Name (Key) _____ Period _____ Date 11/12

The Nucleus & Radioactive Decay – Quiz Review

Part A – Mass Defect & Nuclear Binding Energy

1. Find the mass defect of oxygen-16 if the measured atomic mass is 15.994915 amu.
   1 proton = 1.007276 amu, 1 neutron = 1.008665 amu, and 1 electron = 0.0005486 amu.

$^{16}_{8}O$ ← nuclide

$8p^+ \times 1.007276\,amu = 8.058208$
$8n^0 \times 1.008665\,amu = 8.06932$
$8e^- \times 0.0005486\,amu = 0.0043888$
$+$
$16.131916\,8\,amu - 15.994915\,amu = 0.1370018\,amu$

2. Calculate the nuclear binding energy of oxygen-16 given that 1 amu = 1.6605×10^{-27} kg.

(1) $0.1370018\,amu \left| \frac{1.6605\times10^{-27}\,kg}{1\,amu} \right. = 2.2749\times10^{-28}\,kg$ (2)

(1) convert from amu → kg

(2) Calculate Energy: $E = mc^2$
$= (2.2749\times10^{-28}\,kg)(3.00\times10^{8}\,m/s)^2$
$= 2.05\times10^{-11}\,J$

Part B – Nuclear Decay

Write equations for the following nuclear decay reactions. Make sure that both mass numbers and atomic numbers are balanced on each side.

3. Decay of polonium-218 by alpha (α) emission.

$^{218}_{84}Po \rightarrow {}^{4}_{2}He + {}^{214}_{82}Pb$

4. Decay of carbon-14 by beta (β-) emission.

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

5. Decay of chlorine-32 by positron (β+) emission.

$^{32}_{17}Cl \rightarrow {}^{0}_{+1}e + {}^{32}_{16}S$

6. Decay of promethium-142 by electron capture.

$^{142}_{61}Pm + {}^{0}_{-1}e \rightarrow {}^{142}_{60}Nd$

Part C – Half-Life

7. The half-life of phosphorous-30 is 2.5 min. If you start with 35 g of phosphorus-30, how many grams would remain after 20.0 min?

$n = \frac{20.0\,min}{2.5\,min} = 8 \qquad M_f = 35g(.5)^8 = 0.14g$

8. The half-life of polonium-210 is 138.4 days. How many milligrams of polonium-210 remain after 415.2 days if you start with 2.0 mg of the isotope?

$n = \frac{415.2}{138.4} = 3 \qquad M_f = 2.0mg(.5)^3 = 0.25g$

$20.0g \times \frac{1}{2} = 10.0g \times \frac{1}{2} = 5.00g$ so $n = 2$ half-lives

9. 20.0 g of a radioactive isotope are present at 1:00 p.m., and 5.0 g remain at 2:00 p.m.

   a. How many half-lives have gone by? 2

   b. How long is the half-life of the isotope? 30 minutes ($\frac{1}{2}$ hour)

   c. Predict how many grams will be left at 2:30 p.m. 2.50 g

Part D: Questions

10. Compare an alpha particle, beta particle, and gamma ray in terms of mass, charge, particle makeup and what can be used to stop them. Make a chart or table.

	mass	charge	particle	stopped by
Alpha →	4	+2	^4_2He	paper
Beta →	~0	−1	$^0_{-1}e$	lead
Gamma →	0	0	electromagnetic radiation	concrete

11. List 3 ways nuclear chemistry is used by human beings.

→ to create electricity in Nuclear Power plants → weapons
→ Medical diagnosis + treatment → nuclear submarines
→ Dating Artifacts → food irradiation

12.

Match each item with the correct statement below.

a. positron
b. alpha particle
c. beta particle
d. transuranium element
e. gamma radiation
f. transmutation

D — element with atomic number greater than 92
B — emitted helium nucleus
C — energetic electron from decomposed neutron
E — high-energy photons emitted by a radioisotope
A — particle of charge +1 and mass equal to that of an electron

Match each item with the correct statement below.

a. fission
b. fusion
c. nuclide
d. radioisotope
e. parent nuclides
f. daughter nuclides

D — element with unstable nucleus that undergoes nuclear decay
C — in nuclear chemistry the atom is referred to as one of these
A — splitting of nucleus into smaller fragments
B — the sun and other stars produce energy through this process
F — nuclides produced by the decay of heavier nuclides