Rossmoyne Senior High School Semester One

ATAR course examination, 2021

Question/Answer Booklet

CHEMISTRY - UNIT 1

WA Student Number: In figures | | | | | | | | | |

In words _____

Circle Teacher Name **BARNES DHUE FAGAN LLOYD HOLYOAKE THOMPSON VENTER**

Time allowed for this paper

Reading time before commencing work: ten minutes
Working time: two and a half 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	20	20	35	20	25
Section Two Short answer	7	7	50	63	35
Section Three Extended answer	4	4	60	72	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 2021: Part I 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.

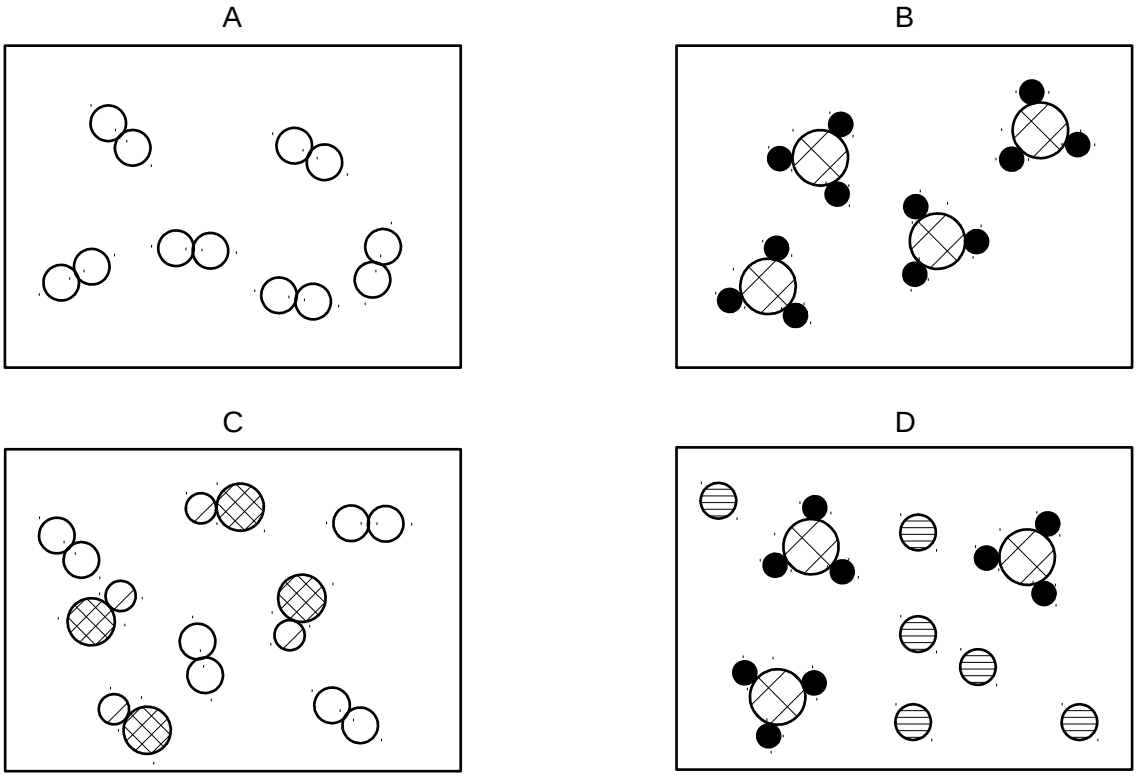
Section One: Multiple-choice **25% (20 marks)**

This section has **20** 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. 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: 35 minutes.

Questions 1 and 2 relate to the diagram below.

Four sealed canisters below (A, B, C and D) each contain different gas samples. The gases are represented by circles; each circle is an atom, and each pattern is a different type of atom.



1. The contents of which canister(s) would be described as a pure substance?

(a) A only.
(b) B only.
(c) A and B only.
(d) A and D only.

2. Which canister contains a noble gas?

(a) A
(b) B
(c) C
(d) D

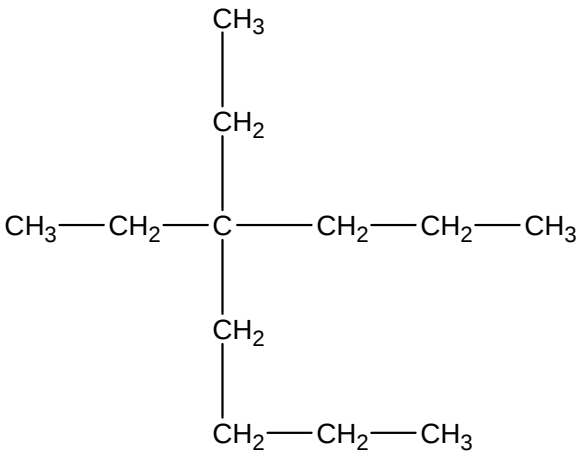
3. Which of the following is **not** common to both diamond and graphite?

(a) Covalent network bonding.
(b) High degree of hardness.
(c) Insoluble in water.
(d) Composed of carbon atoms.

4. Glow worms produce a blue-green light via a catalysed chemical reaction involving the chemical compound luciferin. Which statement regarding this reaction is correct?

(a) This reaction is endothermic.
(b) This reaction has a positive enthalpy change.
(c) The system gains energy from the surroundings.
(d) The reactants have greater enthalpy than the products.

5. Give the IUPAC name of the organic molecule below.



(a) 3-butyl-3-propylpentane.
(b) 3-ethyl-3-butylhexane.
(c) 3-ethyl-3-propylheptane.
(d) 4,4-diethyloctane.

6. In which one of the following compounds do the two ions have the same electron configuration?

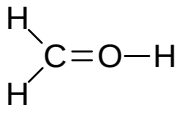
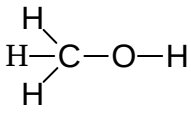
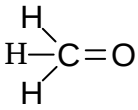
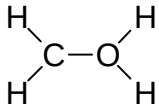
(a) Na_2O

(b) LiF

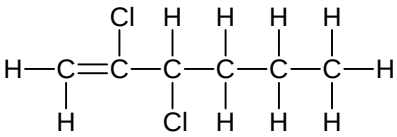
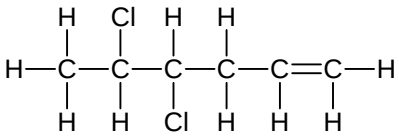
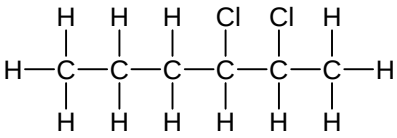
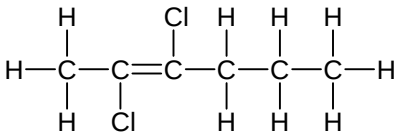
(c) KBr

(d) $MgC\ell_2$

7. Which diagram correctly represents the bonding in the molecule, methanol, CH_3OH?

(a) 	(b) 
(c) 	(d) 

8. Select the structure that correctly represents the compound with the IUPAC name '2,3-dichlorohex - 1 - ene.'

(a) 	(b) 
(c) 	(d) 

9. The correct IUPAC name for $CH_3CH_2CCH_3CHCH_3$ is

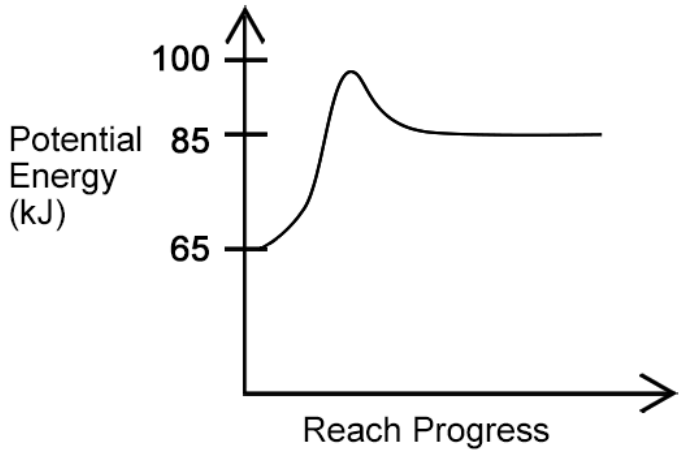
(a) 3–methylpentane.

(b) 2–methylpentane.

(c) 3–methylpent–2–ene.

(d) 2–methylpent–3–ene.

10. For the energy profile diagram below, select the row which correctly classifies the reaction as exothermic or endothermic and provides the correct heat of reaction.

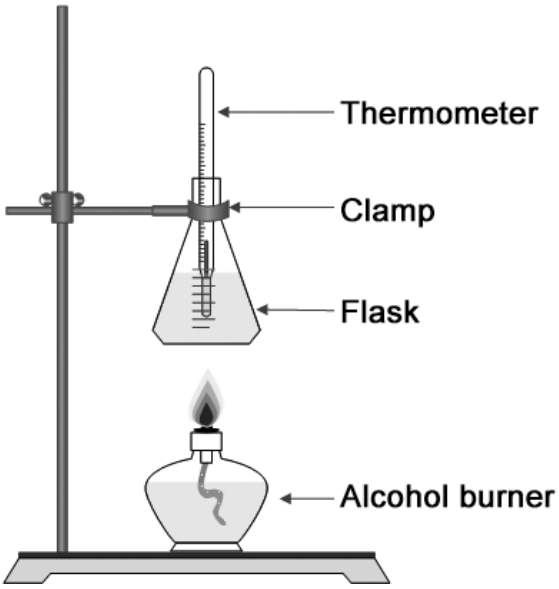


	Exothermic or Endothermic	Heat of reaction
(a)	Exothermic	–85kJ
(b)	Endothermic	+85kJ
(c)	Exothermic	–20kJ
(d)	Endothermic	+20kJ

Questions 11 - 14 refer to the experiment below investigating the energy output of various alcohols

Method

1. Measure 100 mL of cold tap water into a conical flask.
2. Clamp the flask at a suitable height so that an alcohol burner can easily be placed below.
3. Weigh the alcohol burner (and cap) containing the alcohol and record this mass and the name of the alcohol.
4. Record the initial temperature of the water in the flask.
5. Place the alcohol burner under the flask and light the wick.
6. Allow the alcohol to heat the water so the temperature rises by 40 °C.
7. Replace the cap to extinguish the flame.
8. Reweigh the alcohol burner and cap and record the mass.
9. Calculate
10. Using a fresh 100 mL of cold tap water, repeat the experiment with other alcohols.



11. Which one of the following is the dependent variable for this experiment?

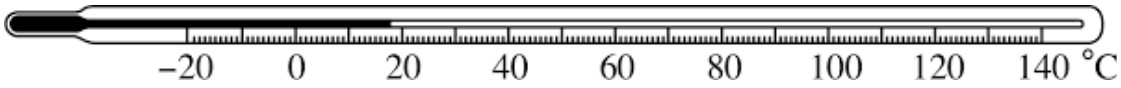
    (a) the change in temperature of the water
    (b) the mass of alcohol used to heat the water
    (c) the type of alcohol placed in the burner
    (d) the time taken to heat up the water by 40^{o}C

12. Which one of the following is the most important variable that must be controlled to ensure this experiment is valid?

    (a) distance between burner and conical flask
    (b) initial temperature of the water
    (c) initial mass of the alcohol used

(d) same thermometer and conical flask used each time

13. Below is an image of the thermometer with the initial temperature reading. Which of the following is the correct reading?



(a) 18 ± 1 °C
(b) 19 ± 1 °C
(c) 18.0 ± 0.5 °C
(d) 19 ± 0.5 °C

14. The data collected during this experiment is

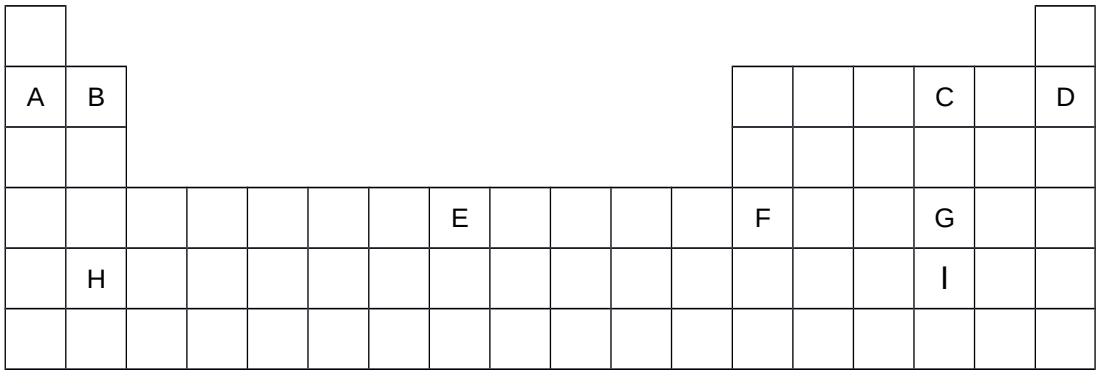
(a) primary data and it is quantitative.
(b) primary data and it is qualitative.
(c) secondary data and it is quantitative.
(d) secondary data and it is qualitative.

15. Which correctly lists the formulae for the stated ions?

	hydrogencarbonate	**sulfide**	**dichromate**
(a)	$H_2CO_3^-$	SO_4^{2-}	$Cr_2O_7^{2-}$
(b)	HCO_3^-	S^{2-}	Cr_2^{6+}
(c)	H_2CO_3	SO_3^{2-}	CrO_4^{2-}
(d)	HCO_3^-	S^{2-}	$Cr_2O_7^{2-}$

Questions 16, 17 and 18 relate to the periodic table below.

Consider the following partially drawn periodic table. Refer to the elements labelled A - I to answer the following questions.



16. Which pair of elements would have the same number of valence electrons?

(a) A and B
(b) C and D
(c) B and H
(d) F and G

17. Which of the following elements would have the largest atomic radius?

(a) C
(b) E
(c) F
(d) G

18. Which of the following elements would have the highest electronegativity?

(a) C
(b) D
(c) G
(d) I

19. Which of the following ionic formulae is not written correctly?

(a) Fe_2O_3
(b) $FeCl_2$
(c) Fe_2NO_3
(d) $FePO_4$

20. Copper saucepans conduct heat well because

(a) they have a shiny lustrous appearance.
(b) they contain dissociated electrons.
(c) the metal atoms are free to move around.
(d) the delocalised electrons can move freely.

End of Section One

Section Two: Short answer 35% (65 Marks)

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

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.

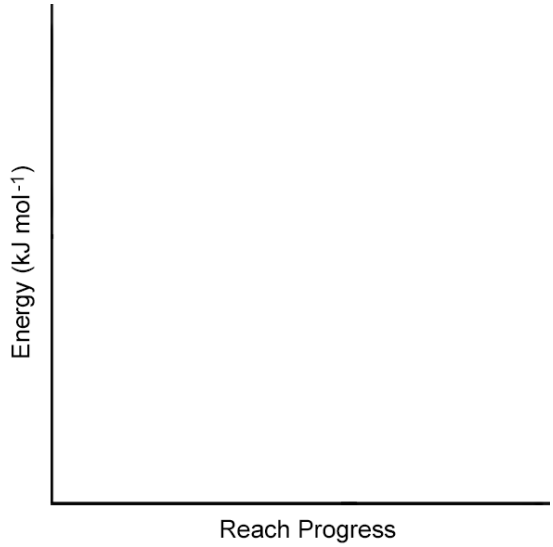
Suggested working time: 50 minutes.

Question 21 (11 marks)

Consider the combustion of propane (a fuel derived from fossil fuels) in excess oxygen gas. This reaction is said to have a change in enthalpy (ΔH) of –2000 kJ mol^{-1}. The reaction also has an activation energy of approximately 200 kJ.

(a) Write a balanced thermochemical equation for the combustion of propane. (3 marks)

(b) In the space below sketch an energy profile diagram being sure to label the reactants, products, change in enthalpy (ΔH) and activation energy (E_a). (5 marks)



(c) Explain in terms of bond breaking and bond formation why this reaction is an exothermic reaction. (3 marks)

Question 22 **(7 marks)**

The subatomic particle arrangement of an atomic species can be written in symbol form, using the notation shown in the following example;

$$^{23}_{11}Na^{+}$$

(a) Complete the table for the species above. (3 marks)

Number of protons	Number of neutrons	Electron configuration

(b) Using the same notation as sodium above, write the symbol for an atomic species that matches each of the following descriptions. (4 marks)

Description	Symbol
A group 2 metal in period 4.	
An anion with the same electron configuration as a neon atom.	
An element in group 15 which exists as a diatomic gas at room temperature.	
A potassium ion with 22 neutrons.	

Question 23 **(6 marks)**

Below is a list of common cations and anions.

Name of substance	Cation	Anion	Chemical formula
Potassium sulfide	K^+	S^{2-}	
Iron(III) dichromate	Fe^{3+}	$Cr_2O_7^{2-}$	
Calcium ethanoate	Ca^{2+}	CH_3COO^-	
Lead(IV) hydroxide	Pb^{4+}	OH^-	

(a) Complete the table above by combining these ions to write an ionic formula for each of the four substances. (4 marks)

(b) Describe the nature of, and key parts that make up an 'ionic bond' (2 marks)

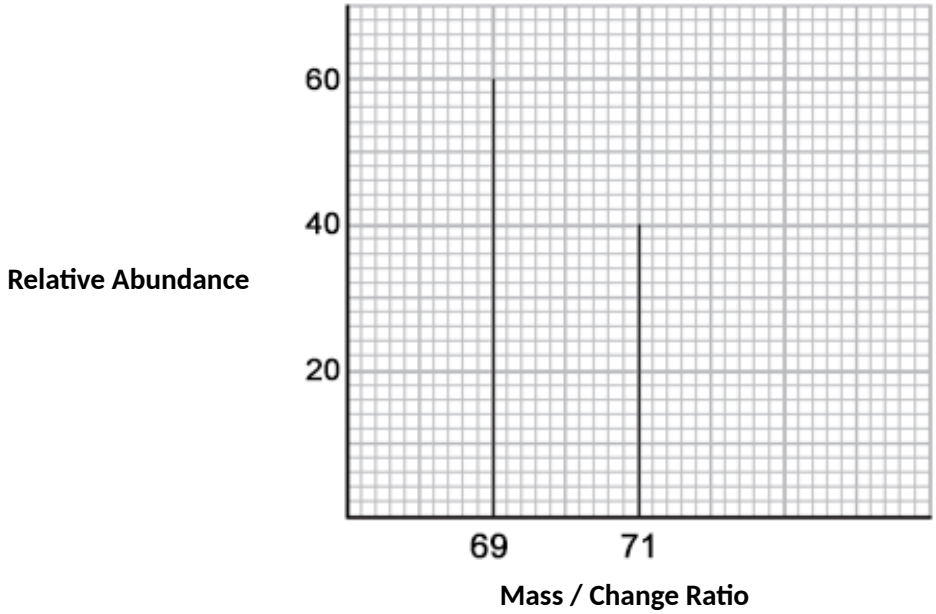
Question 24 **(6 marks)**

Draw an electron dot diagrams (Lewis structure) for the following substances. Represent all valence electrons

Hydrogen sulfide	
Silver oxide	
CH_2O	

Question 25 **(14 marks)**

The mass spectrum for an element is shown below



(a) State **two** differences and **one** similarity between the isotopes represented above.
(3 marks)

Difference_____

_____

Difference_____

_____

Similarity_____

_____

(b) Calculate the relative atomic mass of the element using the data in the mass spectrum.
(3 marks)

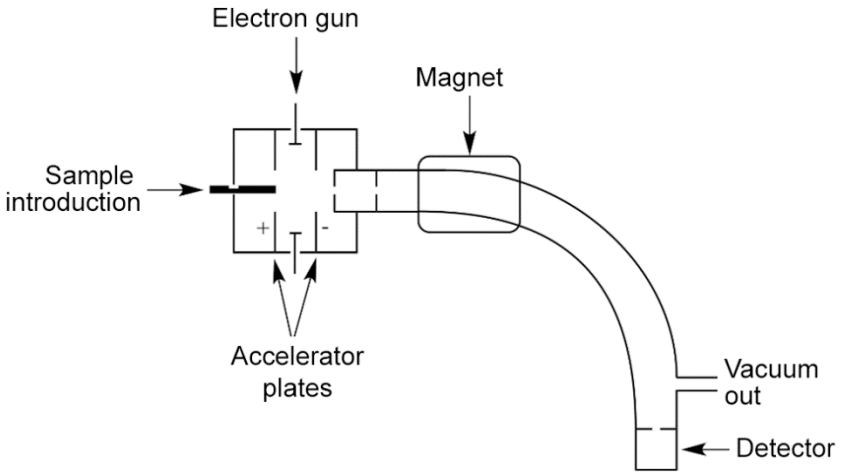
_____

_____

_____

Question 25 (continued)

Below is a diagram of a mass spectrometer used to obtain the mass spectrum on the previous page.



(c) After the sample is injected into the mass spectrometer, ionisation occurs. Describe this process and state what forms. (3 marks)

(d) Explain how the mass spectrometer causes the different isotopes to separate. (3 marks)

(e) As shown in the diagram, a mass spectrometer operates under a vacuum (no air present). State a reason for this requirement. (2 marks)

_____

_____

Question 26 **(7 marks)**

Amoxycillin and cefalexin are antibiotics that can be used to treat bacterial infections. Information regarding these two compounds is provided in the table below.

	Molecular formula	Molecular mass ($g\ mol^{-1}$)
amoxycillin	$C_{16}H_{19}N_3O_5S$	365.402
cefalexin	$C_{18}H_{17}N_3O_4S$	371.406

(a) Which antibiotic contains a higher percentage by mass of oxygen? Support your answer with appropriate calculations. (3 marks)

A sample of amoxycillin was taken for analysis. It was treated so that all the nitrogen was converted to nitrogen dioxide, $NO_2(g)$. The mass of $NO_2(g)$ was determined to be 0.364 g.

(b) Calculate the initial mass of amoxycillin that had been analysed. (4 marks)

Question 27 **(6 marks)**

The use of nanoparticles in cosmetics has become widespread in recent years. One example is the addition of gold nanoparticles (nanogold) to face cream. Research has suggested that the nanogold provides antifungal, antibacterial and anti-inflammatory benefits, as well as improving the firmness of skin.

(a) Give one (1) reason consumers may be concerned about the use of nanoparticles in cosmetics such as face cream. (1 mark)

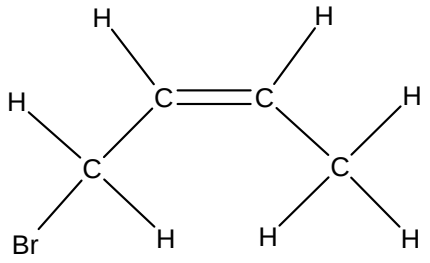
A sample of face cream was analysed by atomic absorption spectroscopy (AAS) to determine the concentration of nanogold present.

The face cream was dissolved and aspirated into a flame. A beam of light, at a wavelength matching that of gold, was then passed through the flame. This light was produced by a hollow cathode lamp containing gold atoms.

(b) Explain, in terms of electron behaviour, how the gold atoms in the hollow cathode lamp can create an emission spectrum with these unique wavelengths. (5 marks)

Question 28 **(8 marks)**

(a) Complete the table below by writing the IUPAC name or drawing a structural diagram for each organic substance. (6 marks)

Structural diagram	IUPAC name
	
	1,2-dichloro-3-ethylpentane
	2-methylpropene

(b) Write a chemical equation for the catalysed reaction that occurs between benzene and chlorine gas. Use structural formulae for all organic substances. (2 marks)

End of Section Two

Section Three: Extended answer 40% (72 Marks)

This section contains **four** 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 and include appropriate units where applicable.

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.

Suggested working time: 60 minutes.

Question 29 **(18 marks)**

Nanotechnology is a field of research and innovation concerned with building 'things' – generally, materials and devices – on the scale of atoms and molecules. A nanometre is one–billionth of a metre. (1 nanometre (nm) = 10^{-9} metres).

(a) The diameter on one oxygen atom is approximately 0.14 nm. Calculate how many oxygen atoms lined up in a row would fit in a one nanometre space. (1 mark)

(b) Would more or fewer lithium atoms (than oxygen atoms) fit across this one nanometre distance? Use your understanding of atomic structure to justify your answer. (5 marks)

(c) State which property a substance **must** have to be classified as a nanomaterial. (2 marks)

(d) The properties of nanomaterials differ significantly from the materials from which they are derived. For example, a given mass of material in nanoparticulate form is much more reactive than the same mass of the material made up of larger particles. State the reason for this difference in properties. (2 marks)

(e) State the name of one carbon–based nanomaterial. (1 mark)

(f) The carbon–based nanomaterials have distinctly different physical properties from the bulk material, graphite. Describe the bonding structure of graphite and state **three** physical properties of graphite. (7 marks)

Question 30 **(19 marks)**

Below is a list of solid substances with some of their physical properties

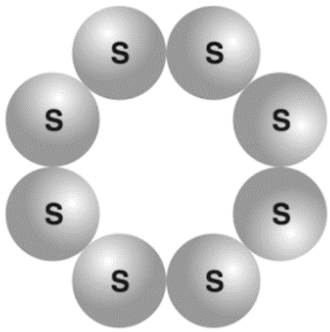
Name of substance	Melting point	Conductivity in solid form	Conductivity when mixed with water
Copper	1085 ^{o}C	High	Not tested
Copper(II) sulfate	110 ^{o}C	Nil	Medium
Chromium(III) sulfate	90 ^{o}C	Nil	Medium
Sulfur	115 ^{o}C	Nil	Nil

(a) Of the **four** substances copper is the substance with the highest melting point and highest conductivity. Use your understanding of the structure of copper to explain these observations. (4 marks)

(b) Explain why copper(II) sulfate and chromium(III) sulfate can conduct electricity when in aqueous solution but not when solid. (4 marks)

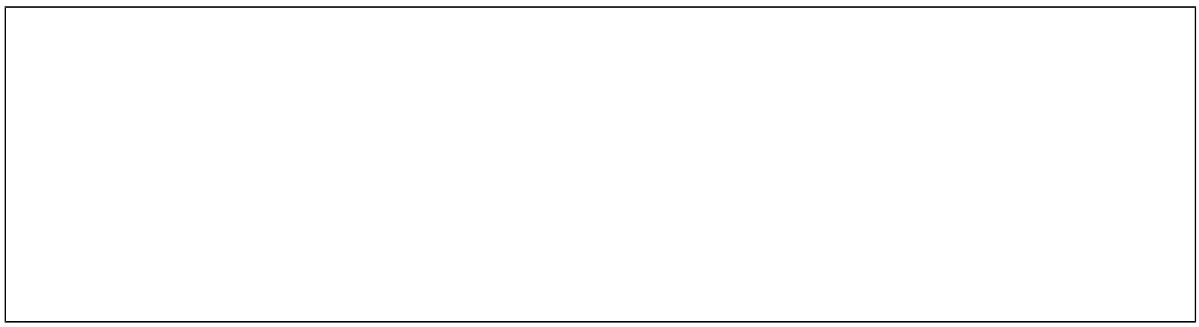
(c) It was observed that despite equal moles of copper(II) sulfate and chromium(III) sulfate being added to water the chromium(III) sulfate solution showed evidence of a slightly higher ability to conduct electricity. Explain this observation. (3 marks)

(d) Sulfur is classified as a covalent molecular substance; its molecular structure is represented below. Name the bond present within this structure, describe the nature of the bond and classify the bond as either a strong or weak bond. (4 marks)



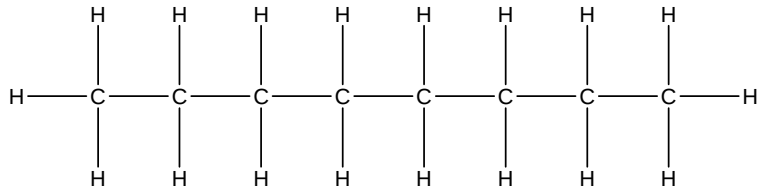
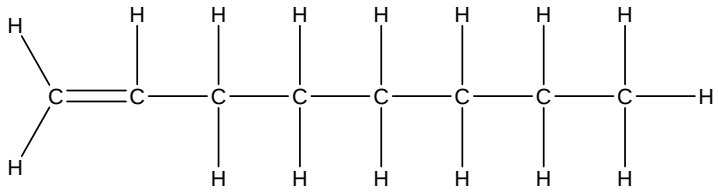
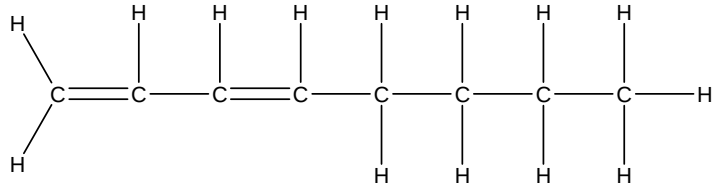
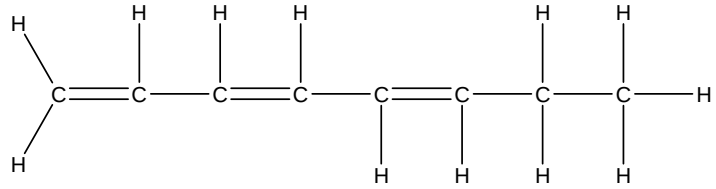
Sulfur
S_8

(e) In the space below, write the balanced chemical equation for the reaction that would occur between solid sulfur and chromium metal to form chromium III sulfide. Include all states of matter. (4 marks)



Question 31 **(17 marks)**

A group of students were investigating the effect of ‘degree of saturation’ on the reactivity of organic compounds. In order to do this, they obtained samples of the four (4) organic compounds shown in the table below.

Structural diagram	IUPAC Name
	octane
	oct-1-ene
	octa-1,3-diene
	octa-1,3,5-triene

(a) Describe the difference between a ‘saturated’ and an ‘unsaturated’ organic compound, and provide an example of each from the table above. (3 marks)

The students began the investigation by measuring a 10.0 g sample of each organic liquid into four separate test tubes. To each test tube they added 0.50 g of liquid bromine. The test tubes were immediately stoppered, and the contents were gently and continuously swirled.

The time taken for the red colour of the bromine liquid to fade to colourless was measured. The students recorded their results in the table below.

	Time taken for red to fade to colourless (seconds)			
Compound	Trial 1	Trial 2	Trial 3	Average
octane	red colour was not observed to fade			–
oct-1-ene	6.07	5.98	6.13	
octa-1,3-diene	2.94	3.07	3.11	
octa-1,3,5-triene	2.06	2.01	2.04	

(b) Complete the table above by calculating the average time taken for the remaining three test tubes. (3 marks)

(c) Give one reason why the students performed multiple trials. (1 mark)

_____

_____

_____

_____

(d) Complete the table below, by listing the variables for this investigation. (3 marks)

Independent variable	
Dependent variable	
One (1) controlled variable	

For this experiment, it was important that the moles of organic liquid be present **in excess**, ensuring the liquid bromine would be entirely consumed by any reaction that occurs.

(e) Why is it important for the organic liquid to be present in excess? (1 mark)

_____

_____

(f) Name the type of reaction that would have taken place in the test tube containing oct-1-ene. Write a chemical equation for this reaction, using structural formulae. (3 marks)

Name of reaction type	
Chemical equation	

Whilst no reaction was observed in the test tube containing octane, these substances **can** react when exposed to appropriate conditions.

(g) State the conditions that would be required for a reaction to take place, and name the type of reaction that would occur under these circumstances. (2 marks)

Conditions required	
Name of reaction type	

(h) Write a conclusion that the students could draw from the data collected in this investigation. Your conclusion should relate to your stated variables. (1 mark)

_____

_____

_____

_____

Question 32 **(18 marks)**

A group of chemistry students were investigating the trends in first ionisation energy of various elements. The students made the following hypothesis;

"The first ionisation energy of an element will increase with increasing atomic number."

In order to investigate further, the students researched online to find the relevant data, which they summarised in the table below.

Element	O	F	Ne	Na	Mg	Al	Si	P
Atomic number	8	9	10	11	12	13	14	15
First ionisation energy ($kJ\ mol^{-1}$)	1314	1681	2081	496	738	578	787	1012

(a) Define 'first ionisation energy'. (2 marks)

(b) State whether the data obtained by the students would be classified as ‘primary’ or ‘secondary’ data. Justify your answer. (2 marks)

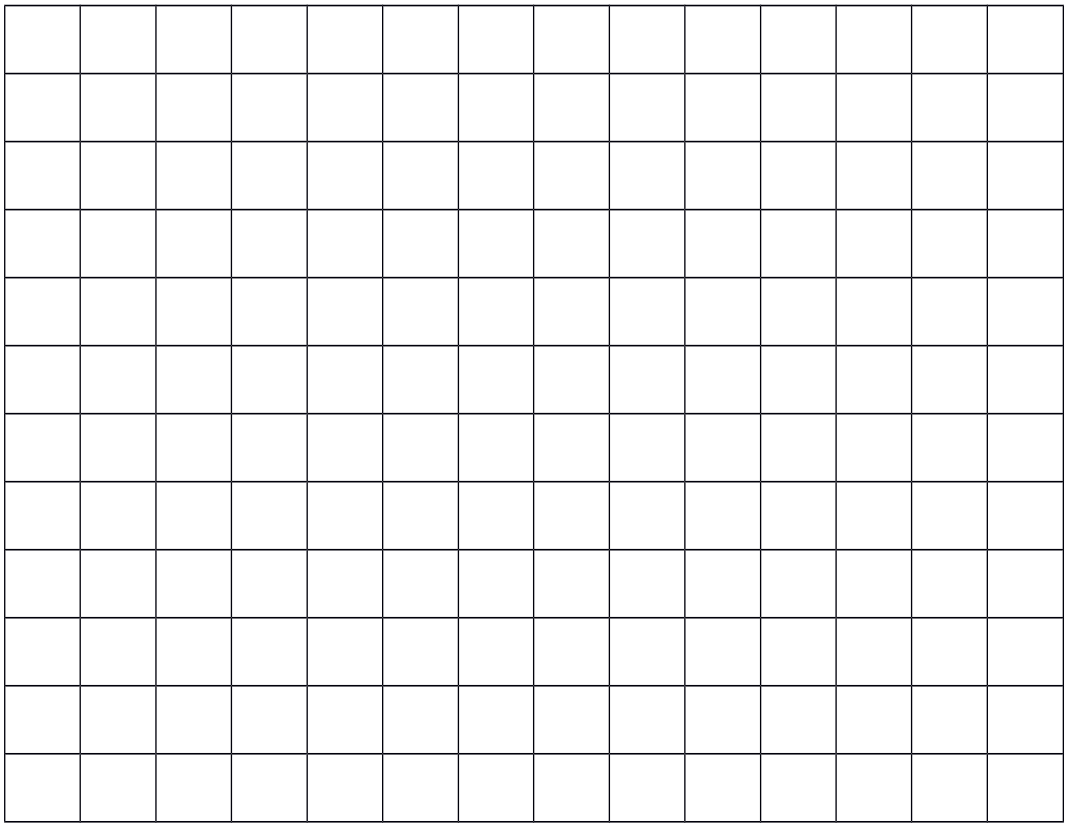
_____

_____

_____

_____

(c) Graph the data collected by the students, using the grid below. (4 marks)



(d) Explain the increasing trend in first ionisation energy for the elements with atomic number 13-15. (3 marks)

(e) Explain why there is such a large difference in the first ionisation energy of neon and sodium. (2 marks)

(f) Suggest an appropriate range, in which the first ionisation energy of the element with atomic number 16 would fall. Justify your answer. (3 marks)

(g) Which of the elements studied by the students would have (2 marks)

(i) the highest electronegativity? _____

(ii) the smallest atomic radius? _____

End of questions

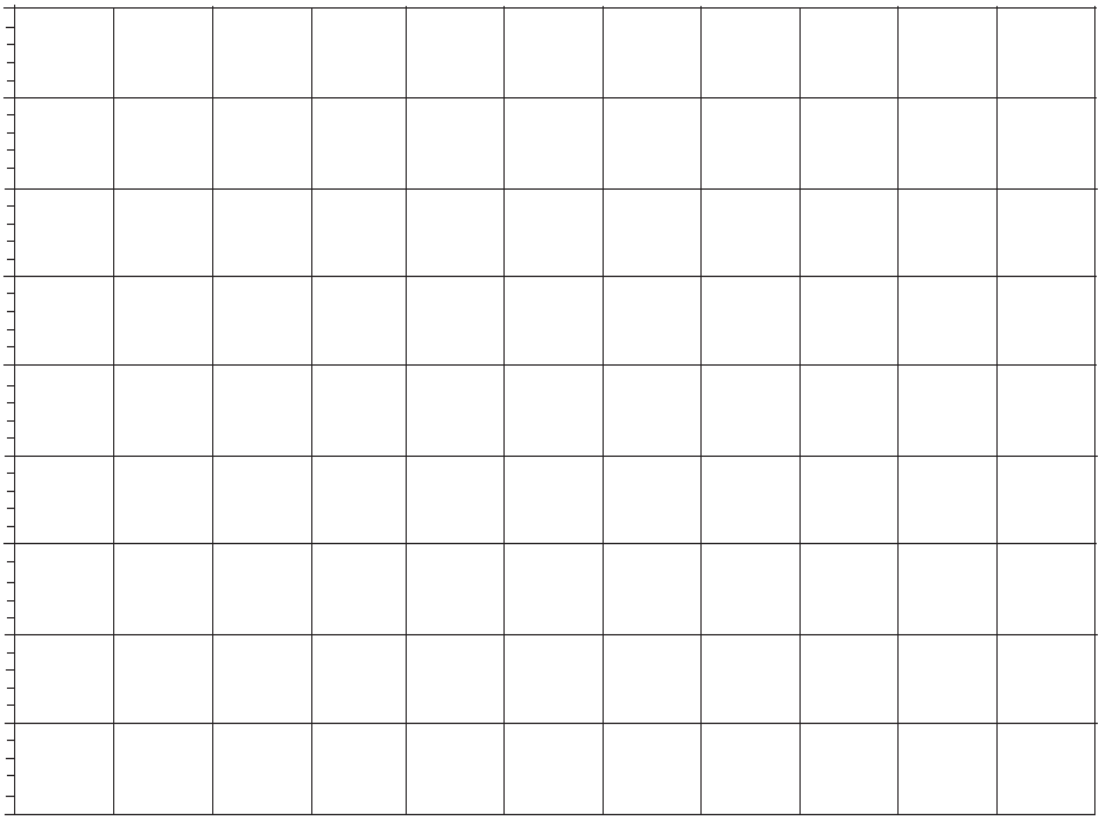
Supplementary page

Question number: _____

Supplementary page

Question number: _____

Spare grid



Teacher	questions	Mark	%
AB	1-20		/25
JV	21,22		
BL	23,24		
JT	25		
AB	26		
MD	27,28		
TOTAL Part B			% B /35
SH	29		
SH	30		
SF	31		
SF	32		
TOTAL Part C			% C /40
		Total %	