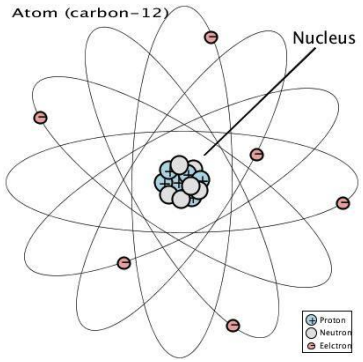
Age Graphing – Teacher Notes

If you look at the position of the element carbon in the periodic table, you will be able to find how many protons an atom of carbon has. A neutral atom of carbon must have the same number of protons as electrons.

How many protons does carbon have in its nucleus? 6
If its mass number is 12, how many neutrons does carbon usually have in its nucleus? 6
How many electrons does carbon have in its external electron cloud? 6



Carbon's chemical behaviour depends on the number of electrons it has within its outer shell. It can, and does have different numbers of neutrons in its nucleus. Early chemists realised this when they compared its measured atomic weight with its mass number

The mass number of an element is the sum of protons and neutrons in that atom's nucleus.
What should the mass number of carbon be 12 (6 protons and 6 neutrons)
When the average weight of carbon is estimated we find however that it is not 12 but **12.00096**
The measurement is precise and accurate. What could the scientific explanation for this increased number be? Some atoms of carbon have more than 6 neutrons in their nucleus. They must be few because the deviation from 12 is small. Actually only one trillionth of all carbon atoms are carbon- 14

Carbon isotopes

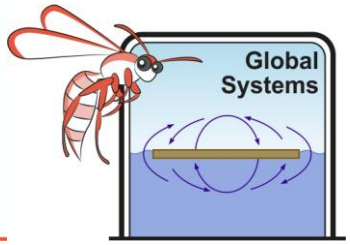
Carbon - 12 or ^{12}C has 6 neutrons	and is 99% of all carbon on Earth
Carbon – 13 or ^{13}C has 7 neutrons	and is less than 1% of all carbon on Earth
Carbon - 14 or ^{14}C has 8 neutrons	and is 1 trillionth of all carbon on Earth

Radioactive carbon is formed in the upper atmosphere when a nitrogen atom is struck by a thermal neutron from the Sun. Write this equation below.

1 neutron + nitrogen-14 = carbon – 14 + 1proton + energy.

$$n + {}^{14}N = {}^{14}C + p + e$$

Draw a diagram of carbon – 14 below. (HINT you can use the diagram of carbon – 12 above to help)
(as above but with 8 neutrons instead of 6 neutrons)



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Carbon – 14 will react with oxygen to form carbon monoxide and subsequently carbon dioxide in the atmosphere. It will then be taken up by plants during photosynthesis and enter the food chain.
Write a balanced equation for the first reaction where carbon monoxide is formed.

Carbon + oxygen = carbon monoxide

$2C + O_2 = 2CO$

Write a balanced equation for the second reaction where carbon dioxide is formed.

$2CO + O_2 = 2CO_2$

There may only be a little ^{14}C compared to ^{12}C but it is very useful. Being radioactive its path can be traced as it moves through global cycles. Its natural breakdown to more stable nitrogen occurs at a known rate and can be used to age organic materials.

Using carbon -14 to estimate age

A small percentage of carbon – 14 is continuously being produced in the upper atmosphere. Plants take in carbon dioxide in the process of photosynthesis. One trillionth of this will contain carbon – 14. If an animal eats the plant, it too will have the isotope in its body.
When the plant or animal dies the unstable isotope will start to decay back to nitrogen-14. Decay occurs at a known measured rate.
The time it takes carbon – 14 to lose half of its radioactivity is 5,730 years. This is called its ***"half life".***
It will take another half-life of 5,730 years for half of the remaining carbon – 14 to break down and every 5,730 years the amount of remaining isotope will be halved. By estimating what percentage of the original amount remains we can tell how long ago the organism died.
Use the table below to estimate how much carbon- 14 will remain after the first 7 half lives have passed.

Time	Number of half lives lost	Percentage of C-14 remaining
Start	0	100%
5,730 years	1	50%
11,460 years	2	25%
17,190 years	3	12.5%
22,920 years	4	6.25%
28,650 years	6	3.15%
34,650 years	7	1.58%

Use the graph paper provided to draw up this data.
HINTS
Use a pencil (not 2B), ruler and eraser
The graph should fit over most of the page and be easy to read.
What will the title of your graph be? The percentage of C-14 remaining over 34,650 years
What label should you put on the X axis (horizontal axis) and which units will you use? Time in years
What label will you put on the Y axis (vertical axis) and which units will you use? The amount of carbon – 14 remaining as a percentage of the original amount.
Will this be a line graph or a bar graph? Explain your answer. A line graph as it describes a change in one thing. A bar graph describes differences between different things.
How much carbon – 14 remains after 9,000 years? Approximately 32%

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