Name: …… **( )** **Class:** ……

MONTFORT SECONDARY SCHOOL

PRELIMINARY EXAMINATION 2022

Secondary 4 Express

CHEMISTRY **6092/02**
Paper 2 **24 Aug 2022(Wed)**

1 hour 45 minutes

READ THESE INSTRUCTIONS FIRST

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

Section A [50 marks]
Answer **all** questions in the spaces provided.

Section B [30 marks]
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 22.

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

This document consists of **22** printed pages.

Setter: Mr Ramesh

Section A (Total 50 marks)

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

A1 Name the method of separation used in each of the following processes. [4]

	Process	Method of separation
(a)	To obtain iodine from a mixture of iodine and sodium chloride.	
(b)	To obtain petrol from a mixture of water and petrol.	
(c)	To obtain the salt formed when hydrochloric acid reacts with sodium hydroxide.	
(d)	To obtain butane from crude oil.	
(e)	To obtain the product formed when carbon dioxide is bubbled into calcium hydroxide.	

[Total:4]

A2 The table shows some information about substances **A** to **D**.

substance	melting point/ °C	boiling point/ °C	Does it conduct electricity when it is a solid?	Does it conduct electricity when molten?
A	-7	59	no	no
B	1251	1970	no	yes
C	1240	2100	yes	yes
D	1650	2230	no	no

(a) Use only the letters **A, B, C** or **D** to answer the following questions.

(i) Which substance is most likely to be a metal?

…… [1]

(ii) Which substance is a reddish brown liquid at room temperature and which could be used to test if an organic compound is saturated?

……..[1]

(iii) Which substance is most likely to be sand?

……..[1]

(b) **(i)** What type of bonding is present in substance **B?**

……..[1]

(ii) Explain your answer.

……...

……....

……..[2]

[total:6]

A3 **(a)** Complete the following table about the preparation of soluble salts.

Give the chemical formulae of **all** reagents and salts which are to be used in the preparation of the salts.

method number	type of method	reagent 1	reagent 2	soluble salt formed
1	Reacting an acid with a metal		sulfuric acid, H_2SO_4	
2	Reacting an acid with an insoluble base			copper(II) sulfate, $CuSO_4$
3	Reacting an acid with an insoluble carbonate	Magnesium carbonate, $MgCO_3$		
4				sodium chloride, NaCl

[5]

(b) Write a balanced ionic equation for any one of the above reactions.

[1]

(c) Explain why copper(II) sulfate and sodium chloride cannot be prepared using method 1.

……..

……..

…….[2]

[total:8]

A4 When sodium is burned in air, a mixture of sodium oxide, Na_2O, and sodium peroxide, Na_2O_2, is formed. The mixture reacts with water according to the following equations.

$$Na_2O + H_2O \longrightarrow 2\ NaOH$$

$$Na_2O_2 + H_2O \longrightarrow 2\ NaOH + H_2O_2$$

The following information will allow you to calculate the relative amounts of the two oxides produced when sodium is burned.

The mixture obtained by burning a sample of sodium was dissolved in distilled water and made up to 100 cm^3 to give solution **H.**

(a) A 25.0 cm^3 portion of solution **H** was titrated with 0.100 mol/dm^3 hydrochloric acid with methyl orange as the indicator.
22.5 cm^3 of the acid was required to reach the end point.

Calculate the total amount in moles of NaOH in 100 cm^3 of solution **H**.

[2]

(b) The H_2O_2 content of solution **H** was found by titration of another 25.0 cm^3 portion with 0.0200 mol/dm^3 $KMnO_4$.

The following reaction occurs.

$$2MnO_4^- + 5H_2O_2 + 6H^+ \longrightarrow 2Mn^{2+} + 5O_2 + 8H_2O$$

10.0 cm^3 of $KMnO_4$ solution was required to reach the end point.

(i) How was the end point determined in the two different titrations?

……..

……..

……[2]

(ii) Calculate the amount in moles of the H_2O_2 in 100 cm^3 of solution **H**.

[2]

(c) Hence, calculate the amount in moles of Na_2O and Na_2O_2 formed during the burning of the sodium sample.

[2]

(d) Complete the table below to suggest the oxidation states of the oxygen in each oxide.

oxide	**oxidation state of oxygen**
sodium oxide, Na_2O	
sodium peroxide, Na_2O_2	

[2]
[total:10]

A5 A toilet cleaner contains the acid salt, sodium dihydrogen phosphate, NaH_2PO_4.

Sodium dihydrogen phosphate can be made by reacting sodium hydroxide with phosphoric acid.

$$NaOH\ (aq) + H_3PO_4\ (aq) \rightarrow NaH_2PO_4\ (aq) + H_2O\ (l)$$

Sodium dihydrogen phosphate reacts with sodium hydroxide to form sodium hydrogen phosphate.

$$NaOH\ (aq) + NaH_2PO_4\ (aq) \rightarrow NaHPO_4\ (aq) + H_2O\ (l)$$

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

……...

……...

……...

……..[2]

(b) **(i)** Write an ionic equation for the reaction between sodium hydroxide and phosphoric acid.

[1]

(ii) Suggest the name and formula of the other salt formed from sodium hydroxide and phosphoric acid.

……...

……[2]

(c) The table shows information about other acidic compounds.

name	pH of a 0.5 mol/dm^3 solution	
sodium dihydrogen phosphate	4.5	Increasing acid strength ↓
ethanedioic acid	3.0	
sulfuric acid	1.0	

(i) Explain why sulfuric acid behaves as a *strong* acid but ethanedioic acid behaves as a *weak* acid.

……...

……...

……...

……..[2]

(ii) Both sulfuric and ethanedioic acids are dibasic. Describe an experiment, other than measuring pH, that you could carry out to show that sulfuric acid is a strong acid but ethanedioic acid is a weak acid.

State what measurements you would make and what results you would expect.

…….....

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..[3]

[total:10]

A6 State if the statements below are true (T) or false (F) in the brackets provided. If it is false, make the necessary corrections.

(a) The melting points of the elements increases down Group I. [ ]

……..

(b) The compounds of Group I elements are all ionic. [ ]

……

(c) Bromine displaces iodine from aqueous potassium iodide. [ ]

……

(d) The density of the elements increases down Group VII. [ ]

……

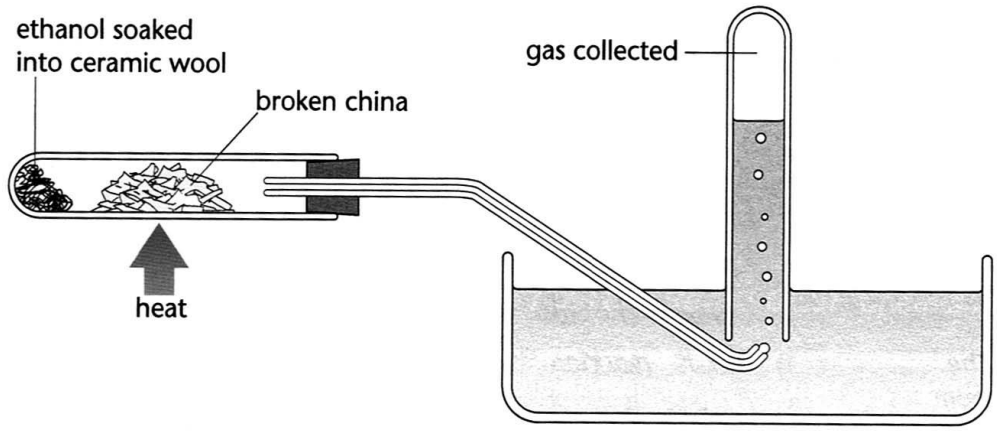
(e) When moving across a period from left to right, the oxide changes from acidic to basic. [ ]

……

[3]

[total:3]

A7 Ethanol was dehydrated by passing the vapour over strongly heated broken china (porcelain chips). The diagram shows the apparatus that was used.



The gas collected was tested. The results are shown in the table.

Test	Result/Observation
Lighted splint	Burns with a slightly smoky flame.
Bromine water	

(a) Write down the name of the gas collected and draw its structure below.

Name of gas: ……

[2]

(b) The test for bromine water has been left blank. State what will be observed by completing the table. [1]

(c) Write a balanced chemical equation for the reaction taking place at the broken china.

[1]

(d) Ethyl methanoate is an ester which can be formed from ethanol.

(i) Write down the name and draw the structural formula of the other substance which reacts with ethanol to form ethyl methanoate.

Name of substance: ……

[2]

(ii) Draw the structure of the ester.

[1]

(iii) Another substance is produced in this reaction. By giving the name of this substance, explain what type reaction is taking place.

……..

……..

……..

……[1]

(iv) Give one use for esters.

……..

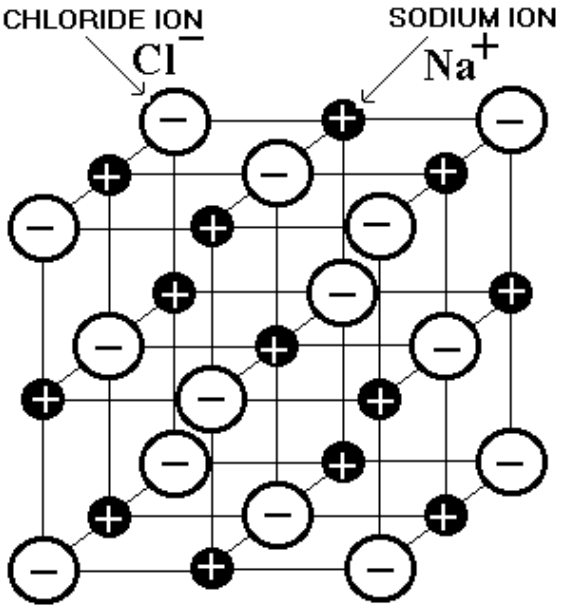
……[1]

[total: 9]

END OF SECTION A
Section B (Total 30 marks)
Answer all **three** questions in this section.

B8 This information comes from a website about salt.

Salt is mostly sodium chloride, the ionic compound with the formula NaCl, representing equal proportions of sodium and chloride ions. Sea salt and freshly mined salt (much of which is sea salt from prehistoric seas) also contain small amounts of trace elements (which in these small amounts are generally good for plant and animal health). Mined salt is often refined in the production of table salt; it is dissolved in water to form brine, purified via precipitation of other minerals out of solution, and re-evaporated. Salt crystals are translucent and cubic in shape; they normally appear white but impurities may give them a blue or purple tinge.



SODIUM CHLORIDE LATTICE STRUCTURE

A single salt crystal consists of a vast ionic lattice of sodium and chloride ions. The lattice structure means that salt crystals are very hard with regular shapes and do not conduct electricity.

A major application of salt is de-icing of roadways in sub-freezing weather. In some countries, winter temperatures fall below 0 °C. This causes accidents because vehicles slide on the slippery surface. De-icers are mixtures of chemical compounds that are spread on the roads to melt the ice. The minimum freezing point of a water-salt mixture is −21.12 °C (−6.02 °F) for 23.31 wt% (percentage by weight) of salt.

Another very important use of salt is to provide the huge amounts of chlorine that are used every day. Chlorine is made industrially by electrolysis of concentrated aqueous sodium chloride. This produces chlorine as an element.

(a) The website uses the words element and compound. Explain what these words mean.

……

……

……

……[2]

(b) The website states that brine is, 'purified via precipitation of other minerals out of solution'. The main impurities present in mined salt are magnesium and calcium salts which can be easily removed by treating the brine solution with chemicals. Suggest a suitable chemical, giving its chemical formula as well, for this.

……[1]

(c) Explain why the lattice structure of sodium chloride causes the crystals to be very hard with regular shapes and which do not conduct electricity.

……

……

……

……

……

……

……

……[3]

(d) Use information from the website to explain why salt is used in de-icing (removal of ice) of roads in cold weather.

……

……

……

……[1]

(e) The website says that we use ‘huge amounts of chlorine’ every day.

(i) Give a large scale use of chlorine.

……

……[1]

(ii) Explain why chlorine is made by electrolysing *concentrated* aqueous sodium chloride. Include ionic equations to support your answer.

……

……

……

……

……

……[2]

[total:10]

B9 When copper is extracted from its ores, chalcopyrite and chalcocite (copper sulfides), by heating in the blast furnace, it contains carbon impurities.

(a) Suggest how the carbon impurities get into the copper.

……

……

……

……..[1]

(b) Copper for electrical wiring needs to have a very high purity.

(i) With the aid of a labelled diagram, describe how impure copper can be purified by electrolysis, using aqueous copper (II) sulfate as an electrolyte. Write equations for the reactions at the electrodes and state what will be observed.

……...

……...

……..

……...

……...

…….[4]

(ii) What happens to the concentration of the aqueous copper (II) sulfate during the electrolysis?

Explain your reasoning.

……...

……...

……..

……[2]

(c) **(i)** Draw a diagram to show the metallic bonding in pure copper.

[1]

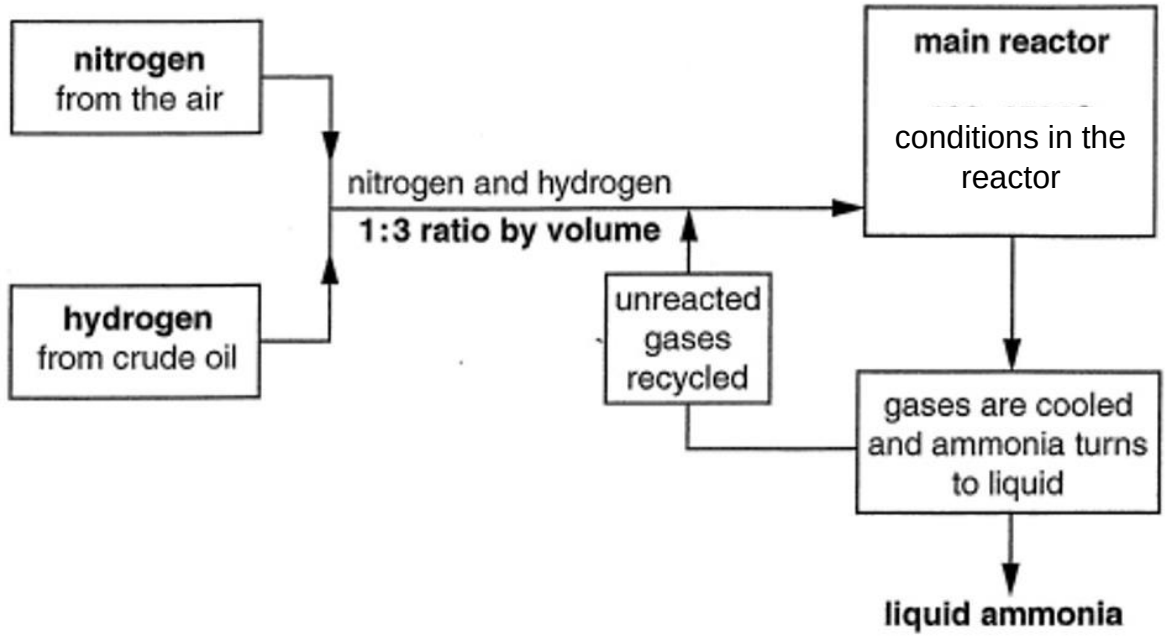
(ii) Show with a clearly labelled diagram, how you could set up a simple electric cell using copper as one of the electrodes.

[2]

[total:10]

EITHER

B10 The Haber process for making ammonia can be represented using a flow diagram.



(a) The conditions in the main reactor have been left blank. What are the conditions to obtain the highest yield of ammonia at the lowest cost?

……

……..[1]

(b) Give the names of the two processes by which nitrogen and hydrogen are obtained from air and crude oil respectively.

nitrogen ……

hydrogen ……..

[1]

(c) The nitrogen and hydrogen are mixed in a 1:3 ratio by volume.

Explain why the gases are mixed in 1:3 ratio. Include an equation in your answer.

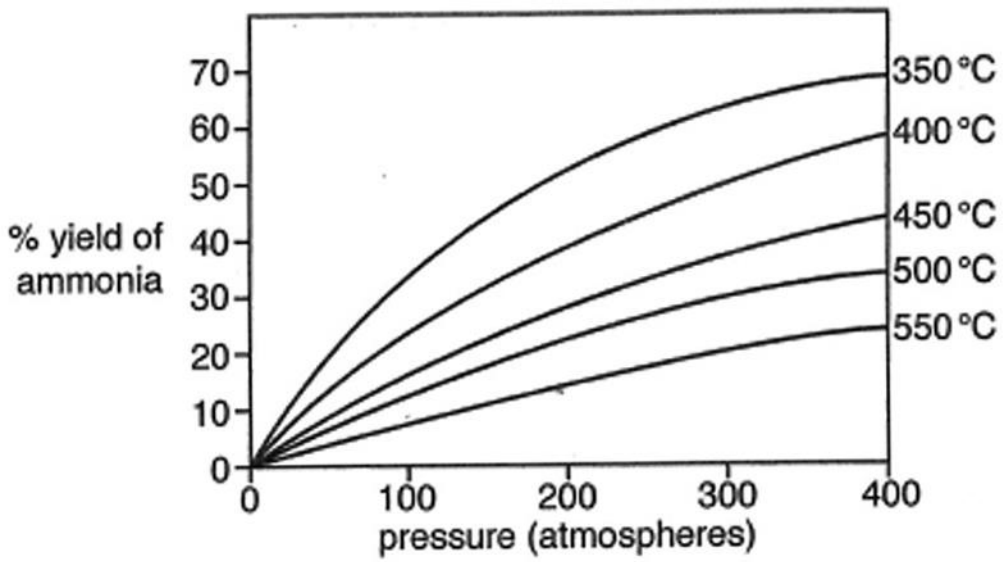
. ……...

……...

……..

……..[2]

(d) The graph shows the yield of ammonia that is made under different conditions.



Nowadays the process has been adapted to work at a pressure of 50 atmospheres.

(i) Explain, in terms of collisions between (reacting) particles, how a lower pressure affects the rate of reaction in the reactor.

……...

……

……

……

……[2]

(ii) Use the graph to predict how a lower pressure affects the relative amounts of ammonia, nitrogen and hydrogen that leave the main reactor.

Explain your reasoning.

……

……

……

……

……[2]

(iii) What effect does a lower pressure have on the **final** amount of ammonia made from a **fixed** amount of nitrogen and hydrogen?

Explain your reasoning.

……

……

……

……

……..[2]

[total:10]

OR

B10 The table shows some information about an homologous series of carbon compounds called ethers.

name	formula	boiling point/°C
methoxymethane	CH_3OCH_3	-24.8
methoxyethane	$CH_3OC_2H_5$	7.0
methoxypropane	$CH_3OC_3H_7$	
		70.3

(a) **(i)** Deduce the name and formula of the next member of the ether homologous series.

name ……..

formula ……..

[1]

(ii) Hence, deduce the general formula for an ether.

……..[1]

(b) **(i)** Suggest a value for the boiling point of methoxypropane.

……..[1]

(ii) Explain why the boiling point of this homologous series increase down the series.

……....

……..

……..

……..[1]

(c) **(i)** Draw the structural formula of methoxymethane below.

[1]

(ii) Deduce the structural formula and name of an isomer of methoxymethane.

name of isomer: ……

[2]

(d) Methoxymethane is bubbled into some bromine water in a test tube. State and explain what will be observed.

……...

……..

……..

…….[2]

(e) One of the first anaesthetics used to stop pain during surgical operations was ethoxyethane. It is explosively flammable and so was very hazardous for doctors to use.

Write an equation for the complete combustion of ethoxyethane. State symbols are not required.

[1]

[total:10]

END OF PAPER

The Periodic Table of Elements

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

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

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