Mineralogy Exam 2 **Name**_____

2009 **NDSU Dept of Geosciences**

1. Matching: (2 points each; only one answer is necessary) [14 pts]

_____ polymorphs	A. example of a reconstructive phase transition
_____ 3-coordinated	B. CO_3^{2-}
_____ van der Waals	C. identical chemistry, but different crystal structures
_____ diamond —> graphite	D. halite structure group
_____ sanidine —> microcline	E. example of an order-disorder phase transition
_____ galena	F. a type of weak dipole bonding
_____ 6-coordinated	G. octahedral coordination

2. Short answer: (3 points each) [15 pts]

a. In our textbook, a mineral is named and classified mainly by what criteria?

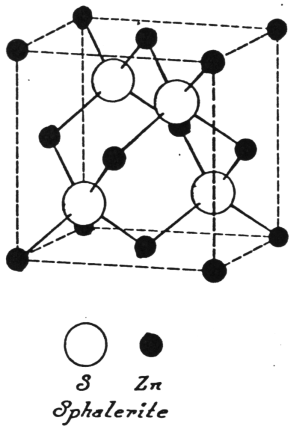
b. What is electronegativity?

c. For elements in the same column of the periodic table, the ionic radii _____ as the atomic number (Z) increases.

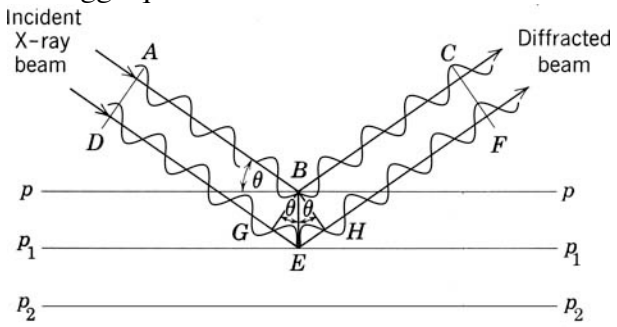
d. When the high quartz form of SiO_2 is cooled (at 1 atm) below 573°C, it instantly rearranges its structure to that of low quartz. This is an example of what kind of phase transition?

e. Describe why in a typical filament X-ray tube, both Kα and Kβ X-rays are produced from the target.

3. Draw a projection looking down the 001 direction onto the base of the sphalerite structure. Indicate the identity of the atoms and their locations using fractional coordinates. [6 pts]



4. For the following figure, name the distance B-E_____. What is the difference in path length between A-B-C, compared to D-E-F? _____. Does this geometry satisfy the Bragg equation? _____. [15 pts]



5. Ilmenite ($FeTiO_3$) can be processed to produce TiO_2 for paint pigments. [20 pts]

a. What is the weight % TiO_2 in ilmenite? FW TiO_2 = 79.90; FeO = 71.85

b. Titanium metal is also a product that can be recovered. What is the weight % Ti in ilmenite? FW of Oxygen = 16.00

6. A police detective asks you to identify a red powder that has been recovered from a suspect's vehicle. You decide to carry out an XRD analysis. [30 pts]

   a. Describe a typical glass slide preparation for XRD analysis.

   b. What information do you gain from a powder XRD analysis? What data are output, and what steps do you carry out to process the data and to identify the material?

c. You suspect the material is the mineral litharge. The PDF card is reproduced below.

- What is the crystal system of litharge? _____
- What is its point group? _____
- What is the volume of the unit cell? _____
- You measure a moderate peak at $2\theta = 48.593°$. Calculate the d of this peak using Bragg's Law (show all work). What peak (hkl) do you suspect this to be?

5-561

PbO

Lead Oxide — Litharge, syn

Rad. $CuK\alpha_1$ **λ** 1.5405 **Filter** Ni **d-sp**
Cut off **Int.** Diffractometer **$I/I_{cor.}$**
Ref. Swanson, Fuyat, *Natl. Bur. Stand. (U.S.), Circ. 539*, **II** 30 (1953)

Sys. Tetragonal **S.G.** P4/nmm (129)
a 3.9729 **b** **c** 5.0217 **A** **C** 1.2640
α **β** **γ** **Z** 2 **mp**
Ref. Ibid.

D_x 9.35 **D_m** **SS/FOM** $F_{27} = 25.9(0.023,46)$

εα **nωβ** 2.665 **εγ** 2.535 **Sign** **2V**
Ref. Ibid.

Color Red
X-ray pattern at 27 C. Sample from National Lead Company. Spectroscopic analysis: <0.01% Bi, Cu, Fe, Si; <0.001% Ca, Mg. Crystal system refined in 1975. Polymorph: massicot (tetragonal). Merck Index, 8th Ed., p. 613. Romarchite. PSC: tP4.

d Å	Int	hkl	d Å	Int	hkl
5.018	5	001	0.9365	3	330
3.115	100	101	0.9200	3	323
2.809	62	110			
2.510	18	002			
2.124	1	102			
1.988	8	200			
1.872	37	112			
1.675	24	211			
1.558	6	202			
1.542	11	103			
1.438	2	113			
1.405	5	220			
1.282	2	301			
1.256	3	310			
1.226	4	222			
1.219	5	311			
1.1977	<1	104			
1.1462	2	114			
1.1232	2	312			
1.0768	3	321			
1.0610	2	204			
1.0386	<1	303			
1.0254	<1	214			
0.9738	1	105			
0.9462	1	411			