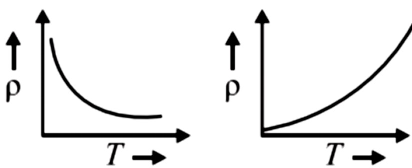
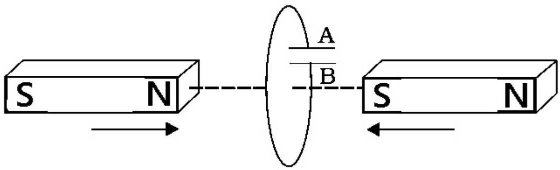
Pre-Board Examination : 2025-26

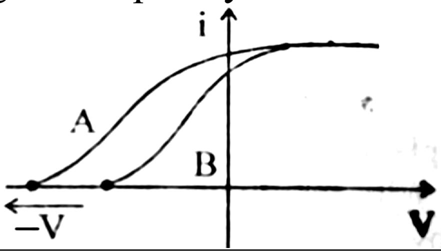
Sub : Physics

(The figures in the margin indicate full marks for the questions)

Time – 3 hours **Full marks-70**

1.	**Answer following questions : 1x8=8**
a	Inside a conductor , electric field is _________ (zero / constant) , where as electric potential is _________ (zero/constant). [Fill up both the blank positions] 1
Ans	Ans - zero , constant
b	The temperature (T) dependence of resistivity of materials A and material B is represented by fig (i) and fig (ii) respectively. Identify material A and material B.  fig. (i) fig. (ii) (a) A is copper and B is germanium (b) A is germanium and B is copper (c) A is nichrome and B is germanium (d) A is copper and B is nichrome 1
Ans	Ans- (b) A is germanium and B is copper
c	If two identical currents , flowing through straight conductors of infinite extent, seperated by 10 cm in vacuum , made to attract each other by a force of 2×10^{-6} N /m , then magnitude of the current is ________ . (Fill up the blank) 1

Ans	The force per unit length F/L between two parallel straight conductors carrying currents I_1 and I_2 separated by a distance d in vacuum is given by the formula: $$\frac{F}{L} = \frac{\mu_0}{4\pi}\frac{2I_1I_2}{d}$$ Given that $I_1 = I_2 = I$, $d = 10\text{ cm} = 0.1\text{ m}$, and the force per unit length is 2×10^{-6} N/m, $$2 \times 10^{-6} = 10^{-7} \times \frac{2 \times I^2}{0.1}$$ $$I^2 = 1$$ $$I = 1\text{ A}$$
d	Predict the polarity of the capacitor as shown in the following diagram  1
Ans	Based on the magnetic flux change induced by the approaching magnets, the left plate (A) of the capacitor will be positive (+), and the right plate (B) will be negative (−). Lenz's Law indicates an anticlockwise induced current (viewed from the left), resulting in higher potential on plate A.
e	Draw the ray diagram showing the rotation of a ray

	by 90^0,while passing through an isosceles prism. 1
f	In the following figure which radiation, A or B has higher frequency? 1 
Ans	Ans - Since stopping potential for A is more , so KE is also more , hence A is having higher frequency .
g	Nucleus of an atom of mass no. 24 and atomic no. 11 consists of: (i) 11 protons and 13 neutrons (ii) 11 electrons, 11 protons and 13 neutrons (iii) 11 protons and 13 electrons (iv) 11 electrons, 11 protons and 11 neutrons
Ans	Ans- he nucleus of an atom with a mass number of 24 and an atomic number of 11 consists of **11 protons** and **13 neutrons**.
h	In intrinsic semiconductors at room temperature, which of the following statement about n_e (concentration of free electrons) and n_h (concentration of holes) is correct - (a) $n_e > n_h$ (b) $n_e < n_h$ (c) $n_e = n_h$ **(d)** $n_e >> n_h$
Ans	Ans = (c) $n_e = n_h$
2	Match the following -----------------------4 x½ =2 (A)Electric potential ---------- (a) [$M^0 L^{-2} T^1 A^1$] (B)Electric permittivity -------- (b) [$M^{-1} L^{-2} T^4 A^2$]

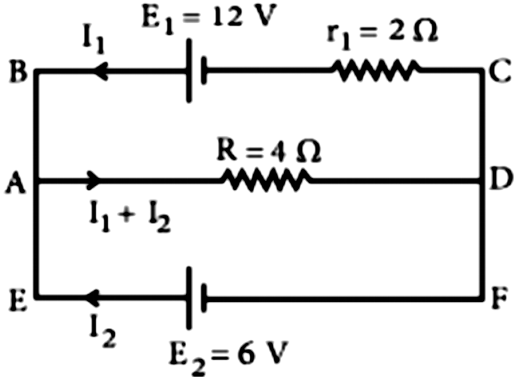
	(C) Capacitance ---------------- (c) [$M^{-1} L^{-3} T^{4} A^{2}$] (D) Electric polarisation ------ (d) [$M^{1} L^{2} T^{-3} A^{-1}$]
Ans	Ans- (A) -----(d) (B) -----(c) (C) -----(b) (D) ------(a)
3	Define the term 'mobility' of charge carriers in a current carrying conductor. Prove that mobility of charge carriers decreases with rise in temperature . ½ + 1½ =2
4	The oscillating electric field of an electromagnetic wave is given by: ½ + ½ +1 =2 $E = 30 \sin [2 \times 10^{11} t + 300 \pi x]$ Vm^{-1} (a) Obtain the value of the wavelength of the electromagnetic wave. (b) Write down the expression for the oscillating magnetic field.
Ans	Ans- Comparing with the standard form $E=E_0\sin[\omega t + kx]$, we have the following parameters: Amplitude: $E_0 = 30$ Vm^{-1} Angular frequency: $\omega = 2\times10^{11}$ rad s^{-1} Wave number: $k=300\ \pi m^{-1}$ The wave number k is related to the wavelength λ by the formula: $\lambda = \frac{2\pi}{k}$

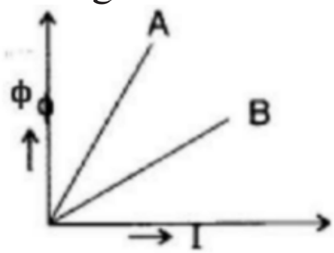
	Substituting the value of k $\lambda = \frac{2\pi}{300\pi} = \frac{1}{150}$ m ≈ 0.00667 m $= 6.67 \times 10^{-3}$ m The relationship between the amplitudes of the electric and magnetic fields in a vacuum is $B_0 = \frac{E_0}{c}$, where c is the speed of light (3×10^8 ms^{-1}): $B_0 = \frac{30}{3 \times 10^8} = 10 \times 10^{-8} = 10^{-7}$ T The magnetic field oscillates in phase with the electric field $B = B_0 \sin[\omega t + kx]$ $B = 10^{-7} \sin[2\times10^{11}t + 300\pi x]$ T
5	a) Arrange the following electromagnetic waves in the descending order of their wavelengths. (i) Microwaves (ii) Infrared rays (iii) Ultraviolet radiation (iv) gamma-rays (b) Write one use each of any two of them . 2 Or Write down Maxwell's equations. 2
Ans	Ans- The correct descending order of wavelength is: Microwaves (Longest wavelength), Infrared rays , Ultraviolet radiation , Gamma-rays (Shortest wavelength) Uses of Microwaves: Used in radar systems for aircraft navigation and in microwave ovens to cook food.

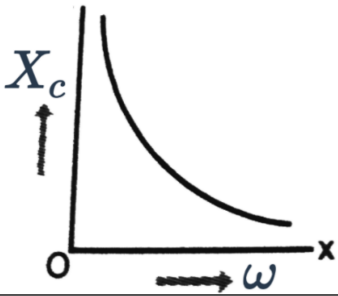
	Uses of Infrared rays: Used in remote control switches for household electronics and in thermal imaging. Uses of Ultraviolet radiation: Used in water purifiers to kill bacteria and for sterilizing surgical instruments. Uses of Gamma-rays: Used in the treatment of cancer (radiotherapy) and for sterilizing medical equipment.
6	What are coherent sources of light ? Write down the condition for sustained interference . 2
7	Draw the graphs showing that stopping potential is independent of intensity of incident light but depends on the frequency of the incident light. Or Draw the graph between stopping potential and frequency of incident radiation and from obtain threshold frequency and Planck's constant. 1+1=2
8	Monochromatic light of frequency 6.0×10^{14} Hz is produced by a laser. The power emitted is 2×10^{-3} W (a)What is the energy of a photon in the light beam? (b) How many photons per second are emitted by the source? ½ + 1½ =2
Ans	The energy of a single photon E is determined by the formula $E = h\nu$, where $h$is Planck's constant (6.63×10^{-34} Js) and

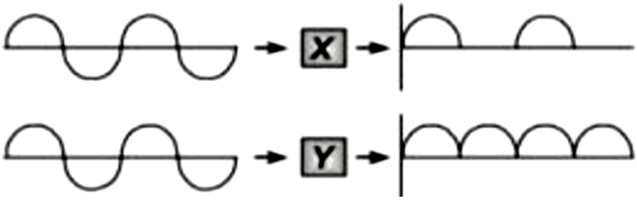
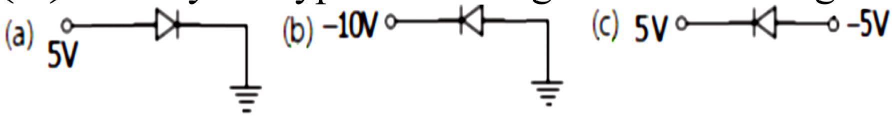
	ν is the frequency of light (6.0×10^{14}Hz). $E=(6.63\times10^{-34})\times(6.0\times10^{14})=3.978\times10^{-19}$J The number of photons emitted per second n is the ratio of total power emitted P to the energy of a single photon E . $$n = \frac{P}{E}$$ Substituting $P = 2\times10^{-3}$ W and $E = 3.978\times10^{-19}$ J $$n = \frac{2\times10^{-3}}{3.978\times10^{-19}} \approx 5.03\times10^{15} \text{ photons/s}$$
9	Define impact parameter . Two alpha particles P and Q deflect by 10° and 120° angles in Rutherford's gold foil experiment. Which of the following is DEFINITELY true about the two particles? 1+1=2 A. Impact parameter of P > Impact parameter of Q B. Impact parameter of P < Impact parameter of Q.
Ans	Since impact parameter is inversely proportional to the angle scattering , so impact parameter of P is more than that of Q .
10	Define 1 amu .Calculate the energy equivalent of 1amu in MeV. 2 Or Explain how energy is produced in Sun . 2
11	Draw the energy band diagram (at T > 0 K) for n-type

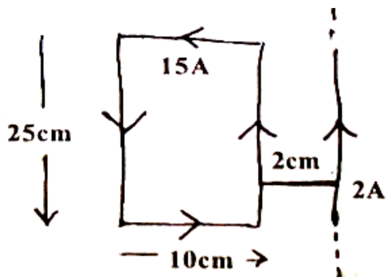
	and p-type semiconductors. 2 Or An intrinsic semiconductor has equal electron and hole concentration of 6 x 10^{16} m^{-3}. On doping with certain impurity the electron concentration increases to 9×10^{22} m^{-3}. Identify the extrinsic semiconductor. Calculate the new hole concentration. 2
Ans	Here, $n_i = 10^{16}$ m^{-3}, $n_h = 5 \times 10^{22}$ m^{-3} As $n_e n_h = n_i^2$ $\therefore n_e = \frac{n_i^2}{n_h} = \frac{(10^{16} m^{-3})^2}{5 \times 10^{22} m^{-3}} = 2 \times 10^9 m^{-3}$ A pure semiconductor has equal electron and hole concentration of 10^{16} m^{-3} Doping by indium increases n_h to 5×10^{22} m^{-3}. Then, the value of n_e in the doped semiconductor is **$2 \times 10^9/m^3$**.
12	Find an expression for electric potential due to a point charge at any position . 3 Or Find an expression for electric field due to a straight conductor of infinite extend of uniform line charge density **λ** , using Gauss's law . 3
13	Applying Kirchhoff's laws of current electricity , establish the Wheatstone bridge's balanced condition. 3 Or In the electric network shown in figure, use

	Kirchhoff's rules to calculate the power consumed by the resistance R = 4Ω.  3
Ans	For loop ABCDA $-12 + 2I_1 + 4(I_1 + I_2) = 0$ $\therefore \quad 3I_1 + 2I_2 = 6 \quad ...(i)$ For loop ADFEA $-4(I_1 + I_2) + 6 = 0$ $\therefore \quad 2I_1 + 2I_2 = 3 \quad ...(ii)$ Solving (i) and (ii), we get $I_1 = 3A$ $I_2 = -1.5A$ Hence, power consumed by the resistor $P = (I_1 + I_2)^2 R = (1.5)^2 \times 4W = 9$ watt
14	Using Biot Savart's law , find an expression magnetic Field due a current loop at a point on its axis. 3 Or A long straight wire of a circular cross-sectional radius 'R', carrying steady current I , which is

	uniformly distributed across this cross-section. Using Ampere's circuital law , calculate the magnetic field at a distance (r) (i) region $r < R$ and (ii) $r >$ R . Establish your result graphically . 3
15	Derive an expression for the mutual inductance of two long co-axial solenoids of same length wound one over the other. 3 Or (i) 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 larger value of self-inductance?  **(ii)** Prove that Lenz's law is obeying the principle of conservation of mechanical energy . 1+2=3
Ans	(i) From the relation, ϕ = LI, it follows that the self inductance of a conductor is equal to the slope of its graph between φ and I. Since slope of A > slope of B So, the self inductance of the conductor A has the larger value.
16	A sinusoidal voltage is applied to an electric circuit Containing element X in which current leads the voltage by π/2. 1+1+1=3 (a) Identify X

	(b)Write the formula for the reactance of X & name it (c)Draw the graph showing the variation of the reactance of X with frequency of ac voltage. Or What is RMS value of an AC ? Obtain its relation with peak value of the AC . 1+2=3
Ans	(a) X is a capacitor . (b)The formula for the reactance of X is known as capacitive reactance & its formula is $X_C = \frac{1}{\omega C}$ (b) The graph showing the variation of the capacitive reactance with frequency of ac voltage is – (c) The capacitive reactance of a capacitor is  $X_c = \frac{1}{\omega C}$ $X_c \propto \frac{1}{\omega}$
17	Derive the lens maker's formula for a convex lens of refractive index 'μ' and focal length 'f ' with 'R_1'and 'R_2' as the radii of curvature , placed in air. 2½+½=3 Or (i)Write down the condition for minimum deviation. (ii)Obtain the relation between refractive Index of a prism and angle of minimum deviation . 1+2=3
18	Draw the IV characteristics of a PN junction diode . From it, identify and define knee voltage and zener

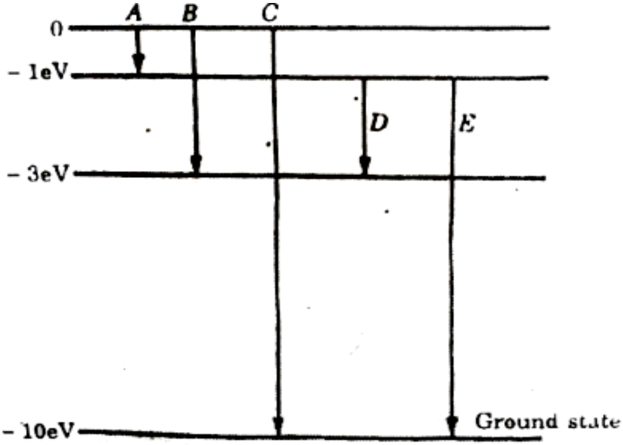
	voltage . 1+1+1=3 Or What are the two main processes involved in the formation of PN junction diode . Explain them . 3
19	With the help of a circuit diagram, explain , how a *PN* junction diode works as a fullwave rectifier. Draw the input and output wave-forms. 3
	Or (i) An a.c. signal is fed into two circuits X and Y and the corresponding output in the two cases have the wavefront shown in figure. Identify X and Y.  1 (ii) A p-n junction diode has a depletion layer of thickness 500 nm and an electric field 16 x 10^5 V/m. Find the barrier potential created the depletion layer .1 **(iii)** Identify the types of baising in the following :-  1
Ans	(i) X is half wave rectifier , Y is full wave rectifier

	Thickness of depletion layer (d): 500 nm $= 500 \times 10^{-9}$ m $= 5 \times 10^{-7}$ m Electric field (E): 16×10^5 V/m The barrier potential (V_B) is related to the electric field (E) and the thickness of the depletion region (d) (ii) $V_B = E \cdot d = (16 \times 10^5 \text{ V/m}) \times (5 \times 10^{-7} \text{ m})$ $= 80 \times 10^{-2}$ V $= 0.8$ V (iii)(a) Forward baising (b) Forward baising (c) Reverse baising
20	State Bohr's postulates . 3 Or State the laws of photo electric effect . 3
21	**(i)** Find the expression for torque acting on a bar magnet placed in uniform magnetic field . **(ii)** Differentiate between Diamagnetic, Paramagnetic and Ferromagnetic substances. 2+ 3 =5 Or **(i)** Find an expression for the force acting between two parallel conductors of infinite extent , carrying currents in same direction **(ii)** Figure shows a rectangular current carrying loop of side 25 cm and 10 cm , carrying a current of 15A , placed 2cm away from a long straight conductor carrying a current of 2A . 

	What is the direction and magnitude of the net force acting on the loop ? 3 + 2 =5
Ans	The magnetic force per unit length between two parallel conductors is given by $F/L = \dfrac{\mu_0 I_1 I_2}{2\pi r}$. The closer side is at a distance $r_1 = 2\text{ cm} = 0.02\text{ m}$ from the long wire. $F_1 = \dfrac{\mu_0 I_1 I_2 L}{2\pi r_1} = \dfrac{(4\pi \times 10^{-7}) \times 2 \times 15 \times 0.25}{2\pi \times 0.02}$ $F_1 = \dfrac{2 \times 10^{-7} \times 30 \times 0.25}{0.02} = 7.5 \times 10^{-5}\text{ N}$ The farther side is at a distance $r_2 = 2\text{ cm} + 10\text{ cm} = 12\text{ cm} = 0.12\text{ m}$. $F_2 = \dfrac{\mu_0 I_1 I_2 L}{2\pi r_2} = \dfrac{(4\pi \times 10^{-7}) \times 2 \times 15 \times 0.25}{2\pi \times 0.12}$ $F_2 = \dfrac{2 \times 10^{-7} \times 30 \times 0.25}{0.12} = 1.25 \times 10^{-5}\text{ N}$ The net force is the difference between the m $F_{net} = F_1 - F_2 = 7.5 \times 10^{-5}\text{ N} - 1.25 \times 10^{-5}\text{ N} = 6.25 \times 10^{-5}\text{ N}$ The direction of this force is towards the long conductor
	Or (i) Find the expression for torque acting on a bar magnet placed in uniform magnetic field . (ii) Differentiate between Diamagnetic, Paramagnetic

	and Ferromagnetic substances. 2+ 3 =5
22	**(i)** With the help of a neat and labeled ray diagram, obtain an expression for the magnifying power of the astronomical telescope in normal adjustment . Find the expression for its magnifying power. **(ii)** A small telescope has an objective lens of focal length 144cm and an eyepiece of focal length 6.0cm . What is the magnifying power of the telescope? What is the separation between the objective and the eyepiece? 2½+1+1+½ =5
Ans	Focal length of the objective lens, f_o = 144 cm Focal length of the eyepiece, f_e = 6.0 cm The magnifying power of the telescope is given as: $m = \frac{f_o}{f_e} = \frac{144}{6} = 24$ The separation between the objective lens and the eyepiece is calculated as: $f_o + f_e = 144 + 6 = 150$ cm
	Or (i) What is plane wavefront ? Draw it (ii) Using Huygen's principle establish prove laws of reflection . (iii) The intensity of two superposing waves are $4I_0$ and I_0 . The intensity of the bright fringe is $7I_0$. Find out the phase difference between the two superposing

	waves . 1+2½+1½= 5
Ans	(iii) The intensities of the two individual waves and the resultant intensity at the point of superposition are • Intensity of wave 1 (I_1) = $4I_0$ • Intensity of wave 2 (I_2) = I_0 • Resultant intensity (I_{res}) = $7I_0$ The general formula for the resultant intensity when two waves interfere is: $I_{res} = I_1 + I_2 + 2\sqrt{I_1 I_2}\cos(\phi)$ where ϕ is the phase difference. Substitute the given values $7I_0 = 4I_0 + I_0 + 2\sqrt{(4I_0)(I_0)}\cos(\phi)$ $7I_0 = 5I_0 + 2\sqrt{4I_0^2}\cos(\phi)$ $7I_0 = 5I_0 + 4I_0\cos(\phi)$ $2I_0 = 4I_0\cos(\phi)$ $\cos(\phi) = \frac{2I_0}{4I_0} = \frac{1}{2}$ $\phi = 60^\circ$ or $\frac{\pi}{3}$ radians
23	(i) Draw the energy level diagram to show the different series of hydrogen spectra. (ii) Find the limit of Balmar series of Hydrogen spectrum .

	(iii) The energy levels of an atom of element X are shown in the diagram. Which one of the level transitions will result in the emission of photons of wavelength 620nm? support your answer with mathematical calculations. Find the longest wavelength in the following spectra .  1½+1+2½ = 5
Ans	**For shortest wavelength in Balmer series $n_f = 2, n_1 = \infty$** $\frac{1}{\lambda} = R\left[\frac{1}{n_f^2} - \frac{1}{n_i^2}\right] \Rightarrow \frac{1}{\lambda} = R\left[\frac{1}{4}\right] = \frac{R}{4}$ $\Rightarrow \lambda = \frac{4}{1.097 \times 10^7} m = 3.646 \times 10^{-7} m = 3646\ Å$ **For longest wavelength in Balmer series $n_f = 2, n_1 = 3$** $\frac{1}{\lambda} = R\left[\frac{1}{n_f^2} - \frac{1}{n_i^2}\right] \Rightarrow \frac{1}{\lambda} = R\left[\frac{1}{4} - \frac{1}{9}\right] = \frac{5}{36} R$ $\Rightarrow \lambda = \frac{36}{5 \times 1.097 \times 10^7} m = 6.563 \times 10^{-7} m = 6563\ Å$ (ii) (iii)

	The wavelength emitted λ = 620 nm ∴ Corresponding energy $E = h\frac{c}{\lambda}$ $= \frac{6.6 \times 10^{-34} \times 3 \times 10^{8}}{620 \times 10^{-9} \times 1.6 \times 10^{-19}} eV = 2eV$ This corresponds to the transition D. In which energy emitted is $\Delta E = -1 - (-3) = 2eV$
	Or **(i)** Draw the graph showing the variation of binding energy per nucleon with the mass number. Give few significance of the graph With the help of the graph , explain the phenomenon of nuclear fission and fusion . **(ii)** The table below represents the binding energy per nucleon and mass number of a few elements. (table below) Study the table and answer the following questions.

Element	Mass Number	Binding energy per nucleon (MeV)
Hydrogen	1	0
Helium`	2	7.4
Lithium	6	4.9
Iron	56	8.8
Gold	197	7.7
Uranium	238	7.5

	(a)Which one is having highest binding energy ? (b) Which element has the highest mass defect per nucleon ? Calculate. (c) Of lithium and gold which element has a more tightly bound nucleus? 2½+½+1½+½= 5
Ans	**(a) Iron (Fe)** has the highest binding energy per nucleon at **8.8 MeV**. **(b)** Mass defect per nucleon = $\frac{\Delta m}{A}$ $= \frac{\Delta m x 931 MeV}{A x 931 MeV} = \frac{BE}{A x 931 MeV}$ Since BE/A is highest for Fe , so it has highest mass defect per nucleon . (c) Of lithium and gold , gold has a more tightly bound nucleus as it has highest binding per nucleon.