OCR A-Level Chemistry A

Lattice enthalpy, entropy and free energy mark scheme · goes with “Lattice enthalpy, entropy and free energy” · whiteboardchemistry.com/revision/exam-questions/ocr-a-level-chemistry/

Mark schemes

Lattice enthalpy, entropy and free energy · 9 questions

Q1 · June 2022 · Paper 1 (Periodic table, elements and physical chemistry) · Q10 · [1 mark]

Answer: **A**

ΔH –ve · ΔS –ve

Q2 · June 2022 · Paper 1 (Periodic table, elements and physical chemistry) · Q9 · [1 mark]

Answer: **A**

½ $Br_2(l) \rightarrow Br(g)$

Q3 · June 2023 · Paper 1 (Periodic table, elements and physical chemistry) · Q15 · [1 mark]

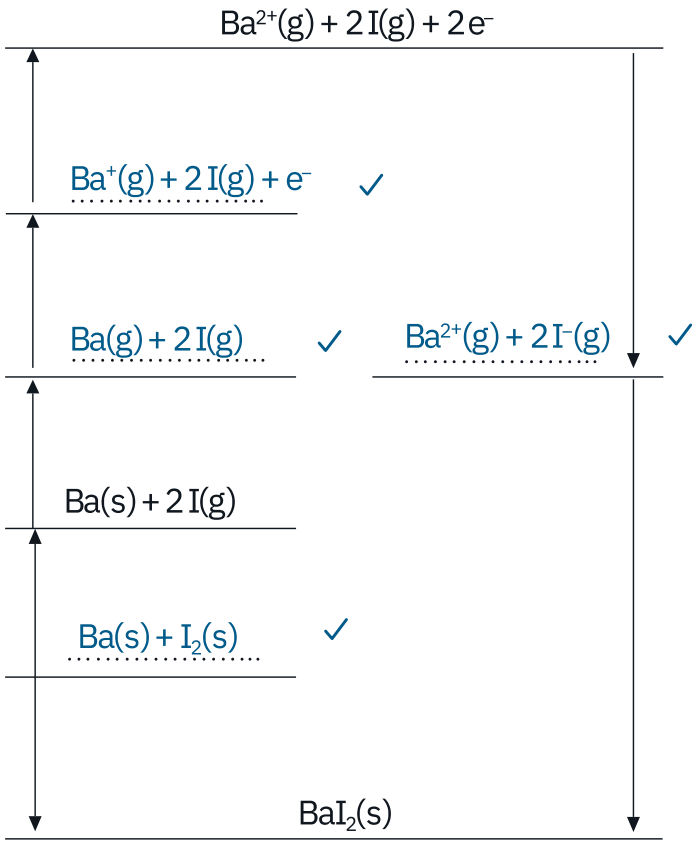
Answer: **B**

Only 1 and 2

Q4 · June 2023 · Paper 1 (Periodic table, elements and physical chemistry) · Q16 · [10 marks]

OCR MARK SCHEME EXAMINER GUIDANCE

16(a)(i)



[4 marks]

16(a)(ii)

FIRST CHECK THE ANSWER ON ANSWER LINE

If answer = –1872 award 2 marks

ΔH lattice = 2(+296) – 965 – 503 – 180 + 2(–107)– 602 ✓

ΔH lattice = –1872 (kJ mol^{-1}) ✓

[2 marks]

ALLOW *for 1 mark +1872 (wrong sign on answer)*

Common errors for 1 mark

–3056 (–296 x 2 instead of 296 x2)

–2168 (296 x 1 instead of 296 x2)

–1765 (–107 x 1 instead of –107 x 2)

–1512 (180 instead of –180)

–1444 (107 x 2 instead of –107 x 2)

–866 (503 instead of –503)

–668 (602 instead of –602)

+58 (965 instead of -965)

For other answers, check for a single transcription error or calculation error which could merit 1 mark if all values have been used.

DO NOT ALLOW *any answer which involves two errors*

16(b)

Ist IE of Mg and Sr

(Mg) removes electron from shell closer to the nucleus / smaller atomic radius ✓

Greater nuclear attraction (between atom and outer electron) ✓

2nd/1st IE of Sr

2^{nd} electron removed from cation/positively charged ion

OR

proton:electron ratio (in (1)+ ion) is greater (than in atom) ✓

Greater nuclear attraction / attraction between ion (and outer electron) ✓

[4 marks]

ORA throughout

ALLOW *going down the group for comparison of Mg/Sr*

Assume 'it' means Mg

ALLOW *(Mg) fewer shells*

ALLOW *less shielding*

ALLOW *removal of electron from 3s rather than 5s*

ALLOW *Greater attraction between nucleus (and outer electron)*

ALLOW *Sr^+ ion smaller (than Sr atom)*

ALLOW same *number of protons/nuclear charge attracting one fewer electron*

IGNORE *repulsion between electrons in the s orbital*

IGNORE *shielding*

Q5 · June 2023 · Paper 1 (Periodic table, elements and physical chemistry) · Q18 · [11 marks]

OCR MARK SCHEME

EXAMINER GUIDANCE

18(a)

FIRST CHECK THE ANSWER ON ANSWER LINE

If answer = –4950 award 3 marks

- $q = mc\Delta T = 150 \times 4.18 \times 10.5 = 6583.5$ (J) **OR** 6.5835 (kJ) ✓
- $n(C_7H_{16}) = \frac{0.133}{100} = 1.33 \times 10^{-3}$ ✓
- $\Delta_c H = \frac{q}{n} = \frac{6.5835}{1.33 \times 10^{-3}} = -4950$ kJ mol^{-1}

– sign required ✓

[3 marks]

ALLOW *3 SF up to the calculated value*

Ignore RE after 3SF

IGNORE *sign*

ALLOW ECF *from incorrect q and/or n*

Common errors for 2 marks

+4950 kJ mol^{-1} (wrong sign)

-5077 (use of 0.0013 and 6.6 2SF)

-5064 (use of 0.0013 2SF)

-4962 (use of 6.6kJ use of 2SF)

18(b)

FIRST CHECK THE ANSWER ON ANSWER LINE

If answer = –3535 award 2 marks

$186 = \Delta_c H(C_9H_{20}) - \Delta_c H(C_5H_{12}) - 2\,\Delta_c H(C_2H_4)$

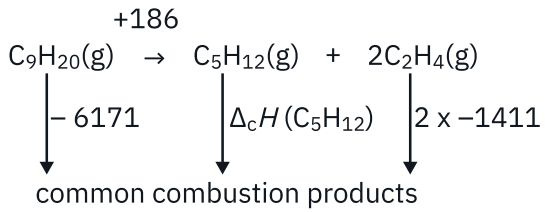
IGNORE *any incorrect combustion products on bottom line.*

Common errors for 1 mark

+3535 (wrong sign for final answer)

+8807 (use of +6171)

OR From Hess cycle with all numerical values used and correct multiples used/labelled



✓

$\Delta_c H(C_5H_{12}) = (-6171) - 2(-1411) -186 = -3535$ kJ mol^{-1} ✓

[2 marks]

-9179 (use of +1411)

-4946 (use of 1 x -1411)

-3163 (use of +186)

For other answers, check for a single transcription error or calculation error using all values which could merit 1 mark

18(c)(i)

(ΔS) is positive

AND

more molecules / moles of (gaseous) product /produced ✓

[1 mark]

ALLOW *reaction produces more (gaseous) molecules /moles of products than reactants*

IGNORE *explanations based on ΔG*

18(c)(ii)

Best fit line drawn ✓

(–)ΔS = correct gradient from graph

OR (–)0.127 (kJ K^{-1} mol^{-1}) ✓

ΔS = gradient × –1000 = (+)127 (J K^{-1} mol^{-1}) ✓

Minimum T ($\Delta G = 0$) = 370 (K) ✓

ΔH (y-intercept) = (+)46 (kJ mol^{-1}) ✓

[5 marks]

Allow ***ECF*** *throughout*

Place tick for line of best fit on the graph

Allow lines that will extrapolate to y axis at 43-47 and x axis at 820-840

DO NOT ALLOW *outside ranges*

ALLOW *rounding to 2SF*

e.g. $(-)\Delta S = \frac{105}{830} = (-)0.127$

ALLOW *(–)0.122 to (–)0.131*

ALLOW *122 to 131*

This mark subsumes gradient mark

ALLOW *340 to 370*

ALLOW *67 to 97* ***AND*** *°C*

DO NOT ALLOW *-ve T in K*

ALLOW *43 to 47*

Candidates can receive full credit for calculating ΔS, T and/or ΔH from previously determined values

e.g

$$T = \frac{\Delta H}{\Delta S} = \frac{46}{0.127} = 362K$$

Q6 · June 2023 · Paper 1 (Periodic table, elements and physical chemistry) · Q9 · [1 mark]

Answer: **B**

–254

Q7 · June 2024 · Paper 1 (Periodic table, elements and physical chemistry) · Q16 · [17 marks]

OCR MARK SCHEME

16(a)(i)

FIRST CHECK ANSWER ON ANSWER LINE

If answer = –117 kJ mol^{-1}, award 4 marks.

ΔH = –286– (–188)

= –98 kJ mol^{-1} ✓

ΔS = 70 + ½(205) – 110 = 62.5 (J K^{-1} mol^{-1})

or 0.0625 (kJ K^{-1} mol^{-1}) ✓

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

= –98 – (298 × 0.0625) ✓

ΔG = –117 kJ mol^{-1} (3SF) ✓

[4 marks]

EXAMINER GUIDANCE

ALLOW ECF *throughout*

ALLOW *–98000 – (298 × 62.5)*

Common Errors for ΔG

3 marks

–18700 (ΔS not converted to kJ)

–493 (ΔH = –286 + (–188) = –474)

–147 (ΔS = 165: not halving 205)

–99.6 (T not converted to K)

–18.7 (ΔH not converted J but ΔS J K^{-1} mol^{-1})

(+)79.4 (–188 – (–286) = +98)

2 marks

(+) 117 (incorrect signs for ΔH and ΔS)

Final Answer MUST BE 3 SF

16(a)(ii)

(Rate of reaction) slow

OR Activation energy high ✓

[1 mark]

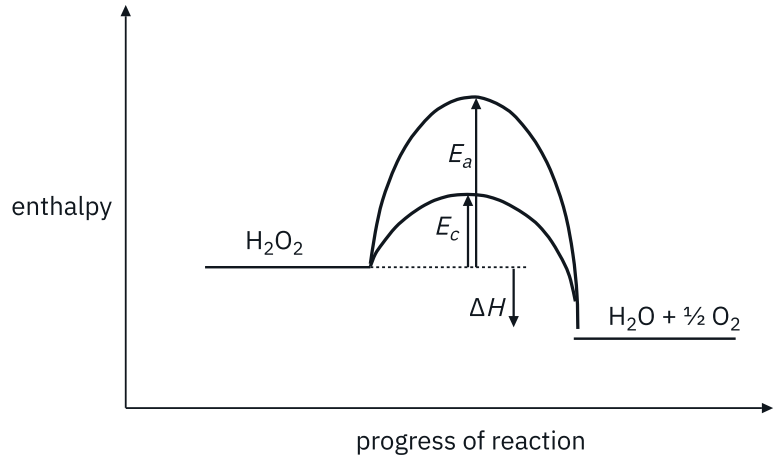
ALLOW *ΔG takes no account of rate of reaction*

ALLOW *molecules do not have sufficient energy to equal or exceed the activation energy.*

IGNORE *molecules do not have sufficient energy to react.*

DO NOT ALLOW *there is not enough activation energy*

16(b)(i)



Care enthalpy profile must match ΔH sign in16 a) i) – check calculation

ALLOW *endothermic profile as* ***ECF*** *from + ΔH calculated in 16 a) i) for all three marks*

State symbols not required

ΔH DO NOT ALLOW $-\Delta H$

DO NOT ALLOW *double headed arrow on ΔH*

ALLOW *ΔH arrow even with small gap at the top and bottom,*

H_2O_2 on LHS **AND** H_2O + ½ O_2 on RHS

AND

Δ*H* labelled with product line below reactant line

AND

Arrow downwards ✓

E_a correctly labelled ✓

E_c correctly labelled with $E_c < E_a$ ✓

[3 marks]

i.e. line does not quite reach reactant or product line.

E_a and E_c

ALLOW *no arrowhead or arrowheads at both end of E_a or E_c lines*

E_a or E_c lines must reach maximum (or near to maximum) on curve

ALLOW *overlapping lines* ***OR*** *lines on side reaching maximum*

For E_a, **ALLOW** AE **OR** A_E **OR** Eact **OR** suitable alternatives

ALLOW ECF *marks for E_a and E_c for correctly labelled endothermic diagram from a –ΔH value (from16 a) i))*

16(b)(ii)

(MnO_2) is in different phase/state (to the reactant / H_2O_2)

OR

catalyst is a solid **AND** reactant is liquid ✓

[1 mark]

ASSUME 'it' is MnO_2

ALLOW *'species in the reaction'*

IGNORE *references to products*

16(b)(iii)

Mn is +2 **AND** +3

OR

Mn is +1 **AND** +6 ✓

[1 mark]

+ required

ALLOW *2+ and 3+*

DO NOT ALLOW *Mn^{2+} Mn^{3+}*

DO NOT ALLOW *+ 4 (this is the oxidation state in MnO_2)*

16(c)(i)

(Enthalpy / heat energy change / released when) 1 mol of (ionic lattice) ✓

Is formed from its gaseous ions ✓

[2 marks]

ALLOW *1 mol of (ionic) compound/product/substance*

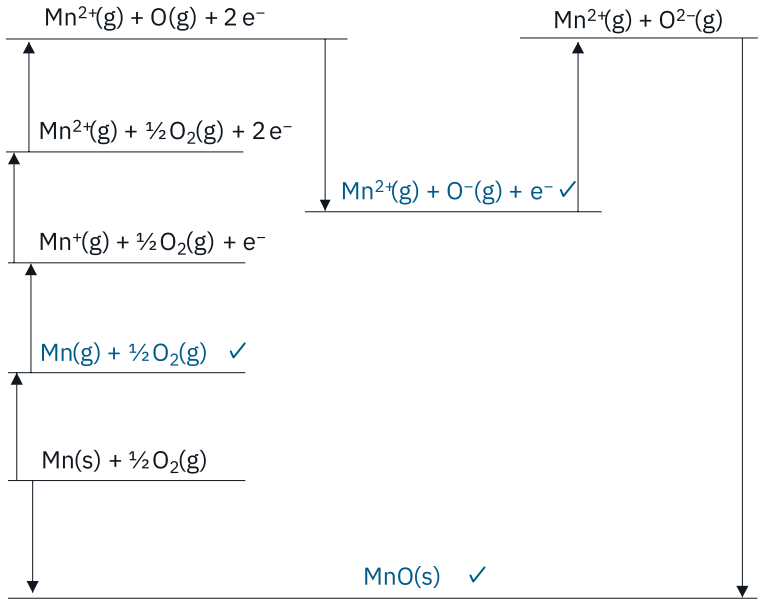
IGNORE *energy released/required*

ALLOW *$M^+(g) + X^-(g) \rightarrow MX(s)$*

DO NOT ALLOW *one mole of gaseous ions*

16(c)(ii)

Care: State symbols are required



[3 marks]

16(c)(iii)

FIRST CHECK ANSWER ON ANSWER LINE

If answer = –3798 award 2 marks

ΔH lattice

= –281 – 249 – 717 – 1509 – (–141) – 798 + (–385) ✓

ΔH lattice = –3798 (kJ mol^{-1}) ✓

[2 marks]

Common errors for 1 mark

-4080 (use of -141)

-3674 (use of +249/2 and correctly rounded)

-3673.5 (use of +249/2)

-3236 (use of +281)

-3300 (use of +249)

-3028 (use of -385)

-2364 (use of +717)

-2202 (use of +798)

-780 (use of +1509)

+3798 (wrong sign on answer)

For other answers, check for a single transcription error or calculation error which could merit 1 mark

Q8 · June 2025 · Paper 1 (Periodic table, elements and physical chemistry) · Q3 · [1 mark]

Answer: **B**

An electron is added to a negative ion.

Q9 · November 2021 · Paper 1 (Periodic table, elements and physical chemistry) · Q11 · [1 mark]

Answer: **A**

ΔH: + · ΔS: +

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