Quiz, Chapter 30 Name: MARIE CURIE Score: 20 / 20

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

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

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

$$m_{\text{electron}} = 9.11 \times 10^{-31}\ \text{kg} = 5.485\,799 \times 10^{-4}\ \text{u} = .511\ \text{MeV/c}^2,$$

$$m_{\text{hydrogen}} = 1.007\,825\ \text{u}$$

$$m_{\text{neutron}} = 1.008\,665\ \text{u}$$

$$1\ \text{u} = 1.660\,540 \times 10^{-27}\ \text{kg} = 931.49\ \text{MeV/c}^2$$

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

A. The number of neutrons yes	**B.** The mass yes	**C.** The half life yes	**D.** The binding energy yes	**E.** All of these.

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

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

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?

$N = N_0 e^{-t(.693/t_{1/2})}$

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

OR $\frac{3\text{ h}}{.5\text{ h}} = 6$ 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).

$^{239}_{94}Pu \longrightarrow {}^{4}_{2}He + {}^{235}_{92}U$

239 − 4 = 235 nucleons

94 − 2 = 92 protons

6. [4 pts] What is the binding energy per nucleon for Uranium-238? (Its mass is 238.050 784 u, and it is the element with 92 protons.)

$^{238}_{92}U_{146}$

238 − 92 = 146 neutrons

92 protons + 146 neutrons

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

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