

Name: _____ ()

Class: _____

PRELIMINARY EXAMINATION
GENERAL CERTIFICATION OF EDUCATION ORDINARY LEVEL

CHEMISTRY

Paper 2

6092/02
19 August 2024
1 hour 45 minutes

READ THESE INSTRUCTIONS FIRST

Write your name, register number, and class clearly in the spaces provided at the top of this page.
Write in dark blue or black pen only.
You may use a soft pencil for any diagrams or graphs.
Do not use highlighters, glue, and correction fluid or correction tape.

Section A

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

Section B

Answer **one** question.

Write your answers in the spaces provided.

A copy of Periodic Table is provided on page 22.

The number of marks is given in brackets [] at the end of each question or part question.
The use of a scientific calculator is expected, where appropriate.

For Examiner's Use	
Section A (70)	
Section B (10)	
Total (80)	

This document consists of **22** printed pages and **1** blank page.



圣尼各拉女校
CHIJ ST NICHOLAS GIRLS' SCHOOL

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Section AAnswer **all** questions.

- 1** Use the list of substances to answer the questions.



Each substance can be used once, more than once or not at all.

- (a)** Which covalent substance has a boiling point lower than poly(ethene) but higher than oxygen? Explain your answer in terms of bonding and structure.

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[3]

- (b)** Which substance can be used to make fertilizers?

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[1]

- (c)** Which substance can react with both aqueous sodium hydroxide and hydrochloric acid to form salts?

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[1]

- (d)** Which substance can reduce copper(II) oxide to copper?

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[1]

- (e)** Which substance consists an element with an oxidation state of -3?

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[1]

- (f)** Which substance, in aqueous solution, has the highest pH?

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[1]

[Total: 8 marks]

- 2 The following information was found on a 100PLUS can:

NUTRITIONAL INFO

Serving per package: 1 Serving size: 325ml

	Per serving	Per 100ml
Energy	370 kJ 88 kcal	113 kJ 27 kcal
Total fat	0 g	0 g
Protein	0 g	0 g
Carbohydrate	22.1 g	6.8 g
- Sucrose	15.6 g	4.8 g
- Glucose	6.5 g	2.0 g
Sodium	156 mg	48 mg
Potassium	46 mg	14 mg
Calcium	2 mg	0.6 mg
Chloride	127 mg	39 mg
Phosphate	55 mg	17 mg

Ingredients: Carbonated water, sucrose, glucose, citric acid, sodium citrate, sodium chloride, potassium phosphate, citrus flavouring, preservative (sodium benzoate E211) and calcium phosphate.



These substances exist as **aqueous ions** in the mixture
(1 g = 1000 mg)

- (a) Suggest the formula of a positive ion which is found in 100PLUS, but not listed in the table above. Describe a simple test to confirm the presence of this ion.

.....

 [2]

- (b) A student wanted to prepare a sample of potassium phosphate. Suggest the reagents and method used to prepare aqueous potassium phosphate.

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 [2]

- (c) Describe a test that can be carried out to show the presence of chloride ions in 100PLUS.

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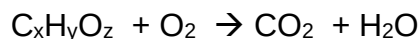
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[2]

- (d) Besides sodium chloride, there are other sodium compounds present in 100PLUS. Using the information given in the table, show by calculation that this is true.

[2]

- (e) The energy which a can (serving) of 100PLUS provides comes from the breaking down of the carbohydrates (sucrose and glucose) in our bodies. This can be represented by the **unbalanced** equation:



Draw an energy profile diagram of the above reaction. Label clearly the reactants and products, enthalpy change and activation energy of the reaction.

[3]

(f) Ethanol can be produced using 100PLUS as the starting reagent. This reaction is like the process of obtaining bioethanol from glucose in sugarcane.

(i) List the conditions and state what must be added for this reaction to occur.

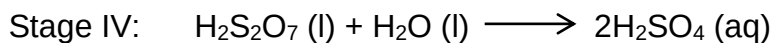
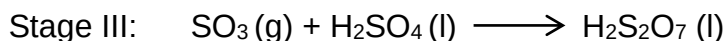
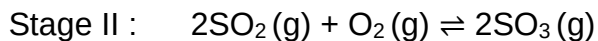
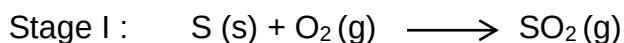
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(ii) Write three chemical equations to explain why bioethanol is considered environmentally sustainable.

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..... [2]

[Total: 15 marks]

- 3** Sulfuric acid, which is used in the manufacture of detergents and fertilisers, is a strong dibasic acid that can be manufactured industrially through the Contact Process. The steps below show the reactions taking place during the Contact Process.



- (a)** Which stage of the process is the pressure least likely to affect the rate of reaction?

..... [1]

- (b)** Stage II occurs in the presence of the catalyst vanadium (V) oxide.

A student thinks that the catalyst reduces the activation energy for the reaction and therefore the enthalpy change of the reaction is lower. Do you agree? Explain your answer.

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 [2]

- (c)** Which of the reactions above are redox reactions? Explain your answer in terms of oxidation state.

.....

 [2]

- (d)** The percentage yield for the production of sulfuric acid from sulfur is only 30 %. Based on the information above, explain why.

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 [1]

- (e) Write the overall chemical equation for Stage I to Stage IV.

..... [1]

- (f) The emissions from a power station contain a significant amount of sulfur dioxide. It is produced due to the combustion of coal that contains sulfur. This reaction is the same as Stage I in the Contact Process. Sulfur dioxide can cause acid rain.

- (i) State another pollutant that causes acid rain and describe how this pollutant is formed.

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..... [2]

- (ii) Using a suitable ionic equation, explain the effect of acid rain on buildings containing zinc structures or limestone.

..... [1]

- (iii) Suggest one substance which can be used to reduce the effects of acid rain on water bodies without leaving behind an alkaline solution.

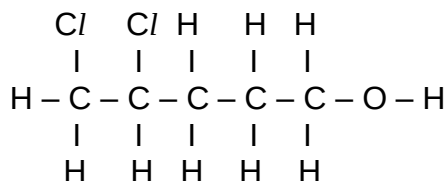
..... [1]

- (iv) State one harmful effect of sulfur dioxide on humans.

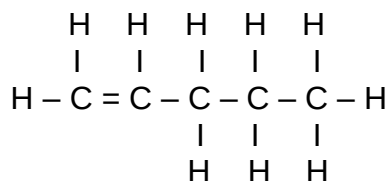
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[Total: 12 marks]

- 4 1,2-dichloropentanol can be synthesized from pent-1-ene using suitable reagents and conditions. The structures of these organic compounds are given below.



1,2-dichloropentanol



pent-1-ene

- (a) Draw the full structural formula of an isomer for 1,2-dichloropentanol that can be oxidized to a carboxylic acid.

[1]

- (b) 1,2-dichloropentanol can be synthesized from pent-1-ene in two separate steps.
State the reagents and conditions for each of the reactions involved.

.....

[2]

- (c) The labels on the bottles containing these two organic compounds had dropped off. Describe a chemical test that can be carried out, together with any observations that you would expect, to identify the compound in each bottle.

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[3]

[Total: 6 marks]

- 5 Chlorine is a group 17 element. Statements 1 to 4, regarding the properties of chlorine and its compounds, are given below.

1. All metal chlorides are soluble in water.
2. Chlorine oxide dissolves in water to form a solution with a pH of less than 7.
3. Chlorine is a weaker oxidizing agent than bromine.
4. Chlorine molecules are far apart and moving randomly at room temperature and pressure.

- (a) Which statements are false? Explain your answer.

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[4]

- (b) Hot iron wool reacts with chlorine gas to form iron(III) chloride ash. The brown iron(III) chloride ash is dissolved in water to form yellow aqueous iron (III) chloride. When iron is added to yellow aqueous iron(III) chloride, green aqueous iron(II) chloride is formed.

- (i) Write a balanced chemical equation for the reaction between hot iron wool and chlorine gas.

..... [1]

- (ii) Explain, in terms of electron transfer, why chlorine is an oxidising agent in the reaction in **b(i)**.

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

- (iii) Describe a chemical test to confirm that iron(II) ions have been formed.

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..... [1]

- (iv) Iron(III) chloride and iron(II) chloride have different chemical properties. Describe a chemical test, other than the one in **b(iii)**, to distinguish them.

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..... [2]

[Total: 9 marks]

- 6 Mass spectrometry is an important technique which can identify the amount and type of chemicals present in a sample by using a machine called a mass spectrometer. In general, the two quantities that can be measured are the mass/charge ratio (m/z) and the relative abundance of particles in the sample.

Mass/charge (m/z) ratio: This is calculated by dividing the mass of an ion by its charge. For example, a sodium-23 ion, $^{23}_{11}\text{Na}^+$, would have a m/z value of 23. Hence, the m/z value of an ion with a charge of $1+$ is essentially its relative mass.

Relative abundance: This refers to the percentage of a particular isotope which occurs in nature. For example, in a sample of chlorine, the relative abundance of chlorine-35 is 75% and chlorine-37 is 25%.

The following steps show how mass spectrometry is done.

Step 1: Ionisation - the sample is vapourised. Energy is then used to knock off one or more electrons from atoms or molecules in the sample, changing them into positive ions. If enough energy is supplied, some bonds of the molecules are broken, and smaller ions are formed eg a ethane molecule can be broken down into smaller ions like CH_2^+ , CH_3^+ .

Step 2: Acceleration – the ions formed from Step 1 are accelerated through the spectrometer by the use of negatively charged plates.

Step 3 : Deflection and detection - the ions are deflected by a magnetic field and are detected electrically.

Step 4: Mass spectrum – the mass spectrometer records the m/z value and relative abundance of all ions in the form of a histogram, called a mass spectrum.

Fig 6.1 shows the mass spectrum of a pure sample of lithium.

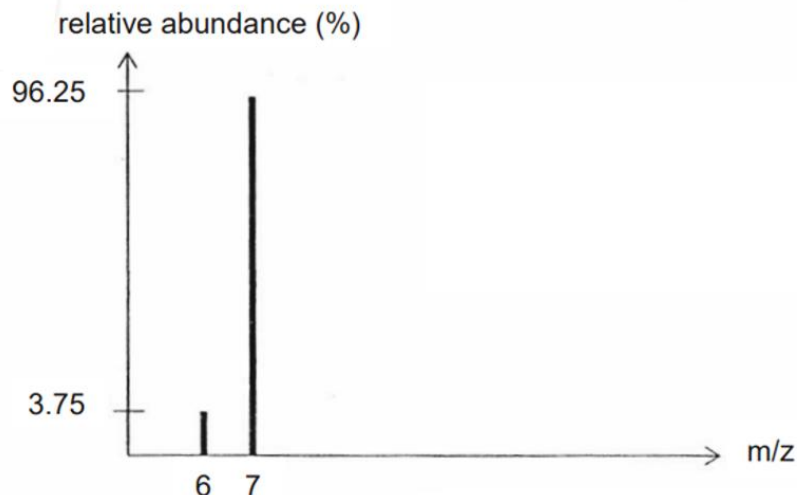


Fig 6.1

Fig 6.2 shows the mass spectrum of a pure sample of chlorine.

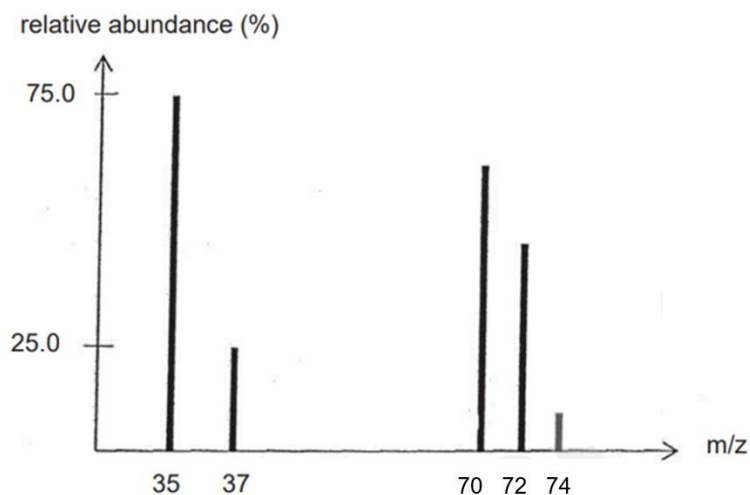


Fig 6.2

Fig 6.3 shows the mass spectrum of a pure sample of an unknown hydrocarbon.

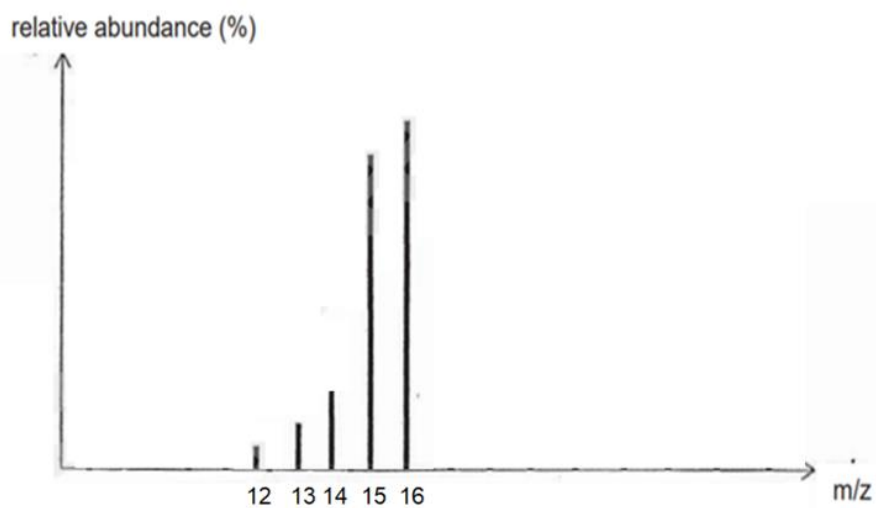


Fig 6.3

(a) (i) Explain how the data in **Fig 6.1** shows that there are two isotopes of lithium.

.....

[2]

(ii) Calculate the average relative atomic mass of lithium.

[1]

(b) Chlorine-35 and chlorine-37 are the only two known isotopes of chlorine. Use the data in **Fig 6.2** to suggest why there were three additional peaks of 70, 72 and 74 on the mass spectrum of chlorine.

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.....[3]

(c) (i) A student comments that the unknown hydrocarbon is methane.
Explain why the data in **Fig 6.3** shows that this is true.

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.....[1]

(ii) Suggest the formula of the ion which has a m/z value of 13.

.....[1]

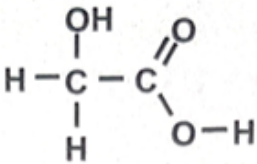
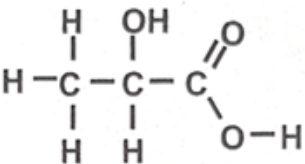
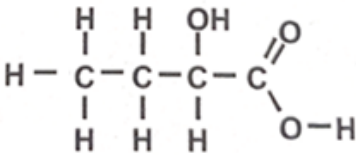
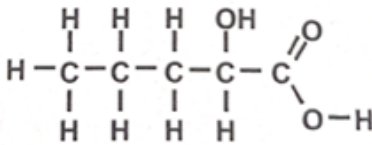
(iii) Another mass spectrometry analysis was carried out on a sample of chloromethane.

State the highest m/z value in the mass spectrum of chloromethane and suggest the species that correspond to this m/z value.

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.....[2]

[Total: 10]

- 7 The table below shows a group of organic compounds known as AHA or alpha hydroxy acids. These compounds are widely used in the cosmetics industry and medically as chemical peels to treat skin.

name	molecular formula	structural formula	pH of 1.0 mol/dm ³ of acid
hydroxyethanoic acid	C ₂ H ₄ O ₃		1.91
hydroxypropanoic acid	C ₃ H ₆ O ₃		1.93
hydroxybutanoic acid	C ₄ H ₈ O ₃		1.99
hydroxypentanoic acid	C ₅ H ₁₀ O ₃		2.07

- (a) Describe what is observed when a magnesium strip is placed in a test tube containing hydroxyethanoic acid dissolved in methylbenzene, an organic solvent. Explain your answer.

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.....[2]

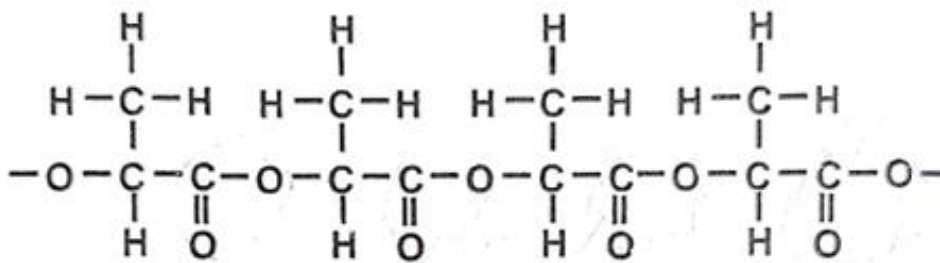
- (b) Explain how the electrical conductivity of the acid is related to its pH value.

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.....[2]

- (c) In an experiment, excess aqueous sodium carbonate is added to 20.0 cm³ of 0.1 mol/dm³ hydroxyethanoic acid. The experiment is repeated using the same volume and concentration of hydroxypentanoic acid. Using collision theory, describe and explain the difference in observation between the two experiments.

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..... [3]

- (d) PLA, or poly(lactic acid), is a biodegradable polymer that is used in medical implants and decomposable packaging materials.



- (i) PLA can be recycled by depolymerization. Draw the structure of the product formed.

[1]

- (ii) Users of non-biodegradable polymers are encouraged to recycle them. Suggest one economic issue of recycling these polymers.

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.....[1]

- (iii) State another chemical method to recycle polymers.

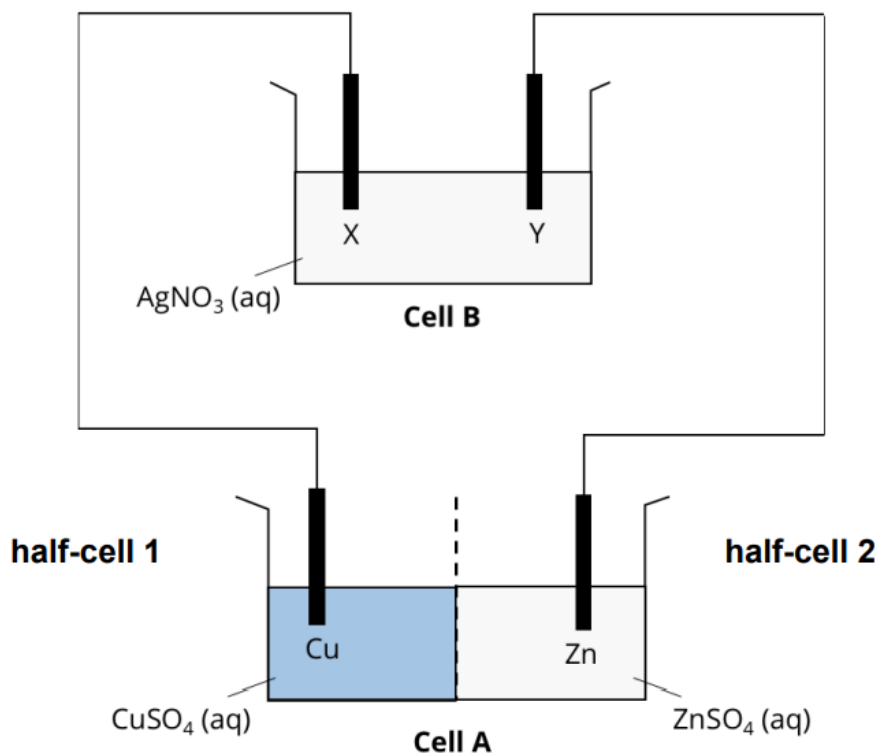
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[Total: 10]

Section B

Answer **one** question from this section.

- 8 The diagram below shows how a copper/zinc cell (Cell A) is used to drive the electrolysis of Cell B. The dotted line in Cell A shows a semi-permeable membrane that keeps the copper(II) sulfate and zinc sulfate solutions from mixing.



- (a) Write half ionic equations to show the reactions that happen at these electrodes in **Cell A**:

Zinc electrode:

.....[1]

Copper electrode

.....[1]

- (b) A student wants to electroplate an object with silver using **Cell B**. At which electrode, X or Y, should the student place the object? Explain your answer.

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..... [2]

- (c) In a second experiment, some students wanted to measure the potential difference of Cell A with the use of a voltmeter. A potential difference of +0.42 V was measured. The students made the following predictions.

James: 'The potential difference of Cell A will become -0.42 V if we switch the positions of half-cell 1 and half-cell 2.'

Megan: 'The potential difference of Cell A will become less than +0.42 V if half-cell 2 was replaced with magnesium and magnesium nitrate.'

Do you agree with James and Megan? Explain your answer.

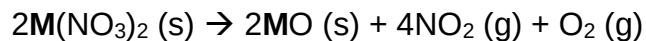
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..... [4]

- (d) In this experiment, 500 cm^3 of 1.0 mol/dm^3 aqueous copper(II) sulfate was used in Cell A. 19.2 g of copper was deposited. Calculate the concentration of copper(II) ions in the electrolyte at the end of the experiment.

[2]

[Total: 10]

- 9 The nitrates of four metals, **A**, **B**, **C** and **D** were heated and the temperature at which the nitrates decomposed were measured. The way the metal nitrates decompose is similar to that of the carbonates,



where **M** is a metal.

metal nitrates	decomposition temperature / °C	colour of metal oxide
nitrate of metal A	200	white
nitrate of metal B	330	white
nitrate of metal C	180	black
nitrate of metal D	630	white

- (a) Using the information from the table, arrange the four metals in order of increasing reactivity. Explain your answer.

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..... [3]

- (b) A student claimed that an unknown metal **E** is the most reactive metal among metals **A**, **B**, **C** and **D**.

Using another method, and the nitrates in the table, suggest how you would verify that the student's claim is true.

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.....[3]

- (c) Metal **E** does not react readily with cold water but reacts vigorously with steam. Suggest the identity of metal **E** and describe how metal **E** can be extracted from its oxide.

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.....[2]

- (d) If the percentage yield of nitrogen dioxide is 90% when 200 kg of magnesium nitrate is heated, calculate the mass of nitrogen dioxide formed.

[2]

[Total: 10]

~~End of Paper~~

The Periodic Table of Elements

Group																						
1	2	Key										13	14	15	16	17	18					
		1 H hydrogen 1																				
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		3	4	5	6	7	8	9	10	11	12	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	22	23	24	25	26	27	28	29	30	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	40	41	42	43	44	45	46	47	48	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	73	74	75	76	77	78	79	80	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	105	106	107	108	109	110	111	112	113 Nh nihonium –			114 Fl flerovium –	115 Lv livermorium –	116 Ts tennessine –	117 Og oganesson –	118 – – –

lanthanoids

actinoids

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	euporium	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
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	—