Mineralogy Exam 2 **Name**_____
2015 **NDSU Dept of Geosciences**

1. Match the best answer: (2 points each; only one answer is necessary) [9 pts]

_____ metamict	A. example of omission solid solution
_____ 6-coordinated	B. has the outward crystal form of a different mineral
_____ pseudomorph	C. X-ray amorphous
_____ forsterite-fayalite	D. octahedral coordination
_____ …ABABABAB…	E. isostructural with hematite
_____ corundum	F. complete substitutional solid solution series
_____ pyrrhotite, $Fe_{(1-x)}S$	G. CO_3^{2-}
_____ 3-coordinated	H. cubic closest packing
_____…ABCABCABC…	I. hexagonal closest packing

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

a. CIRCLE the correct answer: Large atoms hold their outer valence electrons
more strongly / more loosely than do smaller atoms.

b. Halite (NaCl) has a _____-desmic bonding scheme. The Na+ ions have
_____ coordination.

c. We would expect NaF to be softer than MgO because:

d. 3. Why is graphite so soft (H = 1-2), yet also has such a high melting point (approx. 3650 °C)?

e. What is the valence of iron in hematite (Fe_2O_3)? What is the valence of pure metallic iron?

3. The water content of FeOOH can be determined by heating the sample and measuring the weight loss. Write a balanced chemical formula for the decomposition of FeOOH into oxides, assuming all iron is as Fe^{+3}. What would be the percent weight loss?
Atomic weights: Fe = 55.85; O = 16.00; H = 1.01 [15 pts]

4. Someone brings in a sample with metallic luster for identification. [15 pts]
You identify it as galena based on the following observed characteristics:

Crystallography (crystal system and point group) _____

Typical habit / cleavage _____

Hardness / Specific Gravity _____

Just to be sure, you analyze the sample using SEM-EDS. What information about the sample do you expect to learn from that instrument? How does the technique work (what are the inputs and outputs; draw a schematic diagram).

5. What are the Coordination Number and name of coordination polyhedron for: [12 pts]

Ca^{+2} and F^{-} in fluorite

Ca^{+2} CN _____ name_____

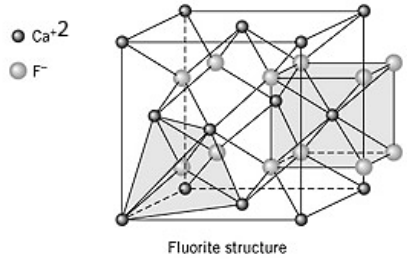
F^{-} CN _____ name_____

S^{2-} (A) and an empty position (B) in sphalerite

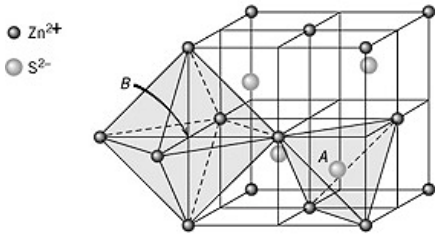
S^{2-} CN _____ name_____

(empty) CN _____ name_____

What are the chemical formulae for fluorite and sphalerite?



Fluorite structure



Sphalerite structure

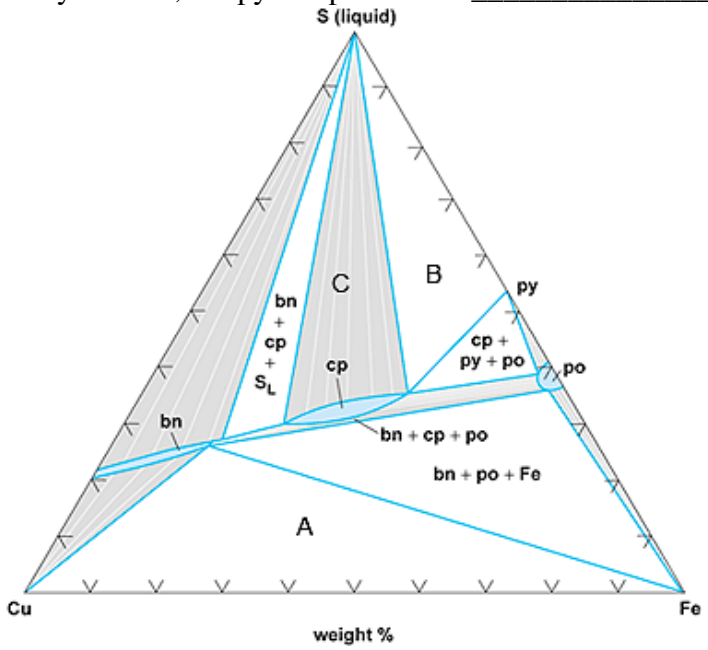
6. For the following compatibility diagram, what phases are stable at [16 pts]

point A? _____ point B? _____ point C? _____

What are the chemical formulae for

po _____ py _____ cp _____

Why is po represented by an area, but py is a point? _____



Phase relations in the copper-iron-sulfur system at 700°C (1290°F). Gray areas are 2-phase regions. The bornite and chalcopyrite phases are stable over considerable composition ranges. Vapor coexists with all phases and phase assemblages. Abbreviations are bn, bornite; cp, chalcopyrite; po, pyrrhotite; py, pyrite; S_L, liquid sulfur. (*After R. A. Yund and G. Kullerud, Thermal stability of assemblages in the Cu-Fe-S system, J. Petrol., 7:454–488, 1966*)

7. You find a white powder seemingly growing on the concrete in your basement. You decide to carry out an XRD analysis, and find a match with calcite (info below). [18 pts]

5-586 ★

$CaCO_3$

Calcium Carbonate — Calcite, syn

Rad. CuKα_1 **λ** 1.5405 **Filter** Ni **d-sp**
Cut off **Int.** Diffractometer **I/I$_{cor.}$** 2.00
Ref. Swanson, Fuyat, *Natl. Bur. Stand. (U.S.), Circ. 539*, **II** 51 (1953)

Sys. Rhombohedral (Hex) **S.G.** R$\bar{3}$c (167)
a 4.989 **b** **c** 17.062 **A** **C** 3.4199
α **β** **γ** **Z** 6 **mp**
Ref. Ibid.

D$_x$ 2.71 **D$_m$** 2.71 **SS/FOM** F$_{30}$=49.9(.0163,37)

εα 1.487 **nωβ** 1.659 **εγ** **Sign** − **2V**
Ref. *Dana's System of Mineralogy, 7th Ed.*, **2** 142

Color Colorless
X-ray pattern at 26 C. Sample from Mallinckrodt Chemical Works. Spectroscopic analysis: <0.1% Sr; <0.01% Ba; <0.001% Al, B, Cs, Cu, K, Mg, Na, Si, Sn; <0.0001% Ag, Cr, Fe, Li, Mn. Merck Index, 8th Ed., p. 190. Other form: aragonite. Calcite group, calcite subgroup.
*Not permitted by space group.
PSC: hR10.

d Å	Int	hkl	d Å	Int	hkl
3.86	12	012	1.1538	3	134
3.035	100	104	1.1425	1	226
2.845	3	006	1.1244	<1	12$\underline{1}$1
2.495	14	110	1.0613	1	20$\underline{1}$4
2.285	18	113	1.0473	3	404
2.095	18	202	1.0447	4	318
1.927	5	024	1.0352	2	10$\underline{1}$6
1.913	17	018	1.0234	<1	21$\underline{1}$3
1.875	17	116	1.0118	2	30$\underline{1}$2
1.626	4	211	0.9895	<1	321
1.604	8	122	0.9846	1	232
1.587	2	10$\underline{1}$0	0.9782	1	[13$\underline{1}$0]
1.525	5	214	0.9767	3	12$\underline{1}$4
1.518	4	208	0.9655	2	324
1.510	3	119	0.9636	4	408*
1.473	2	125	0.9562	<1	20$\underline{1}$6*
1.440	5	300	0.9429	2	410
1.422	3	00$\underline{1}$2	0.9376	2	22$\underline{1}$2
1.356	1	217			
1.339	2	02$\underline{1}$0			
1.297	2	128			
1.284	1	306			
1.247	1	220			
1.235	2	11$\underline{1}$2			
1.1795	3	21$\underline{1}$0			

- What is the crystal system of calcite, using our textbook's nomenclature? _____
- You measure a moderate peak at 2θ = 48.504°. Calculate the d of this peak using Bragg's Law (show all work). What peak (hkl) do you suspect this to be? _____
- Show how to calculate the c-axis length from the 0 0 6 and 0 0 12 peaks.

Extra credit: what are lodestones and what was an important use in the past centuries? [2 pts]