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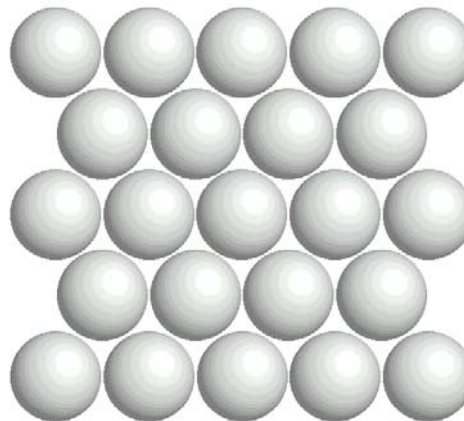
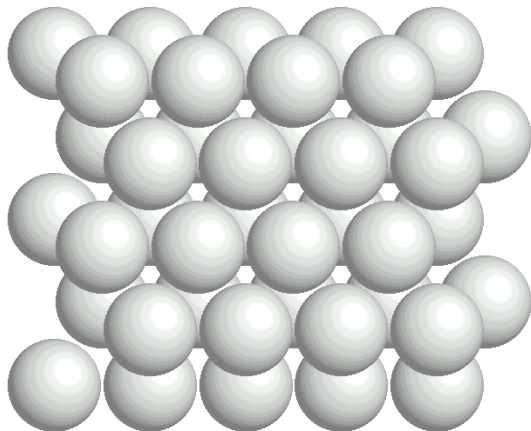
Geos 306, Mineralogy  
Midterm, Sept 14, 2005  
100 pts

1. (8 pts) What are the 4 most abundant elements found in the Earth and what are their atomic abundances?

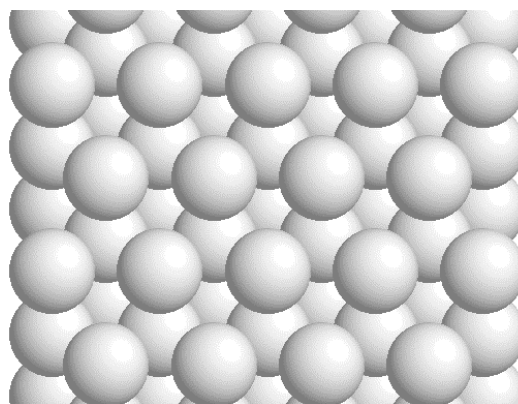
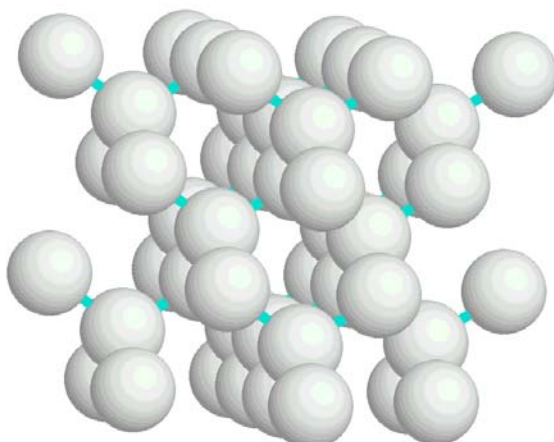
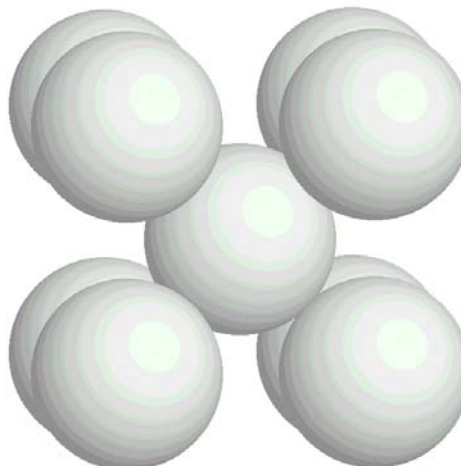
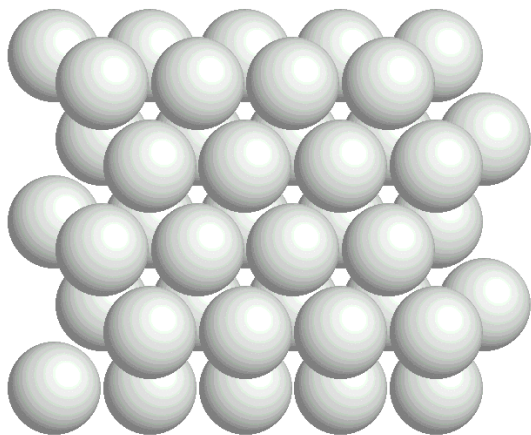
2. (12 pts) Make three spin diagrams that describe the electronic structures of atomic iron (Fe), and the two ionic states,  $\text{Fe}^{2+}$  and  $\text{Fe}^{3+}$ .

3. (20 pts) Enumerate the 7 types of bonding, with a short description and an example of each.

4. a) (10 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) (10 pts) Label the packing type for each of the following diagrams.



5. (15 pts) Derive the radius-ratio rule parameter ( $r_C/r_A = .414$ ) for a 4-coordinated square planar cation. Draw a picture and carefully label everything so that your answer can be evaluated properly.

6. (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 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.