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

SECONDARY EDUCATION CERTIFICATE LEVEL

MAY 2016 SESSION

SUBJECT:	**Chemistry**
PAPER NUMBER:	I
DATE:	26th April 2016
TIME:	4:00 p.m. to 6:05 p.m.

Useful data:

Relative atomic masses: H = 1; O = 16; S = 32; Ba = 137; He=4

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

The molar volume for gases at STP: 22.4 dm³

_____

Directions to Candidates

- *Write your index number in the space at the top left-hand corner of this page.*

- ***Answer ALL questions.*** *Write all your answers in the spaces provided in this booklet.*

- *The mark allocation is indicated at the end of each question. Marks allocated to parts of questions are also indicated in brackets.*

- *You are reminded of the necessity for orderly presentation in your answers.*

- *In calculations you are advised to show all the steps in your working, giving your answer at each stage.*

- *The use of electronic calculators is permitted.*

- *A **Periodic Table** is printed on the back of this booklet.*

For examiners' use only:

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

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

1. Give the name of the process that occurs when each of the following changes take place.

(a)	The cooling of ethanol vapour during distillation.	
(b)	The cooling of a glass of water to a temperature below 273 K at atmospheric pressure.	
(c)	The strong heating of iodine crystals.	
(d)	Raising the temperature of a block of ice to 10 ^{o}C at atmospheric pressure.	
(e)	The loss in the amount of perfume when a bottle of the substance has been left open.	

Total: 5 marks

5

2. Complete the following paragraph about the atom and its structure.

An atom consists of a nucleus surrounded by electrons. Electrons are _____

charged and are found around the nucleus in _____. The electronic

configuration of a magnesium atom can be represented as _____. The mass in

the atom is due to the total mass of _____ and _____. Atoms

with the same number of _____ but a different number of

_____ are called isotopes.

Total: 7 marks

7

3. A group of students are carrying out reactions in which gases are produced. They tabulate the results obtained. In the 'Conclusion' column give the **name** (not symbols) of the gas produced in each reaction.

Experiment	Observations on the Gas Produced	Conclusion
a.	Pungent gas, turns acidified potassium dichromate from orange to green	
b.	Gas forms misty white fumes in air	
c.	Pungent gas, greenish yellow gas, turns blue litmus red then bleaches it	
d.	Gas burns with a smoky yellow flame	

Total: 4 marks

4

4. Acids are very important compounds in chemistry and take part in several reactions.
   (a) Nitric acid reacts with copper(II) carbonate, $CuCO_3$.

   (i) Give a balanced chemical equation for this reaction.

   _____ *(2)*

   (ii) Give **two** changes that occur during this reaction.

   _____

   _____ *(2)*

   (b) Some hydrogen chloride is bubbled carefully into a beaker which contains water and some strips of blue litmus paper. A colour change is observed in the litmus paper. However, if hydrogen chloride is bubbled into a beaker which contains methylbenzene and a strip of blue litmus paper, the colour of the litmus paper does not change. Explain these observations.

   _____

   _____

   _____ *(3)*

   Total: 7 marks

7

5. Oxides of elements show different properties.
    (a) Classify each of the oxides in the Table as **acidic**, **basic**, **amphoteric** or **neutral**.

Oxide	Type
Sodium oxide, Na_2O	
Sulfur dioxide, SO_2	
Aluminium oxide, Al_2O_3	
Carbon oxide, CO	

(4)

    (b) From the Table above, choose any oxide which reacts with water and give a balanced chemical equation for its reaction with water.

    _____ *(2)*

    Total: 6 marks

    6

6. Ethene, C_2H_4, is an *unsaturated* hydrocarbon.
    (a) Explain the term *unsaturated*.

    _____ *(1)*

    (b) Give the name **and** structure of another unsaturated hydrocarbon which belongs to a **different** homologous series from ethene.

      (i) Name: _____

     (ii) Structure:

    (2)

    (c) Draw the structure of the product obtained when ethene reacts with:

(i) chlorine;	(ii) hydrogen chloride.

    (2)

    Total: 5 marks

    5

_____

7. A student has a gas jar which contains a mixture of carbon dioxide and carbon monoxide that was collected after some hydrocarbon fuel was burnt.

   (a) Which one of these two gases is considered as being more dangerous in a closed garage?

   _____ *(1)*

   (b) Why was carbon monoxide also produced during this combustion?

   _____

   _____ *(1)*

   (c) Explain how a sample of pure carbon monoxide may be collected from the mixture in the gas jar.

   _____

   _____ *(2)*

   (d) Carbon monoxide acts as a reducing agent when it reacts with heated lead(II) oxide. Give a balanced equation for the reaction.

   _____ *(2)*

Total: 6 marks

6

8. This question is about the action of electricity on materials.

   (a) Complete the following Table so as to show whether the substances indicated are **conductors** or **non-conductors** of electricity. The first one has been done for you.

Substance	Conductor	Non-Conductor
Pure distilled water		✓
Solid silver		
Solid table salt		
Copper(II) sulfate solution		
Molten calcium chloride		

(4)

(b) Predict the product at the anode and at the cathode when each of the following substances are electrolysed using inert electrodes.

Substance	Product at the Anode	Product at the Cathode
Aqueous copper(II) nitrate		
Molten potassium iodide		

(4)

Total: 8 marks

8

9. This question is about chemical bonding.
    (a) Showing outer electrons only, draw dot-cross diagrams to show the bonding in:

    (i) carbon dioxide;

    (ii) sodium oxide.

(4)

(b) Predict which of the two substances (carbon dioxide or sodium oxide) has the highest melting point. Explain this in terms of the bonding involved.

_____

_____

_____ *(2)*

Total: 6 marks

6

_____

10. This question is about gases.

(a) A gym exercise ball has been filled with air at a pressure of 4×10^6 Pa and has a volume of 25 dm^3 when the temperature in the gym is 18 ^{o}C. What will its volume be if the temperature changes to 23 ^{o}C at a pressure of 3×10^6 Pa?

_____

_____

_____

_____ *(3)*

(b) Which of the two gases, 4 g He or 4 g H$_2$, occupies more volume at standard temperature and pressure? Show your working.

_____

_____

_____ *(3)*

Total: 6 marks

6

DO NOT WRITE ABOVE THIS LINE
_____

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

11.

(a) A mass of 1.71 g pure barium hydroxide is transferred *quantitatively* to a 250 cm^3 volumetric flask and made up to the mark with distilled water. Using a pipette, 25.0 cm^3 of the barium hydroxide solution are placed in a conical flask and a few drops of methyl orange indicator are added. Hydrochloric acid is added slowly from a burette until the endpoint is reached. The titre value is 12.6 cm^3.

(i) Explain the term *quantitatively*.

_____ *(1)*

(ii) What will the colour change of the indicator at the endpoint be?

_____ *(1)*

(iii) Calculate the number of moles of barium hydroxide which are placed in the volumetric flask.

_____

_____ *(2)*

(iv) Calculate the number of moles of barium hydroxide which are transferred from the volumetric flask to the conical flask.

_____

_____ *(1)*

(v) Calculate the concentration, in mol dm^{-3}, of the hydrochloric acid used given that the equation for the reaction is:

$$Ba(OH)_2 \text{ (aq)} + 2\text{ HCl (aq)} \rightarrow BaCl_2 \text{ (aq)} + 2\text{ H}_2O \text{ (l)}$$

_____

_____

_____

_____ *(4)*

_____

(b) In a different experiment an amount of 4.46 g of pure barium hydroxide is added to excess sulfuric acid. Calculate the mass of barium sulfate that can be precipitated according to the equation:

$$Ba(OH)_2 \text{ (aq)} + H_2SO_4 \text{ (aq)} \rightarrow BaSO_4 \text{ (s)} + 2 H_2O \text{ (l)}$$

_____

_____

_____

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_____

_____

_____ *(7)*

(c) In laboratory experiments, distilled water is used since tap water is hard and may also contain other impurities.

   (i) Name or give the formulae of two substances that make tap water 'hard'.

   _____ *(2)*

   (ii) Describe a simple test to distinguish between a sample of hard water and soft water.

   _____

   _____ *(2)*

Total: 20 marks

20

_____

12.

(a) In a practical session students were given a white solid **P.** They were informed that **P** is a Group II compound. The students wrote short notes of their results in a Table as shown below.

Test	Observations
P + water	Soluble in water
P (aq) + NaOH (aq)	White precipitate, **Q**, insoluble in excess
P (aq) + NH$_3$ (aq)	White precipitate, **Q**, insoluble in excess
P (s) + concentrated H$_2$SO$_4$ followed by gentle heating in a fume cupboard	White misty fumes, **R**
P (aq) + few drops sodium carbonate solution	White precipitate, **S**
P (aq) + one drop silver nitrate solution	White precipitate, **T**, soluble in ammonia solution
Flame test on **P**	Negative

(i) Use the information given in the Table above to identify, by names **or** formulae, the substances **P**, **Q**, **R**, **S** and **T**.

P _____

Q _____

R _____

S _____

T _____   *(5)*

(ii) Give a balanced ionic equation, including state symbols, for the reaction of **P** to form **Q**.

_____

_____ *(3)*

(iii) Give a balanced ionic equation, including state symbols, for the reaction of **P** to form **T**.

_____

_____ *(2)*

(b)   A second group of students were presented with some greenish-blue crystals, labelled **A.**

On heating the solid **A,** a black solid, **B**, was obtained together with a brown gas, **C** and a colourless gas **D**. Colourless droplets of water were observed near the mouth of the test tube.

A few drops sodium hydroxide solution and some pieces of aluminium foil were added to **A**. On warming a pungent gas, **E**, was obtained which turned moist red litmus blue.

(i)   Give the names or formulae of the substances **A**, **B**, **C**, **D**, and **E**.

A _____

B _____

C _____

D _____

E _____   *(5)*

(ii)   Give a balanced equation to show the action of heat on substance **A**.

_____   *(2)*

(iii)   If red litmus is not available, suggest another test to identify substance **E**.

_____

_____   *(2)*

(iv)   The identity of the cation in **A** can be confirmed by adding dilute sodium hydroxide to a solution of **A**. What is the colour of the precipitate formed?

_____   *(1)*

Total: 20 marks

20

PERIODIC TABLE

Key

Relative atomic mass — A
X
Z — Atomic Number

I	II														III	IV	V	VI	VII	VIII
1 H 1																				4 He 2
7 Li 3	9 Be 4														11 B 5	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	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	80 Br 35	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	128 Te 52	127 I 53	131 Xe 54
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	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															

140 Ce 58	141 Pr 59	144 Nd 60	147 Pm 61	150 Sm 62	152 Eu 63	157 Gd 64	159 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	247 Bk 97	251 Cf 98	252 Es 99	257 Fm 100	258 Md 101	259 No 102	260 Lr 103

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SECONDARY EDUCATION CERTIFICATE LEVEL

MAY 2016 SESSION

SUBJECT:	**Chemistry**
PAPER NUMBER:	IIA
DATE:	27th April 2016
TIME:	4:00 p.m. to 6:05 p.m.

Useful data:

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

Standard temperature and pressure (STP): 0 ^{o}C and 1 atm

The molar volume for gases at STP: 22.4 dm^{3}

1 Faraday = 96500 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.** Write all your answers in the spaces provided in this booklet.*

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- *The use of electronic calculators is permitted.*

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For examiners' use only:

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

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

1. Fill in the blanks in the following statements.

   (a) When a mixture of water and sand is filtered, the water passes through while the sand remains in the filter paper as a _____.

   (b) One can separate a mixture of sodium chloride and ammonium chloride by strong heating, because ammonium chloride _____.

   (c) Two immiscible liquids can be separated by using a _____ _____.

   (d) Water can be obtained from its mixture with sodium chloride by _____.

   (e) Dissolved substances that have different colours, such as inks and plant dyes, can be separated by _____.

   (f) The two components of an alcohol-water mixture can be separated by _____ _____.

Total: 6 marks

6

2. Complete the following paragraph about reverse osmosis.

Reverse osmosis (RO) is a process of water purification that uses a _____ membrane to remove larger soluble particles from water. In RO, an applied pressure is used to overcome osmotic pressure. The _____ is retained on the pressurized side of the membrane and the pure solvent is allowed to pass to the other side. This membrane should not allow large molecules or ions through the pores (holes), but should allow smaller components of the solution, most importantly the _____, to pass freely.

Total: 3 marks

3

3. Oxygen can be prepared by the catalytic *decomposition* of hydrogen peroxide.
   (a) Explain the term *decomposition*.

   _____

   _____ *(1)*

   (b)
   (i) Write the chemical equation that represents the 'catalytic *decomposition* of hydrogen peroxide'.

   _____ *(2)*

   (ii) Write the name of a suitable catalyst for this reaction.

   _____ *(1)*

   (c)
   (i) What is a suitable way of collecting the oxygen produced in this reaction?

   _____ *(1)*

   (ii) Indicate a test to confirm the presence of oxygen.

   _____ *(1)*

   Total: 6 marks

   6

4. While cleaning the laboratory, a technician found four containers each containing a white solid. Unfortunately the labels on these containers where either lost or badly damaged. However these containers were found on the shelf where the salts of Group I and II metals were stored. In trying to identify the contents of the containers the technician conducted a flame test on each of the white solids.
   (a) Describe the correct procedure to carry out a flame test in a laboratory.

   _____

   _____

   _____ *(3)*

   (b) Why is a flame test never sufficient to fully identify an unknown salt?

   _____ *(1)*

(c) Complete the Table below to show what conclusions the technician would draw from the observations listed below.

Container	Flame colour	Conclusion
A	Bright yellow	
B	Orange-red	
C	No change	
D	Lilac	

(2)

Total: 6 marks

6

5. These are some chemical reactions involving sulfuric acid:

   A. Sulfuric acid + **X** → magnesium sulphate + water

   B. Sulfuric acid + **Y** → carbon + water

   C. Sodium hydrogencarbonate + sulfuric acid → sodium sulfate + water + carbon dioxide

   D. Solid sodium chloride + sulfuric acid → hydrogen chloride + sodium hydrogensulfate

   (a) State which of the reactions above are only possible with **concentrated** sulfuric acid.

   _____ *(2)*

   (b) Identify substances **X** and **Y**.

   X _____   **Y** _____
   (2)

   (c) Write a balanced chemical equation for reaction **C**.

   _____ *(2)*

   Total: 6 marks

   6

6. A straight chain hydrocarbon is made up of five carbon atoms and twelve hydrogen atoms.
    (a) Draw the structural formula of this compound.

    (1)

    (b) Give the name of this hydrocarbon: _____ *(1)*

    (c) Name the homologous series that this hydrocarbon belongs to.

    _____ *(1)*

    (d) Some compounds have *isomers.*
      (i) Explain the term *isomers*.

    _____

    _____ *(1)*

      (ii) Draw the structural formula of **two** isomers of the compound drawn in part (a).

Isomer 1	Isomer 2

    (2)
    Total: 6 marks

7. PVC is an *addition polymer*.

    (a) What does the abbreviation PVC stand for? _____ *(1)*

    (b) Explain the terms *addition* and *polymer* as used in this context.

    _____

    _____ *(2)*

    (c) Draw the structural formula of the **monomer** of the polymer PVC.

    (1)

    (d) Draw the structural formula of PVC, showing four monomer units bonded together.

    (2)
    Total: 6 marks

6

6
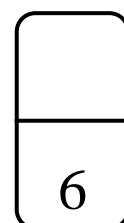
8. The elements of Group I and Group II of the Periodic Table are metals.
   (a) Indicate the common feature in the electronic configuration of Group I and Group II elements respectively.

   (i) Group I: _____

   (ii) Group II: _____ *(1)*

   (b) Group I and Group II metals have specific names. Give the names by which Group I and Group II are called.

   (i) Group I: _____

   (ii) Group II: _____ *(2)*

   (c) Why are these elements classified as metals in terms of electron exchange?

   _____

   _____ *(1)*

   (d) Explain why potassium is more reactive than:

   (i) sodium;

   _____

   _____ *(1)*

   (ii) calcium.

   _____

   _____ *(1)*

   Total: 6 marks

   6

9. A student added 100 cm^3 of 0.5 mol dm^{-3} hydrochloric acid to 3 small pieces of magnesium ribbon (an excess) in a flask connected to a gas syringe. The student plotted the volume of gas produced against time and obtained graph C.
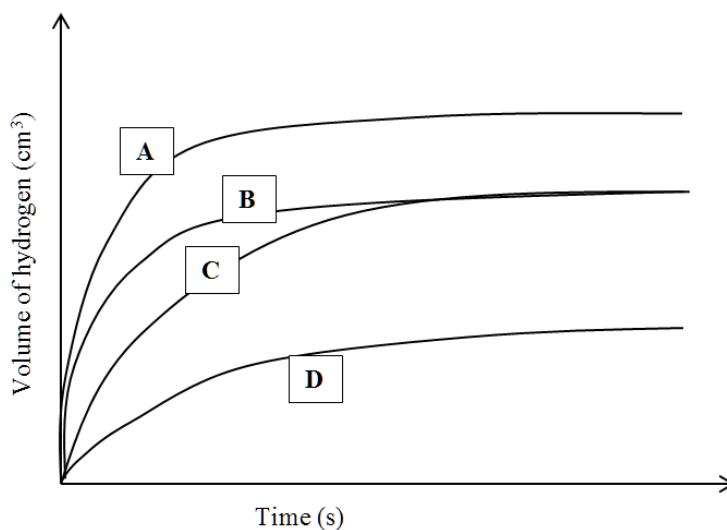
(a) Give **three** conditions for a reaction to give graph B.

(i)   _____

(ii)   _____

(iii) _____ *(3)*

(b) If the same three pieces of magnesium ribbon react with 100 cm^3 of 0.1 mol dm^{-3} nitric acid solution graph D is obtained. Explain briefly.

_____

_____

_____ *(3)*

(c) Indicate which of the following three cases fits with the data represented in graph A. Justify your answer.

(i)   the same three pieces of magnesium ribbon + 500 cm^3 of 0.1 mol dm^{-3} nitric acid.
(ii)   the same three pieces of magnesium ribbon + 100 cm^3 of 0.1 mol dm^{-3} hydrochloric acid + catalyst.
(iii) the same three pieces of magnesium ribbon + 100 cm^3 of 0.5 mol dm^{-3} sulfuric acid.

_____

_____

_____ *(3)*

Total: 9 marks

9

10. A compound is composed of carbon, hydrogen and oxygen. It was analysed and the following results were obtained:

- Mass of sample = 15.20 g
- Mass of carbon in sample = 6.05 g
- Mass of hydrogen in sample = 1.03 g

(a) Find its empirical formula.

_____

_____

_____

_____

_____

_____ *(4)*

(b) If the relative molecular mass of the compound is 180, find its molecular formula.

_____

_____

_____

_____ *(2)*

Total: 6 marks

6

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

11. The following is a part of a student's lab report.

Experiment	Procedure	Observations
X	Substance **A** was gently heated.	The blue crystals changed to a white powder and droplets of liquid condensed at the mouth of the boiling tube.
Y	Substance **B** was heated at first gently and then more strongly in a bunsen flame.	Two gases were given off, one of them brown. A yellow residue remained that neutralised both an acidic and an alkaline solution.
Z	Substance **C** was heated at first gently and then more strongly in a bunsen flame.	A yellow residue which cooled to a white solid was formed. A gas that turns lime water cloudy was also given off.

(a) Write conclusions for experiments X, Y and Z and, hence, identify salts **A**, **B** and **C**. *(6)*

(b) Select any **two** compounds from **A**, **B** and **C** and write balanced chemical equations for their thermal decomposition. *(4)*

(c) Sodium hydrogencarbonate undergoes the following dehydration reaction at 200°C:

$$2 \ NaHCO_3 \rightarrow Na_2CO_3 + H_2O + CO_2$$

Assuming that 4.2 g of sodium hydrogencarbonate were heated, and that reaction was complete, calculate:

 (i) the number of moles of sodium carbonate produced; *(4)*

 (ii) the mass of water formed; and *(3)*

 (iii) the volume of carbon dioxide produced measured at s.t.p.. *(3)*

Total: 20 marks

12. Consider the electrolysis of dilute sulfuric acid solution using platinum electrodes.
    (a) Draw a labelled diagram of the apparatus, considering that the products at the electrodes are to be collected. *(4)*

    (b) Give the half equations for the reactions at:

      (i) the cathode; *(2)*

      (ii) the anode. *(2)*

    (c) Indicate which of the reactions above is an oxidation reaction and which one is a reduction reaction. Give a reason for your answer. *(2)*

    (d) By using your answers to parts (b) and (c), write the overall redox reaction taking place in the cell. *(2)*

    (e) During this electrolysis experiment, a student wanted to collect 100 cm^3 (at s.t.p.) of the product at the cathode. A current of 5 A was used. Calculate:

      (i) the time required to produce 100 cm^3 of the product at the cathode (at s.t.p.). *(5)*

      (ii) the volume of gas collected at the anode (at s.t.p.). *(1)*

    (f) What is observed if the setup is fitted with carbon electrodes and the solution used is copper(II) sulfate? *(2)*

    Total: 20 marks

13. This question is about iron and its extraction in the blast furnace.
    (a) Iron is an example of a *transition metal*.

      (i) List **three** chemical properties of transition metals. *(3)*

      (ii) List **three** physical properties of metals. *(3)*

    (b) Iron is extracted from its ore in a blast furnace. Give a brief explanation of the processes occurring in the blast furnace so that iron is produced. Your answer should include any equations for the reactions that take place. *(7)*

    (c) When iron is reacted with warm hydrochloric acid and the solution obtained is evaporated gently until crystals start to form, pale green crystals **G** are obtained. When red hot iron is placed in a gas jar containing gaseous chlorine, a brown solid **H** forms. Identify the products in each reaction and explain the role of chlorine. *(3)*

    (d) Write balanced chemical equations for the reaction of iron with:

      (i) steam;

      (ii) water and oxygen. *(4)*

    Total: 20 marks

14. One of the cheapest sources of nitrogen is air, where nitrogen is found mixed with other gases.
    (a) Explain briefly how nitrogen is obtained from air.   *(3)*

    (b) Calculate the maximum volume of nitrogen that can be obtained from 250 dm^3 of air.
                                                                                      (2)

    (c) One of the main uses of nitrogen is in the Haber process. During this process nitrogen is reacted with hydrogen in the following reaction. The mixture reaches a state of *dynamic equilibrium*:

$$N_2 + 3 H_2 \rightleftharpoons 2 NH_3 \quad \Delta H = -92 \text{ KJ mol}^{-1}$$

      (i)   Explain the term *dynamic equilibrium* in terms of the speed of reaction.   *(1)*

      (ii) When the temperature at which a reaction takes place is increased, it will usually make the reaction go faster. Explain why this happens in terms of particles.   *(3)*

      (iii) What temperature and pressure are adopted in the Haber process? Explain why such conditions are used.   *(4)*

      (iv) A catalyst is used in this process. Suggest a suitable catalyst for the reaction and explain its effects on the equilibrium position and the speed by which this is obtained.
                                                                                      (3)

    (d) Hydrogen is used to prepare hydrogen chloride by synthesis:

$$Cl_2 + H_2 \rightarrow 2 HCl$$
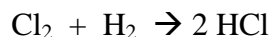
      (i)   A volume of 60 dm^3 of chlorine is mixed with 40 dm^3 of hydrogen and the reaction started. Assuming that the reaction goes to completion, calculate the volume of hydrogen chloride produced. All volumes are measured at the same temperature and pressure.   *(3)*

      (ii) Hence, calculate the total volume at the end of the reaction.   *(1)*

Total: 20 marks

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PERIODIC TABLE

Key

$$\frac{A}{X}$$
Z

Relative atomic mass — A
Atomic Number — Z

I	II												III	IV	V	VI	VII	VIII
																		4 **He** 2
1 **H** 1													11 **B** 5	12 **C** 6	14 **N** 7	16 **O** 8	19 **F** 9	20 **Ne** 10
7 **Li** 3	9 **Be** 4												27 **Al** 13	28 **Si** 14	31 **P** 15	32 **S** 16	35.5 **Cl** 17	40 **Ar** 18
23 **Na** 11	24 **Mg** 12												70 **Ga** 31	73 **Ge** 32	75 **As** 33	79 **Se** 34	80 **Br** 35	84 **Kr** 36
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		115 **In** 49	119 **Sn** 50	122 **Sb** 51	128 **Te** 52	127 **I** 53	131 **Xe** 54
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		204 **Tl** 81	207 **Pb** 82	209 **Bi** 83	209 **Po** 84	210 **At** 85	222 **Rn** 86
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	192 **Ir** 77	195 **Pt** 78	197 **Au** 79	201 **Hg** 80							
223 **Fr** 87	226 **Ra** 88	227 **Ac** 89																

140 **Ce** 58	141 **Pr** 59	144 **Nd** 60	147 **Pm** 61	150 **Sm** 62	152 **Eu** 63	157 **Gd** 64	159 **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	247 **Bk** 97	251 **Cf** 98	252 **Es** 99	257 **Fm** 100	258 **Md** 101	259 **No** 102	260 **Lr** 103

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

SECONDARY EDUCATION CERTIFICATE LEVEL

MAY 2016 SESSION

SUBJECT:	**Chemistry**
PAPER NUMBER:	IIB
DATE:	27th April 2016
TIME:	4:00 p.m. to 6:05 p.m.

Useful data:

Relative atomic masses: H = 1; C = 12; O = 16; Na = 23; Fe = 56

Standard temperature and pressure (STP): 0 ^{0}C and 1 atm

The molar volume for gases at STP: 22.4 dm^3

1 Faraday = 96500 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.*** *Write all your answers in the spaces provided in this booklet.*

- *The mark allocation is indicated at the end of each question. Marks allocated to parts of questions are also indicated in brackets.*

- *You are reminded of the necessity for orderly presentation in your answers.*

- *In calculations you are advised to show all the steps in your working, giving your answer at each stage.*

- *The use of electronic calculators is permitted.*

- *A **Periodic Table** is printed on the back of this booklet.*

For examiners' use only:

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

_____

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

1. Some of the following statements are **true** while others are **false**. Consider each statement and then write **True (T)** or **False (F)** next to each in the space provided.

    (a) In filtration the substance that remains on the filter paper is called the filtrate.

    (b) Sublimation can be used to separate a mixture of sand and water.

    (c) Filtration can be used to separate the colours found in grass.

    (d) To separate a mixture of sugar and chalk, water is first added, the mixture is stirred well and then filtered.

    (e) A mixture of miscible oils can be separated using fractional distillation.

    (f) A mixture of vinegar and oil can be separated using a separating funnel.

Total: 6 marks

6

2. Complete the following paragraph using the words below. Each word may be used more than once or not at all.

pressure	*pure*	*semi-permeable*
reversed	*impermeable*	*sea*

When sea water and pure water are separated by a _____ membrane, water

passes from the side where there is _____ water to the side where there is

_____ water. This is called osmosis. If, however, a _____ is

applied on the _____ water the process is reversed. However since the

membrane is _____ it will only allow the small water particles to pass

through leaving behind the salt.

Total: 6 marks

6

3. The following diagram shows the apparatus that may be used to prepare a sample of oxygen in the laboratory.
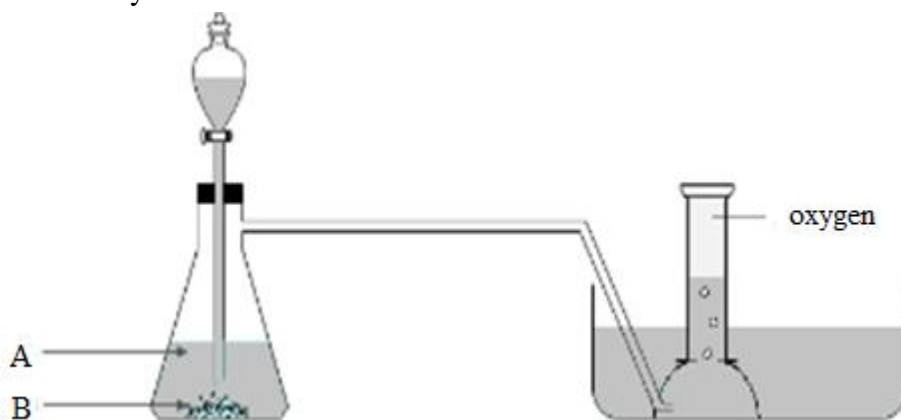
(a) Give the **names** of the substances labelled **A** and **B** in this experiment.

Substance **A**: _____ *(1)*

Substance **B**: _____ *(1)*

(b) What is the function of substance **B** in this experiment?

_____ *(1)*

(c) In the experiment shown, the liquid in the gas jar and the trough is water. Give **two** reasons why water is used in these parts of the apparatus.

Reason 1: _____ *(1)*

Reason 2: _____ *(1)*

(d) Indicate a test to confirm the presence of oxygen.

_____ *(1)*

Total: 6 marks

6

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4. The Table below reports the observations that a student made while doing a series of flame tests during a school practical.

Test	Observation	Conclusion	
Flame test on a sample of salt **A**	Bright yellow flame	Cation in solid **A**:	
Flame test on a sample of salt **B**		Cation in solid **B**:	K^+
Flame test on a sample of salt **C**	Orange-red flame	Cation in solid **C**:	

(a) Fill in the blanks in the Table above.   *(3)*

(b) Outline the correct procedure to carry out a flame test in a laboratory.

_____

_____

_____ *(3)*

Total: 6 marks

6

5. These are some chemical reactions involving sulfuric acid:

   A. Magnesium hydroxide + sulfuric acid → magnesium sulfate + water

   **B.** Sugar + sulfuric acid → carbon + water

   C. Sodium hydrogencarbonate + sulfuric acid → sodium sulfate + water + carbon dioxide

   D. Solid sodium chloride + sulfuric acid → hydrogen chloride + sodium hydrogensulfate

(a) State which of the reactions above are only possible with **concentrated** sulfuric acid.

_____ *(2)*

(b) Complete the following equations to show how dilute sulfuric acid reacts.

(i) $Mg(OH)_2 + H_2SO_4 \rightarrow$ _____ *(2)*

(ii) $2\,NaHCO_3 + H_2SO_4 \rightarrow$ _____ *(2)*

Total: 6 marks

6
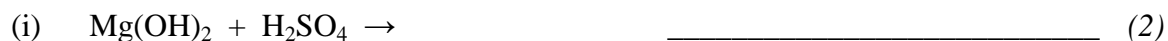
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6. Sodium and potassium are both very reactive elements.
    (a) Give the electronic configuration of an **atom** of:

     (i)   sodium _____ *(1)*

     (ii) potassium _____ *(1)*

    (b) Give the electronic configuration of a stable **ion** of potassium:

         _____ *(1)*

    (c) Give the name used to refer to Group I of the Periodic Table.

         _____ *(1)*

    (d) On the basis of the electronic configuration which you have given as your answer in (a), explain why potassium is a more reactive element than sodium.

         _____

         _____ *(1)*

    (e) Explain in terms of the electronic configuration of sodium and potassium why you would expect both these elements to react in the same way.

         _____

         _____ *(1)*

                                                         Total: 6 marks

                                                         6

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7. A straight chain saturated hydrocarbon has a molecular formula of C_5H_{12}.
    (a) Draw the structural formula of this compound.

                                                                              (1)

    (b) Give the name of this hydrocarbon: _____ *(1)*

    (c) Name the homologous series that this hydrocarbon belongs to.

         _____ *(1)*

    (d) Some compounds have *isomers.*
      (i) Explain the term *isomers*.

           _____

           _____ *(1)*

      (ii) Draw the structural formula of **two** isomers of the compound drawn in part (a).

Isomer 1	Isomer 2

                                                                              (2)

Total: 6 marks

6

_____

8. The material known as Teflon is made up of many tetrafluoroethene molecules (C_2F_4) joined together.

   (a) Draw the structural formula of tetrafluoroethene.

   (1)

   (b) What type of chemical compound is Teflon?

   _____ *(1)*

   (c) Draw the structural formula of Teflon containing at least 3 tetrafluroethene molecules joined together.

   (2)

   (d) Teflon is used widely to coat pots and pans. Suggest two properties of Teflon that make it suitable for this purpose.
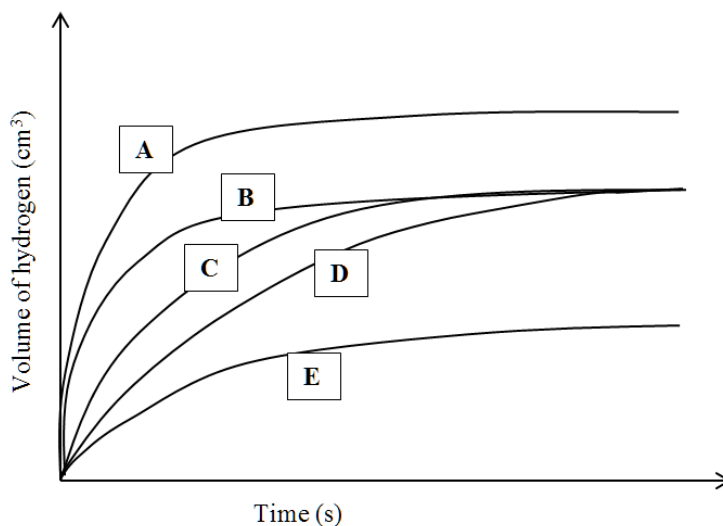
   (i) Property 1: _____

   (ii) Property 2: _____ *(2)*

   Total: 6 marks

   6

_____

9. A student added 100 cm^3 of 0.5 mol dm^{-3} hydrochloric acid at to 3 small pieces of magesium in in a flask connected to a gas syringe. All the magnesium reacted. The student plotted the volume of gas against time and obtained graph C.

Which graph would the student obtain if:

(a) the same 3 pieces of magnesium + 500 cm^3 of 0.1 mol dm^{-3} hydrochloric acid?

(b) the same mass of magnesium in **powder** form + 100 cm^3 of 0.5 mol dm^{-3} hydrochloric acid?

(c) the same 3 pieces of magnesium + 100 cm^3 of 0.5 mol dm^{-3} nitric acid?

(d) the same 3 pieces of magnesium + 100 cm^3 of 0.5 mol dm^{-3} hydrochloric acid at a higher temperature?

(e) the same 3 pieces of magnesium + 100 cm^3 of 0.5 mol dm^{-3} hydrochloric acid in the presence of a catalyst?

(f) the same 3 pieces of magnesium + 100 cm^3 of 0.5 mol dm^{-3} sulfuric acid?

Total: 6 marks

6

10. An organic substance has the following percentage composition by mass:

- 40% carbon
- 6.67% hydrogen
- 53.33% oxygen

(a) Find its empirical formula.

_____

_____

_____

_____

_____

_____ *(4)*

(b) If the relative molecular mass of the compound is 180, find its molecular formula.

_____

_____

_____

_____ *(2)*

Total: 6 marks

6

_____

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

11. The following is a part of a student's Lab Report.

Test	Observation
X heated gently, then more strongly, in a bunsen flame	• **X** = white solid • Crackling sound • Yellow residue (**Q**) which can neutralise both HCl and NaOH • Brown gas (**R**) given off • Gas relights glowing splint
Y heated gently, then more strongly, in a bunsen flame	• Y = white solid • Yellow residue (**S**) formed, turns white on cooling • Gas (**T**) turns lime water milky

(a) Identify **Q**, **R**, **S** and **T** and, hence, identify substances **X** and **Y**. *(6)*

(b) Write down balanced chemical equations for the thermal decomposition of **X** and **Y**. *(4)*

(c) Sodium hydrogencarbonate undergoes the following dehydration reaction at 200 °C:

$$2\ NaHCO_3 \rightarrow Na_2CO_3 + H_2O + CO_2$$

Assuming that 4.2 g of sodium hydrogencarbonate were heated, and that reaction was complete, calculate:

  (i) the number of moles of sodium hydrogencarbonate used; *(3)*

  (ii) the number of moles of water and carbon dioxide produced; *(3)*

  (iii) the mass of water formed; and *(2)*

  (iv) the volume of carbon dioxide produced measured at s.t.p.. *(2)*

Total: 20 marks

_____

12. Consider the electrolysis of dilute sulfuric acid solution using platinum electrodes as shown in the diagram below.
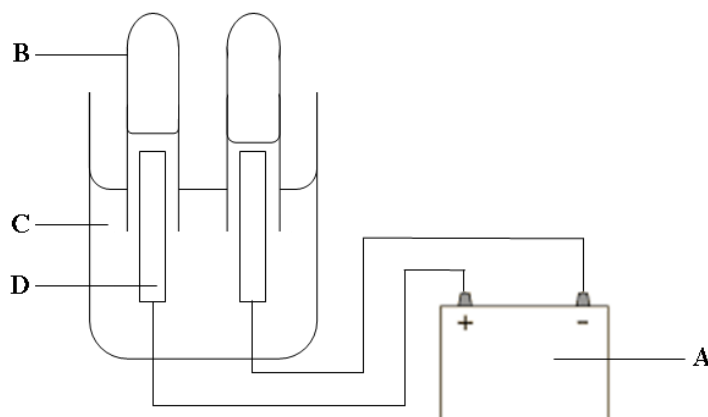
(a) Look at the above diagram and label **A**, **B**, **C** and **D**.   *(4)*

(b) Give the half equations for the reactions at

 (i)   the cathode; and   *(2)*

 (ii) the anode.   *(2)*

(c) Indicate which of the reactions given in your answer to part (b) is an oxidation reaction and which one is a reduction reaction. Give a reason for your answer.   *(2)*

(d) By using your answers to parts (b) and (c), write the overall redox reaction taking place in the cell.   *(2)*

(e) Platinum electrodes are *inert.*
 (i)   What is meant by *inert*?   *(1)*

 (ii) What is observed if the platinum electrodes were to be replaced by copper ones? *(2)*

(f) During this electrolysis experiment, a current of 5 A was passed for 16 minutes.

 (i)   Given that Q = It, calculate the total charge used.   *(2)*

 (ii) Given that 1 Faraday is equivalent to 96,500 C and using the equation in (b)(i), calculate the moles of product liberated at the cathode.   *(3)*

Total: 20 marks

13. One of the cheapest sources of nitrogen is air, where nitrogen is found mixed with other gases.

(a) What is the percentage volume of nitrogen in air? *(1)*

(b) Explain briefly how nitrogen is obtained from air. *(3)*

(c) One of the main uses of nitrogen is in the Haber Process. During this process nitrogen is reacted with hydrogen in the following reaction. The mixture reaches a state of *dynamic equilibrium*.

$$N_2 + 3 H_2 \rightleftharpoons 2 NH_3 \quad \Delta H = -92 \text{ kJ mol}^{-1}$$
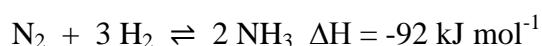
(i) What information does the value $\Delta H = -92$ kJ mol^{-1} provide? *(2)*

(ii) What does the symbol $\rightleftharpoons$ mean? *(1)*

(iii) Explain the term *dynamic equilibrium* in terms of the speed of reaction. *(1)*

(iv) When the temperature at which a reaction takes place is increased, it will usually make the reaction go faster. Explain why this happens in terms of particles. *(3)*

(v) Explain why a moderate temperature of 400 $^{\circ}$C to 450 $^{\circ}$C is used in the Haber Process rather than a higher one. *(2)*

(vi) The Haber Process also makes use of a high pressure of around 200 atmospheres. How does using this high pressure help to produce more ammonia? *(2)*

(vii) A catalyst is used in this process. Suggest a suitable catalyst for the reaction and explain its effects on the equilibrium position and the speed by which this is obtained. *(3)*

(viii) Give **two** uses of ammonia besides it being used as a reagent in the laboratory. *(2)*

Total: 20 marks

_____

14. This question is about iron and its extraction in the blast furnace.

  (a)
   (i)   What are metals such as iron and copper called?   *(1)*

   (ii)   List **three** properties that characterize elements such as iron and copper.   *(3)*

  (b) Iron is extracted from its ore in a blast furnace.

   (i)   List the solid raw materials that are used in the production of iron in a blast furnace.
                                                                              (3)

   (ii)   Give a brief explanation of how these raw materials behave in the blast furnace so
          that iron is produced. Your answer should include any equations for the reactions that
          take place.   *(7)*

  (c) A mass of 2.8 g of iron filings was reacted completely with 1.68 dm^3 of chlorine gas
       measured at s.t.p. to form the metal chloride.

   (i)   How many moles of iron took part in this reaction?   *(1)*

   (ii)   How many moles of chlorine gas reacted with the iron filings?   *(1)*

   (iii) How many moles of chlorine **atoms** reacted with the iron filings? *(1)*

   (iv)   From your answers to c(i) and c(iii) deduce the formula of the iron chloride formed in
          this reaction.   *(1)*

   (v)   Write the equation for the reaction that takes place between iron and chlorine.   *(2)*

                                                                 Total: 20 marks

SEC06/2B.16m

SEC06/2B.16m

SEC06/2B.16m

SEC06/2B.16m

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PERIODIC TABLE

Key

Relative atomic mass → A
X
Z → Atomic Number

I	II			III	IV	V	VI	VII	VIII
									4 **He** 2
1 **H** 1									
7 **Li** 3	9 **Be** 4			11 **B** 5	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			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								

Transition metals:

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
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
139 **La** 57	178.5 **Hf** 72	181 **Ta** 73	184 **W** 74	186 **Re** 75	190 **Os** 76	192 **Ir** 77	195 **Pt** 78	197 **Au** 79	201 **Hg** 80
227 **Ac** 89									

Lanthanides and Actinides:

140 **Ce** 58	141 **Pr** 59	144 **Nd** 60	147 **Pm** 61	150 **Sm** 62	152 **Eu** 63	157 **Gd** 64	159 **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	247 **Bk** 97	251 **Cf** 98	252 **Es** 99	257 **Fm** 100	258 **Md** 101	259 **No** 102	260 **Lr** 103