Q1.

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)**

Q2.

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

Q3.

	Answer	Additional guidance	Mark
(i)	260 (g)		**(1)** **AO2**

	Answer	Additional guidance	Mark
(ii)	(54 days is) 3 half-lives (1) 65 (1)	260 ÷ 2 (÷ 2) or 520 ÷ 2 ÷ 2 (÷ 2) 18, 36, 54 (represents 3 half-lives) 54/18 = 3 (half-lives) ecf answer to 4ci ÷ 4 130 scores 1 mark award full marks for the correct answer without working	**(2)** **AO2**

Q4.

Question number	Answer	Additional guidance	Mark
CS2	33 days is 3 half-lives (1) $2.1(25) \times 10^{22}$ (1)	$\frac{1.7 \times 10^{23}}{2\ (\times 2 \times 2)}$ 2.1(25) to any other power of ten scores mp1 only award full marks for correct answer without working.	**(2)** **AO2**

Q5.

	Answer	Acceptable answers	Mark
(i)	Idea of 2 half-lives (1) 11 400 = 2 × 5700 Idea of halving activity twice (1) 0.55 × 2 × 2 Calculation (1) 2.2 (Bq)	11 400 / 5700 = 2 2.2 (Bq) for three marks	**(3)**

Q6.

Question number	Answer	Additional guidance	Mark
	mass in g / time in days 1600 / 0 800 (1) / 29 400 / 58 (1)	numbers in correct boxes	**(2)**

Q7.

Question number	Answer	Additional guidance	Mark
	33 days is 3 half-lives (1) $2.1(25) \times 10^{22}$ (1)	$\frac{1.7 \times 10^{23}}{2\ (\times 2 \times 2)}$ 2.1(25) to any other power of ten scores mp1 only award full marks for correct answer without working.	**(2)** **AO2**

Q8.

Question Number	Answer	Additional guidance	Mark
	processing (1) $\frac{125\ 000}{1\ 000\ 000}$ OR $\frac{1}{8}$ OR 3 half-lives or 3 x 5700 evaluation (1) 17 100	 accept an appropriate attempt using more than one halving 17 000 award full marks for the correct answer without working	**(2)**

Q9.

Question number	Answer	Additional guidance	Mark
	recognition of there being **4 half lives** involved (1) so fraction of **1/16** involved (1) evaluation (1) 2.4 (kBq)	 allow 2 marks for 4.8 (kBq) (used three instead of 4 half lives) allow 1 mark for any other $(1/2)^n$ being involved i.e. for answers that round to 19.3 (kBq), 9.63 (kBq), 1.2(kBq) award full marks for the correct answer without working	**(3)**

Q10.

Question number	Answer	Additional guidance	Mark
	Determines number of half-lives and rounds (1) 263/87.7 = 3 Determines that 3 half-lives is 1/2 × 1/2 × 1/2 = 1/8 (1) Determines mass of Pu-238 after 3 half-lives (1) 925/8 = 115.625 (g) Determines average energy released per second (1) 115.625 × 0.54 = 62.4 (J)	 allow repeated division by 2 allow ecf from step 2 for 1 mark (mass of Pu-238 after1 half-life 925/2 = 462.5 (g)) allow ecf from 1 half-life or from step 3	**(4)**