PHYSICS

12th JEE

Electric Charges and Field

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ELECTRIC CHARGES AND FIELDS

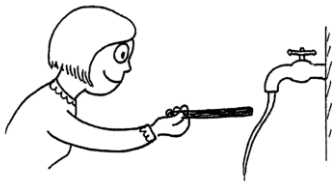
DPP-01

[Electric Charges, Basic Properties of Electric Charge, Charging Methods, Electroscope, Conductors And Insulators]

1. A body can be negatively charged by

(A) Giving excess of electrons to it
(B) Removing some electrons from it
(C) Giving some protons to it
(D) Removing some neutrons from it

2. In normal cases thin stream of water bends toward a negatively charged rod. When a positively charged rod is placed near the stream, it will bend in the



(A) Opposite direction.
(B) Same direction.
(C) It won't bend at all.
(D) Can't be predicted.

3. A soap bubble is given a negative charge, then its radius

(A) Decreases
(B) Increases
(C) Remains unchanged
(D) Nothing can be predicted as information is insufficient

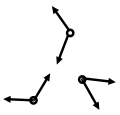
4. Two bodies are charged by rubbing one against the other During the process, one becomes positively charged while the other becomes negatively charged. Then mass of each body

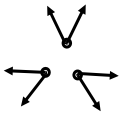
(A) Remains unchanged
(B) Increases marginally
(C) Total mass changes slightly
(D) Changes slightly but the total mass remains unchanged

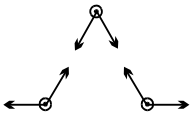
5. When a glass rod is rubbed with silk, it

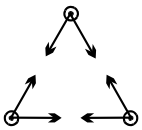
(A) Gains electrons from silk
(B) Gives electrons to silk
(C) Gains protons from silk
(D) Gives protons to silk

6. The figure below shows the forces that three charged particles exert on each other. Which of the four situations shown can be correct.

(I) 

(II) 

(III) 

(IV) 

(A) all of the above
(B) none of the above
(C) II, III
(D) II, III & IV

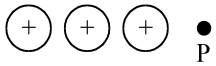
7. A glass rod rubbed with silk and used to charge a gold leaf electroscope and the leaves are observed to diverge. The electroscope thus charged is exposed to X-rays for a short period. Then

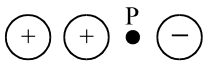
(A) The divergence of leaves will not be affected
(B) The leaves will diverge further
(C) The leaves will collapse
(D) The leaves will melt

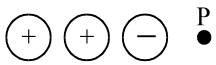
8. Five balls numbered 1 to 5 are suspended using separate threads. Pairs (1, 2), (2, 4) and (4, 1) show electrostatic attraction, while pair (2, 3) and (4, 5) show repulsion. Therefore ball 1 must be

(A) Positively charged
(B) Negatively charged
(C) Neutral
(D) Made of metal

9. Given are four arrangements of three fixed electric charges. In each arrangement, a point labeled P is also identified — test charge, +q, is placed at point P. All of the charges are the same magnitude, Q, but they can be either positive or negative as indicated. The charges and point P all lie on a straight line. The distances between adjacent items, either between two charges or between a charge and point P, are all the same.

I. 

II. 

III. 

IV. 

Correct order of choices in a decreasing order of magnitude of force on P is

(A) II > I > III > IV (B) I > II > III > IV
(C) II > I > IV > III (D) III > IV > I > II

10. The charge on 500 cc of water due to protons will be

(A) 6.0×10^{27} C
(B) 2.67×10^{7} C
(C) 6×10^{23} C
(D) 1.67×10^{23} C

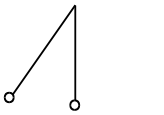
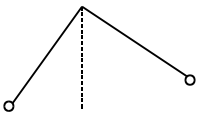
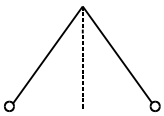
DPP-02

[Coulombs Law and Superposition Principle]

1. There are two charges +10μC having mass 10 mg and +5μC having mass 5 mg. The ratio of their accelerations under coulomb's force acting between them is

(A) 1 : 2 (B) 1 : 1
(C) 2 : 1 (D) 4 : 1

2. Two metal spheres of the same mass are suspended from a common point by a light insulating string. The length of each string is same. The spheres are given electrical charges + Q on one, and +3Q on the other. Which of the following diagrams below best show the resulting position of the spheres?

(A)  (B) 
(C)  (D) 

3. +2C and +6C two charges are repelling each other with a force of 12 N. If each charge is given –2C of charge, then the value of force will be:

(A) 4N (Attractive)
(B) 4N (Repulsive)
(C) 8N (Repulsive)
(D) Zero

4. Two equal point charges each of 3μC are separated by a certain distance in metres. If they are located at $\left(\hat{i}+\hat{j}+\hat{k}\right)$ and $\left(2\hat{i}+3\hat{j}+3\hat{k}\right)$, then the electrostatic force between them is:

(A) $9\times10^{3}\ N$
(B) $9\times10^{-3}\ N$
(C) $3\times10^{-3}\ N$
(D) $9\times10^{-2}\ N$

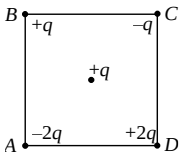
5. Two small conducting sphere of equal radius have charges +10 μC and –20 μC respectively and placed at a distance R from each other experience force F_1. If they are brought in contact and separated to the same distance, they experience force F_2. The ratio of F_1 to F_2 is:

(A) 1 : 2 (B) – 8 : 1
(C) 1 : 8 (D) – 2 : 1

6. Three charge +4q, Q and q are placed in a straight line of length ℓ such that +q & +4q are on the ends of line & Q is at the midpoint of line. What should be the value of Q in order to make the net force on q to be zero?

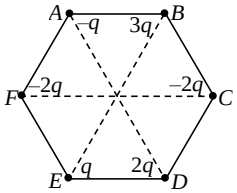
(A) $-q$ (B) $-2q$
(C) $-q/2$ (D) $4q$

7. Four charges are arranged at the corners of a square ABCD, as shown. The force on a +ve charge kept at the centre of the square is –



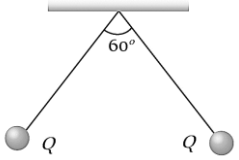
(A) zero
(B) along diagonal AC
(C) along diagonal BD
(D) perpendicular to the side AB

8. Six charges are placed at the corner of a regular hexagon as shown. If an electron is placed at its centre O, force on it will be -



(A) zero (B) along OF
(C) along OC (D) None of these

9. Two small spherical balls each carrying a charge Q = 10μC (10 *micro-coulomb*) are suspended by two insulating threads of equal lengths 1m each, from a point fixed in the ceiling. It is found that in equilibrium threads are separated by an angle 60° between them, as shown in the figure. What is the tension in the threads



(Given: $\frac{1}{(4\pi\varepsilon_0)}=9\times10^{9}\ Nm^2/C^2$)

(A) 18 N (B) 1.8 N
(C) 0.18 N (D) None of the above

10. Charge q_2 of mass m revolves around a stationary charge q_1 in a circular orbit of radius r. The orbital periodic time of q_2 would be:

(A) $\left[\frac{4\pi^2 mr^3}{kq_1q_2}\right]^{1/2}$

(B) $\left[\frac{kq_1q_2}{4\pi^2 mr^3}\right]^{1/2}$

(C) $\left[\frac{4\pi^2 mr^4}{kq_1q_2}\right]^{1/2}$

(D) $\left[\frac{4\pi^2 mr^2}{kq_1q_2}\right]^{1/2}$

DPP-03

[Coulombs Law and Superposition Principle]

1. Two identical charges repel each other with a force equal to 10 g-wt when they are 0.6 m apart in air. (g = 10 ms^{-2}) The value of each charge is:

(A) $2mC$ (B) 2×10^{-7}C
(C) $2nC$ (D) 2μC

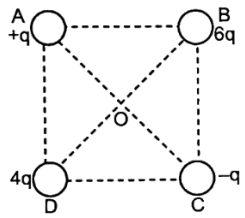
2. A charge q_1 exerts some force on a second charge q_2. If third charge q_3 is brought near, the force that q_1 exerts on q_2 and net force on q_2 respectively

(A) decreases, increases
(B) increases, increases
(C) remains unchanged, may increase or decrease
(D) remains unchanged, remains unchanged

3. Two identical size conducting balls A and B have positive charges q_1 and q_2 respectively but $q_1 \neq q_2$. The balls are brought together so that they touch each other and then kept in their original positions. The force between them is:

(A) Less than that before the balls are touched
(B) Greater than that before the balls are touched
(C) Same as that before the balls are touched
(D) Zero

4. Four charges are arranged at the corners of a square *ABCD*, as shown in the adjoining figure. The force on the charge q kept at the centre O is:



(A) zero
(B) along the diagonal *AC*
(C) along the diagonal *BD*
(D) perpendicular to side *DC*

5. An electron is moving round the nucleus of a hydrogen atom in a circular orbit of radius r. The coulomb force $\vec{F}$ on the electron is (where $K = \frac{1}{4\pi\varepsilon_0}$) :

(A) $-K\frac{e^1}{r^3}\hat{r}$ (B) $K\frac{e^1}{r^3}\vec{r}$
(C) $-K\frac{e^2}{r^3}\vec{r}$ (D) $K\frac{e^1}{r^2}\hat{r}$

6. F_g and F_e represents gravitational and electrostatic force respectively between protons situated at a distance 11μm. The ratio of F_g/F_e is of the order of:

(A) 10^{42} (B) 10^{36}
(C) 10^{-36} (D) 10^{-43}

7. Two charges placed in air repel each other by a force of 10^{-4} N. When oil is introduced between the charges, the force on the charge becomes 2.5×10^{-5} N. The dielectric constant of oil is:

(A) 2.5 (B) 0.25
(C) 2.0 (D) 4.0

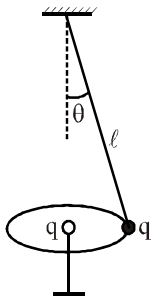
8. The charges on two spheres are +7μC and –5μC respectively. They experience a force F. If each of them is given additional charge of –2μC, the new force of attraction will be:

(A) F (B) $F/2$
(C) $F/\sqrt{3}$ (D) $2F$

9. A bead of mass m and charge +q is constrained to move freely on vertical y-axis. A charge +Q is fixed at the origin. The bead is at rest at (0, a). Now it is displaced slightly so that it executes SHM. Its time period is

(A) $2\pi\sqrt{\frac{2a}{g}}$ (B) $2\pi\sqrt{\frac{a}{g}}$
(C) $2\pi\sqrt{\frac{a}{2g}}$ (D) $\pi\sqrt{\frac{a}{g}}$

10. A spherical bob of mass m and charge q suspended from a string of length ℓ rotates about a fixed charge identical to that of the bob (Fig.). The angle between the string and the vertical is θ. Find the angular velocity of uniform rotation of the bob. It is given that $\frac{Kq^2}{m\ell^2} = g$



(A) $\sqrt{\frac{g}{\ell}(\sec\theta - \cos ec^3\theta)}$ (B) $\sqrt{\frac{g}{\ell}\cos\theta}$
(C) $\sqrt{\frac{g}{\ell}\sec\theta}$ (D) $\sqrt{\frac{g}{\ell}}$

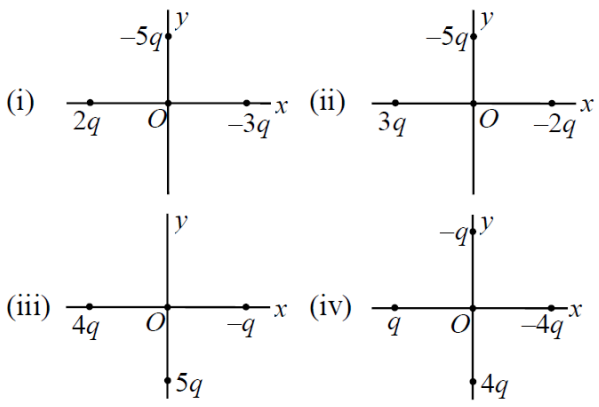
DPP-04
[Electric Field]

1. A proton and an electron are placed in a same uniform electric field.
(A) The electric forces acting on them will be equal
(B) The magnitudes of the forces will be equal
(C) Their accelerations will be equal
(D) The magnitudes of acceleration will be equal

2. Consider two-point charges of equal magnitude and opposite sign separated by a certain distance. The neutral point due to them
(A) Does not exist
(B) Will be in mid-way between them
(C) Lies on the perpendicular bisector of the line joining the two
(D) Will be closer to the negative charge

3. The electric charge in uniform motion produces
(A) An electric field only
(B) A magnetic field only
(C) Both electric and magnetic field
(D) Neither electric nor magnetic field

4. Figures shows four situations in which charged particles are at equal distances from the origin. If E_1, E_2, E_3 and E_4 be the magnitude of the net electric fields at the origin in four situations (i), (ii), (iii) and (iv) respectively, then-



(A) $E_1 = E_2 = E_3 = E_4$
(B) $E_1 = E_2 > E_3 > E_4$
(C) $E_1 < E_2 < E_3 = E_4$
(D) $E_1 > E_2 = E_3 < E_4$

5. A charged water drop of radius r is in equilibrium in an electric field. If charge on it is equal to charge on an electron, then intensity of electric field will be : (density of water = ρ, assume gravity)

(A) $\frac{8\pi r^3\rho g}{3e}$ (B) $\frac{\pi r^3\rho g}{3e}$
(C) $\frac{6\pi r^3\rho g}{15e}$ (D) $\frac{4\pi r^3\rho g}{3e}$

6. A point charge 50 μC is located in the XY plane at the point of position vector $\vec{r}_0 = 2\hat{i} + 3\hat{j}$. what is the electric field at the point of position vector $\vec{r} = 8\hat{i} - 5\hat{j}$.
(A) 1200 V/m
(B) 0.04 V/m
(C) 900 V/m
(D) 4500 V/m

7. Four charges q, $2q$, $-4q$ and $2q$ are placed in order at the four corners of a square of side b. The net field at the centre of the square is –

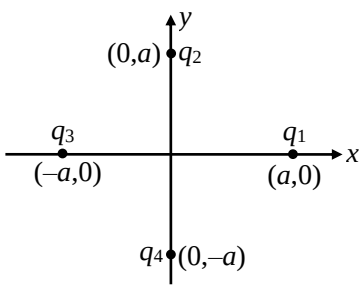
(A) $\frac{q}{2\pi\varepsilon_0 b^2}$ from + q to – $4q$

(B) $\frac{5q}{2\pi\varepsilon_0 b^2}$ from + q to – $4q$

(C) $\frac{10q}{2\pi\varepsilon_0 b^2}$ from + q to – $4q$

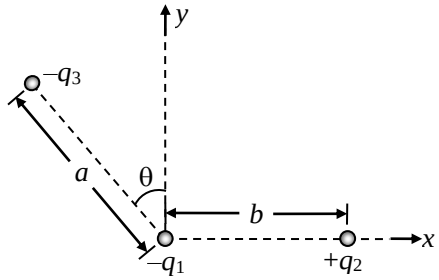
(D) $\frac{20q}{2\pi\varepsilon_0 b^2}$ from – $4q$ to + q

8. Four charges q_1, q_2, q_3 and q_4 are placed at the positions as shown in the figure, given $q_1 + q_2 + q_3 + q_4 = 0$. The electric field on z-axis -



(A) is always along +ve z-axis
(B) is always along –ve z-axis
(C) is always zero
(D) may be perpendicular to z-axis or zero depending on charges

9. Three charges $-q_1$, $+q_2$ and $-q_3$ are placed as shown in the figure. The x-component of the force on $-q_1$ is proportional to –



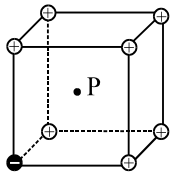
(A) $\frac{q_2}{b^2} - \frac{q_3}{a^2}\sin\theta$

(B) $\frac{q_2}{b^2} - \frac{q_3}{a^2}\cos\theta$

(C) $\frac{q_2}{b^2} + \frac{q_3}{a^2}\sin\theta$

(D) $\frac{q_2}{b^2} + \frac{q_3}{a^2}\cos\theta$

10. Consider a regular cube with positive point charge +Q in all corners except for one which has a negative point charge –Q. Let the distance from any corner to the center of the cube be r. What is the magnitude of electric field at point P, the center of the cube?



(A) $E = 7k_eQ/r^2$

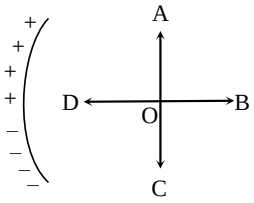
(B) $E = 1k_eQ/r^2$

(C) $E = 2k_eQ/r^2$

(D) $E = 6k_eQ/r^2$

DPP-05
[Electric Field]

1. The linear charge density on upper half of a segment of ring is λ and at lower half it is –λ. The direction of electric field at centre O of ring is :



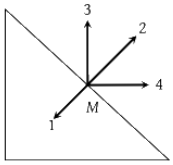
(A) along OA (B) along OB
(C) along OC (D) along OD

2. 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) $\frac{mg}{e}$

(C) $\frac{e}{mg}$ (D) $\frac{e^2}{m^2}g$

3. Three identical point charges, as shown, are placed at the vertices of an isosceles right angled triangle. Which of the numbered vectors coincides in direction with the electric field at the mid-point *M* the hypotenuse?



(A) 1 (B) 2
(C) 3 (D) 4

4. A positive charge q is placed at the origin of the x-axis. Another positive charge Q is placed at the point L on the positive x-axis. Where on the straight line between the two charges does the electric field equal zero?

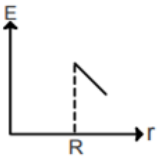
(A) x = $L\sqrt{q}/\left(\sqrt{Q}+\sqrt{q}\right)$

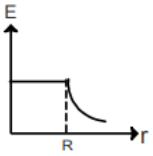
(B) x = L/2

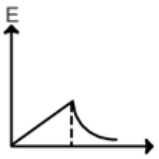
(C) x = qQ/L^2

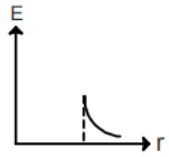
(D) x = $L\sqrt{qQ}/\left(q+Q\right)$

5. Which one of the following graphs represents the variation of electric field strength E with distance r from the centre of a uniformly charged non-conducting sphere

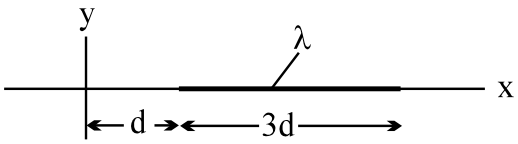
(A) 

(B) 

(C) 

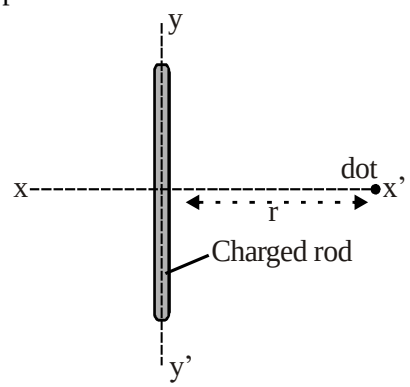
(D) 

6. A continuous line of charge of length 3d lies along the x-axis, extending from x + d to x = + 4d. the line carries a uniform linear charge density λ.
In terms of d, λ and any necessary physical constants, find the magnitude of the electric field at the origin.



(A) $\lambda / 5\pi\varepsilon_0 d$
(B) $\lambda / 4\pi\varepsilon_0 d$
(C) $3\lambda / 16\pi\varepsilon_0 d$
(D) $3\lambda / 8\pi\varepsilon_0 d$

7. A uniformly charged rod is kept on y-axis with centre at origin, as shown. Which of the following actions will increase the electric field strength at the position of the dot?



(A) Make the rod longer without changing the charge
(B) Make the rod shorter without changing the charge
(C) Make the rod shorter without changing the linear charge density
(D) Rotate the rod about yy'

8. Non-conducting ring of radius R has uniformly distributed positive charge Q. A small part of the ring, of length d, is removed (d << R). The electric field at the centre of the ring will now be-

(A) directed towards the gap, inversely proportional to R^3
(B) directed towards the gap, inversely proportional to R^2
(C) directed away from the gap, inversely proportional to R^3
(D) directed away from the gap, inversely proportional to R^2

9. The maximum electric field intensity on the axis of a uniformly charged ring of charge q and radius R will be:

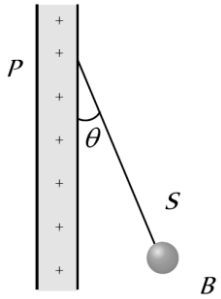
(A) $\frac{1}{4\pi\varepsilon_0}\frac{q}{3\sqrt{3}R^2}$

(B) $\frac{1}{4\pi\varepsilon_0}\frac{2q}{3R^2}$

(C) $\frac{1}{4\pi\varepsilon_0}\frac{2q}{3\sqrt{3}R^2}$

(D) $\frac{1}{4\pi\varepsilon_0}\frac{3q}{2\sqrt{3}R^2}$

10. A charged ball B hangs from a silk thread *S*, which makes an angle θ with a large charged conducting sheet *P*, as shown in the figure. The surface charge density σ of the sheet is proportional to

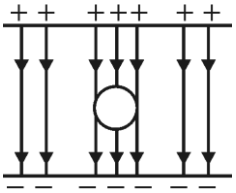


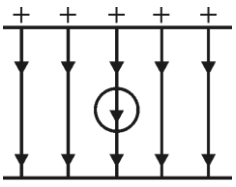
(A) sin θ (B) tan θ
(C) cos θ (D) cot θ

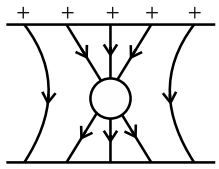
DPP-06

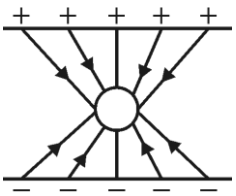
[Motion of a Charged Particle in Uniform Electric Field, Electric Field Lines]

1. An uncharged sphere of metal is placed inside a charged parallel plate capacitor. The lines of force look like.

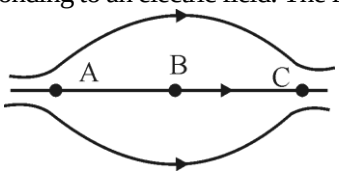
(A) 

(B) 

(C) 

(D) 

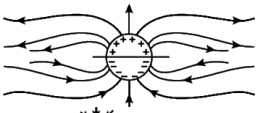
2. The figure shows some of the electric field lines corresponding to an electric field. The figure suggests



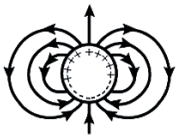
(A) $E_A > E_B > E_C$ (B) $E_A = E_B = E_C$

(C) $E_A = E_C > E_B$ (D) $E_A = E_C < E_B$

3. A long cylindrical shell carries positive surface charge σ in the upper half and negative surface charge $-\sigma$ in the lower half. The electric field lines around the cylinder will look like figure given in: (figure are schematic and not drawn to scale)

(A) 

(B) 

(C) 

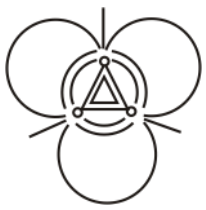
(D) 

4. A charged particle of charge q and mass m is released from rest in an uniform electric field E. Neglecting the effect of gravity, the kinetic energy of the charged particle after time 't' seconds is

(A) $\frac{Eqm}{t}$ (B) $\frac{E^2q^2t^2}{2m}$

(C) $\frac{2E^2t^2}{mq}$ (D) $\frac{Eq^2m}{2t^2}$

5. Three positive charges of equal value *q* are placed at the vertical of an equilateral triangle. The resulting lines of force should be sketched as in

(A)  (B) 

(C)  (D) 

6. **Statement-1 :** When a charge is placed at rest in an electric field its path will always be along electric line of force.

Statement-2 : The force on the charge is along the tangent drawn on electric field line.

(A) Statement-1 is true, statement-2 is true and statement-2 is correct explanation for statement-1.

(B) Statement-1 is true, statement-2 is true and statement-2 is NOT the correct explanation for statement-1.

(C) Statement-1 is true, statement-2 is false.

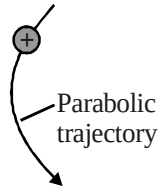
(D) Statement-1 is false, statement-2 is true.

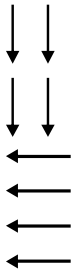
7. A proton is released from rest 10cm from a large sheet carrying a surface charge density of -2.21×10^{-9} Cm^{-2}. It will strike the sheet after the time:

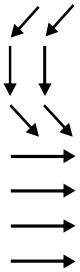
(A) 4 μ s (B) 2 μ s

(C) $2\sqrt{2}$ μ s (D) $4\sqrt{2}$ μ s

8. Which of electric field can be responsible for the proton's trajectory as shown below ?



(A) 

(B) 

(C)

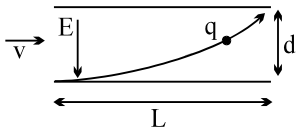
(D)

9. A uniform electric field $\vec{E}$ exists between the plates of a charged condenser. A charged particle enters the space between the plates and perpendicular to $\vec{E}$. The path of the particle between the plates is a:

(A) Hyperbola (B) Parabola

(C) Circle (D) Straight line

10. In an ink-jet printer, an ink droplet of mass m is given a negative charge q by a computer controlled charging unit, and then enters at speed v the region between two deflecting parallel plates of length L separated by distance d (see figure). All over this region exists a downward electric field which you can assume to be uniform. Neglecting the gravitational force on the droplet, the maximum charge that it can be given so that it will not hit a plate is most closely approximated by



(A) $\frac{mv^2E}{dL^2}$ (B) $\frac{mv^2d}{EL^2}$

(C) $\frac{2dmv^2}{EL^2}$ (D) none

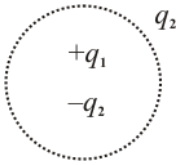
DPP-07

[Electric Flux, Gauss Law]

1. If the electric flux entering and leaving an enclosed surface respectively is ϕ_1 and ϕ_2 the electric charge inside the surface will be

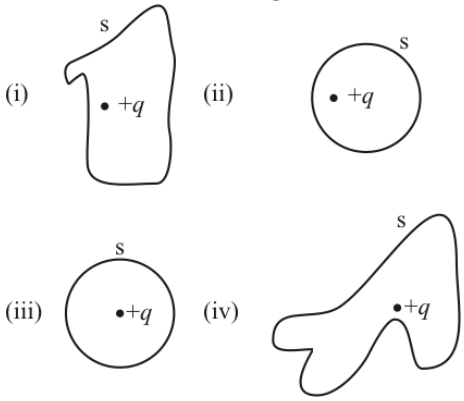
(A) $(\phi_1 + \phi_2)\varepsilon_0$ (B) $(\phi_2 - \phi_1)\varepsilon_0$
(C) $(\phi_1 + \phi_2)/\varepsilon_0$ (D) $(\phi_2 - \phi_1)/\varepsilon_0$

2. Consider the charge configuration and spherical Gaussian surface as shown in the figure. When calculating the flux of the electric field over the spherical surface field will be due to



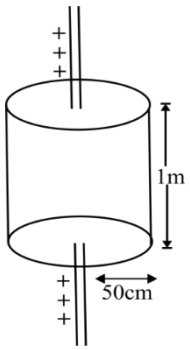
(A) q_2
(B) only the positive charge
(C) all the charges
(D) $+q_1$ and $-q_1$

3. The electric flux through the surface



(A) In Fig. (iv) is the largest
(B) In Fig. (iii) is the least
(C) In Fig. (ii) is same as Fig. (iii) but is smaller than Fig. (iv)
(D) Is the same for all the figures

4. Electric charge is uniformly distributed along a long straight wire of radius 1mm. The charge per cm length of the wire is Q coulomb. Another cylindrical surface of radius 50cm and length 1m symmetrical encloses the wire as shown in the figure. The total electric flux passing through the cylindrical surface is:



(A) $\frac{Q}{\varepsilon_0}$ (B) $\frac{100Q}{\varepsilon_0}$
(C) $\frac{100Q}{(\varepsilon_0)^2}$ (D) $\frac{100Q}{(\pi\varepsilon_0)}$

5. A long string with a charge of λ per unit length passes through an imaginary cube of edge a. The maximum flux of the electric field through the cube will be

(A) $\lambda a/\varepsilon_0$ (B) $\sqrt{2}\,\lambda a/\varepsilon_0$
(C) $6\lambda a^2/\varepsilon_0$ (D) $\sqrt{3}\,\lambda a/\varepsilon_0$

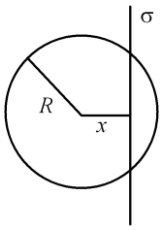
6. A cube of side l is placed in a uniform field E, where $E = E\hat{i}$. The net electric flux through the cube is:

(A) Zero (B) $l^2 E$
(C) $4l^2E$ (D) $6l^2 E$

7. A point charge q is located at the point (0, 0, –a). Consider a hemispherical surface of radius 'a' with its centre at the origin and $z \geq 0$. The modulus of the electric flux through the hemispherical surface is

(A) $q/\in_0$
(B) $q/\left(2\sqrt{2}\in_0\right)$
(C) $\left(1-\frac{1}{\sqrt{2}}\right)q/\in_0$
(D) $\left(1-\frac{1}{\sqrt{2}}\right)q/\left(2\in_0\right)$

8. An infinite, uniformly charged sheet with surface charge density σ cuts through a spherical Gaussian surface of radius R at a distance x from its center, as shown in the figure. The electric flux ϕ through the Gaussian surface is



(A) $\frac{\pi R^2 \sigma}{\varepsilon_0}$

(B) $\frac{2\pi(R^2 - x^2)\sigma}{\varepsilon_0}$

(C) $\frac{\pi(R - x)^2 \sigma}{\varepsilon_0}$

(D) $\frac{\pi(R^2 - x^2)\sigma}{\varepsilon_0}$

9. A solid non-conducting spherical body has a volume charge density given by $\rho = \rho_0\left(1 - \frac{r}{R}\right)$, where R is radius of the sphere, and r is distance from the center. Maximum intensity of the electric field is

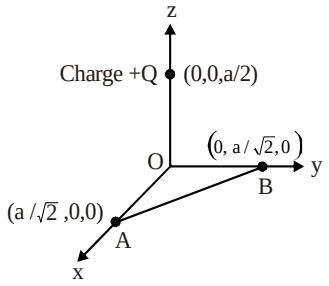
(A) $\frac{1}{9}\rho_0 \frac{R}{\epsilon_0}$

(B) $\frac{1}{12}\frac{\rho_0 R}{\epsilon_0}$

(C) $\frac{3}{4}\frac{\rho_0 R}{\epsilon_0}$

(D) $\frac{\rho_0 R}{4\epsilon_0}$

10. A point charge Q is kept at a point (0, 0, a/2) as shown in the figure.
Find the electrostatic flux through surface OABO.



(A) $\frac{Q}{6\varepsilon_0}$

(B) $\frac{Q}{12\varepsilon_0}$

(C) $\frac{Q}{24\varepsilon_0}$

(D) $\frac{Q}{48\varepsilon_0}$

DPP-08
[Electric Flux, Gauss Law]

1. The total electric flux through a cube when a charge $8q$ is placed at one corner of the cube is

(A) $\varepsilon_0 q$ (B) $\frac{q}{\varepsilon_0}$

(C) $4\pi\varepsilon_0 q$ (D) $\frac{q}{4\pi\varepsilon_0}$

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

(A) Be doubled
(B) Increase four times
(C) Be reduced to half
(D) Remain the same

3. Mark the correct options -

(A) Gauss's Law is valid only for symmetrical charge distributions
(B) Gauss's Law is valid only for charges placed in vacuum
(C) The electric field calculated by Gauss's Law is the field due to the charges enclosed by the surface
(D) The flux of the electric field through a closed surface due to all the charges is equal to the flux due to the charges enclosed by the surface

4. If an insulated non-conducting sphere of radius R has charge density ρ. The electric field at a distance r from the centre of sphere ($r < R$) will be

(A) $\frac{\rho R}{3\varepsilon_0}$ (B) $\frac{\rho r}{\varepsilon_0}$

(C) $\frac{\rho r}{3\varepsilon_0}$ (D) $\frac{3\rho r}{\varepsilon_0}$

5. A spherically symmetric charge distribution is characterised by a charge density having the following variation :

$\rho(r) = \rho_0\left(1-\frac{r}{R}\right)$ for $r < R$

$\rho(r) = 0$ for $r \geq R$

where r is the distance from the centre of the charge distribution and ρ_0 is a constant. The electric field at an internal point ($r < R$) is :

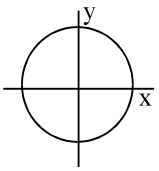
(A) $\frac{\rho_0}{4\varepsilon_0}\left(\frac{r}{3}-\frac{r^2}{4R}\right)$ (B) $\frac{\rho_0}{12\epsilon_0}\left(\frac{r}{3}-\frac{r^2}{4R}\right)$

(C) $\frac{\rho_0}{\epsilon_0}\left(\frac{r}{3}-\frac{r^2}{4R}\right)$ (D) $\frac{\rho_0}{3\epsilon_0}\left(\frac{r}{3}-\frac{r^2}{4R}\right)$

6. The total flux of the electric field through the six faces of a certain cube is $+\phi_E$ where ϕ_E is a positive constant. Which of the following statements is not necessarily true?

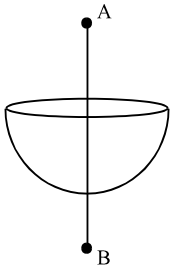
(A) More electric field lines exit the cube than enter the cube
(B) The cube encloses a net positive charge
(C) The net charge enclosed by the cube is $+\varepsilon_0\phi_E$
(D) The flux of the electric field through one face of the cube is $+\frac{1}{6}\phi_E$

7. 1 μC charge is uniformly distributed on a spherical shell given by equation $x^2 + y^2 + z^2 = 25$. What will be intensity of electric field at a point (1, 1, 2)?



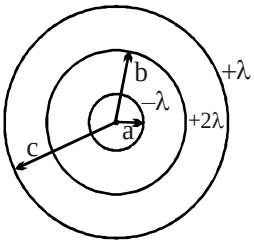
(A) 5 N/C
(B) 45 N/C
(C) $\frac{5\sqrt{3}}{2}$ N/C
(D) Zero

8. The diagram shows a uniformly charged hemisphere of radius R. It has volume charge density ρ. If the electric field at a point 2R distance above its center is E then what is the electric field at the point which is 2R below its center?



(A) $\rho R/6\varepsilon_0 + E$
(B) $\rho R/12\varepsilon_0 - E$
(C) $-\rho R/6\varepsilon_0 + E$
(D) $\rho R/24\varepsilon_0 + E$

9. Find the electric field due to three concentric thin long cylinders of linear charge densities –λ, +2λ and λ just outside the outer cylinder.



(A) $\frac{2k\lambda}{c}+\frac{4k\lambda}{b}-\frac{2k\lambda}{a}$

(B) $\frac{4k\lambda}{a}+\frac{k\lambda}{b}$

(C) $\frac{4k\lambda}{c}$

(D) None of these

10. Let $\rho(r)=\frac{Q}{\pi R^4}r$ be the charge density distributed for a solid sphere of radius R and total charge Q. For a point 'p' inside the sphere at distance r_1 from the centre of the sphere, the magnitude of electric field is

(A) 0

(B) $\frac{Q}{4\pi\varepsilon_0 r_1^2}$

(C) $\frac{Qr_1^2}{4\pi\varepsilon_0 R^4}$

(D) $\frac{Qr_1^2}{3\pi\varepsilon_0 R^4}$

DPP-09

[Electric Dipole, Electric field due a Electric Dipole]

1. A point Q lies on the perpendicular bisector of an electrical dipole of dipole moment p. If the distance of Q from the dipole is *r* (much larger than the size of the dipole), then electric field at Q is proportional to

(A) p^{-1} and r^{-2} (B) p and r^{-2}

(C) p^2 and r^{-3} (D) p and r^{-3}

2. The electric field due to an electric dipole at a distance *r* from its centre in axial position is E. If the dipole is rotated through an angle of 90° about it perpendicular axis, the electric field at the same point will be

(A) E (B) E/4

(C) E/2 (D) 2E

3. Two electric dipoles of moment P and 8P are placed in opposite direction on a line at a distance of 15 cm. The electric field will be zero at point between the dipoles whose distance from the dipole of moment P is

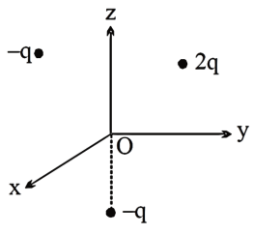
(A) 5 cm

(B) $\frac{25}{9}$ cm

(C) 10 cm

(D) $\frac{4}{13}$ cm

4. Three-point charges 2q, –q and –q are located respectively at (0, *a*, *a*), (0, –*a*, *a*) and (0, 0, – *a*) as shown. The dipole moment of this distribution is:-



(A) 2qa in the y-z plane at $\tan^{-1}\left(\frac{1}{4}\right)$ with z-axis

(B) $\sqrt{17}$ qa in the y-z plane at $\tan^{-1}\left(\frac{1}{4}\right)$ with z-axis

(C) $\sqrt{5}$ qa in the x-y plane at $\tan^{-1}(4)$ with y-axis

(D) 4qa in the x-y plane at $\tan^{-1}(4)$ with y-axis

5. An electric dipole of dipole moment $\vec{p}$ is placed at the origin along the x-axis. The angle made by electric field with x-axis at a point P, whose position vector makes an angle θ with x-axis, is:

(where, $\tan\alpha = \frac{1}{2}\tan\theta$)

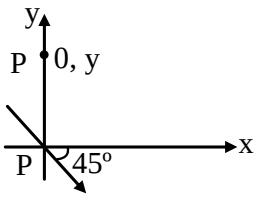
(A) α

(B) θ

(C) θ + α

(D) θ + 2α

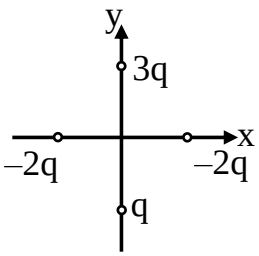
6. A dipole is placed at origin of coordinate system as shown in figure, find the electric field at point P(0, y).



(A) $\frac{KP}{y^3}(-\hat{i}-2\hat{j})$ (B) $\frac{KP}{\sqrt{2}y^3}(\hat{i}+2\hat{j})$

(C) $\frac{KP}{\sqrt{2}y^3}(-\hat{i}-2\hat{j})$ (D) None of these

7. 4 charges are placed each at a distance 'a' from origin. The dipole moment of configuration is-



(A) $2qa\hat{j}$ (B) $3qa\hat{j}$

(C) $2aq\,[\hat{i}+\hat{j}]$ (D) None of these

8. A short dipole is placed along x-axis with centre at origin. The electric field at a point P, which is at a distance r from origin such that $\overrightarrow{OP} = \vec{r}$ makes an angle of 45° with x-axis, is directed along a direction making –

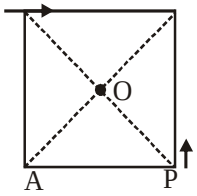
(A) $\tan^{-1}(0.5)$ with x-axis

(B) $\pi/4 + \tan^{-1}(0.5)$ with x-axis

(C) $\pi/4 + \tan^{-1}(0.5)$ with y-axis

(D) $\tan^{-1}(0.5)$ with y-axis

9. Two short dipoles of dipole moment p are placed at two corners of a square as shown in the figure. What is the ratio of magnitudes of electric field at two points O and A?



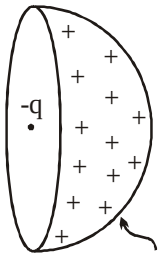
(A) 2

(B) $2\sqrt{2}$

(C) 1

(D) $\sqrt{2}$

10. The electric dipole moment of system formed by point charge –q and uniformly charged hemisphere as shown in the figure is



Uniformly charged nonconducting hemisphere having total surface charge +q

(A) $\frac{qR}{2}$

(B) qR

(C) $\frac{qR}{4}$

(D) $\frac{qR}{3}$

DPP-10

[Electric Dipole, Dipole in a Uniform External Field, Short Dipole in Non-Uniform Electric Field]

1. An electric dipole consisting of two opposite charges of 2×10^{-6} C each separated by a distance of 3 cm is placed in a electric field of magnitude 2×10^5 N/C along the direction making 90° with the field. Torque acting on the dipole is:

(A) 12×10^{-1} Nm
(B) 12×10^{-2} Nm
(C) 12×10^{-3} Nm
(D) 12×10^{-4} Nm

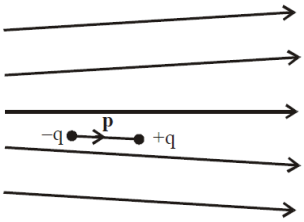
2. A sample of HCl gas is placed in an electric field of 3×10^4 NC^{-1}. The dipole moment of each HCl molecule is 6×10^{-30} C × m. The maximum torque that can act on a molecule is

(A) 2×10^{-34} C^2 $N^{-1}m$
(B) 2×10^{-34} Nm
(C) 18×10^{-26} Nm
(D) 0.5×10^{-34} $C^{-2}N^{-1}m^{-1}$

3. An electric dipole is placed in an uniform electric field with the dipole axis making an angle θ with the direction of the electric field. The orientation of the dipole for stable equilibrium is:

(A) $\frac{\pi}{6}$
(B) $\frac{\pi}{3}$
(C) 0
(D) $\frac{\pi}{2}$

4. Electric field lines in which an electric dipole p is placed as shown. Which of the following statements is correct?



(A) The dipole will not experience any force.
(B) The dipole will experience a force towards right.
(C) The dipole will experience a force towards left.
(D) The dipole will experience a force upwards

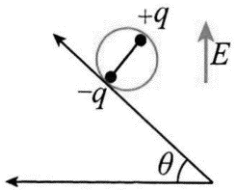
5. Two opposite and equal charges of magnitude 4×10^{-8} coulomb each when placed 2×10^{-2} cm apart from a dipole. If this dipole is placed in an external electric field of 4×10^8 N/C, the value of maximum torque and the work required in rotating it through 180° from its initial orientation which is along electric field will be: (Assume rotation of dipole about an axis passing through centre of the dipole):

(A) 64×10^{-4} N-m and 44×10^{-4} J
(B) 32×10^{-4} N-m and 32×10^{-4} J
(C) 64×10^{-4} N-m and 32×10^{-4} J
(D) 32×10^{-4} N-m and 64×10^{-4} J

6. An electric dipole (dipole moment p) is placed at a radial distance r >> a (where a is dipole length) from an infinite line of charge having linear charge density +λ. Dipole moment vector is aligned along radial vector r force experienced by dipole is:-

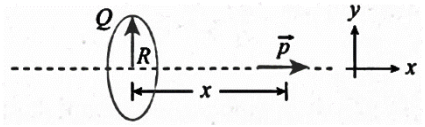
(A) $\frac{\lambda p}{2\pi\varepsilon_0 r^2}$, attractive
(B) $\frac{\lambda p}{2\pi\varepsilon_0 r^3}$, attractive
(C) $\frac{\lambda p}{2\pi\varepsilon_0 r^2}$, repulsive
(D) $\frac{\lambda p}{2\pi\varepsilon_0 r^3}$, repulsive

7. A wheel having mass u has charges +q and –q on diametrically opposite points. It remains in equilibrium on a rough inclined plane in the presence of uniform vertical electrical field E =



(A) ug / q
(B) $ug / 2q$
(C) $ug \tan\theta / 2q$
(D) None of these

8. A dipole having dipole moment 'p' is place at the axis of a charged ring having charge Q and radius R, at a distance x from the centre as shown in figure. Find the force experienced by the dipole moment $\vec{p} = p\hat{i}$ placed along the axis of the uniformly charged ring.



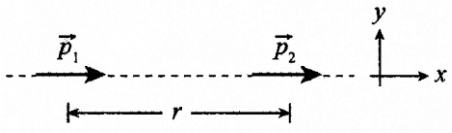
(A) $\frac{QP}{4\pi \in_0}\left(\frac{R^2-3x^2}{\left(R^2+x^2\right)^{5/2}}\right)$

(B) $\frac{QP}{4\pi \in_0}\left(\frac{R^2-x^2}{\left(R^2+x^2\right)^{5/2}}\right)$

(C) $\frac{QP}{4\pi \in_0}\left(\frac{R^2-2x^2}{\left(R^2+x^2\right)^{5/2}}\right)$

(D) $\frac{QP}{4\pi \in_0}\left(\frac{R^2+x^2}{\left(R^2+x^2\right)^{5/2}}\right)$

9. Two dipole of dipole moments $\vec{p}_1$ and $\vec{p}_2$ are aligned along the x-axis and separated by a distance r as shown in figure. Find the magnitude of force of interaction between the dipoles.



(A) $\frac{1}{4\pi \in_0}\frac{6P_1P_2}{r^4}$ (B) $\frac{1}{4\pi \in_0}\frac{3P_1P_2}{r^4}$

(C) $\frac{1}{4\pi \in_0}\frac{6P_1P_2}{r^3}$ (D) $\frac{1}{4\pi \in_0}\frac{3P_1P_2}{r^3}$

10. A and B are two points on the axis and the perpendicular bisector respectively of an electric dipole. A and B are far away from the dipole and at equal distance from it. The field at A and B are $\vec{E}_A$ and $\vec{E}_B$.

(A) $\vec{E}_A = \vec{E}_B$

(B) $\vec{E}_A = 2\vec{E}_B$

(C) $\vec{E}_A = -2\vec{E}_B$

(D) $|\vec{E}_B| = \frac{1}{2}|\vec{E}_A|$ and $\vec{E}_B$ is perpendicular to $\vec{E}_A$