

Chapter 14 · Semiconductor Electronics

CBSE Class 12 Physics (042) · Unit IX · Unit IX = 7 marks · Ultimate Revision Sheet

SCOPE ALERT — OFFICIAL 2026-27 SYLLABUS

The chapter has been cut to: **energy bands (qualitative)**, **intrinsic and extrinsic semiconductors**, **p and n type**, **p-n junction**, **diode I-V characteristics in forward and reverse bias**, and **the diode as a rectifier**.

Transistors, logic gates, Zener diodes and LEDs are **NOT** in the 2026-27 list. Confirm with your teacher before skipping them, since many school tests still include them.

60-SECOND RECALL

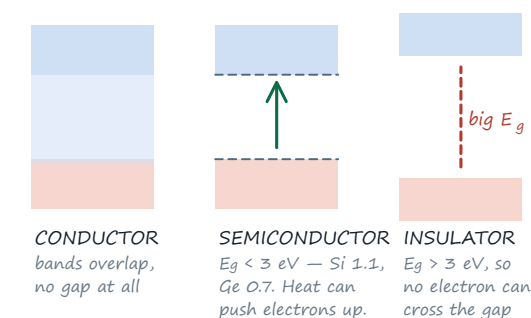
Band gap	Conductor 0 (overlap) · Semiconductor ≈1 eV · Insulator >3 eV
Intrinsic	$n_e = n_h = n_i$ · pure Si or Ge
n-type	Pentavalent dopant (P, As, Sb) · electrons majority
p-type	Trivalent dopant (B, Al, In) · holes majority
Mass action	$n_e n_h = n_i^2$
Forward bias	Barrier decreases · resistance low · current in mA
Reverse bias	Barrier increases · resistance high · current in μA
Barrier potential	Si 0.7 V · Ge 0.3 V

1. Energy Bands qualitative only

THE THREE MATERIALS

Material	Band gap E_g	Behaviour
Conductor	Zero — valence and conduction bands overlap	Electrons move freely; resistance rises with temperature
Semiconductor	Small, ≈1 eV (Si 1.1 eV, Ge 0.7 eV)	Insulator at 0 K; conducts when heated or doped. Resistance falls with temperature
Insulator	Large, > 3 eV	Conduction band effectively empty

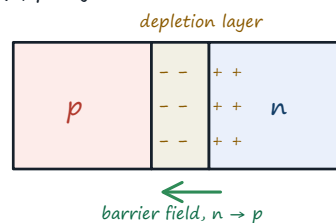
(a) Energy bands (qualitative only)



upper band = conduction
lower band = valence

Doped Si stays **NEUTRAL** overall.

(b) p-n junction



Barrier potential: Si $\approx 0.7 \text{ V}$, Ge $\approx 0.3 \text{ V}$

FORWARD bias (p to +): barrier shrinks, depletion layer narrows, current flows.

REVERSE bias (p to -): barrier grows, layer widens, only tiny leakage current.

The depletion layer has no free carriers — that is exactly why it resists current.

A diode conducts **one way only**, and the reason is the depletion layer widening or narrowing — say that, not just “it allows current in one direction”.

2. Intrinsic and Extrinsic Semiconductors

INTRINSIC A pure semiconductor. Breaking a covalent bond creates an electron-hole pair, so $n_e = n_h = n_i$. Conductivity is very low at room temperature and rises with temperature.

EXTRINSIC — doping

	n-TYPE	p-TYPE
Dopant	Pentavalent — P, As, Sb	Trivalent — B, Al, In
Called	Donor impurity	Acceptor impurity
Majority carriers	Electrons	Holes
Minority carriers	Holes	Electrons
Energy level created	Donor level just below the conduction band	Acceptor level just above the valence band

$$n_e n_h = n_i^2 \text{ (law of mass action, holds for both types)}$$

TRAP A doped semiconductor is still electrically NEUTRAL. n-type does not mean negatively charged — it means electrons are the majority carriers. This is asked almost every year. Doping raises conductivity by a factor of thousands while changing the atom count by about 1 in 10^6 .

3. The p-n Junction

- HOW THE JUNCTION FORMS**
1. **Diffusion:** holes diffuse $p \rightarrow n$ and electrons diffuse $n \rightarrow p$, because of the concentration difference.
 2. **Depletion region:** they recombine near the junction, leaving **immobile ions** — a region with **no free carriers**.
 3. **Barrier potential:** these ions set up an electric field (n side positive, p side negative) which opposes further diffusion. Si 0.7 V, Ge 0.3 V.
 4. **Drift** (minority carriers moving under the field) balances diffusion, and equilibrium is reached.

BIASING — the comparison that carries the marks

Basis	FORWARD BIAS	REVERSE BIAS
Connection	p to +, n to -	p to -, n to +
Depletion width	Decreases	Increases
Barrier potential	Decreases	Increases
Resistance	Low (~ohms)	High (~MΩ)
Current	mA, by majority carriers	μA, by minority carriers
Special feature	Knee (cut-in) voltage	Breakdown voltage; current is nearly constant until then

A diode therefore conducts well in **one direction only** — it acts as a **switch**, closed in forward bias and open in reverse.

4. The Diode as a Rectifier

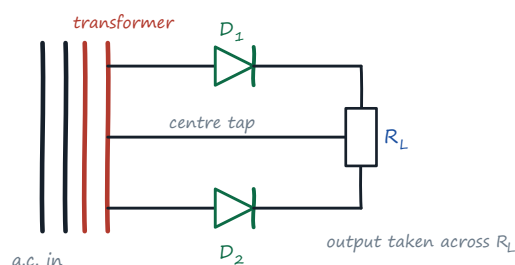
THE TWO CIRCUITS

	HALF-WAVE	FULL-WAVE
Diodes used	One	Two (centre-tap transformer)
Output	Only one half of each cycle	Both halves , both made positive
Output frequency	Same as input (50 Hz)	Twice the input (100 Hz)
Efficiency	Low	About twice as high

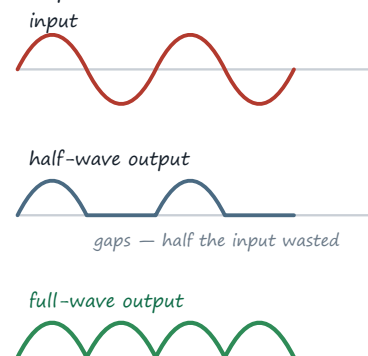
Working: in each half cycle the diode that is **forward biased** conducts and the other blocks, so current through the load always flows in the **same direction**.

A **capacitor filter** across the load smooths the pulsating DC by charging at the peaks and discharging through the load in between.

Full-wave rectifier (centre-tap) — both halves of the input are used



Only **ONE** diode conducts at a time:
D₁ on the positive half, D₂ on the
negative half — but current through
RL runs the **SAME** way both times.



Both are still pulsating d.c., so a filter
capacitor follows in a real supply.

That last line is the whole idea: the two diodes take turns, but the load current never reverses. Output frequency is **2×** the input for full-wave, **1×** for half-wave.

5. Question Triggers what the wording is really asking

If the question says...	The answer is...
"doped with phosphorus / arsenic"	n-type , donor, electrons majority
"doped with boron / indium"	p-type , acceptor, holes majority
"is an n-type semiconductor negatively charged?"	No — it is electrically neutral
"current of a few μA only"	Reverse bias — minority carriers
"depletion layer becomes thinner"	Forward bias
"output frequency is 100 Hz for 50 Hz input"	Full-wave rectifier
"resistance decreases on heating"	Semiconductor

MOST-ASKED BOARD QUESTIONS

- [3M]** Explain the formation of a **p-n junction**, the depletion region and the barrier potential.
- [3M]** Draw the **I-V characteristics** of a diode in forward and reverse bias and explain them.
- [3M]** Draw a **full-wave rectifier**, explain its working, and sketch input and output waveforms.

4. [2M] Distinguish between *intrinsic* and *extrinsic* semiconductors, and between *n-* and *p-type*.
5. [2M] Compare conductors, semiconductors and insulators on the *basis of energy bands*.
6. [1M] Give the barrier potential of a *silicon* diode. → **0.7 V**

THE HABIT THAT SCORES — For every diode question, first say which way it is biased, then say what happens to the *depletion width* and the *barrier potential*. Those two phrases appear in the marking scheme for nearly every answer in this chapter.