Name _____

# GEOL3010 Exam II Nov 14, 2017

I. (20) Define the following terms:

A. Dispersion

Index of refraction is a function of wavelength (color).

B. Indicatrix

An ellipsoidal figure representing the indices of refraction for the various vibration directions for light in a crystal.

C. Diffraction

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

D. Pleochroism

Absorption of light is a function of direction in a crystal.

E. Liquidus

The line on a temperature-composition phase diagram above which the system is completely liquid.

II. (15) I want to synthesize a sample of wadsleyite with a composition (formula) of $Mg_{1.70}Fe_{0.30}SiO_4$ by mixing together powdered oxide reagents of $SiO_2$, MgO, and FeO. (Oxide molecular weights are 60.086, 40.312, and 71.846 g, respectively as listed.) If I need a total of one gram (1000 mg) of starting material, how many milligrams of each oxide do I need to weigh out and mix together? (Hint: calculate weight percentages first.)

| Oxide | MolWt Oxide | Moles per form. | g/form | wt% | mg/g |
|---|---|---|---|---|---|
| $SiO_2$ | 60.086 | 1.000 | 60.086 | 40.012 | 400.12 |
| MgO | 40.312 | 1.700 | 68.530 | 45.635 | 456.35 |
| FeO | 71.846 | 0.300 | 21.554 | 14.353 | 143.53 |
| | | | 150.170 | 100.00 | 1000.00 |

III. A. (10) Periclase (MgO), is a relatively rare metamorphic alteration product of dolomite, but is also believed to be a significant constituent of the lower mantle co-existing with bridgmanite. The crystal structure of periclase is cubic with a cell edge of 4.21Å and Z of 4 for pure MgO. MgO has a molecular weight of 40.3114g. Calculate the density of periclase.

$\rho = z\ FW / A\ V$

$\rho = 4\ \ 40.3114 / .6023 \times (4.21)^3$

$\rho = 3.588 g/cm^3$

III. B. (10) The index of refraction of periclase is 1.74. What is the speed of light in periclase?

$V = c/i$
$V = 3.0 \times 10^8 / 1.74$
$V = 1.724 \times 10^8$ m/s

III. C. (10) Calculate the 2θ angle for Cu Kα radiation (λ = 1.5405Å) for the (2 0 0) and (111) X-ray diffraction peaks of periclase (*a* = 4.212 Å).

$d_{200} = a / 2$
$d_{200} = 2.106$

$2\theta = 2 \sin^{-1} \lambda/2d$
$2\theta = 2 \sin^{-1} 1.5405/4.212$
$2\theta = 42.91°$

$d_{111} = a / 1.732$
$d_{111} = 2.432$

$2\theta = 2 \sin^{-1} 1.5405/4.864$
$2\theta = 36.93°$

IV. (15) Siderite, $FeCO_3$, is trigonal and uniaxial negative. Its two indices of refraction are 1.575 and 1.782.

A. A laser beam enters a siderite crystal propagating in the *c*-direction and vibrating in the *a*-*b* plane. Do you expect this light beam to experience strong birefringence?
___No_____

Why?___looking down the optic axis_____

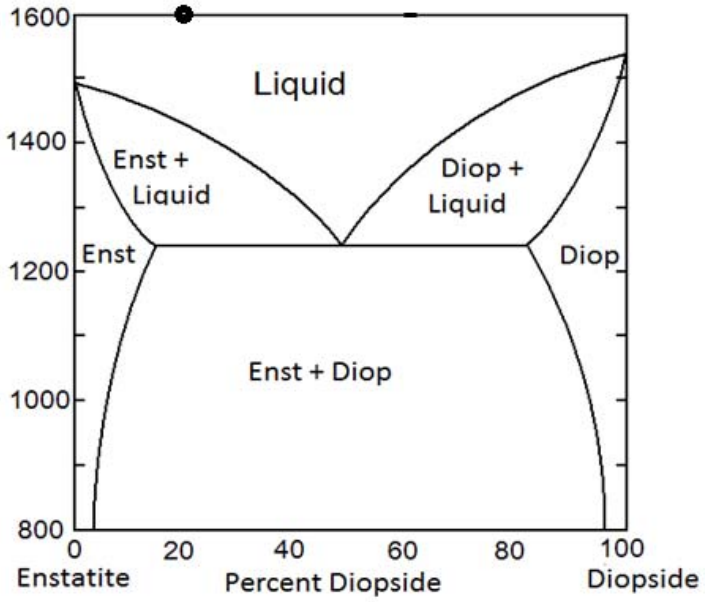
B. The laser beam enters the crystal propagating parallel to the *a*-axis and vibrating in the a-c plane. Do you expect this beam to experience strong birefringence?
____Yes_____

Why?____looking perpendicular to optic axis_____

C. In this latter orientation (propagating parallel to *a* and vibrating in the *a*-*c* plane), do you expect to see strong pleochroism? ____Yes_____

Why? ___Fe-bearing and looking perpendicular to optic axis_____

V. (20) Below is a simplified melting (T-X) diagram for enstatite ($Mg_2Si_2O_6$) – diopside ($CaMgSi_2O_6$). There is limited crystalline solution between the end member. Starting with a liquid composition 80% enstatite and 20% 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? _____1450º_____

B. How many phases are present at 1300ºC? _____2_____

C. At what temperature does the last liquid disappear? _____1240º_____

D. What is the composition of the last liquid to crystallize? ___En50Di50_____

E. How many phases are present at 1100ºC? _____2_____

F. What is the composition of the enstatite phase at 1100ºC? ____En90Di10_____

G. What is the composition of the diopside phase at 1100ºC? ____En12Di88_____