Honors Chemistry

Answers to More Chapter 6 Study Questions

1. a) From the $\Delta H_f°$ Table:

(i) $0.5\ H_2(g) + 0.5\ Br_2(l) \rightarrow HBr(g) \quad \Delta H = -36.2$ kJ

(ii) $0.5\ H_2(g) + 0.5\ Cl_2(g) \rightarrow HCl(g) \quad \Delta H = -92.3$ kJ

2 x (i) = $H_2(g) + Br_2(l) \rightarrow 2\ HBr(g) \quad \Delta H = 2(-36.2) = -72.4$ kJ

-2 x (ii) = $2\ HCl(g) \rightarrow H_2(g) + Cl_2(g) \quad \Delta H = -2(-92.3) = 184.6$ kJ

overall reaction: $2\ HCl(g) + Br_2(l) \rightarrow 2\ HBr(g) + Cl_2(g) \quad \Delta H = -72.4 + 184.6 = 112.2$ kJ endothermic

b) (i) $0.5\ N_2(g) + 1.5\ H_2(g) \rightarrow NH_3(g) \quad \Delta H = -46.2$ kJ

(ii) $H_2(g) + 0.5\ O_2(g) \rightarrow H_2O(l) \quad \Delta H = -285.8$ kJ

-4 x (i) $4\ NH_3(g) \rightarrow 2\ N_2(g) + 6\ H_2(g) \quad \Delta H = -4(-46.2) = 184.8$ kJ

6 x (ii) $6\ H_2(g) + 3\ O_2(g) \rightarrow 6\ H_2O(l) \quad \Delta H = 6(-285.8) = -1715$ kJ

overall reaction: $4\ NH_3(g) + 3\ O_2(g) \rightarrow 2\ N_2(g) + 6\ H_2O(l) \quad \Delta H = 184.8 - 1715 = -1530$ kJ exothermic

c) (i) $N_2(g) + 2\ H_2(g) \rightarrow N_2H_4(l) \quad \Delta H = +50.6$ kJ

(ii) $0.5\ N_2(g) + O_2(g) \rightarrow NO_2(g) \quad \Delta H = +33.9$ kJ

(iii) $H_2(g) + 0.5\ O_2(g) \rightarrow H_2O(l) \quad \Delta H = -285.8$ kJ

-1 x (i) $N_2H_4(l) \rightarrow N_2(g) + 2\ H_2(g) \quad \Delta H = -50.6$ kJ

2 x (ii) $N_2(g) + 2\ O_2(g) \rightarrow 2\ NO_2(g) \quad \Delta H = 2(33.9) = 67.8$ kJ

2 x (iii) $2\ H_2(g) + O_2(g) \rightarrow 2\ H_2O(l) \quad \Delta H = 2(-285.8) = -571.6$ kJ

overall reaction: $N_2H_4(g) + 3\ O_2(g) \rightarrow 2\ NO_2(g) + 2\ H_2O(l) \quad \Delta H = -554.4$ kJ exothermic

2. a) $488\ kJ \times \dfrac{2\ mol\ P}{574\ kJ} = 1.70$ moles P

b) $122\ g\ PCl_3 \times \dfrac{1\ mol\ PCl_3}{137.3\ g\ PCl_3} \times \dfrac{574\ kJ}{2\ mol\ PCl_3} = 255$ kJ

c) $27.0\ kJ \times \dfrac{3\ mol\ Cl_2}{574\ kJ} \times \dfrac{70.9\ g\ Cl_2}{1\ mol\ Cl_2} = 10.0\ g\ Cl_2$

3. Q (J) = specific heat (J/g °C) x mass (g) x ΔT (°C); $\Delta T = 23.36 - 25.00 = -1.64$°C.

Q = 4.18 J/g °C x 50.0 g x (–1.64°C) = –343 joules

$1\ mole\ KClO_3 \times \dfrac{122.6\ g\ KClO_3}{1\ mol\ KClO_3} \times \dfrac{343\ joules}{1.00\ g\ KClO_3} = 42{,}100$ joules = 42.1 kJ

$\Delta H = +42.1$ kJ

4. $2\ C_6H_6(l) + 15\ O_2(g) \rightarrow 12\ CO_2(g) + 6\ H_2O(l)$

(i) $6\ C(s) + 3\ H_2(g) \rightarrow C_6H_6(l)$ $\Delta H = +48.5$ kJ
(ii) $C(s) + O_2(g) \rightarrow CO_2(g)$ $\Delta H = -393.5$ kJ
(iii) $H_2(g) + 0.5\ O_2(g) \rightarrow H_2O(l)$ $\Delta H = -285.8$ kJ

-2 x (i) $2\ C_6H_6(l) \rightarrow 12\ C(s) + 6\ H_2(g)$ $\Delta H = -2(+48.5) = -97.0$ kJ
12 x (ii) $12\ C(s) + 12\ O_2(g) \rightarrow 12\ CO_2(g)$ $\Delta H = 12(-393.5) = -4722$ kJ
6 x (iii) $6\ H_2(g) + 3\ O_2(g) \rightarrow 6\ H_2O(l)$ $\Delta H = 6(-285.8) = -1715$ kJ

overall reaction: $2\ C_6H_6(l) + 15\ O_2(g) \rightarrow 12\ CO_2(g) + 6\ H_2O(l)$ $\Delta H = -6534$ kJ

5. Given: $P(s) + 1.5\ H_2(g) \rightarrow PH_3(g)$ $\Delta H = +9.2$ kJ
Find $\Delta H_f^\circ(P_4H_{10}) = x$

overall reaction: $4\ PH_3(g) + 8\ O_2(g) \rightarrow P_4O_{10}(s) + 6\ H_2O(g)$ $\Delta H = -4500$ kJ

(i) $P(s) + 1.5\ H_2(g) \rightarrow PH_3(g)$ $\Delta H = +9.2$ kJ
(ii) $4\ P(s) + 5\ O_2(g) \rightarrow P_4O_{10}(s)$ $\Delta H = x$
(iii) $H_2(g) + 0.5\ O_2(g) \rightarrow H_2O(g)$ $\Delta H = -241.8$ kJ

-4 x (i) $4\ PH_3(g) \rightarrow 4\ P(s) + 6\ H_2(g)$ $\Delta H = -4(9.2) = -36.8$ kJ
1 x (ii) $4\ P(s) + 5\ O_2(g) \rightarrow P_4O_{10}(s)$ $\Delta H = x$
6 x (iii) $6\ H_2(g) + 3\ O_2(g) \rightarrow 6\ H_2O(g)$ $\Delta H = 6(-241.8) = -1451$ kJ

overall reaction: $4\ PH_3(g) + 8\ O_2(g) \rightarrow P_4O_{10}(s) + 6\ H_2O(g)$ $\Delta H = -4500$ kJ
-4500 kJ $= (-36.8 + x + -1451)$ kJ; $x = -4500 + 36.8 + 1451$ kJ $= -3012$ kJ

$\Delta H_f^\circ(P_4H_{10}) = -3012$ kJ