## 8.3.2 Carbon dating

videos

There are 3 isotopes of carbon: *carbon-12*, *carbon-13* and *carbon-14*.

*(1) How do these isotopes differ?*

The most naturally abundant of these is *carbon-12*. *Carbon-12* and *carbon-13* are stable (non-radioactive). *Carbon-14* is radioactive. *Carbon-14* decays via beta minus emission to *nitrogen-14*, with a half life of approximately 5730yr.

*(2) Write a nuclear equation for carbon-14 decay.*

When plants grow, they incorporate carbon into their structure by absorbing carbon dioxide from the air. *Carbon-12* and *carbon-14* are both absorbed and behave chemically identically. Both are incorporated into the structure of the plant. Therefore, the ratio of *carbon-14* to *carbon-12* in the air is also the ratio in the structure of the living plant. As the plant grows and new cells are produced, this ratio is maintained. When the plant dies, the non-radioactive *carbon-12* atoms will remain. However, the radioactive *carbon-14* atoms will decay over time. This means that the ratio of *carbon-14* to *carbon-12* will decrease with time. Archeologists can measure the ratio of *carbon-14* to *carbon-12* in ancient organic material, to calculate how old the material is.

The ratio of *carbon-14* to *carbon-12* in the atmosphere is about 1 to $1 \times 10^{12}$. A 1 gramme sample of pure carbon will have an activity of 0.192Bq.

*(3) Work out the number N of carbon-14 atoms in a 1g sample of carbon obtained from a modern plant.*

*(4) From the half life, work out the decay constant for carbon-14.*

*(5) A 1g sample of carbon from an ancient wooden boat was found to have an activity of 0.082Bq. Work out the age of the boat.*