ಕರ್ನಾಟಕ ಸರ್ಕಾರ

ಶಾಲಾ ಶಿಕ್ಷಣ ಇಲಾಖೆ (ಪದವಿ ಪೂರ್ವ)

18ನೇ ಅಡ್ಡರಸ್ತೆ, ಮಲ್ಲೇಶ್ವರಂ, ಬೆಂಗಳೂರು -560012

Web site: *https://www.pue.karnataka.gov.in/*

ಮತ್ತು

ಕರ್ನಾಟಕ ಶಾಲಾ ಪರೀಕ್ಷೆ ಮತ್ತು ಮೌಲ್ಯನಿರ್ಣಯ ಮಂಡಲಿ

6ನೇ ಅಡ್ಡರಸ್ತೆ, ಮಲ್ಲೇಶ್ವರಂ, ಬೆಂಗಳೂರು -560003

Web site: *https://kseab.karnataka.gov.in/*

2025 – 26ನೇ ಸಾಲಿನ ದ್ವಿತೀಯ ಪಿಯುಸಿ ಪ್ರಶ್ನೆ ಕೋಠಿ

ವಿಷಯ ಸಂಕೇತ: 33

ವಿಷಯ: ಭೌತಶಾಸ್ತ್ರ

GOVERNMENT OF KARNATAKA

Department of School Education (Pre University)

18th Cross, Malleshwaram Bengaluru- 560012

Web site: https://www.pue.karnataka.gov.in/

and

Karnataka School Education and Assessment Board

6th Cross, Malleshwaram Bengaluru- 560003

Web site: *https://kseab.karnataka.gov.in/*

2025 – 26 II PUC QUESTION BANK

SUBJECT CODE: 33

SUBJECT NAME: PHYSICS

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II PUC CHAPTERWISE MARKS ALLOTMENT

TIME: 3 HOURS **33 – PHYSICS** **Max Marks: 70**

UNIT NUMBER	UNIT NAME	Number of Teaching Hours	Marks Allotted	Page Number
1	ELECTRIC CHARGES AND FIELDS	**12**	**11**	**1 – 9**
2	ELECTRIC POTENTIAL AND CAPACITANCE	**12**	**11**	**10 – 20**
3	CURRENT ELECTRICITY	**15**	**13**	**21 – 30**
4	MOVING CHARGES AND MAGNETISM	**13**	**11**	**31 – 40**
5	MAGNETISM AND MATTER	**6**	**5**	**41 – 46**
6	ELECTROMAGNETIC INDUCTION	**8**	**7**	**47 – 52**
7	ALTERNATING CURRENT	**8**	**7**	**53 – 59**
8	ELECTROMAGNETIC WAVES	**3**	**3**	**60 – 63**
9	RAY OPTICS AND OPTICAL INSTRUMENTS	**11**	**9**	**64 – 71**
10	WAVE OPTICS	**8**	**7**	**72 – 76**
11	DUAL NATURE OF RADIATION AND MATTER	**6**	**5**	**77 – 82**
12	ATOMS	**4**	**4**	**83 – 87**
13	NUCLEI	**5**	**4**	**88 – 91**
14	SEMICONDUCTOR DEVICES AND ELECTRONICS	**9**	**8**	**92 – 96**
TOTAL		**120**	**105**	**---**
15	**2025 Board Exam Question papers (3 Papers)**	**---**	**---**	**97 – 109**
16	**2024 Board Exam Question Papers (3 Papers)**	**---**	**---**	**110 – 121**
17	**2024 - 25 Model Question papers (3 Papers)**	**---**	**---**	**122 – 136**
18	**Practice Papers (2 Papers)**	**---**	**---**	**137 – 144**

CHAPTER 1. ELECTRIC CHARGES AND FIELDS

MULTIPLE CHOICE QUESTIONS

1. When a glass rod is rubbed with silk cloth, (E)

(A) silk cloth will lose electrons to glass rod
(B) glass rod will lose electrons to the silk cloth
(C) glass rod acquires negative charge
(D) silk acquires positive charge

2. The electric field at a distance 'r' from infinitely long straight uniformly charged wire is (E)

(A) inversely proportional to r
(B) inversely proportional to cube of r
(C) inversely proportional to square of r
(D) independent of r

3. Which one of the following charges can not exist on a body? (E)

(A) 2e (B) 3e (C) 3.5e (D) – 4e

4. The electrostatic force between the two charges in vacuum is given by $F = k\ \frac{q_1 q_2}{r^2}$ where k is (E)

(A) $9 \times 10^9 \text{Nm}^2/\text{C}^2$ (B) $9 \times 10^9 \text{NC}^2/\text{m}^2$ (C) $9 \times 10^{-9} \text{Nm}^2/\text{C}^2$ (D) $9 \times 10^9 \text{N}$

5. The force on any charge due to a number of other charges is the vector sum of all the forces on that charge due to the other charges. This statement is called (E)

(A) quantization principle of charges
(B) principle of superposition of electric forces
(C) principle of homogeneity
(D) additivity of charges

6. The direction of electric field vector at a point on the equatorial line of a dipole is (E)

(A) in the same direction of dipole moment
(B) in the opposite direction to the dipole moment
(C) towards negative charge
(D)towards positive charge

7. Dipole moment is a vector quantity, which is pointing from (E)

(A) $-q$ to $+q$ along the axis of an electric dipole.
(B) $+q$ to $-q$ along the axis of an electric dipole.
(C) infinity to $+q$
(D) $+q$ to infinity.

8. Name the physical quantity which has the dimensional formula[LTA] (E)

(A) line charge density (B) capacitance (C) dipole moment (D)charge

9. _____ placed in an electric field experiences a force in the direction opposite to the electric field. (E)

(A) An electron (B) A positive charge (C) A neutron (D) A proton.

10. When a free electric dipole placed in a non-uniform electric field, the dipole will experience (E)

(A) both force and torque
(B) only force but not torque
(C) only torque but not force
(D) neither torque nor force

11. Electrostatic field lines can never form closed loops. This is due to (E)

(A) Conservation of charges.
(B) Conservation of momentum.
(C) Quantization of electric charges
(D) Conservative nature of electrostatic field

12. SI unit of electric flux is **(E)**

(A) NC^{-1} (B) Weber (C) $NC^{-1}m^2$ (D) $Nm^{-2}C$

13. Electric field intensity at a distance *r* from center of uniformly charged sphere outside the sphere is *E*. Which one of the following is correct? **(E)**

(A) $E\ \alpha q$ and $E\ \alpha\frac{1}{r}$ (B) $E\ \alpha\ \frac{1}{q}$ and $E\ \alpha\frac{1}{r}$ (C) $E\ \alpha q$ and $E\ \alpha\frac{1}{r^2}$ (D) $E\ \alpha q$ and $E\alpha\frac{1}{r^3}$

14. The electric field due to an electric dipole at any point on its axis, which is at distance *r* (*r*>> length of dipole) from its center varies according to **(E)**

(A) $E \propto r$ (B) $E \propto \frac{1}{r}$ (C) $E \propto \frac{1}{r^2}$ (D) $E \propto \frac{1}{r^3}$

15. Identify the wrong statement **(E)**

(A) Electric field lines start from positive charges and end at negative charges.

(B) In case of a single charge, electric field lines may start or end at infinity.

(C) Two field lines can never cross each other.

(D) Electrostatic field lines form closed loops.

16. The physical quantity with SI unit Cm^{-1} is **(E)**

(A) volume charge density (B) surface charge density

(C) linear charge density (D) electric dipole moment

17. If 'n' electrons are removed from a neutral body, then the charge acquired by it is **(E)**

$(A) -ne$ (B) $+ne$ (C) $-\frac{e}{n}$ (D) $+\frac{e}{n}$

18. Two identical point charges of +1 C separated by a distance 1 m in air experience repulsive force of magnitude **(E)**

(A) $1\ N$ (B) $9\ \times 10^9\ N$ (C) $9\ \times 10^{-9}\ N$ (D) $10^9\ N$

HOTS QUESTIONS

19. Some physical quantities are listed in column 1 and the SI UNITS are listed in column 2. Identify the correct match **(D)**

COLUMN 1	COLUMN 2
(i) Electric field	(a) $C^2N^{-1}m^{-2}$
(ii) Electric flux	(b) $N\ C^{-1}$
(iii) Permittivity	(c) Vm

(A) (i)-(b), (ii)-(c), (iii)-(a)

(B) (i)-(b), (ii)-(a), (iii)-(c)

(C) (i)-(c), (ii)-(b), (iii)-(a)

(D) (i)-(a), (ii)-(c), (iii)-(b)

20. Statement (1): The electric field lines never cross each other.

Statement (2): If they did, the field at the point of intersection will not have a unique direction, which is not possible. **(D)**

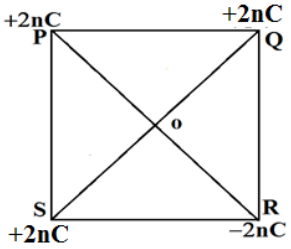
(A) Both statements are correct Statement (2) is the correct explanation for Statement (1)

(B) Both statements are correct Statement (2) is not the correct explanation for Statement (1)

(C) Statement (1) is correct but Statement (2) is wrong.

(D) Statement (2) is correct but Statement (1) is wrong.

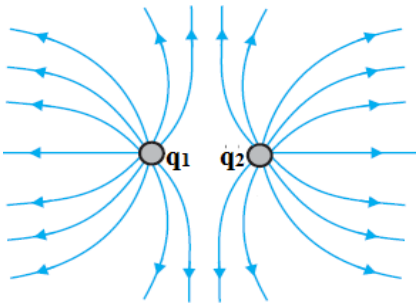
21. Four charges are placed at the corners of a square PQRS as shown in the figure. The direction of the resultant electric field at the intersection of the diagonals is **(D)**



(A) Towards P (B) Towards Q

(C) Towards R (D) Towards S

22. The following figure shows the electric field around the two charges where, **(D)**



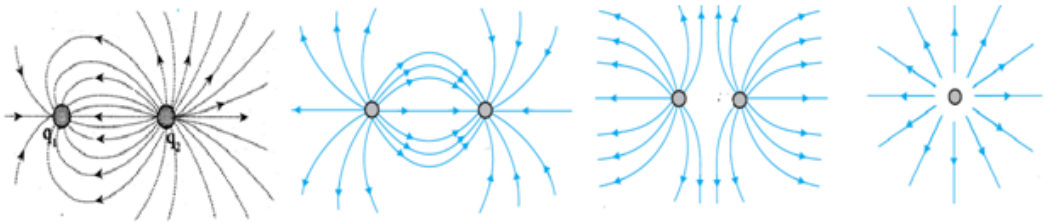
(A) q_1 is positive, q_2 is negative

(B) q_1 is negative, q_2 is positive

(C) both charges are positive

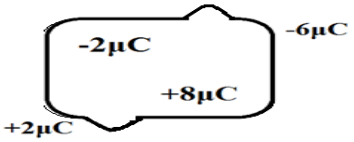
(D) both charges are negative

23. Which one of the following shows the electric field lines due to an electric dipole? **(D)**



(A) **(B)** **(C)** **(D)**

24. The given figure is related to Gauss's law in electrostatics: $\phi = \frac{q}{\varepsilon_o}$, where q is equal to **(D)**



(A) +2 μC (C) – 8 μC

(B) – 6 μC (D) +6 μC

25. Some physical quantities are listed in column 1 and their dimensions are listed in column 2. Identify the correct match **(D)**

(A) (i)-(b), (ii)-(c), (iii)-(a)
(B) (i)-(c), (ii)-(b), (iii)-(a)
(C) (i)-(b), (ii)-(a), (iii)-(c)
(D) (i)-(a), (ii)-(c), (iii)-(b)

COLUMN 1	COLUMN 2
(i) Electric field	(a) $[AT]$
(ii) Electric flux	(b) $[MLT^{-3}A^{-1}]$
(iii) Electric charge	(c) $[ML^3 T^{-3} A^{-1}]$

FILL IN THE BLANKS

SET-1 [*neutral, negative , positive, maximum, zero, infinity*] **(E)**

1. The electric field lines due to a single positive charge end at _____.
2. The electric field inside a uniformly charged spherical shell is _____.
3. If area vector $\Delta\vec{S}$ of a surface is parallel to the applied electric field $\vec{E}$, then the electric flux ϕ through the surface is at its_____.
4. A neutron does not experience any force in an electric field because neutron is _____.
5. A body gains a _____ charge when it loses electrons.

SET-2 (*vacuum, outward, weak, zero, strong, charge*) **(E)**

6. Gold leaf electroscope is used to detect _____ present on a body.
7. The electrostatic force between two charges is maximum in_____.
8. In case of a positive source charge, the electric field will be directed radially _____ from the charge
9. The electric field lines crowd where the electric field is _____. .
10. The total electric flux through a closed surface enclosing electric dipole is_____.

SET-3 (*polar, scalar, conserved, insulator, vector, conductor*) **(E)**

11. The charge transferred to a _____ is readily gets distributed over its entire surface.
12. The total charge of the isolated system is always _____.
13. The centres of negative charges and of positive charges of _____ molecules do not coincide.
14. Electric flux is a _____ quantity.
15. Electric dipole moment is a _____ quantity.

TWO MARKS QUESTIONS

1. Name the types of charges are acquired by a plastic rod and a piece of wool when they are rubbed against each other. **(E)**
2. Which are the two types of charges named by Benjamin Franklin? **(E)**
3. Draw the neat, labeled diagram of gold leaf electroscope. **(A)**

4. What are electric conductors? Give an example. **(E)**

5. What are electric insulators? Give an example. **(E)**

6. 'Electric charges are quantized'. Explain. **(A)**

7. State and explain Coulomb's law. **(A)**

8. Write the Coulomb's law in vector form and explain the terms. **(A)**

9. Name the SI unit for charge. Define the SI unit of charge. **(A)**

10. The force between two point charges is *F*. Find the new force when the distance between them is halved.**(A)**

11. Define electric field at a point. What is meant by '*source charge*'? **(E)**

12. Write the expression for electric field at a point due to a point charge in vector form and explain the terms.**(A)**

13. What are the factors on which electric field at a point due to a point source charge depends? **(A)**

14. What are electric field lines? Do electrostatic field lines form closed loops? **(E)**

15. Sketch the electric field lines due to (a) a negative charge. (b) pair of equal positive charges. **(A)**

16. Sketch the electric field lines due to (a) a positive charge. (b) a dipole. **(A)**

17. Can two electric field lines intersect each other? Justify your answer. **(A)**

18. Define electric flux through an area element. Mention its SI unit. **(A)**

19. Define electric dipole moment. Mention its SI unit. **(E)**

20. When does an electric dipole placed in a uniform electric field experience
(a) maximum torque and (b) minimum torque? **(A)**

21. Define linear charge density. Write its SI unit. **(E)**

22. Define surface charge density. Write its SI unit. **(E)**

23. Define volume charge density. Write its SI unit. **(E)**

24. State and explain Gauss's law in electrostatics. **(A)**

25. Mention any two basic properties of electric charges**.** **(E)**

26. Write two properties of electric field lines. **(E)**

TWO MARKS NUMERICAL PROBLEMS

[For numerical problems take $\varepsilon_o = 8.85 \times 10^{-12}\ F\ m^{-1}$ and $\frac{1}{4\pi\varepsilon_o} = 9 \times 10^9 N\ m^2 C^{-2}$]

1. A glass rod is rubbed by silk cloth. Glass rod acquires a charge of 1.6×10^{-13}C. Find the number of electrons are transferred to the silk cloth. **(A)**

2. A test charge of magnitude 1.5×10^{-9} C is placed at a point where electric field is 5.4×10^4 NC^{-1}. Find the the force experienced by the test charge. **(A)**
3. A charge of 1μC is distributed on a circular ring of radius 5 cm. Find the linear charge density. **(A)**
4. A charge of 1μC is distributed over a metallic spherical shell whose radius is 5 cm. Find the surface charge density. **(A)**
5. An electric dipole with dipole moment 4×10^{-9}Cm is making an angle of 30° with the direction of a uniform electric field of magnitude 5×10^4 NC^{-1}. Calculate the magnitude of the torque acting on the dipole. **(A)**
6. A charge of 1nC is placed in air. Estimate the electric field at a distance of 2cm from the charge. **(A)**
7. Two point charges 2nC and -4nC are located at 0.02m apart in vacuum. Find the electrostatic force between them. **(A)**
8. A 2 μC point charge placed at a point 'P' in an uniform electric field experiences a force of 1.6×10^{-6} N. Find the magnitude of the electric field at 'P'. **(A)**

THREE MARKS QUESTIONS

1. Describe an experiment to demonstrate that there are two types of charges using glass rod and plastic rod. **(A)**
2. Define linear charge density. Mention the expression for electric field at a point due to an infinite line of charge and explain the terms. **(E)**
3. State Coulomb's law. Show that it agrees with Newton's third law. **(A)**
4. Write the three basic properties of electric charges. **(E)**
5. State the principle of superposition of electric forces. Three equal positive charges are placed on the three corners A, B and C of a square ABCD. Sketch a diagram to show the resultant force on the charge at B. **(A)**
6. Write three properties of electric field lines. **(E)**
7. Derive the expression for the torque experienced by an electric dipole placed in a uniform electric field. **(A)**
8. State and explain Coulomb's law. Define '1 çoulomb'. **(A)**

THREE MARKS NUMERICAL PROBLEMS

[For numerical problems take $\varepsilon_o = 8.85 \times 10^{-12}\ F\ m^{-1}$ and $\frac{1}{4\pi\varepsilon_o} = 9 \times 10^9 N\ m^2 C^{-2}$]

1. Two point charges 20μC and 10μC are separated by a distance of 0.05m in free space. Find the elctrostatic force between them. Also find the force when a dielectric medium of dielectric constant 3 is introduced between the charges. **(A)**
2. Two point charges q_A = 3μC and q_B = –3 μC are located 20 cm apart in vacuum. Find the electric field at the midpoint O of the line AB joining the two charges. **(A)**

3. A point charge +5μC is placed at the center of the cube of side 4cm. Find the electric flux through each square surface of the cube. **(A)**
4. Calculate the number of electrons to be removed or added to a neutral conductor to make it gain a charge of +6nC of on its surface. **(A)**
5. An infinite line charge produces a field of 9×10^4 N/C at a distance of 2 cm. Calculate the linear charge density. **(A)**
6. Two thin metal plates with large area are parallel and close to each other. On their inner faces, the plates have surface charge densities of opposite signs and of magnitude 17.0×10^{-12} C/m^2. Assuming the charged plates to be infinite sheets of charges, find the magnitude and direction of the electric field at a point present between the plates? **(A)**
7. Two positive charges of 0.2μC and 0.8μC are placed at a distance 0.15m apart. Find the position of the point on the line joining them where the electric field zero. **(D)**

FIVE MARKS QUESTIONS

1. Derive the expression for electric field at a point on the axial line of an electric dipole. **(D)**
2. Derive the expression for electric field at a point on the equatorial plane of an electric dipole. **(D)**
3. State Gauss' law in electrostatics. Using Gauss law, derive the expression for the electric field due to an infinitely long straight uniformly charged wire. **(D)**
4. State Gauss' law in electrostatics. Derive the expression for electric field due to a uniformly charged infinite plane sheet using Gauss law. **(D)**
5. Arrive at the expression for the electric field due to a thin uniformly charged spherical shell at a point outside the shell using Gauss law. Write the expression for electric field on its surface. **(D)**

FIVE MARKS NUMERICAL PROBLEMS

[For numerical problems take $\varepsilon_o = 8.85 \times 10^{-12}\ F\ m^{-1}$ and $\frac{1}{4\pi\varepsilon_o} = 9 \times 10^9 N\ m^2 C^{-2}$]

1. Charges of +10nC, – 20nC,– 10nC and +20nC are placed at the corners A, B, C and D respectively of a square ABCD of side 0.05m. Calculate the resultant force on the charge at D. **(D)**
2. Four charges +Q, +2Q, +3Q and +4Q are placed at the corners of a square ABCD of side 0.1m respectively. The electric field at the center of the square is 5.1×10^3 NC^{-1}. Find Q. **(D)**
3. Two oppositely charged small metallic spheres placed 0.5m apart attract each other with a force of 0.108N. When they are connected to each other by a copper wire for a short while, they begin to repel with a force of 0.036N. Calculate the initial charges on the spheres. **(D)**

4. Two charged particles are separated by a distance of 0.2m in air. The charge on one particle is twice the charge on the other. If the electrostatic force between the two charges is 8×10^{-3}N, find the magnitude of individual charges. Also find the new separation required between the two charges if the electrostatic force has to be 2×10^{-3}N. **(D)**

5. A pendulum bob of mass 80mg and carrying charge 2×10^{-8}C is at rest at a certain angle with the vertical in a horizontal uniform electric field of 20,000Vm^{-1}. Find the tension in the thread of the pendulum and the angle it makes with the vertical. **(D)**

6. Two point charges each of +3 μ C are placed at the two corners A and B of an equilateral triangle ABC of side 0.1 m. Find the magnitude and direction of the resultant electric field at C. **(D)**

7. Two point charges +10 μC and -5 μC are separated by a distance of 0.2 m in air. Calculate the electric field at the midpoint of line .joining two charges. If a point charge of 2 nC is placed at that mid-point, find the magnitude of electric force experienced by it. **(D)**

8. An electric dipole consists of two point charges ±2 μC which are 4.0 mm apart. Determine the magnitude of electric field at

(i) a point on the axial line of the dipole 40 cm away from its centre O and

(ii) a point which is 50 cm away from O on the equatorial line of the dipole. **(A)**

9. Two identical metal spheres with charges +6 nC and -2 nC are separated by a distance 0.1 m in air. Find the magnitude of the electrostatic force between them. Also find the force between the same two spheres when they are brought into contact and placed at their initial position. **(D)**

10. A uniform spherical shell of radius 0.2 m has a charge of 18 μC. Find the surface charge density of the spherical shell. Also find the electric field due to the shell at a distance of 0.4 m from the centre of the shell. **(A)**

11. A negatively charged oil drop is prevented from falling under gravity by applying a vertical electric field of 100 Vm^{-1}. If the mass of the drop is 1.6×10^{-6} kg, calculate i) the magnitude of the charge and ii) the number of electrons carried by the drop. (Given, g = 10 ms^{-2}) **(A)**

12. Electric charges of + 10 μC and - 5 μC are placed at two corners A and B of an equilateral triangle ABC of side 5 cm. Calculate the magnitude of the resultant electric field at vertex C. **(A)**

13. A negatively charged spherical shell of radius 0.1 m produces an electric field of 5×10^4 N C^{-1} at a point distant 0.2 m from the centre of the shell. Calculate the charge on the spherical shell. Also Calculate the number of extra electrons present on the spherical shell. **(A)**

ANSWER KEYS TO MULTIPLE CHOICE QUESTIONS

1	**B**	**6**	**B**	**11**	**D**	**16**	**C**	**21**	**C**
2	**A**	**7**	**A**	**12**	**C**	**17**	**B**	**22**	**C**
3	**C**	**8**	**C**	**13**	**C**	**18**	**B**	**23**	**B**
4	**A**	**9**	**A**	**14**	**D**	**19**	**A**	**24**	**D**
5	**B**	**10**	**A**	**15**	**D**	**20**	**A**	**25**	**A**

ANSWER TO FIBs

SET-1	1. infinity	2. zero	3. maximum	4. neutral	5. positive
SET-2	**6.** charge	**7.** vacuum	8. outward	9. strong	10. zero
SET-3	11. conductor	12. conserved	13. polar	14. scalar	15. vector

CHAPTER 2. ELECTROSTATIC POTENTIAL AND CAPACITANCE

MULTIPLE CHOICE QUESTIONS

1. Name the physical quantity whose SI unit is joule per coulomb. (E)

(A) Power (B) Electric field (C) Electric potential (D) Dipole moment

2. A unit of energy among the following is (E)

(A) V (B) Vm (C) Vm^{-1} (D) eV

3. Equal charges are given to the two spheres of different radii. The potential will: (E)

(A) Be more on bigger sphere (B) Be more on smaller sphere

(C) Be equal on both the spheres (D) Depend on the nature of the materials of the spheres

4. For linear dielectrics, the ratio of dielectric polarisation to the magnitude of applied electric field is equal to (E)

(A) mobility (B) dipole moment (C) $\varepsilon_o \times$ Susceptibility (D) permittivity

5. The dimension of electric polarisation is given by (E)

(A) $[L^{-2}AT]$ (B) [LAT] (C) $[ML^2A^{-1}T^{-3}]$ (D) $[M^{-1}L^{-2}A^2T^{-4}]$

6. The electric potential at the surface of a charged spherical shell of radius 10 cm is 20 V. The electric potential at the center of the shell is (E)

(A) Zero (B) 10 V (C) 20 V (D) 30 V

7. The electric field at a point which is very close to the surface of a charged conductor with surface charge density σ is (E)

(A) $E = \frac{\sigma}{2\varepsilon_0}$ (B) $E = \frac{\sigma}{\varepsilon_0}$ (C) $E = \frac{2\varepsilon_0}{\sigma}$ (D) $E = \frac{2\sigma}{\varepsilon_0}$

8. The energy density between the plates of a charged capacitor is given by (E)

(A) $\frac{1}{2}CV^2$ (B) $\frac{1}{2}\varepsilon_o V^2$ (C) $\frac{1}{2}\varepsilon_o E^2$ (D) $\frac{1}{2}QV$

9. The potential energy of an electric dipole placed in a uniform electric field is (E)

(A) $-\vec{p}.\vec{E}$ (B) $-\vec{p} \times \vec{E}$ (C) $\frac{1}{2}CV^2$ (D) $\frac{1}{2}\varepsilon_o E^2$

10. An electric dipole is placed in a uniform electric field. The dipole moment makes an angle θ with the electric field. For what angle θ is the potential energy of the dipole maximum? (E)

(A) $\theta = 0^o$ (B) $\theta = 45^o$ (C) $\theta = 90^o$ (D) $\theta = 180^o$

11. Capacitance of a capacitor is defined as C = q/V. A factor on which capacitance of the capacitor depends is: (E)

(A) only on charge q (C) only on geometry of the conductors of capacitor

(B) only on potential deference V (D) all of the above factors q, V and geometry.

12. Capacity of a parallel plate capacitor can be increased by **(E)**

(A) increasing the distance between the plates (B) increasing the thickness of the plates

(C) decreasing the area of the plates (D) decreasing the distance between the plates

13. The potential energy of a capacitor is stored in the _____ between the plates of the capacitor.(E)

(A) electric charges (B) electric field (C) magnetic field (D) current

14. Which of the following correctly describes the behavior of polar and non-polar dielectrics in an electric field? **(E)**

(A) Both polar and non-polar dielectrics have permanent dipole moments, but only nonpolar dielectrics align in an external field.

(B) Polar dielectrics align their dipole moments with the external field, while in the case of non-polar dielectrics a dipole moment is induced in response to the field.

(C) Non-polar dielectrics align their permanent dipole moments in an external field, while polar dielectrics remain unaffected.

(D) Polar dielectrics and non-polar dielectrics behave identically in the presence of an electric field, showing no difference in polarization.

15. The electric potential (V) produced by a negative point charge at a distance 'r' from it is ____ and varies with 'r' as _____. **(E)**

(A) $negative, \frac{1}{r}$ (B) $negative, \frac{1}{r^2}$ (C) $positive, \frac{1}{r}$ (D) $positive, \frac{1}{r^2}$

16. The magnitude of electric potential produced by a point charge at a point depends **(E)**

(A) only on the magnitude of charge.

(B) only on the distance of the point from the charge.

(C) only on the medium present between the charge and the given point.

(D) on all the above factors.

17. The electric potential produced by a point charge (V_P) and an electric dipole (V_D) at large distance 'r' from them vary with 'r' as **(E)**

(A) $V_P \propto \frac{1}{r^2}\ and\ V_D \propto \frac{1}{r^3}$ (B) $V_P \propto \frac{1}{r}\ and\ V_D \propto \frac{1}{r^2}$

(C) $V_P \propto \frac{1}{r^3}\ and\ V_D \propto \frac{1}{r^2}$ (D) $V_P \propto \frac{1}{r^2}\ and\ V_D \propto \frac{1}{r}$

18. If M and N are the points present on the axial line and equatorial line of an electric dipole respectively at finite distances from the centre of the dipole with V_M and V_N as the corresponding electric potentials, then **(E)**

(A) $V_M = 0\ and\ V_N \neq 0$ (B) $V_M \neq 0\ and\ V_N = 0$

(C) $both\ V_M\ and\ V_N\ not\ equal\ to\ zero$ (D) $both\ V_M\ and\ V_N\ equal\ to\ zero$

19. If P, Q and R are the points present inside, on the surface and outside a charged spherical conductor respectively, then **(E)**

(A) electric potentials at P and R are same (B) electric potentials at P and Q are same

(C) electric potentials at Q and R are same (D) electric potentials at all the three points are same

20. An equipotential surface is a surface with a constant value of **(E)**

(A) electric charges. (B) electric field.

(C) electric potential. (D) surface charge density.

21. The equipotential surfaces of an isolated point charge are **(E)**

(A) coaxial cylindrical surfaces.

(B) plane surfaces parallel to each other.

(C) concentric spherical surfaces centred at the charge.

(D) spherical surfaces but not centred at the charge.

22. The energy gained by an electron accelerated through a potential difference of 1 V is **(E)**

(A) 1 J (B) 1.6×10^{19} eV (C) 1 eV (D) 1 erg

23. Identify the wrong statement. **(E)**

(A) The electric field at any point inside a charged conductor is zero..

(B) The electric field at any point on the surface of a charged conductor is normal to the surface.

(C) The net charge at any point inside a charged conductor is zero.

(D) The electric potential at every point inside a charged conductor has a constant value and is less the value corresponding to the surface of that conductor.

24. The capacitance of a parallel plate capacitor is independent of **(E)**

(A) the nature of the medium present between the plates of the capacitor.

(B) the area of the plates of the capacitor.

(C) the potential difference applied between the plates of the capacitor.

(D) the distance of separation between the plates of the capacitor.

HOTS QUESTIONS

25. An electric dipole is placed inside an insulating spherical shell. Pick the wrong statement among the following: **(D)**

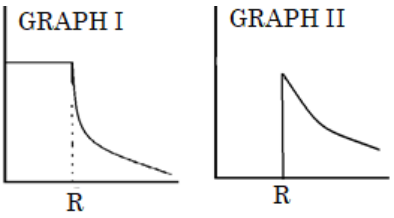
(A) Net charge enclosed by the shell is zero

(B) Sphere acts as equipotential surface.

(C) Electric flux through the sphere is zero.

(D) Electric field is not uniform across the surface of the spherical shell.

26. The following graphs show the variations of two physical quantities with distance '*r*' from the center of a uniformly charged spherical shell. Identify the graphs. **(D)**



(A) First graph shows variation of E versus r and second is V versus r

(B) First graph shows variation of V versus r and second is E versus r

(C) Both graphs shows the variation of V versus r

(D) Both graphs shows the variation of E versus r

27. Statement 1: The electric field inside a conductor is zero. **(D)**

Statement 2: All the charges reside only on the surface of the conductor.

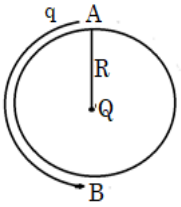
(A) Both statements are correct and Statement 2 is the correct explanation for the Statement 1.

(B) Both statements are correct and Statement 2 is not correct explanation for the Statement 1.

(C) Statements 1 is correct and Statement 2 is wrong

(D) Statements 1 is wrong and Statement 2 is correct

28. An imaginary sphere radius *R* is drawn around a charge *Q*, keeping the charge *Q* at its center. The work required to move a test charge *q* from point A to point B on the sphere is **(D)**



(A) $q(2R)$ (C) zero

(B) qV_A (D) qV_B

29. Consider the following statements: **(D)**

Statement 1: The equipotential surface at a point is always normal to the electric field at that point.

Statement 2: If the electric field were not normal to the equipotential surface, work has to be done in moving a test charge on the surface.

(A) Both statements are correct and Statement 2 is the correct explanation for the Statement 1.

(B) Both statements are correct and Statement 2 is not the correct explanation for the Statement 1.

(C) Statements 1 is correct and Statement 2 is wrong.

(D) Statements 1 is wrong and Statement 2 is correct.

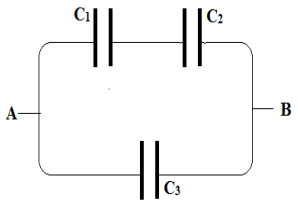
30. The equivalent capacitance of the combination is **(D)**

(A) $\frac{C_1C_2}{C_1+C_2}+\frac{1}{C_3}$

(B) $\frac{C_1C_2+C_2C_3+C_3C_1}{C_1+C_2+C_3}$

(C) $\frac{C_1C_2C_3}{C_1+C_2+C_3}$

(D) $\frac{C_1C_2+C_2C_3+C_3C_1}{C_1+C_2}$



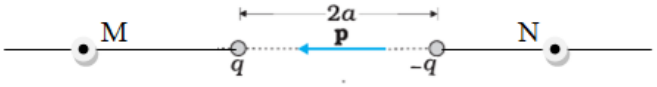
31. If V_M and V_N are the electric potentials produced by the electric dipole at the points M and N shown in the figure, then **(A)**

(A) V_M *is negative and* V_N *is positive*

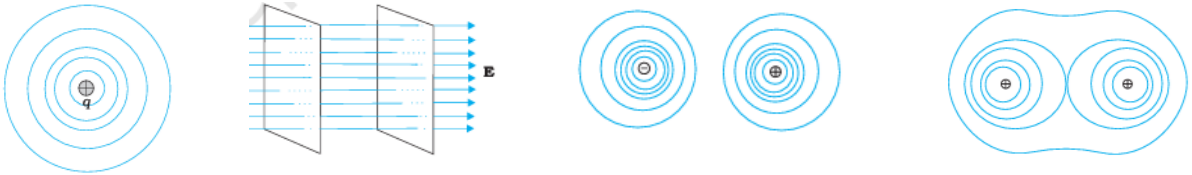
(B) V_M *is positive and* V_N *is negative*

(C) *both* V_M *and* V_N *are positive*

(D) *both* V_M *and* V_N *are negaitive*



32. The diagram representing the equipotential surfaces of an electric dipole is **(E)**



(A) **(B)** **(C)** **(D)**

33. Here are the two statements related to equipotential surfaces. **(A)**

Statement I : The potential difference between any two points of an equipotential surface is zero.

Statement II : External work is required to move a point charge from one point to another point on an equipotential surface.

(A) Both the statements are correct.

(B) Statements I is correct and statement II is wrong

(C) Both the statements are wrong.

(D) Statements I is wrong and statement II is correct.

34. Identify the wrong statement. **(A)**

(A) Potential energy of a system of two like charges is positive and increases with decrease in separation between the charges.

(B) Potential energy of a system of two like charges is positive and decreases with decrease in separation between the charges.

(C) Potential energy of a system of two unlike charges is negative and decreases with decrease in separation between the charges.

(D) Potential energy of a system of two unlike charges is negative and increases with increase in separation between the charges.

35. Some physical quantities are listed in column 1 and their dimensions are listed in column 2. Identify the correct match **(D)**

(A) (i)-(b), (ii)-(c), (iii)-(a)

(B) (i)-(c), (ii)-(b), (iii)-(a)

(C) (i)-(b), (ii)-(a), (iii)-(c)

(D) (i)-(a), (ii)-(c), (iii)-(b)

COLUMN 1	COLUMN 2
(i) Electric potential	(a) $[MLT^{-3}A^{-1}]$
(ii) Capacitance	(b) $[ML^2T^{-3}A^{-1}]$
(iii) Dielectric strength	(c) $\left[M^{-1}L^{-2}T^4A^2\right]$

FILL IN THE BLANKS

SET-1 [*zero, constant, dielectric constant, electric dipole, point charge*] **(E)**

1. The electric potential at all the points on the surface of a uniformly charged spherical shell is…….

2. The potential energy of an electric dipole, when dipole moment $\vec{p}$ is perpendicular to electric field $\vec{E}$ is……

3. The ratio of permittivity of a medium to the permittivity of free space is called …….

4. The electric potential at a point due to a/an …… varies inversely as its distance from the given point.

5. The electric potential at any point on the equatorial plane of a/an ……. is zero.

SET-2 [*zero, positive, normal, constant, negative, decreases*] **(E)**

6. The potential energy of a system of two unlike point charges is _____.

7. The electric field always acts in the direction in which the potential _____.

8. The work required to move a charge between any two points on an equipotential surface is _____.

9. The electric field at any point on the surface of a charged conductor acts _____ to the surface.

10. The electric potential is _____ over the volume of a charged conductor.

SET-3 [*zero, electrostatic shielding, non-polar, dielectric strength, spherical, polar*] **(E)**

11. The equipotential surfaces corresponding to an isolated point charge are _____ in shape.

12. The net charge at any point inside a charged conductor is _____.

13. The electric field inside the cavity of a charged conductor is zero and is known as _____.

14. The dipole moment of a _____ molecule is zero in the absence of external electric field.

15. The maximum electric field that a dielectric can withstand without break-down is called its _____.

SET-4 [*polar, series, zero, capacitor, parallel, non-polar*] **(E)**

16. The potential difference between any two points on the surface of a charged conductor is _____.

17. The _____ molecules have non zero dipole moment even in the absence of external electric field.

18. A system of two conductors separated by an insulator used to store charges is called a _____.

19. In _____ combination of capacitors, the charges on the two plates are same on each capacitor.

20. In _____ combination of capacitors, the potential difference across each capacitor will be same.

TWO MARKS QUESTIONS

1. Define electrostatic potential at a point. Mention its SI unit. **(E)**

2. What is electrostatic shielding? Mention one use of it. **(E)**

3. Write the expression for the potential at any point due to an electric dipole and explain the terms. **(A)**

4. What the amount of work done in moving a charge from the center of a charged spherical shell to any point inside it? Justify your answer. **(A)**

5. *The electrostatic potential energy of a system of two like charges is positive*. Explain. **(A)**

6. In the expression for the relation between electric field and potential which are the two important conclusions we arrive at? **(A)**

7. What are the two main factors on which the extent of polarization of a dielectric medium depends? **(A)**

8. What are dielectrics? Define electric polarization. **(E)**

9. What are polar molecules? Give an example. **(E)**

10. What are non-polar molecules? Give an example. **(E)**

11. Write any two differences between polar and non-polar molecules. **(E)**

12. What is dielectric strength? Mention its SI unit **(E)**

13. Define electric polarization for linear isotropic dielectrics. Mention its SI unit **(E)**

14. What is meant by equipotential surface? Draw equipotential surfaces for an electric dipole. **(A)**

15. Draw equipotential surfaces for (a) a uniform electric field and (b) an isolated point charge. **(A)**

16. What is a capacitor? What is it use? **(E)**

17. Define the capacitance of a capacitor. Write the circuit symbol for a capacitor. **(E)**

18. Name the SI unit of capacitance. Define the SI unit of capacitance. **(E)**

19. Write the expression for electric energy density in case of a charged capacitor and explain the symbols used. **(A)**

20. Write the expression for energy stored in a charged capacitor and explain the terms. **(A)**

TWO MARKS NUMERICAL PROBLEMS

[For numerical problems take $\varepsilon_o = 8.85 \times 10^{-12}\ F\ m^{-1}$ and $\frac{1}{4\pi\varepsilon_o} = 9 \times 10^9 N\ m^2 C^{-2}$]

1. Find the potential at a point due to a charge of 4×10^{-9} C located 9 cm away from it. **(A)**

2. An electric dipole is placed in a uniform electric field with dipole moment vector perpendicular to the external electric field. Find the work required to turn the dipole so as to align dipole moment vector anti parallel to electric field. Given: Dipole moment = 6 μCm, External electric field = 10^6 Vm^{-1}. **(A)**

3. The electrostatic potential at a point is 10 V. Find the work required to move a charge of 20 μC from infinity to that point. **(A)**

4. Capacitance of a parallel plate capacitor with air between the plates is 18 pF. When air is replaced by a dielectric slab, the capacitance becomes 54 pF. Find the dielectric constant of the slab. **(A)**

5. A 600 pF capacitor is charged by a 200 V supply. It is then disconnected from the supply and is connected to another uncharged 600 pF capacitor. Find the common potential difference. **(A)**

6. The amount of work required to bring a point charge of +2 nC from infinity to a point P is 10^{-7} J. Assuming the electric potential at infinity to be zero, calculate the electric potential at P. **(A)**
7. The amount work done in moving a point charge of 3μC from a point M to N in an electric field is 60 nJ. Calculate the potential difference between M and N. **(A)**
8. Potential difference of 2 V is applied across a capacitor of 5 nF. Calculate the potential energy stored in the capacitor. **(A)**
9. Three capacitors of capacitances 2 pF, 3 pF and 5 pF are connected in parallel. Calculate the total capacitance of the combination. **(A)**

THREE MARKS QUESTIONS

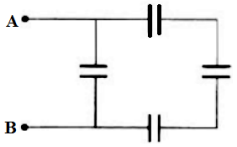
1. Derive the expression for electric potential due to a system of charges. **(A)**
2. Obtain the expression for the relation between electric field and electric potential. **(A)**
3. Arrive at the expression for the potential energy of a system of two charges in the absence of external electric field. **(A)**
4. Obtain the expression for the potential energy of a system of two charges in the presence of an external electric field. **(A)**
5. Derive an expression for energy stored in an electric dipole placed in a uniform electric field. **(A)**
6. Mention any three important results regarding electrostatics of conductors. **(E)**
7. Write two differences between polar and non-polar dielectrics. Give an example for each. **(A)**
8. Mention any three factors on which the capacitance of a parallel plate capacitor depends. **(E)**
9. Derive the expression for the effective capacitance of a series combination of two capacitors. **(A)**
10. Arrive at the expression for the effective capacitance of a parallel combination of two capacitors. **(A)**

THREE MARKS NUMERICAL PROBLEMS

[For numerical problems take $\varepsilon_o = 8.85 \times 10^{-12}\ F\ m^{-1}$ and $\frac{1}{4\pi\varepsilon_o} = 9 \times 10^9 N\ m^2 C^{-2}$]

1. Capacitance of a parallel plate capacitor is 1nF and the plates are separated by a distance of 2mm. Find the area of each plate of the capacitor. **(A)**
2. Two charges of 10μC and 5μC are 12cm apart. Find the work done in bringing charges 2cm closer. **(A)**
3. Two capacitors of capacitances 2 pF and 4 pF are connected in parallel across 100V supply. Find the total capacitance of the combination. Determine the charge on each capacitor. **(A)**
4. Two capacitors of capacitances 2 pF and 4 pF are connected in series across 100 V dc supply. Find the total capacitance of the combination. Determine the potential difference across each capacitor. **(A)**

5. In the following diagram, the capacitance of each capacitor is equal to 3μF. Find the equivalent capacitance across AB. **(A)**



6. An electric dipole of dipole moment 6×10^{-6} C m is aligned in the direction of uniform electric field of 10^6 Vm^{-1}. Calculate the potential energy of the dipole. **(A)**
7. Find the electrostatic potential energy of a system consisting of two point charges of 7 μC and –2 μC separated by 0.18 m (with no external field). **(A)**
8. Point charges of 3nC, –2nC and 4nC are placed at the vertices A, B and C of an equilateral triangle ABC of side 0.2m. Find the potential energy of the system. **(A)**
9. In a parallel plate capacitor with air between the plates, each plate has an area of 6×10^{-6} m^2 and the distance between the plates is 3 mm. Calculate the capacitance of the capacitor.
   [Given the value of $\varepsilon_0 = 8.85 \times 10^{-12}$ Fm^{-1}] **(A)**
10. Three capacitors of capacitances 2 pF, 3 pF and 6 pF are connected in series. Calculate the total capacitance of the combination. **(A)**
11. Charges 2μC, 4μC and 6μC are placed at the three corners A, B and C respectively of a square ABCD of side 0.2 m. Find the charge that must be placed at the fourth corner so that the total potential at the centre of the square is zero. **(A)**

FIVE MARKS QUESTIONS

1. Define electrostatic potential due to an isolated point charge and arrive at the expression for electric potential at a point due to an isolated point charge. **(D)**
2. Define capacitance of a capacitor. Arrive at the expression for the capacitance of a parallel plate capacitor with air between the plates. **(A)**
3. Derive an expression for electric potential at a point due to an electric dipole. **OR**

   Derive the expression for electric potential, $V = \frac{1}{4\pi\in_0}\frac{p\cos\theta}{r^2}$ for an electric dipole. **(D)**
4. Derive an expression for the electric potential energy of a system of three charges in the absence of external electric field. **(D)**

FIVE MARKS NUMERICAL PROBLEMS

[For numerical problems take $\varepsilon_o = 8.85 \times 10^{-12}\ F\ m^{-1}$ and $\frac{1}{4\pi\varepsilon_o} = 9 \times 10^9 N\ m^2 C^{-2}$]

1. Two charges 5×10^{-8}C and -3×10^{-8}C are located 16 cm apart in vacuum. Find the positions along line passing through the two charges at which the electric potential zero? **(D)**

2. Three charges +2nC, +4nC, and +8nC are placed at the corners A, B and C respectively of a square ABCD of sides 0.2 m. Calculate the work done to transfer a charge of +2nC from the corner D to the center of the square. **(D)**

3. An 800pF capacitor is charged by a 100V battery. Find the energy stored by the capacitor. The capacitor is now disconnected from the battery and connected to another uncharged 800 pF capacitor. Find the electrostatic energy of the system? **(D)**

4. Two capacitors of capacitances 2μF and 8μF are connected in series and the resulting combination is connected across a 300V battery. Calculate the charge and the energy stored in each capacitor**. (D)**

5. In a parallel plate capacitor with air between the plates, each plate has an area of 6×10^{-3} m^2 and the distance between the plates is 3mm. Calculate the capacitance of the capacitor. If the magnitude of charge on each plate is 1.8×10^{-9}C, find the energy stored in the capacitor. **(D)**

6. When two capacitors are connected in series with a 4 kV line, the energy stored in the system 8 J. If the same capacitors are connected in parallel across the same line, the energy stored is 36 J. Find the individual capacitances. **(D)**

7. In a parallel plate capacitor with circular plates each of radius of each plate is 5 cm and they are separated by a distance of 2 mm. Calculate the capacitance and the energy stored, when it is charged by connecting the battery of 200 V. [$\varepsilon_0 = 8.85 \times 10^{-12}$ Fm^{-1}]. **(A)**

8. Point charges of 3nC, **–**2nC and 4nC are placed at the vertices A, B and C of an equilateral triangle ABC of side 0.2m. Find the potential energy of the system. Also find the amount of work required to place the same charges at the vertices of an equilateral triangle of side 0.1m. **(D)**

9. In a parallel plate capacitor with air between the plates, each plate has a square shape of sides 2 cm. If the plates are separated by a distance 1 mm and the capacitor is connected to a potential difference of 50 V, then **(A)**

(a) Calculate the capacitance of the capacitor.

(b) Find the charge on each plate and energy stored in the capacitor. Given: $\epsilon_o = 8.854 \times 10^{-12}$ Fm^{-1}.

10. Two capacitors of capacitances 6 μF and 12 μF are connected in series and the combination is connected to a source of emf 30 V. Calculate **(D)**

(i) the equivalent capacitance of the combination,

(ii) the charge stored in 12 μF capacitor and

(iii) the potential difference across 6 μF capacitor.

ANSWER KEY TO MULTIPLE CHOICE QUESTIONS

1	C	6	C	11	C	16	D	21	C	26	B	31	B
2	D	7	B	12	D	17	B	22	C	27	A	32	C
3	B	8	C	13	B	18	B	23	D	28	C	33	B
4	C	9	A	14	B	19	B	24	C	29	A	34	B
5	A	10	D	15	A	20	C	25	B	30	D	35	A

ANSWERS TO FIBs

SET-1: **1. constant** **2. zero** **3. dielectric constant** **4. point charge** **5. electric dipole**

SET-2: **6.** ***negative*** **7.** ***decreases*** **8.** ***zero*** **9. normal** **10.** ***constant***

SET-3: **11.** ***spherical*** **12. zero** **13.** ***electrostatic shielding*** **14.** ***non-polar*** **15.** ***dielectric strength***

SET-4: **16.** ***zero*** **17.** ***polar*** **18.** ***capacitor*** **19.** ***series*** **20.** ***parallel***

CHAPTER 3. CURRENT ELECTRICITY

MULTIPLE CHOICE QUESTIONS

1. The SI unit of electric current is **(E)**

(A) coulomb (B) ampere (C) volt (D) farad

2. When no current is passed through a conductor, **(E)**

(A) the free electrons do not move.

(B) the average speed of a free electron over a large period of time is not zero.

(C) the average velocity of a free electron over a large period of time is zero.

(D) the average of the velocities of all the free electrons at an instant is non zero.

3. In the absence of an electric field, the mean velocity of free electrons in a conductor at absolute temperature (T) is **(E)**

(A) Zero (B) independent of T (C) proportional to T (D) proportional to T^2

4. Ohm's law is valid when the temperature of conductor is **(E)**

(A) very low (B) very high (C) constant (D) varying

5. In the equation AB = C, A is the current density, C is the electric field, Then B is **(E)**

(A) resistivity (B) conductivity (C) resistance (D) potential difference

6. Which of the following is non-ohmic resistance? **(E)**

(A) Lamp filament (B) Copper wire (C) Carbon resistor (D) Semiconductor diode

7. The relaxation time in conductors **(E)**

(A) increases with the increase of temperature (B) decreases with the increase of temperature

(C) it does not depend on temperature (D) all of sudden changes at 400 K

8. With increase in temperature the conductivity of **(E)**

(A) semiconductors increases and metals decreases.

(B) metals increases and of semiconductor decreases.

(C) in both metals and semiconductors increases.

(D) in both metal and semiconductor decreases.

9. Drift velocity of electrons is due to **(E)**

(A) motion of conduction electrons due to random collisions.

(B) motion of conduction electrons due to electric field E

(C) repulsion to the conduction electrons due to inner electrons of ions.

(D) collision of conduction electrons with each other.

10. Constantan wire is used for making standard resistance, because it has **(E)**

(A) high melting point (B) low specific resistance

(C) high specific resistance (D) negligible temperature coefficient of resistance

11. The resistivity of a wire **(E)**

(A) increases with the length of the wire

(B) decreases with the area of cross-section

(C) decreases with the length and increases with the cross-section of wire

(D) none of the above statement is correct

12. *n* identical cells of each emf *E* and internal resistance *r* are connected in series. An external resistance *R* is connected in series with this combination. The current through *R* is **(E)**

(A) $\frac{nE}{R+nr}$ (B) $\frac{nE}{nR+r}$ (C) $\frac{E}{R+nr}$ (D) $\frac{nE}{R+r}$

13. If the terminals of a cell are connected to an external resistance then the potential difference across its terminals is **(E)**

(A) more than emf of the cell (B) less than emf of the cell

(C) equal to emf of the cell (D) equal to potential drop across its internal resistance

14. Kirchhoff's first law, i.e., $\sum I = 0$ at a junction, deals with the conservation of **(E)**

(A) Energy (B) Momentum (C) Charge (D) angular momentum

15. If in the experiment of Wheatstone bridge, the positions of cell and galvanometer are interchanged, then balance point will **(E)**

(A) change

(B) remain unchanged

(C) depend on the internal resistance of cell and resistance of galvanometer

(D) None of these

16. The mobile charge carriers in case of metallic conductors are **(E)**

(A) electrons and positive ions. (B) positive and negative ions.

(C) electrons and holes. (D) electrons.

17. The mobile charge carriers in case of electrolytic solutions are **(E)**

(A) electrons and positive ions. (B) positive and negative ions.

(C) electrons and holes. (D) electrons.

18. The mobile charge carriers in case of an ionised gas are **(E)**

(A) electrons and positive ions. (B) positive and negative ions.

(C) electrons and holes. (D) electrons.

19. The resistance of a conductor depends **(E)**

(A) only on the length of the conductor. (B) only on area of cross-section of the conductor.

(C) only on the nature of the material. (D) on all the factors.

20. Identify the wrong statement. **(E)**

(A) Resistance of a conductor is directly proportional to the length of the conductor.

(B) Resistance of a conductor is inversely proportional to the area of cross-section of the conductor.

(C) Resistance of a conductor depends on the nature of the material of the conductor and temperature.

(D) Resistivity of the material of a conductor depends on the dimensions of the conductor.

21. Current density is a _____ and its SI unit is _____. **(E)**

(A) scalar, ampere. (B) scalar, Am^{-2}. (C) vector, ampere. (D) vector, Am^{-2}.

22. The correct expression for mobility (μ) is (symbols have their usual meanings) **(E)**

(A) $\mu = \frac{e}{\tau m}$ (B) $\mu = \frac{e\tau}{m}$ (C) $\mu = \frac{em}{\tau}$ (D) $\mu = \frac{m\tau}{e}$

23. Here are two statements related to cells. **(E)**

Statement-I: The device used to maintain steady current in a circuit is called a cell.

Statement-II: The potential difference between the terminals of a cell in open circuit is called emf.

(A) Both the statements are wrong. (B) Statements I is correct and statement II is wrong

(C) Both the statements are correct. (D) Statements I is wrong and statement II is correct.

24. The correct expression for conductivity of a material (σ) is (symbols have usual meanings) **(E)**

(A) $\boldsymbol{\sigma = \frac{m}{ne^2\tau}}$ (B) $\boldsymbol{\sigma = \frac{n}{me^2\tau}}$ (C) $\boldsymbol{\sigma = \frac{ne^2\tau}{m}}$ (D) $\boldsymbol{\sigma = \frac{me^2\tau}{n}}$

25. Kirchhoff's loop rule is based on the law of conservation of **(E)**

(A) energy (B) momentum (C) charge (D) mass

HOTS Multiple Choice Questions:

26. Column-I gives certain physical terms associated with flow of current through a metallic conductor. Column-II gives some mathematical relations involving electrical quantities. Match Column-I and Column-II with appropriate relations. **(D)**

Column I	Column II
(i) Relaxation Time	(a) $\mathbf{nev_d}$
(ii) Drift Velocity	**(b)** $\mathbf{\frac{E}{J}}$
(iii) Current Density	**(c)** $\mathbf{\frac{m}{ne^2\rho}}$
(iv) Electrical Resistivity	**(d)** $\mathbf{\frac{eE}{m}\tau}$

(A) (i)-(d), (ii)-(c), (iii)-(b), (iv)-(a) (B) (i)-(c), (ii)-(d), (iii)-(a), (iv)-(b)

(C) (i)-(a), (ii)-(d), (iii)-(b), (iv)-(c) (D) (i)-(b), (ii)-(a), (iii)-(c), (iv)-(d)

27. The resistance of a wire is R Ω. If it is melted and stretched to n times its original length, its new resistance will be **(D)**

(A) $\frac{R}{n^2}$ (B) nR (C) $\frac{R}{n}$ (D) n^2R

28. Statement I: When a wire is not connected to battery, then no current flow.
Statement II: In the absence of electric field free electrons moves randomly or does not move in particular direction. **(D)**

(A) Both Statements I and Statement II are true and the Statement II is a correct explanation of the Statement I.

(B) Both Statements I and Statement II are true but Statement II is not a correct explanation of the Statement I.

(C) Statement I is true but the Statement II is false.

(D) Statement I and Statement II both are false.

29. Which of the following is different from the others? **(D)**

(A) volt^{2}ohm^{-1} (B) ampere^{2}ohm (C) volt-ampere (D) joule second^{-2}

30. When a steady current flows through a metal conductor of non-uniform cross-section, then drift velocity is **(D)**

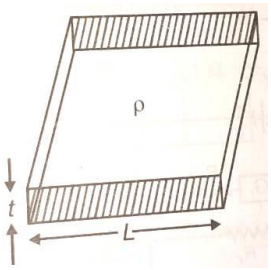
(A) Independent of area of cross-section

(B) Directly proportional to the area of cross-section

(C) Inversely proportional to the area of cross- section

(D) Inversely proportional to the square of area of cross-section

31. Consider a thin square sheet of side L and thickness t, made of a material of resistivity ρ. The resistance between two opposite faces, shown by the shaded areas in the figure is **(D)**



(A) Directly proportional to t (B) Directly proportional to L

(C) Independent of t (D) Independent of L

32. Identify the wrong statement. **(D)**

(A) Drift velocity acquired by charge carriers per unit electric field gives their mobility.

(B) In metallic conductors with increase in temperature, the resistivity increases.

(C) In semiconductors with increase in temperature, the resistivity decreases.

(D) The temperature coefficient of resistivity of metallic conductors is negative.

33. The general expression for resistivity of a material is given by $\rho = \frac{m}{ne^2\tau}$. (Symbols have their meanings). Identify the correct statement. **(D)**

(A) In metals with increase in temperature, n remains constant and τ increases.

(B) In metals with increase in temperature, n remains constant and τ decreases.

(C) In semiconductors with increase in temperature, n decreases and τ increases.

(D) In semiconductors with increase in temperature, both n and τ increase.

34. Some physical quantities are listed in column 1 and their dimensions are listed in column 2. Identify the correct match **(D)**

(A) (i)-(b), (ii)-(c), (iii)-(a)

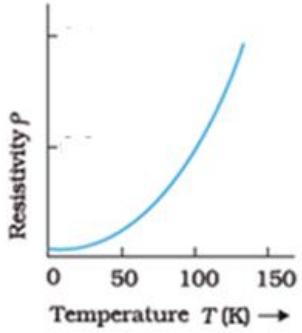
(B) (i)-(c), (ii)-(b), (iii)-(a)

(C) (i)-(b), (ii)-(a), (iii)-(c)

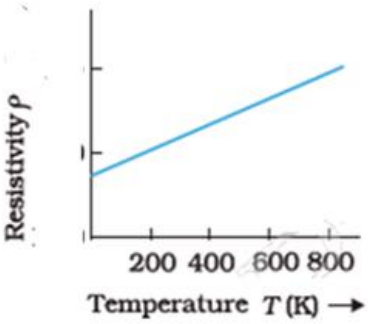
(D) (i)-(c), (ii)-(a), (iii)-(b)

COLUMN 1	COLUMN 2
(i) Resistance	(a) [$L^{-2}A$]
(ii) Current density	(b) [$ML^3T^{-3}A^{-2}$]
(iii) Resistivity	(c) [$ML^2T^{-3}A^{-2}$]

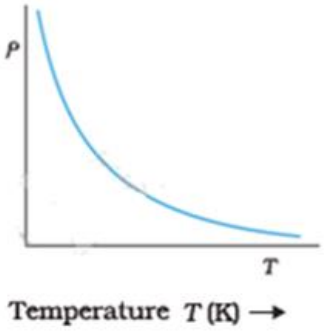
35. The graphs representing the variation of resistivity of different materials with temperature are given below. Identify the correct option.



Graph-i



Graph-ii



Graph-iii

(A) Graph-i is for semiconductors, Graph-ii is for metals and Graph-iii is for alloys.

(B) Graph-i is for metals, Graph-ii is for alloys and Graph-iii is for semiconductors.

(C) Graph-i is for metals, Graph-ii is for semiconductors and Graph-iii is for alloys.

(D) Graph-i is for semiconductors, Graph-ii is for alloys and Graph-iii is for metals.

FILL IN THE BLANKS

SET-1: (***mobility, energy, charge, electric resistivity, electric current, semiconductor***) **(E)**

1. Net flow of charges in a particular direction constitute an_____.
2. The magnitude of the drift velocity per unit electric field is _____.
3. The SI unit of _____ is Ωm.
4. For _____, as the temperature increases, their resistivity decreases.
5. The Kirchhoff's junction rule is based on law of conservation of _____.

SET-2: (***galvanometer, inversely, less, directly, zero, drift velocity***) **(E)**

6. Resistance of a conductor is _____ proportional to its length.
7. Maximum current flows in a cell present in a circuit when the external resistance is _____.
8. The average velocity with which the free electrons in a conductor drift under the action electric field is called _____.
9. A Wheatstone network is said to be balanced if the current through the _____ is zero.
10. In a closed circuit, the terminal potential difference will be _____ than the emf.

SET-3: (***decreases, directly, emf, inversely, opposite, scalar***) **(E)**

11. Electric current is a _____ quantity.

12. The free electrons in a conductor drift in the direction _____ to the electric field present along the length of conductor.

13. The relaxation time of conduction electrons in a material _____ with increase in temperature.

14. The power wasted in the transmission wires in the form of heat is _____ proportional to the square of the voltage.

15. The potential difference between the terminals of a cell when it is in open circuit is its _____.

TWO MARKS QUESTIONS

1. A large number of free electrons are present in metals. Why there is no current in the absence of electric field? **(A)**

2. State and explain Ohm's law. **(A)**

3. How does the resistance of a conductor vary with its (i) length and (ii) area of cross section? **(A)**

4. Mention the expression for resistance in terms of resistivity and explain the terms. **(A)**

5. Mention any two factors on which resistivity of a metal depend. **(E)**

6. Write any two differences between resistance and resistivity. **(A)**

7. Define current density in a conductor. Mention its SI unit. **(E)**

8. Write equivalent form of Ohm's law in terms of current density and conductivity. Explain the terms. **(A)**

9. Draw V-I graph for (a) a conductor (b) a semiconductor diode. **(A)**

10. Define the terms (i) drift velocity and (ii) relaxation time. **(E)**

11. Name the mobile charge carriers in metals. Write the expression for mobility of charge carriers in terms of their average collision time (relaxation time). **(E)**

12. Define mobility of free electron. Give its SI unit. **(E)**

13. Obtain the expression for mobility of free electron in terms of relaxation time. **(A)**

14. Write the expression for resistivity in terms of number density and relaxation time and explain the terms. **(E)**

15. Write an expression for the resistivity of a metallic conductor, showing its variation over a limited range of temperature and explain the terms. **(A)**

16. How does the resistivity of a metallic conductor (copper) vary with temperature? Show its variation graphically. **(A)**

17. How does the resistivity of alloys (nichrome) vary with temperature? Show its variation graphically. **(A)**

18. How does the resistivity of a semiconductor vary with temperature? Show its variation graphically. **(A)**

19. Mention the expression for power loss (ohmic loss) in a conductor and explain the terms. **(E)**

20. Why high voltage power from power generating station is preferred than high current for transmission of electrical power. **(A)**

21. Define emf and internal resistance of a cell. **(E)**

22. Write any two differences between emf and terminal p. d. of a cell. **(A)**

23. Terminal potential difference is less than the emf of a cell. Why? **(A)**

24. State and explain Kirchhoff's junction rule/ current law. **(A)**

25. State and explain Kirchhoff's loop rule / voltage law. **(A)**

TWO MARKS NUMERICAL PROBLEMS

1. Find the number of electrons that should flow per second in a conductor to provide a current of 1A. **(A)**

2. A potential difference of 20 volts is applied across the ends of a resistance of 5 Ω. Find the current through the resistor. **(A)**

3. An electric bulb draws a current of 0.35 A for 20 minutes. Calculate the amount of electric charge that flows through the circuit. **(A)**

4. Two cells of emf 5 V and 4 V with internal resistances 2 Ω and 1 Ω are connected in series such that they tend to send the current in opposite direction. Calculate the effective emf of the combination. **(A)**

5. Two cells of emf 3 V and 2 V with internal resistances 2 Ω and 1 Ω are connected in parallel such that they tend to send the current in opposite direction. Calculate the effective emf of the combination. **(A)**

6. A cell of emf 2 V and internal resistance 1 Ω is connected across a resistor of 9 Ω. Find the terminal potential difference of the cell. **(A)**

7. Calculate the resistance of a 40 W automobile headlight designed for 12 V. **(A)**

8. A conductor of cross sectional area 5×10^{-6} m^2 is carrying a current of 3 A.
Find the current density in the conductor. **(A)**

9. A conductor of resistance 5 Ω is carrying a current of 2 A. Calculate the amount of power dissipated in the conductor. **(A)**

THREE MARKS QUESTIONS

1. Write any three factors on which resistance of a conductor depend. **(E)**

2. Arrive at $\vec{J} = \sigma\vec{E}$, where symbols have their usual meaning **OR** Derive the expression for current density in terms of electric field and conductivity of the material using Ohm's law. **(A)**

3. Write any three limitations of Ohm's law. **(A)**
4. What is meant by drift of free electrons in a conductor? Write two factors on which drift velocity depends. **(A)**
5. Derive an expression for drift velocity of free electrons in conductor. **(A)**
6. Derive the expression $I = neAv_d$. **(A)**
7. Define the terms 'drift velocity' and 'mobility' of free electrons in a conductor. Give the relation between them. **(E)**
8. Name the mobile charge carriers in (i) metals, (ii) an ionized gas and (iii) electrolyte. **(E)**
9. Obtain an expression for current drawn by an external resistance using Ohm's law. Or. Arrive at the relation between terminal potential difference and emf of a cell using ohm's law. **(A)**

THREE MARKS NUMERICAL PROBLEMS

10. Charge through a cross section of conductor is given by $Q = (2t^2 - 5t)$ C. Find the current through the conductor at the instant $t = 2$ s. **(A)**
11. Find the average drift speed of free electrons in a copper wire of cross sectional area 10^{-7} m^2 carrying current of 1.5 A and having free electron density 8.5×10^{28} m^{-3}. **(A)**
12. A current of 2 A is flowing through a conductor of resistance 4 Ω. Find the electrical energy consumed by the conductor in 10 s. **(A)**

FIVE MARKS QUESTIONS

1. Assuming the expression for drift velocity, arrive at the expression for electrical conductivity of a material. **(D)**
2. Deduce the expressions for the equivalent emf and internal resistance of two different cells connected in series. **(D)**
3. Derive the expressions for the equivalent emf and internal resistance of two different cells that are connected in parallel. **(D)**
4. Obtain the condition for balance of Wheatstone bridge using Kirchhoff's rules. **(D)**

NUMERICAL PROBLEMS

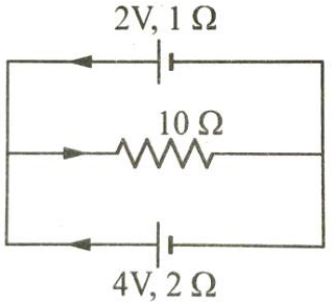
1. A copper wire has 3×10^{22} free electrons in 0.021 m length. The drift velocity of electrons is 2×10^{-5} ms^{-1}. Find the number electrons that would pass through a given cross-section of the wire in one second? **(D)**
2. A copper wire has a diameter of 0.5 mm and resistivity of 1.68×10^{-8} Ωm. Find the length of this wire to make its resistance of 2 Ω. How much does the resistance change if the diameter is doubled? **(D)**

3. A battery of 6V gives a current of 2 A when connected to a resistance of 2 Ω. Find the internal resistance and the terminal potential difference of battery? **(A)**

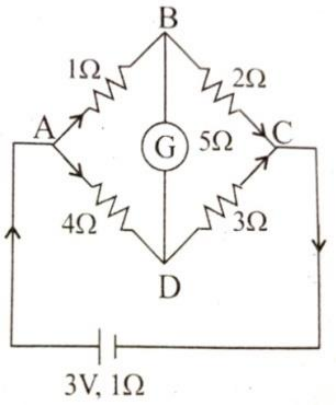
4. Two cells of emf 3 V and 4 V and internal resistance 1 Ω and 2 Ω respectively are connected in parallel so as to send the current in the same direction through an external resistance of 10 Ω. Find the potential difference across 10 Ω resistor. **(D)**

5. Calculate the current density and average drift speed of conduction electrons in a copper wire of cross sectional area 1.0×10^{-7} m^2 carrying a current of 1.5 A. Given free electron density of copper is 8×10^{28} electrons/m^3. **(A)**

6. Calculate the power dissipated in 10 Ω resistor in the given circuit. **(D)**



7. In the given circuit, calculate the current through the galvanometer (I_g) **(D)**



8. 10 g mass of nichrome piece is drawn into a wire of area of cross-section 0.5 mm^2. Calculate the resistance of this wire. Given density of nichrome 8.4×10^3 kgm^{-3} and resistivity of the material of the wire as 1.0×10^{-6} Ωm. **(D)**

9. The number density of free electrons in a copper conductor is estimated to be 8.5×10^{28} m^{-3}. How long does an electron take to drift from one end of a wire 3.0 m long to its other end? The area of cross-section of the wire is 2.0×10^{-6} m^2 and it is carrying a current of 3.0 A. **(D)**

10. A wire having length 2.0 m, diameter 1.0 mm and resistivity 1.963×10^{-8} Ω m is connected in series with a battery of emf 3 V and internal resistance 1Ω. Calculate the resistance of the wire and current in the circuit. **(D)**

11. Two cells of emf 2 V and 4 V and internal resistance 1Ω and 2Ω respectively are connected in parallel so as to send the current in the same direction through an external resistance of 15Ω. Find the currents through different branches of the circuit. **(D)**

12. A 2 m copper wire with radius 1 mm is carrying a current of 2.0 A. The number density of free electrons in copper is 8.5×10^{28} m^{-3}. Calculate: [Given: $e = 1.6 \times 10^{-19}$ C]

(a) Current density (b) Drift velocity of free electrons.

(c) The time taken by the electron to drift from one end of the wire to the other end. **(D)**

13. A wire of length 3.5 m and uniform cross-sectional area of 5.0×10^{-6} m^2 has a resistance of 10 Ω. What is the resistivity of the material at the given temperature? What will be its new resistance if its length is 20% more than the earlier length? **(A)**

14. The terminal potential difference of a cell connected to an external resistance of 4 Ω is 8 V. When the same cell is connected to an external resistance of 9 Ω, the current through the resistance is 1 A. calculate the emf and internal resistance of the cell. **(D)**

ANSWER KEYS TO MULTIPLE CHOICE QUESTIONS

1	B	**6**	D	**11**	D	**16**	D	**21**	D	**26**	B	**31**	D
2	C	**7**	B	**12**	A	**17**	B	**22**	B	**27**	D	**32**	D
3	A	**8**	A	**13**	B	**18**	A	**23**	C	**28**	A	**33**	B
4	C	**9**	B	**14**	C	**19**	D	**24**	C	**29**	D	**34**	D
5	A	**10**	D	**15**	B	**20**	D	**25**	A	**30**	C	**35**	B

ANSWERS TO FIBs

SET-1 : 1. electric current 2. mobility 3. electric resistivity 4. semiconductor 5. Energy

SET-2 : 6. directly 7 zero 8. drift velocity 9. galvanometer 10. less

SET-3 : 11. scalar 12 opposite 13. *decreases* 14. inversely 15. Emf

CHAPTER 4: MOVING CHARGES AND MAGNETISM

MULTIPLE CHOICE QUESTIONS

1. **Who concluded that moving charges or currents produces a magnetic field?** **(E)**

   (A) J. C. Maxwell (B) H. C. Oersted (C) J. A. Fleming (D) J. C. Bose

2. **When a magnetic compass needle is carried nearby to a straight wire carrying current, then**
   (I) the straight wire cause a noticeable deflection in the compass needle.
   (II) the alignment of the needle is tangential to an imaginary circle with straight wire as its centre and has a plane perpendicular to the wire **(E)**

   (A) (I) is correct (B) (II) is correct
   (C) both (I) and (II) are correct (D) neither (I) nor (II) is correct

3. **If a current I is flowing in a straight wire parallel to x axis and magnetic field is there along the y axis then** **(E)**

   (A) The wire experiences force in x direction
   (B) The wire experiences force in y direction
   (C) The wire experiences no force
   (D) The wire experiences force in z direction

4. **A strong magnetic field is applied on a stationary electron. Then the electron** **(E)**

   (A) moves in the direction of the field. (B) remains stationary.
   (C) moves perpendicular to the direction of the field
   (D) moves opposite to the direction of the field.

5. **The radius of the circle described by a charged particle moving perpendicular to a uniform magnetic field depends on** **(E)**

   (A) its mass only (B) its velocity only
   (C) both mass and velocity (D) neither mass nor velocity

6. **The frequency of rotation of the charge particle in a uniform magnetic field is independent of** **(E)**

   (A) velocity of the particle (B) charge of the particle
   (C) mass of the particle (D) strength of the magnetic field

7. **Which of the following statements is not true regarding Biot-Savart's law,** **(E)**

   (A) the magnetic field is proportional to the length of the current element,
   (B) the magnetic field is proportional to the current through the current element
   (C) the magnetic field is inversely proportional to the distance of the point
   (D) the magnetic field is proportional to the sine of the angle between the current direction and the line joining the current element and the point

8. The value of permeability of free space is **(E)**

(A) $4\pi\times 10^{-7}$ H/m (B) 9×10^{9} Nm^2/C^2 (C) 8.854×10^{-12} F/m (D) 3×10^{8} m/s

9. A long straight wire carrying a current induced magnetic induction at any place that is **(E)**

(A) proportional to the distance from the wire

(B) independent of distance.

(C) inversely proportional to the distance from the wire

(D) inversely proportional to the square of the distance from the wire

10. An electron is projected with uniform velocity along the axis of a current carrying long solenoid. Which of the following is true? **(E)**

(A) The electron will be accelerated along the axis.

(B) The electron path will be circular about the axis.

(C) The electron will experience a force at 45° to the axis and hence execute a helical path.

(D) The electron will continue to move with uniform velocity along the axis of the solenoid.

11. If the beams of electrons and protons move parallel to each other in the same direction, they **(E)**

(A) Attract each other (B) Repel each other (C) No relation (D) Neither attracts nor repel.

12. A rectangular coil carrying current is placed in a non-uniform magnetic field. On the coil, the total

(A) force is non-zero (B) force is zero (C) torque is zero (D) none of these **(E)**

13. A conducting circular loop of radius *r* carries a constant current *I*. It is placed in a uniform magnetic field *B*, such that *B* is perpendicular to the plane of the loop. The magnetic force acting on the loop is **(E)**

(A) Ir^2B (B) $2\pi rIB$ (C) Zero (D) πr^2IB

14. In a moving coil galvanometer the deflection (Φ) on the scale by a pointer attached is **(E)**

(A) $\left(\frac{NA}{kB}\right)I$ (B) $\left(\frac{N}{kAB}\right)I$ (C) $\left(\frac{NAB}{k}\right)I$ (D) $\left(\frac{NAB}{kI}\right)$

15. Resistance of an ideal ammeter is **(E)**

(A) Infinity (B) 100 Ω (C) Zero (D) 1 Ω

16. The magnetic field is produced **(E)**

(A) only by moving charges. (B) only by stationary charges.

(C) by both stationary and moving charges. (D) neither by stationary nor by moving charges.

17. A charged particle moving in a uniform magnetic field experiences no force when the angle between velocity vector and field vector is **(E)**

(A) 0^0 (B) 60^0 (C) 90^0 (D) 30^0

18. A charged particle moving in a uniform magnetic field experiences maximum force when the angle between velocity vector and field vector is **(E)**

(A) 0^0 (B) 180^0 (C) 60^0 (D) 90^0

19. The magnitude of force that acts on a particle moving perpendicular to a uniform magnetic field depends **(E)**

(A) only on the charge of the particle. (B) only on the velocity of the particle.

(C) only on the strength of the magnetic field. (D) on all the three factors.

20. An electron, a proton, a neutron and an alpha particle are moving with same velocity perpendicular to a uniform magnetic field. The particle which experiences zero force is **(E)**

(A) proton (B) neutron (C) electron (D) alpha particle

21. An electron, a proton, a neutron and an alpha particle are moving with same velocity perpendicular to a uniform magnetic field. The particle which experiences maximum force in the field is **(E)**

(A) proton (B) neutron (C) electron (D) alpha particle

22. Identify the wrong statement **(E)**

(A) A neutral particle moving in a magnetic field experiences no force.

(B) A stationary charged particle won't experience any force due to magnetic field.

(C) A charged particle moving parallel or anti-parallel to magnetic field experiences no force.

(D) A charged particle moving perpendicular to a magnetic field experiences zero force.

23. A charged particle entering a region of uniform magnetic field takes a circular path if the angle between velocity vector and field vector is **(E)**

(A) 0^0 (B) 180^0 (C) 60^0 (D) 90^0

24. The angular velocity of a charged particle moving in a region of uniform magnetic field is independent of **(E)**

(A) the charge of the particle. (B) the velocity of the particle.

(C) the strength of the magnetic field. (D) the mass of the particle.

25. A charged particle entering a region of uniform magnetic field takes a helical path if the angle between velocity vector and field vector is **(E)**

(A) 0^0 (B) 180^0 (C) 60^0 (D) 90^0

26. Which of the following relation represent Ampere circuital law? **(E)**

(A) $\oint \vec{B} . \overrightarrow{dA} = 0$ (B) $\oint \vec{B} . \vec{dl} = \mu_0 I$ (C) $\oint \vec{E} . \overrightarrow{dA} = \frac{q}{\varepsilon_0}$ (D) $\oint \vec{E} . \vec{dl} = -\frac{d\phi_B}{dt}$

27. Parallel currents _____ and anti-parallel currents _____. **(E)**

(A) attract, also attract (B) repel, attract (C) repel, also repel (D) attract, repel

28. Two infinitely long straight parallel conductors separated by a distance 1 m in air are carrying same amount of current 'I' in same direction. The magnetic force per unit length on each conductor is 2×10^{-7} Nm^{-1}. Then the value of 'I' and nature of the force between the two conductors are (E)

(A) 1 A and repulsion (B) 1 A and attraction

(C) 2 A and repulsion (D) 2 A and attraction

29. A moving coil galvanometer can be converted into an ammeter by connecting a (E)

(A) low resistance in parallel with galvanometer (B) low resistance in series with galvanometer

(C) high resistance in parallel with galvanometer (D) high resistance in series with galvanometer

30. A moving coil galvanometer can be converted into a voltmeter by connecting a (E)

(A) low resistance in parallel with galvanometer (B) low resistance in series with galvanometer

(C) high resistance in parallel with galvanometer (D) high resistance in series with galvanometer

HOTS MULTIPLE CHOICE QUESTIONS

31. A charged particle moves in a gravity free space without change in its velocity. Which of the following is not possible? (D)

(A) $E = 0, B = 0$ (B) $E \neq 0, B = 0$ (C) $E = 0, B \neq 0$ (D) $E \neq 0, B \neq 0$

32. A positive charge is moving in combined gravitational and magnetic field. The charge moves without any change in velocity. If the velocity of charge is along east, then the direction of magnetic field is along (D)

(A) North (B) South (C) Upwards (D) Downwards

33. A charge *q*, mass *m* is moving in uniform circular motion under action of a magnetic field *B*. If the radius of circle is '*R*', then the magnetic moment associated with the charge is given by (D)

(A) $\frac{qBR}{2}$ (B) qBR (C) $\frac{q^2BR^2}{2m}$ (D) $\frac{q^2BR^2}{m}$

34. Statement I: A current carrying wire is placed parallel to magnetic field. The force on it due the magnetic field is zero.

Statement II: The net charge on current wire is zero. **(D)**

(A) Both Statements I and Statement II are true and the Statement II is a correct explanation of the Statement I.

(B) Both Statements I and Statement II are true but Statement II is not a correct explanation of the Statement I.

(C) Statement I is true but the Statement II is false.

(D) Statement I and Statement II both are false.

35. Match the physical quantities of Column I with their units in Column II **(D)**

Column I	Column II
(i) Current Sensitivity	**(a) Am^{-1}**
(ii) Intensity of Magnetic Field	**(b) Am^2**
(iii) Magnetic Dipole Moment	**(c) div A^1**

(A) (i)-(c), (ii)-(b), (iii)-(a)

(B) (B) (i)-(c), (ii)-(a), (iii)-(b)

(C) (i)-(a),(ii)-(c), (iii)-(b)

(D) (D)(i)-(b), (ii)-(a), (iii)-(c)

36. An ammeter and a milli-ammeter are converted from identical galvanometers. Which one has smaller resistance? **(D)**

(A) Ammeter (B) Milliammeter (C) Both have equal resistances

(D) The resistance of ammeter may be more than or equal to that of milli-ammeter depending upon its range

37. An electron moving along positive X-axis enters uniform magnetic field acting along positive Y-axis. The direction of magnetic force experienced by it is **(D)**

(A) negative X-axis (B) positive Z- axis (C) negative Z-axis (D) negative Y-axis

38. A proton moving along positive Y-axis enters uniform magnetic field acting along positive X-axis. The direction of magnetic force experienced by it is **(D)**

(A) negative X-axis (B) positive Z- axis (C) negative Z-axis (D) negative Y-axis

39. Here are two statements related to magnetic force. **(D)**

Statement-I: Magnetic field cannot be used to change the kinetic energy of a charged particle.

Statement-II: The work done by magnetic force acting on the charged particle moving in uniform magnetic field is zero as it is perpendicular to the velocity vector.

(A) Both the statements are wrong

(B) Both the statements are correct and statement II is the correct explanation for I

(C) Both the statements are correct and statement II is not the correct explanation for I

(D) Only statement I is correct.

40. The physical quantities related to magnetism are listed in column I and the dimensions are listed in column II. Identify the correct match **(D)**

(A) (i) - (b), (ii) - (c), (iii) - (a)

(B) (i) - (c), (ii) - (b), (iii) - (a)

(C) (i) - (a), (ii) - (b), (iii) - (c)

(D) (i) - (c), (ii) - (a), (iii) - (b)

Column I	Column II
(i) Magnetic field	(a) $[MLT^{-2}A^{-2}]$
(ii) Magnetic permeability	(b) $[L^2 A]$
(iii) Magnetic moment	(c) $[M T^{-2}A^{-1}]$

FILL IN THE BLANKS

SET-1: (E)

(*Ampere's circuital law, high, Lorentz force, Laplace's law, Right hand thumb rule, magnetic dipole*)

1. When the charged particles move in a combined magnetic and electric field, then the force acting is known as _____.
2. The direction of the magnetic field due to a current loop is found using the_____.
3. The alternative form of Biot-Savart's law is _____.
4. Current carrying circular coil is equivalent to _____.
5. Resistance of an voltmeter is _____.

SET-2: (*perpendicular, attract, opposite, repel, ammeter, magnetic field*) (E)

6. Moving charges or currents produce a _____ in the surrounding space.
7. The directions of force on proton and electron moving in same direction in a uniform magnetic field are _____.
8. A charged particle entering a uniform magnetic field traces a circular path if velocity and magnetic field are _____ to each other.
9. Two infinitely long conductors carrying currents in the same direction _____ each other.
10. A moving coil galvanometer with a shunt resistance in parallel is called _____.

TWO MARKS QUESTIONS

1. Write the expression for magnetic force acting on a charged particle moving in a uniform magnetic field and explain the terms. **(E)**
2. When is the force on a charged particle moving in a uniform magnetic field
   (a) maximum and (b) minimum? **(A)**
3. Does a moving charge always experience a force in a magnetic field? Explain. **(A)**
4. A proton and an electron enter a magnetic field at the same angle and with the same speed. Do they experience the same force? Justify your answer. **(A)**
5. What is Lorentz force? Write the expression representing this force. **(E)**
6. Can a magnetic field do any work on a moving charge? Justify your answer. **(A)**
7. Can a uniform magnetic field change the kinetic energy of a moving charge? Justify your answer. **(A)**
8. Write the expression for the force acting on a current carrying conductor in a magnetic field and explain the terms. **(A)**
9. When is the force on a conductor carrying current in a magnetic field (a) maximum and (b) minimum? **(E)**

10. Write the expression for radius of circular path described by a charged particle in a uniform magnetic field and explain the terms. **(E)**

11. A proton and an electron moving with the same momentum enter a magnetic field at right angles to it. Find the ratio of the radii of their trajectory. **(A)**

12. Write the expression for angular frequency of a charged particle moving perpendicular to a uniform magnetic field and explain the terms. **(E)**

13. Write the expression for the pitch of the helical path traced by an electron in a uniform magnetic field and explain the terms. **(A)**

14. Write the vector form of Biot-Savart's law and explain the terms. **(A)**

15. Write the expression for magnetic field at a point due to current element and explain the terms. **(A)**

16. When is the magnetic field at a point due to a current element (1) maximum and (2) minimum? **(E)**

17. Write the expression for the magnet field produced at a point on the axis of circular current loop and explain the terms. **(E)**

18. How will magnetic field strength at the center of the circular current loop change, if the current through the coil is halved and radius of the loop is doubled? **(A)**

19. State and explain Ampere's circuital law. **(A)**

20. Write the expression for magnetic field at a point due to long straight current carrying conductor and explain the terms. **(E)**

21. How does the magnetic field at a point due to straight long current carrying conductor vary with the (a) strength of the current and (b) Perpendicular distance of the point from the conductor. **(A)**

22. Write an expression for magnetic field at a point inside current carrying solenoid and explain the terms used. **(E)**

23. Mention the factors on which the magnetic fields at a point inside a solenoid depend. **(E)**

24. How does the magnetic field at a point inside an air cored solenoid vary with the (i) number turns per unit length and (ii) strength of a current though the solenoid. **(A)**

25. Write the expression for the force between two long straight parallel conductors carrying currents and explain the terms. **(E)**

26. What is the nature of the force between two parallel conductors carrying currents in the (a) same direction and (b) opposite direction? **(E)**

27. Define '*ampere*' by writing the expression for force between two parallel currents. **(A)**

28. How does the force between the conductors carrying currents vary with (a) strength of current in the conductor and (b) the distance between the conductors? **(A)**

29. When is the torque on a current loop placed in a uniform magnetic field
(i) maximum and (ii) minimum? **(E)**

30. Mention the two cases in which the torque on the current loop in uniform magnetic field becomes zero.**(A)**

31. Write an expression for angular deflection produced by a coil in moving coil galvanometer and explain the terms. **(E)**

32. Draw a neat labeled diagram of moving coil galvanometer. **(A)**

33. What is the role of soft iron cylinder inside the coil in a moving coil galvanometer? **(A)**

34. Define current sensitivity of a moving coil galvanometer. Mention its SI unit. **(E)**

35. Define voltage sensitivity of a moving coil galvanometer. Mention its SI unit. **(E)**

36. Mention the two reasons because of which a galvanometer cannot be used directly as ammeter. **(A)**

37. Mention the two reasons because of which a galvanometer cannot be used directly as voltmeter. **(A)**

TWO MARKS PROBLEMS

[FOR NUMERICAL PROBLEMS TAKE $\mu_o = 4\pi \times 10^{-7} H\, m^{-1}$]

38. A proton enters a uniform magnetic field of 0.1 T with a velocity of 2 x 10^6 ms^{-1} perpendicular to the field. Calculate the magnetic force on the proton. Given: Charge on proton = 1.6 x 10^{-19} C **(A)**

39. A solenoid has 1000 turns/m. A current of 5 A in flowing through it. Calculate the magnetic field inside the solenoid. **(A)**

40. A circular coil of radius 0.2 m with 10 turns is carrying a current of 1 A. Calculate the magnitude of magnetic moment of the coil. **(A)**

41. A conductor of length 0.5 m carrying a current of 2 A is perpendicular to uniform magnetic field of 0.02 T. Calculate the magnitude of magnetic force on the conductor. **(A)**

42. Calculate the magnetic moment associated with a circular loop of area 2×10^{-2} m^2 carrying a current of 3 A. **(A)**

43. A current loop of magnetic dipole moment 10 Am^2 is freely suspended in a uniform magnetic field of 5 x 10^{-3} T and its plane is present in the direction of magnetic field. Calculate the torque that acts on the current loop. **(A)**

THREE MARKS QUESTIONS

1. Briefly describe Oersted's experiment about magnetic field due to current. **(A)**

2. On what factors the force experienced by a charged particle moving in a magnetic field depends? **(E)**

3. Derive the expression for the magnetic force acting on a conductor carrying current in a uniform magnetic field. **(A)**

4. What is the nature of trajectory of a charged particle in a uniform magnetic field with initial velocity at an angle (i) 0° (ii) 90° and (iii) in between 0° and 90°, with the direction of the magnetic field? **(E)**

5. Obtain the expression for radius of circular path described by a charged particle in a uniform magnetic field. **(A)**
6. Obtain the expression for the angular frequency of a charged particle moving perpendicular to a uniform magnetic field. **(A)**
7. What is pitch of helical path traversed by a charge particle moving in a uniform magnetic field? Obtain an expression for it. **(A)**
8. State and explain of Biot-Savart's law. **(A)**
9. Assuming the expression for the magnetic field at a point on the axis of a circular current loop, obtain the expression for the magnetic field at the center of the loop. **(A)**
10. Derive the expression for the magnetic field due to a straight infinite current carrying wire using Ampere's circuit law. **(A)**
11. Derive the expression for the magnetic field at a point inside an air cored long current carrying solenoid by using Ampere's circuital law. **(D)**
12. With the help of a circuit diagram, explain how to convert a galvanometer into an ammeter. **(A)**
13. With the help of a circuit diagram, explain how to convert a galvanometer into a voltmeter. **(A)**
14. Write any three factors on which the current sensitivity of a moving coil galvanometer depends. **(E)**
15. Write any three factors on which the voltage sensitivity of a moving coil galvanometer depends. **(E)**
16. Mention any three ways to increase the current sensitivity of moving coil galvanometer? **(A)**
17. Mention any three ways to increase the voltage sensitivity of moving coil galvanometer? **(A)**
18. Mention any three differences between ammeter and voltmeter. **(A)**
19. Using suitable expression, show that the voltage sensitivity of a pointer galvanometer remains constant even when we double the number of turns used in the coil of galvanometer. **(A)**

THREE MARKS PROBLEMS

[FOR NUMERICAL PROBLEMS TAKE $\mu_o = 4\pi \times 10^{-7} H\, m^{-1}$]

20. A straight wire of mass 200 g and length 1.5 m carries a current of 2A. It is suspended in mid-air by a uniform horizontal magnetic field. Calculate the magnitude of the magnetic field. **(A)**
21. A horizontal overhead power lines carries a current of 90 A in east to west direction. Find the magnitude and direction of the magnetic field due to the current 1.5m below the line. **(A)**
22. A current loop of area 20×10^{-4} m² carrying a current 0.2A is placed such that its plane makes an angle of 60° with a magnetic field of strength 4×10^{-2} T. Calculate the torque exerted on it. **(A)**
23. A circular coil of wire consisting of 100 turns, each of radius 8.0 cm carries a current of 0.40 A. Calculate the magnitude of the magnetic field B at the centre of the coil? **(A)**
24. A solenoid of length 0.5 m has a radius of 1 cm and is made up of 500 turns. It carries a current of 5 A. Calculate the magnitude of the magnetic field well inside the solenoid. **(A)**

25. A circular coil of wire consisting of 100 turns, average radius 3.14 cm carries a current of 200 mA. Calculate the magnitude of magnetic field at the centre of coil. Given $\mu_o = 4\pi \times 10^{-7} Hm^{-1}$ **(A)**

FIVE MARKS QUESTIONS

1. Derive the expression for magnetic field at a point on the axis of a circular current loop. **(D)**

2. Derive the expression for the force between two long straight parallel conductors carrying currents and hence define ampere. **(D)**

3. Obtain the expression for the torque acting on a rectangular current loop placed in a uniform magnetic field. When is the torque maximum? **(A)**

4. With neat labeled diagram, explain the working of a moving coil galvanometer. [OR] Give the theory of moving coil galvanometer. **(D)**

NUMERICAL PROBLEMS

[FOR NUMERICAL PROBLEMS TAKE $\mu_o = 4\pi \times 10^{-7} H\, m^{-1}$]

1. An electron beam passes through a magnetic field of 2×10^{-3} T and an electric field of 3.4×10^4 V/m, both acting simultaneously. If the path of an electron remains undeviated, calculate the speed of the electrons. If the electric field is removed, what will be the radius of the circular path? Given, mass of electron = 9.1×10^{-31} kg and charge of electron = 1.9×10^{-19} C. **(D)**

2. A straight wire of length $\frac{\pi}{2}$m is bent into a circular shape. O is the center of the circle formed and P is a point on its axis which is at a distance 3 times the radius from O. A current of 1 A is passed through it. Calculate the magnitude of the magnetic field at the points O and P. **(D)**

3. Two circular coils of mean radii 0.1 m and 0.05 m consisting of 5 turns and 10 turns respectively are arranged concentric to one another with their planes at right angles to each other. If a current of 2 A is passed through each of them, calculate the magnitude of the resultant magnetic field at their common centre. **(D)**

4. Two straight parallel conductors of 2 m length are 0.2 m apart. Find the magnitude of the force acting on the conductors if a current of 3 A flows through each of them. Also find the force per unit length of the conductor. **(D)**

5. A rectangular coil of length 0.25 m and breadth 0.1 carrying a current 12 A is placed with its longer side parallel to a long straight conductor 0.02 m apart carrying a current of 20 A. Calculate the net force on the coil. **(D)**

6. A galvanometer of resistance 50 Ω requires a current of 2 mA for full scale deflection. How do you convert it into (a) an ammeter of range 0 - 3 A and (b) a voltmeter of range 0 - 5 V. **(A)** .

7. A wire of length 0.26 m is bent to form a circular loop. If 2A of current is flowing through this loop, calculate the magnetic field due to this loop at a point P, which is at a distance of 0.15m from its centre on its axis. Also find the magnetic field at the centre of the loop. **(D)**

8. Calculate the radius of the path of an electron (mass 9×10^{-31} kg and charge 1.6×10^{-19} C) moving at a speed of 3×10^{7} m/s in a magnetic field of 6×10^{-4} T perpendicular to it. Also calculate its angular frequency and period of revolution. **(A)**

9. Two very 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 in air. Estimate the force per unit length on each wire. Also find the force on a 10 cm section of wire A. **(A)**

10. A circular coil of 30 turns and radius 8.0 cm carrying a current of 6.0 A is suspended vertically in a uniform horizontal magnetic field of magnitude 1.0 T. The field lines make an angle of 60º with the normal of the coil. Calculate i) the magnetic dipole moment of the coil and ii) the magnitude of the counter torque that must be applied to prevent the coil from turning. **(A)**

11. A circular coil of 100 turns carries a current of 5 A. The magnetic fields at two points on the axis of the coil are in the ratio of 8:1. If the points are at a distance of 5 cm and 20 cm respectively from the center, calculate

(i) the radius of the coil and

(ii) the magnitude of the magnetic field at the center of the coil.

ANSWER KEYS TO MULTIPLE CHOICE QUESTIONS

1	B	**6**	A	**11**	B	**16**	A	**21**	D	**26**	B	**31**	B	**36**	A
2	C	**7**	C	**12**	A	**17**	A	**22**	D	**27**	D	**32**	A	**37**	C
3	D	**8**	A	**13**	C	**18**	D	**23**	D	**28**	B	**33**	C	**38**	C
4	B	**9**	C	**14**	C	**19**	D	**24**	B	**29**	A	**34**	B	**39**	B
5	C	**10**	D	**15**	C	**20**	B	**25**	C	**30**	D	**35**	B	**40**	D

ANSWERS TO FIBs

SET-1: 1.Lorentz force 2. Right hand thumb rule 3. Ampere's circuital law 4. magnetic dipole 5. high

SET-2: 6. magnetic field 7. opposite 8. perpendicular 9 attract 10. ammeter

CHAPTER 5. MAGNETISM AND MATTER

MULTIPLE CHOICE QUESTIONS

1. Consider the following statements: (A)

Statement – I: Magnetic field lines do not intersect each other.

Statement II: If the magnetic field lines intersect, the magnetic field would not be unique at the point of intersection.

With reference to the above statements:

(A) both statement-I and statement-II are true & statement-II is the correct explanation of the statement-I.

(B) both statement-I and statement-II are true & statement-II is not correct explanation of the statement-I.

(C) statement - I is true and statement - II is false.

(D) both statement – I and statement – II are false.

2. When the angle between the magnetic moment of a small compass needle and the uniform magnetic field in which it is placed is $\theta = 180°$: (A)

(A) the torque on the needle is maximum. (B) the needle is in stable equilibrium.

(C) the potential energy of the needle is zero. (D) the needle in unstable equilibrium.

3. A magnetized needle placed in a uniform magnetic field, in general, experiences: (E)

(A) both force and a torque. (B) a force but no torque.

(C) a torque but no force. (D) neither a force nor a torque.

4. When freely suspended, a magnet comes to rest in the direction: (E)

(A) North- South (B) East –West (C) South – East (D) South – West

5. According to Gauss law in magnetism: (E)

(A) magnetic flux through a closed surface may be non-zero.

(B) magnetic monopoles do not exist.

(C) there can be sources or sinks of magnetic field.

(D) the magnetic flux through any surface is zero.

6. The dimensional formula for magnetic intensity is: (E)

(A) [LA] (B) $[L^{-1}A]$ (C) $[LA^{-1}]$ (D) $[L^{-1}A^{-1}]$

7. If the magnetic susceptibility of a material is 100, its relative permeability is: (A)

(A) 100 (B) 99 (C) 101 (D) 10

8. For which one of the following substances, the magnetic susceptibility low and positive? (A)

(A) Bismuth (B) Copper (C) Iron (D) Sodium

9. In the following table, column – I lists magnetic substances and column – II lists some magnetic properties of substances. (A)

COLUMN – I	COLUMN – II
(a) Diamagnetic Substances	(p) $\mu < \mu_o$
(b) Paramagnetic substances	(q) Domain formation
(c) Ferromagnetic substances	(r) $\chi_m > 1$

The best match between column – I and column – II is:

(A) (a) → (p), (b) → (q), (c) → (r) (B) (a) → (p), (b) → (r), (c) → (q)

(C) (a) → (q), (b) → (r), (c) → (p) (D) (a) → (r), (b) → (p), (c) → (q)

10. The atoms in which kind of magnetic materials have permanent magnetic dipole moment? (E)

(A) only diamagnetic substances (B) only paramagnetic substances

(C) only ferromagnetic substances (D) both para- and ferromagnetic substances

11. Which magnetic property is a strong effect? (E)

(A) Paramagnetism (B) Diamagnetism

(C) Ferromagnetism (D) Both paramagnetism and ferromagnetism

12. If a magnetic substance is kept in a magnetic field and if free to move, then which of the following substance moves out of the magnetic field? (E)

(A) Diamagnetic substance (B) Paramagnetic substance

(C) Ferromagnetic substance (D) Both diamagnetic & paramagnetic substance

13. The ratio between magnetization and magnetic intensity: (E)

(A) is called permeability (B) is called relative permeability

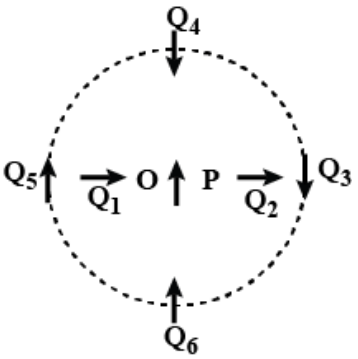
(C) is a dimensionless quantity (D) is the reciprocal of susceptibility

HOTS QUESTIONS

14. A compass needle of magnetic moment *m* is placed in a uniform magnetic field of *B* such that the angle between them is θ. The ratio magnitude of the torque on the needle to the potential energy of the needle is proportional to: (D)

(A) sin θ (B) cos θ (C) tan θ (D) sec θ

15. The following figure shows a small magnetized needle P placed at a point O. The arrow shows the direction of its magnetic moment. The other arrows show different positions (and orientations of the magnetic moment) of another identical magnetized needle Q. (D)



Which one of the following statements is false for the above configuration?

(A) In configurations PQ_1 and PQ_2, the system is not is not in equilibrium.

(B) The system will be stable equilibrium for configurations PQ_3 and PQ_6.

(C) The system will be unstable equilibrium for configurations PQ_4 and PQ_5.

(D) PQ_6 corresponds to maximum potential energy state among the given configurations.

16. Needles N_1, N_2 and N_3 are made of a ferromagnetic, a paramagnetic and a diamagnetic substance respectively. A magnet when brought close to them will: (A)

(A) Attract N_1 strongly but repel N_2 and N_3 weakly. (B) Attract N_1 and N_2 strongly but repel N_3

(C) Attract N_1 strongly, N_2 weakly & repel N_3 weakly (D) Attract all 3 of them.

FILL IN THE BLANKS

(***perfect-diamagnetic, paramagnetic, diamagnetic, ferromagnetic, non-magnetic, hard ferromagnetic***)

1. _____ property is present in all materials. **(E)**

2. When a material is placed in a magnetic field, the field inside it is slightly enhanced. The material is a _____ substance. **(E)**

3. A substance has a relative permeability of 1000. The material is _____. **(E)**

4. Super-conductors show _____ behavior. **(E)**

5. In some materials the magnetization persists even after the external field is removed. Such materials are called _____ substances. **(E)**

TWO MARKS QUESTIONS

1. Write any two properties of a bar magnet. **(E)**

2. Can two magnetic field lines intersect each other? Justify your answer. **(A)**

3. Write the expression for the potential energy of a dipole placed in a uniform magnetic field. Explain the terms. **(E)**

4. When is the potential energy of a dipole in placed in a uniform magnetic field
(i) minimum and (ii) maximum? **(E)**

5. What are the conditions for (i) stable equilibrium and (ii) unstable equilibrium of a compass needle in terms of its magnetic moment and the uniform magnetic field? **(A)**

6. Write the expression for the torque on small magnetic needle in a uniform magnetic field. Explain the terms. **(E)**

7. Write the expression for the time-period of small oscillations of small magnetic needle in a uniform magnetic field and explain the terms. **(E)**

8. Define magnetic flux. Write its SI unit. **(E)**

9. Mention two differences between Gauss law in magnetism and Gauss law in electrostatics. **(A)**

10. Define magnetization of a magnetic material. Mention its S.I unit **(E)**

11. Define magnetic intensity. Give its S.I unit. **(E)**

12. Define susceptibility of a substance. How are susceptibility and relative permeability related to each other? **(E)**

13. Define magnetic permeability. Write its SI unit. **(E)**

14. Define relative permeability. What are its dimensions? **(E)**

15. Among magnetic intensity, magnetic permeability, relative permeability and magnetic susceptibility, which two physical quantities are dimensionless quantities? **(E)**

16. What is diamagnetism? Give an example of a diamagnetic material. **(E)**

17. What is Meissner effect? Which materials show this property? **(E)**

18. Which materials show perfect diamagnetism? What is the value of magnetic susceptibility for such substances? **(E)**

19. What is paramagnetism? Give an example of a paramagnetic material. **(E)**

20. Draw the behavior of magnetic field lines near (i) a diamagnetic substance and (ii) a paramagnetic substance. **(A)**

21. What is ferromagnetism? Give an example of a ferromagnetic material. **(E)**

22. Write any two differences between paramagnetic and ferromagnetic substances. **(A)**

23. What are domains? What happens to the domain structure at large temperatures? **(E)**

24. What are hard ferromagnets? Give an example. **(E)**

25. What are soft ferromagnets? Give an example. **(E)**

26. Write the susceptibility and relative permeability ranges for diamagnetic substances. **(E)**

27. Write the susceptibility and relative permeability ranges for paramagnetic substances. **(E)**

28. Write the susceptibility and relative permeability ranges for ferromagnetic substances. **(E)**

29. What happens to a ferromagnetic substance at high temperatures? Explain. **(A)**

TWO MARKS NUMERICAL PROBLEMS

1. The magnetic susceptibility of a ferromagnetic substance is 1499. Find the relative permeability and permeability of the substance. **(A)**

2. A short bar magnet placed with its axis at 30° with a uniform external magnetic field of 0.25 T experiences a torque of magnitude equal to 4.5×10^{-2} Nm. Calculate the magnitude of magnetic moment of the magnet. **(A)**

3. A short bar magnet of magnetic moment m = 0.32 JT^{-1} is placed in a uniform magnetic field of 0.15 T. What is the potential energy of the magnet in (i) its stable equilibrium position and (ii) its unstable equilibrium position? **(A)**

4. A closely wound solenoid of 800 turns and area of cross section 2.5×10^{-4} m^2 carries a current of 3.0 A. What is its associated magnetic moment? **(A)**

THREE MARKS QUESTIONS

1. Mention any three properties of magnetic field lines. **(E)**

2. State and explain Gauss's law in magnetism. Write its significance. **(E)**

3. Derive the expression for magnetic potential energy of a magnetic dipole (a bar magnet) placed in a uniform magnetic field. **(A)**

4. List any three properties of diamagnetic materials. **(E)**

5. Write any three properties of paramagnetic materials. **(E)**
6. Mention any three properties of ferromagnetic materials. **(E)**
7. Differentiate between diamagnetic and paramagnetic materials. **(A)**
8. Write any three differences between diamagnetic and ferromagnetic materials. **(A)**
9. Which materials show perfect diamagnetism? Write the susceptibility and relative permeability values for such materials. **(E)**

THREE MARKS NUMERICAL PROBLEMS

1. A solenoid has a core of a material with relative permeability 400. The windings of the solenoid are insulated from the core and carry a current of 2 A. If the number of turns is 1000 per metre, calculate (a) the magnetic intensity H, (b) magnetization, M, and (c) the magnetic field inside the material B. **(D)**
2. A bar magnet of magnetic moment 1.5 J T^{-1} lies aligned with the direction of a uniform magnetic field of 0.22 T. Find the amount of work required by an external torque to turn the magnet to align its magnetic moment: (i) normal to the field direction, (ii) opposite to the field direction. **(D)**
3. A closely wound solenoid of 2000 turns and area of cross-section 1.6×10^{-4} m^2, carrying a current of 4.0 A, is suspended through its centre allowing it to turn in a horizontal plane.

(a) Find the magnetic moment associated with the solenoid? (b) Find the force and the magnitude of the torque on the solenoid if a uniform horizontal magnetic field of 7.5×10^{-2} T is set up at an angle of 30° with the axis of the solenoid. **(D)**

ANSWERS

MULTIPLE CHOICE QUESTIONS

1	2	3	4	5	6	7	8
A	D	C	A	B	B	C	D
9	10	11	12	13	14	15	16
B	D	C	A	C	C	D	C

FILL IN THE BLANKS

1. Diamagnetic, 2. Paramagnetic, 3. Ferromagnetic, 4. Perfect-diamagnetic, 5. Hard ferromagnetic

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CHAPTER 6. ELECTROMAGNETIC INDUCTION

MULTIPLE CHOICE QUESTIONS

1. The SI unit of magnetic flux is: (E)

(A) T (B) T m^{-2} (C) Wb m^{-2} (D) Wb

2. Consider the following statements: (E)

Statement – I: Lenz law gives the polarity of induced emf in a circuit.

Statement – II: Lenz law is in accordance with the law of conservation of energy.

Between the given two statements:

(A) both are true (B) Only statement – I is true.

(C) only statement – II is true (D) both are false.

3. In electromagnetic induction, the induced e.m.f. in a coil is independent of: (E)

(A) change in the magnetic flux (B) time of change of magnetic flux

(C) resistance of the circuit (D) number of turns in the coil

4. An emf is induced across the ends moving conductor coil in a magnetic field. This is in accordance with: (E)

(A) Ampere's law (B) Gauss law in electrostatics

(C) Gauss law in magnetism (D) Faraday's law

5. The dimensional formula of inductance is: (A)

(A) $[ML^2T^2A^{-2}]$ (B) $[ML^2T^{-2}A^{-2}]$ (C) $[ML^2T^{-2}A^2]$ (D) $[ML^2T^2A^2]$

6. Inductance of a coil is independent of: (A)

(A) the geometry of the coil. (B) the medium inside the coil.

(C) the current through the coil. (D) the number of turns in the coil.

7. The phenomena of induction of an emf in a coil due to change in current through the same coil is called: (E)

(A) Mutual induction (B) Self induction

(C) Motional emf (D) induction of magnetic field.

8. Which physical quantity plays the role of electrical inertia? (E)

(A) Motional emf (B) Mutual-inductance (C) Induced current (D) Self-inductance

9. If the current flowing through a coil is doubled, the magnetic energy stored by it: (A)

(A) is also doubled. (B) becomes halved.

(C) becomes four times. (D) becomes one-fourth the initial value.

10. Match column – I with appropriate options in column – II. **(A)**

COLUMN – I	COLUMN – II
(a) Self-induced emf	**(p) Motional emf**
(b) EMF induced in a rod moving in a magnetic field	**(q) Electromagnetic induction by changing the orientation of the loop.**
(c) AC generator	**(r) Mutual induction**
(d) Transformer	**(s) Back emf**

(A) (a) → (s); (b) → (p); (c) → (q); (d) → (r) (B) (a) → (r); (b) → (p); (c) → (q); (d) → (s)

(C) (a) → (p); (b) → (q); (c) → (r); (d) → (s) (D) (a) → (s); (b) → (p); (c) → (r); (d) → (q)

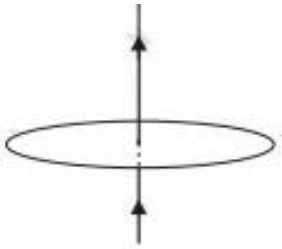
11. In an ac generator, when the plane of the armature is parallel to the magnetic field, **(A)**

(A) both the magnetic flux and emf are maximum. (B) both magnetic flux and emf are zero.

(C) the magnetic flux is zero and emf is maximum. (D) magnetic flux is maximum and emf is zero

HOTS QUESTIONS

12. The figure shows a long straight current carrying wire placed along the axis of a circular conducting ring. When viewed from above: **(D)**



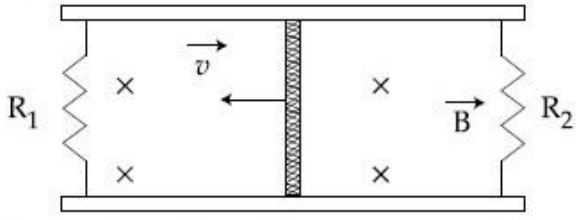
(A) the induced current in the ring is clockwise if the current through the wire is increasing.

(B) the induced current in the ring is anticlockwise if the current through the wire is increasing.

(C) the induced current in the ring is clockwise if the current through the wire is decreasing.

(D) there is no induced current in the ring even when the current through the wire is changing.

13. The following figure shows a conducting rod moving towards left on a rectangular conduction loop. The whole setup is placed in a perpendicular magnetic field pointing into the plane of the paper as shown. **(D)**



(A) The direction of induced current in the left part is anticlockwise and in the right part is clockwise.

(B) The direction of induced current in the left part is clockwise and in the right part is anticlockwise.

(C) The direction of induced current in both the parts is anticlockwise.

(D) There is no induced current in the left part.

14. If the angular speed of the rotating armature of an ac generator is increased: (D)

(A) the frequency of ac increases while the peak emf remains the same.

(B) the peak emf increases while the frequency of ac remains the same.

(C) both the frequency of ac and the maximum emf increase.

(D) both the frequency of ac and the maximum emf remain the same.

15. Consider the following two statements: (A)

STATEMENT – I: When two coils are wound on each other, the mutual induction between the coils is maximum.

STATEMENT – II: Mutual induction does not depend on the orientation of the coils.

Between the two statements:

(A) Statement – I is false and statement – II is true. (B) Both statements are true.

(C) Statement – I is true and statement – II is false. (D) Both statements are false.

FILL IN THE BLANKS

(***increases, remains the same, decreases, electric field, magnetic field, becomes zero***)

1. According to the phenomena of electromagnetic induction, a time varying magnetic field induces a/an _____. **(E)**

2. As the speed of a conducting rod moving perpendicular to a uniform magnetic field decreases, the motional emf induced across it _____. **(A)**

3. If the current through a coil increases, its self-inductance _____. **(A)**

4. When an iron rod is inserted inside a coil, its self-inductance _____. **(A)**

5. A current carrying coil stores energy in the form of _____. **(E)**

TWO MARKS QUESTIONS

1. Define magnetic flux through a surface. Give its mathematical formula in vector form. **(E)**

2. An area A is placed in a uniform magnetic field such that the plane is making an angle θ with the field. For what angle θ, is the magnetic flux through the surface (a) maximum (b) minimum? **(A)**

3. State and explain Faraday's law of electromagnetic induction. **(E)**

4. State Lenz's law in electromagnetic induction. What is its significance? **(E)**

5. What is motional emf? Write the expression for the motional emf induced in a straight conductor moving perpendicular to a uniform magnetic field. **(E)**

6. Write the expression for the motional emf across the ends of a conducting rod rotating about one of its ends in a plane perpendicular to a uniform magnetic field. Explain the terms. **(E)**
7. What is inductance? Write its SI unit. **(E)**
8. Mention any two factors inductance of a coil depends on. **(E)**
9. Is inductance a scalar or a vector quantity? Write the dimensional formula for inductance. **(E)**
10. Give the expression for mutual inductance between two co-axial solenoids and explain the terms. **(E)**
11. Mention the expression for self-inductance of a coil and explain the terms. **(E)**
12. What happens to the self-inductance of a coil if (i) an iron rod is inserted into it; (ii) the current through it is increased? **(A)**
13. (i) What is back emf? (ii) Which physical quantity plays the role of electrical inertia? **(E)**
14. Mention the expression for magnetic energy density. Explain the terms. **(E)**
15. What is AC generator? What is its working principle? **(E)**
16. Draw a neat-labeled diagram of AC generator. **(A)**
17. How does the peak emf induced in an ac generator depend on: (i) the number of turns in the coil; (ii) the time period of revolution of the coil? **(A)**
18. Mention any one type of AC generator. What is the frequency of ac in India? **(E)**

TWO MARKS NUMERICAL PROBLEMS

1. The magnetic flux linked with a coil changes from 5×10^{-3} Wb to 3×10^{-3} Wb in 0.01 second. Calculate the magnitude of the induced emf in the coil. **(A)**
2. A wheel with 10 metallic spokes each 0.5 m long is rotated with a speed of 120 revolutions per minute in a plane normal to the horizontal component of earth's magnetic field 0.4×10^{-4} T. What is the induced emf between the axle and the rim of the wheel? **(A)**
3. The pedals of a stationary bicycle are attached to a 100-turn coil of area 0.10 m^2. The coil rotates at half a revolution per second and it is placed in a uniform magnetic field of 0.01 T perpendicular to the axis of rotation of the coil. What is the maximum voltage generated in the coil? **(A)**
4. A vertical copper disc of diameter 20 cm makes 10 revolutions per second about a horizontal axis passing through its center. A uniform magnetic field 10^{-2} T acts perpendicular to the plane of the disc. Calculate the potential difference between its center and rim. **(A)**
5. The electric current in a coil of self-inductance 0.05 H changes from + 2 A to – 2 A in a time interval of 0.1 s. Find the magnitude of the induced emf in the coil. **(A)**
6. Current in a circuit falls from 5.0 A to 0.0 A in 0.1 s. If an average emf of 200 V induced, give an estimate of the self-inductance of the circuit. **(A)**
7. A pair of adjacent coils has a mutual inductance of 1.5 H. If the current in one coil changes from 0 to 20 A in 0.5 s, what is the change of flux linkage with the other coil? Assume that there is no leakage of magnetic flux. **(A)**

8. Calculate the magnetic energy stored in a coil of self – inductance 0.05 H carrying a current of 0.2 A. **(A)**

9. A coil of self-inductance stores an energy of 3.75 J when it carries a current of 5 A. Find the self-inductance of the coil. **(A)**

THREE MARKS QUESTIONS

1. Describe Faraday's coil and magnet experiment to demonstrate the phenomena of electromagnetic induction. **(E)**

2. Explain Faraday's coil and coil experiment to demonstrate the phenomena of electromagnetic induction when there is a relative motion between the coils. **(E)**

3. Discuss Faraday's observation on what happens in a coil with a galvanometer when the current through a neighboring coil is suddenly varied with the help of a switch. **(E)**

4. State Lenz law. With the help of an example, explain how the direction of induced current in electromagnetic induction is in accordance of law of conservation of energy. **(A)**

5. Derive the expression for motional emf in a conducting rod moving in uniform magnetic field. **(A)**

6. Mention any three factors motional emf depends on. **(E)**

7. Obtain the expression for co-efficient of mutual inductance between two co-axial solenoids. **(D)**

8. Mention any three factors on which the mutual inductance between a pair of coil depends. **(E)**

9. Derive the expression for the coefficient of self-induction of a coil. **(D)**

10. Mention any three factors on which the self-inductance of a coil depends. **(E)**

11. Derive the expression for the emf induced in a coil due to a varying current in the coil. **(A)**

12. Obtain the expression for energy stored in an inductor. **(A)**

13. Explain the working of an AC generator with a neat-labeled diagram. **(A)**

THREE MARKS NUMERICAL PROBLEMS

1. The magnetic flux through a coil of 10 turns changes with time as $\phi_B(t) = t^2 - 2t + 4$ Wb. Find the magnitude of the induced emf at $t = 3$ s. **(A)**

2. A square loop of side 10 cm and resistance 0.5 Ω is placed vertically in the east-west plane. A uniform magnetic field of 0.10 T is set up across the plane in the north-east direction. The magnetic field is decreased to zero in 0.70 s at a steady rate. Determine the magnitudes of induced emf and current during this time-interval. **(A)**

3. The magnetic field inside a coil of length 0.5 m and area of cross section 100 cm^2 is 1.585×10^{-3} T. What is the magnetic energy density inside the coil? Also, calculate the magnetic energy stored by the coil. **(A)**

FIVE MARKS QUESTIONS

1. (a) What is an AC generator? **(A)**
   (b) What is the principle behind the working of an ac generator.
   (c) Derive an expression for the instantaneous emf generated in an ac generator.

FIVE MARKS NUMERICAL PROBLEMS

1. A circular coil of radius 10 cm, 500 turns and resistance 2 Ω is placed with its plane perpendicular to the horizontal component of the earth's magnetic field. It is rotated about its vertical diameter through 180° in 0.25 s. Estimate the magnitudes of the emf and current induced in the coil. Horizontal component of the earth's magnetic field at the place is 3.0×10^{-5} T. **(A)**
2. A long solenoid with 15 turns per cm has a small loop of area 2.0 cm^2 placed inside the solenoid normal to its axis. If the current carried by the solenoid changes steadily from 2.0 A to 4.0 A in 0.1 s, what is the induced emf in the loop while the current is changing? If the loop has a resistance of 5×10^{-3} Ω, what is the power dissipated across it? **(D)**
3. A rectangular wire loop of sides 8 cm and 2 cm with a small cut is moving out of a region of uniform magnetic field of magnitude 0.3 T directed normal to the loop. What is the emf developed across the cut if the velocity of the loop is 1 cm s^{-1} in a direction normal to the (a) longer side, (b) shorter side of the loop? For how long does the induced voltage last in each case**?** **(A)**
4. A horizontal straight wire 10 m long extending from east to west is falling with a speed of 5.0 m s^{-1}, at right angles to the horizontal component of the earth's magnetic field, 0.30×10^{-4} Wb m^{-2}. **(D)**

   (a) What is the instantaneous value of the emf induced in the wire?

   (b) What is the direction of the emf? (c) Which end of the wire is at the higher electrical potential?

ANSWERS

MULTIPLE CHOICE QUESTIONS

1	2	3	4	5
D	A	C	D	B
6	7	8	9	10
C	B	D	C	A
11	12	13	14	15
C	D	B	C	C

FILL IN THE BLANKS

1. Electric Field, 2. decreases,3. remains the same, 4. increases, 5. magnetic field

CHAPTER 7. ALTERNATING CURRENT

MULTIPLE CHOICE QUESTIONS

1. Which one of the following statements is wrong? (E)

(A) AC can be easily and efficiently stepped up or stepped down.

(B) It is economical to transmit dc over large distances.

(C) The average value of sinusoidal alternating current or voltage over a complete cycle is zero.

(D) The average power consumed by a ac circuit over a complete cycle may not be zero.

2. In a purely capacitive circuit, if the frequency of ac is doubled, the capacitive reactance will: (A)

(A) get doubled (B) become four times

(C) get halved (D) remain constant.

3. The phenomena of resonance exhibited by an ac circuit: (E)

(A) only if both *L* & *C* are present in the circuit. (B) only if both *L* & *R* are present in the circuit.

(C) only if both *R* & *C* are present in the circuit. (D) only *R* is present in the circuit.

4. The dimensional formula of *LC* is (*L* is self-inductance and *C* is capacitance) (A)

(A) [T] (B) $[T^2]$ (C) $[T^{-1}]$ (D) $[T^{-2}]$

5. The principle behind working of a transformer is: (E)

(A) Eddy currents (B) Self-induction (C) Mutual induction (D) Hysteresis

6. The use of laminated core in a transformer reduces energy loss due to: (E)

(A) flux leakage (B) coil resistance (C) hysteresis (D) Eddy currents

7. The frequency of ac is increased, the impedance of a series LCR circuit: (A)

(A) continuously increases (B) continuously decreases

(C) first increases and then decreases (D) first decreases and then increases

8. Power factor for a purely resistive circuit is: (E)

(A) zero (B) unity (C) infinity (D) 0.5

9. At resonance, a series *LCR* ac circuit behaves like a: (E)

(A) purely capacitive circuit. (B) purely resistive circuit.

(C) purely inductive circuit (D) *LC* circuit

10. The power factor of a series *LCR* circuit is maximum when: (E)

(A) $X_L = X_C$ (B) $X_C = 0$ (C) $X_L > X_C$ (D) $X_L < X_C$

11. At resonance, the voltage across resistance is equal to: (A)

(A) the voltage across *L* (B) the voltage across *C*

(C) the applied voltage (D) the sum of voltages across *L* & *C*

12. For a transformer, $\frac{N_s}{N_p} = 100$. This means that: (E)

(A) the output current is 100 times the input current(B) the transformer is a step-down transformer

(C) the output power is 100 times the input power. (D) the input current is 100 times the output current.

HOTS QUESTIONS

13. The column – I lists the component through which alternating current is passed. The column – II lists quantities related column – I.

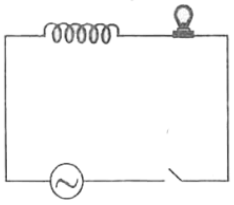
Match column – I with appropriate options form column – II: (D)

COLUMN – I	COLUMN – II
(A) Pure resistor	**(p) The current leads the voltage by π /2**
(B) Pure capacitor	**(q) The current lags behind the voltage by π /2**
(C) Pure Inductor	**(r) Reactance of the circuit is independent of frequency of ac.**
(D) A series LCR circuit	**(s) average power dissipated over a complete cycle is non-zero.**

(A) (a) → (r); (b) → (q); (c) → (p); (d) → (s) (B) (a) → (r, s); (b) → (p); (c) → (q); (d) → (s)

(C) (a) → (s); (b) → (p); (c) → (q); (d) → (r) (D) (a) → (s); (b) → (q); (c) → (p); (d) → (r)

14. A light bulb and an open coil inductor are connected to an ac source through a key as shown in the figure. (D)

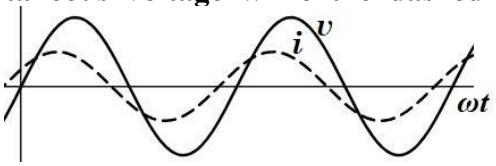


The switch is closed and after sometime, an iron rod is inserted into the interior of the inductor. As the iron rod is inserted, the glow of the light bulb:

(A) decreases. (B) increases.

(C) is unchanged . (D) may increase or decrease

15. The following figure represents the variation of voltage and current of an ac with time. The solid line represents the instantaneous voltage while the dashed line represents the instantaneous current.



From the figure, we can infer that the circuit is: (D)

(A) purely resistive (B) purely inductive.

(C) a series *LCR* circuit with $X_L > X_C$. (D) a series *LCR* circuit with $X_L < X_C$

FILL IN THE BLANKS

(***equal to unity, less than unity, greater than unity, zero, π/2, π***)

1. The phase difference between voltage and current in the case of ac through a pure capacitor is _____. **(E)**

2. The power factor of a series *LCR* circuit at resonance is _____. **(E)**

3. At resonance of series *LC*R circuit, the voltage across combination of *L* and *C* is _____. **(A)**

4. In a series *LCR* ac circuit, the current leads the voltage by π/3. The ratio between the capacitive reactance and the inductive reactance for the circuit is _____. **(A)**

5. For a step-down transformer, the ratio of primary current to secondary current is _____. **(A)**

TWO MARKS QUESTIONS

1. What is the phase difference between the current and the voltage in the case of a (i) purely resistive circuit and (ii) purely capacitive circuit? **(E)**

2. What is the average power dissipated over a complete cycle of ac in the case of (i) purely resistive circuit (ii) purely inductive circuit? **(E)**

3. Write any two differences between inductive reactance and capacitive reactance. **(A)**

4. An AC source of voltage is connected to a resistor. Draw phasor diagram and the sinusoidal voltage – current waveforms for the circuit. **(A)**

5. An AC source of voltage is connected to an ideal capacitor. Draw phasor diagram and the sinusoidal voltage – current waveforms for the circuit. **(A)**

6. An AC source of voltage is connected to an ideal inductor. Draw phasor diagram and the sinusoidal voltage – current waveforms for the circuit. **(A)**

7. What is capacitive reactance? How does it vary with the frequency of ac? **(E)**

8. What is inductive reactance? How does it vary with the frequency of ac? **(E)**

9. What is resonance of a series LCR circuit? Mention any one application of resonance in series LCR circuits. **(E)**

10. Draw impedance diagram for a series LCR circuit. Write the expression for the phase difference between the current and the voltage in a series LCR circuit. **(A)**

11. What is a transformer? What is its working principle? **(E)**

12. Give any two differences between step- up transformer and step- down transformer. **(A)**

13. Explain how the following source of energy loss in a transformer can be minimized (i) Resistance of the windings (ii) Hysteresis. **(E)**

14. Explain how the following source of energy loss in a transformer can be minimized:
(i) Flux leakage and (ii) Eddy Currents. **(E)**

15. A bulb is connected in series with an inductance coil and a capacitor to an ac source. Explain what happens to the brightens of the bulb when: (i) an iron rod is inserted into the inductor and (ii) a dielectric slab is introduced into the capacitor. **(D)**

16. How do the capacitive reactance and inductive reactance vary with the frequency of AC? **(E)**

17. Draw the variation of peak current with frequency of ac for a series LCR circuit. Write the expression for the frequency at which the impedance of the circuit is minimum. **(A)**

18. What is wattless current? What is the value of power factor of a series LCR circuit at resonance? **(E)**

19. Write the power factors for (i) a purely capacitive circuit and (ii) purely resistive circuit. **(E)**

20. At resonance, a series LCR circuit behaves like a purely resistive circuit. Justify. **(A)**

21. Why is alternating voltage stepped up to very high values using transformers during transmission of electrical energy? Explain. **(A)**

22. What is a transformer? Mention its principle. **(E)**

TWO MARKS NUMERICAL PROBLEMS

1. Alternating current is represented by the equation $i = 10\sin(314t)\ A$. Find the value of frequency of AC. **(E)**

2. The voltage across a resistor varies with time as $v = 100\sin(50t)\ V$. Calculate the value of the rms voltage. **(E)**

3. Find the capacitive reactance of an ac circuit of frequency 100 Hz. Given $C = 32\ \mu F$. **(A)**

4. In an inductive ac circuit, the value of inductance is 0.2 H and the frequency of ac is 50 Hz. Calculate the inductive reactance. **(A)**

5. In a series *LCR* circuit, the rms voltages across *L*, *C* and *R* are 50 V, 10 V and 40 V respectively. Calculate the value of the input rms voltage. **(A)**

6. The phase difference between the voltage and the current in an ac circuit is 60°. Find the power factor for the circuit. **(E)**

7. Find the resonant frequency for a series LCR circuit with $R = 50\ \Omega$ $L = 0.5$ H and $C = 8\ \mu F$. **(A)**

8. For a series *LCR* circuit with $L = 0.5$ H and $C = 8\ \mu F$ and $R = 10\ \Omega$. If the applied rms voltage is 50 V, what is the average power dissipated by the circuit at resonance? **(A)**

9. The turns ratio of number of turns in secondary to primary coils in a transformer is 50. If the voltage across the primary of the transformer is 220 V, find the voltage across its secondary. **(E)**

10. A power transmission line feeds input power at 2300 V to a step-down transformer with its primary windings having 4000 turns. What should be the number of turns in the secondary in order to get output power at 230 V? **(A)**

THREE MARKS QUESTIONS

1. Derive the expression for current in case of AC applied to a pure resistor. **(A)**

2. Obtain the expression for the average power dissipated over a complete cycle of AC by a resistor. **(A)**
3. Show that the average power over one complete cycle is zero in case of a capacitor connected to a sinusoidal AC. **(A)**
4. Derive the expression for the average power dissipated in a series RLC circuit. **(A)**
5. What is resonance in LCR series circuit? Obtain the expression for resonant frequency of it. **(A)**
6. Mention any three energy losses in a transformer. **(E)**
7. Explain how power is dissipated by writing the expression for power factor in case of (i) pure inductive or capacitive (ii) purely resisitve (iii) series LCR at resonance circuits. **(A)**
8. Give the construction and working of a transformer. **(A)**

THREE MARKS NUMERICAL QUESTIONS

1. A light bulb is rated at 100 W for a 220 V supply. Find (a) the resistance of the bulb; (b) the peak voltage of the source; and (c) the rms current through the bulb. **(A)**
2. The rms voltage and the rms current through an ac circuit are 50 V and 2 A respectively. If the average power across the circuit is 50 W, what is the phase difference between the voltage and the current? **(A)**
3. A pure inductor of 25.0 mH is connected to a source of 220 V. Find the inductive reactance and rms current in the circuit if the frequency of the source is 50 Hz. **(A)**
4. An L-C-R series circuit is connected to an external emf $\varepsilon = 200 \sin 100\pi t$ V. The values of the capacitance and resistance in the circuit are 1 μF and 100 Ω respectively. Find the inductance for which current in the circuit is maximum. **(A)**

FIVE MARKS QUESTIONS

1. Obtain the expression for current in case of AC applied to an inductor. Show that the current lags behind the voltage by π/2. Draw the phasor diagram and voltage – current waveforms. **(D)**
2. Derive the expression for current in case of AC applied to a capacitor. Show that the current leads the voltage by π/2. Draw the phasor diagram and voltage – current waveforms. **(D)**
3. Derive the expression for impedance and hence the current of an RLC series circuit connected to an AC using phasor diagram. **(D)**

FIVE MARKS NUMERICAL QUESTIONS

1. A 50 Ω resistor, 0.5 H inductor and 200 μF capacitor are connected in series with 220 V and 50 Hz source. Find the impedance of the circuit and hence the current. **(D)**
2. A 15.0 μF capacitor is connected to a 220 V, 50 Hz source. Find the capacitive reactance and the current (rms and peak) in the circuit. If the frequency of the ac source is doubled, what happens to the current? **(A)**
3. A resistor of 200 Ω and a capacitor of 15.0 mF are connected in series to a 220 V, 50 Hz ac source.
   (a) Calculate the current in the circuit;
   (b) Calculate the voltage (rms) across the resistor and the capacitor. **(A)**

4. A current of 4 A flows in a coil when connected to a 12 V d.c. source. If the same coil is connected to 12 V, 50 Hz a.c. source, a current of 2.4 A flows in the circuit. Calculate the value of the self-inductance of the coil. **(D)**

5. A resistance of 10 Ω is connected in series with an inductor of inductance 0.5 H. These two are connected to 200 V, 50 Hz a.c. source. Calculate the capacitance that should be put in series with the combination to obtain the maximum current. Also, find the current through the circuit. **(D)**

6. A source of 220 V, 40 Hz is connected to a series combination of 6 Ω resistor, 0.01 H inductor. Calculate the phase angle and the power factor of the circuit. **(A)**

7. A sinusoidal voltage of peak value 283 V and frequency 50 Hz is applied to a series LCR circuit in which $R = 3\ \Omega$, $L = 25.48$ mH, and $C = 796$ mF. Find (a) the impedance of the circuit; (b) the phase difference between the voltage across the source and the current; (c) the power dissipated in the circuit; and (d) the power factor. **(D)**

8. A LCR circuit connected is to a variable frequency 230 V source. $L = 5.0$ H, $C = 80$ μF, $R = 40\ \Omega$.
(a) Determine the source frequency that drives the circuit in resonance.
(b) Obtain the impedance of the circuit and the amplitude of current at the resonating frequency.
(c) Determine the rms potential drops across the three elements of the circuit. **(D)**

9. In a step-down transformer having primary to secondary turns ratio 20 : 1, the input voltage applied is 250 V and output current is 8 A. Assuming 100% efficiency calculate (i) voltage across the secondary coil, (ii) current in primary coil (iii) output power. **(A)**

10. An LCR circuit contains resistance of 100 Ω and supply of 200 V at 300 rad/second. If only capacitance is taken out from the circuit and the rest of the circuit is joined, current lags behind the voltage by 60°. If on the other hand, only inductor is taken out, the current leads by 60° with applied voltage.
Find the current flowing in the circuit. **(D)**

11. A bulb of 60 V, 10 W is connected with 100 V, 60 Hz ac source with an inductance coil in series. If bulb illuminates with its full intensity then calculate the value of self-inductance of coil. **(D)**

12. One 80 V, 50 W bulb is to be connected to 100 V, 50 Hz ac line. A suitable capacitor is connected in series with the bulb so that the bulb glows with its full intensity. Find the value of the capacitance of the capacitor. **(D)**

13. A series LCR circuit contains a pure inductor of inductance L, a capacitor of capacitance 10 μF and resistor of resistance 50 Ω so as to draw maximum current from AC source of 200 V, 50 Hz. Find the value of 'L'. Also find the value of that maximum current. **(D)**

14. A resistor 100 Ω, a pure inductance coil of L = 0.5 H and capacitor are in series in a circuit containing an ac of 200V, 50 Hz. In the circuit current is ahead of the voltage by 30°. Find the value of the capacitance of the capacitor. **(D)**

15. A series LCR circuit with L = 0.5 H and R =100 Ω is connected to a 200 V, 50 Hz a.c. supply. (a) Calculate the value of capacitance of the capacitor that drives the circuit into resonance. (b) Find the value of voltage across the inductor at resonance. **(D)**

16. A series *LCR* circuit consists of an inductor of inductance 200 mH, a capacitor of capacitance 50 μF and resistor of resistance 100 Ω, connected to a variable frequency 220 V source.

(a) Determine the source frequency which drives the circuit in resonance.

(b) Find the impedance and amplitude of current in the circuit at resonance.

17. An inductor and a resistor are connected in series with 100 V, 50 Hz ac source. If the current in the circuit is 1 A and current lags the voltage by $\frac{\pi}{3}$, calculate the resistance of the resistor.

18. A *LCR* series circuit is connected to a variable frequency 230 V AC source. If L = 1.0 H, C = 400 μF and R = 20 Ω,

(i) determine the source frequency that drives the circuit into resonance and

(ii) calculate the impedance and current in the circuit at resonance.

19. A resistor of 200 Ω and an inductor of self-inductance 1.0 H are connected in series to an AC source of 200 V, 50 Hz. Find the impedance of the circuit and current in the circuit.

ANSWERS

MULTIPLE CHOICE QUESTIONS

1	2	3	4	5
B	C	A	B	C
6	7	8	9	10
D	D	B	B	A
11	12	13	14	15
C	D	B	A	D

FILL IN THE BLANKS

1. *π/2* ***2.*** *equal to unity* ***3.*** *zero* ***4.*** *greater than unity* ***5.*** *less than unity*

CHAPTER 8. ELECTROMAGNETIC WAVES

MULTIPLE CHOICE QUESTIONS

1. Displacement current is produced due to **(E)**

(A) Constant electric field (B) constant magnetic field

(C) Changing electric field (D) changing magnetic field

2. The expression for displacement is **(E)**

(A) $i_d = \varepsilon_0^2 \frac{d\phi_E}{dt}$ (B) $i_d = \mu_0 \varepsilon_0 \frac{d\phi_E}{dt}$ (C) $i_d = \mu_0 \frac{d\phi_E}{dt}$ (D) $i_d = \varepsilon_0 \frac{d\phi_E}{dt}$

3. Electromagnetic wave theory was proposed by **(E)**

(A) Michael Faraday (B) Louis de Broglie (C) J C Maxwell (D) Albert Einstein

4. Choose the false statement. **(A)**

(A) Electromagnetic waves are produced by accelerated charged particles.

(B) For electromagnetic waves $\frac{E_0}{B_0} = c$ where E_o and B_o are electric and magnetic field amplitudes.

(C) Electromagnetic waves are transverse in nature.

(D) Electromagnetic waves can be deflected by electric field and magnetic field.

5. An electromagnetic wave going through vacuum is described by $E = E_0 \sin(kx - \omega t)$, and $B = B_0 \sin(kx - \omega t)$ then **(E)**

(A) $E_0B_0 = \omega k$ (B) $E_0\omega = B_0k$ (C) $E_0k = B_0\omega$ (D) $E_0B_0 = 1/\omega k$

6. Out of the following options which one can be used to produce an electromagnetic wave? (E)

(A) A chargeless particle (B) An accelerating charge

(C) A charge moving at constant velocity (D) A stationary charge

7. Which electromagnetic waves are used in long range communication? **(E)**

(A) Gamma rays (B) IR-rays (C) Radio waves (D) Ultraviolet

8. The increasing order of wavelength of infrared, microwave, ultraviolet and gamma rays is (A)

(A) microwave, infrared, ultraviolet, γ- rays (B) γ- rays, ultraviolet, infrared, microwaves

(C) microwaves, γ- rays, infrared, ultraviolet (D) infrared, microwave, ultraviolet, γ- rays

9. The ultraviolet region of the electromagnetic spectrum lies between **(E)**

(A) x-ray region and visible region (B) gamma ray region and x-ray region

(C) visible region and microwave region (D) IR region and radio wave region

10. The wavelength range of x-rays is **(E)**

(A) $< 10^{-3}$ nm (B) 1 nm - 10^{-3} nm (C) 400 nm to 1 nm (D) 0.1 m to 1 mm

11. The electromagnetic waves suitable for RADAR systems used in aircraft navigation are (E)

(A) Gamma rays (B) Ultraviolet rays (C) Microwaves (D) Infrared waves

HOTS QUESTIONS

12. Statement i: Displacement current goes through the gap between the plates of a capacitor when the charge on the plates of the capacitor does not change.

Statement ii: The displacement current arises in the region in which the electric field is constant with time. (E)

(A) Statements i and ii both are correct and statement ii is a correct explanation for statement i.

(B) Statements i and ii both are correct but statement ii is not correct explanation for statement i.

(C) Statements i is correct but ii is wrong.

(D) Both the statements are wrong.

13. Statement i: Electromagnetic waves are transverse in nature.

Statement ii: The electric and magnetic fields in electromagnetic waves are perpendicular to each other and to the direction of propagation. (E)

(A) Statements i and ii both are correct and statement ii is a correct explanation for statement i.

(B) Statements i and ii both are correct but statement ii is not correct explanation for statement i.

(C) Statements i is correct but ii is wrong.

(D) Both the statements are wrong.

14. Statement I: The velocity of electromagnetic waves depends on electric and magnetic properties of the medium.

Statement II: Velocity of electromagnetic waves in free space is constant. (E)

(A) Statements I and II both are correct and statement II is a correct explanation for statement I.

(B) Statements I and II both are correct but statement II is not correct explanation for statement I.

(C) Statements I is correct but II is wrong.

(D) Both the statements are wrong.

15. Statement I: Infrared radiations are sometimes referred to as heat waves.

Statement II: Infrared radiation plays an important role in maintaining the average temperature of the earth. (E)

(A) Statements i and ii both are correct and statement ii is a correct explanation for statement i.

(B) Statements i and ii both are correct but statement ii is not correct explanation for statement i.

(C) Statements i is correct but ii is wrong.

(D) Both the statements are wrong.

16. Statement I: Microwave ovens raise the temperature of the food containing water molecules.

Statement II: When the frequency of microwaves are matched with the resonant frequency of water molecules, the energy of the waves is transferred efficiently to the molecules. (A)

(A) Statements I and II both are correct and statement II is a correct explanation for statement I.

(B) Statements I and II both are correct but statement II is not correct explanation for statement I.

(C) Statements I is correct but II is wrong.

(D) Both the statements are wrong.

FILL IN THE BLANKS

(radio waves, X – rays, gamma rays, infra-red waves, microwaves, ultraviolet rays)

1. _____ are produced using magnetron valves. **(E)**
2. Cellular phones use _____ to transmit voice communication in the UHF band. **(E)**
3. _____ maintain the earth's warmth. **(E)**
4. The electromagnetic waves which have the least wavelength are_____. **(E)**
5. Ozone layer absorbs _____. **(E)**

TWO MARKS QUESTIONS

1. What is displacement current? Write the expression for it. **(E)**
2. Write the expression for displacement current and explain the terms. **(E)**
3. Write Ampere-Maxwell's equation and explain the terms. **(E)**
4. Give any two properties of electromagnetic waves. **(E)**
5. Give any two applications of X-rays. **(E)**
6. Give any two applications of UV-rays. **(E)**
7. Give any two applications of IR-rays. **(E)**
8. Give any two uses of microwaves. **(E)**
9. Mention any two uses of radio waves. **(E)**
10. Name the electromagnetic waves used for the following applications.
    (a) The radar systems used in aircraft navigation. **(E)**
    (b) The remote switches of household electronic systems such as TV. **(E)**

11 . What is the wavelength range of gamma rays. Mention one use of gamma rays. **(E)**

12. Write the expression for the speed of light (i) in vacuum and (ii) in a medium in terms of permittivity and permeability. **(E)**

13. Which electromagnetic waves are used in (i) Aircraft navigation (ii) LASIK eye surgery? **(E)**

14. Mention the method of production of (i) Microwaves and (ii) X – rays. **(E)**

15. Give the method of production and method of detection of radio waves. **(E)**

16. Give the method of production and method of detection of microwaves. **(E)**

17. Give the method of production and method of detection of infrared rays. **(E)**

18. Give the method of production and method of detection of ultraviolet rays. **(E)**

19. Give the method of production and method of detection of x- rays. **(E)**

20. Give the method of production and method of detection of gamma rays. **(E)**

21. Name the electromagnetic waves used a) to kill germs in water purifiers and
b) in remote switches of TV. **(E)**

KEY ANSWERS FOR MULTIPLE CHOICE QUESTIONS

Q. No	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Ans	C	D	C	D	C	B	C	B	A	B	C	D	A	B	A	A

ANSWER TO FIBs

1. Microwaves 2. Radio waves 3. Infrared waves
4. Gamma rays 5. Ultraviolet rays

CHAPTER 9. RAY OPTICS AND OPTICAL INSTRUMENTS

MULTIPLE CHOICE QUESTIONS

1. In reflection of light, the angle of reflection is **(E)**

(A) more than incident angle (B) less than incident angle

(C) equal to angle of incidence (D) more or less than incident angle

2. Focal length of a spherical mirror depends on **(E)**

(A) object distance (B) image distance

(C) both object and image distances (D) radius of curvature

3. When an object is placed at infinity from a spherical mirror, the image is formed at **(E)**

(A) infinity (B) principal focus (C) at centre of curvature (D) pole

4. The focal length of a spherical mirror is **(E)**

(A) equal to radius of curvature (B) two times the radius of curvature

(C) half of the radius of curvature (C) not depends on radius of curvature

5. For reflection in spherical mirrors, all distances are measured from the **(E)**

(A) pole (B) principal focus (C) centre of curvature (D) from object

6. In refraction of light **(E)**

(A) $\frac{\sin i}{\sin r} = 1$ (B) $\frac{i}{r}$ = constant (C) $sin\, i \times sin\, r$ = constant (D) $\frac{\sin i}{\sin r}$ = constant

7. For total internal reflection of light **(E)**

(A) light should be travelling from rarer medium to denser medium

(B) light should be travelling from denser medium to rarer medium

(C) light should incident along the normal.

(D) the angle of incidence should be equal to 90^0.

8. An object of finite height is placed in front of a concave mirror within its focus. It forms **(A)**

(A) a real enlarged image (B) a real diminished image

(C) a virtual enlarged image (D) a virtual diminished image

9. The speed of light in a medium depends on **(E)**

(A) angle of incidence (B) angle of refraction (C) refractive index (D) its mass density

10. Refractive index of a medium depends on **(E)**

(A) thickness of the medium (B) angle of incidence

(C) mass density of the medium (D) optical properties of the medium

11. When a light ray travels from rarer medium to denser medium, its **(E)**

(A) speed increases (B) speed decreases (C) wavelength increases (D) frequency decreases

12. Snell's law fails in the case of **(A)**

(A) light travelling from denser to rarer (B) oblique incidence

(C) when light travelling from rarer to denser (D) normal incidence

13. The principle of optical fibres is **(E)**

(A) reflection of light (B) refraction of light (C) dispersion of light (D) total internal reflection

14. The focal length of a lens is depends on **(A)**

i) refractive index of the material

ii) radii of curvature of two surfaces

iii) diameter of the aperture

(A) only option i) is correct (B) only option i) and ii) are correct

(C) only ii and iii are correct (D) option i, ii and iii are correct

15. Two thin lenses of focal lengths f_1 and f_2 are in contact. The power of the combination is **(A)**

(A) $\frac{f_1+f_2}{2}$ (B) $\frac{f_1+f_2}{f_1 f_2}$ (C) $\frac{f_1 f_2}{f_1+f_2}$ (D) $\frac{\sqrt{f_1}}{\sqrt{f_2}}$

16. The angle of minimum deviation of a prism is depends on **(A)**

(A) only angle of the prism (B) only refractive index of the prism

(C) angle of incidence (D) both angle of the prism and its refractive index

17. A ray of light is incident on glass-air interface at an angle greater than the critical angle for the pair of media. Then the ray undergoes **(E)**

(A) refraction only (B) partial reflection and partial refraction

(C) total internal reflection (D) grazes the surface at the interface of the two media

18. The magnification of a refracting telescope is **(E)**

(A) $\frac{f_o}{f_e}$ (B) $\frac{f_e}{f_o}$ (C) $f_o + f_e$ (D) $fo.fe$

19. A lens of large focal length and large aperture is best suited as an objective of an astronomical telescope since (E)

(i) a large aperture contributes to the quality and visibility of the images.

(ii) a large area of the objective ensures better light gathering power.

(iii) a large aperture provides a better resolution

(A) only (i) and (ii) (B) only (ii) and (iii) (C) only (i) and (iii) (D) (i), (ii) and (iii)

HOTS QUESTIONS

20. Statement i: A convex mirror is preferred over a plane mirror in vehicles to observe traffic coming from behind.

Statement ii: Convex mirrors have large field of view and images of real objects formed by convex mirrors are erect. (D)

(A) Statements i and ii both are correct but statement ii is not a correct explanation for statement i.

(B) Statements i and ii both are correct and statement ii is the correct explanation for statement i.

(C) Statements i is correct but ii is wrong.

(D) Statements i is wrong but ii is correct.

21. Statement i: The images formed by total internal reflections are much brighter than those formed by mirrors or lenses.

Statement ii: In total internal reflection, the light is completely reflected and there is no loss of intensity of light. (A)

(A) Statements i and ii both are correct and statement ii is correct explanation for statement i.

(B) Statements i and ii both are correct but statement ii is not correct explanation for statement i.

(C) Statements i is correct but ii is wrong.

(D) Both the statements are wrong.

22. Statement i: The focal length of equiconvex lens of refractive index 1.5 placed in air is equal to radius of curvature of either face.

Statement ii: For equi-convex lens radius of curvature of both the faces is same. (D)

(A) Statements i and ii both are correct but statement ii is not a correct explanation for statement i.

(B) Statements i and ii both are correct and statement ii is a correct explanation for statement i.

(C) Statements i is correct but ii is wrong.

(D) Statements i is wrong but ii is correct.

23. Statement i: If a glass prism is immersed in water its angle of minimum deviation is increases.
Statement ii: Angle of minimum deviation of a prism is increases with increase in the refractive index of the prism. **(A)**

(A) Statements i and ii both are correct but statement ii is not a correct explanation for statement i.

(B) Statements i and ii both are correct and statement ii is a correct explanation for statement i.

(C) Statements i is correct but ii is wrong.

(D) Statements i is wrong but ii is correct.

24. Statement i: In a simple microscope, the object is placed at distance slightly less than the focal length of the objective lens.
Statement ii: When the object is placed within the focal point of a convex lens, an enlarged, erect image is formed. **(A)**

(A) Statements i and ii both are correct but statement ii is not a correct explanation for statement i.

(B) Statements i and ii both are correct and statement ii is a correct explanation for statement i.

(C) Statements i is correct but ii is wrong.

(D) Statements i is wrong but ii is correct.

25. Statement i: In compound microscope, the focal length of objective lens is large whereas the focal length of eyepiece is small.
Statement ii: The magnification of compound microscope varies inversely to the focal lengths of both objective lens and eye lens. **(A)**

(A) Statements i and ii both are correct but statement ii is not a correct explanation for statement i

(B) Statements i and ii both are correct and statement ii is a correct explanation for statement i.

(C) Statements i is correct but ii is wrong.

(D) Statements i is wrong but ii is correct.

26. Statement i: In refracting telescope, the focal length of objective lens is large whereas the focal length of eyepiece is small.
Statement ii: The magnification of refracting telescope directly proportional to the focal length of objective lens and varies inversely with the focal length of eye lens. **(A)**

(A) Statements i and ii both are correct and statement ii is a correct explanation for statement i.

(B) Statements i and ii both are correct but statement ii is not correct explanation for statement i.

(C) Statements i is correct but ii is wrong.

(D) Statements i is wrong but ii is correct.

FILL IN THE BLANKS

(*inversely proportional, refraction, parallel, critical angle, total internal reflection, reflection*)

1. The bottom of a swimming pool appears to be raised above is due to _____. **(E)**

2. Optical fibres are working on the principle of _____. **(E)**

3. For total internal reflection of light, the angle of incident must be greater than _____. **(E)**

4. At minimum deviation position, the refracted ray inside the prism is _____ to the base of the prism. **(A)**

5. The magnification of compound microscope is _____ to focal length of eye lens. **(E)**

TWO MARKS QUESTIONS

1. State the laws of reflection. **(E)**

2. State the laws of refraction. **(E)**

3. Give the conditions for total internal reflection. **(E)**

4. An object is placed at a distance of 25 cm from a concave mirror of focal length 15 cm. Find the position of image formed. **(A)**

5. Mention two applications of total internal reflection. **(E)**

6. What are optical fibres? What is the principle of optical fibres? **(E)**

7. Mention any two uses of optical fibres. **(E)**

8. Mention the factors on which focal length of a lens depends. **(E)**

9. Define power of the lens and give its SI unit. **(E)**

10. Calculate the power of a convex lens of focal length 25 cm. **(A)**

11. Two thin convex lenses of focal length 30 cm and 60 cm are kept in contact. Calculate the equivalent focal length of a combination. **(A)**

12. Two thin lenses produce magnifications of 1.5 and 3 respectively of a small object for a certain object distance. What will be the magnification if the lenses are kept in contact and the object is placed at the same distance from the combination? **(A)**

13. Two lenses of power + 2.5 D and – 1 D are kept in contact with each other. What is the power of the combination? **(A)**

14. Draw the ray diagram of image formation in simple microscope when the image is at near point. **(E)**

15. Draw the ray diagram of image formation in simple microscope when the image is at infinity. **(A)**

16. State one advantage and one disadvantage of forming an image at infinity rather than at the near point in a simple microscope. **(A)**

17. Write the expression for magnification of the image formed in simple microscope. Explain the terms. **(E)**

18. Draw the ray diagram of image formation in compound microscope. **(A)**

19. Write the expression for magnification of the image formed at infinity in compound microscope. Explain the terms used. **(E)**

20. What are the natures of intermediate and final image formed by a compound microscope? **(A)**

21. Draw the ray diagram of image formation in refracting telescope. **(A)**

22. Write the expression for magnification of the image formed in refracting telescope. Explain the terms used. **(E)**

23. Telescopes have large diameter objective lenses. Give two reasons. **(A)**

24. Reflecting telescopes are preferred over refracting telescopes. Give two reasons. **(A)**

25. 'Modern telescopes use a concave mirror rather than a lens for the objective'. Give any two reasons to support this statement. **(A)**

THREE MARKS QUESTIONS

1. Give the sign conventions used in geometric optics. Or Give the Cartesian sign convention used to measure distances and heights in spherical mirrors. **(E)**

2. Prove that, the focal length of a spherical mirror is half of its radius of curvature. **(A)**

3. Give any three applications of optical fibres. **(E)**

4. Obtain the relation between refractive index and critical angle. **(A)**

5. From prism formula, obtain the expression for the deviation produced by a thin prism. **(A)**

6. A small telescope has an objective lens of focal length 144 cm and an eye piece of focal length 6 cm. What is the magnifying power of the telescope? **(A)**

FIVE MARKS QUESTIONS

1. Derive the mirror equation $\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$. **(A)**

2. Derive the relation $-\frac{n_1}{u} + \frac{n_2}{v} = \frac{n_2 - n_1}{R}$ for a refraction through a spherical surface where symbols having their usual meaning. OR Derive the relation connecting n, u, v and R for refraction through a spherical surface. **(D)**

3. Derive Lens maker's formula. **(D)**

4. Obtain the expression for equivalent focal length of a combination of two thin lenses in contact. **(A)**

5. Obtain the expression for refractive index of a prism in terms of angle of the prism A and angle of minimum deviation D. OR Derive the expression $n = \frac{\sin\frac{A+D}{2}}{\sin\frac{A}{2}}$ where symbols have their usual meaning. **(D)**

NUMERICAL PROBLEMS

1. A point object is placed at a distance of 40 cm from a concave mirror of focal length 15 cm. If the object is displaced through a distance of 20 cm towards the mirror, by how much distance will the image be displaced? **(A)**

2. A small bulb (a point source) is placed at the bottom of a tank containing water to a depth of 80 cm. What is the radius of the circular surface of water through which light emerge out? Refractive index of water is 1.33. **(D)**

3. The radii of curvature of two surfaces of a convex lens is 0.2 m and 0.22 m. Find the focal length of the lens if refractive index of the material of the lens is 1.5. Also find the change in focal length, if it is immersed in water of refractive index 1.33. (**A)**

4. Double convex lens is to be manufactured from a glass of refractive index 1.52, with both faces of same radius of curvature. What is the radius of curvature required if the focal length is 25 cm. What will be new focal length when the lens is immersed in water of refractive index 1.33. **(A)**

5. An object of height 3 cm is placed 14 cm in front of a concave lens of focal length 21 cm. Find the position, nature and size of the image formed. **(D)**

6. Two lenses of focal length 0.2 m and 0.3 m are kept in contact. Find the focal length of the combination, Calculate powers of two lenses and combination. **(A)**

7. Calculate the refractive index of material of an equilateral prism having an angle of minimum deviation of 40^0. Also calculate the angle of incidence. **(A)**

8. A ray of light is incident at 40^o on one face of an equilateral prism of refractive index 1.55. Calculate the angle of deviation as it emerges from the other surface. **(A)**

9. An equilateral prism is made of glass. When a beam of light is incident on a face of the prism the angle of minimum deviation is found to be 40^o. Calculate the refractive index of the prism. If this prism is immersed in water of refractive index 1.33, find the new angle of minimum deviation. **(D)**

10. An object of height 3 cm is placed 21 cm in front of a convex lens of focal length 14 cm. Find the position and magnification of the image. What happens to the height of image if the object is moved further away from the lens? **(D)**

11. An object of height 1 mm is kept perpendicular to the axis of a thin convex lens of power +10 D. The distance between the object and the lens is 15 cm. Find the position, nature and the height of the image formed. **(D)**

12. At what angle should a ray of light be incident on the face of an equilateral prism, so that it just suffers total internal reflection at the other face? The refractive index of the material of the prism is 1.5. **(D)**

13. An object of 1 mm is placed 15 cm in front of a concave lens of 20 cm radius of curvature. Find the position, nature and size of the image formed. **(A)**

14. A ray of light is incident at 45° on one face of an equilateral prism of refractive index 1.56. Calculate the angle of deviation as it emerges from the other surface. **(D)**

15. An equi-convex lenses is to be manufactured from a glass of refractive index 1.5. Find the radius of curvature of the surfaces of the lens if the focal length is to be 20 cm. Also find the new focal length of the lens if it is immersed in water. (Given: the refractive index of water = 1.33) **(D)**

KEY ANSWERS FOR MULTIPLE CHOICE QUESTIONS

Q. No	1	2	3	4	5	6	7	8	9	10
Ans	C	D	B	C	A	D	B	C	C	D
Q. No	11	12	13	14	15	16	17	18	19	20
Ans	B	D	D	B	B	D	C	A	D	B
Q. No	21	22	23	24	25	26				
Ans	A	A	D	B	D	A				

ANSWERS TO FILL IN THE BLANKS

1. Refraction, 2. Total internal reflection, 3. Critical angle, 4. Parallel, 5. Inversely proportional

CHAPTER 10. WAVE OPTICS

MULTIPLE CHOICE QUESTIONS

1. Wave theory of light is proposed by **(E)**

(A) Isaac Newton (B) Christiaan Huygens (C) Foucault (D) Snell

2. According to Huygen's principle, the speed of the secondary wavelets is **(E)**

(A) Twice that of the wave (B) zero (C) same as the wave (D) infinite

3. To observe sustained interference pattern on a screen placed at a suitable distance in Young's double slit experiment, which of the following condition/s is/are necessary? **(E)**

(i) Sources of light should be coherent.

(ii) Sources of light should be narrow.

(ii) Sources of light should be very close.

(A) only (i) (B) both (i) and (ii) (C) both (ii) and (iii) (D) all (i), (ii) and (iii)

4. Two light sources are said to be coherent when both the sources of light emit light of **(E)**

(A) same amplitude and in-phase (B) same intensity and wavelength

(C) same speed (D) same wavelength and constant phase difference

5. In Young's double-slit experiment with monochromatic light, how is fringe width affected, if the screen is moved closer to the slits? **(E)**

(A) Independent (B) Remains the same (C) Increases (D) Decreases

6. What would be the resultant intensity at a point of destructive interference, if there are two identical coherent waves of intensity I_0 producing an interference pattern? **(E)**

(A) 5 I_0 (B) 2 I_0 (C) zero (D) I_0

7. Diffraction effect is exhibited by _____. **(E)**

(A) only sound waves (B) only light waves

(C) only matter waves (D) all types of waves

8. In single slit diffraction experiment, the width of the slit is made double of its original width. Then the central maximum of the diffraction pattern will become **(E)**

(A) narrower and fainter (B) narrower and brighter

(C) broader and fainter (D) broader and brighter

9. What is the cause of diffraction? **(E)**

(A) Interference of primary wavelets (B) Interference of secondary wavelets

(C) Reflection of primary wavelets (D) Reflection of secondary wavelets

10. Which of the following phenomenon confirms the transverse nature of light waves? **(E)**

(A) Refraction of light (B) Diffraction of light

(C) interference of light (D) Polarization of light

11. Electromagnetic theory of light was proposed by

(A) Descartes (B) Christian Huygens (C) Maxwell (D) Newton

HOTS QUESTIONS

12. Statement I: If we use two sodium lamps illuminating two pinholes, we will not observe any interference fringes.

Statement II: The light waves coming out from two independent sources of light will not have any fixed phase relationship and hence they are incoherent. (D)

(A) Both statement I and II are true and II is the correct explanation of I.

(B) Both statements are true but II is not the correct explanation of I.

(C) Statement I is true but II is false.

(D) Both statements I and II are false.

13. Statement I: We can hear around corners, but we cannot see around corners.

Statement II: Wavelength of sound wave is much greater than wavelength of light. (D)

(A) Both statements are true and statement II is correct explanation for statement I.

(B) Both statements are true but statement II is not correct explanation for statement I.

(C) Statement I is true but statement II is false.

(D) Statement I is false and statement II is true.

14. Statement I: If we observe carefully at the shadow cast by an opaque object, close to the region of geometrical shadow, there are alternate dark and bright regions.

Statement II: The alternate dark and bright regions are due to diffraction. (A)

(A) Both statement I and II are true and II is the correct explanation of I.

(B) Both statements are true but II is not the correct explanation of I.

(C) Statement I is true but II is false.

(D) Both statements I and II are false.

15. Statement I: We do not encounter diffraction effects of light in everyday observations.

Statement II: The wavelength of light is much smaller than the dimensions of most obstacles (A)

(A) Both statements are true and statement II is correct explanation for statement I.

(B) Both statements are true but statement II is not correct explanation for statement I.

(C) Statement I is true but statement II is false.

(D) Statement I is false and statement II is true.

16. Statement I: Intensity of light wave is determined by the square of the amplitude of the wave.

Statement II: The intensity of light in the photon picture is determined by the number of photons crossing unit area per unit time (A)

(A) Both the statements are true.

(B) Both the statements are false.

(C) Statement I is true but statement II is false.

(D) Statement I is false and statement II is true.

FILL IN THE BLANKS

(*diffraction, half, wavelength, energy, spherical, interference, frequency*)

1. A wavefront coming from a point source of light is a _____ wavefront. **(E)**

2. When a wave gets refracted into a denser medium, _____ remains the same. **(E)**

3. The modification in the distribution of light intensity due to superposition of two or more light waves is called _____ of light. **(E)**

4. The colours on a compact disc (CD) is due to _____ of light. **(E)**

5. Interference and diffraction are consistent with law of conservation of _____. **(E)**

6. If light from an ordinary sodium lamp is passed through a polaroid sheet, then the intensity of emergent light becomes _____ of the incident intensity. **(E)**

TWO MARKS QUESTIONS

1. What is a wavefront? Name the wavefront emitted by a point source of light at a small distance. **(E)**

2. What is the shape of the wavefront in each of the following cases: **(E)**

(a) Light emerging out of a convex lens when a point source is placed at its focus.

(b) The portion of the wavefront of light from a distant star intercepted by the Earth.

3. Write the conditions for constructive interference in terms of phase difference. **(A)**

4. Write the conditions for constructive interference in terms of path difference. **(A)**

5. Write the conditions for destructive interference in terms of phase difference. **(A)**

6. Write the conditions for destructive interference in terms of path difference. **(A)**

7. Name any two phenomena of light which confirms the wave nature of light. **(E)**

8. Give the expressions for the resultant intensity and resultant amplitude at a point, when two identical coherent waves each of intensity 'I_0', amplitude 'a' and phase difference 'ϕ' produce an interference pattern. **(A)**

9. What is meant by diffraction of light? Give an example. **(E)**

10. Mention the conditions for diffraction minima and secondary maxima. **(A)**

11. Write the expression for Malus' law of polarization of light and explain the terms. **(A)**

THREE MARKS QUESTIONS

1. Using Huygen's principle, show that the angle of incidence is equal to the angle of reflection during plane wavefront reflected by a plane surface. **(A)**

2. Give the shape of wavefront obtained on reflection/refraction, when a plane wavefront incident on (i) a prism (ii) a convex lens and (iii) a concave mirror. **(A)**

3. What is interference of light? Write the conditions for constructive interference and destructive interference in terms of phase difference. **(A)**

4. Write any three differences between interference pattern and diffraction pattern. **(A)**

5. Mention the any three applications of Polaroids. **(E)**

FIVE MARKS QUESTIONS

1. State Huygen's principle. Derive Snell's law of refraction for a plane wave using Huygen's principle. **(A)**
2. Give the theory of interference and hence arrive the conditions of constructive and destructive interference pattern in terms of phase difference between two waves. OR Derive the expression for resultant amplitude when two coherent waves superpose each other. Write conditions of constructive and destructive interference pattern in terms of phase difference between two waves. **(A)**

NUMERICAL PROBLEMS

1. Monochromatic light of wavelength 589 nm is incident from air on a water surface.
   Calculate the wavelength, frequency and speed of (a) reflected light, and (b) refracted light.
   Given: Refractive index of water is 1.33. **(A)**
2. Let the intensity of un-polarised light incident on P_1 be I. What is the intensity of light crossing polaroid P_2, when the pass-axis of P_2 makes an angle 90^o with the pass-axis of P_1? **(A)**
3. A beam of un-polarised light is incident on an arrangement of two polaroids successively. If the angle between the pass axes of the two polaroids is 60^o, then what percentage of light intensity emerges out of the second polaroid? **(A)**
4. A beam of light consisting of two wavelengths of 4200 Å and 5600 Å is used to obtain interference fringes in Young's double slit experiment. Distance between the slits is 0.8 mm and distance between slits and screen is 1.2 m. Compute the least distance of the point from the central maximum where the bright fringes due to both the wavelengths coincide. **(D)**
5. In Young's double slit experiment, distance between the slits is 0.5 mm. When the screen is kept at a distance of 100 cm from the slits, the distance of 9^{th} bright fringe from the central fringe is 8.1 mm. Find the wavelength of light used. **(A)**
6. In Young's double slit experiment, the slits are separated by 0.6 mm and the screen is placed at a distance of 1m from the slits. The distance between the first dark fringe and fourth bright fringe is found to be 0.6 cm. Calculate the wavelength of the light used. **(D)**
7. In Young's double slit experiment, distance between the slits is 1.0 mm. The screen is kept at a distance of 1.2 m from the slits. If the wavelength of light used is 600 nm, find the positions of 5^{th} bright fringe and 3^{rd} dark fringe. **(A)**
8. In Young's double slit experiment the slits are separated by 0.15 mm and the screen is placed at a distance of 1.0 m away from the slits. The distance between the central bright fringe and the fifth dark fringe is measured to be 1.35 cm. Calculate the wavelength of the light used. What will be the distance of 5^{th} dark fringe from the central bright fringe if the wavelength of light is increased by 20% of the initial value using the same setup? **(A)**

9. In Young's double slits experiment, the slits are separated by a distance of 0.5 mm and the screen is at a distance of 1.2 m from the slits. If the distance of 9^{th} bright fringe from the central maximum is 1.3 cm, calculate the wavelength of light used. Also calculate the distance of 5^{th} dark fringe from the central maximum. **(A)**

ANSWERS TO MULTIPLE CHOICE QUESTIONS

Q. No	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Ans	B	C	D	D	D	C	D	B	B	D	C	A	A	A	A	A

ANSWERS TO FILL IN THE BLANKS

1. spherical *2. frequency* *3. interference* *4. diffraction* *5. energy* *6. Half*

CHAPTER-11 : DUAL NATURE OF RADIATION AND MATTER

MULTIPLE CHOICE QUESTIONS

1. Cathode ray particles are same as **(E)**

(A) Protons (B) Electrons (C) α – particles (D) Neutrons

2. In discharge tube, the cathode ray particles travel with the speed of **(E)**

(A) 3×10^8 m s^{-1} (B) 6×10^7 m s^{-1} (C) 2×10^8 m s^{-1} (D) 2×10^6 m s^{-1}

3. The minimum energy required by the electron to escape from metal surface is called as **(E)**

(A) work function (B) ionisation energy (C) stopping potential (D) field emission

4. Alkali metals emit electrons when they are illuminated by **(E)**

(A) Infrared waves (B) visible light (C) radio waves (D) microwaves

5. Heavy metals like zinc and cadmium emit electrons when they are illuminated by **(E)**

(A) Infrared waves (B) Microwaves (C) Ultraviolet rays (D) visible light

6. The graph of photoelectric current versus intensity of incident radiation ($\upsilon > \upsilon_0$) is **(E)**

(A) A straight line with y-intercept (B) A straight line with x-intercept

(C) A straight line passing through origin (D) A non-linear curve

7. In photoelectric effect, the time lag between incidence of light and electron emission is of the order **(E)**

(A) 10^{-9} s (B) 10^{-5} s (C) 10^{-4} s (D) 10^9 s

8. The de Broglie wavelength of a moving particle is independent of _____ of the particle. **(E)**

(A) charge (B) mass (C) speed (D) momentum

9. Emission of electrons from a metal surface by suitably heating is called **(E)**

(A) Photoelectric emission (B) Thermionic emission

(C) Field emission (D) Secondary emission

10. In photoelectric effect experiment, if only the frequency of incident radiation is increased, then **(E)**

(A) The maximum kinetic energy of photoelectrons decreases. (B) The stopping potential increases

(C) The photoelectric current increases (D) The photoelectric current decreases

11. Which of the following experiment proved that "the charge is quantized" ? **(E)**

(A) Millikan's oil drop experiment (B) de Broglie experiment

(C) α-particle scattering experiment (D) Hertz experiment

12. The particle behavior of light was confirmed by following experiments. **(E)**

(i) A H Compton, on scattering of X-rays from electrons. (ii) A Einstein, for photoelectric effect.

(iii) Millikan, for charge of electrons. (iv) J.J Thomson's, on discharge tube experiment.

Choose the correct option

(A) (i), (ii) & (iii) (B) (i), (ii) & (iv) (C) (ii), (iii) & (iv) (D) all of the above

13. Photon energy is independent of **(E)**

(A) Intensity of radiation (B) frequency of radiation

(C) wavelength of radiation (D) wavenumber of light

14. In a photon-particle collision, which of the following is conserved (E)

(A) Only total energy is conserved

(B) Only total momentum is conserved

(C) Both total momentum and total energy are conserved

(D) Neither total momentum nor total energy is conserved

15. Macroscopic particles in our daily life do not show wave-like properties, because (E)

(A) They are not associated with waves (B) Their wavelength is extremely high

(C) Their wavelength is zero (D) Their wavelength is negligibly small

16. The gathering and focusing mechanism of light by the eye lens is described by (E)

(a) Wave nature of light (b) Particle nature of light

(A) only (a) (B) only (b) (C) Both (a) and (b) (D) neither (a) nor (b)

17. The absorption of light energy by retina of eye is described by (E)

(a) Wave nature of light (b) Particle nature of light

(A) only (a) (B) only (b) (C) Both (a) and (b) (D) neither (a) nor (b)

18. The slope of the graph plotted between kinetic energy (in joules) of photoelectrons and frequency (in Hz) of incident radiation in photoelectric effect is (E)

(A) h (B) e (C) h/e (D) e/h

19. The saturation current during photoelectric emission ($\upsilon > \upsilon_0$) depends on (E)

(A) frequency of incident radiation (B) intensity of incident radiation

(C) speed of incident radiation (D) wavelength of incident radiation

20. Einstein's photoelectric equation was experimentally verified by (E)

(A) Heinrich Hertz (B) Max Planck (C) J J Thomson (D) R A Millikan

HOTS QUESTIONS

21. The value of e/m was found to be (D)

(i) Dependent on nature of metal. (ii) Independent of the nature of metal

(iii) Dependent on the gas in discharge tube (iv) Independent on the gas in discharge tube.

Choose the correct option

(A) (i) and (iv) (B) (ii) and (iv) (C) (i) and (iii) (D) (ii) and (iii)

22. The following statements are related to photoelectric emission.

Statement–I: The photoelectric current is directly proportional to intensity of incident radiation.

Statement–II: The maximum kinetic energy of photoelectron increases with the increase of frequency of incident radiation. (D)

(A) Both the statements I and II are true.

(B) Both the statements I and II are false.

(C) Statement-I is false and statement-II is true.

(D) Statement-I is true and statement-II is false

23. The slope of straight line obtained by plotting stopping potential (V_0) versus frequency (υ) of incident light in Photoelectric effect experiment is **(D)**

(A) ϕ_0/h (B) h/e (C) ϕ_0/h (D) h/e^2

24. In a photoelectric experiment, the wavelength of incident radiation is reduced from 6000 Å to 5000 Å then **(D)**

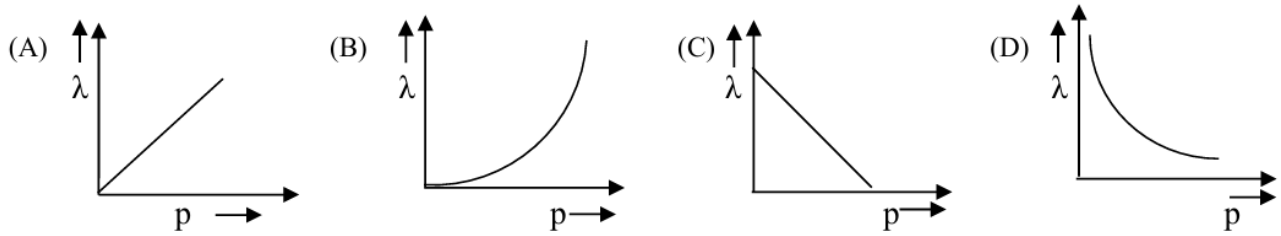
(A) the maximum kinetic energy of emitted electrons will decrease.

(B) the stopping potential will increase.

(C) the maximum speed of emitted electrons will decrease.

(D) the value of work function of the metal will increase.

25. Which of the following figures represents the variation of de-Broglie wavelength (λ) of a particle with its momentum (p) ? **(D)**



FILL IN THE BLANKS

(***kinetic energy, energy, de-Broglie, Heinrich Hertz, intensity, wave, particle, photon***)

1. The phenomenon of photoelectric emission was discovered by _____ **(E)**

2. Stopping potential is the measure of _____ of liberated electrons. **(E)**

3. Wavelength associated with material particles in motion is called as _____ wavelength. **(E)**

4. The Maxwell's equations of electromagnetism established the _____ nature of light. **(E)**

5. In interaction with matter, light behaves as if it is made up of packet of energy called _____. **(E)**

6. During photoelectric emission, the number of photoelectron emitted is directly proportional to _____of incident light. **(E)**

7. The photoelectric emission is based on the law of conservation of _____ **(E)**

TWO MARKS QUESTIONS

1. On what factors does the work function of the metal depend? **(E)**

2. Define electron volt. Express its value in SI unit. **(E)**

3. Write Einstein's equation of photoelectric effect and explain the terms. **(E)**

4. Explain the Hertz observations on photoelectric effect. **(A)**

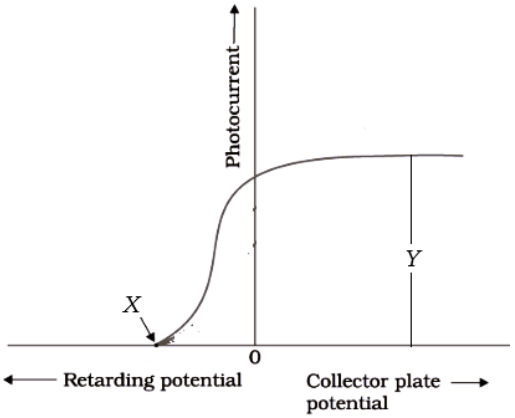
5. Show graphically, how the photocurrent varies with stopping potential for different frequencies but same intensity of incident radiation. **(A)**

6. Show the variation of stopping potential with frequency of the incident radiation graphically. **(E)**

7. An alpha particle, a proton and an electron are moving with equal kinetic energy. Which one of these particles has the longest de-Broglie wavelength? Give reason. **(D)**

8. Explain briefly de Broglie hypothesis on dual nature of matter. **(A)**

9. The variation of photoelectric current with collector plate potential for a frequency of incident light is as shown in the below diagram. From the diagram, name the physical quantities *X* and *Y*. **(A)**



THREE MARKS QUESTIONS

1. Mention the three types of electron emission. **(E)**

2. Explain briefly the Hallwach's experimental observations on photoelectric effect. **(A)**

3. Write any three experimental observations of photoelectric effect. **(A)**

4. Write any three properties of photon. **(E)**

5. Explain briefly Lenard's experimental observations on photoelectric effect. **(A)**

6. The work function of certain metal is 4.2 eV. Will this metal give photoelectric emission for the incident radiation of wavelength 330 nm? Justify. **(A)**

FIVE MARKS QUESTIONS

1. a) With a neat diagram, describe an experiment to study the photoelectric effect. (3) **(A)**

b) How does photoelectric current and stopping potential depends on intensity of incident radiation in photoelectric effect. (2) **(A)**

2. a) Mention the equation for de-Broglie's wavelength of matter waves of a moving particle and explain the terms. (2) **(E)**

b) Using Einstein's photoelectric equation, explain experimental results of photoelectric effect. (3) **(A)**

3. a) Who proposed the dual nature of matter? (1) **(E)**

b) What are matter waves? (1)

c) Define the following terms: (3)

(i) Photoelectric saturation current (ii) Threshold frequency (iii) Stopping potential.

NUMERICAL PROBLEMS

(In numerical problems take: Planck's constant $h = 6.63 \times 10^{-34}$ J s, mass of electron = 9.1×10^{-31} kg and electronic charge e = 1.6×10^{-19} C)

1. Find the maximum frequency of X-rays produced by 30 kV electrons. **(A)**

2. The photoelectric cut off voltage in a certain experiment is 1.5 V.
What is the maximum kinetic energy of photoelectrons emitted? Express it in joules. **(E)**

3. Calculate the stopping potential of electrons emitted from Cesium metal if the maximum kinetic energy is 0.346 eV. **(E)**

4. Calculate the de Broglie wavelength associated with an electron moving with a speed of 2×10^5 m s^{-1}.
Given h = 6.626×10^{-34} J s and mass of electron m = 9.1×10^{-31} kg **(A)**

5. In an experiment on photoelectric effect, the slope of the cut-off voltage versus frequency of incident light is found to be 4.12×10^{-15} Vs. Calculate the value of Planck's constant. **(A)**

6. Calculate the de Broglie wavelength of
(a) a bullet of mass 0.040 kg travelling at the speed of 1.0 km/s,
(b) a dust particle of mass 1.0×10^{-9} kg drifting with a speed of 2.2 m/s? **(A)**

7. A monochromatic source of light of power 36 mW emits photons of wavelength 589 nm.
Calculate (a) the energy of photon emitted by the source and
(b) the number of photons emitted by the source per second. **(A)**

8. The work function of Caesium metal is 2.14 eV. When light of frequency 6×10^{14} Hz is incident on the metal surface, photoemission of electrons occurs. Given Planck's constant $h = 6.626 \times 10^{-34}$ Js
Find (a) Energy of incident photon (b) Maximum kinetic energy of photoelectrons. **(A)**

9. The threshold frequency for a certain metal is 3.3×10^{14} Hz. If light of frequency 8.2×10^{14} Hz is incident on the metal, find the stopping potential for the photoelectric emission. **(A)**

10. The work function of Caesium is 2.14 eV. Find
(a) the threshold frequency for Caesium
(b) the wavelength of the incident light if the photocurrent is brought to zero by a stopping potential of 0.6V. **(A)**

11. Light of frequency 8.4×10^{14} Hz is incident on a metal surface. Electrons with their maximum speed of 7.5×10^5 m s^{-1} are ejected from the surface. Calculate the (i) stopping potential for electrons and
(ii) work function of the metal surface. $h = 6.626\times10^{-34}$ Js and mass of electron $m = 9.1\times10^{-31}$ kg. **(A)**

12. When a light of frequency 6.0×10^{14} Hz is incident on a metal surface, electrons with a maximum speed of 5.0×10^5 m/s are ejected from the surface. Calculate the threshold frequency for photoemission of electrons? Given: Planck's constant $h = 6.626\times10^{-34}$ Js and mass of electron $m = 9.1 \times 10^{-31}$ kg. **(A)**

13. When light of frequency 2.2×10^{15} Hz is incident on a surface, the stopping potential for the photoelectrons emitted is found to be 6.6 V. When light of frequency 4.6×10^{15} Hz is used, stopping potential is found to be 16.5 V. Calculate the Planck's constant.
Given: speed of light in vacuum is 3×10^8 m s^{-1} and electronic charge e = 1.6×10^{-19} C. **(D)**

14. When light of wavelength 400 nm is incident on a photosensitive surface, the stopping potential for the photoelectrons emitted is found to be 0.96 V. When light of wavelength 500 nm is incident on the same photosensitive surface, the stopping potential is found to be 0.34 V. Calculate the Planck's constant. Given: speed of light in vacuum is 3×10^{8} m s^{-1} and electronic charge e = 1.6×10^{-19} C. **(D)**

15. Light of frequency 6 x 10^{14} Hz falls on a metal surface of work function 2.0 eV. Find the maximum kinetic energy of photoelectrons emitted by the surface. Given: h = 6.63 x 10^{-34} Js **(A)**

16. The work function of cesium is 2.14 eV. Calculate the threshold frequency for cesium. **(A)**

17. Light of frequency 7.21×10^{14} Hz is incident on a metal surface. Electrons with maximum kinetic energy of 1.64×10^{-19} J are ejected from the surface. Calculate the threshold frequency for the emission of photoelectrons from the surface? Given: Planck's constant, $h = 6.625 \times 10^{-34}$ J s. **(A)**

18. Find the ratio of de – Broglie wavelengths corresponding to an electron and a proton moving with same speed. Given: mass of electron, $m_e = 9.1 \times 10^{-31}$ kg and mass of proton, $m_p = 1.67 \times 10^{-27}$ kg **(A)**

ANSWER KEY TO MULTIPLE CHOICE QUESTIONS

1	**B**	**6**	**C**	**11**	**A**	**16**	**A**	**21**	**B**
2	**B**	**7**	**A**	**12**	**A**	**17**	**B**	**22**	**A**
3	**A**	**8**	**A**	**13**	**A**	**18**	**A**	**23**	**B**
4	**B**	**9**	**B**	**14**	**C**	**19**	**B**	**24**	**B**
5	**C**	**10**	**B**	**15**	**D**	**20**	**D**	**25**	**D**

ANSWERS TO FILL IN THE BLANKS

1. Heinrich Hertz, **2.** kinetic energy **3.** de-Broglie **4.** wave **5.** photon **6.** intensity **7.** energy

CHAPTER - 12: ATOMS

MULTIPLE CHOICE QUESTIONS

1. The condensed matter and dense gases at all temperature emit electromagnetic radiation due to(E)

(A) high temperature (B) oscillations of atoms and molecules

(C) in-elastic collision between atoms and molecules (D) excitation of electrons

2. Statement I: The light emitted by mercury vapour lamp is due to individual atoms but not due to interactions between atoms or molecules.

Statement II: The average spacing between the mercury atoms in vapour is large (A)

(A) Both statements I and II are true and II is correct explanation of I

(B) Both statements I and II are true but II is not correct explanation of I

(C) Statement I is true but II is false

(D) Both statements I and II are false.

3. The source of alpha(α)-particle in Geiger-Marsden experiment is (E)

(A) radium-226 (B) bismuth-214 (C) radon-222 (D) cobalt-60

4. The thickness of gold foil in Geiger-Marsden alpha(α)-particle scattering experiment is (A)

(A) 2.1×10^{-7} mm (B) 1.2×10^{-4} mm (C) 2.1×10^{-4} mm (D) 2.1 cm

5. The detector in Geiger-Marsden alpha (α)-particle scattering experiment is coated with (E)

(A) silver nitrate screen (B) phosphorescent (C) barium sulphide (D) zinc sulphide

6. From kinetic theory, the size of an atom was known to be (E)

(A) 10^{-10} m (B) 10^{-14} m (C) 10^{-18} m (D) 10^{-22} m

7. The size of atom is about _____ times larger than the size of the nucleus (E)

(A) 10^2 to 10^3 (B) 10^3 to 10^4 (C) 10^4 to 10^5 (D) 10^5 to 10^6

8. The alpha(α)-particles are nuclei of (E)

(A) Hydrogen atom (B) Deuterium atom (C) Beryllium atom (D) Helium atom

9. Rutherford's alpha(α)-particle scattering experiment determines the size of (E)

(A) Nucleus (B) Electron (C) Proton (D) Neutron

10. The negative sign in electrostatic potential energy of an electron signifies that (E)

(A) Potential energy of an electron is unstable (B) Electrostatic force is in the $-\vec{r}$ direction.

(C) Kinetic energy of all electron is constant (D) Electrostatic force is repulsive

11. The emission line spectrum is the characteristics of (E)

(A) a molecule (B) a solid (C) an atom (D) a liquid

12. The emission line spectrum serves as (E)

(A) Paper print of gases (B) Photo print of gases

(C) Colour print of gases (D) Finger print of gases

13. Bohr's atomic model imitates **(E)**

(A) sun-earth system (B) earth-moon system (C) sun-planet system (D) sun-comet system

14. The principal quantum number for Bohr Radius is **(E)**

(A) n = 1 (B) n = 2 (C) n = 3 (D) n = 4

15. The minimum energy required to free the electron from the ground state of the hydrogen atom is called **(E)**

(A) first excitation energy (B) zero potential energy

(C) excitation energy (D) ionisation energy

16. According to Louis de-Broglie, waves associated with orbital electrons are **(E)**

(A) Progressive waves (B) Stationary waves (C) Longitudinal waves (D) Continuous waves

17. Bohr model is applicable to **(E)**

(A) Hydrogen atom (B) Helium atom (C) Lithium atom (D) all atoms

18. For an electron revolving around the nucleus, **(E)**

(A) kinetic energy and potential energy are positive, total energy is negative

(B) kinetic energy is positive, potential energy and total energy are negative

(C) potential energy is negative, kinetic energy and total energy are positive

(D) kinetic energy and potential energy are negative, total energy is positive.

19. According to Bohr's postulates, angular momentum of an electron in its orbit around a nucleus is equal to **(E)**

(A) equal to an integral multiple of $h/2\pi$ (B) equal to an integral multiple of $2\pi/h$

(C) equal to an integral multiple of $h^2\pi$ (D) equal to an integral multiple of $2h/\pi$

20. In Geiger and Marsden α-particle scattering experiment, when impact parameter is zero, then **(E)**

(A) angle of scattering is zero (B) angle of scattering is 180^o

(C) angle of scattering is equal to 90^o (D) alpha particle enters the gold nucleus.

HOTS QUESTIONS

21. Statement I: The atom is electrically neutral.

Statement II: An atom contains equal amount positive charge to neutralize negative charge of the electrons. **(A)**

(A) Both statements I and II are true and II is correct explanation of I

(B) Both statements I and II are true but II is not correct explanation of I

(C) Statement I is true but II is false

(D) Both statements I and II are false.

22. Statement I: Many of α-particles pass through the gold foil in α-particle scattering experiment

Statement II: Only about 0.14% of the incident α-particles scatter by more than 1^o. **(A)**

(A) Both statements I and II are true and II is correct explanation of I

(B) Both statements I and II are true but II is not correct explanation of I

(C) Statement I is true but II is false

(D) Both statements I and II are false.

23. Radius of first orbit of hydrogen atom is r. The radius of its fourth orbit will be **(A)**

(A) 2r (B) 4r (C) 16r (D) 64r

24. When an electron in hydrogen atom revolves in stationary orbit, it **(D)**

(A) does not radiate energy though its velocity changes.

(B) does not radiate energy and velocity remains unchanged.

(C) radiates energy but its velocity is unchanged.

(D) radiates energy with the change of velocity.

25. When a hydrogen atom is raised from the ground state to an excited state **(D)**

(A) potential energy increases and kinetic energy decreases.

(B) potential energy decreases and kinetic energy increases.

(C) Both kinetic energy and potential energy increases

(D) Both kinetic energy and potential energy decreases

26. According to classical theory of atom, **(D)**

Statement I: The electron will fall into the nucleus.

Statement II: An accelerated electron emits radiation in its orbit.

(A) Both I and II are true and II is correct explanation of I

(B) Both I and II are true but II is not correct explanation of I

(C) I is true but II is false (D) Both I and II are false.

27. In alpha particle scattering experiment conducted by Geiger and Marsden, in case of head-on collision, the impact parameter (b) and angle of scattering (θ) are respectively **(A)**

(A) b = 0 and θ = π (B) b = 0 and θ = π/2 (C) b = 0 and θ = 0 (D) b = large and θ = π

28. de Broglie hypothesis provides an explanation for **(E)**

(A) J. J. Thomson's atomic model (B) Rutherford's nuclear model of atom

(C) Geiger-Marsden experiment (D) Bohr's postulate of quantization of angular momentum

FILL IN THE BLANKS

(nucleus, –13.6 eV, fixed, +13.6 eV, different, dark, ground state, bright)

1. Hydrogen atom always gives a spectrum with _____ relative position between the lines. **(E)**

2. The entire mass of an atom is concentrated in a small volume called _____. **(E)**

3. Energy of the electron in the first orbit of hydrogen atom is _____. **(E)**

4. Electron revolve around the nucleus with _____ energy in different states **(E)**

5. Ionization energy of the hydrogen atom is _____. **(E)**

6. Line emission spectrum consist of bright line on a _____background. **(E)**

7. Line absorption spectrum consist of dark line on a _____ background. **(E)**

TWO MARKS QUESTIONS

1. Write the two limitations of Bohr's atom model. **(E)**

2. Briefly describe Rutherford's nuclear model of the atom. **(E)**

3. What is ionization energy of an electron? Give its value for ground state of hydrogen atom. **(E)**

4. What does the negative sign in total energy of the electron signifies? What happens if total energy is positive? **(D)**

5. Write the expression for radius of n^{th} orbit of electron in hydrogen atom. Explain the terms. **(A)**

7. Mention the expression for energy of the n^{th} stationary orbit of hydrogen atom. Explain its terms. **(A)**

8. Draw the trajectories traced by different alpha particles in Geiger–Marsden experiment. **(A)**

9. Calculate the energy required to excite an electron from ground state to second excited state. **(A)**

10. The ground state energy of hydrogen atom is –13.6 eV. What are the kinetic and potential energies of the electron in this state? **(A)**

11. Explain J J Thomson's plum pudding model on atomic structure. **(A)**

12. Draw energy level diagram of hydrogen atom. **(A)**

13. How are total energy of an electron revolving in an orbit of hydrogen atom and radius of the orbit related to the principal quantum number of that orbit? **(A)**

THREE MARKS QUESTIONS

1. Write the three postulates of Bohr's atom model. **(A)**

2. Give de-Broglie's explanation of Bohr's second postulate of quantization of angular momentum. **(A)**

3. Draw the neat labelled diagram representing the schematic arrangement of Geiger-Marsden experimental setup for the alpha particle scattering. **(A)**

4. Define impact parameter. What are the angle of scattering for (a) minimum impact parameter and (b) larger impact parameter. **(A)**

5. Draw a labelled diagram representing the schematic arrangement of Geiger-Marsden alpha particle scattering experiment. Write an observation of the experiment. **(A)**

NUMERICAL PROBLEMS

1. In a Geiger-Marsden experiment, what is the distance of closest approach to the nucleus if a 7.7 MeV alpha-particle before it comes momentarily to rest and reverses its direction? **(D)**

2. The radius of the innermost electron orbit of a hydrogen atom is 5.3×10^{-11} m. Determine the radii of the n = 2 and n =3 orbits. **(D)**

3. A hydrogen atom initially in the ground level absorbs a photon, which excites it to the n = 4 level. Determine the wavelength and frequency of photon. Ground state energy of electron = – 13.6 eV **(D)**

4. The electron in a given Bohr orbit has a total energy of –1.5 eV. Calculate its (a) kinetic energy (b) potential energy (c) wavelength of emitted light, when the electron makes a transition to the ground state. Given: Ground state energy of electron = – 13.6 eV **(D)**

ANSWER KEY TO MULTIPLE CHOICE QUESTIONS

1	**B**	**6**	**A**	**11**	**C**	**16**	**B**	**21**	**A**	**26**	**A**
2	**A**	**7**	**C**	**12**	**D**	**17**	**A**	**22**	**A**	**27**	**A**
3	**B**	**8**	**D**	**13**	**C**	**18**	**B**	**23**	**C**	**28**	**D**
4	**C**	**9**	**A**	**14**	**A**	**19**	**A**	**24**	**A**		
5	**D**	**10**	**B**	**15**	**D**	**20**	**B**	**25**	**A**		

ANSWERS TO FILL IN THE BLANKS

1. fixed **2.** nucleus **3.** –13.6eV **4.** different **5.** +13.6eV **6.** dark **7.** Bright

CHAPTER – 13 : NUCLEI

MULTIPLE CHOICE QUESTIONS

1. Nucleus of an atom whose atomic mass is 24 consists of (E)

(A) 11 electrons, 11 protons and 13 neutrons (B) 11 electrons, 13 protons and 11 neutrons

(C) 11 protons and 13 neutrons (D) 11 protons and 13 electrons

2. Isotopes are the nuclei having (E)

(A) Same number of protons but different number of neutrons

(B) Same number of neutrons but different number of protons

(C) Same number of protons and neutrons.

(D) different number of protons and different number of neutrons.

3. The radius of a nucleus of mass number A is directly proportional to (E)

(A) A^3 (B) A (C) $A^{2/3}$ (D) $A^{1/3}$

4. Nuclear forces are (A)

(A) Short ranged, attractive and charge independent

(B) Short ranged, attractive and charge dependent

(C) Long ranged, repulsive and charge independent

(D) Long ranged, repulsive and charge dependent

5. Density of any nucleus is (E)

(A) 2.29×10^{10} kg m^{-3} (B) 2.29×10^{17} kg m^{-3} (C) 2.29×10^{12} kg m^{-3} (D) 2.29×10^{13} kg m^{-3}

6. Binding energy of a nucleus is (E)

(A) energy given to its nucleus during its formation.

(B) total mass of nucleus converted to energy units.

(C) energy required to break the nucleus into constituent nucleons.

(D) total kinetic energy and potential energy of the nucleons in the nucleus.

7. The binding energy per nucleon is maximum in the case of (E)

(A) ${}_{2}^{4}He$ (B) ${}_{26}^{56}Fe$ (C) ${}_{56}^{141}Ba$ (D) ${}_{92}^{235}U$

8. For effective nuclear forces, the distance should be (E)

(A) 10^{-10} m (B) 10^{-13} m (C) 10^{-15} m (D) 10^{-10} m

9. Two nucleons are separated by a distance of 1×10^{-15} m. The nuclear force between them is F_1 if both are neutrons, F_2 if both are protons, F_3 if one is a proton and other is a neutron. Then (D)

(A) $F_2 > F_1 > F_3$ (B) $F_2 < F_1 = F_3$ (C) $F_1 = F_2 = F_3$ (D) $F_2 < F_1 < F_3$

10. Radioactivity is (E)

(A) Reversible process (B) Controlled process

(C) Spontaneous process (D) Cyclic process

11. Which is not found during radioactive decay? **(E)**

(A) emission of alpha particles (B) emission of β-particles

(C) emission of X-rays (D) emission of γ-rays

12. Fusion reaction takes place at high temperature because **(A)**

(A) Atoms are ionised at high temperature (B) Molecules break-up at high temperature

(C) Nuclei break-up at high temperature

(D) Kinetic energy is high enough to overcome repulsion between nuclei.

13. The explosion of the atomic bomb takes place due to **(E)**

(A) Uncontrolled nuclear fission (B) Nuclear fusion

(C) Scattering (D) Thermionic emission

14. Energy generation in stars is mainly due to **(E)**

(A) Photoelectric emission (B) Fission of heavy nucleus

(C) Fusion of lighter nuclei (D) Fusion of heavy nuclei

15. Fusion reaction is initiated with the help of **(E)**

(A) Low temperature (B) High temperature (C) Neutrons (D) protons

HOTS QUESTIONS:

16. In $^{226}_{88}Ra$ nucleus, there are **(A)**

(A) 138 protons and 88 neutrons (B) 138 neutrons and 88 protons

(C) 226 protons and 88 electrons (D) 226 neutrons and 138 electrons

17. The mass and energy equivalent to 1u respectively **(A)**

(A) 1.66×10^{-27} g, 9.315 MeV (B) 1.66×10^{-31} g, 1 MeV

(C) 1.66×10^{-27} g, 1 MeV (D) 1.66×10^{-27} kg, 931.5 MeV

18. M_n and M_p represent mass of neutron and proton respectively. If an element having nuclear mass M has N-neutrons and Z-protons, then the correct relation will be **(D)**

(A) $M < [NM_n + ZM_P]$ (B) $M > [NM_n + ZM_P]$ (C) $M = [NM_n + ZM_P]$ (D) $M = N[M_n + M_P]$

19. Two nucleons are separated by a distance of 1×10^{-15} m. The net force between them is F_1 if both are neutrons, F_2 if both are protons, F_3 if one is a proton and other is a neutron. Then **(D)**

(A) $F_2 > F_1 > F_3$ (B) $F_2 < F_1 = F_3$ (C) $F_1 = F_2 = F_3$ (D) $F_2 < F_1 < F_3$

20. Which of the following is a fusion reaction? **(D)**

(A) $_1H^2 +_1 H^2 \rightarrow_2 He^4$ (B) $_0n^1 +_7 N^{14} \rightarrow_6 C^{14} +_1 H^1$

(C) $_0n^1 +_{92} U^{238} \rightarrow_{93} Np^{239} + \beta^{-1} + \gamma$ (D) $_1H^3 \rightarrow_2 He^3 + \beta^{-1} + \gamma$

21. Match the following columns: **(D)**

(A) a - ii, b - iii, c - i

(B) a - iii, b - ii, c - i

(C) a - ii, b- i, c - iii

(D) a - iii, b -i, c - ii

Column-I		Column-II	
(a)	Isotopes	(i)	Nuclei having same number of neutrons
(b)	Isobars	(ii)	Nuclei having same number of protons
(c)	Isotones	(iii)	Nuclei having same number of nucleons

22. Among the following, which set of nuclei are isotopes? (A)

(A) ${}^{14}_{6}\text{C}$ and ${}^{14}_{7}\text{N}$ (B) ${}^{3}_{2}\text{He}$ and ${}^{3}_{1}\text{H}$ (C) ${}^{235}_{92}\text{U}$ and ${}^{238}_{92}\text{U}$ (D) ${}^{28}_{14}\text{Si}$ and ${}^{73}_{32}\text{Ge}$

23. Among the following, which set of nuclei are isotones? (A)

(A) ${}^{14}_{6}\text{C}$ and ${}^{16}_{8}\text{O}$ (B) ${}^{3}_{2}\text{He}$ and ${}^{3}_{1}\text{H}$ (C) ${}^{235}_{92}\text{U}$ and ${}^{238}_{92}\text{U}$ (D) ${}^{28}_{14}\text{Si}$ and ${}^{73}_{32}\text{Ge}$

FILL IN THE BLANKS

(nuclear fission, independent, 26.7 MeV, atomic mass unit, mass spectrometer, nuclear fusion)

1. _____ is $\left(\frac{1}{12}\right)^{th}$ of mass of the carbon-12 atom in stable state. **(E)**

2. The instrument used to measure the atomic masses is _____. **(E)**

3. The nuclear density is _____ of its mass number. **(E)**

4. The source of energy in nuclear reactors, which produce electricity is _____. **(E)**

5. Four hydrogen atoms combine to form ${}^{4}_{2}He$ atom with a release of _____ of energy. **(E)**

6. The source of energy generation in stars is _____. **(E)**

TWO MARKS QUESTIONS

1. What are isotopes? Give an example. **(E)**

2. What are isobars? Give an example. **(E)**

3. What are isotones? Give an example. **(E)**

4. What are the orders of nuclear radius and nuclear density? **(E)**

5. Write the expression for mass defect. Explain the terms. **(A)**

6. What is nuclear binding energy? What is its origin? **(E)**

7. What is mass defect of nucleus? Give the relation between binding energy and mass defect. **(E)**

8. What is a controlled thermonuclear fusion? Explain. **(A)**

THREE MARKS QUESTIONS

1. Write the names and formula of isotopes of hydrogen. **(E)**

2. Show that 1 atomic mass unit (u) = 1.66×10^{-27} kg **(A)**

3. Explain Einstein's mass-energy relation. **(A)**

4. Define the term '*mass defect*' and '*binding energy*' with respect to nucleus of an atom. Write their relationship. **(E)**

5. Draw the binding energy per nucleon v/s mass number curve. Mention it's any two salient features. **(A)**

6. Give three features of nuclear binding force. **(E)**

7. Write the three types of radioactive decay. **(E)**

8. Draw a graph showing the variation of potential energy as a function of their distance of separation. What is the significance of negative potential energy in this graph? **(A)**

9. What is nuclear fission? Explain with an example (equation). **(E)**

10. What is nuclear fusion? Explain with an example (equation). **(E)**

11. Explain the features of binding energy curve. Give two conclusions drawn from the curve. (A)

12. Distinguish between nuclear fission and nuclear fusion. **(A)**

NUMERICAL PROBLEMS

1. Calculate the energy equivalent of 1 g of substance. **(E)**
2. Two nuclei have mass numbers in the ratio 8 : 125. What is the ratio of their nuclear radii? **(A)**
3. What is the radius of a nucleus of mass number 27? Given R_0=1.2 f m. **(A)**
4. Determine the nuclear radius of $^{64}_{29}Cu$. Given:R_o = 1.2 *f*m. **(A)**
5. Obtain the ratio of the nuclear radii of the gold isotope $_{79}Au^{197}$ and the silver isotope $_{47}Ag^{107}$ **(A)**
6. Calculate the mass defect of oxygen nucleus ($^{16}_{8}O$) using the following data in MeV: **(A)**
   Mass of proton = 1.007825 u; Mass of neutron =1.008665 u; Mass of oxygen nucleus = 15.995 u
7. Mass defect of chlorine ($^{35}_{17}Cl$) nucleus is 0.31092 u.
   Calculate binding energy and binding energy per nucleon of chlorine nucleus. **(A)**
8. Calculate the binding energy and binding energy per nucleon of the nucleus $^{209}_{83}Bi$, given that nuclear mass of Bi is 208.980388u, mass of proton = 1.007825 u, mass of neutron = 1.008665 u. **(A)**
9. Calculate energy released in joule when 2 gram of U^{235} undergoes fission completely as per the following equation. $^{235}_{92}U + ^{1}_{0}n \rightarrow ^{141}_{56}Ba + ^{92}_{36}Kr + 3^{1}_{0}n$ + energy. **(D)**
   Given: rest mass of U^{235} = 235.044 u; rest mass of Ba^{141} = 140.920 u;
   rest mass of Kr^{92} = 91.885 u; rest mass of $^{1}_{0}n$ = 1.009 u.
10. Determine the (i) Charge, (ii) Size and (iii) Density of $_{26}Fe^{56}$ nucleus. **(A)**
    Given 1u = 1.66 $\times 10^{-27}$ kg, R_0 = 1.2 fermi and Mass of $_{26}Fe^{56}$ = 55.85 u
11. How long can an electric lamp of 100 W be kept glowing by fusion of 2.0 kg deuterium? **(D)**
    The fusion reaction can be taken as $^{2}_{1}H + ^{2}_{1}H \rightarrow ^{3}_{2}He + ^{1}_{0}n$ + 3.27 MeV

KEY ANSWER FOR MULTIPLE CHOICE QUESTIONS

1	**C**	**6**	**C**	**11**	**C**	**16**	**B**	**21**	**A**
2	**A**	**7**	**B**	**12**	**D**	**17**	**D**	**22**	**C**
3	**D**	**8**	**C**	**13**	**A**	**18**	**A**	**23**	**A**
4	**A**	**9**	**C**	**14**	**C**	**19**	**C**		
5	**B**	**10**	**C**	**15**	**B**	**20**	**A**		

ANSWERS TO FILL IN THE BLANKS

1) Atomic mass unit **2)** mass spectrometer **3)** independent

4) nuclear fission **5)** 26.7 MeV **6)** nuclear fusion

CHAPTER-14: SEMICONDUCTOR DEVICES AND ELECTRONICS

MULTIPLE CHOICE QUESTIONS

1. Which of the following pairs are elemental semiconductors? (E)

(A) silicon and aluminium (B) silicon and germanium

(C) germanium and cadmium (D) aluminium and cadmium

2. The energy band that determines the electrical conductivity of the material is (E)

(i) conduction band (ii) energy gap (iii) valence band

(A) only (i) (B) both (i) and (ii) (C) both (ii) and (iii) (D) all (i), (ii) and (iii)

3. In an intrinsic semiconductor, number of free electrons is (E)

(A) more than number of holes (B) less than the number of holes

(C) equal to number of holes (D) more than number of atoms.

4. The electrical conductivity of germanium can be increased by (E)

(i) increasing the temperature (ii) doping with acceptor impurities (iii) doping with donor impurities

(A) only (i) (B) only (i) and (ii)

(C) only (ii) and (iii) (D) all (i), (ii) and (iii)

5. When the electrical conductivity of a semiconductor is only due to the breaking of its covalent bonds, then the semiconductor is said to be (E)

(A) p-type (B) n-type (C) intrinsic (D) extrinsic

6. The valence of an impurity added to germanium crystal in order to convert it into a *p*-type semiconductor is (E)

(A) 6 (B) 5 (C) 4 (D) 3

7. The majority charge carriers in p-type semiconductor are (E)

(A) Electrons (B) Protons (C) Holes (D) Neutrons

8. A semiconductor dopped with a donor impurity is (E)

(A) *p*-type (B) *n*-type (C) *npn* type (D) *pnp* type

9. A *p*-type semiconductor can be obtained by doping (A)

(A) Arsenic to pure silicon (B) Gallium to pure silicon

(C) Antimony to pure germanium (D) Phosphorous to pure germanium

10. The thickness of depletion layer in a p-n junction is approximately (E)

(A) 0.1 μm (B) 1 mm (C) 1 cm (D) 1m

11. The diffusion current in a p-n junction is greater than the drift current in magnitude (D)

(A) if the junction is forward-biased (B) if the junction is reverse-biased

(C) if the junction is unbiased (D) both (A) and (B)

12. When a *p-n* junction diode is reverse biased and biasing voltage is increased (D)

(A) Electrons and holes are attracted towards each other and move towards the depletion region

(B) Electrons and holes move away from the junction or depletion region.

(C) effective potential barrier decreases. (D) No current flow takes place

13. The cut-in voltage for silicon diode is approximately **(E)**

(A) 0.2 V (B) 0.7 V (C) 1.1 V (D) 1.4 V

14. The *p-n* junction diode is used as **(E)**

(A) An amplifier (B) A rectifier (C) An oscillator (D) A modulator

15. The output of the full-wave rectifier is **(E)**

(A) Pure AC (B) pure DC (C) pulsating DC (D) pulsating AC

16. The List - I and List - Il respectively represent materials and energy band gap E_g **(E)**

Identify the correct match.

(A) (i) - (q); (ii) - (r); (iii) - (p)

(B) (i) - (r); (ii) - (p); (iii) - (q)

(C) (i) - (p); (ii) - (r); (iii) - (q)

(D) (i) - (r); (ii) - (q); (iii) - (p)

List - I	List - Il
(i) Conductors	(p) $E_g > 3eV$
(ii) Insulators	(q) $E_g < 3eV$
(iii) Semiconductors	(r) $E_g = 0$

17. The purpose of doping in semiconductors is to **(E)**

(A) Increase the conductivity (B) Increase the strength of material

(C) Increase the resistivity (D) Make resistivity independent of temperature

18. The element that can be used as acceptor impurity to dope silicon is **(E)**

(A) antimony (B) arsenic (C) boron (D) phosphorous

19. The element that can be used as donor impurity to dope germanium is **(E)**

(A) aluminium (B) indium (C) boron (D) phosphorous

20. In an n-type silicon, which of the following statement is true? **(E)**

(A) Electrons are majority carriers and trivalent atoms are the dopants.

(B) Electrons are minority carriers and pentavalent atoms are the dopants.

(C) Holes are minority carriers and pentavalent atoms are the dopants.

(D) Holes are majority carriers and trivalent atoms are the dopants.

HOTS QUESTIONS

21. The forbidden energy band gap in conductors, semiconductors and insulators are Eg_1, Eg_2 and Eg_3 respectively. The correct relation among them is **(A)**

(A) $Eg_1 = Eg_2 = Eg_3$ (B) $Eg_1 < Eg_2 < Eg_3$ (C) $Eg_1 > Eg_2 > Eg_3$ (D) $Eg_1 < Eg_2 > Eg_3$

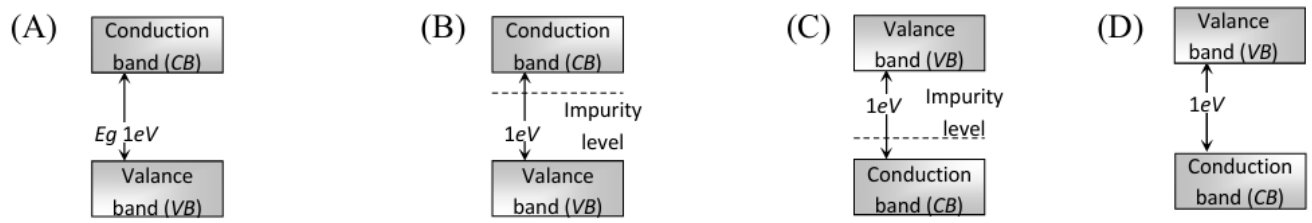
22. The energy band gaps in germanium and silicon respectively are **(A)**

(A) 0.72 eV, 1.1 eV (B) 1.1 eV, 0.7 eV (C) 1.1 eV, 0.3 eV (D) 0.3 eV, 1.1 eV

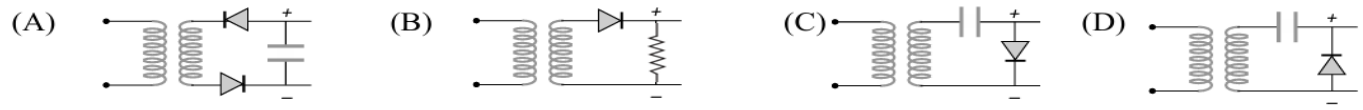
23. In a semiconductor, the concentration of electrons is 8×10^{14} cm^{-3} and concentration of the holes is 5×10^{8} cm^{-3}. The semiconductor is **(A)**

(A) p-type (B) *n*-type (C) Intrinsic (D) *pnp*-type

24. Which of the following energy band diagram shows the *N*-type semiconductor? (A)



25. Which is the correct diagram of a half-wave rectifier? (A)



FILL IN THE BLANKS

(*depletion region, electrons, saturation current, one, valence band, holes*)

1. _____is the lower band which is completely occupied by the 4N valence electron at temperature of absolute zero. **(E)**
2. The ratio of number of holes to number of electrons in an intrinsic semiconductor is _____. **(E)**
3. In n-type semiconductor, the number of _____ is more than the number of holes. **(E)**
4. The space charge region on either side of the junction where no mobile charge carriers are present is called as _____. **(E)**
5. In a reverse biased p-n junction, the current through the circuit is called reverse _____. **(E)**

TWO MARKS QUESTIONS

1. Explain the formation of energy bands in solid. **(A)**

2. What is a semiconductor? Give an example. **(E)**

3. What is an intrinsic semiconductor? Give an example. **(E)**

4. Draw the energy band diagrams of intrinsic semiconductor at temperatures T=0 K and T > 0K. **(A)**

5. What is meant by doping? What are dopants? **(E)**

6. Name two types of extrinsic semiconductors. **(E)**

7. Explain how a hole in a semiconductor is formed? **(E)**

8. Why majority charge carriers increase on doping a pure semiconductor? **(E)**

9. Explain how a p-type semiconductor is obtained from an intrinsic semiconductor. **(E)**

10. Explain how a n-type semiconductor is obtained from an intrinsic semiconductor. **(E)**

12. Name the majority and minority charge carriers in p-type semiconductors. **(E)**

13. Draw the energy band diagram of p-type semiconductor. **(A)**

14. Draw the energy band diagram of n-type semiconductor. **(A)**

15. Mention two important processes that occur during the formation of p-n junction. **(A)**

16. Give the circuit symbol of a p-n junction diode. Mention the significance of arrow in it. **(A)**

17. What happens to the width of depletion layer of a p-n junction diode when it is
(i) forward biased and (ii) reverse biased? **(E)**

16. What is (a) a rectifier (b) rectification? **(E)**

17. Mention any two differences between half wave and full wave rectifiers. **(A)**

18. Number of holes will always be greater than the number of free electrons in a *p*-type semiconductor. Explain. **(A)**

19. Number of free electrons will always be greater than the number of holes in a *n*-type semiconductor. Explain. **(A)**

THREE MARKS QUESTIONS

1. What is the range of the resistivity in (i) conductor (ii) semiconductor (iii) insulator. **(E)**

2. Define (i) valence band (ii) conduction band and (iii) energy gap. **(E)**

3. Classify conductors, semiconductors and insulators on the basis of energy gap. **(A)**

4. What is the range of the energy gap in a (i) conductor (ii) semiconductor and (iii) insulator. **(E)**

5. Mention the differences between intrinsic semiconductor and extrinsic semiconductor. **(A)**

6. What is an extrinsic semiconductor? Write a brief note on *p*-type semiconductor using its covalent bond structure or energy band structure.

7. Write the differences between n-type semiconductor and p-type type semiconductor. **(A)**

8. Explain the working of p-n junction diode when it is in forward bias. **(A)**

9. Explain the working of p-n junction diode when it is in reverse bias. **(A)**

10. How is forward biasing different from reverse biasing in a p-n junction diode? **(A)**

11. Define the terms (i) cut-in voltage (ii) breakdown voltage and (iii) reverse saturation current. **(A)**

12.

FIVE MARKS QUESTIONS

1. Draw the I-V characteristics of p-n junction diode and hence discuss the resistance of the junction in both forward bias and reverse bias conditions. **(A)**

2. Describe with suitable block diagram, action of pn – junction diode under forward bias condition. Also draw its I-V characteristics. **(A)**

3. Describe with suitable block diagram, action of pn – junction diode under reverse bias condition. Also draw its I-V characteristics. **(A)**

4. What is a half wave rectifier? Describe with a circuit diagram, the working of a semiconductor diode as a half wave rectifier. Draw input and output waveforms. **(A)**

5. What is a full wave rectifier? Describe with a circuit diagram, the working of a semiconductor diode as a full wave rectifier. Draw input and output waveforms. **(A)**

KEY ANSWER FOR MULTIPLE CHOICE QUESTIONS

1	**B**	**6**	**D**	**11**	**A**	**16**	**B**	**21**	**B**
2	**A**	**7**	**C**	**12**	**B**	**17**	**A**	**22**	**A**
3	**C**	**8**	**B**	**13**	**B**	**18**	**C**	**23**	**B**
4	**D**	**9**	**B**	**14**	**B**	**19**	**D**	**24**	**B**
5	**C**	**10**	**A**	**15**	**C**	**20**	**C**	**25**	**B**

ANSWERS TO FILL IN THE BLANKS

1. valence band 2. one 3. electrons 4. depletion region 5. saturation current

II PUC ANNUAL EXAMINATION – 1, MARCH 2025

SUBJECT: 33 - PHYSICS **MAX. MARKS: 70**

Time: 3 hours **Max Marks: 70** **No. of questions : 45**

GENERAL INSTRUCTIONS:

i) All Parts from A to D are compulsory. Part-E is only for visually challenged students.

ii) For Part-A questions, first written answers will be considered for awarding marks.

iii) Answers without relevant diagram / figure / circuit wherever necessary will not carry any marks.

iv) Direct answers to numerical problems without relevant formula and detailed solutions will not carry any marks.

PART – A

I. Pick the correct option among the four given options for ALL of the following questions: 15 × 1 = 15

1 **A point charge q_1 exerts a force F on another point charge q_2 when placed at a fixed distance. If another point charge q_3 is brought near q_2, the force on q_2 due to q_1:**

(a) increases (b) decreases

(c) may increase or increase (d) does not change

2 **Equipotential surfaces for an isolated point charge are _____ in shape.**

(a) spherical (b) planar (c) cylindrical (d) conical

3 **Resistivity of a metal wire depends on its:**

(a) area of cross-section (b) length

(c) material (d) volume

4 **The following table lists magnetic fields due to different current configurations. Column I lists the current configurations and column II lists expressions for magnetic fields. Symbols have usual meanings.**

Column – I	Column – II
(i) At a distance r from an infinitely long straight wire.	(p) $B = \mu_o nI$
(ii) At the centre of a circular current loop of radius r.	(q) $B = \frac{\mu_o I}{2r}$
(iii) At the centre of a current carrying solenoid.	(r) $B = \frac{\mu_o I}{2\pi r}$

Match the current configurations in Column - I with the correct magnetic - field expressions in Column - II.

(a) (i) – (p), (ii) – (q), (iii) – (r) (b) (i) – (r), (ii) – (q), (iii) – (p)

(c) (i) – (r), (ii) – (p), (iii) – (q) (d) (i) – (q), (ii) – (r), (iii) – (p)

5 **'The net magnetic flux through any closed surface is zero'. This law is called**

(a) Gauss' law in electrostatics (b) Gauss' law in magnetism

(c) Ampere's circuital law (d) Faraday's law of electromagnetic induction

6 Consider the following statements:

Statement 1: AC generator worked on the principle of electromagnetic induction.

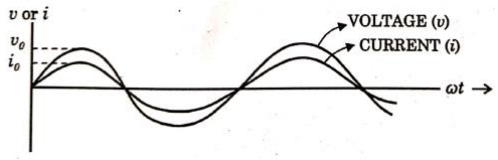
Statement 2: In an AC generator, as the armature is rotated in a uniform magnetic field, the magnetic flux linked with the coil changes which induces an emf in the coil. Among the above two statements:

(a) Both statements are true (b) Both statements are false.

(c) Statement 1 is true and statement 2 is false

(d) Statement 2 is false and statement 2 is true

7 The variation of voltage and current through an a.c. circuit with time is as shown in the figure.



Along with the a.c. source, the circuit:

(a) has a series combination of resistance and capacitance

(b) has only inductance (c) has only capacitance

(d) may have only resistance or may have a suitable series combination of inductance (L), capacitance (C) and resistance (R)

8 Transformer cores are usually laminated. This is to reduce energy loss due to:

(a) flux leakage (b) winding resistance

(c) eddy currents (d) hysteresis

9 'Ampere-Maxwell Law' is written as (symbols have usual meanings):

(a) $\oint \vec{B} \cdot d\vec{l} = \mu_o I + \mu_o \varepsilon_o \frac{d\phi_E}{dt}$ (b) $\oint \vec{B} \cdot d\vec{l} = \mu_o I + \varepsilon_o \frac{d\phi_E}{dt}$

(c) $\oint \vec{B} \cdot d\vec{l} = \mu_o I$ (d) $\oint \vec{E} \cdot d\vec{l} = -\frac{d\phi_B}{dt}$

10 Final image of a real object formed by a compound microscope is _____ with respect to the object.

(a) real, inverted and magnified (b) virtual, erect and magnified

(c) virtual, erect and diminished (d) virtual, inverted and magnified

11 Which one of the following statements is WRONG about interference of light?

(a) Light waves of same wavelength coming from two independent sources can be coherent and can produce interference.

(b) When the path difference between two interfering waves in $n\lambda$, bright fringe is produced (here n = 0, 1, 2, … and λ is the wavelength of light)

(c) When the phase difference between two interfering waves is $(2n + 1)\pi$, dark fringe is produced (here n = 0, 1, 2, …)

(d) In Young's double slit experiment, dark and bright fringes are equally spaced.

12 **A ball is dropped from a certain height and it falls freely under gravity. During the fall, the de Broglie wavelength associated with it:**

(a) keeps increasing (b) keeps decreasing

(c) is zero (d) may increase or decrease

13 **In Rutherford's α–ray scattering experiment, α–particles of specific energy are projected towards a thin gold foil. If the impact parameter for the a-particles is zero, the angle of scattering is:**

(a) $\theta = 0°$ (b) $\theta = 90°$

(c) $\theta = 180°$ (d) $\theta = 45°$

14 **Binding energy per nucleon of a nucleus is a measure of its:**

(a) radius (b) mass

(c) volume (d) stability

15 **The energy gap for silicon is:**

(a) 0.72 eV (b) 1.1 eV

(c) 3 eV (d) 5 eV

II. Fill in the blanks by choosing appropriate answer given in the bracket for ALL of the following questions: **5 × 1 = 5**

(*diamagnetic*, *ferromagnetic*, *instantaneous*, *transverse*, *force*, *torque*)

16 An electric dipole placed in a uniform electric field experiences a net _____.

17 Water is an example for _____ material.

18 When a _____ rod is inserted into a coil, its self- inductance increases

19 Polarization of light shows that light is a _____ wave.

20 Photoelectric effect is a/ an _____ effect

PART – B

III. Answer any FIVE of the following questions: **5 × 2 = 10**

21 Define electric potential energy of a system of charges. What happens to the potential energy of a system of two unlike charges when the distance between them is increased (assume there is no external electric field)?

22 List any two limitations of Ohm's law.

23 Write the expression for Lorentz force and explain the terms.

24 State Lenz's law. What is its significance?

25 Give any two uses of microwaves.

26 How are focal length (f) and radius of curvature (R) of a spherical mirror related? What is the sign of focal length of a convex mirror?

27 Mention the conditions for total internal reflection.

28 An intrinsic semiconductor crystal doped with pentavalent atoms has an electron concentration of $5 \times 10^{22}\ m^{-3}$. If, at thermal equilibrium, the intrinsic concentration $n_i = 1.5 \times 10^{16}\ m^{-3}$, find the hole concentration.

PART – C

IV. Answer any FIVE of the following questions: **5 × 3 = 15**

29 Mention three properties of electric field lines.

30 Derive the expression for the equivalent capacitance of two capacitors connected in parallel.

31 Explain with a circuit diagram, how a galvanometer can be converted into voltmeter.

32 Define the terms: a) Magnetization b) Magnetic permeability and c) Magnetic susceptibility.

33 Derive the expression for motional emf induced in a rod moving in a uniform magnetic field.

34 When a light radiation of energy 3 eV falls on a metal surface, photoelectrons with a maximum kinetic energy 1 eV are emitted from the surface. Find the threshold frequency for the metal surface. (Given: Planck's constant, $h = 6.63 \times 10^{-34}$ J s; Charge on electron $e = 1.6 \times 10^{-19}$ C).

35 State the postulates of Bohr's hydrogen atom model.

36 Write any three properties of nuclear force.

PART – D

V. Answer any THREE of the following questions: **3 × 5 = 15**

37 Derive the expression for the electric potential at a point due to a point charge.

38 Arrive at the condition for balance of a Wheatstone's network using Kirchhoff's rules.

39 Obtain the expression for the force per unit length between two infinitely long straight parallel current carrying conductors placed in vacuum. Hence define the unit 'ampere'.

40 a) State Huygen's principle

b) Prove Snell's law of refraction using Huygen's principle by considering refraction of a plane wave by a surface.

41 a) What is a rectifier?

b) With the help of a circuit diagram, input and output waveforms, explain the working of a full wave rectifier.

VI. Answer any TWO of the following questions: **2 × 5 = 10**

42 A uniformly charged spherical shell of radius 10 cm has a surface charge density of 16 $\mu C\ m^{-2}$. Find the electric field due to the shell at a distance of

a) 20 cm from the centre of the shell. b) 5 cm from the centre of the shell.

43 Two identical cells each of emf 15 V either connected in series or connected in parallel across an external resistance of 5 Ω produce the same current through the resistor.

a) Calculate the value of internal resistance of the cell.

b) Find the current through the external resistor in either case.

44 A series *LCR* circuit with $L = 0.5$ H and $R = 100\ \Omega$ is connected to a 200 V, 50 Hz a.c. supply.

a) Calculate the value of capacitance of the capacitor that drives the circuit into resonance.

b) Find the value of voltage across the inductor at resonance.

45 An object of height 1 mm is kept perpendicular to the axis of a thin convex lens of power + 10 D. The distance between the object and the lens is 15 cm. Find the position and height of the image formed.

PART – E

7 When a.c. is passed through an a.c. circuit, it is observed that the voltage and the current are in phase. Along with the a.c. source, the circuit:

(a) has a series combination of resistance and capacitance.

(b) has only inductance. (c) has only capacitance.

(d) may have only resistance or may have a suitable series combination of inductance (L), capacitance (C) and resistance (R).

II PUC ANNUAL EXAMINATIONS-2 (APRIL-2025)

Time: 3 hours. **Max Marks: 70** **No of questions: 45**

General Instructions:

1. ***All parts A to D are compulsory. Part-E is only for visually challenged students.***
2. ***For Part – A questions, first written-answer will be considered for awarding marks.***
3. ***Answers without relevant diagram / figure / circuit wherever necessary will not carry any marks.***
4. ***Direct answers to numerical problems without relevant formula and detailed solutions will not carry any marks.***

PART – A

I. Pick the correct option among the four given options for ALL of the following questions: 15×1= 15

1. According to Coulomb's law, electrostatic force F between two-point charges separated by the distance r varies as

(a) $F \propto \frac{1}{r}$ (b) $F \propto r$ (c) $F \propto \frac{1}{r^2}$ (d) $F \propto r^2$

2. The maximum electric field that a dielectric medium can withstand without breakdown is called

(a) dielectric constant (b) dielectric strength (c) dielectric polarization (d) electrical susceptibility

3. The electric current per unit area of cross-section of a conductor is called

(a) Conductivity (b) Resistivity (c) Current density (d) Mobility

4. A Galvanometer which is converted to ammeter has

(a) low resistance in series (b) low resistance in parallel

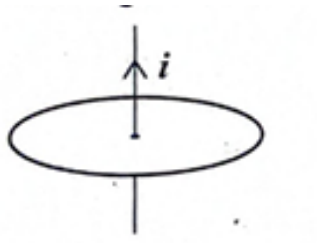
(c) high resistance in series (d) high resistance in parallel

5. The substances which have the tendency to move from stronger to weaker part of external magnetic field are

(a) Diamagnetic (b) Ferromagnetic

(c) Paramagnetic (d) Ferro and Paramagnetic

6. A long straight wire having increasing current at steady rate is placed along the axis of a circular metal ring as shown in the figure. When viewed from above towards the ring, the wire



(a) induces clockwise current in the ring

(b) induces anti-clockwise current in the ring

(c) does not induce current in the ring

(d) induces current in the ring which changes its direction with respect to time

7. A transformer works on the principle of

(a) Mutual induction (b) Self induction

(c) Force on coil in magnetic field (d) Torque on coil in magnetic field

8. The existence of electromagnetic waves by a set of equations was given by

(a) Michel Faraday (b) Andre Ampere (c) Albert Einstein (d) JC Maxwell

9. The relation between focal length f and radius of curvature R of a spherical mirror is

(a) R = f (b) R=f/2 (c) f=R/2 (d) f = 1/ R

10. Statement I: Wave fronts obtained from a point source of light in an isotropic medium are always spherical at finite distance.

Statement II: Speed of light in an isotropic medium is constant.

(a) Only Statement I is correct (b) Only Statement II is correct

(c) Both Statement I and Statement Il are wrong (d) Both Statement I & Statement II are correct

11. Which of the following phenomenon confirms the transverse nature of light waves?

(a) Diffraction (b) Polarization (c) Interference (d) Reflection

12. Emission of electrons from a metal surface by heating is called as

(a) Photo-electric emission (b) Field emission

(c) Secondary emission (d) Thermionic emission

13. Bohr's atom model is applicable to only

(a) Hydrogen atom (b) Gold atom (c) Silver atom (d) Oxygen atom

14. Match the following columns:

Column I		Column-II	
(a)	Isotopes	(i)	Nuclei having same number of neutrons
(b)	Isobars	(ii)	Nuclei having same number of protons
(c)	Isotones	(ii)	Nuclei having same number of nucleons

(a) a - ii, b - iii, c - i

(b) a - iii, b - ii, c - i

(c) a - ii, b- i, c - iii

(d) a - iii, b -i, c - ii

15. The impurity atoms added to a pure semiconductor crystal to convert it into p-type semiconductor are

(a) tetravalent (b) trivalent (c) pentavalent (d) hexavalent II.

II. Fill in the blanks by choosing appropriate answer given in the bracket for all of the following questions: **5 × 1 = 5**

[electrostatic potential, refraction, reflection, Iron, linear, zero]

16. In a uniform charge distribution, the ratio of electric charge to the length is _____ charge density.

17. _____ is equal to work done to transfer unit positive test charge from infinity to a point in electric field opposite to field.

18. An example for ferromagnetic substance is _____.

19. The phase difference between peak value of voltage and current in a pure resistive circuit is _____.

20. The bottom of a tank filled with water appears to be raised, it is due to _____ of light.

PART – B

III. Answer any FIVE of the following questions: **5 × 2 = 10**

21. Give any two properties of electric field lines.

22. Find the force on a point charge 2×10^{-6} C placed at a point in a uniform electric field of 0.8 NC^{-1}.

23. State Kirchhoff's rules of electrical networks.

24. Mention any two factors on which current sensitivity of a galvanometer depends.

25. Draw a neat diagram of a simple a.c. generator and label the parts.

26. Write the expression for average power in an a.c LCR circuit and explain the terms.

27. Mention any two uses of infrared radiations.

28. a) Draw a diagram of unbiased depletion region of p-n junction showing immobile charges.

b) What is meant by rectification?

PART – C

IV. Answer any FIVE of the following questions: **5 × 3 = 15**

29. a) What is meant by an equipotential surface?

b) Draw equipotential surfaces for uniform electric field and a point charge.

30. Derive an expression for magnetic field due to a straight infinite conductor carrying current using Ampere's circuital law.

31. Define a) magnetic susceptibility and b) magnetic relative permeability and write an expression relating them.

32. a) What is meant by electromagnetic induction?

b) State and explain Faraday's law of electromagnetic induction.

33. Calculate the resonant angular frequency of a series LCR ac circuit.

Given R=100 Ω, L=1.0 mH and 1.0 nF.

34. Write the two conditions for total internal reflection of light and mention its one technological application.

35. Deduce an expression for total energy of electron in an orbit of hydrogen atom in terms of radius of orbit.

36. (a) What is meant by Nuclear fusion? Explain. (b) Why it is thermonuclear reaction?

PART – D

V. Answer any THREE of the following questions: **3 × 5 = 15**

37. Deduce an expression for electric field at a point outside a thin uniformly-charged spherical shell using Gauss's law.

38. Obtain an expression for electrical conductivity of conducting electrons in a metallic conductor in terms of charge (e) and mass (m) of the electrons.

39. Derive an expression for magnetic field at a point on the axis of a circular current loop.

40. (a) Prove Snell's law of refraction of light, when a plane wavefront passes from rarer to denser medium. **(3)**

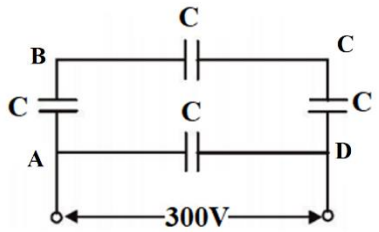
b) Mention any two uses of polaroids. **(2)**

41. a) Explain the classification of solids using band theory. **(3)**

b) Give any two differences between intrinsic and extrinsic semiconductors. **(2)**

VI. Answer any TWO of the following questions: **2 × 5 = 10**

42. A network of four 9μF capacitors is connected to a 300V supply as shown in figure. Determine (a) Equivalent capacitance of the network and (b) The charge on each capacitor.



43. Two cells 8V, 1Ω and 10V, 2Ω are connected in parallel such that they send currents in the same direction through an external resistance 20Ω. Find the current and potential difference across 20Ω.

44. A sharp object of height 3.0 cm is placed at 21 cm in front of a convex lens of focal length 14 cm. Find the position and magnification of the image. What happens to the height of the image if the object is moved further away from the lens?

45. The work function of a metal is 2.20 eV when radiation of frequency 6.50×10^{14} Hz incident on the metal surface photo emission of electrons occurs. Calculate (a) energy of incident photon and (b) stopping potential of photoelectrons. (Given, $h=6.63\times10^{-34}$ Js and $e = 1.6 \times 10^{-19}$ C)

II PUC ANNUAL EXAMINATION – 3 JUNE– 2025

Subject: PHYSICS **Subject code: 33**

GENERAL INSTRUCTIONS:

i) All Parts from A to D are compulsory. Part-E is only for visually challenged students.

ii) For Part-A questions, first written answers will be considered for awarding marks.

iii) Answers without relevant diagram / figure / circuit wherever necessary will not carry any marks.

iv) Direct answers to numerical problems without relevant formula and detailed solutions will not carry any marks.

PART – A

I. **Pick the correct option among the four given options for ALL of the following questions: 15 × 1 = 15**

1. The total charge of an electric dipole is

a) Infinity b) Zero c) +e d) –e

2. Identify the 'WRONG' statement regarding electrostatics of conductors.

a) Electric field inside a charged conductor is zero

b) There is no excess charge inside a charged conductor

c) Electric potential is constant throughout the volume of a conductor

d) Electric field is tangential at all points on the surface of a charged conductor

3. The magnitude of drift velocity per unit electric field is called

a) mobility b) current density c) resistivity d) conductivity

4. Statement I: A galvanometer is converted into an ammeter by connecting a resistor of low resistance in parallel with it.

Statement II: The voltage sensitivity of a galvanometer depends on number of turns of the coil.

Pick the correct answer:

a) Both statements I and II are correct b) Both statements I and II are wrong

c) Only statement I is correct d) Only statement II is correct

5. A small compass needle of magnetic dipole moment 'm' is placed in uniform magnetic field 'B' at an angle θ, then the magnetic potential energy of the needle is

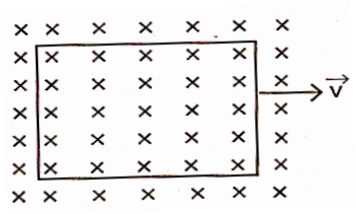
a) +mB sinθ b) –mB sinθ c) +mB cosθ d) –mB cosθ

6. The Polarity of induced emf is given by

a) Faraday's law b) Lenz's law

c) Gauss's law in magnetostatics d) Ampere's circuital law

7. **A rectangular loop is moving out of a uniform magnetic field region to a field-free region with constant velocity $\vec{v}$ as shown in figure. Then, in the coil**



a) No emf is induced b) No current is induced

c) Constant emf is induced d) Varying emf is induced

8. **In purely inductive ac circuit, the power factor is**

a) +1 b) –1 c) 0 d) ∞

9. **In which of the following sequence, does electromagnetic waves are arranged in increasing order of wavelength?**

a) X-rays, ultraviolet rays, microwaves b) Ultraviolet rays, X-rays, microwaves

c) Microwaves, Ultraviolet rays, X-rays d) X-rays, Microwaves, Ultraviolet rays

10. **A ray of light travelling from denser to rarer medium undergoes total internal reflection when the angle of incidence**

a) is less than critical angle. b) is greater than critical angle.

c) is equal to critical angle. d) is zero.

11. **For which one of the following phase difference between two coherent light waves, the constructive interference takes place?**

a) $\pi/2$ b) π c) 2π d) 3π

12. **If Planck's constant and basic unit of electric charge are 'h' and 'e' respectively, then in photoelectric effect, the graph between stopping potential (V) and frequency (γ) is a straight line with slope equal to**

a) h/e b) e/h c) e d) h

13. **de Broglie hypothesis provides an explanation for**

a) J. J. Thomson's atomic model b) Rutherford's nuclear model of atom

c) Geiger-Marsden experiment

d) Bohr's second postulate of quantization of angular momentum

14. **The nuclear radius 'R' depends on mass number 'A' as**

a) $R \propto A^2$ b) $R \propto A^{1/2}$ c) $R \propto A^3$ d) $R \propto A^{1/3}$

15. **The List - I and List - II respectively represent materials and energy band gap E_g**

Identify the correct match.

a) (i) - (q); (ii) - (r); (iii) - (p)

b) (i) - (r); (ii) - (p); (iii) - (q)

c) (i) - (p); (ii) - (r); (iii) - (q)

d) (i) - (r); (ii) - (q); (iii) - (p)

List - I	List - II
(i) Conductors	(p) $E_g > 3eV$
(ii) Insulators	(q) $E_g < 3eV$
(iii) Semiconductors	(r) $E_g = 0$

II. Fill in the blanks by choosing appropriate answer given in the brackets for ALL the following questions **5×1 =5**

(magnetic flux, magnetic susceptibility, electric dipole moment, greater than, photon, half of) :

16. Polar molecules have permanent _____.

17. The _____ through any closed surface is zero.

18. In step-up transformer, the number of turns in secondary coil is _____ the number of turns in primary coil.

19. The intensity of light coming out of a single polaroid is _____ the incident intensity.

20. In interaction of radiation with matter, radiation behaves as if it is made up of packet of energy called _____.

PART – B

III. Answer any FIVE of the following questions: **5 × 2 = 10**

21. State and explain Coulomb's law in electrostatics.

22. Graphically represent the variation of resistivity with absolute temperature for the following materials. (i) Copper (ii) Semi conductor

23. What is Lorentz force? Write the expression for it.

24. The current in a coil falls from 2A to 0 in time 0.1s. If an average emf of 20V is induced in this coil, then calculate its self-inductance.

25. Give any two uses of infrared waves.

26. Define power of a lens. Write its SI unit.

27. Write two advantages of reflecting telescope over refracting telescope.

28. On which factors does the conductivity of extrinsic semiconductor depend?

PART – C

IV. Answer any FIVE of the following questions: **5 × 3 = 15**

29. Write three properties of electric field lines.

30. Obtain an expression for effective capacitance of two capacitors connected in parallel.

31. A square coil of side 10 cm, 50 turns, carrying a current of 10A is placed in uniform magnetic field of 0.80 T in such a way that, the normal drawn to the plane of the coil makes an angle 30° with the direction of magnetic field. Find the magnitude of torque experienced by the coil.

32. Distinguish between diamagnetic and paramagnetic materials.

33. Derive an expression for motional emf induced in a straight conductor moving perpendicular to the uniform magnetic field.

34. Write three experimental observations of photoelectric effect.

35. State the three postulates of Bohr's atomic model.

36. Mention the characteristic features of nuclear force.

PART – D

V. Answer any THREE of the following questions: **3 × 5 = 15**

37. Define electrostatic potential. Obtain an expression for electrostatic potential at a point due to an isolated point charge.

38. Using Kirchhoff's laws, arrive at the balancing condition of the Wheatstone bridge.

39. Derive an expression for magnetic field at a point on the axis of a circular current loop.

40. a) State Huygen's principle of wavefronts. (2)

b) Using Huygen's principle, show that the angle of incidence is equal to the angle of reflection, when a plane wavefront is reflected by a plane surface. (3)

41. a) What is full-wave rectifier? (1)

b) Explain the working of a full-wave rectifier using neat circuit diagram. (3)

c) Draw input-output waveforms of full-wave rectifier. (1)

VI. Answer any TWO of the following questions: **2 × 5 = 10**

42. Two-point charges 2μC and 3μC are placed at the two corners A and B of an equilateral triangle ABC of side 0.2 m. Calculate the magnitude of resultant electric field at the corner C of that triangle.

43. Two identical cells either connected in series or in parallel combination give the same value of current 0.5A through an external resistor of resistance 2 Ω. Find the emf and internal resistance of each cell.

44. A resistor of 100 Ω, an inductor of 200 mH and a capacitor of 100 μF are connected in series to a 220V, 50 Hz ac source. Calculate (i) impedance and (ii) current in the circuit.

45. The angle of minimum deviation produced in a glass prism is 40°. Calculate the refractive index of the material of the prism, if the refracting angle of prism is 60°. Also calculate the new angle of minimum deviation when the prism is immersed in water of refractive index 1.33.

II PUC ANNUAL EXAMINATION – 1 (MARCH – 2024)

Time: 3 hours 15 min. **PHYSICS** **Max Marks: 70**

General Instructions:

1. *All parts are compulsory.*
2. *For Part – A questions, first written-answer will be considered for awarding marks.*
3. *Answers without relevant diagram / figure / circuit wherever necessary will not carry any marks.*
4. *Direct answers to the numerical problems without detailed solutions will not carry any marks.*

PART-A

I. Pick the correct option among the four given options for ALL of the following questions: 15×1= 15

1. The electric dipole placed in a uniform electric field will be in unstable equilibrium when the angle between direction of electric field and dipole moment is

(A) 0^o (B) 60^o (C) 90^o (D) 180^o

2. The capacitance of a capacitor is 6×10^{-6} farad. It is connected to 200 volt cell. The energy released by the capacitor when it is discharged completely will be

(A) 0.12J (B) 0.24J (C) 0.6J (D) 12J

3. The current density is a

(A) scalar quantity and its SI unit is Am^2 (B) vector quantity and its SI unit is A/m^3

(C) vector quantity and its SI unit is A/m^2 (D) scalar quantity and its SI unit is A/m

4. A current I flows along the length of an infinitely long, straight, thin walled pipe. The magnetic field

(A) at all the points inside the pipe is same but not zero (B) at any point inside the pipe is zero

(C) is zero only on the axis of the pipe (D) is different at different points inside the pipe.

5. The universal property among all substances is

(A) Diamagnetism (B) Para magnetism (C) Ferromagnetism (D) Non-magnetism

6. A bar magnet is kept along the axis of a circular coil. If the magnet is rotated about its axis, then

(A) a current will be induced in the coil. (B) no current will be induced in the coil

(C) an emf and current both will be induced in the coil (D) only an emf will be induced in the coil.

7. Current in a coil changes from 1.6A to 0.2A in seconds inducing an emf of 2.8V. The value of self-inductance of coil is

(A) 40H (B) 28H (C) 4H (D) 56H

8. The resonance phenomnon is exhibited by a circuit only if the following components are present

(A) L and R (B) R and C (C) L and C (D) None of these.

9. According to the generalised Ampere-Maxwell law, $\oint \vec{B}.d\vec{\ell}$ is equal to

(A) $\mu_o i_c + \mu_o \varepsilon_o \frac{d\varphi_E}{dt}$ (B) $\mu_o i_c$ (C) $\varepsilon_o \frac{d\varphi_E}{dt}$ (D) $\mu_o \varepsilon_o \frac{d\varphi_E}{dt}$

10. Modern reflecting telescopes use concave mirror as objective than a lens because

(I) No chromatic aberration in a mirror. (II) Giving mechanical support to a mirror is easier

(A) I is true, II is false (B) I is false, II is true

(C) Both I and II are true (D) Both I and II are false

11. According to Huygens's principle, the speed of secondary wavelets in forward direction is

(A) twice that of the wave (B) zero

(C) same as the wave (D) infinite

12. We do not see wave-like properties of macroscopic particles in our daily life because

(A) they are not associated with waves (B) their wavelength is extremely high

(C) their wavelength is zero (D) their wavelength is negligibly small

13. In Rutherford's alpha (α) -particle scattering experiment, at the distance of closest approach of an α-particle with gold nucleus

(A) both kinetic energy and potential energy are equal

(B) entire kinetic energy is converted into potential energy

(C) Entire potential energy is converted into kinetic energy

(D) both kinetic energy and potential energy are zero

14. If r is the distance between nucleons, nuclear force is

(A) attractive for distance r = 0.5 fm (B) attractive for distance r < 0.8 fm

(C) repulsive for distance r > 0.8 fm (D) repulsive for distance r < 0.8 fm

15. P-type semiconductor is electrically

(A) positive (B) negative

(C) neutral (D) negative as its temperature increases

II. Fill in the blanks by choosing appropriate answer given in the brackets for ALL the following questions: *(decreasing, interference, helium, greater, diffraction, increasing):* **5×1=5**

16. The torque on a rectangular current loop in a uniform magnetic field may be increased by _____ the area of the loop.

17. The mutual inductance of coaxial solenoids can be decreased by _____ the number of turns per unit length of inner solenoid.

18. Fringes of unequal intensities are obtained in _____ pattern.

19. Alpha particle is a _____ nucleus.

20. The value of energy band gap in insulators is _____than 3 eV.

PART – B

III. Answer any FIVE of the following questions: 5 × 2 = 10

21. State and explain Gauss' law in electrostatics.

22. Two point charges 5×10^{-8} C and -3×10^{-8} C are located **10cm** apart. Find the point between the two charges where the net electric potential is zero.

23. A charged particle is moving with a uniform speed v at an angle θ to a uniform magnetic field B. What are the values of θ when it experiences (a) maximum force and (b) minimum force?

24. Define susceptibility and magnetisation for a magnetic material.

25. Write the principle of AC generator. Mention the expression for induced emf across the coil of ac generator.

26. Give any two sources of energy loss in practical transformers.

27. Mention any two applications of ultraviolet rays.

28. What is power of a lens? Write its SI unit.

29. Distinguish between intrinsic and extrinsic semiconductors.

PART – C

IV. Answer any FIVE of the following questions: 5 × 3 = 15

30. Mention any three properties of electric field lines.

31. Deduce $E = -\frac{dV}{dx}$ where the symbols have their usual meaning.

32. Give any three limitations of Ohm's law.

33. Explain the method of converting galvanometer into a voltmeter.

34. Mention any three properties of paramagnetic materials.

35. Lenz's law is the consequence of law of conservation of energy. Explain.

36. Write the cartesian sign conventions adopted for measuring distances during reflection of light in spherical mirrors.

37. Write the three postulates of Bohr's atomic model.

38. Mass defect of $_7N^{14}$ is **0.11236u**. Calculate the binding energy and binding energy per nucleon of $_7N^{14}$ in MeV.

PART – D

V. Answer any THREE of the following questions: 3 × 5 = 15

39. (a) What are polar and non polar molecules? **(2)**

(b) Derive an expression for the capacitance of a parallel plate capacitor. **(3)**

40. Arrive at the expressions for equivalent emf and internal resistance of two cells connected in series.

41. Deduce the expression for the magnetic field on the axis of a circular current loop.

42. (a) What is interference of light? **(1)**

(b) Give the conditions for constructive and destructive interference of light in terms of path difference. **(2)**

(c) Mention any two applications of polaroids. **(2)**

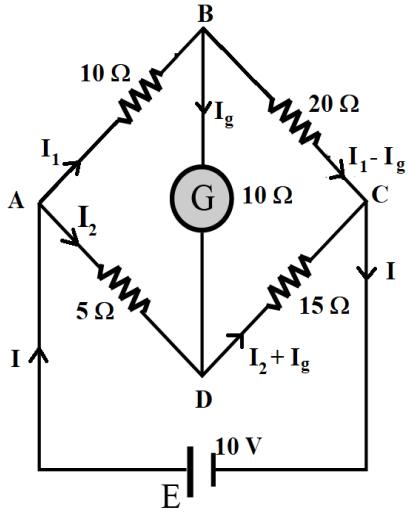
43. Write Einstein's photoelectric equation. Using the equation explain the experimental observations of photoelectric effect.

44. What is a rectifier? Explain the working of p–n junction diode as a full wave rectifier with a circuit and input-output waveforms.

VI. Answer any TWO of the following questions: 2 × 5 = 10

45. Two point charges +15μC and –10μC are separated by a distance of 20cm in air. Calculate the electric field at the mid-point of the line joining the two charges. If a point charge of 20mC is placed at the mid-point, what is the magnitude of electric force experienced by it?

46. In the given Wheatstone's network, calculate the value of electric current flowing through the galvanometer.



47. A sinusoidal voltage of 250V and frequency 50 Hz is applied to a series LCR circuit. R = 6 Ω, L = 25mH and C = 796μF. Calculate (a) the impedance of the circuit (b) the power factor.

48. A small bulb (a point source of light) is placed at the bottom of a tank containing water to a depth of 80 cm. What is the radius of the circular surface of water through which light emerges out? Refractive index of water is 1.33.

II PUC ANNUAL EXAMINATIONS – 2 (APRIL – 2024)

Time: 3 hours 15 min. **II PUC PHYSICS** **Max Marks: 70**

General Instructions:

1. ***All parts are compulsory.***
2. ***For Part – A questions, first written-answer will be considered for awarding marks.***
3. ***Answers without relevant diagram / figure / circuit wherever necessary will not carry any marks.***
4. ***Direct answers to the numerical problems without detailed solutions will not carry any marks.***

PART-A

I. Pick the correct option among the four given options for ALL of the following questions: 15×1= 15

1. How many electrons must be removed from a body to acquire a charge of +1C?

(a) 6.256×10^{12} (b) 6.256×10^{18} (c) 1.66×10^{18} (d) 1.6×10^{12}

2. Water molecule is a polar molecule because

(a) the centres of positive and negative charges coincide

(b) the centres of positive and negative charges do not coincide

(c) it does not have permanent dipole moment

(d) in an external electric field, it does not induce charges.

3. The resistance R of a metallic conductor is inversely proportional to ……..

(a) length of the conductor (b) area of cross section of the conductor

(c) both length & area of cross section of the conductor (d) temperature of the conductor

4. SI unit of magnetic field is

(a) gauss (b) newton metre ampere (c) tesla (d) newton metre

5. The net magnetic moment per unit volume of a substance is

(a) magnetisation (b) magnetic permeability

(c) magnetic susceptibility (d) magnetic flux

6. The magnitude of induced emf in a circuit is equal to the time rate of change of magnetic flux through the circuit. This the statement of

(a) Gauss's law in magnetism (b) Faraday's law of electromagnetic induction

(c) Ampere's circuital law (d) Biot-Savart's law

7. Statement I : Inductance is a scalar quantity

Statement II : Dimensional formula of inductance is $[ML^2T^{-2}A^{-2}]$

(a) Statement I is correct and statement II is wrong

(b) Both statements I and II are correct.

(c) Both statements I and II are wrong

(d) Statement I is wrong and statement II is correct.

8. Mutual induction is the working principle of

(a) ammeter (b) electric motor (c) transformer (d) voltmeter

9. Which one of the following electromagnetic waves has highest frequency?

(a) X-rays (b) radio waves (c) Infra-red waves (d) Gamma rays

10. The ratio of speed of light in vacuum to the speed of light in a medium gives:

(a) absolute refractive index of the medium

(b) relative refractive index of the medium

(c) relative mass density of the medium

(d) mass density of the medium

11. Statement -I : Light is a transverse electro-magnetic wave.

Statement - II: Polarisation of light confirms transverse nature of light.

(a) Statement I is correct and statement II is wrong

(b) Statement I is wrong and statement II is correct.

(c) Both statements are correct and statement II is the correct confirmation of statement I.

(d) Both statements I and II are wrong

12. Following particles are moving with same speed. Which one of them has the longest Broglie wavelength?

(a) Proton (b) neutron (c) alpha particle (d) electron

13. The plum pudding model of atom was given by

(a) J.J. Thomson (b) Rutherford (c) Niels Bohr (d) Einstein

14. Which one of the following is NOT a characteristic of nuclear force?

(a) Strongest force (b) saturated force

(c) charge independent force (d) charge dependent force

15. An intrinsic semiconductor is

(a) A substance having equal number of free electrons and holes at room temperature

(b) A substance having unequal number of free electrons and holes at room temperature

(c) A conductor at temperature T = 0 K. (d) An insulator at room temperature

II. Fill in the blanks by choosing appropriate answer given in the brackets for ALL the following questions. ***(Heavy nucleus, diffraction, attract, decreases, Lenz's law, repel)*** **5 × 1 = 5**

16. Two parallel long straight conductors carrying currents in the same direction _____ each other.

17. _____ gives polarity of induced emf

18. The phenomenon of formation of alternate dark and bright regions at the sharp edges of geometrical shadow of opaque objects is called _____

19. The breaking of _____ into two nuclei of intermediate masses and release of energy is called nuclear fission.

20. During forward bias of p-n junction, as forward potential increases, width of depletion region _____

PART – B

III. Answer any FIVE of the following questions: **5 × 2 = 10**

21. State and explain Gauss's law in electrostatics.

22. Two capacitors 3μF and 6μF are connected in series. Find the equivalent capacitance of the combination.

23. Mention the angle between the direction of motion charged particle and direction of magnetic field, when the charged particle experiences (i) maximum force and (ii) minimum force.

24. Give any two properties of magnetic field lines.

25. Write an expression for induced emf in a straight conductor moving perpendicular to a uniform magnetic field and explain the terms.

26. Write an expression for instantaneous current in an ac circuit containing pure capacitor and explain the terms

27. Give two applications of UV rays.

28. Define critical angle for a medium. Mention the relation between refractive index and critical angle of a medium.

29. Write any two differences between p-type and n-type semi-conductors.

PART – C

IV. Answer any FIVE of the following questions: **5 × 3 = 15**

30. Mention any three properties of electric charges.

31. Derive the relation between electric field and electric potential in a unform electric field.

32. State and explain Kirchhoff's rules of electrical network.

33. With a circuit diagram, explain the process of conversion of a galvanometer into voltmeter.

34. Write any three differences between diamagnetic and ferromagnetic substances.

35. Obtain an expression for instantaneous induced emf in an ac generator.

36. Draw a ray diagram of refraction of monochromatic light through a prism. Mention the expression for deviation in a thin prism.

37. Deduce the expression for energy of electron in hydrogen atom in terms of radius of the orbit.

38. Calculate the binding energy of oxygen nucleus $\left({}^{16}_{8}\mathrm{O}\right)$ in MeV using the following data:

Mass of oxygen nucleus = 15.99053 u, Mass of proton = 1.00727u, Mass of neutron = 1.00866u

PART – D

V. Answer any THREE of the following questions: **3 × 5 = 15**

39. Obtain an expression for electrostatic potential at a point due to an isolated point charge.

40. Deduce the expression for equivalent emf and equivalent internal resistance when two different cells are connected in parallel.

41. Derive an expression for the magnetic field at a point on the axis of a circular current loop.

42. (a) What are coherent sources? **(1)**

(b) Mention the conditions for constructive and destructive interreference of light in terms of path difference. **(2)**

(c) Write any two uses of polaroids. **(2)**

43. (a) What is meant by photoelectric effect? **(1)**

(b) Mention any two experimental observations of photoelectric effect? **(2)**

(c) Write Einstein's photoelectric equation and explain the terms **(2)**

44. With a neat circuit diagram explain the working of p-n junction diode as a full wave rectifier. Also draw input and output waveforms.

VI. Answer any TWO of the following questions: **2 × 5 = 10**

45. The electrostatic force on a small sphere of charge '0.4μC' due to another small sphere of charge '–0.8μC' in air separated by distance is 0.2N. (a) Find the distance between the two spheres.

(b) What is the magnitude and nature of the force on the second sphere due to the first?

46. The number density of free electrons in a metallic wire is $8\times10^{28}\,m^{-3}$. The area of cross section of the wire is $1.5\times10^{-6}m^2$ & carries a current of 2A. Find the drift velocity of free electrons & current density

47. A sinusoidal voltage of rms value 10 volts and frequency 50Hz is applied to a series LR circuit in which R = 3Ω and L=12.75mH. Find (a) impedance of the circuit (b) rms current (c) phase difference between current and voltage.

48. Double convex lenses are to be manufactured from a glass of refractive index 1.52, with both faces of same radius of curvature. What is the radius of curvature required if the focal length is to be 25cm? What will be the new focal length of the lens when it is immersed in water of refractive index 1.33?

II PUC ANNUAL EXAMINATIONS - 3 (JUNE - 2024)

Time: 3 hours 15 min. **II PUC PHYSICS** **Max Marks: 70**

General Instructions:

1. ***All parts are compulsory.***
2. ***For Part – A questions, first written-answer will be considered for awarding marks.***
3. ***Answers without relevant diagram / figure / circuit wherever necessary will not carry any marks.***
4. ***Direct answers to the numerical problems without detailed solutions will not carry any marks.***

PART-A

II. Pick the correct option among the four given options for ALL of the following questions: 15×1 = 15

1. The electric dipole placed in an uniform electric field experiences

(a) only force (b) only torque

(c) both force and torque (d) neither force nor torque

2. A sphere has a charge Q. Relative to V = 0 at infinity, the electrostatic potential V and electric field E inside the sphere are

(a) V = 0, E = 0 (b) V≠ 0 and E = 0 (c) V≠0 and E≠0 (d) V=0 and E≠0

3. The ratio of magnitude of drift velocity and electric field is

(a) Acceleration (b) resistivity (c) conductivity (d) mobility

4. The relation between permittivity of free space (ε_o), permeability of free space (μ_o) and speed of light in vacuum (c) is given by

(a) $\varepsilon_o\mu_o = c$ (b) $\varepsilon_o\mu_o = c^2$ (c) $\varepsilon_o\mu_o = \frac{1}{c^2}$ (d) $\varepsilon_o\mu_o = \frac{1}{c}$

5. Below are two statements related to diamagnetism

Statement-I : Diamagnetic materials do not have permanent magnetic moment.

Statement-II : The resultant magnetic moment of individual electrons neutralize each other.

(a) Both statements I and II are correct and II statement is not the correct explanation for I

(b) Both statements I and II are correct and II statement is the correct explanation for I

(c) Statement I is wrong and statement II is correct.

(d) Statement I is correct and statement II is wrong.

6. Lenz's law is the law of conservation of

(a) Momentum (b) charge (c) resistance (d) energy

7. Self inductance of a coil measures its

(a) Magnetic flux (b) electrical inertia (c) motional emf (d) mutual inductance

8. The opposition to current in series LCR circuit is called

(a) resistance (b) capacitive reactance

(c) inductive reactance (d) impedance

9. The concept of displacement current was introduced by

(a) Gauss (b) Ampere (c) Maxwell (d) Faraday

10. The resolving power of a telescope can be increased by

(a) using objective of larger diameter (b) using eyepiece of smaller diameter

(c) using objective of smaller diameter (d) using eye piece of larger diameter

11. Polaroids are used to

(a) produce coherent waves (b) control the intensity of light

(c) produce diffraction pattern (d) produce interreference pattern

12. The statements given below are related to the properties of photons

(I) Photons are electrically neutral.

(II) Photons are undeflected by electric and magnetic fields

(III) Photons are light waves

(IV) In photon-particle collision, total energy and momentum are not conserved.

(a) Only statements I and III are correct (b) Only statements II and IV are correct

(c) Only statements I and II are correct (d) Only statements I and IV are correct

13. The result of Geiger-Marsden experiment leads to the discovery of

(a) atom (b) nucleus

(c) radioactivity (d) line spectra of hydrogen

14. Stellar energy is due to

(a) nuclear fission (b) β-decay (c) α-decay (d) thermonuclear fusion

15. In intrinsic semi-conductors

(a) only free electrons are present (b) only holes are present

(c) number of free electrons is equal to the number of holes

(d) number of free electrons is not equal to the number of holes

II. Fill in the blanks by choosing appropriate answer given in the brackets for ALL the following questions. ***(Diffraction, Circular, silicon, independent, interference, AC generator)*** **5 × 1 = 5**

16. The charged particle moving perpendicular to the direction of uniform magnetic field traverse a _____ path.

17. The device working on the principle of electromagnetic induction is _____

18. Encroachment of light in the region of geometrical shadow is called _____

19. The nuclear density is _____ of its mass number.

20. _____ is an example for elemental semiconductor.

PART – B

III. Answer any FIVE of the following questions: **5 x 2 = 10**

21. State and explain Gauss' law in electrostatics.

22. The potential at a point is given by $V = ax - bx^2$ where a and b are constants. Find the value of electric field at that point.

23. Write the expression for Lorentz's force and explain the terms used.

24. Define magnetisation and write its SI unit.

25. Write the angle between magnetic field lines and normal to a surface when the magnetic flux through the surface is (a) maximum and (b) minimum

26. Give the value of power factor for (a) purely resistive circuit and (b) purely inductive circuit

27. Mention any two applications of microwaves.

28. Two thin convex lenses of focal lengths f_1 and f_2 are kept in contact. Write the expressions for effective focal length and power of the combination.

29. Distinguish between conductors and insulators on the basis of band theory.

PART – C

IV. Answer any FIVE of the following questions: **5 × 3 = 15**

30. Mention any three basic properties of electric charge.

31. Obtain an expression for potential energy of a system of two charges in the absence of electric field.

32. Mention any three factors on which resistance of a conductor depends.

33. Explain the process of conversion of a given galvanometer into an ammeter.

34. Write any three properties of magnetic field lines.

35. Describe the coil and magnet experiment of electromagnetic induction.

36. Write two conditions for total internal reflection of light and hence define critical angle.

37. Give any three limitations of Bohr's atom model of hydrogen.

38. Determine the radius of nucleus of mass number 125. Given : $R_o = 1.2 \times 10^{-15}$m

PART – D

V. Answer any THREE of the following questions: **3 × 5 = 15**

39. (a) Derive an expression for equivalent capacitance of two capacitors connected in series **(3)**

(b) Write any two properties of equipotential surfaces. **(2)**

40. Deduce the condition for balance of a Wheatstone's bridge using Kirchhoff's laws.

41. Using Biot-Savart's law, arrive at the expression for magnetic field at a point on the axis of a circular current loop.

42. (a) Prove the law of reflection of a plane wave using Huygen's principle. **(3)**

(b) Draw a schematic diagram of refraction of a plane wavefront by a thin prism. **(2)**

43. What is photoelectric effect? Write the experimental observations of photoelectric effect.

44. What is rectification? Using p-n junction diode and relevant circuit diagram explain the working of half wave rectifier. Write the input and output waveforms.

VI. Answer any TWO of the following questions: **2 × 5 = 10**

45. The electrostatic force on a metal sphere of charge 0.6μC due to another identical metal sphere of charge –1.2μC is 45×10^{-3}N. Find the distance between two spheres. Also find the force between the same two spheres when they are brought into contact and then placed in their initial position.

46. The number density of free electrons in copper is estimated to be 8.5×10^{28} m^{-3}. A copper wire of length 5.0m and area of cross-section 1.5 mm^2 is carrying a current of 3.0 A. Calculate the drift velocity of electrons. How long does an electron take to drift from one end of the wire to its other end?

47. A sinusoidal voltage of 220V and 50Hz is applied to a series LCR circuit, in which R=10Ω, L=25.48mH and C=796 μF. Find (a) frequency at which resonance occurs. (b) the value of current at resonance.

48. An equilateral prism of refractive index 1.532 is placed in air. If a parallel beam of light is incident on one face of the prism at the minimum deviation position, find the angle of deviation.

MODEL QUESTION PAPER - 1 2024-25

II PUC - PHYSICS (33)

Time: 3 hours. **Max Marks: 70**

No of questions: 45

General Instructions:

1. ***All parts A to D are compulsory. Part-E is only for visually challenged students.***
2. ***For Part – A questions, first written-answer will be considered for awarding marks.***
3. ***Answers without relevant diagram / figure / circuit wherever necessary will not carry any marks.***
4. ***Direct answers to numerical problems without relevant formula and detailed solutions will not carry any marks.***

PART – A

I. Pick the correct option among the four given options for ALL of the following questions: **15 × 1 = 15**

1. The S.I. unit of electric charge is

(A) coulomb metre (B) coulomb per metre (C) coulomb (D) per coulomb

2. The angle between equipotential surface and electric field is

(A) 90º (B) 0º (C) 180º (D) 45º

3. Statement-I: The resistivity of metals increases with increase in temperature.

Statement-II: Increasing the temperature of metals causes more frequent collisions of electrons.

(A) both I and II are true and II is the correct explanation of I.

(B) both I and II are true but II is not the correct explanation of I.

(C) I is true but II is false.

(D) both I and II are false.

4. A moving coil galvanometer can be converted into a voltmeter by connecting

(A) a low resistance in parallel with galvanometer.

(B) a low resistance in series with galvanometer.

(C) a high resistance in parallel with galvanometer.

(D) a high resistance in series with galvanometer.

5. When a bar magnet is suspended freely, it points in the direction of

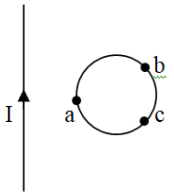
(A) east-west (B) north-south

(C) northeast-southeast (D) northwest-southwest

6. The energy stored in an inductor of inductance *L* in establishing the current *I* in it is

(A) $\frac{1}{2}LI$ (B) LI^2 (C) LI (D) $\frac{1}{2}LI^2$

7. The direction of current induced in the loop 'abc' shown in the figure is



(A) along 'abc' if I is increasing (B) along 'acb' if I is decreasing

(C) along 'acb' if I is increasing (D) along 'acb' if I is constant

8. An ideal step-up transformer decreases _____ .

(A) current (B) voltage (C) power (D) frequency

9. The displacement current is due to

(A) flow of electrons (B) flow of protons

(C) changing electric field (D) changing magnetic field

10. An object of finite height is placed in front of a concave mirror within its focus. It forms

(A) a real enlarged image (B) a real diminished image

(C) a virtual enlarged image (D) a virtual diminished image

11. A beam of un-polarised light of intensity I_0 is passed through a pair of polaroids with their pass-axes inclined at an angle of θ. The intensity of emergent light is equal to

(A) $I_0 \cos^2 \theta$ (B) $I_0 \cos \theta$ (C) $\frac{I_0}{2} cos\, \theta$ (D) $\frac{I_0}{2} \cos^2 \theta$

12. Emission of electrons from a metal surface by heating it is called

(A) photoelectric emission (B) thermionic emission

(C) field emission (D) secondary emission

13. When alpha particles are passed through a thin gold foil, most of them go undeviated because

(A) most of the region in an atom is empty space

(B) alpha particles are positively charged particles

(C) alpha particles are heavier particles

(D) alpha particles move with high energy

14. Nuclei with same atomic number are called

(A) isotopes (B) isobars (C) isomers (D) isotones

15. The column-I is the list of materials and the column-II, the list of energy band gaps E_g. Identify the correct match.

Column-I	Column-II
(i) conductors	(a) $E_g < 3\ eV$
(ii) insulators	(b) $E_g = 0\ eV$
(iii) semiconductors	(c) $E_g > 3\ eV$

(A) (i) - (a), (ii) - (b), (iii) - (c) (B) (i) - (b), (ii) - (a), (iii) - (c)

(C) (i) - (c), (ii) - (a), (iii) - (b) (D) (i) - (b), (ii) - (c), (iii) - (a)

II. Fill in the blanks by choosing appropriate answer given in the bracket for ALL the following questions: **5 × 1 = 5**

(photon, polar, zero, infinite, phase, phasor)

16. A molecule possessing permanent dipole moment is called _____ molecule.

17. The net magnetic flux through any closed surface is _____.

18. A rotating vector used to represent alternating quantities is called _____.

19. A wavefront is a surface of constant _____.

20. In interaction with matter, light behaves as if it is made up of packet of energy called _____.

PART – B

III. Answer any FIVE of the following questions: **5 × 2 = 10**

21. State and explain Gauss's law in electrostatics.

22. Define drift velocity and mobility of free electrons in conductors.

23. A long air-core solenoid of 1000 turns per unit length carries a current of 2 A. Calculate the magnetic field at the mid-point on its axis.

24. Give the principle of AC generator. Why is a current induced in an AC generator called alternating current?

25. Write any two uses of ultraviolet radiations.

26. Name the objective used in a) refracting type telescope and b) reflecting type telescope.

27. Write the two conditions for the total internal reflection to occur.

28. Name the majority and the minority charge carriers in n-type semiconductor.

PART – C

IV. Answer any FIVE of the following questions: **5 × 3 = 15**

29. Write any three properties of electric field lines.

30. Obtain the expression for the effective capacitance of two capacitors connected in parallel.

31. What is Lorentz force? Write its expression and explain the terms.

32. Write any three differences between diamagnetic and paramagnetic materials.

33. Describe an experiment to demonstrate the phenomenon of electromagnetic induction using a bar magnet and a coil.

34. Give any three results of experimental study of photoelectric effect.

35. Write the three postulates of Bohr's atom model.

36. Find the energy equivalent of one atomic mass unit, first in joule and then in MeV. Given: $1u = 1.6605 \times 10^{-27}\ kg$, $e = 1.602 \times 10^{-19}\ C$ and $c = 2.9979 \times 10^{8}\ m\,s^{-1}$.

PART – D

V. Answer any THREE of the following questions: 3 × 5 = 15

37. Derive the expression for the electric field at a point on the axis of an electric dipole.

38. Two cells of different emfs and different internal resistances are connected in series. Derive the expression for effective emf and effective internal resistance of the combination.

39. Derive the expression for the magnetic field at a point on the axis of a circular current loop.

40. a) Two coherent waves of a constant phase difference undergo interference. Obtain the expression for the resultant displacement. **(3)**

b) Write the conditions for constructive and destructive interference in terms of phase difference. **(2)**

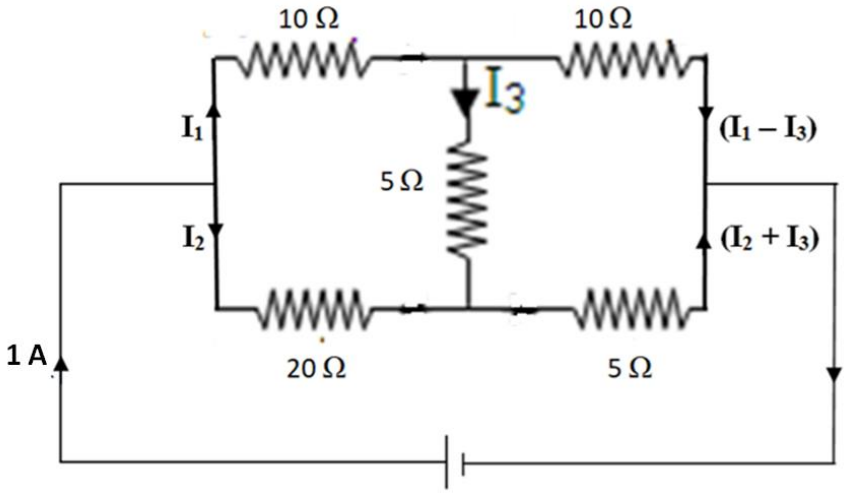
41. What is a rectifier? Explain the working of a full-wave rectifier using a neat circuit diagram. Draw its input-output waveforms.

VI. Answer any TWO of the following questions: 2 × 5 = 10

42. a) Calculate the potential at point P due to a charge of 400nC located 9 cm away.

b) Obtain the work done in moving a charge of 2nC from infinity to the point P. Does the answer depend on the path along which the charge is moved?

43. In the following network, find the current I_3.



44. An AC source of frequency 50Hz is connected in series with an inductor of 1H, a capacitor of 90μF and a resistor of 100Ω. Does the current leads or lags the voltage? Calculate the phase difference between the current and the voltage.

45. An equilateral prism is made of glass of unknown refractive index. A parallel beam of light is incident on a face of the prism. The angle of minimum deviation is 40°. Find the refractive index of the material of the prism. If the prism is placed in water of refractive index 1.33, find the new angle of minimum deviation of a parallel beam of light.

PART – E

(For Visually Challenged Students only)

7) A circular conducting loop is placed in the plane of the paper to the right of a long straight conductor carrying current I in the upward direction. The direction of current induced in the loop is

(A) clockwise if I is increasing

(B) anti clockwise if I is decreasing

(C) anti clockwise if I is increasing

(D) anti clockwise if I is constant

43) In a Wheatstone bridge, AB = 10Ω , BC = 10Ω , CD = 5Ω and DA = 20Ω are connected in cyclic order. A galvanometer of 5Ω is connected between B and D. A current of 1A enters at A and leaves the network at C. Find the current through the galvanometer.

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MODEL QUESTION PAPER - 2 2024-25

II PUC - PHYSICS (33)

Time: 3 hours. **Max Marks: 70**

No of questions: 45

General Instructions:

1. ***All parts (A TO D) are compulsory. PART-E is only for visually challenged students.***
2. ***For Part – A questions, first written-answer will be considered for awarding marks.***
3. ***Answers without relevant diagram / figure / circuit wherever necessary will not carry any marks.***
4. ***Direct answers to numerical problems without relevant formula and detailed solutions will not carry any marks.***

PART – A

I. Pick the correct option among the four given options for ALL of the following questions: **15 × 1 = 15**

1. 'The total electric flux through a closed surface in air is equal to $\frac{1}{\varepsilon_0}$ times the total charge enclosed by that surface'. This is the statement of

(A) Coulomb's law in electrostatics (B) Gauss's law in magnetism

`(C) Gauss's law in electrostatics (D) Ampere's circuital law

2. The electric potential due to a negative point charge at a distance 'r' is

(A) positive and it varies as $\frac{1}{r^2}$ (B) positive and it varies as $\frac{1}{r}$

(C) negative and it varies as $\frac{1}{r^2}$ (D) negative and it varies as $\frac{1}{r}$

3. Identify the WRONG statement from the following

(A) The drift speed acquired by free electrons per unit electric field is called mobility.

(B) The conductivity of semiconductors decreases with increase in temperature.

(C) The conductivity of conductors decreases with increase in temperature.

(D) Alloys are widely used in the construction of standard resistors.

4. The physical quantities related to magnetism are listed in column I and the dimensions are listed in column II. Identify the correct match

Column I	Column II
(i) Magnetic field	(a) $[MLT^{-2}A^{-2}]$
(ii) Magnetic permeability	(b) $[L^2 A]$
(iii) Magnetic moment	(c) $[M T^{-2}A^{-1}]$

(A) (i) - (b), (ii) - (c), (iii) - (a) (B) (i) - (c), (ii) - (b), (iii) - (a)

(C) (i) - (a), (ii) - (b), (iii) - (c) (D) (i) - (c), (ii) - (a), (iii) - (b)

5. The ferromagnetic material among the following is

(A) copper (B) nickel (C) lead (D) calcium

6. The following are the statements related to self-inductance:

(i) The self-inductance of a coil depends on its geometry and on the permeability of the medium inside it.

(ii) The self-inductance is a measure of electrical inertia and opposes the change in current in the coil.

(A) Both the statements are wrong (B) Only statement (i) is correct

(C) Both the statements are correct (D) Only statement (ii) is correct

7. In a transformer, N_P and N_S are the number of turns present in its primary and secondary coils respectively. The transformer is said to be a step-up transformer if

(A) $N_P < N_S$ (B) $N_P > N_S$ (C) $N_P = N_S$ (D) $N_P >> N_S$

8. The expression for displacement current i_d is

(A) $i_d = \varepsilon_0^2 \frac{d\phi_E}{dt}$ (B) $i_d = \mu_0 \varepsilon_0 \frac{d\phi_E}{dt}$ (C) $i_d = \mu_0 \frac{d\phi_E}{dt}$ (D) $i_d = \varepsilon_0 \frac{d\phi_E}{dt}$

9. Identify the statement which is true for a compound microscope from the following.

(A) Its objective is a convex lens of greater aperture.

(B) Its eyepiece is a convex lens of smaller aperture.

(C) The image formed by its objective is real and inverted.

(D) Its eyepiece produces the final image, which is virtual and diminished.

10. Diffraction effect is exhibited by _____ .

(A) only sound waves (B) only light waves

(C) only matter waves (D) all types of waves

11. In photoelectric effect experiment if only the frequency of incident radiation is increased, then

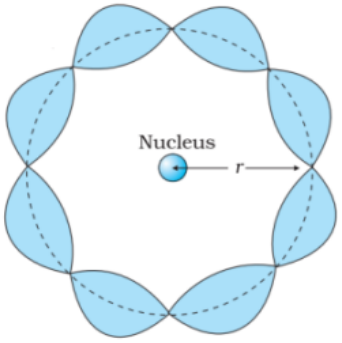
(A) the maximum kinetic energy of photoelectrons decreases. (B) the stopping potential increases.

(C) the photoelectric current increases. (D) the photoelectric current decreases.

12. The impact parameter is minimum in alpha (α) - scattering experiment for the scattering angle of

(A) 180^0 (B) 0^0 (C) 120^0 (D) 90^0

13. A standing wave is shown on a circular orbit where a certain number of de Broglie wavelengths fit into the circumference of the orbit. The principal quantum number (n) of the orbit and radius (r) of the orbit are respectively:



(A) 8 and $\frac{4\lambda}{\pi}$ (B) 4 and $\frac{4\lambda}{\pi}$

(C) 8 and $\frac{2\lambda}{\pi}$ (D) 4 and $\frac{2\lambda}{\pi}$

14. The radioactive decay in which very high energy photons are emitted is called _____.

(A) gamma decay (B) alpha decay (C) negative β decay (D) positive β decay

15. When a forward bias is applied to a p-n junction, it

(A) raises the potential barrier. (B) reduces the majority carrier current to zero.

(C) lowers the potential barrier. (D) raises the width of depletion region.

II. Fill in the blanks by choosing appropriate answer given in the bracket for ALL the following questions: 5 × 1 = 5

(zero, paramagnetic, transverse, ac generator, one, diamagnetic)

16. The magnetic susceptibility is negative for _____ materials.

17. The device which works on the principle of electromagnetic induction is _____.

18. The power factor of an AC circuit containing pure resistor is _____.

19. The light waves are _____ in nature.

20. The charge of a photon is _____.

PART – B

III. Answer any FIVE of the following questions: 5 × 2 = 10

21. 'The charges are additive in nature'. Explain.

22. What is an equipotential surface? What will be the shape of equipotential surfaces corresponding to a single point charge?

23. Give any two differences between current and current density.

24. A moving coil galvanometer gives full scale deflection when 500 μA of current passes through it. If the number of divisions on either side of the galvanometer is 50, find its current sensitivity.

25. State Faraday's law and Lenz's law of electromagnetic induction.

26. Name the electromagnetic waves used for the following applications.

a) The radar systems used in aircraft navigation.

b) The remote switches of household electronic systems such as TV.

27. How does the total energy of an electron revolving in n^{th} orbit of hydrogen atom depend on the principal quantum number of the orbit? What is the significance of the negative sign in the expression for total energy of electron in a hydrogen atom?

28. What are intrinsic and extrinsic semiconductors?

PART – C

IV. Answer any FIVE of the following questions: 5 × 3 = 15

29. What is an electric dipole? Define electric dipole moment. Give its direction.

30. What is a capacitor? Mention any two factors on which the capacitance of a parallel plate capacitor depends.

31. Derive an expression for angular frequency of revolution for a charged particle moving perpendicular to a uniform magnetic field.

32. Mention any three properties of magnetic field lines.

33. A horizontal straight wire 10 m long is falling with a speed of 5.0 m s^{-1}, at right angles to a magnetic field, 0.30×10^{-4} Wbm^{-2}. Find the instantaneous value of the emf induced in the wire.

34. Derive the relation between radius of curvature and focal length in case of a concave mirror.

35. Give Einstein's explanation of photoelectric effect and write Einstein's photoelectric equation.

36. Define 'binding energy' and 'mass defect'. Write the relation between them.

PART – D

V. Answer any THREE of the following questions: 3 × 5 = 15

37. a) Obtain an expression for potential energy of an electric dipole placed in a uniform electric field. **(3)**

b) Define energy density of a charged capacitor. How is the energy density related to electric field present between the plates of capacitor? **(2)**

38. Derive an expression for effective emf and effective internal resistance of two cells of different emfs and internal resistances connected in parallel.

39. Derive an expression for force per unit length on two infinitely long thin parallel straight conductors carrying currents and hence define 'ampere'.

40. a) What is a wavefront? **(1)**

b) Explain refraction of light through a thin prism with a diagram. **(2)**

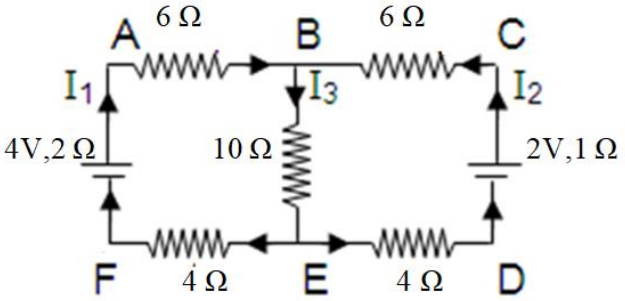
c) Give any two differences between constructive and destructive interferences of light. **(2)**

41. What is a half-wave rectifier? Explain the working of a half-wave rectifier using neat circuit diagram. Also draw input-output waveforms corresponding to it.

VI. Answer any TWO of the following questions: 2 × 5 = 10

42. Two point charges of +4 nC and +8 nC are placed at the points A and B respectively separated by a distance 0.2 m in air. Find the magnitude of the resultant electric field at the midpoint 'O' of the line joining A and B. What will be the magnitude of resultant electric field at 'O' if +4 nC is replaced by another +8 nC charge?

43. Find the currents I_1 and I_2 in the given electrical network.



44. A series LCR circuit contains a pure inductor of inductance 5 H, a capacitor of capacitance 20 μF and resistor of resistance 40 Ω. If the AC source of 200 V, 50 Hz is present in the circuit, find the impedance. Also find the resonant frequency of the circuit.

45. An object is placed at a distance 0.3 m from a convex lens of focal length 0.2 m. Find the position and nature of the image formed. Also find the distance through which the object should be moved to get an image of linear magnification '-1'.

PART – E

(For Visually Challenged Students only)

13) The standing wave pattern of matter waves associated with an electron revolving in a stable orbit is containing 4 complete waves. The principal quantum number (n) and radius (r_n) of the orbit are respectively

(A) 8 and $\frac{4\lambda}{\pi}$ (B) 4 and $\frac{4\lambda}{\pi}$ (C) 8 and $\frac{2\lambda}{\pi}$ (D) 4 and $\frac{2\lambda}{\pi}$

43) The positive terminals of two cells of emfs 4 V and 2 V with internal resistances 2 Ω and 1 Ω are connected by a uniform wire of resistance 12 Ω. Their negative terminals are connected by a second uniform wire of resistance 8 Ω. The mid points of these two wires are connected by a third uniform wire of resistance 10 Ω. Find the current through 4 V cell.

&&&&

MODEL QUESTION PAPER – 3 2024–25

II PUC – PHYSICS (33)

Time: 3 hours **Max Marks: 70** **No. of questions : 45**

GENERAL INSTRUCTIONS:

1. All PARTS (A to D) are compulsory. PART-E is only for visually challenged students.

2. For PART – A questions, first written-answer will be considered for awarding marks.

3. Answers without relevant diagram / figure / circuit wherever necessary will not carry any marks.

4. Direct answers to numerical problems without relevant formula and detailed solution will not carry any marks.

PART – A

I. Pick the correct option among the four given options for ALL of the following questions: 15 × 1 = 15

1. The SI unit of surface charge density is _____ .

(A) C m^{-1} (B) C m^{-2} (C) C m^{-3} (D) kg m^{-3}

2. The values of electric field(E) and electric potential(V) at any point on the equatorial plane of an electric dipole are such that

(A) E =0, V=0 (B) E =0, V≠0 (C) E ≠ 0, V=0 (D) E ≠0, V≠0

3. If the potential difference across a capacitor is doubled, then the energy stored in it

(A) is doubled (B) is quadrupled (C) is halved (D) remains same

4. A wire has a non-uniform cross-sectional areaas shown in the figure. A steady current I flows through it. Which one of the following statements is correct?

(A) The drift speed of electron is constant.

(B) The drift speed of electron increases while moving from *A* to *B*.

(C) The drift speed of electron decreases while moving from *A* to *B*.

(D) The drift speed of electron varies randomly.

5. A charged particle of charge q is moving in a uniform magnetic field. The angle between the velocity(v) of the charged particle and magnetic field(B) is θ. The trajectory of the charged particle varies with angle θ. Match the following table by choosing the appropriate trajectory traced by the charged particle for different possible values of angleθ.

Angle	Trajectory
(i) θ = 0°	(a) circle
(ii) θ = 45°	(b) straight line
(iii)θ = 90°	(c) helix

(A) (i)–(a) , (ii)–(b), (iii) – (c)

(B) (i) –(b) , (ii) – (c), (iii) – (a)

(C)(i) –(b) , (ii) – (a), (iii) – (c)

(D) (i) –(c) , (ii) – (b), (iii) – (a)

6. Below are the two statements related to magnetic flux and magnetic field lines.

Statement-I : The net magnetic flux through any closed surface is zero.

Statement-II: The number of magnetic field lines leaving the surface is balanced by the number of lines entering it.

(A) Both the statements I and II are correct and II is the correct explanation for I.

(B) Both the statements I and II are correct and II is not the correct explanation for I.

(C) Statement I is wrong but the statement II is correct.

(D) Statement I is correct but the statement II is wrong.

7. The polarity of induced emf in a coil is given by_____

(A) Lenz's law (B) Faraday's law (C) Gauss's law in magnetism (D) Ampere's circuital law

8. In a transformer, the windings of the primary and secondary coils are wound one over the other to reduce the energy loss due to _____

(A) flux leakage (B) resistance of the windings

(C) eddy currents (D) hysteresis

9. The electromagnetic waves suitable for RADAR systems used in aircraft navigation are

(A) Gamma rays (B) Ultraviolet rays (C) Microwaves (D) Infrared waves

10. A ray of light is incident on glass-air interface at an angle greater than the critical angle for the pair of media. Then the ray undergoes

(A) refraction only (B) partial reflection and partial refraction

(C) total internal reflection (D) grazes the surface at the interface of the two media.

11. To observe sustained interference pattern on a screen placed at a suitable distance in Young's double slit experiment, which of the following condition/s is/are necessary?

(a) Sources of light should be coherent.

(b)Sources of light should be narrow.

(c) Sources of light should be very close.

(A) only (a) (B) both (a) and (b) (C) both (b) and (c) (D) all (a),(b) and (c)

12. The de Broglie wavelength of a moving particle is independent of _____ of the particle.

(A) charge (B) mass (C) speed (D)momentum

13. For an electron revolving around the nucleus,

(A) kinetic energy and potential energy are positive, total energy is negative.

(B) kinetic energy is positive, potential energy and total energy are negative.

(C)potential energy is negative, kinetic energy and total energy are positive.

(D) kinetic energy and potential energy are negative, total energy is positive.

14. The ratio of nuclear densities of $_{13}Al^{27}$ and $_{29}Cu^{64}$ is

(A) 1:1 (B) 3:4 (C) 13: 29 (D) 27:64

15. The energy band gap in conductor, insulator and semiconductor are respectively E_1 , E_2 and E_3.The relation between them is

(A) $E_1 = E_2 = E_3$ (B) $E_1 < E_2 < E_3$ (C) $E_1 > E_2 > E_3$ (D) $E_1 < E_3 < E_2$

II. Fill in the blanks by choosing appropriate answer given in the bracket for ALL of the following questions: 5 × 1 = 5

(mutual induction, inductance, diffraction, magnification, quantisation, interference)

16. One of the basic properties of electric charge is_____.

17. The ratio of the magnetic flux-linkage to the current in a coil is called _____.

18. The principle of working of a transformer is _____.

19. A microscope is used to produce large _____of small objects.

20. The phenomenon of bending of light around the edges of an obstacle is called _____.

PART – B

III. Answer any FIVE of the following questions: 5 × 2 = 10

21. Name the two factors on which the resistance of a metallic wire depends.

22. When does a current carrying conductor placed in a uniform magnetic field experience
(i) maximum force and (ii) minimum force?

23. Define "magnetisation of a sample". How is it related to magnetic intensity?

24. A boy peddles a stationary bicycle. The pedals of the bicycle are attached to a coil of 100 turns, each turn of area 0.20 m^2. The coil rotates at 6 rotations per second and it is placed in a uniform magnetic field of 0.01T perpendicular to the axis of rotation of the coil. Calculate the maximum value of emf generated in the coil.

25. What is displacement current? Give the expression for it.

26. Mention two uses of polaroids.

27. Write two limitations of Bohr's atom model.

28. How can a semiconductor diode be forward biased? What happens to the width of the depletion region when forward bias voltage is increased?

PART – C

IV. Answer any FIVE of the following questions: 5 × 3 = 15

29. Derive the expression for the torque on an electric dipole placed in a uniform electric field.

30. Give three results of electrostatics of conductors.

31. State and explain Biot-Savart's law with a suitable diagram.

32. Write the three differences between diamagnetic and ferromagnetic materials.

33. Derive the expression for motional emf induced in a straight conductor moving perpendicular touniform magnetic field.

34. A small candle is placed at a distance of 20 cm in front of a concave mirror of radius of curvature 30 cm. At what distance from the mirror should a screen be placed in order to obtain a sharp image? What is the nature of the image?

35. Using Huygen's principle, show that the angle of reflection is equal to the angle of incidence when a plane wavefront is reflected by a plane surface.

36. Write the three features of nuclear force.

PART – D

V. Answer any THREE of the following questions: 3 × 5 = 15

37. State Gauss's law in electrostatics. Derive an expression for the electric field at a point due to an infinitely long thin uniformly charged straight wire using Gauss's law.

38. Arrive at the balance condition of Wheatstone bridge using Kirchhoff's rules.

39. What is the principle behind the working of a moving coil galvanometer? With the help of a neat labelled diagram, obtain the expression for the angular deflection produced in moving coil galvanometer.

40. Derive the expression for refractive index of the material of the prism in terms of angle of minimum deviation and angle of the prism.

41. (a)Write three differences between intrinsic semiconductor and extrinsic semiconductor. **(3)**

(b) Draw the energy band diagrams of (i) n-type and

(ii) p-type semiconductors at temperature T > 0K **(2)**

VI. Answer any TWO of the following questions: 2 × 5 = 10

42. Three capacitors of capacitances 2μF, 3μF, 6μF are connected in series.

(a) Determine the effective capacitance of the combination.

(b) Find the potential difference across 6μF capacitor if the combination is connected to a 60 V supply.

43. For copper, the number density of free electrons is 8.5×10^{28} m^{-3} and resistivity is $1.7 \times 10^{-8}\Omega$ m. Calculate the conductivity of copper and relaxation time of free electrons in copper.

(The mass of electron= 9.1×10^{-31}kg and e = 1.6×10^{-19} C)

44. A resistor of 50Ω, a pure inductor of 250mH and a capacitor are in series in a circuit containing an AC source of 220 V, 50 Hz. In the circuit, current leads the voltage by 60°. Find the capacitance of the capacitor.

45. When light of wavelength 400 nm is incident on a photosensitive surface, the stopping potential for the photoelectrons emitted is found to be 0.96 V. When light of wavelength 500 nm is incident on the same photosensitive surface, the stopping potential is found to be 0.34 V. Calculate the Planck's constant. Given: speed of light in vacuum is 3×10^{8} m s^{-1} and e = 1.6×10^{-19} C.

PART – E

(FOR VISUALLY CHALLENGED STUDENTS ONLY)

4. A wire has a non-uniform cross-sectional area in which end A of the wire has smaller area than that of end B. A steady current Iflows through it. Which one of the following statements is correct?

(A) The drift speed of electron is constant.

(B) The drift speed of electron increases while moving from *A* to *B*.

(C) The drift speed of electron decreases while moving from *A* to *B*.

(D) The drift speed of electron varies randomly.

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PRACTICE QUESTION PAPER – 1

II PUC – PHYSICS (33)

Time: 3 hours Max Marks: 70 No. of questions : 45

GENERAL INSTRUCTIONS:

i. All parts (PART – A to PART – D) are compulsory.

ii. For PART – A questions, only the first written answer will be considered for awarding marks.

iii. Answers without relevant diagram / figure / circuit wherever necessary will not carry any marks.

iv. Direct answers to numerical problems without detailed solutions will not carry any marks.

PART – A

I. Pick the correct option among the four given options for all the following questions: (15 × 1 = 15)

1. **According to Gauss law in electrostatics, the electric flux through a closed surface is equal to:**
   a) $q\varepsilon_o$ b) q/ε_o c) $\mu_o I$ d) μ_o/I
2. **The electric dipole moment per unit volume in a dielectric is called**
   a) Electric polarisation b) Electrification c) Volume charge density d) Magnetisation
3. **If a conductor at room temperature is heated, then its resistivity**
   a) decreases b) remains constant c) becomes zero d) increases
4. **Statement (i): When two parallel wires hanging freely are connected in series to a battery, they attract each other.**
   Statement (ii): Parallel wires carrying current in the same direction attract each other. Choose the correct option.
   a) Both statements are correct. Statement (ii) is the explanation of Statement (i)
   b) Both statements are correct. Statement (ii) is not the explanation of Statement (i)
   c) Statement (i) is wrong but Statement (ii) is correct
   d) Statement (i) is correct but Statement (ii) is wrong
5. **The ratio of magnetisation to magnetic intensity is**
   a) Relative magnetic permeability b) Magnetic dipole moment
   c) Magnetic susceptibility d) Magnetic permeability
6. **Lenz's law is a consequence of conservation of**
   a) energy b) linear momentum c) angular momentum d) charge
7. **The motional emf induced in a straight conductor moving perpendicular to a uniform magnetic field depends on**
   (i) strength of magnetic field (ii) speed of the conductor (iii) length of the conductor
   a) Only (i) and (ii) b) Only (ii) and (iii)
   c) Only (i) and (iii) d) All (i), (ii) and (iii)

8. In a pure inductive circuit, the phase difference between the current and voltage is

a) π b) $\pi/2$ c) $\pi/3$ d) $\pi/6$

9. The source of electromagnetic wave is

a) Stationary charge b) Charge in uniform motion

c) Accelerating charge d) Uniform electric field

10. For transmitting audio and video signals for long distances through optic fiber cables, the following phenomenon is used.

a) Total internal reflection b) Reflection

c) Refraction d) Interference

11. Match the Column-I and Column-II correctly.

Column – I	Column – II
(i) Interference	**(p) Restricting the electric vibrations in a particular plane**
(ii) Diffraction	**(q) Superposition of two coherent waves**
(iii) Polarisation	**(r) Bending of light around the sharp edges of obstacles**

a) (i) – (p); (ii) – (r); (iii) – (q) b) (i) – (q); (ii) – (p); (iii) – (r)

c) (i) – (r); (ii) – (p); (iii) – (q) d) (i) – (q); (ii) – (r); (iii) – (p)

12. If a photon is moving in a region containing both electric and magnetic fields, then it is

a) deflected by only electric field b) deflected by only magnetic field

c) deflected by both electric and magnetic fields

d) neither deflected by electric field nor by magnetic field

13. The minimum energy required to free the electron from the ground state of the hydrogen atom is

a) – 13.6 eV b) 13.6 eV c) 12.09 eV d) 1.51 eV

14. The volume of an atomic nucleus is directly proportional to

a) atomic number b) mass number

c) cube root of mass number d) cube root of atomic number

15. The energy gap in conductors, semiconductors and insulators are E_1 , E_2 and E_3 respectively. The relation between them is

a) $E_1 < E_2 < E_3$ b) $E_1 > E_2 > E_3$ c) $E_1 < E_2 > E_3$ d) $E_1 = E_2 = E_3$

II. Fill in the blanks by choosing appropriate answer given in the bracket for all the following questions: (5 × 1 = 5)

[Magnetic flux, matter, normal, electric flux, mutual induction, transverse]

16. At the surface of a charged conductor, the electrostatic field must be _____ to the surface at every point.

17. The net _____ through any closed surface is zero.

18. A transformer works on the principle of _____.

19. The polarisation of light can be successfully explained on the basis of _____ nature of light.

20. The wave associated with moving material particles is called _____ waves.

PART – B

III. Answer any five of the following questions: (5 × 2 = 10)

21. State Coulomb's law in electrostatics and write the Coulomb's law in vector form.

22. Draw the Wheatstone bridge circuit and write the condition for its balance.

23. Discuss any two cases in which the magnetic force on a charged particle in a magnetic field is zero.

24. Kamala peddles a stationary bicycle. The pedals of the bicycle are attached to a 100 turn coil of area 0.10 m2. The coil rotates at an angular frequency of π rad/s and it is placed in a uniform magnetic field of 0.01 T perpendicular to the axis of rotation of the coil. Calculate the maximum voltage generated in the coil.

25. Write any two uses of X-rays.

26. Mention the expression for refractive index of a glass prism and hence explain the terms in it

27. Draw a labeled ray diagram for the formation of image at near point by a compound microscope.

28. Write any two differences between p-type and n-type semiconductors.

PART – C

IV. Answer any five of the following questions: (5 × 3 = 15)

29. Mention the basic properties of electric charge.

30. Derive an expression for potential energy of system of two charges in the absence of external electric field.

31. Define current sensitivity of a galvanometer. Explain with a relevant diagram, the conversion of galvanometer to ammeter.

32. Write any three differences between diamagnetic and ferromagnetic materials.

33. Consider a coil of self-inductance L carrying a current I. If the current in the coil starts changing, then arrive at the expression for emf induced in it.

34. Write any three experimental observations of photoelectric effect.

35. Give de Broglie's explanation of Bohr's second postulate of quantisation of angular momentum.

36. Calculate the mass defect and binding energy (in MeV) of the $^{56}_{26}Fe$ nucleus from the following data.
m_p = 1.007825 u; m_n = 1.008665 u and m = 55.934939 u

PART – D

V. Answer any three of the following questions: (3 × 5 = 15)

37. Define capacitance. Derive an expression for capacitance of a parallel plate capacitor with air between the plates.

38. Derive the expression for conductivity of a material $\sigma = \frac{ne^2\tau}{m}$, where the symbols have their usual meaning.

39. a) State and explain Ampere's circuital law. (2)

b) Obtain an expression for the magnetic field of a current carrying solenoid. (3)

40. a) What is a wave front? (1)

b) Prove Snell's law for refraction of plane waves in denser medium using Huygen's principle. (4)

41. What is rectification? With a neat diagram, explain the working of p-n junction diode as full wave rectifier and hence draw input and output wave forms.

VI. Answer any two of the following questions: (2 × 5 = 10)

42. Two-point charges $q_A = 3\ \mu c$ and $q_B = -3\ \mu c$ are located 20 cm apart in vacuum. a) What is the electric field at the midpoint 'O' of the line AB joining the two charges? b) If a negative test charge of magnitude 1.5×10^{-9} C is placed at this point, what is the force experienced by the test charge?

43. Two cells of emf 2V and 3V each having internal resistance 1Ω are connected in parallel combination so as to send the current in the same direction. a) Calculate the equivalent emf and equivalent internal resistance of the combination. b) If this combination is connected across an external resistor of resistance 2Ω, then determine the terminal potential difference across the resistor

44. An a.c. source of emf, $\varepsilon = 282 \sin 100\ \pi t$ volt is connected to a series LCR circuit with $L = 40/\pi$ H, $C = 10/\pi\ \mu$F and R = 2 kΩ. Calculate the frequency of a.c. source and impedance of the circuit.

45. A red image of an object is formed at a distance of 20 cm from a lens in air. On placing another lens in contact with the above lens, the image gets shifted 10 cm towards the combination. Determine the focal length of second lens.

PRACTICE QUESTION PAPER – 2

II PUC – PHYSICS (33)

Time: 3 hours **Max Marks: 70** **No. of questions : 45**

GENERAL INSTRUCTIONS:

i) All Parts from A to D are compulsory. Part-E is only for visually challenged students.

ii) For Part-A questions, first written answers will be considered for awarding marks.

iii) Answers without relevant diagram / figure / circuit wherever necessary will not carry any marks.

iv) Direct answers to numerical problems without relevant formula and detailed solutions will not carry any marks.

PART - A

I. Pick the correct option among the four given options for all of the following: **15 × 1 = 15**

1. The electrostatic force between two point charges does not depend on

a) Magnitude of charges
b) Distance between the charges
c) Medium where charges are present
d) Mass of the charges

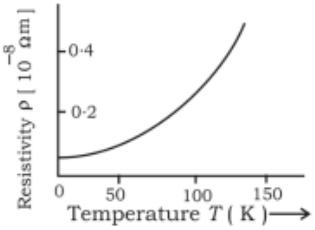
2. The electrostatic potential due to an electric dipole at a point in the equatorial plane is

a) Zero
b) $\frac{p\cos\theta}{4\pi\varepsilon_o r^3}$
c) $\frac{2p\cos\theta}{4\pi\varepsilon_o r^2}$
d) $\frac{p\cos\theta}{4\pi\varepsilon_o r}$

3. Column I contains graph of resistivity against temperature. Different materials are listed in Column II. Identify the correct match.

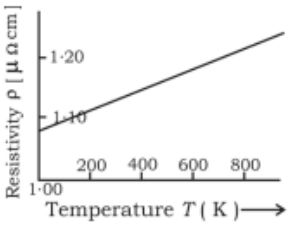
Column I **Column II**

I



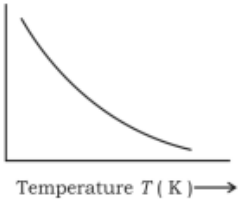
A. Semiconductor

II.



B. Copper

III. ρ



C. Nichrome

	I	II	III
a)	B	A	C
c)	C	B	A

	I	II	III
b)	B	C	A
d)	A	C	B

4. The magnetic field B at a distance R due to straight infinite wire, carrying current i is equal to

a) $B = \frac{\mu_o I}{4\pi R}$ b) $B = \frac{\mu_o I}{4\pi R^2}$ c) $B = \frac{\mu_o I}{2\pi R}$ d) $B = \frac{\mu_o I}{2\pi R^2}$

5. The ratio of magnetisation to magnetic intensity is called

a) Magnetic permeability b) Relative magnetic permeability

c) Magnetic moment d) Magnetic susceptibility

6. The magnitude of induced emf in a coil is equal to

a) Magnetic flux through the coil b) Rate of change of magnetic flux through the coil

c) Electric flux through the coil d) Rate of change of electric flux through the coil

7. Thick winding wires are used in transformers, to reduce the energy loss due to

a) Flux leakage b) Eddy current

c) Resistance d) Hysteresis

8. When heavy metals are bombarded by high energy electrons, the electromagnetic waves generated are

a) X-rays b) Radio waves c) Microwaves d) Infrared radiations

9. The working principle of optical fibres is

a) Reflection b) Refraction

c) Total internal reflection d) Partial reflection and refraction Code

10. Polaroids are used in sunglasses to

a) Increase the intensity of incident light b) Increase the frequency of incident light

c) Control the intensity of light d) Control the velocity of light

11. The de Broglie wavelength of proton [λ_p] and an electron [λ_e] moving with same velocity is related as

a) $\lambda_e > \lambda_p$ b) $\lambda_e < \lambda_p$ c) $\lambda_e = \lambda_p$ d) $\lambda_e > h/\lambda_p$

12. Bohr's atomic model is called as

a) Plum Pudding model b) Quantum model c) Nuclear model d) Vector atom model

13. When an electron makes a transition from higher non-radiating orbit to another of lower orbit, then its kinetic energy [K] and potential energy [U] are

a) K decreases and U increases b) Both K and U decrease

c) Both K and U increase d) K increases and U decreases

14. The nuclides with different mass numbers but same number of neutrons are called

a) Isotones b) Isotopes c) Isobars d) Isomers

15. The process of adding impurity to pure semiconductor is called

a) Biasing b) Doping c) Rectifying d) Filtering

II. Fill in the blanks by choosing the appropriate answer given in the brackets for all the following questions : 5 × 1 = 5

[inertia, one, zero, photons, decreases, increases]

16. The magnetic flux through any closed surface is equal to _____.

17. Self inductance L of a coil plays the role of _____.

18. Power factor of pure resistive circuit is equal to_____.

19. In single slit diffraction experiment of light, on either side of central bright region the intensity keeps on _____.

20. The particles of light energy are called _____.

PART – B

III. Answer any five of the following questions : 5 × 2 = 10

21. Explain the quantisation of charges.

22. Mention any two factors on which the capacitance of parallel plate capacitor depends.

23. State Kirchhoff's current law. What is the significance of this law?

24. Calculate the magnetic field at the centre of circular coil of radius 3·14 m carrying a current of 2 A. (Given: $\mu_o = 4\pi \times 10^{-7}$ T m A^{-1})

25. What is an AC generator? Why the current induced in it is called alternating current?

26. What is displacement current? Write its expression.

27. Write any two limitations of Rutherford's atomic model.

28. Name the majority charge carriers in a) n-type of semiconductor b)p-type of semiconductor.

PART – C

IV. Answer any five of the following questions: 5 × 3 = 15

29. Write any three properties of electric field lines.

30. a) What are polar and non-polar molecules?

b) Write one use of electrostatic shielding.

31. With the circuit diagram explain the conversion of galvanometer into voltmeter.

32. Write any three differences between diamagnetic and ferromagnetic materials.

33. Current in the coil of 4 H falls from 5A to 2A. If the induced emf in the coil is 20 V, calculate the time taken.

34. Name the two types of telescope based on the objective used. Also mention any one factor on which magnifying power of telescope depends.

35. List any three experimental observations of photoelectric effect.

36. What is nuclear fission and fusion? Write any one neutron induced fission reaction of $_{92}U^{235}$ isotope.

PART – D

V. Answer any three of the following questions: **3 × 5 = 15**

37. Obtain an expression for electrostatic potential due to point charge in free space.

38. Derive an expression for effective emf and internal resistance of two cells of different emfs and internal resistances connected in parallel.

39. a) Obtain an expression for radius of a charged particle moving perpendicular to uniform magnetic field.
b) What is the nature of force between two conductors carrying parallel and antiparallel current. (3 + 2)

40. a) Deduce the expression for resultant displacement when two coherent waves superpose.
b) Write the condition for constructive and destructive interference in terms of phase difference. (3 + 2)

41. What is rectification? Explain the working of full wave rectifier with neat circuit diagram. Also draw input and output waveform.

VI. Answer any two of the following questions: **2 × 5 = 10**

42. Two charges of equal magnitude + 3 n C are placed at two corners X and Y of an equilateral triangle XYZ of side 10 cm. Find the magnitude of resultant electric field at point Z. Also calculate the force acting on a charge of magnitude + 2mC at Z.

43. The copper wire of length 5 m and radius 0·25 mm carries a current 5A. The number density of electrons in copper wire is $8{\cdot}5 \times 10^{28}$ m^{-3}. Calculate the time taken by an electron to drift from one end to other end of the wire. [Charge of electron e = $1{\cdot}6 \times 10^{19}$ C]

44. A series LCR circuit with R = 3Ω, L = 12·7 mH and C = 398 μF is connected to an AC source of peak value 28·4 V and frequency 50 Hz. Determine the rms value of current.

45. Double convex lens of radii of curvature 10 cm and 15 cm is placed in air. Its focal length is 12 cm. Find the refractive index of material of lens. Also find its new focal length when it is completely immersed in liquid of refractive index 1·5.

PART – E

[For visually challenged students only]

3. Column I contains the relation between variation of resistivity with temperature. Column II contains the materials. Identify the correct match.

Column – I	Column – II
I. Resistivity increases nonlinearly with temperature	A. Semiconductor
II. Resistivity increases linearly with temperature.	B. Copper
III. Resistivity decreases nonlinearly with temperature	C. Nichrome

Department of School Education (Pre University), 18th Cross, Malleshwaram Bengaluru- 560012;

and

Karnataka School Education and Assessment Board, 6th Cross, Malleshwaram Bengaluru- 560003

2025 – 26 II PUC PHYSICS QUESTION BANK DEVELOPMENT COMMITTEE

SI. NO.	NAME	DESIGNATION	NAME, ADDRESS OF THE COLLEGE
1.	VENKATESH K V COMMITTEE MEMBER	LECTURER	SARVODAYA PU COLLEGE, TUMAKUR, TUMAKUR DIST.
2.	ADITHYA RAO K V COMMITTEE MEMBER	LECTURER	GOVERNMENT PU COLLEGE, SRINGERI, CHIKMAGALUR DIST.
3.	SHREENIVASA M BHAT COMMITTEE MEMBER	LECTURER	GOVERNMENT PU COLLEGE, KARWAR, UTTARA KANNADA DIST.

QUESTION BANK PREPARATION COMMITTEE (2024 – 25)

SI. NO.	NAME	DESIGNATION	NAME ADDRESS OF THE COLLEGE
1.	MAHESH B COORDINATOR	PRINCIPAL	GOVERNMENT PU COLLEGE, MYLANAYAKANAHOSAHALLI, RAMANAGARA DIST
2.	ADITHYA RAO K V COMMITTEE MEMBER	LECTURER	GOVERNMENT PU COLLEGE, SRINGERI, CHIKMAGALUR DIST.
3.	DEVARAJ TALAKALLU, COMMITTEE MEMBER	LECTURER	GOVT. SCIENCE PU COLLEGE, DASTIKOPPA, DHARWAD DIST
4	MAHESH, COMMITTEE MEMBER	LECTURER	GOVT. PU COLLEGE FOR GIRLS, RAMANAGARA, RAMANAGARA DIST
5	PRASANNA K V, COMMITTEE MEMBER	LECTURER	GOVT. PU COLLEGE, KOPPA, CHIKMAGALUR DIST
6	PRAKASH COMMITTEE MEMBER	LECTURER	GOVT. PU COLLEGE FOR GIRLS, CHENNAPATNA, RAMANAGARA DIST
7	CHETHANA, COMMITTEE MEMBER	LECTURER	GOVT. PU COLLEGE FOR BOYS, CHANNAPATNA, RAMANAGARA DIST