BUDHA DAL PUBLIC SCHOOL, PATIALA
Pre Board Examination (12 December 2025)
Class XII (Science)
Subject – Physics - 042 (Set - B)

Time: 3hrs **M.M. 70**

General Instructions:

(1) There are 33 questions in all. All questions are compulsory.
(2) This question paper has five sections: Section A, Section B, Section C, Section D and Section E.
(3) All the sections are compulsory.
(4) Section A contains sixteen questions, twelve MCQ and four Assertion-Reasoning based of 1 mark each, Section B contains five questions of two marks each, Section C contains seven questions of three marks each, Section D contains two case study based questions of four marks each and Section E contains three long answer questions of five marks each.
(5) Use of calculators is not allowed.
(6) You may use the following values of physical constants where ever necessary

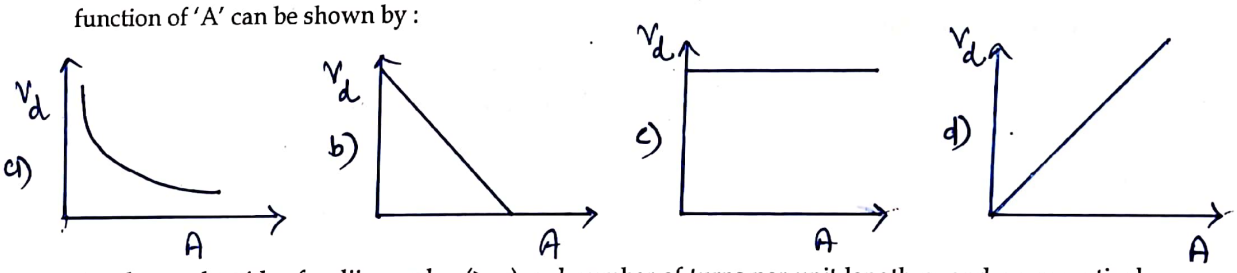
i) $c = 3 \times 10^8$ m/s
ii) $me = 9.1 \times 10^{-31}$ kg
iii) $e = 1.6 \times 10^{-19}$ C
iv) $\mu 0 = 4\pi \times 10^{-7}$ TmA−1
v) $h = 6.63 \times 10^{-34}$ Js
vi) $\varepsilon 0 = 8.854 \times 10^{-12}\ C^2\ N^{-1}\ m^{-2}$
Vii) Avogadro's number = 6.023×10^{23} per gram mole

Section - A

Q1. Two identical point charges are placed at the two vertices A and B of an equilateral triangle of side l. The magnitude of the electric field at the third vertex P is E. If a hollow conducting sphere of radius $(l/4)$ is placed at P, the magnitude of the electric field at point P now becomes:

a) $.> E$ b) E c) E/2 d) zero

Q2. A steady current flows through a metallic wire whose area of cross-section (A) increases continuously from one end of the wire to the other. The magnitude of drift velocity (V_d) of the free electrons as a function of 'A' can be shown by :



Q3. Two long solenoids of radii r_1 and r_2 (> r_1) and number of turns per unit length n_1 and n_2 respectively are co-axially wrapped one over the other. The ratio of self-inductance of inner solenoid to their mutual inductance is

a) $\frac{n_1}{n_2}$ b) $\frac{n_2}{n_1}$ c) $\frac{n_1 r_1^2}{n_2 r_2^1}$ d) $\frac{n_1 r_1^2}{n_2 r_2^2}$

Q4. In an interference experiment, third bright fringe is obtained at a point on the screen with a light of 700 nm. What should be the wavelength of the light source in order to obtain the fifth bright fringe at the same point?

a) 420 nm b) 750 nm c) 630 nm d) 500 nm

Q5. Critical angle of glass is θ_1 and that of water is θ_2. The critical angle for water and glass surface would be $(\mu_g = \frac{3}{2}, \mu_w = \frac{4}{3})$

a) less than θ_2 b) between θ_1 *and* θ_2 c) greater than θ_2 d) less than θ_1

6. Electromagnetic waves of wavelength of the order of a few meters were first produced and detected in the laboratory by:

b) J.C. Maxwell b) J.C. Bose c) H.R. Hertz d) G. Marconi

Q7. The radius of the innermost electron orbit of a hydrogen atom is 5.3×10^{-11} m. The radius of the n = 3 orbit is:

a) 1.01×10^{-10} m b) 1.59×10^{-10} m c) 2.12×10^{-10} m d) 4.77×10^{-10} m

Q8. Which of the following material has its magnetic susceptibility x in the range $0 < x < \varepsilon$, where ε is positive and small?

a) Aluminium b) Water c) Gadolinium d) Bismuth

Q9. A galvanometer of resistance 10 Ω gives full-scale deflection when 1mA current passes through it. The resistance required to convert it into a voltmeter reading up to 2.5 V is:

a) 24.9 Ω b) 249 Ω c) 2490 Ω d) 24900 Ω

Q10. Which of the following quantity/ quantities remains same in primary and secondary coils of an ideal transformer?

a) Current only b) Voltage only c) Power only d) Magnetic flux and Power both

Q11. The potential energy between two nucleons inside a nucleus in minimum at a distance of about

a) 0.8 fm b) 1.6 fm c) 2.0 fm d) 2.8 fm

Q12. In an AC circuit, the instantaneous values of current (in A) and voltage (in V) are $I = 5 \sin \omega t$ and $E = 200 \cos(\omega t + \frac{\pi}{3})$ respectively. The phase difference between voltage and current at any instant is:

a) $\frac{5\pi}{6}$ b) $\frac{5\pi}{4}$ c) $\frac{5\pi}{2}$ d) $\frac{3\pi}{2}$

In the following questions, a statement of Assertion (A) is followed by a statement of Reason (R). Mark the correct choice as:

a) **Both A and R correct and R is the correct explanation of A.**
b) **Both A and R correct and R is not the correct explanation of A**
c) **A is not correct but R is correct.**
d) **A is correct but R is not correct**

Q13. **Assertion (A) :** The potential energy of an electron revolving in any stationary orbit in a hydrogen atom is positive.

Reason (R) : The total energy of a charged particle is always positive.

Q14. **Assertion (A) :** Electric field is always normal to equipotential surfaces and along the direction of decreasing order of potential.

Reason (R) : Negative gradient of electric potential is electric field.

Q15. **Assertion (A) :** The magnifying power of a compound microscope is negative.

Reason (R) : The final image formed is erect with respect to the object.

Q16. **Assertion (A) :** Propagation of light through an optical fibre is due to total internal reflection taking place at the core-cladding interface.

Reason (R) : Refractive index of the material of the cladding of the optical fibre is greater than that of the core.

Section - B

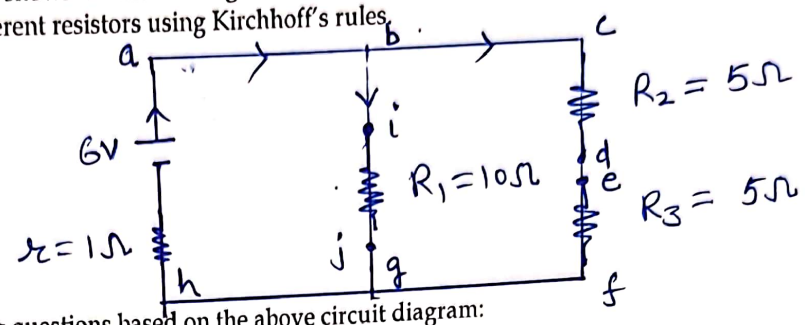
Q17. The electric field in an electromagnetic wave in vacuum is given by :

$$\vec{E} = \left(3.6\frac{N}{C}\right)\left[\cos\left(1.5\frac{rad}{m}\right)y + (4.5 \times 10^8\ rad/s)\ t\right]\hat{\imath}$$

a) Find the wavelength and frequency of the wave.

b) What is the amplitude of the magnetic field of the wave?

18. The following figure shows a circuit diagram. We can find the currents through and potential differences across different resistors using Kirchhoff's rules.



Answer the following questions based on the above circuit diagram:

a) Which points are the same potential in the circuit?

b) What is the current through arm bg?

c) What is the power dissipated in resistance R_2?

Q19. Draw the energy level diagram for hydrogen atom. Mark the transitions corresponding to the series lying in the ultraviolet region, visible region and infrared region.

OR

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 a α –particle of double the kinetic energy?

Q20. Use Biot-Savart's law to obtain an expression for the magnetic field at the centre of a circular loop of radius 'a' the carrying a current 'I'. Draw the magnetic field lines for a current loop indicating the direction of magnetic field.

Q21. A bar magnet of moment 6 J/T is aligned at 60^0 with a uniform external magnetic field of 0.44 T. Calculate the torque on the magnet when is the torque maximum?

Section - C

Q22. 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.

Q23. n – identical cells, each of emf E and internal resistance r are connected in series. Later on it was found out that two cells 'X' and 'Y' are connected in reverse polarities. Calculate the potential difference across the cell 'X'.

Q24. a) Define 'Mass defect' and Binding energy' of a nucleus. Describe 'Fission process' on the basis of binding energy per nucleon.

b) A deuteron contains a proton and a neutron and has a mass of 2.013553u. Calculate the mass defect for it in u and its energy equivalence in MeV. (m_p = 1.007277u, m_n = 1.005665u,

1u = 931.5 MeV/C^2)

OR

a) Show the variation of binding energy per nucleon with mass number. Write the significance of the binding energy curve.

b) Two nuclei with lower binding energy per nucleon form a nuclei with more binding energy per nucleon

i) What type of nuclear reaction is it?

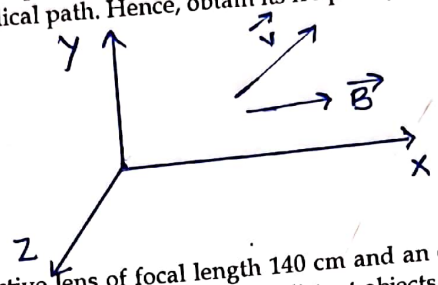
ii) Whether the total mass of nuclei increases, decreases or remains unchanged?

iii) Does the process require energy or produce energy?

Q25. 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 turn N_1 and N_2 and radii r_1 and r_2 ($r_2 > r_2$).

Define the term wavefront. Using Huygens' wave theory, verify the laws of refraction.

A particle of mass m and charge q is moving with a velocity $\vec{v}$ in a magnetic field $\vec{B}$ as shown in the figure. Show that it follows a helical path. Hence, obtain its frequency of revolution.



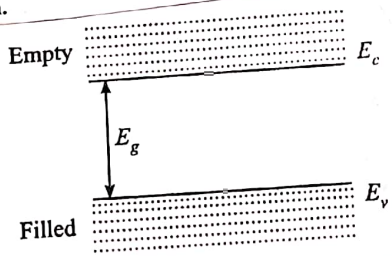
Q28. A small telescope has an objective lens of focal length 140 cm and an eyepiece of focal length 5.0 cm. Find the magnifying power of the telescope for viewing distant objects when the final image is formed at the least distance of distinct vision.

Section - D

Case Based Questions:

Q29. Read the following passage and answer the following:

In semiconductor electronics, materials are characterized by their unique arrangement of atoms and their associated electron configurations. The behavior of electrons in a semiconductor, whether it's silicon, germanium, or any other material, is determined by its band structure. In these semiconductors, there is a valence band, which is fully occupied by electrons, and a conduction band, which is initially empty at absolute zero. The energy difference between the top of the valence band and the bottom of the conduction band is known as the band gap. The size of this band gap determines whether the material is an insulator, semiconductor, or conductor. In semiconductors, the band gap is small enough that electrons can be excited from the valence band to the conduction band by thermal energy, leading to current conduction. (An)



(*i*) What is the significance of the band gap in semiconductors?

(*a*) It represents the energy required to move an electron from the valence band to the conduction band.

(*b*) It determines the color of the semiconductor.

(*c*) It represents the total energy of the semiconductor.

(*d*) It determines the size of the semiconductor.

(*ii*) Which band in a semiconductor is fully occupied by electrons at absolute zero?

(*a*) Conduction band (*b*) Valence band

(*c*) Forbidden band (*d*) None of the above

(*iii*) What determines the classification of a material as an insulator, semiconductor, or conductor?

(*a*) Number of electrons (*b*) Size of the material

(*c*) Band gap (*d*) Atomic number

(*iv*) In semiconductors, what can cause electrons to move from the valence band to the conduction band?

(*a*) Pressure (*b*) Thermal energy

(*c*) Magnetic field (*d*) Atomic interactions

OR

Which of the following statements about the conduction band at absolute zero is true?

(*a*) It is partially occupied by electrons.

(*b*) It is fully occupied by electrons.

(*c*) It contains only protons.

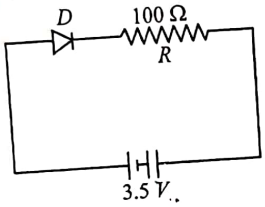
(*d*) It is empty.

Read the following passage and answer the following:

A semiconductor diode is basically a p-n junction with metallic contacts provided at the ends for the application of an external voltage. It is a two terminal device. When an external voltage is applied across a semiconductor diode such that p-side is connected to the positive terminal of the battery and n-side to the negative terminal, it is said to be forward biased. When an external voltage is applied across the diode such that n-side is positive and p-side is negative, it is said to be reverse biased. An ideal diode is one whose resistance in forward biasing is zero and the resistance is infinite in reverse biasing. When the diode is forward biased, it is found that beyond forward voltage called knee voltage, the conductivity is very high. When the biasing voltage is more than the knee voltage the potential barrier is overcome and the current increases rapidly with increase in forward voltage. When the diode is reverse biased, the reverse bias voltage produces a very small current about a few micro amperes which almost remains constant with bias. This small current is reverse saturation current.

(An)(CBSE SQP, 2023)

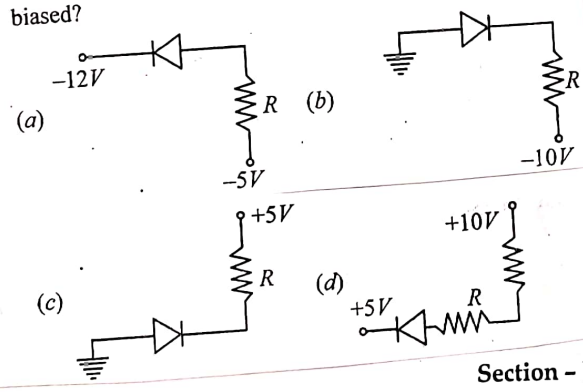
(i) In the given figure, a diode D is connected to an external resistance $R = 100\ \Omega$ and an emf of 3.5 V. If the barrier potential developed across the diode is 0.5 V, the current in the circuit will be:



(a) 40 mA (b) 20 mA

(c) 35 mA (d) 30 mA

(ii) In which of the following figures, the pn diode is reverse biased?



Section – E

(iii) Based on the V-I characteristics of the diode, we can classify diode as

(a) bilateral device

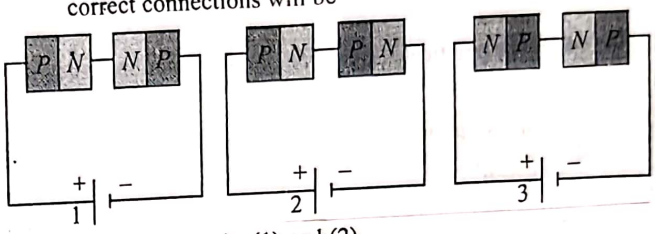
(b) ohmic device

(c) non-ohmic device

(d) passive element

OR

Two identical PN junctions can be connected in series by three different methods as shown in the figure. If the potential difference in the junctions is the same, then the correct connections will be

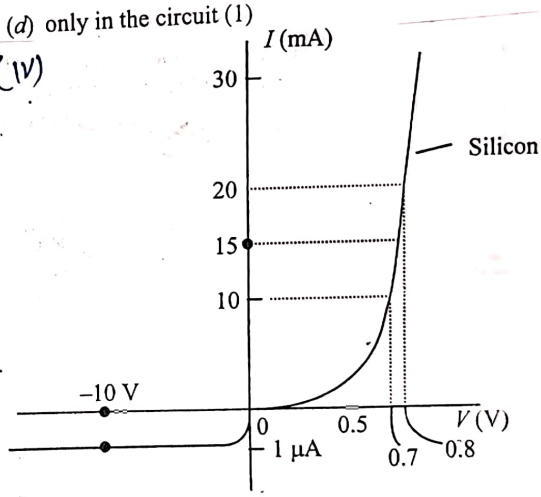


(a) in the circuits (1) and (2)

(b) in the circuits (2) and (3)

(c) in the circuits (1) and (3)

(d) only in the circuit (1)



The V-I characteristic of a diode is shown in the figure. The ratio of the resistance of the diode at $I = 15$ mA to the resistance at V = −10 V is

(a) 100 (b) 10^6

(c) 10 (d) 10^{-6}

Q31. a) A convex lens (n = 1.52) has a focal length of 15.0 cm in air. Find its focal length when it is immersed in liquid of refractive index 1.65. What will be the nature of the lens?

b) A ray of light incident on face AB of an equilateral glass prism, shows minimum deviation of 30^0. Calculate the speed of the light through the prism.

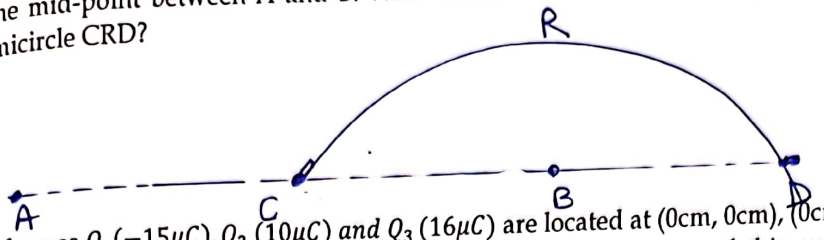
OR

a) An equi – convex lens of focal length f is cut into two identical plane convex lenses. How will the power of each part be related to the focal length of the original lens?

b) Derive the prism formula for glass prism.

B-5

Charges (+q) and (-q) are placed at the points A and B respectively which are at a distance 2 L apart. C is the mid-point between A and B. What is the work done in moving a charge +Q along the semicircle CRD?



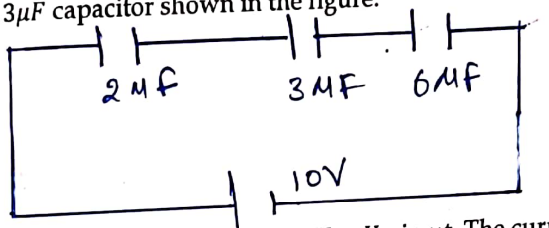
b) Three point charges $Q_1(-15\mu C), Q_2\ (10\mu C)$ *and* $Q_3\ (16\mu C)$ are located at (0cm, 0cm), (0cm, 3cm) and (4cm, 3cm) respectively. Calculate the electrostatic potential energy of this system of charges.

OR

a) (i) An electric dipole is held in a uniform electric field. Using suitable diagram, show that it does not undergo any translatory motion. Derive the expression for the torque acting on it.
(ii) What would happen if the external electric field E is increasing parallel to $\vec{p}$.

b) Derive an expression for the electric field at a point on the equatorial plane of an electric dipole consisting of charges q an -q separated by a distance 2 a.

c) Find the charge on $3\mu F$ capacitor shown in the figure.



Q33. A device X is connected across an AC source of voltage $V = V_0 \sin \omega t$. The current through X is given as $I = I_0 \sin\left(\omega t + \frac{\pi}{2}\right)$.

a) Identify the device X and write the expression for its reactance.

b) Draw graphs showing variation of voltage and current with time over one cycle of AC for X.

c) How does the reactance of the device X vary with frequency of the AC? Show this variation graphically.

d) Draw the phasor diagram for the device X.

OR

a) Write three points of differences of paramagnetic, diamagnetic and ferromagnetic materials, giving one example for each.

b) Explain the principle and working of moving coil galvanometer. Why the magnetic field is made radial in it?