Index Number:_____ SEC06/1.18m

L-Università ta' Malta

MATRICULATION AND SECONDARY EDUCATION CERTIFICATE EXAMINATIONS BOARD

SECONDARY EDUCATION CERTIFICATE LEVEL
2018 MAIN SESSION

SUBJECT:	**Chemistry**
PAPER NUMBER:	I
DATE:	23rd May 2018
TIME:	9:00 a.m. to 11:05 a.m.

Useful data:

Relative atomic masses: H = 1; C = 12; O = 16; S = 32; Cl = 35.5; K = 39; Zn = 65; Ba = 137

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

The molar volume for gases at stp = 22.4 dm^3

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

$\Delta H = mc\Delta\theta$

Directions to Candidates

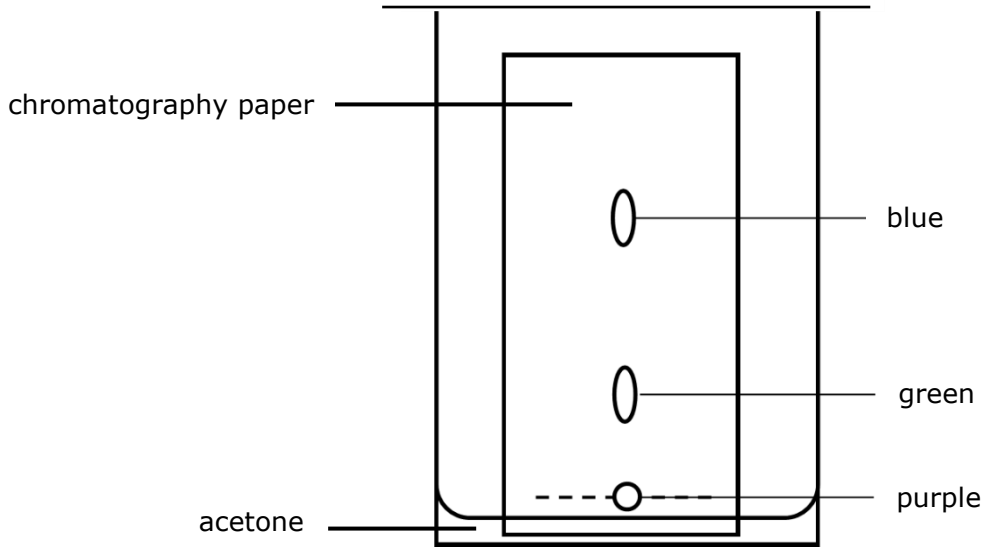
- Write your index number in the space at the top left-hand corner of this page.
- Answer **ALL** questions.
- Write all your answers in the spaces provided in this booklet.
- The mark allocation is indicated at the end of each question. Marks allocated to parts of questions are also indicated in brackets.
- 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	**6**	**8**	**5**	**6**	**4**	**7**	**7**	**6**	**5**	**6**	**20**	**20**	**100**

SECTION A

1) A drop of black ink is transferred on the dotted line on a chromatography (filter) paper which is allowed to stand in liquid acetone. Three colours were seen at the end of the experiment as shown below.



a) What is the role of acetone in this experiment?

_____ (1)

b) From the diagram above, identify:
i) the most soluble component of black ink;

_____ (1)

ii) the least soluble component of black ink.

_____ (1)

c) When the experiment is repeated using water instead of acetone, the drop of black ink remained on the starting line and only blue was seen a few centimetres above the dotted line. Draw **ONE** conclusion from this experiment.

_____

_____ (1)

d) Predict whether the black ink used in this experiment boils at a single temperature or a range of temperatures. Give **ONE** reason for your answer.

_____

_____ (2)

(Total: 6 marks)

6

2) Hydrogen is produced when dilute hydrochloric acid is added to zinc powder according to the equation:

$$Zn\ (s) + 2\ HCl\ (aq) \rightarrow ZnCl_2\ (aq) + H_2\ (g)$$

a) Calculate the volume of hydrogen, measured at standard temperature and pressure, that may be collected when reacting 26.0 g zinc powder with excess hydrochloric acid.

_____

_____

_____

_____

_____

_____ (6)

b) The hydrogen gas produced in part (a) is placed in a container such that the pressure is kept the same but the temperature is increased to 20 °C. Will the new volume be larger or smaller than in part (a)? Explain.

_____

_____

_____ (2)

(Total: 8 marks)

8

3) The word bank below presents some metals.

iron	potassium	silver	zinc	aluminium

a) Complete the table that follows by choosing a suitable metal from the word bank above.

(i)	is the most reactive with water.	
(ii)	gives no reaction with copper(II) sulfate solution.	
(iii)	forms a white protective layer when exposed to air.	

(3)

b) Give a balanced equation to show the reaction of zinc powder with silver nitrate solution.

_____ (2)

(Total: 5 marks)

5

4) A student adds sodium hydroxide solution to a small amount of iron(II) sulfate solution in a test tube. An immediate precipitate is observed.

a) Give a balanced ionic equation, including state symbols, to represent the reaction.

_____

_____ (3)

b) What is the colour of the precipitate?

_____ (1)

c) On standing, a change in the colour of the precipitate is noted. Explain.

_____

_____ (1)

d) Give **ONE** reason why the above experiment shows that iron may be considered a transition element.

_____ (1)

(Total: 6 marks)

6

5) Magnesium chloride and chloromethane are both chlorides.

a) Showing outer electrons only, draw dot-and-cross diagrams to show the bonding in magnesium chloride, $MgCl_2$, and chloromethane, CH_3Cl.

magnesium chloride, $MgCl_2$

chloromethane, CH_3Cl

(Total: 4 marks)

4

6) The compounds given below are hydrocarbons that belong to the same homologous series.

A C_5H_{12}	**B** C_3H_8	**C** CH_4	**D** C_4H_{10}

a) Give the general formula which applies to this homologous series.

_____ (1)

b) Give the name of substance **B**.

_____ (1)

c) From the list above, choose **ONE** hydrocarbon that has isomers and draw **TWO** of its isomers.

(2)

d) Compounds **A**, **B**, **C**, and **D** have different boiling points. Arrange the hydrocarbons in order of their boiling points, starting with the one with the lowest boiling point.

_____ (1)

e) These hydrocarbons are good fuels.

i) State **ONE** reason why these hydrocarbons are good fuels.

_____ (1)

ii) Why should these substances be burnt in a plentiful supply of air or oxygen?

_____ (1)

(Total: 7 marks) 7

7) Sea water can be polluted with excess sulfates from sources such as insufficiently treated waste water. In an experiment, the sulfate concentration of sea water was calculated as follows:

- a sample of 250 cm^3 of sea water was taken;
- dilute hydrochloric acid was added;
- aqueous barium chloride was added;
- a precipitate formed;
- the precipitate was collected, dried, and weighed.

$$Ba^{2+}(aq) + SO_4^{2-}(aq) \rightarrow BaSO_4(s)$$

a) What is the colour of the precipitate?

_____ (1)

b) Suggest a suitable separation technique to collect the precipitate.

_____ (1)

c) In one experiment, 2.91 g of precipitate were collected.

i) Calculate the number of moles of barium sulfate in this mass.

_____

_____ (2)

ii) What is the number of moles of sulfate ions in 250 cm^3 of the sea water sample?

_____ (1)

iii) Calculate the concentration, in mol dm^{-3}, of sulfate in the sea water sample.

_____

_____ (1)

d) If dilute hydrochloric acid were **not** added, more mass would precipitate on addition of barium chloride. Explain.

_____

_____ (1)

(Total: 7 marks)

7

8) Water is an important substance in everyday life. Under different conditions it can exist in different states.

a) State **TWO** ways how the behaviour of the water particles in steam is different from the behaviour of the water particles in ice.

_____

_____ (2)

b)

i) When excess liquid water is added to some sugar in a beaker, the sugar dissolves completely. Explain what happens in terms of the particles present.

_____

_____ (1)

ii) In part (b)(i), identify the:

Solute: _____ (1)

Solvent: _____ (1)

c) When a small amount of water is added to some solid substances, a saturated solution may be produced. What happens when a saturated solution is warmed gently?

_____ (1)

(Total: 6 marks)

6

9) A group of students conclude that in order for iron to rust two conditions are necessary.

a) State these **TWO** conditions.

_____ (2)

b) How can each of the following iron objects be protected against rusting? Mention **ONE** different method for each:

i) a garden bench; _____

ii) a gate; _____

iii) moving parts in an engine. _____ (3)

(Total: 5 marks)

5

10) Excess dilute nitric acid is added to magnesium carbonate in a conical flask which is connected to a glass syringe. Three experiments were carried out, as shown in the table that follows.

$$MgCO_3\,(s) + 2HNO_3\,(aq) \rightarrow Mg(NO_3)_2\,(aq) + H_2O\,(l) + CO_2\,(g)$$

Experiment	Magnesium carbonate	Concentration of nitric acid
A	2g, powder	0.8 mol dm^{-3}
B	2g, chips (granules)	0.8 mol dm^{-3}
C	2g, powder	1.0 mol dm^{-3}

a) On the same axis below sketch graphs to show the volume changes of the carbon dioxide gas produced in each of the experiments. Label the graphs **A**, **B**, or **C** according to the respective experiment.

(3)

b) Why is graph **A** not expected to be exactly the same as graph **B**?

_____

_____ (1)

c) Consider the following reaction:

$$CaCO_3\,(s) \leftrightharpoons CaO\,(s) + CO_2\,(g)$$

The symbol $\leftrightharpoons$ shows that a dynamic equilibrium may be set up in the reaction.

i) Explain the term dynamic equilibrium.

_____ (1)

ii) Why is the above equilibrium **not** reached if the container is left open?

_____ (1)

(Total: 6 marks)

6

SECTION B

11)

a) Air is a mixture of several substances, the primary components being oxygen and nitrogen. Many of the components are extracted using fractional distillation.

i) Why can oxygen and nitrogen be obtained separately from air through fractional distillation?

_____ (1)

ii) Describe how the test for oxygen is performed in the laboratory including the expected result.

_____ (1)

b) In the laboratory, oxygen may be prepared by the decomposition of hydrogen peroxide in the presence of a catalyst.

i) Give the name and formula of a suitable catalyst.

- name: _____ (1)
- formula: _____ (1)

ii) Give a balanced equation for the decomposition of hydrogen peroxide.

_____ (2)

iii) Why is hydrogen peroxide best stored in dark bottles? Give **ONE** reason.

_____ (1)

c) Potassium chlorate, $KClO_3$, decomposes on heating in the presence of a catalyst according to the equation:

$$2\ KClO_3\ (s) \rightarrow 2\ KCl\ (s) + 3\ O_2\ (g)$$

In a particular experiment, after taking all safety precautions, 20.16 dm^3 of oxygen, measured at stp, were collected after heating an amount of potassium chlorate. Calculate the mass of the solid potassium chlorate that was heated.

_____

_____

_____

_____

_____

_____

_____ (7)

d) The 20.16 dm^3 oxygen gas produced in part (c) was reacted with 45.0 dm^3 of carbon monoxide in a closed container.

i) Give a balanced equation for the reaction between oxygen and carbon monoxide.

_____ (2)

ii) Using your answer to part (d)(i) and given that all the gases are measured at the same temperature and pressure, calculate the volume of carbon monoxide which remains unreacted.

_____

_____

_____ (4)

(Total: 20 marks)

20

12)

a) Some chemical and physical changes are endothermic.

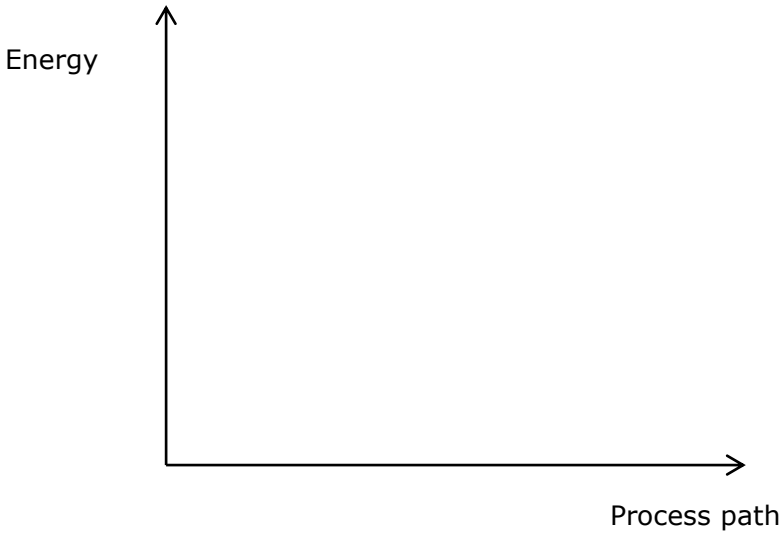
i) Explain why certain chemical reactions are endothermic.

_____

_____ (3)

ii) On the axis below sketch an energy profile for the evaporation of water, which is an endothermic physical process. Clearly show (i) the energies associated with water in the liquid and gaseous phase and (ii) the change of energy, ΔH.

$H_2O\ (l) \rightarrow H_2O\ (g)$



(3)

b) A group of students are to carry out an experiment to determine the heat of neutralisation. The following chemicals are available:

potassium hydroxide, KOH	sulfuric acid, H_2SO_4	nitric acid, HNO_3
ethanoic acid, CH_3COOH	sodium carbonate, Na_2CO_3	ammonia solution, NH_3

i) To determine the heat of neutralisation between an acid and a base, the students decided to use a strong alkali and a strong, monobasic acid. From the above list, choose:

- a strong, monobasic acid: _____ (1)
- a strong alkali: _____ (1)

ii) Should the acid and the alkali be mixed quickly or very slowly? Give **ONE** reason for your answer.

_____

_____ (2)

iii) Give a balanced ionic equation, including state symbols, to represent the neutralisation reaction.

_____

_____ (3)

c)

i) In an experiment, 0.43 g hexane were heated in a spirit lamp. The energy given out raised the temperature of 330 g water from 25 °C to 40 °C. Calculate the enthalpy of combustion per mole of hexane, C_6H_{14}.

_____

_____

_____

_____

_____ (5)

ii) The value obtained in part (c)(i) is less that the value found in a data book. Suggest **TWO** reasons for this difference in the values.

_____

_____ (2)

(Total: 20 marks)

20

PERIODIC TABLE

I	II											III	IV	V	VI	VII	VIII
																	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															

Key

Relative atomic mass — A; X; Z — *Atomic Number*

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

Index Number:_____ SEC06/2A.18m

L-Università ta' Malta

MATRICULATION AND SECONDARY EDUCATION CERTIFICATE EXAMINATIONS BOARD

SECONDARY EDUCATION CERTIFICATE LEVEL
2018 MAIN SESSION

SUBJECT:	**Chemistry**
PAPER NUMBER:	IIA
DATE:	25th May 2018
TIME:	9:00 a.m. to 11:05 a.m.

Useful data:

Faraday constant = 96,500 C

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

The molar volume for gases at stp = 22.4 dm^3

Q = It

Directions to Candidates

- Write your index number in the space at the top left-hand corner of this page.
- Answer **ALL** questions from Section A. Write all your answers for Section A in the spaces provided in this booklet.
- Answer **TWO** questions from Section B. Write all your answers for Section B on the script/s provided.
- 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**	**Total**
Score														
Maximum	**7**	**5**	**7**	**9**	**8**	**6**	**8**	**4**	**6**	**20**	**20**	**20**	**20**	**100**

SECTION A
Answer ALL questions from this section.

1) The following equations show the action of heat on some chemicals which are commonly found in the laboratory.
   a) Complete the following equations by writing the correct formula in each blank.

      i) $MgCO_3 \longrightarrow$ _____ + CO_2

      ii) $Zn(OH)_2 \longrightarrow$ _____ + H_2O

      iii) 2 $NaHCO_3 \longrightarrow$ _____ + _____ + H_2O

      iv) $FeSO_4.7H_2O \longrightarrow$ _____ + _____ (6)

   b) Give **ONE** observation for the heating of zinc oxide, ZnO.

      _____

      _____ (1)

(Total: 7 marks) 7

2) Fill in the blanks by choosing the correct word from the following list. Each word may be used once, more than once or not all.

water	positive	hydrogen
negative	hydroxide	carbonate

When hydrogen chloride is dissolved in water, it produces _____ ions as the only _____ ions. When a _____ is added to this solution it produces a salt, water molecules and carbon dioxide gas. No effervescence is noted if a _____ is added since this reaction will produce only a salt and _____.

(Total: 5 marks) 5

3) Diamond and graphite are both made of carbon atoms.

a) Draw a labelled diagram showing how the carbon atoms are arranged in graphite.

(2)

b) Why is graphite a conductor of electricity? Explain with reference to its structure.

_____

_____ (2)

c) A chemical reaction occurs when carbon monoxide and iron(III) oxide are heated together.

i) Give the equation for this reaction.

_____ (2)

ii) Why is carbon monoxide considered to be a reducing agent in this reaction?

_____ (1)

(Total: 7 marks)

7

4) The table below shows the substances produced at each electrode when some solutions are electrolysed using inert electrodes.

Solution	Substance formed at the anode	Substance formed at the cathode
dilute sulfuric acid	oxygen	hydrogen
concentrated sodium chloride		
copper(II) sulfate		

a) Complete the table above. (4)

b) Although carbon electrodes are inert electrodes, they still need to be changed after the electrolysis of sulfuric acid. Give **ONE** reason.

_____

_____ (1)

c) A solution of copper(II) sulfate loses its colour when electrolysed using carbon electrodes but it does not lose its colour when electrolysed using copper electrodes.

i) Why does a solution of copper(II) sulfate lose its colour when electrolysed using carbon electrodes?

_____

_____ (1)

ii) Why does a solution of copper(II) sulfate **not** lose its colour when electrolysed using copper electrodes?

_____

_____ (1)

b) A current of 2 A was passed through a solution for 1 hour. Calculate the amount (in moles) of electrons that pass through the solution.

_____

_____ (2)

(Total: 9 marks)

9

5) Ethene and ethyne are both unsaturated hydrocarbons.

a) Give the equation for the reaction between ethene and chlorine by showing the structural formulae of both ethene and the product of the reaction.

_____ (2)

b) When ethyne reacts with chlorine it first forms 1,2-dichloroethene. Being an alkene, 1,2-dichloroethene reacts further with chlorine to form a saturated compound A. Use this information and your knowledge of the chemistry of ethene to draw the structure of each compound in the following reaction scheme.

(3)

c) How can one show that both ethene and ethyne are unsaturated hydrocarbons?

_____

_____ (1)

d) Give the name and structural formula of the product of the hydration of ethene:

i) name; _____

ii) structural formula. _____ (2)

(Total: 8 marks)

8

6) Petroleum is a mixture of hydrocarbons which is separated into different fractions by fractional distillation. The different fractions shown in the table below are obtained.

Fraction	Hydrocarbon mixture
Fraction A	CH_4 - C_4H_{10}
Fraction B	C_5H_{12} - C_9H_{20}
Fraction C	$C_{10}H_{22}$ - $C_{15}H_{32}$
Fraction D	$C_{16}H_{34}$ - $C_{25}H_{52}$
Fraction E	$C_{26}H_{54}$ -

a) Give **ONE** use for:

i) Fraction A: _____ (1)

ii) Fraction B: _____ (1)

b) From the table, which fraction would evaporate first? Give **ONE** reason for your answer.

_____

_____ (2)

c) Although mankind depends heavily on these chemicals, many countries are trying to limit their use. Give **ONE** reason for this.

_____

_____ (1)

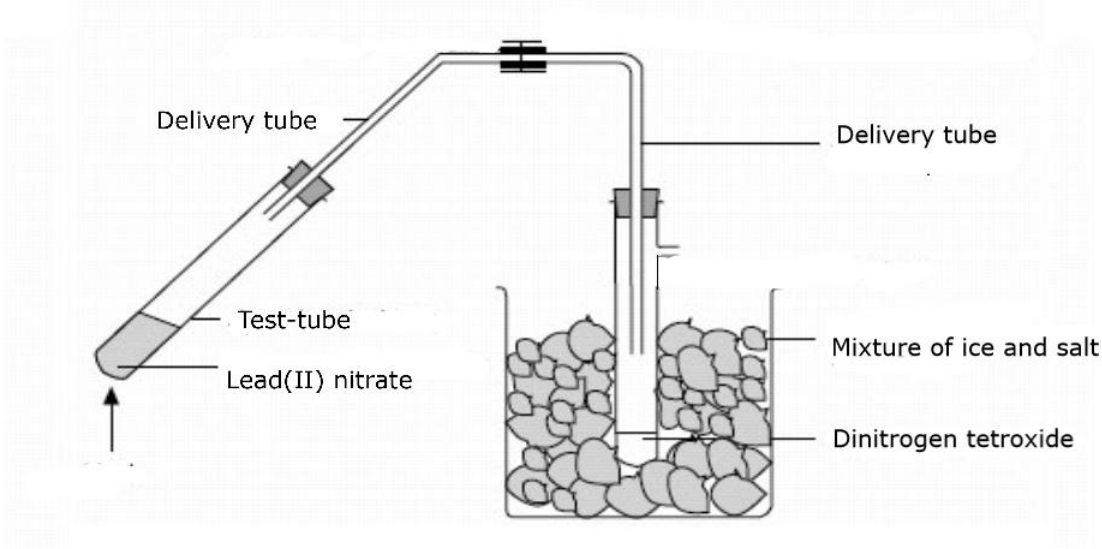
d) Name the process by which ethene is produced from compounds such as those from Fraction C.

_____ (1)

(Total: 6 marks)

6

7) The diagram below shows the laboratory preparation of nitrogen dioxide.



Adapted from https://byjus.com/chemistry/

a) Give the balanced equation for the reaction that takes place during this experiment.

_____ (2)

b) What does this method of preparation show about the boiling point of nitrogen dioxide?

_____ (1)

c) Nitrogen dioxide is not collected over water because it is very soluble in water. Give the names of the **TWO** products formed when nitrogen dioxide dissolves in water.

_____ (2)

d) Emission of nitrogen dioxide produced in the internal combustion engines of vehicles is reduced by catalytic converters.

i) In a catalytic converter nitrogen dioxide is reduced by carbon monoxide producing nitrogen and another gas. Give a balanced equation for this reaction.

_____ (2)

ii) Why is the use of catalytic converters only partially efficient at eliminating pollution? Give **ONE** reason.

_____ (1)

(Total: 8 marks)

8

8) A student reacted a sample of hydrochloric acid with a 25.0 cm^3 of 0.50 mol dm^{-3} sodium carbonate solution, to be able to determine the concentration of the acid. The student repeated the experiment four times. The following results were obtained.

Experiment	1	2	3	4
Burette reading no. 1	0.00 cm^3	23.80 cm^3	1.50 cm^3	24.20 cm^3
Burette reading no. 2	23.80 cm^3	46.55 cm^3	24.20 cm^3	46.85 cm^3
Volume used	23.80 cm^3	22.75 cm^3	22.70 cm^3	22.65 cm^3

$$Na_2CO_3\,(aq) + 2\,HCl\,(aq) \rightarrow 2\,NaCl\,(aq) + H_2O\,(l) + CO_2\,(g)$$

Calculate:

a) the average titre value for the experiment;

_____ (1)

b) the amount (in moles) of sodium carbonate used in this experiment;

_____

_____ (1)

c) the amount (in moles) of hydrochloric acid that took part in the reaction;

_____

_____ (1)

d) the concentration of the hydrochloric acid used in this experiment.

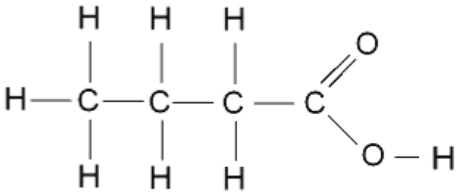
_____

_____ (1)

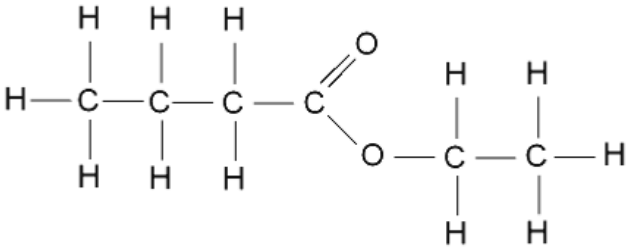
(Total: 4 marks)

4

9) The structures of substances **A** and **C** are shown below. Substance **A** reacts with an alcohol **B** in the presence of concentrated sulfuric acid to form substance **C**. Substance **C** is characterised by a fruity smell.



Substance A



Substance C

a) Name substance **A** and alcohol **B**:

substance **A**; _____ alcohol **B**; _____ (2)

b) Name the homologous series to which each of substances **A** and **C** belong.

substance **A**; _____ substance **C**; _____ (2)

c) Why is concentrated sulfuric acid used in the reaction described above? Give **TWO** reasons.

_____

_____ (2)

(Total: 6 marks)

6

SECTION B
Answer TWO questions from this section.

10) Nitrogen is a very important raw material in the chemical industry. It is obtained by the fractional distillation of liquid air.
   a) Briefly outline the steps for the fractional distillation of liquid air. (3)
   b) Nitrogen is a very unreactive substance. Explain with reference to its structure. (1)
   c) One of the major uses of nitrogen is the production of ammonia by the Haber process. The heat of reaction for the production of ammonia is —46 kJ/mol. Briefly outline this process by giving:
      i) the balanced equation for the reaction of this process; (2)
      ii) the catalyst used; (1)
      iii) the conditions (temperature and pressure) of the reaction; (2)
      iv) a discussion of the effects of temperature and pressure to obtain the best yield of ammonia. (4)
   d) Fritz Haber was awarded the Nobel Prize for chemistry for his invention of this process, as it was feared that the world would run out of food. How does the production of ammonia help to solve such a problem? (1)
   e) Ammonia is also a reducing agent.
      i) Give the balanced equation for the reaction of ammonia with copper(II) oxide. (2)
      ii) Draw a diagram to suggest the apparatus which could be used to carry out the experiment in part (e)(i). (2)
   f) Describe how the test for ammonium ions is performed including the expected result. (2)

(Total: 20 marks)

11) Chlorine is an element in Group 7 of the Periodic Table.
   a) Draw a well-labelled diagram to explain how a sample of pure, dry chlorine is prepared in the laboratory. Your diagram should include the materials used and any measures taken to ensure that dry chlorine is collected. (4)
   b) Give another method or piece of equipment besides that drawn in part (a) which can be used to collect dry chlorine. (1)
   c) Describe the chemical test and relevant observations to confirm the presence of:
      i) chlorine; (2)
      ii) chloride ions. (2)
   d) The order of reactivity of chlorine, bromine and iodine can be identified by reacting the elements with salts of the other elements within the group. Describe this experiment. The description should include:
      i) the method followed; (3)
      ii) a table that includes the expected results; (4)
      iii) an ionic equation (omitting spectator ions and including state symbols) for **ONE** of the reactions that occur; (3)
      iv) the conclusion made about the reactivity of chlorine, bromine and iodine. (1)

(Total: 20 marks)

12) A teacher gave the students dry samples of iron(II) sulfide and sodium sulfite. One student was not paying attention and did not note which sample was which. Not wanting to draw any correction from the teacher, the student added dilute hydrochloric acid to both samples.

a) Give the balanced equation for the reaction of iron(II) sulfide with hydrochloric acid. (2)

b) Although the teacher could **not** see the student working, the teacher realised that the reaction in part (a) was taking place. How did the teacher find out? (1)

c) Give **ONE** safety precaution for the addition of acid to iron(II) sulfide. (1)

d) Give the balanced equation for the reaction of sodium sulfite with dilute hydrochloric acid. (2)

e) The student placed a piece of damp blue litmus at the mouth of the test tube of the reaction in part (d).

i) What change should be observed? (1)

ii) Why is this test insufficient to confirm the identity of the gas produced? (1)

iii) Describe the chemical test and relevant observations to confirm the presence of this gas. (2)

f) Sulfur dioxide and hydrogen sulfide react together according to the equation shown below. This is a redox reaction.

$$2\ H_2S\ (g) + SO_2\ (g) \rightarrow 2\ H_2O\ (l) + 3\ S\ (s)$$

i) Predict **ONE** observation for this reaction. (1)

ii) Which sulfur atom is being reduced, that in hydrogen sulfide or that in sulfur dioxide? Give **ONE** reason for your answer. (2)

iii) Hence, which is the strongest reducing agent, hydrogen sulfide or sulfur dioxide? Give **ONE** reason for your answer. (2)

g) A small amount of one of the gases in part (f) is added to food and drinks to avoid oxidation. Predict, giving **ONE** reason for your answer, which of sulfur dioxide or hydrogen sulfide is added to food and drinks to avoid oxidation. (2)

h) The oxidation of sulfur dioxide to sulfur trioxide is an important step in the Contact process. Name the catalyst used for this reaction. (1)

i) Explain how to distinguish between sodium sulfate and sodium sulfite in the laboratory using aqueous barium chloride and any other material/s of your choice. (2)

(Total: 20 marks)

13) 'Alkali metals' and 'alkaline earth metals' are names given to two groups of the Periodic Table.

a) Distinguish between the alkali metals and the alkaline earth metals in terms of their:

i) appearance and hardness; (2)

ii) reaction with air (oxygen); (2)

iii) reaction with water. (2)

b) Are the oxides of alkaline earth metals acidic, basic or amphoteric? How can this be tested in the laboratory? (2)

c) When substance **A** is heated strongly, a white solid **B** and carbon dioxide are formed. When solid **B** is added to water, another white solid, **C**, forms. Solid **C** is slightly soluble in water. The mixture of **C** with water is used for whitewashing and eventually **C** reacts with a constituent of air. In a flame test, compound **C** imparts a brick-red colour to the flame.

i) Describe how a flame test is carried out in the laboratory. (3)

ii) Identify substances **A**, **B**, and **C**. (3)

iii) Write balanced equations for the **THREE** reactions described above. (6)

(Total: 20 marks)

DO NOT WRITE ABOVE THIS LINE

PERIODIC TABLE

I	II											III	IV	V	VI	VII	VIII
																	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															

Key

Relative atomic mass — A
X
Z — *Atomic Number*

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

Index Number:_____ SEC06/2B.18m

L-Università ta' Malta

MATRICULATION AND SECONDARY EDUCATION CERTIFICATE EXAMINATIONS BOARD

SECONDARY EDUCATION CERTIFICATE LEVEL
2018 MAIN SESSION

SUBJECT:	**Chemistry**
PAPER NUMBER:	IIB
DATE:	25th May 2018
TIME:	9:00 a.m. to 11:05 a.m.

Useful data:

Relative atomic masses: H = 1; C = 12; N = 14; O = 16; Na = 23; Al = 27

Faraday constant = 96,500 C

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

The molar volume for gases at stp = 22.4 dm^3

Q = It

Directions to Candidates

- Write your index number in the space at the top left-hand corner of this page.
- Answer **ALL** questions from Section A. Write all your answers for Section A in the spaces provided in this booklet.
- Answer **TWO** questions from Section B. Write all your answers for Section B in the script/s provided.
- 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 from this section.

1) Chemical substances behave differently in the presence of heat. Match the compounds on the left with their response to heat on the right.

copper(II) sulfate pentahydrate	•	•	does not change
copper(II) carbonate	•	•	burns with a sooty, yellow flame
carbon (coal)	•	•	decomposes to produce a white powder, carbon dioxide and water vapour
iron(III) hydroxide	•	•	changes from blue-green to black powder
calcium hydrogencarbonate	•	•	changes from blue crystals to white powder
potassium carbonate	•	•	decomposes to produce a dark powder and water vapour

(Total: 6 marks)

6

2) Fill in the blanks by choosing the correct word from the word bank below. Each word may be used once, more than once, or not at all.

four	three	structure	hard
reducing	allotropes	insulator	conductor

Diamond and graphite are _____ of carbon. This means that although both are made of the same element, their _____ is different. Each carbon atom in diamond is combined to _____ other carbon atoms. This makes diamond a very _____ natural material. On the other hand, graphite is a _____ of electricity. Carbon (graphite) can be heated with some metal oxides, such as copper(II) oxide, to produce the metal since carbon acts as a _____ agent.

(Total: 6 marks)

6

3)

a) Complete the following word equations:

i) hydrochloric acid + zinc → _____ + hydrogen (1)

ii) sulfuric acid + copper(II) oxide → _____ + water (1)

b) Convert the following word equation to a balanced chemical equation:

calcium carbonate + hydrochloric acid → calcium chloride + water + carbon dioxide

_____ (2)

c) Hydrogen chloride gas dissolves in both water and methylbenzene but only one of the solutions is acidic.

i) Which solution, hydrogen chloride in water or hydrogen chloride in methylbenzene, is acidic?

_____ (1)

ii) Why is only one of these solutions acidic?

_____

_____ (1)

(Total: 6 marks)

6

4) A concentrated copper(II) chloride solution is electrolysed using inert electrodes.

a) State the ion that will be attracted towards the:

i) cathode; _____ (1)

ii) anode. _____ (1)

b) What happens, if anything, to the colour of the copper(II) chloride solution after some time?

_____ (1)

c) Give an ionic half equation for the reaction happening at the cathode.

_____ (2)

d) What would happen at the anode if copper electrodes were used?

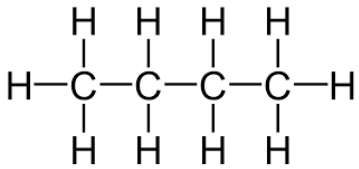
_____ (1)

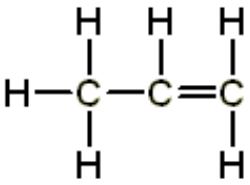
(Total: 6 marks)

6

5)

a) Write the names of the molecules below in the spaces provided.





_____ _____

(2)

b) Name the substance that is produced when ethene reacts with:

i) hydrogen gas: _____ (1)

ii) hydrogen chloride gas: _____ (1)

c) While alkenes react by addition reactions, alkanes react by substitution reactions. By referring to the structures in part (a), explain this difference between alkanes and alkenes.

_____

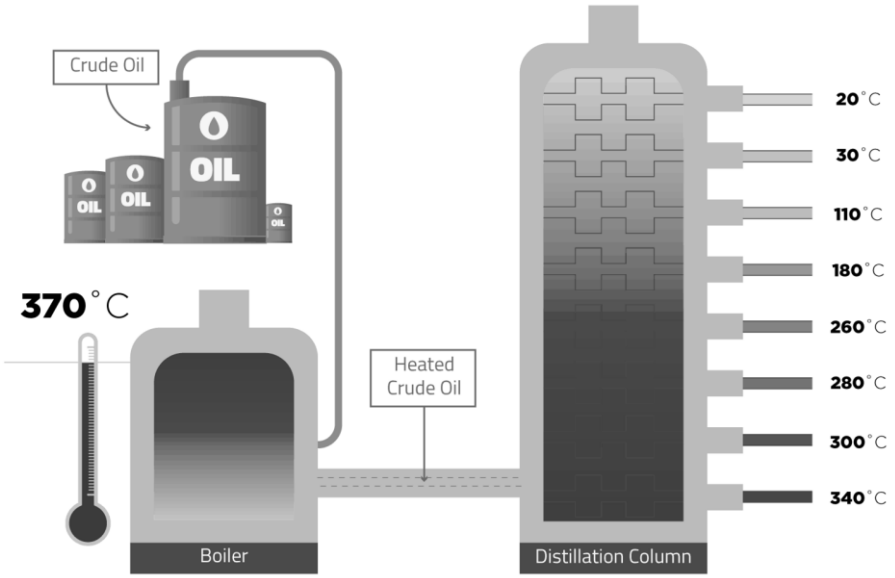
_____

_____ (2)

(Total: 6 marks)

6

6) Crude oil is a mixture of hydrocarbons. The diagram below outlines how this mixture is separated in industry.



Picture adapted from http://www.learnaboutair.com/

a) Does the average length of the carbon chain increase or decrease on going up the distillation column? Explain your answer.

_____

_____ (2)

b) Name **ONE** fraction obtained by this industrial process and suggest **ONE** use for this fraction.

_____

_____ (2)

c) The heavier fractions that are produced contain molecules, such as $C_{12}H_{26}$, that have limited use. These large molecules are cracked to form more usable ones. Suggest **TWO** molecules that will form when one molecule of $C_{12}H_{26}$ is cracked.

_____ (2)

(Total: 6 marks)

6

7) Carboxylic acids are a homologous series of organic compounds.

a) Draw the structural formula of propanoic acid showing all the bonds.

(2)

b) Name the products formed when ethanoic acid reacts with sodium.

_____ (2)

c) Ethanoic acid reacts with an organic substance **A** to form ethyl ethanoate and water. Ethyl ethanoate is characterised by a fruity smell.

i) Identify the organic substance **A**.

_____ (1)

ii) To which homologous series does ethyl ethanoate belong?

_____ (1)

(Total: 6 marks)

6

8) Nitrogen dioxide can be produced in the laboratory by the thermal decomposition of a salt.

a) What is the colour of nitrogen dioxide?

_____ (1)

b) Name a compound that can be heated to produce nitrogen dioxide in the laboratory.

_____ (1)

c) Nitrogen dioxide dissolves readily in water. Will the pH of the resultant solution be less than, equal to, or greater than 7?

_____ (1)

d) Nitrogen dioxide present in air causes acid rain. Give **TWO** disadvantages of acid rain.

_____

_____ (2)

e) Name **ONE** other gas, besides carbon dioxide and nitrogen dioxide, which is produced by the burning of fossil fuels and causes acid rain.

_____ (1)

(Total: 6 marks)

6

9) The electrolysis of bauxite produces aluminium. The half equation for this reaction follows:

$$Al^{3+} + 3\ e^{-} \rightarrow Al$$

a) Calculate the number of moles of electrons that would be required to produce 9,000 g of aluminium.

_____

_____ (2)

b) Convert the value calculated in part (a) to Faradays.

_____ (1)

c) Calculate the charge required to produce the mass of aluminium stated in part (a).

_____

_____ (1)

d) Calculate the time, in seconds, it would take for this amount of aluminium to be produced if the current used was 100,000 A.

_____

_____ (2)

(Total: 6 marks)

6

10) A student was required to prepare a 0.50 mol dm^{-3} standard solution of sodium carbonate.

a) Calculate the relative formula mass of Na_2CO_3.

_____

_____ (1)

b) Calculate the mass in grams of Na_2CO_3 required if 1 dm^3 of this solution was prepared.

_____

_____ (1)

c) Calculate the mass in grams of Na_2CO_3 that would be required if 250 cm^3 of this solution (of concentration 0.50 mol dm^{-3}) were needed.

_____

_____ (1)

d) A sample of 25.0 cm^3 of this Na_2CO_3 solution (of concentration 0.50 mol dm^{-3}) reacts with 20.0 cm^3 of HCl solution whose concentration is unknown. The balanced chemical equation for this reaction follows:

$$Na_2CO_3\,(aq) + 2\,HCl\,(aq) \rightarrow 2\,NaCl\,(aq) + H_2O\,(l) + CO_2\,(g)$$

i) Calculate the amount (in moles) of Na_2CO_3 in 25.0 cm^3 of solution.

_____

_____ (1)

ii) What is the amount (in moles) of HCl in 20.0 cm^3 of solution?

_____

_____ (1)

iii) Calculate the concentration, in mol dm^{-3}, of the HCl solution.

_____

_____ (1)

(Total: 6 marks)

6

SECTION B
Answer TWO questions from this section.

11) This question is about sulfur dioxide and hydrogen sulfide. Both compounds of sulfur have a strong, characteristic smell and are reducing agents. Sulfur dioxide is important for the Contact Process.

a) Both sulfur dioxide and hydrogen sulfide have distinct smells.

i) Describe the smell of hydrogen sulfide. (1)

ii) Describe the smell of sulfur dioxide. (1)

iii) Describe the chemical test and relevant observations to confirm the presence of sulfur dioxide. (2)

b) Both sulfur dioxide and hydrogen sulfide can be produced in the laboratory by the action of dilute hydrochloric acid on a salt. Name a salt to which hydrochloric acid can be added to produce:

i) sulfur dioxide; (1)

ii) hydrogen sulfide. (1)

c) Sulfur dioxide and hydrogen sulfide react together according to the equation shown below. This is a redox reaction.

$$2\ H_2S\ (g) + SO_2\ (g) \rightarrow 2\ H_2O\ (l) + 3\ S\ (s)$$

i) Predict **ONE** observation for this reaction. (1)

ii) Which sulfur atom is being reduced, that in hydrogen sulfide or that in sulfur dioxide? Give **ONE** reason for your answer. (2)

iii) Hence, which is the strongest reducing agent, hydrogen sulfide or sulfur dioxide? Give **ONE** reason for your answer. (2)

d) A small amount of one of these gases is added to food and drinks to avoid oxidation. Predict, giving **ONE** reason for your answer, which of sulfur dioxide or hydrogen sulfide is added to food and drinks to avoid oxidation. (2)

e) Write balanced chemical equations for each of the following steps in the Contact Process:

i) the production of sulfur dioxide; (2)

ii) the oxidation of sulfur dioxide; (2)

iii) the production of oleum. (2)

f) Name the catalyst used for the reaction in part (e)(ii). (1)

(Total: 20 marks)

12) The production of nitrogenous fertilisers is important as it significantly increases the Earth's food production. The process involves several steps.

a) In the first stage, nitrogen is obtained from air.

i) What is the percentage of nitrogen in air? (1)

ii) Name the industrial process by which nitrogen is obtained from air. (1)

iii) Briefly outline how nitrogen is obtained by the process mentioned in part (a)(ii). (3)

iv) Why is nitrogen unreactive? Refer to the bonding present. (2)

b) In the second stage, nitrogen is reacted with hydrogen to produce ammonia. This reaction reaches chemical equilibrium.

i) Write a balanced equation for this process. (2)

ii) Name the catalyst used in this process. (1)

iii) List typical values for pressure and temperature that are required to produce optimum yield of ammonia. (2)

iv) Name **ONE** use of ammonia, apart from production of fertilisers. (1)

c) In the third stage, ammonium salts are produced. Ammonium sulfate is one of many nitrogenous fertilisers.

i) Name a substance that can be added to ammonia to produce ammonium sulfate. (1)

ii) Describe chemical tests and relevant observations to confirm the presence of ammonium ions and sulfate ions. (4)

iii) Calculate the percentage nitrogen in ammonium sulfate, $(NH_4)_2SO_4$. (2)

(Total: 20 marks)

13) Chlorine, bromine, and iodine are three elements that are found in the Periodic Table.

a) What is the name of the group that these three elements form part of? (1)

b) This group contains other elements. Give the name of **ONE** of these elements. (1)

c) List **TWO** similarities between the elements in this group. (2)

d) Comment on the trend going down this group with respect to:

i) boiling point; (1)

ii) reactivity. (1)

e) The order of reactivity of chlorine, bromine and iodine can be identified by reacting the elements with salts of the other elements within the group. A partly filled table for this experiment is shown below.

	Cl_2	**Br_2**	**I_2**
Cl^-	No reaction		
Br^-			
I^-			

Describe this experiment. The description should include:

i) the method followed; (3)

ii) a table (as shown above) that includes the results expected; (3)

iii) an ionic equation, including state symbols and omitting spectator ions, for **ONE** of the reactions that occur. (3)

f) Write a balanced equation to show what happens when chlorine is mixed with water. (2)

g) The solution obtained in part (f) has bleaching properties. Which substance in this solution shows these properties? (1)

h) Describe how the test for chloride ions is performed including the expected result. (2)

(Total: 20 marks)

14) Sodium, potassium, magnesium and calcium are elements in the Periodic Table.

a) Classify these elements as alkali metals and alkaline earth metals. (2)

b) Distinguish between alkali metals and alkaline earth metals in terms of their:

i) appearance and hardness; (2)

ii) reaction with air (oxygen); (2)

iii) reaction with water. (2)

c) Explain, by referring to their electron configuration, how the reactivity of alkali metals changes on going down the group. (2)

d) When calcium carbonate is heated strongly, a white solid **A** and carbon dioxide are formed. When solid **A** is added to water, another white solid, **B**, forms. Solid **B** is slightly soluble in water. This mixture of **B** is used for whitewashing and eventually **B** turns back to calcium carbonate on reacting with carbon dioxide in air.

i) Identify substances **A** and **B**. (2)

ii) Write balanced equations for the **THREE** reactions described above. (6)

e) Describe the chemical test and relevant observations to confirm the presence of calcium ions in a solution. (2)

(Total: 20 marks)

DO NOT WRITE ABOVE THIS LINE

DO NOT WRITE ABOVE THIS LINE

PERIODIC TABLE

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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															

Key

Relative atomic mass — A; X; Z — *Atomic Number*

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