Name of the Student:_____
Max. Marks : 19 Marks **Time : 19 Minutes**

Mark Schemes

Q1.

Question Number	Answer		Mark
(a)	A radioactive atom has an unstable nucleus which emits α, β, or γ radiation [at least one of α β γ named]	(1) (1)	2
(b)	$C \rightarrow {}^{11}_{5}B + {}^{0}_{1}e^{+} + \nu_e$ Top line correct Bottom line correct	 (1) (1)	2
(c)	Attempt at mass diference calculation Attempt at conversion from (M)eV to J $\Delta E = 1.4 \times 10^{-13}$ (J) Example of calculation: $\Delta E = 10\,253.6 - 10252.2\text{-}0.5 = 0.889$ MeV $\Delta E = 0.889\ \text{MeV} \times 1.6 \times 10^{-13}\ \text{J MeV}^{-1} = 1.42 \times 10^{-13}$ J	(1) (1) (1)	3
(d)	The idea that the sample will not produce radiation for very long (because carbon-11 has a relatively short half-life) β particles are not very ionising **Or** positrons are not very ionising **Or** boron is safe in small amounts	(1) (1)	2
(e)	Use of $\lambda t_{1/2} = \ln 2$ $(\lambda = 5.68 \times 10^{-4}\ \text{s}^{-1})$ Use of $A = A_0 e^{-\lambda t}$ Use $A = 1.58 \times 10^{6}$ Bq in $A = A_0 e^{-\lambda t}$ $A_0 = 1.2 \times 10^{7}$ Bq Example of calculation: $\lambda = \frac{0.693}{1220\,\text{s}} = 5.68 \times 10^{-4}\ \text{s}^{-1}$ $1.58 \times 10^{6}\ \text{Bq} = A_0 e^{-5.68 \times 10^{-4}\ \text{s}^{-1} \times 60 \times 60\ \text{s}}$ $A_0 = 1.22 \times 10^{7}$ Bq	(1) (1) (1) (1)	4
	Total for question		13

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Q2.

<table>
<tr><th>Question Number</th><th>Acceptable answers</th><th>Additional guidance</th><th>Mark</th></tr>
<tr><td>*</td><td>
This question assesses a student's ability to show a coherent and logically structured answer with linkages and fully-sustained reasoning.
Marks are awarded for indicative content and for how the answer is structured and shows lines of reasoning.
The following table shows how the marks should be awarded for indicative content.
<table>
<tr><th>Number of indicative marking points seen in answer</th><th>Number of marks awarded for indicative marking points</th><th>Max linkage mark available</th><th>Max final mark</th></tr>
<tr><td>6</td><td>4</td><td>2</td><td>6</td></tr>
<tr><td>5</td><td>3</td><td>2</td><td>5</td></tr>
<tr><td>4</td><td>3</td><td>1</td><td>4</td></tr>
<tr><td>3</td><td>2</td><td>1</td><td>3</td></tr>
<tr><td>2</td><td>2</td><td>0</td><td>2</td></tr>
<tr><td>1</td><td>1</td><td>0</td><td>1</td></tr>
<tr><td>0</td><td>0</td><td>0</td><td>0</td></tr>
</table>
</td><td>
The following table shows how the marks should be awarded for structure and lines of reasoning.
<table>
<tr><th></th><th>No. of marks awarded for structure of answer and sustained line of reasoning</th></tr>
<tr><td>Answer shows a coherent and logical structure with linkages and fully sustained lines of reasoning demonstrated throughout</td><td>2</td></tr>
<tr><td>Answer is partially structured with some linkages and lines of reasoning</td><td>1</td></tr>
<tr><td>Answer has no linkages between points and is unstructured</td><td>0</td></tr>
</table>
Guidance on how the mark scheme should be applied:
The mark for indicative content should be added to the mark for lines of reasoning. For example, an answer with five indicative marking points which is partially structured with some linkages and lines of reasoning scores 4 marks (3 marks for indicative content and 1 mark for partial structure and some linkages and lines of reasoning). If there are no linkages between points, the same five indicative marking points would yield an overall score of 3 marks (3 marks for indicative content and no marks for linkages).
</td><td>6</td></tr>
<tr><td></td><td>
Indicative content:
• Requires a (very) high temperature
• Nuclei all have positive charge leading to a large repulsive force between nuclei
• At high temperature nuclei have high kinetic energy, sufficient to overcome repulsion
• Nuclei must get close enough to fuse (accept reference to close enough for strong force)
• Requires (very) high density
• Collision rate must be high enough to sustain fusion
</td><td></td><td></td></tr>
</table>

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