Name: ( )	Class/TG:

SERVE·LEAD·EXCEL

GREENDALE SECONDARY SCHOOL

Preliminary Examination 2023

CHEMISTRY **6092/01**

Paper 1 Multiple Choice
Secondary 4 Express

25 August 2023
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, class and register number on the Answer Sheet and on the Question Paper 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 on this question paper.
A copy of the Periodic Table is printed on Page 16.
The use of an approved scientific calculator is expected, where appropriate.

This document consists of **18** printed pages.

[Turn over

1 In a volumetric experiment involving the addition of hydrochloric acid to 25.0 cm^3 of aqueous sodium hydroxide it is necessary to determine when the reaction is just complete.

Which piece of apparatus could be used to determine the end-point of the reaction?

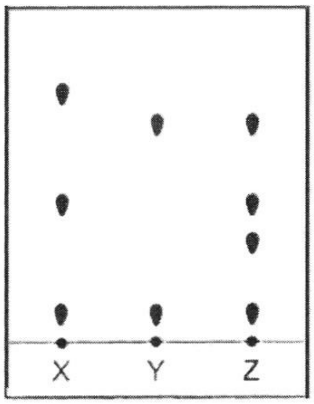
A balance

B gas syringe

C stopwatch

D thermometer

2 X, Y and Z are all mixtures of alcohols. A paper chromatogram is obtained for the samples of X, Y and Z.



Which row is correct?

	statement 1	statement 2
A	Z contains at least four alcohols.	X, Y and Z could contain the same alcohol.
B	Z contains at least four alcohols.	X, Y and Z could not contain the same alcohol.
C	Z contains no more than four alcohols.	X, Y and Z could contain the same alcohol.
D	Z contains no more than four alcohols.	X, Y and Z could not contain the same alcohol.

3 A crystalline product contains a mixture of two salts.

A student tests the mixture to determine which ions are present. The results are shown.

test number	test	observations
1	add dilute nitric acid, then	effervescence as a gas is produced which gives a white precipitate with limewater
	add aqueous silver nitrate	no precipitate is formed
2	add aqueous sodium hydroxide and warm, then	dissolves and a gas is produced turning moist red litmus paper blue
	add aluminium foil	effervescence as a gas is produced which turns moist red litmus paper blue

Which is present in the mixture?

A ammonium carbonate and sodium chloride

B ammonium carbonate and sodium sulfate

C ammonium nitrate and sodium carbonate

D ammonium nitrate and sodium chloride

4 The nucleus of N^{3-} contains a total of 31 particles. 15 of the particles have a charge.

Which statement about the ion is correct?

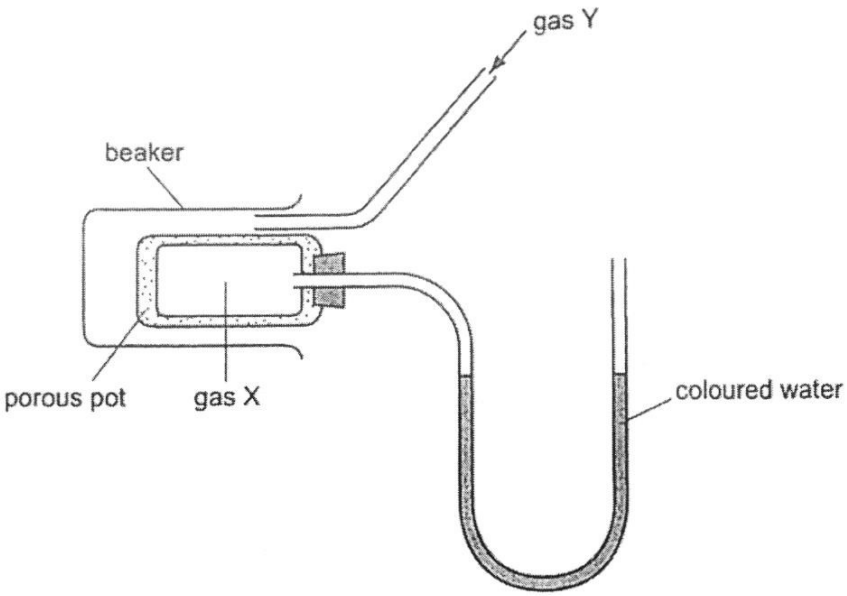
A It contains 15 neutrons and 12 electrons.

B It contains 15 protons and 12 electrons.

C It contains 15 protons and 15 electrons.

D It contains 16 neutrons and 18 electrons.

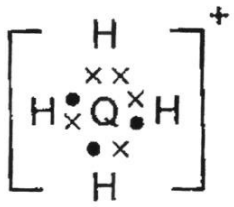
5 The apparatus can be used to show the diffusion of gases.



Which pair of gases X and Y would cause **no** movement of the water?

	X	Y
A	C_2H_4	C_2H_6
B	C_2H_4	N_2
C	CO_2	C_2H_6
D	CO	NO_2

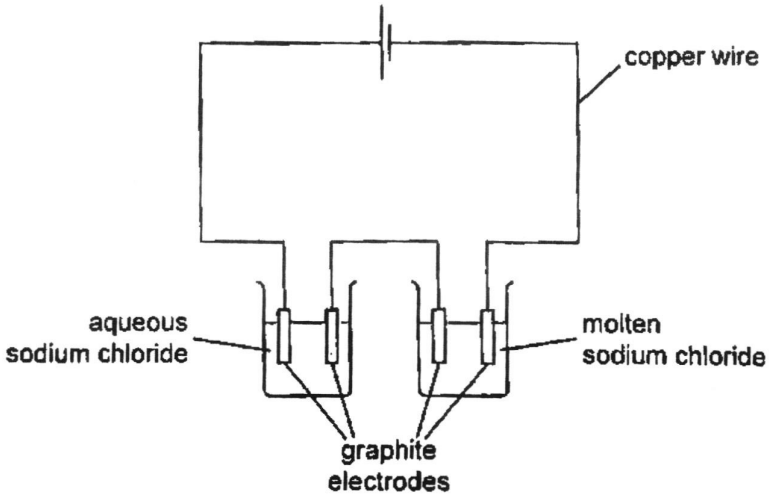
6 The ion QH_4^+ can be represented by the "dot-and-cross" diagram shown.



To which Group in the Periodic Table does Q belong?

A I **B** III **C** IV **D** V

7 The diagram shows the electrolysis of aqueous sodium chloride and of molten sodium chloride.



Which substance has both positive ions and mobile electrons?

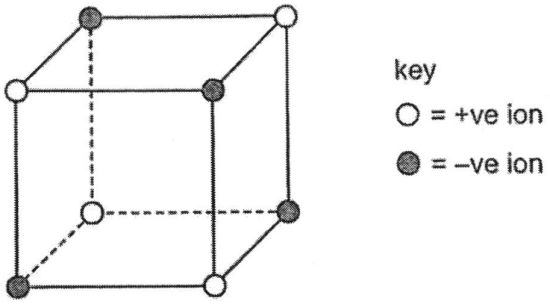
A aqueous sodium chloride

B copper wire

C graphite electrodes

D molten sodium chloride

8 The diagram shows the arrangement of the ions in an ionic crystal.



Which compound **cannot** have this arrangement of the ions?

A calcium oxide, CaO

B copper(II) sulfate, $CuSO_4$

C magnesium chloride, $MgCl_2$

D sodium chloride, $NaCl$

9 8 g of X_2O_3, an oxide of element X, contains 5.6 g of X.

How many moles of X does 5.6 g of the element contain?

A $\frac{2.4}{16} \times \frac{2}{3}$ **B** $\frac{2.4}{16} \times \frac{3}{2}$ **C** $\frac{8}{16} \times \frac{2}{3}$ **D** $\frac{8}{16} \times \frac{3}{2}$

10 What is the ratio of the volume of 2 g of hydrogen to the volume of 16 g of methane, both volumes at r.t.p.?

A 1 to 1 **B** 1 to 2 **C** 1 to 8 **D** 2 to 1

11 Which volume of 0.1 mol/dm^3 hydrochloric acid is required to react completely with 25 cm^3 of 0.2 mol/dm^3 aqueous sodium carbonate?

A 100 cm^3 **B** 50 cm^3 **C** 25 cm^3 **D** 6.25 cm^3

12 The equation for the burning of hydrogen is

$$2H_2(g) + O_2(g) \rightarrow 2H_2O(g)$$

One mole of hydrogen gas is mixed with one mole of oxygen gas and burnt.

What will be present after the reaction?

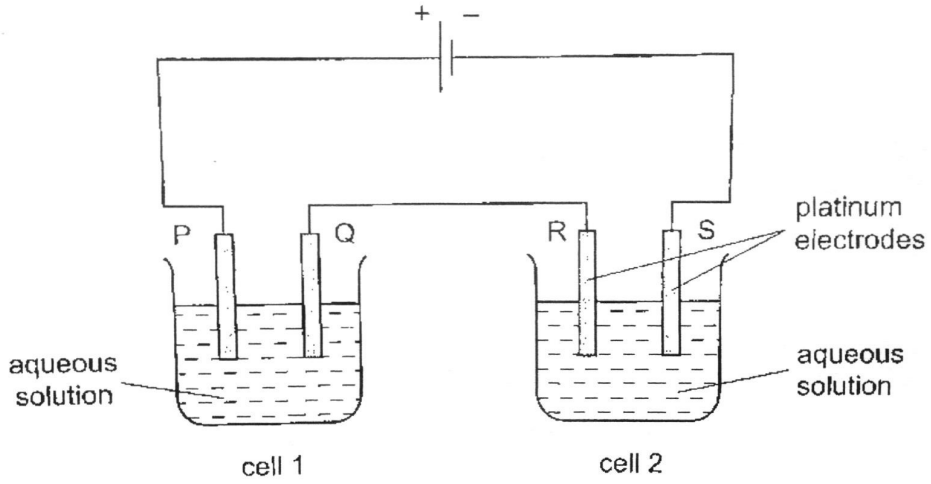
A 1 mol of steam only

B 1 mol of steam + 0.5 mol of oxygen gas

C 1 mol of steam + 0.5 mol of hydrogen gas

D 2 mol of steam only

13 In the diagram, each cell contains an aqueous solution of a single salt and all four electrodes are platinum. Electrodes Q and S increase in mass during the electrolysis but no gas is given off at Q or S.



If the increase in mass of Q is greater than the increase of mass of S in the same time, which statement must be true?

1 The cation of the solution in cell 1 is different from the cation of the solution in cell 2.

2 The current flowing in cell 1 is greater than the current flowing in cell 2.

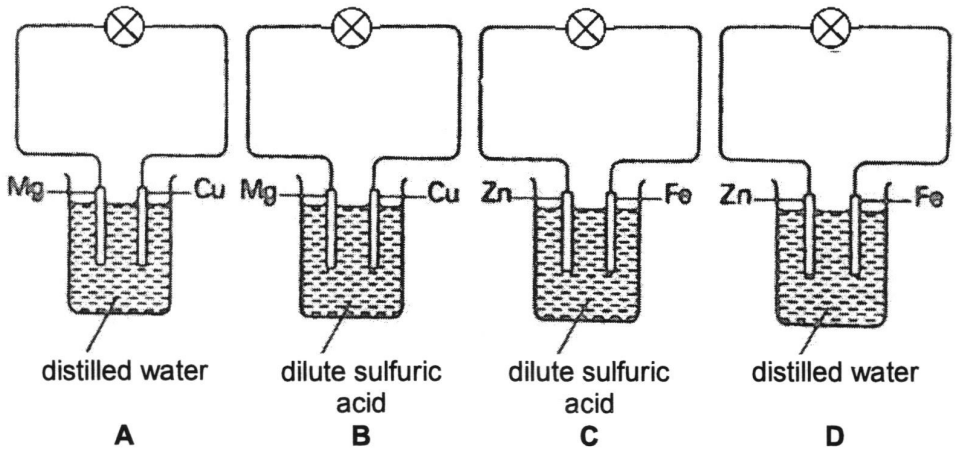
3 The cation in cell 1 is the same as in cell 2 but the solution in cell 1 is more concentrated than in cell 2.

4 The loss of mass of electrode P is less than the loss of mass of electrode R.

A 1 only **B** 1 and 2

C 2 and 3 **D** 4 only

14 In which of the following circuits is the bulb likely to shine most brightly?



15 The scheme shows four stages, I to IV, in the conversion of solid candlewax, $C_{30}H_{62}$, into carbon dioxide and water.

I $C_{30}H_{62}(s) \rightarrow C_{30}H_{62}(l)$

II $C_{30}H_{62}(l) \rightarrow C_{30}H_{62}(g)$

III $C_{30}H_{62}(g) + 45.5O_2(g) \rightarrow 30CO_2(g) + 31H_2O(g)$

IV $30CO_2(g) + 31H_2O(g) \rightarrow 30CO_2(g) + 31H_2O(l)$

Which stages are exothermic?

A I and II **B** II and III

C III and IV **D** I and IV

16 These statements are about the activation energy of a chemical reaction.

1 Chemical reactions in gases and liquids take place when molecules collide with sufficient energy to overcome the activation energy.

2 If the activation energy for a reaction is high, many of the collisions have enough energy to be successful and the reaction is fast.

3 A catalyst reduces the activation energy for a reaction and therefore the overall enthalpy change of the reaction is lower.

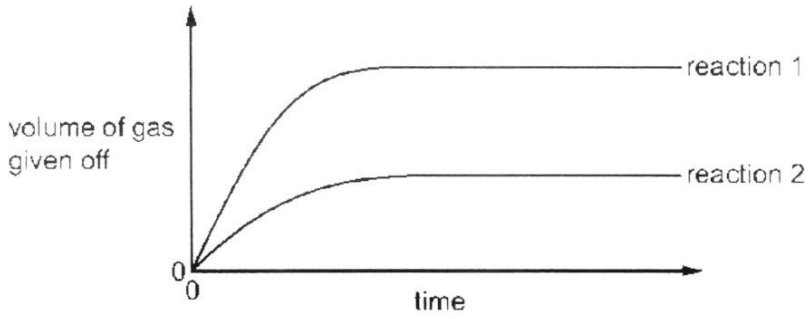
Which statements are correct?

A 1 only **B** 1 and 2

C 2 and 3 **D** 3 only

17 Excess magnesium ribbon is reacted with a fixed volume of hydrochloric acid and the volume of gas given off over time is measured.

The results of two different experiments are shown.



Which statement explains the differences between the results of the two experiments?

A Reaction 1 uses a catalyst.

B The acid used is twice as concentrated in reaction 1.

C The magnesium ribbon is in smaller pieces in reaction 2.

D The temperature is higher in reaction 2.

18 Disproportionation is a reaction in which the same element is both oxidised and reduced.

Which reaction is an example of disproportionation?

A $3Cu + 8HNO_3 \rightarrow 3Cu(NO_3)_2 + 2NO + 4H_2O$

B $Cl_2 + 2NaOH \rightarrow NaCl + NaOCl + H_2O$

C $Fe_2(SO_4)_3 + 2KI \rightarrow 2FeSO_4 + K_2SO_4 + I_2$

D $2Pb(NO_3)_2 \rightarrow 2PbO + 4NO_2 + O_2$

19 The oxides of two elements, X and Y, are separately dissolved in water and the pH of each solution tested.

oxide tested	pH of solution
X	1
Y	13

Which information about X and Y is correct?

	oxide is acidic	oxide is basic	metal	non-metal
A	X	Y	X	Y
B	X	Y	Y	X
C	Y	X	X	Y
D	Y	X	Y	X

20 Salt PQ is to be prepared by reacting the carbonate of P with the acid HQ. The titration method is to be used to carry out the preparation.

What are the solubilities of the carbonate, the acid and the salt?

	carbonate of P	acid HQ	salt PQ
A	insoluble	soluble	insoluble
B	insoluble	soluble	soluble
C	soluble	insoluble	insoluble
D	soluble	soluble	soluble

21 What is the source of hydrogen in the industrial production of ammonia?

A cracking of hydrocarbons

B electrolysis of aqueous sodium hydroxide

C fractional distillation of liquefied air

D reaction of a Group I metal with water

22 The elements sodium to argon form Period 3 of the Periodic Table.

Which row describes the trend across Period 3 from left to right?

	number of outer-shell electrons	tendency to lose electrons
A	decreases	decreases
B	decreases	increases
C	increases	decreases
D	increases	increases

23 These statements are about the Group I elements of the Periodic Table.

1 They are equally reactive.
2 They become less metallic as the proton number increases.
3 They form chlorides of similar formulae.
4 Their melting points increase as the proton number increases.

Which statements are correct?

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

24 Which element in the table is most likely to be a transition metal?

element	melting point in °C	density in g/cm^3	number of chlorides known
A	–7	3.10	2
B	113	2.07	1
C	1083	8.92	2
D	1521	1.12	1

25 The reactions of metals P, Q, R and S are shown.

metal	reaction with water	reaction with hydrochloric acid	reduction of the metal oxide with carbon
P	no reaction	no reaction	reduced
Q	slow	vigorous	no reaction
R	vigorous	vigorous	no reaction
S	very slow	vigorous	reduced

Which is the order of reactivity of the metals?

	least reactive ⟶			most reactive
A	P	S	Q	R
B	P	Q	S	R
C	R	S	Q	P
D	R	Q	S	P

26 Iron is extracted from its ore in a blast furnace in a redox reaction.

Which substance is reduced in the blast furnace?

1 carbon dioxide
2 coke
3 haematite
4 limestone

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

27 Carbon dioxide and methane are both greenhouse gases.

Which activity produces both gases?

A farming animals
B cracking alkanes
C the thermal decomposition of limestone
D use petrol-powered cars

28 Which gas can be removed from the exhaust gases of a petrol-powered car by its catalytic converter?

A carbon monoxide **B** carbon dioxide

C nitrogen **D** steam

29 Which statement about the fractional distillation of petroleum is correct?

A Only one compound is collected at each level of the fractionating column.

B The higher the fractionating column, the greater the temperature.

C The most flammable molecules are collected at the bottom of the fractionating column.

D The molecules reaching the top of the fractionating column have the smallest relative molecular masses.

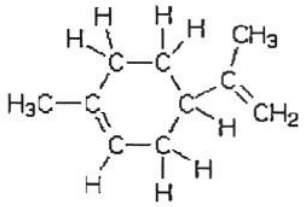
30 Two alkane molecules are isomers.

Which properties will be the same for both molecules?

1 general formula
2 molecular formula
3 structural formula

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

31 The liquid limonene can be extracted from oranges. It has the structural formula shown.



A student made a few statements about limonene.

1 It is a hydrocarbon.
2 It is saturated.
3 It undergoes addition reaction with hydrogen.

Which statements about limonene are correct?

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

32 Alkenes can be produced by cracking large hydrocarbon molecules.

Which equations represent possible reactions when tetradecane, $C_{14}H_{30}$, is cracked?

1 $C_{14}H_{30} \rightarrow C_2H_6 + C_3H_6 + C_4H_8 + C_5H_{10}$

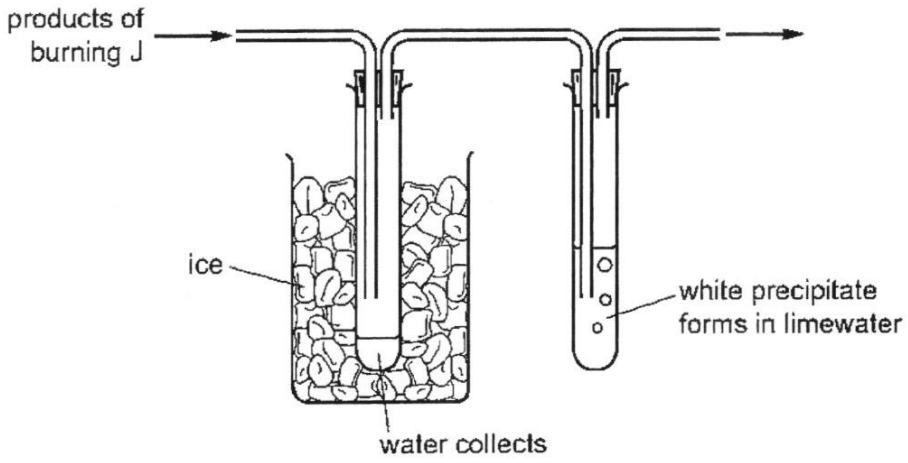
2 $C_{14}H_{30} \rightarrow H_2 + C_2H_4 + C_3H_6 + C_4H_8 + C_5H_{10}$

3 $C_{14}H_{30} \rightarrow C_2H_6 + 4C_3H_6$

4 $C_{14}H_{30} \rightarrow C_2H_6 + C_3H_8 + C_9H_{18}$

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

33 The products formed by burning substance J are passed through the apparatus shown.



What substance is J?

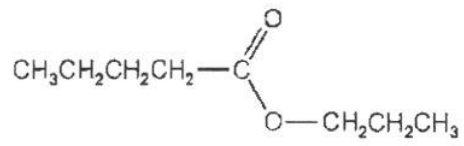
A carbon monoxide **B** ethanol

C hydrogen **D** sulfur

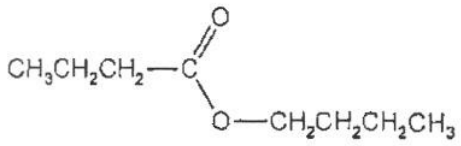
34 Pentanoic acid has the formula $CH_3CH_2CH_2CH_2COOH$.

Which formula represents butyl pentanoate?

A



B



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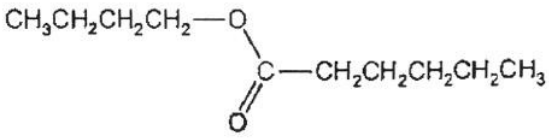
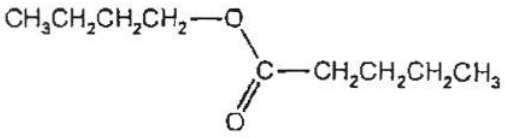


D

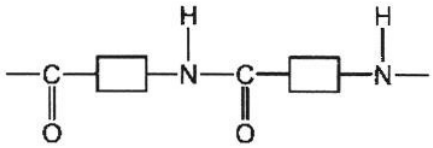


35 In the hydrogenation of a vegetable oil, 3 mol of hydrogen is used for 1 mol of the vegetable oil.

How many moles of carbon-carbon double bonds are there in 1 mol of the vegetable oil?

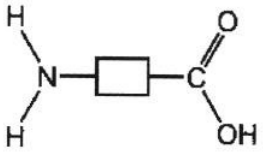
A 1 mol **B** 1.5 mol **C** 3 mol **D** 6 mol

36 The partial structure of a polyamide is shown.



Which monomers would produce this polymer?

1



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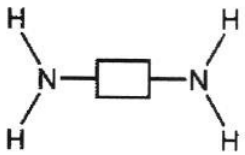

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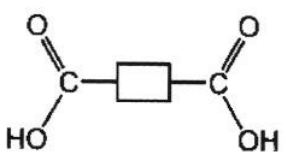
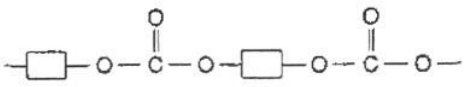


A 1 only **B** 1 and 3 **C** 1, 2 and 3 **D** 2 and 3

37 Poly(carbonates) are synthetic polymers. Their structure can be as shown.



Which of the following has a type of linkage similar to that of a poly(carbonate)?

A nylon

B poly(ethene)

C polyvinyl chloride

D Terylene

38 Scrap iron is often recycled.

Which reason for recycling is **not** correct?

A It reduces the amount of pollution at the site of the ore extraction.

B It reduces the amount of waste taken to landfill sites.

C It reduces the need to collect the scrap iron.

D It saves natural resources.

39 High carbon steel is used in manufacturing processes.

Which properties does high carbon steel have?

1 It is brittle.

2 It is malleable.

3 It is soft.

4 It is strong.

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

40 The table gives information about the ability of four substances to conduct electricity.

substance	
W	does not conduct under any conditions
X	conducts only in aqueous solution
Y	conducts when molten and when solid
Z	conducts when molten and in aqueous solution

What could these four substances be?

	W	X	Y	Z
A	Pb	HC*l*	NaC*l*	S
B	S	HC*l*	NaC*l*	Pb
C	S	HC*l*	Pb	NaC*l*
D	S	NaC*l*	HC*l*	Pb

Name: ( )	Class/TG:

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GREENDALE SECONDARY SCHOOL

Preliminary Examination 2023

Chemistry **6092/02**

Paper 2 **24 August 2023**
Secondary 4 Express **1 hour 45 minutes**

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

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 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 of 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.

For Examiner's Use	
Paper 1	**/ 40**
Paper 2 Section A	**/ 50**
Paper 2 Section B	**/ 30**
Total	**/ 120**

This document consists of **21** printed pages and **1** blank page.

[Turn over

Section A

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

A1 The diagram shows part of the Periodic Table.

I	II								III	IV	V	VI	VII	0
										C	N	O	F	
	Mg								Al				Cl	Ar
K	Ca				Cr				Ni	Cu	Zn					Br	
																I	
									Pt								

Fig. 1.1

Answer the following questions using only the symbols of the elements in the diagram.

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

Give the symbol of the element that:

(a) is a catalyst in the manufacture of margarine

..... [1]

(b) reacts violently with water

..... [1]

(c) is about one percent by volume of dry air

..... [1]

(d) reacts with potassium iodide to form a brown solution

..... [1]

(e) forms an ion with a charge of 2–.

..... [1]

[Total: 5]

A2 In 1886, the modern electrolytic process for the extraction of aluminium was discovered in the USA by C. Hall.

(a) Before this discovery, the only method of extracting the metal was by heating aluminium oxide with sodium in vacuum.

(i) Write a balanced equation for the extraction process.

..... [2]

(ii) Explain why sodium is able to extract aluminium from aluminium oxide.

.....

.....

..... [1]

(b) Aluminium can be produced by the electrolysis of molten aluminium oxide which has a melting point of 2072 °C.

However, for easier electrolysis, aluminium oxide is dissolved in molten cryolite, Na_3AlF_6 and the mixture is maintained at 900 °C. The electrolysis is then carried out using graphite electrodes.

(i) Explain why aluminium oxide must be mixed with cryolite.

.....

..... [1]

(ii) Write an ionic equation at the cathode.

..... [2]

(iii) Suggest why the gas given off at the anode is a mixture of oxygen and carbon dioxide.

.....

.....

.....

..... [2]

[Total: 8]

A3 The structure of malic acid is shown.

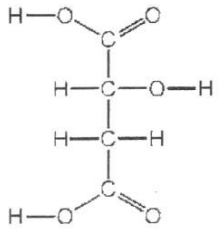

Fig. 3.1

(a) Complete Table 3.2 by giving the results of each tests for aqueous malic acid.

Table 3.2

test	result
add Universal Indicator solution	
add acidified potassium manganate(VII)	

[2]

(b) When malic acid is heated it forms compound F.

The structure of compound F is shown.

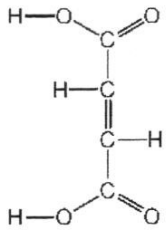

Fig. 3.3

(i) Explain why compound F is described as unsaturated.

.....

..... [1]

(ii) Describe how you could find out if compound F is unsaturated.

.....

.....

.....

..... [2]

A3 **(c)** Compound F can form polymers through addition polymerisation.

(i) State the meaning of addition polymerisation.

.....

.....

.....

..... [2]

(ii) Draw the structural formula of the addition polymer formed by compound F.

Show two repeating units in your drawing.

[1]

[Total: 8]

A4 Bromine is one of the halogens in Group VII.

(a) Bromine is obtained from the bromide ions in sea water. Sea water is concentrated by evaporation. Chlorine gas is bubbled through the solution. Chlorine oxidises the bromide ion to bromine.

(i) Write the ionic equation for the reaction between chlorine and bromide ions.

..... [2]

(ii) Explain using the idea of oxidation states why the bromide ion is oxidised.

.....

.....

.....

.....

..... [2]

(b) Bromine reacts with phosphorus to form phosphorus tribromide.

Draw a diagram showing the arrangement of the valence electrons in one molecule of this covalent compound.

[2]

(c) A compound contains 22.2% carbon, 3.70% hydrogen and 74.1% bromine by mass.

Calculate the empirical formula of this compound.

[2]

[Total: 8]

A5 Some cars have components made from an alloy of aluminium and silicon.

Silicon is extracted from silicon dioxide in sand by heating the sand to 2000 °C in a furnace with carbon. The reaction is shown.

$$SiO_2 + 2C \rightarrow Si + 2CO$$

Sand also contain small amounts of aluminium oxide. Aluminium oxide remains in the silicon after the reaction with carbon and further processes are needed to remove it.

(a) What conclusions can you make from this information about the relative reactivity of carbon, silicon and aluminium?

Use ideas about reduction to explain your answer.

.....

.....

.....

..... [2]

A5 **(b)** Table 5.1 shows information about the oxides of carbon, silicon and aluminium.

Table 5.1

oxide	melting point/°C	electrical conductivity
carbon monoxide	–205	Does not conduct in any state.
silicon dioxide	1600	Does not conduct in any state.
aluminium oxide	2000	Conducts when molten.

(i) Using ideas about bonding and structure, explain the differences between the properties of the oxides of carbon, silicon and aluminium.

.....

.....

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.....

..... [4]

(ii) Deduce the oxides that react with aqueous sodium hydroxide.

..... [2]

[Total: 8]

A6 This question is about ammonia and oxides of nitrogen.

(a) Ammonia is manufactured by the Haber process using finely divided iron as a catalyst.

Explain how a catalyst increases the rate of reaction.

.....

..... [1]

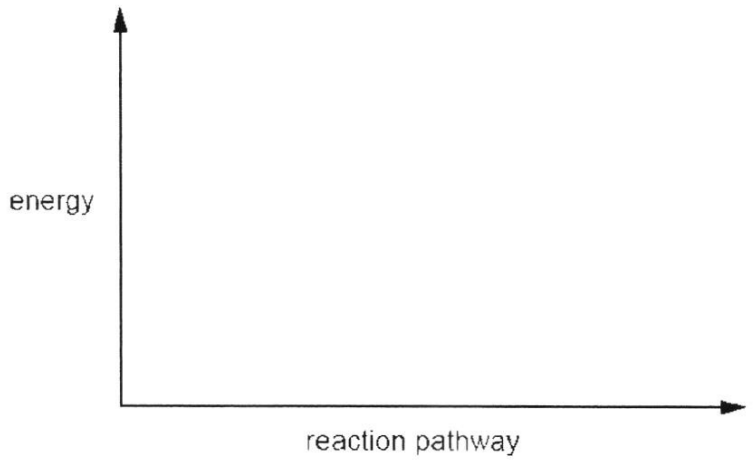
(b) Ammonia can also be formed by the reduction of nitrogen(I) oxide, N_2O, with hydrogen.

The reaction is exothermic.

$$N_2O + 4H_2 \rightarrow 2NH_3 + H_2O$$

Complete and label the energy profile diagram for this reaction to include:

- the reactants and products
- the enthalpy change of the reaction, ΔH
- the activation energy, E_a.



[3]

(c) Nitrogen oxides are pollutants in the atmosphere and contribute to acid rain.

State **one** effect of acid rain on buildings.

.....

.....

..... [1]

[Total: 5]

A7 A student investigates the reaction of 20 cm^3 of 0.1 mol/dm^3 hydrochloric acid with excess calcium carbonate.

$$CaCO_3 + 2HCl \rightarrow CaCl_2 + CO_2 + H_2O$$

The rate of reaction is found by measuring the volume of carbon dioxide gas produced as time increases.

The results are shown on the graph.

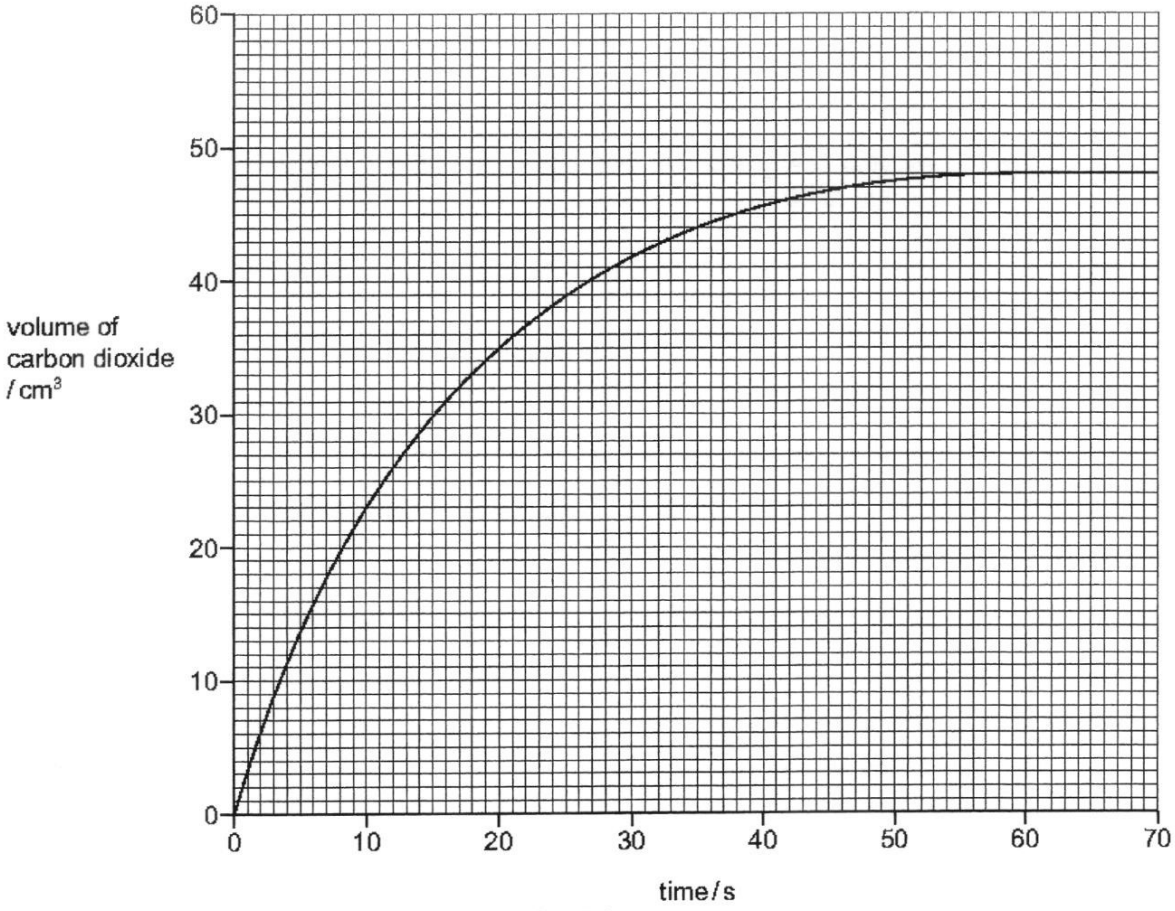


Fig. 7.1

(a) State the time at which half the amount of hydrochloric acid is used.

..... [1]

(b) The experiment is repeated with 0.05 mol/dm^3 hydrochloric acid.

All other conditions stay the same.

Draw a line **on the grid** to show how the volume of carbon dioxide gas produced changes as the time changes. [2]

A7 **(c)** Explain, in terms of collisions between reacting particles, the effect of increasing temperature on the rate of reaction.

.....

.....

.....

.....

.....

..... [3]

(d) Describe how you would use the graph in Fig. 7.1 to determine the speed of the reaction at 40 s.

.....

.....

.....

..... [2]

[Total: 8]

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 Acids and pH

Solutions of different acids of the same concentration (in mol/dm^3) have different properties. The concentration of hydrogen ions, the pH and the rate of reaction with metals and carbonates may be different, even with the initial concentration of the acid is the same.

Table 8.1 gives the information about the solutions of acids at different concentrations.

Table 8.1

name of acid	concentration of acid in mol/dm^3	concentration of hydrogen ions in solution in mol/dm^3	pH
hydrochloric acid	0.01	0.01	2.0
	0.10	0.10	1.0
	0.20	0.20	0.7
sulfuric acid	0.01	0.02	1.7
	0.02	0.04	1.4
ethanoic acid	0.01	0.0004	3.4
	0.05	0.0009	3.0
	0.10	0.0013	2.9

General Equations for Reactions of Acids

Some sources, such as textbooks and websites, represent the general formula of an acid as HA, where A is an anion. HA can be used to give general equations for the reactions of acids.

For example, the reaction of acids with Group II metal hydroxides may be shown as:

equation 1 $2HA + M(OH)_2 \rightarrow MA_2 + 2H_2O$

And the reaction of acids with any metal can be shown as:

equation 2 $xHA + M \rightarrow MA_x + \frac{x}{2} H_2$

where x is the value of the positive charge on the metal ion.

B8 **(a)** **(i)** Which acids in Table 8.1 fit the general formula HA and which do not?

Explain your reasoning with reference to the ions present in each acid.

.....

.....

.....

..... [2]

(ii) Construct a general equation for the reaction of an acid with Group I carbonates.

Use HA as the general formula for an acid and M as the symbol for a Group I metal.

..... [1]

(iii) Write an equation for the reaction of calcium with ethanoic acid.

Show, with reference to the value of x, why equation 2 agrees with your equation.

.....

.....

.....

..... [2]

(b) **(i)** A student looks at the data in Table 8.1 and suggests the following relationship.

$$\text{pH} \propto \frac{1}{\text{initial concentration of acid}}$$

Use the data to show that this relationship is incorrect.

.....

.....

.....

..... [2]

B8 **(b)** **(ii)** State and explain the factors that affect the pH of an acid using the information from Table 8.1.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... [3]

(iii) Complete Table 8.2.

Use the data in Table 8.1 to help you.

Table 8.2

acid	concentration of acid in mol/dm^3	concentration of hydrogen ions in solution in mol/dm^3	predicted pH
nitric acid	0.04		
sulfuric acid	0.05		

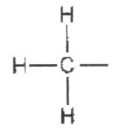
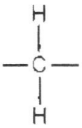
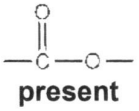
[2]

[Total: 12]

B9 Compounds **X**, **Y** and **Z** are isomers.

Table 9.1 shows some information about each isomer.

Table 9.1

isomer	number of  present	number of  present	number of  present	empirical formula	M_r	pH of 0.1 mol/dm^3 solution
X	1	2	1	C_2H_4O	88	3
Y	2	0	1	C_2H_4O	88	3
Z	2	1	1	C_2H_4O	88	insoluble in water

(a) Which data in Table 9.1 best support the statement that X, Y and Z are isomers?

.....

.....

..... [1]

(b) Use the information in Table 9.1 to deduce and draw the structural formula for each isomer.

Identify the functional group present in each isomer.

isomer X

functional group .....

isomer Y

functional group .....

isomer Z

functional group .....

[5]

(c) Magnesium was added to a solution of isomer **X** and to a solution of isomer **Y**.

State and explain what you would expect to observe during these reactions.

Include reference to rate of reaction in your answer.

.....

.....

.....

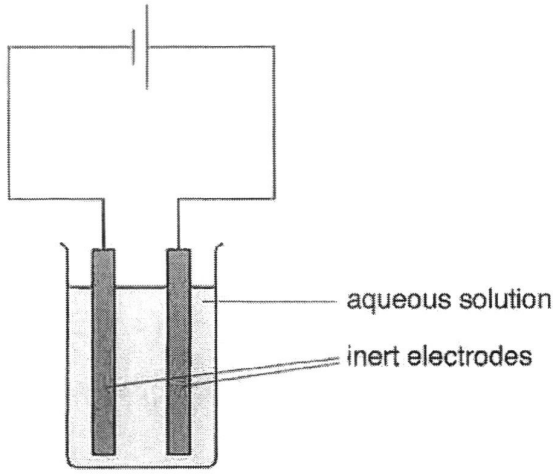
..... [2]

[Total: 8]

EITHER

B10 Copper(II) chloride and copper(II) sulfate are both copper salts.

(a) The diagram shows the apparatus that a student used to electrolyse aqueous solutions of the salts.



Complete Table 10.1.

Table 10.1

solution	name of products of electrolysis		ionic equation for reaction at each electrode
concentrated aqueous copper(II) chloride	at negative electrode		
	at positive electrode		
dilute aqueous copper(II) chloride	at negative electrode		
	at positive electrode		

[4]

B10 (b) The student did some tests using four reagents, A, B, C and D.

In each test he added a different reagent to separate fresh samples of aqueous copper(II) chloride and copper(II) sulfate.

Table 10.2 shows what reagents he used.

	reagent
A	zinc powder
B	acidified aqueous silver nitrate
C	acidified aqueous barium nitrate
D	aqueous sodium hydroxide

(i) Which two reagents give the **same** observations for both aqueous copper(II) chloride and aqueous copper(II) sulfate?

..... [1]

(ii) Describe what the student would **observe** when he adds each of the four reagents to separate fresh samples of aqueous copper(II) chloride and aqueous copper(II) sulfate.

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..... [5]

[Total: 10]

OR

B10 (a) Magnetite, Fe_3O_4, is one form of iron oxide in iron ore.

Calculate the percentage by mass of iron in magnetite.

[2]

(b) When iron is extracted from haematite, Fe_2O_3, in the blast furnace, waste gases and solid waste products are formed.

(i) Name three main waste products of this process.

.....

..... [2]

(ii) Write equations to show how they are formed.

.....

.....

..... [3]

(c) The Statue of Liberty in New York is made from an iron frame covered with copper plates.

In 2004, work had to be carried out to stop the iron frame from rusting away.

The iron frame was rusting much faster than normal where it was in contact with the copper.

(i) Explain why copper in contact with iron causes the **iron** to rust faster than normal.

.....

.....

.....

..... [2]

(ii) Would you expect the **copper** in contact with iron to corrode faster or slower than normal?

Explain your reasoning.

.....

.....

.....

..... [1]

[Total: 10]

4E Chemistry Prelim Exam 2023

Answers

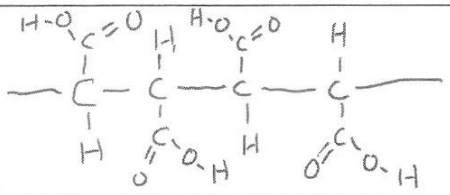
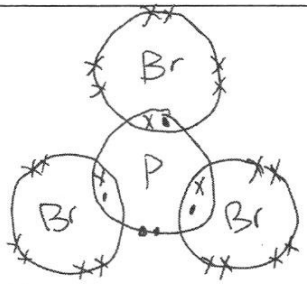
Paper 1

1	2	3	4	5	6	7	8	9	10
D	A	C	D	B	D	B	C	A	A
11	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
A	B	A	B	C	A	B	B	B	D
21	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
A	C	C	C	A	B	A	A	D	A
31	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**
B	C	B	D	C	A	D	C	B	C

Paper 2 Section A

Qn	Answer	Mark
1(a)	Ni	[1]
1(b)	K	[1]
1(c)	Ar	[1]
1(d)	F / C*l* / Br	[1]
1(e)	O	[1]
	TOTAL	**[5]**
2(a)(i)	$Al_2O_3 + 6Na \rightarrow 3Na_2O + 2Al$	[2]
2(a)(ii)	Sodium is more reactive than aluminium, so it displaces and extract aluminium from aluminium oxide.	[1]
2(b)(i)	To lower the melting point of aluminium oxide	[1]
2(b)(ii)	$Al^{3+}(l) + 3e^- \rightarrow Al(l)$	[2]
2(b)(iii)	Oxide anion is discharged as oxygen gas at the anode. The oxygen gas then reacts with the carbon of graphite electrode to form carbon dioxide gas.	[1] [1]
	TOTAL	**[8]**
3(a)	<table><tr><th>test</th><th>result</th></tr><tr><td>add Universal Indicator solution</td><td>(Universal Indicator turns from) green to yellow/orange</td></tr><tr><td>add acidified potassium manganate(VII)</td><td>(acidified potassium manganate(VII) turns from) purple to colourless</td></tr></table>	[1] [1]
3(b)(i)	It has carbon-carbon double bonds.	[1]
3(b)(ii)	Add F into aqueous bromine. If aqueous bromine turns from reddish brown to colourless, it is unsaturated.	[1] [1]

<table>
<tr><th>Qn</th><th>Answer</th><th>Mark</th></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td>3(c)(i)</td><td>A process where many unsaturated monomers bond together to form large molecules / long chain molecules / macromolecules without losing any molecules / atoms.</td><td>[1]

[1]</td></tr>
<tr><td>3(c)(ii)</td><td>  </td><td>[1]</td></tr>
<tr><td></td><td>TOTAL</td><td>[8]</td></tr>
<tr><td>4(a)(i)</td><td>$Cl_2(g) + 2Br^-(aq) \rightarrow Br_2(aq/l) + 2Cl^-(aq)$</td><td>[2]</td></tr>
<tr><td>4(a)(ii)</td><td>The oxidation state of bromine <u>increases</u> from <u>-1 in bromide ion</u> to <u>0 in bromine</u>.</td><td>[1]
[1]</td></tr>
<tr><td>4(b)</td><td>  </td><td>[1]

[1]</td></tr>
<tr><td>4(c)</td><td>
<table>
<tr><td>Element</td><td>C</td><td>H</td><td>Br</td></tr>
<tr><td>Mass/g</td><td>22.2</td><td>3.70</td><td>74.1</td></tr>
<tr><td>Amount/mol</td><td>$\frac{22.2}{12} = 1.85$</td><td>$\frac{3.7}{1} = 3.7$</td><td>$\frac{74.1}{80} = 0.926$</td></tr>
<tr><td>Mole ratio</td><td>$\frac{1.85}{0.926} = 2.0$</td><td>$\frac{3.7}{0.926} = 4.0$</td><td>$\frac{0.926}{0.926} = 1.0$</td></tr>
</table>
Empirical formula = C_2H_4Br</td><td>[1]

[1]</td></tr>
<tr><td></td><td>TOTAL</td><td>[8]</td></tr>
<tr><td>5(a)</td><td>Carbon is more reactive than silicon and is able to reduce silicon dioxide to silicon.

Carbon is less reactive than aluminium as carbon cannot reduce aluminium oxide to aluminium.

(Increasing reactivity: silicon, carbon, aluminium)</td><td>[1]

[1]</td></tr>
<tr><td>5(b)(i)</td><td>Carbon monoxide is a covalent compound with simple molecular / covalent structure.</td><td>[4]</td></tr>
</table>

Qn	Answer	Mark

Hence, smaller amount of energy is needed to overcome the weak intermolecular forces of attraction between the molecules. Hence CO has low melting point.

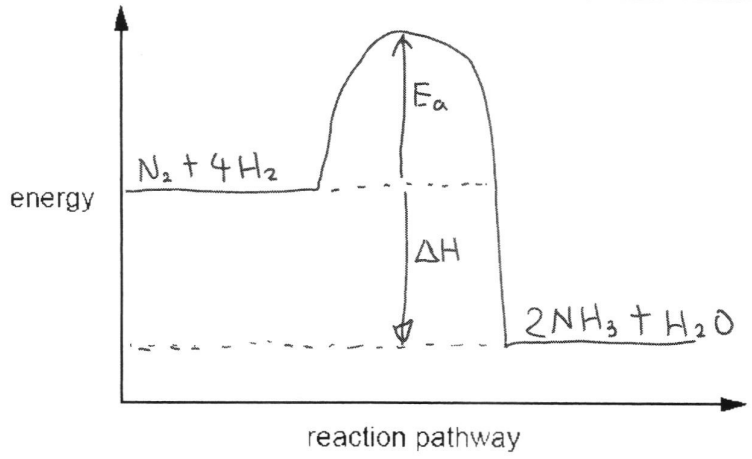
Silicon dioxide is a covalent compound with giant molecular / covalent structure.
Large amount of energy is needed to overcome the many strong covalent bonds between silicon atoms and oxygen atoms. Hence, SiO_2 has a very high melting point.

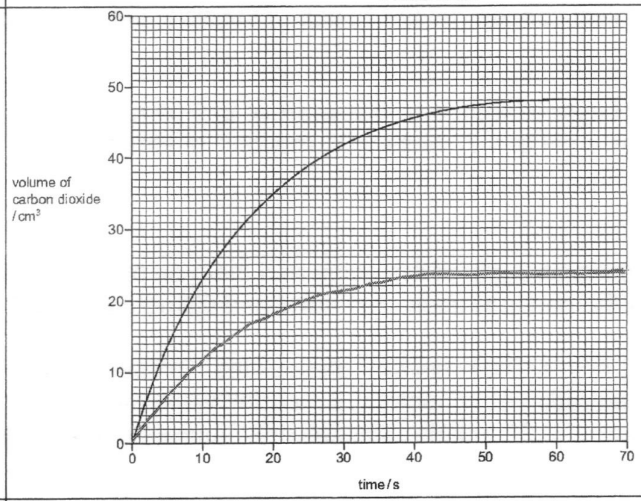
Aluminium oxide is an ionic compound with giant ionic / crystal lattice structure.
Large amount of energy is needed to overcome strong electrostatic forces of attraction between aluminium cations and oxide anions. Hence, Al_2O_3 has high melting point.

CO and SiO_2 cannot conduct electricity as both have no charge carriers, no free moving ions and electrons to conduct electricity as all the valence electrons are used up for bonding.

In molten state, the giant ionic / crystal lattice structure of Al_2O_3 breaks down, hence there are free moving aluminium cations and oxide anions to conduct electricity.

	Al_2O_3	SiO_2	CO
bonding	ionic	covalent	Covalent
structure	has a giant ionic / crystal lattice structure	has a giant molecular / covalent structure	has a simple molecular / covalent structure
energy required and	Large amount of energy needed to overcome	Large amount of energy needed to overcome	Small amount of energy needed to overcome
Attractive forces and	strong electrostatic forces of attraction between aluminium cations and oxide anions.	strong covalent bonds between silicon atoms and oxygen atoms.	weak intermolecular forces of attraction between molecules.
melting & boiling points	highest, melting point higher than 25°C	high, melting point higher than 25°C	lowest, boiling point lower than 25°C
Electrical conductivity	In molten state, the giant ionic /	SiO_2 does not conduct	CO cannot conduct

Qn	Answer				Mark
		crystal lattice structure of Al_2O_3 breaks, hence there are free moving aluminium cations and oxide anions to conduct electricity.	electricity as all the valence electrons are used up for bonding and there are no free moving electrons to conduct electricity.	electricity as it has no charge carriers, no free moving ions and electrons to conduct electricity.	
5(b)(ii)	Silicon dioxide Aluminium oxide				[1] [1]
				TOTAL	**[8]**
6(a)	Catalysts provide an alternative (reaction) pathway that has lower <u>activation energy</u>.				[1]
6(b)					[1] [1] [1]
6(c)	Acid rain <u>corrodes</u> buildings made of <u>limestone / marble / metal</u>.				[1]
				TOTAL	**[5]**
7(a)	<u>10.5 min</u>				[1]

Qn	Answer	Mark
7(b)		[1] [1]
7(c)	When the temperature of the acid is increased, the acid particles gain energy and the number of particles having energy equal or greater than activation energy increases; The particles collide at higher frequency and thus, the frequency of effective collisions between the reactant particles increases; Hence, rate of reaction increases.	[1] [1] [1]
7(d)	Draw a <u>tangent</u> to the graph <u>at 40 s</u>; Calculate the gradient / slope of the tangent which is the speed of reaction.	[1] [1]
	TOTAL	**[8]**

Section B

Qn	Answer	Mark
8(a)(i)	Hydrochloric acid and ethanoic acid. Both hydrochloric acid and ethanoic acid are monobasic acids - one mole of the acid produces one mole of hydrogen ions, H^+. So they fit the formula, HA. As for sulfuric acid, it is a dibasic acid – one mole of the acid produces two moles of H^+ ions. Hence, it does not follow the general formula of HA.	 [1] [1]
8(a)(ii)	$2HA + M_2CO_3 \rightarrow 2MA + H_2O + CO_2$	[1]
8(a)(iii)	$2CH_3COOH + Ca \rightarrow Ca(CH_3COO)_2 + H_2$ Hence, following equation 2, $x = 2$ By substituting $x = 2$ and CH_3COO^- as A^-, this equation follows equation 2.	[1] [1]

<table>
<tr><th>Qn</th><th>Answer</th><th>Mark</th></tr>
<tr><td>8(b)(i)</td><td>For the same initial concentration of each of the acid, the pH is not the same;

0.01 mol/dm^3 of hydrochloric acid has a pH of 2, 0.01 mol/dm^3 of sulfuric acid has a pH of 1.7, while 0.01 mol/dm^3 of ethanoic acid has a pH of 3.4;</td><td>[1]

[1]</td></tr>
<tr><td>8(b)(ii)</td><td>The factors are the strength of the acids and the type of acids, both of which affect the concentration of H^+ ions and ultimately the pH;

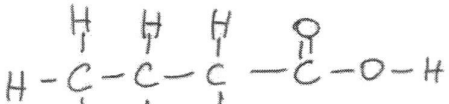
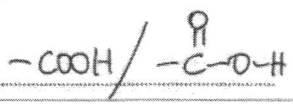
Dibasic sulfuric acid of 0.01 mol/dm^3 dissociates / ionises to produce twice the concentration of H^+ ions 0.02 mol/dm^3 while monobasic hydrochloric acid of 0.01 mol/dm^3 dissociates / ionises to produce the same concentration of H^+ ions 0.01 mol/dm^3;

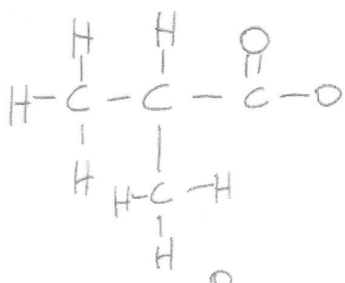
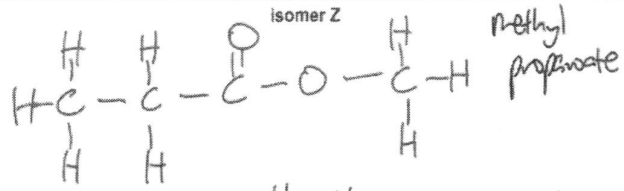
Ethanoic acid is a weak acid, where 0.01 mol/dm^3 of the acid undergoes partial ionisation to produce 0.0004 mol/dm^3 of H^+ ions which is much lower than 0.01 mol/dm^3 of H^+ ions of a strong acid hydrochloric acid at the same concentration;</td><td>[1]

[1]

[1]</td></tr>
<tr><td>8(b)(iii)</td><td><table><tr><th>acid</th><th>concentration of hydrogen ions in mol/dm^3</th><th>predicted pH</th></tr><tr><td>hydrochloric acid</td><td>0.04</td><td>1.6</td></tr><tr><td>sulfuric acid</td><td>0.10</td><td>0.5</td></tr></table></td><td>[1]

[1]</td></tr>
<tr><td></td><td>TOTAL</td><td>[12]</td></tr>
<tr><td>9(a)</td><td>Molecular mass AND the number of $-CH_3$ and $-CH_2-$ bonds present.

(Same molecular mass indicates that they have the same molecular formula but different structural formula, consisting the different number of $-CH_3$ and $-CH_2-$ groups.)</td><td>[1]</td></tr>
<tr><td>9(b)</td><td>Isomer X
 
functional group –COOH /  </td><td>[2]</td></tr>
</table>

Qn	Answer	Mark
	isomer Y  functional group ..... $-COOH$ / $-\overset{O}{\overset{\|}{C}}-O-H$ isomer Z  methyl propanoate ethyl ethanoate functional group ..... $-\overset{O}{\overset{\|}{C}}-O-$ / $-COO-$	[3]
9(c)	Effervescence observed **AND** Magnesium reacts readily / moderately with each isomer, and displaces the hydrogen ions in carboxylic acids, weak acids, to form hydrogen gas. Rate of reaction is the same for both weak acids as the pH is the same.	[1] [1]
	TOTAL	**[8]**
E10a	negative electrode: copper **AND** $Cu^{2+}(aq) + 2e- \rightarrow Cu(s)$ positive electrode: chlorine gas **AND** $2Cl^{-}(aq) \rightarrow Cl_2(g) + 2e-$ negative electrode: copper **AND** $Cu^{2+}(aq) + 2e- \rightarrow Cu(s)$ positive electrode: water **AND** oxygen gas **AND** $4OH^{-}(aq) \rightarrow 2H_2O(l) + O_2 + + 4e-$	[1] [1] [1] [1]
E10bi	A **AND** D	[1]
E10bii	A: both solutions turned from blue to colourless and pink/reddish brown solid formed.	[1] [1]

Qn	Answer	Mark
	B: white precipitate formed when B is added to copper(II) chloride **AND** Blue solution remained blue when B is added to copper(II) sulfate / No precipitate formed. C: Blue solution remained blue when C added to copper(II) chloride / No precipitate formed. **AND** White precipitate formed when C added to copper(II) sulfate. D: both solutions formed blue precipitate which is insoluble in excess NaOH(aq).	[1] [1] [1]
	TOTAL	**[10]**
O10a	Percentage by mass of iron in magnetite $= \frac{3\times56}{56\times3+16\times4}$ x 100% = 72.4%	[1] [1]
O10bi	Carbon dioxide **AND** carbon monoxide calcium silicate / slag	[1] [1]
O10bii	$Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$ $C + CO_2 \rightarrow 2CO$ $CaO + SiO_2 \rightarrow CaSiO_3$	[1] [1] [1]
O10ci	Iron is more reactive than copper, So it will lose electrons to copper.	[1] [1]
O10cii	Slower **AND** iron corrode in place of copper, providing <u>sacrificial protection</u>.	[1]
	TOTAL	**[10]**