

**General Instructions:**

There are 33 questions in all. All questions are compulsory.

This question paper has five sections: Section A, Section B, Section C, Section D and Section E

Section A contains sixteen questions, twelve MCQ and four Assertion Reasoning based of 1 mark each, Section B contains five questions of two marks each, Section C contains seven questions of three marks each, Section D contains two case study based questions of four marks each and Section E contains three long answer questions of five marks each.

**SECTION -A**

1. An electric dipole having a dipole moment of  $4 \times 10^{-9}$  C m is placed in a uniform electric field such that the dipole is in stable equilibrium. If the magnitude of the electric field is  $3 \times 10^3$  N/C, what is the work done in rotating the dipole to a position of unstable equilibrium?

- (a) zero
- (b)  $1.2 \times 10^{-5}$  J
- (c)  $2.4 \times 10^{-5}$  J
- (d)  $- 1.2 \times 10^{-5}$  J

2. An infinite line of charge has a linear charge density of  $10^{-7}$  C/m. What will be the magnitude of the force acting on an alpha particle placed at a distance of 4 cm from the line of charge?

- (a)  $14.4 \times 10^{-15}$  N
- (b)  $7.2 \times 10^{-15}$  N
- (c)  $4.5 \times 10^4$  N
- (d)  $9 \times 10^4$  N

3. Which of the following is not the property of an equipotential surface?

(a) They do not cross each other.

(b) The work done in carrying a charge from one point to another on an equipotential surface is zero.

(c) For a uniform electric field, they are concentric spheres.

(d) They can be imaginary spheres.

4. An ammeter of resistance 0.81 ohm reads up to 1 A. The value of the required shunt to increase the range to 10 A is

(a) 0.9 ohm

(b) 0.09 ohm

(c) 0.03 ohm

(d) 0.3 ohm

5. Two wires have lengths, diameters and specific resistances all in the ratio of 1 : 2. The resistance of the first wire is 10 ohm. Resistance of the second wire (in ohm) will be:

(a) 10

(b) 20

(c) 5

(d) infinite

6. The large scale transmission of electrical energy over long distances is done with the transformers. The voltage output of the generator is stepped-up because of

(a) reduction of current

(b) reduction of current and voltage both

(c) power loss is cut down

(d) a and c both

7. Unit of conductance is

(a) Dyne

(b) Siemen

(c) Ohm

(d) Volts

8. The relative permeability of a substance X is slightly less than unity and that of substance Y is slightly more than unity, then

(a) X is paramagnetic and Y is ferromagnetic

(b) X is diamagnetic and Y is ferromagnetic

(c) X and Y both are paramagnetic

(d) X is diamagnetic and Y is paramagnetic

9. In a moving coil galvanometer the current through the coil produces a torque to turn the coil. The torque is balanced by

(a) magnetic moment

(b) a helical spring deflection

(c) eddy current torque

(d) gravitational torque

10. The electrostatic potential on the perpendicular bisector due to an electric dipole is

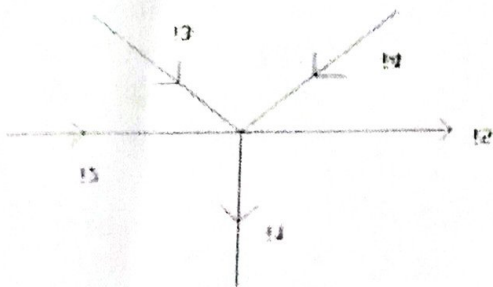
(a) Zero

(b) 1

(c) Infinite

(d) Negative

11. Relation between currents according to KCL is



(a)  $i_1 = i_2 = i_3 = i_4 = i_5$

(b)  $i_1 + i_4 + i_3 = i_5 + i_2$

(c)  $i_1 - i_5 = i_2 - i_3 - i_4$

(d)  $i_1 + i_5 = i_2 + i_3 + i_4$

12. An ammeter of resistance 0.81 ohm reads up to 1 A. The value of the required shunt to increase the range to 10 A is *if the no of turns in coil is double*

(a) 0.9 ohm

(b) 0.09 ohm

(c) 0.03 ohm

(d) 0.3 ohm

*if the no of turns in coil is double then, of inductance*  
① Double  
②  $\frac{1}{2}$   
③ 4 time  
④ None change

For question numbers 13, 14, 15 and 16, two statements are given-one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as 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

13. Assertion: When capacitive reactance is smaller than the inductive reactance in series L-C-R circuit, voltage leads the current.

Reason: In series L-C-R circuit inductive reactance greater than capacitive reactance

14. Assertion (A): The conductivity of intrinsic semiconductors increases with an increase in temperature.

Reason (R): Increase in temperature decreases the average time between collisions of electrons.

15. Assertion (A): The direction of the electric field is always perpendicular to the equipotential surface.

Reason (R): Work is done by the electric force in moving a charge between any two points on an equipotential surface is zero.

16. Assertion: The magnetic field at the ends of a very long current carrying solenoid is half of that at the center.

Reason: If the solenoid is sufficiently long, the field within it is uniform. Select the most appropriate answer from the options given below:

### SECTION- B

17. Draw one equipotential surfaces (1) Due to uniform electric field (2) For a point charge ( $q < 0$ )?

18. The storage battery of a car has an emf of 12V. If the internal resistance of the battery is  $0.4 \Omega$ , what is the maximum current that can be drawn from the battery?

OR

19. Write any three factors on which internal resistance of a cell depends.  
 19. A hollow metal sphere of radius 5 cm is charged so that the potential on its surface is 10 V. Find potential at its center.

OR

- Determine the magnitude of the magnetic field B at the center of the circular coil of wire carrying a current of 0.4 A and having 100 turns with 8 cm being the radius of each turn.  
 20. Define the term 'Mobility' of charge carriers in a conductor. Write its S.I. unit.  
 21. Derive an expression for the torque experienced by an electric dipole placed in uniform electric field.

### SECTION-C

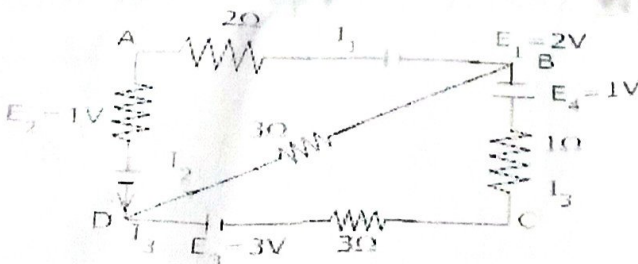
22. What is drift velocity? Derive expression for drift velocity of electrons in a good conductor in terms of relaxation time of electrons?

23. If the radius of the Gaussian surface enclosing a charge is halved, how does the electric flux through the Gaussian surface change?

24. State Kirchoff's rules. Explain briefly how these rules are justified.

OR

In the network shown, find the values of current in a given circuit.



25. Explain the principle of Wheatstone bridge for determining an unknown resistance.  
 26. State Biot- Savarts law. Derive an expression for magnetic field at the center of a circular coil of n-turns carrying current - I?

27. Identify the part of the electromagnetic spectrum which:

- (a) produces heating effect.  
 (b) is absorbed by the ozone layer in the atmosphere.  
 (c) is use for studying crystal structure of atom.

$$[u = -PE \cos \theta]$$

Write any one method of the production of each of the above radiations.

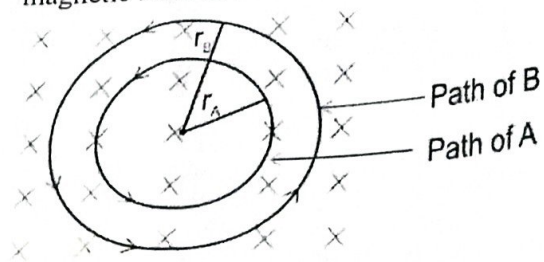
OR

A parallel plate capacitor with air between the plates has a capacitance of 8pF. What will happen to the capacitance of it if the distance between the plates is halved and the region is filled with a substance of dielectric constant 6?

28. Derive an expression for the torque experienced by a magnetic dipole in a uniform magnetic field.

OR

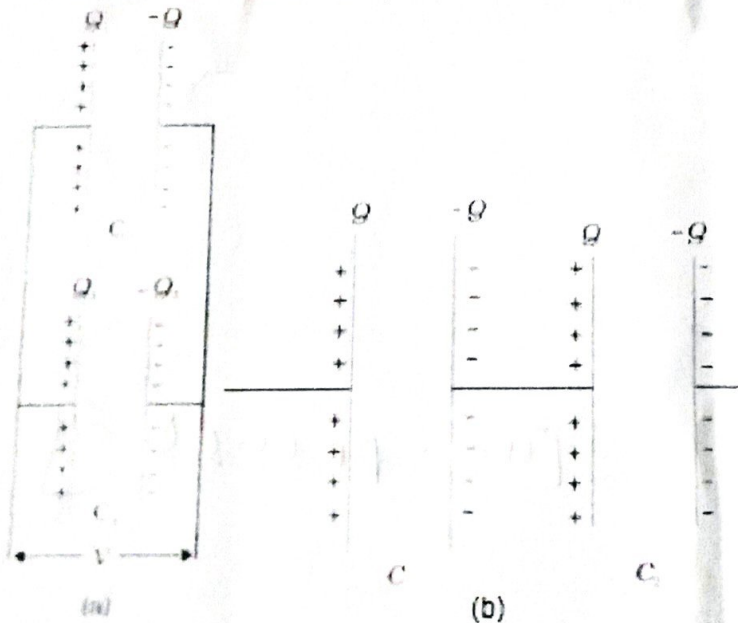
Two charges A and B, each having a velocity of  $v$ , traverse circular paths in a uniform magnetic field as shown below



- (a) Compare the charge-to-mass ratio of the two particles A and B. Show the necessary mathematical calculations.  
 (b) Which of the two particles is likely to be a proton if the other is an alpha particle? Give reason.

#### SECTION- D

29. If two or more capacitors are connected in series, the overall effect is that of a single (equivalent) capacitor having the sum total of the plate spacing of the individual capacitors. If two or more capacitors are connected in parallel, the overall effect is that of a single equivalent capacitor having the sum total of the plate areas of the individual capacitors. (figure (a) shows parallel combination and (b) shows series combination)



1. Capacity can be increased by connecting capacitors in:

- (a) parallel  
 (b) series

(c) both a and b

(d) none of these

2. Three capacitors having a capacitance equal to 2F, 4F and 6F are connected in parallel. Calculate the effective parallel capacitance:

(a) 10 F

(b) 11 F

(c) 12 F

(d) 13 F

3. When capacitors are connected in the series remains the same.

(a) voltage

(b) capacitance

(c) charge

(d) resistance

4. The plates of a parallel plate capacitor are 10 cm apart and have an area equal to  $2\text{m}^2$ . If the charge on each plate is , the electric field at a point:

(a) between the plates will be zero

(b) outside the plates will be zero

(c) between the plates will change from point to point

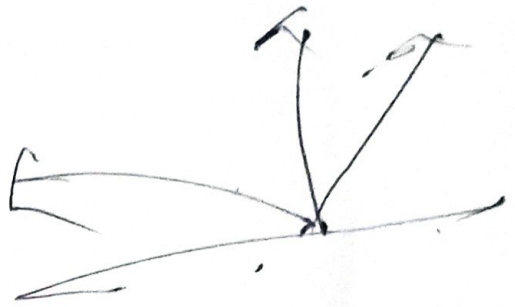
(d) between the plates will be

OR

5. Four 10 F capacitors are connected in series, calculate the equivalent capacitance.

(a) 1.5 F

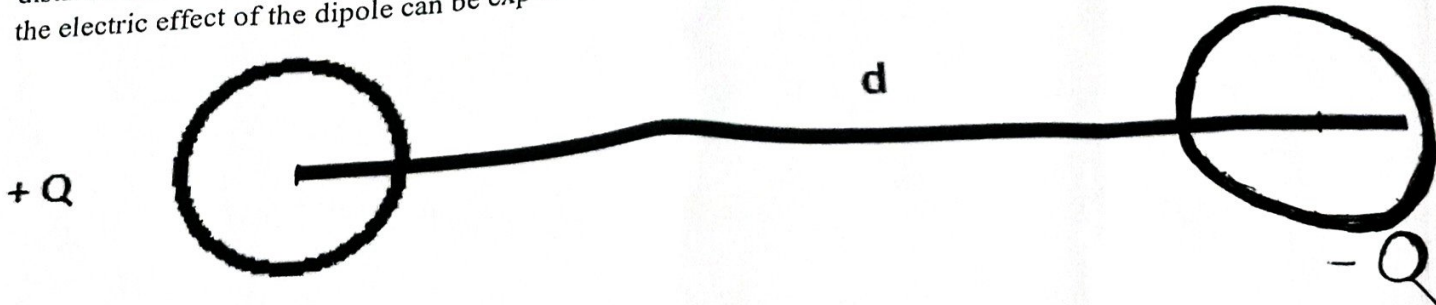
(b) 2.5 F



(c) 3.5 F

(d) 4.5 F

30. Electric dipole consists of a pair of equal and opposite point charges separated by a small distance and its strength is measured by the dipole moment. The field around the dipole in which the electric effect of the dipole can be experienced is called the dipole field.



1. The electric dipole moment is:

(a) a scalar quantity

(b) neither scalar nor vector quantity

(c) a vector quantity

(d) none of these

2. Electric field due to the electric dipole is

(a) cylindrically symmetric

(b) spherically symmetric

(c) none of these

(d) asymmetric

3. The SI unit of dipole moment is:

(a) C/m

(b) C-m



(c)  $\text{C/m}^2$

(d)  $\text{C}\cdot\text{m}^2$

4. Charges  $20 \text{ nC}$  are separated by  $5 \text{ mm}$ . Calculate the magnitude of dipole moment:-

(a)  $10^{-7} \text{ C}\cdot\text{m}$

(b)  $10^{10} \text{ C}\cdot\text{m}$

(c)  $10^{-10} \text{ C}\cdot\text{m}$

(d)  $10^{-8} \text{ C}\cdot\text{m}$

OR

When an electric dipole is placed in a uniform electric field, it experiences

(a) Neither any force nor any torque

(b) Force but no torque

(c) Force as well as torque

(d) Torque but no net force

OR

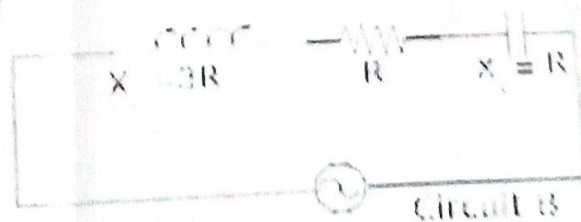
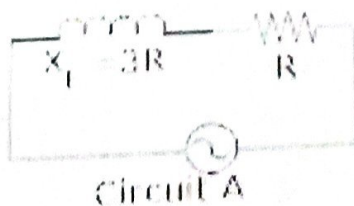
### SECTION- E

31. (a) State Gauss's theorem in electrostatics. Using this theorem, derive an expression for the electric field intensity due to infinitely long, straight wire of linear charge density  $\lambda \text{ cm}^{-1}$ .  
(b) Define self-inductance. Derive an expression for self-inductance for long solenoid.

OR

Derive an expression electric field due to electric dipole at axial point and give the relation between electric field at axial point and equatorial point.

32. (i) Derive an expression for the capacitance of a parallel plate capacitor with air present between the two plates.  
(ii) Figure shows two electric circuits A and B. Calculate the ratio of power factor of the circuit B to the power factor of the circuit A?



OR

Draw a labelled diagram of moving coil galvanometer. Prove that in a radial magnetic field, the deflection of the coil directly proportional to the current following in the coil.

33. (a) State the theorem which relates the enclosed charge, inside a closed surface, with the electric flux through it. Use this theorem to obtain the electric field due to a uniformly charged thin spherical shell at an (i) outside point (ii) inside point.
- (b) Two long and parallel straight wires A and B carrying currents of 8.0 A and 5.0 A in the same direction are separated by a distance of 4.0 cm. Estimate the force on a 10 cm section of wire A.

OR

(a) Explain with the help of labeled diagram, the principle construction and working of a transformer?

(b) An ideal transformer having a ferromagnetic core consists of two coils having 500 turns (primary) and 50 turns (secondary) respectively. (a) What is the voltage across the secondary coil, if the rms voltage across the primary coil is 240 V? (b) What will be the individual currents in the two coils (primary and secondary), if the secondary has a resistive load of 20 ohms? dipole.