# Half Life

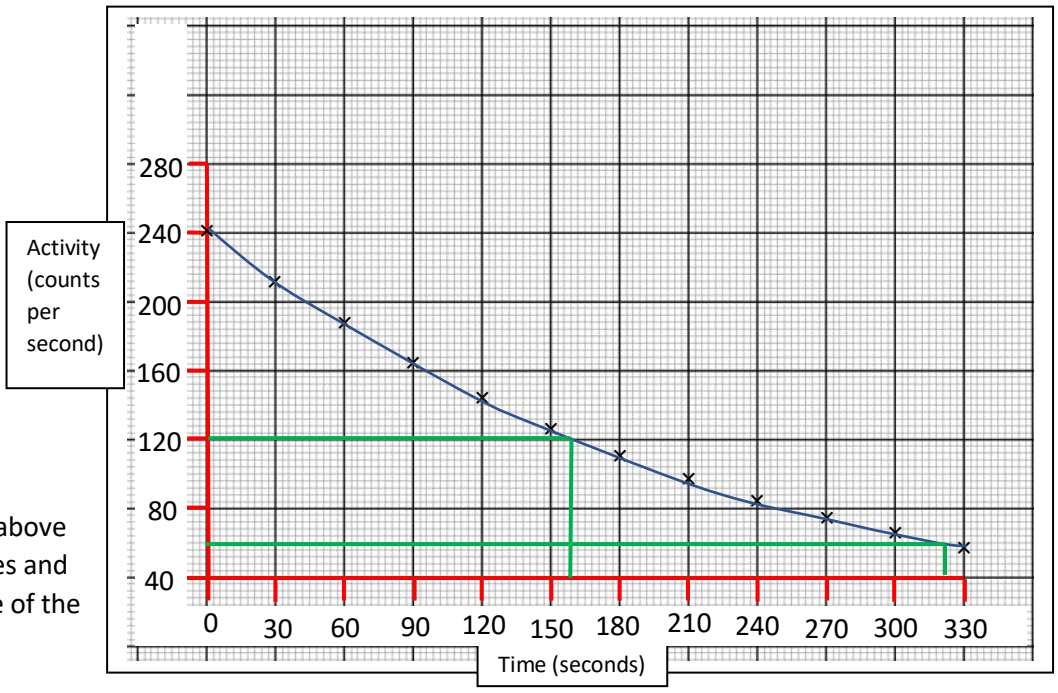
**All answers to calculations should be to 2 significant figures.**

1.Define the term half life

Half Life of a radioactive isotope is the average time it takes for the number of nuclei of the isotope in a sample to halve.

2a. Using the data below, plot a graph of activity in counts per second against time in seconds.

| Time (seconds) | Activity (counts per second) |
|---|---|
| 0 | 241 |
| 30 | 212 |
| 60 | 188 |
| 90 | 165 |
| 120 | 145 |
| 150 | 127 |
| 180 | 112 |
| 210 | 99 |
| 240 | 87 |
| 270 | 76 |
| 300 | 67 |
| 330 | 59 |




2b. Using the graph above draw on two half lives and work out the half life of the isotope.

159 seconds, see green line above.

3. Polonium-210 has a half life of 140 days. If an original sample of Polonium-210 has an activity of 500Bq what will its activity be after 420 days.

Half life 1 2 3

500Bq → 250Bq → 125Bq → 62.5(63) Bq

Days 140 280 420

Answer 63 Bequerels.

4. Polonium-218 has a half life of 5 minutes. A teacher took a sample of Polonium-218 out of a box. 15 minutes later the teacher measured the count rate in Becquerels and was found to be 800. What would the count rate had been when the sample was being removed from the box?

Draw a similar flow diagram to above, but start from the right and work backwards towards the left.

Half life 1 2 3

6400Bq → 3200Bq → 1600Bq → 800Bq

Minutes 5 10 15

So, working backwards, the original count rate is 6400Bq

5. A scientist discovered a new radioactive isotope which he called Alphium. The count rate was 600Bq and decreased to 75 Bq over a period of 9 hours. What is the half life of Alphium?

| Half life | 1 | 2 | 3 |
|---|---|---|---|
| 600Bq → | 300Bq → | 150Bq → | 75Bq |

This has taken 9 hours for 3 half lives, therefore it is 3 hours per half life

6. Technetium-99m has a half life of 6 hours. After 87.5% of the original isotope had undergone radioactive decay the count rate was 30 counts per second. How long did it take for 87.5% of the sample to decay?

| Half life | 0 | 1 | 2 | 3 |
|---|---|---|---|---|
| Amount remaining | 100% | 50% | 25% | 12.% |
| Amount decayed | 0% → | 50% → | 75% → | 87.5% |
| Time period (hours) | | 6 | 12 | 18 |

So, 18 hours.

7. Carbon-14 is used for radioactive dating to find the age of an object that contains carbon. Carbon-14 has a half life of 5730 years. In the year 2000 a piece of wood was extracted from a bog which was found to contain 0.125g of carbon-14. When the wood was originally formed it contained 1g of carbon-14. Calculate the year that the wood was formed.

| Half life | | 1 | 2 | 3 |
|---|---|---|---|---|
| Mass of material | 1g → | 0.5g → | 0.25g → | 0.125g |
| Time taken (years) | | 5730 | 11460 | 17190 |

So, the piece of wood is 17190 years old. As it is currently the year 2000, then the wood was originally formed in the year

2000-17190 = -15190 , or BC 15190.

8. A radioactive isotope undergoes 5 half lives.

8a. Express as a fraction the amount of the isotope the amount left after 5 half lives

| Half life | 0 | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| Amount remaining | 1 → | 1/2 → | 1/4 → | 1/8 → | 1/16 → | 1/32 |

8b. Express as a percentage the amount of the isotope that has decayed

If 1/32 is remaining, then that means that 31/32 has decayed.

So, 31/32 x 100 = 96.9%, 97%

9.Uranium-235 is used in nuclear fuel rods and it has a half life of 700 million years. Due to the long half life it will take a significant amount of time for the count rate to decrease. However, over a time span of 50 to 100 years the activity or count rate of Uranium-235 actually seems to increase slightly.

9a. Suggest a reason for the increase in count rate over the 50-100 year time period.

During the decay process, some daughter nuclei are produced. However, these are also radioactive. This means that the total amount of radioactivity will increase slightly.

Q10. A sample decays to 1/256$^{th}$ of its original count rate over a period of 5 minutes. Calculate the half life in seconds.

| Half lives | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|---|
| Amount present | 1 | 1/2 | 1/4 | 1/8 | 1/16 | 1/32 | 1/64 | 1/128 | 1/256 |

Total of 8 half lives over 5 minutes (300 seconds). Therefore,

300 seconds/8 = 37.5 seconds per half life.

Q11. Explain why temperature will not affect half life

Radioactive decay is a random process, so it is not affected by changes in temperature, or other factors.