NEW TOWN SECONDARY SCHOOL
Preliminary Examination
Secondary 4 Express / 5 Normal (Academic)

NAME					
CLASS				INDEX NUMBER	

Science (Chemistry)

5076/03, 5078/03

Paper 3 Chemistry

19 August 2022

Candidates answer on the Question Paper.

1 hour 15 minutes

No Additional Materials are required.

1100 – 1215

READ THESE INSTRUCTIONS FIRST

Write your name, register number and class in the spaces provided above.
You may use an HB pencil for any diagrams, graphs, tables or rough working.
Write in dark blue or black pen.
Do not use staples, paper clips, glue or correction fluid.

The use of an approved scientific calculator is expected, where appropriate.
You may lose marks if you do not show your working or if you do not use appropriate units.

Section A (45 marks)

Answer **all** questions.

Write your answers in the spaces provided on the question paper.

Section B (20 marks)

Answer any **two** questions.

Write your answers in the spaces provided on the question Paper.

A copy of the Data Sheet is printed on page 17.
A copy of the Periodic Table is printed on page 18.

The number of marks is given in brackets [ ] at the end of each question or part question.

For Examiner's Use		
Paper 1		
Paper 3 Section A		
Paper 3 Section B	Q___	
	Q___	
Total		

This document consists of **18** printed pages.

Setter: Ms Caley Ng

Section A (45 marks)

Answer **all** the questions in the spaces provided.

1 Choose from the following substances to answer the questions.

nitrogen dioxide	**argon**	**calcium hydroxide**	**carbon monoxide**
oxygen	**lithium oxide**	**sodium hydroxide**	**zinc oxide**

Each substance may be used once, more than once or not at all.

Identify the substance which

(a) contributes to acid rain

…… [1]

(b) is used to control pH in soils

…… [1]

(c) reacts with both acids and bases

…… [1]

(d) is used to fill tungsten bulbs

…… [1]

[Total: 4]

2 ^{24}Mg, ^{25}Mg and ^{26}Mg are isotopes of magnesium.

(a) Define *isotopes*.

……

…… [1]

(b) Complete Table 2.1 to describe the structure of a magnesium atom and a magnesium ion.

Table 2.1

	number of		
	protons	neutrons	electrons
a ^{24}Mg atom	12		
a ^{25}Mg ion			10

[4]

(c) A student made the following claim:

"The chemical formula for magnesium chloride is $MgCl_2$, no matter which isotope is used."

With reference to the electronic configuration of magnesium, explain if you agree with the student.

……

……

……

…… [2]

[Total: 7]

3 In the early 1800's, Friedrich Wöhler, a German chemist, first isolated beryllium metal. The chemical equation for the reaction he used to isolate beryllium metal from beryllium chloride is:

$$BeCl_2\ (s) + 2K\ (s) \rightarrow 2KCl\ (s) + Be\ (s)$$

(a) Explain, in terms of oxidation states, whether this reaction is considered a redox reaction.

……

……

…….. [2]

(b) Wöhler had to ensure that the reaction vessel containing potassium was dry before reacting with beryllium chloride.

Explain why the reaction vessel has to be kept dry.

……

…… [1]

[Total: 3]

4 Carbon monoxide is one of the common air pollutants in the atmosphere.

(a) Describe and explain the harmful effect of carbon monoxide on human.

……

……

…….. [2]

(b) Carbon monoxide burns in oxygen to form carbon dioxide as shown:

$$2CO\,(g) \;+\; O_2\,(g) \;\rightarrow\; 2CO_2\,(g)$$

Calculate the volume of oxygen required to burn 0.14 g of carbon monoxide.

[Relative atomic masses: A_r: C, 12; O, 16]

volume of oxygen required = …… [3]

(c) Draw a 'dot and cross' diagram to show the arrangement of the outer shell electrons in a molecule of carbon dioxide.

[Proton numbers: C, 6; O, 8]

[2]

(d) Explain, with reference to the structure and bonding, why carbon dioxide has a low boiling point.

…….

…….

…….. [2]

[Total: 9]

5 A group of students have written out instructions for the preparation of a pure, dry sample of copper(II) sulfate crystals.

They have made several mistakes.

Read their instructions and complete Table 5.1 with **three** of their mistakes and corrections of these mistakes.

Student-written instructions to prepare pure, dry copper(II) sulfate crystals.

1. Wear safety goggles and gloves.
2. Warm copper powder with dilute sulfuric acid to form a solution of copper(II) sulfate, $CuSO_4$.
3. Filter the mixture to remove any unreacted solids.
4. Heat the filtrate until most of the solvent has evaporated. Leave to cool.
5. Separate the crystals by filtering.
6. Rinse the crystals with large amounts of cold water.
7. Press dry the crystals with filter paper.

Table 5.1

students' mistake	corrections to mistake

[3]

[Total: 3]

6 A student did an experiment to investigate the factors that affect the rate of the following reaction.

$$2HCl\,(aq) + Mg\,(s) \rightarrow MgCl_2\,(aq) + H_2\,(g)$$

Dilute hydrochloric acid at room temperature was placed in a flask on a weighing balance. Excess powdered magnesium was added to the acid.

The total mass of the flask and its contents was recorded at fixed time intervals. The results of his experiment is shown in Fig. 6.1.

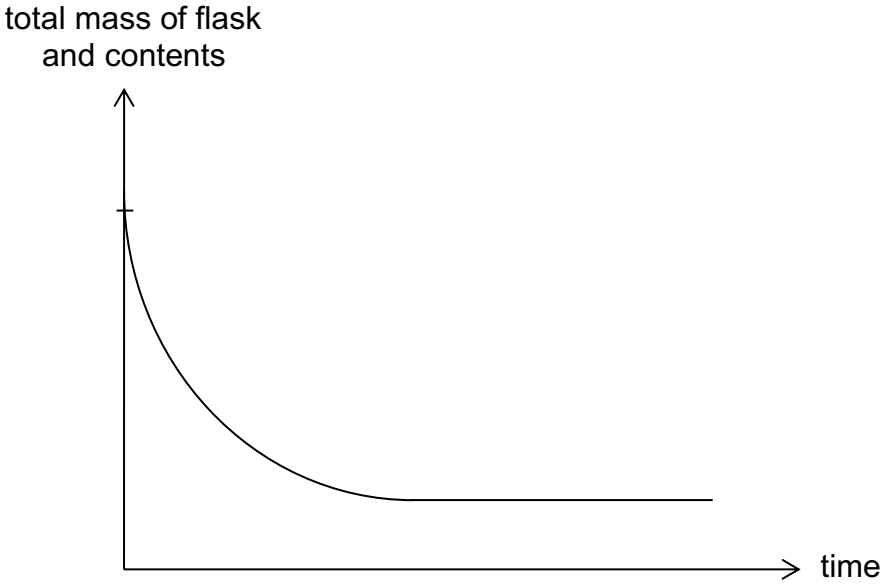


Fig. 6.1

(a) The student repeated the above experiment using the same mass of magnesium strip instead of powder.

Add to Fig. 6.1 the graph you would expect. Label as **graph (a)**. [2]

(b) Use your knowledge of reacting particles to explain the effect of increasing the temperature of the reaction mixture on the rate of the reaction.

…….

…….

…….

…….. [3]

(c) Describe a chemical test and observation for the gas given off during this chemical reaction.

test: ……

observation: ……

…….... [2]

(d) Another student conducted a similar experiment. Instead of using magnesium powder, the student replaced it with zinc powder to react with the same volume and concentration of dilute hydrochloric acid at room temperature.

Describe the difference in the rate of reaction, if any.

……..…… [1]

[Total: 8]

7 Fig. 7.1 describes some of the substances that result from the chemical reactions of an aqueous solution of salt **K**.

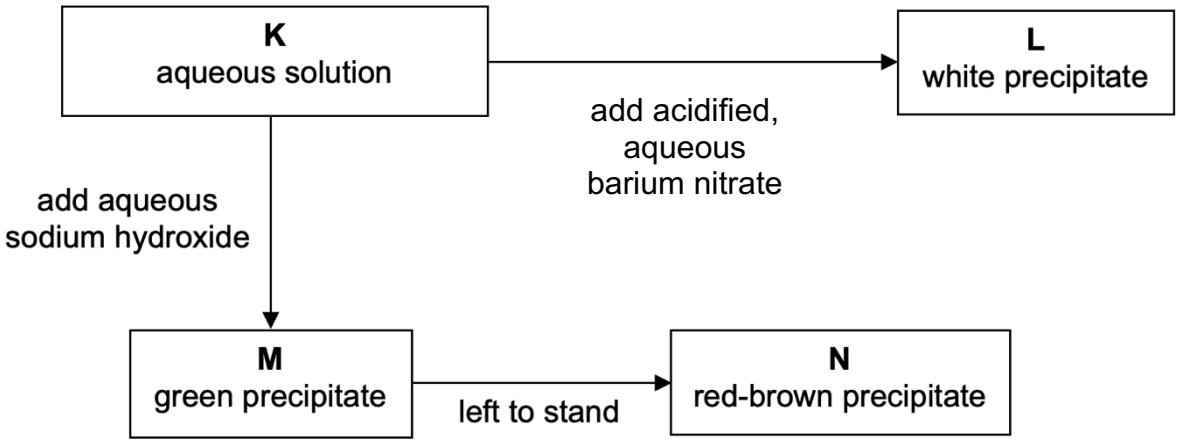


Fig. 7.1

(a) Identify each of **K**, **L**, **M** and **N**.

K ……..

L …….

M ……..

N …….. [4]

(b) Write a balanced chemical equation for any **one** of the reactions in Fig. 7.1.

…….…….…….. [2]

[Total: 6]

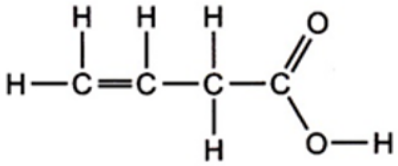
8 **(a)** Organic compounds are placed in an homologous series.
Give **two** general properties of an homologous series.

……

……

…….. [2]

(b) The structure of an organic compound, X, is shown below.



In a molecule of X, there are two different functional groups.

Circle and label the functional group that would react with aqueous sodium hydroxide. [1]

(c) **(i)** Draw the structure of the product formed when X is reacted with hydrogen gas in the presence of a suitable catalyst.

[1]

(ii) Suggest a suitable catalyst for the reaction in **(c)(i)**.

…….. [1]

[Total: 5]

Section B (20 marks)

Answer any **two** questions in this section.

Write your answers in the spaces provided.

9 **(a)** Chlorine, bromine and iodine are placed in Group VII of the Periodic Table.

(i) Describe a trend in the physical property in Group VII.

……

…….. [1]

(ii) Astatine is below iodine in Group VII.

Describe the observations when astatine is added to aqueous potassium iodide. Explain your answer.

……

……..…… [2]

(b) Calcium reacts with chlorine to form calcium chloride, $CaCl_2$.

(i) Draw a 'dot and cross' diagram to show the arrangement of electrons in $CaCl_2$. Show only the outermost shell of electrons.

[2]

(ii) State whether calcium chloride is able to conduct electricity at room temperature. Explain your answer in terms of the bonding in calcium chloride.

……

……

……..…… [2]

(c) Silver chloride is another compound that contains chlorine.

Describe how a pure sample of silver chloride can be prepared from silver nitrate solution.

……

……

……

……

……

…… [3]

[Total: 10]

10 **(a)** Iron(III) oxide, Fe_2O_3, occurs naturally in rocks as haematite.

(i) Name the main impurity found in haematite.

…… [1]

(ii) Iron is extracted from haematite in a blast furnace.

Name **two** raw materials, other than haematite, that are added to the blast furnace.

…… [2]

(iii) Describe the two reactions used to remove the impurity mentioned in **(a)(i)** in the blast furnace.

You may support your answer with relevant chemical equations.

……

……

……

……

……

……..…… [2]

(b) Iron(III) oxide is used to prepare potassium ferrate(VI), K_2FeO_4, as shown in the reaction.

$$Fe_2O_3 + 3Cl_2 + 10KOH \rightarrow 2K_2FeO_4 + 6KCl + 5H_2O$$

(i) A 2.00 g sample of iron(III) oxide is added to 20.0 cm^3 of 4.00 mol/dm^3 potassium hydroxide.

Calculate the number of moles of iron(III) oxide used.

[Relative atomic masses: A_r: Fe, 56; O, 16]

number of moles = …… [1]

(ii) Calculate the number of moles of potassium hydroxide used.

[Relative atomic masses: A_r: K, 39; O, 16; H, 1]

number of moles = …… [1]

(iii) Using your answers in **(b)(i)** and **(ii)**, deduce which reagent, iron(III) oxide or potassium hydroxide, is the limiting reagent.

limiting reagent is …… [1]

(iv) Hence, calculate the mass of potassium ferrate(VI) formed in this reaction.

mass of potassium ferrate(VI) = …… [2]

[Total: 10]

11 In industries, cracking is done on long-chain alkanes to convert them to shorter-chain alkanes and alkenes.

Cracking was carried out on hydrocarbon, $C_{17}H_{36,}$ to produce ethene, pentene and hydrocarbon, **X**.

$$C_{17}H_{36} \rightarrow 2C_2H_4 + 2C_5H_{10} + \mathbf{X}$$

(a) **(i)** State the conditions required for cracking.

…… [1]

(ii) Deduce the molecular formula of hydrocarbon **X**.

…… [1]

(iii) Describe a laboratory test to distinguish between ethene and **X**.

test ……

observation ……

…… [2]

(b) Ethene, in the presence of small amount of acid, can undergo addition reaction with water to form ethanol.

Draw the full structural formula of ethanol. Show all the bonds in your answer.

[1]

(c) Ethanol can also be made from glucose, $C_6H_{12}O_6$, by fermentation. A student tried to make ethanol using the set-up in Fig. 11.1.

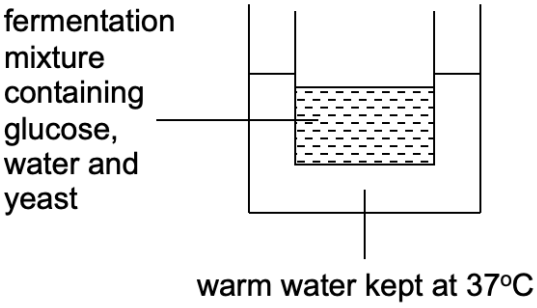


Fig. 11.1

(i) Explain why the temperature of the fermentation mixture should not exceed 37 °C.

……

…… [1]

(ii) After 5 days, the student tested the fermentation mixture with blue and red litmus paper.

Describe and explain his observations.

……

……

…… [2]

(d) Ethanol can be used as a fuel when burnt in excess air.

Write a balanced chemical equation for the reaction.

…… [2]

[Total: 10]

END OF PAPER

DATA SHEET

Colours of Some Common Metal Hydroxides

calcium hydroxide	white
copper(II) hydroxide	light blue
iron(II) hydroxide	green
iron(III) hydroxide	red-brown
lead(II) hydroxide	white
zinc hydroxide	white

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											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 –		

Key

proton (atomic) number
atomic symbol
name
relative atomic mass

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 –

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.)