

GLY 251 - CRYSTAL OPTICS AND CHEMISTRY

02 June 2006

Internal examiner: Prof R.K.W. Merkle,
External examiner Dr. H. Mouri

Answer all questions. Write legibly. No creative spelling permitted. Use sketches where applicable. Points for each question are given in brackets. Total possible points = 100

1. Discuss the difference between:
(a) Ionic Radii - Radius ratios [5]
(b) Isostructuralism - Polymorphism [5]
2. Why are cubic minerals isotropic and why are tetragonal minerals uniaxial? [10]
3. In its 3+ state, indium has an ionic size of 0.81 \AA . Sn^{4+} has a size of 0.71 \AA .
Discuss the likelihood of their mutual substitution. [10]
4. Discuss the definition of a Mineral and what unique aspects are important for calculations as requested below. [10]
5. Describe how characteristic X-rays are generated, using a sketch showing the electron orbitals and an energy level diagram, and show the characteristic peaks in terms of wavelength. [10]
6. Derive Bragg's law using a sketch showing the relation between planar spacing and diffraction angle and discuss how X-ray diffraction is used to identify minerals. [10]
7. Discuss the stability of solid solutions with lowering of temperature. [10]
8. The following analysis is of a feldspar. Calculate from this chemical analysis (given in weight %) the molecular proportion of anorthite [10] and give the proper name for this feldspar. [5]

SiO_2	53.06	Atomic weights are: Si = 28.086
Al_2O_3	29.74	O = 15.999
Na_2O	4.06	Al = 26.982
CaO	12.81	Na = 22.990

Ca = 40.078

The following analysis is of a chromite. Calculate from this chemical analysis (given in weight %):

- a) the coefficients of Zn and V in the mineral formula to 4 decimal places, [5]
- b) the recalculated content of FeO and Fe_2O_3 to 2 decimal places [5]
- c) the recalculated total considering Fe^{2+} and Fe^{3+} to 2 decimal places. [5]

Cr_2O_3	35.35	Atomic weights are: Cr = 51.996
Al_2O_3	13.25	O = 15.999
MgO	2.29	Al = 26.982
FeO_{tot}	45.08	Fe = 55.847
TiO_2	1.50	Mg = 24.305
MnO	1.22	Ti = 47.88
ZnO	1.17	Zn = 65.39
V_2O_3	1.32	V = 50.9415
		Mn = 54.938