Q1.

	Answer	Acceptable answers	Mark
	A		**(1)**

Q2.

	Answer	Acceptable answers	Mark
	D It is the time it takes for half the atoms to decay		**(1)**

Q3.

Question number	Answer	Additional guidance	Mark
	The time taken for the activity of a radioactive nuclide to halve (1)	accept for nuclide: isotope sample	**(1)**

Q4.

	Answer	Acceptable answers	Mark
	☒ **D**		**(1)**

Q5.

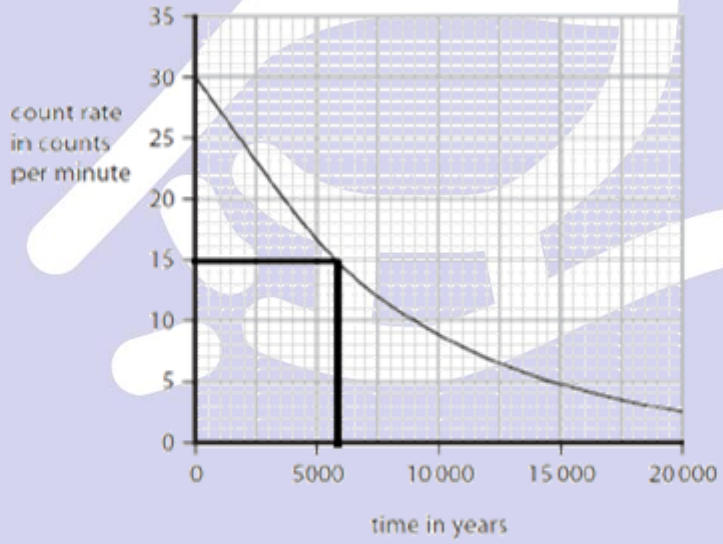
	Answer	Acceptable answers	Mark
	☒ **B** becquerel		**(1)**

Q6.

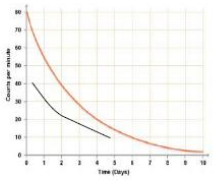
	Answer	Acceptable answers	Mark
(a)	A		**(1)**
(b)	axes labelled correctly With label or unit (1) correct shaped smooth curve (1) line does not reach zero activity (1)	activity / Bq / count rate ignore radioactivity time/ seconds/ any time unit	**(3)**

Total for question = 10 marks

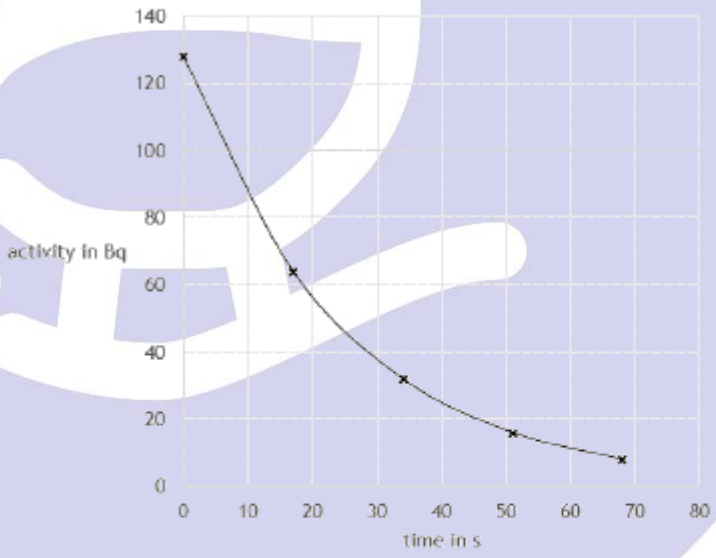
Q7.

Question Number	Answer	Additional guidance	Mark
(iii)	indication of horizontal line between 14 and 16 and / or vertical line between 5250 and 6250 (1)  value between 5250 (years) and 6250 (years) inclusive (1)	accept alternative indications e.g. cross on curve accept any halving pairs e.g. going between 20 cpm and 10 cpm award full marks for the correct answer with no working	(2) AO3

Q8.

	Answer	Acceptable answers	Mark
i	1.9-2 (days)		(1)
ii	 plotting (0,40), (2,20) and (4,10) **OR ANY** line which passes through those coordinates (1) smooth curve through those points (1)	Ignore any part of line after 4 days	(2)

Q9.

	Answer	Additional guidance	Mark
	plots at three of: 17,64 (1) 34,32 (1) 51,16 (1) 68,8 (1) tolerance ±1 s ±4 Bq	 allow line passing through correct point(s) ignore incorrect curve if no other marks scored allow 1 mark for evidence of halving activity e.g. 128 to 64	(3) AO3

Q10.

Question Number	Answer	Acceptable answers	Mark
(i)	1250 (million years) (1)	Between 1200 and 1300 (my) inclusive	**(1)**

Question Number	Answer	Acceptable answers	**Mark**
(ii)	2 half lives (1) 2500 (million years) (1)	 Allow ecf from (bi) Give full marks for answer between 2400 and 2600 with no working.	**(2)**

Q11.

Question Number	Answer	Acceptable answers	Mark
(b)(i)	evidence of halving activity eg line on graph at 80 (Bq) or two lines at, say, 100 and 50. (1) 8 (days) gains both marks (2)	accept halving in answer space e.g. 160 -> 80 or 80 -> 40 or 160 ÷ 2 = 80 NOT 160 ÷ 40 or 131 ÷ {2 or 4} or 40 ÷ 2 (unless clearly an activity)	**(2)**

Question Number	Answer	Acceptable answers	Mark
(b)(ii)	idea of two half-lives (1) but, 16 (days) gains both marks (2)	halving of 800 twice, e.g. 400 AND 200 seen Allow ECF from graph eg allow half-life from graph x 2 for both marks	**(2)**

Q12.

Question Number	Answer		Mark
	• point after first half-life 6, 40 (1) • point after second half-life 12, 20 (1) • point after third half-life 18, 10 (1)	within 1 small square by eye smooth curve starting at 80, with a decreasing gradient passing through one correct half-life point scores 2 marks smooth curve starting at 80, with a decreasing gradient passing through two correct half-life points scores 3 marks **if no other mark scored** smooth curve showing decreasing gradient but not going through any correct points scores 1 mark	**(3)** AO 3 1a

Q13.

	Answer	Acceptable answers	Mark
(i)	suitable lines on graph to show halving after about 200 000 years (2) • horizontal line at 750 +or –50 Bq on y-axis to curve (1) • meeting (by eye) vertical line from x-axis between 190,000 years and 230,000 years (1)	use of data from graph to show halving after about 200 000 years 1500/2 =750(Bq) or 1600/2=800(Bq) gives a half-life of 210,000 +or- 20 000 (years)	**(2)**

Q14.

Question Number	Answer	Acceptable answers	Mark
(b)(i)	From the graph Time taken to fall (from 8000) to 4000 (1) = 5.3 (years) (1)	Any other suitable pair of readings from the graph. Between 5.1 and 5.5 Full marks for correct answer even if no working is evident	**(2)**

Question Number	Answer	Acceptable answers	Mark
(b)(ii)	3 x 5.3 (= 15.9 years)	Allow attempt at extrapolation only if the answer is between 15.5 and 16.5 Allow ecf of 3 half lives from bi.	**(1)**