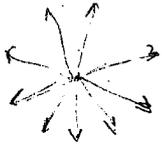


UNIVERSITY OF PRETORIA

GLY 251 – CRYSTAL CHEMISTRY AND OPTICS

2. Semester test



Answer all the questions and use sketches where applicable.

Theory questions [10 each] *effectiveness of how much light is refracted* $n = \frac{v_v}{v}$ *velocity in vacuum*
at normal to a vacuum $n = \frac{v_v}{v}$ *velocity in medium*

- X 1. Define the index of refraction and its relationship to the velocity of light in a medium.
- ✓ 2. Describe the polarization of light and how plane polarized light is produced, and how its vibration direction is determined.
- ✓ 3. Define Snell's law and show with a sketch how light is refracted when passing from one medium to another.
- ✓ 4. What is the Becke line and what can it be used for?
- ✓ 5. What is birefringence and retardation and how are they related?
- ✓ 6. Describe why you get extinction of anisotropic minerals every 90 degrees.
- ✓ 7. Sketch the interference figure for a uniaxial positive mineral and discuss how the optic character and refractive indices are determined.
- ✓ 8. Describe the concept of phase of light and why two light waves interfere constructively or destructively.
- X 9. Describe the relation between frequency, velocity and wavelength of light and what happens when it enters a denser medium such as glass.
10. Discuss whether optical microscopy is a useful technique.

Practical questions

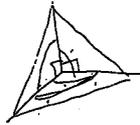
1. The thin section contains a uniaxial mineral. Determine the optical character and describe how you derive at your answer. Sketch a grain of this mineral and describe all relevant optical characteristics. [20]
2. The thin section contains a strongly twinned mineral. Determine the optical character and the extinction angle. [20]
3. Search for the brown, very strongly pleochroic mineral and determine the extinction angle. Discuss what you can deduce from the extinction of this mineral about the swinging direction of the polarizer. [10]

1. (a) Discuss the definition of a Mineral and what unique aspects need to be considered for it to qualify as a mineral? 5 Points

2. Define the 7 crystal systems and describe how they differ from each other in cell dimensions and what the essential symmetry elements are. 20 Points

3. Discuss the concepts of radius ratio, isostructuralism, polymorphism, and the different types of solid solutions. Also give the factors that determine the extent of solid solutions. 15 Points

4. Describe the symmetry operators that generate the point groups and show how they would generate a motif on a stereographic projection, assuming that the operators are vertical. 10 Points



Answer all the questions and use sketches where applicable.

Theory questions

- Discuss the definition of a mineral and what unique aspects are important. [10]
- Explain the difference between the generation of continuous X-rays and of characteristic X-rays, and why the latter occur only at specific wavelengths. [10]
- What controls solid solution? [10]
- Define the following terms: Ionic radius, isostructuralism, polymorphism, polytypism, substitutional solid solution. [10]
- What is Bragg's equation, what are its components, and what can it be used for (give an example using the equation) [10]
- Write down the general formulae (i.e., taking all possible substitutions into account) of the minerals diopside, orthopyroxene, and plagioclase. [10]
- Construct a question about the crystallographic structure of a mineral and its role for variation in mineral composition - and answer it. [10]

Practical questions

Atomic Weights	
Si	28.0855
Al	26.98154
O	15.9994
K	39.0983
Cu	63.546
Fe	55.847
Ti	47.88
Cr	51.996
Mn	54.9380
V	50.9415
S	32.066

1. If leucite is $KAlSi_3O_8$, how much more SiO_2 does K-feldspar contain? [25]

Answer all the questions and use sketches where applicable.

Theory questions

- Discuss the definition of a mineral and what unique aspects are important. [10]
- Discuss the different types of defects in minerals. [10]
- Explain the difference between the generation of continuous X-rays and of characteristic X-rays, and why the latter occur only at specific wavelengths. [10]
- What controls solid solution? [10]
- Define the following terms: Ionic radius, isostructuralism, polymorphism, polytypism, substitutional solid solution. [10]
- Sketch a rough triangular diagram and label the apices as Cu (bottom left), Fe (bottom right) and S (top). Plot the minerals pyrite, troilite, bornite, chalcopyrite, and chalcocite in terms of their molar compositions. [10]
- If $CuK\alpha = 1.54178 \text{ \AA}$ and the 2θ angle is 45° , what d-spacing would be represented in an XRD pattern? [10]
- Densities of SiO_2 polymorphs are:
 Quartz = 2.649
 Keatite = 2.503
 Coesite = 2.896
 Cristobalite = 2.331
 Tridymite = 2.452
 Stishovite = 4.286
 Sketch out a possible (schematic) pressure-temperature diagram for the SiO_2 polymorphs. [10]

Total marks out of [80]

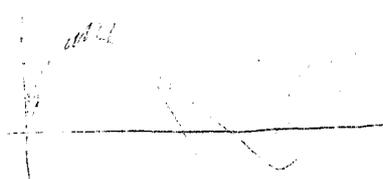
- Define the index of refraction and its relationship to the velocity of light in a medium. (3)
- Describe plane polarized light and how its vibration direction is determined. (3)
- Define Snell's law and show with a sketch how light is refracted when passing from one medium to another. $\frac{\sin \theta_1}{\sin \theta_2} = \frac{n_2}{n_1}$ (6)
- Describe the lens effect and the internal reflection effect that forms the basis of the Becke line method to determine the refractive index of a mineral. (10)
Using Snell's law
- What is birefringence and retardation and how are they related? (8)
- Describe why you get extinction of anisotropic minerals every 90 degrees. (5)
- Sketch the interference figure for a uniaxial positive mineral and discuss how the optic character and refractive indices are determined. (15)

Clear Label
Explain

50 Points

positive

$f = \frac{v}{\lambda}$
 $\lambda = \frac{v}{f}$



$\Delta(\text{rad})$
 $\Delta = (C + a)$
 $\Delta = \Delta$

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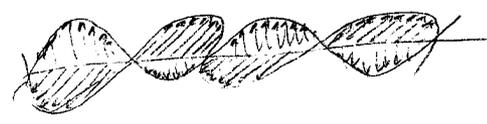
2. Semester test **THEORY**

Answer all the questions and use sketches where applicable.

Theory questions [10 each]

1. ✓ What is the difference between uniaxial positive and uniaxial negative? ✓
2. ✓ What is retardation, and how can you use it to determine the thickness of a thin section?
3. ✓ I postulate that light that travels from air into minerals encounters resistance, gets tired, and therefore slows down. Your comments please.
4. ✓ Mass extinctions in the geological record happened every ~ 60-90 million years. Discuss the relationship to extinction of anisotropic minerals every 90 degrees under the microscope.
5. ✓ A friend mentioned something like a Beckham line or a Becker line or a Back line in connection with microscopy. Please explain what the correct term is, what it stands for, and why you should bother.

Becke line use to determine n_g



[Faint handwritten notes]