

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

$$\text{Binding Energy: } m_n \quad | \quad 1.675 \times 10^{-27} \text{ kg} = 1.008665 \text{ u} = 940 \text{ MeV c}^{-2} \quad \text{u} \quad | \quad 1.661 \times 10^{-27} \text{ kg} = 931.5 \text{ MeV c}^{-2} \quad {}^1_1\text{H} = 1.007825 \text{ u}$$

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)

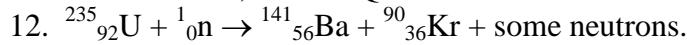
6. Balancing Nuclear Reactions: Find the missing nucleus: d = deuterium, t = tritium

a.	b.	c.	d.
${}^{38}_{17}\text{Cl} + {}^1_1\text{H or d} \rightarrow {}^{40}_{17}\text{Cl}$	${}^{52}_{23}\text{V} + {}^1_0\gamma \rightarrow {}^{51}_{22}\text{Ti}$	${}^{65}_{28}\text{Ni} + {}^4_2\text{He or } \alpha \rightarrow {}^{68}_{30}\text{Zn}$	${}^{81}_{37}\text{Rb} + {}^1_1\text{H or d} \rightarrow {}^{82}_{38}\text{Sr}$
${}^{41}_{21}\text{Sc} + {}^2_1\text{H} \rightarrow {}^{44}_{22}\text{Ti}$	${}^{51}_{24}\text{Cr} + {}^0_0\gamma \rightarrow {}^{55}_{26}\text{Fe}$	${}^{22}_{10}\text{Ne} + {}^1_0\text{n} \rightarrow {}^{23}_{11}\text{Na}$	${}^{31}_{16}\text{S} + {}^2_1\text{H} \rightarrow {}^{28}_{14}\text{Si}$
${}^{12}_{6}\text{C} + {}^2_1\text{H or d} \rightarrow {}^{10}_{5}\text{B}$	${}^{146}_{67}\text{Ho} \rightarrow {}^{145}_{66}\text{Dy}$	${}^{9}_{4}\text{Be} + {}^1_1\text{H or d} \rightarrow {}^{11}_{5}\text{B}$	${}^{7}_{3}\text{Li} + {}^1_1\text{H or d} \rightarrow {}^{8}_{3}\text{Li}$

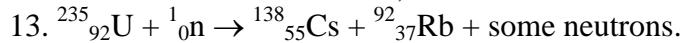
Finding the Q value: Find the Q value for the following reactions. Label the reaction as either energy requiring, (endoergic) or energy releasing (exoergic). You will need to look up the masses in a table.

7. ${}^7_3\text{Li} + {}^4_2\text{He} \rightarrow {}^4_2\text{He}$. (Exo, Q = 17.35 MeV)
8. ${}^7_3\text{Li} + {}^1_0\text{H} \rightarrow {}^3_1\text{H}$. (Exo, Q = +4.783 MeV)
9. ${}^7_3\text{Li} + {}^{10}_5\text{B} \rightarrow {}^1_0\text{n}$. (Endo, Q = -2.790 MeV)
10. ${}^{12}_6\text{C} + {}^{14}_7\text{N} \rightarrow {}^{14}_7\text{N}$. (Exo, Q = 4.015 MeV)
11. ${}^{14}_7\text{N} + {}^1_1\text{H} \rightarrow {}^{17}_8\text{O}$. (Endo, Q = -1.192 MeV)

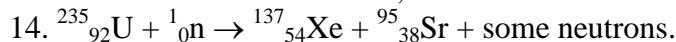
Fission Reactions: For each of the following (fictitious) fission reactions, determine the number of free neutrons liberated, and the Q value of the reaction as a whole:



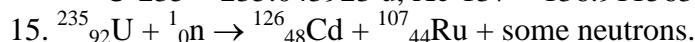
U-235 = 235.043923 u, Ba-141 = 140.914406 u, Kr-90 = 89.919524 u (5 neutrons, Q = +163.3 MeV)



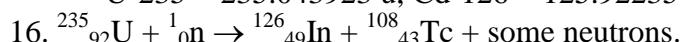
U-235 = 235.043923 u, Cs-138 = 137.911011 u, Rb-92 = 91.919725 u (6 neutrons, Q = +158.2 MeV)



U-235 = 235.043923 u, Xe-137 = 136.911563 u, Sr-95 = 94.919358 u (4 neutrons, Q = +174.2 MeV)



U-235 = 235.043923 u, Cd-126 = 125.922354 u, Ru-107 = 106.909907 u (3 neutrons, Q = +181.0 MeV)



U-235 = 235.043923 u, In-126 = 125.916465 u, Tc-108 = 107.918480 u (2 neutrons, Q = +186.6 MeV)