ROSSMOYNE SENIOR HIGH SCHOOL
Science

Semester 1, Examination 2019

Chemistry Unit 1
Question/Answer Booklet

Student Number: | | |es| | | | | | | |

In words _____

_____

Time allowed for this paper
Reading time before commencing work: ten minutes
Working time for paper: 2 ½ hours (150 minutes)

Materials required/recommended for this paper
To be provided by the supervisor
This Question/Answer Booklet

To be provided by the candidate
Standard items: pens, pencils, eraser, correction fluid, ruler, highlighters

Special items: nil

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.

Circle your Teacher's name:
**Mr Dhue,   Mr Fagan,   Mr Faulkner,   Mr Holyoake,   Mr Lloyd,
Ms Smith,   Mr Venter,**

Structure of this paper

Section	Number of questions available	Number of questions to be answered	Suggested working time (minutes)	Marks available	Percentage of exam
Section One:	20	20	35	/40	/25
Section Two:	6	6	53	/56	/35
Section Three:	5	5	62	/64	/40
					100

Instructions to candidates

1. Answer the questions in the space provided.

2. You must be careful to confine your responses to the specific questions asked and to follow any instructions that are specific to a particular question.

3. Spare pages are included at the end of this booklet. They can be used for planning your responses and/or as additional space if required to continue an answer.
   - Planning: If you use the spare pages for planning, indicate this clearly at the top of the page.
   - Continuing an answer: If you need to use the space to continue an answer, indicate in the original answer space where the answer is continued, i.e. give the page number. Fill in the number of the question(s) that you are continuing to answer at the top of the page.

Section One: Multiple-choice   **25%   (40 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.

---

1.   Consider the flame test data in the table below.

| Element	Flame colour
Li	red
Na	orange
Cs	blue-violet
Ca	orange-red
Cu	blue-green

Which 2 elements could be **most easily** distinguished by a flame test?

(a)   Na and Ca.
(b)   Cu and Cs.
(c)   Ca and Li.
(d)   Cu and Na.

2.   Select the option where the formulas for the three named ions are given correctly.

	nitrite	**cyanide**	**permanganate**
(a)	NO_3^-	CN^-	MnO^{4-}
(b)	NO_2^-	Cy^-	MnO_4^-
(c)	N^{3-}	Cy^-	MnO^{4-}
(d)	NO_2^-	CN^-	MnO_4^-

3.   A particular isotope of tin is designated $^{119}_{50}Sn$. The +2 cation of this isotope contains which of the following?

(a)   48 protons, 69 neutrons and 50 electrons.
(b)   69 protons, 119 neutrons and 48 electrons.
(c)   50 protons, 119 neutrons and 54 electrons.
(d)   50 protons, 69 neutrons and 48 electrons.

4.	Complete the coefficients below to balance the equation correctly.

$$\_\_\_ \ AlBr_3 \ + \ \_\_\_ \ K_2SO_4 \ \rightarrow \ \_\_\_ \ KBr \ + \ \_\_\_ \ Al_2(SO_4)_3$$
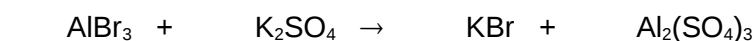
(a)	2,	1,	2,	1
(b)	2,	3,	3,	1
(c)	1,	3,	3,	2
(d)	2,	3,	6,	1

5.	Which one of the following statements about Atomic Absorption Spectroscopy is **true**?

(a)	It is based on the ability of electrons releasing energy while moving from higher energy level to lower energy level.
(b)	It cannot provide qualitative or quantitative results.
(c)	It can detect a large variety of all elements in very low concentrations.
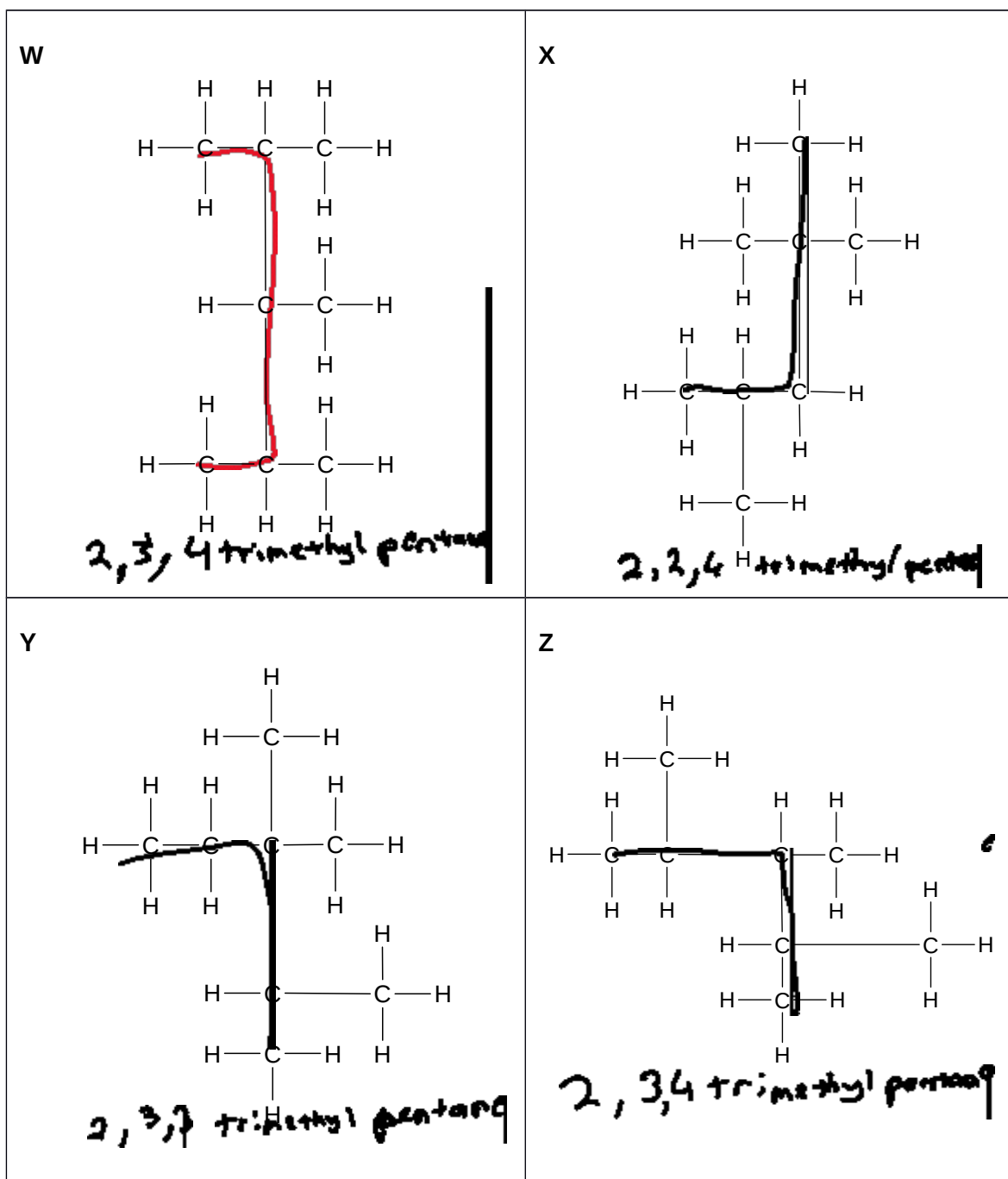(d)	It can detect a range of metal ions but not non–metals.

6.	Niels Bohr contributed to our understanding of the atom, primarily by proposing

(a)	the existence of neutrons within the atom.
(b)	the existence of electrons within the atom.
(c)	the presence, location and size of the nucleus.
(d)	the motion of electrons within specific energy levels.

7.	Imagine you completed an investigation, submitted your findings and were then told by your teacher that your investigation was not valid. To solve this problem, you should

(a)	redesign your experimental method.
(b)	repeat the experiment many times and average the results.
(c)	buy new, high accuracy equipment so you can obtain more precise results.
(d)	have just one scientist collect all the data to make the results more reliable.

8. Which 2 molecules below would have the same IUPAC name?

W

H—C—C—C—H (with H's on top)

2,3,4 trimethyl pentane

X

2,2,4 trimethyl pentane

Y

2,3,3 trimethyl pentane

Z

2,3,4 trimethyl pentane

(a) W and X
(b) X and Y
(c) Y and Z
(d) **W and Z**

5

9. Which one of the following sets of elements are listed in increasing order of first ionisation energy?

    (a) Li, Na, K.
    (b) F, O, N.
    (c) Ne, Ar, Kr.
    (d) B, C, N.

10. Classify the type of bonding that occurs in the 3 compounds below.

	ZnI_2	H_2O_2	SiH_4
(a)	ionic	covalent	ionic
(b)	ionic	covalent	covalent
(c)	covalent	covalent	ionic
(d)	covalent	ionic	covalent

11. The non-IUPAC name "1–bromo-2,2–dimethylethane" corresponds to the structure of substance **X**. What is the IUPAC name of substance **X**?
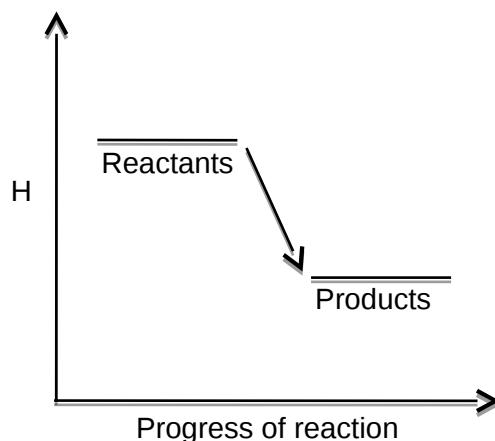
    (a) 2–dimethyl–1–bromoethane
    (b) 1–bromo–2–methylpropane
    (c) 2–(bromomethyl)–propane
    (d) 2–methyl–3–bromopropane
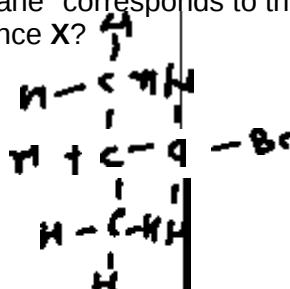
12. Mass spectrometers separate isotopes of different elements based on their

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

Questions 13 and 14 refer to the enthalpy change diagram below.

13.   This reaction is _____X_____. It would _____Y_____ the surroundings.

	X	**Y**
(a)	endothermic	take in heat from
(b)	endothermic	release heat to
(c)	exothermic	take in heat from
(d)	exothermic	release heat to

14.   Which statement regarding the energy of the 'system + surroundings' in this reaction is **correct**?

   (a)   The total amount of energy is increased.
   (b)   The total amount of energy is decreased.
   (c)   The total amount of energy is the same.
   (d)   The law of conservation of energy does not apply in this situation.

15.   Which of the following equations represent addition reactions?

   I $CH_3–CH=CH_2 + Br_2 \rightarrow CH_3–CHBr–CH_2Br$
   II $CH_2=CH_2 + H_2O \rightarrow CH_3–CH_2–OH$
   III $CH_3OH + HBr \rightarrow CH_3Br + H_2O$
   IV $CH_3–CH_2–CH_2–OH + HC\ell \rightarrow CH_3–CH_2–CH_2C\ell + H_2O$
   V $CH_3–CH_2–CH_2–CH_2–OH \rightarrow CH_3–CH_2–CH_2=CH_2 + H_2O$

   (a)   I and II.
   (b)   I and III.
   (c)   III and IV.
   (d)   V only.

16. Which of the following are compounds?

> (i) ammonia
> (ii) water
> (iii) oxygen gas
> (iv) carbon monoxide
> (v) silicon

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

17. A molecule of alanine, $H_2NCH(CH_3)COOH$, contains

(a) 3 atoms of carbon.
(b) 4 atoms of hydrogen.
(c) 5 atoms of carbon.
(d) 6 atoms of hydrogen.

18. Which one of the following statements is **true** about trends in the periodic table?

(a) Within Group 17, as the atomic number increases, the first ionisation energy decreases.
(b) Elements on the right-hand side of the table are less electronegative than elements on the left.
(c) Elements on the left–hand side of a period have a higher ionisation energy than elements on the right–hand.
(d) The number of valence electrons of the elements decreases when moving from left to right along the third row.

19. Exothermic reactions always result in

(a) a greater mass of products compared to reactants.
(b) a decrease in the number of chemical bonds.
(c) a decrease in enthalpy.
(d) a decrease in the temperature of the surroundings.

20. The formula of cerium(III) sulfate is $Ce_2(SO_4)_3$. What is the correct formula of cerium(III) phosphate?

(a) $CePO_4$
(b) CeP
(c) $Ce_2(PO_4)_3$
(d) $Ce_3(PO_4)_2$

End of Section One

Section Two: Short answer 35% (56 marks)

This section has **6** questions. Answer **all** questions. Write your answers in the spaces provided.

When calculating numerical answers, show your working or reasoning clearly. Express numerical answers to the appropriate number of significant figures and include appropriate units where applicable.

Spare pages are included at the end of this booklet. They can be used for planning your responses and/or as additional space if required to continue an answer.
- Planning: If you use the spare pages for planning, indicate this clearly at the top of the page.
- Continuing an answer: If you need to use the space to continue an answer, indicate in the original answer space where the answer is continued, i.e. give the page number. Fill in the number of the question(s) that you are continuing to answer at the top of the page.

Suggested working time: 53 minutes.

Question 21 **(5 marks)**

Complete the table below.
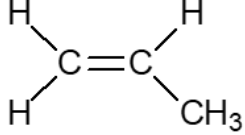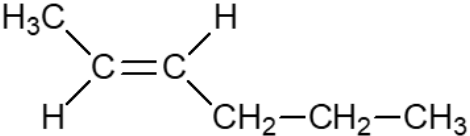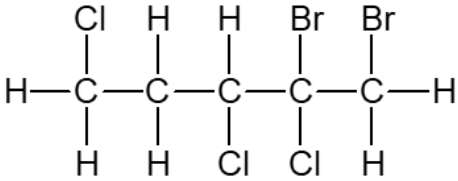
Formula	Name
Nd_2CrO_4	Sodium Chromate
N_2O_4	Dinitrogen tetroxide
$Fe_2(H_2PO_4)_3$	Iron (III) dihydrogenphosphate
$(NH_4)_2SO_4$	Ammonium sulfate
CBr_4	Carbon tetrabromide

Question 22

(a)   Complete the table below.   (8 marks)

Structural Formula	IUPAC Name
H\C=C/H with H below left C and CH₃ below right C	Prop-
|	2,3–dimethylpent–2–ene
H₃C\C=C/H with H below left C and CH₂—CH₂—CH₃	
H—C—C—C—C—C—H with Cl H H Br Br on top and H H Cl Cl H on bottom	

.

(b)   Select one molecule from the table in part (a) that can exist as a *cis* isomer and draw its *cis* structure below.   (2 marks)

(c)   Samples of benzene and hept–1–ene appear similar in that they are colourless, clear liquids. Their chemical reactions, however are quite different. Draw the full structural formula of the organic product when bromine water reacts with each of these substances and name the product.   (6 marks)

Hept–1–ene / Br₂ Product	Benzene / Br₂ product
Name:	Name:

Question 23 (9 marks)

A pure sample of an element is isolated and analysed by mass spectrometry to determine its relative atomic mass. The data from this analysis is shown below.
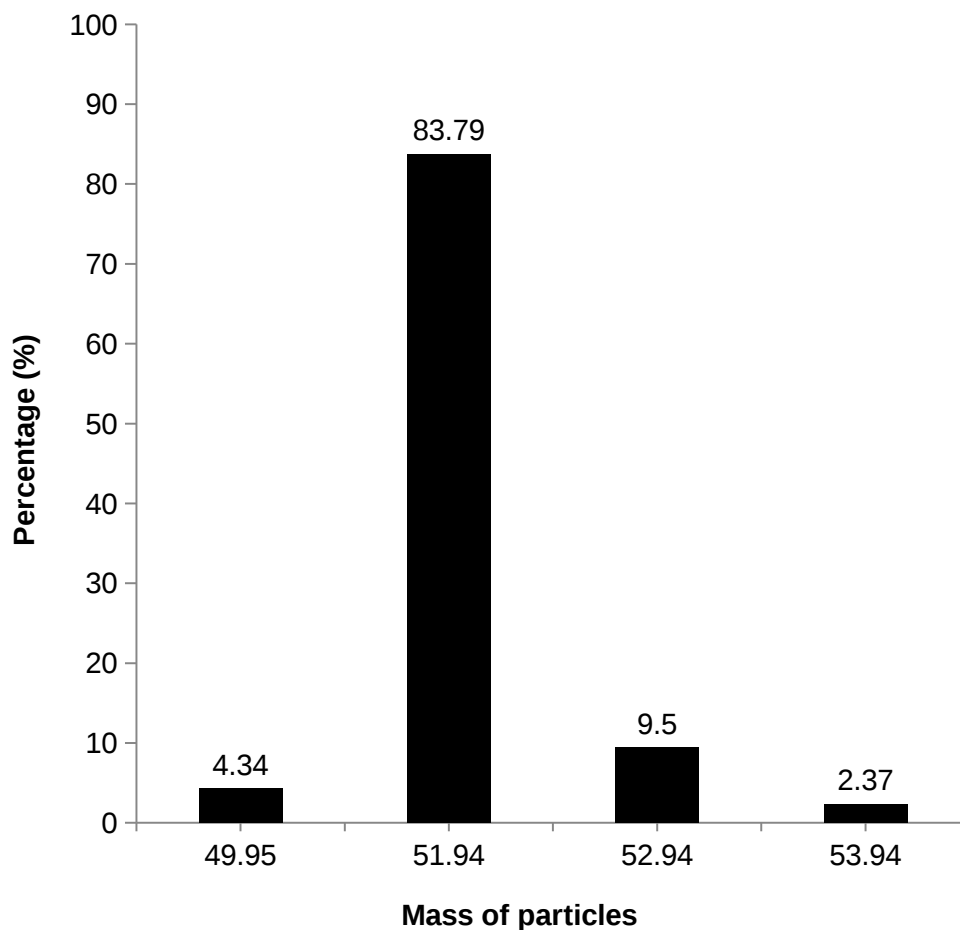
The process of mass spectrometry involves 4 steps;

1. Ionisation

2. Acceleration

3. Deflection

4. Detection

(a) Write the names of the first 2 steps involved in mass spectrometry in the spaces above.

(2 marks)

In step 3, the various particles are deflected based on their mass. (You may assume that all particles in the mass spectrometer have the same charge.)

(b)   How are the particles deflected?   (1 mark)

       magnet_____

(c)   Explain how atoms of an element can have different masses, and elaborate on the composition of this element by using the graph on the previous page.   (3 marks)

       _____

       _____

       _____

       _____

       _____

(d)   Calculate the relative atomic mass of the element. Identify this element by name or symbol.
                                                                                           (3 marks)

Question 24 **(8 marks)**

Lead metal can be extracted from several different compounds, the most common of which is galena, or lead(II) sulfide (PbS). The overall process for the extraction of lead from an ore containing galena can be represented by the equation below.

$$2\ PbS(s)\ +\ 3\ O_2(g)\ +\ C(s)\ \rightarrow\ 2\ Pb(s)\ +\ 2\ SO_2(g)\ +\ CO_2(g)$$
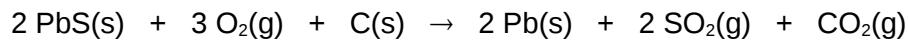
If 327 kg of galena (PbS) was available;

(a) Calculate the mass of $O_2(g)$ required to react with the PbS(s). (4 marks)

$n(PbS) = m/M \quad 327 \times 10^3 / 239.3$

$\qquad = 1366.49$

$n(O_2) : \dfrac{3}{2} \times 1366.49 = 2049.73$

$m(O_2) : nM = 2049.73 \times 2(16)$

$\qquad = 65591 g = 65.6\ kg$

(b) Calculate the maximum mass of Pb(s) that could be extracted from the PbS(s). (2 marks)

$n(Pb) = n(PbS) = 1366.49$

$m(Pb) : nM = 1366.49 \times 207$

$\qquad = 283kg$

(c) If the ore is 69.3% galena, calculate the starting mass of ore required. (2 marks)

$327 = 69.3$

$? = 100$

$\dfrac{100}{69.3} \times 327$

$\qquad = 472\ kg$

Question 25 (11 Marks)

The structures of diamond and graphite are drawn below.
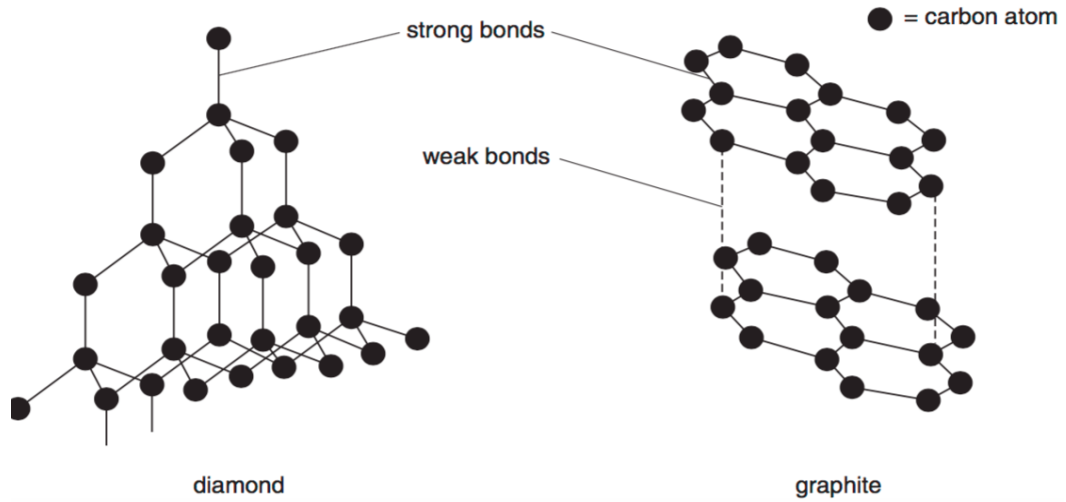
(a) State the name of the "strong bonds" shown on the diagram in the space below. (1 mark)

Covalent bonds_____

(b) Diamond is noted for its hardness and graphite is used as a lubricant because of its soft slippery properties.

(i) Explain why there is such a difference in this physical property of these carbon structures. (3 marks)

_____

_____

_____

_____

(ii)   Explain why there is a significant difference in the electrical conductivity of diamond and graphite.   (2 marks)

_____

_____

_____

_____

(c)   Carbon is also found in nanomaterials. Describe how the structure of a carbon nano-particle is different in three ways from either structure in part (a).   (3 marks)

_____

_____

_____

_____

_____

(d)   List **two** possible health issues that might be related to the use of nano-particles.   (2 marks)

_____

_____

_____

_____

Question 26 **(7 marks)**

Ethanol (C_2H_5OH) is a fuel that is produced by two main methods. The hydration of ethene produces ethanol, whilst the fermentation of glucose produces bioethanol. Ethanol and bioethanol are identical in structure, however bioethanol is classified as a biofuel.

(a)   What is a 'biofuel'? Explain why biofuels produce a much lower level of overall carbon emissions compared to fossil fuels. (3 marks)

_____
_____
_____
_____
_____
_____

When liquid ethanol is combusted, it produces water vapour, carbon dioxide gas.

(b)   Write a balanced **thermochemical** equation for this combustion process. Include phase symbols. (4 marks)

$$C_2H_5OH_{(l)} + 2O_{2(g)} \rightarrow 3H_2O_{(g)} + 2CO_{2(g)} \quad E$$
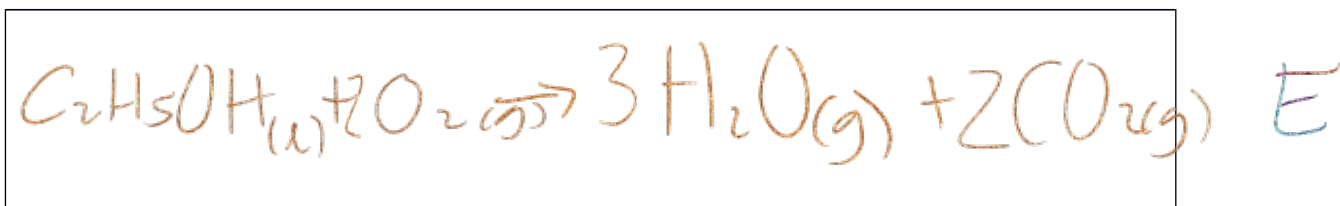
End of Section Two

Section Three: Extended answer   **40%**   **(64 marks)**

This section contains **five (5)** questions. You must answer **all** questions. Write your answers in the spaces provided below.

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.

Spare pages are included at the end of this booklet. They can be used for planning your responses and/or as additional space if required to continue an answer.
- Planning: If you use the spare pages for planning, indicate this clearly at the top of the page.
- Continuing an answer: If you need to use the space to continue an answer, indicate in the original answer space where the answer is continued, i.e. give the page number. Fill in the number of the question(s) that you are continuing to answer at the top of the page.

Suggested working time: 62 minutes.

Question 27   **(8 marks)**

Calcium carbonate is used in some toothpastes. To determine the mass of calcium carbonate in one gram of toothpaste, a 10.40 g sample of the toothpaste was reacted with hydrochloric acid solution.

When calcium carbonate reacts with hydrochloric acid solution the products are calcium chloride, water and carbon dioxide.

(a)   If the molecular equation describing this reaction is

$$CaCO_3 + 2HC\ell \rightarrow CaC\ell_2 + CO_2 + H_2O$$

Write a balanced ionic equation for the reaction taking place, include state symbols.

                                                               (2 marks)

$CaCO_3 (s) + 2HC\ell (aq) \rightarrow CaC\ell_2 (aq) + CO_2 (g) + H_2O$
$2H^+ 2C\ell^- \quad Ca^{2+} 2C\ell^-$

$CaCO_3 (s) + 2H^+ (aq) \rightarrow Ca^{2+} (aq) + CO_2 (g) + H_2O$
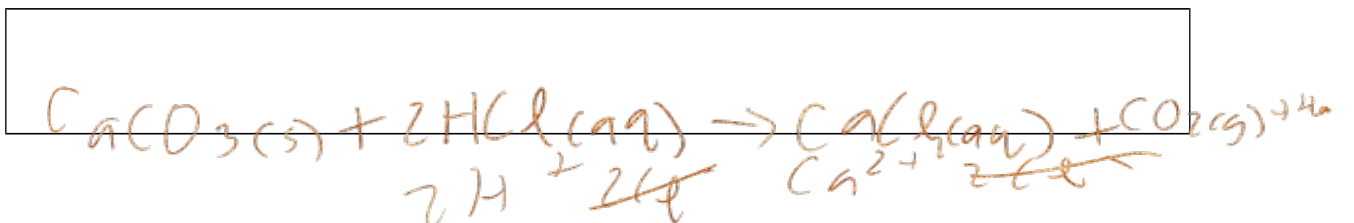
(b) If 3.570 g of carbon dioxide is produced, calculate the mass of calcium carbonate present in the 10.40 g sample. (4 marks)

$$n(CO_2) = \frac{3.57}{12.01 + 32}$$

$$= 0.0811 \text{ mol}$$

$$n(CaCO_3) = \frac{1}{1} \times 0.0811$$

$$= 0.0811 \text{ mol}$$

$$M(CaCO_3) = 0.0811 \times (40.08 + 12.01 + (8)$$

$$= 8.12 \text{ g}$$

(c) Calculate the mass of calcium carbonate in one gram the toothpaste. (1 mark)

in 10.40g. $\frac{8.12}{10.40} = 0.78 \text{ g}^{?}$

(d) By referring to the given equation in part (a) state what assumption has been made about the reaction of the acid with the toothpaste. (1 mark)

Hcl is in excess

21

Question 28 (16 marks)

A chemistry student had two unlabelled beakers, each containing a different colourless liquid. One contained hexane, $CH_3CH_2CH_2CH_2CH_2CH_3(l)$, and the other hex-1-ene, $CH_2CHCH_2CH_2CH_2CH_3(l)$.

The student added a few drops of liquid bromine, $Br_2(l)$, to each beaker in order to distinguish the liquids.

(a)   Why is it important that the liquid bromine be limiting (i.e. only a few drops are added) for this distinguishing test to be effective? (2 marks)

_____

_____

_____

_____

Whilst no immediate or visible reaction was observed to occur with the hexane, in the presence of an appropriate catalyst, a slow reaction has the potential to take place.

(b)   Write a balanced equation for this reaction, including phase symbols, and name the type of reaction that is occurring. (4 marks)

Equation: ~~Substitution~~

$CH_2CHCH_2CH_2CH_2CH_3(l) + Br_2(l) \rightarrow$

$CHBr \cdot CH_2CH_2CH_2CH_3(l)$

Type of reaction:

The equation for the reaction with liquid hex-1-ene is shown below.

If 8 drops of bromine liquid are added to the beaker containing hex-1-ene and shaken;

(c)   Calculate the mass of 1,2-dibromohexane produced. Assume 1 drop = 0.05 g.   (4 marks)

8 drop = 0.4g

$$n(Br) = \frac{0.4}{79.9 \times 2}$$

$$= 0.0025031 \text{ mol}$$

$$n(CHBr\ CHBr\ CH_2\ CH_2\ CH_2\ CH_3)$$

$$= \frac{1}{1} \times 0.0025031$$

$$= 0.0025031 \text{ mol}$$

$$0.0025031 \times ((6 \times 12.01) + (11 \times 1.008) + (79.9 \times 2)))$$

$$= 279.99 \text{ g}$$

If hex-3-ene had been used in place of hex-1-ene in the reaction above;

(d)   Draw and name the product of the reaction.   (2 marks)

Structural diagram:	IUPAC name:
$CH_3\ CHBr\ CHBr\ CH_2\ CH_2CH_3$	3,4 - di bromo - hex - 3 - ene

The organic substance 'citronellol' is found in citronella and essential oils isolated from lemongrass. It is used in soaps, candles, incense, cosmetics and insect repellents. A molecule of citronellol is shown below.
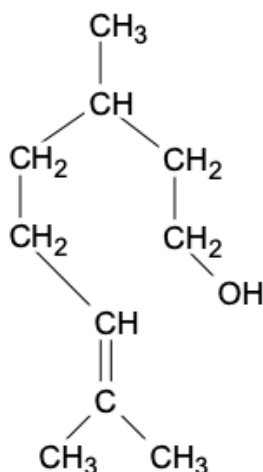
A pure sample of liquid citronellol was mixed with a few drops of iodine water, I_2(aq).

(e)   Write a balanced equation for the reaction that would take place and name the type of reaction occurring.   (2 marks)

Equation:

$CH_3 CH_3 CH CH_2 CH_2 CH CH_3 CH_2 CH_2 CH_2 OH + I_2$

$\rightarrow$ $CH_3 CH_3 I CHI CH_2 CH_2 CH_2 CH_3 CH_2 CH_2 OH$

Type of reaction: Addition

(f)   Calculate the percent by mass of carbon in citronellol.   (2 marks)

$$\% C = \frac{12.01 \times 10}{(12.01 \times 10) + 16 + 18(1.008)} \times 100$$

$\Rightarrow$ 77.86%

Question 29 **(14 marks)**

Design a process where, if you were given a mixture of iron filings, salt and charcoal, you could separate each component.

(a) Prepare a list of essential equipment you will need to request to complete this exercise.

(5 marks)

_____   _____

_____   _____

_____   _____

_____   _____

_____   _____

_____   _____

(b) Describe how you would separate the different substances from the mixture. Identify the separation techniques you would choose and show two details of how each one specifically separates an item from the mixture. (9 marks)

Technique One:

_____

_____

_____

_____

_____

_____

_____

_____

Technique Two:

_____

_____

_____

_____

_____

_____
_____
_____
_____

_____

Technique Three:

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

Question 30 **(10 marks)**

Sodium (Na), magnesium (Mg), sulfur (S_8) and chlorine (Cl_2) are all elements located in period 3 of the Periodic Table.

(a)   State and explain the trend in electronegativity across period 3.   (3 marks)

_____

_____

_____

_____

_____

_____

_____

_____

Sodium and magnesium are both good conductors of electricity while sulfur and chlorine are not.

(b)   Explain this difference in terms of the structure and bonding of the species present in these elements.   (3 marks)

_____

_____

_____

_____

_____

_____

_____

_____

Consider two of the ionic compounds that could form from these elements; sodium chloride (NaCl) and magnesium sulfide (MgS).

(c)   Using the concepts of ionisation energy and electronegativity, explain how the chemical bonds within NaCl or MgS form. (4 marks)

_____

_____

_____

_____

_____

_____

_____

_____

_____

Question 31 **(16 marks)**

Complete the following table: (5 marks)

| Physical or Chemical Change	Process is exothermic or endothermic	Enthalpy of products (H) is higher/lower
Propane gas is burnt		
Ice is placed in water and melts		
The two atoms making up an oxygen molecule are separated		
Solid carbon dioxide (dry ice) sublimes to its gaseous form		
A sodium gas ion gains an electron to become sodium gas		

Fuels such as methane combust by reaction with oxygen to produce carbon dioxide and water. This process is accompanied by the release of heat energy to the surroundings.

(a)   Write the equation for the combustion of octane. Include the energy term in your equation. (2 marks)

The heats of reaction for the combustion of some alkanes are shown in the table below.

Fuel	ΔH (kJ mol^{-1})
methane	-890
butane	-2881
pentane	-3536
octane	-5510

(b)   Plot ΔH (kJ mol^{-1}) of the combustion reaction versus the number of carbon atoms in each compound on the grid below.   (2 marks)

Number of carbon atoms
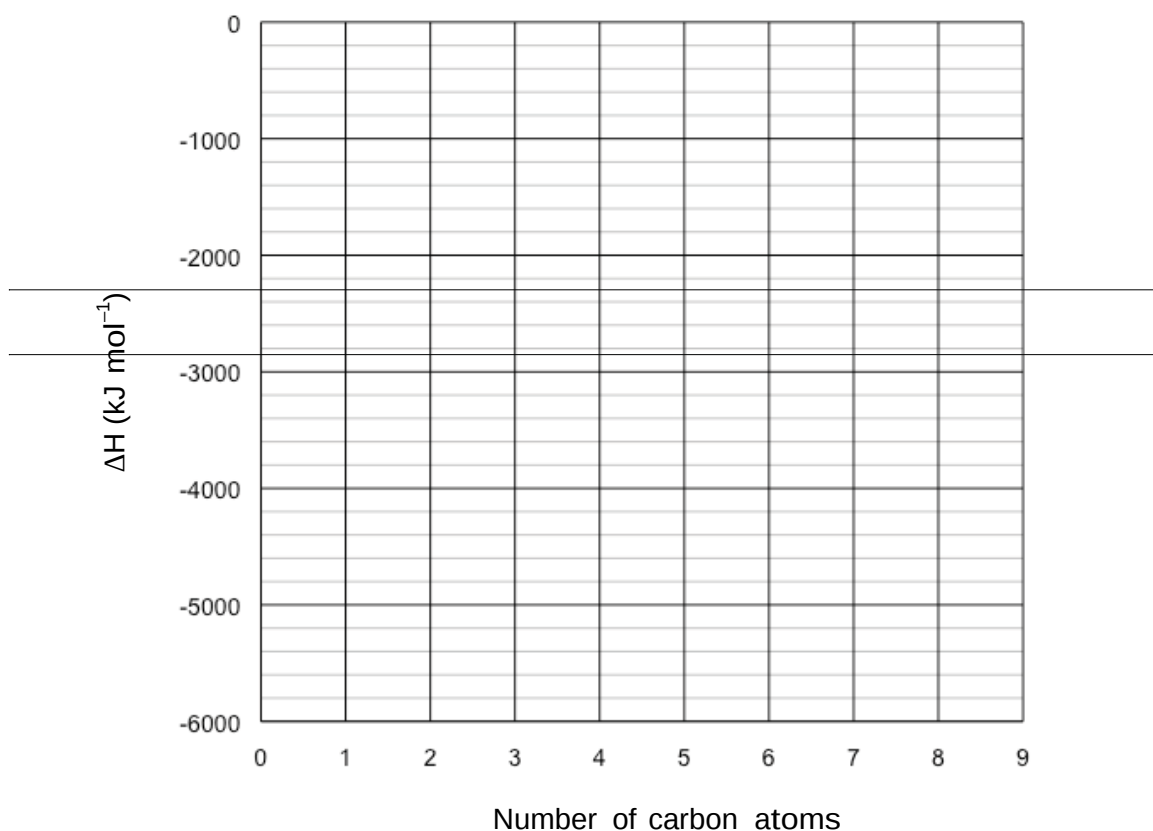
(c)   State the relationship between the number of carbon atoms in the fuel compound and ΔH.   (1 mark)

(d)   Predict, and write below, an approximate value for the heat of reaction for the combustion of hexane.   (1 mark)

Hydrogen gas may also be used as a fuel, and reacts with oxygen when ignited to form water according to the reaction below.

$$2 H_2(g) + O_2(g) \rightarrow 2 H_2O(l)$$
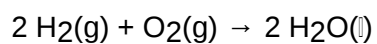
1200 kg of hydrogen gas is ignited in air to form H_2O.

(e)   What volume of oxygen gas will react with this mass of hydrogen at S.T.P.? Your answer must be expressed with the appropriate number of significant figures and must include units.   (4 marks)

(f)   Given that air is approximately 20% oxygen by volume, what volume of air would be required to react with 1200 kg of hydrogen gas?   (1 mark)

END OF PAPER

Spare

Spare answer page

Question number: _____

Spare answer page

Question number: _____

Spare answer page

Question number: _____

_____ Question number: _____

BL	MC	/40
MD	21	/5
MD	22	/16
SF	23	/9
BL	24	/8
BL	25	/11
JV	26	/7
JV	27	/8
SH	28	/16
KS	29	/14
SF	30	/10
TF	31	/16