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

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

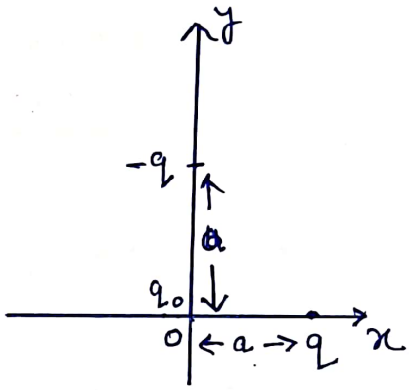
General Instructions:

(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

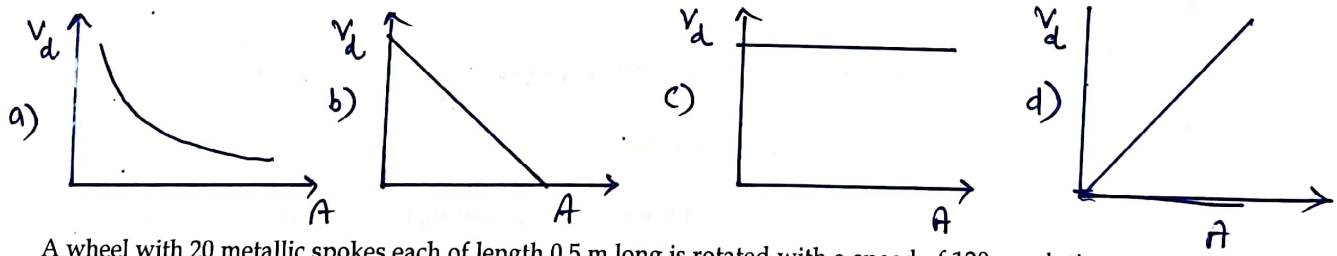
Section - A

Q1. Three charges $q, -q$ *and* q_0 are placed as shown in figure. The magnitude of the net force on the charge q_0 at point O is



a) 0 b) $\frac{2kqq_0}{a^2}$ c) $\frac{\sqrt{2}kqq_0}{a^2}$ d) $\frac{1}{\sqrt{2}}\frac{kqq_0}{a^2}$

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. A wheel with 20 metallic spokes each of length 0.5 m long is rotated with a speed of 120 revolution per minute in a plane normal to the horizontal component of earth magnetic field at a place. If magnetic field is 0.4×10^{-4} T at the place, then induced emf between the axle and the rim of the wheel is:

a) 6.28×10^{-5} V b) 3.14×10^{-5} V c) 1.256×10^{-5} V d) 1.57×10^{-5} V

Q4. Electromagnetic waves of wavelength of the order of a few meters were first produced and detected in the laboratory by:

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

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

Q6. In a single-slit diffraction experiment, the width of the slit is halved. The width of the central maximum, in the diffraction pattern, will become.

a) half b) twice c) four times d) one-fourth

Q7. The energy of an electron in the ground state of hydrogen atom is $-13.6\ eV$. The kinetic and potential energy of the electron in the first excited state will be:

a) -13.6 eV, 27.2 eV b) -6.8 eV, 13.6 eV c) 3.4 eV. -6.8 eV d) 6.8 eV, -3.4 eV

Q8. The magnetic field due to a small magnetic dipole of dipole moment 'M' at a distance 'r' from the centre along the axis of the dipole is given by:

a) $\frac{\mu_0}{4\pi} \times \frac{2M}{r^3}$ b) $\frac{\mu_0}{4\pi} \times \frac{M}{r^3}$ c) $\frac{\mu_0}{4\pi} \times \frac{M}{2r^3}$ d) $\frac{\mu_0}{4\pi} \times \frac{2M}{r^2}$

Q9. 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) $\frac{3\pi}{2}$

Q10. Who among the following, is not a cause of power loss in a transformer?

a) Eddy currents are produced in the soft iron core of a transformer

b) Electric flux sharing is not properly done in primary and secondary coils

c) Humming sound produced in the transformers due to magnetostriction

d) Primary coil is made up of a very thick copper wire

Q11. The ratio of the nuclear densities of two nuclei having mass numbers 64 and 125 is:

a) $\frac{64}{125}$ b) $\frac{4}{5}$ c) $\frac{5}{4}$ d) 1

Q12. 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

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) :** An alpha particle is moving towards a gold nucleus. The impact parameter is maximum for the scattering angle of 180^0.

Reason (R) : The impact parameter in an alpha particle scattering experiment does not depend upon the atomic number of the target nucleus.

Q14. **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.

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) :** An electron has a higher potential energy when it is at a location associated with a negative value of potential and has a lower potential energy when at a location associated with a positive potential.

Reason (R) : Electrons move from a region of higher potential to a region of lower potential.

Section - B

Q17. a) How is an EM wave produced?

b) Give one use of electromagnetic radiations obtained in nuclear disintegrations.

A-2

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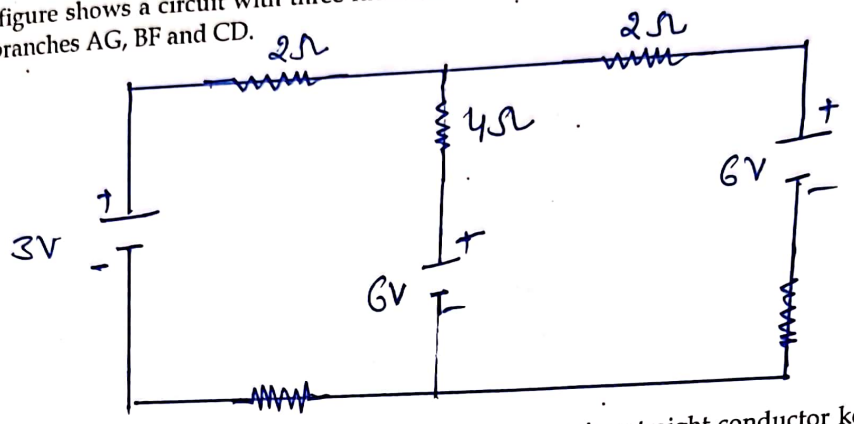
18. The figure shows a circuit with three ideal batteries. Find the magnitude and direction of currents in the branches AG, BF and CD.



Q19. Derive an expression for the force acting on a current carrying straight conductor kept in a magnetic field. State the rule which is used to find the direction of this force. Give one condition under which this force is (i) maximum and (ii) minimum.

Q20. A bar magnet moment 6 J/T is aligned a 60^0 with a uniform external magnetic field of 0.44 T. Calculate the work done in turning the magnet to align its magnetic moment (a) normal to the magnetic field (b) opposite to the magnetic field.

Q21. 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?

OR

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.

Section – C

Q22. Explain briefly with the help of necessary diagrams, the forward and the reverse biasing of a p-n junction diode. Also, draw their characteristic curves in the two cases.

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 is 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. In a compound microscope, an object is placed at a distance of 1.5 cm from the objective of focal length 1.25 cm. If the eyepiece has a focal length of 5cm and the final image is formed at the near point, find the magnifying power of the microscope.

Q26. Define the term wavefront. Using Huygens' wave theory, verify the laws of reflection.

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.

Q28. 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 ($r_2 > r_2$).

Section - D

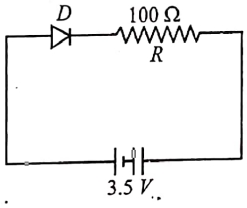
Case Based Questions:

Q29. 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)

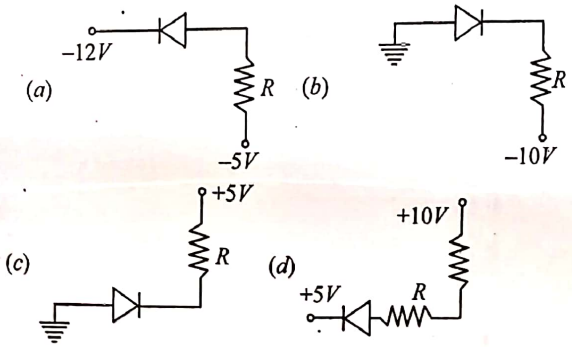
(*i*) In the given figure, a diode D is connected to an external resistance $R = 100\ \Omega$ and an emf of 3.5 V. If the barrier potential developed across the diode is 0.5 V, the current in the circuit will be:



(*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?



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

(*a*) bilateral device

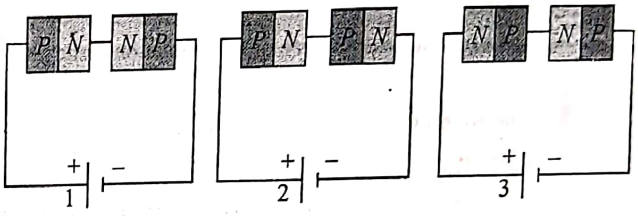
(*b*) ohmic device

(*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



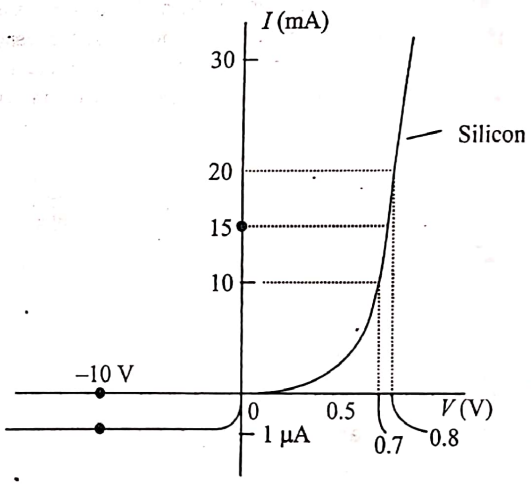
(*a*) in the circuits (1) and (2)

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

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

(*d*) only in the circuit (1)

(*iv*)



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

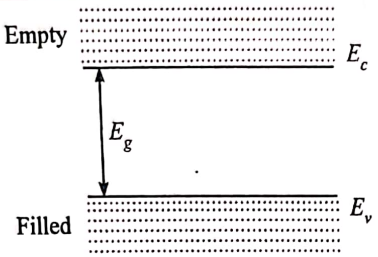
(*a*) 100 (*b*) 10^6

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

A-4

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.

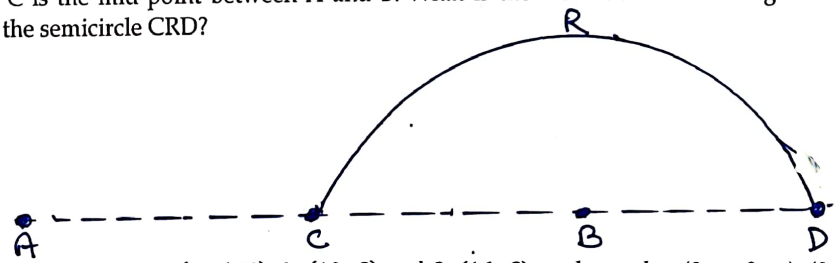
(*b*) It is fully occupied by electrons.

(*c*) It contains only protons.

(*d*) It is empty.

Section – E

Q31. a) 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-5