I went to Zhanda's recitation

1

Calculate and compare: the change in thermal energy associated with heating an atoms from room temperature, $300K$, to $1500K$ using the expression

$E_{thermal} = k_b T$

To the energy of a photon with a wavelength of $500nm$ using the expression

$E_{photon} = \frac{h_{planck} c}{\lambda}$

Where:

- $k_b = 1.3806503 \times 10^{-23} \ \frac{m^2 kg}{s^2 K}$
- $h_{planck} = 6.62607015 \times 10^{-34} \ \frac{J}{Hz}$
- $c = 299792458 \ \frac{m}{s}$

✓ **Answer**

$300K \rightarrow 1500K$
$E_{thermal} = k_b T$
$E_{thermal} = k_b (1200K)$
$E_{thermal} = 1.6569 \times 10^{-20} \ J$

$E_{photon} = \frac{h_{planck} c}{\lambda}$
$E_{photon} = \frac{h_{planck} c}{500nm}$
$E_{photon} = \frac{6.62607015 \times 10^{-34} \ \frac{J}{Hz} 299792458 \ \frac{m}{s}}{5 \times 10^{-7} \ m}$
$E_{photon} = 3.97 \times 10^{-19} \ J$

There is around 25x more energy in the photon that that of the increase of kinetic energy in the heating of the atom.

2

If aluminum is heated from room temperature to its melting point (660°C) it expands 1.5%. What is the bond length at room temperature and what is it just below its melting point?

✓ **Answer**

$25^\circ C \rightarrow 660^\circ C \qquad : 1.5\% \uparrow$
Aluminium has a radius of $0.1431\ nm$

$0.1431\ nm \cdot 1.015 = 0.1452\ nm$

The bond length is $0.1431\ nm$ normally and $0.1452\ nm$ at its melting point

3

The book makes the distinction between atomic structure and crystal structure. Briefly explain the difference in your own words.

✓ **Answer**

Atomic structure is the structure within the atom: protons, neutrons, electrons, charge, etc. But crystal structure is the structure of the arrangement of multiple atoms and how they relate to each other.

4

The atomic packing factor is defined in the book as “the sum of the sphere volumes of all atoms within a unit cell (assuming the atomic hard-sphere model) divided by the unit cell volume.” How is the radius of the atomic hard-model described in the book.

✓ **Answer**

"When describing crystalline structures, atoms (or ions) are thought of as being solid spheres having well-defined diameters. This is termed the

atomic hard sphere model in which spheres representing nearest-neighbor atoms touch one another."

The radius at which the atoms would touch each other is how the radius is defined.

5

Showing all your work, show that the atomic packing factor for body-centered cubic is 68% and for face-centered cubic is 74%.

✓ **Answer**

BCC: 68%

2 atoms per cube, radius of $\frac{a\sqrt{3}}{2}$
$V = 2 \cdot \frac{4}{3}\pi\frac{a\sqrt{3}}{4}^3$
$V = 0.6802a^3$
$= 68\%$

FCC: 74%

4 atoms per cube, radius of $\frac{a}{\sqrt{2}}$
$V = 4 \cdot \frac{4}{3}\pi\frac{a}{2\sqrt{2}}^3$
$V = 0.7404a^3$
$= 74\%$