Homework 12

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October 2021

1. Number of hydrogen in sun: $\frac{1.989*10^{30}}{1.674*10^{-27}} = 1.188 * 10^{57}$.
   Energy released $13 * 1.188 * 10^{57} = 1.544 * 10^{58}\text{eV} = \frac{1.544*10^{58}}{1.602*10^{12}} = 9.640 * 10^{45}\text{erg}$.
   Solar luminosity: $3.826 * 10^{33}\frac{\text{erg}}{\text{s}}$. Then, $\frac{9.640*10^{45}}{3.826*10^{33}} = 2.520 * 10^{12}\text{s} = \frac{2.520*10^{12}}{60*60*24*365.25} = 7.985 * 10^{4}$ years.
   This is much less than the age of the Earth. This means that the Sun's energy is not entirely chemical, especially in this scenario. This energy would only sustain the sun for a fraction of the amount of time that it has been alive.

2. (a) $\Delta m = (12.00000 + 12.00000) - (23.98504) = 0.01496$.
   $E = mc^2 = \frac{0.01496*(1.67*10^{-27})*(3*10^8)^2}{1.6*10^{-13}} = 14.053$ MeV
   Since the initial mass is greater than the final mass, the reaction is exothermic.
   (b) $\Delta m = (12.00000+12.000000)-(15.99491+2(4.002603)) = -0.000116$
   $E = mc^2 = \frac{-0.000116*(1.67*10^{-27})*(3*10^8)^2}{1.6*10^{-13}} = -0.109$ MeV
   Since the initial mass is less than the final mass, the reaction is endothermic.
   (c) $\Delta m = (18.99840 + 1.007825) - (15.99491 + 4.002603) = 0.008712$
   $E = mc^2 = \frac{0.008712*(1.67*10^{-27})*(3*10^8)^2}{1.6*10^{-13}} = 8.184$ MeV
   Since the initial mass is greater than the final mass, the reaction is exothermic.

3. (a) $27\|v$
   (b) $27\|2\|$He
   (c) γ

4. Total number of Copper 63 atoms: $\frac{3.2}{62.92960*(1.6605402*10^{-24}} = 3.062 * 10^{22}$ atoms.
   $\Delta m = ((29(1.00783)+34(1.00867))-62.92960)*3.062*10^{22} = 1.813*10^{22}$
   $E = mc^2 = \frac{(1.813*10^{22})*(1.67*10^{-27})*(3*10^8)^2}{1.6*10^{-13}} = 1.703 * 10^{25}$ MeV

5. $\frac{10.0*3.27}{2*(2.014102)(1.661*10^{-27})} = 4.887 * 10^{27}$ MeV $= 4.887 * 10^{27} * 1.602 * 10^{-13} = 7.829 * 10^{14}\text{J}$
   $t = \frac{7.829*10^{14}}{100} = 7.829 * 10^{12}\text{s} = \frac{7.829*10^{12}}{60*60*24*365.25} = 2.5 * 10^{5}$ years.

6. $E = mc^2 = \frac{(42.958770 - 41.958630 - 1.00866)*(1.67*10^{-27})*(3*10^8)^2}{1.6*10^{-13}} = -8.003475$ MeV. The amount of energy required to remove a neutron from Ca43 is around 8.003475 MeV.

7. $E = mc^2 = \frac{(9.012182 + 4.002603 - 12.00000 - 1.008665)*(1.67*10^{-27})*(3*10^8)^2}{1.6*10^{-13}} = 5.748975$ MeV

8. (a) $E = mc^2 = \frac{(1(1.00727647) + 1(1.008665) - 2.014102)*(1.67*10^{-27})*(3*10^8)^2}{1.6*10^{-13}} =$ 1.728 MeV or 0.864 MeV/nucleon.

   (b) $E = mc^2 = \frac{(2(1.00727647) + 2(1.008665) - 4.002603)*(1.67*10^{-27})*(3*10^8)^2}{1.6*10^{-13}} =$ 27.505 MeV or 6.876 MeV/nucleon

   (c) $E = mc^2 = \frac{(26(1.00727647) + 30(1.008665) - 55.934939)*(1.67*10^{-27})*(3*10^8)^2}{1.6*10^{-13}} =$ 483.026 MeV or 8.625 MeV/nucleon

   (d) $E = mc^2 = \frac{(92(1.00727647) + 146(1.008665) - 238.050786)*(1.67*10^{-27})*(3*10^8)^2}{1.6*10^{-13}} =$ 1769.538 MeV or 7.435 MeV/nucleon.

9. Part 1: $E = mc^2 = \frac{(2(1.007825) - 2.014102 - 0.0005486)*(1.67*10^{-27})*(3*10^8)^2}{1.6*10^{-13}} =$ 0.939 MeV
   Part 2: $E = mc^2 = \frac{(2(0.0005486) - 0)*(1.67*10^{-27})*(3*10^8)^2}{1.6*10^{-13}} = 1.031$ MeV
   Part 3: $E = mc^2 = \frac{(2.014102 + 1.007825 - 3.016029)*(1.67*10^{-27})*(3*10^8)^2}{1.6*10^{-13}} = 5.540$ MeV
   Part 4: $E = mc^2 = \frac{(2(3.016029) - 4.002603 - 2(1.007825))*(1.67*10^{-27})*(3*10^8)^2}{1.6*10^{-13}} =$ 12.968 MeV
   Total: $0.939 + 1.031 + 5.540 + 12.968 = 20.478$ MeV