

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

SECONDARY EDUCATION CERTIFICATE LEVEL

SEPTEMBER 2014 SESSION

SUBJECT:	Chemistry
PAPER NUMBER:	I
DATE:	1 st September 2014
TIME:	9:00 a.m. to 11:00 a.m.

Useful data

Relative atomic mass: O = 16

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

The molar volume for gases at STP = 22.4 dm³

Directions to Candidates

- *Write your index number in the space at the top left-hand corner of this page.*
- *Answer ALL questions. Write 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	6	6	6	6	6	7	6	5	6	20	20	100

DO NOT WRITE ABOVE THIS LINE

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

1. Write **TRUE** or **FALSE** next to each of these statements:

(a)	A pure substance always has a transparent colour.	
(b)	Sea water is a mixture of various substances.	
(c)	Milk in liquid form is a suspension.	
(d)	Water is acting as a solute when sugar dissolves in water.	
(e)	A stain on clothes requires a solvent to remove it.	
(f)	When oil is added to water a solution is produced.	

[Total: 6 marks]

6

2. A student needs to check if a mixture contains some water. A friend suggests using anhydrous copper(II) sulfate.

(a) Complete the following word equation:

anhydrous copper(II) sulfate + water → _____ (2 marks)

(b) Rewrite your answer to part (a) using symbols so as to give a balanced equation.

(2 marks)

(c) State **two** observations that can be made during the reaction in part (a).

Observation 1: _____

Observation 2: _____

(2 marks)

[Total: 6 marks]

6

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3. Ammonium chloride is a salt of ammonia.

- (a) Give a balanced equation to show the equilibrium that is set up when ammonium chloride is heated in a boiling tube.

(2 marks)

- (b) Draw a labelled diagram to show what occurs when some ammonium chloride is heated in a boiling tube.

(3 marks)

- (c) What name is given to the process that occurs in the experiment in part (b)?

(1 mark)

[Total: 6 marks]

4. Complete the following paragraph by using terms from the list given below. *Each term can be used once, more than once or not at all.*

**shining white darker grey neutralisation silver
lighter red copper redox photocatalysis**

Some interesting reactions are helped by the presence of light. The process is known as _____ . Not all substances are affected in the same way. Silver chloride is a _____ solid. It turns _____ in sunlight and changes to a _____ colour. This happens because a _____ reaction occurs and the colour observed is due to a deposit of solid _____ .

[Total: 6 marks]

DO NOT WRITE ABOVE THIS LINE

5. (a) State **two** observations that can be made when a small piece of magnesium ribbon is heated in a gas jar of oxygen.

Observation 1: _____

Observation 2: _____

(2 marks)

- (b) (i) Calcium is in the same group of the Periodic Table as magnesium. Which of the two metals, calcium or magnesium, reacts **more vigorously** with a dilute acid?

(1 mark)

(ii) What does 'more vigorously' mean?

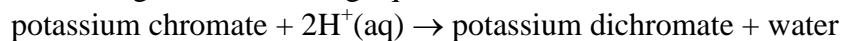
(1 mark)

- (c) Give a balanced equation to show the reaction of calcium with dilute hydrochloric acid.

(2 marks)

[Total: 6 marks]

6. Yellow potassium chromate, K_2CrO_4 , changes to orange potassium dichromate, $K_2Cr_2O_7$, in solution according to the following equation:



- (a) (i) What does $H^+(aq)$ represent?

(1 mark)

(ii) Give the name and formula of a substance which contains H^+ that can be used in the reaction shown.

(2 marks)

- (b) State **one** observation that can be made in each case if:

(i) some water is added to the mixture;

(ii) some water is removed from the mixture.

(2 marks)

- (c) Why is it useful to stir the mixture?

(1 mark)

[Total: 6 marks]

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7. Compound **Z** has the structure $\text{CH}_3\text{CH}=\text{CHCH}_3$.

(a) (i) To what homologous series does compound **Z** belong?

(ii) What are the typical reactions that compounds such as **Z** give?

(2 marks)

(b) Give:

(i) the molecular formula of **Z**: _____

(ii) the empirical formula of **Z**: _____

(2 marks)

(c) Compound **Q** has a structure $\text{CH}_3\text{CH}_2\text{CH}_3$.

(i) Give the name of a reagent that can be used to distinguish between **Q** and **Z**.

(1 mark)

(ii) State **two** observations that will be made in the reaction/s in part (c)(i).

Observation 1: _____

Observation 2: _____

(2 marks)

[Total: 7 marks]

7

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8. (a) A gas syringe contains 20 cm^3 of oxygen, measured at standard temperature and pressure.

(i) Calculate the number of moles of oxygen present in the syringe.

(2 marks)

(ii) Calculate the mass, in grams, of oxygen present in the syringe.

(2 marks)

(b) Use your answer to part (a)(i) to give the number of moles of oxygen **atoms** present in the syringe.

(2 marks)

[Total: 6 marks]

9. (a) Ethene has the structure $\text{CH}_2=\text{CH}_2$. Under the right conditions ethene can form a polymer.

(i) What is a polymer?

(1 mark)

(ii) Draw a polymer of ethene showing **two** repeating units.

(2 marks)

(b) PVC is a synthetic polymer having many uses in everyday life. Mention **two** common uses for PVC.

Use 1: _____

Use 2: _____

(2 marks)

[Total: 5 marks]

6

5

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10. A metal container filled with nitrogen gas is fitted with a piston as shown in the diagram.



(a) The container is heated.

(i) What will happen to the gas particles in the container?

(2 marks)

(ii) What will be observed to occur?

(1 mark)

(iii) Explain your answer to part (a)(ii).

(1 mark)

(b) If a heavy stone is placed on top of the piston what effect will this have on the gas inside the container?

(2 marks)
[Total: 6 marks]

6

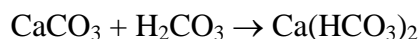
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Section B: Answer BOTH questions. Write your answers on the lined pages provided.

11. Lucy, a chemistry student, examined the inside of an electric kettle and observed that its heating element was covered with a limescale deposit, as shown in the picture. She read an online science article stating that limescale is a form of calcium carbonate that is deposited from hard water. In Malta, water is quite hard as rainwater has to flow over limestone deposits as it trickles down into the water table.



Lucy read that the following reaction takes place when rainwater falls over limestone, which causes the water to become hard:



- (a) (i) What is the name of the acid shown in the equation above?

(1 mark)

- (ii) Write a balanced chemical equation showing how the acid is formed in rainwater.

(2 marks)

- (iii) Is the acid shown in the equation a weak or a strong acid?

(1 mark)

- (iv) Explain which of the two calcium compounds shown in the equation is responsible for causing hardness in water.

(2 marks)

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(b) In the electric kettle, hard water is exposed to a high temperature and the following reaction occurs: $\text{Ca}(\text{HCO}_3)_2 \rightarrow \text{CaCO}_3 + \text{H}_2\text{O} + \text{CO}_2$

(i) Copy the equation and include the correct state symbol for each substance.

(4 marks)

(ii) Use the equation to explain how limescale is being formed in the kettle.

(3 marks)

(iii) The water in the kettle boils at around 101.3 °C. Explain why it does not boil exactly at 100 °C.

(2 marks)

(c) Lucy decides to clean the limescale-covered heating element of the kettle using dilute hydrochloric acid solution.

(i) Describe **two** observations she would note after pouring the acid in the kettle.

Observation 1: _____

Observation 2: _____

(2 marks)

(ii) Write a balanced chemical equation showing the reaction of dilute hydrochloric acid with limescale.

(2 marks)

(iii) Why is it not such a good idea to clean a kettle with dilute hydrochloric acid?

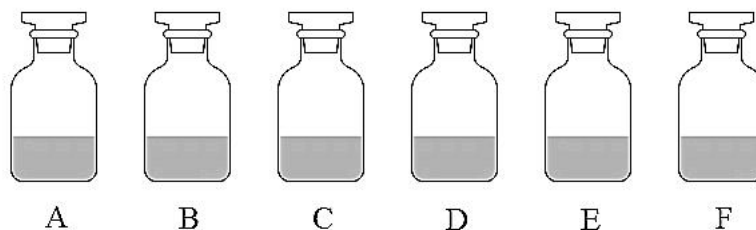
(1 mark)

[Total: 20 marks]

20

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12. John, a laboratory technician, has found six reagent bottles containing substances in solution. The bottles are labelled **A** to **F** as shown in the diagram. John knows that these bottles contain the following substances: lead(II) nitrate, sodium sulfate, potassium bromide, calcium chloride, ammonium carbonate, sodium hydroxide. However, he does not know which is which.



John carried out a chemical test on each of the six solutions. His results are shown in the table below.

Substance	Chemical Test
A	When a drop of solution A was placed with a nichrome loop in the Bunsen flame, a lilac colour was briefly seen.
B	A white precipitate was formed when sodium hydroxide solution was added dropwise to solution B . When excess sodium hydroxide solution was added, the precipitate did not dissolve.
C	When a solution of copper(II) chloride was added to a solution of C , a gelatinous blue precipitate was formed.
D	When a few drops of acidified barium chloride solution were added to solution D , a persistent white precipitate was formed.
E	When a colourless solution of potassium iodide was added to solution E , a bright yellow precipitate was formed.
F	When sodium hydroxide solution was added to solution F and the mixture was then heated, a gas that turned moist red litmus paper blue was produced.

- (a) (i) Use the list of chemicals and the results of the chemical tests to identify substances **A**, **B**, **C**, **D**, **E** and **F**.

Substance **A**: _____

Substance **B**: _____

Substance **C**: _____

Substance **D**: _____

Substance **E**: _____

Substance **F**: _____

(12 marks)

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-
- (ii) Write a balanced chemical equation that includes state symbols to show the reaction of substance **E** with potassium iodide solution.

(3 marks)

- (b) John wants to identify conclusively the identity of substance **B**. By means of the chemical test shown in the table, he determined the cation of **B** and thus deduced its identity.

- (i) Describe another chemical test that John can perform on solution **B** in order to confirm the identity of its anion.
-
-
-

(3 marks)

- (ii) The same test mentioned in part (b)(i) can be used to confirm the anion of substance **A**. Describe what would be observed in this case.
-
-
-

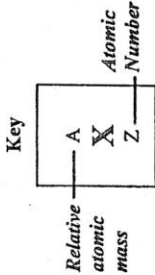
(2 marks)

[Total: 20 marks]

20

PERIODIC TABLE

I	II	III	IV	V	VI	VII	VIII
1 H 1	7 Li 3	11 Na 11	12 C 6	14 N 7	16 O 8	19 F 9	20 Ne 10
23 Na 11	24 Mg 12	27 Al 13	28 Si 14	31 P 15	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
85 Rb 37	88 Sr 38	89 Y 39	91 Zr 40	93 Nb 41	96 Mo 42	99 Tc 43	101 Ru 44
133 Cs 55	137 Ba 56	139 La 57	178.5 Hf 72	181 Ta 73	184 W 74	186 Re 75	190 Os 76
223 Fr 87	226 Ra 88	227 Ac 89	201 Hg 80	195 Pt 78	197 Au 79	204 Tl 81	209 Pb 82
			112 Cd 48	106 Pd 46	108 Ag 47	119 Sn 50	127 I 53
			65 Zn 30	59 Ni 28	63.5 Cu 29	75 As 33	84 Kr 36
			115 In 49	103 Rh 45	106 Pd 46	122 Sb 51	131 Xe 54
			204 Tl 81	192 Ir 77	195 Pt 78	209 Bi 83	222 Rn 86
				157 Gd 64	159 Tb 65	162 Dy 66	165 Ho 67
				150 Sm 62	152 Eu 63	159 Tb 65	162 Dy 66
				147 Pm 61	150 Sm 62	157 Gd 64	162 Dy 66
				144 Nd 60	147 Pm 61	152 Eu 63	157 Gd 64
				141 Pr 59	144 Nd 60	150 Sm 62	157 Gd 64
				139 La 57	141 Pr 59	147 Pm 61	150 Sm 62
				91 Pa 91	93 Np 93	94 Pu 94	95 Am 95
				238 U 92	237 Np 93	244 Pu 94	243 Am 95
				232 Th 90	238 U 92	244 Pu 94	243 Am 95
				175 Lu 71	169 Tm 69	162 Dy 66	165 Ho 67
				260 Lr 103	258 Md 101	251 Cf 98	252 Es 99
				259 No 102	258 Md 101	251 Cf 98	252 Es 99
				173 Yb 70	169 Tm 69	162 Dy 66	165 Ho 67
				260 Lr 103	259 No 102	251 Cf 98	252 Es 99



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UNIVERSITY OF MALTA, MSIDA

SECONDARY EDUCATION CERTIFICATE LEVEL

SEPTEMBER 2014 SESSION

SUBJECT:	Chemistry
PAPER NUMBER:	IIB
DATE:	1 st September 2014
TIME:	4:00 p.m. to 6:00 p.m.

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	6	6	6	20	20	20	20	100

DO NOT WRITE ABOVE THIS LINE**Section A: Answer all questions in this section: Write your answers in the spaces provided.**

1. (a) (i) Give the electronic configuration of sulfur (atomic number = 16) and oxygen (atomic number = 8).

Electronic configuration of oxygen: _____

Electronic configuration of sulfur: _____ (2 marks)

- (ii) Elements react by losing or gaining electrons or by sharing them with other elements. What is oxygen expected to do when it reacts with hydrogen?

(1 mark)

- (iii) Write the symbol for an atom of sulfur that reacted by gaining two electrons.

(1 mark)

- (b) How does the electronic configuration of elements change:

- (i) across a period of the Periodic Table?

(1 mark)

- (ii) down a group of the Periodic Table?

(1 mark)

[Total: 6 marks]

2. (a) Write the equation for the reaction between ammonia and sulfuric acid.

(2 marks)

- (b) Sulfuric acid and ammonia are two chemicals which are widely used in industry. Fill the following table by giving one large-scale use of sulfuric acid, ammonia and the chemical formed in part (a). Give a different use for every chemical.

Chemical	Use
Sulfuric acid	
Ammonia	
Compound formed by the reaction of sulfuric acid and ammonia	

(3 marks)

- (c) Police in England interrogated a man who was storing an abnormal amount of ammonium compounds in his backyard. What did they suspect?

(1 mark)

[Total: 6 marks]

6

6

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3. (a) Write an equation for the reaction of hydrochloric acid on iron(II) sulfide.

(2 marks)

(b) List **two** observations for the reaction in part (a).

Observation 1: _____

Observation 2: _____

(2 marks)

(c) On the 7th of June 2014 Skynews reported that “A 10-year old boy has died and his father is fighting for his life after they were overcome by slurry fumes”. Give the name of a strongly smelling gas that may have been a constituent of the “slurry fumes” (sewage fumes).

(1 mark)

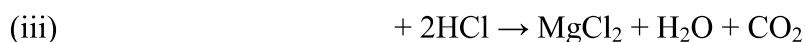
(d) What precaution should be taken when carrying out an experiment in the laboratory and such gases are present as products?

(1 mark)

[Total: 6 marks]

6

4. (a) Complete the following equations:



(4 marks)

(b) List **two** large-scale uses of chlorine.

Use 1: _____

Use 2: _____

(2 marks)

[Total: 6 marks]

6

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5. (a) Explain why drying is considered to be a physical change whereas dehydration is considered to be a chemical change.

(i) Drying: _____

(ii) Dehydration: _____

(2 marks)

- (b) Give the equation of a reaction where dehydration takes place.

(2 marks)

- (c) Complete the following sentences:

Cobalt(II) chloride of formula $\text{CoCl}_2 \cdot 6\text{H}_2\text{O}$ has water of crystallisation; it is called a _____ salt.

Cobalt(II) chloride that has no water of crystallisation is called an _____ salt.

(2 marks)

[Total: 6 marks]

6

6. Identify the gas, by giving its name or formula, from the following tests:

Test for gas	Gas
Decolourises potassium permanganate solution	
Forms a white precipitate when bubbled through lime water	
Turns moist red litmus blue	
Relights a glowing splint	
Gives white fumes with a glass rod dipped in ammonia solution is brought in contact with the gas	
Bleaches moist litmus paper	
Burns with a pop	

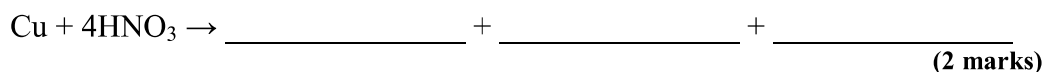
[Total: 6 marks]

6

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7. (a) Besides behaving as an acid, nitric acid may also behave as an oxidising agent.
 (i) Write an equation for a reaction where nitric acid behaves as an acid.

- (ii) In its reaction with copper, nitric acid behaves as an oxidising agent. Complete the following equation: (2 marks)



- (b) Give the oxidation state of copper before and after the reaction.

Oxidation state of copper before the reaction: _____

Oxidation state of copper after the reaction: _____

(2 marks)
 [Total: 6 marks]

8. 1g of solid sodium hydroxide neutralises completely 12.5 cm³ of 2 mol dm⁻³ of sulfuric acid.

- (a) Calculate the number of moles of sodium hydroxide that reacted with sulfuric acid.

- (b) Calculate the number of moles present in 12.5 cm³ of 2 mol dm⁻³ of sulfuric acid. (2 marks)

- (c) Considering the ratio of the number of moles of sodium hydroxide and sulfuric acid reacting together, write the equation for the reaction that takes place. (2 marks)

(2 marks)
 [Total: 6 marks]

6

6

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9. (a) Give the equation for the combustion of hydrogen in air.

(2 marks)

(b) “Hydrogen (H₂) is being explored as a fuel for passenger vehicles. It can be used in fuel cells to power electric motors or burned in internal combustion engines (ICEs). It is an environmentally friendly fuel that has the potential to dramatically reduce our dependence on imported oil, but several significant challenges must be overcome before it can be widely used.”

<http://www.fueleconomy.gov/feg/hydrogen.shtml>

(i) Give **two** reasons why hydrogen may be considered to be “an environmentally friendly fuel”.

Reason 1: _____

Reason 2: _____

(2 marks)

(ii) List **two** significant challenges that must be overcome before hydrogen can be widely used.

Challenge 1: _____

Challenge 2: _____

(2 marks)**[Total: 6 marks]**

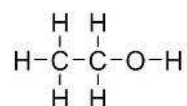
10. (a) What are isomers?

6

(b) Pentane (C₅H₁₂) has **two** isomers. Draw the structural formulae of the **two** isomers.

(2 marks)

(c) Ethanol has the following structural formula:



Draw the structural formula of an isomer of ethanol.

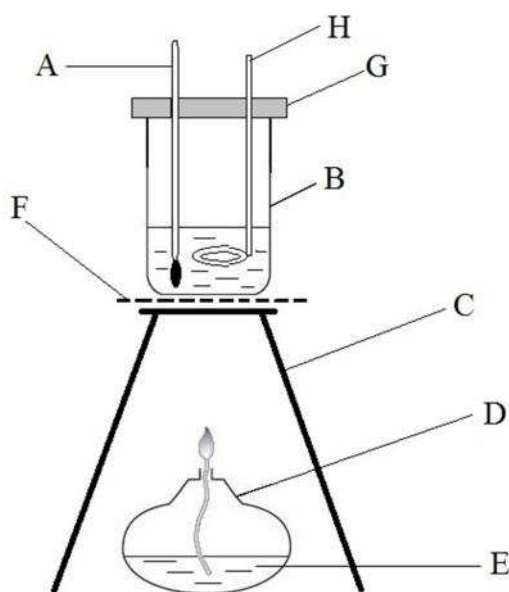
(2 marks)
[Total: 6 marks]

6

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

11.



Diane wants to investigate which of the three available fuels releases most energy when burnt. She sets up the apparatus as shown in the diagram.

The three fuels available are: methanol, ethanol and propanol.

Diane places the equivalent of 1.0 g of methanol in apparatus **D** and uses it to heat 150 cm³ of water in apparatus **B**. She measures the change in temperature of the water when all the methanol has been burnt.

She then repeats the experiment with the two other fuels, ethanol and propanol.

- (a) (i) Write down the eight names for the apparatus or materials labelled **A** to **H** in the diagram. **(8 marks)**
- (ii) The position of apparatus **D** is one of the causes of errors. Explain why and what Diane needs to do to reduce this source of error. **(2 marks)**
- (iii) Explain why apparatus **F** is also the cause of errors. **(1 mark)**
- (iv) Explain how the pieces of equipment **G** and **H** are helping to reduce experimental errors. **(4 marks)**
- (b) (i) Name the homologous series to which all the three fuels belong to. **(1 mark)**
- (ii) Draw the structures of methanol and propanol. **(2 marks)**
- (c) Diane performs all three runs of the experiment and writes down the results she obtained in the table below.

Fuel (1.0 g of each is burnt)	Temperature rise of water (°C)
methanol	36
ethanol	47
propanol	53

Write a conclusion from this investigation.

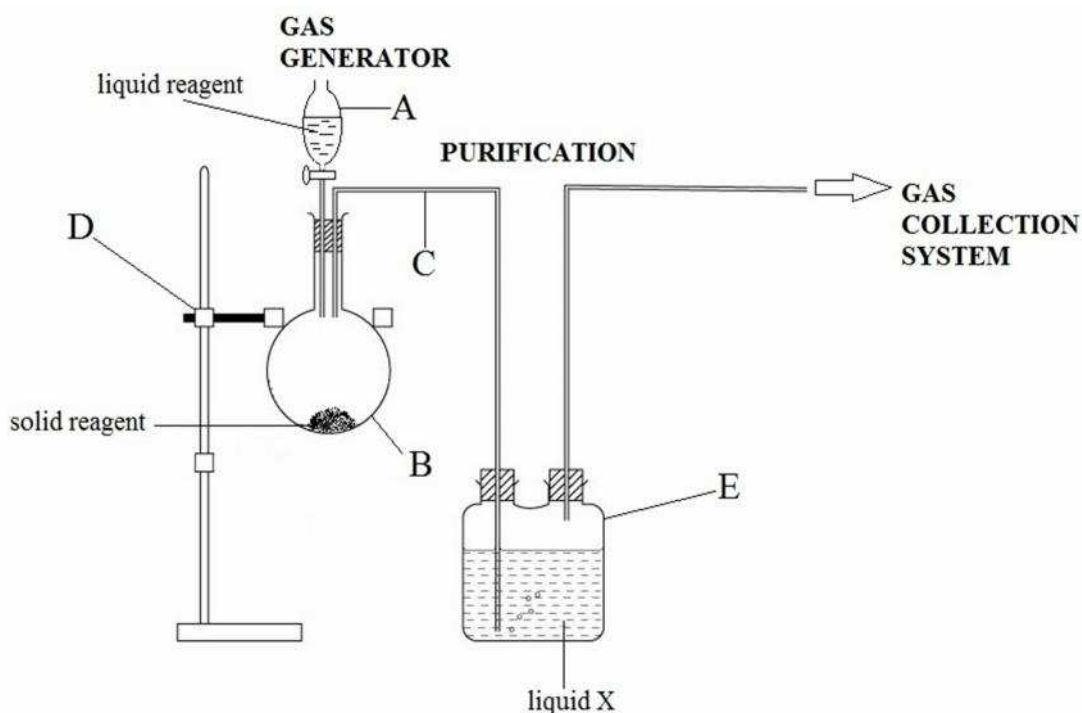
(2 marks)

[Total: 20 marks]

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12. Mario wants to prepare dry samples of four gases in the laboratory. The four gases are: hydrogen, oxygen, carbon dioxide and sulfur dioxide.

He uses the setup shown below for the preparation of the four gases.



- (a) (i) Write the correct names for the apparatus labelled **A**, **B**, **C**, **D** and **E**. **(5 marks)**
 (ii) Write the chemical name for a suitable liquid **X**. **(1 mark)**
- (b) Copy the table below and complete the missing information.

Gas	Liquid reagent	Solid reagent	Heating required	Collecting system
hydrogen	dilute sulfuric acid			
chlorine		manganese(IV) oxide		
carbon dioxide			no	
sulfur dioxide				downward delivery

(12 marks)

- (c) Write a balanced chemical equation that shows how the reagents mentioned in the table above will react to produce sulfur dioxide gas. **(2 marks)**

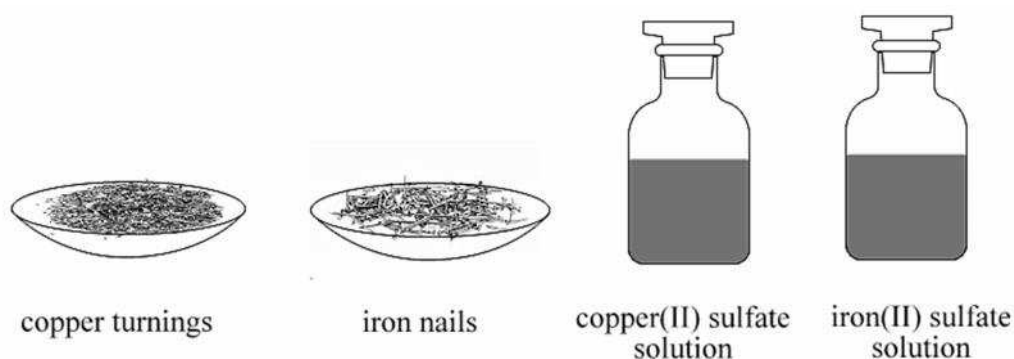
[Total: 20 marks]

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13. This question is about iron and copper. Both metals belong to the same collection of elements in the Periodic Table.

- (a) (i) What is the name of this collection of metals in the Periodic Table to which iron and copper belong? **(1 mark)**
- (ii) List **two** common properties of iron and copper that show that they belong to this collection. **(2 marks)**
- (iii) List **two** differences in the properties of iron and copper. **(2 marks)**

- (b) Paul wants to carry out a simple investigation to confirm which of the two metals is more reactive.
The following materials are available:

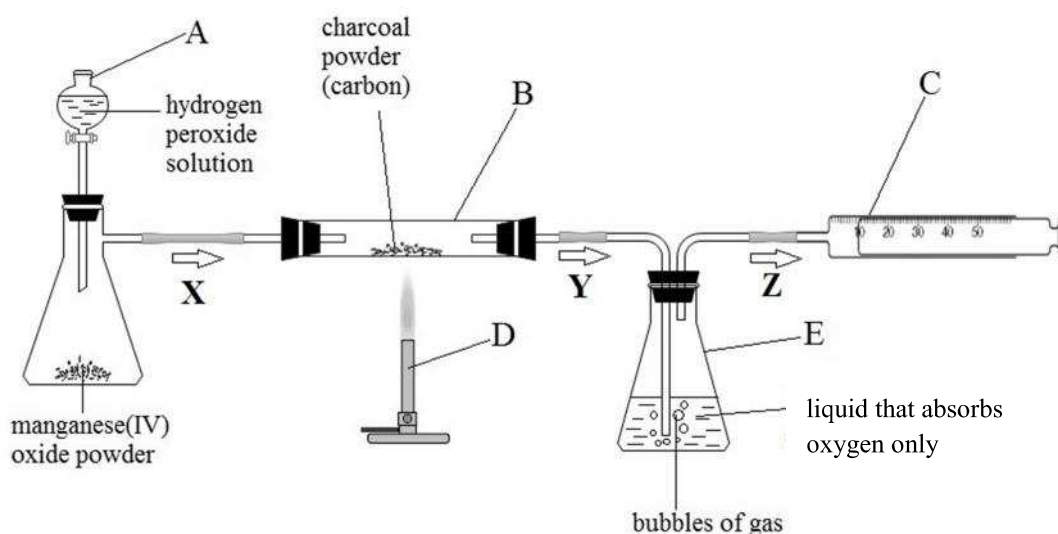


- (i) Describe the method that Paul can use in order to carry out this investigation. **(2 marks)**
- (ii) Write down all the observations that Paul is expected to note. **(3 marks)**
- (iii) Explain the observations mentioned in part (b)(ii) by referring to the chemical properties of iron and copper. **(4 marks)**
- (iv) Write a balanced chemical equation (that includes state symbols) related to one of the changes that is expected to be observed. **(3 marks)**
- (v) Name the type of reaction that is taking place. **(1 mark)**
- (c) During another experiment, a small amount of sodium hydroxide solution was added to the solutions used in the investigation above. Two precipitates were formed.
Name **each** of the **two** precipitates and describe their colour. **(2 marks)**

[Total: 20 marks]

DO NOT WRITE ABOVE THIS LINE

14. The diagram below shows an experiment that was carried out in a school laboratory. This experiment involved the production, handling and collection of gases.



- (a) Write the correct names for the apparatus labelled **A**, **B**, **C**, **D** and **E**. **(5 marks)**
- (b) Hydrogen peroxide solution is allowed to drop from apparatus **A** onto the manganese(IV) oxide powder below.
- Write a balanced chemical equation for the reaction taking place. **(2 marks)**
 - Identify the gas that is flowing along point **X**. **(1 mark)**
 - What is the role of the manganese(IV) oxide in this reaction? **(1 mark)**
- (c) The charcoal powder is reacting with the gas coming from direction **X**.
- Write a balanced chemical equation for this reaction. **(2 marks)**
 - Identify the **two** gases that are flowing through point **Y** and explain where these gases are coming from. **(4 marks)**
 - Identify the gas that is flowing through point **Z** and being collected in the gas syringe. **(1 mark)**
 - List **two** other possible methods for collecting the gas flowing through point **Z** instead of the gas syringe. **(2 marks)**
- (d) Two chemistry students were discussing possible changes to this experiment.
- Name another solid substance that could be used instead of charcoal, which would produce a different gas if used in this experimental setup. **(1 mark)**
 - Name the gas collected in the syringe if this new solid is used. **(1 mark)**

[Total: 20 marks]

PERIODIC TABLE

I	II	III	IV	V	VI	VII	VIII
1 H 1	7 Li 3	11 B 5	12 C 6	14 N 7	16 O 8	19 F 9	20 Ne 10
23 Na 11	9 Be 4	27 Al 13	28 Si 14	31 P 15	32 S 16	35.5 Cl 17	40 Ar 18
39 K 19	40 Ca 20	70 Ga 31	73 Ge 32	75 As 33	79 Se 34	80 Br 35	84 Kr 36
85 Rb 37	88 Sr 38	115 In 49	119 Sn 50	122 Sb 51	128 Te 52	127 I 53	131 Xe 54
133 Cs 55	137 Ba 56	204 Tl 81	207 Pb 82	209 Bi 83	209 Po 84	210 At 85	222 Rn 86
223 Fr 87	226 Ra 88						
45 Sc 21	48 Ti 22	56 Fe 26	59 Co 27	59 Ni 28	63.5 Cu 29	65 Zn 30	
89 Y 39	91 Zr 40	101 Ru 44	103 Rh 45	106 Pd 46	108 Ag 47	112 Cd 48	
139 La 57	178.5 Hf 72	186 Re 75	192 Ir 77	195 Pt 78	197 Au 79	201 Hg 80	
227 Ac 89							
140 Ce 58	141 Pr 59	150 Sm 62	152 Eu 63	157 Tb 65	162 Dy 66	165 Ho 67	173 Yb 70
232 Th 90	231 Pa 91	244 Pu 94	243 Am 95	247 Bk 97	251 Cf 98	252 Es 99	259 No 102
	144 Nd 60	150 Sm 62	152 Eu 63	157 Tb 65	162 Dy 66	165 Ho 67	175 Lu 71
	238 U 92	244 Pu 94	243 Am 95	247 Bk 97	251 Cf 98	252 Es 99	260 Lr 103

