ELECTRONICS

1- Fundamentals → ECE 246 +(Lab)

2- ECE 347 +(Lab)

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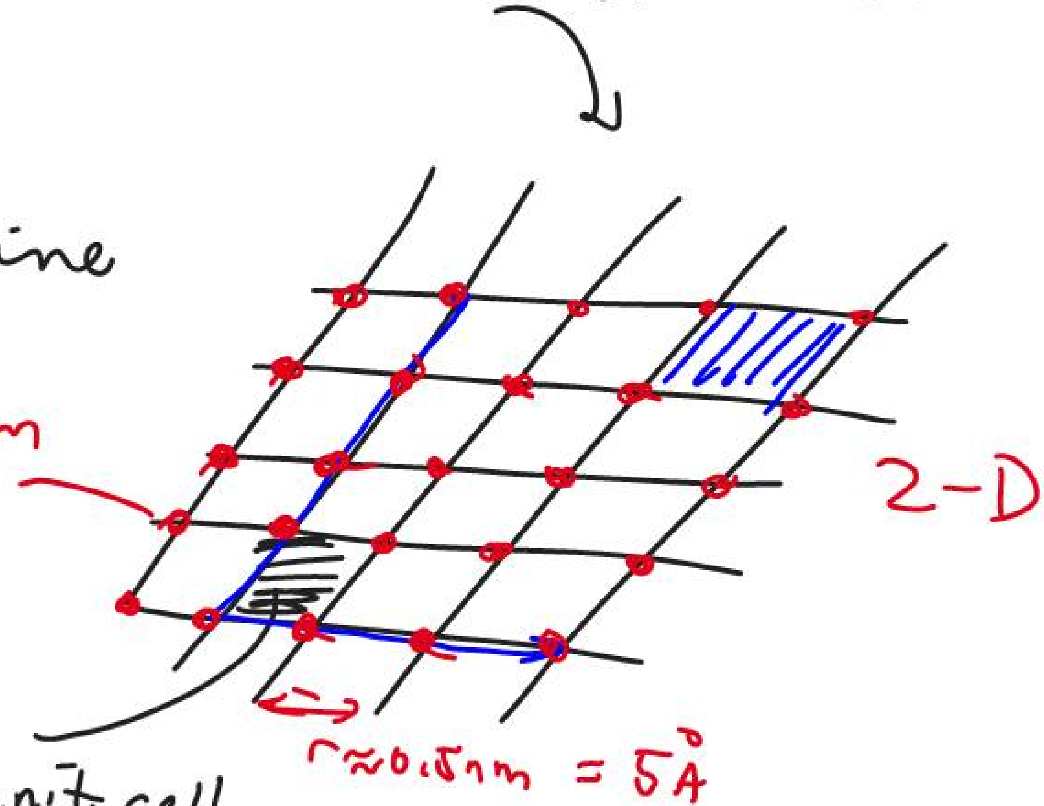
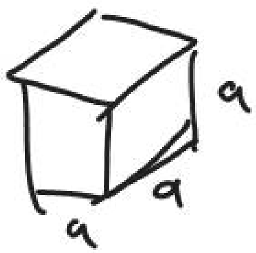
Solids

- amorphous
- crystalline
- poly crystalline



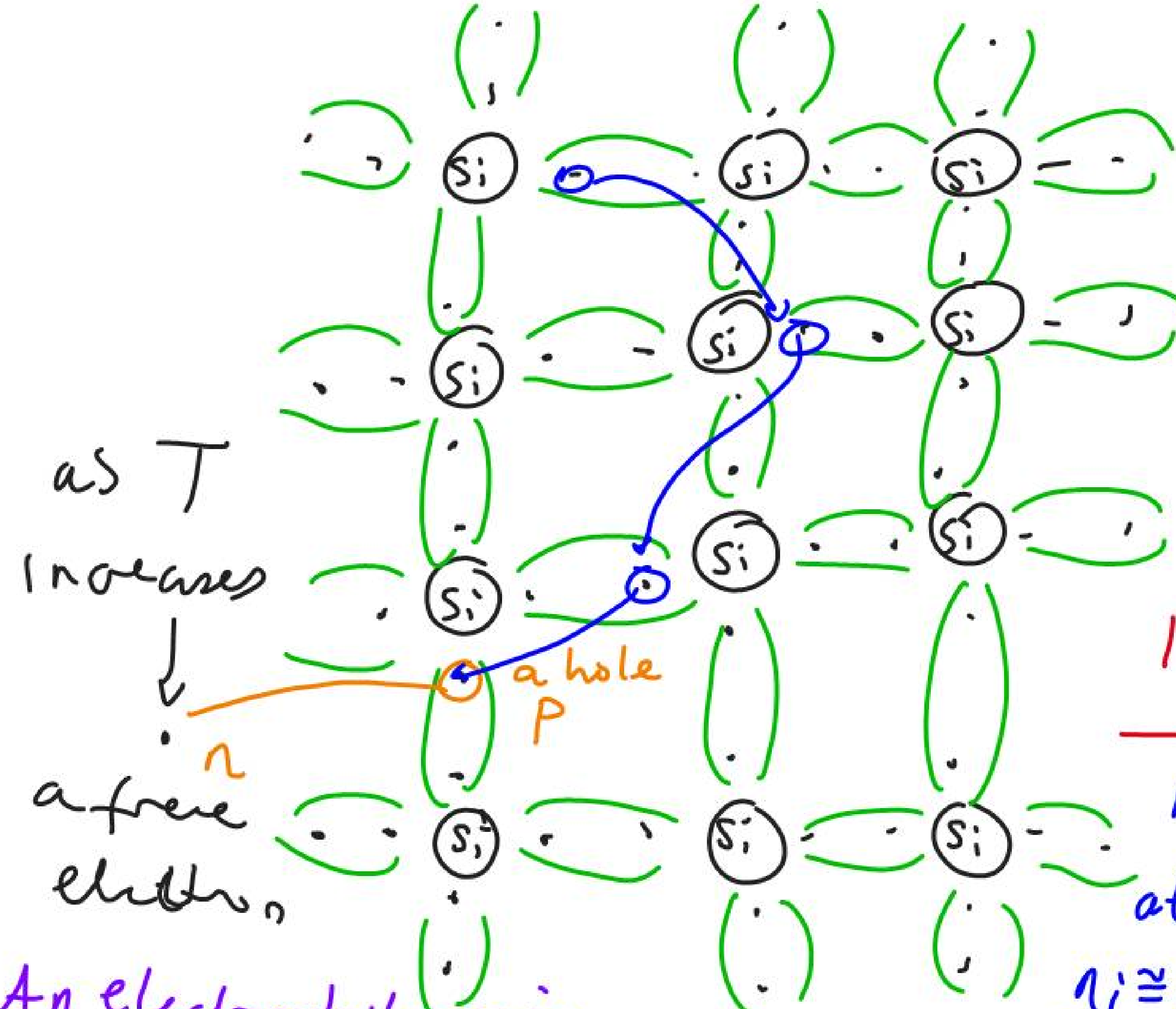
$\mathrm{Si} \sim 10^{23}$ atoms/cm^3

$\text{Å} = 10^{-10}\,m$



$V = a^3$ $\qquad \frac{1}{a^3} \cong 10^{23}$ $\qquad a^3 = 10^{-23}$

$a \cong 10^{-23/3} \cong 10^{-8}\,cm \cong 10^{-10}\,m$



An electron-hole pair
EHP

Valence electrons

$Si = 1s^2 2s^2 2p^6 3s^2 3p^2$

(14) Atomic number → = # of protons

In Intrinsic semiconductor:

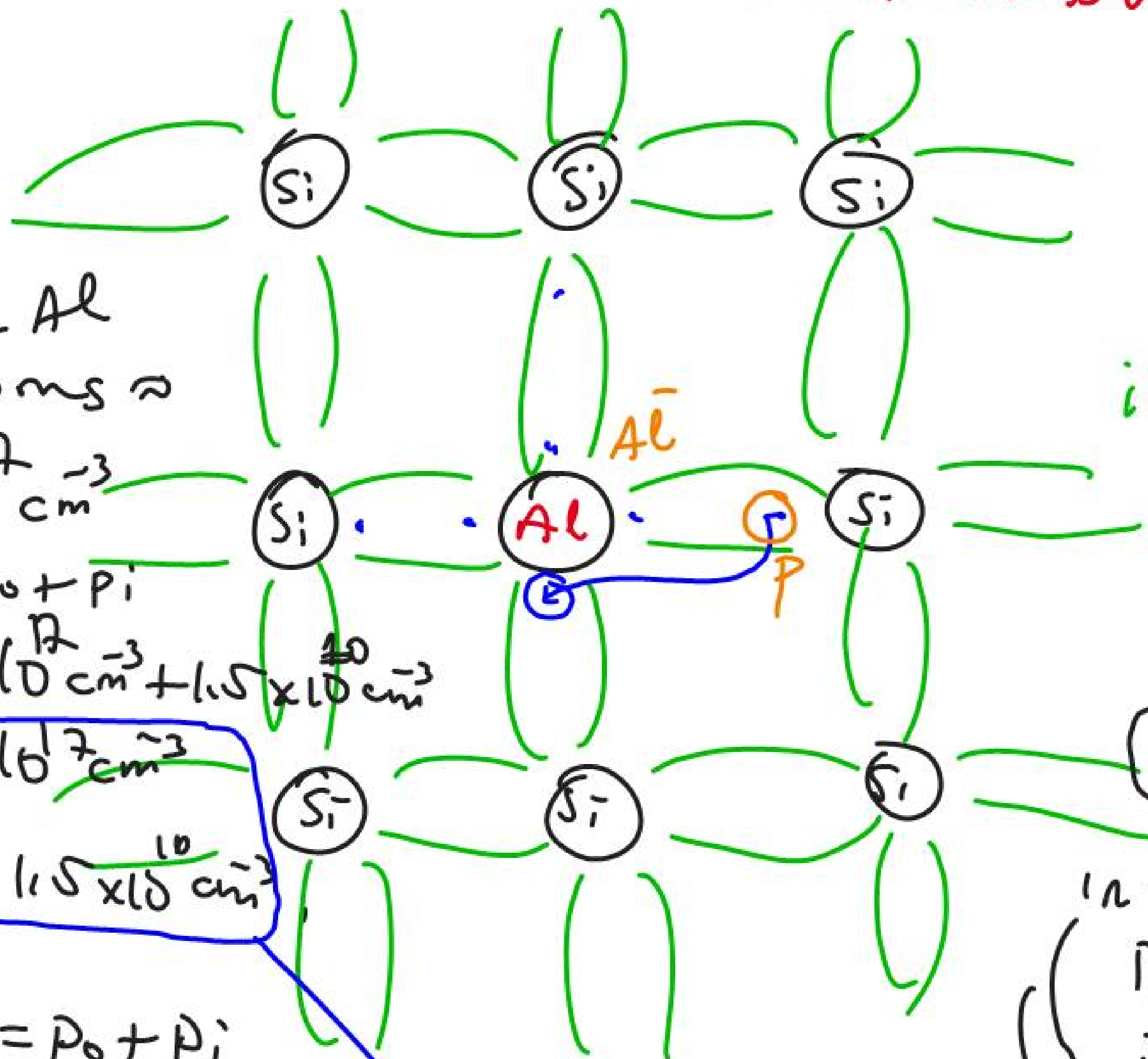
$n_i = p_i$

at 300°K

$n_{i_{Si}} \cong 1.5 \times 10^{10} \, cm^{-3}$

Intrinsic semiconductor (no foreign atoms)

EXTRINSIC SEMICONDUCTOR



A foreign atom of Group III.

(ex. Al)

impurity atoms

3 valence electrons

for each Al atom a hole (p) is generated

$\boxed{n_i = p_i}$ EHP + p_0

in total:

n_i electrons

$p_i + p_0$ holes

p_0 = # of Al atoms

# of Al atoms ≈ $10^{17}\ cm^{-3}$

$p = p_0 + p_i$

$p = 10^{17}\ cm^{-3} + 1.5 \times 10^{10}\ cm^{-3}$

$p = 10^{17}\ cm^{-3}$

$n = 1.5 \times 10^{10}\ cm^{-3}$

$p = p_0 + p_i$

$n = n_i$

a p-type semiconductor

holes = MAJORITY CARRIERS

electrons = MINORITY "

n-type Semiconductor

We introduce group V atoms (P, Sb, Ar ...)

Group V atom has 5 electrons (valence)

1e for each Group V atom as an impurity cannot fill in the covalent bonds, and become easily a free electron.

$n = n_0 + n_i$

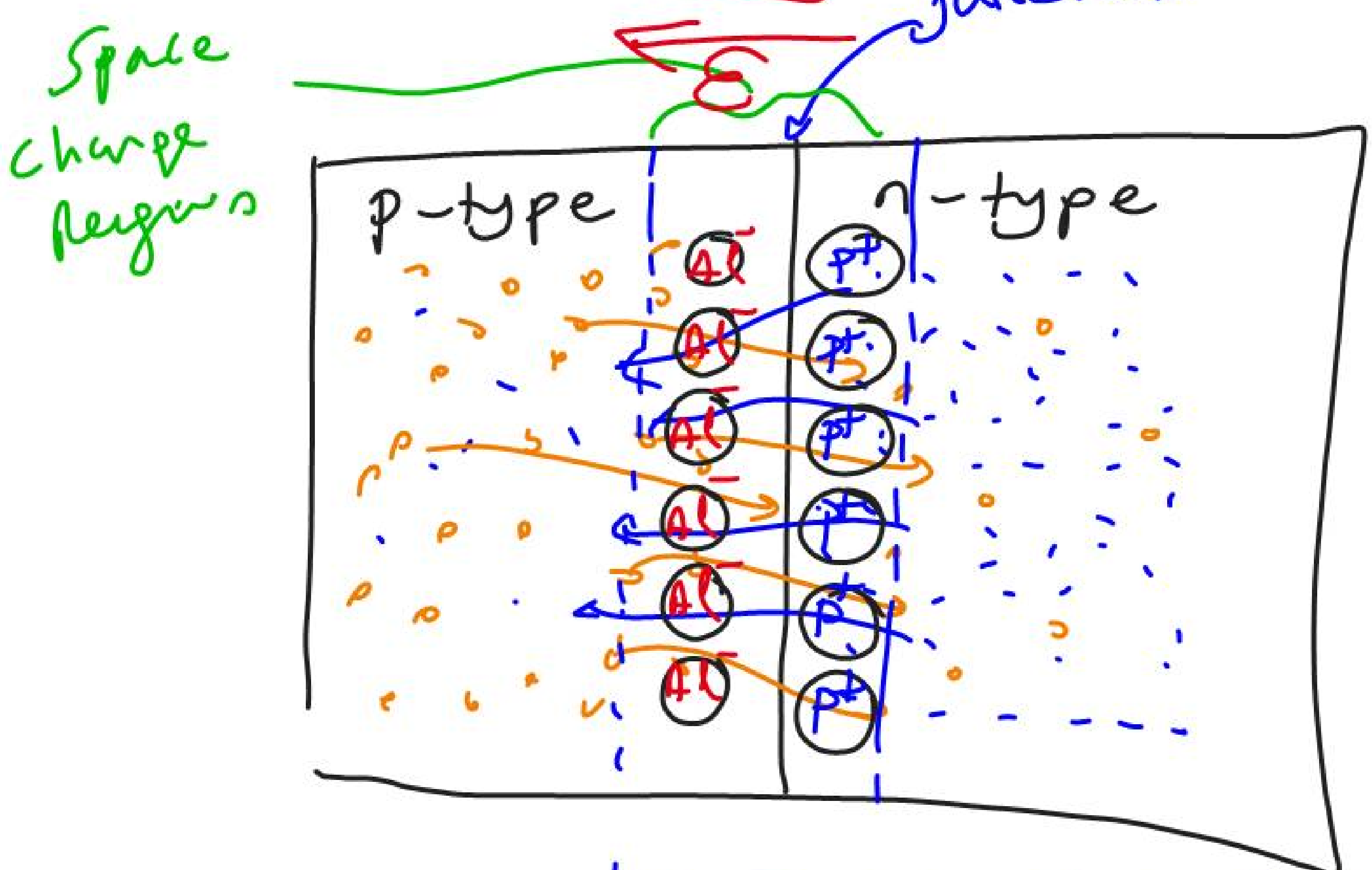
$p = p_i$

n_0 = the number of electrons contributed by Group V atom = # of Group V atoms

$n >> p$

↓ majority — ↳ minority carriers

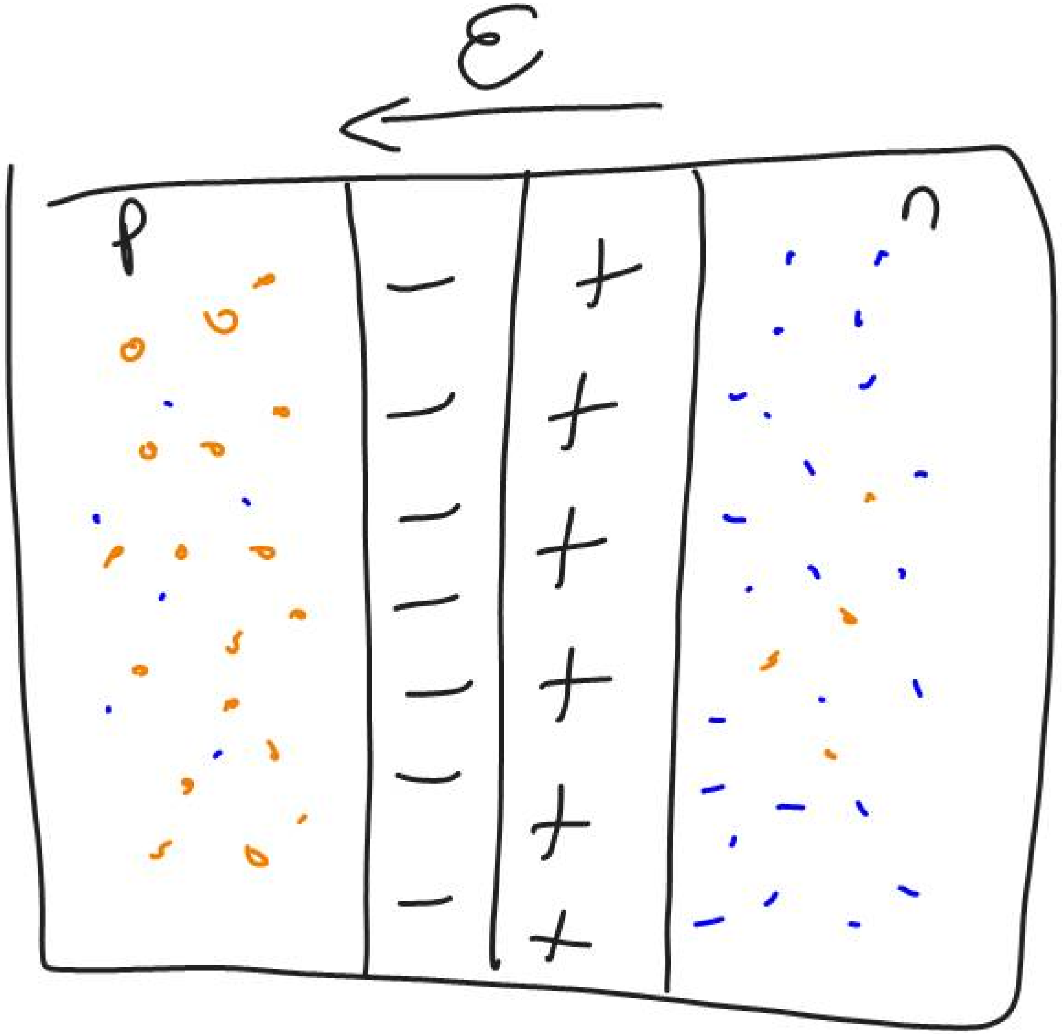
A DIODE



ℰ = built-in electric field due to the space charge region around the junction

diffusion takes place first (concentration gradient)

when electrons & holes meet they recombine and disappear



$1.6\times10^{-19}\,C$

$F = q(\vec{v}\times\vec{B} + \vec{\mathcal{E}})$

Lorentz Force