Doping

- A manufacturing process that adds free charge carriers (free electron or hole) into a pure semiconductor material to increase its conductivity .

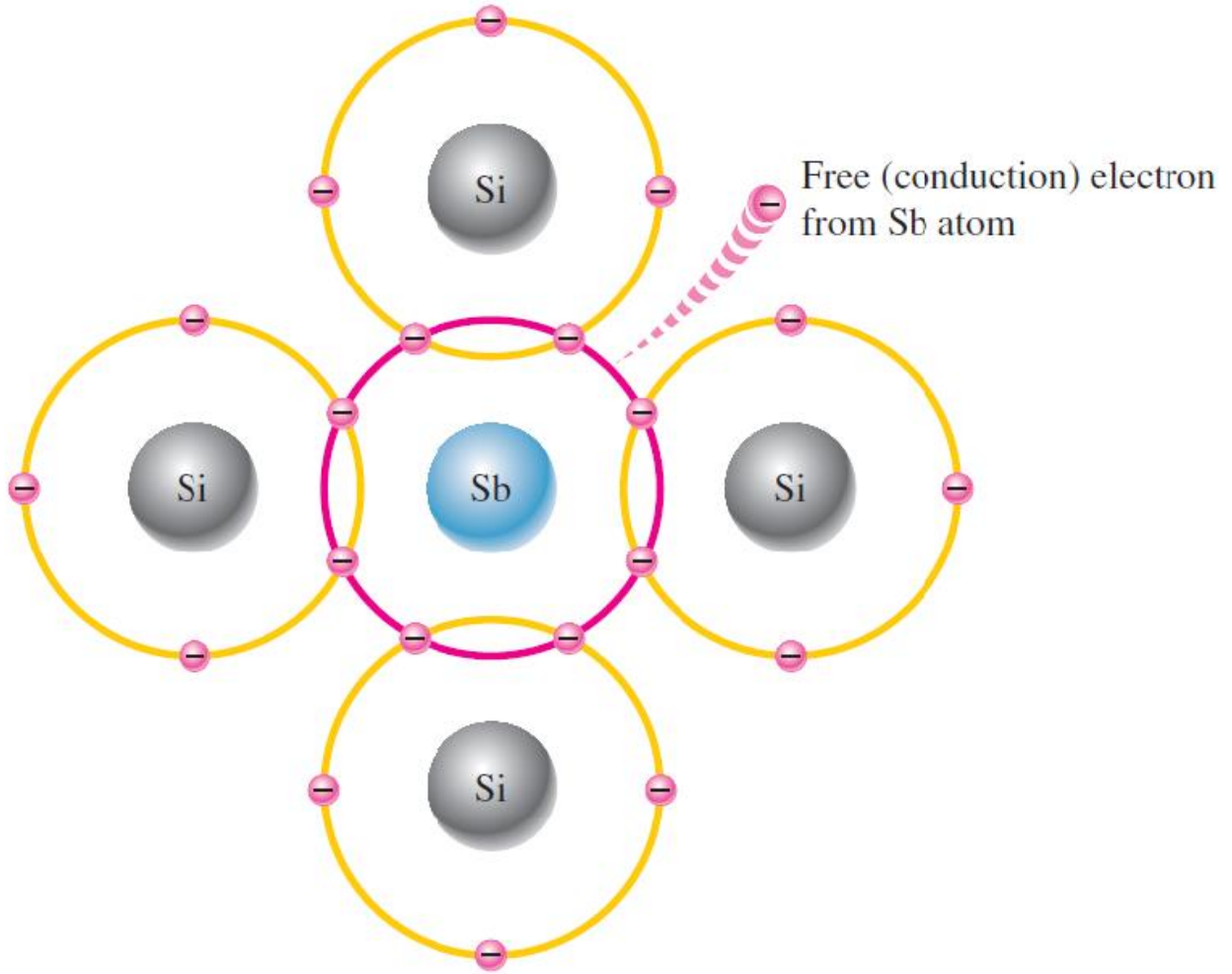
- Doping → n-type or p-type material

N - type semiconductor

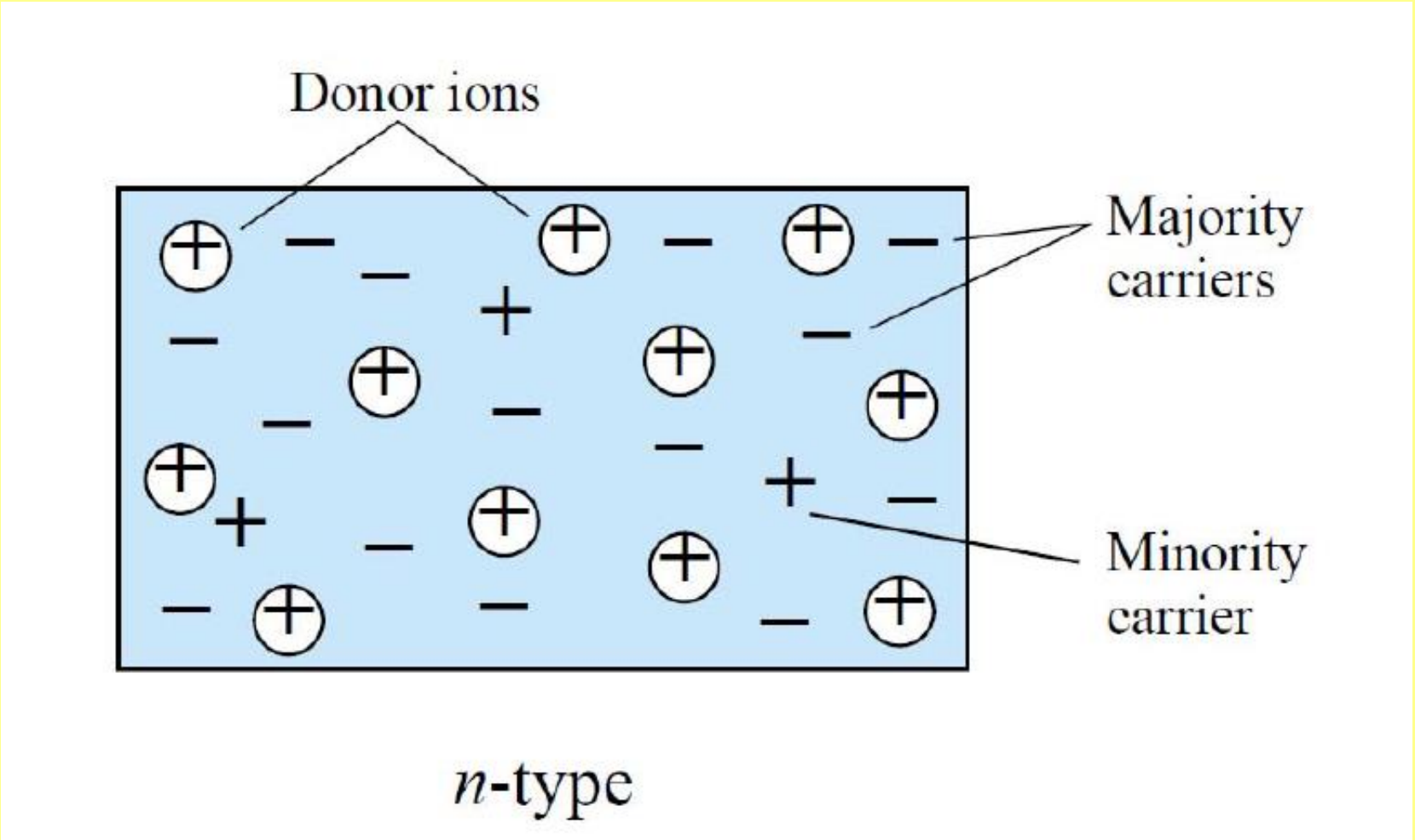
Sb (antimony) has five valence electrons and it is called a donor atom.

We add (10^{15} -10^{17}) Sb atoms/ cm3

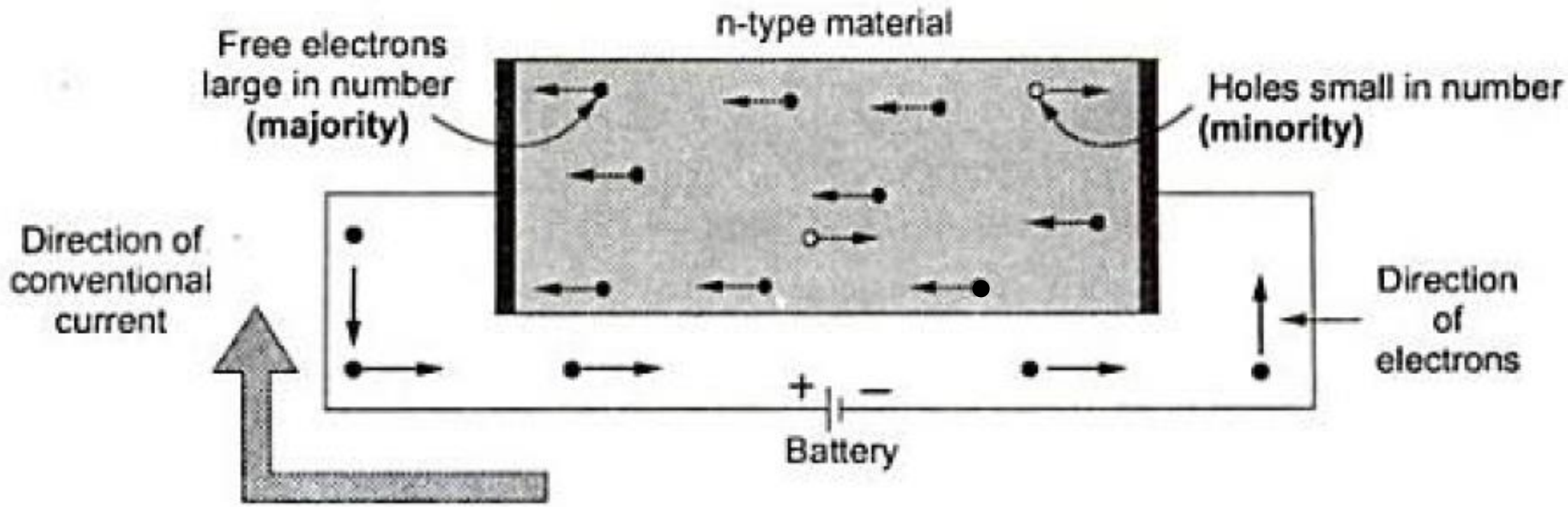
At room temperature there is $5x10^{22}$ atoms/ cm3 in pure Si .



In the n-type material the free electrons are the majority and the holes are the minority.



Conduction in n-type material



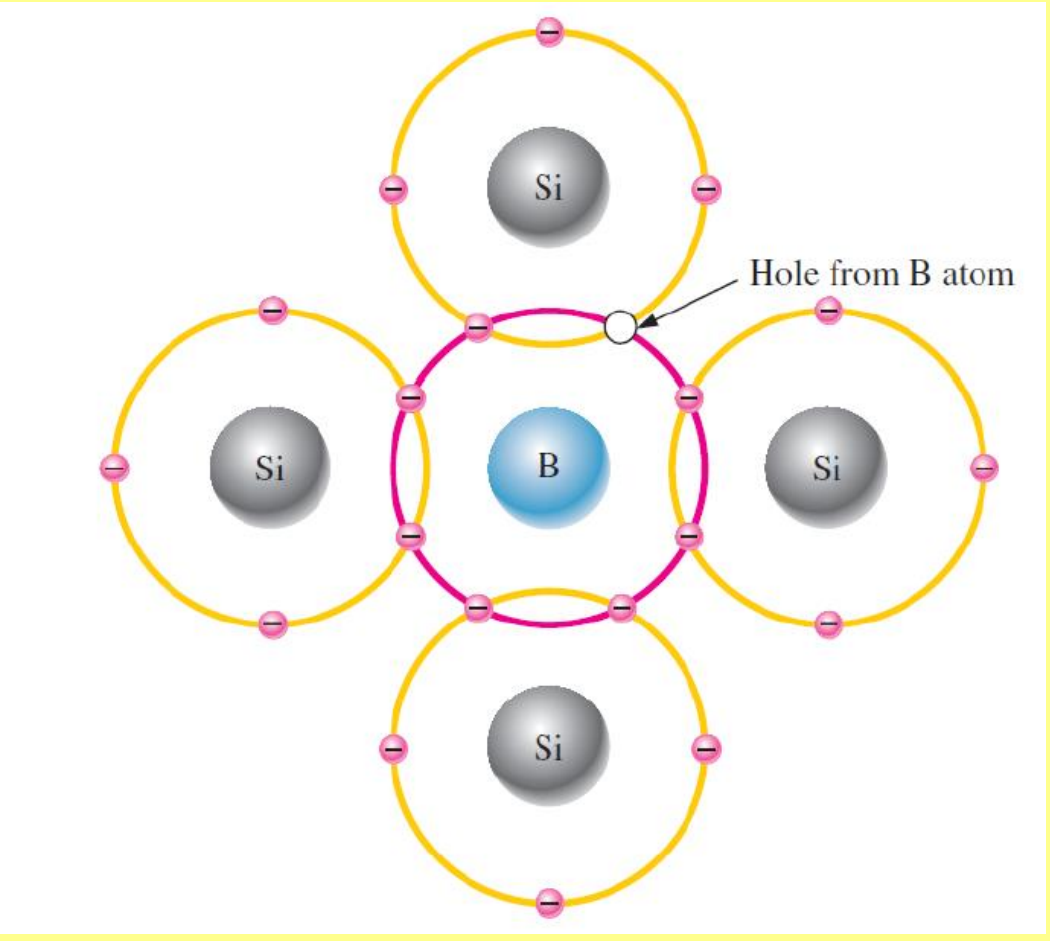
Conduction in n-type material

P - type semiconductor

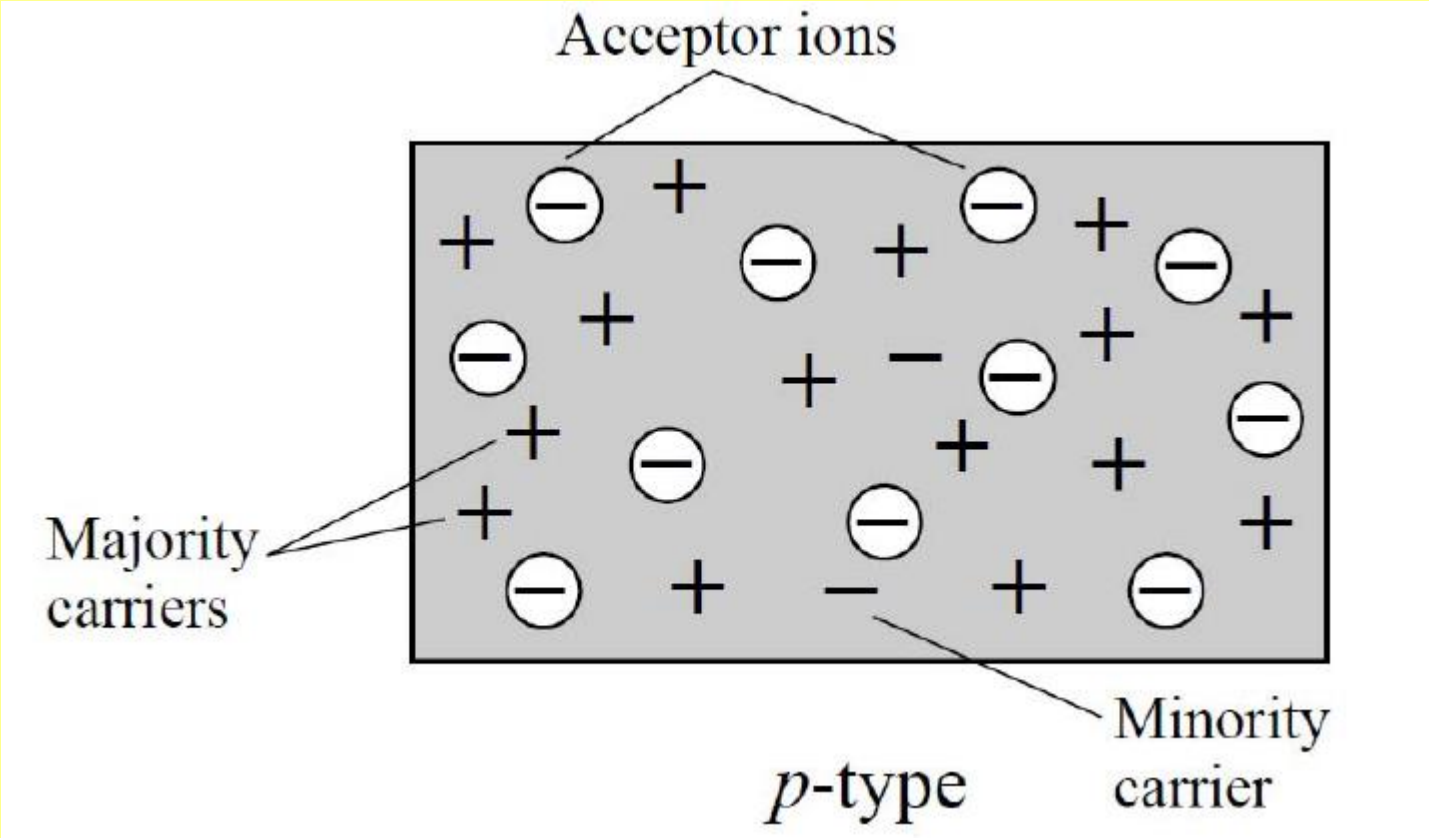
B (Boron) has three valence electrons (acceptor atom)

We add (10^{15} -10^{17}) B atoms/cm3

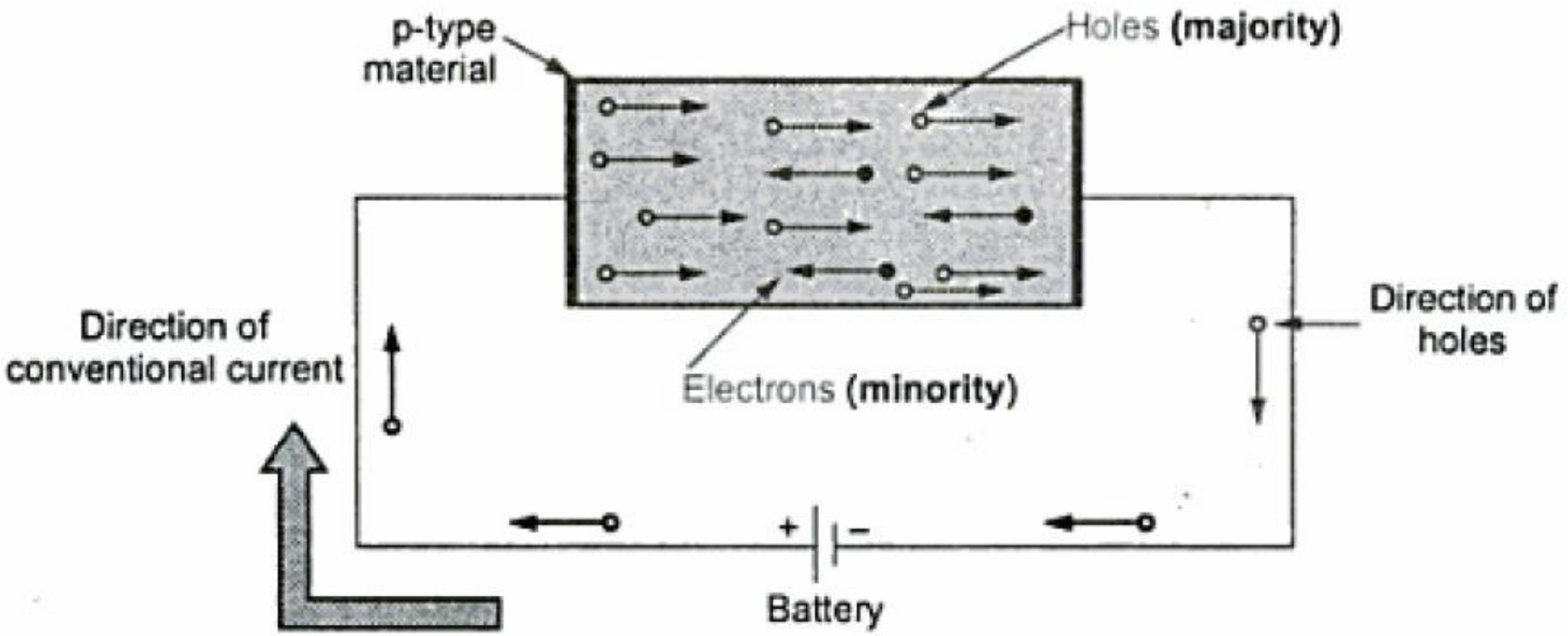
At room temperature there is $5x10^{22}$ atoms/cm3 in pure Si .



In the p-type material the holes are the majority and the free electrons are the minority .



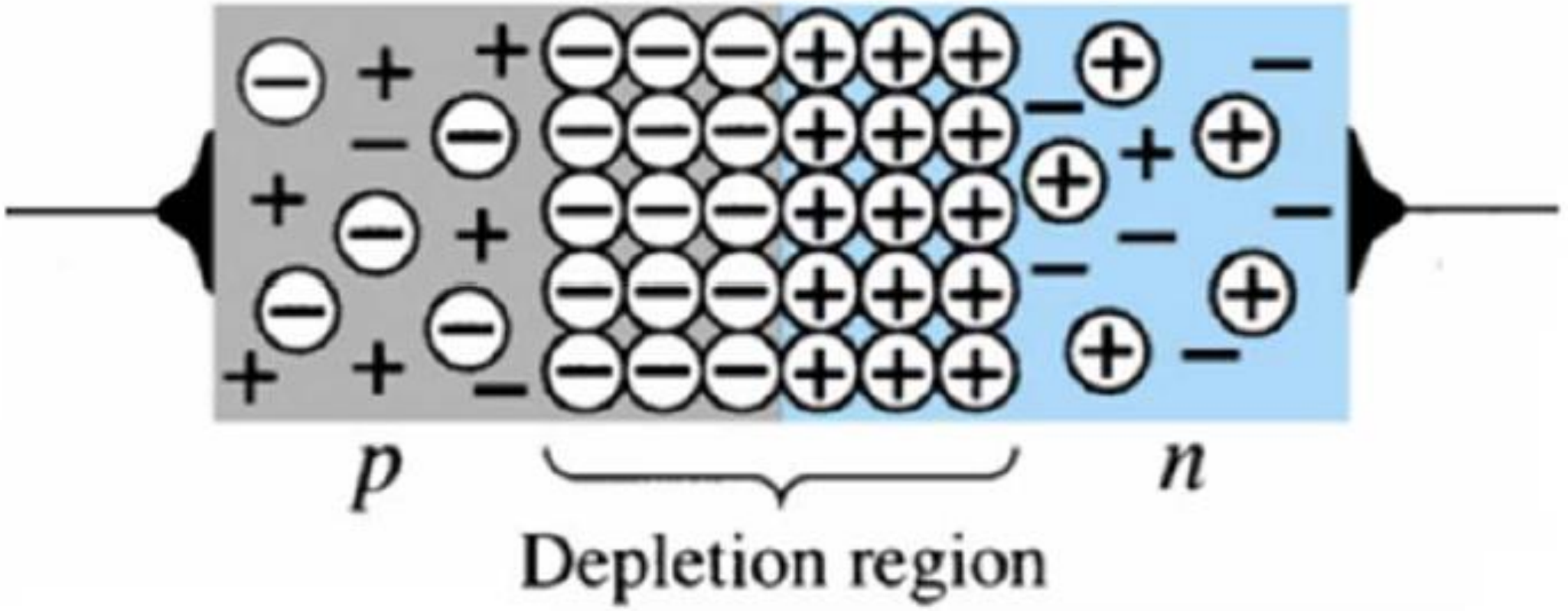
Conduction in p-type material



Conduction in p-type material

Pn junction

- The p-n junction is the basis for diodes, certain transistors ,and other devices.



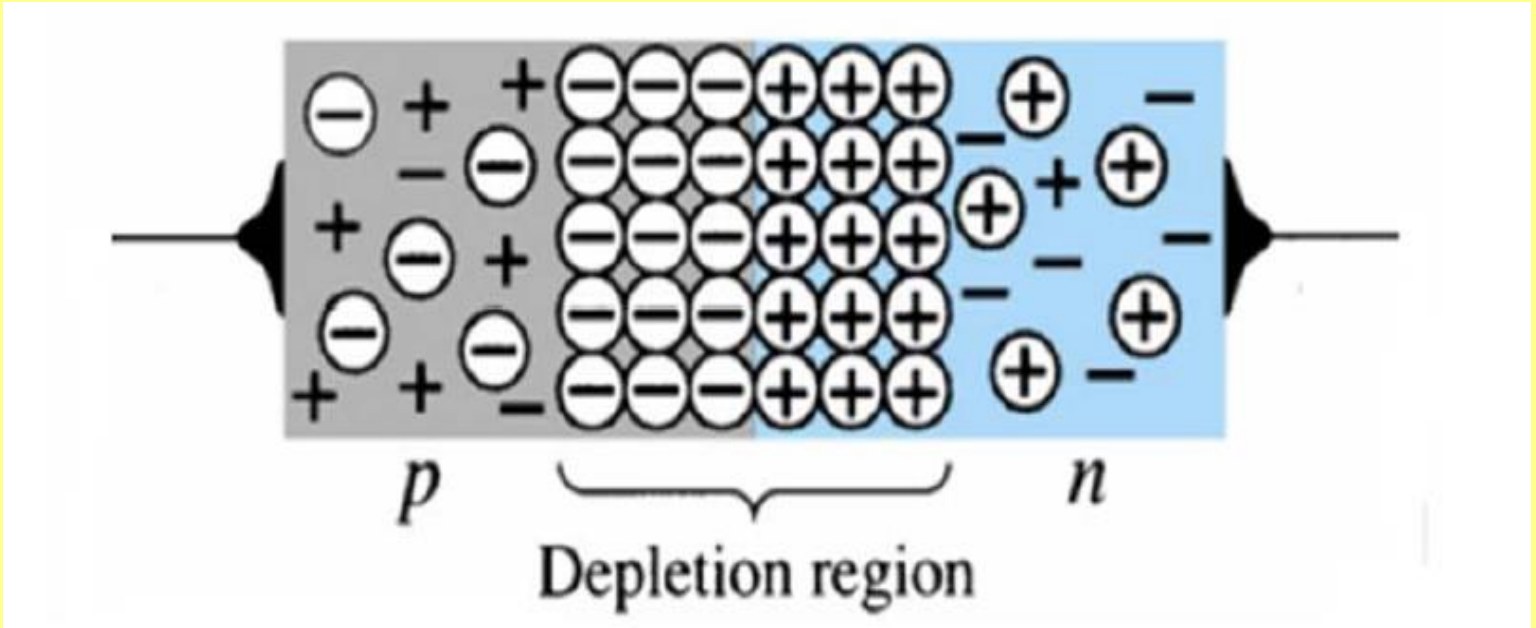
1) Electrons from the n-type material near the junction diffuse a cross the junction.

2) These electrons fill the holes in the p-type material adjacent to the junction.

3) As a result of electrons leaving the n-type material , donor ions are created on the n side of the junction .

4) When these electrons fill holes in the p side of the junction ,accepter ions are produced.

5) A wall of stationary positive ions is aligned with a wall of negative ions along the n and p sides of the junction .

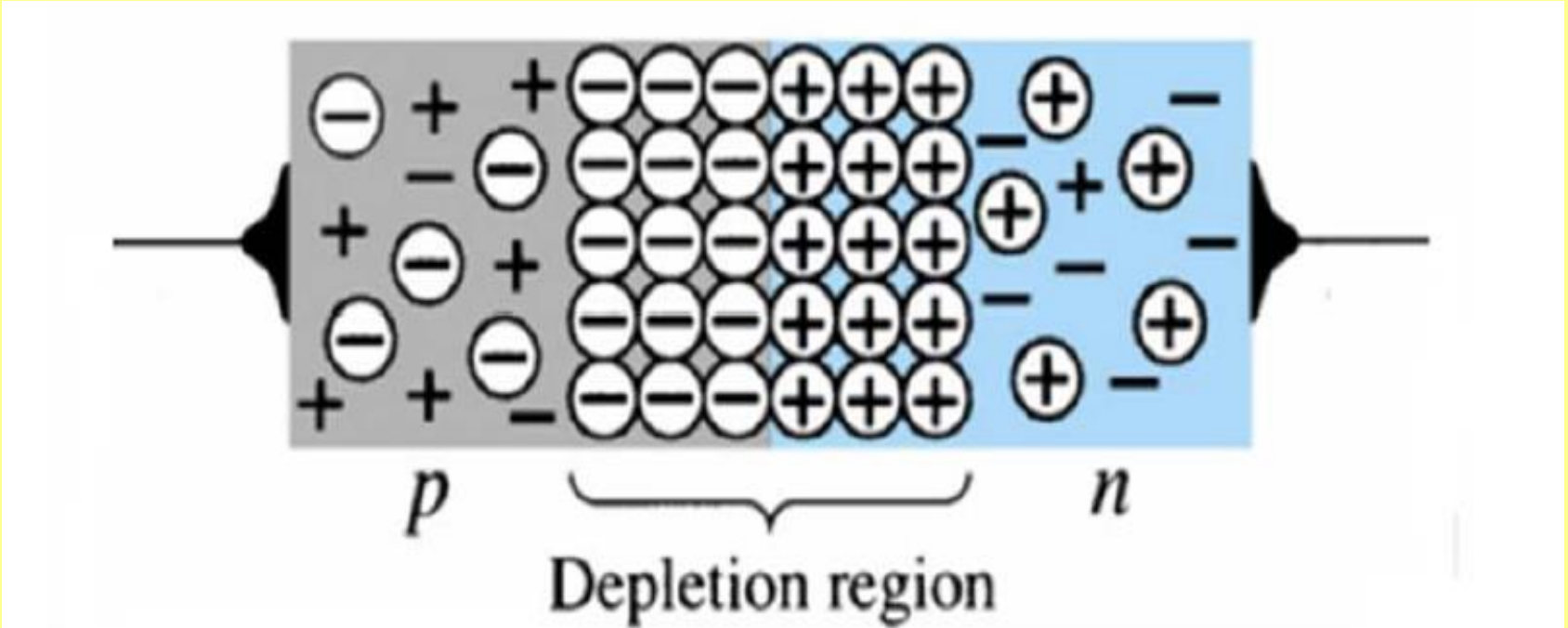


6) The space occupied between the ion walls is called depletion region.

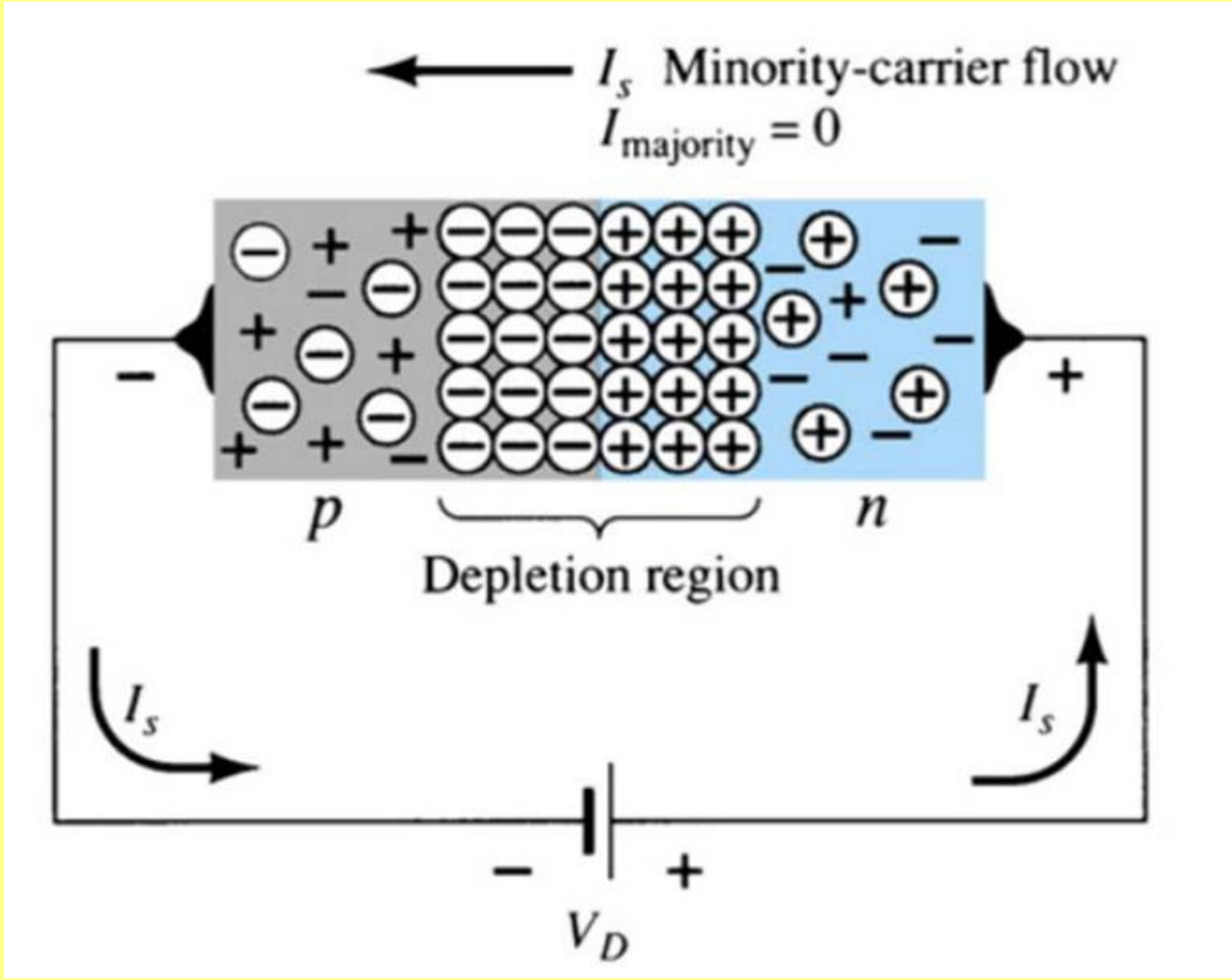
7)Whenever there exists a positive charge with respect to a negative charge , a voltage difference is set between charges ;(Junction potential, Junction barrier).

8) The junction potential acts as potential barrier that tend to prevent majority carriers from crossing the junction.

9) Minority carriers are aided by the junction potential .



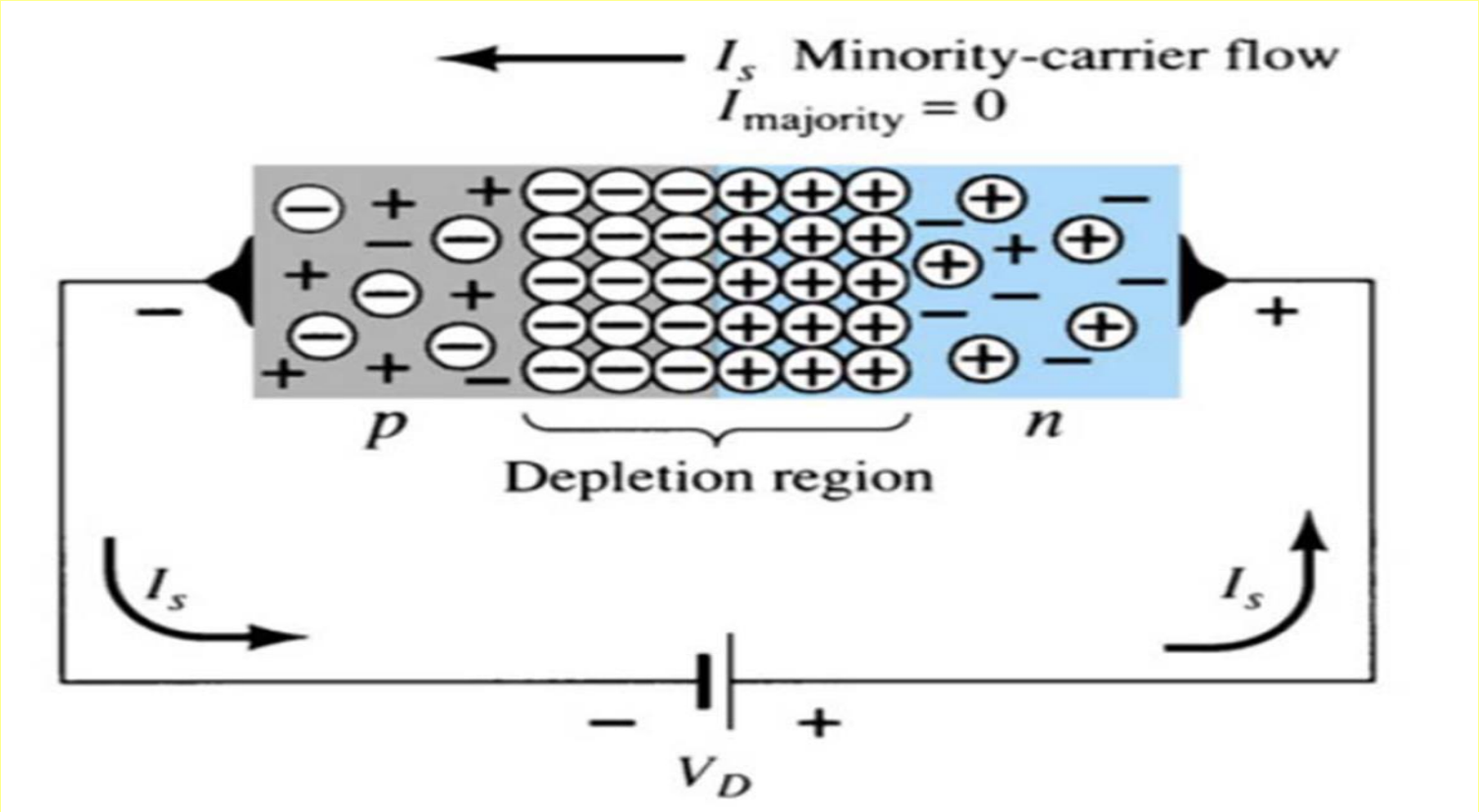
Reverse bias of a pn junction



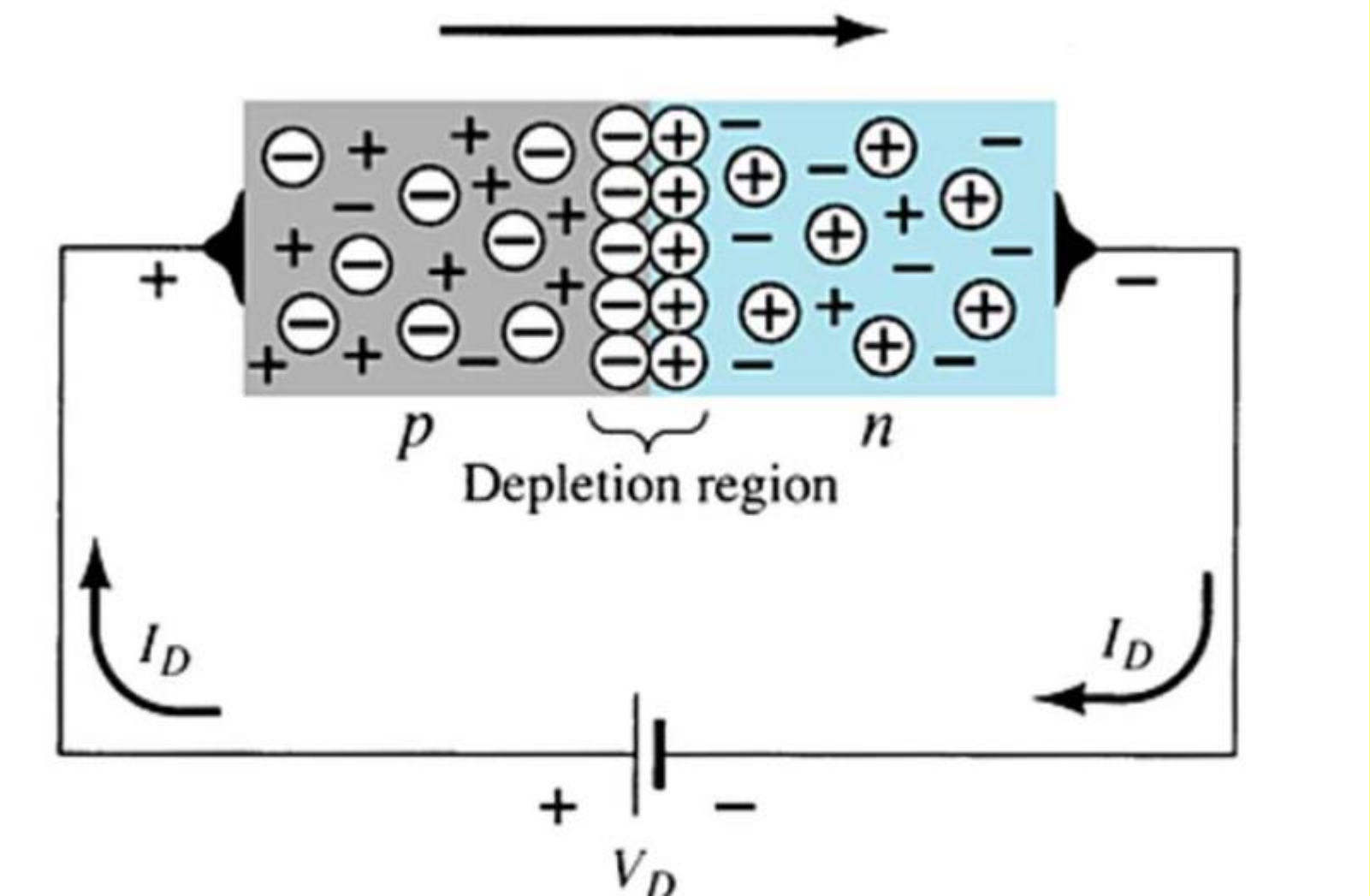
- The reverse voltage causes the depletion region to widen .

- The electrons in the n-type material are attracted toward the positive terminal of the voltage source .

- The holes in the p-type material are attracted toward the negative terminal of the voltage source .



Forward bias of a pn junction



- The forward voltage causes the depletion region to narrow
- The electrons and holes are pushed toward the p-n junction
- The electrons and holes have sufficient energy to cross the p-n junction