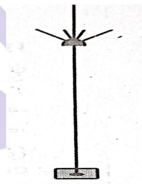
NEW STANDARD ACADEMY

Marks: 70

Date : 10-11-25 CLASS : 12^{TH} **PHYSICS** Time: 3 hours.

SECTION A

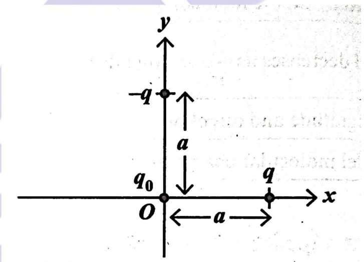
The following questions are multiple-choice questions with one correct answer. Each question carries 1 mark. There is no internal choice in this section.

1. If the net electric flux through a closed surface is zero, then we can infer
   (a) no net charge is enclosed by the surface.
   (b) uniform electric field exists within the surface.
   (c) electric potential varies from point to point inside the surface.
   (d) charge is present inside the surface.
2. An infinite line of charge has a linear charge density of 10^{-7} C/m. What will be the magnitude of the force acting on an alpha particle placed at a distance of 4 cm from the line of charge?
   (a) 14.4×10^{-15} N (b) 7.2×10^{-15} N
   (c) 4.5×10^{4} N (d) 9×10^{4} N
3. For a Gaussian surface through which the net flux is zero, the following statements COULD be true.
   P. No charges are inside the Gaussian surface.
   Q. The net charge inside the surface is zero.
   R. The electric field is zero everywhere on the surface.
   S. The number of field lines entering is equal to the number of lines exiting the surface.
   Which of the statements is/are DEFINITELY true?
   (a) Only statement Q
   (b) Both statements P and S
   (c) Both statements Q and R
   (d) Both statements Q and S
4. A lightning conductor is made of a conducting material with one of its ends earthed while the other end has several sharp metal spikes. It protects the building from lightning by either neutralizing or conducting the charge of the cloud in the sky to the ground.
   
   Identify ONE statement from below given that DOES NOT contribute to the correct explanation of the working principle of a lightning conductor.
   (a) Charge density on the surface of metal spikes is inversély proportional to the radius of curvature.
   (b) Charges are distributed uniformly on the surface of conductors irrespective of their shapes.
   (c) The surface of a charged conductor behaves as an equipotential surface.
   (d) Charges reside only on the outside of a charged conductor.
5. In an experiment three microscopic latex spheres are sprayed into a chamber and became charged with charges +3e, 5e and -3e respectively. All the three spheres came in contact simultaneously for a moment and got separated. Which one of the following are possible values for the final charge on the spheres?
   (a) 5e, - 4e, 5e (b) 6e, 6e, - 7e

(c) - 4e, 3.5e, 5.5e (d) 5e, - 8e, 7e

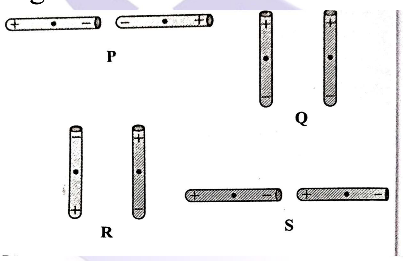
6. An object has charge of 1 C and gains 5.0 $\times 10^{18}$ electrons. The net charge on the object becomes-
(a) -0.80 C (b) +0.80 C
(c) +1.80 C (d) +0.20 C

7. Three charges q, -q, q, are placed as shown in figure. The magnitude of the net force on the charge q_0 at point O is $\left[k = \frac{1}{4\pi\varepsilon_0}\right]$



(a) 0 (b) $\frac{2kqq_0}{a^2}$
(c) $\frac{\sqrt{2}kqq_0}{a^2}$ (d) $\frac{1}{\sqrt{2}}\frac{kqq_0}{a^2}$

8. Two insulated rods have opposite static charges at their ends. The rods are mounted at their centers, so they are free to rotate in plane of paper. The charged rods are mounted at their centres so that they are free to rotate in the plane of the screen. The two rods can be held in the following 4 orientations as shown below.



Identify which of these orientations are stable such that they return to their original orientation if slightly displaced.
(a) Orientations P and Q are stable. Orientations R and S are unstable.
(b) Orientations and R are stable. Orientations P and S are unstable.
(c) Orientations Q and S are stable. Orientations P and R are unstable.
(d) Orientations P and R are stable. Orientations Q and S are unstable.

9. A square sheet of side 'a' is lying parallel to XY plane at z = a The electric field in the region is E=c $Z^2\hat{k}$. The electric flux through the sheet is
(a) a^4 c (b) 1/3 a^3 c
(a) 1/3 a^4 (d) 0

10. An electric dipole placed in an electric field of intensity 2×10^5 N / C at an angle of 30° experiences a torque equal to 4 Nm. The charge on the dipole of dipole length 2 cm is
(a) 7 μC (b) 8 mC
(c) 2 mC (d) 5 (c) mC

11. An electric dipole placed in an electric field of intensity 2×10^5 N / C at an angle of 30° experiences a torque equal to 4 Nm. The charge on the dipole of dipole length 2 cm is
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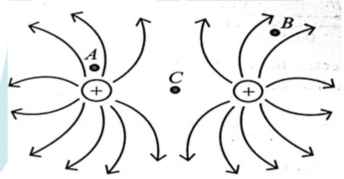
(c) 2 mC (d) 5 mC

12. Electric field lines are pictorial representations of electric fields due to static charges on the plane of a paper.



Study the given electric field representation and identify one INCORRECT qualitative impression given by this representation.
(a) The electric field at point A is stronger than at point B.
(b) The electric field distribution is two-dimensional.
(c) The electric field at point C is zero.
(d) The electric field always points away from a positive charge.

Questions number 13 to 16 are Assertion (A) and Reason (R) type questions. Two statements are given - one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer from the codes (a), (b), (c) and (d) as given below.

(a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).
(c) Assertion (A) is true, but Reason (R) is false.

(b) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of Assertion (A).
(d) Both Assertion (A) and Reason (R) are false.

13. Assertion (A): A negative charge in an electric field starts to move along the direction of the electric field.
Reason (R): On a negative charge a force acts in the opposite direction of the electric field.
14. Assertion (A): A negative charge in an electric field starts to move along the direction of the electric field.
Reason (R): On a negative charge a force acts in the opposite direction of the electric field.
15. Assertion (A): An electric dipole is in stable equilibrium when placed in a uniform electric field with its dipole moment opposite to the field. Reason (R): No torque acts on an electric dipole when its dipole moment is in a direction opposite to the field
16. Assertion (A): Two protons repel each other.
Reason (R): Like charges repel each other while unlike charges attract each other.

SECTION-B

This section contains 5 questions with internal choice in one question. The following questions are very short answer type and carry 2 marks each.

17. The work done in moving a charge particle between two points in an uniform electric field, does not depend on the path followed by the particle. Why?
18. Draw the pattern of electric field lines, when a point charge-Q is kept near an uncharged conducting plate.
19. A point charge causes an electric flux $-3\times 10^{-16}\ N-m^2/C$ to pass through a spherical Gaussian surface.
(a) Calculate the value of the point charge.
(b) If the radius of the Gaussian surface is doubled, how much flux would pass through the surface?
20. A metallic spherical shell has an inner radius R_1 and outer radius R_2 A charge Q is placed at the centre of the spherical cavity. What will be surface charge density on
(i) the inner surface, and
(ii) the outer surface?
21. If 10º electrons move out of a body to another body every second, how much time is required to get a total charge of 1 C on the other body?

SECTION-C

This section contains 7 questions with internal choice in one question. The following questions are short answer type and carry 3 marks each

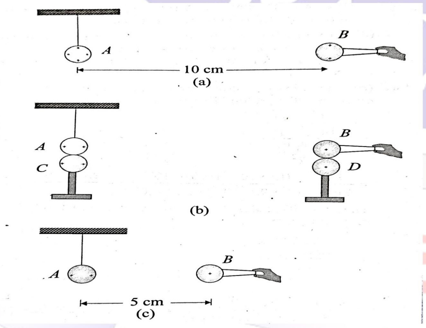
22. Two charges of value 2 μC and -50 μC are placed 80 cm apart. Calculate the distance of point from the smaller charge where the intensity is zero.
23. (a).Calculate the maximum torque experienced by a water molecule whose electric dipole moment is 6.2 × 10-30C-m, when it is placed in an electric field of intensity 106 N/C.
(b) If the net electric flux through a closed surface is zero, what can be said about change inside. What is Gaussian surface?
24. A hollow conducting sphere of inner radius r_1 and outer radius r_2 has a charge Q on its surface. A point charge -q is also placed at the centre of the sphere.
(a) What is the surface charge density on the (i) inner and (ii) outer surface of the sphere?
(b) Use Gauss' law of electrostatics to obtain the expression for the electric field at a point lying outside the sphere.
25. (a)An infinitely long thin straight wire has a uniform linear charge density λ. Obtain the expression for the electric field (E) at a point lying at a distance x from the wire, using Gauss' law.
(b) Show graphically the variation of this electric field E as a function of distance x from the wire.
26. 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 and masses respectively.

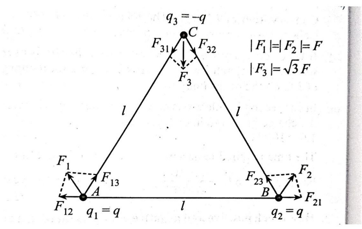
(a) Compare the strength of these forces by determining the ratio of their magnitudes (i) for an electron and a proton and (ii) for two protons.

(b) Estimate the accelerations of electron and proton due to the electrical force of their mutual attraction when they are 1Å (= 10^{-10} m) apart? ($m_p = 1.67 \times 10^{-27}$ kg, m = 9.11×10^{-31} kg)

27. 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. (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. (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. (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



28. Consider the charges q, q, and -q placed at the vertices of an equilateral triangle, as shown in figure. What is the force on each charge?



SECTION D

29. Two identical point charges, q each, are kept 2 m apart in air. A third point charge Q of unknown magnitude and sign is placed on the line joining the charges such that the system remains in equilibrium. Find the position and nature of Q.

30. (a) Use Gauss' law to obtain an expression for the electric field due to an infinitely log thin straight wire with uniform linear charge density λ.

(b) An infinitely long positively charged straight wire has a linear charge density λ. An electron is revolving in a circle with a constant speed v such that the wire passes through the centre, and is perpendicular to the plane, of the circle. Find the kinetic energy of the electron in terms of magnitudes of its charge and linear charge density λ on the wire.

(a) Draw a graph of kinetic energy as a function of linear charge density λ.

31. a) Using Gauss law, derive expression for electric field due to a spherical shell of uniform charge distribution σ and radius R at a point lying at a distance x from the centre of shell, such that

(i) $0 < x < R$ and

(ii) $x > R$

32. (a) Derive an expression for the electric field at any point on the equatorial line of an electric dipole. (b) Two point charges qA = 3μC and qB = - 3μC are located 20 cm apart in vaccum. What is the electric field at the midpoint O of the line AB joining two charges?

33. An electric field is uniform and acts along +x direction in the region of positive x. It is also uniform with the same magnitude but acts in -x direction in the region of negative x. The value of the field is E = 200N / C for x > 0 and E = - 200 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 flat face is at $x = +10$ cm and the other is at $x = -10$ cm.

Find:

(i) The net outward flux through the cylinder.

(ii) The net charge present inside the cylinder.