GLY4200C Name_____
90 points September 19, 2012
17 took exam - Numbers to the left of the question number in red are the number of incorrect responses. Instructor comments are in blue.

Florida Atlantic University
MINERALOGY -- MIDTERM 1 EXAMINATION KEY

True-False - Print the letter T or F in the blank to indicate if each of the following statements is true or false. Illegible answers are wrong. (1 point each)

1 T 1. In any stable chemical bond, energy is released as the two atoms or ions combine.

1 F 2. Anions are atoms which have gained one or more electrons, and which are positively charged.

1 F 3. Specific gravity has the dimensions of g/cm^3 in mineralogy.

5 F 4. A clear, colorless piece of calcite is said to have a transparent luster.

6 T 5. The 2p subshell has a smaller average size than the 3p subshell.

0 F 6. The 5f subshell can hold a maximum of ten electrons.

2 T 7. Covalently bonded substances are sometimes composed of discrete molecules.

12 F 8. In an atom, the number of protons must equal the number of neutrons. protons = electrons

3 T 9. Large ions are easier to polarize than small ions.

2 F 10. Moh's scale of hardness is a linear scale.

1 T 11. Properties like piezoelectricity, pyroelectricity, and electrostriction may be described by tensors of various orders.

1 T 12. Streak color is a more reliable tool for identification of minerals than is the actual color.

3 F 13. Covalently bonded substances yield ions in aqueous solution.

5 T 14. In the Bohr model of the atom, electrons are distributed in specific orbits of discrete energy levels (AKA shells).

2 T 15. Non-metallic elements are found on the right side of the periodic table.

5 F 16. Structures containing V, VII, IX, and X coordinated ions are always found in structures in which the anions are close-packed. See text, page 73

___ 17. Question repeated - omit

5 T 18. Piezoelectricity is a directional property, which is described mathematically as a third-order tensor.

2 T 19. There are several ways to turn an atom into an ion, such as heat, light, or the exchange of electrons with another atom.

1 T 20. The manner in which elements are held together, the chemical bond, determines many physical properties displayed by minerals.

Multiple-Choice - Choose the best response to each statement or question. Print the letter corresponding to your choice in the blank. (1 point each)

1 A 1. The bonding in diamond is of what type?
A. Covalent
B. Ionic
C. Van der Waals
D. Hydrogen

3 B 2. What is the coordination number of the Al^{3+} ion in tetrahedral coordination?
A. III
B. IV
C. VI
D. VIII

2 C 3. The bonding between layers in graphite is due to what type of bonds?
A. Covalent
B. Ionic
C. Van der Waals
D. Metallic

6 A 4. The electrostatic valency principle was first stated by:
A. Linus Pauling Rule 2
B. James Dana
C. Wolfgang Pauli
D. Neils Bohr

2 C 5. The quantum number ℓ for a given orbital is one. What letter designates this orbital?
A. d
B. f
C. p
D. s

5 A 6. Which type of orbital is being filled across the Second Transition row?
A. d
B. f
C. p
D. s

14 C 7. One centimeter is equivalent to how many nanometers? The question asked for cm to nm, NOT nm to cm
A. 10^{-9}
B. 10^{-7}
C. 10^{7}
D. 10^{9}

1 C 8. Schiller luster is an example of what property?
A. Luster
B. Diaphaneity
C. Iridescence
D. Allochromatic

1 B 9. A glass-like luster is:
A. Adamantine
B. Vitreous
C. Resinous
D. Pearly

4 D 10. In cubic (hexahedral) coordination, the coordination number is:
A. III
B. IV
C. VI
D. VIII

3 C 11. Most of the volume of an atom is filled by:
A. Neutrons
B. Protons
C. Electrons
D. The nucleus

7 C 12. Which of the following cations would be most likely to share a face in octahedral coordination?
A. Al^{3+}, 0.051nm
B. Be^{2+}, 0.035nm
C. K^{+}, 0.133nm
D. Si^{4+}, 0.039nm

1 B 13. Minerals like the micas, which can be bent without breaking, but which return to their original shape after bending, are:
A. Adamantine
B. Elastic
C. Flexible
D. Malleable

0 A 14. The hard, brilliant luster characteristic of diamond is:
A. Adamantine
B. Pearly
C. Resinous
D. Vitreous

2 A 15. When two minerals have the same structure but different chemical compositions they are:
A. Isostructural
B. Polytypous
C. Polymorphous
D. Pseudomorphous

4 D 16. If n=4, the maximum value of ℓ is?
A. Zero
B. 1
C. 2
D. 3

9 B 17. The quantum number which determines the orientation of the orbital in space is the:
A. Azimuthal quantum number - shape of the orbital
B. Magnetic quantum number - location in space
C. Principal quantum number
D. Spin quantum number

2 C 18. The reflection of light from a mineral's surface is a property called:
A. Color
B. Diaphaneity
C. Luster
D. Opalescence

2 D 19. Heat detectors often use which of the following mineral properties?
A. Diaphaneity
B. Fluorescence
C. Magnetism
D. Pyroelectricity

0 B 20. Compounds ending in ? are simple binary compounds containing 2 elements.
A. -ate
B. -ide
C. -ite
D. None of the above

0 C 21. Which of the following is not true of minerals?
A. They are crystalline
B. They exhibit a small range of chemical and physical properties
C. They are formed by the processes of organic nature
D. They are naturally occurring

0 D 22. Which type of minerals may be cut with a knife?
A. Ductile
B. Elastic
C. Malleable
D. Sectile

5 D 23. The effective radius of an ion depends on:
A. The type of neighboring ions
B. The number of neighboring ions
C. The charge of the ion
D. All of the above

1 D 24. Which quantum number has allowed values ±½?
A. *l*, azimuthal quantum number
B. m, magnetic quantum number
C. n, principal quantum number
D. s, spin quantum number

3 C or D 25. When cations and anions have similar sizes, the radius ratio approaches one. What is the coordination number? See text, page 71

A. IV
B. VI
C. VIII
D. XII

14 B 26. Which of the following ions is found with C.N. = III? Small r.r. of 0.155-0.225, so you need a small cation - also C occurs in CO_3^{2-} group used as an example in class

A. Al^{3+}
B. C^{4+}
C. Fe^{3+}
D. Na^{+}

Valance Electrons - List the valence electrons of the following species. (1 point each)

5 1. Cl $3s^2\ 3p^5$

7 2. Ca $4s^2$ 3d electrons are not valence electrons here

7 3. Ni $3d^8\ 4s^2$

Valance States - List the most common valance states of each of the following ions, unless a particular state is designated. (1 point each) Be sure to include the sign.

Example: Cr +3

2 1. Li +1

3 2. Cl -1

1 3. Al +3

8 4. Eu (Europous) +2 You need to remember that REE elements are usually 3+, except for Eu, which can be 2+, and that -ous is the lower oxidation state

Fill-Ins - Write in the word or words which best completes each statement or answers each question. (1 point per blank)

1 1. The Si-Si distance in silicon metal is 0.234nm. What is the Si radius? 0.117 nm

4 2. When the bonding is partially covalent, partially ionic, the bond is said to be a RESONANT bond.

1 3. How many significant figures are expressed in the number 0.00537? THREE

5 4. When a mineral possesses cleavage in two or more directions what property, in addition to the number of cleavage directions present, must be specified? THE ANGLE BETWEEN THE CLEAVAGE PLANES MUST BE SPECIFIED

5-7. List three species (atoms or ions, as indicated) with the electronic configuration

$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6$

3 5. Ar (Atom)

5 6. Cl^-, S^{2-} (Anion)

7 7. K^+, Ca^{2+}, Sc^{3+} (Cation)

2 8. Electrons that are available for chemical bonding are called VALANCE Electrons

4 9. Which ion is larger, Mn^{2+} or Mn^{3+}? Mn^{2+}

4 10. ELECTRONEGATIVITY is a measure of the ability of an atom in a crystal structure to gain or lose electrons to its outer shell.

Matching - Match the discovery in column one with the person associated with the discovery in column two. Answers may be used once, more than one, or not at all (One point each)

	Column 1	Column 2
1	Q 1. The first person to discover a second variety of the same element, thus originating the concept of isotopes.	A. Georgius Agricola B. Lorenzo Romano Amedeo Carlo Avogadro C. Johann Jakob Balmer D. Niels Henrik David Bohr E. Marie Sklodowska-Curie F. Paul Jacques Curie G. Pierre Curie H. Louis Victor De Broglie I. Fritz Wolfgang London J. Dmitri Ivanovich Mendeleev K. Friedrich Mohs L. Henry G.J. Moseley M. Wolfgang Ernst Pauli N. Linus Carl Pauling O. Erwin Schrödinger P. Nicholas Steno Q. Harold Clayton Urey R. Johannes Diderik van der Waals
0	K 2. Hardness is often measured by comparing the hardness of an unknown mineral with a series of known minerals on the scale invented by this person.	
2	D 3. Danish scientist who proposed an early model of the atom.	
1	F,G 4.The discovery that a momentary charge is developed when certain crystals are squeezed in 1881 was by these two men.	
3	O 5. Quantum theory predicts the allowed orbitals of electrons are solutions of whose equation?	
3	E 6. This person proposed the first theory of radioactivity, and won Nobel Prizes for two different scientific disciplines.	
5	N 7. This person won the Nobel Prize in Chemistry in 1954 for his work on the nature of the chemical bond.	
3	A 8. German physician who published *De Re Metallica* in 1556, which signaled the emergence of mineralogy as a science. See text, page 10	

Discussion questions - Write a complete, concise answer to each of the following questions. Diagrams (labeled) may be used to supplement your written answers, where appropriate. Points as shown

15.5 1. Diamond is the highest naturally occurring mineral, and graphite is one of the softest. Both are made of carbon. Explain what causes the extreme difference in the hardness behavior of these minerals. What does the name "graphite" allude to? (3 points)

IN DIAMOND, THERE IS A THREE DIMENSIONAL NETWORK OF COVALENT CARBON-CARBON BONDS, ALL OF EQUAL STRENGTH. IN THE GRAPHITE STRUCTURE, CARBON ATOMS WITHIN A PLANE ARE COVALENTLY BONDED, BY BONDS WHICH ARE STRONG THEN THE C-C BONDS IN DIAMOND. BUT THE BONDS BETWEEN LAYERS IN GRAPHITE ARE RESIDUAL VAN DER WAALS BONDS, WHICH ARE VERY WEAK. THEY BREAK EASILY, GIVING GRAPHITE AN EXTREMELY LOW HARDNESS. THE NAME GRAPHITE ALLUDES TO THE ABILITY OF GRAPHITE TO RUB OFF EASILY, EVEN ON SUBSTANCES AS SOFT AS PAPER, THUS PRODUCING "WRITING".

41.5 2. Why does xenon have a higher boiling point than neon? (3 points)

BONDING IN THE INERT GASES IS DUE TO INDUCED TEMPORARY DIPOLES, THE "DIPOLE-DIPOLE" TYPE OF VAN DER WAALS BONDING. XENON IS A MUCH LARGER ATOM THAN NEON, WITH MANY MORE ELECTRONS. THE MORE ELECTRONS PRESENT, AND THE LARGER DISTANCE THROUGH WHICH THEY CAN MOVE, THE BIGGER THE POSSIBLE TEMPORARY DIPOLES AND THEREFORE THE BIGGER THE DISPERSION FORCES. THUS, XENON ATOMS ARE "STICKIER" OR MORE STRONGLY BONDED THAN NEON ATOMS, AND XENON HAS THE HIGHER BOILING POINT.

40.5 3. Give the equation for Coulomb's Law, and define all symbols used in your equation. (4 points)

$$F \simeq (Z_1 Z_2)/r^2$$

where F is the force of attraction between ions, Zi = charge on each ion and r is the distance between ions.

37.0 4. Which compound, NaF or MgO, would you expect to have the highest melting point? Why? (3 points)

The compounds are ionic, so Coulombs law, $F = (Z_1 Z_2)/r^2$, is applicable. MgO, where both ions have double charges, should have much stronger bonds than in NaF, where both ions have single charges. Stronger bonds mean the boiling point of MgO should be considerably higher. MgO actually melts at 2820°C, while NaF melts at 988°C.

Problems - Do each of the following problems. Show all work. Label answers, including units, if any. Express answers to the correct number of significant figures. List any formula used, and defined all symbols used in the formula. "Miraculous answers", unsupported by all necessary calculations, will receive little or no credit.

21.0 1. The mineral stibnite, Sb_2S_3, is orthorhombic with cell dimensions a = 1.122 nm, b = 1.130 nm, c = 0.384 nm. Z = 4. What is the calculated value of the density? (5 points)
Data: Atomic weights: Antimony, 121.75; Sulfur, 32.064

D = (Z x M)/ (N x V)

$$M = (2(121.75) + 3(32.064)) = 339.692$$

$$V = a \bullet b \bullet c = (1..122 \bullet 10^{-7})(1.130 \bullet 10^{-7})(0.384 \bullet 10^{-7})$$
$$= 4.869 \bullet 10^{-22}\, cm^3$$

$$D = \frac{4(339.692)}{(6.023 \bullet 10^{23})(4.869 \bullet 10^{-22})} = \frac{1358.77}{293.26} = 4.63 \frac{g}{cm^3}$$

5.0 2. Calculate the specific gravity of a mineral whose weight in air is 3.13 grams and whose weight in water is 2.11 grams. (3 points)

$$\frac{W_a}{W_a - W_w} = SG$$

$$\frac{3.13}{3.13 - 2.11} = \frac{3.13}{1.02} = 3.07$$

Midterm 1 Results

81.5	A-	
76.0		
75.5		
75.0	B	
71.5		
70.5	C+	
68.5		**MEAN = 68.3 (75.8%)**
67.5		
67.0 - 2		**MEDIAN = 67.2**
66.0		
65.5 - 2	C	
64.5		
64.0	C-	
61.5	D+	
53.5	F	

Previous Years Results - Midterm 1 - 9th out of 20

Term, Year	Mean (percent)
Fall, 2012	75.8
Fall, 2011	69.8
Fall, 2010	73.8
Fall, 2009	72.2
Spring, 2009	71.0
Fall, 2007	76.5
Fall, 2006	80.8
Fall, 2005	68.5
Spring, 2004	65.7
Fall, 2002	81.3
Spring, 2001	70.5
Spring, 2000	74.7
Fall, 1998	74.3
Fall, 1997	72.8
Fall, 1996	80.4
Fall, 1995	76.0
Fall, 1994	78.6
Fall, 1993	85.6
Fall, 1992	86.9
Fall, 1991	90.4