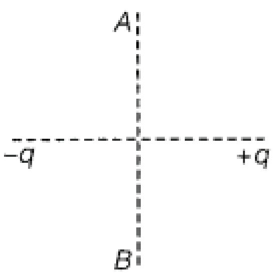
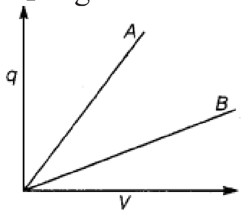
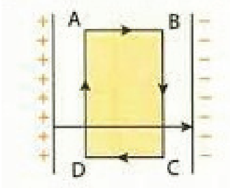
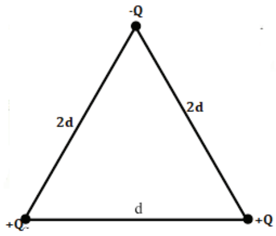
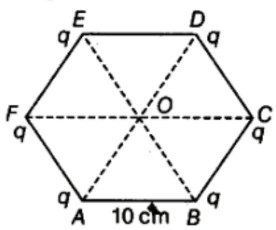
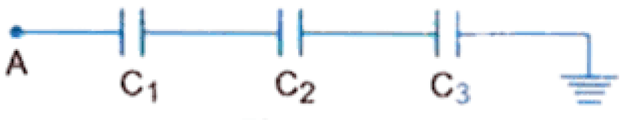
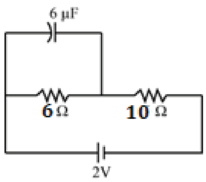
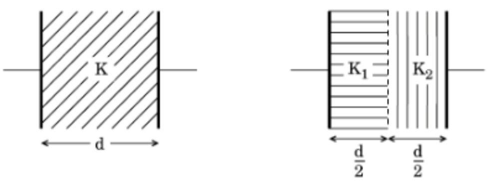
ELECTRIC POTENTIAL & CAPACITORS

MULTIPLE CHOICE QUESTIONS	
1	A capacitor of capacitance C has a charge Q and stored energy W. If the charge is increased to 2Q, the stored energy will be (a) $\frac{W}{4}$ (b) $\frac{W}{2}$ (c) 2W (d) 4W
2	A battery is used to charge a capacitor till the potential difference between the plates become equal to the emf (V) of the battery. The ratio of the energy stored in the capacitor to the work done by the battery will be (a) ½ (b) 2 (c) ¼ (d) 4
3	The electric potential V at any point (x,y,z) in space is given by $V=3x^2$ where x,y,z are all in metre. The electric field at the point (1m,0,2m) is (a) 6V/m along -x axis (b) 6V/m along +x axis (c) 1.5V/m along -x axis (d) 1.5V/m along +x axis

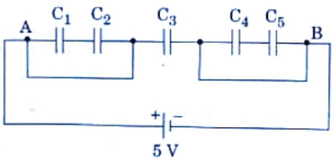
4	A parallel plate capacitor with oil in between the plates (dielectric constant of oil is 2) has a capacitance 'C'. If the oil is removed, what will be the new capacitance (a) $\frac{C}{\sqrt{2}}$ (b) $\frac{C}{2}$ (c) $2C$ (d) $\sqrt{2}\,C$
5	A conducting sphere of radius R carrying charge Q lies inside an uncharged conducting shell of radius 2R. If they are connected by a metal wire, the amount of heat that will be produced is (a) $\frac{1}{4\pi\varepsilon_0}\frac{Q^2}{R}$ (b) $\frac{1}{4\pi\varepsilon_0}\frac{Q^2}{2R}$ (c) $\frac{1}{4\pi\varepsilon_0}\frac{Q^2}{3R}$ (d) $\frac{1}{4\pi\varepsilon_0}\frac{Q^2}{4R}$
6	A metallic sphere has a charge of 10μC. A unit negative charge is brought from point A to another point B both 100cm away from the sphere, but A being east of it while B being on west. The net work done is (a) $\frac{2}{10}$J (b) $-\frac{1}{10}J$ (c) Zero (d) Data insufficient
7	A parallel plate air capacitor having a capacitance 'C' is half-filled by a medium of dielectric constant 5. What % change will be there in the capacitance of the capacitor? (a) 200% increase (b) 400% decrease (c) 400% increase (d) 66.6% increase
8	Two parallel plate capacitors X and Y have same plate area and same separation between the plates. X has air between the plates and Y has a dielectric medium of K=4. When they are connected in series with a source of 12V, what is the ratio of energies stored in X to Y (a) 1:4 (b) 8:1 (c) 4:1 (d)$\sqrt{2}$:
9	An electric charge 10^{-3} μC is placed at the origin (0,0) of (x, y) co-ordinate system. Two points A and B are situated at $(\sqrt{2}, \sqrt{2})$ and (2,0) respectively. The potential difference between the points A and B will be (a) 4.5 V (b) Zero (c) 2.0V (d) 9.0V
10	Two identical metal plates are given positive charges q_1 and q_2 ($q_1 > q_2$). If they are now brought near to each other to form a capacitor with capacitance C, what will be the potential difference between the plates? (a) $(q_1+q_2)/2C$ (b) $(q_1+q_2)/C$ (c) $(q_1- q_2)/C$ (d) $(q_1-q_2)/2C$

VERY SHORT ANSWER TYPE QUESTION (1 MARK)	
11	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. 
12	Why electrostatic potential is constant throughout the volume of the conductor and has the same value as on its surface?

13	The given graph shows the 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 C_1. Which line (A or B) corresponds to C_1 and why? 
14	 A uniform electric field exists between the two parallel plates of a capacitor. What is the work done in taking a unit positive charge along the path ABCD?
15	Is the electro static potential necessarily be zero at a point where electric field is zero? Justify
16	A large hollow metallic sphere A is charged positively to a potential of 100V and a small sphere B to a potential of 50V. Now B is placed inside A and they are connected by a wire. In which direction will the charge flow?
17	An Aluminium sheet foil is introduced midway between the plates of a parallel plate capacitor of capacitance 'C'. What will be the new capacitance if (a) the foil is electrically insulated (b) the foil is connected to the positive plate of the capacitor?
18	What is the total potential energy of the configuration shown here: 
19	How does the energy stored in a capacitor change if after disconnecting from the battery, the plates are moved farther? Justify
20	Draw the equipotential surfaces corresponding to (a) A constant electric field in Z-direction (b) A field that uniformly increases in magnitude
	SHORT ANSWER TYPE QUESTIONS (2MARK)
21	(i) Two circular metal plates, each of radius 10cm are kept parallel to each other at a distance of 1mm. What kind of capacitor do they make? (ii) If the radius of each of the plates is increased by a factor of $\sqrt{2}$ and distance of separation reduced to half, calculate the ratio of capacitance in both case
22	A regular hexagon of side 10cm has charge 5μC at all vertices. Calculate the potential at the centre. 
23	Calculate the potential difference in the capacitance C_2 in the circuit shown. The potential at A is 90V and C_1 = 20 μF , C_2 = 30 μF, C_3=15 μF.

	
24	Find the charge on the 6 μF capacitor shown in the figure. 
25	A capacitor of unknown capacitance is connected across a battery of V volts. The charge stored in it is 360 μC. When the potential is reduced by 120V, the charge stored in it becomes 120 μC. Calculate the potential V and capacitance C
26	Find the ratio of the potential differences that must be applied across the parallel and series combination of two identical capacitors so that energy stored, in two cases, becomes the same.
27	A parallel plate capacitor having plate area $100cm^2$ and separation 1.0mm holds a charge of 0.12μC when connected to a 120V battery. Find the value of dielectric constant of material filling the gap.
28	A capacitor 200 pF is charged by a 300V battery. The battery is disconnected and the charged capacitor is connected to another uncharged capacitor 100pF. Calculate the difference in the final and initial energy stored.
29	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  (Case 1) (Case 2)
30	An electric field E = 20**i**+30**j** exists in space. if the potential at the origin is taken to be zero, then what is the potential at (2m,2m)?
	SHORT ANSWER TYPE QUESTIONS (3 MARKS)
31	A parallel plate is charged by a battery. When the battery remains connected, a dielectric slab is inserted in the space between the plates. Explain what changes if any, occur in the values of (a) its capacitance (b) electric field between the plates and (c) energy stored in the capacitor be affected? Justify your answer giving necessary mathematical expression for each case.
32	A parallel plate capacitor is charged by a battery to a potential. The battery is disconnected and a dielectric slab is inserted to completely fill the space between the plates. How will (a) its capacitance (b) electric field between the plates and (c) energy stored in the capacitor be affected? Justify your answer giving necessary mathematical expression for each case.

33 In the figure given below, find the equivalent capacitance of the network between A and B



$C_1 = C_5 = 8\mu F$, $C_2 = C_3 = C_4 = 4\ \mu F$

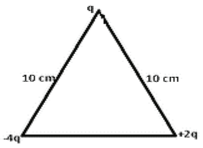
(i) Calculate effective capacitance between A and B

(ii) Maximum charge supplied by the source

(iii) The energy stored in the network

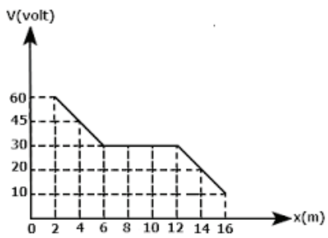
34 Two point charges $+Q_1$ and $-Q_2$ are placed at a distance 'r' apart. Obtain the expression for the amount of work done to place a third charge Q_3 at the midpoint of the line joining the two.

35



Calculate the work done to dissociate the system of three charges placed at the vertices of a triangle as shown. Given: $q = 1.6 \times 10^{-10}$ C

36



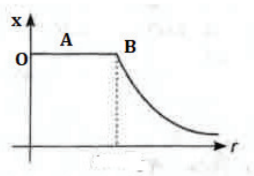
The variation of potential with distance from a fixed point is as shown in the figure. What is the electric field at (i) x = 8m (ii) x = 14m?

37 A graph showing variation between two physical quantity 'x' with 'r', where 'r' is the distance from the center of a charged conducting sphere.

(i) Name the physical quantity 'x'

(ii) What does the distance 'OB' represent?

(iii) At what point the electric field of this conducting sphere (a) minimum (b) maximum?
Write the values



38 What should be the charge on a sphere of radius 4cm, so that when it is brought in contact with another sphere of radius 2cm carrying a charge of 10μC, there is no transfer of charge from one to another.

39

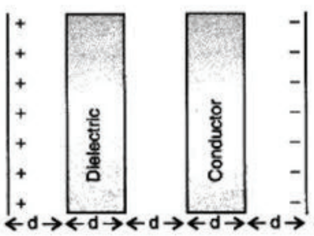
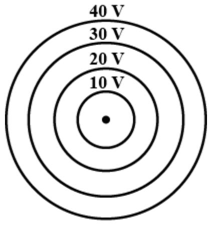
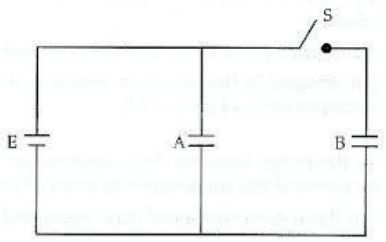
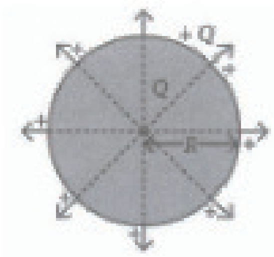


	Figure shows a parallel plate capacitor of charge densities $+\sigma$ and $-\sigma$. A dielectric slab of constant K and a conducting slab both are of thickness 'd' are inserted in between the plates. Find the potential difference between the plates. Plot the graph between the E and x taking x=0 at +ve plate and x = 5d at -ve plate
40	(a) Two isolated metal spheres A and B have radii R and 2R respectively and same charge q. Find which of the two spheres has greater (i) capacitance (ii) energy density just outside the spheres. (b) Concentric equipotential surfaces due to a point charge at the centre are shown. Identify the polarity of the charge and draw the field lines. 
	LONG ANSWER TYPE QUESTIONS (5 MARKS)
41	(a) Derive the expression for the PE of a system of 2 charges q_1 and q_2 located at $\mathbf{r_1}$ and $\mathbf{r_2}$ respectively in an external electric field. (b) Can electric field exist tangential to equipotential surfaces? Give reason.
42	Explain briefly the process of charging a parallel plate capacitor when it is connected across DC battery. A capacitor of capacitance 'C' is charged to 'V' volts by a battery. After sometime battery is disconnected and distance is doubled. Now a dielectric slab of constant, $1 < K < 2$, is introduced to fill the gap between the plates. How will the following get affected: (i) the electric field between the plates (ii) the energy stored in the capacitor. Justify your answer by writing necessary expressions.
43	Two identical parallel plate capacitors A and B are connected to a battery V volt with a switch 'S' closed. The switch is now opened and the free space between the plates of the capacitor is filled with a medium of dielectric constant K. Find the ratio of the total energy stored in both capacitors before and after the introduction of the dielectric. 
44	(a) Define Electrostatic potential due to point charge. (b) If 'n' similar drops of mercury each of capacitance C, surface charge density 'σ', Energy 'E' and potential 'V' combine to form a big drop, then calculate the capacitance, surface charge density, energy and potential of the big drop.
45	(a) Does the capacitance C of a capacitor increase, decrease or remain same when (i) the charge on it is tripled (ii) the potential difference across the plates is halved? Justify your answer. (b) Two metal spheres A and B of radius 'r' and '2r' whose centres are separated by a distance '6r' are given charges Q each and are potential V_1 and V_2 respectively. Find the ratio of V_1 to V_2 (c) If the spheres are now connected by a wire, what amount of charge will flow through the wire?

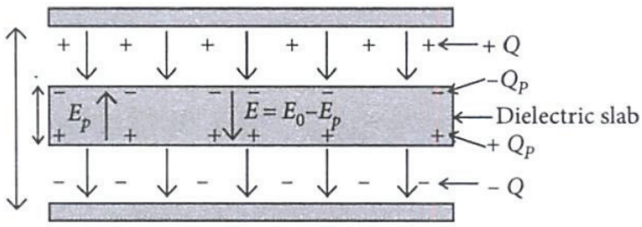
CASE BASED QUESTIONS (Each sub question carry 1 mark)

46 The electrical capacitance of a conductor is the measure of its ability to hold electric charge. Figure shows an isolated spherical conductor of radius R. The charge Q is uniformly distributed over its entire surface. It can be assumed to be concentrated at the centre of the sphere. The potential at any point on the surface of the spherical conductor will be $V=Q/4\pi\varepsilon_0 R$. Capacitance of the spherical conductor situated in vacuum is $C = QV = 4\pi\varepsilon_0 R$ Clearly, the capacitance of a spherical conductor is proportional to its radius



(i) If an isolated sphere has a capacitance 50pF. Then radius is
(a) 90 cm (b) 45 cm (c) 45 m (d) 90 m
(ii) How much charge should be placed on a capacitance of 25 pF to raise its potential to 10^5 V?
(a) 1μC (b) 1.5μC (c) 2μC (d) 2.5μC
(iii) Metallic sphere of radius R is charged to potential V. Then charge q is proportional to
(a) V (b) R (c) both V and R (d) none of these.
(iv) If 64 identical spheres of charge q and capacitance C each are combined to form a large sphere. The charge and capacitance of the large sphere is
(a) 64q, C (b) 16q,4C (c) 64q,4C (d) 16q,64C

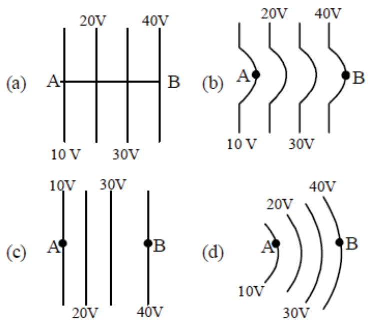
47 A dielectric slab is a substance that does not allow the flow of charges through it but permits them to exert electrostatic forces on one another.
When a dielectric slab is placed between the plates, the field E_o polarises the dielectric. This induces charge $-Q_p$ on the upper surface and $+ Q_p$ on the lower surface of the dielectric. These induced charges set up a field E_p inside the dielectric in the opposite direction of external field E.



(i) In a parallel plate capacitor, the capacitance increases from 4μF to 80μF on introducing a dielectric medium between the plates. What is the dielectric constant of the medium?
(a) 10 (b) 20 (c) 50 (d) 80

(ii) A parallel plate capacitor with air between the plates has a capacitance of 8 pF. 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 capacitor in the second case.
(a) 20 pF (b) 40 pF (c) 60 pF (d) 80 pF

(iii) A dielectric introduced between the plates of a parallel plate capacitor with battery remain connected
(a) decreases potential difference between the plates
(b)decreases the electric field between the plates
(c) increases the charge on the plates
(d) all the above

	(iv) A parallel plate capacitor of capacitance 1 pF has separation between the plates d. When the distance of separation becomes 2d and wax of dielectric constant x is inserted in it the capacitance becomes 2 pF. What is the value of x? (a) 2 (b) 8 (c) 4 (d) 1
48	The surface on which all points have the same potential is called the equipotential surface. On the equipotential surface, to move a charge from one point to another no work is required. Equipotential Points: The same electric potential points on the electric field are called equipotential points. The line or curve connecting the points is known as an equipotential line. The surface on which the point lies is called the equipotential surface. The volume in which the points are filled is known as an equipotential volume. In an equipotential surface, if a point charge is said to move from point V_A to V_B, then the work done in moving the charge is given by, $W = q_0 (V_A - V_B)$ As $V_A - V_B$ is said to be zero and the total work done, $W = 0$.  (i) Which of the above figures represent uniform electric field? (a) fig (a) only (b) fig (a & c) (c) fig (b & d) (d) all the above (ii) A charge +Q is moved from point A to point B. Choose the correct statement: (a) Work done in fig(d) is the least (b) Work done in fig (a) is greater than that in other cases (c) Work done in fig (a) & (c) are equal but greater than that in fig(b &d) (d) Work done in all three cases is equal (iii) A charge -3μC is taken from a point P to point Q where potential difference is 2.4V. Calculate the work done (a) 0 J (b) 7.2 J (c) – 7.2 J (d) -7.2 μJ (iv) Suppose a charge +20 μC is trapped at the centre of a uniformly charged conducting sphere of radius 5cm and surface charge density 15 μC/cm^2. What is the work done required to move the 20 μC to the surface? (a) 100 μJ (b) 300 μJ (c) Zero (d) 25 μJ

Assertions & Reasons Questions

Select the most appropriate answer from the options given below:

A) Both A and R are true and R is the correct explanation of A

B) Both A and R are true but R is not the correct explanation of A.

C) A is true but R is false.

D) A is false and R is also false.

1. A- The work done by an electrostatic field in moving a charge from one point to another depends only on the initial and the final points.
   R- Electrostatic force is a conservative fore.
2. A- For a point charge potential V=kQ/r is applicable for Q>0 &Q<0
   R- for Q < 0, the force on a unit positive test charge is attractive

3. A- The electric field at every point is normal to the equipotential surface passing through that point.
   R- No work is required to move a test charge on an equipotential surface.
4. A- For a uniform electric field E along the x -axis, the equipotential surfaces are planes parallel to the y-z plane.
   R- Electric field is in the direction in which the potential increases.
5. A- A non polar molecule is one in which the centres of positive and negative charges are separated.
   R- Non polar molecules have a permanent dipole moment.
6. A- In an external electric field, the positive and negative charges of a non polar molecule are displaced in opposite directions.
   R- Oxygen & Hydrogen are non polar molecules.
7. A- When a dielectric is inserted between the plates of a capacitor, capacitance increases.
   R- The dielectric is polarised by the field.
8. A- A capacitor with large capacitance can hold large amount of charge Q at a relatively small V.
   R- The charge of the capacitor leaks away due to the reduction in insulating power of the intervening medium.
9. A- When capacitors are connected in series net capacitance decreases.
   R- In series combination, charges on the two plates are the same on each capacitor.

10. A- Two concentric spherical shell of different radius are at potential V_A and V_B. If outer shell is earthed then potential difference will not be changed.
    R- Potential difference between the surfaces of two concentric spherical shells does not depends on the charge on the outer shell.

11. A- When a capacitor is charged by a battery, both the plates receive charge equal in magnitude, no matter sizes of plates are identical or not.
    R -. The charge distribution on the plates of capacitor is in accordance with charge conservation principle

12. A- When a charged capacitor is filled completely with a metallic slab, its capacitance is increased by a large amount.
    R -The dielectric constant for metal is infinite.
13. A: Electric potential of a positively charged body may be negative.
    R - The potential of a conductor does not depend on the charge of the conductor.
14. A – In the absence of an external electric field, the dipole moment per unit volume of a polar dielectric is zero.
    R – The dipoles of a polar dielectric are randomly oriented.

ANSWERS - ASSERTION REASON

1. A

2. A

3. A

4. C

5. D

6. B

7. A

8. B

9. B

10.D

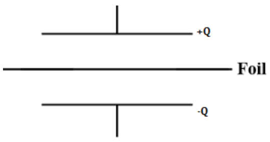
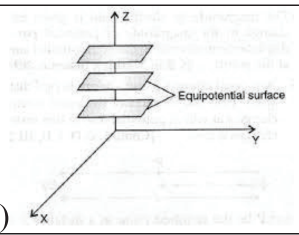
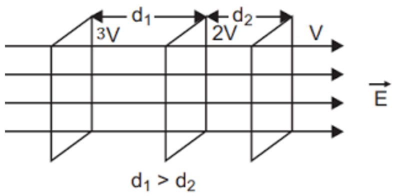
11.C

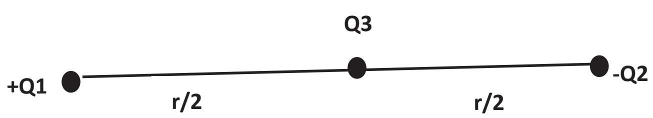
12.A

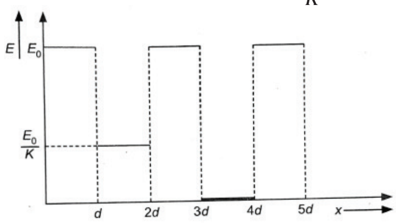
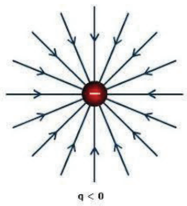
13.C

ANSWERS

1	(d) 4W
2	(a) ½. If V is the emf of the battery, Work done = QV = CV^2 . The energy stored = ½ CV^2
3	(a) 6V/m along -x axis Electric potential $V = 3x^2$ $E = -dV/dx$ $E = -6x$ At the point (1,0,2) Electric field $E = 6\times1 = -6V/m$
4	(b) $\frac{C}{2}$
5	(d) $\frac{1}{4\pi\varepsilon_0}\frac{Q^2}{4R}$
6	(c) Zero
7	(d) 66.6% increase (Hint: Series combination of 2 capacitors of spacing d/2)
8	(c) 4:1
9	(b) Zero
10	(d) $(q_1-q_2)/2C$ Hint: $E = E_1 - E_2 = \frac{\sigma_1-\sigma_2}{2\varepsilon_0} = \frac{q_1-q_2}{2\varepsilon_0 A}$; V = Ed
11	Work done in the process is zero. Because, equatorial plane of a dipole is equipotential surface and work done in moving charge oh equipotential surface is zero. $W = qV_{AB} = q \times 0 = 0$
12	Since, electric field intensity inside the conductor is zero. So, electrostatic potential is a constant. But, $E = -\Delta V/\Delta r$ $\therefore E = 0, \Delta V = 0$ or $V_2 - V_1 = 0, V_2 - V_1$ The potential at every point inside the conductor remains same.
13	Line B corresponds to Q because slope (q/V) of B is less than slope of A.
14	Zero. Electrostatic field is a conservative field

15	No. $E = -\frac{dV}{dr}$. That is, even when E = 0, potential can be a non zero constant
16	From B to A. When sphere B is placed inside the sphere A, total potential of B become 150V. So charge flow from higher potential to lower potential.
17	(a) With foil electrically insulated, the arrangement is a series combination. Both capacitors having d/2 separation between the plates. So effective capacitance C_s = 2C/2 = C  (b) Capacitance become twice as the distance reduces to d/2
18	$U = k\frac{Q.Q}{d} + k\frac{Q.(-Q)}{2d} + k\frac{(-Q).Q}{2d} = 0$
19	Energy increases. The capacitance, C decreases as plate distance increase. As the battery is disconnected, $U = \frac{q^2}{2C}$ which will increase
20	 (a)  (b)
21	(i) Parallel plate capacitor (ii) $r' = \frac{r}{\sqrt{2}}. A' = \frac{A}{2}$. $But\ d' = \frac{d}{2}$. $So\ C' = 4C. \therefore Ratio, \frac{C}{C\prime} = \frac{1}{4}$
22	Potential V = $6.\frac{1}{4\pi\varepsilon_0}\frac{q}{r}$ = 2.7x10^6 V
23	For series combination C_s = 20/3 μF Charge on C_s , Q = C_s V = 600 μC. Charge stored is same for all capacitors in series. Potential drop on C_2 , V_2 = Q/ C_2 = 20V
24	Current through the circuit $I = \frac{2}{6+10} = \frac{1}{8}A$ Voltage across 6Ω resistor, V'= IR = $\frac{6}{8} = \frac{3}{4}V$ Charge on the capacitor, Q = CV' = 4.5 μC
25	Given, Q = CV = 360 μC. ……………(i) On reducing the voltage by 120V, Q' = C (V-120) = 120 μC …………(ii) On solving eqn(i) & (ii) ; V = 180V Then unknown capacitance, C = Q/V = 2 μF
26	For identical capacitors: $C_s = \frac{C}{2}$; $C_p = 2C$ $U_s = U_p$

	$C_sVs^2 = \frac{1}{2}C_pVp^2$. $\therefore \frac{V_p}{V_s} = \sqrt{\frac{C/2}{2C}} = \frac{1}{2}$
27	$C = \frac{Q}{V} = 10^{-9}F. From\ the\ formula, C = K\frac{\varepsilon_o A}{d}, K = 11.3$
28	$U_i = \frac{1}{2}C_1{V_1}^2 = 9 \times 10^{-6}J$ Common potential after both capacitors connected, $V_{common} = \frac{C_1V_1+C_2V_2}{C_1+C_2} = 200V$ $U_f = \frac{1}{2}C_p{V_{com}}^2 = \frac{1}{2}300pF\ x(200)^2 = 6 \times 10^{-6}J$ Difference in energy = (9 – 6) x 10^{-6} J = 3 x 10^{-6} J
29	Case 2 is a series combination $C_1 = K\frac{\varepsilon_o A}{d}$; $C_2 = (\frac{2K_1K_2}{K_1+K_2})\frac{\varepsilon_o A}{d}$ $Since, C_1 = C_2 ; K = \frac{2K_1K_2}{K_1 + K_2}$
30	$\Delta V = -E_x\Delta x - E_y\Delta y = (-20 \times 2 - 30 \times 2) = -100V$
31	(i) Capacitance increases as C’ = KC (K>1) (ii) Potential difference remans same as battery remain connected. So E = $\frac{V}{d}$ remain same (iii) Energy, U = $\frac{1CV^2}{2}$; U’ = KU
32	(a) The capacitance increases as the dielectric constant K>1. Potential difference V= CQ. As C increases and Q remains the same since the battery is disconnected, the p.d. between the plates decreases. (b) Electric field E = $\frac{V}{d}$ where V is the p.d. and d the separation between the plates. As V decreases and d remains the same, electric field also decreases. (c)Energy stored in a capacitor U = $\frac{1Q^2}{2C}$. As Q is constant and C increases, U decreases.
33	Since C1,C2 are short circuited, the net charge on them = 0 Similarly, net charge on C4 and C5 =0 So effective capacitance = C3 = 4µF Then, Q = CV = 4µF x 5 = 20 µC Energy stored, U = $\frac{1}{2}CV^2 = 50$µJ
34	 $W = k\frac{Q_1Q_3}{r/2} - \frac{Q_3Q_2}{r/2} = 2k(\frac{Q_1Q_3 - Q_3Q_2}{r})$
35	Work done = - (PE) $W = k\frac{q_1q_2 + q_1q_3 + q_2q_3}{r}$ Substituting, W = 2.3 x 10-8 J
36	$E = -\frac{dV}{dx}$ (i) At x = 8m, V is constant. E = 0 (ii) At x = 14m, V is gradually decreasing. $E = -\frac{(10-30)}{(16-12)} = 5V/m$

37	(i) Electric potential (ii) OB = radius of the sphere (iii) E_{max} is at surface (x = radius) , at B E_{min} is x < radius
38	For no transfer of charge, V1 = V2 $k\frac{q_1}{r_1} = k\frac{q_2}{r_2}$; then q1 = 20μC
39	(i) V = $E_o d + \frac{E_o d}{K} + E_o d + 0 + E_o d = 3E_o d + \frac{E_o d}{K}$ 
40	(a) (i) $C \propto R$; Capacitance of sphere B is greater $(ii)\ energy\ density = \frac{U}{Volume} = \frac{Q^2/2C}{\frac{4}{3}\pi R^3}$. On solving, $\frac{U_A}{U_B} = 16:1$ (b) Negative charge. 
41	Derivation. No, if the electric field has tangential component, then work done in moving a charge between any two points on an equipotential surface will not be zero.
42	Hint: C_1 = C; V_1 = V and Q_1 = CV When battery is disconnected, Q remains same. So after distance is doubled and battery disconnected, C_2 = KC/2 $C_1V_1 = C_2V_2$; Electric field E_1 = Vd and $E_2 = E_1/K$
43	When switch is connected, $U_A = U_B = \frac{1}{2}CV^2$ Total energy $U_i = 2\,(\frac{1}{2}CV^2) = CV^2$ After the introduction of dielectric slab and switch opened, $C_A = C_B$ = KC P.D across A = V; P.D across B = V/K (since Q remains same for A and B) $U_A = \frac{1}{2}KCV^2$; $U_B = \frac{1}{2K}CV^2$ On adding final energy, $U_f = (\frac{K^2+1}{K})\ \frac{1}{2}CV^2$ Ratio, $\frac{U_f}{U_i} = (\frac{K^2+1}{2K})$

44	(b) Volume of big drop $=n\times$ volume of small drop $4/3\pi R^3 = n\times 4/3\pi r^3$ $R = n^{1/3}\, r$ Capacitance of small drop, $C = 4\pi\varepsilon_0 r$ Capacitance of big drop, $C' = 4\pi\varepsilon_0 R = 4\pi\varepsilon_0\, n^{1/3} r$ $C' = n^{1/3}\, C$ The potential of small drop $V = q/C = q/4\pi\varepsilon_0 r$ The potential of big drop $V' = nq/\, n^{1/3}\, C$ $V' = n^{2/3}\, V$ $\therefore$ Energy of small drop $E = ½\, CV^2$ Energy of big drop $E' = ½ C'V'^2$ $\therefore$ *Energy* $E' = n^{5/3}$ E
45	(a) No change in capacitance since C does not depend on Q or V (b) V = kQ/r . So the ratio $V_1:V_2 = 2:1$ (c) When connected by a wire, the potentials become equal. On equating, $Q_1' = Q_2'/2$. Charge flowing = Q/3 (electric charge is conserved. 2Q = Q1'+ Q2' = 3 Q2'/2.)
46	(i) 45 cm (ii) 2.5μC (iii) V and R (iv) 64q,4C ($q' = nq$; $C' = n^{1/3}\, C$)
47	(i) 20 ($C' = KC$) (ii) 80 pF (iii) increases the charge on the plates (*Battery connected V remains same)* (iv) 4
48	(i) fig (a) only (ii) Work done in all three cases is equal (iii) -7.2 μJ *(iv)* Zero *(the potential inside a charged sphere is uniform)*