



<b><u>FACULTY</u></b>	: Science
<b><u>DEPARTMENT</u></b>	: Geology
<b><u>CAMPUS</u></b>	: APK
<b><u>MODULE</u></b>	: GLG01B1 OPTICAL AND ANALYTICAL MINERALOGY
<b><u>SEMESTER</u></b>	: Second
<b><u>EXAM</u></b>	: Main Exam <b>MEMO</b>

<b><u>DATE</u></b>	: 28 October 2021	<b><u>SESSION</u></b>	: 08:30-11:30
<b><u>ASSESSOR(S)</u></b>	DR T OWEN-SMITH DR G BELYANIN		
<b><u>MODERATOR</u></b>	PROF M ELBURG		
<b><u>DURATION</u></b>	: 3 HOURS	<b><u>MARKS</u></b>	: 180

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NUMBER OF PAGES: 6 PAGES

INSTRUCTIONS:

1. Answer ALL THE QUESTIONS.
  2. Number your answers clearly
  3. Answer section A and section B in separate books
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## **SECTION A: OPTICAL MINERALOGY [90 marks]**

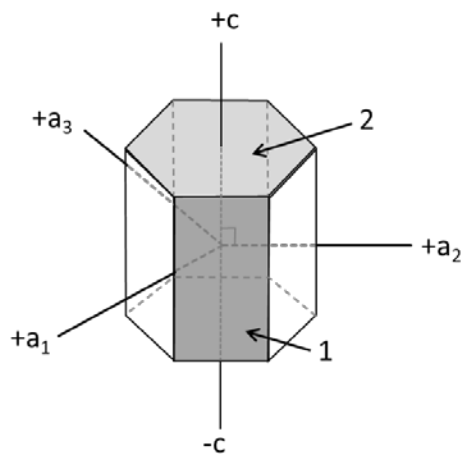
### **Question 1 [8 marks]**

What is the difference between constructive and destructive wave interference? Use diagrams to illustrate your answer. **[8 marks]**

See Lecture 3 and mark accordingly.

### **Question 2 [11 marks]**

Consider the crystal in the diagram below:



- a) To which crystal system does this mineral belong? Give a reason for your answer. **[2 marks]**
- b) Give an example of a common mineral that belongs to this crystal system. **[1 mark]**
- c) Give both the Weiss parameters and Miller indices for each of the two shaded planes. **[8 marks]**

a) See Lecture 2 and mark accordingly

b) See Lecture 2

c) See Lecture 2

### **Question 3 [18 marks]**

- a) What are the differences between an isotropic and an anisotropic mineral? How would you distinguish between these under the microscope? **[12 marks]**

- b) Under what circumstances does an anisotropic mineral behave like an isotropic mineral?  
Explain. [6 marks]

a) See Lecture 4

b) See Lecture 4

#### **Question 4** [17 marks]

- a) Explain step-by-step how you would determine the sign of elongation of a mineral under the microscope. [11 marks]
- b) Is it possible for a uniaxial negative crystal that is elongated along the c-axis to have a positive elongation? Explain your answer with a sketch. [6 marks]

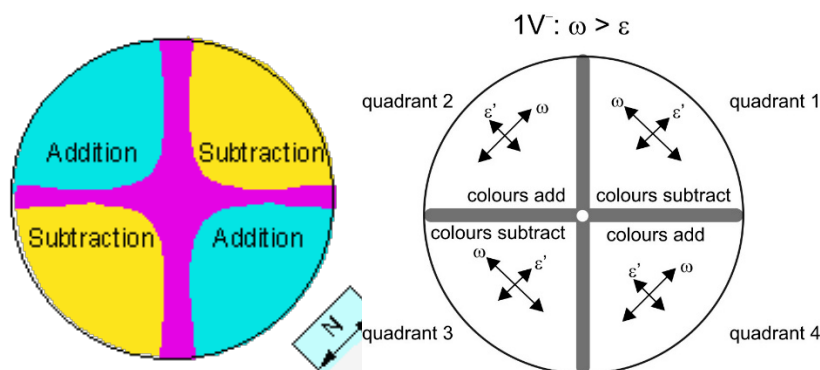
a) See Lecture 5

b) See Lecture 5

#### **Question 5** [20 marks]

- a) Draw a centred optic axis interference figure for a uniaxial negative mineral, indicating the appropriate colours for determination of the optic sign. Use this diagram to explain why the areas of darkness and areas of colour appear where they do in the figure. [12 marks]
- b) Give the Miller indices for the plane of the crystal that must be parallel to the microscope stage to produce the interference figure in (a) above. [2 marks]
- c) What type of interference figure would be observed for the section parallel to the (010) plane? [2 marks]
- d) Under the microscope, what would be the differences in appearance between the grains in the orientations described in (b) and (c) above? [4 marks]

a)



See Lecture 6

b) See Lecture 6 and 2

c) See Lecture 6

d) See Lecture 6

**Question 6 [16 marks]**

The mineral *khumbudzoite* ( $2V = 30^\circ$ ) has the following refractive indices and absorption colours:

$\gamma = 1.644$       blue

$\beta = 1.643$       yellow

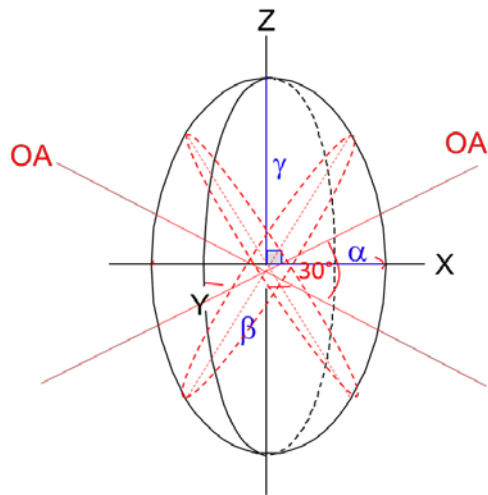
$\alpha = 1.633$       pink

- a) Is this mineral uniaxial or biaxial? Give a reason for your answer. [2 marks]
- b) Is the mineral optically positive, negative or neutral? Give a reason for your answer. [2 marks]
- c) Draw and label the optical indicatrix for *khumbudzoite*. [5 marks]
- d) Draw the perpendicular section through the indicatrix for light propagated down one of the optic axes. [2 marks]
- e) What absorption colour(s) would you see for the section in (d) above? [1 mark]
- f) What absorption colour(s) would you see for the section showing maximum interference colours in cross-polarised light? Give reasons for your answer. [4 marks]

a) See Lecture 7

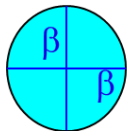
b) See Lecture 7

c)



See Lecture 6

d)



e) See Lecture 7

f) See Lecture 7

## **SECTION B: ANALYTICAL MINERALOGY [90 marks]**

### **Question 1 [8 marks]**

Give examples of at least TWO **diagnostic** optical properties (different pleochroism, interference colours, birefringence, cleavage etc.) to distinguish between (short description):

- Serpentine and talc [2 marks]
- Plagioclase and microcline [3 marks]
- Tremolite and orthopyroxene [3 marks]

- Lecture notes 7
- Lecture notes 8
- Lecture notes 5 and 6

### **Question 2 [25 marks]**

Indicate to which mineral **Family** and mineral **Group** each of these minerals belongs. What is the **Si:O** ratio for each family? Give the **Chemical formula** of each mineral and provide **one** example of a rock where the mineral commonly occurs. **[5 marks each]**

- a) Fayalite
- b) Hedenbergite
- c) Anthophyllite
- d) Muscovite
- e) Sanidine

- a) Lecture notes 2
- b) Lecture notes 5
- c) Lecture notes 6
- d) Lecture notes 7
- e) Lecture notes 8

**Question 3 [8 marks]**

Give a brief description of the occurrence and mineral associations of glaucophane-riebeckite. **[8 marks]**

Lecture notes 6

**Question 4 [8 marks]**

- a) How do we call two or more crystalline mineral compounds having a different chemical composition but identical structure? **[2 marks]**

Lecture notes 1

- b) Describe three examples of these type of minerals (for three different mineral families) and write their chemical formulae. **[6 marks]**

All lecture notes

**Question 5 [7 marks]**

- a) What is the main alteration product of olivine? Write the chemical reaction. **[2 marks]**
- b) If you add CO<sub>2</sub> to the alteration mineral from question *a*, what other mineral can you get? Write the chemical reaction. **[3 marks]**
- c) In which rock type(s) do you expect to observe processes *a* and *b*? **[2 marks]**

Lecture notes 2 and 7

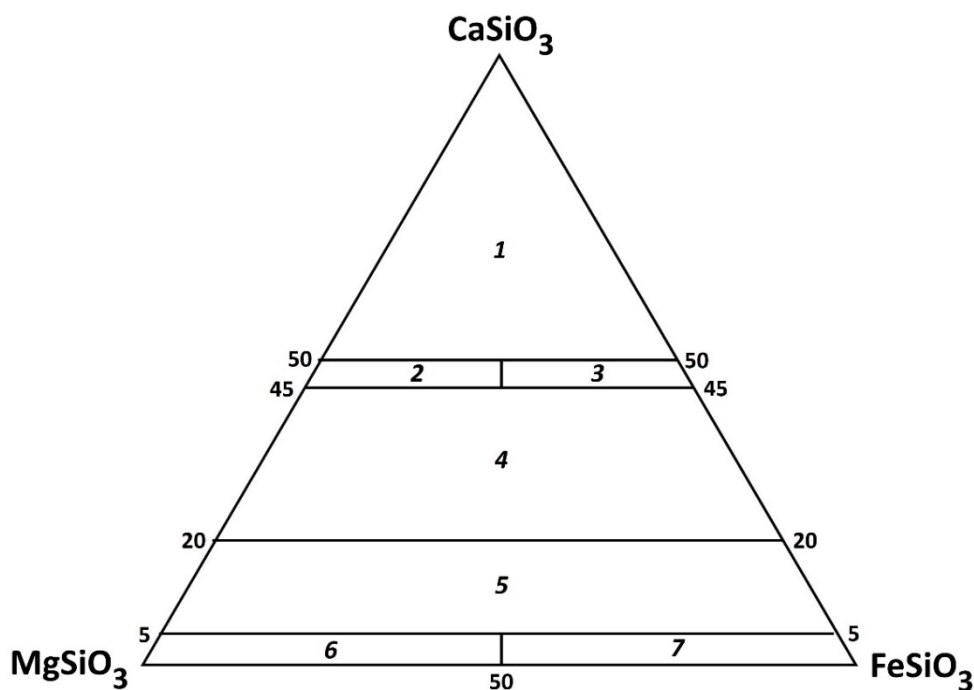
**Question 6 [6 marks]**

- a) What is **perthite**? Describe and illustrate with a sketch. [3 marks]
- b) What is the cause of formation of perthite? In which type(s) of rocks would you expect to observe it? [3 marks]

Lecture notes 8

**Question 7 [17 marks]**

- a) On the ternary classification diagram for pyroxenes, name minerals 1, 2, 3, 4, 5, 6 and 7 (consider minerals 6 and 7 orthorhombic). [2 marks each]
- b) Give the name of the pyroxene with  $\text{CaSiO}_3=10\%$ ,  $\text{MgSiO}_3=40\%$ ,  $\text{FeSiO}_3=50\%$ . [3 marks]



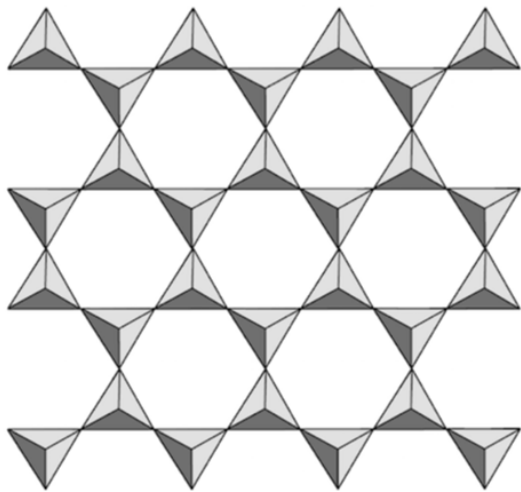
Lecture notes 3 and 5

**Question 8 [11 marks]**

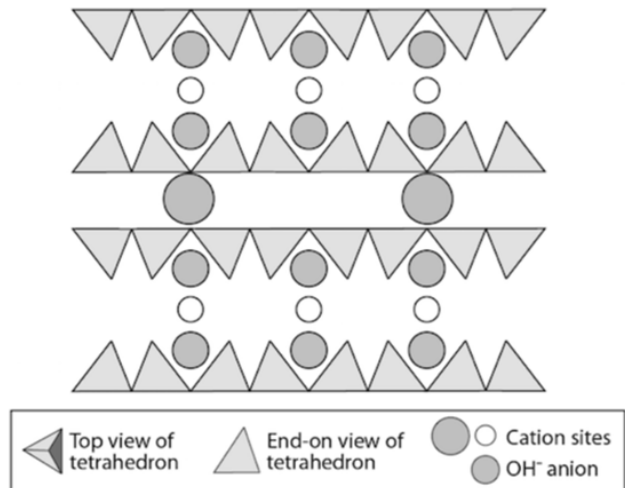
Based on the images of crystal structure and cation sites over the page:

- a) Name the mineral family that has this type of crystal structure. [5 marks]
- b) Name at least two minerals belonging to this family. [6 marks]

**View looking down on the sheet of tetrahedra**



**View looking end-on at sheets of tetrahedra**



Lecture notes 7