Name	Class				Index Number		

BROADRICK SECONDARY SCHOOL
SECONDARY 4 EXPRESS
PRELIMINARY EXAMINATION 2021

CHEMISTRY 6092/01

Paper 1 Multiple Choice

September 2021

Additional Materials: Multiple Choice Answer Sheet 1 hour

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, highlighters, glue or correction fluid.
Write your name, class and index number on the Answer Sheet 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 in this question paper.

A copy of the Periodic Table is printed on page 2.

The total marks for this paper is 40.

For Examiner's Use
40

This document consists of **17** printed pages including this cover page.

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The Periodic Table of Elements

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

Key

proton (atomic) number
atomic symbol
name
relative atomic mass

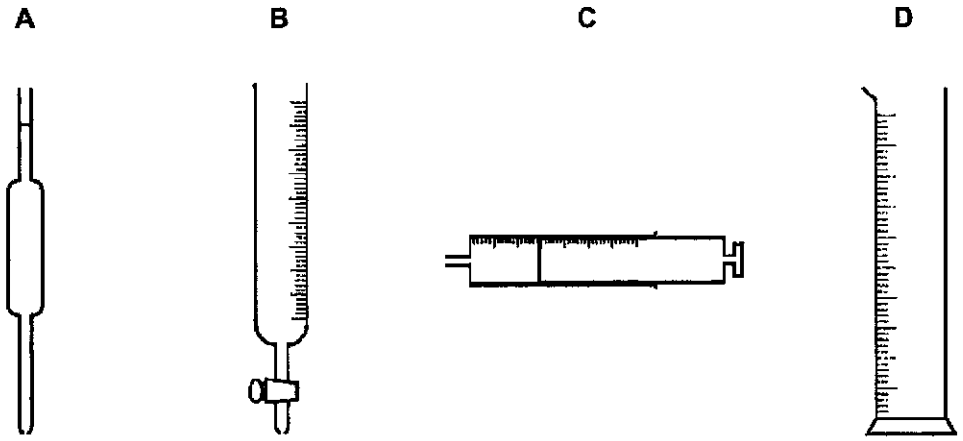
lanthanoids	57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium –	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175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

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

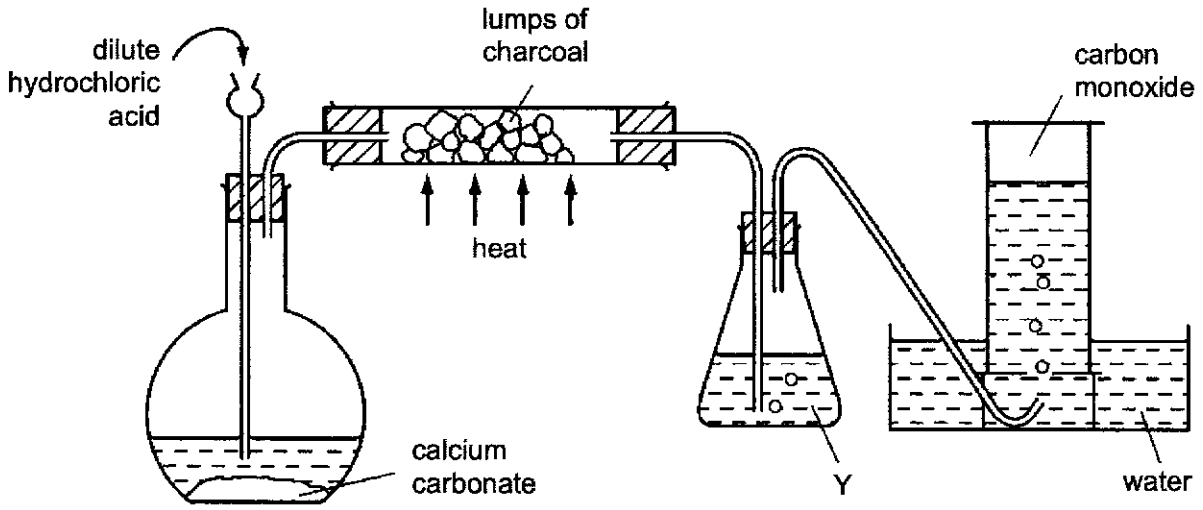
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1 The diagram shows four pieces of apparatus that are used to measure the volume of a gas or liquid.

Which piece of apparatus should always be filled to the same level?



2 The diagram shows apparatus used to obtain carbon monoxide.



What is the main purpose of Y?

A to dry the gas

B to prevent water from being sucked back on to the hot charcoal

C to remove carbon dioxide from the gas

D to remove hydrogen chloride from the gas

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3 The following measurements are made on some pure water:

- its boiling point (b.p.)
- its freezing point (f.p.)
- its pH

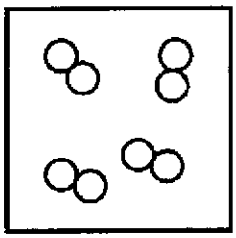
Sodium chloride is now dissolved in the water and the measurements are repeated.

Which measured values will change?

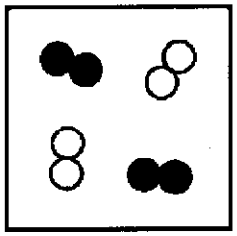
	b.p.	f.p.	pH
A	✓	✓	✓
B	✓	✓	✗
C	✗	✗	✓
D	✗	✗	✗

4 Which diagram shows a mixture of an element and a compound?

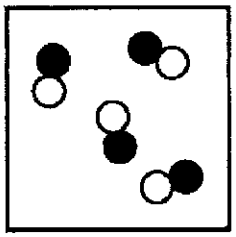
A



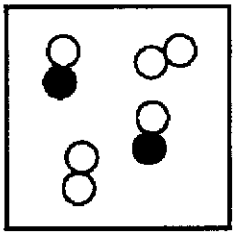
B



C



D



5 The melting points and boiling points of four elements are shown.

element	melting point / °C	boiling point / °C
W	-7	60
X	-101	-34
Y	114	184
Z	39	688

In which elements do the particles vibrate about fixed positions at 0 °C?

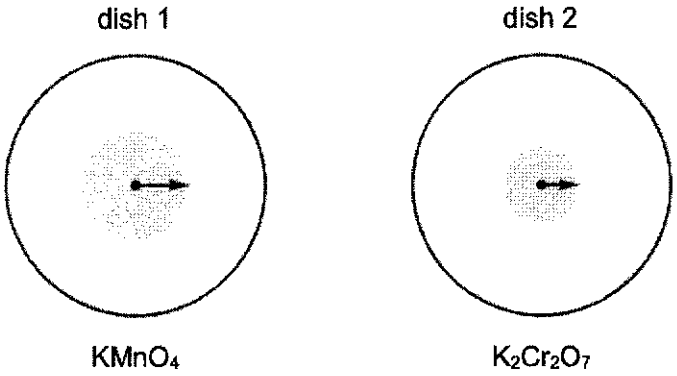
A W and X **B** W and Z **C** X and Y **D** Y and Z

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6 Small crystals of purple potassium manganate(VII), $KMnO_4$, and orange potassium dichromate(VI), $K_2Cr_2O_7$, were placed at the centres of separate petri dishes filled with agar jelly. They were left to stand under the same physical conditions.

After some time, the colour of each substance had spread out as shown.



The lengths of the arrows indicate the relative distances travelled by particles of each substance.

Which statement is correct?

A Diffusion is faster in dish 1 because the mass of the particles is greater.

B Diffusion is faster in dish 2 because the mass of the particles is greater.

C Diffusion is slower in dish 1 because the mass of the particles is lower.

D Diffusion is slower in dish 2 because the mass of the particles is greater.

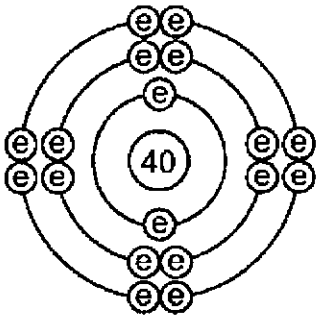
7 Which row shows the properties of a particle present in a hydrogen atom, ${}^{1}_{1}H$?

	relative charge	relative mass
A	0	1
B	0	$\frac{1}{1836}$
C	+1	1
D	+1	$\frac{1}{1836}$

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8 The diagram shows the electronic structure of a particle with a nucleon number (mass number) of 40.



The table shows the suggestions that three students, 1, 2 and 3, made to identify the particle.

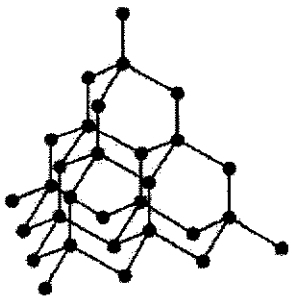
	student		
	1	2	3
particle	Ar	C*l*	Ca^{2+}

Which students are correct?

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

9 Which diagram best represents the structure of a substance that is a good conductor of electricity at 25 °C?

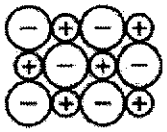
A



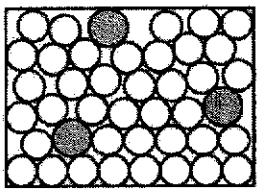
B



C



D



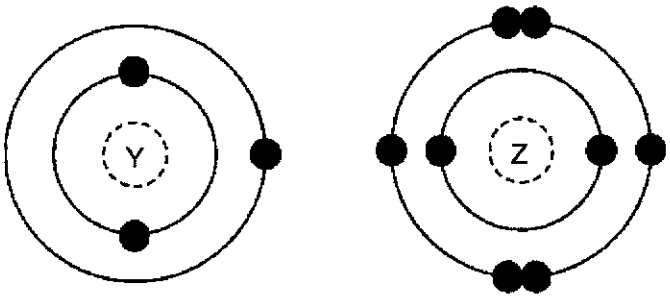
10 How many electrons are shared between the atoms in a molecule of methane, CH_4, and in a molecule of water, H_2O?

	methane	water
A	4	2
B	4	4
C	8	2
D	8	4

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11 The electronic structures of two atoms, Y and Z, are shown.



Y and Z combine together to form a compound.
What is the type of bonding in the compound and what is the formula of the compound?

	type of bonding	formula
A	covalent	YZ_2
B	covalent	Y_2Z
C	ionic	YZ_2
D	ionic	Y_2Z

12 Which statement describes the attractive forces between molecules (intermolecular forces)?

A They are strong covalent bonds which hold molecules together.

B They are strong ionic bonds which hold molecules together.

C They are weak forces formed between covalently-bonded molecules

D They are weak forces which hold ions together in a lattice.

13 Sulfur and selenium (Se) are found in the same group of the Periodic Table.

What are the expected formulae of the compounds that contain selenium?

A SeO, Na_2Se and $NaSeO_4$

B SeO_2, Na_2Se and $NaSeO_4$

C SeO_2, Na_2Se and Na_2SeO_4

D SeO_3, NaSe and $NaSeO_4$

14 A piece of chalk has a mass of 23.0 g. Chalk is impure calcium carbonate.
When analysed, the chalk is found to contain 0.226 moles of pure calcium carbonate, $CaCO_3$.

What is percentage purity of the piece of chalk?
[M_r: $CaCO_3$, 100]

A 0.983 % **B** 1.02 % **C** 77.0 % **D** 98.3 %

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15 Magnesium reacts with dilute hydrochloric acid according to the equation shown.

$$Mg + 2HCl \rightarrow MgCl_2 + H_2$$

2.4 g of magnesium is reacted with 100 cm^3 of 1 mol/dm^3 of dilute hydrochloric acid.

The following statements are made.

1 1.2 dm^3 of hydrogen is formed.
2 4.75 g of magnesium chloride is formed.
3 0.2 g of hydrogen is formed.
4 No magnesium is left when the reaction is completed.

Which statements about the reaction are correct?

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

16 There are two monobasic acids with the same concentration of 1.0 mol/dm^3.
One of them is a weak acid while the other is a strong acid.

Which of the following methods are suitable to test the acid strength?

1 using pH meter
2 measuring their electrical conductivity
3 study the rate of reaction with carbonates

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

17 An excess of calcium hydroxide is added to an alkali soil.

What happens to the pH of the soil?

	change in pH	final pH
A	decrease	5
B	decrease	7
C	increase	7
D	increase	10

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18 Elements Q and R both burn in air.
The oxides formed both dissolve in water.

The solution of the oxide formed from element Q turns Universal Indicator red.
The solution of the oxide formed from element R turns Universal Indicator blue.

What are Q and R?

	Q	R
A	carbon	sulfur
B	sodium	magnesium
C	sodium	sulfur
D	sulfur	sodium

19 Which pair of substances would **not** be suitable for producing a large quantity of carbon dioxide?

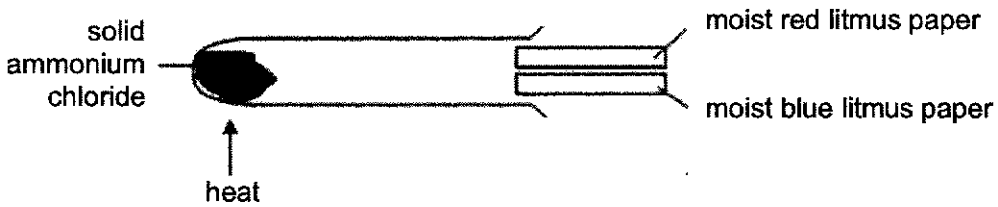
A copper(II) carbonate and dilute nitric acid

B lead(II) carbonate and dilute sulfuric acid

C sodium carbonate and dilute hydrochloric acid

D zinc carbonate and dilute sulfuric acid

20 A student heated some solid ammonium chloride in a test tube. Two gases were formed.
He tested the gases with moist litmus papers as shown below.



Which of the following describes the colour change of the moist litmus papers?

A The red litmus turned blue. There was no further change.

B The blue litmus turned red. There was no further change.

C The red litmus turned blue first. After a while, both pieces of litmus papers turned red.

D The blue litmus turned red first. After a while, both pieces of litmus papers turned blue.

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21 Substance X dissolves in water to form a colourless solution.
This solution reacts with acidified aqueous silver nitrate to give a yellow precipitate.

What is substance X?

A calcium iodide **B** copper(II) chloride

C iron(II) iodide **D** sodium chloride

22 In which equation does oxidation of the underlined substance occur?

A $2CuO + C \rightarrow CO_2 + \underline{2Cu}$

B $Fe_2O_3 + \underline{3CO} \rightarrow 2Fe + 3CO_2$

C $2Mg + O_2 \rightarrow \underline{2MgO}$

D $\underline{MnO_2} + 4HCl \rightarrow MnCl_2 + 2H_2O + Cl_2$

23 A colourless gas is passed into each of the two different solutions.
The results for each solution are shown in the table.

solution	result
aqueous potassium iodide	remains colourless
acidified potassium manganate(VII)	purple to colourless

What is the role of this colourless gas?

A an oxidising agent

B a reducing agent

C both an oxidising agent and a reducing agent

D neither an oxidising agent nor a reducing agent

24 The bodies of aircraft are often made using aluminium.

Which two properties of aluminium make it suitable for this purpose?

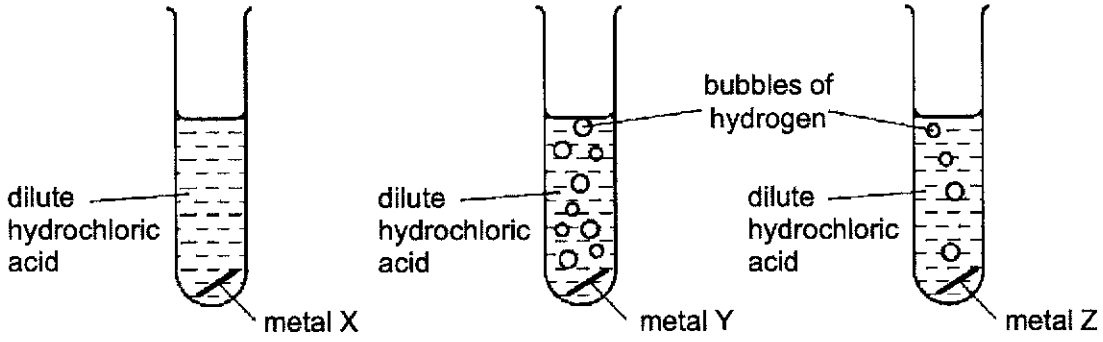
	property 1	property 2
A	good conductor of electricity	good conductor of heat
B	good conductor of electricity	strong
C	good conductor of heat	low density
D	strong	low density

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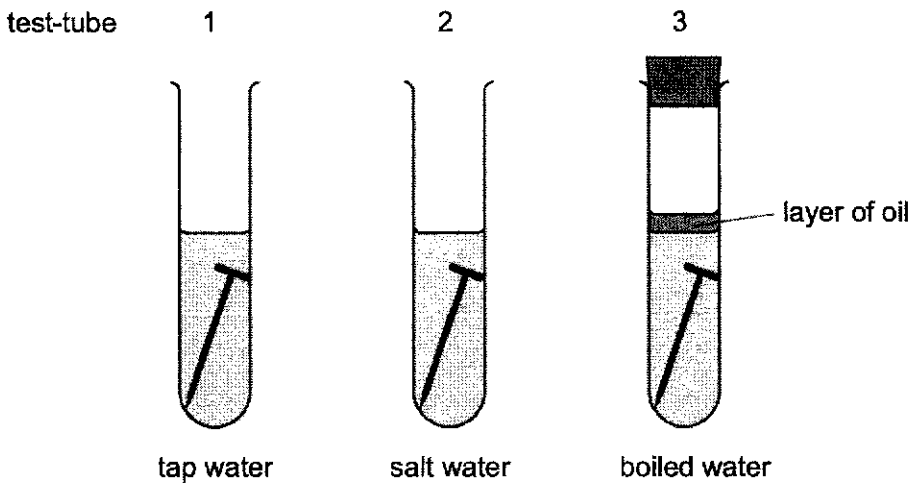
25 The diagrams show the reactions of three different metals with dilute hydrochloric acid.



What are the metals X, Y and Z?

	X	Y	Z
A	copper	magnesium	iron
B	copper	iron	magnesium
C	magnesium	iron	copper
D	iron	magnesium	copper

26 The diagrams show experiments to investigate rusting of iron nails.

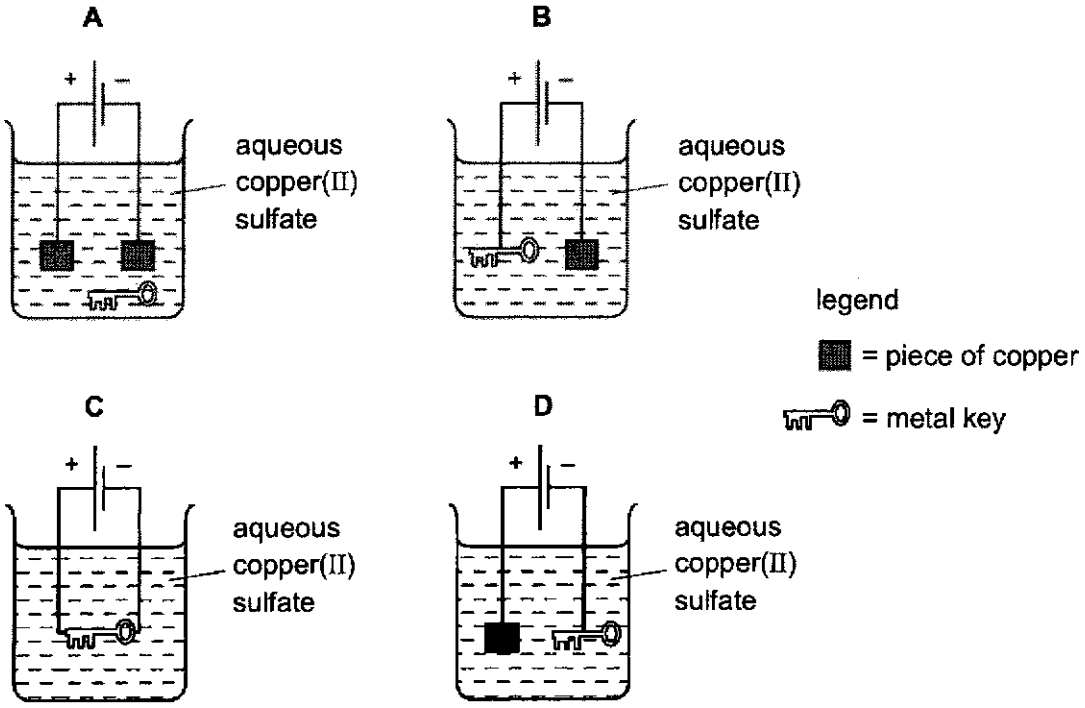


In which test-tube(s) do the nails rust?

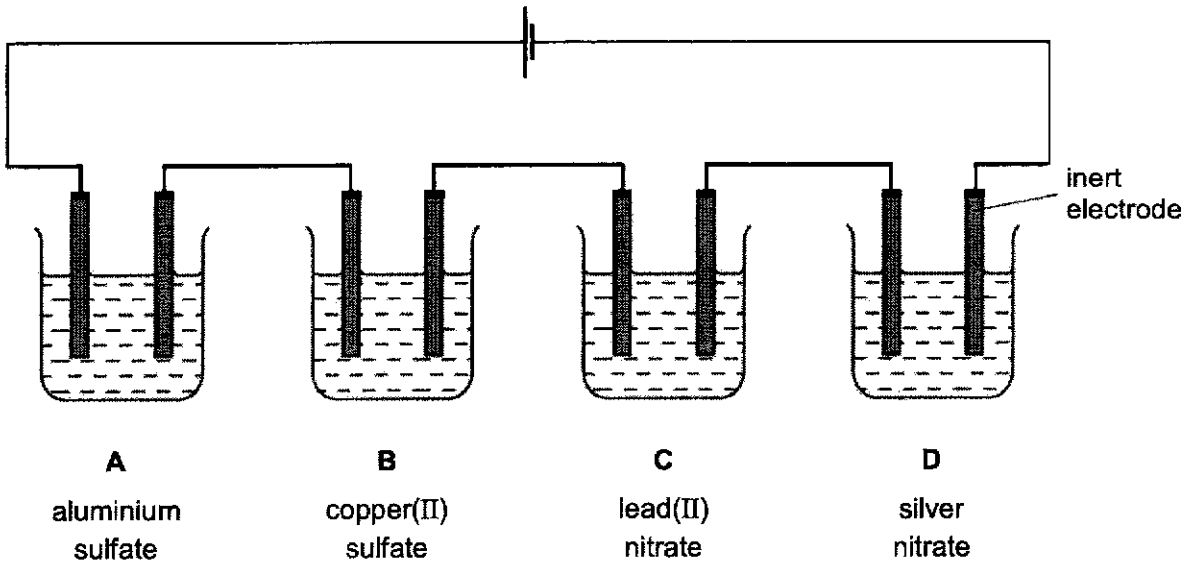
A 1 only **B** 1 and 2 **C** 1 and 3 **D** 1, 2 and 3

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27 In which set of apparatus is the metal key electroplated with copper?



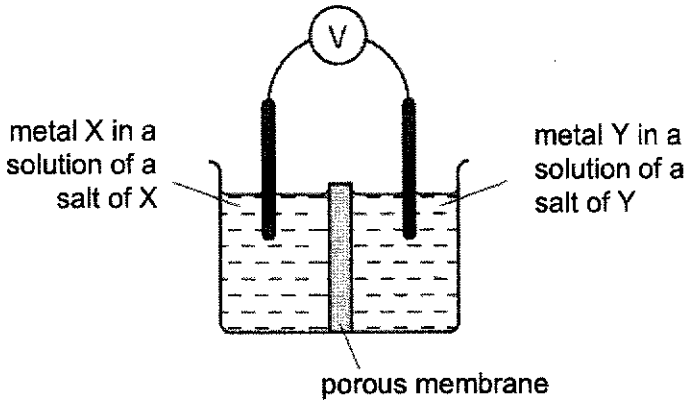
28 When electrolysed using inert electrodes, which dilute solution would produce the greatest increase in mass at the cathode?
[A_r: Al, 27; Cu, 64; Pb, 207; Ag, 108]



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29 Which pair of metals X and Y will produce the highest voltage when used as electrodes in a simple cell?



	metal X	metal Y
A	copper	silver
B	magnesium	silver
C	magnesium	zinc
D	zinc	copper

30 An element is in Period 3 and Group VII of the Periodic Table.

Which statement about this element is correct?

A The element will form ions of 1+ charge.

B The element will have 3 electrons in its outer shell.

C The element will have 7 electrons in its outer shell.

D The element will have 7 electron shells in its atom.

31 A new element oxfordium, Ox, was discovered with the following properties.

solubility	electrical conductivity	formula of element	bonding in a molecule of Ox_2
insoluble in water	does not conduct	Ox_2	Ox ≡ Ox

In which group of the Periodic Table should oxfordium be placed?

A Group III **B** Group V **C** Group VI **D** Group VII

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32 Which properties do the elements chromium, iron and vanadium have in common?

1 They all conduct electricity.

2 They, or their compounds, can act as catalysts.

3 They all form coloured compounds.

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

33 The table compares the strengths of the bonds for reactions of the type below.

$$X_2 + Y_2 \rightarrow 2XY$$

Which reaction is most exothermic?

	bonds in X_2	bonds in Y_2	bonds in XY
A	strong	strong	strong
B	strong	strong	weak
C	weak	weak	strong
D	weak	weak	weak

34 Hydrogen-oxygen fuel cells can be used to power cars. Platinum is used as a catalyst. The amount of energy produced per gram is shown for three fuels.

fuel	energy produced per g of fuel / kJ
hydrogen	143
methane	55
petrol	44

Which statement is correct and is an advantage of a hydrogen-oxygen fuel cell?

A Hydrogen is difficult to store.

B Hydrogen produces less energy per gram than methane or petrol.

C The only product is water.

D Platinum is rare and expensive.

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35 Which process is endothermic?

A adding water to anhydrous copper(II) sulfate

B burning magnesium to make the oxide

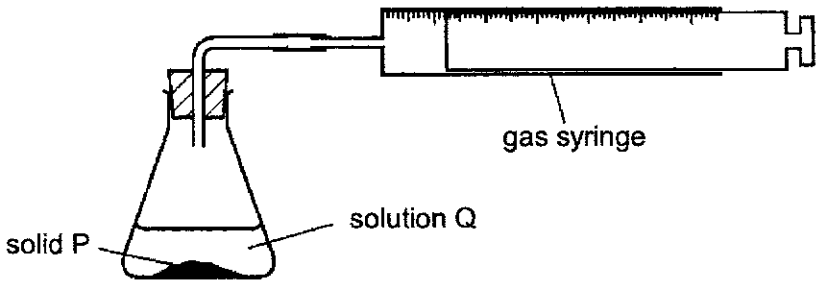
C heating water to make steam

D neutralising acidic industrial waste

36 The raw materials for the Haber process are hydrogen and nitrogen.
What are the sources of the hydrogen and nitrogen?

	source of hydrogen	source of nitrogen
A	ethanol	NPK fertilisers
B	crude oil	air
C	dilute sulfuric acid	air
D	water	ammonium nitrate

37 An experiment was conducted to investigate the rate of reaction when 1 g of solid P reacts with 100 cm^3 of solution Q.



The experiment took place too quickly for any measurements to be taken.

Which change could be made to slow down the reaction?

A add a catalyst

B decrease the particle size of solid P

C decrease the concentration of solution Q

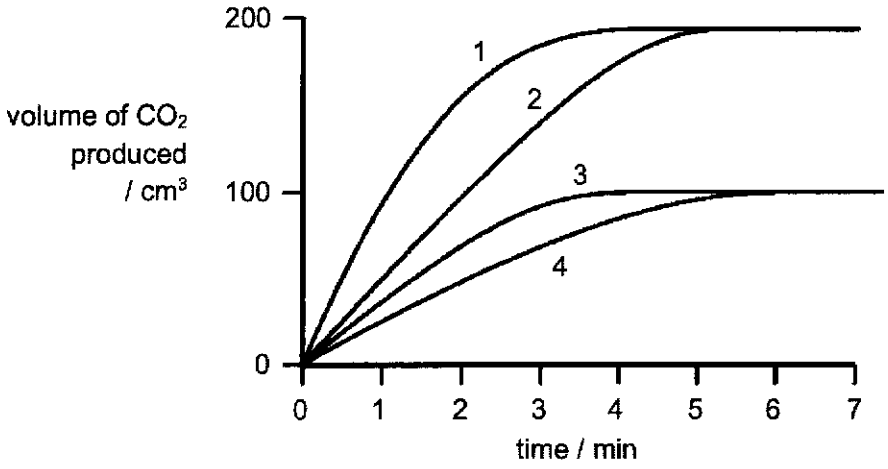
D increase the temperature

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38 In four separate experiments, 1, 2, 3 and 4, dilute nitric acid was added to excess marble chips and the volume of carbon dioxide formed was measured.

In all four experiments the same volume of dilute nitric acid was used.
Its concentration, or temperature, or both concentration and temperature, were changed.

The results of the experiments are shown on the graph.



Which statement is correct?

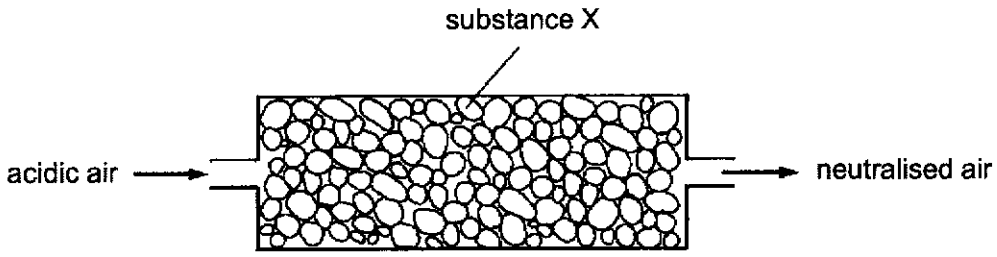
A A lower concentration of acid was used in experiment 3 than in experiment 1.

B Experiment 4 was faster than experiment 3.

C The acid used in experiment 2 was of a lower concentration than in experiment 1.

D The temperature of the acid was the same in experiments 1 and 2.

39 Air containing an acidic impurity was neutralised by passing it through a column containing substance X.



What is substance X?

A calcium oxide

B sand

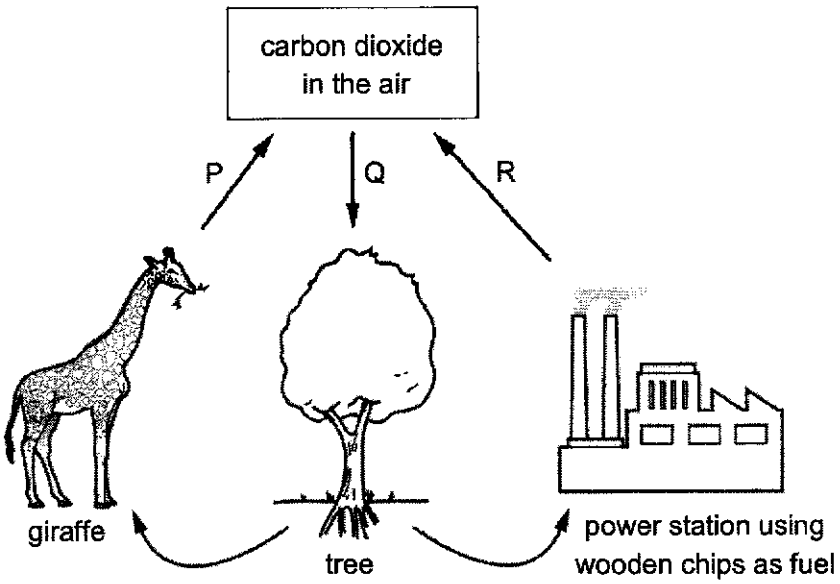
C sodium chloride

D concentrated sulfuric acid

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40 The diagram shows part of the carbon cycle.



What are the processes P, Q and R?

	P	Q	R
A	respiration	combustion	photosynthesis
B	respiration	photosynthesis	combustion
C	combustion	photosynthesis	respiration
D	photosynthesis	combustion	respiration

--- End of Paper 1 ---

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PRELIMINARY EXAMINATION 2021

CHEMISTRY 6092/02

Paper 2

Candidates answer on Question Paper.

August 2021

1 hour 45 minutes

READ THESE INSTRUCTIONS FIRST

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

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

Section B [28 marks]
Answer all **three** questions, the last question is in the form either/or.
Write your answers in the spaces provided on the question paper.

At the end of the examination, fasten the separate answer paper securely to the question paper.

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 2.
The total number of marks for this paper is 78.

Target Grade:	
Actual Grade:	
For Examiner's Use	
Section A	
B10	
B11	
B12 ( )	
Total	78

This document consists of **21** printed pages including this cover page.

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The Periodic Table of Elements

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

Key: proton (atomic) number; atomic symbol; name; relative atomic mass

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

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

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Section A [50 marks]

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

A1 **(a)** Choose from the following compounds to answer the questions below.

For Examiners' Use

ammonium sulfate

calcium oxide

copper(II) chloride

nitrogen dioxide

sodium iodide

sulfur dioxide

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

Which compound

(i) forms a yellow precipitate with aqueous silver nitrate,

..... [1]

(ii) is used as a fertiliser,

..... [1]

(iii) is a pollutant arising from lightning activity.

..... [1]

(b) Explain why sodium iodide will not conduct electricity when solid but will conduct when dissolved in water.

.....

.....

..... [2]

[Total: 5]

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A2 The table below shows the properties of some non-metallic elements A, B, C and D.

For Examiners' Use

element	state at room temperature	colour	melting point / °C	electrical conductivity
A	solid	black	3317	good
B	solid	grey	1410	poor
C	gas	green	- 101	does not conduct
D	solid	yellow	119	does not conduct

(a) Which two elements have giant covalent structures?
Give a reason for your answer.

elements ..... and .....

.....

..... [2]

(b) In terms of structure and bonding, suggest how substance A is able to conduct electricity.

.....

.....

.....

..... [2]

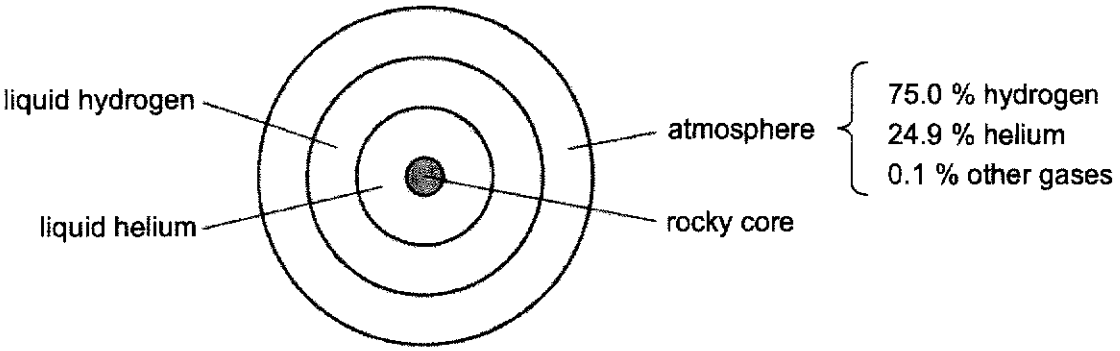
[Total: 4]

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A3 The diagram shows the composition of the planet Saturn.

For Examiners' Use



(a) Describe how Saturn's atmosphere differs from the Earth's atmosphere.
Give two differences.

1: .....

.....

2: .....

..... [2]

(b) Some properties of hydrogen and helium are given in the table.

element	density of the liquid in g/cm^3	melting point / °C	boiling point / °C
hydrogen	0.07	- 259	- 253
helium	0.15	- 272	- 269

(i) Use the information to suggest why the layer of liquid hydrogen in Saturn floats on top of the liquid helium.

..... [1]

(ii) What is the physical state of hydrogen at - 250 °C?
Explain your answer.

.....

..... [2]

[Total: 5]

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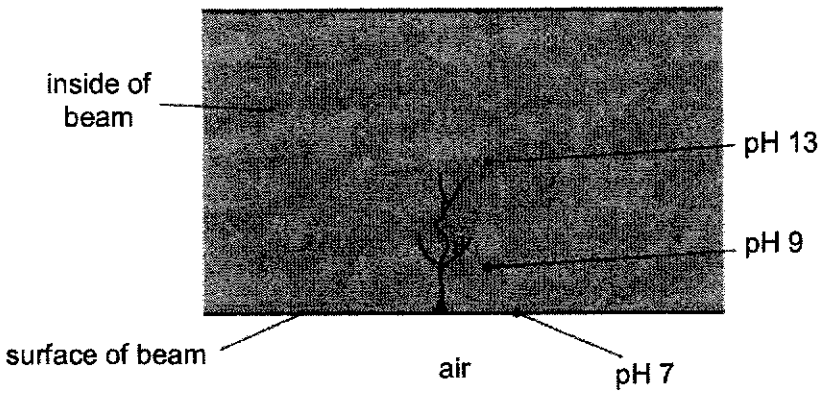
A4 Concrete is made from cement (mainly calcium oxide), sand and water. When set, concrete is slightly porous.

When rain water seeps through concrete, some of the uncombined calcium oxide dissolves to form aqueous calcium hydroxide, $Ca(OH)_2$.

(a) The aqueous calcium hydroxide in wet concrete reacts with carbon dioxide in the air.

$$Ca(OH)_2 + CO_2 \rightarrow CaCO_3 + H_2O$$

The diagram shows the pH at various points inside a cracked concrete beam.



Describe and explain the change in pH from the surface to the centre of the beam.

.....

.....

.....

..... [3]

(b) 25.0 cm^3 of an aqueous solution of calcium hydroxide reacts exactly with 18.0 cm^3 of 0.040 mol/dm^3 of dilute hydrochloric acid.

$$Ca(OH)_2 + 2HCl \rightarrow CaCl_2 + 2H_2O$$

Calculate the concentration, in mol/dm^3, of the aqueous of calcium hydroxide.

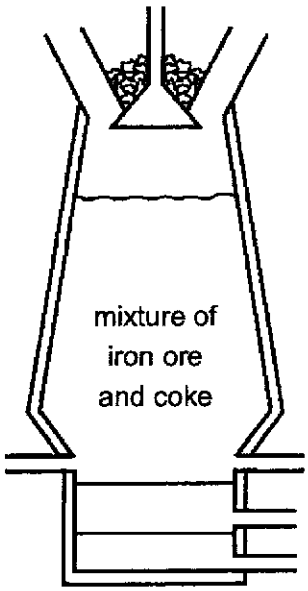
concentration = ... mol/dm^3 [3]

[Total: 6]

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A5 The diagram shows a blast furnace used in the extraction of iron.

For Examiners' Use



(a) On the diagram above, write:

(i) the letter **A** to show where the air blast enters the furnace, [1]

(ii) the letter **S** to show where the slag exits the furnace. [1]

(b) An oxide of iron is present in iron ore and is used as a raw material in the extraction of iron.

Explain, including chemical equations, how iron is extracted from the ore in a blast furnace. State symbols are **not** required.

.....

.....

.....

..... [3]

[Total: 5]

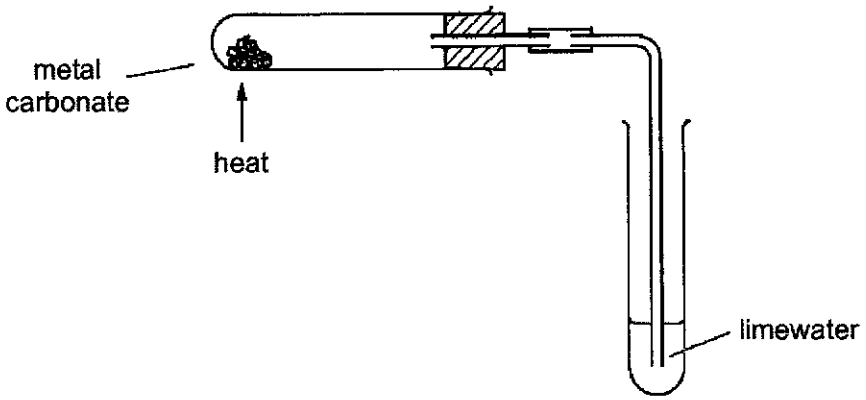
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A6 A student investigates the rate of decomposition of four metal carbonates.
When metal carbonates are heated, they decompose and a gas is liberated.

For each of the metal carbonates, the student use the following apparatus to measure the time taken for a white precipitate to form in a sample of limewater.



The results of the investigation are shown in the table.

metal carbonate	time taken for a white precipitate to form in limewater / s
calcium carbonate	600
copper(II) carbonate	220
iron(II) carbonate	340
zinc carbonate	380

(a) Name the gas that forms a white precipitate in limewater.

.....

[1]

(b) Describe and explain the trend in the time taken for limewater to turn milky in relation to the thermal stability of the metal carbonates.

.....

.....

.....

..... [3]

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(c) (i) To ensure that the investigation is a fair test, the amount of heat supplied must be constant in each experiment.
Suggest how this could be done.

For Examiners' Use

.....

..... [1]

(ii) Suggest another measure you would take to ensure a fair test in this investigation.

.....

..... [1]

[Total: 6]

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A7 A student investigated the reaction of excess magnesium with dilute hydrochloric acid.

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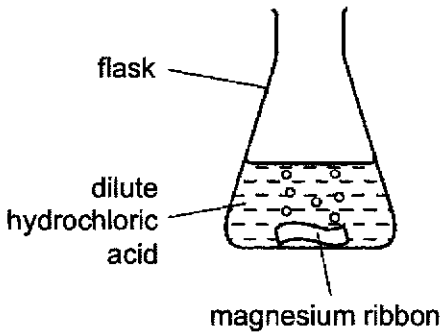
$$Mg(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + H_2(g)$$

She measured the volume of gas given off at various times during the reaction.

(a) Draw a 'dot and cross' diagram for magnesium chloride.
Show the outer shell electrons only.

[2]

(b) Complete the diagram to show the apparatus she would use to collect and measure the volume of gas given off.
Label the apparatus.



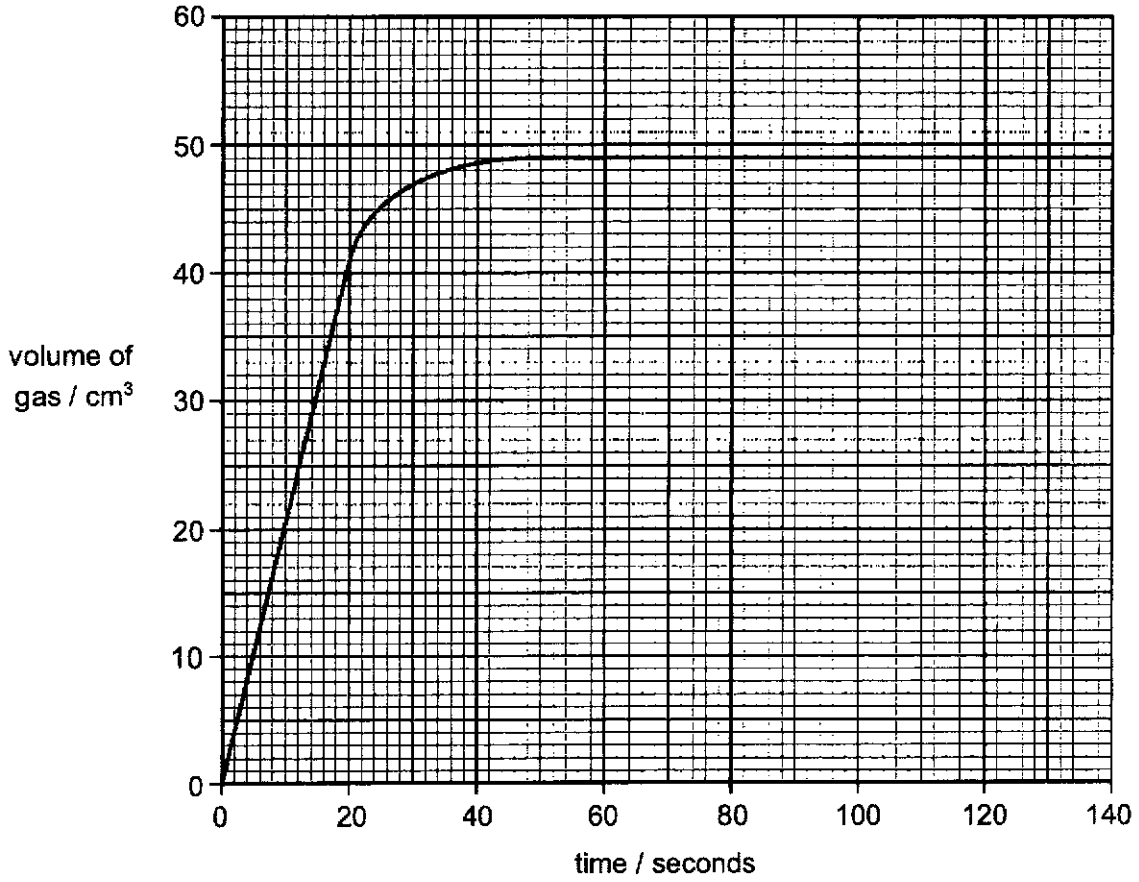
[2]

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(c) The student carried out the reaction at 25 °C using magnesium ribbon. Her results are shown below.

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(i) How long does it take for the reaction to stop? ..... seconds [1]

(ii) What is the volume of hydrogen produced after 20 seconds?

..... cm^3 [1]

(d) **(i)** What would be the effect on that rate of reaction by repeating the experiment at 15 °C instead of 25 °C? Explain your answer in terms of collisions between particles.

.....

.....

..... [2]

(ii) Sketch on the grid provided in **(c)**, the curve you would expect for **(d)(i)**. [1]

[Total: 9]

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A8 Ammonia is manufactured by combining nitrogen and hydrogen at high temperature and pressure.

For Examiners' Use

$$\text{nitrogen} + \text{hydrogen} \overset{\text{catalyst}}{\rightleftharpoons} \text{ammonia}$$

(a) (i) What is the meaning of the symbol $\rightleftharpoons$?

.....

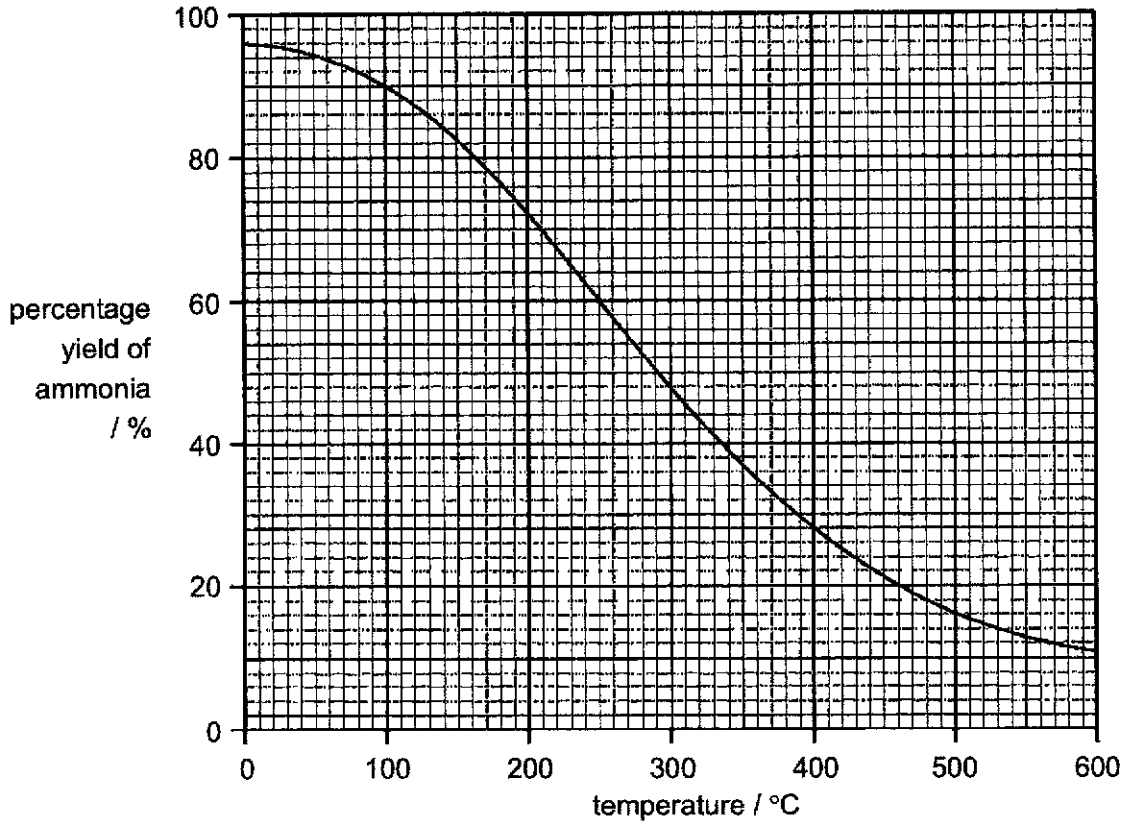
[1]

(ii) What is the purpose of the catalyst?

.....

[1]

(b) The graph shows the percentage yield of ammonia at different temperatures.



(i) Describe how the percentage yield of ammonia changes with temperature.

.....

[1]

(ii) Deduce the percentage yield of ammonia at 400 °C.

.....

[1]

[Total: 4]

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For Examiners' Use

A9 Bromine is an element found in Group VII.

The properties of some Group VII elements are provided in the table below.

elements	melting point / °C	boiling point / °C	density in g/cm^3	electron arrangement of atom
fluorine	-220	-188	1.51	2, 7
chlorine	-101	-35	1.56	2, 8, 7
bromine	-7	59		2, 8, 18, 7
iodine	114	184	4.93	2, 8, 18, 18, 7

(a) Provide the group name for the elements found in Group VII.

.....

[1]

(b) Use the information in the table to estimate the density of bromine.

.....

[1]

(c) Gaseous chlorine was bubbled into a solution of potassium iodide and a reaction took place.

(i) Write the ionic equation for this reaction.

.....

[2]

(ii) Explain how this reaction shows the relative reactivity of chlorine and iodine.

.....

.....

.....

[2]

[Total: 6]

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Section B [30 marks]

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

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

For Examiners' Use

B10 Sorrel is a small green plant with spear-shaped, deep green leaves and reddish-brown veins.



(a) The pigments in the sorrel leaf can be separated by chromatography.

(i) Describe how chromatography can be used to separate different pigments.

.....

.....

..... [2]

(ii) Explain what is meant by R_f value.

.....

..... [1]

(b) Sorrel plants contain a poisonous chemical X.
What can be deduced about X from each of the following three pieces of information?

(i) When X is warmed with acidified potassium manganate(VII), the solution changes from purple to colourless.

..... [1]

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For Examiners' Use

(ii) A 0.1 mol/dm^3 solution of X has a pH of 3 whereas a 0.1 mol/dm^3 solution of hydrochloric acid has a pH of 1.

..... [1]

(iii) When a few drops of aqueous sodium hydroxide is added to X, a brown precipitate is observed.

..... [1]

(c) Analysis of 10.0 g of chemical X shows that it contains 2.67 g carbon, 0.22 g hydrogen and the remaining being oxygen.

(i) Deduce the empirical formula of X.

empirical formula ..... [3]

(ii) Given that the relative molecular mass of X is 90, deduce the molecular formula of X.

molecular formula ..... [1]

[Total: 10]

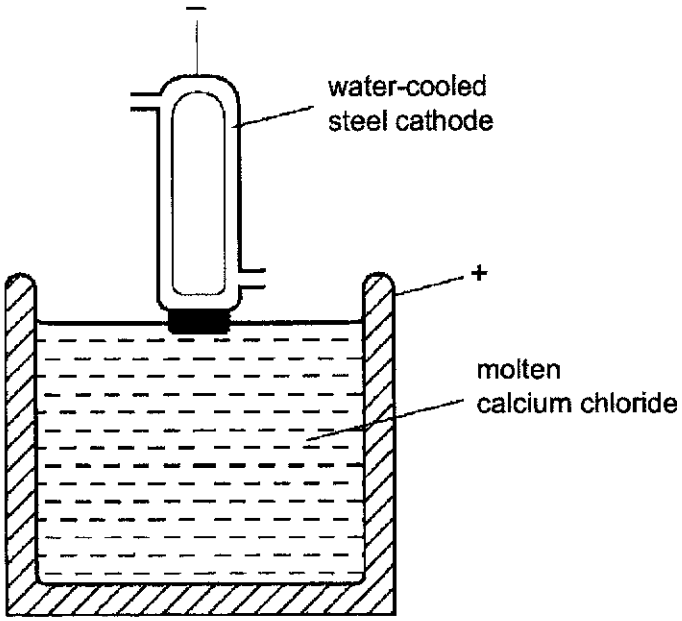
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B11 Electrolysis involves the chemical decomposition of a compound, either when molten or in aqueous solution, by the passage of an electric current.

For Examiners' Use

(a) Calcium is manufactured by the electrolysis of molten calcium chloride.



(i) State the products formed

at the anode, ...

at the cathode. ..... [2]

(ii) Suggest a non-metal that can be used as an anode in this electrolysis.

..... [1]

(iii) A stream of inert gas is blown over the calcium as it is removed from the molten calcium chloride.

Suggest the identity of the inert gas and explain why a stream of inert gas is blown over the hot calcium.

.....

.....

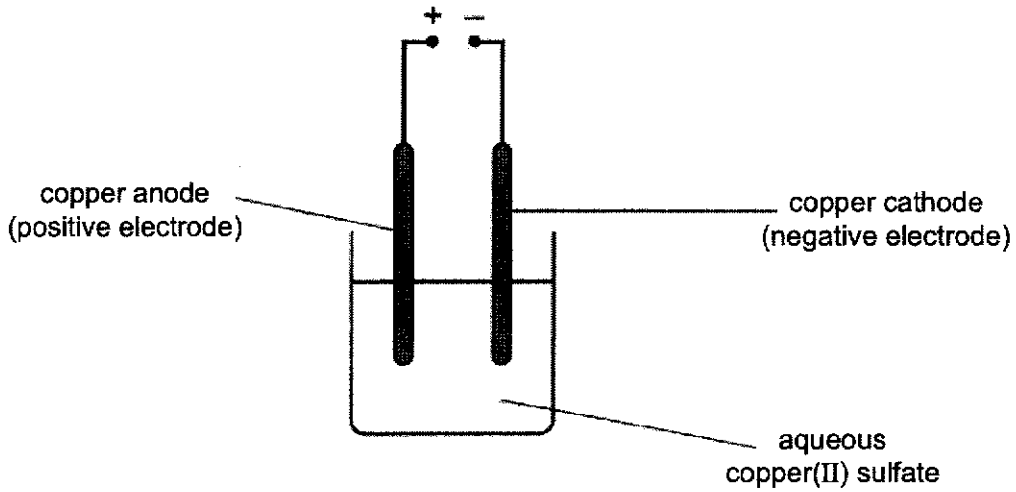
..... [2]

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For Examiners' Use

(b) An electrolysis of aqueous copper(II) sulfate was conducted using the apparatus shown below.



The copper cathode was weighed before and after the electrolysis.

experiment number	current used / A	time taken / s	mass of cathode	
			before electrolysis / g	after electrolysis / g
1	2.0	180	1.24	1.36
2	4.0	180	1.20	1.44
3	2.0	360	1.34	1.58

(i) Explain, with the aid of a half-equation, why the cathode increases in mass.

.....

.....

..... [2]

(ii) It was observed that the colour intensity of the blue aqueous copper(II) sulfate remained the same before and after the electrolysis.
Explain this observation.

.....

..... [1]

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(iii) In experiment 2, the mass of the anode was also weighed before and after the electrolysis.
At the start, the anode has a mass of 1.45 g.
Determine the mass of the anode at the end of the electrolysis.

For Examiners' Use

mass of anode at end of electrolysis = ... g [1]

(iv) A fourth experiment was conducted, this time using a current of 8.0 A for 90 seconds.
At the start, the cathode has a mass of 1.51 g.
Predict the mass of the cathode at the end of the electrolysis.

mass of cathode at end of electrolysis = ... g [1]

[Total: 10]

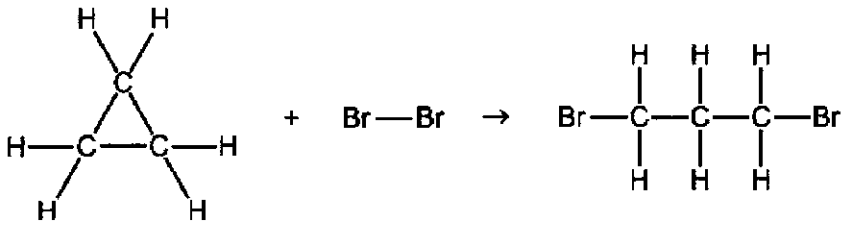
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B12 EITHER

For Examiners' Use

Cyclopropane is a colourless gas.
Cyclopropane reacts with bromine at room temperature. The chemical equation for the reaction is shown.



cyclopropane + bromine → dibromopropane

(a) (i) What is the empirical formula of cyclopropane?

..... [1]

(ii) Describe the expected observation when cyclopropane is bubbled into aqueous bromine.

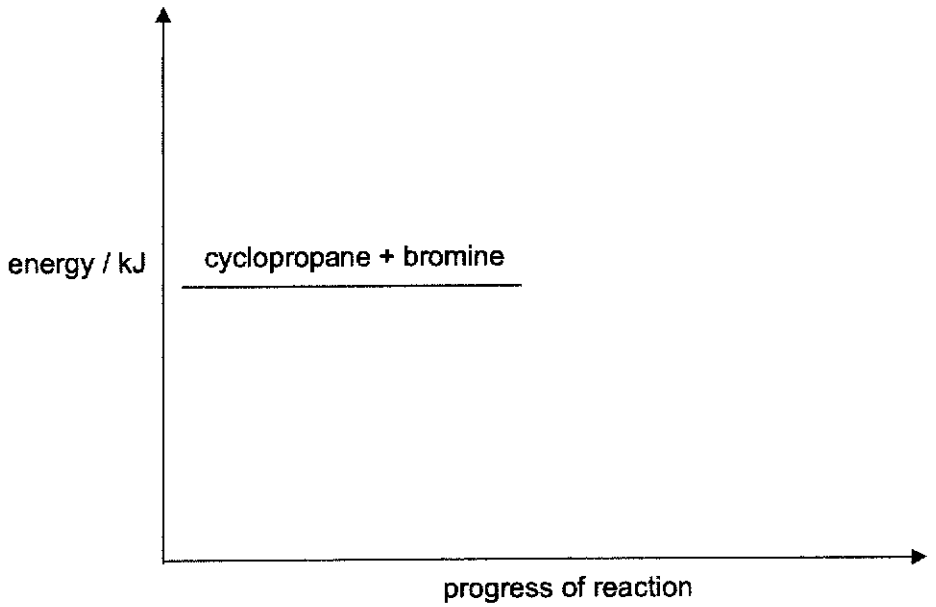
.....

..... [1]

(b) The reaction of cyclopropane with bromine is exothermic.

Complete the energy level diagram for this reaction by

- adding the product of the reaction,
- labelling the enthalpy change, ΔH.

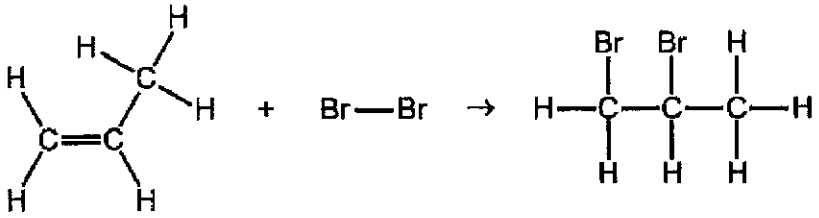


[2]

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(c) Propene also reacts with bromine.



(i) Name the type of reaction that occurs between propene and bromine.

..... [1]

(ii) Use the bond energies in the table to calculate the energy change, ΔH, for the reaction between propene and bromine.

bond	C — H	C — C	Br — Br	C — Br	C = C
bond energy in kJ/mol	412	348	193	285	611

energy change = ... kJ/mol [2]

(d) The boiling point of bromine is 59 °C and the boiling point of iodine is 184 °C.
Use your knowledge of bonding to help you explain the difference in the boiling points.

.....

.....

.....

..... [3]

[Total: 10]

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B12 OR

This question was set on the Common Last Topic and has been removed.

[Total: 10]

---- End of Paper 2 ----

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Sec 4 Express Chemistry 6092
Preliminary Examination 2021 Answers

Paper 1

Answer to MCQ [40 marks]

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

Paper 2

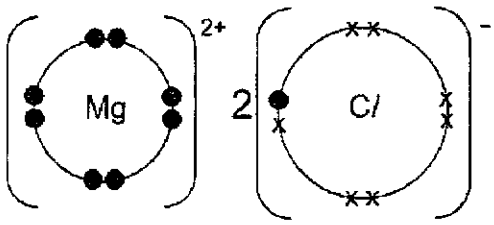
Answer to Section A [50 marks]

No.			Answers	Mk	Tot Mk
A1	a	i	sodium iodide	1	5
		ii	ammonium sulfate	1	
		iii	nitrogen dioxide	1	
	b		in solid state, ions cannot move / are held in fixed position / in lattice ; in solution, ions become mobile / free-moving to act as charge carriers ;	2	
A2	a		A and B ; very high melting points ;	2	4
	b		In substance A (graphite), each (carbon) atom uses three valence electrons for covalent bonding ; or each (carbon) atom is bonded to 3 other carbon atoms. The fourth electron is delocalised / mobile or the non-bonded electron can act as the charge carriers along the (graphene) layer but not between the layers ;	2	
A3	a		any 2 points • greater percentage of helium on Saturn / less helium on Earth • greater percentage of hydrogen on Saturn / no or little hydrogen on Earth • no or very little nitrogen on Saturn / Earth has about 78% nitrogen / Earth has a lot of nitrogen • no oxygen on Saturn / oxygen on Earth / Earth has about 21% oxygen • lower percentage of other gases on Saturn / more of other gases on Earth • greater percentage of argon on Earth / less argon on Saturn	2	5
	b	i	liquid hydrogen is less dense than liquid helium	1	
		ii	gas ; - 250 °C is above the boiling point ;	2	

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No.			Answers	Mk	Tot Mk
A4	a		Any three points: • pH increases inside beam / pH reduces near the crack • carbon dioxide (in solution) is slightly acidic • on the surface of the beam, CO_2 reacts / neutralises $Ca(OH)_2$ • crack allows CO_2 to enter inside of the beam • reaction of CO_2 with $Ca(OH)_2$ reduces alkalinity / lowers pH • further inside the beam, lesser (or no) CO_2 / little or no reaction of CO_2 with $Ca(OH)_2$	3	6
	b		no. of moles of HCl = 0.04 x 0.018 = 0.00072 mol ; no. of moles of $Ca(OH)_2$ = 0.5 x 0.00072 = 0.00036 mol ; concentration of $Ca(OH)_2$ = 0.00036 ÷ 0.025 = 0.0144 mol/dm^3 ; Allow ECF	3	
A5	a	i	**A** shown correctly (on either left or right top pipes at base of furnace)	1	5
		ii	**S** shown correctly on the bottom right outlet (upper of the two layers)	1	
	b		1 mark awarded for each step 1) In the blast furnace, coke burns in air to produce carbon dioxide: $C(s) + O_2(g) \rightarrow CO_2(g)$ 2) Carbon dioxide reacts with more coke to produce carbon monoxide: $CO_2(g) + C(s) \rightarrow 2CO(g)$ 3) Carbon monoxide reduces haematite to produce molten iron: $Fe_2O_3(s) + 3CO(g) \rightarrow 2Fe(l) + 3CO_2(g)$ Note: - answers must be in the correct sequence - state symbols are not required - marks awarded for correct chemical equation, even without word description	3	

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A6	a		carbon dioxide	1	6
	b		The more thermally stable the metal carbonate, the longer the time taken for limewater to turn milky ; The more reactive the metal is, the more stable is its metal carbonate ; hence it will take greater amount of energy to decompose the metal carbonate to liberate carbon dioxide gas, hence the longer time taken ;	3	
	c	i	same height of flame / same opening of air hole / same amount of gas is supplied / flame is the same distance from the test tube / same strength of flame	1	
		ii	same volume / concentration of limewater used or same mass / moles / surface area / particle size of solid metal carbonate used	1	
A7	a		 Legend /key: • electron of magnesium x electron of chlorine [1] correct Mg^{2+} ion [1] correct Cl^- ion	2	9
	b		Gas syringe or inverted measuring cylinder with gas tube labelled; Gas tube leading from closed apparatus to flask or from inverted measuring cylinder with mouth underwater to flask ;	2	
	c	i	44 – 48 (seconds)	1	
		ii	41 (cm^3)	1	
		i	rate of reaction will be slower / will decrease ; at lower temperature, lesser particles will possess Activation energy / sufficient energy, leading to decreased frequency of successful collisions ;	2	
		ii	initial gradient starting from origin and less steep than original graph ends up at the same final volume at time later than 48 s	1	
A8	a	i	reversible reaction	1	4
		ii	speeds up the reaction / increases the rate of reaction	1	
	b	i	when temperature increases, percentage yield decreases	1	
		ii	28 %	1	

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Broadrick Secondary School **CLT removed version**
Sec 4 Express Chemistry 6092
Preliminary Examination 2021 Answers

A9	a		halogens	1	6
	b		values between 1.6 – 4.9 (actual: 3.12)	1	
	c	i	$Cl_2(g) + 2I^-(aq) \rightarrow 2Cl^-(aq) + I_2(aq)$ correct balanced ionic equation ; all correct state symbols (award only when equation is correct);	2	
		ii	Chlorine is more reactive than iodine; Hence chlorine is able to displace iodine from potassium iodide to form potassium chloride and iodine ;	2	

No.			Answers	Mk	Total Mark
B 10	a	i	Any two points: • chromatography paper (with bottom of paper) placed in solvent (ethanol or water), with start line above the solvent • spot of the sample (**X**) placed on start line / origin • allow solvent to move up the paper / pigments are separated as they move (vertically) up the paper Allow: well-labeled diagram of paper chromatography set-up	2	10
		ii	ratio of the distance travelled by the sample (spot) to the distance travelled by the solvent	1	
	b	i	**X** is a reducing agent / **X** is oxidised by acidified potassium manganate(VII)	1	
		ii	**X** is a weak acid / weaker acid than hydrochloric acid	1	
		iii	**X** contains iron(III) or Fe^{3+} ions	1	
	c	i	<table><tr><td></td><td>C</td><td>H</td><td>O</td></tr><tr><td>mass</td><td>2.67</td><td>0.220</td><td>7.11</td></tr><tr><td>A_r</td><td>12</td><td>1</td><td>16</td></tr><tr><td>moles</td><td>0.2225</td><td>0.220</td><td>0.444375</td></tr><tr><td>whole no. ratio</td><td>1</td><td>1</td><td>2</td></tr></table> [2] Empirical formula:CHO_2 ;	3	
		ii	n (M_r of CHO_2) = 90 n [12 + 1 + 2(16)] = 90 n = 2 $C_2H_2O_4$	1	

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B 11	a	i	chlorine; calcium; allow 1m for calcium and chlorine identified the other way round	1 1	10
		ii	graphite / carbon	1	
		iii	any noble gas (e.g. helium / neon / argon / krypton) or nitrogen ; to prevent it from reacting with air / oxygen ;	2	
	b	i	$Cu^{2+}(aq) + 2e^- \rightarrow Cu(s)$; Cathode gets plated with copper ;	2	
		ii	The rate of copper anode ionising is the same as the rate of copper(II) ions discharged at the cathode.	1	
		iii	1.21 (g)	1	
		iv	1.75 (g)	1	
B12	**EITHER**				
	a	i	CH_2	1	10 – 2 = 8
		ii	~~Aqueous bromine is decolourised from reddish-brown to colourless~~	~~1~~	
	b		horizontal line drawn to the right of and below the reactant line ; ΔH shown and correctly labelled with single-headed arrow pointing in the correct direction (downwards) ;	2	
	c	i	~~Addition reaction~~	~~1~~	
		ii	Energy absorbed for bond breaking = 611 + 348 + 6(412) + 193 = 3624 kJ Energy released for bond forming = 2(348) + 2(285) + 6(412) = 3738 kJ } [1] ΔH = 3624 - 3738 = **-114 kJ/mol** ;	2	
	d		• iodine has a larger molecular size / higher M_r than bromine • iodine has stronger intermolecular forces of attraction • iodine requires greater amount of energy to overcome these forces of attraction	3	

B12 OR question on Organic Chemistry has been removed.

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