

Name: _____

Geos 306
2007 Final (200 pts)

1. (20 pts) Construct electronic spin diagrams for Mg, Mg²⁺, Al, Al³⁺, S, S²⁻.

2. (20 pts) Barite, BaSO_4 , is an important mineral used to make paints, drilling mud, and put into a solution to drink so that X-rays can be used to follow the flow of fluids in the body.
- (12 pts) Determine the coordination numbers of Ba and S, and then determine the bonding arrangement around O. (Assume the following radii, $r(\text{O}) = 1.35 \text{ \AA}$, $r(\text{S}) = 0.31 \text{ \AA}$, $r(\text{Ba}) = 1.35 \text{ \AA}$).
 - (4 pts) What are the average SO and BaO bond lengths?
 - (4 pts) Which is the stronger bond, and why?

3. (5 pts) Draw a picture of a hexagonal lattice; indicate the origin and the cell edges. Then draw the vector $[210]$.

4. (10 pts) Consider a crystal with hexagonal symmetry, $a = 4.177 \text{ \AA}$, $c = 2.665 \text{ \AA}$.
- (a) Draw a figure showing the plane (110).
 - (b) Compute the d-spacing of (110)?
 - (c) Using Cu radiation, $\lambda = 1.54 \text{ \AA}$, what position in 2θ would the (110) peak be found.

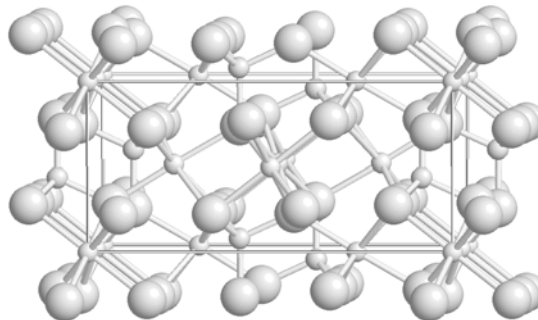
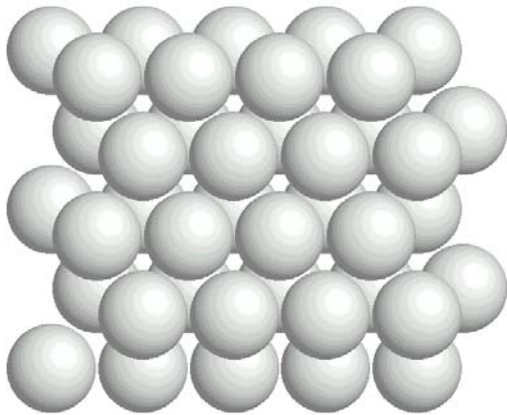
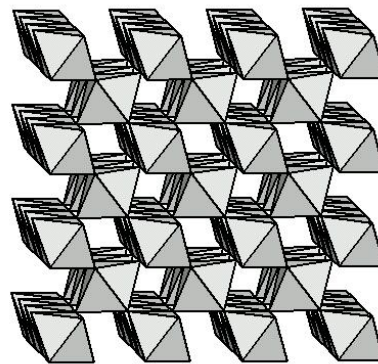
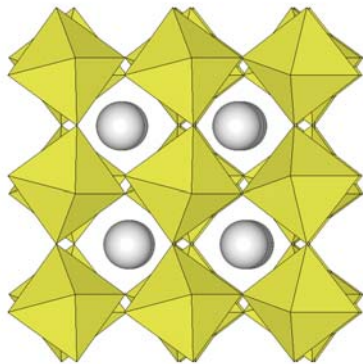
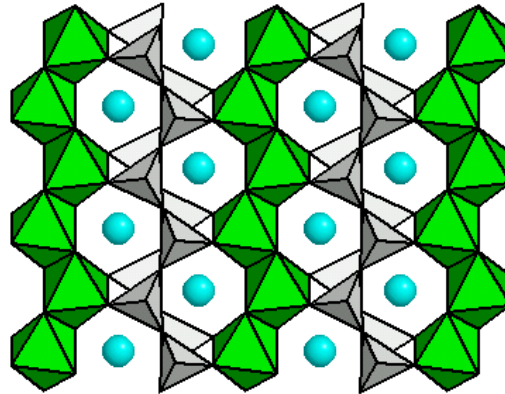
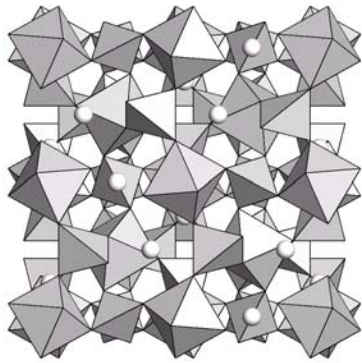
5. (20 pts) Enstatite is MgSiO_3 orthopyroxene with cell edges $a = 18.233 \text{ \AA}$, $b = 8.8191 \text{ \AA}$, $c = 5.1802 \text{ \AA}$ and $Z = 16$. Recall that Avagadro's number is $6.023 \times 10^{23} \text{ mole}^{-1}$ and that $10^8 \text{ \AA} = 1 \text{ cm}$.
- Determine the cell volume of enstatite.
 - Determine the molecular weight of MgSiO_3 .
 - Determine the density of enstatite.

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

	Weight percent			
Na ₂ O	11.82			
Al ₂ O ₃	19.44			
SiO ₂	68.74			

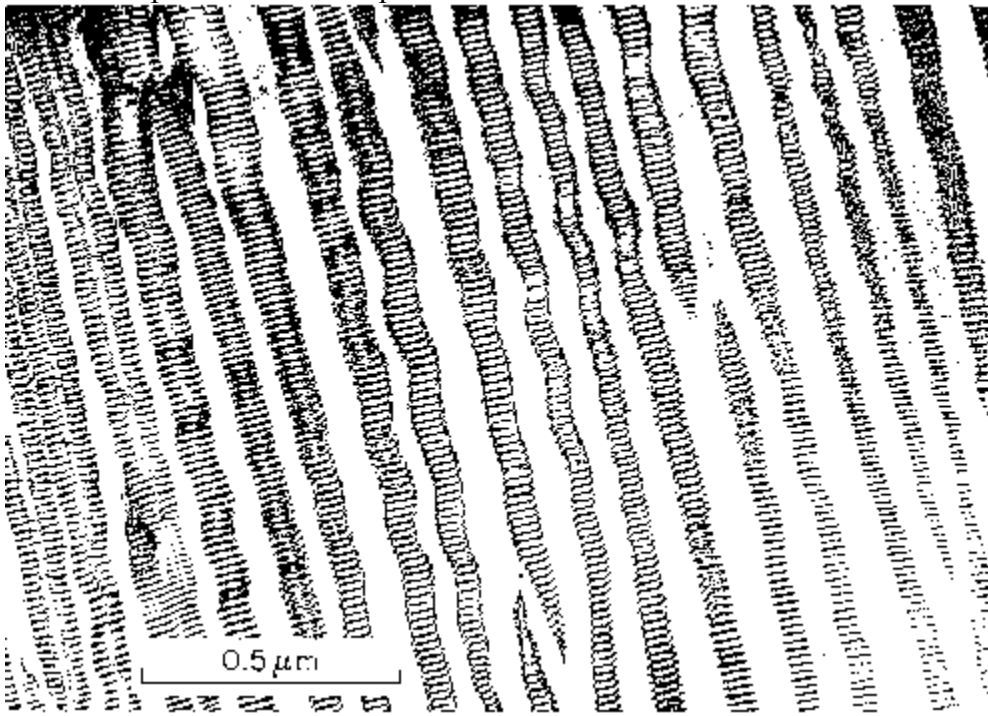
7. (20 pts) Sketch a diagram showing the structure of the earth. Make a table and define the boundaries of each region by
- depth,
 - temperature, and
 - pressure.
- Include the surface and the center of the earth in your answer.
- List the important mineral phases that are found in each of the different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

8. (20 pts) For each illustration:
- Provide representative chemical formula for each, assuming composition is from Mg,Fe,Si,O space.
 - Name the minerals whose structures are illustrated and whose chemistry matches that given in part a).



9. (5 pts) What is the geotherm?
10. (5 pts) What is the most common mineral phase in the Earth?
11. (5 pts) At the highest pressures, (for instance, like the pressures in the sun), what will happen to *compounds*, and why. Hint: think about the ways that FeO transforms under pressure.
12. (10 pts) Draw the phase diagram of the natural silica polymorphs.

13. (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.



14. (20 pts) a) What are the 4 most abundant elements in the Earth and what are their atomic percentages?

b) If we put all of these 4 elements into pyroxene, olivine and a metal component, what percentage of atoms would be in each phase? Ie. x% of the atoms are contained in pyroxene, y% are contained in olivine, and z% are in the _____ metal component.

c) If the remaining 6% of the elements were also oxides, then the metal component of the earth would increase by 6%. If this metal component completely occupied the core, what is the radius of the core? Assume the volume of the earth occupied by metals in the core is 16% (Note, this is a portion of the answer to part b)). Compare this to the observed radius of the core. Note that the volume of a sphere is $V = 4/3 \pi r^3$.