Worksheet

Nuclear Chemistry

Problem #1. Complete and ***balance*** the following equations by supplying the missing particles or energy ray. ***Identify the type*** of radioactive decay for each reaction.

a) $^{224}_{88}Ra \rightarrow {}^{220}_{86}Rn + \_\_\_\_\_$

b) $^{226}_{88}Ra \rightarrow {}^{222}_{86}Rn + {}^{4}_{2}He + \_\_\_\_\_$

c) $^{232}_{90}Th \rightarrow {}^{232}_{91}Pa + \_\_\_\_\_$

d) $^{13}_{7}N \rightarrow {}^{13}_{6}C + \_\_\_\_\_$

e) $^{235}_{92}U + {}^{1}_{0}n \rightarrow \_\_\_\_\_ + {}^{91}_{36}Kr + 3\,{}^{1}_{0}n$

f) $^{249}_{98}Cf + \_\_\_\_\_ \rightarrow {}^{257}_{104}X + 4\,{}^{1}_{0}n$

Problem #2. Write complete and balance equations for each of the following processes, or write the shorthand notation for the given reaction:

a) $^{10}_{5}B\,(\alpha, p)\,{}^{13}_{6}C$

b) $^{107}_{47}Ag\,(n, 2n)\,{}^{106}_{47}Ag$

c) $^{23}_{11}Na + {}^{1}_{0}n \rightarrow {}^{24}_{11}Na + \_\_\_\_\_$

d) $^{238}_{92}U + {}^{12}_{6}C \rightarrow {}^{246}_{98}Cf + 4\,{}^{1}_{0}n$

e) $\_\_\_\_\_\,(^{3}_{1}H,\ n)\,{}^{4}_{2}He$

f) $^{81}_{35}Br\,(\_\_\_, n)\,{}^{256}_{101}Md$

Problem #3. Write nuclear equations for the following process:

a) krypton-81 undergoes beta decay

b) alpha decay of uranium-238

c) electron capture of lead-206

d) thorium-230 undergoes alpha emission

e) positron emission of radium-226

f) neutron bombardment of zirconium-99

g) thorium-230 decays a radium isotope

h) nitrogen-13 undergoes beta decay

i) iodine-131 undergoes beta decay

j) gold-195 undergoes electron decay

Problem #4. A piece of wood from an ancient artifact has a carbon-14 activity of 11.7 disintegrations per min. per gram of carbon. Current carbon-14 activity in fresh samples is 15.3 disintegrations per min. per grams of carbon. The half-life of carbon is 5730 yrs. calculate the age of the wood sample.

Problem #5. The half-life of nucleus Rn-222 is 3.88 days. How many mg of a 5000 mg sample of Rn-222 remains after sixty days?

Problem #6. What is the original mass of C-14 in a sample if 10.00 mg of it remains after 20,000 years? The half-life of C-14 is 5730 years.

Problem #7. Calculate the energy of 1.0 amu in joules using the Einstein's relationship.
(1 J= 1 $kg.m^2/s^2$, 1g =$6.02x10^{23}$ amu) $E = C^2 (\Delta m)$

Problem #8. For the nuclear reaction

$$^{14}_{7}N + ^{4}_{2}He \rightarrow ^{17}_{8}O + ^{1}_{1}H$$

calculate the energy in joules associated with the reaction of one atom of nitrogen-14 with one atom of He-4 , given that isotopic masses(amu) are N-14 (14.00307); He-4 (4.00260); O-17 (16.99991); and H-1(1.007825).

Problem #9. Carbon-14 decays as follows:

$$^{14}_{6}C \rightarrow ^{0}_{-1}e + ^{14}_{7}N$$

isotopic masses are 14.00307 for nitrogen-14 and 14.00324 for carbon-14. What energy change occurs in the beta decay of C-14?

Problem #10. Calculate the nuclear binding energy of Li-7 and Cl-35 if this nucleous has a mass of 7.01435 amu. (m_p =1.00728 amu , m_n = 1.00867 amu)

Problem #11. $^{56}_{26}Fe$ has a mass defect of 0.58872 amu. What is its binding energy per nucleon?

Problem #12. Predict which of the following nuclides are likely to be radioactive (Briefly justify your choice) and determine the mode of decay.

a) Carbon-14	b) Xenon-118	c) Plutonium-239
d) Indium-120	e) He-4	f) Ca-40
g) Tc-98	h) Zn-64	i) Br-90
j) Ag-103		