.0 cm radius centered on the charge. (a) If the radius of the Gaussian surface were doubled, how much flux would pass through the surface? (b) What is the value of the point charge?

Answer

NCERT Question 1.21:

A conducting sphere of radius 10 cm has an unknown charge. If the electric field 20 cm from the centre of the sphere is 1.5×10^3 N/C and points radially inward, what is the net charge on the sphere?

Answer

Electric field intensity (E) at a distance (d) from the centre of a sphere containing net charge q is given by the relation,

$$E = \frac{q}{4\pi \epsilon_0 d^2}$$

Where,

q = Net charge = 1.5×10^3 N/C

d = Distance from the centre = 20 cm = 0.2 m

ϵ_0 = Permittivity of free space

And, $\frac{1}{4\pi \epsilon_0} = 9 \times 10^9 \text{ N m}^2 \text{ C}^{-2}$

$\therefore q = E(4\pi \epsilon_0) d^2$

$= \frac{1.5 \times 10^3 \times (0.2)^2}{9 \times 10^9}$

$= 6.67 \times 10^9$ C

$= 6.67$ nC

NCERT Question 1.22:

A uniformly charged conducting sphere of 2.4 m diameter has a surface charge density of 80.0 $\mu C/m^2$. (a) Find the charge on the sphere. (b) What is the total electric flux leaving the surface of the sphere?

Answer

NCERT Question 1.23:

An infinite line charge produces a field of 9×10^4 N/C at a distance of 2 cm. Calculate the linear charge density.

Answer

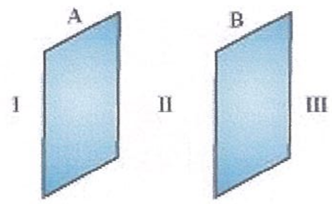
Electric field produced by the infinite line charges at a distance d having linear charge density λ is given by the relation,

NCERT Question 1.24:

Two large, thin metal plates are parallel and close to each other. On their inner faces, the plates have surface charge densities of opposite signs and of magnitude 17.0×10^{-22} C/m^2. What is **E**: (a) in the outer region of the first plate, (b) in the outer region of the second plate, and (c) between the plates?

Answer

The situation is represented in the following figure.



NCERT Question 1.25:

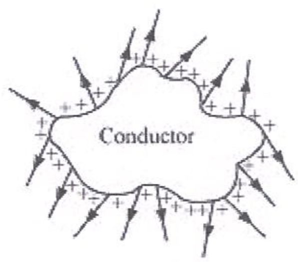
An oil drop of 12 excess electrons is held stationary under a constant electric field of 2.55 $\times 10^4$ N C^{-1} in Millikan's oil drop experiment. The density of the oil is 1.26 g cm^{-3}. Estimate the radius of the drop. ($g = 9.81$ m s^{-2}; $e = 1.60 \times 10^{-19}$ C).

Answer

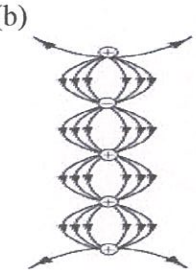
NCERT Question 1.26:

Which among the curves shown in Fig. 1.35 cannot possibly represent electrostatic field lines?

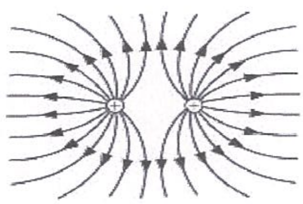
(a)



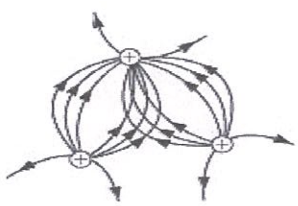
(b)



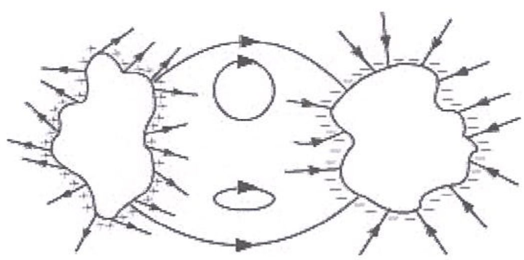
(c)



(d)



(e)



NCERT Question 1.27:

In a certain region of space, electric field is along the z-direction throughout. The magnitude of electric field is, however, not constant but increases uniformly along the positive z-direction, at the rate of 10^5 NC^{-1} per metre. What are the force and torque experienced by a system having a total dipole moment equal to 10^{-7} Cm in the negative z-direction?

Answer

Dipole moment of the system, $p = q \times dl = -10^{-7}$ C m

Rate of increase of electric field per unit length,

$$\frac{dE}{dl} = 10^{+5} \text{ N C}^{-1}$$

Force (F) experienced by the system is given by the relation,

$$F = qE$$

$$F = q\frac{dE}{dl} \times dl$$

$$= p \times \frac{dE}{dl}$$

$$= -10^{-7} \times 10^{-5}$$

$$= -10^{-2} \text{ N}$$

The force is -10^{-2} N in the negative z-direction i.e., opposite to the direction of electric field. Hence, the angle between electric field and dipole moment is $180°$.

Torque (τ) is given by the relation,

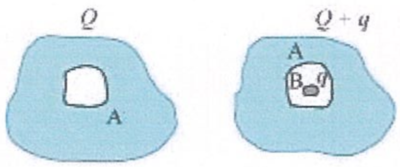
$$\tau = pE \sin 180°$$

$$= 0$$

Therefore, the torque experienced by the system is zero.

NCERT Question 1.28:

A conductor A with a cavity as shown in Fig. 1.36(a) is given a charge Q. Show that the entire charge must appear on the outer surface of the conductor. (b) Another conductor B with charge q is inserted into the cavity keeping B insulated from A. Show that the total charge on the outside surface of A is $Q + q$ [Fig. 1.36(b)]. (c) A sensitive instrument is to be shielded from the strong electrostatic fields in its environment. Suggest a possible way.



(a) (b)

Answer

Let us consider a Gaussian surface that is lying wholly within a conductor and enclosing the cavity. The electric field intensity E inside the charged conductor is zero.

Let q is the charge inside the conductor and ϵ_0 is the permittivity of free space.

According to Gauss's law,

Flux, $\phi = \vec{E}.\vec{ds} = \frac{q}{\epsilon_0}$

Here, $E = 0$

$\frac{q}{\epsilon^0} = 0$

$\because \epsilon_0 \neq 0$

$\therefore q = 0$

Therefore, charge inside the conductor is zero.

The entire charge Q appears on the outer surface of the conductor.

The outer surface of conductor A has a charge of amount Q. Another conductor B having charge $+q$ is kept inside conductor A and it is insulated from A. Hence, a charge of amount $-q$ will be induced in the inner surface of conductor A and $+q$ is induced on the outer surface of conductor A. Therefore, total charge on the outer surface of conductor A is $Q + q$.

A sensitive instrument can be shielded from the strong electrostatic field in its environment by enclosing it fully inside a metallic surface. A closed metallic body acts as an electrostatic shield.

NCERT Question 1.29:

A hollow charged conductor has a tiny hole cut into its surface. Show that the electric field in the hole is $\left(\dfrac{\sigma}{2\epsilon_0}\right)\hat{n}$

Answer

NCERT Question 1.30:

Obtain the formula for the electric field due to a long thin wire of uniform linear charge density λ without using Gauss's law. [*Hint:* Use Coulomb's law directly and evaluate the necessary integral.]

Answer

NCERT Question 1.31:

It is now believed that protons and neutrons (which constitute nuclei of ordinary matter) are themselves built out of more elementary units called quarks. A proton and a neutron consist of three quarks each. Two types of quarks, the so called 'up' quark (denoted by u) of charge (+2/3) e, and the 'down' quark (denoted by d) of charge (−1/3) e, together with electrons build up ordinary matter. (Quarks of other types have also been found which give rise to different unusual varieties of matter.) Suggest a possible quark composition of a proton and neutron.

Answer

NCERT Question 1.32:

Consider an arbitrary electrostatic field configuration. A small test charge is placed at a null point (i.e., where $\mathbf{E} = 0$) of the configuration. Show that the equilibrium of the test charge is necessarily unstable.

Verify this result for the simple configuration of two charges of the same magnitude and sign placed a certain distance apart.

Answer

NCERT Question 1.33:

A particle of mass m and charge $(-q)$ enters the region between the two charged plates initially moving along x-axis with speed vx (like particle 1 in Fig. 1.33). The length of plate is L and an uniform electric field E is maintained between the plates. Show that the vertical deflection of the particle at the far edge of the plate is $qEL^2/(2m v_x^2)$.

Compare this motion with motion of a projectile in gravitational field discussed in Section 4.10 of Class XI Textbook of Physics.

Answer

NCERT Question 1.34:

Suppose that the particle in Exercise in 1.33 is an electron projected with velocity $v_x = 2.0 \times 10^6$ m s^{-1}. If E between the plates separated by 0.5 cm is 9.1×10^2 N/C, where will the electron strike the upper plate? ($|e| = 1.6 \times 10^{-19}$ C, $m_e = 9.1 \times 10^{-31}$ kg.)

Answer

Velocity of the particle, $v_x = 2.0 \times 10^6$ m/s

Separation of the two plates, $d = 0.5$ cm $= 0.005$ m

Electric field between the two plates, $E = 9.1 \times 10^2$ N/C

Charge on an electron, $q = 1.6 \times 10^{-19}$ C

Mass of an electron, $m_e = 9.1 \times 10^{-31}$ kg

Let the electron strike the upper plate at the end of plate L, when deflection is s.

Therefore,

$$s = \frac{qEL^2}{2mv_x^2}$$

$$L = \sqrt{\frac{2dmv_x^2}{qE}}$$

$$= \sqrt{\frac{2 \times 0.005 \times 9.1 \times 10^{-31} \times \left(2.0 \times 10^6\right)^2}{1.6 \times 10^{-10} \times 9.1 \times 10^2}}$$

$$= \sqrt{0.025 \times 10^{-2}} = \sqrt{2.5 \times 10^{-4}}$$

$$= 1.6 \times 10^{-2} \text{ m}$$

$$= 1.6 \text{ cm}$$

CBSE previous years' questions

1. Define electric flux. Write its S.I. units. **(Year : 2008, 09, 12) Marks allotted : 1**

A. Total number of electric lines of force passing through a given area normally is called electric flux through that area.

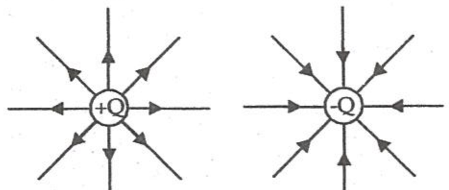
$\phi_E = \vec{E} \cdot \vec{A}$ Its S.I. unit is $Nm^2 C^{-1}$

2. (a) The electric field E due to a point charge at any point near it is defined as $E = \lim_{q \to 0} \frac{F}{q}$ where q is the test charge and F is the force acting on it. What is the physical significance of $\lim_{q \to 0}$ in this expression?

(b) Draw the electric field lines of a point charge Q when (i) $Q > 0$ and (ii) $Q < 0$. **(2008) 2**

A. (a) $\lim_{q \to 0}$ indicates that the test charge is a point charge and is so small in magnitude that it does not modify the electric field of the source charge.

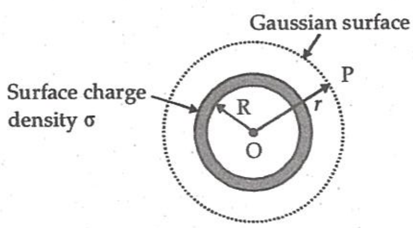
(b)

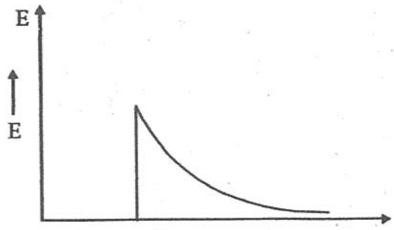


(i) $Q > 0$ (ii) $Q < 0$

3. State Gauss's theorem. A thin conducting spherical shell of radius R has charge Q spread uniformly over its surface. Using Gauss's law, derive an expression for an electric field at a point outside the shell. Draw a graph of electric field E(r) with distance r from the centre of the shell for $0 \le r \le \infty$. **(2008, 09, 11) 3**

A.
$$\oint \vec{E}.ds = \frac{q}{\varepsilon_0}$$
$$E \times 4\pi r^2 = \frac{Q}{\varepsilon_0}$$
$$E = \frac{1}{4\pi\varepsilon_0} \frac{Q}{r^2}$$





4. A spherical rubber balloon carries a charge that is uniformly distributed over its surface. As the balloon is blown up and increases in size, how does the total electric flux coming out of the surface change? Give reason. **(2008) 2**

A. As electric flux does not depend upon the shape and size of the closed surface, the electric flux coming out of the surface will remain same as long as the charge enclosed by it remains same.

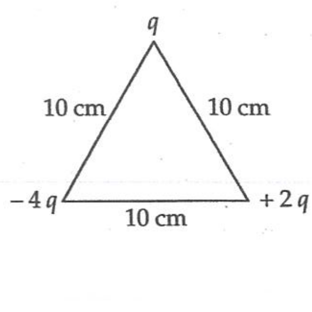
5. Define the term electric dipole moment of a dipole. State its S.I. unit. **(2008, 11, 13) 1**

A. Dipole moment is the product of charge 'q' & the separation between the pair of charge q & $-q$ or $p = q \times 2a$

S.I. unit: Cm.

6. (a) Derive an expression for the torque experienced by an electric dipole kept in a uniform electric field.

(b) Calculate the work done to dissociate the system of three charges placed on the vertices of a triangle as shown. Here $q = 1.6 \times 10^{-10}$C **(2008) 5**



A. (a) Refer point no. 37 for the derivation of expression for torque.

(b) Work done(W) = −(electric P.E of the system)

$$W = -\frac{1}{4\pi\varepsilon_0 l}(q_1q_2 + q_2q_3 + q_3q_1) = -\frac{9\times10^9}{10^{-1}}(-4q\times q + q\times 2q + 2q\times -4q) = 9\times10^{11}\times(1.6\times10^{-10})^2\,\text{J}$$

$$= 2.3\times10^{-8}\,\text{J}$$

7. Derive an expression for the potential energy of an electric dipole of dipole moment $\vec{p}$ in an electric field $\vec{E}$. **(2008) 2**

A. See point no. 39 of *To the Point* Theory.

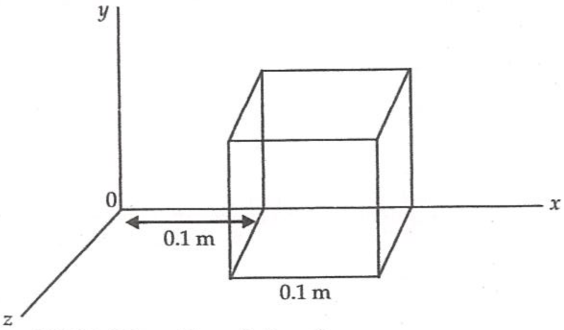
8. In which orientation, a dipole placed in a uniform electric field is in (i) stable, (ii) unstable equilibrium? **(2008, 10) 1**

A. When dipole is (i) parallel to field ; (ii) antiparallel to the field.

9. A charge q is enclosed by a spherical surface of radius R. If the radius is reduced to half, how would the electric flux through the surface change? **(2008, 09) 1**

A. Remains same

10. The electric field components due to a charge inside the cube of side 0.1 m are as shown :



$E_x = \alpha x$, where $\alpha = 500$ N/C-m; $E_y = 0$, $E_z = 0$.

Calculate (i) the flux through the cube, and (ii) the charge inside the cube. **(2008) 4**

A. Net flux, $\Phi = (E_L - E_R)A = 500(-0.1 + 0.2)0.01 = 0.5\ \text{N m}^2\text{C}^{-1}$

Charge enclosed $Q = \varepsilon_0\Phi = 4.42\times10^{-12}\ \text{C} = 8.85\times10^{-12}\times0.5\ \text{C} = 0.5\,\varepsilon_0\ \text{Nm}^2\text{C}^{-1}$

11. (a) Using Gauss' law, derive an expression for the electric field intensity at any point outside a uniformly charged thin spherical shell of radius R and charge density σ C/m^2. Draw the field lines when the charge density of the sphere is (i) positive, (ii) negative.

(b) A uniformly charged conducting sphere of 2.5 m diameter has a surface charge density of 100 μC/m^2. Calculate the

(i) charge on the sphere,

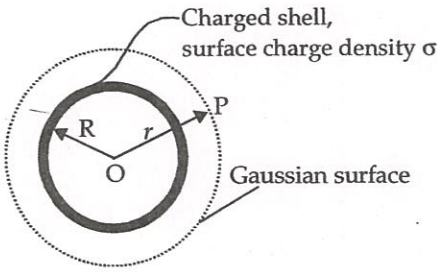
(ii) total electric flux passing through the sphere. **(2008) 5**

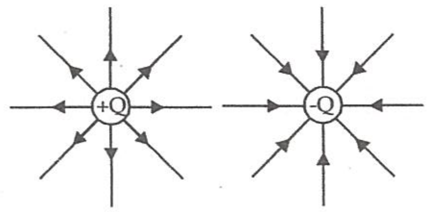
A. (a)

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

$$\oint E ds \cos\theta = \frac{\sigma 4\pi R^2}{\varepsilon_0}$$

$$E4\pi r^2 = \frac{\sigma 4\pi R^2}{\varepsilon_0} = \frac{\sigma R^2}{\varepsilon_0 r^2}$$





(i) $Q > 0$ (ii) $Q < 0$

(b) (i) $q = \sigma 4\pi R^2 = 100 \times 10^{-6} \times 4 \times 3.14 \times \left(\frac{2.5}{2}\right)^2$

$= 19.6 \times 10^{-4}$ C

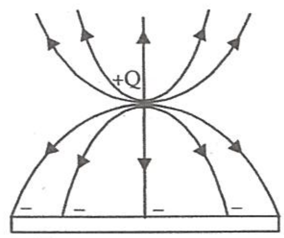
(ii) flux, $\phi = \frac{q}{\varepsilon_0} = \frac{19.6 \times 10^{-4}}{8.85 \times 10^{-12}} = 2.2 \times 10^8 \text{ Nm}^2\text{C}^{-1}$ (or $= 2.2 \times 10^8$ Vm)

12. State Gauss' law in electrostatics. Use this law to derive an expression for the electric field due to an infinitely long straight wire of linear charge density $\lambda \text{ Cm}^{-1}$. **(2009) 3**

A. Refer to point no. 46 of *To The Point* Theory.

13. A positive point charge ($+q$) is kept in the vicinity of an uncharged conducting plate. Sketch electric field lines originating from the point on to the surface of the plate.
Derive the expression for the electric field at the surface of a charged conductor. **(2009) 3**

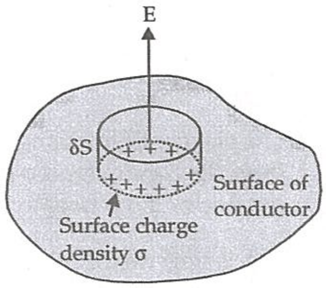
A.



Field at the surface of a charged conductor
We have, by Gauss's law,

$$E dS = \frac{|\sigma| \delta S}{\varepsilon_0}$$

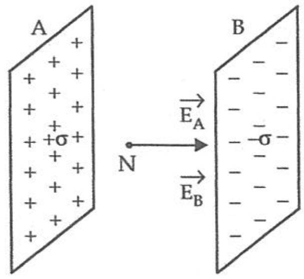
$$\therefore \quad E = \frac{|\sigma|}{\varepsilon_0}$$



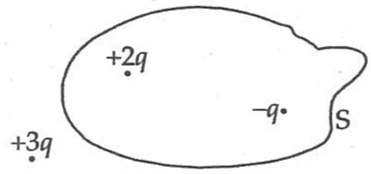
14. Use Gauss's law to derive the expression for the electric field between two uniformly charged large parallel sheets with surface charge densities σ and –σ respectively. **(2009) 3**

A. At a point N between the plates A and B, $\vec{E}_A$ and $\vec{E}_B$ are equal in magnitude and both are directed in same direction and are, therefore, added up, hence net electric field is given by

$$\vec{E} = \vec{E}_A + \vec{E}_B = \frac{\sigma}{2\varepsilon_0} + \frac{\sigma}{2\varepsilon_0} = \frac{\sigma}{\varepsilon_0}$$



15. Figure shows three point charges, $+2q$, $-q$ and $+3q$. Two charges $+2q$ and $-q$ are enclosed within a surface 'S'. What is the electric flux due to this configuration through the surface 'S'? **(2010) 1**



A. Electric flux $\phi = \frac{(+2q-q)}{\varepsilon_0} = \frac{q}{\varepsilon_0}$

16. A spherical conducting shell of inner radius r_1 and outer radius r_2 has a charge 'Q'. A charge 'q' is placed at the centre of the shell.

(a) What is the surface charge density on the (i) inner surface, (ii) outer surface of the shell?

(b) Write the expression for the electric field at a point $x > r_2$ from the centre of the shell. **(2010) 2**

A. (a) (i) Surface charge density on inner surface, $\sigma = \frac{-q}{4\pi r_1^2}$

(ii) Surface charge density on outer surface, $\sigma = \frac{Q+q}{4\pi r_2^2}$

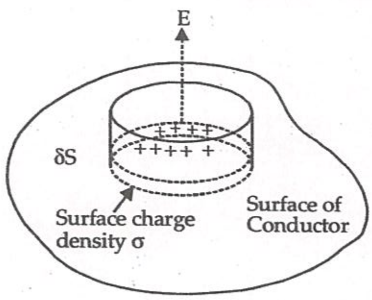
Electric field at (an outside) point distant x from centre of the shell, $E = \frac{Q+q}{4\pi\varepsilon_0 x^2}$

17. Show that the electric field at the surface of a charged conductor is given by $\vec{E} = \frac{\sigma}{\varepsilon_0}\hat{n}$, where σ is the surface charge density and $\hat{n}$ is a unit vector normal to the surface in the outward direction. **(2010) 2**

A.

By Gauss's law, $E\,\delta S = \frac{\sigma \delta S}{\varepsilon_0}$

$\Rightarrow \quad E = \frac{\sigma}{\varepsilon_0}$



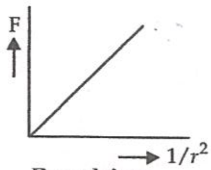
The electric field strength is directed radially away from the conductor if σ is positive and towards the conductor if σ is negative.

If $\hat{n}$ is unit vector normal to surface in outward direction, then

In vector form, $\vec{E} = \frac{\sigma}{\varepsilon_0}\hat{n}$

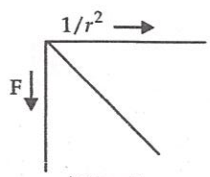
18. Plot a graph showing the variation of coulomb force (F) versus $\left(\frac{1}{r^2}\right)$, where r is the distance between the two charges of each pair of charges : (1 μC, 2 μC) and (2 μC, –3 μC). Interpret the graphs obtained. **(2011) 2**

A. (a)



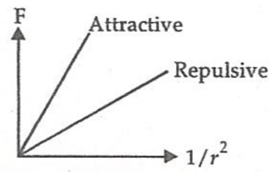
Repulsive

(b)



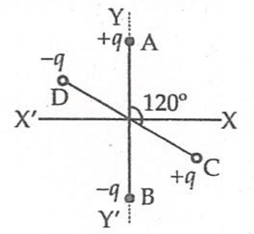
Attractive

Alternatively



Attractive force is greater than repulsive force since magnitude of the slope is more for attraction.

19. Two small identical electrical dipoles AB and CD, each of dipole moment 'p' are kept at an angle of 120° as shown in the figure. What is the resultant dipole moment of this combination ? If this system is subjected to electric field $(\vec{E})$ directed along +X direction, what will be the magnitude and direction of the torque acting on this ? **(2011) 2**



A. Resultant dipole moment = p
The magnitude of torque is $pE \sin 30° = pE/2$
The direction of torque is clockwise when viewed from above.
(or $\vec{\tau}$ is perpendicular to both $\vec{p}$ and $\vec{E}$).

20. A thin straight infinitely long conducting wire having charge density λ is enclosed by a cylindrical surface of radius r and length l, its axis coinciding with the length of the wire. Find the expression for the electric flux through the surface of the cylinder. **(2011) 2**

A. Charge enclosed by the cylindrical surface $q = \lambda l$

$$\text{Flux, } \phi = \frac{q}{\varepsilon_0} = \frac{\lambda l}{\varepsilon_0}$$

Alternatively, $$\phi = \oint \vec{E}.\vec{ds} = \frac{q}{\varepsilon_0} = \frac{\lambda l}{\varepsilon_0}$$

21. 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°. **(2012) 2**

A. (i) $\vec{F_1} = q\vec{E}$ and $\vec{F_2} = -q\vec{E}$

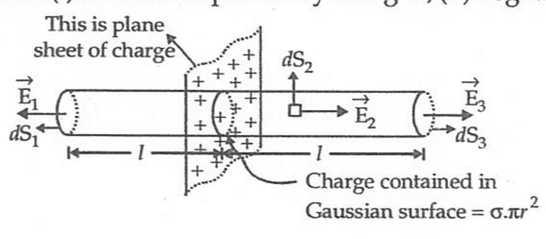
$\vec{F}_{net} = \vec{F_1} + \vec{F_2}$

$\therefore F_{net} = 0$

(ii) $W = pE(\cos\theta_1 - \cos\theta_2) = 2pE$

22. (a) Using Gauss's law, prove that the electric field at a point due to a uniformly charged infinite plane sheet is independent of the distance from it.
(b) How is the field directed if (i) the sheet is positively charged, (ii) negatively charged? **(2012) 3**

A. (a)



Outward flux through the Gaussian surface is

$$2EA = \frac{\sigma A}{\varepsilon_0}$$

$$\therefore E = \frac{\sigma}{2\varepsilon_0}$$

Vectorically, $\vec{E} = \frac{\sigma}{2\varepsilon_0}\hat{n}$, where $\hat{n}$ is a unit vector normal to the plane, away from it.

Hence, electric field is independent of the distance from sheet.

(b) For positively charged sheet : away from the sheet
For negatively charged sheet : towards the plane sheet

23. A charge 'q' is placed at the centre of a cube of side l. What is the electric flux passing through each face of the cube? **(2012) 1**

A. $\phi = q / 6\varepsilon_0$

24. A charge 'q' is placed at the centre of a cube of side l. What is the electric flux passing through two opposite faces of the cube? **(2012) 1**

A. $\phi = \frac{q}{3\varepsilon_0}$

25. Why should electrostatic field be zero inside a conductor? **(2012) 1**

A. Conductors (such as metals) possess free electrons. If a net electric field exists in the conductor, these free charges will experience a force which will set a current flow. When no current flows, the resultant force and the electric field must be zero. Thus, under electrostatic conditions, the value of $\vec{E}$ at all points within the conductor is zero.

26. Derive the expression for the electric field of a dipole at a point on the equatorial plane of the dipole. **(2013) 2**

A. Refer to point no. 35 of *To The Point* Theory.

27. Using Gauss' law deduce the expression for the electric field due to a uniformly charged spherical conducting shell of radius R at a point (i) outside and (ii) inside the shell.

Plot a graph showing variation of electric field as a function of $r > R$ and $r < R$. (r being the distance from the centre of the shell). **(2013) 5**

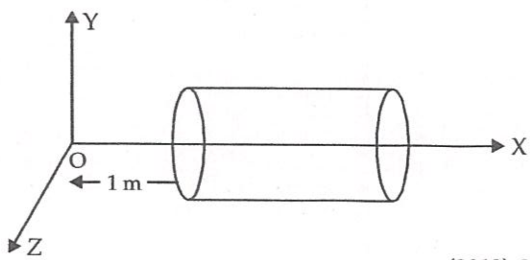
A. Refer to point no. 49 of *To The Point* Theory.

28. Two charges of magnitudes $-2Q$ and $+Q$ are located at points $(a, 0)$ and $(4a, 0)$ respectively. What is the electric flux due to these charges through a sphere of radius '$3a$' with its centre at the origin? **(2013) 1**

A. $\frac{-2Q}{\varepsilon_0}$

29. A hollow cylindrical box of length 1 m and area of cross-section 25 cm^2 is placed in a three dimensional coordinate system as shown in the figure. The electric field in the region is given by $\vec{E} = 50x\hat{i}$, where E is in NC^{-1} and x is in metres.

Find (i) Net flux through the cylinder.
(ii) Charge enclosed by cylinder.



(2013) 3

A. (i) The magnitude of the electric field at the left face is $E = 50\ NC^{-1}$.
Therefore flux through this face,
$\phi_L = EA \cos\theta = 50 \times 25 \times 10^{-4} \times \cos 180^0 = -125 \times 10^{-3}\ NC^{-1}\ m^2$
The magnitude of the electric field at the right face is $E = 100\ NC^{-1}$
Therefore flux through this face,
$\phi_R = 100 \times 25 \times 10^{-4} \cos 0° = 250 \times 10^{-3}\ N^{-1}\ m^2$
Therefore net flux through the cylinder is $\phi_R + \phi_L = 125 \times 10^{-3}\ NC^{-1}\ m^2$

(ii) Charge enclosed by the cylinder
$Q = \phi_{net} \times \varepsilon_0 = 125 \times 10^{-3} \times 8.856 \times 10^{-12}\ C = 1107 \times 10^{-15}\ C = 1.107\ pC$

30. Two equal balls having equal positive charge 'q' coulombs are suspended by two insulating strings of equal length. What would be the effect on the force when a plastic sheet is inserted between the two? **(2014) 1**

A. Force decreases.

31. Why do the electrostatic field lines not form closed loops? **(2014) 1**

A. They start from positive charges and end on negative charges.
[*Alternatively :*
Electric field is conservative in nature.]

32. Why do the electric field lines never cross each other? **(2014) 1**

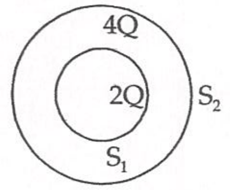
A. At the point of intersection of the two field lines, there will be two directions for the electric field. This is not acceptable.

33. Given a uniform electric field $\vec{E} = 5 \times 10^3\ \hat{i}$ N/C, find the flux of this field through a square of 10 cm on a side whose plane is parallel to the *y-z* plane. What would be the flux through the same square if the plane makes a 30° angle with the *x*-axis? **(2014) 2**

A. $\phi = EA \cos\theta = 5 \times 10^3 \times 10^{-2} \cos 0°\ NC^{-1}\ m^2 = 50\ NC^{-1}\ m^2$
$\phi = 5 \times 10^3 \times 10^{-2} \cos 60°\ NC^{-1}\ m^2 = 25\ NC^{-1}\ m^2$

34. (a) Deduce the expression for the torque acting on a dipole of dipole moment $\vec{p}$ in the presence of a uniform electric field $\vec{E}$.

(b) Consider two hollow concentric spheres, S_1 and S_2, enclosing charges 2Q and 4Q respectively as shown in the figure. (i) Find out the ratio of the electric flux through them. (ii) How will the electric flux through the sphere S_1 change if a medium of dielectric constant 'ε_r' is introduced in the space inside S_1 in place of air? Deduce the necessary expression.



(2014) 5

A. (a) Refer to point no. 37 of *To The Point* Theory.

(b) As per Guass's Theorem
Electric Flux = $\oint \vec{E}.\vec{dS} = \frac{q_{enclosed}}{\varepsilon_0}$

$\therefore$ For sphere S_1, flux enclosed $= \phi_1 = \frac{2Q}{\varepsilon_0}$

For sphere S_2, flux enclosed $= \phi_2 = \frac{2Q + 4Q}{\varepsilon_0} = \frac{6Q}{\varepsilon_0}$

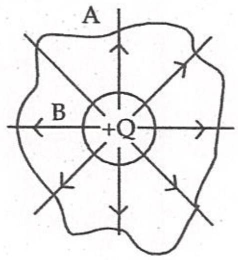
$\therefore \frac{\phi_1}{\phi_2} = \frac{1}{3}$

When a medium of dielectric constant ε_r is introduced in sphere S_1 the flux through S_1 would be
$\phi_1' = \frac{2Q}{\varepsilon_r}$

35. (a) "The outward electric flux due to charge + Q is independent of the shape and size of the surface which encloses it." Give two reasons to justify this statement.

(b) Two identical circular loops '1' and '2' of radius R each have linear charge densities $-\lambda$ and $+\lambda$ C/m respectively. The loops are placed coaxially with their centres $R\sqrt{3}$ distance apart. Find the magnitude and direction of the net electric field at the centre of loop '1'. **(2015) 5**

A. (a) The figure shows two surfaces A and B of different shapes and sizes enclosing a given charge +Q.

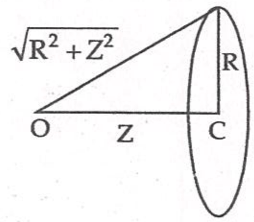


(i) For a given charge, the number of field lines, emanating from it, depends only on the net charge enclosed and not on the shape or size of surface enclosing it.

(ii) By Gauss's law of electrostatics, the outward flux of the electric field is the $\oint \vec{E}\cdot\vec{ds} = \frac{Q}{\varepsilon_0}$. This is same for both the surfaces, since both enclose the same charge (Q).

(b) The field at an axial point of a circular loop of radius R and linear charge density λ, is given by

$$\vec{E} = \frac{\lambda R}{2\varepsilon_0}\frac{Z}{(R^2+Z^2)^{3/2}}\hat{z}$$



The field at C

is $\vec{E} = \vec{E}_1 + \vec{E}_2 = 0 + \frac{\lambda R}{2\varepsilon_0}\frac{R\sqrt{3}}{(2R)^3}$ towards left

$$= \frac{\lambda\sqrt{3}}{16\varepsilon_0 R} \text{ towards left}$$

($\vec{E}_1 = 0$ since $Z = 0$)

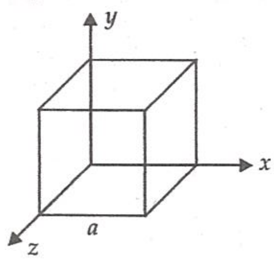
($\vec{E}_2$ is towards left because λ is (+) ve)

36. What is the electric flux through a cube of side 1 cm which encloses an electric dipole? **(2015) 1**

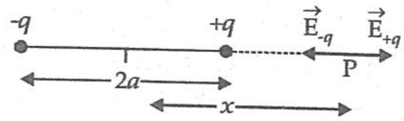
A. Zero

37. (a) An electric dipole of dipole moment $\vec{p}$ consists of point charges $+q$ and $-q$ separated by a distance $2a$ apart. Deduce the expression for the electric field $\vec{E}$ due to the dipole at a distance x from the centre of the dipole on its axial line in terms of the dipole moment $\vec{p}$. Hence show that in the limit $x >> a$, $\vec{E} \longrightarrow \vec{p} / (4\pi\varepsilon_0 x^3)$.

(b) Given the electric field in the region $\vec{E} = 2x\hat{i}$, find the net electric flux through the cube and the charge enclosed by it. **(2015) 5**



A. (a) Electric field intensity at point P due to charge $-q$



$$\vec{E}_{-q} = \frac{1}{4\pi\varepsilon_0}\cdot\frac{q}{(x+a)^2}(\hat{x})$$

Due to charge $+q$

$$\vec{E}_{+q} = \frac{1}{4\pi\varepsilon_0}\cdot\frac{q}{(x-a)^2}(\hat{x})$$

Net Electric field at point p

$$\vec{E} = \vec{E}_{-q} + \vec{E}_{+q}$$

$$= \frac{q}{4\pi\varepsilon_0}\times\left[\frac{1}{(x-a)^2} - \frac{1}{(x+a)^2}\right](\hat{x})$$

$$= \frac{q}{4\pi\varepsilon_0}\left[\frac{4aqx}{(x^2-a^2)^2}\right](\hat{x}) = \frac{1}{4\pi\varepsilon_0}\frac{(q\times 2a)2x}{(x^2-a^2)^2}(\hat{x})$$

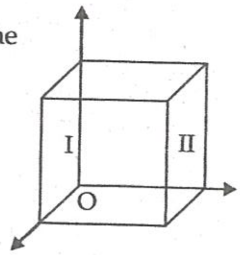
$$\vec{E} = \frac{1}{4\pi\varepsilon_0}\cdot\frac{2px}{(x^2-a^2)^2}\hat{x}$$

For $x >> a$

$(x^2-a^2)^2 \simeq x^4$

$$\vec{E} = \frac{1}{4\pi\varepsilon_0}\cdot\frac{2p}{x^3}\hat{x}$$

(b) Only the faces perpendicular to the direction of x-axis contribute to the electric flux. The remaining faces of the cube give zero contribution.



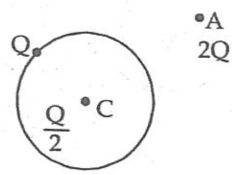
Total Flux $\phi = \phi_I + \phi_{II}$

$$= \oint_I \vec{E}.\vec{ds} + \oint_{II} \vec{E}.\vec{ds}$$

$$= 0 + 2(a).a^2$$

$\therefore$ $\phi = 2a^3$

38. A thin metallic spherical shell of radius R carries a charge Q on its surface. A point charge $\frac{Q}{2}$ is placed at its centre C and an other charge +2Q is placed outside the shell at a distance x from the centre as shown in the figure. Find (i) the force on the charge at the centre of shell and at the point A, (ii) the electric flux through the shell. **(2015) 3**



A. Net Force on the charge $\frac{Q}{2}$, placed at the centre of the shell is zero.

Force on charge '2Q' kept at point A

$$F = E\times 2Q = \frac{1\left(\frac{3Q}{2}\right)2Q}{4\pi\varepsilon_0} = \frac{(K)3Q^2}{r^2}$$

Electric flux through the shell $\phi = \frac{Q}{2\varepsilon_0}$

39. Use Gauss's law to find the electric field due to a uniformly charged infinite plane sheet. What is the direction of field for positive and negative charge densities? **(2016) 2**

A. Refer to point no. 47 of *To The Point* Theory.

40. How does the electric flux due to a point charge enclosed by a spherical Gaussian surface get affected when its radius is increased? **(2016) 1**

A. Electric flux remains unaffected.

41. A charge is distributed uniformly over a ring of radius '*a*'. Obtain an expression for the electric intensity E at a point on the axis of the ring. Hence show that for points at large distances from the ring, it behaves like a point charge. **(2016) 3**

A. Obtaining an expression for Electric field intensity

$$E = \frac{1}{4\pi\varepsilon_0}\frac{Qx}{(x^2 + a^2)^{\frac{3}{2}}}, \text{ where total charge } Q = \lambda \times 2\pi a$$

Showing behaviour at large distance. At large distance *i.e.*, $x >> a$

$$E \simeq \frac{1}{4\pi\varepsilon_0}\cdot\frac{Q}{x^2}.$$ This is the electric field due to a point charge at distance x.

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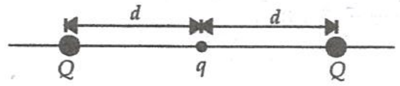
QUESTIONS FOR : ENGINEERING ENTRANCE EXAM [J.E.E]

ELECTRIC CHARGES AND FIELDS :-

1. Two charges, each equal to q, are kept at $x = -a$ and $x = a$ on the x-axis. A particle of mass m and charge $q_0 = \frac{q}{2}$ is placed at the origin. If charge q_0 is given a small displacement ($y << a$) along the y-axis, the net force acting on the particle is proportional to
(a) $-\frac{1}{y}$ (b) y (c) $-y$ (d) $\frac{1}{y}$
2013 *(JEE Main)*

2. The net electric force on a charge of +3 μC at the mid-point on the line joining two charges of magnitude +2 μC and −2 μC separated by the distance of 6 mm, is
(a) 6000 N (b) 500 N
(c) 12000 N (d) zero *(J & K CET)*

3. A particle of mass M and charge q is at rest at the midpoint between two other fixed similar charges each of magnitude Q placed a distance $2d$ apart. The system is collinear as shown in the figure. The particle is now displaced by a small amount x ($x << d$) along the line joining the two charges and is left to itself. It will now oscillate about the mean position with a time period (ε_0 = permittivity of free space)



(a) $2\sqrt{\frac{\pi^3 M\varepsilon_0 d}{Qq}}$ (b) $2\sqrt{\frac{\pi^2 M\varepsilon_0 d^3}{Qq}}$
(c) $2\sqrt{\frac{\pi^3 M\varepsilon_0 d^3}{Qq}}$ (d) $2\sqrt{\frac{\pi^3 M\varepsilon_0}{Qqd^3}}$
(WB JEE)

4. Two spheres of electric charges +2 nC and −8 nC are placed at a distance d apart. If they are allowed to touch each other, what is the new distance between them to get a repulsive force of same magnitude as before?
(a) $\frac{d}{2}$ (b) d (c) $\frac{3d}{4}$ (d) $\frac{4d}{3}$
(Karnataka CET)

5. A charge of 0.8 coulomb is divided into two charges Q_1 and Q_2. These are kept at a separation of 30 cm. The force on Q_1 is maximum when
(a) $Q_1 = Q_2 = 0.4$ C
(b) $Q_1 \approx 0.8$ C, Q_2 negligible
(c) Q_1 negligible, $Q_2 \approx 0.8$ C
(d) $Q_1 = 0.2$ C, $Q_2 = 0.6$ C *(WB JEE)*

6. Two charges + 6 μC and + 15 μC are placed along the x-axis at $x = 0$ and $x = 2$ m respectively. A negative charge is placed between them such that the resultant force on it is zero. The negative charge is placed at
(a) $x = 0.775$ m (b) $x = 1.2$ m
(c) $x = 0.5$ m
(d) position depends on the amount of charge
(OJEE)

2009

7. A charge Q is placed at each of the opposite corners of a square. A charge q is placed at each of the other two corners. If the net electrical force on Q is zero, then Q/q equals
(a) $-2\sqrt{2}$ (b) −1 (c) 1 (d) $-\frac{1}{\sqrt{2}}$
(AIEEE)

8. The electric intensities at a point due to two point charges in the x-y plane and $3\hat{i} - 2\hat{j}$ and $-2\hat{i} + 4\hat{j}$. The magnitude of the resultant intensity at that point is
(a) 2.08 V m^{-1} (b) 2.24 V m^{-1}
(c) 1.8 V m^{-1} (d) 3.5 V m^{-1} *(J & K CET)* 2017

9. A particle with charge e and mass m, moving along the X-axis with a uniform speed u, enters a region where a uniform electric field E is acting along the Y-axis. The particle starts to move in a parabola. Its focal length (neglecting any effect of gravity) is
(a) $\frac{2mu^2}{eE}$ (b) $\frac{eE}{2mu^2}$ (c) $\frac{mu}{2eE}$ (d) $\frac{mu^2}{2eE}$
(WB JEE)

10. The electric field strength in N C^{-1} that is required to just prevent a water drop carrying a charge 1.6×10^{-19} C from falling under gravity is ($g = 9.8$ m s^{-2}, mass of water drop = 0.0016 g)
(a) 9.8×10^{-16} (b) 9.8×10^{16}
(c) 9.8×10^{-13} (d) 9.8×10^{13}
(e) 9.8×10^{10} *(Kerala PET)*

11. An electron of mass m, charge e falls through a distance h meter in a uniform electric field E. Then time of fall,
(a) $t = \sqrt{\frac{2hm}{eE}}$ (b) $t = \frac{2hm}{eE}$
(c) $t = \sqrt{\frac{2eE}{hm}}$ (d) $t = \frac{2eE}{hm}$
(Karnataka CET)

MASS PHYSICS

PREVIOUS YEARS' MCQ'S FOR ENTRANCE EXAMS

QUESTIONS FOR : ENGINEERING ENTRANCE EXAM [J.E.E]

TOPIC : ELECTRIC FIELD & CHARGE DISTRIBUTION.

12. In the uniform electric field of $E = 1 \times 10^4$ N C^{-1}, an electron is accelerated from rest. The velocity (in m s^{-1}) of the electron when it has travelled a distance of 2×10^{-2} m is nearly ($\frac{e}{m}$ of electron $= 1.8 \times 10^{11}$ C kg^{-1})

(a) 1.6×10^6 (b) 0.85×10^6
(c) 0.425×10^6 (d) 8.5×10^6

(Karnataka CET)

13. Acceleration of a charged particle of charge 'q' and mass 'm' moving in a uniform electric field of strength 'E' is

(a) $\frac{qE}{m}$ (b) $\frac{m}{qE}$ (c) mqE (d) $\frac{q}{mE}$

(Karnataka CET 2012, J & K CET 2011)

14. A charged particle of mass m and charge q is released from rest in an uniform electric field E. The kinetic energy of the particle after time t is

(a) $\frac{E^2q^2t^2}{2m}$ (b) $\frac{2E^2t^2}{mq}$ (c) $\frac{Eqm}{2t}$ (d) $\frac{Eq^2m}{2t^2}$

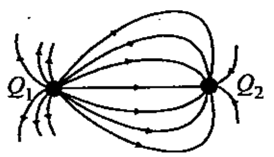
(OJEE)

15. A negatively charged oil drop is prevented from falling under gravity by applying a vertical electric field 100 V m^{-1}. If the mass of the drop is 1.6×10^{-3} g, the number of electrons carried by the drop is ($g = 10$ m s^{-2})

(a) 10^{18} (b) 10^{15} (c) 10^{12} (d) 10^9

(UP GBTU 2012, Kerala PET 2010)

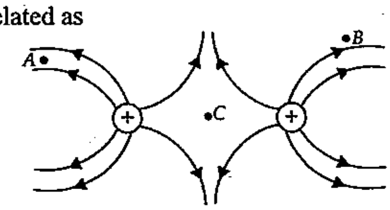
16. A few electric field lines for a system of two charges Q_1 and Q_2 fixed at two different points on the x-axis are shown in the figure. These lines suggest that



(a) $|Q_1| > |Q_2|$ (b) $|Q_1| < |Q_2|$
(c) at a finite distance to the left of Q_1 the electric field is zero
(d) at a finite distance to the right of Q_2 the electric field is zero

(IIT JEE)

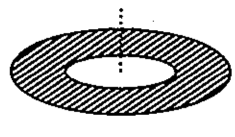
17. The figure below shows the electric field lines due to two positive charges. The magnitudes E_A, E_B and E_C of the electric fields at points A, B and C respectively are related as



~~(a) $E_A > E_B > E_C$~~ www.masssphysics.com (b) $E_B > E_A > E_C$
(c) $E_A = E_B > E_C$ (d) $E_A > E_B = E_C$ *(OJEE)*

a) $E_A > E_B > E_C$

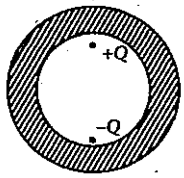
18. A thin disc of radius $b = 2a$ has a concentric hole of radius a in it (see figure). It carries uniform surface charge σ on it. If the electric field on its axis at height h ($h << a$) from its centre is given as Ch then value of C is



(a) $\frac{\sigma}{a\varepsilon_0}$
(b) $\frac{\sigma}{2a\varepsilon_0}$
(c) $\frac{\sigma}{4a\varepsilon_0}$
(d) $\frac{\sigma}{8a\varepsilon_0}$

2015 *(JEE Main Online)*

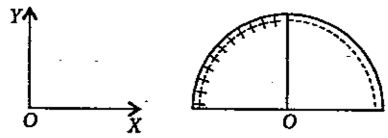
19. Shown in the figure are two point charges +Q and −Q inside the cavity of a spherical shell. The charges are kept near the surface of the cavity on opposite sides of the centre of the shell. If σ_1 is the surface charge on the inner surface and Q_1 net charge on it and σ_2 the surface charge on the outer surface and Q_2 net charge on it then



(a) $\sigma_1 \neq 0, Q_1 \neq 0 ; \sigma_2 \neq 0, Q_2 \neq 0$
(b) $\sigma_1 \neq 0, Q_1 = 0 ; \sigma_2 \neq 0, Q_2 = 0$
(c) $\sigma_1 \neq 0, Q_1 = 0 ; \sigma_2 = 0, Q_2 = 0$
(d) $\sigma_1 = 0, Q_1 = 0 ; \sigma_2 = 0, Q_2 = 0$

2015 *(JEE Main Online)*

20. A wire, of length L(= 20 cm), is bent into a semi-circular arc. If the two equal halves of the arc, were each to be uniformly charged with charges $\pm Q$, [$|Q| = 10^3 \varepsilon_0$ Coulomb where ε_0 is the permittivity (in SI units) of free space] the net electric field at the centre O of the semi-circular arc would be



(a) $(50 \times 10^3$ N/C$)\hat{j}$ (b) $(25 \times 10^3$ N/C$)\hat{i}$
(c) $(25 \times 10^3$ N/C$)\hat{j}$ (d) $(50 \times 10^3$ N/C$)\hat{i}$

(JEE Main Online) 2010

21. Four charges equal to $-Q$ are placed at the four corners of a square and a charge q is at its centre. If the system is in equilibrium, the value of q is

(a) $\frac{-Q}{4}(1+2\sqrt{2})$ (b) $\frac{Q}{4}(1+2\sqrt{2})$
(c) $\frac{-Q}{2}(1+2\sqrt{2})$ (d) $\frac{Q}{2}(1+2\sqrt{2})$

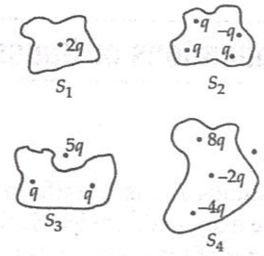
MASS PHYSICS

PREVIOUS YEARS' MCQ'S FOR ENTRANCE EXAMS

QUESTIONS FOR : ENGINEERING ENTRANCE EXAM [J.E.E]

TOPIC: GAUSS'S LAW

22. Four closed surfaces and corresponding charge distributions are shown below.



[redacted]. Let the respective electric fluxes through the surfaces be Φ_1, Φ_2, Φ_3 and Φ_4. Then

(a) $\Phi_1 = \Phi_2 = \Phi_3 = \Phi_4$ (b) $\Phi_1 > \Phi_3; \Phi_2 < \Phi_4$
(c) $\Phi_1 > \Phi_2 > \Phi_3 > \Phi_4$ (d) $\Phi_1 < \Phi_2 = \Phi_3 > \Phi_4$

2017 *(JEE Main Online)*

24. A charge Q placed at the center of a metallic spherical shell with inner and outer radii R_1 and R_2 respectively. The normal component of the electric field at any point on the Gaussian surface with radius between R_1 and R_2 will be

(a) zero (b) $\frac{Q}{4\pi R_1^2}$
(c) $\frac{Q}{4\pi R_2^2}$ (d) $\frac{Q}{4\pi(R_1 - R_2)^2}$
(e) $\frac{Q}{4\pi(R_2 - R_1)^2}$ *(Kerala PET)*

2016

25. A point charge $+Q$ is placed at a distance $d/2$ directly above the centre of a square of side d. The magnitude of electric flux through the square is

(a) $\frac{Q}{6}$ (b) $\frac{Q}{6\varepsilon_0}$ (c) $\frac{Qd}{6\varepsilon_0}$ (d) $\frac{Q\varepsilon_0}{6d}$

(AMU (Engg.))

26. The electric flux passing through a cube of side a, which holds a charge q at one of its corners is

(a) $\frac{q}{\varepsilon_0}$ (b) $\frac{q}{8\varepsilon_0}$ (c) $\frac{q}{4\varepsilon_0}$ (d) $\frac{q}{2\varepsilon_0}$

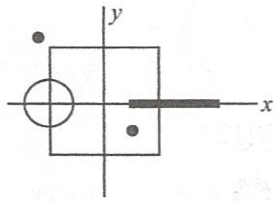
(J & K CET 2016, COMEDK 2015, WB JEE 2010)

27. The electric flux through a closed surface area S enclosing charge Q is ϕ. If the surface area is doubled, then the flux is

(a) 2ϕ (b) $\phi/2$ (c) $\phi/4$ (d) ϕ

(J & K CET)

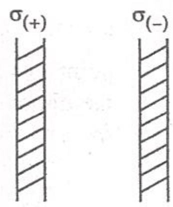
28. A disk of radius $a/4$ having a uniformly distributed charge 6 C is placed in the x-y plane with its centre at $(-a/2, 0, 0)$. A rod of length a carrying a uniformly distributed charge 8 C is placed on the x-axis from $x = a/4$ to $x = 5a/4$. Two point charges −7 C and 3 C are placed at $(a/4, -a/4, 0)$ and $(-3a/4, 3a/4, 0)$, respectively. Consider a cubical surface formed by six surfaces $x = \pm a/2, y = \pm a/2, z = \pm a/2$. The electric flux through this cubical surface is



(a) $\frac{-2\text{ C}}{\varepsilon_0}$ (b) $\frac{2\text{ C}}{\varepsilon_0}$ (c) $\frac{10\text{ C}}{\varepsilon_0}$ (d) $\frac{12\text{ C}}{\varepsilon_0}$

(IIT JEE)

29. Figure shows the portions of two infinite parallel non-conducting sheets having the magnitude of the surface charge densities $\sigma_{(+)} = 6.8\ \mu C/m^2$ and $\sigma_{(-)} = 4.3\ \mu C/m^2$ for the positively and negatively charged sheets, respectively. Find the electric field $\vec{E}$ between the sheets



(a) 6.3×10^5 N/C towards right
(b) 6.3×10^5 N/C towards left
(c) 1.41×10^5 N/C towards right
(d) 1.41×10^5 N/C towards left *(AMU (Engg.))*

30. Let $E_1(r)$, $E_2(r)$ and $E_3(r)$ be the respective electric fields at a distance r from a point charge Q, an infinitely long wire with constant linear charge density λ, and an infinite plane with uniform surface charge density σ. If $E_1(r_0) = E_2(r_0) = E_3(r_0)$ at a given distance r_0, then

(a) $Q = 4\sigma\pi r_0^2$ (b) $r_0 = \frac{\lambda}{2\pi\sigma}$
(c) $E_1(r_0/2) = 2E_2(r_0/2)$
(d) $E_2(r_0/2) = 4E_3(r_0/2)$ *(JEE Advanced)*

31. 4×10^{10} electrons are removed from a neutral metal sphere of diameter 20 cm placed in air. The magnitude of the electric field (in N C^{-1}) at a distance of 20 cm from its centre is

(a) Zero (b) 5760
(c) 640 (d) 1440 *(Karnataka CET)*

32. A positive charge Q is situated at the centre of a cube. The electric flux through any face of the cube is (in SI units)

(a) $\frac{Q}{6\varepsilon_0}$ (b) $4\pi Q$ (c) $\frac{Q}{4\pi\varepsilon_0}$ (d) $\frac{Q}{6\pi\varepsilon_0}$

(WB JEE)

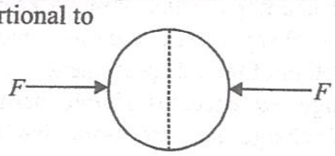
33. Let there be a spherically symmetric charge distribution with charge density varying as $\rho(r) = \rho_0\left(\frac{5}{4} - \frac{r}{R}\right)$ upto $r = R$, and $\rho(r) = 0$ for $r > R$, where r is the distance from the origin. The electric field at a distance r $(r < R)$ from the origin is given by

(a) $\frac{\rho_0 r}{3\varepsilon_0}\left(\frac{5}{4} - \frac{r}{R}\right)$ (b) $\frac{4\pi\rho_0 r}{3\varepsilon_0}\left(\frac{5}{3} - \frac{r}{R}\right)$

(c) $\frac{\rho_0 r}{4\varepsilon_0}\left(\frac{5}{3} - \frac{r}{R}\right)$ (d) $\frac{4\rho_0 r}{3\varepsilon_0}\left(\frac{5}{4} - \frac{r}{R}\right)$

(AIEEE)

34. A uniformly charged thin spherical shell of radius R carries uniform surface charge density of σ per unit area. It is made of two hemispherical shells, held together by pressing them with force F (see figure). F is proportional to



(a) $\frac{1}{\varepsilon_0}\sigma^2 R^2$ (b) $\frac{1}{\varepsilon_0}\sigma^2 R$

(c) $\frac{1}{\varepsilon_0}\frac{\sigma^2}{R}$ (d) $\frac{1}{\varepsilon_0}\frac{\sigma^2}{R^2}$ *(IIT JEE)*

35. An infinite line charge produces a field of 18×10^5 N/C at a distance of 4 cm. What is the linear charge density?

(a) 18 μC/m (b) 5 μC/m
(c) 4 μC/m (d) 10 μC/m *(J & K CET)*

36. A plane square sheet of charge of side 0.5 m has uniform surface charge density. An electron at 1 cm from the centre of the sheet experiences a force of 1.6×10^{-12} N directed away from the sheet. The total charge on the plane square sheet is $(\varepsilon_0 = 8.854 \times 10^{-12}\ C^2\ m^{-2}\ N^{-1})$

(a) 16.25 μC (b) – 22.15 μC
(c) – 44.27 μC (d) 144.27 μC
(e) 8.854 μC

(Kerala PET)

37. Two equal and opposite charges of masses m_1 and m_2 are accelerated in an uniform electric field through the same distance. What is the ratio of their accelerations if their ratio of masses is $\frac{m_1}{m_2} = 0.5$?

(a) $\frac{a_1}{a_2} = 2$ (b) $\frac{a_1}{a_2} = 0.5$

(c) $\frac{a_1}{a_2} = 3$ (d) $\frac{a_1}{a_2} = 1$

(Karnataka CET)

38. A spherical conductor of radius 2 cm is uniformly charged with 3 nC. What is the electric field at a distance of 3 cm from the centre of the sphere ?

(a) $3 \times 10^4\ V\ m^{-1}$ (b) $3 \times 10^6\ V\ m^{-1}$
(c) $3 \times 10^{-4}\ V\ m^{-1}$ (d) $3\ V\ m^{-1}$

(Karnataka CET)

2013

39. The electric field in a region is given by

$\vec{E} = \frac{A}{x^3}\hat{i} + By\,\hat{j} + Cz^2\hat{k}.$

The SI units of A, B and C are, respectively

(a) $\frac{N m^3}{C}, V/m^2, \frac{N}{m^2 C}$

(b) $V m^2, V/m, \frac{N}{m^2 C}$

(c) $V/m^2, V/m, \frac{NC}{m^2}$

(d) $V/m, \frac{N m^3}{C}, \frac{NC}{m}$ *(AMU (Engg.))*

40. A particle of mass M and charge q is released from rest in a region of uniform electric field of magnitude E. After a time t, the distance travelled by the charge is S and the kinetic energy attained by the particle is T. Then, the ratio T/S

(a) remains constant with time t
(b) varies linearly with the mass M of the particle
(c) is independent of the charge q
(d) is independent of the magnitude of the electric field E.

(WB JEE)

ELECTRIC CHARGES AND FIELDS

1. Suppose the charge of a proton and an electron differ slightly. One of them is $-e$, the other is $(e + \Delta e)$. If the net of electrostatic force and gravitational force between two hydrogen atoms placed at a distance d (much greater than atomic size) apart is zero, then Δe is of the order of
[Given mass of hydrogen $m_h = 1.67 \times 10^{-27}$ kg]
(a) 10^{-23} C (b) 10^{-37} C
(c) 10^{-47} C (d) 10^{-20} C *(NEET)* 2017

2016

2. Two identical charged spheres suspended from a common point by two massless strings of lengths l, are initially at a distance d ($d << l$) apart because of their mutual repulsion. The charges begin to leak from both the spheres at a constant rate. As a result, the spheres approach each other with a velocity v. Then v varies as a function of the distance x between the spheres, as
(a) $v \propto x^{-1/2}$ (b) $v \propto x^{-1}$
(c) $v \propto x^{1/2}$ (d) $v \propto x$ *(NEET Phase-I)*

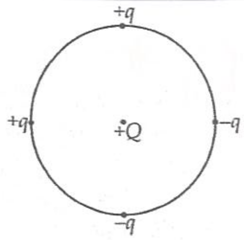
3. **Assertion :** Acceleration of charged particle in non-uniform electric field does not depend on velocity of charged particle.
Reason : Charge is an invariant quantity. That is amount of charge on particle does not depend on frame of reference.
(a) Both assertion and reason are true and reason is the correct explanation of assertion.
(b) Both assertion and reason are true but reason is not the correct explanation of assertion.
(c) Assertion is true but reason is false.
(d) Both assertion and reason are false. *(AIIMS)* 2014

4. An electric charge does not have which of the following properties?
(a) Total charge conservation
(b) Quantization of charge
(c) Two types of charge
(d) Circular line of force *(J & K CET)*

2009

5. The number of electrons in 2 coulomb of charge is
(a) 5×10^{29} (b) 12.5×10^{18}
(c) 1.6×10^{19} (d) 9×10^{11} *(WB JEE)*

6. Four charges, $+q, +q, -q, -q$ are placed on the circumference of a circle of radius r. What is the force on the charge $+Q$ placed at the centre of the circle as shown in the figure?



(a) $\frac{1}{4\pi\varepsilon_0}\frac{Qq}{r^2}$ (b) $\frac{1}{4\pi\varepsilon_0}\frac{\sqrt{8}Qq}{r^2}$
(c) $\frac{1}{4\pi\varepsilon_0}\frac{8Qq}{r^2}$ (d) $\frac{1}{4\pi\varepsilon_0}\frac{2Qq}{r^2}$ *(UP CPMT)*

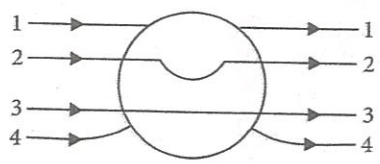
7. Four charges equal to $-Q$ are placed at the four corners of a square and a charge q is at its centre. If the system is in equilibrium, the value of q is
(a) $\frac{-Q}{4}(1+2\sqrt{2})$ (b) $\frac{Q}{4}(1+2\sqrt{2})$
(c) $\frac{-Q}{2}(1+2\sqrt{2})$ (d) $\frac{Q}{2}(1+2\sqrt{2})$

8. The magnitude of electric field required to balance an oil drop of mass m, carrying charge q is
(g = acceleration due to gravity)
(a) $\frac{q}{m}$ (b) $\frac{mg}{q^2}$ (c) mgq (d) $\frac{mg}{q}$ *(J & K CET)*

9. An α-particle of mass 6.4×10^{-27} kg and charge 3.2×10^{-19} C is situated in a uniform electric field of 1.6×10^5 V m^{-1}. The velocity of the particle at the end of 2×10^{-2} m path when it starts from rest is
(a) $2\sqrt{3} \times 10^5$ m s^{-1} (b) 8×10^5 m s^{-1}
(c) 16×10^5 m s^{-1} (d) $4\sqrt{2} \times 10^5$ m s^{-1} *(Karnataka CET)*

10. A charged particle is placed in uniform electric field. Its path will be
(a) straight line (b) parabola
(c) circle (d) helix *(UP CPMT)*

11. A metallic solid sphere is placed in a uniform electric field. Which path, the lines of force follow as shown in figure?



(a) 1 (b) 2
(c) 3 (d) 4 *(AIIMS)*

TOPIC: ELECTRIC FIELD AND DIPOLE

12. Pick out the statement which is incorrect.
   (a) The electric field lines forms closed loop.
   (b) Field lines never intersect.
   (c) The tangent drawn to a line of force represents the direction of electric field.
   (d) A negative test charge experiences a force opposite to the direction of the field.
   (Karnataka CET)

2014

13. **Assertion** : A charged particle free to move in an electric field always moves along an electric field line.
   Reason : The electric field lines diverge from a negative charge and converge at a positive charge.
   (a) Both assertion and reason are true and reason is the correct explanation of assertion.
   (b) Both assertion and reason are true but reason is not the correct explanation of assertion.
   (c) Assertion is true but reason is false.
   (d) Both assertion and reason are false. *(AIIMS)*

14. If $\vec{E}_{ax}$ and $\vec{E}_{eq}$ represents electric field at a point on the axial and equatorial line of a dipole. If points are at a distance r from the centre of the dipole, for $r >> a$
   (a) $\vec{E}_{ax} = \vec{E}_{eq}$ (b) $\vec{E}_{ax} = -\vec{E}_{eq}$
   (c) $\vec{E}_{ax} = -2\vec{E}_{eq}$ (d) $\vec{E}_{eq} = 2\vec{E}_{ax}$
   (Karnataka CET)

2015

15. Consider an electric dipole placed in a region of non-uniform electric field. Choose the correct statement out of the following options.
   (a) The dipole will experience only a force.
   (b) The dipole will experience only a torque.
   (c) The dipole will experience both force and the torque.
   (d) The dipole will neither experience a force nor a torque.
   (J & K CET 2015, COMEDK 2014)

16. The angle between the dipole moment and electric field at any point on the equatorial plane is
   (a) 90° (b) 45° (c) 0° (d) 180°
   (Karnataka CET)

17. An electric dipole is placed at an angle of 30° with an electric field intensity 2×10^5 N C^{-1}. It experiences a torque equal to 4 N m. The charge on the dipole, if the dipole length is 2 cm, is
   (a) 8 mC (b) 2 mC (c) 5 mC (d) 7 μC
   2016 *(NEET Phase-II)*

18. A point dipole is located at the origin in some orientation. The electric field at the point (10 cm, 10 cm) on the x-y plane is measured to have a magnitude 1.0×10^{-3} V/m. What will be the magnitude of the electric field at the point (20 cm, 20 cm)?
   (a) 5.0×10^{-4} V/m (b) 2.5×10^{-4} V/m
   (c) It will depend on the orientation of the dipole.
   (d) 1.25×10^{-4} V/m *(J & K CET)*

2011

19. The electric field at a point due to an electric dipole, on an axis inclined at an angle $\theta (< 90°)$ to the dipole axis, is perpendicular to the dipole axis, if the angle θ is
   (a) $\tan^{-1}(2)$ (b) $\tan^{-1}\left(\frac{1}{2}\right)$
   (c) $\tan^{-1}(\sqrt{2})$ (d) $\tan^{-1}\left(\frac{1}{\sqrt{2}}\right)$

20. The direction of electric field intensity $(\vec{E})$ at a point on the equatorial line of an electric dipole of dipole moment $(\vec{p})$ is
   (a) along the equatorial line towards the dipole
   (b) along the equatorial line away from the dipole
   (c) perpendicular to the equatorial line and opposite to $(\vec{p})$
   (d) perpendicular to the equatorial line and parallel to $(\vec{p})$. *(BHU 2010, Kerala PMT 2008)*

2009

21. The angle between the electric dipole moment $\vec{P}$ and the electric field intensity $\vec{E}$ due to it on the axial line at an external point is
   (a) 0° (b) 90°
   (c) 180° (d) 45° *(BHU)*

22. Electric field E at broadside on position due to electric dipole varies with distance r as
   (a) $E \propto \frac{1}{r^2}$ (b) $E \propto \frac{1}{r}$
   (c) $E \propto r$ (d) $E \propto \frac{1}{r^3}$ *(UP CPMT)*

23. An electric dipole is placed in space. If we move around it we will feel
   (a) electric field (b) magnetic field
   (c) both (d) none of these
   (UP CPMT)

MASS PHYSICS

PREVIOUS YEARS' MCQ'S FOR ENTRANCE EXAMS

QUESTIONS FOR : MEDICAL ENTRANCE EXAM [N.E.E.T]

TOPIC: DIPOLE AND FLUX

24. A positive point charge is brought near an isolated metal cube.
(a) The cube becomes negatively charged
(b) The cube becomes positively charged
(c) The interior becomes positively charged and the surface becomes negatively charged
(d) The interior remains charge free and the surface gets non uniform charge distribution. *(AIIMS)*

2014

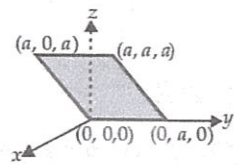
25. An infinite line charge produces a field of 18×10^5 N/C at a distance of 4 cm. What is the linear charge density?
(a) 18 μC/m (b) 5 μC/m
(c) 4 μC/m (d) 10 μC/m *(J & K CET)*

26. Electric field at a point of distance r from a uniformly charged wire of infinite length having linear charge density λ is directly proportional to
(a) r^{-1} (b) r (c) r^2 (d) r^{-2}
(e) $\sqrt{r}$ *(Kerala PMT)*

27. In a region, the intensity of an electric field is given by $\vec{E} = 2\hat{i}+3\hat{j}+\hat{k}$ in N C^{-1}. The electric flux through a surface $\vec{S} = 10\hat{i}$ m^2 in the region is
(a) 5 Nm^{2}C^{-1} (b) 10 Nm^{2}C^{-1}
(c) 15 Nm^{2}C^{-1} (d) 20 Nm^{2}C^{-1} *(WB JEE)*

2011

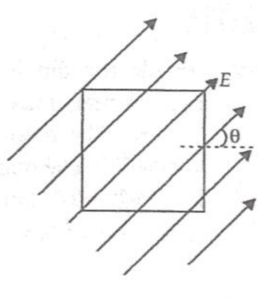
28. Consider an electric field where $\vec{E} = E_0\hat{x}$ is a constant. The flux through the shaded area (as shown in the figure) due to this field is



(a) $2E_0a^2$ (b) $\sqrt{2}E_0a^2$
(c) E_0a^2 (d) $\frac{E_0a^2}{\sqrt{2}}$ *(UP CPMT)*

2010

29. A square surface of side L meter in the plane of the paper is placed in a uniform electric field E(volt/m) acting along the same plane at an angle θ with the horizontal side of the square as shown in figure. The electric flux linked to the surface, in units of volt m is



(a) EL^2 (b) $EL^2\cos\theta$
(c) $EL^2\sin\theta$ (d) zero *(AIPMT)*

30. An electric dipole of dipole moment p is aligned parallel to a uniform electric field E. The energy required to rotate the dipole by 90° is
(a) p^2E (b) pE (c) infinity (d) pE^2 *(NEET Karnataka)*

31. A dipole of dipole moment 'p' is placed in non-uniform electric field along x-axis. Electric field is increasing at the rate of 1 V m^{-1} then the force on dipole is
(a) 0 (b) $2p$ (c) $p/2$ (d) p *(AIIMS)*

2012

32. An electric dipole of moment p is placed in an electric field of intensity E. The dipole acquires a position such that the axis of the dipole makes an angle θ with the direction of the field. Assuming that the potential energy of the dipole to be zero when θ = 90°, the torque and the potential energy of the dipole will respectively be
(a) $pE\sin\theta, -pE\cos\theta$ (b) $pE\sin\theta, -2pE\cos\theta$
(c) $pE\sin\theta, 2pE\cos\theta$ (d) $pE\cos\theta, -pE\sin\theta$ *(AIPMT)*

2011

33. An electric dipole is placed in an uniform electric field with the dipole axis making an angle θ with the direction of the electric field. The orientation of the dipole for stable equilibrium is
(a) $\frac{\pi}{6}$ (b) $\frac{\pi}{3}$ (c) 0 (d) $\frac{\pi}{2}$ *(J & K CET)*

2010

34. An electric dipole of moment $\vec{p}$ is placed in a uniform electric field $\vec{E}$. Then
(i) the torque on the dipole is $\vec{p}\times\vec{E}$.
(ii) the potential energy of the system is $\vec{p}\cdot\vec{E}$.
(iii) the resultant force on the dipole is zero.
(a) (i), (ii) and (iii) are correct
(b) (i) and (iii) are correct and (ii) is wrong
(c) only (i) is correct
(d) (i) and (ii) are correct and (iii) is wrong
(e) (i), (ii) and (iii) are wrong *(Kerala PMT)*

35. In a certain region of space, electric field is along the z-direction throughout. The magnitude of electric field is however not constant, but increases uniformly along the positive z-direction at the rate of 10^5 N C^{-1} m^{-1}. The force experienced by the system having a total dipole moment equal to 10^{-7} C m in the negative z-direction is
(a) -10^{-2} N (b) 10^{-2} N
(c) 10^{-4} N (d) -10^{-4} N *(AIIMS)*

16

TOPIC : GAUSS'S LAW

36. The electric flux passing through a cube of side a, which holds a charge q at one of its corners is

(a) $\frac{q}{\varepsilon_0}$ (b) $\frac{q}{8\varepsilon_0}$ (c) $\frac{q}{4\varepsilon_0}$ (d) $\frac{q}{2\varepsilon_0}$

(J & K CET 2016, COMEDK 2015, AIPMT 2012, J & K CET, WB JEE 2010, BHU 2008)

37. If there is only one type of charge in the universe, then ($\vec{E} \to$ Electric field, $\vec{ds} \to$ Area vector)

(a) $\oint \vec{E}\cdot\vec{ds} \neq 0$ on any surface

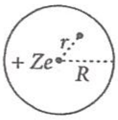
(b) $\oint \vec{E}\cdot\vec{ds}$ could not be defined

(c) $\oint \vec{E}\cdot\vec{ds} = \infty$ if charge is inside

(d) $\oint \vec{E}\cdot\vec{ds} = 0$ if charge is outside, $= \frac{q}{\varepsilon_0}$ if charge is inside

(Karnataka CET)

38. An early model for an atom considered it to have a positively charged point nucleus of charge Ze, surrounded by a uniform density of negative charge upto a radius R. The atom as a whole is neutral. The electric field at a distance r from the nucleus is ($r < R$)



(a) $\frac{Ze}{4\pi\varepsilon_0}\left[\frac{1}{r^2}-\frac{r}{R^3}\right]$ (b) $\frac{Ze}{4\pi\varepsilon_0}\left[\frac{1}{r^3}-\frac{r}{R^2}\right]$

(c) $\frac{Ze}{4\pi\varepsilon_0}\left[\frac{r}{R^3}-\frac{1}{r^2}\right]$ (d) $\frac{Ze}{4\pi\varepsilon_0}\left[\frac{r}{R^3}+\frac{1}{r^2}\right]$

2017 *(AIIMS)* NC ERT

2015

39. A hemisphere is positively charged uniformly. The electric field at a point on a diameter away from the centre is directed

(a) perpendicular to the diameter
(b) parallel to the diameter
(c) at an angle tilted towards the diameter
(d) at an angle tilted away from the diameter

(AIIMS)

40. A charge q is uniformly distributed on a ring of radius a. A sphere of an equal radius is constructed with its centre lying on the periphery of the ring. The flux of electric field through the surface of the sphere will be

(a) $\frac{q}{\varepsilon_0}$ (b) $\frac{q}{2\varepsilon_0}$ (c) $\frac{q}{3\varepsilon_0}$ (d) $\frac{q}{4\varepsilon_0}$

 (AIIMS)

41. The electric flux through a closed surface area S enclosing charge Q is ϕ. If the surface area is doubled, then the flux is

(a) 2ϕ (b) $\phi/2$ (c) $\phi/4$ (d) ϕ

(J & K CET)

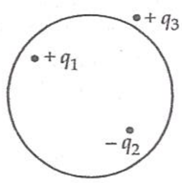
42. **Assertion:** Gaussian surface is considered carefully.
Reason: The point where electric field to be calculated should be with in the surface.

(a) Both assertion and reason are true and reason is the correct explanation of assertion.
(b) Both assertion and reason are true but reason is not the correct explanation of assertion.
(c) Assertion is true but reason is false.
(d) Both assertion and reason are false. *(AIIMS)*

43. **Assertion:** Gauss's law shows diversion when inverse square law is not obeyed.
Reason: Gauss's law is a consequence of conservation of charges.

(a) Both assertion and reason are true and reason is the correct explanation of assertion.
(b) Both assertion and reason are true but reason is not the correct explanation of assertion.
(c) Assertion is true but reason is false.
(d) Both assertion and reason are false. *(AIIMS)*

44. The adjoining figure shows a spherical Gaussian surface and a charge distribution. When calculating the flux of electric field through the Gaussian surface, the electric field will be due to



(a) $+q_3$ alone
(b) $+q_1$ and $+q_3$
(c) $+q_1, +q_3$ and $-q_2$
(d) $+q_1$ and $-q_2$ *(AMU (Med.))*

45. There is a point charge q located at the centre of a cube. What is the electric flux of this point charge, through a face of the cube?

(a) $\frac{q}{\varepsilon_0}$ (b) $\frac{q}{6\varepsilon_0}$ (c) $\frac{q}{3\varepsilon_0}$

(d) It will depend upon the size of the cube.

(J & K CET)

2011

46. A charge Q is enclosed by a Gaussian spherical surface of radius R. If the radius is doubled, then the outward electric flux will

(a) increase four times (b) be reduced to half
(c) remain the same (d) be doubled *(AIPMT)*

47. The total electric flux through a cube when a charge $8q$ is placed at one corner of the cube is

(a) $\varepsilon_0 q$ (b) $\frac{\varepsilon_0}{q}$ (c) $4\pi\varepsilon_0 q$ (d) $\frac{q}{4\pi\varepsilon_0}$

(e) $\frac{q}{\varepsilon_0}$ *(Kerala PMT)*