

ESO 205T

# Nature and Properties of Materials

Interaction session: 11-12 Monday

Tutorial: 11-12 Thursday



## Assignment 4

Due by 8 October 2020 11 am

## Question 1

We had learned in the class that carbon occupies interstitial voids in both BCC alpha iron and FCC gamma iron. The solubility of carbon in FCC gamma iron is higher than BCC alpha iron though FCC structure has higher packing fraction. Explain the higher solubility of carbon in FCC gamma iron by determining the size of voids in FCC and BCC iron.

Given: radius of iron atom = 126 pm and radius of carbon atom = 70 pm

## Question 2

Calculate the packing fraction of diamond cubic structure. Revisit the packing fraction and co-ordination number of monoatomic SC, BCC and FCC to comment on a relationship between packing fraction and co-ordination number.

## Question 3

We have seen the NaCl structure in great details. Calculate the planar density of 100, 101 and 111 planes of MgO that has the same structure as that of NaCl. Comment on the stability of the planes in terms of charge neutrality.

Given: radius of  $\text{Mg}^{2+}$  and  $\text{O}^{2-}$  ions is 0.086 nm and 0.126 nm respectively. Assume anion-cation contact along the cell edge to determine the lattice parameter of MgO.

## Question 4

The bonding characteristic of an ionic solid is given by

$$U = -A/r + B/r^8$$

Plot the attractive, repulsive and total energy as a function of inter atomic distance on the same graph. On a graph above, draw the corresponding attractive, repulsive and net force.

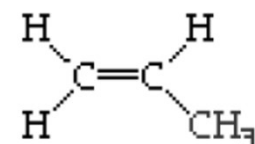
If the equilibrium separation between the atoms is 0.25 nm for value of  $A = 10^{-28}$  Jm, determine the value of B for plotting the aforementioned curves. Also determine the Youngs modulus of the material.

Plot the curves using Origin or matlab or python, use excel as the last resort

## Question 5

Find the number-average and weight-average molecular weight of polypropylene along with degree of polymerization for the following material.

Molecular weight range (g/mol)	Number fraction	Weight fraction
8,000-16,000	0.05	0.02
16,000-24,000	0.16	0.10
24,000-32,000	0.24	0.20
32,000-40,000	0.28	0.30
40,000-48,000	0.20	0.27
48,000-56,000	0.07	0.11



## Question 6

Determine the ratio of butadiene to styrene in a copolymer with molecular weight of 350,000 g/mol and degree of polymerization of 4425.

