

Contemporary Physics
Semester 2: Chapter 30

May 2, 2000

Work Sheet #16 The Nucleus

Atomic mass unit: $u = 1.66 \times 10^{-27} \text{ kg}$ $1 \text{ eV} = 1.602 \times 10^{-19} \text{ J}$ $c = 3 \times 10^8 \text{ m/s}$
 $E = m c^2$ $m_p = 1.67265 \times 10^{-27} \text{ kg} = 1.007276 \text{ u}$ $m_n = 1.67495 \times 10^{-27} \text{ kg} = 1.008665 \text{ u}$
 $m_e = 9.11 \times 10^{-31} \text{ kg} = .000549 \text{ u}$ $m_{\text{He atom}} = 4.002603 \text{ u}$

$$N = N_0 2^{-\frac{t}{T}} = N_0 e^{-\lambda t} \quad \text{with} \quad \lambda = \frac{\ln 2}{T}$$

1. (8) Consider ^{238}U

a)(2) How many protons are there in the ^{238}U nucleus?

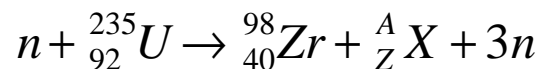
b)(2) How many neutrons are there in the ^{238}U nucleus?

c)(4) What is the mass of a Uranium nucleus? Express this in both kilograms and in atomic mass units.

2. (18) Each of the following are emitted by nuclei: Alpha Particles, Beta Particles, Positrons, Neutrons, Neutrinos and Gamma Rays. Complete the following table summarizing their properties.

Particle	Alpha Particle	Beta Particle	Positron	Neutron	Neutrino	Gamma Ray
mass in kg						
mass in u						
charge						

3. (12) Consider the following reactions:



a)(2) What is the atomic number of the element X? What element is this?

b)(2) What is the mass number of the element X?

c)(2) What is the atomic number of the element X? What element is this? ${}_{60}^{144}\text{Nd} \rightarrow \mathbf{a} + {}_Z^A\text{X} + \mathbf{g}$

d)(2) What is the mass number of the element X?

c)(2) What is the atomic number of the element X? What element is this? ${}_1^3\text{H} \rightarrow {}_Z^A\text{X} + e^- + \mathbf{n}$

d)(2) What is the mass number of the element X?

4. (18) The activity A of a sample of N atoms is the number of decays per second. It is equal to $A = \lambda N$ where λ is the decay constant.

a)(5) Plutonium-236 has a half life of 2.85 years. How long must you wait for the activity to drop from 1024 decays per second to 1 count per second?

b)(4) What is the value of the decay constant λ for Plutonium-236?

c)(4) How many atoms of Plutonium-236 are initially present?

d)(5) How many atoms of Plutonium-236 are present 2 years later?