Summary for Tutorial 2 & 3

QL
(Dated: September 26, 2008)

Keep in mind: You still need to read the lecture notes. My summary can’t have everything in it. If there’s an error, please email me.

I. CROSS SECTION

Cross section $\sigma$ is the probability for a reaction to occur. $\sigma \approx \pi R^2$, in which $R$ is the radius of target nucleus. The unit for $\sigma$ is barn. 1 barn = $1 \times 10^{-24}$ cm$^2$.

II. YIELD

Yield is the total probability for a reaction to occur (for one incident particle).

$$Y = \sigma \cdot n_0 \cdot d$$

With $n_0$ the nuclei density of the target material [particle/cm$^3$]. $d$ is the thickness of the target.

III. X-RAY INTENSITY

If we use $I(d)$ to denote the intensity after x-ray passed through the material, and use $I_0$ to denote the original intensity of the x-ray. We have:

$$I(d) = I_0 \cdot e^{-\mu d}$$

$\mu$ is the attenuation coefficient for the material and $d$ is its thickness.

Thus the transmission ratio is $\frac{I(d)}{I_0}$, the absorption ratio is $1 - \frac{I(d)}{I_0}$

IV. ABSORPTION EDGE

Absorption edge is the energy needed for ionizing electrons from inner shells. For K-edge, the energy needed is:

$$E_K = (Z - 1)^2 \cdot 13.6[\text{eV}]$$

For L-edge:

$$E_L = (Z - \sigma_L)^2 \cdot 13.6 \cdot \frac{1}{4}[\text{eV}]$$

For M-edge:

$$E_M = (Z - \sigma_M)^2 \cdot 13.6 \cdot \frac{1}{9}[\text{eV}]$$

With $Z$ the atomic number.

V. X-RAY ENERGY

K-series are the transitions from $n_i \geq 2$ to $n_f = 1$. The x-ray energy from these transitions is given by:

$$E_x = E_{n_i} - E_{n_f} = E_{n_i} - E_1 = (Z - 1)^2 \cdot 13.6 \cdot (1 - \frac{1}{n_i^2})[\text{eV}]$$

(6)

L-series are the transitions from $n_i \geq 3$ to $n_f = 2$. The energy is:

$$E_x = E_{n_i} - E_{n_f} = E_{n_i} - E_2 = (Z - \sigma)^2 \cdot 13.6 \cdot \left(\frac{1}{22} - \frac{1}{n_i^2}\right)[\text{eV}]$$

(7)