

Name _____

GEOL 3010

Sample Final Exam

I. (15) Define the following:

A. Mineral

A mineral is a naturally occurring homogeneous solid of definite, but not fixed, chemical composition and an ordered atomic arrangement that is formed by inorganic processes.

B. Symmetry operation

A symmetry operation is a transposition that leaves an object invariant.

C. Siderophile

The siderophiles are those elements of the Periodic Table that form metallic bonds with Fe and are enriched in the core and in iron meteorites and depleted in the crust and mantle.

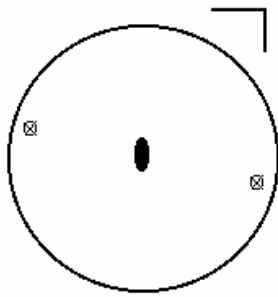
D. Birefringence

The property of having different indices of refraction for light vibrating in different directions.

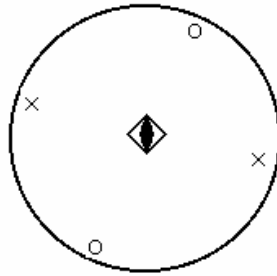
E. Optic plane

The optic plane is the planar section of the biaxial indicatrix containing the two optic axes.

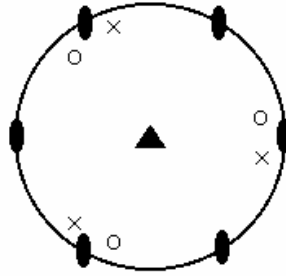
II. (6) For each of the following point-group symmetry diagrams, identify the point group (crystal class) and crystal system



A.



B.



C.

Point Group: 2/m

-4

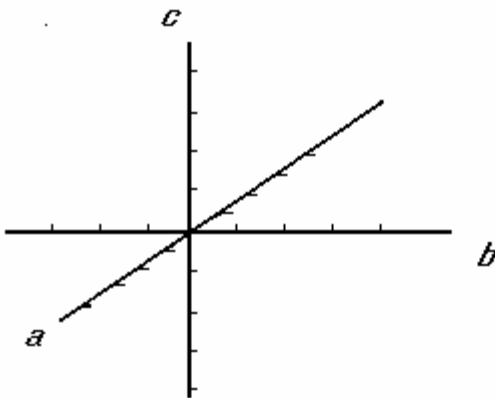
622

Crystal System: monoclinic

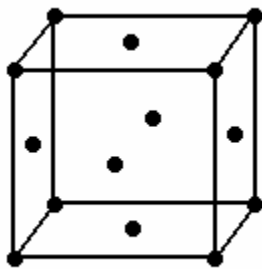
tetragonal

hexagonal

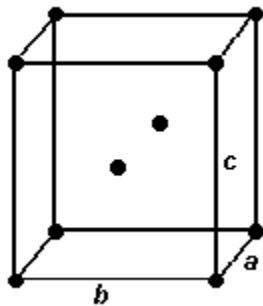
III.(6) Illustrated below are a set of orthogonal crystallographic axes with unit-cell tick marks. Draw on the diagram the axial intercepts of a lattice plane with Miller indices (2 0 3).



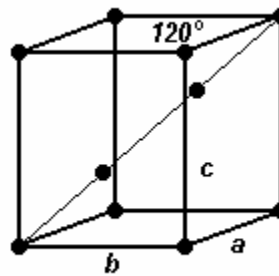
IV. (6) Identify the lattice type (P, A, B, C, I, F, or R) for each of the following:



F



A



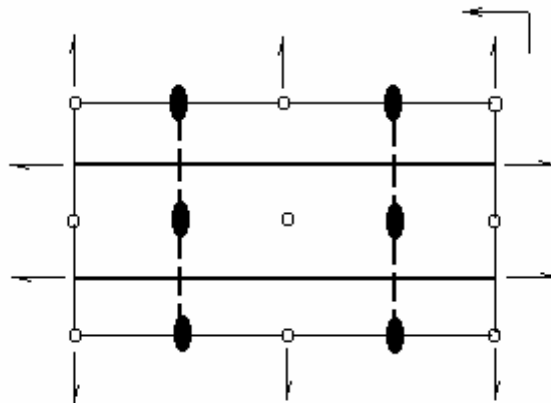
R

V. (12) Name the crystal system for each of the following sets of axial constraints. For each, give also the optic class (Isotropic (I), Uniaxial(U), or Biaxial (B)).

Constraints	Optic Class
A. $a = b = c; \alpha = \beta = \gamma = 90^\circ$ <u>cubic</u>	<u>I</u>
B. $a = b; \alpha = \beta = 90^\circ \gamma = 120^\circ$ <u>hexagonal, trigonal</u>	<u>U</u>
C. $a = b; \alpha = \beta = \gamma = 90^\circ$ <u>Tetragonal</u>	<u>U</u>
D. $\alpha = \beta = \gamma = 90^\circ$ <u>Orthorhombic</u>	<u>B</u>
E. $\alpha = \gamma = 90^\circ$ <u>Monoclinic</u>	<u>B</u>
F. No axial or angle constraints <u>Triclinic</u>	<u>B</u>

VI. (8) Shown below is a symmetry diagram for a primitive orthorhombic space group in standard orientation (a -vertical, b horizontal, and c normal to page). Give the Hermann-Mauguin symbol for the space group and for the crystal class (point group) to which it belongs.

axis	plane
a _____	_____
b _____	_____
c _____	_____
H-Msymbol _____	_____
Point Group _____	_____



2_1 m
 2_1 a
 2 b

$P 2_1/m 2_1/a 2/b = Pmab$

VII. (12) Last July, some colleagues and I synthesized a sample of the mineral ringwoodite using the 5000-ton press at the Bavarian Geological Institute at Bayreuth in Germany. Ringwoodite is the high pressure form of olivine (Mg,Fe)₂SiO₄ but unlike olivine, it can accept significant amounts of hydrogen. It is thought to be a major component of the mantle between depths of 525 and 670 km. Given below is a chemical analysis of the sample we made. Calculate the formula (Numbers of Si, Mg, Fe, and H cations per four oxygens) and its formula weight.

Oxide	MolWt Oxide	Wt%	Moles oxide	Moles Cations	Moles Oxygen
SiO ₂	60.086	39.82	0.66272	0.66272	1.32543
MgO	40.312	45.89	1.13837	1.13837	1.13837
FeO	71.846	11.46	0.15951	0.15951	0.15951
H ₂ O	18.015	2.83	0.15709	0.31418	0.15709
					2.78040 x 1.43864 = 4.00

AtWt Cations per 4 Oxygens

Si	28.087	0.9534	26.7782
Mg	24.305	1.6377	39.8045
Fe	55.847	0.2295	12.8156
H	1.008	0.4520	0.4556
O	15.9994	4.0000	63.9976

Formula Weight: 143.8515

VIII. (10) Ringwoodite is a spinel, and I measured its cubic (Z=8) cell parameter as 8.0924Å. Calculate the density of this sample.

$$R = (Z \cdot FW) / (A^3 \cdot V)$$

$$R = (8 \cdot 143.8515) / (6.022 \times 10^{23} \cdot 8.0924^3 \times 10^{-24})$$

$$R = 1150.812 / (0.6022 \cdot 8.0924^3)$$

$$R = 3.6061 \text{ g/cm}^3$$

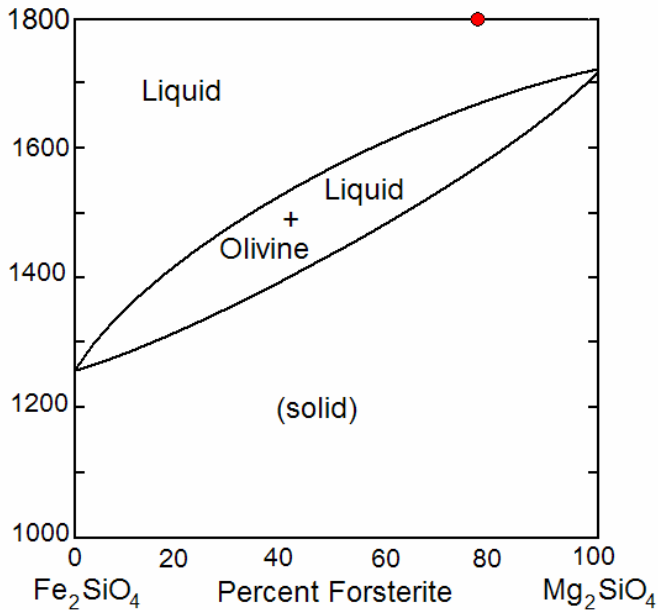
IX. (5) Ringwoodite has an index of refraction of 1.710. What is the speed of light in ringwoodite?

$$V = 3 \times 10^8 / 1.710 = 1.7544 \times 10^8 \text{ m/s}$$

X. (10) Name a mineral and give the formula in each of the following groups:

- A. Phosphate Apatite $\text{Ca}_5(\text{PO}_4)_3\text{F}$
- B. Oxide Periclase MgO
- C. Carbonate Calcite CaCO_3
- D. Sulfide Pyrite FeS_2
- E. Sulfate Barite BaSO_4

XI (10) Below is a melting (T-X) diagram for forsterite (Mg_2SiO_4) – fayalite (Fe_2SiO_4). Starting with a liquid of composition 80% Fo and 20 % Fa at 1800°C (dot) answer the following questions based on the diagram assuming perfect equilibrium between crystals and solid:



- A. At what temperature do the first crystals form? 1675°
- B. What is the composition of the first crystals to form? $\text{Fo}_{95}\text{Fa}_5$
- C. How many phases are present at 1600°C? 2
- D. At what temperature does the last liquid disappear? 1550°
- E. What is the composition of the last liquid to crystallize? $\text{Fo}_{50}\text{Fa}_{50}$

XII. (2 extra) Circle the correct spelling:

- A. Mineralogy, Minerology, Minorology
- B. Occurance, Occurrence, Occurance, Occurence, Ocurrence, Occurrence