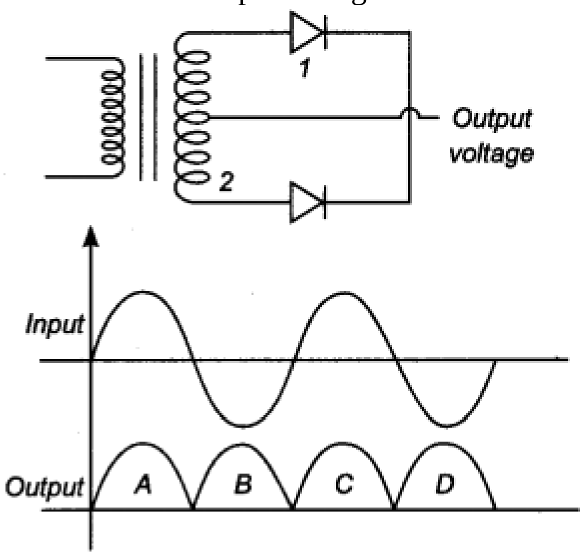
	INDIAN SCHOOL AL WADI AL KABIR	
Class: XII	**Department: SCIENCE 2025– 26** **SUBJECT: PHYSICS**	**Date: 18/11/2025**
Worksheet No: 14 **WITH ANSWERS**	**CHAPTER / UNIT: SEMICONDUCTOR ELECTRONICS: MATERIALS, DEVICES AND SIMPLE CIRCUITS**	**Note:** **A4 FILE FORMAT**
CLASS & SEC:	**NAME OF THE STUDENT:**	**ROLL NO.:**

Multiple choice questions:

1. Electrical conductivity of a semiconductor
   (a) decreases with the rise in its temperature.
   (b) increases with the rise in its temperature.
   (c) does not change with the rise in its temperature.
   (d) first increases and then decreases with the rise in its temperature
2. A n-type semiconductor is
   (a) negatively charged.
   (b) positively charged.
   (c) neutral.
   (d) none of these
3. A full-wave rectifier circuit along with the input and output voltages is shown in the figure. The contribution to output voltage from diode 2 is



   (a) A, C
   (b) B, D
   (c) B, C
   (d) A, D
4. When an electric field is applied across a semiconductor
   (a) holes move from lower energy level to higher energy level in the conduction band.
   (b) electrons move from higher energy level to lower energy level in the conduction band.

(c) holes in the valence band move from higher energy level to lower energy level.
(d) holes in the valence band move from lower energy level to higher energy level.

5. The conduction band in a solid is partially filled at 0 K. The solid sample is
   (a) conductor (b) semiconductor (c) insulator (d) none of these
6. In intrinsic semiconductor at room temperature, the number of electrons and holes are
   (a) equal (b) zero (c)unequal (d) infinite
7. The forbidden energy band gap in conductors, semiconductors and insulators are E_{G1}, E_{G2} and E_{G3} respectively. The relation among them is
   (a) $E_{G1} = E_{G2} = E_{G3}$ (b) $E_{G1} > B_{G2} > E_{G3}$
   (c) $E_{G1} < E_{G2} < E_{G3}$ (d) $E_{GI} < E_{G2} > E_{G3}$
8. n-type semiconductor is obtained when
   (a) germanium is doped with arsenic
   (b) germanium is doped with indium
   (c) germanium is doped with aluminium
   (d) silicon is doped with indium
9. A p-type semiconductor is obtained by doping silicon with
   (a) germanium (b) gallium (c) bismuth (d) phosphorus
10. Which type of semiconductor is obtained by mixing arsenic with silicon?
    (a) n-type (b) p-type (c) Both (d) None.
11. The dominant mechanisms for motion of charge carriers in forward and reverse biased silicon p-n junction are
    (a) drift in forward biased, diffusion in reverse bias
    (b) diffusion in forward biased, drift in reverse bias
    (c) diffusion in both forward and reverse bias
    (d) drift in both forward and reverse bias
12. The electrical resistance of depletion layer is large because
    (a) it has no charge carriers
    (b) it has few holes as charge carriers
    (c) it contains few electrons as charge carriers
    (d) it contains few ions as charge carriers
13. What is the current in the circuit shown in Fig

    (a) 10^{-2} A (b) 10 A (c) 1A (d) zero

ASSERTION - REASON BASED QUESTIONS

Direction: - In the following questions, a statement of assertion is followed by a statement of reason. Mark the correct choice as:

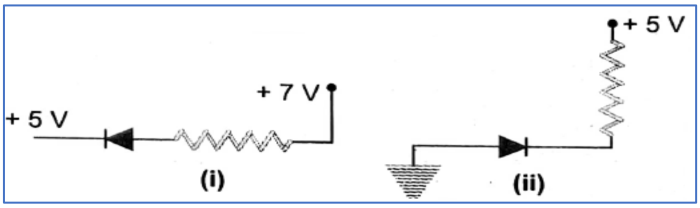
(a) If both assertion and reason are true and reason is the correct explanation of assertion.
(b) If both assertion and reason are true but reason is not correct explanation of assertion.
(c) If assertion is true, but reason is false.
(d) If both assertion and reason are false.

14. **Assertion (A):** The impurities in p-type Si are not pentavalent atoms.
    Reason (R): The hole density in valance band in p-type semiconductor is almost equal to the acceptor density.
15. **Assertion (A):** At absolute zero temperature, a semiconductor behaves like an insulator.
    Reason (R): At absolute zero, all the electrons in a semiconductor are bound and there are no free electrons to conduct electricity.
16. **Assertion (A):** The conductivity of an intrinsic semiconductor is increased by doping.
    Reason (R): Doping introduces more charge carriers in the semiconductor, thereby increasing its conductivity.
17. **Assertion (A):** In a p-type semiconductor, holes are the majority charge carriers.
    Reason (R): Doping a semiconductor with a trivalent impurity creates holes in the valence band.

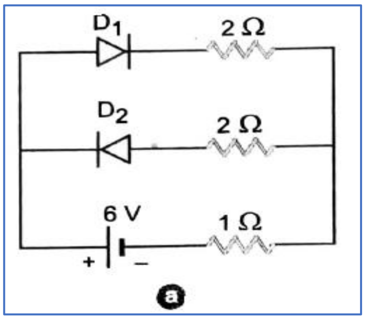
18. **Assertion (A):** In an n-type semiconductor, electrons are the majority charge carriers.
Reason (R): Doping a semiconductor with a pentavalent impurity adds more free electrons to the conduction band.
19. **Assertion (A):** A p-n junction diode conducts current only when it is forward biased.
Reason (R): In forward bias, the potential barrier at the junction is reduced, allowing charge carriers to flow across the junction.

<u>SHORT ANSWER TYPE QUESTIONS (2 marks)</u>

20. What is doping? Why doping is done in semiconductor?
21. The forbidden energy gap of germanium is 0.72 eV. What do you understand by it?
Why do Ge and Si are semiconductors? Is Ohm's law obeyed in semiconductors or not?
22. Out of electron and hole, which one has higher mobility and why?
How does the forbidden energy gap of an intrinsic semiconductor vary with the increase in temperature
23. What happens when a forward bias is applied to a p-n junction?
24. In the following circuits, Fig. which one of the two diodes is forward biased and which is reverse biased?



25. What is an ideal junction diode?
26. For the circuit shown in Fig, find the current flowing through the 1Ω resistor. Assume that the two diodes are ideal diodes.



<u>SHORT ANSWER TYPE QUESTIONS (3 marks)</u>

27. (a) Draw the energy-band diagram for conductors, semiconductors, and insulators at T = 0 K. How is an electron-hole pair formed in a semiconductor at room temperature?
(b) Carbon and silicon both are members of the IV group of the periodic table and have the same lattice structure. Carbon is an insulator whereas silicon is a semiconductor. Explain.
28. State the principle of working of p-n diode as a rectifier. Explain, with the help of a circuit diagram, the use of a p-n diode as a full wave rectifier. Draw a sketch of the input and output waveforms
29. Explain with the help of a circuit diagram, the use of a diode as a half wave rectifier.

<u>LONG ANSWER TYPE QUESTIONS (5 marks)</u>

30. [i]With the help of a diagram, distinguish between forward and reverse biasing of a diode
[ii] Draw V-I characteristics of a p-n junction diode in [a] forward [b] reverse biased
31. Explain the formation of depletion layer and barrier potential in p-n junction diode and define knee voltage, potential barrier.
32. A semiconductor has equal electron and whole concentration of $6 \times 10^{8} m^{-3}$. On doping with certain

impurity, electron concentration increases to $8\times 10^{12} m^{-3}$.

i. Identify the new semiconductor

ii. Calculate the new hole concentration.

iii. How does the energy gap vary with doping?

CASE STUDY QUESTIONS

33. When p side of p-n junction is connected to positive terminal of battery and n side of p-n junction is connected to negative terminal of battery then the p-n junction is said to be in forward bias mode or forward biased. And When p side of p-n junction is connected to negative terminal of battery and n side of p-n junction is connected to positive terminal of battery then the p-n junction is said to be in reverse bias mode or reverse biased. The diode used to rectify an AC voltage is called as rectifier. Zener diode is also a p-n junction diode which works in reverse bias condition and used as voltage regulator. Also, p-n junction diodes are used in solar cells which is used to convert light energy into electrical energy. Light emitting diodes are also p-n junction diodes which are used to produce light.

    i. The rectifier in which the rectified output is only for half of the input AC wave is called as___

    a) full wave rectifier

    b) half wave rectifier

    c) transformer

    d) transducer

    ii. What is dynamic resistance?

    iii. What is barrier potential?

34. Materials are classified on the basis of their conductivity as metals, semiconductors and insulators. Metals are having low resistivity and high conductivity. While semiconductors are having resistivity and conductivity in between metals and insulators. And finally, insulators are those which are having high resistivity or very low conductivity. Semiconductors may exist as elemental semiconductors and also compound semiconductors. Si and Ge are elemental semiconductor and CdS, GaAs, CdSe, anthracene, polypyrrole etc. are the compound semiconductors. Each electron in an atom has different energy level and such different energy levels continuing forms the band of energy called as energy bands. Those energy band which has energy levels of Valence electrons is called as Valence band. And the energy band which is present above the Valence band is called as conduction band.

    i. In case of p-type semiconductors___

    a) $n_h << n_e$

    b) $n_h = n_e$

    c) $n_h >> n_e$

    d) $n_h = n_e = 0$

    ii. An intrinsic semiconductor behaves like _____ at T = 0K.

    a) conductor

    b) metal

    c) non metal

    d) insulator

    iii. If the energy band gap Eg> 3 eV then such materials are called as

    a) conductors

    b) semiconductors

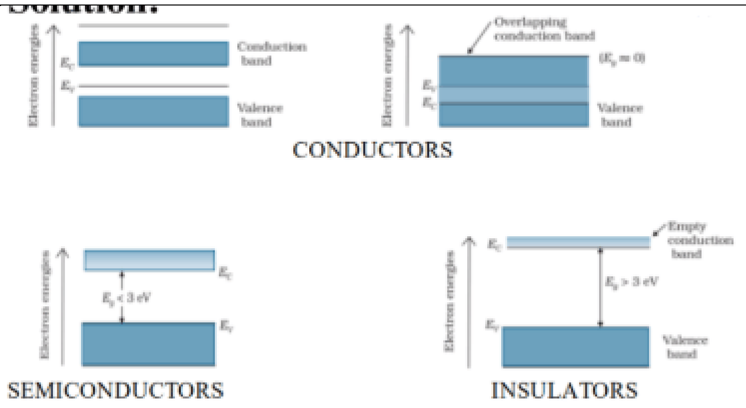
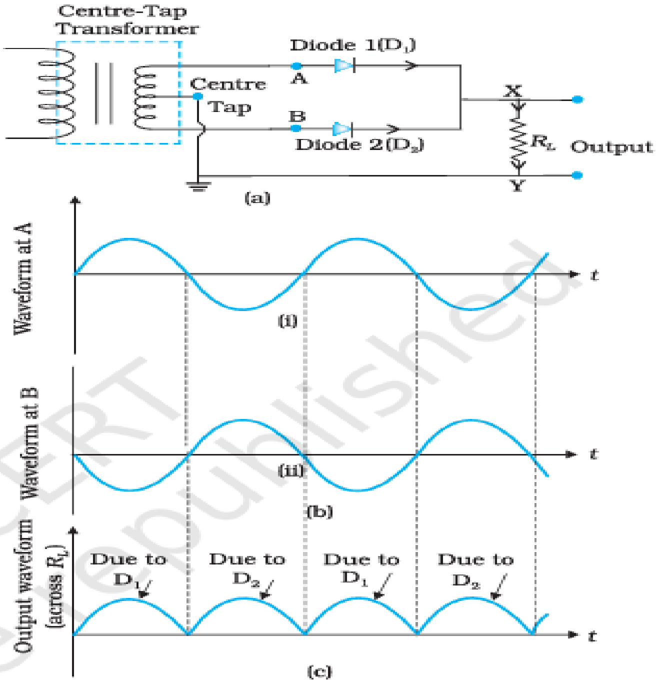
    c) insulators

    d) superconductors

    iv. What is energy band gap in case of materials?

    v. How p-type and n-type semiconductors are formed?

ANSWER KEY	
1	(b) increases with the rise in its temperature.
2	(c) n-type semiconductors are neutral because neutral atoms are added during doping.
3	(b) B, D In the positive half cycle of input ac signal diode D_1 is forward biased and D_2 is reverse biased so in the output voltage signal, A and C are due to D_1. In negative half cycle of input ac signal, D2 conducts, hence output signals B and D are due to D_2
4	(c) holes in the valence band move from higher energy level to lower energy level. When electric field is applied across a semiconductor, the electrons in the conduction band move from lower energy level to higher energy level. While the holes in valence band move from higher energy level to lower energy level, where they will be having more energy.
5	(a) conductor
6	(a) equal
7	(c) $E_{G1} < E_{G2} < E_{G3}$
8	(a) germanium is doped with arsenic
9	(b) gallium
10	(a) n-type
11	(b) diffusion in forward biased, drift in reverse bias
12	(a) it has no charge carriers
13	(d) zero
14	(b) If both assertion and reason are true but reason is not correct explanation of assertion.
15	(a) If both assertion and reason are true and reason is the correct explanation of assertion.
16	(a) If both assertion and reason are true and reason is the correct explanation of assertion.
17	(a) If both assertion and reason are true and reason is the correct explanation of assertion.
18	(a) If both assertion and reason are true and reason is the correct explanation of assertion.
19	(a) If both assertion and reason are true and reason is the correct explanation of assertion.
20	Doping is a process of deliberate addition of a desirable impurity in a pure semiconductor to modify its properties in a controlled manner. To increase the number of mobile electrons/holes and hence to increase the conductivity.
21	It states that if an energy of 0.72 eV is given to an electron in the valence band of germanium it will jump to the conduction band, crossing an energy gap of 0.72 eV. In the energy band diagram of Ge and Si. The energy gap is 0.72 eV and 1.1 eV respectively between conduction band and valence band. As a result of it, they behave as semiconductor. In semiconductors, Ohms law is obeyed only for low electric field(less than 10^6 Vm).
22	Electron has higher mobility than the hole because electron needs less energy to move in a semiconductor. The energy gap of an intrinsic semiconductor does not change with the increase in temperature.
23	The size of the depletion layer decreases. The resistance becomes low. The movement of the majority carriers takes place across the junction, resulting current, known as forward current which increases rapidly with increase in forward voltage.
24	(i) p-n junction is forward biased (ii) p-n junction is reverse biased
25	An ideal junction diode is one which acts as a perfect conductor when forward biased and perfect insulator when reverse biased.
26	Here, diode D_2, is reverse biased, it offers infinite resistance.

	$I = \frac{6}{(2+1)} = 2$ A.
27	 At room temperature, thermal energy is sufficient for electrons to break free from the bonds and create a vacancy called a hole. Hence, an electron-hole pair is formed. (b) The valence electrons in carbon and silicon lie in the second and third orbit respectively. So, the energy required to remove an electron will be less for silicon as compared to carbon. Hence, the number of free electrons for conduction in silicon is significant but negligibly small for carbon.
28	A p-n junction diode allows current to flow only in one direction (forward bias) and blocks current in the reverse direction (reverse bias). This unidirectional property enables the diode to convert alternating current (AC) into direct current (DC), a process called rectification. • **Forward Bias:** Diode conducts (low resistance) • **Reverse Bias:** Diode does not conduct (high resistance)  **FIGURE 14.19** (a) A Full-wave rectifier circuit: (b) Input wave forms given to the diode D_1 at A and to the diode D_2 at B: (c) Output waveform across the load R_L connected in the full-wave rectifier circuit.
29	Refer the notes
30	Refer the notes
31	Refer the notes

32	i. New semiconductor obtained is N-type as $n_e > n_h$ after doping. ii. **Ans.** It is known that $n_e n_h = n_i^2$ Clearly, $n_h = \frac{n_i^2}{n_e} = \frac{36 \times 10^{16}}{8 \times 10^{12}}$ $\Rightarrow n_h = 4.5 \times 10^4 m^{-3}$ iii. With doping, the energy gap decreases due to generated donor levels in between the valence band and the conduction band.
33	i. b) half wave rectifier ii. The ratio of small change in voltage ΔV to a small change in current ΔI is called as dynamic resistance and is given by $r_d = \Delta V / \Delta I$ iii. The electric potential required to restrict the movement of electron from n-side to p-side across p-n junction is called as barrier potential.
34	i. c) $n_h >> n_e$ ii. d) insulator iii. c) insulators iv. The energy difference between top of the Valence band and bottom of the conduction band is called as energy band gap. On the basis of energy band gap materials are also classified. Metals are having nearly zero energy band gap. Semiconductors are having 0.2 eV to 3 eV energy band gap. And insulators are having energy band gap more than 3eV. v. When trivalent impurity like B, Al, In are added to extrinsic semiconductor like Ge or Si then p-type Ge or Si semiconductor is formed. And when pentavalent impurity like As, Sb, P are added to extrinsic semiconductors like Ge or Si then n-type Ge or Si semiconductor is formed.

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