Name	Index Number	Class

HUA YI SECONDARY SCHOOL

Preliminary Examination

4E 4E

CHEMISTRY 6092/2

Paper 2 24 August 2020

1 hour 45 minutes

Candidates answer on the Question Paper.
No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your Name, Index Number and Class on all the work you hand in.
Write in dark blue or black pen.
You may use a pencil for any diagrams, graphs, tables or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid.

Section A
Answer **all** questions.
Write your answers in the spaces provided on the question paper.

Section B
Answer **all three** questions, the last question is in the form of either/or.
Answer all the questions in the spaces provided on the question paper.

The number of marks is given in brackets [ ] at the end of each question or part question.
A copy of the Periodic Table is printed on page 23.

The use of an approved scientific calculator is expected, where appropriate.

For Examiner's Use	
Section A	
Section B	
Total	

This document consists of **23** printed pages **including** the cover page.
© HYSS 2020
No part of this document may be reproduced in any form or transmitted in any form or by any means without the prior permission of Hua Yi Secondary School.

[Turn Over]

Setter: Mr Chong KQ

Section A

Answer **all** the questions in this section in the spaces provided.
The total mark for this section is 50.

A1 Use the list of substances to answer the questions. You may use them either once or more than once.

zinc	sulfur	francium	iron
carbon dioxide	ozone	silicon dioxide	copper
sodium	magnesium	astatine	sulfuric acid

(a) Which substance is an air pollutant?

…… [1]

(b) Which substance is used as a catalyst in the Haber process?

…… [1]

(c) Which substance is used for galvanising?

…… [1]

(d) Which substance will form a carbonate that will not decompose on heating?

…… [1]

(e) Which substance is a good conductor of electricity when in aqueous state and contains covalent bonds?

…… [1]

(f) Which element is the least reactive non-metal?

…… [1]

(g) Which substance when reacted with carbon produces a reducing agent?

…… [1]

[Total: 7]

A2 The table below shows some properties of gases in dry air.

gas in dry air	density / kg/m^3	melting point / °C	boiling point / °C	percentage in air / %
nitrogen	1.2506	- 210	- 196	78.08
oxygen	1.4290	- 219	- 183	20.95
carbon dioxide	1.977	- 57	- 57	0.033
helium	0.1785	- 272	- 269	0.00052
neon	0.8999	- 249	- 246	0.0019
argon	1.7837	- 189	- 186	0.934
krypton	3.74	- 157	- 153	0.00011
xenon	5.86	- 112	- 108	0.0000087

(a) In 1895, Lord Rayleigh isolated nitrogen from dry air by passing the dry air through chemical reagents that remove oxygen and carbon dioxide. He then discovered that nitrogen from dry air had a different density to pure nitrogen produced from chemical reactions. He concluded that nitrogen extracted from dry air was mixed with another gas. The density of nitrogen extracted from dry air was higher than the density of pure nitrogen.

Explain Lord Rayleigh's observations and experimental results with reference to the data in the table.

……..……..

……..……..

……..…….. [2]

(b) Minimising air pollution is essential for health and for the environment. In an effort to do that, low sulfur fuels are being introduced. Ordinary diesel contains 500 ppm (parts per million) of sulfur but low sulfur diesel contains less than 50 ppm.

Explain why this is an advantage to the environment. You may include any relevant chemical reactions.

……..……..

……..……..

……..……..

……..……..

……..……..

……..…….. [3]

[Total: 5]

A3 Different elements with various characteristics are categorised in the Periodic Table.

(a) The table shows some properties of four Group VII elements, fluorine, chlorine, bromine and iodine found in a very old record book. Some of the information for these elements cannot be found and they are not arranged according to their position in the group of the modern Periodic Table.

element	boiling point / °C	reaction with hydrogen
X	185	reacts if heated strongly
fluorine	- 218	explosive reaction in dim light
bromine	59	**Y**
Z	- 34	explosive reaction in sunlight

(i) Suggest the identity of **X** and **Z**. Explain your answer using the information from the table and your knowledge about Group VII periodic trends.

……

……

……

……

……

……. [3]

(ii) Write a chemical equation to show a halogen displacement reaction of chlorine with a suitable potassium halide.

……. [1]

(b) The transition elements are in the centre block of the Periodic Table.

(i) Give **one** characteristic property of transition elements.

……. [1]

(ii) Transition elements act as catalysts to increase the rate of industrial processes. Catalysts are expensive to buy but they are able to reduce costs in the long run. Give **two** reasons to explain why catalysts can help to reduce costs in the long run.

……

……

……

…… [2]

[Total: 7]

A4 The table shows the percentage of ammonia formed at different temperatures and pressures in the Haber process.

pressure/ atm	ammonia formed (%)				
	temperature / °C				
	100	200	300	400	500
10	88.2	50.7	14.7	3.9	1.2
25	91.7	63.6	27.4	8.7	2.9
50	94.5	74.0	39.5	15.3	5.6
100	96.7	81.7	52.5	25.2	10.6
200	98.4	89.0	66.7	38.8	18.3
400	99.4	94.6	79.7	55.4	31.9
1000	99.9	98.3	92.6	79.8	57.5

Use the information in the table to answer the following questions.

(a) Describe how the percentage of ammonia formed changes with temperature and pressure.

……

……

……

…… [2]

(b) **(i)** State the temperature and pressure that will produce the highest percentage of ammonia formed.

…… [1]

(ii) Explain why these conditions are not used commercially in the industries.

……

……

……

…… [2]

[Total: 5]

A5 The concentration of potassium manganate(VII) can be determined through redox titration.

(a) Excess aqueous potassium iodide was first added to 25.0 cm^3 of the potassium manganate (VII) of unknown concentration.

$$2MnO_4^- + 10I^- + 16H^+ \rightarrow 2Mn^{2+} + 5I_2 + 8H_2O$$

(i) Identify the oxidising agent in the above reaction. Explain your answer in terms of oxidation states.

……

……

……

…… [2]

(ii) Suggest how to ensure that excess potassium iodide was added.

……

…… [1]

(b) The iodine produced is titrated with aqueous sodium thiosulfate. Starch is being used as an indicator to detect the presence of I_2 as the starch-iodine complex product has a dark blue colour.

$$I_2 + 2S_2O_3^{2-} \rightarrow S_4O_6^{2-} + 2I^-$$

26.0 cm^3 of 0.0500 mol/dm^3 of sodium thiosulfate was used to reach the endpoint of the titration.

(i) Using ideas about oxidation state, explain why the titration between iodine and sodium thiosulfate is a redox reaction.

……

……

……

…… [2]

(ii) Describe the observation at the endpoint of the titration.

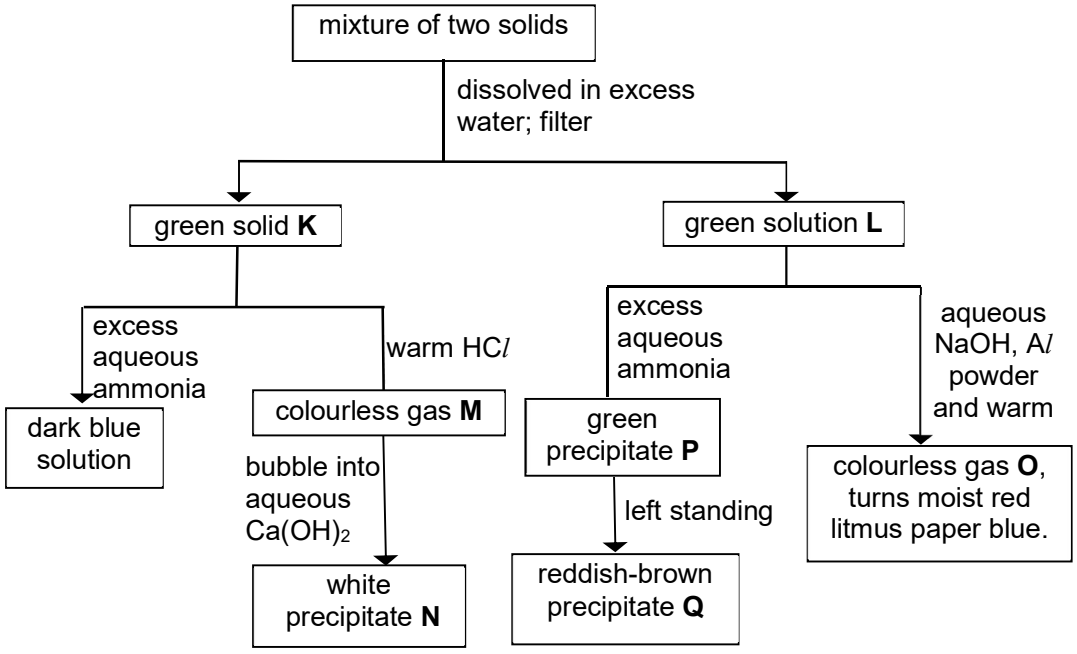
…… [1]

(iii) Calculate the concentration (in mol/dm^3) of the potassium manganate(VII) solution used.

[3]

[Total: 9]

A6 The diagram shows a series of reactions of the two salts in a mixture.



(a) Identify the following compounds:

green solid **K** ……

green solution **L** ……

white precipitate **N** ……

colourless gas **O** ……

reddish brown precipitate **Q** …… [2]

(b) Explain in terms of electron transfer, if **P** has been oxidised or reduced in the formation of reddish - brown precipitate **Q**.

……

…… [2]

(c) Write an ionic equation with state symbols for the reaction that produces precipitate **P**.

…… [1]

(d) If the cation in solid **K** is Pb^{2+}, explain why hydrochloric acid cannot be added to produce the same observations.

……..

……..

……..

……. [2]

[Total: 7]

A7 Hydrazine is often used as a rocket fuel as it can be stored conveniently as a liquid and further heated to its gaseous state. It reacts with oxygen to form pure gaseous products.

$$N_2H_4\ (g) + O_2\ (g) \rightarrow N_2\ (g) + 2H_2O\ (g) \qquad \Delta H = -\ 622\ kJ/mol$$

(a) **(i)** What is 'enthalpy change'?

……..

……. [1]

(ii) Explain what the ΔH in the reaction between hydrazine and oxygen represents.

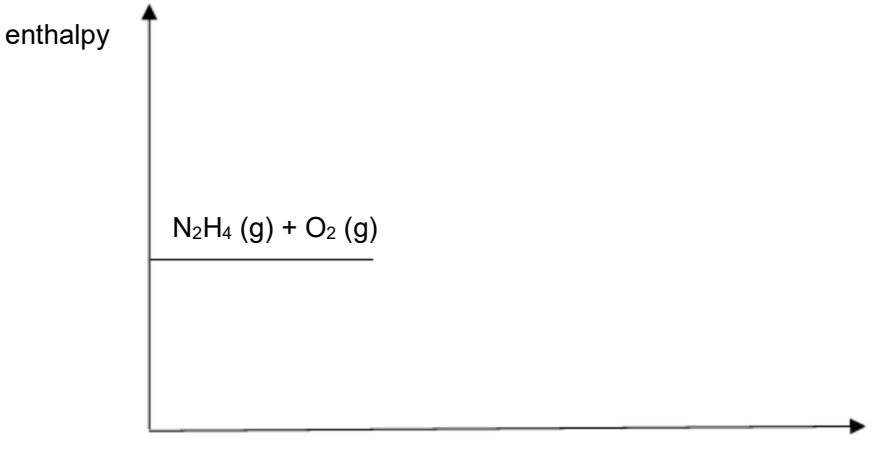
……..

……. [1]

(iii) Suggest why this reaction is not harmful to the environment.

……. [1]

(b) Complete and label the energy profile diagram by showing clearly the enthalpy change and activation energy for the reaction of hydrazine and oxygen.



[3]

(c) The bond energies of some bonds are shown below:

bond	bond energy (kJ/mol)
N – H	390
N ≡ N	945
N – N	163
F – F	158
H – F	565

The reaction between hydrazine (N_2H_4) and fluorine can be represented as follows:

$$N_2H_4 + 2F_2 \rightarrow N_2 + 4HF$$

(i) Use the bond energies given in the table to calculate the enthalpy change for the complete reaction of one mole of gaseous hydrazine and fluorine.

[2]

(ii) Using information from **7(a)** to **(c)(i)**, evaluate whether the reaction of hydrazine with fluorine or oxygen will be a more efficient rocket fuel.

……..

……..

……..

……. [2]

[Total: 10]

Section B

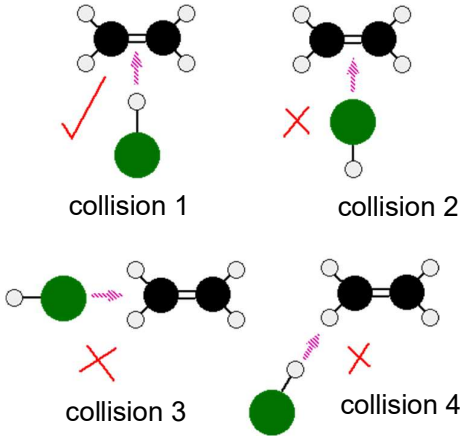
Answer **all three** the questions in this section in the spaces provided.
The last question is in the form of an either / or and only one of the alternatives should be attempted.

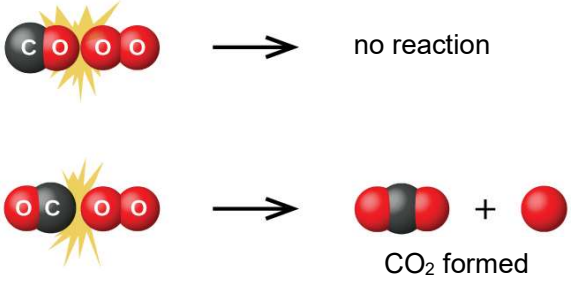
B8 Collision Theory of Molecular Interaction

Max Trautz in 1916 and William Lewis proposed the Collision theory independently in 1918. The collision theory provides an understanding on how particles interact to cause a reaction and the formation of new products. It depicts a qualitative explanation of chemical reactions and the rates at which they occur. For a reaction to occur and product particles formed, successful effective collisions must take place. This can only happen if all three conditions, in how the reacting particles interact, are fulfilled.

In an elementary Chemistry textbook, it was stated that the reacting particles must possess two conditions in order for effective collisions to occur. However, in an advanced Chemistry textbook, it is mentioned that a third condition must also be fulfilled in order for the reacting particles to form product particles. It is further explained that not every collision that fulfils the two condition will lead to a reaction. The third condition of 'steric requirement', must also be attained by the reacting particles for a reaction to occur.

The diagrammatic illustrations of the third condition that reacting particles must have are as shown.



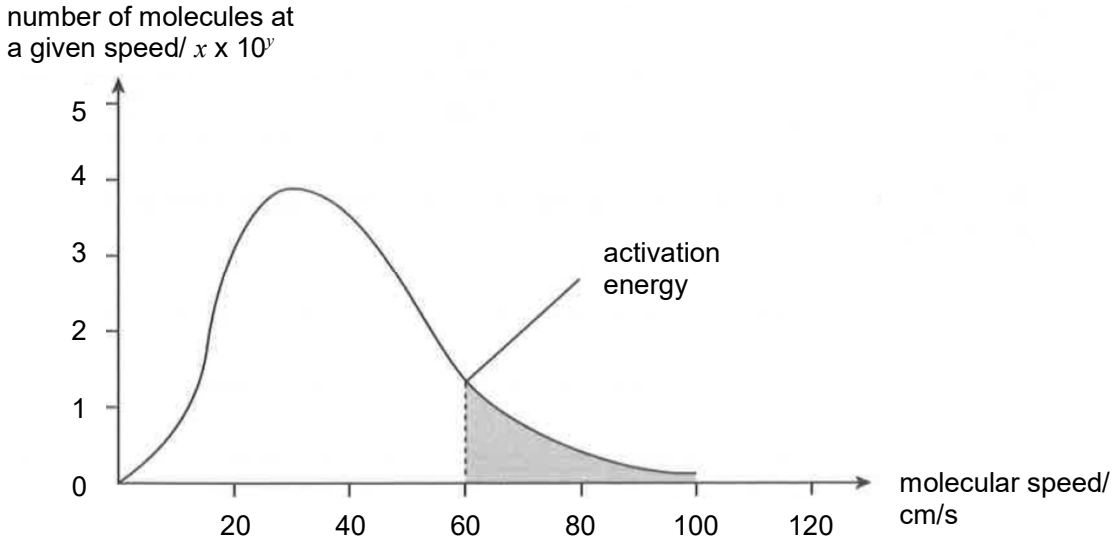


Energies of Reacting Particles and The Maxwell-Boltzmann distribution

During a reaction, all reacting particles vibrate and move with different amount of energy. At any given temperature, the kinetic energies of all the reacting particles in a substance vary largely. The kinetic energy of any particle of the same mass, is directly proportional to the molecular speed it is travelling at.

The Maxwell – Boltzmann distribution is a statistical representation of a probability distribution for describing the speeds of various particles within a stationary confined space at a specific temperature. Graph 1 illustrates this concept, where the y-axis is defined as the number of molecules at a given speed and the x-axis defined as the molecular speed of the particles. The activation energy shows the amount of molecules that possess sufficient energy required for a reaction to occur.

Graph 1



A group of scientists conducted experiments **A** to **D**, to find out how various factors affect the speed of the reaction. Substance **Y** forms a cloudy suspension when added to water. Over time, **Y** breaks down to form a homogeneous solution. Table 1 shows the results for all four experiments with equal samples of **Y** used for each experiment.

Table 1

experiment	contents	temperature/°C	time taken/s
A	**Y** + 20 cm^3 distilled water	30.0	91
B	**Y** + 20 cm^3 distilled water + **Z**	30.0	72
C	**Y** + 20 cm^3 distilled water + **Z**	60.0	16
D	**Y** + 20 cm^3 distilled water	60.0	50

(a) Using your knowledge of the Collision Theory, state the **two** conditions that reacting particles must have in order for effective collisions to take place.

……..

……..

…….. [2]

(b) **(i)** With reference to the diagrammatic illustrations, suggest what could be the third condition of 'steric requirement' that reacting particles must have for effective collisions to take place.

……..

…….. [1]

(ii) Use the diagrammatic illustrations provided to explain your reasoning for **b(i)**.

……..

…….. [1]

(c) Use the information from Graph 1 to answer this part of the question.

(i) Describe how the number of molecules at a given speed changes with the molecular speed.

……..

……..

……..

…….. [2]

(ii) Suggest the molecular speed of majority of the molecules.

…….. [1]

(d) **(i)** Using your knowledge of the collision theory, explain how the change made in experiment **D** has caused a faster rate of reaction as compared to experiment **A**.

……..

…….. [1]

(ii) Graph 1 was drawn using the conditions in experiment **A**.

Sketch another graph on Graph 1 to show the probability distribution for the reacting particles if the conditions in experiment **D** was used instead.

Label your sketch on Graph 1 clearly as **d(ii)**. [1]

(e) **(i)** Suggest the role of substance **Z**.

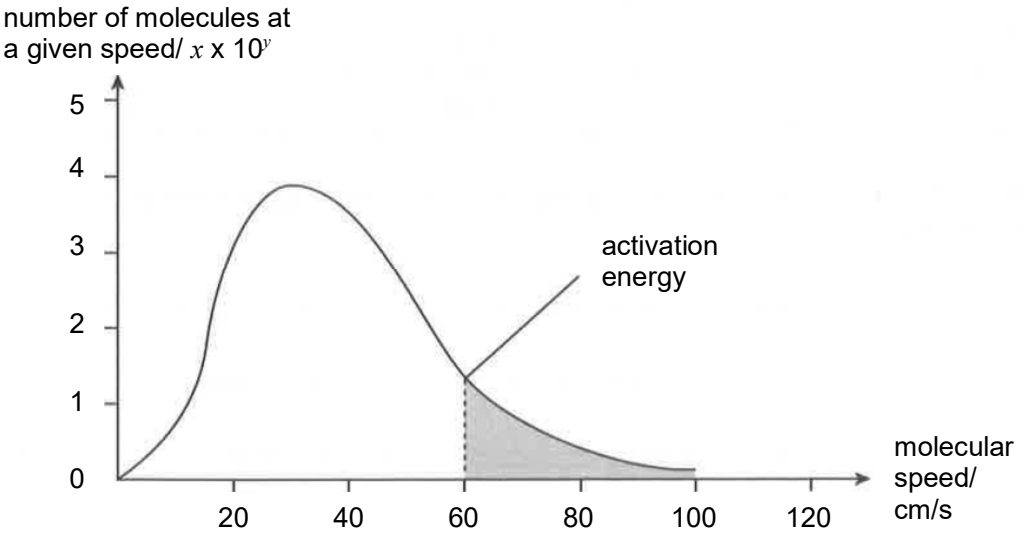
…….. [1]

(ii) With reference to one pair of experiments in Table 1, explain your answer for **e(i)**.

……..

…….. [1]

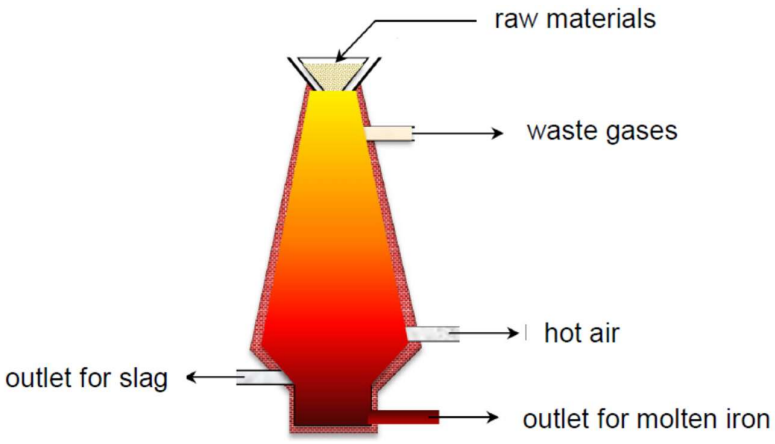
(iii) Assuming that Graph 1 was drawn for experiment **A** at a given temperature of 30°C and with reference to the data shown for experiment **B** in Table 1, indicate on Graph 1 provided below, the change on the graph you would make if it was made for experiment **B**.



[1]

[Total: 12]

B9 Iron is extracted from a metal ore in a blast furnace.



(a) State the raw materials that are added into the blast furnace.

……..…… [1]

(b) Write equations for the following reactions occurring in the blast furnace:

(i) the formation of molten iron; and

…….. [1]

(ii) the formation of slag.

…….. [1]

(c) Some extracted iron was placed in a blue nitrate solution. A few days later, a solid coating appeared on the surface of the iron. The coated iron was found to be able to conduct electricity.

(i) Write the chemical equation, without state symbols, for the formation of the solid coating on the iron.

…….. [1]

(ii) Suggest if this solid could be extracted from its ore in a blast furnace as well.

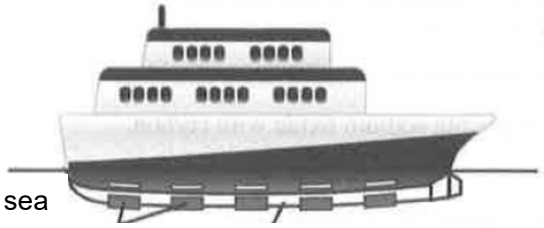
Explain your reasoning.

……..

…….. [2]

(d) Iron in the form of steel is often used in the construction of ships due to its requirement of a material with a high level of strength and stability.

Exposed zinc blocks are attached to the steel hulls of ships as shown below to prevent the hull from rusting.



A student commented that “the zinc prevents the steel hull from rusting by forming a protective barrier around the steel hull”.

Explain how zinc prevents the steel hull from rusting and why the student is inaccurate in his comment.

……

……

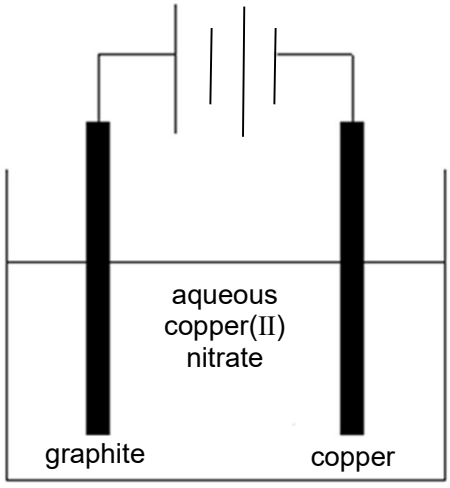
……

…… [2]

[Total: 8]

EITHER

B10 The diagram shows a setup of the electrolysis of copper(II) nitrate solution using a graphite electrode and a copper electrode.



(a) State the observation at the graphite electrode and write down the half equation for the reaction that takes place.

……

……

……

……

……

…… [2]

(b) Describe and explain any colour change in the solution after the electrolysis has taken place for some time.

……

……

……

……

……

…… [2]

(c) If the positions of the electrodes were swopped, will the observations be different from what was described in **(a)** and **(b)**? Explain your answer.

……

……

……

……

……

……

……

…… [3]

(d) Explain why graphite and copper can be used as electrodes in the electrolysis setup.

……

……

……

……

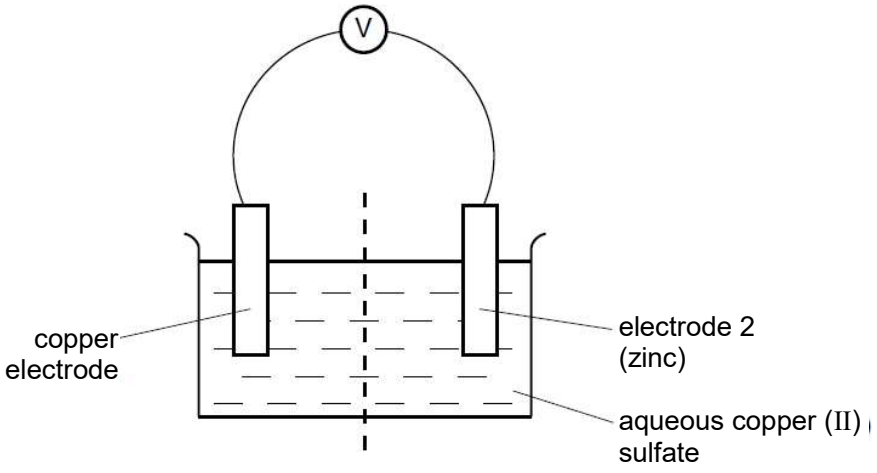
……

…… [3]

[Total: 10]

OR

B10 **(a)** The diagram shows a simple cell that can be used to generate electricity.



(i) Write an ionic equation for the reaction between zinc and aqueous copper(II) sulfate.

…… [1]

(ii) Draw an arrow on Fig. 10.2 to show the direction of the flow of electrons in the wire. [1]

(iii) The voltage of the cell was measured when the following metals were used as electrode 2.

copper iron silver zinc

Complete Table 1 by listing the metals in the correct order.

Table 1

meter reading / V	metal
+1.10	
+0.78	
0.00	
-0.46	

[1]

(iv) When metal **M** was used as electrode 2, it produced a higher voltage than +1.10 V.

Suggest the identity of metal **M**.

…… [1]

(b) Mortar is a building material used to hold bricks and stonework in position. It is a much older building material as compared to cement and has often been used since the Roman times. Mortar is made by mixing calcium hydroxide (slaked lime), sand and water into a paste. Mortar thickens and hardens over many years on standing in air. This is due to two processes:

- The water evaporates.
- The slaked lime reacts with carbon dioxide in the air to form calcium carbonate.

$$Ca(OH)_2(s) + CO_2(g) \rightarrow CaCO_3(s) + H_2O(l)$$

(i) Suggest why the reaction of calcium hydroxide with carbon dioxide is a slow process.

……

……

……

……

……

…… [2]

(ii) Use your answer to part **b(i)** to help you answer this question.

An archaeologist found two pieces of mortar. One very old piece was found from a Roman mansion built about 300 AD. The other piece was from a modern cottage built in 1995. State what the archaeologist could test for to prove that one of the pieces of mortar was much older than the other piece and give the results he would expect.

……

……

……

……

……

……

……

…… [2]

(iii) Calcium carbonate decomposes on heating to form calcium oxide (lime). Some students decided to grow corn in the school's garden. They mixed lime and a fertiliser containing ammonium nitrate, in an attempt to enrich the soil with nutrients. Explain why the corn plants did not give a good yield.

……..

……..

……..

……. [2]

[Total: 10]

End of Paper

The Periodic Table of Elements

Group																	
I	II											III	IV	V	VI	VII	0
							1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9		**Key** proton (atomic) number atomic symbol name relative atomic mass									5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
11 Na sodium 23	12 Mg magnesium 24											13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium -	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
55 Cs caesium 133	56 Ba barium 137	57 – 71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium –	85 At astatine –	86 Rn radon –
87 Fr francium –	88 Ra radium –	89 – 103 actinoids	104 Rf Rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	108 Hs hassium –	109 Mt meitnerium –	110 Ds darmstadtium –	111 Rg roentgenium –	112 Cn copernicium –		114 Fl flerovium –		116 Lv livermorium –		

lanthanoids	57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium –	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
actinoids	89 Ac actinium –	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium –	94 Pu plutonium –	95 Am americium –	96 Cm curium –	97 Bk berkelium –	98 Cf californium –	99 Es einsteinium –	100 Fm fermium –	101 Md mendelevium –	102 No nobelium –	103 Lr lawrencium –