## Problem Set #1: Crystallography

1. Noble metals such as Cu, Ag, and Au form face-centered cubic structures. Given the molar mass of Ag is 107.87g/mol and the density is 10.5g/cm$^3$, determine the distance between nearest neighbours.

2. (a) Draw the conventional (eg. cubic) non-primitive unit cell for Si.

   (b) Label the following on the Si unit cell:

   (i) $(111)$

   (ii) $(100)$

   (iii) $[110]$

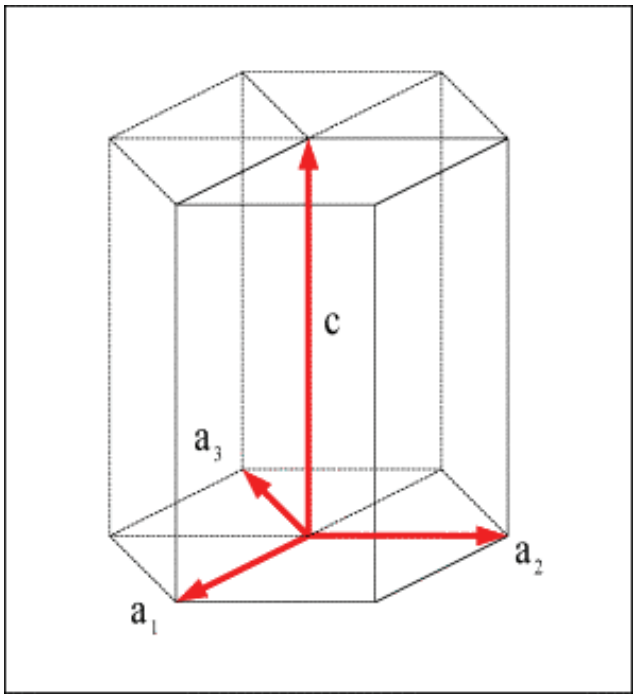
   (c) The figure below shows a hexagonal unit cell with axial directions **$a_1$, $a_2$, $a_3$, and c**. Label the following:

   (i) $(1100)$

   (ii) $(10\bar{1}0)$

   (iii) $(0001)$

   (iv) $[0110]$




3. (a) Do all Bravais lattices have an inversion center?

   (b) Do all crystal structures have an inversion center? If not, explain why and provide an example.

   (c) During semiconductor device fabrication, it is common to use thin-film deposition tools such as sputtering or electron-beam (E-beam) evaporation. When using these tools, it is important to have an in-situ thickness monitor to ensure precise device fabrication. Using symmetry arguments, explain how a Quartz crystal can be used as an in-situ thickness monitor.