**Problems from 30.2 - Nuclear Reactions - (you will get a table of neutral atom masses)**

**Binding Energy:**    11H = 1.007825 u

1. Find the binding energy and the binding energy per nucleon of Helium-4 (28.30 MeV, 7.074 MeV)
2. Find the binding energy and binding energy per nucleon of Fluorine-19. (147.8 MeV, 7.779 MeV)
3. Find the binding energy and binding energy per nucleon of Silicone-28. (236.5 MeV, 8.448 MeV)
4. Find the binding energy and binding energy per nucleon of Argon-36. (306.7 MeV, 8.520 MeV)
5. Find the binding energy and binding energy per nucleon of Chromium-52. (456.3 MeV, 8.776 MeV)

**6. Balancing Nuclear Reactions:** Find the missing nucleus: d = deuterium, t = tritium

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| --- | --- | --- | --- |
| a. | b. | c. | d. |
| ? (t,p) 4017Cl  3817Cl | 5223V (n,?)5122Ti  21H or d | 6528Ni (,n)6830Zn  42He or α | 8137Rb(p,γ)?  8238Sr |
| ?(,p) 4422Ti  4121Sc | 5124Cr (,?)5526Fe  00γ | 2210Ne(d,?)2311Na  10n | 2814Si(α,n)?  3116S |
| ?(d,α)105B  126C | 14566Dy (d,n)?  14667Ho | ?(t,n)115B  94Be | 73Li(?,p)83Li  21H or d |

**Finding the Q value:** Find the Q value for the following reactions. Label the reaction as either energy requiring, (endoergic) or energy releasing (exoergic). You will need to look up the masses in a table.

1. 73Li(p,α)42He. (Exo, Q = 17.35 MeV)
2. 63Li(n,α)31H. (Exo, Q = +4.783 MeV)
3. 73Li(α, n) 105B. (Endo, Q = -2.790 MeV)
4. 126C(t,n)147N. (Exo, Q = 4.015 MeV)
5. 147N(α,p)178O. (Endo, Q = -1.192 MeV)

Fission Reactions: For each of the following (fictitious) fission reactions, determine the number of free neutrons liberated, and the Q value of the reaction as a whole:

1. 23592U + 10n → 14156Ba + 9036Kr + some neutrons. U-235 = 235.043923 u, Ba-141 = 140.914406 u, Kr-90 = 89.919524 u (5 neutrons, Q = +163.3 MeV)
2. 23592U + 10n → 13855Cs + 9237Rb + some neutrons. U-235 = 235.043923 u, Cs-138 = 137.911011 u, Rb-92 = 91.919725 u (6 neutrons, Q = +158.2 MeV)
3. 23592U + 10n → 13754Xe + 9538Sr + some neutrons. U-235 = 235.043923 u, Xe-137 = 136.911563 u, Sr-95 = 94.919358 u (4 neutrons, Q = +174.2 MeV)
4. 23592U + 10n → 12648Cd + 10744Ru + some neutrons. U-235 = 235.043923 u, Cd-126 = 125.922354 u, Ru-107 = 106.909907 u (3 neutrons, Q = +181.0 MeV)
5. 23592U + 10n → 12649In + 10843Tc + some neutrons. U-235 = 235.043923 u, In-126 = 125.916465 u, Tc-108 = 107.918480 u (2 neutrons, Q = +186.6 MeV)