Index number: _____ SEC06/1.12s

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

SECONDARY EDUCATION CERTIFICATE LEVEL

SEPTEMBER 2012 SESSION

SUBJECT:	**Chemistry**
PAPER NUMBER:	I
DATE:	6th September 2012
TIME:	9:00 a.m. to 11:00 a.m.

Useful data
Relative atomic masses: H = 1; O = 16; S=32; Zn = 65; Ag = 108
Avogadro constant = 6.02 x 10^{23}
The molar volume for gases at s.t.p. = 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 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 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.*

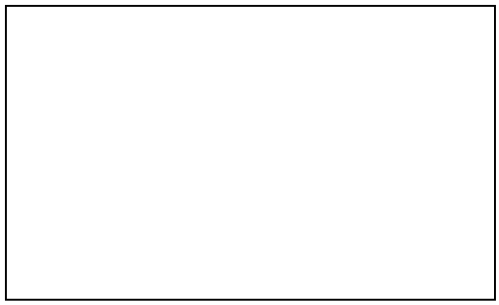
For examiners' use only:

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

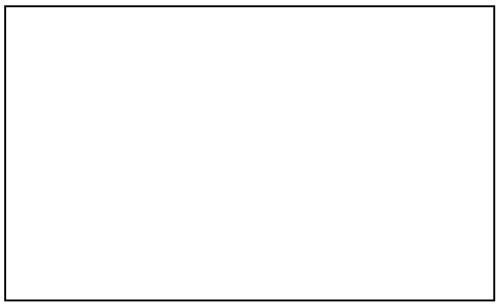
DO NOT WRITE ABOVE THIS LINE

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

1. (a) In the spaces provided below show the arrangement of particles in a solid and a liquid.



solid



liquid

(2 marks)

(b) (i) When smoke particles in air are seen through the microscope, the particles can be observed to move around in different directions at random. Briefly explain this movement in terms of particles.

_____

_____

_____

(2 marks)

(ii) What is the scientific name for the process in (b)(i)?

_____

(1 mark)

(iii) Give **one other** example where one may see this process taking place.

_____

(1 mark)
[Total: 6 marks]

6

DO NOT WRITE ABOVE THIS LINE

2. The three metals Cu, Fe and Mg are added in turn to solutions of each of the substances $MgSO_4$, $FeSO_4$ and $CuSO_4$.

   (a) Complete the following table by writing down the expected observations. Some parts of the table have already been filled.

	$MgSO_4$	**$FeSO_4$**	**$CuSO_4$**
Cu			**No change**
Fe		**No change**	
Mg	**No change**		**Pinkish brown solid deposited, blue colour of solution fades**

(5 marks)

   (b) Put the elements Cu, Fe and Mg in order of their reactivity, starting with the most reactive.

_____

(1 mark)

[Total: 6 marks]

6

3. The halogens react with hydrogen to give the respective hydrogen halide. Part (a) below reports these reactions, some of which are incomplete.

   (a) Complete the reactions where necessary:

   $H_2 + F_2 \rightarrow$ _____

   $H_2 + Cl_2 \rightarrow 2HCl$

   $H_2 + Br_2 \rightarrow 2HBr$

   $H_2 + I_2 \rightarrow 2HI$

   $H_2 + At_2 \rightarrow$ _____ **(2 marks)**

(b) (i) Which of these reactions would you expect to be **most vigorous**?

_____

(1 mark)

(ii) Which of these reactions would you expect to be the **slowest**?

_____

(1 mark)
[Total: 4 marks]

4

4. (a) Give the name and structural formula of the **second** member of the homologous series which has the general formula of $\mathbf{C_nH_{2n+1}OH}$.

Name: _____

Structural formula:

(2 marks)

(b) (i) Give the equation for the reaction between the substance in (a) and PCl_5.

_____

(2 marks)

(ii) What is the main observation in the reaction in (b)(i)?

_____

(1 mark)

(iii) Why is it not possible to use the reaction in (b)(i) to distinguish between the substance in (a) and ethanoic acid?

_____

(1 mark)

(iv) Suggest a test that may be carried out to distinguish between the substance in (a) and ethanoic acid. Give the expected observation.

_____

_____

_____

(2 marks)
[Total: 8 marks]

8

DO NOT WRITE ABOVE THIS LINE

5. Zinc sulfide reacts with oxygen as shown in the equation below: 0.025 moles of zinc sulfide were roasted in an abundant supply of oxygen.

$$2ZnS(s) + 3O_2(g) \rightarrow 2ZnO(s) + 2SO_2(g)$$

(a) How many moles of oxygen gas were required so that the zinc sulfide reacts completely?

(2 marks)

(b) What volume at s.t.p. would the quantity of oxygen in (a) occupy?

(2 marks)

(c) What volume of sulfur dioxide would be generated if all gas volumes are measured at the same temperature and pressure?

(2 marks)

(d) What mass of zinc oxide is produced in this reaction?

(2 marks)

[Total: 8 marks]

8

DO NOT WRITE ABOVE THIS LINE

6. Water is present abundantly in our surroundings. Many substances dissolve in it.

(a) Give **two** physical properties of pure water.

Property 1: _____

Property 2: _____

(2 marks)

(b) Anhydrous copper(II) sulfate may be used to identify the presence of water. Give the equation that represents this test and indicate any colour changes which may occur.

Equation: _____

Any colour change: _____

(3 marks)

(c) The composition of air dissolved in water is different from the composition of air in our surroundings. Explain.

_____

_____

_____

(1 mark)

[Total: 6 marks]

6

7. A current of electricity was passed through a solution of silver nitrate for 5 minutes. During this experiment silver metal was deposited at one electrode while a gas was released at the other electrode.

(a) Give the equation for the reaction that takes place at each electrode:

At the cathode: _____

_____

At the anode: _____

_____

(2 marks)

(b) (i) How many moles of silver were deposited if the mass of one electrode increased by 1.08 g?

(1 mark)

(ii) How many moles of electrons were required to deposit 1.08 g of silver?

(1 mark)

(iii) What volume of gas measured at s.t.p. would be collected at the other electrode?

(2 marks)
[Total: 6 marks]

6

8. A sample of hydrated zinc sulfate, $ZnSO_4.xH_2O$, weighing 3.59 g was heated to constant mass in a crucible to give 2.01 g of solid residue.

(a) How many moles of solid residue remained in the crucible?

(2 marks)

(b) How many moles of substance were lost during the experiment?

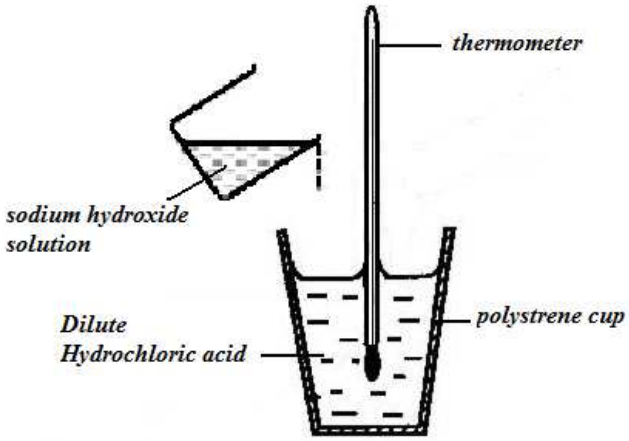
(2 marks)

(c) Calculate the value of x in the formula $ZnSO_4.xH_2O$.

(2 marks)
[Total: 6 marks]

6

9. The diagram below shows the apparatus used to determine the heat of neutralisation of hydrochloric acid with sodium hydroxide solution.



(a) The heat of neutralisation of a strong acid with a strong alkali is -57.3 kJmol^{-1}. Is this reaction endothermic or exothermic?

_____

(1 mark)

(b) After performing this experiment in the laboratory, a student gave the value of -57.3 kJmol^{-1} as the correct answer to the calculation of the enthalpy of neutralisation. The teacher concluded that the student cheated. Give a reason why the teacher concluded that the student cheated.

_____

_____

(1 mark)

(c) Explain why the heat of neutralisation of a strong alkali with a weak acid is less than -57.3 kJmol^{-1}.

_____

_____

_____

(2 marks)
[Total: 4 marks]

4

DO NOT WRITE ABOVE THIS LINE

10. On heating ammonium chloride the following reaction takes place:

$$NH_4Cl(s) \rightleftharpoons NH_3(g) + HCl(g)$$

(a) (i) State Le Chatelier's principle.

(2 marks)

(ii) After the reaction reaches equilibrium, indicate a factor that would shift the position of the equilibrium to the left hand side.

(1 mark)

(iii) How would the presence of a catalyst affect a reversible reaction?

(1 mark)

(b) (i) Ammonium chloride goes directly from the solid state to the gaseous state without passing through the liquid state. What is the name of this process?

(1 mark)

(ii) Give the name of another substance that behaves similarly to ammonium chloride.

(1 mark)

[Total: 6 marks]

6

DO NOT WRITE ABOVE THIS LINE

Section B: Answer BOTH questions. Write your answers on the lined pages provided.

11. Two unknown compounds **A** and **E** give the reactions described below.

A bright yellow flame is produced when a white solid **A** is placed in a Bunsen burner flame**.** When a solution of **A** is added to barium chloride solution a white precipitate **B** is formed. **B** however disappears when dilute hydrochloric acid is added to it giving a gas **C**, which is colourless and odourless**.** When **C** is passed through calcium hydroxide solution a white precipitate **D** is obtained.

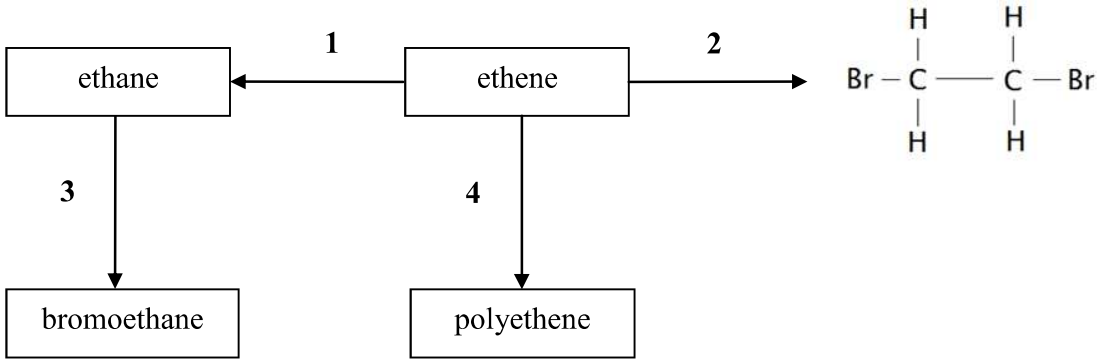
When a colourless solution of **E** reacts with sodium hydroxide and the mixture is heated, a pungent smelling gas **F** is evolved. **F** gives white fumes of **G** when it comes in contact with a glass rod that has been dipped in concentrated hydrochloric acid solution. When **E** is added to barium chloride solution, a white precipitate **H** which is insoluble in dilute hydrochloric acid is formed.

(a) From the observations described above, identify the unknown substances denoted by the letters **A** to **H.** **(8 marks)**

(b) Give the chemical equations, including state symbols, for **all** the reactions that are described above. **(12 marks)**

[Total: 20 marks]

12. Consider the following diagram and answer the questions below.



(a) (i) What type of reaction is taking place in the changes marked **1, 2, 3** and **4**? **(4 marks)**

(ii) Write the structural formula for ethane, ethene, bromoethane and polyethene. **(5 marks)**

(iii) Give the name of the **two** substances that are required to bring about the change in reaction **1**. **(2 marks)**

(iv) Write the chemical equation for reaction **2**. **(2 marks)**

(v) Give the name of the other product produced during reaction **3**. **(1 mark)**

(vi) State **two** uses of polyethene. **(2 marks)**

(b) Ethene may be converted to ethanol.

(i) Name the type of reaction that takes place during this change. **(1 mark)**

(ii) Outline the conditions for the conversion of ethene to ethanol on an industrial scale. **(3 marks)**

[Total: 20 marks]

DO NOT WRITE ABOVE THIS LINE

DO NOT WRITE ABOVE THIS LINE

DO NOT WRITE ABOVE THIS LINE

DO NOT WRITE ABOVE THIS LINE

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.12s

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

SECONDARY EDUCATION CERTIFICATE LEVEL

MAY 2012 SESSION

SUBJECT:	**Chemistry**
PAPER NUMBER:	IIB
DATE:	6th September 2012
TIME:	4:00 p.m. to 6:00 p.m.

Useful data

Relative atomic masses: H = 1; C = 12; N = 14; O = 16; Na = 23; S = 32
The molar volume for gases at s.t.p. = 22.4 dm^3
Standard temperature and pressure (s.t.p.): 0 ^oC (273K) and 1 atm
Avogadro constant = 6.02 x 10^{23}

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 and any TWO questions from Section B. Write 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 calculations you are advised to show all the steps in your working, giving your answer at each stage.*
- *The use of electronic calculators is permitted.*
- *A **Periodic Table** is printed on the back of this booklet.*

For examiners' use only:

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

DO NOT WRITE ABOVE THIS LINE

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

1. Give a balanced equation and **one** observation for the reaction that occurs when:

   (a) hydrogen gas and oxygen gas are exploded in a closed container which is then cooled.

   Equation: _____

   Observation: _____

   (3 marks)

   (b) nitrogen monoxide, NO, reacts with the oxygen in the air.

   Equation: _____

   Observation: _____

   (3 marks)
   [Total: 6 marks]

6

2. Complete the following paragraph by using words from the list below. Each term may be used once, more than once or not at all.

   molecules molten pink gas ions conductor solution insulator black electrode

   Sugar is a substance which is found in all homes. On heating strongly it produces a _____ residue. A sugar solution does not conduct electricity since it does not contain _____.

   Sodium chloride conducts electricity both when _____ or in _____.

   Copper is used in electricity cables because copper is a _____ while solid sodium chloride is an _____ .

   [Total: 6 marks]

6

3. (a) Showing outer electrons only, give dot-cross diagrams for:
   (i) sodium fluoride, NaF;

   (2 marks)

(ii) methane, CH_4.

(2 marks)

(b) One of the compounds in (a) does not dissolve in water.

(i) Which one is it? _____

(ii) Give a reason for your answer to (b)(i). _____

_____

(2 marks)
[Total: 6 marks]

6

4. Indicate whether each of these statements is **true** or **false**.

(a) The best method to collect carbon dioxide gas is over water. _____

(b) Carbon dioxide is the most abundant gas in the atmosphere around us. _____

(c) A mixture of oxygen and water vapour may be dried using filter paper. _____

(d) A good fuel gives out a lot of energy when it burns. _____

(e) When lead(II) nitrate is heated a popping / crackling sound is heard. _____

(f) Hydrogen gas may be collected by downward delivery. _____

[Total: 6 marks]

6

DO NOT WRITE ABOVE THIS LINE

5. (a) In an experiment a volume of 500 cm^3 of chlorine gas was collected. This experiment had been carried out at 1 atmosphere pressure and 25°C. It was decided to increase the pressure of the container to 3 atmospheres, while at the same time increasing the temperature to 35°C. Calculate the new volume of the gas.

(4 marks)

(b) Describe a simple test that can be carried out to confirm that the gas collected in (a) is chlorine.

(2 marks)
[Total: 6 marks]

6

6. (a) Washing-soda can be represented by the chemical formula $Na_2CO_3.10H_2O$. Calculate the percentage of water of crystallisation in washing soda.

(3 marks)

(b) Washing-soda is an ***efflorescent*** substance. Explain the term in italics.

(2 marks)

(c) Why is $Na_2CO_3.10H_2O$ given the name 'washing-soda'?

(1 mark)
[Total: 6 marks]

6

DO NOT WRITE ABOVE THIS LINE

7. (a) The taste of some fruits is mainly due to carboxylic acids. These are safe to eat because they are ***weak acids***. Explain the term in italics.

_____

(1 mark)

(b) Carboxylic acids react like any other acid. Complete the following word equation:

Ethanoic acid + potassium hydroxide → _____ + _____

(2 marks)

(c) When ethanoic acid is reacted with propanol, a fruity smell is noted.

(i) Name the substance which may be used to speed up this reaction.

_____

(1 mark)

(ii) What type of reaction has occurred?

_____

(1 mark)

(iii) Suggest a use for the substance formed by this reaction.

_____

(1 mark)
[Total: 6 marks]

6

8. (a) (i) Give the names of two substances which when reacted together produce a mixture of products from which zinc chloride, $ZnCl_2$, can be collected.

Substance 1: _____

Substance 2: _____

(2 marks)

(ii) Give a balanced equation for the reaction in (a)(i).

_____

(2 marks)

(b) Give the name and formula of a substance which when added to zinc chloride solution will precipitate zinc carbonate.

Name: _____

Formula: _____

(2 marks)
[Total: 6 marks]

6

9. Give ionic equations for each of the following reactions:

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

(2 marks)

(b) $AgNO_3(aq) + KI(aq) \rightarrow AgI(s) + KNO_3(aq)$

(2 marks)

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

(2 marks)
[Total: 6 marks]

6

10. Consider the following metals:

aluminium copper iron silver zinc potassium calcium

From the list above choose **ONE** metal which:

(a) is the least reactive with oxygen_____

(b) gives a vigorous reaction with cold water_____

(c) can be used to protect iron from rusting: _____

(d) has a soluble carbonate: _____

(e) has an oxide which is used as a drying agent for ammonia gas:

_____

(f) forms a protective oxide layer in air, which stops further corrosion:

_____
[Total: 6 marks]

6

DO NOT WRITE ABOVE THIS LINE

Section B: Answer TWO questions from this section. Write your answers in the lined pages provided.

11. (a) The bubbles in fizzy drinks are due to dissolved carbon dioxide. It is recommended that for healthy teeth we limit the amount of such drinks in our diet. Suggest a reason for this. **(2 marks)**

(b) Carbon monoxide is another oxide of carbon but it is a lot more dangerous than carbon dioxide.

(i) Give **one** reason why carbon monoxide is so dangerous. **(1 mark)**

(ii) Carbon monoxide has no smell and no colour. Give a chemical test that can be used to prove the presence of carbon monoxide. **(1 mark)**

(c) A student has a gas syringe which contains a mixture of carbon dioxide and carbon monoxide. Describe clearly how carbon monoxide can be obtained from this mixture. **(3 marks)**

(d) Carbon monoxide can be used as a reducing agent. Describe a simple experiment to show how the oxide Fe_3O_4 may be reduced to metallic iron, using carbon monoxide gas. Your explanation must include a labelled diagram and a balanced equation. **(7 marks)**

(e) Cars cause atmospheric pollution due to the gases that are produced.

(i) Give the name or formula of another gas, besides carbon monoxide, that is found in car exhaust. **(1 mark)**

(ii) Explain how the catalytic converter helps to minimize the harmful effects of these gases. Write a chemical equation to represent **one** of the changes taking place. **(4 marks)**

(iii) In extreme cases the exhaust fumes coming out of car exhaust pipes is black. What substance is responsible for this black colour? **(1 mark)**

[Total: 20 marks]

12. (a) Hydrogen peroxide, H_2O_2, decomposes in the presence of a catalyst producing oxygen gas. Some hydrogen peroxide is placed in a conical flask which is connected to a gas syringe. At the same time a stop watch is started and the volume of oxygen produced is noted.
The equation for the reaction is: $2H_2O_2(l) \rightarrow 2H_2O(l) + O_2(g)$

(i) Draw a well-labelled diagram of the apparatus used in the experiment. **(2 marks)**

(ii) Give the name or formula of a catalyst that may be used for this reaction. **(1 mark)**

(iii) Calculate the number of moles of oxygen formed if 5.6 dm^3 of oxygen measured at s.t.p. were to be collected. **(2 marks)**

(iv) Calculate the mass of oxygen collected in (iii). **(2 marks)**

(v) Calculate the number of moles of hydrogen peroxide that reacted to form this amount of oxygen. **(2 marks)**

(vi) Draw a graph of volume of oxygen formed against time, when no catalyst is used. Label the two axes appropriately and label this graph **A**. **(4 marks)**

(vii) Using the same set of axes as in (vi), draw another graph to show what happens if a catalyst is used for the same reaction. Label this graph **B**. **(2 marks)**

(viii) Explain the difference, if any, between the two situations shown by graphs **A** and **B**. **(2 marks)**

(b) Some reactions must be carried out in the presence of light.

(i) Mention the name of a type of such reaction. **(1 mark)**

(ii) Give an example of such a reaction. **(2 marks)**

[Total: 20 marks]

13. (a) Nitrogen and hydrogen are reacted together to produce large amounts of ammonia gas, for which there exists a big demand.

(i) How are nitrogen and hydrogen obtained on a large scale? **(2 marks)**

(ii) Give a balanced equation for the reaction of nitrogen and hydrogen. **(2 marks)**

(iii) This reaction is exothermic. Give an energy level diagram for the reaction, labelling the axes and the diagram appropriately. **(5 marks)**

(b) Ammonia can react with oxygen according to the following equation:

$$4NH_3(g) + 5O_2(g) \rightarrow 4NO(g) + 6H_2O(l)$$

This is the first step in converting ammonia to nitric acid in the Ostwald Process.

(i) Oxygen is acting as an oxidising agent in this reaction. Explain. **(2 marks)**

(ii) Give balanced equations for the other two steps in the process. **(4 marks)**

(c) Ammonium sulfate, $(NH_4)_2SO_4$, is a fertilizer that may be manufactured from ammonia by reaction with sulfuric acid.

(i) Calculate the percentage of nitrogen in this fertiliser. **(4 marks)**

(ii) Give the name or formula of another fertiliser that may be made from ammonia. **(1 mark)**

[Total: 20 marks]

DO NOT WRITE ABOVE THIS LINE

14. Describe clearly how the **underlined** substance indicated in each of the following mixtures may be obtained from the mixture. Your answer must include a diagram of the apparatus that is used for the process.

    (a) **Iodine** from a mixture of iodine and potassium chloride. **(6 marks)**

    (b) **Water** from milk. **(7 marks)**

    (c) **Salt** (sodium chloride) from a mixture of sand and salt **(7 marks)**

[Total: 20 marks]

DO NOT WRITE ABOVE THIS LINE

DO NOT WRITE ABOVE THIS LINE

DO NOT WRITE ABOVE THIS LINE

DO NOT WRITE ABOVE THIS LINE

DO NOT WRITE ABOVE THIS LINE

DO NOT WRITE ABOVE THIS LINE

PERIODIC TABLE

Key

Relative atomic mass — A
X
Z — Atomic Number

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

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