CHAPTER -1

ELECTRIC CHARGES AND FIELDS

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

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

(i) Proportional to r (ii) Proportional to $\frac{1}{r}$

(iii) Proportional to r^2 (iv) Independent of r

(b) A thin spherical shell of radius 'R' is uniformly charged to a surface charge density σ .Using Gauss's theorem derive the expression for the electric field produced outside the shell. (Score:1+2) **[JUNE-2016]**

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

(i) 10^{13} times (ii) 10^{10} times

(iii) 10^{11}times (iv) 10^{6} times

(b) A point charge of 2 μc is placed at the centre of a cubic Gaussian surface of side 0.5 cm. What is the next flux through the surface? (Given ε_0 =8.85 × $10^{-12}C^2/N/m^2$). (Score:1+2) **[MARCH-2016]**

3. In symmetric charge configurations the electric field can be easily calculated using Gauss's law. According to Gauss's law,

a) The electric flux through any closed spherical surface enclosing a charge q is given by

(i) $q\epsilon_0$ (ii)q/ϵ_0

(iii) $\frac{1q}{4\pi \in_0 r}$ (iv) $4\pi \in_0 qr$

b) Obtain an expression for electric field at a point P due to a thin shell of radius R, when the point is at a distance r from the centre of the shell.

c) A sphere of radius 'a' is made of insulating material and has a charge distributed uniformly throughout its volume. Let the charge density be ρ . Find the field due to the charge for r $\leq$ a.

(Score:1+2+ 2) **[JUNE-2015]**

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

(A) State Gauss's law in electrostatics (1)

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

(i) Outside the shell (ii) Inside the shell (2+1)

(C) Suppose you are in a cave deep within the earth. Are you safe from thunder and lightning? Why? (1)

[MARCH 2015]

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

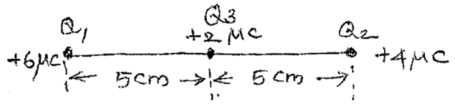
(a) Why is it safe to be inside a bus than sheltered under a tree during lighting?

(Score: 2) **[JUNE 2014]**

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

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

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



i) Find the force on the charge Q_3?

ii) In which direction will this force act?

(Score: 1+2+1) **[JUNE 2014]**

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

a) Q=e b) Q=$\frac{1}{e}$

c) Q=ne d) Q=e

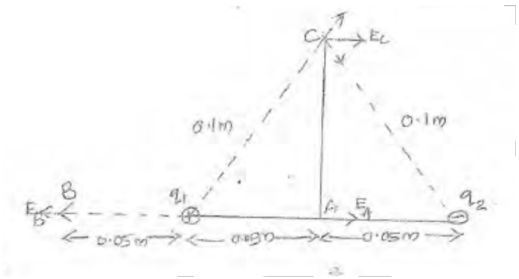
(Score: 1)

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

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

(Score: 2)

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



(Score: 2) **[MARCH 2014]**

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

a) Gauss's law implies that the total electric flux through a closed surface is zero if no charge is enclosed by the surface. (Score: ½)

b) This law is useful for the calculation of electrostatic field when the system doesn't possess any symmetry. (Score: ½)

c) In a uniform electric field, we know that the dipole experiences no net force; but experiences a torque having a relation with P and E is given by PEsinθ, where the parameters P and E have their usual meaning. (Score: 1)

[MARCH 2014]

9. The electric flux due to an electric field $\vec{E}$ through a surface $\overrightarrow{\Delta s}$ is given by $\vec{E}.\overrightarrow{\Delta s}$.

a) The SI unit of electric flux is

1. $\frac{Newton}{Coulomb}$
2. Volt
3. Volt x metre
4. $\frac{Volt}{Metre}$ (Score: 1)

b) Imagine that a charge 'Q' is situated at the centre of a hollow cube. What is the electric flux through one side of the cube? (Score: 1)

[MAY 2013]

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

a) Below are some statements about Gauss's law. Say whether they are true or false: (Score: 1)

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

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

b) Apply Gauss's law to find the electric field due to an infinitely long plane sheet of charge. (Score: 1)

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

(Score: 2) **[MARCH 2013]**

11. A) The electrostatic force between two charges is governed by Coulomb's law. On which factors does the electrostatic force between two charges depend and how?

(Score: 1)

B) If the air medium between the two charges is placed by water what change you expect in the electrostatic force and why? (Score: 1)

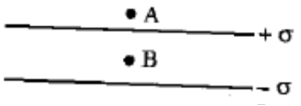
C) An electric dipole is placed in an external electric field. Obtain an expression for the potential energy of the dipole. (Score: 2)

D) Two point charges +16μc and -9μc are placed 8 cm apart in air. You are asked to place a +10μc charge is zero. Where will you place the charge? Make necessary calculations. (Score: 3)

[JUNE 2012]

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

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



(Score: 1) **[MARCH 2012]**

13. The idea of 'Electric field lines' is useful in pictorially mapping the electric field around charges.

a) Give any two properties of electric lines of force. (Score: 1)

b) State Gauss's theorem, in electrostatics. (Score: 1)

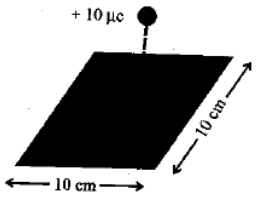
c) Using the theorem, derive an expression for electric field due to a uniformly charged spherical shell

i) at a point outside the shell

ii) at a point inside the shell

(Score:2 ½)

d) A point charge of +10 μc is at a distance of 5 cm directly above the centre of a square of side 10 cm as shown in figure. What is the electric flux through the square? (Score:1 ½)



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

a. Name this arrangement.
b. Define its moment. What is its direction?
c. If the above system is placed in a spherical shell. What would be the net electric flux coming out of it?
d. The above system of two charges is placed in an external electric field E, at an angle θ with it. Obtain relation for the torque acting on it.

(Score: 1+1+1+2) **[SAY 2011]**

15. A body of mass m is charged negatively. State whether the following statements are true or false.

a) During charging, there is change in mass of body.
b) The body can be charged to 2.5e where 'e' is the charge of an electron.
c) While charging the body by induction new charges are created in it.
d) The force between two charged objects is less when there is a medium between them (than in vacuum). (½ x 4) **[MARCH-2011]**

16. Draw the electric lines of force surrounding the charges if

a) a `+ q` charge and a `- q` charge are separated at a distance `a` apart in air.
b) Two `-q` charges are placed at a distance `a` apart in air.

(Score: 1+1) **[JUNE-2010]**

17. One can determine the direction of electric field around a stationary charge with the help of electric field lines.

a) What do you understand by the term 'electric flux'? Give its SI unit.
b) State Gauss's theorem in electrostatics and express it in mathematical form.
c) Consider a spherical shell of radius 'R' is uniformly charged with charge '+q'. By using Gauss's theorem, find electric field intensity at a point 'P'.
(i) Outside this spherical shell
(ii) Inside the spherical shell.

(Score: 1 ½ +1 ½+3) **[JUNE 2010]**