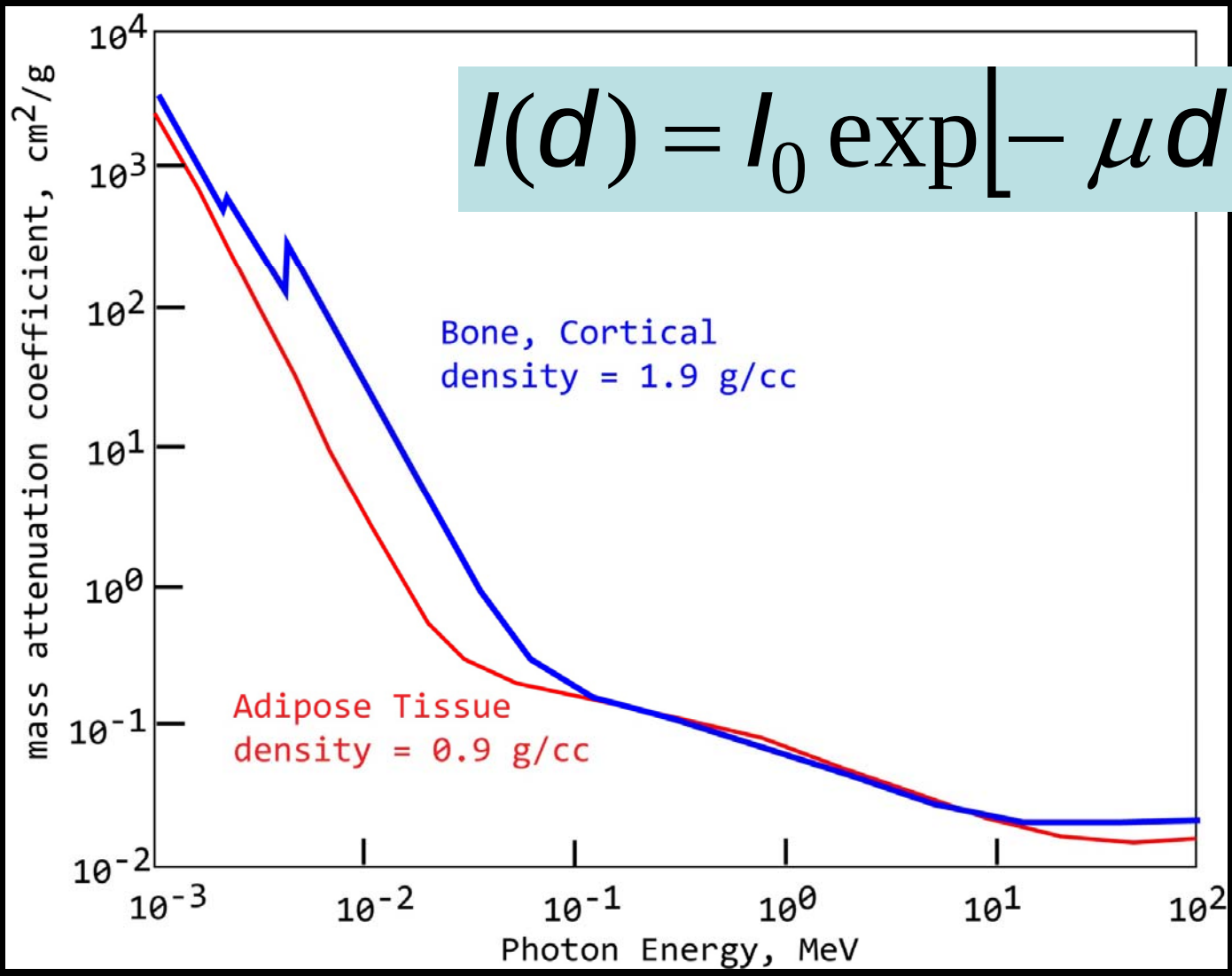
A normal chest X-ray

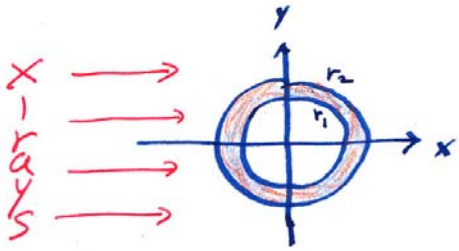
Why can the radiologist see your bones?



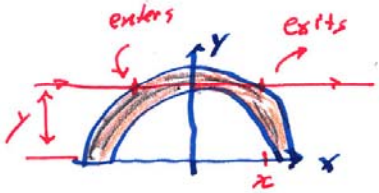
Seventy percent of bone is made up of the inorganic mineral hydroxyapatite, which includes calcium phosphate, calcium carbonate, calcium fluoride, calcium hydroxide and citrate. {Elements Ca, P, O, H}

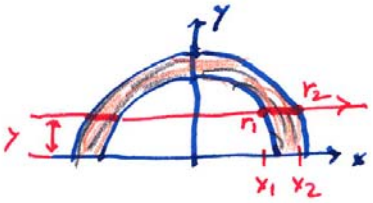
X-ray image of a bone

Model of a bone : The hard material is a cylindrical shell with inner radius $= r_1$ and outer radius r_2.



A geometry problem : How far does the X-ray go through hard bone (D), as a function of y ?



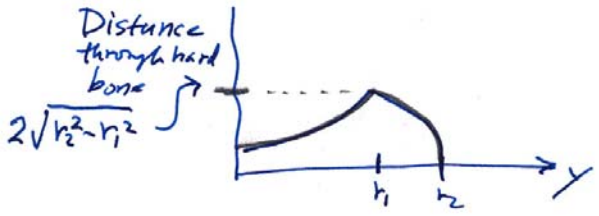


- For $y > r_2$: $D = 0$
- For $r_1 < y < r_2$: $x^2 + y^2 = r_2^2$

$$D = 2x = 2\sqrt{r_2^2 - y^2}$$

- For $0 < y < r_1$: $\begin{cases} x_1^2 + y^2 = r_1^2 \\ x_2^2 + y^2 = r_2^2 \end{cases}$

$$D = 2(x_2 - x_1) = 2\sqrt{r_2^2 - y^2} - 2\sqrt{r_1^2 - y^2}$$



EXCEL

A normal chest X-ray

Computed Tomagraphy (CT)

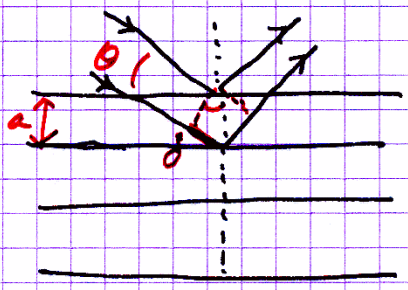
During a computerized tomography (CT) scan, a thin X-ray beam rotates around an area of the body, generating a 3-D image of the internal structures

A.D.A.M.

Eeew! Gross!
CT abdomen

Homework Set 5

P23 Bragg Scattering



parallel atomic planes scatter the X-rays

$\delta = a \sin\theta$

Path difference $= 2\delta$

Constructive interference $2\delta = \lambda$

$2a \sin\theta = \lambda$

(a) An example in NaCl: $a = 0.282$ nm

$\theta = 7$ degrees

$\Rightarrow \lambda = 0.0687$ nm

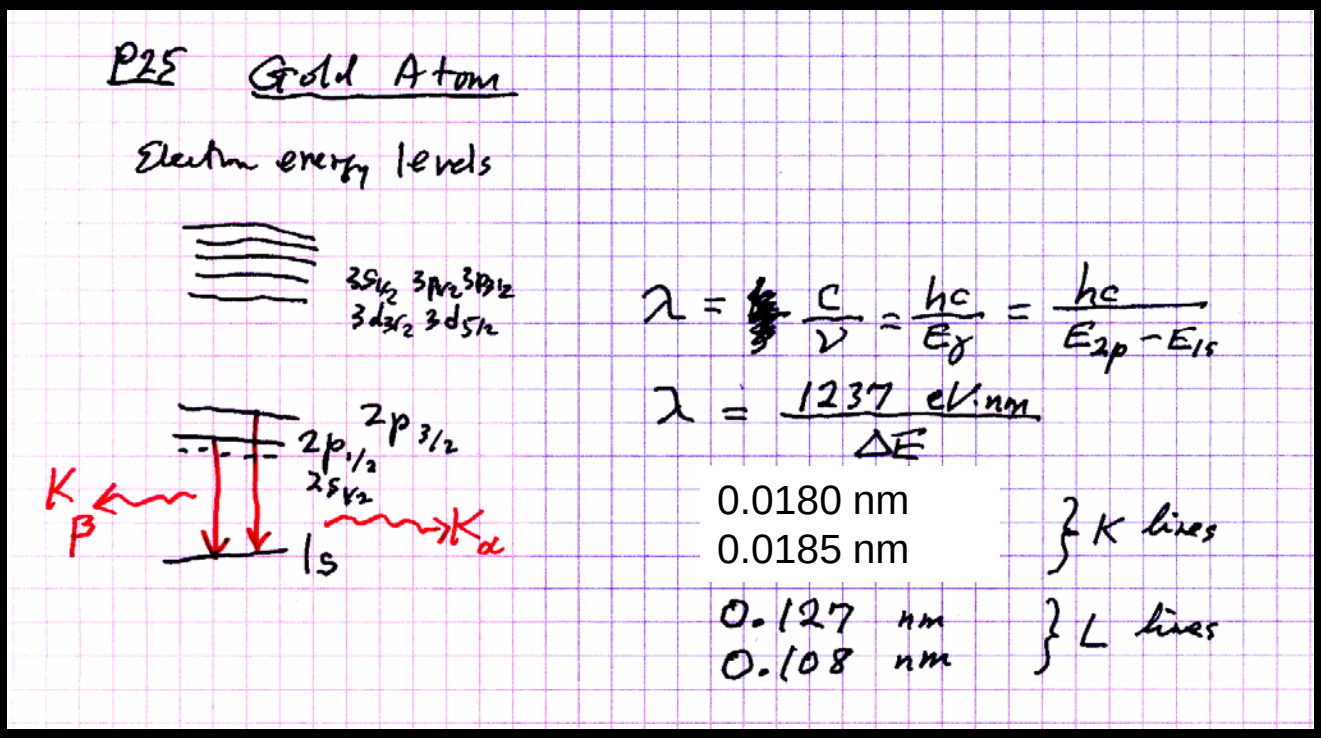
(b) $E = eV = h\nu = \frac{hc}{\lambda}$

$V = \frac{hc}{e\lambda} = \frac{2\pi \cdot 197 \text{ eV·nm}}{e \; 0.0687 \text{ nm}} = 18{,}060 \text{ V}$

$= 18$ kV

79 196.97
Au
Gold

K 1s	$L_1$2s	$L_2$2$p_{1/2}$	$L_3$2$p_{3/2}$	$M_1$3s	$M_2$3$p_{1/2}$	$M_3$3$p_{3/2}$	$M_4$3$d_{3/2}$	$M_5$3$d_{5/2}$
80,725.	14,353.	13,734.	11,919.	3,425.	3,148.	2,743.	2,291.	2,206.



Example. $2p_{3/2} \rightarrow 1s$

$$\Delta E = 80{,}725 - 11{,}919 = 68{,}806 \text{ eV}$$

$$\lambda = \frac{hc}{\Delta E} = \frac{1237 \text{ eV - nm}}{68806 \text{ eV}} = 0.0180 \text{ nm}$$