New Specification

Rewarding Learning

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
2009

Centre Number	
71	

Candidate Number

Chemistry

Assessment Unit AS 2

assessing

Module 2: Further Physical and Inorganic Chemistry and Introduction to Organic Chemistry

[AC121]

AC121

THURSDAY 11 JUNE, AFTERNOON

TIME

1 hour 30 minutes.

INSTRUCTIONS TO CANDIDATES

Write your Centre Number and Candidate Number in the spaces provided at the top of this page.
Answer **all sixteen** questions.
Answer **all ten** questions in **Section A**. Record your answers by marking the appropriate letter on the answer sheet provided. Use only the spaces numbered 1 to 10.
Keep in sequence when answering.
Answer **all six** questions in **Section B**. Write your answers in the spaces provided in this question paper.

INFORMATION FOR CANDIDATES

The total mark for this paper is 100.
Quality of written communication will be assessed in question **15(d)(iii)**.
In Section A all questions carry equal marks, i.e. **two** marks for each question.
In Section B the figures in brackets printed down the right-hand side of pages indicate the marks awarded to each question or part question.
A Periodic Table of Elements (including some data) is provided.

For Examiner's use only	
Question Number	**Marks**
Section A	
1–10	
Section B	
11	
12	
13	
14	
15	
16	
Total Marks	

Section A

Examiner Only	
Marks	Remark

For each of the following questions only **one** of the lettered responses (A–D) is correct.

Select the correct response in each case and mark its code letter by connecting the dots as illustrated on the answer sheet.

1 A free radical is a particle with

A an unpaired electron.
B a negative charge.
C a positive charge.
D a lone pair of electrons.

2 Which one of the following hydrocarbons contains a double bond?

A CH_4
B C_2H_2
C C_2H_4
D C_2H_6

3 Which one of the following describes the reaction between hydroxide ions and 1-bromopentane?

A Electrophilic addition
B Electrophilic substitution
C Nucleophilic addition
D Nucleophilic substitution

4 Which one of the following equations corresponds to a standard enthalpy of formation?

A $2NO(g) \rightarrow N_2(g) + O_2(g)$
B $2H_2(g) + O_2(g) \rightarrow 2H_2O(g)$
C $Na(s) + Cl(g) \rightarrow NaCl(s)$
D $Mg(s) + Br_2(l) \rightarrow MgBr_2(s)$

Examiner Only
Marks | Remark

5 Which one of the following reagents could detect the presence of ethanol in Gasohol which can be regarded as a mixture of alkanes, alkenes and ethanol?

A bromine
B hydrogen chloride
C sodium
D universal indicator

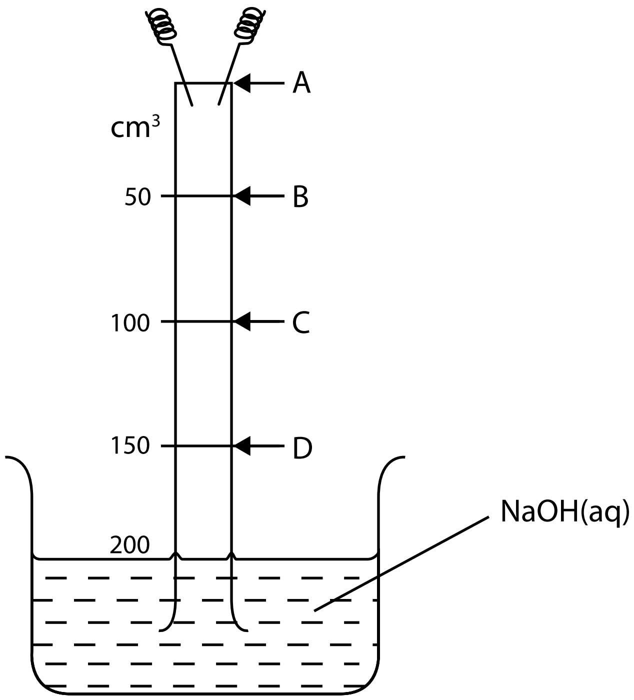
6 How many structural isomers exist with the formula, C_4H_{10}?

A 1
B 2
C 3
D 4

7 A tube is filled with 50 cm^3 of methane and 150 cm^3 of oxygen at room temperature over a beaker containing NaOH(aq) as shown.
The following reaction took place when a spark was applied to the mixture:

$$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$$

When the tube is cooled to room temperature, what level will the liquid have reached?



8 In which one of the following pairs will **neither** of the hydroxides dissolve in an excess of aqueous sodium hydroxide?

A $Al(OH)_3$ and $Fe(OH)_2$
B $Al(OH)_3$ and $Zn(OH)_2$
C $Fe(OH)_2$ and $Mg(OH)_2$
D $Mg(OH)_2$ and $Zn(OH)_2$

9 Which one of the following substances has the highest boiling point?

A CH_3CH_2Cl
B $CH_3CH_2CH_2OH$
C $CH_3CH_2CH_2CH_3$
D $CH_3CH_2CH_2CH_2CH_3$

10 In the laboratory preparation of a halogenoalkane, any acidic impurities present are removed using

A sodium chloride
B sodium hydrogencarbonate
C sodium hydroxide
D sodium sulphate

Examiner Only	
Marks	Remark

Section B

Answer all **six** questions in this section

11 The table below shows the results of analysing four aqueous solutions.

compound	**colour of aqueous solution**	**addition of aqueous barium chloride**	**other information**
A	blue	white precipitate	blue-green flame test
B	colourless	white precipitate	pH = 1
C	yellow	yellow precipitate	yellow/orange flame test
D	colourless	white precipitate	lilac flame test

Name the four compounds.

A ______________________________

B ______________________________

C ______________________________

D ______________________________ [4]

Examiner Only	
Marks	Remark

12 Hydrogen is produced on an industrial scale by the reaction between methane and steam. The reaction is endothermic.

Examiner Only	
Marks	Remark

$$CH_4(g) + 2H_2O(g) \rightleftharpoons CO_2(g) + 4H_2(g)$$

The reaction is carried out at 1023 K and a pressure of 40 atmospheres in the presence of a nickel catalyst.

(a) Explain the use of a temperature of 1023 K.

____

____

____ [3]

(b) Calculate the atom economy for the reaction assuming that the carbon dioxide is a waste product and comment on the value obtained.

____

____

____

____ [4]

Examiner Only	
Marks	Remark

(c) Use the following bond energies to calculate ΔH for the reaction.

	$kJ\ mol^{-1}$
C–H	413
O–H	464
C=O	805
H–H	436

____

____

____ [3]

(d) Although the raw materials are cheap, the running costs of this reaction are significant. Suggest **two** reasons for this.

____

____ [2]

(e) Another reaction which can occur is

$$CH_4(g) + H_2O(g) \rightarrow CO(g) + 3H_2(g)$$

(i) Explain why this reaction is environmentally undesirable.

____ [1]

(ii) Suggest how the occurrence of this reaction could be prevented.

____

____ [1]

(iii) Calculate the volume of hydrogen produced at 20 °C and 1 atmosphere pressure from the reaction of 4 tonnes of methane with steam.

____

____

____ [3]

Examiner Only	
Marks	Remark

13 Chloromethane, CH_3Cl, is the largest natural source of ozone-depleting chlorine compounds in the atmosphere. Some common tropical plants emit considerable quantities of chloromethane.

(a) Chloromethane may be prepared in the laboratory by the reaction of methanol with a mixture of sodium chloride and concentrated sulphuric acid which generates hydrogen chloride.

(i) Describe the chemical test to show that hydrogen chloride is produced.

____ [2]

(ii) Write the equation for the reaction of methanol with hydrogen chloride.

____ [1]

(iii) The preparation of chloromethane is difficult because it is a gas at room temperature and pressure.
Suggest how this would cause problems during the preparation.

____ [1]

(b) Another method of preparing chloromethane is by the reaction of methane with chlorine in the presence of ultra violet light. The reaction proceeds by a free radical mechanism.

(i) Write the equation for the reaction of methane with chlorine to form chloromethane.

____ [1]

(ii) Give the electronic structure of a chlorine radical.

____ [1]

(iii) What is the role of the ultra violet light?

____

____ [2]

(iv) Ethane is formed as an impurity during the reaction. Explain how it is formed.

____

____ [1]

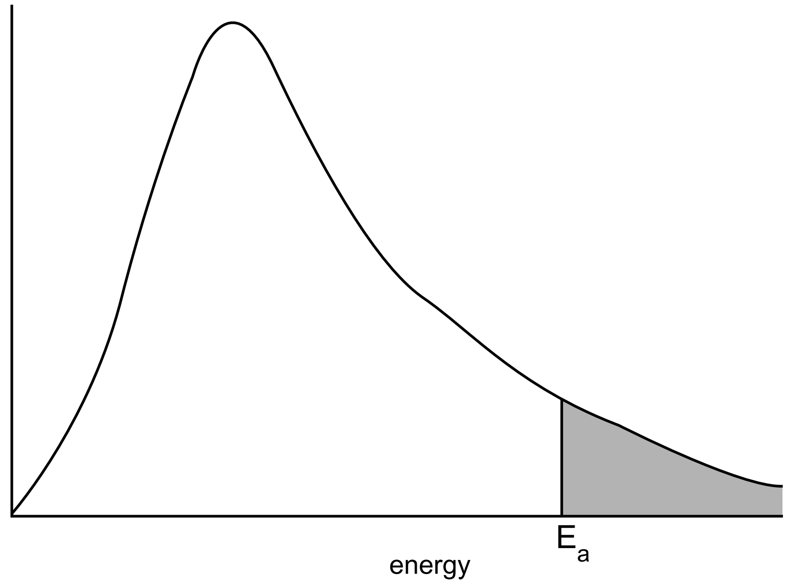
(c) Complete the scheme below writing the formulae of the organic products.

Examiner Only	
Marks	Remark

$$\xleftarrow{NH_3} CH_3Cl \xrightarrow{NaOH(aq)}$$

[2]

14 The diagram shows the distribution curve for the energies of the molecules of a gas in a given system. E_a is the activation energy for a particular reaction.



(a) (i) Label the vertical axis on the diagram. [1]

(ii) Explain why the curve starts at the origin.

____

____ [1]

(iii) Why does the curve not intersect the horizontal axis at higher energies?

____

____ [1]

(iv) What does the shaded area represent?

____

____ [2]

Examiner Only	
Marks	Remark

(b) (i) Draw a curve on the graph representing the distribution of energies for the same molecules at a higher temperature. [2]

(ii) By reference to the curve you have drawn in part **(i)**, explain the effect of the higher temperature on the rate of a chemical reaction.

____

____

____ [1]

(c) By reference to the distribution curve, explain the effect of a catalyst on the rate of a chemical reaction.

____

____

____ [2]

Examiner Only	
Marks	Remark

15 Magnesium sulphate occurs as the mineral Epsom salts, $MgSO_4.7H_2O$. Calcium sulphate occurs as gypsum, $CaSO_4.2H_2O$. Barium sulphate contains no water of crystallisation.

Examiner Only	
Marks	Remark

(a) Magnesium, calcium and barium are regarded as **s-block** elements. Explain this term.

______________________________ [1]

(b) Hydration of the sulphate is related to the trend in solubility of the Group II sulphates. State this trend.

______________________________ [1]

(c) When heated, the hydrated salts lose water to form the anhydrous sulphate. Further heating causes the sulphate to decompose to form the oxide and sulphur trioxide.

(i) Calculate the percentage yield of $CaSO_4$ when 34.4 g gypsum is heated to form 26.0 g of anhydrous calcium sulphate.

____

____

______________________________ [3]

(ii) Write the equation for the decomposition of anhydrous calcium sulphate.

______________________________ [1]

(iii) The thermal stability of the Group II sulphates may be explained in a similar way to that of the carbonates. Explain the relative stability of the sulphates with reference to the cations involved.

____

____

______________________________ [3]

(d) The enthalpy change for the hydration of magnesium sulphate may be determined using Hess's law.

$$MgSO_4(s) + 7H_2O(l) \rightarrow MgSO_4.7H_2O(s)$$

(i) State Hess's law.

____

____ [2]

(ii) Use the following data to calculate the molar enthalpy of hydration of magnesium sulphate. You may wish to construct an enthalpy cycle.

When 0.10 mol of anhydrous $MgSO_4$ was dissolved in 100 g of water, the temperature rose by 9 °C. When 0.10 mol of $MgSO_4.7H_2O$ was dissolved in 100 g of water, the temperature dropped 3 °C. (The specific heat capacity for water is $4.2\,J\,°C^{-1}g^{-1}$.)

[4]

(iii) Suggest how you would carry out this experiment in the laboratory, stating the equipment used, the measurements made and the possible sources of error. Explain how these errors can be minimised.

____

____

____

____

____

____ [5]

Quality of written communication [2]

Examiner Only	
Marks	Remark

Examiner Only	
Marks	Remark

16 Propenonitrile, $CH_2{=}CHCN$, can be polymerised to form a fibre known as Orlon, used for making clothes.

(a) Propenonitrile is manufactured from propene, ammonia and oxygen in the presence of molybdenum. Water is produced together with propenonitrile.

(i) Write an equation for the reaction.

____ [2]

(ii) Suggest the role of the molybdenum.

____ [1]

(iii) Suggest how you could use infra-red spectroscopy to show that no propene was present in the product from the reaction.

____

____

____ [2]

(b) Propenonitrile may be prepared in the laboratory using chloroethene and sodium cyanide. Write the equation for the reaction.

____ [2]

Examiner Only	
Marks	Remark

(c) **(i)** What is the molecular formula for propenonitrile?

____ [1]

(ii) What is the empirical formula for propenonitrile?

____ [1]

(iii) Draw the structure of a propenonitrile molecule, showing **all** the bonds present.

[2]

(iv) Explain whether propenonitrile is able to exist in *cis* and *trans* (E–Z) forms.

____

____ [2]

(d) Propenonitrile polymerises to form poly(propenonitrile) known as Orlon.

(i) Draw a diagram to represent the structure of Orlon, showing two of the repeating units.

[2]

(ii) State the type of polymerisation taking place.

____ [1]

Published Mark Schemes for GCE AS Chemistry

Summer 2009

Issued: October 2009

NORTHERN IRELAND GENERAL CERTIFICATE OF SECONDARY EDUCATION (GCSE) AND NORTHERN IRELAND GENERAL CERTIFICATE OF EDUCATION (GCE)

MARK SCHEMES (2009)

Foreword

Introduction

Mark Schemes are published to assist teachers and students in their preparation for examinations. Through the mark schemes teachers and students will be able to see what examiners are looking for in response to questions and exactly where the marks have been awarded. The publishing of the mark schemes may help to show that examiners are not concerned about finding out what a student does not know but rather with rewarding students for what they do know.

The Purpose of Mark Schemes

Examination papers are set and revised by teams of examiners and revisers appointed by the Council. The teams of examiners and revisers include experienced teachers who are familiar with the level and standards expected of 16 and 18-year-old students in schools and colleges. The job of the examiners is to set the questions and the mark schemes; and the job of the revisers is to review the questions and mark schemes commenting on a large range of issues about which they must be satisfied before the question papers and mark schemes are finalised.

The questions and the mark schemes are developed in association with each other so that the issues of differentiation and positive achievement can be addressed right from the start. Mark schemes therefore are regarded as a part of an integral process which begins with the setting of questions and ends with the marking of the examination.

The main purpose of the mark scheme is to provide a uniform basis for the marking process so that all the markers are following exactly the same instructions and making the same judgements in so far as this is possible. Before marking begins a standardising meeting is held where all the markers are briefed using the mark scheme and samples of the students' work in the form of scripts. Consideration is also given at this stage to any comments on the operational papers received from teachers and their organisations. During this meeting, and up to and including the end of the marking, there is provision for amendments to be made to the mark scheme. What is published represents this final form of the mark scheme.

It is important to recognise that in some cases there may well be other correct responses which are equally acceptable to those published: the mark scheme can only cover those responses which emerged in the examination. There may also be instances where certain judgements may have to be left to the experience of the examiner, for example, where there is no absolute correct response – all teachers will be familiar with making such judgements.

The Council hopes that the mark schemes will be viewed and used in a constructive way as a further support to the teaching and learning processes.

CONTENTS

New Specification

Rewarding Learning

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
2009

Chemistry

Assessment Unit AS 1

assessing

Module 1: Basic Concepts in Physical and Inorganic Chemistry

[AC111]

WEDNESDAY 3 JUNE, MORNING

MARK SCHEME

		AVAILABLE MARKS

Section A

1 A

2 B

3 C

4 A

5 D

6 A

7 D

8 C

9 B

10 B

[2] for each correct answer [20] 20

Section A **20**

AVAILABLE MARKS

Section B

11 **(a)**

Molecule	Attractive force
Ammonia	Hydrogen bonds
Hydrogen chloride	Dipole-Dipole
Methane	Van der Waals

[1] each [3]

(b) More/longer/fixed Hydrogen bonds (between the water molecules) [1] give ice a more open structure (and so a lower density) [1] [2]

(c)

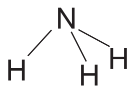


Diagram [1]
Repulsion between electron pairs [1]
Mention of **four** pairs or comment on lone pair [1] [3] 8

12 **(a)**

	Number of protons	Number of electrons	Number of neutrons
Neon-20	10	10	10
Neon-21	10	10	11
Neon-22	10	10	12

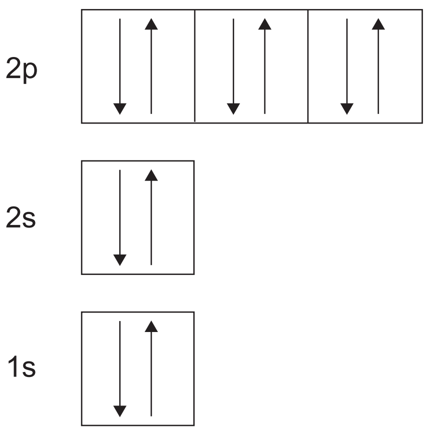
[–1] for each mistake [2]

(b) $$\frac{(20 \times 90.92) + (21 \times 0.26) + (22 \times 8.82)}{100}$$

= 20.18
[–1] for each mistake [2]

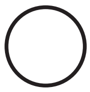
(c) Carbon-12 isotope [1]

(d)



Subshell labels [1] electronic arrangement [1]
[–1] for each mistake [2]

AVAILABLE MARKS

(e)  

s orbital p orbital
[1] each [2] 9

13 (a) $CaCO_3 + 2HCl \rightarrow CaCl_2 + H_2O + CO_2$
[2], [–1] for each mistake [2]

(b) A solution of known concentration [1]

(c) (2 x 20)/1000 = 0.04 mole
(0.1 x 18.6)/1000 = 0.00186 mole
0.0186
0.04 – 0.0186 = 0.0214
(0.0214/2) x 100 = 1.07(g)
(1.07/1.12) x 100 = 95.5%
[–1] for each mistake [6]

(d) phenolphthalein/methyl orange [1]
from colourless [1] to pink/from red [1] to yellow [1] [3] 12

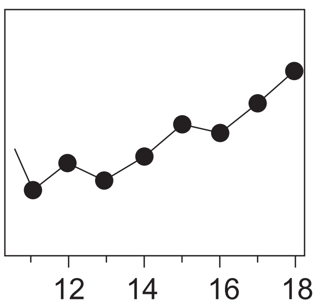
14 (a) (i) Atomic number [1]

(ii) Their (outer) electrons are in the d-subshell [1]

(b) (i) Melting point increases to silicon [1]
then decreases (to argon) [1] [2]

(ii) Atomic radius decreases across the period [1]
Shielding remains the same but nuclear charge increases [1] [2]

(iii)



General rise across the period [1]
Fall between Groups 2 and 3 [1]
Fall between Groups 5 and 6 [1] [3] 9

AVAILABLE MARKS

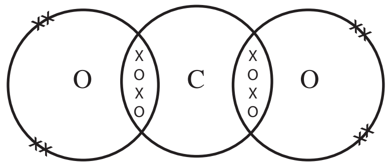
15 (a) (i) Pair(s) of electrons shared between (two) atoms [1]

(ii) Diamond: Carbon atoms joined to 4 others [1] tetrahedrally [1]
Graphite: hexagonal rings of carbon atoms [1] in layers [1] [4]

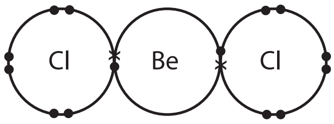
(iii) Free electrons [1] are able to move [1] around the layers [2]

(iv) Strong (covalent) bonds [1] throughout the giant (tetrahedral) structure [1]

(b) (i)



[–1] for each mistake [1]



[–1] for each mistake [1]

(ii) Octet rule: eight electrons in the outer shell (when bonded) [1]
Be (has less than 8) in beryllium chloride/has only 4 electrons in its outer shell [1] [2] 12

16 (a) (i) Sodium: nichrome wire [1]/(conc HCl) blue flame [1]/yellow [1]
Chloride: (make a solution) silver nitrate [1] white precipitate [1]
or dissolve in HNO_3 [1] (solution) [5]

Quality of written communication [2]

(ii) $Na^+ \; \cdot\ddot{\underset{\cdot\cdot}{Cl}}\!: \; \rightarrow \; Na^+ \; \overset{\times}{:}\!\ddot{\underset{\cdot\cdot}{Cl}}\!:^{\,-}$ [4]

(b) (i) In the solution the ions are free to move, (they cannot move in the solid) [1]

(ii) Chlorine atoms are both oxidised (0 to +1) [1] and reduced (0 to –1) [1] this is disproportionation [1] [3]

(iii) Colourless solution [1]
turns yellow [1] [2]

(iv) $Cl_2 + 2Br^- \rightarrow 2Cl^- + Br_2$ [1]

				AVAILABLE MARKS
	(c) **(i)**	$H_2SO_4 + NaCl \rightarrow NaHSO_4 + HCl$ (–1 if Na_2SO_4)	[2]	
	(ii)	Steamy fumes/purple vapour/yellow solid/fizzing/heat evolved/ grey-black solid/ rotten egg smell/choking gas (SO_2) any **two**, [1] each	[2]	22
17	**(a)**	Level 2 to level 1 [1] indication of downwards [1]	[2]	
	(b)	An electron leaves the atom/energy levels come together	[1]	
	(c) **(i)**	$H(g) \rightarrow H^+(g) + e^-$ (–1 for each mistake)	[2]	
	(ii)	$3 \times 10^8 = 91.1 \times 10^{-9} \times$ frequency 3.29×10^{15}	[1]	
	(iii)	$E = hf = (6.63 \times 10^{-34}) \times (3.29 \times 10^{15}) = 2.18 \times 10^{-18}$ [1] $(2.18 \times 10^{-18}) \times (6.02 \times 10^{23}) = 1314\,kJ\,mol^{-1}$ [1]	[2]	8
			Section B	**80**
			Total	**100**

New Specification

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ADVANCED SUBSIDIARY (AS)
General Certificate of Education
2009

Chemistry

Assessment Unit AS 2

assessing

Module 2: Further Physical and Inorganic Chemistry and Introduction to Organic Chemistry

[AC121]

THURSDAY 11 JUNE, AFTERNOON

MARK SCHEME

Quality of written communication:

2 marks	The candidate expresses ideas clearly and fluently through well-linked sentences and paragraphs. Arguments are generally relevant and well-structured. There are few errors of grammar, punctuation and spelling.
1 mark	The candidate expresses ideas clearly, if not always fluently. Arguments may sometimes stray from the point. There may be some errors of grammar, punctuation and spelling, but not such as to suggest a weakness in these areas.
0 marks	The candidate expresses ideas satisfactorily, but without precision. Arguments may be of doubtful relevance or obscurely presented. Errors in grammar, punctuation and spelling are sufficiently intrusive to disrupt the understanding of the passage.

Section A

			AVAILABLE MARKS
1	A		
2	C		
3	D		
4	D		
5	C		
6	B		
7	B		
8	C		
9	B		
10	B		
[2] for each correct answer		[20]	20
		Section A	**20**

Section B

AVAILABLE MARKS

11 copper sulphate [1]
sulphuric acid [1]
sodium chromate [1]
potassium sulphate [1] [4] 4

12 **(a)** reaction is endothermic + mention of high temperature [1]
reaction moves to RHS to absorb heat [2]
increased temperature speeds up reaction [1]
To a maximum of [3] [3]

(b) Comment/statement on formula for % atom economy [2]
$CH_4(g) + 2H_2O(g) \rightarrow CO_2(g) + 4H_2(g)$
16 36 44 8

$$\frac{8}{52} \times 100 = 15.4\% \ [2]$$

atom economy very low [1]
(no problem with disposal of carbon dioxide [1])
except that it causes global warming [1]
need to find a use for the carbon dioxide [1]
large amount of waste produced [1]
To a maximum of [4] [4]

(c) energy needed to break bonds in reactants
4C—H = $4 \times 413 = 1652$
4O—H = $4 \times 464 = 1856$ total = 3508

energy needed to break bonds in products
2C═O = $2 \times 805 = 1610$
4H—H = $4 \times 436 = 1744$ total = 3354

+3508 – 3354 = (+)154 kJ [3]

(d) high pressure (is expensive to maintain/thicker pipes needed) [1]
high temperature/endothermic (needs fuel which is expensive) [1] [2]

(e) **(i)** carbon monoxide is poisonous [1]

(ii) use an excess of water/steam [1]

(iii) $1CH_4 \rightarrow 3H_2$
$16\,g \rightarrow 3 \times 24\,dm^3$
16 tonnes $\rightarrow 10^6 \times 3 \times 24\,dm^3$
4 tonnes $\rightarrow 10^6 \times 3 \times 6\,dm^3$
$= 1.8 \times 10^7\,dm^3$ [3] 17

AVAILABLE MARKS

13 (a) (i) conc. ammonia [1]
white smoke [1] [2]

(ii) $CH_3OH + HCl \rightarrow CH_3Cl + H_2O$ [1]

(iii) the gas would escape from the reaction flask/needs to be condensed/difficult to collect [1]

(b) (i) $CH_4 + Cl_2 \rightarrow CH_3Cl + HCl$ [1]

(ii) $1s^2 2s^2 2p^6 3s^2 3p^5$ [1]

(iii) provides the energy [1]
to break the Cl—Cl bond [1] [2]

(iv) $^{\bullet}CH_3 + {}^{\bullet}CH_3 \rightarrow C_2H_6$ [1]

(c) CH_3NH_2/$CH_3\overset{+}{N}H_3\ Cl^-$ [1]
CH_3OH [1] [2] 11

14 (a) (i) number of molecules [1]

(ii) no molecules hence no energy [1]

(iii) there are always some molecules with (a higher/some) energy [1]

(iv) the number of particles [1]
with (energy greater than) the activation energy [1] [2]

(b) (i) peak moves to the RHS [1]
and is lower [1] [2]

(ii) more particles have (energy greater than) the activation energy [1]

(c) the activation energy is less [1]
the number of particles with the required activation energy is greater [1] [2] 10

AVAILABLE MARKS

15 **(a)** the outer shells contain s electrons [1]

(b) the solubility of the sulphates decreases down the group [1]

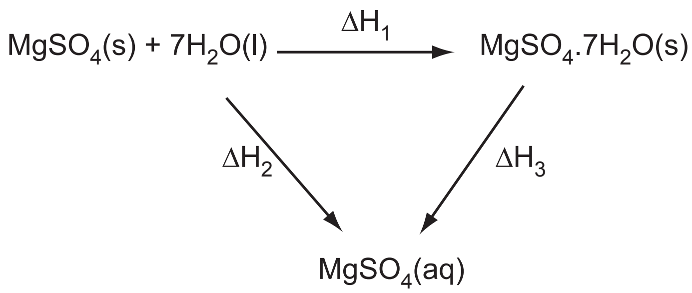
(c) **(i)** $CaSO_4.2H_2O = 40 + 32 + 64 + 2 \times 18 = 172$
$CaSO_4 = 40 + 32 + 64 = 136$
172 g of gypsum gives 136 g of anhydrous calcium sulphate
34.4 g of gypsum gives $136/172 \times 34.4$ g of anhydrous calcium sulphate = 27.2 g
percentage yield = $26.0/27.2 \times 100 = 95.588 = 95.6\%$ [3]

(ii) $CaSO_4 \rightarrow CaO + SO_3$ [1]

(iii) the size of the cation increases down the group [1]
the polarising power of the cation is decreased [1]
charge density less [1]
anion is "deformed" [1]
Any three from four [3]

(d) **(i)** the enthalpy change in a reaction is independent of the route taken [2]

(ii)



$\Delta H_1 + \Delta H_3 = \Delta H_2$

$\Delta H_2 = 10 \times 100 \times 4.2 \times 9 = 37.8 \times 10^3$ J = –37.8 kJ (exothermic)
$\Delta H_3 = 10 \times 100 \times 4.2 \times 3 = 12.6 \times 10^3$ J = +12.6. kJ (endothermic)

$\Delta H_1 + 12.6 = -37.8 \quad \Delta H_1 = -50.4$ kJ [4]

(iii) Any **three** from **four**:
- insulated container/plastic cup [1]
- add solid to water [1] with stirring [1]
- measure temperature before and after with thermometer [1]

major error is heat loss [1]
increase insulation/use lid/stop draughts [1]
(Maximum [5]) [5]

Quality of written communication [2] 22

AVAILABLE MARKS

16 **(a)** **(i)** $C_3H_6 + NH_3 + 1.5O_2 \rightarrow CH_2{=}CHCN + 3H_2O$ [2]

(ii) catalyst [1]

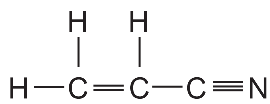
(iii) the IR spectra are unique for a compound they will differ [1]
because of the different position of the C=C absorption [1]/
fingerprint regions of each don't match
or
superimpose the spectra of each compound
they will be different [2]

(b) $CH_2{=}CHCl + NaCN \rightarrow CH_2{=}CHCN + NaCl$ [2]

(c) **(i)** C_3H_3N [1]

(ii) C_3H_3N [1]

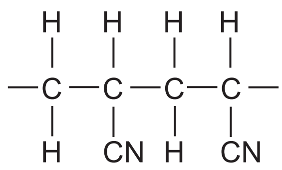
(iii)



[2]

(iv) no [1]
propenonitrile contains CH_2 group/explain by drawing structures [1] [2]

(d) **(i)**



[2]

(ii) addition polymerisation [1] 16

Section B	**80**
Total	**100**

New Specification

Rewarding Learning

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
2009

Chemistry

Assessment Unit AS 3

assessing

Module 3: Practical Examination 1

[AC131]

MONDAY 11 MAY, AFTERNOON

MARK SCHEME

AVAILABLE MARKS

Section A

1 Titration exercise

(a) **(i)** Rinse out a pipette with one of the solutions and (using a pipette filler) transfer/pipette a known volume of the solution into a conical flask [1]
(ii) Add 2 or 3 drops of phenolphthalein [1]
(iii) Rinse out the burette with the other solution and fill the burette [1]
(iv) Add the solution from the burette until the end point is reached [1]
(v) Repeat (for accuracy) [1]

To a maximum of [4]

(b) Table [1]
Significant figures [2]
Calculation of average titre [2]
Titration consistency [3]
Agreement with supervisor's titre [4] [12]

NOTES:

Table:
Table should include initial burette reading, final burette reading, and volume delivered for rough and accurate titrations. [1]

Significant figures:
All burette readings should be to at least one decimal place – each mistake is penalised by [1].
(However, initial burette readings of 0 are penalised once only)
If used, the second decimal position should be 0 or 5 only – other values are penalised by [1]. [2]

Average titre:
The average titre should be calculated and units should be included.
Accurate titrations only should be used.
The use of the rough value is [–1].
The average value can be two or three decimal places, e.g. 25.375/25.38
An incorrect calculation is 0. [2]

Titration consistency:
This is the difference between the first and second accurate readings.

Difference less than or equal to	Mark
0.1	3
0.2	2
0.3	1
0.4	0

[3]

AVAILABLE MARKS

Titration agreement with supervisor:
This is the difference between the candidate's calculated average titre and the supervisor's value.

Difference less than or equal to	Mark
±0.1	[4]
±0.2	[3]
±0.3	[2]
±0.4	[1]
±0.5	[0]

[4]

(c) Colourless to pink/red (or vice-versa depending on titration) [1]

(d) $CH_3COOH(aq) + NaOH(aq) \rightarrow CH_3COONa(aq) + H_2O(l)$
[1] for equation, [1] for state symbols [2]

(e) **(i)** Correct calculation using volume in dm^3 [2]

Number of moles = concentration ($mol\,dm^{-3}$) $\times \dfrac{\text{volume } (cm^3)}{1000}$

(ii) Uses 1 : 1 ratio from equation
If equation incorrectly balanced in **(d)** the candidate's ratio should be used (i.e. carry error through (c.e.t.)) [1]

(iii) Correct calculation using volume in dm^3
Divide by volume (in dm^3) of ethanoic acid used in titration [2]

(iv) Correct calculation
Multiply by RMM of ethanoic acid [1] [6] 25

2 Observation/deduction

Safety goggles must be worn at all times and care should be exercised during this practical examination.

(a) You are provided with a mixture of two salts, labelled A, which have a common cation. Carry out the following experiments on the mixture. Record your observations and deductions in the spaces below and identify the two salts.

Experiment	Observations	Deductions	
1 Describe the appearance of A.	*White solid* [1]	*Does not contain a Transition metal ion. Group I or II/Ammonium compound/s-block ion present* [1]	[2]
2 Dip a wire loop in concentrated hydrochloric acid; touch sample A with the wire, then hold it in a blue Bunsen flame.	*Yellow/orange/golden* [1]	*Na^+/Sodium ion/compound (present)* [1]	[2]
In a fume cupboard: **3** Add about 1 cm^3 of concentrated sulphuric acid to a half spatula-measure of A in a test tube. Test the gas given off using a glass rod which has been dipped into concentrated ammonia solution.	*Bubbling/fizz/gas given off/ effervescence/frothing* [1] *Misty/Steamy fumes* [1] *White smoke/cloudy/ solid/fumes* [1]	*Hydrogen chloride/HCl (g) or chloride/Cl^-* [1]	[4]
4 Make up a solution of A by dissolving a half spatula-measure of A in a test tube half-full of dilute nitric acid. Put 1 cm^3 of the solution into each of two separate test tubes.	*No effervescence* [1] *Colourless solution* [1]	*Not carbonate or hydrogencarbonate or sulphite* [1]	
(a) (i) Add a few drops of silver nitrate solution into the first test tube.	*White solid/ precipitate* [1]		
(ii) Add about 1 cm^3 of concentrated ammonia into the first test tube.	*White precipitate dissolves/ disappears* [1]	*Chloride* [1]	
(b) Add a few drops of barium chloride solution into the second test tube.	*White solid/ precipitate* [1]	*Sulphate* [1]	

[8]

Name the two salts present in A:

Sodium chloride [1]

Sodium sulphate [1]

AVAILABLE MARKS

(b) You are provided with an aqueous solution containing an organic substance X. Carry out the following experiments. Record your observations and deductions in the spaces below.

Experiment	Observations	Deductions	
1 Describe the solution and add a few drops on to Universal Indicator paper.	*Colourless (solution)* [1] *Shades of green* [1]	*Not a carboxylic acid/* *Neutral* [1]	[3]
In a fume cupboard: **2** Shake a small volume of the solution with bromine water.	*Yellow/orange colour* [1] *remains* [1]	*Saturated or no C═C* [1] *Not an alkene/not unsaturated*	[3]
3 Heat about 2 cm^3 of the solution with 2 cm^3 of acidified potassium dichromate solution.	*Orange* [1] *to green* [1] *Change in smell* [1]	*Primary or secondary alcohol/not a tertiary alcohol/aldehyde* [1] *can be oxidised/aldehyde or ketone formed* *is a reducing agent* [1]	[5]

AVAILABLE MARKS

Based on the above tests, suggest

A functional group(s) which may be present in X:

OH [1]

A functional group(s) which the tests used above show is absent in X:

C═C or —COOH [1]

To a maximum of [29] 29

Section A **54**

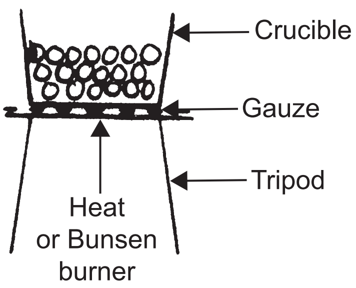
AVAILABLE MARKS

Section B

3 Planning

(a) (i) contains water of crystallisation [1]

(ii)



Heat/Bunsen burner – correctly labelled [1]
Tripod and gauze – correctly labelled [1]
Crucible – correctly labelled [1] [4]
(–1 for each omission)

(b) (i) Mass of container, e.g. crucible [1]
Mass of crucible + (hydrated) sodium carbonate [1]

(ii) Heat and weigh [1]
Repeat [1]
Until there is no further decrease in mass/to constant mass [1]

(iii) Allow apparatus (crucible) to cool/use gloves/use tongs [1] [6]

(c) (i) 11.44 – 4.24 = 7.20 g [1]

(ii) 7.2 ÷ 18 = 0.4 moles [1]

(iii) 4.24 ÷ 106 = 0.04 moles [1]

(iv)

Na_2CO_3	H_2O
0.04	0.4
1	10

[1]

$x = 10$ [1] [5]

(d) (i) 2.65 ÷ 106 = 0.025 mole [1]

(ii) $q = m \times c \times \Delta T$
$50.0 \times 4.2 \times 4.8 = 1008\,J$ [2]
(units not required)

(iii) 1008 ÷ 1000 = 1.008 kJ [1]
1.008 ÷ 0.025 = –40.3 kJ mol^{-1}
(units not required) (minus sign required) [1] [5]

20

AVAILABLE MARKS

4 **(a)** mass = density × volume = 0.81 × 13.7 = 11.10 g [1]

(b) 11.10 ÷ 74 = 0.150 moles [1]

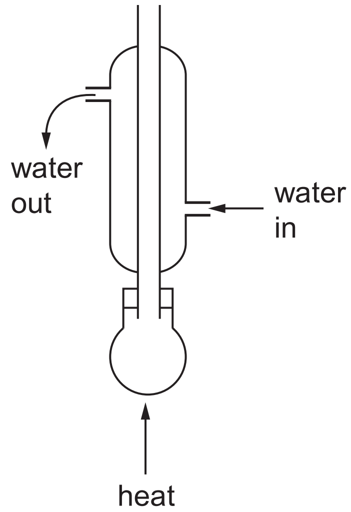
(c) 1:1 ratio 0.150 moles [1]

(d) Actual yield = 10.28 ÷ 137 = 0.075 moles [1]

(e) (Actual yield ÷ Theoretical yield) × 100 = % yield [1]

(f) Percentage yield = (0.075 ÷ 0.150) × 100 = 50% [1] 6

5 **(a)**



Condenser should have water in and water out as shown [3]
no heat source [–1]
no double jacket on condenser [–1]
condenser sealed at top [–1]
top of flask must not be open [–1]
no labels [–1]

(b) To ensure smooth boiling [1] 4

				AVAILABLE MARKS
6	**(a)**	Sodium hydroxide or NaOH	[1]	
	(b)	Potassium thiocyanate or KCNS	[1]	
	(c)	Blood red solution forms (If candidate gives the result of a positive test for part **(a)** this can be credited i.e. $Fe^{2+} \rightarrow$ green precipitate; $Fe^{3+} \rightarrow$ red/brown precipitate	[1]	3
7	**(a)**	Add water The layer which increases in volume is the aqueous layer Qualitative explanation using densities [2]	[1] [1]	
	(b)	Acts as a drying agent	[1]	3
			Section B	**36**
			Total	**90**

New Specification

Rewarding Learning

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
2009

Chemistry

Assessment Unit AS 3

assessing

Module 3: Practical Examination 2

[AC132]

FRIDAY 15 MAY, MORNING

MARK SCHEME

Section A

AVAILABLE MARKS

1 Titration exercise

(a) **(i)** Rinse out a pipette with one of the solutions and (using a pipette filler) transfer/pipette a known volume of the solution into a conical flask [1]
(ii) Add 2 or 3 drops of phenolphthalein [1]
(iii) Rinse out the burette with the other solution and fill the burette [1]
(iv) Add the solution from the burette until the end point is reached [1]
(v) Repeat (for accuracy) [1]

To a maximum of [4]

(b) Table [1]
Significant figures [2]
Calculation of average titre [2]
Titration consistency [3]
Agreement with supervisor's titre [4] [12]

NOTES:

Table:
Table should include initial burette reading, final burette reading, and volume delivered for rough and accurate titrations. [1]

Significant figures:
All burette readings should be to at least one decimal place – each mistake is penalised by [1]
(However, initial burette readings of 0 are penalised once only)
If used, the second decimal position should be 0 or 5 only – other values are penalised by [1] [2]

Average titre:
The average titre should be calculated and units should be included.
Accurate titrations only should be used.
The use of the rough value is [–1]
The average value can be two or three decimal places, e.g. 25.375/25.38
An incorrect calculation is 0. [2]

Titration consistency:
This is the difference between the first and second accurate readings.

Difference less than or equal to	Mark
0.1	3
0.2	2
0.3	1
0.4	0

[3]

Titration agreement with supervisor:
This is the difference between the candidate's calculated average titre and the supervisor's value.

AVAILABLE MARKS

Difference	Mark
±0.1	[4]
±0.2	[3]
±0.3	[2]
±0.4	[1]
±0.5	[0]

[4]

(c) Colourless to pink/red (or vice-versa depending on titration) [1]

(d) $CH_3COOH(aq) + NaOH(aq) \rightarrow CH_3COONa(aq) + H_2O(l)$
[1] for equation, [1] for state symbols [2]

(e) **(i)** Correct calculation using volume in dm^3 [2]

Number of moles = concentration $(mol\,dm^{-3}) \times \dfrac{\text{volume } (cm^3)}{1000}$

(ii) Uses 1 : 1 ratio from equation
If equation incorrectly balanced in **(d)** the candidate's ratio should be used (i.e. carry error through (c.e.t.) [1]

(iii) Correct calculation using volume in dm^3
Divide by volume (in dm^3) of ethanoic acid used in titration [2]

(iv) Correct calculation
Multiply by RMM of ethanoic acid [1] [6] 25

2 Observation/deduction

Safety goggles must be worn at all times and care should be exercised during this practical examination.

(a) You are provided with a mixture of two salts, labelled B, which have a common cation. Carry out the following experiments on the mixture. Record your observations and deductions in the spaces below and identify the two salts.

Experiment	Observations	Deductions	
1 Describe the appearance of B.	*White solid* [1]	*Does not contain a Transition metal ion. Group I or II/Ammonium compound/s-block ion present* [1]	[2]
2 Dip a wire loop in concentrated hydrochloric acid; touch sample B with the wire, then hold it in a blue Bunsen flame.	*Pink/Purple/Lilac* [1]	*K^+/Potassium ion/ compound (present)* [1]	[2]
In a fume cupboard: **3** Add about 1 cm^3 of concentrated sulphuric acid to a half spatula-measure of B in a test tube. Heat the test tube gently.	*Grey/black solid* [1] *Steamy fumes* [1] *Purple gas/clouds/fumes* [1]	*Iodine or iodide I^-* [1]	[4]
4 Make up a solution of B by dissolving a half spatula-measure of B in a test tube half-full of water. Put 1 cm^3 of the solution into each of two separate test tubes.	*Colourless solution* [1]		
(a) (i) Add a few drops of silver nitrate solution into the first test tube.	*Yellow solid/ precipitate* [1]		
(ii) Add about 2 cm^3 of concentrated ammonia into the first test tube.	*Yellow precipitate remains* [1]	*Iodide* [1]	
(b) Add a few drops of barium chloride solution to the second test-tube and then add 2 cm^3 of dilute nitric acid.	*White solid precipitate* [1] *No effervescence/does not dissolve* [1]	*Sulphite/Sulphate* [1] *Not carbonate or hydrogen carbonate/sulphite* [1]	[8]

Name the two salts present in B:

Potassium iodide [1]

Potassium sulphate [1]

AVAILABLE MARKS

(b) You are provided with an aqueous solution containing an organic substance Y. Carry out the following experiments. Record your observations and deductions in the spaces below.

Experiment	Observations	Deductions	
1 Describe the solution and add a few drops on to Universal Indicator paper.	*Colourless (solution)* [1] *Shades of green* [1]	*Not a cartoxylic acid/Neutral* [1]	
In a fume cupboard: **2** Shake a small volume of the solution with bromine water.	*Yellow/orange colour* [1] *remains* [1]	*Saturated/no C═C* [1] *Not an alkene/not unsaturated*	[3]
3 Heat about 2 cm^3 of the solution with a few drops of acidified potassium dichromate solution.	*Orange* [1] *to green* [1] *Change in smell* [1]	*Primary or secondary alcohol/ not a tertiary alcohol/aldehyde* [1] *can be oxidised/aldehyde or ketone formed* *is a reducing agent* [1]	[3] [5]

AVAILABLE MARKS

Based on the above tests, suggest

A functional group(s) which may be present in Y:

OH [1]

A functional group(s) which is absent from Y:

C═C or —COOH [1]

To a maximum of [29] 29

Section A **54**

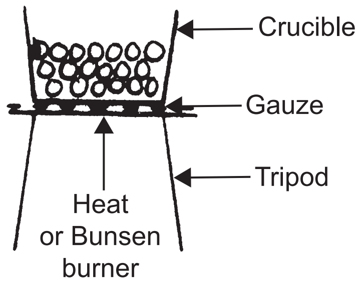
Section B

AVAILABLE MARKS

3 Planning

(a) (i) contains water of crystallisation [1]

(ii)



Heat/Bunsen burner – correctly labelled [1]
Tripod and gauze – correctly labelled [1]
Crucible – correctly labelled [1] [4]
([–1] for each omission)

(b) (i) mass of container, e.g. crucible [1]
Mass of crucible + hydrated zinc sulphate [1]

(ii) Heat and weigh [1]
Repeat [1]
Until there is no further decrease in mass/to constant mass [1]

(iii) Allow apparatus (crucible) to cool/use gloves/use tongs [1] [6]

(c) (i) 8.63 – 4.85 = 3.78 g [1]

(ii) 3.78 ÷ 18 = 0.21 moles [1]

(iii) 4.85 ÷ 161 = 0.03 moles [1]

(iv)

$ZnSO_4$	H_2O	
0.03	0.21	
1	7	[1]

$x = 7$ [1] [5]

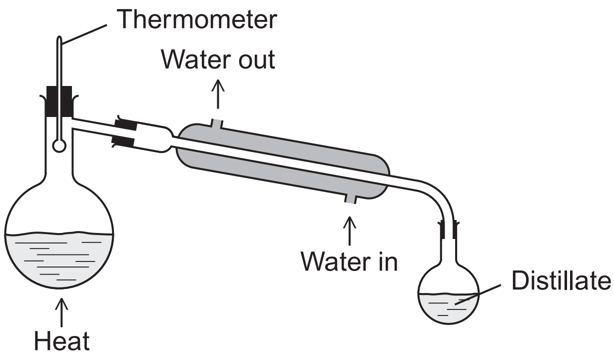
(d) (i) 0.5 × (50.0 ÷ 1000) = 0.025 mole [1]

(ii) $q = m \times c \times \Delta T$ [1]
$50 \times 4.2 \times 25.3 = 5313$ J [1]
(units not required)

(iii) 5313 ÷ 1000 = 5.313 kJ [1]
5.313 ÷ 0.025 = –212.5 kJ mol^{-1} [1] [5] 20
(units not required) (minus sign required)

				AVAILABLE MARKS
4	(a)	mass = density × volume = 1.05 × 11.4 = 11.97 g	[1]	
	(b)	11.97 ÷ 60 = 0.200 moles	[1]	
	(c)	0.200 moles	[1]	
	(d)	Actual yield = 5.28 ÷ 88 = 0.06 moles	[1]	
	(e)	(Actual yield ÷ Theoretical yield) × 100 = % yield	[1]	
	(f)	Percentage yield = (0.06 ÷ 0.200) × 100 = 30%	[1]	6

5 **(a)** [2]



		Condenser should have water in and water out as shown no heat source [–1] no double jacket on condenser [–1] distillation flask open at top [–1] thermometer missing [–1] no labels [–1]	[1]	
	(b)	To ensure smooth boiling	[1]	4
6	(a)	Ammonia solution/$NH_3(aq)$	[1]	
	(b)	(pale) blue precipitate/solid forms precipitate dissolves in excess to form a (deep) blue solution	[1] [1]	3
7	(a)	Add water the layer which does not increase in volume is the organic layer Qualitative explanation using densities [2]	[1] [1]	
	(b)	Acts as a drying agent	[1]	3
			Section B	**36**
			Total	**90**

New Specification

Rewarding Learning

Centre Number

71	

Candidate Number

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
January 2010

Chemistry

Assessment Unit AS 2

assessing

Module 2: Further Physical and Inorganic Chemistry and Introduction to Organic Chemistry

[AC121]

THURSDAY 21 JANUARY, AFTERNOON

AC121

TIME

1 hour 30 minutes.

INSTRUCTIONS TO CANDIDATES

Write your Centre Number and Candidate Number in the spaces provided at the top of this page.
Answer **all fifteen** questions.
Answer **all ten** questions in **Section A**. Record your answers by marking the appropriate letter on the answer sheet provided. Use only the spaces numbered 1 to 10.
Keep in sequence when answering.
Answer **all five** questions in **Section B**. Write your answers in the spaces provided in this question paper.

INFORMATION FOR CANDIDATES

The total mark for this paper is 100.
Quality of written communication will be assessed in Question **14(e)**.
In Section A all questions carry equal marks, i.e. **two** marks for each question.
In Section B the figures in brackets printed down the right-hand side of pages indicate the marks awarded to each question or part question.
A Periodic Table of Elements (including some data) is provided.

For Examiner's use only	
Question Number	Marks
Section A	
1–10	
Section B	
11	
12	
13	
14	
15	
Total Marks	

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Section A

For each of the following questions only **one** of the lettered responses (A–D) is correct.

Select the correct response in each case and mark its code letter by connecting the dots as illustrated on the answer sheet.

1 The reaction of hydrogen bromide with ethene is an example of

A electrophilic addition.
B electrophilic substitution.
C nucleophilic addition.
D nucleophilic substitution.

2 Which one of the chlorides described below, all of formula MCl_2, is a chloride of a Group II element?

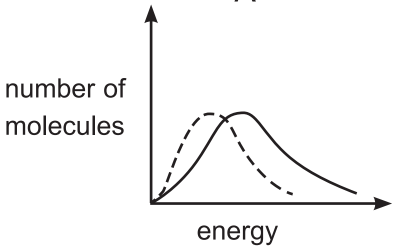
A white solid, melting point 280 °C, boiling point 304 °C, fairly soluble in water to give a colourless neutral solution with poor electrical conductivity
B white solid, melting point 815 °C, readily soluble in water to give a green-blue solution with good electrical conductivity
C white solid, melting point 875 °C, readily soluble in water to give a colourless neutral solution with good electrical conductivity
D white solid, melting point 672 °C, gives pale green solution with good electrical conductivity

3 Which one of the following is a chain propagation step in the chlorination of methane?

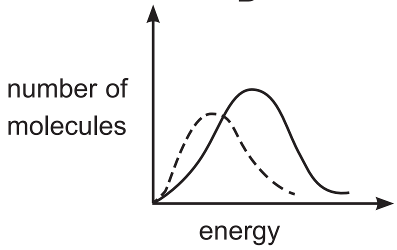
A $H\bullet + Cl_2 \rightarrow HCl + Cl\bullet$
B $Cl\bullet + CH_4 \rightarrow CH_3Cl + H\bullet$
C $CH_3\bullet + Cl_2 \rightarrow CH_3Cl + Cl\bullet$
D $CH_3\bullet + HCl \rightarrow CH_3Cl + H\bullet$

4 Which one of the graphs below most accurately represents the distribution of molecular energies in a gas at 500 K if the dotted curve represents the distribution for the same gas at 300 K?

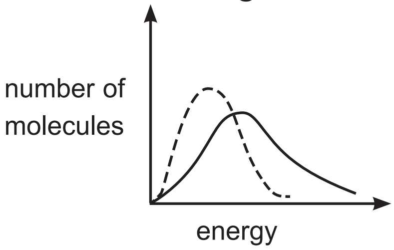
A



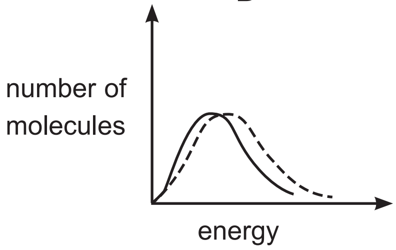
B



C



D



5 A pure hydrocarbon was isolated from bottled gas used for heating. 10 cm^3 of the hydrocarbon was completely combusted in 70 cm^3 of oxygen (an excess). The final gaseous mixture contained 30 cm^3 of carbon dioxide and 20 cm^3 of unreacted oxygen. All volumes were measured under identical conditions.
Which one of the the following is the molecular formula of the hydrocarbon?

A C_2H_4
B C_2H_6
C C_3H_6
D C_3H_8

6 Which one of the following occurs when a molecule absorbs infra-red radiation?

A Electrons in the bonds are excited.
B The bonds bend and eventually break.
C The bonds rotate.
D The bonds vibrate.

7 Which one of the following will **not** give a yellow precipitate with a solution of iodine in sodium hydroxide?

A butan-1-ol
B butan-2-ol
C ethanol
D propan-2-ol

8 The formula of the precipitate produced when solutions of magnesium chloride and sodium hydrogencarbonate are mixed and boiled is:

A $Mg(OH)_2$
B $Mg(HCO_3)_2$
C $MgCO_3$
D MgO

9 5.0g of butan-1-ol (RMM 74) reacted with an excess of hydrogen bromide and 6.4g of 1-bromobutane (RMM 137) were obtained after purification. The percentage yield of 1-bromobutane was:

A 42%
B 54%
C 69%
D 78%

10 A solution of a salt gives a yellow/orange colour when sprayed into a blue Bunsen flame and a white precipitate when added to acidified barium chloride solution. The salt is

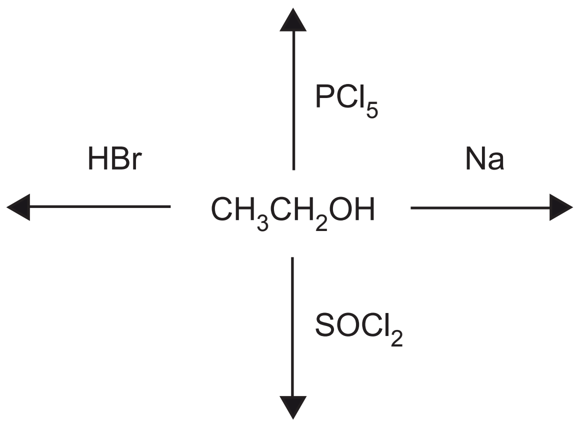
A potassium carbonate.
B potassium sulphate.
C sodium carbonate.
D sodium sulphate.

Section B

Examiner Only	
Marks	Remark

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

11 Complete the following flow scheme showing the organic compound formed in each reaction.



[4]

12 Poly(tetrafluoroethene) is made in a two stage reaction from chlorodifluoromethane.

(a) In the first stage chlorodifluoromethane is cracked to give tetrafluoroethene.

$2CHClF_2(g) \rightleftharpoons CF_2{=}CF_2(g) + 2HCl(g) \qquad \Delta H = +128\ \text{kJ mol}^{-1}$

(i) Explain what is meant by the term **thermal cracking**.

____

____ [2]

(ii) Explain, using the ΔH value, whether the reaction is exothermic or endothermic.

____ [1]

Examiner Only	
Marks	Remark

(iii) Explain, in terms of reaction rate and equilibrium, whether a high or low pressure should be used.

____

____

____

____ [3]

(iv) Explain, in terms of reaction rate and equilibrium, whether a high or low temperature should be used.

____

____

____

____ [3]

(v) Hydrogen chloride is a product of the reaction. Describe a chemical test for hydrogen chloride gas.

____

____ [2]

(b) The second stage involves the polymerisation of tetrafluoroethene.

(i) Complete the following equation which represents the polymerisation reaction.

$$n\ CF_2{=}CF_2 \rightarrow$$

[2]

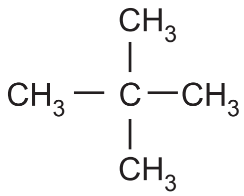
(ii) Why is tetrafluoroethene able to polymerise?

____ [1]

(iii) What type of polymerisation does tetrafluoroethene undergo?

____ [1]

13 Three pentanes are possible theoretically and all occur in natural gas and petroleum gas. Their structures, "trivial" names and boiling points are shown below.

structure	name	boiling point/°C
$CH_3CH_2CH_2CH_2CH_3$	normal pentane	36°
	isopentane	28°
	neopentane	9°

(a) Write the general formula for an alkane.

____ [1]

(b) The three pentanes are regarded as **structural isomers**. Explain this term.

____

____ [2]

(c) How would the pentanes be obtained from petroleum?

____ [2]

(d) Deduce the IUPAC names for isopentane and neopentane.

isopentane _______________________________________ [1]

neopentane _______________________________________ [1]

Examiner Only

Marks	Remark

(e) Explain why the pentanes have different boiling points.

[2]

(f) All three pentanes burn in a limited and in a plentiful supply of air.

(i) Write the equation for the complete combustion of pentane.

[2]

(ii) Write an equation for the incomplete combustion of pentane to form carbon monoxide.

[2]

(g) **(i)** A pentane reacts with chlorine to form a chlorinated pentane. The percentage composition of the chlorinated pentane is shown below.

	% by mass
chlorine	60.7
carbon	34.2
hydrogen	5.1

Deduce the empirical formula of the chlorinated pentane.

[3]

(ii) Explain whether this chlorinated pentane has a higher or lower boiling point than the three pentanes.

[1]

Examiner Only	
Marks	Remark

14 The world production of calcium oxide is currently 280 million tonnes annually. It is used extensively in steel making and the construction industries.
The production of calcium oxide involves heating limestone (calcium carbonate) in a kiln at a temperature of 1200 °C.

$$CaCO_3 \rightarrow CaO + CO_2$$

The heat needed to sustain the reaction is provided by the combustion of fossil fuels.

(a) Compare the thermal stability of calcium carbonate with the other Group II metal carbonates.

____

____ [2]

(b) Explain how the thermal stability of a Group II carbonate is related to the charge and size of the cation.

____

____ [2]

(c) Explain how the manufacture of calcium oxide contributes to global warming.

____

____ [2]

(d) The calcium oxide produced is basic and reacts with water and dilute acids.

(i) Write the equation for the reaction of calcium oxide with hydrochloric acid.

____ [2]

(ii) Write the equation for the reaction of calcium oxide with water to form calcium hydroxide.

____ [1]

Examiner Only	
Marks	Remark

(e) A saturated solution of calcium hydroxide is known as limewater. Describe how you would prepare limewater and use it to test for carbon dioxide, stating the result of a positive test.

____

____

____

______________________________ [4]

Quality of written communication [2]

(f) Write the equation for the reaction of aqueous calcium hydroxide with carbon dioxide including state symbols.

______________________________ [2]

(g) 5 dm^3 of polluted air containing an excess of carbon dioxide was passed through limewater so that all the carbon dioxide present was precipitated as calcium carbonate. The mass of calcium carbonate formed was 0.05 g. Use the following headings to calculate the percentage by volume of carbon dioxide in the air sample.
All measurements were carried out at 20°C and 1 atmosphere pressure.

Mass of one mole of $CaCO_3$ in grams

____

Number of moles of $CaCO_3$ in 0.05 g of calcium carbonate

____

Number of moles of CO_2 required to produce 0.05 g of calcium carbonate

____

Volume of CO_2 in dm^3 required to produce 0.05 g of calcium carbonate

____

Percentage of carbon dioxide in the polluted air

____

[5]

Examiner Only	
Marks	Remark

Examiner Only	
Marks	Remark

15 Ethanol is produced in large quantities for use as a fuel. The mixture of ethanol with gasoline (petrol) is known as gasohol.

(a) (i) Explain, using an equation, how ethanol is manufactured from ethene.

____

____

____ [3]

(ii) Explain another industrial method of producing ethanol.

____

____ [2]

(b) Explain how you would carry out a chemical test to show that ethanol was present in a sample of gasohol.

____

____

____ [3]

(c) The equation for the combustion of ethanol is shown below:

$$CH_3CH_2OH + 3O_2 \rightarrow 2CO_2 + 3H_2O$$

Use the following bond energies to calculate the enthalpy change for the combustion.

	$kJ\ mol^{-1}$
C—O	360
C—H	413
O—H	464
C═O	805
O═O	498
C—C	347

____

____

____ [4]

Examiner Only	
Marks	Remark

(d) The gases produced by the combustion of the gasohol can be passed through a catalytic converter.

(i) What are carbon monoxide, unburnt hydrocarbons and nitrogen oxides converted to in the converter?

carbon monoxide ______________________________ [1]

unburnt hydrocarbons ______________________________ [1]

nitrogen oxides ______________________________ [1]

(ii) Occasionally the catalyst is poisoned. Explain how this occurs and how the catalyst is affected.

____

____

______________________________ [3]

(iii) Explain the role of the catalyst using a simple labelled enthalpy level diagram. Assume the reactions catalysed are exothermic.

____

______________________________ [4]

THIS IS THE END OF THE QUESTION PAPER

6048

Published Mark Schemes for GCE AS Chemistry

January 2010

Issued: April 2010

NORTHERN IRELAND GENERAL CERTIFICATE OF SECONDARY EDUCATION (GCSE) AND NORTHERN IRELAND GENERAL CERTIFICATE OF EDUCATION (GCE)

MARK SCHEMES (2010)

Foreword

Introduction

Mark Schemes are published to assist teachers and students in their preparation for examinations. Through the mark schemes teachers and students will be able to see what examiners are looking for in response to questions and exactly where the marks have been awarded. The publishing of the mark schemes may help to show that examiners are not concerned about finding out what a student does not know but rather with rewarding students for what they do know.

The Purpose of Mark Schemes

Examination papers are set and revised by teams of examiners and revisers appointed by the Council. The teams of examiners and revisers include experienced teachers who are familiar with the level and standards expected of 16- and 18-year-old students in schools and colleges. The job of the examiners is to set the questions and the mark schemes; and the job of the revisers is to review the questions and mark schemes commenting on a large range of issues about which they must be satisfied before the question papers and mark schemes are finalised.

The questions and the mark schemes are developed in association with each other so that the issues of differentiation and positive achievement can be addressed right from the start. Mark schemes therefore are regarded as a part of an integral process which begins with the setting of questions and ends with the marking of the examination.

The main purpose of the mark scheme is to provide a uniform basis for the marking process so that all the markers are following exactly the same instructions and making the same judgements in so far as this is possible. Before marking begins a standardising meeting is held where all the markers are briefed using the mark scheme and samples of the students' work in the form of scripts. Consideration is also given at this stage to any comments on the operational papers received from teachers and their organisations. During this meeting, and up to and including the end of the marking, there is provision for amendments to be made to the mark scheme. What is published represents this final form of the mark scheme.

It is important to recognise that in some cases there may well be other correct responses which are equally acceptable to those published: the mark scheme can only cover those responses which emerged in the examination. There may also be instances where certain judgements may have to be left to the experience of the examiner, for example, where there is no absolute correct response – all teachers will be familiar with making such judgements.

The Council hopes that the mark schemes will be viewed and used in a constructive way as a further support to the teaching and learning processes.

CONTENTS

New Specification

Rewarding Learning

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
January 2010

Chemistry

Assessment Unit AS 1

assessing

Basic Concepts in Physical and Inorganic Chemistry

[AC111]

THURSDAY 14 JANUARY, MORNING

MARK SCHEME

Section A

		AVAILABLE MARKS
1 C		
2 C		
3 D		
4 B		
5 C		
6 B		
7 B		
8 B		
9 A		
10 B		
[2] for each correct answer	[20]	20
	Section A	**20**

Section B

AVAILABLE MARKS

11 **(a)**

Particle	Relative mass	Relative charge
Proton	1	+ 1
Electron	$\frac{1}{1840}$	– 1
Neutron	1	0

1 mark per particle [3]

(b) Number of protons + Number of neutrons [1]

Number of protons [1]

Atoms which have the same number of protons but different numbers of neutrons [1]

(c) **(i)** Cl [1] 35 [1] [2]

(ii)

Ion	Atomic Number	Mass Number	Number of Neutrons	Electronic Structure
X^{2+}	**20**	**40**	20	$1s^22s^22p^63s^23p^6$
Y^-	**17**	**35**	18	$1s^22s^22p^63s^23p^6$
Z^{2-}	**8**	16	**8**	$1s^22s^22p^6$

1 mark per particle [3]

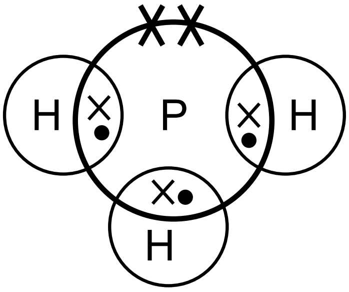
(d) **(i)** The average mass of an atom of an element [1] relative to (one twelfth of) the mass of an atom of carbon-12. [1] [2]

(ii) [(70 × 20.55) + (72 × 27.37) + (73 × 7.67) + (74 × 36.74) + (76 × 7.67)] ÷ 100

72.7 [2] 15

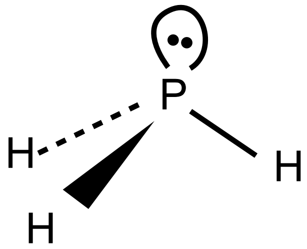
	AVAILABLE MARKS

12 (a) (i)



[2]

(ii)



[1]

Pyramidal [1]

(iii) In the outer shell of the central P atom there are (3) bonding pairs and (1) lone pair of electrons [1] which repel [1] [2]

(iv) approximately 107° [1]
Lone pair-bonding pair repulsion is greater than bonding pair-bonding pair repulsion [1] [2]

(b) (i) coordinate (dative covalent) bond [1]

(ii) the phosphorus atom shares its lone pair with the H^+ ion [2]

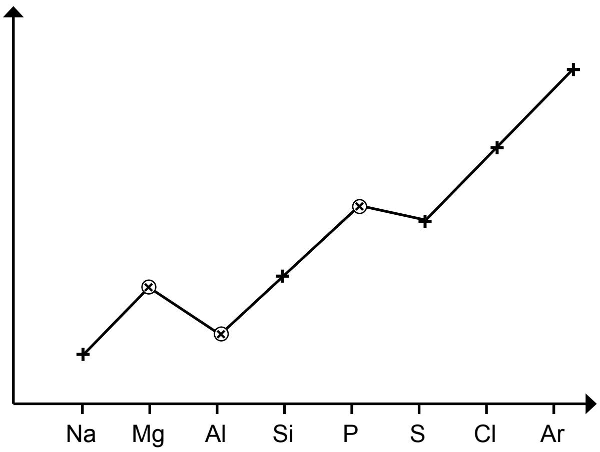
(c) Hydrogen bonding in ammonia [1]
is stronger than dipole-dipole (or van der Waals') in phosphine [1] [2] 13

					AVAILABLE MARKS
13	**(a)**	**(i)**	Phenolphthalein	[1]	
		(ii)	colourless [1] to pink [1]	[2]	
	(b)	**(i)**	$CH_3COOH + NaOH \rightarrow CH_3COONa + H_2O$	[2]	
		(ii)	21.4 and 21.3 into table Average titre = 21.35 cm^3	[1] [1]	
		(iii)	$0.1 \times (21.35/1000) = 2.135 \times 10^{-3}$	[1]	
		(iv)	$(2.135 \times 10^{-3}) \div (0.025) = 0.0854$	[1]	
		(v)	0.854	[1]	
	(c)	Rinsing the pipette (2-3 times) with undiluted vinegar Use of pipette filler Meniscus on mark Mixing/inverting solution in volumetric flask Rinsing the pipette (2-3 times) with diluted vinegar Max = 4		[4]	
		Quality of written communication		[2]	16

AVAILABLE MARKS

14 (a) Energy required to convert one mole of gaseous atoms to gaseous ions with single positive charges. [2]

(b) (i)



Point for Mg above Na but not above that for Si
point for Al below that for Mg but not below Na [1]

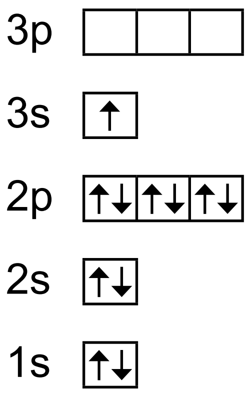
Point for P above that for S and below that for Cl [1]

(ii) increasing nuclear charge [1]
Shielding approximately constant/atomic radius decreases [1]

(iii) $1s^2 2s^2 2p^6 3s^2$ [1]

(iv) (stability of) filled subshell for Mg atom [1]
Stability not present in aluminium/$3p^1$/outer electron is in higher energy subshell [1] [2]

(c) (i)



Labels [1] Configuration [1] [2]

(ii) Al^{3+} (g) $\rightarrow$ Al^{4+} (g) + e^- [2]

(iii) Outer electron in Al^{2+} is further from nucleus/more shielded/ stability of sub shell full Al^{3+}(higher energy level) 2 from 3 [2] 15

					AVAILABLE MARKS
15	**(a)**	**(i)**	The ability/power of an atom to attract bonding electrons towards itself in a covalent bond	[2]	
		(ii)	decreases [1] Shared pair is further from nucleus [1] more shielded [1]	[3]	
	(b)	**(i)**	+6 [1] to +4 [1]	[2]	
		(ii)	$2Br^- \rightarrow Br_2 + 2e^-$	[2]	
		(iii)	$H_2SO_4 + \mathbf{2}H^+ + \mathbf{2e^-} \rightarrow SO_2 + \mathbf{2}H_2O$	[1]	
		(iv)	$H_2SO_4 + 2H^+ + 2Br^- \rightarrow SO_2 + 2H_2O + Br_2$	[1]	
		(v)	red-brown gas	[1]	
		(vi)	reducing agent	[1]	
		(vii)	chloride ions are not strong enough reducing agents to reduce concentrated sulphuric acid	[1]	
		(viii)	$NaCl + H_2SO_4 \rightarrow NaHSO_4 + HCl$	[2]	
	(c)	**(i)**	cream [1] precipitate [1]	[2]	
		(ii)	Ag^+ (aq) + Br^- (aq) → AgBr (s) Equation [1] State symbols [1]	[2]	
		(iii)	cream precipitate dissolves	[1]	21
				Section B	**80**
				Total	**100**

New Specification

Rewarding Learning

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
January 2010

Chemistry

Assessment Unit AS 2

assessing

Module 2: Further Organic, Physical and Inorganic Chemistry and Introduction to Organic Chemistry

[AC121]

THURSDAY 21 JANUARY, AFTERNOON

MARK SCHEME

Section A

		AVAILABLE MARKS
1	A	
2	C	
3	C	
4	C	
5	D	
6	D	
7	A	
8	C	
9	C	
10	D	
[2] marks for each correct answer	[20]	20
	Section A	**20**

AVAILABLE MARKS

Section B

11 **(a)** CH_3CH_2Cl

CH_3CH_2ONa

CH_3CH_2Cl

CH_3CH_2Br [4] 4

12 **(a)** **(i)** molecule broken down (into a smaller molecule) [1]
using heat (and a catalyst) [1]

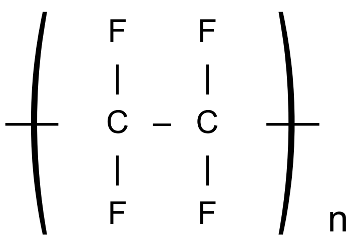
(ii) endothermic as ΔH is +ve [1]

(iii) low pressure [1]
more molecules on RHS [1]
but reaction rate is (slightly) slower [1]

(iv) high temperature
reaction is endothermic/ absorbs heat → RHS
and rate is increased [3]

(v) conc ammonia (solution) [1]
white smoke/fumes [1]

(b) **(i)**



[2]

(ii) contains a double bond/ C = C/ unsaturated [1]

(iii) addition [1] 15

		AVAILABLE MARKS
13 **(a)** C_nH_{2n+2}	[1]	
(b) same molecular formula	[1]	
different arrangement of atoms etc	[1]	
(c) fractional distillation	[2]	
(d) 2 – methylbutane or methylbutane	[1]	
2, 2 – dimethylpropane or dimethylpropane	[1]	
(e) van der Waals forces greatest between chains		
more branched lower b.pt	[2]	
(f) **(i)** $C_5H_{12} + 8O_2 \rightarrow 5CO_2 + 6H_2O$	[2]	
(ii) $2C_5H_{12} + 11O_2 \rightarrow 10CO + 12H_2O$	[2]	

(g) **(i)**

$$\left.\begin{array}{llll} Cl & \frac{60.7}{35.5} = 1.71 & 1 & \\ C & \frac{34.2}{12} = 2.85 & 1.66 & 1\frac{2}{3} = \frac{5}{3} \\ H & \frac{5.1}{1} = 5.1 & 3 & \end{array}\right\} [1]$$

$$1 : \frac{5}{3} : 3$$

$$\therefore\ 3 : 5 : 9$$

$C_5H_9Cl_3$ or $Cl_3C_5H_9$ [3]

(ii) has a higher b.pt. because chloropentane has a greater mass than pentane/ polar /more van der Waals [1] 17

		AVAILABLE MARKS
14 **(a)** more stable than ($BeCO_3$), $MgCO_3$	[1]	
less stable than $SrCO_3$/ $BaCO_3$	[1]	
(b) the size of cation increases down Gp = Group passim [1] charge density decreases down Gp polarisation power decreases down Gp max of 2	[2]	
(c) produces CO_2 $CaCO_3 \rightarrow CaO + CO_2$	[1]	
and CO_2 from combustion of fossil fuels	[1]	
(d) **(i)** $CaO + 2HCl \rightarrow CaCl_2 + H_2O$	[2]	
(ii) $CaO + H_2O \rightarrow Ca(OH)_2$	[1]	
(e) add $Ca(OH)_2$ to water stir / until no more dissolves filter blow CO_2 through limewater/collect CO_2 in pipette/ add to container of CO_2 seal and shake goes milky/chalky/cloudy	[4]	
max of 4		
QWC	[2]	
(f) $Ca(OH)_2(aq) + CO_2(g) \rightarrow CaCO_3(s) + H_2O(l)$	[2]	
(g) 100g of $CaCO_3$ $\frac{0.05}{100} = 5 \times 10^{-4}$ mol of $CaCO_3$ 5×10^{-4} mol CO_2 $5 \times 10^{-4} \times 24\ dm^3 = 0.012\ dm^3$ % $CO_2 = \frac{0.012}{5} \times 100 = 0.24\%$	[5]	22

						AVAILABLE MARKS
15	**(a)**	**(i)**	$C_2H_4 + H_2O \rightarrow C_2H_5OH$		[1]	
			steam/ high temp		[1]	
			H_3PO_4		[1]	
		(ii)	fermentation		[1]	
			sugars		[1]	

(b)

acidified dichromate		Iodine	[1]
warm	**or**	alkali	[1]
(orange) → green		yellow solid	[1]

(c)

bonds broken	5C—H	= 5 × 413	= 2065
	1C—C	= 1 × 347	= 347
	1C—O	= 1 × 360	= 360
	1O—H	= 1 × 464	= 464
	3O=O	= 3 × 498	= 1494
bonds formed	4C=O	= 4 × 805	= 3220
	6O—H	= 6 × 464	= 2784

bonds broken = +4730
bonds formed = –6004

$\Delta H = -1274\ kJ\ mol^{-1}$ [4]

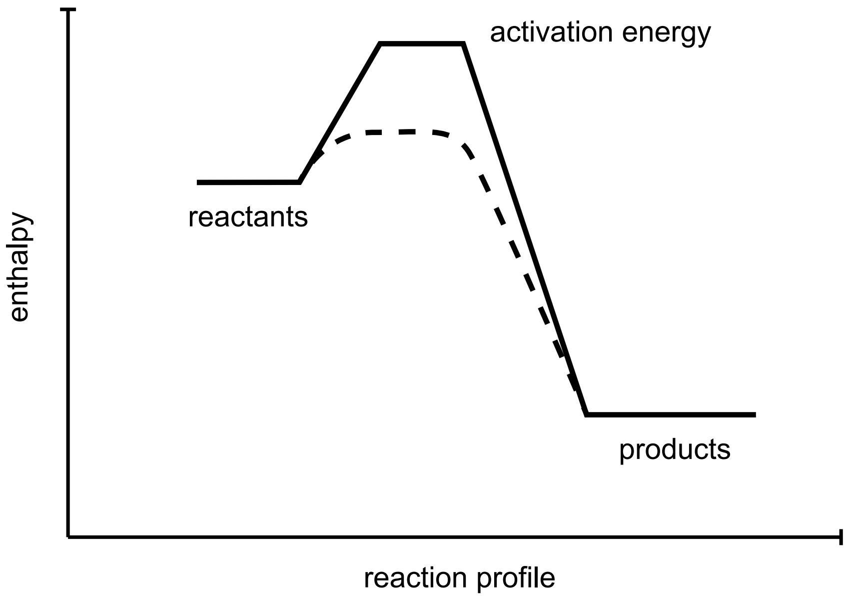
AVAILABLE MARKS

(d) **(i)** $CO \rightarrow CO_2$ [1]

$CxHy \rightarrow CO_2 + H_2O$ [1]

$NO_x \rightarrow N_2\ (+CO_2)$ [1]

(ii) lead [1]
covers the surface [1]
molecules prevented from chemisorption/ catalyst effect reduced [1]



activation energy lowered by the catalyst [4] 22

Section B	**80**
Total	**100**

New Specification

Rewarding Learning

Centre Number

71	

Candidate Number

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
2010

Chemistry

Assessment Unit AS 2

assessing

Module 2: Organic, Physical and Inorganic Chemistry

[AC121]

AC121

THURSDAY 17 JUNE, AFTERNOON

TIME

1 hour 30 minutes.

INSTRUCTIONS TO CANDIDATES

Write your Centre Number and Candidate Number in the spaces provided at the top of this page.
Answer **all seventeen** questions.
Answer **all ten** questions in **Section A**. Record your answers by marking the appropriate letter on the answer sheet provided. Use only the spaces numbered 1 to 10. Keep in sequence when answering.
Answer **all seven** questions in **Section B**. Write your answers in the spaces provided in this question paper.

INFORMATION FOR CANDIDATES

The total mark for this paper is 100.
Quality of written communication will be assessed in question **16(b)(i)**.
In Section A all questions carry equal marks, i.e. **two** marks for each question.
In Section B the figures in brackets printed down the right-hand side of the pages indicate the marks awarded to each question or part question.
A Periodic Table of Elements (including some data) is provided.

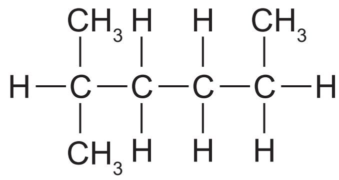
For Examiner's use only	
Question Number	**Marks**
Section A	
1–10	
Section B	
11	
12	
13	
14	
15	
16	
17	
Total Marks	

Section A

For each of the following questions only **one** of the lettered responses (A–D) is correct.

Select the correct response in each case and mark its code letter by connecting the dots as illustrated on the answer sheet.

1 The correct name for the compound with the following structure



is

A 1,1,4-trimethylbutane.
B 1,4-dimethylpentane.
C 1,4,4-trimethylbutane.
D 2-methylhexane.

2 A mixture of two salts (X and Y) produced the following results.

Test	Observation
Flame test	Yellow/orange colour
Addition of HNO_3(aq)	No effervescence
Addition of $AgNO_3$(aq)	Yellow precipitate
Addition of $BaCl_2$(aq)	White precipitate

X and Y could be

A potassium iodide and potassium carbonate
B sodium chloride and sodium carbonate
C sodium chloride and sodium sulphate
D sodium iodide and sodium sulphate

3 When heated with acidified potassium dichromate solution, which one of the following alcohols does **not** cause the solution to change from orange to green?

A butan-1-ol
B butan-2-ol
C 2-methylpropan-1-ol
D 2-methylpropan-2-ol

4 0.05 moles of a liquid fuel was used to increase the temperature of 200 g of water by 10 K. The heat capacity of water is 4.2 J $g^{-1}K^{-1}$.
What is the molar enthalpy of combustion of the fuel?

A -8.4 kJ mol^{-1}
B -168 kJ mol^{-1}
C -420 kJ mol^{-1}
D -8400 kJ mol^{-1}

5 The reaction between bromoethane and ethanolic potassium hydroxide is described as

A electrophilic addition
B elimination
C free radical substitution
D nucleophilic substitution

6 Which one of the following lists both sets of compounds in order of increasing solubility (least soluble first, most soluble last)?

	Sulphates	**Hydroxides**
A	$MgSO_4$, $CaSO_4$, $SrSO_4$, $BaSO_4$	$Ba(OH)_2$, $Sr(OH)_2$, $Ca(OH)_2$, $Mg(OH)_2$
B	$MgSO_4$, $CaSO_4$, $SrSO_4$, $BaSO_4$	$Mg(OH)_2$, $Ca(OH)_2$, $Sr(OH)_2$, $Ba(OH)_2$
C	$BaSO_4$, $SrSO_4$, $CaSO_4$, $MgSO_4$	$Mg(OH)_2$, $Ca(OH)_2$, $Sr(OH)_2$, $Ba(OH)_2$
D	$BaSO_4$, $SrSO_4$, $CaSO_4$, $MgSO_4$	$Ba(OH)_2$, $Sr(OH)_2$, $Ca(OH)_2$, $Mg(OH)_2$

7 Which one of the following alcohols gives a positive iodoform test?

A butan-1-ol
B butan-2-ol
C 2-methylpropan-1-ol
D 2-methylpropan-2-ol

8 Which one of the following hydrocarbons has the empirical formula C_3H_5?

A $CH_3CH{=}CH_2$
B $CH_3(CH_2)_3CH{=}CH_2$
C $(CH_3)_3CCH_2CH_2CH_3$
D $CH_2{=}CHCH_2CH_2CH{=}CH_2$

9 Which one of the following substances is **not** formed when methane reacts with chlorine in the presence of ultraviolet light?

A dichloromethane
B ethane
C hydrogen
D hydrogen chloride

10 An aqueous solution produced a precipitate on addition of a few drops of aqueous sodium hydroxide. The precipitate dissolved on addition of excess sodium hydroxide but not on addition of excess ammonia. The solution contains

A $Al^{3+}(aq)$.
B $Fe^{3+}(aq)$.
C $Mg^{2+}(aq)$.
D $Zn^{2+}(aq)$.

Section B

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

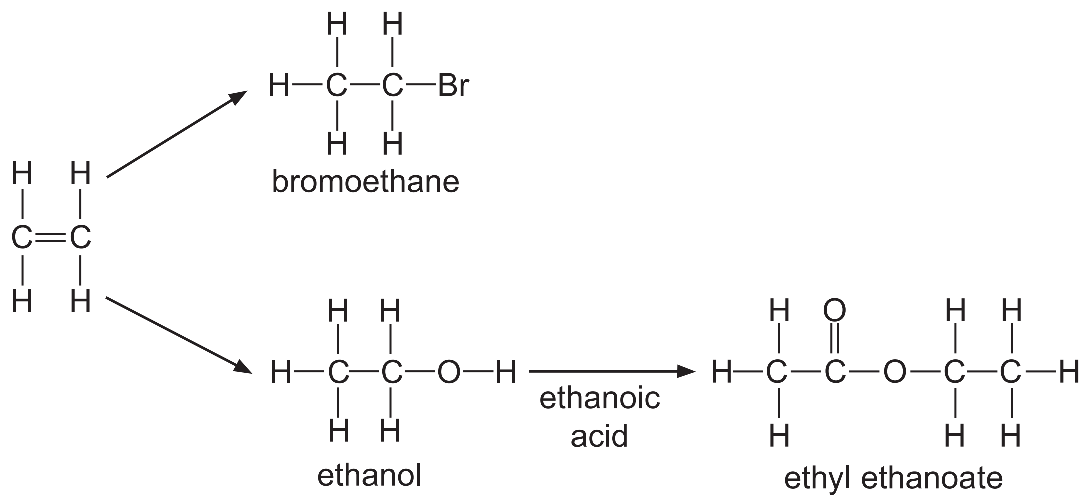
Examiner Only	
Marks	Remark

11 Analysis of a compound, which contains carbon, hydrogen and bromine only, showed that 22.2% of its mass is carbon and 3.7% is hydrogen. The relative molecular mass of the compound is 216.

Calculate the molecular formula of the compound.

[3]

12 Consider the following sequence of reactions:



(a) (i) Name the mechanism for the conversion of ethene to bromoethane.

____ [2]

(ii) Draw a flow scheme to represent the mechanism for the conversion of ethene to bromoethane.

[3]

(b) (i) Name the type of reaction which occurs when ethanoic acid and ethanol react to form ethyl ethanoate.

____ [1]

(ii) Name another reagent which reacts with ethanol to form ethyl ethanoate.

____ [1]

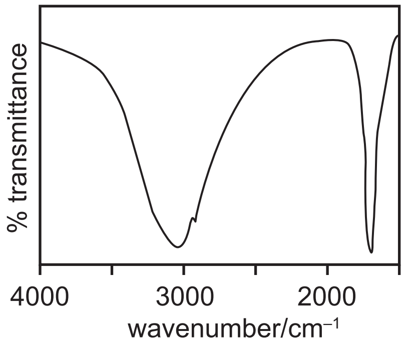
Examiner Only	
Marks	Remark

(iii) Part of three infra-red spectra A, B and C are given below. The spectra are those of ethanol, ethanoic acid and ethyl ethanoate but not necessarily in that order.

- O—H bonds produce deep, broad absorptions between 2500–3500 cm^{-1}.
- C=O bonds produce deep, sharp absorptions between 1650–1750 cm^{-1}.

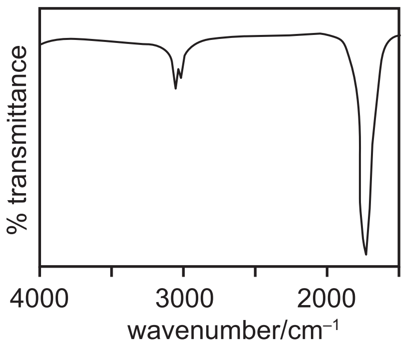
Identify each compound from its spectrum.

A



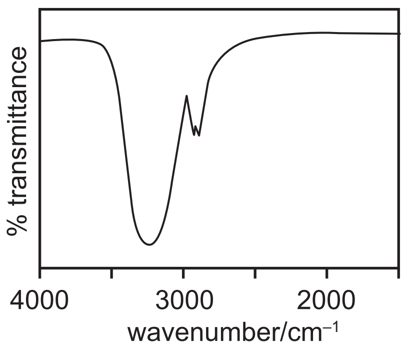
____

B



____

C



____

[2]

Examiner Only	
Marks	Remark

Examiner Only	
Marks	Remark

13 Fractional distillation of crude oil is used to produce hydrocarbon fuels. The diesel fraction contains heptadecane molecules which have the formula $C_{17}H_{36}$. Incomplete combustion of diesel produces carbon monoxide.

(a) **(i)** Write an equation for the incomplete combustion of heptadecane to form carbon monoxide.

____ [2]

(ii) What is fitted to the exhaust system of a car to change carbon monoxide into carbon dioxide?

____ [1]

(b) Thermal cracking of long chain hydrocarbons produces shorter chain hydrocarbons.

Write an equation for the thermal cracking of heptadecane in which ethene and propene are produced in a 2:1 ratio with only one other product.

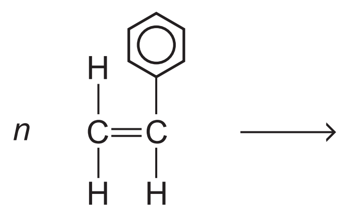
____ [2]

(c) Ethene and propene can be converted into polythene and polypropene respectively.

(i) Name the type of reaction involved in the conversion of propene to polypropene.

____ [2]

(ii) Suggest the equation for the conversion of styrene to polystyrene:



styrene

[1]

Examiner Only

Marks	Remark

(d) Ethene and propene do not exhibit geometric isomerism.

(i) Draw the structure and give the name of a **branched** alkene, with molecular formula C_6H_{12}, which exhibits geometric isomerism.

____ [2]

(ii) Draw the structures of the geometric isomers for the molecule identified in **d(i)**.

[2]

14 Many enthalpy changes, including enthalpies of combustion, can be determined by experiment. Others can be deduced using Hess's Law.

Examiner Only

Marks	Remark

(a) **(i)** State Hess's Law.

____

____ [2]

(ii) Define the term **standard enthalpy of combustion**.

____

____

____ [2]

(iii) Use the standard enthalpies of formation given in the table below to calculate the enthalpy change for the complete combustion of methane:

$$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$$

Compound	$\Delta H_f^{\ominus}$/kJ mol^{-1}
CO_2	–394
H_2O	–286
CH_4	–75

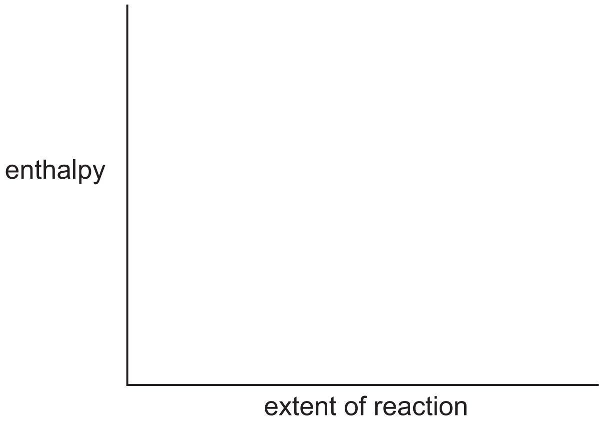
____

____

____ [2]

(b) Enthalpy changes can also be calculated using average bond enthalpies. When bond enthalpies were used to estimate the enthalpy of reaction for the complete combustion of methane, it was found to have a value of -698 kJ mol^{-1}.

(i) Complete the enthalpy level diagram for this reaction.



[1]

(ii) What is meant by the term **average bond enthalpy**?

____

____ [2]

(iii) Using the estimated enthalpy of reaction and the bond enthalpies given in the table below, calculate the bond enthalpy of the C—H bond in methane.

bond	bond enthalpy/kJ mol^{-1}
C=O	743
O=O	496
O—H	463

____

____

____

____ [3]

15 The second stage in the production of nitric acid involves the reaction of nitrogen monoxide with oxygen to form nitrogen dioxide. When nitrogen monoxide and oxygen are mixed under suitable conditions a dynamic equilibrium is established.

$$2NO(g) + O_2(g) \rightleftharpoons 2NO_2(g) \qquad \Delta H = -116\,kJ\,mol^{-1}$$

(a) Explain what is meant by the term **dynamic equilibrium**.

____

____ [2]

(b) State and explain how increasing the pressure will affect the equilibrium yield of nitrogen dioxide.

____

____

____

____ [2]

(c) State and explain how increasing the temperature will affect the equilibrium yield of nitrogen dioxide.

____

____

____

____ [2]

(d) State and explain the effect a catalyst has on the equilibrium yield of nitrogen dioxide.

____

____

____ [2]

Examiner Only	
Marks	Remark

Examiner Only	
Marks	Remark

(e) The first stage in the production of nitric acid involves ammonia.

(i) State the temperature and pressure used in the production of ammonia by the Haber process.

____

____ [2]

(ii) Why is the temperature used in the Haber process described as a compromise temperature?

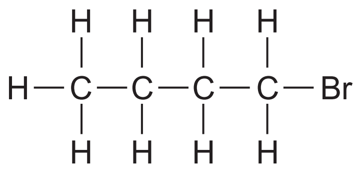
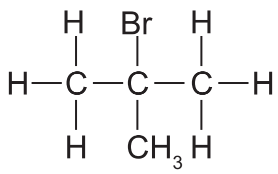
____

____ [1]

16 There are four bromoalkanes with the formula C_4H_9Br.

(a) Complete the following table by drawing the missing structures, giving the missing name and indicating the classification for each.

(P = Primary, S = Secondary and T = Tertiary)

Structure and Name	Classification
 1-bromobutane	P
 2-bromo-2-methylpropane	
1-bromo-2-methylpropane	
______________________________	

[6]

Examiner Only	
Marks	Remark

Examiner Only

Marks	Remark

(b) (i) 1-bromobutane can be prepared by refluxing a mixture containing butan-1-ol, water, sodium bromide and concentrated sulphuric acid for 45 minutes. Describe the remaining steps required to produce a pure, dry sample of this haloalkane.

____

____

____

____

____

____

____

____ [4]

Quality of written communication [2]

(ii) 11.1 g of butan-1-ol was used to prepare 1-bromobutane and 12.3 g was obtained.

$$C_4H_9OH + HBr \rightarrow C_4H_9Br + H_2O$$

Calculate the percentage yield.

____

____

____ [3]

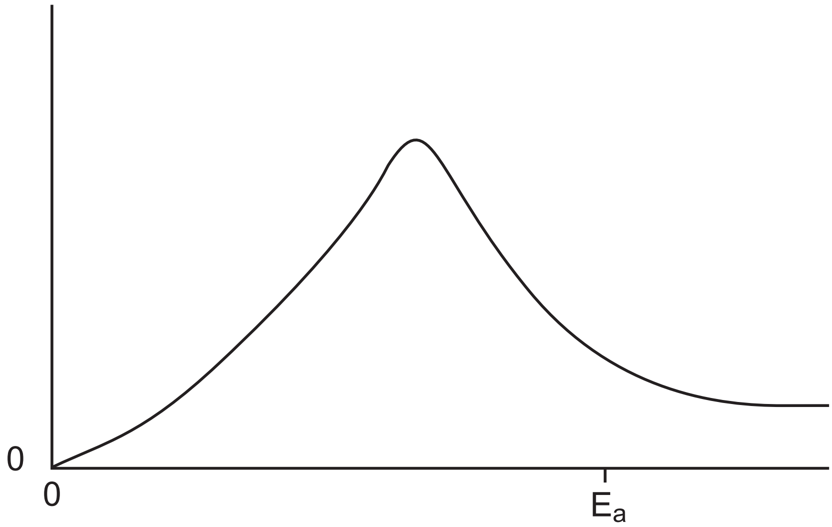
(c) When heated with aqueous sodium hydroxide 1-bromobutane was converted into butan-1-ol.

How could the resulting solution be tested to prove that it contains bromide ions?

____

____ [2]

17 The Maxwell-Boltzmann distribution for a mixture of SO_2 and O_2 which react to form SO_3 at 450 K is shown below.



(a) (i) Label the axes on the above diagram. [2]

(ii) Suggest why the curve starts at the origin.

____

____ [1]

(iii) Draw a second curve, on the same axes, for the same mixture of gases at 440 K. [2]

(iv) By making reference to the two curves, state and explain the effect of reducing the temperature on the rate of reaction.

____

____

____

____ [2]

Examiner Only	
Marks	Remark

(b) Catalysts are used in many industrial processes. Name the catalyst used in each of the following processes.

(i) the Contact process

____ [1]

(ii) the conversion of sunflower oil to margarine

____ [1]

(iii) the Haber process

____ [1]

(iv) the reaction of steam with ethene

____ [1]

(c) Manganese(IV) oxide catalyses the decomposition of hydrogen peroxide solutions:

$$2H_2O_2 \rightarrow 2H_2O + O_2$$

(i) Explain, in terms of activation energy and reaction pathway, how a catalyst works.

____

____

____ [2]

(ii) Calculate the volume of oxygen gas (measured at 20 °C and 1 atmosphere of pressure) which would be produced when a 50.0 cm^3 sample of 2 mol dm^{-3} hydrogen peroxide solution undergoes complete decomposition.

____

____

____

____ [3]

Examiner Only	
Marks	Remark

THIS IS THE END OF THE QUESTION PAPER

935-063-1 6566.02 **R**

Published Mark Schemes for GCE AS Chemistry

Summer 2010

Issued: October 2010

NORTHERN IRELAND GENERAL CERTIFICATE OF SECONDARY EDUCATION (GCSE) AND NORTHERN IRELAND GENERAL CERTIFICATE OF EDUCATION (GCE)

MARK SCHEMES (2010)

Foreword

Introduction

Mark Schemes are published to assist teachers and students in their preparation for examinations. Through the mark schemes teachers and students will be able to see what examiners are looking for in response to questions and exactly where the marks have been awarded. The publishing of the mark schemes may help to show that examiners are not concerned about finding out what a student does not know but rather with rewarding students for what they do know.

The Purpose of Mark Schemes

Examination papers are set and revised by teams of examiners and revisers appointed by the Council. The teams of examiners and revisers include experienced teachers who are familiar with the level and standards expected of 16 and 18-year-old students in schools and colleges. The job of the examiners is to set the questions and the mark schemes; and the job of the revisers is to review the questions and mark schemes commenting on a large range of issues about which they must be satisfied before the question papers and mark schemes are finalised.

The questions and the mark schemes are developed in association with each other so that the issues of differentiation and positive achievement can be addressed right from the start. Mark schemes therefore are regarded as a part of an integral process which begins with the setting of questions and ends with the marking of the examination.

The main purpose of the mark scheme is to provide a uniform basis for the marking process so that all the markers are following exactly the same instructions and making the same judgements in so far as this is possible. Before marking begins a standardising meeting is held where all the markers are briefed using the mark scheme and samples of the students' work in the form of scripts. Consideration is also given at this stage to any comments on the operational papers received from teachers and their organisations. During this meeting, and up to and including the end of the marking, there is provision for amendments to be made to the mark scheme. What is published represents this final form of the mark scheme.

It is important to recognise that in some cases there may well be other correct responses which are equally acceptable to those published: the mark scheme can only cover those responses which emerged in the examination. There may also be instances where certain judgements may have to be left to the experience of the examiner, for example, where there is no absolute correct response – all teachers will be familiar with making such judgements.

The Council hopes that the mark schemes will be viewed and used in a constructive way as a further support to the teaching and learning processes.

CONTENTS

New Specification

Rewarding Learning

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
2010

Chemistry

Assessment Unit AS 1

assessing

Basic Concepts in Physical and Inorganic Chemistry

[AC111]

MONDAY 7 JUNE, MORNING

MARK SCHEME

			AVAILABLE MARKS
1	D		
2	B		
3	D		
4	B		
5	B		
6	B		
7	B		
8	B		
9	D		
10	C		
[2] for each correct answer		[20]	20
		Section A	**20**

Section B

AVAILABLE MARKS

11 **(a)** 14 [1]

(b) **(i)** Al (g) → Al^+ (g) + e^-

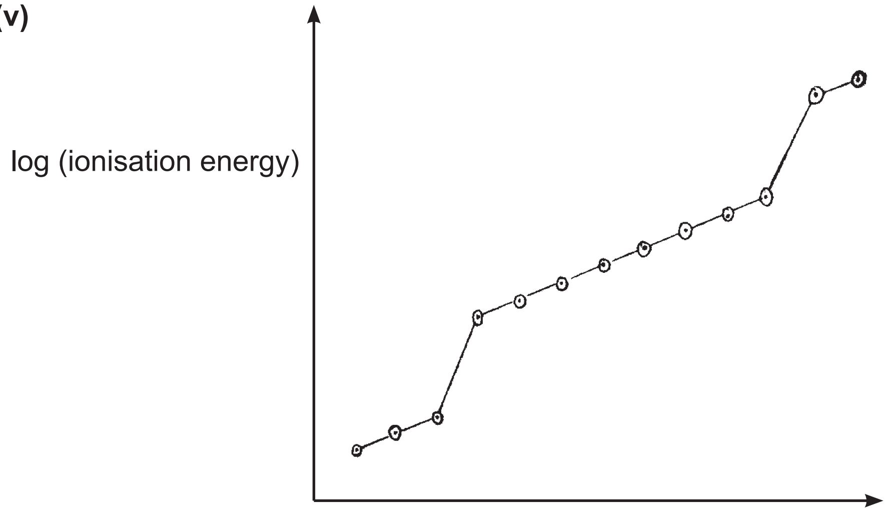
Equation [1] State symbols [1] [2]

(ii) Outer electron for boron is closer to nucleus [1] and is less shielded [1] (than for aluminium) [2]

(iii) stability of filled 3s shell for magnesium [1] aluminium has $3p^1$ configuration [1] [2]

(iv) $1s^22s^22p^5$ [1]

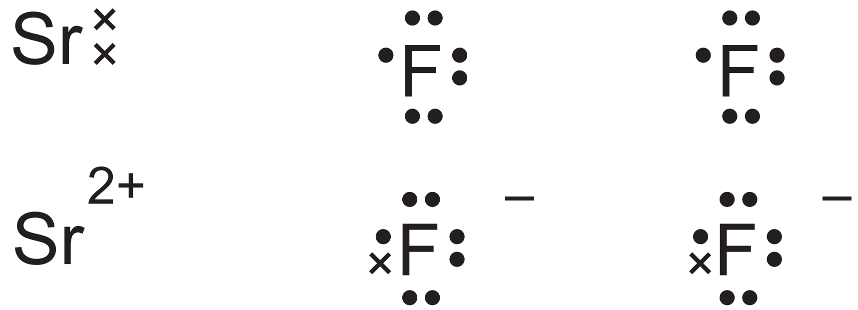
(v)



[2] 10

AVAILABLE MARKS

12 (a) (i)



Sr atom [1]
F atom [1]
1 : 2 ratio [1]
correct electron transfer + charges [1]

(ii) solid strontium – good electrical conductor
solid strontium fluoride – poor electrical conductor } [1]
solid strontium – delocalised electrons [1]
solid strontium fluoride – ions are not free to move [1]

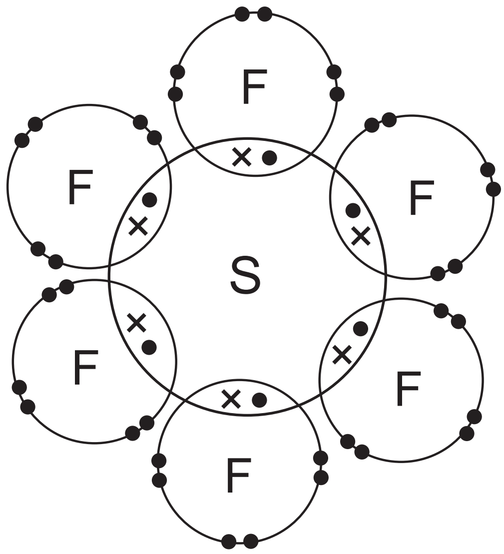
(b) (i) The ability/power of an atom to attract bonding electrons in a covalent bond [2]

(ii)

$$\overset{\delta+}{S} — \overset{\delta-}{F}$$

[1]

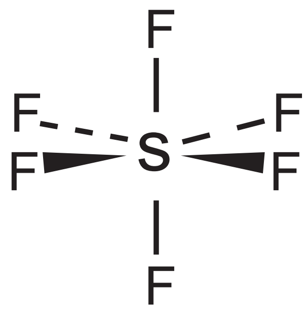
(iii)



[2]

(iv) does not apply to sulphur (12 electrons in outer shell) [1]
does apply to fluorine (8 electrons in outer shell)/octet rule – has 8 e^- in outer shell [1]

(v)



[1]

Octahedral [1]
(six) bonding pairs [1] repel equally [1] [2]

(vi) dipoles [1] cancel [1] [2]

(c) **(i)** coordinate/dative (covalent) bond [1]

(ii) both shared electrons come from nitrogen/lone pair of electrons on nitrogen shared (donated) [1] 22

13 **(a)** **(i)** loss of electrons [1]

(ii) decrease in oxidation state/number [1]

(b) **(i)** +5 [1]

(ii) +2 [1]

(c) **(i)** $2I^- \rightarrow I_2 + 2e^-$ [1]

(ii) $2HNO_3 + 6H^+ + 6I^- \rightarrow 2NO + 4H_2O + 3I_2$ [2]

(d) reference to **covalent bonding**/**crystalline**
molecular covalent **structure**/**diatomic**/**I_2**
van der Waals' attractions between molecules
1 mark for each two bold points mentioned – Max [3] marks

more soluble in hexane than water [1]
since iodine and hexane are non-polar [1] and water is polar [1]
like dissolves like [1]
Max [4] marks Max [5] marks

Quality of written communication [2] 14

AVAILABLE MARKS
22
14

					AVAILABLE MARKS
14	**(a)**	**(i)**	$Cl_2 + 2NaOH \rightarrow NaCl + NaOCl + H_2O$	[2]	
		(ii)	simultaneous reduction and oxidation [1] of the same element/in the same reaction [1]	[2]	
	(b)	**(i)**	$H_2 + Cl_2 \rightarrow 2HCl$	[2]	
		(ii)	HF – hydrogen bonding/polar HCl – polar/less polar than HF Greater energy needed to separate molecules	[1] [1] [1]	
		(iii)	H−Cl bond stronger than H−I bond does not break as easily when heated	[1] [1]	
	(c)	**(i)**	white [1] precipitate [1]	[2]	
		(ii)	$Ag^+ (aq) + Cl^- (aq) \rightarrow AgCl (s)$ Equation [1] State symbols [1]	[2]	
		(iii)	(white) precipitate dissolves	[1]	16

					AVAILABLE MARKS
15	**(a)**	**(i)**	contains no water (of crystallisation)	[1]	
		(ii)	0.0375	[1]	
		(iii)	6.07g	[1]	
		(iv)	0.337	[1]	
		(v)	9	[1]	
	(b)	**(i)**	solution of known concentration	[1]	
		(ii)	$Na_2CO_3 + 2HCl \rightarrow 2NaCl + H_2O + CO_2$	[2]	
		(iii)	methyl orange	[1]	
	(c)	**(i)**	yellow/orange [1] red/pink [1]	[2]	
		(ii)	0.00285	[1]	
		(iii)	0.001425	[1]	
		(iv)	0.01425	[1]	
		(v)	1.5105	[1]	
		(vi)	2.06	[1]	
		(vii)	0.1144	[1]	
		(viii)	8	[1]	18
				Section B	**80**
				Total	**100**

New Specification

Rewarding Learning

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
2010

Chemistry

Assessment Unit AS 2

assessing

Module 2: Organic, Physical and Inorganic Chemistry

[AC121]

THURSDAY 17 JUNE, AFTERNOON

MARK SCHEME

Section A

		AVAILABLE MARKS
1	D	
2	D	
3	D	
4	B	
5	B	
6	C	
7	B	
8	D	
9	C	
10	A	
[2] for each correct answer	[20]	20
	Section A	**20**

Section B

AVAILABLE MARKS

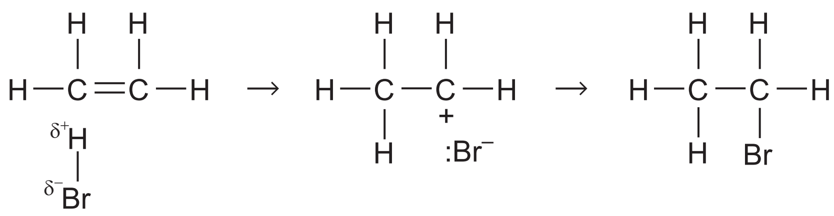
11

Element	Moles	Ratio
C	22.2 ÷ 12 = 1.85	2
H	3.7 ÷ 1 = 3.70	4
Br	74.1 ÷ 80 = 0.93	1

Moles [1]
Empirical Formula = C_2H_4Br [1]
216 ÷ 108 = 2 Molecular Formula = $C_4H_8Br_2$ [1] 3

12 **(a)** **(i)** Electrophilic [1] addition [1] [2]

(ii)



Dipole/H in HBr approaches the C═C [1]
Structure of carbocation intermediate [1]
bromide ion(Br^-) [1]

(b) **(i)** esterification [1]

(ii) ethanoyl chloride [1]

(iii) A = Ethanoic acid [1]
B = Ethyl ethanoate [1] 9
C = Ethanol

	AVAILABLE MARKS

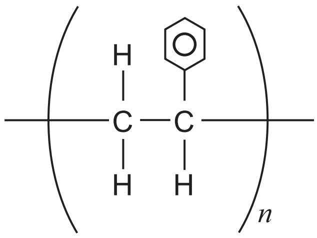
13 **(a)** **(i)** Either: $C_{17}H_{36} + 17\tfrac{1}{2}O_2 \rightarrow 17CO + 18H_2O$
Or: $2C_{17}H_{36} + 35O_2 \rightarrow 34CO + 36H_2O$ [2]

(ii) catalytic converter [1]

(b) Either: $C_{17}H_{36} \rightarrow 2C_2H_4 + C_3H_6 + C_{10}H_{22}$
Or: $C_{17}H_{36} \rightarrow 4C_2H_4 + 2C_3H_6 + C_3H_8$ [2]

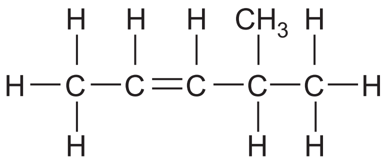
(c) **(i)** addition [1] polymerisation [1] [2]

(ii)



[1]

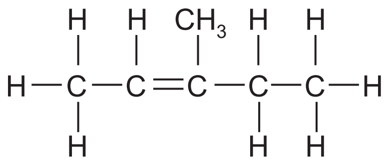
(d) **(i)** Either:



[1]

4-methylpent-2-ene [1]

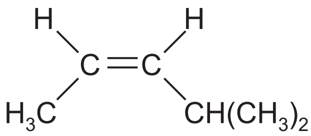
Or:

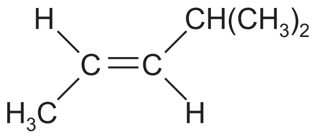


[1]

3-methylpent-2-ene [1] [2]

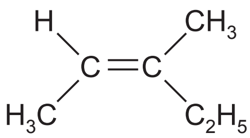
(ii) Either:

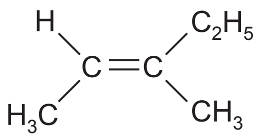




Distinction between *cis* and *trans* not necessary

Or:





Distinction between *E* and *Z* not necessary [2] 12

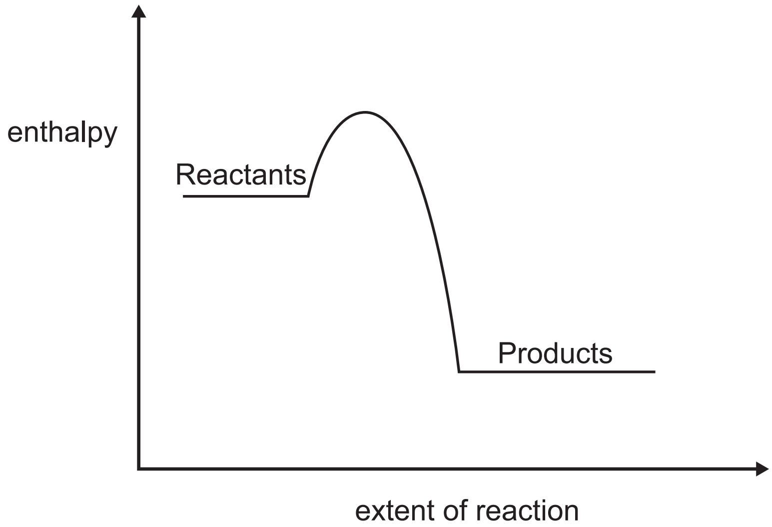
AVAILABLE MARKS

14 (a) (i) Enthalpy change(s) [1]
is/are independent of the route taken [1]

(ii) Enthalpy change which occurs when 1 mole of a substance undergoes complete combustion in oxygen under standard conditions. [2]

(iii) $(-394) + (-286 \times 2) + (+75)$ [1]
$-891\,\text{kJ mol}^{-1}$ [1]

(b) (i)



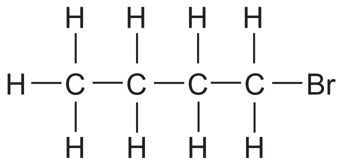
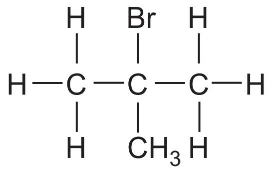
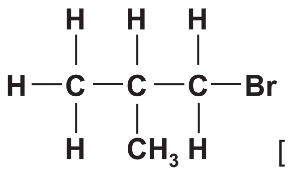
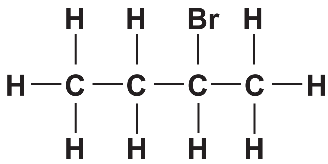
[1]

(ii) Energy required to break one mole of a given bond averaged over many compounds. Error [–1] [2]

(iii) $-698 = 4(\text{C—H}) - 2346$
$4(\text{C—H}) = 1648$
$412\,\text{kJ mol}^{-1}$ [3] 12

				AVAILABLE MARKS
15	**(a)**	Rate of forward reaction = Rate of reverse reaction	[1]	
		The amount of any given reactant or product remains constant	[1]	
	(b)	Increase	[1]	
		3 moles (g) LHS 2 moles (g) RHS		
		Equilibrium shifts to RHS to oppose the change	[1]	
	(c)	Decrease	[1]	
		(Forward) reaction is exothermic		
		Equilibrium shifts to LHS to oppose the change/cool the system	[1]	
	(d)	No effect on yield	[1]	
		Increases the rate of the forward and reverse reactions equally	[1]	
	(e)	**(i)** 400–500 °C [1] 200–300 atm [1]	[2]	
		(ii) Compromise between rate and yield [1]	[1]	11

16 (a)

Structure and Name	Classification
 1-bromobutane	P
 2-bromo-2-methylpropane	**T** [1]
 [1] 1-bromo-2-methylpropane	**P** [1]
 [1] **2-bromobutane** [1]	**S** [1]

[6]

AVAILABLE MARKS

		AVAILABLE MARKS
(b) **(i)** Distil and collect the 1-bromobutane at its boiling point	[1]	
Shake crude product with a solution of sodium carbonate in a separating funnel	[1]	
Release pressure	[1]	
Separate the organic layer	[1]	
Shake with a drying agent, e.g. anhydrous calcium chloride	[1]	
Filter	[1]	
	(max = [4])	

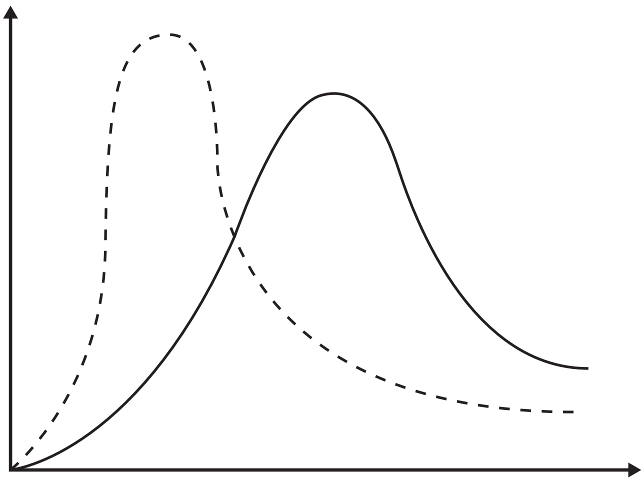
Quality of written communication

2 marks The candidate expresses ideas clearly and fluently through well-linked sentences and paragraphs. Arguments are generally relevant and well-structured. There are few errors of grammar, punctuation and spelling.

1 mark The candidate expresses ideas clearly, if not always fluently Arguments may sometimes stray from the point. There may be some errors of grammar, punctuation and spelling, but not such as to suggest a weakness in these areas.

0 marks The candidate expresses ideas satisfactorily, but without precision. Arguments may be of doubtful relevance or obscurely presented. Errors in grammar, punctuation and spelling are sufficiently intrusive to disrupt the understanding of the passage.

Quality of written communication	[2]	
(ii) $11.10 \div 74 = 0.15$ moles of butan-1-ol	[1]	
$12.33 \div 137 = 0.09$ moles of 1-bromobutane	[1]	
$(0.09 \div 0.15) \times 100 = 60\%$	[1]	
(c) Add an aqueous solution of silver nitrate	[1]	
A cream precipitate forms	[1]	17

17	**(a)**	**(i)**	*y* axis = number of molecules *x* axis = (kinetic) energy	[1] [1]
		(ii)	Either: all molecules have some energy/are moving Or: no molecules have zero (kinetic) energy	[1]
		(iii)		
			maximum to LHS of original and higher lower number of molecules at higher energies	[1] [1]
		(iv)	Number of molecules with energy greater than the activation energy decreases as temperature drops	[2]
	(b)	**(i)**	vanadium(V) oxide	[1]
		(ii)	nickel	[1]
		(iii)	iron	[1]
		(iv)	phosphoric acid	[1]
	(c)	**(i)**	provides an alternative pathway with lower activation energy	[1] [1]
		(ii)	moles of hydrogen peroxide = $2 \times 0.05 = 0.1$ mole 2:1 ratio so moles of oxygen = 0.05 Volume (dm^3) = $0.05 \times 24 = 1.2$ dm^3 (1200 cm^3)	[1] [1] [1]

AVAILABLE MARKS
16

Section B	**80**
Total	**100**

New Specification

Rewarding Learning

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
2010

Chemistry

Assessment Unit AS 3

assessing

Module 3: Practical Examination 1

[AC131]

FRIDAY 14 MAY, MORNING

MARK SCHEME

CHEMISTRY

Assessment Unit AS 3

assessing

Module 3: Practical Examination 1

AVAILABLE MARKS

Annotation

1. Please do all marking in red ink.
2. All scripts are checked for mathematical errors. Please adopt the system of one tick (✓) equals [1] mark e.g. if you have awarded 4 marks for part of a question then 4 ticks (✓) should be on this candidate's answer.
3. As candidates have access to scripts please do not write any inappropriate comments on their scripts.

Mark Scheme

Section A

1 **(a)** Rinse the pipette with oven cleaner [1]
Pipette $25cm^3$ of the oven cleaner into the $500cm^3$ volumetric flask and make up to mark using distilled water [1]
(Stopper and) shake the flask/invert [1]
Using a pipette filler [1]
Rinse the pipette with the diluted solution and transfer $25cm^3$ conical flask [1]
(1 mark each to a maximum of four) [4]

(b) Table [1]
Significant figures [2]
Calculation of the average titre [2]
Titration consistency [3]
Agreement with supervisor's titre [4] [12]

NOTES

Table:
Table should include initial burette reading, final burette reading, and volume delivered. The average titre should be calculated and the units included. Units missing (-1)

Significant figures:
All burette readings should be to at least one decimal place – each mistake is penalised by 1 mark.
(However initial burette readings of 0 are penalised once only.)
If used, the second decimal place position should be 0 or 5 only – other values will be penalised by 1 mark.

Average titre
Accurate titrations only should be used.
The use of a rough value is (-1).
The average value can be two decimal places, e.g. 25.37
An incorrect calculation is 0.
Mark denied if:
(i) only one accurate titration done
(ii) if titre not calculated correctly

Titration consistency

This is the difference between the first and second accurate readings

Difference	Mark
±0.1	[3]
±0.2	[2]
±0.3	[1]
±0.4	[4]

Titration agreement with the supervisor

Difference	Mark
±0.1	[4]
±0.2	[3]
±0.3	[2]
±0.4	[1]
±0.5	[0]

Please note that the supervisor's titre should be recorded at the bottom of page 3 in the candidate's script in RED INK.
The marks for table, significant figures etc should be recorded on the left-hand side of the candidate's table of results.

AVAILABLE MARKS

(c) yellow to orange/red [1]

(d) $NaOH + HCl \longrightarrow NaCl + H_2O$ [1]

(e) **(i)** Correct calculation using average titre i.e. $\frac{\text{titre} \times 0.1}{1000}$ [1]

(ii) Use of 1:1 ratio [1]

(iii) Moles of sodium hydroxide in 500cm^3 of diluted oven cleaner (×20) [1]

(iv) Moles of sodium hydroxide in 25cm^3 of undiluted oven cleaner (same value as **(iii)**) [1]

(v) Concentration of sodium hydroxide in oven cleaner (mol dm^{-3}) (×40) [1]

(vi) Concentration in g dm^{-3} (× 40) [1]

(vii) (gdm^{-3}/1000) (× 100) [1]

In part **(e)**, carry error through (c.e.t.) if appropriate. 25

2 Observation and deduction

Safety glasses should be worn at all times and care should be taken during this practical examination.

(a) You are provided with a mixture of two salts, labelled A, which have a common cation.
Carry out the following experiments on the mixture.
Record your observations and deductions in the spaces below and identify the two salts.

Please note that the total marks for each box should be written in the box and not in the examiner's column.

Experiment	Observations	Deductions
1) Make a solution of A by dissolving a spatula of A in a test tube half-full of water. Warm gently. Transfer 1cm^3 of the solution into each of two separate test tubes. (a) Add a few drops of sodium hydroxide solution to the first test tube. Then add a further 3cm^3 of the sodium hydroxide solution to the test tube. (b) Add a few drops of ammonia solution to the second test tube. Then add a further 3cm^3 of the ammonia solution to the test tube.	*Colourless solution [1]* *White precipitate [1]* *Insoluble in excess [1]* *White precipitate [1]* *Insoluble in excess [1]* [5]	*Possibly magnesium, Zinc or Aluminium ion [1]* *Possibly magnesium / ion or compounds [1]* *Confirms the presence of magnesium ion or compounds [1]* [3]
2) Make a solution of A by dissolving half a spatula – measure of A in a test tube half – full of nitric acid solution. Warm gently. Transfer 1cm^3 of the solution into each of two separate test tubes. (a) (i) Add a few drops of silver nitrate solution to the first test tube. (ii) Then add about 2cm^3 of dilute ammonia solution to the same test tube. (b) Add a few drops of barium chloride solution to the second test tube.	*No effervescence [1]* *White precipitate [1]* *Precipitate dissolves [1]* *White precipitate [1]* [4]	*Not a carbonate/hydrogen carbonate [1]* *Possibly chloride ion [1]* *Chloride ion present [1]* *Sulphate ion present [1]* [4]

Name the two salts present in A:

Magnesium chloride [1]

Magnesium sulphate [1]

An incorrect deduction can be carried through to naming the salts.
A deduction based on an incorrect observation can be credited on the basis of carry error through (c.e.t.).
In **2 (a) (i)** and **(ii)** mark denied if 'chlorine' is given.

(b) You are provided with an organic liquid labelled B. Carry out the following experiments on the liquid. Record your observations and deductions in the spaces below.

Experiment	Observations	Deductions
1) Place 10 drops of B in a test tube and add $1cm^3$ of water.	*Forms one layer/mixes completely/dissolves/ colourless solution [1]* [1]	*Soluble/miscible with water [1]* *Forms H-bonds with water [1]* [2]
2) Place 10 drops of B on a watch glass placed on a heat proof mat and ignite it using a splint.	*Yellow/blue flame [1]* *Clean flame/little or no smoke [1]* [2]	*Low carbon content/saturated compound/C:H low/short chain/contains oxygen [1]* [1]
3) Add approximately 10 drops of B to a test tube one quarter full of bromine water and mix well.	*Yellow/orange colour remains [1]* [1]	*Alkene present/Saturated/ no C=C bonds present [1]* [1]
4) Add ten drops of B to $2cm^3$ of acidified potassium dichromate solution in a test tube. Warm the mixture gently.	*Orange to green [1]* *Change of smell [1]* [2]	*Primary or secondary alcohol / Not a tertiary alcohol [1]* *Can be oxidised/reducing agent / aldehyde or ketone formed [1]* [2]

Based on the tests above, suggest:

AVAILABLE MARKS

a functional group which may be present in B.

-OH [1]

a functional group which is absent in B.

C=C [1]

Mark to a maximum of 29 marks for question 2 29

N.B. Liquid is ethanol

Section A Total **54**

Section B

				AVAILABLE MARKS
3	**(a)**	**(i)** Mass of the container Mass of the container + lead oxide	[2]	
		(ii) Carry out in a fume cupboard/use gloves/tongs/allow to cool [1] Carbon monoxide is poisonous/apparatus is hot [1]	[2]	
		(iii) Heat and reweigh [1] until the mass is constant [1]	[2]	
		(iv) Prevents reoxidising the lead/stops air re-entering [1] Allows the metal to cool/apparatus still hot [1]	[2]	
	(b)	**(i)** 1.39-1.26 = 0.13g	[1]	
		(ii) $0.13/16 = 8.125 \times 10^{-3}$	[1]	
		(iii) $1.26/207 = 6.087 \times 10^{-3}$	[1]	
		(iv) Pb:O = 6.087×10^{-3}: 8.125×10^{-3} Pb:O = 3:4 Pb_3O_4 **(-1 for each mistake)**	[2]	
	(c)	**(i)** $2PbS + 3O_2 \rightarrow 2PbO + 2SO_2$	[2]	
		(ii) $2PbO + C \rightarrow 2Pb + CO_2$	[1]	
		(iii) 20.32/100 × 8.5 = 1.73g 207/239 × 100 = 86.61% 1.73/100 × 86.61 = 1.50g 1.500/20.32 × 100 = 7.38%	[4]	20
	In parts **(b)** and **(c)**, carry error through if appropriate.			
4	**(a)**	Repeated boiling and condensing of a reaction mixture without loss of reactants	[1]	
	(b)	**(i)** Place sample in a separating funnel Add sodium hydrogencarbonate / carbonate solution and shake	[2]	
		(ii) Add suitable named anhydrous solid to the sample [1] Filter/decant [1]	[2]	
		(iii) Distil the sample Collect the sample boiling between 210 - 212°C	[2]	7

			AVAILABLE MARKS
5 **(a)**	Dip nichrome wire/silica rod into concentrated hydrochloric acid and then into the solid [1] Heat in a blue Bunsen flame [1] Orange/yellow flame indicates the presence of sodium [1]	[3]	
(b)	Add dilute hydrochloric acid to the solid [1] Bubble the gas given off through limewater [1] If the limewater turns milky/cloudy then carbonate/hydrogencarbonate ions are present [1]	[3]	
(c)	Make a solution of the solid [1] Add a solution of magnesium ions [1] A white precipitate indicates a carbonate, no precipitate indicates a hydrogencarbonate [1]	[3]	9
		Section B Total	**36**
		Paper Total	**90**

New Specification

Rewarding Learning

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
2010

Chemistry

Assessment Unit AS 3

assessing

Module 3: Practical Examination 2

[AC132]

TUESDAY 18 MAY, AFTERNOON

MARK SCHEME

AVAILABLE MARKS

CHEMISTRY

Assessment Unit AS 3

assessing

Module 3: Practical Examination 2

Mark Scheme

Annotation
1. Please do all marking in red ink.
2. All scripts are checked for mathematical errors. Please adopt the system of one tick (✓) equals [1] mark e.g. if you have awarded 4 marks for part of a question then 4 ticks (✓) should be on this candidate's answer.
3. As candidates have access to scripts please do not write any inappropriate comments on their scripts.

Section A

1 (a) Rinse the pipette with distilled water and then drain cleaner [1]
Pipette $25cm^3$ of the oven cleaner into the $500cm^3$ volumetric flask and make up to mark using distilled water [1]
(Stopper and) shake the flask/invert [1]
Using a pipette filler [1]
Rinse the pipette with the diluted solution and transfer $25cm^3$ conical flask [1]
(1 mark each to a maximum of four) [4]

(b) Table [1]
Significant figures [2]
Calculation of the average titre [2]
Titration consistency [3]
Agreement with supervisor's titre [4] [12]

NOTES

Table:
Table should include initial burette reading, final burette reading, and volume delivered. The average titre should be calculated and the units included. Units missing (-1).

Significant figures:
All burette readings should be to at least one decimal place – each mistake is penalised by 1 mark.
(However initial burette readings of 0 are penalised once only.)
If used, the second decimal place position should be 0 or 5 only – other values will be penalised by 1 mark.

Average titre
Accurate titrations only should be used.
The use of a rough value is (-1).
The average value can be two decimal places, e.g. 25.37
An incorrect calculation is 0.
Mark denied if:
(i) only one accurate titration done
(ii) if titre not calculated correctly

AVAILABLE MARKS

Titration consistency

This is the difference between the first and second accurate readings

Difference	Mark
±0.1	[3]
±0.2	[2]
±0.3	[1]
±0.4	[0]

Titration agreement with the supervisor

Difference	Mark
±0.1	[4]
±0.2	[3]
±0.3	[2]
±0.4	[1]
±0.5	[0]

Please note that the supervisor's titre should be recorded at the bottom of page 3 in the candidate's script in RED INK.
The marks for table, significant figures etc should be recorded on the left-hand side of the candidate's table of results.

(c) yellow to orange/red [1]

(d) $KOH + HCl \longrightarrow KCl + H_2O$ [1]

(e) **(i)** Correct calculation using average titre i.e. $\frac{\text{titre} \times 0.1}{1000}$ [1]

(ii) Use of 1:1 ratio [1]

(iii) Moles of potassium hydroxide 500cm^3 of diluted drain cleaner (×20) [1]

(iv) Moles of potassium hydroxide in 25cm^3 of undiluted drain cleaner (same value as **(iii)**) [1]

(v) Concentration of potassium hydroxide in drain cleaner (mol dm^{-3}) (×40) [1]

(vi) Concentration in mol dm^{-3} (× 56) [1]

(vii) (gdm^{-3}/1000) × 100 [1]

In part **(e)**, carry error through (c.e.t.) if appropriate. 25

2 Observation and deduction

AVAILABLE MARKS

Safety glasses should be worn at all times and care should be taken during this practical examination.

(a) You are provided with a mixture of two salts, labelled X, which have a common cation. Carry out the following experiments on the mixture.
Record your observations and deductions in the spaces below and identify the two salts.

Please note that the total marks for each box should be written in the box and not in the examiner's column.

Experiment	Observations	Deductions
1) Make a solution of X by dissolving half a spatula-measure of X in a test tube half-full of water. Transfer 1cm^3 of this solution into each of two separate test tubes.	*Colourless solution [1]*	
(a) Add a few drops of sodium hydroxide solution to the first test tube. Then add a further 10cm^3 of the sodium hydroxide solution to the test tube.	*White precipitate [1]* *soluble in excess [1]*	*Possibly Magnesium, Zinc or Aluminium ion [1]* *Possibly zinc or aluminium ion or compounds [1]*
(b) Add a few drops and of ammonia solution to the second test tube. Then add a further 5cm^3 of the ammonia solution to the test tube.	*White precipitate [1]* *soluble in excess [1]* [5]	*Confirms the presence of zinc ion or compounds [1]* [3]
2) Make a solution of X by dissolving half a spatula-measure of X in a test tube half-full of nitric acid solution. Transfer 1cm^3 of this solution into each of two separate test tubes.	*No effervescence [1]*	*Not a carbonate/hydrogen carbonate [1]*
(a) (i) Add a few drops of silver nitrate solution to the first test tube.	*White precipitate [1]*	*Possibly chloride ions [1]*
(ii) Then add about 5cm^3 of dilute ammonia solution to the same test tube.	*Precipitate dissolves [1]*	*Chloride ion present [1]*
(b) Add a few drops of barium chloride solution to the second test tube.	*White precipitate [1]* [4]	*Sulphate ion present [1]* [4]

Name the two salts present in X:

Zinc chloride [1]

Zinc sulphate [1]

An incorrect deduction can be carried through to naming the salts.
A deduction based on an incorrect observation can be credited on the basis of carry error through (c.e.t.).
In **2 (a) (i)** and **(ii)** mark denied if 'chlorine' is given.

(b) You are provided with an organic liquid labelled Y. Carry out the following experiments on the liquid. Record your observations and deductions in the spaces below.

Experiment	Observations	Deductions
1) Place 10 drops of Y in a test tube and add 1cm^3 of water.	*Immiscible/2 layers [1]* [1]	*No H-bonds/No -OH present/non-polar [1]* *Less dense than water [1]* [2]
2) Place 10 drops of Y on a watch glass placed on a heat proof mat and ignite it using a splint.	*Smoky [1]* *Yellow flame [1]* [2]	*Unsaturated/high carbon content [1]* [1]
3) Add approximately 10 drops of Y to a test tube one quarter full of bromine water and mix well.	*Yellow/orange/brown [1]* *Turns colourless [1]* [2]	*Alkene present/ Unsaturated/C=C bonds present [1]* [1]
4) Add 10 drops of Y to 2cm^3 of acidified potassium dichromate solution in a test tube. Warm the mixture gently.	*Remains orange /no change [1]* [1]	*Possibly a tertiary alcohol/ Not a primary or secondary alcohol [1]* *Not reducing agent/not oxidation [1]* [2]

Based on the tests above, suggest:

AVAILABLE MARKS

a functional group which may be present in Y.

C=C [1]

a functional group which is absent in Y.

-OH [1]

Mark to a maximum of 29 marks for question 2 29

N.B. The Liquid is turpentine

Section A Total **54**

Section B

AVAILABLE MARKS

3	(a)	(i)	Mass of the container Mass of the container + copper oxide	[2]	
		(ii)	Flush out the apparatus with hydrogen/use gloves/tongs/allow to cool [1] Hydrogen – air mixture is explosive/apparatus is hot [1]	[2]	
		(iii)	Heat and reweigh [1] until the mass is constant [1]	[2]	
		(iv)	Prevents reoxidising the copper/stops air re-entering [1] Allows the metal to cool/apparatus still hot [1]	[2]	
	(b)	(i)	2.16 – 1.92 = 0.24g	[1]	
		(ii)	0.24/16 = 0.015	[1]	
		(iii)	1.92/64 = 0.030	[1]	
		(iv)	Cu:O = 0.030:0.015 Cu:O = 2:l Cu_2O **(-1 for each mistake)**	[2]	
	(c)	(i)	$2Cu_2S + 3O_2 \rightarrow 2Cu_2O + 2SO_2$	[2]	
		(ii)	$2Cu_2O + Cu_2S \rightarrow 6Cu + SO_2$	[1]	
		(iii)	25.86/100 × 34.8 = 8.999g 64/184 × 100 = 34.78% 8.999/100 × 34.78 = 3.130g 3.130/25.86 × 100 = 12.1%	[4]	20

In parts **(b)** and **(c)**, carry error through if appropriate.

4	(a)		Repeated boiling and condensing of a reaction mixture without loss of reactants	[1]	
	(b)	(i)	Place sample in a separating funnel Add sodium hydrogencarbonate / carbonate solution and shake	[2]	
		(ii)	Add suitable named anhydrous solid to the sample Filter/decant [1]	[2]	
		(iii)	Distil the sample Collect the sample boiling between 90 – 92°C	[2]	7

				AVAILABLE MARKS
5	**(a)**	Dip nichrome wire/silica rod into concentrated hydrochloric acid and then into the solid [1] Heat in a blue Bunsen flame [1] lilac flame indicates the presence of potassium [1]	[3]	
	(b)	Add dilute nitric acid to solid followed by silver nitrate solution [1] White precipitate shows chloride [1] Yellow precipitate shows iodide [1]	[3]	
	(c)	Silver chloride is soluble in dilute and concentrated ammonia solution [1] forming a colourless solution [1] Silver iodide is insoluble in dilute and concentrated ammonia solution [1]	[3]	9
			Section B Total	**36**
			Paper Total	**90**

Centre Number

71	

Candidate Number

Rewarding Learning

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
January 2011

Chemistry

Assessment Unit AS 2

assessing

Module 2: Organic, Physical and Inorganic Chemistry

[AC121]

THURSDAY 20 JANUARY, AFTERNOON

AC121

TIME

1 hour 30 minutes.

INSTRUCTIONS TO CANDIDATES

Write your Centre Number and Candidate Number in the spaces provided at the top of this page.
Answer **all seventeen** questions.
Answer **all ten** questions in **Section A**. Record your answers by marking the appropriate letter on the answer sheet provided. Use only the spaces numbered 1 to 10. Keep in sequence when answering.
Answer **all seven** questions in **Section B**. Write your answers in the spaces provided in this question paper.

INFORMATION FOR CANDIDATES

The total mark for this paper is 100.
Quality of written communication will be assessed in question **17(b)**.
In Section A all questions carry equal marks, i.e. **two** marks for each question.
In Section B the figures in brackets printed down the right-hand side of the pages indicate the marks awarded to each question or part question.
A Periodic Table of Elements (including some data) is provided.

For Examiner's use only	
Question Number	**Marks**
Section A	
1–10	
Section B	
11	
12	
13	
14	
15	
16	
17	
Total Marks	

BLANK PAGE

Section A

For each of the following questions only **one** of the lettered responses (A–D) is correct.

Select the correct response in each case and mark its code letter by connecting the dots as illustrated on the answer sheet.

1 Which one of the following colours do barium ions give in a flame test?

A Blue–green
B Green
C Red
D Yellow

2 Which one of the following represents a propagation step in the chlorination of methane?

A $CH_4 + Cl_2 \rightarrow CH_3Cl^{\bullet} + HCl$
B $CH_4 + Cl^{\bullet} \rightarrow CH_3^{\bullet} + HCl$
C $CH_3^{\bullet} + Cl^{\bullet} \rightarrow CH_3Cl$
D $CH_4 + Cl^{\bullet} \rightarrow CH_3Cl + H^{\bullet}$

3 CFC–114, used as a refrigerant, contains 14.0% carbon, 44.4% fluorine and the remainder is chlorine. Which one of the following is the empirical formula of CFC–114?

A $CFCl$
B CF_2Cl
C $C_2F_4Cl_5$
D $C_3F_6Cl_4$

4 A solution of a sulphate gave a white precipitate when both sodium hydroxide and ammonia solutions were separately added to it. The white precipitate was soluble in excess of both sodium hydroxide and ammonia solutions.
Which one of the following is the sulphate?

A $Al_2(SO_4)_3$
B $MgSO_4$
C Na_2SO_4
D $ZnSO_4$

5 Which one of the following molecules can exist as *cis* and *trans* (E–Z) isomers?

A $CH_2{=}CHCH(CH_3)CH_3$
B $CH_2{=}CHCH_2CH_2CH_3$
C $CH_3CH{=}CHCH_2CH_3$
D $CH_3C(CH_3){=}CHCH_3$

6 Copper can be extracted by heating copper(II) oxide with carbon.

$$2CuO(s) + C(s) \rightarrow 2Cu(s) + CO_2(g)$$

Which one of the following is the atom economy of the reaction?

A 40.0%
B 69.5%
C 74.4%
D 80.0%

7 Which one of the following represents the standard enthalpy change for the formation of ethanol?

A $2C(g) + 6H(g) + O(g) \rightarrow C_2H_5OH(g)$
B $2C(s) + 3H_2(g) + O(g) \rightarrow C_2H_5OH(l)$
C $2C(s) + 3H_2(g) + \frac{1}{2}O_2\,(g) \rightarrow C_2H_5OH(g)$
D $2C(s) + 3H_2(g) + \frac{1}{2}O_2\,(g) \rightarrow C_2H_5OH(l)$

8 The following table shows the enthalpy change of neutralisation for some acid-base reactions:

Acid	**Base**	**Enthalpy change of neutralisation/kJ mol^{-1}**
HCl	NaOH	–57.2
X	NaOH	–55.2
HCl	**Y**	–52.2
HNO_3	KOH	**Z**

The identities of X, Y and Z are:

	X	**Y**	**Z**
A	ethanoic acid	ammonia solution	–57.2
B	sulphuric acid	ammonia solution	–55.2
C	ethanoic acid	sodium hydroxide	–52.2
D	sulphuric acid	sodium hydroxide	–57.2

9 Which one of the following alcohols will give a positive result in the iodoform test?

A $CH_3CH_2CH_2CH_2CH_2OH$
B $CH_3CH_2CH_2CH(OH)CH_3$
C $CH_3CH_2CH(OH)CH_2CH_3$
D $CH_3C(CH_3)_2CH_2OH$

10 The standard enthalpies of combustion for carbon, hydrogen and ethyne, C_2H_2, are given below.

	Standard enthalpy of combustion (kJ mol^{-1})
$C(s) + O_2(g) \rightarrow CO_2(g)$	–394
$H_2(g) + \frac{1}{2}O_2(g) \rightarrow H_2O(l)$	–286
$C_2H_2(g) + 2\frac{1}{2}O_2(g) \rightarrow 2CO_2(g) + H_2O(l)$	–1300

Which one of the following is the standard enthalpy of formation of ethyne?

A –226 kJ mol^{-1}
B +226 kJ mol^{-1}
C –620 kJ mol^{-1}
D +620 kJ mol^{-1}

Section B

Examiner Only	
Marks	Remark

Answer **all seven** questions in this section.

11 (a) Airbags used in cars contain sodium azide, NaN_3. During a crash the airbag rapidly fills with nitrogen gas from the following reaction:

$$2NaN_3(s) \rightarrow 2Na(s) + 3N_2(g)$$

ΔH for the reaction is positive.

(i) What name is given to reactions in which ΔH is positive?

____ [1]

(ii) Label the axes below and draw an enthalpy level diagram for the reaction.

[3]

(iii) When fully inflated the airbag contains $50\,dm^3$ of nitrogen at $20\,°C$ and one atmosphere pressure. What mass of sodium azide is needed to produce this volume of nitrogen?

____

____

____ [3]

Examiner Only	
Marks	Remark

(b) Catalytic converters help to reduce environmental damage due to vehicle exhaust emissions.

(i) Give an equation to show how unburnt heptane, C_7H_{16}, is removed from the exhaust emissions.

____ [2]

(ii) In the catalytic converter, carbon monoxide can react with nitrogen(II) oxide to form nitrogen. Write an equation for this reaction.

____ [2]

12 Magnesium, calcium and barium are found in Group II of the Periodic Table.

Examiner Only	
Marks	Remark

(a) Explain why the Group II elements are regarded as s-block elements.

____

____ [1]

(b) **(i)** Write an equation, including state symbols, for the first ionisation energy of magnesium.

____ [2]

(ii) State and explain the change in the value of the first ionisation energy from magnesium to barium.

____

____

____

____

____ [3]

(c) Calcium hydroxide can be decomposed by heating.

(i) Write an equation for the decomposition of calcium hydroxide.

____ [1]

(ii) Compare and explain the thermal stability of magnesium hydroxide with barium hydroxide.

____

____

____

____ [3]

(iii) Explain the difference in pH value when 0.1 mole of magnesium hydroxide and 0.1 mole of barium hydroxide are stirred with separate 100 cm^3 portions of water.

____

____

____ [2]

Examiner Only	
Marks	Remark

Examiner Only	
Marks	Remark

13 Crude petroleum is the source of hydrocarbons such as alkanes.

(a) How are alkanes obtained from crude petroleum?

____ [1]

(b) Octane, C_8H_{18}, is an alkane which is a constituent of petrol.

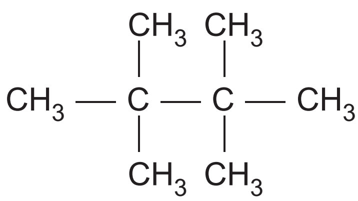
(i) Octane is a saturated hydrocarbon.
What is meant by the terms **saturated** and **hydrocarbon**?

____

____

____ [2]

(ii) Give the systematic name for the isomer of octane shown below.



____ [1]

(c) Alkenes, such as propene, can be obtained from alkanes such as octane.

(i) What name is given to the process of forming alkenes from alkanes?

____ [1]

(ii) State **one** condition which is necessary for this process.

____ [1]

(iii) Write an equation for the formation of propene from octane.

____ [1]

Examiner Only	
Marks	Remark

(iv) Describe a chemical test for an unsaturated hydrocarbon such as propene.

____

____

____ [2]

(v) Write an equation for the reaction involved in the test described in part **(iv)**.

____ [1]

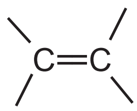
(d) Explain why alkenes are more reactive than alkanes.

____

____ [1]

(e) Alkenes such as propene react with hydrogen bromide.

(i) Use a flow diagram to suggest the mechanism for the reaction between an alkene and hydrogen bromide.

You may represent the alkene as: 

[3]

(ii) What name is given to the type of reaction between propene and hydrogen bromide?

____ [2]

14 Some "ice packs" used to treat sports injuries contain ammonium nitrate and water. A capsule containing the water is broken, the ammonium nitrate dissolves and the temperature falls.

Examiner Only	
Marks	Remark

(a) The following results were obtained when ammonium nitrate was added to some water.

Mass of water = 100 g
Mass of ammonium nitrate = 5.0 g
Initial temperature = 25.0 °C
Final temperature = 24.1 °C

Specific heat capacity of water = 4.2 J g^{-1} $°C^{-1}$

(i) Calculate the enthalpy change taking place.

____

____ [2]

(ii) How many moles of ammonium nitrate were used?

____

____ [1]

(iii) Calculate the molar enthalpy change for dissolving the ammonium nitrate in 100 g of water.

____

____ [1]

(b) One manufacturer makes an "ice pack" containing 120 g of water. What mass of ammonium nitrate will be needed to produce a temperature fall of 25.0 °C?

____

____

____ [2]

Examiner Only	
Marks	Remark

15 The Birkeland-Eyde process for the manufacture of nitric acid was developed in 1903. In the first step of the process nitrogen and oxygen react as follows:

$$N_2(g) \quad + \quad O_2(g) \quad \rightleftharpoons \quad 2NO(g) \qquad \Delta H = +180\ \text{kJ mol}^{-1}$$

Explain the effect, if any, of each of the following changes on the **yield** of nitrogen(II) oxide and on **the rate of the reaction**.

(a) Increasing the temperature.

____

____

____

____ [3]

(b) Adding more nitrogen.

____

____

____

____ [3]

(c) Increasing the pressure.

____

____

____

____ [3]

(d) Adding a catalyst.

____

____

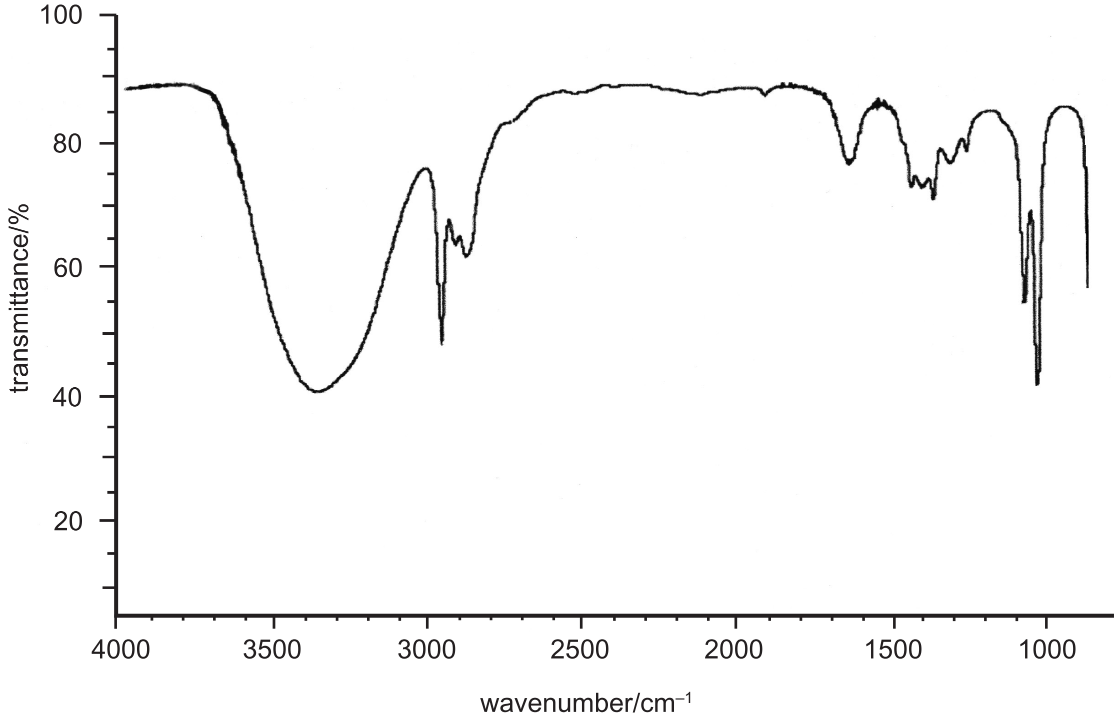
____ [2]

16 Some wine is thought to be contaminated by ethanal and ethanoic acid.

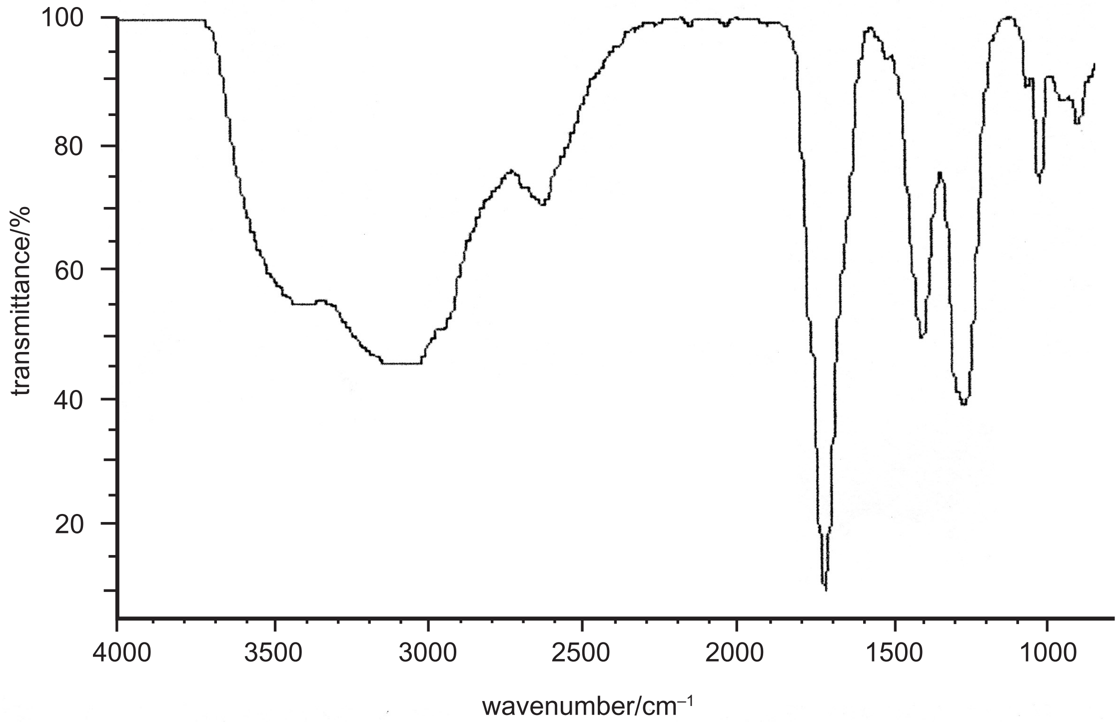
Examiner Only	
Marks	Remark

(a) A sample of the wine was subjected to infra-red spectroscopy and the results compared to the spectra for ethanol, ethanal and ethanoic acid. The infra-red spectra for ethanol, ethanal and ethanoic acid are shown below (not necessarily in that order).

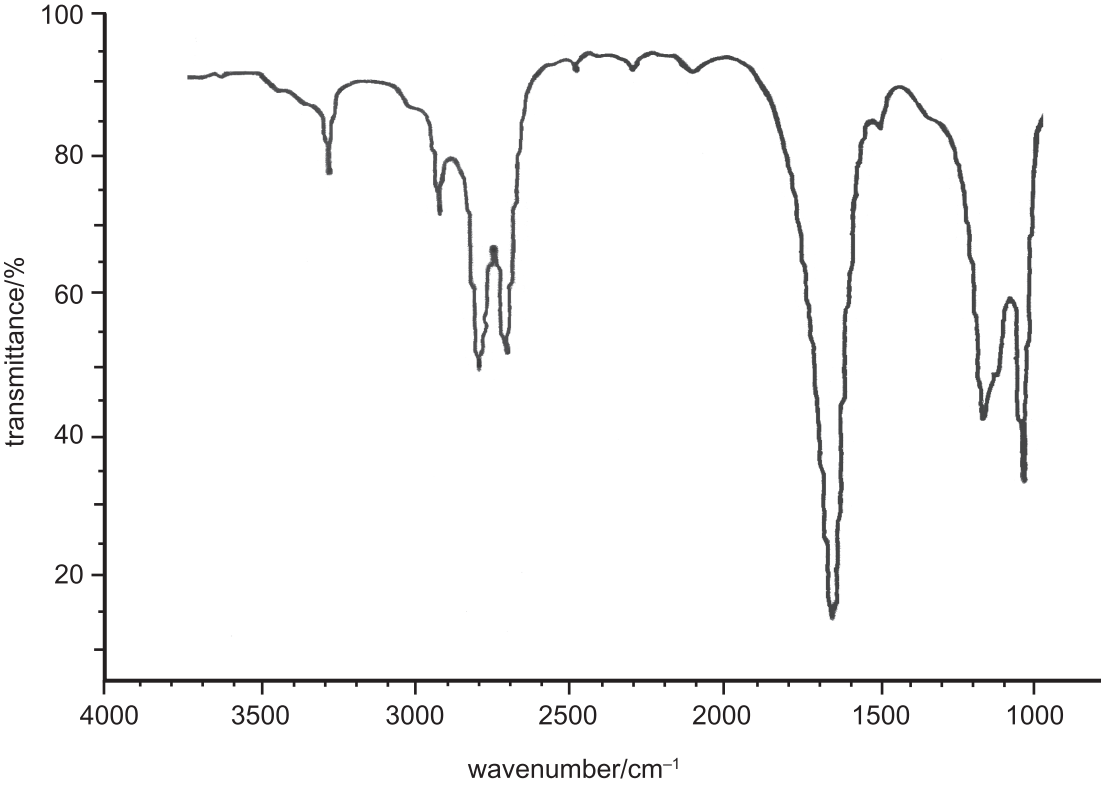
Spectrum A



Spectrum B



Spectrum C



(i) Explain how the absorption of infra-red radiation arises in molecules.

____

____ [1]

(ii) The table below gives some infra-red absorption data.

Bond	Wavenumber/cm^{-1}
C — H	2850–3300
C ═ C	1620–1680
C ═ O	1680–1750
C — O	1000–1300
(alcohols) O — H	3230–3550
(acids) O — H	2500–3000

Use this data to identify the absorptions at:

Spectrum A: (broad) 3000 cm^{-1} ____________________________

Spectrum C: 1000 cm^{-1} _________________________________ [2]

(iii) Identify the molecule responsible for:

Spectrum B: ____

Spectrum C: ____ [2]

(b) Ethanol can be oxidised to ethanal or ethanoic acid depending on the experimental technique used.

(i) Name a suitable oxidising agent.

____ [1]

(ii) Give the formula of the ion formed by reduction of this oxidising agent.

____ [1]

Examiner Only

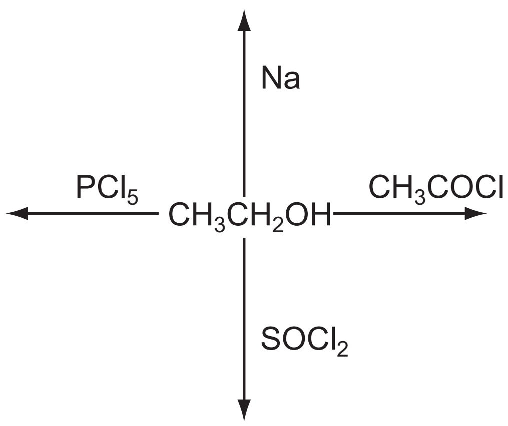
Marks	Remark

(iii) Give the experimental techniques required to form

Ethanal: ____ [1]

Ethanoic acid: ____ [1]

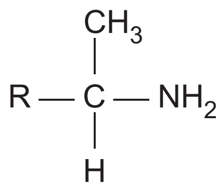
(c) Complete the diagram below giving the formula of the organic compound formed in each case.



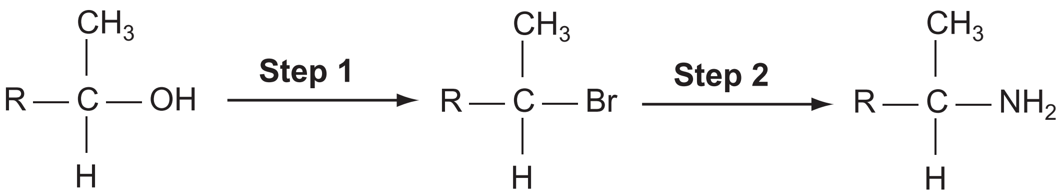
[4]

Examiner Only	
Marks	Remark

17 Amphetamines were once used to treat obesity, mild depression and some behavioural disorders.
The general formula for an amphetamine can be represented as:



Amphetamines can be synthesised in the following steps.



(a) **(i)** Suggest a suitable reagent for **Step 1**.

____ [1]

(ii) What type of reaction is taking place in **Step 1**?

____ [2]

(iii) Suggest a suitable reagent and conditions for carrying out **Step 2**.

____

____ [2]

Examiner Only	
Marks	Remark

Examiner Only	
Marks	Remark

(b) The liquid product obtained from **Step 1** is impure. Giving experimental details explain how it can be separated, dried and purified.

____

____

____

____

____

____

____ [4]

Quality of written communication [2]

THIS IS THE END OF THE QUESTION PAPER

111598

Rewarding Learning

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
January 2011

Chemistry

Assessment Unit AS 2

assessing

Module 2: Organic, Physical and Inorganic Chemistry

[AC121]

THURSDAY 20 JANUARY, AFTERNOON

MARK SCHEME

Section A

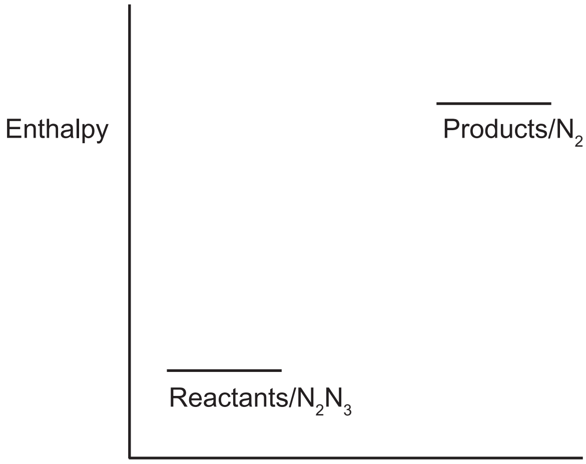
			AVAILABLE MARKS
1	B	[2]	
2	B	[2]	
3	B	[2]	
4	D	[2]	
5	C	[2]	
6	C	[2]	
7	D	[2]	
8	A	[2]	
9	B	[2]	
10	B	[2]	20

Section B

AVAILABLE MARKS

11 (a) (i) Endothermic [1]

(ii)



Reaction path/reaction co-ordinate/extent of reaction/progress

([–1] for each mistake) [3]

(iii) Moles of N_2 = 50/24 = 2.083 mole
Moles of NaN_3 = 2.083 × 2/3 = 1.389 mole
Mass of NaN_3 = 1.389 × 65 = 90.28 g
([–1] for each mistake) [3]

(b) (i) $C_7H_{16} + 11O_2 \rightarrow 7CO_2 + 8H_2O$ [2]

(ii) $2CO + 2NO \rightarrow 2CO_2 + N_2$ [2] 11

AVAILABLE MARKS

12 **(a)** The outer electrons are in the s-subshell/orbital/shell [1]

(b) **(i)** $Mg(g) \rightarrow Mg^{+}(g) + e^{-}$
(equation [1], state symbols [1]) [2]

(ii) 1st ionisation energy decreases going down the group [1]
Increased shielding (from inner electrons) [1]
Outer electrons further from the nucleus [1] [3]

(c) **(i)** $Ca(OH)_2 \rightarrow CaO + H_2O$ [1]

(ii) $Mg(OH)_2$ less stable than $Ba(OH)_2$ [1]
Mg^{2+} smaller/high charge density [1]
Polarisation of OH^{-}/Comparison in size to O^{2-}/OH^{-} [1] [3]

(iii) pH of $Ba(OH)_2 > Mg(OH)_2$ [1]
Solubility of the hydroxides increases going down the group [1] [2] 12

13 **(a)** Fractional distillation [1]

(b) **(i)** **Hydrocarbon** – compound containing carbon and hydrogen only [1]
Saturated – contains no C=C bonds [1] [2]

(ii) 2,2,3,3-tetramethylbutane [1]

(c) **(i)** Cracking [1]

(ii) High temperature/catalyst [1]

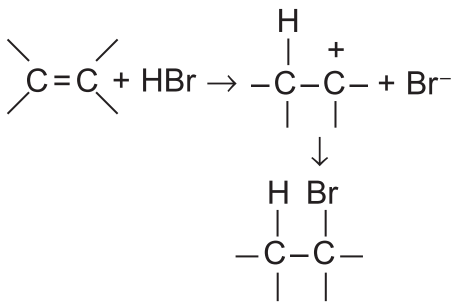
(iii) $C_8H_{18} \rightarrow C_5H_{12} + C_3H_6$ **or**
$C_8H_{18} \rightarrow C_2H_6 + 2C_3H_6$ [1]

(iv) Shake propene gas with bromine water
Decolourises [1] bromine water [1] [2]

(v) $C_3H_6 + Br_2 \rightarrow C_3H_6Br_2$ [1]

(d) High electron density around the double bond [1]

(e) **(i)**



[3]

(ii) Electrophilic [1] addition [1] [2] 16

					AVAILABLE MARKS
14	**(a)**	**(i)**	$\Delta H = mc\Delta T = 100 \times 4.2 \times 0.9$ [1] = 378 J [1]	[2]	
		(ii)	5/80 = 0.0625	[1]	
		(iii)	378/0.0625 = 6048 (J mol^{-1})	[1]	
	(b)		5 g produces 0.9 ºC change $\frac{5}{0.9} \times 25$ g produces 25 ºC change $\frac{5}{0.9} \times 25 \times \frac{120}{100}$ in 120 g water = 166.7 g	[2]	6
15	**(a)**		Rate of reaction increases as more molecules will have enough energy to react when they collide [1] (Equilibrium moves to the right) increasing the yield of NO [1] The forward reaction is endothermic/removes the extra heat [1]	[3]	
	(b)		Rate of the reaction will increase due to increased concentration [1] Equilibrium moves to the right increasing the yield of NO [1] This removes the additional N_2 (restoring the equilibrium) [1]	[3]	
	(c)		Rate of the reaction will increase as this increases the concentration of the gases [1] Equilibrium position is unaffected [1] Same volume/number of molecules on each side [1]	[3]	
	(d)		Rate of the reaction increases as the catalyst provides an alternative pathway with a lower energy [1] The catalyst will not affect the position of the equilibrium and the yield will not change [1]	[2]	11
16	**(a)**	**(i)**	Molecular vibrations	[1]	
		(ii)	**Spectrum A:** C—H bond [1] **Spectrum C:** C—O bond [1]	[2]	
		(iii)	**Spectrum B:** ethanoic acid [1] **Spectrum C:** ethanal [1]	[2]	
	(b)	**(i)**	$H^+/Cr_2O_7^{2-}$ acidified dichromate	[1]	
		(ii)	Cr^{3+}	[1]	
		(iii)	Ethanal: Heat under distillation [1] Ethanoic acid: Heat under reflux [1]	[2]	
	(c)		Na $\rightarrow$ CH_3CH_2ONa [1] $CH_3COCl \rightarrow CH_3COOCH_2CH_3$ [1] $SOCl_2 \rightarrow CH_3CH_2Cl$ [1] $PCl_5 \rightarrow CH_3CH_2Cl$ [1]	[4]	13

		AVAILABLE MARKS
17 (a) (i) HBr	[1]	
(ii) Nucleophilic [1] substitution [1]	[2]	
(iii) Heat [1] with (concentrated) ammonia [1]	[2]	
(b) Use of separating funnel [1] Use of $NaHCO_3$ solution (to remove acid impurities) – release pressure [1] Use of anhydrous Na_2SO_4 or $CaCl_2$ (for drying) – filter [1] Distil (product for final purification) [1]	[4]	
Quality of written communication	[2]	11
	Section B	**80**
	Total	**100**

Rewarding Learning

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
2011

Centre Number	
71	

Candidate Number

Chemistry

Assessment Unit AS 2

assessing

Module 2: Organic, Physical and Inorganic Chemistry

[AC122]

FRIDAY 24 JUNE, MORNING

AC122

TIME

1 hour 30 minutes.

INSTRUCTIONS TO CANDIDATES

Write your Centre Number and Candidate Number in the spaces provided at the top of this page.
Answer **all sixteen** questions.
Answer **all ten** questions in **Section A**. Record your answers by marking the appropriate letter on the answer sheet provided. Use only the spaces numbered 1 to 10. Keep in sequence when answering.
Answer **all six** questions in **Section B**. Write your answers in the spaces provided in this question paper.

INFORMATION FOR CANDIDATES

The total mark for this paper is 100.
Quality of written communication will be assessed in question **12(b)**.
In Section A all questions carry equal marks, i.e. **two** marks for each question.
In Section B the figures in brackets printed down the right-hand side of the pages indicate the marks awarded to each question or part question.
A Periodic Table of Elements (including some data) is provided.

For Examiner's use only	
Question Number	**Marks**
Section A	
1–10	
Section B	
11	
12	
13	
14	
15	
16	
Total Marks	

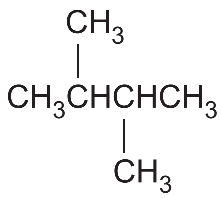
Section A

Examiner Only	
Marks	Remark

For each of the following questions only **one** of the lettered responses (A–D) is correct.

Select the correct response in each case and mark its code letter by connecting the dots as illustrated on the answer sheet.

1 Which one of the following is the IUPAC name for the hydrocarbon shown below?



A 1,4-dimethylbutane
B 2,3-dimethylbutane
C 1,4-dimethylhexane
D 2,3-dimethylhexane

2 1.4 g of an alkene gives 3.8 g of a dichloroalkane on reaction with chlorine. Which one of the following is the molecular formula of the alkene?

A C_2H_4
B C_3H_6
C C_4H_8
D C_6H_{12}

3 Which one of the following lists the products of hydrolysis of chloromethane with "heavy water", D_2O?
(The symbol D represents an atom of deuterium, an isotope of hydrogen)

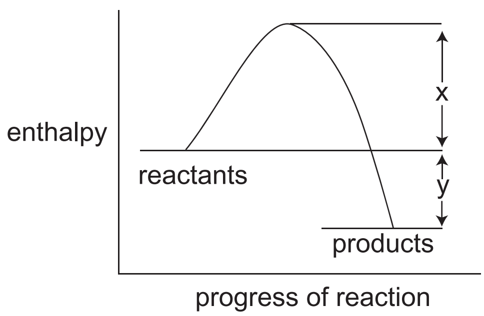
A $CH_3OH + HCl$
B $CH_3OH + DCl$
C $CH_3OD + HCl$
D $CH_3OD + DCl$

Examiner Only	
Marks	Remark

4 The enthalpy change for the combustion of graphite is $-393.5\,\text{kJ mol}^{-1}$ and that of diamond is $-395.4\,\text{kJ mol}^{-1}$.
Which one of the following is the enthalpy change for the reaction C(graphite) $\rightarrow$ C(diamond)?

A $-1.9\,\text{kJ mol}^{-1}$
B $+1.9\,\text{kJ mol}^{-1}$
C $-788.9\,\text{kJ mol}^{-1}$
D $+788.9\,\text{kJ mol}^{-1}$

5 The energy level diagram for a reversible reaction is shown below.



Which one of the following is correct?

A The activation energy of the forward reaction is x
B The activation energy of the reverse reaction is y
C The forward reaction is endothermic
D The enthalpy change for the reverse reaction is y–x

6 The reaction of bromine with water can be represented by the following equation:

$$Br_2 \quad + \quad H_2O \quad \rightleftharpoons \quad Br^- \quad + \quad OBr^- \quad + \quad 2H^+$$

Which one of the following reagents would move the equilibrium position to the right?

A nitric acid
B sodium carbonate
C sodium bromide
D sulfuric acid

Examiner Only	
Marks	Remark

7 What is the number of moles of oxygen required for the complete combustion of one mole of butane?

A 5.5
B 6
C 6.5
D 7

8 When bromobutane is prepared by the reaction of butanol with concentrated hydrobromic acid in the presence of concentrated sulfuric acid which one of the following is **not** found in the reaction flask?

A bromine
B butanol
C butane
D hydrogen bromide

9 The mechanism of the reaction between ethene and hydrogen bromide is

A electrophilic addition.
B electrophilic substitution.
C nucleophilic addition.
D nucleophilic substitution.

10 In ethanol the attractions between adjacent molecules are

A covalent bonds only.
B hydrogen bonds only.
C hydrogen bonds and van der Waals forces only.
D van der Waals forces only.

Section B

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

11 Complete the following table:

Formula	Name
SCN^-	
	potassium dichromate
CHI_3	
	thionyl chloride

[4]

Examiner Only	
Marks	Remark

Examiner Only	
Marks	Remark

12 Crude petroleum is the major source of hydrocarbons. They are obtained by fractional distillation.

Whilst the use of petroleum products is of major benefit to mankind there are many environmental problems caused by the spillage and combustion of hydrocarbons. The recent spillage of crude petroleum onto the shores of the USA was a serious event in world economics.

(a) What are the products from the incomplete combustion of hydrocarbons?

____ [2]

(b) Discuss the environmental problems associated with spillage and the combustion of hydrocarbons.

____

____

____

____

____

____

____

____

____ [5]

Quality of written communication [2]

13 The table below shows some information about the Group II elements.

	magnesium	**calcium**	**strontium**	**barium**
atomic number	12	20	38	56
atomic radius/nm	0.160	0.197	0.215	
density/g cm^{-3}	1.74	1.54	2.6	3.5

(a) Explain why none of the Group II elements are found on the Earth's surface as free elements.

____

____ [1]

(b) Use the atomic number to determine the electronic configuration of calcium.

____ [1]

(c) The atomic radius of the Group II elements shows a trend as the group is descended.

(i) Explain why the atomic radius increases down the group.

____

____ [1]

(ii) Suggest whether the values of the atomic radii of the Group I elements are larger or smaller than those of the Group II elements.

____

____ [2]

(iii) Predict a value for the atomic radius of barium.

____ [1]

(iv) Use the values in the table to suggest why barium has the highest density of the group.

____

____ [2]

Examiner Only

Marks	Remark

(d) All of the Group II elements form ions from their atoms.

(i) If the symbol for a Group II element is M what is the symbol for its ion?

____ [1]

(ii) Explain what is meant by the term **first ionisation energy**.

____

____ [1]

(iii) Write the equation for the first ionisation energy of magnesium including state symbols.

____ [2]

(e) The density of the Group II elements relative to water indicates whether the metal should float or sink as it is reacting.

(i) State and explain whether calcium floats or sinks.

____

____ [2]

(ii) State **two** further observations when calcium reacts with water.

____

____ [2]

(iii) Write the equation for the reaction of calcium with water.

____ [2]

Examiner Only	
Marks	Remark

(iv) Draw a labelled diagram, to show how the gas given off when calcium reacts with water can be collected. Use a test tube and a beaker.

[3]

Examiner Only	
Marks	Remark

(f) Barium carbonate is roasted with carbon to produce barium oxide according to the equation below.

$$BaCO_3 \rightarrow BaO + CO_2$$

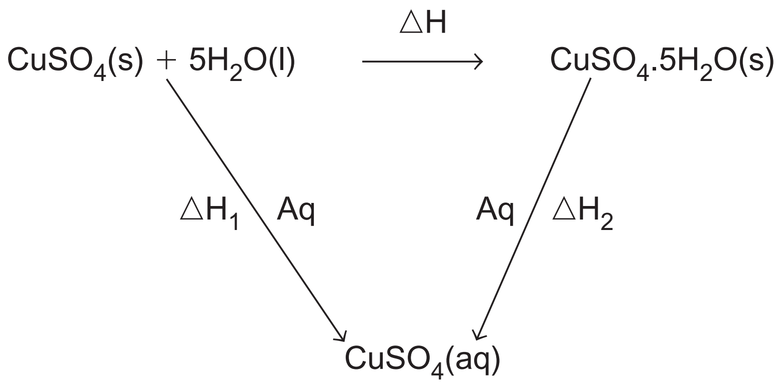
Calculate the atom economy of the reaction.

____

____

____ [3]

14 The following diagram shows the enthalpy changes that occur during the determination of the enthalpy change of the reaction of copper(II) sulfate with water to form copper(II) sulfate pentahydrate i.e.



(a) (i) 8.0 g of anhydrous copper(II) sulfate ($CuSO_4$) added to 100 g of water caused the temperature to rise by 1.2 °C. Calculate the enthalpy change, $\triangle H_1$.
(Assume that the specific heat capacity of water is 4.2 J g^{-1} °C^{-1}.)

____

____ [1]

(ii) 12.5 g of hydrated copper(II) sulfate ($CuSO_4.5H_2O$) added to 100 g of water caused the temperature to fall by 1.4 °C. Calculate the enthalpy change $\triangle H_2$.
(Assume that the specific heat capacity of water is 4.2 J g^{-1} °C^{-1}.)

____

____ [1]

(b) State Hess's law.

____

____ [2]

Examiner Only	
Marks	Remark

(c) Use the values calculated in parts **(a)(i)** and **(a)(ii)** to calculate the molar enthalpy of reaction $\triangle H$.

____

____

____ [3]

(d) At the end of the experiment a test was carried out to show that the solution produced contained Cu^{2+} ions.

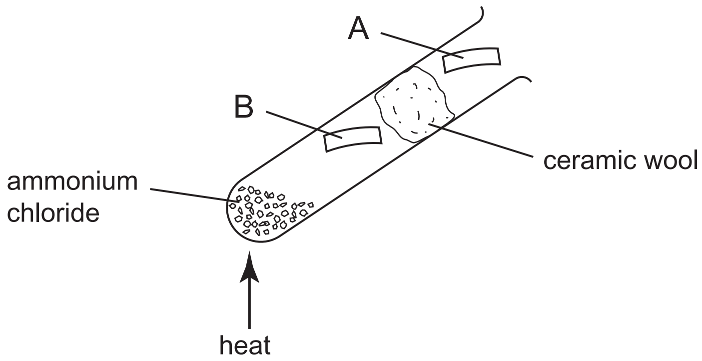
Describe how you would use aqueous ammonia to test and confirm the presence of Cu^{2+}.

____

____ [2]

Examiner Only	
Marks	Remark

15 Crystals of ammonium chloride were heated in a test tube as shown below.



The pH paper placed at A turns blue and the pH paper placed at B turns red.

The ammonium chloride, when heated, dissociates to form an equilibrium mixture.

$$NH_4Cl(s) \rightleftharpoons NH_3(g) + HCl(g)$$

(a) **(i)** Explain why the pH paper changes to a blue colour at A.

____ [1]

(ii) Explain why the pH paper changes to a red colour at B.

____ [1]

(b) Suggest the purpose of the ceramic wool.

____ [1]

(c) Heat is needed to decompose the ammonium chloride. Explain whether the forward reaction is exothermic or endothermic.

____

____ [2]

Examiner Only

Marks	Remark

Examiner Only

Marks	Remark

(d) Ammonium chloride dissolves in water to form aqueous ammonium and chloride ions.

$$NH_4Cl(s) \quad + \quad Aq \longrightarrow NH_4^+(aq) \quad + \quad Cl^-(aq)$$

(i) Describe how you would test for aqueous ammonium ions.

____

____ [3]

(ii) Describe how you would test for aqueous chloride ions.

____

____ [3]

(e) Ammonium chloride is quite soluble in water, 37.2 g dissolve in 100 cm^3 of water at 20 °C. Calculate the maximum volume of ammonia gas that could be obtained from this solution at 20 °C and one atmosphere pressure.

____

____

____ [3]

16 The structure of t-butyl chloride (tertiary chlorobutane) one of the isomers of the chlorobutanes is shown below.

$(CH_3)_3CCl$

t-butyl chloride

(a) Deduce the systematic name for t-butyl chloride

____ [2]

(b) There are three other isomers of t-butyl chloride which are known. They are shown in the table below.

butyl chloride	**structure**	**boiling point/°C**
t-butyl chloride	$(CH_3)_3CCl$	51–52
n-butyl chloride	$CH_3CH_2CH_2CH_2Cl$	78–79
sec-butyl chloride	$CH_3CH_2CHClCH_3$	68–70
iso-butyl chloride	$(CH_3)_2CHCH_2Cl$	68–69

(i) What is the general formula for chloroalkanes?

____ [1]

(ii) What is the general molecular formula for the chlorobutanes?

____ [1]

(iii) Suggest, in terms of intermolecular forces, why the boiling point of t-butyl chloride is so different from the other chlorobutanes.

____

____ [2]

(iv) Explain what is meant by the term **isomer**.

____

____ [2]

(v) Suggest the meaning of the term **sec**.

____ [1]

Examiner Only

Marks	Remark

(c) t-butyl chloride is easily made from the corresponding alcohol according to the following reaction.

$$(CH_3)_3COH \quad + \quad HCl \quad \rightarrow \quad (CH_3)_3CCl \quad + \quad H_2O$$

The preparation is carried out in a separating funnel. 25 g of t-butyl alcohol and 85 cm^3 of concentrated hydrochloric acid (an excess) are shaken from time to time over 20 minutes. The mixture is allowed to stand for a few minutes and the lower acid layer removed. The crude t-butyl chloride is washed with sodium hydrogencarbonate solution and then with water. Anhydrous calcium sulfate is swirled with the t-butyl chloride in a conical flask. The liquid is decanted, 2–3 chips of porous porcelain added and distilled to collect 28 g of t-butyl chloride at 51–52 °C.

(i) After each shaking the separating funnel is inverted and the tap opened. Explain the reason for this procedure.

____ [1]

(ii) Explain why the t-butyl chloride is shaken with sodium hydrogencarbonate solution.

____ [1]

(iii) Explain why the t-butyl chloride is shaken with water.

____ [1]

(iv) Explain why the t-butyl chloride is swirled with anhydrous calcium sulfate.

____ [1]

(v) Explain why porous porcelain is added before distillation.

____ [1]

(vi) Calculate the percentage yield of t-butyl chloride.

____

____

____

____ [3]

Examiner Only	
Marks	Remark

Examiner Only	
Marks	Remark

(d) When added to water t-butyl chloride undergoes "spontaneous solvation". Hydrolysis immediately occurs to produce the alcohol. Compare the speed of this hydrolysis to that of n-butyl chloride and suggest why there is such a difference in speed.

____

____

____

____ [3]

THIS IS THE END OF THE QUESTION PAPER

Rewarding Learning

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
2011

Chemistry

Assessment Unit AS 2

assessing

Module 2: Organic, Physical and Inorganic Chemistry

[AC121] [AC122]

FRIDAY 24 JUNE, MORNING

MARK SCHEME

Section A

		AVAILABLE MARKS
1	B	
2	B	
3	D	
4	B	
5	A	
6	B	
7	C	
8	C	
9	A	
10	C	
[2] for each correct answer	[20]	20
	Section A	**20**

Section B

AVAILABLE MARKS

11 thiocyanate (ion) [1]
$K_2Cr_2O_7$ [1]
iodoform/triiodomethane [1]
$SOCl_2$ [1] 4

12 **(a)** H_2O, C, CO or names [2]

(b) <u>spillage</u> aesthetic aspects [1]
oil on birds/animals (explained) [1] oil on plants (explained) [1]
non-biodegradable [1]
<u>combustion</u> CO_2 – greenhouse effect/global warming [1]
problems with particulates (smoke, carbon) explained –
respiratory problems [1]
carbon monoxide is poisonous [1]
sulfur dioxide – acid rain [1]
or oxides of nitrogen
hydrocarbons – non renewable [1] [5]

Quality of written communication [2] 9

13 **(a)** metals are (very) reactive/react with O or S/form compounds [1]

(b) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2$ [1]

(c) **(i)** increased number of shells [1]

(ii) larger atomic radius in Group 1 due to smaller nuclear charge [2]

(iii) 0.160 0.197 0.215 0.224
0.037 0.018 0.009 [1]

(iv) size of strontium similar/close to barium [1]
mass of barium larger than strontium [1] [2]

(d) **(i)** M^{2+} [1]

(ii) energy needed to convert 1 mole of gaseous atoms into gaseous ions with a charge of 1+ [1]

(iii) $Mg(g) \rightarrow Mg^{+}(g) + e^{-}$ [2]

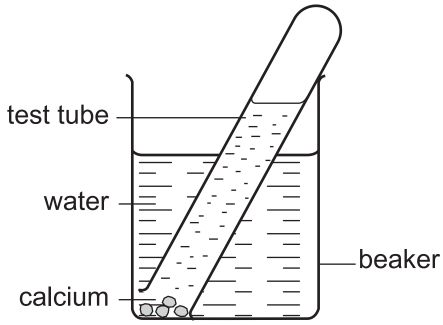
AVAILABLE MARKS

(e) (i) calcium heavier/denser than water [1]
sinks [1] [2]

(ii) bubbles [1]
white solid appears [1]
heat evolved [1]
Ca gets smaller [1] any 2 [2]

(iii) $Ca + 2H_2O \rightarrow Ca(OH)_2 + H_2$ [2]

(iv)



[3]

(f) $BaCO_3 \rightarrow BaO + CO_2$

$BaCO_3 = 137 + 12 + 48 = 197$
$BaO = 137 + 16 = 153$

atom economy = $153/197 \times 100 = 77.7\%$
$= 78\%$ [3] 24

14 (a) (i) $100 \times 1.2 \times 4.2 = -504\,J$ ($-10.08\,kJ\,mol^{-1}$) [1]

(ii) $100 \times 1.4 \times 4.2 = +588\,J$ ($+11.76\,kJ\,mol^{-1}$) [1]

(b) enthalpy change is independent of route [2]
(in a series of reactions)

(c) $CuSO_4 = 64 + 32 + 64 = 160$
$5H_2O = 5 \times 18 = 90$
$CuSO_4.5H_2O = 160 + 90 = 250$

12.5 g = 12.5/250 = 0.05 mol
8.0 g = 8.0/160 = 0.05 mol

$\Delta H + \Delta H_2 = \Delta H_1$

$\Delta H + 588 = -504$
$\Delta H = -588 - 504 = -1092\,J$

For one mol $-1092/0.05 = -21840\,J\,mol^{-1}$
$-21.84\,kJ\,mol^{-1}$ [3]

(d) blue precipitate [1]
in xs ammonia dissolves to give dark/deep blue solution [1] [2] 9

					AVAILABLE MARKS
15	**(a)**	**(i)**	ammonia present which is alkaline	[1]	
		(ii)	hydrogen chloride present which is acidic	[1]	
	(b)		to separate NH_3 from HCl	[1]	
	(c)		endothermic [1] equilibrium absorbs heat/to reduce temperature [1]/heat is needed	[2]	
	(d)	**(i)**	add sodium hydroxide (essential) [1]/heat [1] stopper/glass rod with conc HCl giving white fumes/smoke [1]	[3]	
		(ii)	add silver nitrate solution (essential) [1] white [1] precipitate [1]	[3]	
	(e)		$NH_4Cl = 14 + 4 + 35.5 = 53.5$ $37.2/53.5 = 0.695\,\text{mol}$ $0.695 \times 24\,\text{dm}^3 = 16.69\,\text{dm}^3 = 16.7\,\text{dm}^3$	[3]	14
16	**(a)**		2-chloro(-2-)methylpropane	[2]	
	(b)	**(i)**	$C_nH_{2n+1}Cl$	[1]	
		(ii)	C_4H_9Cl	[1]	
		(iii)	less van der Waals forces [1] spherical molecule/branching [1] **or** linear molecules greater attractive forces [1]	[2]	
		(iv)	same molecular formula [1] different structure [1]	[2]	
		(v)	secondary	[1]	
	(c)	**(i)**	release the pressure/gases	[1]	
		(ii)	remove acids/hydrogen chloride/hydrochloric acid	[1]	
		(iii)	remove inorganic material/NaCl/$NaHCO_3$/alcohol/soluble impurities	[1]	
		(iv)	dry the butyl chloride	[1]	

(v) smooth boiling [1]

(vi) $(CH_3)_3COH = C_4H_9OH = C_4H_{10}O$
$= 48 + 10 + 16 = 74$

$25/74 = 0.34$ mol

$(CH_3)_3CCl = C_4H_9Cl$
$= 48 + 9 + 35.5 = 92.5$

$28/92.5 = 0.30$ mol

percentage yield $= 0.30/0.34 \times 100 = 88\%$ [3]

(d) faster [1]
reference to tertiary versus primary structure [1]
weaker (C — Cl) bond or correct reference to S_N1/S_N2 [1] [3]

	AVAILABLE MARKS
	20
Section B	**80**
Total	**100**

Rewarding Learning

Centre Number

71	

Candidate Number

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
January 2012

Chemistry

Assessment Unit AS 2

assessing

Module 2: Organic, Physical and Inorganic Chemistry

[AC122]

AC122

THURSDAY 19 JANUARY, AFTERNOON

TIME

1 hour 30 minutes.

INSTRUCTIONS TO CANDIDATES

Write your Centre Number and Candidate Number in the spaces provided at the top of this page.
Answer **all sixteen** questions.
Answer **all ten** questions in **Section A**. Record your answers by marking the appropriate letter on the answer sheet provided. Use only the spaces numbered 1 to 10. Keep in sequence when answering.
Answer **all six** questions in **Section B**. Write your answers in the spaces provided in this question paper.

INFORMATION FOR CANDIDATES

The total mark for this paper is 100.
Quality of written communication will be assessed in question **12(c)**.
In Section A all questions carry equal marks, i.e. **two** marks for each question.
In Section B the figures in brackets printed down the right-hand side of the pages indicate the marks awarded to each question or part question.
A Periodic Table of Elements (including some data) is provided.

For Examiner's use only	
Question Number	**Marks**
Section A	
1–10	
Section B	
11	
12	
13	
14	
15	
16	
Total Marks	

Section A

For each of the following questions only **one** of the lettered responses (A–D) is correct.

Select the correct response in each case and mark its code letter by connecting the dots as illustrated on the answer sheet.

1 The standard enthalpy of formation of water is $-286\,kJ\,mol^{-1}$. Which one of the following is the enthalpy change when hydrogen reacts with oxygen to form 1 g of water?

A $+15.9\,kJ$
B $-15.9\,kJ$
C $+31.8\,kJ$
D $-31.8\,kJ$

2 Which one of the following statements about the alcohol shown below

$$CH_3CH_2CHOHCH_3$$

is **not** correct?

A It takes part in the iodoform reaction
B It is oxidised to an aldehyde
C It has the molecular formula $C_4H_{10}O$
D It has the systematic name butan–2–ol

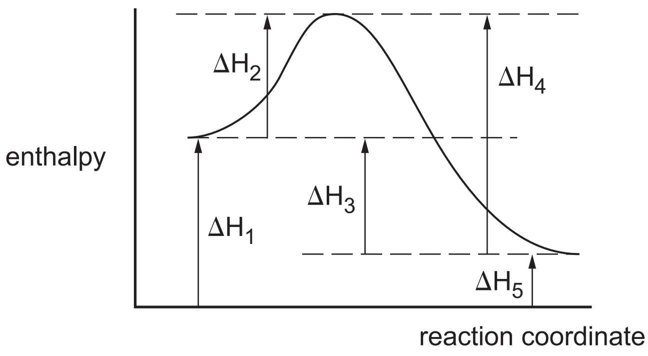
3 X and Y are two atoms which are joined together to form a covalent bond, X–Y. X is more electronegative than Y. Which one of the following pairs of species is produced by homolytic fission of this bond?

A $X^{+} + Y^{-}$
B $X^{-} + Y^{+}$
C $X^{\bullet} + Y^{\bullet}$
D $X^{:} + Y$

4 In which one of the following pairs will **neither** hydroxide dissolve in an excess of aqueous sodium hydroxide?

A aluminium hydroxide and magnesium hydroxide
B aluminium hydroxide and zinc hydroxide
C magnesium hydroxide and iron(II) hydroxide
D zinc hydroxide and calcium hydroxide

5 The diagram represents the enthalpy of a reversible reaction plotted against the reaction co-ordinate.



Which one of the listed enthalpies would be altered by the use of a catalyst?

A $\Delta H_1 + \Delta H_5$
B $\Delta H_2 + \Delta H_3$
C $\Delta H_2 + \Delta H_4$
D $\Delta H_3 + \Delta H_4$

6 Which one of the following is the number of possible isomers of formula $C_2H_3Cl_3$?

A 2
B 3
C 4
D 5

7 Which one of the following processes is endothermic?

A $Ba \rightarrow Ba^+ + e^-$
B $Ca + 2H_2O \rightarrow Ca(OH)_2 + H_2$
C $H^+ + OH^- \rightarrow H_2O$
D $N_2 + 3H_2 \rightarrow 2NH_3$

8 Which one of the following equations represents the standard enthalpy change of formation of barium chloride?

A $Ba(g) + Cl_2(g) \rightarrow BaCl_2(s)$
B $Ba(s) + Cl_2(g) \rightarrow BaCl_2(s)$
C $Ba^{2+}(g) + 2Cl^-(g) \rightarrow BaCl_2(s)$
D $Ba^{2+}(s) + 2Cl^-(g) \rightarrow BaCl_2(s)$

9 Which one of the following molecules can **not** act as a nucleophile?

A CH_3NH_2
B CH_4
C H_2O
D NH_3

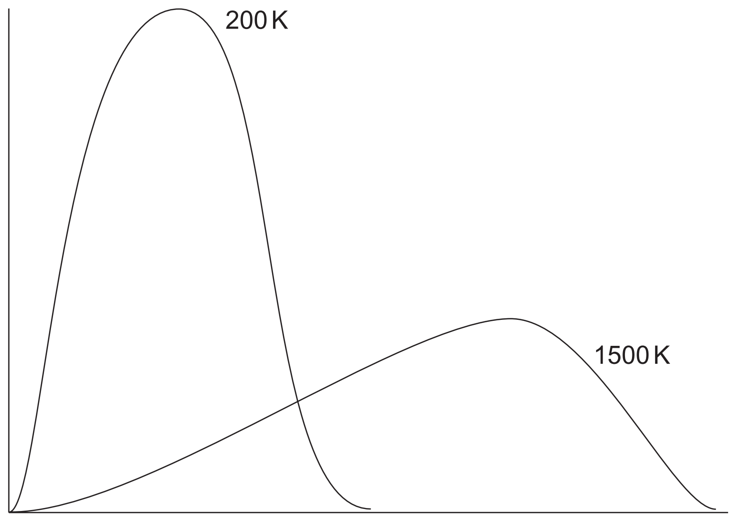
10 Which one of the following is the volume of oxygen required for the complete combustion of $100\,cm^3$ of butane at room temperature and pressure?

A $400\,cm^3$
B $500\,cm^3$
C $650\,cm^3$
D $1300\,cm^3$

Section B

Answer **all six** questions in this section.

11 The diagram below shows the Maxwell-Boltzmann distribution curves for the molecules in a gas at temperatures of 200 K and 1500 K.



(a) Label the axes. [2]

(b) Draw the shape of the distribution curve for 500 K on the same graph. [2]

(c) Explain why all the graphs start at point (0, 0).

____

____ [2]

Examiner Only	
Marks	Remark

12 Strontium sulfate, $SrSO_4$, is a white solid which occurs in nature as the mineral celestine. It closely resembles barium sulfate in many of its properties.

(a) Strontium sulfate is moderately soluble in water.

$$SrSO_4(s) + aq \rightleftharpoons Sr^{2+}(aq) + SO_4^{2-}(aq)$$

The table below shows the solubility of strontium sulfate at different temperatures.

solubility/g dm^{-3}	**temperature/°C**
0.0111	18
0.0135	25

(i) Explain whether the dissolving of strontium sulfate is an exothermic or endothermic process.

____

____ [2]

(ii) Compare the solubility of strontium sulfate with that of calcium and barium sulfates.

____

____ [2]

(b) Strontium sulfate may be prepared in the laboratory by reacting strontium with water and then mixing the strontium hydroxide produced with dilute sulfuric acid.

(i) Write the equation for the reaction of strontium with water.

____ [2]

(ii) Write the equation for the reaction of strontium hydroxide with sulfuric acid.

____ [2]

Examiner Only	
Marks	Remark

(c) Celestine and barite, $BaSO_4$, are two minerals which may be distinguished from each other using a flame test. Describe how a flame test can be carried out and state the colour expected for barite. Celestine produces a red flame.

____

____

____

____

____ [4]

Quality of written communication [2]

(d) Strontium sulfate decomposes on heating to form the oxide and sulfur trioxide. Its thermal stability can be explained in a similar way to that of the carbonate.

(i) Write the equation for the decomposition of strontium sulfate.

____ [1]

(ii) Explain the thermal stability of strontium sulfate.

____

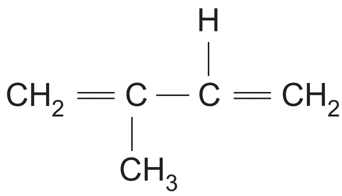
____

____ [2]

Examiner Only	
Marks	Remark

Examiner Only	
Marks	Remark

13 Rubber is a polymer of isoprene, C_5H_8, whose structural formula is shown below.



(a) (i) Draw the full structure of isoprene showing **all** the bonds present.

[1]

(ii) Explain whether isoprene is capable of forming *cis* and *trans* (E–Z) isomers.

____

____ [2]

(b) Deduce the systematic name for isoprene.

____ [1]

(c) Isoprene is fully hydrogenated when it reacts with hydrogen in the presence of a metal catalyst.

(i) Write the equation for the reaction.

____ [1]

(ii) Name the metal catalyst.

____ [1]

(iii) In what form is the solid metal used?

____ [1]

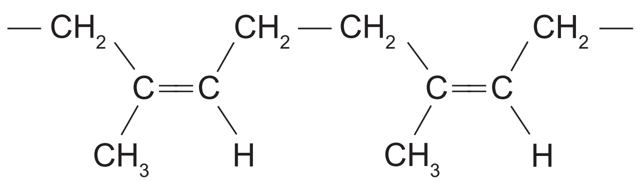
(iv) Isoprene has a boiling point of 34 °C. The product, pentane, has a boiling point of 24 °C. What does this suggest about the intermolecular forces between the molecules in pentane compared to isoprene?

____

____

____ [2]

(d) Isoprene polymerises to form rubber. A section of the polymer is shown below.



One important artificial rubber is neoprene, a polymer of chloroprene, $CH_2{=}CClCH{=}CH_2$.

Draw a section of the neoprene structure.

[2]

Examiner Only
Marks | Remark

(e) Isoprene reacts with bromine to form a bromo-derivative with the following percentage composition:

carbon	26.3%
hydrogen	3.5%
bromine	70.2%

(i) Deduce the empirical formula for the bromo-derivative.

____

____

____ [3]

(ii) Draw a structural formula for the bromo-derivative.

[1]

(f) Mixtures of isoprene vapour and air are potentially explosive. Name **two** products which are formed during the incomplete combustion but not during the complete combustion of isoprene.

1. ____

2. ____ [2]

Examiner Only

Marks	Remark

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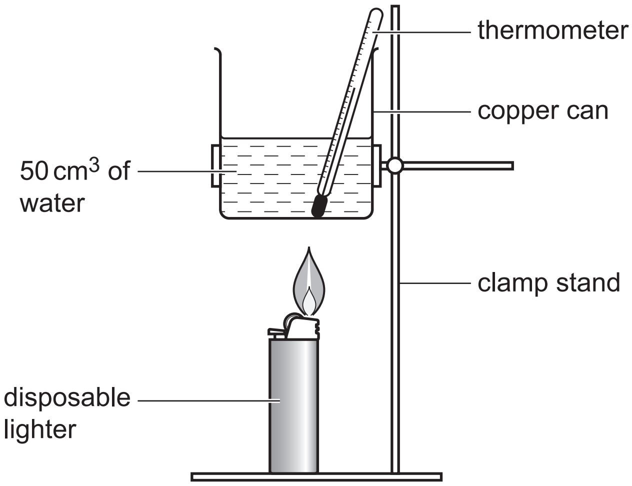
(Questions continue overleaf)

14 Disposable lighters contain liquid butane. When the pressure is released the butane forms a gas and escapes. A spark from the flint ignites the gas which burns to release heat.

The following experiment was carried out to determine the molar enthalpy of combustion of butane.



The lighter was weighed before the butane was ignited and weighed again after the butane had burned to raise the temperature of the water in the copper can by 55 °C.

Specific heat capacity of water is $4.2\,J\,g^{-1}\,°C^{-1}$)

The following results were obtained:

mass of lighter before ignition	= 15.00 g
mass of lighter after burning	= 14.53 g
temperature of water before heating	= 25 °C
temperature of water after heating	= 80 °C
mass of water	= 50 g

Examiner Only	
Marks	Remark

(a) Calculate the molar enthalpy of combustion of butane using the following headings.

number of grams of butane burned

____ [1]

relative formula mass of butane

____ [1]

number of moles of butane burnt

____ [1]

heat received by 50 g of water

____ [1]

molar enthalpy of combustion of butane

____

____ [1]

(b) A similar experiment was carried out to determine the molar enthalpy of combustion of ethanol. A value of half the theoretical value of $-1367\,kJ\,mol^{-1}$ was obtained.
State **three** reasons for the low experimental value.

____

____

____

____ [3]

(c) Explain why the molar enthalpy of combustion of butane is theoretically more than that of ethanol.

____

____ [2]

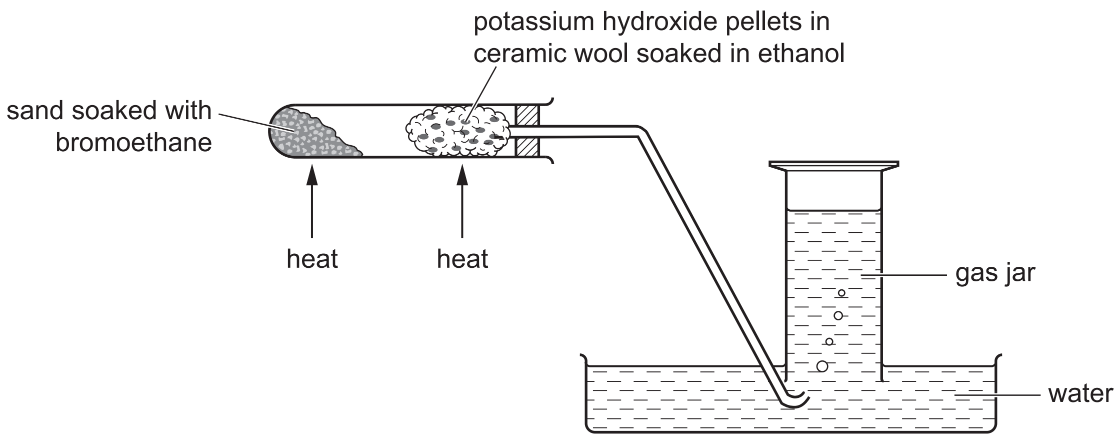
(d) The butane is ignited using a spark from the lighter. State and explain whether the spark acts as a catalyst.

____

____ [2]

15 Bromoethane is a colourless liquid which boils at 38 °C. 9.1 g of bromoethane dissolve in one litre of water at room temperature. It undergoes an elimination reaction with ethanolic potassium hydroxide.

(a) The following experiment shows the reaction of bromoethane with ethanolic potassium hydroxide.



(i) Write the equation for the reaction of bromoethane with ethanolic potassium hydroxide.

____ [1]

(ii) Name the gas collected in the gas jar.

____ [1]

(iii) Describe a chemical test to confirm the identity of the gas.

____

____ [2]

(iv) How does the collection of this gas prove that an *elimination* reaction has taken place?

____

____ [1]

Examiner Only	
Marks	Remark

(b) Bromoethane reacts differently with aqueous potassium hydroxide, as nucleophilic substitution takes place.

(i) Write the equation for the reaction.

____ [1]

(ii) Explain the meaning of the term **nucleophilic substitution**.

____

____ [2]

(iii) Draw a flow scheme to illustrate the mechanism for the reaction of bromoethane with hydroxide ions.

[3]

(iv) Explain, in terms of bond enthalpy and polarity why the hydrolysis of chloroethane is slower than that of bromoethane.

____

____

____ [3]

Examiner Only	
Marks	Remark

16 Ammonia is made industrially from nitrogen and hydrogen. It does not burn in air but it will burn in oxygen.

$$4NH_3 + 3O_2 \rightarrow 2N_2 + 6H_2O$$

(a) **(i)** Name the industrial process used to make ammonia.

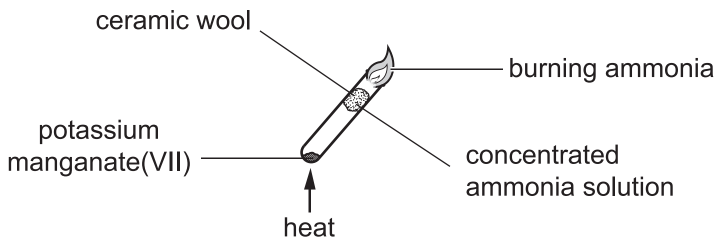
____ [1]

(ii) Suggest why neither ammonia nor hydrogen burns during the manufacture of ammonia.

____

____ [1]

(b) The apparatus shows how ammonia can be burnt in a stream of oxygen provided by the decomposition of heated potassium manganate(VII).



(i) Potassium manganate(VII) thermally decomposes according to the following equation.

$$2KMnO_4 \rightarrow K_2MnO_4 + O_2 + MnO_2$$

Calculate the volume of oxygen produced at 20 °C and one atmosphere pressure when 2.5 g of potassium manganate(VII) are heated.

____

____

____ [3]

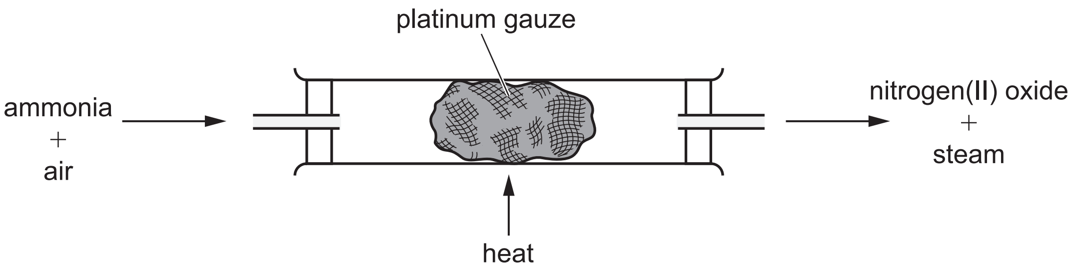
(ii) Before the ceramic wool is placed in the test tube the gas may be tested to see that oxygen is being given off. Describe the chemical test for oxygen.

____

____ [2]

Examiner Only	
Marks	Remark

(c) When mixed with air and passed through a heated platinum gauze ammonia forms nitrogen(II) oxide and steam.



$$4NH_3 + 5O_2 \rightarrow 4NO + 6H_2O$$

(i) Suggest the purpose of the platinum gauze.

______________________________ [1]

(ii) Explain why gauze is used rather than a pile of platinum powder.

____

______________________________ [1]

(iii) Explain why the laws of chemical equilibrium cannot be applied to this particular mixture of ammonia and oxygen.

______________________________ [1]

(iv) Using the bond energies below calculate the enthalpy change per mole of ammonia and state whether the reaction is exothermic or endothermic.

bond	**bond energy/kJ mol^{-1}**
N–H	391
O=O	498
N=O	587
H–O	464

____

____

____

______________________________ [4]

Examiner Only	
Marks	Remark

THIS IS THE END OF THE QUESTION PAPER

Rewarding Learning

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
January 2012

Chemistry

Assessment Unit AS 2

assessing

Module 2: Organic, Physical and Inorganic Chemistry

[AC122]

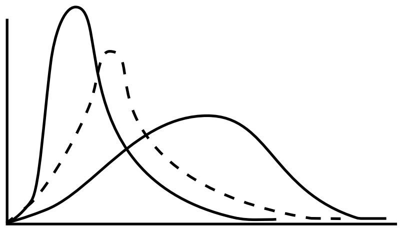
THURSDAY 19 JANUARY, AFTERNOON

MARK SCHEME

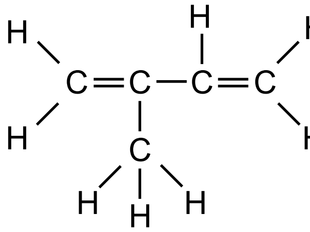
Section A

		AVAILABLE MARKS
1 B		
2 B		
3 C		
4 C		
5 C		
6 A		
7 A		
8 B		
9 B		
10 C		
[2] for each correct answer	[20]	20
	Section A	**20**

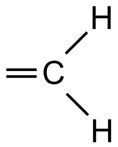
Section B

				AVAILABLE MARKS
11 **(a)**	number of particles – *y* axis	[1]		
	(kinetic) energy – *x* axis	[1]	[2]	
(b)			[2]	
(c)	0 particles	[1]		
	0 energy	[1]	[2]	6
12 **(a)** **(i)**	solubility increases with increase in temperature/ goes to the RHS as temperature increases	[1]		
	∴ endothermic	[1]	[2]	
(ii)	less soluble than $CaSO_4$	[1]		
	more soluble than $BaSO_4$	[1]	[2]	
(b) **(i)**	$Sr + 2H_2O \rightarrow Sr(OH)_2 + H_2$		[2]	
(ii)	$Sr(OH)_2 + H_2SO_4 \rightarrow SrSO_4 + 2H_2O$		[2]	
(c)	nichrome/platinum wire	[1]		
	blue flame	[1]		
	conc. hydrochloric acid	[1]		
	green	[1]	[4]	
	Quality of written communication		[2]	
(d) **(i)**	$SrSO_4 \rightarrow SrO + SO_3$		[1]	
(ii)	size of cation/charge on cation sulfate ion distorted/deformed by Sr^{2+} (Any **two**)		[2]	17

13 (a) (i)



error [–1] [1]

(ii) no
because of  [1]

groups the same i.e. H and H
(reference to both C=C) [1] [2]

(b) 2-methylbut(a)-1,3-diene **or** 2-methyl-1,3-butadiene [1]

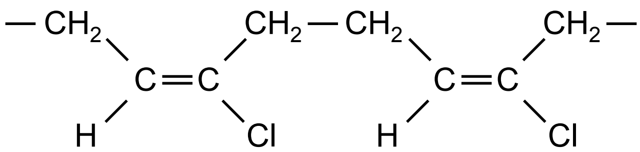
(c) (i) $C_5H_8 + 2H_2 \rightarrow C_5H_{12}$ [1]

(ii) nickel [1]

(iii) finely divided [1]

(iv) van der Waals forces [1]
greater in isoprene [1] [2]

(d)



[2]

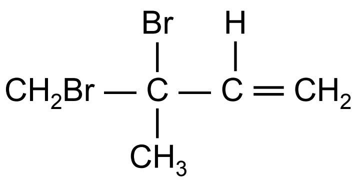
(e) (i)

C	26.3	$\frac{26.3}{12}$	=	2.19	$\frac{2.19}{0.88}$	=	2.5
H	3.5	$\frac{3.5}{1}$	=	3.5	$\frac{3.5}{0.88}$	=	3.97
Br	70.2	$\frac{70.2}{80}$	=	0.88	$\frac{0.88}{0.88}$	=	1

error [–1] ×2 $C_5H_8Br_2$

[3]

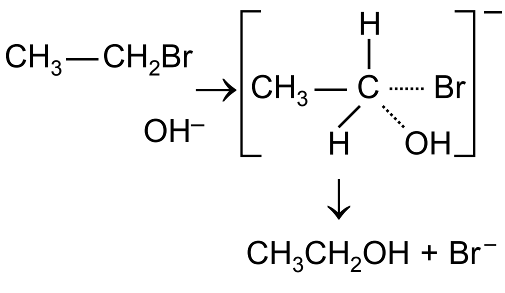
(ii)



or bromine on double bond [1]

(f) carbon [1]
carbon monoxide (either order) [1] [2]

AVAILABLE MARKS: 17

					AVAILABLE MARKS
14	**(a)**	0.47g	[1]		
		$C_4H_{10} = 58$	[1]		
		$\frac{0.47}{58} = 0.0081$ mol	[1]		
		$50 \times 4.2 \times 55 = 11550$ J	[1]		
		$\frac{11550}{0.0081} = (-)1425.9$ kJ	[1]	[5]	
	(b)	draughts	[1]		
		incomplete combustion	[1]		
		loss heat to the copper can	[1]	[3]	
	(c)	more bonds produced in combustion of butane	[1]		
		forming bonds gives out heat	[1]	[2]	
	(d)	no	[1]		
		the spark is heat/not a chemical	[1]	[2]	12
15	**(a)**	**(i)** $C_2H_5Br + KOH \rightarrow KBr + H_2O + C_2H_4$		[1]	
		(ii) ethene		[1]	
		(iii) bromine water	[1]		
		goes colourless	[1]	[2]	
		(iv) gas is not one of the reactants		[1]	
	(b)	**(i)** $C_2H_5Br + KOH \rightarrow C_2H_5OH + KBr$		[1]	
		(ii) nucleophile – ion or molecule with lone pair of electrons/ attracted to an area of low electron density	[1]		
		substitution – one (functional) group replaced by another	[1]	[2]	
		(iii) 		[3]	
		(iv) bond enthalpy of C—Cl greater	[1]		
		C—Cl is more polar	[1]		
		bond enthalpy more important	[1]	[3]	14

						AVAILABLE MARKS
16	**(a)**	**(i)**	Haber Process		[1]	
		(ii)	no oxygen present		[1]	
	(b)	**(i)**	$KMnO_4 = 39 + 55 + 64 = 158$ $2.5\,g = \frac{2.5}{158} = 0.0158$ mol 1 mol $\rightarrow$ 0.5 mol O_2 $\therefore\ \frac{0.0158}{2} \times 24\ dm^3 = 0.1896$ $= 190\ cm^3$ error [–1]		[3]	
		(ii)	glowing splint relights	[1] [1]	[2]	
	(c)	**(i)**	catalyst/speeds up the reaction		[1]	
		(ii)	gas passes through		[1]	
		(iii)	not in a sealed container/reaction not reversible		[1]	
		(iv)	bonds before 12 N—H = 12 × 391 = 4692 5 O=O = 5 × 498 = 2490 7182 bonds after 4 N=O = 4 × 587 = 2348 12 O—H = 12 × 464 = 5568 7916 $\Delta H = +7182 - 7916$ $= -734 \div 4 = 183.5$ $\therefore$ –ve exothermic error [–1]		[4]	14
					Section B	**80**
					Total	**100**

Rewarding Learning

Centre Number

71	

Candidate Number

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
2012

Chemistry

Assessment Unit AS 2

assessing

Module 2: Organic, Physical and Inorganic Chemistry

[AC122]

TUESDAY 19 JUNE, AFTERNOON

AC122

TIME

1 hour 30 minutes.

INSTRUCTIONS TO CANDIDATES

Write your Centre Number and Candidate Number in the spaces provided at the top of this page.
Answer **all fifteen** questions.
Answer **all ten** questions in **Section A**. Record your answers by marking the appropriate letter on the answer sheet provided. Use only the spaces numbered 1 to 10. Keep in sequence when answering.
Answer **all five** questions in **Section B**. Write your answers in the spaces provided in this question paper.

INFORMATION FOR CANDIDATES

The total mark for this paper is 100.
Quality of written communication will be assessed in question **14(b)(iv)**.
In Section A all questions carry equal marks, i.e. **two** marks for each question.
In Section B the figures in brackets printed down the right-hand side of the pages indicate the marks awarded to each question or part question.
A Periodic Table of Elements (including some data) is provided.

For Examiner's use only	
Question Number	**Marks**
Section A	
1–10	
Section B	
11	
12	
13	
14	
15	
Total Marks	

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Section A

For each of the following questions only **one** of the lettered responses (A–D) is correct.

Select the correct response in each case and mark its code letter by connecting the dots as illustrated on the answer sheet.

1 The forces of attraction between ethanol molecules are

A permanent dipole-dipole attractions only.
B permanent dipole-dipole attractions and hydrogen bonds.
C hydrogen bonds.
D hydrogen bonds and van der Waals' forces.

2 Which one of the following is a propagation step in the chlorination of methane?

A $Cl_2 \rightarrow 2Cl^\bullet$
B $CH_4 + Cl^\bullet \rightarrow CH_3Cl + H^\bullet$
C $CH_4 \rightarrow CH_3^\bullet + H^\bullet$
D $CH_4 + Cl^\bullet \rightarrow CH_3^\bullet + HCl$

3 0.47 g of a hydrocarbon was completely burnt in air. The heat produced raised the temperature of 200 g of water by 28.2 °C. The standard enthalpy of combustion of the hydrocarbon is $-2220\,kJ\,mol^{-1}$.
The specific heat capacity of water is $4.2\,J\,g^{-1}°C^{-1}$
Which one of the following is the molar mass of the hydrocarbon?

A 40
B 44
C 185
D 199

4 Which one of the following **decreases** as Group II is descended from magnesium to barium?

A Atomic radius
B First ionisation energy
C Reactivity with water
D Solubility of the hydroxides

5 A solution of a white solid gives a white precipitate with concentrated ammonia solution. This precipitate is soluble in excess concentrated ammonia solution. The solution of the white solid also gives a white precipitate with barium chloride solution. Which one of the following does the solution contain?

A Aluminium chloride
B Aluminium sulfate
C Zinc chloride
D Zinc sulfate

6 Absorption of infra-red radiation by molecules is caused by

A electronic transitions.
B electronic vibrations.
C molecular transitions.
D molecular vibrations.

7 An organic compound consists of 40.7% carbon, 5.1% hydrogen and 54.2% oxygen and has a relative molecular mass of 118.
Which one of the following is the molecular formula of the compound?

A $C_3H_2O_5$
B $C_4H_6O_4$
C $C_5H_{10}O_3$
D $C_6H_{14}O_2$

8 Calcium nitrate undergoes thermal decomposition as follows:

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

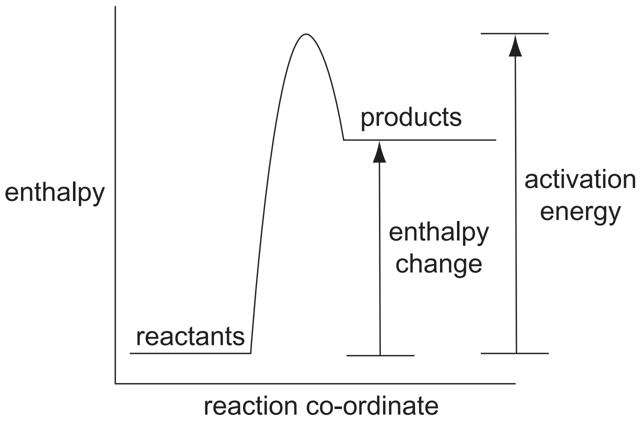
Which one of the following is the total volume of gas formed when 8.20 g of calcium nitrate are completely decomposed at room temperature and pressure?

A 0.6 dm^3
B 2.4 dm^3
C 3.0 dm^3
D 6.0 dm^3

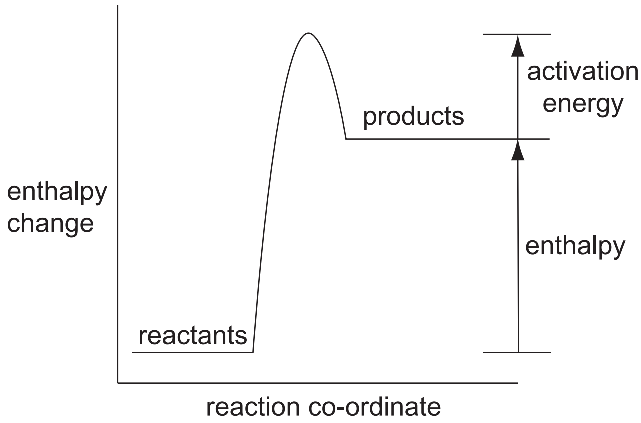
9 The reaction between bromobutane and aqueous sodium hydroxide is an example of

A electrophilic addition.
B electrophilic substitution.
C nucleophilic addition.
D nucleophilic substitution.

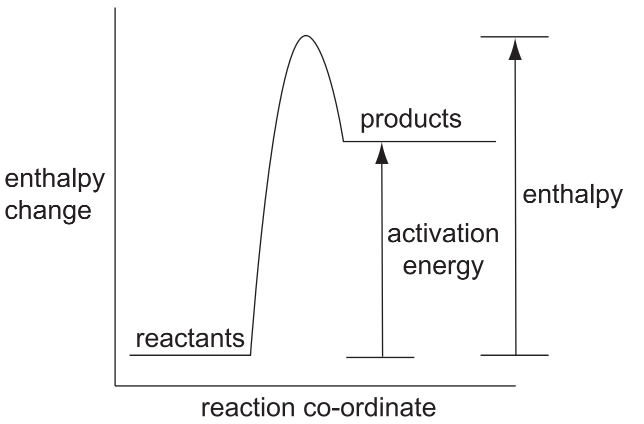
10 Which one of the following represents a correctly labelled enthalpy level diagram?



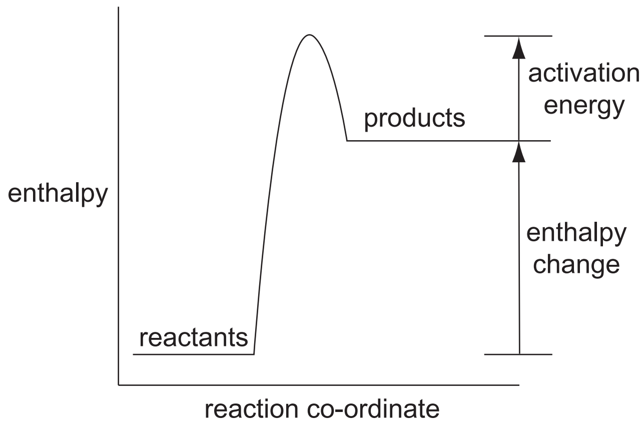
A



B



C



D

Section B

Answer **all five** questions in this section.

Examiner Only	
Marks	Remark

11 Salicylic acid, extracted from willow bark, was used as a painkiller. Today salicylic acid is used to manufacture aspirin.

Aspirin can be prepared in the laboratory by reacting salicylic acid with ethanoic anhydride according to the following equation:

$$C_6H_4(OH)COOH + (CH_3CO)_2O \rightarrow HOOCC_6H_4OCOCH_3 + CH_3COOH$$

salicylic acid	ethanoic anhydride	aspirin	ethanoic acid

(a) A student reacted 3.00 g of salicylic acid with 6.0 cm^3 of ethanoic anhydride.

(i) How many moles of salicylic acid were used?

____ [1]

(ii) What mass of ethanoic anhydride was used?
(Density of ethanoic anhydride = 1.08 $g\,cm^{-3}$)

____ [1]

(iii) How many moles of ethanoic anhydride were present?

____ [1]

(iv) What is the maximum number of moles of aspirin which could be formed?

____ [1]

(v) Calculate the maximum mass of aspirin which could be formed.

____ [1]

(vi) The student isolated 3.08 g of aspirin. Calculate the percentage yield of aspirin obtained by the student.

____

____ [1]

(b) (i) Explain what is meant by the term **atom economy** of a reaction.

____

____ [1]

(ii) Calculate the atom economy of the reaction to prepare aspirin.

____

____ [2]

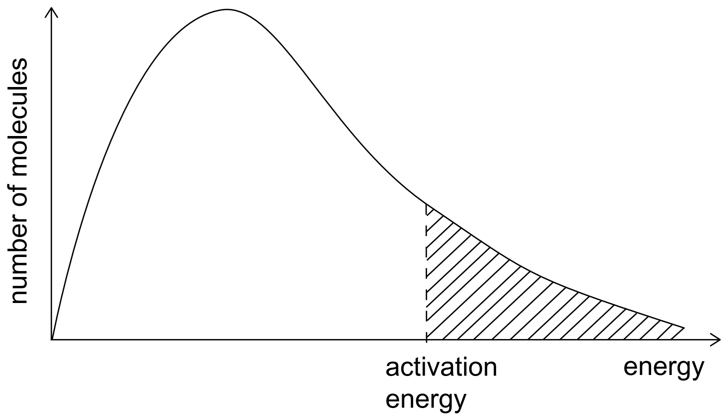
Examiner Only	
Marks	Remark

12 The first step in the Ostwald Process for the manufacture of nitric acid is the oxidation of ammonia.

$$4NH_3(g) + 5O_2(g) \rightleftharpoons 4NO(g) + 6H_2O(g) \qquad \Delta H = -950\,kJ\,mol^{-1}$$

(a) The reaction is carried out at approximately 900 °C.

The diagram below shows the distribution of molecular energies in the reaction mixture at 900 °C.



(i) What is the name given to this distribution of molecular energies in gases?

____ [1]

(ii) Draw on the diagram the distribution of the molecular energies at 1500 °C. [2]

(iii) Use the diagram to explain why the rate of the reaction is faster at 1500 °C.

____

____

____ [2]

(iv) Explain how the yield of nitrogen(II) oxide is affected by increasing the temperature to 1500 °C.

____

____

____ [2]

Examiner Only

Marks	Remark

(b) The reaction is carried out at 4 – 10 atmospheres pressure.

(i) Explain how increasing the pressure to 100 atmospheres would affect the rate of the reaction.

____

____

____

____ [2]

(ii) Explain how increasing the pressure to 100 atmospheres would affect the yield of the nitrogen(II) oxide.

____

____

____

____ [2]

(c) The catalyst used in the reaction contains rhodium and platinum.

(i) Explain, referring to the diagram, how the catalyst increases the rate of the reaction.

____

____

____

____ [2]

(ii) Explain the effect, if any, the catalyst has on the yield of the nitrogen(II) oxide.

____

____

____

____ [2]

Examiner Only	
Marks	Remark

13 But-1-ene and but-2-ene are gaseous isomers of C_4H_8.

Examiner Only	
Marks	Remark

(a) But-1-ene contains a carbon-carbon double bond, C=C, as well as carbon-carbon single bonds, C—C.

(i) Compare and explain the difference in bond strength and bond length of C=C and C—C.

____

____

____

____ [3]

(ii) Explain why but-1-ene is more reactive than butane.

____

____

____ [2]

(iii) Describe a test, including any observations, to show the presence of C=C in but-1-ene.

____

____

____ [3]

(b) But-2-ene exists as E—Z isomers.

(i) Draw and label the E and Z isomers of but-2-ene.

[2]

(ii) Explain why but-2-ene can exist as E and Z isomers.

____

____ [2]

(c) But-1-ene can be polymerised to form poly(but-1-ene).

(i) What type of polymerisation does but-1-ene undergo?

____ [1]

(ii) Draw a section of poly(but-1-ene) showing **two** repeating units.

[2]

Examiner Only	
Marks	Remark

14 Barium carbonate has a variety of uses which include ceramic glazes and rat poisons.

Examiner Only	
Marks	Remark

(a) Barium carbonate can be prepared by heating barium sulfide, BaS, with sodium carbonate. Write an equation for this reaction.

____ [1]

(b) Barium carbonate is decomposed at 1360 °C.

(i) Write the equation for the decomposition of barium carbonate.

____ [1]

(ii) In industry coke (carbon) is added. Suggest the role of coke in this process.

____ [1]

(iii) Compare the thermal stability of barium carbonate to calcium carbonate, explaining any difference.

____

____

____

____ [3]

(iv) Describe how you would carry out a flame test to distinguish between barium carbonate and calcium carbonate, giving the result for each compound.

____

____

____

____

____

____ [5]

Quality of written communication [2]

(c) Describe a chemical test to distinguish between sodium carbonate and sodium hydrogencarbonate solids.

____

____

____

____ [3]

Examiner Only	
Marks	Remark

15 C_4H_9OH can be produced by fermentation of a sugar solution using the bacterium *clostridium acetobutylicum*.

(a) (i) Suggest **two** conditions necessary for this fermentation process.

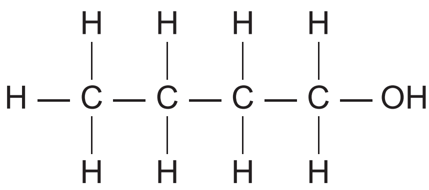
____

____ [2]

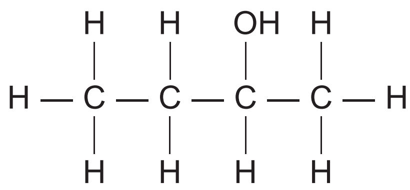
(ii) The fermentation process produces a mixture of alcohols and propanone. Suggest how the mixture may be separated.

____ [1]

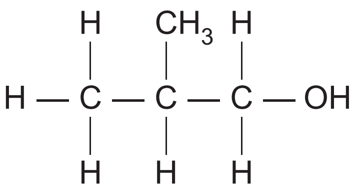
(b) C_4H_9OH has four isomers; butan-1-ol, butan-2-ol and two others, **A** and **B**.



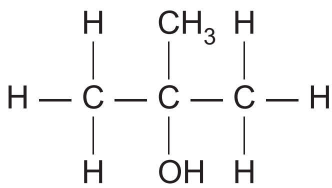
Butan-1-ol



Butan-2-ol



A



B

(i) Give the systematic names of isomers **A** and **B**.

A ____

B ____ [2]

Examiner Only	
Marks	Remark

Examiner Only
Marks | Remark

(ii) Describe, giving experimental details and any observations, how you would use the iodoform test to distinguish between butan-1-ol and butan-2-ol.

____

____

____

____ [4]

(iii) Name a reagent you could use to distinguish between isomers **A** and **B**. Include any observations that occur when it is reacted with **A** and **B**.

____

____

____

____ [3]

Examiner Only

Marks	Remark

(c) Butan-1-ol has potential as a biofuel, which is an alternative fuel.

(i) Suggest why butan-1-ol can be considered as an alternative fuel.

____

____ [1]

(ii) The equation for the combustion of butan-1-ol is given below.

$$C_4H_9OH(l) + 6O_2(g) \rightarrow 4CO_2(g) + 5H_2O(g)$$

Use the standard enthalpies of formation given in the table below to calculate the standard enthalpy of combustion for butan-1-ol.

	Standard enthalpy of formation $kJ\,mol^{-1}$
Butan-1-ol	−327
Carbon dioxide	−394
Water	−286

____

____

____ [3]

(iii) What are the conditions used for measuring standard enthalpies of formation?

____

____ [2]

(iv) Why is no value given for the standard enthalpy of formation of oxygen?

____ [1]

Examiner Only

Marks	Remark

(d) Ethanol can also be used as a biofuel. The enthalpy of combustion of ethanol can be calculated using bond enthalpies.

(i) Explain what is meant by the term **bond enthalpy**.

____

____

____ [2]

(ii) Use the bond enthalpies given in the table below to calculate the enthalpy of combustion of ethanol.

$$C_2H_5OH + 3O_2 \rightarrow 2CO_2 + 3H_2O$$

Bond	**Bond enthalpy kJ mol^{-1}**
C—C	+347
C—H	+413
C—O	+358
O—H	+464
O=O	+498
C=O	+805

____

____

____

____ [3]

(iii) Using experimental data the standard enthalpy of combustion of ethanol is found to be $-1407\,kJ\,mol^{-1}$.
Explain the difference between this value and that obtained using bond enthalpies.

____

____ [1]

THIS IS THE END OF THE QUESTION PAPER

112044

Rewarding Learning

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
2012

Chemistry

Assessment Unit AS 2

assessing

Module 2: Organic, Physical and Inorganic Chemistry

[AC122]

TUESDAY 19 JUNE, AFTERNOON

MARK SCHEME

Section A

			AVAILABLE MARKS
1	D		
2	D		
3	B		
4	B		
5	D		
6	D		
7	B		
8	C		
9	D		
10	A		
[2] for each correct answer		[20]	20
		Section A	**20**

Section B

					AVAILABLE MARKS
11	**(a)**	**(i)**	Moles of salicylic acid = 3/138 = 0.0217	[1]	
		(ii)	Mass of ethanoic anhydride = 1.08 × 6 = 6.48 (g)	[1]	
		(iii)	Moles of ethanoic anhydride = 6.48/102 = 0.0635	[1]	
		(iv)	0.0217 mole	[1]	
		(v)	0.0217 × 180 = 3.91(g)	[1]	
		(vi)	(3.08/3.91) × 100 = 78.8%	[1]	
	(b)	**(i)**	$\frac{\text{Mass of desired product}}{\text{Total mass of reactants}} \times 100$	[1]	
		(ii)	180/240 × 100 = 75%	[2]	9
12	**(a)**	**(i)**	Maxwell-Boltzmann distribution	[1]	
		(ii)	Same shape: peak to the right [1] peak lower [1]	[2]	
		(iii)	More of the molecules will have energy greater than the activation energy [1] More of the collisions will be successful [1]	[2]	
		(iv)	(The reaction is exothermic so) the equilibrium will move to the left (to reduce the temperature) [1] The yield of NO will decrease [1]	[2]	
	(b)	**(i)**	Increasing the pressure reduces the volume/the molecules are closer together/conc. increases [1] More collisions will increase the rate of the reaction [1]	[2]	
		(ii)	There are more molecules/greater volume of gas on the right hand side so equilibrium moves to the left to reduce the volume [1] Yield of NO decreases [1]	[2]	
	(c)	**(i)**	(The catalyst) provides (an alternative pathway of) lower activation energy [1] More of the collisions will be successful (and the rate of the reaction increases) [1]	[2]	
		(ii)	(The catalyst) speeds up the forward and reverse reactions equally [1] (There is no effect on the equilibrium so there is) no change in the yield of NO [1]	[2]	15

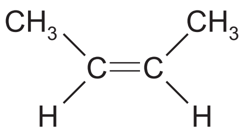
AVAILABLE MARKS

13 (a) (i) C=C contains sigma and pi bond [1]
C—C contains only a sigma bond [1]
C=C is stronger and shorter than C—C [1] [3]

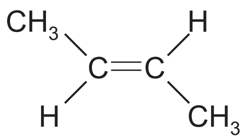
(ii) C=C is a centre of high electron density [1]
can undergo addition reactions/attracted by electrophiles [1] [2]

(iii) Add bromine water [1] * essential
changes colour from orange/brown/yellow [1]
to colourless [1] [3]

(b) (i)



Z



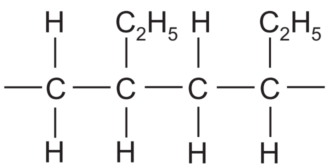
E

[1] for diagram [1] for labels [2]

(ii) No free rotation about the C=C [1]
Both C in C=C have two different atoms/gps attached [1] [2]

(c) (i) Addition [1]

(ii)



([–1] for each mistake) [2] 15

14 (a) $BaS + Na_2CO_3 \rightarrow BaCO_3 + Na_2S$ [1]

(b) (i) $BaCO_3 \rightarrow BaO + CO_2$ [1]

(ii) The coke burns to produce heat [1]

(iii) $BaCO_3$ is more stable [1]
Ba^{2+} is larger [1]
Less polarising/lower charge density [1]
(or converse) [3]

(iv) Dip (nichrome) wire in conc. HCl [1]
Dip in solid [1]
and hold in blue (Bunsen) flame [1]
Barium gives a green flame [1]
Calcium gives a brick red flame [1] [5]

Quality of written communication [2]

(c) Dissolve in water [1]
add Mg^{2+} ions(aq) [1] CO_3^{2-} forms white ppt [1]
or add Mg^{2+} ions(aq) [1] HCO_3^- no ppt formed [1] [3] 16

					AVAILABLE MARKS
15	**(a)**	**(i)**	Warmth/heat [1] Absence of air/oxygen [1]/anaerobic	[2]	
		(ii)	(Fractional) distillation	[1]	
	(b)	**(i)**	**A**: (2-) methylpropan-1-ol [1] **B**: (2-) methylpropan-2-ol [1]	[2]	
		(ii)	Add iodine (solution) (I_2 dissolved in KI solution) [1] and NaOH solution [1] warm [1] butan-2-ol will form yellow crystals [1] antiseptic smell [1] any 4 from 5	[4]	
		(iii)	Add acidified potassium dichromate [1] A will turn the solution (from orange to) green [1] B no change [1]	[3]	
	(c)	**(i)**	Renewable/clean fuel/instead of a fossil fuel	[1]	
		(ii)	$\Delta H + (-327) = 4(-394) + 5(-286)$ $\Delta H = -1576 - 1430 + 327$ $\Delta H = -2679$ (kJ mol^{-1}) ([–1] for each mistake)	[3]	
		(iii)	1 atmosphere pressure [1] 298 K [1]	[2]	
		(iv)	Oxygen is an element	[1]	
	(d)	**(i)**	Energy required to break [1] one mole of a (covalent) bond [1]	[2]	
		(ii)	Bonds broken – Bonds formed (347 + 358 + 5(413) + 464 + 3(498)) – (4(805) + 6(464)) 4728 – 6004 = –1276 kJ ([–1] for each mistake)	[3]	
		(iii)	Bond enthalpies are average values (and so this value is only an estimate)	[1]	25
				Section B	**80**
				Total	**100**

Rewarding Learning

Centre Number

71	

Candidate Number

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
January 2013

Chemistry

Assessment Unit AS 2

assessing

Module 2: Organic, Physical and Inorganic Chemistry

[AC122]

WEDNESDAY 16 JANUARY, MORNING

AC122

TIME

1 hour 30 minutes.

INSTRUCTIONS TO CANDIDATES

Write your Centre Number and Candidate Number in the spaces provided at the top of this page.
Answer **all sixteen** questions.
Answer **all ten** questions in **Section A**. Record your answers by marking the appropriate letter on the answer sheet provided. Use only the spaces numbered 1 to 10. Keep in sequence when answering.
Answer **all six** questions in **Section B**. Write your answers in the spaces provided in this question paper.

INFORMATION FOR CANDIDATES

The total mark for this paper is 100.
Quality of written communication will be assessed in Question **15(c)**.
In Section A all questions carry equal marks, i.e. **two** marks for each question.
In Section B the figures in brackets printed down the right-hand side of the pages indicate the marks awarded to each question or part question.
A Periodic Table of Elements (including some data) is provided.

For Examiner's use only	
Question Number	**Marks**
Section A	
1–10	
Section B	
11	
12	
13	
14	
15	
16	
Total Marks	

BLANK PAGE

Section A

For each of the following questions only **one** of the lettered responses (A–D) is correct.

Select the correct response in each case and mark its code letter by connecting the dots as illustrated on the answer sheet.

1 Which one of the following hydroxides is the most soluble in water?

- **A** Barium hydroxide
- **B** Calcium hydroxide
- **C** Magnesium hydroxide
- **D** Strontium hydroxide

2 How many structural isomers have the formula C_5H_{12}?

- **A** Two
- **B** Three
- **C** Four
- **D** Five

3 Which one of the following is a tertiary alcohol?

- **A** pentan-2-ol
- **B** pentan-3-ol
- **C** 2-methylpentan-1-ol
- **D** 2-methylpentan-2-ol

4 Propan-1-ol can be dehydrated to form propene:

$$CH_3CH_2CH_2OH \rightarrow CH_3CH{=}CH_2 + H_2O$$

30.0 g of propan-1-ol produces 16.8 g of propene. Which one of the following is the percentage yield?

- **A** 50.0
- **B** 60.0
- **C** 70.0
- **D** 80.0

5 Which one of the following metal chlorides gives a green colour in a flame test?

A $BaCl_2$

B $CaCl_2$

C KCl

D NaCl

6 Which one of the following is the mass of magnesium oxide required to neutralise 25.0 cm^3 of 0.1 mol dm^{-3} hydrochloric acid?

A 0.025 g

B 0.050 g

C 0.100 g

D 0.250 g

7 Which one of the following is the number of π (pi) bonds present in propene?

A One

B Two

C Three

D Six

8 Which one of the following is formed by the complete oxidation of propan-2-ol?

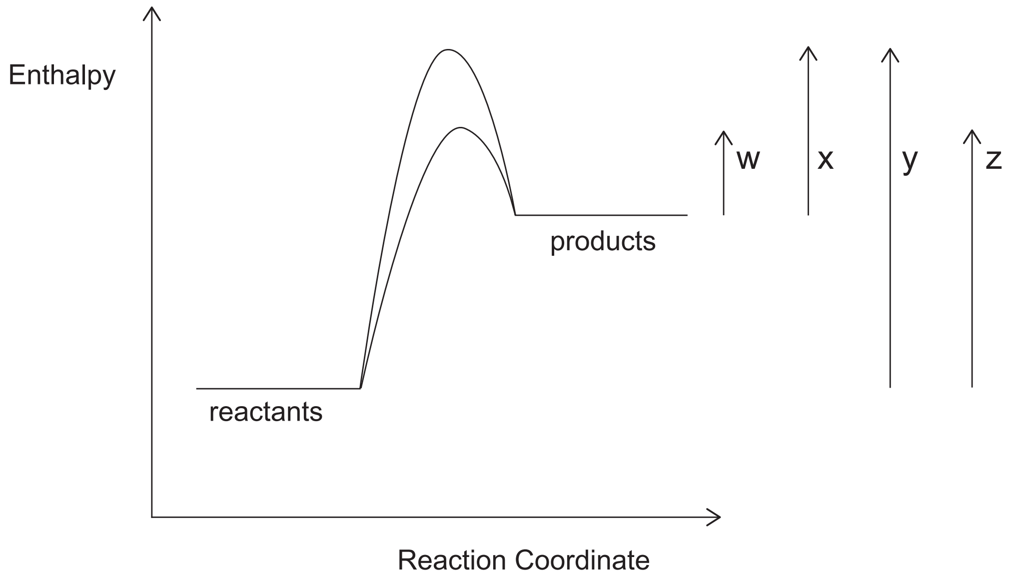
A a carboxylic acid

B a ketone

C a secondary alcohol

D an aldehyde

9 Which one of the following pairs of enthalpy changes shows how a catalyst works in an endothermic reaction?



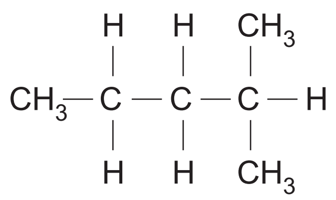
A w and x

B w and z

C x and y

D y and z

10 Which one of the following is the IUPAC name for the hydrocarbon shown below?



A 1,1-dimethylbutane

B 4,4-dimethylbutane

C 2-methylpentane

D 1,1,3-trimethylpropane

Section B

Answer **all six** questions in this section in the spaces provided.

11 An excess of methane reacts with chlorine, in the presence of light, to form chloromethane as the main product.

$$CH_4 + Cl_2 \rightarrow CH_3Cl + HCl$$

(a) Name the type of mechanism for this reaction.

____ [2]

(b) Write an equation for the initiation step.

____ [1]

(c) Write **two** equations for the propagation steps.

____

____ [2]

(d) Write an equation for the termination step which results in the formation of ethane.

____ [1]

Examiner Only	
Marks	Remark

Examiner Only	
Marks	Remark

12 The empirical formula of a molecular covalent compound can be calculated using percentage composition by mass.

(a) Explain the term **empirical formula** as applied to a molecular covalent compound.

____

____ [1]

(b) Explain the term **molecular formula** as applied to a molecular covalent compound.

____

____ [1]

(c) An oxide of phosphorus contains 43.7% by mass of phosphorus. The relative molecular mass of the oxide is 284. This oxide reacts with sodium hydroxide to form sodium phosphate (Na_3PO_4) and water as the only products.

(i) Calculate the empirical and molecular formulae of the oxide.

____

____

____

____

____

empirical formula: ______________________________

molecular formula: ______________________________ [4]

(ii) Write an equation for the reaction of the oxide with sodium hydroxide.

____ [2]

13 3-methylpent-2-ene, $CH_3CH{=}C(CH_3)CH_2CH_3$, exists as stereoisomers.

Examiner Only	
Marks	Remark

(a) (i) Explain the meaning of the term **stereoisomers**.

____

____

____ [2]

(ii) Give **two** reasons why 3-methylpent-2-ene exists as stereoisomers.

____

____

____ [2]

(iii) Draw the E-isomer of 3-methylpent-2-ene.

[1]

(iv) Draw and name a structural isomer of 3-methylpent-2-ene which cannot form stereoisomers.

____ [2]

(b) 3-methylpent-2-ene is an unsaturated hydrocarbon. It can be converted into a saturated hydrocarbon by catalytic hydrogenation.

(i) Name the catalyst used in the hydrogenation reaction and describe its state.

____ [2]

(ii) Write an equation for the reaction and use it to calculate the percentage atom economy for the equation.

____

____

____ [2]

(c) 3-methylpent-2-ene can undergo addition polymerisation. Draw a section of the resulting polymer chain showing **two** repeating units.

[1]

Examiner Only	
Marks	Remark

14 Recently chemists have developed alternatives to fossil fuels. Ethanol obtained from a biological source may have a significant role to play, e.g. some of the petrol sold in the UK and Ireland contains up to 10% ethanol. In Brazil the percentage is even higher.

Examiner Only

Marks | Remark

(a) The standard enthalpy of combustion of ethanol can be calculated using Hess's Law.

(i) State Hess's Law.

____

____ [2]

(ii) Define the term **standard enthalpy of combustion**.

____

____

____ [2]

(iii) Use the standard enthalpies of formation given in the table below to calculate the standard enthalpy of combustion of ethanol.

Compound	$\Delta H_f^\ominus$/kJ mol^{-1}
$C_2H_5OH(l)$	−277
$CO_2(g)$	−394
$H_2O(l)$	−286

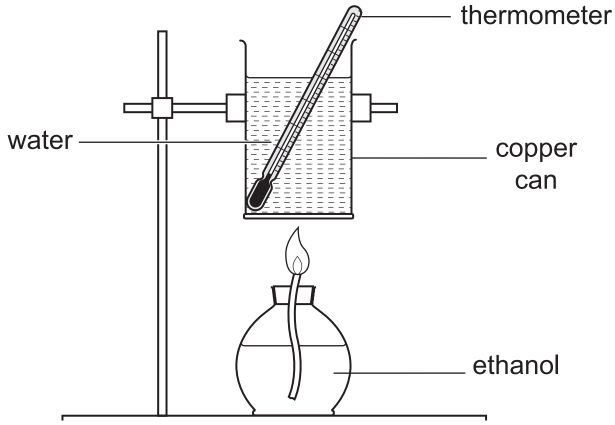
$$C_2H_5OH(l) + 3O_2(g) \rightarrow 2CO_2(g) + 3H_2O(l)$$

____

____

____ [3]

(b) The enthalpy of combustion for ethanol can also be obtained experimentally by using the apparatus shown below:



The results of the experiment are summarised in the table below:

Mass of water in the copper can	200.0 g
Mass of spirit burner + ethanol (before burning)	150.0 g
Mass of spirit burner + ethanol (after burning)	148.6 g
Initial temperature of water	18.0 °C
Final temperature of water	42.0 °C

(i) Calculate the heat energy released by the combustion of the ethanol using the equation:

heat energy released (J) = mass of water × 4.18 × temperature rise

____

____ [1]

(ii) Calculate the enthalpy of combustion of ethanol in kJ mol^{-1}.

heat energy released (in kJ) ______________________

moles of ethanol ______________________

enthalpy of combustion ______________________ [3]

(iii) State **two** reasons to explain the difference between this experimental value and the theoretical value obtained in **(a)(iii)**.

____

____

____ [2]

Examiner Only	
Marks	Remark

Examiner Only	
Marks	Remark

15 Group II carbonates and nitrates decompose when heated. Magnesium carbonate decomposes to form magnesium oxide and carbon dioxide. Magnesium nitrate forms magnesium oxide, nitrogen(IV) oxide and oxygen.

(a) (i) Write an equation for the decomposition of magnesium nitrate.

____ [2]

(ii) Suggest whether or not strontium nitrate would be more or less stable than magnesium nitrate when heated. Explain your reasoning.

____

____

____ [2]

(b) Nitrogen(IV) oxide is a brown gas which can form the colourless gas, dinitrogen tetroxide, N_2O_4, in a dynamic equilibrium.

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

(i) Explain the term **dynamic equilibrium**.

____

____ [2]

(ii) What is observed when the pressure on the equilibrium mixture is increased? Explain your answer.

____

____

____ [3]

(iii) What is observed when the equilibrium mixture is cooled? Explain your answer.

____

____

____ [3]

Examiner Only	
Marks	Remark

(c) Describe how a solution of magnesium nitrate can be used to distinguish between solid samples of potassium carbonate and potassium hydrogencarbonate. Give experimental details, observations and include an ionic equation, with state symbols, for any reaction which occurs.

____

____

____

____

____

____

____

______________________________ [4]

Ionic equation

______________________________ [2]

Quality of written communication [2]

(d) Sodium nitrate decomposes when heated to produce sodium nitrite and oxygen:

$$2NaNO_3 \rightarrow 2NaNO_2 + O_2$$

Calculate the volume of oxygen produced, at 20 °C and a pressure of 1 atmosphere, when 4.25 g of sodium nitrate decomposes.

Moles of sodium nitrate

______________________________ [1]

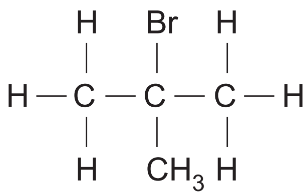
Moles of oxygen produced

______________________________ [1]

Volume of oxygen, cm^3

______________________________ [1]

16 2-bromo-2-methylpropane is a tertiary halogenoalkane.



(a) What is the general formula for a bromoalkane?

____ [1]

(b) Why is 2-bromo-2-methylpropane classified as a tertiary halogenoalkane?

____

____

____ [2]

(c) 2-bromo-2-methylpropane reacts with aqueous potassium hydroxide to produce a tertiary alcohol.

(i) Name the type of mechanism for this reaction.

____ [1]

(ii) Write an equation for the first step in the mechanism.

____ [1]

(iii) Draw the structure of the organic product in the first step.

____ [1]

(iv) Write an equation for the second step in the mechanism.

____ [1]

Examiner Only	
Marks	Remark

(d) How could infrared spectroscopy be used to distinguish between 2-bromo-2-methylpropane and the tertiary alcohol produced in this reaction?

____

____

____ [2]

(e) 2-bromo-2-methylpropane reacts with ethanolic potassium hydroxide to produce a different product.

(i) Write an equation for this reaction.

____ [2]

(ii) Name the organic product.

____ [1]

(iii) Name the type of reaction.

____ [1]

(f) 1-bromobutane is a structural isomer of 2-bromo-2-methylpropane.

(i) Define the term **structural isomer**.

____

____ [2]

(ii) State, giving reasons for your choice, which of these two compounds would be expected to have the higher boiling point.

____

____

____

____ [3]

Examiner Only	
Marks	Remark

113598

Rewarding Learning

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
January 2013

Chemistry

Assessment Unit AS 2

assessing

Module 2: Organic, Physical and Inorganic Chemistry

[AC122]

WEDNESDAY 16 JANUARY, MORNING

MARK SCHEME

Section A

		AVAILABLE MARKS
1	A	
2	B	
3	D	
4	D	
5	A	
6	B	
7	A	
8	B	
9	D	
10	C	
[2] for each correct answer	[20]	20
	Section A	**20**

Section B

AVAILABLE MARKS

11 **(a)** free radical [1]
substitution [1] [2]

(b) $Cl_2 \rightarrow 2\ Cl^{\bullet}$ [1]

(c) $CH_4 + Cl^{\bullet} \rightarrow CH_3^{\bullet} + HCl$ [1]
$CH_3^{\bullet} + Cl_2 \rightarrow CH_3Cl + Cl^{\bullet}$ [1]

(d) $CH_3^{\bullet} + CH_3^{\bullet} \rightarrow C_2H_6$ [1] 6

12 **(a)** A formula which shows the simplest whole number ratio of atoms of each element in a compound [1]

(b) A formula which shows the actual number of atoms of each element in a molecule [1]

(c) **(i)**

P	O
43.7	56.3
1.410	3.519
1	2.5
2	5

empirical formula P_2O_5

$284 \div 142 = 2$

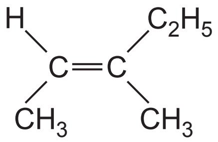
molecular formula P_4O_{10} [4]

(ii) $12NaOH + P_4O_{10} \rightarrow 4Na_3PO_4 + 6H_2O$ [2] 8

AVAILABLE MARKS

13 **(a)** **(i)** Same structural formula [1]
Different arrangement in (3D) space – dependent on first statement [1] [2]

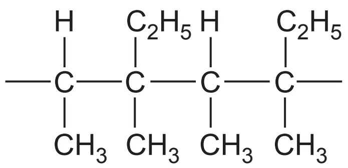
(ii) Restricted rotation about C═C [1]
Both carbons in C═C have 2 different atoms/groups attached [1] [2]

(iii)

[1]

(iv) e.g. $CH_2 = CH(CH_2)_3CH_3$ [1]
Correct name, e.g. hex-1-ene [1] [2]

(b) **(i)** Finely divided [1]
nickel [1] [2]

(ii) $C_6H_{12} + H_2 \rightarrow C_6H_{14}$ [1]
100% [1] [2]

(c)

[1] 12

14 **(a)** **(i)** Enthalpy change [1]
independent of route taken [1] [2]
(provided the initial and final conditions are the same)

(ii) Enthalpy change when one mole of a substance is completely burnt in oxygen under standard conditions [2]

(iii) $[(2 \times –394) + (3 \times –286)] – [(–277)]$
$–1646 + 277 = –1369$ kJ mol^{-1} [3]

(b) **(i)** 20064 J [1]

(ii) 20.064 kJ [1]
moles of ethanol = 0.0304 [1]
–659 kJ mol^{-1} [1] [3]

(iii) heat lost to surroundings [1]
Incomplete combustion [1] [2] 13

						AVAILABLE MARKS
15	**(a)**	**(i)**	$2Mg(NO_3)_2 \rightarrow 2MgO + 4NO_2 + O_2$		[2]	
		(ii)	More stable	[1]		
			Sr^{2+} is larger than Mg^{2+}/less polarising/smaller charge density	[1]	[2]	
	(b)	**(i)**	Rate of forward reaction = rate of backward reaction	[1]		
			Amount of any given reactant or product remains constant	[1]	[2]	
		(ii)	Brown to colourless	[1]		
			2 moles (g) on LHS 1 mole (g) on RHS	[1]		
			Equilibrium shifts to RHS to reduce pressure	[1]	[3]	
		(iii)	Brown to colourless	[1]		
			(forward) reaction is exothermic	[1]		
			equilibrium shifts to RHS (to increase temperature)	[1]	[3]	
	(c)	Dissolve samples in water		[1]		
		Add solution of magnesium nitrate to each		[1]		
		Solution of potassium carbonate – white [1] precipitate [1]		[1]		
		Solution of potassium hydrogencarbonate – no ppt		[1]	[4]	
		Any 4 from 5				
		$Mg^{2+}(aq) + CO_3^{2-}(aq) \rightarrow MgCO_3(s)$			[2]	
		Quality of written communication			[2]	
	(d)	0.050			[1]	
		0.025			[1]	
		600			[1]	23

AVAILABLE MARKS

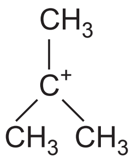
16 (a) $C_nH_{2n+1}Br$ [1]

(b) Three carbons (directly) attached [1]
to the same carbon as Br [1] [2]

(c) (i) Nucleophilic
substitution [1]

(ii) $(CH_3)_3CBr \rightarrow (CH_3)_3C^+ + Br^-$ [1]

(iii)



[1]

(iv) $(CH_3)_3C^+ + OH^- \rightarrow (CH_3)_3COH$ [1]

(d) Absence [1]
of O–H absorption [1] [2]

(e) (i) $(CH_3)_3CBr + KOH \rightarrow CH_2{=}C(CH_3)_2 + H_2O + KBr$ [2]

(ii) 2–methylpropene or methylpropene [1]

(iii) Elimination [1]

(f) (i) Same molecular formula [1]
Different structural formula [1] [2]

(ii) 1-bromobutane [1]
No branching/greater contact between molecules [1]
Greater van der Waals forces [1] [3] 18

Section B **80**

Total **100**

Rewarding Learning

Centre Number	
71	

Candidate Number

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
2013

Chemistry

Assessment Unit AS 2

assessing

Module 2: Organic, Physical and Inorganic Chemistry

[AC122]

WEDNESDAY 19 JUNE, MORNING

AC122

TIME

1 hour 30 minutes.

INSTRUCTIONS TO CANDIDATES

Write your Centre Number and Candidate Number in the spaces provided at the top of this page.
Answer **all fifteen** questions.
Answer **all ten** questions in **Section A**. Record your answers by marking the appropriate letter on the answer sheet provided. Use only the spaces numbered 1 to 10. Keep in sequence when answering.
Answer **all five** questions in **Section B**. Write your answers in the spaces provided in this question paper.

INFORMATION FOR CANDIDATES

The total mark for this paper is 100.
Quality of written communication will be assessed in Question **12(c)**.
In Section A all questions carry equal marks, i.e. **two** marks for each question.
In Section B the figures in brackets printed down the right-hand side of pages indicate the marks awarded to each question or part question.
A Periodic Table of the Elements, containing some data, is included in this question paper.

For Examiner's use only	
Question Number	**Marks**
Section A	
1–10	
Section B	
11	
12	
13	
14	
15	
Total Marks	

Section A

For each of the following questions only **one** of the lettered responses (A–D) is correct.

Select the correct response in each case and mark its code letter by connecting the dots as illustrated on the answer sheet.

1 Which one of the following compounds has the highest boiling point?

A 2,3-dimethylbutane

B Hexane

C 2-methylpentane

D 3-methylpentane

2 When a solution of potassium chromate is added to a solution containing barium ions

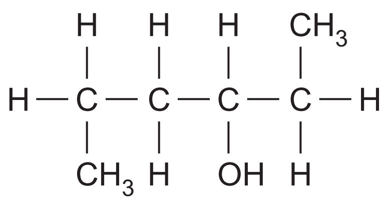
A a yellow precipitate forms.

B a white precipitate forms.

C an orange to green colour change occurs.

D the potassium chromate solution remains orange.

3 Which one of the following is the name of the alcohol below?



A 1,4-dimethylbutan-2-ol

B 1,4-dimethylbutan-3-ol

C Hexan-3-ol

D Hexan-4-ol

4 Methane reacts with excess chlorine to form tetrachloromethane.

$$CH_4 + 4Cl_2 \rightarrow CCl_4 + 4HCl$$

Which one of the following is the atom economy for the formation of CCl_4?

A 25.7%

B 44.2%

C 51.3%

D 80.8%

5 Which one of the following is a tertiary alcohol?

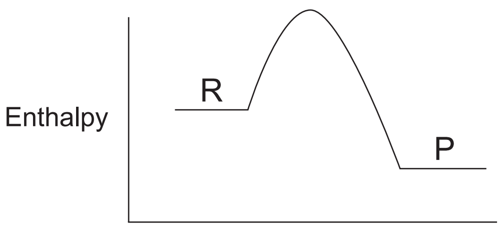
A 2-methylbutan-2-ol

B 2-methylbutan-3-ol

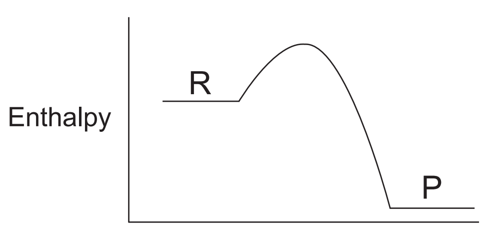
C Pentan-2-ol

D Pentan-3-ol

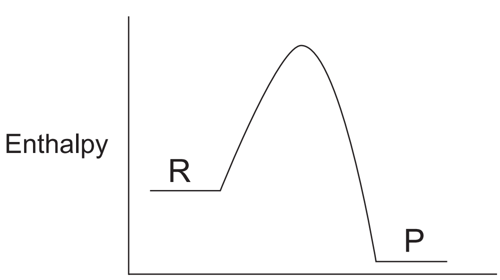
6 Which one of the following reaction profiles represents a reaction for which the enthalpy change is numerically greater than the activation energy?



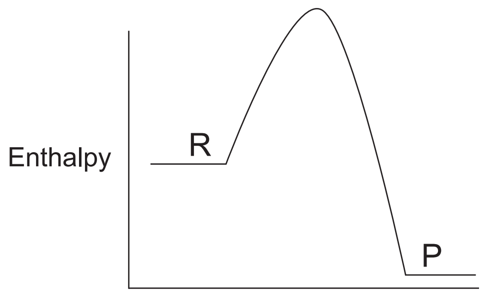
A



B

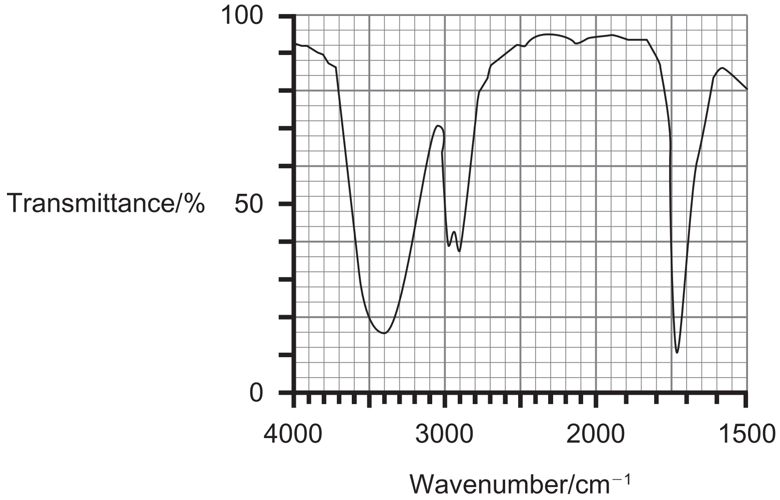


C



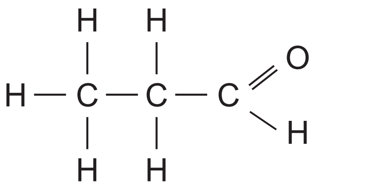
D

7 Which one of the following molecules produces the infrared spectrum shown below?

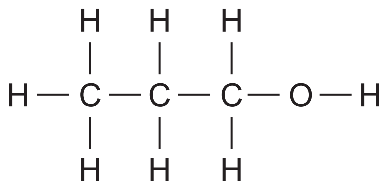


Bond	**Wavenumber (cm^{-1})**
O — H (alcohols)	3200–3700 strong broad
C — H	2700–3300 medium sharp
O — H (carboxylic acids)	2500–3200 strong broad
C ═ O	1680–1780 strong sharp

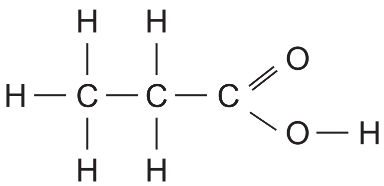
A



B



C



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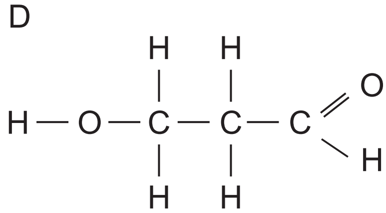


8 Which one of the following alkenes may be formed when 3-bromo-2-methylpentane reacts with ethanolic potassium hydroxide?

A 1,1-dimethylbut-1-ene

B 2-methylpent-3-ene

C 4-methylpent-2-ene

D 4-methylpent-3-ene

9 The standard enthalpies of combustion of carbon (C), hydrogen (H_2) and propane (C_3H_8) are -394, -286 and $-2219\,kJ\,mol^{-1}$ respectively. Which one of the following is the standard enthalpy of formation of propane in $kJ\,mol^{-1}$?

A -1539

B -107

C $+107$

D $+1539$

10 Which one of the following alcohols can be oxidised to form a ketone?

A Butan-1-ol

B Butan-2-ol

C 2-methylpropan-1-ol

D 2-methylpropan-2-ol

Section B

Answer **all five** questions in this section.

Examiner Only	
Marks	Remark

11 The elements in Group II of the Periodic Table, from magnesium to barium, have similar chemical properties and are known as the alkaline earth metals.

(a) The s-block of the Periodic Table consists of the elements in Groups I and II.

(i) Give the electronic configuration of a calcium atom.

____ [1]

(ii) In terms of electronic configuration, what do s-block elements have in common?

____

____ [1]

(iii) Write an equation, including state symbols, to represent the first ionisation energy of calcium.

____ [2]

(iv) State and explain the trend in the first ionisation energies as Group II is descended.

____

____

____ [3]

(b) Magnesium reacts vigorously with both hydrochloric and sulfuric acids to form solutions of magnesium chloride and magnesium sulfate.

(i) Write the equation for the reaction of magnesium with hydrochloric acid.

____ [2]

(ii) State **two** observations when this reaction is carried out.

____

____ [2]

(iii) Name a reagent which can be used to distinguish between solutions of magnesium chloride and magnesium sulfate.

____ [1]

(iv) What is observed when this reagent is added to each solution?

____

____ [2]

(v) Write the ionic equation, including state symbols, for any reaction which occurs when the reagent named in **(iii)** above is used.

____ [2]

(c) The hydroxides and sulfates of Group II show significant variations in solubility.

(i) Give the formula of the most soluble Group II hydroxide.

____ [1]

(ii) Give the formula of the least soluble Group II sulfate.

____ [1]

(iii) State and explain the trend in the thermal stability of the hydroxides as Group II is descended.

____

____

____ [2]

(iv) Write the equation for the thermal decomposition of magnesium hydroxide.

____ [1]

Examiner Only	
Marks	Remark

(d) The elements in Group II react with water.

(i) State the trend in reactivity with water of the elements from magnesium to barium.

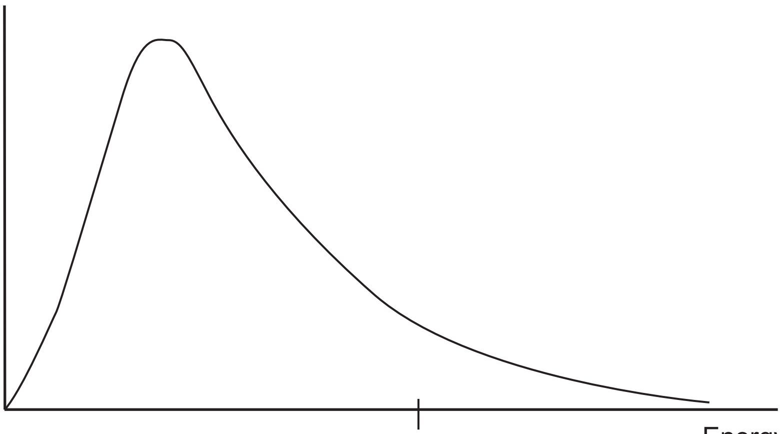
____ [1]

(ii) Write the equation for the reaction of barium with water.

____ [2]

Examiner Only	
Marks	Remark

12 The diagram shows a Maxwell–Boltzmann distribution curve for a mixture of sulfur dioxide and oxygen at temperature T.
E_a = activation energy



(a) On the diagram, sketch the distribution curve for the same mixture at a higher temperature. [2]

(b) Use these distribution curves to explain why the reaction between sulfur dioxide and oxygen is faster at the higher temperature.

____

____ [2]

(c) Use the distribution curve to explain the role of a catalyst and why the reaction between sulfur dioxide and oxygen is faster in the presence of a catalyst.

____

____

____

____

____

____

____ [4]

Quality of written communication [2]

Examiner Only	
Marks	Remark

13 There are several compounds with the molecular formula C_6H_{12}. The molecules present in these compounds are described as structural isomers. Some compounds, with molecular formula C_6H_{12}, exist as geometric isomers.

Examiner Only	
Marks	Remark

(a) What are **structural isomers**?

____

____ [2]

(b) Give the name and structural formula for an isomer of C_6H_{12} which does not exist as a geometric isomer.

____ [2]

(c) **(i)** What are **geometric isomers**?

____

____ [2]

(ii) Name an isomer of C_6H_{12} which exists as geometric isomers.

____ [1]

(iii) Give **two** reasons why this isomer exists as geometric isomers.

____

____

____ [2]

(iv) Draw the **two** geometric isomers and identify the Z isomer.

[3]

(d) Give the empirical formula of all the compounds with molecular formula C_6H_{12}.

____ [1]

Examiner Only	
Marks	Remark

14 Ethene reacts with steam in a reversible reaction to form ethanol:

$$C_2H_4(g) + H_2O(g) \rightleftharpoons C_2H_5OH(g)$$

The reaction establishes a position of dynamic equilibrium.

(a) What is meant by the term **dynamic equilibrium**?

____

____ [2]

(b) Use the following average bond enthalpy values to calculate the enthalpy change for the reaction.

Bond	**Average Bond Enthalpy ($kJ\,mol^{-1}$)**
C — C	347
C ═ C	612
C — H	413
C — O	358
O — H	464

____

____

____

____ [3]

(c) **(i)** State and explain the effect of an increase in pressure on the yield of ethanol.

____

____ [2]

Examiner Only
Marks Remark

(ii) State and explain the effect of an increase in temperature on the yield of ethanol.

____

____

____

____ [2]

(iii) State the effect of using a catalyst on the yield of ethanol.

____ [1]

(d) State the conditions and a catalyst used in the industrial production of ethanol from ethene and steam.

____

____ [3]

(e) Assuming an 80% yield, what mass of ethene would be required to produce 460 kg of ethanol?

____

____

____ [3]

Examiner Only	
Marks	Remark

15 Methylpropene reacts with hydrogen bromide to form two products, the major product being 2-bromo-2-methylpropane.

Examiner Only	
Marks	Remark

(a) Hydrogen bromide is a polar molecule.

(i) Using the diagram below, show the polarity of the hydrogen bromide molecule.

H — Br

[1]

(ii) Use the polarity of the hydrogen bromide molecule to explain why it is attracted to methylpropene molecules.

____

____ [2]

(b) The formation of 2-bromo-2-methylpropane occurs in two steps.

(i) Write an equation for the first step of the mechanism showing the structure of the intermediate.

____ [2]

(ii) Write an equation for the second step of the mechanism showing the structure of 2-bromo-2-methylpropane.

____ [1]

Examiner Only	
Marks	Remark

(iii) Name the mechanism of the reaction.

______________________________ [1]

(iv) Suggest the name of the minor product.

______________________________ [1]

(c) Methylpropene is an unsaturated hydrocarbon.

(i) What is an **unsaturated hydrocarbon**?

____

______________________________ [2]

(ii) Calculate the volume of hydrogen gas, measured at 20 °C and one atmosphere pressure, required to saturate 4.2 g of methylpropene.

____

____

______________________________ [3]

(d) Under suitable conditions, methylpropene can be converted into poly(methylpropene).

(i) Name the type of reaction occurring.

______________________________ [2]

(ii) Draw the structure of poly(methylpropene) showing three repeating units.

______________________________ [2]

Rewarding Learning

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
2013

Chemistry

Assessment Unit AS 2

assessing

Module 2: Organic, Physical and Inorganic Chemistry

[AC122]

WEDNESDAY 19 JUNE, MORNING

MARK SCHEME

General Marking Instructions

Introduction

Mark schemes are published to assist teachers and students in their preparation for examinations. Through the mark schemes teachers and students will be able to see what examiners are looking for in response to questions and exactly where the marks have been awarded. The publishing of the mark schemes may help to show that examiners are not concerned about finding out what a student does not know but rather with rewarding students for what they do know.

The Purpose of Mark Schemes

Examination papers are set and revised by teams of examiners and revisers appointed by the Council. The teams of examiners and revisers include experienced teachers who are familiar with the level and standards expected of students in schools and colleges.

The job of the examiners is to set the questions and the mark schemes; and the job of the revisers is to review the questions and mark schemes commenting on a large range of issues about which they must be satisfied before the question papers and mark schemes are finalised.

The questions and the mark schemes are developed in association with each other so that the issues of differentiation and positive achievement can be addressed right from the start. Mark schemes, therefore, are regarded as part of an integral process which begins with the setting of questions and ends with the marking of the examination.

The main purpose of the mark scheme is to provide a uniform basis for the marking process so that all the markers are following exactly the same instructions and making the same judgements in so far as this is possible. Before marking begins a standardising meeting is held where all the markers are briefed using the mark scheme and samples of the students' work in the form of scripts. Consideration is also given at this stage to any comments on the operational papers received from teachers and their organisations. During this meeting, and up to and including the end of the marking, there is provision for amendments to be made to the mark scheme. What is published represents this final form of the mark scheme.

It is important to recognise that in some cases there may well be other correct responses which are equally acceptable to those published: the mark scheme can only cover those responses which emerged in the examination. There may also be instances where certain judgements may have to be left to the experience of the examiner, for example, where there is no absolute correct response – all teachers will be familiar with making such judgements.

Section A

			AVAILABLE MARKS
1	B		
2	A		
3	C		
4	C		
5	A		
6	B		
7	D		
8	C		
9	B		
10	B		
[2] for each correct answer		[20]	20
		Section A	**20**

Section B

						AVAILABLE MARKS
11	**(a)**	**(i)**	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2$		[1]	
		(ii)	Highest energy electron in an s-subshell		[1]	
		(iii)	$Ca(g) \rightarrow Ca^+(g) + e^-$		[2]	
		(iv)	Decreases Electron further from nucleus/higher in energy More shielded	[1] [1] [1]	[3]	
	(b)	**(i)**	$Mg + 2HCl \rightarrow MgCl_2 + H_2$		[2]	
		(ii)	Magnesium gets smaller/disappears Heat produced Bubbles/fizz/effervescence Any **two** from three		[2]	
		(iii)	Barium chloride (**or** silver nitrate) (aq)		[1]	
		(iv)	White precipitate with magnesium sulfate No precipitate with magnesium chloride (**or** opposite way round with silver nitrate)	[1] [1]	[2]	
		(v)	$Ba^{2+}(aq) + SO_4^{2-}(aq) \rightarrow BaSO_4(s)$ **Or** $Ag^+(aq) + Cl^-(aq) \rightarrow AgCl(s)$		[2]	
	(c)	**(i)**	$Ba(OH)_2$		[1]	
		(ii)	$BaSO_4$		[1]	
		(iii)	Increases Cation gets bigger/charge density of cation decreases	[1] [1]	[2]	
		(iv)	$Mg(OH)_2 \rightarrow MgO + H_2O$		[1]	
	(d)	**(i)**	Increases		[1]	
		(ii)	$Ba + 2H_2O \rightarrow Ba(OH)_2 + H_2$		[2]	24
12	**(a)**		Peak shifts to right and peak is lower Other drawing errors [–1]		[2]	
	(b)		Number of molecules with energy greater than E_a increases	[1] [1]	[2]	
	(c)		Catalyst provides an alternative route of lower activation energy E_a More molecules have energy greater than E_a Number/frequency of successful collisions (between SO_2 and O_2 molecules) increases	[1] [1] [1] [1]	[4]	
			Quality of written communication		[2]	10

AVAILABLE MARKS

13 (a) Same molecular formula [1]
Different structural formula [1] [2]

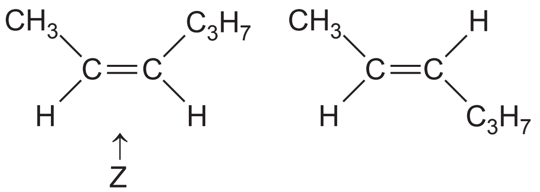
(b) Correct structure, e.g. $CH_2{=}CH_2(CH_2)_3CH_3$ [1]
Correct name, e.g. hex-1-ene [1] [2]

(c) (i) Same structural formula [1]
Non-superimposable/different 3D spatial arrangement [1] [2]

(ii) e.g. hex-2-ene, hex-3-ene, 3-methylpent-2-ene, 4-methylpent-2-ene [1]

(iii) Restricted rotation about C=C [1]
Both carbons in the C=C have two different atoms/groups attached [1] [2]

(iv)



[2]
Correct identification of Z isomer [1] [3]

(d) CH_2 [1] 13

14 (a) Rate of forward reaction = rate of backward reaction [1]
Amount of any given reactant or product remains constant [1] [2]

(b) Bonds broken 3192
Bonds formed 3234
Enthalpy change $-42\ kJ\,mol^{-1}$ [3]

(c) (i) Increases [1]
2 moles of gas on LHS, 1 mole of gas on RHS [1] [2]

(ii) Decreases [1]
Reaction is exothermic [1] [2]

(iii) No effect [1]

(d) 330 °C/(300–400 °C) [1]
60 atm/(50–75 atm) [1]
Phosphoric acid/H_3PO_4 [1] [3]

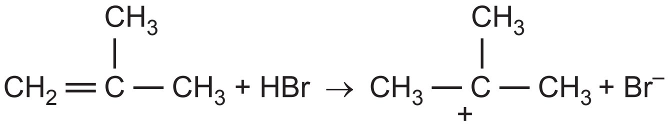
(e) Moles of ethanol = 10 000 moles (actual yield)
Moles of ethene = 12 500 moles (theoretical yield)
Mass of ethene = 350 kg units needed [3]
Each error [–1] 16

15 (a) (i) $\overset{\delta^+}{H}—\overset{\delta^-}{Br}$ [1]

AVAILABLE MARKS

(ii) C═C centre of high electron density [1]
H end of HBr is electrophilic [1] [2]

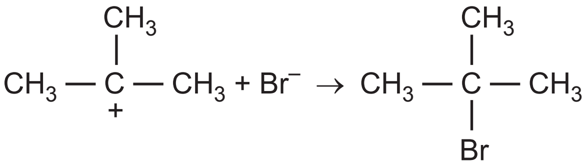
(b) (i)



[1]

Correct structure for carbocation [1] [2]

(ii)



[1]

(iii) Electrophilic addition [1]

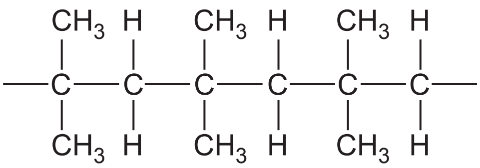
(iv) 1-bromo-2-methylpropane [1]

(c) (i) Contains hydrogen and carbon only [1]
Contains a C═C/C≡C [1] [2]

(ii) Moles of methylpropene = $\frac{4.2}{56}$ = 0.075
Moles of hydrogen = 0.075
Volume of hydrogen = 1.8 dm^3 [3]
each error [–1]

(d) (i) Addition [1]
polymerisation [1] [2]

(ii)



[2] 17

Section B **80**

Total **100**

Rewarding Learning

Centre Number	
71	

Candidate Number

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
January 2014

Chemistry

Assessment Unit AS 2

assessing

Module 2: Organic, Physical and Inorganic Chemistry

[AC122]

AC122

THURSDAY 16 JANUARY, MORNING

TIME

1 hour 30 minutes.

INSTRUCTIONS TO CANDIDATES

Write your Centre Number and Candidate Number in the spaces provided at the top of this page.
Answer **all fifteen** questions.
Answer **all ten** questions in **Section A**. Record your answers by marking the appropriate letter on the answer sheet provided. Use only the spaces numbered 1 to 10. Keep in sequence when answering.
Answer **all five** questions in **Section B**. Write your answers in the spaces provided in this question paper.

INFORMATION FOR CANDIDATES

The total mark for this paper is 100.
Quality of written communication will be assessed in Question **11(d)**.
In Section A all questions carry equal marks, i.e. **two** marks for each question.
In Section B the figures in brackets printed down the right-hand side of pages indicate the marks awarded to each question or part question.
A Periodic Table of the Elements, containing some data, is included in this question paper.

For Examiner's use only	
Question Number	**Marks**
Section A	
1–10	
Section B	
11	
12	
13	
14	
15	
Total Marks	

Section A

For each of the following questions only **one** of the lettered responses (A–D) is correct.

Select the correct response in each case and mark its code letter by connecting the dots as illustrated on the answer sheet.

1 A solution of an unknown solid when sprayed into the blue flame of a Bunsen burner produced a crimson colour. When silver nitrate solution was added to this solution a white precipitate was observed. The solution contained

A calcium chloride.

B calcium sulfate.

C lithium chloride.

D lithium sulfate.

2 Which one of the following can act as a free radical?

A Cl

B Cl^-

C Cl^+

D Cl_2

3 Propan-2-ol is produced from the reaction of propene and steam. Assuming a 65% yield, which one of the following is the mass of propene required to produce 390 g of propan-2-ol?

A 253.5 g

B 273.0 g

C 420.0 g

D 600.0 g

4 Which one of the following is the molecular formula of methyl propanoate?

A $CH_3CH_2COOCH_3$

B C_2H_4O

C $C_4H_8O_2$

D $HCOOCH_2CH_2CH_3$

5 Which one of the following reagents could be used to distinguish between propan-1-ol and propan-2-ol?

A Acidified potassium dichromate

B Alkaline iodine

C Ethanoic acid

D Thionyl chloride

6 Which one of the following is the atom economy for the production of iron in the Thermite Process?

$$2Al + Fe_2O_3 \rightarrow 2Fe + Al_2O_3$$

A 25.2%

B 26.2%

C 50.1%

D 52.3%

7 Which one of the following sets of observations is **not** correct for the addition of dilute ammonia solution to a solution of the metal ion?

	metal ion solution	**addition of drops of dilute ammonia solution**	**addition of excess dilute ammonia solution**
A	Al^{3+}	precipitate formed	precipitate remains
B	Cu^{2+}	precipitate formed	precipitate remains
C	Mg^{2+}	precipitate formed	precipitate remains
D	Zn^{2+}	precipitate formed	precipitate redissolves

8 Which one of the following alkenes will exhibit *cis* and *trans* (E-Z) isomerism?

A $(CH_3)_2C{=}CH_2$

B $CH_3CH{=}CHCH_3$

C $H_2C{=}CHCl$

D $C_2H_5(CH_3)C{=}C(CH_3)_2$

9 Using the bond enthalpies below calculate which one of the following is the enthalpy of combustion of propane.

bond	bond enthalpy/kJ mol^{-1}
C — C	347
C — H	413
O — H	464
O$=$O	498
C$=$O	805

A -198 kJ mol^{-1}

B -361 kJ mol^{-1}

C -1707 kJ mol^{-1}

D -2054 kJ mol^{-1}

10 Which one of the following compounds will produce equal volumes of carbon dioxide and water vapour when burnt completely in oxygen?

A C_2H_2

B C_2H_4

C C_2H_6

D C_2H_5OH

Section B

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

11 Barium oxide is formed by the thermal decomposition of barium carbonate.

(a) **(i)** Write an equation for the decomposition of barium carbonate.

____ [1]

(ii) Explain why calcium carbonate will decompose at a lower temperature than barium carbonate.

____

____

____

____ [3]

(b) Barium oxide can also be formed from the combustion of barium. What colour is the flame when barium is burned?

____ [1]

(c) Barium hydroxide can be formed from barium oxide.

(i) How would you convert barium oxide into barium hydroxide?

____ [1]

(ii) State the trend in solubility of the Group II hydroxides.

____ [1]

(iii) Write an equation for the reaction between barium hydroxide and sulfuric acid.

____ [1]

(iv) What colour is the solid product in the reaction in part **(c)(iii)**?

____ [1]

Examiner Only	
Marks	Remark

(d) Describe tests, other than a flame test, to confirm the presence of barium ions and carbonate ions in separate solutions.

____

____

____

____

____

____ [4]

Quality of written communication [2]

Examiner Only	
Marks	Remark

12 Paraffin wax is a mixture of alkanes containing 20–40 carbon atoms. The alkane with 20 carbon atoms is known as icosane.

Examiner Only	
Marks	Remark

(a) **(i)** What is the general formula for an alkane?

____ [1]

(ii) What is the molecular formula of icosane?

____ [1]

(iii) Alkanes are **saturated**. What does this term mean?

____ [1]

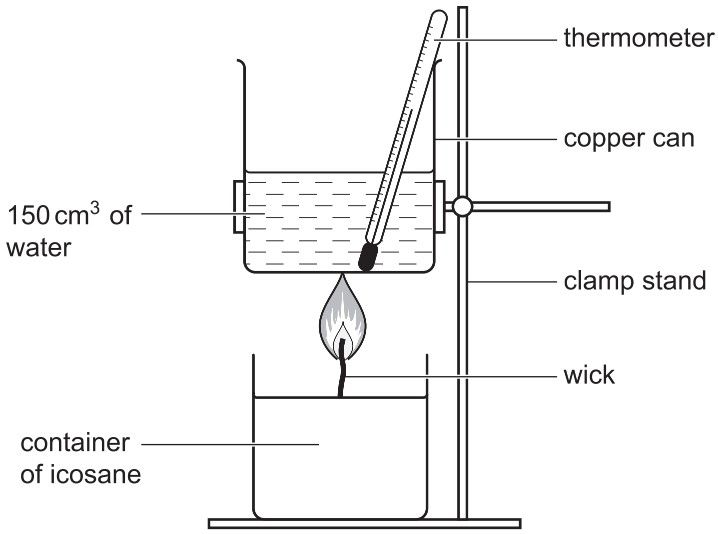
(b) Explain why icosane is a solid at room temperature whereas ethane is a gas.

____

____

____ [2]

(c) A calorimeter is set up as shown in the diagram below using a container of icosane with a wick in it. A student carried out an experiment and recorded all measurements in a table.



(i) Complete the table.

Initial mass of icosane	26.2 g
Final mass of icosane	25.3 g
Mass of icosane burned	
Initial water temperature	19 °C
Final water temperature	80 °C
Temperature change	
Mass of water	150 g

[1]

Examiner Only
Marks | Remark

Examiner Only	
Marks	Remark

(ii) Use the following headings to calculate the enthalpy of combustion of icosane (RMM = 282).

Calculate the number of moles of icosane burned.

____ [1]

Calculate the amount of heat energy in joules transferred to the water as the icosane is burned (the specific heat capacity of water is 4.18 J g^{-1} °C^{-1}).

____

____ [1]

Calculate the enthalpy of combustion of icosane in kJ mol^{-1}.

____

____

____ [3]

(iii) Give one practical reason why the experimental value you calculated is significantly different from a value quoted in a data book.

____

____ [1]

(d) Icosane needs a plentiful supply of air to burn completely.

(i) Write an equation for the complete combustion of icosane.

____ [2]

(ii) Give the chemical formula of a different compound that is formed in the incomplete combustion of icosane.

____ [1]

Examiner Only	
Marks	Remark

13 A catalytic converter is a device in a car exhaust system in which a catalyst is spread thinly over a honeycomb structure.

(a) Explain, in terms of energy, what is meant by the term **catalyst**.

____

____ [2]

(b) The following equilibrium reaction takes place in a catalytic converter.

$$2CO + 2NO \rightleftharpoons 2CO_2 + N_2 \qquad \Delta H = -745\,kJ\,mol^{-1}$$

(i) State and explain the effect of a decrease in temperature on the above equilibrium.

____

____ [2]

(ii) State and explain the effect of an increase in pressure on the above equilibrium.

____

____ [2]

(iii) Use the following headings to calculate the total volume of gas produced when 5.6 g of carbon monoxide passes through a catalytic converter.

Relative molecular mass of carbon monoxide

____

Number of moles of carbon monoxide

____

Number of moles of gas produced

____

Volume of gas produced

____ [4]

(c) Explain why cars fitted with catalytic converters must not be fuelled with leaded petrol.

____

____ [1]

14 Ethanol is the main alcohol found in alcoholic drinks. It is produced by the fermentation of sugars.

Examiner Only	
Marks	Remark

(a) Ethanol is a **primary** alcohol. What does this term mean?

____

____ [1]

(b) State **one** effect of alcohol on an individual's ability to drive.

____

____ [1]

(c) Early breathalysers involved the motorist blowing into a tube containing crystals of potassium dichromate mixed with concentrated sulfuric acid.

(i) What colour change occurs when acidified potassium dichromate reacts with ethanol?

____ [2]

(ii) Write an equation for the oxidation of ethanol using [O] to represent the acidified potassium dichromate.

____ [2]

(d) In the case of a positive breathalyser test the motorist is tested a second time using infrared spectroscopy.

(i) State and explain the effect of infrared radiation on molecules.

____

____

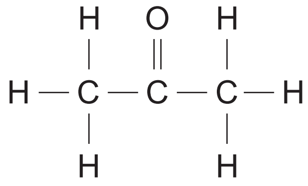
____ [2]

Examiner Only

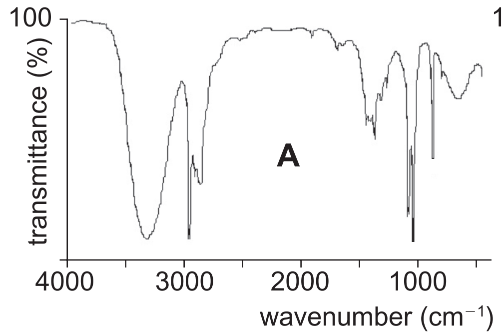
Marks	Remark

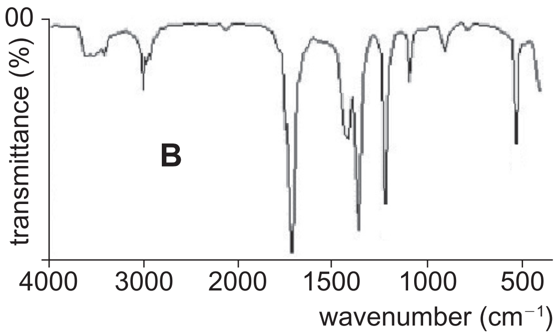
(ii) The infrared spectrum must be carefully read to distinguish between ethanol and propanone, which is found in the breath of diabetics. Use the data in the following table to determine which spectrum, A or B, is for ethanol. Explain your choice and refer to both spectra in your answer.

bond	wavenumber (cm^{-1})
C — H	2850–3300
C ═ O	1680–1750
C — O	1000–1100
O — H	3230–3550



propanone





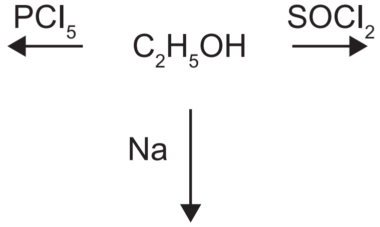
____

____

____

____ [3]

(e) Give the structure of the organic product formed when ethanol reacts with each of the following reagents.



[3]

(f) Ethanol reacts with propanoic acid in a dynamic equilibrium to form an ester according to the following equation.

$$C_2H_5OH + C_2H_5COOH \rightleftharpoons C_2H_5COOC_2H_5 + H_2O$$

(i) Name the ester that is formed in the reaction.

______________________________ [1]

(ii) Name the catalyst used in the reaction.

______________________________ [1]

(iii) Explain the term **dynamic equilibrium**.

____

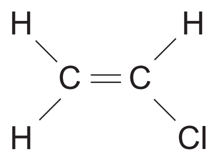
______________________________ [2]

(iv) Suggest another reagent that could be used in place of propanoic acid to produce the same ester.

______________________________ [1]

Examiner Only	
Marks	Remark

15 Vinyl chloride, CH_2CHCl, is an important compound as it is used to manufacture polyvinylchloride (PVC).



vinyl chloride

(a) The first stage in the production of vinyl chloride is the reaction of ethene with chlorine. The product from this reaction then undergoes thermal cracking to form vinyl chloride.

(i) Write an equation for the reaction of ethene with chlorine.

____ [1]

(ii) Name the product formed when ethene reacts with chlorine.

____ [2]

(iii) What is meant by the term **thermal cracking**?

____

____ [2]

(iv) When the product of the reaction in **(a)(i)** is thermally cracked to produce vinyl chloride what is the other product formed?

____ [1]

(v) What type of polymerisation is used to convert the monomer vinyl chloride to the polymer PVC?

____ [1]

Examiner Only	
Marks	Remark

(b) A by-product of PVC production is chloroethane.

Examiner Only	
Marks	Remark

(i) Draw a dot and cross diagram showing all the outer shell electrons in a chloroethane molecule.

[1]

(ii) Draw a flow scheme to show the mechanism for the reaction of hydrogen chloride with ethene which is similar to the reaction of hydrogen bromide with ethene.

[3]

(iii) What is the name given to this mechanism?

____ [2]

(iv) What type of covalent bond in ethene is broken during this reaction?

____ [1]

Examiner Only	
Marks	Remark

(c) Chloroethane can also be made by reacting chlorine with ethane in a reaction that is similar to that of chlorine with methane.

(i) Name the experimental condition required for this reaction to take place.

____ [1]

(ii) Write equations for the propagation steps for this reaction.

____

____ [2]

(iii) Name the alkane produced in a termination step of this reaction.

____ [1]

(d) Chloroethane will react with ammonia in solution. Write an equation for this reaction and name the organic product.

Equation ____ [1]

Name ____ [1]

THIS IS THE END OF THE QUESTION PAPER

Rewarding Learning

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
January 2014

Chemistry

Assessment Unit AS 2

assessing

Module 2: Organic, Physical and Inorganic Chemistry

[AC122]

THURSDAY 16 JANUARY, MORNING

MARK SCHEME

General Marking Instructions

Introduction

Mark schemes are published to assist teachers and students in their preparation for examinations. Through the mark schemes teachers and students will be able to see what examiners are looking for in response to questions and exactly where the marks have been awarded. The publishing of the mark schemes may help to show that examiners are not concerned about finding out what a student does not know but rather with rewarding students for what they do know.

The Purpose of Mark Schemes

Examination papers are set and revised by teams of examiners and revisers appointed by the Council. The teams of examiners and revisers include experienced teachers who are familiar with the level and standards expected of students in schools and colleges.

The job of the examiners is to set the questions and the mark schemes; and the job of the revisers is to review the questions and mark schemes commenting on a large range of issues about which they must be satisfied before the question papers and mark schemes are finished.

The questions and the mark schemes are developed in association with each other so that the issues of differentiation and positive achievement can be addressed right from the start. Mark schemes, therefore, are regarded as part of an integral process which begins with the setting of questions and ends with the marking of the examination.

The main purpose of the mark scheme is to provide a uniform basis for the marking process so that all the markers are following exactly the same instructions and making the same judgements in so far as this is possible. Before marking begins a standardising meeting is held where all the markers are briefed using the mark scheme and samples of the students' work in the form of scripts. Consideration is also given at this stage to any comments on the operational papers received from teachers and their organisations. During this meeting, and up to and including the end of the marking, there is provision for amendments to be made to the mark scheme. What is published represents this final form of the mark scheme.

It is important to recognise that in some cases there may well be other correct responses which are equally acceptable to those published; the mark scheme can only cover those responses which emerged in the examination. There may also be instances where certain judgements may have to be left to the experience of the examiner, for example, where there is no absolute correct response – all teachers will be familiar with making such judgements.

Section A

		AVAILABLE MARKS
1	C	
2	A	
3	C	
4	C	
5	B	
6	D	
7	B	
8	B	
9	D	
10	B	
[2] for each correct answer	[20]	20
	Section A	**20**

Section B

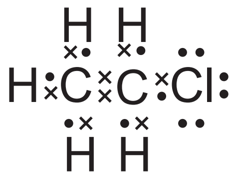
AVAILABLE MARKS

11	**(a)**	**(i)**	$BaCO_3 \rightarrow BaO + CO_2$		[1]	
		(ii)	Ca^{2+} is smaller (than Ba^{2+})/Ca^{2+} has greater charge density	[1]		
			causes more polarisation of carbonate	[1]		
			so less heat is required to decompose	[1]	[3]	
	(b)		green (flame)		[1]	
	(c)	**(i)**	add water		[1]	
		(ii)	increases down Group		[1]	
		(iii)	$Ba(OH)_2 + H_2SO_4 \rightarrow BaSO_4 + 2H_2O$		[1]	
		(iv)	white		[1]	
	(d)		add potassium chromate solution	[1]		
			yellow precipitate confirms barium ion	[1]		
			add magnesium ions solution	[1]		
			white precipitate confirms carbonate ion	[1]	[4]	
			Quality of written communication		[2]	15
12	**(a)**	**(i)**	C_nH_{2n+2}		[1]	
		(ii)	$C_{20}H_{42}$		[1]	
		(iii)	contains no C $=$ C or C $\equiv$ C bond		[1]	
	(b)		icosane has larger RMM/more electrons	[1]		
			and therefore stronger van der Waals forces	[1]	[2]	
	(c)	**(i)**	0.9 g 61 ºC		[1]	
		(ii)	0.9/282 = 0.0032	[1]		
			$\Delta H = mc\Delta T = 150 \times 4.18 \times 61 = 38\,247$ J	[1]		
			$(38\,247/0.0032)/1000 = 11\,952$ kJ mol^{-1}	[2]		
			insertion of negative sign	[1]	[5]	
		(iii)	heat loss to surroundings/can is not insulated/incomplete combustion		[1]	
	(d)	**(i)**	$C_{20}H_{42} + 30.5\,O_2 \rightarrow 20\,CO_2 + 21\,H_2O$ **or** $2\,C_{20}H_{42} + 61\,O_2 \rightarrow 40\,CO_2 + 42\,H_2O$		[2]	
		(ii)	CO		[1]	15

						AVAILABLE MARKS
13	**(a)**		it provides a different reaction pathway	[1]		
			of lower (activation) energy	[1]	[2]	
	(b)	**(i)**	equilibrium shifts to RHS	[1]		
			in exothermic direction/to produce heat	[1]	[2]	
		(ii)	equilibrium shifts to RHS	[1]		
			where there are fewer molecules	[1]	[2]	
		(iii)	28	[1]		
			0.2	[1]		
			0.3	[1]		
			$7.2\,dm^3$ ($7200\,cm^3$)	[1]	[4]	
	(c)		lead would poison/coat the surface of the catalyst		[1]	11
14	**(a)**		RCH_2OH/one alkyl group/other carbon bonded to the carbon which is bonded to the O—H		[1]	
	(b)		impaired judgment/slow reactions		[1]	
	(c)	**(i)**	orange [1] to green [1]		[2]	
		(ii)	$C_2H_5OH + [O] \rightarrow CH_3CHO + H_2O$ **or** $C_2H_5OH + 2[O] \rightarrow CH_3COOH + H_2O$		[2]	
	(d)	**(i)**	the molecule absorbs infrared radiation	[1]		
			and the bonds vibrate	[1]	[2]	
		(ii)	A is ethanol [1] because the peak for O—H/C—O is present	[1]		
			(B is) propanone as the peak for C=O is present	[1]	[3]	
	(e)		C_2H_5Cl [1] C_2H_5ONa [1] C_2H_5Cl [1]		[3]	
	(f)	**(i)**	ethyl propanoate		[1]	
		(ii)	concentrated sulfuric acid		[1]	
		(iii)	rate of forward reaction is equal to the rate of the backward reaction	[1]		
			amount of each reactant/product remains constant	[1]	[2]	
		(iv)	propanoyl chloride		[1]	19

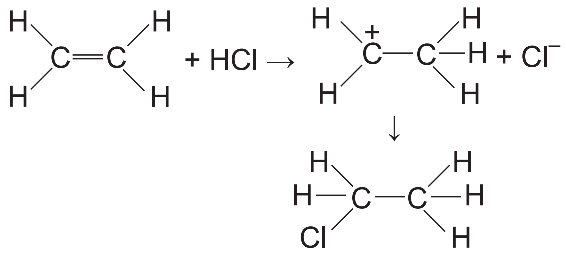
15	**(a)**	**(i)**	$C_2H_4 + Cl_2 \rightarrow CH_2ClCH_2Cl$ (allow $C_2H_4Cl_2$ for product)		[1]
		(ii)	1,2-dichloroethane		[2]
		(iii)	using heat to break large molecules into smaller molecules	[1] [1]	[2]
		(iv)	HCl/hydrogen chloride		[1]
		(v)	addition		[1]

(b) **(i)**



[1]

(ii)



[3]

([–1] each error)

(iii)	electrophilic [1] addition [1]		[2]
(iv)	pi/π		[1]

(c)

(i)	ultraviolet light		[1]
(ii)	$C_2H_6 + Cl\bullet \rightarrow C_2H_5\bullet + HCl$	[1]	
	$C_2H_5\bullet + Cl_2 \rightarrow C_2H_5Cl + Cl\bullet$	[1]	[2]
(iii)	butane		[1]

(d) $C_2H_5Cl + 2NH_3 \rightarrow C_2H_5NH_2 + NH_4Cl$
or $C_2H_5Cl + NH_3 \rightarrow C_2H_5NH_2 + HCl$ [1]
ethylamine/aminoethane [1] [2]

AVAILABLE MARKS: 20

Section B	**80**
Total	**100**

Centre Number

71	

Candidate Number

Rewarding Learning

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
2014

Chemistry

Assessment Unit AS 2

assessing

Module 2: Organic, Physical and Inorganic Chemistry

[AC122]

AC122

TUESDAY 17 JUNE, AFTERNOON

TIME

1 hour 30 minutes.

INSTRUCTIONS TO CANDIDATES

Write your Centre Number and Candidate Number in the spaces provided at the top of this page.
Answer **all seventeen** questions.
Answer **all ten** questions in **Section A**. Record your answers by marking the appropriate letter on the answer sheet provided. Use only the spaces numbered 1 to 10. Keep in sequence when answering.
Answer **all seven** questions in **Section B**. Write your answers in the spaces provided in this question paper.

INFORMATION FOR CANDIDATES

The total mark for this paper is 100.
Quality of written communication will be assessed in Question **13(b)(ii)**.
In Section A all questions carry equal marks, i.e. **two** marks for each question.
In Section B the figures in brackets printed down the right-hand side of pages indicate the marks awarded to each question or part question.
A Periodic Table of the Elements, containing some data, is included in this question paper.

For Examiner's use only	
Question Number	**Marks**
Section A	
1–10	
Section B	
11	
12	
13	
14	
15	
16	
17	
Total Marks	

Section A

For each of the following questions only **one** of the lettered responses (A–D) is correct.

Select the correct response in each case and mark its code letter by connecting the dots as illustrated on the answer sheet.

1 Equal volumes of 1-chlorobutane and 1-iodobutane are warmed with aqueous silver nitrate in the presence of ethanol. Which one of the following is the reason why the 1-chlorobutane reacts more slowly?

A The C–Cl bond is more polar than the C–I bond

B The C–Cl bond is stronger than the C–I bond

C The C–I bond is more polar than the C–Cl bond

D The C–I bond is stronger than the C–Cl bond

2 Which one of the following is correct as Group II is descended?

	Solubility of hydroxides	**Solubility of sulfates**
A	decreases	decreases
B	decreases	increases
C	increases	decreases
D	increases	increases

3 Which one of the following is the colour of the flame produced when a barium compound is placed in a blue Bunsen burner flame?

A Crimson

B Green

C Lilac

D Orange

4 Which one of the following shows the effect on the yield of ammonia in the Haber process?

	Pressure increase	**Temperature increase**
A	yield decreases	yield decreases
B	yield decreases	yield increases
C	yield increases	yield decreases
D	yield increases	yield increases

5 Which one of the following mixtures will react to produce a compound with molecular formula C_4H_7N?

A 1-bromobutane and ammonia

B 1-bromobutane and potassium cyanide

C 1-bromopropane and ammonia

D 1-bromopropane and potassium cyanide

6 The reaction shown below

$$C_2H_5Br + KOH \rightarrow C_2H_4 + KBr + H_2O$$

is an example of

A dehydration.

B elimination.

C free radical substitution.

D nucleophilic substitution.

7 Which one of the following is the mass of magnesium required to react with 50.0 cm^3 of 0.1 mol dm^{-3} hydrochloric acid?

A 0.005 g

B 0.060 g

C 0.120 g

D 0.240 g

8 Which one of the following lists the compounds in order of increasing boiling point?

A	$CH_3CH_2CH_3$	CH_3CH_2F	CH_3CH_2OH
B	$CH_3CH_2CH_3$	CH_3CH_2OH	CH_3CH_2F
C	CH_3CH_2F	CH_3CH_2OH	$CH_3CH_2CH_3$
D	CH_3CH_2OH	CH_3CH_2F	$CH_3CH_2CH_3$

9 When an organic compound was reacted with chlorine, the organic product was found to have a relative molecular mass which had increased by 69. Which one of the following is the reaction mechanism?

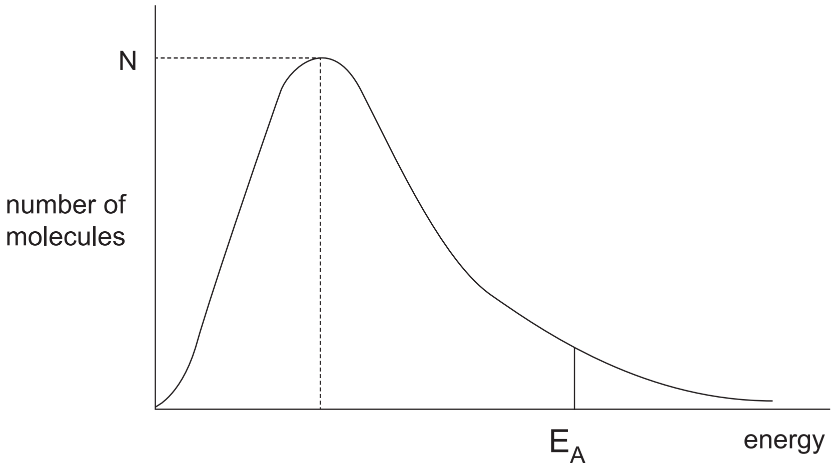
A elimination

B electrophilic addition

C free radical substitution

D nucleophilic substitution

10 The Maxwell–Boltzmann distribution for a reaction mixture is shown below. N is the number of molecules with the most probable energy and E_A is the activation energy.



Which one of the following shows the effect on E_A and on N of increasing the temperature?

	E_A	N
A	constant	decreases
B	constant	increases
C	decreases	decreases
D	decreases	increases

Section B

Examiner Only	
Marks	Remark

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

11 Butan-1-ol is used to prepare 1-bromobutane according to the following equation:

$$C_4H_9OH + HBr \rightarrow C_4H_9Br + H_2O$$

(a) **(i)** Give an equation to explain the term **percentage yield**.

percentage yield =

[1]

(ii) Assuming a 40% yield, what mass of butan-1-ol would be required to produce 5.48 g of 1-bromobutane?

moles of 1-bromobutane

____

moles of butan-1-ol

____

mass of butan-1-ol

____ [3]

(b) **(i)** Give an equation to explain the term **atom economy**.

atom economy =

[1]

(ii) Calculate the atom economy for the formation of 1-bromobutane from butan-1-ol.

____

____ [1]

Examiner Only
Marks | Remark

12 Qualitative analysis can be used to distinguish between aqueous solutions containing different metal ions.

(a) For each of the following pairs of metal ions, give an aqueous reagent which can be used to distinguish between the aqueous solutions and state the expected observations for each ion.

(i) Iron(II) ions and iron(III) ions.

Reagent ______________________________ [1]

Observations ______________________________

____

______________________________ [2]

(ii) Aluminium ions and zinc ions.

Reagent ______________________________ [1]

Observations ______________________________

____

______________________________ [2]

(b) Addition of an aqueous solution of potassium chromate can be used to test for the presence of barium ions.

(i) What is observed when barium ions react with chromate ions?

______________________________ [1]

(ii) Write an ionic equation, including state symbols, for the reaction of barium ions with chromate ions.

______________________________ [2]

13 The fluorohydrocarbon below exists in two stereoisomeric forms.

$$CH_3CH_2CH{=}CFCH_2CH_3$$

(a) Name this fluorohydrocarbon using IUPAC rules.

______________________________ [2]

(b) **(i)** Draw and label the structures of the E and Z isomers of this fluorohydrocarbon.

[1]

(ii) Explain why one of the structures you have drawn is classified as the Z isomer.

____

____

____

____

______________________________ [3]

Quality of written communication [2]

Examiner Only	
Marks	Remark

(c) (i) Draw a structural isomer of the fluorohydrocarbon which does **not** exist as stereoisomers.

[1]

(ii) Explain, in terms of the structure of this molecule, why it does not exist as stereoisomers.

____

____ [2]

Examiner Only	
Marks	Remark

Examiner Only	
Marks	Remark

14 Propene reacts with hydrogen bromide to form two isomers, the major product being 2-bromopropane.

(a) Explain why hydrogen bromide is attracted to propene.

____

____

____ [2]

(b) Suggest flow schemes for the mechanisms of the reaction of hydrogen bromide with propene to form 1-bromopropane and 2-bromopropane, showing the structure of both intermediates.

[4]

(c) **(i)** Suggest how you would separate a mixture of 1-bromopropane and 2-bromopropane.

____ [1]

(ii) Suggest how you would use infra-red spectroscopy to identify an unknown sample of bromopropane as either 1-bromopropane or 2-bromopropane.

____

____ [1]

Examiner Only	
Marks	Remark

(d) Suggest why 2-bromopropane is the major product.

____ [1]

(e) Name the mechanism of these reactions.

____ [1]

(f) Propene undergoes addition polymerisation to form polypropene.
Draw the structure of polypropene showing **three** repeating units.

[2]

Examiner Only	
Marks	Remark

15 Under a particular set of conditions incomplete combustion of propane occurred according to the following equation:

$$C_3H_8(g) + 4O_2(g) \rightarrow CO_2(g) + 2CO(g) + 4H_2O(l)$$

The total volume of gases produced occupied a volume of 9000 dm^3. The molar gas volume, under these conditions, is 30 dm^3.

(a) Define the term **molar gas volume**.

____

____ [2]

(b) (i) Calculate the number of moles of carbon monoxide produced in this combustion.

____

____ [2]

(ii) Calculate the number of moles of oxygen used in this combustion.

____

____ [1]

(iii) Calculate the mass of propane, in kg, burned.

____

____ [3]

(iv) Calculate the number of molecules of propane burned.

____

____ [1]

(c) Under a different set of conditions, methane undergoes incomplete combustion to produce carbon dioxide and carbon monoxide in a 2:1 ratio. Write an equation for this incomplete combustion.

____ [2]

Examiner Only	
Marks	Remark

16 Butane is sold commercially as “bottled gas”. It undergoes complete combustion according to the following equation:

$$2C_4H_{10} + 13O_2 \rightarrow 8CO_2 + 10H_2O$$

and has a standard enthalpy of combustion of –2876.5 kJ mol^{-1}.

(a) Calculate the amount of energy released for every kilogram of carbon dioxide released.

____

____

____ [3]

(b) Hess’s Law can be used to calculate enthalpy changes, such as the standard enthalpy of formation of butane, which cannot be measured by experiment.

(i) Define the term **standard enthalpy of formation**.

____

____ [3]

(ii) Write an equation, with state symbols, which represents the standard enthalpy of formation of butane.

____ [2]

(iii) Use the standard enthalpy of combustion of butane and the following data to calculate the standard enthalpy of formation of butane.

	Standard enthalpy of combustion (kJ mol^{-1})
Carbon (C)	–393.5
Hydrogen (H_2)	–285.8

____

____

____

____ [3]

Examiner Only	
Marks	Remark

17 The formula for ethylene glycol is shown below:

$$\begin{array}{l} CH_2OH \\ | \\ CH_2OH \end{array}$$

(a) Use IUPAC rules to give the systematic name of ethylene glycol.

______________________________ [1]

(b) What is the empirical formula of ethylene glycol?

______________________________ [1]

(c) Ethylene glycol reacts vigorously with an *excess* of ethanoyl chloride.

(i) Suggest **two** observations in this reaction.

____

______________________________ [2]

(ii) Name the type of reaction occurring.

______________________________ [1]

(iii) Draw the structure of the organic product.

[2]

(iv) Suggest a test for the inorganic product formed in this reaction.

____

______________________________ [2]

Examiner Only	
Marks	Remark

(d) Ethylene glycol contains primary alcohol groups. When heated under reflux with excess acidified potassium dichromate the solution changes from orange to green.

(i) Why are the alcohol groups in ethylene glycol classified as primary?

____

____ [1]

(ii) Name the type of reaction occurring.

____ [1]

(iii) Draw the structure of the organic product.

[1]

(iv) Name the functional group present in the organic product.

____ [1]

(v) What would be the most significant difference between the infra-red spectrum of the organic product and that of ethylene glycol?

____

____ [1]

(e) Write an equation for the reaction of ethylene glycol with an excess of phosphorus pentachloride.

[2]

(f) Explain, in terms of structure, why an iodoform test does not give a positive result with ethylene glycol.

____

____ [1]

(g) The boiling point of ethylene glycol is 197 °C and that of ethanol is 78 °C. Explain this large difference in boiling points.

____

____

____ [3]

Examiner Only	
Marks	Remark

THIS IS THE END OF THE QUESTION PAPER

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