AQA A-Level Chemistry

Thermodynamics mark scheme · goes with “Thermodynamics” · whiteboardchemistry.com/revision/aqa-a-level-chemistry/exam-questions

Mark schemes

Thermodynamics · 6 questions

Q1 · June 2017 · Paper 3 · Q32 · [1 mark]

Answer: **C**

Q2 · June 2018 · Paper 3 · Q14 · [1 mark]

Answer: **A**

Q3 · June 2018 · Paper 3 · Q33 · [1 mark]

Answer: **D**

Q4 · June 2025 · Paper 1 · Q4 · [12 marks]

04.1

Standard pressure/100 kPa and a stated temperature/298 K

allow 1 bar

do not accept 1 atm

[1 mark]

04.2

M1 $\Delta H^{\ominus} = (2 \times -602) + (4 \times 34) - (2 \times -790) = 512$ kJ mol^{-1}

M2 $\Delta S^{\ominus} = (27 \times 2) + (4 \times 240) + 205 - (2 \times 164) =$

891 J K^{-1} mol^{-1}

M3 $\Delta S^{\ominus} = 0.891$ kJ K^{-1} mol^{-1}

M4 $T = \dfrac{(\Delta H)}{(\Delta S)}$

M5 $T = \dfrac{(512)}{(0.891)} = 575$ K

M3: ΔS divided by 1000

M3: Allow ΔH = 512 000 $Jmol^{-1}$

[5 marks]

04.3

M1 $-1132 = (12 \times 388) + (7 \times 496) - (8 \times N{-}O) - (12 \times 463)$

M2 (8 N–O) = 3704 kJ mol^{-1}

M3 BE N–O = 463 kJ mol^{-1}

M1 Allow 8x =8128-5556+1132

M3 = $\frac{M2}{8}$ *to give a positive value*

[3 marks]

04.4

Heterogeneous

[1 mark]

04.5

M1 (forward) reaction is exothermic

M2 equilibrium moves/shifts to lower the temperature OR equilibrium moves/shifts to oppose the increase in temperature

M1 reverse reaction is endothermic

Ignore favours

M2: Equilibrium moves/shifts to the left/backwards is insufficient

[2 marks]

Q5 · June 2024 · Paper 1 · Q8 · [14 marks]

(a) (Ions are) point charges

OR

(Ions are) perfect spheres

OR

No covalent character

Do not accept atoms or molecules in answer

Allow no polarisation of ions

[1 mark]

(b) 2 Na^+ (g) + 2 e^- + O(g)

2 Na(s) + ½O_2(g)

[2 marks]

(c) -416 + x = 248 + (2 × 109) + (2 × 494) - 142 + 844

enthalpy of lattice dissociation = (+) 2572 (kJ mol^{-1})

−2572 (kJ mol^{-1}) scores 1 mark

[2 marks]

(d) O^- repels the electron (being added)

Allow negative ion repels electron

[1 mark]

(e) Oxide ions

M1 have higher (negative) charge

OR

smaller size

OR

higher charge density/higher charge:size ratio (than chloride ions).

M2 stronger attraction between (O^{2-} and Na^{+}/oppositely charged) ions

Ignore electronegativity

[2 marks]

(f) Enthalpy of solution = 771 - 406 - 364

= (+)1 (kJ mol^{-1})

Allow 1 mark for -1 (kJmol^{-1})

[2 marks]

(g) It reacts with water

OR

It reacts to form (a solution of) NaOH

Do not accept - It dissolves in water

[1 mark]

(h) M1 $T = \frac{\Delta H}{\Delta S}$

M2 $T = \frac{411}{(90.1 \times 10^{-3})} = 4562$ (K)

M3 T = 4562 - 273 = 4289 (°C)

M3 = M2 - 273

M3: Allow 4290 (°C)

[3 marks]

Q6 · June 2023 · Paper 1 · Q5 · [16 marks]

(a) (Enthalpy change = lattice dissociation energy + hydration energies of ions)

M1 Enthalpy change = +2237 – (2 x 364) – 1650

M2 = –141 kJ mol^{-1}

[2 marks]

(b) Temperature goes up/increases

Allow answer consequential on (a)

[1 mark]

(c) M1 fluoride ions/F^- (ions) are smaller

OR

M1 F^- has a higher charge density

Do not accept fluorine atoms/ions are smaller

M2 stronger attraction (of fluoride ion) to δ+ on H/ electron deficient H (in water)

M2 do not accept ionic bonds

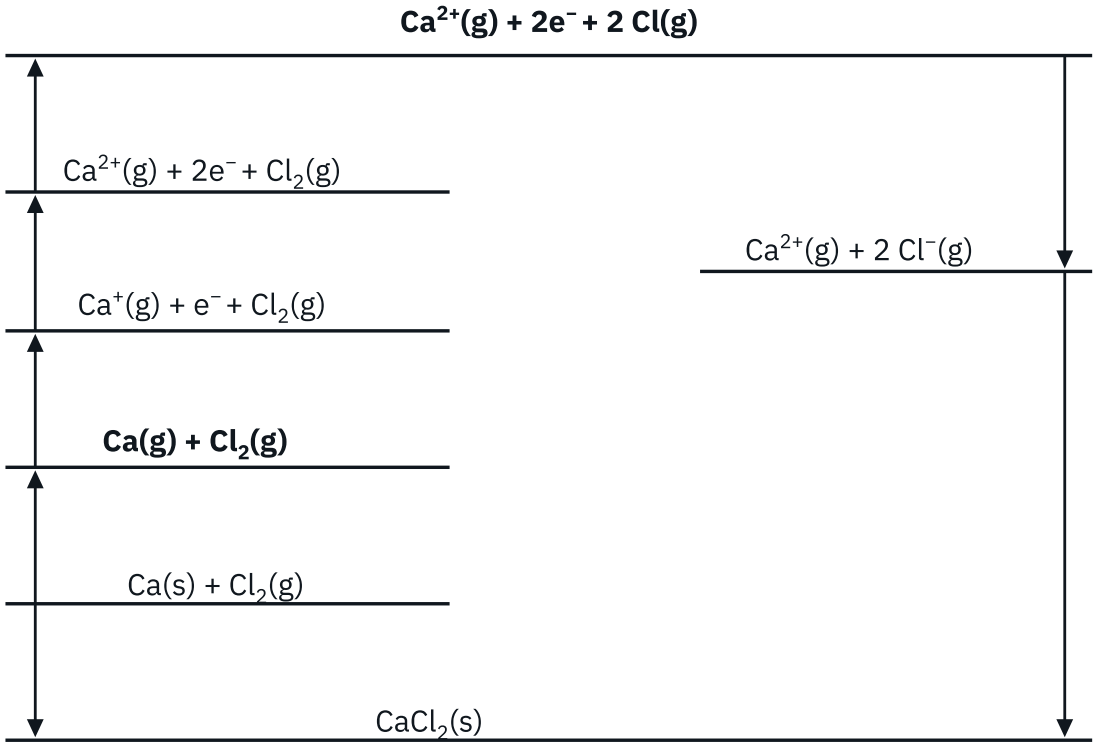
Do not accept more energy to break bonds

Do not accept stronger attraction to H^+

Ignore electronegativity and shielding

[2 marks]

(d)



[2 marks]

(e) −795 = 193 + 590 + 2nd IE + (121 **x 2**) + (−364 **x 2**) − 2237

= (+) 1145 (kJ mol^{-1})

M1: Allow −795 = −1940 + 2nd IE

[2 marks]

(f) Electron removed from a positive charge/ion

OR

Electron removed from smaller ion/electron removed closer to nucleus

OR

Stronger attraction between same number of protons and fewer electrons

[1 mark]

This question is marked using levels of response.

(g)

	Level 3 5-6 marks	All stages are covered and the description of each stage is generally correct and virtually complete. Answer is communicated coherently and shows a logical progression from stage 1 to stage 2 and stage 3
	Level 2 3-4 marks	All stages are covered but the description of each stage may be incomplete or may contain inaccuracies OR two stages are covered and are generally correct and virtually complete. Answer is mainly coherent and shows progression from stage 1 to stage 2 and/or stage 3.
	Level 1 1-2 marks	Two stages are covered but the description of each stage may be incomplete or may contain inaccuracies OR only one stage is covered but is generally correct and virtually complete. Answer includes isolated statements and these are presented in a logical order.
	0 marks	Insufficient correct chemistry to gain a mark.

Stage 1 comparing values from perfect ionic model

1a Value for $CaCl_2$ is larger

OR

Values for KCl and AgCl are similar

OR

Values for $CaCl_2$ > AgCl > KCl

1b Ca^{2+} has a larger charge/ is a smaller ion

OR

Ag^+ and K^+ have smaller charge or larger ions

1c $CaCl_2$ has stronger ionic bonds or stronger attraction between + and - ions ($Ca^{2+}$and Cl^-)

OR

AgCl and KCl have weaker ionic bonds or weaker attraction between + and - ions (Ag^+/ K^+ and Cl^-)

Stage 2 similarities in the perfect ionic model and Born-Haber cycle values

2a $CaCl_2$ has similar values (between the perfect ionic model and Born-Haber cycle)

2b KCl has similar values (between the perfect ionic model and Born-Haber cycle)

2c $CaCl_2$ and KCl have (almost) perfect ionic bonding or + ions are point charges/(perfectly) spherical

Stage 3 difference in the perfect ionic model and Born-Haber cycle values

3a AgCl has larger difference in values (between the perfect ionic model and Born-Haber cycle)

3b AgCl contains (some) covalent character

3c Ag^+ more polarising/distorts electron cloud more

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