

Index number: _____

SEC06/1.12m

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

SECONDARY EDUCATION CERTIFICATE LEVEL

MAY 2012 SESSION

SUBJECT: **Chemistry**
PAPER NUMBER: I
DATE: 17th May 2012
TIME: 09:00 a.m. to 11:00 a.m.

Useful data

Relative atomic masses: H = 1; C = 12; N = 14; O = 16; Na = 23; S=32; Cl = 35.5

The molar volume for gases at s.t.p. = 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 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.*
- *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	7	6	6	5	6	6	5	5	7	7	20	20	100

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

1. The paragraphs that follow have some missing terms. Choose appropriate terms from the list given so as to complete the paragraphs. Each term may be used once, more than once or not at all.

hydrogen **chlorine** **nitrogen** **nitrogen dioxide**
electrolysis **nitric acid** **heating** **dilute** **concentrated**

- (a) In the Haber process nitrogen and _____ react to produce ammonia. On oxidation, ammonia initially gives nitrogen monoxide (also called nitric oxide) which in contact with air produces the brown gas _____. This gas is absorbed in water forming _____ and nitrogen monoxide.
- (b) Large amounts of sodium hydroxide are required in industry. It may be manufactured by the _____ of _____ sodium chloride solution. During this process two gases are also produced. These are _____ and _____.

[Total: 7 marks]

2. (a) When some substances are heated a chemical change occurs. Give balanced equations to show:
- (i) the action of heat on lead(II) nitrate;
- _____ (2 marks)
- (ii) the reaction that occurs when a small piece of magnesium ribbon is heated in a gas jar full of oxygen.
- _____ (2 marks)

- (b) State **one** observation that can be made during the reaction in (a)(i).
- _____ (1 mark)

- (c) Give a safety precaution that must be followed in the reaction in (a)(ii).
- _____ (1 mark)

[Total: 6 marks]

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3. (a) Complete the following statements:

(i) A sugar solution does not conduct electricity since _____

(1 mark)

(ii) When dilute sulfuric acid is electrolysed using inert electrodes _____ gas is produced at the anode (the positive electrode) and _____ gas is produced at the cathode (the negative electrode). (2 marks)

(b) Consider the following elements: iron, copper, silver, aluminium, sodium.
Choose **ONE** element from the list which:

(i) deposits copper when added to copper(II) nitrate solution _____

(ii) can produce iron when heated with iron(III) oxide _____

(iii) is too dangerous to add to dilute sulfuric acid _____

(3 marks)

[Total: 6 marks]

4. (a) Ammonia may be prepared in the laboratory by warming an ammonium salt with an alkali.

(i) Give a balanced equation for the reaction between ammonium sulfate, $(\text{NH}_4)_2\text{SO}_4$, and potassium hydroxide solution.

(2 marks)

(ii) Give a chemical test that may be used to prove that ammonia has been produced.

(1 mark)

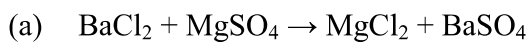
(b) Showing outer electrons only, give a dot-cross diagram for the ammonia molecule.

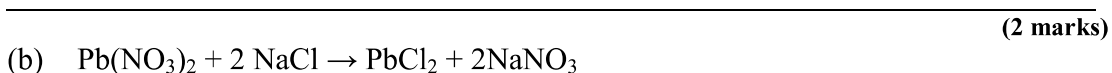
(2 marks)

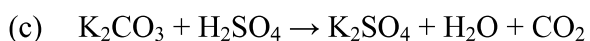
[Total: 5 marks]

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5. Give ionic equations for the following chemical reactions:







(2 marks)
[Total: 6 marks]

6. A compound **J** contains 30.43% nitrogen and 69.57% oxygen.(a) Calculate the empirical formula of **J**.

(4 marks)

(b) Compound **J** has a relative molecular mass of 92. Deduce the molecular formula of **J**.

(2 marks)
[Total: 6 marks]

6

6

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7. Sulfur burns in air at atmospheric pressure producing sulfur dioxide gas.
- (a) What is the maximum mass of sulfur dioxide that may be collected if 24.0 g of sulfur are burned in excess oxygen?
The equation for the reaction is: $S(s) + O_2(g) \rightarrow SO_2(g)$

(3 marks)

- (b) Mention **ONE** observation that can be made during the reaction in (a).

(1 mark)

- (c) How is the sulfur dioxide gas produced in (a) collected?

(1 mark)

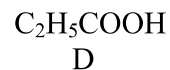
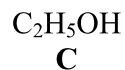
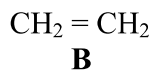
[Total: 5 marks]

5

Turn the page for the next question.

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8. Consider the following compounds:



(a) (i) Which substance gives a yellow smoky flame when burned in a plentiful supply of oxygen?

(ii) Give the formula of a compound, which belongs to a different homologous series to those given in the list above, but which will give the same type of flame as the compound in (a)(i).

(2 marks)

(b) Give the formula or structure of an isomer of substance **C**.

(1 mark)

(c) Write a balanced equation for the reaction of substance **D** with sodium hydroxide solution.

(2 marks)

[Total: 5 marks]

5

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9. **Q, R and T** are three elements. The letters are **NOT** their usual symbols. **T** and **R** have atomic numbers 12 and 8 respectively.

(a) Give the electronic configurations of **T** and **R**.

T: _____

R: _____ (2 marks)

(b) (i) Using the letters **T** and **R**, give the formula of the compound formed between **T** and **R**.

(1 mark)

(ii) In what Period of the Periodic Table is element **T**?

(1 mark)

(iii) From the following list, draw a **circle** round a possible melting temperature for the compound in (b)(i).

-20⁰ C 40⁰C 100⁰C 2800⁰ C

(1 mark)

(c) (i) The element **Q** is known to be crystalline, with a giant molecular structure and weak Van der Waals' forces holding the molecules together. **Q** does not conduct electricity. **Draw a circle** around one of the substances in the following list to indicate a possible identity for **Q**.

graphite iodine diamond sodium

(1 mark)

(ii) Suggest a simple test that may be carried out to confirm your choice in (c)(i).

(1 mark)

[Total: 7 marks]

7

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10. A student carries out some experiments to show how lumps of calcium carbonate react with dilute hydrochloric acid.

- (a) In the space below, sketch a graph of concentration against time so as to show how the concentration of the hydrochloric acid changes as the experiment proceeds. Label the graph A.

(2 marks)

- (b) **Using the same set of axes for the graph in part (a)**, sketch another graph to represent the change in concentration of hydrochloric acid if the calcium carbonate lumps and hydrochloric acid are heated to 35 °C. Label this graph B.

(2 marks)

- (c) **Using the same set of axes for the graph in (a)** above, sketch a possible graph to show how the concentration of the hydrochloric acid would change when the reaction is carried out with powdered calcium carbonate and heated to 35 °C. Label this graph C.

(2 marks)

- (d) Suggest a reason why the reaction of powdered calcium carbonate with hydrochloric acid is much faster if concentrated hydrochloric acid is used instead of dilute hydrochloric acid.

(1 mark)

[Total: 7 marks]

7

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Section B: Answer BOTH questions. Write your answers on the lined pages provided.

11. Some anhydrous sodium carbonate in a container is known to be contaminated with sodium chloride. A group of students have been asked to determine the approximate percentage impurity in the sodium carbonate.

This is the experimental procedure that they followed:

- A mass of 3.50 g of the mixture was dissolved in a small amount of distilled water, which was then transferred to a volumetric flask. The volume was made up to a total 250 cm³ by adding more distilled water. The contents were then well-mixed.
- A burette was filled with hydrochloric acid of concentration 0.39 mol dm⁻³.
- An exact volume of 25.00 cm³ of solution was removed from the volumetric flask and transferred to a conical flask.
- Two drops of methyl orange indicator were added. Methyl orange is red in acidic solution and yellow in alkali.
- Dilute hydrochloric acid was then added from the burette until full neutralization occurred. They obtained the following readings:

1 st titre value	2 nd titre value	3 rd titre value
13.50 cm ³	13.00 cm ³	12.90 cm ³

The equation for the reaction is: $\text{Na}_2\text{CO}_3(\text{aq}) + 2\text{HCl} \rightarrow 2\text{NaCl}(\text{aq}) + \text{H}_2\text{O}(\text{l}) + \text{CO}_2(\text{g})$

- (a) (i) Why is the indicator used in the titration? (1 mark)
 (ii) Where is the indicator added: to the solution in the burette or to that in the conical flask? (1 mark)
 (iii) What colour change occurs at the end-point? (1 mark)
- (b) Calculate the average titre value. (1 mark)
- (c) Calculate the number of moles of hydrochloric acid used. (2 marks)
- (d) Calculate the number of moles of sodium carbonate neutralized. (1 mark)
- (e) Calculate the number of moles of sodium carbonate in the 250 cm³ solution in the volumetric flask. (1 mark)
- (f) Calculate the mass of sodium carbonate in the volumetric flask. (1 mark)
- (g) (i) Calculate the mass of **sodium chloride** in the contaminated mixture.
 (ii) Calculate the percentage by mass of **sodium chloride** in the contaminated mixture. (2 marks)
- (h) If sulfuric acid of the same concentration had been used instead of the hydrochloric acid, what volume of sulfuric acid would have been required? Explain your answer. (2 marks)

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- (i) What apparatus was used to transfer the 25.00 cm^3 of mixture from the volumetric flask to the conical flask safely? (2 marks)
- (j) The average titre reading that was obtained was too high. Suggest **TWO** possible reasons related to the titration for this high value. (2 marks)
- (k) One of the students in the group wanted to use a filter paper to weigh the solid while another one wanted to use a small plastic container. Which of the two methods is the proper way to weigh out the solid? Give **TWO** reasons for your answer. (3 marks)

[Total: 20 marks]

12. (a) Consider the following properties of substance **Z**.
- **Z** does not react with cold water but when **Z** is placed in steam a reaction occurs and a gas, **V**, is given off. **V** is flammable and burns with a pop.
 - **Z** reacts with hydrochloric acid producing a light green solution, **Q**, and gas **V** is given off.
 - **Z** reacts with chlorine gas producing substance **Y**.
- (i) Identify **Z**, **V**, **Q** and **Y**. (4 marks)
- (ii) Give a balanced equation for the reaction of **Z** with steam. (2 marks)
- (iii) Give an ionic equation to show how a small amount of **Q** in solution would react with sodium hydroxide solution. (2 marks)
- (b) **W** is a black solid. **W** has the following properties:
- **W** reacts with dilute nitric acid forming a blue solution **G**. The reaction is exothermic.
 - When sodium hydroxide solution is added to a small amount of **G** in a test tube a pale blue gelatinous precipitate, **L**, forms, which does not dissolve in excess sodium hydroxide solution.
 - If **W** is heated using suitable apparatus and reacted with hydrogen gas a metal **B** is obtained and colourless droplets of substance **N** are noted.
- (i) Identify **W**, **G**, **L**, **B** and **N**. (5 marks)
- (ii) Give a balanced equation for the reaction of **W** with dilute nitric acid. (2 marks)
- (iii) Give a balanced equation, including state symbols, for the reaction of **W** with hydrogen gas. (2 marks)
- (iv) Describe a test that may be used to confirm the identity of substance **N**. (2 marks)
- (v) Describe what happens when **L** is heated. (1 mark)

[Total: 20 marks]

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PERIODIC TABLE

I	II																III	IV	V	VI	VII	VIII																												
1	H	1																							4	He	2																							
7	Li	3	9	Be	4															16	O	8	19	F	9	10	Ne	10																						
23	Na	11	24	Mg	12															32	S	16	35.5	Cl	17	40	Ar	18																						
39	K	19	40	Ca	20	45	Sc	21	48	Ti	22	51	V	23	52	Cr	24	55	Mn	25	56	Fe	26	59	Co	27	59	Ni	28	63.5	Cu	29	65	Zn	30	70	Ga	31	73	Ge	32	75	As	33	79	Se	34	84	Kr	36
85	Rb	37	88	Sr	38	89	Y	39	91	Zr	40	93	Nb	41	96	Mo	42	99	Tc	43	101	Ru	44	103	Rh	45	106	Pd	46	108	Ag	47	112	Cd	48	115	In	49	119	Sn	50	122	Sb	51	127	I	53	131	Xe	54
133	Cs	55	137	Ba	56	178.5	Hf	72	181	Ta	73	186	Re	75	190	Os	76	192	Ir	77	195	Pt	78	197	Au	79	201	Hg	80	204	Tl	81	207	Pb	82	209	Bi	83	209	Po	84	210	At	85	222	Rn	86			
223	Fr	87	226	Ra	88	227	Ac	89																		84	Po	84	85	At	85	86	Rn	86																

140	Ce	58	141	Pr	59	144	Nd	60	147	Pm	61	150	Sm	62	152	Eu	63	157	Gd	64	162	Dy	66	165	Ho	67	167	Er	68	169	Tm	69	173	Yb	70	175	Lu	71
232	Th	90	231	Pa	91	238	U	92	237	Np	93	244	Pu	94	243	Am	95	247	Cm	96	251	Cf	98	252	Es	99	257	Fm	100	258	Md	101	259	No	102	260	Lr	103

Key		
Relative atomic mass	A	Atomic Number
Z	X	Z

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

SECONDARY EDUCATION CERTIFICATE LEVEL

MAY 2012 SESSION

SUBJECT: **Chemistry**
 PAPER NUMBER: IIA
 DATE: 22nd May 2012
 TIME: 09:00 a.m. to 11:00 a.m.

Useful data

Relative atomic masses: H = 1; O=16; S=32; Cu = 63.5

The molar volume for gases at s.t.p. = 22.4 dm³

Standard temperature and pressure (s.t.p.): 0 °C and 1 atm

Faraday constant: 96,500 C

$Q = It$

$Q = mc\Delta\theta$

Directions to Candidates

- Write your index number in the space at the top left-hand corner of this page.
- Answer ALL questions in Section A and any TWO questions from Section B. Write 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.
- 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.

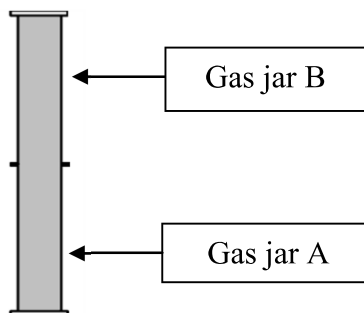
For examiners' use only:

Question	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Total
Score															
Maximum	6	5	6	6	5	5	6	7	8	6	20	20	20	20	100

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

1. (a) An experiment was carried out in the laboratory during a Chemistry lesson. A drop of bromine was added to gas jar **A**. Immediately, another gas jar **B** was placed above it as shown in the diagram below.



Comment on:

- (i) The concentration of bromine in gas jar **A** and gas jar **B** **at the start** of the experiment.

- (ii) The concentration of bromine in gas jar **A** and gas jar **B** **after 20 minutes** from the start of the experiment. (1 mark)

- (iii) Name the process that is taking place. (1 mark)

- (iv) Mention **one** safety precaution you would take when carrying out this experiment. (1 mark)

- (b) In 1827, the botanist Robert Brown observed through his microscope that fine pollen grains on the surface of water were moving about in a random way. It was 96 years later (in 1923) that Norbert Weiner explained what Brown had observed. This is called Brownian motion after the scientist who first observed this phenomenon. (1 mark)

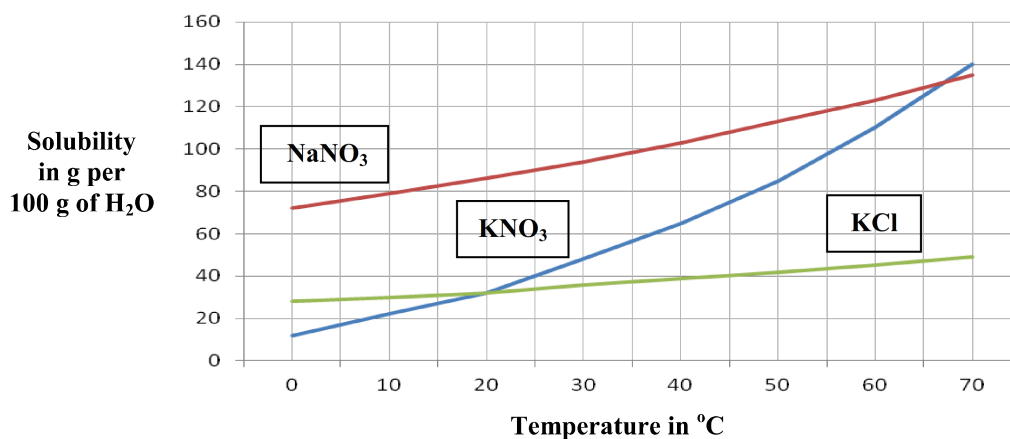
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Explain briefly this motion in terms of simple kinetic theory.

(2 marks)
[Total: 6 marks]

6

2. The following graph shows the solubility curves for sodium nitrate, potassium nitrate and potassium chloride.



- (a) Which is the most soluble of the three salts at 10 °C? Give its solubility (in g per 100 g of water) to the nearest 10.

(2 marks)

- (b) How much potassium chloride dissolves in 100 g of water at 45 °C?

(1 mark)

- (c) A solution containing 100 g of potassium nitrate in 100 g of water is at 60 °C. It is cooled to 20 °C. Describe and explain the changes, if any, that take place.

(2 marks)
[Total: 5 marks]

5

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3. Sodium chloride, diamond, graphite, iodine and copper have giant crystalline structures.

- (a) Although sodium chloride and copper are both solids at room temperature, the **bonding** present is different. Name and describe briefly the type of bonding present in each case.

(2 marks)

- (b) The type of bonding in graphite and copper is different but they both conduct electricity.

- (i) Explain briefly how graphite and copper **conduct electricity**.

(2 marks)

- (ii) Both graphite and diamond are composed of carbon atoms, but while graphite conducts electricity diamond does not. Explain why.

(1 mark)

- (c) Explain briefly why a solution of sodium chloride conducts electricity while solid sodium chloride does not.

(1 mark)

[Total: 6 marks]

6

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4. There are over one million organic compounds. These are grouped into a number of homologous series, such as: alkanes, alkenes, alkynes, alcohols and carboxylic acids.

(a) Considering propane:

(i) draw its structural formula;

(1 mark)

(ii) give the general formula of its homologous series.

(1 mark)

(b) Butane has two isomers. Explain the term 'isomers'.

(1 mark)

(c) The process of fermentation involves the conversion of glucose (of chemical formula $C_6H_{12}O_6$) to ethanol and carbon dioxide gas.

(i) Write a balanced equation for the reaction that takes place during fermentation and indicate the catalyst that speeds up this reaction.

(2 marks)

(ii) Ethanol can undergo oxidation. Name the product that can form during this reaction.

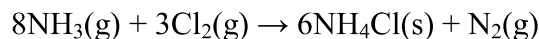
(1 marks)

[Total: 6 marks]

6

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5. When chlorine is added to excess ammonia at room temperature, the following reaction occurs:



- (a) If the volume of ammonia that reacts is 160 cm^3 :

- (i) what volume of nitrogen is produced, and
(ii) what volume of chlorine is used?

Assume that all gas volumes are measured at the same temperature and pressure.

(2 marks)

- (b) If the volumes in part (a) were measured at 1 atmosphere and 27°C , calculate the volume of nitrogen at standard temperature and pressure (0°C and 1 atmosphere).

(3 marks)

[Total: 5 marks]

6. Hydrated copper(II) sulfate was **heated to constant mass** in a crucible: 1.9 g of $\text{CuSO}_4 \cdot x\text{H}_2\text{O}$ gave 1.2 g of residue.

- (a) (i) How many grammes of water were present in 1.9 g of hydrated salt?

(1 mark)

- (ii) Calculate the percentage by mass of water in the $\text{CuSO}_4 \cdot x\text{H}_2\text{O}$.

(1 mark)

- (iii) Describe what changes are observed when the $\text{CuSO}_4 \cdot x\text{H}_2\text{O}$ is heated to constant mass.

(1 mark)

5

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- (b) Explain what is meant by 'heated to constant mass'.

(2 marks)
[Total: 5 marks]

7. Electrolysis of a copper(II) sulfate solution, using two copper electrodes, was carried out. A current of 3 amps was passed for 2 minutes through the solution.

- (a) (i) Calculate the amount of charge that passes through the solution.

(1 mark)

- (ii) Given that 1 Faraday is 96,500 C, what is the number of moles of electrons that flow through the solution?

(1 mark)

- (b) (i) Write the half equation of the reaction at the anode.

(1 mark)

- (ii) What is the change in mass at the anode?

(2 marks)

- (c) Comment on the concentration of copper(II) ions in solution after the electrolysis stops.

(1 mark)
[Total: 6 marks]

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8. A volume of 25 cm^3 of a 1.5 mol dm^{-3} hydrochloric acid solution was placed in a polystyrene cup. For complete neutralization, 37.5 cm^3 of sodium hydroxide solution were required.

(a) (i) Write the equation for the acid-base reaction that takes place.

_____ (1 mark)
(ii) How many moles of acid are present in 25 cm^3 of a 1.5 mol dm^{-3} hydrochloric acid solution?

_____ (1 mark)
(iii) What is the number of moles of alkali that neutralise the acid?

_____ (1 mark)
(iv) Calculate the concentration of the sodium hydroxide solution in mol dm^{-3} .

_____ (2 marks)

- (b) Calculate the quantity of heat evolved if the temperature of the mixture in the titration above increases by $8 \text{ }^\circ\text{C}$. Assume that the density of the solution is 1 g cm^{-3} . The specific heat capacity of water is $4.18 \text{ J }^\circ\text{C}^{-1} \text{ g}^{-1}$.

_____ (2 marks)

[Total: 7 marks]

7

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9. Chlorine, bromine and iodine are in Group 7 of the Periodic Table. The order of reactivity of the halogens changes on going down the group.

(a) Chlorine, bromine and iodine have similar electronic configurations and similar chemical properties. Explain briefly.

(2 marks)

(b) Two students were asked to carry out the following reactions. They did not know if the reactions would occur or not. Write the observations that they made, and include also the ionic equation/s if any reaction/s occurred:

(i) Bromine water is added to potassium chloride solution.

(ii) Chlorine water is added to potassium bromide solution.

(3 marks)

(c) The possible reactions that are considered in part (b) are called displacement reactions. The reactions can also be classified in another way. What can they be also called?

(1 mark)

(d) The displacement reactions involving chlorine, bromine and iodine show how the reactivity of the halogens changes on going down the group. Explain briefly.

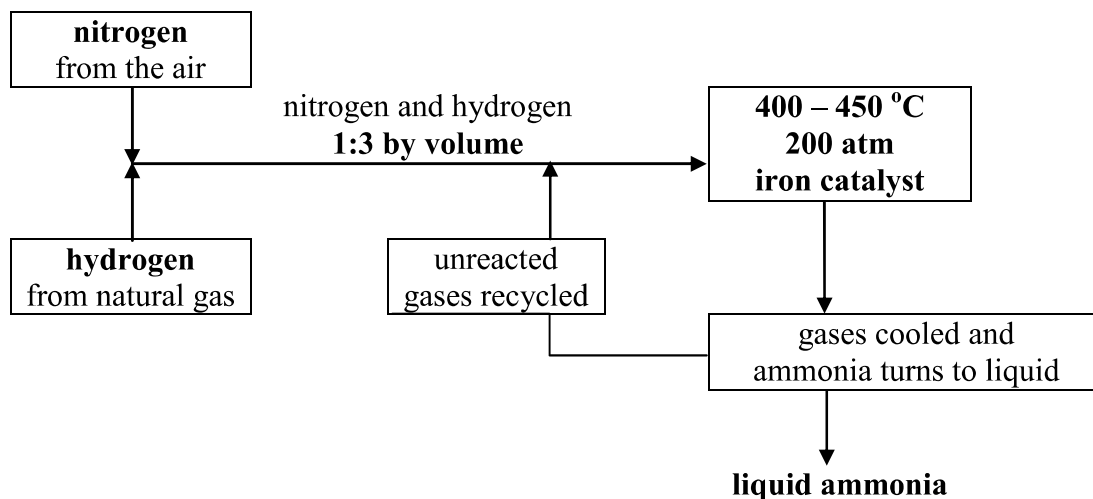
(2 marks)

[Total: 8 marks]

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10. The Haber process combines nitrogen from the air with hydrogen derived mainly from natural gas, to form ammonia. The reaction is reversible and the production of ammonia is exothermic: $\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \rightleftharpoons 2\text{NH}_3(\text{g})$ $\Delta\text{H} = -92 \text{ kJ mol}^{-1}$

The reaction can be outlined in the flow diagram below.



- (a) Predict what happens to the position of the equilibrium in the above reaction for each of the following cases.
- (i) The pressure is increased.

(1 mark)

- (ii) A catalyst is included.

(1 mark)

- (iii) The temperature is increased.

(2 marks)

- (b) Considering the predictions in part (a) and the aim of the process of producing the highest amount of ammonia possible, explain why the process is carried out at a pressure of 200 atmospheres and a temperature of 400 – 450 °C.

(2 marks)
[Total: 6 marks]

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Section B: Answer TWO questions from this Section. Write your answers in the lined pages provided.

11. The diagram below shows part of the Periodic Table of elements. The symbols of the elements are shown and the group numbers are indicated on top.

1	2											3	4	5	6	7	8
		H															He
Li	Be											B	C	N	O	F	Ne
Na	Mg											Al	Si	P	S	Cl	Ar
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr

- (a) (i) What are the names given to Groups 1, 2 and 8? (3 marks)
- (ii) Write a balanced equation for the reaction of sodium with water. (2 marks)
- (iii) Write a balanced equation for the reaction of Mg with steam. (2 marks)
- (iv) Explain how the reactivity of the elements changes on moving down Group 1. Illustrate your answer with suitable examples. (2 marks)
- (v) Compare the type of bonding in the two compounds formed between K and Cl, and C and O. (2 marks)
- (vi) Do the compounds in (v) have the same physical properties? Explain. (2 marks)
- (b) Fe and Cu are considered as less reactive metals. They are present, with other metals, in the shaded part of the Periodic Table.
- (i) What name is given to the elements found in the shaded part of the Periodic Table? (1 mark)
- (ii) These elements show variable valency (oxidation state). Explain this statement, illustrating your answer with **TWO** suitable examples. (2 marks)
- (iii) These elements show two other general properties. Mention these properties, explain each one briefly and illustrate your answer with a suitable example in **each** case. (4 marks)
- [Total: 20 marks]

12. Outline the preparation of a solid sample of each of the following salts in the laboratory. Assume that all standard laboratory equipment and the required chemicals are available. Include well-labelled diagrams and balanced chemical equations wherever required.

- (a) sodium chloride
 (b) copper(II) sulfate
 (c) potassium nitrate
 (d) calcium carbonate.

[4 x 5 marks = 20 marks]

DO NOT WRITE ABOVE THIS LINE

13. (a) Alkanes are **saturated** while alkenes and alkynes are **unsaturated** hydrocarbons.
- (i) Distinguish between the **TWO** underlined terms. (2 marks)
 - (ii) Which of the two types of hydrocarbons is best for use as a fuel at home? (1 mark)
 - (iii) Assuming complete combustion, write a balanced equation for the combustion of propane. (2 marks)
 - (iv) Describe a simple laboratory test – other than combustion – that can be used to distinguish between a saturated and an unsaturated hydrocarbon. (2 marks)
 - (v) Alkanes and alkenes typically undergo different **types** of reaction. Name the two types of reaction, illustrating your answer with an example in each case. (4 marks)
 - (vi) A gradual change in physical properties of straight chain alkanes is noted as the length of the hydrocarbon chain changes. Explain this statement, taking melting and boiling point as example, giving reasons for the change in physical properties. (4 marks)
- (b) A typical reaction that alkenes undergo is **polymerisation**, as in the case of polyethene, PTFE and PVC.
- (i) Explain briefly what is meant by the term '**polymerisation**'. (1 mark)
 - (ii) The polymers polyethene, PTFE and PVC are produced through an addition polymerisation reaction. Considering one of these three polymers, outline the polymerisation reaction that takes place for **ONE** of these polymers. (4 marks)
- [Total: 20 marks]**

DO NOT WRITE ABOVE THIS LINE

14. (a) **Sodium hydrogencarbonate**, also known as sodium bicarbonate, is a white solid that is crystalline but often appears as a fine powder. It has a slightly salty, alkaline taste resembling that of washing soda (sodium carbonate).
- (i) Name a common use of this hydrogencarbonate in the home. (1 mark)
 - (ii) Write a balanced equation, including state symbols, of the reaction between sodium hydrogencarbonate and hydrochloric acid. (2 marks)
 - (iii) When heated above 70 °C, sodium hydrogencarbonate decomposes gradually: write a balanced equation, including state symbols, for this decomposition reaction. (2 marks)
- (b) **Copper(II) carbonate** is a blue-green compound forming part of the verdigris patina that is found on weathered brass, bronze, and copper.
- (i) When heated to about 290 °C, copper(II) carbonate decomposes. Write a balanced reaction to represent this reaction. (1 mark)
 - (ii) Describe the changes that can be observed during this reaction. (1 mark)
 - (iii) A gas is produced in this decomposition reaction. Describe a test that indicates the presence of this gas, and write the chemical equation of the reaction taking place during this test. (3 marks)
- (c) **Calcium carbonate** (limestone or chalk) undergoes thermal decomposition when strongly heated at temperatures of about 850 °C.
- (i) Write a balanced equation to represent the decomposition of limestone. (1 mark)
 - (ii) Give the common name of the residue left after decomposition. (1 mark)
 - (iii) Water is added to the residue that is left after decomposition in (i). Write the equation that represents the chemical reaction that takes place. (2 marks)
 - (iv) What colour is given when a sample of the residue is flame tested? (1 mark)
- (d) **Ethanoic acid** is an organic acid, also known by the name of acetic acid. It is a colourless liquid; it is the main component of vinegar (apart from water) and has a distinctive sour taste and pungent smell. It is classified as a weak acid.
- (i) What is meant by the term 'weak acid'? (1 mark)
 - (ii) The reaction between ethanoic acid and ethanol is catalysed by concentrated sulfuric acid. Write a balanced equation that represents this reaction. (2 marks)
 - (iii) Name this type of reaction, and give a characteristic of the main product of this reaction. (2 marks)

[Total: 20 marks]

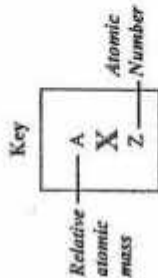
PERIODIC TABLE

I	II
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1 H 1	9 Be 4	40 Ca 20	45 Sc 21
7 Li 3	24 Mg 12	88 Sr 38	89 Y 39
23 Na 11	39 K 19	85 Rb 37	133 Cs 55
			223 Fr 87
			226 Ra 88
			227 Ac 89

III	IV	V	VI	VII	VIII
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11 B 5	12 C 6	14 N 7	16 O 8	19 F 9	20 Ne 10
27 Al 13	28 Si 14	31 P 15	32 S 16	35.5 Cl 17	40 Ar 18
70 Ga 31	73 Ge 32	75 As 33	79 Se 34	80 Br 35	84 Kr 36
115 In 49	119 Sn 50	122 Sb 51	128 Te 52	127 I 53	131 Xe 54
204 Tl 81	207 Pb 82	209 Bi 83	209 Po 84	210 At 85	222 Rn 86



65 Zn 30	63.5 Cu 29	59 Ni 28	59 Co 27	56 Fe 26	55 Mn 25	52 Cr 24	51 V 23	48 Ti 22	45 Sc 21
112 Cd 48	108 Ag 47	106 Pd 46	103 Rh 45	101 Ru 44	99 Tc 43	96 Mo 42	93 Nb 41	91 Zr 40	89 Y 39
201 Hg 80	197 Au 79	195 Pt 78	192 Ir 77	190 Os 76	186 Re 75	184 W 74	181 Ta 73	178.5 Hf 72	139 La 57

167 Er 68	169 Tm 69	173 Yb 70	175 Lu 71
257 Fm 100	258 Md 101	259 No 102	260 Lr 103
165 Ho 67	162 Dy 66	159 Tb 65	157 Gd 64
252 Es 99	251 Cf 98	247 Bk 97	247 Cm 96
152 Eu 63	150 Sm 62	147 Pm 61	144 Nd 60
243 Am 95	244 Pu 94	237 Np 93	238 U 92
141 Pr 59	140 Ce 58	141 Pr 59	144 Nd 60
232 Th 90	231 Pa 91	237 Np 93	238 U 92

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

SECONDARY EDUCATION CERTIFICATE LEVEL

MAY 2012 SESSION

SUBJECT: **Chemistry**
 PAPER NUMBER: IIB
 DATE: 22nd May 2012
 TIME: 09:00 a.m. to 11:00 a.m.

Useful data

Relative atomic masses: H = 1; N = 14; O = 16; Cl = 35.5; Cu = 63.5

The molar volume for gases at s.t.p. = 22.4 dm³

Standard temperature and pressure (s.t.p.): 0 °C and 1 atm

1 mole = 6.02 x 10²³

Density of water = 1 g cm⁻³

Faraday constant: 96,500 C

$Q = It$

$Q = mc\Delta\theta$

Directions to Candidates

- Write your index number in the space at the top left-hand corner of this page.
- Answer ALL questions in Section A and any TWO questions from Section B. Write 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.
- 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	13	14	Total
Score															
Maximum	6	6	7	6	6	6	6	5	6	6	20	20	20	20	100

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

1. (a) (i) In the space provided draw a diagram to show the bonding in a metal.

(2 marks)

- (ii) Suggest why some metals can be hammered into different shapes.

(1 mark)

- (iii) Explain why all metals conduct electricity.

(1 mark)

- (b) Iron is a transition metal. List **TWO** properties by which these metals may be identified.

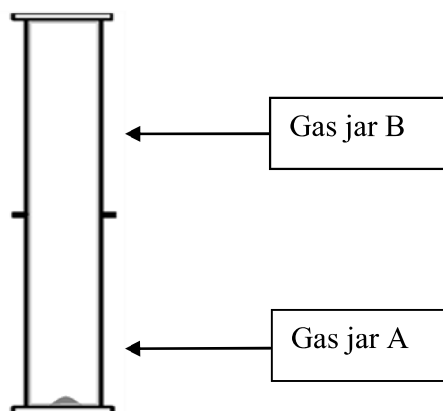
Property (i): _____

Property (ii): _____

(2 marks)

[Total: 6 marks]

2. (a) A drop of bromine was placed in a gas jar. Another gas jar was placed over it as shown in the diagram below. The apparatus was observed after 1 minute and again after 15 minutes.



6

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- (i) Describe what observation is expected after:

1 minute _____

15 minutes _____

(2 marks)

- (ii) What is the name of the process that has taken place in (a) (i)?

(1 mark)

- (iii) Where in the laboratory should the experiment be carried out as a safety precaution? (Bromine has many health hazards).

(1 mark)

- (b) (i) Explain what can be observed if a student places some fine carbon dust in water and looks at it under the microscope.

(1 mark)

- (ii) Give the name that best describes what takes place in the experiment in (b)(i).

(1 mark)

[Total: 6 marks]

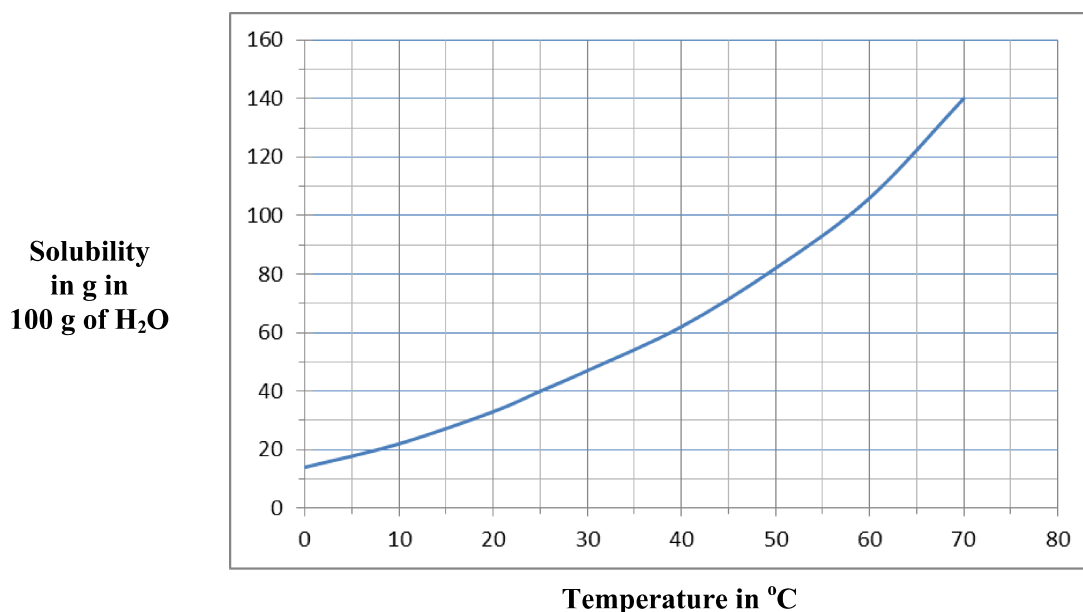
3. Fill in the blanks with the following words: **solute, solvent, disappears, solution**. Each word can be used once, more than once or not at all.

- (a) In making a _____ the solid that disappears is said to be the _____, and the liquid that makes the solid disappear is said to be the _____. A hot _____ can have more soluble solid dissolved in it than a cold one. (4 marks)

Question 3 continues on the next page.

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- (b) The following graph shows the solubility curve for potassium nitrate.



- (i) How much potassium nitrate dissolves in 100 g of water at 70 °C?

(1 mark)

- (ii) How much potassium nitrate dissolves in 100 g of water at 25 °C?

(1 mark)

- (iii) Predict what happens when a solution containing 140 g of potassium nitrate dissolved in 100 g of water is cooled to 25 °C.

(1 mark)

[Total: 7 marks]

4. (a) Fill in and complete the table below by stating what will happen when each of the following reactants are mixed together. Some have already been filled for you.

	Potassium chloride solution	Potassium bromide solution	Potassium iodide solution
Addition of chlorine	No Reaction		
Addition of bromine		No Reaction	A violet solid is deposited
Addition of Iodine	No Reaction		No Reaction

(2 marks)

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- (b) Give the ionic equation for the reaction between bromine and potassium iodide solution.

(2 marks)

- (c) Use the observations in part (a) to explain why chlorine is considered to be the most reactive while iodine is the least reactive among the three halogens chlorine, bromine and iodine.

(2 marks)

[Total: 6 marks]

5. Grandma tried to store orange peel in a jar, however when she opened the jar after a few weeks it smelled strongly of alcohol.

- (a) (i) Give the name of the process that has taken place in the jar.

(1 mark)

- (ii) If the orange peel contained glucose ($C_6H_{12}O_6$) suggest a name for the alcohol that has been formed in this process.

(1 mark)

- (iii) This process may be accelerated by a natural catalyst. Give the name of the substance that speeds up this reaction.

(1 mark)

- (iv) Give the equation for the reaction that takes place using glucose ($C_6H_{12}O_6$) as the reactant.

(1 mark)

- (b) Grandpa on the other hand had a bottle of wine which he kept in a warm sunny place. When he opened the bottle he found that it smelt of vinegar.

- (i) Give the name of the chemical responsible for the smell of vinegar.

(1 mark)

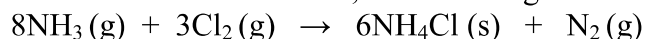
- (ii) If the reaction is carried out in the laboratory, suggest the name of a chemical that may be used, to change the alcohol in the wine into vinegar.

(1 mark)

[Total: 6 marks]

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6. When excess ammonia is added to chlorine, the following reaction takes place:



- (a) What volume of chlorine is required to produce 280 cm^3 of nitrogen N_2 , when all volumes are measured at s.t.p.?

(1 mark)

- (b) (i) How many moles of chlorine gas are required for this reaction?

(2 marks)

- (ii) What mass of ammonium chloride is produced in (b) (i)?

(3 marks)

[Total: 6 marks]

7. Two copper electrodes were immersed in a solution of copper(II) sulfate. In the experiment a current of 3 amperes was passed through the electrodes for 5 minutes.

- (a) (i) Give the equation for the reaction that takes place at the cathode.

(1 mark)

- (ii) Calculate the quantity of electricity that passes through the solution during this experiment.

(1 mark)

DO NOT WRITE ABOVE THIS LINE

- (b) (i) Given that 1 Faraday is 96,500 C, calculate the number of moles of electrons that are produced by this current.

(1 mark)

- (ii) Calculate the mass of copper deposited at the end of the experiment.

(3 marks)

[Total: 6 marks]

8. Zinc carbonate was heated to constant mass in a crucible.

- (a) Give an equation, including state symbols, for the reaction that takes place.

(2 marks)

- (b) What colour change would be observed during the experiment?

(1 mark)

- (c) List the steps required to ensure that there would be no further change in mass during the experiment.

(2 marks)

[Total: 5 marks]

6

5

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9. In an experiment, 30 cm^3 of 1 mol dm^{-3} nitric acid were added to 30 cm^3 of 1 mol dm^{-3} potassium hydroxide solution in a polystyrene cup.

(a) Write down the equation for the reaction that takes place.

_____ (1 mark)

(b) How many moles of alkali were present in 30 cm^3 of 1 mol dm^{-3} potassium hydroxide solution?

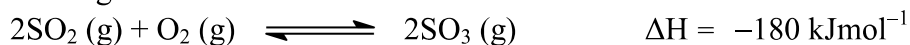
_____ (2 marks)

(c) If the temperature of the mixture increased by $6.5 \text{ }^\circ\text{C}$, calculate the quantity of heat evolved during the experiment if the specific heat capacity of water is $4.18 \text{ J g}^{-1} \text{ }^\circ\text{C}^{-1}$.

_____ (3 marks)

[Total: 6 marks]

10. The following reversible reaction is used in the Contact Process.



(a) (i) Comment on the rates of the forward and reverse reactions at equilibrium.

_____ (1 mark)

(ii) However on an industrial scale it is not desirable that this reaction reaches equilibrium. List **THREE** factors which will affect the position of equilibrium.

_____ (3 marks)

(b) State **TWO** things that are done in the Contact process so that the forward reaction is favoured.

_____ (2 marks)

[Total: 6 marks]

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Section B: Answer TWO questions from this section. Write your answers in the lined pages provided.

11. The diagram below shows part of the outline of the Periodic Table. The letters used are NOT symbols of elements.

A	R																		
B	S																		
C	T																		

- (a) (i) What are the columns of the Periodic Table called? (1 mark)
 (ii) What are the rows of the Periodic Table called? (1 mark)
- (b) (i) Give the electronic configuration of the elements **A**, **B** and **C** in the Periodic Table. (3 marks)
 (ii) Which of **A**, **B** and **C** is the most reactive? (1 mark)
 (iii) Explain your answer to (b) (ii) (3 marks)
- (c) Put the elements **B**, **C**, **S** and **T** in order of their reactivity. (2 marks)
- (d) (i) How many electrons do **W** and **X** have in their outer shell? (1 mark)
 (ii) What happens in terms of electrons when **W** reacts with other elements? (1 mark)
- (e) Use the electronic configuration to explain how element **G** is expected to react. (2 marks)
- (f) (i) Explain in terms of their electronic structure why the elements **K**, **L** and **M** are said to have a valency of zero. (2 marks)
 (ii) What is the name that is given to the elements in the same column as **K**, **L** and **M**? (1 mark)
- (g) What type of bonding will form between: (i) **B** and **H**; and (ii) **W** and **G**? (2 marks)
- [Total: 20 marks]

12. A group of students have been presented with standard laboratory equipment and a number of chemicals:

magnesium oxide

sodium sulfate

hydrochloric acid

potassium hydroxide

lead(II) nitrate

Describe how they would prepare samples of the following salts in the laboratory. Your explanation should include well-labelled diagrams and balanced equations for any reaction that takes place. Not all chemicals need to be used.

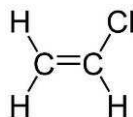
- (a) Magnesium chloride; and
 (b) Lead(II) sulfate.

[Total: 20 marks]

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13. Ethene, C₂H₄, is the first member of the **homologous series** of alkenes.

- (a) What is a homologous series? (1 mark)
- (b) Give the name and structural formulae of the **first three** members of alkenes. (5 marks)
- (c) The simplest alkene, ethene, is a gas at room temperature. How does the boiling point of alkenes vary with increasing hydrocarbon chain length? (1 mark)
- (d) (i) What are isomers? (2 marks)
(ii) Give the structural formulae of **two** isomers for the alkene that contains **four carbon atoms per molecule**. (2 marks)
- (e) (i) Alkenes are known as **unsaturated** hydrocarbons. Define the term **unsaturated**. (1 mark)
(ii) One of the properties of unsaturated hydrocarbons is their ability to undergo **addition polymerization**. What is **addition polymerization**? (1 mark)
(iii) The diagram below shows a molecule of an alkene. Write an equation to show what happens when this monomer undergoes polymerization.



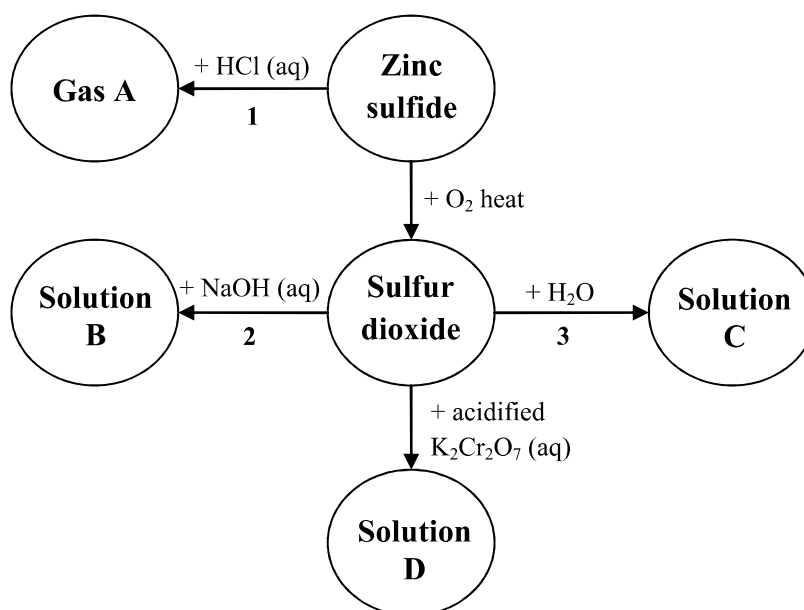
(2 marks)

- (iv) Give the name and **ONE** use for the substance that is formed by the polymerization that occurs in (e) (iii). (2 marks)
- (f) (i) Give the equation for the complete combustion of ethene. (2marks)
(ii) Why would it be hazardous to burn ethene in a limited supply of air? (1 mark)

[Total: 20 marks]

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14. Study the following reaction scheme and answer the questions below.



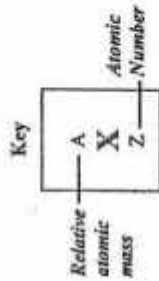
- (a) Write balanced equations for the reactions denoted by **1**, **2** and **3**. (6 marks)
- (b) (i) Identify a place where gas **A** is likely to be present. Why is this gas considered to be dangerous? (2 marks)
 (ii) Draw a dot-and-cross diagram for a molecule of gas **A**. (2 marks)
- (c) Solution **C** could be a cause of harm to the environment.
 (i) Explain how solution **C** comes to be present in the environment. (2 marks)
 (ii) List **TWO** harmful effects of substance **C** on the environment. (2 marks)
- (d) The reaction of sulfur dioxide gas with acidified potassium dichromate may be used to identify the presence of the gas.
 (i) What colour change would be observed during this reaction? (2 marks)
 (ii) Give another chemical test which may be used in the laboratory to test for the presence of sulfur dioxide gas. Describe the expected results. (2 marks)
- (e) Give **TWO** industrial uses of sulfur dioxide gas. (2 marks)

[Total: 20 marks]

PERIODIC TABLE

I	II
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1 H 1	9 Be 4	40 Ca 20	45 Sc 21
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23 Na 11		137 Ba 56	139 La 57
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115 In 49	119 Sn 50	122 Sb 51	128 Te 52	127 I 53	131 Xe 54
204 Tl 81	207 Pb 82	209 Bi 83	209 Po 84	210 At 85	222 Rn 86

65 Zn 30	63.5 Cu 29	59 Ni 28	59 Co 27	56 Fe 26	55 Mn 25	52 Cr 24	51 V 23	48 Ti 22	45 Sc 21
112 Cd 48	108 Ag 47	106 Pd 46	103 Rh 45	101 Ru 44	99 Tc 43	96 Mo 42	93 Nb 41	91 Zr 40	89 Y 39
201 Hg 80	197 Au 79	195 Pt 78	192 Ir 77	190 Os 76	186 Re 75	184 W 74	181 Ta 73	178.5 Hf 72	139 La 57

140 Ce 58	141 Pr 59	144 Nd 60	147 Pm 61	150 Sm 62	152 Eu 63	157 Tb 65	162 Dy 66	165 Ho 67	167 Er 68	169 Tm 69	173 Yb 70	175 Lu 71
232 Th 90	231 Pa 91	238 U 92	237 Np 93	244 Pu 94	243 Am 95	247 Cm 96	251 Cf 98	252 Es 99	257 Fm 100	258 Md 101	259 No 102	260 Lr 103