Thermochemistry/Practice-Calorimetry and Heat of Reaction/ Name: Key

Show all the work for the calculations and give the answers in the correct significant figures.

1) Calculate the heat capacity of a piece of iron if a temperature rise from 18 to 69 °C requires 672 J of heat. (Ans: 13 J/°C)

$\Delta T = 69 - 18 = 51°C$.

$q = C\Delta T$

$C = \frac{q}{\Delta T} = \frac{672}{51} = \boxed{13\ J/°C}$.

2) How much heat in KJ is required to raise the temperature of
   a) A 320.0 g of water from 15.0 to 96.0 °C? (Ans: 108 KJ)

$q = ms\Delta T$

$q = 320g \times \frac{4.18\ J}{g°C} \times (96-15)°C$

$= \boxed{108\ KJ}$

   b) And 74.3 g of ethanol from -36.4 to 44.5 °C? (Ans: 14.8 KJ)

$q = 74.3g \times \frac{2.46\ J}{g°C} \times (44.5-(-36.4))°C$

$= \boxed{14.8\ KJ}$

3) A 638 g block of lead initially at 27.0 °C absorbs 2044 J of heat. What is the final temperature of the lead block? (Ans: 52.0 °C)

$q = ms\Delta T$

$\Delta T = \frac{q}{ms} = \frac{2044\ J}{638g \times \frac{0.128\ J}{g°C}} = 25°C$.

$25°C = T_f - 27.0°C$.

$\boxed{T_f = 52°C}$

4) A 500.0 mL sample of 0.500 M NaOH at 20.00 °C is mixed with an equal volume of 0.500 M HCl at the same temperature in a foam cup calorimeter. The temperature rises to 23.21 °C. What is the ΔH of the reaction? (Ans: -53.5 KJ/mol)

total vol = 500 + 500 = 1000 mL ≡ 1000 g.

① $q_{cal} = MS\Delta T = 1000\,g\ soln \times \frac{4.18\,J}{g\,°C} \times (23.21-20)\,°C = 13.42\,kJ$

$q_{rxn} = -q_{cal} = -13.42\ kJ$.

② Calculate mols $0.5\,L \times \frac{0.5\,mol}{L} = 0.25\,mol\ NaOH \times \frac{1\,mol\ H_2O}{1\,mol\ NaOH} = 0.25\,mol$

③ molar ΔH = $\frac{-13.42\ kJ}{0.25\,mol} = \boxed{-53.7\ kJ}$

5) A 1.50 g sample of NH_4NO_3 (s) is added to 35.0 g of water in a foam cup calorimeter and stirred until dissolved. The temperature of the solution drops from 22.7 to 19.4 °C. What is the heat of solution of the NH_4NO_3? (Ans: +27 KJ/mol)

① $q_{cal} = MS\Delta T = 35\,g\,H_2O \times \frac{4.18\,J}{g\,°C} \times (19.4-22.7)\,°C = -483\,J$

② $q_{rxn} = -q_{cal} = +483\,J$ (endo)

$NH_4NO_3 = 80.05\,g/mol$

③ $\frac{483\,J}{1.5\,g\,NH_4NO_3} \times \frac{80.05\,g\ NH_4NO_3}{1\,mol} = \boxed{26\,kJ/mol}$.

6) Use the equations given to calculate the enthalpy change for the equation given below.

$2C\ (graphite) + O_2(g) \longrightarrow 2CO(g)$ ΔH = ? (Ans: -221.0 KJ)

Given:

a) $C(graphite) + O_2\ (g) \longrightarrow CO_2\ (g)$ ΔH = -393.5 KJ × 2

b) $2CO\ (g) + O_2\ (g) \longrightarrow 2CO_2\ (g)$ ΔH = -566.0 KJ inv

$2C + 2O_2 \longrightarrow 2CO_2$ $(-393.5) \times 2$

$2CO_2 \longrightarrow 2CO + O_2$ $+566.0$

$\boxed{-221.0\,kJ}$

7) Use the equations given to calculate the enthalpy change for the equation given below.

$2NO_2\ (g) \longrightarrow N_2O_4\ (g)$ $\quad \Delta H = ?$ (Ans: -24.0 KJ)

Given:

a) $N_2\ (g) + 2O_2\ (g) \longrightarrow N_2O_4\ (g)$ $\quad \Delta H = +9.2$ KJ – as is

b) $N_2\ (g) + 2O_2\ (g) \longrightarrow 2NO_2\ (g)$ $\quad \Delta H = +33.2$ KJ inv

$N_2 + 2O_2 \longrightarrow N_2O_4$ $\quad +9.2$ kJ

$2NO_2 \longrightarrow N_2 + O_2$ $\quad -33.2$ kJ

-24.0 kJ

8) Use the standard enthalpies of formation from the Appendix to calculate the standard enthalpy change for the following reactions.

a) $Al_2O_3\ (s) + 3H_2O(l) \longrightarrow 2Al(OH)_3(s)$ (Ans: ~~-19~~ 7698 KJ)

b) $C_2N_2\ (g) + 2O_2\ (g) \longrightarrow 2CO_2\ (g) + N_2\ (g)$ (Ans: -1095.9 KJ)

(a) $Al_2O_3 + 3H_2O \longrightarrow 2Al(OH)_3$

$(-1676) \quad 3(-2858) \quad (2\times -1276)$

$-1676 + (-8574) \quad (-2552)$

-10250

$\Delta H = \text{prod} - \text{react} = (-2552) - (-10250)$

$= +7698$ kJ

(b) $C_2N_2 + 2O_2 \longrightarrow 2CO_2 + N_2$

$(308.9) + 2(0) \quad 2(-393.5) + 0$

$308.9 \quad -787$

$\Delta H = \text{prod} - \text{react} = -787 - (308.9)$

$= -1095.9$ kJ