# Starter

- Humans have a hearing range of up to 20,000/2,000 Hz
- Frequency is the number of half/complete waves that pass through a point in 1 second
- If we increase the amplitude of a sound wave it will be louder/quieter
- Ultrasound is a transverse/longitudinal wave
- In longitudinal waves, the vibrations and direction of the wave travel at right angles/parallel to each other
- Ultrasound can be used to check for broken bones/break up kidney stones
- An advantage of ultrasound over X-rays is they do/don't harm living cells

**Extension**: describe how an ultrasound scan works

# Match the word (letter) to it's definition (number)

| | |
|---|---|
| A - isotope | 1 – isotope of an element that's radioactive |
| B - radioisotope | 2 – device used to measure radiation |
| C – half-life | 3 – atoms with the same number of protons but different neutrons |
| D – Geiger counter | 4 – unit of activity |
| E – becquerels (Bq) | 5 – protons and neutrons |
| F - ionisation | 6 – the average time taken for half the nuclei in a radioactive sample to decay |
| G - nucleon | 7 – the loss or gain of electrons from an atom, making it charged |

# Objectives

Revise some of the 'radiation and radioactivity' topics from P4
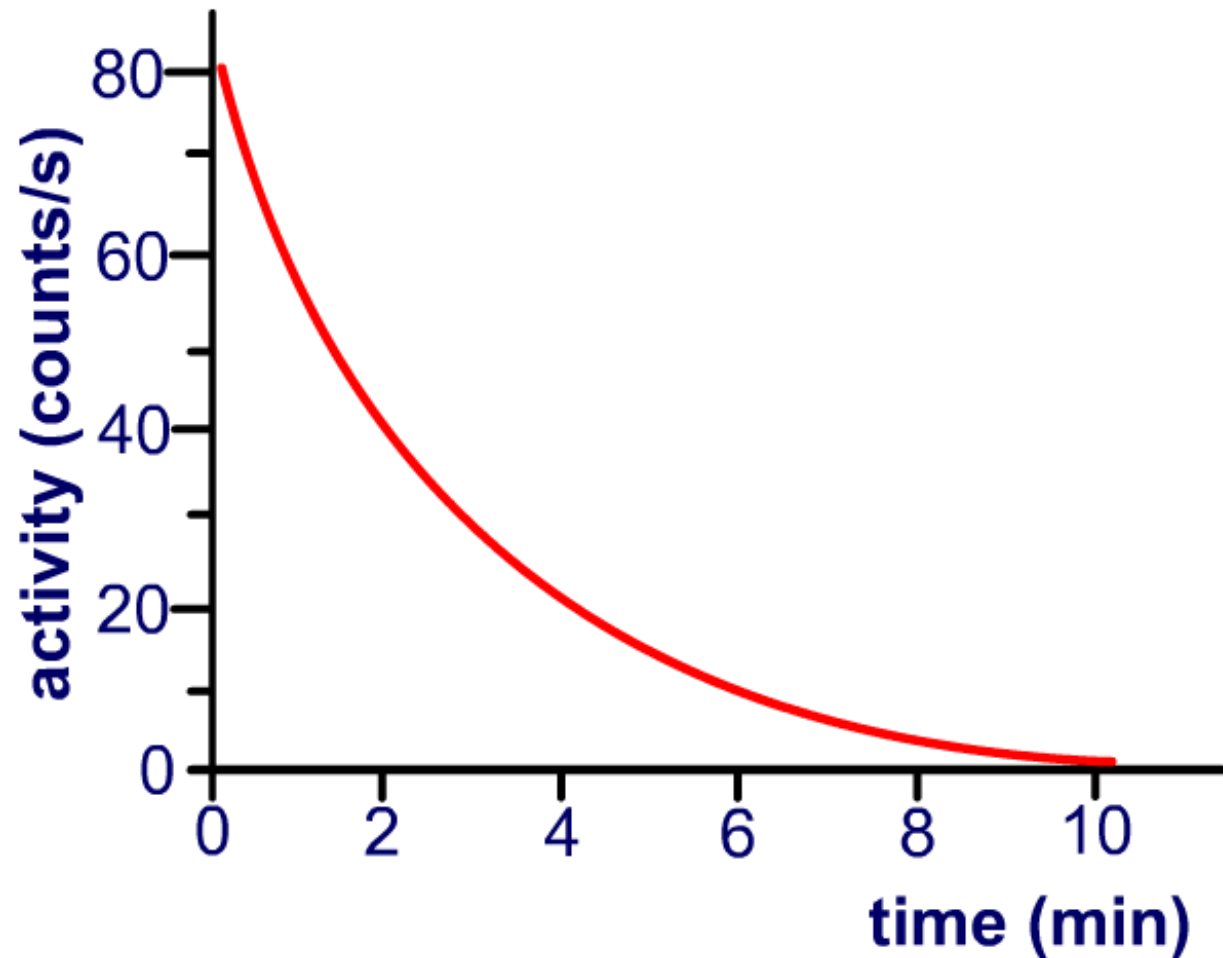
# What are the 3 main types of radiation?

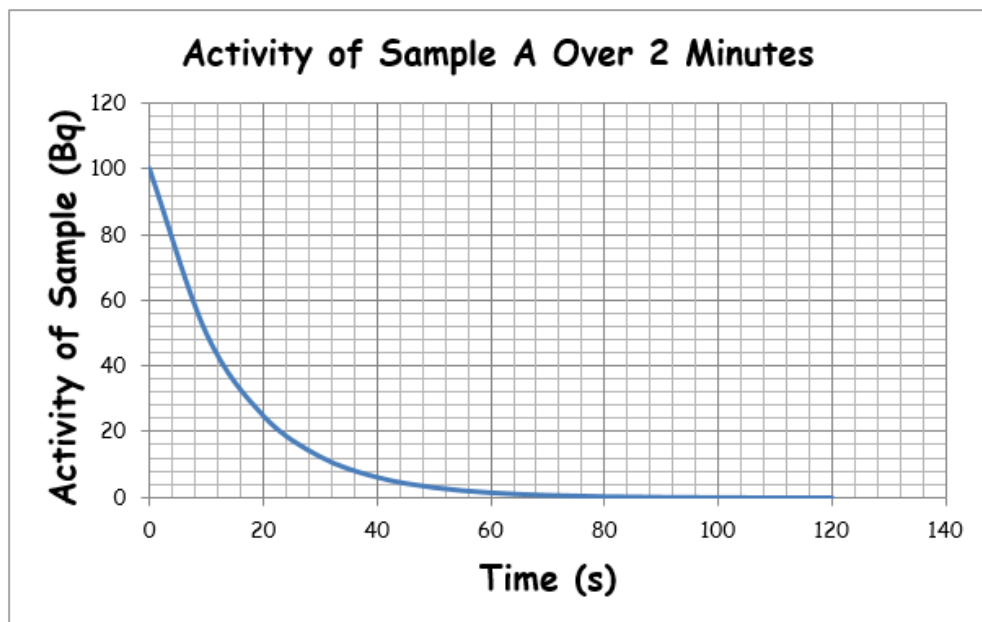| | |
|---|---|
| Penetrates the furthest | A |
| Is positively charged | B |
| Is negatively charged | C |
| Most ionising | D |
| The nucleus isn't changed | E |
| Travels very fast | F |
| Stopped by paper | G |
| Is a fast moving electron | H |
| Is made up of 2 protons and 2 neutrons | I |
| Stopped by aluminium | J |
| Stopped by lead | K |
| When emitted (released) it removes excess (extra) energy | L |

# Half-life

Is the **average time** it takes for **half** the nuclei present to decay. It's the time for the **activity to half**.

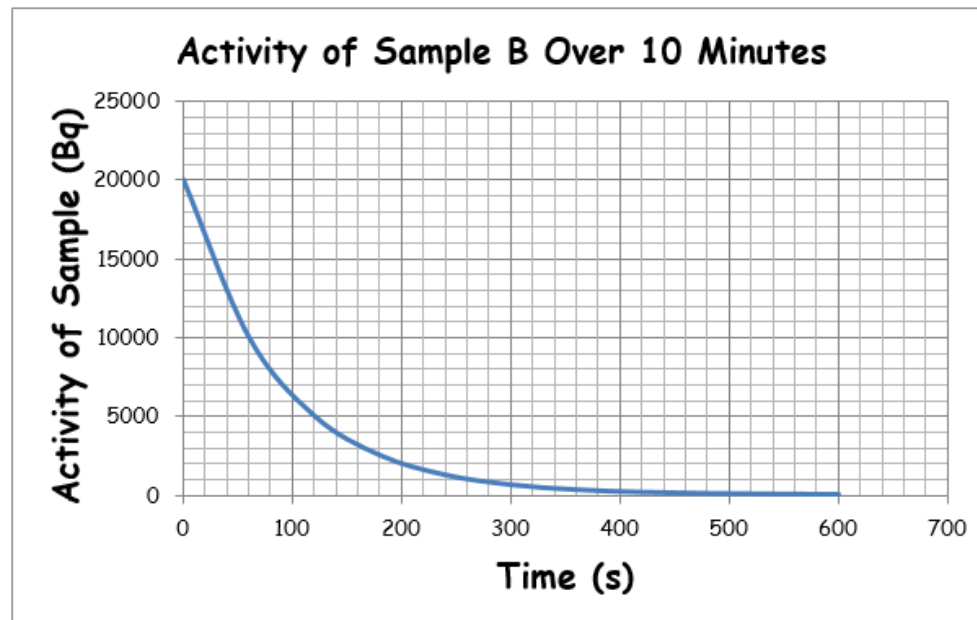What is the half-life for the radioisotope on the right?

Sample A

Activity of Sample A Over 2 Minutes

Half Life = _____

Sample B

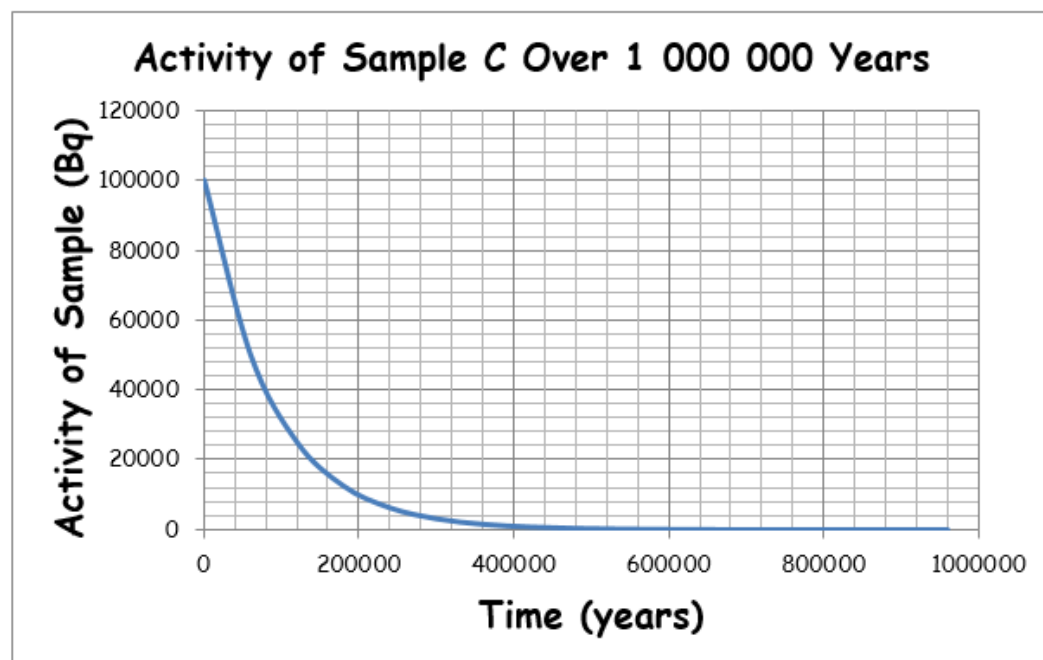Activity of Sample B Over 10 Minutes

Half Life = _____

**Extension:** draw your own half-life graph and get somebody to calculate the half-life

## Sample C

### Activity of Sample C Over 1 000 000 Years



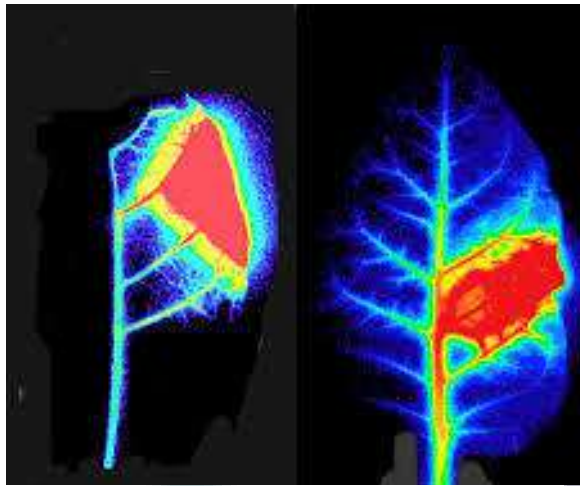Half Life = _____

## Calculating Half Life:

*Example: A sample of cobalt-60 has an activity of 2000 Bq. What will the activity be after 10 years? Cobalt-60 has a half life of 5 years.*

_____

_____

_____

_____

*Example: A sample of strontium-90 has an activity of 5000 Bq. After 120 years the activity has fallen to 625 Bq. What is the half life of strontium-90?*

_____

_____

_____

_____

# What are the uses of radioisotopes?



Radioactive cobalt
Gamma rays
Helmet
Target

Counter
Detector
Ground
Pipe
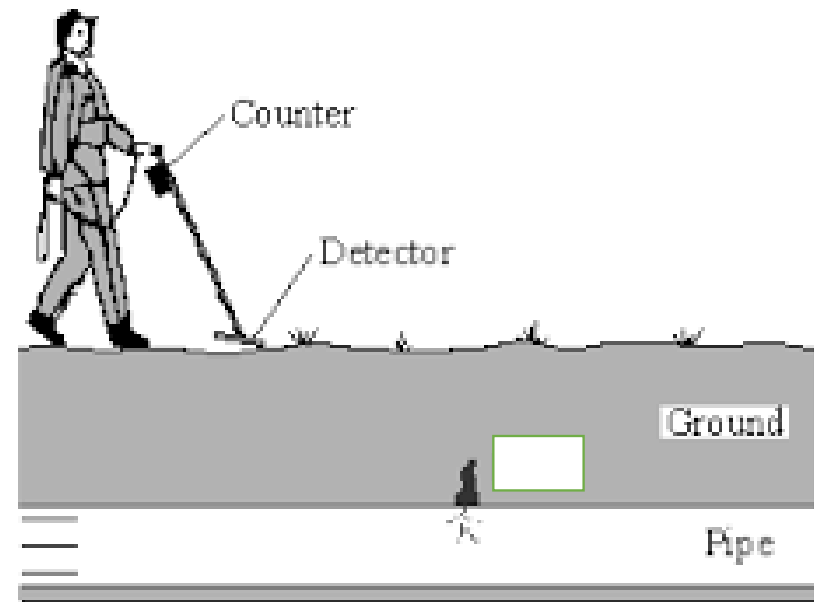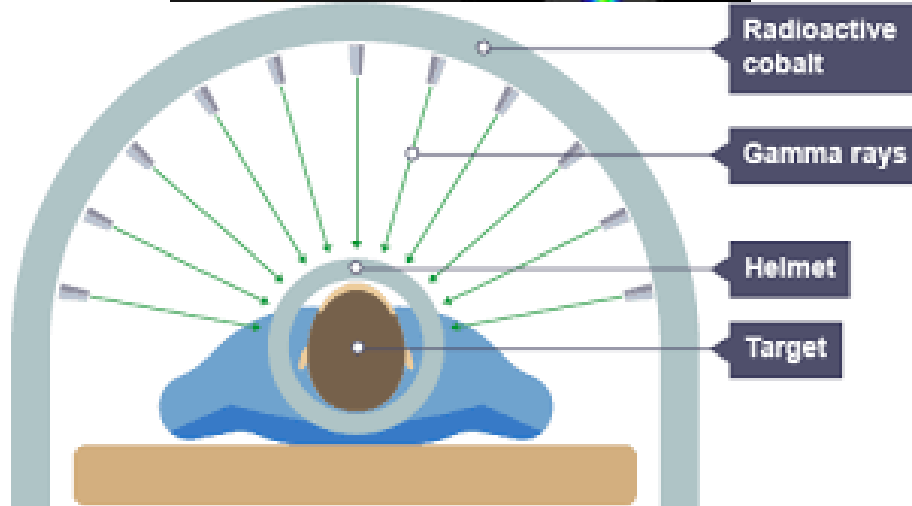
**12** An engineer thinks that a water pipe in a field is partly blocked.

The pipe is underground.

She can use a tracer to investigate the problem.

Look at the information about the tracers that she could use.

| Tracer | Radiation | Half life | Penetrating power |
|--------|-----------|-----------|-------------------|
| A | alpha | 2 hours | stopped by paper |
| B | beta | 48 hours | stopped by 3mm aluminium |
| C | beta | 12 hours | stopped by 3mm aluminium |
| D | gamma | 3 minutes | can penetrate lead and concrete |
| E | gamma | 24 hours | can penetrate lead and concrete |

The engineer chooses which tracer to use.

She puts this tracer in the water pipe.

Explain which tracer she should use and describe how she finds the position of the partial blockage.

*The quality of written communication will be assessed in your answer to this question.*

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| Question | Answer | Marks | Guidance |
|---|---|---|---|
| 12 | **[Level 3]**<br>**Gives a detailed description of the method**<br>**AND**<br>**chooses tracer E giving a correct justification.**<br>Quality of written communication does not impede communication of the science at this level<br>(5 – 6 marks)<br><br>**[Level 2]**<br>**Gives a simple or partial description of the method**<br>**AND**<br>**chooses tracer D or E with a supporting reason.**<br>Quality of written communication partly impedes communication of the science at this level<br>(3 – 4 marks)<br><br>**[Level 1]**<br>**Gives a simple or partial description of the method involved**<br>**OR**<br>**chooses tracer D or E with a supporting reason**<br>Quality of written communication impedes communication of the science at this level<br>(1 – 2 marks)<br><br>**[Level 0]**<br>Insufficient or irrelevant science. Answer not worthy of credit.<br>(0 marks) | 6 | **This question is targeted up to grade C**<br><br>**Indicative scientific points at level 3 for choice of tracer is:**<br>gamma E emitter chosen for its appropriate (long enough to detect) half-life<br>**AND**<br>penetrates soil / pipe<br><br>**Indicative scientific points at level 2 / level 1 for choice of tracer is**<br>E emitter chosen for its appropriate (long enough to detect) half-life<br>**OR**<br>D / E emitter chosen for its appropriate (short enough not to cause harm) half life<br>**OR**<br>D / E / gamma source chosen for soil penetration<br><br>**Description at all levels may include:**<br>• uses a detector<br>• measures radiation on surface along the pipe<br>• blockage is where count rate changes / blockage shows a larger reading / blockage followed by a reduced reading<br><br>**Use the L1, L2, L3 annotations in Scoris; do not use ticks.** |
| | **Total** | **6** | |

# Plenary

2 protons and 2 neutrons         Gamma

Alpha

Negatively charged

Decay                    Beta

Half-life

Nucleus is unchanged

# Nuclear decay equations



Alpha Decay of a Uranium-238 nucleus

Parent nucleus

$^{4}_{2}He$

emitted α particle

Key
proton
neutron

decay event

$^{238}_{92}U$

Daughter nucleus
$^{234}_{90}Th$

$$^{238}_{92}U \longrightarrow ^{234}_{90}Th + ^{4}_{2}\alpha$$

# Nuclear decay equations



$$^{14}_{6}C \rightarrow ^{14}_{7}N + ^{0}_{-1}\beta$$
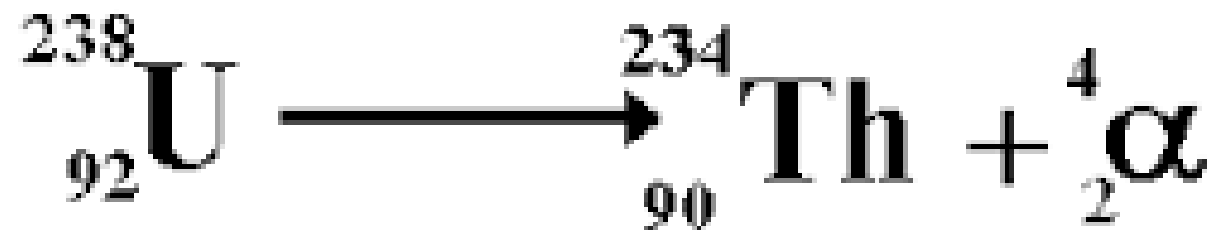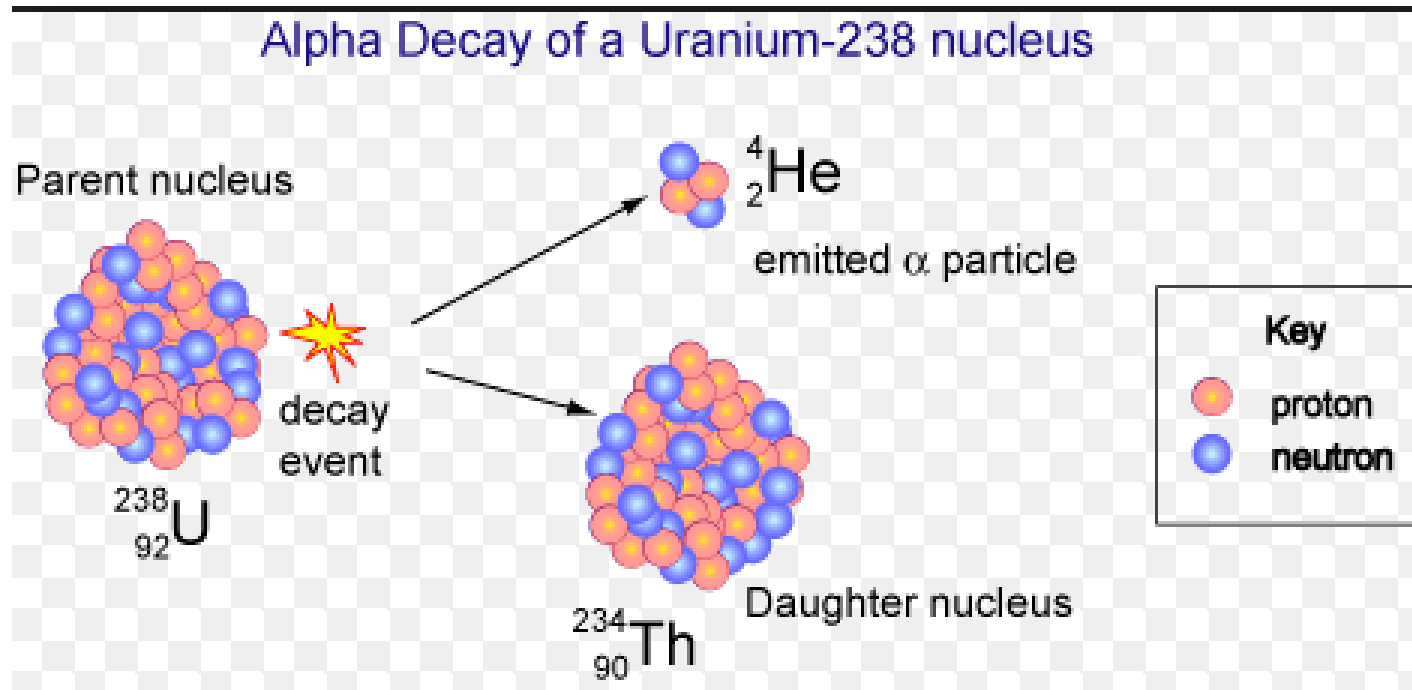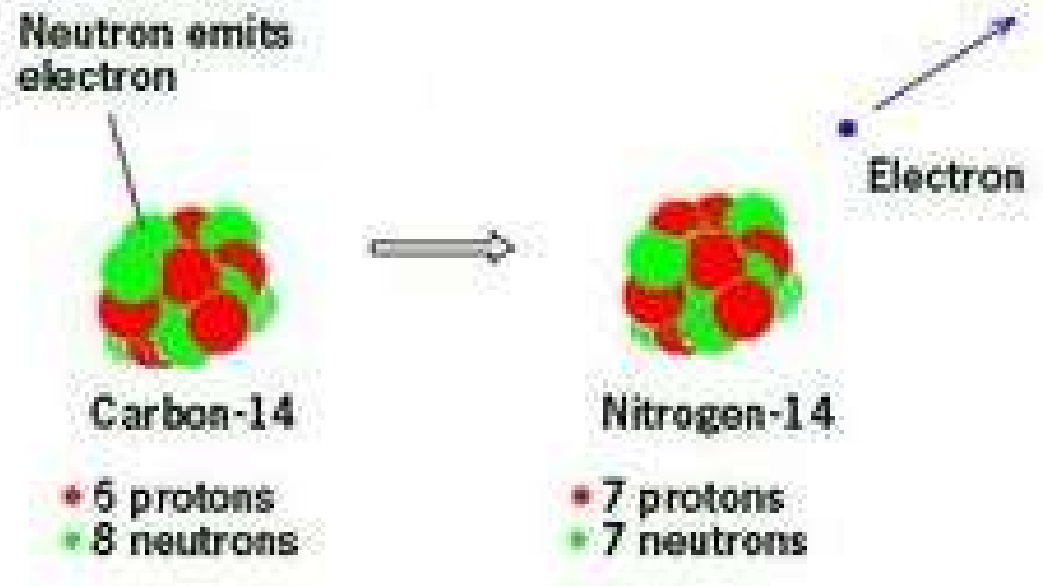
# Task

- Complete the worksheet on nuclear equations
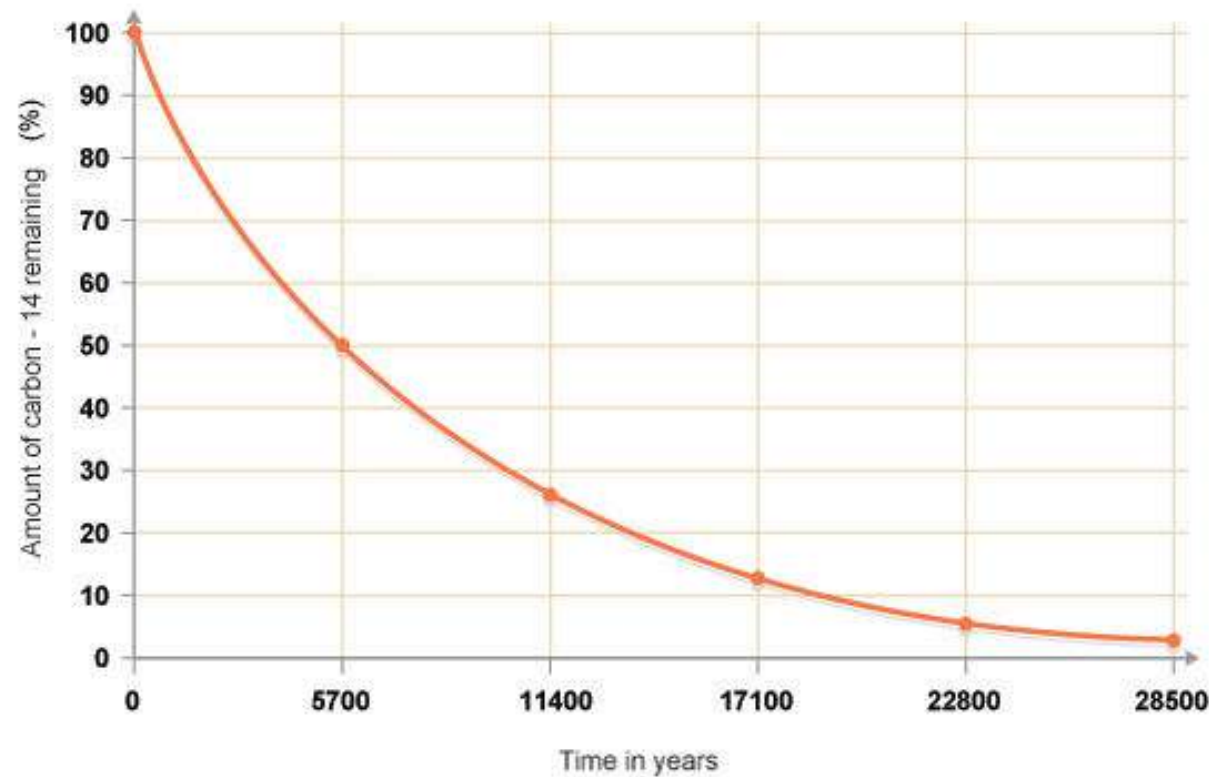- If you're stuck you have 2 options:

1. Ask someone who knows the answer
2. Put your hand up and I will come over

**Extension**: if you finish make up some of your own exam style questions on radioactivity

# Radiocarbon-dating

- **Carbon-14** is a radioactive isotope of carbon
- By measuring how much carbon-14 there is in something, we can work out it's approximate age



Role play
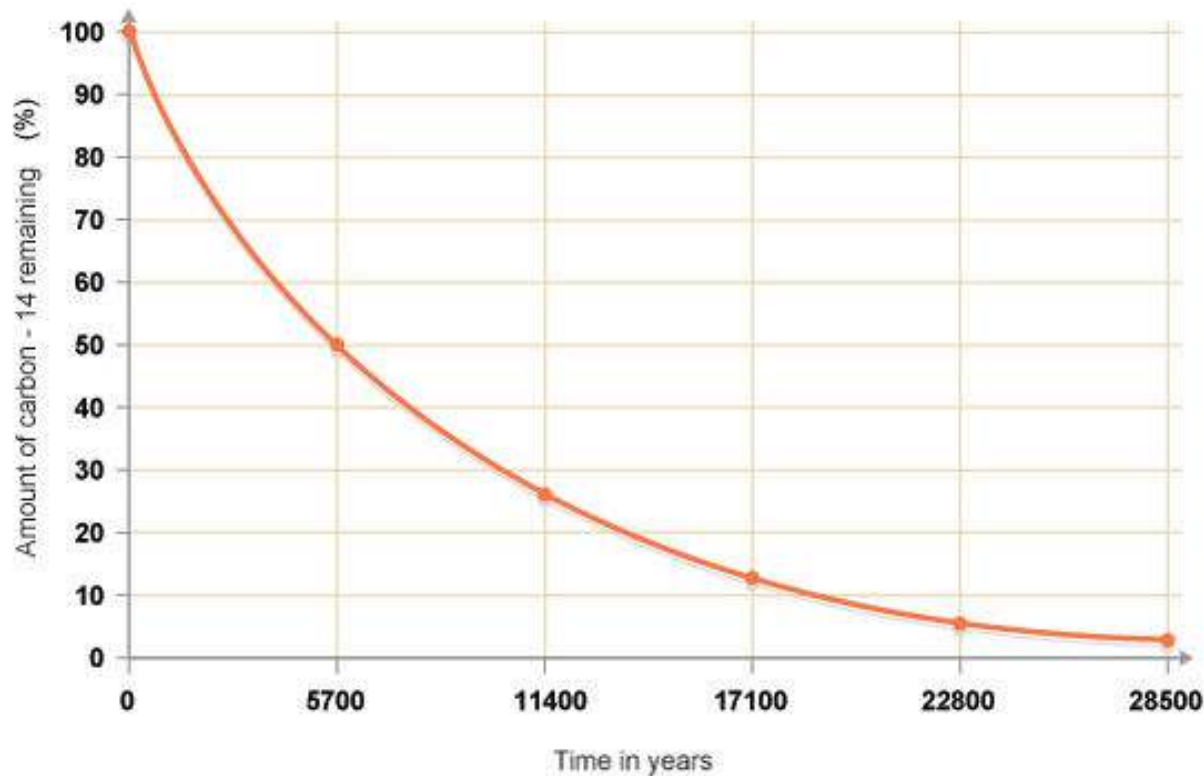
**Q.** If there is 50% C-14 left, about how old will the object be?

**Q.** If there is 10% of C-14 left, about how old will the object be?