

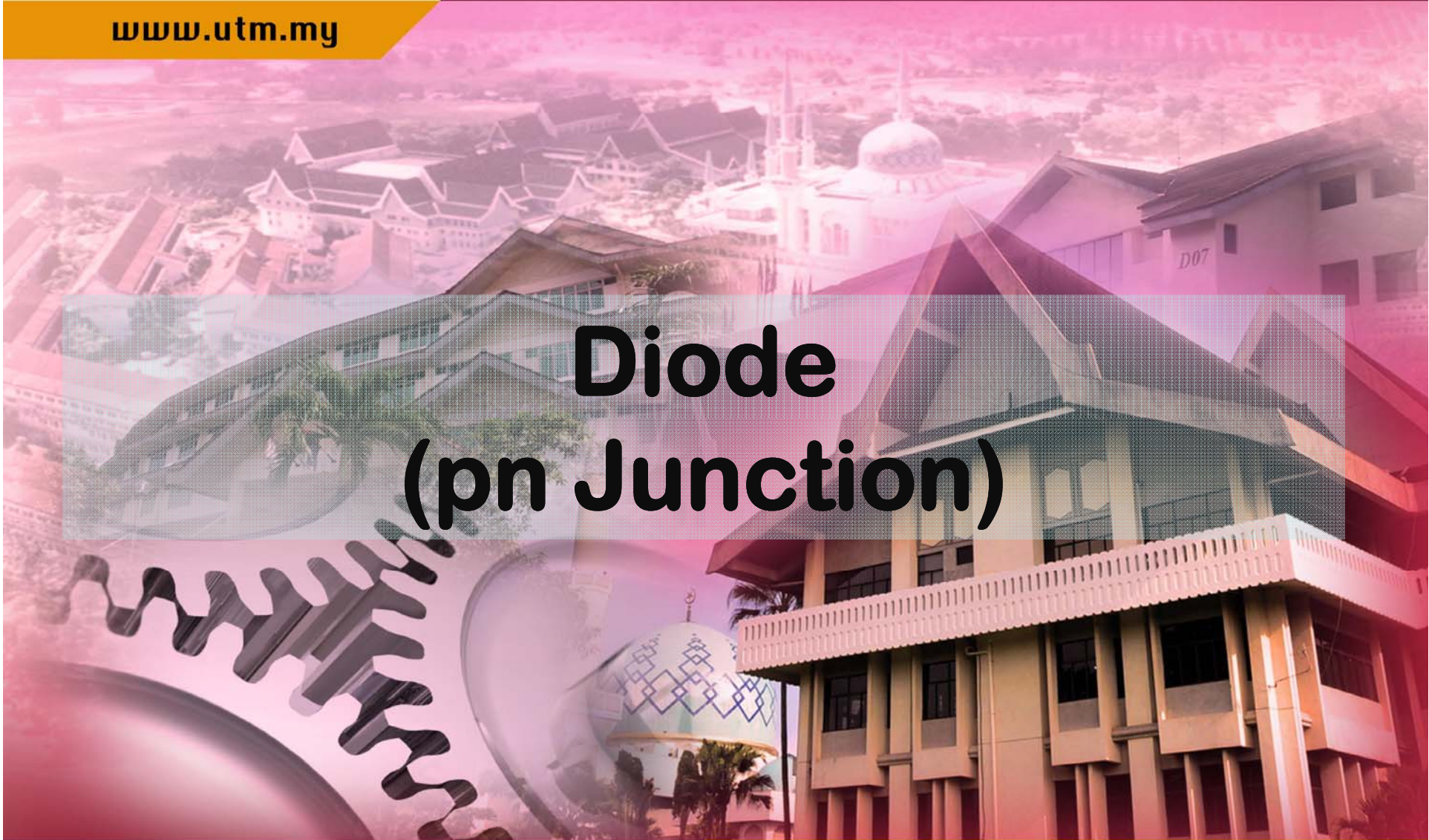


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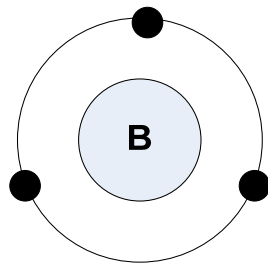
Diode (pn Junction)





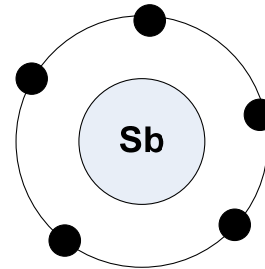
Neutral and Charged atoms

P-type impurity (Boron)



Neutral
+5 (proton)
-5 (electron)

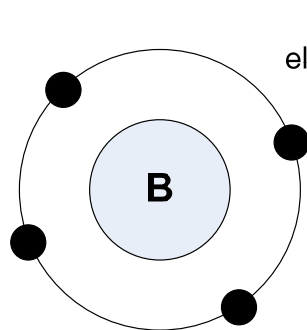
N-type impurity (Antimony)



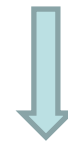
Neutral
+51 (proton)
-51 (electron)



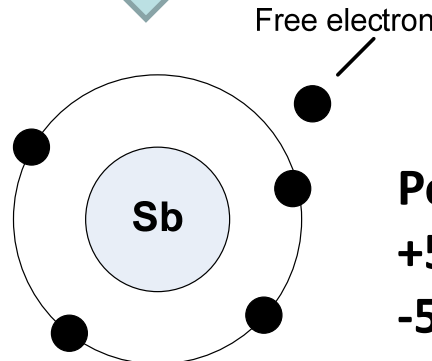
Silicon doping



Negative charge
+5 (proton)
-6 (electron)



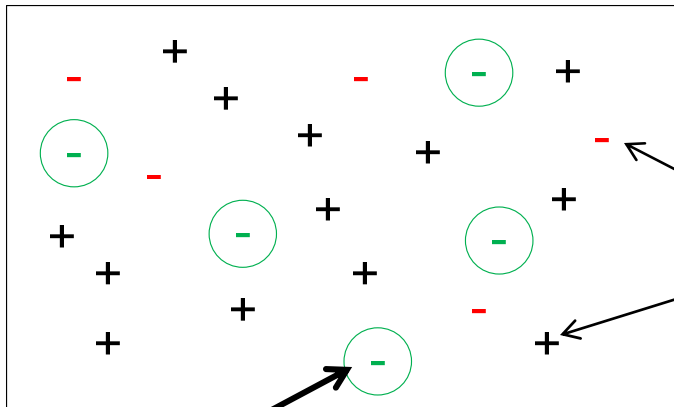
Silicon doping



Positive charge
+51 (proton)
-50 (electron)



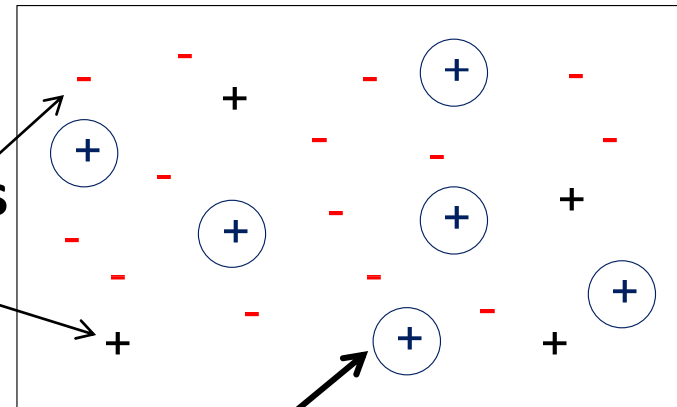
P-type Silicon



Negative ions (Boron)

-- majority holes, minority electrons

N-type Silicon



Positive ions (antimony)

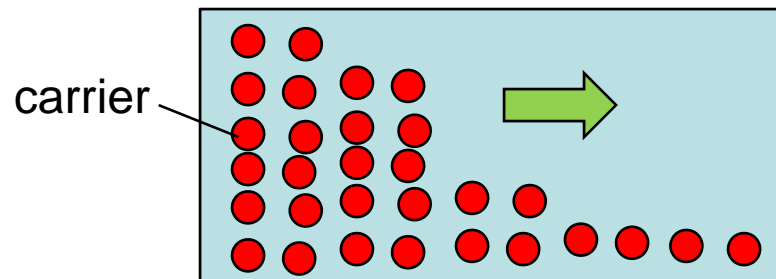
-- majority electron, minority holes



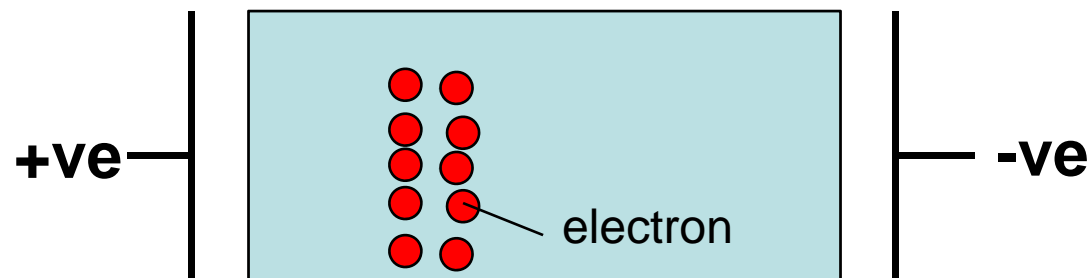
Charge carrier transport

- **Charge carrier**; electron and hole (*ionized impurities are not charge carrier)
- 2 carrier transport:

1. **Diffusion**: movement from high density region to low density region

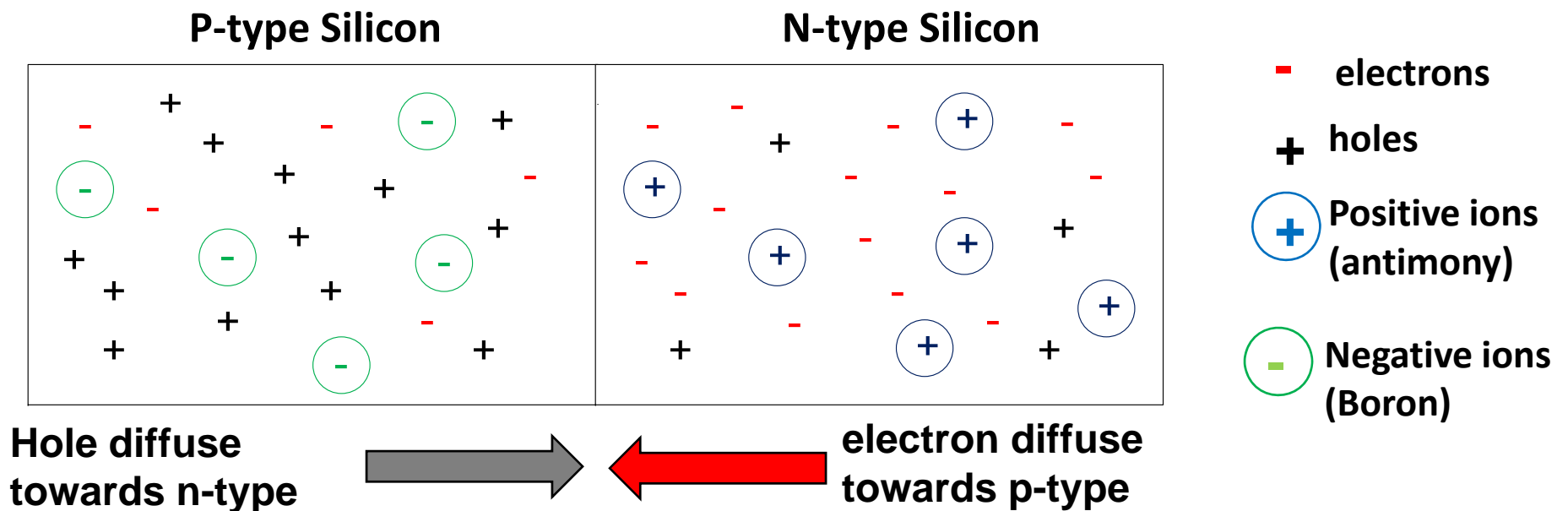


2. **Drift**: due to the electric field (applied voltage)





P-type semiconductor make contact with n-type semiconductor
→ **PN junction**



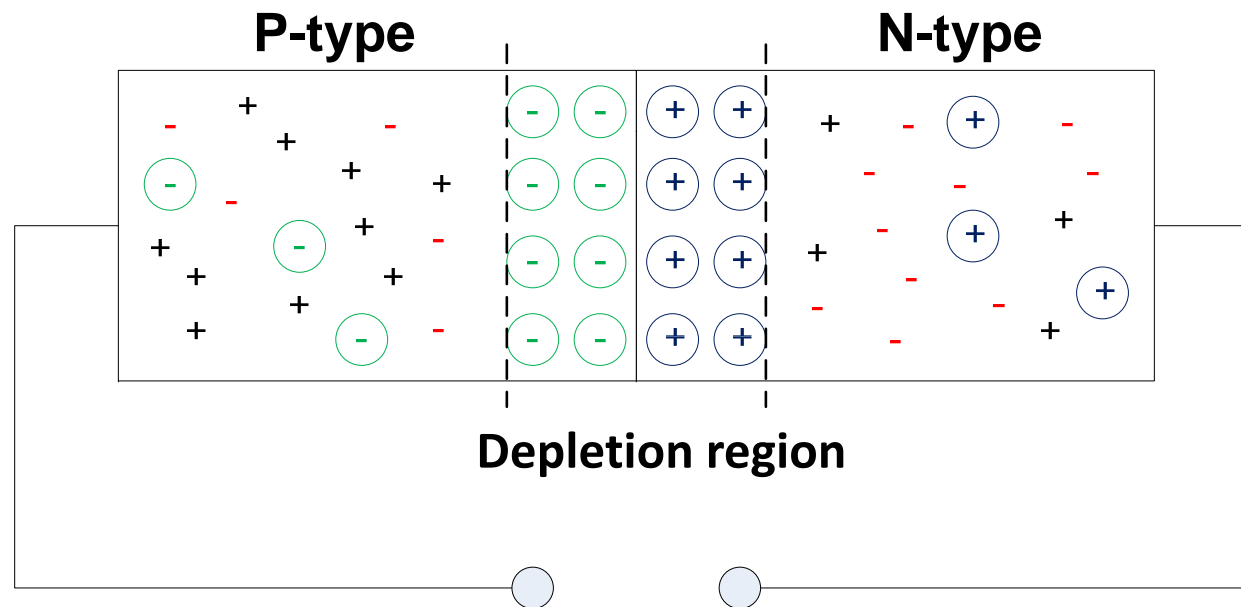
Electron and hole recombine at the junction/boundary

Positive and negative ions (impurities) remains at the junction



PN Junction (zero biased)

(*Bias: apply voltage)



No voltage source – negative ions attract positive ions at surface

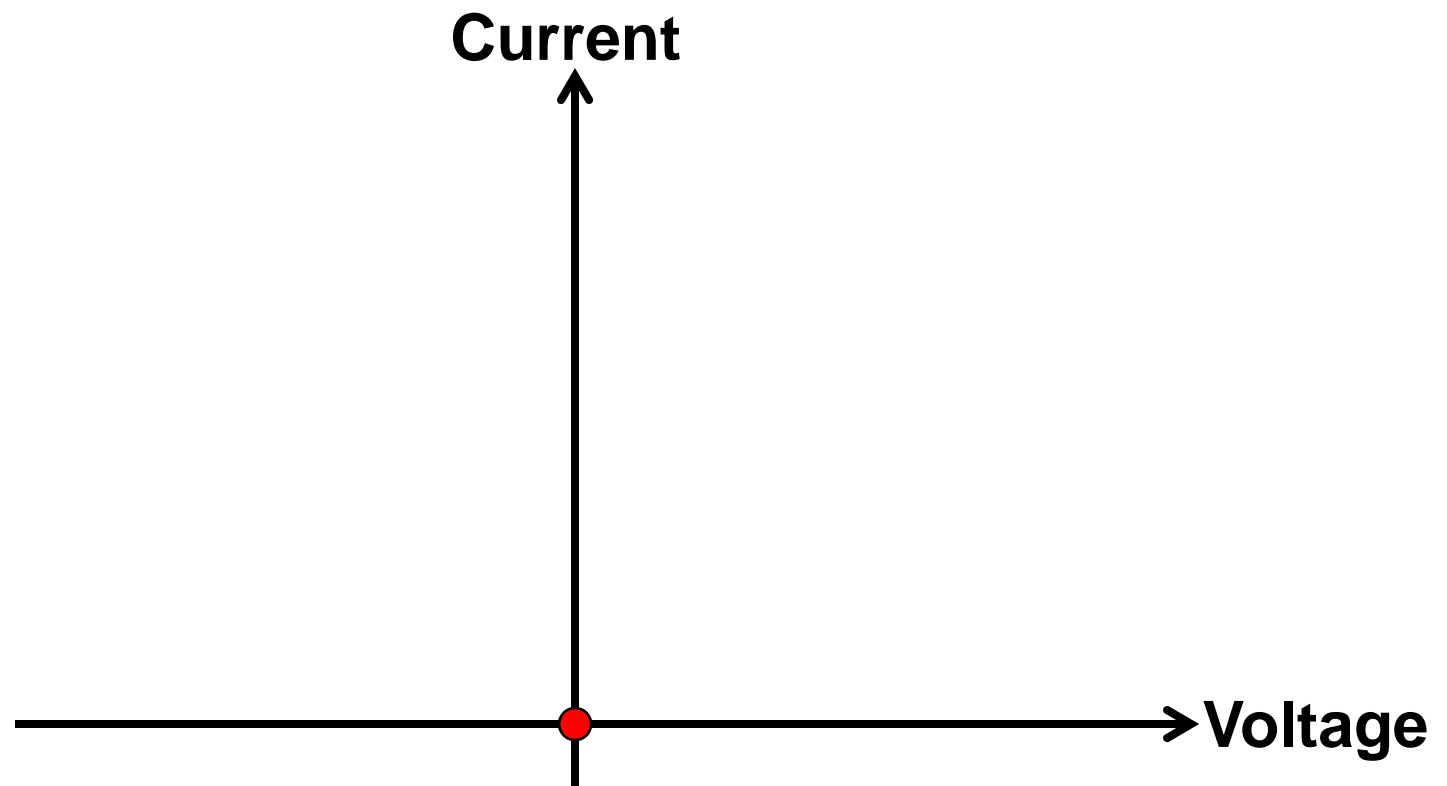
Depletion region: Region of uncovered positive and negative ions, depleted of free electrons and holes



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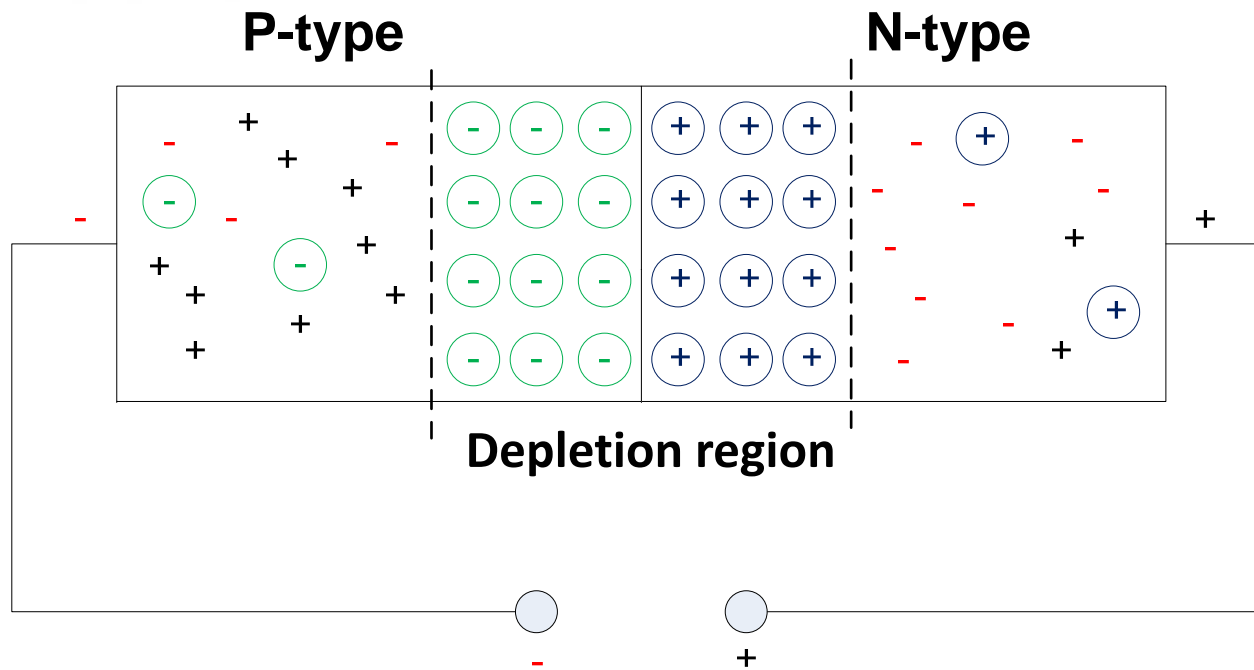
Current-voltage characteristics (zero biased)



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PN Junction (reverse biased)



Depletion region width increases, electrons cannot flow results in no current

Negatively charged Boron repelled against negative source

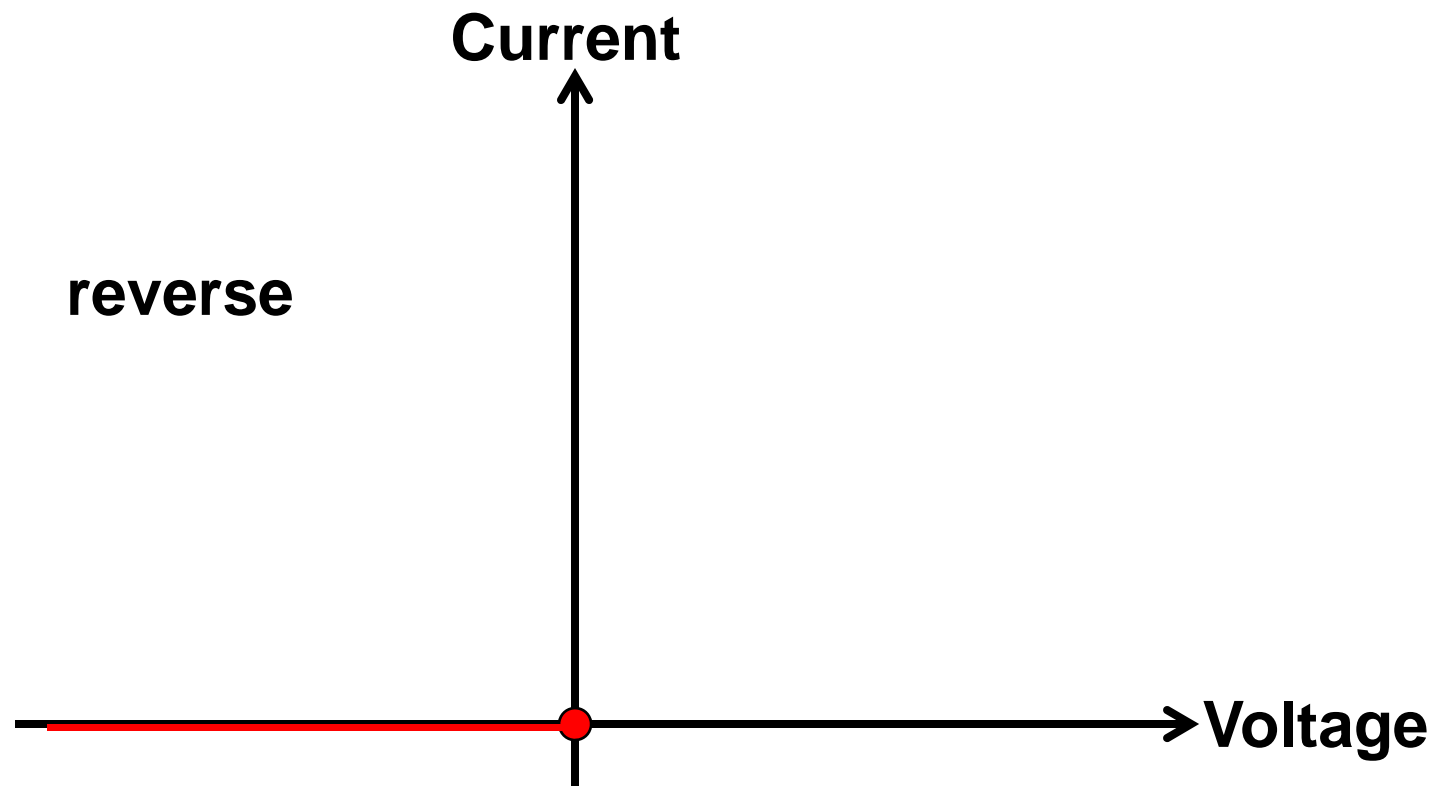
Positively charged Antimony repelled against positive source



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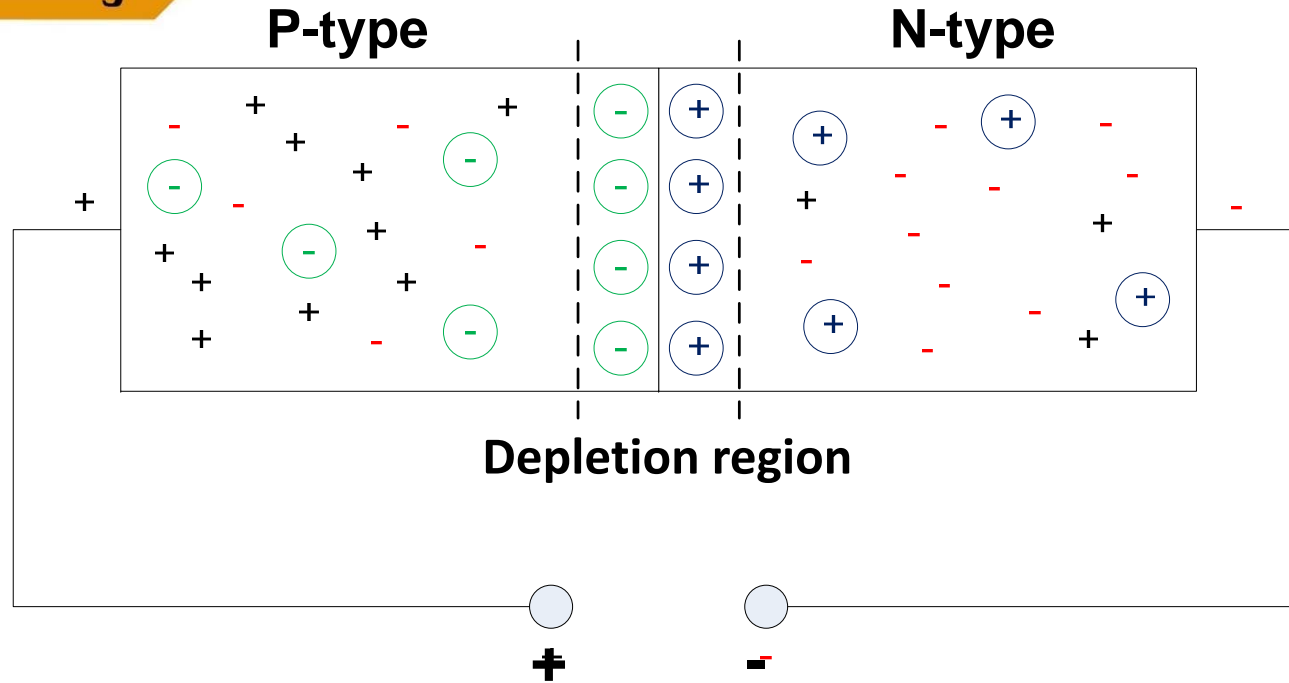
Current-voltage characteristics (zero +reverse biased)



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PN Junction (forward biased)



Depletion region decreases, electrons flow from n-type to p-type, results in current flow

Negatively charged Boron attracts to positive source

Positively charged Antimony attracts to negative source



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Current-voltage characteristics (zero +reverse+forward biased)

