Name _____ **Box #** _____ **Score** ____ **/ 20** **Date** _____

AP Physics – Worksheet #20: Chapter 30
Nuclear Physics

Atomic mass unit: u = 1.6605×10^{-27} kg = 931.49 MeV 1 eV = 1.602×10^{-19} J $E = m c^2$ $c = 3 \times 10^8$ m/s
$m_e = 9.11 \times 10^{-31}$ kg = .000549 u $m_p = 1.67265 \times 10^{-27}$ kg = 1.007276 u $m_n = 1.67495 \times 10^{-27}$ kg = 1.008665 u

$$BEPN = \frac{\left[M - Z \cdot m_e - Z \cdot m_p - (A - Z) \cdot m_n\right]}{A} \cdot 931.49 \frac{MeV}{u}$$

1. For the elements listed in the table below calculate the binding energy per nucleon in MeV and make a graph of the binding energy per nucleon as a function of mass number.

Element	Mass (amu)	Atomic Number (Z)	Mass Number (A)	Binding Energy per nucleon
Hydrogen	1.007825	1	1	
Helium	3.016049	2	3	
Beryllium	7.016930	4	7	
Carbon	12.000000	6	12	
Sodium	22.989770	11	23	
Iron	55.934939	26	56	
Silver	106.905095	47	107	
Indium	114.90388	49	115	
Gadolinium	157.92411	64	158	
Gold	196.96656	79	197	
Uranium	235.043925	92	235	

2. How much energy is released in the following reactions? The atomic masses of ^{98}Zr and ^{135}Te are 97.9120 u and 134.9087 u.

a) $n + {}^{235}_{92}U \rightarrow {}^{98}_{40}Zr + {}^{135}_{52}Te + 3\text{n}$

b) ${}^{2}_{1}H + {}^{3}_{1}H \rightarrow {}^{4}_{2}He + {}^{1}_{0}n$

The atomic masses of Deuterium, Tritium and ^{4}He are 2.014102, 3.016049 and 4.002603 u.

c) Which of these two reactions is one of fusion? Which of these two reactions is one of fission? Explain your answers.

3. The binding energy per nucleon of ^{4}He is -7.08 MeV while the binding energy per nucleon of deuterium, ^{2}H, is -1.11 MeV.

a) How many nucleons are there in 100 kg of deuterium?

b) How much energy is released when 100 kg of deuterium is fused to form ^{4}He?

c) How many nucleons are there in 100 kg of ^{235}U?

d) How much energy is released when 100 kg of ^{235}U fissions to form nuclei with mass numbers of about 115?

e) The explosion of 1 metric ton (1000 kg) of TNT, trinitrotoluene ($CH_3C_6H_2(NO_2)_3$, yields about $4x10^9$ J. How many eV per nucleon is released? How does this compare for the corresponding numbers for parts b) and d) above?