M1. (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 $Ag(s) \rightarrow Ag(g)$ only change

1

step 2 $Ag(s) \rightarrow Ag^+(g) + e^-$ only change

1

step 3 $\frac{1}{2}Cl_2(g) \rightarrow Cl(g)$ only change

This step can be first, second or third

1

(ii) 127 + 289 + 732 + 121 – 364

1

= 905 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

[15]

M2. (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

[18]

M3. (a) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6$ **1**

(b) $S^-(g)$ **1**

(c) The negative S^- ion **1**

repels the electron being added **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 **1**

nearer to the nucleus or attracted by Ca^+ ion **1**

(f) Correct cycle

e.g. + 178 + 279 + 590 +1145 – 200 + E – 3013 + 482 = 0 **1**

= 539 **1**

Allow one mark for – 539

[11]

M4. (a) (i) Δ*H* atomisation/sublimation of magnesium

1

(ii) Bond/dissociation enthalpy of Cl-Cl

OR 2 × *H* atomisation of chlorine

1

(iii) Second ionisation enthalpy of magnesium

1

(iv) 2 × 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 Δ*H* reaction = $\Sigma\Delta H_f$ products – $\Sigma\Delta H_f$ reactants

1

= – 653 – (2 × –133)

1

= – 427 ($kJmol^{-1}$)

Allow +427 to score (1) mark

Other answers; award (1) for a correct ΔH reaction expression

1

(c) Δ*H* soln $MgCl_2$ = – Δ*H* Lat.form. + Δ*H* hyd.Mg^{2+} + 2Δ*H* hyd.Cl^-

1

or cycle

= 2502 – 1920 – (2 × 364)

1

= – 146 ($kJmol^{-1}$)

Allow + 146 to score (1) mark

Other answers; award (1) for a correct ΔH soln $MgCl_2$ expression/cycle

1

[12]

M5.A

[1]