

KEY

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Name _____ Period _____ Date _____

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

PART A - MASS DEFECT & NUCLEAR BINDING ENERGY

PROBLEMS

- 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.

$$\begin{array}{r}
 8p \times 1.007276 \text{ amu} = 8.058208 \text{ amu} \\
 8n \times 1.008665 \text{ amu} = 8.06932 \text{ amu} \\
 8e^- \times 0.0005486 \text{ amu} = 0.0043888 \text{ amu} \\
 \hline
 16.131917 \text{ amu} \\
 - 15.994915 \text{ amu} \\
 \hline
 0.1370018 \text{ amu}
 \end{array}$$

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

$$\frac{0.1370018 \text{ amu}}{1 \text{ amu}} \times 1.6605 \times 10^{-27} \text{ kg} = 0.22749 \times 10^{-27} = 2.2749 \times 10^{-28} \text{ kg}$$

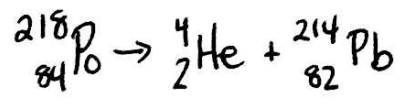
$$E = mc^2 = (2.2749 \times 10^{-28} \text{ kg}) (3.00 \times 10^8 \text{ m/s})^2 = 6.82 \times 10^{-20} \text{ J}$$

(Handwritten corrections: 6.82×10^{-19} and $2.05 \times 10^{-11} \text{ J}$)

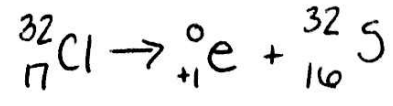
PART B - NUCLEAR DECAY

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

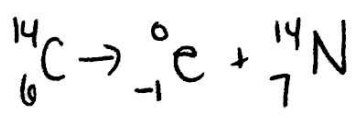
- Decay of polonium-218 by alpha (α) emission.



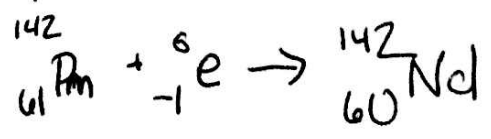
- Decay of chlorine-32 by positron (β^+) emission.



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



- Decay of promethium-142 by electron capture.



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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. 2.5 g

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