0 1

The average person in the UK receives an annual dose of roughly **2.7 mSv** from all sources of background radiation. The below table details the approximate dose which someone will someone will receive from a number of different activities.

Activity	Dose (mSv)
Eating a banana	0.0001
Having a dental X-ray	0.005
Flying from London to New York	0.08
Working in a nuclear power station for one year	0.18
Having a CT scan (full-body)	20
Spending six months in orbit on a space station	80

0 1 . 1

Calculate the number of bananas someone would have to eat in order to receive a radiation dose equivalent to their total annual background dose.

Answer = Total annual background dose ÷ dose from one banana
Answer = 2.7 ÷ 0.0001
Answer = **27,000**

0 1 . 2

In hospitals, CT (Computed Tomography) scans involve the use of X-rays. Doctors will only ask for such scans to be performed when medically necessary. Explain why they are keen to avoid the use of such scans if possible.

A single full-body CT delivers a dose of (roughly) 20 mSv which is much greater than the average annual background dose of 2.7 mSv [1].

Doctors will want to minimise the radiation dose administered / they will want to ensure that the benefits of the scan outweigh the risks involved from giving the patient this dose [1].

0 1 . 3

What effects can ionising radiation have on cells within the body?

It can damage or kill cells [1] or lead to cell mutation [1].

0 1 . 4

Single doses of greater than one sievert (1 Sv) can lead to severe radiation sickness or death. How many times greater than the average annual UK background radiation dose is a dose of 1 Sv?

Answer = 1 ÷ 0.0027
Answer = **370** times greater

0 2 Carbon dating can be used to estimate the age of a fossil. This technique relies on the fact that a particular isotope of carbon called carbon-14 is radioactive.

0 2 . 1 Carbon-14 undergoes beta decay to form nitrogen-14. Complete the following nuclear equation for the beta decay of carbon-14.

$$^{14}_{6}\mathrm{C} \longrightarrow {}^{14}_{7}\mathrm{N} + {}^{0}_{-1}\mathrm{e}$$

0 2 . 2 Outline the way in which carbon dating is used to estimate the age of a fossil.

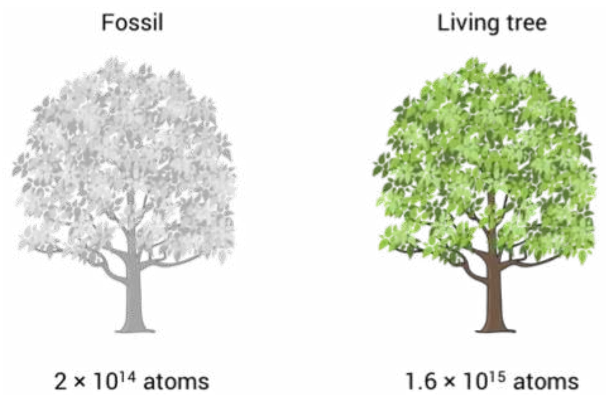
All living things contain (a tiny amount of) C-14 [1].

When they die, the amount of C-14 they contain begins to decrease (they are no longer taking in any new C-14 nuclei, and the C-14 which they contain decays) [1].

By measuring the amount of C-14 in a dead plant or animal, we can estimate its age (to be more precise, scientists actually compare the ratio of C-14 to 'normal' C-12 in a fossil) [1].

0 2 . 3 An archaeologist uncovers the fossil of a tree and wants to know its age.

The fossil is found to contain 2×10^{14} carbon-14 atoms. A living tree of the same size contains 1.6×10^{15} carbon-14 atoms.



Estimate the age of the fossil. The half-life of carbon-14 is 5700 years.

Living tree contains 1.6×10^{15} carbon-14 atoms.
Once it dies, after 1 half-life, tree contains half this number of C-14
($\frac{1}{2} \times 1.6 \times 10^{15} = 0.8 \times 10^{15} = 8 \times 10^{14}$ carbon-14 atoms).

After 2 half-lives, contains 4×10^{14} carbon-14 atoms.
After 3 half-lives, contains 2×10^{14} carbon-14 atoms.

Age = 3 half-lives = 3 × 5700 = **17,100 years**