INS – CHEMISTRY WORKSHOP – WEEK 1 – SPRING

(1)

22.0°C
90.0g
cold

55.0°C
hot

37°C
final

heat absorbed by cold water = heat given off by hot water

$$m_{cold} \, c_{cold} \, \Delta T = m_{hot} \, c_{hot} \, \Delta T$$

$$(90.0g)(\cancel{4.184J \, g^{-1} K^{-1}})(15K) = m_{hot} (\cancel{4.184J \, K^{-1} g^{-1}})(18K)$$

$$m_{hot} = \frac{(90.0g)(15K)}{(18K)} = \underline{\underline{75.0g}}$$

(2) heat given off by (Al + Fe) = heat absorbed by water

$$m_{Al} \, c_{Al} \, (\Delta T)_{Al} + m_{Fe} \, c_{Fe} \, (\Delta T)_{Fe} = m_{water} \, c_{water} \, (\Delta T)_{water}$$

T_f = final tempt. of all materials in °C

$$\left.\begin{aligned} &(5.00g)(0.89 J \, °C^{-1} g^{-1})(100 - T_f)°C + \\ &(10.00g)(0.45 J \, °C^{-1} g^{-1})(100 - T_f)°C \end{aligned}\right\} = (97.3g)(4.184 J \, °C^{-1} g^{-1})(T_f - 22)°C$$

$$(4.45 + 4.5)\cancel{J} \, [100 - T_f] = 407.10 \, \cancel{J} \, (T_f - 22)$$

$$895 - 8.95 T_f = 407.10 T_f - 8956.27$$

$$9851.27 = 416.05 T_f$$

$$T_f = \underline{23.68°C}$$

(3) Heat absorbed by bomb calorimeter $\Bigg\} = (1.56\ kJ\ ^\circ C^{-1})(3.2\ ^\circ C)$

$= 4.992\ kJ$

= heat given off by burning 0.1964 g of quinone

$\therefore$ Energy of combustion per gram of quinone $\Bigg\} = \dfrac{4.992\ kJ}{0.1964\ g} = \underline{\underline{25.418\ kJ/g}}$

quinone molar mass $= [6(12.01) + 4(1.008) + 2(16)]\ g/mol$

$= 228.192\ g/mol$

Energy of combustion per mole of quinone $\Bigg\} = 4.992\ kJ \times \left(\dfrac{228.192 g}{0.1964 g} \times \dfrac{1}{mol}\right)$

$= \underline{\underline{5799.27\ kJ/mol}}$

(4)

	ΔH (kJ)
$\frac{1}{2}(2ClF(g) + O_2(g) \longrightarrow Cl_2O(g) + F_2O(g))$	$167.4 \times \frac{1}{2}$
$\frac{1}{2}(Cl_2O(g) + 3F_2O(g) \longrightarrow 2ClF_3(g) + 2O_2(g))$	$-341.4 \times \frac{1}{2}$
$\frac{1}{2}(2F_2(g) + O_2(g) \longrightarrow 2F_2O(g))$	$-43.4 \times \frac{1}{2}$

$$\left.\begin{array}{l} ClF(g) + \cancel{\tfrac{3}{2}O_2(g)} + \\ \cancel{\tfrac{1}{2}Cl_2O(g)} + \cancel{\tfrac{3}{2}F_2O(g)} + F_2(g) \end{array}\right\} \longrightarrow \begin{array}{l} \cancel{\tfrac{1}{2}Cl_2O(g)} + \cancel{\tfrac{3}{2}F_2O(g)} \\ + ClF_3(g) + \cancel{O_2(g)} \end{array}$$

$$ClF(g) + F_2(g) \longrightarrow ClF_3(g)$$

$$\Delta H_{rn} = \frac{1}{2}(167.4) + \frac{1}{2}(-341.4) + \frac{1}{2}(-43.4)\ kJ$$

$$\Delta H_{rn} = \underline{\underline{-108.7\ kJ}}$$

(4)

			$\underline{\underline{\Delta H (kJ)}}$
$C_6H_4(OH)_2\ (aq)$	$\longrightarrow$	$C_6H_4O_2(aq) + H_2(g)$	177.4
$H_2O_2(aq)$	$\longrightarrow$	$H_2(g) + O_2(g)$	$+191.2$
$2\left[H_2(g) + \frac{1}{2}O_2(g)\right.$	$\longrightarrow$	$\left.H_2O(g)\right]$	-241.2×2
$2\left[H_2O(g)\right.$	$\longrightarrow$	$\left.H_2O(l)\right]$	-43.8×2

+

$$\left.\begin{matrix} C_6H_4(OH)_2\ (aq) + H_2O_2(aq) + \\ \cancel{2H_2(g)} + \cancel{O_2(g)} + \cancel{2H_2O(g)} \end{matrix}\right\} \rightarrow \begin{matrix} C_6H_4O_2(aq) + \cancel{2H_2(g)} + \cancel{O_2(g)} \\ + \cancel{2H_2O(g)} + 2H_2O(l) \end{matrix}$$

$$C_6H_4(OH)_2\ (aq) + H_2O_2(aq) \longrightarrow C_6H_4O_2(aq) + 2H_2O(l)$$

$$\Delta H_{rn} = \left[177.4 + 191.2 + 2(-241.2) + 2(-43.8)\right] kJ$$

$$= \underline{\underline{-201.4\ kJ}}$$

(5) $\Delta H_{rn}^{\theta} = 6\Delta H_f^{\theta}[NO(g)] + 6\Delta H_f^{\theta}[H_2O(g)] - 4\Delta H_f^{\theta}[NH_3(g)] - 5\Delta H_f^{\theta}[O_2(g)]$

$= [6(90.29) + 6(-241.83) - 4(-45.90) - 5(0)]$ kJ

$= -725.64$ kJ

$\Delta H_{rn}^{\theta} = 2\Delta H_f^{\theta}[NO_2(g)] - 2\Delta H_f^{\theta}[NO(g)] - \Delta H_f^{\theta}[O_2(g)]$

$= [2(33.1) - 2(90.29) - 0]$ kJ

$= -114.38$ kJ

$\Delta H_{rn}^{\theta} = 4\Delta H_f^{\theta}[HNO_3(aq)] + \Delta H_f^{\theta}[NO(g)] - 3\Delta H_f^{\theta}[NO_2(g)] - \Delta H_f^{\theta}[H_2O(l)]$

$= 4(-207.36) + 90.29 - 3(33.1) - (-285.83)$ k

$= -552.62$ kJ

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