MATRL 100A: Structure and Properties I, Assignment 3

This assignment is due on Wednesday, October 25.

Chapter 3

1. Estimate the density of a neutron star by assuming it consists of a close packed arrangement of neutrons. $m_n = 1.675 * 10^{-27}$ kg ($\approx$ 1 amu) and $r_n = 2.0$ fm.

   Fun fact: Large neutron stars can actually exceed this density slightly. It is proposed that the cores of these stars form exotic phases of matter such as a Bose-Einstein condensate or supercritical fluids, but no one knows for sure.

2. Show that the c/a ratio for an ideal HCP packing (ideal means each atom has 12 nearest neighbors with same bond length to each) is 1.63. *Hint: look for tetrahedra with side length a in the conventional hexagonal unit cell.*

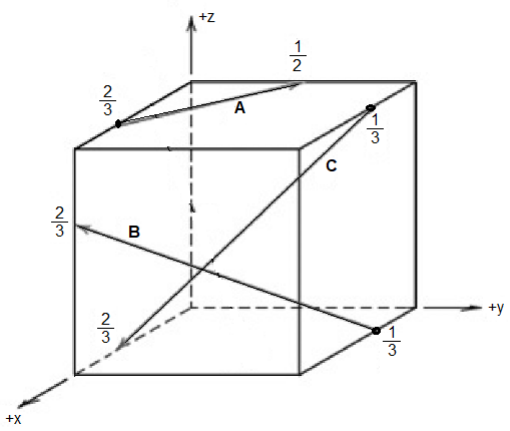
3. Draw the following crystallographic directions in a cubic unit cell

   (a) $[1\,1\,0]$
   (b) $[0\,2\,1]$
   (c) $[2\,\bar{1}\,2]$

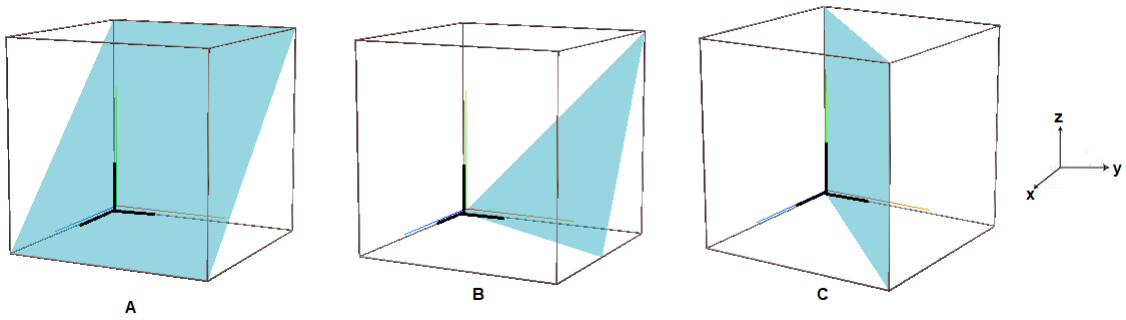
4. Draw the following crystallographic planes in a cubic unit cell

   (a) $(1\,1\,1)$
   (b) $(0\,1\,2)$
   (c) $(2\,0\,\bar{1})$

5. Identify the crystallographic directions shown in the unit cell below.



6. Identify the crystallographic planes shown in the unit cells below.



7. An X-ray diffraction peak for the (111) plane in silver (FCC) is found at $2\theta = 38.2^\circ$ when Cu K-α radiation is used. Given that the Cu K-α wavelength is 0.154 nm, compute the following for silver:

   (a) Interplanar spacing (d) of the (111) planes *(Bragg Law)*

   (b) Lattice constant *(Equation 3.22)*

   (c) Radius of a silver atom

   (d) Mass of a silver atom given that the density of silver is 10.5 g/cm^3