

Semiconductor Electronics — CBSE Pattern Test 2

Class 12 Physics · 90 minutes · 40 marks · Sections A–D with answer key · Narayan Gurukul Academy

Test 2 — CBSE Pattern (90 minutes, 40 marks)

Class 12 Physics · Semiconductor Electronics · Narayan Gurukul Academy (ClassApna)

General Instructions: (1) This paper has four sections — Section A (1×10), Section B (2×4), Section C (3×4) and Section D (5×2) — total 40 marks. Time allowed: 90 minutes.
(2) All questions are compulsory. No overall choice is given; internal choice, where allowed, is clearly marked.
(3) For MCQ questions choose the single correct option; for VSA answers write a single line.
(4) Take $g = 10 \text{ m/s}^2$. All symbols carry their usual meaning. Use of a calculator is not permitted.

Section A — MCQ & VSA ($10 \times 1 = 10$ marks)

1. In an intrinsic semiconductor at absolute zero, the valence band is
 - (A) completely filled and the conduction band empty
 - (B) partly filled
 - (C) empty
 - (D) overlapping with the conduction band
2. A p-n junction is formed by
 - (A) joining a p-type and an n-type semiconductor
 - (B) doping silicon with carbon
 - (C) heating a metal
 - (D) cooling a semiconductor
3. The depletion region of a p-n junction contains
 - (A) immobile ions
 - (B) free electrons
 - (C) free holes
 - (D) nothing
4. A half-wave rectifier uses
 - (A) one diode
 - (B) two diodes
 - (C) four diodes
 - (D) three diodes
5. An LED converts
 - (A) electrical energy into light
 - (B) light into electricity
 - (C) heat into light
 - (D) light into heat
6. The emitter of a transistor is
 - (A) heavily doped
 - (B) lightly doped
 - (C) moderately doped
 - (D) undoped
7. The current gain of a common-emitter amplifier is the ratio of
 - (A) the collector current to the base current

- (B) the emitter current to the base current
 - (C) the base current to the collector current
 - (D) the collector current to the emitter current
8. The output of an AND gate is high when
- (A) all inputs are high
 - (B) any input is high
 - (C) all inputs are low
 - (D) inputs differ
9. What is a rectifier?
10. Name the majority charge carriers in a p-type semiconductor.

Section B — Short Answer I ($4 \times 2 = 8$ marks)

11. The current gain of a common-emitter amplifier is 100. If the base current changes by $40 \mu\text{A}$, find the change in the collector current.
12. In a common-emitter amplifier, the base current is $50 \mu\text{A}$ and the collector current is 5 mA . Find the emitter current.
13. State one use each of an LED and a solar cell.
14. Write the truth table of a two-input NOR gate.

Section C — Short Answer II ($4 \times 3 = 12$ marks)

15. Draw the energy band diagrams of conductors, insulators and semiconductors and explain the differences.
16. Explain the working of a half-wave rectifier and draw the input and output waveforms.
17. Describe the working of a photodiode and a solar cell, stating one use of each.
18. Describe the construction of an n-p-n transistor and explain the biasing of its junctions for normal operation.

Section D — Long Answers ($2 \times 5 = 10$ marks)

19. What is a p-n junction? Explain the formation of the depletion region and potential barrier, and describe the working of the diode in forward and reverse bias. Draw its I-V characteristics.
20. Draw the logic symbols and truth tables of the OR, AND and NOT gates. Explain how NAND and NOR gates are used as universal gates, giving the equivalent circuits.

Answer Key (Marking Scheme)

- Q1 — (A) completely filled and the conduction band empty. Q2 — (A) joining a p-type and an n-type semiconductor. Q3 — (A) immobile ions. Q4 — (A) one diode.
- Q5 — (A) electrical energy into light. Q6 — (A) heavily doped. Q7 — (A) the collector current to the base current. Q8 — (A) all inputs are high.
- Q9 — A device that converts alternating current into direct current.
- Q10 — Holes.
- Q11 — $\Delta I_C = \beta \Delta I_B = 100 \times 40 \mu\text{A} = 4 \text{ mA}$.
- Q12 — $I_E = I_B + I_C = 0.05 + 5 = 5.05 \text{ mA}$.
- Q13 — LED: displays/indicators; solar cell: converts sunlight to electricity.
- Q14 — Output is 1 only when both inputs are 0; otherwise 0.

Q15 — Conductors overlap, semiconductors have a small gap (≈ 1 eV), insulators a large gap (> 3 eV).

Q16 — One diode conducts for the positive half cycle only, giving a pulsating DC.

Q17 — Photodiode in reverse bias responds to light; solar cell converts light to electricity for power supply.

Q18 — Emitter heavily doped, base lightly doped and thin, collector moderately doped; emitter-base forward biased, collector-base reverse biased.

Q19 — See notes; diffusion forms the depletion region and barrier; I-V characteristics as shown.

Q20 — Truth tables as in notes; NAND/NOR can each realise the three basic gates, hence universal.