Session #13: Homework Problems

Problem #1

Show that green light ($\lambda = 5 \times 10^{-7}$ m) can excite electrons across the band gap of silicon (Si).

Problem #2

(a) Electromagnetic radiation of frequency 3.091×10^{14} Hz illuminates a crystal of germanium (Ge). Calculate the wavelength photoemission generated by this interaction. Germanium is an elemental semiconductor with a band gap, E_g, of 0.7 eV.

(b) Sketch the absorption spectrum of germanium, i.e., plot % absorption vs. wavelength, λ.

Problem #3

Potassium (K) and beryllium (Be) are metals which exhibit good electrical conductivity. Explain for both elements the reasons for the observed conductivity on the basis of the band structure.

Problem #4

A pure crystalline material (no impurities or dopants are present) appears red in transmitted light.

(a) Is this material a conductor, semiconductor or insulator? Give the reasons for your answer.

(b) What is the approximate band gap (E_g) for this material in eV?

Problem #5

An unknown material is transparent to light of frequencies (ν) up to 1.3×10^{14} s^{-1}. Draw a meaningful schematic band structure for this material.

Problem #6

A material exhibits an "optical band edge" (transition from absorption of light to transmission) at $\nu = 5 \times 10^{14}$ Hz (s^{-1}).

(a) Draw a diagram which reflects the indicated optical behavior.

(b) What do you expect the color of this material to be when viewed in daylight?

(c) What is the band gap (E_g) of this material?

3.091SC Introduction to Solid State Chemistry
Fall 2009