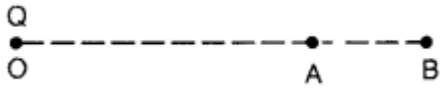
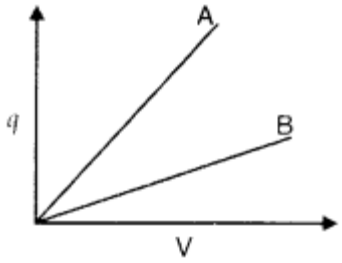
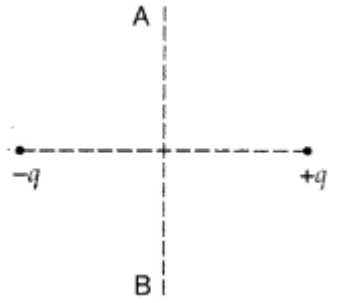
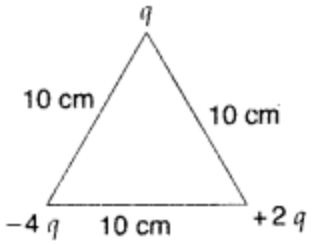
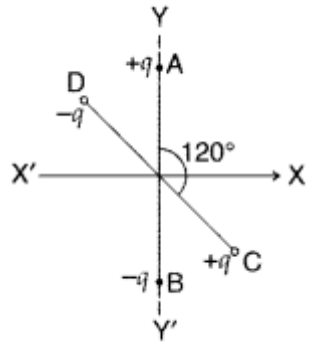
DAV PUBLIC SCHOOL THERMAL COLONY, PANIPAT

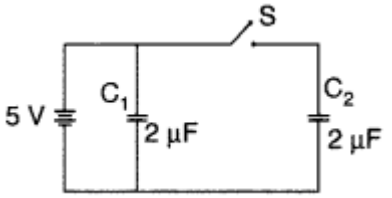
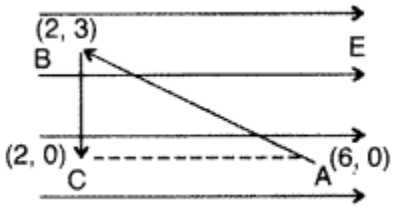
Class 12 Physics Assignment

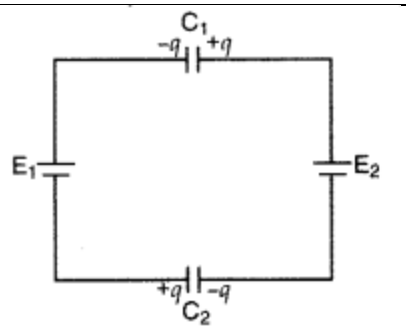
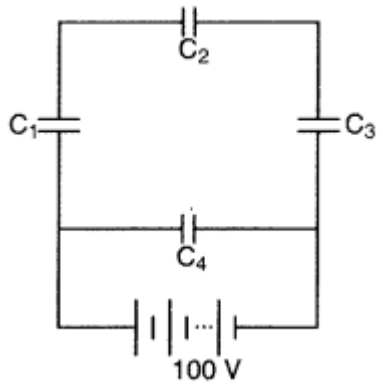
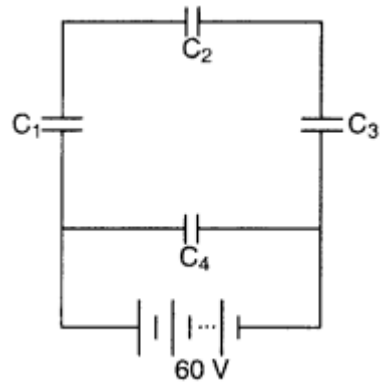
Chapter 2 – ElECTROSTATIC POTENTIAL AND CAPACITANCE

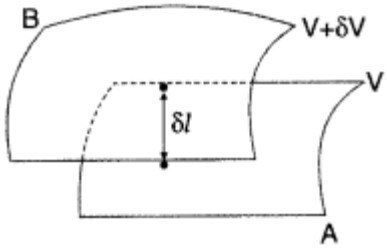
1	A 500 μC charge is at the centre of a square of side 10 cm. Find the work done in moving a charge of 10 μC between two diagonally opposite points on the square.
2	What is the electrostatic potential due to an electric dipole at an equatorial point?
3	What is the work done in moving a test charge q through a distance of 1 cm along the equatorial axis of an electric dipole?
4	Define the term 'potential energy' of charge 'q' at a distance V in an external electric field.
5	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? 
6	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?
7	A hollow metal sphere of radius 10 cm is charged such that the potential on its surface is 5 V. What is the potential at the centre of the sphere?
8	Why is electrostatic potential constant throughout the volume of the conductor and has the same value (as inside) on its surface?
9	Why must the electrostatic potential inside a hollow charged conductor be the same at every point?
10	What is the geometrical shape of equipotential surfaces due to a single isolated charge?
11	Two charges 2μC and – 2μC are placed at points A and B 5 cm apart. Depict an equipotential surface of the system.
12	What is the amount of work done in moving a point charge around a circular arc of radius r at the centre of which another point charge is located?
13	Two charges 4μC and -4μC are placed at points A and B 3 cm apart. Depict an equipotential surface of the system
14	"For any charge configuration, equipotential surface through a point is normal to the electric field." Justify.

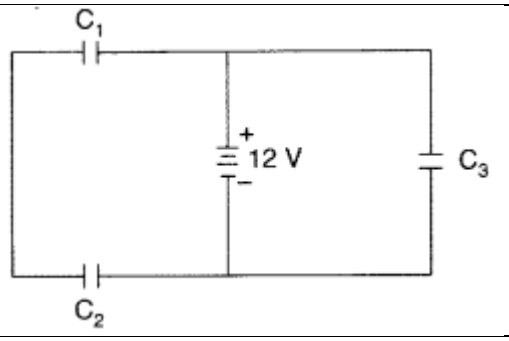
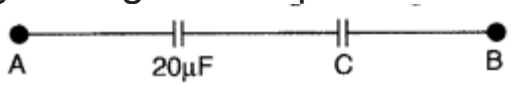
15	Two equal balls having equal positive charge ‘q’ coulombs are suspended by two insulating strings of equal length. What would be the effect on the force when a plastic sheet is inserted between the two .
16	The given graph shows variation of charge ‘q’ versus potential difference ‘V’ for two capacitors C_1 and C_2. Both the capacitors have same plate separation but plate area of C_2 is greater than that of C_1. Which line (A or B) corresponds to C_1 and why? 
17	A charge ‘q’ is moved from a point A above a dipole of dipole movement ‘p’ to a point B below the dipole in equatorial plane without acceleration. Find the work done in the process. 
18	Derive the expression for the electric potential at any point along the axial line of an electric dipole be a point on the axis of the dipole at a distance r from its centre O.
19	Derive an expression for the potential energy of an electric dipole of dipole movement $\vec{p}$ in the electric field $\vec{E}$.
20	Two point charges, $q_1 = 10 \times 10^{-8}$C, $q_2 = -2 \times 10^{-8}$C are separated by a distance of 60 cm in air. (i) Find at what distance from the 1st charge, q_1 would the electric potential be zero. (ii) Also calculate the electrostatic potential energy of the system.
21	Two point charges 4Q, Q are separated by lm in air. At what point on the line joining the charges is the electric field intensity zero? Also calculate the electrostatic potential energy of the system of charges, taking the value of charge, $Q = 2 \times 10^{-7}$C.
22	Two-point charges 20 x 10^{-6} C and -4 X 10^{-6} C are separated by a

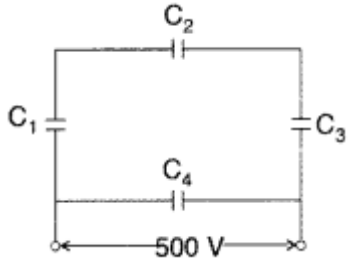
	distance of 50 cm in air. (i) Find the point on the line joining the charges, where the electric potential is zero. (ii) Also find the electrostatic potential energy of the system.
23	Calculate the work done to dissociate the system of three charges placed on the vertices of a triangle as shown. 
24	(i) Can two equipotential surfaces intersect each other? Give reasons. (ii) Two charges -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)?
25	Draw 3 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.
26	Two uniformly large parallel thin plates having charge densities + σ and – σ are kept in the X-Z plane at a distance ‘d’ apart. Sketch an equipotential surface due to electric field between the plates. If a particle of mass m and charge q’ remains stationary between the plates, what is the magnitude and direction of this field?
27	Two small identical electrical dipoles AB and CD, each of dipole moment ‘p’ are kept at an angle of 120° as shown in the figure. What X’ is the resultant dipole moment of this combination? If this system is subjected to electric field (E) directed along + X direction, what will be the magnitude and direction of the torque acting on this? 

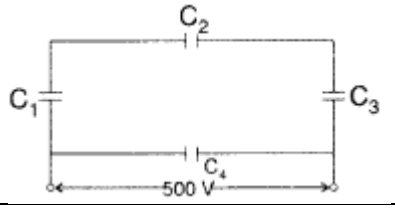
28	Figure shows two identical capacitors C_1 and C_2, each of 2 μF capacitance, connected to a battery of 5 V. Initially switch 'S' is left open and dielectric slabs of dielectric constant K = 5 are inserted to fill completely the space between the plates of the two capacitors. How will the charge and  (ii) potential difference between the plates of the capacitors be affected after the slabs are inserted?
29	Net capacitance of three identical capacitors in series is 1 pF. 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.
30	Draw a plot showing the variation of (i) electric field (E) and (ii) electric potential (iii) with distance r due to a point charge Q
31	A test charge 'q' is moved without acceleration from A to C along the path from A to B and then from B to C in electric field E as shown in the figure.  (i) Calculate the potential difference between A and C. (ii) At which point (of the two) is the electric potential more and why?.
32	An electric dipole is held in a uniform electric field. (i) Show that the net force acting on it is zero. (ii) The dipole is aligned parallel to the field. Find the work done in rotating it through the angle of 180
33	Determine the potential difference across the plates of the capacitor 'C_1' of the network shown in the figure.

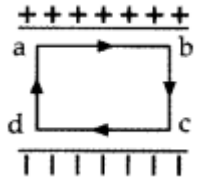
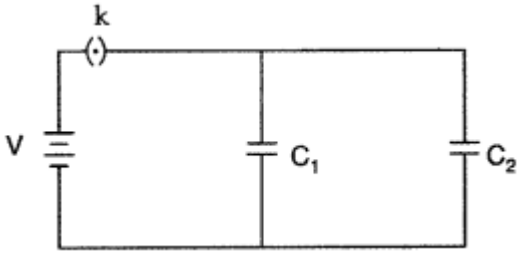
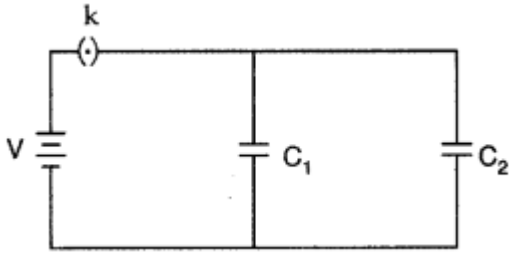
	 [Assume $E_2 > E_1$]
34	A network of four capacitors, each of capacitance 15 μF, is connected across a battery of 100 V, as shown in the figure. Find the net capacitance and the charge on the capacitor C_4. 
35	A network of four capacitors, each of capacitance 30 pF, is connected across a battery of 60 V as shown in the figure. Find the net capacitance and the energy stored in each capacitor. 
36	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 of $4\sqrt{3}$ Nm. Calculate the potential energy of the dipole, if it has charge ± 8 nC.
37	An electric dipole of length 2 cm, when placed with its axis making an angle of 60° with a uniform electric field, experiences a torque of $8\sqrt{3}$ Nm.

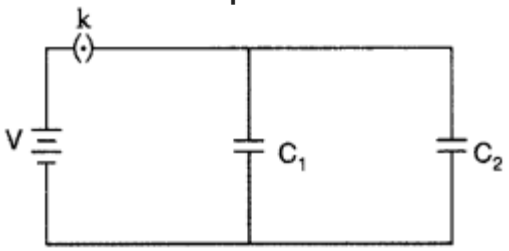
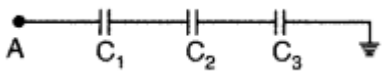
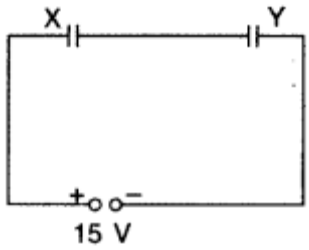
	Calculate the potential energy of the dipole, if it has a charge of ± 4 nC.
38	An electric dipole of length 1 cm, which placed with its axis making an angle of 60° with uniform electric field, experiences a torque of $6\sqrt{3}$ Nm. Calculate the potential energy of the dipole, if it has a charge of ± 2 nC.
39	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.
40	Two point charges q_1 and q_2 are located at $r1$ and $r2$ respectively in an external electric field E .Obtain the expression for the total work done in assembling this configuration.
41	Two point charges q and -2q are kept 'd' distance apart. Find the location of the point relative to charge 'q' at which potential due to this system of charges is zero.
42	Two closely spaced equipotential surfaces A and B with potentials V and V + δV, (where δV is the change in V), are kept δl distance apart as shown in the figure.  Deduce the relation between the electric field and the potential gradient between them. Write the two important conclusions concerning the relation between the electric field and electric potentials.
43	Why does current in a steady state not flow in a capacitor connected across a battery? However momentary current does flow during charging or discharging of the capacitor. Explain.
44	Three identical capacitors C_1 C_2 and C_3 of capacitance 6 μF each are connected to a 12 V battery as shown. Find (i) charge on each capacitor (ii) equivalent capacitance of the network (iii) energy stored in the network of capacitors. (Delhi 2009)

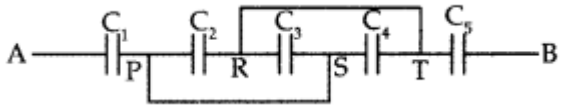
	
45	The equivalent capacitance of the combination between A and B in the given figure is 4 μF.  (i) Calculate capacitance of the capacitor C. (ii) Calculate charge on each capacitor if a 12 V battery is connected across terminals A and B. (iii) What will be the potential drop across each capacitor?
46	Two parallel plate X and Y 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 $\varepsilon_r = 4$. (i) Calculate capacitance of each capacitor if equivalent capacitance of the combination is 4 μF. (ii) Calculate the potential difference between the plates of X and Y. (iii) What is the ratio of electrostatic energy stored in X and Y
47	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) the capacitance, (ii) the electric field between the plates and (iii) the energy stored in the capacitor, be affected? Justify your answer.
48	(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.
49	A parallel plate capacitor is charged by a battery. After sometime the battery is disconnected and a dielectric slab with its thickness equal to the plate separation is inserted between the plates. How will

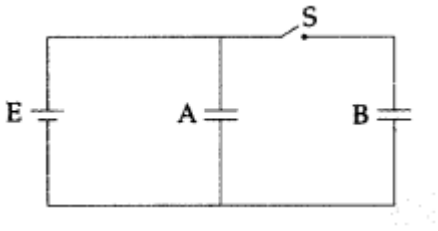
	(i) the capacitance of the capacitor, (ii) electric field between the plates and (iii) the energy stored in the capacitor be affected? Justify your answer in each case.
50	(a) Depict the equipotential surfaces for a system of two identical positive point charges placed a distance 'd' apart. (b) Deduce the expression for the potential energy of a system of two point charges q_1 and q_2 brought from infinity to the points $r1$and $r2$respectively in the presence of external electric field E.
51	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 remains connected. A dielectric slab of thickness d and dielectric constant k is now placed between the plates. What change, if any, will take place in : (i) charge on plates? (ii) electric field intensity between the plates? (iii) capacitance of the capacitor? Justify your answer in each case.
52	A parallel plate capacitor is charged to a potential difference V by a d.c. source. The capacitor is then disconnected from the source. If the distance between the plates is doubled, state with reason how the following will change; (i) electric field between the plates, (ii) capacitance, and (iii) energy stored in the capacitor.
53	A network of four capacitors each of 12μF 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. 
54	A network of four capacitors each of 15 μF capacitance is connected cf to a 500 V supply as shown in the figure. Determine (a) equivalent capacitance of the network and

	(b) charge on each capacitor. 
55	Deduce the expression for the electrostatic energy stored in a capacitor of capacitance 'C' and having charge 'Q'. How will the (i) energy stored and (ii) the electric field inside the capacitor be affected when it is completely filled with a dielectric material of dielectric constant 'K'? .
56	A capacitor of unknown capacitance is connected across a battery of V volts. The charge stored in it is 360 μC. When potential across the capacitor is reduced by 120 V, the charge stored in it becomes 120 μC. Calculate: (i) The potential V and the unknown capacitance C. (ii) What will be the charge stored in the capacitor, if the voltage applied had increased by 120 V?
57	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.
58	Calculate the amount of work done to dissociate a system of three charges 1 μC, 1 μC and -4 μC placed on the vertices of an equilateral triangle of side 10 cm.
59	A capacitor of unknown capacitance is connected across a battery of V volts. The charge stored in it is 300 μC. When potential across the capacitor is reduced by 100 V, the charge stored in it becomes 100 V. Calculate the potential V and the unknown capacitance. What will be the charge stored in the capacitor if the voltage applied had increased by 100
60	Draw the equipotential surfaces due to an electric dipole. Locate the points where the potential due to the dipole is zero
61	Two thin concentric shells of radii r_1 and r_2 ($r_2 > r_1$) have charges q_1 and q_2. Write the expression for the potential at the surface of inner and outer shells.
62	(a) Obtain the expression for the energy stored per unit volume in a charged parallel plate capacitor.

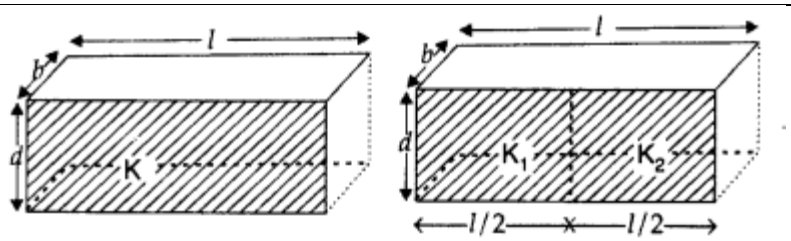
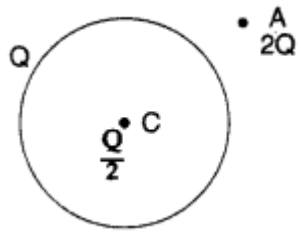
	(b) The electric field inside a parallel plate capacitor is E. Find the amount of work done in moving a charge q over a closed rectangular loop a b c d a. 
63	Derive the expression for the capacitance of a parallel plate capacitor having plate area A and plate separation d.
64	Two parallel plate capacitors of capacitances C_1 and C_2 such that $C_1 = 3C_2$ are connected across a battery of V volts as shown in the figure. Initially the key (k) is kept dosed to fully charge the capacitors. The key is now thrown open and a dielectric slab of dielectric constant 'K' is inserted in the two capacitors to completely fill the gap between the plates,  Find the ratio of (i) the net capacitance and (ii) the energies stored in the combination, before and after the introduction of the dielectric slab.
65	Two parallel plate capacitors of capacitances C_1 and C_2 such that $C_1 = 2C_2$ are connected across a battery of V volts as shown in the figure. Initially the key (k) is kept closed to fully charge the capacitors. The key is now thrown open and a dielectric slab of dielectric constant 'K' is inserted in the two capacitors to completely fill the gap between the plates.  Find the ratio of (i) the net capacitance and (ii) the energies stored in the combination, before and after the

	introduction of the dielectric slab.
66	Two parallel plate capacitors of capacitances C_1 and C_2 such that $C_1 = (C_2)/2$ are connected across a battery of V volts as shown in the figure. Initially the key (k) is kept closed to fully charge the capacitors. The key is now thrown open and a dielectric slab of dielectric constant 'K' is inserted in the two capacitors to completely fill the gap between the plates.  Find the ratio of (i) the net capacitance and (ii) the energies stored in the combination, before and after the introduction of the dielectric slab.
67	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.
68	Calculate the potential difference and the energy stored in the capacitor C_2 in the circuit shown in the figure. Given potential at A is 90 V, C_1 = 20 μF, C_2 = 30 μF and C_3 = 15 μF. 
69	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 ε_r = 4.  (i) Calculate capacitance of each capacitor if equivalent capacitance of

	the combination is 4 pF. (ii) Calculate the potential difference between the plates of X and Y. (iii) Estimate the ratio of electrostatic energy stored in X and Y.
70	Define an equipotential surface. Draw equipotential surfaces : (i) in the case of a single point charge and (ii) in a constant electtic 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. (All India 2015)
71	A parallel plate capacitor, of capacitance 20pF, is conneted to a 100 V supply. After sometime the battery is disconnected, and the space, between the plates of the capacitor is filled with a dielectric, of dielectric constant 5. Calculate the energy stored in the capacitor (i) before (ii) after the dielectric has been put in between its plates.
72	(i) Find equivalent capacitance between A and B in the combination given below. Each capacitor is of 2 μF capacitance  (ii) If a dc source of 7 V is connected across AB, how much charge is drawn from the source and what is the energy stored in the network?
73	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.
74	(i) Derive the expression for the electric potential due to an electric dipole

	at a point on its axial line. (ii) Depict the equipotential surfaces due to an electric dipole. ,where $\gamma\hat{}$ is the unit vector along the position vector OP.
75	Two identical capacitors of 12 pF each are connected in series across a battery of 50 V. How much electrostatic energy is stored in the combination ? If these were connected in parallel across the same battery, how much energy will be stored in the combination now? Also find the charge drawn from the battery in each case.
76	Two identical 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. 
77	(a) Write two properties by which electric potential is related to the electric field. (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.
78	A capacitor of unknown connected across a battery of V volt. A charge of 360 pC is stored in it. When the potential across the capacitor is reduced by 120 V, the charge stored in the capacitor becomes 120 pC. Calculate V and the unknown capacitance. What would have been the charge on the capacitor if the voltage were increased by 120 V?
79	A capacitor of unknown capacitance is connected across a battery of V volt. A charge of 240 pC is stored in it. When the potential across the capacitor is reduced by 80 V, the charge stored in the capacitor becomes

	80 pC. Calculate V and the unknown capacitance. What would have been the charge in the capacitor if the voltage were increased by 80 V?
80	A capacitor of unknown capacitance is connected across a battery of V volt. A charge of 120 μC is stored in it. When the potential across the capacitor is reduced by 40 V, the charge stored in the capacitor becomes 40 μC. Calculate V and the unknown capacitance. What would have been the charge in the capacitor if the voltage were increased by 40 V?
81	A parallel plate capacitor of capacitance C is charged to a potential V by a battery. Without disconnecting the battery, the distance between the plates is tripled and a dielectric medium of k = 10 is introduced between the plates is tripled and a dielectric medium of k = 10 is introduced between the plates of the capacitor. Explain giving reasons, how will the following be affected: (i) capacitance of the capacitor (ii) charge on the capacitor, and (iii) energy density of the capacitor.
82	Derive the expression for the electric potential at any point P, at distance r from the centre of an electric dipole, making angle a, with its axes.
83	Derive an expression for the energy stored in a parallel plate capacitor. On charging a parallel plate capacitor to a potential V, the spacing between the plates is halved, and a dieletric medium of $\varepsilon_r = 10$ is introduced between the plates, without disconnecting the d.c. source. Explain, using suitable expressions, how the (i) capacitance, (ii) electric field and (iii) energy density of the capacitor change.
84	(a) Obtain the expression for the potential due to an electric dipole of dipole moment p at a point V on the axial line. (b) Two identical capacitors of plate dimensions l × b and plate separation d have di-electric slabs filled in between the space of the plates as shown in the figure.

	 Obtain the relation between the dielectric constants K, K_1 and K_2.
85	(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 Q2 is placed at its centre C and another charge +2Q is placed 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.
86	Question 90. (i) If two similar large plates, each of area A having surface charge densities +a and -a 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 a. If they are connected to each other with a conducting wire, in which direction will the charge flow and why?
87	(a) Obtain the expression for the potential due to a point charge. (b) Use the above expression to show that the potential, due to an electric

	dipole (length 2a), varies as the ‘inverse square’ of the distance r of the ‘field point’ from the centre of the dipole for r > a.
88	(a) Define the SI unit of capacitance. (b) Obtain the expression for the capacitance of a parallel plate capacitor. (c) Derive the expression for the affective capacitance of a series combination of n capacitors.