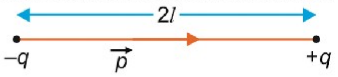
CHAPTER 1

Define electric dipole moment. Is it a scalar or a vector quantity? What are its SI unit?
[*CBSE Sample Paper 2021, (AI) 2011, 2013, (F) 2009, 2012, 2013*]

The electric dipole moment is defined as the product of either charge and the distance between the two charges. Its direction is from negative to positive charge.



i.e., $|\vec{p}| = q(2l)$

Electric dipole moment is a vector quantity.

Its SI unit is coulomb-metre.

Find expressions for the force and torque on an electric dipole kept in a uniform electric field.
[*CBSE (AI) 2014; 2019 (55/5/1); 2020 (55/3/1); 2020 (55/5/1); CBSE Sample Paper 2021*]

OR

(*i*) Define torque acting on a dipole of dipole moment $\vec{p}$ placed in a uniform electric field $\vec{E}$. Express it in the vector form and point out the direction along which it acts.

(*ii*) What happens if the field is non-uniform?

(*iii*) What would happen if the external field $\vec{E}$ is increasing (*i*) parallel to $\vec{p}$ and (*ii*) anti-parallel to $\vec{p}$? **[*CBSE (F) 2016*]**

(*i*) Using Gauss Theorem show mathematically that for any point outside the shell, the field due to a uniformly charged spherical shell is same as the entire charge on the shell, is concentrated at the centre. **[*CBSE 2019 (55/4/1)*]**

(*ii*) Why do you expect the electric field inside the shell to be zero according to this theorem?

OR **[*CBSE Allahabad 2015*]**

A thin conducting spherical shell of radius R has charge Q spread uniformly over its surface. Using Gauss's theorem, derive an expression for the electric field at a point outside the shell. **[*CBSE Delhi 2009*]**

Draw a graph of electric field $E(r)$ with distance r from the centre of the shell for $0 \le r < \infty$.

OR

Find the electric field intensity due to a uniformly charged spherical shell at a point (*i*) outside the shell and (*ii*) inside the shell. Plot the graph of electric field with distance from the centre of the shell. **[*CBSE North 2016; 2020 (55/1/1)*]**

OR

Using Gauss's law obtain the expression for the electric field due to a uniformly charged thin spherical shell of radius R at a point outside the shell. Draw a graph showing the variation of electric field with r, for $r > R$ and $r < R$. **[*CBSE (AI) 2013; 2020 (55/2/1)*]**

(*i*) Use Gauss' law to obtain an expression for the electric field due to an infinitely long thin straight wire with uniform linear charge density λ. **[*CBSE 2020 (55/5/1), 2023 (55/2/1)*]**

(*ii*) An infinitely long positively charged straight wire has a linear charge density λ. An electron is revolving in a circle with a constant speed v such that the wire passes through the centre, and is perpendicular to the plane, of the circle. Find the kinetic energy of the electron in terms of magnitudes of its charge and linear charge density λ on the wire.

(*iii*) Draw a graph of kinetic energy as a function of linear charge density λ. **[*CBSE 2023 (55/2/1)*]**

CHAPTER 2

Draw an equipotential surface for a system consisting of two charges Q, – Q separated by a distance r in air. Locate the points where the potential due to the dipole is zero.

[CBSE Delhi 2017, (AI) 2008, 2013, 2019 (55/2/1), 2020 (55/4/2)]

Derive an expression for the electric potential at a point due to an electric dipole. Mention the contrasting features of electric potential of a dipole at a point as compared to that due to a single charge. *[CBSE Delhi 2008, 2017]*

A parallel plate capacitor is charged by a battery, which is then disconnected. A dielectric slab is then inserted in the space between the plates. Explain what changes, if any, occur in the values of

(*i*) capacitance

(*ii*) potential difference between the plates

(*iii*) electric field between the plates, and

(*iv*) the energy stored in the capacitor.

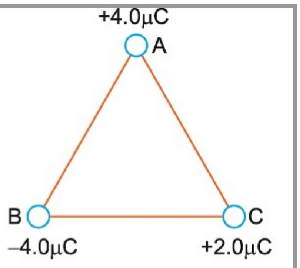
[CBSE Delhi 2010, (AI) 2009, 2012]

$Q = CV = 17.7 \times 10^{-12} \times 100 = 1.77 \times 10^{-9}$ coulomb = **1.77 nC**

State the significance of negative value of electrostatic potential energy of a system of charges.

Three charges are placed at the corners of an equilateral triangle ABC of side 2.0 m as shown in figure. Calculate the electric potential energy of the system of three charges.

[CBSE, 2023] [55/2/1]



Three concentric metallic shells A, B and C of radii a, b and c ($a < b < c$) have surface charge densities $+\sigma$, $-\sigma$ and $+\sigma$ respectively as shown in the figure.

If shells A and C are at the same potential, then obtain the relation between the radii a, b and c.

[CBSE (F) 2014, 2019 (55/5/1)]

CHAPTER 3

Define electrical conductivity of a conductor and give its SI unit. On what factors does it depend? *[CBSE Delhi 2014, (East) 2016, CBSE 2023 (55/4/1)]*

Two wires one of manganin and the other of copper have equal length and equal resistance. Which one of these wires will be thicker? *[CBSE (AI) 2012, (South) 2016] [HOTS]*

Define the terms (*i*) drift velocity, (*ii*) relaxation time. *[CBSE Delhi 2011, (AI) 2013]*

Define the term 'mobility' of charge carriers in a current carrying conductor. Obtain the relation for mobility in terms of relaxation time. *[CBSE 2020 (55/2/1)]*

(*a*) Two cells of emf E_1 and E_2 have their internal resistances r_1 and r_2, respectively. Deduce an expression for the equivalent emf and internal resistance of their parallel combination when connected across an external resistance R. Assume that the two cells are supporting each other.

(*b*) In case the two cells are identical, each of emf $E = 5$ V and internal resistance $r = 2\ \Omega$, calculate the voltage across the external resistance $R = 10\ \Omega$. *[CBSE 2020 (55/1/1)]*

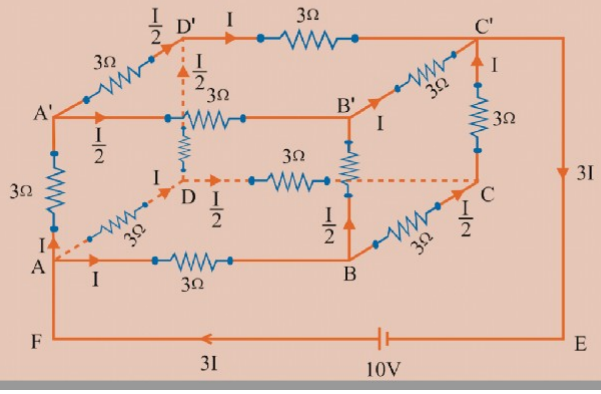
Derive condition of balance of a Wheatstone bridge.

OR

Draw a circuit diagram showing balancing of Wheatstone bridge. Use Kirchhoff's rules to obtain the balance condition in terms of the resistances of four arms of Wheatstone Bridge.

[CBSE Delhi 2013, 2015]

Twelve wires each having a resistance of 3Ω are connected to form a cubical network. A battery of 10 V and negligible internal resistance is connected across the diagonally opposite corners of this network. Determine its equivalent resistance and the current along each edge of the cube. [*CBSE 2019 (55/3/1)*]



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Deduce Ohm's law using the concept of drift velocity.

OR

Define the term 'drift velocity' of charge carriers in a conductor. Obtain the expression for the current density in terms of relaxation time. [*CBSE (F) 2014*]

OR

Define relaxation time of the free electrons drifting in a conductor. How is it related to the drift velocity of free electrons? Use this relation to deduce the expression for the electrical resistivity of the material. [*CBSE (AI) 2012*]

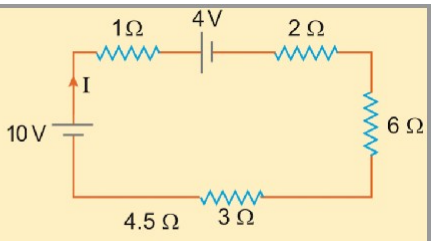
OR

(*i*) On the basis of electron drift, derive an expression for resistivity of a conductor in terms of number density of free electrons and relaxation time. On what factors does resistivity of a conductor depend? [*CBSE 2023 (55/2/1)*]

(*ii*) Why alloys like constantan and manganin are used for making standard resistors? [*CBSE Delhi 2016*]

(*i*) High current is to be drawn safely from (1) a low-voltage battery, and (2) a high-voltage battery. What can you say about the internal resistance of the two batteries?

(*ii*) Calculate the energy supplied by the batteries to the circuit shown in the figure, in one minute. [*CBSE 2023 (55/4/1)*]



CHAPTER 4

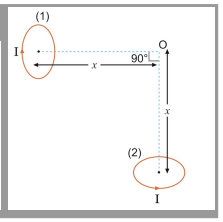
A narrow beam of protons and deuterons, each having the same momentum, enters a region of uniform magnetic field directed perpendicular to their direction of momentum. What would be the ratio of the circular paths described by them? [*CBSE (F) 2011*]

OR

A proton and a deuteron having equal momenta enter in a region of uniform magnetic field at right angle to the direction of the field. Find the ratio of the radii of curvature of the path of the particle. [*CBSE Delhi 2013*]

Two small identical circular loops, marked (1) and (2), carrying equal currents, are placed with the geometrical axes perpendicular to each other as shown in the figure. Find the magnitude and direction of the net magnetic field produced at the point *O*.

[*CBSE (F) 2013, 2014*]



Two identical coils *P* and *Q* each of radius *R* are lying in perpendicular planes such that they have a common centre. Find the magnitude and direction of magnetic field at the common centre of the two coils, if they carry currents equal to *I* and $\sqrt{3}\ I$ respectively.

[*CBSE (F) 2016, 2019 (55/5/1)*] [*HOTS*]

Two circular loops *A* and *B*, each of radius 3 m, are placed coaxially at a distance of 4 m. They carry currents of 3 A and 2 A in opposite directions respectively. Find the net magnetic field at the centre of loop *A*.

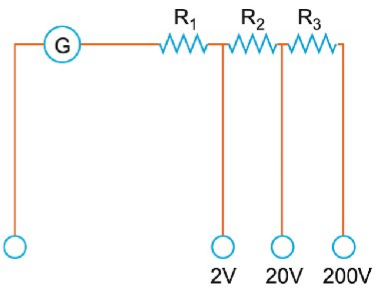
[*CBSE 2023 (55/4/1)*]

(*a*) Briefly explain how a galvanometer is converted into an ammeter. [*CBSE 2023 (55/2/1)*]

(*b*) A galvanometer coil has a resistance of 15 Ω and it shows full scale deflection for a current of 4 mA. Convert it into an ammeter of range 0 to 6 A. [*CBSE 2019 (55/4/1)*]

A multirange voltmeter can be constructed by using a galvanometer circuit as shown in the figure. We want to construct a voltmeter that can measure 2 V, 20 V and 200 V using a galvanometer of resistance 10 Ω and that produces maximum deflection for current of 1 mA. Find the value of R_1, R_2 and R_3 that have to be used.

[*NCERT Exemplar, CBSE Sample Paper 2018*]



Here, $G = 10\ \Omega$, $I_g = 1\ \text{mA} = 10^{-3}\ \text{A}$

(*i*) State Biot-Savart Law. Using this law, find an expression for the magnetic field at the centre of a circular coil of *N*-turns, radius *R*, carrying current *I*. [*CBSE 2019 (55/1/1), 2023 (55/1/1)*]

(*ii*) Sketch the magnetic field for a circular current loop, clearly indicating the direction of the field. [*CBSE (F) 2010, Central 2016, 2023 (55/1/1)*]

(*i*) Derive an expression for the magnetic field at a point on the axis of a current carrying circular loop. [*CBSE 2019 (55/3/1), 2023 (55/3/1)*]

OR

Using Biot-Savart's law, derive an expression for magnetic field at any point on axial line of a current carrying circular loop. Hence, find magnitude of magnetic field intensity at the centre of circular coil. [*CBSE Sample Paper 2020*]

(*ii*) Two co-axial circular loops L_1 and L_2 of radii 3 cm and 4 cm are placed as shown. What should be the magnitude and direction of the current in the loop L_2 so that the net magnetic field at the point *O* be zero?

(*a*) A straight thick long wire of uniform circular cross-section of radius '*a*' is carrying a steady current *I*. The current is uniformly distributed across the cross-section. Use Ampere's circuital law to obtain a relation showing the variation of the magnetic field (B_r) inside and outside the wire with distance *r*, ($r \le a$) and ($r > a$) of the field point from the centre of its cross-section. What is the magnetic field at the surface of this wire? Plot a graph showing the nature of this variation.

(*b*) Calculate the ratio of magnetic field at a point $\frac{a}{2}$ above the surface of the wire to that at a point $\frac{a}{2}$ below its surface. What is the maximum value of the field of this wire?

[*CBSE Delhi 2010; Chennai 2015*]

Using Ampere's circuital law find an expression for the magnetic field at a point on the axis of a long solenoid with closely wound turns. [*CBSE (F) 2010, 2019(55/2/1)*]

Two long straight parallel conductors carry steady current I_1 and I_2 separated by a distance d. If the currents are flowing in the same direction, show how the magnetic field set up in one produces an attractive force on the other. Obtain the expression for this force. Hence define one ampere. [*CBSE Delhi 2016*]

OR

Derive an expression for the force per unit length between two long straight parallel current carrying conductors. Hence define SI unit of current (ampere).

[*CBSE (AI) 2009, 2010, 2012, Patna 2015, 2020 (55/3/1)*]

Derive an expression for torque acting on a rectangular current carrying loop kept in a uniform magnetic field B. Indicate the direction of torque acting on the loop.

[*CBSE Delhi 2013; (F) 2009, 2019 (55/1/1), 2020 (55/1/1)*]

OR

Deduce the expression for the torque $\vec{\tau}$ acting on a planar loop of area $\vec{A}$ and carrying current I placed in a uniform magnetic field B.

If the loop is free to rotate, what would be its orientation in stable equilibrium?

[*CBSE Ajmer 2015*]

Draw the labelled diagram of a moving coil galvanometer. Prove that in a radial magnetic field, the deflection of the coil is directly proportional to the current flowing in the coil. [*CBSE (F) 2012*]

OR

(*a*) Draw a labelled diagram of a moving coil galvanometer. Describe briefly its principle and working.

(*b*) Answer the following:

(*i*) Why is it necessary to introduce a cylindrical soft iron core inside the coil of a galvanometer?

(*ii*) Increasing the current sensitivity of a galvanometer may not necessarily increase its voltage sensitivity. Explain, giving reason. [*CBSE (AI) 2014*]

OR

Explain, using a labelled diagram, the principle and working of a moving coil galvanometer. What is the function of (*i*) uniform radial magnetic field, (*ii*) soft iron core?

Define the terms (*i*) current sensitivity and (*ii*) voltage sensitivity of a galvanometer. Why does increasing the current sensitivity not necessarily increase voltage sensitivity?

[*CBSE Allahabad 2015, 2019 (55/1/2)*]

A galvanometer of resistance G is converted into a voltmeter to measure upto V volts by connecting a resistance R_1 in series with the coil. If a resistance R_2 is connected in series with it, then it can measure upto $V/2$ volts. Find the resistance, in terms of R_1 and R_2, required to be connected to convert it into a voltmeter that can read upto 2 V. Also find the resistance G of the galvanometer in terms of R_1 and R_2. [*CBSE Delhi 2015*]

OR

To convert a given galvanometer into a voltmeter of ranges $2V$, V and $\frac{V}{2}$ volt, resistance R_1, R_2 and R_3 ohm respectively, are required to be connected in series with the galvanometer. Obtain the relationship between R_1, R_2 and R_3. [*CBSE 2020 (55/3/1)*]

CHAPTER 5

Write any two points of difference between a diamagnetic and a paramagnetic substance. [*CBSE 2023 (55/3/1)*]

Write two properties of a material suitable for making (*a*) a permanent magnet, and (*b*) an electromagnet. [*CBSE (AI) 2017*]

A small magnetised needle *P* is placed at the origin of *x*–*y* plane with its magnetic moment pointing along the *y*-axis. Another identical magnetised needle *Q* is placed in two positions, on by one. [*CBSE 2023 (55/4/1)*]

Case 1 : at (*a*, 0) with its magnetic moment pointing along *x*-axis.

Case 2 : at (*a*, 0) with its magnetic moment pointing along *y*-axis.

(*a*) In which case is the potential energy of *P* and *Q* minimum?

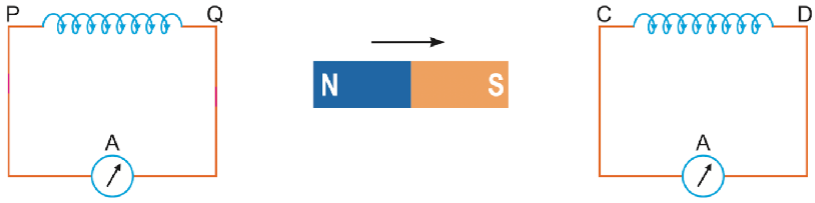
(*b*) In which case is *P* and *Q* not in equilibrium?

Justify your answers.

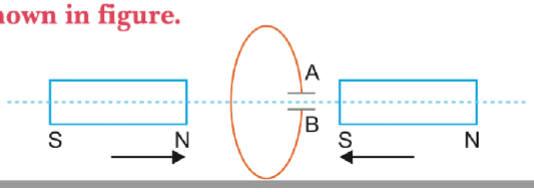
Write three points of differences between para-, dia- and ferro- magnetic materials, giving one example for each. [*CBSE 2019 (55/1/1)*]

CHAPTER 6

A bar magnet is moved in the direction indicated by the arrow between two coils *PQ* and *CD*. Predict the directions of induced current in each coil. [*CBSE (AI) 2012, 2017*]



Predict the polarity of the capacitor *C* connected to coil, which is situated between two bar magnets moving as shown in figure. [*CBSE Delhi 2011, (AI) 2017*]

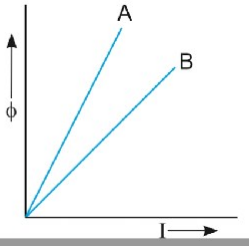


(*a*) How does the mutual inductance of a pair of coils change when

(*i*) distance between the coils is increased and

(*ii*) number of turns in the coils is increased? [*CBSE (AI) 2013*]

(*b*) A plot of magnetic flux (ϕ) versus current (*I*), is shown in the figure for two inductors *A* and *B*. Which of the two has large value of self-inductance? [*CBSE Delhi 2010*]



(*c*) How is the mutual inductance of a pair of coils affected when

(*i*) separation between the coils is increased?

(*ii*) the number of turns in each coil is increased?

(*iii*) a thin iron sheet is placed between the two coils, other factors remaining the same?

Justify your answer in each case. [*CBSE (AI) 2013*]

(*a*) (*i*) Mutual inductance decreases

Define self-inductance of a coil. Show that magnetic energy required to build up the current I in a coil of self inductance L is given by $\frac{1}{2}LI^2$. [*CBSE Delhi 2012*]

OR

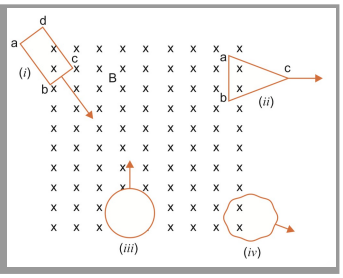
Define the term self-inductance of a solenoid. Obtain the expression for the magnetic energy stored in an inductor of self-inductance L to build up a current I through it. [*CBSE (AI) 2014*]

A long solenoid of radius r consists of n turns per unit length. A current $I = I_0 \sin \omega t$ flows in the solenoid. A coil of N turns is wound tightly around it near its centre. What is:

(a) the induced emf in the coil?

(b) the mutual inductance between the solenoid and the coil? [*CBSE 2023 (55/1/1)*]

Figure shows planar loops of different shapes moving out of or into a region of magnetic field which is directed normal to the plane of loops downwards. Determine the direction of induced current in each loop using Lenz's law. [*CBSE (AI) 2010, (F) 2014*]



(a) What is induced emf? Write Faraday's law of electromagnetic induction. Express it mathematically.

(b) A conducting rod of length 'l', with one end pivoted, is rotated with a uniform angular speed 'ω' in a vertical plane, normal to a uniform magnetic field 'B'. Deduce an expression for the emf induced in this rod. [*CBSE Delhi 2013, 2012*]

If resistance of rod is R, what is the current induced in it?

Derive expression for self inductance of a long air-cored solenoid of length l, cross-sectional area A and having number of turns N. [*CBSE 2023 (55/2/1), (55/4/1)*]

What is meant by the term 'mutual inductance' of a pair of coils? Obtain an expression for the mutual inductance of two long coaxial solenoids, each of length l but having different number of turns N_1 and N_2 and radii r_1 and r_2 ($r_2 > r_1$). [*CBSE 2023 (55/3/1)*]

OR

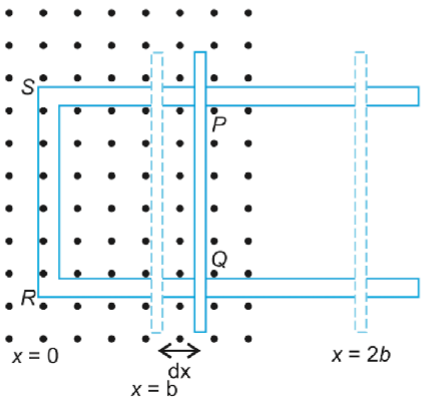
(a) Define mutual inductance and write its SI units. [*CBSE 2019 (55/1/1)*]

(b) Derive an expression for the mutual inductance of two long co-axial solenoids of same length wound one over the other.

(c) In an experiment, two coils C_1 and C_2 are placed close to each other. Find out the expression for the emf induced in the coil C_1 due to a change in the current through the coil C_2. [*CBSE Delhi 2015*]

State Faraday's law of electromagnetic induction.

Figure shows a rectangular conductor $PQRS$ in which the conductor PQ is free to move in a uniform magnetic field B perpendicular to the plane of the paper. The field extends from $x = 0$ to $x = b$ and is zero for $x > b$. Assume that only the arm PQ possesses resistance r. When the arm PQ is pulled outward from $x = 0$ to $x = 2b$ and is then moved backward to $x = 0$ with constant speed v, obtain the expressions for the flux and the induced emf. Sketch the variations of these quantities with distance $0 \leq x \leq 2b$. [*CBSE (AI) 2010, (North) 2016*]



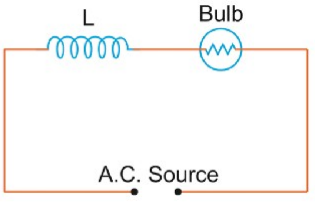
CHAPTER 7

The power factor of an *ac* circuit is 0.5. What is the phase difference between voltage and current in this circuit? [*CBSE (F) 2015, (South) 2016*]

What is wattless current? [*CBSE Delhi 2011, Chennai 2015*]

The coil of an ac generator consists of 100 turns of wire, each of area $0.5 m^2$. The resistance of the wire is 100 Ω. The coil is rotating in a magnetic field of 0.8 T perpendicular to its axis of rotation, at a constant angular speed of 60 radian per second. Calculate the maximum emf generated and power dissipated in the coil. [*CBSE 2023 (55/2/1)*]

An inductor L of reactance X_L is connected in series with a bulb B to an *ac* source as shown in figure. Explain briefly how does the brightness of the bulb change when (*i*) number of turns of the inductor is reduced (*ii*) an iron rod is inserted in the inductor and (*iii*) a capacitor of reactance $X_C = X_L$ is included in the circuit. [*CBSE Delhi 2014, 2015*]



A series LCR circuit with $R = 20\ \Omega$, $L = 2\ H$ and $C = 50\ \mu F$ is connected to a 200 volts ac source of variable frequency. What is (*i*) the amplitude of the current, and (*ii*) the average power transferred to the circuit in one complete cycle, at resonance? (*iii*) Calculate the potential drop across the capacitor. [*CBSE 2023 (55/4/1)*]

(*i*) Find the value of the phase difference between the current and the voltage in the series LCR circuit shown below. Which one leads in phase: current or voltage?

(*ii*) Without making any other change, find the value of the additional capacitor, C_1, to be connected in parallel with the capacitor C, in order to make the power factor of the circuit unity. [*CBSE Delhi 2017, Allahabad 2015*]

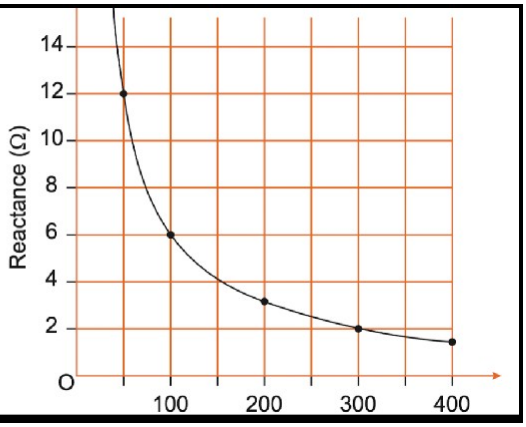
The figure shows the graphical variation of the reactance of a capacitor with frequency of ac source.

(*a*) Find the capacitance of the capacitor.

(*b*) An ideal inductor has the same reactance at 100 Hz frequency as the capacitor has at the same frequency. Find the value of inductance of the inductor.

(*c*) Draw the graph showing the variation of the reactance of this inductor with frequency.

[*CBSE 2020 (55/2/1)*]



An electric lamp connected in series with a capacitor and an *ac* source is glowing with of certain brightness. How does the brightness of the lamp change on reducing the (*i*) capacitance and (*ii*) frequency? [*CBSE Delhi 2010, (North) 2016*]

(*a*) A 44 mH inductor is connected to 220 V, 50 Hz *ac* supply. Determine the rms value of current in the circuit. [*NCERT*] [*CBSE (AI) 2013, 2012*]

(*b*) What is the net power absorbed by the circuit in a complete cycle?

An *ac* source of emf $V = V_0 \sin \omega t$ is connected to a capacitor of capacitance *C*. Deduce the expression for the current (*I*) flowing in it. Plot the graph of (*i*) *V* vs. ωt, and (*ii*) *I* vs. ωt.

[*CBSE 2020 (55/2/1), 2023 (55/3/1)*]

(*i*) Draw a labelled diagram of *ac* generator. Derive the expression for the instantaneous value of the emf induced in the coil. [*CBSE Sample Paper 2021*]

(*ii*) A circular coil of cross-sectional area 200 cm^2 and 20 turns is rotated about the vertical diameter with angular speed of 50 rad s^{-1} in a uniform magnetic field of magnitude 3.0×10^{-2} T. Calculate the maximum value of the current in the coil. [*CBSE Delhi 2017*]

(*a*) Describe briefly, with the help of a labelled diagram, the working of a step up transformer.

(*b*) Write any two sources of energy loss in a transformer. [*CBSE (F) 2012*]

(*c*) A step up transformer converts a low voltage into high voltage. Does it not violate the principle of conservation of energy? Explain. [*CBSE Delhi 2011, 2009*]

OR

Draw a schematic diagram of a step-up transformer. Explain its working principle. Deduce the expression for the secondary to primary voltage in terms of the number of turns in the two coils. In an ideal transformer, how is this ratio related to the currents in the two coils?

How is the transformer used in large scale transmission and distribution of electrical energy over long distances? [*CBSE (AI) 2010, (East) 2016*]

OR

State the working of ac generator with the help of a labelled diagram.

The coil of an *ac* generator having *N* turns, each of area *A*, is rotated with a constant angular velocity ω. Deduce the expression for the alternating emf generated in the coil.

What is the source of energy generation in this device? [*CBSE (AI) 2011*]

Explain with the help of a labelled diagram, the principle and working of an *ac* generator. Write the expression for the emf generated in the coil in terms of speed of rotation. Can the current produced by an *ac* generator be measured with a moving coil galvanometer?

OR

Describe briefly, with the help of a labelled diagram, the basic elements of an *ac* generator. State its underlying principle. Show diagrammatically how an alternating emf is generated by a loop of wire rotating in a magnetic field. Write the expression for the instantaneous value of the emf induced in the rotating loop. [*CBSE 2023 (55/2/1)*]

(*a*) An alternating voltage $V = V_m \sin \omega$ applied to a series *LCR* circuit drives a current given by $i = i_m \sin(\omega t + \phi)$. Deduce an expression for the average power dissipated over a cycle.

(*b*) For circuits used for transporting electric power, a low power factor implies large power loss in transmission. Explain. [*CBSE (F) 2011*]

OR

A voltage $V = V_0 \sin \omega t$ is applied to a series *LCR* circuit. Derive the expression for the average power dissipated over a cycle.

Under what condition is (*i*) no power dissipated even though the current flows through the circuit, (*ii*) maximum power dissipated in the circuit? [*CBSE (AI) 2014*]

OR

(*a*) An *ac* source of voltage $V = V_0 \sin \omega t$ is connected to a series combination of *L*, *C* and *R*. Use the phasor diagram to obtain expressions for impedance of the circuit and phase angle between voltage and current. Find the condition when current will be in phase with the voltage. What is the circuit in this condition called?

(*b*) In a series *LR* circuit $X_L = R$ and power factor of the circuit is P_1. When capacitor with capacitance *C* such that $X_L = X_C$ is put in series, the power factor becomes P_2. Calculate $\frac{P_1}{P_2}$. [*CBSE Delhi 2016*]

(*a*) What is impedance?

(*b*) A series *LCR* circuit is connected to an *ac* source having voltage $V = V_0 \sin \omega t$. Derive expression for the impedance, instantaneous current and its phase relationship to the applied voltage. Find the expression for resonant frequency.

[*CBSE Delhi 2010, 2023(55/1/1)*]

CHAPTER 8

(*a*) Name the e.m. waves which are suitable for radar systems used in aircraft navigation. Write the range of frequency of these waves.

(*b*) If the Earth did not have atmosphere, would its average surface temperature be higher or lower than what it is now? Explain.

(*c*) An e.m. wave exerts pressure on the surface on which it is incident. Justify.

[*CBSE Sample Paper-2022, Term-2*]

Electromagnetic waves of wavelengths λ_1, λ_2 and λ_3 are used in radar systems, in water purifiers and in remote switches of TV, respectively.

(*i*) Identify the electromagnetic waves, and

(*ii*) Write one source of each of them. [*CBSE 2022 (55/3/1), Term-2*]

(*i*) How are infrared waves produced? Write their one important use.

(*ii*) The thin ozone layer on top of the stratosphere is crucial for human survival. Why?

[*CBSE East 2016; 2019 (55/4/1)*]

(*a*) How does oscillating charge produce electromagnetic waves?

(*b*) Sketch a schematic diagram depicting oscillating electric and magnetic fields of an em wave propagating along + *z*-direction. [*CBSE (F) 2014, Delhi 2016*]

Consider an induced magnetic field due to changing electric field and an induced electric field due to changing magnetic field. Which one is more easily observed? Justify your answer.

[*CBSE 2023 (55/1/1)*]

CHAPTER 9

Will the focal length of a lens for red light be more, same or less than that for blue light?

[*HOTS*] [*NCERT Exemplar*]

You are given following three lenses. Which two lenses will you use as an eyepiece and as an objective to construct an astronomical telescope? Give reason.

Lenses	Power (D)	Aperture (cm)
L_1	3	8
L_2	6	1
L_3	10	1

[*CBSE Delhi 2009, CBSE (AI) 2017*]

An object is placed in front of a converging lens. Obtain the conditions under which the magnification produced by the lens is (*i*) negative and (*ii*) positive.

[*CBSE 2022 (55/3/1), (55/3/3), Term-2*]

(*i*) What is total internal reflection? Under what conditions does it occur?

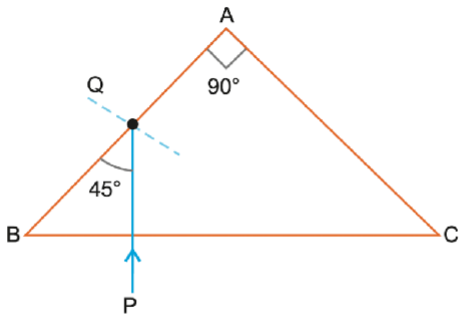
[*CBSE 2022 (55/2/1), Term–2*]

(*ii*) Find a relation between critical angle and refractive index.

(*iii*) Name one phenomenon which is based on total internal reflection.

[*CBSE (East) 2016, 2019 (55/1/1)*]

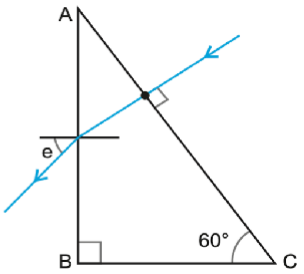
A ray of light *PQ* enters an isosceles right angled prism *ABC* of refractive index 1.5 as shown in figure. [*CBSE 2020 (55/4/1)*]



(*i*) Trace the path of the ray through the prism.

(*ii*) What will be the effect on the path of the ray if the refractive index of the prism is 1.4?

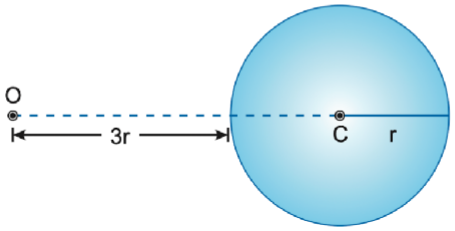
Calculate the angle of emergence (e) of the ray of light incident normally on the face AC of a glass prism ABC of refractive index $\sqrt{3}$. How will the angle of emergence change qualitatively, if the ray of light emerges from the prism into a liquid of refractive index 1.3 instead of air? [*CBSE 2020 (55/5/1)*]



A beam of light converges at a point P. Now a convex lens is placed in the path of the convergent beam at 15 cm from P. At what point does a beam converge if the convex lens has a focal length 10 cm? [*CBSE 2019 (55/4/1)*]

The focal lengths of the objective and the eye-piece of a compound microscope are 1.0 cm and 2.5 cm respectively. Find the tube length of the microscope for obtaining a magnification of 300. [*CBSE 2023 (55/2/1)*]

A point object is placed at O in front of a glass sphere as shown in figure.
Show the formation of image by the sphere. [*CBSE 2022 (55/3/1), (55/3/3), Term-2*]



An unsymmetrical double convex thin lens forms the image of a point object on its axis. Will the position of the image change if the lens is reversed? [*HOTS*] [*NCERT Exemplar*]

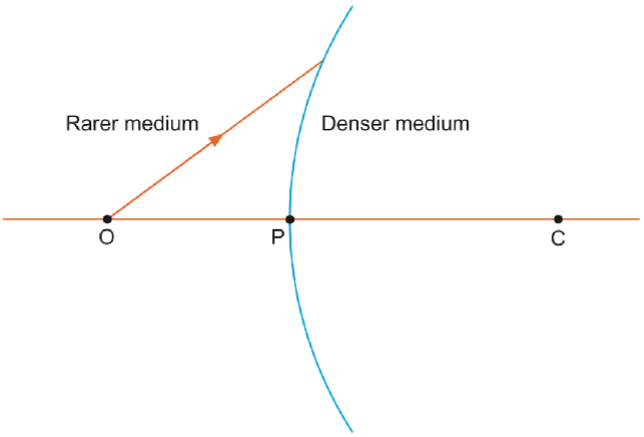
Define power of a lens. Write its units. Deduce the relation $\frac{1}{f} = \frac{1}{f_1} + \frac{1}{f_2}$ for two thin lenses kept in contact coaxially. [*CBSE (F) 2012, 2019 (55/4/3), 2020 (55/4/1)*]

Draw a ray diagram for formation of image of a point object by a thin double convex lens having radii of curvature R_1 and R_2. Hence, derive lens maker's formula for a double convex lens. State the assumptions made and sign convention used. [*CBSE (F) 2013, (Central) 2016, 2020 (55/2/1)*]

A spherical surface of radius of curvature R, separates a rarer and a denser medium as shown in the figure.

Complete the path of the incident ray of light, showing the formation of a real image. Hence derive the relation connecting object distance 'u', image distance 'v', radius of curvature R and the refractive indices n_1 and n_2 of two media. [*CBSE 2023 (55/1/1)*]

Briefly explain, how the focal length of a convex lens changes, with increase in wavelength of incident light.



[*CBSE Delhi 2014; Central 2016; (F) 2017; Sample Paper 2016*]

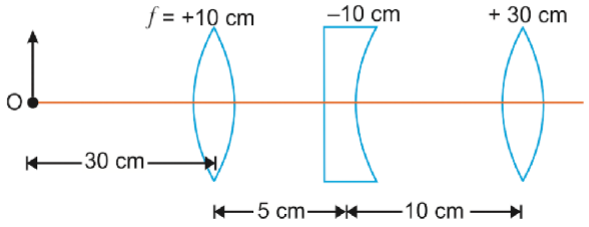
An object is placed in front of a concave mirror. It is observed that a virtual image is formed. Draw the ray diagram to show the image formation and hence derive the mirror equation $\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$. [*CBSE 2020 (55/1/1)*]

OR

(*i*) Derive the mirror formula. What is the corresponding formula for a thin lens?

(*ii*) Draw a ray diagram to show the image formation by a concave mirror when the object is kept between its focus and the pole. Using this diagram, derive the magnification formula for the image formed. [*CBSE Delhi 2011*]

Find the position of the image formed of an object 'O' by the lens combination given in the figure. [*2019 (55/4/1)*]



Use the mirror equation to show that

(*a*) an object placed between f and $2f$ of a concave mirror produces a real image beyond $2f$. [*CBSE Delhi 2015, (F) 2017, 2019 (55/3/3)*]

(*b*) a convex mirror always produces a virtual image independent of the location of the object.

(*c*) an object placed between the pole and focus of a concave mirror produces a virtual and enlarged image. [*NCERT*] [*CBSE (AI) 2011*]

(*i*) Name the phenomenon on which the working of an optical fibre is based. [*CBSE 2022 (55/1/1), Term–2*]

(*ii*) What are the necessary conditions for this phenomenon to occur? [*CBSE 2022 (55/3/1), Term–2*]

(*iii*) Draw a labelled diagram of an optical fibre and show how light propagates through the optical fibre using this phenomenon. [*CBSE 2019, CBSE 2022 (55/1/1), (55/2/3), Term–2*]

An angular magnification of 30X is desired using an objective of focal length 1.25 cm and an eye-piece of focal length 5 cm. How would you set up the compound microscope?

[*NCERT*] [*CBSE Sample Paper 2018*]

How is the working of a telescope different from that of a microscope?

[*CBSE Delhi 2012, 2019 (55/2/3)*]

Draw a graph to show the angle of deviation δ with the variation of angle of incidence i for a monochromatic ray of light passing through a prism of refracting angle A. Deduce the relation

$$n = \frac{\sin\left(\frac{A + \delta_m}{2}\right)}{\sin\left(\frac{A}{2}\right)}$$

[*CBSE Delhi 2011, 2016; (F) 2011, 2017; Sample Paper 2016, 2020(55/4/1)*]

OR

Draw a ray diagram showing refraction of a ray of light through a triangular glass prism. Hence, obtain the relation for the refractive index (μ) in terms of angle of prism (A) and angle of minimum deviation (δ_m). [*CBSE 2023(55/3/1)*]

(*a*) State two main considerations taken into account while choosing the objective of astronomical telescope.

(*b*) Draw a ray diagram of reflecting type telescope. State its magnifying power.

(*c*) State the advantages of reflecting type telescope over the refracting type.

[*CBSE Sample Paper 2021*]

(*i*) Draw a labelled ray diagram to obtain the real image formed by an astronomical telescope in normal adjustment position. Define its magnifying power.

[*CBSE Sample paper-2022, Term-2*] [*CBSE 2019 (55/1/2)*]

(*ii*) You are given three lenses of power 0.5 D, 4 D and 10 D to design a telescope.

(*a*) Which lenses should be used as objective and eyepiece? Justify your answer.

(*b*) Why is the aperture of the objective preferred to be large? [*CBSE (Central) 2016*]

Explain with the help of a labelled ray diagram, how is image formed in an astronomical telescope. Derive an expression for its magnifying power.

[*CBSE (F) 2014, 2019 (55/1/1) 2020 (55/1/1), 2023 (55/4/1)*]

OR

Draw a ray diagram showing the image formation of a distant object by a refracting telescope. Define its magnifying power and write the two important factors considered to increase the magnifying power.

Describe briefly the two main limitations and explain how far these can be minimised in a reflecting telescope. [*CBSE (F) 2015, 2023 (55/2/1)*]

(*a*) Draw the labelled ray diagram for the formation of image by a compound microscope. Derive an expression for its total magnification (or magnifying power), when the final image is formed at the near point. [*CBSE Sample paper 2022, Term-2*] [*CBSE 2019 (55/5/1)*]

Why both objective and eyepiece of a compound microscope must have short focal lengths?

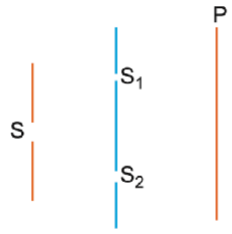
(*b*) Draw a ray diagram showing the image formation by a compound microscope. Hence obtain expression for total magnification when the image is formed at infinity.

[*CBSE Delhi 2013*]

CHAPTER 10

(*i*) In a Young's double-slit experiment $SS_2 - SS_1 = \frac{\lambda}{4}$, where S_1 and S_2 are the two slits as shown in the figure.

Find the path difference ($S_2P - S_1P$) for constructive and destructive interference at P.



(*ii*) What is the effect on the interference fringes in a Young's double-slit experiment, if the monochromatic source S is replaced by a source of white light? [*CBSE 2023 (55/4/1)*]

A beam of light consisting of two wavelengths 600 nm and 500 nm is used in a Young's double slit experiment. The slit separation is 1.0 mm and the screen is kept 0.60 m away from the plane of the slits. Calculate :

(*i*) the distance of the second bright fringe from the central maximum for wavelength 500 nm, and

(*ii*) the least distance from the central maximum where the bright fringes due to both the wavelengths coincide. [*CBSE 2022 (55/3/3), Term-2*]

Draw the intensity pattern for single slit diffraction and double slit interference for (*i*) the fringes produced in interference, and (*ii*) the Hence, state two difference between interference and diffraction. [*CBSE AI 2017*]

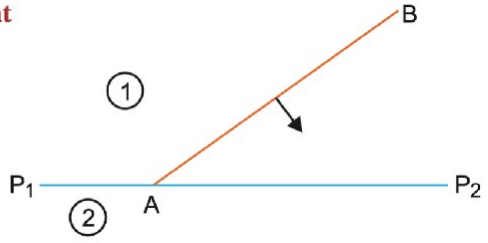
Draw the diagrams to show the behaviour of plane wavefronts as they (*a*) pass through a thin prism, and (*b*) pass through a thin convex lens and (*c*) reflect by a concave mirror. [*CBSE Bhubaneshwar 2015, CBSE Sample Paper 2021*]

OR

Use Huygens principle to show reflection/refraction of a plane wave by (*i*) concave mirror, and (*ii*) a convex lens. [*CBSE 2023 (55/3/1)*]

Define the term 'wave front of light'. A plane wave front AB propagating from denser medium (1) into a rarer medium (2) is incident on the surface P_1P_2 separating the two media as shown in fig.

Using Huygen's principle, draw the secondary wavelets and obtain the refracted wave front in the diagram. [*CBSE 2020 (55/5/1)*]



Draw the graph showing intensity distribution of fringes with phase angle due to diffraction through single slit. [*CBSE Sample Paper 2021, CBSE 2023 (55/4/1)*]

How does the fringe width of interference fringes change, when the whole apparatus of Young's experiment is kept in water (refractive index 4/3)? [*CBSE Delhi 2011*] [*HOTS*]

Describe diffraction of light due to a single slit. Explain formation of a pattern of fringes obtained on the screen and plot showing variation of intensity with angle θ in single slit diffraction. [*CBSE Delhi 2010, (F) 2013, (AI) 2014*]

(*a*) In Young's double slit experiment, discuss the conditions for (*i*) constructive, and (*ii*) destructive interference at a point on the screen. Draw a graph showing variation of the resultant intensity in the interference pattern against position '*X*' on the screen.

[*CBSE Delhi 2016, (AI) 2012*]

(*b*) Compare and contrast the pattern which is seen with two coherently illuminated narrow slits in Young's experiment with that seen for a coherently illuminated single slit producing diffraction.

Use Huygens' principle to show how a plane wavefront propagates from a denser to rarer medium. Hence, verify Snell's law of refraction.

[*CBSE Allahabad 2015, Sample Paper 2016, 2021; 2019(55/1/1), 2020(55/1/1), 2023(55/1/1)*]

(*i*) Is the frequency of reflected and refracted light same as the frequency of incident light?

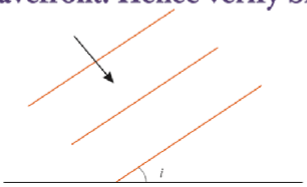
(*ii*) Does the decrease in speed imply a reduction in the energy carried by light wave?

[*CBSE Delhi 2013*]

OR

A plane wavefront propagating in a medium of refractive index 'n_1' is incident on a plane surface making the angle of incidence '*i*' as shown in the figure. It enters into a medium of refractive index 'n_2' ($n_2 > n_1$). Use Huygens' construction of secondary wavelets to trace the propagation of the refracted wavefront. Hence verify Snell's law of refraction.

[*CBSE (F) 2015, 2023 (55/5/1)*]



(*a*) How is a wavefront defined? Using Huygen's constructions draw a figure showing the propagation of a plane wave refracting at a plane surface separating two media. Hence verify Snell's law of refraction. [*CBSE 2023 (55/1/1)*]

When a light wave travels from rarer to denser medium, the speed decreases. Does it imply reduction its energy? Explain. [*CBSE Delhi 2008, 2013, (F) 2011, 2012*]

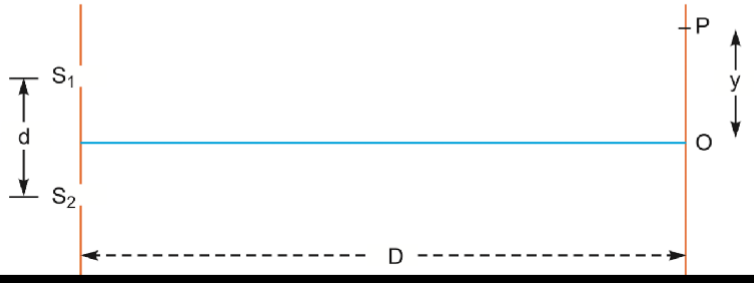
(*b*) When monochromatic light travels from a rarer to a denser medium, explain the following, giving reasons:

Define the term wavefront. Using Huygen's wave theory, verify the law of reflection.

[*CBSE (55/1/1) 2019, 2020 (55/2/1), 2023 (55/5/1)*]

The intensity at the central maxima (*O*) in a Young's double slit experiment is I_0. If the distance *OP* equals one-third of the fringe width of the pattern, show that the intensity at point *P* would be $\frac{I_0}{4}$.

[*CBSE (F) 2011, 2012*]



CHAPTER 11

Define intensity of radiation on the basis of photon picture of light. Write its SI unit.
[*CBSE (AI) 2014; 2019 (55/1/1)*]

Define the term 'threshold frequency' in relations to photoelectric effects.
[*CBSE (F) 2011, 2019 (55/1/1), 2020 (55/2/1)*]

Plot suitable graphs to show the variation of photoelectric current with the collector plate potential for the incident radiation of **[*CBSE 2022 (55/1/1), Term-2*]**

(*i*) the same intensity but different frequencies ν_1, ν_2 and ν_3 ($\nu_1 < \nu_2 < \nu_3$)

(*ii*) the same frequency but different intensities I_1, I_2 and I_3 ($I_1 < I_2 < I_3$)

Explain briefly the reasons why wave theory of light is not able to explain the observed features of photo-electric effect. **[*CBSE Delhi 2013; (AI) 2013; (F) 2010; 2019 (55/2/1)*]**

Write Einstein's photoelectric equation. State clearly the three salient features observed in photoelectric effect which can explain on the basis of this equation. **[*CBSE 2023 (55/1/1)*]**

The maximum kinetic energy of the photoelectrons gets doubled when the wavelength of light incident on the surface changes from λ_1 to λ_2. Derive the expressions for the threshold wavelength λ_0 and work function for the metal surface.
[*CBSE Delhi 2015; (AI) 2010; 2020 (55/2/1)*]

An electron and a proton, each have de Broglie wavelength of 1.00 nm.

(*a*) Find the ratio of their momenta.

(*b*) Compare the kinetic energy of the proton with that of the electron.

[*NCERT*] [*CBSE (F) 2013*]

A proton and an α-particle have the same de Broglie wavelength. Determine the ratio of (*i*) their accelerating potentials (*ii*) their speeds. **[*CBSE Delhi 2015; 2019 (55/4/1)*]**

A proton and an alpha particle are accelerated through the same potential. Which one of the two has (*i*) greater value of de Broglie wavelength associated with it and (*ii*) less kinetic energy? Give reasons to justify your answer. **[*CBSE North 2016, Delhi 2014*]**

CHAPTER 12

Define the distance of closest approach. An α-particle of kinetic energy '*K*' is bombarded on a thin gold foil. The distance of the closest approach is '*r*'. What will be the distance of closest approach for an α-particle of double the kinetic energy?
[*CBSE Delhi 2017, 2022 (55/1/1), Term-2*]

The ground state energy of hydrogen atom is –13.6 eV. What is the kinetic and potential energies of the electron in the ground and second excited state? **[*CBSE (AI) 2010, 2011, Bhubaneshwar 2015*]**

Using the postulates of Bohr's model of hydrogen atom, obtain an expression for the frequency of radiation emitted when atom make a transition from the higher energy state with quantum number n_i to the lower energy state with quantum number n_f ($n_f < n_i$). [*CBSE (AI) 2013, (F) 2012, 2011*]

OR

Using Bohr's postulates, obtain the expression for the total energy of the electron in the stationary states of the hydrogen atom. Hence draw the energy level diagram showing how the line spectra corresponding to Balmer series occur due to transition between energy levels. [*CBSE Delhi 2013, Guwahati 2015*]

OR

Using Rutherford model of the atom, derive the expression for the total energy of the electron in hydrogen atom. What is the significance of total negative energy possessed by the electron? [*CBSE (AI) 2014*]

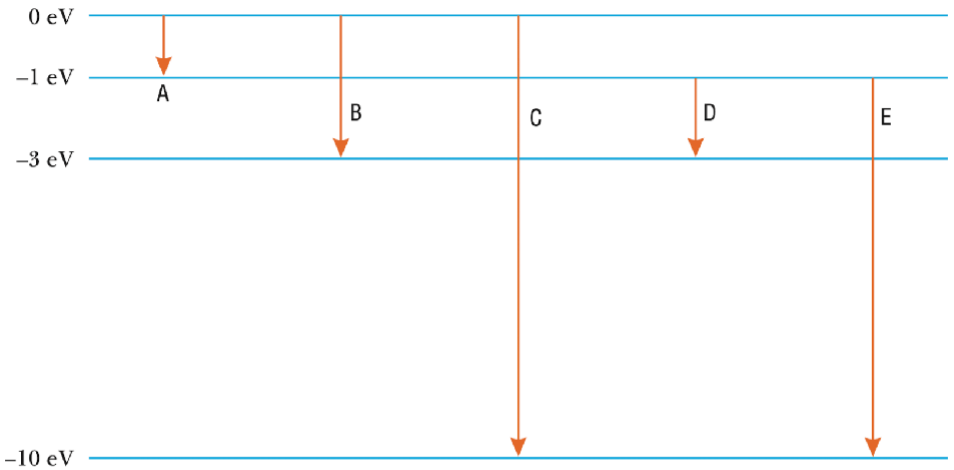
Obtain the first Bohr's radius and the ground state energy of a muonic hydrogen atom, *i.e.*, an atom where the electron is replaced by a negatively charged muon (μ^-) of mass about 207 m_e that orbits around a proton.

(Given for hydrogen atom, radius of first orbit and ground state energy are 0.53×10^{-10} m and – 13.6 eV respectively) [*CBSE 2019 (55/5/1)*]

The energy of hydrogen atom in an orbit is –1.51 eV. What are kinetic and potential energies of the electron in this orbit? [*CBSE 2022 (55/3/3), Term–2*]

Using Bohr's atomic model, derive the expression for the radius of n^{th} orbit of the revolving electron in a hydrogen atom. [*CBSE 2020 (55/1/1), 2023 (55/3/1)*]

The energy levels of an atom are given below in the diagram.



Which of the transitions belong to Lyman and Balmer series? Calculate the ratio of the shortest wavelengths of the Lyman and the Balmer series of the spectra. [*CBSE Chennai 2015, CBSE 2019 (55/2/3)*]

Draw the graph showing the variation of the number (N) of scattered alpha particles with scattering angle (θ) in Geiger – Marsden experiment. Infer two conclusions from the graph. [*CBSE 2022 (55/1/1), Term-2*]

CHAPTER 13

(*i*) What characteristic property of nuclear force explains the constancy of binding energy per nucleon (*BE*/*A*) in the range of mass number '*A*' lying $30 < A < 170$?

(*ii*) Show that the density of nucleus over a wide range of nuclei is constant independent of mass number *A*.

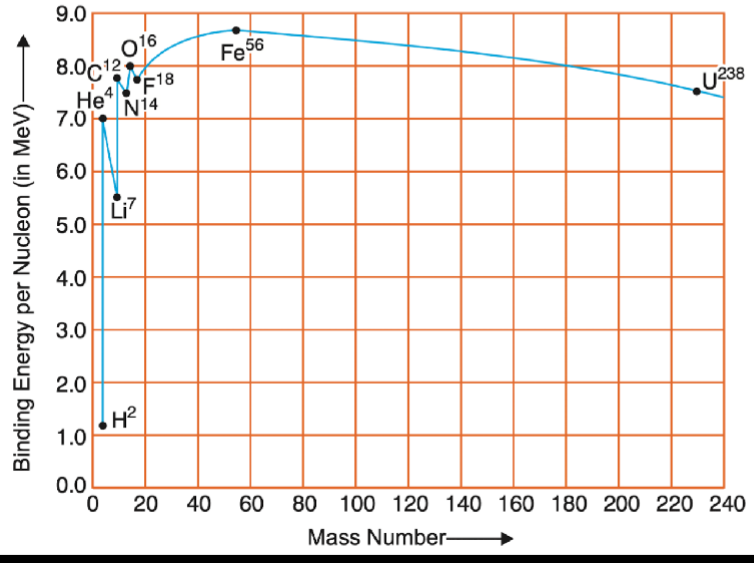
[*CBSE 2023 (55/2/1)*]

The electron in a hydrogen atom is typically found at a distance of about 5.3×10^{-11} m from the nucleus which has a diameter of about 1.0×10^{-15}m. Assuming the hydrogen atom to be a sphere of radius 5.3×10^{-11} m, what fraction of its volume is occupied by the nucleus?

[*CBSE 2022 (55/3/3), Term-2*]

Draw a graph showing the variation of binding energy per nucleon as a function of mass number *A*. The binding energy per nucleon for heavy nuclei ($A > 170$) decreases with the increase in mass number. Explain.

[*CBSE 2023 (55/3/1)*]



(*i*) Distinguish between isotopes and isobars.

(*ii*) Two nuclei have different mass numbers A_1 and A_2. Are these nuclei necessarily the isobars of the same element? Explain.

[*CBSE 2022 (55/3/1), (55/3/3), Term-2*]

Two nuclei may have the same radius, even though they contain different number of protons and neutrons. Explain.

[*CBSE 2022 (55/3/3), Term-2*]

OR

Draw a diagram to show the variation of binding energy per nucleon with mass number for different nuclei and mention its two features. Why do lighter nuclei usually undergo nuclear fusion?

[*CBSE 2023 (55/2/1)*]

Draw the graph showing the variation of binding energy per nucleon with the mass number for a large number of nuclei $2 < A < 240$. What are the main inferences from the graph? How do you explain the constancy of binding energy in the range $30 < A < 170$ using the property that the nuclear force is short-ranged? Explain with the help of this plot the release of energy in the processes of nuclear fission and fusion.

[*CBSE (AI) 2010, 2011, Chennai 2015, South 2016, 2020 (55/5/2)*]

(*i*) Distinguish between nuclear fission and fusion giving an example of each.

(*ii*) Explain the release of energy in nuclear fission and fusion on the basis of binding energy per nucleon curve. **[*CBSE 2023 (55/2/1)*]**

Draw a graph showing the variation of potential energy between a pair of nucleons as a function of their separation. Indicate the regions in which the nuclear force is (*i*) attractive, (*ii*) repulsive.

Write two important conclusions which you can draw regarding the nature of the nuclear forces. **[*CBSE 2019 (55/4/2), 2020 (55/3/1)*]**

CHAPTER 14

What are energy bands? Write any two distinguishing features between conductors, semiconductors and insulators on the basis of energy band diagrams. **[*CBSE (AI) 2014, North 2016*]**

OR

Draw the necessary energy band diagrams to distinguish between conductors, semiconductors and insulators. How does the change in temperature affect the behaviour of these materials? Explain briefly. **[*CBSE Patna 2015, 2020 (55/4/1)*]**

What is meant by doping of an intrinsic semiconductor? Name the two types of atoms used for doping of Ge/Si. **[*CBSE 2022 (55/3/1), Term-2*]**

Explain the property of a *p-n* junction which makes it suitable for rectifying alternating voltages. Differentiate between a half-wave and a full-wave rectifier. **[*CBSE 2023 (55/3/1)*]**

Briefly explain how the diffusion and drift currents contribute to formation of potential barrier in a *p-n* junction diode. **[*CBSE 2023 (55/1/1)*]**

OR

Explain briefly the two processes that occur in *p-n* junction region to create a potential barrier. **[*CBSE 2020 (55/3/1)*]**

In a pure semiconductor crystal of Si, if antimony is added then what type of extrinsic semiconductor is obtained. Draw the energy band diagram of this extrinsic semiconductor so formed. **[*CBSE Sample Paper 2022, Term-2*]**

OR

A germanium crystal is doped with antimony. With the help of energy-band diagram, explain how the conductivity of the doped crystal is affected. **[*CBSE 2023 (55/4/1)*]**

Draw energy band diagrams of *n*-type and *p*-type semiconductors at temperature T > 0 K, depicting the donor and acceptor energy levels. Mention the significance of these levels. **[*CBSE 2022 (55/1/1), Term-2, 2023 (55/2/1)*]**

Draw energy band diagrams of an *n*-type and *p*-type semiconductor at temperature $T > 0$ K. Mark the donor and acceptor energy levels with their energies. **[*CBSE (F) 2014, 2020 (55/3/3)*]**

Draw the energy band diagram when intrinsic semiconductor (Ge) is doped with impurity atoms of Antimony (Sb). Name the extrinsic semiconductor so obtained and majority charge carriers in it. **[*CBSE Sample Paper 2021, 2022, Term-2*]**

State the principle of working of *p-n* diode as a rectifier. Explain with the help of a circuit diagram, the use of *p-n* diode as a full wave rectifier. Draw a sketch of the input and output waveforms. [*CBSE Delhi 2012, 2020 (55/3/2)*]

OR

Draw a circuit diagram of a full wave rectifier. Explain the working principle. Draw the input/output waveforms indicating clearly the functions of the two diodes used.

[*CBSE (AI) 2011, 2020 (55/1/3)*]

OR

With the help of a circuit diagram, explain the working of a junction diode as a full wave rectifier. Draw its input and output waveforms. Which characteristic property makes the junction diode suitable for rectification? [*CBSE Ajmer 2015, North 2016, 2023 (55/4/1)*]

OR

Draw the circuit diagram of a full wave rectifier and explain its working. Also give the input and output waveforms. [*CBSE Delhi 2019, 2020, (55/1/3), 2022 (55/2/1), Term-2*]

OR

Explain with a proper diagram how an ac signal can be converted into *dc* (pulsating) signal with output frequency as double than the input frequency using *p–n* junction diode. Give its input and output waveforms. [*CBSE Sample Paper 2022, Term-2*]

(*a*) State briefly the processes involved in the formation of *p-n* junction explaining clearly how the depletion region is formed.

(*b*) Using the necessary circuit diagrams, show how the V–I characteristics of a *p-n* junction are obtained in (*i*) Forward biasing (*ii*) Reverse biasing

How are these characteristics made use of in rectification? [*CBSE Delhi 2014*]

OR

Draw the circuit arrangement for studying the *V–I* characteristics of a *p-n* junction diode (*i*) in forward bias and (*ii*) in reverse bias. Draw the typical *V–I* characteristics of a silicon diode. [*CBSE 2023 (55/1/1)*]

Describe briefly the following terms:

(*i*) "minority carrier injection" in forward bias

(*ii*) "breakdown voltage" in reverse bias. [*CBSE Chennai 2015*]

Draw *V – I* characteristics of a *p–n* junction diode. Answer the following questions, giving reasons:

(*i*) Why is the current under reverse bias almost independent of the applied potential upto a critical voltage?

(*ii*) Why does the reverse current show a sudden increase at the critical voltage?

[*CBSE (AI) 2013, CBSE 2019*]

Name the important process that occurs during the formation of a *p-n* junction. Explain briefly, with the help of a suitable diagram, how a *p-n* junction is formed. Define the term 'barrier potential'. [*CBSE (F) 2011, Central 2016*]

OR

Describe briefly, with the help of a diagram, the role of the two important processes involved in the formation of a *p-n* junction.

[*CBSE (AI) 2012, Bhubaneshwar 2015, 2020 (55/4/1), 2023 (55/3/1), (55/4/1)*]

Distinguish between 'intrinsic' and 'extrinsic' semiconductors.

[*CBSE Delhi 2015, (F) 2017, 2023 (55/1/1)*]