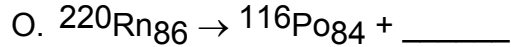


Nuclear Chemistry Problem Set (9)

1 H															2 He		
3 Li	4 Be											5 B	6 C	7 N	8 O	9 F	10 Ne
11 Na	12 Mg											13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
55 Cs	56 Ba	57 La	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn
87 Fr	88 Ra	89 Ac	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt									

58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu
90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr

1. What is the difference between $^{27}_{13}\text{Al}$ and $^{27}\text{Al}_{13}$?
2. Complete the following decay reactions
 - A. $^{27}\text{Al}_{13} + 2^1\text{H}_1 \rightarrow \text{_____} + 4^4\text{He}_2$
 - B. $^7\text{Li}_3 + \text{_____} \rightarrow 2\ ^4\text{He}_2$
 - C. $^9\text{Be}_4 + 4^4\text{He}_2 \rightarrow ^{12}\text{C}_6 + \text{_____}$
 - D. $^{23}\text{Na}_{11} + 2^1\text{H}_1 \rightarrow ^{24}\text{Na}_{11} + \text{_____}$
 - E. $^{81}\text{Kr}_{36} + ^0\text{e}_{-1} \rightarrow \text{_____}$
 - F. $^{104}\text{Ag}_{47} \rightarrow ^0\text{e}_{-1} + \text{_____}$
 - G. $^{73}\text{Ga}_{31} \rightarrow ^0\text{e}_{-1} + \text{_____}$
 - H. $^{104}\text{Cd}_{48} \rightarrow ^{104}\text{Ag}_{47} + \text{_____}$
 - I. $\text{_____} + ^0\text{e}_{-1} \rightarrow ^{54}\text{Cr}_{24}$
 - J. $^{135}\text{I}_{53} \rightarrow ^{135}\text{Xe}_{54} + \text{_____}$
 - K. $^{245}\text{Bk}_{97} \rightarrow 4^4\text{He}_2 + \text{_____}$
 - L. $^{238}\text{U}_{92} + ^{12}\text{C}_6 \rightarrow ^{246}\text{Cf}_{98} + \text{_____}$
 - M. $^{96}\text{Mo}_{42} + 2^1\text{H}_1 \rightarrow ^1\text{n}_0 + \text{_____}$
 - N. $^{184}\text{Hg}_{80} \rightarrow ^{184}\text{Au}_{79} + \text{_____}$



3. Define subcritical mass in your own words.
4. Define critical mass in your own words
5. Define supercritical mass in your own words.
6. What is the purpose of either Cd or B rods in a fission reactor?
7. What is the significance of the "Band of Stability"?
8. What is the difference between fission and fusion?
9. For each of the decay reactions you completed in #2, above, write the kind of decay each reaction represents.
10. List 3 characteristics for "usual" chemical reactions and 3 for nuclear chemical reactions.
11. Cobalt-60 has a half-life of 5.26 years. If 1.25 g of ^{60}Co was allowed to decay, how much would be present after a) one half-life, b) 5 half-lives and c) 10 half-lives?
12. Selenium-75 has a half-life of 120 days. If we began with 10 g ^{75}Se , how much would remain after a) 60 days, b) 360 days, c) 600 days and d) 1200 days?
13. The rate constant for the decay of ^{45}Ca is $4.23 \times 10^{-3} \text{ days}^{-1}$. What is the half life of ^{45}Ca ?
14. The rate constant for the decay of ^{36}Cl is $2.30 \times 10^{-6} \text{ yr}^{-1}$; what is the half life of ^{36}Cl ?
15. The half-life of ^{51}Cr is 27.72 days. What is the rate constant for the decay of ^{51}Cr ?
16. The half life for the decay of ^{109}Cd is 470 days. What is the rate constant for this decay?
17. A sample of rock was found to contain 2.07×10^{-5} mole of ^{40}K and 1.15×10^{-5} mol of ^{40}Ar . If we assume that all of the ^{40}Ar came from the decay of ^{40}K , what is the age of the rock ($t_{1/2} = 1.3 \times 10^9$ years for ^{40}K)?

18. The ^{14}C content of an ancient piece of wood was found to be one-eighth of that in living trees. How old is this piece of wood? ($t_{1/2} = 5770$ years for ^{14}C)?
19. A rock contains 0.955 g of uranium-238 and 0.275 g of lead-206. No other isotopes of Pb are present. How long ago did the uranium first begin to decay? ($t_{1/2} = 4.5 \times 10^9$ years for ^{238}U) **CHECK THE ANSWER KEY ON THIS ONE BEFORE DOING IT.**
20. Technitium-99m (which has a history of being used as a radiotracer to study the heart, lung and liver for damage) has a half-life of 6 hours. Calculate the rate constant for $^{99\text{m}}\text{Tc}$.