SAITECHINFO CENTUM CYCLIC UNIT TEST | ELECTRIC FIELD AND CHARGES | CLASS 12 PHYSICS

### Class 12 - Physics

Time Allowed: 1 hour and 30 minutes   **Maximum Marks: 45**

1. The magnitude of electric field due to a point charge 2q, at distance r is E. Then the magnitude of electric field due to a uniformly charged thin spherical shell of radius R with total charge q at a distance $\frac{r}{2}$ (r >> R) will be **[1]**

   a) 0   b) 2E

   c) $\frac{E}{4}$ d) 4

2. Eight dipoles of charges of magnitude **e** are placed inside a cube. The total electric flux coming out of the cube will be- **[1]**

   a) $\frac{16e}{\epsilon_o}$ b) $\frac{e}{\epsilon_o}$

   c) Zero   d) $\frac{8e}{\epsilon_o}$

3. A point charge situated at a distance 'r' from a short electric dipole on its axis, experiences a force $\vec{F}$. If the distance of the charge is '2r', the force on the charge will be: **[1]**

   a) $\frac{\vec{F}}{16}$ b) $\frac{\vec{F}}{4}$

   c) $\frac{\vec{F}}{8}$ d) $\frac{\vec{F}}{2}$

4. An electric dipole of dipole moment 2×10^{-8} C-m in a uniform electric field experiences a maximum torque of 6×10^{-4} N-m. The magnitude of electric field is **[1]**

   a) 3.0×10^4 Vm^{-1} b) 2.2×10^3 Vm^{-1}

   c) 1.2×10^4 Vm^{-1} d) 4.2×10^3 Vm^{-1}

5. Which among the curves shown in figure possibly represent electrostatic field lines? **[1]**
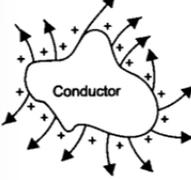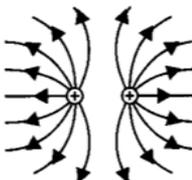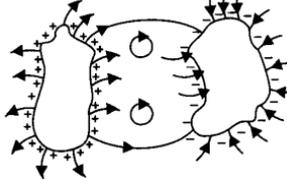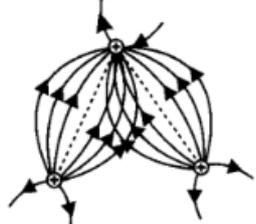
6. Two thin concentric and coplanar spherical shells, of radii a and b (b > a) carry charges, q and Q, respectively. Find the magnitude of the electric field, at a point at distance x, from their common centre for: **[3]**

i. $0 < x < a$

ii. $a \leq x < b$

iii. $b \leq x < \infty$

7. Calculate the field due to an electric dipole of length 10 cm and consisting of charges of $\pm 100 \ \mu$C at a point 20 cm from each charge. **[3]**

8. An electric dipole of dipole moment $\vec{p}$ is placed in a uniform electric field $\vec{E}$. Write the expression for the torque $\vec{\tau}$ experienced by the dipole. Identify the two pairs of perpendicular vectors in the expression. Show diagrammatically the orientation of the dipole in the field for which the torque is **[3]**

   i. maximum,

   ii. half the maximum value and

   iii. zero

9. A charged particle, of charge 2 μC and mass 10 milligram, moving with a velocity of 1000 m/s enters a uniform electric field of strength 10^3 NC^{-1} directed perpendicular to its direction of motion. Find the velocity and displacement, of the particle after 10 s. **[3]**

10. An electric dipole of dipole moment **p** is placed in a uniform electric field **E**. Obtain the expression for the torque τ experienced by the dipole. Identify two pairs of perpendicular vectors in the expression. **[3]**

11. State Gauss' law in electrostatics. Using this law, derive an expression for the electric field due to a uniformly charged infinite plane sheet. **[5]**

12. A uniform electric field $\vec{E} = $ E$_x$ $\hat{i}$ N/C for x > 0 and $\vec{E} = $ -E$_x$ $\hat{i}$ N/C for x < 0 are given. A right circular cylinder of length/cm and radius r cm has its centre at the origin and its axis along the x-axis. Find out the net outward flux. Using Gauss's law write the expression for the net charge within the cylinder. **[5]**

13. a. Gauss's law in electrostatics is tijue for any closed surface, no matter what its shape or size is. Justify this statement with the help of a suitable example. **[5]**

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

   c. Given the electric field in the region $\vec{E} = 2x\hat{i}$, find the net electric flux through tne cube and the charge enclosed by it.
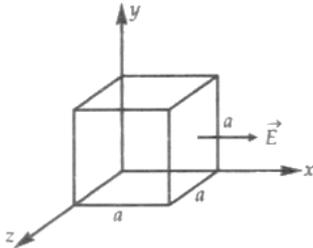
14. i. State Coulomb's law in electrostatics and write it in vector form, for two charges. **[5]**

   ii. 'Gauss's law is based on the inverse-square dependence on distance contained in the Coulomb's law.' Explain.

   iii. Two charges A (charge q) and B (charge 2q) are located at points (0, 0) and (a, a) respectively. Let $\hat{i}$ and $\hat{j}$ be the unit vectors along x-axis and y-axis respectively. Find the force exerted by A on B, in terms of $\hat{i}$ and $\hat{j}$.

15. **Read the text carefully and answer the questions:** **[5]**

In 1909, Robert Millikan was the first to find the charge of an electron in his now-famous oil-drop experiment. In that experiment, tiny oil drops were sprayed into a uniform electric field between a horizontal pair of oppositely charged plates. The drops were observed with a magnifying eyepiece, and the electric field was adjusted so that the upward force on some negatively charged oil drops was just sufficient to balance the

downward force of gravity. That is, when suspended, upward force qE just equaled Mg. Millikan accurately measured the charges on many oil drops and found the values to be whole number multiples of 1.6×10^{-19} C the charge of the electron. For this, he won the Nobel prize.
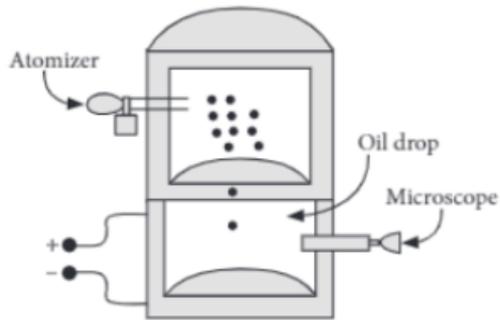
(a)   If a drop of mass 1.08×10^{-14} kg remains stationary in an electric field of 1.68×10^5 NC^{-1}, then the charge of this drop is

     a) 6.40×10^{-19} C   b) 4.8×10^{-19} C

     c) 3.2×10^{-19} C   d) 1.6×10^{-19} C

(b)   Extra electrons on this particular oil drop (given the presently known charge of the electron) are

     a) 4   b) 5

     c) 8   d) 3

(c)   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 ms^{-2})

     a) 10^9 b) 10^{18}

     c) 10^{12} d) 10^{15}

(d)   The important conclusion given by Millikan's experiment about the charge is

     a) charge has no definite value   b) charge is quantized

     c) charge is never quantized   d) charge on oil drop always increases

(e)   If in Millikan's oil drop experiment, charges on drops are found to be $8\mu C, 12\mu C, 20\mu C$, then quanta of charge is

     a) $20\mu C$ b) $12\mu C$

     c) $8\mu C$ d) $4\mu C$