Bukit Batok Secondary School

GCE 'O' LEVEL PRELIMINARY EXAMINATION 2020

SECONDARY 4 EXPRESS

CHEMISTRY 6092/01

Paper 1 Multiple Choice

02 Sep 2020
0845 – 0945

1 hour

Additional Materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, glue or correction fluid.
Write your name, index number and class on the Answer Sheet in the spaces provided.

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 separate 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.

1 Which of the following substances may be condensed using a water condenser?

	substance	melting point / °C	boiling point / °C
A	ammonia	-78	-33
B	butane	-135	-0.5
C	hydrogen chloride	-115	-85
D	pentane	-130	36

2 A public health inspector suspects that a lollipop contains traces of a poisonous green dye (boiling point 73 °C) as well as two harmless orange and red dyes (boiling points 69 °C and 73 °C respectively).

Which of the following is the best method by which the green dye may be separated?

A chromatography
B filtration
C fractional distillation
D separating funnel

3 What can be deduced about two gases that have the same molecular mass?

A They have the same boiling point.
B They have the same number of atoms in one molecule.
C They have the same solubility in water at room temperature.
D They have the same rate of diffusion at room temperature and pressure.

4 Which of the following correctly describe the particles in a **dilute** sugar solution at room temperature?

	sugar molecules	water molecules
A	close together, moving at random	close together, moving at random
B	widely separated, not moving	widely separated, moving at random
C	widely separated, moving at random	close together, moving at random
D	widely separated, moving at random	close together, not moving

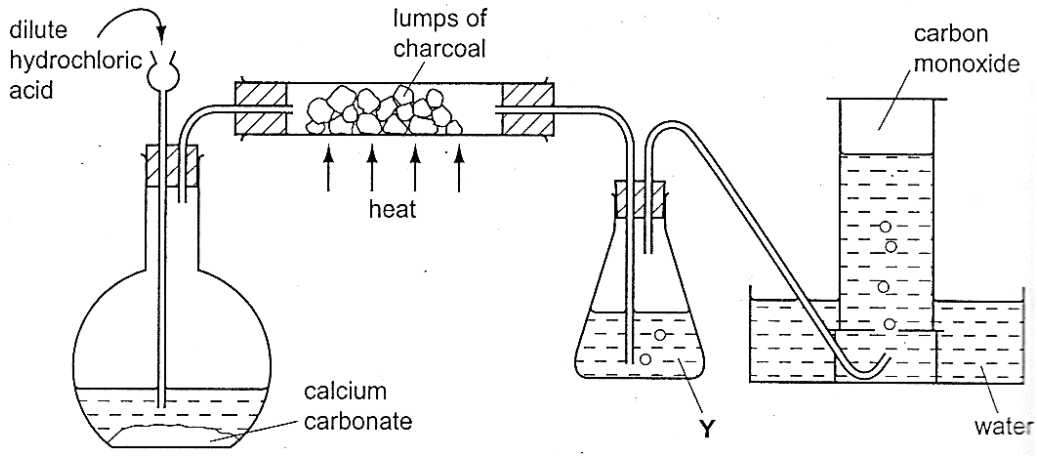
5 At which temperature does a concentrated aqueous solution of sodium chloride begin to boil?

A 93 °C **B** 99 °C **C** 100 °C **D** 104 °C

6 Which of the following sets of substances consists of an element, a compound and a mixture?

A diamond, sugar and ice
B graphite, crude oil and methane
C milk, graphite and air
D steam, chlorine and ethanol

7 The diagram shows the apparatus used to obtain carbon monoxide.



What is the main purpose of Y?

A to dry the gas
B to prevent water from being sucked back into the hot carbon
C to remove carbon dioxide from the gas
D to remove hydrogen chloride from the gas

8 The nucleon number and proton number of an atom of X and an atom of Y are shown.

	X	Y
proton number	19	17
nucleon number	39	37

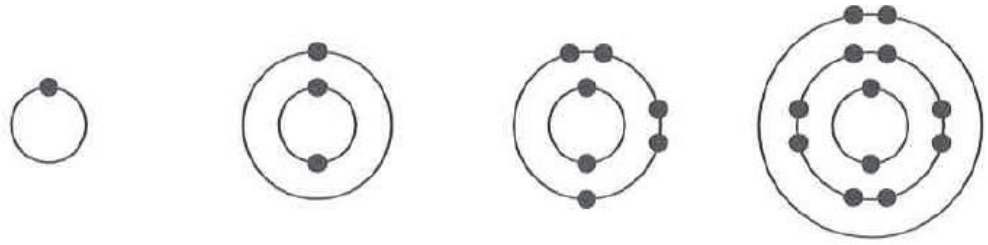
The following statements are made on X and Y.

1 An ion of X has more electrons than an ion of Y.
2 Both ions have same number of valence electrons.
3 Both ions have same number of neutrons.
4 Both react together to form a covalent compound XY.

Which statement(s) is/are correct?

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

9 The diagrams show the electronic structures of four elements.



element 1 element 2 element 3 element 4

The following statements are made on the four elements.

1 Elements 1 and 2 are good electrical conductors.
2 Elements 2 and 4 have high melting points.
3 Element 2 is more reactive than element 4.
4 Element 4 has a giant lattice structure.

Which statements are true about the four elements?

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

10 Carbon disulfide is a simple covalent compound used in manufacturing polymers.

Which of these statements would you predict to be true about carbon disulfide?

A It has a low boiling point and conducts electricity when molten.
B It has a low boiling point and is soluble in organic solvents.
C It is a crystalline solid at room temperature and conducts electricity when molten.
D It is a crystalline solid at room temperature and is soluble in organic solvents.

11 In which pair of covalent molecules does oxygen form at least one double bond on both molecules?

A CO_2 and C_2H_5OH
B CO_2 and O_2
C H_2O and C_2H_5OH
D H_2O and O_2

12 The formula of thallium carbonate is Tl_2CO_3 and that of sodium chlorite is $NaClO_2$.

What is the formula of thallium chlorite?

A $TlClO_2$ **B** Tl_2ClO_2 **C** $Tl(ClO_2)_2$ **D** $Tl_2(ClO_2)_3$

13 Which molecule has the least number of electrons involved in covalent bonds?

A C_2H_2 **B** C_2H_4 **C** H_2S **D** N_2

14 Both magnesium oxide and aluminium oxide are solids at room temperature.
Magnesium oxide has a melting point of 2852 °C and a boiling point of 3600 °C.
Aluminium oxide has a melting point of 2072 °C and a boiling point of 2880 °C.

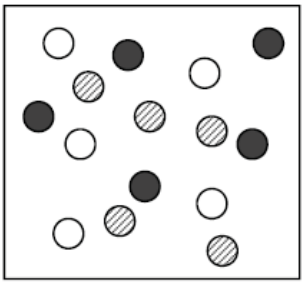
Over which temperature range will both pure compounds conduct electricity?

A 2000 °C to 2072 °C
B 2500 °C to 2852 °C
C 2072 °C to 2852 °C
D 2852 °C to 2880 °C

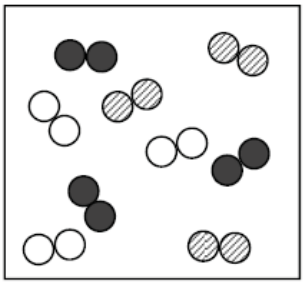
15 A gaseous compound is made up of nitrogen, oxygen and chlorine.

Which diagram shows a pure sample of the gas molecules?

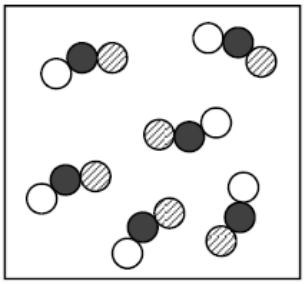
A



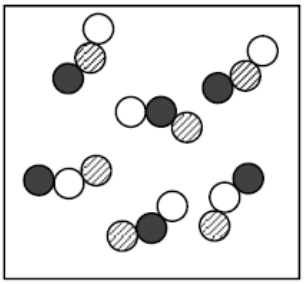
B



C



D



16 Which statement best explains why graphite is often employed as a dry lubricant in hot machines?

A Each carbon atom uses only three out of four valence electrons for bonding.
B The carbon atoms in each layer are held by weak covalent bonds.
C The carbon atoms in graphite are connected in a tetrahedral arrangement.
D The different layers of carbon atoms are held by weak intermolecular forces of attraction.

17 Silicon carbide has a structure similar to diamond. Boron nitride has a structure similar to graphite. Bronze is a mixture of metals.

Which statements about silicon carbide, boron nitride and bronze are correct?

1 All are bonded covalently.
2 All are insoluble in water.
3 All except silicon carbide conduct electricity when solid.
4 All except bronze have high melting points.

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

18 In an experiment, excess hydrochloric acid was added to 0.5 g of chalk and 100 cm^3 of carbon dioxide was produced at room temperature and pressure.

What is the percentage purity of calcium carbonate in the sample of chalk?

A 1.20 % **B** 2.20 % **C** 41.7 % **D** 83.3 %

19 What volume of air is needed to completely combust 1 dm^3 of ethyne, C_2H_2 to form carbon dioxide and water? (Assume air contains 20 % of oxygen)

A 2.5 dm^3 **B** 5.0 dm^3 **C** 12.5 dm^3 **D** 25.0 dm^3

20 In which reaction does the smallest percentage change in volume occur?

A $CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(l)$
B $C_3H_8(g) + 5O_2(g) \rightarrow 3CO_2(g) + 4H_2O(l)$
C $2H_2S(g) + SO_2(g) \rightarrow 3S(s) + 2H_2O(l)$
D $4NH_3(g) + 3O_2(g) \rightarrow 2N_2(g) + 6H_2O(l)$

21 A student writes down four statements about two gases, hydrogen chloride and carbon dioxide.

- One mole of each gas has the same mass.
- One mole of each gas occupies the same volume at room temperature and pressure.
- One mole of each gas has the same number of atoms.
- One mole of each gas has the same number of molecules.

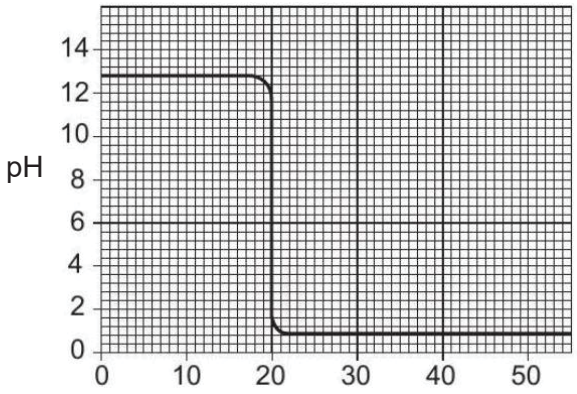
How many of these statements is/are correct?

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

22 49.2 g of hydrated magnesium sulfate is heated and cooled repeatedly until it reaches a constant mass of 24.0 g. Assuming only water of crystallisation is lost when hydrated magnesium sulfate is heated, what is the formula of the hydrated magnesium sulfate?

A $MgSO_4.3H_2O$
B $MgSO_4.5H_2O$
C $MgSO_4.7H_2O$
D $MgSO_4.10H_2O$

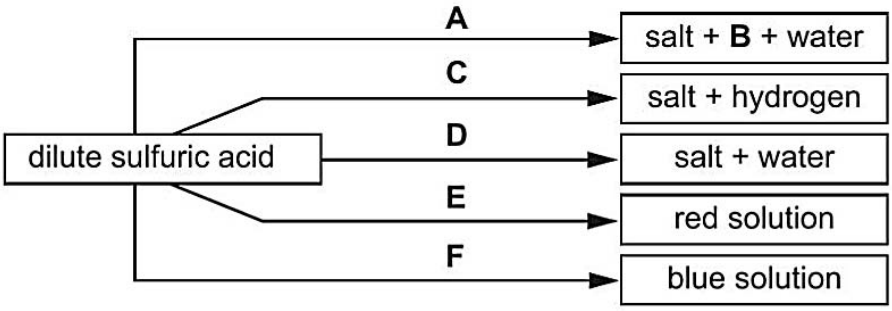
23 A pH probe measures the pH changes during a titration experiment. In the experiment, an unknown acid, HX of concentration 0.1 mol / dm^3, was added from a burette to 25.0 cm^3 of dilute sodium hydroxide. The graph shows the results of the experiment.



Which statement is **incorrect** about the results obtained from the experiment?

A Concentration of alkali used is 0.1 mol / dm^3.
B Formula of salt formed is NaX.
C HX is a strong acid.
D Neutralisation occurs when 20.0 cm^3 of HX is added to sodium hydroxide.

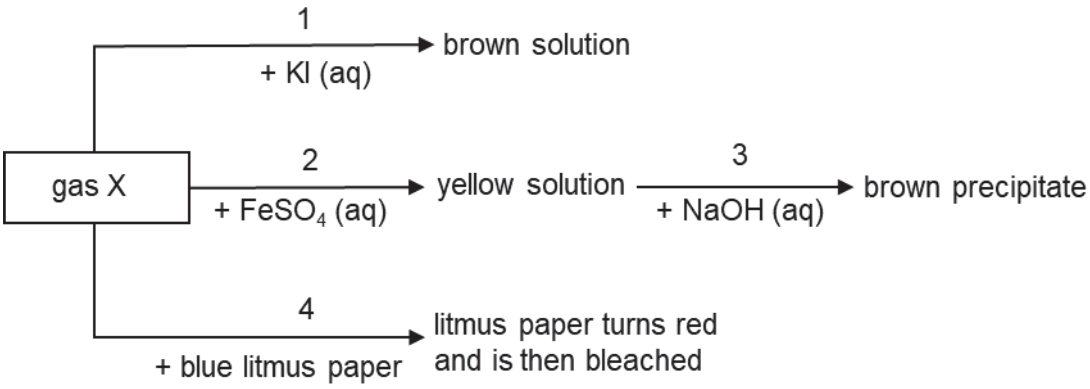
24 The flow chart shows some reactions of dilute sulfuric acid.
Six unknown substances, A, B, C, D, E and F are shown in the chart.



Substance E is identified as Universal Indicator. What are the possible identities of the other five unknown substances?

	A	B	C	D	F
A	Mg	H_2	NaOH	Fe_2O_3	CuO
B	Na_2CO_3	CO_2	Mg	NaOH	Fe_2O_3
C	$NaHCO_3$	CO_2	Mg	NaOH	CuO
D	$NaHCO_3$	CO_2	Cu	NaOH	CuO

25 The scheme below shows reactions of a gas X.



Which statement is **incorrect**?

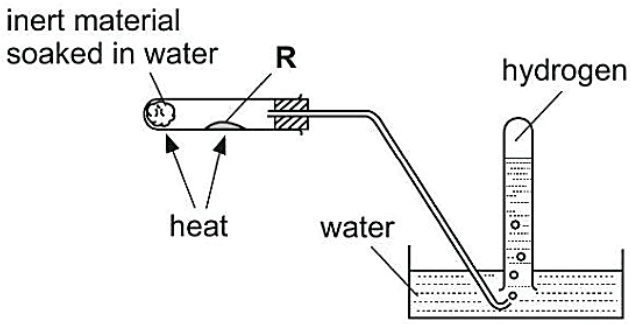
A Gas X is chlorine.
B In stage 1, iodide ion is oxidised as it gains electrons to form iodine.
C In stage 2, iron(II) sulfate acts as a reducing agent.
D The brown precipitate formed in stage 3 is iron(III) hydroxide.

26 A small piece of sodium is added to aqueous copper(II) sulfate.

Which of the following is **not** observed during the reaction?

A Blue precipitate is formed.
B Blue solution is formed.
C Sodium burns with a yellow flame.
D Sodium darts around vigorously on the surface of the solution.

27 The diagram shows an experiment to produce and collect hydrogen.



What is substance R?

A copper
B copper(II) oxide
C lead(II) oxide
D zinc

28 Which method is the most suitable for the extraction of barium?

A electrolysis of its molten ore
B electrolysis of concentrated aqueous barium chloride
C heating its ore alone
D heating its ore with carbon

29 Steel is an alloy of iron with a very small percentage of carbon.

Which statement is correct?

A A decrease in percentage of carbon makes the steel more brittle.
B An increase in percentage of carbon makes the steel softer.
C Carbon disrupts the metallic structure of iron.
D Iron atoms are of the same size as carbon atoms.

30 Iron is extracted from iron ore in the Blast Furnace.

The equations show some reactions that happen in the Blast Furnace.

1 $C + O_2 \rightarrow CO_2$
2 $CO_2 + C \rightarrow 2CO$
3 $Fe_2O_3 + 3CO \rightarrow 2Fe + 3\,CO_2$
4 $CaCO_3 \rightarrow CaO + CO_2$
5 $SiO_2 + CaO \rightarrow CaSiO_3$

Which two equations show different elements in compounds being reduced?

A 1 and 2 **B** 2 and 3 **C** 3 and 4 **D** 4 and 5

31 Elements W, X, Y and Z are in the same period but different groups of the Periodic Table.

W reacts with oxygen to form W_2O, a basic oxide.
X reacts with oxygen to form XO_2, an acidic oxide.
Y is an oxide which reacts with both an acid and a base.
Z reacts with W to form an ionic compound of formula WZ.

What is the order of these four elements across the Periodic Table?

A WXYZ **B** WYXZ **C** WYZX **D** ZWYX

32 The Periodic Table shows trends down each group and across each period.

Which trend is true for both down a group and across a period?

A Proton number increases.
B The number of electron shells increases.
C The number of valency electrons increases.
D There is a change in character from metallic to non-metallic.

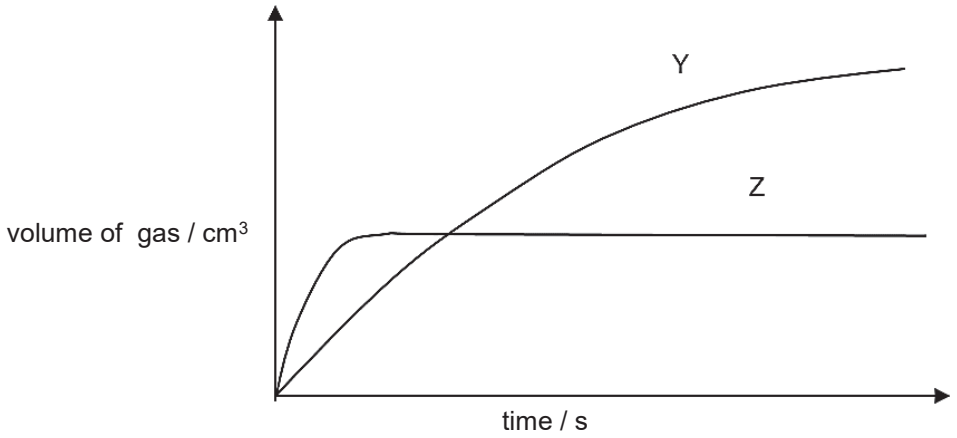
33 The scheme shows four stages 1 to 4, in the conversion of solid candle wax, $C_{30}H_{62}$, into carbon dioxide and water.

1 $C_{30}H_{62}(s) \rightarrow C_{30}H_{62}(l)$
2 $C_{30}H_{62}(l) \rightarrow C_{30}H_{62}(g)$
3 $C_{30}H_{62}(g) + 45.5O_2(g) \rightarrow 30CO_2(g) + 31H_2O(g)$
4 $30CO_2(g) + 31H_2O(g) \rightarrow 30CO_2(g) + 31H_2O(l)$

Which stages are exothermic?

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

34 Manganese(IV) oxide catalyses the decomposition of aqueous hydrogen peroxide to water and oxygen. In order to follow the rates of this reaction for two different solutions of hydrogen peroxide the total volumes of oxygen evolved were recorded at regular time intervals and the results were plotted. In each experiment, the same mass of catalyst was used and the temperature was the same.



If graph Y corresponds to 20 cm^3 of 4.0 mol / dm^3 hydrogen peroxide solution, what is the volume and concentration of graph Z?

A 5 cm^3 of a 8.0 mol / dm^3 solution
B 10 cm^3 of a 2.0 mol / dm^3 solution
C 20 cm^3 of a 4.0 mol / dm^3 solution
D 20 cm^3 of a 8.0 mol / dm^3 solution

35 Ammonia is produced by the Haber process.

Which statement is correct?

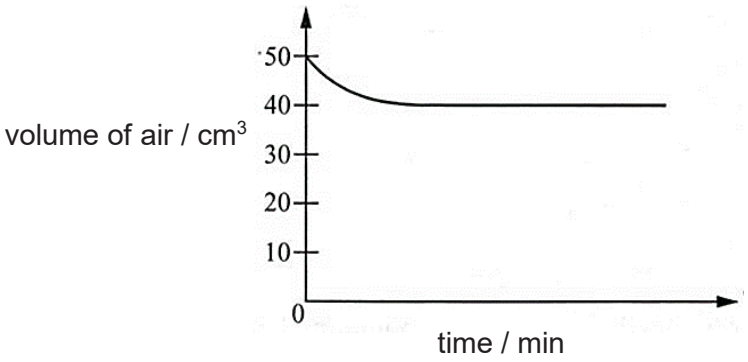
A Air is used as one of the raw materials.
B A high pressure of 500 atm and temperature of 450 °C are used in the process.
C Hydrogen is obtained from crude oil.
D Iron is used as a catalyst to increase the activation energy in the process.

36 A catalytic converter in a car exhaust system changes pollutants into less harmful products.

Which change does **not** occur in a catalytic converter?

A carbon dioxide → carbon
B carbon monoxide → carbon dioxide
C nitrogen oxides → nitrogen
D unburned hydrocarbons → carbon dioxide and water

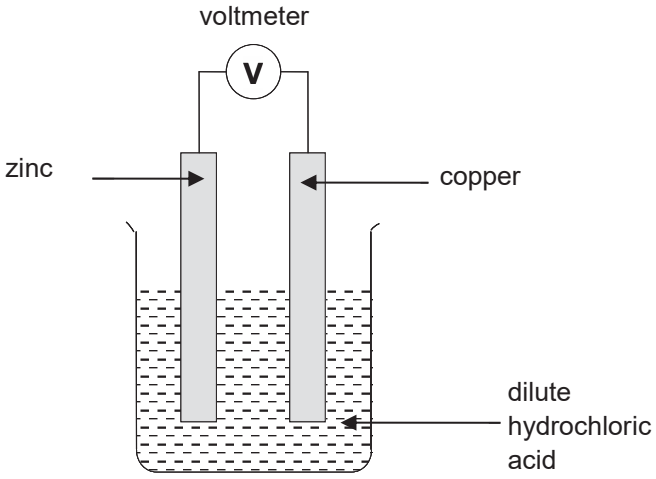
37 The graph below shows the change in the volume of air in a vessel.



Which of the following reactions is likely to cause this change?

A $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$
B $2H_2O_2 \rightarrow 2H_2O + O_2$
C $2Mg + O_2 \rightarrow 2MgO$
D $N_2 + 3H_2 \rightleftharpoons 2NH_3$

38 The diagram shows a set-up of a simple cell.



Which of the following describes the reaction at the cathode?

A $2Cl^- \rightarrow Cl_2 + 2e^-$
B $Cu \rightarrow Cu^{2+} + 2e^-$
C $2H^+ + 2e^- \rightarrow H_2$
D $4OH^- \rightarrow 2H_2O + O_2 + 2e^-$

39 Which one of the following describes what happens during the electrolysis of concentrated sodium chloride solution using graphite electrodes?

A The pH of the solution increases.
B The gaseous products dissolve in the solution to form hydrochloric acid.
C The sodium chloride solution becomes more dilute.
D Unequal volumes of gases are collected at the electrodes.

40 During the electrolysis of dilute aqueous hydrochloric acid, 9.6 cm^3 of hydrogen gas is collected at the cathode at room temperature and pressure.

Which statement about the electrolysis is correct?

A 4.8 cm^3 of chlorine gas is collected at the anode.
B 4.8 cm^3 of oxygen gas is collected at the anode.
C 9.6 cm^3 of chlorine gas is collected at the anode.
D 9.6 cm^3 of oxygen gas is collected at the anode.

End of Paper

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DATA SHEET

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

lanthanoids	57 La Lanthanum 139	58 Ce Cerium 140	59 Pr Praseodymium 141	60 Nd Neodymium 144	61 Pm Promethium 147	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 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.).

Name: …… Index no: …… Class: ……..…

Bukit Batok Secondary School

GCE 'O' LEVEL PRELIMINARY EXAMINATION 2020

SECONDARY 4 EXPRESS

CHEMISTRY **6092/02**

Paper 2 **27 Aug 2020**

0800 – 0945

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 in the spaces provided at the top of this page.
Write in dark blue or black pen.
You may use a pencil for any diagrams, graphs or rough working.
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.

At the end of the examination, fasten all your work securely together.
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 the last page.

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

For Examiner's Use	
Section A	/ 50
B10	/ 12
B11	/ 8
B12 E / O	/ 10
Total	/ 80

Section A

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

A1 This question is about the elements in Period 4.

For each of the following, identify and name an element from Period 4, which matches the description.

(a) Its only oxidation state is 0.

..... [1]

(b) It is a liquid at room temperature and pressure.

..... [1]

(c) It forms an ion with a charge of 3–.

..... [1]

(d) It reacts readily with cold water to form a compound of the type $M(OH)_2$ and hydrogen.

..... [1]

[Total: 4]

A2 The following ionic equations represent some common reactions.

A	$Ba^{2+}(aq) + SO_4^{2-}(aq) \rightarrow BaSO_4(s)$
B	$2Cl^-(aq) \rightarrow Cl_2(g) + 2e^-$
C	$Cr^{3+}(aq) + 3e^- \rightarrow Cr(s)$
D	$Cu^{2+}(aq) + 2OH^-(aq) \rightarrow Cu(OH)_2(s)$
E	$H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$
F	$2I^-(aq) + Br_2(aq) \rightarrow I_2(aq) + 2Br^-(aq)$

Use the letters **A**, **B**, **C**, **D**, **E** or **F** to answer the following questions.

(a) Which equation shows only reduction? ……. [1]

(b) Which equation shows a neutralisation reaction? ……. [1]

(c) Which equation shows a displacement reaction? ……. [1]

(d) Which equation shows a reaction that forms a white precipitate? ..……. [1]

(e) Which equation shows what happens when brine is electrolysed? ..…….. [1]

[Total: 5]

A3 The diagram shows a Group in a Periodic Table designed by John Newlands in 1864. The Group contains elements found in Group VII (the halogens) of the modern Periodic Table (fluorine, chlorine, bromine and iodine) and other elements.

H
F
C*l*
Co / Ni
Br
Pd
I
Pt / Ir

(a) Newlands arranged the elements according to their relative atomic masses.
What determines the order of the elements in the modern Periodic Table?

..... [1]

(b) Use your modern Periodic Table to suggest why Newlands put cobalt and nickel in the same place.

..... [1]

(c) Cobalt, nickel, palladium, platinum and iridium are now classified as transition elements.

Compare **two** ways in which the properties of transition elements are different from the halogens.

.....

.....

.....

..... [2]

(d) Hydrogen is difficult to be placed in the modern Periodic Table.

(i) Give **one** property of hydrogen which is similar to the first two elements in Group VII.

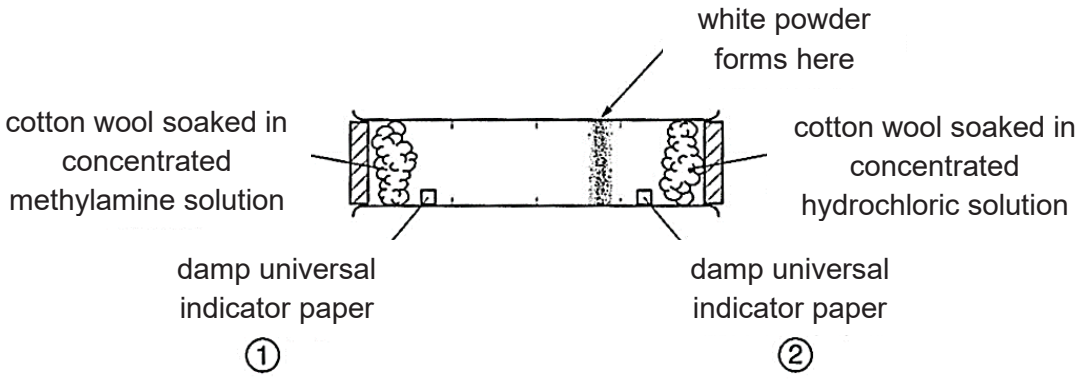
..... [1]

(ii) Give **one** property of hydrogen which is similar to the elements in Group I.

..... [1]

[Total: 6]

A4 This experiment was set up to investigate the movement of gaseous methylamine and gaseous hydrogen chloride. Methylamine has similar properties to ammonia.



(a) The white powder forms on the tube due to the reaction between gaseous methylamine, CH_3NH_2 and gaseous hydrogen chloride to make solid methylammonium chloride.

Write an equation for the formation of methylammonium chloride.

..... [1]

(b) The tube contains two pieces of Universal Indicator paper.

Complete the table to show the colours and pH values of each piece of paper at the end of the experiment.

Universal Indicator paper	colour	pH
1		
2		

[2]

(c) Explain why the white powder does **not** form in the centre of the tube.

.....

.....

.....

.....

..... [3]

[Total: 6]

A5 Finland generates energy from burning of fossil fuels which produces carbon dioxide. This gives rise to increased carbon dioxide emission and poses environmental problems. However, carbon dioxide can be removed by reacting with magnesium oxide to form magnesium carbonate.

(a) Magnesium oxide is formed from the thermal decomposition of magnesium silicate, $MgSiO_3$, a major component in mineral rocks. In this process, silicon dioxide is also produced.

Write a balanced equation for the thermal decomposition of magnesium silicate.

..... [1]

(b) During the thermal decomposition of mineral rocks, impurities like sulfur dioxide are also produced.

Arrange magnesium oxide, sulfur dioxide, and silicon dioxide in order of increasing acidity. Explain your reasoning, in terms of pH values.

.....

.....

.....

..... [3]

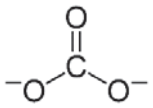
(c) Outline how magnesium oxide can be separated from a mixture of magnesium oxide and silicon dioxide.

.....

.....

..... [2]

(d) This is the structure of the carbonate ion in magnesium carbonate.



Draw a dot-and-cross diagram to show the bonding in the carbonate ion.
Show the outer shell electrons only.

[1]

[Total: 7]

A6 Ammonium phosphate can be prepared by reacting dilute phosphoric acid, H_3PO_4, with aqueous ammonia. It is one of the three possible salts, as the acid is tribasic.

The following show the dissociations of phosphoric acid and sulfuric acid:

$$H_2SO_4 \rightarrow 2H^+ + SO_4^{2-}$$
$$H_3PO_4 \rightleftharpoons 3H^+ + PO_4^{3-}$$

(a) Explain whether phosphoric acid is a strong or weak acid.

.....

..... [1]

(b) Describe a **simple** test to distinguish sulfuric acid from phosphoric acid.

.....

.....

..... [2]

(c) Other than ammonium phosphate, suggest the chemical formula of another salt that is formed in the reaction between dilute phosphoric acid and aqueous ammonia.

..... [1]

[Total: 4]

A7 Human activities in recent centuries have increased the amounts of heat absorbing gases in the atmosphere. These gases upset the Earth's heat balance by trapping heat, and thus caused the Earth's temperature to rise.

Listed in the table are five main greenhouses gases.

greenhouse gas	heat trapping effectiveness, compared to carbon dioxide	contribution to the greenhouse effect	current annual rate of increase in air
carbon dioxide	1	50 %	0.4 %
methane	30	18 %	1.0 %
nitrous oxide	150	6 %	0.3 %
ozone	2000	12 %	1.5 %
CFCs	10000	14 %	2.0 %

(a) Describe how the greenhouse gases in the Earth's atmosphere support a conducive living environment.

.....

..... [1]

(b) The use of CFCs has greatly decreased in recent years, yet the amount of CFCs in the atmosphere is still increasing, and is expected to do so for some years.

Explain why.

.....

..... [1]

(c) Suggest why 50% of the greenhouse effect is caused by carbon dioxide although its heat-trapping effectiveness is very poor, compared to the other gases.

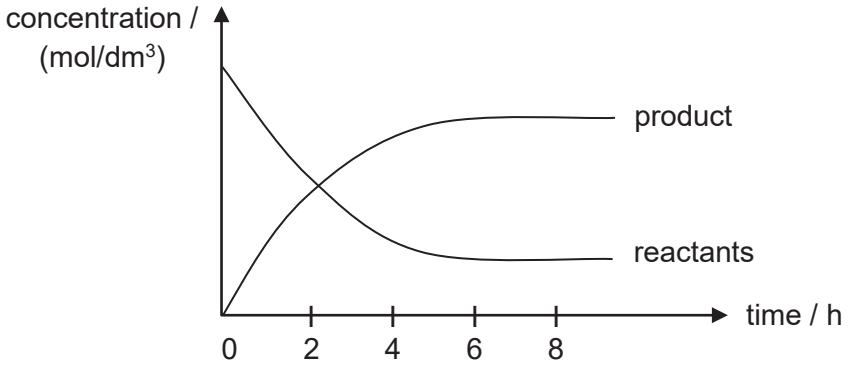
.....

..... [1]

[Total: 3]

A8 The manufacture of ammonia using the Haber Process represents a reversible chemical reaction.

The graph below shows the concentrations of reactants and product, in Haber Process, over a period of eight hours for an uncatalysed reversible reaction.



(a) Write a chemical equation to represent the manufacture of ammonia.

..... [1]

(b) **(i)** On the same axis above, sketch the concentration-time graphs for reactants and product when iron catalyst is added into the reaction.

Label the graph **P** for products, and **R** for reactants. [2]

(ii) Sketch a graph below to show how the rates of the forward and reverse reactions change, over a period of eight hours.

In your graph,

- label the forward and backward reactions, and
- indicate the time where the rate of the forward reaction equals to the rate of the reverse reaction, with a symbol **x**.

[2]

[Total: 5]

A9 In the early 19th century, a chemist, Frederich Wohler, was the first to isolate aluminium metal. At a high temperature, potassium was reacted with aluminium chloride to form potassium chloride and aluminium.

Today's chemists would classify this reaction as both *exothermic* and *redox.*

(a) **(i)** Write the ionic equation for the reaction.

..... [1]

(ii) Explain why this reaction is classified as a redox reaction, in terms of electron transfer.

.....

.....

.....

..... [2]

(iii) Determine the mass of aluminium chloride needed to produce 0.54 kg of aluminium metal.

[2]

(b) Discuss if sodium can be used in place of potassium.

.....

..... [1]

(c) Draw the energy profile diagram for this reaction.

Your diagram should include

- labels for the axes
- labels for the reaction enthalpy change, activation energy, and
- formulae of reactants and products.

[3]

(d) Wohler used the same technique to successfully isolate beryllium from beryllium chloride.

As far as possible, rank these four metals (aluminium, beryllium, potassium, and sodium), in order of their increasing reactivities.

..... [1]

[Total: 10]

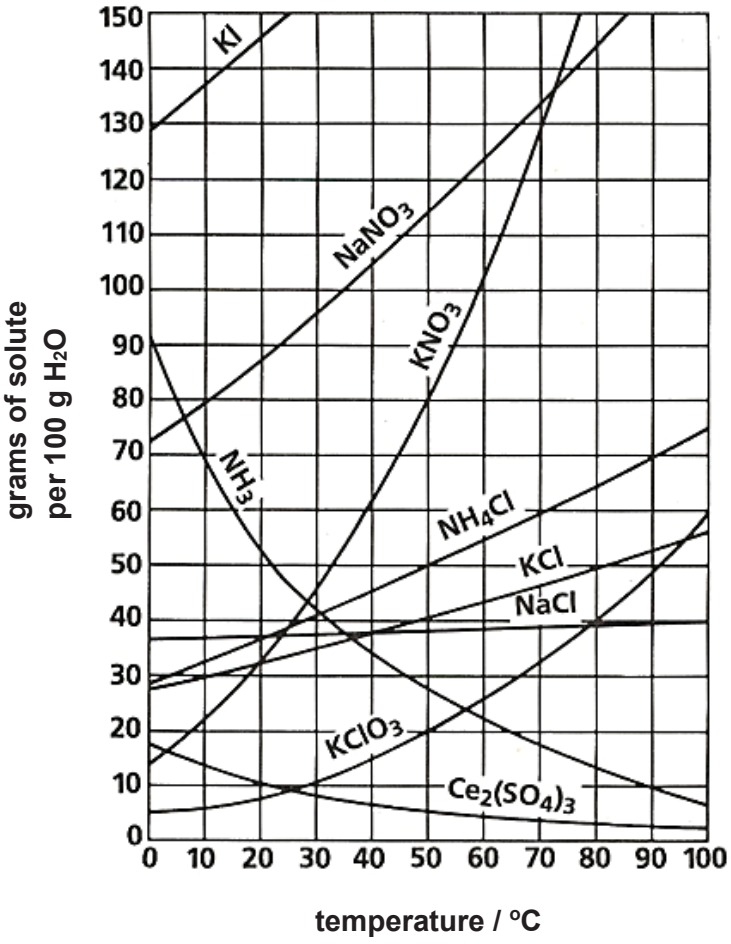
Section B

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.

B10 Solubility of Compounds

The solubility of a compound, at a certain temperature, is the maximum number of grams of the compound which dissolve in 100 grams of water at that temperature.

The relationship between solubility and temperature can be expressed by a solubility curve. The solubility curves of some compounds are shown.



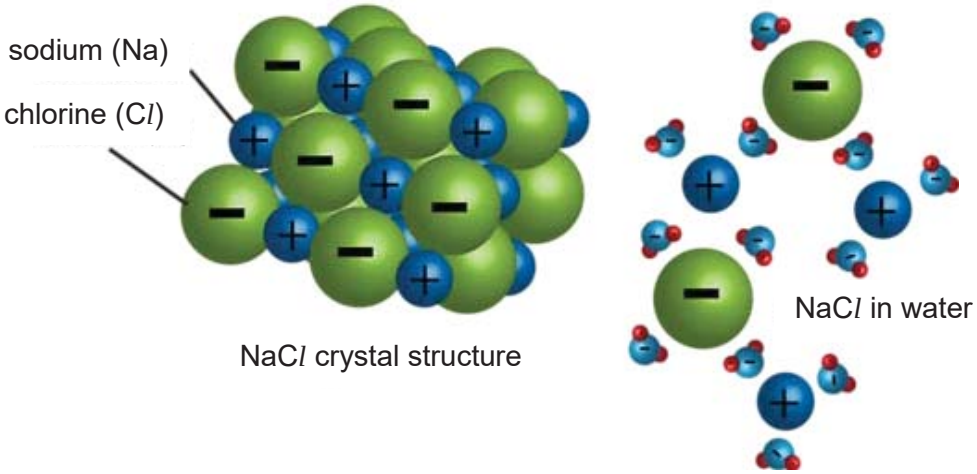
Sparingly Soluble Ionic Compounds

The dissolving and precipitating of ionic compounds are phenomena that occur both within us and around us. For example, the dissolving of enamel on teeth in acidic solutions causes tooth decay; the precipitation of certain salts in our kidneys produces kidney stones; the precipitation of calcium carbonate from underground water forms stalactites and stalagmites inside caves.

Although solids of ionic compounds are generally known to be soluble in water, some ionic solids have low solubility. Such ionic compounds are said to be sparingly soluble in water.

The solubility of ionic compounds depends on the forces of attraction between

- the cations and anions of the same solid, and
- the water molecules and the ions of the solid.



The solubility of sparingly soluble ionic compounds can be estimated from its solubility product, K_{sp}, which is a constant value that is only affected by temperature. The higher the K_{sp} value, the more soluble the compound will be.

The table below shows the K_{sp} values of some common ionic compounds.

Table B1

compound	chemical formula	K_{sp} (mol^2/dm^6) at 25 °C
lead sulfate	$PbSO_4$	2.5×10^{-8}
calcium carbonate	$CaCO_3$	5.0×10^{-9}
calcium sulfate	$CaSO_4$	2.0×10^{-5}
silver chloride	AgCl	2.0×10^{-10}

Predicting Precipitation

The K_{sp} value can be used to predict whether precipitation will occur when two solutions are mixed. This can be done by comparing the K_{sp} value to the ionic product. Ionic product is a measure of the amount of ions present in solution in a given situation.

For instance,

$$BaSO_4(s) \rightleftharpoons Ba^{2+}(aq) + SO_4^{2-}(aq)$$

Ionic product = [concentration of Ba^{2+} ions] x [concentration of SO_4^{2-} ions]

Table B2

situation	outcome
Ionic product = K_{sp}	solution is just saturated, no further solute can dissolve
Ionic product < K_{sp}	solution is not saturated, more solute can dissolve
Ionic product > K_{sp}	solution is saturated, precipitation will occur

(a) Why do the solubility curves not go beyond 100 ^oC?

..... [1]

(b) With reference to the solubility curves, name the compound which is the least soluble at 90 °C.

..... [1]

(c) If 200 g of a saturated solution of sodium nitrate at 50 °C was evaporated to dryness, what mass of sodium nitrate would remain?

[2]

(d) Using the information provided, explain why sodium chloride is very soluble in water while silver chloride is only sparingly soluble.

.....

.....

.....

..... [2]

(e) Suggest the relationship between temperature and K_{sp} value of an ionic compound.

..... [1]

(f) State the least soluble compound found in **Table B1**.

..... [1]

(g) 0.02 mol/dm^3 of calcium nitrate solution is added to the same volume of 0.005 mol/dm^3 of sodium sulfate solution at 25 ^{o}C.

(i) Name the sparingly soluble compound that is formed.

……..……..……..... [1]

(ii) Using the information provided in **Tables B1 and B2**, determine, by calculation of the ionic product of the sparingly soluble compound, if precipitation will occur.

[2]

(h) Without further addition of any reagent, suggest how the amount of solid precipitated out from a saturated solution can be increased.

..... [1]

[Total: 12]

B11 Aqueous barium hydroxide is considered as a strong alkali that can be used to neutralise dilute sulfuric acid. Aqueous barium hydroxide and different volumes of dilute sulfuric acid are added to six different test tubes.
The concentrations and volumes of the two solutions are listed in the following table.

test tube	1	2	3	4	5	6
volume of 0.5 mol/dm^3 aqueous barium hydroxide / cm^3	10.0	10.0	10.0	10.0	10.0	10.0
volume of 1.0 mol/dm^3 dilute sulfuric acid / cm^3	2.0	3.0	4.0	5.0	6.0	7.0

(a) Write a balanced chemical equation, with state symbols, for the reaction between aqueous barium hydroxide and dilute sulfuric acid.

..... [2]

(b) **(i)** Outline how the products in test tube **4** can be separated.

.....

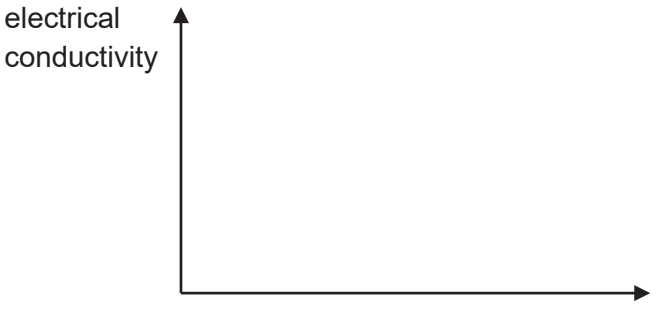
.....

..... [2]

(ii) Calculate the theoretical yield of the product that is formed in test tube **4**.

[2]

(c) The electrical conductivities of the mixture in each of the six test tubes are measured. Sketch how the electrical conductivities vary with the different volumes of sulfuric acid added.

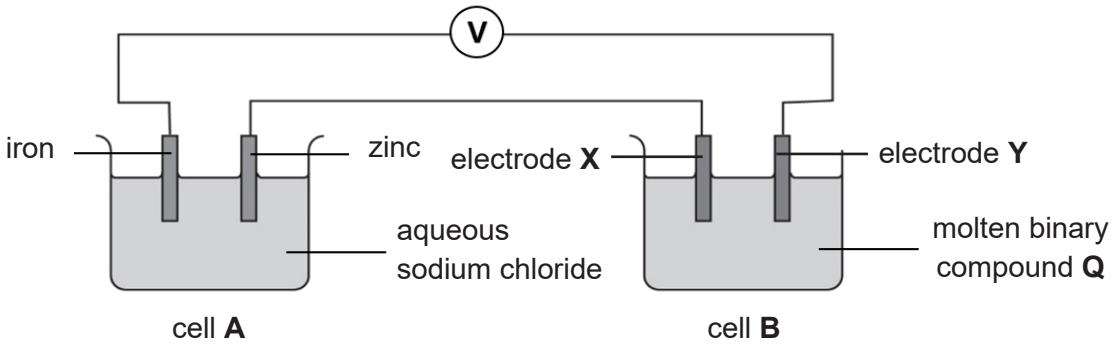


[2]

[Total: 8]

EITHER

B12 The diagram below shows two cells. Cell **A** produces electrical energy for the electrolysis of the molten binary compound **Q** in cell **B**.



(a) **(i)** Show clearly on the diagram, using arrows, the direction of movement of electrons in the wire. [1]

(ii) Determine which of the electrodes **X** and **Y** in cell **B** is the anode and cathode.

electrode **X**: …… electrode **Y**: ……. [1]

(b) Write the ionic half equations at the iron and zinc electrodes in cell **A**.

iron electrode: ..……...……...…….. [1]

zinc electrode: …….……..…….... [1]

(c) The table below shows the observations at the anode and cathode in cell **B**.

anode	cathode
effervescence of a colourless gas which relights a glowing splint	pinkish-brown solid formed

(i) Suggest the chemical formula of the molten binary compound **Q**.

……...…….....…….……....……. [1]

(ii) Hence, if 48 cm^3 of gas is obtained at the anode, what is the mass of the solid formed at the cathode?

[2]

(d) The iron electrode in cell **A** is replaced by magnesium.

Describe and explain the differences in the observations at the electrodes in cell **B**.

……

……

……

……

……

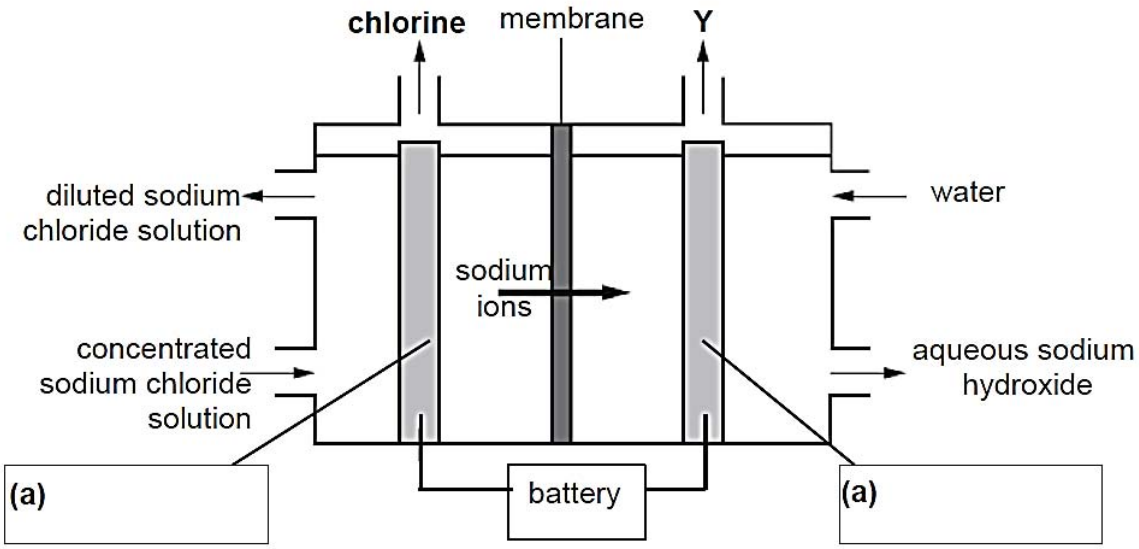
…… [3]

[Total: 10]

OR

B12 Sodium hydroxide is a very useful industrial chemical.

The diagram shows a set-up used to produce aqueous sodium hydroxide from concentrated sodium chloride solution.



(a) Label on the diagram the anode and the cathode. [1]

(b) Identify **Y** and explain your answer.

.....

.....

..... [2]

(c) Explain how aqueous sodium hydroxide is formed as a product.

.....

..... [1]

(d) Describe a simple test, to test for the presence of chlorine gas.

.....

..... [1]

(e) The membrane used in the set-up is porous. A porous membrane has pores of a specific size so that only particles with sizes smaller than the pores can pass through the membrane.

The porous membrane is necessary for aqueous sodium hydroxide to be collected as the only product without any contamination from the chloride ions in the set-up.

Explain why the porous membrane prevents contamination from chloride ion.

.....

.....

..... [2]

(f) If dilute sodium chloride solution is used in the set-up instead of concentrated sodium chloride solution, the results would be different.

Describe and explain two differences in the results.

.....

.....

.....

.....

.....

..... [3]

[Total: 10]

DATA SHEET

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

lanthanoids	57 La Lanthanum 139	58 Ce Cerium 140	59 Pr Praseodymium 141	60 Nd Neodymium 144	61 Pm Promethium 147	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 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.).