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 (reflection, glide plane, screw axis, mirror, 1-fold, 2-fold, 3-fold 4-fold, 6-fold rotations, inversion, roto-inversion)

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

C. Siderophile (lithophile, chalcophile, atmophile)

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.

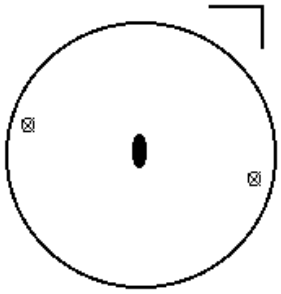
D. Birefringence (pleochroism, refraction, diffraction)

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

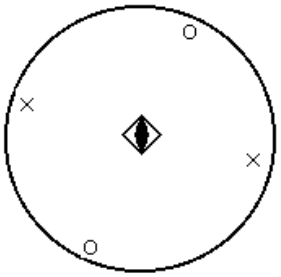
E. Optic plane, (Optic normal, Acute or obtuse bisectrix, optic axis, 2V, indicatrix. Etc)

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

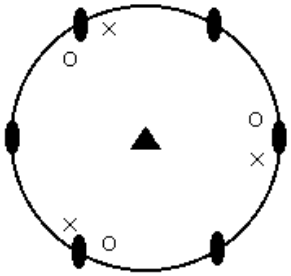
II. (6) For each of the following point-group symmetry diagrams, identify the point group (crystal class) and crystal system



A



B.

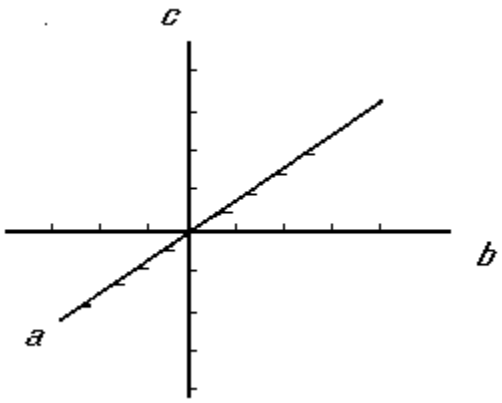


C.

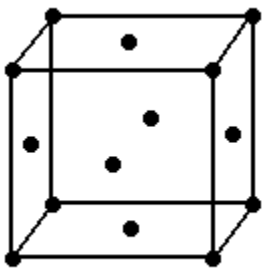
Point Group: ____2/m_____ _____-4_____ _____32_____

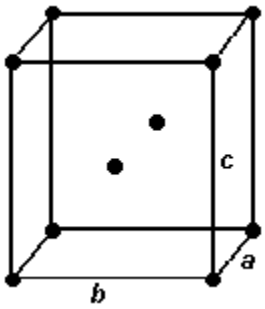
Crystal System:_monoclinic_ __tetragonal_____ _____trigonal___

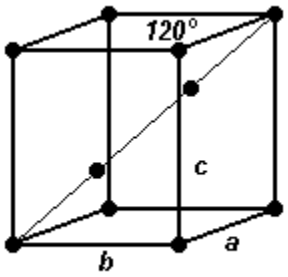
III.(6) Illustrated below are a set of orthogonal crystallographic axes with unit-cell tic marks. Draw on the diagram the axial intercepts of a lattice plane with Miller indices (2 0 3).



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).

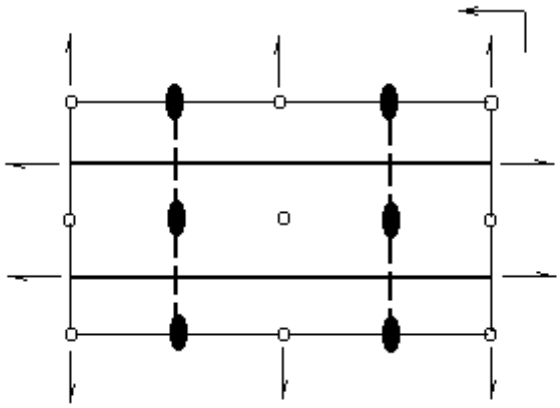
	Constraints	Optic Class
A. $a = b = c$; $\alpha = \beta = \gamma = 90°$	cubic	I
B. $a = b$; $\alpha = \beta = 90° \gamma = 120°$	hexagonal, trigonal	U
C. $a = b$; $\alpha = \beta = \gamma = 90°$	Tetragonal	U
D. $\alpha = \beta = \gamma = 90°$	Orthorhombic	B
E. $\alpha = \gamma = 90°$	Monoclinic	B
F.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

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 $(Mg,Fe)_2SiO_4$ 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_2O	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.

$R = (Z*FW)/(A* V)$
$R = (8*143.8515)/(6.022 \times 10^{23} * 8.0924^3 \times 10^{-24})$
$R = 1150.812 / (0.6022 * 8.0924^3)$
$R = 3.6061\ g/cm^3$

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

$V = 3 \times 108 / 1.710 = 1.7544 \times 10^8\ m/s$

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

A. Phosphate ___Apatite_____ $Ca_5(PO_4)_3F$_____

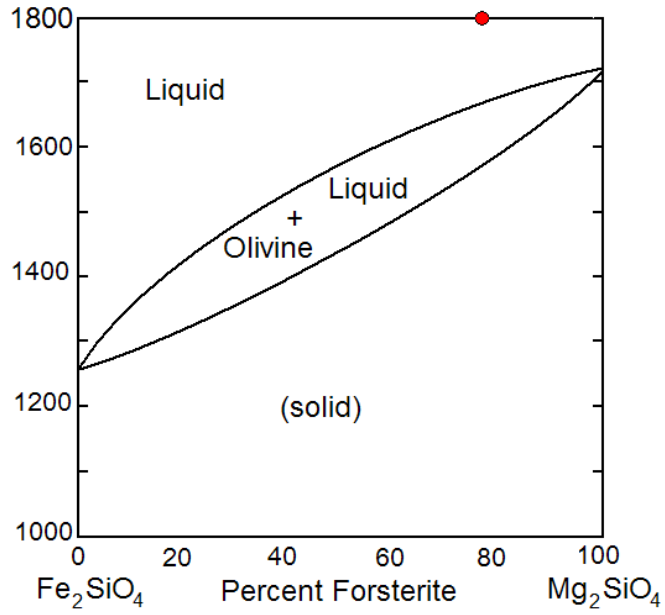
B. Oxide_____Periclase_____ _____MgO_____

C. Carbonate _____Calcite_____ _____CaCO3_____

D. Sulfide _____Pyrite_____ _____FeS2_____

E. Sulfate _____Barite_____ ____BaSO4_____

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 1800ºC (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? _____**1675º**_____

B. What is the composition of the first crystals to form? _____**$Fo_{95}Fa_5$**_____

C. How many phases are present at 1600ºC? _____**2**_____

D. At what temperature does the last liquid disappear? ___**1550º**_____

E. What is the composition of the last liquid to crystallize? ___**$Fo_{50}Fa_{50}$**_____

XII. (2 extra) Circle the correct spelling:

A. Mineralogy, Minerology, Minorology

B. Occurance, Occurrence, Occurrance, Occurence, Ocurense, Occurrense