CHAPTERWISE QUESTION

PHYSICS (042)

ELECTRIC CHARGES AND FIELDS

CLASS: XII **TIME: 3 hrs**

Mark : 70

SECTION-A **16 × 1 = 16**

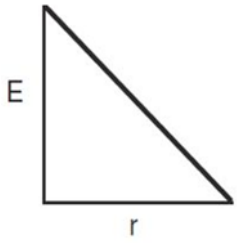
1. Two-point charges placed in a medium of dielectric constant 5 are at a distance r between them, experience an electrostatic force 'F'. The electrostatic force between them in vacuum at the same distance r will be

   (a) 5F (b) F (c) F/2 (d) F/5

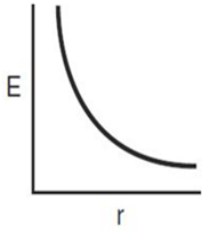
2. A charge of magnitude 3e and mass 2m is moving in an electric field $\underset{E}{\rightarrow}$. The acceleration imparted to the charge is

   (a) 2Ee/3m (b) 3Ee/2m (c) 2m/3Ee (d)3m/2Ee

3. For a point charge the graph between electric field E versus distance r is given by



(a)



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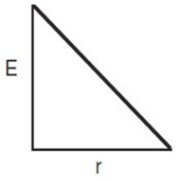

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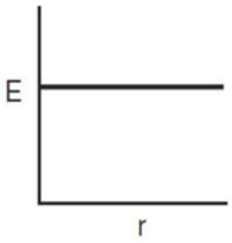


(d

4. Four charges + 8C, - 3C, +5C and -10C are kept inside a closed surface. What will be the outgoing flux through the surface?

   (a)26Vm (b)0Vm (c)10Vm (d)8Vm

5. Three charges +Q, q, +Q are placed respectively, at distance, 0, d//2 and d from the origin, on the x-axis. If the net force experienced by +Q placed at x=0, is zero, then value of q is

   (a) +Q/2 b) - Q/2 c) -Q/4 d) +Q/4

6. A charge Q is placed at each of the two opposite corners of a square. A charge q is placed at each of the other two corners. If the net electric force on Q is zero, then Q/q equals

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

7. The torque acting on a electric dipole of dipole moment $\vec{P}\ placed$ in uniform electric field $\vec{E}$is

   (a)$\vec{P} \times \vec{E}$ (b)$\vec{P}.\vec{E}$ (c)$\vec{P} \times (\vec{E} \times \vec{P})$ (d)$\vec{E} \cdot \frac{\vec{P}}{P\hat{}2}$

8. An electric charge q is placed at one of the corners of a cube of side a. The electric flux on one of its faces will be

   a) $\frac{q}{6\varepsilon_0}$ b) $\frac{q}{24\varepsilon_0}$ c) $\frac{q}{48\varepsilon_0}$ d) $\frac{q}{8\varepsilon_0}$

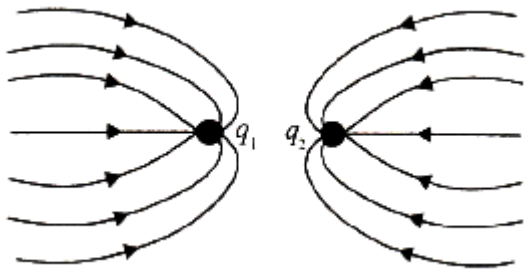
9. Charge Q is enclosed by a Gaussian spherical surface of radius R. If the radius is doubled, then the outward electric flux will

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

10. An electric dipole is placed at an angle of 30° with an electric field intensity of 2×10^5 N/C. It experiences a torque equal of 4 Nm. The charge on the dipole, if the dipole length is 2 cm, is

    (a) 8 mC (b) 2 mC (c) 5 mC (d) 7μC

11. figure gives electric lines of force due to two charges q_1 and q_2. What are the signs of the two charges?



    (a) q_1 is positive but q_2 is negative (b) q_1 is negative but q_2 is positive
    (c) both are negative (d) both are positive

12. A point charge + q is placed at the centre of a cube of side l. The electric flux emerging from the cube is

    (a) $6ql^2/\varepsilon_0$ (b) $q/6l^2\varepsilon_0$ (c) zero (d) q/ε_0

For Questions 13 to 16, two statements are given –one labelled Assertion (A) and other labelled Reason (R). Select the correct answer to these questions from the options as given below.

a) If both Assertion and Reason are true and Reason is correct explanation of Assertion.

b) If both Assertion and Reason are true but Reason is not the correct explanation of Assertion.

c) If Assertion is true but Reason is false.

d) If both Assertion and Reason are false.

13. **Assertion(A) :** A negatively charged object may have a positive, zero or negative potential

Reason (R) : A negative charge on an object is due to deficiency of free protons.

14. **Assertion(A)** : In a nonuniform electric field, a dipole will have translatory as well as rotatory motion.

Reason(R) : In a nonuniform electric field, a dipole experiences a force as well as torque.

15. Assertion(A) : Acceleration of charged particle in non-uniform electric field does not depend on velocity of charged particle.

Reason(R) : Charge is an invariant quantity That is amount of charge on particle does not depend on frame of reference.

16. Assertion(A) : A metallic shield in the form of a hollow shell, can be built to block an electric field.

Reason(R) : In a hollow spherical shell, electric field inside is not zero at every point.

SECTION-B **4 × 2 = 8**

17. Two-point charges placed at a distance ′r′ in air exert a force ′F′ on each other. At what distance will these charges experience the same force F in a medium of dielectric constant K?

OR

A point charge is placed at the centre of spherical Gaussian surface. How will electric flux ϕ_E changed if

(a) The sphere is replaced by a cube of same or different volume?

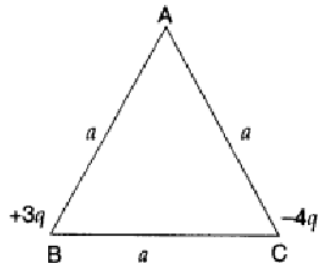
(b) The charge is moved off-center in the original sphere, still remaining inside?

(c) The charge is moved just outside the original sphere?

(d) A second charge is placed inside the Gaussian surface?

18. Three charges +q, +q and -2q are placed at the vertices of an equilateraltriangle. What is the dipole moment of the system?

19. Two-point charges + 3q and – 4q are placed at the vertices 'B' and 'C' of an equilateral triangle.ABC of side 'a' as given in the figure Find



(i) The magnitude and

(ii) The direction of the resultant electric field at the vertex A due to these two charges.

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

b) Explain why two field lines never cross each other at any point.

SECTION-C **6 × 3 = 18**

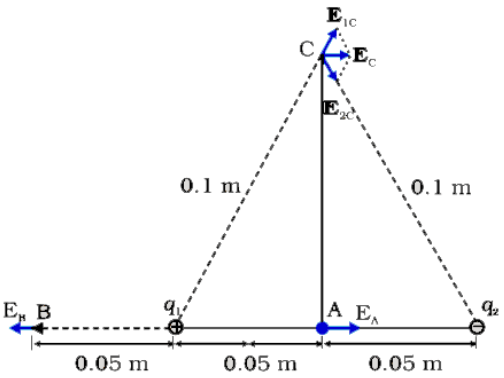
21. A system has two charges $q_A = 2.5 \times 10^{-7}$C and $q_B = -2.5 \times 10^{-7}$C located at point A(0,0,−15)cm and B(0,0,15)cm respectively. What is the total charge and electric dipole moment of the system?

22. Charges of +5μC,+10μC and −10μC are placed in air at the corners A,B and C of an equilateral triangle ABC, having each side equal to 5 cm. Determine the resultant force on the charge at A.

OR

Plot a graph showing the variation of coulomb force (F) versus ($1/r^2$), where r is the distance between two charges of each pair of charges (1μC, 2μC) and (2μC , -3μC). Interpret the graphs obtained.

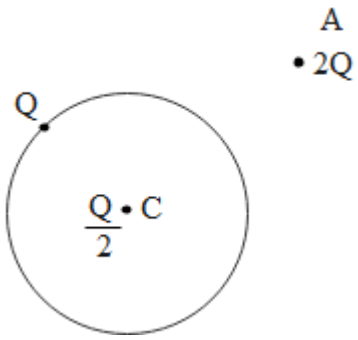
23. Two-point charges $q_1$andq_2, of magnitude $+10^{-8}$ C and -10^{-8} C, respectively, are placed 0.1 m apart. Calculate the electric fields at points A, B and C shown in Fig.



24. A thin metallic spherical shell of radius R carries a charge Q on its surface. A point charge Q/2 is placed at the centre C and another charge +2Q is placed outside the shell at A at a distance x from the centre as shown in the figure.

Find (i) force on the charge at the centre of the shell and at point A.

(ii) the electric flux through the shell.

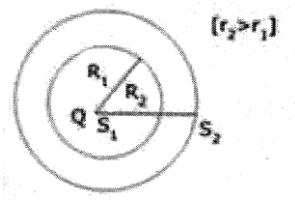


25 (i) Derive an expression for the electric field at a point on the equatorial plane of an electric dipole.

(ii) Depict the orientation of the dipole in (a) stable, (b) unstable equilibrium in a uniform electric field.

26. Electric charge is uniformly distributed on the surface of a spherical balloon. Show how electric intensity and electric potential vary

a) on the surface b) inside and c) outside



SECTION-D $4 \times 5 = 20$

Case Study Based Questions

27. Read the following paragraph and answer the questions that follow.

For electrostatics, the concept of electric field is convenient, but not really necessary. Electric field is an elegant way of characterizing the electrical environment of a system of charges. Electric field at a point in the space around a system of charges tells you the force a unit positive test charge would experience if placed at that point (without disturbing the system). Electric field is a characteristic of the system of charges and is independent of the test charge that you place at a point to determine the field. The term field in physics generally refers to a quantity that is defined at every point in space and may vary from point to point. Electric field is a vector field, since force is a vector quantity

(1) Which of the following statement is correct? The electric field at a point is

(a) always continuous.

(b) continuous if there is a charge at that point.

(c) discontinuous only if there is a negative charge at that point.

(d) discontinuous if there is a charge at that point.

(2) The force per unit charge is known as

(a) electric flux (b) electric field

(c) electric potential (d) electric current

(3) The SI unit of electric field is

(a) N/m (b) N-m (c) N/C (d) N/C^2

OR

The magnitude of electric field intensity E is such that, an electron placed in it would experience an electrical force equal to its weight is given by

(a) mge (b) mg/e (c) e/mg (d) e^2g/m^2

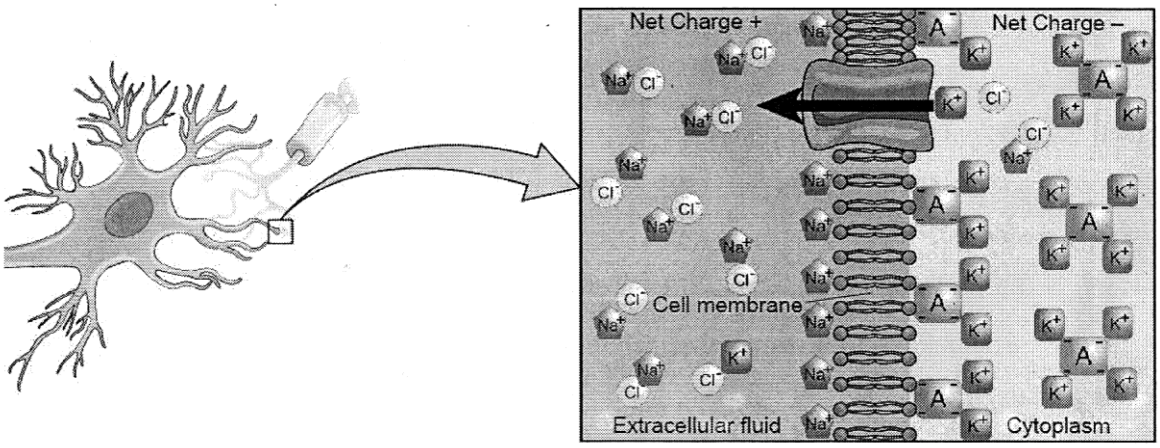
(4) At a particular point, Electric field depends upon

(a) Source charge Q only (b) Test Charge q_0 only.

(c)Both q and q_0 (d)Neither Q nor q_0

28. **Read the following paragraph and answer any four questions that follow.**

Neurons maintain different concentrations of certain ions across their cell membranes. Imagine the case of a boat with a small leak below the water line. In order to keep the boat afloat, the small amount of water entering through the leak has to be pumped out, which maintains a lower water level relative to the open sea. Neurons do the same thing, but they pump out positively charged sodium ions. In addition, they pump in positively charged potassium ions. Thus there is a high concentration of sodium ions present outside the neuron, and a high concentration of potassium ions inside. Thus sodium channels allow sodium ions through the membrane while potassium channels allow potassium ions through.



(i) When neuron pump out and in the positive sodium and positive potassium ions respectively which property of charge is to be followed

(a) Quantisation of charge (b) Additivity of charges

(c) Conservation of charges (d) Associativity of charge

(ii) Coulomb's law is true for

(a) atomic distances (= 10^{-11} m) (b) nuclear distances (= 10^{-15} m)

(c) charged as well as uncharged particles (d) all the distances

(iii) Electric lines of force about a positive sodium or potassium ions are

(a) circular anticlockwise (b) circular clockwise

(c) radial, inwards (d) radial, outwards

(iv) Electric flux produced by positive Potassium ions indicates that electric lines are directed

(a) outwards (b) inwards (c) either (a) or (b) (d) None of these

(v) Electric flux over a surface of neuron in an electric field may be

(a) positive (b) negative (c) zero (d) All of the above

SECTION E **4 × 5 = 20**

29. (a) Using Gauss's 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.

(b) Plot a graph showing variation of electric field as function of r > R and r < R (r being the distance from the center of the shell).

(c) A square plane sheet of side 10cm is inclined at an angle of 30° with the direction of a uniform electric field of 200 NC^{-1}. Calculate the electric flux passing through the sheet.

OR

(a) Use Gauss' law to derive the expression for the electric field (E) due to a straight uniformly charged infinite line of charge density λ (C/m).

(b) Draw a graph to show the variation of E with perpendicular distance r from the line of charge.

30. (i) Obtain the expression for the torque vector τ experienced by an electric dipole of dipole moment vector p uniform electric field, vector E.

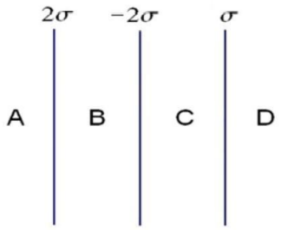
(ii) What will happen if the field were not uniform?

(iii) What would happen if the external field E is increasing (a) parallel to p

and (b) anti-parallel to p?

31. (a) Use Gauss's theorem to find the electric field due to a uniformly charged infinitely large plane thin sheet with surface charge density σ

(b) There are three infinite long thin sheets having surface charge density $+2\sigma$,-2σ and $+\sigma$ respectively. Find the magnitude and direction of electric field at a point to the left of sheet of charge density $+2\sigma$ and to the right of sheet of charge density $+\sigma$.



32. Define electric flux and write its SI unit. The electric field compounds in the figure shown are $E_x = \alpha x$, $E_y = 0$, $E_z = 0$ where α = 100 N/cm. Calculate the charge within the cube, assuming a = 0.1 m.