Class 12 Physics · Chapter 14: Semiconductor Electronics: Materials, Devices and Simple Circuits

Worksheet · 20 marks · about 40 minutes · based on NCERT

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1. A hole in a silicon crystal is best described as [1]

(a) a free electron with its charge reversed by the lattice
(b) a positively charged silicon nucleus that moves through the lattice
(c) a vacancy in a covalent bond, behaving as a particle of effective charge +q
(d) an empty site from which a whole silicon atom has left the lattice

2. A pure (intrinsic) germanium crystal at room temperature has 2.4×10^{19} free electrons per cubic metre. The number of holes per cubic metre in it is [1]

(a) 2.4×10^{19}
(b) 5.8×10^{38}
(c) 4.8×10^{19}
(d) zero, since holes need a trivalent dopant

3. In an unbiased p-n junction, the depletion region contains [1]

(a) mobile holes on the n-side and mobile electrons on the p-side
(b) immobile ionised donors on the n-side and immobile ionised acceptors on the p-side
(c) immobile ionised acceptors on the n-side and immobile ionised donors on the p-side
(d) equal numbers of free electrons and holes on both sides

4. To plot the reverse-bias characteristic of a silicon diode, the current should be measured with [1]

(a) a milliammeter, since the reverse current is large
(b) a microammeter, since the reverse current is of the order of microamperes
(c) an ammeter reading in amperes, since breakdown may occur
(d) a voltmeter in series with the diode

5. The forward current of a diode stays almost zero until about 0.2 V and then rises steeply. The diode is most likely made of [1]

(a) silicon
(b) germanium
(c) diamond (carbon)
(d) tin

6. A silicon diode rated for 50 mA is connected in forward bias directly across a 3.0 V cell, with no resistor in the circuit. What will happen to the diode, and why? [2]

7. In a half-wave rectifier, why must the diode's reverse breakdown voltage be sufficiently higher than the peak of the ac voltage from the transformer? [2]

8. A silicon crystal contains N atoms. How many electron states are there in its valence band and in its conduction band, and how are they occupied at absolute zero? [2]

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9. An electric field is applied along a bar of intrinsic silicon, from end X (higher potential) to end Y. (a) In which direction do the free electrons and the holes move? (b) Explain how a hole moves when no particle of positive charge actually travels, and why the two currents add. [3]

10. Boron is added to silicon. (a) Explain why each boron atom produces one hole and becomes a negative ion. (b) Where does the acceptor level E_A lie in the band diagram? (c) The crystal has far more holes than electrons. Why is it still electrically neutral? [3]

11. A thin p-type silicon wafer has part of it converted into n-type. Explain how the diffusion and drift currents across the junction change as the junction forms, and why the final net current is zero. [3]