Chapter - 04

Electrostatic Potential & Capacitance

Very Short Answer Type Questions

01. Define electric potential.

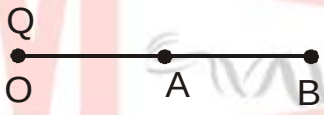
02. Name the physical quantity which has its unit joule coulomb^{-1}. Is it a scalar or vector?

03. Is electrostatic potential necessarily zero at a point where electric field strength is zero. Illustrate your answer.

04. A charge 5C is placed at a point. What is the work required to carry 1C of charge once round it in a circle of 12 cm radius?

05. Can two equipotential surfaces intersect each other? Justify your answer.

06. 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, if Q is (i) positive (ii) negative?



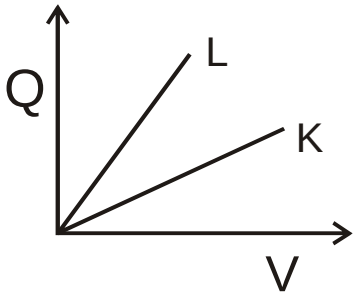
07. Can ever the whole charge of a body be transferred to the other? If yes how and if not why not?

08. The Safest way to protect yourself from lighting is to be inside a car. Comment.

09. What is the electro static potential due to an electric dipole at an equatorial point?

10. A metal plate is introduced between the plates of a charged parallel plate capacitor. What is its effect on the capacitance of the capacitor?

11. The following graph shows the variation of charge Q with voltage V, for two capacitors K and L. In which capacitor is more electrostatic energy is stored?



12. Define the term dielectric constant of a medium in terms of capacitance of a capacitor.

13. Sketch graph to show how charge Q given to a capacitor of capacity C varies with potential difference V?

Short Answer Type Questions (2 marks)

14. Derive the expression for the electric potential at a distance 'r' from a isolated point charge.

15. A point charge 'q' is placed at O as shown in figure. If $V_P - V_Q$ positive when (i) q > 0 (ii) q < 0? Justify your answer.

16. Two point charges 4 μC, -2 μC are separated by a distance of 1m in air. At what point on the line joining the charges is the electric potential zero?

17. 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.

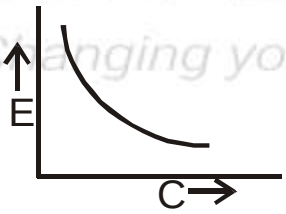
18. 2 μC charge is placed at each corner of a square ABCD of side $2\sqrt{2}$ cm. Calculate electric potential at the centre O of the square.

19. Derive an expression for the electric potential at a point along the axial line of an electric dipole.

20. Given a solid and hallow metal sphere of same radius are charged to same potential, which will hold more charge?

21. Graphically indicate the variation of the capacitance of a parallel plate capacitor with and Distance.

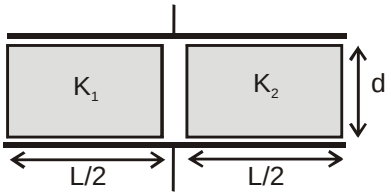
22. The graph showing variation of Energy stored in capacitor against the value of capacitance 'C'. Which quantity is kept constant for this graph ?.



23. Does the capacitance of a capacitor increases, decreases or remain same
(a) When charge on it is doubled
(b) When the potential difference across it is tripled?

24. A parallel plate capacitor has a capacity of $6\mu F$ in air and $60\mu F$ when dielectric medium is introduced. What is the dielectric constant of the medium?

25. Two dielectric slabs of dielectric constant K_1 and K_2 have been filled in between the plates of capacitor as shown in fig. what will be the capacitance of the capacitor?



Short Answer Type Questions (3 marks)

26. (i) Depict the equipotential surfaces for a system of two identical positive point charges placed at distance 'd' apart.

(ii) Can two equipotential surfaces intersect each other? Give reasons.

(iii) Two charge -q and +q are located at points A (0, 0, -a) and B (0, 0, +a) respectively. How much work is done in moving a test charge from point P(7, 0, 0) to Q (-3, 0, 0).

27. Explian the underlying principle of working of a parallel plate capacitor. If two similar plates each of area A having surface charge densities $+\sigma$ and $-\sigma$ are separated by a distance 'd' in air. Find out expression for

(i) The electric field at points between two plates

(ii) The potential difference between the plates.

(iii) The capacitance of the capacitor so formed.

28. Derive an expression for the capacitance of a parallel plate capacitor filled with a dielectric.

29. A parallel plate capacitor is charged by a battery. After some time the battery is disconnected and a dielectric slab of dielectric constant K is inserted between the plates. How would (i) Capacitance, (ii) the electric field between the plates and (iii) the energy stored in the capacitor be affected? Justify your answer.

30. Two charges 3×10^{-8} C and -2×10^{8}C are placed 15 cm apart. At what points on the line joining the two charges is the electric potential zero? Take the potential at infinity to be zero.

31. A cube of side b has a charge q at each of its vertices. Determine the potential and electric field due to this charge array at the centre of the cube.

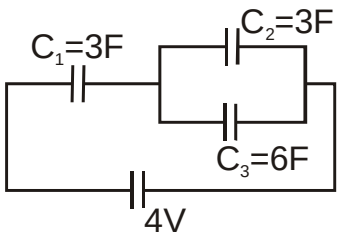
32. The air in between the plates of a parallel plate capacitor is replaced by a medium of dielectric constant K (K>1). How does it affect :

(a) Charge on the plate ? (b) P.d. between plates?

(c) $\vec{E}$ between plates ? (d) Energy stored in capacitor ?

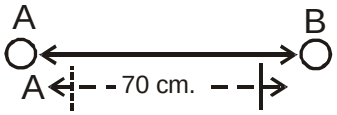
33. 75% of the distance 'd' between the parallel plates of capacitor is filled with a material of dielectric constant K. Find the charge in capacitor if the original capacitance was C_o.

34. In the circuit diagram, find out the charge on the capacitor C_1



35. Two point charges 10 x 10^{-8} C and -4 x 10^{-8} C are separated by a distance of 70 cm in air as shown in figure

(i) Find at what distance from a point A would the electric potential be zero.



(ii) Also calculate the electrostatic potential energy of the system

36. An electric dipole of length 4 cm when placed with its axis making an angle of 60^0 with the uniform electric field experience a torque of $4\sqrt{3}\ N.m.$ calculate the (i) magnitude of electric field (ii) P.E. of the dipole, if the dipole has charges of $\pm 8nC$.

Long Answer Type Questions (5 marks)

37. Derive an expression for potential at point on

(i) an axial line of dipole (ii) an equitorial line of dipole.

38. Derive the expression for the potential energy of an electric dipole of dipole moment $\vec{p}$ placed in a uniform electric field $\vec{E}$ .Find out the orientation of the dipole when it is in

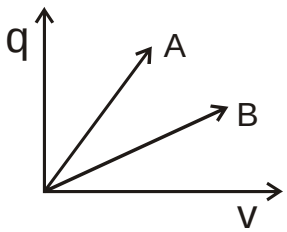
(i) Stable equilibrium (ii) Unstable equilibrium.

MODEL QUESTIONS

Short Answer Type Questions (2 marks)

01. 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.

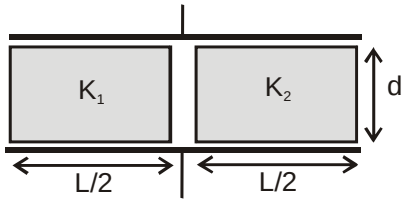
02. The given graph shows the variation of charge 'q' versus potential difference V for two capacitors C_1 and C_2. The two capacitors have same plate separation but the plate area of C_2 is double than that of C_1. Which of the lines in the graph correspond to C_1 and C_2 and why?



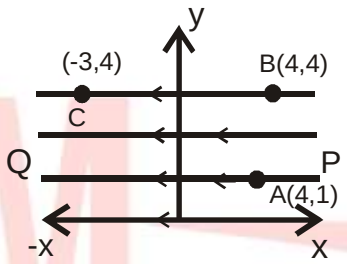
03. Obtain the expression for the energy stored in a parallel plate capacitor with a dielectric medium of dielectric constant K between its plates.

04. 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 d/2, 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.

05. Two dielectric slabs of dielectric constants K_1 and K_2 are filled in between the two plates, each of area A, of the parallel plate capacitor as shown in the figure. Find the net capacitance of the capacitor.



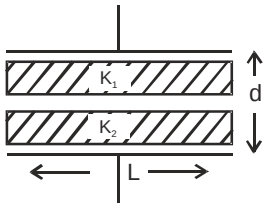
06. A uniform electric field $\vec{E}$ of 300 NC^{-1} is diverted along PQ. A, B and C are three points in the field having x and y coordinates (in meters) as shown in the figure. Calculate potential difference between the points (i) A and B and (ii) B and C



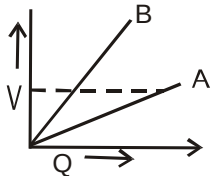
07. A 4 μF capacitor is charged by a 200V supply. Then it is disconnected from the supply and is connected to another uncharged 2 μF capacitor. How much electrostatic energy of the first capacitor is lost in the form of heat and electromagnetic radiation?

08. Find the ratio of the potential differences that must be applied across the parallel and series combination of two identical capacitors, so that the energy stored in the two cases becomes the same.

09. In fig. what will be the capacitance of capacitor ?

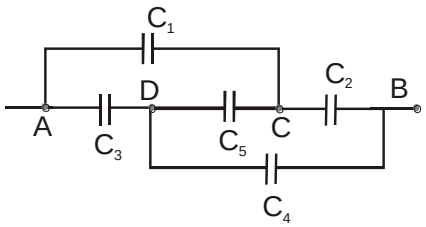


10. The graph shows the variation of voltage V across the plates, of two capacitors A and versus increase of charge 'Q' stored on them. Which of the two capacitors has higher capacitance ? Give reason.

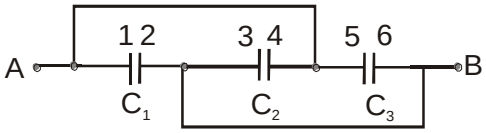


11. In vande-Graff generator the shell electrode is at 25 x 10^5 V. The dielectric strength of the gas surrounding the electrode is 5 x 10^7 V/m. Find the radius of shell.

12. Find the equivalent capacitance between A and B. Given $C_1 = C_2 = C_3 = C_4 = 8\mu F$ $= C_5 = 10\mu F$



13. Calculate the equivalent capacitance between points A and B.



14. At a point due to a point charge, the values of electric field intensity and potential are 30 N C^{-1} and 15 JC^{-1} respectively. Calculate

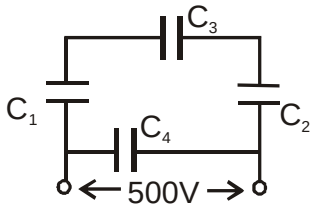
(i) The magnitude of the charge. (ii) Distance of the charge from the point of observation.

15. An electric dipole is placed with its axis making an angle of 30^0 to a uniform electric field. If it experiences a torque of $10\sqrt{3}Nm$, calculate the P.E. of the dipole.

Short Answer Type Questions (3 marks)

16. 27 drops of same size are charged at 220V each. They coalesce to form a bigger drop. Calculate the potential of bigger drop.

17. A network of 4 capacitors each of 12 μ F capacitance is connected to a 500 V supply as shown in the figure. Determine (a) equivalent capacitance of the network and (b) charge on each capacitor.



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

(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?