

Bouguer's Law -

Layers of equal thickness absorb equal fractions of incident radiation intensity

One filter: $I_1 = t I_0$

where t is: -the transmission fraction
-a number between 0 and 1.

Two filters: $I_2 = t I_1 = t(t I_0) = t^2 I_0$

Three filters: $I_3 = t I_2 = t(t^2 I_0) = t^3 I_0$

Any number (n) of filters: $I_n = t^n I_0$

If you make a change from layers of filters to a continuous media, such as ozone in the atmosphere, then the mathematics becomes an exponential function:

$I_x = I_0 \exp(-ax) = I_0 e^{-ax}$ where x is distance and a is the absorption coefficient. a has units of m^{-1}

It can also be written in powers of 2,

$I_x = I_0 2^{-x/T}$ where T is the thickness needed to cut the intensity in half.

It can also be written in powers of 10,

Optical Density (OD) = $\log_{10}(I_0 / I_x)$

Then $I_x = I_0 10^{-(OD)}$

Exponential Functions

The equation:

$$I_x = I_0 \exp(-ax) = I_0 e^{-ax}$$

or

$$I_x = I_0 2^{-x/T}$$

has the properties:

- a) graph is linear on semi-log graph paper
- b) constant ratio between function values for constant differences in x values, e.g. a constant growth or decay percentage.
- c) the change in x to double the function's value, or cut it in half, is constant.

Rule of 70:

Doubling (halving) constant = 70/ (percent change)

- 5% growth doubles in $70/ 5 = 14$ years
- 5% decline halves in $70/ 5 = 14$ years