AP Physics- Nuclear Physics Worksheet – Mass Equivalent to Energy

Atomic mass unit -- unified mass unit = u (make sure you have a periodic table!)

 

1. Find Binding E of deuterium

Mass of tritium nucleus: 





Add masses together:



Binding E:





Mass of tritium is less than mass of parts.

Mass difference represents energy released

1. Calculate the energy released when 1.05 kg of U-235 undergoes fission. Each fission produces 208 MeV.







1. An unstable nucleus that is initially at rest decays into a nucleus of fermium-252 containing 100 protons and 152 neutrons and an alpha particle that has a kinetic energy of 8.42 *MeV*. The atomic masses of helium-4 and fermium-252 are 4.00260 *u* and 252.08249 *u*, respectively.
   1. What is the atomic number of the original unstable nucleus?



* 1. What is the velocity of the alpha particle? (Neglect relativistic effects for this calculation.)









* 1. Where does the kinetic energy of the alpha particle come from? Explain briefly.

***Mass Equivalence: The original nucleus decays into the product particles and energy.***

*Energy Conservation: Potential or binding energy was converted into kinetic energy.*

* 1. Suppose that the fermium-252 nucleus could undergo a decay in which a β- particle was produced. How would this affect the atomic number of the nucleus? Explain briefly.

*Atomic number increases by one. A neutron converts into a proton and an electron.*



1. A polonium nucleus of atomic number 84 and mass number 210 decays to a nucleus of lead by the emission of an alpha particle of mass 4.0026 atomic mass units and kinetic energy 5.5 *MeV*. (1 *u* = 931.5 *MeV/c2* = 1.66 x 10‑27 *kg*.)
   1. Determine each of the following.
      1. The atomic number of the lead nucleus

**Number of Protons **

* + 1. The mass number of the lead nucleus

# Number of Nucleons

* 1. Determine the mass difference between the polonium nucleus and the lead nucleus, taking into account the kinetic energy of the alpha particle but ignoring the recoil energy of the lead nucleus.

***The kinetic energy of the alpha particle is the mass difference of the two nuclei.***

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* 1. Determine the speed of the alpha particle. A classical (nonrelativistic) approximation is adequate.

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The alpha particle is scattered from a gold nucleus (atomic number 79) in a "head‑on" collision.

* 1. Write an equation that could be used to determine the distance of closest approach of the alpha particle to the gold nucleus. It is not necessary to actually solve this equation.

**At closest approach *KE* goes to zero and electric potential goes to max (Throw something up and *KE* is zero while *PE* is max. *KE* become *UE*)**

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1. In this nuclear reaction  two deuterium nuclei combine in a fusion reaction to form Helium three and a neutron. The mass of a deuterium nuclei is 2.014 102 u. The mass of a helium-3 nuclei is 3.016 029 u. The mass of a solo neutron is 1.008 665 u. Calculate the following: (a) the mass defect for the production of a helium-3 nuclei in this reaction, (b) the energy release from a single fusion reaction in joules, (c) the energy release from a single fusion reaction in mega-electron volts, (d) A moderate sized city requires 2.0 x 109 J of energy in one year. Calculate the number of deuterium atoms that must be fused in order to produce this amount of energy.
2. 
3. 





1. 

Or (another way to do it).



The answers are slightly different because the conversion factors are rounded off.

1. 