GLY4200C Name_____

90 points September 18, 2019

4 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)

3 F 1. Edward Salisbury Dana said minerals always have "a certain characteristic atomic structure which is expressed in its crystalline form and other properties."

0 T 2. Mineral identifications are made on the basis of a combination of tests for different properties. No single test, or single property, is enough to identify a mineral.

1 F 3. Luster refers to the transmission of light through a mineral.

0 T 4. Streak color is much more likely than color to be diagnostic in identifying a mineral.

3 T 5. The 3d orbitals lie between the 4s and 4p orbitals, so the 4s orbital is filled before the 3d.

3 F 6. Ionic, covalent, and metallic bonds are examples of intermolecular bonds. Intramolecular

1 T 7. When a chemical bond is formed, energy is released.

0 T 8. Most minerals are compounds.

2 F 9 Minerals whose bonds are at least partially metallic are transparent in thin section.

0 F 10. Dispersion forces are only experienced in molecules with permanent dipoles.

0 F 11. If a crystal has more than one type of bond the strongest bonds present determine the physical properties, which may be very directional.

1 T 12. For ionically bonded substances, coordinated ions always cluster about the coordinating ion in such a way that their centers lie at the apices of a polyhedron.

2 T 13. X-rays, which have a shorter wavelength than light, are able to be diffracted by crystals whole interplanar spacings are near the wavelength of the X-radiation.

3 F 14. High-spin ferrous ion is larger than low-spin ferrous ion.

2 T 15. Ionic radii increase with increasing coordination number.

2 F 16. Ionic radii increase with increasing oxidation state.

0 T 17. If one orbital contains two electrons, the "s" quantum number for these electrons cannot be the same

1 F 18. Ionic bonds are highly directional.

0 F 19. Anions are atoms which have gained one or more electrons, and which are positively charged.

0 T 20. Minerals which show a true, characteristic color are said to be idiochromatic.

0 T 21. Properties like piezoelectricity, pyroelectricity, and electrostriction may be described by tensors of various orders.

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

0 C 1. The definition of a mineral says that minerals are produced naturally. What is the one exception to this idea?
A. Materials produced by volcanic eruptions
B. Materials produced by meteorite impacts
C. Biomineralization
D. All of the above

1 B 2. A copper penny would fall between which pair of minerals on the Moh's scale of hardness?
A. Talc-gypsum
B. Calcite-fluorite
C. Apatite-orthoclase
D. Quartz-topaz

0 D 3. The terms brittle, ductile, elastic, flexible, and malleable describe which property?
A. Cleavage
B. Fracture
C. Hardness
D. Tenacity

0 B 4. The terms conchoidal, fibrous, hackly, splintery and uneven describe which property?
A. Cleavage
B. Fracture
C. Hardness
D. Tenacity

1 B 5. Play of Colors and Opalescence are examples of:
A. Fluorescence
B. Iridescence
C. Phosphorescence
D. None of the above

1 C 6. How many components does the piezoelectric modulus, d_{ijk}, have?
A. 3
B. 9
C. 27
D. 81

3 B 7. What is the atomic number?
A. The number of electrons on an atom or ion
B. The number of protons in the nucleus of an atom or ion
C. The number of protons plus neutrons in an atom or ion
D. The number of protons plus neutrons plus electrons in an atom or ion

2 B 8. Atoms of different isotopes of the same element will have different numbers of what?
A. Electrons
B. Neutrons
C. Protons
D. Any of the above

0 A 9. ℓ is known as what?
A. Azimuthal Quantum Number
B. Magnetic Quantum Number
C. Principal Quantum Number
D. Spin Quantum Number

1 B 10. The magnetic quantum number determines:
A. The direction of rotation of the electron itself
B. The orientation of the orbital in space
C. The subshell to which an electron belongs
D. Which shell of electrons is being discussed

1 D 11. Which orbitals are spherically symmetric?
A. d
B. f
C. p
D. s

0 D 12. The n = 2 shell contains which type of subshell(s)?
A. d
B. p
C. s
D. Both s and p

1 D 13. This type of bonding results from the valance electrons forming a "sea of electrons" around cations, resulting in good electrical and thermal conductivity.
A. Covalent
B. Hydrogen
C. Ionic
D. Metallic
E. Van der Waals

1 C 14. Electrostatic attraction between two oppositely charged ions creates this type of bonding. Substances bonded in this manner are poor electrical and thermal conductors except near the melting point.
A. Covalent
B. Hydrogen
C. Ionic
D. Metallic
E. Van der Waals

1 B 15. This type of intermolecular bonding accounts for many of the unusual properties of water, as well as for the unzipping of DNA strands, which allows sexual reproduction.
A. Covalent
B. Hydrogen
C. Ionic
D. Metallic
E. Van der Waals

0 C 16. What is the coordination number of a octahedral polyhedron?
A. II
B. IV
C. VI
D. VIII

3 D 17. How many sides does an octahedral polygon have?
A. 2
B. 4
C. 6
D. 8

0 B 18. What is the bond angle associated with a tetragonal polyhedron?
A. 180°
B. 109.5°
C. 90°
D. 60°

2 C 19. Most of the volume of an atom is filled by:
A. Neutrons
B. Protons
C. Electrons
D. The nucleus

2 B 20. Which of the following sets of quantum numbers best describes a 3d electron?
A. (1,0,0,½)
B. (3,2,2,-½)
C. (3,1,-1,½)
D. (4,3,3,-½)

1 B 21. A glass-like luster is:
A. Adamantine
B. Vitreous
C. Resinous
D. Pearly

0 B 22. Which type of orbital is being filled across the Rare Earth Element row?
A. d
B. f
C. p
D. s

1 A 23. The principal quantum number is denoted n. What property does it describe?
A. Angular momentum of electron
B. Orientation of the electron orbital
C. Shape of the electron orbital
D. Spin of the electron

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

3.0 1. I $5s^2 5p^5$

1.5 2. Be $2s^2$

2.5 3. Co $3d^7 4s^2$

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.

1 1. F 1-

2 2. S (-ide) 2-

3 3. Cr (-ous) 3+

Species - List three species (ions or atoms) with the electronic configuration (1 point each)

$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^6$

Possibilities include:

4 Se^{2-} Br^{1-} Kr Rb^{1+} Sr^{2+}

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

0 1. Which gas is released when a mineral fizzes vigorously in response to a drop of acid applied to its surface? CARBON DIOXIDE

2 2. The name of a naturally magnetic form of magnetite is LODESTONE (Caution - spelling counts)

0 3. Some crystals, when squeezed in certain directions, will develop a momentary electric current. This effect is known as PIEZOELECTRICITY.

2 4. Name a device which employs the converse piezoelectric effect. QUARTZ WATCHES USE THIS EFFECT. "CRYSTAL" RADIOS, ALTHOUGH SELDOM USED TODAY, ALSO USE THIS EFFECT.

0 5. In the equation $P_i = p_i \Delta T$, what does ΔT stand for? CHANGE IN TEMPERATURE

2.5 6. The elements molybdenum, rhodium, palladium, silver and cadmium belong to the part of the periodic table described as the SECOND TRANSITION row.

2 7. When a bond has elements of more than one type of ideal bond, i.e. partial ionic, partial covalent, it is said to be a RESONANT bond

2 8. $F \propto \frac{Z_1 Z_2}{r^2}$ is a statement of whose law? COULOMBS

3 9. What does F in the equation in question 8 stand for? THE FORCE OF ATTRACTION BETWEEN TWO IONS

3 10. What does Z_1 stand for? THE CHARGE ON THE FIRST ION

0 11. A curving fracture typical of broken glass is described as CONCHOIDAL.

4 12. If n = 3, what are the possible values of m? ±2, ±1, 0

1 13. The symbol REE stands for RARE EARTH ELEMENT.

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

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

Column 1

1 I 1. This French physicist suggested that, like light, electrons could act as both particles and waves, and the waves produced by an electron confined in its orbit about the nucleus set up a standing wave of specific wavelength, energy and frequency.

1 E 2. Although he did not discover the pyroelectric effect, this Scottish physicist named it in 1824.

0 M 3. The common scale of mineral hardness is named after this Austrian mineralogist who first proposed it.

3 L 4. From his studies he was able to correct the atomic weights of indium, beryllium, and uranium in the 19th century.

0 D 5. He placed electrons circling the nucleus in concentric circles around the nucleus, an improvement on the original model of the atom, but still not correct.

1 B 6. In 1811 he first stated the molecular hypothesis which says that, at the same temperature and pressure, equal volumes of all gases contain the same number of molecules. For this, a fundamental constant of nature was named for him.

1 R 7. This Austrian physicist formulated the wave equation which describes the motion of electrons around an atomic nucleus, although solutions of the equation can only be approximated.

1 L 8. This Russian scientist proposed that, "the properties of the elements are a periodic function of their atomic masses."

Column 2

A. Georgius Agricola
B. Lorenzo Romano Amedeo Carlo Avogadro
C. Johann Jakob Balmer
D. Niels Henrik David Bohr
E. Sir David Brewster
F. Marie Sklodowska-Curie
G. Paul Jacques Curie
H. Pierre Curie
I. Louis Victor De Broglie
J. Carl Linnaeus
K. Fritz Wolfgang London
L. Dmitri Ivanovich Mendeleev
M. Friedrich Mohs
N. Henry G.J. Moseley
O. Wolfgang Ernst Pauli
P. Linus Carl Pauling
Q. Johann George Schmidt
R. Erwin Rudolf Josef Alexander Schrödinger
S. Nicholas Steno
T. Harold Clayton Urey
U. Johannes Diderik van der Waals

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

5 1. On the practical scale of mineral hardness, glass (5.5) and a steel file (6.5) were mentioned. Why are these considered practical standards? (2 points)

In many places in America, especially along roads, broken glass is easily found. Many pocket knives have a variety of blades, often including a steel file.

5 2. Describe the use of a Brunton compass in detecting the presence of magnetic minerals in a rock. (2 points)

The Brunton compass is placed on a flat, non-magnetic surface and the needle is allowed to stabilize. A sample is passed near the needle without touching the compass. If the needle moves, there is a magnetic mineral in the rock.

2 3. Although bismuth is radioactive, placing a sample of bismuth near a radiation meter will produce no reaction. Explain why. (2 points)

Bismuth has an extraordinarily long half life. The chance of even one radioactive decay event occurring in a short time is very small, and would be much less than the rate of observed background radiation (noise).

1.5 4. Nickel is [Ar] $3d^8 4s^2$, while copper, the next highest element in the periodic table, is [Ar] $3d^{10} 4s^1$, rather than [Ar] $3d^9 4s^2$. Why? (1 point)

A completed subshell, in this case $3d^{10}$, is energetically favorable, so it stabilizes the $3d^{10} 4s^1$ arrangement. Atoms always seek to be in the lowest possible energy levels, even when the differences are small.

1.5 5. On the periodic table, the symbols for both technetium and promethium are shown in hollow outline, meaning they are not naturally occurring. Why is this the case? (1 point)

Both are radioactive, with half-lives much shorter than the earth, so they have disappeared from the earth.

2 6. As the size of alkaline earth elements increases, the ionization potential decreases. Why? (1 point)

The ionization potential is defined as the energy necessary to remove the outermost electron from an atom. Larger atoms have their outermost electrons in orbitals further from the nucleus, and the electron is thus easier to remove.

3.5 7. Diamond and graphite are both composed of carbon, yet diamond has a hardness of 10 while graphite is 1. Explain the difference. Which mineral has the strongest bonds? (2 points)

Diamond has a three dimensional network of equivalent bonds. In graphite, the hexagonal sheets (graphene) have very strong bonds, stronger than those in diamond. However, the sheets are held together with weak Van der Waals bonds, accounting for the low hardness. (See Figure 1)

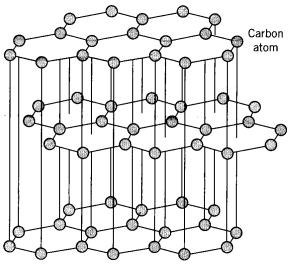

Figure 1

4.0 8. Explain why S is larger than Cl, and Ar is larger than Cl, even though all are in the same row of the periodic table. (2 points)

Both S and Cl are predominantly covalently bonded. Since Cl has one more proton than S, the electrons are pulled in tighter and ions may overlap, shrinking the effective radius. Ar doesn't form bonds, so the Van der Waals radius is used, which does not allow overlap, and thus Ar is larger.

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.

2 1. A sample of gudmundite, FeSbS, has a weight in air of 22.15 grams. The same sample has a weight in water of 18.86 grams. What is G? (2 points)

$$G = \frac{W_A}{W_A - W_W} = \frac{22.15}{22.15 - 18.86} = \frac{22.15}{3.290} = 6.733$$

10.5 2. The mineral stephanite, Ag_5SbS_4, is orthorhombic, with unit cell dimensions:

a = 7.70 Å, b = 12.32 Å, c = 8.48 Å Z = 4

What is the calculated value of the density, expressed in a) grams per cubic centimeter and b) kilograms per cubic meter? (5 points)

$$D = \frac{Z \bullet M}{N \bullet V}$$

$$M = 5(107.87) + 121.76 + 4(32.066) = 789.374 \frac{g}{mol}$$

$$V = a \bullet b \bullet c = (7.70 \bullet 10^{-8})(12.32 \bullet 10^{-8})(8.48 \bullet 10^{-8}) = 8.044 \bullet 10^{-22} \frac{cm^3}{mol}$$

$$D = \frac{4(789.374)}{(6.023 \bullet 10^{23})(8.044 \bullet 10^{-22})} = \frac{3157.49}{484.49} = 6.51 \frac{g}{cm^3}$$

$$6.51 \frac{g}{cm^3} = \bullet \frac{10^6 \, cm^3}{m^3} \bullet \frac{kg}{1000 \, g} = 6510 \frac{kg}{m^3}$$

Previous Years Results - Midterm 1

Term, Year	Mean (percent)
Fall, 2019	69.0
Fall, 2018	72.9
Fall, 2017	73.7
Fall, 2016	81.8
Fall, 2015	74.0
Fall, 2014	78.2
Fall, 2013	79.7
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