

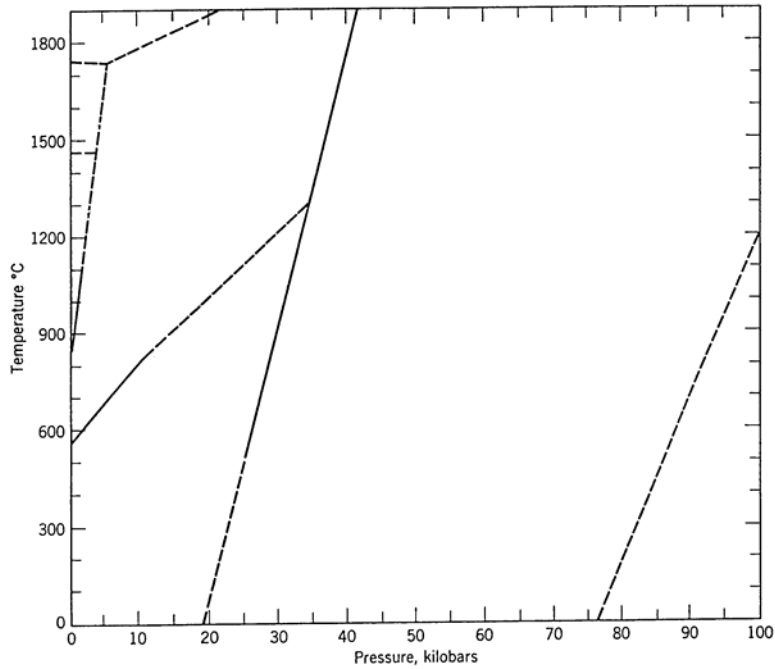
Name: \_\_\_\_\_

Geos 306  
2009 Final (200 pts)

1. (20 pts)
  - a) What are the 4 most abundant elements in the Earth and what are their atomic percentages?
  - b) Use these percentages to compute the maximum abundance of perovskite and magnesio-wustite in the lower mantle.

2. (10 pts) Apply Pauling's rules to quartz and stishovite and estimate which Si-O bond length is longer and which mineral has the stronger SiO bonds.

3. (20 pts) The following diagram is the phase diagram for silica.  
 a) Label the various regions.



- b) Suppose a diamond crystal was found with a coesite inclusion. Plot the geotherm onto the silica phase diagram and estimate the minimum depth that the diamond had to have come from. Use the following table for your estimate of the geotherm:

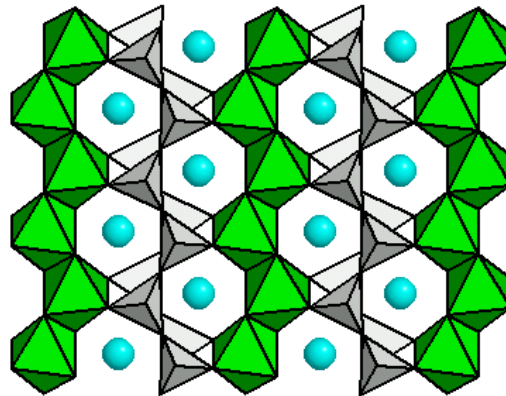
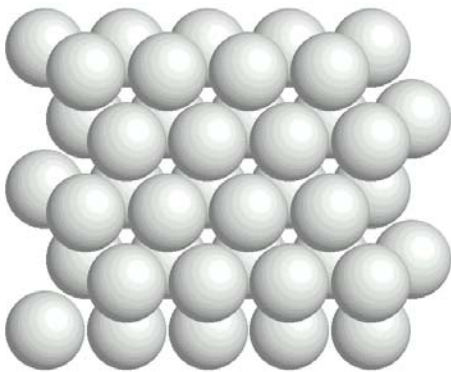
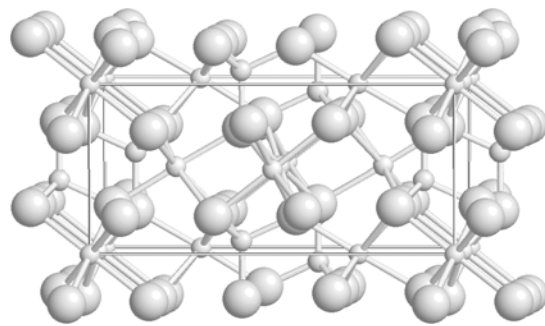
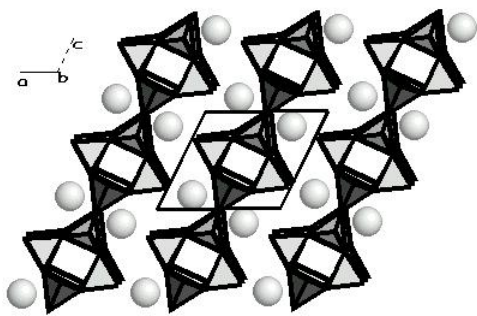
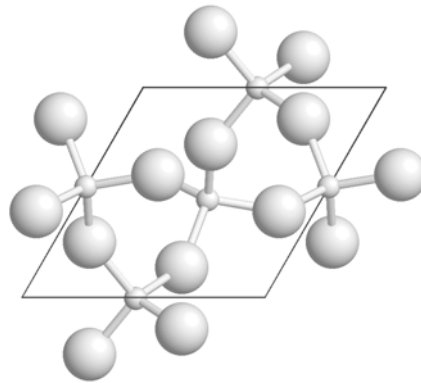
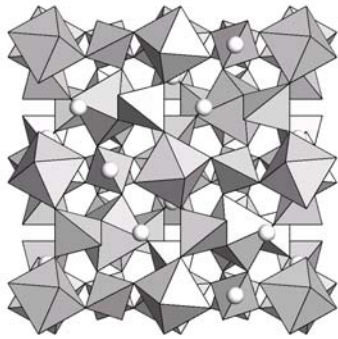
Depth (km)	P (GPa)	T (K)
0	0	300
3	.3	366
15	.337	630
24.4	.604	743
40	1.122	930
80	2.450	1155
150	4.780	1550
220	7.110	1622
310	10.2	1714

4. (20 pts) Enstatite,  $\text{MgSiO}_3$ , is an orthopyroxene with cell edges  $a = 18.23 \text{ \AA}$ ,  $b = 8.84 \text{ \AA}$ ,  $c = 5.19 \text{ \AA}$  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  $\text{MgSiO}_3$ .
  - Determine the density of enstatite in units of  $\text{gm/cm}^3$ .
  - Would you expect its density to be higher or lower than feldspar? Give a reason for your answer.

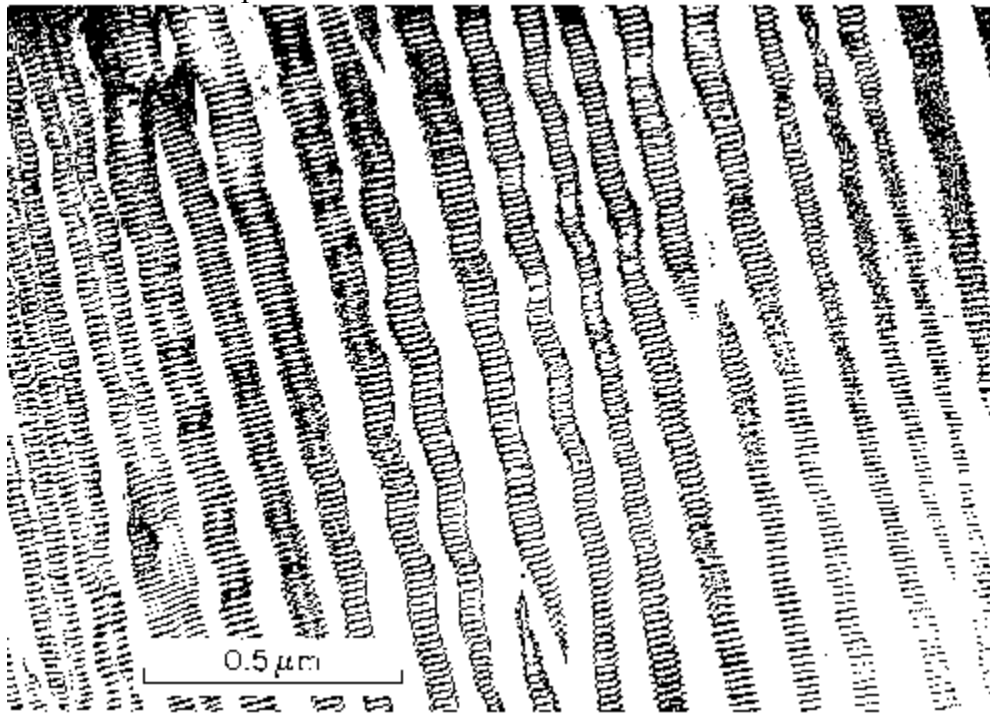
5. (20 pts) Write the chemical composition of diopside and then determine the weight percentages of its oxide components.

6. (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.

7. (10 pts) For each illustration, provide representative mineral name and chemical formula for each.



8. (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.



9. (14 pts) Give the names and formulas for 7 different garnets.

10. (6 pts) Give the names and formulas for 3 different olivines.

11. (8 pts) Give the names and formulas for 4 different spinels.

12. (12 pts) Give names and formula for 6 different pyroxenes.

13. (10 pts) Give names and formula for 5 different feldspars.

14. (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  $2\theta$  would the (110) peak be found.