Name of the Student:_____
Max. Marks : 23 Marks **Time : 23 Minutes**

Mark Schemes

Q1.

Question Number	Acceptable answers	Additional guidance	Mark
(i)	• (Spontaneous) – independent of external conditions (1) • (Random) – cannot predict when a decay will occur (1)	Accept cannot tell which nucleus will decay next	2
(ii)	• The probability of decay (in a specified time) may be determined (1) • (Probability may be applied accurately because) very large numbers are involved (1)	For MP1 accept reference to the proportion of nuclei decaying at a specified time	2

Q2.

Question Number	Acceptable Answer	Additional Guidance	Mark
	• decay happens without any external stimulus **Or** decay is unaffected by external factors (such as temperature) (1)	Do not credit references to the randomness of the decay	1

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Q3.

Question Number	Acceptable Answer	Additional Guidance	Mark
	• (isotopes are atoms/nuclides with the) same number of protons but different numbers of neutrons/nucleons (in the nucleus) **(1)**	Ignore references to the number of electrons in the atoms Do not credit mass number or atomic number	1

Q4.

Question Number	Acceptable answers	Additional guidance	Mark
	• would be of form $Q = Q_0 e^{-kt}$ **(1)** • plot ln charge against time **(1)** • if straight line with negative gradient it's exponential **(1)** **Or** • would be of form $Q = Q_0 e^{-kt}$ **(1)** • Calculate Q/Q_0 for pairs of values with same time interval t **(1)** **Or** calculates $t_{1/2}$ at least twice • If equal, then it's exponential **(1)**	MP3 accept some indication that gradient is negative For both MS options MP3 is dependent on MP2	3

Q5.

Question Number	Acceptable Answer	Additional Guidance	Mark
	• α radiation would be absorbed by the plastic bottle **(1)** • β radiation can penetrate the plastic bottle therefore it could/must be β radiation **(1)**		2

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Q6.

Question Number	Acceptable answers	Additional guidance	Mark
	Max three from: • Very high temperatures (1) • High magnetic flux density (1) • Bombardment by neutrons (1) • Material is a plasma or material is fully ionised (1)	Accept T~10^7 K -10^8 K for MP1 Accept conditions for stars: High density High pressure	3

Q7.

Question Number	Acceptable answers	Additional guidance	Mark
	An explanation that makes reference to the following points: • Small(er) nuclei fuse to form larger nuclei (1) • The binding energy (per nucleon) increases releasing energy (1) or mass deficit increases and $\Delta E = c^2 \Delta m$ (1) • Comparison of values from the graph	Example comparison: Calculation of $\Delta E_{binding}$, e.g.From 5.2 MeV at 12 nucleons to 8.7 MeV at 50 nucleons; H to He is 7 MeV;	3

Q8.

Question Number	Acceptable Answer	Additional Guidance	Mark
(i)	• Smooth best fit curve drawn on graph (1) • Time for count rate to fall by half once (1) • Time for count rate to fall by half twice and mean time calculated (1) • $t_{1/2}$ = 60 s → 80 s (1)	Alternative approaches for MP2 and MP3 Read 2 values from graph and use exponential equation **Or** draw tangent to curve at $t = 0$ and read off the time intercept Example of calculation 9.0 s^{-1} → 4.5 s^{-1} t = 75 s 4.5 s^{-1} → 2.25 s^{-1} t = 75 s If background count is taken into consideration, t will be lower	4

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Question Number	Acceptable Answer	Additional Guidance	Mark
(ii)	An explanation that makes reference to the following points: • There will be background radiation **Or** decay is exponential and so count rate will "never" reach zero **(1)** • The data logger output includes counts due to background radiation as well as the source radiation **Or** The count rate can't be corrected automatically **(1)**	MP2: accept references to GM-tube	**2**

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