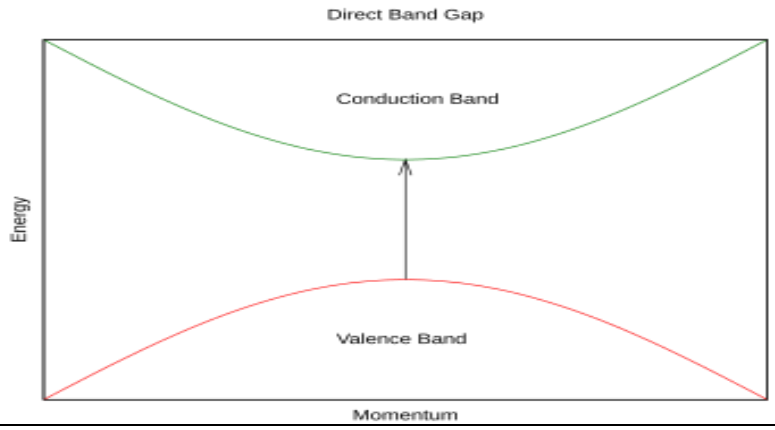
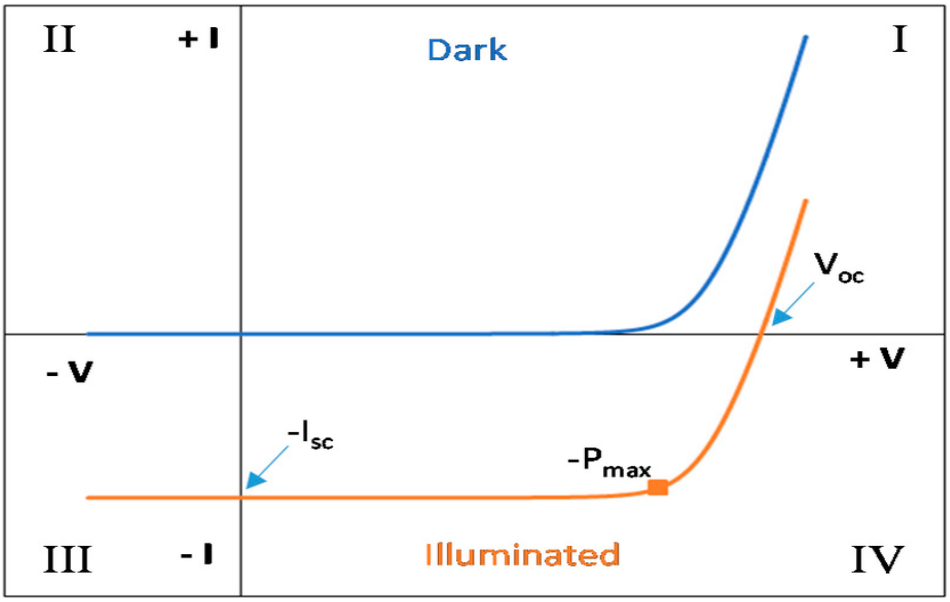
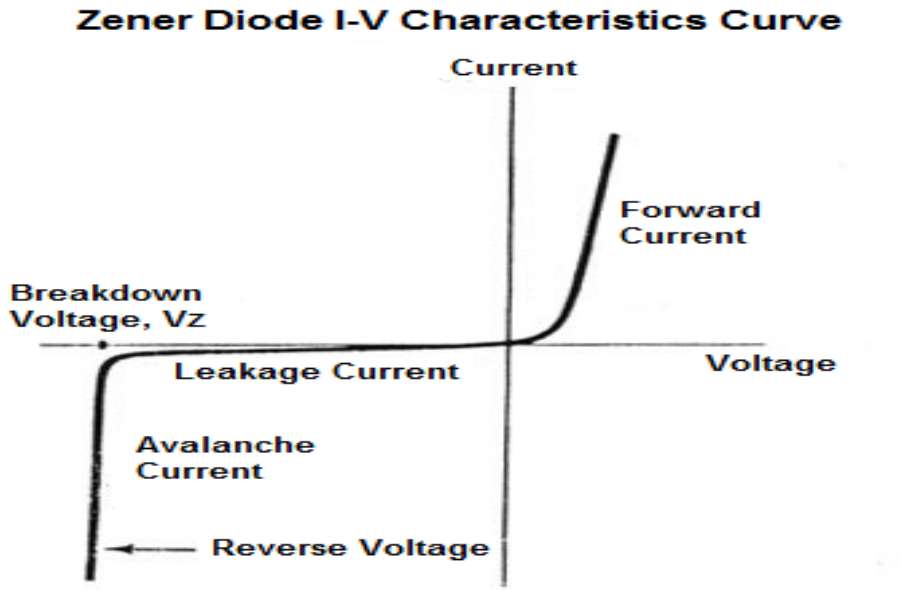
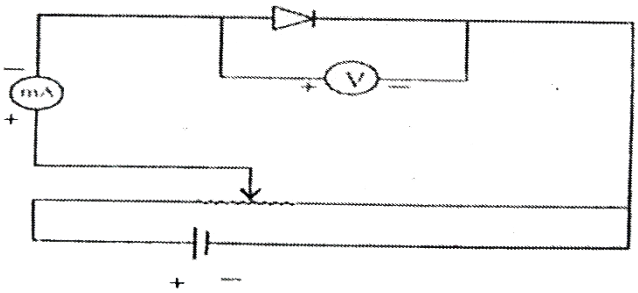
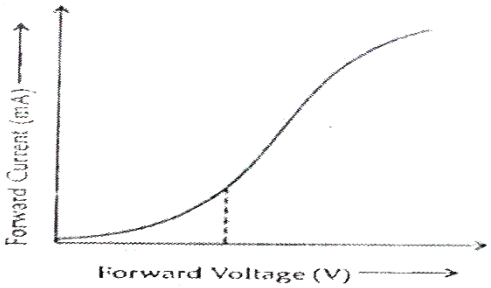
Class 12– CBSE– Physics– Chapter–Semiconductor Electronics

Max Marks – 20 Time: 40 minutes

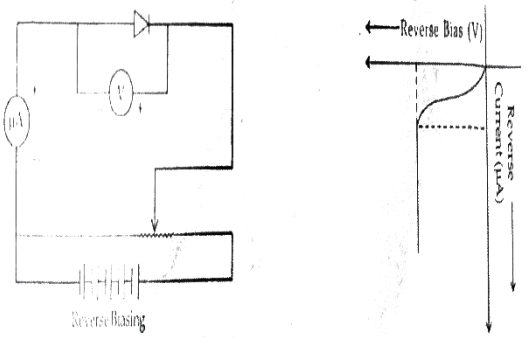
S.No.	Questions/Problems	Marks
1.	The conductivity of a semiconductor increases with: (a) Increase in temperature Answer (b) Decrease in temperature (c) Constant temperature (d) None of these	1
2.	Assertion (A): In an n-type semiconductor, electrons are the majority carriers. Reason (R): Pentavalent impurities donate extra electrons to the semiconductor. (a) Both A and R are true, and R is the correct explanation of A. Answer (b) Both A and R are true, but R is not the correct explanation of A. (c) A is true, but R is false. (d) A is false, but R is true.	1
3.	Draw the energy band diagram for a p-type semiconductor. Label the valence band, conduction band, and acceptor level. Why is the Fermi level closer to the valence band in p-type semiconductors? Ans :  	2
4.	Explain the working principle of a photodiode. Draw its I-V characteristic curve for illumination and dark conditions. Ans : Working Principle: Photodiode operates in reverse bias. Photons generate electron-hole pairs, increasing reverse current.	2

	I-V Curve:  • Dark condition: Low reverse current. • Illuminated: Higher reverse current.	
5.	(a) Define depletion region in a p-n junction diode. How is it formed? (b) With the help of a circuit diagram, explain how a p-n junction diode acts as a half-wave rectifier. (c) Write the expression for the average value of output voltage in half-wave rectification Ans : (a) Depletion Region: A region devoid of free charge carriers at the p-n junction. Formed due to diffusion of electrons and holes, creating immobile ions. (b) Half-wave Rectifier: AC Input → Diode (anode to p, cathode to n) → Load Resistor → Ground Explanation: Diode conducts only during positive half-cycle, blocking negative half-cycle. (c) Average Output Voltage: $V_{avg} = \frac{V_m}{\pi}$, *where* V_m= peak input voltage.	3
6.	(a) Draw the symbol and I-V characteristics of a Zener diode. (b) Explain how a Zener diode works as a voltage regulator. (c) Calculate the load voltage if a Zener diode of breakdown voltage 5.1 V is connected in parallel with a load resistor R_L=1kΩ and the input voltage is 8 V.	3

	Ans : (a)  Symbol: ⏝ (Arrow indicates conventional current direction). I-V Curve: Sharp increase in reverse current at breakdown voltage (V_Z). (b) Voltage Regulator: Zener diode maintains constant output voltage by operating in reverse breakdown. Excess current flows through Zener, protecting load. (c) Load Voltage: $V_L = V_Z = 5.1V$ (parallel connection).	
7.	(a) What is a transistor? Draw the circuit diagram of a common-emitter (CE) n-p-n transistor configuration. (b) Explain transistor action with the help of arrow directions showing emitter, base, and collector currents. (c) Derive the relation between emitter current (I_E), base current (I_B), and collector current (I_C). (d) Define current gain (β) and write its expression. Ans : (a) Transistor: A 3-layer semiconductor device (e.g., n-p-n). CE Configuration Diagram: Emitter → Base → Collector (Input: Base-Emitter, Output: Collector-Emitter) (b) Transistor Action: - Emitter injects electrons into base. - Base (thin) allows few electrons to recombine; most diffuse to collector. - Collector current $I_C \approx$ Emitter current I_E (since I_B is small).	4

	Arrows: I_E into emitter, I_B into base, I_C into collector. (c) Relation: $I_E=I_B+I_C$. (d) Current Gain (β): $\beta=\frac{I_C}{I_B}$	
8.	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. Ans: (a) (i) p-n junction diode under forward bias: The V-I characteristics of p-n junction in forward bias is shown below: p-side is connected to the positive terminal and n-side to the negative terminal. Applied voltage drops across the depletion region. Electron in n-region moves towards the p-n junction and holes in the p-region move towards the junction. The width of the depletion layer decreases and hence, it offers less resistance. Diffusion of majority carriers takes place across the junction. This leads to the forward current.   (ii) p-n junction under reverse bias : Positive terminal of battery is connected to n-side and negative terminal to p-side Reverse bias supports the potential barrier. Therefore, the barrier height increases and the width of depletion region also increases.	4

Due to the majority carriers, there is no conduction across the junction. A few minority carriers cross the junction after being accelerated by high reverse bias voltage.



This constitutes a current flow in opposite direction, which is called reverse current.
The V-I characteristics of p-n junction diode in reverse bias is shown on previous page.
p-n junction diode is used as a half-wave rectifier. Its working is based on the fact that the resistance of p-n junction becomes low when forward biased an becomes high when reverse biased.
These characteristics of diode is used in rectification.