1 A radioactive source emits only $\beta$- particles.

(a) A scientist wishes to investigate the deflection of $\beta$-particles by an electric field. Draw a labelled diagram to suggest a suitable experimental arrangement.

(b) State how the apparatus would be used to show the deflection of the $\beta$-particles by the electric field.

(c) State how the results would show the deflection of the $\beta$-particles.

(d) Explain the direction of the deflection obtained.

[ Total : 7 ]
2 (a) The decay of a nucleus of radium $^{226}_{88}\text{Ra}$ leads to the emission of an $\alpha$-particle and leaves behind a nucleus of radon (Rn).

In the space below, write an equation to show this decay. [2]

(b) In an experiment to find the range of $\alpha$-particles in air, the apparatus in Fig. 11.1 was used.

![Diagram of the apparatus](image)

**Fig. 11.1**

The results of this experiment are shown below.

<table>
<thead>
<tr>
<th>Distance from source to detector (cm)</th>
<th>Count Rate (counts/minute)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>681</td>
</tr>
<tr>
<td>2</td>
<td>441</td>
</tr>
<tr>
<td>3</td>
<td>317</td>
</tr>
<tr>
<td>4</td>
<td>19</td>
</tr>
<tr>
<td>5</td>
<td>21</td>
</tr>
</tbody>
</table>

(i) State what causes the count rate 9 cm from the source.

(ii) Estimate the count rate that is due to the source at a distance of 2 cm.

(iii) Suggest a value for the maximum distance that $\alpha$-particles can travel from the source.

(iv) Justify your answer to (iii).
3 (a) A radioactive isotope emits only $\alpha$-particles.

(i) In the space below, draw a labelled diagram of the apparatus you would use to prove that no $\beta$-particles or $\gamma$-radiation are emitted from the isotope.

(ii) Describe the test you would carry out.

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(iii) Explain how your results would show that only $\alpha$-particles are emitted.

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Fig. 11.1 shows a stream of $\alpha$-particles about to enter the space between the poles of a very strong magnet.

Describe the path of the $\alpha$-particles in the space between the magnetic poles.

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Fig. 11.1

[Total : 9]
4 (a) A sodium nucleus decays by the emission of a β-particle to form magnesium.

(i) Complete the decay equation below.

\[ \text{Na}^{24}_{11} \rightarrow \text{Mg} + \beta^- \]

(ii) Fig. 11.1 shows β-particles from sodium nuclei moving into the space between the poles of a magnet.

\[ \text{N} \quad \beta\text{-particles} \quad \text{S} \]

Describe the path of the β-particles between the magnetic poles.

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Fig. 11.1

[5]
(b) Very small quantities of a radioactive isotope are used to check the circulation of blood by injecting the isotope into the bloodstream.

(i) Describe how the results are obtained.

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(ii) Explain why a $\gamma$-emitting isotope is used for this purpose rather than one that emits either $\alpha$-particles or $\beta$-particles.

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[4]

[Total : 9]
Fig. 10.1 is part of the decay curve for a sample of a $\beta$-emitting isotope.

\[ \text{time / days} \]
\[ 0 \quad 5 \quad 10 \quad 15 \quad 20 \]
\[ 0 \quad 25 \quad 50 \quad 75 \quad 100 \]

% activity

**Fig. 10.1**

(a) Use Fig. 10.1 to find the half-life of the isotope. 

\[ \text{half-life} = \ldots \ldots [1] \]

(b) Complete Fig. 10.1 as far as time = 20 days, by working out the values of a number of points and plotting them. Show your working. [2]

(c) The decay product of the $\beta$-emitting isotope is not radioactive. Explain why the sample of the radioactive isotope will be safer after 20 days than after 1 day. Support your answer by reference to the graph.

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(d) The isotope used for this decay curve may be represented by the symbol $^A_ZX$. Write down an equation, by filling in the gaps below, to show the $\beta$-decay of this isotope to a decay product that has the symbol $Y$.

\[ ^A_ZX \rightarrow \ldots \ldots + Y \] [2]