Carbon-14 Dating
(Extra Credit Project #5)

When the neutron collides with a nitrogen atom, a nitrogen-14 (seven protons, seven neutrons) atom turns into a carbon-14 atom.

Plants absorb carbon dioxide and incorporate carbon-14 through photosynthesis.

Animals and people eat plants and take in carbon-14.

Following death and burial, wood and bones lose C-14 as it changes to N-14 by beta decay.

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MAC 1105 College Algebra
TR 9:00 – 10:15
Section #3067
December 4, 2007
Carbon-14 Dating is a method used by scientists to find the age of an organic compound. This form of determining an object’s age was discovered in 1949 at the University of Chicago by a chemist named Willard Frank Libby and his coworkers. Libby had previously done research on uranium as part of the Manhattan Project during World War II. (Porter) Immediately following the war, he and his colleagues developed the carbon-14 dating method that was the first method for dating material that had a biological origin. For his work, Libby was awarded the Nobel Prize in Chemistry in 1960.

Through his research, Libby had realized that “all living things had a relatively constant carbon 14 to carbon 12 ratio as found in the atmosphere.” (Porter) However, once a plant or animal died it would stop absorbing carbon and therefore the carbon 14 isotope would decay while the carbon 12 would not. As a result, the ratio between the two would change and by measuring this change, it was possible to determine the age of the substance. (Porter)

The process Libby used to measure the decay “involved measuring radioactivity in solid carbon using modified Geiger counters. If the radioactivity was lower, more decay had occurred and the carbon was older.” (Porter) A formula to calculate how old a sample is by carbon-14 dating is as follows: \[ t = \left[ \ln \left( \frac{N_f}{N_o} \right) / (-0.693) \right] \times t_{1/2} \] where \( \ln \) is the natural logarithm, \( N_f/N_o \) is the percent of carbon-14 in the sample compared to the amount in living tissue, and \( t_{1/2} \) is the half-life of carbon-14 (5,700 years). (Brain)

Carbon-14 dating impacted a variety of scientific fields, including archeology, geology, geophysics, and other branches of science. In addition, it could be obtained on a variety of materials, including wood, charcoal, shells, bones, antlers, and peat providing...
they were less than about 50 or 60,000 years old. “Beyond 60,000 years there is hardly any radiocarbon left in a sample that is original.” (Higham) Also, very old material (beyond 30,000 years) is extremely difficult to accurately test because it is often contaminated. (Higham)

Prior to publishing his report in 1949, Libby tested his method on prehistoric Egyptian carbon samples from whose age was known. For example, a sample of acacia wood from the tomb of a pharaoh named Zoser was dated using the carbon-14 dating method. Zoser was known to have lived during the 3rd Dynasty in Egypt between 2700-2600 BC. When the wood sample was tested with the carbon-14 dating method, it confirmed what was already known which was the wood was from that same time period. (Higham)

As one might imagine, a multitude of items have been tested over the years. Some of which are considered famous. For example, many of the Dead Sea Scrolls have been dated by using the method. In addition, the Iceman, a famous frozen body found in northern Italy in 1991 was dated and showed that he lived approximately 5500 years ago. (Higham)

Though carbon-14 dating can be very accurate, there are some uncertainties. Among these are the atmospheric conditions that can provoke discrepancies in the amount of carbon-14 present. Along with this, some plants have the ability to hide or evoke more carbon-14 than the next plant, making measurements more imprecise. (Carbon-14 Dating)

Despite the uncertainties, carbon-14 dating is still a very important aspect of our life today. Without it, it would be much more difficult and time-consuming to accurately
determine the age of an organic compound, thus creating an unclear and imprecise history timeline. Instead of spending large amounts of time trying to figure out when something happened, archeologists, for example, could now spend more time on other things like how and why they happened. (Higham) Carbon-14 dating is relevant to our math class because in order to determine the age of a sample, math is needed. For example, one must have knowledge of basic algebra, order of operations, and logarithms, topics covered in our class, in order to complete the carbon-14 dating equation.
Works Cited


