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ANSWER BOOK

Radioactive decay and half-life

Nuclear physics · Year 13

AQA 3.8.1.3, 3.8.1.4 · CIE 11.1, 23.2 · OCR A 6.4.3

10 questions · 30 marks

NAVY EDITION

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SECTION A · Warm-up

A1 The half-life is the average time taken for the number of undecayed nuclei (or the activity) of a sample to fall to half its initial value. [2]

A2 $A = \lambda N = 0.02 \times 1.0 \times 10^{20} = 2.0 \times 10^{18}$ Bq. [2]

A3 $T_{½} = \ln 2 / \lambda$ ($\approx 0.693/\lambda$). [2]

SECTION B · Standard

B1 $\lambda = \ln 2 / T_{½} = 0.693/6.0 = 0.1155$ hour^{-1}. [3]

B2 15 days = 3 half-lives, so $N = N_0/2^3 = (8.0 \times 10^{20})/8 = 1.0 \times 10^{20}$ undecayed nuclei. [4]

B3 $A = A_0/2^2 = 400/4 = 100$ Bq. [3]

B4 $\lambda = \ln 2/8.0 = 0.0866$ s^{-1}. $A = \lambda N = 0.0866 \times 5.0 \times 10^{18} = 4.33 \times 10^{17}$ Bq. [3]

SECTION C · Stretch

C1 $\lambda = \ln 2/10 = 0.0693$ hour^{-1}. $A = 600 \times e^{-0.0693} \times 25 = 106$ Bq. [4]

C2 $800/50 = 16 = 2^4$, so 4 half-lives have passed. Time = $4 \times 3.0 = 12$ days. [4]

C3 It will most likely decay by beta-minus emission. A neutron changes into a proton (emitting an electron and an antineutrino), which reduces the neutron-to-proton ratio and moves the nuclide towards the stable line. [3]