NAME: _____ ( ) CLASS: _____

FAIRFIELD METHODIST SCHOOL (SECONDARY)

PRELIMINARY EXAMINATION 2020

SECONDARY 4 EXPRESS

CHEMISTRY **6092/02**

Paper 2

Duration: 1hour 45 minutes

READ THESE INSTRUCTIONS FIRST

Write your name, index number and class on all the work you hand in.
Write in dark blue or black pen.
You may use a pencil for any diagrams 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.

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 page 20.

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

Parent's/Guardian's Signature:

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

Name : _____( ) Class: _____

Section A

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

A1 **Table 1** describes the relative masses and charges of some particles, which may be subatomic particles, atoms or ions.

Table 1

particle	relative mass	relative charge
H	1	0
J	1	1+
K	2	0
L	4	0
M	7	1+
N	9	2+

Use the letters **H**, **J**, **K**, **L**, **M**, **N** to answer the questions.

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

(a) Which particle is a proton?

..... [1]

(b) Which particle could be an atom of helium?

..... [1]

(c) Which particle could be an ion of a Group I element?

..... [1]

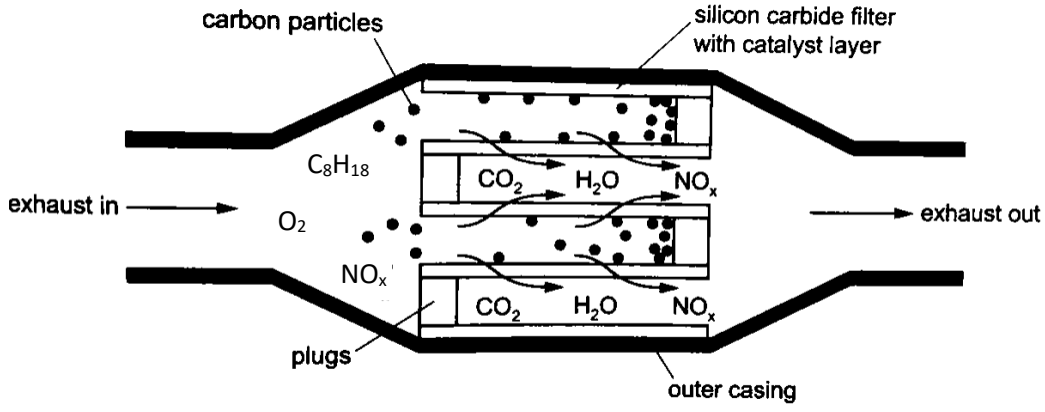
(d) Suggest an identity for particle **N**.

..... [1]

Name : _____( ) Class: _____

A2 Nearly all petrol and diesel vehicles have some kind of catalytic converter fitted to the exhaust to reduce the amount of polluting substances emitted into the atmosphere.

For diesel engines, the catalytic converter may also include a particle filter to remove solid particles of carbon.



(a) The walls of the particle filter are made of silicon carbide, SiC. This is a hard solid that will not melt at high temperatures of the exhaust.

Suggests how the structure and bonding in silicon carbide makes it resistant to melting, even at high temperature.

.....

.....

.....

.....

..... [3]

(b) The catalyst helps to remove other pollutants from the exhaust. The equation shows one of the reactions taking place in the catalytic converter.

$$2CO + O_2 \rightarrow 2CO_2$$

(i) Explain what is meant by the term *catalyst*.

.....

..... [1]

(ii) Use the information from the diagram to deduce another equation for a possible reaction occurring in the catalytic converter.

..... [1]

(c) Diesel engines may also be fitted with a second catalytic converter to remove the remaining oxides of nitrogen. This second converter uses ammonia as the reducing agent. One possible reaction is shown by the following unbalanced equation.

$$..... NH_3 + ... NO_2 \rightarrow ..... N_2 + ... H_2O$$

(i) Balance the chemical equation above. [1]

(ii) Explain, in terms of oxidation state, whether this is a redox reaction.

.....

.....

..... [2]

(d) State one environmental consequence of oxides of nitrogen.

.....

..... [1]

Name : _____( ) Class: _____

A3 A chemical company makes salts for use in fertilisers.

(a) **Table 3** shows some names and formulae of salts used in fertilisers.

Complete the table by filling in the missing information.

Table 3

name of salt	formula of salt
potassium sulfate	K_2SO_4
potassium phosphate	K_3PO_4
	NH_4NO_3
calcium phosphate	

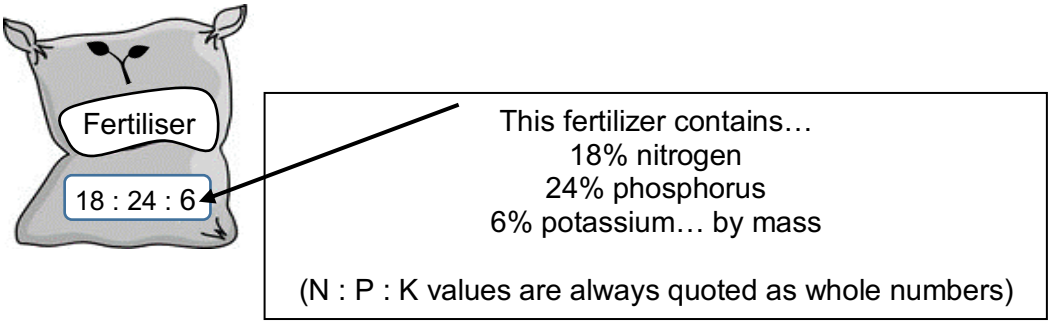
[2]

(b) The salts are put into bags and sold as fertilisers. Fertilisers provide plants with the essential elements (nitrogen, phosphorus and potassium).

Which two salts in the table could be combined to make a fertiliser which contains all three essential elements?

…… and …… [1]

(c) Each bag has a label which gives the N : P : K ratio. The N : P : K ratio shows the ratio by mass of nitrogen, phosphorus and potassium in the fertiliser.



Calculate the N : P : K ratio of potassium phosphate.

[2]

(d) Slaked lime, $Ca(OH)_2$, is often added to treat the soil after rain to reduce the soil acidity. When a fertiliser containing the salt, NH_4NO_3, is used immediately after treatment with slaked lime, the fertiliser would not be effective due to a reduction in the nitrogen content.

Explain, with the aid of a chemical equation, why the fertiliser containing NH_4NO_3 would lose its effectiveness.

.....

..... [2]

A4 Both copper and aluminium are good conductors of electricity.

(a) Explain, with the aid of a labelled diagram, how the structure of copper enables the conduction of electricity. Use ideas of structure and bonding in your answer.

.....

.....

.....

..... [3]

(b) Describe another property of copper, other than electrical conductivity, that makes it suitable for use as electrical wires.

.....

..... [1]

(c) Even though copper has a higher electrical conductivity than aluminium, aluminium is the preferred material for making of overhead cables. Suggest why.

..... [1]

Name : _____( ) Class: _____

A5 **Fig. 5** shows an experiment in which excess steam was passed over hot iron filings. The products of the reaction are iron oxide, Fe_3O_4, and a gas.

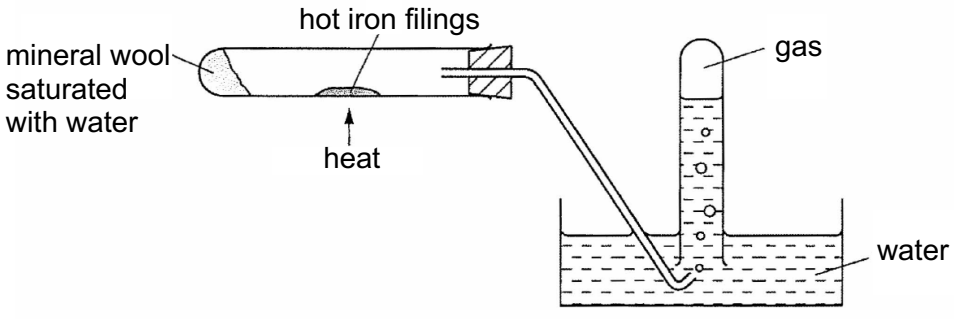


Fig. 5

(a) Write an equation, including state symbols, for the reaction.

..... [2]

(b) Describe how observations would be different if the experiment was repeated using

(i) magnesium

..... [1]

(ii) copper

..... [1]

(c) The table shows the change in mass of the experiment.

mass of iron filings (impure) at the start	1.25 g
mass of iron oxide, Fe_3O_4 at the end	1.45 g

Use the results to calculate the percentage purity of iron.

..... % [3]

Name : _____( ) Class: _____

A6 Ethanol, C_2H_5OH, can be produced by reacting ethene, C_2H_4, and steam at 300°C and 60 atmospheres with phosphoric(V) acid as a catalyst. **Fig. 6.1** shows the process to produce ethanol.

$$C_2H_4\ (g) + H_2O\ (g) \rightleftharpoons C_2H_5OH\ (g) \qquad (\Delta H = -42\ kJ/mol)$$

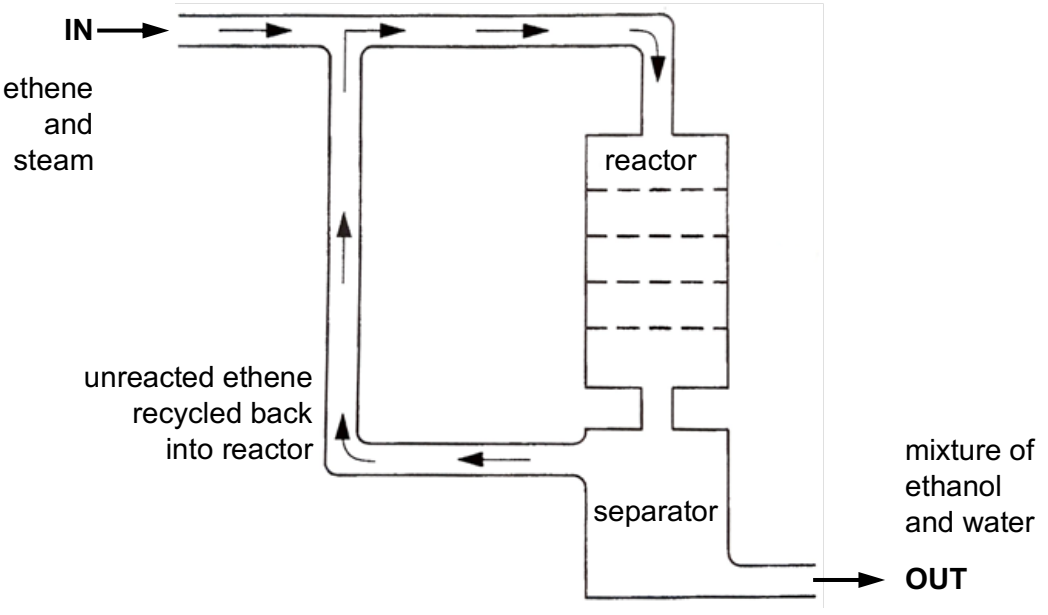


Fig. 6.1

(a) Draw the dot-and-cross diagram to show the arrangement of outer shell electrons in a molecule of ethene.

[2]

(b) Suggest how ethene is separated from ethanol and water in the separator.

..... [1]

(c) The overall percentage yield of the reaction is 95%.

Calculate the mass of ethane required to produce 2 tonnes of ethanol.

..... tonnes [3]

(d) State what happens to the percentage yield of the reaction when

(i) the temperature of the reaction is increased.

..... [1]

(ii) the pressure of the reaction is increased.

..... [1]

(e) Name a method which can be used to separate ethanol from water.

..... [1]

(f) Draw the energy level diagram for the reaction between ethene and water.

[2]

(g) **Fig 6.2** shows the structure of ethanol while **Table 6** shows information of bond energies.

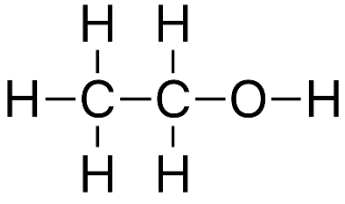


Fig. 6.2

Bond	Bond Energy (kJ/mol)
C – H	410
O – H	468
C – O	360
C – C	350

Table 6

Calculate the bond energy of a C=C bond.

..... kJ/mol [2]

Name : _____( ) Class: _____

A7 The labels of five colourless solutions, **V**, **W**, **X**, **Y** and **Z** were missing from their containers and a qualitative analysis was conducted to identify the five solutions. The five labels are shown in **Fig 7**.

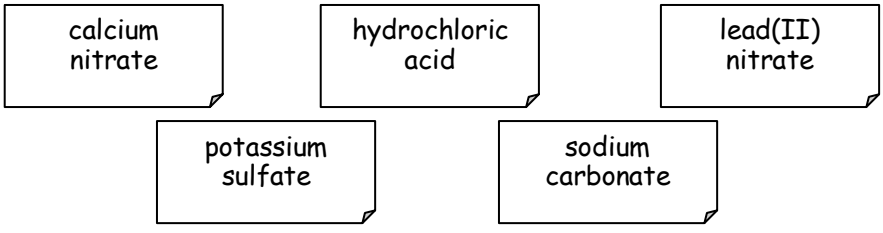


Fig. 7

Equal volumes of two different solutions were mixed with one another each time and the observations were recorded in **Table 7**.

Solutions	**V**	**W**	**X**	**Y**	**Z**
V	-	no visible reaction	white precipitate formed	white precipitate formed	white precipitate formed
W	no visible reaction	-	no visible reaction	white precipitate formed	white precipitate formed
X	white precipitate formed	no visible reaction	-	no visible reaction	effervescence observed
Y	white precipitate formed	white precipitate formed	no visible reaction	-	no visible reaction
Z	white precipitate formed	white precipitate formed	effervescence observed	no visible reaction	-

Table 7

Identify the five solutions.

V: .....

W: .....

X: .....

Y: .....

Z: .....

[5]

Name : _____( ) Class: _____

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.

B8 Principles of absorption spectroscopy

A spectrophotometer is an optical instrument which measures the absorptivity of a sample. It consists of a light source and a detector. **Fig. 8** shows the components of a spectrophotometer.

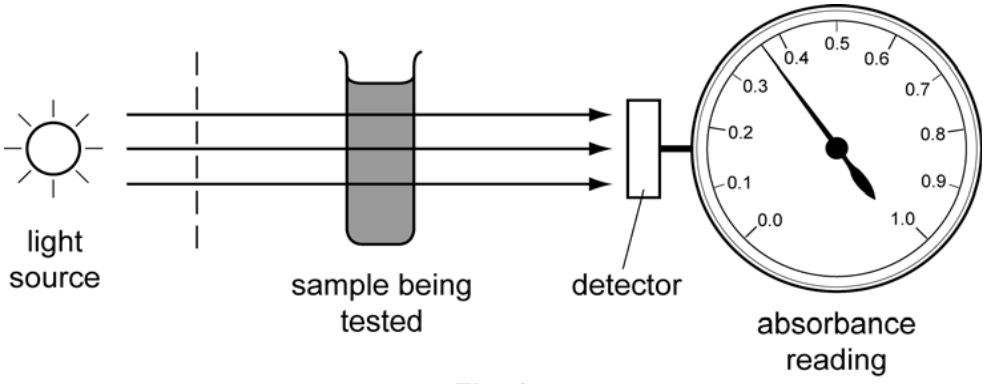


Fig. 8

This technique involves passing light through a coloured solution sample and measuring the amount of light absorbed by the sample. The absorbance reading obtained is proportional to the colour intensity of the solution. In order to determine the concentration of an unknown solution, a calibration curve is first set up by measuring the absorbance of a number of solutions of known concentrations.

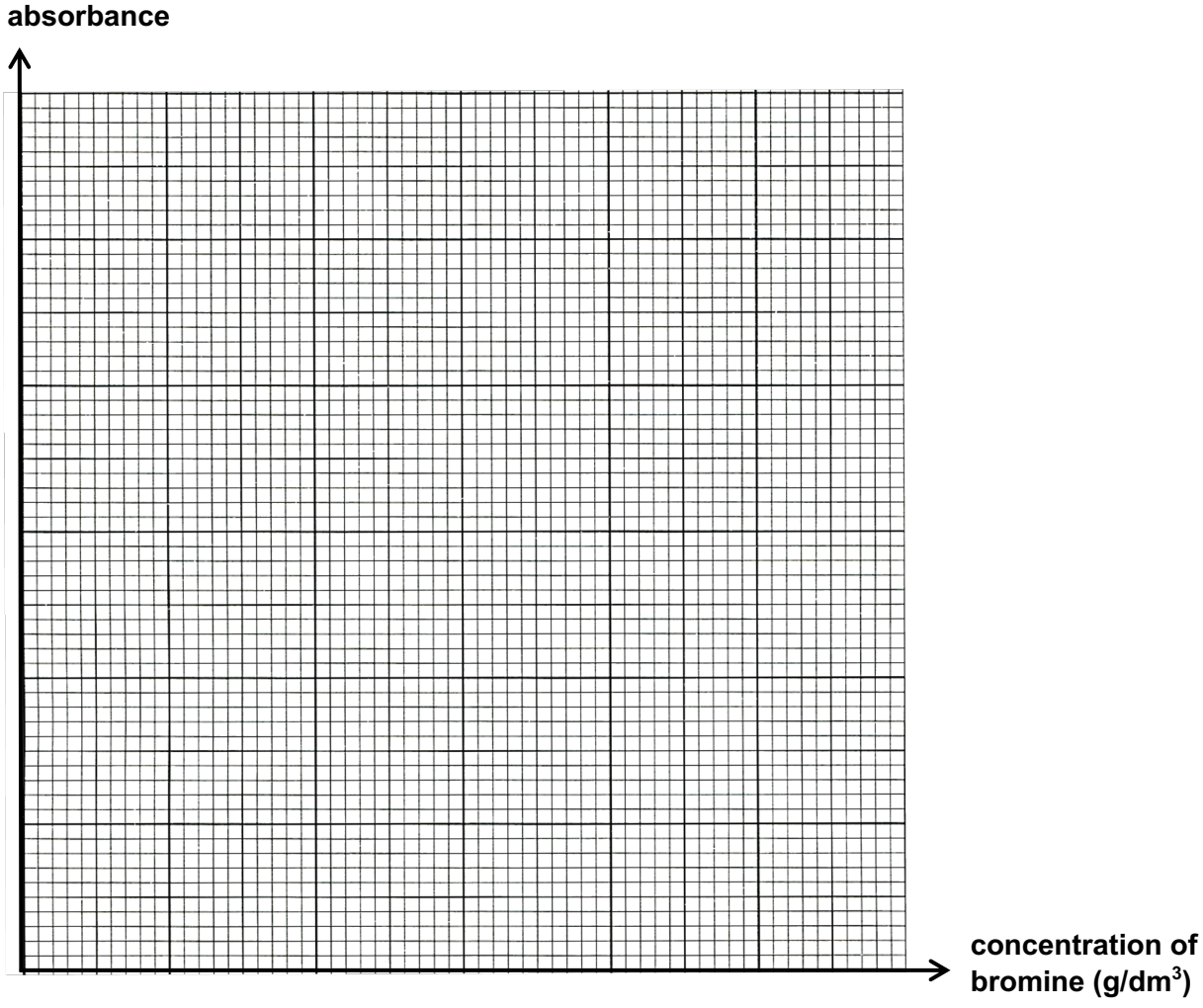
The data below shows the concentration of the standard bromine solutions of and their respective absorbance.

concentration of bromine (g/dm^3)	**absorbance**
0.00	0.00
0.05	0.24
0.10	0.46
0.15	0.70
0.20	0.76
0.25	0.78

Bromine in sea water

Bromine typically exists in sea water in the form of soluble bromide ions. To investigate the concentration of bromide ions present in a sample of sea water using absorption spectrometry, a suitable oxidant, such as chlorine gas is bubbled into the sample of sea water to produce bromine. The absorbance of the resulting solution can then be measured to determine the concentration of bromide ions.

(a) Plot the calibration curve in the axes given.



[2]

(b) Explain the relationship between the concentration of bromine in the solution and its absorbance reading.

.....

..... [2]

(c) Using your calibration curve in **(a)**, determine the concentration of the unknown bromine solution with an absorbance of 0.50.

..... [1]

(d) Explain why the calibration curve is not suitable for the investigation of solutions with high concentration of bromine.

..... [1]

(e) Calculate the concentration of the unknown bromine solution in mol/dm^3

..... mol/dm^3 [1]

(f) Write the ionic equation for the reaction between bromide ion and chlorine gas.

..... [1]

(g) Explain why it is necessary to oxidise bromide ions to aqueous bromine before measuring its absorbance.

.....

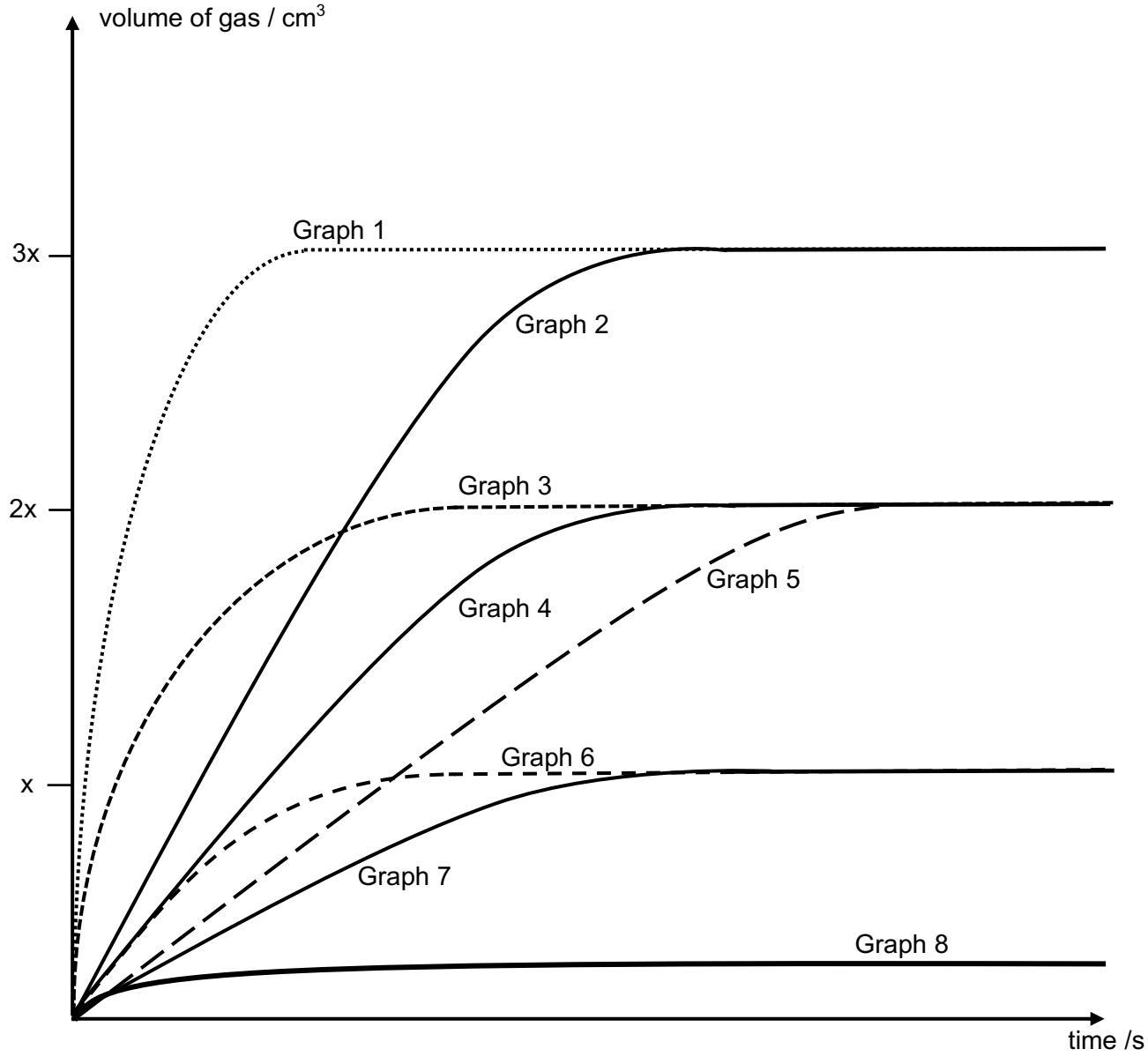
..... [2]

(h) Name another element which can be bubbled into sea water to produce aqueous bromine.

..... [1]

Name : _____( ) Class: _____

B9 A student had carried out 8 experiments using different carbonates with different acids. The volume of gas produced from the reaction is measured and recorded. Graphs of the 8 experiments are shown below.



Graph 4 was obtained using excess granular calcium carbonate and 100 cm^3 of 0.04 mol/dm^3 of hydrochloric acid.

(a) Without changing the concentration and volume of the acid use in Graph 4, suggest with explanation, how graph 5 can be obtained.

.....

.....

.....

..... [3]

(b) During the experiment, the student used a 50.0 cm^3 pipette to measure the volume of acid used. [4]

Calculate the volume of acid and concentration of the acid use for graphs 1, 2, 6 and 7.

graph	type of acid	type of carbonate	volume of acid /cm^3	concentration of acid / mol/dm^3
1	sulfuric	granular sodium carbonate		
2	hydrochloric	granular calcium carbonate		
3	sulfuric	granular sodium carbonate	50	0.04
4	hydrochloric	granular calcium carbonate	100	0.04
6	sulfuric	granular sodium carbonate		
7	hydrochloric	granular calcium carbonate		

(c) The student tried mixing 100 cm^3 of 0.04 mol/dm^3 sulfuric acid to excess of powdered calcium carbonate. The results produced graph 8.

Comment on graph 8.

.....

..... [2]

Name : _____( ) Class: _____

EITHER

B10 The Bayer Process is used to purify bauxite, an ore of aluminium. The bauxite ores contains mainly aluminium oxide and impurities such as iron(III) oxide. Crushed bauxite is treated with ***moderately concentrated chemical*** at temperatures of between 140°C to 240°C and pressure of 35 atmospheres. The reaction produces a mixture containing a solution of aluminium ions and solids, the resulting mixture is then filtered to obtained a concentrated aluminum solution. The filtrate is then processed to produce aluminium oxide for the purpose of electrolysis.

Student **A** suggested the moderately concentrated chemical to be hydrochloric acid, while

Student **B** suggested the moderately concentrated chemical to be sodium hydroxide.

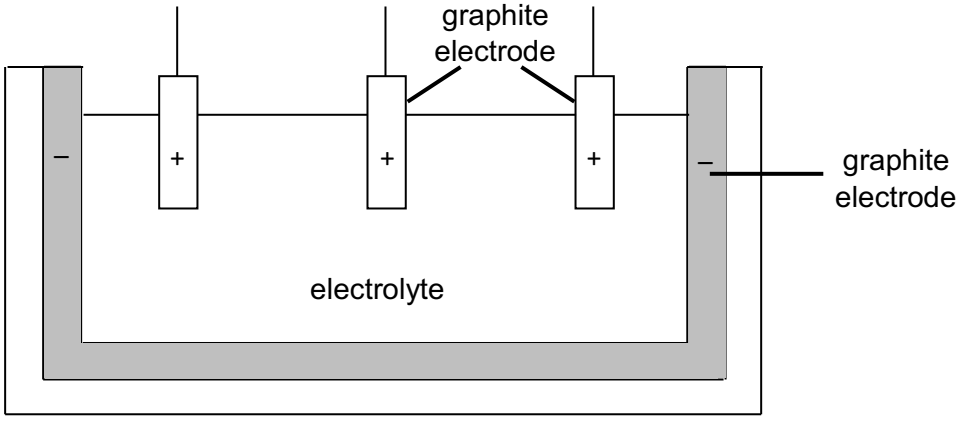
(a) Suggest with explanation, which solution, moderately concentrated hydrochloric acid **or** sodium hydroxide, should be added to bauxite.

.....

.....

..... [3]

(b) Two other students decided to set up the following to extract pure aluminium.



Student **C** decided to use molten aluminium oxide as the electrolyte

Student **D** decided to use dilute aqueous aluminium chloride solution as the electrolyte.

(i) Describe one similarity and one difference in the products formed by both students.

similarity ..... [1]

difference .....

..... [1]

(ii) Write the ionic half equation for the reaction taking place at the anode for both student **C** and student **D**.

Student **C** ..... [1]

Student **D** ..... [1]

(iii) When student **C** was performing the electrolysis, he added a substance named cryolite to his electrolyte.

Suggest why cryolite was added to the electrolyte .

.....

..... [2]

(iv) It was suggested to both students that the one of the electrode should be replaced regularly.

Identify which electrode should be replaced and provide an explanation.

.....

..... [1]

OR

B10 **Fig. 10** shows the cross-section of a zinc-carbon battery.

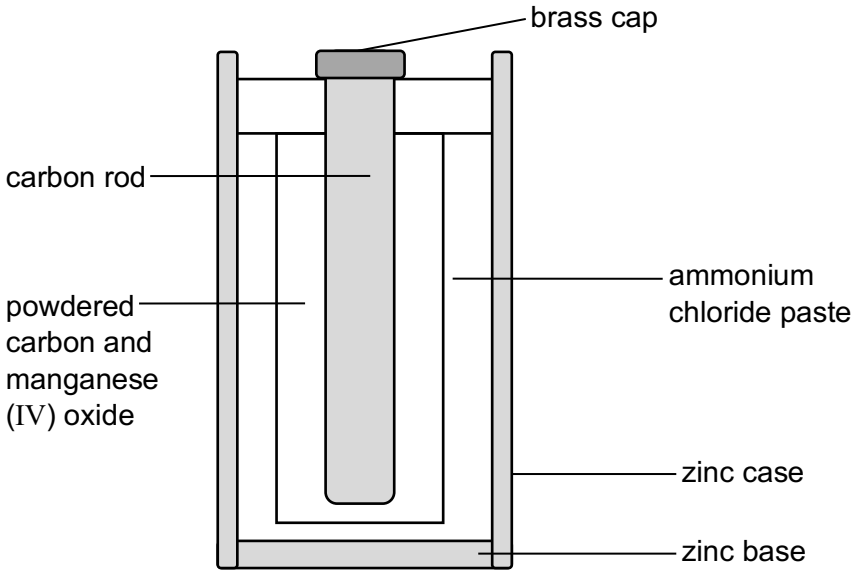


Fig.10

The equation represents the overall reaction in a battery.

$$Zn\ (s) + 2MnO_2\ (s) + 2NH_4Cl\ (aq) \rightarrow Mn_2O_3\ (s) + Zn(NH_3)_2Cl_2\ (aq) + H_2O\ (l)$$

Ammonia gas and hydrogen gas are produced at the carbon electrode. Hydrogen gas reacts with manganese (IV) oxide, MnO_2, to give water, while ammonia gas reacts with zinc chloride, $ZnCl_2$, to give $Zn(NH_3)_2Cl_2$.

(a) State the electrolyte present in the battery.

.....[1]

(b) Write the ionic half-equations for the reactions occurring at the electrodes.

cathode: .....

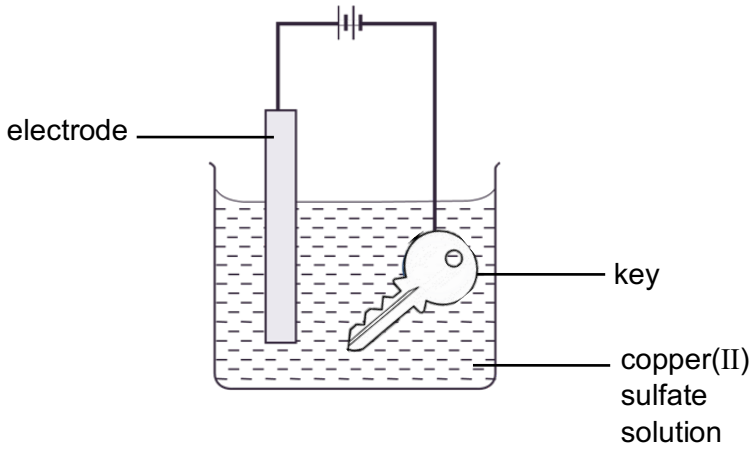
anode: .....[2]

(c) After prolonged usage, leaking of ammonium chloride paste will occur. Explain why.

.....

.....[1]

(d) Two students set up the following for electroplating a key with a thin layer of copper.



Student **E** decided to use platinum electrode while student **F** decided to use copper electrode.

(i) Describe one similarity and one difference in the observations made during electroplating.

similarity: .....

difference: .....

..... [2]

(ii) Why is copper a suitable metal for electroplating?

..... [1]

(iii) Student **E** used 300 cm^3 of 0.5 mol/dm^3 copper(II) sulfate solution for the electroplating process. Calculate the concentration of copper(II) sulfate solution after 0.4g of copper was coated on the key. *Assume negligible change in volume of solution.*

..... mol/dm^3 [3]

End of Paper

Name : _____ ( ) Class: _____

The Periodic Table of Elements

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

Key

proton (atomic) number
atomic symbol
name
relative atomic mass

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

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