GROUP 4: OXIDATION STATE TRENDS

1. a) Work out the oxidation states of carbon in these compounds: CH_4, CO and CO_2.

   b) Which of these compounds is the most thermodynamically stable? Explain your reasoning.

   c) Typical oxidation states for the Group 4 elements are +2 and +4. How does the relative stability of these two oxidation states vary as you go down the group?

   d) Carbon monoxide is a major reducing agent in the blast furnace extraction of iron from ores such as Fe_2O_3. Write the equation for this reaction and explain what is happening in oxidation and reduction terms.

2. Tin forms two ions, Sn^{2+} and Sn^{4+}. The tin(IV) ion is the more stable, and the tin(II) ion is a good reducing agent.

   a) Briefly, why are tin(II) ions reducing agents?

   Assuming that the tin(II) ions end up as simple tin(IV) ions, write equations to show tin(II) ions reducing

   b) Fe^{3+} ions to Fe^{2+} ions;

   c) MnO_4^- ions (in the presence of hydrogen ions) to Mn^{2+} ions;

   d) IO_3^- ions (in the presence of hydrogen ions) to iodine molecules (I_2). (You probably haven't met this before, but by this time, you should be able to work it out. Now is a good point to find out whether you can!)

3. Lead also forms two oxidation states, Pb(II) and Pb(IV), but in this case, the lead(II) is the more stable.

   a) Give two simple examples, including equations, of lead chemistry which illustrate this.

   b) Lead has the electronic structure $[Kr]4d^{10}4f^{14}5s^25p^65d^{10}6s^26p_x^16p_y^1$. Lead's chemistry is dominated by the *inert pair effect*. This is also present, but to a much lesser extent, in tin chemistry.

   Explain what the inert pair effect is, and how it affects the relative stabilities of the 2+ and 4+ ions in tin and lead chemistry. You are ***not*** expected to explain the underlying cause of the inert pair effect.