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PHYSICS KINEMATICS

UNIT-1

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IIT-JEE, NEET AND CBSE EXAMS

PRACTICE PAPER

IIT-JEE

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01

UNIT:I
ELECTROSTATICS

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UNIT-I ELECTROSTATICS
CHAPTER 1 -ELECTRIC CHARGES AND FIELDS

Gist:

1 **Charge :**
Charge is an intrinsic property of elementary particles of matter which gives rise to electric force between various objects.

2 Two types of charges: Positive and negative.

3 Transference of electrons is the cause of frictional electricity.

4 Basic properties of electric charge :

i) Additivity of charges: Total charge is the algebraic sum of individual charges.
ii) Conservation of charges: The total charge of an isolated system is always conserved.
iii) Quantization of charges : Charge of an object is always in the form of integral multiple of electronic charge and never its fraction

5 **Coulomb's Law**
It states that the electrostatic force of interaction or repulsion acting between two stationary point charges is given by

$$F = \frac{1}{4\pi\varepsilon_0} \cdot \frac{q_1 q_2}{r^2}$$

where, q_1 and q_2 are the stationary point charges and r is the separation between them in air or vacuum.

Also, $$\frac{1}{4\pi\varepsilon_0} = 9 \times 10^9 \text{ N-m}^2/\text{C}^2$$

where, ε_0 = permittivity of free space = 8.85419×10^{-12} $\text{C}^2/\text{N-m}^2$

The force between two charges q_1 and q_2 located at a distance r in a medium other than free space may be expressed as

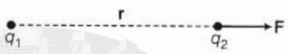
$$F = \frac{1}{4\pi\varepsilon} \cdot \frac{q_1 q_2}{r^2}$$

where, ε is **absolute permittivity** of the medium.

Now, $$\frac{F_{\text{vacuum}}}{F} = \frac{\frac{1}{4\pi\varepsilon_0} \cdot \frac{q_1 q_2}{r^2}}{\frac{1}{4\pi\varepsilon} \cdot \frac{q_1 q_2}{r^2}} = \frac{\varepsilon}{\varepsilon_0} = \varepsilon_r$$

where, ε_r is called **relative permittivity** of the medium also called **dielectric constant** of the medium.

In vector form,



$$\mathbf{F} = \frac{1}{4\pi\varepsilon_0} \cdot \frac{q_1 q_2}{|\mathbf{r}|^2} \hat{\mathbf{r}} \quad \text{or} \quad |\mathbf{F}| = \frac{1}{4\pi\varepsilon_0} \cdot \frac{q_1 q_2}{r^2}$$

6 **Dielectric constant**
The ratio of force between two charges in vacuum to the force acting between when they are shifted in a medium is called relative permittivity or dielectric constant of the medium. where is also called the relative permittivity and is the permittivity of medium.

7 Electrostatic force due to continuous charge distribution:

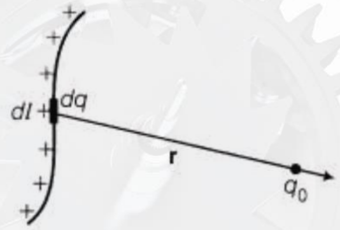
(*i*) **Linear Charge Distribution**

$$dq = \lambda\, dl$$

where, λ = linear charge density

$$d\mathbf{F} = \frac{1}{4\pi\varepsilon_0} \cdot \frac{q_0\,(dq)}{|\mathbf{r}|^2}\,\hat{\mathbf{r}} \Rightarrow d\mathbf{F} = \frac{1}{4\pi\varepsilon_0} \cdot \frac{q_0\,(\lambda\, dl)}{|\mathbf{r}|^2}\,\hat{\mathbf{r}}$$

Net force on charge q_0, $\mathbf{F} = \frac{q_0}{4\pi\varepsilon_0} \int_l \frac{\lambda\, dl}{|\mathbf{r}|^2}\,\hat{\mathbf{r}}$

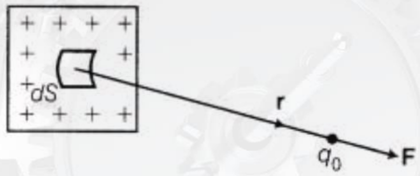


(*ii*) **Surface Charge Distribution**

$$dq = \sigma\, dS$$

where, σ = surface charge density

Net force on charge q_0, $\mathbf{F} = \frac{q_0}{4\pi\varepsilon_0} \int_S \frac{\sigma\, dS}{|\mathbf{r}|^2}\,\hat{\mathbf{r}}$

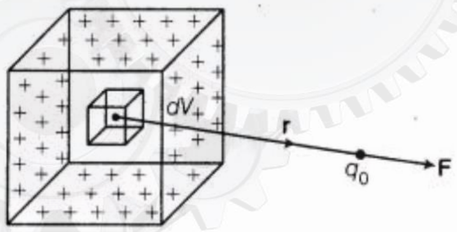


(*iii*) **Volume Charge Distribution**

$$dq = \rho\, dV$$

where, ρ = volume charge density

Net force on charge q_0, $\mathbf{F} = \frac{q_0}{4\pi\varepsilon_0} \int_V \frac{\rho\, dV}{|\mathbf{r}|^2}\,\hat{\mathbf{r}}$



i) linear charge distribution(λ): = Charge/Length =C/m
ii) Surface charge distribution(σ): σ= Charge/Area = C/m^2
iii) Volume charge distribution(ρ) : ρ = Charge/ Volume = C/m^3

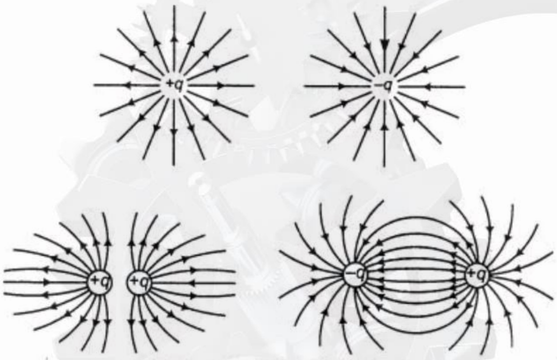
Electric Field Lines Electric field lines are a way of pictorially mapping the electric field around a configuration of charge(s). These lines start on positive charge and end on negative charge. The tangent onthese lines at any point gives the direction of field at that point.

Properties:
1. Field lines from a positive charge to negative charge
2. Direction of filed lines shown by the tangent to the field lines.
3. Electric field lines emerge normal from positive charge and terminate at negative charge.
4. They never intersect each other.

This can be explained by method of contradiction at two field lines E1 & E2 interest at P as shown in the figure. Then there may be two tangents at E1 and E2. Which is not possible. Since one and only one tangent can be drawn. Therefore, our assumption is wrong.

5. Electric field contract in length which shows that opposite charges attract.
6. Electric field lines exert lateral pressure which shows that like charges repel.

N is a point which shows field intensity is zero called neutral point.



Different electric field lines

7. Closer field lines indicate the stronger region and rarer field lines shows weaker region.
8. Single positive charge radiates field lines radially outward (q > 0).
9. Single negative charge radiates field lines radially inward (q < 0).

8 **Electric Field Intensity** The electric field intensity at any point due to source charge is defined as the force experienced per unit positive test charge placed at that point without disturbing the source charge. It is expressed as

$$\mathbf{E} = \lim_{q_0 \to 0} \frac{\mathbf{F}}{q_0}$$

Here, $q_0 \to 0$, i.e. the test charge q_0 must be small, so that it does not produce its own electric field.

SI unit of electric field intensity (**E**) is N/C and it is a vector quantity.

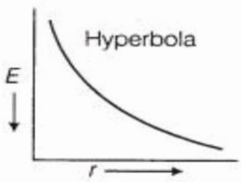
Electric field intensity at P is, then

$$\mathbf{E} = \frac{1}{4\pi\varepsilon_0} \cdot \frac{q}{|\mathbf{r}|^2}\hat{\mathbf{r}}$$

The magnitude of the electric field at a point P is given by

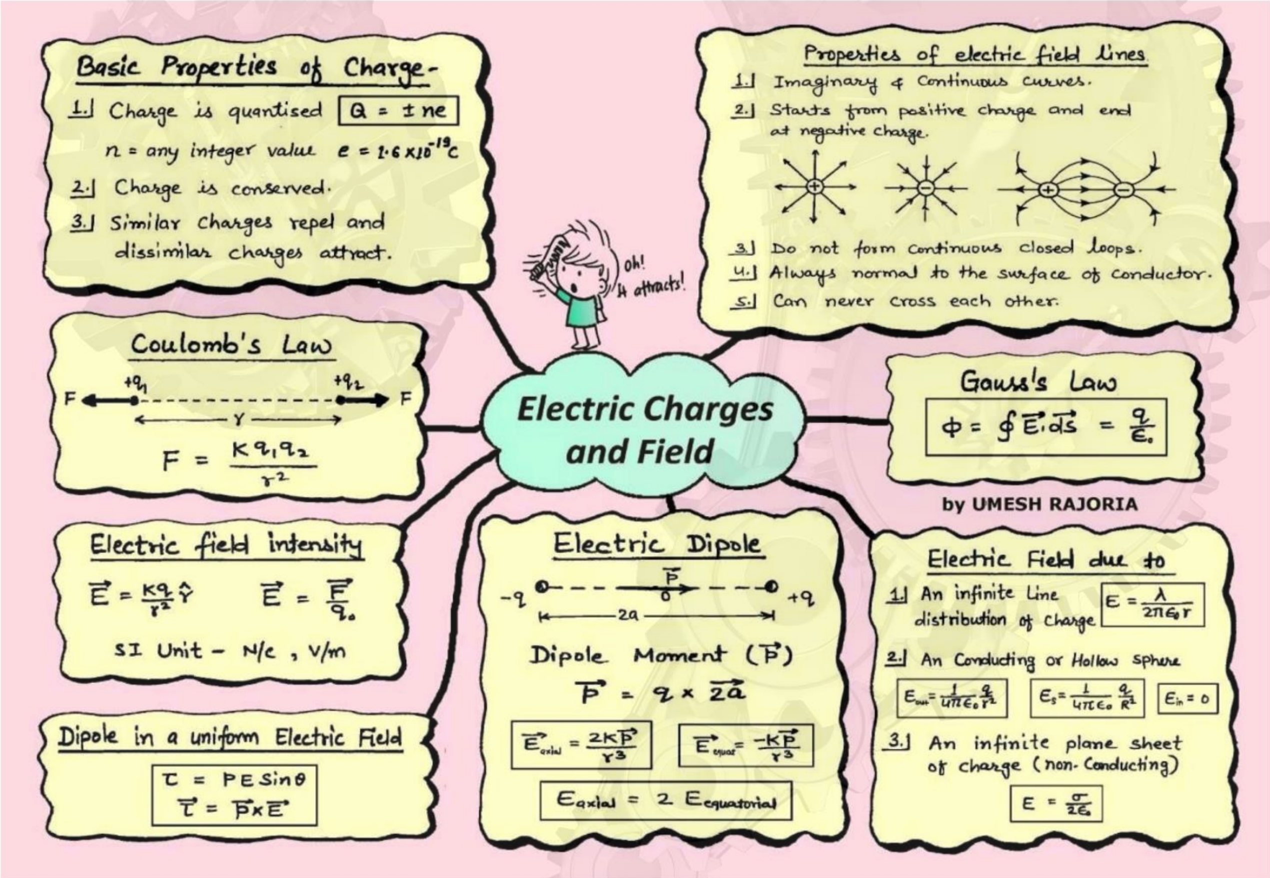
$$|\mathbf{E}| = \frac{1}{4\pi\varepsilon_0} \cdot \frac{q}{r^2}$$

If $q > 0$, i.e. positive charge, then **E** is directed away from source charge. On the other hand if $q < 0$, i.e. negative charge, then **E** is directed towards the source charge.



$$\mathbf{E} \propto \frac{1}{r^2}$$

MIND MAP


Basic Properties of Charge-
1.] Charge is quantised Q = ±ne
n = any integer value e = 1.6×10^-19 C
2.] Charge is conserved.
3.] Similar charges repel and dissimilar charges attract.
Oh! It attracts!
Properties of electric field lines
1.] Imaginary & Continuous curves.
2.] Starts from positive charge and end at negative charge.
3.] Do not form continuous closed loops.
4.] Always normal to the surface of conductor.
5.] Can never cross each other.
Coulomb's Law
F = Kq1q2/r²
Electric Charges and Field
Gauss's Law
Φ = ∮E·ds = q/ε₀
by UMESH RAJORIA
Electric field intensity
E = Kq/r² r̂   E = F/q₀
SI Unit – N/C , V/m
Electric Dipole
Dipole Moment (P)
P = q × 2a
E_axial = 2KP/r³   E_equat = −KP/r³
E_axial = 2 E_equatorial
Electric Field due to
1.] An infinite Line distribution of Charge E = λ/2πε₀r
2.] An Conducting or Hollow Sphere
E_out = 1/4πε₀ q/r²   E_s = 1/4πε₀ q/R²   E_in = 0
3.] An infinite plane sheet of charge (non-Conducting)
E = σ/2ε₀
Dipole in a uniform Electric Field
τ = PE Sinθ
τ = P × E

IMPORTANT FORMULAE

1. **Electrostatic force between two charges**

   $F = K.\frac{q_1q_2}{r^2} = \frac{1}{4\pi\epsilon_0\epsilon_r}.\frac{q_1q_2}{r^2}$

   For air, $\epsilon_r = 1$

   Fair $= \frac{1}{4\pi\epsilon_0}.\frac{q_1q_2}{r^2} = 9\times10^9\ \frac{q_1q_2}{r^2}$

2. **Electric field intensity due to a point charge,** $\vec{E} = \lim_{q_0\to0}\frac{\vec{F}}{q_o}$

3. **Electric field intensity due to infinite linear charge density (λ)**

   $E = \frac{1}{4\pi\epsilon_0}.\frac{2\lambda}{r}$

4. **Electric field intensity near an infinite thin sheet of surface charge density** σ

   $E = \frac{\sigma}{2\epsilon_0}$

   For thick sheet $= \frac{\sigma}{\epsilon_0}$.

5. **Electric potential,** $V = \lim_{q_0\to0}\frac{w}{q_o}$

   Electric potential due to a point charge, $V = \frac{1}{4\pi\epsilon_0}.\frac{q}{r}$

6. **Relation between electric field and potential** $E = -\frac{dV}{dr} = \frac{V}{r}$ (numerically)

7. **Dipole moment,** $\vec{P} = q.2\vec{l}$

8. **Torque on a dipole in uniform electric field,** $\vec{\tau} = \vec{p}\times\vec{E}$.

9. **Potential energy of dipole,** $U = -\vec{p}.\vec{E} = -pE\cos\theta$

10. **Work done in rotating the dipole in uniform electric field from orientation** Q_1 **to** Q_2 **is**

    $W = U_2 - U_1 = pE(\cos\theta_1 - \cos\theta_2)$

11. **Electric field due to a short dipole**

    (i) at axial point, $E_{axis} = \frac{1}{4\pi\epsilon_0}.\frac{2p}{r^3}$

    (ii) at equatorial point, $E_1 = \frac{1}{4\pi\epsilon_0}.\frac{p}{r^3}$

12. **Electric potential due to a short dipole**

    (i) At axial point, $V_{axis} = \frac{1}{4\pi\epsilon_0}.\frac{p}{r^2}$

    (ii) At equatorial point, $V = 0$.

13. **Dielectric constant,** $K = \frac{\epsilon}{\epsilon_0} = \frac{C_{med}}{C_{air}}$

14. **Capacitance of parallel plate capacitor**

    (i) $C = \frac{A\epsilon_0 K}{d}$, in medium of dielectric constant K

    (ii) $C = \frac{A\epsilon_0}{d-t(1-\frac{1}{K})}$; if space between plate partially filled with dielectric of thickness t.

15. **Combination of capacitors :-**

    (i) In series, $\frac{1}{C} = \frac{1}{C_1}+\frac{1}{C_2}+\frac{1}{C_3}$, $q_1 = q_2 = q_3$, $V = V_1 + V_2 + V_3$

    (ii) In parallel, $C = C_1 + C_2 + C_3$, $q = q_1 + q_2 + q_3$, $V_1 = V_2 = V_3 = V$

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MCQ-LEVEL1

1 A force of 4N is acting between two charges in air. If the space between them is completely filled with glass (relative permittivity = 8), then the new force will be
(a) 2N (b) 5N (c) 0.5N (d) 0.2N

2 A charge q is placed at the center of the line joining two equal charges Q. The system of three charges will be in equilibrium if q is equal to
(a) –Q/2 (b) –Q/4 (c)Q/2 (d) Q/4

3 Two point charges Q and -3Q are placed some distance apart. If the electric field at the location of Q is E, the field at the location of -3Q is
(a) E (b) -E (c) E/3 (d) -E/3

4 An electric dipole when placed in a uniform electric field will have minimum potential energy, if the angle between dipole moment and electric field is
(a) Zero (b) π/ 2 (c) π/3 (d) π

5 An electric dipole consists of two opposite charges of magnitude 1μC separated by a distance of 2cm. The dipole is placed in an electric filed 10^{-5} V/m. The maximum torque
(a) 10^{-3} Nm (b) 2 x10^{-13} Nm (c) 3 x10^{-3} N (d) 4x10^{-3} Nm

ASSERTION AND REASON QUESTIONS

DIRECTION: Read the two statements
Assertion (A) and Reason (R) carefully to mark the correct option out of the options given below:
(a) Assertion and Reason both are correct statements and Reason is correct explanation for Assertion.
(b) Assertion and Reason both are correct statements but Reason is not correct explanation for Assertion.
(c) Assertion is correct statement but Reason is wrong statement.
(d) Assertion is wrong statement but Reason is correct statement

6 Assertion: No two electric lines of force can intersect each other.
Reason: Tangent at any point of electric line of force gives the direction of electric field

7 Assertion: Coulombs law of force is applicable for point charges at rest.
Reason: Coulombs law is a central force.

8 Assertion: Electric charge is quantized.
Reason: Charging is because of transfer of an integral number of protons or electrons.

9 Assertion: If there exists coulomb attraction between two bodies, both of them may not be charged.
Reason: In coulomb attraction two bodies are oppositely charged

10 Assertion: Surface charge density of an irregularly shaped conductor is non uniform
Reason: Surface density defined as charge per unit area

11 An electric dipole having a dipole moment of 4 × 10^{-9} C m is placed in a uniform electric field such that the dipole is in stable equilibrium. If the magnitude of the electric

field is 3 × 10^3 N/C, what is the work done in rotating the dipole to a position of unstable equilibrium?
(a) zero (b) 1.2 × 10-5 J (c) 2.4 × 10-5 J (d) - 1.2 × 10-5 J

12 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

13 Polar molecules are the molecules :
(a)having a permanent electric dipole moment
(b)having zero dipole moment
(c)acquire a dipole moment only in the presence of electric field due to displacement of charges
(d)acquire a dipole moment only when magnetic field is absent
Polar molecules have centres of positive and negative charges separated by some distance, so they have permanent dipole moment. (NEET2021)

14 The angle between the electric lines of force and the equipotential surface is
(a) 0◦ (b) 90◦ (c) 180◦ (d)45◦ (NEET 2022)

15 Metal cube of side 5 cm is charged with 6μC. The surface charge density on the cube is

(a) 0.125×10^{-3}Cm^{-2} (b)0.25×10^{-3}Cm^{-2} (c)4×10^{-3}Cm^{-2} (d)0.4×1^{-3} Cm^{-2}

16 According to Gauss law of electrostatics, electric flux through a closed surface depends on :

(a)the area of the surface
(b)the quantity of charges enclosed by the surface
(c) the shape of the surface
(d)the volume enclosed by the surface

17 σ is the uniform surface charge density of a thin spherical shell of radius R. The electric field at any point on the surface of the spherical shell is :

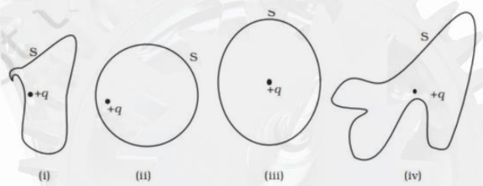
(a) $\sigma/\epsilon_o R$ (b) σ/ϵ_o (c) $\sigma/2\epsilon_o$ (d) $\sigma/4\epsilon_o$

18 The vehicles carrying inflammable fluids usually have metallic chains touching the ground:

(a) To protect tyres from catching dirt from ground
(b) It is a custom
(c) To alert other vehicles
(d) To conduct excess charge due to air friction to ground and prevent sparking

MCQ LEVEL2

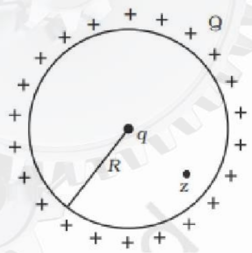
1 .The electric flux through the surface



(a) In figure (iv) is the largest
(b) In figure (iii) is the least
(c) In figure (ii) is same as in figure (iii) but is smaller than in figure (iv)
(d) Is the same for all the figures. (NCERT EXEMPLAR)

2 A spherical conductor of radius 10cm has a charge 3.2×10^{-7}C distributed uniformly. What is the magnitude of electric field at a point 15 cm from the centre of the sphere?
(a)1.28×10^{4}N/C (b) 1.28×10^{5}N/C (c) 1.28×10^{6}N/C (d) 1.28×10^{7}N/C

3 A positive charge Q is uniformly distributed along a circular ring of radius R. A small test charge q is placed at the centre of the ring in the figure. Then



(a) If q > 0 and is displaced away from the centre in the plane of the ring, it will be pushed back towards the centre.
(b) If q < 0 and is displaced away from the centre in the plane of the ring, it will never return to the centre and will continue moving till it hits the ring.
(c) If q < 0, it will perform SHM for small displacement along the axis.
(d) q at the centre of the ring is in an unstable equilibrium within the plane of the ring for q > 0.

4 Two-point charges A and B having charges + Q and -Q respectively, are placed at a distance apart and the force acting between them is F. If 25% charge on A is transferred to B,then the force between the charges becomes(NEET 2019)
(a)4F/3 (b) F (c) 9F/16 (d)16F/9

5 A hemisphere is uniformly charged positively. 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.

6 The Electric field at a point is
(a) always continuous.
(b) continuous if there is no 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.

7 A uniform electric field E= $2X10^3$ N/C is acting along the positive x axis. The flux in ($NC^{-1}m^2$) of this field through a square of 10cm on a side whose plane is parallel to the y-z plane is
(a) 20 (b) 30 (c) 10 (d) 40

8 An electric dipole is placed at an angle of 30◦ with an electric field of intensity $2x10^5$N/C. It experiences a torque equal to 4Nm.The charge on the diploe length is 2cm is
(a) 8 mC (b) 4 m C (c) 6 mC (d) 2 mC

9 A metal cube of side 5cm is charged with 6 μC. The surface charge density of the cube is
(a) $0.125x10^{-3}Cm^{-2}$ (b)$0.25x10^{-3}Cm^{-2}$ (c)$4x10^{-3}Cm^{-2}$ (d)$0.4x10^{-3}Cm^{-2}$

10 The electric field due to a short electric dipole at a large distance (r) from center of dipole on the equatorial plane varies with distance as
(a) r (b) 1/r (c) $1/r^3$ (d) $1/r^2$

MCQ LEVEL3

1 A vertical electric field of magnitude $4.9x10^5$N/C just prevents a water droplet of mass 0.1 g from falling .The value of charge on the droplet will be
(a)$1.6 \ x10^{-9}$ C (b) $2.0x10^{-9}$C (c) $3.2x10^{-9}$ C (d) $0.5x \ 10^{-9}$C
(JEE MAIN 2022)

2 For a uniformly charged ring of radius R, the electric field on its axis has the largest magnitude at a distance h from the centre .Then the value of h is
R/√5 (b) R/√2 (c) R (d) R√2 (JEE MAIN 2019)

3 According to Gauss law of electrostatics, electric flux through a closed surface depends on
(a) Area of the surface
(b) The quantity of charges enclosed by the surface
(c) The shape of the surface
(d) The volume enclosed by the surface

4 An electric dipole is placed at an angle of 30◦ with an electric field of intensity $2x10^5$ N/C. It experiences a torque equal to 4 N m. Calculate the magnitude of charge on the dipole, if the dipole length is 2 cm.
(a) 6 mC (b) 4 mC (c) 2 mC (d) 8 Mc

5 Two identical conducting spheres P and S with charge Q on each, repel each other with a force 16 N. A third identical uncharged conducting sphere R is successively brought in contact with the two spheres. The new force of repulsion between P and S is (JEE MAINS 2024)

(a) 1 N (b) 6 N (c) 12 N (d) 4 N

6 An electron falls from rest through a vertical distance h in a uniform and vertically upward directed electric field E. The direction of electric field is now reversed, keeping its magnitude the same. A proton is allowed to fall from rest in it through the same vertical distance h. The time of fall of the electron, in comparison to the time of fall of the proton is

(a) Smaller (b) 5 times greater (c) 10 times greater (d)equal

7 A spherical conductor of radius 10 cm has a charge of 3.2×10^{-7} C distributed uniformly. That is the magnetude of electric field at a point 15 cm from the centre of the sphere?

(a) 1.28×10^{5} N/C (b) 1.28×10^{7} N/C (c) 1.28×10^{-9} N/C (d)1.28×10^{11} N/C

8 Two uniformly charged spherical conductors A and B of radii 5 mm and 10 mm are separated by a distance of 2 cm. If the spheres are connected by a conducting wire, then in equilibrium condition, the ratio of the magnitudes of the electric fields at the surface of the sphere A and B will be :

(A) 1 : 2 (b) 2 : 1 (c) 1 : 1 (d) 1 : 4(JEE MAINS 2022)

9 Sixty four conducting drops each of radius 0.02 m and each carrying a charge of 5 μC are combined to form a bigger drop. The ratio of surface density of bigger drop to the smaller drop will be :

(A) 1 : 4 (b) 4 : 1 (c) 1 : 8 (d) 8 : 1 (JEE MAINS 2022)

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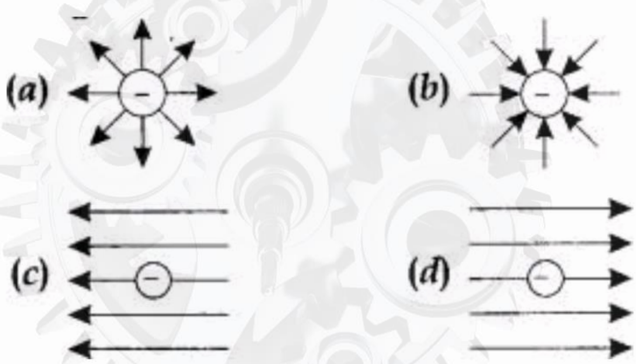
CASE STUDY QUESTIONS

Photocopiers work on the principle that 'opposites attract'. Toner is a powder that is used to create the printed text and images on paper. The powder is negatively charged, and so it is attracted to something positive – the paper. The drum, which is located in the heart of a photocopier, is positively charged using static electricity. An image of the master copy is transferred onto the drum using a laser. The light parts of the image (the white areas on a piece of paper) lose their charge so become more negative, and the black areas of the image (where the text is) remain positively charged.

- Which of the following figures represent the electric field lines due to a single negative charge?



I. If a body is negatively charged, then it has
   a. excess of electrons
   b. excess of protons
   c. deficiency of electron
   d. deficiency of neutrons

II. A charged particle is free to move in an electric field. It will travel
   a. always along a line of force
   b. along a line of force, if its initial velocity is zero
   c. along a line of force, if it has some initial velocity in the direction of an acute angle with the line of force
   d. none of the above

III. Which of the following statements is incorrect?

(I)The charge q on a body is always given by q = ne, where n is any integer, positive or negative.

(II)By convention, the charge on an electron is taken to be negative.

(III)The fact that electric charge is always an integral multiple of e is termed as quantisation of charge.

(IV)The quantisation of charge was experimentally demonstrated by Newton in 1912.

(a) Only I (b) Only II (c) Only IV (d) Only III

2MARKS-LEVEL1

1. Why do the electric field lines never cross each other?

2. Define electric flux. Write its S.I. unit. 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?

3 MARKS LEVEL 1

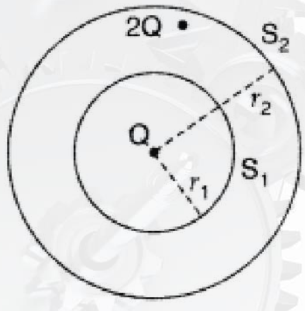
1. State Gauss' law in electrostatics. Using this law derive an expression for the electric field due to a uniformly changed infinite plane sheet.
2. An electric dipole of dipole moment p is placed in a uniform electric field E?. Obtain the expression for the torque τ experienced by the dipole. Identify two pairs of perpendicular vectors in the expression.

5MARKS LEVEL1

1. An electric dipole of dipole moment p consists of point charges + q and – q separated by a distance 2a apart. Deduce the expression for the electric field 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 p?.
2. (i) Derive the expression for electric field at a point on the equatorial line of an electric dipole.
   Depict the orientation of the dipole in (a) stable (b) unstable equilibrium in a uniform electric field.

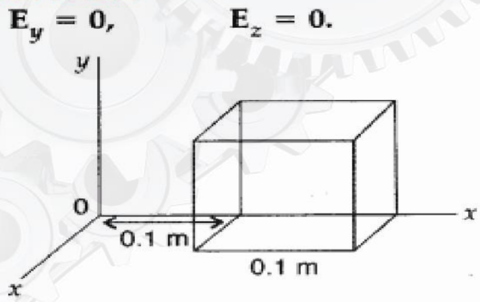
NUMERICALS LEVEL1

1. Given a uniform electric field $\vec{E}=4\times10^3\hat{i}$ N/C. Find the flux of this field through a square of 5 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? (Delhi 2014)
2. A sphere S_1 of radius r_1 encloses a net charge Q. If there is another concentric sphere S_2 of radius r_2 ($r_2 > r_1$) enclosing charge 2Q, find the ratio of the electric flux through S_1 and S_2. How will the electric flux through sphere S_1 change if a medium of dielectric constant K is introduced in the space inside S_2 in place of air?



NUMERICALS -LEVEL2

1. (a)Define electric flux. Write its SI units.
   (b) 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

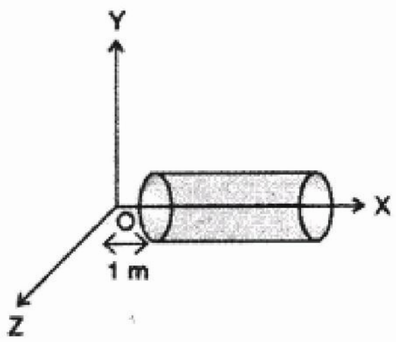
   

   Calculate
   (i) the flux through the cube, and
   (ii) the charge inside the cube.

NUMERICALS -LEVEL3

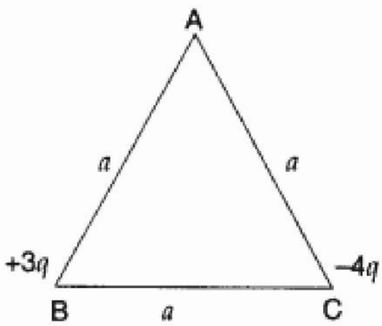
1. A hollow cylindrical box of length 1m and area of cross-section 25 cm^2 is placed in a three dimensional coordinate system as shown in the figure. The electric field in the region is given by $\vec{E}=50x\hat{i}$ where E is in NC^{-1} and x is in metres. Find

   - Net flux through the cylinder.
   - Charge enclosed by the cylinder. (Delhi 2013



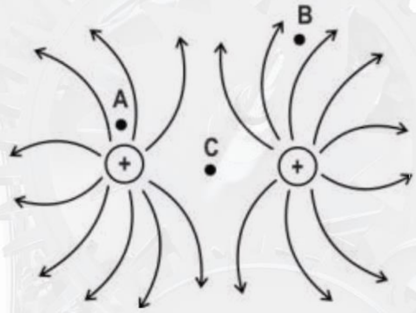
. 2. Two point charges + 3q and – 4q are placed at the vertices 'B' and 'C' of an equilateral triangle ABC of side 'a' as given in the figure. Obtain the expression for

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



COMPETENCY BASED QUESTION

1.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.

2 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
B. Q B. Both statements P and S
C. Both statements Q and R
D. D. Both statements Q and S

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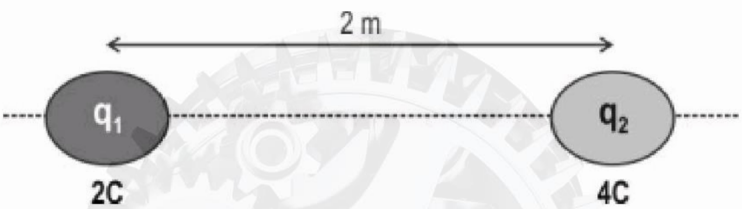
Two positive charges q1 and q2 lie along a straight line separated by a distance of 2 m as shown.

(a) Find a location along the straight line joining the two charges, where if a positive charge q3 is placed, it experiences a zero-resultant force.

(b) Will the resultant force on q3 placed at the location of part (a) still be zero, if it is negatively charged? Explain.



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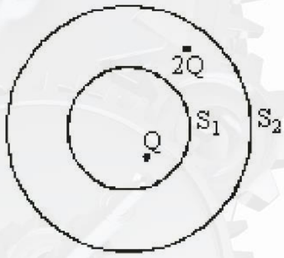
SELF ASSESSSMENT TEST

M.M 40

ANSWER ALL THE QUESTIONS

1. What is the work done in moving a test charge q through a distance of 1 cm along the equatorial axis of an electric dipole? (1)

2. S1and S2are two parallel concentric spheres enclosing charges Q and 2 Q respectively as shown in Fig.The ratio of the electric flux through S1and S 2 (1)



3. What is the dimensional formula for ε_0 ? (1)

4. Define electric flux(1)

5. Name the physical quantity whose S.I unit is J/C.Is it a scalar or a vector quantity?(1)

6. An oil drop of 12 excess electrons is held stationary under a constant electric field of 2.55×10^4 V m^{-1}in Millikan's oil drop experiment. The density of the oil is 1.26 g cm^{-3}. Estimate the radius of the drop. Given that g = 9.81 m $s^{-2}$and e = 1. 6 $x10^{-19}$ C. (2)

7. What is the force between two small charged spheres having charges of $2x10^{-7}$c and $3x10^{-7}$c placed 30 cm apart in air ? (2)

8. The sum of two point charges is 9 μc .They repel each other is force of 2 N. When kept 30 cm apart in free space. Calculate the value of each charge. (2)

9.An electric dipole with dipole moment $4x10^{-9}$Cm is aligned at 30°with the direction of a uniform electric field of magnitude $5x10^4$N/C. Calculate the magnitude of the torque acting on the dipole (2)

10.Two charges $5x10^{-8}$c and $-3x10^{-8}$C are located 16cm apart. At what points on the line joining the two charges is the electric potential zero? (2)

11.Derive the formula for electric field of an electric dipole for the following two cases(a) axial line (b) equatorial line. (5)

CASE STUDY -5marks

1. Lightning is an electric current. Within a thundercloud way up in the sky, many small bits of ice (frozen raindrops) bump into each other as they move around in the air. All of those collisions create an electric charge. After a while, the whole cloud fills up with electrical charges. The positive charges or protons form at the top of the cloud and the negative charges or electrons form at the bottom of the cloud. Since opposites attract, that causes a positive charge to build up on the ground beneath the cloud. The grounds electrical charge concentrates around anything that sticks up, such as mountains, people, or single trees. The charge coming up from these points eventually connects with a charge reaching down from the clouds and lightning strikes.

(i) Charge is the property associated with matter due to which it produces and experiences

(a) electric effects only

(b) magnetic effects only

(c) both electric and magnetic effects

(d) None of these

(ii) When some charge is transferred to ...*A*... it readily gets distributed over the entire surface of ... *A*... If some charge is put on ... *B*..., it stays at the same place. Here, A and B refer to

(a) insulator, conductor (b) conductor, insulator

(c)insulator, insulator (d)conductor, conductor

(iii) On charging by conduction, mass of a body may

(a) Increase (b) decreases

© increase or decrease (d) None of these

(b) If one penetrates a uniformly charged spherical cloud, electric field strength

a. decreases directly as the distance from the centre
b. increases directly as the distance from the centre
c. remains constant
d. None of these

(c) The law, governing the force between electric charges in the cloud is known as

a. Ampere's law b. Ohm's law c.Faraday's law d.Coulomb's law

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