Index Number:_____ SEC06/1.19m

L-Università ta' Malta

MATRICULATION AND SECONDARY EDUCATION CERTIFICATE EXAMINATIONS BOARD

SECONDARY EDUCATION CERTIFICATE LEVEL
2019 MAIN SESSION

SUBJECT:	**Chemistry**
PAPER NUMBER:	I
DATE:	22nd May 2019
TIME:	9:00 a.m. to 11:05 a.m.

Useful data:

Relative atomic masses: H = 1; N = 14; O = 16; Mg = 24; S = 32; Cl = 35.5; Pb = 207.

Standard temperature and pressure (stp): 0 °C and 1 atm (760 mm Hg)

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

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

Faraday constant = 96500 C mol^{-1}

Avogadro constant, L = 6.02 x 10^{23}

Q = It

$\Delta H = mc\Delta\theta$

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.
- 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**	**6**	**6**	**6**	**6**	**5**	**6**	**8**	**6**	**5**	**20**	**20**	**100**

Section A

1.

a) In the table below fill in the missing information for the two elements, A and B.

Element	Proton Number	Electronic configuration	Group in Periodic Table
A	17		7
B		2, 4	

(3)

b) Use the information in part (a) to state the type of bonding present in a compound consisting of the elements A and B.
Type of bonding: _____ (1)

c) Element A can exist as two different atoms that have different atomic mass.
i) State the name given to such atoms.

_____ (1)

ii) Why do the two atoms in part (c) (i) react in the same way?

_____ (1)

(Total: 6 marks)

6

2. Lead(II) nitrate is reacted with hydrochloric acid according to the equation:

$$Pb(NO_3)_2\,(aq) + 2HCl\,(aq) \rightarrow PbCl_2\,(s) + 2HNO_3\,(aq)$$

a) In the experiment 0.1 mol of lead(II) nitrate dissolved in aqueous solution, is reacted with excess hydrochloric acid.
i) Calculate the mass of lead(II) nitrate used.

_____

_____ (3)

ii) How many moles of chloride ions are present in the lead(II) chloride formed?

_____

_____ (2)

b) Give **ONE** reason why excess hydrochloric acid is used in the experiment.

_____ (1)

(Total: 6 marks)

6

3. Potassium iodide, KI, is a very common laboratory chemical. The table below contains statements about potassium iodide which may be true or false.
Write True or False next to each statement as appropriate.

	Statement	**True** or **False**
a)	Potassium iodide is soluble in water.	
b)	Solid potassium iodide conducts electricity.	
c)	Potassium iodide has a relatively high melting point.	
d)	Solid potassium iodide is held together by electrostatic forces of attraction.	
e)	Potassium iodide contains potassium atoms and iodine atoms.	
f)	Potassium iodide is formed by the sharing of electrons.	

6

(Total: 6 marks)

4.

a) Salts may be prepared using various methods.

i) Give a balanced equation to show the reaction when dilute hydrochloric acid is added to zinc oxide to produce zinc chloride.

(2)

ii) Give a balanced ionic equation, omitting spectator ions and including state symbols, to show the formation of copper(II) carbonate by the reaction between copper(II) sulfate and sodium carbonate.

(3)

b) A neutralisation reaction during a titration between potassium hydroxide solution, KOH, and sulfuric acid, H_2SO_4, produces potassium sulfate in solution. Name a suitable indicator to use during the titration.

(1)

6

(Total: 6 marks)

Please turn the page.

5.

a) A group of students in the laboratory have been given various mixtures to separate. They need to decide on the appropriate apparatus to use. In the spaces provided below, for each situation, draw a suitable well-labelled diagram of the apparatus that will give satisfactory separation of the substance in bold.

i)
Crystals of **sugar** from a solution of sugar in water.

ii)
Oil from a mixture of oil and vinegar.

(4)

b) State the **TWO** steps students need to follow to obtain sand from a mixture of sand and sugar.

Step 1: _____

Step 2: _____ (2)

(Total: 6 marks)

6

6.

a) Paula and Mark were asked to research information about hydrogen. Give balanced equations for the following reactions.

i) The reaction of dilute sulfuric acid with iron filings.

_____ (2)

ii) The reaction between hydrogen and copper(II) oxide.

_____ (2)

b) The reaction in part (a) (ii) is a redox reaction. Give the name or formula of the substance which is reduced.

Substance reduced: _____ (1)

(Total: 5 marks)

5

7. Consider the following statement:

'The most common effect of hard water on the skin is unnecessary dryness and irritation. This is due to hard water's inability to properly dissolve soaps …'

https://www.westlakedermatology.com/blog/how-hard-water-can-damage-the-skin/

a) Give the names or formulae of **TWO** substances that cause hardness in water.

Substance 1: _____ Substance 2: _____ (2)

b) Why is it more difficult to rinse soap away whenever hard water is used? You may explain this using an equation.

_____

_____ (2)

c) Mention another disadvantage of hard water besides its effect on soap.

_____ (1)

d) Hard water has also some advantages in our everyday lives. Mention **ONE** advantage.

_____ (1)

(Total: 6 marks)

6

8. In an experiment, 11.4 g of a hydrated compound of magnesium, $MgSO_4.xH_2O$, is heated to constant mass. After weighing, it is found that 6.0 g of solid powder remains while 5.4 g of water vapour is removed.

a) Calculate the amount of water in moles.

_____

_____ (3)

b) Calculate the number of moles of magnesium sulfate in the 6.0 g remaining after the hydrate was heated to constant mass.

_____

_____ (3)

c) Use the answers from parts (a) and (b) to find the chemical formula of the hydrated magnesium sulfate compound.

_____

_____ (2)

(Total: 8 marks)

8

Please turn the page.

9.

a) When nitrates are heated, different types of products may be formed. Give balanced equations to show the action of heat on:

i) sodium nitrate, $NaNO_3$;

_____ (2)

ii) lead(II) nitrate, $Pb(NO_3)_2$.

_____ (2)

b) Hydrated copper(II) sulfate, $CuSO_4.5H_2O$, decomposes on heating. Mention **ONE** observation that may be made during this decomposition.

_____ (1)

c) Why is anhydrous copper(II) sulfate very useful in chemistry experiments?

_____ (1)

(Total: 6 marks)

6

10.

a) Although saturated hydrocarbons belong to the family of the alkanes, their physical properties can be different. By considering the lengths of their carbon chains, suggest the states at room temperature of propane, C_3H_8, and dodecane, $C_{12}H_{26}$.

Propane: _____ Dodecane: _____ (2)

b) Natural gas, oil and coal are all fossil fuels. Natural gas is a mixture of substances with methane occupying the highest percentage.

i) Give **ONE** reason why natural gas may be considered as a better fuel than coal.

_____

_____ (1)

ii) Give **ONE** reason why coal may be considered a better fuel than methane.

_____

_____ (1)

iii) The use of coal and petroleum as fuels poses problems for the environment. Explain.

_____

_____ (1)

(Total: 5 marks)

5

Section B:

11. The rate of reaction depends on various factors. Two students were asked to investigate the reaction between solid potassium carbonate and dilute hydrochloric acid which follows the equation:

$$K_2CO_3\,(s) + 2HCl\,(aq) \rightarrow 2KCl\,(aq) + H_2O\,(l) + CO_2\,(g)$$

a) What is the meaning of the term rate of reaction?

(2)

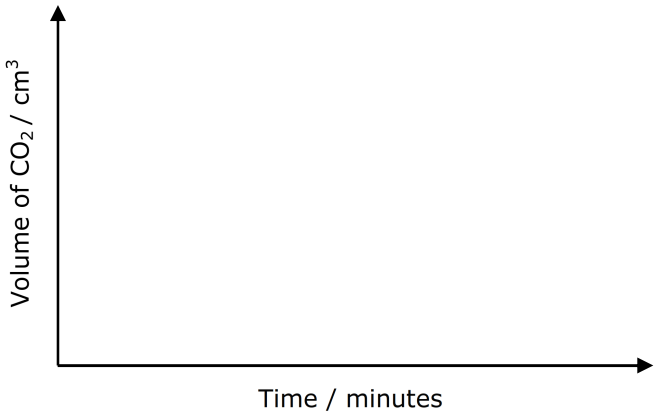
b) Draw a labelled diagram to show the setup used to investigate the rate of reaction. The setup must include: the reaction flask, its contents, the gas collected and the apparatus collecting the gas.

(5)

c)

i) On the axes provided, sketch graphs from the start of the reaction to a few minutes after the reaction stops, to show the change in volume of carbon dioxide produced when excess dilute hydrochloric acid is added to:

- 5 g of chunks of potassium carbonate. Label your graph C.
- 3 g of powdered potassium carbonate. Label your graph D.



(4)

ii) Which of the reactions in part (c) (i) finishes first? Give **ONE** reason.

(2)

Question continues on next page.

d) State the effect that an increase in temperature will have on the experiment in part (c). Explain.

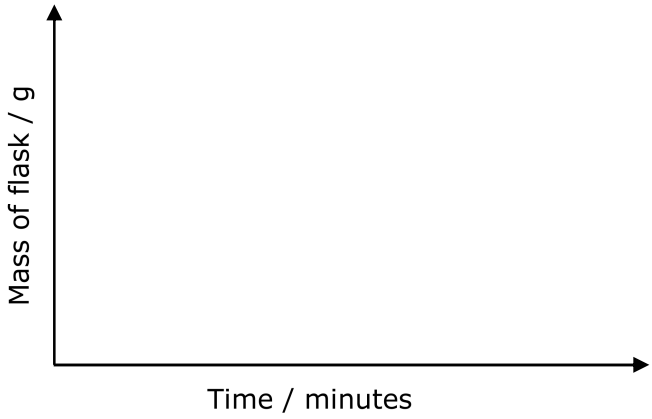
(3)

e) Two other experiments are carried out to investigate the effect of two different concentrations of the acid as shown in the table below.

i)	4 g powdered potassium carbonate.	Excess HCl of concentration 0.6 mol dm^{-3}.
ii)	4 g powdered potassium carbonate.	Excess HCl of concentration 0.3 mol dm^{-3}.

The change in mass of the flask and its contents is investigated.

On the axes below, sketch graphs to show the change in mass of the flask for each of the experiments. Label your graphs i) and ii) accordingly.



(4)

(Total: 20 marks)

20

12.

a) In a chemical reaction bonds are broken and new ones formed. During these processes, energy changes occur which may be exothermic or endothermic.
Draw a labelled energy diagram for an endothermic reaction, including labels for: x-axis, y-axis, energy levels for the reactants and products, activation energy, and energy change for the reaction.

(6)

b) A group of students are asked to find the heat of neutralisation of the reaction between sodium hydroxide solution and hydrochloric acid.
Name the apparatus needed for the following measurements:

i) measurement of volumes;

_____ (1)

ii) change in temperature.

_____ (1)

c) In the experiment, 50 cm^3 of sodium hydroxide solution of concentration 1 mol dm^{-3} are reacted with 50 cm^3 of hydrochloric acid of concentration 1 mol dm^{-3}. There is a temperature change from 25 °C to 30 °C.
Assume that 1 cm^3 of solution has a mass of 1 g.

i) Write a balanced chemical equation for the reaction between hydrochloric acid and sodium hydroxide solution.

_____ (2)

ii) Calculate the energy given out in the reaction including the units.

_____

_____

_____ (4)

iii) Calculate the number of moles of water produced in the reaction.

_____

_____ (2)

Question continues on next page.

iv) Use your answers to parts (c) (ii) and (c) (iii) to calculate the heat of neutralisation.

_____

_____ (2)

d) The answer you obtained does not match the value as given in data books. State **TWO** possible sources of error in the experiment.

_____

_____

_____ (2)

(Total: 20 marks)

20

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PERIODIC TABLE

I	II											III	IV	V	VI	VII	VIII
1 **H** 1																	4 **He** 2
7 **Li** 3	9 **Be** 4											11 **B** 5	12 **C** 6	14 **N** 7	16 **O** 8	19 **F** 9	20 **Ne** 10
23 **Na** 11	24 **Mg** 12											27 **Al** 13	28 **Si** 14	31 **P** 15	32 **S** 16	35.5 **Cl** 17	40 **Ar** 18
39 **K** 19	40 **Ca** 20	45 **Sc** 21	48 **Ti** 22	51 **V** 23	52 **Cr** 24	55 **Mn** 25	56 **Fe** 26	59 **Co** 27	59 **Ni** 28	63.5 **Cu** 29	65 **Zn** 30	70 **Ga** 31	73 **Ge** 32	75 **As** 33	79 **Se** 34	80 **Br** 35	84 **Kr** 36
85 **Rb** 37	88 **Sr** 38	89 **Y** 39	91 **Zr** 40	93 **Nb** 41	96 **Mo** 42	99 **Tc** 43	101 **Ru** 44	103 **Rh** 45	106 **Pd** 46	108 **Ag** 47	112 **Cd** 48	115 **In** 49	119 **Sn** 50	122 **Sb** 51	128 **Te** 52	127 **I** 53	131 **Xe** 54
133 **Cs** 55	137 **Ba** 56	139 **La** 57	178.5 **Hf** 72	181 **Ta** 73	184 **W** 74	186 **Re** 75	190 **Os** 76	192 **Ir** 77	195 **Pt** 78	197 **Au** 79	201 **Hg** 80	204 **Tl** 81	207 **Pb** 82	209 **Bi** 83	209 **Po** 84	210 **At** 85	222 **Rn** 86
223 **Fr** 87	226 **Ra** 88	227 **Ac** 89															

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.19m

L-Università ta' Malta

MATRICULATION AND SECONDARY EDUCATION CERTIFICATE EXAMINATIONS BOARD

SECONDARY EDUCATION CERTIFICATE LEVEL
2019 MAIN SESSION

SUBJECT:	**Chemistry**
PAPER NUMBER:	IIA
DATE:	23rd May 2019
TIME:	9:00 a.m. to 11:05 a.m.

Useful data:

Relative atomic masses: O= 16; Fe = 56.

Standard temperature and pressure (stp): 0 °C and 1 atm (760 mm Hg)

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

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

Faraday constant = 96500 C mol^{-1}

Avogadro constant, L = 6.02 x 10^{23}

Q = It

$\Delta H = mc\Delta\theta$

Directions to Candidates

- Write your index number in the space at the top left-hand corner of this page.
- Answer **ALL** questions 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 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.
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- 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.
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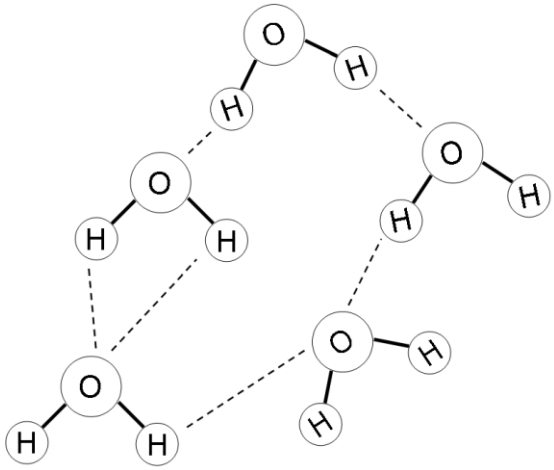
For examiners' use only:

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

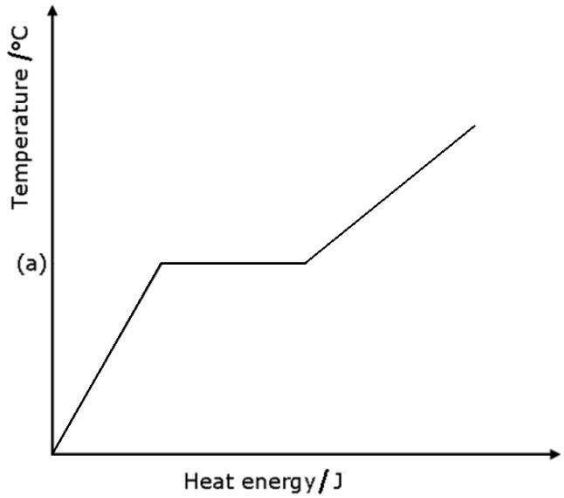
Section A: Answer ALL questions.

1. The diagram below shows the arrangement of H_2O molecules in liquid water.



a) On the diagram, label:
   i) a covalent bond;
   ii) an intermolecular force. (2)

b) On heating a sample of water, the temperature starts to rise gradually until, before the water starts to boil, the temperature stops rising for some time. This is shown in the diagram below.



   i) Suggest a value for the temperature marked (a) on the diagram.

_____ (1)

   ii) State whether the evaporation of water is an endothermic or an exothermic process.

_____ (1)

   iii) Why does the temperature stop to increase for some time even though heat energy is still being supplied?

_____ (1)

(Total: 5 marks)

5

2. Marcus is comparing the reaction of calcium in air with that of the same element in pure oxygen.
   a) For this he needs to prepare, collect, and store oxygen.
      i) Write the chemical equation for a reaction to produce oxygen.

_____ (2)

      ii) Suggest a suitable method to collect the oxygen which is to be used in a later experiment.

_____ (1)

   b) Compare the reaction of calcium in air with that of calcium in pure oxygen, referring to:
      i) **TWO** similarities between the two reactions;

_____

_____ (2)

      ii) **ONE** difference between the two reactions.

_____ (1)

(Total: 6 marks)

6

3. Catherine investigates the solubility of oxygen and nitrogen in sea water. She obtains air from sea water by heating large volumes of the mixture. She then passes 100 cm^3 of the air sample over heated copper until no change is observed. Once the apparatus cools, 63 cm^3 of gases remain.
   a) Give **ONE** physical change observed when air is passed over heated copper.

_____ (1)

   b) Why is the apparatus allowed to cool down before the final reading of volume is taken?

_____ (1)

   c) Calculate the percentage of oxygen in the air which was dissolved in the sea water sample.

_____ (1)

   d) Compare your answer to part (c) with the percentage volume of oxygen in air. Hence, comment on the solubility of nitrogen and oxygen in water.

_____

_____ (2)

(Total: 5 marks)

5

Please turn the page.

4. Explain the following statements about carbon and its oxides.

a) Diamond is much harder than graphite.

(2)

b) A mixture of carbon dioxide and carbon monoxide is bubbled through dilute sodium hydroxide solution to obtain a purified sample of one of these oxides.

(2)

c) Environmental concerns about carbon footprint focus on the quantity of carbon dioxide released in the atmosphere.

(2)

(Total: 6 marks)

6

5. In World War I, Germany's access to potassium nitrate (saltpetre) from South America was stopped by a blockade by the other European powers. Fritz Haber produced ammonia from nitrogen and hydrogen, restoring Germany's access to nitrates.

a) Write a balanced chemical equation for the reaction between nitrogen and hydrogen in the Haber Process.

(2)

b) Ammonia in the laboratory is prepared by heating together a mixture of solid ammonium chloride and calcium hydroxide. Give a balanced equation for this reaction.

(2)

c) The ammonia produced may be tested in two ways, using moist red litmus paper, and hydrogen chloride gas. Complete the result for each test.

i)	Effect on moist red litmus paper	
ii)	With hydrogen chloride gas	

(2)

(Total: 6 marks)

6

6. Gunpowder is a mixture of potassium nitrate, sulfur, and carbon. They react according to the following (simplified) redox equation:

$$2KNO_3\,(s) + S\,(s) + 3C\,(s) \rightarrow K_2S\,(s) + N_2\,(g) + 3CO_2\,(g)$$

a) Identify **ONE** substance which is being:

i) oxidised; _____

ii) reduced. _____ (2)

b) The explosive side of the reaction is due to the sudden increase in pressure caused by the production of nitrogen and carbon dioxide gases.

i) Calculate the total volume occupied by the gases at stp when 2 moles of potassium nitrate react completely with carbon and sulfur as shown in the above equation.

_____

_____ (3)

ii) During this reaction, the temperature is in excess of 1,500 K. Calculate the volume occupied by gases in part (b) (i) if the temperature is changed from stp to 1,500 K. Assume that the pressure stays the same.

_____

_____ (2)

(Total: 7 marks)

7

7. Sodium is obtained by the electrolysis of molten sodium chloride. One of the main ores of sodium chloride is rock salt, where sodium chloride is found mixed with insoluble substances such as sand and gravel.

a) How is sodium chloride obtained from this mixture? Tick the correct separation technique.

☐	Distillation	☐	Recrystallisation
☐	Separating column	☐	Solution, then filtration (1)

b) Identify the substance produced at the anode in a cell used for the electrolysis of molten sodium chloride.

_____ (1)

c) Why is molten sodium chloride instead of aqueous sodium chloride, used to produce sodium?

_____ (1)

d) Construct an ionic half equation for the reaction at the cathode.

_____ (2)

e) Explain why the equation in part (d) is a reduction. Give your answer in terms of oxidation numbers.

_____ (1)

(Total: 6 marks)

6

8. The series of tests below were carried out to identify two inorganic substances X and Y.

X is a white powder which dissolves in dilute hydrochloric acid with effervescence to produce a colourless solution, B, and a gas, A. Gas A produces a white precipitate when bubbled through lime water. On addition of dilute sodium hydroxide to B, a white precipitate which is insoluble in excess alkali is formed. X imparts a brick red colour in a flame test.

Y is a white powder which dissolves in dilute hydrochloric acid with effervescence to produce a colourless solution, C, and a gas, D. Gas D turns acidified potassium dichromate from orange to green. On addition of dilute sodium hydroxide to C, a white precipitate which is insoluble in excess alkali is formed. Y imparts no colour in a flame test.

Identify substances A, B, C, D, X and Y:

A: _____ B: _____

C: _____ D: _____

X: _____ Y: _____

(Total: 6 marks)

6

9. Answer the following questions about metals.

a) Name a metal which does **not** react with dilute sulfuric acid.

_____ (1)

b) Although aluminium is more reactive than many metals, such as iron, a solid piece of unpolished aluminium does **not** corrode. Explain.

_____

_____ (2)

c) A piece of aluminium is added to test tube A containing zinc sulfate solution. A piece of copper is added to test tube B also containing zinc sulfate solution.

i) In which test tube does a reaction occur? Explain your answer.

_____

_____ (2)

ii) Give a balanced ionic equation, omitting spectator ions and including state symbols, for the reaction taking place in part (c) (i).

_____

_____ (3)

(Total: 8 marks)

8

10. Ethene undergoes several reactions.

a) Industrially, ethene is obtained following the breaking of long chain hydrocarbons in crude oil. Name this process.

_____ (1)

b) Draw structures to show the organic compound formed when ethene reacts with:

i) Hydrogen	ii) Chlorine	iii) Steam

(3)

c) One of the compounds drawn in part (b) reacts with phosphorus(V) chloride to liberate white misty fumes. Identify this compound.

_____ (1)

(Total: 5 marks)

5

Please turn the page.

Section B: Answer TWO questions from this Section.

11. Sulfur dioxide is a pollutant gas but also an important substance for the chemical industry.
    a) Give **ONE** source of sulfur dioxide in the atmosphere. (1)

    b) Give **ONE** harmful effect of sulfur dioxide in the atmosphere. (1)

    c) Give a balanced chemical equation for **EACH** of the following methods of preparing sulfur dioxide.
       i) Burning sulfur. (2)
       ii) Oxidation of copper using concentrated sulfuric acid. (2)

    d) A closed system containing sulfur dioxide and oxygen can reach dynamic equilibrium according to the following reversible reaction.

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g) \quad \Delta H = -197 \text{ kJ mol}^{-1}$$

       i) Explain the terms reversible reaction and dynamic equilibrium in order to distinguish between the two. (2)
       ii) Give **TWO** ways by which the equilibrium can be shifted to the right to produce more sulfur trioxide. (2)
       iii) Explain why each of the methods in part (d) (ii) has this effect on the equilibrium. (2)
       iv) Give a suitable catalyst to speed up this reaction. (1)
       v) Explain why adding a catalyst does **not** affect the equilibrium position. (1)

    e) The reaction shown in part (d) is used in the Contact Process to produce sulfuric acid. Explain how sulfur trioxide is converted to sulfuric acid in this process. (2)

    f) Concentrated sulfuric acid can be used to produce other acids and to dehydrate certain substances. Exemplify each case by giving a balanced chemical equation for the reaction of concentrated sulfuric acid with:
       i) solid sodium chloride; (2)
       ii) ethanol. (2)

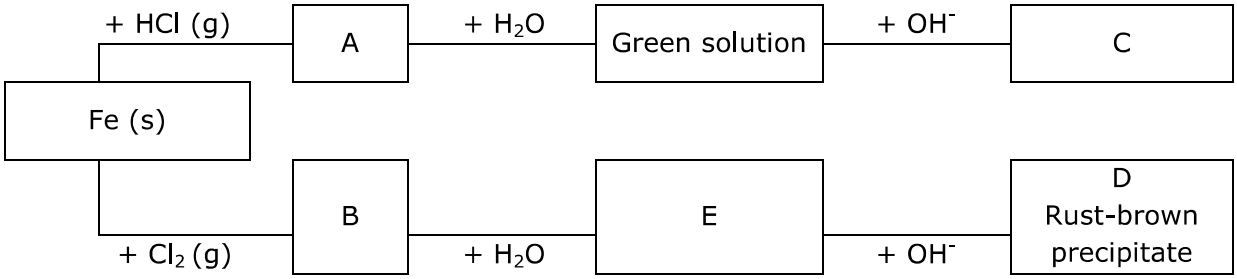
(Total: 20 marks)

12. The extraction of iron from its ore through the Blast Furnace is an important chemical process.
    a) Name the main ore of iron. (1)

    b) Give **ONE** use of iron. (1)

    c) The main ore of iron consists mainly of iron(III) oxide which is reduced in the Blast Furnace using carbon monoxide.
       i) Identify the **TWO** other solids which are heated with the iron ore in the Blast Furnace. (2)
       ii) Write down a balanced chemical equation for the reduction of iron(III) oxide using carbon monoxide. (2)
       iii) The main impurity in the iron ore is silica (SiO_2). Explain how this is removed from the mixture in the Blast Furnace. (2)

d) Study the following reaction scheme and identify:
   i) the compounds of iron: A, B, C, and D; (4)
   ii) the colours of substance C and of solution E. (2)

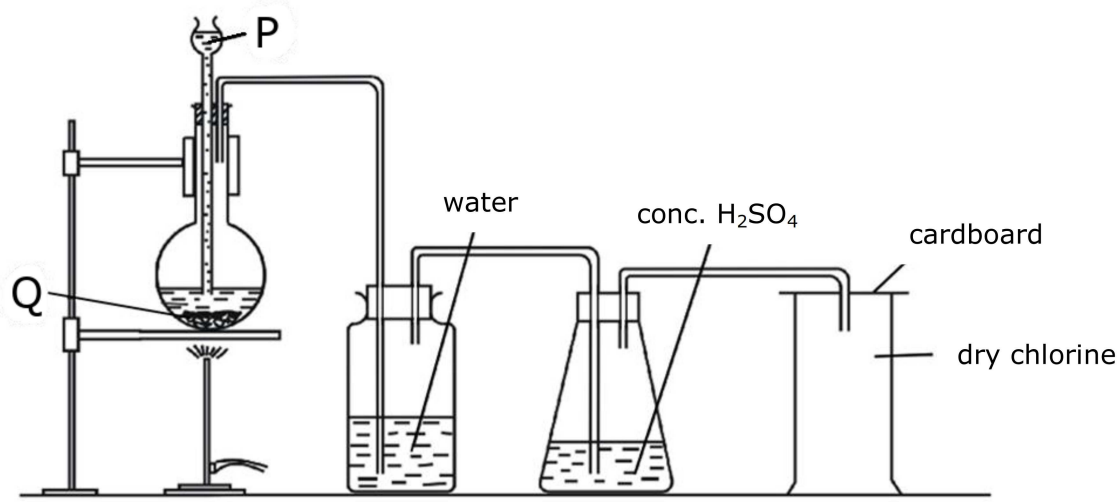


e) In 2015, about 3.3×10^{12} kg of iron ore were mined in the world. Assuming this mass to be only iron(III) oxide and the extraction of iron from its ore to be 100% efficient, calculate the mass of iron that can be extracted from this mass of ore. (3)

f) A big problem in the use of iron is its readiness to rust.
   i) Give **TWO** requirements for iron to rust. (2)
   ii) Give **ONE** way to prevent rusting. (1)

(Total: 20 marks)

13. Chlorine is prepared in the laboratory using the apparatus shown below.



Picture adapted from: https://www.advance-africa.com/Chemistry-Notes-Form-3.html

a) Identify substances P and Q. (2)

b) Write down a balanced chemical equation for the reaction between P and Q to produce chlorine. (2)

c) Why are the products of the reaction passed through:
   i) water; (1)
   ii) concentrated sulfuric acid? (1)

d) Why is it possible to collect chlorine using the method shown in the diagram? (1)

This question continues on next page.

e) Chlorine is easily recognised due to its properties. For chlorine gas, state the:
   i) colour; (1)
   ii) smell; (1)
   iii) effect on moist red litmus paper; (1)
   iv) effect on moist blue litmus paper. (1)

f) Chlorine dissolves in water to produce two acids. Identify these **TWO** acids. (2)

g) In an experiment, chlorine gas is bubbled through separate solutions of sodium bromide and sodium iodide.
   i) Give **ONE** observation for each reaction. (2)
   ii) Write a balanced ionic equation, omitting spectator ions and including state symbols, for the reaction of chlorine with sodium bromide. (3)
   iii) Which reaction happens faster: chlorine with sodium bromide or chlorine with sodium iodide? Explain your answer. (2)

(Total: 20 marks)

14. This question is about the metals sodium, magnesium, potassium, and calcium.
   a) These metals can be distinguished based on their appearance and physical properties. Identify each of A, B, C, and D as sodium, magnesium, potassium, or calcium. (4)

A	Soft silvery-white metal. It has a low density (it floats on water) and it is soft enough to be cut with a knife.
B	Soft silvery-white metal. Softer and has a lower density than A.
C	Dark grey metal which is reasonably hard. Although it has a relatively low density for a metal, it sinks in water.
D	Dark grey metal. It can be cut with a knife by applying enough force. Although it sinks in water, its density is lower than that of C.

   b) These metals can also be identified by their reactions with water. Identify each of E, F, G and H as sodium, magnesium, potassium, or calcium. (4)

E	Reacts very vigorously with cold water, producing an alkali and hydrogen gas. The hydrogen usually catches fire due to the heat of reaction, producing a lilac coloured flame.
F	Reacts slowly with cold water. Effervescence is observed and a sparingly soluble white substance is formed.
G	Does not react visibly with cold water. Reacts very vigorously with steam to produce a white powder and hydrogen gas.
H	Reacts vigorously with cold water, producing an alkali and hydrogen gas.

c) Describe a simple test to show that the:
   i) solution obtained when E and H react with water is alkaline; (1)
   ii) precipitate obtained when F and G react with water is basic. (1)

d) Write a balanced chemical equation for the reaction of E with water. (2)

e) By referring to electron configurations, explain why sodium is more reactive than:
   i) lithium; (2)
   ii) magnesium. (2)

f) Since ancient times, known metals were obtained by roasting (heating) the ores. However, experiments to obtain pure elements by heating carbonate of soda (sodium carbonate) and limestone (calcium carbonate) were unsuccessful. The elements were only first isolated in the 1800s when Humphry Davy passed electricity through these common substances.
   i) Explain the effect of heat on:
      • sodium carbonate; (1)
      • calcium carbonate. (2)
   ii) Why is it relatively hard to obtain metals such as sodium and calcium from their compounds? (1)

(Total: 20 marks)

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PERIODIC TABLE

I	II											III	IV	V	VI	VII	VIII
1 **H** 1																	4 **He** 2
7 **Li** 3	9 **Be** 4											11 **B** 5	12 **C** 6	14 **N** 7	16 **O** 8	19 **F** 9	20 **Ne** 10
23 **Na** 11	24 **Mg** 12											27 **Al** 13	28 **Si** 14	31 **P** 15	32 **S** 16	35.5 **Cl** 17	40 **Ar** 18
39 **K** 19	40 **Ca** 20	45 **Sc** 21	48 **Ti** 22	51 **V** 23	52 **Cr** 24	55 **Mn** 25	56 **Fe** 26	59 **Co** 27	59 **Ni** 28	63.5 **Cu** 29	65 **Zn** 30	70 **Ga** 31	73 **Ge** 32	75 **As** 33	79 **Se** 34	80 **Br** 35	84 **Kr** 36
85 **Rb** 37	88 **Sr** 38	89 **Y** 39	91 **Zr** 40	93 **Nb** 41	96 **Mo** 42	99 **Tc** 43	101 **Ru** 44	103 **Rh** 45	106 **Pd** 46	108 **Ag** 47	112 **Cd** 48	115 **In** 49	119 **Sn** 50	122 **Sb** 51	128 **Te** 52	127 **I** 53	131 **Xe** 54
133 **Cs** 55	137 **Ba** 56	139 **La** 57	178.5 **Hf** 72	181 **Ta** 73	184 **W** 74	186 **Re** 75	190 **Os** 76	192 **Ir** 77	195 **Pt** 78	197 **Au** 79	201 **Hg** 80	204 **Tl** 81	207 **Pb** 82	209 **Bi** 83	209 **Po** 84	210 **At** 85	222 **Rn** 86
223 **Fr** 87	226 **Ra** 88	227 **Ac** 89															

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.19m

L-Università ta' Malta

MATRICULATION AND SECONDARY EDUCATION CERTIFICATE EXAMINATIONS BOARD

SECONDARY EDUCATION CERTIFICATE LEVEL
2019 MAIN SESSION

SUBJECT:	**Chemistry**
PAPER NUMBER:	IIB
DATE:	23rd May 2019
TIME:	9:00 a.m. to 11:05 a.m.

Useful data:

Relative atomic masses: H = 1; N = 14; O = 16; Na = 23.

Standard temperature and pressure (stp): 0 °C and 1 atm (760 mm Hg)

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

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

Faraday constant = 96500 C mol^{-1}

Avogadro constant, L = 6.02 x 10^{23}

Q = It

$\Delta H = mc\Delta\theta$

Directions to Candidates

- Write your index number in the space at the top left-hand corner of this page.
- Answer **ALL** questions 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 spaces provided in this booklet.
- The mark allocation is indicated at the end of each question. Marks allocated to parts of questions are also indicated in brackets.
- You are reminded of the necessity for orderly presentation in your answers.
- In calculations you are advised to show all the steps in your working, giving your answer at each stage.
- The use of electronic calculators is permitted.
- A Periodic Table is printed on the back of this booklet.

For examiners' use only:

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

Section A: Answer ALL questions.

1. Fill in the blanks in the following paragraph with words chosen from the word bank below. Every word may be used once, more than once or not at all.

lose	cooling	stronger	gain
evaporating	weak	mass	volume

A gas has neither shape nor _____. This is because there are _____ forces which hold the particles together. On condensing, the particles _____ some of their energy and start to form _____ attractive forces. On further _____, the particles form a solid as they _____ more energy and will only be able to vibrate in their fixed positions.

(Total: 6 marks)

6

2.

a) When some substances such as common salt are added to water they disappear as they dissolve. In this process, water is called a solvent. Give the correct name for each of the following.

i)	The solid that dissolves in the water.	
ii)	A mixture of water and solid in which the solid dissolves.	
iii)	A mixture of small particles of a solid and liquid in which the solid does not dissolve.	
iv)	A mixture of water and a solid in which the solid has dissolved but which cannot hold any more dissolved substance in it.	

(4)

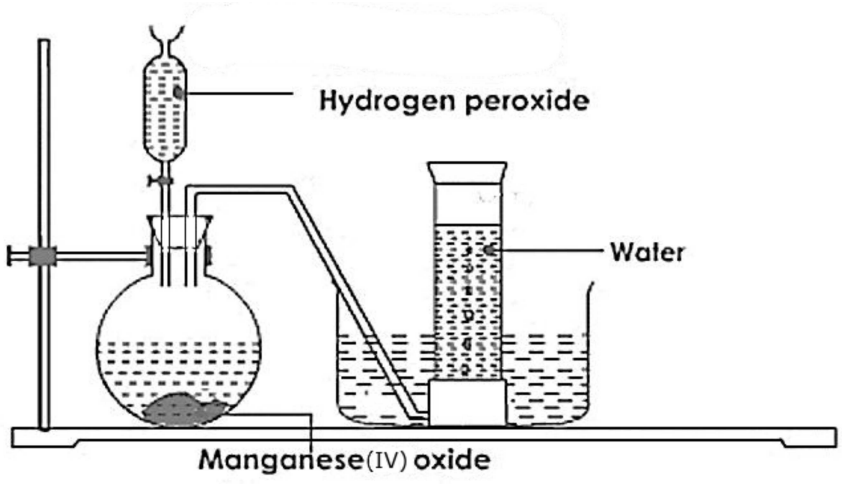
b) Sometimes water will react with substances that are placed in it. Give the equation for the change that takes place when sodium is placed in water. State symbols are not required.

_____ (2)

(Total: 6 marks)

6

3. The following shows a diagram for the laboratory preparation of a gas.



https://lh3.googleusercontent.com

a) Give the name of the gas that is prepared in the laboratory using the above apparatus.

_____ (1)

b) What does this experiment tell you about the solubility of this gas in water?

_____ (1)

c) Give another method which may be suitable for the collection of this gas.

_____ (1)

d) This gas reacts with metals such as calcium. Describe a simple test to show that the solid produced is basic.

_____

_____

_____ (3)

6

(Total: 6 marks)

Please turn the page.

4. Nitric acid behaves both as an acid and as an oxidizing agent.

   a) Give the equation for the reaction between nitric acid and copper(II) carbonate. Include state symbols.

_____ (3)

   b) The reaction between copper and concentrated nitric acid is represented by the equation shown below.

$$Cu + 4HNO_3 \rightarrow Cu(NO_3)_2 + 2H_2O + 2NO_2$$

      i) Show that nitric acid is acting as an oxidizing agent in this reaction.

_____ (1)

      ii) Give **TWO** colour changes observed when this reaction takes place.

_____

_____ (2)

(Total: 6 marks)

6

5. Carbon may exist in nature as a number of allotropes.

   a) What are allotropes?

_____

_____ (2)

   b) Give the name of **TWO** allotropes of carbon.

_____ (2)

   c) Carbon reacts with oxygen to form either carbon dioxide or carbon monoxide. Explain how one can prove that carbon dioxide is an acidic oxide while carbon monoxide is a neutral oxide.

_____

_____

_____ (2)

(Total: 6 marks)

6

6. In the laboratory, ammonia is prepared using the reaction below.

$$(NH_4)_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + 2H_2O + 2NH_3$$

a) How many moles of ammonia are present, when 2 dm^3 of ammonia measured at stp are produced?

_____

_____ (1)

b) Calculate the mass of ammonia in 2 dm^3 at stp.

_____

_____ (2)

c) How many moles of sodium hydroxide are required to produce 2 dm^3 of ammonia at stp?

_____

_____ (2)

d) The number of moles calculated in part (c) are present in 150 cm^3 of sodium hydroxide solution. What is the concentration of the alkali in mol dm^{-3} ?

_____

_____ (2)

7

(Total: 7 marks)

Please turn the page.

7. During the purification of copper by electrolysis, an anode of impure copper and a cathode of pure copper are placed in a solution of copper(II) sulfate.

   a) Give the equation for the change that takes place at the anode.

_____ (2)

   b) Give the equation for the change that takes place at the cathode.

_____ (2)

   c) What type of reaction takes place at the anode?

_____ (1)

   d) What type of reaction takes place at the cathode?

_____ (1)

(Total: 6 marks)

6

8. The metals in the following list are **not** in order of their chemical reactivity.

magnesium	copper	calcium	zinc	sodium	iron

   a) Place these elements in order of their reactivity, placing the most reactive first.

_____

_____ (2)

   b) From these metals, which is the least likely to lose electrons?

_____ (1)

   c) Give **TWO** observations when powdered zinc is added to a solution of copper(II) sulfate.

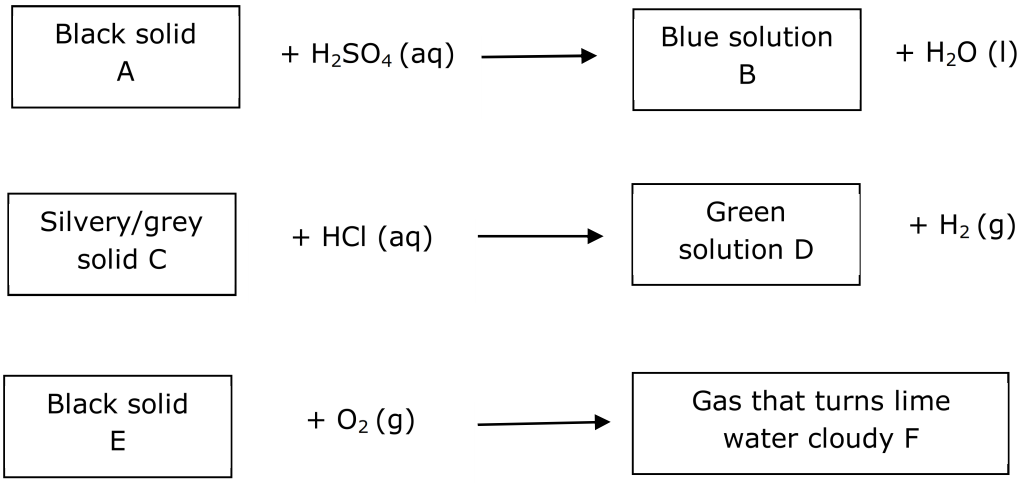
   Observation 1: _____ (1)

   Observation 2: _____ (1)

(Total: 5 marks)

5

9. Study the following reactions and identify the substances labelled A, B, C, D, E and F.



Substance	Name
A	
B	
C	
D	
E	
F	

(6)

6

(Total: 6 marks)

Please turn the page.

10.

a) In the space provided below, draw the structural formulae of ethene and ethyne.

Structural formula of ethene	Structural formula of ethyne

(2)

b) Give the structural formulae of the substances formed when both ethene and ethyne react with hydrogen chloride gas.

Structural formula of the product formed when ethene reacts with hydrogen chloride gas.	Structural formula of the product formed when ethyne reacts completely with hydrogen chloride gas.

(2)

c) Name the product of the reaction between ethene and steam.

_____ (1)

d) Name the product when the substance formed in part (c) undergoes oxidation.

_____ (1)

(Total: 6 marks)

6

Section B: Answer TWO questions from this Section.

11. The main reaction in the Contact Process for the manufacture of sulfuric acid is:

$$2SO_2 + O_2 \rightleftharpoons 2SO_3 \quad \Delta H = -197 \text{ kJ mol}^{-1}$$

a) Give equations for **TWO** other reactions that are required to produce sulfuric acid. (3)

b) The reaction shown above may reach a state of dynamic equilibrium.
   i) Explain briefly when this happens. (1)
   ii) Mention **THREE** conditions that can be changed to shift the equilibrium such that more sulfur trioxide is produced. (3)
   iii) How do the conditions mentioned in part (b) (ii) help to shift the equilibrium to the right? (3)

c) The sulfur dioxide used above is manufactured on a large scale. However, sulfur dioxide is a major pollutant.
   i) Give **TWO** reasons why sulfur dioxide is a pollutant. (2)
   ii) Name another source for the presence of sulfur dioxide in air. (1)

d) Sulfuric acid is a very important chemical and may be used in several ways. Give balanced chemical equations to show how sulfuric acid may be used as:
   i) an acid with sodium hydroxide; (2)
   ii) a dehydrating agent with ethanol; (2)
   iii) an oxidizing agent with copper to produce copper(II) sulfate, water and sulfur dioxide. (2)

e) Give **ONE** other use of sulfuric acid in the laboratory not mentioned in part (d). (1)

(Total: 20 marks)

12. Iron (Fe) is extracted from its ore (Fe_2O_3), in the Blast Furnace.

a) Write equations for the reactions that take place in the Blast Furnace related to the formation of the reducing agent and the reduction of the ore. (6)

b) Limestone is also added to the other raw materials in the Blast Furnace. Give **TWO** reasons for this. (2)

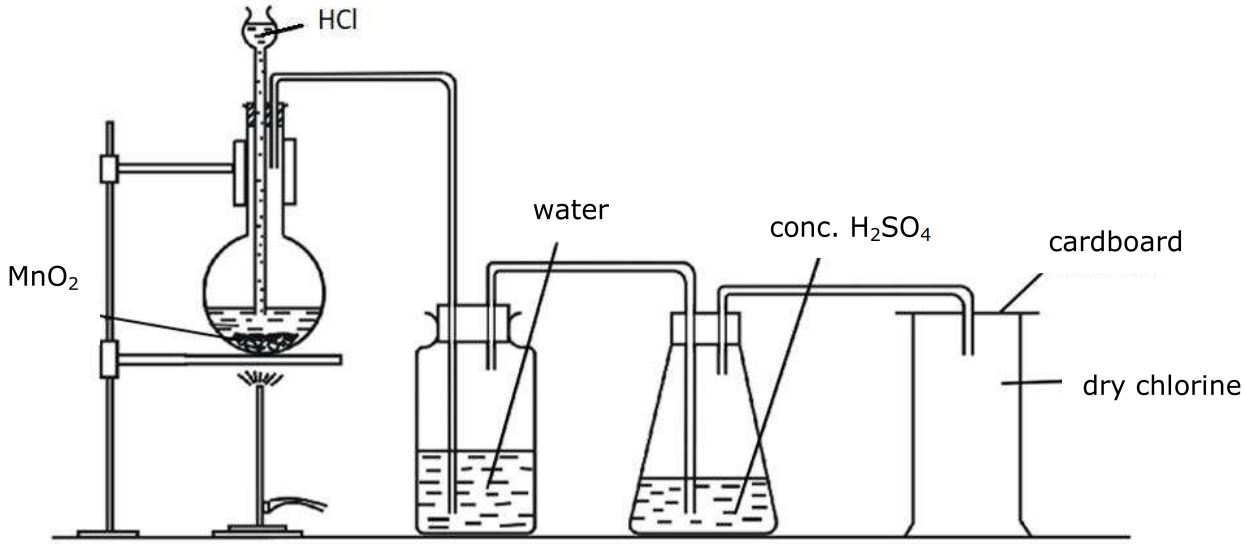
c) Iron is a transition element.
   i) Give **THREE** properties that are characteristic of transition metals. (3)
   ii) Show how iron exhibits **TWO** of the properties in part (c) (i). (2)

d) For an experiment to show how iron reacts with steam:
   i) draw a labelled diagram of the apparatus; (3)
   ii) list any precautions taken during the experiment. (1)

e) What substances are formed when iron reacts with:
   i) hydrochloric acid? (2)
   ii) chlorine? (1)

(Total: 20 marks)

13. Chlorine is a poisonous gas and is prepared in the laboratory in a fume cupboard.



Picture adapted from: https://www.advance-africa.com/Chemistry-Notes-Form-3.html

a) Give the equation for the preparation of this gas. (2)

b) Explain why it is important that during the laboratory preparation of chlorine:
   i) the thistle funnel used must be under the surface of the liquid; (1)
   ii) the impure chlorine gas is passed through water; (1)
   iii) after passing the impure chlorine through water, it is passed through concentrated sulfuric acid; (1)
   iv) the gas is collected by downward delivery. (1)

c) The reaction of chlorine with water is as follows:

$$Cl_2 + H_2O \rightarrow HCl + HClO$$

Bromine reacts in a similar manner. Give the equation for the reaction of bromine with water. (2)

d) What is observed when chlorine is bubbled through the following solutions?
Do not mention the decolourisation of chlorine gas.
   i) Potassium iodide; (1)
   ii) Sodium bromide; (1)
   iii) Sodium chloride. (1)

e) How would you expect the reaction between bromine and hydrogen to differ from that between iodine and hydrogen? (2)

f) Place iodine, chlorine and bromine in order of their reactivity putting the most reactive first. (3)

g) Chlorine has a characteristic yellow-green colour, but how would one test for its presence in the laboratory? (2)

h) State **TWO** uses of chlorine. (2)

(Total: 20 marks)

14. This question is about groups 1 and 2 of the Periodic Table.

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

i) Draw the electron structure of magnesium showing **all** electrons. (2)

ii) Which of magnesium or calcium is the most reactive? Explain why. (2)

b) In Malta, some building blocks are made of limestone (calcium carbonate). Builders lay these blocks using mortar (the stuff builders put in between the blocks), containing quicklime (calcium oxide) mixed with sand and water.

In industry, limestone is heated strongly until it decomposes to form quicklime and carbon dioxide. Quicklime changes to slaked lime (calcium hydroxide) when it comes in contact with water.

In time, the slaked lime absorbs carbon dioxide from the air to form limestone crystals which lock the blocks together.

Give the equation, including state symbols, for the chemical reaction that takes place when:

i) limestone changes to quicklime; (3)

ii) quicklime changes to slaked lime; (3)

iii) slaked lime changes to limestone. (3)

c) Sodium and potassium are metals that are found in Group 1 of the Periodic Table.

i) How does the electron structure of sodium and potassium differ from that of magnesium and calcium? (1)

ii) Why do sodium and potassium react similarly? (1)

iii) Why is sodium more reactive than magnesium? (2)

iv) Why is potassium more reactive than sodium? (2)

v) Sodium is more reactive than calcium. Explain. (1)

(Total: 20 marks)

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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