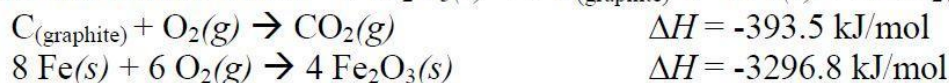


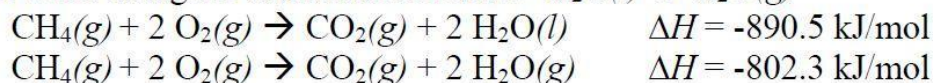
Thermodynamics
6.9 Hess's Law
Worksheet Key

- 1) Determine the value of the enthalpy change, ΔH_{rxn} , for the following reaction using the information below. $2 \text{Fe}_2\text{O}_3(s) + 3 \text{C}_{(\text{graphite})} \rightarrow 4 \text{Fe}(s) + 3 \text{CO}_2(g)$



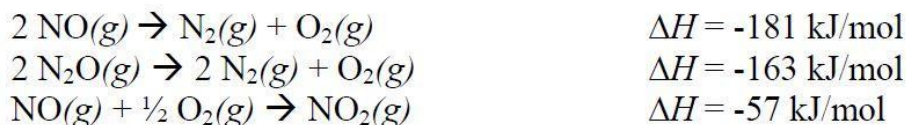
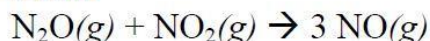
Reaction	Enthalpy(ΔH)
$3 \text{C}_{(\text{graphite})} + 3 \text{O}_2(g) \rightarrow 3 \text{CO}_2(g)$	$3 \times (-393.5 \text{ kJ/mol})$
$2 \text{Fe}_2\text{O}_3(s) \rightarrow 4 \text{Fe}(s) + 3 \text{O}_2(g)$	$-0.5 \times (-3296.8 \text{ kJ/mol})$
$3 \text{C}_{(\text{graphite})} + 2 \text{Fe}_2\text{O}_3(s) \rightarrow 4 \text{Fe}(s) + 3 \text{CO}_2(g)$	$\Delta H_{\text{rxn}} = 467.9 \text{ kJ/mol}$

- 2) Determine the value of the enthalpy change, ΔH_{vap} , for the evaporation of one mole of water using the information below. $\text{H}_2\text{O}(l) \rightarrow \text{H}_2\text{O}(g)$



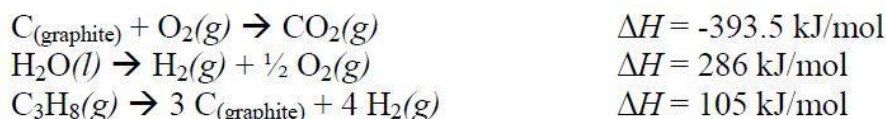
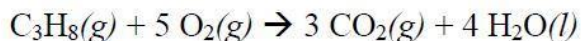
Reaction	Enthalpy (ΔH)
$1/2 \text{CO}_2(g) + \text{H}_2\text{O}(l) \rightarrow 1/2 \text{CH}_4(g) + \text{O}_2(g)$	$-0.5 \times (-890.5 \text{ kJ/mol})$
$1/2 \text{CH}_4(g) + \text{O}_2(g) \rightarrow 1/2 \text{CO}_2(g) + \text{H}_2\text{O}(g)$	$0.5 \times (-802.3 \text{ kJ/mol})$
$\text{H}_2\text{O}(l) \rightarrow \text{H}_2\text{O}(g)$	$\Delta H_{\text{vap}} = 44.1 \text{ kJ/mol}$

- 3) Determine the value of the enthalpy change, ΔH_{rxn} , for the following reaction using the information below.



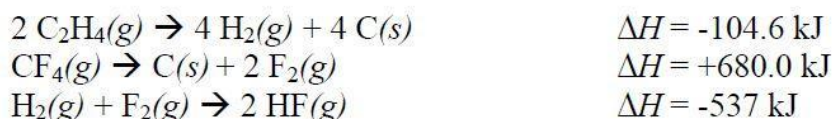
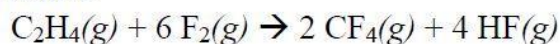
Reaction	Enthalpy(ΔH)
$\text{N}_2\text{O}(g) \rightarrow \text{N}_{2(g)} + 1/2 \text{O}_{2(g)}$	$(-163 \text{ kJ/mol}) \div 2$
$\text{NO}_{2(g)} \rightarrow \text{NO}_{(g)} + 1/2 \text{O}_{2(g)}$	$(-1)(-57 \text{ kJ/mol})$
$\text{N}_{2(g)} + \text{O}_{2(g)} \rightarrow 2 \text{NO}_{(g)}$	$(-1)(-181 \text{ kJ/mol})$
$\text{N}_2\text{O}_{(g)} + \text{NO}_{2(g)} \rightarrow 3 \text{NO}_{(g)}$	$\Delta H_{\text{rxn}} = 157 \text{ kJ/mol}$

- 4) Determine the value of the enthalpy change, ΔH_{rxn} , for the following reaction using the information below.



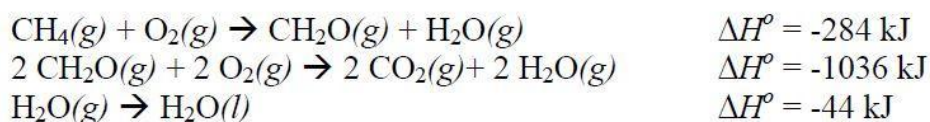
Reaction	Enthalpy(ΔH)
$\text{C}_3\text{H}_{8(g)} \rightarrow 3 \text{C}_{(\text{graphite})} + 4 \text{H}_{2(g)}$	105 kJ/mol
$4 \text{H}_{2(g)} + 2 \text{O}_{2(g)} \rightarrow 4 \text{H}_2\text{O}_{(l)}$	$-4 \times (286 \text{ kJ/mol})$
$3 \text{C}_{(\text{graphite})} + 3 \text{O}_2 \rightarrow 3 \text{CO}_2$	$3 \times (-393.5 \text{ kJ/mol})$
$\text{C}_3\text{H}_{8(g)} + 5 \text{O}_{2(g)} \rightarrow 3 \text{CO}_{2(g)} + 4 \text{H}_2\text{O}_{(l)}$	$\Delta H_{\text{rxn}} = -2220 \text{ kJ/mol}$

- 5) Determine the value of the enthalpy change, ΔH_{rxn} , for the following reaction using the information below.



Reaction	Enthalpy(ΔH)
$\text{C}_2\text{H}_2(g) \rightarrow 2\text{H}_2(g) + 2\text{C}(s)$	$-104.6 \text{ kJ/mol} \div 2$
$2\text{C}(s) + 4\text{F}_2(g) \rightarrow 2\text{CF}_4(g)$	$-2 \times (680.0 \text{ kJ/mol})$
$2\text{H}_2(g) + 2\text{F}_2(g) \rightarrow 4\text{HF}(g)$	$2 \times (-537 \text{ kJ/mol})$
$\text{C}_2\text{H}_2(g) + 6\text{F}_2(g) \rightarrow 2\text{CF}_4(g) + 4\text{HF}(g)$	$\Delta H_{\text{rxn}} = -2486 \text{ kJ/mol}$

- 6) Determine the value of the enthalpy change, $\Delta H^\circ_{\text{rxn}}$, for the following reaction using the information below.



Reaction	Enthalpy(ΔH)
$\text{CH}_{4(g)} + \text{O}_{2(g)} \rightarrow \text{CH}_2\text{O}_{(g)} + \text{H}_2\text{O}_{(g)}$	-284 kJ/mol
$\text{CH}_2\text{O}_{(g)} + \text{O}_{2(g)} \rightarrow \text{CO}_{2(g)} + \text{H}_2\text{O}_{(g)}$	$0.5 \times (-1036 \text{ kJ/mol})$
$2 \text{H}_2\text{O}_{(g)} \rightarrow 2 \text{H}_2\text{O}_{(l)}$	$2 \times (-44 \text{ kJ/mol})$
$\text{CH}_{4(g)} + 2 \text{O}_{2(g)} \rightarrow \text{CO}_{2(g)} + 2 \text{H}_2\text{O}_{(l)}$	$\Delta H_{\text{rxn}} = -8.90 \times 10^2 \text{ kJ/mol}$

- 7) Determine the value of the enthalpy change, $\Delta H^\circ_{\text{rxn}}$, for the following reaction using the information below.



Reaction	Enthalpy(ΔH)
$\text{C}_{(s)} + \text{O}_{2(g)} \rightarrow \text{CO}_{2(g)}$	-394 kJ/mol
$\text{CO}_{2(g)} \rightarrow \text{CO}_{(g)} + 1/2 \text{O}_{2(g)}$	$-0.5 \times (-566 \text{ kJ/mol})$
$\text{H}_2\text{O}_{(g)} \rightarrow \text{H}_{2(g)} + 1/2 \text{O}_{2(g)}$	$-0.5 \times (-484 \text{ kJ/mol})$
$\text{C}_{(s)} + \text{H}_2\text{O}_{(g)} \rightarrow \text{CO}_{(g)} + \text{H}_{2(g)}$	$\Delta H_{\text{rxn}} = 131 \text{ kJ/mol}$