Nuclear Physics

Modern physics · 4 questions · step-by-step answers at the end

Name: Date: Score: / 4

USEFUL EQUATIONS

$E = mc^2$ $A = \lambda N$ $N = N_0\, e^{-\lambda t}$ $\lambda = \ln 2 / t_{½}$

Questions

Show your working in the space under each question.

1. What fraction of a sample remains after a time equal to 1/λ?

2. Carbon-14 has a half-life of 5730 years. Find its decay constant in s^{-1} and the activity of a sample containing 1.0×10^{12} atoms.

3. The activity of a source falls from 400 Bq to 50 Bq in 30 minutes. Find the half-life and the decay constant.

4. How much energy, in joules, is equivalent to a mass of 1 u?

Step-by-step answers

Nuclear Physics

1. $N/N_0 = e^{-1} =$ **0.37** (37%).

2. 1. $t_{½} = 5730 \times 3.16 \times 10^{7} = 1.81 \times 10^{11}$ s.
2. $\lambda = \ln 2/t_{½} = 0.693/1.81 \times 10^{11} =$ **3.8×10^{-12} s^{-1}**.
3. $A = \lambda N = 3.8 \times 10^{-12} \times 1.0 \times 10^{12} =$ **3.8 Bq**.
Answer: 3.8×10^{-12} s^{-1}; 3.8 Bq

3. Three half-lives, so $t_{½} =$ **10 min**; $\lambda = \ln 2/600 =$ **1.2×10^{-3} s^{-1}**.

4. 931.5 MeV $= 931.5 \times 10^{6} \times 1.6 \times 10^{-19} =$ **1.5×10^{-10} J**.