P-N Junction

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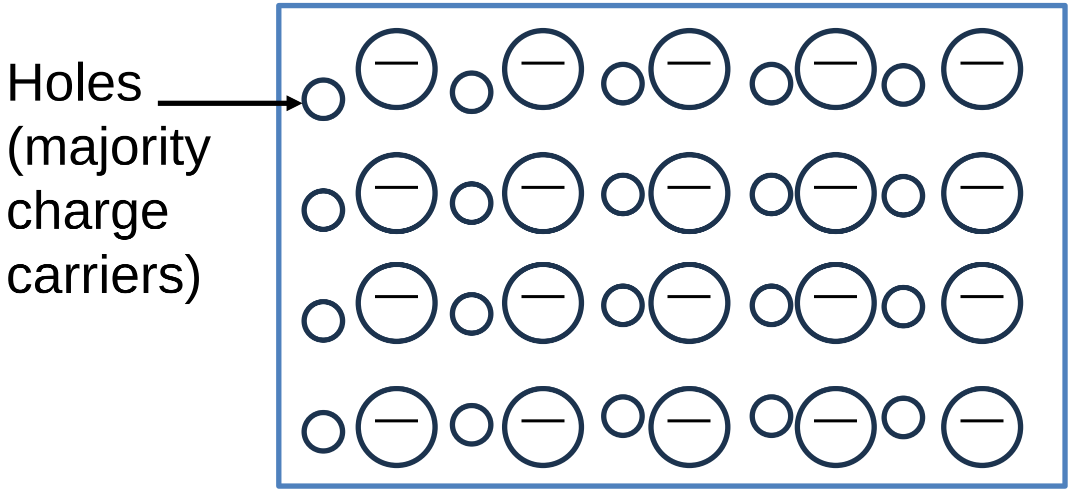
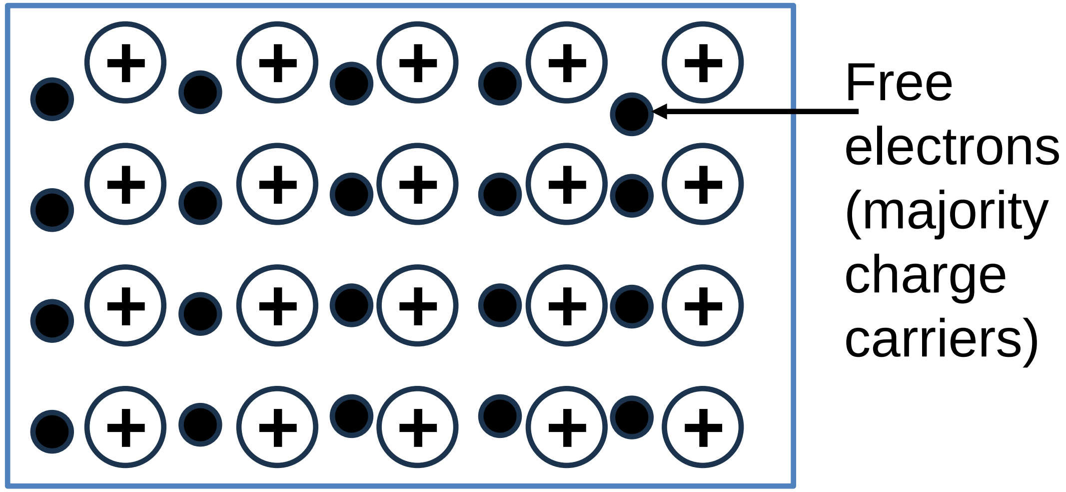
P-TYPE AND N-TYPE MATERIALS:



P-type material



N-type material

In P-type semiconductor holes are the majority charge carriers.

Addition of an electron in a hole makes an atom a negatively charged immobile ion.

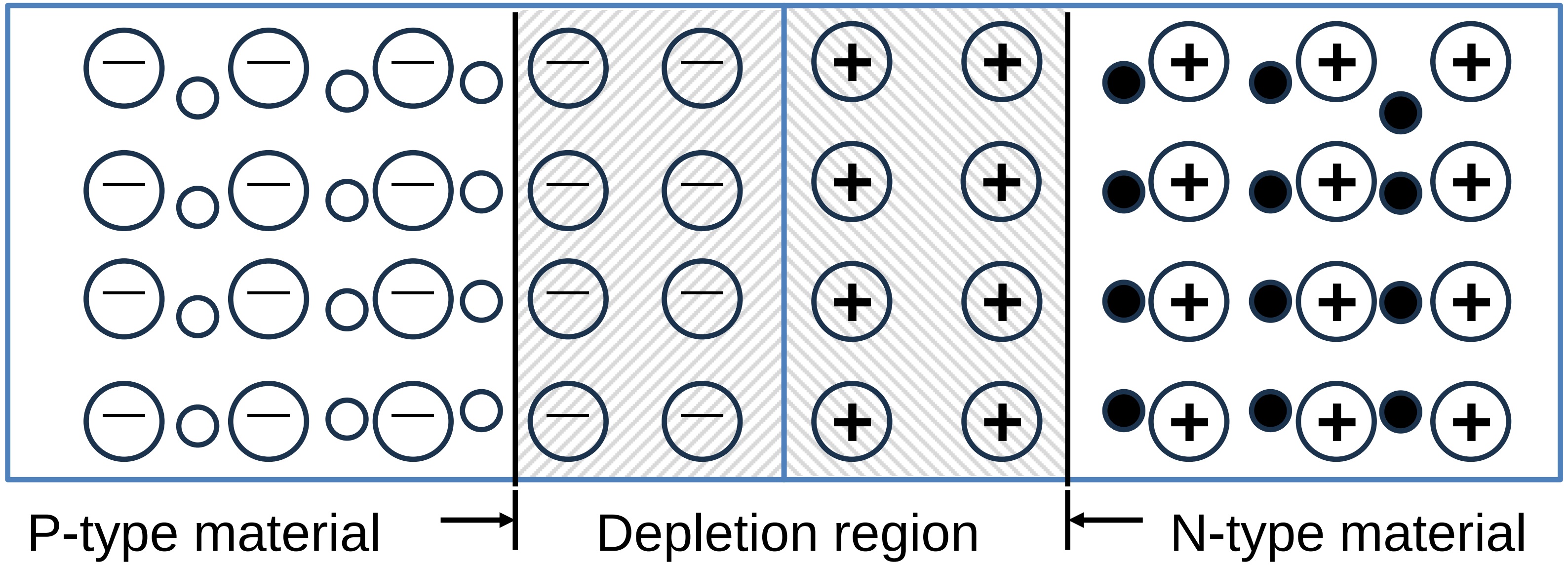
Thus, a P-type semiconductor will have negative ions and holes as majority carrier.

In N-type semiconductors electrons are the majority charge carriers.

When an electron moves out of an atom, the atom becomes a positively charged immobile ion.

Thus, a N-type semiconductor will have positive ions and holes as majority carrier.

PN JUNCTION:



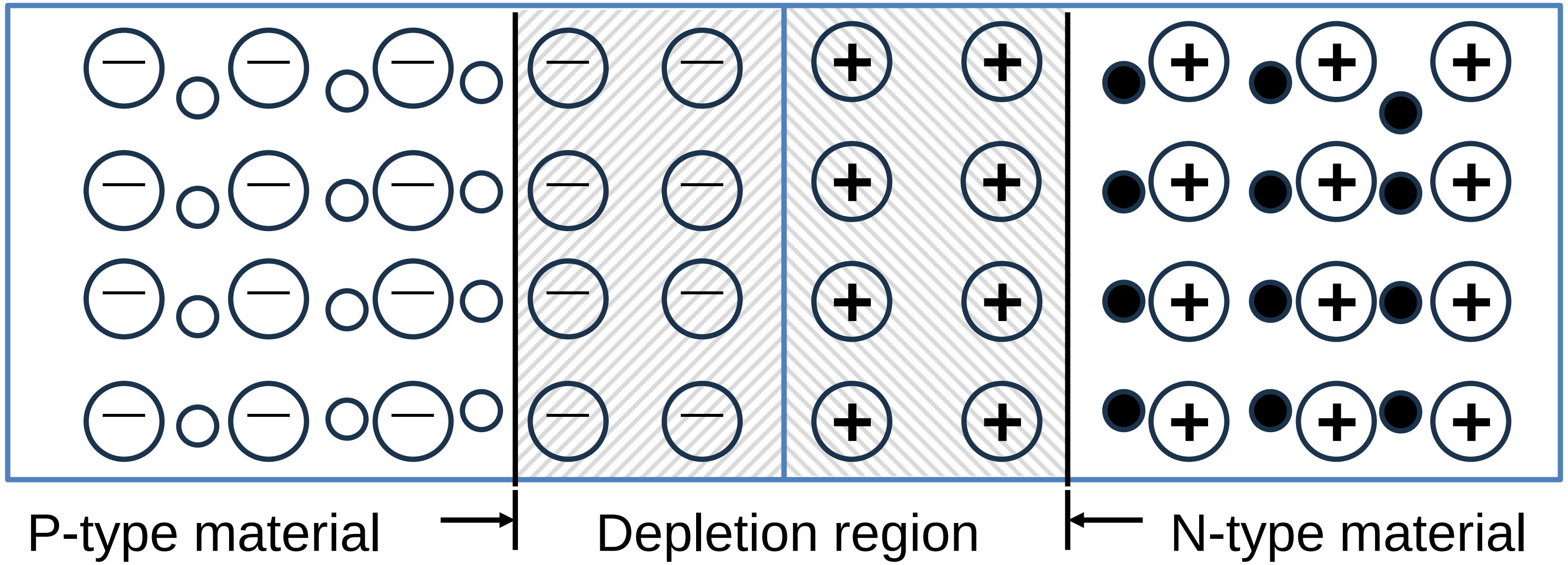
When a P-type semiconductor is joined with an N-type semiconductor, through a special technique, a junction called PN junction is formed.

At the PN junction, free electrons from the N-type material will to diffuse into the P-side and combine with a hole nearest to the junction.

The free electron crossing over from the N-side to the P-side will leave behind positive immobile ions on the N-side of the junction.

The electrons crossing over the junction will occupy the holes in the P-type material making the atoms negatively charged immobile ions.

PN JUNCTION:



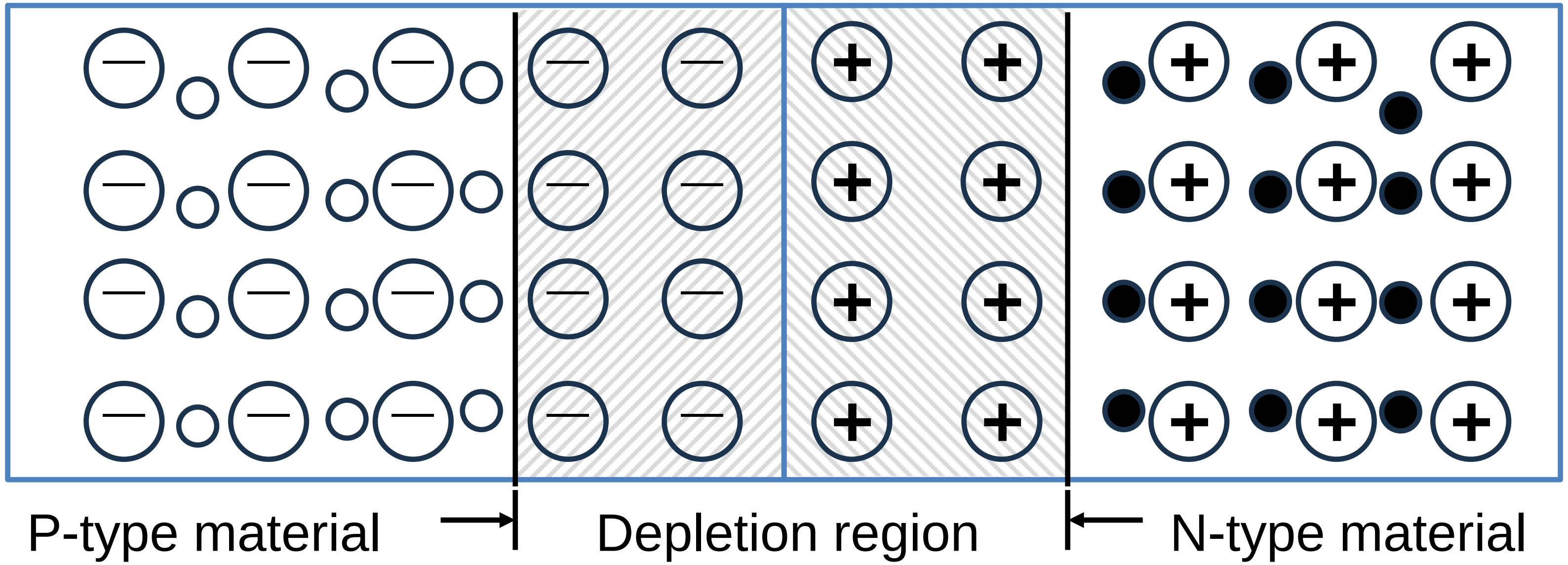
When a PN junction is formed there is an initial diffusion of electrons and holes.

Thus, on one side of the junction there is an accumulation of negative ions and on the other side there is accumulation of positive ions.

The shaded portion on both sides of the PN junction is having only immobile ions of opposite polarities is called the depletion region which creates a potential difference, i.e., barrier voltage.

Barrier voltage at the junction stops any further diffusion of charge carriers.

PN JUNCTION:



The barrier voltage depends upon the amount of doping, charge carriers, and the junction temperature.

For germanium the barrier voltage is 0.3 V and for silicon the barrier voltage is 0.7 V at room temperature (25°C).

Note: The thickness of the depletion region has been shown expanded. In actual PN junction, this layer is very thin, of the order of micrometer.

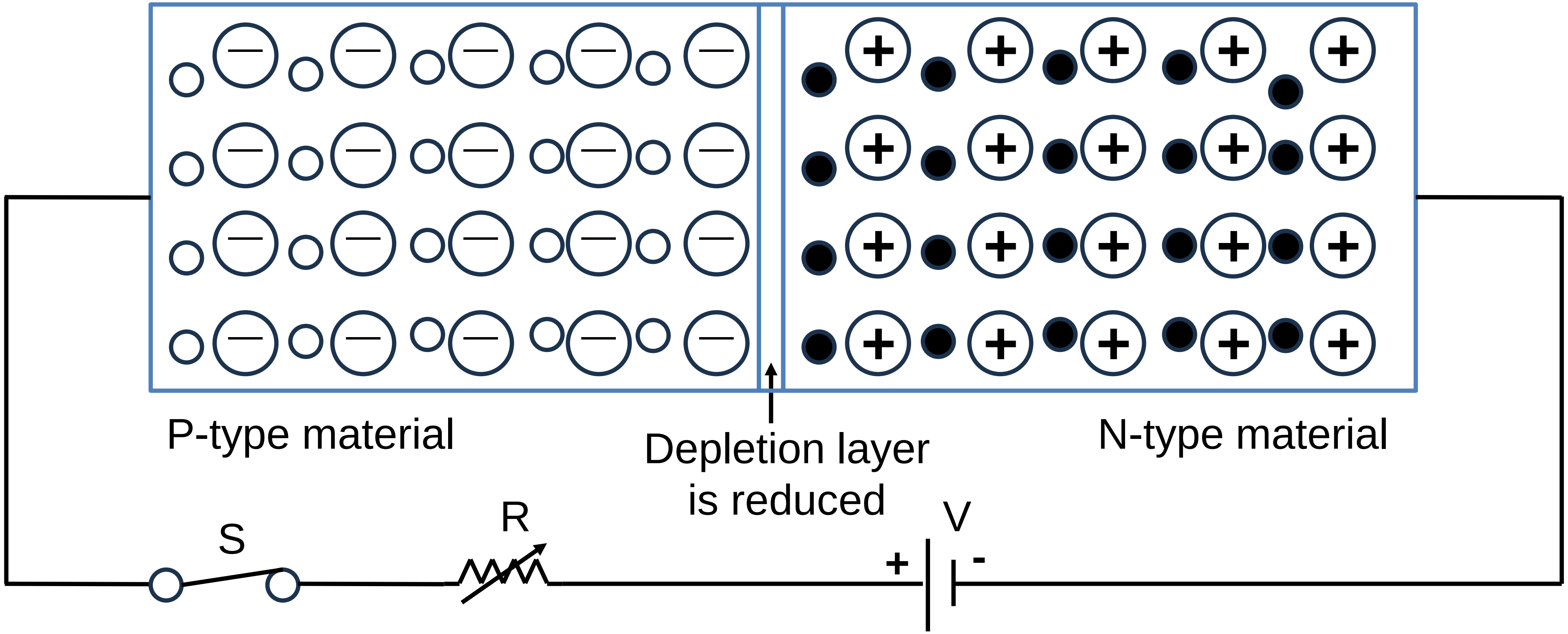
BIASING OF PN JUNCTION:

Biasing of a PN junction means application of some external voltage across the two sides of the PN junction.

When the P-side is connected to the positive terminal of a battery and the N-side is connected to the negative terminal, the PN junction is said to be a forward-biased junction.

If the positive terminal of the battery is connected to the N-side and the negative terminal on the P-side, the PN junction is said to be a reverse-biased junction.

FORWARD BIASED PN JUNCTION:

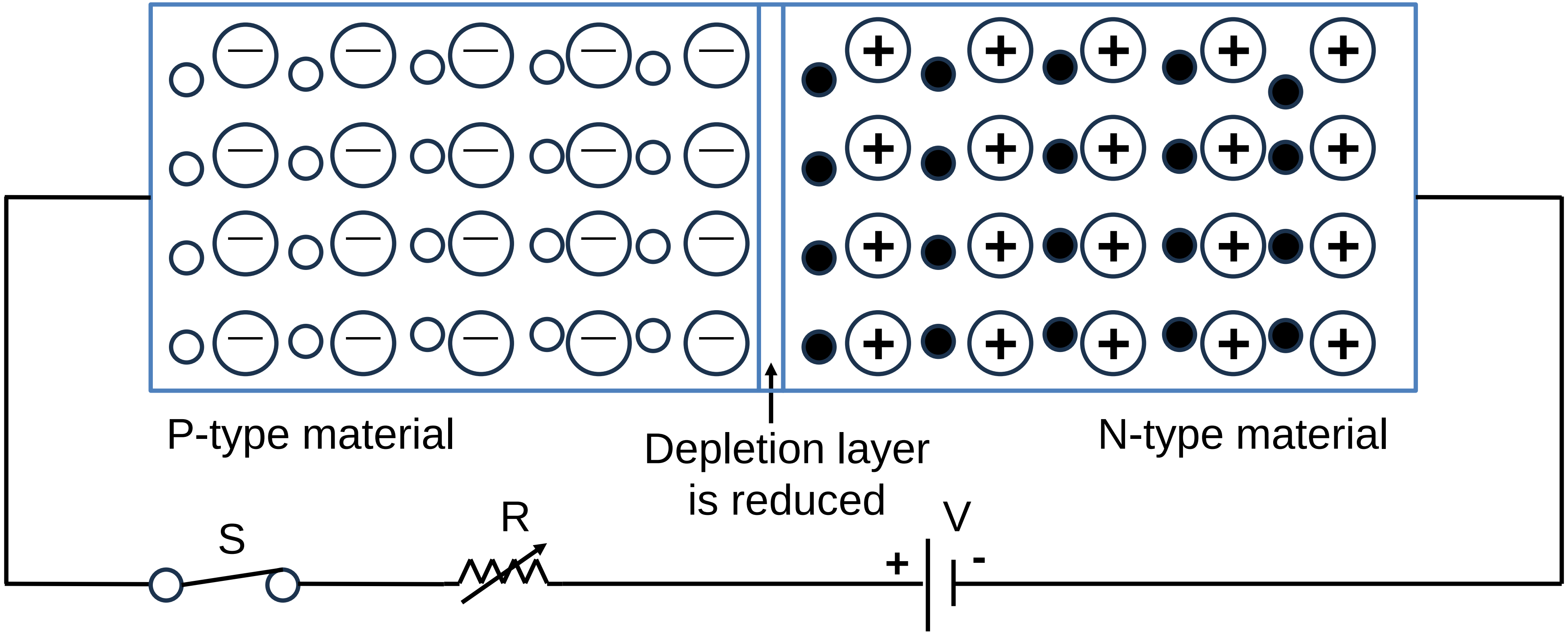


When the PN junction is forward biased, the positive terminal of the battery will repel the holes on the P-side and the electrons on the N-side will be repelled by the negative terminal of the battery.

Therefore, the width of the depletion layer and the potential barrier will reduce.

If the applied voltage is gradually increased, the depletion layer and barrier potential will disappear.

FORWARD BIASED PN JUNCTION:

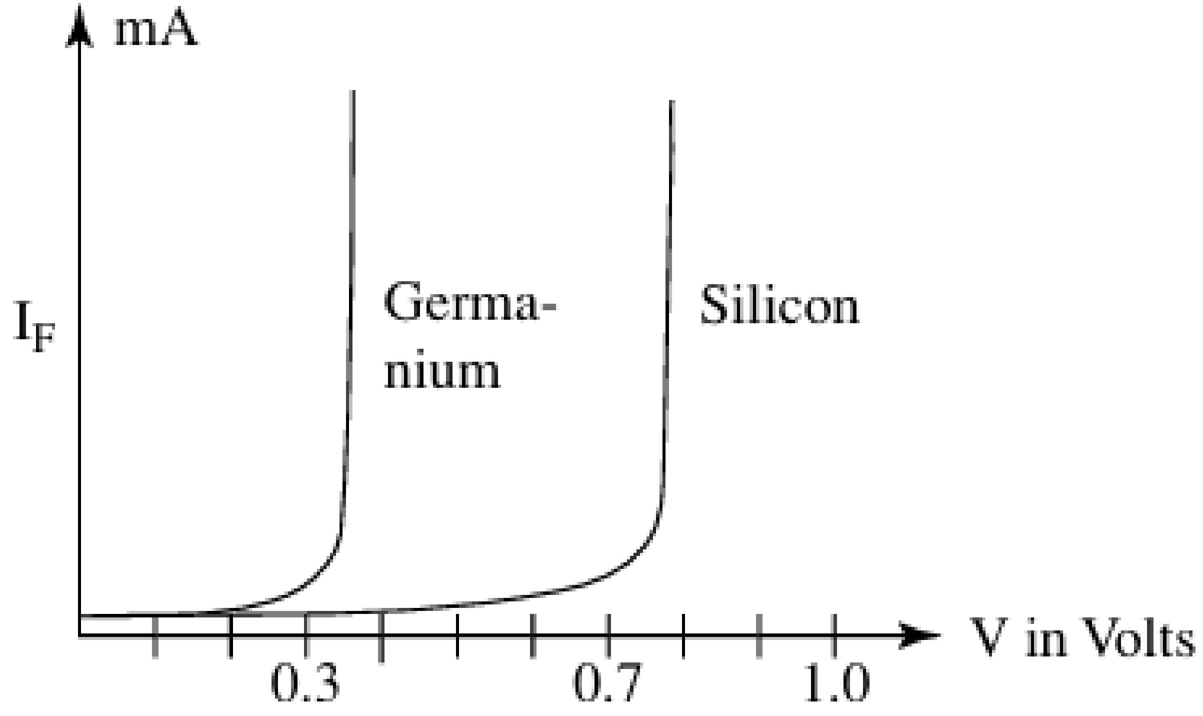


When the potential barrier is overcome, the depletion layer disappears.

Electrons from the N-side are attracted by the positive terminal of the battery and the holes from the P-side get attracted by the negative terminal of the battery.

Thus, in forward-biased PN junction, the potential barrier is neutralized and the forward current I_F flows across the PN junction.

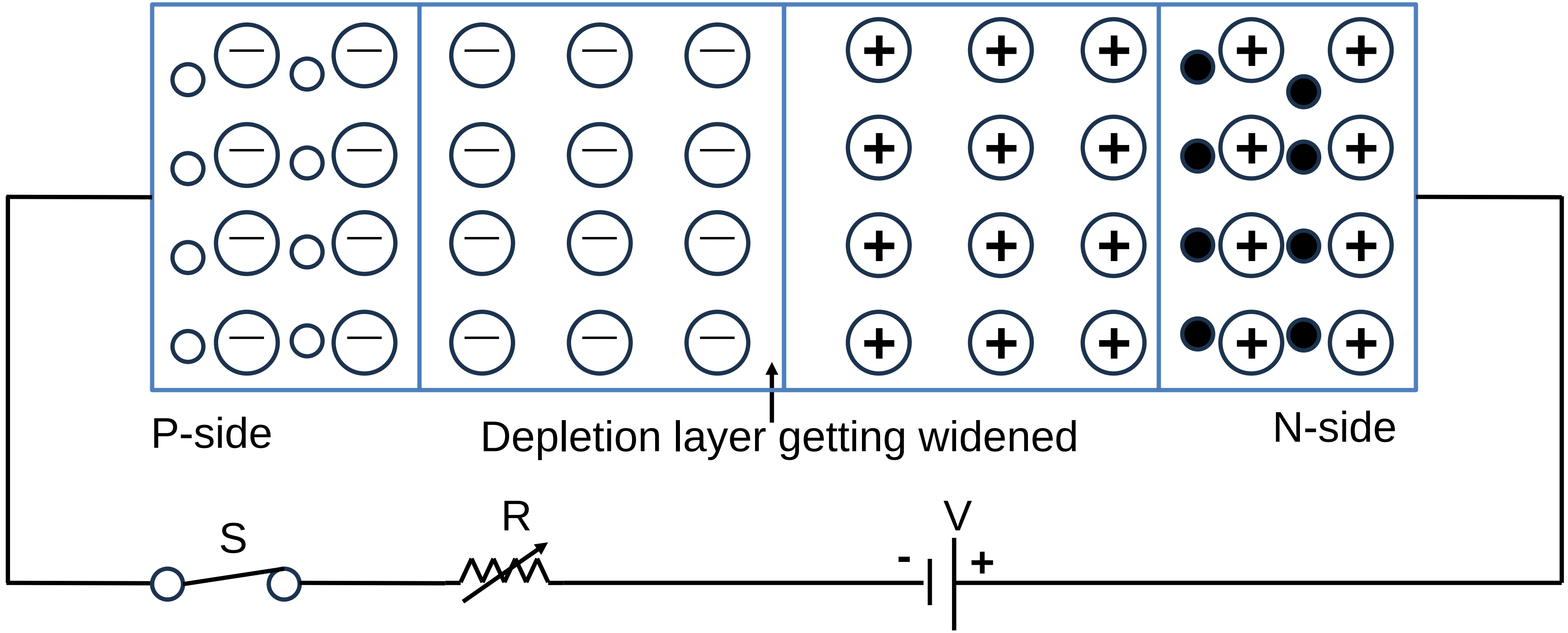
FORWARD CHARACTERISTICS FOR GERMANIUM AND SILICON:



The barrier potential for germanium is 0.3 V and it is 0.7 V for silicon.

With increase of forward voltage beyond 0.3 V or 0.7 V for germanium and silicon, respectively, the forward current I_F increases as shown by the above characteristics.

REVERSE BIASED PN JUNCTION:

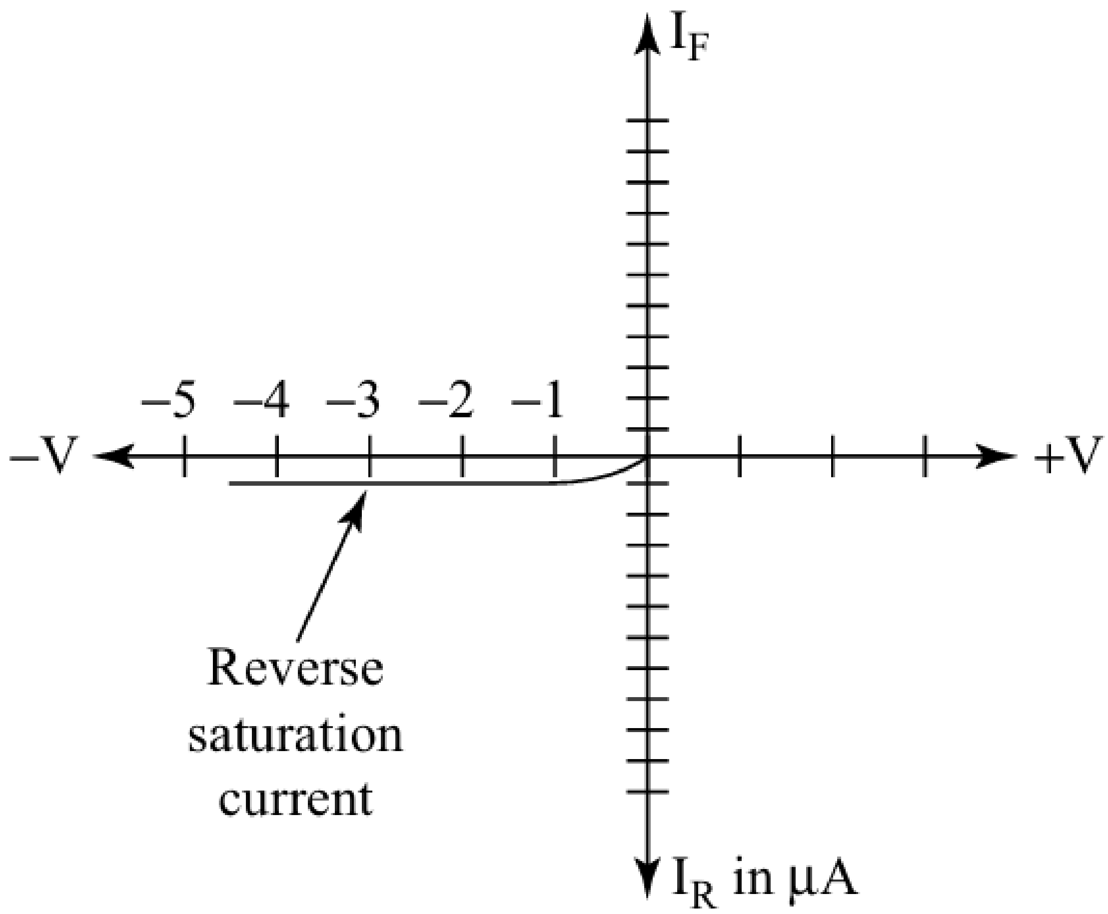


In reverse biasing, the negative terminal of the battery is connected to the P-side and the positive terminal is connected to the N-side of the PN junction.

The holes of the P-side are attracted by the negative terminal and the electrons of the N-side are attracted by the positive terminal of the battery.

Thus, the depletion layer gets widened and the barrier potential increases as the applied voltage is gradually increased.

REVERSE BIASED PN JUNCTION:



A reverse-biased, p–n junction offers very high resistance to current flow.

However, a very small amount of reverse current flows through the junction due to the minority charge carriers.

This current is called as reverse saturation current.

SUMMARY:

1) PN junction is forward biased if its P-side is connected to the positive terminal of the supply and N-side is connected to the negative terminal of the supply.
2) The depletion layer gets narrowed down on application of forward voltage.
3) The majority charge carriers current is established in a forward-biased PN junction.
4) Barrier potential for germanium is 0.3 V and for silicon is 0.7 V at room temperature. These are the voltage drops across the PN junction when forward current flows.
5) When P-side is connected to the negative terminal and N-side is connected to the positive terminal of the supply, the PN junction is said to be reverse biased.
6) The width of the depletion layer, and hence the barrier potential increases when the junction is reverse biased.
7) A minutely small current flows through a reverse-biased PN junction due to the minority charge carriers.
8) A forward-biased PN junction offers very small resistance to current flow while a reverse-biased PN junction offers very high resistance to current flow.

Thank You