Neap:

Trial Examination 2018

VCE Chemistry Units 1&2

Written Examination

Question and Answer Booklet

Reading time: 15 minutes
Writing time: 2 hours 30 minutes

Student's Name: _____

Teacher's Name: _____

Structure of booklet

Section	*Number of questions*	*Number of questions to be answered*	*Number of marks*	*Suggested time (minutes)*
A	30	30	30	40
B	9	9	90	110
			Total 120	Total 150

Students are permitted to bring into the examination room: pens, pencils, highlighters, erasers, sharpeners, rulers and one scientific calculator.
Students are NOT permitted to bring into the examination room: blank sheets of paper and/or correction fluid/tape.

Materials supplied

Question and answer booklet of 25 pages

Data booklet

Answer sheet for multiple-choice questions

Instructions

Write **your name** and your **teacher's name** in the space provided above on this booklet and in the space provided on the answer sheet for multiple-choice questions.

Unless otherwise indicated, the diagrams in this booklet are **not** drawn to scale.

All written responses must be in English.

At the end of the examination

Place the answer sheet for multiple-choice questions inside the front cover of this booklet.
You may keep the data booklet.

Students are NOT permitted to bring mobile phones and/or any other unauthorised electronic devices into the examination room.

SECTION A – MULTIPLE-CHOICE QUESTIONS

Instructions for Section A

Answer **all** questions in pencil on the answer sheet provided for multiple-choice questions.

Choose the response that is **correct** or that **best answers** the question.

A correct answer scores 1; an incorrect answer scores 0.

Marks will **not** be deducted for incorrect answers.

No marks will be given if more than one answer is completed for any question.

Unless otherwise indicated, the diagrams in this book are **not** drawn to scale

Question 1

A particular metal produces hydrogen gas when reacted with cold water or with dilute hydrochloric acid.

It is likely that this metal

A. will react very slowly in air when heated to form an oxide layer.

B. could be either of the elements silver or gold.

C. reacts readily with steam to give hydrogen gas.

D. does not react with oxygen regardless of the conditions.

Use the following information to answer Questions 2 and 3.

A mixture of sand (SiO_2) and salt (NaCl) was separated by adding water to dissolve the salt, and then filtering the liquid. Half of the filtrate was allowed to dry in air and the other half was dried in an oven at 100°C.

Question 2

Which one of the following is the best description of the structure of SiO_2?

A. discrete molecules in which the atoms are held together by covalent bonds

B. a lattice of positive and negative ions held together by electrostatic attraction

C. a giant network lattice of silicon and oxygen atoms held together by covalent bonds

D. molecules of SiO_2 arranged in an array with dispersion forces between the molecules

Question 3

Which filtrate would produce smaller crystals of NaCl?

A. the filtrate dried in air

B. the filtrate dried in the oven

C. Both filtrates would produce crystals of the same size.

D. No deduction about crystal size can be made without using a magnifying glass to examine the crystals.

Use the following information to answer Questions 4 and 5.

The element antimony (Sb) has an atomic number of 51.

Question 4

In the ion $^{121}Sb^{2+}$ the number of neutrons and electrons, respectively, are

A. 70 and 49.
B. 70 and 53
C. 121 and 49.
D. 121 and 53.

Question 5

Which one of the following statements concerning antimony is correct?

A. The electronegativity of antimony is greater than that of nitrogen (N) (Z = 7).
B. The atomic radius of antimony is greater than that of rubidium (Rb) (Z = 37).
C. The metallic character of antimony is greater than that of phosphorus (P) (Z = 15).
D. The first ionisation energy of antimony is greater than that of xenon (Xe) (Z = 54).

Question 6

Which one of the following is a major **disadvantage** in the use of polymer materials?

A. Very little modification to the properties of a polymer is possible.
B. The cost of an item is much greater than an identical item made from other materials.
C. The main source of the raw materials used to make polymers is limited.
D. When subjected to very high temperatures, the polymer materials decompose.

Question 7

Which one of the following correctly gives the molecules with their corresponding shape?

	V-shaped	Tetrahedral
A.	HF	NH_3
B.	CO_2	SiH_4
C.	N_2	SF_6
D.	H_2S	CCl_4

Question 8

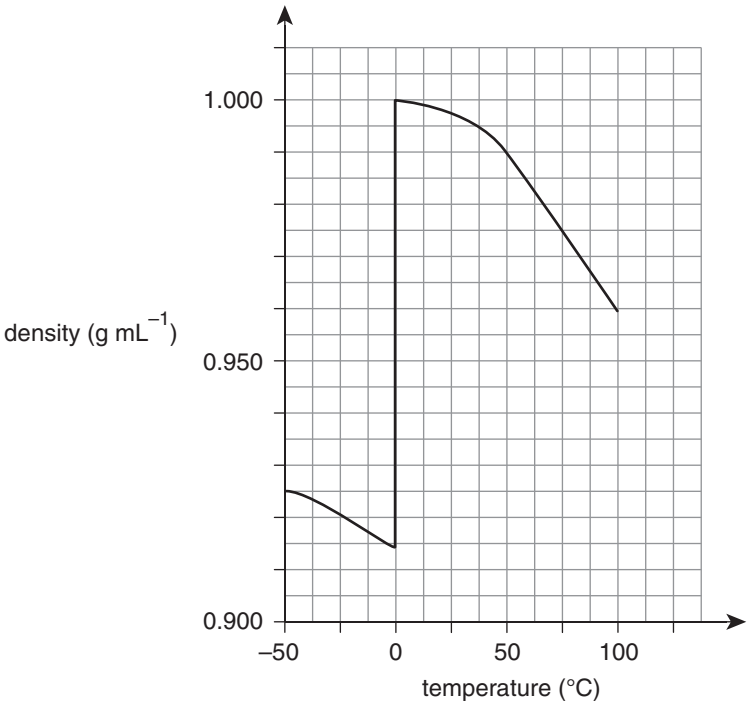
There are limitations in using the ionic bonding model to explain the properties of an ionic compound.

Which one of the following is **not** easily explained using the model?

A. the ability to conduct electricity in different states
B. hardness with a tendency to shatter in certain situations
C. that melting generally requires high temperatures
D. that some ionic compounds are insoluble in water

Use the following information to answer Questions 9 and 10.

The variation of the density of water with temperature is shown in the graph below.



Question 9

Consider the following statements which relate to the data in the graph.

I Water at 75°C will float on water at 25°C.

II Changing the temperature of water from –50°C to –25°C requires energy to be removed and results in a decrease in density.

III Water molecules in ice are packed closer together than water molecules in liquid water at 0°C.

Which of these statements are **incorrect**?

A. I and II only
B. II and III only
C. I and III only
D. I, II and III

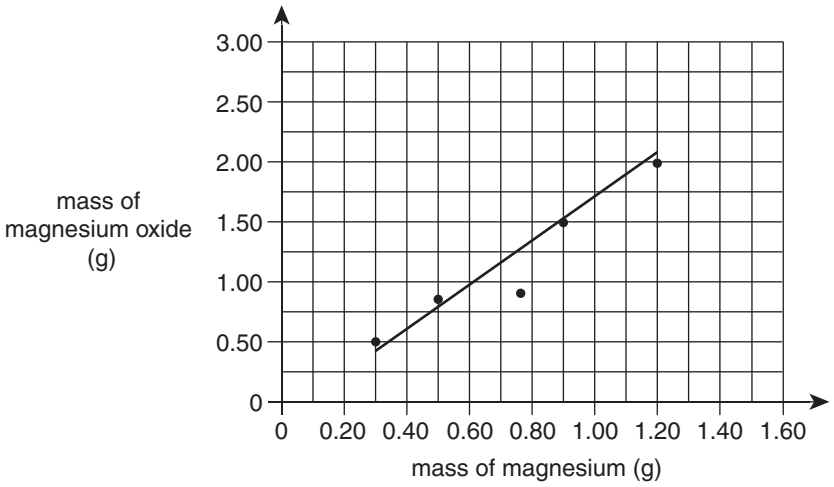
Question 10

Which type of interaction would be disrupted as water is being heated from 0°C to 50°C?

A. hydrogen bonding only
B. hydrogen bonding and dispersion forces only
C. covalent bonds and dispersion forces only
D. covalent bonds, hydrogen bonding and dispersion forces

Use the following information to answer Questions 11 and 12.

To confirm the empirical formula of magnesium oxide (MgO), a known mass of pure magnesium ribbon was burnt in oxygen gas. The product was cooled and weighed to find the mass of oxygen which had reacted with the magnesium. The experiment was repeated with different masses of magnesium ribbon and the results were graphed as shown below.



Question 11

If 3.29 g of magnesium ribbon had been burnt in oxygen, how many grams of oxygen gas would be expected to be used in the reaction?

A. 1.09
B. 2.17
C. 3.29
D. 5.46

Question 12

One of the values in the graph does not fit with the trend of the other values.

Which one of the following is **not** a possible explanation for the value which does not fit?

A. Some magnesium oxide was lost during the experiment.
B. The mass of magnesium ribbon was recorded incorrectly.
C. A portion of magnesium ribbon was left unreacted.
D. An excess of oxygen gas was used in the reaction.

Question 13

The results of an investigation into the properties of a carbon-based polymer sample are shown in the table below.

Appearance	flexible and clear
Strength	strip of sample stretches and breaks when 500 g weight is attached
Heated rod applied	softens when heated polymer hardens after metal rod is removed

Which one of the following is the best description of the polymer?

A. a thermosetting plastic with little cross-linking

B. a thermosetting plastic which could not be recycled

C. a thermosoftening plastic which could be recycled

D. a thermosoftening plastic with extensive cross-linking

Question 14

Two elements with their electron configurations are listed in the table below.

Element	Electron configuration
M	$1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^1$
Q	$1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^5$

Which one of the following is the most likely compound to be formed by a combination of these elements?

A. an ionic compound of formula MQ_3

B. an ionic compound of formula M_3Q

C. a molecular compound of formula MQ_3

D. a molecular compound of formula M_3Q

Question 15

Listed below are three atomic species, identified using the symbols W, X and Y.

$$^{56}_{26}W \quad ^{58}_{26}X \quad ^{58}_{27}Y$$

Which of these species are isotopes of the same element?

A. W and X, as they have the same atomic number.

B. W and X, as they have the same mass number.

C. X and Y, as they have the same atomic number.

D. X and Y, as they have the same mass number.

Question 16

Which one of the following is a conjugate **redox** pair?

A. H_2O and OH^-

B. Na^+ and NaCl

C. HNO_3 and NO_3^-

D. Ca and Ca^{2+}

Question 17

40 mL of 0.10 M sodium hydroxide is added to 60 mL of 0.10 M hydrochloric acid.

The concentration of hydronium ion (in M) in the final solution is closest to

A. 1.0×10^{-7}

B. 2.0×10^{-3}

C. 2.0×10^{-2}

D. 3.3×10^{-3}

Use the following information to answer Questions 18–19.

The percentage ionisation of three different acids of concentration 0.10 M is shown in the table below.

Acid	citric	ethanoic	nitric
% ionisation	8	1.3	100

Question 18

The pH of 0.10 M citric acid is closest to

A. 1.0

B. 1.9

C. 2.1

D. 8.0

Question 19

The three acid solutions are colourless liquids and have the same appearance. To distinguish between the three acid solutions, the following methods were suggested:

I measure the electrical conductivity of each liquid

II use different indicators and observe the colour changes

III determine the volume of a strong base needed to neutralise a set volume of each acid solution

Which of these methods could be used to distinguish between the three acid solutions?

A. I and II only

B. II and III only

C. I and III only

D. I, II and III

Question 20

75.0 mL of 0.546 M sodium chloride solution was taken and diluted with water to produce a solution of concentration 0.164 M.

What volume of water, in mL, was added in the dilution?

A. 22.5

B. 97.5

C. 175

D. 250

Question 21

The latent heat of vaporisation of water is approximately five times the value for methane.

Which one of the following is the best explanation for this difference?

A. The covalent bonds in water are stronger than those present in methane.

B. At room temperature, water is a liquid whereas methane is a gas.

C. Water molecules have a higher relative molecular mass than methane molecules.

D. The bonds between the molecules are weaker for methane than for water.

Use the following information to answer Questions 22 and 23.

The pH values of three different solutions at the same concentration at 25°C are shown in the table below.

Solution	Na_2SO_4	$NaHSO_4$	H_2SO_4
pH at 25°C	7.0	3.0	1.0

Question 22

Which one of the following statements about the solutions is correct?

A. The concentration of all of the solutions is 0.10 mol L^{-1}.

B. The acidity of Na_2SO_4 solution is more than double that of $NaHSO_4$ solution.

C. Adding water to a sample of H_2SO_4 solution will decrease its pH.

D. In the Na_2SO_4 solution, $[H_3O^+] = [OH^-] = 10^{-7.0}$ M.

Question 23

Which of the solutions will react with both a strong acid and a strong base?

A. Na_2SO_4 only

B. $NaHSO_4$ only

C. H_2SO_4 only

D. Na_2SO_4 and $NaHSO_4$

Question 24

Sodium carbonate (Na_2CO_3) is used as a primary standard in volumetric analysis.

What mass of sodium carbonate is needed to produce 250.0 mL of 0.612 M standard solution?

A. 1.44 g

B. 3.85 g

C. 16.2 g

D. 43.3 g

Question 25

Oxidation is said to have occurred when

A. a non-metal ion reacts to form a gaseous molecule of the non-metal.

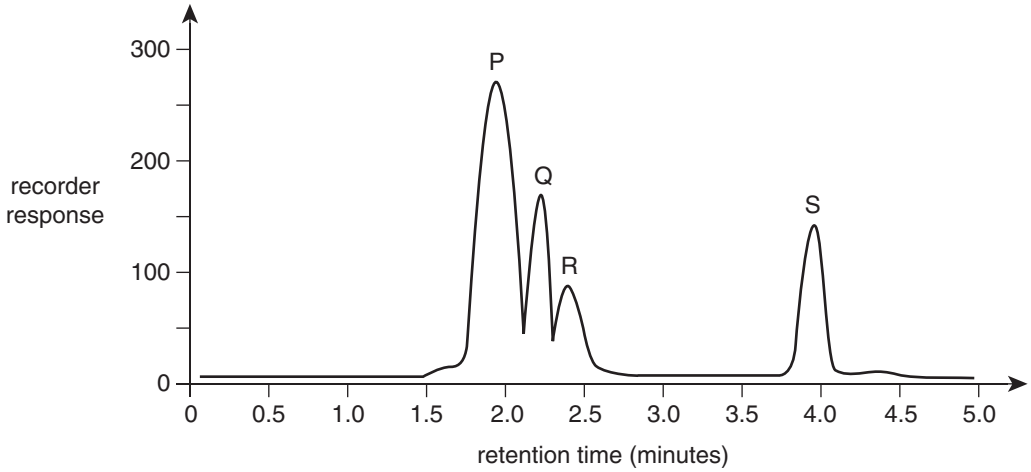
B. a metallic ion precipitates from a solution as an insoluble salt.

C. a metal ion becomes a metal atom.

D. oxygen changes from the liquid state to the gaseous state.

Use the following information to answer Questions 26 and 27.

The water in the dams on two different farms was analysed by high-performance liquid chromatography (HPLC) using the same instrument under identical conditions. The result of farm 1's analysis is shown below with the peaks labelled P, Q, R and S.



Question 26

Which one of the following statements is **incorrect**?

A. Each of the four peaks shows the presence of a different compound in the water.

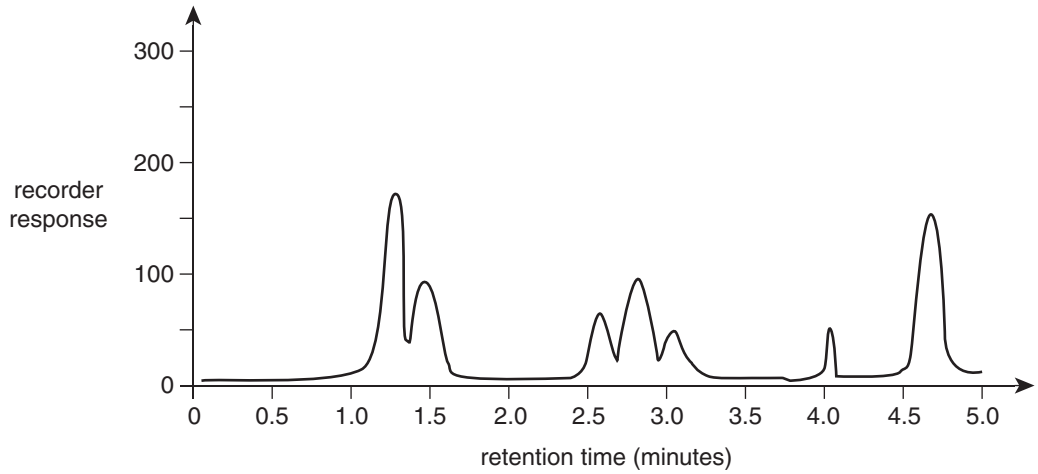
B. Lowering the temperature of the column would decrease each retention time.

C. Component P is least strongly attracted to the HPLC column.

D. Component R has the lowest concentration of any of the components.

Question 27

Component S in the dam water analysis of farm 1 has been shown to be a particular pesticide of concentration 20 ppm. The following HPLC analysis is for dam water on farm 2.



Which of the following is the most likely concentration of the pesticide in the water from farm 2?

A. 0 ppm

B. 3 ppm

C. 10 ppm

D. 20 ppm

Question 28

Which one of the following shows an **incorrect** concentration of the solution formed when 1.0 g of chlorine gas (Cl_2) is dissolved completely in 250 000 L of water?

A. 4.0×10^{-5} % m/v

B. 4.0×10^{-6} g L^{-1}

C. 5.6×10^{-8} M

D. 4.0×10^{-3} ppm

Question 29

A strip of lead (Pb) is placed in a solution containing both copper ions and zinc ions.

Which one of the following would **not** be expected to occur?

A. A deposit appears on the surface of the lead.

B. The concentration of the zinc ion in the solution decreases.

C. The blue colour of the solution caused by the copper ion slowly fades.

D. The lead strip slowly dissolves.

Question 30

Which one of the following relating to the solubility of methane gas (CH_4) molecules in water is correct?

	Methane gas solubility in water	**Change in solubility with increasing temperature**
A.	very low	decrease
B.	very low	increase
C.	very high	decrease
D.	very high	increase

END OF SECTION A

SECTION B

Instructions for Section B

Answer **all** questions in the spaces provided. Write using blue or black pen.

Give simplified answers to all numerical questions, with an appropriate number of significant figures; unsimplified answers will not be given full marks.

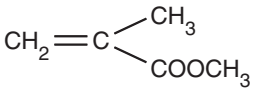
Show all working in your answers to numerical questions; no marks will be given for an incorrect answer unless it is accompanied by details of the working.

Ensure chemical equations are balanced and that the formulas for individual substances include an indication of state, for example, $H_2(g)$, NaCl(s).

Unless otherwise indicated, the diagrams in this book are **not** drawn to scale.

Question 1 (5 marks)

The structural formula of methyl 2-methylpropenoate, also known as methyl methacrylate, is shown below.



a. The following *unbalanced* equation represents the chemical reaction occurring when methyl methacrylate undergoes complete combustion.

$$\_\_\_\_C_5H_8O_2(g) + \_\_\_\_O_2(g) \rightarrow \_\_\_\_CO_2(g) + \_\_\_\_H_2O(g)$$

Balance the equation by writing the correct coefficients in the spaces in the equation above. 1 mark

b. Tick **one** box in the grid below to show whether all bonds in $C_5H_8O_2$ are polar, and whether the $C_5H_8O_2$ molecule is polar. 1 mark

	All bonds are polar	**Not all bonds are polar**
Molecule is polar		
Molecule is not polar		

c. Pentenoic acid is a structural isomer of methyl methacrylate.

i. Give the semi-structural formula of the carboxyl functional group found in pentenoic acid. 1 mark

_____

ii. What does the term 'pent' reveal about the structure of pentenoic acid? 1 mark

_____

d. Methyl methacrylate is a monomer used to form an addition polymer.

Draw a small section of this polymer. 1 mark

Question 2 (11 marks)

An organic compound is known to have the following composition by mass: 48.7% carbon, 8.1% hydrogen and 43.2% oxygen. The relative molecular mass (RMM) of the compound is 74.

a. **i.** Determine the empirical formula of the compound (working must be shown). 2 marks

_____

_____

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_____

_____

_____

_____

ii. Show that the molecular formula of the compound is $C_3H_6O_2$. 1 mark

_____

_____

_____

b. The compound was found to be an ester.

i. Give a common use of esters in industry or consumer products. 1 mark

_____

ii. The alcohol used to produce the ester is ethanol.
Give the systematic name of the ester. 1 mark

_____

iii. Write the semi-structural (condensed) formula of the ester. 1 mark

_____

c. Draw the structural formula, showing all bonds, for **an isomer** of the ester named in **part b. ii.** 1 mark

d. Ethanol can be produced by an addition reaction between ethene and steam.

i. Give the semi-structural formula for ethene. 1 mark

_____

ii. Ethene is a gas at room temperature, while ethanol is a liquid.
Explain why the boiling point of ethanol is much higher than that of ethene. 3 marks

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Question 3 (18 marks)

The first transition series in the periodic table consists of metallic elements from scandium (Sc) to zinc (Zn).

a. **i.** Other than ductility (that is, able to be drawn into wires), state **one** property which is common to main group metals and transition series metals. 1 mark

_____

ii. Using the metallic bonding model, explain why metals are ductile. 2 marks

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_____

b. State **one** property of transition series metals which is **not** a property of the main group metals. 1 mark

_____

c. Scandium is the first element in the first transition series.

i. Write the electronic configuration for a scandium atom using subshell notation. 1 mark

_____

ii. Write the electronic configuration for a doubly charged scandium cation using subshell notation. 1 mark

_____

d. Information about the first transition series elements cobalt (Co) and nickel (Ni) is shown below.

Element	Atomic number	Relative atomic mass
Co	27	58.9
Ni	28	58.7

i. Explain why Ni has a higher atomic number than Co. 1 mark

_____

_____

ii. Generally, the relative atomic mass (RAM) values of the elements increase across the series.

Explain why Ni has a lower RAM than Co. 2 marks

_____

_____

_____

_____

iii. Explain why there are ten elements in the first transition series. 2 marks

_____

_____

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_____

_____

e. The following information about copper was obtained using a mass spectrometer.

Isotope	^{63}Cu	^{65}Cu
RAM	62.93	64.93

Calculate the percentage abundance of the heavier isotope. 2 marks

_____

_____

_____

_____

f. The transition metal iron is usually modified by particular treatments prior to being used.

Complete only **one** column in the table below to explain the *purpose* of the treatment of iron by using coatings OR heat treatment OR production of alloys. 1 mark

Possible methods of modifying iron prior to its use		
Coating the iron	**Heat treatment of iron**	**Making an alloy from iron**

g. The transition metal chromium is extracted from chromium oxide by reaction with aluminium:

$$Cr_2O_3(aq) + 2Al(s) \rightarrow Al_2O_3(aq) + 2Cr(s)$$

i. Calculate the percentage composition by mass of chromium in chromium oxide. 2 marks

_____

_____

_____

ii. In one reaction, 100 kg of aluminium was used.

How many atoms of aluminium are present in this mass? 2 marks

_____

_____

_____

Question 4 (10 marks)

a. Lithium chloride, diamond and glucose ($C_6H_{12}O_6$) were tested for their ability to conduct electricity.

i. Which of these compounds, if any, will conduct electricity as a solid? Explain your choice for each compound in terms of structure and bonding. 3 marks

_____

_____

_____

_____

_____

_____

_____

ii. Which of these compounds, if any, will conduct electricity as a liquid? Explain your choice for each compound in terms of structure and bonding. 3 marks

_____

_____

_____

_____

_____

_____

_____

b. Draw a diagram of the structure of solid diamond. 2 marks

c. Small diamonds are part of the drilling heads which are used to drill through rock in oil and gas exploration.

i. Which property of diamond is utilised in this application? 1 mark

_____

ii. Explain how the property identified in **part c. i.** is consistent with the structure of diamond drawn in **part b.** 1 mark

_____

_____

Question 5 (13 marks)

Aluminium is one of the most widely used metals globally.

a. Aluminium reacts readily in air to produce a layer of aluminium oxide which does not allow oxygen gas or water to penetrate.

Write a balanced chemical equation for this reaction. 2 marks

_____

b. An experiment was conducted to determine the relative reactivity of aluminium with three other metals: X, Y and Z. Freshly polished samples of each of the metals were placed separately in solutions of the metal ions and any displacement reaction (deposition of a metal) was noted. The results of the experiment are shown in the table below.

	Al	**Metal X**	**Metal Y**	**Metal Z**
$\mathbf{Al^{3+}}$		no reaction	displacement	no reaction
$\mathbf{X^{2+}}$	displacement		displacement	no reaction
$\mathbf{Y^{2+}}$	no reaction	no reaction		no reaction
$\mathbf{Z^{2+}}$	displacement	displacement	displacement	

Commencing with the most reactive metal, use X, Y, Z and Al to show the order of reactivity of the four metals. 2 marks

_____

c. As with all reactive metals, aluminium will react with an acid.

i. Write a balanced **ionic** equation for the reaction of aluminium with sulfuric acid (H_2SO_4). 2 marks

_____

ii. Write the half-equation for the oxidation process which occurs in the reaction between aluminium and the acid. 1 mark

_____

iii. Identical pieces of pure aluminium were reacted separately with 1.0 M HCl (a strong acid) and 1.0 M HCOOH (a weak acid).

Outline how the observations in the experiments would be different. 1 mark

_____

_____

_____

_____

d. Aluminium is produced from the mineral alumina, which is refined from a substance known as bauxite. Sodium hydroxide (NaOH) is used in the extraction process.

i. Sodium hydroxide solutions contain the strong base, hydroxide ion.

Why is the hydroxide ion classified as a strong base? 1 mark

_____

_____

ii. Samples of waste water from the alumina refinery were found to contain sodium hydroxide. Volumetric analysis was used to determine the concentration of sodium hydroxide in the waste water. The following results were recorded:

volume of waste water sample analysed	20.00 mL
concentration of hydrochloric acid used in titrations	0.135 M
average titre of HCl required to reach the **endpoint**	14.65 mL

Calculate the concentration of sodium hydroxide (in mol L^{-1}) in the waste water. 3 marks

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_____

_____

_____

_____

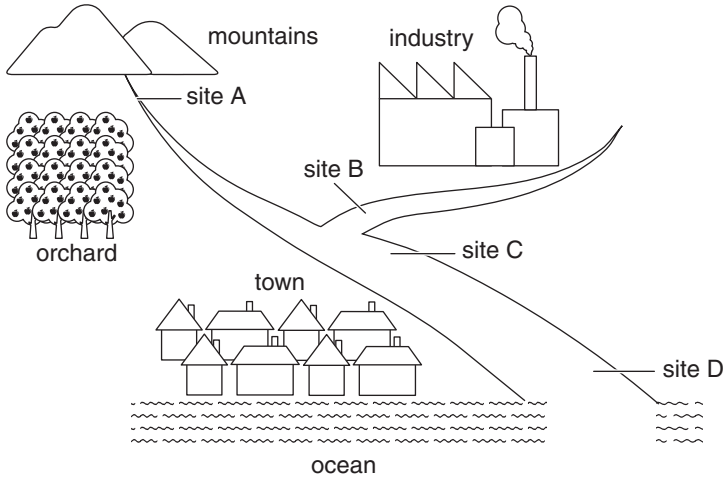
iii. What is meant by the 'endpoint' of the titration? 1 mark

_____

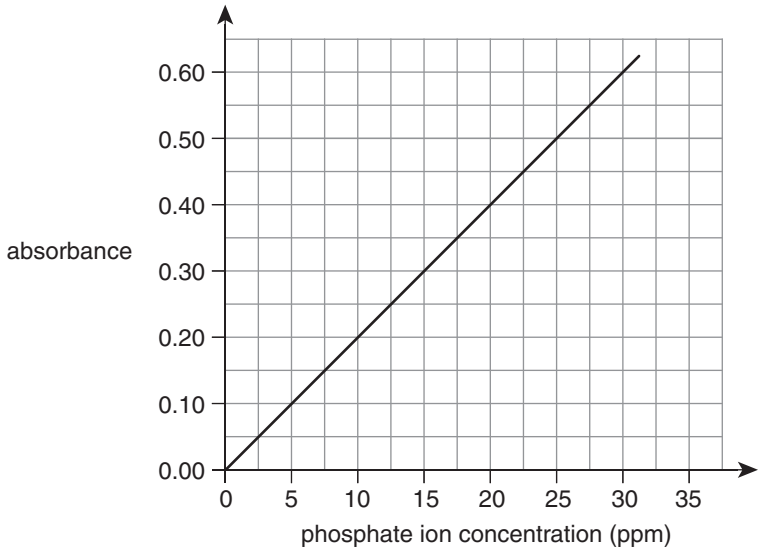
_____

Question 6 (7 marks)

The map below shows a region in which water from industry, an orchard and a town finds its way into the river system. Water samples were collected at sites A, B, C and D and transported to a laboratory for a range of water quality tests.



a. UV-visible spectroscopy was used to analyse water samples for phosphate ion content. Each water sample was treated with a special reagent to form a phosphate ion complex which is coloured blue. Standard solutions of known concentration of phosphate ion were similarly treated with the reagent and used to produce the calibration graph shown below.



i. The absorbance of the water sample from site C is 0.35.

What is the phosphate ion concentration of the sample in parts per million? 1 mark

_____

ii. The phosphate ion concentrations at sites A and B are both close to zero.

Suggest **one** reason why the concentration at site C is so high. 1 mark

_____

_____

_____

iii. The absorbance of the water sample from site D is 0.70.

Explain what action could be taken to determine the phosphate ion concentration in this water sample accurately. 2 marks

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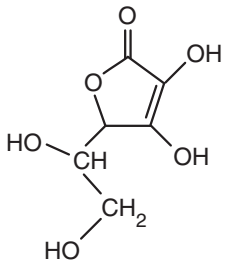
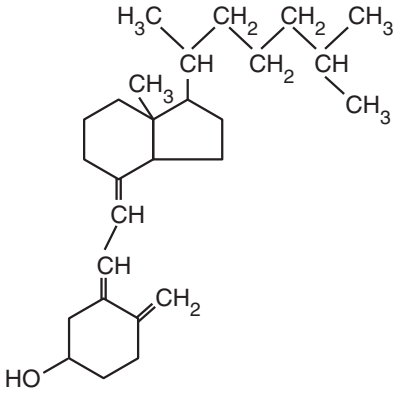
_____

b. Site D will include waste materials from the town. The molecular structures of two of the compounds in this waste material are shown below.



I



II

Which compound/s is/are likely to be water-soluble? Give an explanation for each choice in terms of structure and bonding. 2 marks

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_____

_____

_____

_____

c. To determine the concentration of iron in the water samples, any iron present as Fe^{2+} ions was reacted with a particular reagent to form the orange–yellow complex iron(II)-1,10-phenanthroline. UV-visible spectroscopy was again used for analysis.

Explain why it is necessary to use a different wavelength of light in this UV-visible analysis compared to that used in the phosphate ion analysis. 1 mark

_____

_____

_____

Question 7 (14 marks)

Two related compounds, potassium chloride (KCl) and potassium chlorate ($KClO_3$), have precisely the same solubility of 57 grams per 100 g of water at 98°C. At lower temperatures, KCl is much more soluble in water than $KClO_3$.

a. **i.** Calculate the molarity of KCl at 98°C at its maximum solubility, assuming the density of water is 1.0 g $mL^{-1.}$ 2 marks

_____

_____

_____

ii. When KCl dissolves in water, dissociation occurs. When HCl is added to water, ionisation occurs.

Explain the difference between ionisation and dissociation. 2 marks

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_____

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iii. KCl is soluble in water because water molecules are able to keep both potassium ions and chloride ions in solution.

With the aid of a labelled diagram to show the interactions and bond type between the chloride ions and water molecules, explain how water molecules keep the chloride ions in solution. 3 marks

_____

_____

_____

b. Solutions of KCl conduct electricity because ions are free to move.

Outline the steps needed in a laboratory to determine the concentration of a solution of KCl using electrical conductivity. 3 marks

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c. An experiment was conducted to find the solubility of $KClO_3$ over a range of temperatures. The following method was used:

1. Heat 10.0 mL of pure water from 20°C to 85°C in a large test tube.
2. Add 4.00 g of solid $KClO_3$ and agitate to dissolve.
3. Allow to cool and note the temperature at which crystals of $KClO_3$ first appear.
4. Add a further 2.0 mL of pure water to the test tube and heat to 85°C to dissolve crystals.
5. Repeat steps 3 and 4 until five tests have been completed as shown in the table of results below.

	Test A	**Test B**	**Test C**	**Test D**	**Test E**
Contents of test tube	4.00 g of $KClO_3$ + 10.0 mL of water	a further 2.0 mL of water	a further 2.0 mL of water	a further 2.0 mL of water	a further 2.0 mL of water
Temperature at which crystals first appeared	82°C	74°C	68°C	63°C	59°C

i. Calculate the amount of energy (in J) used to heat the 10.0 mL of water in step 1.
Assume that the density of the water is 1.0 g mL^{-1}. 1 mark

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ii. What type of solution is present when crystals first appear in step 3? 1 mark

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iii. Calculate the solubility of $KClO_3$ at 59°C in grams per 100 g of water. 2 marks

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Question 8 (7 marks)

A 2.00 g sample of a particular fertiliser was analysed to determine the sulfate (SO_4^{2-}) content using the following steps:

1. The sample was added to water in a beaker and stirred thoroughly.
2. The contents of the beaker was filtered and some pure water was washed through the filter paper into the filtered liquid.
3. 50.0 mL of 0.750 M barium chloride solution was added to the filtered liquid.
4. The barium sulfate precipitate formed was isolated and found to weigh 3.54 g.

a. The equation for the precipitation reaction in step 3 is as follows:

$$MgSO_4(aq) + BaCl_2(aq) \rightarrow MgCl_2(aq) + BaSO_4(s)$$

Write the ionic equation for the precipitation reaction. 1 mark

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b. **i.** Why was filtration carried out in step 2? 1 mark

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ii. Calculate the number of mole of barium sulfate formed in step 4. 1 mark

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iii. Calculate the mass of SO_4^{2-} in the barium sulfate precipitate. 1 mark

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iv. Find the percentage by mass of SO_4^{2-} in the fertiliser sample. 1 mark

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c. State **one** assumption which was used in the investigation. 1 mark

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d. Suggest **one** way in which the reliability of the result of the analysis could be improved. 1 mark

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Question 9 (5 marks)

In addition to its ability to dissolve many substances, water can act as an acid, a base, an oxidising agent and a reducing agent.

a. Consider the reaction shown in the following equation:

$$2Cl_2(g) + 2H_2O(l) \rightarrow 4HCl(aq) + O_2(g)$$

How is water acting in this reaction? Indicate your response by circling one or more of the terms listed below. 1 mark

acid *base* *oxidising agent* *reducing agent*

b. Water may appear in the equation for a redox reaction but may not be either the oxidising or reducing agent.

Consider the reaction shown in the following equation:

$$C_2H_6O(aq) + MnO_4^-(aq) + H^+(aq) \rightarrow C_2H_4O_2(aq) + Mn^{2+}(aq) + H_2O(l)$$

i. Write a balanced half-equation for the oxidation process occurring in this reaction. 1 mark

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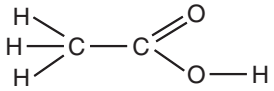
ii. The structural formula of the product $C_2H_4O_2$ is shown below. This product is an acid.



Circle **one** acidic proton on the diagram of the CH_3COOH molecule. 1 mark

iii. The concentration of a solution of C_2H_6O was investigated using volumetric analysis based on the reaction shown.

10.0 mL of C_2H_6O solution was diluted to a total volume of 100.0 mL in a volumetric flask. A 20.00 mL aliquot of this diluted C_2H_6O solution was pipetted into a small conical flask. The flask contents were titrated with a standardised acidified MnO_4^- solution until the endpoint was detected.

In the table below, fill in the liquid which should be used for the final rinse of each piece of glassware immediately prior to its use in this volumetric analysis. 2 marks

Glassware	Liquid used for final rinse prior to use
100.0 mL volumetric flask	
50.0 mL burette	

END OF QUESTION AND ANSWER BOOKLET