Chapter 21 and 23 practice problems

1. A wooden object is claimed to have been found in an Egyptian pyramid and is offered for sale to an art museum. Analysis of the object determines that it contains 35.4 mg of Carbon-14. A fresh sample of the same kind of wood contains 62.1 mg of Carbon-14. Is this object likely to have come from a pyramid from 3500 years ago?

$$\lambda = \frac{\ln 2}{k} \Rightarrow k = \frac{\ln 2}{\lambda} = \frac{\ln 2}{5730\ \text{y}} = 0.0001291\ \text{y}^{-1}$$

$$\ln \frac{N_t}{N_o} = -kt$$

$$t = \frac{\ln \frac{N_t}{N_o}}{-k} = \frac{\ln \frac{35.4}{62.1}}{-\left(0.0001291\ \text{y}^{-1}\right)} = 4354\ \text{y}$$

Because the measured age is older than 3500 years, the item is likely to be authentic.

2. How much energy in MJ is release when 1.00 mol of Lithium-6 undergoes the following reaction:

$$^{6}_{3}\text{Li} + {}^{1}_{0}\text{n} \rightarrow {}^{4}_{2}\text{He} + {}^{3}_{1}\text{H}$$

Use the data from your textbook.

$$\Delta m = \left(4.00260\ \text{g} + 3.01605\ \text{g}\right) - \left(6.01512\ \text{g} + 1.008665\ \text{g}\right) = -0.005135\ \text{g}$$

$$= -5.135\times10^{-6}\ \text{kg}$$

$$E = \Delta mc^2 = \left(-5.135\times10^{-6}\ \text{kg}\right)\left(2.998\times10^{8}\ \text{m s}^{-1}\right)^2 = -4.615\times10^{11}\ \text{J}$$

$$= -4.615\times10^{5}\ \text{MJ}$$

3. Balance the following nuclear reactions

   a. $^{59}_{27}\text{Co} + {}^{1}_{0}\text{n} \rightarrow {}^{56}_{25}\text{Mn} + {}^{4}_{2}\text{He}$

   b. $^{235}_{92}\text{U} + {}^{1}_{0}\text{n} \rightarrow {}^{99}_{40}\text{Zr} + {}^{135}_{52}\text{Te} + 2\ {}^{1}_{0}\text{n}$

   c. Positron emission of Phosphorus-30 $^{30}_{15}\text{P} \rightarrow {}^{0}_{1}\text{e} + {}^{30}_{14}\text{Si}$

4. Which of the following complexes are tetrahedral and which are square planar based on the data provided?

   a. $Ni(en)_2^{2+}$ (diamagnetic) because it is diamagnetic and Nickel is a d^8 ion the hybridization must be dsp^2 and it is square planar

   b. $FeCl_4^-$ (green color) because we see green it must absorb red therefore Δ is small, therefore the complex is tetrahedral

   c. $Ag(CO)_4^+$ (low spin) With Ag^+ it's always low spin so the only way to tell is by the fact that CO is a strong ligand so Δ must be large the complex is square planar

5. Name the following transition metal complexes or complex ions

   a. $[CrBr_2(NH_3)_4]^+$
   Tetraamminedibromochromium(III) ion

   b. $[AlF_6]^-$
   Hexafluoroaluminate(V) ion

   c. $[Fe(CN)_5(SCN)]^{4-}$
   Pentacyanatothiocyanatoferrate(II) ion

   d. $[Ag(S_2O_3)_2]^{3-}$
   dithiosulfatoargentate(I) ion

   e. $[Co(SO_4)(NH_3)_5]^+$
   Pentaamminesulfatocobalt(III) ion

6. Write formulas from the following names

   a. Dicyanoargentate(I) ion
   $[Ag(CN)_2]^-$

   b. Pentaaquahydroxoaluminum(III) chloride
   $[Al(OH)(H_2O)_5]Cl_2$

   c. Ethylenediaminedithiocyanatocopper(II)
   $[Cu(SCN)_2(en)]$

7. $Cr(en)_3^{2+}$ is low spin, what sort of hybridization does it have?
Low spin, maximum pairing of electrons d orbital available it is d^2sp^3.

8. $Fe(NO_2)_2(en)_2$ is polar, does it have optical isomers?
If it's polar the NO_2 ligands are cis and it has optical isomers.

9. $MoCl_2(H_2O)_2^+$ is non-polar, does it have geometric isomers?

It's non polar so it's square planar, so it does have geometric isomers.

10. A compound with the overall formula $CoCl_6 \cdot 3H_2O$ is dissolved in water. Electrical conductivity measurements indicate that there are 3 ions per formula unit. Gentle heating of the compound results in a slight mass loss. X-ray crystallography measurements indicate that the Cobalt has octahedral geometry. Write a formula for this compound indicating what the ligands are, what the anions are and if how many waters of hydration there are. (i.e. $[ML_{1n}L_{2m}]A_y \cdot xH_2O$)

$[CoCl_4(H_2O)_2]Cl_2 \cdot H_2O$