AP Chemistry

Study Guide Answers

Chapter 21

Name: _____

Date: _____ Per: _____

1. The splitting of the nucleus into lighter nuclei is called ___fission_____.
2. When light mass nuclei combine to form a heavier, more stable nucleus this is called _____fusion____.
3. Write an equation for the alpha decay of bismuth-213. _____$^{213}_{83}Bi \rightarrow {}^{4}_{2}He + {}^{209}_{81}Tl$_____.
4. Write an equation for the beta decay of silver-106. _____$^{106}_{47}Ag \rightarrow {}^{0}_{-1}e + {}^{106}_{48}Cd$_____.
5. Describe the difference between beta decay and electron capture. ___In beta decay, an electron is emitted from the nucleus as a neutrons transforms into a proton. In electron capture (or K capture or beta capture) an electron is taken in from the electron cloud by the nucleus to convert a proton into a neutron. _____.
6. The mass of a lithium-7 atom* is 7.01600amu. Calculate it mass defect.

Proton Mass 1.007276amu
Neutron Mass 1.008665amu
Electron Mass 0.0005486amu

p^+ mass = 3 x 1.007276 amu = 3.021828 amu
n^o mass = 4 x 1.008665 amu = 4.034660 amu
e^- mass = 7 x 0.0005486 amu = 0.0016458 amu *(* mass is for atom, not nucleus)*
Theoretical Mass = 7.058138 amu
Mass defect = 7.058138 amu – 7.01600 amu = **0.04213 amu**

7. Calculate the nuclear binding energy of one lithium-6 atom. The actual measured atomic mass of lithium-6 is 6.015amu.

p^+ mass = 3 x 1.007276 amu = 3.021828 amu
n^o mass = 3 x 1.008665 amu = 3.025995 amu
e^- mass = 7 x 0.0005486 amu = 0.0016458 amu *(* mass is for atom, not nucleus)*
Theoretical Mass = 6.049468 amu
Mass defect = 6.049468 amu – 6.015 amu = 0.034468 amu *(must be expressed in kg to use $E=mc^2$)*

$$0.034468 \text{ amu} \left| \frac{1 \text{ gram}}{6.022 \times 10^{23} \text{ amu}} \right| \frac{1 \text{ kilogram}}{1000 \text{ grams}} = 5.723812687 \times 10^{-29} \text{ kg}$$

$E = mc^2 = 5.723812687 \times 10^{-29}$ kg $\cdot (3.00 \times 10^8 \text{m/s})^2 =$ **5.15×10^{-12}J**

Since I used 3 sig figs for 'c', I rounded the final answer to 3 sig figs.

8. Oxygen has an unstable isotope O-17 that has a mass of 17.00454. Calculate the binding energy of the oxygen nucleus in MeV.

p^+ mass = 8 x 1.007276 amu = 8.058208 amu
n^o mass = 9 x 1.008665 amu = 9.077985 amu
e^- mass = 8 x 0.0005486 amu = 0.0043888 amu *(* mass is for atom, not nucleus)*
Theoretical Mass = 17.140518 amu
Mass defect = 17.140518 amu – 17.00454 = 0.136018 amu *(must be expressed in kg to use $E=mc^2$)*

$$0.136018 \text{ amu} \left| \frac{1 \text{ gram}}{6.022 \times 10^{23} \text{ amu}} \right| \frac{1 \text{ kilogram}}{1000 \text{ grams}} = 2.259008004 \times 10^{-28} \text{ kg}$$

$E = mc^2 = 2.259008004 \times 10^{-28}$ kg $\cdot (3.00 \times 10^8 \text{m/s})^2 = 2.03382036 \times 10^{-11}$J

1eV = 1.60×10^{-19} joules *(I'd give this value to you in the test.)*

$$2.03382036 \times 10^{-11} \text{J} \left| \frac{1 \text{ eV}}{1.60 \times 10^{-19} \text{ J}} \right| \frac{1 \text{ MeV}}{1000\,000 \text{ eV}} = 127 \text{ MeV}$$

Since I used 3 sig figs for 'c' and the eV conversion, I rounded the final answer to 3 sig figs.

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9. Assuming a half-life of 1599 years in how many years will 1/16 of a given amount of radium-226 remain?

   6396 years

10. Atoms containing radioactive nuclei are called radioisotopes .