ARCHIVE

CBSE QUESTION BANK

(CLASS – XII)

PHYSICS

(CBSE)

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PHYSICS

ELECTROSTATICS

One Mark Questions

1. Two point charges $q_A = +3\mu C$ and $q_B = -3\mu C$ are located 20 cm apart in vacuum. **(2003)**
   (i) Find the electric field at the mid point of the line AB joining the two charges
   (ii) If a negative test charge of magnitude 1.5×10^{-9} C is placed at the centre, find the force experienced by the test charge.

2. Sketch a graph to show how the charge 'Q' acquired by a capacitor of capacitance 'C' varies with increase in potential difference between its plates. **(2003)**

3. Write the S.I. unit of (i) electric field intensity and (ii) electric dipole moment. **(2003)**

4. An electric dipole of dipole moment 20×10^{-6} cm is enclosed by a closed surface. What is the net flux coming out of the surface? **(CBSE 2005)**

5. An electrostatics field line cannot be discontinuous. Why? **(A.I. 2005)**

6. How does the Coulomb force between two point charges depend upon the dielectric constant of the intervening medium? **(A.I. 2005)**

7. Two electric field lines never cross each other. Why? **(A.I. 2005)**

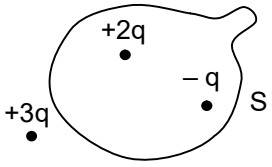
8. Define the term electric dipole moment. Is it a scalar or a vector quantity? **(CBSE 2006)**

9. Define the term 'dielectric constant' of a medium in terms of capacitance of a capacitor. **(2006)**

10. Draw an equipotential surface for a system consisting of two charges Q, – Q separated by a distance 'r' in air. **(2008)**

11. 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? **(2009)**

12. Figure shows three point charges + 2q, – q and + 3q. Two charges + 2q and – q are enclosed within a surface 'S'. What is the electric flux due to this configuration through the surface 'S'? **(2010)**



13. In which orientation, a dipole placed in a uniform electric field is in (i) stable, (ii) unstable equilibrium? **(2010)**

14. Define electric dipole moment. Write its S.I. unit. **(A.I. 2011)**

15. A hollow metal sphere of radius 5 cm is charged such that the potential on its surface is 10 V. What is the potential at the centre of the sphere? **(2011)**

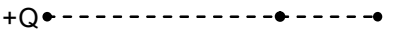
16. Why should electrostatic field be zero inside a conductor? **(CBSE 2012)**

17. Two charges of magnitudes + 4Q and –Q are located at points (a, 0) and (–3a, 0) respectively. What is the electric flux due to these charges through a sphere of radius '2a' with its centre at the origin? **(DELHI 2013)**

18. Why do the electric field lines never cross each other? **(DELHI 2014)**

19. What is the electric flux through a cube of side 1 cm which encloses an electric dipole? **(DELHI 2015)**

20. A point charge +Q is placed at point O as shown in the figure. Is the potential difference $V_A - V_B$ positive, negative or zero? **(DELHI 2016)**



21. How does the electric flux due to a point charge enclosed by a spherical Gaussian surface get affected when its radius is increased? **(DELHI 2016)**

22. What is the amount of work done in moving a point charge Q around a circular arc of radius r at the centre of which another point charge q is located? **(A.I. 2016)**

23. Draw a plot showing variation of electric field with distance from the centre of a solid conducting sphere of radius R, having a charge of +Q on its surface. **(2017)**

24. Does the charge given to a metallic sphere depend on whether it is hollow or solid? Give reason for your answer. **(DELHI 2017)**

25. Draw the pattern of electric field lines when a point charge +q is kept near an uncharged conducting plate. **(CBSE 2019)**

Select the most appropriate option from those given question (Q.26 and 27)

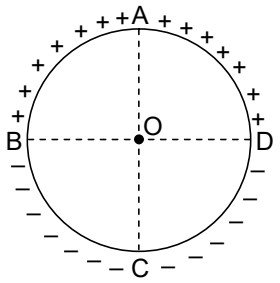
26. If the net electric flux through a closed surface is zero, then we can infer **(2020)**
(A) No net charge is enclosed by the surface.
(B) Uniform electric field exists within the surface.
(C) Electric potential varies from point to point inside the surface.
(D) Charge is present inside the surface.

27. An electric dipole consisting of charges + q and – q separated by a distance L is in stable equilibrium in a uniform electric field $\vec{E}$. The electrostatic potential energy of the dipole is $\vec{E}$.
(A) qLE (B) zero (C) – qLE (D) – 2 qEL **(2020)**

28. The magnitude of the electric field due to a point charge object at a distance of 4.0m is 9N/C. From the same charged object, the electric field of magnitude, 16 N/C will be at a distance of **(2023)**
(A) 1m (B) 2m (C) 3m (D) 6m

29. A point P lies at a distance x from the midpoint of an electric dipole on its axis. The electric potential at point P is proportional to **(2023)**
(A) $\frac{1}{x^2}$ (B) $\frac{1}{x^3}$ (C) $\frac{1}{x^4}$ (D) $\frac{1}{x^5}$

30. **Assertion (A):** Equal amount of positive and negative charges are distributed uniformly on two halves of a thin circular ring as shown in the figure. The resultant electric field the centre O of the ring is along OC.



Reason (R): It is so because the net potential at O is not zero.
(A) If both Assertion (A) and Reason (R) are true and Reason (R) is correct explanation of Assertion (A).
(B) If both Assertion (A) and Reason (R) are true and Reason (R) is not the correct explanation of Assertion (A).
(C) If Assertion (A) is true but Reason (R) is false.
(D) If both Assertion (A) and Reason (R) are false.
(2024)

Two Marks Questions

1. Two similarly and equally charged identical metal spheres A and B repel each other with a force of 2×10^{-5} N. A third identical uncharged sphere C is touched with A and then placed at the mid–point between A and B. Calculate the net electric force on C. **(2003)**

2. An electric dipole of length 8 cm, when placed with its axis making an angle of 60° with a uniform electric field experiences a torque of $8\sqrt{3}$ Nm. Calculate the (i) magnitude of the electric field, (ii) potential energy of the dipole, if the dipole has charges of ± 4 nC. **(2004)**

3. An electric dipole of length 4 cm, when placed with its axis making an angle of 30° with a uniform electric field experiences a torque of 4 Nm. Calculate the (i) magnitude of the electric field. (ii) Potential energy of the dipole, if the dipole has charges of ± 10 nC. **(2004)**

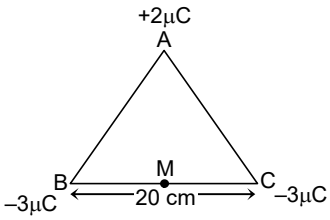
4. An electric dipole of length 4 cm, when placed with its axis making an angle of 60° with a uniform electric field experiences a torque $4\sqrt{3}$ of Nm. Calculate the (i) magnitude of the electric field. (ii) Potential energy of the dipole, if the dipole has charges of ± 8nC. **(2004)**

5. Define 'electric line of force' and give its two important properties. **(CBSE 2005)**

6. (a) Why does the electric field inside a dielectric decrease when it is placed in an external electric field?
(b) A parallel plate capacitor with air between the plates has a capacitance of 8 pF. What will be the capacitance if the distance between the plates be reduced by half and the space between them is filled with a substance of dielectric constant K = 6?
(CBSE 2005)

OR

(c) Three point charges of + 2μC, – 3μC and – 3μC are kept at the vertices A, B and C respectively of an equilateral triangle of side 20 cm as shown in the figure. What should be the sign and magnitude of the charge to be placed at the mid–point (M) of side BC so that the charge at A remains in equilibrium?



7. An electric dipole is held in a uniform electric field. (i) Using suitable diagram, show that it does not undergo any translatory motion, and (ii) derive an expression for the torque acting on it and specify its direction. **(CBSE 2005)**

8. Define electric field intensity. Write its S.I. unit. Write the magnitude and direction of electric field intensity due to an electric dipole of length 2a at the mid–point of the line joining the two charges. **(A.I. 2005)**

9. A charge q is placed at the centre of the line joining two equal charges Q. Show that the system of three charges will be in equilibrium if q = – Q/4. **(A.I. 2005)**

OR

A 5μF capacitor is charged by a 100 V supply. The supply is then disconnected and the charged capacitor is connected to another uncharged 3μF capacitor. How much electrostatic energy of the first capacitor is lost in the process of attaining the steady situation?

10. Two fixed point charges + 4e and + e units are separated by a distance 'a'. Where should the third point charge be placed for it to be in equilibrium? **(A.I. 2005)**

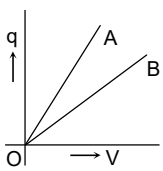
OR

A 4μF capacitor is charged by a 200 V supply. The supply is then disconnected and the charged capacitor is connected to another uncharged 2μF capacitor. How much electrostatic energy of the first capacitor is lost in the process of attaining the steady situation?

11. A parallel capacitor is to be designed with a voltage rating 1 kV using a material of dielectric constant 3 and dielectric strength of above 10^7 Vm^{-1}. For safety we would like the field never to exceed say, 10% of the dielectric strength. What minimum area of the plats is required to have a capacitance of 50 pF? **(A.I. 2005)**

12. The electric field and electric potential at any point due to a point charge kept in air is 20 NC^{-1} and 10 JC^{-1} respectively. Compute the magnitude of this charge. **(CBSE 2006)**

13. The given graph shows the variation of charge q versus potential difference V for two capacitors. The two capacitors C_1 and C_2 have same plate separation but the plate area of C_2 is double than that of C_1. Which of the lines in the graph correspond to C_1 and C_2 and why? **(CBSE 2006)**



14. Two capacitors of capacitance of 6μF and 12μF are connected in series with a battery. The voltage across the 6μF capacitor is 2V. Compute the total battery voltage. **(A.I. 2006)**

OR

A parallel plate capacitor with air between the plates has a capacitance of 8pF. The separation between the plates is now reduced by half and the space between them is filled with a medium of dielectric constant 5. Calculate the value of capacitance of the capacitance in the second case.

15. The electric field E due to a point charge at any point near it is defined as $E = \lim_{q \to 0} \frac{F}{q}$ where q is the test charge and F is the force acting on it. What is the physical significance of $\lim_{q \to 0}$ in this expression? Draw the electric field lines of a point charge Q when.
(i) Q > 0 and
(ii) Q < 0 **(CBSE 2007)**

16. Define electric flux. Write its S.I. units. A spherical rubber balloon carries a charge that is uniformly distributed over its surface. As the balloon is blown up and increases in size, how does the total electric flux coming out of the surface change? Give reason. **(CBSE 2007)**

17. Derive an expression for the torque acting on an electric dipole, which is held in a uniform electric field when the axis of the dipole makes an angle θ with the electric field. **(CBSE 2008)**

18. Draw equipotential surfaces corresponding to a field that uniformly increases in magnitude but remains constant along Z–direction. How are these surfaces different from that of a constant electric field along Z–direction? **(2009)**

19. Define electric flux. Write its S.I. unit?
A charge q is enclosed by a spherical surface of radius r. If the radius is reduce to half, how would the electric flux through the surface change? **(CBSE 2009)**

20. A thin straight infinitely long conducting wire having charge density λ is enclosed by a cylindrical surface of radius r and length ℓ, its axis coinciding with the length of the wire. Find the expression for the electric flux through the surface of the cylinder. **(CBSE 2011)**

21. Plot a graph showing the variation of coulomb force(F) versus $\left(\frac{1}{r^2}\right)$, where r is the distance between the two charges of each pair of charges (1μC, 2μC) and (2μC, – 3μC). Interpret the graphs obtained. **(A.I. 2011)**

22. Net capacitance of three identical capacitors in series is 1 μF. What will be their net capacitance if connected in parallel? Find the ratio of energy stored in the two configurations if they are both connected to the same source. **(CBSE 2011)**

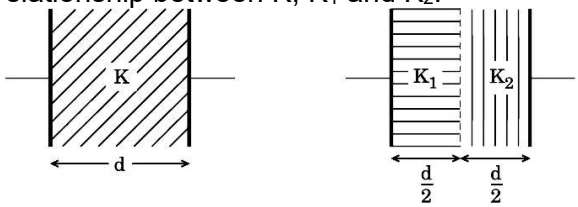
23. Draw a plot showing the variation of (i) electric field (E) and (ii) electric potential (V) with distance r due to a point charge Q. **(CBSE 2012)**

24. A slab of material of dielectric constant K has the same area as that of the plates of a parallel plate capacitor but has the thickness 2d/3, where d is the separation between the plates. Find out the expression for its capacitance when the slab is inserted between the plates of the capacitor. **(DELHI 2013)**

25. A parallel plate capacitor of capacitance C is charged to a potential V. It is then connected to another uncharged capacitor having the same capacitance. Find out the ratio of the energy stored in the combined system to that stored initially in the single capacitor. **(DELHI 2014)**

26. Find the electric field intensity due to a uniformly charged spherical shell at a point (i) outside the shell and (ii) inside the shell. Plot the graph of electric field with distance from the centre of the shell. **(A.I. 2016)**

27. The space between the plates of a parallel plate capacitor is completely filled in two ways. In the first case, it is filled with a slab of dielectric constant K. In the second case, it is filled with two slabs of equal thickness and dielectric constants K_1 and K_2 respectively as shown in the figure. The capacitance of the capacitor is same in the two cases. Obtain the relationship between K, K_1 and K_2. **(CBSE 2020)**



(Case 1) (Case 2)

28. (a) Four point charges of 1 μC, – 2 μC, 1 μC and – 2 μC are placed at the corners A, B, C and D respectively, of a square of side 30 cm. Find the net force acting on a charge of 4 μC placed at the centre of the square. **(2024)**

OR

(b) Three point charges 1 pC each, are kept at the vertices of an equilateral triangle of side 10 cm. Find the net electric field at the centroid of triangle.

Three Marks Questions

1. Give the principle of working of a Van de Graff generator. With the help of a labelled diagram, diagram, describe its construction and working. How is the leakage of charge minimized from the generator? **(2003)**

2. A 20μF capacitor is charged by a 30 V dc supply and then connected across an uncharged 50μF capacitor. Calculate (i) the final potential difference across the combination, and (ii) the initial and final energies. How will you account for the difference in energy? **(2004)**

3. State Gauss's theorem in electrostatics. Using this theorem, derive an expression for the electric field intensity due to an infinite plane sheet of charge of charge density $\sigma C/m^2$. **(2004)**

4. State Gauss's theorem. Apply this theorem to obtain the expression for the electric field intensity at a point due to an infinitely long, thin, uniformly charged straight wire. **(A.I. 2005)**

5. Using Gauss's theorem, show mathematically that for any point outside the shell, the field due to a uniformly charged thin spherical shell is the same as if the entire charge of

the shell is concentrated at the centre. Why do you expect the electric field inside the shell to be zero according to this theorem? **(A.I. 2006)**

6. What is electric flux? Write its S.I. units. Using Gauss's theorem, deduce an expression for the electric field at a point due to a uniformly charged infinite plane sheet. **(CBSE 2006)**

7. Deduce an expression for the electric potential due to an electric dipole at any point on its axis. Mention one contrasting feature of electric potential of a dipole at a point as compared to that due to a single charge. **(CBSE 2007)**

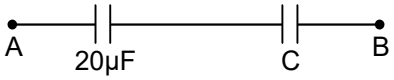
8. A parallel plate capacitor, each with plate area A and separation d, is charged to a potential difference V. The battery used to charge it is then disconnected. A dielectric slab of thickness d and dielectric constant K is now placed between the plates. What change, if any, will take place in: **(CBSE 2007)**
   (i) Charge on the plates
   (ii) Electric field intensity between the plates
   (iii) Capacitance of the capacitor
   Justify your answer in each case.

9. Use Gauss's law to derive the expression for the electric field between two uniformly charged large parallel sheets with surface charge densities σ and $-\sigma$ respectively. **(CBSE 2009)**

OR

   (a) A charge + Q is placed on a large spherical conducting shell of radius R. Another small conducting sphere of radius r carrying charge 'q' is introduced inside the large shell and is placed at its centre. Find the potential difference between two points, one lying on the sphere and the other on the shell.
   (b) How would the charge between the two flow if they are connected by a conducting wire? Name the device which works on this fact.

10. The equivalent capacitance of the combination between A and B in the given figure is 4F.



   (i) Calculate capacitance of the capacitor C.
   (ii) Calculate charge on each capacitor if a 12V battery is connected across terminals A and B.
   (iii) What will be the potential drop across each capacitor? **(CBSE 2009)**

11. State Gauss's law in electrostatics. Using this law derive an expression for the electric field due to a uniformly charged infinite plane sheet. **(CBSE 2009)**

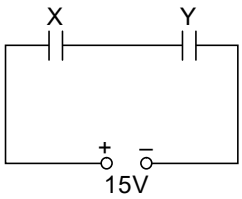
12. (a) Depict the equipotential surfaces for a system of two identical positive point charges placed a distance 'd' apart. **(2010)**
   (b) Deduce the expression for the potential energy of a system of two point charges q_1 and q_2 brought from infinity to the points $\vec{r}_1$ and $\vec{r}_2$ respectively in the presence of external electric field $\vec{E}$.

13. A parallel–plate capacitor is charged to a potential difference V by a dc source. The capacitor is then disconnected from the source. If the distance between the plates is doubled, state with reason how the following change: **(2010)**
(i) Electric field between the plates
(ii) Capacitance, and
(iii) Energy stored in the capacitor

14. Two capacitors of unknown capacitances C_1 and C_2 are connected first in series and then in parallel across a battery of 100 V. If the energy stored in the two combinations is 0.045 J and 0.25 J respectively, determine the value of C_1 and C_2. Also calculate the charge on each capacitor in parallel combination. **(DELHI 2015)**

15. A charge is distributed uniformly over a ring of radius 'a'. Obtain an expression for the electric intensity E at a point on the axis of the ring. Hence show that for points at large distances from the ring, it behaves like a point charge. **(DELHI 2016)**

16. Two parallel plate capacitors X and Y have the same area of plates and same separation between them. X has air between the plates while Y contains a dielectric medium of $\varepsilon_r = 4$. **(DELHI 2016)**



(i) Calculate capacitance of each capacitor if equivalent capacitance of the combination is $4\mu F$.
(ii) Calculate the potential difference between the plates of X and Y.
(iii) Estimate the ratio of electrostatic energy stored in X and Y.

17. (a) Write two properties by which electric potential is related to the electric field. **(2017)**
(b) Two point charges q_1 and q_2, separated by a distance of r_{12} are kept in an external electric field. Derive an expression for the potential energy of the system of two charges in the field.

OR

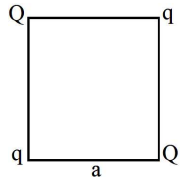
State Gauss's law in electrostatics. Derive an expression for the electric field due to an infinitely long straight uniformly charged wire.

18. A capacitor of unknown capacitance is connected across a battery of V volt. A charge of 360 μC is stored in it. When the potential across the capacitor is reduced by 120 V, the charge stored in the capacitor becomes 120 μC. Calculate V and the unknown capacitance. What would have been the charge on the capacitor if the voltage were increased by 120 V? **(2017)**

19. A 12 pF capacitor is connected to a 50 v battery. How much electrostatic energy is stored in the capacitor? If another capacitor of 6 pF is connected in series with it with the same battery connected across the combination, find the charge stored and potential difference across each capacitor. **(DELHI 2017)**

20. (i) Derive the expression for the electric potential due to an electric dipole at a point on its axial line. **(DELHI 2017)**
(ii) Depict the equipotential surfaces due to an electric dipole.

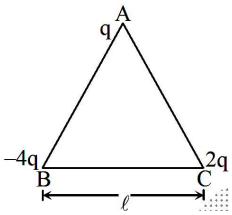
21. Four point charges Q, q, Q and q are placed at the corners of a square of side 'a' as shown in the figure. **(CBSE 2018)**



Find the:
(a) resultant electric force on a charge Q, and
(b) potential energy of this system.

OR

(a) Three point charges q, – 4q and 2a are placed at the vertices of an equilateral triangle ABCD of side 'ℓ' a shown in the figure. Obtain the expression for the magnitude of the resultant electric force acting on the charge q.
(b) Find out the amount of the work done to separate the charges at infinite distance.



22. (a) Draw the equipotential surfaces due to an electric dipole. **(CBSE 2019)**
(b) Derive an expression for the electric field due to a dipole of dipole moment $\vec{p}$ at a point on its perpendicular bisector.

23. (a) Two charged conducting spheres of radii 'a' and 'b' are connected to each other by a wire. Find the ratio of the electric fields at their surfaces. **(2023)**

OR

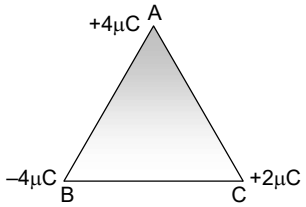
(b) A parallel plate capacitor (A) of capacitance C is charged by a battery to voltage V. The battery is disconnected and an uncharged capacitor (B) of capacitance 2C is connected across A. Find the ratio of **(2023)**
(i) Final charges on A and B.
(ii) Total electrostatic energy stored in A and B finally and that stored in A, initially.

Four Marks Questions

1. (a) (i) Use Gauss's law to obtain an expression for the electric field due to an infinitely long thin straight wire with uniform linear charge density λ. **(2023)**
(ii) An infinitely long positively charged straight wire has a linear charge density λ. An electron is revolving in a circle with a constant speed ν such that the wire passes through the centre and is perpendicular to the plane, of the circle. Find 1111the kinetic energy of the electron in terms of magnitudes of its charge and linear charge density λ on the wire.
(iii) Draw a graph of kinetic energy as a function of linear charge density λ.

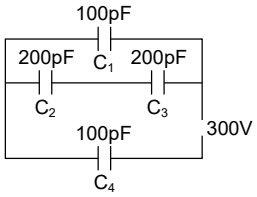
OR

(b) (i) Consider two identical point charges located at points (0,0) and (a, 0). **(2023)**
(1) Is there a point on the line joining them at which the electric field is zero?
(2) Is there a point on the line joining them at which the electric potential is zero?
(ii) State the significance of negative value of electrostatic potential energy of a system of charges.
Three charges are placed at the corners of an equilateral triangle ABC of side 2.0m as shown in figure, Calculate the electric potential energy of the system of three charges.



Five Marks Questions

1. (a) Derive an expression for the energy stored in a parallel plate capacitor C, charged to a potential difference V. **(2008)**
   (b) Obtain the equivalent capacitance of the network given below. For a supply of 300 V, determine the charge and voltage across C_4.



2. Explain the principle of a device that can build up high voltages of the order of a few million volts. Draw a schematic diagram and explain the working of this device. Is there any restriction on the upper limit of the high voltage set up in this machine? Explain. **(CBSE 2012)**

OR

   (a) Define electric flux. Write the S.I. units.
   (b) Using Gauss's law, prove that the electric field at a point due to a uniformly charged infinite plane sheet is independent of the distance from it.
   (c) How is the field directed if (i) the sheet is positively charged, (ii) negatively charged?

3. (a) Define electric dipole moment. Is it a scalar or a vector? Derive the expression for the electric field of a dipole at a point on the equatorial plane of the dipole.
   (b) Draw the equipotential surfaces due to an electric dipole. Locate the points where the potential due to the dipole is zero. **(CBSE 2013)**

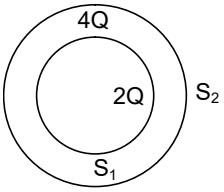
OR

Using Gauss' law deduce the expression for the electric field due to a uniformly charged spherical conducting shell of radius R at a point (i) outside and (ii) inside the shell.
Plot a graph showing variation of electric field as a function of r > R and r < R (r being the distance from the centre of the shell).

4. Draw a labelled diagram of Van de Graff generator. State its working principle to show how by introducing a small charged sphere into a larger sphere, a large amount of charge can be transferred to the outer sphere. State the use of this machine and also point out its limitations. **(2014)**

OR

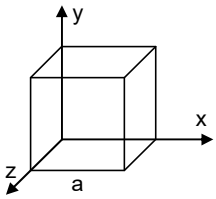
   (a) Deduce the expression for the torque acting on a dipole of dipole moment $\vec{p}$ in the presence of a uniform electric field $\vec{E}$
   (b) Consider two hollow concentric spheres, S_1 and S_2, enclosing charges 2Q and 4Q respectively as shown in the figure (i) Find out the ratio of the electric flux through them. (ii) How will the electric flux through the sphere S_1 change if a medium of dielectric constant 'εr' is introduced in the space inside S_1 in place of air? Deduce the necessary expression.



5. (a) An electric dipole of dipole moment $\vec{p}$ consists of point charges +q and −q separated by a distance 2a apart. Deduce the expression for the electric field due to the dipole

at a distance x from the centre of the dipole on its axial line in terms of the dipole moment $\vec{p}$. Hence show that in the limit $x >> a$, $E \to 2p/\left(4\pi\varepsilon_0 x^3\right)$. **(DELHI 2015)**

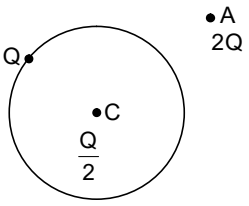
(b) Given the electric field in the region $\vec{E} = 2x\hat{i}$, find the net electric flux through the cube and the charge enclosed by it.



OR

(a) Explain, using suitable diagrams, the difference in the behaviour of a (i) conductor and (ii) dielectric in the presence of external electric field. Define the terms polarization of a dielectric and write its relation with susceptibility.

(b) A thin metallic spherical shell of radius R carries a charge Q on its surface. A point charge $\frac{Q}{2}$ is placed at its centre C and an other charge +2 outside the shell at a distance x from the centre as shown in the figure. Find (i) the force on the charge at the centre of shell and at the point A, (ii) the electric flux through the shell.



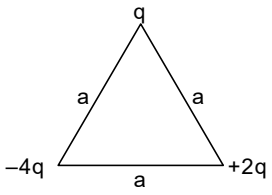
6. (a) Distinguish, with the help of a suitable diagram, the difference in the behaviour of a conductor and a dielectric placed in an external electric field. How does polarised dielectric modify the original external field? **(A.I. 2016)**

(b) A capacitor of capacitance C is charged fully by connecting it to a battery of emf E. It is then disconnected from the battery. If the separation between the plates of the capacitor is now doubled, how will the following change?
(i) charge stored by the capacitor.
(ii) field strength between the plates.
(iii) energy stored by the capacitor.
Justify your answer in each case.

OR

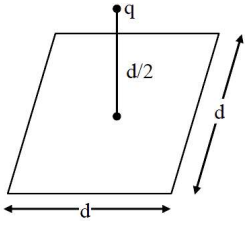
(a) Explain why, for any charge configuration, the equipotential surface through a point is normal to the electric field at that point. Draw a sketch of equipotential surfaces due to a single charge (– q), depicting the electric field lines due to the charge.

(b) Obtain an expression for the work done to dissociate the system of three charges placed at the vertices of an equilateral triangle of side 'a' as shown.



7. (a) Define electric flux. Is it a scalar or a vector quantity?
A point charges q is at a distance of d/2 directly above the centre of a square of side a, as shown in the figure. Use Gauss' law to obtain the expression for the electric flux through the square. **(CBSE 2018)**

(b) If the point charge is now moved to a distance 'd' from the centre of the square and the side of the square is doubled,



explain how the electric flux will be affected.

OR

(a) Use Gauss' law to derive the expression for the electric field ($\vec{E}$) due to a straight uniformly charged infinite line of charge density λC/m.

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

(c) Find the work done in bringing a charge q from perpendicular distance r_1 to r_2 ($r_2 > r_1$).

8. (a) Describe briefly the process of transferring the charge between the two plates of a parallel plate capacitor when connected to a battery. Derive an expression for the energy stored in a capacitor. **(CBSE 2019)**

(b) A parallel plate capacitor is charged by a battery to a potential difference V. It is disconnected from battery and then connected to another uncharged capacitor of the same capacitance. Calculate the ratio of the energy stored in the combination to the initial energy on the single capacitor.

OR

(a) Derive an expression for the electric field at any point on the equatorial line of an electric dipole.

(b) 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.

9. (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) $x > R$. **(CBSE 2020)**

(b) 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 = 200 N/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.

OR

(a) Find the expression for the potential energy of a system of two point charges q_1 and q_2 located at $\vec{r}_1$ and $\vec{r}_2$, respectively in an external electric field $\vec{E}$. **(CBSE 2020)**

(b) Draw equi-potential surfaces due to an isolated point charge (– q) and depict the electric field lines.

(c) Three point charges +1 μC, –1 μC and +2 μC are initially infinite distance apart. Calculate the work done in assembling these charges at the vertices of an equilateral triangle of side 10 cm.

10. (a) (i) Draw equipotential surfaces for an electric dipole.

(ii) Two point charges q_1 and q_2 are located at $\vec{r}_1$ and $\vec{r}_2$ respectively in an external electric field $\vec{E}$. Obtain an expression for the potential energy of the system.

(iii) The dipole moment of a molecule is 10^{-30} C-m. It is placed in an electric field $\vec{E}$ of 10^5 V/m such that its axis is along the electric field. The direction of $\vec{E}$ is suddenly changed by 60° at an instant. Find the change in the potential energy of the dipole, at that instant.

OR

(b) (i) A thin spherical shell of radius R has a uniform surface charge density σ. Using Gauss' law, deduce an expression for electric field (i) outside an (ii) inside the shell. **(2024)**

(ii) Two long straight thin wires AB and CD have linear charge densities 10 μC/m and –20 μC/m, respectively. They are kept parallel to each other at a distance 1 m. Find the magnitude and direction of the net electric field at a point midway between them.