SNS COLLEGE OF TECHNOLOGY

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Department of Biomedical Engineering

Course Name: 23BMB101-Electron Devices and Circuits

I Year : II Semester

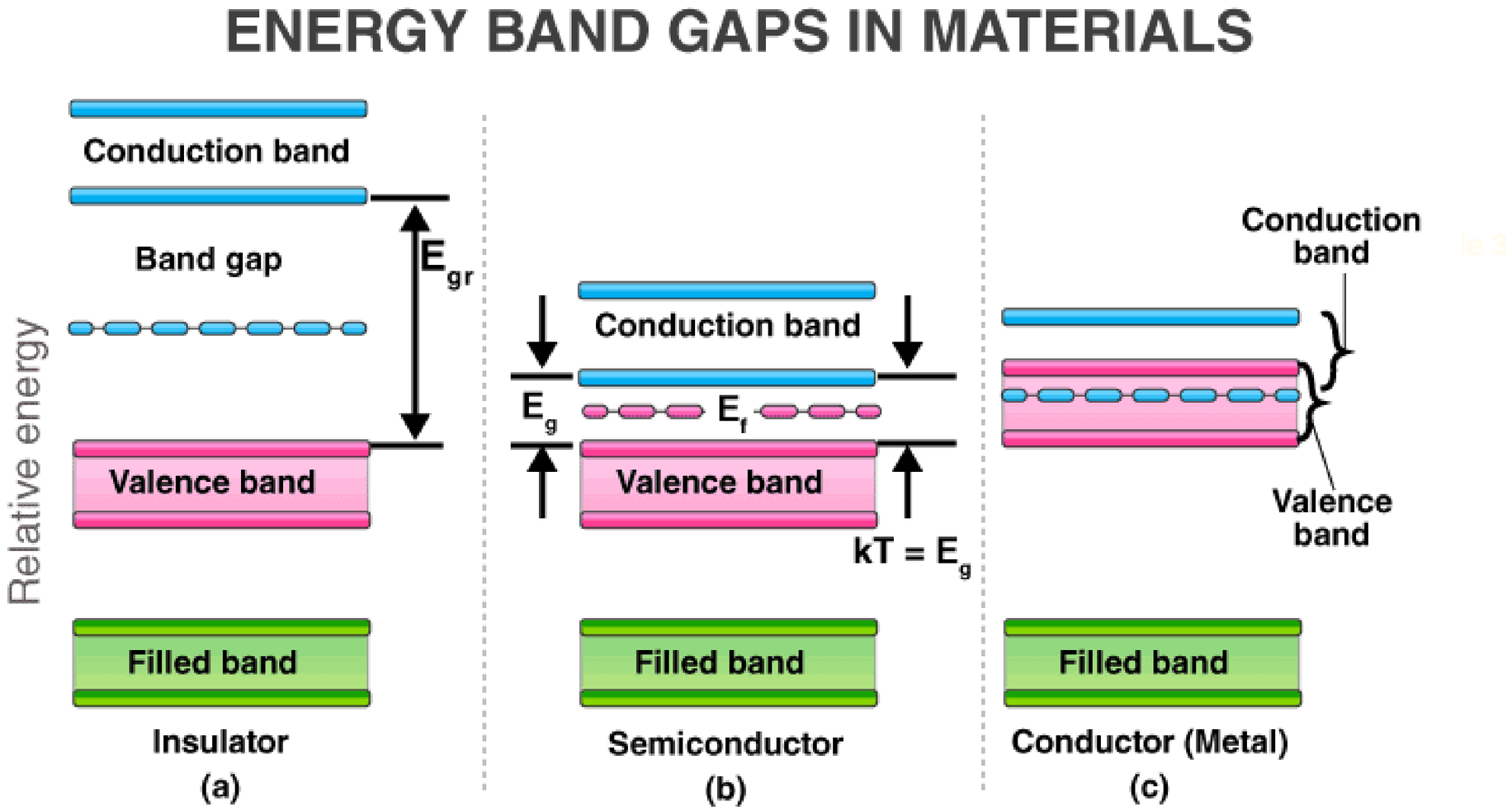
Unit I –Semiconductor Diodes

Topic : Overview of Semiconductors

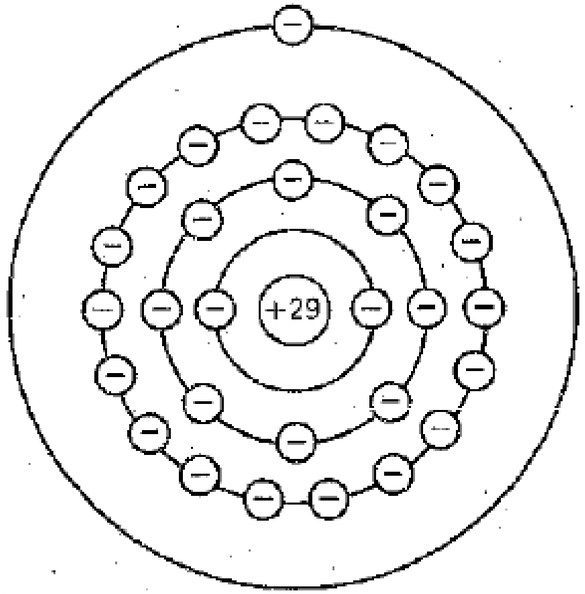
INTRODUCTION

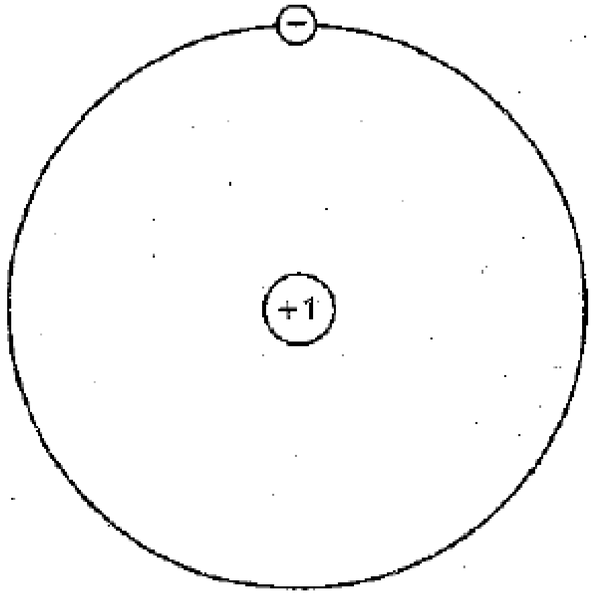
- Semiconductors are the materials which have a conductivity between conductors (generally metals) and non-conductors or insulators (such as ceramics).
- Semiconductors can be compounds such as gallium arsenide or pure elements, such as germanium or silicon.
- A semiconductor is a substance whose resistivity lies between the conductors and insulators.
  - ✓ Semiconductors have the resistivity which is less than insulators and more than conductors.
  - ✓ Semiconductors have negative temperature co-efficient. The resistance in semiconductors increases with the decrease in temperature and vice versa.
  - ✓ The conducting properties of a semiconductor change, when a suitable metallic impurity is added to it, which is a very important property.

Band Theory in Semiconductors

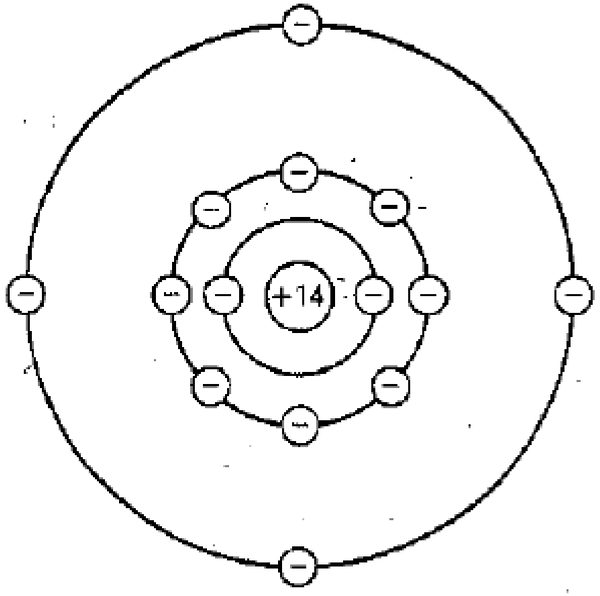


Copper

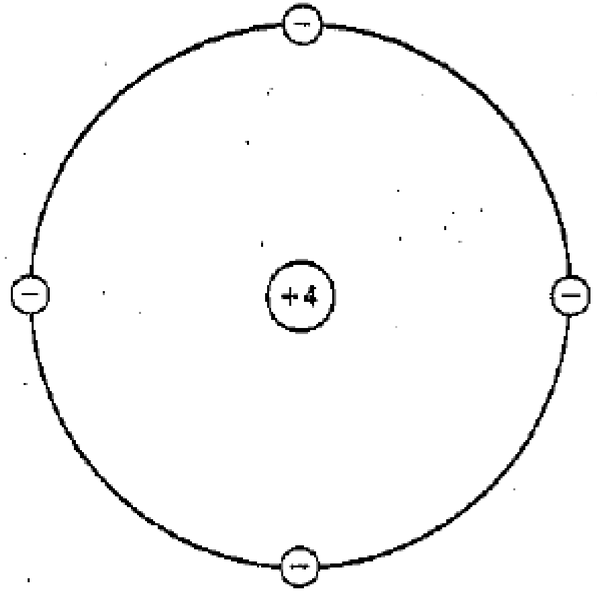




Silicon



(a)

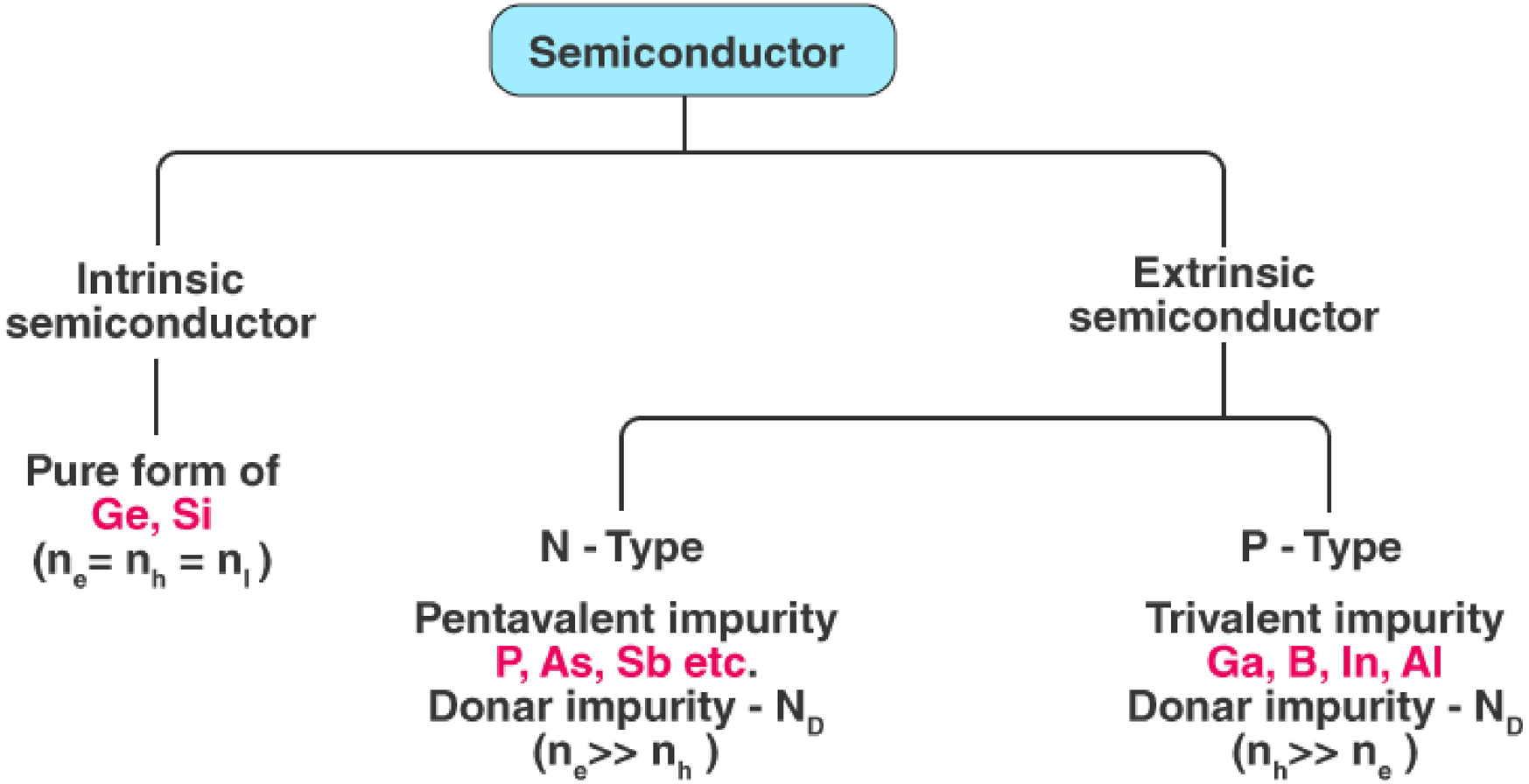


(b)

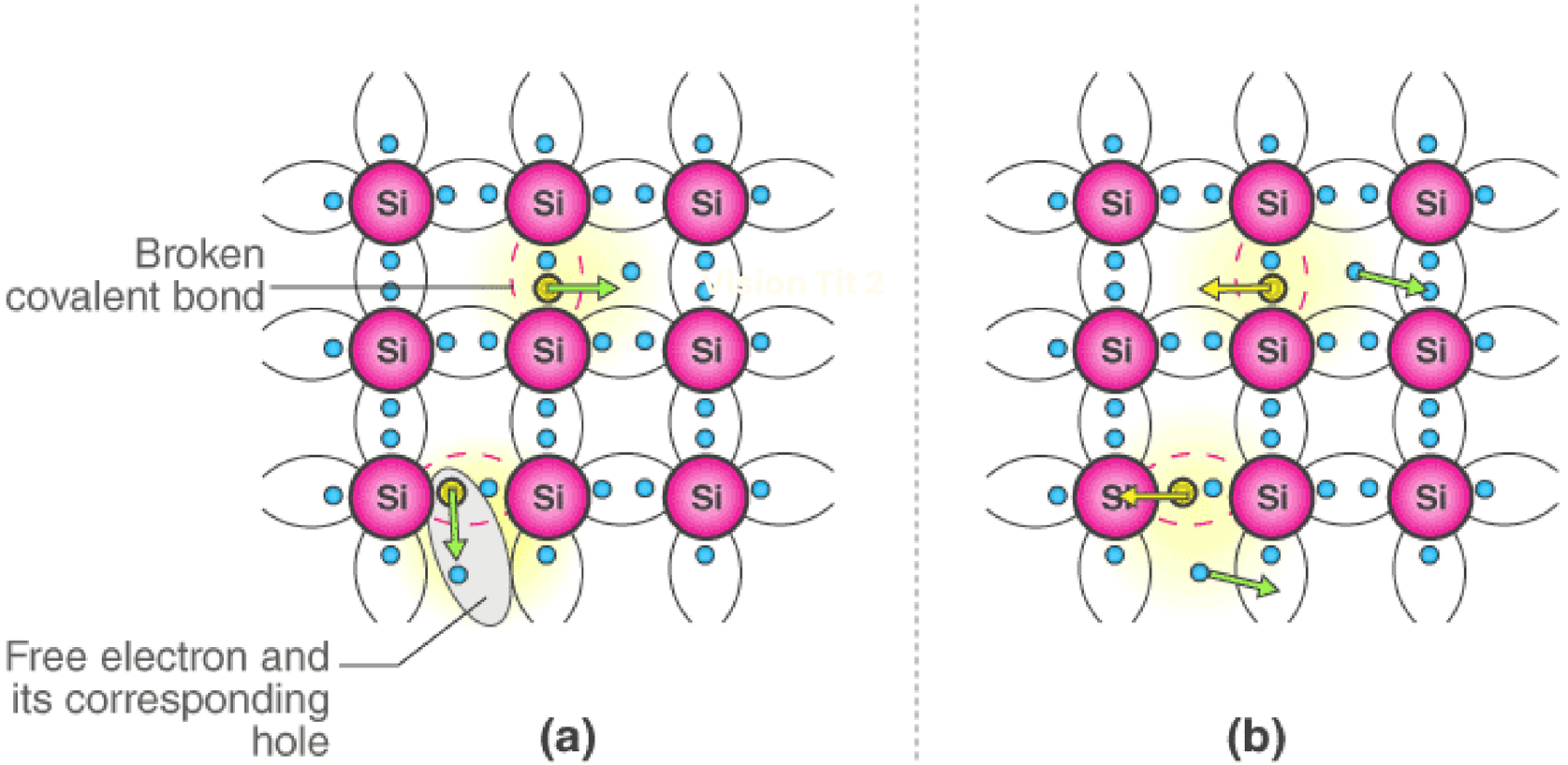
Properties of Semiconductors

- Semiconductors can conduct electricity under preferable conditions or circumstances. This unique property makes it an excellent material to conduct electricity in a controlled manner as required.
- Unlike conductors, the charge carriers in semiconductors arise only because of external energy.
  - ✓ **Resistivity**: 10^{-5} to 10^{6} Ωm
  - ✓ **Conductivity**: 10^{5} to 10^{-6} mho/m
  - ✓ **Temperature coefficient of resistance**: Negative
  - ✓ **Current Flow**: Due to electrons and holes

Types of Semiconductors



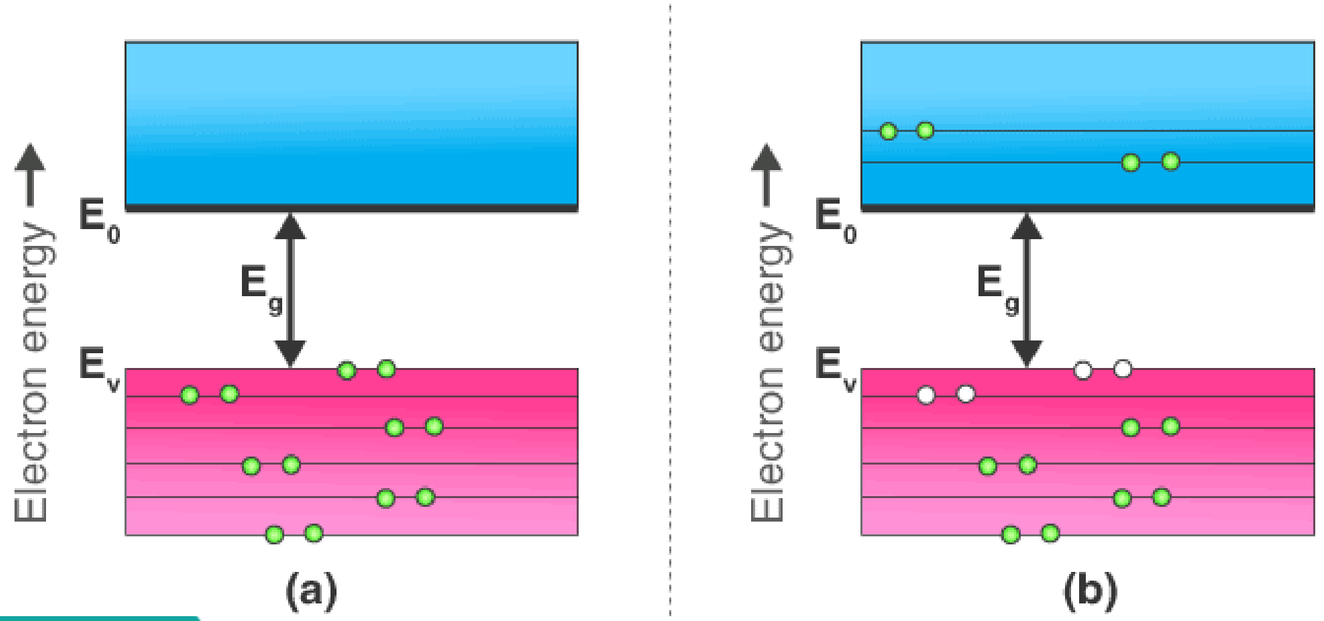
Intrinsic Semiconductor



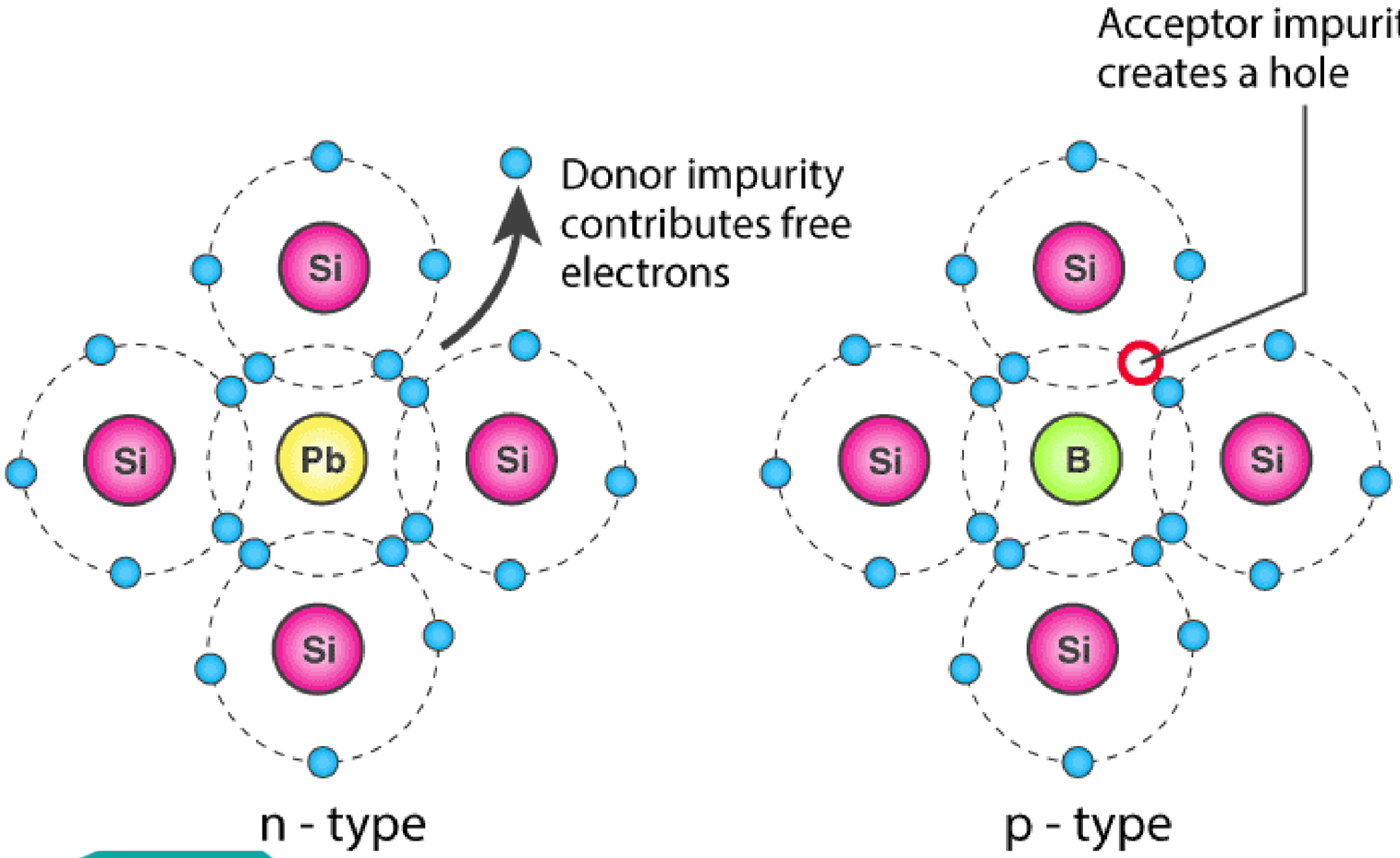
Intrinsic Semiconductor

An **intrinsic type of semiconductor material** is made to be very pure chemically.

- Germanium (Ge) and Silicon (Si) are the most common type of intrinsic semiconductor elements.
- They have four valence electrons (tetravalent). They are bound to the atom by covalent bond at absolute zero temperature.



Extrinsic Semiconductor



Difference Between Intrinsic and Extrinsic Semiconductors

Intrinsic Semiconductor	Extrinsic Semiconductor
Pure semiconductor	Impure semiconductor
Density of electrons is equal to the density of holes	Density of electrons is not equal to the density of holes
Electrical conductivity is low	Electrical conductivity is high
Dependence on temperature only	Dependence on temperature as well as on the amount of impurity
No impurities	Trivalent impurity, pentavalent impurity

N-Type Semiconductor

- ✓ Mainly due to electrons
- ✓ Entirely neutral
- ✓ Majority – Electrons and Minority – Holes

- When a pure semiconductor (Silicon or Germanium) is doped by pentavalent impurity (P, As, Sb, Bi) then, four electrons out of five valence electrons bonds with the four electrons of Ge or Si.
- Thus, the impurity atom donates a free electron for conduction in the lattice and is called “Donar“.
- As conduction is due to a large number of free electrons, the electrons in the n-type semiconductor are the MAJORITY CARRIERS and holes are the MINORITY CARRIERS.

P-Type Semiconductor

- ✓ Mainly due to holes
- ✓ Entirely neutral
- ✓ Majority – Holes and Minority – Electrons

- When a pure semiconductor is doped with a trivalent impurity (B, Al, In, Ga) then, the three valence electrons of the impurity bonds with three of the four valence electrons of the semiconductor.
- These impurity atoms which are ready to accept bonded electrons are called “Acceptors“.
- As conduction is due to a large number of free holes, the holes in the p-type semiconductor are the MAJORITY CARRIERS and electrons are the MINORITY CARRIERS.

Uses of Semiconductors in Everyday life

- Temperature sensors are made with semiconductor devices.
- They are used in 3D printing machines
- Used in microchips and self-driving cars
- Used in calculators, solar plates, computers and other electronic devices.
- Transistor and MOSFET used as a switch in Electrical Circuits are manufactured using the semiconductors.