Name of the Student:_____
Max. Marks : 20 Marks **Time : 20 Minutes**

Mark Schemes

Q1.

Question Number	Acceptable answers		Additional guidance	Mark
(i)	• Use of $\ln 2 = \lambda t_{1/2}$ • $\lambda = 4.92 \times 10^{-18}$ (s^{-1})	(1) (1)	Example of calculation $\lambda = \ln 2 / 1.41 \times 10^{17}$ s $= 4.92 \times 10^{-18}$ s^{-1}	2
(ii)	• Calculate rate = counts / time • Subtract background radiation • Use of $A = -\lambda N$ • Calculates $N \times$ atomic mass • Calculates percentage by mass • Answer = 0.17% (ecf for λ from (a)(i))	(1) (1) (1) (1) (1) (1)	Example of calculation background rate = 525 / (10 × 60) s = 0.875 s^{-1} vase count rate = 3623 / (5 × 60) s = 12.077 s^{-1} corrected rate = 11.2 s^{-1} for whole vase = 11.2 s^{-1} × 0.0177 m^2 / 6.36×10^{-5} m^2 = 3117 s^{-1} N = 3117 / 4.91×10^{-18} s^{-1} = 6.348×10^{20} Mass = $6.348 \times 10^{20} \times 238 \times 1.66 \times 10^{-27}$ kg = 2.51×10^{-4} kg Percentage = 2.51×10^{-4} kg × 100 / 0.149 = 0.17%	6
(iii)	Max 2 from: • Alpha particles could have been absorbed by the glass • Alpha particles will be emitted in all directions, not just towards the detector • Some alpha particles could have been detected from other parts of the vase • The count could include radiation from decay products • Some alpha particles could be absorbed by the GM tube window	(1) (1) (1) (1) (1)		2

Q2.

Question Number	Acceptable Answer	Additional Guidance	Mark
	A description that makes reference to the following: • (Remove the source and) record background count for specified time and subtract from equivalent quantity **(1)** • Divide by time to give a count rate. **(1)**	There needs to be two clear steps. Subtract a count from a count, or a count rate from a count rate and divide a count by time to obtain a count rate.	**2**

Q3.

Question Number	Acceptable answers	Additional guidance	Mark
	• correct values of A and Z for α and β • 5 α • 4 β	Example of calculation: $^{226}_{88}Ra \rightarrow {}^{206}_{82}Pb + x\ {}^{4}_{2}\alpha + y\ {}^{0}_{-1}\beta$ $226 - 206 = 4x$ $x = 5$ $88 - 82 - (5 \times 2) = -y$ $y = 4$ $^{226}_{88}Ra \rightarrow {}^{206}_{82}Pb + 5\ {}^{4}_{2}\alpha + 4\ {}^{0}_{-1}\beta$	**(3)**

Q4.

Question Number	Acceptable answers	Additional guidance	Mark
	• attempt to determine mass difference between radium and radon-plus-alpha **(1)** • conversion to kg **(1)** • Use of $\Delta E = c^2\Delta m$ **(1)** • Use of 1.6×10^{-19} factor **(1)** • Answer = 4.87 (MeV) **(1)**	$\Delta m = 225.97713\text{u} - (221.97040\text{u} + 4.00151\text{ u})$ $= 5.22 \times 10^{-3}$ u = $5.22 \times 10^{-3} \times 1.66 \times 10^{-27}$ kg = 8.67×10^{-30} kg $\Delta E = c^2\Delta m = (3 \times 10^8\text{ m s}^{-1})^2 \times 8.67 \times 10^{-30}$ kg = 7.80×10^{-13} J ΔE in MeV = 7.80×10^{-13} J ÷ 1.6×10^{-19} C = 4.87 MeV	**5**