WJEC Physics GCSE
Topic 2.8: Half life
Questions by topic

1.

Living animals take in small amounts of radioactive carbon-14. After death, the amount of carbon-14 in their bodies decreases, because the carbon-14 atoms decay. The amount of carbon-14 remaining in the bones of an animal's skeleton can be used to estimate its age.

Carbon-14 is a beta emitter, with a half-life of 5720 years.

(a) State what is meant by the following statements: [3]

(i) carbon-14 is a beta emitter;

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(ii) carbon-14 has a half-life of 5720 years.

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(b) Complete the decay equation for carbon-14 shown below. [3]

$$^{14}_{6}C \rightarrow \overset{\cdots\cdots}{\underset{\cdots\cdots}{\cdots}}N + \overset{\cdots\cdots}{\underset{\cdots\cdots}{\cdots}}e$$

(c) (i) A bone taken from a skeleton, found at an archaeological site, contains 10 units of carbon-14. An identical bone in a living animal contains 160 units of carbon-14. Use your understanding of half-life to calculate the age of the skeleton. [2]

age = ... years

(ii) Explain why this method of calculating the age of bones is unreliable for skeletons believed to be less than 100 years old. [2]

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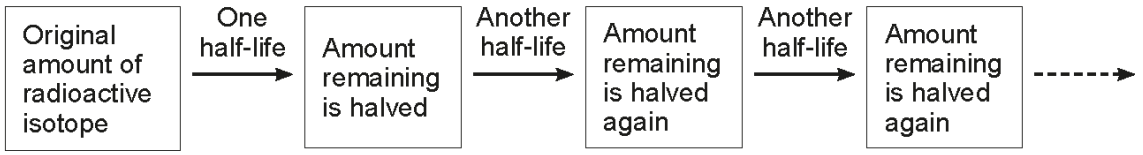
10

2.

The mass of a sample of a radioactive isotope is 64 g and it has a count rate of 800 counts per minute. It is a gamma emitter.

It has a half-life of 30 minutes.

Radioactive decay follows the pattern below:



(a) (i) Find out how many half-lives it takes for the count rate to fall to 50 counts per minute. [1]

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(ii) How long does it take for the count rate to fall to 50 counts per minute? [2]

time = ...

unit .....

(iii) What mass of the radioactive isotope remains at this time? [1]

mass = ... g

(b) Explain why this radioactive isotope would be suitable as a radioactive tracer in medicine. [2]

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6

3.

The table below shows information about some radioisotopes.

Radioisotope	Half-life	Method of decay
Tellurium-133	12 minutes	beta
Astatine-211	7.2 hours	alpha
Cobalt-60	5 years	beta and gamma
Caesium-137	30 years	beta
Americium-241	432 years	alpha

(a) Using the information in the table, select the most suitable radioisotope for the tasks below, and give reasons for your choice. [4]

(i) Treating cancer by injecting the radioisotope directly into the tumour.

Name of radioisotope: .....

Reasons:

I. .....

.....

II. .....

.....

(ii) To sterilise packaged surgical instruments.

Name of radioisotope: .....

Reasons:

I. .....

.....

II. .....

.....

(b) A sample of tellurium-133 has an initial activity of 288 Bq.

(i) How many half-lives occur in 1 hour? ..... [1]

(ii) Calculate the activity of the sample after 1 hour. [2]

activity = ... Bq

7

4.

A student does an experiment with **dice** to investigate **radioactive decay**. The dice, which represent radioactive atoms, are thrown together onto the floor. Those that show a **six** are removed. These represent the atoms whose nuclei have decayed. The remaining dice (undecayed atoms) are thrown again and the process is repeated several times.

The student starts with **600** dice.

(a) (i) Predict how many of the dice would show a "six" on the first throw. [1]

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(ii) State why the student cannot predict **which** dice will show a "six". [1]

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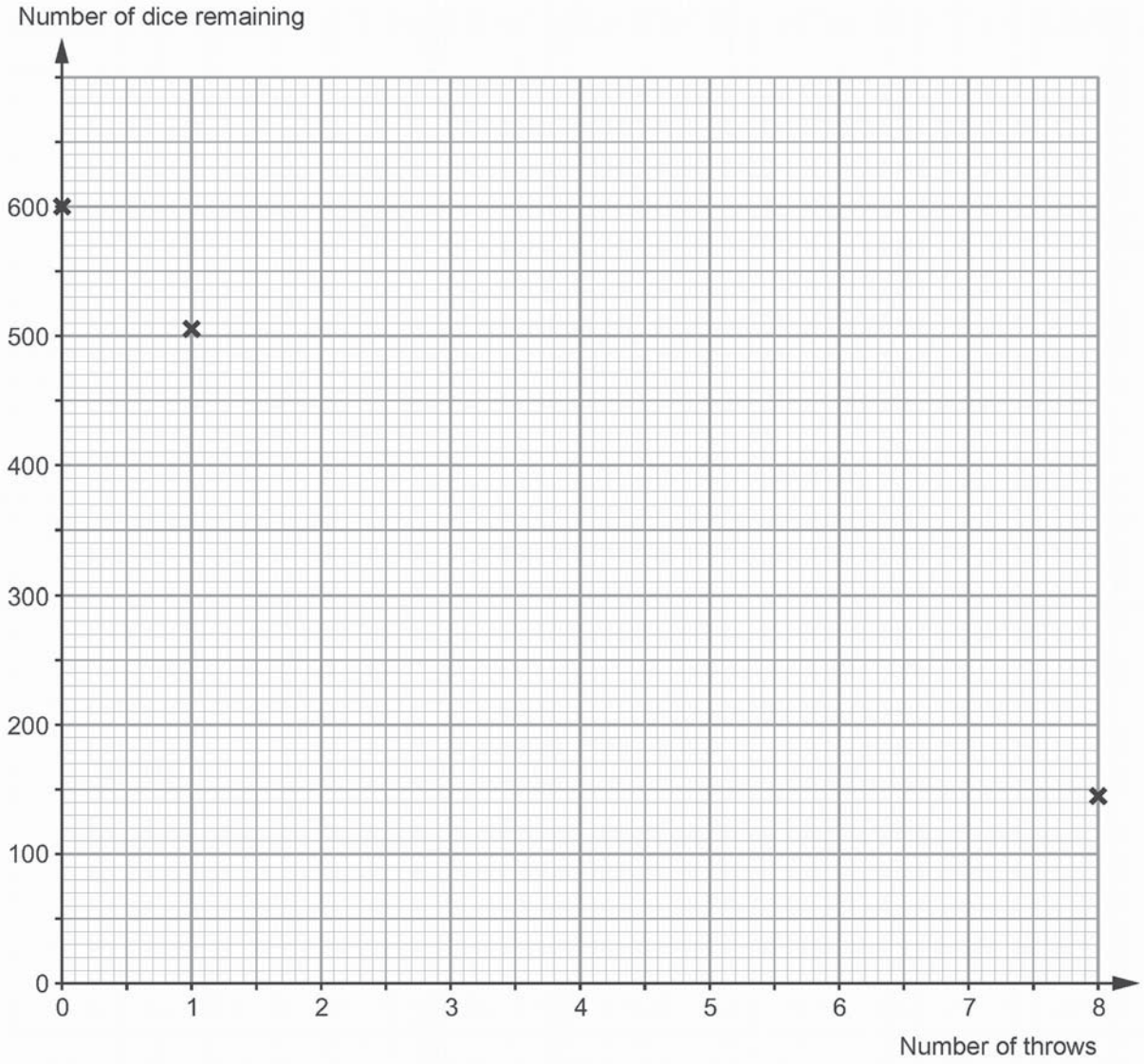
(b) The results of the experiment are shown in the table below.

Throw	Number of sixes	Number of dice remaining
0	0	600
1	95	505
2	85	420
3	.....	350
4	60	290
5	50	240
6	40	200
7	30	170
8	25	145

(i) **Fill in the gap** in the table above. [1]

(ii) Plot the results on the grid below and draw a suitable line. [3]
Three points have been plotted for you.



(iii) **Draw lines on to your graph** to enable you to find the **half-life** of the dice. [2]

half-life of dice = ... throws

(c) Americium-241 is a radioactive substance which is used in smoke alarms in houses. It decays by emitting alpha particles.

(i) State why Americium-241 is radioactive. [1]

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(ii) What is an alpha particle? [1]

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(iii) Explain why the use of Americium-241 in house smoke alarms when in normal use, does not present a significant health risk to people living in the houses. [2]

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5.

A smoke detector works as follows:

- It uses a radioactive source that emits alpha particles.
- The alpha particles ionise the air inside the detector causing an electric current.
- Any smoke getting into the detector absorbs the alpha particles and changes the current.
- The change in current sets off the alarm.

(a) (i) What is an alpha particle? ..... [1]

(ii) Explain why the detector would not work if the radioactive source emitted gamma rays only. [2]

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(iii) Explain why, in normal use, the radioactive source in the detector is not a risk to human health. [2]

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(b) Americium-241 has a half-life of 432 years. Curium-242 has a half-life of 160 days. Both isotopes are alpha emitters.

(i) Explain why Americium-241 is more suitable for use in the smoke detector than Curium-242. [2]

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(ii) An average smoke detector contains about 0.4 micrograms (μg) of Americium-241 which has an initial activity of 52 000 units.

(I) Name the unit of activity. ..... [1]

(II) Calculate how long it will take for the activity to drop to 26 000 units. [2]

Time = ... years

(III) Calculate the mass of Americium-241 remaining after 864 years. [2]

Mass remaining = ... μg

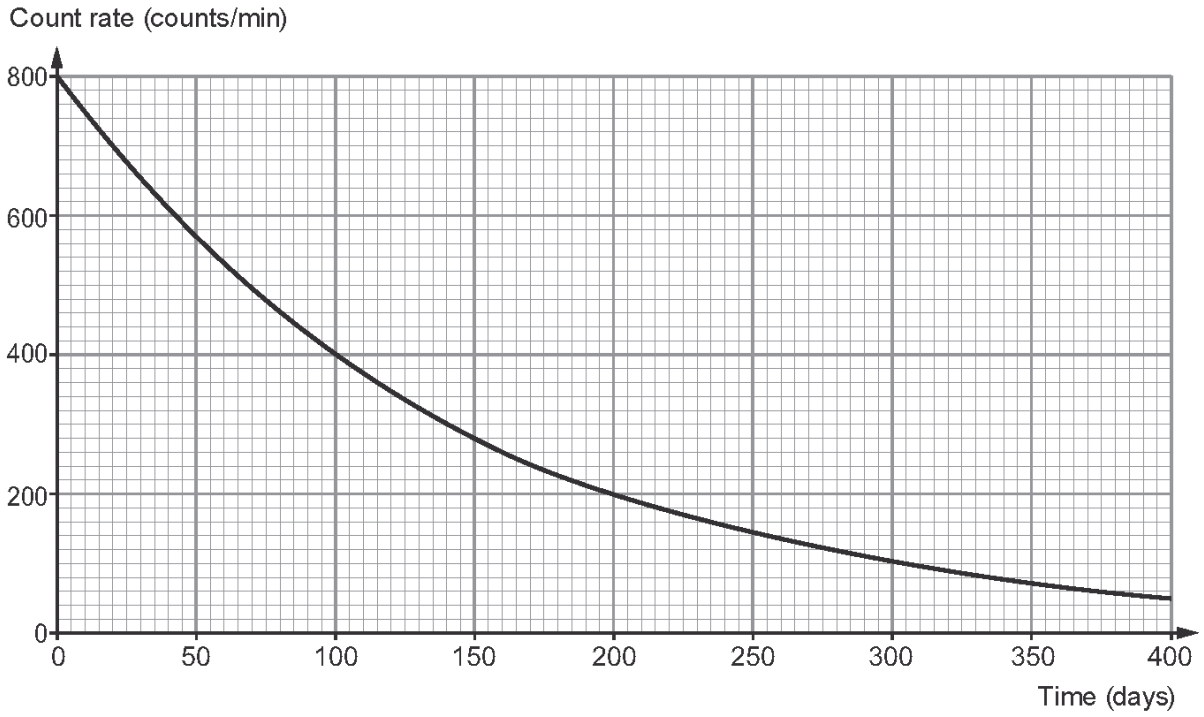
12

6.

(a) Put ticks (✓) in the boxes that correctly give the meaning of the **half-life** of a radioactive substance. [2]

The time taken for the radioactivity to halve.	
The time taken for the atoms to split in half.	
The time taken for the number of undecayed particles to halve.	
The time taken for the count rate to halve.	
The time taken for half of the alpha particles to decay.	

(b) The following graph shows the decay curve for a radioactive substance.



(i) Use information from the graph on page 6 to write down the count rate after 100 days. [1]

count rate = ... counts/min

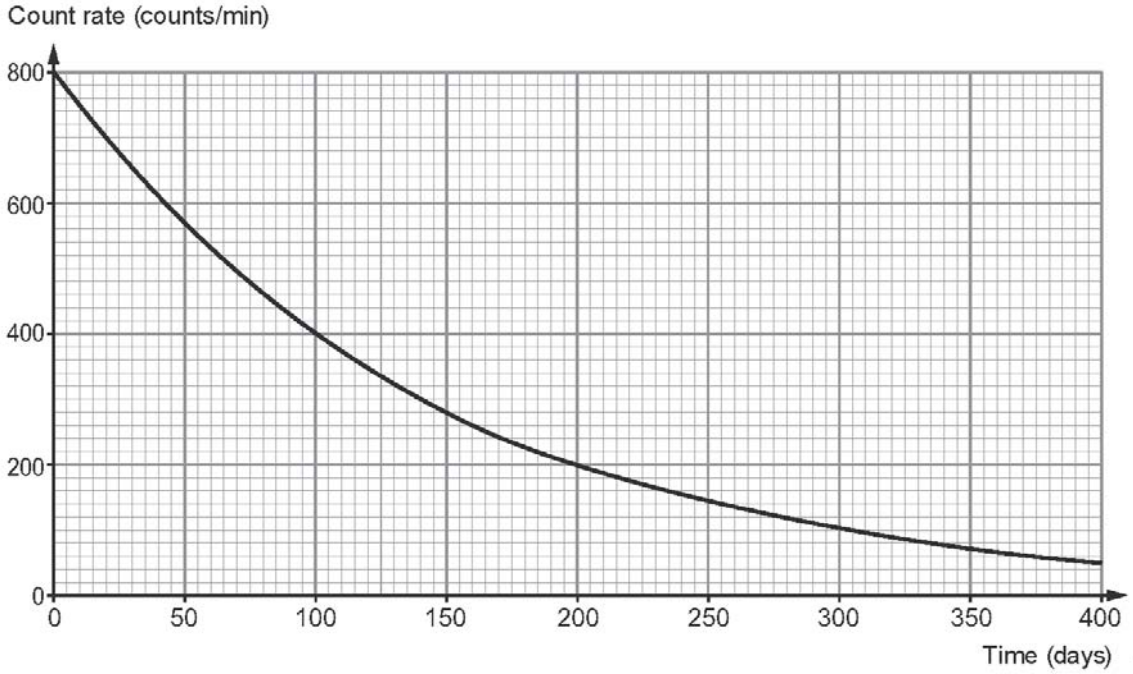
(ii) Write down the half-life of this radioactive substance. [1]

half-life = ... days

(iii) Write down the time it would take for the count rate to fall from 50 to 25 counts/min. [1]

time = ... days

(iv) Draw a decay curve on the grid **below** for a radioactive substance that has a starting count rate of 800 counts/min and a shorter half-life than the one shown. [1]



6

7.

(a) State what the term "half-life of a radioactive substance" means. [2]

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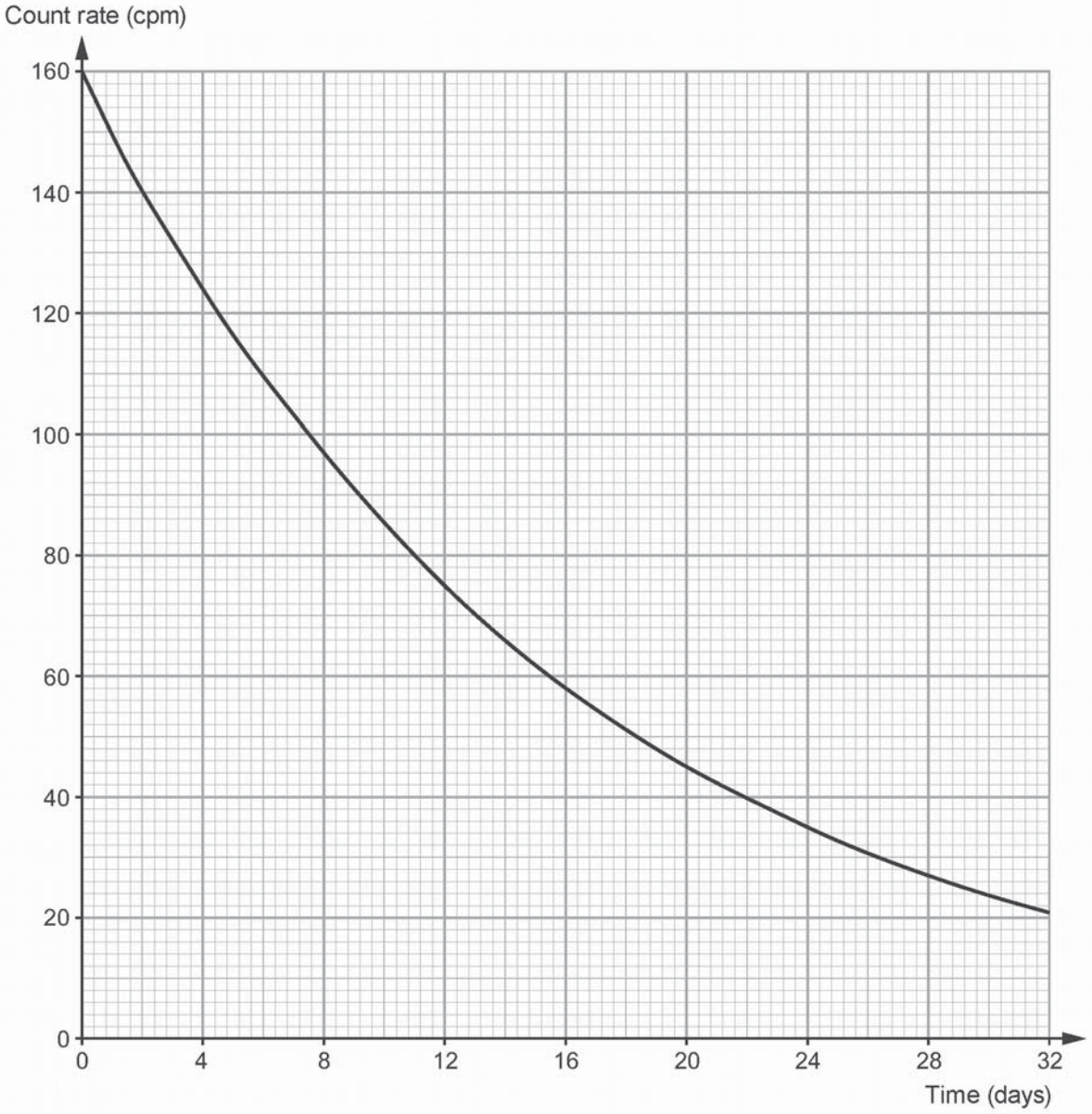
The graph below shows how the count rate in counts per minute (cpm) changes with time for a sample of a radioactive substance.



(b) **Draw lines on the graph** to show how to find the half-life of this radioactive substance and write down its value. [2]

half-life = ... days

(c) Describe **how you would use this graph** to find the time taken for the activity of a different sample of the same substance to fall from 2400 cpm to 1000 cpm. [2]

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