General Certificate of Education Ordinary Level
JUYING SECONDARY SCHOOL, SINGAPORE
Secondary Four Express
Preliminary Examination

CANDIDATE NAME	

CENTRE NUMBER	S						INDEX NUMBER					

CHEMISTRY

6092/02

Paper 2

26 August 2022

1 hour 45 minutes

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

READ THESE INSTRUCTIONS FIRST

Write your Centre number, index number and name on all the work you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, 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 24.

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

Section A

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

A1 **(a)** Fig. 1.1 shows part of the Periodic Table.

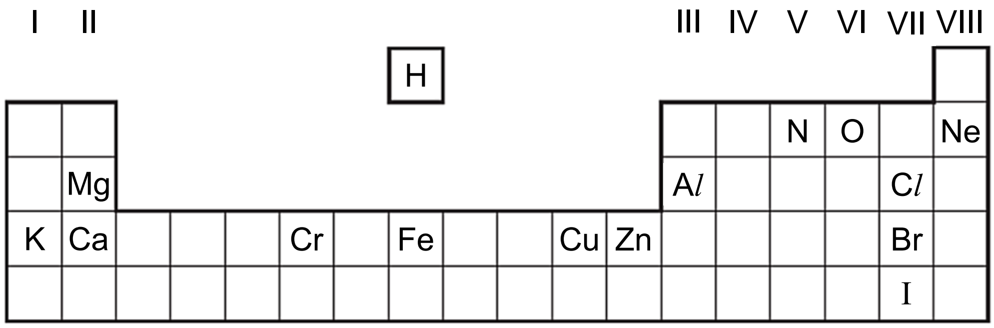


Fig. 1.1

Answer the questions using only the symbols of the elements in Fig. 1.1.

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

State the symbol of an element that:

(i) is a monoatomic gas at room temperature;

.... [1]

(ii) is used to test for unsaturated hydrocarbons;

.... [1]

(iii) displaces bromine from its halide;

.... [1]

(iv) has 24 protons in each atom;

.... [1]

(v) forms an amphoteric oxide.

.... [1]

(b) An atom has the electronic configuration 2, 8, 4.

State which period and group the atom belongs to in the Periodic Table.

………………………………………………………………………………………..….. [1]

(c) To find out the nucleon number of a C*l* atom, a student checks the Periodic Table and records the nucleon number as 35.5.

Explain why the student is incorrect and what should be done instead.

……………………………………………………………………………………………….

……………………………………………………………………………………………….

……………………………………………………………………………………………… [2]

[Total: 8]

A2 Fig. 2.1 shows an electrolytic cell.

The terminals of the battery are labelled as **1** and **2**, while the graphite electrodes are labelled as **X** and **Y**. A few drops of Universal Indicator are added to the electrolyte.

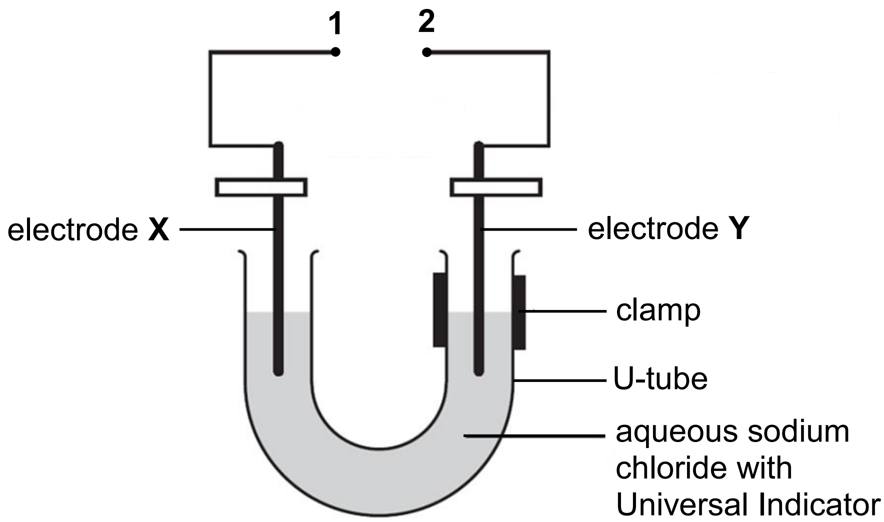


Fig. 2.1

(a) When the experiment begins, colourless gases are observed to form at both electrodes. Table 2.2 shows the results of the gas tests performed.

Table 2.2

test	gas at electrode **X**	gas at electrode **Y**
lighted splint	extinguishes with 'pop'	burns strongly
glowing splint	extinguishes	relights

(i) Explain which terminal, **1** or **2**, acts as the negative terminal of the battery.

....

....

.... [2]

(ii) Write the ionic half-equation for the reaction at electrode **Y**.

.... [1]

(b) At the start of the experiment, the Universal Indicator in the U-tube is green in colour.

As the experiment progresses, the solution at electrodes **X** and **Y** on each end of the U-tube turns to a different colour.

(i) State the colour observed at electrode **X**.

……………………………………………………………………………………… [1]

(ii) Explain why at electrode **Y** the indicator turns red initially but is then bleached to colourless after some time.

………………………………………………………………………………………………

………………………………………………………………………………………………

………………………………………………………………………………………………

………………………………………………………………………………………………

……………………………………………………………………………………… [3]

(c) In another experiment, some changes are made to the set-up in Fig. 2.1.

- The battery is removed and replaced with a lamp.
- The electrolyte is replaced with silver nitrate solution without adding any indicator.
- Electrode **X** is replaced with copper and electrode **Y** is replaced with silver.

(i) Explain why the lamp is observed to light up.

………………………………………………………………………………………………

……………………………………………………………………………………… [1]

(ii) Describe **two** observations that would be seen after some time.

………………………………………………………………………………………………

………………………………………………………………………………………………

……………………………………………………………………………………… [2]

[Total: 10]

A3 Solutions of iron(II) chloride and iron(III) chloride are added separately to solutions of potassium iodide and acidified potassium manganate.

(a) Complete Table 3.1 to show the colour changes to potassium iodide and acidified potassium manganate.

Table 3.1

	iron(II) chloride solution	iron(III) chloride solution
potassium iodide solution	no change to potassium iodide	
acidified potassium manganate solution		no change to potassium manganate

[2]

(b) One of the reactions in Table 3.1 can be represented by the ionic equation shown.

$$MnO_4^-(aq) + 8H^+(aq) + 5Fe^{2+}(aq) \rightarrow 5Fe^{3+}(aq) + Mn^{2+}(aq) + 4H_2O(l)$$

Use oxidation states to explain why this is a redox reaction.

....

....

.... [2]

(c) Describe a different chemical reaction to distinguish between solutions of iron(II) chloride and iron(III) chloride.

In your answer, include the observations to be made for each solution, and an ionic equation for any **one** of the reactions.

....

....

....

.... [3]

[Total: 7]

A4 **(a)** Sulfamic acid, H_2NSO_3H, is a strong acid frequently used for the removal of rust from iron structures.

(i) A 0.105 g sample of sulfamic acid is dissolved in water to form a solution.

The solution requires 10.8 cm^3 of 0.100 mol/dm^3 aqueous potassium hydroxide for complete neutralisation.

Calculate the number of moles of sulfamic acid that react with **one** mole of potassium hydroxide.

[3]

(ii) State the conditions required for rust to form on iron structures.

.... [1]

(b) Methylamine, CH_3NH_2, is a weak base.

(i) A sample of methylamine is added to water.

$$CH_3NH_2 + H_2O \rightleftharpoons CH_3NH_3^+ + OH^-$$

Predict the pH of aqueous methylamine and explain your answer.

....

.... [2]

(ii) Methylamine can neutralise acids such as dilute hydrochloric acid, to form the salt methylammonium chloride.

$$CH_3NH_2 + HCl \rightarrow CH_3NH_3Cl$$

Hence, write a balanced equation for the reaction between methylamine and sulfuric acid, and suggest the name of the salt formed.

....

.... [2]

[Total: 8]

A5 **(a)** An experiment is conducted to investigate the thermal stability of the carbonates of four different metals, **P**, **Q**, **R** and **S**.

The metal carbonates are heated strongly and the volumes of carbon dioxide gas produced in the first 5 minutes are recorded in Table 5.1.

Table 5.1

carbonate of metal	time (min)	1	2	3	4	5
P	volume of carbon dioxide (cm^3)	5	11	16	21	27
Q		3	6	9	12	15
R		0	0	0	0	0
S		8	16	24	32	40

(i) Explain which metal carbonate has the lowest thermal stability.

....

.... [1]

(ii) Table 5.2 shows information about the ions of metals **P**, **Q**, **R** and **S**.

The charge density is the ratio of the charge to the radius of the ion.

Table 5.2

ion	radius of ion (nm)	charge density
$\mathbf{P}^{2+}$	0.114	17.5
$\mathbf{Q}^{+}$	0.116	8.62
$\mathbf{R}^{+}$	0.152	6.58
$\mathbf{S}^{2+}$	0.073	27.4

Deduce and describe the relationship between charge density and thermal stability of the metal carbonates.

....

.... [1]

(iii) Arrange metals **P**, **Q**, **R** and **S** in order, from the least to the most reactive.

.... [1]

(iv) Suggest the identity of metal **R** and explain your answer using evidence from both Table 5.1 and Table 5.2.

....

....

....

....

.... [3]

(b) Some properties of chromium are listed.

- Large amount of energy is needed to turn chromium into liquid.
- Chromium has delocalised and mobile electrons.
- Many chromium compounds are soluble in water.
- Hydrated chromium(III) sulfate is green.
- Chromium forms the chlorides $CrCl_2$ and $CrCl_3$.
- Oxides of chromium speed up reactions in the manufacture of plastics.

Use the information above to describe:

(i) **two** properties of chromium which are different from properties of Group I metals;

....

.... [2]

(ii) **two** properties of chromium which are similar to properties of Group I metals.

....

.... [2]

[Total: 10]

A6 Alcohols can be partially oxidised to form aldehydes first, before further oxidation to form carboxylic acids.

Aldehydes are a homologous series of organic compounds.

Fig. 6.1 shows the apparatus used for the partial oxidation of an alcohol.

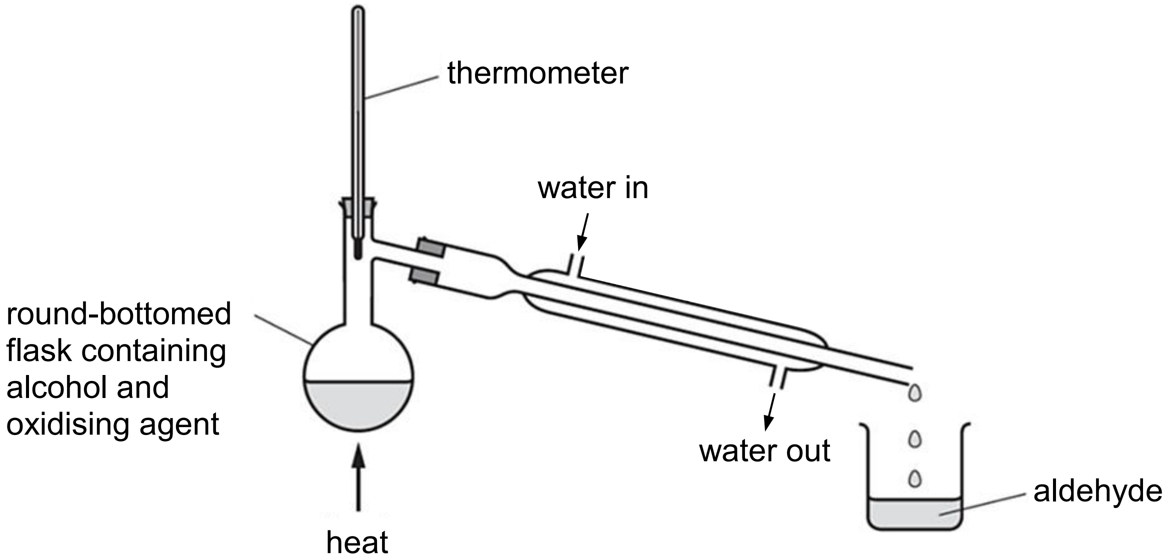


Fig. 6.1

(a) **(i)** Name the experimental technique used in Fig. 6.1.

.... [1]

(ii) Describe one error to be corrected in the set-up to ensure minimum loss of product.

....

.... [1]

(iii) The aldehyde produced is transferred to a tightly-sealed container.

Explain why this is necessary.

....

.... [1]

(b) Complete Table 6.2 which shows some information about aldehydes.

Table 6.2

name		ethanal	propanal	butanal
molecular formula	CH_2O	C_2H_4O	C_3H_6O	

[2]

(c) Fig. 6.3 shows the structural formula of propanal.

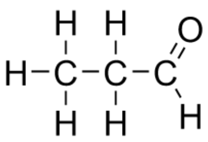


Fig. 6.3

Propanal has the same molecular formula but a different structure as another organic compound propanone.

(i) State the relationship between propanal and propanone.

.... [1]

(ii) Propanone belongs to a homologous series called ketones. Ketones also have the C=O group.

Draw the structure of propanone, C_3H_6O.

Show all of the atoms and all of the bonds.

[1]

[Total: 7]

Section B

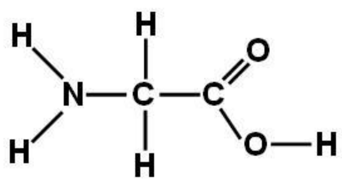
Answer all **three** questions in this section.

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

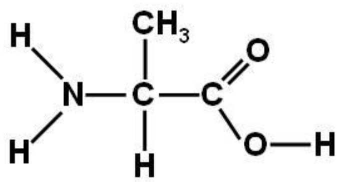
B7 The structure of proteins

Proteins are macromolecules made up of many amino acids chemically combined together by amide linkages. There are 20 types of naturally-occurring amino acids.

Fig. 7.1 shows the structures of two common amino acids, glycine and alanine.



glycine



alanine

Fig. 7.1

During cooking processes, food which contain proteins are prone to sticking to frying pans. Sticking is caused by chemical bonds forming between the food and material of the pan, especially iron.

The structure and use of Teflon

Methods to reduce sticking aim to reduce or prevent contact between the food and the surface of a frying pan. The most common method is the use of a Teflon coating. Teflon, which is poly(tetrafluoroethane), is a saturated molecule that contains only strong carbon-carbon and carbon-fluorine single bonds.

Fig. 7.2 shows that at the microscopic level, the smooth surface of the pan actually appears uneven with small nooks and crannies. Teflon is melted and then applied onto the surface of the pan, where it seeps into these small spaces. Upon cooling, the Teflon coating becomes physically locked in place.

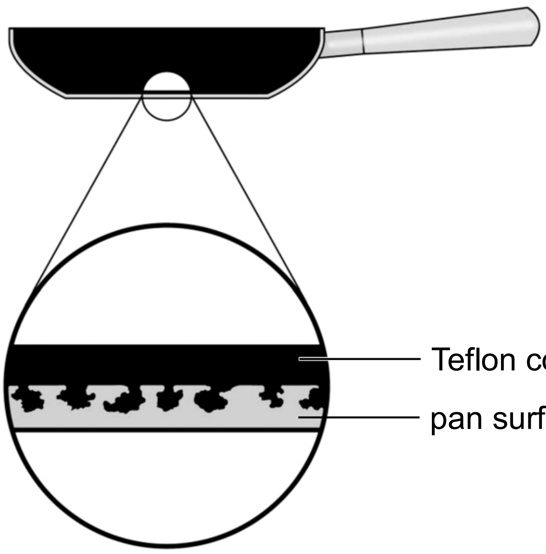


Fig. 7.2

The structure and use of cooking oil

Before non-stick pans were invented, sticking could still be avoided by heating some oil in the pan before cooking. Cooking oil is an ester formed from a glycerol molecule, $C_3H_8O_3$, which has three hydroxyl groups, and three molecules of stearic acid, $C_{17}H_{35}COOH$, which has a long hydrocarbon chain.

Fig. 7.3 shows the structure of a molecule of cooking oil.

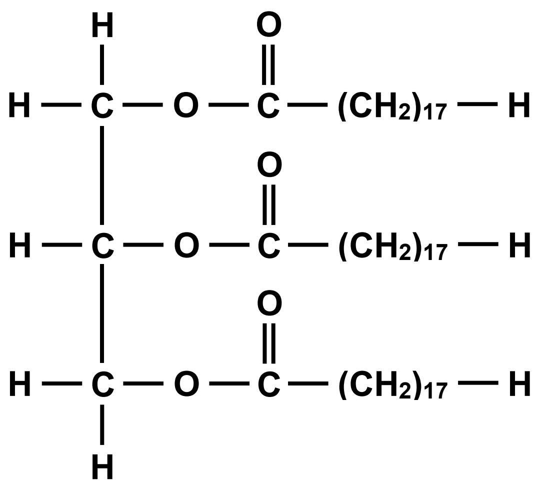


Fig. 7.3

The oil, being liquid, fills in the spaces on the surface of the pan. At frying temperatures, each long hydrocarbon chain of the oil molecule crack to produce two shorter chains, one of which is an alkene with 10 carbon atoms. The alkene then polymerises under suitable conditions to produce a polymer of an even greater chain length. This polymer forms a layer on the pan and remains solid even at high temperatures.

(a) **(i)** From Fig. 7.1, state the **two** functional groups found in an amino acid.

…………………………………………………………………………………..… [1]

(ii) Hence, explain why food containing proteins are prone to sticking to the material of frying pans.

…………………………………………………………………………………………

…………………………………………………………………………………..… [1]

(b) The amino acids glycine and alanine can react to form a molecule with amide linkage and a water molecule. Fig. 7.4 shows the structures of these molecules.

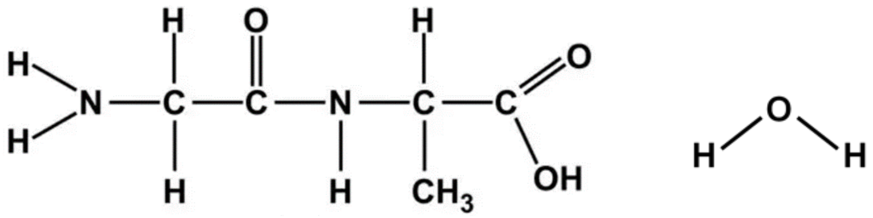


Fig. 7.4

Use values for Table 7.5 to calculate the enthalpy change, ΔH, for the reaction.

Table 7.5

bond	bond energy (kJ/mol)	bond	bond energy (kJ/mol)
C–O	452	O–H	499
C–N	770	N–H	331

[3]

(c) **(i)** Deduce and draw the structural formula of the Teflon monomer.

[1]

(ii) Explain, using your knowledge of the kinetic particle theory, how Teflon becomes coated on the surface of a frying pan.

…………………………………………………………………………………………

…………………………………………………………………………………………

……………………………………………………………………………………….. [2]

(d) Based on the information and Fig. 7.3, explain why cooking oil is described as an *ester*.

…………………………………………………………………………………………

…………………………………………………………………………………………

……………………………………………………………………………………….. [2]

(e) **(i)** State the chemical formula of the alkene formed when cooking oil cracks.

…………………………………………………………………………………….… [1]

(ii) Briefly explain why a polymer remains solid at high temperatures.

…………………………………………………………………………………………

…………………………………………………………………………………….… [1]

[Total: 12]

B8 The decomposition of hydrogen peroxide produces oxygen.

Fig. 8.1 shows the apparatus used by a student to measure the volume of oxygen produced at regular time intervals. Large lumps of manganese(IV) oxide are used as the catalyst for the reaction.

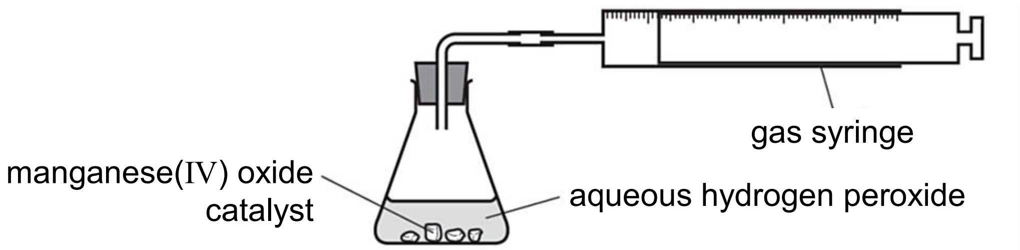


Fig. 8.1

Fig. 8.2 shows a graph of the results.

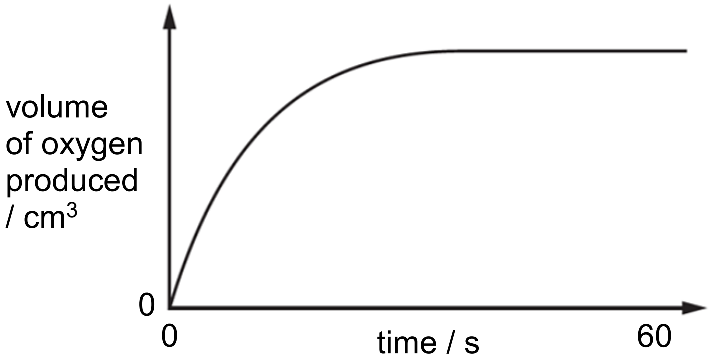


Fig. 8.2

(a) Describe what happens to the rate of reaction as time increases to 60 s, and use ideas about collisions between particles to explain why it changes in this way.

....

....

....

....

....

....

.... [4]

(b) The experiment is repeated using the same mass of powdered manganese(IV) oxide. All other conditions remain the same.

Sketch a graph on the axes of Fig. 8.2 to show how the volume of oxygen will change with time. [1]

(c) The equation for the decomposition of hydrogen peroxide is shown.

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

25.0 cm^3 of aqueous hydrogen peroxide forms 60.0 cm^3 of oxygen at room temperature and pressure.

Calculate the concentration of aqueous hydrogen peroxide at the start of the experiment.

Show your working.

[3]

[Total: 8]

EITHER

B9 The ionisation energy of an atom is the minimum amount of energy required to remove an electron from the atom.

Table 9.1 shows the ionisation energy required to remove the first valence electron from an atom of elements in Period 3, and the chemical formulae of their hydrides.

Table 9.1

element	Na	Mg	A*l*	Si	P	S	C*l*	Ar
ionisation energy (kJ / mol)	496	738	577	786	1060	1000	1256	1520
chemical formula of the hydride	NaH		AlH_3	SiH_4	PH_3	H_2S	HCl	

(a) Describe and explain the general trend in ionisation energy across the Period 3 elements.

....

....

....

.... [2]

(b) **(i)** Complete Table 9.1 by filling in the chemical formula of magnesium hydride. [1]

(ii) Draw a 'dot-and-cross' diagram to show the bonding in phosphorus hydride.

Show outer electrons only.

[2]

(iii) Use ideas about bonding and structure to describe and explain how magnesium hydride and phosphorus hydride would differ in melting point and electricity conductivity.

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[Total: 10]

OR

B9 The chemical equation shows what happens to potassium chlorate(V), $KClO_3$, when it is heated to 400 °C in the presence of a catalyst, copper(II) oxide.

$$2KClO_3 \xrightarrow{CuO} 2KCl + 3O_2$$

Table 9.2 shows some properties of the substances involved in the reaction.

Table 9.2

	$KClO_3$	CuO	KCl	O_2
melting point / °C	356	1326	772	-219
boiling point / °C	–	2000	1407	-183
solubility in water	soluble	insoluble	soluble	slightly soluble
electrical conductivity	conducts in aqueous state		conducts in aqueous and molten states	

(a) **(i)** Explain why there is no boiling point stated for potassium chlorate(V).

.... [1]

(ii) Complete Table 9.2 by describing the electrical conductivity of CuO and O_2. [1]

(iii) Use ideas about bonding and structure to describe and explain the differences in melting and boiling points of CuO, KCl and O_2.

....

....

....

....

....

.... [3]

(b) **(i)** Draw a 'dot-and-cross' diagram to show the bonding in KCl.

Show outer electrons only.

[2]

(ii) Describe how a solution of KCl can be prepared by titration, including the reactants to use.

You do not need to include the apparatus.

....

....

....

....

.... [3]

[Total: 10]

BLANK

The Periodic Table of Elements

Group

I	II											III	IV	V	VI	VII	0
				Key			1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9			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.).