Chemistry CP

Name:

Hess' Law Problems

Date:

Level 2

1. From the following equations and enthalpy values,
   $H_2(g) + Cl_2(g) \rightarrow 2\ HCl\ (g)$ $\Delta H^o = -185$ kJ
   $2\ H_2(g) + O_2(g) \rightarrow 2\ H_2O\ (g)$ $\Delta H^o = = -483.7$ kJ
   calculate ΔH^o for the following reaction:
   $4\ HCl\ (g) + O_2(g) \rightarrow 2\ Cl_2(g) + 2\ H_2O(g)$

2. Calculate the enthalpy change, ΔH, for the formation of 1 mole of strontium carbonate (the material that gives the red color in fireworks) from its elements.
   $Sr(s) + C(graphite) + 3/2\ O_2(g) \rightarrow SrCO_3(s)$ $\Delta H^o = ?$
   The information available to you is:
   $Sr(s) + ½\ O_2(g) \rightarrow SrO\ (s)$ $\Delta H^o = -592$ kJ
   $SrO(s) + CO_2(g) \rightarrow SrCO_3(s)$ $\Delta H^o = -234$ kJ
   $C(graphite) + O_2(g) \rightarrow CO_2(g)$ $\Delta H^o = -394$ kJ

3. We want to know the enthalpy change for the reaction of lead(II) chloride with chlorine to give lead (IV) chloride:
   $PbCl_2(s) + Cl_2(g) \rightarrow PbCl_4(l)$ $\Delta H^o = ?$
   We already know that $PbCl_2(s)$ can be formed from the metal and $Cl_2(g)$:
   $Pb(s) + Cl_2(g) \rightarrow PbCl_2(s)$ $\Delta H^o = -359.4$ kJ
   and that $PbCl_4(l)$ can be formed directly from the elements:
   $Pb(s) + 2\ Cl_2\ (g) \rightarrow PbCl_4(g)$ $\Delta H^o = -329.3$ kJ
   Calculate the unknown ΔH^o from this information.

4. Lead has been known and used since ancient times. To obtain the metal, the ore PbS (galena), is first heated in air to form PbO,
   $PbS(s) + 3/2\ O_2(g) \rightarrow PbO(s) + SO_2(g)$ $\Delta H^o = -413.7$ kJ
   and the lead (II) oxide is reduced with carbon.
   $PbO(s) + C(graphite) \rightarrow Pb(s) + CO(g)$ $\Delta H^o = +106.8$ kJ
   To obtain the lead from 1.00 kg of pure PbS, how much heat energy is required or evolved (at constant pressure)?

CHALLENGE PROBLEM (Optional)

5. The following reaction is one that occurs in a blast furnace when iron is extracted from its ores.
   $Fe_2O_3\ (s) + 3\ CO\ (g) \rightarrow 2\ Fe(s) + 3\ CO_2(g)$
   Evaluate ΔH^o for this reaction at 298 K given the following enthalpy changes at 298K.
   $3\ Fe_2O_3(s) + CO(g) \rightarrow 2\ Fe_3O_4(s) + CO_2(g)$ $\Delta H^o = -46.4$ kJ
   $FeO(s) + CO(g) \rightarrow Fe(s) + CO_2(g)$ $\Delta H^o = 9.0$ kJ
   $Fe_3O_4(s) + CO(g) \rightarrow 3\ FeO(s) + CO_2(g)$ $\Delta H^o = -41.0$ kJ