GLY4200C Name_____
90 points October 24, 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 2 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. A pinacoid is a open form consisting of two parallel faces.

4 F 2. In the monoclinic system, $\alpha \neq \beta \neq \gamma \neq 90°$.

0 T 3. Symbols such as 4/m $\bar{3}$ 2/m or $\bar{3}$ 2/m are known as Hermann-Mauguin symbols.

5 T 4. The symbol [032] represents a line parallel to the x-axis.

1 F 5. The composition surface of contact twins is irregular (non-planar).

1 T 6. In the term "point group", group refers to a collection of mathematical operations which, taken together, define all possible, nonidentical, symmetry combinations

3 F 7. The external appearance of the crystal must reflect its internal symmetry.

3 T 8. The symbol 2/m 2/m 2/m implies three two-fold axes which are mutually perpendicular.

10 F 9. Polysynthetic twinning is a type of multiple penetration twinning. It is contact twinning

2 T 10. Cyclic twinning is a type of contact twinning with non-parallel composition surfaces.

1 T 11. It is possible for one crystal to exhibit twinning according to multiple twin laws. Gridiron or tartan twinning in microcline is an example.

5 F 12. Complex operations involve a combination of two simple operations, both of which must exist independently.

1 F 13. Elements which are more abundant are always used in greater quantity than elements with lower abundances.

0 T 14. There is a definite chemical discontinuity between the lower mantle and the outer core.

2 F 15. High-spin Fe^{3+} is smaller than low-spin Fe^{3+}.

3 T 16. If two ions have the same charge, the smaller ion will enter a crystal structure preferentially.

2 T 17. Crystal classes are defined by the thirty-two possible point groups.

1 T 18. The sequence ABCABCABABCABC is an example of a stacking defect.

4 F 19. As nuclei grow, their surface area/volume ratio increases.

8 F 20. Ions with filled d orbitals have a strong contribution to magnetism from the d electrons.

0 T 21. Diamagnetic minerals are weakly repelled from a magnet in the presence of a strong external field.

2 T 22. High pressure dimorphs are generally harder than their low pressure counterparts.

5 F 23. Infra-red radiation has a shorter wavelength than ultraviolet radiation.

3 F 24. Essentially all valuable metals are in the major or minor element range. Trace elements are too scarce to be economically mined.

7 F 25. At high pressures, minerals exhibit more tolerance for ionic substitution than at lower pressures.

9 F 26. When a paramagnetic material is heated above the Curie temperature, magnetic domains align and the material becomes ferro magnetic.

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 D 1. Crystals may grow in which of the following ways?
A. Dehydration of an aqueous solution
B. Direct growth from a vapor
C. Crystallization from the molten state
D. All of the above

2 C 2.The reflection operation has as its element:
A. A point
B. An axis
C. A plane
D. None of the above

4 B 3. The external appearance of a crystal is called the:
A. Form
B. Habit
C. Structure
D. Lattice

2 C 4. Which of the following symbols represents a line?
A. (UVW)
B. {UVW}
C. [UVW]
D. All of the above

2 D 5. A form with all four faces parallel to a common axis is a(n):
A. Scalenohedron
B. Pinacoid
C. Pyramid
D. Prism

3 B 6. The symbol 6mm means:
A. A six-fold rotation axis with one set of parallel mirror planes
B. A six-fold rotation axis with two sets of parallel mirror planes
C. A six-fold rotation axis with a perpendicular mirror plane
D. All of the above

2 B 7. Which region of the earth is believed to be composed of 80% iron and 20% nickel?
A. Crust
B. Inner core
C. Mantle
D. Outer core

8 D 8. Which region of the earth ranges from 2900 to 5100 kilometers below the surface of the earth?
A. Crust
B. Inner core
C. Mantle
D. Outer core

3 A 9. The symmetry operation inversion is associated with which type of symmetry element?
A. Point
B. Axis
C. Plane
D. Cube

4 A 10. Which of the following is not a closed form?
A. Ditrigonal prism
B. Hexagonal dipyramid
C. Scalenohedron
D. Tetrahexahedron

3 B 11. In terms of weight per cent, the three most common elements in the earth's crust are:
A. Silicon, iron, aluminum
B. Oxygen, silicon, aluminum
C. Oxygen, calcium, silicon
D. Oxygen, silicon, iron

0 C 12. Trace elements have abundances less what weight percent?
A. 0.001
B. 0.01
C. 0.1
D 1.0

2 A 13. The unit cell vector **a** is associated with which crystal axis?
A. X
B. Y
C. Z
D. It depends on the crystal system

3 C 14. The angle α lies between which crystallographic axes?
A. X and Y
B. X and Z
C. Y and Z
D. It depends on the crystallographic system

3 B 15. In the tetragonal system, {100} includes which of the following faces?
A. (100), (010), (001), ($\bar{1}$00), (0$\bar{1}$0), (00$\bar{1}$)
B. (100), (010), (001), ($\bar{1}$00)
C. (100), (010), (001)
D. (0$\bar{1}$0), (00$\bar{1}$)

3 A 16. Which of the following vectorial properties may be discontinuous?
A. Color banding
B. Electrical conductivity
C. Index of refraction
D. Seismic velocity

0 A 17. Visible light has wavelengths between 400 and 700 nanometers. What color is represented by wavelengths near 400 nm?
A. Blue
B. Green
C. Orange
D. Red

1 D 18. Why is milky quartz white?
A. Fluoride ion occurs as interstitial impurities
B. Replacement of Si^{4+} by Al^{3+}
C. Cr^{3+} ion replaces some Si^{4+}
D. Inclusions of water occur as quartz is precipitated from hydrothermal solution

3 A 19. Which of the following forms of radiation is the most energetic?
A. Gamma
B. Infra-red
C. Ultraviolet
D. Visible

8 B 20. For a 3d electron, the biggest contribution to the magnetic field comes from:
A. The movement of the electron as it orbits the nucleus
B. The spin of the electron on its own axis
C. Both are equally important
D. d electrons do not generate magnetic forces

3 C 21. What color has next longer wavelength after orange in the visible spectrum?
A. Blue
B. Yellow
C. Red
D. Green

0 B 22. Which of the following ions would be most likely to be found in an interstitial site?
A. Al^{3+}
B. H^{+}
C. I^{1-}
D. Pb^{2+}

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
0	_H_ 1. This British mineralogist and crystallographer, in 1839, devised a universally accepted system of indices used to describe the orientation of crystallographic planes and crystal faces relative to crystallographic axes.	A. Auguste Bravais
1	_I_ 2. The discovery that in antiferromagnetic materials the magnetic susceptibility is low, but increases up to a temperature is named for this man, and the material them becomes paramagnetic.	B. Jacques Curie
1	_A_ 3. The statement. "Common crystal faces are parallel to lattice planes that have high lattice node density" is known as the Law of _____.	C. Marie Curie
1	_F_ 4. Swiss-born Norwegian mineralogist and petrologist who made the observation that, for ions of similar radius but different charges, the ion with the higher charge enters the crystal preferentially	D. Pierre Curie
3	_G_ 5. He wrote the law which says, "Crystal faces make simple rational intercepts on crystal axes."	E. Yakov Frankel
1	_A_ 6. He wrote Études Crystallographiques in 1849 in which he showed the fourteen patterns which meet the requirements for a lattice.	F. Victor M. Goldschmidt
		G. René J. Huay
		H. William Hallows Miller
		I. Louis E.F. Néel
		J. Walter H. Schottky

Diagrams and Figures - A series of slides will be shown. Each of these is a photo or a diagram previously seen in class. Diagrams may have been altered to remove labels, etc. Answer each question as the slide is shown. (1 point each)

4 B 1. The lattice shown here is:
A. C
B. F
C. I
D. P

6 A 2. The lattice shown here is:
A. C
B. F
C. I
D. P

7 C 3.The form shown is a:
A. Pinacoid
B. Pyramid
C. Sphenoid
D. Dome

0 C 4. The form illustrated here is a:
A. Dipyramid
B. Dome
C. Prism
D. Sphenoid

9 D 5. The axes system shown here belongs to which crystal system?
A.Hexagonal
B. Monoclinic
C. Tetragonal
D. Triclinic

10 A 6. The axes system shown here belongs to which crystal system?
A. Hexagonal
B. Monoclinic
C. Tetragonal
D. Triclinic

1 A 7. The operation shown here is known as:
A. Inversion
B. Reflection
C. Rotation
D. Roto-reflection

0 A 8. The form illustrated here is a:
A. Dipyramid
B. Dome
C. Prism
D. Sphenoid

11 B 9. The complex symmetry operation shown here is a:
A. $\bar{2}$
B. $\bar{4}$
C. 2 tilda
D. 4 tilda

0 T 10. (T-F) The picture illustrates dendritic crystal habit.

3 C 11. This pie chart illustrates the major element composition of the earth. The pinkish color on the left represents:
A. Aluminum
B. Oxygen
C. Silicon
D. Sodium

1 A 12. The type of crystal defect illustrated here is a:
A. Frenkel defect
B. Grain boundary defect
C. Schottky defect
D. Stacking defect

3 B 13. The type of crystal defect illustrated here is a:
A. Frenkel defect
B. Grain boundary defect
C. Schottky defect
D. Stacking defect

4 A 14. The picture illustrates what phenomenon associated with minerals?
A. Ex-solution
B. Glass
C. Metamict
D. Pseudomorphism

2 D 15. The pictures shown here illustrate twinning in which mineral?
A. Microcline
B. Pyrite
C. Rutile
D. Staurolite

___ 16. The object shown here is called: (Take your pick)
A. The Great Pumpkin - 5
B. Jack O'Lantern -6 Jack wins for the fourth year in a row
C. Toothy - 5
D. All of the above - 1

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

1-2. The Twin Law must specify two things. These are:

4 1) TWIN ELEMENT (TWIN OPERATION OK) and

10 2) ORIENTATION OF THE TWIN ELEMENT.

7 3. A three-faced form whose faces intersect in a point is called PYRAMID form.

12 4. List the faces which belong to {110} in the tetragonal system. (1 point)

(110) $(1\bar{1}0)$

$(\bar{1}10)$ $(\bar{1}\bar{1}0)$

5-6. Questions omitted due to duplication,

15 **7.** The substitution Ca^{2+} & $A1^{3+} \leftrightarrow Na^{+}$ and Si^{4+} is known as a COUPLED substitution.

12 8. Classes of planes in a crystal which are symmetrically equivalent are known as FORMS.

3 9. Naturally magnetic varieties of rock containing iron oxide are known as LODE stone.

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

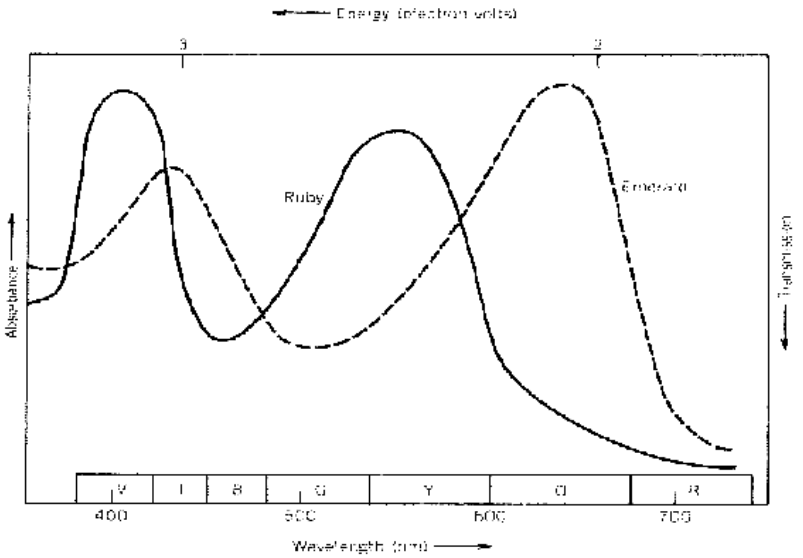

Figure 1

43.5 1. Refer to figure 1. What color is emerald? Ruby? Explain why these colors are seen. What ion is responsible for the color in both minerals? Why are the colors different? (6 points)

EMERALD IS GREEN, RUBY IS RED. RUBY HAS STRONG ABSORPTION IN BOTH THE BLUE AND THE GREEN TO YELLOW PARTS OF THE SPECTRUM. THE LEAST ABSORPTION IS IN THE RED. EMERALD ABSORBS STRONGLY IN THE BLUE AND THE RED, LEAVING GREEN. EMERALD IS A GEM VARIETY OF BERYL, $Be_3Al_2Si_6O_{18}$. RUBY IS A GEM VARIETY OF CORUNDUM, Al_2O_3. IN BOTH MINERALS, SMALL AMOUNTS OF CR^{3+} REPLACE AL^{3+}. IN BERYL, ALUMINUM OR CHROMIUM IONS ARE IN DISTORTED OCTAHEDRAL COORDINATION WITH OXYGEN FROM SiO_4 OR BeO_4 TETRAHEDRA. THE BONDING IS RESONANT BETWEEN IONIC AND COVALENT. THE COVALENT COMPONENT WEAKENS THE CRYSTAL FIELD AROUND THE ALUMINUM OR CHROMIUM IONS. IN CORUNDUM, OXYGEN FORMS HEXAGONAL CLOSE-PACKED LAYERS, WITH THE ALUMINUM OR CHROMIUM IONS IN INTERSTICES BETWEEN LAYERS. THIS RESULTS IN A STRONG CRYSTAL FIELD AROUND THESE CATIONS. THE SPECTRA OF EMERALD AND BERYL CLEARLY REFLECT THE STRENGTH OF THE CRYSTAL FIELD.

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.

24.5 1. Calculate the Miller Index of the following plane of the mineral scheelite. (3 points)

a = 0.525 nm Tetragonal
c = 1.140 nm

x-intercept = ∞
y-intercept = 0.519 nm
z-intercept = 0.382 nm

$$\frac{\infty}{0.525} = \infty \qquad \frac{0.519}{0.525} \cong 1 \qquad \frac{0.382}{1.140} \cong \frac{1}{3}$$

$$\frac{1}{\infty} = 0 \qquad \frac{1}{1} = 1 \qquad \frac{1}{\frac{1}{3}} = 3$$

MILLER INDEX IS (0 1 3)

18.5 2. Calculate the zone axis of the following pair of planes. (3 points)

(402) $(\bar{2}3\bar{1})$

$$4 \mid 0\ 2\ 4\ 0 \mid 2$$
$$\bar{2} \mid 3\ \bar{1}\ \bar{2}\ 3 \mid \bar{1}$$

$$0 \cdot \bar{1} - 2 \cdot 3, \quad 2 \cdot \bar{2} - 4 \cdot \bar{1}, 4 \cdot 3 - 0 \cdot \bar{2}$$
$$\bar{6}, 0, 1\ 2 = [\ \bar{1}\ 0\ 2\ ]$$

51 3. What is the charge on copper in devillite, $Cu_4Ca(SO_4)_2(OH)_6 \cdot 3H_2O$? (Show your reasoning) (4 points) Would you expect this mineral to have color, other than either black or white? Explain your reasoning.

Water is neutral and does not contribute.

Total Charge on ions is:

Calcium	+2	
Oxygen	-28	
Sulfur	+12	Sulfur is +6 in sulfate
Hydrogen	+6	

Total is -8, so four coppers must have a charge of +8, and copper is Cu^{+2}

Since Cu^{+2} is d^9, d-d transitions are possible, and the mineral should be colored. (It is dark emerald-green to bluish green)

A truly devilish question, apparently.

Devillite in hand specimen,
Estrie, Quebec, Canada

HAPPY HALLOWEEN!

Midterm 2 Results

84.5 - 2	A-	
80.5		
80.0	B+	
75.0		
74.5 - 2		
73.5		
72.0	B-	**MEAN = 72.1 (80.1%)**
69.5	C+	**MEDIAN = 72**
69.0		
68.0		
67.5		
67.0 - 2	C	
64.0	C-	
53.5	F	

Exams to Date - 180 points possible

166.0	A-	
159.5	B+	
150.5		
150.0	B	
146.5 - 2		
145.0	B	**MEAN = 140.5 (78.0%)**
139.0	C+	
138.0 - 2		**MEDIAN = 138.3**
135.0		
134.0		
132.0	C	
130.5		
130.0		
126.5	C-	
121.0	D+	

2011

MEDIAN = 138.5
MEAN = 137.0 (76.1%)

Previous Years Results - Midterm 2 - 12th out of 20

Term, Year	Mean, %
Fall, 2012	80.1
Fall, 2011	81.7
Fall, 2010	80.8
Fall, 2009	85.2
Spring, 2009	84.6
Fall, 2007	85.5
Fall, 2006	95.1
Fall, 2005	82.6
Spring, 2004	71.3
Fall, 2002	79.3
Spring, 2001	80.0
Spring, 2000	77.6
Fall, 1998	80.2
Fall, 1997	81.1
Fall, 1996	76.5
Fall, 1995	73.1
Fall, 1994	78.5
Fall, 1993	78.9
Fall, 1992	89.1
Fall, 1991	86.7