HOMEWORK #2 (55 PTS) **NAME:______KEY________________________________**

BMEN 343 **ID #:____**

DUE: 25 September 2009 at the BEGINNING OF CLASS:

- There are 2 pages (front and back) to this homework. Answers should be given neatly, in order, and in the space provided or in stapled attached pages if necessary. Show work for full credit. Put the final answer in a box when appropriate.

True or False:

1. **(2 pt)** T F The close-packed plane stacking sequence for HCP is "ABCABC…".
False: (HCP is "ABABAB…")
2. **(2 pt)** T F There is 1 atom in the interior mid-plane of a HCP (expanded) unit cell.
False (3 atoms)
3. **(2 pt)** T F In the rock salt (NaCl) crystal structure, the coordination numbers of anions and cations are both 8.
False (6 for NaCl and 8 for CsCl)
4. **(2 pt)** T F In the unit cell of CsCl, one cation is situated at the center of the cube.
True
5. **(2 pt)** T F In a FCC unit cell, atoms touch each other across a face diagonal.
True: face diagonal (for FCC) or body diagonal (for BCC)
6. **(2 pt)** T F In ZnS, ionic bonding predominates.
False (although a ceramic, small %ionic character)
7. **(2 pt)** T F Silica glasses do not have short-range order.
False (do not have long-range order)

Brief Answer

1. Provide a brief definition of "polycrystalline" (**4 pts**).

Refers to crystalline materials that are composed of more than one crystal or grains (collection of small crystals)

2. Explain why the ceramic silicon nitride has the formula: Si_3N_4. **(10 pts)**

Note: (a) In other words, why is the ratio of Si:N = 3:4. (b) To answer this question you must: for each element, specifically explain *what ions forms and why* (i.e. state the valence electronic configuration of each neutral atom and why it forms a specific charged ion). Can continue answer in space on top of page 2.

(3 pt) Si: **$3s^2 3p^2$** so it tends to form **Si^{4+}** by losing its 4 valence electrons (thereby creating a filled valence shell)

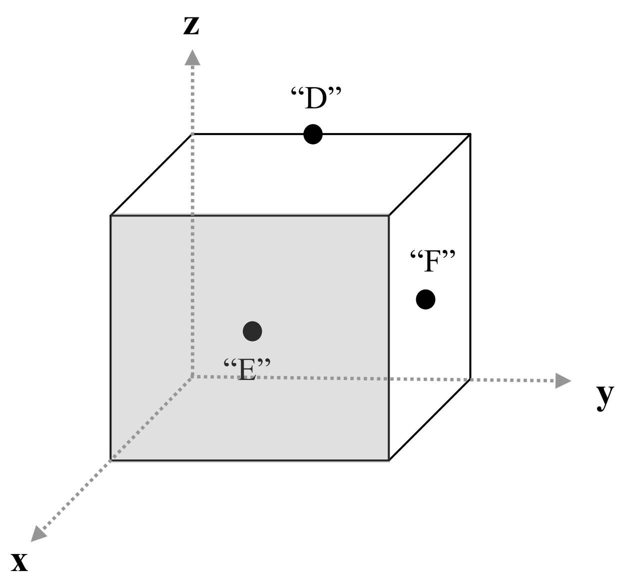
(3 pt) N: **$2s^2 2p^3$** so it tends to form **Ni^{3-}** by accepting 3 more valence electrons (thereby creating a filled valence shell)

(6 pt) Total crystal structure of ceramics must by **electrically neutral**. Charge of Si^{+4} and Ni^{3-} can only be balanced if Si:N = 3:4. (For credit, must indicate that charges must be balanced and this ratio fulfills it).

Problem Solving

2. Determine the *point coordinates* of the points "D", "E", and "F" designated within the cubic unit cell below. Fill in the table below. **(9 pts)**

Note: "**D**" is at the mid-point of the edge length; "**E**" is at the center of the "front face" (shaded), "F" is at the center "right face".

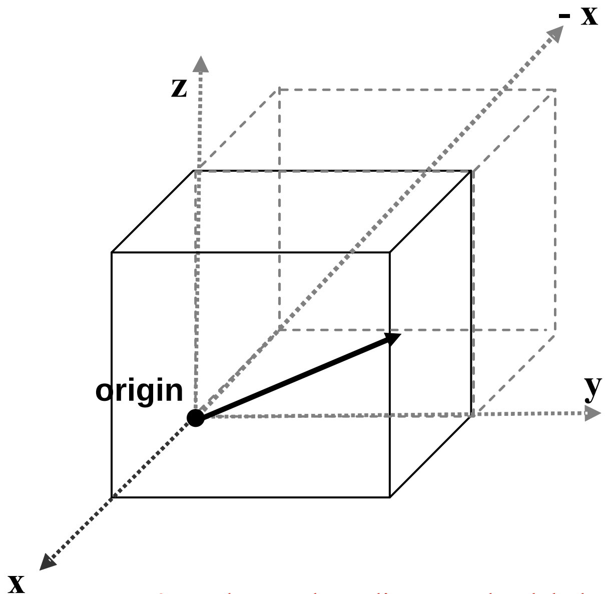


If brackets or parentheses, -1 point per each answer.
If commas, -1 per each answer.

	Fractional Lengths			
Point	***x axis***	***y axis***	***z axis***	***Point Coordinates***
D	0	1/2	1	0 ½ 1
E	1	1/2	1/2	1 ½ ½
F	1/2	1	1/2	½ 1 ½

2. Clearly draw a $[\bar{2}\ 1\ 0]$ direction within a cubic unit cell. Fill in table below. Label x, y, and z axes (and any negative axes) and origin. **(8 pts)**

Notes:
1. Complete the table.
2. Directional indices are the (a) point coordinates where vector ends (if vector ends at a corner) or (b) point coordinates reduced to smallest integer values (if vector ends at unit cell edge).



2 pt: draw cube, adjacent cube, label axes, label origin
6 pt: draw direction correctly—"adjacent cube" should be clearly drawn (or -2); the vector should clear hit the edge at 1/2 distance.

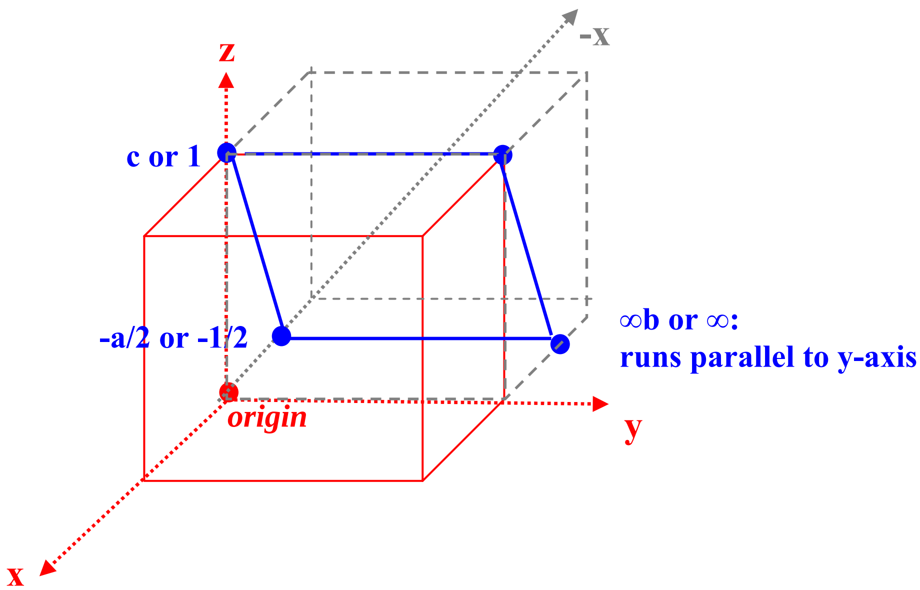
- If direction is correct, but table is incorrect, deduct one point for each incorrect entry.

	x axis	y axis	z axis
Projection	-a	a/2	0
Projection in terms of a	-1	1/2	0
Reduction	-2	1	0
Enclosure	$[\bar{2}$	1	0]

Note: Largest # is a reduction from 1. In this case, "2" is a reduction from 1.
Note: On exams, you will not be required to complete a table but it might help to do so.

3. Sketch within a cubic unit cell the following plane: $(\bar{2}\ 0\ 1)$. **Label** x, y, and z axes, intercepts, and the origin. If direction extends out of the cubic unit cell, draw the adjacent unit cell with a dashed line and label "negative" axes. Be sure to mark all intercepts *on/near your drawing*. **(10 pts).** You may construct a table to help you do this question but it is not required.

Notes:
Remember that the Miller Indices are the reciprocals of the axial intercepts.
1. Complete the table to determine intercepts.
2. Find each intercept by moving FROM THE ORIGIN along each designated axis the appropriate distance.
3. If plane extends outside of original unit cell, be sure you clearly draw the adjacent unit cell (e.g. with a dashed line) so that your intercepts and plane drawings are clear.



1 pt for cube; x, y, and z-axes; origin labeled
1 pt for –x axis labeled and drawn.
3 pt : 1 pt each for correct intercepts: **-a/2 or -1/2**(x axis); **∞b or ∞: runs parallel to y-axis; c or 1** (z-axis).
4 pt for plane drawn correctly: all or nothing

	x axis	*y axis*	*z axis*
Intercepts	-a/2	∞b	c
Intercepts in terms of a	-1/2	∞	1
Reciprocals of intercepts	-2	0	1
Reduction (not necessary, all integers)	-2	0	1
Enclosure	$(\bar{2}$	0	1)