

Mark schemes

1



(b) (i) Enthalpy change for formation of 1 mol of substance
Allow heat energy change, NOT energy 1

From its elements 1

Reactants and products/all substances in their standard states
Or normal states at 298 K, 1 bar (100 kPa) 1



(iii) $\Delta H_f(\text{CaF}_2) = \Delta H_a(\text{Ca}) + 1\text{st IE}(\text{Ca}) + 2^{\text{nd}} \text{IE}(\text{Ca}) + \text{BE}(\text{F}_2) + 2 \times \text{EA}(\text{F}) - \Delta H_L(\text{CaF}_2)$
Or labelled diagram 1

$= 193 + 590 + 1150 + 158 + (2 \times -348) - 2602$ 1

$= -1207 \text{ kJ mol}^{-1}$
Correct answer scores 3

-842 scores 2 (transfer error)

-859 scores 1 only (using one E.A.)

Units not required, wrong units lose 1 mark 1

(c) Electrostatic attraction stronger/ionic bonding stronger/attraction
between ions stronger/more energy to separate ions
Molecular attraction/atoms/intermolecular forces CE=0 1

Because fluoride (ion) smaller than chloride
Do not allow F or fluorine 1

(d) (i) $\Delta H = \Delta H_L + \Sigma \Delta H_{\text{hyd}} = 2237 - 1650 + (2 \times -364)$
Can be on cycle/diagram 1

$= -141 \text{ kJ mol}^{-1}$
Correct answer scores 2
Units not required, wrong units lose 1 mark 1

(ii) Decreases
If ans to (d)(i) positive allow increases 1

Reaction exothermic/ ΔH -ve
If (d)(i) +ve allow endothermic/ ΔH + ve 1

(Equilibrium) shifts to left/backwards
(as temperature rises)/equilibrium
opposes the change
If (d) (i) +ve allow shifts to right/forwards/equilibrium opposes the change
If no answer to (d) (i) assume -ve ΔH used
If effect deduced incorrectly from any ΔH CE = 0 for these 3 marks 1

(e) u.v. absorbed: electrons/they move to higher energy
(levels)/electrons excited 1

visible light given out: electrons/they fall back down/move to
lower energy (levels)
Must refer to absorbing u.v. NOT visible light or this must be implied. 1

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(a) 242
Units not essential 1

(b) Bond is shorter or bonding pair closer to nucleus
Allow Cl is a smaller atom
Allow fewer electron shells
do not allow smaller molecules 1

So attraction (between nucleus and) (to) bond pair is stronger
Allow shared pair (or bonding electrons) held more tightly
Mention of Cl loses M2 1

(c) Net attraction between the chlorine nucleus and the extra electron
Allow Cl⁻ ion more stable than Cl 1

- (d) (i) step 1 $\text{Ag(s)} \rightarrow \text{Ag(g)}$ only change 1
- step 2 $\text{Ag(s)} \rightarrow \text{Ag}^+(\text{g}) + \text{e}^-$ only change 1
- step 3 $\frac{1}{2}\text{Cl}_2(\text{g}) \rightarrow \text{Cl(g)}$ only change
This step can be first, second or third 1
- (ii) $127 + 289 + 732 + 121 - 364$ 1
- $= 905 \text{ kJ mol}^{-1}$
-905 scores 1 mark only 1
- (e) (i) Ions can be regarded as point charges (or perfect spheres)
Allow no polarisation
OR *only bonding is ionic*
OR *no covalent character* 1
- (ii) Greater
Electronegativity argument or mention of intermolecular, CE = 0 1
- Chloride ions are smaller than bromide
Mark independently but see above 1
- They are attracted more strongly to the silver ions
Mark independently 1
- (iii) AgCl has covalent character
Ignore reference to molecules 1
- Forces in the lattice are stronger than pure ionic attractions
Allow stronger bonding OR additional/extra bonding 1

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- 3** (a) (i) $1s^2 2s^2 2p^6 3s^2 3p^6$ 1

- (ii) The negative S^- ion 1
- repels the added electron 1
- (iii) Step B is the atomisation enthalpy of sulphur 1
- Step D is the second ionisation enthalpy of calcium 1
- (iv) Electrons nearer to the nucleus 1
- Electrons removed from a positive species or more strongly attracted 1
- (v) $+178 + 279 + 590 + 1145 - 200 + 539 + G + 482 = 0$ 1
- $G + 3013 = 0$ hence $G = -3013$ 1
- (b) The model used assumes the ions are spherical and in a lattice 1
- The calculated value is smaller than the cycle value or stronger attraction 1
- Indicating some covalent character or ions are polarised 1
- (c) (i) For a reaction to occur $\Delta G < 0$ 1
- ΔS is positive and large as a gas is evolved 1
- $T\Delta S$ is larger than ΔH and ΔG is negative 1
- (ii) ΔS is negative 1
- Four moles gaseous reactant forming or more moles of gaseous product 1
- At high temperature $T\Delta S$ is larger than ΔH and ΔG is positive 1

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4	(a) $1s^2 2s^2 2p^6 3s^2 3p^6$	1
	(b) $S^-(g)$	1
	(c) The negative S^- ion repels the electron being added	1 1
	(d) (i) Enthalpy of atomisation of sulphur	1
	(ii) Second ionisation enthalpy of calcium	1
	(iii) Second electron affinity of sulphur	1
	(e) Electron more strongly attracted nearer to the nucleus or attracted by Ca^+ ion	1 1
	(f) Correct cycle e.g. $+ 178 + 279 + 590 + 1145 - 200 + E - 3013 + 482 = 0$ $= 539$	1 1
	Allow one mark for $- 539$	
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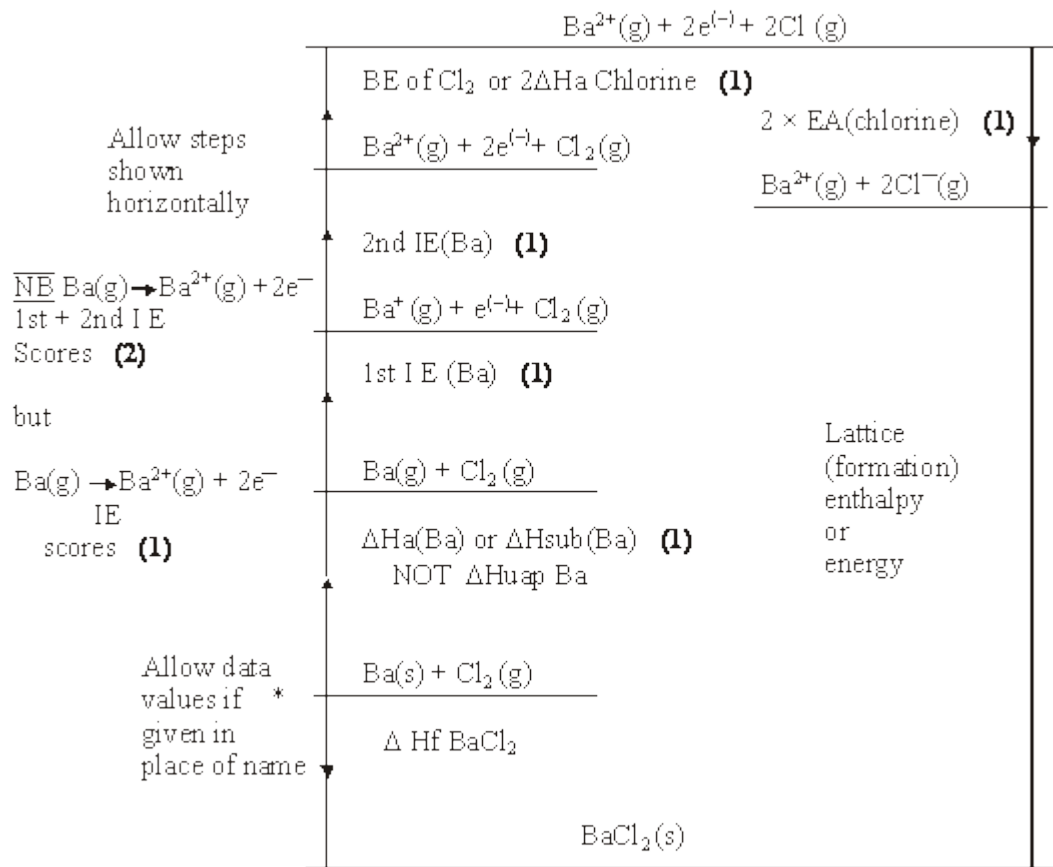
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- (a) (i) ΔH atomisation/sublimation of magnesium 1
- (ii) Bond/dissociation enthalpy of Cl-Cl
OR $2 \times H$ atomisation of chlorine 1
- (iii) Second ionisation enthalpy of magnesium 1
- (iv) $2 \times$ electron affinity of chlorine 1
- (v) Lattice formation enthalpy of $MgCl_2$ 1
- (b) Equation $2MgCl(s) \rightarrow MgCl_2(s) + Mg(s)$
State symbols not required but penalise if incorrect 1
- Calculation $\Delta H_{\text{reaction}} = \Sigma \Delta H_f \text{ products} - \Sigma \Delta H_f \text{ reactants}$ 1
- $= -653 - (2 \times -133)$ 1
- $= -427 \text{ (kJmol}^{-1}\text{)}$
Allow +427 to score (1) mark
Other answers; award (1) for a correct D H reaction expression 1
- (c) $\Delta H_{\text{soln}} MgCl_2 = -\Delta H_{\text{Lat.form.}} + \Delta H_{\text{hyd.Mg}^{2+}} + 2\Delta H_{\text{hyd.Cl}^-}$ 1
- or cycle
 $= 2502 - 1920 - (2 \times 364)$ 1
- $= -146 \text{ (kJmol}^{-1}\text{)}$
Allow + 146 to score (1) mark
Other answers; award (1) for a correct $\Delta H_{\text{soln}} MgCl_2$ expression/cycle 1

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(a) (i)



ONLY consider species involved in the step marked

(ii) Cycling clockwise about (*)
CE if step missing

$$\Delta H_a \text{Ba} + 1^{\text{st}} \text{IEBa} + 2^{\text{nd}} \text{IE Ba} + 2\Delta H_a \text{Cl} + 2\text{EA} \text{Cl} + \text{LE} - \Delta H_f \text{BaCl}_2 = 0 \quad (1)$$

$$+180 + 503 + 965 + 2 \times 122 + 2\text{EA} - 2056 + 859 = 0 \quad (1)$$

$$\text{EA} = -695/2 = - (347 \text{ to } 348) \quad (1)$$

Ignore units
Calculation -1 for each error
Mark conseq.

- Notes: -695 scores (2)
- +(347 to 348) scores (2)
- (286 to 287) scores (2)
- +(286 to 287) scores (1)
- 573 scores (1)
- +573 scores (0)

(b) $\Delta S = \Sigma S \text{ products} - \Sigma S \text{ reactants}$
 $= (63 + 223) - 124 = 162$ (1)

$\Delta G = \Delta H - T\Delta S$ or $\Delta H = T\Delta S$ or $T = \Delta H/\Delta S$ (1)
or used correctly

$\Delta H = 859 \times 10^3$ (1) = $T \times 162$

$T = (5\,300 \text{ to } 5304)$ K (1)

Penalise if units °C

-1 for each error + mark conseq.

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[1]

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[1]