Example-1

A 75 g piece of Ag metal is heated to 80°C and dropped into 50 g of water at 23.2°C. The final temperature of the Ag-H_2O mixture is 27.6°C. What is the specific heat of silver?

(specific heat of water 4.18 J/g°C)

Ag

$m = 75\ g$

$T_i = 80°C$

$T_f = 27.6°C$

$C_p = ?$

H_2O

$m = 50\ g$

$T_i = 23.2°C$

$T_f = 27.6°C$

$C_p = 4.18$

$$q_{Ag} = -q_{H_2O}$$

$$\underbrace{m \cdot c \cdot \Delta T}_{Ag} = -\underbrace{m \cdot c \cdot \Delta T}_{H_2O}$$

$$75 \times c \times (27.6 - 80) = -50 \times 4.18 \times (27.6 - 23.2)$$

$$c_{Ag} = \frac{-50 \times 4.18 \times (27.6 - 23.2)}{75 \times (27.6 - 80)} = 0.234\ J/g°C$$

Example-2

Given the following information:

$2\times \quad \frac{1}{2}N_2(g) + \frac{3}{2}H_2(g) \rightarrow NH_3(g) \qquad \Delta H^o{}_1$

$2\times \quad NH_3(g) + \frac{5}{4}O_2(g) \rightarrow NO(g) + \frac{3}{2}H_2O(l) \qquad \Delta H^o{}_2$

$-3\times \quad H_2(g) + \frac{1}{2}O_2(g) \rightarrow H_2O(l) \qquad -\Delta H^o{}_3$

Determine the ΔH^o for the following reaction, expressed in terms of $\Delta H^o{}_1, \Delta H^o{}_2$ and $\Delta H^o{}_3$.

$$N_2(g) + O_2(g) \rightarrow 2NO(g) \qquad \Delta H^o$$

$N_2 + 3H_2 \longrightarrow 2NH_3 \qquad 2\Delta H^\circ_1$

$2NH_3 + \frac{5}{2}O_2 \longrightarrow 2NO + 3H_2O \qquad 2\Delta H^\circ_2$

$3H_2O \longrightarrow 3H_2 + \frac{3}{2}O_2 \qquad -3\Delta H^\circ_3$

$N_2 + O_2 \longrightarrow 2NO$

$\Delta H = 2\Delta H^\circ_1 + 2\Delta H^\circ_2 - 3\Delta H^\circ_3$

Example-3

A bomb calorimetry experiment is performed with xylose, $C_5H_{10}O_5(s)$, as the combustible substance. The data obtained are

Combustion

exo → -ve

Mass of xylose burned:	1.183 g
Heat capacity of calorimeter:	4.728 kJ/°C
Initial calorimeter temperature:	23.39°C
Final calorimeter temperature:	27.19°C

What is the heat of combustion of xylose, in kilojoules per mole?

ΔH

(Xylose: 150.13 g/mol)

$q = m \cdot c \cdot \Delta T$

$= 1.183 \times 4.728 \times (27.19 - 23.39)$

$= -17.97$ kj

$\Delta H = \frac{q}{n} = \frac{-17.97}{0.007879} = -2280.7$ kj/mol

$n = \frac{m}{Mr} = \frac{1.183}{150.13} = 0.007879$ mol

Example-4

A 3.57 g sample of a KCl-$KClO_3$ mixture is decomposed by heating and produces 119 mL O_2 (g) measured at 22.4°C and 738 mmHg. What is the mass percent of $KClO_3$ in the mixture? ($KClO_3$: 122.6 g/mol)

$$2X \quad 2KClO_3 \longrightarrow 3O_2 + 2KCl.$$

O_2

$$V = \frac{119}{1000} \text{ ml} = 0.119 \text{ L}$$

$$T = 22.4^\circ C + 273 = 295.4 \text{ K}$$

$$P = \frac{738}{760} \text{ mmHg} = 0.97 \text{ atm}$$

$$R = 0.0821$$

$$PV = nRT$$

$$n_{O_2} = \frac{PV}{RT} = \frac{0.97 \times 0.119}{0.0821 \times 295.4} = 0.004759 \text{ mol.}$$

$$n_{KClO_3} = \frac{0.004759 \times 2}{3}$$

$$= 0.00317 \text{ mol}$$

$KClO_3$	O_2
2	3
n	0.004759

$$n = \frac{2 \times 0.004759}{3}$$

$m_{KClO_3} = n \times M_r = 0.00317 \times 122.6 = 0.389\ g$

$\% m_{KClO_3} = \frac{m_{KClO_3}}{m_{sample}} \times 100$

$= \frac{0.389}{3.57} \times 100 = 10.89\%$

Example 5

- How many joules of work is done when 0.225 mol of N2 gas at 23°C is compressed to 1.5L in volume at 0.75atm pressure?

$w = ?\ j$

$n = 0.225\ mol$

$T = 23°C + 273 = 300\ K$

$V_f = 1.5\ L$

$P_i = 0.75\ atm$

$V_i = ?$ → $PV_i = nRT$

$P_f \rightsquigarrow P_{ext}$? → $P_1V_1 = P_2V_2$

$w = -P_{ext} \Delta V$

$* \quad P_iV_i = nRT$

$V_i = \frac{nRT}{P} = \frac{0.225 \times 0.0821 \times 300}{0.75} = 7.28\ L$

* $P_i V_i = P_f V_f$

$$P_f = \frac{P_i V_i}{V_f} = \frac{0.75 \times 7.28}{1.5} = 3.64 \text{ atm}$$

* $w = -P_{ext} \Delta V = -3.64 \times (1.5 - 7.28) \times 101$

$= 2124.96$ J