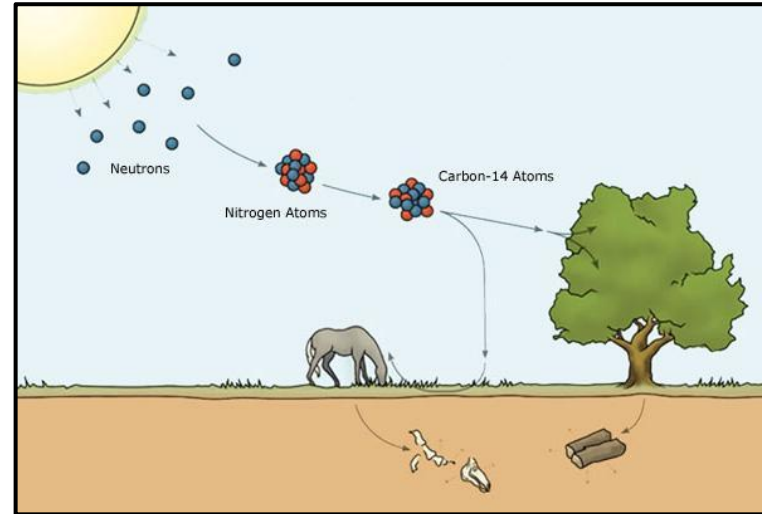# Carbon Dating and Exponential Decay

Carbon Dating

Carbon dating is the process used to determine the age of organic material, using the ratio of unstable to stable isotopes of Carbon.

- Carbon 14 is an unstable isotope of carbon, in a steady ratio to carbon 12
- Carbon 14 decays after death, carbon 12 does not

Half Life

Carbon has a half life of 5,750 years.

Half life- the amount of time it takes for a quantity to be reduced by half

Example:

An isotope has a half life of 2 years, beginning with 80g.

2 years = 40g, 4 years = 20g, 6 years = 10g, etc

Exponential Decay

Exponential Decay Formula: $A = Pe^{kt}$

By using what we already know about how carbon decays, we can use the formula for exponential decay to determine the decay rate of carbon 14, and set up an equation.

Finding the Rate of Decay

Since carbon has a half life of 5,750 years, we know that after that time, the amount of carbon 14 will have decreased by half. In the decay formula

$$A = Pe^{kt}$$

A= the final quantity

P= the initial quantity

K= the rate of decay

T= time

Finding the Rate of Decay

In our new equation, we can simply plug in the values we already know

A= 1/2, since if we started with 1, after 5,750 years this would have decreased by half

P= 1

K= x, what we need to find

T= 5,750 years, the time it takes for 1 to become ½

New Equation: $(½) = 1e^{k(5,750)}$

Finding the Rate of Decay

Then simply solve for K

$$(½) = e^{k5750}$$

$$\ln(½)=k(5,750)$$

$$\ln(½)/(5,750)=k$$

$$k= -0.000121$$

The rate of decay for carbon 14 is -0.000121

Formula for Radiocarbon Dating

Now that we know the rate of decay, we can plug it into the exponential decay formula to find the formula for the decay of carbon.

$$A = Pe^{(-0.000121)t}$$