

Insert School Logo

**Semester One  
Examination 2022  
Question/Answer booklet**

**CHEMISTRY  
UNIT 1**

Name: \_\_\_\_\_

Teacher: \_\_\_\_\_

***TIME ALLOWED FOR THIS PAPER***

Reading time before commencing work: Ten minutes  
Working time for the paper: Three hours

***MATERIALS REQUIRED/RECOMMENDED FOR THIS PAPER***

**To be provided by the supervisor:**

This Question/Answer Booklet  
Multiple-choice Answer Sheet  
Chemistry Data Book

**To be provided by the candidate:**

Standard items: pens, pencils, eraser or correction fluid, ruler, highlighter.

Special items: calculators satisfying the conditions set by the SCSA for this subject.

***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 notes or other items of a non-personal nature in the examination room. 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 exam
Section One: Multiple-choice	25	25	50	25	25
Section Two: Short answer	10	10	60	77	35
Section Three: Extended answer	5	5	70	86	40
<b>Total</b>					100

## Instructions to candidates

1. 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. 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.

Sections Two and Three: Write your answers in this Question/Answer Booklet.

2. 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.
3. 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.
4. 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.
5. The Chemistry Data Book is **not** 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. 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.

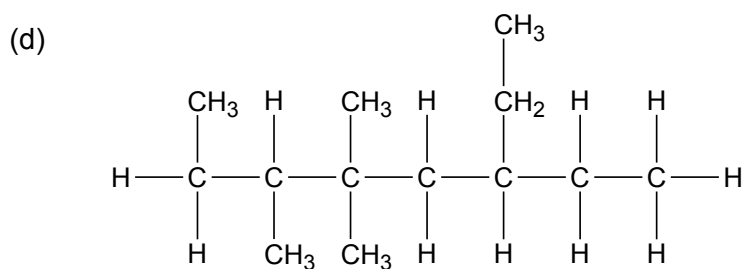
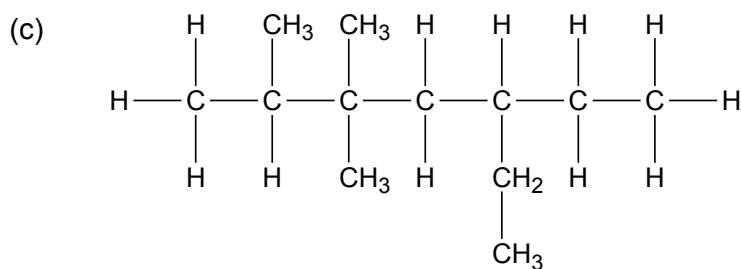
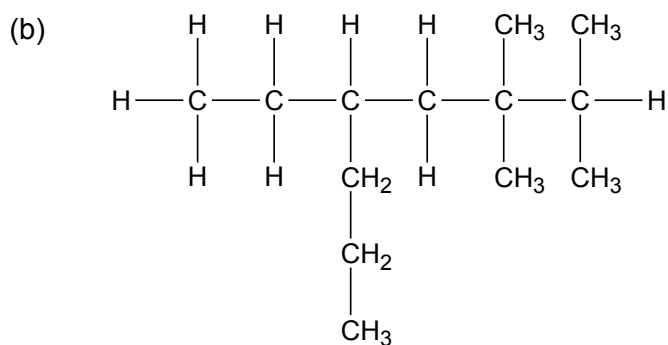
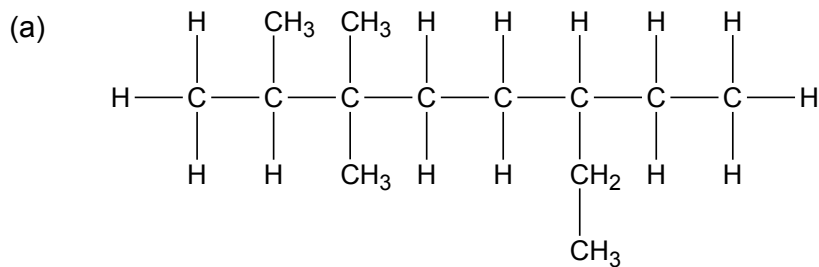
1. An atom of silicon-30 would have
- (a) 30 protons in its nucleus.
  - (b) 14 protons in its electron cloud.
  - (c) 16 electrons in its nucleus.
  - (d) 8 electrons in its second energy level.
2. Element X reacts to form ions with a charge of 2+. The first five ionisation energies of element X are most likely to be
- |     | 1 <sup>st</sup> | 2 <sup>nd</sup> | 3 <sup>rd</sup> | 4 <sup>th</sup> | 5 <sup>th</sup> |
|-----|-----------------|-----------------|-----------------|-----------------|-----------------|
| (a) | 578             | 1817            | 2745            | 11577           | 14842           |
| (b) | 1089            | 2353            | 4621            | 6223            | 37831           |
| (c) | 550             | 1064            | 4138            | 5500            | 6910            |
| (d) | 419             | 3052            | 4420            | 5877            | 7975            |

**Questions 3 and 4 refer to the analysis techniques performed by a mass spectrometer.**

When a substance enters the mass spectrometer it is ionised, resulting in the formation of different species, each having a 1+ charge.

3. A charge of 1+ occurs as a result of
- (a) a proton being added.
  - (b) a proton being removed.
  - (c) an electron being added.
  - (d) an electron being removed.
4. The ionisation process is necessary because only charged species
- (a) can be deflected by a magnetic field.
  - (b) can be accelerated to sufficiently high speeds.
  - (c) are able to have their mass measured.
  - (d) are stable in a high voltage environment.

5. Which of the following structural diagrams correctly represents the compound 5-ethyl-2,3,3-trimethyloctane?



6. Which compound would **not** display all the following physical properties?

1. High melting point
2. Hard and brittle
3. Non-conductor of electricity

- (a) MgO(s)  
 (b) P<sub>2</sub>O<sub>3</sub>(s)  
 (c) NH<sub>4</sub>Cl(s)  
 (d) SiO<sub>2</sub>(s)

See next page

Questions 7 and 8 refer to the following information.

Consider the incomplete table below.

Name	Formula	Covalent or ionic bonding?
potassium phosphide	A	X
B	H <sub>2</sub> O <sub>2</sub>	Y
strontium nitrite	C	Z

7. Which of the following correctly identifies A, B and C?

	A	B	C
(a)	K <sub>3</sub> P	hydrogen peroxide	Sr(NO <sub>2</sub> ) <sub>2</sub>
(b)	K <sub>3</sub> P	dihydrogen dioxide	Sr(NO <sub>3</sub> ) <sub>2</sub>
(c)	K <sub>3</sub> PO <sub>4</sub>	hydrogen peroxide	Sr <sub>3</sub> N <sub>2</sub>
(d)	K <sub>3</sub> PO <sub>4</sub>	hydrogen dioxide	Sr(NO <sub>2</sub> ) <sub>2</sub>

8. Which of the following correctly identifies X, Y and Z?

	X	Y	Z
(a)	ionic	covalent	ionic
(b)	covalent	covalent	ionic
(c)	covalent	ionic	both
(d)	ionic	covalent	both

9. Biogas can be produced by

- (a) extraction of coal seam gas.
- (b) fracking to obtain shale gas.
- (c) drilling into gas reservoirs below the ocean floor.
- (d) anaerobic digestion of organic matter.

10. Which of the following statements regarding benzene is/are correct?

- (i) Benzene is unsaturated.
  - (ii) Benzene contains delocalised electrons.
  - (iii) Benzene conducts electricity.
- (a) (i) only.
  - (b) (ii) only.
  - (c) (i) and (ii) only.
  - (d) (ii) and (iii) only.

11. The electrons of an atom are held in orbit around the nucleus due to
- contact forces.
  - frictional forces.
  - electrostatic forces.
  - gravitational forces.
12. Silver is an excellent conductor of electricity. However, silver nanoparticles can display different properties to bulk silver. Experiments have shown that some silver nanoparticles lose their ability to conduct electricity. This is because silver nanoparticles
- are no longer considered to be metallic substances.
  - do not contain delocalised electrons which can conduct an electric current.
  - are not large enough to transmit an electric current from one particle to another.
  - form spherical covalent molecules with a similar shape to a soccer ball.
13. Which two (2) substances would produce the same colour in a flame test?
- $\text{NaNO}_3$
  - $\text{KNO}_3$
  - $\text{NaCl}$
  - $\text{MgCl}_2$
- (i) and (ii).
  - (i) and (iii).
  - (ii) and (iv).
  - (iii) and (iv).
14. During the formation of chemical bonds, which of the following behaviours are fluorine atoms **least** likely to exhibit?
- Gaining electrons.
  - Losing electrons.
  - Forming ionic bonds.
  - Forming covalent bonds.
15. Which of the following would contain the greatest number of atoms?
- 1.009 g of hydrogen gas
  - 14.01 g of nitrogen gas
  - 16.00 g of oxygen gas
  - 19.00 g of fluorine gas
16. Isotopes of an element would have the same
- mass.
  - boiling point.
  - density.
  - ionic charge.

Questions 17, 18 and 19 refer to the following information.

A colourless liquid (Substance A) was poured into a round-bottom flask which was part of a distillation apparatus set-up. The liquid was then heated to its boiling point. After a period of time, it was observed that only a white solid (Substance B) remained in the round-bottom flask, whilst a colourless liquid (Substance C) was now present in a beaker which captured the distillate as it ran out of the condenser.

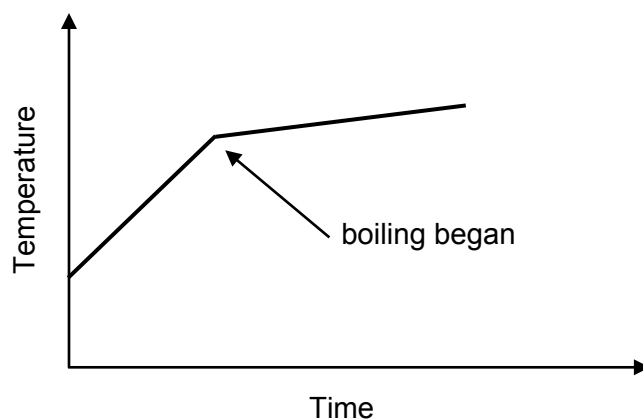
17. Substance A is

- (a) an element.
- (b) a compound.
- (c) a homogeneous mixture.
- (d) a heterogeneous mixture.

18. The identity of Substance B could be

- (a) copper(II) chloride.
- (b) barium carbonate.
- (c) cobalt nitrate.
- (d) zinc sulfate.

19. Substance C was taken and further analysed. The liquid was heated to its boiling point, whilst the temperature was constantly measured. The following heating curve was obtained.



This data suggest that Substance C is a

- (a) pure substance, because the liquid began to boil after a short amount of time.
- (b) pure substance, because the temperature rose constantly as heat was applied.
- (c) mixture, because a large amount of heat was required to initiate boiling.
- (d) mixture, because no fixed boiling point was observed.

20. Which of the following phase changes is **exothermic**?

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

See next page

21. Consider the following information.

1. Elements W and X are in the same period, but W has a higher electronegativity.
2. Elements X and Y are in the same group, but X has the higher electronegativity.
3. Element Z is in the same period as Y and the same group as W.

Which element has the highest electronegativity?

- (a) W
- (b) X
- (c) Y
- (d) Z

22. One of the organic compounds below has a different structure to the other three.

$\text{CH}_3\text{---C}(\text{CH}_3)_2\text{---}\underset{\text{Br}}{\text{CH}}\text{---CH}=\text{CH}\text{---CH}_3$	$\text{CH}_3\text{---CH}=\text{CH}\text{---CHBr---}\underset{\text{CH}_3}{\overset{\text{CH}_3}{\text{C}}}\text{---CH}_3$
$\text{CH}_3\text{---CH}=\text{CH}\text{---}\underset{\text{Br}}{\text{CH}}\text{---CH}(\text{CH}_3)\text{---}\underset{\text{CH}_3}{\text{CH}_2}$	$\text{(CH}_3)_3\text{C---}\underset{\text{Br}}{\text{CH}}\text{---CH---}\underset{\text{CH}_3}{\text{CH}}$

Identify the IUPAC name of the unique compound.

- (a) 4-bromo-5,6-dimethylhex-2-ene
- (b) 4-bromo-5,5-dimethylhex-2-ene
- (c) 4-bromo-5-methylhept-2-ene
- (d) 4-bromo-5,5,5-trimethylpent-2-ene

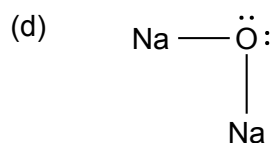
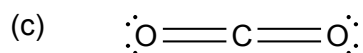
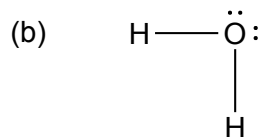
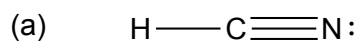
23. Which of these processes results in the formation of products with a **higher** enthalpy than the reactants?

- (i)  $\text{Al}(\text{g}) \rightarrow \text{Al}^+(\text{g}) + \text{e}^-$
- (ii)  $2 \text{N}(\text{g}) \rightarrow \text{N}_2(\text{g})$
- (iii)  $\text{CH}_4(\text{g}) + 2 \text{O}_2(\text{g}) \rightarrow \text{CO}_2(\text{g}) + 2 \text{H}_2\text{O}(\text{g})$

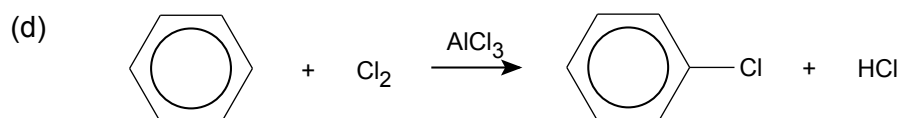
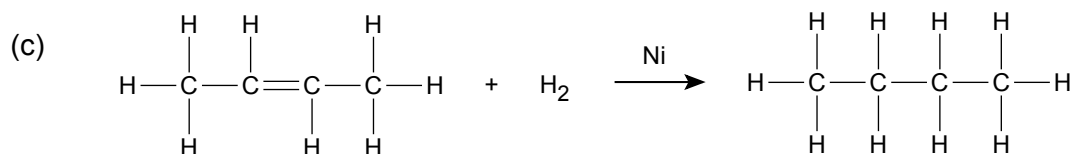
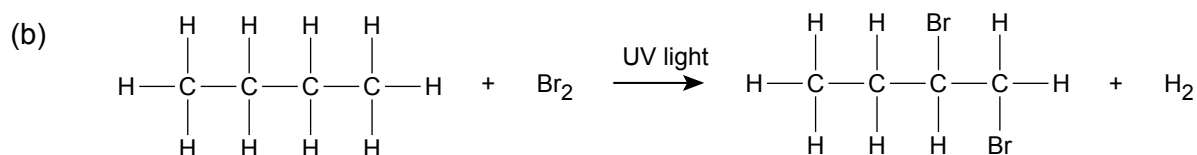
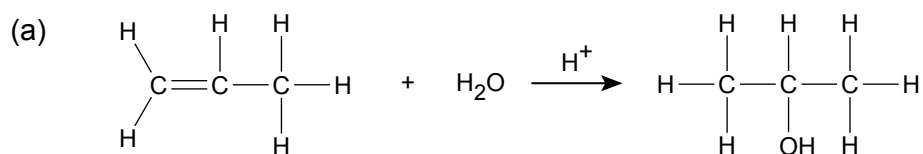
- (a) (i) only.
- (b) (ii) only.
- (c) (iii) only.
- (d) (i) and (iii) only.



24. Which of the following diagrams **inaccurately** represents the formation of **covalent** bonds?



25. Which of the following reactions will **not** occur?



**End of Section One**

See next page

**Section Two: Short answer****35% (77 marks)**

This section has 10 questions. Answer **all** questions. Write your answers in the spaces provided.

Supplementary pages for planning/continuing your answers 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****(10 marks)**

In 1869, the Russian chemist Mendeleev presented the first version of his periodic table. This table contained all the known elements at the time, and also left gaps for elements that were yet to be discovered.

	H 1.01									
	Li 6.94	Be 9.01	B 10.8	C 12.0	N 14.0	O 16.0	F 19.0			
third row →	Na 23.0	Mg 24.3	Al 27.0	Si 28.1	P 31.0	S 32.1	Cl 35.5			
	K 39.1	Ca 40.1		Ti 47.9	V 50.9	Cr 52.0	Mn 54.9	Fe 55.9	Co 58.9	Ni 58.7
	Cu 63.5	Zn 65.4			As 74.9	Se 79.0	Br 79.9			
	Rb 85.5	Sr 87.6	Y 88.9	Zr 91.2	Nb 92.9	Mo 95.9		Ru 101	Rh 103	Pd 108
	Ag 108	Cd 112	In 115	Sn 119	Sb 122	Te 128	I 127			
	Cs 133	Ba 137	La 139		Ta 181	W 184		Os 194	Ir 192	Pt 195
	Au 197	Hg 201	Tl 204	Pb 207	Bi 209					
↑ first column				Th 232		U 238				

Consider the third row of Mendeleev's table, as indicated on the diagram above.

- (a) Identify the characteristic common to all elements in this row, which results in them being located in period 3 of the modern periodic table. (1 mark)

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- (b) State and explain the trend in atomic radii, as you move left to right across this row. (3 marks)

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Consider the first column of Mendeleev's table, as indicated on the diagram above.

- (c) Identify the reason that elements like Cu and Ag are no longer placed in group 1 of the modern periodic table. (1 mark)

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Mendeleev was able to predict the existence of gallium years before it was discovered. He also predicted some of the properties of gallium, such as that it would be a soft, silvery metal and have a melting point of around 30 °C, which turned out to be quite accurate.

- (d) Describe how the layout of the periodic table allowed Mendeleev to make predictions such as these. (2 marks)

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- (e) Identify the element that was later discovered to sit between Ca and Ti. (1 mark)

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Mendeleev's periodic table did not contain any Noble gases. Since these elements do not often form chemical bonds or take part in chemical reactions, they were difficult to observe.

- (f) Explain why the Noble gases are so unreactive. (2 marks)

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**Question 27****(5 marks)**

Carbenicillin ( $C_{17}H_{18}N_2O_6S$ ) is an antibiotic that can be used to treat bacterial infections.

A patient was told to take one carbenicillin tablet every 6 hours for 3–7 days. Each tablet contained 764 mg of carbenicillin.

Calculate the total number of carbenicillin molecules the patient would have ingested in a 24 hour period.

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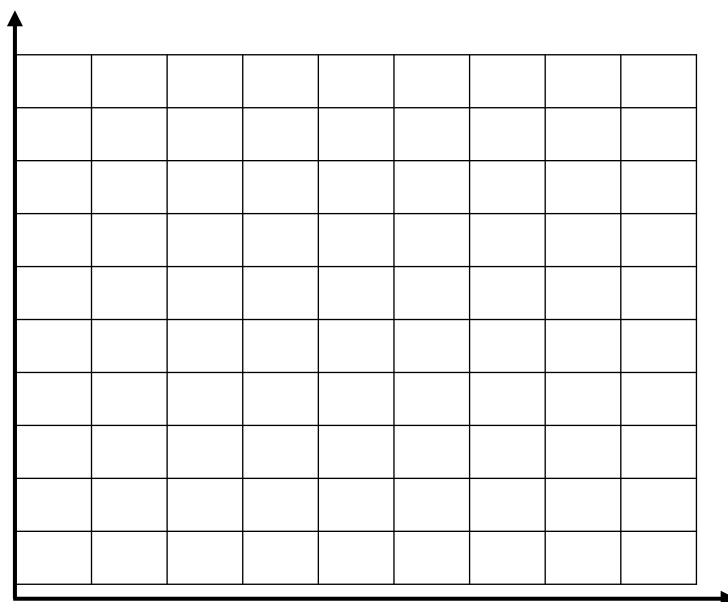
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**Question 28****(7 marks)**

A particular element has five (5) different naturally occurring isotopes. Information regarding the isotopic composition of this element is provided in the table below.

Relative isotopic mass	Percent abundance (%)
80	3.6
82	12.0
83	12.0
84	57.0
86	15.4

- (a) On the grid below, draw the mass spectrum that would have been produced by this element upon analysis. (4 marks)



- (b) Calculate the relative atomic mass and thereby identify this element. (3 marks)

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**Question 29****(9 marks)**

The table below provides select information regarding the subatomic particle arrangement of species V–Z.

The following information is also known.

1. There are two pairs of isotopes represented.
2. The lighter isotope in each pair is a neutral species.
3. Four of these species have a Noble gas electron configuration.
4. Two of these species are ions; one is a 2+ cation and one is a 2- anion.

	Number of protons	Number of neutrons	Electron configuration	Mass number
V	18			40
W		20	2, 8, 8	
X		18		34
Y		18		36
Z	16			36

(a) Use the information provided to complete the table above. (5 marks)

(b) Define an isotope. (1 mark)

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(c) Define an ion and describe the difference between how cations and anions form. (3 marks)

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## Question 30

(6 marks)

A chemist collected several water samples from a well. These were then analysed by atomic absorption spectroscopy (AAS) to determine whether the water contained acceptable levels of cadmium. Guidelines state that cadmium levels in drinking water should be below  $3 \text{ g L}^{-1}$ .

The method used is outlined below.

1. Standard water samples containing cadmium were prepared by serial dilution. These standard samples contained cadmium concentrations of  $1 \text{ g L}^{-1}$ ,  $2 \text{ g L}^{-1}$ ,  $4 \text{ g L}^{-1}$ ,  $8 \text{ g L}^{-1}$ ,  $16 \text{ g L}^{-1}$  and  $32 \text{ g L}^{-1}$ . **Half the standards were prepared using distilled water, and half were prepared using tap water.**
2. The standard cadmium samples were analysed by AAS and the absorbance of each was measured at  $228.8 \text{ nm}$ .
3. A calibration curve was produced from this data.
4. Each well water sample was then analysed by AAS and the absorbance was measured at  $228.8 \text{ nm}$ . **This analysis was repeated five times on each well water sample.**
5. The absorbance values of the well water samples were then compared to the calibration curve to determine the cadmium concentration.

- (a) Consider the **bolded** section of Step 1. Explain how this would have decreased the validity of this analysis. (2 marks)

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- (b) Consider the **bolded** section of Step 4. Explain how this would have increased the reliability of this analysis. (2 marks)

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- (c) Has the chemist collected primary or secondary data? Justify your choice. (2 marks)

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**Question 31****(8 marks)**

Lonsdaleite is an allotrope of carbon, sometimes referred to as 'hexagonal diamond'. When meteors hit Earth, the heat and pressure of the impact can transform graphite into Lonsdaleite. The carbon atoms in Lonsdaleite form a three-dimensional network, but with a different crystal structure to diamond.

- (a) Define the term 'allotrope'. (1 mark)

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- (b) Explain why graphite can conduct electricity, but when it is converted into Lonsdaleite it cannot. (4 marks)

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- (c) Identify what makes fullerenes different from the other allotropes of carbon such as graphite, diamond and Lonsdaleite. (1 mark)

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- (d) State two (2) examples of fullerenes. (2 marks)

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2	



**Question 32****(5 marks)**

Phenanthrene is an aromatic hydrocarbon which is used to make dyes, plastics and pesticides.

Analysis by x-ray crystallography showed the structure of phenanthrene to contain 14 carbon atoms. It is also known that carbon makes up 94.34% by mass of phenanthrene.

- (a) Determine the molecular mass of phenanthrene. (2 marks)

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- (b) Determine the molecular formula of phenanthrene. (3 marks)

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**Question 33****(9 marks)**

A group of chemistry students was asked to design a chemical pathway to synthesise the compound 2,3-dibromopentane.

- (a) Write a chemical equation showing how 2,3-dibromopentane could be produced by an addition reaction. Use structural formulae. (2 marks)

- (b) Write chemical equations for a two-step process showing how 2,3-dibromopentane could be produced by a substitution reaction. Use structural formulae. (4 marks)

Step 1
Step 2

- (c) Explain why the addition reaction pathway is a superior choice for synthesising 2,3-dibromopentane, compared to the substitution pathway. (3 marks)

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**Question 34****(9 marks)**

Some impure aluminium sulfite powder was placed in a beaker containing excess nitric acid. The powder dissolved, producing water, sulfur dioxide gas and aluminium nitrate solution.

- (a) Write a balanced molecular equation for this chemical reaction. (3 marks)

- (b) Write a balanced ionic equation for this reaction. (1 mark)

A 1.82 g sample of impure aluminium sulfite powder was used, and this produced 0.97 g of sulfur dioxide gas.

- (c) Calculate the percentage purity of the aluminium sulfite powder. State your answer to the appropriate number of significant figures. (5 marks)

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**Question 35****(9 marks)**

When a bath bomb is placed in water, it dissolves and effervesces vigorously. The effervescence is due to the reaction between sodium hydrogencarbonate and citric acid, which produces the gas carbon dioxide.

A bath bomb was placed into a large bowl of water, whilst the temperature of the water was measured at regular intervals. The results are shown in the table below.

	Initial	After 10 s	After 20 s	After 30 s
Temperature (°C)	21	18	16	15

- (a) Classify this reaction as endothermic or exothermic. (1 mark)

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- (b) Use the Law of Conservation of Energy to explain what caused the observed temperature change. (3 marks)

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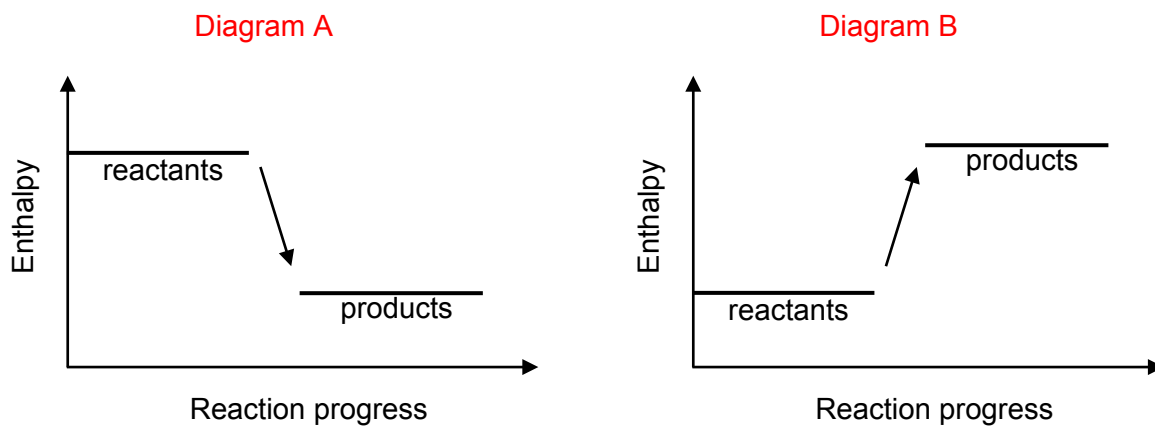
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- (c) Which enthalpy change diagram (i.e. A or B) could be used to represent this reaction? (circle your choice) (1 mark)



- (d) Describe how the processes of bond breaking and bond making relate to the sign of the enthalpy change in this reaction. (4 marks)

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**End of Section Two**

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**Section Three: Extended answer****40% (86 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.

Supplementary pages for planning/continuing your answers 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****(18 marks)**

John Dalton was an English chemist, credited with introducing 'atomic theory' to the field of chemistry. His valuable contributions in this area still form the basis of our modern understanding of atoms. Dalton's atomic theory can be summarised by the following points.

1. Elements are made up of atoms, which are unable to be divided.
2. All atoms of a given element are identical.
3. Atoms of a given element differ from other elements.
4. Different atoms can join in simple ratios to form compounds.
5. In chemical reactions, atoms cannot be created or destroyed, only rearranged.

Consider how our understanding of atoms has changed since this initial theory was proposed.

- (a) Provide a reason that justifies why points 1 and 2 above are no longer considered to be accurate. (2 marks)

1.	
2.	







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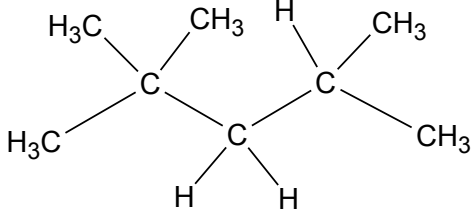
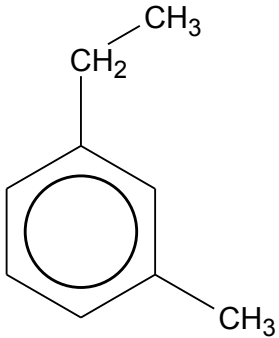
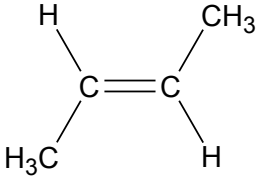
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## Question 37

(17 marks)

Petrol is the primary fuel used in spark ignition engines. It is produced from the fossil fuel crude oil, and consists of a mixture of hydrocarbons. Whilst the exact composition of petrol varies, octane is generally used as the representative or 'average' component of petrol.

In addition to octane, several other petrol components, as well as their common names, are shown in the table below.

Common name	Structure	IUPAC name
isooctane		
3-ethyltoluene		
butylene		

(a) Complete the table above, by writing the IUPAC name of each compound. (3 marks)

As demand for sustainable energy increases, biofuels such as bioethanol are being produced in greater quantities. Bioethanol can be blended with petrol to produce E10 fuel. This blend is composed of 10% ethanol and 90% petrol and is suitable for use in most modern vehicles.

(b) Describe two (2) differences between a fossil fuel and a biofuel. (4 marks)

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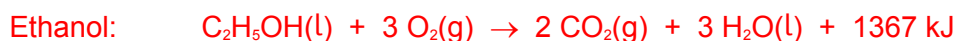
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The choice of fuel for a particular use is influenced by many factors such as energy output and carbon emissions, as well as social, economic, cultural and political values.

The chemical equations for the combustion of both ethanol and octane are given below.



The following table provides a comparative summary of select data regarding the performance and properties of ethanol and octane as fuels.

	Heat of combustion	Energy content	Mass of CO <sub>2</sub> (g) produced per gram of fuel combusted	Mass of CO <sub>2</sub> (g) produced per megajoule (MJ) of energy produced
Ethanol	1367 kJ mol <sup>-1</sup>	29.7 kJ g <sup>-1</sup>	1.91 g	64.4 g
Octane				

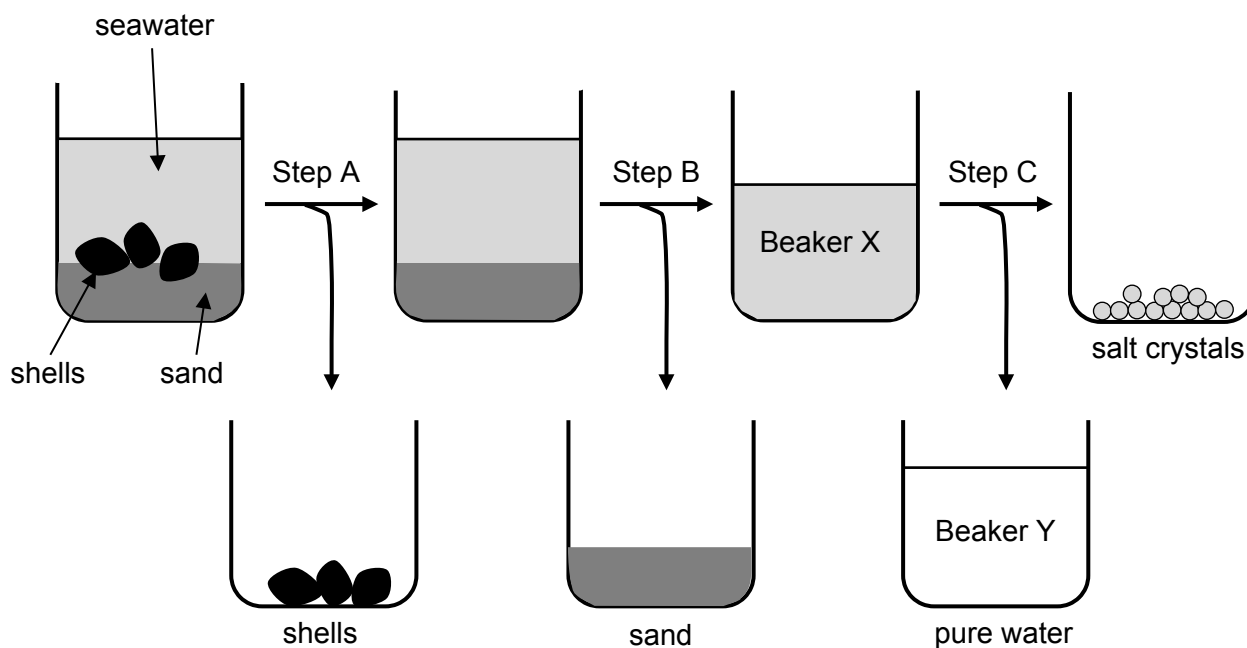


## Question 38

(16 marks)

A group of chemistry students was given a large beaker containing a volume of seawater. In addition to many dissolved ions, such as  $\text{Na}^+(\text{aq})$ ,  $\text{Cl}^-(\text{aq})$ ,  $\text{Mg}^{2+}(\text{aq})$ ,  $\text{SO}_4^{2-}(\text{aq})$  and  $\text{Ca}^{2+}(\text{aq})$ , the seawater contained sand ( $\text{SiO}_2$ ), as well as shell fragments ( $\text{CaCO}_3$ ).

The students were asked to separate the seawater into its components. The method they used is summarised in the diagram below.



- (a) Identify the separation technique that was used at Steps A, B and C, as shown in the diagram above, and state the physical property upon which that separation technique is based. (6 marks)

	Separation technique	Physical property upon which separation depends
Step A		
Step B		
Step C		

- (b) Explain, in terms of structure and bonding, why sand is not soluble in water. (3 marks)

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- (c) Explain, in terms of structure and bonding, why the contents of Beaker X would conduct electricity, whereas the contents of Beaker Y would not. (4 marks)

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Seawater also contains trace amounts of metals such as gold, cobalt and silver. It is known that 1 g of gold is found in every 100 million tonnes of seawater. If Beaker X contained 425 g of seawater;

- (d) Calculate the total number of gold atoms that would have been present. (3 marks)

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Iron alloys are the most common metals used in all areas of modern industry. Two of the many desirable properties of iron are its high melting point and its malleability. With a melting point of 1538 °C, it can be used to line furnaces and manufacture machinery and tools. The malleability of iron enables it to be formed into many different structures, such as support beams, railway lines and cookware.

- (b) Explain, in terms of the structure and bonding present in iron, how each of these properties arise. (4 marks)

High melting point	
Malleable	

One of the less desirable properties of iron is its susceptibility to corrosion when exposed to oxygen and water. There are different techniques used to prevent the corrosion of iron, many of which involve coating the iron to prevent contact with oxygen and/or water.

One recent study found that incorporating cerium(IV) oxide,  $\text{CeO}_2(\text{s})$ , nanoparticles into the coating greatly improved the resistance of the iron to corrosion.

- (c) Define a nanoparticle. (1 mark)

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- (d) Explain how the incorporation of nanoparticles in the coating material provides superior corrosion resistance. (3 marks)

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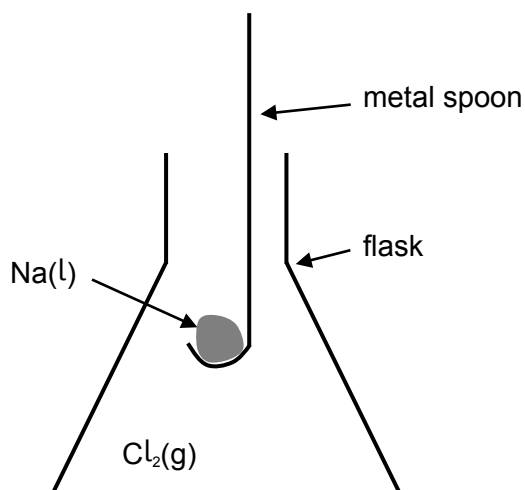
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**Question 40****(19 marks)**

When molten sodium metal,  $\text{Na(l)}$ , is placed in a flask filled with chlorine gas,  $\text{Cl}_2(\text{g})$ , a rapid reaction takes place. A large amount of heat and light energy is generated, as a white ionic solid is formed.



- (a) Explain, in terms of electron behaviour, why sodium and chlorine react to form an ionic bond. Your answer should refer to both ionisation energy and electronegativity. (6 marks)

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When 4.81 g of sodium metal reacts in the presence of excess chlorine gas, 86.0 kJ of energy is produced.

- (b) Calculate the value of the enthalpy change for this process, and then write a balanced thermochemical equation for this reaction, incorporating this value. (7 marks)

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Thermochemical equation:

- (c) Identify two (2) safety risks associated with carrying out this reaction in the laboratory, and suggest a specific safety measure required to minimise each of these risks. (4 marks)

	Safety risk	Safety measure to reduce risk
1		
2		

- (d) If this reaction was carried out using fluorine,  $F_2(g)$ , instead of chlorine, predict how the value of the enthalpy change would be affected. Justify your answer. (2 marks)

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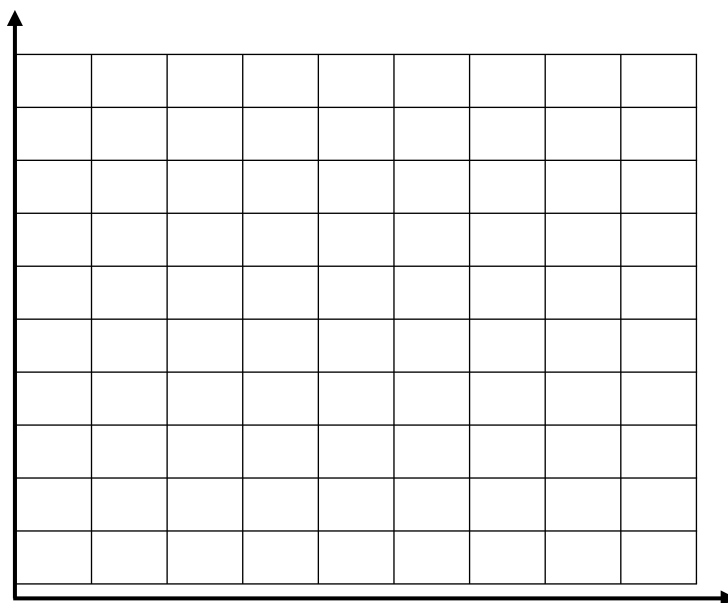
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Question 28 (a)



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