

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

Geos 306  
2008 Final (200 pts)

1. (20 pts) List 7 common types of bonding found in minerals along with a short description and an example of each.

2. (25 pts) Pyrope,  $\text{Mg}_3\text{Al}_2\text{Si}_3\text{O}_{12}$ , is an important rock-forming mineral whose presence indicates a high-pressure, or deep earth source. It usually has a deep red color and can be found with diamonds. Assuming the following radii,  $r(\text{O}) = 1.30 \text{ \AA}$ ,  $r(\text{Mg}) = 0.98 \text{ \AA}$ ,  $r(\text{Al}) = 0.65 \text{ \AA}$ ,  $r(\text{Si}) = 0.35 \text{ \AA}$ , then
- (15 pts) determine the coordination numbers of Mg, Al, and Si;
  - (5 pts) determine the number of Mg, Al and Si atoms to which each O is bonded.
  - (3 pts) What are the average MgO, AlO and SiO bond lengths?
  - (2 pts) Which is the weakest and which is the strongest bond in the pyrope structure.

3. (12 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						

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

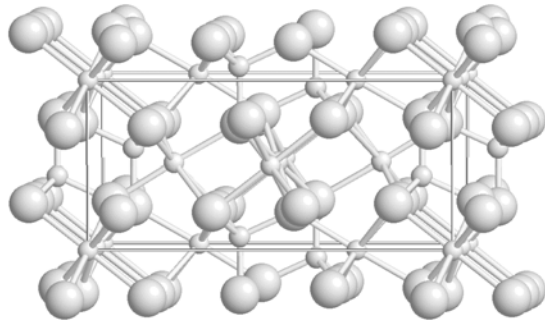
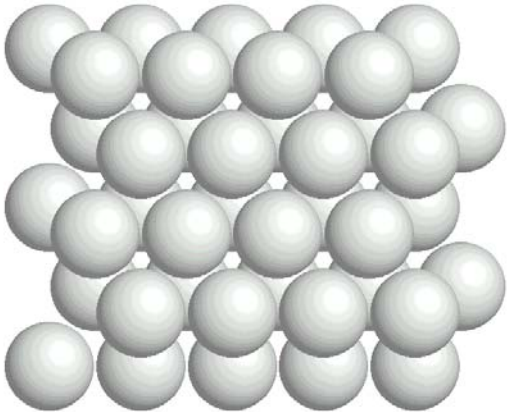
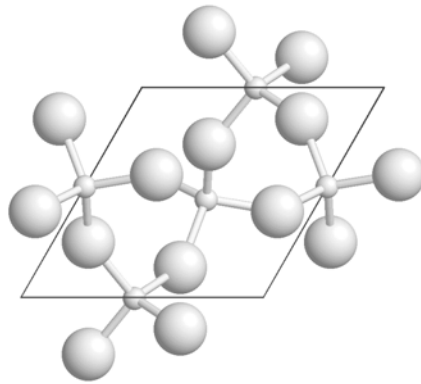
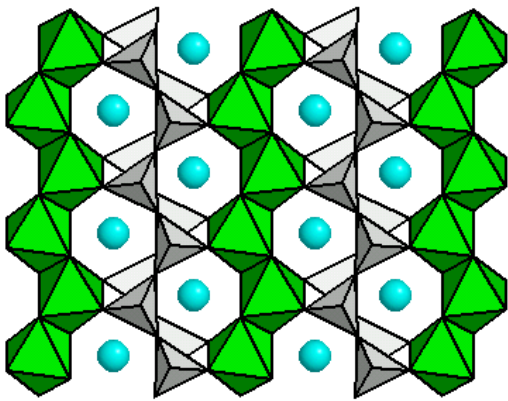
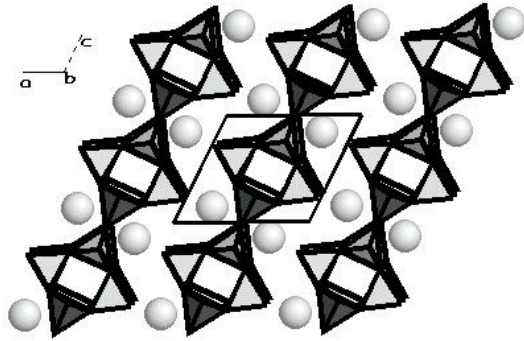
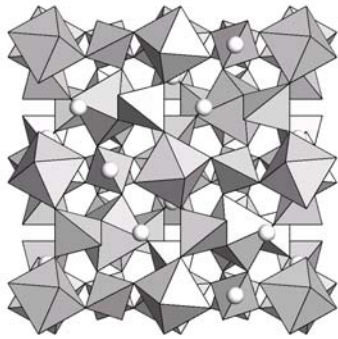
5. (20 pts) Pyrope,  $\text{Mg}_3\text{Al}_2\text{Si}_3\text{O}_{12}$ , is a cubic garnet with cell edges  $a = 11.459 \text{ \AA}$  and  $Z = 8$ . Recall that Avagadro's number is  $6.023 \times 10^{23} \text{ mole}^{-1}$  and that  $10^8 \text{ \AA} = 1 \text{ cm}$ .
- Determine the cell volume of pyrope.
  - Determine the molecular weight of  $\text{Mg}_3\text{Al}_2\text{Si}_3\text{O}_{12}$ .
  - Determine the density of pyrope in units of  $\text{gm/cm}^3$ .
  - Is its density higher or lower than quartz? Give a reason for your answer.

6. (20 pts) From the microprobe analyses of a spinel from San Carlos, Arizona, the following oxide weight percents were measured. Determine the chemical composition of this sample of spinel.

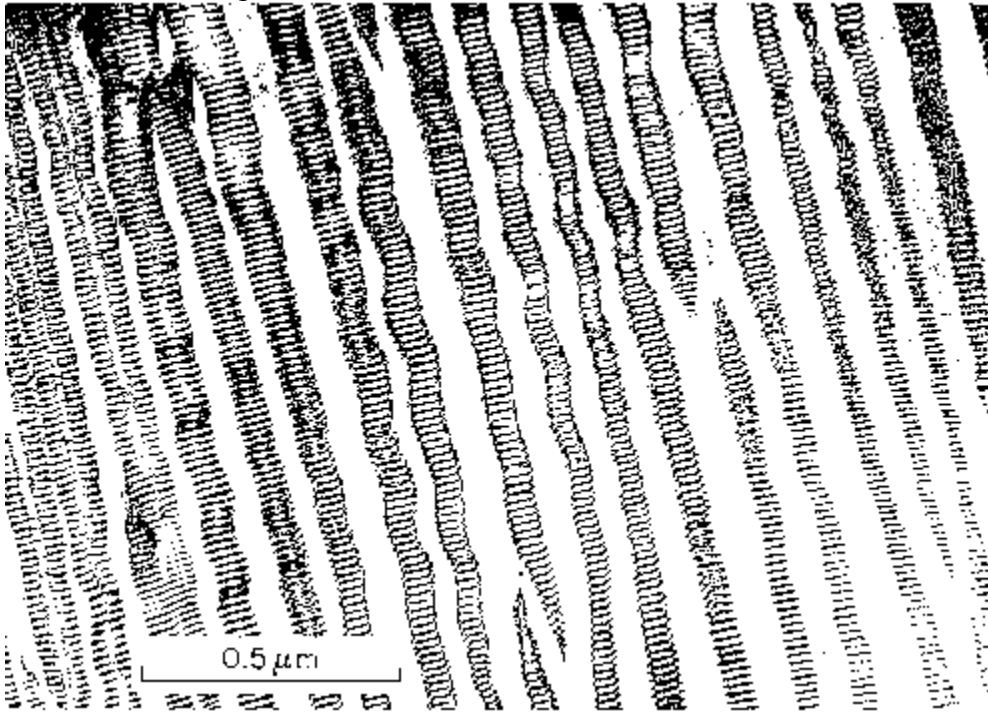
	Weight percent			
MgO	26.4			
Al <sub>2</sub> O <sub>3</sub>	53.6			
Cr <sub>2</sub> O <sub>3</sub>	20.0			

7. (20 pts) Sketch a diagram showing the structure of the earth. Include the surface and the center of the earth in your answer. Make a table and define the boundaries of each region by
- a) depth,
  - b) temperature, and
  - c) pressure.
  - d) List the important mineral phases that are found in each of the different regions.

8. (6 pts) For each illustration, provide representative mineral name and chemical formula for each.



9. (20 pts) The image provided below is an electron microscopic picture of a sample of feldspar, of bulk composition ~50% K-spar, ~30% albite, ~20% anorthite.
- Identify each of the 3 feldspar phases in the image.
  - Describe and explain their mixing properties. Provide your explanation at the atomic scale in terms of cation radii. Draw a ternary mixing diagram of the alkali cations that also shows the temperature effect.
  - Names each of the different phases defined by Al/Si ordering in the K-spars and in albite, including the type of temperature conditions you would expect to find these phases.



10. (9 pts) Draw the phase diagram of the natural silica polymorphs.
11. (4 pts) What are the 4 most abundant elements in the Earth and what are their atomic percentages?
12. (6 pts) Name three gemstones from the pyroxene group and give their chemical formulas.
13. (14 pts) Give the names and formulas for 7 different garnets.
14. (6 pts) Give the names and formulas for 3 different olivines.
15. (8 pts) Give the names and formulas for 4 different spinels.