

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

Geosciences 306, Mineralogy

First Midterm, 2010

100 pts

1. (10 pts)

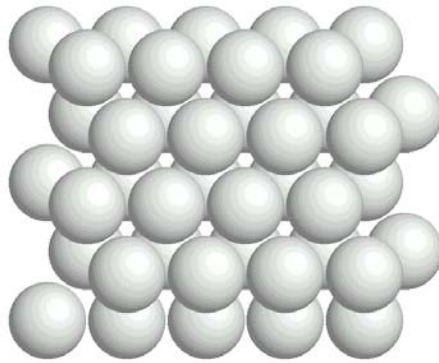
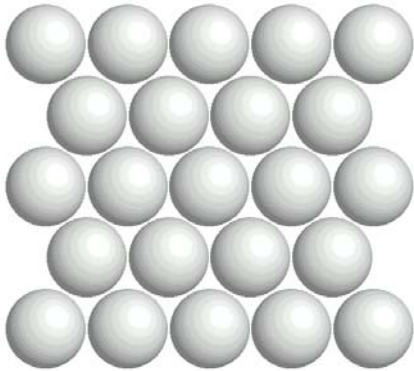
- a. What are the 4 most abundant elements in the Earth and what are their atomic percentages?
- b. For each of the four elements, name one mineral that contains the element.
- c. Write 5 charge balanced hypothetical ideal chemical formulas of minerals that contain combinations of ONLY these elements.

2. (20 pts) Describe the electronic structures of atomic magnesium (Mg), phosphorus (P) and iron (Fe) using spin diagrams. Make spin diagrams for  $\text{Fe}^{2+}$ ,  $\text{Fe}^{3+}$ .

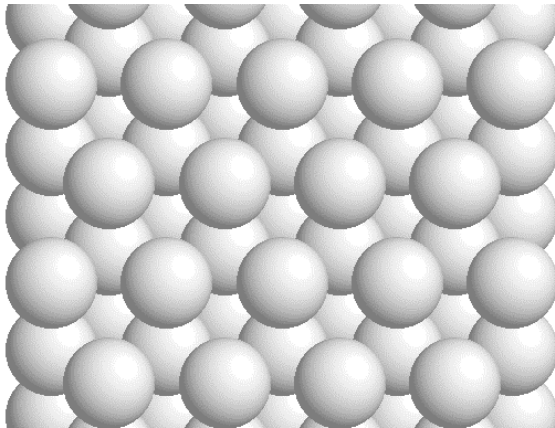
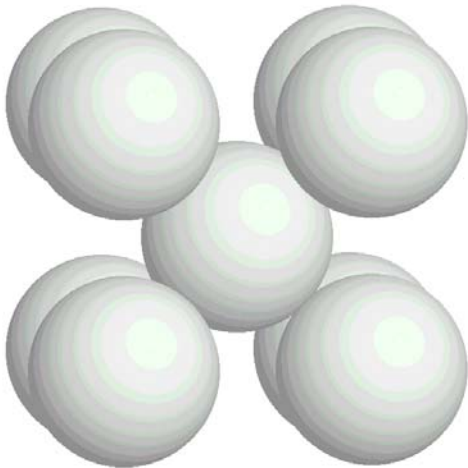
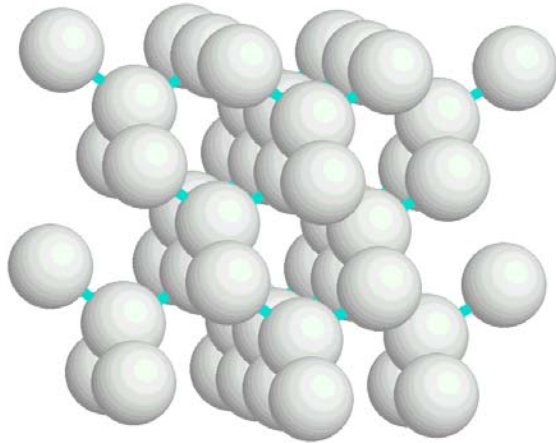
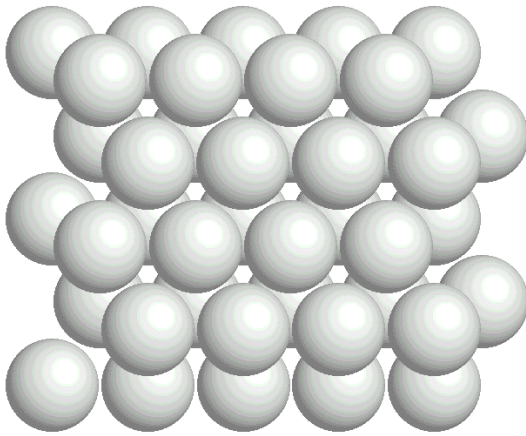
3. (10 pts) Derive the radius-ratio rule parameter ( $r_C/r_A = .155$ ) for an trigonal planar 3-coordinated cation. Draw a picture and carefully label everything so that your answer can be evaluated properly.

4. (15 pts) List 7 common types of bonding found in minerals along with a short description and an example of each.

5. a) (5 pts) Suppose the illustrated figures represent closest-packed arrangements of anions. Identify the different locations where cations could be coordinated with 2, 3, 4, 6, or 12 anions. In the position of the cation, write its coordination number.



- b) (5 pts) Label the packing type for each of the following diagrams.



6. (20 pts) Pyrope,  $\text{Mg}_3\text{Al}_2\text{Si}_3\text{O}_{12}$ , is an important rock-forming mineral whose presence usually indicates a high-pressure, or deep earth source. It 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.

7. (10 pts) From the microprobe analyses of a mineral, the following oxide weight percents were measured. Determine the chemical composition of this sample.

	Weight percent			
MgO	47.80			
CO <sub>2</sub>	52.20			

Bonus point: name the mineral!

8. (5 pts) The mineral stishovite is the high-pressure polymorph of silica found deep within the earth, or at meteorite impact sites. It is characterized as consisting of  $\text{SiO}_6$  polyhedra, rather than  $\text{SiO}_4$  as for the other silica polymorphs. Using a rationale based on Pauling's radius-ratio principles, explain why the Si goes from 4-coordinated in quartz to 6-coordinated in stishovite. What is the coordination number of the O atom in stishovite?