Centre Number						Candidate Number				
Surname										
Other Names										
Candidate Signature										

For Examiner's Use	
Examiner's Initials	
Question	Mark
1	
2	
3	
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5	
6	
7	
TOTAL	

General Certificate of Education
Advanced Subsidiary Examination
June 2011

Chemistry CHEM1

Unit 1 Foundation Chemistry

Monday 23 May 2011 1.30 pm to 2.45 pm

For this paper you must have:
- the Periodic Table/Data Sheet, provided as an insert (enclosed)
- a calculator.

Time allowed
- 1 hour 15 minutes

Instructions
- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- All working must be shown.
- Do all rough work in this book. Cross through any work you do not want to be marked.

Information
- The marks for questions are shown in brackets.
- The maximum mark for this paper is 70.
- The Periodic Table/Data Sheet is provided as an insert.
- Your answers to the questions in **Section B** should be written in continuous prose, where appropriate.
- You will be marked on your ability to:
  – use good English
  – organise information clearly
  – use accurate scientific terminology.

Advice
- You are advised to spend about 50 minutes on **Section A** and about 25 minutes on **Section B**.

Section A

Answer **all** questions in the spaces provided.

1 Mass spectrometry can be used to identify isotopes of elements.

1 (a) (i) In terms of fundamental particles, state the difference between isotopes of an element.

.....

.....

(1 mark)

1 (a) (ii) State why isotopes of an element have the same chemical properties.

.....

.....

(1 mark)

1 (b) Give the meaning of the term *relative atomic mass.*

.....

.....

.....

(2 marks)

(Extra space).....

.....

1 (c) The mass spectrum of element **X** has four peaks. The table below gives the relative abundance of each isotope in a sample of element **X**.

m/*z*	64	66	67	68
Relative abundance	12	8	1	6

1 (c) (i) Calculate the relative atomic mass of element **X**.
Give your answer to one decimal place.

.....

.....

.....

.....

.....

(3 marks)

1 (c) (ii) Use the Periodic Table to identify the species responsible for the peak at *m*/*z* = 64

.....

(2 marks)

1 (d) Suggest **one** reason why particles with the same mass and velocity can be deflected by different amounts in the same magnetic field.

.....

.....

(1 mark)

1 (e) Explain how the detector in a mass spectrometer enables the abundance of an isotope to be measured.

.....

.....

.....

(2 marks)

(Extra space) .....

.....

12

2 Norgessaltpeter was the first nitrogen fertiliser to be manufactured in Norway. It has the formula $Ca(NO_3)_2$

2 (a) Norgessaltpeter can be made by the reaction of calcium carbonate with dilute nitric acid as shown by the following equation.

$$CaCO_3(s) + 2HNO_3(aq) \longrightarrow Ca(NO_3)_2(aq) + CO_2(g) + H_2O(l)$$

In an experiment, an excess of powdered calcium carbonate was added to 36.2 cm^3 of 0.586 mol dm^{-3} nitric acid.

2 (a) (i) Calculate the amount, in moles, of HNO_3 in 36.2 cm^3 of 0.586 mol dm^{-3} nitric acid. Give your answer to 3 significant figures.

.....

.....

(1 mark)

2 (a) (ii) Calculate the amount, in moles, of $CaCO_3$ that reacted with the nitric acid. Give your answer to 3 significant figures.

.....

.....

(1 mark)

2 (a) (iii) Calculate the minimum mass of powdered $CaCO_3$ that should be added to react with all of the nitric acid. Give your answer to 3 significant figures.

.....

.....

.....

(2 marks)

2 (a) (iv) State the type of reaction that occurs when calcium carbonate reacts with nitric acid.

.....

(1 mark)

2 (b) Norgessaltpeter decomposes on heating as shown by the following equation.

$$2Ca(NO_3)_2(s) \longrightarrow 2CaO(s) + 4NO_2(g) + O_2(g)$$

A sample of Norgessaltpeter was decomposed completely.

The gases produced occupied a volume of $3.50 \times 10^{-3}\,m^3$ at a pressure of 100 kPa and a temperature of 31 °C.
(The gas constant $R = 8.31\,J\,K^{-1}\,mol^{-1}$)

2 (b) (i) Calculate the total amount, in moles, of gases produced.

.....

.....

.....

.....

(3 marks)

2 (b) (ii) Hence calculate the amount, in moles, of oxygen produced.

.....

.....

(1 mark)

2 (c) Hydrated calcium nitrate can be represented by the formula $Ca(NO_3)_2.xH_2O$ where x is an integer.

A 6.04 g sample of $Ca(NO_3)_2.xH_2O$ contains 1.84 g of water of crystallisation.

Use this information to calculate a value for x.
Show your working.

.....

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.....

.....

(3 marks)

12

Turn over ▶

3 Fluorine and iodine are elements in Group 7 of the Periodic Table.

3 (a) Explain why iodine has a higher melting point than fluorine.

.....

.....

.....

(2 marks)

(Extra space).....

.....

3 (b) (i) Draw the shape of the NHF_2 molecule and the shape of the BF_3 molecule.
Include any lone pairs of electrons that influence the shape.
In each case name the shape.

Shape of NHF_2 Shape of BF_3

Name of shape of NHF_2 .....

Name of shape of BF_3 .....

(4 marks)

3 (b) (ii) Suggest a value for the F—N—F bond angle in NHF_2

.....

(1 mark)

3 (c) State the strongest type of intermolecular force in a sample of NHF_2

.....

(1 mark)

3 (d) A molecule of NHF_2 reacts with a molecule of BF_3 as shown in the following equation.

$$NHF_2 + BF_3 \longrightarrow F_2HNBF_3$$

State the type of bond formed between the N atom and the B atom in F_2HNBF_3
Explain how this bond is formed.

Name of type of bond .....

How bond is formed .....

.....

.....

(2 marks)

10

Turn over for the next question

4 There are several types of crystal structure and bonding shown by elements and compounds.

4 (a) (i) Name the type of bonding in the element sodium.

.....

(1 mark)

4 (a) (ii) Use your knowledge of structure and bonding to draw a diagram that shows how the particles are arranged in a crystal of sodium.
You should identify the particles and show a minimum of six particles in a two-dimensional diagram.

(2 marks)

4 (b) Sodium reacts with chlorine to form sodium chloride.

4 (b) (i) Name the type of bonding in sodium chloride.

.....

(1 mark)

4 (b) (ii) Explain why the melting point of sodium chloride is high.

.....

.....

.....

.....

(2 marks)

(Extra space) .....

.....

4 (c) The table below shows the melting points of some sodium halides.

	NaCl	NaBr	NaI
Melting point / K	1074	1020	920

Suggest why the melting point of sodium iodide is lower than the melting point of sodium bromide.

.....

.....

(1 mark)

7

Turn over for the next question

5 This question is about the first ionisation energies of some elements in the Periodic Table.

5 (a) Write an equation, including state symbols, to show the reaction that occurs when the first ionisation energy of lithium is measured.

.....

(1 mark)

5 (b) State and explain the general trend in first ionisation energies for the Period 3 elements aluminium to argon.

Trend .....

Explanation .....

.....

.....

(3 marks)

(Extra space).....

.....

5 (c) There is a similar general trend in first ionisation energies for the Period 4 elements gallium to krypton.
State how selenium deviates from this general trend and explain your answer.

How selenium deviates from this trend .....

Explanation .....

.....

.....

(3 marks)

(Extra space).....

.....

5 (d) Suggest why the first ionisation energy of krypton is lower than the first ionisation energy of argon.

.....

.....

.....

(1 mark)

5 (e) The table below gives the successive ionisation energies of an element.

	First	Second	Third	Fourth	Fifth
Ionisation energy / kJ mol^{-1}	590	1150	4940	6480	8120

Deduce the group in the Periodic Table that contains this element.

.....

(1 mark)

5 (f) Identify the element that has a 5+ ion with an electron configuration of $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}$

.....

(1 mark)

10

Turn over for the next question

Section B

Answer **all** questions in the spaces provided.

6 (a) There is a risk of gas explosions in coal mines. This risk is mainly due to the presence of methane. If the percentage of coal-mine methane (CMM) in the air in the mine is greater than 15%, the explosion risk is much lower. CMM slowly escapes from the mine into the atmosphere.

Write an equation to show the complete combustion of methane.

Suggest **one** reason why there is a much lower risk of an explosion if the percentage of CMM is greater than 15%.

State why it is beneficial to the environment to collect the CMM rather than allowing it to escape into the atmosphere.

.....

.....

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.....

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.....

(3 marks)

(Extra space) .....

.....

.....

6 (b) Methane can be obtained from crude oil. Some of this crude oil contains an impurity called methanethiol (CH_3SH). This impurity causes environmental problems when burned.

Write an equation to show the complete combustion of methanethiol.

State why calcium oxide can be used to remove the sulfur-containing product of this combustion reaction.

State **one** pollution problem that is caused by the release of this sulfur-containing product into the atmosphere.

.....

.....

.....

.....

.....

.....

(3 marks)

(Extra space).....

.....

.....

6

Turn over for the next question

7 Pentane is a member of the alkane homologous series.

7 (a) Give the general formula for the homologous series of alkanes.

.....

(1 mark)

7 (b) One of the structural isomers of pentane is 2,2-dimethylpropane.

Draw the displayed formula of 2,2-dimethylpropane.

State the type of structural isomerism shown.

.....

(2 marks)

7 (c) A molecule of hydrocarbon **Y** can be thermally cracked to form one molecule of pentane and two molecules of ethene only.

Deduce the molecular formula of **Y**.

State why high temperatures are necessary for cracking reactions to occur.

Give **one** reason why thermal cracking reactions are carried out in industry.

.....

.....

.....

.....

.....

.....

(3 marks)

(Extra space) .....

.....

.....

7 (d) Write an equation for the incomplete combustion of pentane to form a solid pollutant.

Suggest why this solid pollutant is an environmental problem.

.....

.....

.....

.....

(2 marks)

(Extra space) .....

.....

Question 7 continues on the next page

7 (e) Pentane can react with chlorine as shown in the following equation.

$$C_5H_{12} + Cl_2 \longrightarrow C_5H_{11}Cl + HCl$$

Calculate the percentage atom economy for the formation of $C_5H_{11}Cl$

Deduce how many straight-chain isomers of $C_5H_{11}Cl$ could be formed.

.....

.....

.....

.....

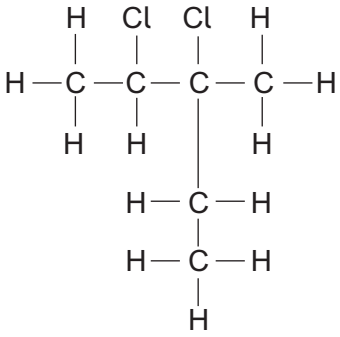
.....

(3 marks)

(Extra space).....

.....

7 (f) Consider the following compound.



Name this compound.

Deduce the empirical formula of this compound.

.....

.....

.....

.....

(2 marks)

13

END OF QUESTIONS

Centre Number						Candidate Number				
Surname										
Other Names										
Candidate Signature										

For Examiner's Use	
Examiner's Initials	
Question	Mark
1	
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TOTAL	

General Certificate of Education
Advanced Subsidiary Examination
June 2011

Chemistry CHEM2

Unit 2 Chemistry in Action

Friday 27 May 2011 1.30 pm to 3.15 pm

For this paper you must have:
- the Periodic Table/Data Sheet, provided as an insert (enclosed)
- a calculator.

Time allowed
- 1 hour 45 minutes

Instructions
- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- All working must be shown.
- Do all rough work in this book. Cross through any work you do not want to be marked.

Information
- The marks for questions are shown in brackets.
- The maximum mark for this paper is 100.
- The Periodic Table/Data Sheet is provided as an insert.
- Your answers to the questions in **Section B** should be written in continuous prose, where appropriate.
- You will be marked on your ability to:
  – use good English
  – organise information clearly
  – use accurate scientific terminology.

Advice
- You are advised to spend about 1 hour 15 minutes on **Section A** and about 30 minutes on **Section B**.

Section A

Answer **all** questions in the spaces provided.

1 The rate of a chemical reaction is influenced by the size of the activation energy. Catalysts are used to increase the rates of chemical reactions but are not used up in the reactions.

1 (a) Give the meaning of the term *activation energy*.

.....

.....

.....

.....

(2 marks)

1 (b) Explain how a catalyst increases the rate of a reaction.

.....

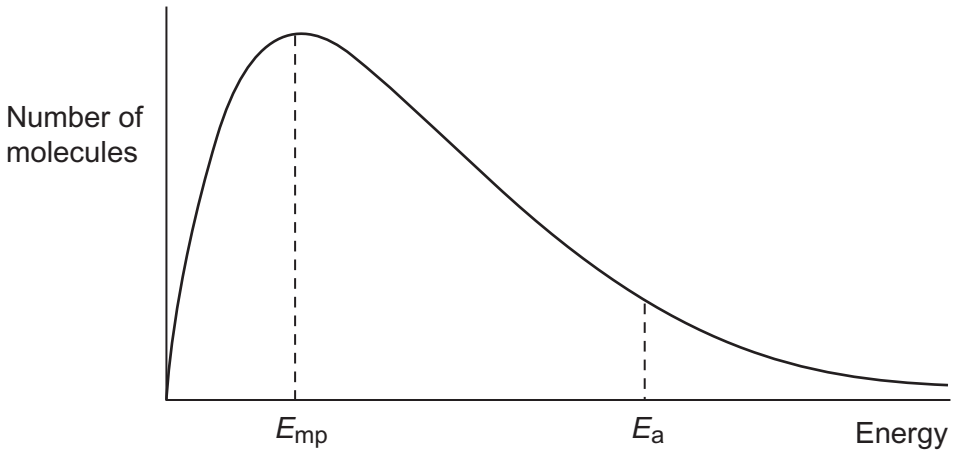
.....

.....

.....

(2 marks)

1 (c) The diagram below shows the Maxwell–Boltzmann distribution of molecular energies, at a constant temperature, in a gas at the start of a reaction.
On this diagram the most probable molecular energy at this temperature is shown by the symbol E_{mp}
The activation energy is shown by the symbol E_a



To answer the questions **1 (c) (i)** to **1 (c) (iv)**, you should use the words **increases**, **decreases** or **stays the same**. You may use each of these answers once, more than once or not at all.

1 (c) (i) State how, if at all, the value of the most probable energy (E_{mp}) changes as the total number of molecules is increased at constant temperature.

.....

(1 mark)

1 (c) (ii) State how, if at all, the number of molecules with the most probable energy (E_{mp}) changes as the temperature is decreased without changing the total number of molecules.

.....

(1 mark)

1 (c) (iii) State how, if at all, the number of molecules with energy greater than the activation energy (E_a) changes as the temperature is increased without changing the total number of molecules.

.....

(1 mark)

1 (c) (iv) State how, if at all, the area under the molecular energy distribution curve changes as a catalyst is introduced without changing the temperature or the total number of molecules.

.....

(1 mark)

1 (d) For each of the following reactions, identify a catalyst and name the organic product of the reaction.

1 (d) (i) The fermentation of an aqueous solution of glucose.

Catalyst .....

Name of organic product .....

(2 marks)

1 (d) (ii) The hydration of but-2-ene.

Catalyst .....

Name of organic product .....

(2 marks)

12

Turn over ▶

2 This question is about the extraction of titanium from titanium(IV) oxide by a two-stage process.
The first stage in the process produces titanium(IV) chloride. In the second stage, titanium(IV) chloride is converted into titanium.
The enthalpy change for the second stage can be determined using Hess's Law.

2 (a) Give **one** reason why titanium is **not** extracted directly from titanium(IV) oxide using carbon.

.....

.....

(1 mark)

2 (b) Give the meaning of the term *enthalpy change*.

.....

.....

.....

(1 mark)

2 (c) State Hess's Law.

.....

.....

.....

.....

(1 mark)

2 (d) Define the term *standard enthalpy of formation*.

.....

.....

.....

.....

.....

.....

(3 marks)

2 (e) The following standard enthalpy of formation data refer to the second stage in the extraction of titanium.

	$TiCl_4(g)$	Na(l)	NaCl(s)	Ti(s)
$\Delta H_f^{\ominus}$ / kJ mol^{-1}	–720	+3	–411	0

2 (e) (i) State why the value for the standard enthalpy of formation of Na(l) is **not** zero.

.....

.....

(1 mark)

2 (e) (ii) Use data from the table to calculate a value for the standard enthalpy change of the following reaction.

$$TiCl_4(g) + 4Na(l) \longrightarrow 4NaCl(s) + Ti(s)$$

.....

.....

.....

.....

.....

.....

.....

(3 marks)

2 (e) (iii) State the role of sodium in this reaction.

.....

(1 mark)

11

Turn over ▶

3 (a) Give the **formula** of a Group 2 metal hydroxide used in agriculture.

.....

(1 mark)

3 (b) Identify a sodium halide that does **not** undergo a redox reaction when added as a solid to concentrated sulfuric acid.

.....

(1 mark)

3 (c) Chlorine gas reacts with cold dilute sodium hydroxide solution to form sodium chloride and another chlorine-containing compound, **X**.
Give the **formula** of **X**.

.....

(1 mark)

3 (d) Give the **formula** of the substance responsible for the orange colour when chlorine gas is bubbled through an aqueous solution of sodium bromide.

.....

(1 mark)

3 (e) Solid sodium iodide undergoes a redox reaction with concentrated sulfuric acid.
Give the **formula** for each of the following in this reaction.

Formula of the solid reduction product .....

Formula of the oxidation product .....

(2 marks)

3 (f) Draw the structure of each of the following organic compounds.

3 (f) (i) The hydrocarbon that is a chain isomer of methylpropene, but does **not** exhibit E–Z stereoisomerism.

(1 mark)

3 (f) (ii) The alcohol that is a position isomer of butan-2-ol.

(1 mark)

3 (f) (iii) The hydrocarbon that has a peak, due to its molecular ion, at $m/z = 44$ in its mass spectrum.

(1 mark)

3 (f) (iv) The bromoalkane that reacts with sodium cyanide to produce propanenitrile.

(1 mark)

10

4 Metals are usually extracted from oxides.
Some of these oxides occur naturally. Other oxides are made by roasting sulfide ores in air, producing sulfur dioxide as a by-product.
For the extraction of some metals, the oxide needs to be converted into a chloride.

4 (a) The ore molybdenite contains molybdenum disulfide (MoS_2).
The first stage in the extraction of molybdenum is to roast the ore in air to form molybdenum oxide (MoO_3) and sulfur dioxide.

4 (a) (i) Write an equation for the first stage in this extraction.

.....

(1 mark)

4 (a) (ii) The release of sulfur dioxide into the atmosphere causes environmental problems and wastes a valuable resource. Identify **one** environmental problem and identify **one** use for the sulfur dioxide.

Environmental problem .....

.....

.....

Use for sulfur dioxide .....

.....

.....

(2 marks)

4 (a) (iii) Pure molybdenum is formed in the second stage by the reduction of MoO_3 using hydrogen.
Write an equation for this reaction.

.....

(1 mark)

4 (a) (iv) State **one** risk in using hydrogen gas in metal extractions.

.....

.....

(1 mark)

4 (b) Calcium is an expensive metal. It is extracted by the electrolysis of molten calcium chloride.

4 (b) (i) State why calcium chloride must be molten for electrolysis to occur.

.....

.....

(1 mark)

4 (b) (ii) Write an equation for the reaction that takes place at the negative electrode during this electrolysis.

.....

(1 mark)

4 (b) (iii) Identify the major cost in this extraction of calcium.

.....

.....

(1 mark)

8

Turn over for the next question

5 A sample of nitrogen dioxide gas (NO_2) was prepared by the reaction of copper with concentrated nitric acid.

5 (a) (i) Balance the equation for the reaction of copper with concentrated nitric acid.

$$Cu + \ldots\ldots HNO_3 \longrightarrow Cu(NO_3)_2 + \ldots\ldots NO_2 + \ldots\ldots H_2O$$

(1 mark)

5 (a) (ii) Give the oxidation state of nitrogen in each of the following compounds.

HNO_3 .....

NO_2 .....

(2 marks)

5 (a) (iii) Deduce the half-equation for the conversion of HNO_3 into NO_2 in this reaction.

.....

(1 mark)

5 (b) The following equilibrium is established between colourless dinitrogen tetraoxide gas (N_2O_4) and dark brown nitrogen dioxide gas.

$$N_2O_4(g) \rightleftharpoons 2NO_2(g) \qquad \Delta H = +58\,kJ\,mol^{-1}$$

5 (b) (i) Give two features of a reaction at equilibrium.

Feature 1 .....

.....

.....

.....

Feature 2 .....

.....

.....

.....

(2 marks)

5 (b) (ii) Use Le Chatelier's principle to explain why the mixture of gases becomes darker in colour when the mixture is heated at constant pressure.

.....

.....

.....

.....

.....

.....

(2 marks)

5 (b) (iii) Use Le Chatelier's principle to explain why the amount of NO_2 decreases when the pressure is increased at constant temperature.

.....

.....

.....

.....

.....

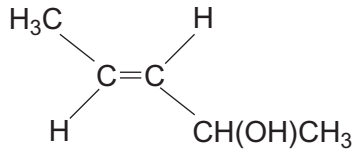
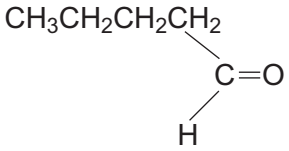
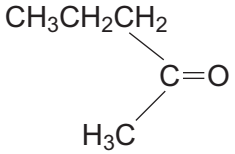
.....

(2 marks)

10

Turn over for the next question

6 The table below shows the structures of three isomers with the molecular formula $C_5H_{10}O$

Isomer **1** 	(*E*)-pent-3-en-2-ol
Isomer **2** 	pentanal
Isomer **3** 	

6 (a) Complete the table by naming Isomer **3**. *(1 mark)*

6 (b) State the type of structural isomerism shown by these three isomers.

.....

(1 mark)

6 (c) The compound (*Z*)-pent-3-en-2-ol is a stereoisomer of (*E*)-pent-3-en-2-ol.

6 (c) (i) Draw the structure of (*Z*)-pent-3-en-2-ol.

(1 mark)

6 (c) (ii) Identify the feature of the double bond in (*E*)-pent-3-en-2-ol and that in (*Z*)-pent-3-en-2-ol that causes these two compounds to be stereoisomers.

.....

(1 mark)

6 (d) A chemical test can be used to distinguish between separate samples of Isomer **2** and Isomer **3**.
Identify a suitable reagent for the test.
State what you would observe with Isomer **2** and with Isomer **3**.

Test reagent .....

Observation with Isomer **2** .....

.....

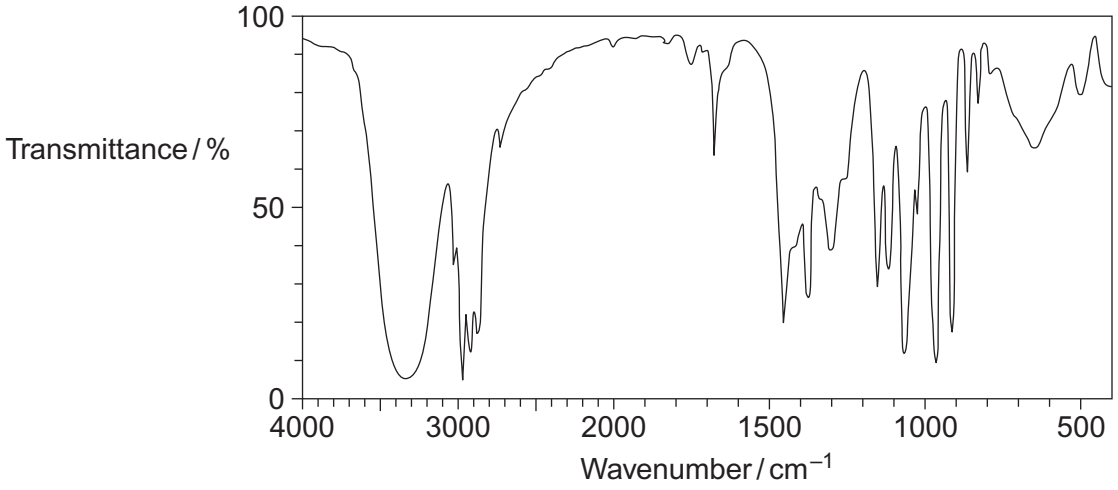
Observation with Isomer **3** .....

.....

(3 marks)

Question 6 continues on the next page

6 (e) The following is the infrared spectrum of one of the isomers **1**, **2** or **3**.



6 (e) (i) Deduce which of the isomers (**1**, **2** or **3**) would give this infrared spectrum.
You may find it helpful to refer to **Table 1** on the Data Sheet.

.....

(1 mark)

6 (e) (ii) Identify two features of the infrared spectrum that support your deduction.
In each case, identify the functional group responsible.

Feature 1 and functional group .....

.....

.....

.....

Feature 2 and functional group .....

.....

.....

.....

(2 marks)

10

Turn over for the next question

DO NOT WRITE ON THIS PAGE
ANSWER IN THE SPACES PROVIDED

7 Halogens are used to make halogenated organic compounds.

7 (a) The refrigerant used in air conditioners is a mixture of fluorinated alkanes.
These compounds are made by fluorination reactions.
The mechanism for the reaction of fluorine with an alkane or with a fluoroalkane is a free-radical substitution similar to the reaction of chlorine with methane.

7 (a) (i) Write the overall equation for the reaction of fluorine with methane to form trifluoromethane (CHF_3).

.....

(1 mark)

7 (a) (ii) Write equations for the following steps in the mechanism for the reaction of fluorine with trifluoromethane (CHF_3) to form tetrafluoromethane (CF_4).

Initiation step

.....

First propagation step

.....

Second propagation step

.....

A termination step leading to the formation of hexafluoroethane.

.....

(4 marks)

7 (b) Chlorofluorocarbons (CFCs) were used as refrigerants.
In the upper atmosphere, ultra-violet radiation breaks bonds in the CFCs to produce a reactive intermediate that catalyses the decomposition of ozone.

7 (b) (i) An example of a CFC is 1,1,1-trichloro-2,2-difluoroethane.
Draw the displayed formula of this CFC.

(1 mark)

7 (b) (ii) Identify a bond in a CFC that is broken by ultra-violet radiation to produce a reactive intermediate.
Give the name of this reactive intermediate that catalyses the decomposition of ozone.
Write an overall equation for this decomposition of ozone.

Bond broken .....

Name of the reactive intermediate .....

Overall equation

.....

(3 marks)

9

Turn over for the next question

Section B

Answer **all** questions in the spaces provided.

8 (a) Some scientists thought that the waste water from a waste disposal factory contained **two** sodium halides.

They tested a sample of the waste water.

They added three reagents, one after the other, to the same test tube containing the waste water.

The table below shows their results.

Reagent added	Observations
1. Silver nitrate solution (acidified with dilute nitric acid)	A cream precipitate formed
2. Dilute ammonia solution	A yellow precipitate remained
3. Concentrated ammonia solution	The yellow precipitate did not dissolve

8 (a) (i) Identify the yellow precipitate that did **not** dissolve in concentrated ammonia solution.
Write the **simplest** ionic equation for the formation of this precipitate from silver ions and the correct halide ion.
Identify the other sodium halide that must be present in this mixture of two sodium halides.

.....

.....

.....

.....

(3 marks)

8 (a) (ii) Give **one** reason why the silver nitrate solution was acidified before it was used in this test.

.....

.....

.....

(1 mark)

8 (a) (iii) The method that the scientists used could **not** detect one type of halide ion.
Identify this halide ion.
Give **one** reason for your answer.

.....

.....

.....

.....

(2 marks)

8 (b) The scientists thought that the waste water also contained dissolved barium ions.
An aqueous solution of sodium sulfate can be used to test for the presence of dissolved barium ions.

Write the **simplest** ionic equation for the reaction between barium ions and sulfate ions to form barium sulfate.

State what is observed in this reaction.

Give a use for barium sulfate in medicine and explain why this use is possible, given that solutions containing barium ions are poisonous.

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(4 marks)

Question 8 continues on the next page

8 (c) The scientists also analysed the exhaust gases from an incinerator used to destroy waste poly(ethene).
Mass spectrometry showed that there was a trace gas with a precise M_r = 28.03176 in the exhaust gases from the incinerator.

The table below contains some precise relative atomic mass data.

Atom	Precise relative atomic mass
^{12}C	12.00000
^{1}H	1.00794
^{16}O	15.99491

Use the data to show that the trace gas is ethene. Show your working.

Suggest why both ethene and carbon monoxide might have been identified as the trace gas if the scientists had used relative atomic masses to a precision of only one decimal place.

Write an equation for the incomplete combustion of ethene to form carbon monoxide and water only.

Ethene is used to make poly(ethene).
Draw the displayed formula for the repeating unit of poly(ethene).
Name this type of polymer.

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(5 marks)

15

9 Organic reaction mechanisms help chemists to understand how the reactions of organic compounds occur.
The following conversions illustrate a number of different types of reaction mechanism.

9 (a) When 2-bromopentane reacts with ethanolic KOH, two structurally isomeric alkenes are formed.

9 (a) (i) Name and outline a mechanism for the conversion of 2-bromopentane into pent-2-ene as shown below.

$$CH_3CH_2CH_2CHBrCH_3 \xrightarrow{\text{ethanolic KOH}} CH_3CH_2CH{=}CHCH_3$$

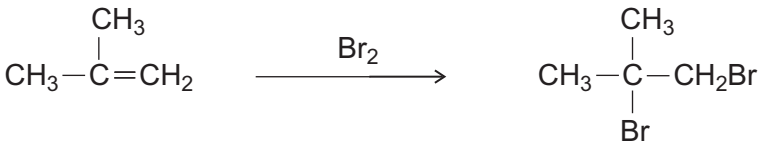
(4 marks)

9 (a) (ii) Draw the structure of the other structurally isomeric alkene produced when 2-bromopentane reacts with ethanolic KOH.

(1 mark)

Question 9 continues on the next page

9 (b) Name and outline a mechanism for the following conversion.



(5 marks)

9 (c) Name and outline a mechanism for the following conversion.

$$CH_3CH_2CH_2Br \xrightarrow{NH_3} CH_3CH_2CH_2NH_2$$

(5 marks)

15

END OF QUESTIONS

There are no questions printed on this page

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