Name of the Student:_____
Max. Marks : 17 Marks **Time : 17 Minutes**

Mark Schemes

Q1.

Question Number	Acceptable answers		Additional guidance	Mark
(i)	• Calculate no of nuclei • Use of $\ln 2 = t_{½} \times \lambda$ • Use of $A = \lambda N$ • $A = 3.97 \times 10^4$ (Bq)	(1) (1) (1) (1)	Example of calculation $N = (5.18 \times 10^{-5}\text{ g}/230\text{ g}) \times 6.02 \times 10^{23}$ $= 1.36 \times 10^{17}$ $\lambda \times (75\,400 \times 3.15 \times 10^7)\text{ s} = \ln 2$ $\lambda = 2.92 \times 10^{-13}\text{ s}^{-1}$ $A = 2.92 \times 10^{-13}\text{ s}^{-1} \times 1.36 \times 10^{17}$ $A = 3.97 \times 10^4\text{ Bq}$	4
(ii)	• Calculates decays in one year (ecf from (b)(i)) • Use of $pV = NkT$ • uses $T = 295$ K • $V = 5.09 \times 10^{-14}\text{ m}^3$	(1) (1) (1) (1)	Example of calculation ecf λ from (a) decays in one year $= 3.97 \times 10^4\text{ Bq} \times 3.15 \times 10^7\text{ s}$ $= 1.25 \times 10^{12}$ $1.00 \times 10^5\text{ Pa} \times V = 1.25 \times 10^{12} \times 1.38 \times 10^{-23}\text{ J K}^{-1} \times 295\text{ K}$ $V = 5.09 \times 10^{-14}\text{ m}^3$	4
(iii)	• Use of $½\, m \langle c^2 \rangle = 3/2\, kT$ **Or** Use of $pV = \frac{1}{3}Nm\langle c^2 \rangle$ (allow ecf for N, V from (b)(ii)) • uses $m = 4u$ • $\sqrt{\langle c^2 \rangle} = 1360\text{ m s}^{-1}$	(1) (1) (1)	Example of calculation $½\, m \langle c^2 \rangle = 3/2\, kT$ $½ \times (4 \times 1.66 \times 10^{-27}\text{ kg}) \times \langle c^2 \rangle = 3/2 \times 1.38 \times 10^{-23}\text{ J K}^{-1} \times 295\text{ K}$ $\langle c^2 \rangle = 1\,840\,000\text{ m}^2\text{ s}^{-2}$ $\sqrt{\langle c^2 \rangle} = 1360\text{ m s}^{-1}$ Accept the use of proton/neutron mass instead of u	3

Q2.

Question Number	Acceptable answers	Additional guidance	Mark
	• use of $\Delta E = mc\Delta\theta$ **(1)** • use of $P = E/t$ **(1)** • Correct calculation of an appropriate quantity **and** comment consistent with their value. **(1)**	**MP2** Candidates need to calculate either a time, a final temperature, an energy or a power Examples: Yes, because $t = 30$ s, which is less than one minute **Or** Yes, because it could reach temperature of 408 °C in one minute **Or** Yes, because it would transfer 156 000 J in one minute **Or** Yes, because the power required is 1.3 kW <u>Example of calculation</u> $\Delta E = 0.89\ \text{kg} \times 450\ \text{J kg}^{-1}\ \text{K}^{-1} \times (215\ °\text{C} - 18\ °\text{C})$ $= 78\ 900\ \text{J}$ $t = 78\ 900\ \text{J} \div 2600\ \text{W} = 30\ \text{s}$	**3**

Q3.

Question Number	Acceptable answers	Additional guidance	Mark
	• Use of $\Delta Q = mc\Delta\theta$ **(1)** • … for correct temperature differences **(1)** • Final temperature is 61.4 °C which is above range **(1)**	<u>Example of calculation</u> $0.180\ \text{kg} \times 4200\ \text{J kg}^{-1}\ \text{K}^{-1} \times (82\ °\text{C} - \theta_f)$ $= 0.068\ \text{kg} \times 3900\ \text{J kg}^{-1}\ \text{K}^{-1} \times (\theta_f - 2.7\ °\text{C})$ $\theta_f = 61.4\ °\text{C}$ Answers making comparisons based on equivalent Physics may be awarded MP3 e.g. 16 600 J must be transferred from coffee to reach 60°C but required energy transfer to milk is only 15 200 J	**3**