Chemistry 832: Solid State Structural Methods, Spring 2000

Laboratory Exercise #L2, X-Ray Absorption

[See G, L, R p262, International Tables, (Pitt. I(A))-13)]

The equation for X-ray absorption is: $I = I_o e^{-\mu t}$ where:

- I_o is the incident beam intensity
- I is the transmitted beam intensity
- μ is the linear absorption coefficient
- t is the path length through the material.

The value of the linear absorption coefficient is: $\mu = \rho \, \Sigma g_i(\mu/\rho)_i$ where:

- ρ is the density of the material
- g_i is the mass fraction of the ith element
- $(\mu/\rho)_i$ is the mass absorption coefficient of the ith element.

Selected values of $(\mu/\rho)_i$ in cm^2/g

Element	Z	CuKα	MoKα
H	1	0.4	0.4
C	6	4.6	0.6
N	7	7.5	0.9
O	8	11.5	1.3
Pb	82	232.0	120.0

Exercises:

(1) Calculate the path length, t, over which beams of Cu and Mo radiation become reduced in intensity by a factor of one thousand when passing through:

(a) Air (density = 0.0012 g/cm^3)

(b) Flesh (i.e. assume water as a model)

(c) Lead (density = 11.3 g/cm^3).

(2) For the Cu diffractometer, how much of the intensity is lost in air between the crystal and the detector with a typical crystal to detector distance of 50 cm (typical for macromolecules)? In a He beam path, how much is lost? How much intensity do you gain on going from air to He?

(3) How much is lost due to a Be window (assume Be window thickness of 0.5 mm).

(4) How much does our safety enclosure decrease the intensity of Cu and Mo radiation:

(a) On the steel side panels?

(b) On the glass front panels?

Note: Clearly explain any assumptions you make and the sources of any data you use that is not on this handout!!!!!!