

APOLLO

Measuring enthalpy changes

HL

Chemistry

First assessment 2025

8 questions | questions

22. Which equation correctly shows **both** enthalpy of formation, $\Delta H^\ominus_f$, of a compound and enthalpy of combustion, $\Delta H^\ominus_c$, of its elements?

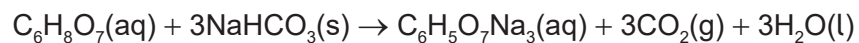
- A. $\text{CO(g)} + \frac{1}{2}\text{O}_2\text{(g)} \rightarrow \text{CO}_2\text{(g)}$
- B. $\frac{1}{2}\text{N}_2\text{(g)} + 1\frac{1}{2}\text{H}_2\text{(g)} \rightarrow \text{NH}_3\text{(g)}$
- C. $2\text{S(s)} + 3\text{O}_2\text{(g)} \rightarrow 2\text{SO}_3\text{(g)}$
- D. $\text{H}_2\text{(g)} + \frac{1}{2}\text{O}_2\text{(g)} \rightarrow \text{H}_2\text{O(l)}$

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Turn over

2220-0201

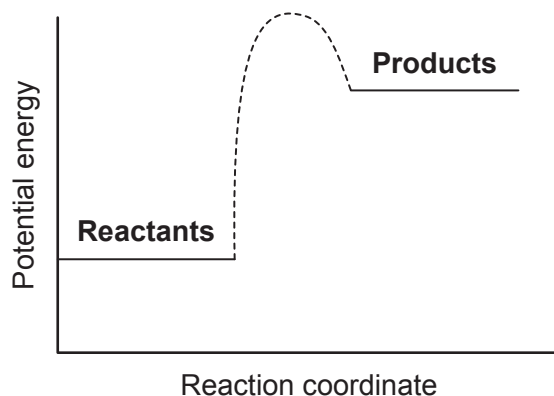
23. 0.050 mol of sodium hydrogencarbonate was added to 50 cm³ of 2.0 mol dm⁻³ solution of citric acid.



The initial temperature of the solution was 298 K and the final temperature was 297 K.
What is the enthalpy of this reaction in kJ mol⁻¹? ($c_w = 4.18 \text{ J g}^{-1} \text{ K}^{-1}$, $Q = mc\Delta T$)

- A. +4.18
- B. -4.18
- C. +12.5
- D. -12.5

18. What is the correct interpretation of this energy profile?



	Relative stability	Temperature of surroundings
A.	reactants more stable than products	decreases
B.	reactants more stable than products	increases
C.	reactants less stable than products	decreases
D.	reactants less stable than products	increases

— 3 —

2225-0213

20. Which statement about an exothermic reaction is correct?

- A. Temperature decreases and the products have higher enthalpy than the reactants.
- B. Temperature decreases and the products have lower enthalpy than the reactants.
- C. Temperature increases and the products have higher enthalpy than the reactants.
- D. Temperature increases and the products have lower enthalpy than the reactants.

21. The energy from burning 0.321 g of methanol causes the temperature of 200 cm³ of water to rise by 5.00 K. What is the enthalpy of combustion of the methanol in kJ mol⁻¹?

Specific heat capacity of water: 4.18 J g⁻¹ K⁻¹, M_r methanol = 32.05 g mol⁻¹

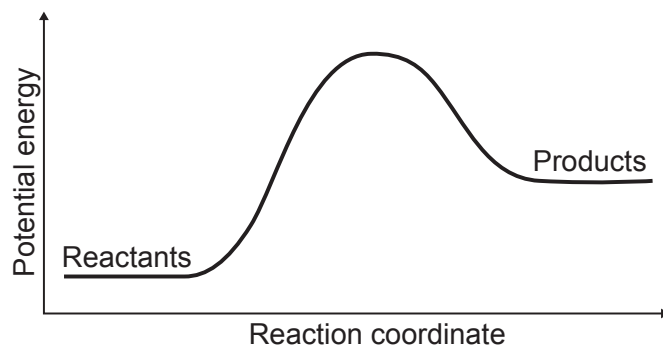
$$Q = mc\Delta T$$

- A. -417
- B. -579
- C. -23 200
- D. -417 000

— 3 —

2225-0213

20. The potential energy profile of a reaction is shown.



Which reaction has this energy profile?

- A. $\text{N}_2(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2\text{NO}(\text{g})$
- B. $2\text{H}(\text{g}) \rightarrow \text{H}_2(\text{g})$
- C. $\text{NaOH}(\text{aq}) + \text{HCl}(\text{aq}) \rightarrow \text{NaCl}(\text{aq}) + \text{H}_2\text{O}(\text{l})$
- D. $\text{CH}_4(\text{g}) + 2\text{O}_2(\text{g}) \rightarrow \text{CO}_2(\text{g}) + 2\text{H}_2\text{O}(\text{l})$

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Turn over
0020-0207

Section B

Answer **all** questions. Answers must be written within the answer boxes provided.

2. A student was asked to identify an unknown metal with a mass of 1.28 g using calorimetry. The metal was placed in beaker **A** with boiling water at 100.00 °C until the metal reached the same temperature as the water. The metal was then quickly transferred to beaker **B** with 5.65 g of water which had an initial temperature of 25.00 °C. The final temperature of the water in beaker **B** and the metal was 26.77 °C.

Data for unknown metal sample	
Mass of unknown metal/g	1.28
Initial temperature of metal/°C	100.00
Mass of cool water in beaker B /g	5.65
Initial temperature of water in beaker B /°C	25.00
Final temperature of water in beaker B and metal/°C	26.77

- (a) Determine the amount of energy transferred from the metal to the water in beaker **B** using sections 1 and 2 of the data booklet.

[2]

- (b) Determine the specific heat capacity of the metal assuming the heat absorbed by the water in beaker **B** in (a) is equal to the heat released by the metal.

Use section 1 of the data booklet.

If you did not get an answer to (a) use 40.5 J although this is not the correct answer.

[2]

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(Question 2 continued)

- (c) State the name of the unknown metal using the table. [1]

Metal	Specific heat capacity (J g ⁻¹ K ⁻¹)
Lead	0.129
Silver	0.235
Iron	0.449
Aluminium	0.897

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- (d) Deduce **two** sources of systematic error for this experiment based on the results. [2]

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- (e) State another physical property that could be used to identify the metal without damaging the sample. [1]

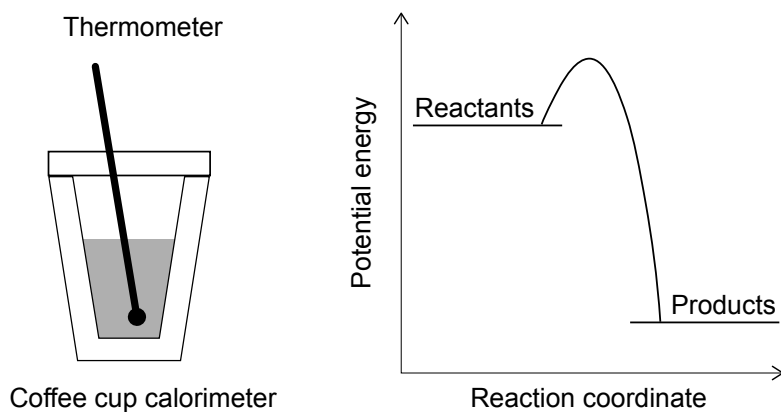
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0020–0200

20. The potential energy profile for a “coffee cup” calorimetry experiment is shown.



What is the correct interpretation of this reaction?

	Temperature	Type of reaction
A.	increases	exothermic
B.	increases	endothermic
C.	decreases	exothermic
D.	decreases	endothermic

Turn over