Q1.

1 Magnesium is used extensively in the form of alloys as a constructional material due to its low density (1.7 g cm^{-3}, compared to 7.8 g cm^{-3} for iron). It is usually prepared by the electrolysis of magnesium chloride, $MgCl_2$, at a temperature a little above its melting point of 715 °C.

(a) Suggest the half-equation that represents the production of magnesium at the cathode during the electrolysis.

....[1]

(b) What will be the product at the other electrode?

....[1]

(c) Suggest **two** properties of its atoms that could explain why magnesium is less dense than iron.

....

....[2]

One of the reasons the melting point of magnesium chloride is quite high is because it has a fairly high lattice energy.

(d) **(i)** Explain the term *lattice energy*.

....

....

(ii) Write a balanced equation including state symbols to represent the lattice energy of magnesium chloride.

....

....[4]

(e) Suggest, with an explanation in each case, how the lattice energy of magnesium chloride might compare with that of

(i) sodium chloride, $NaCl$,

....

....

(ii) calcium chloride, $CaCl_2$.

....

....[4]

(f) Use the following data to calculate a value for the lattice energy of sodium chloride.

ΔH_f (NaC*l*)	=	$-411\ kJ\ mol^{-1}$
ΔH_{at} (Na)	=	$107\ kJ\ mol^{-1}$
ΔH_{at} (C*l*)	=	$122\ kJ\ mol^{-1}$
first ionisation energy of Na	=	$494\ kJ\ mol^{-1}$
electron affinity of C*l*	=	$-349\ kJ\ mol^{-1}$

lattice energy of NaC*l* = ... $kJ\ mol^{-1}$ [3]

[Total: 15]

Q2.

3 Limestone is an important raw material, used in building, steel making and agriculture.

The first stage in using limestone is often to heat it in a kiln.

$CaCO_3(s) \longrightarrow CaO(s) + CO_2(g)$ $\Delta H = +178\ kJ\ mol^{-1}$ reaction **1**

Water is then added to the 'quicklime' produced in the kiln, to make 'slaked lime'.

$CaO(s) + H_2O(l) \longrightarrow Ca(OH)_2(s)$ $\Delta H = -82\ kJ\ mol^{-1}$ reaction **2**

(a) **(i)** Suggest **two** reasons why reaction **1** needs heating to a high temperature.

....

....

(ii) Explain whether $MgCO_3$ would require a higher or a lower temperature than $CaCO_3$ for its decomposition.

....

....

....

[5]

Before the widespread use of cement, bricks and stones used for buildings were bonded together with a mixture of slaked lime, sand and water, known as lime mortar. On exposure to the air, the lime mortar gradually set hard due to the following reaction.

$$Ca(OH)_2(s) + CO_2(g) \longrightarrow CaCO_3(s) + H_2O(l)$$

(b) Use the data given above to calculate the enthalpy change for this reaction.

....

....

.... [1]

(c) One of the major ores of magnesium is the mixed carbonate called dolomite, $CaMg(CO_3)_2$.

Calculate the percentage loss in mass that would be observed when a sample of dolomite is heated at a high temperature until the reaction had finished.

....

....

.... [2]

[Total: 8]

Q3.

(c) Use the following data, together with relevant data from the *Data Booklet*, to construct a Born-Haber cycle and calculate a value for the lattice energy of zinc chloride.

standard enthalpy change of formation of $ZnCl_2$	–415 kJ mol^{-1}
standard enthalpy change of atomisation of Zn(s)	+131 kJ mol^{-1}
electron affinity per mole of chlorine atoms	–349 kJ mol^{-1}

lattice energy = ... kJ mol^{-1} [3]

Q4.

2 **(a)** Describe and explain how the solubilities of the sulfates of the Group II elements vary down the group.

For Examiner's Use

....

....

....

....

....

....[3]

(b) The following table lists some enthalpy changes for magnesium and strontium compounds.

enthalpy change	value for magnesium / $kJ\,mol^{-1}$	value for strontium / $kJ\,mol^{-1}$
lattice enthalpy of $\boldsymbol{M}(OH)_2$	–2993	–2467
enthalpy change of hydration of $\boldsymbol{M}^{2+}(g)$	–1890	–1414
enthalpy change of hydration of $OH^-(g)$	–550	–550

(i) Use the above data to calculate values of $\Delta H^{\ominus}_{solution}$ for $Mg(OH)_2$ and for $Sr(OH)_2$.

$Mg(OH)_2$ ....

....

$\Delta H^{\ominus}_{solution}$ = ... $kJ\,mol^{-1}$

$Sr(OH)_2$ ....

....

$\Delta H^{\ominus}_{solution}$ = ... $kJ\,mol^{-1}$

(ii) Use your results in **(i)** to suggest whether $Sr(OH)_2$ is more or less soluble in water than is $Mg(OH)_2$. State any assumptions you make.

....

....

(iii) Suggest whether $Sr(OH)_2$ would be more or less soluble in hot water than in cold. Explain your reasoning.

....

....

[5]

(c) Calcium hydroxide, $Ca(OH)_2$, is slightly soluble in water.

For Examiner's Use

(i) Write an expression for K_{sp} for calcium hydroxide, and state its units.

K_{sp} = units ....

(ii) 25.0 cm³ of a saturated solution of $Ca(OH)_2$ required 21.0 cm³ of 0.0500 mol dm⁻³ HC*l* for complete neutralisation.

Calculate the $[OH^-(aq)]$ and the $[Ca^{2+}(aq)]$ in the saturated solution, and hence calculate a value for K_{sp}.

$[OH^-(aq)]$ = ...

$[Ca^{2+}(aq)]$ = ...

K_{sp} = ...

(iii) How would the solubility of $Ca(OH)_2$ in 0.1 mol dm^{-3} NaOH compare with that in water?
Explain your answer.

....

....
[6]

[Total: 14]

Q5.

1 Taken together, nitrogen and oxygen make up 99% of the air. Oxygen is by far the more reactive of the two gases, and most of the substances that react with air combine with the oxygen rather than with the nitrogen.

(a) State **one** reason why the molecule of nitrogen, N_2, is so unreactive.

....[1]

Despite the apparent lack of reactivity of N_2, nitrogen atoms have been found to form bonds with almost all of the elements in the Periodic Table. Lithium metal reacts with nitrogen gas at room temperature to give lithium nitride, Li_3N. Magnesium produces magnesium nitride, Mg_3N_2, as well as magnesium oxide, when heated in air.

(b) Calculate the lattice energy of magnesium nitride using the following data, in addition to relevant data from the *Data Booklet*.

enthalpy change	value/kJ mol^{-1}
atomisation of Mg(s)	+148
total of electron affinities for the change $N(g) \longrightarrow N^{3-}(g)$	+2148
enthalpy of formation of $Mg_3N_2(s)$	–461

lattice energy = ...kJ mol^{-1} [3]

(c) Lithium reacts readily with nitrogen, and because of this Li_3N has been considered as a possible intermediate in the 'fixing' of nitrogen to make ammonia-based fertilisers.

For Examiner Use

$$N_2(g) \xrightarrow{+\,Li} Li_3N \xrightarrow{+\,H_2O} NH_3 + \mathbf{A}$$

(i) Construct an equation for the reaction between Li_3N and H_2O, and hence identify compound **A**.

....

(ii) Using your knowledge of the Haber process, consider **one** advantage and **one** disadvantage of using lithium as a means of fixing nitrogen, rather than the Haber process.

advantage of the lithium method

....

disadvantage of the lithium method

....

[3]

(d) Another possible advantage of Li_3N is that it contains a large percentage by mass of nitrogen. Another fertiliser that contains a large percentage by mass of nitrogen is urea, NH_2CONH_2.

(i) Calculate and compare the percentages by mass of nitrogen in Li_3N and NH_2CONH_2.

....

....

....

(ii) What *class* of organic compound is urea?

....

(iii) Write an equation for the production of ammonia by the reaction between urea and water.

....

(iv) Urea can be applied directly to the soil either before or during the growing of crops.
What would be a major **disadvantage** of using lithium nitride in this way?

....

....

[5]

[Total: 12]

Q6.

1 **(a)** **(i)** What is meant by the term *lattice energy*?

....

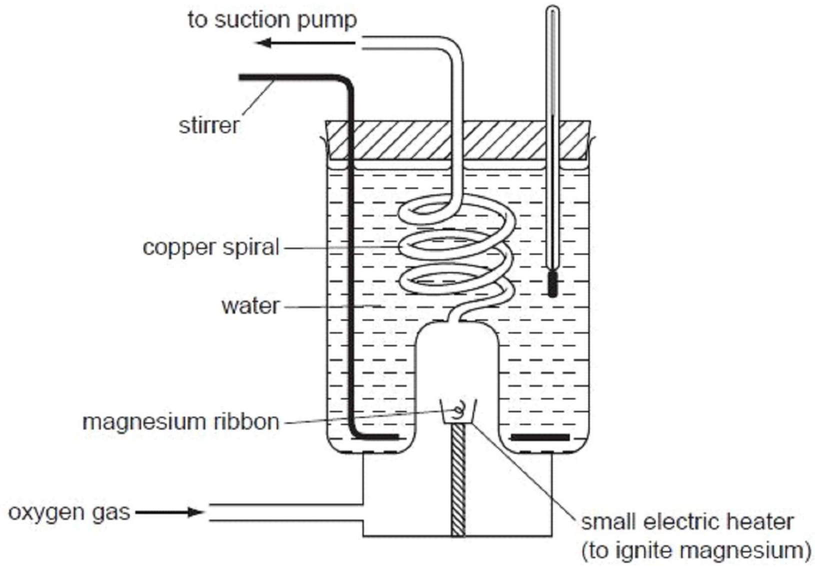
....

(ii) Write an equation to represent the lattice energy of MgO.

....

[3]

(b) The apparatus shown in the diagram can be used to measure the enthalpy change of formation of magnesium oxide, $\Delta H_f^\ominus(MgO)$.



List the measurements you would need to make using this apparatus in order to calculate $\Delta H_f^\ominus(MgO)$.

....

....

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.... [3]

(c) Use the following data, together with appropriate data from the *Data Booklet*, to calculate a value of $\Delta H_f^\ominus$(MgO).

For Examiner's Use

lattice energy of MgO(s)	=	–3791 kJ mol^{-1}
enthalpy change of atomisation of Mg	=	+148 kJ mol^{-1}
electron affinity of the oxygen atom	=	–141 kJ mol^{-1}
electron affinity of the oxygen anion, O^-	=	+798 kJ mol^{-1}

$\Delta H_f^\ominus$(MgO) = ... kJ mol^{-1}
[3]

(d) Write equations, including state symbols, for the reactions, if any, of the following two oxides with water. Suggest values for the pH of the resulting solutions.

oxide	equation	pH of resulting solution
Na_2O		
MgO		

[3]

[Total: 12]

Q7.

1 (a) (i) What is meant by the term *enthalpy change of hydration*, $\Delta H^{\ominus}_{hyd}$?

....

....

(ii) Write an equation that represents the $\Delta H^{\ominus}_{hyd}$ of the Mg^{2+} ion.

....

(iii) Suggest a reason why $\Delta H^{\ominus}_{hyd}$ of the Mg^{2+} ion is greater than $\Delta H^{\ominus}_{hyd}$ of the Ca^{2+} ion.

....

....

(iv) Suggest why it is impossible to determine the enthalpy change of hydration of the oxide ion, O^{2-}.

....

....

[5]

(b) The enthalpy change of solution for $MgCl_2$, $\Delta H^{\ominus}_{sol}(MgCl_2(s))$, is represented by the following equation.

$$MgCl_2(s) + aq \rightarrow Mg^{2+}(aq) + 2Cl^-(aq)$$

Describe the simple apparatus you could use, and the measurements you would make, in order to determine a value for $\Delta H^{\ominus}_{sol}(MgCl_2(s))$ in the laboratory.

....

....

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....

....

.... [4]

(c) The table below lists data relevant to the formation of $MgCl_2(aq)$.

enthalpy change	value / kJ mol^{-1}
$\Delta H_f^\circ(MgCl_2(s))$	–641
$\Delta H_f^\circ(MgCl_2(aq))$	–801
lattice energy of $MgCl_2(s)$	–2526
$\Delta H_{hyd}^\circ(Mg^{2+}(g))$	–1890

By constructing relevant thermochemical cycles, use the above data to calculate a value for

(i) $\Delta H_{sol}^\circ(MgCl_2(s))$,

ΔH_{sol}° = ... kJ mol^{-1}

(ii) $\Delta H_{hyd}^\circ(Cl^-(g))$.

ΔH_{hyd}° = ... kJ mol^{-1}

[3]

(d) Describe and explain how the solubility of magnesium sulfate compares to that of barium sulfate.

....

....

....

....

.... [4]

[Total: 16]

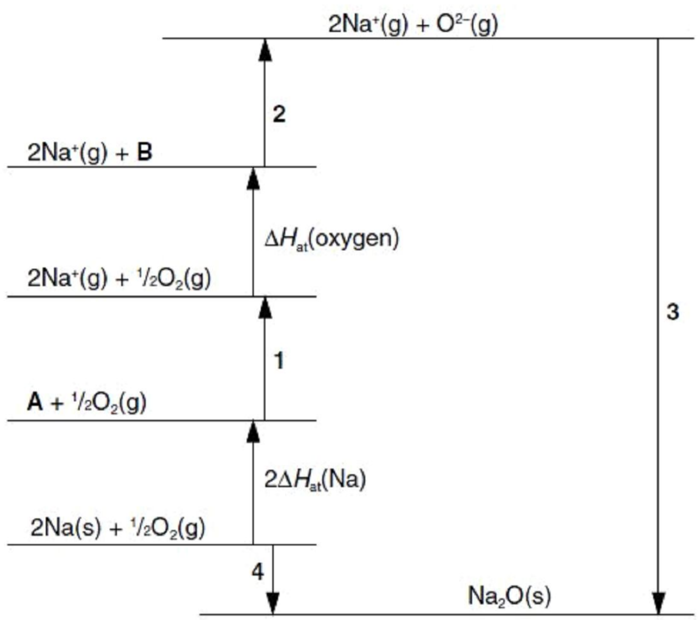
Q8.

use

2 (a) Write an equation to represent the lattice energy of sodium oxide, Na_2O.

....[1]

(b) The Born-Haber cycle shown may be used to calculate the lattice energy of sodium oxide.



(i) In the spaces below, identify the species **A** and **B** in the cycle, including the appropriate state symbols.

species **A** .... species **B** ....

(ii) Identify the enthalpy changes labelled by the numbers **1** to **4** in the cycle.

1 ....

2 ....

3 ....

4 ....

[3]

Use

(c) Use your cycle, the following data, and further data from the *Data Booklet* to calculate a value for the lattice energy of sodium oxide.

Data:	enthalpy change of atomisation for Na(s)	$+107\ kJ\ mol^{-1}$
	first electron affinity of oxygen	$-141\ kJ\ mol^{-1}$
	second electron affinity of oxygen	$+798\ kJ\ mol^{-1}$
	enthalpy change of formation of $Na_2O(s)$	$-414\ kJ\ mol^{-1}$
	enthalpy change of atomisation for oxygen = half the bond energy for O_2.	

[3]

(d) **(i)** How would you expect the magnitude of lattice energy of magnesium oxide to compare with that of sodium oxide? Explain your reasoning.

....

....

....

(ii) State a use of magnesium oxide, and explain how the use relates to your answer in part **(d) (i)**.

....

....

[4]

[Total: 11]

Q9.

6 Many millions of tonnes of limestone, $CaCO_3$, are quarried each year for use in the steel industries of the world, and in agriculture. For use in agriculture, the limestone is often decomposed by heating it in limekilns, and then adding water.

(a) Write balanced equations representing the following two processes.

(i) heating limestone

....

(ii) then adding water

....
[2]

(b) Describe the agricultural use of the product of this process.

....

....
[1]

(c) Describe and explain the trend observed in the thermal stabilities of the carbonates of Group II.

....

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....

....
[3]

[Total : 6]

Q10.

3 Calcium sulphate is a major by-product of flue gas desulphurisation, which is an important method of decreasing the emission of acid-rain gases from power stations. It is used extensively in plaster and cement. Both magnesium sulphate and barium sulphate find uses in medicine.

Describe and explain the variation in the solubilities of the Group II sulphates in water.

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.... [4]

[Total: 4]

Q11.

(c) **(i)** Write a chemical equation representing the lattice energy of AgBr.

....

(ii) Use the following data to calculate a value for the lattice energy of AgBr(s).

first ionisation energy of silver	=	$+731\ \text{kJ mol}^{-1}$
electron affinity of bromine	=	$-325\ \text{kJ mol}^{-1}$
enthalpy change of atomisation of silver	=	$+285\ \text{kJ mol}^{-1}$
enthalpy change of atomisation of bromine	=	$+112\ \text{kJ mol}^{-1}$
enthalpy change of formation of AgBr(s)	=	$-100\ \text{kJ mol}^{-1}$

....

(iii) How might the lattice energy of $AgCl$ compare to that of AgBr? Explain your answer.

....

....

....
[4]

In photography a bromide ion absorbs a photon and releases an electron which reduces a silver ion to a silver atom.

$$Br^- \longrightarrow Br + e^-$$

$$Ag^+ + e^- \longrightarrow Ag$$

(d) Predict whether it would require **more** energy or **less** energy to initiate this process in a $AgCl$ emulsion, compared to a AgBr emulsion. Explain your answer.

....

....

.... [1]

Q12.

3 **(a)** **(i)** Write an equation showing the thermal decomposition of calcium nitrate, $Ca(NO_3)_2$.

....

(ii) State and explain how the thermal stabilities of the nitrates vary down Group II.

....

....

....

....

[4]

(b) The nitrates of calcium, strontium or barium are often added to firework mixtures to produce red or green flames. The equation for the decomposition of one such mixture is as follows.

$$Sr(NO_3)_2(s) + 3C(s) \longrightarrow SrO(s) + N_2(g) + 2CO_2(g) + CO(g)$$

Calculate the volume of gas given off (measured at room temperature and pressure) when a 10.0 g sample of this mixture decomposes. [M_r: $Sr(NO_3)_2$, 211.6]

....

....

.... [2]

(c) Explain in detail how carbon monoxide, produced in this reaction, is poisonous.

....

....

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.... [2]

[Total: 8]

Q13.

2 (a) Describe and explain the trend in the solubilities of the sulphates of the Group II elements.

....

....

....

....

....[4]

(b) The salts formed by the Group II elements with other divalent anions show a similar trend in their solubilities, whereas most of their salts with monovalent anions are very soluble.

Use this information to predict the identities of compounds **A** and **B** in the following description of some reactions of Group II compounds, and write balanced equations for the reactions.

Magnesium hydroxide, $Mg(OH)_2$, is almost insoluble in water. Stirring a mixture of magnesium hydroxide and aqueous ethanedioic acid, $H_2C_2O_4$, produces a clear colourless solution containing **A**. When a solution of calcium nitrate, $Ca(NO_3)_2$, is added, a white precipitate of **B** is formed.

identity of **A** .... identity of **B** ....

equations ....

....[3]

(c) The solubility product, K_{sp}, of magnesium hydroxide has a numerical value of 2.0×10^{-11}.

(i) Write an expression for the K_{sp} of magnesium hydroxide, stating its units.

....

(ii) Use the value of K_{sp} given to calculate the concentration of $Mg(OH)_2$ in a saturated solution.

....

....

(iii) Explain whether magnesium hydroxide would be more or less soluble in 0.1 mol dm^{-3} $MgSO_4(aq)$ than in water.

....

....

[5]

[Total: 12]

Q14.

3 (a) (i) Describe and explain the trend observed in the thermal stability of the carbonates of the Group II elements.

....

....

....

....

....

(ii) By quoting suitable data from the *Data Booklet* suggest how the thermal stabilities of

- zinc carbonate and
- lead carbonate

might compare to that of calcium carbonate.

....

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....
[6]

Q15.

For Examiner's Use

2 Calcium chloride, $CaCl_2$, is an important industrial chemical used in refrigeration plants, for de-icing roads and for giving greater strength to concrete.

(a) Show by means of an equation what is meant by the lattice energy of calcium chloride.

.... [1]

(b) Suggest, with an explanation, how the lattice energies of the following salts might compare in magnitude with that of calcium chloride.

(i) calcium fluoride, CaF_2

....

....

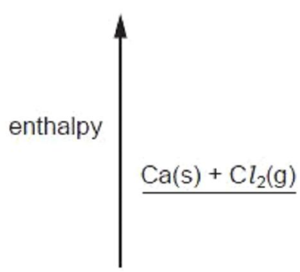
(ii) calcium sulfide, CaS

....

....
[3]

(c) Use the following data, together with additional data from the *Data Booklet*, to calculate the lattice energy of $CaCl_2$.

standard enthalpy change of formation of $CaCl_2$	$-796\ kJ\ mol^{-1}$
standard enthalpy change of atomisation of Ca(s)	$+178\ kJ\ mol^{-1}$
electron affinity per mole of chlorine atoms	$-349\ kJ\ mol^{-1}$



lattice energy = ... $kJ\ mol^{-1}$ [3]

(d) When a solution of $CaCl_2$ is added to a solution of the dicarboxylic acid, malonic acid, the salt calcium malonate is precipitated as a white solid. The solid has the following composition by mass: Ca, 28.2%; C, 25.2%; H, 1.4%; O, 45.2%.

For Examiner's Use

(i) Calculate the empirical formula of calcium malonate from these data.

(ii) Suggest the structural formula of malonic acid.

[3]

[Total: 10]

Q16.

1 **(a)** Describe and explain qualitatively the trend in the solubilities of the sulfates of the Group II elements.

....

....

....

....[3]

(b) The major ore of barium is barytes, $BaSO_4$. This is very unreactive, and so other barium compounds are usually made from the sulfide, BaS. This is obtained by heating the crushed ore with carbon, and extracting the BaS with water.

$$BaSO_4(s) + 4C(s) \longrightarrow BaS(s) + 4CO(g)$$

When 250 g of ore was heated in the absence of air with an excess of carbon, it was found that the CO produced took up a volume of 140 dm^3 at 450 K and 1 atm.

(i) Calculate the number of moles of CO produced.

....

(ii) Calculate the number of moles of $BaSO_4$ in the 250 g sample of the ore.

....

(iii) Calculate the percentage by mass of $BaSO_4$ in the ore.

....

[4]

(c) **(i)** Use the following data and data from the *Data Booklet* to construct a Born-Haber cycle and calculate the lattice energy of BaS.

standard enthalpy change of formation of BaS(s)	$-460\,kJ\,mol^{-1}$
standard enthalpy change of atomisation of Ba(s)	$+180\,kJ\,mol^{-1}$
standard enthalpy change of atomisation of S(s)	$+279\,kJ\,mol^{-1}$
electron affinity of the sulfur atom	$-200\,kJ\,mol^{-1}$
electron affinity of the S^- ion	$+640\,kJ\,mol^{-1}$

F
Exan
U

lattice energy = ... kJ mol^{-1}

(ii) Explain whether the magnitude of the lattice energy of BaS is likely to be greater or less than that of BaO.

....

....

[4]

[Total: 11]

Q17.

4 **(a)** What is meant by the term *bond energy*?

For Examiner's Use

....

.... [2]

(b) Describe and explain what is observed when a red-hot wire is plunged into separate samples of the gaseous hydrogen halides HCl and HI.
How are bond energy values useful in interpreting these observations?

....

....

....

.... [3]

(c) The following reaction occurs in the gas phase.

$$3F_2(g) + Cl_2(g) \longrightarrow 2ClF_3(g), \qquad \Delta H_r^{\ominus} = -328\,\text{kJ mol}^{-1}$$

Use these and other data from the *Data Booklet* to calculate the average bond energy of the Cl-F bond in ClF_3. [2]

[Total: 7]

Q18.

1 **(a)** The halogens chlorine and bromine react readily with hydrogen.

$$X_2(g) + H_2(g) \longrightarrow 2HX(g) \qquad [X = Cl \text{ or } Br]$$

(i) Describe how you could carry out this reaction using chlorine.

....

(ii) Describe **two** observations you would make if this reaction was carried out with bromine.

....

....

(iii) Use bond energy data from the *Data Booklet* to calculate the $\Delta H^{\ominus}$ for this reaction when

X = C*l*,

$\Delta H^{\ominus}$ = ... kJ mol^{-1}

X = Br.

$\Delta H^{\ominus}$ = ... kJ mol^{-1}

(iv) What is the major reason for the difference in these two $\Delta H^{\ominus}$ values?

....

[8]

(b) Some halogens also react readily with methane.

For Examiner's Use

$$CH_4(g) + X_2(g) \longrightarrow CH_3X(g) + HX(g)$$

(i) What conditions are needed to carry out this reaction when X is bromine, Br?

....

(ii) Use bond energy data from the *Data Booklet* to calculate the $\Delta H^{\ominus}$ of this reaction for the situation where X is iodine, I.

$\Delta H^{\ominus}$ = ... kJ mol^{-1}

(iii) Hence suggest why it is not possible to make iodomethane, CH_3I, by this reaction.

....

[4]

(c) Halogenoalkanes can undergo *homolytic fission* in the upper atmosphere.

(i) Explain the term *homolytic fission*.

....

....

(ii) Suggest the most likely organic radical that would be formed by the homolytic fission of bromochloromethane, CH_2BrCl. Explain your answer.

....

....

....

[3]

(d) The reaction between propane and chlorine produces a mixture of many compounds, four of which are structural isomers with the molecular formula $C_3H_6Cl_2$.
Draw the structural or skeletal formulae of these isomers, and indicate any chiral atoms with an asterisk (*).

[3]

[Total: 18]

Q19.

For Examiner's Use

4 **(a)** Write an equation representing the action of heat on calcium nitrate, $Ca(NO_3)_2$.

.... [1]

(b) Describe and explain the trend in the thermal stabilities of the nitrates of the Group II elements.

....

....

....

....

.... [3]

(c) Sodium carbonate is stable to heat, but heating lithium carbonate readily produces $CO_2(g)$.

(i) Suggest an equation for the action of heat on lithium carbonate.

....

(ii) Suggest a reason for the difference in reactivity of these two carbonates.

....

....

(iii) Predict what you would see if a sample of lithium nitrate was heated. Explain your answer.

....

....

.... [4]

[Total: 8]

Q20.

1 **(a)** Gaseous ammonia reacts with gaseous hydrogen chloride to form solid ammonium chloride.

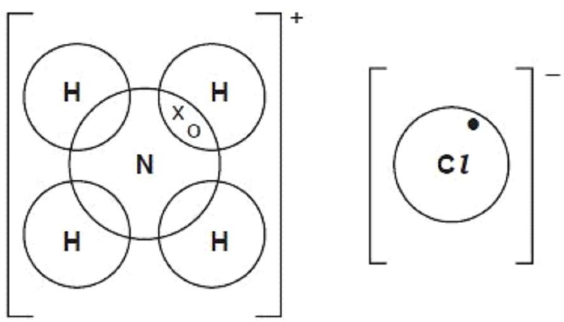
$$NH_3 + HCl \rightarrow NH_4Cl$$

The bonding in ammonium chloride includes ionic, covalent and co-ordinate (dative covalent) bonds.

Complete the following 'dot-and-cross' diagram of the bonding in ammonium chloride. For **each** of the six atoms show **all** the electrons in its outer shell. Three electrons have already been included.

Use the following code for your electrons.

- ● electrons from chlorine
- x electrons from hydrogen
- o electrons from nitrogen



[3]

(b) When a sample of dry ammonia is needed in the laboratory, the gas is passed through a tower containing lumps of solid calcium oxide, CaO.

(i) Suggest why the usual drying agent for gases, concentrated H_2SO_4, is **not** used for ammonia.

....

(ii) Write an equation for the reaction between CaO and H_2O.

....

(iii) Suggest why CaO rather than MgO is used to dry ammonia.

....

[3]

(c) (i) Write an equation showing the thermal decomposition of calcium nitrate, $Ca(NO_3)_2$.

....

(ii) State and explain how the thermal stabilities of the nitrates vary down Group II.

....

....

....

.... [4]

[Total: 10]

For Examiner Use

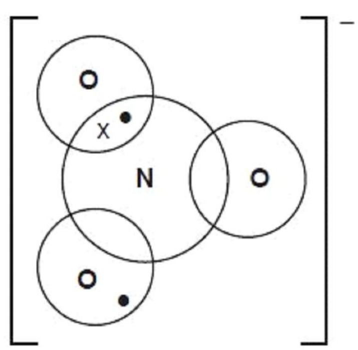
Q21.

1 (a) The nitrate ion, NO_3^-, contains a dative covalent bond.

Complete the following 'dot-and-cross' diagram of the bonding in the nitrate ion. For **each** of the four atoms show **all** the electrons in its outer shell. Three electrons have already been included.

Use the following code for your electrons.

- ● electrons from oxygen
- x electrons from nitrogen
- □ added electron(s) responsible for the overall negative charge



[3]

(b) (i) Write an equation showing the action of heat on magnesium nitrate, $Mg(NO_3)_2$.

....

(ii) Describe and explain the trend that is observed in the thermal stabilities of the Group II nitrates.

....

....

....

....
[4]

(c) When concentrated nitric acid, HNO_3, is added to copper turnings, a brown gas is evolved. Use data from the *Data Booklet* to construct an ionic equation for this reaction.

....

....
[2]

[Total: 9]