

Semester One
ATAR course examination, 2022
Question/Answer Booklet

CHEMISTRY - UNIT 1

WA Student Number: In figures

--	--	--	--	--	--	--	--

In words

Student Name

Time allowed for this paper

Reading time before commencing work: ten minutes
Working time: three hours

Number of additional
answer booklets used
(if applicable):

Materials required/recommended for this paper

To be provided by the supervisor

This Question/Answer booklet
Multiple-choice answer sheet
Chemistry Data booklet

To be provided by the candidate

Standard items: pens (blue/black preferred), pencils (including coloured), sharpener, correction fluid/tape, eraser, ruler, highlighters
Special items: up to three calculators, which do not have the capacity to create or store programmes or text, are permitted in this ATAR course examination

Important note to candidates

No other items may be taken into the examination room. It is **your** responsibility to ensure that you do not have any unauthorised material. If you have any unauthorised material with you, hand it to the supervisor **before** reading any further.

Structure of this paper

Section	Number of questions available	Number of questions to be answered	Suggested working time (minutes)	Marks available	Percentage of examination
Section One Multiple-choice	25	25	50	25	25
Section Two Short answer	10	10	60	74	35
Section Three Extended answer	6	6	70	79	40
Total					100

Instructions to candidates

1. The rules for the conduct of the Western Australian external examinations are detailed in the *Year 11 Information Handbook 2022: Part II Examinations*. Sitting this examination implies that you agree to abide by these rules.
2. Write your answers in this Question/Answer booklet preferably using a blue/black pen. Do not use erasable or gel pens.
3. Answer the questions according to the following instructions.

Section One: Answer all questions on the separate Multiple-choice answer sheet provided. For each question, shade the box to indicate your answer. Use only a blue or black pen to shade the boxes. Do not use erasable or gel pens. If you make a mistake, place a cross through that square, then shade your new answer. Do not erase or use correction fluid/tape. Marks will not be deducted for incorrect answers. No marks will be given if more than one answer is completed for any question.

Section Two and Three: Write your answers in this Question/Answer booklet.

4. When calculating numerical answers, show your working or reasoning clearly. Your working should be in sufficient detail to allow your answers to be checked readily and for marks to be awarded for reasoning. Express numerical answers to the appropriate number of significant figures and include appropriate units where applicable.
5. You must be careful to confine your answers to the specific questions asked and to follow any instructions that are specific to a particular question.
6. Supplementary pages for the use of planning/continuing your answer to a question have been provided at the end of this Question/Answer booklet. If you use these pages to continue an answer, indicate at the original answer where the answer is continued, i.e., give the page number.
7. The Chemistry Data booklet is not to be handed in with your Question/Answer booklet.

Section One: Multiple-choice

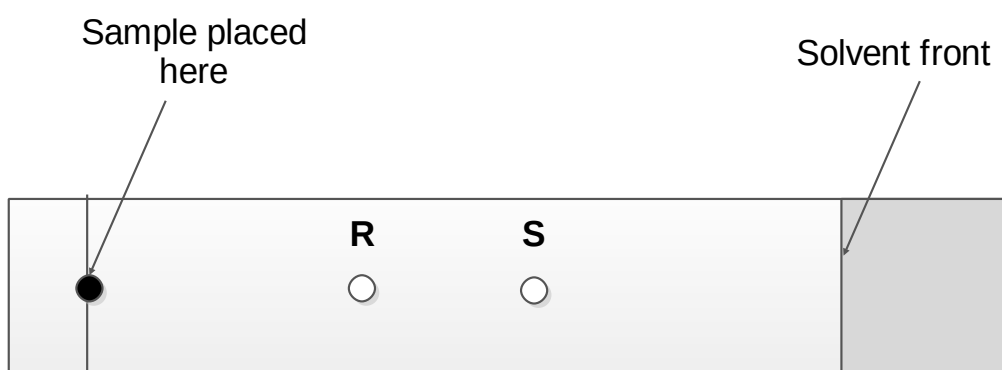
25% (25 Marks)

This section has **25** questions. Answer **all** questions on the separate Multiple-choice answer sheet provided.

For each question shade the box to indicate your answer. Use only a blue or black pen to shade the boxes. Do not use erasable or gel pens. If you make a mistake, place a cross through that square, then shade your new answer. Do not erase or use correction fluid/tape. Marks will not be deducted for incorrect answers. No marks will be given if more than one answer is completed for any question.

Suggested working time: 50 minutes.

1. A mixture is made of two components (R and S). A sample of the mixture was dotted onto chromatography paper, and a chromatogram was developed using an appropriate solvent. The result is shown below.



Component R is absorbed

- (a) more strongly onto the stationary phase and has a larger R_f value than component S.
(b) more strongly onto the stationary phase and has a smaller R_f value than component S.
(c) less strongly onto the stationary phase and has a larger R_f value than component S.
(d) less strongly onto the stationary phase and has a smaller R_f value than component S.
2. Diamond is a solid form of carbon with its atoms arranged in
- (a) a hexagonal array.
(b) the structure of a ring.
(c) in the shape of a football.
(d) rigid three-dimensional structure.
3. The change in enthalpy shown in this equation



Is referred to by chemists as

- (a) activation energy.
(b) ionisation energy.
(c) electronegativity.
(d) exothermic.

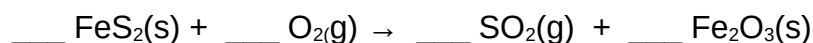
4. The table below shows information about three pure solids A, B and C.

	A	B	C
Approximate melting point (°C)	800	3500	1500
Electrical conductivity in the solid state	nil	low	high
Electrical conductivity in the liquid (melted) state	high	cannot be easily tested	high

Which one of the following describes the bonding present in the three substances?

	A	B	C
(a)	covalent molecular	covalent network	ionic
(b)	ionic	covalent network	metallic
(c)	ionic	metallic	metallic
(d)	covalent molecular	metallic	ionic

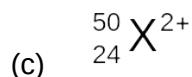
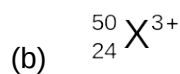
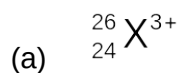
When iron pyrite (FeS_2) is heated in air it forms sulfur dioxide and iron(III) oxide (Fe_2O_3). The **unbalanced** chemical equation is shown below.



5. When the above chemical equation is balanced, the coefficient of sulfur dioxide gas is
- (a) 2.
 (b) 4.
 (c) 7.
 (d) 8.
6. Which row correctly identifies the scientist who made each of these discoveries?

	Neutron	Nucleus	Electron	Electron Shells
(a)	Dalton	Bohr	Rutherford	Chadwick
(b)	Thomson	Dalton	Bohr	Dalton
(c)	Chadwick	Rutherford	Thompson	Bohr
(d)	Bohr	Chadwick	Dalton	Rutherford

7. The ion that contains 24 protons, 26 neutrons and 21 electrons would be represented by which of the following symbols?



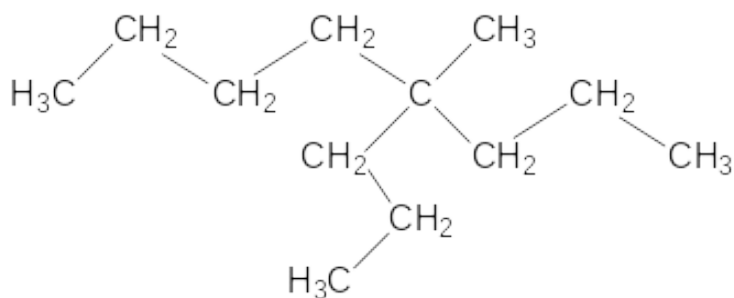
8. The mass of 2.60×10^{22} chlorine **atoms** is closest to

- (a) 3.06 g.
(b) 11.0 g.
(c) 0.765 g.
(d) 1.53 g.

9. Which one of the following species does **not** have a noble gas electron configuration?

- (a) S^{2-}
(b) P^{2-}
(c) Al^{3+}
(d) Sb^{3-}

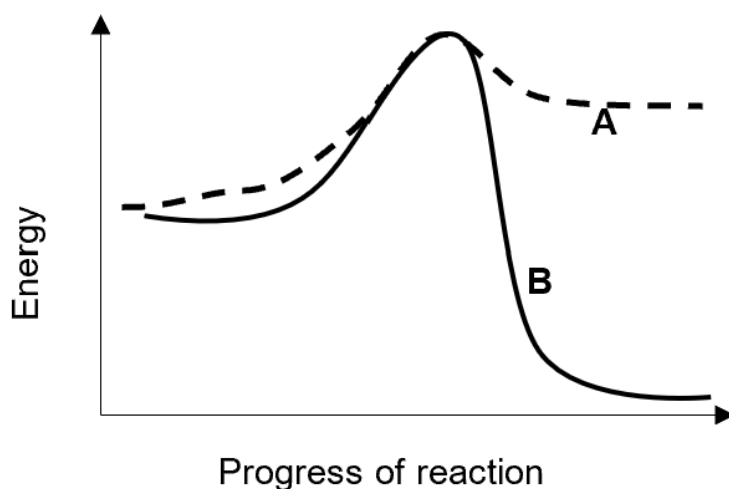
10. Select the correct IUPAC name for:



- (a) 4-methyl-5-ethyloctane
(b) 5-methyl-5-propylheptane
(c) 4-methyl-4-propyloctane
(d) 3-methyl-3-propyloctane

Questions 11 and 12 refer to the following information.

Energy profile diagrams for two **different** unknown chemical reactions (**A** and **B**) are shown below. The two chemical reactions are conducted in two identical beakers at the same temperature and atmospheric pressure.



11. If scientists were comparing reactions A and B it is important that the reactions were conducted many times at the same temperature and pressure to eliminate
- (a) systematic errors.
 - (b) controlled variables.
 - (c) experimental errors.
 - (d) random errors.
12. The enthalpy graph shows that
- (a) reaction **A** is faster than reaction **B**.
 - (b) both chemical reactions require approximately the same activation energy.
 - (c) beaker **A** would be warmer than beaker **B** when the reactions are complete.
 - (d) reaction **A** used a catalyst.
13. Which one of the following atoms has a larger atomic radius than a phosphorus atom?
- (a) nitrogen
 - (b) chlorine
 - (c) aluminium
 - (d) fluorine
14. Which one of the following substances has delocalised electrons?
- (a) graphite
 - (b) iodine
 - (c) sodium chloride solution
 - (d) tetrachloromethane

15. Which one of the following processes has a negative enthalpy change?

- (a) $\text{I}_2(\text{g}) \rightarrow 2 \text{I}(\text{g})$
- (b) $\text{CH}_3\text{OH}(\ell) \rightarrow \text{CH}_3\text{OH}(\text{g})$
- (c) $\text{CO}_2(\text{g}) \rightarrow \text{CO}_2(\text{s})$
- (d) $\text{H}_2\text{O}(\text{s}) \rightarrow \text{H}_2\text{O}(\ell)$

16. Sodium chloride is crystalline because

- (a) it is a regular 3D arrangement of positive and negative ions.
- (b) there is strong electrostatic attraction between oppositely charged ions.
- (c) the crystal contains ions.
- (d) there are free electrons present which reflect light.

17. Which of the following options could correctly complete the following sentence?

“Compounds and mixtures both contain various atoms but the key difference is that compounds have distinct measurable qualities including”

- (i) melting point.
- (ii) boiling points.
- (iii) volume.
- (iv) reactivity.
- (v) hardness.

- | | |
|--------------------------|------------------------------------|
| (a) (i), (iii) and (iv) | (b) (i), (ii), (iv), and (v) |
| (c) (ii), (iii) and (iv) | (d) (i), (ii), (iii), (iv) and (v) |

18. On the Periodic Table, electronegativity

- (a) increases across a period and decreases down a group.
- (b) decreases across a period and decreases down a group.
- (c) increases across a period and increases down a group.
- (d) decreases across a period and increases down a group.

19. Which one of the following is true about C_{60} ?

- (a) Each carbon is bonded covalently to 3 other carbon atoms in a hexagonal ball like structure.
- (b) Each carbon is bonded covalently to 4 other carbon atoms in layers.
- (c) It is a giant lattice structure.
- (d) It is a strong 3D crystalline structure.

Questions 20 and 21 refer to the following diagram.

The top portion of a Periodic Table of elements is shown. The transition metals have been left out of this simple representation. Letters instead of symbols are used to represent the various elements.

A							B
C	D	E	F	G	H	I	J
K	L	M	N	O	P	Q	R
S	T						

20. The formula for a compound of L and Q would be

- (a) L_2Q
- (b) L_2Q_2
- (c) LQ_2
- (d) LQ

21. When forming a compound between L and Q the bonding and process would be

	Bonding	Process – valence electrons are...
(a)	covalent	shared between the atoms.
(b)	covalent	transferred between the atoms.
(c)	ionic	shared between the atoms.
(d)	ionic	transferred between the atoms.

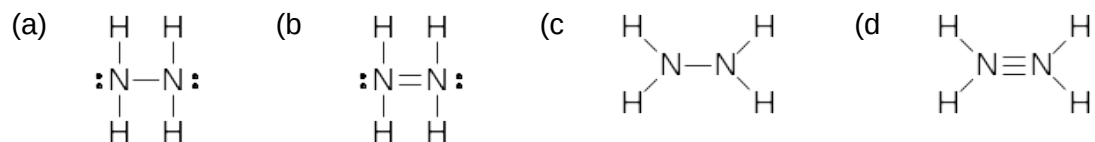
22. A particular element is found in Group 2, Period 6 in the Periodic Table. How many valence electrons does this element have in its neutral state?

- (a) 2
- (b) 8
- (c) 16
- (d) 56

23. Which one of the following best explains why solid magnesium chloride does not conduct electricity but molten magnesium chloride does conduct electricity?

- (a) The magnesium chloride only forms ions in the liquid state.
- (b) The electrons in the magnesium are free to move in the molten magnesium chloride.
- (c) The ions in the solid form are in fixed positions but when melted they are free to move.
- (d) In molten magnesium chloride electrons can move from the magnesium atoms to the chlorine atoms.

24. The molecule N_2H_4 would be best represented by the structure



25. Mass spectrometers separate isotopes of different elements based on

- (a) mass only.
- (b) electric charge only.
- (c) mass and electric charge.
- (d) emission of photons.

End of Section One

Section Two: Short answer

35% (74 Marks)

This section has **ten** questions. Answer **all** questions. Write your answers in the spaces provided.

Supplementary pages for planning/continuing your answer to questions are provided at the end of this Question/Answer booklet. If you use these pages to continue an answer, indicate at the original answer where the answer is continued, i.e., give the page number.

Suggested working time: 60 minutes.

Question 26

(7 marks)

(a) Complete the table below which shows information about some atoms and ions.

(4 marks)

Species	Name of particle	Full symbol of atom or ion	Number of protons	Number of electrons	Number of neutrons
I	Carbon atom	$^{12}_6\text{C}$			6
II	Oxide ion		8		8
III			13	10	14
IV			6	6	8

(b) Use the table in part (a) to answer the following questions, using options I, II, III or IV.

Identify:

(i) **Two** species that are isotopes:

(1 mark)

(ii) **One** species that is a cation.

(1 mark)

(iii) **Two** species that form an ionic compound:

(1 mark)

Question 27

(8 marks)

Complete the table below.

Species	Bonding present (Covalent molecule, covalent network, ionic or metallic)	Electrical conductivity (Yes or no)
silver solid		
graphite		
KCl molten		
SiO ₂ solid		

Question 28

(4 marks)

Bohr, Niels (1885-1962), was a Danish physicist. He worked with J.J. Thomson and Ernest Rutherford before being appointed professor at the University of Copenhagen. He used the quantum theory to explain the structure of the atom. He escaped from German-occupied Denmark (1943) and helped to develop the atom bomb in the United States. After the war he returned to Copenhagen and worked for international cooperation. He was awarded a Nobel Prize in physics in 1922 for his work on atomic structure.

Explain the Bohr model of the atom by referring to his findings regarding the structure of the atom, the forces involved, and list one item of evidence to support the theory.

Question 29**(5 marks)**

Selenium, Se, is used in the manufacture of solar energy devices. It forms an oxide that is 28.84% oxygen by mass. By calculation determine the molecular formula of the oxide showing clear reasoning'.

Question 30

(10 marks)

The “pop test” is used to test for the presence of hydrogen gas. When a test tube of hydrogen is placed near a Bunsen burner flame a fast reaction occurs between the hydrogen and oxygen in the air causing a “pop” sound.

- (a) Write an equation, including state symbols, for the reaction occurring in the “pop” test. (2 marks)

- (b) On the axes below, draw the energy profile diagram for the reaction, labelling the axes, products, reactants, activation energy and overall enthalpy change. (4 marks)



- (c) The water vapour formed in the reaction condenses on the inside of the test tube.
- (i) Will the enthalpy of the water increase or decrease when it condenses on the inside of the test tube?

- (ii) Explain the reason for your answer including an equation

Explanation: _____

Question 31

(13 marks)

A sample of krypton found in a meteorite is analysed in a mass spectrometer. The processes in the mass spectrometer are listed below.

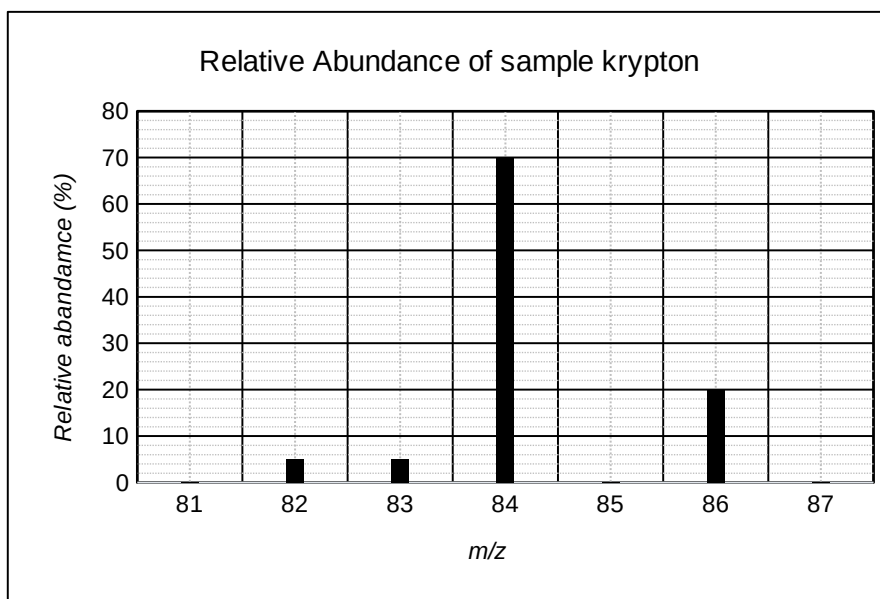
deflection	acceleration	detection	ionisation
-------------------	---------------------	------------------	-------------------

- (a) The correct order for these processes is (2 marks)

- (b) Explain the deflection stage in the mass spectrometer and the purpose of its inclusion. (5 marks)

Question 31 (continued)

(c) The relative abundance of krypton from the meteorite is shown below.



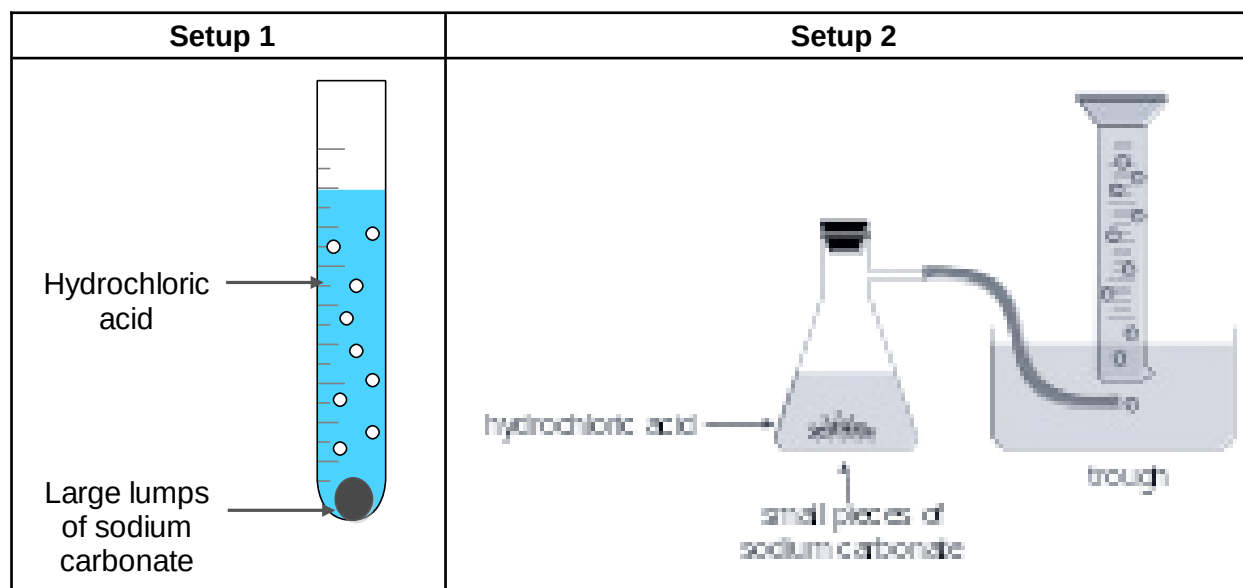
- (c) (i) Use this spectrum to calculate the relative atomic mass of this sample of krypton. (3 marks)

- (ii) Explain why the value found in part (i) is slightly different from the relative atomic mass stated on the Periodic Table. (3 mark)

Question 32

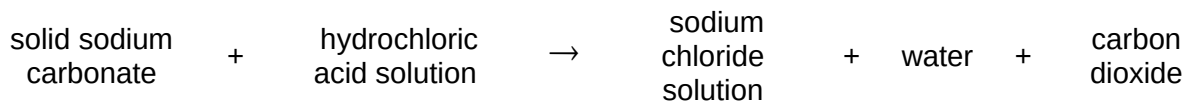
(7 marks)

A student conducted an experiment to investigate the rate of reaction between sodium carbonate and hydrochloric acid using different sized pieces of solid sodium carbonate. The experiment was completed in two different setups, as shown below.



For both setups, the mass of the sodium carbonate was 3.50 g, and 25.0 mL of the hydrochloric acid was used each time.

The chemical reaction can be summarised as;



(a) For the purpose of the investigation,

(i) The independent variable is the (1 mark)

(ii) State **one** reason why the teacher said to the student that the way the investigation was carried out was **not** valid. (1 mark)

Question 32 (continued)

- (b) Write the balanced ionic equation for the experiment. (3 marks)

- (c) During the experiment, gas bubbles were formed. Describe an appropriate test that could be used to identify this gas. (2 marks)

Question 33

(6 marks)

(a) A piece of pure gold metal has a mass of 0.400 g.

(i) Calculate the number of moles of gold atoms in the sample.

(2 marks)

(ii) Calculate the number of gold atoms in the sample.

(1 mark)

(b) An unknown element **X** forms a *diatomic* molecule. If 0.600 mole of the molecule **X** has a mass of 22.8 g. Determine the identity of the element. (3 marks)

Question 34**(5 marks)**

Racing bicycles are made from a variety of materials including metals, such as steel, aluminium titanium, and non-metals such as carbon fibre.

Describe, in terms of the bonding and structure, why metals are suitable to produce a strong bicycle frame, and yet can be fashioned into a complex shape. (5 marks)

Question 35

(9 marks)

Diamond and graphite are both giant covalent substances made of carbon atoms.

diamonds are used in cutting tools

graphite is used in pencils to make marks on paper

- (a) Explain, with reference to structure and bonding, why each substance is suitable for its particular use. (5 marks)

Carbon nanotubes (CNT's) are allotropes of carbon with a cylindrical nanostructure.

- (b) Explain the meaning of the term "allotrope". (2 marks)

Question 35 (continued)

- (c) Read the information below and List **two** reasons that CNT could be used for body armour. (2 marks)

Recently, fibers spun from pure CNTs have been demonstrated [R.H. Baughman, Science 290, 1310 (2000)] and are experiencing rapid development, together with CNT composite fibers. Such super strong fibers will have several applications such as woven fabrics and textiles, transmission line cables, and body and vehicle armor. CNTs are also being employed in order to make textiles stain resistant.

End of Section Two

Section Three: Extended answer

40% (79 Marks)

This section contains **seven** questions. You must answer **all** questions. Write your answers in the spaces provided.

Where questions require an explanation and/or description, marks are awarded for the relevant chemical content and also for coherence and clarity of expression. Lists or dot points are unlikely to gain full marks.

Final answers to calculations should be expressed to the appropriate number of significant figures.

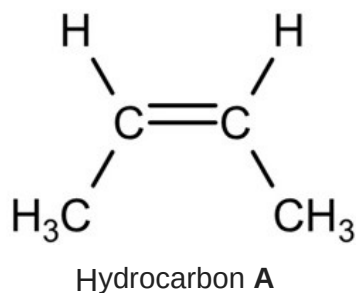
Supplementary pages for planning/continuing your answer to questions are provided at the end of this Question/Answer booklet. If you use these pages to continue an answer, indicate at the original answer where the answer is continued, i.e., give the page number.

Suggested working time: 70 minutes.

Question 36

(23 marks)

The hydrocarbon **A**, shown below is an organic compound. It is a colourless gas that is easily condensed to produce a colourless liquid.

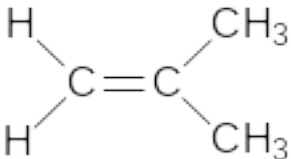
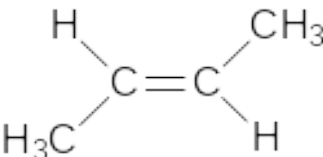


- (a) State the IUPAC name for the hydrocarbon **A**.

(2 marks)

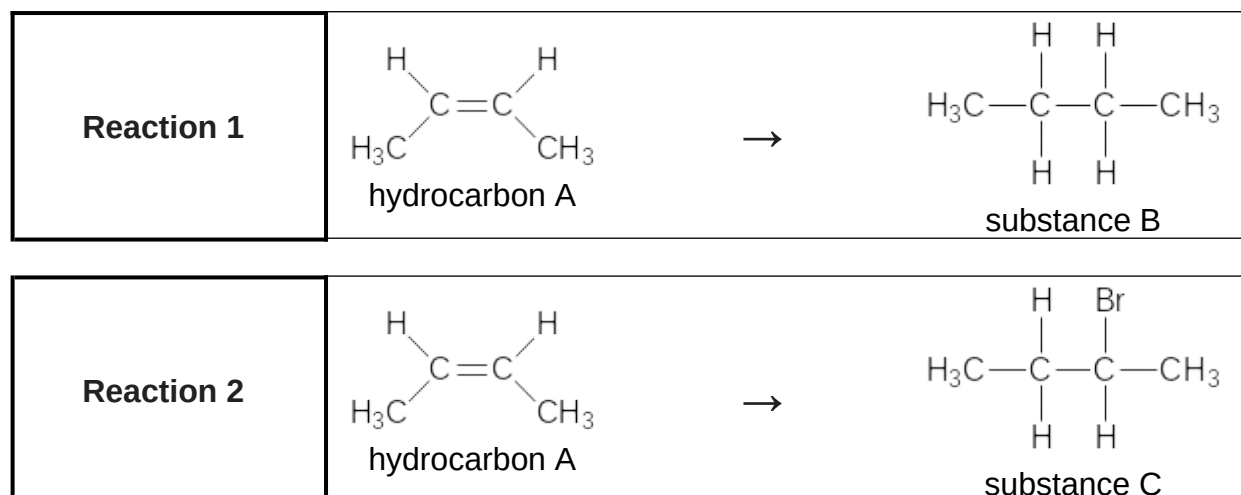
Question 36 (continued)

- (b) Complete the following table by stating an IUPAC name or drawing a full structural formula of the isomers of the hydrocarbon **A**. All hydrogen atoms must be shown. (3 marks)

Full structural formula of isomer of species 1	IUPAC Name
	but-1-ene
	
	

- (c) The incomplete combustion of hydrocarbon **A** forms toxic carbon monoxide gas. Explain why carbon monoxide forms rather than carbon dioxide and provide balanced equations for both the complete and incomplete combustion of hydrocarbon **A**. (3 marks)

Hydrocarbon **A** can be used to produce other organic substances. Two reactions of this hydrocarbon are shown below. Some of the reactants are not shown.



- (d) (i) Complete the following table by stating the type of chemical reaction and reactants involved. (4 marks)

	Name of the type of chemical reaction	Reactant involved
Reaction 1		
Reaction 2		

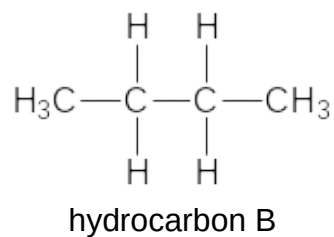
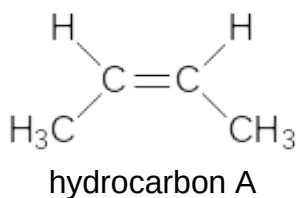
- (ii) Write a balanced chemical equation for each chemical reaction. (4 marks)

Reaction 1: _____

Reaction 2: _____

Question 36 (continued)

- (e) Both hydrocarbons **A** and **B**, are colourless liquids at room temperature. They also have the same number of carbon atoms.

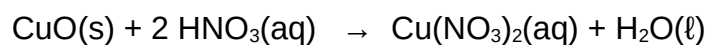


- (i) Draw a circle around the hydrocarbon that is unsaturated. (1 mark)
- (ii) Describe how bromine water can be used to distinguish hydrocarbon A from B. (6 marks)

Question 37

(10 marks)

To produce crystals of hydrated copper(II) nitrate, a sample of 5.60 g of copper(II) oxide is added to excess dilute nitric acid solution. The chemical equation for this reaction is shown below.



- (a) Write an **ionic equation** for the chemical reaction above and state the observation(s). If there is no reaction, write 'no reaction' for the equation and if there is no change observed, write 'no visible reaction' for the observations. Where applicable, use the colours stated in the Chemistry Data Booklet. (3 marks)

Equation: _____

Observations: _____

- (b) The resulting copper(II) nitrate solution is heated and left on a suitable watch-glass overnight. Once dried, the content becomes a dark blue hydrated copper(II) nitrate, $\text{Cu(NO}_3)_2 \cdot 6\text{H}_2\text{O}$. $M=295.647$

Calculate the mass of $\text{Cu(NO}_3)_2 \cdot 6\text{H}_2\text{O}$ that could theoretically be obtained. (3 marks)

- (c) The following day it was discovered that the mass of the hydrated copper(II) nitrate was 12.52 g.

- (i) Name the process used to produce hydrated copper (II) nitrate on the watch-glass. (1 mark)

- (ii) Show by calculation that the percentage yield of hydrated copper(II) nitrate is approximately 60%. (2 marks)

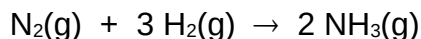
Question 37 (continued)

- (c) (iii) State **one** reason why the percentage yield is less than 100%, even though the chemical reaction is complete. (1 mark)

Question 38

(13 marks)

When nitrogen molecules react with hydrogen molecules, ammonia molecules are formed. The chemical reaction is shown below.



The reaction is exothermic.

- (a) Draw dot diagrams (Lewis structures) for the species involved. Show all valence shell electron pairs as either: or — (6 marks)

N_2		H_2		NH_3
$+$				
\rightarrow				

- (b) The reaction is exothermic. Explain, what can be deduced concerning bond breaking and bond forming in this reaction. (3 marks)

- (c) If the change in enthalpy (ΔH) is -92 kJ mol^{-1} , calculate the total energy, in kJ, that is released or absorbed if 20.0 kg of nitrogen molecules are consumed in the reaction. (4 marks)

(8 marks)

silica (SiO ₂)	sodium chloride (NaCl)	copper (II) chloride (CuCl ₂).
----------------------------	------------------------	--

	Solubility in water (g/100g) at 25 °C	Solubility in ethanol (g/100g) at 25 °C
SiO ₂	0.012	Nil
NaCl	36	0.065
CuCl ₂	61	67

distilled water
filter paper and funnels
stirring rods

This image shows a single sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

Question 40

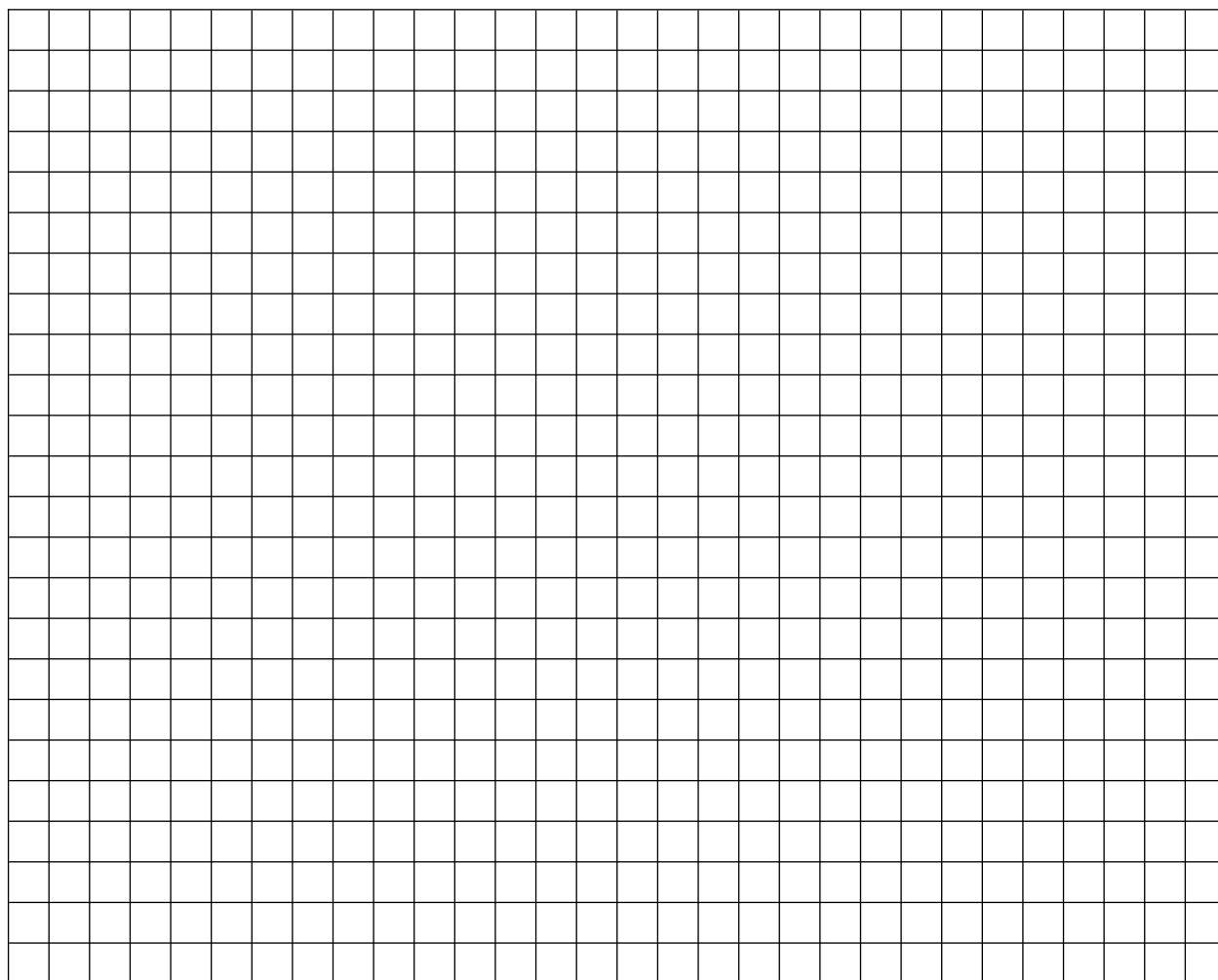
(16 marks)

Iodine deficiency is the most common cause of thyroid disease and can cause permanent brain damage and intellectual disability in babies. A supplement containing potassium iodide is often recommended for adults with iodine deficient diets.

- (a) The solubility of potassium iodide at a range of temperatures is given in the table below.

Temperature	Solubility of potassium iodide
(°C)	(g/100 g H ₂ O)
20	144
30	154
40	152
50	166

- (i) Graph the solubility of potassium iodide at various temperatures on the grid provided. (4 marks)



A spare grid is provided at the end of this Question/Answer booklet. If you need to use it, cross out this attempt and indicate that you have redrawn it on the spare grid.

Question 40 (continued)

- (ii) Determine if a solution containing 680.0 g of potassium iodide in 500.0 g of water at 20.0°C is saturated or unsaturated. Show evidence to support your answer. (3 marks)

- (iii) On heating a saturated solution of potassium iodide containing 25.0 g of water from an initial temperature of 30 °C to a higher temp a further 4.00g of potassium iodide dissolved. Assuming the solution remained saturated, determine the temperature to which the solution was heated. Show all your calculations. (3 marks)

- (b) A flame test is an analytical procedure that can be used in chemistry to detect the presence of certain metal ions. A flame colour of violet indicates the presence of potassium ions.

- (i) Explain how a coloured flame is produced in a flame test. (2 marks)

- (ii) During a flame test, sodium salts emit a bright yellow flame while potassium salts emit a pale violet flame. Explain why different colours are observed. (4 marks)

Question 41

(9 marks)

Metal displacement reactions refer to those chemical reactions where a more reactive metal displaces another less reactive metal present in a compound.

The table below shows if a displacement occurs (✓) when a metal is added to a solution of a metal ion.

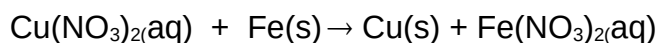
metal	copper(II) nitrate	calcium chloride	iron(II) nitrate	silver nitrate
copper		X	X	✓
iron	✓	X		✓
silver	X	X	X	

- (a) Write the chemical formula for each of the substances used to prepare the solutions.

(4 marks)

copper(II) nitrate	
calcium chloride	
iron(II) nitrate	
silver nitrate	

- (b) According to the table, the iron metal can displace copper from copper(II) nitrate solution. This results in the formation of copper metal and iron(II) nitrate solution as described in the equation below.



Describe the observations that would be made when a small quantity of iron is added to an excess of copper nitrate solution.

(5 marks)

End of questions

Supplementary page

Question number: _____

Question number: _____

Question number: _____

Spare grid

