Chemistry / Environmental Studies L111
Environmental Concerns and Chemical Solutions
Professor Dransfield
Homework 9: Due May 3, 2007

Fifth Edition Question Numbers:

Chapter 7

#47. The energy of fusion from H-2 and He-3 is calculated in question #12 (from last week's HW assignment) as 1.76 x 10^{12} J. Using Table 4.2, we can compare this to the heat released from combustion of H_2.

H_2 + ½ $O_2 \rightarrow H_2O$

This reaction requires us to **break** 1 H-H single bond and ½ of 1 O-O double bond, and to **make** 2 O-H single bonds.

Bonds broken: 1 H-H = 436 kJ

½ O=O = ½ x 498 kJ = 249 kJ

Bonds made: 2 H-O = 2 x (-467) = -934 kJ

Total energy = 249 kJ/mole

The nuclear reaction produces 1.76x10^{12}/249,000 = **7 million times** as much energy from one mole of H2 if we use it in fusion rather than in combustion.

48. What do we know?

$$? + {}_{2}^{4}He \rightarrow {}_{98}^{245}Cf + {}_{0}^{1}n$$

We have 98 protons on the right, and a mass of 246 on the right. If we subtract off the two protons and the mass of 4 already accounted for in the alpha particle, we're left with 96 protons and a mass of 242 to account for. That means that our mystery element, the target, was ${}_{96}^{242}Cm$, Curium-242.

AND From Chapter 8

1. a) Oxidation is the loss of electrons.
   b) Reduction is the gain of electrons.
   c) Because electrons don't exist by themselves – they are always transferred from one species to another.

2. a) Iron is going from a charge of zero to a charge of 2+. This represents a loss of electrons (which have negative charge), and is thus **oxidation**.

b) Nickel goes from +4 to +2 here, which is **reduction**.

c) This one's sneaky. What happens to the O atoms? Nothing. They're -2 on the left and -2 on the right. But 2 of the H atoms go from being +1 in H_2O to having a charge of 0 in H_2. That's **reduction**.

3. a) The anode is where oxidation takes place. Electrons flow from the anode to the cathode, so the zinc electrode must be the anode.

b) $Zn(s) \rightarrow Zn^{2+}(aq) + 2e^-$

c) By elimination, the silver electrode must be the cathode.

d) $Ag^+(aq) + e^- \rightarrow Ag(s)$

6. a) We're given that $Li \rightarrow Li^+$ and $I_2 \rightarrow 2\ I^-$. We just have to balance those two reactions with respect to electrons.

$Li(s) \rightarrow Li^+(aq) + e^-$ (This is oxidation)

$I_2(s) + 2\ e^- \rightarrow 2\ I^-\ (aq)$ (This is reduction)

b) We need to add those 2 half-reactions together to make the net reaction. But to do that, we need to multiply the oxidation half-reaction by 2, to ensure that our electrons cancel out correctly.

$$2\ Li(s) + I_2(s) + 2\ e^- \rightarrow 2Li^+(aq) + 2\ e^- + 2\ I^-(aq)$$

Now all that's left is to cancel the electrons that appear on both sides:

$$2\ Li(s) + I_2(s) \rightarrow 2Li^+(aq) + 2\ I^-(aq)$$

c) Because the lithium is being oxidized, that must take place at the anode. Because the iodine is being reduced, that must take place at the cathode.

12. a) This question IS hard, but don't overthink this first step... look what you need to do in order to balance the electrical charges! In the first reaction, the left hand side of the equation has a total charge of -2, but the right hand side has a charge of 0. If we add 2 electrons to the right hand side, then the charges are balanced:

$$Pb(s) + SO_4^{2-}(aq) \rightarrow PbSO_4(s) + 2e^-$$

Similarly, in the second equation we have a total charge of 4+ + 2- = 2+ on the left hand side, but no electrical charge on the right. We need to add 2 electrons to the left to balance the charge:

$$PbO_2(s) + 4\ H^+(aq) + SO_4^{2-}(aq) + 2e^- \rightarrow PbSO_4(s) + 2\ H_2O(l)$$

b) In the first equation, lead goes from having a charge of 0 in Pb(s) to having a charge of +2 in lead sulfate. That's oxidation. In the second equation, lead goes from having a +4 charge in lead oxide – because each oxygen comes with a -2 charge – to having a +2 charge in lead sulfate. That's reduction.

c) The lead solid is being oxidized, so that's the anode. The lead oxide is being reduced, so that's the cathode.

14. Both kinds of cell transform the energy from spontaneous chemical reactions into electrical energy. But a lead storage battery is sealed. As the reaction proceeds, the anode is consumed. The reaction can be reversed and the battery recharged, but eventually it will physically fail. The fuel cell relies on continually replace the fuel and the oxidant. So long as both continue to flow, the fuel cell will never wear down.

15. Oxygen in H_2O must have a charge of -2 to counter the 2 +1 charges from the hydrogen. Oxygen in O_2 is electrically neutral, as those 2 O atoms are identical and the resulting molecule is electrically neutral. Thus, oxygen being converted from O_2 to H_2O represents a gain of electrons, which is **reduction**.