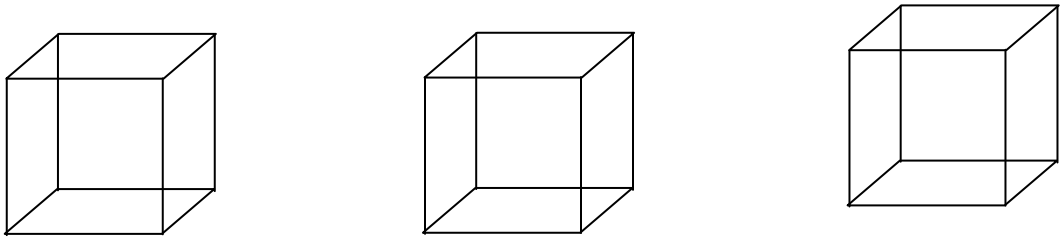
University of Portland
EGR 221 - Materials Science
Exam 1 (CLOSED BOOK, CLOSED NOTES)
September 27, 2013,– **FOR 2015** – green **indicates subject is not on Quiz 2**

NAME_____ area of a circle = πr^2, volume of a sphere = (4/3) πr^3

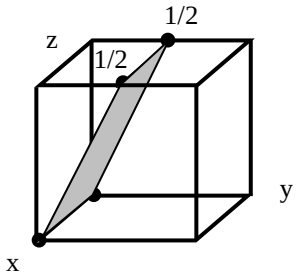
1) [15 %] Draw the following directions and planes for in the unit cells. **Be clear where the origin is located. Show appropriate steps. Label axes.**

a) [1 $\bar{1}$ 2] direction b) (3 0 1) c) (0 1 $\bar{1}$)

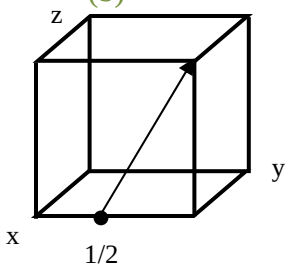


2) [15 %] What are the indices for the following planes and directions? **Show your work** (show the steps). Note, dots (●) indicate where the plane or direction crosses the unit cell. If you choose to "move the origin" – clearly show the new origin location.

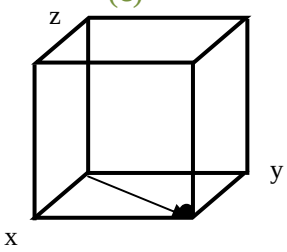
(a)



(b)



(c)



3) [5 %] For BCC, create a 2-dimensional sketch of the (0 0 1) plane and the atoms it contains.

For Problems 4 5, and 6 you MAY include a brief explanation or sketch if you think it would help.

4) [20 %] Fill in the blanks with the correct terms(s).

A) A material for which the properties **do** depend on direction is referred to as:_____ _____.

B) A _____is an example of a point defect (or point imperfection) in a crystal.

C) Body Centered Cubic (BCC), Face Centered Cubic (FCC), and Hexagonal Close Packed (HCP) are three types of_____(hint: NOT "unit cells").

D) A primary interatomic bond involving the non-directional sharing of non-localized valence electrons ("sea of electrons") is called:_____

E) If carbon atoms (which are relatively small) place themselves within the space between iron atoms in a crystal, this is referred to as: _____solid solution.

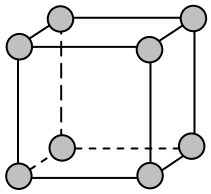
5) [15 pts] Multiple Choice. Pick the single answer in each question that is most correct.

A) The basic, simplest, unit of a crystal structure is referred to as a
   a) grain
   b) unit cell
   c) lattice
   d) cubic structure

B) A special type of grain boundary about which the crystals exhibit symmetry is referred to as (note, these boundaries appear as very straight lines in a photomicrograph):
   a) crystal boundary
   b) grain mirror
   c) grain symmetry
   d) twin, twin boundary, or twin plane
   e) polycrystalline line defect

C) Most metal alloys:
   a) Are polycrystalline
   b) Are highly anisotropic
   c) Are amorphous
   d) Have BCC crystal structures

D) The crystal structure shown here is



a) Face-Centered Cubic (FCC)
b) Body-Centered Cubic (BCC)
c) Hexagonal Close-Packed (HCP)
d) None of the above

E) The highest linear atomic density (a.k.a. linear density) possible is:
a) 1 atom / R (200%)
b) 1 atom / 2R (100%)
c) 0.74 atoms / 2R (74%)
d) None of the above

6) [10 pts] Select the best answer, True or False (T/F).

A) If the atomic radius of a solute atom is much larger than the radii of the solvent it will likely have complete solubility if they have the same crystal structure **T F**

B) The planar atomic density can never be as high as 1 (100%). **T F**

C) For something to be considered an alloy it must contain at least two different elements and at least one of these must be a metallic element. **T F**

D) The coordination number is the ratio of the volume of atoms to the volume of a unit cell. **T F**

E) A mole is a cute fuzzy underground rodent that starred in the movie Caddy Shack. **T F**

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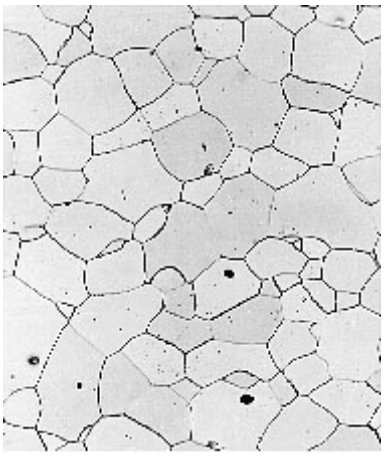
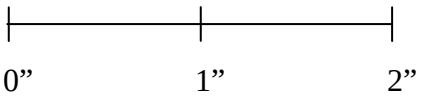
7) [10 pts] Determine the average grain diameter from the image shown below (100X). Draw 4 lines for your analysis. Show all your work.





8) [10 pts] Sketch (2-dimensionally) to help you describe what is meant by both “substitutional solid solution” and “interstitial solid solution.”