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JURONGVILLE SECONDARY SCHOOL
PRELIMINARY EXAMINATION 2022
Secondary 4 Express

STUDENT NAME

CLASS

INDEX NUMBER

CHEMISTRY

6092/01

Paper 1 Multiple Choice

26 August 2022

1 hour

Additional Materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, highlighters, glue or correction fluid.
Write your name, class and index number in the spaces on all the work you hand in.

There are **forty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A**, **B**, **C** and **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the Multiple Choice Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.
A copy of the Periodic Table is printed on page 15.
The use of an approved scientific calculator is expected, where appropriate.

DO NOT OPEN THE BOOKLET UNTIL YOU ARE TOLD TO DO SO

Setter: Mrs Wong Yan Pure

This document consists of **15** printed pages.

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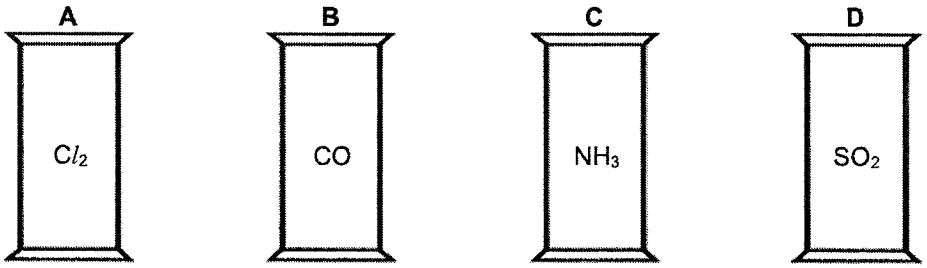
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1 Four identical gas jars are filled with different gases.

The lids are taken off the gas jars and they are left open to the air for a few hours.

Which gas jar will first contain the most air in it?



2 A pale green solution X gives a green precipitate with excess aqueous sodium hydroxide.

An alkaline gas is only given off when the mixture is warmed with powdered aluminium.

Which ions does X contain?

A ammonium and copper(II) ions

B ammonium and iron(II) ions

C copper(II) and nitrate ions

D iron(II) and nitrate ions

3 Which apparatus **cannot** be used to measure the rate of neutralisation between solid sodium carbonate and aqueous hydrochloric acid?

A electronic balance **B** gas syringe

C stopwatch **D** thermometer

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4 An analysis is carried out on a plant extract containing some coloured pigments.

In Fig. 4.1, a small amount of plant extract is dotted on a chromatography paper and separated using solvent A.

After drying the chromatography paper, the chromatography paper is subjected to another separation using solvent B, as shown in Fig. 4.2.

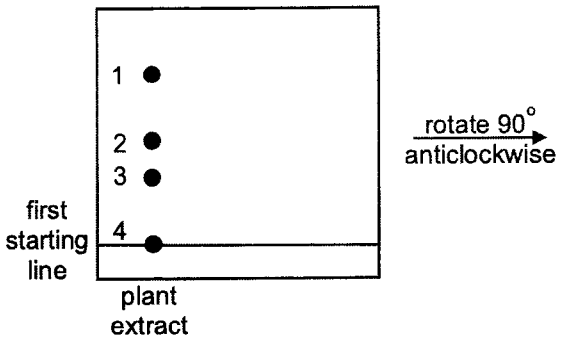


Fig. 4.1

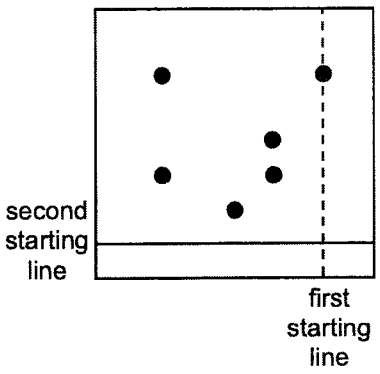


Fig. 4.2

Which statement is **not** true?

A Pigment 2 is less soluble in solvent A than in solvent B.

B Pigment 4 is most likely a pure substance.

C Pigments 1 and 3 have a same substance.

D The components in pigment 1 have different solubilities in solvent B.

5 An ion X^+ contains 23 nucleons and 10 electrons.

What does the nucleus of the ion X^+ contain?

	protons	neutrons
A	9	14
B	10	13
C	11	11
D	11	12

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6 A covalent compound has the following structural formula.

$$X - Y \equiv Z$$

Which row shows the possible electronic structures of the atoms X, Y and Z?

	X	Y	Z
A	1	2,2	2,5
B	1	2,4	2,3
C	2,8,7	2,2	2,3
D	2,8,7	2,4	2,5

7 Peeling onions often cause tearing of the eyes due to the release of a sulfide compound.

Peeling them under running water reduces the problem.

Which statements are true of the sulfide compound?

1 It has a low boiling point.
2 It has small and light ions with weak bonding.
3 It is a covalent compound with weak covalent bonds.
4 It is soluble in water.

A 1 and 2 only **B** 1 and 4 only
C 2 and 3 only **D** 3 and 4 only

8 The strongest ionic crystal lattices are generally observed to consist of highly charged ions combined in a 1 : 1 ratio.

Which two elements are likely to form crystals with the highest melting point?

A aluminium and oxygen **B** calcium and fluorine
C lithium and fluorine **D** magnesium and oxygen

9 Sulfur vapour with a mass of 128 g has the same volume as 16 g of oxygen at the same temperature and pressure.

What is the formula of a molecule of sulfur vapour?

A S_2 **B** S_4
C S_6 **D** S_8

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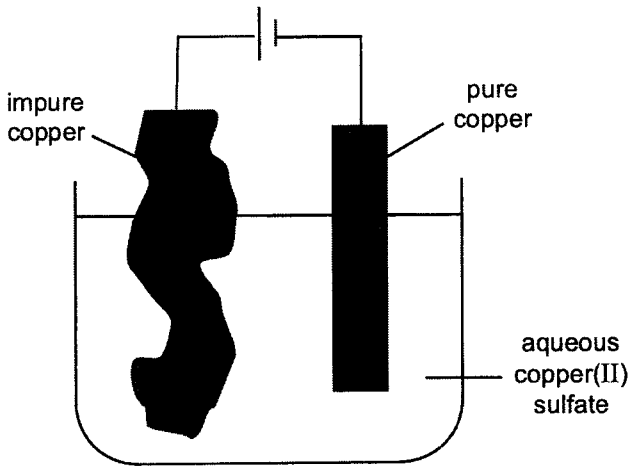
10 75 cm^3 of 0.200 mol / dm^3 of sodium hydroxide is added to 25 cm^3 of 0.200 mol / dm^3 sulfuric acid.

What is the concentration of the excess sodium hydroxide in the resultant solution?

A 0.005 mol / dm^3 **B** 0.010 mol / dm^3

C 0.030 mol / dm^3 **D** 0.050 mol / dm^3

11 A student carried out an electrolytic purification of copper as shown.



The table shows the information about this electrolytic purification.

mass of	before electrolytic purification / g	after electrolytic purification / g
anode	100	10
cathode	10	80

What was the percentage impurity of the impure copper anode?

A 10.0 % **B** 20.0 %

C 30.0 % **D** 90.0 %

12 When gold plating an orchid, a coating containing fine metal or carbon particles is first painted onto the orchid.

Why is this coating applied?

A It allows the gold to form a tough alloy on the orchid's surface.

B It gives the orchid a conductive surface so that it can act as the anode.

C It gives the orchid a conductive surface so that it can act as the cathode.

D It gives the orchid a sticky surface so that the gold plating will not fall off.

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13 Which observation will be made when dilute sulfuric acid is electrolysed using graphite electrodes?

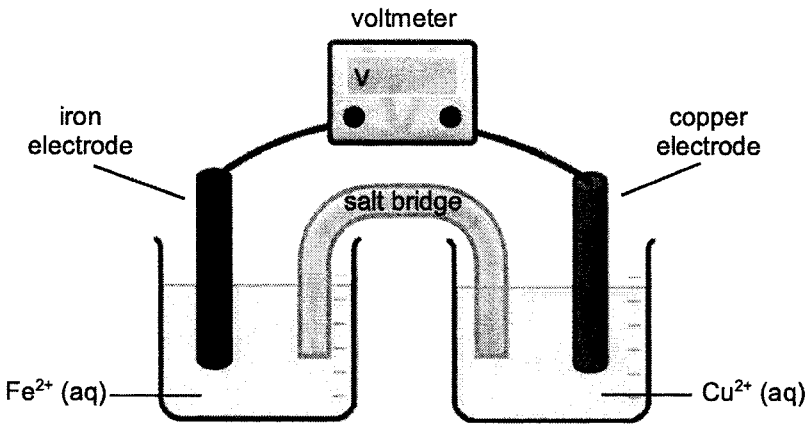
A No gas is evolved at both the cathode and anode.

B The gas evolved at the anode extinguishes a lighted splint with a 'pop' sound.

C The gas evolved at the cathode is less dense than air.

D The gas evolved at the cathode relights a glowing splint.

14 The figure shows the set-up of a simple cell involving iron and copper electrodes immersed in their respective electrolytes.



Which statement is **not** true for the experiment?

A The colour intensity of copper(II) solution decreases over time.

B The electrons flow from left to right through the salt bridge.

C There is a decrease in the mass of iron electrode.

D There is an increase in the mass of copper electrode.

15 The table shows the energy released by the complete combustion of some compounds used as fuels.

compound	formula	M_r	ΔH / kJ / mol
methane	CH_4	16	–880
ethanol	C_2H_5OH	46	–1380
propane	C_3H_8	44	–220
heptane	C_7H_{16}	100	–4800

Which fuel produces the most energy when 1 g of the compound is completely burnt?

A methane **B** ethanol

C propane **D** heptane

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16 The equations for three reactions are given.

reaction 1 $H_2 \rightarrow 2H$

reaction 2 $2H + O \rightarrow H_2O$

reaction 3 $HCl \rightarrow H + Cl$

Which of these reactions are endothermic?

A reaction 1 only

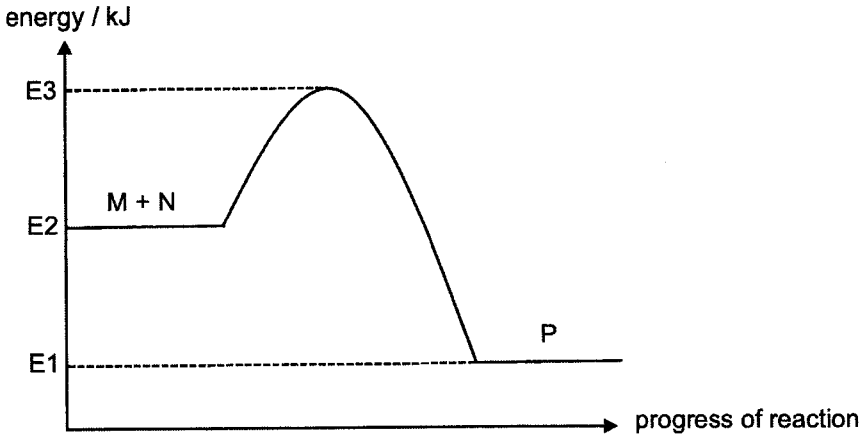
B reactions 1 and 2 only

C reactions 1 and 3 only

D reactions 2 and 3 only

17 The energy profile diagram for the following reaction is shown.

$M + N \rightleftharpoons P \qquad \Delta H = -108 \text{ kJ / mol}$



Which equation represents the activation energy of the forward reaction?

A E1 + E2

B E2 – E1

C E3 – E1

D E3 – E2

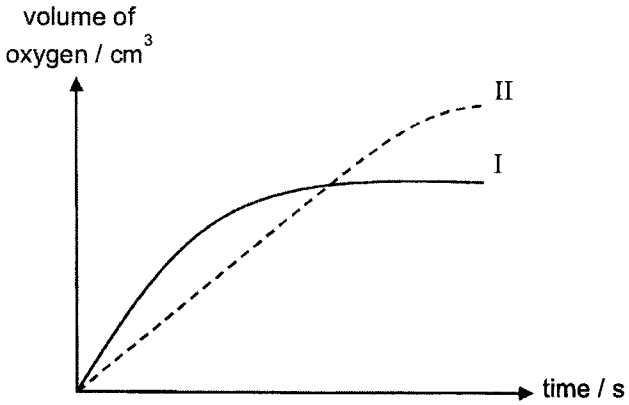
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18 Curve I is obtained by the decomposition of 50 cm^3 of 1 mol / dm^3 aqueous hydrogen peroxide, catalysed by manganese(IV) oxide.

$$2H_2O_2(aq) \rightarrow O_2(g) + 2H_2O(l)$$



Which change will produce curve II?

A adding 60 cm^3 of 1 mol / dm^3 aqueous hydrogen peroxide

B adding 100 cm^3 of 0.1 mol / dm^3 aqueous hydrogen peroxide

C lowering the temperature

D using 75 cm^3 of 0.5 mol / dm^3 aqueous hydrogen peroxide instead

19 Which observation is that of a redox reaction?

A Aqueous potassium iodide turns brown when chlorine gas is bubbled into it.

B Blue precipitate is formed when aqueous ammonia is added to copper(II) nitrate solution.

C Bubbles of gas are observed when an acid reacted with solid magnesium carbonate.

D Solution turned blue when copper(II) sulfate crystals are added to hydrochloric acid.

20 When acidified aqueous hydrogen peroxide is added to aqueous potassium manganate(VII), the reaction takes place:

$$2MnO_4^-(aq) + 5H_2O_2(aq) + 6H^+(aq) \rightarrow 2Mn^{2+}(aq) + 5O_2(g) + 8H_2O(l)$$

Which statement about the reaction is correct?

A Hydrogen peroxide acts as an oxidising agent.

B The oxidation number of manganese changes from +7 to +2.

C The potassium manganate(VII) is oxidised.

D The potassium manganate(VII) solution turns green.

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21 Which salt can only be prepared by titration method?

A aluminium sulfate **B** ammonium sulfate

C copper(II) sulfate **D** iron(II) sulfate

22 Freshly distilled water has a pH of 7.0.

After it was left standing for a short time, the pH was observed to have dropped below 7.0.

Which of the equations best explains the phenomenon?

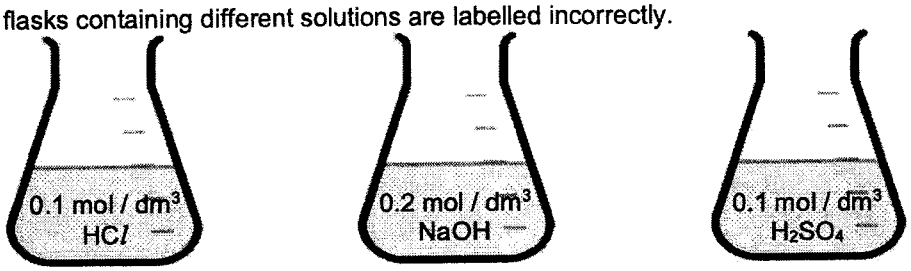
A $HCl(aq) \rightleftharpoons H^+(aq) + Cl^-(aq)$

B $H_2O(l) \rightleftharpoons H^+(aq) + OH^-(aq)$

C $H_2O(l) + CO_2(g) \rightleftharpoons 2H^+(aq) + CO_3^{2-}(aq)$

D $H_2O(l) + NH_3(g) \rightleftharpoons NH_4^+(aq) + OH^-(aq)$

23 Three flasks containing different solutions are labelled incorrectly.



In order to identify the solutions, a student mixes two of the solutions at one time and recording the change in temperature.

Which row shows an **incorrect** explanation to the student's observation?

	observation	explanation
A	There is no change in temperature when two solutions are mixed.	The solutions could be hydrochloric acid and sodium hydroxide respectively.
B	There is no change in temperature when two solutions are mixed.	The solutions could be hydrochloric acid and sulfuric acid respectively.
C	There is temperature rise when two solutions are mixed.	The solutions could be hydrochloric acid and sodium hydroxide respectively.
D	There is temperature rise when two solutions are mixed.	The solutions could be sulfuric acid and sodium hydroxide respectively.

[Turn over

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24 Germanium, Ge, is in the same group of the Periodic Table as carbon.

Which formula would **not** belong to a compound of germanium?

A $NaGeO_3$ **B** Na_4Ge

C GeH_4 **D** GeO_2

25 Which statement is **false** about the Periodic Table?

A Group VII elements are coloured.

B The atomic radii of elements increases down the group.

C The density of alkali metals decreases down the group.

D The metallic nature of the elements increases down the group.

26 Which element is most likely to be a transition metal?

	density / g / cm^3	melting point / °C	number of chlorides
A	0.07	–259	1
B	3.10	–7	2
C	2.07	113	1
D	8.92	1083	2

27 Metal P can reduce steam to hydrogen, but metal Q cannot reduce steam.

Based on this information, which action will cause a reaction to occur?

A heating a mixture of metal Q and oxide of metal P

B heating carbonate of Q strongly

C passing hydrogen over the heated oxide of metal P

D passing steam over the heated oxide of metal P

28 Alloys are usually harder than the metals that they are made of.

Which difference would explain the hardness of alloys?

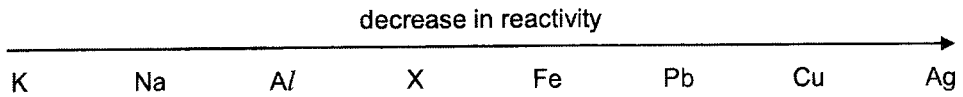
A atomic sizes **B** densities

C electrical conductivities **D** relative atomic masses

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29 The position of metal X in the reactivity series is shown.



What method **cannot** be used to extract X from its ore?

A electrolysis of its aqueous sulfate

B electrolysis of its molten oxide

C reduction of its oxide by heating with coke

D reduction of its sulfide by heating with coke

30 The metal chromium liberates hydrogen from dilute hydrochloric acid, but does not react with cold water.

When a piece of chromium is placed in lead(II) nitrate solution, grey solid is formed.

Which row shows the reactivity of calcium, chromium, lead and platinum in decreasing order?

A calcium, chromium, lead, platinum

B calcium, lead, chromium, platinum

C chromium, calcium, lead, platinum

D platinum, lead, chromium, calcium

31 Why is a tin-plated iron sheet less resistant to rusting than a galvanised iron sheet?

A Iron is less reactive than zinc but more reactive than tin.

B Tin does not adhere to iron as well as zinc.

C Zinc forms a layer that protects the iron surface but tin does not.

D Zinc is more scratch-resistant as compared to tin.

32 Which gas can be removed from the exhaust gases of a petrol-powered car by its catalytic convertor?

A carbon dioxide **B** carbon monoxide

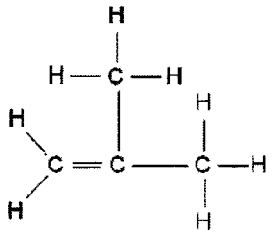
C nitrogen **D** steam

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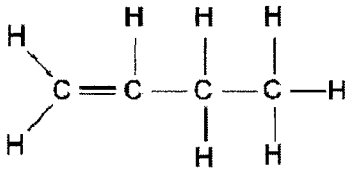
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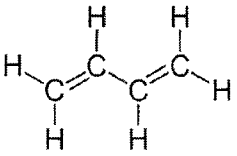
33 Structures of three hydrocarbons are shown.



hydrocarbon 1



hydrocarbon 2



hydrocarbon 3

Which statements about these hydrocarbons are correct?

1 On complete combustion of one mole of each hydrocarbon, they give the same volume of carbon dioxide.

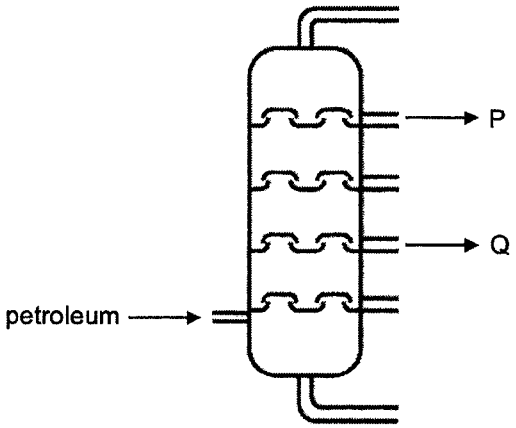
2 They all form addition compounds with bromine.

3 They are all isomers of the same hydrocarbon.

A 1 and 2 only **B** 1 and 3 only

C 2 and 3 only **D** 1, 2 and 3

34 The diagram shows the separation of crude oil into fractions.



Which statement about fractions P and Q is correct?

A P and Q are mainly alkenes.

B P and Q boil at a fixed temperature.

C P can be cracked to meet the higher demands of Q.

D P has a lower boiling point and a higher flammability than Q.

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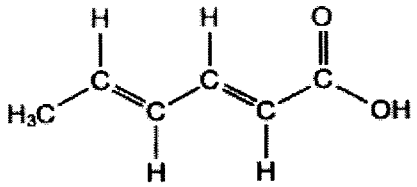
35 A food chemist wants to create the odour of pineapples in a product.

An ester with this odour has the formula $C_3H_7COOC_2H_5$.

Which pair of reactants would produce this ester?

A	CH_3COOH and C_3H_7OH	**B**	C_2H_5COOH and C_2H_5OH
C	C_2H_5COOH and C_3H_7OH	**D**	C_3H_7COOH and C_2H_5OH

36 Sorbic acid is used as a food preservative as it kills fungi and moulds that would possibly grow on food.



Sorbic acid will react with

- bromine in an organic solvent.
- Hydrogen at 200 °C in the presence of nickel catalyst.

How many moles of bromine and hydrogen will be incorporated into one mole of sorbic acid in these reactions?

	moles of bromine	moles of hydrogen
A	2	2
B	2	3
C	2.5	2
D	2.5	3

37 Which property does **not** change when ethene is polymerised to form poly(ethene)?

A	boiling point	**B**	melting point
C	molecular formula	**D**	percentage composition of carbon

[Turn over

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38 Propene reacts with steam at 300 °C in the presence of phosphoric acid as a catalyst to produce a colourless liquid P.

On warming, liquid P with acidified potassium manganate(VII) solution, a colourless liquid Q is produced.

Identify liquids P and Q.

	P	Q
A	propane	butanol
B	propanol	butanoic acid
C	propanol	propanoic acid
D	propyl ethanoate	water

39 Polyunsaturated fats are considered healthy fats as they may reduce your risk of heart disease, especially when substituted for saturated fats.

An example of a polyunsaturated fat is C_6H_9COOH.

How many double covalent bonds are present in one molecule of the acid?

A 1 **B** 2

C 3 **D** 4

40 In which reaction is water produced?

A manufacture of ethanol from ethene

B manufacture of margarine from vegetable oils

C manufacture of poly(ethene) from ethene

D manufacture of Terylene from an alcohol and a carboxylic acid

End of Paper

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THE PERIODIC TABLE OF ELEMENTS

Group I	Group II											Group III	Group IV	Group V	Group VI	Group VII	Group 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 209	85 At astatine 210	86 Rn radon 222
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) numbers
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 162	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
actinoids	89 Ac actinum –	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 any gas is 24 dm^3 at room temperature and pressure (r.t.p.)

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PRELIMINARY EXAMINATION 2022
Secondary 4 Express

STUDENT NAME			
CLASS		INDEX NUMBER	

CHEMISTRY

6092/02

Paper 2

24 August 2022

1 hour 45 minutes

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

READ THESE INSTRUCTIONS FIRST

Write your name, class and index number in the spaces on all the work you hand in.
Write in dark blue or black pen.
You may use pencil for drawing diagrams or graphs.
Do not use staples, paper clips, highlighters, glue or correction fluid.

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

Section B
Answer all **three** questions. The last question is in the form either / or.
Answer all questions in the spaces provided.

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 19.

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

DO NOT OPEN THE BOOKLET UNTIL YOU ARE TOLD TO DO SO

For Examiner's Use	
Section A	/ 50
Section B	/ 30
Total	/ 80

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Section A

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

A1 Table 1.1 shows some properties of four oxides.

Table 1.1

oxide	melting point / °C	electrical conductivity when molten	reaction with water	resulting pH of solution
W	17	poor	exothermic	1
X	1280	good	exothermic	14
Y	1720	poor	none	7
Z	2850	good	very little	8

(a) Use the letters W, X, Y and Z to answer the questions.

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

(i) Which of the oxides are non-metallic oxides?

..... [1]

(ii) Which of the oxides have a giant lattice structure?

..... [1]

(iii) Which of the oxide has a giant molecular structure?

..... [1]

(b) Oxide W is an atmospheric pollutant which changes the colour of potassium manganate(VII), and forms acid rain.

(i) Suggest an identity for oxide W.

..... [1]

(ii) Write an equation to show how oxide W identified in **(b)(i)** forms acid rain.

..... [1]

(iii) State two negative impacts of acid rain on the environment.

.....

.....

.....

..... [2]

[Total: 7]

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A2 Magnesium is best known for burning with a characteristic brilliant white light.

The metal was first produced by Sir Humphry Davy in 1808 by the electrolysis of a molten mixture of magnesia, MgO with mercury oxide. Mercury oxide was added as an impurity and inert electrodes were used during the electrolysis.

(a) Construct ionic half-equation with state symbols to show how the product is formed at the cathode.

..... [1]

(b) Suggest a reason why the product obtained at the cathode was a mixture.

..... [1]

(c) A gas was obtained at the anode.

Describe a positive test to identify the gas formed at the anode.

.....

..... [2]

(d) Give a reason for adding mercury oxide as an impurity.

..... [1]

[Total: 5]

A3 A student tried to prepare magnesium sulfate by reacting sulfuric acid with magnesium oxide.

(a) Explain why this method **cannot** be used to prepare barium sulfate from sulfuric acid and barium oxide.

.....

..... [2]

(b) Describe a suitable method of preparing a pure and dry sample of barium sulfate. Suggest the reagents required.

.....

.....

.....

.....

.....

..... [4]

[Total: 6]

[Turn over

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A4 Table 4.1 lists some physical properties of the metals found in Period 4 of the Periodic Table.

Table 4.1

	proton number	atomic radius / nm	ionic radius / nm	melting point / °C	density / g / cm^3	electrical conductivity / S / m
calcium	20	0.197	0.114	842	1.54	29.8×10^6
iron	26	0.126	0.075	1538	7.86	9.93×10^6
copper	29	0.128	0.087	1084	8.92	59.6×10^6

(a) Explain why the ionic radius of the metal ion is always smaller than its atomic radius.

.....

.....

..... [2]

(b) The high electrical conductivity of copper makes it a very useful element for making electrical components.

Using the data from Table 4.1,, suggest why copper is **not** usually used as overhead electrical cables.

..... [1]

(c) Using the data from Table 4.1, explain why the other metals are unsuitable for making electrical wires.

calcium: .....

..... [1]

iron: .....

..... [1]

[Total: 5]

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A5 Chlorofluorocarbons, CFCs, are sometimes used as propellants in aerosols.

Ozone hole are caused by reactions involving CFCs.

(a) Explain why ozone hole can cause harm to humans.

.....

..... [2]

(b) Difluoromethane, CH_2F_2, is a hydrofluorocarbon. It can be used instead of CFCs in aerosols.

Draw a dot and cross diagram to show the bonding in CH_2F_2, showing only the valence electrons.

[2]

(c) Difluoromethane can be synthesised by reacting methane with fluorine.

$$CH_4 + F_2 \rightarrow CH_3F + \text{substance X}$$

$$CH_3F + F_2 \rightarrow CH_2F_2 + \text{substance X}$$

(i) Name substance X.

..... [1]

(ii) What is the name for this type of reaction?

..... [1]

(iii) State the condition required for the reaction to occur.

..... [1]

(iv) Gaseous bromine will also react with methane. Suggest whether the reaction is faster or slower than fluorine. Explain your answer.

.....

..... [1]

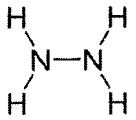
[Total: 8]

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A6 **(a)** One of the early alternative rocket fuels was hydrazine, N_2H_4. The structure of hydrazine is shown.



Liquid hydrazine combined with liquid oxygen in the combustion chamber in the rocket engine to produce thrust for the rocket. The equation of the combustion reaction is shown.

$$N_2H_4(l) + O_2(l) \rightarrow N_2(g) + 2H_2O(l) \qquad \Delta H = -585 \text{ kJ / mol}$$

Table 6.1 shows the bond energies of some covalent bonds.

Table 6.1

bond	N – H	N ≡ N	O = O	O – H	N – N
bond energy / kJ / mol	388	944	496	463	

(i) Calculate the bond energy of N – N bond.

bond energy of N – N bond = ... kJ / mol [2]

(ii) Explain, using bond energies, why the above reaction is exothermic, in terms of bond breaking and bond forming.

.....

..... [1]

(iii) Draw an energy profile diagram for the reaction, showing the activation energy, enthalpy change, reactants and products.

[3]

(b) Butane is a fuel used in portable heaters.

For complete combustion of one mole of butane, the enthalpy change is –2880 kJ.

Calculate the quantity of heat evolved from the combustion of 16 dm^3 of butane, at room temperature and pressure.

heat evolved = ... kJ [2]

[Total: 8]

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A7 Ammonia is manufactured in the Haber process.

(a) Explain, with the help of an equation, why nitrogen and hydrogen are mixed in a ratio of 1 : 3 by volume.

.....

..... [2]

(b) State the essential conditions required in the Haber process.

..... [1]

(c) Ammonia is used to manufacture nitric acid by first converting ammonia to nitrogen monoxide.

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

(i) In terms of the collision between reacting particles, state and explain how the rate changes when the pressure is increased.

.....

..... [1]

(ii) During the reaction, ammonia and oxygen are passed through a powdered catalyst. Explain how the catalyst increases the speed of reaction.

.....

..... [1]

(iii) The formation of nitrogen monoxide can be determined by pH changes. Explain how this is possible.

.....

..... [1]

[Total: 6]

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A8 Fig. 8.1 shows the stages involved in the extraction of zinc from zinc blende, which contains mainly zinc sulfide, ZnS.

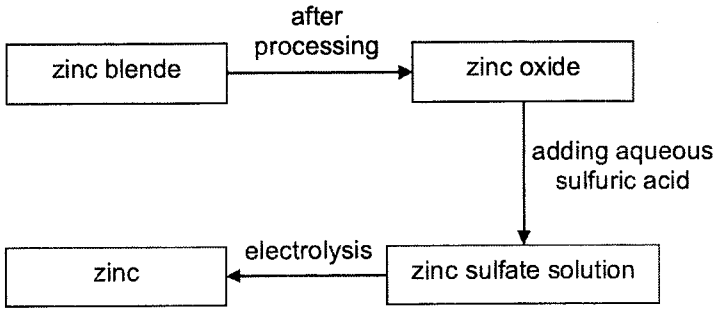


Fig. 8.1

Zinc sulfate solution obtained contained ions of other metals, which are present as impurities in zinc oxide.

(a) It is necessary to remove ions of metals which are less reactive than zinc from zinc sulfate solution before electrolysis.

However, it is not necessary to remove ions of metals which are more reactive than zinc.

Explain why.

.....

.....

.....

..... [2]

(b) Suggest how to remove the metal ions that are less reactive than zinc from zinc sulfate solution before electrolysis.

.....

.....

..... [2]

(c) Suggest a more economical method to reduce zinc oxide to zinc metal.

.....

..... [1]

[Total: 5]

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Section B

Answer all **three** questions in this section.

The last question is in the form of an either / or and only one of the alternatives should be attempted.

B9 Transition metals occupy the middle portions of the long periods of the Periodic Table, between the groups on the left-hand side and the groups on the right-hand side.

Each transition metal may have several oxidation states, which shows the number of electrons that the transition metal would lose if it were to bond with other atoms. Table 9.1 shows the range of oxidation states of the first row of transition metals in their compounds. Some of the oxidation states are uncommon and unstable. The important ones are underlined.

Table 9.1

Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn
								+1	
	+2	+2	<u>+2</u>	<u>+2</u>	<u>+2</u>	<u>+2</u>	<u>+2</u>	<u>+2</u>	<u>+2</u>
<u>+3</u>	<u>+3</u>	+3	<u>+3</u>	+3	<u>+3</u>	<u>+3</u>	+3	+3	
	<u>+4</u>	<u>+4</u>	+4	<u>+4</u>	+4	+4	+4		
		<u>+5</u>	+5	+5					
			<u>+6</u>	+6	+6				
				<u>+7</u>					

Chromium is a hard bluish-white metal, whose name refers to its many colourful compounds. Chromium, like other transition metals, forms a few oxides. Table 9.2 gives some information of the common oxides of chromium.

Table 9.2

formula of oxide	melting point / °C	nature of oxide	colour of oxide
CrO	decomposes at 300 °C	basic	black
Cr_2O_3	2450	amphoteric	dark green
CrO_3	190	acidic	deep red

Transition metals are not as reactive as alkali metals, but they are hard and strong metals. Hence, transition metals are often used for making objects and machineries. An example is titanium which has high strength, is strong as steel but 45% lighter, and is resistant to corrosion. Hence, titanium is used in aircrafts, ships and hip replacement joints. However, titanium is more expensive than iron, and five times more expensive than stainless steel.

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10

Most titanium is extracted from its ore, rutile, which contains titanium dioxide. Titanium cannot be extracted by using carbon as a reducing agent, as titanium forms a carbide, TiC. The presence of carbide makes the metal brittle and thus, titanium is extracted from its ore in two stages as shown in Fig. 9.1

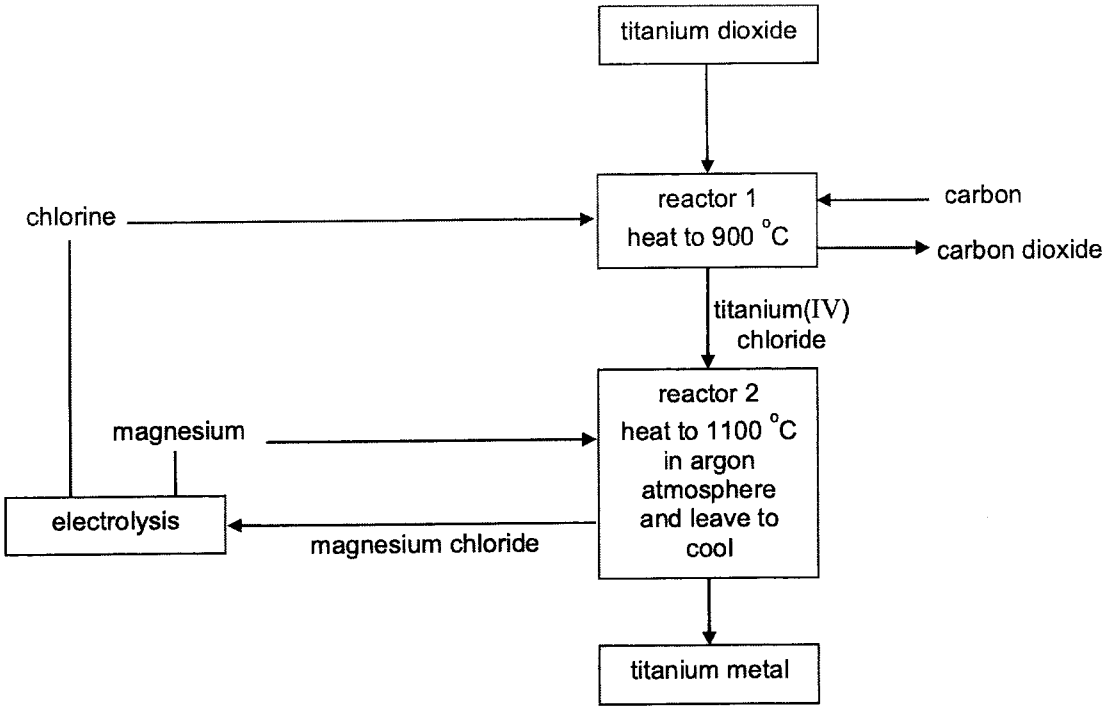


Fig. 9.1

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Fig. 9.2 shows the mass of titanium metal produced from pure rutile ore and impure rutile ore. The difference between the two lines represents the amount of waste rock in the impure ore.

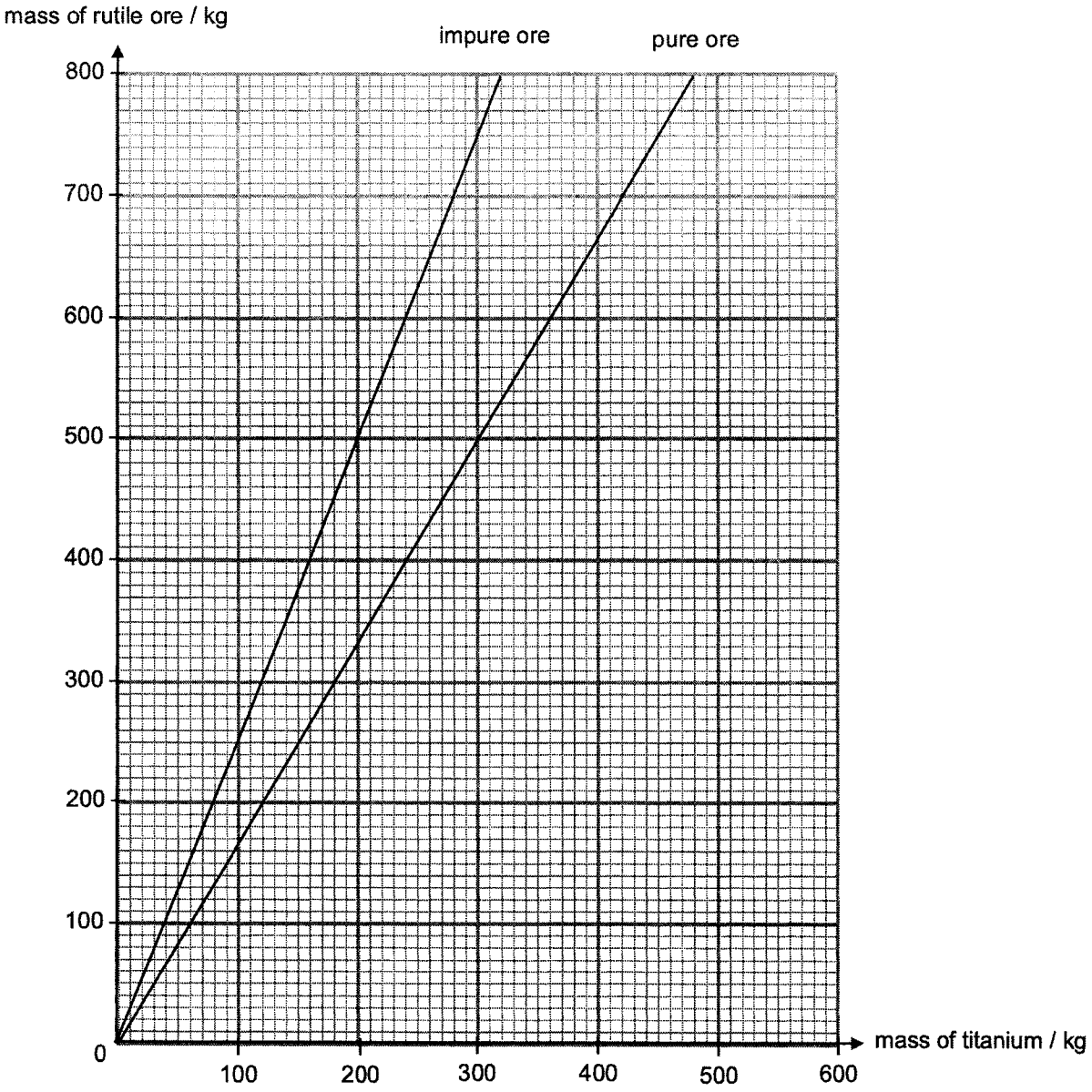


Fig. 9.2

(a) Explain why +2 oxidation state is the most common amongst the transition metals.

.....

..... [1]

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(b) State the relationship between the oxidation state of chromium oxides and the nature of the oxides.

.....

..... [1]

(c) Similar to chromium, manganese also forms a few oxides. The chemistry of manganese resembles that of chromium. Predict the nature of the oxides.

name of oxide	nature of oxide
manganese(VII) oxide	
manganese(IV) oxide	
manganese(II) oxide	

[1]

(d) Describe how magnesium chloride was recycled in Fig. 9.1.

.....

..... [2]

(e) **(i)** From Fig. 9.1, construct the equation to show the reaction which produces titanium metal.

..... [1]

(ii) Besides high temperature, state one other condition for the reaction and explain why this condition is required.

.....

..... [2]

(f) From the impure ore, 300 kg of pure titanium was produced. Calculate the mass of waste rock in the impure ore.

mass ..... kg [1]

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(g) **(i)** State the reducing agents in the extraction of iron and titanium respectively.

.....

..... [1]

(ii) Give two reasons why titanium is more costly than iron even through it is the ninth most abundant element in the Earth's crust.

.....

.....

..... [2]

[Total: 12]

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B10 A toilet detergent contains the acid salt sodium dihydrogen phosphate, NaH_2PO_4.

(a) Explain why sodium dihydrogen phosphate is both an acid and a salt.

.....

.....

..... [2]

(b) Sodium dihydrogen phosphate can be made by reacting sodium hydroxide solution with dilute phosphoric acid, H_3PO_4.

(i) Write the balanced chemical equation for the formation of sodium dihydrogen phosphate, including state symbols.

..... [1]

(ii) Suggest the chemical formula of another possible salt formed from sodium hydroxide solution and dilute phosphoric acid.

..... [1]

(c) Table 11.1 shows information about other acids.

Table 11.1

acid	pH
sodium dihydrogen phosphate	4.5
ethanoic acid	3.8
sulfuric acid	1.0

(i) Explain how sulfuric acid behaves as a strong acid, but ethanoic acid behaves like as a weak acid.

.....

.....

.....

..... [2]

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(ii) Describe an experiment, other than measuring pH and using indicators, how you would carry out an experiment to show that sulfuric acid is a strong acid and ethanoic acid is a weak acid.

State the measurements you would make and expected results.

.....

.....

.....

.....

.....

.....

.....

..... [2]

[Total: 8]

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EITHER

B11 1,1-dichloroethene, $C_2H_2Cl_2$, undergoes polymerisation to form polyvinylidene chloride, PVDC.

The most well-known use of PVDC is as plastic food wraps. PVDC is non-biodegradable and the only way to dispose PVDC is to incinerate. But incinerating PVDC causes serious environmental issues.

(a) Describe one similarity and one difference in structure between 1,1-dichloroethene and polyvinylidene chloride.

.....

.....

..... [2]

(b) Draw the structure of PVDC polymer, showing three repeating units.

[2]

(c) Calculate the number of repeating units in a PVDC polymer if it has a relative molecular mass of 82 450.

number of repeating units ..... [2]

(d) Describe a chemical test to distinguish between 1,1-dichloroethene and PVDC.

.....

.....

..... [2]

(e) Explain why being non-biodegradable is both an advantage and a disadvantage.

.....

.....

..... [2]

[Total: 10]

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OR

B11 Ethers are a group of compounds containing carbon, hydrogen and oxygen as shown in Table 12.1.

Table 12.1

name	molecular formula	boiling point / °C
methoxyethane	$CH_3 - O - CH_2CH_3$	7
ethoxyethane	$CH_3CH_2 - O - CH_2CH_3$	35
Z	$CH_3 - O - CH_2CH_2CH_3$	39
Propoxybutane	$CH_3CH_2CH_2 - O - CH_2CH_2CH_2CH_3$	117

(a) Name ether Z.

..... [1]

(b) With reference to Table 12.1, state and explain the trend observed in the boiling points of ether.

.....

.....

.....

..... [2]

(c) Simple ethers are prepared commercially by the dehydration of alcohols using concentrated sulfuric acid.

Alcohol Y is used to prepare ethoxyethane, $C_2H_5 - O - C_2H_5$, as shown in the equation.

$$2Y \rightarrow C_2H_5 - O - C_2H_5 + H_2O$$

(i) Give the formula of alcohol Y used in the dehydration reaction.

..... [1]

[Turn over

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(ii) Alcohol Y reacted with an organic compound W, CH_2O_2, to form a sweet smelling liquid X.

Give the name and full structural formula of the sweet smelling liquid X.

name: ..... [1]

structure:

[1]

(d) Epoxides also known as oxiranes, are three-membered ring structures in which one of the vertices is an oxygen and the other two are carbons.

The full structural formula for the first member, C_2H_4O, is shown in Fig. 12.1.

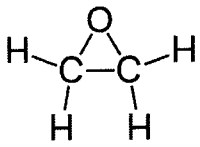


Fig. 12.1

(i) Epoxides can be produced by reacting an alkene with oxygen.

Name the alkene which could be used to produce the first member, C_2H_4O.

..... [1]

(ii) The second member of epoxides has a chemical formula, C_3H_6O, with three atoms in a ring, one of which is oxygen.

Draw the full structural formula of the epoxide, C_3H_6O.

[1]

(e) Epoxides are more reactive than simple ethers due to ring strain. Opening the ring relieves the ring strain and the products are 2 substituted alcohols.

Suggest a way to produce ethanol in the laboratory.

.....

.....

..... [2]

[Total: 10]

End of Paper

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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 209	85 At astatine 210	86 Rn radon 222
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) numbers
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 162	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
actinoids	89 Ac actinum –	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 any gas is 24 dm^3 at room temperature and pressure (r.t.p.)

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Jurongville Secondary School
Science Department 2022
Marking Scheme & Marker's Report

Assessment: Preliminary Examination Chemistry (6092) **Level / Stream:** 4 Express

Paper 1 – Multiple Choice Questions

Question	Answer	Question	Answer	Question	Answer	Question	Answer
1	C	11	C	21	B	31	A
2	D	12	C	22	C	32	B
3	D	13	C	23	A	33	A
4	A	14	B	24	B	34	D
5	D	15	A	25	C	35	D
6	D	16	C	26	D	36	A
7	B	17	D	27	B	37	D
8	D	18	B	28	A	38	C
9	D	19	A	29	A	39	B
10	D	20	B	30	A	40	D

Qn	Marking Scheme	Remarks	Marks	Marker's Report
	Paper 2 Section A			
1(ai)	W and Y		[1]	
(ii)	X and Z		[1]	
(iii)	Y		[1]	
(bi)	sulfur dioxide / SO_2 OR nitrogen dioxide / NO_2	accept both word & chemical formula	[1]	

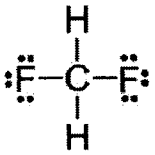
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Qn	Marking Scheme	Remarks	Marks
(ii)	SO_2 (g) + H_2O (l) → H_2SO_3 (aq) OR $2SO_2$ (g) + O_2 (g) + $2H_2O$ (l) → $2H_2SO_4$ (aq) OR $4NO_2$ (g) + $2H_2O$ (l) + O_2 (g) → $4HNO_3$ (aq)	[0] for wrong state symbols state symbols not required	[1]
(iii)	corrodes **limestone / stone** buildings or statues / metal bridges **acidifies** water bodies, **harming** marine / aquatic life causes **acidic soil** / **leaches nutrients** from soil, affecting plant growth	[1] for each impact	[2]
2(a)	Mg^{2+} (l) + 2e → Mg (l)	[0] for no or wrong state symbol	[1]
(b)	Mercury ions were discharged together with magnesium ions, to form a mixture of mercury and magnesium.		[1]
(c)	Test: Place glowing splint near the gas. Observation: Glowing splint relighted / burst into flames / rekindled	[1] for test description [1] for observation	[2]
(d)	**Lower melting point** of MgO in order to reduce energy / cost required to melt electrolyte.		[1]
3(a)	When H_2SO_4 reacts with BaO, **solid $BaSO_4$** is formed. A **layer** of insoluble $BaSO_4$ formed over BaO, **preventing reaction** with H_2SO_4.	[1] formation of $BaSO_4$ [1] coating / layer preventing reaction	[2]
(b)	Step 1: **Mix equal** amounts of H_2SO_4 with $Ba(NO_3)_2$ Step 2: **Filter** mixture Step 3: **Wash** residue / precipitate with deionised / distilled water and **dry** between filter paper	[1] aqueous reactants [1] mix [1] filter [1] wash & dry	[4]
4(a)	Number of electrons is less than number of protons Attraction between nucleus and valence electrons increases OR Metals lost their valence electrons 1 less electron shell	[1] #e < #p [1] attraction OR [1] lose e^- [1] less electron shell	[2]
(b)	High density of 8.92 g / cm^3	[1] inclusive of data	[1]
(c)	calcium: low electrical conductivity / low melting point iron: low electrical conductivity	[1] for Ca [1] for Fe	[2]

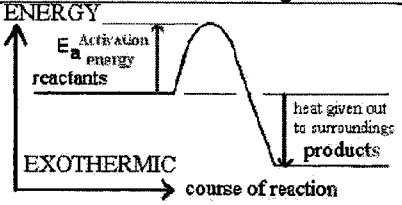
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Qn	Marking Scheme	Remarks	Marks
5(a)	Excessive ultraviolet radiation passes through the ozone hole Too much UV causes skin cancer / immune system damage / eye cataract / genetic mutations	[1] ultraviolet radiation [1] harmful effect	[2]
(b)		[1] bond pair [1] lone pair [-1] full structure or wrong differentiation of electrons	[2]
(ci)	Hydrogen fluoride	[0] for formula HF	[1]
(ii)	Substitution / Halogenation	CAO	[1]
(iii)	Ultraviolet light		[1]
(iv)	Slower reaction Harder to break Br–Br bond than F–F bond OR H–Br bond is less stable than H–F bond OR Br is less reactive than F	[0] for slower [1] slower & lower reactivity	[1]
6(ai)	ΔH = (N–N) + 4(N–H) + (O=O) – (N≡N) – 4(O–H) -585 = (N–N) + (4 x 388) + (496) – (944) – (4 x 463) -585 = (N–N) – 749 N–N = **163 kJ / mol**	[1] working [1] answer	[2]
(ii)	**Total energy** given out for **bond forming** is **greater** than the **total energy** absorbed for **bond breaking**.		[1]

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Qn	Marking Scheme	Remarks	Marks
(iii)		[1] activation energy [1] enthalpy change [1] formulae of reactants + products [-1] for endothermic profile diagram [-1] for double headed arrow	[3]
(b)	No. of mol of 16 dm^3 butane = 16 / 24 = 2 / 3 mol Heat evolved = 2880 x 2/3 = **1920 kJ**	[1] for mol [1] for heat Allow fraction or decimal for mol	[2]
7(a)	N_2 (g) + $3H_2$ (g) ⇌ $2NH_3$ (g) From the equation, 1 mole / volume of N_2 reacts with 3 moles / volumes of H_2.	[1] balanced equation with ⇌ [1] for mole ratio	[2]
(b)	Temperature: between **450 °C** Pressure: between **250 atm** Catalyst: finely divided **iron**	[1] for all 3 conditions	[1]
(ci)	When pressure increases, particles come **closer together**. **Frequency / Rate of effective collisions** increases. Rate of reaction increases.		[1]
(ii)	Catalyst provides **alternate reaction pathway** with a **lower activation energy**		[1]
(iii)	As NO forms, **pH decreases** / pH becomes **neutral**.		[1]
8(a)	**Less reactive** metal ions are **preferentially discharged** instead of zinc ions With more reactive metal ions, **zinc ions are preferentially discharged** instead	[1] less reactive metal ions [1] more reactive metal ions	[2]

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<table>
<tr><th>Qn</th><th>Marking Scheme</th><th>Remarks</th><th>Marks</th></tr>
<tr><td>(b)</td><td>Adding a <u>more reactive metal</u> to <u>displace</u> the less reactive metals in the solution.
Once the less reactive metals are displaced, <u>filter</u> the mixture to remove the less reactive metals as <u>residue</u>.</td><td>[1] add more reactive metal
[1] filtration</td><td>[2]</td></tr>
<tr><td>(c)</td><td>Heating zinc oxide with carbon
<u>OR</u>
Reducing zinc oxide by heating with coke</td><td></td><td>[1]</td></tr>
<tr><td>9(a)</td><td>Oxidation state of +2 forms <u>most stable ion</u>.</td><td>[1]</td><td>[1]</td></tr>
<tr><td>(b)</td><td>As oxidation state increases, oxide becomes more acidic
<u>OR</u>
As oxidation state increases, oxide changes from basic to amphoteric to acidic.</td><td></td><td>[1]</td></tr>
<tr><td>(c)</td><td><table><tr><th>name of oxide</th><th>nature of oxide</th></tr><tr><td>manganese(VII) oxide</td><td><u>acidic</u></td></tr><tr><td>manganese(IV) oxide</td><td><u>amphoteric</u></td></tr><tr><td>manganese(II) oxide</td><td><u>basic</u></td></tr></table></td><td>[1] all correct</td><td>[1]</td></tr>
<tr><td>(d)</td><td><u>Molten</u> $MgCl_2$ was <u>electrolysed</u>
<u>Magnesium</u> metal and <u>chlorine</u> gas produced and recycled</td><td>[1] electrolysis of molten $MgCl_2$
[1] products</td><td>[2]</td></tr>
<tr><td>(e)(i)</td><td>$TiCl_4$ (l) + 2Mg (s) → $2MgCl_2$ (s) + Ti (s)</td><td>[1] equation</td><td>[1]</td></tr>
</table>

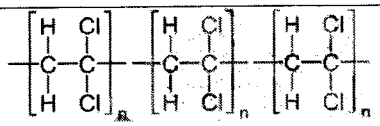
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Qn	Marking Scheme	Remarks	Marks
	Atmosphere of argon To prevent Mg reaction with oxygen which makes metal brittle.	[1] condition [1] explanation	[2]
(f)	750 – 300 = **450 kg**	[0] no working	[1]
(g)(i)	Fe extraction involves CO as reducing agent while Ti extraction uses Mg.	[1] stating both R.A.	[1]
(ii)	More costly as Mg is extracted via electrolysis Requires atmosphere of argon	[1] electrolysis of Mg [1] inert atmosphere R: high temperature as Fe extraction also requires high temp R: 2 stages	[2]
10(a)	Acid – produces H^+ ions when dissolved in water Salt – ionic compound formed when metal ion replaces one or more hydrogen ions of an acid.	[1] for acid [1] for salt	[2]
(bi)	$NaOH\ (aq) + H_3PO_4\ (aq) \rightarrow NaH_2PO_4\ (aq) + H_2O\ (l)$		[1]
(ii)	Na_2HPO4 / Na_3PO_4		[1]
(ci)	H_2SO_4 – dissociates **fully** in water to produce **high concentration / a lot of** of H^+ ions CH_3COOH – dissociates **partially** in water to produce **low concentration / a few** of H^+ ions	[1] full / partial dissociation in water [1] concentration of H^+	[2]
(ii)	Method 1 Add 2 cm strip of magnesium ribbon to 25 cm^3 of 1 mol / dm^3 of sulfuric acid. Measure the time taken for all the magnesium ribbon to finish reacting. Repeat the experiment with same length of magnesium ribbon, same volume and concentration of ethanoic acid. H_2SO_4 will require less time for the magnesium ribbon to react.	[1] logical steps + repeat experiment with same variables [1] measurements + results	[2]

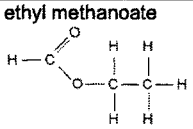
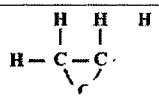
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Qn	Marking Scheme	Remarks	Marks
	Method 2 Add 2 g of $CaCO_3$ into a conical flask with 25 cm^3 of 1 mol / dm^3 of sulfuric acid. Measure the gas evolved in 1 minute Repeat the experiment with the same mass of $CaCO_3$, same volume and concentration of ethanoic acid. H_2SO_4 will produce a greater volume of gas in 1 minute.	Accept both gas collection & mass loss	
11(a)	Similarity: covalent bond / contains C, H and Cl / same emipircal formual Difference: PVDC has large M_r / more C, H and Cl atoms than CH_2Cl_2 / PVDC has no C = C / different molecular formula / giant molecular vs simple molecular	[1] similarity [1] difference	[2]
(b)	 without brackets & 'n'	[1] Cl on same carbon [1] three repeating units [-1] Cl on different carbon [-1] no repeating	[2]
(c)	M_r of $C_2H_2Cl_2$ = **97** Number of repeating units = 82450 / 97 = **850**	[1] M_r of CH_2Cl_2 [1] ans	[2]
(d)	Test: add aqueous bromine / bromine water Observations: Aqueous bromine decolourises in CH_2Cl_2 but remains reddish-brown in PVDC	[1] test [1] observation of the 2 compounds	[2]
(e)	Advantage: long lasting / durable / resistant to corrosion Disdavantage: does not decompose naturally / contributes to waste / difficult to dispose / causes problems or environmental issues during disposal	[1] advantage [1] disadvantage	[2]

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Qn	Marking Scheme	Remarks	Marks
OR 11(a)	methoxypropane		[1]
(b)	As molecule becomes bigger, boiling point increases. **Intermolecular** / **van der waals** **forces of attraction** becomes stronger **More energy** required to overcome the stronger forces of attraction	[1] trend [1] strength of force + energy	[2]
(ci)	CH_3CH_2OH / C_2H_6O / C_2H_5OH		[1]
(ii)	ethyl methanoate 	[1] name [1] full structure	[2]
(di)	ethene	[0] formula	[1]
(ii)			[1]
(e)	**Glucose solution** mixed with **yeast**. Temperature kept at **37 ºC** with the **absence** of oxygen / air Ethanol obtained by **fractional distillation**	[1] glucose with yeast [1] 37 °C + no O_2 + fractional distillation	[2]

-End-

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