Bone Mineral Density Math

- ***Dual-energy X-ray absorptiometry (DEXA).*** *This is the most accurate way to measure BMD. It uses two different X-ray beams to estimate bone density in your spine and hip. Strong, dense bones allow less of the X-ray beam to pass through them. <u>The amounts of each X-ray beam that are blocked by bone and soft tissue are compared to each other.</u> DEXA can measure as little as 2% of bone loss per year. It is fast and uses very low doses of radiation but is more expensive than ultrasound testing.*

- *http://www.webmd.com/osteoporosis/bone-mineral-density*

- Calculation of Bone Mineral Density:
- The basic equations for dual-photon absorptiometry can be derived from a number of underlying assumptions. First, it is assumed that the material is composed of varying amounts of only two substances (in this case bone and soft tissue). Second, it is assumed that scatter can be ignored. Under these circumstances, for any given photon energy, the number of photons striking the detector (N) can be calculated from the number of incident photons (N_0) using Beer's Law.

- Beer's Law:

$$N = N_o \exp - (\mu_s M_s + \mu_b M_b),$$

where μ_s and μ_b represent the mass attenuation coefficients (cm^2/g) of soft tissue and bone (respectively) and M_s and M_b represent the area densities (g/cm^2) of the two tissue types. If data are acquired at two different energies and the above equation rearranged, a set of two equations with two unknowns is generated as follows:

$$\ln\left(\frac{N_{OL}}{N_L}\right) = \mu_{sL} M_s + \mu_{bL} M_b$$

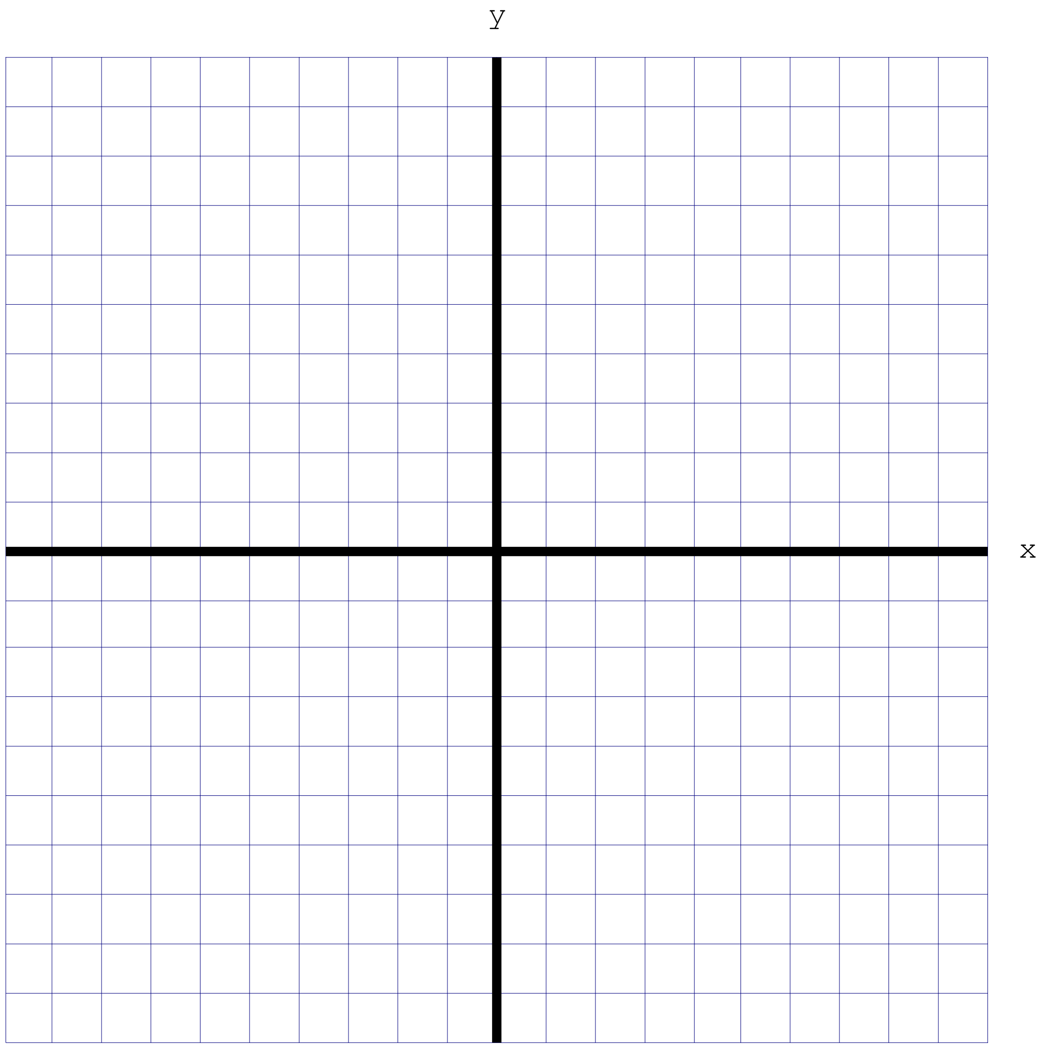
$$\ln\left(\frac{N_{OH}}{N_H}\right) = \mu_{sH} M_s + \mu_{bH} M_b$$

where the subscripts L and H have been added to distinguish the low- and high-energy data sets. The two unknowns are M_s and M_b and the above pair of equations can be solved for either quantity using the method of simultaneous equations (systems).

Exponential Equations

Graph $y = 2^x$

x	y
-2	
-1	
0	
1	
2	
3	



Recall from what you know about inverses…

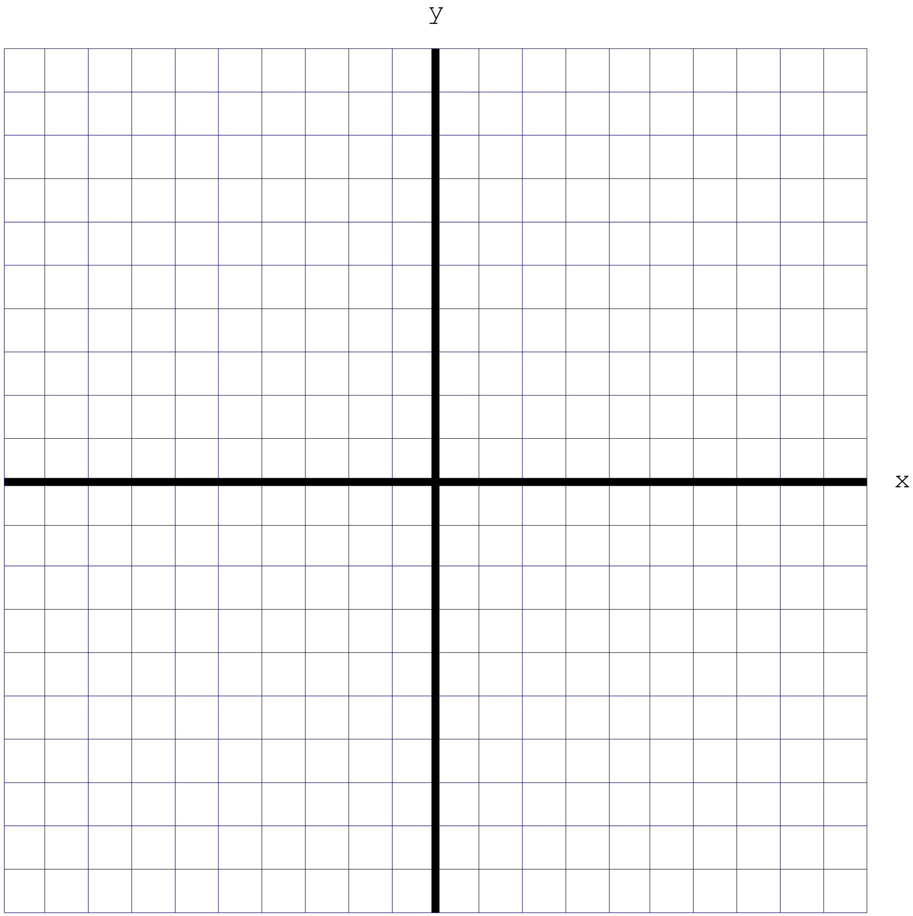
$f(x)$

x	y
-2	¼
-1	½
0	1
1	2
2	4
3	8

$f^{-1}(x)$

x	y
¼	-2
½	-1
1	0
2	1
4	2
8	3

x	y
-2	¼
-1	½
0	1
1	2
2	4
3	8



x	y
¼	-2
½	-1
1	0
2	1
4	2
8	3

- The inverse of exponents are logarithms.
- Logarithmic Function: The logarithmic function $y = \log_a x$, where $a > 0$ and $a \neq 1$, is the inverse of the exponential function $y = a^x$. So, $y = \log_a x$ if $x = a^y$.

- History Synopsis
- Rewriting exponents/logarithms
- Evaluating for a missing piece