

Quiz, Chapter 30

Physics 2020, Adam Johnston / Michelle Arnold

As always, show all your work and circle your final answer.

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$$E = (\Delta m)c^2, \quad N = N_0 e^{-t/\tau}, \quad \tau = \frac{t_{1/2}}{.693}$$

$$1 \text{ Ci} = 3.70 \times 10^{10} \text{ Bq} \quad 1 \text{ eV} = 1.602 \times 10^{-19} \text{ J}$$

$$m_{\text{electron}} = 9.11 \times 10^{-31} \text{ kg} = 5.485799 \times 10^{-4} \text{ u} = .511 \text{ MeV}/c^2$$

$$m_{\text{hydrogen}} = 1.007825 \text{ u}$$

$$m_{\text{neutron}} = 1.008665 \text{ u}$$

$$1 \text{ u} = 1.660540 \times 10^{-27} \text{ kg} = 931.49 \text{ MeV}/c^2$$

1. [3 pts.] What is the difference between a ^{14}C nucleus and a ^{12}C nucleus?

A. The number of neutrons \leftarrow	B. The mass \leftarrow	C. The half life \leftarrow	D. The binding energy \leftarrow	E. All of these.
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2. [3 pts] In a fusion reaction, the total mass (measured precisely) of the products must be

A. the same as the original materials.	B. greater than the original materials.	C. less than the original materials.	E. There is no way to predict this.	D. none of these
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3. [3 pts] A sample of nuclei are described in terms of a "half life." What is this?

A. The time it takes for all nuclei to decay.	B. The time it takes for half the nuclei to decay.	C. Half the time it takes for all the nuclei to decay.	D. Half the time it takes for half the nuclei to decay.	E. 42
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4. [4 pts] An isotope of a certain element has a half life of 30 minutes. What percentage of this isotope remains after 3 hours?

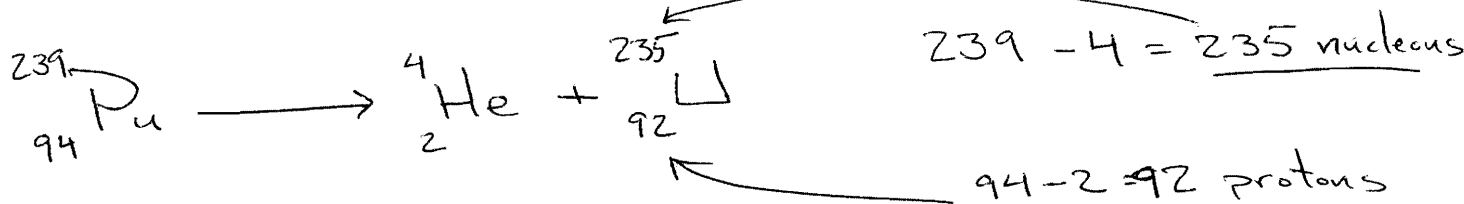
$$N = N_0 e^{-t(t_{1/2})}$$

$$\frac{N}{N_0} = e^{-t(t_{1/2})} = e^{-.693(\frac{3\text{h}}{.5\text{h}})} = 0.0156 = 1.56\%$$

OR $\frac{3\text{h}}{.5\text{h}} = 6 \text{ half-lives}$

$$\frac{N}{N_0} = \left(\frac{1}{2}\right)^6 = \frac{1}{64} = .0156 = 1.56\%$$

5. [3 pts] Plutonium-239 undergoes alpha decay. Plutonium is defined as the element that has 94 protons. Write out the equation that describes this decay. You can represent any unknown element as "X", but include its values for Z (charge) and A (nucleons).



6. [4 pts] What is the binding energy per nucleon for Uranium-238? (Its mass is 238.050784 u, and it is the element with 92 protons.)

$${}_{92}^{238}\text{U} \rightarrow 92 \text{ protons} + 146 \text{ neutrons}$$

$$92(1.007825\text{u}) + 146(1.008665\text{u}) = 239.98499\text{u}$$

$$\frac{(239.98499\text{u} - 238.050784\text{u}) \cdot 931.49 \text{ MeV}/c^2}{238 \text{ nucleons}} = \frac{1802 \text{ MeV}}{238 \text{ nucleons}} = 7.57 \text{ MeV/nucleon}$$