NUCLEAR DECAY

Predict the products of the following nuclear reactions.

1. ${^{40}\text{K}} \rightarrow 
   \begin{array}{c}
   \text{He} \\
   \text{Ca}
   \end{array}
   ^{42} \text{Ca}

2. ${^{235}\text{Pu}} \rightarrow 
   \begin{array}{c}
   \text{He} \\
   \text{U}
   \end{array}
   ^{239} \text{U}

3. ${^{235}\text{U}} \rightarrow 
   \begin{array}{c}
   \text{He} \\
   \text{Th}
   \end{array}
   ^{231} \text{Th}

4. $\text{H} + \text{H} \rightarrow 
   \begin{array}{c}
   \text{He}
   \end{array}
   ^{4} \text{He}

5. $\text{H} + \text{n} \rightarrow 
   \begin{array}{c}
   \text{He} \\
   \text{H}
   \end{array}
   ^{3} \text{H}

6. ${^{27}\text{Al}} + \text{He} \rightarrow 
   \begin{array}{c}
   \text{P} \\
   \text{n}
   \end{array}
   ^{31} \text{P}

7. $\text{Be} + \text{H} \rightarrow 
   \begin{array}{c}
   \text{Li} \\
   \text{He}
   \end{array}
   ^{3} \text{Li}

8. $\text{K} \rightarrow 
   \begin{array}{c}
   \text{He} \\
   \text{Ar}
   \end{array}
   ^{18} \text{Ar}

9. ${^{235}\text{U}} + \text{n} \rightarrow 
   \begin{array}{c}
   \text{Ba} \\
   \text{Kr} \\
   \text{n}
   \end{array}
   ^{146} \text{Ba} + ^{95} \text{Kr} + 3 \text{n}

10. ${^{239}\text{U}} + \text{He} \rightarrow 
    \begin{array}{c}
    \text{Pu}
    \end{array}
    ^{241} \text{Pu} + \text{n}
### Half-Life of Radioactive Isotopes

<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. How much of a 100.0 g sample of $^{198}$Au is left after 8.10 days if its half-life is 2.70 days?</td>
<td>12.5 g</td>
</tr>
<tr>
<td>2. A 50.0 g sample of $^{14}$N decays to 12.5 g in 14.4 seconds. What is its half-life?</td>
<td>7.2 seconds</td>
</tr>
<tr>
<td>3. The half-life of $^{40}$K is 12.4 hours. How much of a 750 g sample is left after 62 hours?</td>
<td>23.4 g</td>
</tr>
<tr>
<td>4. What is the half-life of $^{99}$Tc if a 500 g sample decays to 62.5 g in 639,000 years?</td>
<td>$2.13 \times 10^5$ yrs</td>
</tr>
<tr>
<td>5. The half-life of $^{232}$Th is $1.4 \times 10^{10}$ years. If there are 25.0 g of the sample left after $2.8 \times 10^{10}$ years, how many grams were in the original sample?</td>
<td>1000 g</td>
</tr>
<tr>
<td>6. There are 5.0 g of $^{131}$I left after 40.35 days. How many grams were in the original sample if its half-life is 8.07 days?</td>
<td>1600 g</td>
</tr>
</tbody>
</table>
9) One Half-Life To Live

1) The half-life of cesium-137 is 30. years. How much $^{137}\text{Cs}$ was present originally if, after 120. years, 6.0 g remained?

$6g \rightarrow 12g \rightarrow 24g \rightarrow 48g \rightarrow 96g$

$\frac{120y}{30y} = 4 \text{ half-lives}$

2) The half-life of barium-131 is 12.0 days. How many grams of $^{131}\text{Ba}$ remain after 60. days, if the initial sample weighed 10.0 g?

$10g \rightarrow 5g \rightarrow 2.5 \rightarrow 1.25 \rightarrow 0.625 \rightarrow 0.3125g$

$60/12 = 5 \text{ half-lives}$

3) How much $^{32}\text{P}$ was present originally if, after 72.5 days, 2.0 grams remain (half-life of $^{32}\text{P}$ is 14.3 days)

$2g \rightarrow 4g \rightarrow 8g \rightarrow 16g \rightarrow 32g \rightarrow 64g$

$72.5 \text{ days} / 14.3 \text{ days} = 5 \text{ half-lives}$

4) What is the half-life of a radioactive isotope if 25% of the original mass of the isotope remains after 20. days?

$100 \rightarrow 50 \rightarrow 25 \rightarrow \text{10 days}$

5) A Geiger counter is used to monitor the radioactivity level of a certain isotope. During a 30. hour period, the count rate dropped from 600. counts/minute to 150. counts/minute. What is its half-life?

$600 \rightarrow 300 \rightarrow 150 \rightarrow 75 \rightarrow \text{15 hrs/half life}$

6) An ancient scroll made of papyrus is analyzed, and it is found to contain only 25% of the steady-state concentration of C-14 found in living organisms. How old is the material that the scroll is made of?

$\text{C-14 half-life} = 5730 \text{ years}$

$100 \rightarrow 50 \rightarrow 25 \%$

$5730 \rightarrow 5730 \rightarrow 11460 \text{ years}$

8) A Geiger counter detects 300. counts per minute when a sample of neon-19 is placed under it. Based on Reference Table N, how long will it take for the Geiger counter to drop to 75 counts per minute?

$\text{Ne-19 half-life} = 17.22 \text{ sec}$

$300 \rightarrow 150 \rightarrow 75 \rightarrow 17.22 \text{ sec}$

9) A nuclear bomb test 52.6 years ago generated Sr-90, which dispersed into the surrounding environment. A soil sample today shows 20 micrograms of Sr-90 in a 1-kg sample of soil. How many micrograms of Sr-90 per kg of soil must have been present right after the test blast? Use Reference Table N.

$\text{Sr-90: 29.1 yrs}$

$20 \mu g \rightarrow 40 \mu g \rightarrow 80 \mu g$

$52.6 \text{ years} / 29.1 \text{ years} \approx 2 \text{ half-lives}$