GEOL3010 Exam II Sample

I. (20) Define the following terms and give an example of how each might be used to distinguish various minerals:

A. Refraction

The bending of light due to a change in the velocity of light between two media. In thin section high-index mineral appear to have high relief which can be used to distinguish quartz from orthopyroxene.

B. Dispersion

The index or refraction is a function of wavelength.

C. Pleochroism

The absorption of light is a function of direction in an anisotropic medium.

D. Diffraction

The coherent scattering of a wave by a periodic array of scatterers.

E. Birefringence

The index of refraction in an anisotropic medium is a function of direction so that light is refracted into two separate rays traveling at different velocities in the medium.

Other terms

Optic axis, optic plane, optic normal, biaxial, uniaxial, b x a, b x o, Raman, Moessbauer, Indicatrix, Becke Line.

II. (15) Last summer I synthesized a sample of ringwoodite at 20 GPa and 1400ºC using a 5000-ton multi-anvil press. Given below is a chemical analysis of the sample. Calculate the formula (Numbers of Si, Mg, and Fe cations per four oxygens).

Oxide	MolWt Oxide	Wt%				
SiO_2	60.086	41.80	0.6957	0.6957	1.3913	
MgO	40.312	53.51	1.3274	1.3274	1.3274	
FeO	71.846	4.69	0.0652	0.0652	0.0652	
					2.7839	1.4368

Atom	AtWt	Cations per 4 Oxygens

O	15.9994	4.000	
Si	28.087	0.9996	
Mg	24.305	1.9073	
Fe	55.847	0.0937	$Mg_{1.91}Fe_{0.09}SiO_4$

III. A. (10) Cuprite, Cu_2O, is a minor ore of copper and one of two hemi-oxide minerals. (The other one is ice.) The crystal structure of cuprite is cubic with a cell edge of 4.27Å and Z of 2. Cu_2O has a molecular weight of 143.09 g. Calculate the density of cuprite.

$\rho = Z.FW / AV$

$\rho = 2 \times 143.09 / 0.6023 \times 4.27^3$

$\rho = 6.103\ g/cm^3$

III. B. (10) The index of refraction of cuprite is 2.85, nearly the highest of any mineral and higher than diamond. What is the speed of light in cuprite?

$V = c/n$

$1.05 \times 10^8\ m/s$

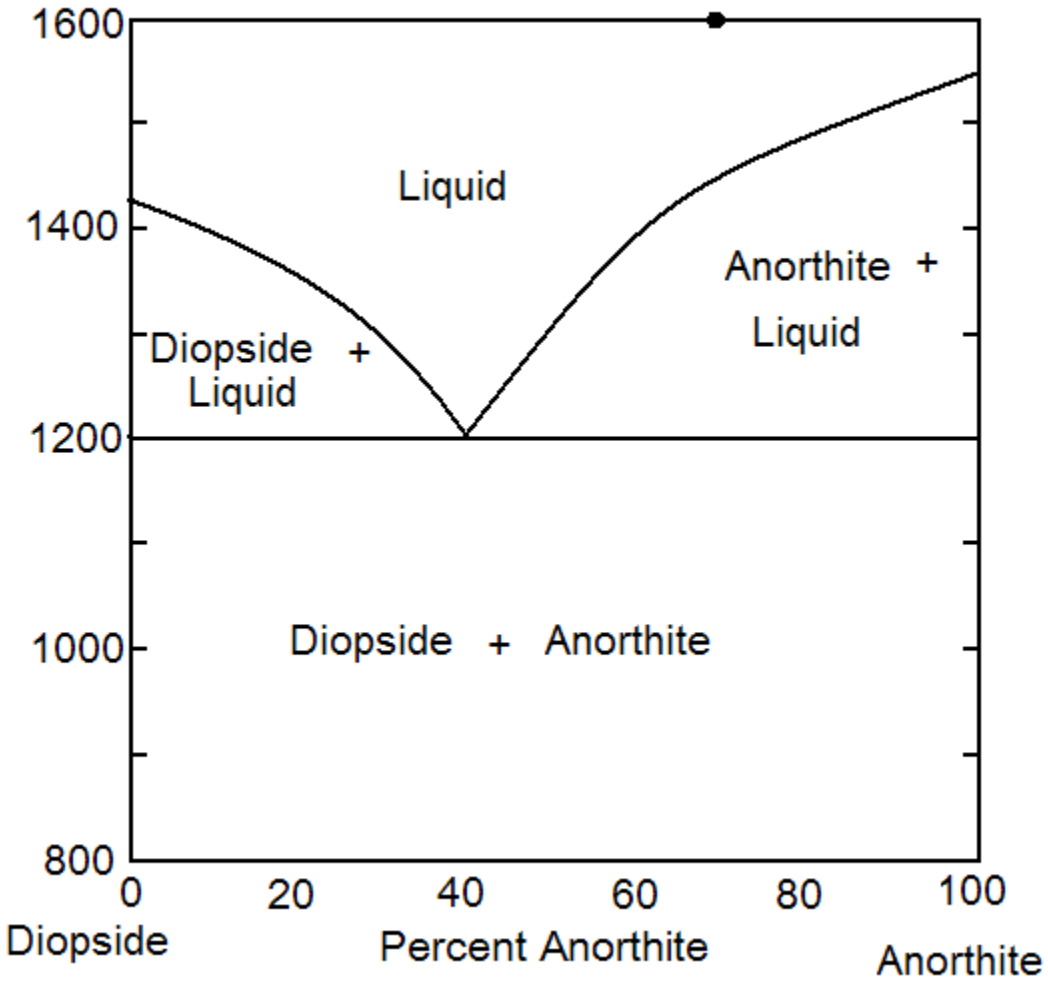
IV. (10) Calculate the 2θ angle for Cu Kα radiation (λ = 1.5405Å) for the (110) and (211) X-ray diffraction peaks of cuprite.

$D_{110} = a / 2^{0.5}$ $\qquad$ $2\theta = 2 \sin^{-1} \lambda/2d$

$D_{110} = 4.27 / 1.414 = 3.020$ $\qquad$ $2\theta = 29.55^o$

$D_{211} = 4.27 / 2.449 = 1.743$ $\qquad$ $2\theta = 2 \sin^{-1} (1.5405/3.486) = 52.44^o$

V (10) Below is a melting (T-X) diagram for diopside ($CaMgSi_2O_6$) – anorthite ($CaAl_2Si_2O_8$). Diopside is a pyroxene and anorthite is a feldspar so there is no solid solution between them. Starting with a liquid of composition 70% anorthite and 30 % diopside at 1600ºC (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? _____**1460º**_____

B. How many phases are present at 1300ºC? _____**2**_____

C. At what temperature does the last liquid disappear? ____**1200º**_____

D. What is the composition of the last liquid to crystallize? ____**$An_{40}Di_{60}$**_____