L-Università ta' Malta

MATSEC
Examinations Board

Specimen Papers

SEC 06 Chemistry

Table of Contents

Specimen Controlled Assessment Level 1-2

MATRICULATION AND SECONDARY EDUCATION CERTIFICATE
EXAMINATIONS BOARD

L-Università ta' Malta

SECONDARY EDUCATION CERTIFICATE LEVEL
SAMPLE PAPER

SUBJECT:	**Chemistry**
PAPER NUMBER:	**Level 1 – 2**
DATE:	
TIME:	2 Hours

Useful data:

Avogadro constant = 6.02×10^{23}

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

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

STP conditions = 0 ^{o}C and 10^5 Pa/1 atm.

Directions to Candidates

- Write your index number in the space at the top left-hand corner of this page.
- Answer **ALL** questions 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.
- The following information is printed on the back of this booklet:
    - Periodic Table
    - Reactivity Series
    - Order of discharge at electrodes
    - List of polyatomic ions and their charges
    - Solubility rules

Answer ALL questions.

1) The atmosphere consists of different gases. When the atmosphere is polluted, other gases are also present.

a) The following gases are found in air.

Nitrogen	Carbon monoxide
Water vapour	Helium

Place them in the appropriate box of the following table. Each box may be used once, more than once or not at all.

	Natural	Man-Made
Element		
Compound		

(4)

b) Find the best match between the following substances and their properties.

Nitrogen	•	• Supports combustion
Water vapour	•	• Toxic gas
Oxygen	•	• Inert
Carbon monoxide	•	• Condenses at 100 ^{o}C

(4)

c) Name **ONE** use for the following gases:

i) Helium: _____ (1)

ii) Carbon dioxide: _____ (1)

(Total: 10 marks)

2) Common salt is a compound that is made of the elements sodium and chlorine that are chemically joined together.

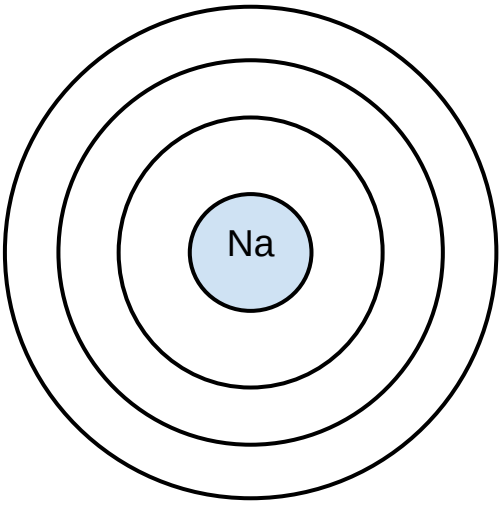
a) Use the Periodic Table provided to give the following information about a sodium atom.

i) Atomic number: _____ (1)

ii) Mass number: _____ (1)

iii) Number of electrons: _____ (1)

b) Draw the electron configuration on the structure of the sodium atom below. (2)



c) Chlorine is an element whose relative atomic mass is 35.5. It consists of two types of chlorine atoms, Cl-35 and Cl-37.

i) What is the name of these kinds of atoms?

_____ (1)

ii) Which of these variations of chlorine is more common?

_____ (1)

(Total: 7 marks)

3)

a) Group 7 of the Periodic Table consists of elements such as chlorine, bromine and iodine.

i) Give the name of this group of elements.

_____ (1)

ii) Name **ONE** use of chlorine compounds that are added to swimming pool water.

_____ (1)

iii) State the colour and physical state of iodine at room temperature.

Colour: _____ (1)

Physical state: _____ (1)

b) Group 1 of the Periodic Table consists of elements such as sodium and potassium.

i) Give the name of this group of elements.

_____ (1)

ii) Name **ONE** physical property typical of these elements.

_____ (1)

iii) Give the chemical formula of potassium bromide.

_____ (2)

iv) Give the name of the compound that forms when potassium reacts with oxygen.

_____ (1)

(Total: 9 marks)

4) Malta's bedrock consists of several layers of sedimentary rock.

a) Limestone is cut from open air sites called quarries. Mention **TWO** environmental impacts of this process.

_____

_____

_____ (2)

b) Limestone contains a high percentage of calcium carbonate.

i) A piece of limestone is added to some hydrochloric acid. Give **ONE** observation for this reaction.

_____ (1)

ii) Describe a chemical test that shows the presence of calcium ions in the solution produced in part (b) (i).

_____

_____ (2)

c) Name **ONE** use of limestone.

_____ (1)

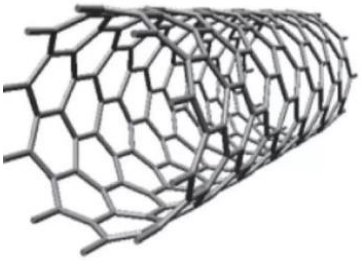
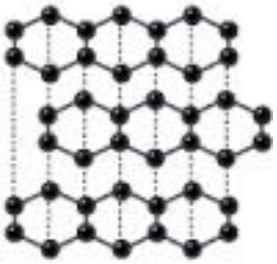
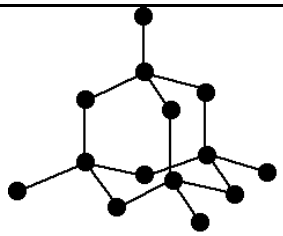
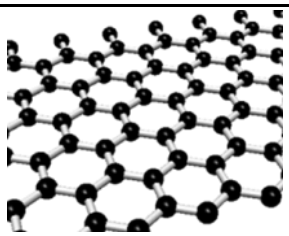
d) Limestone can be used as a starting material to produce quicklime and then slaked lime. State what is required to change:

i) limestone to quicklime; _____ (1)

ii) quicklime to slaked lime. _____ (1)

(Total: 8 marks)

5) Name the following carbon structures:

(Total: 4 marks)

6) Aluminium is an important metal commonly used in the manufacture of balcony rails. It is extracted from bauxite.

a) Name **TWO** advantages of using aluminium instead of iron.

_____

_____ (2)

b) Bauxite needs to be chemically processed so that alumina (purified aluminium oxide) can be obtained. Alumina is then electrolysed to obtain aluminium. Discuss why it makes sense to recycle aluminium.

_____

_____

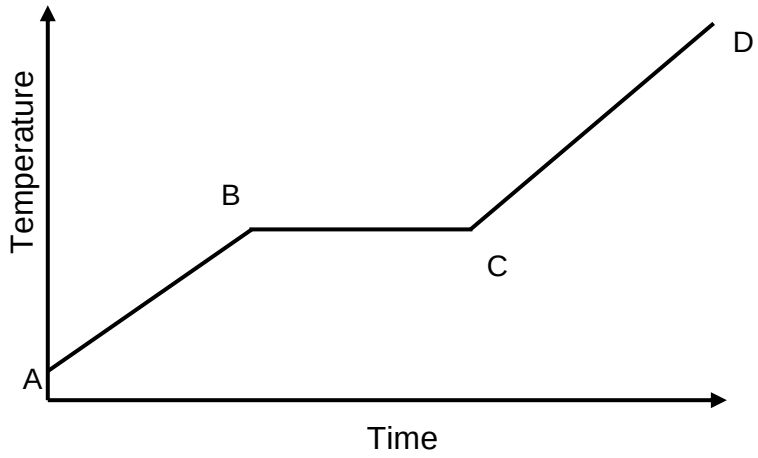
_____ (2)

c) Bauxite is an ore that is usually excavated from open quarries. Mention **ONE** environmental issue related to the mining of aluminium.

_____ (1)

(Total: 5 marks)

7) The sketch below shows a heating curve for a substance that sublimes.



a) What is the state of matter during the parts on the graph indicated by:

i) AB; _____ (1)

ii) CD. _____ (1)

b) Heat is continuously supplied from A to D. State what happens with respect to the:

i) physical state of the substance during phase BC;

_____ (1)

ii) temperature of the substance during phase CD.

_____ (1)

c) Name the reverse process of sublimation.

_____ (1)

d) Underline the correct word in the following statement:

Sublimation is a (chemical/physical) change. (1)

(Total: 6 marks)

8) Pure lead(II) sulfate can be produced in the lab by adding lead(II) nitrate solution to dilute sulfuric acid. Lead(II) sulfate forms a precipitate which is filtered, washed with distilled water and dried.

a) Name **ONE** safety precaution related to sulfuric acid and state the reason for this precaution.

Safety precaution: _____(1)

Reason:_____ (1)

b) State what was done to ensure that pure lead(II) sulfate is produced.

_____ (1)

c) Calculate the relative molecular mass of H_2SO_4.

_____

_____ (2)

d) Calculate the percentage by mass of sulfur in H_2SO_4.

_____

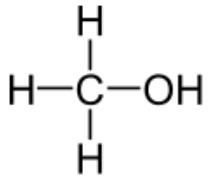
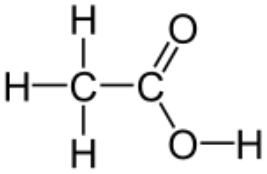
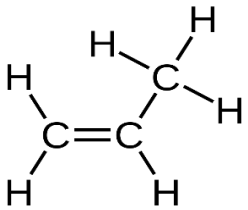
_____ (2)

e) Write a balanced chemical equation for the reaction between lead(II) nitrate solution and sulfuric acid. Include state symbols.

_____ (3)

(Total: 10 marks)

9) Name the homologous series of the following organic molecules.

Structural formula	Homologous Series
	(1)
	(1)
	(1)

(Total: 3 marks)

10) Crude oil is a very important resource that contains a variety of substances.

a) State the type of substances found in crude oil.

_____ (1)

b) Place the following fractions obtained from crude oil in order, starting from the lightest fraction.

naphtha, residue, gasoline/petrol, kerosene, diesel oil, refinery gases, fuel oil

_____ (1)

c) Identify the fraction from which the following fuels are obtained:

i) Liquefied petroleum gas (LPG): _____ (1)

ii) Aeroplane fuel: _____ (1)

iii) Fuels used for trucks and lorries: _____ (1)

d) The global demand for light fuels exceeds that for heavier fuels. For this reason, the molecules in heavier fuels need to be transformed into smaller molecules.

i) Name this process.

_____ (1)

ii) Describe how this process works.

_____ (1)

e) Describe a chemical test that distinguishes between alkanes and alkenes.

_____

_____

_____ (2)

f) Name the homologous series of propane.

_____ (1)

g) Write a balanced chemical equation for the complete combustion of propane (C_3H_8). Include state symbols.

_____ (3)

h) Name **TWO** substances that are produced during incomplete combustion but **not** during complete combustion of hydrocarbons.

_____

_____ (2)

(Total: 15 marks)

11) Alkenes are unsaturated hydrocarbons that are capable of producing polymers. Polythene is a common polymer that has many uses.

a) Give the meaning of the following terms:

i) unsaturated;

_____ (1)

ii) hydrocarbon;

_____ (1)

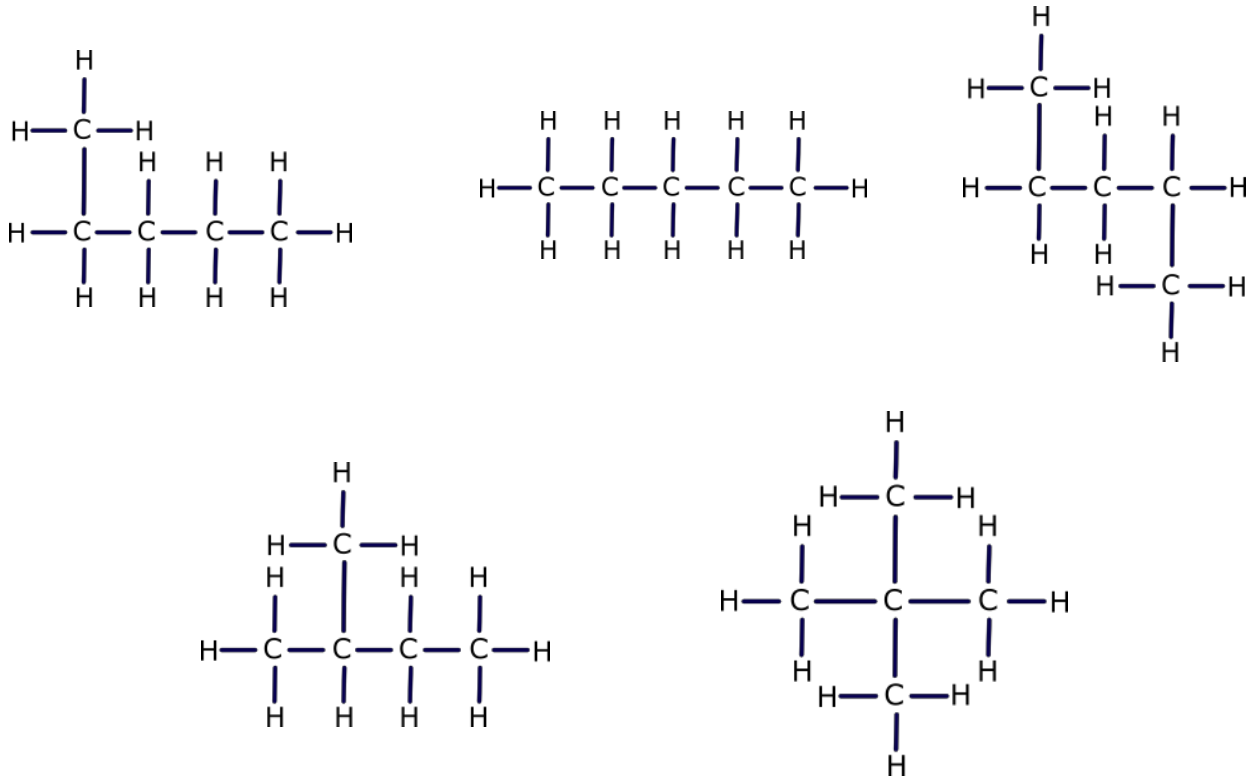
iii) alkene.

_____ (1)

b) Name **ONE** use of polyethene.

_____ (1)

c) Draw a circle around the displayed formulae below that are isomers of pentane which are branched hydrocarbons. (2)



(Total: 6 marks)

12) A student prepared and collected a sample of carbon dioxide gas by reacting hydrochloric acid with magnesium carbonate. The student noted that the reaction is exothermic.

a) Write a balanced chemical equation to represent the reaction between hydrochloric acid and magnesium carbonate. Include state symbols.

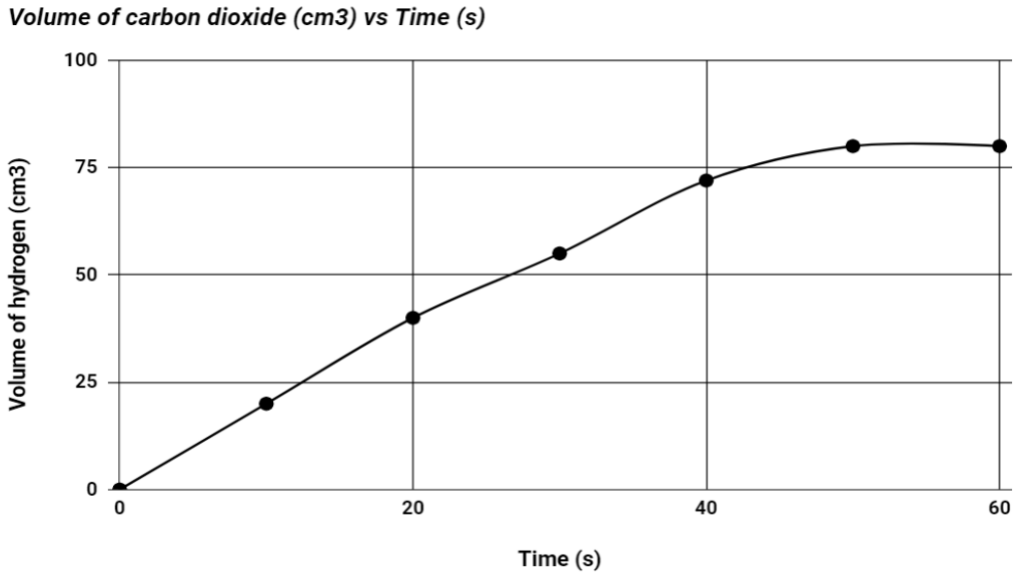
_____ (3)

b) State how the student notes that the reaction is exothermic.

_____ (1)

c) Draw a labelled energy level diagram for an exothermic reaction. (4)

d) The following graph shows the amount of carbon dioxide collected against time.



i) At which point in time does the reaction finish?

_____ (1)

ii) Explain why, another point is plotted on the graph beyond the finishing point.

_____ (1)

iii) From the graph, give the maximum amount of carbon dioxide that is produced.

_____ (1)

e) The student repeats the experiment. State what the student should do to produce:

i) the same amount of carbon dioxide;

_____ (1)

ii) the same amount of carbon dioxide in a shorter period of time;

_____ (1)

f) Carbon dioxide is a gas that is present in the atmosphere; some of it due to natural causes but a substantial amount is due to the combustion of fossil fuels.

i) Explain why carbon dioxide among other gases, is responsible for global warming.

_____ (1)

ii) Mention **TWO** gases that share this property with carbon dioxide.

_____ (2)

iii) State whether a solution of carbon dioxide in water would be alkaline, acidic or neutral.

_____ (1)

(Total: 17 marks)

END OF PAPER

PERIODIC TABLE OF THE ELEMENTS

1	2											3	4	5	6	7	0
							1 **H** Hydrogen 1										4 **He** Helium 2
7 **Li** Lithium 3	9 **Be** Beryllium 4											11 **B** Boron 5	12 **C** Carbon 6	14 **N** Nitrogen 7	16 **O** Oxygen 8	19 **F** Fluorine 9	20 **Ne** Neon 10
23 **Na** Sodium 11	24 **Mg** Magnesium 12											27 **Al** Aluminium 13	28 **Si** Silicon 14	31 **P** Phosphorus 15	32 **S** Sulfur 16	35.5 **Cl** Chlorine 17	40 **Ar** Argon 18
39 **K** Potassium 19	40 **Ca** Calcium 20	45 **Sc** Scandium 21	48 **Ti** Titanium 22	51 **V** Vanadium 23	52 **Cr** Chromium 24	55 **Mn** Manganese 25	56 **Fe** Iron 26	59 **Co** Cobalt 27	59 **Ni** Nickel 28	63.5 **Cu** Copper 29	65 **Zn** Zinc 30	70 **Ga** Gallium 31	73 **Ge** Germanium 32	75 **As** Arsenic 33	79 **Se** Selenium 34	80 **Br** Bromine 35	84 **Kr** Krypton 36
85 **Rb** Rubidium 37	88 **Sr** Strontium 38	89 **Y** Yttrium 39	91 **Zr** Zirconium 40	93 **Nb** Niobium 41	96 **Mo** Molybdenum 42	99 **Tc** Technetium 43	101 **Ru** Ruthenium 44	103 **Rh** Rhodium 45	106 **Pd** Palladium 46	108 **Ag** Silver 47	112 **Cd** Cadmium 48	115 **In** Indium 49	119 **Sn** Tin 50	122 **Sb** Antimony 51	128 **Te** Tellurium 52	127 **I** Iodine 53	131 **Xe** Xenon 54
133 **Cs** Caesium 55	137 **Ba** Barium 56	139 **La** Lanthanum 57	178 **Hf** Hafnium 72	181 **Ta** Tantalum 73	184 **W** Tungsten 74	186 **Re** Rhenium 75	190 **Os** Osmium 76	192 **Ir** Iridium 77	195 **Pt** Platinum 78	197 **Au** Gold 79	201 **Hg** Mercury 80	204 **Tl** Thallium 81	207 **Pb** Lead 82	209 **Bi** Bismuth 83	210 **Po** Polonium 84	210 **At** Astatine 85	222 **Rn** Radon 86

Key:

a
X
Y
b

relative atomic mass
SYMBOL
Name
atomic number

Reactivity series	
Decreasing Reactivity ↓	Potassium
	Sodium
	Calcium
	Magnesium
	Aluminium
	Carbon
	Zinc
	Iron
	Lead
	Copper
	Silver
	Gold
	Platinum

Order of discharge at cathode	
Increasing Ease of Discharge ↓	Na^+
	Mg^{2+}
	Al^{3+}
	Zn^{2+}
	Fe^{2+}
	Pb^{2+}
	H^+
	Cu^{2+}
	Ag^+
	Au^{3+}

Order of discharge at anode
1. For aqueous very dilute solutions OH^- is discharged. 2. For aqueous concentrated solutions containing halide ions (Cl^-, Br^- and I^-), these are discharged in preference to OH^-. 3. SO_4^{2-}, NO_3^- and CO_3^{2-} are never discharged from aqueous solutions

List of polyatomic ions and their charges	
Name	**Formula**
Ammonium	NH_4^+
Nitrate	NO_3^-
Sulfate	SO_4^{2-}
Carbonate	CO_3^{2-}
Hydrogencarbonate	HCO_3^-
Hydroxide	OH^-

Solubility Rules	
Soluble	**Insoluble**
• All nitrates • All hydrogencarbonates • All group 1 metal salts • All ammonium salts • Halides except silver and lead halides • Sulfates except barium, calcium, and lead sulfates	• Carbonates except group 1 metal and ammonium carbonate • Metal oxides except group 1 and 2 metal oxides that react with water. • Hydroxides except group 1 metal and ammonium hydroxides

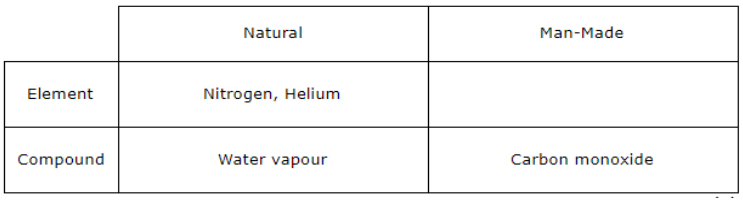
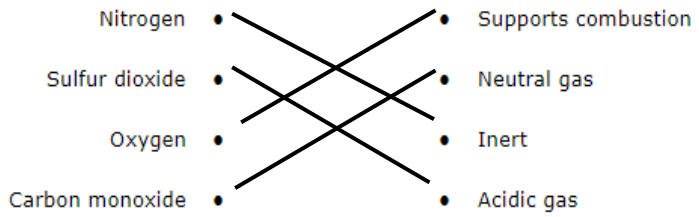
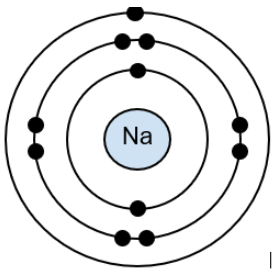
Specimen Controlled Assessment Level 1-2 Marking Scheme

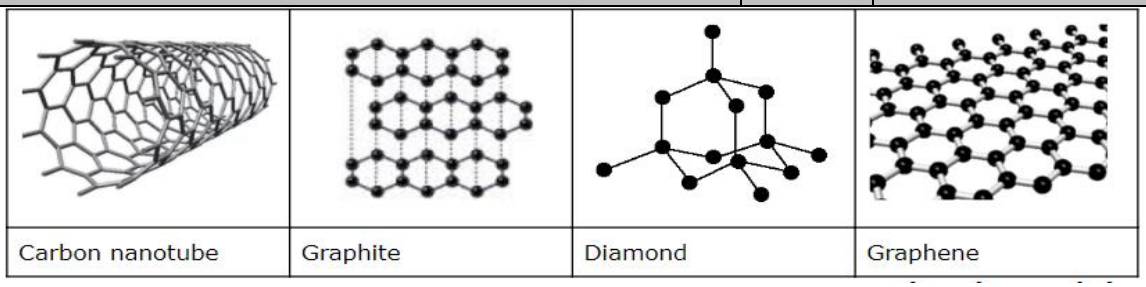
L-Università ta' Malta

MATRICULATION AND SECONDARY EDUCATION CERTIFICATE EXAMINATIONS BOARD

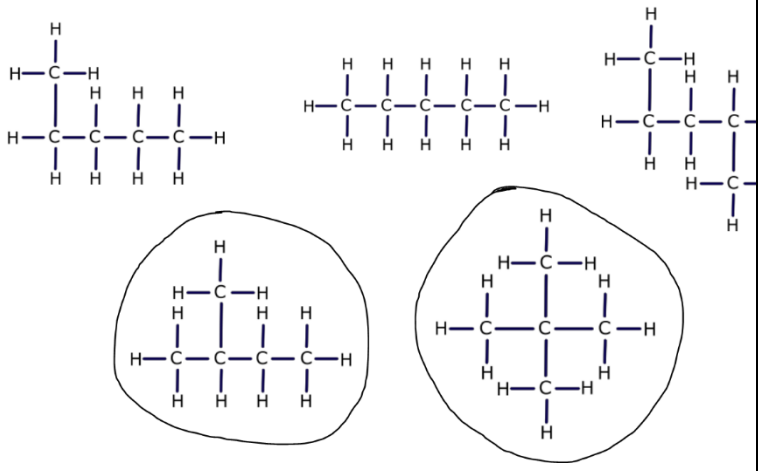
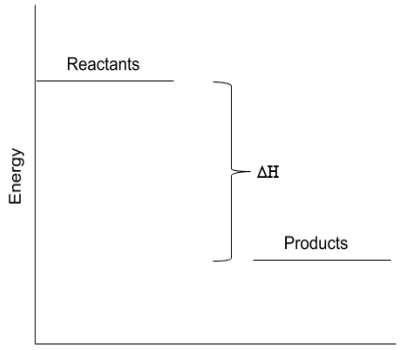
SECONDARY EDUCATION CERTIFICATE LEVEL
SAMPLE PAPER MARKING SCHEME

SUBJECT:	**Chemistry**
PAPER NUMBER:	**Level 1 – 2**
DATE:	
TIME:	2 Hours

Question			Suggested answers	Marks	Additional notes
1	a			4	1 mark for each placing
	b			4	1 mark for each correct match
	c	i	Helium is used to fill high altitude balloons.	1	Accept other correct answers
		ii	Carbon dioxide is used to extinguish fires.	1	Accept other correct answers
			Total	**10**	
2	a	i	11	1	
		ii	23	1	
		iii	11	1	
	b			2	- 1 mark for correct electron configuration - 1 mark for correct order (that is 2 on innermost (first) shell, 8 on the second and 1 on the third).
	c	i	Isotopes	1	
		ii	Cl-35	1	
			Total	**7**	

Question			Suggested answers	Marks	Additional notes
3	a	i	Halogens.	1	
		ii	To sanitise the water	1	
		iii	Dark purple. Solid.	1 1	
	b	i	Alkali metals.	1	
		ii	They are relatively light metals.	1	Accept they float on water.
		iii	KBr	2	1 mark symbols 1 mark for formula
		iv	Potassium oxide.	1	Do not accept the formula
			Total	**9**	
4	a		- Is a very dusty process - Increases the amount of particulates in air - Quarries are an eyesore	2	Any two
	b	i	Effervescence is observed	1	
		ii	Add NaOH(aq) until in excess to a solution containing calcium ions. A white precipitate insoluble in excess NaOH shows the presence of calcium ions.	1 1	
	c		As a building material. OR To make statues.	1	
	d	i	Apply strong heat	1	
		ii	Add water	1	
			Total	**8**	
5			 Carbon nanotube | Graphite | Diamond | Graphene		
			Total	**4**	
6	a		• It does not corrode easily. • It is relatively lightweight.	2	
	b		• Chemical processing of bauxite uses a lot of resources that lead to a higher cost of the metal. • Electrolysis is a high energy process which also increases the cost of the metal. • Recycling aluminium is cheaper than producing it from scratch.	2	Any two
	c		Open quarries lead to increased amounts of dust pollution	1	
			Total	**5**	
7	a	i	Solid	1	
		ii	Gas	1	
	b	i	The substance is undergoing a change of state	1	
		ii	The temperature of the substance is increasing	1	
	c		Deposition	1	
	d		Physical	1	
			Total	**6**	

Question			Suggested answers	Marks	Additional notes
8	a		Latex gloves must be worn due to the corrosiveness of the acid. **OR** Safety specs must be worn to protect the eyes from acid splashes as it is corrosive.	2	1 mark for safety precaution. 1 mark for related reason.
	b		Lead(II) sulfate was filtered then washed with distilled water.	1	
	c		RMM (H_2SO_4): (1x2) + 32 + (16 x 4) = 98	2	1 mark for working. 1 mark for answer.
	d		% by mass = $\frac{mass\ of\ sulfur}{mass\ of\ sulfuric\ acid}$ x 100 = (32/98) x 100 = 32.65 %	2	1 mark for working. 1 mark for answer. Apply follow through.
	e		$Pb(NO_3)_2(aq) + H_2SO_4(aq) \rightarrow PbSO_4(s) + 2HNO_3(aq)$	3	1 mark for chemical formulae. 1 mark for balancing. 1 mark for reversible reaction sign.
			Total	**10**	
9			alcohol, carboxylic acid OR alkanoic acid, alkene	1 1 1	Do not accept names of substances.
			Total	**3**	
10	a		hydrocarbons	1	
	b		refinery gases, gasoline/petrol, naphtha, kerosene, diesel oil, fuel oil and residue.	1	
	c	i	Refinery gas	1	
		ii	Kerosene	1	
		iii	Diesel oil	1	
	d	i	Cracking	1	
	d	ii	Large hydrocarbons are heated until they crack into smaller hydrocarbons.	1	
	e		Alkenes decolourise bromine water while alkanes don't.	2	
	f		Alkane	1	
	g		$C_3H_8(g) + 5O_2(g) \rightarrow 3CO_2(g) + 4H_2O(l)$	3	1 mark for formulae. 1 mark for balancing. 1 mark for state symbols.
	h		Soot, Carbon monoxide	1,1	
			Total	**15**	
11	a	i	An organic substance that has a double or triple bond between two of its carbons.	1	
		ii	An organic substance that contains carbon and hydrogen only.	1	

Question			Suggested answers	Marks	Additional notes
		iii	A hydrocarbon that has a double bond between two of its carbon atoms.	1	
	b		Packaging in the food industry.	1	Accept other correct answers
	c			2	
			Total	**6**	
12	a		$2HCl(aq) + MgCO_3(s) \rightarrow MgCl_2(aq) + H_2O(l) + CO_2(g)$	3	1 mark for chemical formulae. 1 mark for balancing. 1 mark for state symbols.
	b		The reaction vessel increases in temperature during the reaction.	1	
	c			4	1 mark for each label and corresponding correct placement.
	d	i	At the 50th second	1	
		ii	To ensure that reaction has come to an end	1	
		iii	$80cm^3$	1	
	e	i	By using the same amount of substances	1	
		ii	By increasing temperature OR increasing concentration of acid OR by crushing the carbonate into smaller pieces.	1	
	f	i	It is a greenhouse gas	1	
		ii	Water vapour and methane	2	
		iii	Acidic	1	
			Total	**17**	

Specimen Controlled Assessment Level 2-3

MATRICULATION AND SECONDARY EDUCATION CERTIFICATE
EXAMINATIONS BOARD

L-Università ta' Malta

SECONDARY EDUCATION CERTIFICATE LEVEL
SAMPLE PAPER

SUBJECT:	**Chemistry**
PAPER NUMBER:	**Level 2 – 3**
DATE:	
TIME:	2 Hours

Useful data:

Avogadro constant = 6.02×10^{23}

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

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

STP conditions = 0 ^{o}C and 10^5 Pa/1 atm.

Directions to Candidates

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- The following information is printed on the back of this booklet:
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    - Reactivity Series

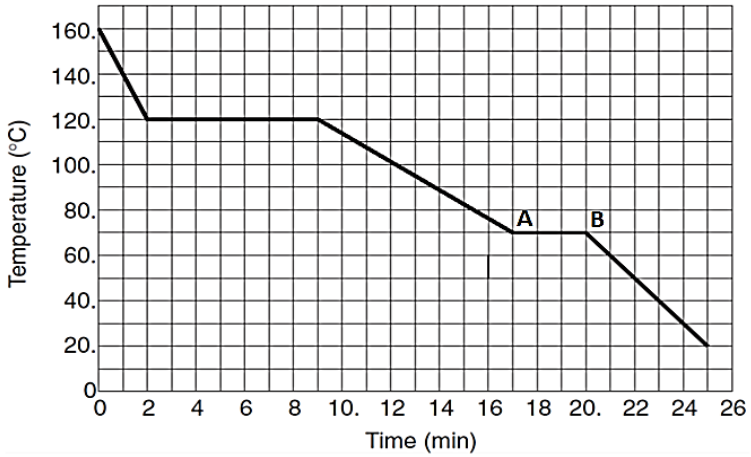
Answer ALL questions.

1)

a) Read the following statements and indicate whether they are True or False. (4)

	True/False
i. The total mass of the reactants before a reaction is not equal to the total mass of the products formed at the end of the reaction.	
ii. Pure water conducts electricity.	
iii. Chlorine gas diffuses slower than fluorine gas.	
iv. The conversion of anhydrous copper(II) sulfate to hydrated copper(II) sulfate is an example of a reversible reaction.	

b) The following graph shows a cooling curve of a pure substance. The graph starts as a gas above its boiling point.



adapted from: http://www.aplusphysics.com/courses/honors/thermo/phase_changes.html

i. Use the graph to write down the temperature at which the gas condenses.

_____ (1)

ii. Use the kinetic theory to explain what happens to the arrangement of particles in the pure substance between 10 to 16 minutes.

_____

_____ (1)

iii. In a different experiment, another cooling curve was plotted. However, this time the line **AB** obtained was at a different distance from the x-axis. Suggest a reason for this observation.

_____ (1)

(Total: 7 marks)

2) The following table shows the electron configuration of five unknown elements labelled **V**, **W**, **X**, **Y** and **Z**. These letters are not the actual chemical symbols of the unknown elements.

Element	Electron Configuration
V	2,1
W	2,4
X	2,6
Y	2,8
Z	2,8,5

a) Use letters **V-Z** to indicate the element which:

i. is a noble gas; _____ (1)

ii. has an atomic number of 6; _____ (1)

iii. is in period 3 of the Periodic Table. _____ (1)

b) Elements **V** and **X** react to form an ionic compound. Write the electronic configuration of an ion of:

i. **V**;_____ (1)

ii. **X**. _____ (1)

c) Give **ONE** physical property of ionic compounds.

_____ (1)

d) State whether the oxide of element **V** is acidic or basic.

_____ (1)

e) Draw a dot-cross diagram (*showing outer electron shells only*) to show bonding in a compound formed when atoms **W** and **X** react together. (2)

(Total: 9 marks)

3) A student wants to investigate how the reactivity of group 1 metals changes along the group. She fills a trough with water and gently drops a small sample of lithium in the trough. Any observations are noted. She then repeats the same procedure for sodium and potassium metals. All alkali metals are stored in separate containers filled with oil.

a) Give **ONE** reason why alkali metals are stored under oil.

_____ (1)

b) Write a balanced chemical equation, to show what happens when a small sample of sodium metal reacts with water.

_____ (2)

c) Explain what happens to the reactivity of group 1 metals on going down the group, in terms of atomic structure.

_____

_____

_____

_____ (3)

d) The student then carefully heated a sample of sodium in air. The compound was analysed and the following results were obtained.

- Mass of sodium = 14.10 g
- Mass of oxygen = 4.90 g

i. Calculate the empirical formula of the compound formed.

_____

_____

_____

_____

_____ (3)

ii. Work out its molecular formula if the relative formula mass of the compound is 62.

_____

_____ (2)

(Total: 11 marks)

4) Local car owners are converting their vehicle's fuel system to liquid petroleum gas (LPG). LPG is a mixture of the following alkanes propane and butane each having the respective molecular formula: C_3H_8 and C_4H_{10}.

a) There are two isomers with the molecular formula C_4H_{10}. Draw the displayed formulae of these **TWO** isomers. (2)

b) Predict whether propane or butane would have the highest boiling point. Give **ONE** reason for your answer.

_____

_____

_____ (2)

c) When burnt in air, both propane and butane undergo complete combustion. Write a balanced chemical equation to show the complete combustion of butane.

_____ (2)

d) Name **ONE** gaseous product which is formed when LPG burns in a limited supply of air rather than when burnt in a plentiful supply of air.

_____ (1)

e) Propene and butene are examples of alkenes. Describe a simple chemical test (other than combustion) to distinguish between samples of propene and propane. Your answer should include any colour changes noted.

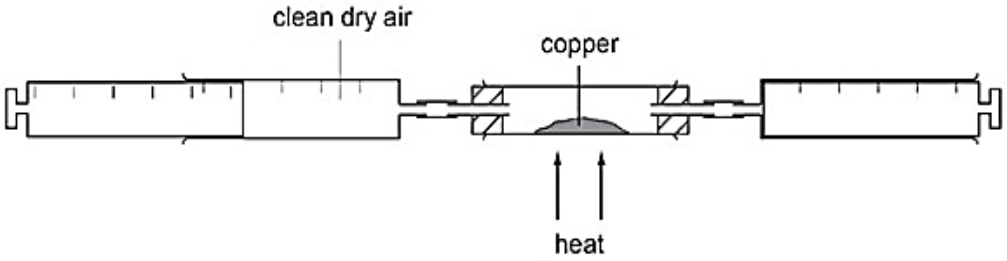
_____

_____

_____ (3)

(Total: 10 marks)

5) Air is a mixture of gases. Two students were asked to measure the percentage of oxygen present in air by setting up the apparatus shown below. They heated a known mass of copper turnings in a combustion tube fixed to two gas syringes. A fixed volume of air was passed over the copper turnings from one gas syringe to the other.



a) Once the reaction was over, the apparatus was allowed to cool before measuring the final volume of the remaining gas in the syringe. Give **ONE** reason for this precaution.

_____

_____ (1)

b) Use the following information to calculate the percentage of oxygen in the sample of air.

- Volume of air in the gas syringe before heating = 75.00 cm^3
- Volume of air in the gas syringe after heating = 59.25 cm^3

_____

_____

_____ (2)

c) Name the main gas component which is left behind in the combustion tube once all of the oxygen is used during the reaction.

_____ (1)

d) A small percentage of air is composed of noble gases. One common noble gas found in air is argon. State **ONE** use of argon.

_____ (1)

(Total: 5 marks)

6) Chlorine gas can be produced in the lab by gently heating a sample of manganese(IV) oxide with concentrated hydrochloric acid. Chlorine gas is then collected in a gas syringe. The reaction can be summarised as shown in the following equation:

$$\underline{Mn}O_2(s) + 4H\underline{Cl}(aq) \rightarrow MnCl_2(aq) + Cl_2(g) + 2H_2O(l)$$

a) The above reaction is an example of a redox reaction. State whether the underlined ions are being oxidised or reduced. Give a reason for your answer in terms of oxidation numbers.

$\underline{Mn}O_2$: _____ (1)

Reason: _____ (1)

H$\underline{Cl}$: _____ (1)

Reason: _____ (1)

b) During the reaction, 5.09 g of solid manganese(IV) oxide were added to excess concentrated hydrochloric acid. All of the manganese(IV) oxide reacted with the acid. Calculate:

i. The number of moles of manganese(IV) oxide used during the reaction.

_____

_____(2)

ii. The number of moles of hydrochloric acid which reacted with solid manganese(IV) oxide.

_____

_____(2)

iii. The volume of chlorine gas collected at standard temperature and pressure (STP).

_____

_____

_____

_____ (3)

iv. Give a suitable test which can be used to prove that the gas produced during the reaction is chlorine gas.

_____(1)

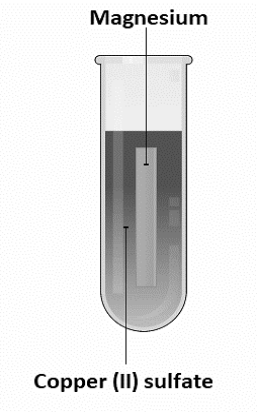
(Total: 12 marks)

7) Consider the following metals: aluminium, copper and calcium.

a) Complete the table below by writing the name of the corresponding element next to each of following statements. Each metal can be used more than once. (5)

	Description	**Elements**
i.	Gives an orange red colour when burnt in a Bunsen burner flame.	
ii.	A metal which does not react with cold water or steam.	
iii.	Deposits zinc when added to a solution of zinc nitrate.	
iv.	Compounds of this metal have variable oxidation states	
v.	A solution of an ionic salt of this metal reacts with sodium hydroxide solution to form a white precipitate which is soluble in excess sodium hydroxide.	

b) A strip of magnesium metal was dipped in a blue solution of copper(II) sulfate.



i. Write a net ionic equation to show the reaction which occurs when a strip of magnesium metal is dipped in a solution of copper(II) sulfate.

_____

_____

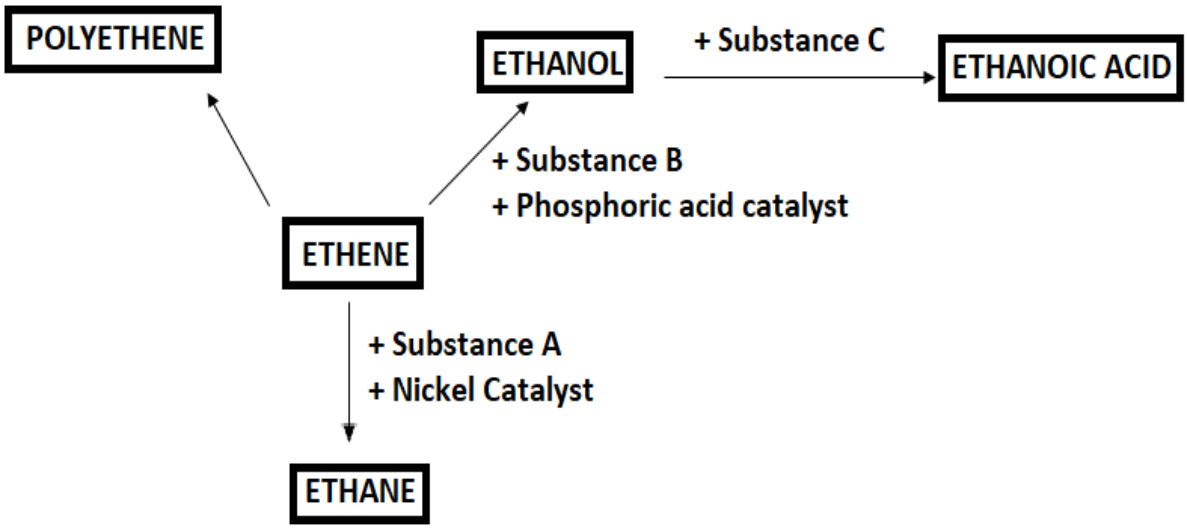
_____ (2)

ii. Give **ONE** observation related to the reaction between magnesium metal and copper(II) sulfate solution.

_____ (1)

(Total: 8 marks)

8) The following scheme shows reaction conversions involving ethene. Letters **A**, **B** and **C** are not actual chemical symbols of the reagents required for successful conversions.



a) Give the chemical name of:

i. Substance **A:** _____

ii. Substance **B:** _____

iii. Substance **C:** _____ (3)

b) Ethanol reacts with ethanoic acid to form an organic compound called ethyl ethanoate.

i. Name the homologous series of the compound ethyl ethanoate.

_____ (1)

ii. Write a balanced chemical equation to show the reaction of ethanol with ethanoic acid.

_____ (2)

c) Write a balanced chemical equation to show how ethanol can also be produced by a fermentation reaction. Include the catalyst used during this reaction.

_____ (2)

d) Polyethene is an addition polymer. Draw the displayed formula of polyethene showing 3 monomer units joined together. (2)

(Total: 10 marks)

9) Ammonia is an important compound, prepared during the Haber Process. The industrial preparation of ammonia involves the reaction of nitrogen with hydrogen gas under special conditions. The reaction which takes place is as follows:

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

a) What does the negative sign of ΔH indicate about the reaction?

_____ (1)

b) Explain, giving reasons, how the position of equilibrium is affected with an increase in pressure.

_____

_____

_____

_____ (3)

c) Usually when the temperature of a reaction increases, the rate of reaction would increase too. Explain this statement in terms of the collision theory.

_____

_____

_____ (2)

d) An iron catalyst is also used in the Haber Process. Discuss the importance of this catalyst in the industrial production of ammonia.

_____

_____

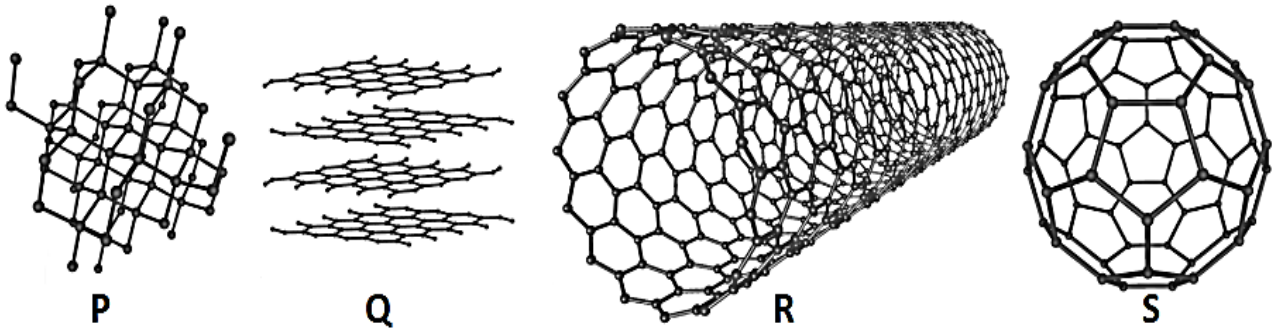
_____ (2)

e) Ammonia can be prepared in the laboratory by reacting an alkali with an ammonium salt. Give a balanced chemical equation, for the reaction of ammonium sulfate with sodium hydroxide solution.

_____ (2)

(Total: 10 marks)

10) Aluminium is a metal of economic importance. It can be extracted from its ore by electrolysis which makes use of carbon electrodes. The following diagrams show four carbon allotropes labelled **P**, **Q**, **R** and **S**.



adapted from https://commons.wikimedia.org/w/index.php?curid=584786

a) Explain why the structures labelled **P, Q, R** and **S** are referred to as allotropes.

_____

_____ (1)

b) Give **ONE** reason why allotrope **Q** is used as an electrode during the electrolytic process of aluminium.

_____ (1)

c) The anode used during the electrolysis of aluminium needs to be replaced from time to time. Explain why.

_____

_____

_____ (2)

d) "Aluminium is extensively recycled because less energy is needed to produce recycled aluminium than to extract aluminium from its ore."

http://www.bbc.co.uk/schools/gcsebitesize/science/aqa_pre_2011/rocks/metalsrev7.shtml

Use this statement to explain how recycling aluminium can have a positive influence on the economy and natural environment.

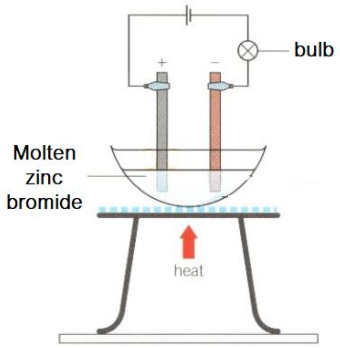
_____

_____

_____

_____ (2)

e) The following diagram shows the electrolysis set up of molten zinc bromide using allotrope **Q** as electrodes.



Describe what will be observed at the cathode and at the anode.

_____

_____ (2)

(Total: 8 marks)

11) Read the following passage and then answer the questions that follow.

An oil-eating bacterium that can help clean up pollution and spills

Research associate Dr. Tarek Rouissi studied "technical data sheets" for many bacterial strains with the aim of finding the perfect candidate for a dirty job: cleaning up oil spills. *Alcanivorax borkumensis,* a harmless marine bacterium, caught his attention. The microorganism is classified as "hydrocarbonoclastic" -- i.e., as a bacterium that uses hydrocarbons as a source of energy. This bacterium is present in all oceans and drifts with the current, multiplying rapidly in areas where the concentration of oil compounds is high, which partly explains the natural degradation observed after some spills.

Alcanivorax borkumensis boasts an impressive set of tools: during its evolution, it has accumulated a range of specific enzymes that degrade almost everything found in oil. To test the microscopic cleaner, the research team purified a few of the enzymes and used them to treat samples of contaminated soil. Professor Satinder Kaur Brar, a researcher working on this project, stated that "the degradation of hydrocarbons using the enzyme extract is really encouraging and reached over 80% for various compounds. It has been tested under a number of different conditions to show that it is a powerful way to clean up polluted land and marine environments."

Text adapted from: Science Daily https://www.sciencedaily.com/releases/2018/04/180409144725.htm

a) Explain why the bacterium *Alcanivorax borkumensis* "multiplies rapidly in areas where the concentration of oil compounds is high".

_____

_____ (2)

b) The mixture of hydrocarbons present in crude oil can be separated from each other by fractional distillation.

i. Suggest **ONE** property of hydrocarbons which allows them to be separated from crude oil by fractional distillation.

_____ (1)

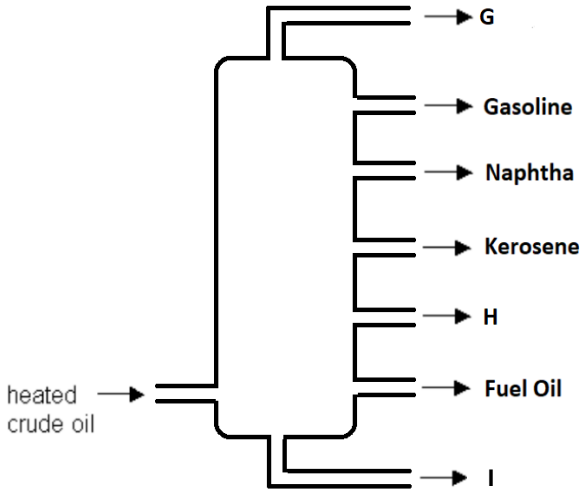
ii. The following is a representation showing the different fractions collected during fractional distillation of crude oil.

Name the fractions labelled **G**, **H and I**.

G: _____

H: _____

I: _____



(3)

c) Ethene can be manufactured by cracking the heavier fractions, which are separated during fractional distillation of crude oil.

i) Explain how cracking is different from fractional distillation.

_____

_____

_____ (2)

ii) Write a balanced chemical equation to show the cracking of $C_{10}H_{22}$ to produce two products: ethene and another hydrocarbon.

_____ (2)

(Total: 10 marks)

END OF PAPER

PERIODIC TABLE OF THE ELEMENTS

1	2											3	4	5	6	7	0
							1 **H** Hydrogen 1										4 **He** Helium 2
7 **Li** Lithium 3	9 **Be** Beryllium 4											11 **B** Boron 5	12 **C** Carbon 6	14 **N** Nitrogen 7	16 **O** Oxygen 8	19 **F** Fluorine 9	20 **Ne** Neon 10
23 **Na** Sodium 11	24 **Mg** Magnesium 12											27 **Al** Aluminium 13	28 **Si** Silicon 14	31 **P** Phosphorus 15	32 **S** Sulfur 16	35.5 **Cl** Chlorine 17	40 **Ar** Argon 18
39 **K** Potassium 19	40 **Ca** Calcium 20	45 **Sc** Scandium 21	48 **Ti** Titanium 22	51 **V** Vanadium 23	52 **Cr** Chromium 24	55 **Mn** Manganese 25	56 **Fe** Iron 26	59 **Co** Cobalt 27	59 **Ni** Nickel 28	63.5 **Cu** Copper 29	65 **Zn** Zinc 30	70 **Ga** Gallium 31	73 **Ge** Germanium 32	75 **As** Arsenic 33	79 **Se** Selenium 34	80 **Br** Bromine 35	84 **Kr** Krypton 36
85 **Rb** Rubidium 37	88 **Sr** Strontium 38	89 **Y** Yttrium 39	91 **Zr** Zirconium 40	93 **Nb** Niobium 41	96 **Mo** Molybdenum 42	99 **Tc** Technetium 43	101 **Ru** Ruthenium 44	103 **Rh** Rhodium 45	106 **Pd** Palladium 46	108 **Ag** Silver 47	112 **Cd** Cadmium 48	115 **In** Indium 49	119 **Sn** Tin 50	122 **Sb** Antimony 51	128 **Te** Tellurium 52	127 **I** Iodine 53	131 **Xe** Xenon 54
133 **Cs** Caesium 55	137 **Ba** Barium 56	139 **La** Lanthanum 57	178 **Hf** Hafnium 72	181 **Ta** Tantalum 73	184 **W** Tungsten 74	186 **Re** Rhenium 75	190 **Os** Osmium 76	192 **Ir** Iridium 77	195 **Pt** Platinum 78	197 **Au** Gold 79	201 **Hg** Mercury 80	204 **Tl** Thallium 81	207 **Pb** Lead 82	209 **Bi** Bismuth 83	210 **Po** Polonium 84	210 **At** Astatine 85	222 **Rn** Radon 86

Key:

a
X
y
b

relative atomic mass
SYMBOL
Name
atomic number

Reactivity series	
	Potassium
	Sodium
	Calcium
	Magnesium
	Aluminium
	Carbon
	Zinc
	Iron
	Lead
	Copper
	Silver
	Gold
	Platinum

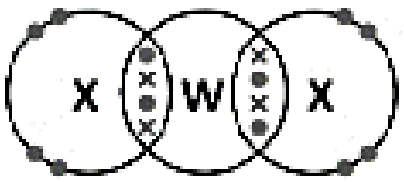
Specimen Controlled Assessment Level 2-3 Marking Scheme

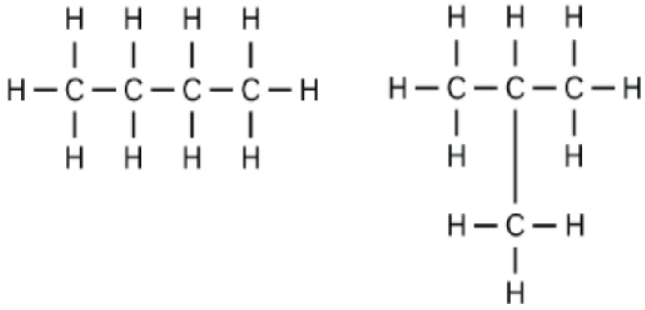
MATRICULATION AND SECONDARY EDUCATION CERTIFICATE EXAMINATIONS BOARD

L-Università ta' Malta

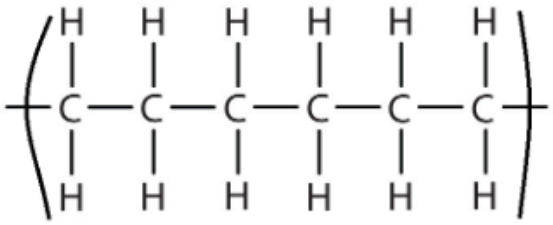
SECONDARY EDUCATION CERTIFICATE LEVEL
SAMPLE PAPER MARKING SCHEME

SUBJECT:	**Chemistry**
PAPER NUMBER:	**Level 2 – 3**
DATE:	
TIME:	2 Hours

Question			Suggested answers	Marks	Remarks
1	a	i	False	1	
		ii	False	1	
		iii	True	1	
		vi	True	1	
	b	i	120 °C	1	deduct ½ mark if units are missing
		ii	As temperature decreases, the kinetic energy of particles decreases, hence particles move closer to each other	1	
		iii	A different substance was used which had it its own varied freezing point.	1	Award ½ mark if it is stated that the substance has a different freezing point, but no reason is given.
			Total:	**7**	
2	a	i	Y	1	
		ii	W	1	
		iii	Z	1	
	b	i	2	1	
		ii	2,8	1	
	c		Conduct electricity when molten or in an aqueous solution **OR** Have high melting and boiling points	1	
	d		Basic oxide	1	
	e			1 mark for sharing of electrons 1 mark for the lone pairs on X	No marks if bonding is not correct
			Total:	**9**	

Question			Suggested answers	Marks	Remarks
3	a		Prevents them from reacting with oxygen in air due to being highly reactive	1	
	b		$2Na + 2H_2O \rightarrow 2NaOH + H_2$	2	1 mark correct equation 1 mark correct balancing
	c		• Reactivity increases down the group • Due to increasing atomic radius and shielding effect • The attraction between the nucleus and the outer electron gets weaker so less energy is needed to remove the outer electron	1 1 1	
	d	i	Moles sodium = 14.10/23 = 0.61 Moles oxygen = 4.90/16 = 0.306 Ratio=2:1 → E.F = Na_2O	1 1 1	
		ii	E.F = (RAM Na)x2 + (RAM O) = 62 M.F = 62/62 = 1 M.F = Na_2O	1 1	
			Total:	**11**	
4	a			2	1 mark for each correct isomer.
	b		Butane • The longer the hydrocarbon chain the more intermolecular forces between molecules so more energy is needed to break the weak bonds.	1 1	Accept Van der Waals forces
	c		$2C_4H_{10} + 13O_2 \rightarrow 8CO_2 + 10H_20$	2	1 mark correct equation 1 mark correct balancing
	d		Carbon monoxide **OR** Water vapour	1	Do not accept carbon (soot)
	e		Adding bromine (water) • When added to propene a colour change from reddish brown to colourless is observed. • When added to propane no colour change is observed.	1 1 1	
			Total:	**10**	

5	a		The remaining air in the apparatus would have a larger volume as air would have expanded on heating	1	
	b		Volume O_2 = Volume before heating – volume after heating = 75.00 - 59.25 = **15.75 cm³** (15.75/75.00) x 100 = **21%**	1 1	
	c		Nitrogen	1	
	d		Any **ONE** of the following: • Used in arc welding • Used in filament light bulbs	1	
			Total:	**5**	
6	a		$\underline{Mn}O_2$ • reduced • decrease in oxidation number (+4 → +2) H$\underline{Cl}$ • oxidised • increase in oxidation number (-1 → 0)	 1 1 1 1	
	b	i	1 mole of MnO_2 = 87g ? = 5.09g 5.09/87 = 0.058moles	1 1	
		ii	Ratio=MnO_2:HCl = 1:4 Moles of hydrochloric acid = 0.058 x 4 = 0.234 moles	1 1	
		iii	Ratio=MnO_2:Cl_2 = 1:1 Moles of chlorine = 0.058 moles 1 mole of Cl_2 = 22.4dm³ 0.058 moles = ? 0.058 x 22.4 = 1.32dm³	1 1 1	
		iv	Chlorine changes moist blue litmus paper red and then bleaches it white	1	
			Total:	**12**	
7	a	i	Calcium	1	
		ii	Copper	1	
		iii	Aluminium **OR** Calcium	1	
		iv	Copper	1	
		v	Aluminium	1	
	b	i	$Mg\ (s) + CuSO_4\ (aq) \rightarrow MgSO_4\ (aq) + Cu\ (s)$ $Mg(s) + Cu^{2+}(aq)\ SO_4^{2-}\ (aq) \rightarrow Mg^{2+}(aq)\ SO_4^{2-}\ (aq) + Cu(s)$ Removing spectator ions $Mg\ (s) + Cu^{2+}(aq) \rightarrow Mg^{2+}\ (aq) + Cu\ (s)$	1 mark correct ionic equation 1 mark correct state symbols	
		ii	Blue coloured solution of copper(II) sulfate starts fading **OR** Reddish-brown deposit of copper observed	1	Do not accept bubbles.
			Total:	**8**	

8	a	i	Hydrogen	1	
		ii	Steam	1	
		iii	Acidified potassium dichromate / aerial oxidation	1	
	b	i	Ester	1	
		ii	$CH_3COOH + C_2H_5OH \rightleftharpoons CH_3COOC_2H_5 + H_2O$	1 mark correct equation 1 mark correct balancing	
	c		$C_6H_{12}O_6 \xrightarrow{\text{enzymes in yeast}} 2C_2H_5OH + 2CO_2$	2	
	d			1 mark for correct structure showing single bonds 1 mark for vacant bonds at the end of both sides of the chain	Incorrect displayed formula of polyethene award 0 marks If no vacant bonds at the end of both sides of the chain deduct 1 mark
			Total:	**10**	
9	a		Heat is given out **OR** The reaction is exothermic	1	
	b		• The position of equilibrium is shifted to the right • The system will try to decrease the pressure by shifting the equilibrium to the side where there is less pressure to minimise the change. • On the right = Less pressure - 2 volumes of gas • On the left = High pressure - 4 volumes of gas (1+3)	1 1 1	
	c		With an increase in temperature: • The reactant particles move quicker due to increased energy. • The particles collide more often and collisions are more successful, resulting in an increase in the rate of reaction.	1 1	
	d		• It increases the rate at which dynamic equilibrium is reached • and so, speeds up the reaction	1 1	
	e		$(NH_4)_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + 2NH_3 + 2H_2O$	2	1 mark for formulae 1 mark balancing
			Total:	**10**	
10	a		They all consist of carbon atoms joined by strong covalent bonds but have different structural arrangements.	1	
	b		It conducts electrical charges due to free moving electrons	1	
	c		Due to high temperatures, the carbon atoms in the graphite electrode react with oxygen released at the anode. These forms oxides of carbon which erode the graphite electrode.	1 1	

	d		• Less fossil fuels are burnt, releasing less carbon dioxide gas in the atmosphere. Carbon dioxide is a greenhouse gas which leads to global warming. • Preserves limited natural resources. No need for mining and extraction, thus conserving raw substances. • Aluminium can be recycled indefinitely for an unlimited number of times. • Recycling aluminium reduces the amount of waste products in landfill sites. This minimizes land pollution and environmental degradation. • Reduces energy consumption • Aluminium extraction plants produce fine cryolite dust which can have a negative impact on the environment. Recycling plants do not produce such pollutants.	2	1 mark for each of any two mentioned points.
	e		A silver grey deposit of zinc observed below cathode Reddish brown fumes of bromine observed at the anode	1 1	
			Total:	**8**	
11	a		• The bacteria feed on hydrocarbons as source of energy • Bacteria multiply faster in areas rich in oil which consists of a mixture of hydrocarbons	1 1	
	b	i	They separate due to having different boiling points.	1	
		ii	G: Refinery Gases H: Diesel Oil I: Residue	1 1 1	
	c	i	• Cracking is the process during which long chained hydrocarbons are broken down into smaller and more useful hydrocarbons in the presence of high temperatures. • Fractional distillation is the process during which the mixture of hydrocarbons making up crude oil are boiled and separate into different fractions, depending on their diverse boiling points.	1 1	
		ii	$C_{10}H_{22} \rightarrow C_2H_4 + C_8H_{18}$	2	1 mark correct equation 1 mark correct balancing
			Total:	**10**	

Specimen Controlled Assessment: Private Candidates Paper Level 1-2-3

MATRICULATION AND SECONDARY EDUCATION CERTIFICATE
EXAMINATIONS BOARD

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SECONDARY EDUCATION CERTIFICATE LEVEL

PRIVATE CANDIDATES SAMPLE PAPER

SUBJECT:	**Chemistry**
PAPER NUMBER:	**Level 1 - 2 - 3**
DATE:	
TIME:	2 Hours

Useful data:

Avogadro constant = 6.02×10^{23}

Specific heat capacity of water = 4200 J kg^{-1} $°C^{-1}$

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

STP conditions = 0 °C and 10^5 Pa/1 atm.

Directions to Candidates

- Write your index number in the space at the top left-hand corner of this page.
- Answer **ALL** questions 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.
- The following information is printed on the back of this booklet:
    - Periodic Table
    - Reactivity Series
    - Order of discharge at electrodes
    - List of polyatomic ions and their charges
    - Solubility rules

Answer ALL questions.

1) A student tested three solutions (**X**, **Y**, and **Z**) with litmus paper to find out whether they are acidic, alkaline or neutral. The observations are listed in the following table.

Solution	Observation with red litmus paper	Observation with blue litmus paper
X	Remains red	Remains blue
Y	Remains red	Turns red
Z	Turns blue	Remains blue

b) State whether **each** solution is acidic, alkaline or neutral.

i) **X** _____ (1)

ii) **Y** _____ (1)

iii) **Z** _____ (1)

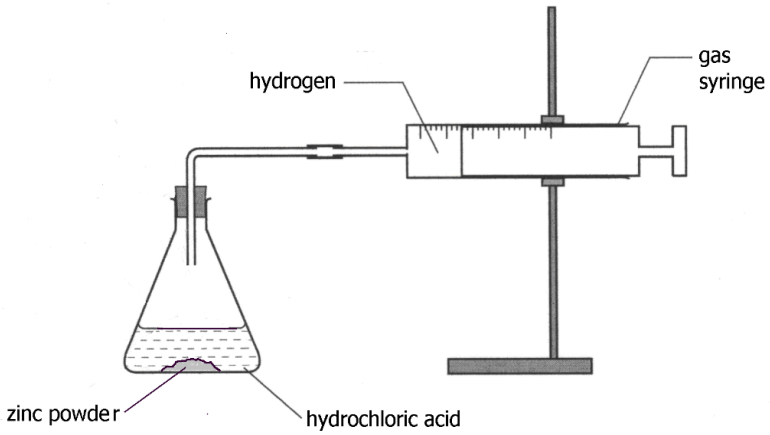
c) The student then tested the solutions using universal indicator. Complete the following table by matching the solution **(X**, **Y** or **Z**) with the appropriate pH.

Solution	pH
	2
	7
	13

(3)

(Total: 6 marks)

2) The following diagram shows the apparatus used to investigate the reaction between zinc and hydrochloric acid.



The reaction occurs as follows:

zinc + hydrochloric acid → zinc chloride + hydrogen

a) Describe a simple test to confirm that the gas produced is in fact hydrogen.

_____

_____ (2)

b) State **TWO** ways by which the reaction can be made to go faster.

i) _____ (1)

ii) _____ (1)

c) Hydrogen may also be collected over water. Draw a labelled diagram of the apparatus set up to prepare and collect hydrogen over water. (7)

d) State **ONE** property of hydrogen. Explain why it is not safe to prepare and collect large volumes of hydrogen because of this property.

Property: _____ (1)

Explanation: _____ (1)

(Total: 13 marks)

3) Two students were investigating endothermic and exothermic reactions. The results are shown in the table below.

	Experiment 1 vinegar + baking soda	**Experiment 2 Hydrochloric acid + magnesium**
Final temperature (°C)	13.40	25.05
Initial temperature (°C)	18.55	21.12
Temperature change (°C)		
Endothermic/exothermic		

a) Find the temperature change in each experiment and write your answer in the table. (2)

b) Use the results to determine whether each reaction is endothermic or exothermic. Write your answer in the table. (2)

(Total: 4 marks)

4) Two students are setting up an experiment using lead(II) bromide and the following apparatus:

crucible, electrodes, connecting wires, wire gauze, tripod,

Bunsen burner, DC power supply and light bulb.

a) Draw a simple labelled diagram of the apparatus that may be set up to show that molten lead(II) bromide is an electrolyte. (6)

b) Give the observations expected if molten lead(II) bromide is an electrolyte.

_____

_____

_____ (3)

c) State what would be observed if a non-electrolyte is tested.

_____

_____ (2)

(Total: 11 marks)

5) Tap-water in Malta is hard water. This is due to salts of calcium and magnesium which are dissolved in it.

a) Describe how a soap solution can be used to show the difference between a sample of hard water and a sample of distilled water. Include any observations recorded.

_____

_____ (2)

b) Describe a simple experiment that can be used to show the presence of temporary hardness in tap-water. Include any observations recorded.

_____

_____ (2)

(Total: 4 marks)

6) An unknown inorganic compound labelled **A** was analysed and the results are given below. You may use the solubility rules to help you answer the questions that follow.

Test	**Observation**
Appearance	White solid
Flame test	Lilac colour
Prepare a solution of compound **A** in water and add dilute nitric acid and silver nitrate.	A cream precipitate **B** is formed.

i) Give the name or formula of substances **A** and **B**.

- **A** _____ (1)
- **B** _____ (1)

ii) Describe how a flame test is performed.

_____

_____

_____ (2)

(Total: 4 marks)

7) A group of students are planning an investigation to find the best catalyst to produce oxygen by the decomposition of hydrogen peroxide. The reaction is quite slow at room temperature. The equation for the reaction is:

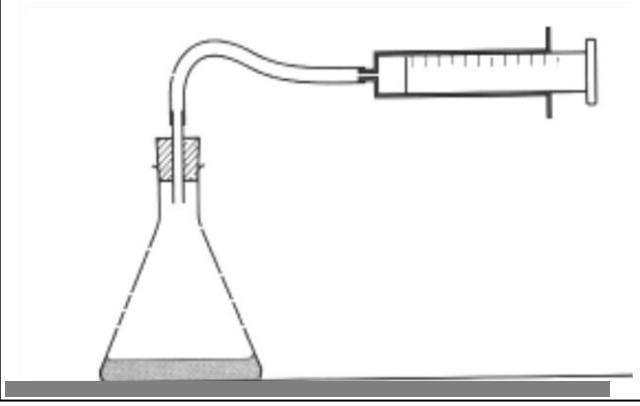
$$2H_2O_2(aq) \rightarrow 2H_2O(l) + O_2(g)$$

We would like to find out which oxide is the best catalyst.

We think that PbO and PbO_2 are equally good catalysts because they are both oxides of lead.

Method (sentences not in order)
1. Repeat the experiment for each oxide.
2. Place 50 cm^3 of water in the conical flask.
3. Measure the volume of oxygen produced every 15 seconds for 5 minutes.
4. Place 0.1g of manganese(IV) oxide in the water.
5. Add 10cm^3 of hydrogen peroxide and seal the flask quickly.
6. Set up the apparatus.

We will use this apparatus



We will record our results using a table:

Time (s)	Volume of oxygen collected when using:			
	MnO_2	MgO	PbO	PbO_2
0				
15				

The following oxides were considered as catalysts:

manganese(IV) oxide (MnO_2)	lead(II) oxide (PbO)
magnesium oxide (MgO)	lead(IV) oxide (PbO_2)

While planning the investigation, the students wrote down notes on pieces of paper. Read what the students wrote and then answer the following questions about this investigation.

b) Choose and write the sentence (from the students' notes) which shows the aim of the investigation.

_____ (1)

c) Choose and write the sentence (from the students' notes) which shows the students' prediction (what they think will happen).

_____ (1)

d) Write the sentences which describe the method in the correct order to show how the students will do the experiment.

_____

_____

_____

_____

_____

_____ (6)

e) Identify the variable that is being investigated in this experiment.

_____ (1)

f) Name **ONE** other variable which should be controlled for the experiment to be fair.

_____ (1)

g) Explain how the results may be used to find the rate of reaction for each experiment.

_____

_____ (2)

h) Explain how the students may use the results to find out which of the four oxides is the best catalyst.

_____

_____ (2)

(Total: 14 marks)

8) Two students obtained a solution of hydrochloric acid of unknown concentration. They start performing a titration in order to find the concentration of the hydrochloric acid solution using sodium carbonate, Na_2CO_3.

a) Make a list of the steps which are required to prepare 250 cm^3 of a 0.5 mol dm^{-3} solution of Na_2CO_3 in distilled water. The first step has been done for you.

i) Measure 13.25 g of Na_2CO_3 accurately using a weighing boat.

ii) _____

_____

iii) _____

_____

iv) _____

_____

v) _____

_____ (4)

b) The students then transfer 25 cm^3 of the prepared Na_2CO_3 solution into a conical flask. Name the apparatus which they should use to measure 25 cm^3 of the solution accurately.

_____ (1)

c) Calculate the number of moles of Na_2CO_3 in the conical flask.

_____

_____ (2)

d) Write a balanced chemical equation for the reaction of hydrochloric acid and sodium carbonate solution.

_____ (2)

e) State what should be added to the conical flask in order to be able to see the endpoint of the titration.

_____ (1)

f) Before starting the titration, the students observe the liquid level of hydrochloric acid in the glassware above as follows:

Write the correct reading which the students should note in their lab book: _____ cm^3 (1)

g) The endpoint of the titration was 47.2 cm^3. Calculate the titre value for this titration.

_____ (1)

h) Calculate the concentration of the hydrochloric acid solution.

_____

_____

_____

_____

_____ (3)

i) State why the students should have done the experiment more than once.

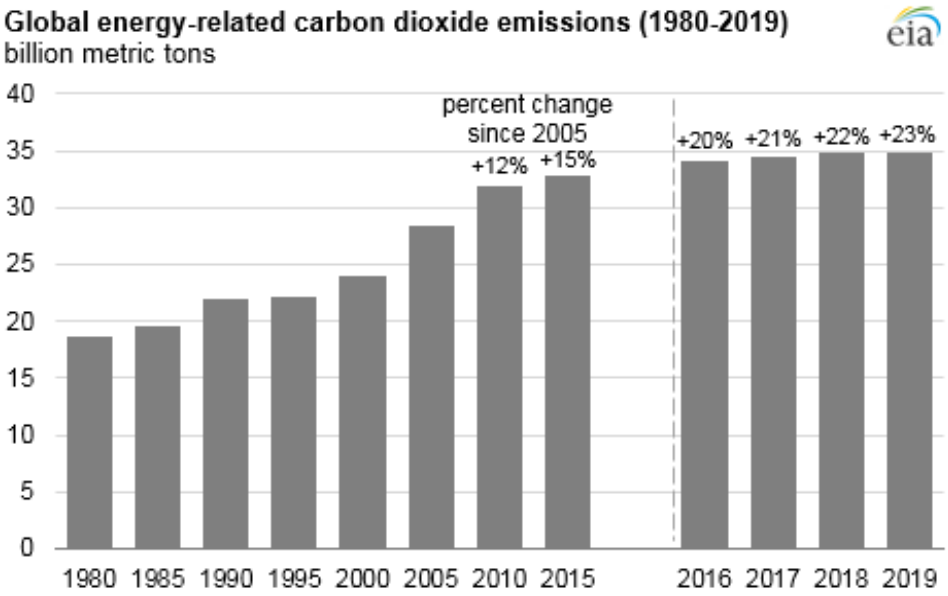
_____ (1)

j) Name **ONE** other experimental precaution which the students should have taken.

_____ (1)

(Total: 17 marks)

9) The graph below shows global energy-related carbon dioxide emissions between 1980 and 2019.



From: https://www.eia.gov/todayinenergy/detail.php?id=34872

a) Describe the trend shown in this graph.

_____ (1)

b) Name the independent variable in the graph.

_____ (1)

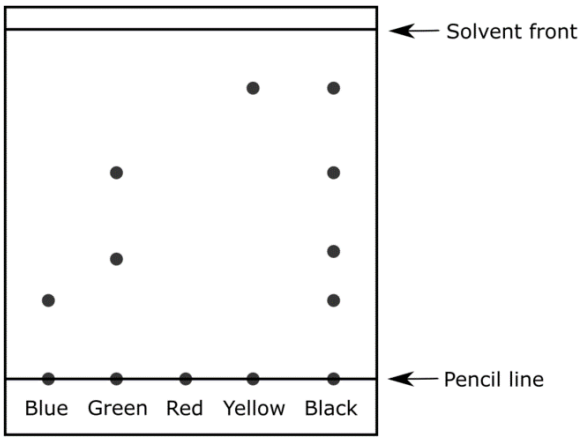
c) The amount of CO_2 in the air can be measured using a sensor attached to a mobile phone or laptop. You have been asked to measure the amount of CO_2 in the air every day for a month. Name **TWO** variables which should be kept constant when making these measurements.

_____

_____ (2)

(Total: 4 marks)

10) The following diagram shows a representation of a paper chromatogram which was obtained when several inks (blue, green, red, yellow, and black) were used as the solutes.



Adapted from https://www.embibe.com

a) State whether the following inks are made of a single substance or a mixture.

i) Blue: _____ (1)

ii) Green: _____ (1)

b) Identify the inks that are components of the black ink.

_____ (1)

c) What can you conclude about the red ink?

_____ (1)

d) How would the chromatogram look if this process were allowed to continue for a long time?

_____

_____ (1)

(Total: 5 marks)

11) Sulfur burns easily in air, forming sulfur dioxide as the main product.

a) Describe a simple experiment which can be used to verify that sulfur dioxide (SO_2) is an acidic gas. Include any important observations expected.

_____

_____

_____ (2)

b) Name **ONE** important safety precaution to be followed when performing this experiment. Give a reason for your answer.

_____

_____ (2)

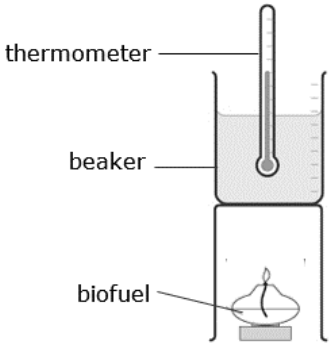
c) Name **ONE** important experimental precaution to ensure that the results are correct. Give a reason for your answer.

_____

_____ (2)

(Total: 6 marks)

12) Biobutanol is a liquid biofuel made from algae which is being used nowadays as alternative to traditional petrol and diesel. You have been used to determine the heat of combustion for this fuel using the apparatus shown below.



a) Suggest **TWO** improvements to the setup shown above and explain why they are necessary.

_____

_____

_____

_____ (4)

b) Justify **TWO** precautions normally taken during this experiment.

_____

_____ (2)

c) The following data was collected from the experiment:

Mass of water = 500 g

Initial temperature of water = 15 °C

final temperature of water = 52 °C

i) Calculate the quantity of heat energy absorbed by water.

_____

_____ (2)

ii) Given that 2.6 g of biobutanol (C_4H_9OH) were burnt, calculate the heat of combustion of this fuel. State the most important assumption made in your calculation.

_____

_____

_____ (3)

d) Given that the heat of combustion of biobutanol is -2676 kJ mol^{-1}, name **ONE** source of error that may affect the accuracy of the value obtained.

_____ (1)

(Total: 12 marks)

END OF PAPER

PERIODIC TABLE OF THE ELEMENTS

1	2											3	4	5	6	7	0
							1 **H** Hydrogen 1										4 **He** Helium 2
7 **Li** Lithium 3	9 **Be** Beryllium 4											11 **B** Boron 5	12 **C** Carbon 6	14 **N** Nitrogen 7	16 **O** Oxygen 8	19 **F** Fluorine 9	20 **Ne** Neon 10
23 **Na** Sodium 11	24 **Mg** Magnesium 12											27 **Al** Aluminium 13	28 **Si** Silicon 14	31 **P** Phosphorus 15	32 **S** Sulfur 16	35.5 **Cl** Chlorine 17	40 **Ar** Argon 18
39 **K** Potassium 19	40 **Ca** Calcium 20	45 **Sc** Scandium 21	48 **Ti** Titanium 22	51 **V** Vanadium 23	52 **Cr** Chromium 24	55 **Mn** Manganese 25	56 **Fe** Iron 26	59 **Co** Cobalt 27	59 **Ni** Nickel 28	63.5 **Cu** Copper 29	65 **Zn** Zinc 30	70 **Ga** Gallium 31	73 **Ge** Germanium 32	75 **As** Arsenic 33	79 **Se** Selenium 34	80 **Br** Bromine 35	84 **Kr** Krypton 36
85 **Rb** Rubidium 37	88 **Sr** Strontium 38	89 **Y** Yttrium 39	91 **Zr** Zirconium 40	93 **Nb** Niobium 41	96 **Mo** Molybdenum 42	99 **Tc** Technetium 43	101 **Ru** Ruthenium 44	103 **Rh** Rhodium 45	106 **Pd** Palladium 46	108 **Ag** Silver 47	112 **Cd** Cadmium 48	115 **In** Indium 49	119 **Sn** Tin 50	122 **Sb** Antimony 51	128 **Te** Tellurium 52	127 **I** Iodine 53	131 **Xe** Xenon 54
133 **Cs** Caesium 55	137 **Ba** Barium 56	139 **La** Lanthanum 57	178 **Hf** Hafnium 72	181 **Ta** Tantalum 73	184 **W** Tungsten 74	186 **Re** Rhenium 75	190 **Os** Osmium 76	192 **Ir** Iridium 77	195 **Pt** Platinum 78	197 **Au** Gold 79	201 **Hg** Mercury 80	204 **Tl** Thallium 81	207 **Pb** Lead 82	209 **Bi** Bismuth 83	210 **Po** Polonium 84	210 **At** Astatine 85	222 **Rn** Radon 86

Key:

a
X
y
b

relative atomic mass
SYMBOL
Name
atomic number

Reactivity series	
Decreasing Reactivity ↓	Potassium
	Sodium
	Calcium
	Magnesium
	Aluminium
	Carbon
	Zinc
	Iron
	Lead
	Copper
	Silver
	Gold
	Platinum

Order of discharge at cathode	
Increasing Ease of Discharge ↓	Na^+
	Mg^{2+}
	Al^{3+}
	Zn^{2+}
	Fe^{2+}
	Pb^{2+}
	H^+
	Cu^{2+}
	Ag^+
	Au^{3+}

Order of discharge at anode
1. For aqueous very dilute solutions OH^- is discharged. 2. For aqueous concentrated solutions containing halide ions (Cl^-, Br^- and I^-), these are discharged in preference to OH^-. 3. SO_4^{2-}, NO_3^- and CO_3^{2-} are never discharged from aqueous solutions

List of polyatomic ions and their charges	
Name	**Formula**
Ammonium	NH_4^+
Nitrate	NO_3^-
Sulfate	SO_4^{2-}
Carbonate	CO_3^{2-}
Hydrogencarbonate	HCO_3^-
Hydroxide	OH^-

Solubility Rules	
Soluble	**Insoluble**
• All nitrates • All hydrogencarbonates • All group 1 metal salts • All ammonium salts • Halides except silver and lead halides • Sulfates except barium, calcium, and lead sulfates	• Carbonates except group 1 metal and ammonium carbonate • Metal oxides except group 1 and 2 metal oxides that react with water. • Hydroxides except group 1 metal and ammonium hydroxides

Specimen Controlled Assessment: Private Candidates Level 1-2-3 Marking Scheme

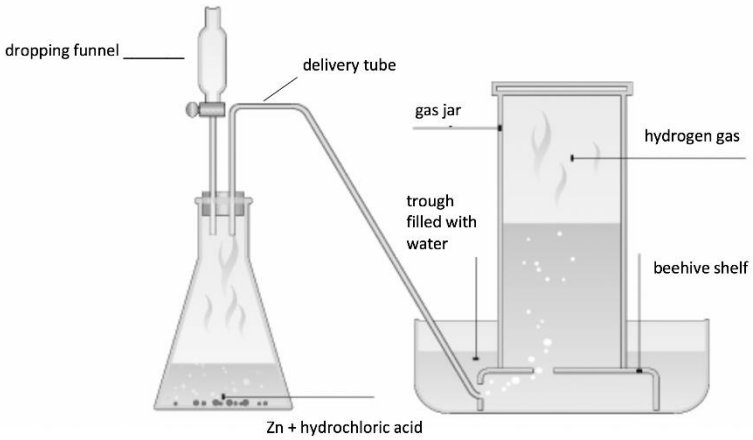
MATRICULATION AND SECONDARY EDUCATION CERTIFICATE EXAMINATIONS BOARD

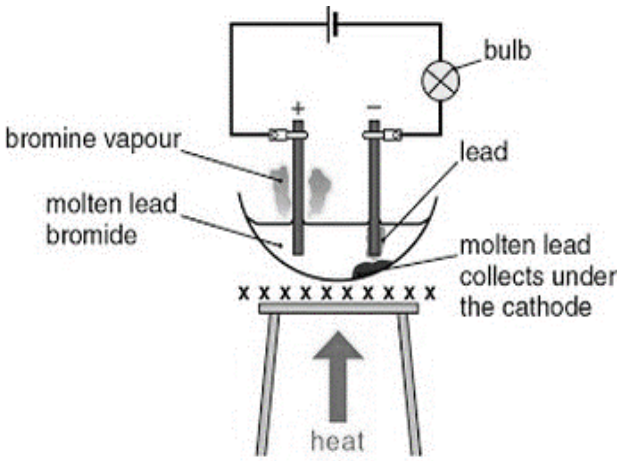
L-Università ta' Malta

SECONDARY EDUCATION CERTIFICATE LEVEL

PRIVATE CANDIDATES' SAMPLE PAPER MARKING SCHEME

SUBJECT:	**Chemistry**
PAPER NUMBER:	**Level 1 - 2 - 3**
DATE:	
TIME:	2 Hours

Question			Suggested answers	Marks	Additional notes
1	a	i	neutral	1	
		ii	acidic	1	
		iii	alkaline	1	
	b		Y = pH2 X = pH7 Z = pH13	1 1 1	
			Total	**6**	
2	a		Place a lighted splint at the top of the test-tube containing a sample of the gas. Hydrogen burns with a pop	1 1	
	b	i	Increase the temperature of the hydrochloric acid	1	
		ii	Increase the concentration of the hydrochloric acid	1	
	c			1 1 1 1 1 1 1	1 mark for the general assembly 1 mark for each labelled item (name and diagram)
	d		Hydrogen is light and diffuses fast. Storing hydrogen is unsafe as it escapes very quickly.	1 1	Accept other possible answers
			Total	**13**	

3			<table><tr><th></th><th>Experiment 1 vinegar + baking soda</th><th>Experiment 2 Hydrochloric acid + magnesium</th></tr><tr><td>Temperature change</td><td>5.15</td><td>3.93</td></tr><tr><td>Endothermic / exothermic</td><td>Endothermic</td><td>Exothermic</td></tr></table>	1 1 1 1	1 mark for temperature change (exp 1) 1 mark for endothermic 1 mark for temperature change (exp 2) 1 mark for exothermic
			Total	**4**	
4	a			1 1 1 1 1 1	1 mark for set up 1 mark for circuit 1 mark for electrodes 1 mark for crucible 1 mark for lead(II) bromide 1 mark for heat source (Bunsen, gauze, tripod)
	b		Bulb lights Reddish vapour around positive electrode Metal deposited around/under the cathode	1 1 1	
	c		No changes around the electrodes. Bulb does not light.	1 1	
			Total	**11**	
5	a		Adding a few drops of soap to equal amounts of water samples and shaking. The distilled water will produce lather while the hard water will produce little or no lather.	1 1	
	b		Place some hard water in a beaker and heat allowing the water to boil. Scale will form on the beaker.	1 1	
			Total	**4**	
6	a		A = Potassium bromide B = Silver bromide	1 1	
	b		Dip a clean wire loop into concentrated hydrochloric acid and then into a solid sample of the compound being tested. Put the loop into the edge of the blue flame from a Bunsen burner observe and record the flame colour produced.	1 1	
			Total	**4**	
7	a		We would like to find out which oxide is the best catalyst.	1	
	b		We think that PbO and PbO_2 are equally good catalysts because they are both oxides of lead.	1	

	c		Place 50 cm^3 of water in the conical flask. Place 0.1 g of manganese(IV) oxide in the water. Set up the apparatus Add 10 cm^3 of hydrogen peroxide and seal the flask quickly. Measure the volume of oxygen produced every 15 seconds for 5 minutes Repeat the experiment for each oxide. Accept also: Set up the apparatus Place 50 cm^3 of water in the conical flask. Place 0.1 g of manganese(IV) oxide in the water. Add 10 cm^3 of hydrogen peroxide and seal the flask quickly. Measure the volume of oxygen produced every 15 seconds for 5 minutes Repeat the experiment for each oxide.	1 1 1 1 1 1	1 mark each
	d		Catalyst.	1	
	e		Volume of peroxide/ temperature/ surface area of catalyst.	1	
	f		Plot a graph of volume of oxygen against time.	1 1	
	g		Compare the graphs obtained. The best catalyst is the one where the reaction was over in the shortest time/ produces a large volume of oxygen in the shortest time/ that has the steepest gradient.	1 1	
			Total	**14**	
8	a	ii	Transfer the solid completely into a volumetric flask. **OR** to a beaker and dissolve solid in water and transfer this solution to the volumetric flask.	1	
		iii	Rinse the weighing boat and add the washings to the contents of the flask. **OR** rinse the beaker and add the washing to the volumetric flask	1	
		iv	Fill the volumetric flask roughly to the ¾ mark with distilled water and make sure that all the solid has dissolved by closing the flask and shaking vigorously.	1	
		v	Allow the solution to settle, then bring the solution up to the mark with distilled water.	1	
	b		Volumetric Pipette	1	Do not accept pipette.
	c		0.5 mol / 4 = 0.0125 mol	1 1	working answer and units
	d		$2HCl + Na_2CO_3 \rightarrow 2NaCl + H_2O + CO_2$	2	1 for balancing 1 for chemical formulae

	e		An acid-base indicator	1	Accept correct examples of indicators.
	f		0.7	1	Note that units are given.
	g		46.5 cm^3	1	
	h		moles of HCl reacted = 0.0125 mol x 2 = 0.0250 mol concentration of HCl = (0.0250/46.5) x 1000 = 0.538 mol/dm^3	1 1 1	 answer and unit
	i		To obtain concordant results/ improve reliability.	1	
	j		Taking readings at eye level. **OR** Checking for and removing any air bubbles. **OR** Rinsing the volumetric pipette with the solution being measured. **OR** Rinsing the burette with the solution being measured.	1	Other answers acceptable Do not accept: • taking multiple readings washing the beaker/weighing boat
			Total	**17**	
9	a		CO_2 emissions have been increasing since 1980.	1	Similar answers acceptable.
	b		Time	1	
	c		Any two variables which might influence. Ex: Time of day, location.	2	1 mark each
			Total	**4**	
10	a	i	Single substance	1	
		ii	Mixture	1	
	b		Blue, green, and yellow.	1	
	c		The red ink is insoluble in the solvent being used.	1	
	d		All the colours would regroup at the top of the chromatogram.	1	
			Total	**5**	
11	a		Passing the gas through water containing an indicator or over a moist indicator strip. Observation: Colour change in indicator (ex: damp blue litmus paper turns red)	2	Award only 1 mark if the word "damp" or "moist" (or equivalent) is not included.
	b		Performing the experiment in a fume hood. Sulfur dioxide is toxic.	2	Other answers acceptable.
	c		Using a control. (Ex: passing air over/through the indicator before passing SO_2) To check that the colour change is really due to the presence of sulfur dioxide.	2	Other answers acceptable.
			Total	**6**	
12	a		1. A stirrer should be used to mix the water to ensure that the temperature of the water is homogenous. 2. A shield should be used to avoid wind draught from interfering with heat transfer from the spirit lamp to the beaker.	2 2	

	b		The thermometer must be read at eye level to prevent inaccurate readings. The spirit lamp must be closed using a spirit lamp cover to avoid loss of biobutanol by evaporation before and after the experiment.	1 1	Accept other relevant precautions and their justification.
	c	i	$E = mc\Delta\theta = 0.5\ kg \times 4200\ J\ kg^{-1}\ °C^{-1} \times (52 - 15)\ °C$ $E = 77{,}700\ J$	1 1	
		ii	Assumption taken is that there were no heat losses during the experiment. $RMM(C_4H_9OH): (12 \times 4) + (1 \times 10) + 16 = 74$ 74 g → 1 mole 2.6 g → 2.6 / 74 = 0.035 moles of biobutanol 0.035 moles → 77,700 J 1 mole → 77,700 / 0.035 = 2,220,000 J = 2,220 kJ Change in heat of combustion = -2,220 kJ mol^{-1}.	1 1 1	
	d		It is evident from comparing the theoretical with the experimental readings that heat losses account for the difference between the values.	1	
			Total	**12**	