

How to use this worksheet. Thirty questions, about 35 minutes. Fix the pairing first: pentavalent dopant gives n-type with electrons as majority carriers, trivalent gives p-type with holes. Remember also that doping **raises** conductivity.

Formula sheet**Silicon: 4 valence electrons, gap ≈ 1.1 eV | Germanium: gap ≈ 0.7 eV****Pentavalent dopant $\rightarrow$ n-type (electrons majority) | Trivalent dopant $\rightarrow$ p-type (holes majority)****Barrier potential: Si ≈ 0.7 V, Ge ≈ 0.3 V | Diode resistance $R = V/I$ | Full-wave ripple = $2 \times$ supply frequency****Section A · Level 1 — Bands, doping and the junction***Ten questions. None should take more than twenty seconds.*

- 1.** The number of valence electrons in a silicon atom is:
(1) 2 (2) 3 (3) 4 (4) 5
- 2.** At absolute zero temperature, a pure semiconductor behaves as:
(1) A conductor (2) An insulator (3) A superconductor (4) A p-type material
- 3.** The majority charge carriers in a p-type semiconductor are:
(1) Electrons (2) Holes (3) Protons (4) Neutrons
- 4.** Which of the following is a trivalent impurity?
(1) Phosphorus (2) Arsenic (3) Antimony (4) Boron
- 5.** The forbidden energy gap in a good conductor is:
(1) Very large (2) About 1 eV (3) Zero or overlapping (4) About 6 eV
- 6.** Doping a pure semiconductor:
(1) Decreases its conductivity (2) Increases its conductivity (3) Has no effect on conductivity (4) Turns it into an insulator
- 7.** The depletion region of an unbiased p-n junction contains:
(1) Only electrons (2) Only holes (3) No free charge carriers (4) Equal free electrons and holes
- 8.** Under forward bias, the width of the depletion region:
(1) Increases (2) Decreases (3) Stays the same (4) Becomes infinite
- 9.** A p-n junction diode conducts appreciably when it is:
(1) Reverse biased (2) Forward biased (3) Unbiased (4) At absolute zero
- 10.** Comparing the energy gaps of silicon and germanium:
(1) Silicon has the larger gap (2) Germanium has the larger gap (3) The gaps are equal (4) Both have zero gap

Working space — Questions 1 to 10*Write the formula before you substitute.***Section B · Level 2 — Diodes, rectifiers and carriers***Nine questions. Know which carrier is which before you answer.*

- 11.** Adding a pentavalent impurity to a pure semiconductor produces:
(1) p-type material (2) n-type material (3) An insulator (4) A conductor
- 12.** In an n-type semiconductor, the minority carriers are:
(1) Electrons (2) Holes (3) Protons (4) Donor ions

13. A half-wave rectifier uses how many diodes?

- (1) One (2) Two (3) Three (4) Four

14. A full-wave bridge rectifier uses how many diodes?

- (1) One (2) Two (3) Three (4) Four

15. The resistance of a p-n junction diode in reverse bias is:

- (1) Very low (2) Zero (3) Very high (4) Equal to its forward resistance

16. A Zener diode is normally used as a:

- (1) Rectifier (2) Amplifier (3) Voltage regulator (4) Oscillator

17. A silicon diode drops 0.7 V while carrying 10 mA. Its effective resistance is:

- (1) $7\ \Omega$ (2) $70\ \Omega$ (3) $700\ \Omega$ (4) $0.07\ \Omega$

18. The small reverse saturation current in a diode is caused by:

- (1) Majority carriers (2) Minority carriers (3) Donor ions (4) Acceptor ions

19. As the temperature of a semiconductor rises, its resistance:

- (1) Increases (2) Decreases (3) Stays constant (4) Becomes infinite

Working space — Questions 11 to 19 Write the formula before you substitute.

Section C · Level 3 — Devices and characteristics

Seven questions. Each needs a device fact plus a piece of reasoning.

20. Compared with an intrinsic semiconductor at the same temperature, the conductivity of an extrinsic semiconductor is:

- (1) Lower (2) Higher (3) The same (4) Always zero

21. A photodiode is normally operated in:

- (1) Forward bias (2) Reverse bias (3) Zero bias only (4) Breakdown

22. Light is emitted by an LED because of:

- (1) Ionisation of the lattice (2) Recombination of electrons and holes (3) Reverse breakdown (4) Thermal radiation

23. The approximate barrier potential of a silicon p-n junction is:

- (1) 0.1 V (2) 0.3 V (3) 0.7 V (4) 1.5 V

24. A full-wave rectifier is supplied from a 50 Hz mains. The ripple frequency of its output is:

- (1) 25 Hz (2) 50 Hz (3) 100 Hz (4) 200 Hz

25. The number of p-n junctions in a bipolar junction transistor is:

- (1) One (2) Two (3) Three (4) Four

26. A solar cell converts light into electricity using the:

- (1) Photoelectric effect in a metal (2) Photovoltaic effect at a junction (3) Thermoelectric effect (4) Piezoelectric effect

Working space — Questions 20 to 26 Write the formula before you substitute.

Section D · Previous year questions — Straight from the AAI ATC papers

Four questions, every one exactly as it appeared in the 2025 papers.

27. A reverse bias voltage of 10 V is applied across a p-n junction diode such that the current flowing through the diode in the reverse bias configuration is 2 μ A. What will be the resistance of the diode in this configuration? [PYQ

2025 · Shift 1]

(1) 5000 k Ω (2) 50 k Ω (3) 500 k Ω (4) 5 k Ω

28. Which of the following statements about extrinsic semiconductors is incorrect? [PYQ 2025 · Shift 1]

(1) In an n-type extrinsic semiconductor, the electrons are the majority charge carriers (2) An extrinsic semiconductor is electrically neutral (3) In an extrinsic semiconductor, an impurity is added (4) The conductivity of an extrinsic semiconductor is less than an intrinsic semiconductor

29. Which of the following materials is commonly used as a pentavalent impurity in n-type semiconductors? [PYQ

2025 · Shift 2]

(1) Gallium (2) Boron (3) Indium (4) Phosphorus

30. Which of the following materials exhibits behaviour that violates Ohm's law under specific conditions? [PYQ

2025 · Shift 2]

(1) A wire made of copper at room temperature, where the current increases in direct proportion to the applied voltage (2) A semiconductor at low temperatures, where the current does not increase linearly with applied voltage (3) A resistor in a simple circuit with a constant voltage source, where the voltage is proportional to the current (4) A metallic wire at constant temperature, where current increases linearly with applied voltage

Working space — Questions 27 to 30 Write the formula before you substitute.

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