

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

**SECONDARY EDUCATION CERTIFICATE LEVEL**

**MAY 2014 SESSION**

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SUBJECT:	<b>Chemistry</b>
PAPER NUMBER:	I
DATE:	14 <sup>th</sup> May 2014
TIME:	9:00 a.m. to 11:00 a.m.

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**Useful data**

**Relative atomic masses: H = 1; C = 12; N = 14; O = 16; Mg = 24; Mn = 55**

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

**The molar volume for gases at STP = 22.4 dm<sup>3</sup>**

**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	6	8	4	6	6	5	6	6	6	7	20	20	100

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

1. Sodium carbonate crystals decompose according to the equation:



(a) What does the ' $\rightleftharpoons$ ' sign mean?

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(1 mark)

(b) **Circle** the term in the following list that can be used to describe the reaction in part (a).

**deliquescence      drying      explosion      efflorescence      redox**

(1 mark)

(c) Give a balanced chemical equation showing the effect of gentle heating on  $\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$  crystals. Include state symbols.

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(3 marks)

(d) One finds small containers containing silica gel for sale in supermarkets. These can be placed in cupboards and wardrobes to decrease the humidity present. What can be done so that the silica gel inside the bag is not wasted but can be reused?

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(1 mark)

[Total: 6 marks]

6

2. Fill in the blanks in the paragraph below by choosing from the following terms. *Each term can be used once or more than once; a number of terms will not be used at all.*

**carbohydrates, sooty, volume, alkyne, clear, addition, high, hydrocarbons, saturation, periodic, mass, alkene, unsaturation, homologous, substitution, low**

Organic compounds are grouped into a number of \_\_\_\_\_ series. Some examples are: alkanes, alkenes, alkynes, alcohols and carboxylic acids. Alkanes, alkenes and alkynes are also called \_\_\_\_\_. The compound with formula  $C_4H_8$  is an \_\_\_\_\_. When burnt it gives a \_\_\_\_\_ flame. This is an indication of \_\_\_\_\_, that is the compound contains a \_\_\_\_\_ percentage by \_\_\_\_\_ of carbon. The typical reactions of compounds in the alkane series are \_\_\_\_\_ reactions.

[Total: 8 marks]

3. Hydrogen sulfide is a gas that can be found in swamps, sewers and in volcanic gases. It is very poisonous, heavier than air and corrosive. It can be prepared in the laboratory by adding a dilute acid to a sulfide of a metal.

(a) Give a balanced equation for the reaction of sodium sulfide,  $Na_2S$ , with an acid.

(2 marks)

(b) By considering the properties of hydrogen sulfide, state:

(i) a way to collect a sample of the gas if the preparation is carried out in the lab;

(1 mark)

(ii) **one** necessary safety precaution when carrying out the preparation in the lab.

(1 mark)

[Total: 4 marks]

8

4

4. When sodium hydroxide reacts with sulfuric acid two salts,  $\text{Na}_2\text{SO}_4$  and  $\text{NaHSO}_4$  can be formed.

(a) Give a balanced equation to show how  $\text{Na}_2\text{SO}_4$  is formed by the reaction between sodium hydroxide and dilute sulfuric acid.

(2 marks)

(b) (i) Give the name for  $\text{NaHSO}_4$ .

(1 mark)

(ii) What name is used to describe salts such as  $\text{NaHSO}_4$ .

(1 mark)

(c) Give the name and formula of another acid that, behaving in a similar way as sulfuric acid, can also form two types of salts.

(2 marks)

[Total: 6 marks]

5. (a) Students often use hydrochloric acid,  $\text{HCl}(\text{aq})$ , in their experiments in the laboratory. During a practical session the students were asked to carry out a set of experiments in which they added dilute hydrochloric acid to different substances. They summarised their results in a Table. Complete the missing data in the Table.

Reactants		Formula of chloride formed	Name of other products
Dilute $\text{HCl}(\text{aq})$	Zinc	$\text{ZnCl}_2$	Hydrogen
Dilute $\text{HCl}(\text{aq})$	Sodium carbonate		Water
Dilute $\text{HCl}(\text{aq})$	Calcium oxide		

(4 marks)

(b) Chlorine gas is a poisonous gas but it has several important uses. State **two** possible uses for chlorine.

Use 1: \_\_\_\_\_

Use 2: \_\_\_\_\_

(2 marks)

[Total: 6 marks]

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6. (a) Give the electronic configurations of the following atoms or ions:

(i) Mg = \_\_\_\_\_

(ii) Li<sup>+</sup> = \_\_\_\_\_

(iii) O<sup>2-</sup> = \_\_\_\_\_

(3 marks)

(b) Give the electronic configuration of the element below Mg in the Periodic Table.

---

(1 mark)

(c) Give the name **or** symbol of the lightest element that exists as single atoms at room temperature and pressure, i.e. under normal conditions.

---

(1 mark)

[Total: 5 marks]

7. In organic chemistry isomerism is very common.

(a) Draw **three** possible structures having the formula C<sub>5</sub>H<sub>12</sub>.

(3 marks)

(b) There are **only two** possible structures with the formula C<sub>2</sub>H<sub>6</sub>O.

(i) Draw the **two** structures.

(ii) Give the chemical name of **one** of the compounds in part (b)(i).

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(3 marks)

[Total: 6 marks]

8. A chemist needs to identify any gases evolved in a reaction.
- (a) Suggest a test (**that does not involve litmus paper or universal indicator paper**) that the chemist can carry out to identify the following gases. Chemical equations are **NOT** required.

Gas	Test
Sulfur dioxide	
Carbon dioxide	
Hydrogen	
Hydrogen chloride	

(4 marks)

- (b) Give an equation, including state symbols, to show why ammonia is an alkaline gas.

(2 marks)

[Total: 6 marks]

9. Ammonia is a very important chemical, not just for use in a laboratory but also in industry and in everyday life.

- (a) Our body produces ammonia, which the liver then changes into urea. Urea has the formula  $\text{NH}_2\text{CONH}_2$ . Calculate the percentage by mass of nitrogen in urea.

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(3 marks)

- (b) Give a balanced equation to show how ammonia and sulfuric acid react to form a fertiliser.

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(2 marks)

- (c) Mention **one** other use for ammonia besides its use to make fertilisers.

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(1 mark)

[Total: 6 marks]

6

6

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10. Magnesium oxide is insoluble in water but it can react with dilute nitric acid.

- (a) Give a balanced equation for the reaction between magnesium oxide and dilute nitric acid.

---

(2 marks)

- (b) A group of students decide to test this reaction out in the laboratory. It is decided to start with a mass of 2.0 g of magnesium oxide in a conical flask. What volume of nitric acid, of concentration  $2.5 \text{ mol dm}^{-3}$ , will be required to react with all the magnesium oxide in the conical flask?

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(4 marks)

- (c) If for the reaction in part (b), instead of using nitric acid, sulfuric acid of the same concentration were to be used, what volume of sulfuric acid would be required for the reaction?

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(1 mark)

[Total: 7 marks]

7

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**Section B: Answer BOTH questions. Write your answers in the spaces provided.**

11. Any substance that gives out heat energy when it burns in air or oxygen can be used as a fuel. However some substances give out more heat energy than others on combustion.

- (a) Two groups of students need to determine whether it is better to use charcoal or lamp spirit to boil some water for cooking spaghetti.
- Group A weighed some charcoal on a filter paper but group B told them that that would give them errors in the experiment.
  - Group B wanted to weigh the lamp spirit that they were going to use in a test tube, but Group A told them that that would not work.
- (i) Suggest **two** disadvantages of weighing the charcoal on a filter paper.
- 

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(2 marks)

- (ii) Suggest **two** reasons why Group B should not have weighed the lamp spirit in a test tube.
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(2 marks)

- (b) (i) Draw a labelled diagram to show the set up of the apparatus used to determine the heat of combustion of lamp spirit.

(4 marks)





- (c) Once their experiment was over, the two groups collected some data from the internet to help them in their calculations with some other fuels. The two groups are provided with 20.0 g of each fuel shown in the Table.

Organic compound	Heat of combustion in $\text{kJ mol}^{-1}$
methanol, $\text{CH}_3\text{OH}$	-726
propan-1-ol, $\text{C}_3\text{H}_7\text{OH}$	-2021

If the 20.0 g samples of the fuels provided are burnt in excess air and the fuels react completely, calculate which fuel gives out more heat.

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(6 marks)

[Total: 20 marks]

12. (a) Chlorine is produced when manganese(IV) oxide oxidises concentrated hydrochloric acid. Draw a well-labelled diagram to show how the apparatus can be set up so that chlorine gas is prepared and collected. Your answer must include the names of all the parts of apparatus used and must also show clearly how a sample of the gas can be collected.

(5 marks)

- (b) Sometimes it is important that a sample of gas collected does not have any water in it.
- (i) Give the name and formula of a substance that can be used to dry the gas before collection.

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(2 marks)

*This question continues on the next page.*

- 
- (ii) Show, using a diagram, how the apparatus in part (a) needs to be altered so that the gas is collected dry.

(1 mark)

- (c) (i) Besides the method of collection of gas that you used in part (a), mention **two** other ways by which chlorine can be collected.

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(2 marks)

- (ii) For **each of the two** methods in part (c)(i) mention **one** disadvantage.

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(2 marks)

- (d) The equation for the reaction is:



In the reaction excess hydrochloric acid is added to 78.3 g of solid manganese(IV) oxide so that all the solid reacts. Calculate:

- (i) the number of moles of manganese(IV) oxide used in the reaction;

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(2 marks)

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(ii) the number of moles of hydrochloric acid used;

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(2 marks)

(iii) the number of moles of chlorine gas produced; and

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(2 marks)

(iv) the volume of chlorine collected, measured at standard temperature and pressure.

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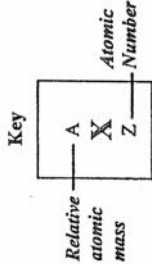
(2 marks)  
[Total: 20 marks]

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PERIODIC TABLE

I		II		III	IV	V	VI	VII	VIII
1 H 1	9 Be 4	20 Ca 20	29 Cu 29	48 Ti 22	56 Fe 26	63.5 Cu 29	79 Se 34	80 Br 35	84 Kr 36
7 Li 3	12 Mg 12	39 K 19	45 Sc 21	51 V 23	59 Co 27	59 Ni 28	73 Ga 31	75 As 33	84 Kr 36
23 Na 11	24 Mg 12	88 Sr 38	89 Y 39	91 Nb 41	99 Tc 43	106 Pd 46	112 In 49	115 Sn 50	127 I 53
39 K 19	40 Ca 20	85 Rb 37	89 Y 39	93 Nb 41	101 Ru 44	108 Ag 47	119 Sn 50	122 Sb 51	131 Xe 54
133 Cs 55	137 Ba 56	139 La 57	139 La 57	181 Ta 73	190 Os 76	197 Au 79	207 Pb 82	209 Bi 83	222 Rn 86
223 Fr 87	226 Ra 88	227 Ac 89	227 Ac 89	178.5 Hf 72	186 Re 75	192 Ir 77	201 Hg 80	204 Tl 81	222 Rn 86
140 Ce 58	141 Pr 59	144 Nd 60	147 Pm 61	150 Sm 62	152 Eu 63	157 Gd 64	165 Ho 67	167 Er 68	175 Lu 71
232 Th 90	231 Pa 91	238 U 92	237 Np 93	244 Pu 94	243 Am 95	247 Cm 96	252 Es 99	257 Fm 100	260 Lr 103
169 Tm 69	173 Yb 70	175 Lu 71	175 Lu 71	162 Dy 66	162 Dy 66	162 Dy 66	169 Tm 69	173 Yb 70	175 Lu 71
167 Er 68	167 Er 68	167 Er 68	167 Er 68	159 Tb 65	159 Tb 65	159 Tb 65	167 Er 68	173 Yb 70	175 Lu 71
165 Ho 67	165 Ho 67	165 Ho 67	165 Ho 67	157 Gd 64	157 Gd 64	157 Gd 64	165 Ho 67	173 Yb 70	175 Lu 71
162 Dy 66	162 Dy 66	162 Dy 66	162 Dy 66	155 Sm 62	155 Sm 62	155 Sm 62	162 Dy 66	173 Yb 70	175 Lu 71
159 Tb 65	159 Tb 65	159 Tb 65	159 Tb 65	150 Sm 62	150 Sm 62	150 Sm 62	159 Tb 65	173 Yb 70	175 Lu 71
157 Gd 64	157 Gd 64	157 Gd 64	157 Gd 64	147 Pm 61	147 Pm 61	147 Pm 61	157 Gd 64	173 Yb 70	175 Lu 71
152 Eu 63	152 Eu 63	152 Eu 63	152 Eu 63	144 Nd 60	144 Nd 60	144 Nd 60	152 Eu 63	173 Yb 70	175 Lu 71
150 Sm 62	150 Sm 62	150 Sm 62	150 Sm 62	141 Pr 59	141 Pr 59	141 Pr 59	150 Sm 62	173 Yb 70	175 Lu 71
147 Pm 61	147 Pm 61	147 Pm 61	147 Pm 61	137 Ba 56	137 Ba 56	137 Ba 56	147 Pm 61	173 Yb 70	175 Lu 71
144 Nd 60	144 Nd 60	144 Nd 60	144 Nd 60	139 La 57	139 La 57	139 La 57	144 Nd 60	173 Yb 70	175 Lu 71
141 Pr 59	141 Pr 59	141 Pr 59	141 Pr 59	139 La 57	139 La 57	139 La 57	141 Pr 59	173 Yb 70	175 Lu 71
140 Ce 58	140 Ce 58	140 Ce 58	140 Ce 58	137 Ba 56	137 Ba 56	137 Ba 56	140 Ce 58	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	252 Es 99	257 Fm 100	260 Lr 103
169 Tm 69	173 Yb 70	175 Lu 71	175 Lu 71	162 Dy 66	162 Dy 66	162 Dy 66	169 Tm 69	173 Yb 70	175 Lu 71
167 Er 68	167 Er 68	167 Er 68	167 Er 68	159 Tb 65	159 Tb 65	159 Tb 65	167 Er 68	173 Yb 70	175 Lu 71
165 Ho 67	165 Ho 67	165 Ho 67	165 Ho 67	157 Gd 64	157 Gd 64	157 Gd 64	165 Ho 67	173 Yb 70	175 Lu 71
162 Dy 66	162 Dy 66	162 Dy 66	162 Dy 66	155 Sm 62	155 Sm 62	155 Sm 62	162 Dy 66	173 Yb 70	175 Lu 71
159 Tb 65	159 Tb 65	159 Tb 65	159 Tb 65	150 Sm 62	150 Sm 62	150 Sm 62	159 Tb 65	173 Yb 70	175 Lu 71
157 Gd 64	157 Gd 64	157 Gd 64	157 Gd 64	147 Pm 61	147 Pm 61	147 Pm 61	157 Gd 64	173 Yb 70	175 Lu 71
152 Eu 63	152 Eu 63	152 Eu 63	152 Eu 63	144 Nd 60	144 Nd 60	144 Nd 60	152 Eu 63	173 Yb 70	175 Lu 71
150 Sm 62	150 Sm 62	150 Sm 62	150 Sm 62	141 Pr 59	141 Pr 59	141 Pr 59	150 Sm 62	173 Yb 70	175 Lu 71
147 Pm 61	147 Pm 61	147 Pm 61	147 Pm 61	137 Ba 56	137 Ba 56	137 Ba 56	147 Pm 61	173 Yb 70	175 Lu 71
144 Nd 60	144 Nd 60	144 Nd 60	144 Nd 60	139 La 57	139 La 57	139 La 57	144 Nd 60	173 Yb 70	175 Lu 71
141 Pr 59	141 Pr 59	141 Pr 59	141 Pr 59	139 La 57	139 La 57	139 La 57	141 Pr 59	173 Yb 70	175 Lu 71
140 Ce 58	140 Ce 58	140 Ce 58	140 Ce 58	137 Ba 56	137 Ba 56	137 Ba 56	140 Ce 58	173 Yb 70	175 Lu 71





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UNIVERSITY OF MALTA, MSIDA

**SECONDARY EDUCATION CERTIFICATE LEVEL**

**MAY 2014 SESSION**

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SUBJECT:	<b>Chemistry</b>
PAPER NUMBER:	IIA
DATE:	16 <sup>th</sup> May 2014
TIME:	9:00 a.m. to 11:00 a.m.

---

**Useful data**

**Relative atomic masses: O = 16; S = 32; Ca = 40; Cu = 63.5**

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

**The molar volume for gases at STP = 22.4 dm<sup>3</sup>**

**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	6	6	6	6	6	8	4	6	20	20	20	20	100

**DO NOT WRITE ABOVE THIS LINE**

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

1. (a) A fine white powder labelled **A** is placed in a small sample of transparent, colourless liquid **B**. When the test tube containing the mixture is shaken, the liquid becomes a cloudy mixture, **X**. Eventually, after being left standing for a few minutes, **A** forms a layer at the bottom and liquid **B** becomes transparent once again.
- (i) Write one word to describe the cloudy mixture **X**.

---

(1 mark)

- (ii) What can be concluded about the solubility of solid **A** in liquid **B**?

---

(1 mark)

- (iii) Suggest **one** suitable example for solid **A** and one for liquid **B**, that when mixed together would produce a mixture like **X**.

---

(2 marks)

- (b) The same powder **A** behaves differently in liquid **C**. On adding powder **A** to a small sample of transparent, colourless liquid **C**, effervescence is observed and powder **A** ‘disappears’ to form a transparent mixture **Y**.

- (i) Write one word to describe the mixture **Y**.

---

(1 mark)

- (ii) When the liquid from mixture **Y** is evaporated, powder **A** is not obtained again. Explain.

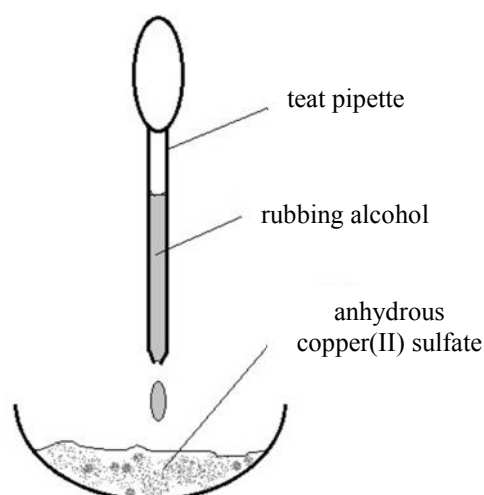
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(1 mark)  
[Total: 6 marks]

6

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2. (a) A student found a colourless liquid in a bottle labelled '*rubbing alcohol*'. He collected a sample of this liquid using a teat pipette and placed a few drops onto some anhydrous copper(II) sulfate, as shown in the diagram.



The student made the following observation: *The white powder of the copper(II) sulfate turned blue on contact with the liquid.*

- (i) What can be concluded about the liquid labelled '*rubbing alcohol*', from the student's observation?

(1 mark)

- (ii) Write a balanced chemical equation showing the reaction of anhydrous copper(II) sulfate with the liquid.

(2 marks)

- (b) The student repeated the same test for another colourless liquid and got the same result: white anhydrous copper(II) sulfate turned blue when it came into contact with this liquid. In addition, the liquid boiled exactly at 100°C and froze exactly at 0°C. What can be concluded about this liquid from these observations? Explain.

(2 marks)

- (c) What colour change would be observed if the same liquid mentioned in part (b) were added to some anhydrous cobalt(II) chloride?

(1 mark)

[Total: 6 marks]

6

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3. (a) A scientist wants to separate a mixture of ammonium chloride and potassium chloride. She tried out two different separation techniques: Technique (1) – solution, filtration and evaporation; and Technique (2) – sublimation.

(i) Explain why Technique (1) is not suitable for separating this mixture.

---

(1 mark)

(ii) Explain why Technique (2) is suitable for separating this mixture.

---

(1 mark)

- (b) Whilst carrying out Technique (2) (that is, sublimation), the mixture was heated in an evaporating dish covered with an inverted filter funnel.

(i) Describe the changes you would expect to observe.

---

(2 marks)

(ii) Write a balanced equation (including state symbols) for the change that takes place when a mixture of ammonium chloride and potassium chloride is heated.

---

(2 marks)

[Total: 6 marks]

4. (a) Magnesium and calcium are two elements found in Group 2 of the Periodic Table.

(i) Write the name given to the Group 2 elements of the Periodic Table.

---

(1 mark)

(ii) Name or write the symbol of the least reactive element in Group 2.

---

(1 mark)

- (b) (i) Write a balanced equation for the reaction of calcium with water at room temperature.

---

(2 marks)

(ii) Give **one** visible change that is observed when the reaction in part (b)(i) takes place.

---

(1 mark)

(iii) State whether the pH of the resulting solution from the reaction in part (b)(i) will be equal, higher or lower than 7.

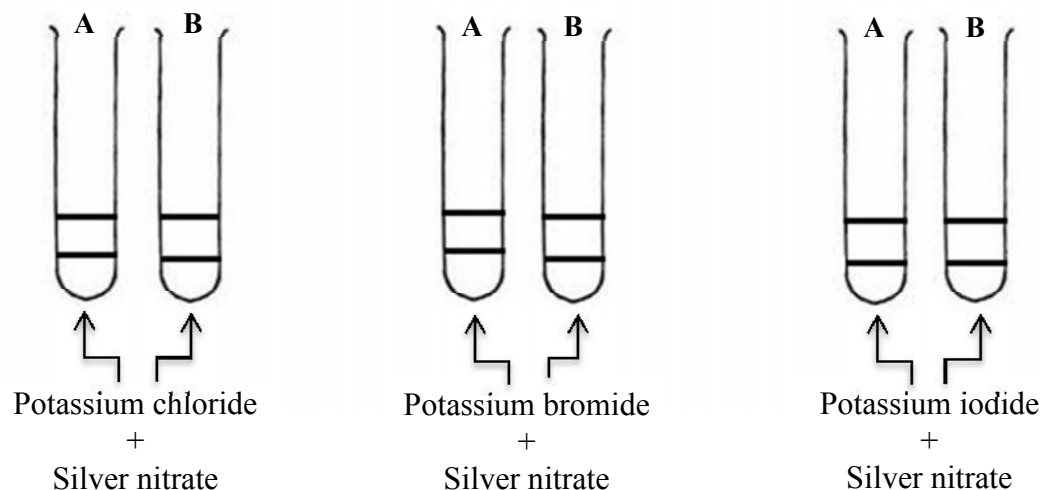
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(1 mark)

[Total: 6 marks]

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5. In an experiment, 2 cm<sup>3</sup> of potassium chloride, potassium bromide and potassium iodide solutions were added separately to each of two test tubes. A few drops of silver nitrate solution were then added to each of the test tubes as shown in the diagram below. The test tubes marked **A** were placed in a darkened cupboard while the test tubes marked **B** were exposed to sunlight.



- (a) A precipitate was formed in each of the test tubes. State the colour of the precipitate in each of the three tubes marked **A**.

Potassium chloride + silver nitrate: \_\_\_\_\_

Potassium bromide + silver nitrate: \_\_\_\_\_

Potassium iodide + silver nitrate: \_\_\_\_\_

**(3 marks)**

- (b) Write a balanced chemical equation showing the reaction of potassium chloride solution with silver nitrate solution.

**(2 marks)**

- (c) State what happens to the precipitates in the test tubes marked **B**.

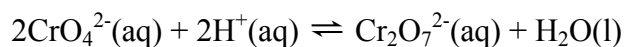
**(1 mark)**

**[Total: 6 marks]**

6

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- 
6. (a) A boiling tube contains 5 cm<sup>3</sup> of potassium chromate solution, which is yellow in colour. The chromate ions in the solution exist in equilibrium with the dichromate ions as shown below.



- (i) What colour change would be observed if 2 cm<sup>3</sup> of 1 mol dm<sup>-3</sup> hydrochloric acid solution were added to the solution in the boiling tube?

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(1 mark)

- (ii) Explain, in terms of chemical equilibria, why such a change is occurring.

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(2 marks)

- (b) Three other solutions are available in the lab. These are:

(A) 1 mol dm<sup>-3</sup> ethanoic acid solution;

(B) 2 mol dm<sup>-3</sup> sodium chloride solution; and

(C) 1 mol dm<sup>-3</sup> sodium hydroxide solution.

- (i) From the three solutions, choose one which when added to the contents of the boiling tube in part (a)(i) would turn the colour of the solution to the original yellow colour.

---

(1 mark)

- (ii) Explain your answer for part (b)(i).

---

(1 mark)

- (iii) Suggest a suitable quantity of solution to be added to produce the colour change.

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(1 mark)

[Total: 6 marks]

6
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7. (a) Draw the structures of the products formed when the following pairs of substances react together, assuming that the second substance in each case is in excess and that where necessary, a suitable catalyst and reaction conditions are present.

(i) Ethene + chlorine

(ii) Propene + hydrogen

(iii) Ethene + hydrogen chloride

(3 marks)

(b) Give the term that describes this type of reaction.

(1 mark)

(c) Describe a simple chemical test to distinguish between the substances octane and octene.

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(2 marks)

[Total: 6 marks]

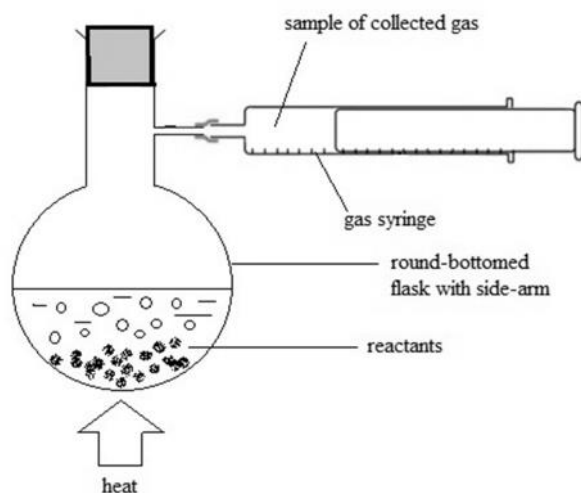
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8. Calcium sulfite reacts with dilute hydrochloric acid upon heating according to the equation:



Using the apparatus shown below, a sample of 0.6 g of calcium sulfite powder is reacted with excess dilute hydrochloric acid. The sulfur dioxide gas produced is collected in the gas syringe attached, pushing the plunger outwards.



- (a) Calculate the number of moles of calcium sulfite that reacted.

**(2 marks)**

- (b) Find the number of moles of sulfur dioxide gas produced.

**(1 mark)**

- (c) The syringe containing the collected gas is allowed to cool to standard temperature and is kept at standard pressure. Calculate the volume of sulfur dioxide collected, in  $\text{cm}^3$ , at STP.

**(2 marks)**

- (d) Assuming that the apparatus is leak proof, suggest a reason why the actual volume of gas collected in the syringe is less than the value calculated in part (c).

**(1 mark)**



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- 
- (e) The sample of gas collected in the syringe is analysed and is found to contain also other gases as impurities, apart from sulfur dioxide. Explain from where these contaminating gases came from.

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(1 mark)

- (f) Assuming that under a set of conditions, 1 mole of sulfur dioxide gas occupies a volume of  $25 \text{ dm}^3$ , what would be the volume of 1 mole of sulfur trioxide gas under the same conditions?

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(1 mark)

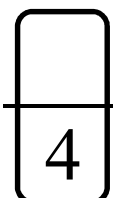
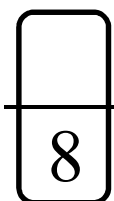
[Total: 8 marks]

9. A volume of  $500 \text{ cm}^3$  of a gas at 1 atmosphere and  $0^\circ\text{C}$  is changed to  $300 \text{ cm}^3$  at 2 atmospheres. Find the new temperature in degrees Celsius.

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(4 marks)

[Total: 4 marks]



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10. The following is a description of two synthetic plastic materials:

- Material **A** is white, rigid and glossy.
- Material **B** is white, waxy and very slippery.

(a) Deduce which of the two materials above is PVC (polyvinyl chloride) and which is PTFE (polytetrafluoroethane).

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(2 marks)

(b) Draw the structures of PVC and PTFE showing a chain of **two** monomer units each.

(2 marks)

(c) Name **one** use for material **A** and **one** use for material **B**.

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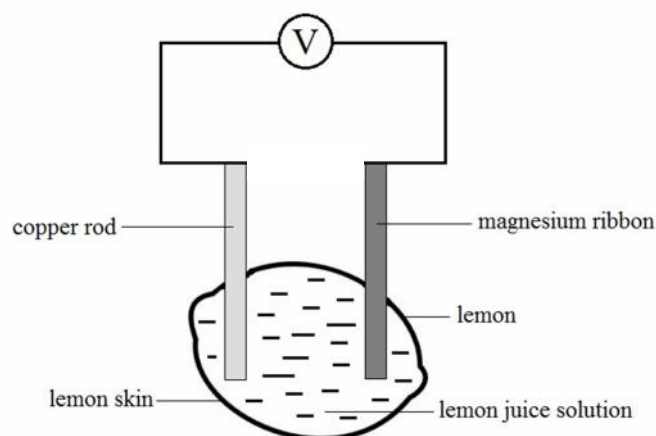
(2 marks)  
[Total: 6 marks]

6

**DO NOT WRITE ABOVE THIS LINE**

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

11. A chemistry student wanted to construct a simple cell using a lemon. She used the set-up shown in the diagram below.



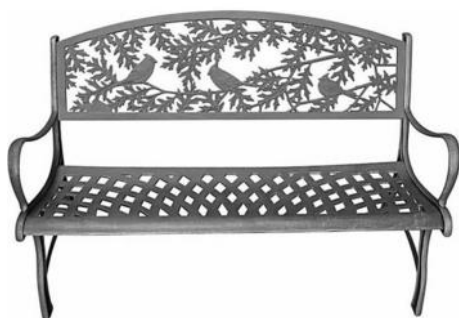
The student gently rolled and squeezed the lemon on the flat laboratory bench, taking care not to break the skin. Then she made two small slits in the skin with a knife and inserted the copper rod in one, and the magnesium ribbon in the other. The copper rod was of a very shiny, reddish-brown colour, whilst the magnesium ribbon had a dull grey colour. As soon as she connected the circuit the voltage read 0.20 V but as time went by, the voltage gradually increased until it reached a maximum of 2.69 V.

- (a) (i) What type of solution does the lemon contain, that enables it to produce a voltage when the two metal rods are dipped in it? **(1 mark)**
- (ii) Explain why the student rolled and squeezed the lemon before starting the experiment. **(2 marks)**
- (iii) Explain why the voltage started off very low and gradually increased to its highest value. **(3 marks)**
- (b) (i) Explain which metal will act as the cathode and which one will act as the anode and state the direction of the flow of electrons. **(5 marks)**
- (ii) Write two ionic half-equations that include state symbols, to illustrate the processes occurring at the cathode and at the anode of the cell. **(4 marks)**
- (c) The student repeated the experiment twice, but with the changes shown below:
- (I) she used two copper rods; and
- (II) she used a copper rod and an iron rod.
- For **each** experiment trial, deduce how the change would affect the voltage output of the cell. Explain your answer. **(5 marks)**

**[Total: 20 marks]**

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12. The pictures below show two items of garden furniture.



**iron garden bench**



**copper flower pot**

Iron and copper are both transition metals.

- (a) (i) List **three** properties that are common to transition metals. **(3 marks)**  
 (ii) List **two** properties of iron and **two** properties of copper and explain how each property mentioned makes the metal suitable for a particular use related to the objects shown in the pictures above. **(4 marks)**  
 (iii) Explain which of the two metals is most suited for outdoor use. **(1 mark)**
- (b) Iron reacts, under certain conditions, with both chlorine and hydrogen chloride.  
 (i) Write **two** balanced chemical equations to represent these two reactions. **(4 marks)**  
 (ii) Name an important common condition that is necessary for both reactions to occur. **(1 mark)**  
 (iii) Explain why two different compounds of iron are produced from these two reactions. **(2 marks)**
- (c) Copper can form compounds in which it exhibits different valencies. Samples of two copper compounds were analysed and found to contain:

<b>Compound A</b>	<b>Compound B</b>
5.29 g of copper	7.07 g of copper
1.33 g of oxygen	0.89 g of oxygen

Find the empirical formulae (showing the working) of the two copper compounds. Identify the compounds by writing their full chemical name. **(5 marks)**

**[Total: 20 marks]**

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13. Strong mineral acids are known for their corrosive properties, as shown by the hazard symbols printed on the bottle labels by chemical manufacturers. Such acids are also described as *corrosive to metals*.



The corrosive effect of dilute hydrochloric acid, dilute sulfuric acid, and dilute ethanoic acid was investigated on the following metals: **iron, magnesium, copper, aluminium**.

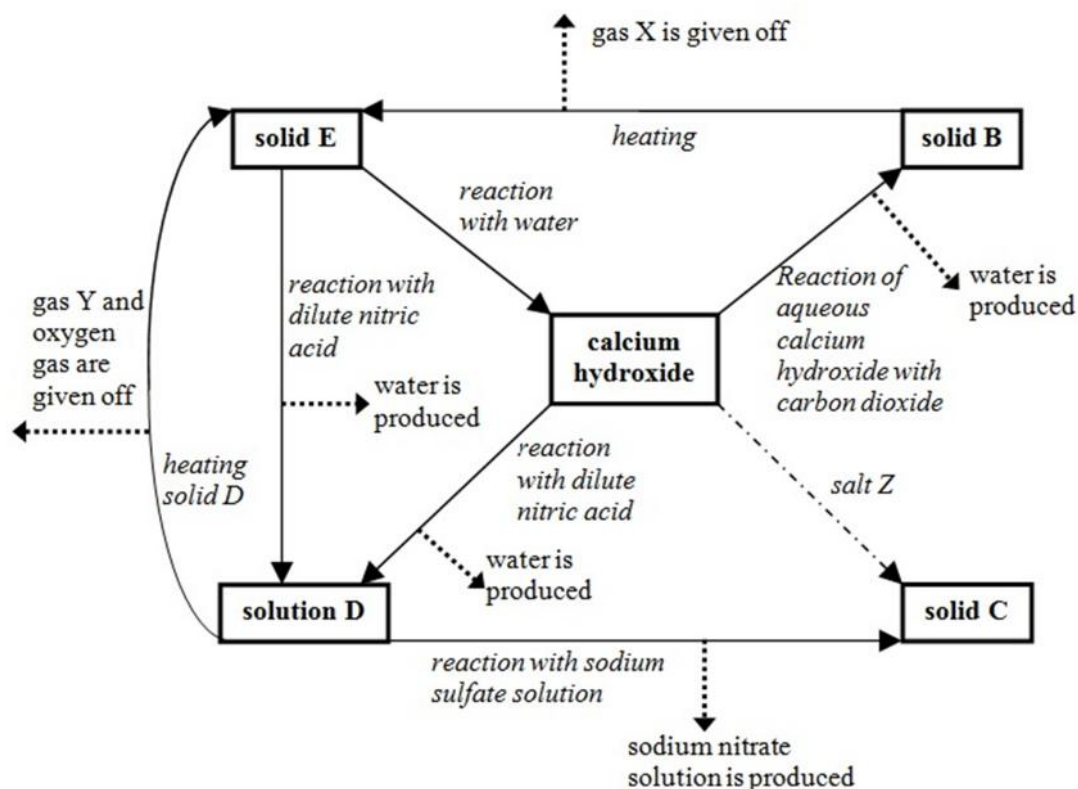
- (a) Outline the steps for carrying out such an investigation. The answer should include:
- (i) the method; and
  - (ii) the precautions taken to ensure fair testing; and then
  - (iii) list the **four** metals in order of reactivity, starting with the most reactive with acids. **(8 marks)**
- (b) (i) Compare the reactions of magnesium with dilute hydrochloric acid and dilute ethanoic acid, with both acids having the same molar concentration. Explain your answer. **(6 marks)**
- (ii) Write the **two** balanced equations showing the reaction of magnesium with dilute hydrochloric acid and with dilute ethanoic acid respectively. **(4 marks)**
- (c) Calcium is a very reactive metal. However, when a granule of calcium is added to dilute sulfuric acid, it is observed that the reaction stops after a short time. Explain why this happens. **(2 marks)**

**[Total: 20 marks]**

*Question 14 is on the next page.*

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14. The scheme below shows a series of chemical reactions.



- (a) Identify **B**, **C**, **D**, **E**, **X** and **Y**: write the chemical name **or** formula of each. (6 marks)
- (b) Write balanced chemical equations for:
- The reaction of solid **E** with water to produce calcium hydroxide.
  - The reaction of calcium hydroxide with dilute nitric acid to produce solution **D**.
  - The reaction of solution **D** with sodium sulfate solution to produce solid **C**. (6 marks)
- (c) Most of the water in solution **D** can be evaporated and a hydrated solid, **D**, can be obtained by crystallisation.
- What is the colour of solid **D**? (1 mark)
  - Write a balanced chemical equation (including state symbols) representing the thermal decomposition of solid **D** to produce solid **E**, and state **one** observation for this reaction. (4 marks)
- (d) Calcium hydroxide solution can be converted directly into solid **C** by reacting it with a solution of salt **Z**.  
Give the chemical name of salt **Z**, and suggest **two** reasons why it is a suitable reactant to produce solid **C** from its reaction with aqueous calcium hydroxide. (3 marks)
- [Total: 20 marks]















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

**SECONDARY EDUCATION CERTIFICATE LEVEL**

**MAY 2014 SESSION**

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SUBJECT:	<b>Chemistry</b>
PAPER NUMBER:	IIB
DATE:	16 <sup>th</sup> May 2014
TIME:	9:00 a.m. to 11:00 a.m.

---

**Useful data**

**Relative atomic masses: H = 1; C = 12; O = 16; Na = 23**

**0°C = 273 K**

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

**The molar volume for gases at STP = 22.4 dm<sup>3</sup> = 22,400 cm<sup>3</sup>**

**Faraday constant: 96,500 C**

**Q = It**

**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															
<b>Maximum</b>	<b>6</b>	<b>5</b>	<b>6</b>	<b>6</b>	<b>4</b>	<b>6</b>	<b>8</b>	<b>6</b>	<b>6</b>	<b>7</b>	<b>20</b>	<b>20</b>	<b>20</b>	<b>20</b>	<b>100</b>

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

1. (a) (i) Give a name for the mixture which forms when a solid **A** 'disappears' in a liquid **X**.

(1 mark)

- (ii) A solid **B** does not 'disappear' when mixed with liquid **X**, even after mixing well. Give a name for the mixture that forms.

(1 mark)

- (iii) Suggest suitable examples for solid **A** and liquid **X** in the mixture in part (a)(i).

Solid **A**: \_\_\_\_\_

Liquid **X**: \_\_\_\_\_

(2 marks)

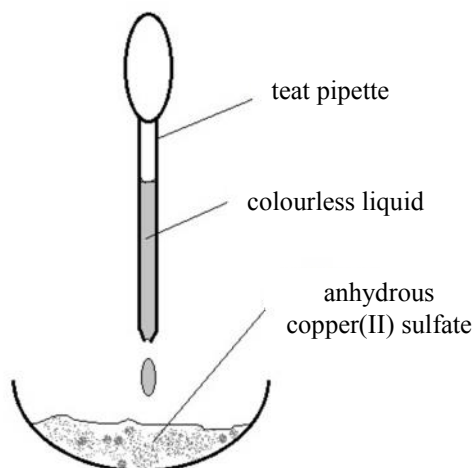
- (b) In the mixture in part (a)(i), the solid **A** is acting as the \_\_\_\_\_

while liquid **X** is acting as the \_\_\_\_\_.

(2 marks)

[Total: 6 marks]

2. A colourless liquid that boils at  $100^{\circ}\text{C}$  and freezes at  $0^{\circ}\text{C}$  was added to solid anhydrous copper(II) sulfate in the experiment shown in the diagram below.



- (a) (i) What colour change is expected in this experiment?

From: \_\_\_\_\_

To: \_\_\_\_\_

(2 marks)

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- 
- (ii) Give the equation for the reaction that takes place in the experiment shown in the diagram above.

---

(2 marks)

- (b) Another colourless liquid gave the same result with copper(II) sulfate as in the experiment shown above, however it did not boil at 100°C or freeze at 0°C. Give a suitable explanation for this.

---

(1 mark)

[Total: 5 marks]

3. (a) Write a balanced equation for the change that takes place when a mixture of ammonium chloride and potassium chloride is heated.

---

(2 marks)

- (b) The mixture in part (a) was heated in an evaporating dish covered with an inverted filter funnel. What change would one expect to see happening during this experiment?

To the ammonium chloride: \_\_\_\_\_

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To the potassium chloride: \_\_\_\_\_

---

(2 marks)

- (c) Give the name of the process that takes place during the change in part (b).

---

(1 mark)

- (d) Name **one** other substance that can undergo a similar change.

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(1 mark)

[Total: 6 marks]

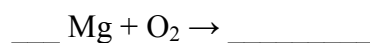
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4. Magnesium and calcium are two elements found in Group 2 of the Periodic Table.

(a) Complete the following equation:



(2 marks)

(b) Calcium reacts with water to form hydrogen and the hydroxide. Give **two** observations for this reaction.

(2 marks)

(c) (i) Give a simple test to show whether the resulting solution is acidic or alkaline.

(1 mark)

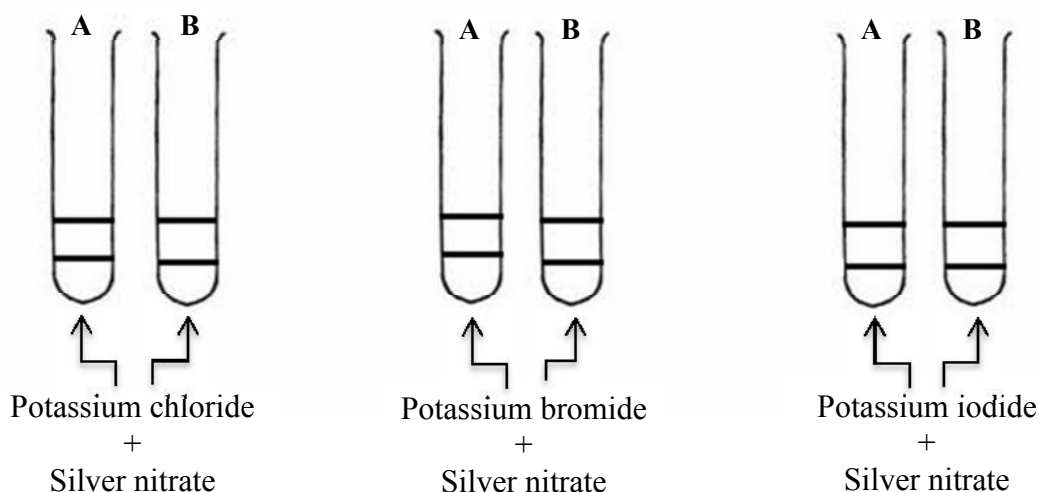
(ii) State whether the resulting solution of the reaction in part (b) has a pH equal to, higher or lower than 7.

(1 mark)

[Total: 6 marks]

5. Three sets of test tubes were set as shown in the diagram below. A few drops of silver nitrate solution were added to each of the test tubes.

The test tubes marked **A** were placed in a darkened cupboard while the test tubes marked **B** were exposed to sunlight.



6



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- (a) A precipitate is formed in each of the test tubes. State the colour of the precipitate in each of the tubes marked **A**.

Potassium chloride + silver nitrate: \_\_\_\_\_

Potassium bromide + silver nitrate: \_\_\_\_\_

Potassium iodide + silver nitrate: \_\_\_\_\_

(3 marks)

- (b) What is observed when the precipitates in the test tubes marked **B** are exposed to sunlight?

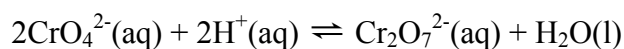
(1 mark)

[Total: 4 marks]

6. (a) A boiling tube contains 1 cm<sup>3</sup> of potassium chromate solution. What is the colour of the solution?

(1 mark)

- (b) A volume of 2 cm<sup>3</sup> of dilute sulfuric acid is added to the solution in the boiling tube in part (a). The following reaction takes place:



What change would be noticed in the boiling tube?

(2 marks)

- (c) What change would one notice if a volume of 4 cm<sup>3</sup> of sodium hydroxide solution is now added to the boiling tube in part (b)?

(2 marks)

- (d) This reaction is in a state of equilibrium. What factor is causing the changes taking place in parts (b) and (c)?

(1 mark)

[Total: 6 marks]

4

6

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7. (a) (i) Complete the following reactions by giving the formula and the name of the product formed.

Reactants	Formula of product	Name of product
Ethene + hydrogen →		
Ethene + hydrogen chloride →		

**(4 marks)**

- (ii) Give the molecular formula and the structural formula of the product of the reaction between propene (C<sub>3</sub>H<sub>6</sub>) and chlorine.

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**(3 marks)**

- (b) How can bromine water be used to distinguish ethene from the product of the reaction between ethene and hydrogen?

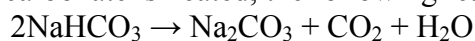
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**(1 mark)****[Total: 8 marks]**

8. When sodium hydrogencarbonate is heated, the following reaction takes place:



- (a) How many moles of carbon dioxide are produced if after reaction 280 cm<sup>3</sup> of the gas are collected at standard temperature and pressure (STP)?

---



---

**(1 mark)**

- (b) How many moles of sodium carbonate are formed during this experiment?

---



---

**(1 mark)**

- (c) How many moles of sodium hydrogencarbonate would be required to produce 280 cm<sup>3</sup> of carbon dioxide measured at STP?

---



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**(1 mark)**

8
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- (d) If the original amount of solid used at the start of this experiment was 3 g, what mass of sodium hydrogencarbonate remains unreacted after reaction?

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(3 marks)  
[Total: 6 marks]

9. (a) The following table shows the formulae of three polymers. Give the **name** of each of the three polymers.

6

Polymer	Formula of polymer	Name of polymer
A	$  \begin{array}{cccccc}  \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} \\    &   &   &   &   &   \\  \text{---C} & \text{---C} & \text{---C} & \text{---C} & \text{---C} & \text{---C} \text{---} \\    &   &   &   &   &   \\  \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H}  \end{array}  $	
B	$  \begin{array}{cccccc}  \text{Cl} & \text{H} & \text{Cl} & \text{H} & \text{Cl} & \text{H} \\    &   &   &   &   &   \\  \text{---C} & \text{---C} & \text{---C} & \text{---C} & \text{---C} & \text{---C} \text{---} \\    &   &   &   &   &   \\  \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H}  \end{array}  $	
C	$  \begin{array}{cccccc}  \text{F} & \text{F} & \text{F} & \text{F} & \text{F} & \text{F} \\    &   &   &   &   &   \\  \text{---C} & \text{---C} & \text{---C} & \text{---C} & \text{---C} & \text{---C} \text{---} \\    &   &   &   &   &   \\  \text{F} & \text{F} & \text{F} & \text{F} & \text{F} & \text{F}  \end{array}  $	

(3 marks)

*Question 9 continues on the next page.*

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- (b) (i) Write down the structural or molecular formula of the monomer from which polymer A is formed.

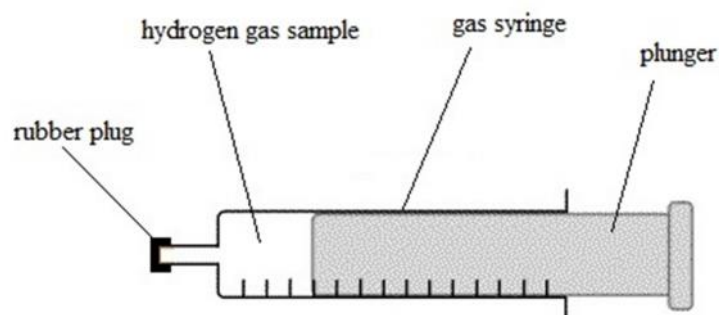
(1 mark)

- (ii) Give **two** uses of polymer A.

(2 marks)

[Total: 6 marks]

10. (a) A volume of  $20 \text{ cm}^3$  of hydrogen gas was collected at room temperature ( $20^\circ\text{C}$ ) in a gas syringe, which was plugged to trap the gas inside.



- (i) State what happens to the pressure of the gas when the plunger is pushed in.

(1 mark)

- (ii) Explain, in terms of molecules, what would happen if the syringe is immersed in water at  $60^\circ\text{C}$ .

(2 marks)

- (b) A volume of  $500 \text{ cm}^3$  of a gas at  $0^\circ\text{C}$  and a pressure of  $760 \text{ mmHg}$  is heated to  $300 \text{ K}$ , keeping the pressure constant. Calculate the new volume.

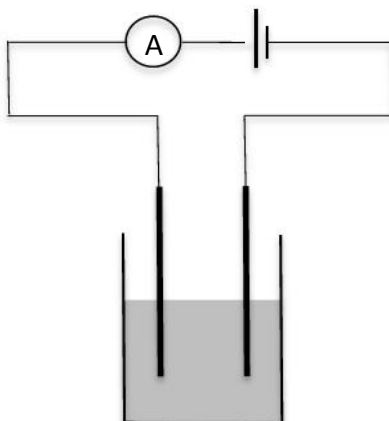
(4 marks)

[Total: 7 marks]

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

11. (a) (i) Draw a labelled diagram of a simple voltaic cell. Label clearly what the electrodes and the solution are made of. **(3 marks)**
- (ii) Indicate which electrode is the cathode of the cell. **(1 mark)**
- (iii) Indicate which electrode is the anode of the cell. **(1 mark)**
- (iv) State at which electrode oxidation takes place. **(1 mark)**
- (v) State at which electrode reduction takes place. **(1 mark)**
- (vi) Write the equation for the reaction that takes place at the cathode. **(2 marks)**
- (vii) Write the equation for the reaction that takes place at the anode. **(2 marks)**
- (viii) State what energy change takes place in the cell. **(1 mark)**
- (b) A cell was set up using inert electrodes and copper(II) sulfate solution, as shown in the diagram below. A current of 3.22 amperes was passed through the circuit for 5 minutes.



- (i) Calculate the quantity of charge that passes through the circuit during this experiment. **(2 marks)**
- (ii) How many moles of electrons pass through the circuit during this time? **(2 marks)**
- (iii) Write the equation for the change that takes place at the anode. **(2 marks)**
- (iv) Calculate the number of moles of product formed at the cathode. **(2 marks)**

**[Total: 20 marks]**

**DO NOT WRITE ABOVE THIS LINE**

12. (a) Hydrochloric acid reacts with both magnesium metal and sodium sulfite.
- Give the ionic equation, including state symbols, for the reaction that takes place when hydrochloric acid reacts with **each** of the above. (2, 2 marks)
  - A gas is given off during the reactions that take place when hydrochloric acid reacts with magnesium metal and sodium sulfite. Give a test that one would carry out in the lab to identify the gas given off in **each** of these reactions. (2, 2 marks)
- (b) (i) Write the balanced chemical equation, including state symbols, for the reaction that takes place between hydrochloric acid and calcium carbonate. (3 marks)
- Give **two** uses of the gas given off during this reaction. (2 marks)
  - Give a chemical test that shows the presence of the gas given off during the reaction in part (b)(i), indicating clearly what is observed. (2 marks)
  - Write the balanced chemical reaction, including state symbols, for the reaction that takes place in part (b)(iii). (3 marks)
- (c) Hydrochloric acid is a **strong acid** while ethanoic acid is a **weak acid**. Distinguish between the underlined terms. (2 marks)
- [Total: 20 marks]**

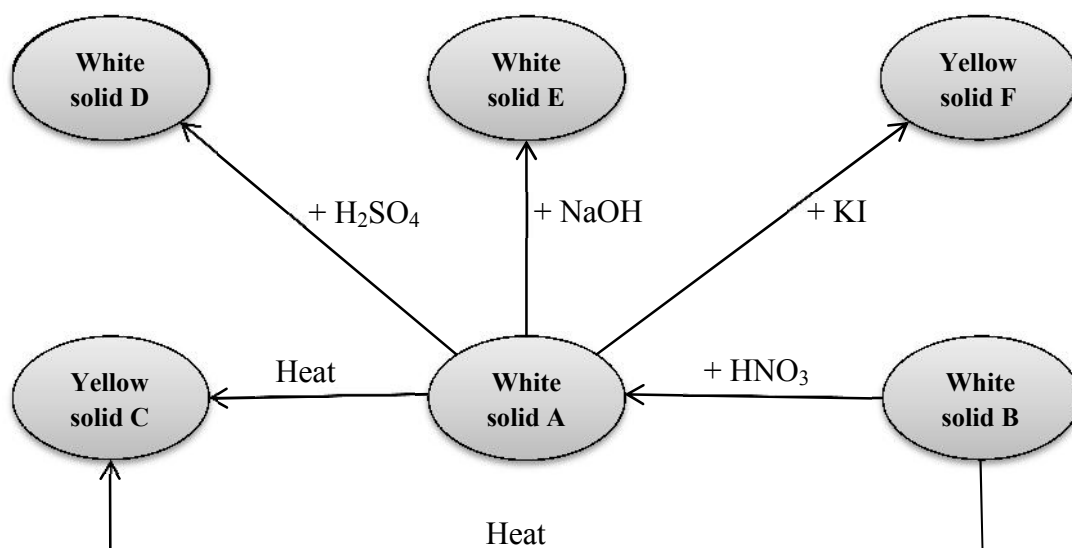
13. When zinc powder is added to a solution containing iron(III) ions the following reaction takes place:



- What is the oxidation state of the iron at the start of the reaction? (1 mark)
    - What is the oxidation state of the iron at the end of the reaction? (1 mark)
    - What type of reaction has taken place? (1 mark)
    - Indicate the colour of the solution after the reaction. (1 mark)
  - Two oxides of copper exist in nature: copper(I) oxide and copper(II) oxide.
    - Give the colour of these two compounds. (2 marks)
    - What colour change would take place when copper(II) oxide is added to sulfuric acid? (2 marks)
  - Iron and copper are transition metals. Give **two** characteristics of transition metals that can be deduced from the changes in parts (a) and (b). (2 marks)
  - Transition metals also have the ability to catalyse reactions. Give an equation for a catalysed reaction, and indicate the transition metal that catalyses it. (3 marks)
  - Give the equation for the reaction between copper(II) sulfate and sodium hydroxide. (2 marks)
    - In the reaction in part (e)(i), 5 cm<sup>3</sup> of 2 mol dm<sup>-3</sup> sodium hydroxide solution reacted completely. Calculate the number moles of sodium hydroxide that reacted. (2 marks)
    - Indicate what changes are noted when the reaction in part (e)(i) takes place. (3 marks)
- [Total: 20 marks]**

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14. Consider the reaction scheme in the diagram shown below. Compounds **A**, **B**, **C**, **D**, **E** and **F** are all lead(II) compounds.



A white solid **B** reacts with dilute nitric acid to give a colourless solution and carbon dioxide gas. When this solution is evaporated a white solid residue **A** is formed.

When solid **A** is heated, a yellow solid **C** is formed and a brown gas **Y** and a gas that relights a glowing splint **Z** are formed. A solution of **A** reacts with sodium hydroxide to give a white solid **E**, which is soluble in excess sodium hydroxide. Furthermore, a solution of **A** would give a yellow precipitate **F** with potassium iodide solution and a white precipitate **D** with sulfuric acid.

- (a) Identify the substances **A**, **B**, **C**, **D**, **E** and **F**. (6 marks)
- (b) Give the chemical names of the gases **Y** and **Z**. (2 marks)
- (c) Give the ionic equations, including the state symbols, for the reaction that a solution of **A** would undergo when it reacts with:
- sulfuric acid;
  - sodium hydroxide; and
  - potassium iodide. (9 marks)
- (d) Give the equation for the action of heat on the white solid **B**. (2 marks)
- (e) Give **one** other change that one would notice when heating solid **A**. (1 mark)

[Total: 20 marks]











