

## MODERN PHYSICS DAY 11: RADIOACTIVE DECAY AND CONSERVATION

CED 15.8 · Skill 3.B · FRQ: Qualitative/Quantitative Translation

**PREDICT**

A nucleus emits an alpha particle. How do the parent mass number  $A$  and atomic number  $Z$  change?

A.  $A-4$ ,  $Z-2$    B.  $A$  fixed,  $Z+1$    C. both fixed   D.  $A-2$ ,  $Z-4$

Use the alpha particle's own  $A$  and  $Z$  values.

### SET UP THE BOOKKEEPING

**ALPHA DAUGHTER WITHHELD UNTIL AFTER THE PREDICTION**

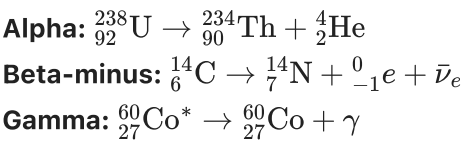
parent ( $A, Z$ )                       $\rightarrow$  daughter ( $?, ?$ )                       $+ {}^4_2\text{He}$

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balance  $A$  and  $Z$  separately before choosing

**NOTES / REASONING**

BALANCED EXAMPLES



| process   | parent A | daughter A | parent Z | daughter Z |
|-----------|----------|------------|----------|------------|
| $\alpha$  | 238      |            | 92       |            |
| $\beta^-$ | 14       |            | 6        |            |
| $\gamma$  | 60       |            | 27       |            |

The antineutrino is outside this course's A/Z arithmetic, but beta-minus is not being described as an electron-only final state.

NOTES / REASONING

**COMPLETE THE EQUATIONS**

1.  ${}_{84}^{210}\text{Po} \rightarrow \square \text{Pb} + {}_2^4\text{He}$

2.  ${}_{55}^{137}\text{Cs} \rightarrow \square \text{Ba} + {}_{-1}^0e + \bar{\nu}_e$

3.  ${}_{27}^{60}\text{Co}^* \rightarrow \square \text{Co} + \gamma$

4. For each equation, state whether the daughter is a different element.

**FOLLOW A DECAY CHAIN**

A parent  ${}^A_ZX$  undergoes one alpha decay, then one beta-minus decay, then gamma emission.

1. Write the final mass number in terms of  $A$ .
2. Write the final atomic number in terms of  $Z$ .
3. Sketch the three arrows and label the emitted radiation.
4. Identify which step or steps changed the element.



Explain why "gamma decay changes the isotope but not the element" is also inaccurate for  $A/Z$  bookkeeping.

