DAV PUBLIC SCHOOL, BUXAR

ELECTROSTATICS

1 Mark Questions

Q.1. An electric dipole of length 2 cm is placed at an angle of 30° with an electric field 2×10^5 N/C. If the dipole experiences a torque of 8×10^{-3} Nm, the magnitude of either charge of the dipole, is **1**

(A) 4 μC (B) 7 μC 2023 Set - 1

(C) 8 mC (D) 2 mC

Q.2. The capacitors, each of 4 μF are to be connected in such a way that the effective capacitance of the combination is 6 μF. This can be achieved by connecting **1**

2023 Set - 1

(A) All three in parallel

(B) All three in series

(C) Two of them connected in series and the combination in parallel to the third.

(D) Two of them connected in parallel and the combination in series to the third.

Q.3. If a positive charge is displaced against the electric field in which it was situated, then *1*

(A) work will be done by the electric field on the charge.

(B) the intensity of the electric field decreases. 2020 Set - 1

(C) energy of the system will decrease.

(D) energy will be provided by external source displacing the charge.

Q.4 The electric flux emerging out from 1 C charge is 2020 Set - 1 *1*

(A) $\frac{1}{\varepsilon_0}$ (B) 4π (C) $\frac{4\pi}{\varepsilon_0}$ (D) ε_0

Q.5 Two capacitors of capacitances C_1 and C_2 are connected in parallel. If a charge Q is given to the combination, the ratio of the charge on the capacitor C_1 to the charge on C_2 will be 2020 Set - 1 *1*

(A) $\frac{C_1}{C_2}$ (B) $\sqrt{\frac{C_1}{C_2}}$ (C) $\sqrt{\frac{C_2}{C_1}}$ (D) $\frac{C_2}{C_1}$

Q.6 A parallel plate capacitor is charged to V volt by a battery. The battery is disconnected and the separation between the plates is halved. The new potential difference across the capacitor will be 2020 Set - 2 *1*

(A) $\frac{V}{2}$ (B) V (C) 2V (D) $\frac{V}{4}$

Q.7. A charge Q is kept at the centre of a circle of radius r. A test charge q_0 is carried from a point X to the point Y on this circle such that arc XY subtends an angle of 60° at the centre of the circle. The amount of work done in this process will be 2020 Set - 2 *1*

(A) $\frac{1}{4\pi\varepsilon_0}\frac{Qq_0}{2r}$ (B) $\frac{1}{4\pi\varepsilon_0}\frac{\sqrt{3}Qq_0}{2r}$ (C) **Zero** (D) $\frac{1}{4\pi\varepsilon_0}\frac{\sqrt{3}Qq_0}{r}$

Q.8. An electric dipole consisting of charges + q and − q separated by a distance r, is kept symmetrically at the centre of an imaginary sphere of radius R (> r). Another point charge Q is also kept at the centre of the sphere. The net electric flux coming out of the sphere will be 2020 Set - 2 *1*

(A) $\frac{-(2q+Q)}{4\pi\varepsilon_0}$ (B) $\frac{Q}{\varepsilon_0}$ (C) $\frac{2q+Q}{\varepsilon_0}$ (D) $\frac{-Q}{\varepsilon_0}$

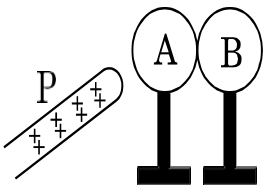
Q.9. Two large conducting spheres carrying charges Q_1 and Q_2 are kept with their centres r distance apart. The magnitude of electrostatic force between them is not exactly $\frac{1}{4\pi\varepsilon_0}\frac{Q_1Q_2}{r^2}$ because 2020 Set - 3 *1*

(A) these are not point charges.
(B) charge distribution on the spheres is not uniform.
(C) charges on spheres will shift towards the centres of their respective spheres.
(D) charges will shift towards the portions of the spheres which are closer and facing towards each other.

Q.10. A charged particle is placed between the two plates of a charged parallel plate capacitor. It experiences a force F. If one plate is removed, then the force on the particle will be *1*

(A) 2F (B) F 2020 Set - 3
(C) $\frac{F}{2}$ (D) Zero

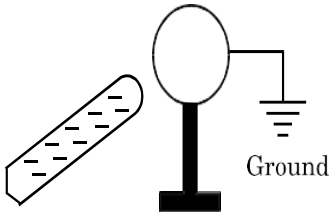
Q.11. Two metallic spheres A and B kept on insulating stands are in contact with each other. A positively charged rod P is brought near the sphere A as shown in the figure. The two spheres are separated from each other, and the rod P is removed. What will be the nature of charges on spheres A and B ?



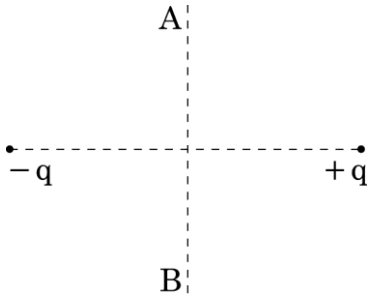
2020 Set – 1,2,3

Q.12. A metal sphere is kept on an insulating stand.

A negatively charged rod is brought near it, then the sphere is earthed as shown. On removing the earthing, and taking the negatively charged rod away, what will be the nature of charge on the sphere ? Give reason for your answer.

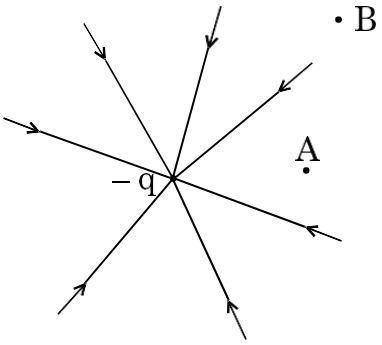


Q.13. A charge 'q' is moved from a point A above a dipole of dipole moment 'p' to a point B below the dipole in equatorial plane without acceleration. Find the work done in the process.



2016 Set – 1,2,3

Q.14. The field lines of a negative point charge are as shown in the figure. Does the kinetic energy of a small negative charge increase or decrease in going from B to A ?



2015 Set – 1,2,3

Q.15. Why do the electric field lines never cross each other?

2014 Set – 3

Q.16. Two charges of magnitudes - 3Q and + 2Q are located at points (a,0) and (4a,0) respectively. What is the electric flux due to these charges through a sphere of radius '5a' with its centre at the origin?

2013 Set – 2

CLASS: XII PHYSICS PYBQP (2013-23) ELECTROSTATICS

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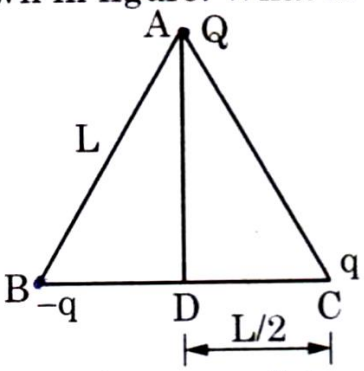
2 Marks Questions

1. Depict the orientation of an electric dipole in (a) stable and (b) unstable equilibrium in an external uniform electric field. Write the potential energy of the dipole in each case.

2023 Set – 1

2. Three point charges Q, q and – q are kept at the vertices of an equilateral triangle of side L as shown in figure. What is



2023 Set – 3

(i) the electrostatic potential energy of the arrangement ? and

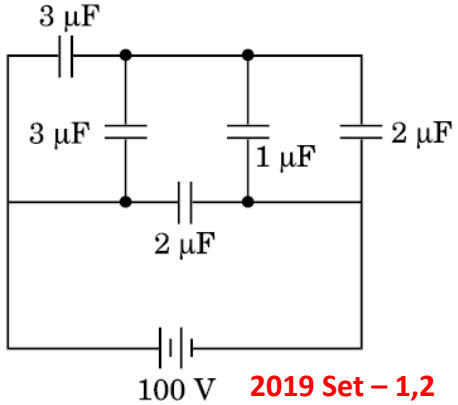
(ii) the potential at point D ?

3. Five point charges, each of charge + q are placed on five vertices of a regular hexagon of side '*l*'. Find the magnitude of the resultant force on a charge – q placed at the centre of the hexagon.

OR

A simple pendulum consists of a small sphere of mass m suspended by a thread of length *l*. The sphere carries a positive charge q. The pendulum is placed in a uniform electric field of strength E directed vertically downwards. Find the period of oscillation of the pendulum due to the electrostatic force acting on the sph e gravitational force.

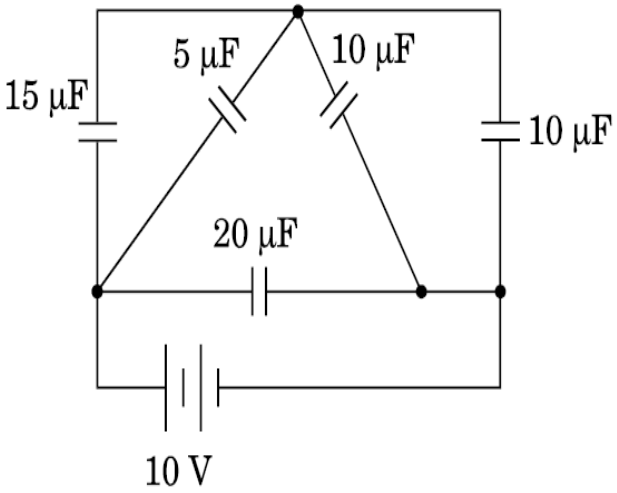
4. The figure shows a network of five capacitors connected to a 100 V stored in the network.



2019 Set – 1,2

5. The figure shows a network of five capacitors connected to a 10 V battery. Calculate the charge acquired by the 5 μF capacitor.

2019 Set – 3



6. A parallel plate capacitor of capacitance C is charged to a potential V. It is then connected to another uncharged capacitor having the same

2014 Set – 3

capacitance. Find out the ratio of the energy stored in the combined system to that stored initially in the single capacitor.

7. 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 is d/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. **2013 Set – 2**

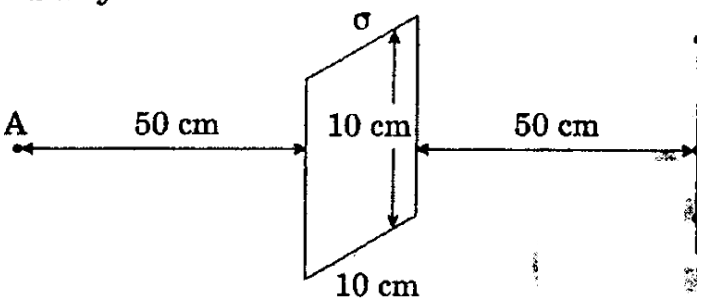
8. A capacitor, made of two parallel plates each of plate area A and separation d, is being charged by an external ac source. Show that the · displacement current inside the capacitor is the same as the current charging the capacitor.

3 Marks Questions

1. (a) A uniformly charged large plane sheet has charge density $\sigma = \left(\frac{1}{18\pi}\right) \times 10^{-15}\ C/m^2$. Find the electric field at point A which is 50 cm from the sheet.

Consider a straight line with three points P, Q and R, placed 50 cm from the charged sheet on the right side as shown in the figure. At which of these points, does the magnitude of the electric field due to the sheet remain the same as that at point A and why ?

2021 Set – 3



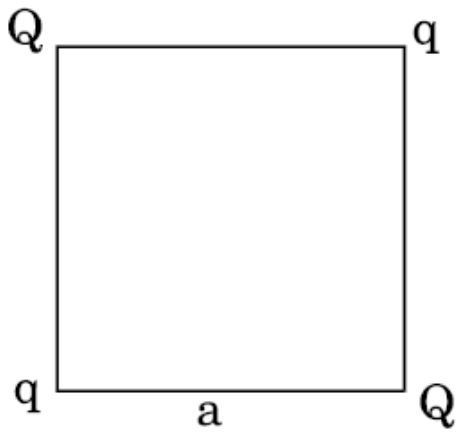
2. (b) Two small identical conducting spheres carrying charge 10 μC and – 20 μC when separated by a distance of r, experience a force F each. If they are brought in contact and then separated to a distance of $\frac{r}{2}$, what is the new force between them in terms of F ?

3. (i) Explain briefly, using a proper diagram, the difference in behaviour of a conductor and a dielectric in the presence of external electric field. **2019 Set – 1**

(ii) Define the term polarization of a dielectric and write the expression for a linear isotropic dielectric in terms of electric field.

4. Four point charges Q, q, Q and q are placed at the corners of a square of side 'a' as shown in the figure.
Find the
resultant electric force on a charge Q, and potential energy of this system.

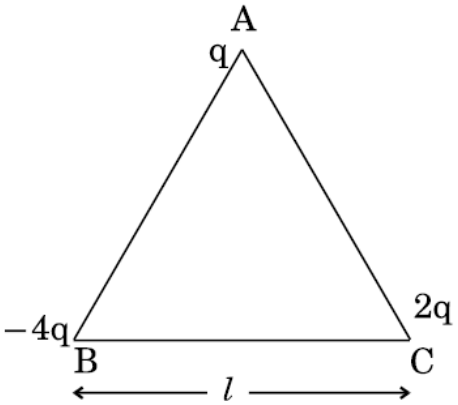
2018 Set – 1



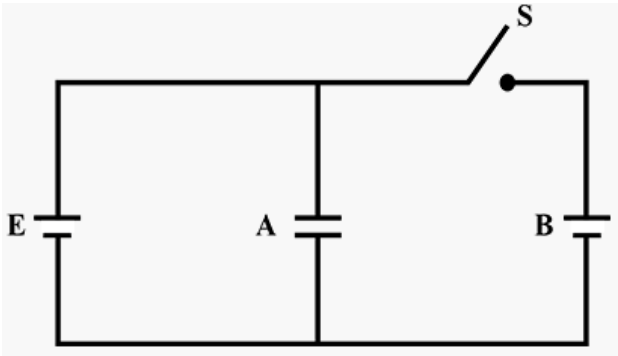
OR

5. Three point charges q, – 4q and 2q are placed at the vertices of an equilateral triangle ABC of side *'l'* as shown in the figure. Obtain the expression for the magnitude of the resultant electric force acting on the charge q.

Find out the amount of the work done to separate the charges at infinite distance. **2018 Set – 1**



6. Two identified parallel plate capacitors A and B are connected to a battery of V volts with the switch S closed. The switch is now opened and the free space between the plates of the capacitors is filled with a dielectric of dielectric constant K. Find the ratio of the total electrostatic energy stored in both capacitors before and after the introduction of the dielectric. **2017 Set – 1**



7. Define an equipotential surface. Draw equipotential surfaces:

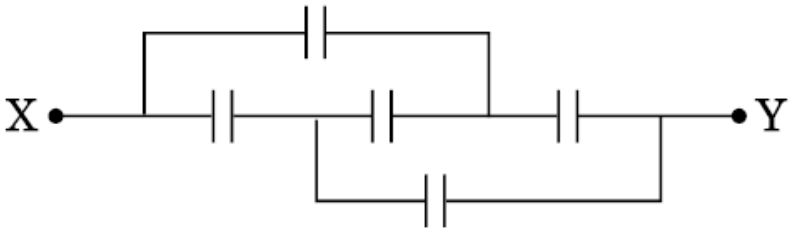
(i) in the case of a single point charge and **2016 Set – 1,2**

(ii) in a constant electric field in Z-direction.

Why the equipotential surfaces about a single charge are not equidistant?

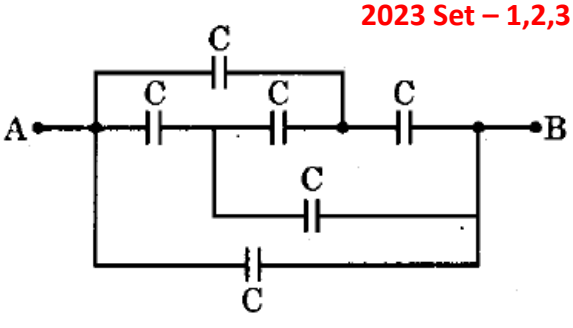
(iii) Can electric field exist tangential to an equipotential surface? Give reason.

8. Find the equivalent capacitance of the network shown in the figure, when each capacitor is of 1 μF. When the ends X and Y are connected to a 6 V battery, find out (i) the charge and (ii) the energy stored in the network.



4 Marks Questions

1. A capacitor is a system of two conductors separated by an insulator. The two conductors have equal and opposite charges with a potential difference between them. The capacitance of a capacitor depends on the geometrical configuration (shape, size and separation) of the system and also on the nature of the insulator separating the two conductors. They are used to store charges. Like resistors, capacitors can be arranged in series **2023 Set – 1,2,3**



or parallel or a combination of both to obtain desired value of capacitance.

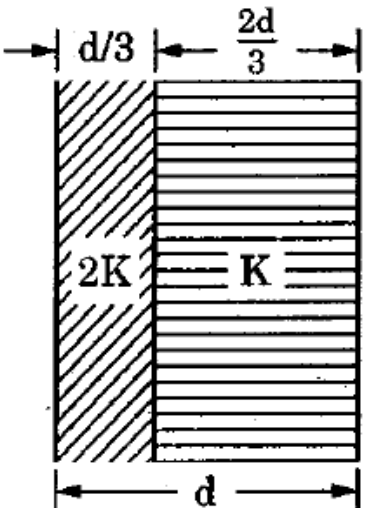
(i) Find the equivalent capacitance between points A and B in the given diagram.

(ii) A dielectric slab is inserted between the plates of a parallel plate capacitor. The electric field between the plates decreases. Explain.

(iii) A capacitor A of capacitance C, having charge Q is connected across another uncharged capacitor B of capacitance 2C. Find an expression for (a) the potential difference across the combination and (b) the charge lost by capacitor A.

2. Two slabs of dielectric constants 2K and K fill the space between the plates of a parallel plate capacitor of plate area A and plate separation d as shown in figure. Find an expression for capacitance of the system.

2023 Set – 1,2,3



5 Marks Questions

1. (a) (i) (A) Why does the electric field inside a dielectric slab decrease when kept in an external electric field ?

(B) Derive an expression for the capacitance of a parallel plate capacitor filled with a medium of dielectric constant K.

(ii) A charge q = 2 μC is placed at the centre of a sphere of radius 20 cm. What is the amount of work done in moving 4 μC from one point to another point on its surface ?

2021 Set – 1,2,3

(iii) Write a relation for polarisation $\vec{P}$ of a dielectric material in the presence of an external electric field.

OR

2. (b) (i) Obtain an expression for the potential energy of an electric dipole placed in a uniform electric field.

(ii) Three capacitors of capacitance C_1, C_2 and C_3 are connected in series to a source of V volt. Show that the total energy stored in the combination of capacitors is equal to sum of the energy stored in individual capacitors.

(iii) A capacitor of capacitance C is connected across a battery. After charging, the battery is disconnected and the separation between the plates is doubled. How will (i) the capacitance of the capacitor, and (ii) the electric field between the plates be affected ? Justify your answer.

3. (a) An electric dipole of dipole moment $\vec{p}$ is placed in a uniform electric field $\vec{E}$ at an angle θ with it. Derive the expression for torque ($\vec{\tau}$) acting on it. Find the orientation of the dipole relative to the electric field for which torque on it is (i) maximum, and (ii) half of maximum.

(b) Two point charges $q_1 = +1\ \mu C$ and $q_2 = +4\ \mu C$ are placed 2 m apart in air. At what distance from q_1 along the line joining the two charges, will the net electric field be zero ?

2020 Set – 1,2,3

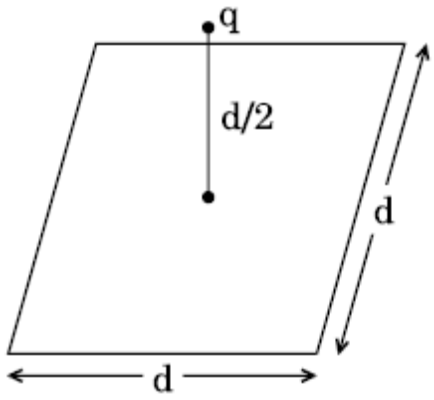
OR

4. (a) Derive an expression for the energy stored in a parallel plate capacitor of capacitance C when charged up to voltage V. How is this energy stored in the capacitor ?

(b) A capacitor of capacitance 1 μF is charged by connecting a battery of negligible internal resistance and emf 10 V across it. Calculate the amount of charge supplied by the battery in charging the capacitor fully.

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

(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

6. (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 λ C/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 ($r_2 > r_1$).

2018 Set – 1,2,3

7. Use Gauss's law to find the electric field due to a uniformly charged infinite plane sheet. What is the direction of field for positive and negative charge densities?

Find the ratio of the potential differences that must be applied across the parallel and series combination of two capacitors C_1 and C_2 with their capacitances in the ratio 1:2 so that the energy stored in the two cases becomes the same.

2016 Set – 1,2,3

OR

8. (a) If two similar large plates, each of area A having surface charge densities $+\sigma$ and $-\sigma$ are separated by a distance d in air, find the expressions for

(a) field at points between the two plates and on outer side of the plates. Specify the direction of the field in each case.

(b) the potential difference between the plates.

(c) the capacitance of the capacitor so formed.

(ii) Two metallic spheres of radii R and 2R are charged so that both of these have same surface charge density σ. If they are connected to each other with a conducting wire, in which direction will the charge flow and why?

9. (a) ''The outward electric flux due to charge + Q is independent of the shape and size of the surface which encloses it.'' Give two reasons to justify this statement.

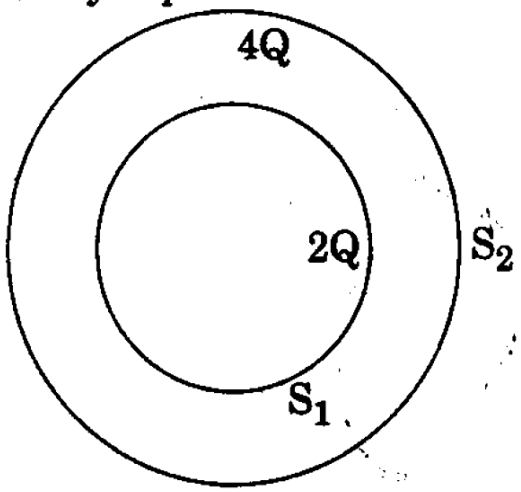
(b) Two identical circular loops '1' and '2' of radius R each have linear charge densities $-\lambda$ and $+\lambda$ C/m respectively. The loops are placed coaxially with their centres $R\sqrt{3}$ distance apart. Find the magnitude and direction of the net electric field at the centre of loop '1'.

2015 Set – 1,2,3

10. (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 'ε_r' is introduced in the space inside S_1 in place of air ? Deduce the necessary expression.**

2014 Set – 1,2,3



10. (i) Define electric dipole moment. Is it a scalar or a vector? Derive the expression for the

(ii) electric field of a dipole at a point on the equatorial plane of the dipole.

(iii) Draw the equipotential surfaces due to an electric dipole. Locate the points where the potential due to the dipole is zero.

2013 Set – 1,2,3

OR

11. 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)

12. (a) Derive an expression for the electric field E due to a dipole of length '2a' at a point distant r from the centre of the dipole on the axial line.

(b) Draw a graph of E versus r for r >> a.

(c) If this dipole were kept in a uniform external electric field E_o, diagrammatically represent the position of the dipole in stable and unstable equilibrium and write the expressions for the torque acting on the dipole in both the cases.

2017 Set – 1,2,3

OR

13. (a) Use Gauss's theorem to find the electric field due to a uniformly charged infinitely large plane thin sheet with surface charge density σ.

(b) An infinitely large thin plane sheet has a uniform surface charge density +σ. Obtain the expression for the amount of work done in bringing a point charge q from infinity to a point, distant r, in front of the charged plane sheet.

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