

GLY 251 – CRYSTAL OPTICS AND CHEMISTRY

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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 following concepts:
 - (a) Ionic Radii – What is the underlying principle and how is it used? [2]
 - (b) Radius ratios – What is the definition and why are they important? [2]
 - (c) Isostructuralism – Define and give examples [2]
 - (d) Polymorphism – Define and give examples [2]
 - (e) Derivative structures – describe with examples from the common sulfide minerals [2]
2. Write down the general formulae (i.e., taking possible substitutions into account) of the minerals wollastonite, troilite, diopside, bornite, and plagioclase. [5]
3. 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. [5]
4. Derive Bragg's law using a sketch showing the relation between planar spacing and diffraction angle. [5]
5. What is the Becke line and what can it be used for? [5]
6. Describe the concept of phase of light and why two light waves interfere constructively or destructively. [5]
7. Describe the relation between frequency, velocity and wavelength of light and what happens when it enters a denser medium such as glass. [5]
8. Discuss the stability of solid solutions with lowering of temperature, and show why stable solid solutions, unmixing and ordering can occur. [5]
9. How would you have to change the structure of a cubic mineral to make it optically biaxial. [5]

Think before you start calculating !!

10. The following analysis is of a feldspar. Calculate from this chemical analysis (given in weight %) the molecular proportion of anorthite and give the proper name for this feldspar. [10]
- | | | | |
|--------------------------------|-------|---------------------|-------------|
| SiO ₂ | 53.06 | Atomic weights are: | Si = 28.086 |
| Al ₂ O ₃ | 29.74 | | O = 15.999 |
| Na ₂ O | 4.06 | | Al = 26.982 |
| CaO | 12.81 | | Na = 22.990 |
| | | | Ca = 40.078 |
11. The following analysis is of a chromite. Calculate from this chemical analysis (given in weight %) the mineral formula and the recalculated content of FeO and Fe₂O₃. [15]
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|--------------------------------|-------|---------------------|-------------|
| Cr ₂ O ₃ | 39.52 | Atomic weights are: | Cr = 51.996 |
| Al ₂ O ₃ | 23.78 | | O = 15.999 |
| MgO | 14.53 | | Al = 26.982 |
| FeO | 21.38 | | Fe = 55.847 |
| | | | Mg = 24.305 |
12. A really strange rock contains plagioclase, quartz, chalcopyrite, galena, and pyrite. The bulk composition of the mix is SiO₂ = 49.97, Al₂O₃ = 19.23; Na₂O = 1.50; CaO = 9.84; Cu = 3.46; Fe = 5.37; Pb = 4.33; S = 8.39. **Atomic weights** are: Si = 28.0855 ; O = 15.999; Al = 26.982; Na = 22.990; Ca = 40.078; Cu = 63.546; Fe = 55.847; Pb = 207.2; S = 32.066.
- Calculate the mineral formula of the plagioclase. [10]
 - Calculate the weight-% plagioclase in the mix. [5]
 - What is the weight % galena in the mix ? [5]
 - How much sulphur is present as pyrite ? [5]