Radioactivity

(8-1) Rutherford's model & $\alpha$ particle scattering.

* The $\alpha$ particle source was encased in metal with a small aperture, allowing a fine beam of $\alpha$ particles to emerge.
* Air was pumped out to leave a vacuum; $\alpha$ particles are absorbed by a few cm of air.
* Gold was chosen because it's malleable; can be made into thin sheets.
* The $\alpha$ particles were detected when they hit a solid 'scintillating' material.

→ Most a particles passed straight through, without being affected.
  → Most of the nucleus is empty space.

→ Some were backscattered
  → Most of the mass of the atom is concentrated in a tiny space.

<table>
<thead>
<tr>
<th>Particle</th>
<th>Mass</th>
<th>Charge</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proton</td>
<td>1</td>
<td>+e</td>
</tr>
<tr>
<td>Neutron</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Electron</td>
<td>0.0005</td>
<td>-e</td>
</tr>
</tbody>
</table>

(8-2) Calculating density of a proton.

Mass = $1.67 \times 10^{-27}$ kg
Radius = $0.8 \times 10^{-15}$ m
\[
\text{volume} = \frac{4}{3} \pi r^3
\]
\[
= \frac{4}{3} \pi \times (0.8 \times 10^{-15})^3
\]
\[
= 2.14 \times 10^{-45} \text{ m}^3
\]

\[
\text{density} = \frac{\text{mass}}{\text{volume}} = 7.8 \times 10^{17} \text{ kg m}^{-3}
\]

**Assumptions:**

1. The shape of the atom is spherical
2. Empty spaces are not considered

**Q-3) What are isotopes?**

- Isotopes are nuclei of the same element, having the same no. of protons, but different no. of neutrons.
- Isotopes have same chemical properties but different physical properties.

**Q-4) Ionising radiation.**

- Ionisation is the loss or gain of electrons.
  
  **What is conserved**
  
  1. Nucleon no.
  2. Photon no.
  3. Mass energy

<table>
<thead>
<tr>
<th>Particle</th>
<th>Mass</th>
<th>Charge</th>
<th>Speed (m/s)</th>
<th>Penetration</th>
</tr>
</thead>
<tbody>
<tr>
<td>α</td>
<td>4</td>
<td>+2e</td>
<td>10^6</td>
<td>paper</td>
</tr>
<tr>
<td>β</td>
<td>1/340</td>
<td>-e</td>
<td>10^8</td>
<td>thin aluminium</td>
</tr>
<tr>
<td>γ</td>
<td>0</td>
<td>0</td>
<td>3 \times 10^8</td>
<td>thick lead</td>
</tr>
</tbody>
</table>

α particle has a higher mass & charge; it is slower than β; γ is more likely to interact with any atom it passes α.
is more likely to cause ionisation.

\[ a \text{ decay} \]
\[
\begin{align*}
A_x & \rightarrow A-4_y + \frac{4}{3} He \\
B^- & \rightarrow A_n + 0e + \bar{\nu} \\
\text{neutron} & \rightarrow \text{proton}
\end{align*}
\]

\[ B^+ \rightarrow A_y + 0e + \nu \\
\text{proton} & \rightarrow \text{neutron}.\]

\( \text{Q-5) Family of sub-atomic particles.} \)

\begin{itemize}
\item \textbf{Hadrons} \rightarrow \text{affected by strong nuclear force}
\item \textbf{Leptons} \rightarrow \text{not affected by strong nuclear force.}
\end{itemize}

\begin{itemize}
\item \textbf{Baryons} \rightarrow 3 \text{quarks}
\item \textbf{Mesons} \rightarrow 2 \text{quarks.}
\end{itemize}

\begin{itemize}
\item \textbf{Protons (uud)}
\item \textbf{Neutrons (uud)}
\end{itemize}

\[ *1 \text{ EV} = 1.6 \times 10^{-19} J \]
\[ *1 \text{ MeV} = 1.6 \times 10^{-13} J \]