1. Electrostatics (Q NO 31, 32)

1.1 Electrostatics

1. State the law of conservation of electric charges.
2. Example: Uranium (\(92\text{U}^{238}\)) can decay by emitting an alpha particle (\(\text{He}^4\) nucleus) and transforming to thorium (\(90\text{Th}^{234}\)).

\[
\text{\(92\text{U}^{238}\)} \rightarrow \text{\(90\text{Th}^{234}\)} + 2\text{He}^4
\]

3. Total charge before decay = +92e,
4. Total charge after decay = 90e + 2e.
Hence, the total charge is conserved. i.e. it remains constant.

2. What do you mean by additive nature of charges? Give an example.
1. The total electric charge of a system is equal to the algebraic sum of electric charges located in the system.
2. Example: The two charged bodies of charges +2q, −5q are brought in contact, the total charge of the system is −3q.

Coulomb's law states that the force of attraction or repulsion between two point charges is directly proportional to the product of the charges and inversely proportional to the square of the distance between them.

\[
F \propto \frac{q_1q_2}{r^2} \quad (OR) \quad F = \frac{1}{4\pi\varepsilon_0} \frac{q_1q_2}{r^2}
\]

One Coulomb is defined as the quantity of charge, which when placed at a distance of 1 metre in air or vacuum from an equal and similar charge experiences a repulsive force of \(9\times10^9\)N.

1.2 Electric Field

5. Give 3 properties of electric lines of force.
1. Lines of force start from positive charge and terminate at negative charge.
2. Lines of force never intersect.
3. The tangent to a line of force at any point gives the direction of the electric field (\(E\)) at that point.

6. What is an electric dipole? Define: the dipole moment.

**Electric dipole:** Two equal and opposite charges separated by a very small distance constitute an electric dipole.

Examples: Water, ammonia, carbon–dioxide.

**Dipole moment:** The dipole moment is the product of the magnitude of the one of the charges and the distance between them.

Electric dipole moment, \(p = 2qd\).

It is a vector quantity and acts from −q to +q.

1.3 Electric potential

1. The electric potential in an electric field at a point is defined as the amount of work done in moving a unit positive charge from infinity to that point against the electric forces.

\[
V = \frac{1}{4\pi\varepsilon_0} \frac{q}{r}
\]

2. It is scalar quantity.

9. Define: Electric potential difference between two points in an electric field.
1. Potential difference between two points in an electric field is defined as the amount of work done in moving a unit positive charge from one point to the other against the electric force.

2. Unit: Volt.

10. Distinguish between electric potential and potential difference.

<table>
<thead>
<tr>
<th>Electric potential</th>
<th>Potential difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electric potential in an electric field at a point is defined as,</td>
<td>The amount of work done in moving a unit positive charge from infinity to that point against the electric forces.</td>
</tr>
<tr>
<td>The amount of work done in moving a unit positive charge from one point to the other against the electric force.</td>
<td></td>
</tr>
</tbody>
</table>

11. What is electrostatic potential energy of a System of two point of charges?
It is equal to the work done to assemble the charges or work done in bringing each charge or work done in bringing a charge from infinite distance.

\[
U = \frac{1}{4\pi\varepsilon_0} \frac{q_1q_2}{r}
\]

2. Unit: joule.
1.4 Gauss’s law and its applications

The electric flux is defined as the total number of electric lines of force, crossing through the given area.

\[
\frac{d\phi}{dS} = \int E \cdot ds = \int E \cdot d\cos \theta
\]

Unit: Nm²C⁻¹.

13. State Gauss’s law.
The total flux of the electric field \(E\) over any closed surface is equal to \(1/\varepsilon_0\) times the net charge enclosed by the surface.

\[
\phi = \frac{Q}{\varepsilon_0}
\]

14. What is electrostatic shielding?
1. It is the process of isolating a certain region of space from external field.
2. It is based on the fact that electric field inside a conductor is zero.

15. During lightning, it is safer to sit inside a car than in an open ground. Why?
1. The metal body of the car provides electrostatic shielding, where the electric field is zero.
2. During lightning the electric discharge passes through the body of the car.

1.5 Electrostatic induction

1. A capacitor is a device for storing electric charges.
2. The capacitance of a conductor is defined as the ratio of the charge given to the conductor to the potential developed in the conductor.

17. Write the applications of a capacitor.
1. They are used in the ignition system of automobile engines to eliminate sparking.
2. They are used to reduce voltage fluctuations in power supplies and to increase the efficiency of power transmission.
3. Capacitors are used to generate electromagnetic oscillations and in tuning the radio circuits.

18. Three capacitors each of capacitance 3 pF are connected in parallel. Find effective capacitance.
The effective capacitance \(C_p\) is \(C_1 + C_2 + C_3\)

\[
= 9 + 9 + 9 = 27 \text{ PF}
\]

19. What are polar molecules? Give an example.
1. A polar molecule is the centre of gravity of the positive charges separated from the centre of gravity of the negative charges by a finite distance.

2. They have a permanent dipole moment
3. Examples: \(\text{N}_2\text{O}, \text{H}_2\text{O}, \text{HCl}, \text{NH}_3\).

20. What are non-polar molecules? Give an example.
1. A non-polar molecule is the centre of gravity of the positive charges coincide with the centre of gravity of the negative charges.
2. The non-polar molecules do not have a permanent dipole moment.
3. Example: \(\text{O}_2, \text{N}_2, \text{H}_2\).

21. What is dielectric polarization?
1. The alignment of the dipole moments of the permanent or induced dipoles in the direction of applied electric field is called polarisation or electric polarisation.
2. The magnitude of the induced dipole moment \(p\) is directly proportional to the external electric field \(E\).

\[
p \alpha E
\]

22. What is action of points (corona discharge)? What is its use?
1. The leakage of electric charges from the sharp points on the charged conductor is known as action of points or corona discharge.
2. This principle is used in the electrostatic machines for collecting charges and in lightning arresters.

QUESTION BANK

3 MARKS QUESTIONS:
1. What do mean by additive nature of charges?
2. State coulomb’s law in electrostatic.
3. Define coulomb on the basis of Coulomb’s law.
4. Mention any 3 properties of electric lines of force
5. What is an electric dipole moment? Define electric dipole moment.
6. Explain the working of microwave oven.
7. Define electric potential at a point.
8. Why is it safer to be inside a car than standing under a tree during lightning?
9. What is polar molecule? Give any two examples.
10. What is non-polar molecule? Give example.
12. State Gauss’s law in electrostatics.
13. What is electrostatic shielding?
14. What is corona discharge? What are its advantages?
15. What is capacitor? Define its capacitance.
16. What are the uses of capacitors?
17. What is corona discharge?
18. What is meant by dielectric polarisation?

5 MARKS QUESTIONS:
1. Write the properties of electric lines of force.
2. Derive an expression torque experienced by an electric dipole placed in a uniform electric field.
3. Define electric potential at a point. Obtain an expression for electric potential due to single charge.
4. What is electrostatic potential energy of a system two point charges? Deduce an expression for it.
5. Deduce an expression for the capacitance of a parallel plate capacitor.
6. Prove that the energy stores in a capacitor is \( \frac{q^2}{2C} \).

10 MARKS QUESTIONS:
1. What is an electric dipole? Derive an expression for the electric field due to an electric dipole at a point on its axial line.
2. Derive an expression for the electric field at a point due to an electric dipole at a point along the equatorial line.
3. Derive an expression for the electric potential at a point due to an electric dipole. Discuss the special cases.
4. State Gauss law. Using Gauss law, obtain the expression for electric field due to an infinitely long straight uniformly charged wire.
5. Explain the principle of a capacitor. Obtain the expression for the capacitance of a parallel plate capacitor.
6. Deduce an expression for the equivalent capacitance of capacitors connected in (1) series and (2) in parallel.
7. Explain the principle, construction and working of a Van-de Graaff generator.

2. Current Electricity (Q. No 33, 34, 35)

2.1 Electric current

1. Define current.
   The current is defined as the rate of flow of charges across any cross-sectional area of a conductor.
   \[ I = \frac{q}{t} \]
   Net charge - \( q \). Time - \( t \).

2. Define: Drift velocity.
   Drift velocity is defined as the velocity with which free electrons get drifted towards the positive terminal, when an electric field is applied.

   The mobility is defined as the drift velocity acquired per unit electric field.
   \[ \mu = \frac{v}{E} \]
   Unit: \( m^2/V \cdot s \).

   The quantity of charge passing per unit time through unit area, taken perpendicular to the direction of flow of charge at that point is called current density.
   \[ j = \frac{q}{A} \]
   Unit: \( A/m^2 \).

5. State Ohm’s law.
   At a constant temperature, the steady current flowing through a conductor is directly proportional to the potential difference between the two ends of the conductor.
   \[ V = IR \]
   \( V \) is potential difference, \( I \) is steady current, \( R \) is Resistance.

6. Define electrical resistivity, and electrical conductivity.
   1. The electrical resistivity of a material is defined as the resistance offered to current flow by a conductor of unit length having unit area of cross section.
   2. The unit of \( \rho \) is ohm m (\( \Omega m \)). It is a constant for a particular material.

   Electrical conductivity:
   The reciprocal of electrical resistivity, is called electrical conductivity.
   \[ \sigma = \frac{1}{\rho} \]
   The unit of conductivity is mho m\(^{-1}\) (\( \Omega^{-1} m^{-1} \)).

2.2 Superconductivity

7. What is superconductivity.
   1. The ability of certain metals, their compounds and alloys to conduct electricity with zero resistance at very low temperatures is called superconductivity.
   2. The materials which exhibit this property are called superconductors.

8. Define critical temperature.
   The temperature at which electrical resistivity of the material suddenly drops to zero and the material changes from normal conductor to a superconductor is called the transition temperature or critical temperature \( T_c \).

9. What are the changes that occur at the superconducting transition temperature?
   1. The electrical resistivity drops to zero.
2. The conductivity becomes infinity.
3. The magnetic flux lines are excluded from the material.

10. Give any three applications of the superconductors.
1. High efficiency ore separating machines may be built using superconducting magnets, which can be used to separate tumor cells from healthy cells by high gradient magnetic separation method.
2. Since the current in a superconducting wire can flow without any change in magnitude, it can be used for transmission lines.
3. Superconductors can be used as memory or storage elements in computers.

2.5 Temperature dependence of resistance

The ratio of increase in resistance per degree rise in temperature to its resistance at 0°C is called as temperature coefficient of resistance.

\[ \alpha = \frac{\Delta R}{R_0 \Delta T} \]

Unit: per °C.

2.6 Internal resistance of a cell

12. Define Internal resistance of a cell
1. During the process of flow of current inside the cell, a resistance is offered to current flow by the electrolyte of the cell. This is termed as the internal resistance of the cell.
2. A freshly prepared cell has low internal resistance and this increases with ageing.

2.7 Kirchhoff's law

1. The algebraic sum of the currents meeting at any junction in a circuit is zero.
2. This law is a consequence of conservation of charges.

The algebraic sum of the products of resistance and current in each part of any closed circuit is equal to the algebraic sum of the emf’s in that closed circuit. This law is a consequence of conservation of energy.

2.8 Potentiometer

15. Compare the Emf and the potential difference.

<table>
<thead>
<tr>
<th>Emf</th>
<th>potential difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>The difference of potentials between the two terminals of a cell in an open circuit is called the electromotive force (Emf) of a cell.</td>
</tr>
<tr>
<td>2</td>
<td>The Emf is independent of external resistance of the circuit.</td>
</tr>
<tr>
<td>3</td>
<td>It is a cause.</td>
</tr>
</tbody>
</table>

2.9 Electric energy and electric power.

16. Distinguish between electric power and electric energy.

<table>
<thead>
<tr>
<th>Electric power</th>
<th>Electric energy</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>The rate of doing electric work.</td>
</tr>
<tr>
<td>2</td>
<td>Unit: watt</td>
</tr>
<tr>
<td>3</td>
<td>Unit: joule.</td>
</tr>
</tbody>
</table>

2.10 Chemical effect of current

First Law: The mass of a substance liberated at an electrode is directly proportional to the charge passing through the electrolyte.
Second Law: The mass of a substance liberated at an electrode by a given amount of charge is proportional to the chemical equivalent of the substance.

2.11 Electric cells

18. What are secondary cells? Give an example?
1. They are rechargeable.
2. The chemical reactions that take place in secondary cells are reversible.
3. The active materials that are used up when the cell delivers current can be reproduced by passing current through the cell in opposite direction.
4. Examples: lead acid accumulator and alkali accumulator.

1. They are rechargeable.
2. They have very low internal resistance.
3. They can deliver a high current if required.
4. They are used in all automobiles like cars, two wheelers, trucks etc.

20. Differentiate between Primary cells and Secondary cells.

<table>
<thead>
<tr>
<th>Primary cells</th>
<th>Secondary cells</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Chemical reactions are irreversible</td>
</tr>
<tr>
<td>2</td>
<td>They can’t be charged</td>
</tr>
<tr>
<td>3</td>
<td>They can’t be delivered high current</td>
</tr>
<tr>
<td>4</td>
<td>They can’t be produced study current for long period.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Secondary cells</th>
<th>Primary cells</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Chemical reactions are reversible</td>
</tr>
<tr>
<td>2</td>
<td>They can be recharged</td>
</tr>
<tr>
<td>3</td>
<td>They can deliver high current</td>
</tr>
<tr>
<td>4</td>
<td>They can produce study current for long period.</td>
</tr>
</tbody>
</table>
QUESTION BANK

3 MARKS QUESTIONS:
1. Define drift velocity. Write its unit.
2. Define mobility. Write its unit.
3. Define resistivity of a material
4. What are the changes observed at transition temperature when the conductor becomes superconductor?
5. What is called superconductivity?
7. Write any three applications of superconductors.
8. Define transition temperature.
10. State Kirchhoff’s 1) current law and 2) voltage law
11. State Kirchhoff’s voltage law
12. Distinguish between emf and potential difference.
13. Distinguish between electric power and electric energy.
15. What are the applications of secondary cells?
16. What are the advantages of secondary cells?

5 MARKS QUESTIONS:
1. Define mobility. Establish the relation between drift velocity and current.
2. Write any five applications of superconductors.
3. Discuss the variation of resistance with temperature with an expression and a graph.
4. When two or more resistors connected in parallel. Derive an expression for effective resistance in the combination.
5. Explain the determination of internal resistance of a cell using a voltmeter.
7. Obtain condition for bridge balance in Wheatstone’s bridge.
8. Explain the principle of potentiometer.
9. Explain the method of compare the emfs of two cells using potentiometer.
10. State and verify Faraday’s first law of electrolysis.
12. Explain the working of Daniel cell.
13. Explain the working of Leclanche cell with diagram.
14. Explain the working of Lead-acid accumulator.

3.1 Heating effect : Joule’s law

1. State Joule’s law of heating.
The heat produced in a conductor is,
1. directly proportional to the square of the current for a given R
2. directly proportional to resistance R for a given I and
3. directly proportional to the time of passage of current.

\[ H = I^2 R t \]

2. Why Nichrome is used as heating element in electric heating devices?
1. It has high specific resistance
2. It has high melting point
3. It is not easily oxidized

3. What is a fuse wire?
1. It is an alloy of lead 37% and tin 63%.
2. It is connected in series in an electric circuit.
3. It has high resistance and low melting point.
4. When large current flows through a circuit due to short circuiting, the fuse wire melts due to heating and hence the circuit becomes open.

5. The electric appliances are saved from damage.

4. What is Seebeck effect?
Seebeck discovered that in a circuit consisting of two dissimilar metals like iron and copper, an emf is developed when the junctions are maintained at different temperatures. Two dissimilar metals connected to form two junctions is called thermocouple. The emf developed in the circuit is thermo electric emf. The current through the circuit is called thermoelectric current. This effect is called thermoelectric effect or Seebeck effect.

5. What is neutral temperature?
Keeping the temperature of the cold junction constant, the temperature of the hot junction is gradually increased. The thermo emf rises to a maximum at a temperature \( \theta_n \) called neutral temperature.

6. Give any two differences between Peltier effect and Joule’s law of heating.

<table>
<thead>
<tr>
<th>Peltier effect</th>
<th>Joule’s heating</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Heat produced is directly proportional to the current, passing through the junction. ( H \propto I )</td>
<td>Heat produced is directly proportional to the square of the current ( H \propto I^2 )</td>
</tr>
<tr>
<td>2 This effect depends direction of the current.</td>
<td>This effect does not depend direction of the current.</td>
</tr>
<tr>
<td>3 Heat is produced and absorbed.</td>
<td>Heat is produced</td>
</tr>
</tbody>
</table>
7. What is temperature of inversion?
At a temperature of the cold junction constant, the temperature of
the hot junction is gradually increased, the thermo emf rises to a
maximum at a temperature called neutral temperature and then
gradually decreases and eventually becomes zero at a particular
temperature (\(\theta_i\)) called temperature of inversion.

8. Define: Peltier coefficient and write its unit.
The amount of heat energy absorbed or evolved at one of the
junctions of a thermocouple when one ampere current flows for
one second (one coulomb) is called Peltier coefficient. It is
denoted by \(\pi\).
Unit: volt.

Thomson suggested that when a current flows through unequally
heated conductors, heat energy is absorbed or evolved throughout
the body of the metal.

3.2 Magnetic effect of current

10. State Maxwell’s right hand cork screw rule.
If a right handed cork screw is rotated to advance along the
direction of the current through a conductor, then the direction of
rotation of the screw gives the direction of the magnetic lines of
force around the conductor.

A magnetic needle suspended at a point where there are two
crossed fields at right angles to each other will come to rest in the
direction of the resultant of the two fields.

\[
B = Bh \tan \theta
\]

12. Define Right hand palm rule
The coil is held in the right hand so that the fingers point in the
direction of the current in the windings. The extended thumb,
points in the direction of the magnetic field.

1. When looked from one end, if the current through the solenoid
   is along clockwise direction, the nearer end corresponds to south
   pole and the other end is north pole.
2. When looked from one end, if the current through the solenoid
   is along anti-clock wise direction, the nearer end corresponds to
   north pole and the other end is south pole

3.5 Magnetic Lorentz force

14. What are the limitations of a cyclotron?
1. Maintaining a uniform magnetic field over a large area of the
   Dees is difficult.
2. At high velocities, relativistic variation of mass of the particle
   upsets the resonance condition.
3. At high frequencies, relativistic variation of mass of the electron
   is appreciable and hence electrons cannot be accelerated by
cyclotron.

3.6 Force on a current carrying conductor placed in a
magnetic field

15. State Fleming’s left hand rule.
1. The forefinger, the middle finger and the thumb of the left hand
   are stretched in mutually perpendicular directions.
2. If the forefinger points in the direction of the magnetic field, the
   middle finger points in the direction of the current, then the
   thumb points in the direction of the force on the conductor.

Ampere is defined as that constant current which when flowing
through two parallel infinitely long straight conductors of
negligible cross section and placed in air or vacuum at a distance
of one metre apart, experience a force of \(2 \times 10^{-7}\) newton per unit
length of the conductor.

3.7 Torque experienced by a current loop in a uniform
magnetic field

The current sensitivity of a galvanometer is defined as the
deflection produced when unit current passes through the
galvanometer.

Current sensitivity \[ \frac{\theta}{i} = \frac{nhA}{C} \]

18. How can we increase the current sensitivity of a
galvanometer?
1. increasing the number of turns
2. increasing the magnetic induction
3. increasing the area of the coil
4. decreasing the couple per unit twist of the suspension wire.

19. How is a galvanometer converted into (a) an ammeter and
(b) a voltmeter?
1. A galvanometer is converted into an ammeter by connecting a
   low resistance in parallel with it. The low resistance is called
   shunt resistance.
2. A galvanometer can be converted into a voltmeter by
   connecting a high resistance in series with it.

20. In a galvanometer, increasing the current sensitivity does
not necessarily increase voltage sensitivity. Explain.
1. An interesting point to note is that, increasing the current
   sensitivity does not necessarily, increase the voltage sensitivity.
2. When the number of turns (n) is doubled, current sensitivity is also doubled (from the equation $\theta / I = nBA / C$).
3. But increasing the number of turns correspondingly increases the resistance (G).
4. Hence voltage sensitivity remains unchanged.

### 3.8 Current loop as a magnetic dipole


1. The magnetic moment of a current loop is defined as the product of the current and the loop area.
2. Its direction is perpendicular to the plane of the loop.
3. Magnetic dipole of moment $M = IA$

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### QUESTION BANK

**3 MARKS QUESTIONS:**

1. What are the characteristics of heating element used in electric heating device?
2. Why nichrome is used as a heating element?
3. Mention any two differences between Peltier effect and Joule’s heating effect.
4. Define Peltier coefficient and write its unit.
5. Define Thomson coefficient.
6. What is neutral temperature of a thermocouple?
7. State Ampere’s circuitual law.
8. State Fleming’s left hand rule.
10. Mention the limitations of cyclotron.
11. How a galvanometer can be converted into i) an ammeter ii) a voltmeter.
12. How we increase the sensitivity of a galvanometer?
13. In a galvanometer, increasing the current sensitivity does not necessarily increase the voltage sensitivity. Explain.

**5 MARKS QUESTIONS:**

1. What are the special features of magnetic Lorentz force?
2. State and explain Biot-savart law.
3. Explain in detail the principle, construction of a tangent galvanometer (diagram, theory not necessary).
4. Explain the conversion of galvanometer into an ammeter.
5. Explain how will you convert a galvanometer into a voltmeter.

**10 MARKS QUESTIONS:**

1. State Joule’s law. Explain Joule’s calorimeter experiment to verify Joule’s laws of heating.
2. Derive an expression for magnetic induction due to an infinitely long straight conductor carrying current. Write the expression for the magnetic induction when the conductor is placed in a medium of permeability $\mu$.
3. Derive the relation for the magnetic induction at a point along the axis of a circular coil carrying current.
4. Explain in detail the principle, construction and theory of T.G.
5. Define Ampere’s circuitual law. Applying it, find the magnetic induction due to a long solenoid carrying current.
6. Deduce an expression for the force acting on a current carrying conductor placed in a magnetic field. Find the magnitude of the force.
7. Obtain expression for force between two long parallel current carrying conductors. Hence define ‘ampere’.
8. Explain in detail the principle, construction, working and limitations of cyclotron with a diagram.
9. Discuss the motion of the charge particle in uniform magnetic field.

### 4. Electromagnetic induction and Alternating current

#### 4.1 Electromagnetic induction

1. Define: magnetic flux.
   
   The magnetic flux ($\phi$) linked with a surface held in a magnetic field ($B$) is defined as the number of magnetic lines of force crossing a closed area ($A$).
   
   $$\phi = BA \cos \theta$$

2. What is electromagnetic induction?
   
   The phenomenon of producing an induced emf due to the changes in the magnetic flux associated with a closed circuit is known as electromagnetic induction.


   **First law:** Whenever the amount of magnetic flux linked with a closed circuit changes, an emf is induced in the circuit. The induced emf lasts so long as the change in magnetic flux continues.

   **Second law:** The magnitude of emf induced in a closed circuit is directly proportional to the rate of change of magnetic flux linked with the circuit.

   The magnitude of emf induced
   
   $$\phi \propto \frac{\Phi_2 - \Phi_1}{t}$$

4. State Lenz’s law.

   Lenz’s law states that the induced current produced in a circuit always flows in such a direction that it opposes the change or cause that produces it.
5. State Fleming’s right hand rule.
1. The forefinger, the middle finger and the thumb of the right hand are held in the three mutually perpendicular directions.
2. If the forefinger points along the direction of the magnetic field and the thumb is along the direction of motion of the conductor, then the middle finger points in the direction of the induced current.
3. This rule is also called Generator rule.

4.2 Self Induction

The coefficient of self induction of a coil is numerically equal to the opposing emf induced in the coil when the rate of change of current through the coil is unity. The unit of self inductance is henry (H).

7. Define the unit of self inductance.
One henry is defined as the self-inductance of a coil in which a change in current of one ampere per second produces an opposing emf of one volt.

8. What is mutual induction?
1. Whenever there is a change in the magnetic flux linked with a coil, there is also a change of flux linked with the neighbouring coil, producing an induced emf in the second coil.
2. This phenomenon of producing an induced emf in a coil due to the change in current in the other coil is known as mutual induction.

1. The coefficient of mutual induction of two coils is numerically equal to the emf induced in one coil when the rate of change of current through the other coil is unity.
2. The unit of coefficient of mutual induction is henry.

10. What are factors depends on coefficient of mutual induction?
1. Size and shape of the coils, number of turns and permeability of material on which the coils are wound.
2. Proximity of the coils.

4.3 Methods of producing induced emf

11. What are the methods of inducing emf in a circuit?
By changing,
1. the magnetic induction (B)
2. area enclosed by the coil (A)
3. the orientation of the coil (θ) with respect to the magnetic field.

4.5 Eddy currents

12. What is eddy current?
1. When a mass of metal moves in a magnetic field or when the magnetic field through a stationary mass of metal is altered, induced current is produced in the metal.
2. This induced current flows in the metal in the form of closed loops resembling ‘eddies’ or whirlpool.
3. Hence this current is called eddy current.
4. The direction of the eddy current is given by Lenz’s law.

4.6 Transformer

13. What is Transformer?
1. Transformer is an electrical device used for converting low alternating voltage into high alternating voltage and vice versa.
2. It transfers electric power from one circuit to another. 3. The transformer is based on the principle of electromagnetic induction.

14. What is efficiency of a transformer?
Efficiency of a transformer is defined as the ratio of output power to the input power.

\[
\eta = \frac{\text{output power}}{\text{input power}}
\]

15. What are the various energy losses of a transformer?

4.7 Alternating current

16. Why can a DC ammeter not read AC?
1. The average value of alternating current over one complete cycle is zero.
2. Therefore, D.C ammeter connected in a A.C circuit will show zero reading.
3. So DC ammeter can not read AC

17. Define: rms value of AC.
The rms value of alternating current is defined as, the value of the steady current, passed through a resistor for a given time, will generate the same amount of heat as generated by an alternating current passed through the same resistor for the same time.

The Q factor of a series resonant circuit is defined as the ratio of the voltage across a coil or capacitor to the applied voltage.

\[
Q = \left( \frac{\text{voltage across L or C}}{\text{applied voltage}} \right)
\]

19. Give the differences between AF choke and RF choke.

<table>
<thead>
<tr>
<th>Audio frequency (A.F) choke</th>
<th>Radio frequency (R.F) choke</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 used in low frequency a.c. circuit</td>
<td>used in high frequency a.c. circuit</td>
</tr>
</tbody>
</table>
2. An iron core is used. Air chokes are used.
3. The inductance may be high. The inductance may be low.
4. Used in fluorescent tubes. Used in wireless receiver circuits.

**QUESTION BANK**

3 MARKS QUESTIONS:
1. What is electromagnetic induction?
2. State Lenz law in electromagnetic induction.
3. State Faraday’s laws of EMI.
5. Define the unit of self-inductance.
6. Mention the methods of producing induced emf.
7. State Fleming’s left hand rule.
8. D.C ammeter cannot be used for measuring A.C. Why?
9. Define r.m.s value of current.
10. Define efficiency of a transformer.

11. What happens to the value of current in RLC series circuit, if the frequency of the source is increased?
12. A capacitor blocks d.c but allows a.c. Why?
14. Give the differences between AF choke and RF choke.
15. State Fleming’s right hand rule.

5 MARKS QUESTIONS:
2. Explain the mutual induction between two long solenoids. Obtain an expression for the mutual inductance of two long solenoids.
3. Explain any two applications of eddy current.
4. Define efficiency of a transformer. Explain the various losses of a transformer? Explain how they can be minimized?
5. Obtain the phase relation between current and voltage in an A.C circuit containing a pure inductance. Draw the necessary graph.
6. Obtain the phase relation between voltage and current in an AC circuit containing a pure inductance. Draw the necessary graph.
7. In an a.c circuit containing a capacitor, the instantaneous emf is $e = E_0 \sin \omega t$. Obtain the expression for current. Explain the phase relationship between emf and current by graph.

5. Electromagnetic waves and wave optics

5.1.1 Electromagnetic waves

1. What are electromagnetic waves?
   1. In an electromagnetic wave, electric and magnetic field vectors are at right angles to each other and both are at right angles to the direction of propagation.
   2. They possess the wave character and propagate through free space without any material medium.
2. State any three uses of IR rays.
   1. Infrared lamps are used in physiotherapy.
   2. Infrared photographs are used in weather forecasting.
   3. As infrared radiations are not absorbed by air, thick fog, mist etc, they are used to take photograph of long distance objects.
3. What are uses of ultra-violet radiations?
   1. They are used to destroy the bacteria and for sterilizing surgical instruments.
2. These are used in detection of forged documents, finger prints in forensic laboratories.
3. They are used to preserve the food items.
4. They help to find the structure of atoms.

5.2 Types of spectra

4. What are emission and absorption spectra?

Emission spectrum: 1. When the light emitted directly from a source is examined with a spectrometer, the emission spectrum is obtained.
2. Every source has its own characteristic emission spectrum.

Absorption spectrum: When the light emitted from a source and pass through an absorbing material then examined with a spectrometer, absorption spectrum is produced.

5. What is band emission spectrum? Give an example.
1. It consists of a number of bright bands with a sharp edge at one end but fading out at the other end.
2. Band spectra are obtained from molecules. 3. It is the characteristic of the molecule. 4. Example: Calcium or Barium salts in a bunsen flame, carbon−di−oxide, ammonia and nitrogen in molecular state in the discharge tube give band spectra.

6. What is Fraunhofer lines?
If the solar spectrum is closely examined, it consists of large number of dark lines. These dark lines are called Fraunhofer lines.

Reason: Light from the central core (photosphere) of the sun passes through sun’s atmosphere, certain wavelengths are absorbed by the chromosphere elements and the spectrum is appear dark lines.

7. What is fluorescence?
1. When an atomic or molecular system is excited into higher energy state by absorption of energy, it returns back to lower energy state in a time less than $10^{-5}$ second and the system is found to glow brightly by emitting radiation of longer wavelength.
2. When ultra violet light is incident on certain substances, they emit visible light.
3. This phenomenon is called fluorescence.

8. What is Phosphorescence?
1. Some substances in which the molecules are excited by the absorption of incident ultraviolet light, and they do not return immediately to original state.
2. The emission of light continues even after the exciting radiation is removed.
3. This type of delayed fluorescence is called phosphorescence.

5.4 Scattering of light
9. Why does the sky appear blue in colour?
1. According to Rayleigh’s scattering law, the shorter wavelengths are scattered much more than the longer wavelengths.
2. The blue appearance of sky is due to scattering of sunlight by the atmosphere.
3. Blue light is scattered to a greater extent than red light.
4. This scattered radiation causes the sky to appear blue.

10. Why does sun appears reddish at sunrise and sunset?
1. At sunrise and sunset the rays from the sun have to travel a larger part of the atmosphere than at noon. 2. Therefore most of the blue light is scattered away and only the red light which is least scattered reaches the observer.
3. Hence, sun appears reddish at sunrise and sunset.

11. What is Tyndal scattering?
1. When the light passes through a colloidal solution its path is visible inside the solution.
2. The scattering of light by the colloidal particles is called Tyndal scattering.
3. Reason: The light is scattered by the particles of solution.

12. What is Raman effect?
1. When the monochromatic light passes through a substance it is scattered.
2. The scattered light contains some additional frequencies other than that of incident frequency. 3. This is known as Raman effect.

13. What are the uses of Raman spectrum?
1. It is used in almost all branches of science.
2. Raman Spectroscopy is applied to study the properties of materials.
3. It is used to analyse the chemical constitution.
4. Raman Spectra of different substances enable to classify them according to their molecular structure.

5.5 Wave front
1. Every point on a given wave front may be considered as a source of secondary wavelets which spread out with the speed of light in that medium.
2. The new wave front is the forward envelope of the secondary wavelets at that instant.

15. State the conditions to achieve total internal reflection.
1. Light must travel from a denser medium to a rarer medium.
2. The angle of incidence inside the denser medium must be greater than the critical angle.
16. What are coherent sources?
1. Two sources emit light waves of the same wave length.
2. Two sources start with same phase or have a constant phase difference.

17. What are the conditions for the formation of sustained interference?
1. The two sources should be coherent
2. Two sources should be very narrow
3. The sources should lie very close to each other to form distinct and broad fringes.

18. What is Band width?
The distance between any two consecutive bright or dark bands is called bandwidth.

\[ \beta = \frac{D \lambda}{d} \]

19. What are condition for obtaining clear and broad interference bands?
1. The screen should be as far away from the source as possible.
2. The wavelength of light used must be larger.
3. The two coherent sources must be as close as possible.

20. What is Newton’s rings?
1. When a plano convex lens of long focal length is placed over an optically plane glass plate.
2. A thin air film with varying thickness is enclosed between them.
3. The thickness of the air film is zero at the point of contact and gradually increases outwards.
4. When the air film is illuminated by monochromatic light normally, alternate bright and dark concentric circular rings are formed with dark spot at the centre.
5. These rings are known as Newton’s rings.

21. Why the centre of Newton’s rings pattern appear dark?
1. The thickness of the air film at the point of contact of lens L with glass plate P is zero.
2. Hence, there is no path difference between the interfering waves.
3. So, it should appear bright.
4. But the wave reflected from the denser glass plate has suffered a phase change of \( \pi \) while the wave reflected at the spherical surface of the lens has not suffered any phase change.
5. Hence the point O appears dark.

22. Distinguish between Fresnel and Fraunhofer diffractions?

<table>
<thead>
<tr>
<th>Fresnel diffraction</th>
<th>Fraunhofer diffraction</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. The source and the screen are at finite distances from the obstacle producing diffraction.</td>
<td>The source and the screen are at infinite distances from the obstacle producing diffraction.</td>
</tr>
<tr>
<td>2. The wave front is spherical or cylindrical.</td>
<td>The wave front undergoing diffraction is plane.</td>
</tr>
<tr>
<td>3. The diffracted rays cannot be brought to focus with the help of a convex lens.</td>
<td>The diffracted rays which are parallel to one another are brought to focus with the help of a convex lens.</td>
</tr>
</tbody>
</table>

The combined width of a slit and a ruling in a plane diffraction grating is called as a grating element.

\[ N = \frac{1}{a + b} \]

24. Distinguish between interference and diffraction fringes.

<table>
<thead>
<tr>
<th>Interference</th>
<th>Diffraction</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Superposition of secondary wavelets from two different wave fronts produced two coherent sources.</td>
<td>Superposition of secondary wavelets emitted from various points of the same wave front.</td>
</tr>
<tr>
<td>2. Fringes are equally spaced.</td>
<td>Fringes are unequally spaced.</td>
</tr>
<tr>
<td>3. Bright fringes are same intensity</td>
<td>Intensity falls rapidly</td>
</tr>
<tr>
<td>4. It has large number of fringes</td>
<td>It has less number of fringes.</td>
</tr>
</tbody>
</table>

25. What is polarisation?
1. The vibrations are restricted to only one plane parallel to the axis of the crystal, the light is said to be plane polarised.
2. The phenomenon of restricting the vibrations into a particular plane is known as polarisation.

The tangent of the polarising angle is numerically equal to the refractive index of the medium.

\[ \tan \theta_p = \mu \]

27. Define: optic axis of a crystal.
1. Inside a double refracting crystal there is a particular direction in which both the rays travel with same velocity.
2. This direction is called optic axis.
3. The refractive index is same for both rays and there is no double refraction along this direction.

28. What is polaroids?
1. A Polaroid is a material which polarises light. 2. The phenomenon of selective absorption is made use of in the construction of polaroids.

29. On what factors does the amount of optical rotation depend?
1. Thickness of crystal
2. Density of the crystal or concentration in the case of solutions.
3. Wavelength of light used
4. The temperature of the solutions.

30. Define: specific rotation?
Specific rotation for a given wavelength of light at a given temperature is defined as the rotation produced by one-decimeter length of the liquid column containing 1 gram of the active material in 1 cc of the solution.

\[ S = \frac{\theta}{IC} \]

QUESTION BANK

3 MARKS QUESTIONS:
1. Write any three uses of infrared radiations.
2. What are emission and absorption spectra?
3. What is band emission spectrum? Give an example.
4. What is Tyndall scattering?
5. Why does sky appear blue in color?
7. Write the conditions for total internal reflection to take place.
8. Write the differences between interference and diffraction bands.
9. Why is the centre of Newton’s ring dark?
10. Distinguish between Fresnel and Fraunhofer diffractions.
11. State and Brewster’s law.
12. Define optic axis of a crystal.
14. On what factors does the amount of optical rotation depends.
15. In Newton’s ring experiment the diameter of certain order of dark ring is measured to be double that of second ring. What is the order of the ring?

5 MARKS QUESTIONS:
1. Derive an expression for radius of nth dark ring in Newton’s ring experiment.
2. State and prove Brewster’s law.
3. Write a note on pile of plates.
4. Write a note on Nicol prism.

10 MARKS QUESTIONS:
1. Explain the emission and absorption spectra.
2. What is Raman scattering? Explain Raman scattering with energy level diagram.
4. On the basis of wave theory, explain the total internal reflection. Write the condition for TIR to take place.
5. What is known as interference of light? Derive an expression for bandwidth of interference fringes in Young’s double slit experiment.
6. Discuss the theory of interference in thin transparent film due to reflected light and obtain condition for the intensity to be maximum and minimum.

6. Atomic Physics

6.1 Discharge of electricity through gases at low pressure
Discovery of electrons
1. What is the principle of Millikan’s oil drop method?
   1. By adjusting uniform electric field suitably, a charged oil drop can be made to move up or down or even kept balanced in the field of view for sufficiently long time.

6.2 Atom models
2. Explain any one of the drawbacks of Rutherford atom model.
   1. According to classical electromagnetic theory, the accelerating electron must radiate energy at a frequency proportional to the angular velocity of the electron.
   2. Therefore, as the electron spiral towards the nucleus, the angular velocity tends to become infinity and hence the frequency of the emitted energy will tend to infinity.
   3. This will result in a continuous spectrum with all possible wavelengths.

3. Define: ionisation potential.
   1. The ionisation potential is that accelerating potential which makes the impinging electron acquire sufficient energy to knock out an electron from the atom and thereby ionise the atom.
   2. 13.6 V is the ionisation potential of hydrogen atom.

   1. For hydrogen atom, the energy required to remove an electron from first orbit to its outermost orbit (n = \infty) is 13.6-0 = 13.6 eV.

5. What is excitation potential energy of an atom?
1. The energy required to raise an atom from its normal state into an excited state is called excitation potential energy of the atom.

Example:
The energy required to transfer the electron in hydrogen atom from the ground state to the first excited state = (13.6 - 3.4) = 10.2 eV.

6. What are Stark and Zeeman effects?
1. When electric or magnetic field is applied to the atom, each of the spectral line split into several lines.
2. The former effect is called as Stark effect, while the latter is known as Zeeman effect.

7. Give the drawbacks of Sommerfeld’s atom model.
1. It could not explain the distribution and arrangement of electrons in atoms.
2. Sommerfeld’s model was unable to explain the spectra of alkali metals such as sodium, potassium etc.
3. It could not explain Zeeman and Stark effect.
4. This model does not give any explanation for the intensities of the spectral lines.

8. What is fine structure of spectral lines?
1. When the spectral line of hydrogen atom is examined by spectrometers having high resolving power, it is found that a single line is composed of two or more close components.
2. This is known as the fine structure of spectral lines.
3. Bohr’s theory could not explain the fine structure of spectral lines.

9. Write down two important facts of Laue experiment on X-ray diffraction.
1. X-rays are electromagnetic waves of extremely short wave length.
2. The atoms in a crystal are arranged in a regular three dimensional lattice.

10. State Moseley’s law.
1. The frequency of the spectral line in the characteristic X-ray spectrum is directly proportional to the square of the atomic number (Z) of the element considered.

\[ \nu \propto Z^2 \text{ or } \sqrt{\nu} = a(Z - b) \]

where a and b are constants.

11. Give the applications of Moseley’s law.
1. The elements are arranged in the periodic table according to the atomic numbers and not according to the atomic weights.
2. Led to the discovery of new elements like Hafnium (72), Technetium (43), Rhenium (75) etc.
3. Helpful in determining the atomic number of rare earths, thereby fixing their position in the periodic table.

6.4 Laser

12. What are the conditions to achieve the laser action?
1. There must be an inverted population i.e. more atoms in the excited state than in the ground state.
2. The excited state must be a metastable state. 3. The emitted photons must stimulate further emission. This is achieved by the use of the reflecting mirrors at the ends of the system.

13. What are the characteristics of laser beam?
The laser beam 1. is monochromatic. 2. is coherent, with the waves, all exactly in phase with one another, 3. does not diverge at all and 4. is extremely intense.

14. Write any three medical applications of laser.
1. In medicine, micro surgery has become possible due to narrow angular spread of the laser beam.
2. It can be used in the treatment of kidney stone, tumour, in cutting and sealing the small blood vessels in brain surgery and retina detachment.
3. The laser beams are used in endoscopy.
4. It can also be used for the treatment of human and animal cancer.

15. Write any three applications of laser in industry.
1. The laser beam is used to drill extremely fine holes in diamonds, hard sheets etc.,
2. It is used for cutting thick sheets of hard metals and welding.
3. It is used to vaporize the unwanted material manufacture of electronic circuit on semiconductor chips.
4. They are used to test the quality of the materials.
2. This energy is known as the ionization potential energy for hydrogen atom.

16. What is hologram?
1. When an object is photographed by a camera, a two dimensional image of three dimensional object is obtained.
2. A three dimensional image of an object can be formed by holography.
3. In ordinary photography, the amplitude of the light wave is recorded on the photographic film.
4. In holography, both the phase and amplitude of the light waves are recorded on the film.
5. The resulting photograph is called hologram.
17. What is Maser? Give the principle of it.
1. The term MASER stands for Microwave Amplification by Stimulated Emission of Radiation.
2. The working of maser is similar to that of laser.
3. The maser action is based on the principle of population inversion followed by stimulated emission.
4. The emitted photon belongs to the microwave frequencies.

**QUESTION BANK**

**3 MARKS QUESTIONS:**
1. Write the principle of Millikan’s oil drop experiment.
2. Explain any one of the drawbacks of the Rutherford atom model.
3. State postulates of Bohr atom model.
4. What are the drawbacks of Sommerfeld atom model?
5. State Mosley’s law. Write its equation.
6. Write the applications of Mosley’s law.
7. Define ionization potential.
8. Write down two important facts of the Laue experiment. On X-ray diffraction.
9. Define ionization potential energy.
10. What are the characteristics of laser?
11. Write the condition to achieve laser action.
12. Write any three applications of laser.
13. Write any three industrial applications of laser.
14. Write any three medical applications of laser.
15. What are the applications of LASER in medical field?
16. What is hologram?

**5 MARKS QUESTIONS:**
1. Write any five properties of cathode rays.
2. Prove that the energy of electron for hydrogen atom in the nth orbit.
3. Explain the spectral series of hydrogen atom.
4. Mention any five properties of X-rays.
5. Explain the origin of characteristic X-rays.
7. Describe Laue’s experiment. What are the facts established by it?
8. State and obtain Bragg’s law.

**10 MARKS QUESTIONS:**
1. Describe the J.J Thomson method of determining the specific charge of an electron.
2. Explain Millikan’s oil drop experiment to determine the charge of an electron.
4. How will you determine the wavelength of X-rays using Bragg spectrometer? Write any five properties of X-rays.
5. Derive Bragg’s law. Explain how Bragg’s spectrometer can be used to determine the wavelength of X-rays?
6. Draw a neat sketch of Ruby Laser. Explain its working with the help of energy level diagram.
7. With the help of energy level diagram explain the working of He-Ne laser.

**7. Dual nature of radiation, Matter and Relativity**

**7.1 Photoelectric effect**

1. What is photoelectric effect?

Photoelectric emission is the phenomena by which a good number of substances, chiefly metals, emit electrons under the influence of radiation such as γ rays, X-rays, ultraviolet and even visible light.

2. Define saturation current.

When the positive potential of A is increased, the photoelectric current is also increased. However, if the positive potential is further increased such that it is large enough to collect all the photoelectrons emitted from the plate C, the photoelectric current reaches a certain maximum value and this current is known as saturation current.

3. What is cut-off or stopping potential?

The minimum negative (retarding) potential given to the anode for which the photoelectric current becomes zero is called the cut-off or stopping potential.


The minimum frequency of incident radiation below which the photoelectric emission is not possible completely, however high the intensity of incident radiation may be. The threshold frequency is different for different metals.

5. State any three laws of photo electric emission?

1. For a given photo sensitive material, there is a minimum frequency called the threshold frequency, below which emission of photoelectrons stops completely, however great the intensity may be.
2. For a given photosensitive material, the photo electric current is directly proportional to the intensity of the incident radiation, provided the frequency is greater than the threshold frequency.
3. The photoelectric emission is an instantaneous process, i.e., there is no time lag between the incidence of radiation and the emission of photo electrons.

4. The maximum kinetic energy of the photo electrons is directly proportional to the frequency of incident radiation, but is independent of its intensity.

6. Define work function.
The work function of a photo metal is defined as the minimum amount of energy required to liberate an electron from the metal surface.

7.2 Photoelectric cells and their applications

7. Name the types of photoelectric cells.
The photoelectric cells are of three types: (i) Photo emissive cell (ii) Photo voltaic cell and (iii) Photo conductive cell.

8. Give three applications of photoelectric cells.
1. Photoelectric cells are used for reproducing sound in cinematography.
2. They are used for controlling the temperature of furnaces.
3. Photoelectric cells are used for automatic switching on and off the street lights.
4. Photoelectric cells are used in the study of temperature and spectra of stars.
5. Photoelectric cells are also used in obtaining electrical energy from sunlight during space travel.
6. These cells are used in instruments measuring light illumination.
7. These cells are used in opening and closing of doors automatically.
8. Photoelectric cells are used in burglar alarm and fire alarm.

7.4 Electron microscope

9. Why X-rays are not used in microscopes?
1. The wavelength of X-rays is smaller than that of the visible light.
2. X-rays cannot be focussed as visible radiations are focussed using lenses.
3. X-rays can not be deflected by electric and magnetic fields.

10. What are the uses of an electron microscope?
1. It is used in the industry, to study the structure of textile fibres, surface of metals, composition of paints etc.
2. In medicine and biology, it is used to study virus, and bacteria.
3. In Physics, it has been used in the investigation of atomic structure and structure of crystals in detail.

11. What are the limitations of electron microscope?
1. An electron microscope is operated only in high vacuum.
2. This prohibits the use of the microscope to study living organisms which would evaporate and disintegrate under such conditions.

7.5 Relativity

12. According to classical mechanics, what is the concept of space?
1. Fixed frame of reference by which the position or motion of any object in the universe could be measured.
2. The geometrical form of an object remains the same irrespective of changes in position or state of motion of the object or observer.

13. According to classical mechanics, what is the concept of time?
1. The time interval between two events has the same value for all observers irrespective of their motion.
2. If two events are simultaneous for an observer they are simultaneous for all observers, irrespective of their position or motion.

14. What is a frame of reference?
A system of co-ordinate axes which defines the position of a particle in two or three dimensional space is called a frame of reference.

15. What are inertial and non-inertial frame of references?
1. Inertial (or) unaccelerated frames:
   1. Bodies in this frame obey Newton’s law of inertia and other laws of Newtonian mechanics.
   2. In this frame, a body remains at rest or in continuous motion unless acted upon by an external force.

2. Non-inertial (or) accelerated frames:
   1. A frame of reference is said to be a non-inertial frame, when a body not acted upon by an external force, is accelerated.
   2. In this frame, Newton’s laws are not valid.

7.6 Special theory of relativity

16. State the fundamental postulates of special theory of relativity?
1. The laws of Physics are the same in all inertial frames of reference.
2. The velocity of light in free space is a constant in all the frames of reference.

QUESTION BANK

3 MARKS QUESTIONS:
1. Define stopping potential
2. What is photoelectric effect? State the laws of photoelectric effect?

3. Mention any three applications of photoelectric cells.

4. What are the limitations electron microscopes?

5. Mention the uses of electron microscope.

6. According to classical mechanics, what is the concept of time?

7. State the special theory of relativity.

8. What are inertial and non-inertial frames of reference?

9. Write two fundamental postulates of special theory of relativity.

10. Differentiate between inertial and non-inertial frames of reference.

5 MARKS QUESTIONS:

1. Define work function. State the laws of photoelectric emission.

2. What is photoelectric effect? State the laws of PEE.

3. Explain the construction and working of photo-emissive cell with diagram.

4. Write any five applications of photoelectric cells.

5. Obtain Einstein’s photoelectric equation.

6. Explain the wave mechanical concept of atom.


8. Explain FitzGerald – Lorentz contraction with an example.

9. Explain time-dilation with an example.

10. At what speed is particle moving if the mass is equal to three times its rest mass?

11. Establish Einstein’s mass energy equivalence $E = mc^2$.

8. Nuclear Physics

8.1 Nucleus

1. Select the pairs of isotopes, isobars and isotones from the following nuclei:
   - $^{11}\text{Na}^{22}$, $^{12}\text{Mg}^{24}$, $^{11}\text{Na}^{24}$, $^{10}\text{Ne}^{23}$ (M-12)
   - Isotopes are $^{11}\text{Na}^{22}$, $^{11}\text{Na}^{24}$
   - Isobars are $^{12}\text{Mg}^{24}$, $^{11}\text{Na}^{24}$
   - Isotones are $^{11}\text{Na}^{24}$, $^{10}\text{Ne}^{23}$

2. In $^{17}\text{Cl}^{35}$, calculate the number of protons, neutrons and electrons.
   - Number of protons = 17, Number of electrons = 17, Number of neutrons = 18

4. Define: 1 amu
   - One atomic mass unit is considered as one twelfth of the mass of carbon atom $^{12}\text{C}$.
   - 1 amu = $1.66 \times 10^{-27}$ kg.

5. Define: mass defect.
   - The difference in the total mass of the nucleons and the actual mass of the nucleus is known as the mass defect.

   - The energy equivalent of mass defect is called as binding energy.
   - Binding energy = $[Zm_p + Nm_n - m] c^2 = \Delta m c^2$. Here, $\Delta m$ is the mass defect.

7. Write any three findings of binding energy curve.
   - 1. The binding energy per nucleon reaches a maximum of 8.8 MeV at A = 56, corresponding to the iron nucleus ($^{56}\text{Fe}^{26}$). Hence, iron nucleus is the most stable.
   - 2. The average binding energy per nucleon is about 8.5 MeV for nuclei having mass number ranging between 40 and 120. These elements are comparatively more stable and non-radioactive.
   - 3. For higher mass numbers the curve drops slowly and the BE/A is about 7.6 MeV for uranium. Hence, they are unstable and radioactive.

8.3 Nuclear force

8.4 Radioactivity

10. What is artificial radioactivity?
   - The phenomenon by which even light elements are made radioactive by artificial or induced methods is called artificial radioactivity.

8.5 Radioactive displacement law

11. What is $\alpha$-decay? Give an example.
   - 1. When a radioactive nucleus disintegrates by emitting an $\alpha$-particle, the atomic number decreases by two and mass number decreases by four.
   - 2. Example: Radium ($^{88}\text{Ra}^{226}$) is converted to radon ($^{86}\text{Rn}^{222}$) due to $\alpha$-decay
     $^{88}\text{Ra}^{226} \rightarrow ^{86}\text{Rn}^{222} + ^2\text{He}^4$

   - One roentgen (1R) is defined as the quantity of radiation which produces $1.6 \times 10^{12}$ pairs of ions in 1 gram of air.
1. The activity of a radioactive substance is defined as the rate at which the atoms decay.
2. Curie is defined as the quantity of a radioactive substance which gives $3.7 \times 10^{10}$ disintegrations per second or $3.7 \times 10^{10}$ becquerel.

8.6 Neutron – Discovery
14. State any three properties of the neutrons.
1. Neutrons are the constituent particles of all nuclei, except hydrogen.
2. As they are neutral particles, they are not deflected by electric and magnetic fields.
3. As neutrons are neutral, they can easily penetrate any nucleus.
4. Neutrons are stable inside the nucleus. But outside the nucleus they are unstable.

15. How do you classify the neutrons in terms of its kinetic energy?
1. Slow neutrons and fast neutrons.
2. Neutrons with energies from 0 to 1000 eV are called slow neutrons.
3. Neutrons with energies in the range between 0.5 MeV and 10 MeV are called fast neutrons.

8.9 Nuclear fission
1. The minimum size in which at least one neutron is available for further fission reaction. The mass of the fissile material at the critical size is called critical mass.
2. The chain reaction is not possible if the size is less than the critical size.

17. What is a breeder reactor?
1. $^{238}_{92}$U and $^{232}_{90}$Th are not fissile materials but are abundant in nature.
2. In the reactor, these can be converted into a fissile material $^{239}_{94}$Pu and $^{233}_{92}$U respectively by absorption of neutrons.
3. The process of producing more fissile material in a reactor in this manner than consumed during the operation of the reactor is called breeding.
4. A fast reactor can be designed to serve as a good breeder reactor.

18. What is the use of control rods? Mention any two control rods.
1. The control rods are used to control the chain reaction.
2. They are very good absorbers of neutrons.
3. The commonly used control rods are made up of elements like boron or cadmium.
4. In our country, boron carbide (B,C) is used as control rod.

8.10 Nuclear fusion
19. Write short notes on proton – proton fusion in sun.
$^1_1$H$^1_1$ + $^1_1$H$^1_1$ → $^2_2$He$^3_3$ + $^0_1$e$^0_0$ + $^0_0$ν (emission of positron and neutrino)
$^1_1$H$^1_1$ + $^1_1$H$^1_1$ → $^2_2$He$^3_3$ + γ (emission of gamma rays)
$^2_2$He$^3_3$ → $^4_2$He$^4_4$ + $^0_1$e$^0_0$ (emission of gamma rays and positron)
Thus four protons fuse together to form an alpha particle and two positrons with a release of large amount of energy.

8.11 Cosmic Rays
20. What are cosmic rays?
The ionising radiation many times stronger than γ-rays entering the earth from all the directions from cosmic or interstellar space is known as cosmic rays.
2. The name, cosmic rays was given by Millikan.
3. The cosmic rays can be broadly classified into primary and secondary cosmic rays.

22. What is pair production and pair annihilation?
Pair production: The conversion of a photon into an electron–positron pair on its interaction with the strong electric field surrounding a nucleus is called pair production.
Pair annihilation: The converse of pair production in which an electron and positron combine to produce a photon is known as annihilation of matter.

8.12 Elementary particles
24. What are leptons? Give examples.
1. Leptons are lighter particles having mass equal to or less than about 207 times the mass of an electron except neutrino and antineutrino.
2. This group contains particles such as electron, positron, neutrino, antineutrino, positive and negative muons.
3. The electron and positron are the antiparticles.
4. Neutrino and antineutrino are also associated with β-ray emission.
5. The neutrinos and antineutrinos are mass less and charge less particles, but carrier of energy and spin.
5. Muons were discovered in cosmic ray studies.

QUESTION BANK
3 MARKS QUESTIONS:
1. What is mass defect?
2. What is □ decay? Give example.
3. Write any three properties of neutron.
4. What is binding energy of a nucleus?
5. Write any 3 conclusions from binding energy curve.
6. Write any three properties of nuclear forces.
7. What do you mean by artificial radioactivity?
8. Define curie.
10. Write proton-proton cycle that takes place in sun and stars.
11. Define critical and critical mass.
12. What are the uses of nuclear reactors?
13. What is the use of control rod in the reactor? Mention any two control rods.
14. What is meant by breeder reactor?
15. Write a note on leptons.
16. What are cosmic rays?
17. How do you classify the neutrons in terms of its kinetic energy.
18. What is pair production and annihilation of matter?
19. Write a note on leptons.

5 MARKS QUESTIONS:
1. Give an explanation for the binding energy curve
2. Explain Soddy-Fajan's radioactive displacement laws.
3. Write notes on biological hazards of radiations.
4. Explain the latitude effect of cosmic rays.
5. Explain how cosmic ray shower is formed.
6. Explain the latitude effect of cosmic rays.
7. Write the properties of $\alpha$-rays.

10 MARKS QUESTIONS:
1. Describe Bainbridge mass spectrometer to determine the isotopic masses of nuclei.
2. Explain the construction and working of GM counter.
3. Obtain an expression for the amount of radioactive substance present at any moment. Obtain the relation between half life and decay constant.
4. What are cosmic rays? Explain the latitude effect of cosmic rays.
5. What is a nuclear reactor? Explain the functions of i) moderator ii) control rods and iii) neutron reflector. Mention the uses of nuclear reactor. (Diagram not necessary)
6. State the law of radioactive disintegration. Obtain the relation $N = N_0 e^{-\lambda t}$. Derive the relation between half-life period and decay constant.

9.1 Semiconductors

1. Draw the energy band diagram of N-type semiconductor and p-type conductor.

Energy band diagram of N-type semiconductor:

Energy band diagram of P-type semiconductor:

2. What is an intrinsic semiconductor? Give examples.
1. A semiconductor which is pure and contains no impurity is known as an intrinsic semiconductor.
2. In an intrinsic semiconductor, the number of free electrons and holes are equal.
3. Examples: Pure Ge, Pure Si.

3. What is meant by doping?
The process of addition of a very small amount of impurity into an intrinsic semiconductor is called doping. The impurity atoms are called dopants.

4. Write the different methods of doping a semiconductor.
1. The impurity atoms are added to the semiconductor in its molten state.
2. The pure semiconductor is bombarded by ions of impurity atoms.
3. When the semiconductor crystal containing the impurity atoms is heated, the impurity atoms diffuse into the hot crystal.

5. What do understand by extrinsic semiconductor?
1. Which an impurity with valancy higher or lower than the valency of the pure semiconductor is added, is extrinsic semiconductor.
2. It is increase the electrical conductivity of the semiconductor.
Example: N-type or P-type semiconductors.

9.3 PN junction diode as rectifier

6. What is rectification?
1. The process in which alternating voltage or alternating current is converted into direct voltage or direct current is known as rectification.

2. The device used for this process is called as rectifier.

### 9.4 Breakdown mechanisms

7. Distinguish between avalanche breakdown and zener breakdown.

<table>
<thead>
<tr>
<th>Avalanche breakdown</th>
<th>Zener breakdown</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Both sides of the PN junction are lightly doped and the depletion layer is large.</td>
<td>Both sides of the PN junction are heavily doped, and the depletion layer is narrow.</td>
</tr>
<tr>
<td>2. The electric field across the depletion layer is not so strong.</td>
<td>The electric field across the depletion layer is so strong.</td>
</tr>
<tr>
<td>3. Covalent bonds are broken by collision of valence electrons.</td>
<td>Covalent bonds are broken by electric field.</td>
</tr>
<tr>
<td>4. Electron hole pairs are produced.</td>
<td>Electrons and holes are produced.</td>
</tr>
</tbody>
</table>

8. What is zener breakdown?

1. When both sides of a PN junction are heavily doped, the depletion region is very narrow.
2. When a small reverse bias is applied, a very strong electric field is produced.
3. This field breaks the covalent bonds, extremely large number of electrons and holes are produced, which gives rise to zener current.

### 9.5 Zener diode


1. Zener diode is a reverse biased heavily doped semiconductor (silicon or germanium) PN junction diode.
2. It is operated exclusively in the breakdown region.
3. Symbol:

```
\[ P \quad N \]
```

### 9.7 Light Emitting Diode (LED)

10. What is light emitting diode? Give any one of its uses.

A light emitting diode (LED) is a forward biased PN junction diode which emits visible light when energized.

Uses: It is used for instrument displays, calculators and digital watches.

### 9.9 Transistor circuit symbols

11. Draw the circuit configuration of NPN transistor’s common collector mode.

```
\[ C \quad E \quad B \]
```

12. Draw the circuit configuration of NPN transistor CB mode.

```
\[ V_{cc} \quad V_{ee} \]
```

13. Draw the circuit diagram of NPN CE mode.

```
\[ V_{ce} \quad V_{cc} \]
```

14. Define the input impedance of a transistor in CE mode.

The input impedance of the transistor $r_i$ is defined as the ratio of small change in base–emitter voltage to the corresponding change in base current at a given $V_{CE}$.

\[
\text{Input impedance, } r_i = \frac{\Delta V_{BE}}{\Delta I_B} \bigg|_{V_{CE}}
\]

15. Define output impedance of a transistor.

The output impedance $r_o$ is defined as the ratio of variation in the collector-emitter voltage to the corresponding variation in the collector current at a constant base current in the active region of the transistor characteristic curves.

\[
\text{Output impedance, } r_o = \frac{\Delta V_{CE}}{\Delta I_C} \bigg|_{I_B}
\]

### 9.11 Transistor amplifier

16. What is bandwidth of the amplifier? (OR) Define bandwidth of an amplifier

Band width is defined as the frequency interval between lower cut off and upper cut off frequency.

\[
\text{BW} = f_u - f_l
\]

### 9.15 Feedback in amplifiers

17. What are the advantages of negative feedback?

1. Highly stabilised gain.
2. Reduction in the noise level.
3. Increased bandwidth.
4. Increased input impedance and decreased output impedance.
5. Less distortion.

### 9.16 Transistor oscillators

18. Give the Burkhuasen criteria for oscillations.
   1. The loop gain $A \beta = 1$
   2. The net phase shift round the loop is $0^\circ$ or integral multiples of $2\pi$.

### 19. What are the essential components of an LC oscillator?

1. Tank circuit: It consists of inductance coil (L) connected in parallel with capacitor (C). The frequency of oscillations as the values of inductance coil and capacitance of the capacitor.
2. Amplifier: The transistor amplifier receives d.c. power from the battery and changes it into a.c. power for supplying to the tank circuit.
3. Feedback circuit: It provides positive feedback (i.e.) this circuit transfers a part of output energy to LC circuit in proper phase, to maintain the oscillations.

### 9.17 Integrated circuit (IC)

20. What is an integrated circuit?

An integrated circuit (IC) consists of a single – crystal chip of silicon, containing both active (diodes and transistors) and passive (resistors, capacitors) elements and their interconnections.

### 21. Mention any 3 advantages of Integrated Circuit (IC).

1. Extremely small in size
2. Low power consumption
3. Reliability
4. Reduced cost
5. Very small weight
6. Easy replacement

### 9.18 Digital electronics

22. Draw the circuit diagram of OR gate using diode and resistor.

23. Draw the circuit diagram of AND gate using diode and resistor.


   **First theorem:** The complement of a sum is equal to the product of the complements.
   If $A$ and $B$ are the inputs, then $\overline{A + B} = \overline{A} \cdot \overline{B}$

   **Second theorem:** The complement of a product is equal to the sum of the complements.
   If $A$ and $B$ are the inputs, then $\overline{A \cdot B} = \overline{A} + \overline{B}$

26. What are universal gates? Why are they called so?

   1. NAND and NOR gates are called Universal gates because they can perform all the three basic logic functions.
   2. NAND and NOR gates are used to construction of basic logic gates (NOT, OR and AND).

### 9.19 Operational amplifier (OP – AMP)

27. Draw the circuit diagram for inverting amplifier using Op-Amp.


29. Draw the difference amplifier using Op-Amp.

### 9.20 Electronic measuring instruments

30. Mention any three uses of cathode ray oscilloscope.

   1. It is used to measure a.c and d.c voltage.
   2. It is used to study the waveforms of a.c voltages.
   3. It is used to find the frequency of a.c voltage.
3 MARKS QUESTIONS:
1. Define the input impedance of a transistor in CE mode.
2. Write the different methods of doping a semiconductor.
3. What is zener diode? Draw its symbol.
4. What is an intrinsic semiconductor? Give examples.
5. What is an extrinsic semiconductor?
6. Draw the energy band diagram of N-type semiconductor and p-type conductor.
7. What is meant by doping?
8. Define output impedance of a transistor.
9. Define input impedance of a transistor in a CE mode.
10. For a transistor to work, how is the biasing provided?
11. Define bandwidth.
12. What is the necessity of modulation?
13. What is zener break down?
14. Distinguish between avalanche breakdown and zener breakdown.
15. Mention any three advantages of negative feedback.
16. What is rectification?
17. What is light emitting diode? Give any one of its uses.
18. Draw the circuit configuration of NPN transistor.
19. Draw the circuit diagram of NPN CE mode.
20. Define band width of an amplifier.
21. What is zener diode?
22. What is zener break down?
23. What are the advantages of negative feedback?
24. Give the Burkhuasen criteria for for oscillations.
25. Define bandwidth of an amplifier
26. What is an integrated circuit?
27. Draw the circuit diagram for an OR gate.
28. Draw the circuit for summing amplifier
29. State De-Morgan’s theorem.
30. What is integrated circuit?
31. Mention any 3 advantages of Integrated Circuit (IC).
32. Draw the circuit diagram of AND gate using diode and resistor.
33. What are universal gates? Why are they called so?
34. Draw NOT gate using transistor
35. What are the essential components of an LC oscillator?
36. Mention the advantages of ICs.
37. Mention any three uses of cathode ray oscilloscope.
38. Give the important parameters of OP AMP?
40. Draw the difference amplifier using Op-Amp.
41. Prove the Boolean identity: \((A + B) (A + C) = A + BC\)

5 MARKS QUESTIONS:
1. Explain the working of a half wave diode rectifier.
2. Explain the working of bridge rectifier with neat diagram.
3. Explain the action of zener diode as a voltage regulator with necessary circuit.
4. Draw the frequency response curve of single stage CE amplifier and discuss the result.
5. Define current amplification factors and obtain the relation between them.
6. Explain the function of transistor as a switch.
7. With the help of circuit diagram, explain the voltage divider biasing of a transistor.
8. What is AND gate? Explain the function of AND gate using electrical circuit and using diodes.
9. Explain how transistor biasing is provided by voltage divider bias method.
10. State and prove De-Morgan’s theorem.
11. Explain the circuit symbol and pin-out configuration of an operational amplifier.
12. Explain how multimeter is used as ohm-meter (multimeter diagram not necessary)
13. Explain the function of an operational amplifier as a summing amplifier.

10 MARKS QUESTIONS:
1. What is rectification? Explain the working of bridge rectifier with necessary waveforms.
2. Explain the function of a bridge rectifier.
3. Explain the output characteristics of N-P-N transistor connected in common emitter configuration with the help of a neat circuit diagram.
4. Discuss the output characteristics of a transistor connected in CE mode with a neat diagram.
5. Explain with a neat diagram, the working of a single stage CE amplifier.
6. What is meant by feedback? Derive an expression for voltage gain of an amplifier with negative feedback.
7. Sketch the circuit of Colpitts oscillator and explain its working.
8. What is an amplifier? Explain its action as (1) inverting amplifier (2) non-inverting amplifier.
9. With circuit diagram, explain the working of an operational amplifier as a summing amplifier.

10. COMMUNICATION SYSTEMS

10.1 Propagation of electromagnetic waves

1. What are the different types of radio wave propagation?
   1. Ground (surface) wave propagation
   2. Space wave propagation
   3. Sky wave (or) ionospheric propagation

2. What is mean by skip distance?
   In the sky wave propagate, for a fixed frequency, the shortest distance between the point of transmission and the point of reception along the surface is known as skip distance.

10.2 Modulation

3. What is the necessity of modulation?
   1. In radio broadcasting, it is necessity to send audio frequency signals (e.g. Music, Speech, etc.) from broad casting station over great distance to a receiver.
   2. The energy of the wave increase with frequency so the audio frequency (20HZ – 20000HZ) is not having large amount of energy and cannot be send about long distance
   3. The radiation of electrical energy is practicable only at high frequencies (e.g.) above 20KHZ.

4. What is called amplitude modulation?
   When the amplitude of high frequency carrier wave is changed in accordance with the intensity of the signal, this process is called as amplitude modulation.

5. Define modulation factor in amplitude modulation?
   The ratio of the change in amplitude of carrier wave after modulation to the amplitude of the un-modulated carrier wave
   \[
   m = \frac{\text{Amplitude change of carrier wave after modulation}}{\text{Amplitude of carrier wave before modulation}}
   \]
   \[
   m = \frac{\text{signal amplitude}}{\text{carrier amplitude}}
   \]

6. Define Bandwidth.
   The band width (channel width) is given by the difference between extreme frequencies i.e. between maximum frequency of USB and minimum frequency of LSB.
   \[
   \text{Channel width} = 2 \times \text{max. frequency of the modulating signal}
   \]
   \[
   = 2 \times (f_s)_{\text{max}}
   \]

7. What are the advantages in amplitude modulation?
   1. Easy transmission and reception.
   2. Lesser band width requirement.
   3. Low cast.

8. What are the limitations of amplitude modulation?
   1. Noise reception
   2. Low efficiency
   3. Small operating range.

9. What is phase modulation? Give its importance?
   Phase of the carrier wave is varied in accordance with the amplitude of the modulating signal and the rate of variation is proportional to signal frequency.
   Advantages:
   1. Small band width.
   2. High transmission speed.
   3. FM signal produced from PM is very stable.

10.4 Radio transmission and reception

10. What are super heterodyne receivers? Give its advantages?
   1. The selected radio signal is converted in to fixed intermediate frequency (say 455 KHz for AM, 10.7 MHz for FM) using mixer and local oscillator.
   2. Selective and sharpness of a receiver is increased.

11. What are the disadvantages of simple (or) straight radio receiver?
   Simple radio receiver circuit has
   1. poor sensitivity
   2. poor selectivity

12. What are the advantages in FM?
   1. Noiseless reception.
   2. Operating range is quite large.
   3. The efficiency of transmission is very high.

13. What are the disadvantages in FM?
   1. A much wide change is required by FM.
   2. FM transmitting and receiving equipments, tends to more complex.

10.5 Television

   Videcon functions on the principle of photo conductivity, where the resistance of target material decreases when exposed to light.

15. What is mean by scanning?
   Scanning is the process by which an electron beam spot is made to move across a rectangular area, so as to cover it completely.

16. What are interlaced scanning?
1. Odd numbered of lines are scanned first, then even number lines during second field.
2. To eliminate flicker effect.
3. Scanning between second lines is called as interlaced scanning.

**10.9 RADAR**

17. Write any three applications of RADAR
1. It is used in air and sea navigation. Plains and ship get detailed report of mountains, rivers, lakes, etc,
2. It is used for safe landing of aircrafts.
3. It is reflected from clouds, so it give weather forecasting.

**10.10 Analog communication and digital communication**

18. What are advantages of digital communication?
1. The transmission quality is high and almost independent of the distance between the terminals.
2. The capacity of the transmission system can be increased.
3. The newer types of transmission media such as light beams in optical fibers and wave guides operating in the microwave frequency extensively use digital communication.

19. What are disadvantages of digital communication?
1. A digital system requires larger bandwidth.
2. It is very difficult to gradually change over from analog to digital transmission.

20. What is called modem?
1. Modem is a device which converts Digital signal into analog signal during ‘transmission’.
2. Analog signal into digital signal during ‘reception’.

Fax is an electronic system for transmitting graphical information by wire or radio.
Uses: used to send printed material through telephone lines by converting into electric signals.

**QUESTION BANK**

3 MARKS QUESTIONS:
1. What are the different types of radio wave propagation?
2. What is meant by skip distance?
3. Define amplitude modulation.
4. Define modulation factor in AM.
5. What is the necessity of modulation?
6. Mention the advantages of frequency modulation.
7. Define modulation factor.
8. What is interlaced scanning?
9. Write any three applications of RADAR.
10. What is fax? Mention its use.

11. What are the advantages of digital communications?
12. Mention the three advantages of fibre optic communication system.

5 MARKS QUESTIONS:
1. Explain the space wave propagation of radio waves.
2. What are the advantages and disadvantages of digital communication?
3. Draw the functional block diagram of AM radio transmitter.
4. Explain with the help of block diagram, the function of FM radio transmitter.
5. With the help of a functional block diagram, explain the operation of a super heterodyne FM receiver.
6. Mention the merits and demerits of digital communication.
7. Write short notes on fibre optical communication and mention its advantages.
8. What is an optical fibre? Mention the advantages of optical communication system.
9. State the principle of Radar. What are the applications of Radar?
10. Mention the principle of RADAR and write its applications.

10 MARKS QUESTIONS:
1. Make an analysis of AM wave. Plot the frequency spectrum.
2. With the help of a functional block diagram, explain the operation of a super heterodyne AM receiver.
3. With the help of block diagram, explain the function of monochrome TV receiver.
4. Explain the construction and working of a vidicon camera tube with neat diagram.
5. With the help of block diagram, explain the function of a RADAR system.
6. Explain the principle and working of RADAR with neat block diagram.
7. Explain transmission and reception of Radar with block diagram.

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