Semiconductor Electronics - Materials, Devices and Simple Circuits

Assertion & Reason Type Questions

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

a. Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion (A).

b. Both Assertion (A) and Reason (R) are true but Reason (R) is not the correct explanation of Assertion (A).

c. Assertion (A) is true but Reason (R) is false.

d. Both Assertion (A) and Reason (R) are false.

Q1. Assertion (A): Electron has higher mobility than hole in a semiconductor.

Reason (R): Mass of electron is less than the mass of hole.

Answer : (a) The ratio of the velocity to the applied field is called the mobility. Since, electron is lighter than holes, they move faster in applied field than holes.

Q2. Assertion (A): Silicon is preferred over germanium for making semiconductor devices.

Reason (R): The energy gap for germanium is more than the energy gap of silicon.

Answer : (c) The energy gap for germanium is less (0.72 eV) than the energy gap of silicon (1.1 eV) and silicon is preferred over germanium for making semiconductor devices.

Q3. Assertion (A): At OK, germanium is a super-conductor.

Reason (R): At OK, germanium offers zero resistance.

Answer : (d) At O K, germanium offers infinite resistance and it behaves as an insulator.

Q4. Assertion (A): The resistivity of a semiconductor increases with temperature.

Reason (R): The atoms of a semiconductor vibrate with larger amplitude at higher temperature thereby increasing its resistivity.

Answer : (d) Resistivity of semiconductors decreases with temperature. The atoms of a semiconductor vibrate with larger amplitudes at higher temperatures thereby increasing it's conductivity not resistivity.

Q5. Assertion (A): The resistance of an intrinsic semiconductor decreases with increase in its temperature.

Reason (R): The number of conduction electrons as well as hole increase in an intrinsic semiconductor with rise in its temperature. **(CBSE 2023)**

Answer : (b) Both Assertion (A) and Reason (R) are true but Reason (R) is not the correct explanation of Assertion (A).

Q6. Assertion (A): An n-type semiconductor has a large number of electrons but still it is electrically neutral.

Reason (R): An n-type semiconductor is obtained by doping an intrinsic semiconductor with a pentavalent impurity.

Answer :

(b) Intrinsic semiconductor (Neutral) + Pentavalent impurity (Neutral) = *n*-type semiconductor (Neutral)

Q7. Assertion (A): Putting p-type semiconductor slab directly in physical contact with n-type semiconductor slab cannot form the pn-junction.

Reason (R): The roughness at contact will be much more than interatomic crystal spacing and continuous flow of charge carriers is not possible. **(CBSE SQP 2023-24)**

Answer : (a) Both Assertion (A) and Reason (R) are true but Reason (R) is the correct explanation of Assertion (A).

Q8. Assertion (A): The depletion layer in the p-n junction is free from mobile charge carriers.

Reason (R): There is no electric field across the junction barrier.

Answer : (c) Due to diffusion of holes from the p-region to the n-region and of electrons from the n-region to the p-region, an electric field is set up across the junction barrier. Once the depletion layer is formed, it is in equilibrium and becomes free of mobile charge carriers.

Q9. Assertion (A): The dominant mechanism for motion of charge carriers in forward and reverse biased silicon p-n junction are drift in both forward and reverse bias.

Reason (R): In reverse biasing, no current flow through the junction.

Answer : (d) In p-n junction, the diffusion of majority carriers takes place when junction is forward biased and drifting of minority carriers takes place across the junction, when reverse biased. The reverse bias opposes the majority carriers but makes the minority carriers to cross the p-n junction. Thus, the small current (in μA) flows during reverse bias.

Q10. Assertion (A): The half wave rectifier work only for positive half cycle of AC.

Reason (R): In half wave rectifier, only one diode is used.

Answer : (a) In half wave rectifier, only one diode is used. Diode is biased only when AC is in positive half cycle. For negative half AC cycle, the diode is reversed biased and there is no output corresponding to that. Since for only one-half cycle, we get a voltage output, because of which it is called half wave rectifier.

Q11. Assertion: A pure semiconductor has negative temperature coefficient of resistance.
Reason: In a semiconductor on raising the temperature, more charge carriers are released, conductance increases and resistance decreases.

Q12. Assertion: If the temperature of a semiconductor is increased then its resistance decreases.
Reason: The energy gap between conduction band and valence band is very small.

Q13. Assertion: In semiconductors, thermal collisions are responsible for taking a valence electron to the conduction band.
Reason: The number of conduction electrons go on increasing with time as thermal collisions continuously take place.

Q14. Assertion: A p-type semiconductors is a positive type crystal.
Reason: A p- type semiconductor is an uncharged crystal.

Q15. Assertion: Silicon is preferred over germanium for making semiconductor devices.
Reason: The energy gap in germanium is more than the energy gap in silicon.

Q16. Assertion: Electron has higher mobility than hole in a semiconductor.
Reason: The mass of electron is less than the mass of the hole.

Q17. Assertion: The number of electrons in a p-type silicon semiconductor is less than the number of electrons in a pure silicon semiconductor at room temperature.
Reason: It is due to law of mass action.

Q18. Assertion: When two semi conductor of p and n type are brought in contact, they form p-n junction which act like a rectifier.
Reason: A rectifier is used to convent alternating current into direct current.

Q19. Assertion: Diode lasers are used as optical sources in optical communication.
Reason: Diode lasers consume less energy.

Q20. Assertion: The diffusion current in a p-n junction is from the p-side to the n-side.
Reason: The diffusion current in a p-n junction is greater than the drift current when the junction is in forward biased.

Q21. Assertion: The drift current in a p-n junction is from the n-side to the p-side.
Reason: It is due to free electrons only.

Q22. Assertion: A p-n junction with reverse bias can be used as a photo-diode to measure light intensity.
Reason: In a reverse bias condition the current is small but it is more sensitive to changes in incident light intensity.

ANSWER KEY 11 to 22

Q11 : (a) In semiconductors, by increasing temperature, covalent bond breaks and conduction hole and electrons increase.

Q12 : (a) In semiconductors the energy gap between conduction band and valence band is small (1 eV). Due to temperature rise, electron in the valence band gain thermal energy and may jumpy across the small energy gap, (to the conduction band). Thus conductivity increases and hence resistance decreases.

Q13 : (c)

Q14 : (d) There is no charge on P-type semiconductor, because each atom of semiconductor is itself neutral.

Q15 : (c) Silicon is cheaper than germanium, so it is preferred over germanium. But energy gap in germanium is smaller than silicon.

Q16 : (a) **Q17 :** (a)

Q18 : (b) Study of junction diode characteristics shows that the junction diode offers a low resistance path, when forward biased and high resistance path when reverse biased. This feature of the junction diode enables it to be used as a rectifier.

Q19 : (c) Statement – 1 is True, Statement- 2 is False

Q20 : (d) Diffusion current is due to the migration of holes and electrons into opposite regions, so it will be from p-side to n-side. Also in forward bias it will increases.

Q21 : (a) **Q22 :** (a)