

Quiz # 3

Name: key*You must show your work to get full credit.*

Here is an example of how even the little we have done with exponentials can be useful. Willard Libby won the 1960 Nobel prize in chemistry for working out how to use the exponential decay of carbon 14,  $^{14}\text{C}$ , can be used to date organic samples that are not too old, say 20,000 years or less. If you want more information about the chemistry and physics involved the Wikipedia article on radiocarbon dating is a good source.

The the method is based on the fact that  $^{14}\text{C}$  has a half life of 5,730 years.

1. Give a formula for the percent of  $^{14}\text{C}$  left in a sample after  $t$  years. Give your answer to 6 decimal places.

$$A = A_0 a^t$$

since we start with 100% Percent left is  $100 (.999879)^t$

$A_0 = 100$ . To find  $a$  solve

$$A(5730) = A_0 a^{5730} = \frac{1}{2} A_0$$

so  $a^{5730} = .5$

$$a = (.5)^{(1/5730)}$$

$$= .999879$$

2. A sample taken from a shroud has only 85.66% of its original  $^{14}\text{C}$  left. How old is it?<sup>1</sup>

We wish to solve

Its age is 1,279 years

$$100 (.999879)^t = 85.66$$

$$(.999879)^t = 85.66/100 = .8566$$

$$t \ln(.999879) = \ln(.8566)$$

$$t = \ln(.8566)/\ln(.999879)$$

$$= 1279.13$$

<sup>1</sup>This is data from 1988 when radiocarbon dating was used to find the age of the Shroud of Turin.