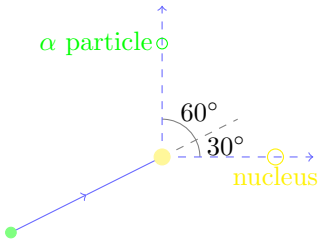
Question

Nuclear Reactions: An alpha particle collides elastically with a stationary nucleus and continues on at an angle of 60° with respect to its original direction of motion. The nucleus recoils at an angle of 30° with respect to this direction. What is the mass number of the nucleus?

Solution

Taking m and M as the respective masses of the α particle and nucleus, with u the initial velocity of the α.



Conservation of momentum

$$mv_\alpha = mucos60 \quad \rightarrow \quad v_\alpha = \frac{u}{2}$$

$$Mv_N = mucos30 \quad \rightarrow \quad v_N = \frac{mu\sqrt{3}}{2M}$$

Conservation of energy

$$\begin{aligned} \tfrac{1}{2}mu^2 &= \tfrac{1}{2}mv_\alpha^2 + \tfrac{1}{2}Mv_N^2 \\ mu^2 &= m\,\frac{u^2}{4} + M\,\frac{3m^2u^2}{4M^2} \\ \frac{3m}{4} &= \frac{3m^2}{4M} \\ m &= M \end{aligned}$$

Hence the mass of the nucleus is the same as that of the α particle, its mass number is 4.