UNIVERSITY OF TORONTO

Tutorial 7 (Week 8)

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Land Acknowledgment

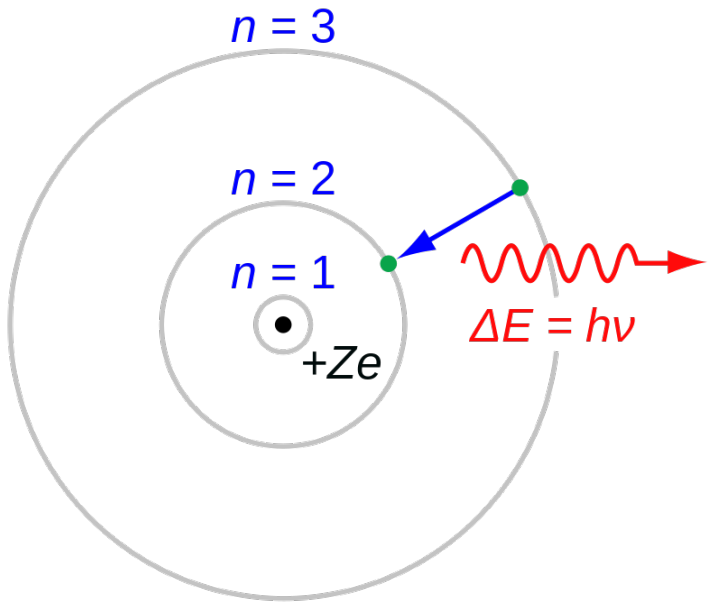
I wish to acknoledge this land on which the University of Toronto operates. For thousands of years it has been the traditional land of the Huron-Wendat, the Seneca, and most recently the Mississaugas of the Credit River. Today, this meeting place is still the home of many Indigenous people from across Turtle Island and we are grateful to have the opportunity to work on this land.

Anouncements

- Quiz 3 happens this Friday
  - Coverage is listed on schedule found on Quercus
- Last assignment will be posted this week

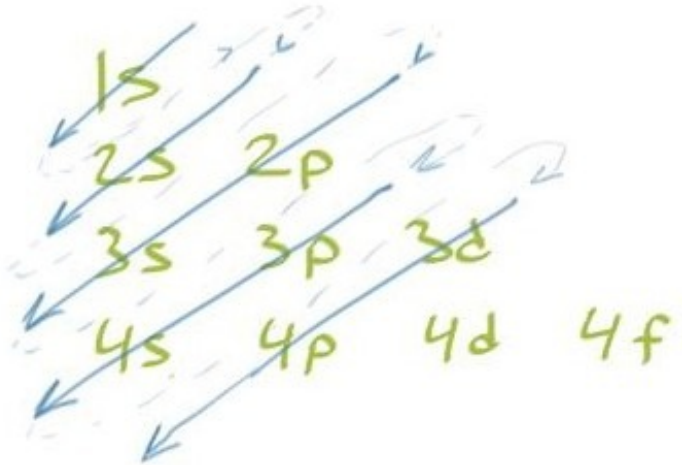
Theory Review

- Bohr Model
  - Electrons are particles moving in discrete orbitals
  - Electron energy is quantized into shells: $E = h\nu = \frac{hc}{\lambda}$



Theory Review

- Quantum-Mechanical Model
  - Quantum Numbers (QM):
    - Principal QM: n = 1, 2, 3, 4... — orbital size and energy: K, L, M, N...
    - Angular QM: l = 0, 1, 2, 3 ... n-1 — orbital shapes: s, p, d, f...
    - Magnetic QM: m_l = -l … 0 … +l — orbital orientation in space, ex. p_x, p_y, p_z
    - Spin QM: m_s = -1/2 or +1/2 — spin up or spin down
  - Electron Configuration
    - C (Z=6): $1s^2\ 2s^2\ 2p^2$
    - Cl (Z=17): $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^5$
    - Some exceptions: Cr & Cu



Theory Review

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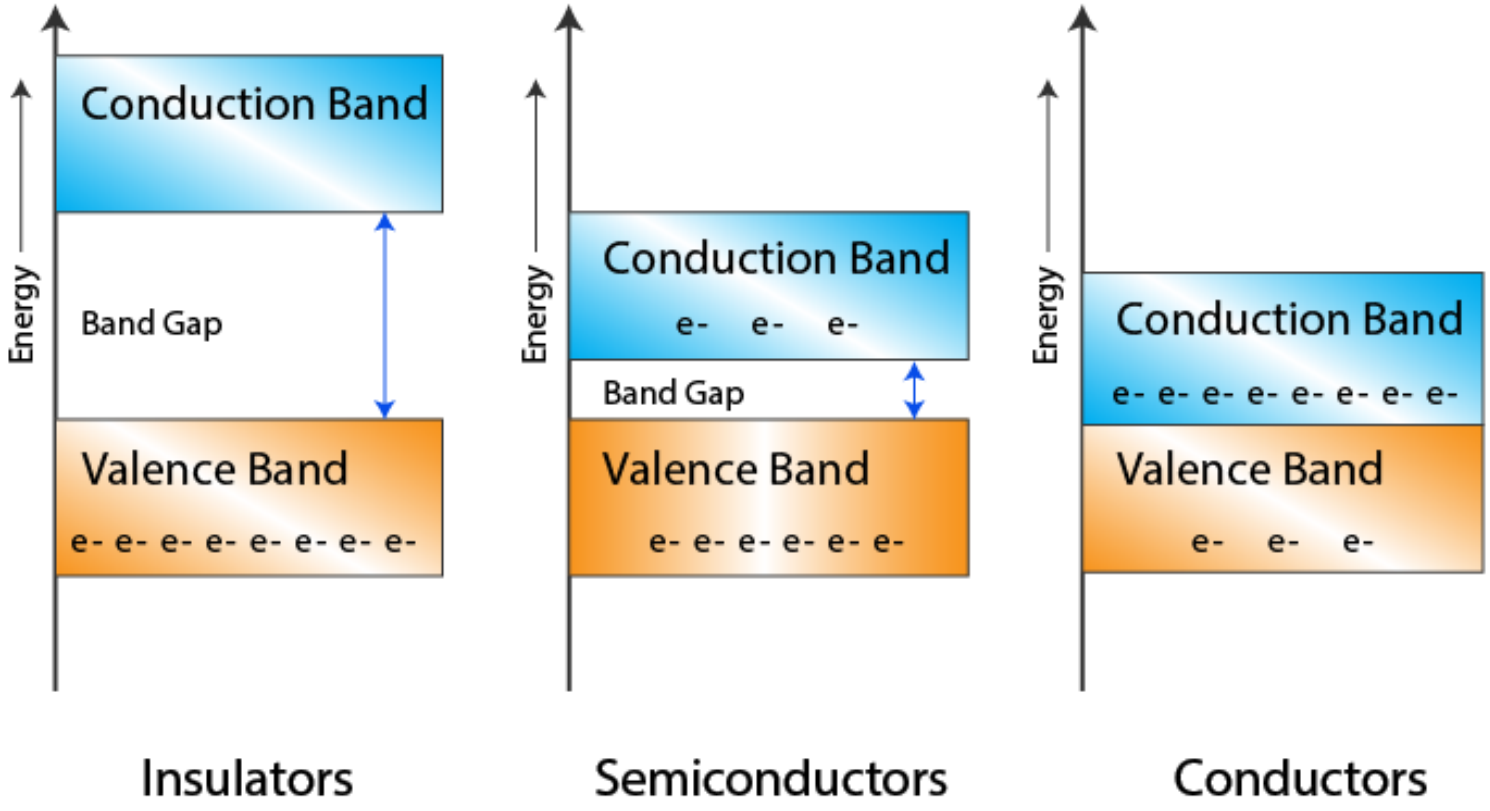
- Chemical Bonds
  - Covalent: shared electrons
  - Ionic: transfered electrons
  - Metallic: semi-free electrons

- Octet Stability
  - Atoms want to “be like” noble gases in terms of electron configuration

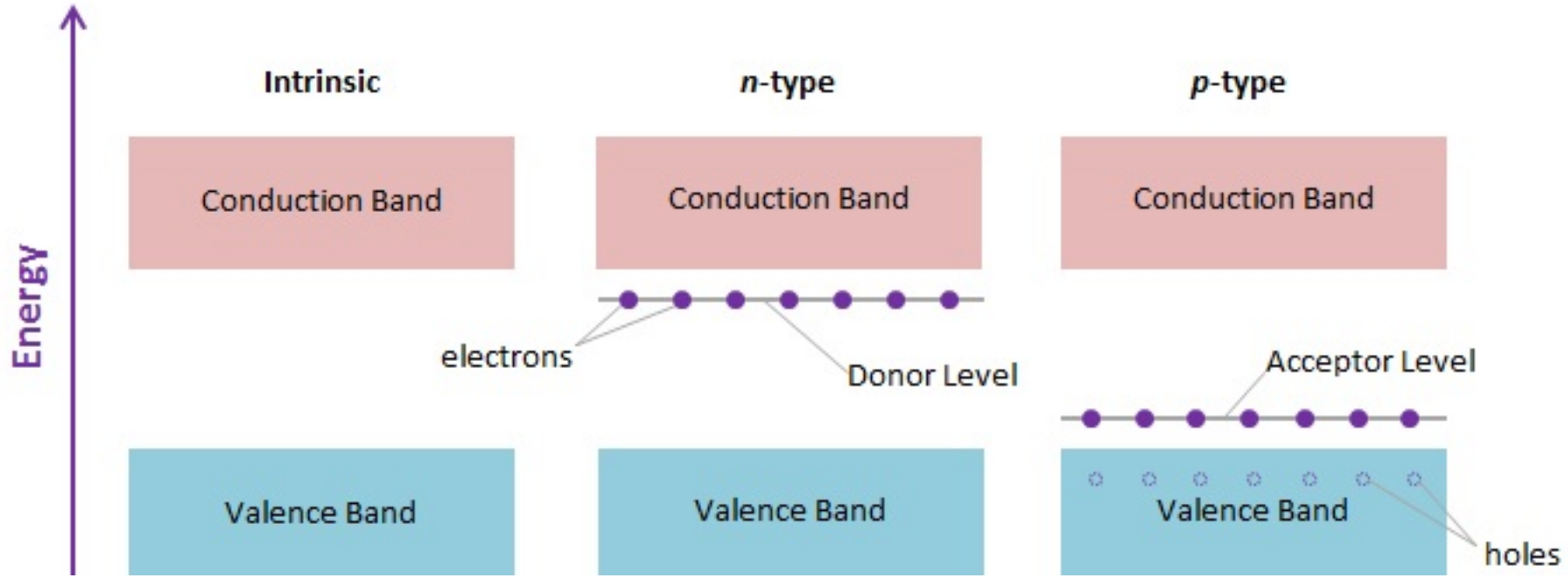
Theory Review

- Band Theory



Theory Review

- Band Theory
  - Doping of semiconductors: $\sigma = nq\mu_n + pq\mu_p$



Quizz (not graded)

1. How many allowable values exist for magnetic quantum number if the angular momentum quantum number is 3.
    a. 3
    b. 4
    c. 6
    d. 7

2. What are the values for the quantum numbers for the highest energy electron in ground state sodium (Z=11)

Quizz (not graded)

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3. Provide the full electron configuration for Nickel 2+ (Z=28 for ground state Ni)

4. A non-metallic material has a bandgap of 2.2 eV. In terms of which wavelength of light that passes through the material, which of the following is true?
   a. The material passes all wavelengths of visible light
   b. The material does not pass any wavelengths of visible light (ie: it is opaque)
   c. The material passes red light but not blue light
   d. The material passes blue light but not red light

5. The following characteristics for both intrinsic and p-type extrinsic GaSb at room temperature. Calculate the hole and electron mobility based on this data --

	σ (Ω m-1)	n (m^{-3})	p (m^{-3})
Intrinsic	2.5×10^{-6}	3.0×10^{13}	3.0×10^{13}
Extrinsic (p-type)	3.6×10^{-5}	4.5×10^{14}	2.0×10^{12}

Quizz (not graded) – Solutions

1. D
2. n = 3, l = 0, ml = 0, ms = -1/2
3. $1s^2 2s^2 2p^6 3s^2 3p^6 3d^8$
4. C

5. ① Intrinsic $\sigma = n \cdot q \cdot \mu_e + p \cdot q \cdot \mu_h$

$2.5 \times 10^{-6} = (3 \times 10^9)(1.609 \times 10^{-19})\mu_e + (3 \times 10^9)(1.609 \times 10^{-19})\mu_h$

$0.52 = \mu_e + \mu_h$

② Extrinsic

$3.6 \times 10^5 = (4.5 \times 10^{14})(1.609 \times 10^{-19})(\mu_e) + (2 \times 10^{12})(1.609 \times 10^{-19})(\mu_h)$

$112.4 = 225\mu_e + \mu_h$

$\therefore \mu_e = 0.5\ m^2/V \cdot s$

$\mu_h = 0.02\ m^2/V \cdot s$