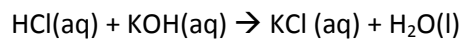


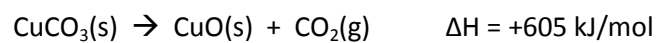
Energetics [S]

1. The neutralisation of hydrochloric acid by potassium hydroxide is exothermic.



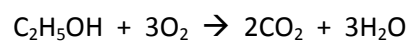
- a. Define the term *exothermic*: **[1]**
- b. In an experiment to determine ΔH for this reaction, 25cm^3 of 1M HCl was added to 25cm^3 of KOH. The temperature of the mixture rose from 24.5°C to 29.5°C .
- i. Calculate the energy used to heat the mixture if the specific heat capacity of water is 4.2 J/K/g : **[1]**
- ii. Calculate the number of moles of hydrochloric acid neutralized: **[1]**
- iii. Hence calculate the energy change per mole (ΔH) for this reaction: **[2]**
- iv. Suggest a reason why your value for ΔH is inaccurate and explain whether it is higher or lower than the true value: **[3]**

2. The thermal decomposition of copper(II) carbonate is strongly endothermic:



Draw an energy profile for this reaction: **[4]**

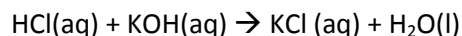
3. Calculate ΔH for the complete combustion of ethanol using the following bond energy data: **[3]**



C-H	+412 kJ/mol	C=O	+799 kJ/mol	C-C	+346 kJ/mol
O=O	+494 kJ/mol	O-H	+459 kJ/mol	C-O	+358 kJ/mol

Energetics [S]

1. The neutralisation of hydrochloric acid by potassium hydroxide is exothermic.



a. Define the term *exothermic*: [1]

releases/gives out (heat) energy [1]

b. In an experiment to determine ΔH for this reaction, 25cm^3 of 1M HCl was added to 25cm^3 of KOH. The temperature of the mixture rose from 24.5°C to 29.5°C .

i. Calculate the energy used to heat the mixture if the specific heat capacity of water is 4.2 J/K/g : [1]

$$E = mc\Delta T = 50 * 4.2 * 5 = 1050\text{ J [1]}$$

ii. Calculate the number of moles of hydrochloric acid neutralized: [1]

$$\text{moles} = \text{conc.} * \text{volume} = 1 * (25/1000) = 0.025\text{ mol [1]}$$

iii. Hence calculate the energy change per mole (ΔH) for this reaction: [2]

$$\Delta H = E(\text{in kJ})/\text{moles} = 1.050/0.025 = - 42\text{ kJ/mol}$$

[1] for number, [1] for minus sign and units

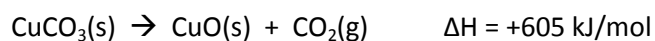
iv. Suggest a reason why your value for ΔH is inaccurate and explain whether it is higher or lower than the true value: [3]

Heat energy is lost to the surroundings... [1]

... so the water temperature doesn't rise as much as it should ... [1]

... so our value is lower than expected [1]

2. The thermal decomposition of copper(II) carbonate is strongly endothermic:



Draw an energy profile for this reaction: [4]

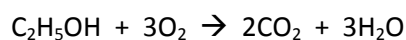
vertical energy/H axis labeled [1]

products energy level higher than reactants [1]

reactants and products identified on their energy levels with correct formulae [1]

ΔH labeled as difference between energy levels [1]

3. Calculate ΔH for the complete combustion of ethanol using the following bond energy data: [3]



C-H	+412 kJ/mol	C=O	+799 kJ/mol	C-C	+346 kJ/mol
O=O	+494 kJ/mol	O-H	+459 kJ/mol	C-O	+358 kJ/mol

$$\text{bonds broken} = 1(\text{C-C}) + 5(\text{C-H}) + 1(\text{C-O}) + 1(\text{O-H}) + 3(\text{O=O})$$

$$= +1(+346) + 5(+412) + 1(+358) + 1(+459) + 3(+494) = +4705 \text{ kJ/mol [1]}$$

$$\text{Bonds made} = 4(\text{C=O}) + 6(\text{O-H})$$

$$= 4(-799) + 6(-459) = -5950 \text{ kJ/mol [1]}$$

$$\Delta H = +4705 - 5950 = -1245 \text{ kJ/mol}$$