

Name of the Student: \_\_\_\_\_

Max. Marks : 20 Marks

Time : 20 Minutes

Mark Schemes

Q1.

| Question Number | Acceptable answers  | Additional guidance   | Mark       |
|-----------------|---|---|------------|
|                 | <ul style="list-style-type: none"> <li>correct values of A and Z for <math>\alpha</math> and <math>\beta</math></li> <li>5 <math>\alpha</math></li> <li>4 <math>\beta</math></li> </ul> | <u>Example of calculation:</u><br>$^{226}_{88}\text{Ra} \rightarrow ^{206}_{82}\text{Pb} + x\ ^4_2\alpha + y\ ^0_{-1}\beta$<br>$226 - 206 = 4x$<br>$x = 5$<br>$88 - 82 - (5 \times 2) = -y$<br>$y = 4$<br>$^{226}_{88}\text{Ra} \rightarrow ^{206}_{82}\text{Pb} + 5\ ^4_2\alpha + 4\ ^0_{-1}\beta$ | <b>(3)</b> |

Q2.

| Question Number | Acceptable answers   | Additional guidance  | Mark     |
|-----------------|--|--|----------|
|                 | <ul style="list-style-type: none"> <li>Use of <math>\Delta E = mc\Delta\theta</math> with a temperature change of <math>80^\circ\text{C}</math> <b>(1)</b></li> <li><math>c = 3.94 \times 10^3 \text{ J kg}^{-1} \text{ C}^{-1}</math> <b>(1)</b></li> </ul> | <u>Example of calculation:</u><br>Temperature rise = $(101 - 21)^\circ\text{C}$<br>$175000 \text{ J} = 0.444 \text{ kg} \times c \times (101 - 21)^\circ\text{C}$<br>$c = 3.94 \times 10^3 \text{ J kg}^{-1} \text{ C}^{-1}$ | <b>2</b> |

Q3.

| Question Number | Acceptable Answer   | Additional guidance | Mark |
|-----------------|---|---------------------|------|
| (i)             | <p>An explanation that makes reference to the following points:</p> <ul style="list-style-type: none"> <li>energy conserved (1)</li> <li>so energy needed over and above rest energy of proton in order to provide the mass of the <math>\pi^0</math> particle (1)</li> </ul> |                     | (2)  |

| Question Number | Acceptable Answer   | Additional guidance   | Mark |
|-----------------|---|---|------|
| (ii)            | <ul style="list-style-type: none"> <li>calculates rest energy of <math>\pi^0</math> (1)</li> <li>134 GeV (1)</li> </ul> | <p><u>Example of calculation:</u></p> $E_k = \frac{938 \text{ GeV}}{7} = 134 \text{ GeV}$ | (2)  |

Q4.

| Question Number | Acceptable answers   | Additional guidance   | Mark |
|-----------------|--|---|------|
|                 | <ul style="list-style-type: none"> <li>attempt to determine mass difference between radium and radon-plus-alpha (1)</li> <li>conversion to kg (1)</li> <li>Use of <math>\Delta E = c^2 \Delta m</math> (1)</li> <li>Use of <math>1.6 \times 10^{-19}</math> factor (1)</li> <li>Answer = 4.87 (MeV) (1)</li> </ul> | $\Delta m = 225.97713\text{u} - (221.97040\text{u} + 4.00151\text{u})$ $= 5.22 \times 10^{-3} \text{ u} = 5.22 \times 10^{-3} \times 1.66 \times 10^{-27} \text{ kg} = 8.67 \times 10^{-30} \text{ kg}$ $\Delta E = c^2 \Delta m = (3 \times 10^8 \text{ m s}^{-1})^2 \times 8.67 \times 10^{-30} \text{ kg} = 7.80 \times 10^{-13} \text{ J}$ $\Delta E \text{ in MeV} = 7.80 \times 10^{-13} \text{ J} \div 1.6 \times 10^{-19} \text{ C} = 4.87 \text{ MeV}$ | 5    |

Q5.

| Question Number | Acceptable answers   | Additional guidance   |                |  |  | Mark      |         |                            |                |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
|-----------------|--|---|----------------|--|--|-----------|---------|----------------------------|----------------|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
|                 | <p>This question assesses a student's ability to show a coherent and logically structured answer with linkages and fully-sustained reasoning.</p> <p>Marks are awarded for indicative content and for how the answer is structured and shows lines of reasoning.</p> <p>The following table shows how the marks should be awarded for indicative content.</p> <p>Indicative content:</p> <p>IC1: set of (metal drift) tubes (in a line)</p> <p>IC2: electrons accelerated by electric field/potential difference</p> <p>IC3: acceleration takes place in the gaps between tubes</p> <p>IC4: adjacent tubes connected to opposite terminals of a power supply or opposite charge/polarity</p> | <table><thead><tr><th>IC points</th><th>IC mark</th><th>Max linkage mark available</th><th>Max final mark</th></tr></thead><tbody><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></tbody></table> <p>IC points 1 and 4 may be awarded with well-drawn diagram</p> <p>IC6 accept reference to distance between centres/ends of tubes must increase to give a fixed alternating frequency</p> |                |  |  | IC points | IC mark | Max linkage mark available | Max final mark | 6 | 4 | 2 | 6 | 5 | 3 | 2 | 5 | 4 | 3 | 1 | 4 | 3 | 2 | 1 | 3 | 2 | 2 | 0 | 2 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 6 |
| IC points       | IC mark  | Max linkage mark available  | Max final mark |  |  |           |         |                            |                |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 6               | 4  | 2   | 6              |  |  |           |         |                            |                |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 5               | 3  | 2   | 5              |  |  |           |         |                            |                |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 4               | 3  | 1   | 4              |  |  |           |         |                            |                |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 3               | 2  | 1   | 3              |  |  |           |         |                            |                |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 2               | 2  | 0   | 2              |  |  |           |         |                            |                |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 1               | 1  | 0   | 1              |  |  |           |         |                            |                |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 0               | 0  | 0   | 0              |  |  |           |         |                            |                |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
|                 | <p>IC5: power supply/p.d./electric field is alternating (so that as electron emerges from one tube the next tube is positive)</p> <p>IC6: time spent in each tube must be the same so as the electrons travel faster the tubes must</p>  |   |                |  |  |           |         |                            |                |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
|                 | be longer / gaps between get longer  |   |                |  |  |           |         |                            |                |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |