

Name: _____

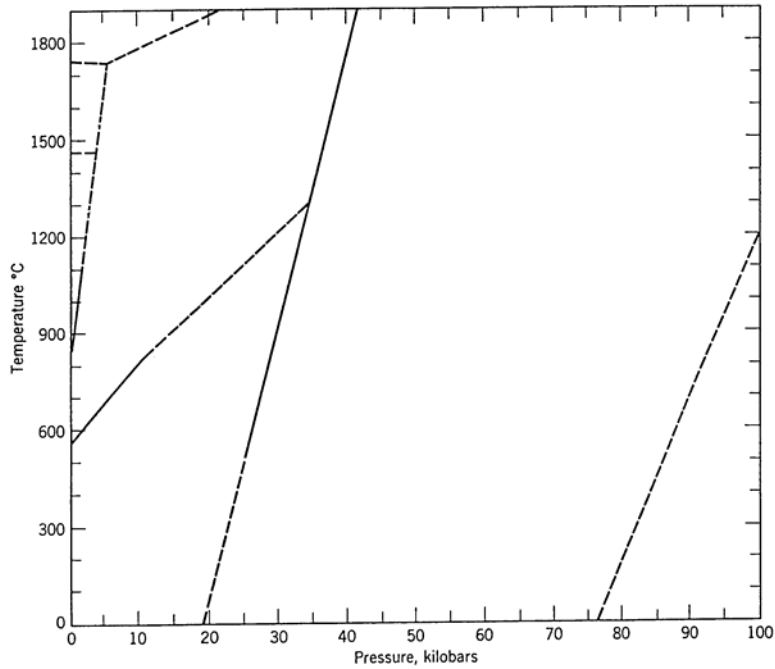
Geos 306
2010 Final (200 pts)

1. (20 pts)
 - a) What are the 4 most abundant elements in 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, as well as the iron metal content in Earth. Compute the radius of the core from the iron content.

2. a) (5 pts) What does the streak of a mineral represent?
b) (5 pts) What does the hardness of a mineral represent?

3. The following diagram is the phase diagram for silica.

a) (10 pts) Label the various regions.



b) (10 pts) 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 may have originated. Use the following table for your estimate of the geotherm:

Depth (km)	P (GPa) (note: 1 GPa = 10 kbar)	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

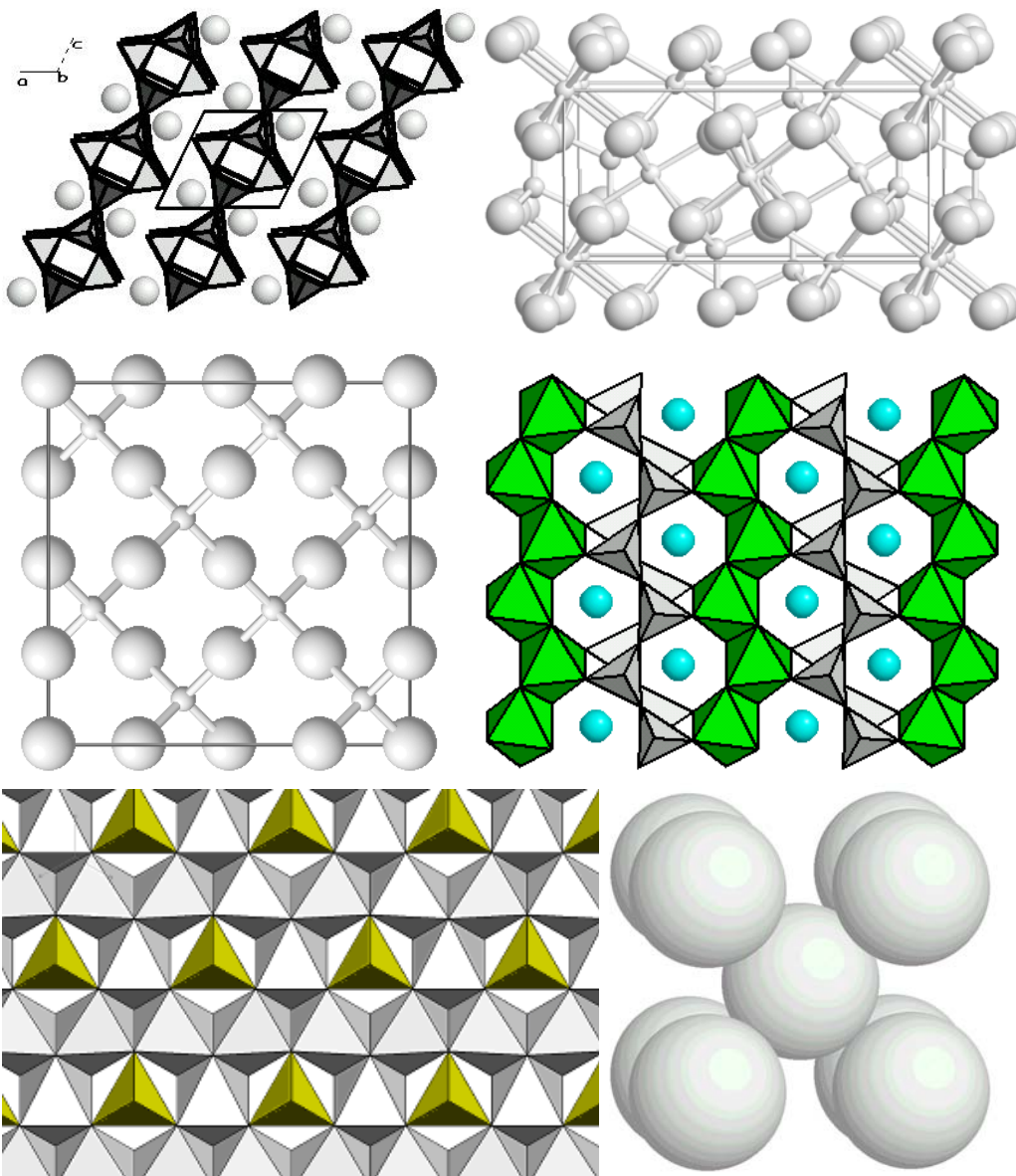
4. (20 pts) In a careful study of the crystal structure of $(\text{Mg}_{0.9}\text{Fe}_{0.1})_2\text{SiO}_4$ olivine, Birle et al (1968) determined that it is orthorhombic with cell edges $a = 4.762 \text{ \AA}$, $b = 10.225 \text{ \AA}$, $c = 5.994 \text{ \AA}$ and $Z = 4$. Recall that Avagadro's number is $6.023 \times 10^{23} \text{ mole}^{-1}$ and that $10^8 \text{ \AA} = 1 \text{ cm}$.
- Determine the cell volume of this olivine.
 - Determine its molecular weight.
 - Determine its density in units of gm/cm^3 .

5. (20 pts) From microprobe analyses the following oxide weight percents were measured. Determine the chemical composition of this sample and name the mineral.

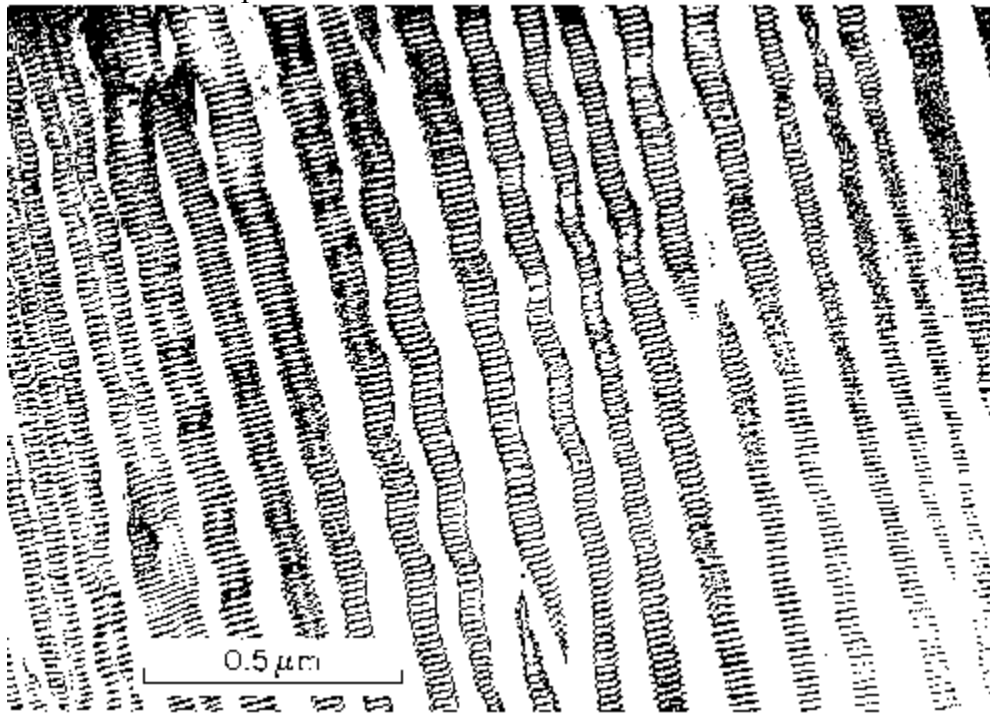
	Weight percent			
Ca	39.5			
P	18.5			
O	38.0			
F	3.8			

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
- depth,
 - temperature, and
 - pressure.
 - 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. (20 pts) (a) Construct electronic spin diagrams for Ca^{2+} , As^{3+} , As^{5-} , O^{2-} , H^{1+} .
(b) Make up two different charge-balanced chemical formulas using Ca^{2+} , As^{3+} , O^{2-} , H^{1+} .
(c) Make up two different charge-balanced formulas using Ca^{2+} , As^{3+} , As^{5-} , O^{2-} , H^{1+} .

10. (20 pts) Draw a picture of a tetragonal lattice projected onto the a - b plane (i.e. you do not need to show the c -direction); indicate the origin and the cell edges.

a) Draw and label the vector $[1 \ -1 \ 0]$.

b) Draw and label the plane $(1 \ -1 \ 0)$.

Assume $a = 3 \text{ \AA}$, $c = 8 \text{ \AA}$.

c) Calculate the length of the $[1 \ -1 \ 0]$ vector.

d) In this case, $[1 \ -1 \ 0]$ is perpendicular to the $(1 \ -1 \ 0)$ plane. Calculate the d-spacing of the $(1 \ -1 \ 0)$ plane.

Using Cu radiation, $\lambda = 1.54 \text{ \AA}$, what position in 2θ would the $(1 \ -1 \ 0)$ peak be found.

11. (5 pts) What is the geotherm?

12. (5 pts) What is the most abundant mineral in Earth?

13. (10 pts) Write a charge-balanced formula for magnetite. Which has the larger radius, Fe^{2+} or Fe^{3+} and why? Considering the sizes of Fe^{2+} and Fe^{3+} , which ones go into the octahedral or tetrahedral sites? Finally, is magnetite an inverse spinel or a normal spinel?