Candidate Name: _____

Class:	
Index No:	

Chong Boon Secondary School

Preliminary Examination 2016
Secondary 4 Express
Chemistry

Paper 1 5073

31 August 2016 (Wednesday)	1 hour

Additional Materials : Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Do not open this booklet until you are told to do so.

Write in soft pencil.
Do not use staples, paper clips, highlighters, glue or correction fluid.
Write your name 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 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 booklet.
A copy of the Periodic Table is printed on page 20.
The use of an approved scientific calculator is expected, where appropriate.

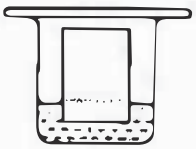
The total mark for this paper is 40.

For Examiner's Use
40

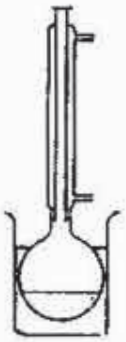
1 Chloroform is an organic liquid that is used as an industrial solvent in dry-cleaning. It does not mix with water.

Which apparatus can be used to separate a mixture of chloroform and water?

A

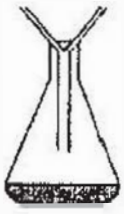


B



C

D



2 Sodium nitrate can be separated from chalk using four processes below.

Which of the following shows the **correct** order in which the processes should be used?

A dissolving, evaporation, crystallisation, filtration

B dissolving, filtration, evaporation, crystallisation

C filtration, crystallisation, evaporation, dissolving

D filtration, evaporation, crystallisation, dissolving

3 Four balloons are each filled with a different gas and left under room temperature for several days. The four gases used to fill the balloons are carbon monoxide, helium, hydrogen and nitrogen.

Which balloon will deflate the fastest?

A balloon with carbon monoxide

B balloon with helium

C balloon with hydrogen

D balloon with nitrogen

4 The melting points of four pure substances, **W**, **X**, **Y** and **Z**, are given below.

substance	melting point / °C
W	80
X	82
Y	85
Z	89

An impure sample of an unknown solid melts over a temperature range of 83 °C to 88 °C.

From the given information, we can infer that the unknown solid is most likely to be

A **W.**

B **X.**

C **Y.**

D **Z.**

5 An element **K** has a nucleon number of 45. The ion, K^{3+}, contains 18 electrons.

How many neutrons are there in an atom of **K**?

A 18

B 21

C 24

D 45

6 The structure of metals consists of positive ions in a 'sea of mobile electrons'.

Which statement correctly describes what happens to the particles in the metallic heating element of an electric kettle when the kettle is switched on?

A Electrons move in both directions in the heating element.

B Electrons move in one direction and the positive ions move in the opposite direction in the heating element.

C Electrons move in one direction only in the heating element.

D Positive ions move in one direction only in the heating element.

7 Which statement describes the arrangement of particles of sodium hydroxide in water?

A Ions are widely spaced and they move randomly.

B Ions are widely spaced but they do not move.

C Molecules are closely packed and they move randomly.

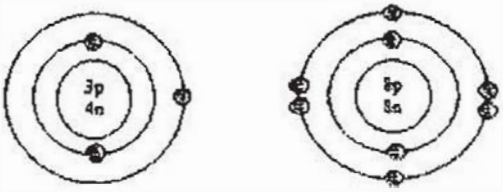
D Molecules are widely spaced and they move randomly.

8 The table shows some properties of diamond and graphite.

Which of the following gives the correct reason for the property?

	property	reason
A	diamond cuts glass	the bonds in glass are stronger than those in diamond
B	diamond is a hard substance	there are many ionic bonds in diamond
C	graphite is a lubricant	there are weak bonds between graphite layers
D	graphite conducts electricity	graphite contains mobile ions

9 The diagrams show the structures of two atoms of the elements **L** and **M** respectively.



L **M**

What is the mass of 1 mole of the compound formed by **L** and **M**?

A 11 g

B 12 g

C 23 g

D 30 g

10 Naphthalene is the main ingredient of mothballs. It contains 93.75% of carbon and 6.25% of hydrogen.

If the relative molecular mass of naphthalene is 128, what is its molecular formula?

A CH

B C_5H_4

C $C_{10}H_8$

D $C_{10}H_{10}$

11 0.20 moles of an element **E** was combined with an excess of element **F** and produced 15.6 g of a compound EF_2.

What could be the electronic configurations of **E** and **F**?

	E	F
A	2,2	2,8,7
B	2,4	2,8,6
C	2,8,1	2,8,6
D	2,8,8,2	2,7

12 Hydrogen sulfide burns in an excess of oxygen according to the equation below.

$$2H_2S(g) + 3O_2(g) \rightarrow 2H_2O(g) + 2SO_2(g)$$

What is the volume of gases produced if 18 dm^3 of hydrogen sulfide are burnt completely in an excess of oxygen at room temperature and pressure?

A 18 dm^3

B 24 dm^3

C 36 dm^3

D 48 dm^3

13 When 25.0 cm^3 of sodium hydroxide is added to 50.0 cm^3 of sulfuric acid, neutralisation occurs.

Which of the following statements is true?

A Sodium hydroxide is four times as concentrated as sulfuric acid.

B Sodium hydroxide is of the same concentration as sulfuric acid.

C Sodium hydroxide is twice as concentrated as sulfuric acid.

D Sulfuric acid is twice as concentrated as sodium hydroxide.

14 A pure hydrocarbon is used in bottled gas and heating.

When 10 cm^3 of the hydrocarbon is burned in 70 cm^3 of oxygen, the final gaseous mixture contains 30 cm^3 of carbon dioxide and 20 cm^3 of unreacted oxygen. All gaseous volumes are measured under identical conditions.

What is the chemical formula of the hydrocarbon?

A C_2H_6

B C_3H_6

C C_3H_8

D C_4H_{10}

15 Which of the following statements about oxides is true?

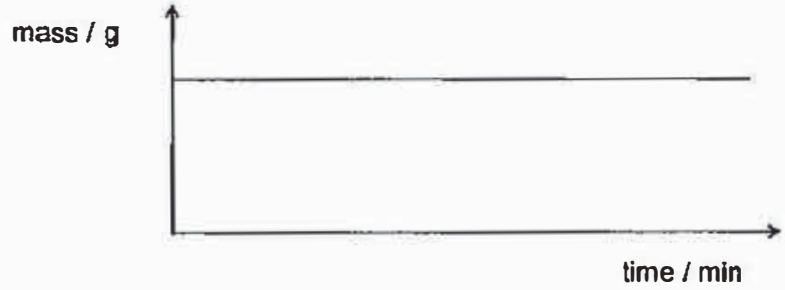
A Carbon monoxide will react with aqueous sodium hydroxide to form a salt and water.

B Copper(II) oxide will react with dilute sulfuric acid to give a blue solution.

C Nitrogen dioxide is a neutral oxide.

D Zinc oxide dissolves readily in water to form an alkaline solution.

16 Two substances are reacted in a conical flask placed on an electronic balance.
The mass of the conical flask and its contents are recorded at regular intervals and the results are shown in the graph below.



Which of the following could be the two substances?

A aqueous sodium hydroxide and aqueous ammonium nitrate

B aqueous silver nitrate and dilute hydrochloric acid

C calcium carbonate and dilute sulfuric acid

D dilute nitric acid and magnesium

17 When a student mixed two solutions he recorded the following observations:

'no effervescence, solution changes colour, no precipitate forms'

The student must have mixed

A dilute nitric acid and lead(II) carbonate.

B sodium hydroxide solution and dilute sulfuric acid.

C potassium chloride solution and silver nitrate solution.

D warmed dilute hydrochloric acid and iron(II) oxide.

18 Some information on three indicators is given below.

indicator	colour in strongly acidic solution	pH at which colour changes	colour in strongly alkaline solution
bromocreosol green	yellow	4.8	blue
methyl red	red	5.2	yellow
thymolphthalein	colourless	9.9	blue

What is the colour seen when each indicator is added to pure water?

	bromocreosol green	methyl red	thymolphthalein
A	blue	red	colourless
B	blue	yellow	blue
C	blue	yellow	colourless
D	yellow	red	blue

19 Separate samples of hydrogen peroxide are added to aqueous potassium iodide and to acidified potassium manganate(VII). The iodide ions are oxidised and the manganate(VII) ions are reduced.

What are the colour changes seen?

	potassium iodide	acidified potassium manganate(VII)
A	brown to colourless	orange to green
B	brown to colourless	purple to colourless
C	colourless to brown	orange to green
D	colourless to brown	purple to colourless

20 Which of the following shows the electronic configuration of a strong reducing agent?

A 2, 1

B 2, 8

C 2, 8, 6

D 2, 8, 7

21 Jarosite has the molecular formula $KFe_3(OH)_6(SO_4)_2$.

What is the oxidation state of iron in the mineral?

A +2

B -2

C +3

D -3

22 Excess zinc is added into a solution containing magnesium nitrate and copper(II) chloride. After the reaction, the mixture is filtered.

Which of the following cations would be present in the filtrate?

A Cu^{2+}, Mg^{2+}

B Cu^{2+}, Zn^{2+}

C Mg^{2+}, Zn^{2+}

D Mg^{2+}, Zn^{2+}, Cu^{2+}

23 Which reaction in the blast furnace is an acid-base reaction?

A $C + CO_2 \rightarrow 2CO$

B $C + O_2 \rightarrow CO_2$

C $CaO + SiO_2 \rightarrow CaSiO_3$

D $Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$

24 Which of the following combinations of type of electrode used, electrolyte and products at the electrode is correct?

	type of electrode	electrolyte	product at the anode	product at the cathode
A	carbon	concentrated hydrochloric acid	chlorine	hydrogen
B	carbon	aqueous sulfuric acid	sulfur	hydrogen
C	copper	aqueous copper(II) sulfate	oxygen	copper
D	platinum	aqueous copper(II) sulfate	hydrogen	copper

25 During the electrolysis of an aqueous solution of a cerium salt, 70 g of cerium is deposited at the cathode by 2 moles of electrons.

What is the formula of the cerium ion?
(A_r of Ce = 140)

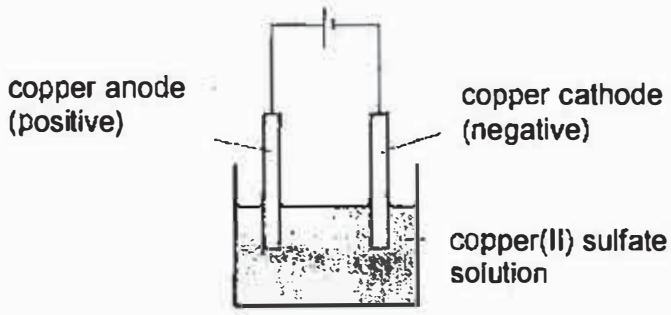
A Ce^{+}

B Ce^{2+}

C Ce^{3+}

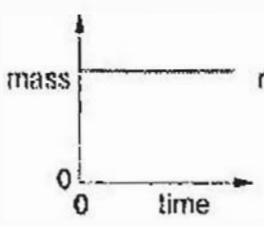
D Ce^{4+}

26 The diagram shows the electrolysis of aqueous copper(II) sulfate using copper electrodes.



Which graph shows how the mass of the cathode changes during electrolysis?

A



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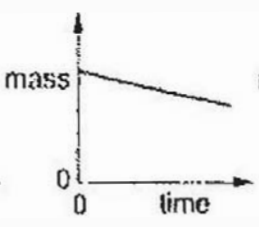
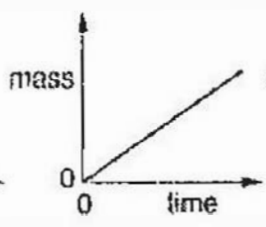
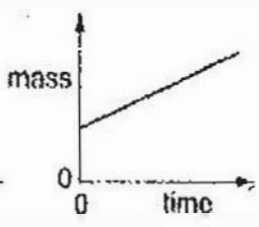


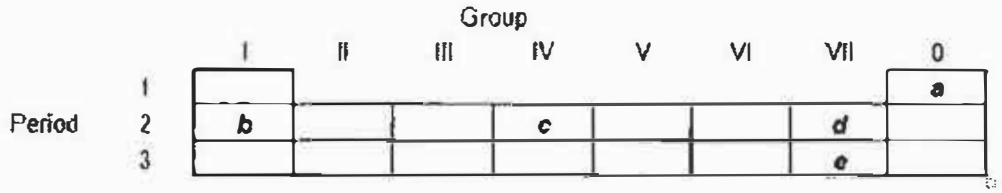
C



D



27 A part of the Periodic Table is shown below.



Which of the following statements is correct?

A **c** forms an ionic compound with ***d***.

B ***e*** is a strong oxidising agent.

C The metallic character of the Period 2 elements increases from ***b*** to ***d***.

D The outermost electron shell of an atom ***a*** is an octet structure.

28 Which of the following changes in the properties of the halogens is **not** correct?

	chlorine → bromine → iodine
A	darker in colour
B	decrease in melting point
C	decrease in rate of diffusion
D	increase in density

29 Rubidium, Rb, is an element in the same group of the Periodic Table as lithium, sodium and potassium.

Which statement about rubidium is correct?

A It can be cut easily.

B It can be produced during the electrolysis of aqueous rubidium chloride.

C It forms an insoluble hydroxide.

D It reacts slowly with water at room temperature.

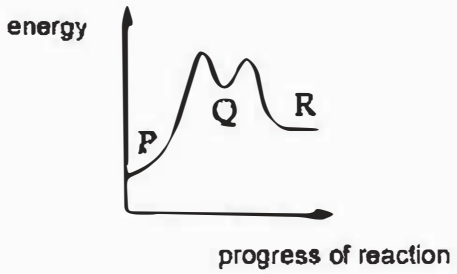
30 In the conversion of compound **P** into compound **R**, it was found that the reaction proceeded by forming compound **Q**, which could be isolated, as an intermediate.
The steps involved are:

P → Q ΔH = negative

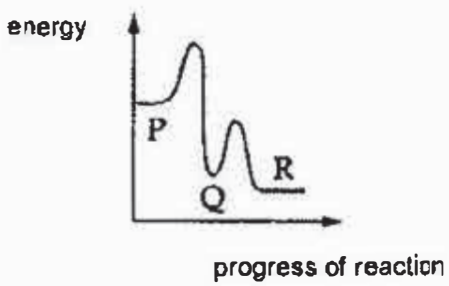
Q → R ΔH = positive

Which of the following energy diagrams represents the conversion of compound **P** into compound **R**?

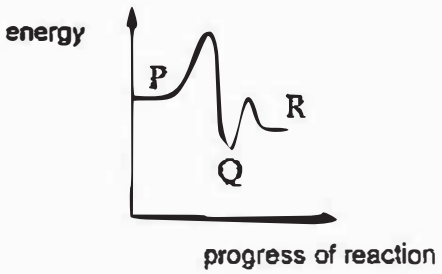
A



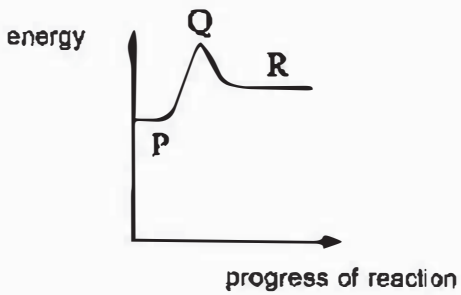
B



C

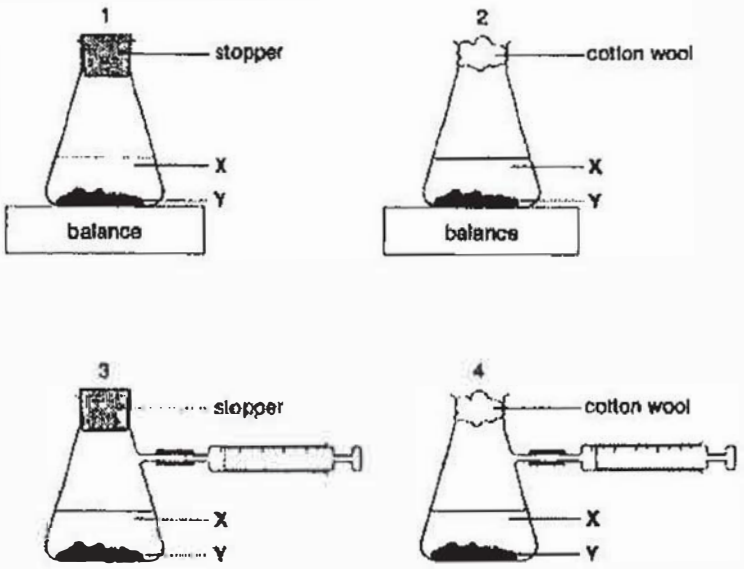


D



31 A liquid **X** reacts with solid **Y** to form a gas.

Which two diagrams show suitable methods for investigating the speed of the reaction?



A 1 and 3

B 1 and 4

C 2 and 3

D 2 and 4

32 A reaction takes place in two stages:

Stage 1
$S_2O_8^{2-}(aq) + 2I^-(aq) + 2Fe^{2+}(aq) \rightarrow 2SO_4^{2-}(aq) + 2I^-(aq) + 2Fe^{3+}(aq)$

Stage 2
$2SO_4^{2-}(aq) + 2I^-(aq) + 2Fe^{3+}(aq) \rightarrow 2SO_4^{2-}(aq) + I_2(aq) + 2Fe^{2+}(aq)$

Which ion is the catalyst in the reaction?

A $Fe^{2+}(aq)$

B $I^-(aq)$

C $SO_4^{2-}(aq)$

D $S_2O_8^{2-}(aq)$

33 Sulfur dioxide and carbon dioxide are gases which affect the atmosphere and the environment.

In what way do these gases affect the environment?

	sulfur dioxide	carbon dioxide
A	acid rain	depletion of ozone layer
B	acid rain	global warming
C	global warming	depletion of ozone layer
D	global warming	acid rain

34 The following statements concern the fuel cell.

I. Hydrogen reacts with oxygen to generate electricity.
II. The hydrogen is obtained from fractional distillation of air.
III. The reaction at the negative electrode is
$O_2(g) + 2H_2O(l) + 4e^- \rightarrow 4OH^-(aq)$

How many statement(s) is/are correct?

A All three statements are correct.

B None of the statements is correct.

C Only one statement is correct.

D Two statements are correct.

35 Propanal CH_3CH_2CHO is a member of a homologous series called the alkanals.

From the chemical formula of propanal, we can conclude that the general formula of alkanal is

A $C_nH_{2n}CHO$

B $C_nH_{3n}CO$

C $C_nH_{2n+1}CHO$

D $C_nH_{2n+1}CH_2OH$

36 Which of the following compounds do **not** have any isomers?

A butane

B chloropropane

C propanol

D propene

37 Linolenic acid, $C_{18}H_{30}O_2$, is an unsaturated monocarboxylic acid found in sunflower oil.

Calculate the number of moles of hydrogen gas needed to completely convert 3 moles of linolenic acid to a saturated compound.

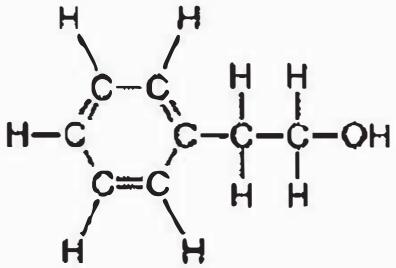
A 3

B 6

C 9

D 18

38 One substance responsible for the fragrance of roses is 2-phenylethanol.
The structure of the molecule is shown below.



Which statement about this molecule is **incorrect?**

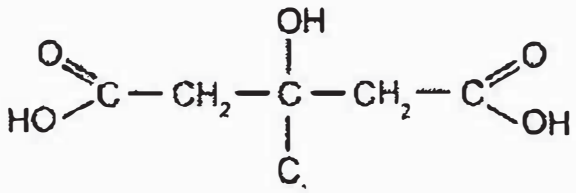
A It can be oxidised by acidified potassium manganate(VII) solution.

B It can decolourise aqueous bromine at room temperature.

C It can undergo condensation polymerisation to form a polyester.

D It is an unsaturated molecule.

39 The structure of citric acid is shown below.



How many moles of sodium hydroxide is needed to neutralise one mole of citric acid?

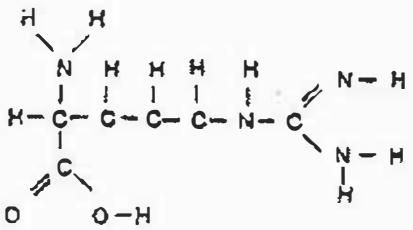
A 1

B 2

C 3

D 4

40 The structure of arginine, an amino acid, is shown below.



Which of the following statements about arginine is true?

A It forms a polymer with the same linkage as terylene.

B It forms an addition polymer with other arginine molecules.

C It only forms carbon dioxide and water when it undergoes combustion.

D It reacts with magnesium to form hydrogen gas.

End of Paper

Candidate Name: _____

Class:	
Index No:	

Chong Boon Secondary School

Preliminary Examination 2016
Secondary 4 Express
Chemistry

Paper 2 **5073**

15 September 2016 (Thursday)	1 hour 45 minutes

Additional Materials : NIL

READ THESE INSTRUCTIONS FIRST

Do not open this booklet until you are told to do so.

Write your name, class and index number on the cover sheet.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, highlighters, glue or correction fluid.

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

Section **B**
Answer all **three** questions, the last question is in the form either/or.
Answer **all** questions in the spaces provided.

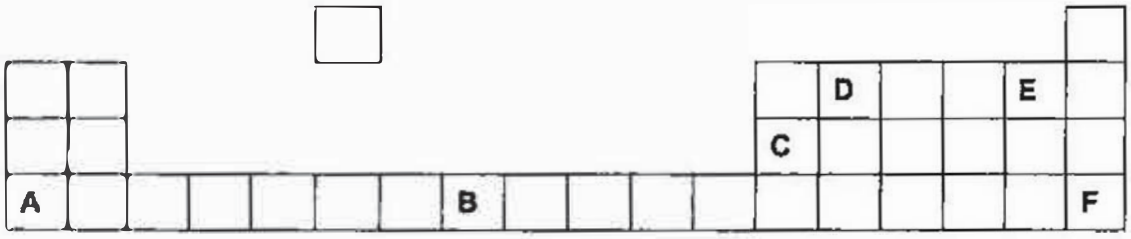
At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.
A copy of the Periodic Table is printed on page 24.
The use of an approved scientific calculator is expected, where appropriate.

For Examiner's Use
80

Section A

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

A1 The position of six elements in the first four periods of the Periodic Table, represented by letters, **A**, **B**, **C**, **D**, **E** and F are shown below.



Select from the letters, **A** to **F**, the element that best fit the following characteristics. The elements, **A** to **F**, can be used once, more than once or not at all.

(a) A monatomic element.

.....[1]

(b) An element which is the strongest oxidising agent.

.....[1]

(c) An element which can be used as a catalyst in chemical reactions.

.....[1]

(d) An element which forms an oxide that reacts with both an acid and a base.

.....[1]

(e) An element that reacts with **E** to form a compound which has a high melting point.

.....[1]

(f) An element which forms coloured compounds.

.....[1]

[Total: 6]

A2 Between the 13th and the 19th Century, artists used a green pigment called Verdigris. They made the pigment by hanging copper foil over boiling vinegar, an aqueous solution of ethanoic acid.

(a) During the preparation of Verdigris, copper atoms, oxygen molecules and hydrogen ions combine to form copper(II) ions and water.
Write the ionic equation, with state symbols, for this reaction.

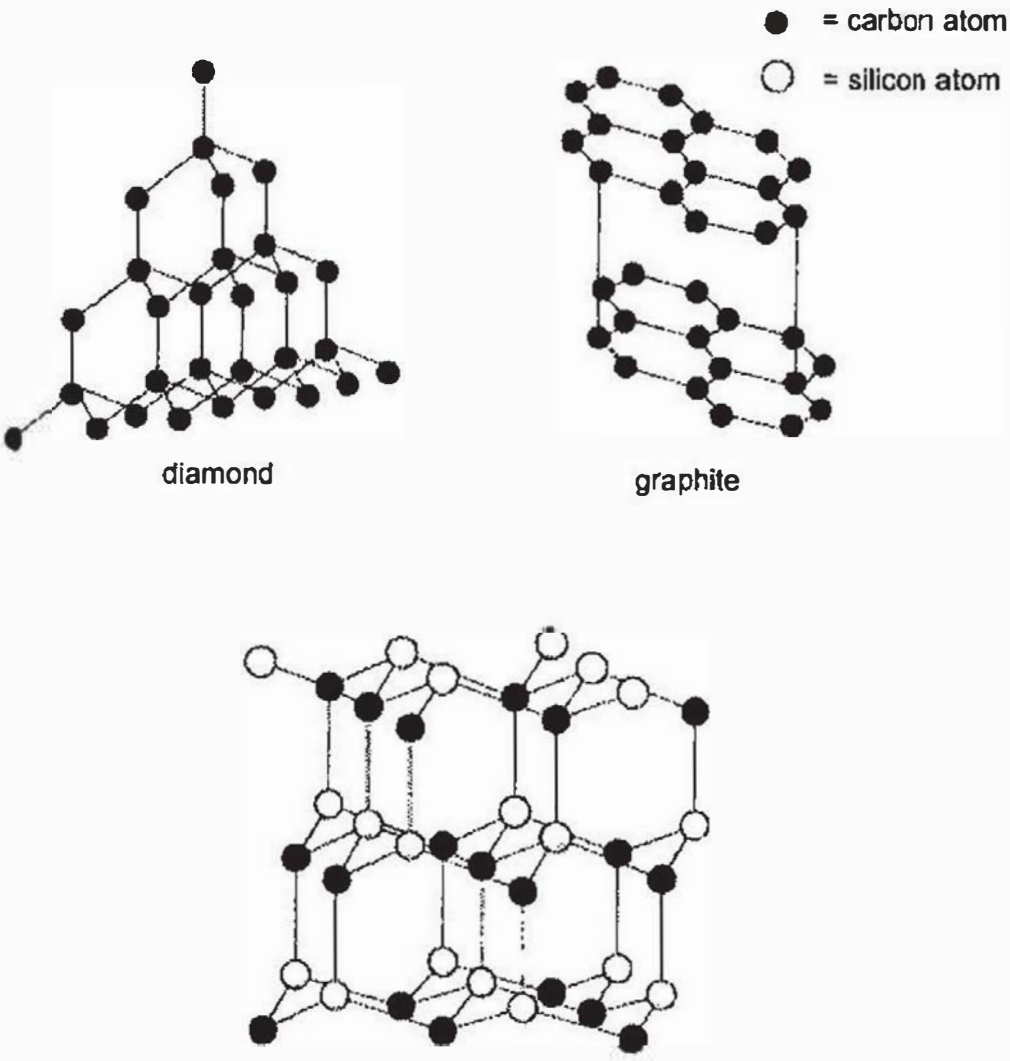
.....[2]

(b) Verdigris has the formula $[Cu(CH_3CO_2)_2]_2.Cu(OH)_2.xH_2O$.
It has a relative formula mass of 552.
Calculate the value of **x** in the formula.

[2]

[Total: 4]

A3 The structures of diamond, graphite and silicon carbide are shown below.



(a) Suggest the formula for diamond, graphite and silicon carbide.

.....

.....[2]

(b) Explain why graphite conducts electricity but silicon carbide does not.

.....

.....

.....

.....[2]

A3 (c) Silicon carbide has a very high melting point.

Explain in terms of structure and bonding, why silicon carbide has a very high melting point.

.....

.....

.....

.....[2]

(d) When a 1.20 g sample of **graphite** is completely burnt in oxygen, 4.40 g of carbon dioxide are produced.
What mass of carbon dioxide is made when a 1.20 g sample of **diamond** is completely burnt in oxygen?

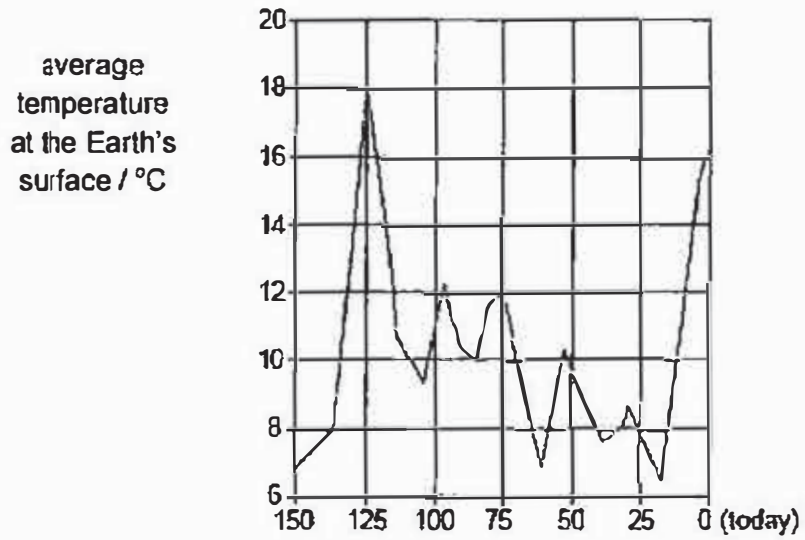
[1]

[Total: 7]

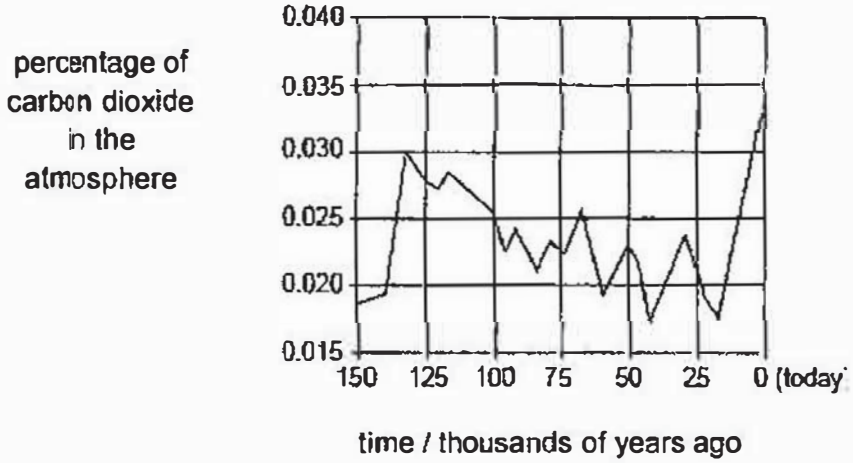
A4 Graph 1 shows how the average temperature of the Earth's surface may have changed over the last 150 thousand years.

Graph 2 shows how the percentage of carbon dioxide in the atmosphere may have changed over the last 150 thousand years.

Graph 1



Graph 2



A4 (a) Carbon dioxide is a greenhouse gas. Scientists think that an increase in the greenhouse gases will result in global warming.

(i) Explain how graphs 1 and 2 support this statement.

.....

.....[1]

(ii) Describe **two** consequences of global warming.

.....

.....

.....

.....[2]

(iii) Draw a 'dot and cross' diagram for carbon dioxide. Show the outer electrons only.

[2]

(b) Chlorofluorocarbons, CFCs, are also greenhouse gases.
Describe how the presence of CFCs in the upper atmosphere increases the amount of ultra-violet light reaching the Earth's surface.

.....

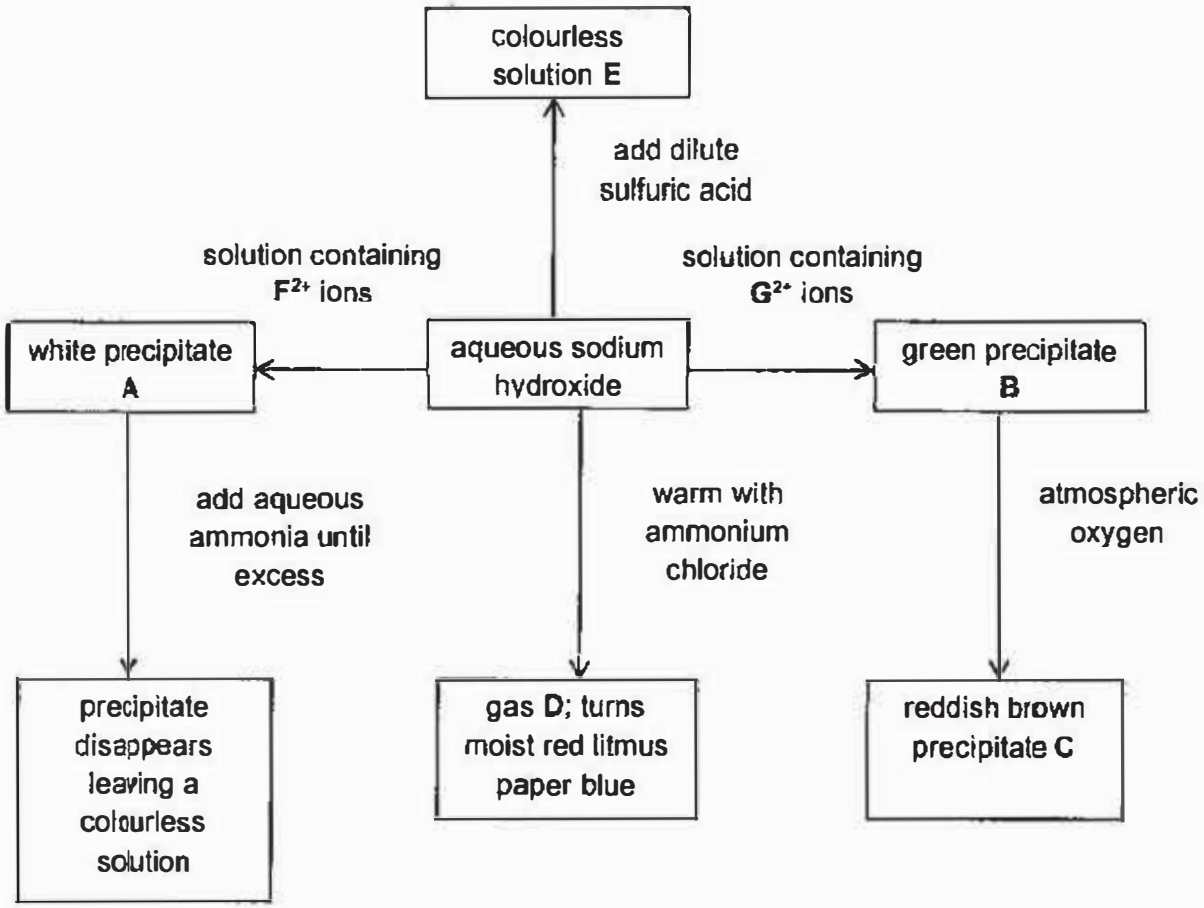
.....

.....

.....[2]

[Total: 7]

A5 The diagram shows some of the properties and reactions of the substances **A**, **B**, **C**, **D** and **E** and ions F^{2+} and G^{2+}.



(a) Suggest identities for the substances **A**, **B**, **C**, **D** and **E** and ions F^{2+} and G^{2+}.

A .....

B .....

C .....

D .....

E .....

F^{2+} .....

G^{2+} .....

[7]

(b) Write a chemical equation for the reaction between aqueous sodium hydroxide andammonium chloride.

.....[1]

[Total: 8]

A6 (a) Zinc alloys are widely used in making aircraft parts and racing car engines.

The table shows some incomplete information about a zinc alloy that contains the elements, zinc, magnesium and zirconium.

element	moles in 400 g of alloy / mol	mass of 400 g of alloy / g
magnesium	0.22	5.28
zinc		
zirconium (Period 5 element)	0.044	

(i) Using the information provided, complete the table.

Show your working below.

[2]

(ii) Explain why the zinc alloy is stronger than the pure metal.

.....

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.....[2]

A6 (b) A student investigates the temperature changes when three metals, **P**, **Q** and **R** were added to zinc sulfate solution.

0.40 g of each metal was added to a test tube containing zinc sulfate solution and the maximum temperature of the mixture was measured and recorded.

The table shows the results obtained by the student.

metal	initial temperature / °C	maximum temperature / °C
P	29.0	29.0
Q	30.0	33.5
R	28.5	34.5

The student concludes that the order of reactivity of the metals is as follows:

most reactive **Q** **R** **P** least reactive zinc

Do you agree with the student's conclusion? Explain your reasoning.

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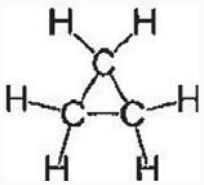
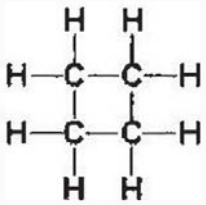
.....[3]

[Total: 7]

A7 The structures of cyclopropane and cyclobutane are the first two members of the homologous series cycloalkanes.
The prefix 'cyclo' refers to the close rings of carbon atoms.



cyclopropane



cyclobutane

(a) Members of a homologous series have a general formula.

(i) Deduce the general formula for the cycloalkanes.

.....[1]

(ii) State one difference in physical property between cyclopropane and cyclobutane.

.....

.....[1]

(b) In the presence of ultraviolet light, cyclopropane reacts with chlorine gas.

Give the full structural formula of two of the organic products formed when cyclopropane reacts with chlorine gas in the presence of ultraviolet light.

[2]

A7 **(c)** Draw the full structural formula of an isomer of cyclopropane.

[1]

[Total: 5]

A8 The table below shows the colours of manganese in different oxidation states.

ion	colour	oxidation state of manganese
MnO_4^-	purple	
Mn^{2+}	pink	+2
MnO_4^{2-}	green	
MnO_2	black	

(a) Fill in the missing oxidation state of manganese in the table. [1]

(b) When solid manganese(II) nitrate, $Mn(NO_3)_2$, is heated, the products are solid manganese(IV) oxide, MnO_2, and a brown gas, NO_2.

(i) Write a balanced chemical equation, including state symbols, for the reaction.

.....[2]

(ii) State the observations when manganese(II) nitrate is heated

.....

.....[1]

(iii) Using the change in oxidation state, explain whether manganese in manganese(II) nitrate is oxidised or reduced.

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.....

.....[2]

[Total: 6]

Section B

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.

The total mark for this section is 30.

89 The information below is about the extraction of zinc.

The method of extraction of zinc has changed as different ores containing the element has been discovered and as technology has improved.

Extraction Process 1

In the earliest process, calamine (impure zinc carbonate) was heated with charcoal in earthenware pots. This two-stage process gives a low yield of zinc.

$$ZnCO_3(s) \rightarrow ZnO(s) + CO_2(g)$$

$$ZnO(s) + C(s) \rightarrow Zn(s) + CO(g)$$

Extraction Process 2

A new two-stage process was developed using zinc sulfide ores. All of the waste gases from this process were released into the atmosphere.

$$2ZnS(s) + 3O_2(g) \rightarrow 2ZnO(s) + 2SO_2(g)$$

$$ZnO(s) + C(s0 \rightarrow Zn(s) + CO(g)$$

Extraction Process 3

This uses the electrolysis of aqueous solutions of aqueous solutions of very pure zinc sulfate. The first step in this process is the same as the first step in Extraction Process 2. The second step uses sulfuric acid made from the SO_2 collected in the first step. The third step involves the electrolysis of zinc sulfate solution, using reactive electrodes, to form pure zinc.

$$2ZnS(s) + 3O_2(g) \rightarrow 2ZnO(s) + 2SO_2(g)$$

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

$$ZnSO_4(aq) \rightarrow Zn(s)$$

B9 **(a)** A student made the following comment on the extraction of zinc:

"Extraction Process 1 is better than Extraction Process 2 because it produces a higher yield of pure zinc".

Assuming that 1 kg of zinc carbonate and zinc sulfide has been used in Extraction Process 1 and Extraction Process 2, explain, using chemical calculations, whether the student's comment is correct.

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.....[2]

(b) Suggest, with reasons, which of the three extraction processes is the most environmentally friendly. You should consider the effects of the products of the extraction processes on man and the environment.

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.....[2]

B9 **(c)** Zinc sulfate solution is electrolysed in Extraction Process 3.

(i) Write an ionic half-equation for the reaction occurring at the anode.

.....[1]

(ii) A factory replaced zinc sulfate solution with molten zinc chloride.
Explain why this is done, giving your reasoning with relevant ionic half-equation.

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.....[2]

(iii) Suggest why molten zinc chloride may not be a good choice to replace aqueous zinc sulfate solution.

.....

.....[1]

(d) Zinc metal has a high melting point and thus, it exists as a solid at room temperature and pressure.
With the aid of a diagram to show the bonding in zinc, explain why zinc has a very high melting point.

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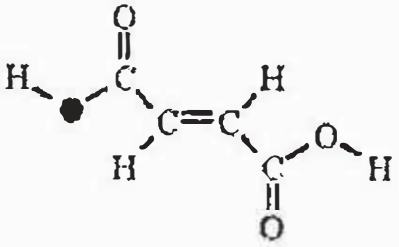
.....[3]

[Total: 11]

B10 Furamic acid is a colourless solid used in food and beverages to provide a fruity taste.
The structural formula of furamic acid is shown below.



The formula of furamic acid can be represented by $HO_2CCH=CHCO_2H$.

(a) A solution of furamic acid reacts with aqueous sodium hydroxide.
Using the formula, write a balanced chemical equation for the reaction between furamic acid and aqueous sodium hydroxide.

.....[1]

(b) On complete combustion, furamic acid forms two products.
Write the balanced chemical equation for the combustion of furamic acid.

.....[1]

(c) (i) Describe what is observed when aqueous bromine is added to a solution of furamic acid.

.....

.....[1]

(ii) Draw the full structural formula of the product formed in **(c) (i)**.

[1]

B10 (d) Furamic acid can undergo addition polymerisation.

(i) Explain what is meant by the term *addition polymerisation*.

.....

.....[1]

(ii) Draw the full structural formula of the repeating unit of the polymer formed.

[1]

(iii) A sample of the polymer was analysed and found to have an average relative molecular mass of 11600.
How many carbon atoms are present in an average chain?

[2]

(iv) Polymers are widely used today.
State one problem caused by the disposal of polymers.

.....

.....[1]

[Total: 9]

EITHER

B11 Hydrogen-oxygen fuel cells are used to generate electricity.
The overall reaction in a hydrogen-oxygen fuel cell is shown below.

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

The reaction is *exothermic*.

(a) Explain the meaning of the term *exothermic*.

.....

.....[1]

(b) Explain, in terms of the energy changes associated with bond breaking and bond forming, why the reaction is exothermic.

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.....[2]

(c) A hydrogen-oxygen fuel cell uses 1500 dm^3 of hydrogen measured at room temperature and pressure.
Calculate the volume of oxygen, measured at room temperature and pressure, used by the fuel cell.
[one mole of any gas at room temperature and pressure occupies a volume of 24 dm^3.]

[2]

B11 **(d)** The electrode reactions in an oxygen-hydrogen fuel cell are shown below.

Equation 1 $O_2(g) + 2H_2O(l) + 4e^- \rightarrow 4OH^-(aq)$

Equation 2 $H_2(g) + 2OH^-(aq) \rightarrow 2e^- + 2H_2O(l)$

Explain why the reaction in a fuel cell involves both oxidation **and** reduction.

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.....[2]

(e) State the common sources of hydrogen and oxygen for the fuel cell.

.....

.....[1]

(f) State one advantage and one disadvantage of using an oxygen-hydrogen fuel cell.

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.....[2]

[Total: 10]

OR

B11 (a) Ammonia is manufactured by the Haber process.

$$N_2 + 3H_2 \rightleftharpoons 2NH_3 \qquad \Delta H = -92.4 \text{ kJ/mol}$$

The table below shows how the percentage yield of ammonia at equilibrium varies with both temperature and pressure.

pressure / atm	% yield at 200 °C	% yield at 300 °C	% yield at 400 °C	% yield at 500 °C
40	72	34	13	5
100	81	51	25	10
200	86	63	36	18
300	88	69	40	24

(i) Describe how, and explain why, the percentage yield of ammonia at equilibrium changes with temperature.

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.....[2]

(ii) Describe how, and explain why, the percentage yield of ammonia at equilibrium changes with pressure.

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.....[2]

(iii) Explain how using a catalyst in the Haber process has an economic advantage.

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.....[2]

B11 **(b)** Ammonia is used to manufacture nitric acid by a two-stage process.

Stage 1 Ammonia is converted to nitrous oxide.

$4NH_3(g) + 5O_2(g) \rightarrow 4NO(g) + 6H_2O(g)$ $\Delta H = -92.4$ kJ/mol

Stage 2 Nitrous oxide is converted to nitric acid.

$4NO(g) + 2H_2O(g) + 3O_2(g) \rightarrow 4HNO_3(aq)$

(i) It is possible to find out whether the reaction in Stage 1 has completed by following the pH changes during the reaction.
Samples of gas are taken from the reaction vessel at intervals and bubbled through water to form a solution. The pH of each solution is measured.
Explain why the measured pH changes during the reaction.

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.....[3]

(ii) Use the equations in the two stages to construct an overall equation for the conversion of ammonia to nitric acid.

.....[1]

[Total : 10]

End of Paper

PAPER 1 (40 marks)

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

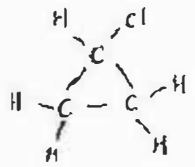
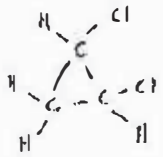
PAPER 2

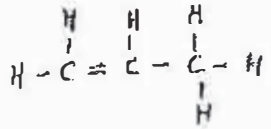
SECTION A: STRUCTURED QUESTIONS [50 MARKS]

Question			Marking Scheme	Marks	Total	Marker's comments
A1	(a)		F	1	6	
	(b)		E	1		
	(c)		B	1		
	(d)		C	1		
	(e)		A / B	1		
	(f)		B	1		
A2	(a)		$2Cu(s) + O_2(g) + 4H^+(aq) \rightarrow 2Cu^{2+}(aq) + 2H_2O(l)$ correct formulae of reactants and products [1] balanced and state symbols [1]	2	4	
	(b)		Mr of $[Cu(CH_3CO_2)_2]_2.Cu(OH)_2$ = 462 [1] x = 90 / 18 = 5 [1]	2		
A3	(a)		Diamond : C Graphite : C Silicon carbide : SiC 1 mistake – minus 1 m	2	7	
	(b)		Graphite has free / delocalized / mobile electrons [1] Silicon carbide does not have free / delocalized / mobile electrons [1]	2		

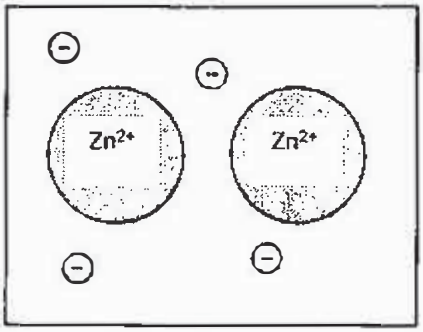
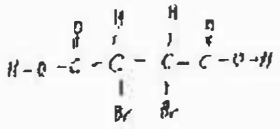
	(c)		SiC has many strong / covalent bonds. [1] A large amount of energy is required to break these bonds. [1]	2		
	(d)		4.40 g	1		
A4	(a)	(i)	Graphs show a trend that high percentage of CO_2 occurs with high temperatures.	1		
		(ii)	Melting of polar ice / rise in sea level / desertification / decrease in crop yields / extreme climate changes / rapid evaporation of water from Earth's surface causing the CO_2 dissolved in the oceans to be released into the atmosphere, adding to the greenhouse effect 1 m each answer any 2 answers	2	7	
		(iii)	 All dots only (1 m) No double bond (0)	2		
	(b)		In the presence of UV radiation, CFCs decompose to form chlorine atoms. [½] Chlorine atoms react with ozone molecules in the stratosphere to form chlorine oxide and oxygen, thus destroying the ozone layer. [1] Harmful UV radiation reaches the Earth through holes in the ozone layer. [½]	2		

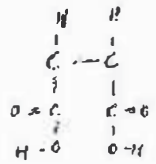
A5	**(a)**		**A** = zinc hydroxide / $Zn(OH)_2$ **B** = iron(II) hydroxide / $Fe(OH)_2$ **C** = iron(III) hydroxide / $Fe(OH)_3$ **D** = ammonia / NH_3 **E** = sodium sulfate / Na_2SO_4 F^{2+} = Zn^{2+} / zinc ion G^{2+} = Fe^{2+} / iron(II) ion each answer 1 m	**7**	**8**	
	(b)		$NaOH + NH_4Cl \rightarrow NaCl + NH_3 + H_2O$	**1**		
A6	**(a)**	**(i)**	Mass of Zr = 0.044 x 91 = 4.00 g Mass of zinc = 400 – 5.28 – 4.00 = 390.72 g Moles of Zn = $\frac{390.72}{65}$ = 6.01 mol 1 mistake minus 1m	**2**	**7**	
		(ii)	In an alloy the atoms of the different metals have different sizes / regular arrangement of atoms in the pure metal is disrupted [1] Atoms of different sizes cannot slide over each other easily when a force is applied. [1] Hence, zinc alloy is stronger than the pure metal.	**2**		

A6	(b)		Order of reactivity should be **R Q zinc P** R produces the highest temp rise; it should be the most reactive. [1] Q produced a larger temp rise than P but smaller than R; its reactivity should be between R and P. [1] P did not produce any temp rise / P did not displace zinc from its solution; P should be less reactive than zinc [1]	3		
A7	(a)	(i)	C_nH_{2n} n denotes the no. of carbon atoms n = 3,4,5,....	1	5	
		(ii)	bp and mp of cyclopropane is lower than cyclobutane / cyclopropane is less viscous than cyclobutane / cyclopropane is more flammable than cyclobutane (any answer)	1		
	(b)		 [1]  [1] or other chlorine substituted products	2		

A8	**(c)**			**1**		
	(a)		MnO_4^- +7 MnO_4^{2-} +6 MnO_2 +4 All correct	**1**	**6**	
	(b)	**(i)**	$Mn(NO_3)_2$ (s) → MnO_2 (s) + $2NO_2$ (g) Balanced equation [1] state symbols [1]	**2**		
		(ii)	Pink $Mn(NO_3)_2$ turns black (MnO_2) with brown gas (NO_2) evolved	**1**		
		(iii)	Mn in $Mn(NO_3)_2$ is oxidised, as the oxidation state of manganese increased from +2 in $Mn(NO_3)_2$ to +4 in MnO_2.	**1** **1**		
B9	**(a)**		Process 1 Moles of $ZnCO_3$ = $\frac{1000}{125}$ = 8.0 mol Mass of Zn = 8.0 x 65 = 520 g [1] Process 2 Moles of ZnS = $\frac{1000}{97}$ = 10.3 mol Mass of Zn = 10.3 x 65 = 669.5 g [1] Process 1 does not produce a higher yield than process 2.	**2**	**11**	

B9	**(b)**		Process 3. (with at least one reason) SO_2 is used to make sulfuric acid. [1] No CO is produced, unlike processes 1 and 2. CO causes headaches / fatigue /breathing difficulties / death / Reduces ability of haemoglobin to transport oxygen SO_2 from process 2 may irritate the eyes / lungs / Cause breathing difficulties / inflammation of the lungs (bronchitis) / Reacts with water in the atmosphere to form acid rain, which corrodes buildings and harms aquatic life and plants Any answer [1] Do not accept : no air pollutant is released to the environment.	**2**		
	(c)	**(i)**	Anode: $4OH^-(aq) \rightarrow 2H_2O(l) + O_2(g) + 4e^-$	**1**		
		(ii)	When molten zinc chloride is used, Zn^{2+} is discharged to form molten zinc. [1] Cathode : $Zn^{2+}(l) + 2e^- \rightarrow Zn(l)$ [1]	**2**		
		(iii)	At the anode: $2Cl^-(l) \rightarrow Cl_2(g) + 2e^-$ The chlorine gas produced reacts with the carbon electrodes to form CCl_4 [1] <u>Or:</u> A high amount of energy is required to maintain the molten zinc chloride, increasing the cost of production of zinc. [1]	**1**		

B9	**(d)**		 [1] Orderly arrangement of zinc ions No. of delocalised electrons proportional to the charge of zinc Strong electrostatic attraction between the positively charged ions and negative electrons [1] large amount of energy needed to break the strong bonds [1]	**3**		
B10	**(a)**		$HO_2CCH=CHCO_2H + 2NaOH \rightarrow NaO_2CCH=CHCO_2Na + 2H_2O$	**1**		
	(b)		$C_4H_4O_4 + 3O_2 \rightarrow 4CO_2 + 2H_2O$	**1**		
	(c)	**(i)**	Reddish brown aqueous bromine is decolourised / turns colourless	**1**		
		(ii)		**1**	**9**	

B10	(d)	(i)	Addition polymerization occurs when unsaturated monomers join together without losing any molecules or atoms.	1		
		(ii)		1		
		(iii)	M_r furamic acid = 116 No. of molecules = $\frac{11600}{116}$ = 100 [1] No. oc carbon atoms = 100 x 4 = 400 [1]	2		
		(iv)	Polymers are non-biodegradable and can cause a build-up of land waste / Produce poisonous gases when burnt / clog up rivers and drains (any answer)	1		

Either B11						
	(a)		Reaction that releases heat / releases energy / energy given out is greater than energy absorbed / reaction mixture gets hot any answer [1]	**1**	**10**	
	(b)		Bond breaking takes in energy / is endothermic and bond forming releases energy / is exothermic [1] More energy is released from the formation of O-H bonds in H_2O than energy taken in from breaking H-H bond in H_2 and O=O bond in O_2. [1]	**2**		
	(c)		Vol of O_2 = $\frac{1500}{2}$ [1] = 750 dm^3 [1]	**2**		
	(d)		First equation involves reduction since electrons are gained / oxygen is reduced because it gains electrons / oxygen is reduced because its oxidation number decreases from 0 in O_2 to -2 in OH^-. [1] Second equation involves oxidation since electrons are lost / hydrogen is oxidised because it loses electrons / hydrogen is oxidised because its oxidation number increases from 0 in H_2 to +1 in H_2O. [1]	**2**		
	(e)		Cracking of large alkane molecules Electrolysis of water / Reaction between alkanes and steam any answer	**1**		

B11	(f)		Advantage – directly converts chemical energy into electrical energy / more energy efficient / makes no pollutants / doesn't release harmful gases / uses a renewable resource [1] Disadvantage – storage problems associated with hydrogen or oxygen / hydrogen explosive / pressurised tanks needed / pollution problems on disposal of fuel cell / pollution problems while manufacturing fuel cells [1]	2		

OR B11					10	
	(a)	**(i)**	The percentage yield of ammonia decreases with increasing temperature. [1] Forward reaction is exothermic / Increasing temperature favours backward reaction. [1]	**2**		
		(ii)	Percentage of ammonia at equilibrium increases with increasing pressure. [1] Increasing pressure favours the forward reaction [1]	**2**		
		(iii)	Catalyst speeds up the reaction / lowers activation energy. [1] Shortens the production or manufacturing time / Lowers energy costs / less energy is used [1]	**2**		
	(b)	**(i)**	Ammonia is an alkaline gas, while oxygen, nitrogen monoxide and water vapour are neutral gases. [1] ammonia gas is gradually used up and as the products are neutral, the pH decreases. [1] When pH value remains constant at 7, it indicates that ammonia gas is used up completely for reaction and left with all the neutral gases. [1]	**3**		
		(ii)	$NH_3 + 2O_2 \rightarrow HNO_3 + H_2O$	**1**		