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UNIVERSITY OF PRETORIA

GLY 251 - CRYSTAL CHEMISTRY AND OPTICS

N.B

1. Semester test

Answer all the questions and use sketches where applicable.

Theory questions [5 marks each]

- 1 Explain the difference between the generation of continuous X-rays and of characteristic X-rays. *fine when atoms decelerates*
- 2 Explain why there is a finite number of specific wavelengths for a given element. *from when collapse of electrons makes a sharp point (high intensity)*
- 3 Discuss how solid solution and exsolution are related and what controls them.
- 4 What stacking order does cubic densest packing have?
- 5 What is the difference between the orthorhombic, monoclinic, and triclinic systems? *1 cell 3 fields*
- 6 Sketch a rough triangular diagram and label the apices as Na (bottom left), K (bottom right) and Ca (top). Plot the feldspar minerals in terms of their molar proportions. *Na 32 0 1*
- 7 If  $\text{CuK}\alpha = 1.54178\text{\AA}$  and the  $2\theta$  angle is  $45^\circ$ , what d-spacing would be represented in an XRD pattern? *52*
- 8 Explain the law on which question 7 is based.
- 9 Discuss whether a 2-fold rotation axis and a mirror plane can have the same effect in a crystal lattice.
- 10 What does (111) mean and what is described?

Practical questions

1 An analysis of a garnet gives  $(\text{Mn, Ca, Fe, Mg})_3\text{AlSi}_3\text{O}_{12}$

SiO <sub>2</sub>	37.233
TiO <sub>2</sub>	0.021
Al <sub>2</sub> O <sub>3</sub>	20.877
FeO	25.277
MnO	6.663
MgO	2.186
CaO	7.334
TOTAL	99.591

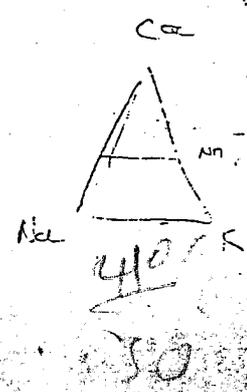
50%

24

20

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44



MOLECULAR WEIGHTS

SiO <sub>2</sub>	60.08
TiO <sub>2</sub>	79.88
Al <sub>2</sub> O <sub>3</sub>	101.96
FeO	71.85
MnO	70.94
MgO	40.3
CaO	56.08

*Pyrope*

*Na<sub>3</sub>Al<sub>3</sub>Si<sub>3</sub>O<sub>12</sub>*

99

orthosilicate  
~~silicate~~  
 $U_3Al_2(SiO_4)_3$

(silicate) and to what group garnet belongs [5]

An oxide mineral gives the analysis:

metal: O  
 3:4

	Wt%
SiO <sub>2</sub>	0.345
TiO <sub>2</sub>	6.577
Cr <sub>2</sub> O <sub>3</sub>	2.5
V <sub>2</sub> O <sub>3</sub>	0.150
FeO	81.800
MgO	3.3
TOTAL	94.672

$FeTiO_3$  - limenite

do not know  
 $FeTiO_3$

MOLECULAR WEIGHTS	
SiO <sub>2</sub>	60.08
TiO <sub>2</sub>	79.88
Cr <sub>2</sub> O <sub>3</sub>	151.99
V <sub>2</sub> O <sub>3</sub>	149.88
FeO	71.85
MgO	40.3

$MgAl_2O_4$

$XY_2O_4$

$FeCr_2O_4$

spinel

Calculate the mineral chemical formula of this spinel [10] and give a revised analysis if necessary [10].

3. Is the following analysis an example of maucherite ( $Ni_{11}As_8$ ) or of nickeline ( $NiAs$ )? Give your arguments [10]

Element	Mass %	Mass
Fe	29.4	55.847
As	69.8	74.922
S	0.21	32.066
Total	99.71	

	Mol. weight	Wt-%	cation equiv	Mol of O	Td 4
* $Cr_2O_3$	151.99	2.5	0.032897	0.01645	0.1145
* FeO	71.81	81.800	1.13912	7.13912	3.964
				1.149365	4

factor = 1.149365

$\therefore (Fe_{3.964} Cr_{0.1145}) O_4 = 3.48$