Hess's Law Problems

1. The enthalpies of the following reactions are given

$Na_{(s)} + \frac{1}{2}Cl_{2(g)} \rightleftharpoons NaCl_{(S)}$	$\Delta H_f^o = -410.5kJ$
$H_{2(g)} + S_{(s)} + 2O_{2(g)} \rightleftharpoons H_2SO_{4(l)}$	$\Delta H_f^o = -810.2kJ$
$2Na_{(s)} + S_{(s)} + 2O_{2(g)} \rightleftharpoons Na_2SO_{4(s)}$	$\Delta H_f^o = -1381.5kJ$
$\frac{1}{2}H_{2(g)} + \frac{1}{2}Cl_{2(g)} \rightleftharpoons HCl_{(g)}$	$\Delta H_f^o = -184.4kJ$

From the above data and equations, calculate ΔH_{rxn}^o for the following reaction:

$2NaCl_{(s)} + H_2SO_{4\,(l)} \rightleftharpoons Na_2SO_{4(s)} + 2HCl_{(g)}$

2. From the following data, calculate the standard heat of formation of $AgCl_{(s)}$:

$Ag_2O_{(s)} + 2HCl_{(g)} \rightleftharpoons 2AgCl_{(s)} + H_2O_{(l)}$	$\Delta H_{rxn}^o = -324.4kJ$
$2Ag_{(s)} + \frac{1}{2}O_{2(g)} \rightleftharpoons Ag_2O_{(s)}$	$\Delta H_{rxn}^o = -71.0kJ$
$\frac{1}{2}H_{2(g)} + \frac{1}{2}Cl_{2(g)} \rightleftharpoons HCl_{(g)}$	$\Delta H_{rxn}^o = -46.2kJ$
$H_{2(g)} + \frac{1}{2}O_{2(g)} \rightleftharpoons H_2O_{(l)}$	$\Delta H_{rxn}^o = -286kJ$

3. Use the following data to determine $\Delta H_{f\,(HBr_{(g)}}^o$:

$KBr_{(aq)} + \frac{1}{2}Cl_{2(g)} \rightleftharpoons KCl_{(aq)} + \frac{1}{2}Br_{2(aq)}$	$\Delta H_{rxn}^o = -48.1kJ$
$\frac{1}{2}H_{2(g)} + \frac{1}{2}Cl_{2(g)} \rightleftharpoons HCl_{(g)}$	$\Delta H_{rxn}^o = -92.9kJ$
$HCl_{(g)} \rightleftharpoons HCl_{(aq)}$	$\Delta H_{rxn}^o = -72.3kJ$
$KOH_{(aq)} + HCl_{(aq)} \rightleftharpoons KCl_{(aq)} + H_2O_{(l)}$	$\Delta H_{rxn}^o = -57.3kJ$
$KOH_{(aq)} + HBr_{(aq)} \rightleftharpoons KBr_{(aq)} + H_2O_{(l)}$	$\Delta H_{rxn}^o = -57.3kJ$
$\frac{1}{2}Br_{2(l)} \rightleftharpoons \frac{1}{2}Br_{2(aq)}$	$\Delta H_{rxn}^o = -2.1kJ$
$HBr_{(g)} \rightleftharpoons HBr_{(aq)}$	$\Delta H_{rxn}^o = -83.1kJ$

4. The enthalpy of combustion for $C_2H_{2(g)}$ is $-1298.3\frac{kJ}{mol}$ and for $C_6H_{6(l)}$ the enthalpy of combustion is $-3264.6\frac{kJ}{mol}$. The complete combustion of any organic compound containing carbon, hydrogen and possibly oxygen involves the reaction of that substance with $O_{2(g)}$ to produce $CO_{2(g)}$ and $H_2O_{(g)}$. Calculate the enthalpy of reaction for the following reaction:

$$3C_2H_{2(g)} \rightleftharpoons C_6H_{6(l)}$$

5. Given the following data:

$CaC_{2\,(s)} + 2H_2O_{(l)} \rightleftharpoons Ca(OH)_{2(s)} + C_2H_{2(g)}$ $\quad \Delta H^o_{rxn} = -129.58kJ$

$CaO_{(s)} + H_2O_{(l)} \rightleftharpoons Ca(OH)_{2(s)}$ $\quad \Delta H^o_{rxn} = -62.7kJ$

$\Delta H^o_{f(CaC_{2(s)})} = -59.787kJ$

$\Delta H^o_{f(CaO_S)} = -635.5kJ$

$\Delta H^o_{f(H_2O_{(l)})} = -286kJ$

Calculate ΔH^o_f for $C_2H_{2(g)}$

6. Given the following data:

$C_3H_{6(g)} + H_{2(g)} \rightleftharpoons C_3H_{8(g)}$ $\quad \Delta H^o_{rxn} = -123.7kJ$

$C_3H_{8(g)} + 5O_{2(g)} \rightleftharpoons 3CO_{2(g)} + 4H_2O_{(l)}$ $\quad \Delta H^o_{rxn} = -2218k$

$\Delta H^o_{f(H_2O_{(l)})} = -286kJ$

Calculate the heat of combustion of propene: $C_3H_{6(g)}$

7. Given the reactions

$C_2H_{2(g)} + \frac{5}{2}O_{2(g)} \rightleftharpoons 2CO_{2(g)} + H_2O_{(g)}$ $\quad \Delta H^o_{rxn} = -1304.2kJ$

$CH_{4(g)} + 2O_{2(g)} \rightleftharpoons CO_{2(g)} + 2H_2O_{(g)}$ $\quad \Delta H^o_{rxn} = -882.0kJ$

Calculate ΔH^o_{rxn} for :

$3CH_{4(g)} + \frac{7}{2}O_{2(g)} \rightleftharpoons C_2H_{2(g)} + CO_{2(g)} + 5H_2O_{(g)}$

8. Given the reactions:

$H_{2(g)} + Cl_{2(g)} \rightleftharpoons 2HCl_{(g)}$ $\quad \Delta H^o_{rxn} = -184.8kJ$

$2H_{2(g)} + O_{2(g)} \rightleftharpoons 2H_2O_{(g)}$ $\quad \Delta H^o_{rxn} = -572.0kJ$

Calculate ΔH^o_{rxn} for :

$4HCl_{(g)} + O_{2(g)} \rightleftharpoons 2Cl_{2(g)} + 2H_2O_{(g)}$

ANSWERS

1. $\Delta H^o_{rxn} = -119.1kJ$
2. $\Delta H^o_f = -100.9\frac{kJ}{mol}$
3. $\Delta H^o_f = -36.1\frac{kJ}{mol}$
4. $\Delta H^o_{rxn} = -630.3\frac{kJ}{mol}$
5. $\Delta H^o_f = -223\frac{kJ}{mol}$
6. $\Delta H^o_{rxn} = -2056\frac{kJ}{mol}$
7. $\Delta H^o_{rxn} = -1342\frac{kJ}{mol}$
8. $\Delta H^o_{rxn} = -202.4kJ$