Name	Class				Index Number		

BROADRICK SECONDARY SCHOOL
SECONDARY 4 EXPRESS
PRELIMINARY EXAMINATION 2023

CHEMISTRY **6092/01**

Paper 1 Multiple Choice

August 2023

Additional Materials: Multiple Choice Answer Sheet

1 hour

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, glue or correction fluid
Write your name, index number and class on the OTAS answer sheet.

There are **forty** questions in 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 Multiple Choice answer sheet.

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

A copy of the Periodic Table is printed on page **17**.

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For Examiner's Use
40

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

Setter : Mr YS Mong

1 An experiment to measure the rate of reaction between different acids and calcium carbonate is to be conducted.

The following apparatus are provided: conical flasks, measuring cylinders and stopwatch.

Which additional pieces of apparatus are needed to measure the rate of reaction?

1 beaker, delivery tube
2 stopper, burette
3 electronic mass balance, cotton wool

A 1 only

B 3 only

C 1 and 3 only

D 1, 2 and 3

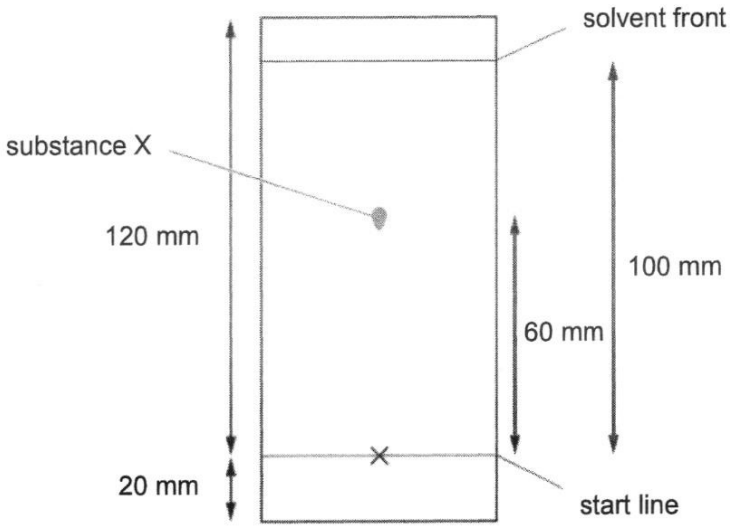
2 Two gases, P and Q, were separately released in a laboratory on a cold day. The experiment was repeated on a hot day. The time taken for the gases to reach the opposite end of the laboratory was recorded for each experiment.

The relative molecular mass of gas P was 32 and the relative molecular mass of gas Q was 71.

Which gas on which day would reach the end of the laboratory in the shortest time?

	gas	day
A	P	cold
B	P	hot
C	Q	cold
D	Q	hot

3 The results of a chromatography experiment containing substance X is shown below. The diagram is **not** drawn to scale.



What is the R_f value of X?

A 0.43

B 0.57

C 0.60

D 1.40

4 Three separations are listed.

1 obtaining water from a mixture of alcohol and water
2 obtaining iodine from a mixture of iodine and iron powder
3 obtaining solid sodium chloride from aqueous sodium chloride

Which techniques would be involved in these separations?

	1	2	3
A	fractional distillation	sublimation	evaporate to dryness
B	fractional distillation	sublimation	filtration
C	filtration	crystallisation	evaporate to dryness
D	sublimation	crystallisation	filtration

5 Which row shows the non-metallic substances in the order of their melting points?

	lowest melting point →		highest melting point
A	fluorine	chlorine	diamond
B	chlorine	fluorine	diamond
C	diamond	fluorine	chlorine
D	diamond	chlorine	fluorine

6 Some properties of substances P, Q, R and S are given in the table below.

substance	percentage composition by mass	electrical conductivity when solid	effect of heat
P	constant	yes	solid burns brightly to form an oxide.
Q	constant	no	solid decomposes to form simpler substances when heated
R	varies	yes	solid melts when heated
S	varies	no	liquid reacts with air to form carbon dioxide and water.

Which classification of the substances as an element, a mixture or a compound is correct?

	element	mixture	compound
A	P	R	Q, S
B	S	Q, R	P
C	R	S	Q, P
D	P	R, S	Q

7 Which of the following substance contains both ionic and covalent bonds?

A Al_2O_3
B $CuSO_4$
C NH_3
D ZnS

8 In which molecule are all the outer electrons of the atoms involved in bonding?

A HF
B H_2O
C NH_3
D CH_4

9 Which of the following elements will have similar chemical properties as magnesium?

A calcium
B lithium
C oxygen
D silicon

10 A newly discovered element has the following properties.

- It has a high melting point.
- Its presence can lower the activation energy of a reaction.

What type of element is this newly discovered element?

A an alkali metal
B a halogen
C a noble gas
D a transition metal

11 Which statement about elements in Group I and Group VII of the Periodic Table is correct?

A Iodine is the darkest coloured halogen.
B Sodium has a higher melting point than potassium.
C Lithium is more reactive with water than potassium.
D Bromine reacts with sodium chloride to produce chlorine.

12 Which compound contains the highest percentage mass of oxygen?

	compound	relative formula mass
A	CaO	56
B	Fe_2O_3	160
C	$KMnO_4$	158
D	$CuCO_3$	124

13 A carbohydrate has the formula $C_6H_{12}O_6$.

One mole of this carbohydrate is burnt in excess oxygen and the gas formed is collected.

What volume of gas, measured at room temperature and pressure, is collected?

A 24 dm^3

B 48 dm^3

C 144 dm^3

D 288 dm^3

14 Four students prepared hydrated copper(II) sulfate crystals ($CuSO_4.5H_2O$) by initially adding excess copper(II) oxide to dilute sulfuric acid.

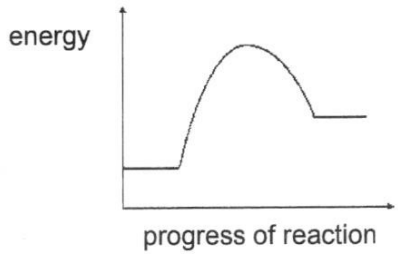
Unreacted copper(II) oxide was removed by filtration and the mass of copper(II) oxide that reacted was calculated.

After crystallisation, the students dried and weighed the crystals.

Which student produced the highest percentage yield of hydrated copper(II) sulfate?

	mass of copper(II) oxide reacted / g	mass of crystals produced / g
A	4.0	10.0
B	8.0	24.0
C	12.0	32.0
D	16.0	40.0

15 The energy profile diagram of a reaction is given below.



Which of the following reactions is **not** represented by the diagram?

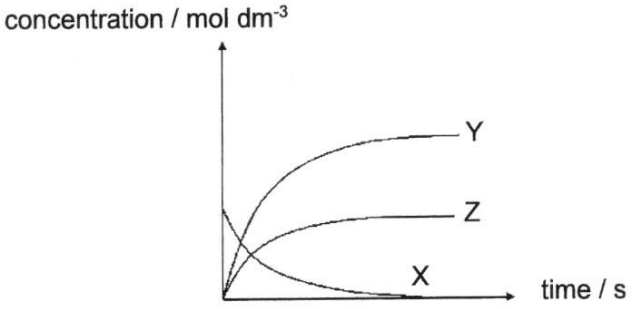
A $2AgNO_3(s) \rightarrow 2Ag(s) + O_2(g) + 2NO_2(g)$

B $H_2O(g) \rightarrow 2H(g) + O(g)$

C $H_2O(g) \rightarrow H_2O(l)$

D $6CO_2(g) + 6H_2O(l) \rightarrow C_6H_{12}O_6(s) + 6O_2(g)$

16 The graph shows the changes in reactant and product concentrations during a chemical reaction.



Which equation represents the reaction?

A $X \rightarrow 2Y + Z$

B $X \rightarrow Y + 2Z$

C $Y + Z \rightarrow X$

D $Z + X \rightarrow 2Y$

17 Calcium carbonate reacts with dilute nitric acid.

$$CaCO_3(s) + 2HNO_3(aq) \rightarrow Ca(NO_3)_2(aq) + H_2O(l) + CO_2(g)$$

Which change will increase the speed of reaction?

A decrease the volume of acid used

B decrease the pressure of the environment in which the reaction is carried out

C increase the temperature

D increase the size of the calcium carbonate solids

18 Which equation does **not** represent a redox reaction?

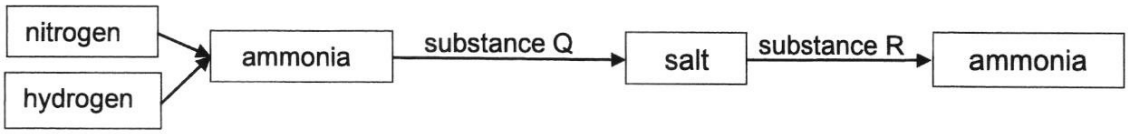
A $2Fe(s) + 3Cl_2(g) \rightarrow 2FeCl_3(s)$

B $2AgBr(s) \rightarrow 2Ag(s) + Br_2(g)$

C $Cu^{2+}(aq) + Mg(s) \rightarrow Cu(s) + Mg^{2+}(aq)$

D $ZnO(s) + H_2SO_4(aq) \rightarrow ZnSO_4(aq) + H_2O(l)$

19 Nitrogen and hydrogen are used to produce ammonia.



Which of the following correctly classifies substance Q and R?

	Q	R
A	acid	acid
B	acid	base
C	base	acid
D	base	base

20 25.0 cm^3 of aqueous sodium hydroxide was transferred into a conical flask. Four students each titrated dilute hydrochloric acid from a burette to the conical flask.

student	1	2	3	4
volume / cm^3	25.20	25.30	25.20	26.10

What could be the reason(s) for the result obtained by student 4?

1 The burette was rinsed with dilute hydrochloric acid.

2 The conical flask was rinsed with deionised water.

3 The conical flask was rinsed with deionised water and sodium hydroxide.

A **2** only

B **3** only

C **1** and **3** only

D **2** and **3** only

21 A student placed a solution of aqueous sodium hydroxide into a beaker.

Which of the following chemicals will cause the pH of the solution to decrease?

A carbon monoxide

B magnesium oxide

C nitrogen monoxide

D zinc oxide

22 Which statement about the production of ammonia using the Haber process is **not** correct?

A The chemical reaction is reversible.

B Iron is used as the catalyst.

C Hydrogen is obtained by cracking.

D One mole of hydrogen reacts with three moles of nitrogen to form two ammonia molecules.

23 Which pollutant is correctly matched to its effect on the environment?

	pollutant	effect
A	carbon monoxide	global warming
B	nitrogen dioxide	global warming
C	methane	acid rain
D	sulfur dioxide	acid rain

24 Which of the following substances will cause the ozone layer to be depleted?

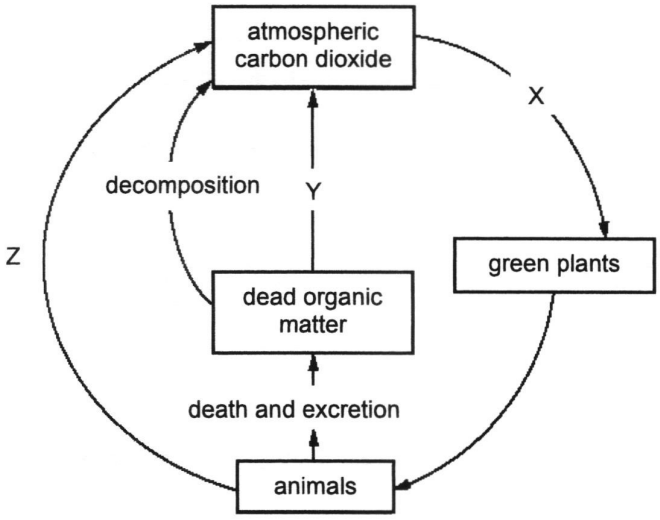
A CH_4

B CF_2Cl_2

C CO

D CO_2

25 The carbon cycle is shown below.



Which row describes processes X, Y and Z?

	X	Y	Z
A	respiration	combustion	photosynthesis
B	respiration	photosynthesis	combustion
C	photosynthesis	combustion	respiration
D	photosynthesis	respiration	combustion

26 A aqueous solution contains barium ions, silver ions and one anion.

What could the anion be?

A chloride

B carbonate

C nitrate

D sulfate

27 The table shows the results of tests carried out on compound Z.

test	result
add aqueous sodium hydroxide and warm	gas evolved turned damp red litmus paper blue
add dilute sulfuric acid	gas evolved formed white precipitate in limewater

What is compound Z?

A ammonium carbonate

B ammonium nitrate

C zinc carbonate

D zinc nitrate

28 Steel is an alloy of iron with a very small percentage of carbon.

Which statement about steel is correct?

A Carbon atoms disrupts the orderly arrangement of iron atoms.

B Higher percentage of carbon makes the steel softer.

C Iron atoms are the same size as carbon atoms.

D Lower percentage of carbon makes the steel more brittle.

29 Chromium is between zinc and iron in the reactivity series.

Which element is able to reduce chromium oxide to chromium?

A carbon

B copper

C iron

D lead

30 Which of the following carbonates does **not** decompose when heated?

A copper(II) carbonate

B magnesium carbonate

C sodium carbonate

D zinc carbonate

31 The table shows the results of adding three metals, P, Q and R, to dilute hydrochloric acid and to water.

metal	dilute hydrochloric acid	water
P	no reaction	no reaction
Q	hydrogen produced	no reaction
R	hydrogen produced	hydrogen produced

What is the order of reactivity of the metals?

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

32 To prevent rusting, steel tools are galvanised by coating the steel with a layer of metal.

Which metal is used as the coating?

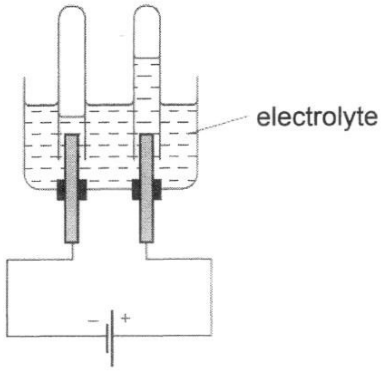
A aluminium

B copper

C silver

D zinc

33 The diagram shows the results of an electrolysis experiment.



Which of the following is the electrolyte used?

A aqueous silver nitrate

B concentrated copper(II) chloride

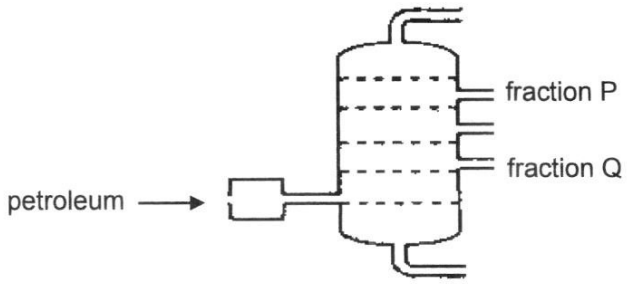
C dilute sulfuric acid

D molten potassium chloride

34 In which electrolysis experiment would there be **no** change in the concentration of the cation in the electrolyte?

	electrolyte	electrode
A	aqueous copper(II) sulfate	carbon
B	aqueous copper(II) nitrate	copper
C	concentrated aqueous potassium chloride	carbon
D	dilute nitric acid	platinum

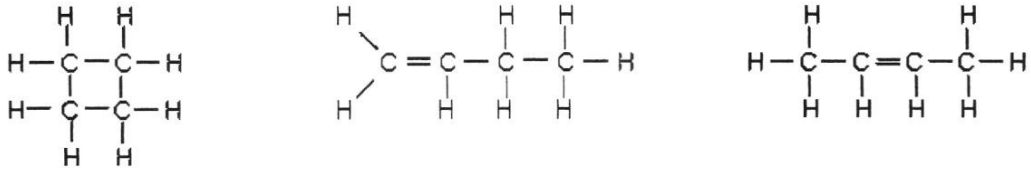
35 The diagram shows the fractional distillation of petroleum.



Which statements about fractions P and Q are correct?

	higher molecular mass	higher viscosity
A	P	P
B	P	Q
C	Q	Q
D	Q	P

36 The diagram shows the structural formulae of three compounds.



Which statement describes all three compounds?

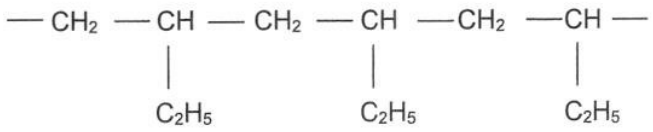
A They can form polymers.

B They are isomers of one another.

C They decolourise aqueous bromine.

D They are from the same homologous series.

37 A polymer has the structure shown.



What is the molecular formula of the monomer?

A C_2H_4

B C_3H_6

C C_4H_8

D C_4H_{10}

38 Which of the following does **not** change during polymerisation of propene to form poly(propene)?

A boiling point

B empirical formula

C mass

D molecular formula

39 Which of the following properties is the same for one mole of methane and one mole of ethanol?

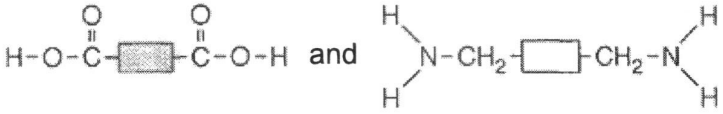
A mass

B number of atoms

C number of molecules

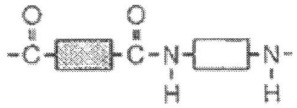
D volume at room temperature and pressure

40 A polymer is to be made from the two molecules shown.

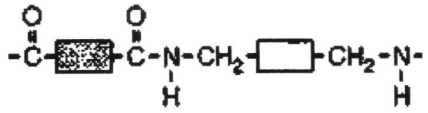


Which diagram shows the structure of the polymer?

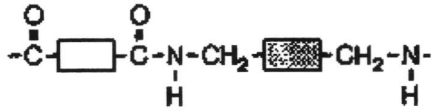
A



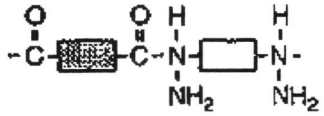
B



C



D



End of Paper

Name	Class				Index Number		

BROADRICK SECONDARY SCHOOL
SECONDARY 4 EXPRESS
PRELIMINARY EXAMINATION 2023

CHEMISTRY **6092/02**

Paper 2

August 2023

Candidates answer on Question Paper
No Additional Materials are required.

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 [30 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.

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 **18**.

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

FOR EXAMINER'S USE	
Section A	/ 50
Section B	/ 30
Total	**/ 80**

This document consists of **18** printed pages including this page

Setter: Mr YS Mong

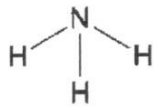
Section A [50 marks]

Answer the following questions in the spaces provided.

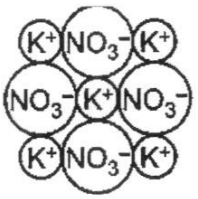
A1 The structures of some substances containing nitrogen are shown below.

For Examiner's Use

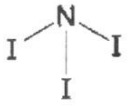
A



B

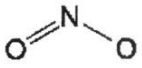


C



D

E



(a) Answer the following questions by choosing from the substances **A**, **B**, **C**, **D** or **E**. You can use each structure once, more than once or not at all.

Which substance represents

(i) a substance with high melting and boiling point,
.....
[1]

(ii) a substance that turns moist red litmus paper blue,
.....
[1]

(iii) a substance that lowers the pH of water,
.....
[1]

(b) State one source of substance E.

..... [1]

[Total: 4]

A2 The Periodic Table shows trends down each group and across each period.

Which trends are only true down a group, which trends are only true across a period and which trends are true for both?

Put a tick (✓) in **one** box for each row.

trend	only true down a group	only true across a period	true for both
The number of electron shells increases.			
The number of valence electrons increases.			
There is a change in character from metallic to non-metallic.			

[3]

[Total: 3]

For Examiner's Use

A3 Some rocks from a distant planet were studied.

The percentage by mass of the elements in compound Y are determined.

element	percentage by mass
potassium	39.4
iron	28.3
oxygen	32.3

(a) Show that the empirical formula of Y is K_2FeO_4.

[2]

(b) A few drops of aqueous K_2FeO_4 are added to a test-tube containing 3 cm^3 of aqueous potassium iodide. The solution in the test-tube changes from colourless to brown.

Given this information, what can you deduce about the chemical properties of K_2FeO_4?

.....

[1]

[Total: 3]

A4 A sample of four gases were mixed together at room temperature and pressure.

The table below shows the melting and boiling points of these four gases.

name of gas	melting point/ °C	boiling point/ °C
argon	-189	-186
nitrogen	-210	-196
oxygen	-219	-183
helium	-272	-269

(a) Which substances exist as liquids at -200 °C?

.....

[1]

(b) Describe the changes in the movement of oxygen molecules when it is heated from -200 °C to -180 °C

For Examiner's Use

.....

.....

..... [2]

[Total: 3]

A5 A student is given a sample of solid sodium carbonate.

The student performed two measurements shown in the table below.

mass of beaker / g	32.05
mass of beaker + sample / g	111.55

The sample was added to 25.00 cm^3 of 0.1 mol/dm^3 dilute nitric acid.

$$Na_2CO_3 + 2HNO_3 \rightarrow 2NaNO_3 + H_2O + CO_2$$

(a) Calculate the number of moles of dilute nitric acid used.

no. of moles of dilute nitric acid: ..... mol [1]

(b) Determine the limiting reagent. Workings should be clearly shown.

limiting reagent: ..... [2]

(c) Calculate the volume of carbon dioxide produced.

For Examiner's Use

volume: ..... cm^3 [2]

(d) With reference to collision theory, describe and explain how a higher concentration of dilute nitric acid would affect the rate of carbon dioxide produced.

.....

.....

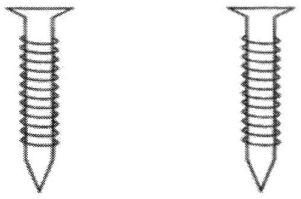
.....

..... [3]

[Total: 8]

A6 An experiment was conducted to investigate the rate of rusting in nails.

Two iron nails were prepared as shown in the diagram below.



iron nail coiled with copper

iron nail coiled with zinc

(a) Which iron nail will take a shorter time to rust? Explain your answer.

.....

.....

.....

..... [2]

(b) Describe, with the use of chemical equations, how iron is obtained from iron ore and coke.

For Examiner's Use

.....

.....

.....

.....

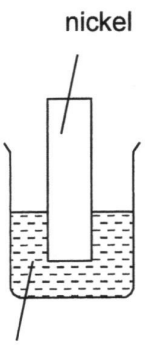
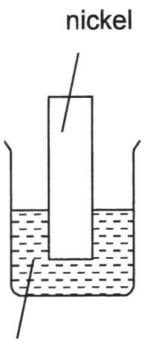
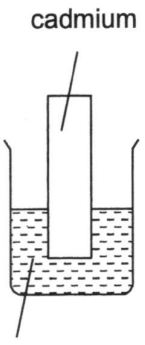
.....

..... [3]

[Total: 5]

A7 Cadmium is a transition element that is used to make rechargeable batteries. It does **not** react with water. An experiment was carried out to determine the reactivity of cadmium.

The results of the experiment obtained is shown below.

experiment			
observations	grey solid in a green solution	no change, solution remains colourless	grey solid in a colourless solution

(a) Arrange the metals, lead, nickel, cadmium and zinc in increasing order of reactivity.

..... [1]

(b) In another experiment, cadmium was added into copper(II) sulfate solution.

For Examiner's Use

Predict two observations and explain your reasoning.

observations.....

.....

.....

reasons.....

.....

.....

..... [4]

(c) Cadmium is expensive to purchase but industries continue to use it as a catalyst in the production of chemicals.

Give two reasons why cadmium is cost effective in producing chemicals in the longer term.

.....

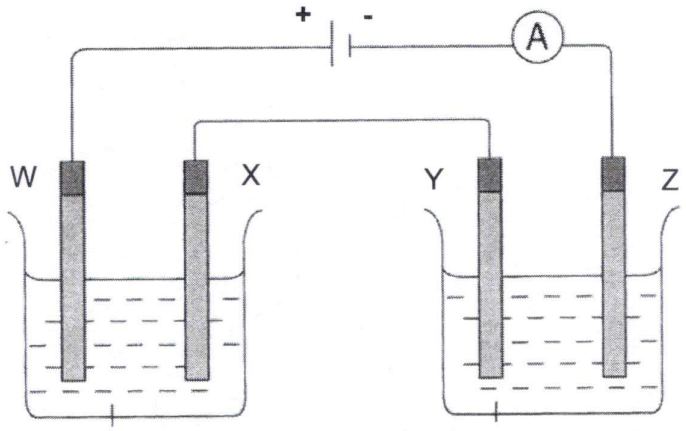
.....

..... [2]

[Total: 7]

A8 The diagram shows the set-up of an electrolysis experiment. W and X are copper electrodes, while Y and Z are silver electrodes.

For Examiner's Use



(a) **(i)** Which two electrodes would increase in mass?

.....

[1]

(ii) Which of the electrodes stated in **(a)(i)** will increase in mass at a faster rate? Suggest a reason your answer.

.....

.....

.....

.....

[2]

(b) When both Y and Z electrodes are replaced with carbon electrodes, bubbles are observed at Y.

(i) Write a half-ionic equation for the formation of this gas at electrode Y.

.....

[1]

(ii) Describe a test for the gas obtained in **(b)(i)**.

.....

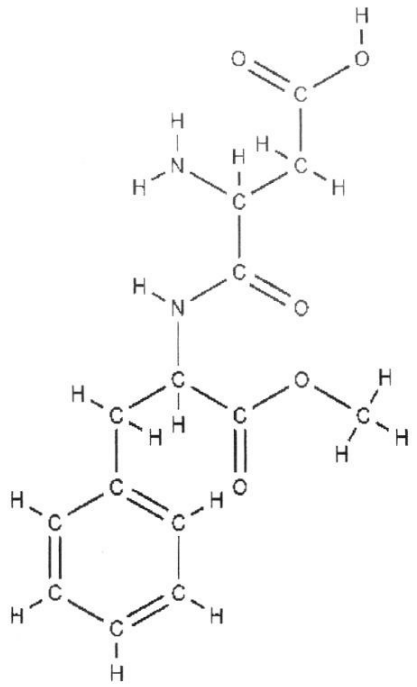
.....

[1]

[Total: 5]

A9 Aspartame is an artificial sweeter that has recently been listed by by the World Health Organisation as a substance that may cause cancer. The structure of aspartame is shown below.

For Examiner's Use

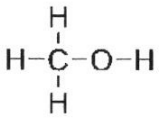
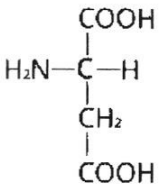


full structural formula of aspartame

(a) Name one functional group present in a molecule of aspartame.

..... [1]

(b) Methanol and aspartic acid are among the products formed when aspartame is broken down in the stomach.

	
methanol	aspartic acid

(i) Describe a chemical test to distinguish between a sample of methanol from a sample of aspartic acid.

.....

.....

.....

..... [2]

For Examiner's Use

(ii) A sample of methanol reacts with ethanoic acid in the presence of concentrated sulfuric acid to form water and substance X.

Name and draw the full structural formula of substance X.

Name: .....

Full structural formula:

[2]

[Total: 5]

A10 The alkanes are a homologous series. The table shows some information about some alkanes.

alkane	relative molecular mass	melting point / °C	boiling point / °C	density at room temperature and pressure in g/dm^3	enthalpy change of combustion in kJ/mol
methane	16	– 182	– 162	0.667	– 889
propane	44	– 188	– 42		– 2217
butane	58	– 138	-1	2.417	– 2880

(a) Calculate the density of propane at room temperature and pressure.
Give your answer to 3 significant figures.

density of propane = ... g/dm^3 [1]

(b) Using the information in the table, explain why the density of butane is higher than that of methane at room temperature and pressure.

.....

.....

..... [2]

(c) (i) Draw the full structural formula of both isomers of butane, C_4H_{10}.

For Examiner's Use

isomer 1	isomer 2

[2]

(ii) A student commented that the enthalpy change of combustion of both isomers of butane would be very similar.

Do you agree? Explain your answer.

.....

.....

..... [2]

[Total: 7]

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.

B11 Read the information about the chlorides of elements in Period 3 of the Periodic Table.

For Examiner's Use

Elements and their chlorides

The formulae and chemical properties of the chlorides of the elements change across Period 3.

The chlorides behave differently when they are added to water. Some of the chlorides dissolve in water to form a solution. Some hydrolyse when they are added to water. This means that they react chemically with water to produce new products.

element	metal/ non-metal	formula of main chloride	bonding in chloride	effect of adding chloride to water	products of adding chloride to water
Na	metal	NaCl	ionic	dissolves	NaCl (aq)
Mg	metal	MgCl2	ionic	dissolves	MgCl2 (aq)
Al	metal	AlCl3	covalent	hydrolyses	complex mixture of products including HCl (aq)
Si	non-metal	SiCl4	covalent	hydrolyses	SiO2 (s) HCl (aq)
P	non-metal	PCl3	covalent	hydrolyses	H3PO3 (aq) HCl (aq)
S	non-metal	S2Cl2	covalent	hydrolyses	complex mixture of products including HCl (aq)
Cl	non-metal	Cl2	covalent	hydrolyses	HClO (aq) HCl (aq)

The reaction of chlorine with water is interesting because it is an example of a disproportionation reaction. Disproportionation happens when the oxidation state of the same element both increases and decreases in the reaction.

The chlorides have different formulae and the ratio of the element to chlorine changes across Period 3. Some examples are shown in the table below.

formula of chloride	ratio of element to chlorine
NaCl	1:1
$MgCl_2$	1:2
$AlCl_3$	1:3

(a) Describe the pattern for the ratio of element to chlorine across Period 3. Include ratios in your answer.

For Examiner's Use

.....

.....

..... [2]

(b) Write the chemical formula of the chloride which forms a precipitate when added to water?

..... [1]

(c) Two students talk about the data.

Student 1:
"I think that whether or not the chloride hydrolyses is linked to the metal or non-metal character of the element.'

Student 2:
"I think that whether or not the chloride hydrolyses is linked to the bonding of the chloride."

Does the information in the table support the ideas of the students? Explain your answer.

.....

.....

.....

..... [3]

(d) Suggest a reason why argon is **not** included in the table of information about Period 3 chlorides?

..... [1]

(e) A student would like to perform an experiment to learn more about the hydrolyses of chlorides in water.

Describe a test to determine whether a chloride has hydrolysed after being added to water. You should include a description of both the positive and negative results.

test .....

results.....

.....

..... [3]

[Total: 10]

B12 Iodine reacts with chlorine to form dark brown iodine monochloride.

For Examiner's Use

$$I_2 + Cl_2 \rightarrow 2ICl$$

bond	energy / kJ per mol
I – I	151
Cl – Cl	242
I – Cl	208

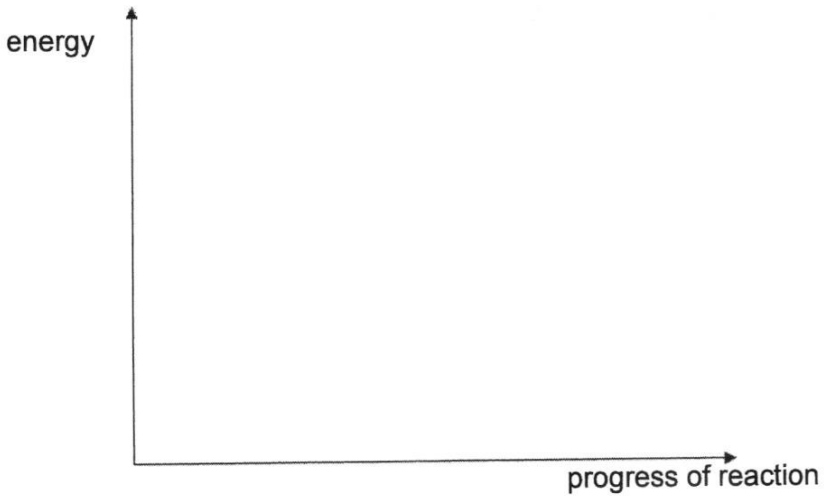
(a) Calculate the overall enthalpy change for the reaction between iodine and chlorine.

overall enthalpy change: ..... kJ/mol [3]

(b) Draw an energy profile diagram for the reaction between iodine and chlorine.

Indicate clearly,

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



[3]

(c) On your diagram in **(b)**, sketch the energy profile diagram for the same reaction when a suitable catalyst is used.

Label this graph as **(c)**. [1]

(d) Chlorine and iodine are both found in Group VII.

For Examiner's Use

Describe an experiment to prove that chlorine is more reactive than iodine. You should include observation(s) in your description.

.....

.....

.....

..... [2]

(e) A student is presented with a set of data showing the boiling points and bond energy.

substance	boiling point (°C)
chlorine (Cl_2)	-34
iodine monochloride (ICl)	97.4

bond	energy / kJ per mol
$Cl - Cl$	242
$I - Cl$	208

A student commented that the boiling point for iodine monochloride is wrong. The student thinks that it should be lower than chlorine because the $I - Cl$ bond is weaker than the $Cl - Cl$ bond.

Do you agree with the student? Explain your answer.

.....

..... [1]

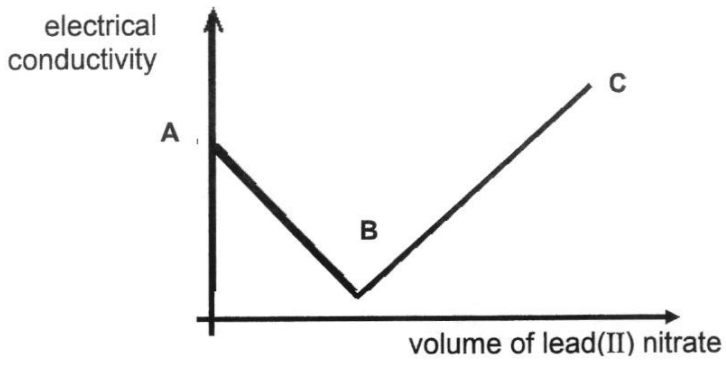
[Total: 10]

EITHER

For Examiner's Use

B13 A washing agent contains the acid, sodium hydrogen sulfate, $NaHSO_4$. Sodium hydrogen sulfate can be made by reacting sodium hydroxide with sulfuric acid, H_2SO_4.

(a) The graph below shows the change in electrical conductivity when lead(II) nitrate solution is added into dilute sulfuric acid.



(i) Write the ionic equation for the reaction between lead(II) nitrate and dilute sulfuric acid.

..... [1]

(ii) Describe and explain the following changes in electrical conductivity from **A** to **B** and to **C.**

.....

.....

.....

.....

..... [3]

(b) Describe how a dry sample of magnesium sulfate can be prepared from dilute sulfuric acid and magnesium carbonate.

For Examiner's Use

.....

.....

.....

.....

..... [3]

(c) Sulfuric acid can be formed by dissolving sulfur dioxide in water followed by an oxidation reaction.

(i) Name the common substance used to remove sulfur dioxide from the flue gas produced from fossil fuel power plants.

..... [1]

(ii) Describe, with the use of suitable chemical equations, how the substance named in **(c)(i)** removes sulfur dioxide from waste gases.

.....

.....

.....

.....

..... [2]

[Total: 10]

For Examiner's Use

OR

B13 The following table shows the melting point and electrical conductivity for five substances.

substance	melting point / °C	electrical conductivity in solid state	electrical conductivity in molten state
graphite	3650	good	poor
diamond	3550	poor	poor
magnesium oxide	2852	poor	good
sodium oxide	1132	poor	good
sulfur dioxide	-73	poor	poor

(a) Explain why the melting point of magnesium oxide is much higher than that of sodium oxide.

.....

.....

.....

..... [3]

(b) With reference to structure and bonding, explain why diamond has high melting and boiling point.

.....

.....

.....

..... [3]

(c) With reference to structure and bonding, explain why graphite is a good conductor of electricity.

.....

..... [2]

(d) Explain why sulfur dioxide is **not** able to conduct electricity in any state.

..... [1]

(e) Other than melting point, boiling and electrical conductivity, state another physical property of sodium oxide.

..... [1]

[Total: 10]

Paper 1

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

Section A

A1

ai B [1]

aii A [1]

aiii E [1]

b From lightning activity / internal combustion engines [1]

A2

trend	only true down a group	only true across a period	true for both
The number of electron shells increases.	✓		
The number of valence electrons increases.		✓	
There is a change in character from metallic to non-metallic.		✓	

[3]

A3 **a**

element	K	Fe	O
% mass	39.4	28.3	32.3
A_r	39	56	16
No. of moles	$\frac{39.4}{39} \approx 1.01$	$\frac{28.3}{56} \approx 0.505$	$\frac{32.3}{16} \approx 2.01$
Simplest ratio	$\frac{1.01}{0.505} \approx \underline{2}$	$\frac{0.505}{0.505} \approx \underline{1}$	$\frac{2.01}{0.505} \approx \underline{4}$

[1] correct number of moles
[1] correct ratio

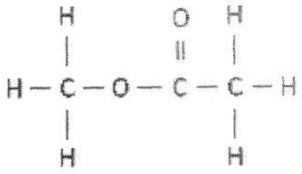
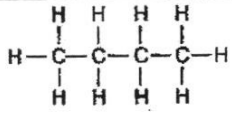
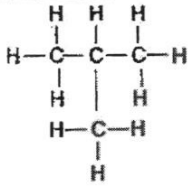
[2]

	b	It is an **oxidising agent.**	[1]
A4	a	**Nitrogen and oxygen**	[1]
	b	**At -200°C**, the oxygen molecules **slide freely and randomly** around one another. As **temperature increase**, molecules **slide faster**. **At -180°C**, the oxygen molecules start to **move freely and randomly at high speeds in all directions**.	[2]
A5	a	No. of moles of dilute nitric acid = 25.00/1000 x 0.1 = **0.0025 mol**	[1]
	b	Mass of sodium carbonate = 79.5 g Number of moles of sodium carbonate = 79.5 / 106 = **0.75 mol** 0.75 mol of sodium carbonate requires 1.50 mol of nitric acid to react completely. [Statement is needed for obtaining final answer mark] **dilute nitric acid is the limitng reagent**. [no mark if working does not convince nitric acid is limiting reagent]	[2]
	c	By mole ratio, 2 moles of dilute nitric acid produces 1 mole of carbon dioxide. Number of moles of carbon dioxide = **0.00125 mol** Volume = 0.00125 x 24000 = **30 cm^3**	[2]
	d	The rate of carbon dioxide produced would **increase.** As the concentration increases, the number of reactant particles per unit volume of nitric acid **increases.** The frequency of collision and **the frequency of effective collision between reactant particles increases.**	[3]
A6	a	**Iron nail with copper**. Iron is **more reactive** than copper. Iron would **sacrifice itself** and **rust** in place of copper. Accept: Zinc is **more reactive** than iron. Zinc would **sacrifice itself** and **corrode** in place of iron.	[2]
	b	$C + O_2 \rightarrow CO_2$ Carbon in coke reacts with oxygen in air to produce carbon dioxide.	

[Turn over

		$CO_2 + C \rightarrow 2CO$ Carbon dioxide reacts with more coke to form carbon monoxide. $Fe_2O_3 + 3CO \rightarrow 3CO_2 + 2Fe$ Iron ore / haematite / iron(III) oxide reacts with carbon monoxide to form iron and carbon dioxide.	[3]
A7	a	Lead, cadmium, nickel, zinc	[1]
	b	Observations: 1. Blue solution turns pale blue / colourless 2. Reddish-brown solid found at bottom of **beaker** / surface of cadmium 3. Size of cadmium metal becomes smaller Any 2 for [2] Reasons: Cadmium is **more reactive** than copper / more reactive than lead. Cadmium **displace Cu^{2+} ions from copper(II) sulfate solution** to form solid copper.	[4]
	c	1. Catalyst can be reused. 2. **Only a small amount** is sufficient to act / function as an effective catalyst 3. The increased value of the larger amount of products produced over time due to the presence of a catalyst is more valuable than the cost of the cadmium catalyst Any 2 for [2]	[2]
A8	**ai**	X and Z	[1]
	aii	Z Each (mole of) silver ion gains 1 (mole of) electron to form one (mole of) silver atom(s) whereas one (mole of) copper(II) ion gains 2 (moles of) electrons to form one (mole of) copper atom. [1]	[2]
	bi	$4OH^-(aq) \rightarrow O_2(g) + 2H_2O(l) + 4e^-$	[1]
	bii	Use a glowing splint. The gas evolved will relight glowing splint. [Allow **ECF** from bi]	[1]
A9	**a**	Carboxyl / amine / ester / amide	[1]

[Turn over

	b	Test: • Use sodium carbonate (metal carbonate) / reactive metal (named) / acidified potassium managanate (VII) Observation: • For aspartic acid - effervescence observed - gas evolved forms white ppt in limewater • For aspartic acid - effervescence observed – gas evolved extinguishes lighted spint with a 'pop' sound • For methanol - acidified potassium manganate (VII) decolourises from purple to colourless.	[2]
	c	Name: Methyl ethanoate Full structural formula:  Methyl ethanoate	[2]
A10	**a**	44 g of propane – 24 dm^3 24dm^3 of propane – 44 g 1 dm^3 of propane = 44/24 = <u>1.83 g/dm^3</u> (3sf)	[1]
	b	Butane molecule has a <u>larger</u> molecular size than methane. Butane molecules are held <u>more</u> closely together by <u>stronger</u> intermolecular forces of attraction.	[2]
	ci	 Butane C_4H_{10}  Iso-Butane C_4H_{10}	[2]
	cii	Yes. The number of <u>carbon- hydrogen</u> and <u>carbon-carbon bonds</u> in each isomer is the same / the bonds broken and formed are identical during combustion although they have different structural formula.	[2]

[Turn over

Section B

B11	**a**	The ratio increases from 1:1 to 1:2,1:3 and 1:4 from Group I to Group IV. The ratio decreases from 1:3 from Group V to 1:1 for Group VI and Group VII.	[2]
	b	$SiCl_4$ (Accept $AlCl_3$ as one of the products is $Al(OH)_3$)	[1]
	c	Student 2 is correct but student 1 is wrong. Student 1 is wrong because not all metal chlorides dissolves. $AlCl_3$ is a metal chloride, but it hydrolyses instead of dissolving when added to water. Student 2 is correct because all chlorides with ionic bonding dissolves whereas all chlorides with covalent bonding hydrolyses when added to water.	[3]
	d	Argon is inert / has a fully fill valence electron shell and does not undergo chemical reactions.	[1]
	e	**Test**: add reactive metal (reject if metal reacts with water) / metal carbonate to the solution after chloride is added or use pH meter / use universal indicator. **Hydrolysed**: Effervescence observed / pH level below 7 / indicator shows solution is acidic (red/orange -state colour) **If not hydrolysed,** No effervescence observed / indicator shows solution is neutral (green -state colour)	[3]

B12	**a**	Energy change from bond forming = 2 x (-208) = - 416 kJ/mol Energy change from bond breaking = +151 + 242 = +393 kJ/mol Overall enthalpy change = -416 + 393 = -23 kJ/mol	[1] [1] [1]
	b	Correct labelling of E_a on diagram. (Upwards) Correct direction of arrow for ΔH. *(Downwards)* Correct labelling of position of energy level of reactants and products. [Allow **ECF** from (a)]	[1] [1] [1]
	c	Diagram should show lowered Ea but rest of diagram should remain unchanged.	[1]
	d	Bubble chlorine gas in a test tube containing aqueous (sodium) iodide. **Accept: soluble iodide** Brown solution / purple solid observed in the test tube.	[1] [1]
	e	No. Chemical bonds are not broken during boiling / boiling point is determined by strength of intermolecular forces of attraction and not strength of covalent bonds.	[1]

B13 Eit	**ai**	$Pb^{2+}(aq) + SO_4^{2-}(aq) \rightarrow PbSO_4(s)$	[1]
	aii	Electrical conductivity **decreases** from A to B and **increases** from B to C. From A to B, the number of mobile ions in the solution **decreases** as $PbSO_4$ is formed. From B to C, **all the dilute sulfuric acid is used up**. All the added lead(II) nitrate dissociates to form mobile ions.	[3]
	b	Add magnesium carbonate in **excess** to dilute sulfuric acid until no more dissolves. **Filter** to remove excess magnesium carbonate. **Heat** the filtrate to evaporate most of the solvent **until a hot saturated solution is obtained**.	[3]

[Turn over

		Cool to allow crystals to form. **Wash** with small amounts of cold distilled water and **dry** between sheets of filter paper.	
	ci	Calcium carbonate	[1]
	cii	$CaCO_3(s) + SO_2(g) \rightarrow CaSO_3(s) + CO_2(g)$ Calcium carbonate reacts with sulfur dioxide to form calcium sulfite. $2CaSO_3(s) + O_2(g) \rightarrow 2CaSO_4(s)$ Calcium sulfite reacts with oxygen to form calcium sulfate.	[2]
B13 Or	a	The Mg^{2+} ions in MgO have **higher charge / twice the charge** than the Na^+ ions in Na_2O. The electrostatic forces of attraction between oppositely charged ions in MgO are stronger than between the ions in Na_2O. **More heat** energy is required to overcome the attractive forces between oppositely charged ions in MgO.	[1] [1] [1]
	b	Diamond has a **giant covalent structure.** Each carbon atom is bonded to four other carbon atoms by **strong covalent bonds**. A lot of thermal energy is required to **break** these bonds.	[3]
	c	In graphite, **each carbon is bonded to three other carbon atoms**. The **4th valence electron not involved in bonding is free to move** across the layer.	[2]
	d	Sulfur dioxide does **not** have any free electrons and does **not** have mobile ions.	[1]
	e	It is soluble in water / insoluble in organic solvents.	[1]