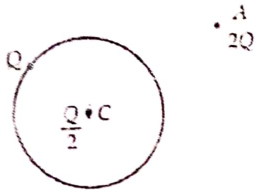
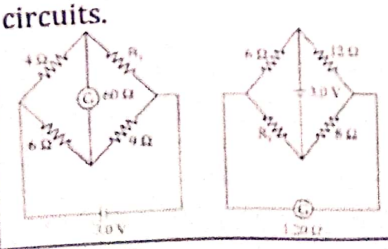
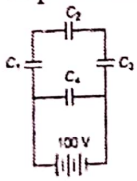
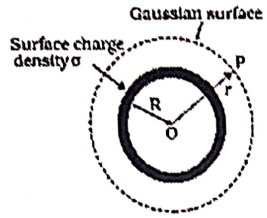
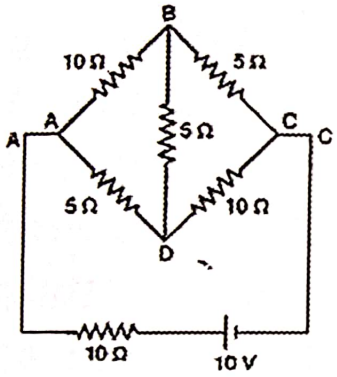
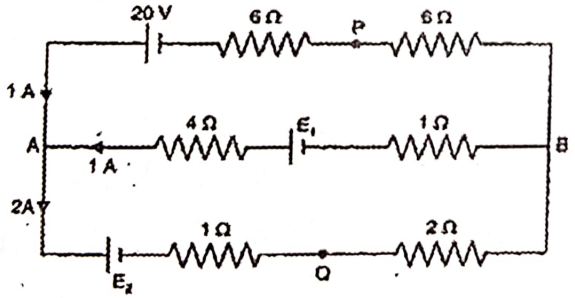
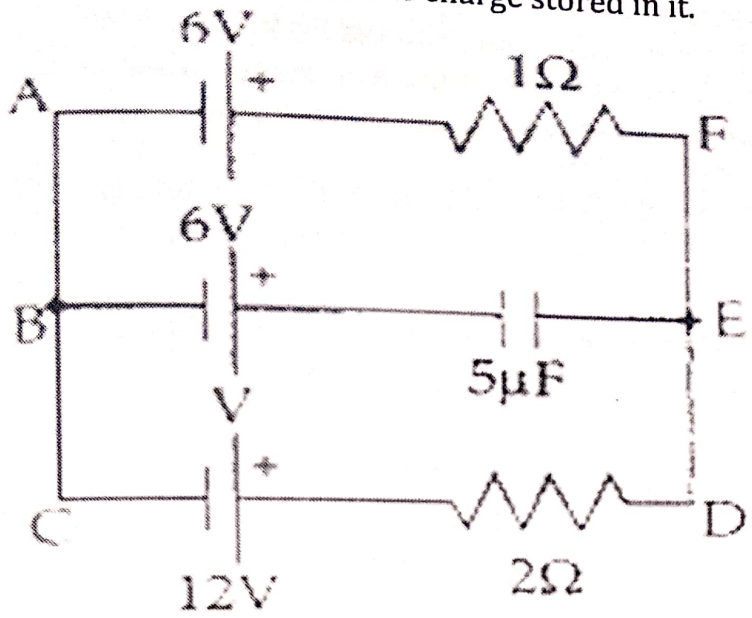
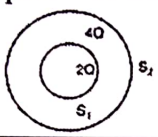
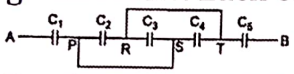
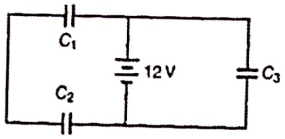
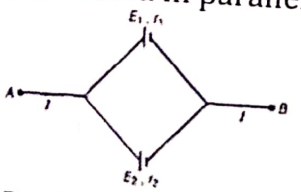
18	A charge Q is distributed uniformly over a metallic sphere of radius R. Obtain the expressions for the electric field (E) and electric potential (V) at a point $0 < x < R$. Show on a plot the variation of E and V with x for $0 < x < 2R$.	[2]
19	A wire of 10 ohm resistance is stretched to thrice its original length. What will be its 1. new resistivity, and 2. new resistance?	[2]
20	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 charge of ± 4nC.	[2]
21	Define electric flux. Write its SI unit. A charge q is enclosed by a spherical surface of radius R. If the radius is reduced to half, how would the electric flux through the surface change? **OR** A thin metallic spherical shell of radius R carries a charge Q on its surface. A point charge $\frac{Q}{2}$ is placed at its centre C and another charge +2Q is placed outside the shell at a distance x from the centre as shown in Fig.  Find: 1. the force on the charge at the centre of the shell and at the point A. 2. the electric flux through the shell.	[2]
22	Obtain the expression for the potential due to an electric dipole of dipole moment p at a point **d** on the axial line.	[2]
23	A parallel plate capacitor, each of plate area A and separation 'd' between the two plates, is charged with charges +Q and - Q on the two plates. Deduce the expression for the energy stored in capacitor.	[2]
24	A voltmeter of resistance 998Ω is connected across a cell of emf 2 V and internal resistance 2 . Find the p.d. across the voltmeter, that across the terminals of the cell and percentage error in the reading of the voltmeter.	[2]
25	The galvanometer, in each of the two given circuits, does not show any deflection. Find the ratio of the resistors R_1 and R_2 used in these two circuits.  	[2]
	Section D	

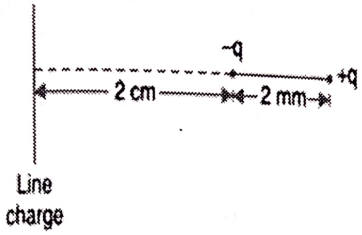
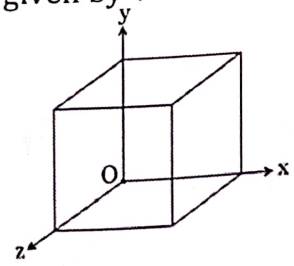
26	S_1 and S_2 are two concentric spheres enclosing charges Q and 2Q respectively as shown in Fig.  1. What is the ratio of the electric flux through S_1 and S_2 ? 2. How will the electric flux through the sphere S_1 , change, if a medium of dielectric constant k is introduced in the space inside S_1 in place of air? 3. How will the electric flux through sphere S_1 change, if a medium of dielectric constant k is introduced in the space inside S_2 , in place of air?	[3]
27	A capacitor is charged with a battery and then its plate separation is increased without disconnecting the battery. What will be the change in 1. charge stored in the capacitor? 2. energy stored in the capacitor? 3. potential difference across the plates of the capacitor? 4. electric field between the platesof thecapacitor?	[3]
28	A network of four capacitors, each of capacitance 15μF, is connected across a battery of 100 V, as shown in the figure. Find the (i) net capacitance and (ii) the charge on the capacitor C_4 .  **OR** An electric dipole is placed in a uniform electric field: 1. Show that no translatory force acts on it. 2. Derive an expression for the torque acting on it. 3. Find work done in rotating the dipole through 180°.	[3]
29	A storage battery of emf 8 V, internal resistance 1Ω, is being charged by a 120 V d.c. source, using a 15 Ω resistor in series in the circuit. Calculate: 1. the current in the circuit, 2. the terminal voltage across the battery during charging, and 3. chemical energy stored in the battery in 5 minutes.	[8]
30	A parallel plate capacitor, each with plate area A and separation d, is charged to a potential difference V. The battery used to charge it is then disconnected. A dielectric slab of thickness d and dielectric constant k is now placed between the plates. What changes, if any, will take place in 1. charge on the plates. 2. electric field intensity between the plates, 3. capacitance of the capacitor.	[8]
	Section E	

31	1. Using Gauss's law, derive an expression for the electric field intensity at any point outside a uniformly charged thin spherical shell of radius R and charge density$\sigma\ C/m^2$. Draw the field lines when the charge density of the sphere is (i) positive, (ii) negative.  2. A uniformly charged conducting sphere of 2.5 m in diameter has a surface charge density of$100\mu C/m^2$ .Calculate (i) Charge on the sphere (ii) Total electric flux passing through the sphere. **OR** 1. Using Gauss law, derive expression for electric field due to a spherical shell of uniform charge distributionσ and radius R at a point lying at a distance x from the centre of shell, such that a. $0 < x < R$, and b. $x > R$. 2. An electric field is uniform and acts along + x direction in the region of positive x. It is also uniform with the same magnitude but acts in - x direction in the region of negative x. The value of the field is E = 200 N/C for $x > 0$ and E = - 200 N/C for $x < 0$. A right circular cylinder of length 20 cm and radius 5 cm has its centre at the origin and its axis along the x - axis so that one flat face is at x = + 10 cm and the other is at x = - 10 cm. Find: a. The net outward flux through the cylinder. b. The net charge present inside the cylinder.	[5]
32	Calculate potential on the axis of a disc of radius R due to a charge Q uniformly distributed on its surface. **OR** 1. Find the expression for the potential energy of a system of two point charges q_1 and q_2 located at $\vec{r}_1$ and $\vec{r}_2$, respectively in an external electric field $\vec{E}$. 2. Draw equipotential surfaces due to an isolated point charge (- q) and depict the electric field lines. 3. Three point charges + 1μ C, - 1 μ C and + 2 μ C are initially infinite distance apart. Calculate the work done in assembling these charges at the vertices of an equilateral triangle of side 10 cm.	[5]

33	Determine the current in each branch of the network shown in figure.  **OR** 1. Find the emf E_1 and E_2 in the circuit of the following diagram and the potential difference between the points Aand B.  2. If in the circuit, the polarity of the battery E_1 , be reversed, what will be the potential difference between Aand B?	**[5]**

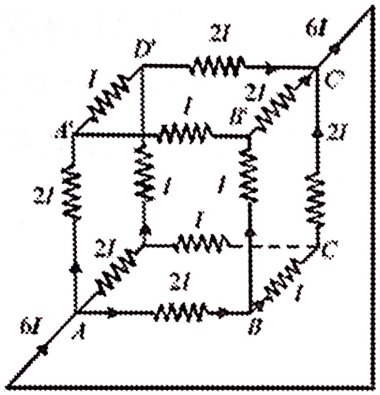
18	In the given circuit, with a steady current, calculate the potential difference across the capacitor and the charge stored in it.  	[2]
19	The current through a wire depends on time as $I = I_0 + \alpha t$, where $I_0 = 10$ A and $\alpha = 4$ As^{-1} .Find the charge that flows across a section of the wire in 10 seconds.	[2]
20	A dipole of dipole moment 'p'is present in a uniform electric field E. Write the value of the angle between p and E for which the torque experienced by the dipole, is minimum.	[2]
21	A cylinder is placed in a uniform electric field$\vec{E}$ with its axis parallel to the field. Show that the total electric flux through the cylinder is zero. **OR** A spherical shell of metal has a radius of 0.25 m and carries a charge of 0.2μ C. Calculate the electric fieldintensity at a point 1. inside the shell, 2. just outside the shell and 3. 3.0 m from the centre of the shell.	[2]
22	Obtain the expression for the potential due to an electric dipole of dipole moment p at a point **d** on the axial line.	[2]
23	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 of the capacitor. Explain giving reasons, how will the following be affected: 1. the capacitance of the capacitor, 2. charge on the capacitor, 3. the energy density of the capacitor.	[2]
24	When 10 cells in series are connected to the ends of resistance of 590, the current is found to be 0.25 A, but when the same cells after beingconnected in parallel are joined to the ends of a 0.05Ω ,the current is 25 A. Calculate the internal resistance and emf of each cell.	[2]
25	In a Wheatstone bridge arrangement, the ratio arms P and Q are nearly equal. The bridge is balanced when R = 500Ω . On interchanging P and Q, the value of R for balancing is 505 . Find the value of X and the ratio $\frac{P}{Q}$.	[2]
	Section D	

26	S_1 and S_2 are two hollow concentric spheres enclosing charges 2Q and 4Q respectively as shown in the figure. 1. What is the ratio of electric flux through S_1 and S_2 ? 2. How will the electric flux through the sphere S_1 change, if a medium of dielectric constant 6 is introduced in the space inside S_1 in the place of air? 	[3]
27	1. Find equivalent capacitance between A and B in the combination given below. Each capacitor is of 2μ F capacitance.  2. 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?	[3]
28	Three identical capacitors C_1 , C_2 and C_3 of capacitances 6 μF each are connected to a 12 V battery as shown below:  Find 1. the charge on each capacitor 2. the equivalent capacitance of the network 3. the energy stored in the network of capacitors. **OR** An electric dipole consists of two opposite charges each of magnitude 1μ C separated by 2 cm. The dipole is placed in an external electric field of $105NC^{-1}$. Find 1. the maximum torque exerted by the field on the dipole 2. the work which the external agent will have to do in turning the dipole through 180° starting from the position 0 = 0°	[3]
29	Two cells of emf E_1 , E_2 and internal resistances r_1 and r_2 respectively are connected in parallel as shown in the figure.  Deduce the expressions for 1. the equivalent emf of the combination. 2. the equivalent resistance of the combination.	[3]
30	A dielectric slab of thickness 1.0 cm and dielectric constant 5 is placed between the plates of a parallel plate capacitor of plate area $0.01m^2$ and separation 2.0 cm. Calculate the change in capacity on introduction of dielectric. What would be the change, if the dielectric slab were conducting?	[3]
	Section E	

31	1. State Gauss's law in electrostatics. Use this law to derive an expression for the electric field due to an infinitely long straight wire of linear charge density $\lambda\ Cm^{-1}$. 2. An electric dipole consists of charges of $2.0 \times 10^{-8} C$ separated by a distance of 2 mm. It is placed near a long line charge of density $4.0 \times 10^{-4} Cm^{-1}$ as shown in the figure below, such that the negative charge is at a distance of 2 cm from the line charge. Calculate the force acting on dipole.  **OR** Using Gauss' law, deduce the expression for the electric field due to a uniformly charged spherical conducting shell of radius R at a point 1. outside the shell 2. inside the shell Plot a graph showing a variation of the electric field as a function of r > R and r < R(r being the distance from the centre of the shell).	[5]
32	1. If two similar large plates, each of area A having surface charge densities $+\sigma$ and $-\sigma$ are separated by a distance d in air, then find the expression for a. the field at points between the two plates and on the 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. 2. Two metallic spheres of radii R and 2R are charged so that both of these have the 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? **OR** 1. Two - point charges q_1 and q_2 are kept r distance apart in a uniform external electric field $\vec{E}$. Find the amount of work done in assembling this system of charges. 2. A cube of side 20 cm is kept in a region as shown in the figure. An electric field $\vec{E}$ exists in the region such that the potential at a point is given by V = 10x + 5, where V is in volt and x is in m.  Find the a. electric field $\vec{E}$, and b. total electric flux through the cube.	[5]

33

1. State Kirchhoffs rules.
2. A battery of 10 V and negligible internal resistance is connected across the diagonally opposite corners of a cubical network consisting of 12 resistors each of 1Ω resistance.

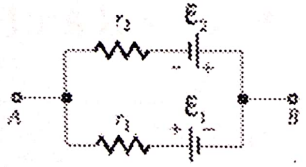


Use Kirchhoffs rules to determine

a. the total current in the network.
b. the equivalent resistance of the network

OR

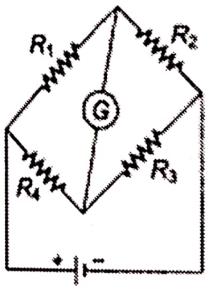
Find the emf (ε_0) and internal resistance (r_0) of a battery which is equivalent to a parallel combination of two batteries of emfs ε_1 and ε_2 and internal resistances r_1 and r_2 respectively, with polarities as shown in the figure.



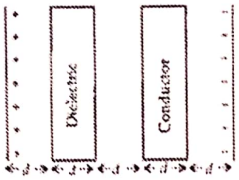
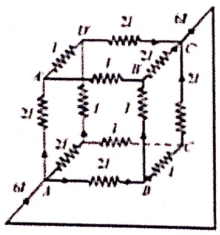
	Section B	
17	An infinite number of charges each equal to 4μ C are placed along x - axis at x = 1 m, x = 2 m, x = 4 m, x = 8 m and so on. Find the total force on a charge of 1 C placed at the origin.	[2]
18	1. Explain the meaning of the statement, electric charge of a body is quantized. 2. Why can one ignore quantization of electric charge when dealing with macroscopic i.e. large scale charges?	[2]
19	Distinguish between electric charge and mass.	[2]

20	Compare electrostatic and gravitational interactions.	[2]
21	What conclusion can you draw from the following observations on a resistor made of alloy manganin?	[2]

Current A	Voltage V	Current A	Voltage V
0.2	3.94	3.0	59.2
0.4	7.87	4.0	78.8
0.6	11.8	5.0	98.6
0.8	15.7	6.0	118.5
1.0	19.7	7.0	138.2
2.0	39.4	8.0	158.0

	Section C	
22	Two conductors are made of the same material and have the same length. Conductor A is a solid wire of diameter 1mm. Conductor B is a hollow tube of outer diameter 2mm and inner diameter 1mm. Find the ratio of resistance R_A to R_B.	[3]
23	For the circuit diagram of a Wheatstone bridge shown in the figure, use Kirchhoff's laws to obtain its balance condition. 	[3]
24	A student connects a cell, of emf ε_2 and internal resistance r_2 with a cell of emf ε_1 and internal resistance r_1, such that their combination has a net internal resistance less than r_1. This combination is then connected across a resistance R. Draw a diagram of the 'set - up' and obtain an expression for the current flowing through the resistance.	[3]
25	State the law of conservation of charge. Give two examples to illustrate it.	[3]
26	Obtain the expression for the torque τ experienced by an electric dipole of dipole moment p in a uniform electric field, E.What will happen, if the field were not uniform?	[3]
27	Show that the force on each plate of a parallel plate capacitor has a magnitude equal to $\left(\frac{1}{2}\right) QE$, where Q is the charge on the capacitor, and E is the magnitude of electric field between the plates. Explain the origin of the factor $\frac{1}{2}$.	[3]
28	A capacitor is made of two circular plates of radius R each, separated by a distance d << R. The capacitor is connected to a constant voltage. A thin conducting disc of radius r << R and thickness t << r is placed at a center of the bottom plate. Find the minimum voltage required to lift the disc if the mass of the disc is m.	[3]
	Section D	

	Section E
31	Derive an expression for the electric field intensity at any point on the axis of a uniformly charged ring. **OR** ABCD is a square of side 5 m. Charges of + 50 C, - 50 C and + 50 C are placed at A, C and D respectively. Find the resultant electric field at B.

32	1. Compare the individual dipole moment and the specimen dipole moment for H_2O molecule and O_2 molecule when placed in a. Absence of external electric field. b. Presence of external electric field. Justify your answer. 2. Given two parallel conducting plates of area A and charge densities $+\sigma$ and $-\sigma$. A dielectric slab of constant k and a conducting slab of thickness d each are inserted in between them as shown a. Find the potential difference between the plates. b. Plot E versus x graph, taking x = 0 at positive plate and x = 5 d at negative plate.  **OR** 1. 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. 2. A chargeq = 2μ Cis placed at the centre of a sphere of radius 20 cm. What is the amount of work done in moving 4 μ Cfrom one point to another point on its surface? 3. Write a relation for polarisation$\vec{P}$ of a dielectric material in the presence of an external electric field.	[5]
33	1. Derive an expression for drift velocity of free electrons. 2. How does drift velocity of electrons in a metallic conductor vary with increase in temperature? Explain. **OR** 1. State Kirchhoffs rules. 2. A battery of 10 V and negligible internal resistance is connected across the diagonally opposite corners of a cubical network consisting of 12 resistors each of 1Ω resistance.  Use Kirchhoffs rules to determine a. the total current in the network. b. the equivalent resistance of the network	[5]