

## Year 11 Semester One Examination, 2018

### Question/Answer Booklet



# CHEMISTRY ATAR UNIT 1

Marks	
Section 1	/40
Section 2	/60
Section 3	/65
<b>Total</b>	<b>/165</b>

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

Teacher:            Ms Brown            Ms Goodwin

*CANDIDATES MUST WRITE IN BLUE OR BLACK INK THROUGHOUT THIS EXAM.*

#### TIME ALLOWED FOR THIS PAPER

Reading time before commencing work:            ten minutes  
Working time for the paper:            two and a half 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 (blue/black preferred), pencils (including coloured), sharpener,  
eraser, correction tape/fluid, ruler, highlighters

Special items:       up to three non-programmable calculators approved for use in the  
WACE examinations.

#### 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	Suggested working time (Minutes)	Number of questions available	Number of questions to be attempted	Approx. % of all marks (rounded)	Marks	Your mark
<b>ONE</b> Multiple choice	38	20	All	25	40	
<b>TWO</b> Short response	53	9	All	35	60	
<b>THREE</b> Extended response	59	5	All	40	65	
	150			100	165	

### 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.

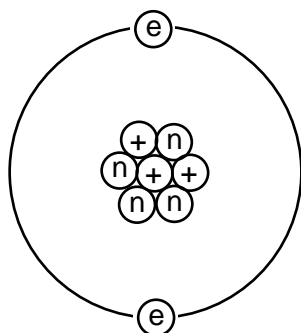
2. When calculating numerical answers, show your working or reasoning clearly. Express numerical answers to the appropriate number of significant figures and include appropriate units where applicable.
3. You must be careful to confine your responses to the specific questions asked and to follow any 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** to be handed in with your Question/Answer Booklet.

**Section One: Multiple-choice****24% (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: 38 minutes.

1. What is the identity of this species?



- ⊕ proton  
 ⊙ neutron  
 ⊙ electron

- (a) Helium atom  
 (b) Lithium atom  
 (c) Helium ion  
 (d) Lithium ion
2. Covalent substances are generally not able to conduct electricity because
- (a) their electrons are localised.  
 (b) their electrons are delocalised.  
 (c) their electrons are transferred.  
 (d) their electrons are shared.
3. Eight consecutive elements in the Periodic Table have the following first ionisation energies:

Ionisation Energies in $\text{kJ mol}^{-1}$							
707	833	870	1010	1170	376	502	540

One of the eight elements is a halogen. The first ionisation energy of the halogen is:

- (a) 1170  
 (b) 1010  
 (c) 870  
 (d) 376

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4. Which of the following formulas represents a substance that contains twice as much hydrogen as oxygen, and half as much carbon as oxygen?
- (a)  $C_4H_8O_6$   
(b)  $C_2H_6O_3$   
(c)  $C_3H_{12}O_6$   
(d)  $C_5H_{10}O_3$
5. The total number of protons and electrons in the hydrogencarbonate ion is
- (a) 63  
(b) 62  
(c) 32  
(d) 31
6. In which of the following combinations of  $0.20 \text{ mol L}^{-1}$  solutions will a green precipitate be formed?
- (a)  $CrCl_3$ ,  $Cu(NO_3)_2$ ,  $Na_2SO_4$   
(b)  $Fe(NO_3)_2$ ,  $NaCl$ ,  $K_2SO_4$   
(c)  $Ni(NO_3)_2$ ,  $CuSO_4$ ,  $KOH$   
(d)  $FeCl_3$ ,  $Na_2CO_3$ ,  $NaOH$
7. Which element is found in group 15, period 5?
- (a) Tin  
(b) Antimony  
(c) Polonium  
(d) Bismuth
8. How many electrons are in the valence shell of the following species?
- |     | <b>Mg</b> | <b>Al<sup>3+</sup></b> | <b>O<sup>2-</sup></b> | <b>P</b> |
|-----|-----------|------------------------|-----------------------|----------|
| (a) | 2         | 3                      | 6                     | 5        |
| (b) | 2         | 8                      | 8                     | 5        |
| (c) | 1         | 6                      | 4                     | 8        |
| (d) | 2         | 0                      | 8                     | 8        |
9. Which of the following isotopes is likely to be the **least** commonly occurring?
- (a) carbon-12  
(b) sulfur-32  
(c) iron-55  
(d) nitrogen-16

10. Which of the formulas below is **incorrect**?
- (a)  $\text{Ba}_2\text{F}$
  - (b)  $\text{CaS}$
  - (c)  $\text{Na}_3\text{P}$
  - (d)  $\text{AlCl}_3$
11. Which of the following substances is **not** able to conduct electricity?
- (a)  $\text{NaCl}(\text{aq})$
  - (b)  $\text{Au}(\text{s})$
  - (c)  $\text{KCl}(\text{s})$
  - (d)  $\text{Hg}(\text{l})$

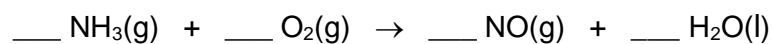
12. Use the table to identify a pair of isotopes.

Element	Number of protons	Number of electrons	Number of neutrons
W	20	21	21
X	19	18	19
Y	19	21	19
Z	20	19	20

- (a) Elements X and W
  - (b) Elements X and Y
  - (c) Elements W and Z
  - (d) Elements Y and W
13. Which of these chemical equations represents an exothermic reaction?
- (i)  $\text{CO} + \text{H}_2\text{O} \rightarrow \text{H}_2 + \text{CO}_2 + 41 \text{ kJ}$
  - (ii)  $\text{CH}_4 + \text{H}_2\text{O} \rightarrow \text{CO} + 3 \text{H}_2 \quad \Delta H = +206 \text{ kJ}$
  - (iii)  $\text{N}_2\text{O}_3 + 40 \text{ kJ} \rightarrow \text{NO} + \text{NO}_2$
- (a) (i) only
  - (b) (ii) only
  - (c) (iii) only
  - (d) (ii) and (iii) only
14. Element X is in group 16 of the periodic table. Which of the following compounds is **least** likely to form?
- (a)  $\text{H}_2\text{X}$
  - (b)  $\text{NaX}$
  - (c)  $\text{MgX}$
  - (d)  $\text{F}_2\text{X}$

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15. Ionic substances are brittle because
- (a) electrons have been transferred between species.
  - (b) electrons are shared between species.
  - (c) they are solids at room temperature.
  - (d) the charged species are arranged in a rigid lattice.

16. What are the coefficients in this equation once correctly balanced?



- (a) 2, 2, 2, 3
  - (b) 1, 3, 1, 2
  - (c) 4, 2, 3, 5
  - (d) 4, 5, 4, 6
17. Which of the following contains the greatest number of **atoms**?
- (a) 3.0 g of Pb
  - (b) 0.01 mol of Ca
  - (c) 0.005 mol of NaCl
  - (d) 0.28 g NO<sub>2</sub>
18. Which of the following are covalent compounds?
- (i) Hydrogen peroxide
  - (ii) Carbon monoxide
  - (iii) Potassium hydroxide
  - (iv) Copper(II) phosphate
  - (v) Sulfurous acid
- (a) (i), (ii) and (v) only
  - (b) (ii) and (v) only
  - (c) (i) and (ii) only
  - (d) (ii), (iii) and (v) only

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**Questions 19 and 20 relate to three common allotropes of carbon; diamond, graphite and fullerenes.**

Consider the list of physical properties given below.

- (i) Conductor of electricity
- (ii) High melting point
- (iii) Hard substance
- (iv) Inert (unreactive) substance
- (v) Atoms form a three dimensional network shape

19. Which of these properties correspond to diamond?

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

20. Which of these properties correspond to graphite?

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

End of Section One





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**Diagrams**

**Question 22****(8 marks)**

- (a) Complete the table below by; (6 marks)
- drawing structural formulas showing **all bonds and atoms**, and
  - writing the molecular formula for each organic molecule.

	Structural diagram	Molar Mass
$\text{Al}_2\text{S}_3$		
$\text{SO}_2$		
$\text{Al}_2(\text{SO}_4)_3$		

- (b) Which of the compounds above contains the highest percentage of sulfur by mass?  
Calculate this value. (2 marks)

**Question 23****(8 marks)**

Consider the elements labelled A-E on the diagram below, which shows the first four periods of the periodic table.

A																	
	B												C	D			
E																	

- (a) Why are A and E both in group 1? (1 mark)

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- (b) Why are B, C and D all in period 2? (1 mark)

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- (c) Why would atoms of element C and E form chemical bonds? State the type of compound formed and describe how the chemical bonds form. (3 marks)

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- (d) Why would atoms of element C and D form chemical bonds? State the type of compound formed and describe how the chemical bonds form. (3 marks)

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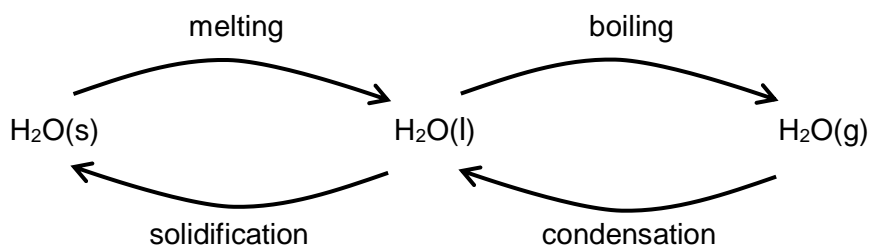


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## Question 24

(6 marks)

Consider the diagram below.



- (a) Name one (1) of the labelled phase changes that is **endothermic**. Justify your choice. (3 marks)

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Bioluminescent Bay in Puerto Rico is a popular tourist attraction because of the microorganisms that live in the water. These types of organisms glow in the dark because they produce light by a special chemical reaction.

- (b) Explain why this reaction is exothermic. (3 marks)

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**Question 25****(8 marks)**

All matter can be classified as either pure substances or mixtures.

- (a) Complete the table below by writing the name or formula of the compound, as well as classifying the compound as having consistent properties with either an ionic or covalent substance. (6 marks)

Name	Formula	Covalent or ionic properties
Ammonium carbonate		
	$\text{Fe}(\text{NO}_3)_3$	
Ethanoic acid		

The table above refers only to pure substances.

- (b) State two (2) ways a mixture differs from a pure substance. (2 marks)

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**Question 26****(7 marks)**

Complete the table below, showing the subatomic particle arrangement of the four different species.

Symbol	Number of protons	Number of neutrons	Electron configuration	Electron energy configuration (s, p, d...)
$^{19}\text{F}$				
	11	12	2, 8	
$^{32}\text{S}^{2-}$	16	16		
	6	8	2, 4	

**Question 27****(7 marks)**

Salts containing the metal potassium (K) have a characteristic lilac (purple) colour in a flame test. A chemistry student was planning on performing flame tests on a series of different salt samples, trying to find one that contained a rare isotope of potassium. However, the student decided that the flame test would not be reliable as the isotope flame colour would be different from usual.

- (a) What is an isotope? (2 marks)

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- (b) Was the student correct? Explain. (3 marks)

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The relative atomic mass ( $A_r$ ) of potassium is 39.10.

- (c) What is the  $A_r$  of an element? What does it indicate that the  $A_r$  of potassium is close to the whole number of 39? (2 marks)

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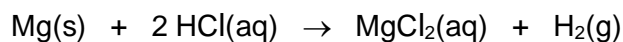
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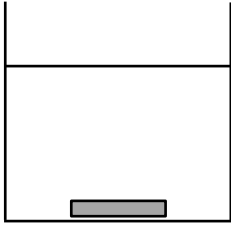
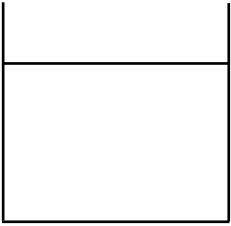
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**Question 28****(6 marks)**

A student was conducting an experiment on the reaction between magnesium metal (Mg) and hydrochloric acid (HCl). Her experimental set up is shown below, as well as the measurements that she made during the investigation.



Start of experiment – Mg mixed with HCl		Mass of empty beaker	34.5 g
		Mass of Mg added	8.9 g
		Mass of HCl added	43.1 g
		Total mass of beaker at start of experiment	
End of experiment – all Mg dissolved		Total mass of beaker at end of experiment	85.8

- (a) State the Law of Conservation of Mass and use this law to calculate the mass of hydrogen gas produced in this experiment. You may assume the acid was in excess and all of the magnesium reacted. (3 marks)

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- (b) If 8.9 g of magnesium was used in the experiment, as stated above, calculate the mass of hydrochloric acid that would have been consumed. (3 marks)

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**Question 29****(4 marks)**

A portion of the periodic table, showing the elements surrounding silicon, is given below. Consider the five elements in the diagram.

	6 <b>C</b> carbon 12.01	
13 <b>Al</b> aluminium 26.98	14 <b>Si</b> silicon 28.09	15 <b>P</b> phosphorus 30.97
	32 <b>Ge</b> germanium 72.63	

- (a) Of these elements, germanium has the largest atomic radius and the smallest first ionisation energy. Explain why, this statement is correct. (3 marks)

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- (b) Which Period 3 element has the highest electronegativity? \_\_\_\_\_

(1 mark)



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**Section Three: Extended answer****40% (65 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.

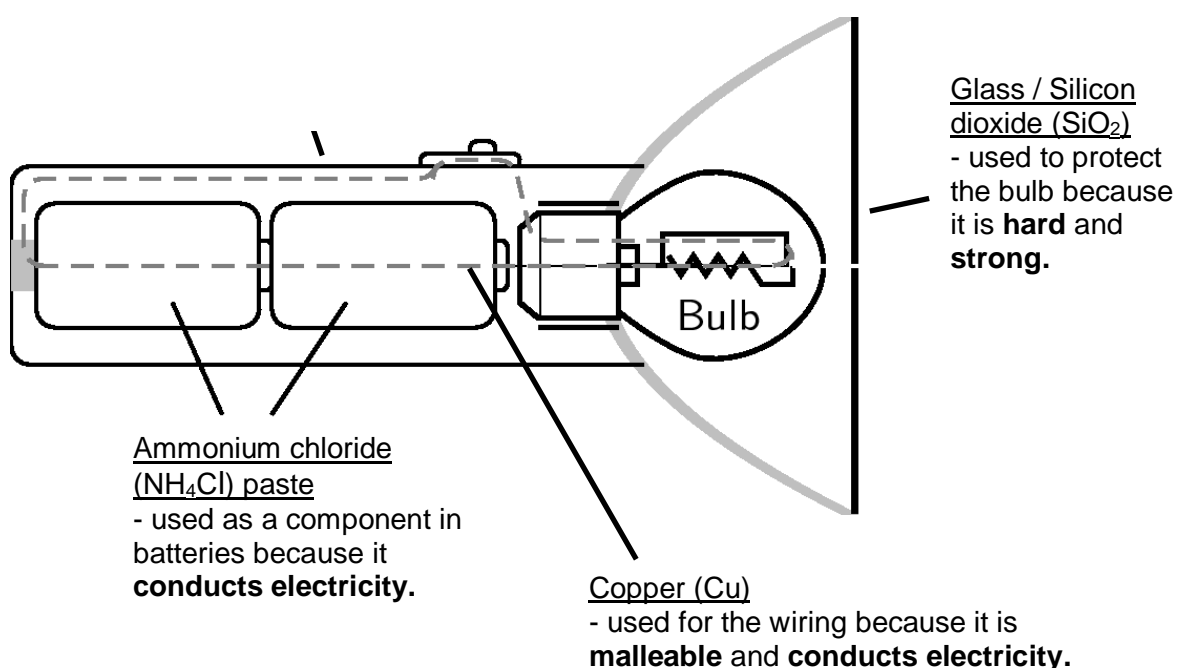
Spare pages are included at the end of this booklet. They can be used for planning your responses and/or as additional space if required to continue an answer.

- 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: 59 minutes.

**Question 30****(11 marks)**

Study the following diagram of a torch (flashlight). Several components have been labelled and some information about the properties of these materials has also been included.







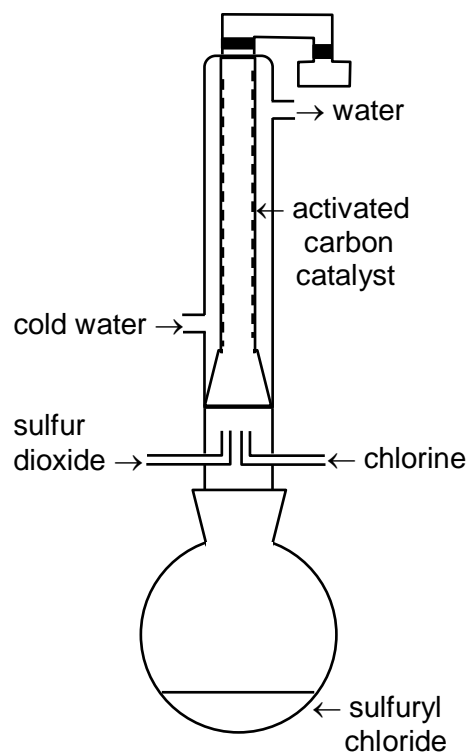
**Diagrams from Q 30 may be drawn here.**

## Question 31

(9 marks)

Sulfuryl chloride is a toxic, corrosive substance with a pungent odour. It isn't found in nature because it reacts quickly with water to produce a mixture of hydrochloric and sulfuric acids. Some information on sulfuryl chloride is shown in the table below.

Formula	$\text{SO}_2\text{Cl}_2$
Melting point	$-54.1\text{ }^\circ\text{C}$
Boiling point	$69.4\text{ }^\circ\text{C}$
Density	$1.67\text{ g mL}^{-1}$



Sulfuryl chloride can be made using the apparatus shown in the diagram to the right. **Sulfur dioxide** and **chlorine gases** are added into the glass reaction vessel. Here they react to form **sulfuryl chloride**. The inner tube of the reaction vessel is coated with an **activated carbon (C) catalyst**. This reaction is **exothermic**, so cold water is used to cool the glass reaction vessel and keep the temperature at around  $30\text{-}40\text{ }^\circ\text{C}$ .

- (a) What phase (state) would sulfuryl chloride be when it forms, if the temperature of the reaction vessel is kept to around  $30\text{-}40\text{ }^\circ\text{C}$ ? Justify your answer. (2 marks)

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- (b) Write a balanced molecular equation for the synthesis of sulfuryl chloride, as described in the reaction above. Include all **bolded** information, as well as phase (state) symbols, in your equation. (2 marks)

- (c) If 87.5 g of sulfur dioxide gas is added into the reaction vessel, what is the maximum mass of sulfuryl chloride that could be produced? (3 marks)

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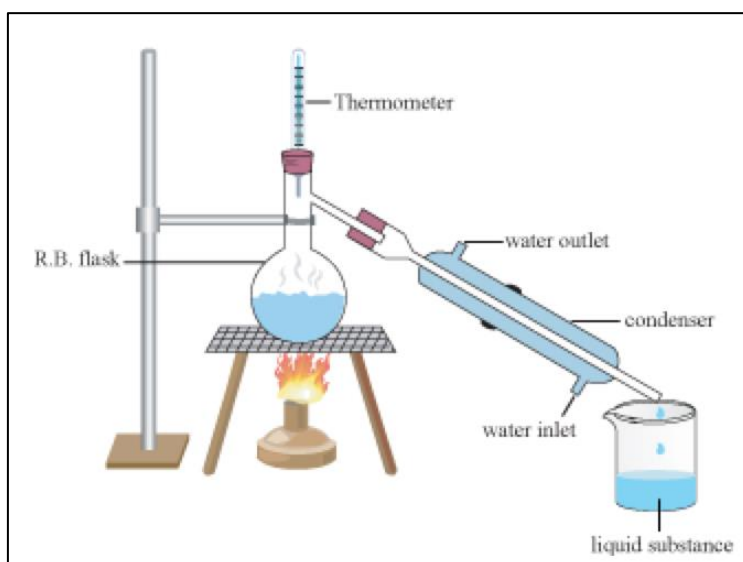
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Once sulfuryl chloride is produced, it is separated from the reaction mixture by distillation. This is done by heating the reaction vessel to 68-70 °C and collecting the sulfuryl chloride fraction (component).

*Distillation is a technique of separating a mixture based on the boiling point differences in the individual components of the mixture. See the diagram below.*



- (d) Why is a temperature of 68-70 °C chosen to separate the sulfuryl chloride during the distillation process? (2 marks)

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**Question 32****(17 marks)**

Three groups of chemistry students (A, B and C) were investigating endothermic and exothermic reactions. Each group was given one reaction to study, as shown in the table below.

<b>Group A</b>	$\text{HCl(aq)} + \text{NaHCO}_3\text{(aq)} \rightarrow \text{NaCl(aq)} + \text{CO}_2\text{(g)} + \text{H}_2\text{O(l)}$
<b>Group B</b>	$\text{CuSO}_4\text{(aq)} + \text{Mg(s)} \rightarrow \text{MgSO}_4\text{(aq)} + \text{Cu(s)}$
<b>Group C</b>	$\text{Ba(OH)}_2\text{(s)} + 2 \text{NH}_4\text{SCN(s)} \rightarrow \text{Ba(SCN)}_2\text{(aq)} + 2 \text{H}_2\text{O(l)} + 2 \text{NH}_3\text{(g)}$

Each group planned their experiment, with the aim to investigate whether their reaction was endothermic or exothermic. They mixed their reagents together in test tubes and recorded the initial temperature of the system, as well as the final temperature once the reaction was finished.

The incomplete results of each group are shown in the tables below.

<b>Group A</b>	<b>Trial 1</b>	<b>Trial 2</b>	<b>Trial 3</b>
Initial temp (°C)	20.5	20.0	21.5
Final temp (°C)	17.0	16.0	18.0
Temperature change (°C)	- 3.5	- 4.0	- 3.5

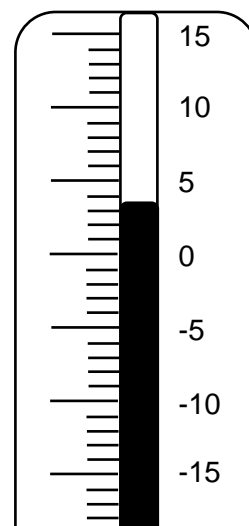
<b>Group B</b>	<b>Trial 1</b>	<b>Trial 2</b>	<b>Trial 3</b>
Initial temp (°C)	22.5	21.5	23.0
Final temp (°C)	25.0	26.5	26.5
Temperature change (°C)	+ 2.5	+ 5.0	+ 3.5

<b>Group C</b>	<b>Trial 1</b>	<b>Trial 2</b>	<b>Trial 3</b>
Initial temp (°C)	18.5	19.0	19.5
Final temp (°C)	4.0	5.5	
Temperature change (°C)	-14.5		

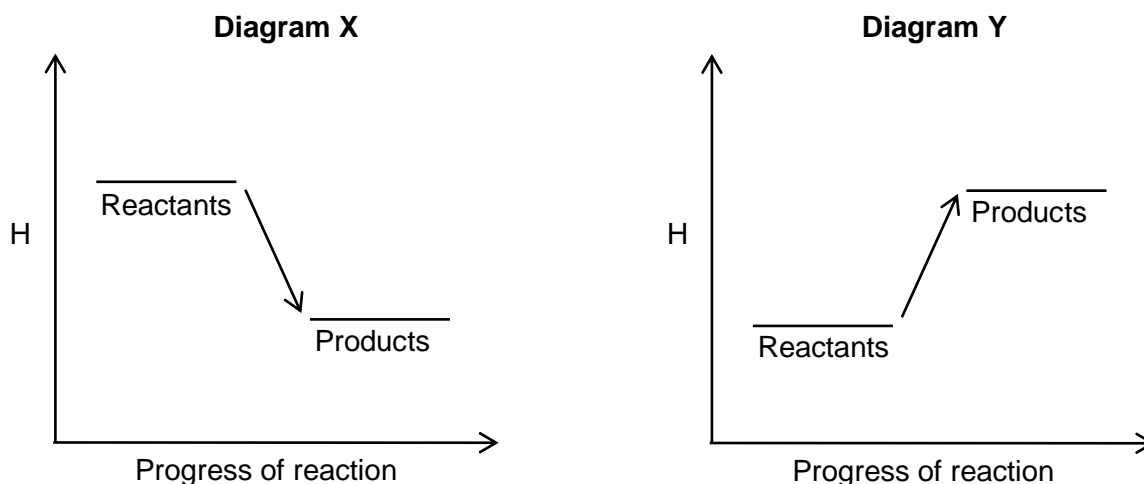


The final temperature reading of group C is shown on the thermometer to the right.

- (a) Complete the tables on the previous page, by reading the final result for group C and recording it in the correct table. Then fill in any other values that are missing, by calculating the change in temperature (i.e. final – initial). (2 marks)



The following diagrams represent the energy changes that can occur during a reaction, as well as illustrate whether a reaction is endothermic or exothermic.



Choose **one** of the reactions investigated (A, B or C) that corresponds to Diagram X.

- (b) State the reaction (A, B or C) and explain what information this diagram provides in terms of the bond breaking and bond making that has occurred in your chosen reaction. (3 marks)

I chose reaction **A** or **B** or **C** (circle your choice of reaction)

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Group B realised that they had forgotten to 'tare' (reset to zero) the balance they used to weigh out the magnesium metal. This resulted in them using **less** Mg(s) than intended in each trial.

- (f) Is this a random or systematic error? Justify your choice and state the likely effect that this error would have had on the final temperatures that group B measured (i.e. higher, lower or unchanged)? (3 marks)

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**Question 33****(19 marks)**

Diesel is a fuel that can be obtained from crude oil. It is used in most forms of transport, from trucks, cars and tractors to aircraft and rail cars. Biodiesel is most commonly produced from vegetable oil in a chemical reaction called transesterification. It can be used in pure form, in many of the same vehicles as regular diesel, however it is often used as a biodiesel-diesel mix.

- (a) Briefly describe two (2) advantages of using biofuels instead of fossil fuels as an energy source. (2 marks)

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- (b) State two (2) reasons it is not always possible for people to use biofuels. (2 marks)

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The table below gives some information regarding diesel and biodiesel.

	Formula	Molecular mass (M)	Energy output (MJ kg <sup>-1</sup> )
Diesel	C <sub>18</sub> H <sub>34</sub>		44.98
Biodiesel	C <sub>18</sub> H <sub>36</sub> O <sub>2</sub>		38.48

- (c) Complete the table by calculating the molecular mass (M) of each fuel. (2 marks)

- (d) Calculate the energy output of **diesel** in kilojoules per mole ( $\text{kJ mol}^{-1}$ ).  
Note:  $1 \text{ MJ} = 1 \times 10^6 \text{ J}$ . (4 marks)

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The equation for the combustion of **biodiesel** is shown below.



If a sample of biodiesel was combusted and 7.045 tonnes of  $\text{CO}_2(\text{g})$  was released into the atmosphere;

- (e) Calculate the mass of biodiesel that would have been consumed. Express your answer to the appropriate number of significant figures. (5 marks)

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- (f) Calculate the amount of energy released. (2 marks)

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- (g) What mass of **diesel** would have been needed to release this same amount of energy? (2 marks)

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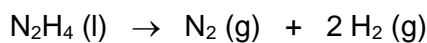
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**Question 34****(9 marks)**

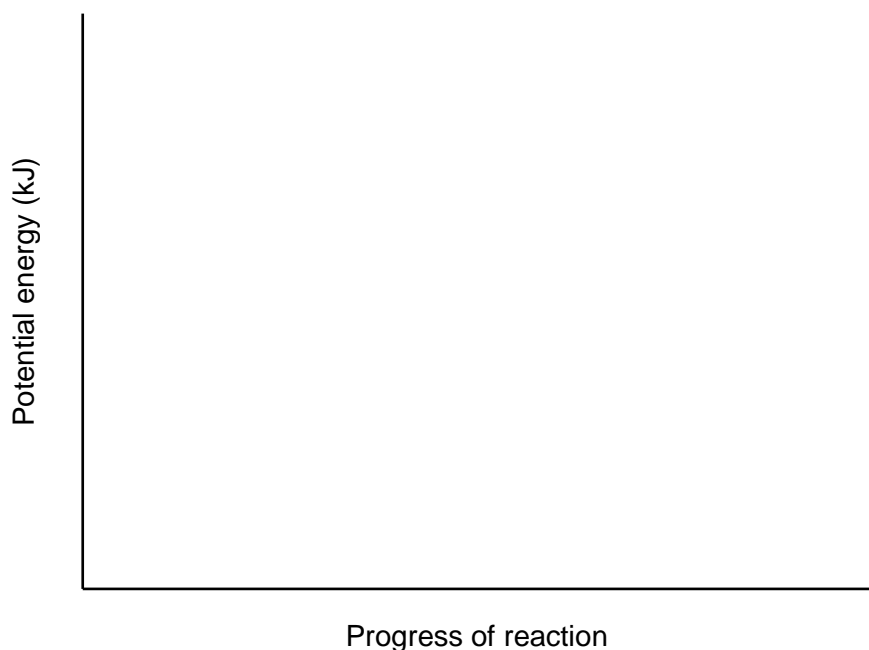
Hydrazine (N<sub>2</sub>H<sub>4</sub>) is a toxic, unstable substance, which is sometimes used in rocket fuels. When hydrazine is passed over a catalyst such as molybdenum nitride on alumina, it decomposes very quickly according to the following equation;



The activation energy for this reaction is 295 kJ mol<sup>-1</sup> and the activation energy for the reverse reaction is 1335 kJ mol<sup>-1</sup>.

- (a) Calculate the enthalpy change ( $\Delta H$ ). (1 mark)
- 

- (b) Sketch a labelled potential energy diagram for the uncatalysed decomposition of hydrazine. Label the activation energy, reverse activation energy and enthalpy change. (4 marks)



- (c) If the molybdenum nitride on alumina catalyst had been used, show the effect this would have on the potential energy diagram above. (1 mark)
- (d) What effect (higher, lower, unchanged) would the addition of a catalyst have on the value of each of the following? (3 marks)
- (i) Activation energy \_\_\_\_\_
- (ii) Reverse activation energy \_\_\_\_\_
- (iii) Enthalpy change \_\_\_\_\_
-





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### **Acknowledgements**

**Question 11** Source: <http://scienceaid.co.uk/chemistry/fundamental/particles.html>

**Question 36** Source: OpenStax, *Physics - grade 10 [caps 2011]*. OpenStax CNX. Jun 14, 2011  
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