

M1.(a) Enthalpy change when 1 mol of an (ionic) compound/lattice (under standard conditions)

Allow heat energy change

1

Is dissociated/broken/separated into its (component) ions

1

The ions being in the gaseous state (at infinite separation)

Mark independently. Ignore any conditions.

1

(b) There is an attractive force between the nucleus of an O atom and an external electron.

Allow any statement that implies attraction between the nucleus and an electron

1

(c) $\text{Mg}^{2+}(\text{g}) + \text{O}(\text{g}) + 2\text{e}^{-}$

Ignore lack of state symbols

Penalise incorrect state symbols

1

$\text{Mg}^{2+}(\text{g}) + \text{O}^{-}(\text{g}) + \text{e}^{-}$

1

$\text{Mg}^{2+}(\text{g}) + \text{O}^{2-}(\text{g})$

1

First new level for Mg^{2+} and O above last on L

If levels are not correct allow if steps are in correct order with arrows in the correct direction and correct ΔH values

1

Next level for Mg^{2+} and O^- below that

Next level for Mg^{2+} and O^{2-} above that and also above that for Mg^{2+} and O

Allow +124

Allow M4 with incorrect number of electrons

- (d) $\text{LE MgO} = 602 + 150 + 736 + 1450 + 248 - 142 + 844$
Note use of 124 instead of 248 CE=0

1

$= +3888 \text{ kJ mol}^{-1}$

Allow 1 for -3888

Allow no units

Penalise wrong units

1

- (e) Forms a protective layer/barrier of MgO / MgO prevents oxygen attacking Mg
Allow activation energy is (very) high
Allow reaction (very) slow

1

- (f) $\Delta G = \Delta H - T\Delta S$
 $\Delta S = \frac{(\Delta H - \Delta G)}{T}$

1

$$\Delta S = (-602 - (-570)) \times 1000 / 298$$

1

$$= -107 \text{ J K}^{-1} \text{ mol}^{-1} / -0.107 \text{ kJ K}^{-1} \text{ mol}^{-1}$$

If units not correct or missing, lose mark

Allow -107 to -108

+107 with correct units scores max 1/3

1

- (g) 1 mol of solid and 0.5 mol of gas reactants form 1 mol solid products
Decrease in number of moles (of gas/species)
Allow gas converted into solid

Numbers of moles/species, if given, must be correct

1

System becomes more ordered

Allow consequential provided ΔS is -ve in 1(f)

If ΔS is +ve in 1(f) can only score M1

1

[16]

M2. (a) (i) (Enthalpy change for formation of) 1 mol (of CaF_2) from its ions

allow heat energy change

do not allow energy or wrong formula for CaF_2

penalise 1 mol of ions

CE=0 if atoms or elements or molecules mentioned

ignore conditions

1

ions in the gaseous state

ions can be mentioned in M1 to score in M2

allow fluorine ions

$\text{Ca}^{2+}(\text{g}) + 2\text{F}(\text{g}) \rightarrow \text{CaF}_2$ scores M1 and M2

1

(ii) (enthalpy change when) 1 mol of gaseous (fluoride) ions (is converted) into aqueous ions / an aqueous solution

allow $\text{F}(\text{g}) \rightarrow \text{F}(\text{aq})$ (ignore + aq)

do not penalise energy instead of enthalpy

allow fluorine ions

do not allow F- ions surrounded by water

1

(b) water is polar / H on water is δ^+ / is electron deficient / is unshielded

1

penalise H+ on water 1 mark

(F- ions) attract water / δ^+ on H / hydrogen

allow H on water forms H-bonds with F-

allow fluorine ions

penalise co-ordinate bonds for M2
penalise attraction to O for M2

1

(c) $\Delta H = -(-2611) - 1650 + 2x - 506$

ignore cycles

M1 is for numbers and signs correct in expression

1

$= -51 \text{ (kJ mol}^{-1}\text{)}$

correct answer scores 2

ignore units even if incorrect

1

[7]

- M3.** (a) Enthalpy change for the formation of 1 mol of gaseous atoms
allow heat energy change for enthalpy change

1

From the element (in its standard state)

ignore reference to conditions

1

Enthalpy change to separate 1 mol of an ionic lattice/solid/compound

enthalpy change not required but penalise energy

1

Into (its component) gaseous ions

mark all points independently

1

(b) $\Delta H_L = -\Delta H_f + \Delta H_a + \text{I.E.} + 1/2E(\text{Cl-Cl}) + \text{EA}$

Or correct Born-Haber cycle drawn out

1

$= +411 + 109 + 494 + 121 - 364$

1

$= +771 \text{ (kJ mol}^{-1}\text{)}$

-771 scores 2/3

+892 scores 1/3

-51 scores 1/3
-892 scores zero
+51 scores zero ignore units

1

- (c) (i) Ions are perfect spheres (or point charges)

1

Only electrostatic attraction/no covalent interaction

mention of molecules/intermolecular forces/covalent bonds

CE = 0

allow ionic bonding only

If mention of atoms CE = 0 for M2

1

- (ii) Ionic

Allow no covalent character/bonding

1

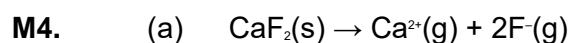
- (iii) Ionic with additional covalent bonding

Or has covalent character/partially covalent

Allow mention of polarisation of ions or description of polarisation

1

[11]



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

[17]