Stage 2 Chemistry — Thermochemistry Answers

1.

(a) releases energy
(b) releases energy
(c) absorbs energy

2. $C_6H_{12}O_{6(aq)} + 6O_{2(g)} \rightarrow 6CO_{2(g)} + 6H_2O_{(l)}$ $\Delta H = -2820 \text{ kJ mol}^{-1}$

3. (a)

(i) endothermic
(ii) exothermic
(iii) exothermic
(iv) endothermic

(b)

(i) iv (photosynthesis)
(ii) iii (C_2H_6)

4.

(a) $m = 100.0 \text{ g} \quad \Delta T = 22.2 \text{ °K}$

$E = mc\Delta T = 100.0 \times 4.18 \times 22.2 = 9.28 \text{ kJ released}$

(b)

$\text{HCl} + \text{NaOH} \rightarrow \text{NaCl} + \text{H}_2\text{O}$

Neither of the original solutions is in excess, so either volume/concentration combination can be used to find the number of moles.

$n = CV = 2.00 \times 0.0500 = 0.100 \text{ mol}$

$\Delta H = \frac{9.28}{0.100} = 92.8 \text{ kJ mol}^{-1}$

$\Delta H = -92.8 \text{ kJ mol}^{-1}$

(c) Polystyrene foam is a good insulator of heat, and heat lost to the outside of the beaker is heat not recorded during the experiment, which is undesirable.

(d) The temperature recorded assumes the heat energy is evenly distributed through the water.

5. (a) M = 56.1 g mol^{-1} so 100 ÷ 56.1 = 1.78 mol, so 1.78 × 55 = 98 kJ released

(b) $n_{HCl} = C_{HCl}V_{HCl} = 0.500 \times 0.200 = 0.100$ mol
$n_{KOH} = C_{KOH}V_{KOH} = 0.400 \times 0.300 = 0.120$ mol
So KOH is in excess, base the energy calculation on 0.100 mol
57.1 × 0.100 = 5.71 kJ released

(c) n = m÷ M = 50 ÷ 56.1 = 0.89 mol. 0.89 × 55 = 49 kJ
n = CV = 0.500 × 2 = 1.00. 1.00 × 57.1 = 57.1 kJ
Combining 500 mL of 2 mol L^{-1} potassium hydroxide with excess acid releases more heat.

6. (a) $NH_4NO_{3(s)} + aq \rightarrow NH_4^+{}_{(aq)} + NO_3^-{}_{(aq)}$ $\Delta H = +26.2 \text{ kJ mol}^{-1}$

(b) (i) $m = 3.00\text{ g} \quad M = 80.052\text{ g mol}^{-1}$

$$n = \frac{m}{M} = \frac{3.00}{80.052} = 3.75 \times 10^{-2}\text{ mol}$$

(ii) $m = 100.00\text{ g} \quad \Delta T = 21.4 - 19.3 = 2.1°\text{K}$

$$E = mc\Delta T = 100 \times 4.18 \times 2.1 = 878\text{ J} = 0.878\text{ kJ}$$

(iii) $$\frac{0.878}{3.75 \times 10^{-2}} = +23\text{ kJ mol}^{-1}$$

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(c) The calculated enthalpy is lower than the expected enthalpy, probably because not all heat absorbed was from the water, or because the water was heated up by the surroundings.