Name KEY Period ____ Date ____ #14

The Nucleus & Radioactive Decay - Ch. 22 (p.701-712)

Part A - Mass Defect & Nuclear Binding Energy

Problems

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.

$8p^+ \times 1.007276\ amu = 8.058208\ amu$
$8n^0 \times 1.008665\ amu = 8.06932\ amu$
$8e^- \times 0.0005486\ amu = 0.0043888\ amu$
$16.131917\ amu$
$-15.994915\ amu$
$0.1370018\ amu$

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

$$0.1370018\ amu \left| \frac{1.6605 \times 10^{-27}\ kg}{1\ amu} \right. = 0.22749 \times 10^{-27-1} = 2.2749 \times 10^{-28}\ kg$$

$$E = mc^2 = \left(2.2749 \times 10^{-28}\ kg\right)\left(3.00 \times 10^{8}\ m/s\right)^2 = 6.82 \times 10^{-20}\ J$$

$.682 \times 10^{-19}$

2.05×10^{-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.

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

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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? $20.0\text{min} \div 2.5\text{min} = 8$

$$m_f = m_i \left(\frac{1}{2}\right)^n$$

$$= (35\text{g})\left(\frac{1}{2}\right)^8 = 0.14\text{g}$$

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? $415.2 \div 138.4 = 3$

$m_i = 2.0\text{mg}$

$$m_f = (2.0\text{mg})\left(\frac{1}{2}\right)^3 = 0.25\text{mg}$$

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 min
   c. Predict how many grams will be left at 2:30 p.m. 2.5g

$$20.0 \times \frac{1}{2} = 10.0\text{g} \times \frac{1}{2} = 5.0\text{g}$$