Heat of Formation Review Problems

1. Given the equation $3\ O_2(g) \rightarrow 2\ O_3(g)$ $\Delta H = +285.4$ kJ, calculate for the reaction $O_3(g) \rightarrow 3/2\ O_2(g)$.

$\Delta H = -285.4 \div 2 = \boxed{-142.7\ kJ}$

2. What is the enthalpy change when 12.8 grams of H2(g) react with excess Cl2(g) to form HCl(g)?

$H_2(g) + Cl_2(g) \rightarrow 2\ HCl(g)$ $\Delta H = -184.6$ kJ

$\frac{12.8\ g\ H_2}{1} \times \frac{1\ mol\ H_2}{2.016\ g} \times \frac{-184.6\ kJ}{1\ mol\ H_2} = \boxed{-1170\ kJ}$

3. Write the heat of formation reaction for each of the following compounds. Include the heat of formation value as shown in the example, $C(s) + \frac{1}{2} O_2(g) \rightarrow CO(g)$ $\Delta H = -110.5$ kJ

Standard Enthalpies of Formation of Some Inorganic Substances at 25°C

SUBSTANCE	ΔH_f° (kJ/mol)	SUBSTANCE	ΔH_f° (kJ/mol)
Ag(s)	0	$H_2O_2(l)$	−187.6
AgCl(s)	−127.04	Hg(l)	0
Al(s)	0	$I_2(s)$	0
$Al_2O_3(s)$	−1669.8	HI(g)	25.94
$Br_2(l)$	0	Mg(s)	0
HBr(g)	−36.2	MgO(s)	−601.8
C(graphite)	0	$MgCO_3(s)$	−1112.9
C(diamond)	1.90	$N_2(g)$	0
CO(g)	−110.5	$NH_3(g)$	−46.3
$CO_2(g)$	−393.5	NO(g)	90.4
Ca(s)	0	$NO_2(g)$	33.85
CaO(s)	−635.6	$N_2O_4(g)$	9.66
$CaCO_3(s)$	−1206.9	$N_2O(g)$	81.56
$Cl_2(g)$	0	O(g)	249.4
HCl(g)	−92.3	$O_2(g)$	0
Cu(s)	0	$O_3(g)$	142.2
CuO(s)	−155.2	S(rhombic)	0
$F_2(g)$	0	S(monoclinic)	0.30
HF(g)	−268.61	$SO_2(g)$	−296.1
H(g)	218.2	$SO_3(g)$	−395.2
$H_2(g)$	0	$H_2S(g)$	−20.15
$H_2O(g)$	−241.8	ZnO(s)	−347.98
$H_2O(l)$	−285.8		

a. HF(g)

$\frac{1}{2} H_2(g) + \frac{1}{2} F_2(g) \rightarrow HF(g)$ $\Delta H = -268.61$ kJ

b. $N_2O_4(g)$

$N_2(g) + 2\ O_2(g) \rightarrow N_2O_4(g)$ $\Delta H = +9.66$ kJ

c. $MgCO_3(s)$

$Mg(s) + C(s) + \frac{3}{2} O_2(g) \rightarrow MgCO_3(s)$

(graphite) $\Delta H = -1112.9$ kJ

4. Calculate heat of reaction for the combustion of benzene, C_6H_6, given the ΔH_f of $C_6H_6(l)$ is +49.0 kJ.

$C_6H_6 + \frac{15}{2} O_2 \rightarrow 6\ CO_2 + 3\ H_2O$

$\Delta H_{rxn} = [6(-393.5\ kJ) + 3(-285.8\ kJ)] - [49.0\ kJ + 0] = \boxed{-3{,}270\ kJ}$

$\sum \Delta H_f$ Products $- \sum \Delta H_f$ Reactants

5. Calculate the heat of formation of octane, $C_8H_{18}(l)$, given the change in enthalpy for the combustion reaction is -5,074.9 kJ/mol.

$C_8H_{18} + \frac{25}{2} O_2 \rightarrow 8\ CO_2 + 9\ H_2O$ $\Delta H = -5{,}074.9$ kJ

$8\ C + 8\ O_2 \rightarrow 8\ CO_2$ $8(-393.5)$

$9\ H_2 + \frac{9}{2} O_2 \rightarrow 9\ H_2O$ $9(-285.8)$

$8\ CO_2 + 9\ H_2O \rightarrow C_8H_{18} + \frac{25}{2} O_2$ $+5{,}074.9$

$8\ C(s) + 9\ H_2(g) \rightarrow C_8H_{18}(l)$ $\boxed{-645.3\ kJ}$