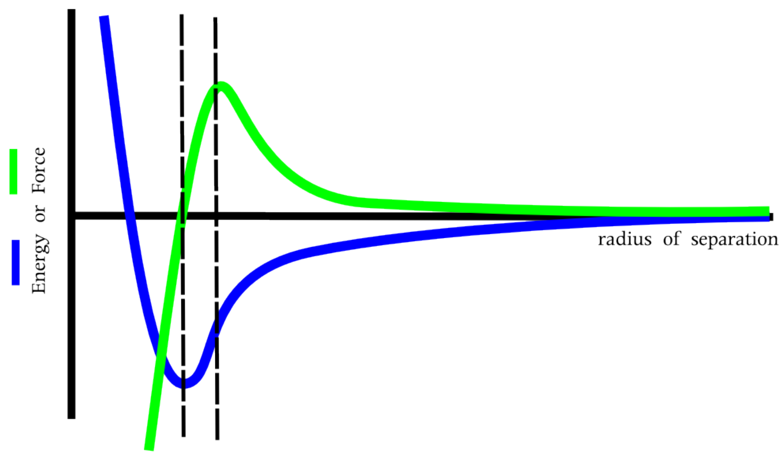
ENGR-1600-01 Quiz 1 - 100 pts Prof. Lewis Name: ____________________

1. Name two features necessary to define a crystal structure. (20 pts total):

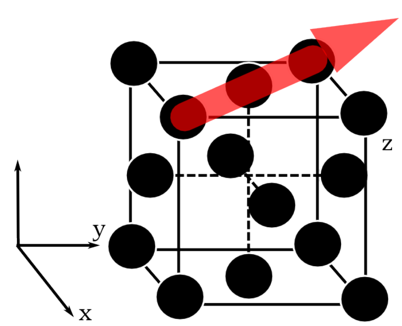
The two items necessary to define a crystal structure are 1) an infinite array of points, or, a lattice and 2) a motif associated with each lattice point.

2. Sketch the graphs of interatomic energy and force. What does the derivative of force at the equilibrium atomic spacing tell us about the macroscopic materials properties for your hypothetical material? (20 pts total):



Recall that the derivative of energy with respect to atomic separation is force. Therefore the second derivative of energy, or, the first derivative of force at r_0 is related to the modulus of the material. Remember that modulus is a measure of the stiffness of a material. It is a non-linear, tensor quantity that can only be approximated using a scalar value.

3. Sketch an FCC unit cell and indicate one close packed direction. How many unique close packed directions does this unit cell possess? (20 pts total):



This unit cell possesses two close packed directions per face and by symmetry six all together. Remember that HCP also has six close packed directions. That implies a connection between the two, yes?

4. Assume the lattice parameter of a BCC unit cell is 'a' and compute the following (20 pts each):

a) the number of atoms in the unit cell, and

There are $8 \times \frac{1}{8}$ *corner atoms and* 1 *center atom. Totaled, there are 2 atoms per unit cell.*

b) the volume of the unit cell in terms of the atomic radius.

The unit cell edge is 'a' and the volume is a^3. *In terms of* $f(R)$ *we know that* $\sqrt{3}a = 4R$. *Thus:*

$$a^3 = \left\{ \frac{4R}{\sqrt{3}} \right\}^3 = \frac{64\sqrt{3}}{9} R^3 \tag{1}$$

Although you were not asked to compute the APF, we now have enough information to do so. Assuming that atoms are spherical (just like cows) we can compute the APF like so:

$$APF = \frac{2\frac{4}{3}\pi R^3}{\frac{64\sqrt{3}}{9}R^3} = 0.68017... \tag{2}$$