OCR A-Level Chemistry A

Enthalpy changes mark scheme · goes with “Enthalpy changes” · whiteboardchemistry.com/revision/exam-questions/ocr-a-level-chemistry/

Mark schemes

Enthalpy changes · 10 questions

Q1 · June 2023 · AS Paper 1 (Breadth in chemistry) · Q11 · [1 mark]

Answer: **D**

The standard enthalpy change of combustion of hydrogen is –286 kJ mol^{-1}.

Q2 · June 2023 · AS Paper 1 (Breadth in chemistry) · Q12 · [1 mark]

Answer: **D**

The enthalpy change for the condensation of a gas to a liquid is a negative value.

Q3 · June 2024 · AS Paper 1 (Breadth in chemistry) · Q11 · [1 mark]

Answer: **C**

–110

Q4 · June 2024 · Paper 1 (Periodic table, elements and physical chemistry) · Q7 · [1 mark]

Answer: **A**

OCR MARK SCHEME

–56

EXAMINER GUIDANCE

ALLOW *-56 (correct numerical answer)*

Q5 · June 2025 · AS Paper 1 (Breadth in chemistry) · Q11 · [1 mark]

Answer: **D**

–726

Q6 · June 2025 · AS Paper 2 (Depth in chemistry) · Q1 · [8 marks]

OCR MARK SCHEME

1(a)

releases OH^-/hydroxide (ions in aqueous solution) ✓

[1 mark]

1(b)

$H^+ + OH^- \rightarrow H_2O$ ✓

EXAMINER GUIDANCE

ALLOW *containing/forms OH^- (ions)*

ALLOW *ionises to give OH^- (ions)*

IGNORE *mention of pH*

IGNORE *state symbols*

[1 mark]

1(c)(i)

FIRST CHECK THE ANSWER ON ANSWER LINE

IF *$\Delta H = -56.1$ (kJ mol^{-1}) award 4 marks*

IF *$\Delta H = (+)56.1$ (kJ mol^{-1}) award 3 marks*

Energy released in J **OR** kJ

$Q = mc\Delta T = 80 \times 4.18 \times 9.4$

= 3143.36 (J) **OR** 3.14336 (kJ) ✓

Calculates nH_2O/nHCl/nNaOH

$\frac{40 \times 1.4}{1000}$ = 0.056(0) (mol) ✓

ΔH per mole H_2O

$\frac{3.14336}{0.056}$ = ± 56.131428....(kJ mol^{-1})

OR

$\frac{3143.36}{0.056}$ = ± 56,131.428.... (J mol^{-1}) ✓

Δ*H* in kJ mol^{-1} to 3 SF **AND** – sign

ΔH = –56.1 (kJ mol^{-1}) ✓

[4 marks]

ALLOW ECF throughout

ALLOW *3140 (J)* ***OR*** *3.14 (kJ)*

DO NOT ALLOW *< 3 SF*

IGNORE *any sign*

IGNORE *units i.e.* ***ALLOW*** *correctly calculated number in J* ***OR*** *kJ* ***OR*** *no units*

IGNORE *trailing zeroes e.g* ***ALLOW*** *0.056*

Sign **NOT** needed

Common Errors

-28.1	3 marks	Use of 40g instead of 80g or 2 x 0.056 mol
-1690	3 marks	+273 for temp change

Final answer must have 3 SF **AND** – sign

1(c)(ii)

Same number of moles (of HCl / H_2O) ✓

Same q/ energy/heat (released)

AND

(spread over a) smaller (total) volume / mass ✓

[2 marks]

IGNORE *responses related to changes in rate of reaction*

ALLOW *calculation which shows number of moles is same i.e. 0.02 x 2.8 = 0.056 (ALLOW ECF from (i) for this calculation)*

ALLOW *ΔH or Enthalpy change for 'heat'*

ALLOW *calculation to give ΔT = 12.5°C (using mass = 60 and same q value) (ALLOW ECF from (i) for this calculation)*

Q7 · June 2025 · Paper 1 (Periodic table, elements and physical chemistry) · Q17 · [16 marks]

OCR MARK SCHEME EXAMINER GUIDANCE

17(a)(i)

Iron is an element (in its standard state) ✓

[1 mark]

Takes no energy to make an element from an element (under standard conditions)

17(a)(ii)

(ΔH =) 3(–394) + 0 – (–824) – 3(–111) ✓

(ΔH =) –25 kJ mol^{-1} ✓

[2 marks]

ALLOW ECF *for one transcriptional error*

Common Errors

1 mark

(+) 763	(no 3 x –394)
(+) 25	(incorrect sign)
–247	(no 3 x –111)
–2339	(+ for – (–824 + 3 x –111))

17(a)(iii)

Fe_2O_3 is a solid and CO_2 is a gas ✓

So CO_2 / gas more disordered

OR greater number of ways a system can be arranged / energy can be dispersed in CO_2 / gas ✓

[2 marks]

ALLOW ORA

17(a)(iv)

15 = 3(214) + 2x – 87 – 3(198)

OR 54 ✓

(2x = 54 so) S = 27 (J K^{-1} mol^{-1}) ✓

[2 marks]

ALLOW ECF *for a calculated value using all numerical values*

Common Errors

1 mark

241	(No 3 *x* 214)
12	(Subtraction backwards)
–171	(No 3 x198)

17(b)

ALLOW 3 SF *up to calculator value*

ΔG at 100°C

($\Delta G = \Delta H - T\Delta S$ =

491 – (373 × 0.543) / 491000 – (373 × 543))

= (+) 288 (kJ mol^{-1}) **OR** (+) 288461 (J mol^{-1}) ✓

Feasibility statement

Not feasible when $\Delta G > 0$ ✓

Minimum Temperature

whole number required

($T = \frac{\Delta H}{\Delta S} = \frac{491000}{543}$)

= 904 **OR** 905 K ✓

[3 marks]

IGNORE *units*

ALLOW ECF *for any positive value determined in M1*

Alternative approach for first two marks

ΔH and $T\Delta S$ at 100°C

$T\Delta S$ = 373 × 0.543

= 202.539

Feasibility statement

($\Delta H > T\Delta S$)

491 > 202.539 **OR** 491000 > 202539 so not feasible

Alternative approach for first two marks

ΔS_{total} at 100°C

$\Delta S_{total} = \Delta S_{surroundings} + \Delta S_{system}$

$= \frac{-\Delta H}{T} + \Delta S_{system}$

$= \frac{-491}{373} + 0.543$

= –0.773(3538874)

Feasibility statement

Not feasible when $\Delta S_{total} < 0$

17(c)(i)

Equal number of (gaseous) reactant and product molecules/moles

OR (pressure) units cancel ✓

[1 mark]

ALLOW *equal number of terms in numerator and denominator*

ALLOW *units cancelling as shown in an equation*

DO NOT ALLOW *references to concentration*

IGNORE *same number of reactants and products (need moles/molecules)*

17(c)(ii)

FIRST CHECK ANSWERS ON THE ANSWER LINES

IF answer = 74(kPa) for both award 3 marks

ALLOW ECF *from incorrect x^2*

ALLOW *$p(H_2O) = p(CO) = x$*

$p(H_2O)\ p(CO) = \dfrac{p(H_2) \times p(CO_2)}{K_p}$

$= \dfrac{211 \times 211}{8.13}$

= 5476.(137761) ✓

(At equilibrium) $p(H_2O) = p(CO)$

/ the same value on both partial pressure answer lines ✓

$p(H_2O)$ **AND** $p(CO) = \sqrt{}$ 5476.(137761)

= 74(.0) (kPa) ✓

[3 marks]

So $x^2 = \dfrac{p(H_2) \times p(CO_2)}{K_p} = 5476.138$

scores first 2 marks

17(c)(iii)

Lower temperature

AND

(forward reaction) is exothermic / reverse reaction is endothermic ✓

K_p (has increased and) equilibrium position shifted to the right ✓

[2 marks]

ALLOW ORA

ALLOW *shifts to the products/increases yield or AW*

ALLOW *value of $p(H_2O)\ p(CO)$ decreased / $p(H_2)\ p(CO_2)$ increased*

Q8 · June 2025 · Paper 1 (Periodic table, elements and physical chemistry) · Q6 · [1 mark]

Answer: **C**

+435

Q9 · June 2025 · Paper 3 (Unified chemistry) · Q6 · [6 marks]

OCR MARK SCHEME

6

Level 3 (5–6 marks)

Calculates CORRECT enthalpy change ΔH_2 using m = 33.5 g in reaction 6.2.

AND

CORRECT enthalpy change ΔH_1 in reaction 6.1

There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.

Level 2 (3–4 marks)

EXAMINER GUIDANCE

TWO APPROACHES: from $n(Na_2CO_3)$ and from $n(HNO_3)$

SEE NEXT DOUBLE PAGE FOR GUIDANCE.

ALLOW *omission of trailing zeroes*

ALLOW *minor slips*

3 SF or more throughout

A: APPROACH based on $n(Na_2CO_3)$

Indicative scientific points may include:

1. Energy change from $mc\Delta T$

Using $m = 30 – 33.5$ g, $c = 4.18/4.2$ and $\Delta T = 4$ calculates a value for **energy change per mole of Na_2CO_3 OR energy change per mole of HNO_3**

AND

the CORRECT amount in mol of Na_2CO_3 **OR** HNO_3

There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.

Level 1 (1–2 marks)

Processes experimental data to obtain:

Calculates energy change correctly from $mc\Delta T$

OR

Attempts to calculate energy change from $mc\Delta T$ with two of m (30–33.5g), c (4.18/4.2) and ΔT (4) correct

AND amount in mol of Na_2CO_3 **OR** HNO_3

There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.

0 marks – No response or no response worthy of credit.

[6 marks]

33.50 × 4.18 × 4.0 = 560.12 (J) **OR** 0.56012 (kJ)

OR 30.0 – 33.15, e.g.

30 × 4.18 × 4.0 = 501.6 (J) **OR** 0.5016 (kJ)

Amount of Na_2CO_3

$n(Na_2CO_3) = \frac{1.97}{106} = 0.01858....$ (mol)

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2. Energy change per mole of Na_2CO_3 in kJ mol^{-1}

From $m = 33.50$ g $= \pm \frac{0.56012}{0.01858....} = \pm 30.138...$

ALLOW *30.11 → 30.15*

From $m = 30$ g $= \pm \frac{0.5016}{0.01858....} = \pm 26.9896...$

ALLOW *±27.0* ***OR*** *±26.9*

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3. ΔH_2 and ΔH_1 CORRECT with signs (From 33.50 ONLY)

Reaction 6.2:

$\Delta H_2 = -30.138$ (kJ mol^{-1})

ALLOW *–30.11 → –30.15*

Reaction 6.1

$\Delta H_1 = 2 \times \Delta H_3 – \Delta H_2$

$= 2 \times 19.8 – (-30.138....) = \Delta H_1 =$ (+)69.7 (kJ mol^{-1})

NOTE*: A clear and logically structured response might include an energy cycle and accurate use of SF, 4.18 and signs throughout*

B: APPROACH using $n(HNO_3)$

Indicative scientific points may include:

1. Energy change from $mc\Delta T$

33.50 × 4.18 × 4.0 = 560.12 (J) **OR** 0.56012 (kJ)

OR 30.0 – 33.15, e.g.

30 × 4.18 × 4.0 = 501.6 (J) **OR** 0.5016 (kJ)

Amount of HNO_3 and the Na_2CO_3

$n(HNO_3)$

$= \frac{1.00 \times 30.0}{1000} = 0.0300$ (mol)

Amount of Na_2CO_3

$n(Na_2CO_3)$

$= \frac{0.0300}{2} = 0.0150$ (mol)

---

2. Energy change per mole of Na_2CO_3 in kJ mol^{-1}

From $m = 33.50$ g $= \pm \frac{0.56012}{0.0150} = \pm 37.34$

From $m = 30$ g $= \pm \frac{0.5016}{0.0150} = \pm 33.44$

** Some may calculate energy change per mole of HNO_3 giving:

$\pm \frac{0.56012}{0.0300} = \pm 18.67$ and $\pm \frac{0.5016}{0.0300} = \pm 16.67$

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3. ΔH_2 and ΔH_1 CORRECT with signs (From 33.50 ONLY)

Reaction 6.2:

$\Delta H_2 = -37.34$ (kJ mol^{-1})

Reaction 6.1

$\Delta H_1 = 2 \times \Delta H_3 - \Delta H_2$

$= 2 \times 19.8 - (-37.34)$

$\Delta H_1 = (+)76.94$ (kJ mol^{-1})

***NOTE**: A clear and logically structured response might include an energy cycle and accurate use of SF, 4.18 and signs throughout*

Q10 · November 2021 · AS Paper 2 (Depth in chemistry) · Q4 · [6 marks]

OCR MARK SCHEME

4(a)

Level 3 (5–6 marks)

Calculates CORRECT enthalpy change with correct signs for ΔH_2 for reaction 2

AND

ΔH_1 for reaction 1.

There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.

Level 2 (3–4 marks)

Calculates a value of ΔH_2 for reaction 2 from the:

Energy change

AND

Amount in mol of $MgCO_3$.

There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.

Level 1 (1–2 marks)

Processes experimental data to obtain the

Energy change from $mc\Delta T$

OR

Amount in moles of $MgCO_3$

There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.

0 marks

No response or no response worthy of credit.

[6 marks]

EXAMINER GUIDANCE

Indicative scientific points may include:

1. Processing experimental data

Energy change from $mc\Delta T$

- Energy in J **OR** kJ

Using 103.01 g or 100.0 g

= 103.01 × 4.18 × 5.0

= 2152.909 (J) **OR** 2.153 (kJ)

3SF or more (2.152909 unrounded)

OR 100.0 × 4.18 × 5.0

= 2090 (J) **OR** 2.09 (kJ)

Amount in mol of $MgCO_3$

$$n(MgCO_3) = \frac{4.215}{84.3} = 0.0500 \text{ (mol)}$$

2. ± value of ΔH_2 for reaction 2

From m = 103.01 g = ± $\frac{2.153}{0.0500}$ = ±43.06 (kJ mol^{-1})

(–43.05818 unrounded)

From m = 100.0 g = ± $\frac{2.09}{0.0500}$ = ±41.8 (kJ mol^{-1})

3. CORRECT enthalpy changes for Reaction 1 and Reaction 2 with signs (using 103.01 g ONLY)

Reaction 2 = –43.06 (kJ mol^{-1})

3SF or more with correct – sign

Reaction 1 $\Delta H_1 = \Delta H_2 - \Delta H_3$

= –43.06 – (–136.1) =

+93.04 (kJ mol^{-1})

3SF or more with correct – sign

ALLOW *omission of trailing zeroes, e.g. 93 for 93.0*

NOTE*: If 100 g used, ΔH is incorrect and L3 cannot be attained*

Source: OCR A-Level Chemistry A past papers. Reproduced for revision at whiteboardchemistry.com.

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