1.

| | $C_7H_6O_3$ | $+7O_{2(g)}$ | $\longrightarrow$ | $7CO_{2(g)}$ | $+ 3H_2O_{(l)}$ |
|---|---|---|---|---|---|
| $\Delta H_f$ | $-585.3$ | $0$ | | $-393.5$ | $-241.8$ |

**BCE**

$$\Delta H = \Sigma n \Delta H_{f\,prod} - \Sigma n \Delta H_{f\,react}$$

$$\Delta H_{comb} = \frac{\Delta H}{n}$$

**System**

$m = 3.16\ g$

$M = 138.13\ g/mol$

$\Delta H_{comb} = \_\_\_$

**Surrounding - $H_2O$**

$m = 5.00\ Kg$

$c = 4.184\ KJ/kg°C$

$T_1 = 23°C$

$T_2 = \_\_\_$ } $\Delta T = \_\_\_$

$\Delta H = -q$ exothermic

$\Delta H = n \Delta H_{comb}$ $\quad q = mc\Delta T$

$= \frac{m}{M} \Delta H_{comb}$

**BCE**

$$\Delta H = \left[\left(7\,mol\,CO_2 \times -393.5\,\frac{KJ}{mol}\right) + \left(3\,mol\,H_2O\right)\left(-241.8\,\frac{KJ}{mol}\right)\right] - \left[\left(1\,mol\,C_7H_6O_3 \times -585.3\,\frac{KJ}{mol}\right) + \left(7\,mol\,O_2 \times 0\,\frac{KJ}{mol}\right)\right]$$

$$= -2754.5\,KJ + -725.4\,KJ - (-585.3\,KJ)$$

$$\Delta H = -2894.6\,KJ$$

$$\Delta H_{comb} = \frac{\Delta H}{n} = \frac{-2894.6\ KJ}{1\,mol\,C_7H_6O_3}$$

$$\left(\frac{M}{M}\right)\Delta H_{comb} = -mc\Delta T$$

$$\left(3.16\,g\,C_7H_6O_3\right)\left(\frac{1\,mol\,C_7H_6O_3}{138.13\,g\,C_7H_6O_3}\right)\left(\frac{-2894.6\,KJ}{1\,mol\,C_7H_6O_3}\right) = -(5.00\,Kg)\left(4.184\,\frac{KJ}{Kg°C}\right)\Delta T$$

$$\Delta T = 3.17°C$$

$$T_2 = T_1 + \Delta T$$

$$\boxed{T_2 = 26.2°C}$$

2. $C_{10}H_{22} + \frac{31}{2} O_2 \longrightarrow 10CO_{2(g)} + 11H_2O_{(g)}$

$\Delta H_f$ $\quad x \quad 0 \quad -393.5 \quad -241.8$

| System - $C_{10}H_{22}$ | Suround - $H_2O$ |
|---|---|
| $m = 6620\,g$ | $m = 1.25\,kg$ |
| $M = 142.32$ | $c = 4.184\,KJ/kg^\circ C$ |
| $\Delta H_{comb} =$ ____ | $T_1 = 24.6^\circ C$, $T_2 = 26.4^\circ C$, $\Delta T = 1.8^\circ C$ |

BCE

$\Delta H = n\,\Delta H_{comb}$

$\Delta H = \Sigma n \Delta H_{f\,prod} - \Sigma n \Delta H_{f\,react}$

$\Delta H = -q$ exothermic

$\Delta H_{comb} = \frac{\Delta H}{n}$ $\quad q = mc\Delta T$

$q = (1.25\,kg)(4.184\,KJ/kg^\circ C)(1.8^\circ C)$

$= 9.414\,KJ$

$\Delta H = -q$

$= -9.414\,KJ$

$\Delta H_{comb} = -9.414\,KJ \times \frac{142.32\,g}{1\,mol\,C_{10}H_{22}} \times \frac{1}{6.620\,g}$

$\Delta H_{comb} = -202.4\,\frac{KJ}{mol}$

$\Delta H = n\,\Delta H_{comb}$

$= (1\,mol\,C_{10}H_{22})(-202.4\,\frac{KJ}{mol})$

$= -202.4\,KJ$

$$-202.4\,KJ = \left[\left(10\,mol\,CO_2 \times -393.5\,\tfrac{KJ}{mol}\right) + \left(11\,mol\,H_2O \times -241.8\,\tfrac{KJ}{mol}\right)\right] - \left[(1\,mol\,C_{10}H_{22})(x) + \left(\tfrac{31}{2}\,mol\,O_2 \times 0\,\tfrac{KJ}{mol}\right)\right]$$

$$-202.4\,KJ = [-3935\,KJ + -2659.8\,KJ] - [(mol\,C_{10}H_{22})(x)]$$

$$(1\,mol\,C_{10}H_{22})(x) = -6594.8 + 202.4$$

$$\Delta H_f = -6392.4\,\frac{KJ}{mol\,C_{10}H_{22}}$$

3.

| Pb | $H_2O$ |
|---|---|
| $m = 436g$ | $m = 50.0g$ |
| $c =$ ____ | $c = 4.184\ J/g^\circ C$ |
| $T_1 = 100^\circ C$ | $T_1 = 25.0^\circ C$ |
| $T_2 = 40.8^\circ C$ | $T_2 = 40.8^\circ C$ |

$$|q_{lost}| = |q_{gain}|$$

$q = mc\Delta T$ $\qquad$ $q = mc\Delta T$

$$(436g)(c)(59.2^\circ C) = (50.0g)(4.184\ J/g^\circ C)(15.8^\circ C)$$

$$c = 0.128\ J/g^\circ C$$

4. $C_{10}H_{8(s)} + 12O_{2(g)} \longrightarrow 10CO_{2(g)} + 4H_2O_{(g)}$

| | | | | | |
|---|---|---|---|---|---|
| $\Delta H_f$ | x | 0 | -393.5 | -241.8 | $\Delta H_{comb} = -5156.8 \frac{kJ}{mol}$ |

$$\Delta H = n\Delta H_{comb}$$

$$\Delta H = \sum n\Delta H_{f\,prod} - \sum n\Delta H_{f\,react}$$

$$\Delta H = (1 mol\ C_{10}H_8)(-5156.8 \tfrac{kJ}{mol})$$

$$\Delta H = -5156.8\ kJ$$

$$-5156.8\ kJ = \left[\left(10 mol\ CO_2 \times -393.5 \tfrac{kJ}{mol}\right) + \left(4 mol\ H_2O \times -241.8 \tfrac{kJ}{mol}\right)\right] - \left[(1 mol\ C_{10}H_8)\Delta H_f + \left(12 mol\ O_2 \times 0 \tfrac{kJ}{mol}\right)\right]$$

$$\Delta H_f = 254.6 \frac{kJ}{mol\ C_{10}H_8}$$

System $C_{10}H_8$

$m = 18.0g$

$M = 128.18 g/mol$

$\Delta H_{comb} = -5156.8 \frac{kJ}{mol}$

Surrounding - $H_2O$

$m = 0.250 kg$

$C = 4.184\ kJ/kg°C$

$T_i = 25°C$

$\Delta H = -q$ exothermic

$\Delta H = n\Delta H_{comb}$ $q = mc\Delta T$

$$\Delta H = 18.0g \times \frac{1 mol}{128.18g} \times -5156.8 \frac{kJ}{mol}$$

$$\Delta H = -724.2\ kJ$$

$$q = 724.2\ kJ$$

$$(0.250 kg)(4.184 \tfrac{kJ}{kg°C})\Delta T = 724.2 kJ$$

$$\Delta T = 692°C$$

↑ indicates state change

$\therefore \Delta H = -q_T$

$q_T = q_1 + q_2 + q_3$

$25°C \rightarrow 100°C$

$q = mc\Delta T$

$= (0.25 kg)(4.184\ kJ/kg°C)(75°C)$

$= 78.45\ kJ$

$l \rightarrow g$

$q = n\Delta h_v$

$= 250g \times \frac{1 mol}{18.0g} \times 40.8 \frac{kJ}{mol}$

$= 566.04\ kJ$

$q_3 = q_T - q_1 - q_2$

$= 724.2 - 78.45 - 566.04 = 79.71 kJ$

$\therefore 79.7 kJ$ to heat $H_2O_{(g)}$

$100°C \rightarrow$

$79.7 kJ = (0.25 kg)(2.01 \tfrac{kJ}{kg°C})\Delta T$

$\Delta T = 158.6°C$

$T_F = 100°C + \Delta T$

$T_F = 258.6°C$

5. $PCl_{3(g)} + \frac{1}{2}O_{2(g)} \rightarrow POCl_{3(g)}$

$\Delta H_f$ $-287.0$ $0$ $x$

System – $PCl_3$

$m = 0.250g$

$M = 137.32 g/mol$

$\Delta H_{comb} = $ ___

Surround – $H_2O$

$m = 0.100 Kg$

$C = 4.184\ KJ/Kg°C$

$\Delta T = 3.44°C$

$\Delta H = -q$ exothermic

$\Delta H = -(0.1kg)(4.184 \frac{KJ}{Kg°C})(3.44°C)$

$= -1.44\ KJ$

$q = mC\Delta T$

$\Delta H_{comb} = \frac{\Delta H}{n}$

$\Delta H_{comb} = \frac{137.32g}{1mol} \times \frac{1}{0.250g} \times -1.44KJ$

$= -790.6 \frac{KJ}{mol}$

BLE

$\Delta H = \sum n \Delta H_{f\,prod} - \sum n \Delta H_{f\,react}$

$\Delta H = n\ \Delta H_{comb}$

$= (1 mol\ PCl_3)(-790.6 \frac{KJ}{mol\ PCl_3})$

$= -790.6\ KJ$

$-790.6KJ = [(1 mol\ POCl_3)(x)] - [(1 mol\ PCl_3)(-287.0 \frac{KJ}{mol}) + (\frac{1}{2} mol\ O_2)(0 \frac{KJ}{mol})]$

$\Delta H_f = -1077.6 \frac{KJ}{mol\ POCl_3}$

6. $2\ NO_{2(g)} \longrightarrow N_2O_{4(g)}$

| | | |
|---|---|---|
| $\Delta H_f$ | 34.0 KJ | x |

a) $\Delta H = n\,\Delta H_{rxn}$ $\quad\quad$ $\Delta H = \Sigma n \Delta H_{f\,prod} - \Sigma n \Delta H_{f\,react}$

$\Delta H = (2\ mol\ NO_2)\left(-57.20 \frac{KJ}{mol}\right)$

$= -114.4\ KJ$

$-114.4 = [(1\ mol\ N_2O_4)\Delta H_f] - [(2\ mol\ NO_2)(34.0 \frac{KJ}{mol})]$

$\Delta H_f = 46.4 \frac{KJ}{mol\ N_2O_4}$

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b) system

$m = \_\_\_\_\_\ g$

$M = 46.01\ g/mol$

$\Delta H_{rxn} = -57.20\ KJ/mol$

surround

$m = 50.7\ g$

$c = 4.184\ J/g^\circ C$

$T_1 = 56.7^\circ C$ ← state change

$T_F = 112^\circ C$

$\Delta H = -q_T$ exothermic

$\Delta H = n\,\Delta H_{rxn}$

$q_T = q_1 + q_2 + q_3$ ← to 112°C

↑ to 100°C ↑ vaporize

$q_1$

$q = mc\Delta T$

$= (50.7g)(4.184\ J/g^\circ C)(43.3^\circ C)$

$= 9185\ J$

$= 9.185\ KJ$

$q_2$

$q = n\,\Delta h_v$

$= 50.7g \times \frac{1mol}{18.02g} \times 40.8 \frac{KJ}{mol}$

$= 114.8\ KJ$

$q_3$

$q = mc\Delta T$

$= (50.7g)(2.01\ J/g^\circ C)(12^\circ C)$

$= 1222.9\ J$

$= 1.223\ KJ$

$q_T = 9.2\ KJ + 1.2KJ + 114.8$

$= 125.2KJ$

$\Delta H = -125.2\ KJ$

$m \times \frac{1mol\ NO_2}{46.01g} \times -57.20 \frac{KJ}{mol} = -125.2\ KJ$

$m = 100.7g$

$m = 100g$