DPP 05

Solution

1. There is no external force, so momentum conservation concept is completely applicable.

$\therefore m\vec{v} = m_1\vec{v}_1 + m_2\vec{v}_2$

or $(m_1 + m_2)\vec{v} = m_1\vec{v}_1 + m_2\vec{v}_2$

2. Let, ${}^{A}_{Z}X \rightarrow {}^{A-4}_{A-2}Y + {}^{4}_{2}He$

$K_\alpha = \frac{m_y}{m_y + m_\alpha}Q = \frac{A-4}{A}Q$

or $48 = \frac{A-4}{A} \times 50 \Rightarrow A = 100$

3. For α-decay: ${}_{x}A^{y} \rightarrow {}_{x-2}B^{y-4} + \alpha$

For β^-decay: ${}_{x}A^{y} \rightarrow {}_{x+1}B^{y} + {}_{-1}\beta^{0}$

For β^+decay: ${}_{x}A^{y} \rightarrow {}_{x-1}B^{y} + {}_{+1}\beta^{0}$

For k-capture, number of protons will not change. So, only case in which number of protons increases is β^-decay.

4. Expected atomic mass of Cu must be less than that of Zn, but it is not so. So, it means Cu is radioactive and unstable and decays to Zn through β-decay.

5. As the alpha particle decays, the daughter nucleus recoils. In such a process, the momentum conservation holds.

So, $p_\alpha = p_D = p$

$K_\alpha = \frac{p^2}{2M_\alpha}$ and $K_D = \frac{p^2}{2M_D}$

As $M_D > M_\alpha$, so, $K_\alpha > K_D$.

6. The complete fission reaction is

${}^{235}_{92}U + n \rightarrow {}^{94}_{40}Zr + {}^{140}_{58}Ce + 2n + 6e^{-1}$

$Q = [m({}^{235}U) - m({}^{94}Zr) - m({}^{140}Ce) - m(n)]c^2 = 208\ MeV$

7. During fusion, binding energy of daughter nucleus is always greater than the total binding energy of the parent nuclei. The difference of binding energies is released.

So, $Q = E_2 - 2E_1$

8. α-decay reduces mass number by 4 and decreases charge number by 2. Where, β-decay keeps mass number unchanged and increases charge by 1.

9. Decrease in mass number $= 232 - 208 = 24$

Number of α-particles emitted $= \frac{24}{4} = 6$

Due to emission of 6 particles, decrease in charge number is 12. But actual decrease in charge number is 8. Clearly, 4β-particles are emitted.