

Geochemistry 575
Theory and Practice of Electron Microprobe Analysis
Final Exam- Fall 2009

Closed book exam. Calculators are permitted.

Answer 10 of the 11 possible questions

Name: _____

Date: _____

I completed this exam in a 3 hour time period without assistance from books, notes, or other outside resources. I have not, and will not, discuss the contents of this exam with other class members.

Signed: _____

Question 1 (10 points):

Briefly discuss the theory of electron microprobe analysis, components of an electron microprobe, and list some types of analysis that can be accomplished using the electron microprobe.

Question 2. (10 points)

Bragg's Law of Diffraction is represented as follows:

$$n\lambda = 2d \sin\theta$$

Define:

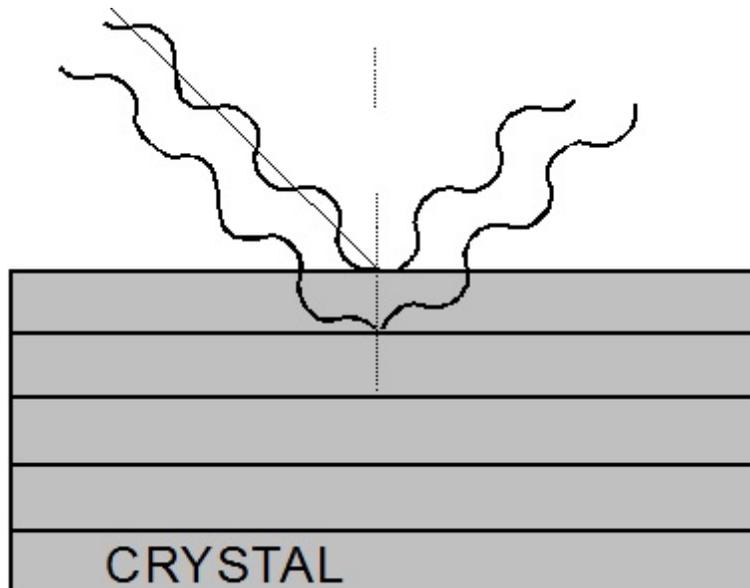
n

λ

d

θ

Indicate λ , d, and θ on the following sketch:



Question 3 (10 points)

1. Discuss how electrons are generated in the electron microprobe, and the general technique used to focus the electron beam on the sample.

Question 4 (10 points)

Define the following:

1. Accelerating voltage. Give a typical accelerating voltage for geological analysis

2. Filament current

3. Beam current

4. Probe current. Give a typical probe current for geological analysis

Question 5. (10 points)

(a) Discuss some characteristics of secondary electrons (SE) generated from a sample surface, and indicate the type of images that can be obtained using SE.

(b) Discuss some characteristics of backscattered electron (BSE) generated from a sample surface, and indicate the type of images that can be obtained using BSE.

Question 6. (10 points).

(a) Explain how X-rays are generated when an electron beam interacts with a sample.

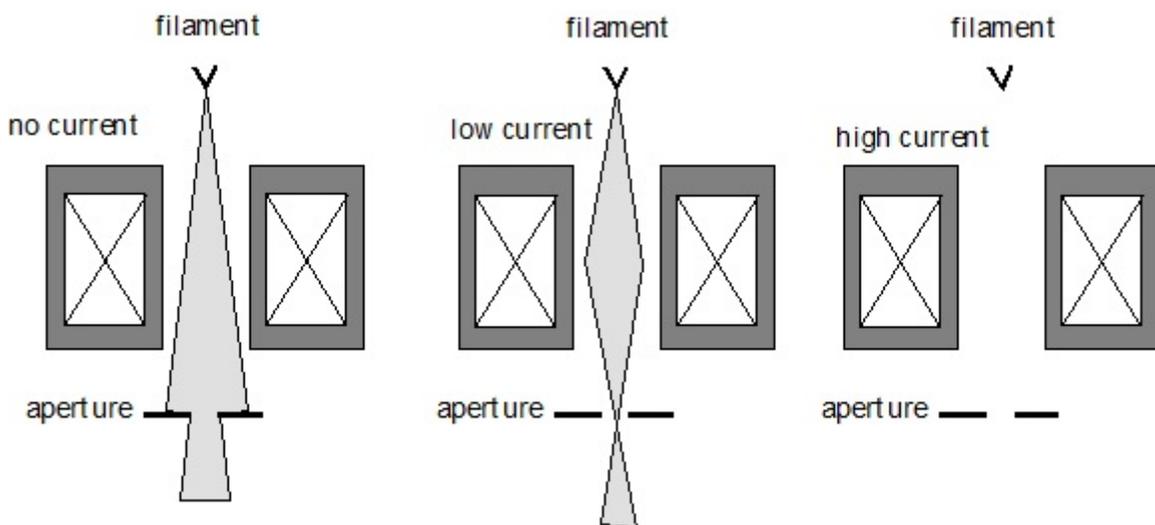
(b) Explain reason that K, L, and M X-ray lines can be generated from a sample, and indicate which have the highest energy.

Question 7 (10 points)

(a). The electromagnetic lenses in the SX-100 have 3 main functions. Name 2 of these three functions.

(b) What are the lenses made of, and, briefly, how do they work?

(c). The following sketches show schematics of the electron beam passing through a non-energized lens (no current) and a weakly energized lens (low current). Sketch in the path of electrons passing through a strongly energized lens (high current). Which configuration, low current or high current will result in the highest number of electrons reaching the sample?



Question 8. (10 points)

Explain the difference between scanning (raster) mode and fixed beam mode in the electron microprobe.

Which mode would you use for the following types of analyses:
Backscattered electron imaging:

Secondary electron imaging:

Qualitative scan:

Line scan:

Quantitative analysis:

X-ray mapping:

Question 9. (10 points)

You have counted on the X-ray peak produced by element "Q" in a sample, and have obtained 50,000 counts.

(a) What is the 1 sigma standard deviation, **in counts**, for that determination?

(b) What is the 1 sigma standard deviation, **in percent**, for that determination?

After completing matrix corrections, you determine that the concentration of "Q" is 50 wt%.

(c) Based on counting statistics, what is the 1 sigma deviation, **in percent**, for this determination?

(d) What is the 1 sigma deviation, in **wt.%**, for this determination?

Question 10. (10 points)

Curved crystals are used for diffraction of X-rays in the spectrometers of an electron microprobe.

a) List the 3 types of crystals that are present in the SX-100 at New Mexico Tech

b) What type of elements are each most suitable for? Either list a range of elements, or discuss the general element characteristics.

c) What feature of the crystal makes it appropriate for given elements?

Question 11. (10 points)

You have a sample that contains an unknown mineral phase that you would like to identify.

Describe two electron microprobe techniques that would allow you to identify the unknown phase. Compare the positive and negative features of the two techniques.