

MATRICULATION AND SECONDARY EDUCATION CERTIFICATE EXAMINATIONS BOARD
UNIVERSITY OF MALTA, MSIDA

SECONDARY EDUCATION CERTIFICATE LEVEL

MAY 2015 SESSION

SUBJECT:	Chemistry
PAPER NUMBER:	I
DATE:	13 th May 2015
TIME:	9:00 a.m. to 11:00 a.m.

Useful data:

Relative atomic masses: O = 16; K = 39; Cu = 63.5

Standard temperature and pressure (STP): 0 °C and 1 atm

The molar volume for gases at STP = 22.4 dm³

Directions to Candidates

- *Write your index number in the space at the top left-hand corner of this page.*
 - *Answer ALL questions. Write all your answers in the spaces provided in this booklet.*
 - *The mark allocation is indicated at the end of each question. Marks allocated to parts of questions are also indicated.*
 - *You are reminded of the necessity for orderly presentation in your answers.*
 - *In calculations you are advised to show all the steps in your working, giving your answer at each stage.*
 - *The use of electronic calculators is permitted.*
 - *A Periodic Table is printed on the back of this booklet.*
-

For examiners' use only:

Question	1	2	3	4	5	6	7	8	9	10	11	12	Total
Score													
Maximum	6	6	6	6	8	7	6	4	5	6	20	20	100

DO NOT WRITE ABOVE THIS LINE

Section A: Answer ALL questions in this Section. Write your answers in the spaces provided.

1. The following paragraph has missing terms. Complete the paragraph using terms from the list given. Each term may be used once, more than once or not at all.

high **simple** **weak** **ionic** **conductor**
non-conductor **strong** **covalent** **low** **large**

The term 'dry ice' is used to describe carbon dioxide which is kept at a very _____ temperature and at a _____ pressure. Carbon dioxide consists of _____ molecules and when dry ice forms _____ intermolecular forces are present.

Graphite consists of carbon atoms arranged in layers in a macromolecular structure. The atoms are held together by strong _____ bonds. Each carbon atom has a free electron which makes graphite a _____ of electricity.

[Total: 6 marks]

6

2. A student was given the following data about three elements labelled X, Y and Z.

<u>Element</u>	<u>Atomic Number</u>
X	9
Y	16
Z	19

- (a) Give the electronic configuration of element Y _____
- (b) **Using the letter given**, state the symbol of the ion formed by element Z _____
- (c) **Using the letter given**, state the symbol of the ion formed by element X _____
- (d) Give the electronic configuration of the ion formed in part (c) _____
- (e) **Using the letters indicated**, give the formula of a possible compound formed between
- (i) X and Z _____
- (ii) Y and Z _____

[Total: 6 marks]

6

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-
3. (a) (i) A small amount of solid sodium hydrogencarbonate, NaHCO_3 , is placed in a boiling tube and gently heated. Give a balanced equation to show the reaction taking place.

(2 marks)

- (ii) State **ONE** observation that can be made during the reaction in part (a)(i).

(1 mark)

- (b) The nitrates of magnesium and lead give similar reactions on heating.

- (i) From your knowledge of lead(II) nitrate give a balanced equation to show the effect of heat on **magnesium nitrate** solid, $\text{Mg}(\text{NO}_3)_2$.

(2 marks)

- (ii) Give **ONE** difference noted if the reaction mentioned in part (b)(i), is carried out using solid sodium nitrate instead of solid magnesium nitrate.

(1 mark)

[Total: 6 marks]

4. A compound of potassium contains 70.9% potassium and 29.1% oxygen by mass.

- (a) Calculate the empirical formula of the compound.

6

(4 marks)

- (b) Given that this compound has a formula mass of 110, find its chemical formula?

(2 marks)

[Total: 6 marks]

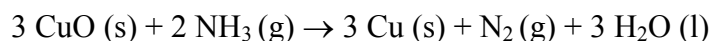
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5. (a) Two children are playing with a balloon which contains 0.8 dm^3 of helium gas at $20 \text{ }^\circ\text{C}$ and a pressure of 1.5 atm . The balloon can take a maximum volume of 0.9 dm^3 . Calculate and check whether the balloon would burst if the temperature is increased to $35 \text{ }^\circ\text{C}$, with the pressure inside the balloon being kept constant.

(4 marks)

- (b) Copper(II) oxide reacts with ammonia on heating according to the following equation



In an experiment, excess ammonia gas is passed over a mass of 53.0 g of hot copper(II) oxide in a combustion tube. Calculate the volume of nitrogen produced, measured at STP.

(4 marks)

[Total: 8 marks]

6. (a) A few drops of lead(II) nitrate solution are added to some potassium iodide solution in a test tube. Give a balanced ionic equation, including state symbols, for the reaction.

(3 marks)

8

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(b) A porcelain boat, with some copper turnings in it, is placed in a combustion tube. The boat is heated and dry chlorine gas is passed over it forming copper(II) chloride, CuCl_2 .

(i) Write a balanced half equation to show the change that chlorine undergoes.

Chlorine half equation _____
(2 marks)

(ii) Which of the elements in the reaction between copper and chlorine is the oxidising agent? Explain.

(2 marks)
[Total: 7 marks]

7

7. (a) This question deals with some properties of various elements.

bromine iodine zinc sulfur calcium iron silver

Complete the Table below using the appropriate elements **from the list given above**.

Properties	Element
A metal that does not react with cold water but reacts with steam.	
A non-metal that occurs as two allotropes when solid.	
An element that can displace zinc from zinc nitrate aqueous solution whilst also releasing a flammable gas.	

(3 marks)

(b) Give a balanced ionic equation, including state symbols, to show the reaction that occurs when some magnesium turnings are added to silver nitrate solution.

(3 marks)
[Total: 6 marks]

6

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8. (a) The graph below (Figure 1) shows the solubility curves for nitrogen and oxygen in water at different temperatures.

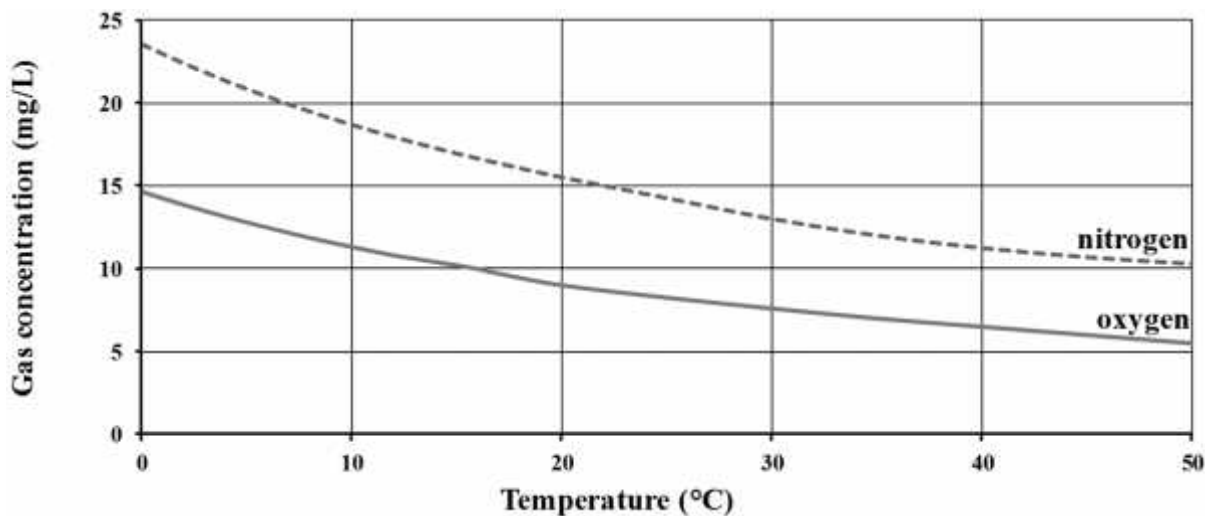


Figure 1

- (i) The solubility curves for the two gases are very similar (Figure 1). What can be concluded from the **shapes** of the curves, about the solubility of the two gases in water?

(1 mark)

- (ii) Use **the graph** (Figure 1) to calculate the approximate **total** concentration of dissolved oxygen and nitrogen gases at 30 °C.

(1 mark)

- (iii) Give **ONE** advantage that results from the fact that these gases are soluble in water.

(1 mark)

- (b) A student has two unlabelled bottles, one containing distilled water and one containing tap water. Suggest a simple test that can be used to distinguish between the two.

(1 mark)
[Total: 4 marks]

4

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9. In industry large amounts of sulfuric acid are prepared using the Contact Process.
- (a) Give the **formula** of a suitable catalyst used when converting sulfur dioxide to sulfur trioxide.

(1 mark)

- (b) The sulfur trioxide formed in the Contact Process is not bubbled into water but instead it is bubbled into concentrated sulfuric acid.

- (i) Give the **formula** and **name** of the product formed in this process.

Formula _____ Name _____

(2 marks)

- (ii) Give **TWO** reasons why in the Contact Process the sulfur trioxide produced is not bubbled directly into water.

(2 marks)

[Total: 5 marks]

10. Complete the missing data in the following Table.

(a) The name and structure of a carboxylic acid having four carbon atoms.	
(b) The formula of the product formed when ethanol reacts with phosphorus(V) chloride.	
(c) A balanced equation for the reaction of ethanol with sodium metal.	
(d) From your knowledge of ethanoic acid, give the formula of the organic product formed when the carboxylic acid in part (a) reacts with ethanol in the presence of a few drops of concentrated sulfuric acid.	

[Total: 6 marks]

5

6

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Section B: Answer ALL questions in this Section. Write your answers in the spaces provided.

11. (a) Aluminium is prepared on a large scale as there is a large demand for it.
- (i) Give a **simple labelled diagram** of the extraction process of aluminium. Your diagram must include the name of the electrolyte, the materials from which the electrodes are made as well as their polarities.

(5 marks)

- (ii) Give an ionic equation for the reaction occurring at the **cathode**.

(2 marks)

- (iii) Give **ONE** reason why the anode needs to be replaced from time to time.

(1 mark)

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-
- (b) Aluminium metal conducts both heat and electricity. Use a labelled diagram to explain how the bonding in aluminium metal enables it to be a good conductor of electricity.

(4 marks)

- (c) (i) Explain the following statement:

‘Magnesium, copper(II) and lead(II) salts in a solution can be distinguished when sodium hydroxide solution is added to separate samples in three test tubes until in excess.’

Your explanation must include the three observations noted during the test.

(6 marks)

- (ii) The soluble salts mentioned in part (c)(i) were all nitrates. Describe a chemical test that can be used in the laboratory to identify nitrate ions in solution.

(2 marks)
[Total: 20 marks]

20

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12. (a) Give **TWO** valid reasons why it can be concluded that sodium chloride is just one compound and not a mixture of sodium and chlorine.

(2 marks)

(b) Maria has been given a mixture of marble chippings and sugar. Her task is to obtain a sample of solid sugar from the mixture. She is aware that distillation is not a suitable method.

(i) Give **TWO** reasons why in this case distillation is not a suitable method.

(2 marks)

(ii) Maria managed to obtain a sample of solid sugar from the mixture. Her experiment consisted of **TWO** different processes. Give labelled diagrams showing the apparatus used for each of the two processes and include a **brief** explanation of each process.

Process 1:

DO NOT WRITE ABOVE THIS LINE

Process 2:

(12 marks)

- (c) During a picnic with friends in the countryside, Peter notices stains on his jeans, from the grass and the flowers he had been kneeling on. A friend of his tried to remove the stains with some water but the situation seemed to become worse since the stains grew larger and various colours appeared. Explain.

(4 marks)
[Total: 20 marks]

20

MATRICULATION AND SECONDARY EDUCATION CERTIFICATE EXAMINATIONS BOARD
UNIVERSITY OF MALTA, MSIDA

SECONDARY EDUCATION CERTIFICATE LEVEL

MAY 2015 SESSION

SUBJECT: **Chemistry**
 PAPER NUMBER: IIA
 DATE: 15th May 2015
 TIME: 9:00 a.m. to 11:00 a.m.

Useful data

Specific heat capacity of water = $4.2 \text{ J g}^{-1} \text{ }^{\circ}\text{C}^{-1}$

$\Delta H = mc\Delta\theta$

Directions to Candidates

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Score															
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Section A: Answer ALL questions in this Section. Write your answers in the spaces provided.

1. (a) Fill in the blank spaces in the following Table:

	Particles	Volume	Shape
Solid			Fixed shape
Liquid	The particles slip and slide over each other		
Gas		Takes the volume of the container	

(6 marks)

(b) Use the Kinetic Theory to explain why:

(i) solids have a fixed shape.

(1 mark)

(ii) gases take the same volume as the container in which they are placed.

(1 mark)

[Total: 8 marks]

2. Complete the following Table related to pollutants.

Pollutant	Source	Negative effect on the environment
Nitrogen dioxide		
		Damages the ozone layer

(4 marks)

[Total: 4 marks]

8

4

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3. *“Iron ore is used to make iron and steel. Iron is produced (extracted) in a Blast Furnace from a solid mixture of ore, coke and limestone which is continuously fed into the top of the Blast Furnace.”*

(a) Give the name of the iron ore used.

(1 mark)

(b) The overall process that occurs within the Blast Furnace can be represented through **three main** chemical reactions. Represent these **THREE** reactions by balanced chemical equations.

(5 marks)

[Total: 6 marks]

4. *“Water varies in the amount of dissolved mineral ions it contains. This determines whether it is hard or soft water. There are advantages and disadvantages to each, but the damage that can be caused to water pipes and appliances by hard water means that water may need to be softened.”*

http://www.bbc.co.uk/schools/gcsebitesize/science/triple_aqa/water/hard_soft_water/revision/1/

(a) There are two types of hard water. Identify the **TWO** types and explain how the two types of hard water can be distinguished by a physical method.

(4 marks)

(b) Explain why it is advantageous to utilize detergents instead of soap when washing using hard water.

(2 marks)

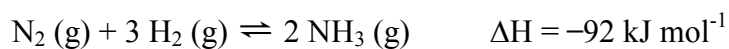
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6

6

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-
5. Ammonia is manufactured by the Haber Process, which involves the following reaction.



A chemist suggests to the manufacturer the conditions that would favour the production of ammonia.

- (a) Briefly explain the conditions of pressure and temperature suggested by the chemist.

Pressure: _____

Temperature: _____

(4 marks)

- (b) In practice a temperature of 450 °C is used. Suggest a reason why this temperature is different from that suggested by the chemist.

(2 marks)
[Total: 6 marks]

6

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6. The reactions of chlorine, iodine and bromine with hydrogen are reported in **Column A**. The values of the heat of reaction for these three reactions are -73 kJ mol^{-1} , -184 kJ mol^{-1} and $+53 \text{ kJ mol}^{-1}$, but **these values are not in the same order as the equations in Column A**.

- (a) Write the correct heat of reaction next to the equation in the **Answer** column to reflect the reactivity in group 7.

Column A	Answer (heat of reaction)
$\text{H}_2 + \text{Cl}_2 \rightarrow 2 \text{HCl}$	
$\text{H}_2 + \text{I}_2 \rightarrow 2 \text{HI}$	
$\text{H}_2 + \text{Br}_2 \rightarrow 2 \text{HBr}$	

(3 marks)

- (b) Explain briefly your answer to part (a).

(1 mark)**[Total: 4 marks]**

7. Mr Borg bought **TWO** brands of vinegar from a supermarket. He wanted to know which brand contained the highest concentration of acid, CH_3COOH . So he titrated 25.0 cm^3 samples of each brand against 0.1 mol dm^{-3} sodium hydroxide solution. The results are reported below:

	Brand A	Brand B
Volume of 0.1 mol dm^{-3} sodium hydroxide solution	14.9 cm^3	12.1 cm^3

- (a) State the name of the acid present in vinegar.

(1 mark)

- (b) Write the equation for the reaction between the acid present in vinegar and sodium hydroxide.

(2 marks)

4

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(c) How many moles of sodium hydroxide reacted with 25.0 cm³ of **Brand A** vinegar?

(1 mark)

(d) How many moles of sodium hydroxide reacted with 25.0 cm³ of **Brand B** vinegar?

(1 mark)

(e) Which brand contains the highest concentration of acid? Explain your answer.

(2 marks)

[Total: 7 marks]

7

8. (a) On mixing solutions of sodium chloride and silver nitrate, a chemical reaction occurs.

(i) Give the ionic equation for this reaction.

(2 marks)

(ii) What will be observed in this reaction?

(1 mark)

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(b) 25.0 cm^3 of 1.0 mol dm^{-3} silver nitrate is added to 25.0 cm^3 of 1.0 mol dm^{-3} of sodium chloride solution in a polystyrene cup. The mixture was carefully stirred with a thermometer and the observed temperature increased by $7.3 \text{ }^\circ\text{C}$.

(i) Assuming that the solutions used have the same density as water, and that the density of water is 1 g cm^{-3} , calculate the amount of heat given out during this reaction.

(1 mark)

(ii) Calculate the number of moles of silver nitrate taking part in the reaction.

(1 mark)

(iii) Calculate the heat of reaction for the production of one mole of product.

(1 mark)

(iv) The value of the heat of reaction for one mole of product is actually $-65.7 \text{ kJ mol}^{-1}$. Why is this value different from the one obtained in part (b)(iii)?

(1 mark)
[Total: 7 marks]

7

9. Air is a mixture of gases. Air is ‘pushed through’ the apparatus shown below. **Flask A** contains potassium hydroxide solution and there are iron filings in **Section B**.

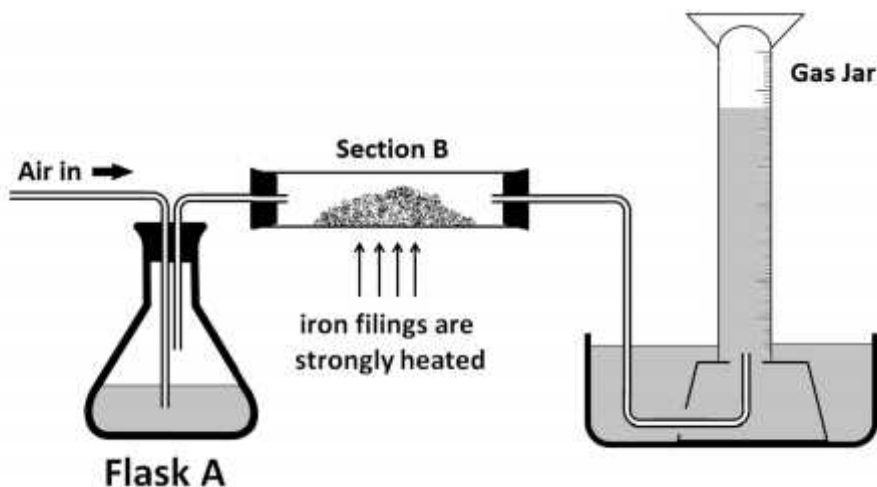


Figure 1

- (a) Explain briefly what happens when the air passes through the solution in **Flask A**.

(1 mark)

- (b) Write the equation for the chemical reaction taking place in **Flask A**.

(2 marks)

- (c) Explain briefly what happens when the air passes through the tube in **Section B**.

(1 mark)

- (d) Write the equation of the chemical reaction taking place in **Section B**.

(2 marks)

- (e) Name the main component of the gas mixture collected in the **gas jar**.

(1 mark)

- (f) Name **ONE** element that would be present, alongside the main component, in the **gas jar**.

(1 mark)
[Total: 8 marks]

8

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10. Pieces of magnesium ribbon react with dilute hydrochloric acid solution. A scientist wants to measure the rate of this reaction by measuring the volume of gas produced when these two chemicals are mixed together.

- (a) Draw a **labelled diagram** of the apparatus that can be used to investigate the rate of reaction between dilute hydrochloric acid and pieces of magnesium ribbon.

(2 marks)

- (b) The volume of gas produced during the reaction of magnesium ribbon pieces with dilute hydrochloric acid was recorded and plotted on a graph paper (Figure 2).

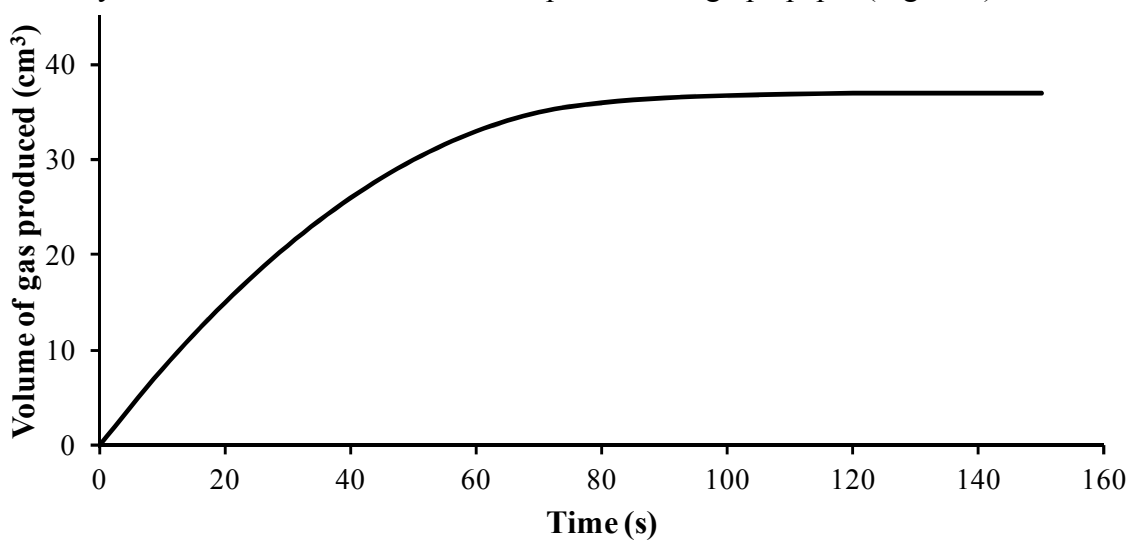


Figure 2

- (i) Using the same graph above (Figure 2), **sketch another plot** to show how the rate of reaction would change if magnesium powder was used instead of the magnesium ribbon when the experiment is carried out at the same temperature.

(1 mark)

- (ii) Give **ONE** reason that justifies your answer to part (b)(i).

(1 mark)

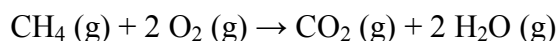
[Total: 4 marks]

4

Section B: Answer TWO questions from this section. Write your answers in the lined pages provided. (Indicate clearly the question numbers being answered)

11. (a) Oxygen is a very reactive element which combines with many elements. Write an equation for the reaction of oxygen with each of the following elements.
- (i) Aluminium
 - (ii) Copper
 - (iii) Sulfur
- (6 marks)**
- (b) (i) There are acidic, basic, amphoteric and neutral oxides. Distinguish between the different types of oxides.
- (4 marks)**
- (ii) Indicate the nature of each oxide produced in the reactions of part (a).
- (3 marks)**
- (c) (i) The colourless nitrogen monoxide (NO) reacts with air to produce a brown gas. Write down the equation that represents this reaction.
- (2 marks)**
- (ii) The brown gas produced is highly soluble in water. What effect would the resulting solution have on litmus?
- (1 mark)**
- (iii) What type of oxide is nitrogen monoxide (NO)?
- (1 mark)**
- (d) Considering the reaction in part (c)(i), 10 cm³ of oxygen and 10 cm³ of nitrogen monoxide (NO) are mixed together in a closed container. Assuming that all the volumes of the gases are measured at the same temperature and pressure, calculate the final volume of the gas container given that a complete reaction occurs between the two reagents.
- (3 marks)**
- [Total: 20 marks]**

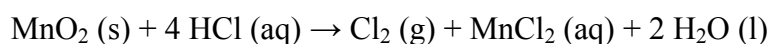
12. (a) Consider the following reaction:



Explain what is being oxidized and what is being reduced in terms of oxygen and hydrogen.

(2 marks)

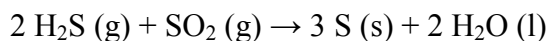
(b) Consider the following reaction:



Explain what is being oxidized and what is being reduced in terms of oxidation numbers.

(4 marks)

(c) Consider the following reaction:



Identify the oxidizing and reducing agents.

(2 marks)

(d) (i) '*Potassium reacts with bromine to produce potassium bromide.*' Explain this redox reaction in terms of exchange of electrons.

(2 marks)

(ii) Write the **TWO** half equations for the redox reaction mentioned in part (d)(i).

(2 marks)

(e) Acids are commonly used in the laboratory in the preparation of salts. Using well-labelled diagrams outline the preparation of a sample of pure dry zinc sulfate starting from sulfuric acid.

(8 marks)

[Total: 20 marks]

Question 13 is on the next page

13. On strong heating, a white solid **A** gives a white solid **B** and two gases **C** and **D**. Gas **C** turns anhydrous copper(II) sulfate from white to blue, while gas **D** turns lime water cloudy. When substance **A** is placed in a Bunsen burner flame, it gives a bright yellow colour.

B reacts with dilute hydrochloric acid to give solution **E** and gas **D**. Then when a solution of lead(II) nitrate is added to solution **E** a white precipitate **F** is formed.

(a) (i) Identify gases **C** and **D**. Explain briefly your answer. (2 marks)

(ii) Write the equation representing the reaction between anhydrous copper(II) sulfate and gas **C**? (2 marks)

(iii) Write the equation for the reaction of gas **D** with lime water. (3 marks)

(b) Identify substances **A**, **B**, **E** and **F**. (4 marks)

(c) Write chemical equations for each of the following reactions:

(i) The action of heat on substance **A**. (2 marks)

(ii) The reaction between hydrochloric acid and substance **B**. (2 marks)

(iii) The reaction of lead(II) nitrate solution with solution **E**. (2 marks)

(d) Two reagent bottles labelled **IRON CHLORIDE** were found in the lab. The colour of the salt inside each bottle was different.

Outline **ONE** simple chemical test that can be carried out to identify which bottle contains the iron(II) salt and which one contains the iron(III) salt.

(3 marks)
[Total: 20 marks]

14. Crude oil is a mixture that can be separated into *fractions* by fractional distillation. Consider the Table below.

Fraction	Substances with carbon chain length of
G	C ₁ to C ₄
H	C ₅ to C ₁₂
I	C ₁₂ to C ₁₆
J	C ₁₆ to C ₁₈
K	C ₁₈ to C ₂₀
L	More than C ₂₀

- (a) (i) What is meant by the term '*fraction*' as used in this question?
(2 marks)
- (ii) Mention **ONE** use for each of the fractions **G, H, I, J, K** and **L** in everyday life.
(6 marks)
- (b) '*There are chain isomers and functional group isomers.*' Explain this statement, using suitable examples.
(6 marks)
- (c) '*Organic compounds are grouped into homologous series.*' Explain this statement.
(6 marks)
[Total: 20 marks]

MATRICULATION AND SECONDARY EDUCATION CERTIFICATE EXAMINATIONS BOARD
UNIVERSITY OF MALTA, MSIDA

SECONDARY EDUCATION CERTIFICATE LEVEL

MAY 2015 SESSION

SUBJECT:	Chemistry
PAPER NUMBER:	IIB
DATE:	15 th May 2015
TIME:	9:00 a.m. to 11:00 a.m.

Useful data

Specific heat capacity of water = $4.2 \text{ J g}^{-1} \text{ }^\circ\text{C}^{-1}$

$\Delta H = mc\Delta\theta$

Directions to Candidates

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Score															
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Section A: Answer ALL questions in this Section. Write your answers in the spaces provided.

1. The Kinetic Theory states that all matter is made up of small indivisible particles as shown in Figure 1.

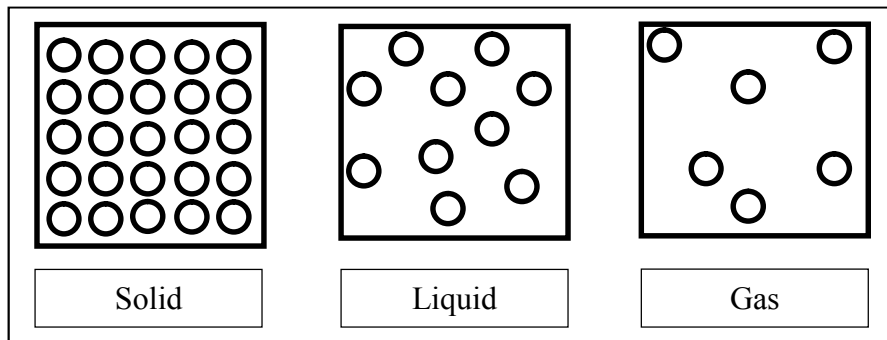


Figure 1

How does this theory explain that:

(a) solids have a fixed shape.

(1 mark)

(b) liquids take the shape of the container in which they are placed.

(1 mark)

(c) gases do not have a fixed volume.

(2 marks)

(d) a piece of lead will change from a solid to liquid when it is strongly heated.

(2 marks)
[Total: 6 marks]

6

2. The following diagram (Figure 2) shows what happens during the combustion of oil.

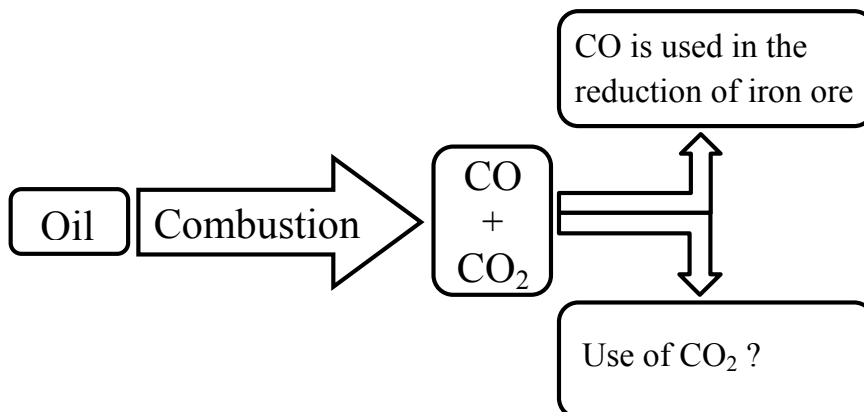


Figure 2

(a) How would one remove carbon dioxide from the mixture of carbon monoxide and carbon dioxide?

(1 mark)

(b) The accumulation of carbon dioxide and carbon monoxide may have undesirable consequences if these build up in the environment. Give **ONE** environmental or health problem related to each substance.

Carbon dioxide _____

Carbon monoxide _____

(2 marks)

(c) Carbon monoxide is used on a large scale in the production of iron from iron ore (Fe_3O_4). Give the equation for the reaction that takes place during this process.

(2 marks)

(d) Mention **ONE** large scale use of carbon dioxide.

(1 mark)

[Total: 6 marks]

	6

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3. The Borg family noticed that the water in their electric kettle was taking longer to boil ever since the white deposit on the heating element became thicker.

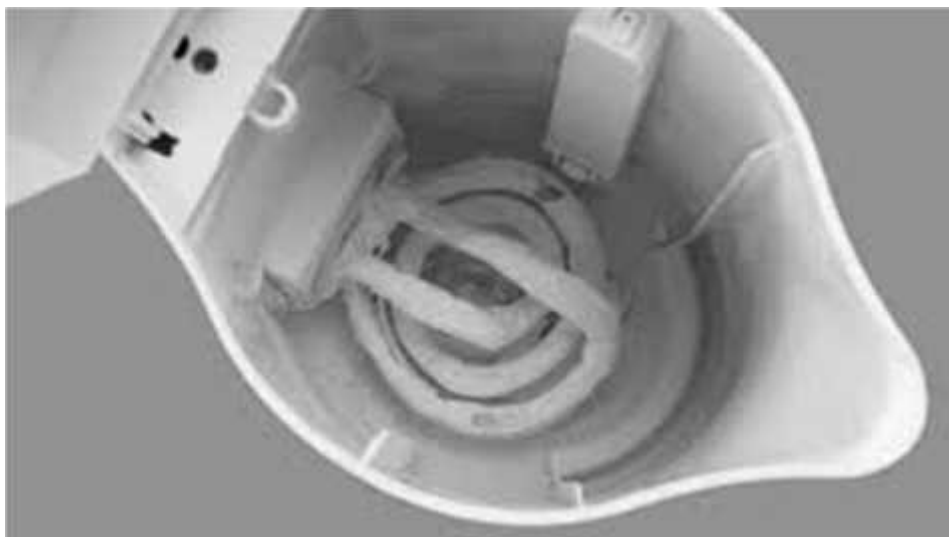


Figure 3

- (a) Give the name or formula of the main chemical that deposits on the heating element of the kettle.

(1 mark)

- (b) This deposit forms through the thermal decomposition of calcium hydrogencarbonate. Write a chemical equation that represents the thermal decomposition of calcium hydrogencarbonate to form the white deposit noted in the kettle.

(2 marks)

- (c) Write an equation and explain how calcium hydrogencarbonate ends up in drinking water.

Equation: _____

Explanation: _____

(4 marks)
[Total: 7 marks]

7

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4. A student bought **TWO** brands of vinegar from a supermarket. He wanted to know which brand contained the highest concentration of ethanoic acid, CH_3COOH . So he titrated 25.0 cm^3 samples of each brand against 0.1 mol dm^{-3} sodium hydroxide solution. Volumes of reagents used were noted in the Table below.

	Brand A	Brand B
Volume of vinegar used during titration	25.0 cm^3	25.0 cm^3
Volume of 0.1 mol dm^{-3} NaOH used during titration	14.9 cm^3	12.1 cm^3

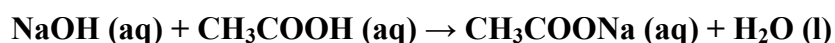
- (a) How many moles of sodium hydroxide are present in 14.9 cm^3 of 0.1 mol dm^{-3} sodium hydroxide solution?

(2 marks)

- (b) How many moles of sodium hydroxide are present in 12.1 cm^3 of 0.1 mol dm^{-3} sodium hydroxide solution?

(2 marks)

- (c) The equation for the reaction between sodium hydroxide and the ethanoic acid present in the vinegar is:



- (i) How many moles of **Brand A** vinegar took part in the reaction?

(1 mark)

- (ii) How many moles of **Brand B** vinegar took part in the reaction?

(1 mark)

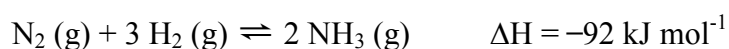
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(d) Which brand of vinegar contains the highest concentration of ethanoic acid?

(1 mark)**[Total: 7 marks]**

7

5. Ammonia is produced through the Haber Process using the following equation.



This reaction reaches equilibrium. However in practice the factory where this reaction takes place tries to shift the equilibrium towards the side of ammonia.

(a) What is the effect of a catalyst on the equilibrium reaction?

(1 mark)

(b) In theory the use of a high concentration of the reactants and a low temperature will shift the equilibrium to the right. Explain briefly why each of these factors favour the forward reaction.

High concentration of reactants: _____

Low temperature: _____

(2 marks)

(c) What conditions of pressure would favour the production of ammonia?

(1 marks)**[Total: 4 marks]**

4

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-
6. (a) Silver nitrate reacts with sodium chloride to produce a white precipitate. Give the ionic equation for the reaction between silver nitrate and sodium chloride.

(2 marks)

- (b) 25.0 cm³ of 1.0 mol dm⁻³ silver nitrate is added to 25.0 cm³ of 1.0 mol dm⁻³ of sodium chloride solution in a polystyrene cup. The mixture was stirred with a thermometer and the observed temperature increased by 7.3°C.

- (i) Assuming that the solutions used have the same density as water, of 1 g cm⁻³, calculate the amount of heat given out during this reaction, considering that water has a specific heat capacity of 4.2 J g⁻¹ °C⁻¹.

(1 mark)

- (ii) How many moles of silver nitrate took part in the reaction?

(1 mark)

- (iii) Calculate the heat of reaction when silver nitrate reacts with sodium chloride to produce one mole of silver chloride.

(1 mark)

- (iv) The real value of the heat of reaction for the production of one mole of silver chloride is -65.7 kJ mol⁻¹. Why is this value different from the one obtained in part (b)(iii)?

(1 mark)
[Total: 6 marks]

6

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7. Air is a mixture of gases. Some of these gases may be separated in the laboratory by means of the apparatus shown below.

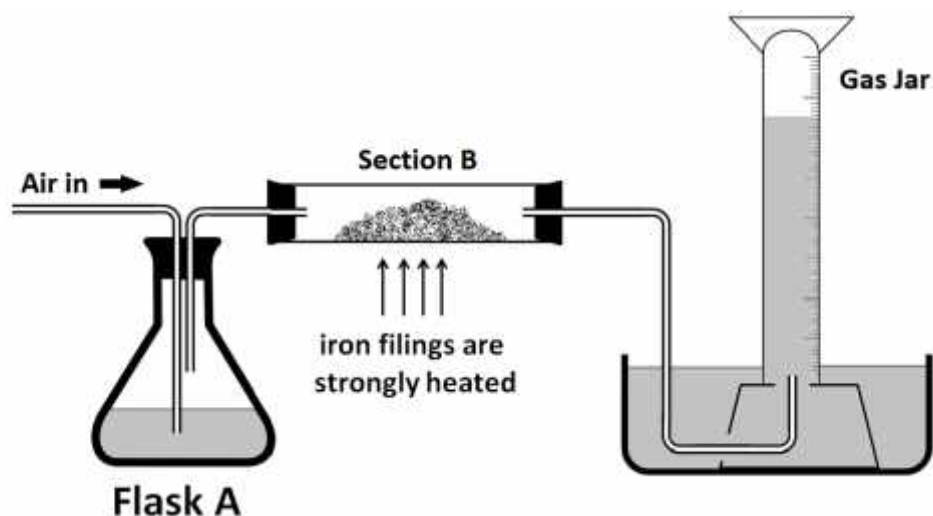


Figure 4

- (a) Potassium hydroxide solution is placed in **Flask A**. Explain what happens when the air passes through this part of the apparatus.

(1 mark)

- (b) What gas is removed when the air passes through **Section B** of the apparatus?

(1 mark)

- (c) What is the main gas collected in the **gas jar**?

(1 mark)

- (d) Mention **TWO** properties of the gas collected in the gas jar **which may be deduced from the experiment shown above?**

(2 marks)

- (e) What trace elements are collected together with the gas in the jar?

(1 mark)

[Total: 6 marks]

6

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8. Iron reacts with dilute hydrochloric acid solution. A scientist wants to measure the rate of this reaction by measuring the volume of gas produced when these two chemicals are mixed together.

(a) Draw a **labelled diagram** of the apparatus that can be used to investigate the rate of reaction between dilute hydrochloric acid and iron chippings.

(2 marks)

(b) The volume of gas produced during the reaction of large iron chippings with dilute hydrochloric acid was recorded and plotted on a graph paper (Figure 5).

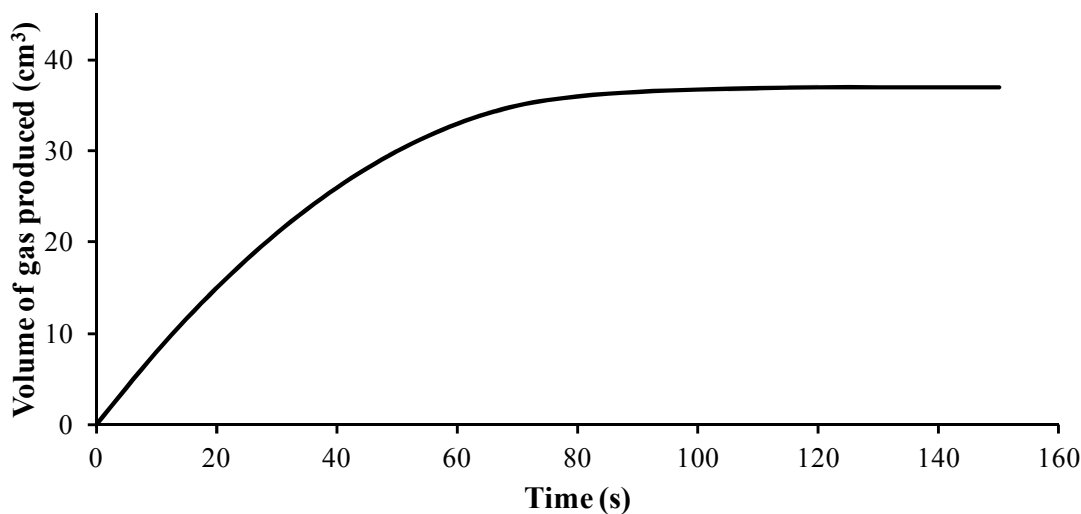


Figure 5

(i) When the same experiment was repeated, at the same temperature, using **iron powder**, it was noted that the reaction was more vigorous (more reactive). Using the same graph above (Figure 5), **sketch another plot** to show how the rate of reaction would appear when iron powder is used instead of the iron chippings.

(1 mark)

(ii) Give **ONE** reason why the reaction with iron powder was more vigorous.

(1 mark)

[Total: 4 marks]

4

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9. The equation for the reaction of chlorine gas with cold sodium hydroxide solution is:



(a) Given that the chemistry of Cl_2 is very similar to that of Br_2 , write down the equation for the reaction of bromine with cold sodium hydroxide solution.

(1 mark)

(b) Column A shows the equation for the reaction between hydrogen and some of the halogens. Column B shows the heat of reaction for these reactions, however **these values are not in the same order as the equations in Column A**. Write the correct heat of reaction next to the equation in the **Answer** column to show how reactivity changes in group 7.

Column A	Answer
$\text{H}_2 + \text{Cl}_2 \rightarrow 2 \text{HCl}$	
$\text{H}_2 + \text{Br}_2 \rightarrow 2 \text{HBr}$	
$\text{H}_2 + \text{I}_2 \rightarrow 2 \text{HI}$	

Column B
$\Delta H = -73 \text{ kJ mol}^{-1}$
$\Delta H = -184 \text{ kJ mol}^{-1}$
$\Delta H = +53 \text{ kJ mol}^{-1}$

(3 marks)

(c) (i) Which chemicals are used in the laboratory preparation of chlorine?

(1 mark)

(ii) Which laboratory test can be used to confirm the presence of chlorine gas?

(1 mark)

[Total: 6 marks]

6

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10. Complete the following Table related to pollutants.

Pollutant	Source	Negative effect on the environment
Nitrogen dioxide		
	A sulfur containing compound, produced from burning of coal and oil.	
	A gas released from old fridges and aerosols.	
	A gaseous alkane, produced from cattle and other livestock.	

(8 marks)
[Total: 8 marks]

8

Section B: Answer TWO questions from this section. Write your answers in the lined pages provided. (indicate clearly the question numbers being answered)

11. (a) Oxygen is a very reactive element which combines with many elements. Write an equation for the reaction of oxygen with each of the following elements.

- (i) Aluminium
- (ii) Magnesium
- (iii) Sulfur

(6 marks)

(b) Which of the **oxides** formed in the reactions of part (a) would react with:

- (i) sulfuric acid
- (ii) sodium hydroxide?

(4 marks)

(c) (i) The colourless nitrogen oxide (NO) reacts with air to produce a brown gaseous oxide. Write down the equation that represents this reaction.

(2 marks)

Question 11 continues on the next page

(ii) The brown gas produced is highly soluble in water. What effect would the resulting solution have on litmus?

(1 mark)

(iii) What type of oxide is the brown gaseous oxide?

(1 mark)

(d) Both oxygen and nitrogen are important raw materials for the chemical industry. Explain briefly how each of these substances may be obtained on a large scale.

(2 marks)

(e) Give **TWO** industrial uses each for oxygen and nitrogen.

(4 marks)

[Total: 20 marks]

12. (a) (i) List **TWO** characteristics of a reduction reaction.

(2 marks)

(ii) Give an equation for a reaction where hydrogen is acting as a reducing agent.

(2 marks)

(iii) Draw a diagram of the apparatus one would use in the laboratory to carry out the reaction mentioned in your answer to part (a)(ii).

(2 marks)

(iv) Name **ONE** precaution that should be taken when carrying out the experiment mentioned in part (a)(iii).

(1 mark)

(b) Carbon dioxide is prepared in the laboratory when a dilute acid is added to a carbonate. Give the ionic equation, including state symbols, for this reaction.

(3 marks)

(c) Explain why the following reaction does not produce any hydrogen in spite of the fact that an acid is reacted with a metal.



(2 marks)

(d) Acids are commonly used in the laboratory in the preparation of salts. Using well-labelled diagrams explain how you would prepare a sample of zinc sulfate starting from sulfuric acid and zinc carbonate.

(8 marks)

[Total : 20 marks]

13. Consider the following notes:

- When white solid **A** is heated strongly, it gives a white solid **B** and two gases **C** and **D**.
- Gas **C** turns anhydrous copper(II) sulfate from white to blue.
- Gas **D** turns lime water cloudy.
- When solid **A** is placed in a clear blue Bunsen flame, it gives a bright yellow coloured flame.
- Solid **B** reacts with dilute hydrochloric acid, giving a solution of **E** and gas **D**.
- When solution **E** is mixed with a solution of lead(II) nitrate, the white precipitate **F** is produced.

(a) (i) Identify gases **C** and **D**.

(2 marks)

(ii) Why does copper(II) sulfate change colour from white to blue?

(1 mark)

(iii) Write the equation for the reaction of gas **D** with lime water.

(3 marks)

(iv) Identify the cation in solid **A**.

(1 mark)

(b) Identify substances **A**, **B**, **E** and **F**.

(4 marks)

(c) Write chemical equations for each of the following reactions:

(i) The action of heat on **A**.

(2 marks)

(ii) The action of hydrochloric acid on **B**.

(2 marks)

(iii) The reaction of lead(II) nitrate solution with solution **E**.

(2 marks)

(d) Two reagent bottles labelled **IRON CHLORIDE** were found in the lab. The colour of the salt inside each bottle was different.

Outline **ONE** simple chemical test that can be carried out to identify which bottle contains the iron(II) salt and which one contains the iron(III) salt.

(3 marks)

[Total: 20 marks]

Question 14 is on the next page

14. Crude oil is a mixture of hydrocarbons which may be separated into the following fractions by fractional distillation. These fractions will not be pure substances but will be made up of a mixture of substances having a carbon chain within a shorter range as seen by the Table below.

Fraction	Mixture of substances with length of carbon chain
G	C₁ to C₄
H	C₅ to C₁₂
I	C₁₂ to C₁₆
J	C₁₆ to C₁₈
K	C₁₈ to C₂₀
L	More than C₂₀

- (a) Mention **ONE** use for each of the fractions **G, H, I, J, K** and **L** in everyday life. **(6 marks)**
- (b) Give the name and the structural formula of four hydrocarbons that makes up fraction **G**. **(8 marks)**
- (c) In a refinery, a process is used which converts molecules which have long chains of carbon atoms into more useful shorter ones.
- (i) What is this process called? **(1 mark)**
- (ii) How is this process brought about? **(2 marks)**
- (d) Give the name of three different homologous series of organic substances. **(3 marks)**
- [Total: 20 marks]**

