Index Number:_____ SEC06/1.17m

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

SECONDARY EDUCATION CERTIFICATE LEVEL

MAY 2017 SESSION

SUBJECT:	**Chemistry**
PAPER NUMBER:	I
DATE:	30th May 2017
TIME:	9:00 a.m. to 11:05 a.m.

Useful data:

Relative atomic masses: H = 1; C = 12

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

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

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**	**6**	**6**	**6**	**6**	**6**	**20**	**20**	**100**

SECTION A

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

1. In the table below, Column A contains six statements which may be true or false. Write true or false in Column B to indicate which statements are true and which ones are false.

	Column A	Column B
(a)	When an ice cube melts at room temperature a chemical change occurs.	
(b)	Sodium chloride is a mixture of sodium and chlorine.	
(c)	Ice and steam consist of the same compound but in different states.	
(d)	When an electric current is passed through sulfuric acid only a physical change occurs.	
(e)	In a mixture of sand and sugar in a beaker, the amount of sugar might not be the same at the top and at the bottom of the beaker.	
(f)	Iron filings are attracted by a magnet but iron(II) sulfide powder is not attracted by a magnet.	

6

(Total: 6 marks)

2. Dilute sulfuric acid may be added to copper(II) oxide so as to obtain copper(II) sulfate.

(a) Give a balanced chemical equation for the reaction.

_____ (2)

(b) What will be the colour of the solution after the reaction?

_____ (1)

(c) Which **ONE** of the two reactants should be present in excess?

_____ (1)

(d) Mention **TWO** processes that are necessary to obtain pure solid copper(II) sulfate crystals after the reaction.

(i) Process 1: _____

(ii) Process 2: _____ (2)

(Total: 6 marks)

6

3. Oxygen, O_2 and ozone, O_3 are allotropes.

(a) What are allotropes?

_____

_____ (1)

(b) What substances must **not** be present in spray cans labelled 'ozone friendly'?

_____ (1)

(c) Mention (i) **ONE** advantage, and (ii) **ONE** disadvantage of ozone in the atmosphere:

(i) an advantage;

_____ (1)

(ii) a disadvantage.

_____ (1)

(d) The allotropes of sulfur are rhombic sulfur and monoclinic sulfur.

(i) In what chemical way are the allotropes of sulfur different from the allotropes of oxygen?

_____

_____ (1)

(ii) In what physical way are the allotropes of sulfur different from the allotropes of oxygen at stp?

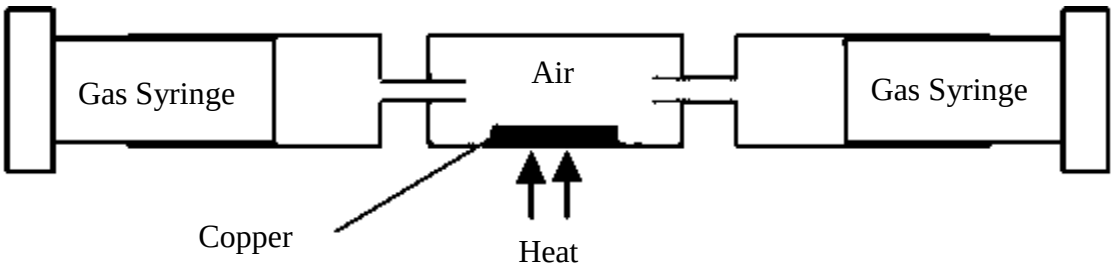
_____ (1)

(Total: 6 marks)

6

Please turn the page.

4. A laboratory session involved finding the percentage of oxygen present in air using the apparatus shown below.



At the beginning of the experiment both gas syringes contained air.

The syringes were used to keep air moving backwards and forward over the heated copper, until the reaction had stopped. The apparatus was allowed to cool and the boat and its contents were weighed.

It was found that in the reaction, 0.001 mole of copper reacted with 0.001 mole of oxygen.

(a) What volume of oxygen, in dm^3 measured at stp, combined with the copper available?

_____

_____ (2)

(b) State **TWO** reasons why such an experiment cannot be carried out using magnesium instead of copper.

_____

_____ (2)

(c) If in another similar experiment the volume of air in the syringes were equal to twice the volume calculated in part (a), would the 0.001 mole copper react completely? Explain your answer.

_____

_____ (2)

(Total: 6 marks)

6

5. A chemistry class was given the following information about the behaviour of some elements, shown in Column A, when they react with the reagents shown in Column B:

Column A	Column B	Observation
copper	cold water	no reaction
zinc	copper(II) chloride solution	reaction occurs
calcium	warm water	slow reaction
zinc	warm water	no reaction

(a) From the information given in the table, place the three elements of Column A in order of reactivity, starting with the most reactive first.

_____ (1)

(b) Give a balanced ionic equation, including state symbols, for the reaction of zinc with copper(II) chloride solution.

_____

_____ (3)

(c) The reaction in part (b) represents a redox reaction.

(i) Which substance is being oxidised?

_____ (1)

(ii) Explain your answer to part (c)(i).

_____ (1)

(Total: 6 marks)

6

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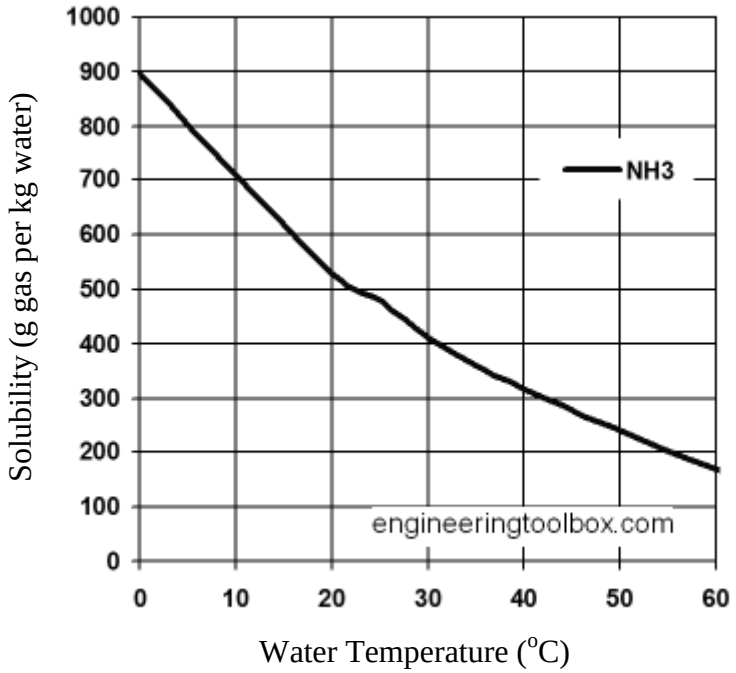
6. Ammonia is considered as being a very soluble gas but it is interesting to note that its solubility in water varies depending on the temperature.



Source: engineeringtoolbox.com

(a) From the graph find the approximate solubility of ammonia in water at 10 ^{o}C.

_____ (1)

(b) Calculate the mass of ammonia which would be released as a gas when the temperature of a 1 kg saturated solution changes from 10 ^{o}C to 30 ^{o}C.

_____

_____ (2)

(c) Ions are produced when ammonia dissolves in water. Give the formulae of the ions formed.

_____ (2)

(d) The solubility of a fictitious gas is 350 g gas per kg water and does not vary with temperature. On the same axis above, sketch the shape that the graph would have. (1)

6

(Total: 6 marks)

7. A group of students are asked to prepare some nitrogen dioxide in the laboratory by cautiously heating lead(II) nitrate, $Pb(NO_3)_2$.

(a) Give a balanced chemical equation for the reaction.

_____ (2)

(b) Which of the gases given off can change the colour of moist blue litmus?

_____ (1)

(c) What is the best way to collect the gases produced in the reaction?

_____ (1)

(d) It is not always easy to clean the test tube after the reaction because the solid seems to 'stick' to the glass. Suggest a chemical way that may be used to remove the solid from the test tube without damaging the test tube.

_____ (1)

(e) Nitrogen dioxide is a pollutant and can cause harmful effects. Mention **ONE** of these harmful effects.

_____ (1)

(Total: 6 marks)

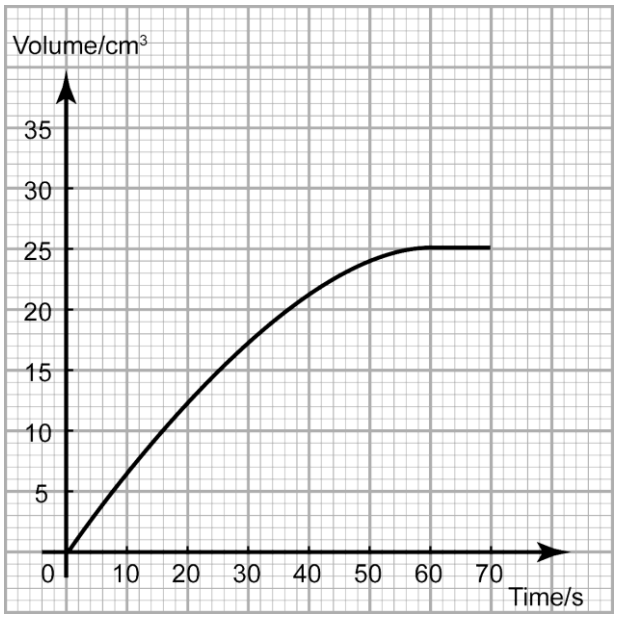
6

Please turn the page.

8. In an experiment, excess dilute hydrochloric acid is added to magnesium carbonate powder and a reaction occurs according to the equation:

$$MgCO_3\,(s) + 2HCl\,(aq) \rightarrow MgCl_2\,(aq) + H_2O\,(l) + CO_2\,(g)$$

The graph shows the volume of carbon dioxide produced as time passes.



Source: http://spmchemistry.onlinetuition.com.my/

(a) Labelling your answers carefully, on the same graph draw curves to show how the experiment would proceed if, all other factors unchanged, the experiment is carried out:

(i) at a higher temperature; (1)

(ii) using a more dilute solution of hydrochloric acid which has the same number of moles. (1)

(b)

(i) If the volume of carbon dioxide collected is measured at stp, how many moles of carbon dioxide were produced?

_____

_____ (2)

(ii) How many moles of hydrochloric acid are needed for the reaction?

_____

_____ (2)

(Total: 6 marks)

6

9. Sulfuric acid is a very commonly used reagent in the laboratory.

(a) Concentrated sulfuric acid reacts with solid potassium chloride. Give a balanced equation, including state symbols, for this reaction.

_____ (3)

(b) Dilute sulfuric acid shows no effect on copper turnings but a reaction is observed if concentrated sulfuric acid is added to copper turnings.

(i) Give a balanced equation for the reaction of concentrated sulfuric acid with copper.

_____ (2)

(ii) Why does concentrated sulfuric acid react with copper?

_____ (1)

(Total: 6 marks)

6

10.

(a) Showing outer electrons only, draw a dot-and-cross diagram to show the bonding in methane, CH_4.

(2)

(b) Give the name of an unsaturated hydrocarbon with three carbon atoms.

_____ (1)

(c) A hydrocarbon with molecular formula C_5H_{12} is heated and undergoes cracking.

(i) What is cracking?

_____ (1)

(ii) Give the formulae of **TWO** possible products after cracking of C_5H_{12}.

_____ (2)

(Total: 6 marks)

6

SECTION B

Answer ALL questions in this section. Write your answers in the spaces provided.

11.

(a) Under the right conditions a reversible reaction may set up a dynamic equilibrium. Explain the term 'dynamic equilibrium'.

_____ (1)

(b) A group of students were given a project in which they had to carry out an esterification reaction in a small closed conical flask and then allow it to stand for several days. The following equation represents the reaction:

$$CH_3COOH\ (aq) + C_2H_5OH\ (l) \rightleftharpoons CH_3COOC_2H_5\ (l) + H_2O\ (l)$$

(i) Explain the effect on the position of equilibrium:

- when a few drops of a suitable catalyst are added to the mixture;

_____

_____ (2)

- if more C_2H_5OH is added to the mixture.

_____

_____ (2)

(ii) The teacher asked the students to add some sodium carbonate to the mixture in the conical flask, keeping the contents at room temperature. What effect will there be on the equilibrium? Explain your answer.

_____

_____

_____ (3)

(c) In the Contact Process, sulfur dioxide reacts with oxygen in the presence of vanadium(V) oxide to produce sulfur trioxide. The temperature used is 450 ^{o}C

$$2\ SO_2\,(g) + O_2\,(g) \leftrightharpoons 2\ SO_3\,(g) \qquad \Delta H = -197\ kJ\ mol^{-1}$$

(i) State the pressure used in this step of the Contact Process.

_____ (1)

(ii) What would happen to the equilibrium if the temperature used were to be higher than 450 ^{o}C? Explain.

_____

_____ (2)

(iii) Draw an energy profile for the forward reaction above, clearly labelling the diagram, axis, and heat of reaction (enthalpy of reaction).

(5)

(iv) How is sulfur dioxide produced in the Contact Process? Why is this method, rather than the production of sulfur dioxide from a sulfite, used in industry?

_____

_____ (2)

(v) In the Contact Process, sulfur trioxide is dissolved in sulfuric acid rather than in water.

- Why is sulfur trioxide not dissolved in water to produce sulfuric acid?

_____ (1)

- What is the name given to the oily liquid formed when sulfur trioxide is dissolved in sulfuric acid?

_____ (1)

(Total: 20 marks)

20

12. Hydrogen has various uses in the chemical industry.

(a)

(i) Draw a well-labelled diagram of the apparatus that can be used to prepare and collect hydrogen gas in the laboratory, starting from iron filings and dilute hydrochloric acid.

(5)

(ii) Give a balanced ionic equation, including state symbols, for the reaction in part (a)(i).

_____

_____ (3)

(iii) Suggest **TWO** reasons why it is **not** recommended to prepare hydrogen starting from lead and dilute sulfuric acid.

_____

_____

_____ (2)

(b) The heat of combustion of hydrogen is -286 kJ mol^{-1}.

(i) Define 'heat of combustion'.

_____

_____ (2)

(ii) Give **ONE** advantage of using hydrogen as a fuel.

_____ (1)

(c) Several substances may be used as fuels. The table below shows heats of combustion of two substances, hydrogen, H_2, and propane, C_3H_8.

Substance	**Heat of combustion / kJ mol^{-1}**
hydrogen	- 286
propane	- 2220

Given 10.0 g samples of each substance in the table, calculate which of the two samples will give out the most heat energy.

_____

_____

_____

_____

_____

_____ (7)

(Total: 20 marks)

20

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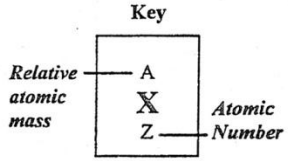
PERIODIC TABLE



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															

140 **Ce** 58	141 **Pr** 59	144 **Nd** 60	147 **Pm** 61	150 **Sm** 62	152 **Eu** 63	157 **Gd** 64	159 **Tb** 65	162 **Dy** 66	165 **Ho** 67	167 **Er** 68	169 **Tm** 69	173 **Yb** 70	175 **Lu** 71
232 **Th** 90	231 **Pa** 91	238 **U** 92	237 **Np** 93	244 **Pu** 94	243 **Am** 95	247 **Cm** 96	247 **Bk** 97	251 **Cf** 98	252 **Es** 99	257 **Fm** 100	258 **Md** 101	259 **No** 102	260 **Lr** 103

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

SECONDARY EDUCATION CERTIFICATE LEVEL

MAY 2017 SESSION

SUBJECT:	**Chemistry**
PAPER NUMBER:	IIA
DATE:	30th May 2017
TIME:	4:00 p.m. to 6:05 p.m.

Useful data:

Relative atomic masses: H = 1; N = 14; O = 16; Na = 23; Mg = 24; S = 32; Cl = 35.5

Avogadro constant L = 6.0×10^{23}

Faraday constant = 96,500 C

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

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

Q = I t

Directions to Candidates

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

For examiners' use only:

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

SECTION A

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

1. Several substances were heated separately in a hard glass tube on a blue Bunsen flame. For each set of observations, give the name of the substance that was present before heating. (For some questions more than one substance might be correct.)

Effect of Heat on Substance	Name of Substance
(a) A green powder decomposed to give a black powder and carbon dioxide gas.	
(b) A white crystalline solid decomposed with a crackling sound producing brown fumes which relit a glowing splint.	
(c) A blue crystalline solid formed a white powder while drops of a colourless liquid formed at the neck of the test tube.	
(d) A white solid which did not decompose.	
(e) A reddish-brown metal turned black.	
(f) A white powder changed colour to yellow when hot and turned white again on cooling.	

(Total: 6 marks) 6

2. Complete the following paragraph about acids, pH and indicators.

Acids are substances that dissociate in water to form _____ ions. Not all acids dissociate to the same degree. Those that dissociate slightly have a higher pH. They are called _____ acids. An example of such an acid is _____ acid. Those that dissociate a lot have a lower pH. They are called _____ acids. An example of such an acid is _____. A suitable indicator to distinguish between pH 1 and pH 6 would be _____ indicator.

(Total: 6 marks) 6

3. The alkali and alkaline earth metals are found in Groups 1 and 2 of the Periodic Table respectively.

(a) Write down the electronic configuration for:

(i) sodium; _____ (1)

(ii) magnesium. _____ (1)

(b) Give a balanced chemical equation to show the reaction between magnesium and steam.

_____(2)

(c) What are the products of the reaction between sodium and water?

_____(2)

(d) While sodium is reacted with cold water, magnesium is reacted with steam. Compare the reactivity of sodium and magnesium in terms of their electronic configuration.

_____

_____

_____(2)

(e) A primary school teacher wants to show young students that metals can react vigorously with water. Sodium and potassium are available in the laboratory.

(i) Why are both metals stored under oil?

_____ (1)

(ii) Suggest the safest metal, from sodium and potassium, to be used in the class demonstration. Explain your answer by referring to the electronic configuration of these alkali metals.

_____

_____ (2)

(iii) Give **ONE** observation for the reaction in part (e)(ii).

_____ (1)

(Total: 12 marks)

12

4. Hard water can cause damages amounting to substantial amounts of money.
   (a) Scale is formed when hard water is heated. What type of hardness causes scale formation?

   _____(1)

   (b) Why is scale formation considered to be a problem?

   _____(1)

   (c) Give a balanced chemical equation for the formation of scale.

   _____(2)

   (d) When it comes to the way soaps and detergents operate during the cleaning process, detergents are said to have an advantage. Why is this so? In your explanation, mention both soaps and detergents.

   _____

   _____(2)

(Total: 6 marks)

6

5. There are **TWO** isomers with the molecular formula C_2H_6O.
   (a) Draw the structural formulae of these **TWO** isomers.

   (2)

   (b) **ONE** of these compounds undergoes oxidation when it reacts with acidified potassium dichromate. What is the name of this compound?

   _____(1)

   (c) What is the name of the substance that forms when the compound in part (b) is oxidised?

   _____(1)

   (d) Give a balanced chemical equation for the reaction between the compound in part (c) and calcium carbonate.

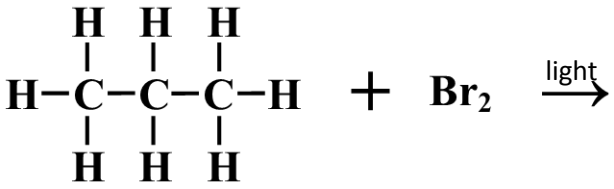
   _____(2)

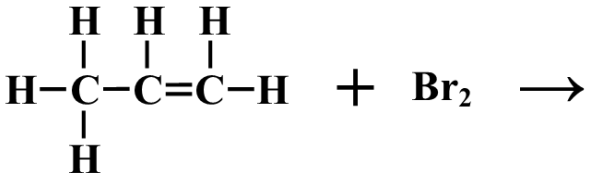
(Total: 6 marks)

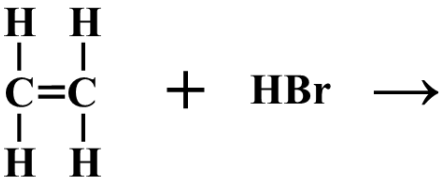
6

6. Alkanes, alkenes, and alkynes are three homologous series of hydrocarbons.

(a) Draw the structure of the organic compound formed when each of the following reactions takes place:







(3)

(b) Describe how bromine water can be used to distinguish between propane and propene.

_____

_____

_____(2)

(c) Why does propyne burn with a sooty (smoky) flame?

_____

_____(1)

(Total: 6 marks)

6

Please turn the page.

7. In the following reaction, 3.76×10^{22} particles of an unknown element **X** reacted completely with excess hydrochloric acid:

$$X + 2\,HCl \rightarrow XCl_2 + H_2$$

(a) If 3.76×10^{22} particles of metal **X** have a mass of 1.50 g, calculate the relative atomic mass of **X**.

_____

_____

_____ (2)

(b) Hence, calculate the mass of XCl_2 which can be obtained from this reaction.

_____

_____

_____ (3)

(c) What is the most likely name of the metal **X**?

_____ (1)

(Total: 6 marks)

6

8. A mass of 10.00 g of hydrated magnesium sulfate crystals were heated until a constant mass of 4.88 g anhydrous magnesium sulfate was obtained. Using the information given, derive a formula for hydrated magnesium sulfate crystals.

_____

_____

_____

_____

_____

(Total: 6 marks)

6

9. Nearly all metals are solids at room temperature and pressure. They are good conductors of heat and electricity. They are also malleable. These properties can be explained by the way the metal atoms are bound together.

(a) Draw a labelled diagram to explain the bonding in metals.

(2)

(b) Referring to the diagram in part (a), explain the bonding in metals.

_____

_____ (1)

(c) Use your diagram and knowledge of the bonding in metals to explain why metals are:

(i) good conductors of electricity; _____

_____ (1)

(ii) solids at stp; _____

_____ (1)

(iii) malleable. _____

_____ (1)

(Total: 6 marks)

6

Please turn the page.

SECTION B

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

10.

(a) A mass of 7.9 g of sodium sulfite was placed in a conical flask. A volume of 10.0 cm^3 of 1.0 mol dm^{-3} sulfuric acid was added and the flask was fitted with a stopper and a delivery tube.

(i) Give the equation for this reaction including all state symbols. (3)

(ii) For the reaction above:

- calculate the amount, in moles, of sodium sulfite used; (2)
- calculate the amount, in moles, of sulfuric acid used; (1)
- determine which reagent is present in excess; (1)
- calculate the volume of gas measured at stp that would be produced after the reaction is complete. (3)

(iii) The gas formed by this reaction may be prepared to a good level of purity in the laboratory using another reaction. Describe the laboratory preparation of this gas using two different reagents than the ones mentioned above. Your answer should include

- the identity of the **TWO** reagents; (2)
- the equation for the reaction; (2)
- any observation that one would make. (1)

(b) Dilute sulfuric acid also reacts with iron(II) sulfide to produce another gas.

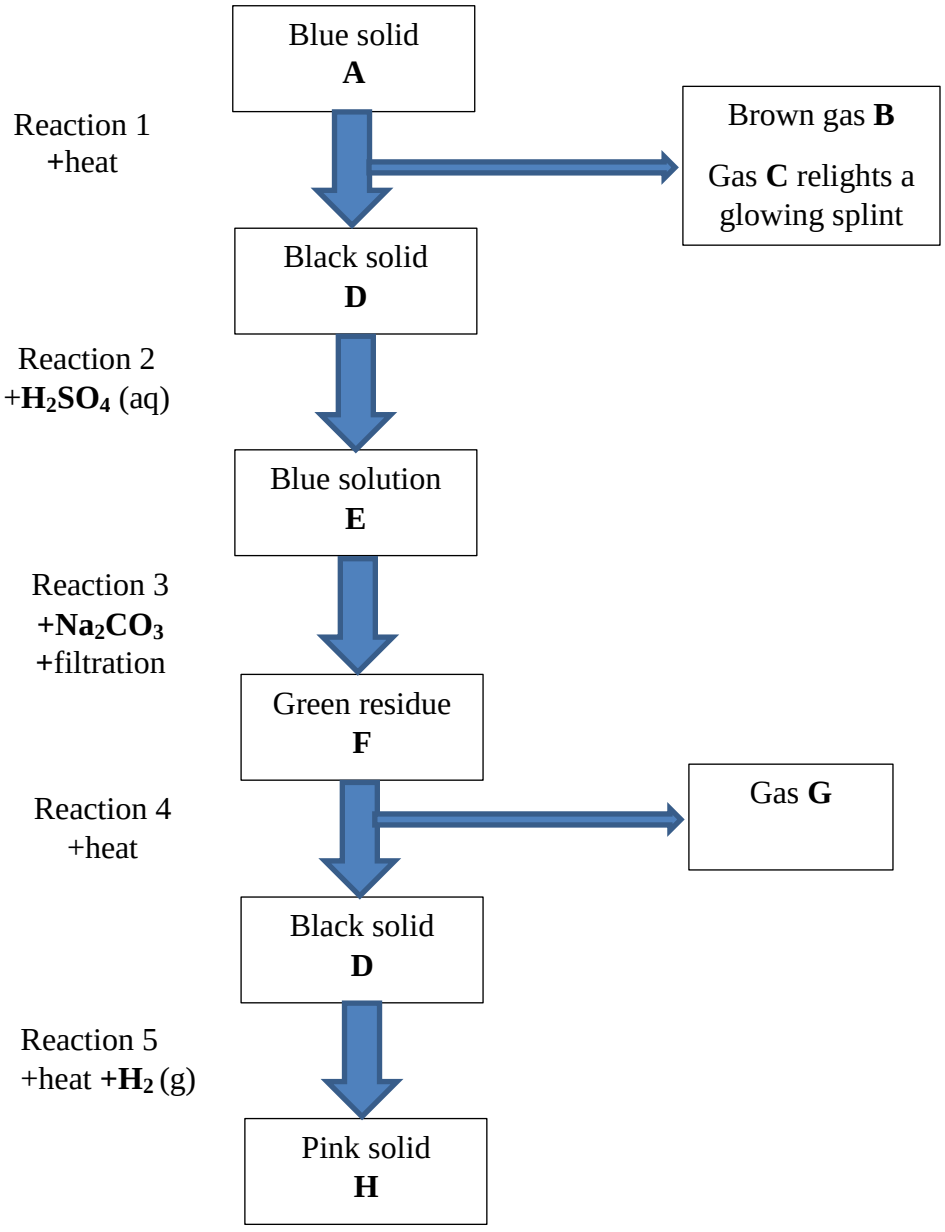
(i) Give the ionic equation, including state symbols, for this reaction. (3)

(ii) A man who went to clean a storage compartment in a ship that was carrying crude sulfate turpentine started to detect a strong smell of rotten eggs. What gas could have caused such a smell? (1)

(iii) As the man went deeper into the storage compartment, he began to shake uncontrollably and collapsed. What is the most likely reason for this? (1)

(Total: 20 marks)

11. Study the following reaction scheme and answer the questions below.



(a) Identify the unknown substances **A**, **B**, **C**, **D**, **E**, **F**, **G** and **H**. (8)

(b) Give the equations for the reactions **1**, **2**, **3**, **4** and **5**. (10)

(c) How can the presence of gas **G** be confirmed? (2)

(Total: 20 marks)

Please turn the page.

12. Ammonium sulfate may be prepared in laboratory by using the following reaction in a fume cupboard. Pure ammonium sulfate can only be obtained from the experiment if no excess reactants are present.

$$2\ NH_3\ (aq) + H_2SO_4\ (aq) \rightarrow (NH_4)_2SO_4\ (aq)$$

(a)

(i) A titration is carried out to determine the volume of sulfuric acid required to neutralise 25 cm^3 of ammonia solution. Describe the procedure, including:

- how glassware was cleaned; (3)
- the procedure for the titration. (4)

(ii) The titration was carried out using methyl orange indicator.

- What is the role of the indicator in a titration? (1)
- Why is the reaction repeated without the indicator? (1)

(iii) Describe how ammonium sulfate is collected from the resultant mixture. (5)

(b) A volume of 25 cm^3 of 1.5 mol dm^{-3} ammonia solution were reacted with 1.0 mol dm^{-3} sulfuric acid.

(i) What volume of sulfuric acid would be required to react completely with the 25 cm^3 of ammonia solution used? (4)

(ii) What mass of ammonium sulfate would have been produced during the reaction? (2)

(Total: 20 marks)

13. Sodium hydroxide is manufactured using membrane cells.

(a)

(i) Draw a diagram of such a cell showing clearly the electrodes, the solution used, and the places where the substances formed during this process leave the cell. (6)

(ii) Explain briefly how the sodium hydroxide produced is separated from the solution from which it is formed in the membrane cell. (2)

(b) Give the equation for the reaction that takes place at the:

(i) anode; (2)

(ii) cathode. (2)

(c) A charge of 134,000 A was passed through a membrane cell for 1 hour.

(i) Using your equation in part (b)(ii), what is the amount, in moles, of hydroxide ions produced when one mole of electrons flows through the cell? (1)

(ii) Hence, calculate the amount, in moles of, hydroxide ions produced when a charge of 134,000 A was passed through a membrane cell for 1 hour. (4)

(iii) Calculate the mass of sodium hydroxide, in kg, produced when a charge of 134,000 A was passed through a membrane cell for 1 hour. (2)

(d) State **ONE** large scale use of sodium hydroxide. (1)

(Total: 20 marks)

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PERIODIC TABLE

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

Key

Relative atomic mass — A
X
Z — Atomic Number

140 Ce 58	141 Pr 59	144 Nd 60	147 Pm 61	150 Sm 62	152 Eu 63	157 Gd 64	159 Tb 65	162 Dy 66	165 Ho 67	167 Er 68	169 Tm 69	173 Yb 70	175 Lu 71
232 Th 90	231 Pa 91	238 U 92	237 Np 93	244 Pu 94	243 Am 95	247 Cm 96	247 Bk 97	251 Cf 98	252 Es 99	257 Fm 100	258 Md 101	259 No 102	260 Lr 103

Index Number:_____ SEC06/2B.17m

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

SECONDARY EDUCATION CERTIFICATE LEVEL

MAY 2017 SESSION

SUBJECT:	**Chemistry**
PAPER NUMBER:	IIB
DATE:	30th May 2017
TIME:	4:00 p.m. to 6:05 p.m.

Useful data:

Relative atomic masses: H = 1; C = 12; O = 16; Na = 23; S = 32; Fe = 56; Cu = 63.5

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

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

1 Faraday = 96,500 C

Q = I t

Directions to Candidates

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

For examiners' use only:

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

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SECTION A

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

1. Fill in the blanks with the following words. Each word may be used once, more than once, or not all.

carbon dioxide	hydrogen	sodium carbonate
unstable	sodium hydrogencarbonate	sugar
volatile	stable	water vapour

The name of the main chemical in baking soda is _____. When baking soda is added to the cake mixture and this is placed in the oven a reaction takes place which releases a solid compound called _____ and a gas called _____, which makes the cake rise. _____ is also given off during this reaction. Baking soda is particularly suited for baking because although it is thermally _____, the solid residue it leaves behind is thermally _____.

(Total: 6 marks) 6

2. A group of students added a few drops of universal indicator to separate samples of some household items. They filled in a table like the one shown below. Fill in the table correctly.

Household item	**Approximate pH**	**Conclusion**
Toilet cleaner	1	
Drain unblocker		Strong alkali
Indigestion tablets	9	
De-ionized water for the steam iron		
Tomato juice		Weak acid

(Total: 6 marks) 6

3. Rubidium and strontium may not be metals that you have studied about in class. However, rubidium is an element in Group 1 while strontium is an element in Group 2 of the Periodic Table. Both elements are found in the same period of the Periodic Table. Use this information to answer the following questions.

(a) What is the name given to the group to which each of these elements belongs:

(i) rubidium: _____ (1)

(ii) strontium: _____ (1)

(b) How many electrons in the outer shell would you expect each of these elements to have:

(i) rubidium: _____ (1)

(ii) strontium: _____ (1)

(c) Predict whether rubidium is more or less reactive than lithium.

_____ (1)

(d) Predict whether rubidium is more or less reactive than strontium.

_____ (1)

(Total: 6 marks)

6

Please turn the page.

4.

(a) Give the electronic configuration of the:

(i) first element of the third period of the Periodic Table.

_____ (1)

(ii) element in Group 7 and Period 2 of the Periodic Table.

_____ (1)

(b)

(i) Why does the element in your answer to part (a)(i) react by losing electrons?

_____ (1)

(ii) Write the formula of the resulting compound when this element reacts with oxygen.

_____ (1)

(c) How would you expect the element in part (a)(ii) to behave in terms of loss or gain of electrons?

_____ (1)

(d) How would you expect the last element of the third period to react in terms of loss or gain of electrons?

_____ (1)

(Total: 6 marks)

6

5. The reaction of hard water with soap (sodium stearate) may be represented by the following equation. In the equation, St represents stearate.

$$2\ NaSt\ +\ Ca(HCO_3)_2\ \rightarrow\ CaSt_2\ +\ 2NaHCO_3$$

(a) Give **TWO** disadvantages caused by this reaction to the washing process.

(i) Disadvantage 1: _____

_____ (1)

(ii) Disadvantage 2: _____

_____ (1)

(b) Why are synthetic detergents considered to be a better option to soap when using hard water?

_____

_____ (1)

(c) When temporary hard water is boiled, a solid deposit called "scale" or "fur" is formed. Continue the equation for the reaction that is responsible for the formation of this "scale" deposit.

$Ca(HCO_3)_2$ (aq) → _____ (2)

(d) Boiling is therefore one way of removing temporary hardness from water. Give **ONE** other method of softening hard water that does not involve the heating of water.

_____ (1)

(**Total: 6 marks**)

6

Please turn the page.

6. Propane, propene, and propyne are hydrocarbons belonging to the homologous series of alkanes, alkenes, and alkynes respectively.

(a) Draw the structures of propane, propene, and propyne.

propane	propene	propyne

(3)

(b) Which **ONE** of propane, propene, and propyne (each compound may be used once, more than once, or not at all):

(i) does **not** decolorize bromine water in the dark?

_____ (1)

(ii) burns with a clean, blue flame?

_____ (1)

(iii) burns with the sootiest flame?

_____ (1)

(Total: 6 marks)

6

7. Isomers are organic molecules with the same molecular formula but a different structural formula. Ethanol has one such isomer.

(a) Draw the structural formulae of ethanol and its isomer in the spaces provided.

ethanol	isomer of ethanol

(2)

(b) Ethanol may be converted to ethanoic acid, CH_3CO_2H, in the laboratory. State **TWO** conditions that must be present for this change to take place.

(i) Condition 1: _____ (1)

(ii) Condition 2: _____ (1)

(c) Write the equation for the reaction of sodium hydroxide with ethanoic acid.

_____ (2)

(Total: 6 marks)

6

Please turn the page.

8. A mass of 1.0 g of copper reacts completely with oxygen gas to produce copper(II) oxide as follows:

$$2\ Cu\ (s) + O_2\ (g) \rightarrow 2\ CuO\ (s)$$

(a) Calculate the amount in moles that is present in 1.0 g of copper.

_____ (1)

(b) Calculate the relative formula mass of copper(II) oxide.

_____ (1)

(c) What is the amount in moles of copper(II) oxide produced?

_____

_____ (2)

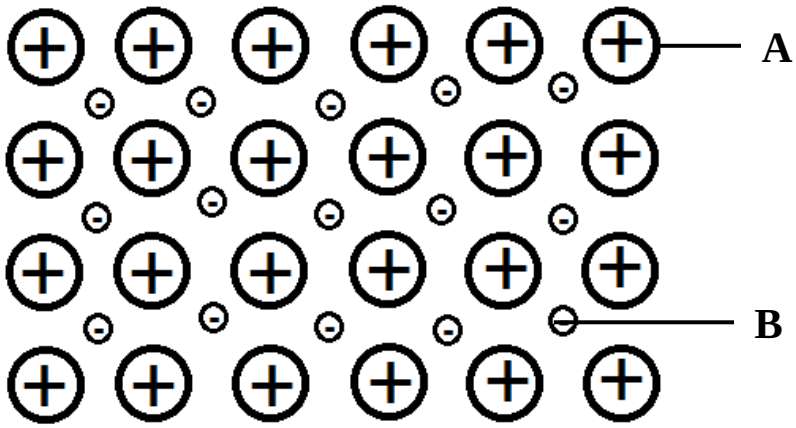
(d) Calculate the mass in grams of copper(II) oxide produced.

_____ (2)

(Total: 6 marks)

6

9. The following diagram shows the bonding in a metal.



(a) What do each of the parts of the diagram labelled **A** and **B** represent?

(i) **A**: _____ (1)

(ii) **B**: _____ (1)

(b) How does this structure explain that:

(i) metals can be hammered into a particular shape?

_____

_____ (1)

(ii) metals conduct electricity?

_____

_____ (1)

(iii) most metals are solids at stp?

_____

_____ (1)

(Total: 5 marks)

5

Please turn the page.

10. When hydrated sodium carbonate is left to stand in a dry environment, it loses some of its water of crystallization.

(a) Give the name for this process.

_____ (1)

(b) Since hydrated sodium carbonate loses only part of its water of crystallization, two hydrates of sodium carbonate exist. "Hydrate A" is found to have 37.06 % of sodium carbonate and 62.94 % of water of crystallization, while "Hydrate B" is found to have 85.50 % of sodium carbonate and 14.50 % of water of crystallization by mass. Work out the formulae of the two hydrates.

"Hydrate A"		**"Hydrate B"**	
Na_2CO_3	H_2O	Na_2CO_3	H_2O
37.06 %	62.94 %	85.50 %	14.50 %
Formula of "Hydrate A"		**Formula of "Hydrate B"**	

(4)

(c) Using your answers to part (b), write the equation for the change that takes place when hydrated sodium carbonate is allowed to stand in air.

_____ (2)

(Total: 7 marks)

7

SECTION B

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

11. The electrolysis of brine is an important industrial process as it produces several substances that are of high economic importance. The electrolytic cell that is used in industry differs from other cells as it has a diaphragm that separates the anode from the cathode compartments. It is called a diaphragm cell. Brine is pumped continuously at one end of the cell while one of the products is pumped continuously out from the other side of the cell.
    (a) Draw a labelled diagram of the diaphragm cell, including (i) the identity of the solutions flowing in and out of the cell, (ii) the identity of the gases produced at both electrodes and the (iii) polarity of the electrodes. (7)
    (b) What is the function of the diaphragm? (1)
    (c) Give a use for each of the **THREE** products of this process. (3)
    (d) Write a balanced half equation to show the reaction happening at the:
        (i) anode; (2)
        (ii) cathode. (2)
    (e) The cell operates with a current of 20 A for 2 hours. Calculate:
        (i) the charge, in Coulombs, used; (2)
        (ii) the amount of electrons, in moles, used; (1)
        (iii) the volume of gas that would be produced at stp at the anode (use your answer to part (d)(i)). (2)

(Total: 20 marks)

12.
    (a) Describe tests, including the expected result, to identify both cations and anions in the following salts:
        (i) sodium nitrate; (4)
        (ii) lead(II) sulfite; (4)
        (iii) iron(III) chloride; (4)
        (iv) ammonium sulfate. (4)
    (b) Identify the substance present in the situations described below.
        (i) **X** is a white solid which is insoluble in water. On heating, a gas and a yellow solid are produced. When passed through a dilute solution of calcium hydroxide, the gas produces a white precipitate. The yellow solid turns white on cooling. This solid neutralizes both acids and alkalis. (2)
        (ii) **Y** is a white solid which is slightly soluble in water to give an alkaline solution. **Y** does not dissolve in dilute sodium hydroxide. On performing a flame test on **Y**, no colour is imparted to the flame. When a sample of solid **Y** is heated, water vapour is produced. **Y** reacts with dilute hydrochloric acid to produce a salt and water. **Y** contains a Group II cation. (2)

(Total: 20 marks)

13. Sodium sulfate can be obtained by mixing sodium hydroxide solution with sulfuric acid in such a way that they neutralise each other perfectly. This can be achieved using a titration.

(a) Describe how the titration is performed. Your answer is to include:

(i) steps adopted to rinse the glassware; (3)

(ii) how sodium hydroxide is transferred to the conical flask; (1)

(iii) the procedure for the titration (4)

(b) An indicator is used to mark the end-point of the reaction.

(i) Suggest a suitable chemical indicator for the reaction. (1)

(ii) A digital pH meter can be used instead of a chemical indicator. What are the advantages of using a digital pH meter rather than a chemical indicator in this particular reaction? (1)

(c) In one such experiment, 25 cm^3 of sodium hydroxide were titrated against a 0.5 mol dm^{-3} sulfuric acid solution according to the equation shown below. The titre value obtained at the end-point was 12.5 cm^3.

$$2\ NaOH\ (aq) + H_2SO_4\ (aq) \rightarrow Na_2SO_4\ (aq) + H_2O\ (l)$$

(i) Calculate the amount of sulfuric acid used. (1)

(ii) Calculate the concentration of the sodium hydroxide solution. (3)

(iii) Calculate the mass of sodium sulfate that would be obtained from this reaction. (3)

(d) A different salt can be prepared by using half the volume of sulfuric acid used in part (c).

(i) Identify this salt. (1)

(ii) What are the ions present in this salt? (2)

(Total: 20 marks)

14. Hydrogen sulfide and sulfur dioxide are two gaseous compounds of sulfur which are toxic to living things.

(a) Hydrogen sulfide can be produced in the laboratory by reacting iron(II) sulfide with hydrochloric acid.

(i) Describe how you would prepare and collect hydrogen sulfide. (3)

(ii) Give **ONE** safety precaution for this experiment. (1)

(iii) Draw a labelled diagram of the apparatus used. (3)

(iv) Write a balanced chemical equation for the reaction between iron(II) sulfide and hydrochloric acid. (2)

(v) Calculate the volume in dm^3 of hydrogen sulfide that would be produced at stp if 2.0 g of iron(II) sulfide reacted completely in this experiment. (4)

(b) Sulfur dioxide can be generated in the lab by using a similar experiment.

(i) Give the **TWO** reactants used to produce relatively pure sulfur dioxide in the laboratory. (2)

(ii) Write a balanced chemical equation for this reaction. (2)

(iii) Sulfur dioxide produced through the combustion of fossil fuels containing sulfur impurities dissolves in rain water to give acid rain. Write a balanced chemical equation for this reaction. (2)

(iv) In an industrial process, sulfur dioxide is produced in order to produce sulfuric acid. Name this industrial process. (1)

(Total: 20 marks)

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PERIODIC TABLE

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

140 **Ce** 58	141 **Pr** 59	144 **Nd** 60	147 **Pm** 61	150 **Sm** 62	152 **Eu** 63	157 **Gd** 64	159 **Tb** 65	162 **Dy** 66	165 **Ho** 67	167 **Er** 68	169 **Tm** 69	173 **Yb** 70	175 **Lu** 71
232 **Th** 90	231 **Pa** 91	238 **U** 92	237 **Np** 93	244 **Pu** 94	243 **Am** 95	247 **Cm** 96	247 **Bk** 97	251 **Cf** 98	252 **Es** 99	257 **Fm** 100	258 **Md** 101	259 **No** 102	260 **Lr** 103