

Name: \_\_\_\_\_

Geos 306  
2<sup>nd</sup> 2010 Midterm (100 pts)

1) (10 pts) Fill in the table that defines the shape and constraints of the unit cell parameters.

System	a	b	c	$\alpha$	$\beta$	$\gamma$
Cubic						
Hexagonal						
Tetragonal						
Orthorhombic						
Monoclinic						
Triclinic						

- 2) (20 pts) Draw a picture of a tetragonal lattice projected onto the  $a$ - $b$  plane (i.e. you do not need to show the  $c$ -direction); indicate the origin and the cell edges.
- Draw and label the vector  $[2 \ -1 \ 0]$ .
  - Draw and label the plane  $(2 \ -1 \ 0)$ .  
Assume  $a = 4 \text{ \AA}$ ,  $c = 6 \text{ \AA}$ .
  - Calculate the length of the  $[2 \ -1 \ 0]$  vector.
  - In this case,  $[2 \ -1 \ 0]$  is perpendicular to the  $(2 \ -1 \ 0)$  plane. Calculate the  $d$ -spacing of the  $(2 \ -1 \ 0)$  plane.
  - Using Cu radiation,  $\lambda = 1.54 \text{ \AA}$ , what position in  $2\theta$  would the  $(2 \ -1 \ 0)$  peak be found.

3) (30 pts) Fill in the missing point group symbols and indicate the crystal system for the point groups on a given row.

G	GUGi	HUG\Hi	System
1		n/a	
2			
3		n/a	
	4/m		
6			
	2/m2/m2/m		
322			
422			
	6/m2/m2/m		
332		n/a	

4) (10 pts) Make a careful drawing and derive Bragg's law for X-ray diffraction.

5) (15 pts) From the microprobe analyses of a solid-solution mineral, the following oxide weight percents were measured. Determine the chemical composition of this sample.

	Weight percent			
MgO	24.054			
SiO <sub>2</sub>	43.030			
FeO	8.576			
Al <sub>2</sub> O <sub>3</sub>	24.340			

Bonus: Name the solid-solution pair of minerals (5 points) (eg diopside-jadeite), or name the mineral (2 points), or name the mineral group (1 point).

- 6) (5 pts) Write down the number of your model and define its point group symmetry.
- 7) (10 pts) Forsterite,  $\text{Mg}_2\text{SiO}_4$ , is one of the most important minerals in the earth, comprising approximately 50% of the upper mantle. It is orthorhombic with cell edges  $a = 4.756 \text{ \AA}$ ,  $b = 10.207 \text{ \AA}$ ,  $c = 5.980 \text{ \AA}$  and  $Z = 4$  (i.e. 4 formula units per unit cell). Recall that Avogadro's number is  $6.023 \times 10^{23} \text{ mole}^{-1}$  and that  $10^8 \text{ \AA} = 1 \text{ cm}$ .
- Determine the cell volume of forsterite.
  - Determine the molecular weight of  $\text{Mg}_2\text{SiO}_4$ .
  - Determine the density of forsterite in units of  $\text{gm/cm}^3$ .