Name	Reg. No	Class

4EX

PURE CHEMISTRY 6092/02

Paper 2

[80 Marks]

PRELIMINARY EXAMINATION

August 2023

1 hour 45 minutes

Additional Materials:
Approved calculator

INSTRUCTIONS TO CANDIDATES:

Do not open this booklet until you are told to do so.
Write your name, index number and class in the spaces at the top of this page and on any separate answer paper used.
Write in dark blue or black pen on both sides of the paper.
Do not use staples, paper clips, highlighters, glue or correction fluid.

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

Paper 2: Section B
Answer **three** questions in the space provided. The last question is in the form of an either/or and only one of the alternatives should be attempted.

FOR EXAMINER'S USE	
Section	**Marks**
Paper 1 MCQ	/ 40
Paper 2: A	/ 50
Paper 2: B	
B 8	/ 12
B 9	/ 8
B10 Either / Or	/ 10

INFORMATION FOR CANDIDATES:
The number of marks is given in brackets [ ] at the end of each question or part question.
A copy of the Periodic Table is printed on page **22**.

This question paper consists of **22** printed pages

Setter: Ms Lim Wei Li Vetter: Mr Chen Yanhui Timothy

Section A (50 marks)

Answer all the questions in this section in the spaces provided.

A1 Use the list of substances to answer the questions.

argon
calcium phosphate
calcium oxide
carbon monoxide
graphite
nitrogen dioxide
potassium nitrate
silicon dioxide

(a) Which **two** substances exist as simple molecules?

....

(b) Which substance reacts with warm aqueous sodium hydroxide and aluminium powder to form a gas that turns moist red litmus paper blue?

....

(c) Which substance dissolves in water to form a solution which neutralises sodium hydroxide?

....

(d) Which substance when heated in a Blast furnace with sand makes slag?

....

(e) Which substance is able to conduct electricity in solid state?

....

[Total:5]

MS 4EX5NA Prelims 2020

Paper 3 Section B

Qn	Solutions

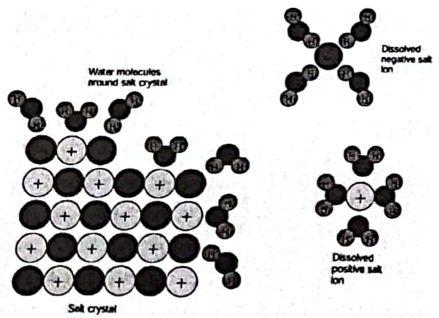
A2 A student measured the temperature change when 5.0 g of ammonium nitrate was dissolved in excess water. The table below shows the results.

initial temperature of solution / °C	21.0
final temperature of solution/ °C	17.7
calculated energy change / J	+1380

(a) Using information from the table, calculate the enthalpy change, in kJ/mol, when one mole of ammonium nitrate dissolves in excess water.

enthalpy change = ...kJ/mol [3]

(b) *The process of dissolving involves both bond forming and bond breaking. The process and description for dissolving an ionic substance are given below.*



Water molecules attract and form forces of attraction to the ions. When the attraction between water molecules and the ions overcomes the attraction between the ions, this causes the ions to separate from the lattice and the salt to dissolve.

Explain, in terms of bond breaking and bond formation, the sign for the enthalpy change for dissolving ammonium nitrate.

....

....

.... [2]

(c) Using kinetic particle theory, describe the changes in the arrangement and movement of ammonium nitrate when it is dissolved in water.

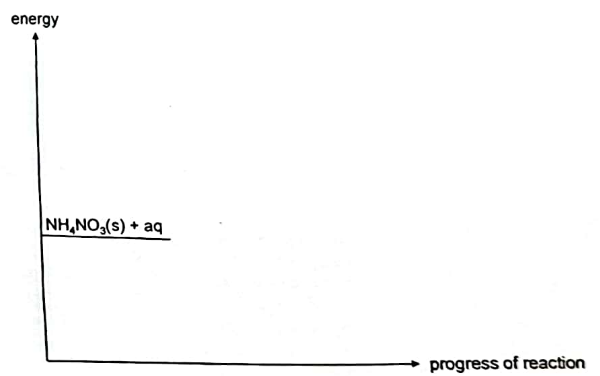
....

....

.... [2]

(d) Complete the energy profile diagram when ammonium nitrate is dissolved in water on the axis provided.

Your diagram should show:
- the products of the process
- the activation energy
- the enthalpy change



[3]

[Total: 10]

A3 Iron(II) sulfate crystals decompose when heated to produce an orange-brown solid **P**, and three gases, **Q**, **R** and **S**.

- Gas **Q** was tested with a piece of filter paper soaked with acidified potassium manganate(VII). Potassium manganate((VII) changed from purple to colourless.
- Analysis of gas **R** showed it contained 40.0% by mass of sulfur and 60.0% by mass of oxygen.
- When gas **S** was condensed, it formed a colourless liquid which turned anhydrous copper(II) sulfate from white to blue.

(a) **(i)** What does the test with potassium manganate(VII) tell you about the role of gas **Q** in the reaction?

.... [1]

(ii) Determine the empirical formula of gas **R**.

Show your working.

empirical formula: ....
[2]

(iii) State the chemical formula of gas **S**.

.... [1]

(b) Solid **P** was dissolved in dilute nitric acid. When aqueous ammonia was added drop-wise, a reddish-brown precipitate was obtained.

Construct an ionic equation, including state symbols, to show the formation of the reddish-brown precipitate.

.... [2]
[Total:6]

[Turn over

A4 An electrolysis tank can be used industrially to produce aluminium from aluminium oxide by carrying out electrolysis on the mixture of cryolite and aluminium oxide, as shown in Figure 4.1. Molten cryolite serves as a solvent for the aluminium oxide and increases the conductivity of the solution. The use of cryolite also reduces some of the energy costs involved in the extraction of aluminium.

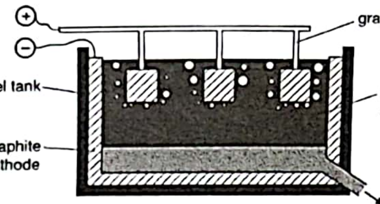


Figure 4.1

(a) Name the type of particles responsible for the transfer of charge in the wires and the electrolyte.

wires: ....

electrolyte:.. [2]

(b) Aluminium oxide has a melting point of 2045 °C.

Explain how the use of cryolite reduces some of the energy costs involved in the extraction of aluminium.

....

.... [1]

(c) Construct the ionic half-equations for the reactions which take place at the electrodes.

anode: ....

cathode: ....

[2]

(d) Suggest why the graphite anodes need to be replaced regularly.

....

.... [1]

(e) Concentrated aluminium chloride can also be electrolysed.

Given that aluminium is above hydrogen in the reactivity series, describe two differences between the products of the electrolysis of concentrated aluminium chloride and the products of the electrolysis of molten aluminium oxide.

....

....

....

.... [2]

[Total: 8]

A5 **(a)** There are two different methods to obtain dichloroethane, CH_2ClCH_2Cl.

Method 1: $CH_2CH_2 + Cl_2 \rightarrow CH_2ClCH_2Cl$
Method 2: $CH_3CH_3 + 2Cl_2 \rightarrow CH_2ClCH_2Cl + 2HCl$

(i) State the conditions needed for method 2.

.... [1]

(ii) State and explain which method will give a higher yield in preparing CH_2ClCH_2Cl.

....

....

.... [2]

[Turn over

(b) Ethanol can also be produced by two methods – fermentation or hydration.

(i) Describe how ethanol can be formed from ethene.

Include the balanced chemical equation, with the necessary reaction conditions.

....

....

.... [2]

(ii) Suggest a reason why manufacturing ethanol by the fermentation process is less preferred than using the hydration process.

....

....

.... [1]

(iii) After the fermentation process, state the method to obtain a pure sample of the ethanol from the liquid mixture.

.... [1]

(iv) Ethanol obtained from sugarcanes, also known as bioethanol, can be used as a fuel.

State an advantage of using bioethanol instead of petrol.

....

.... [1]

[Total: 8]

A6 Table 6.1 below shows some information about a homologous series of organic compounds called aldehydes.

Table 6.1

name	formula	boiling point / °C
methanal	HCHO	-19
ethanal	CH_3CHO	20
propanal	C_2H_5CHO	49
pentanal	C_4H_9CHO	103

(a) Use the information in Table 6.1 to give two pieces of evidence that suggest the aldehydes are a homologous series.

....

....

.... [2]

(b) Butanal is an aldehyde.

Deduce the molecular formula and predict the boiling point of butanal.

molecular formula: ....

predicted boiling point: .... [2]

(c) A student describes aldehydes as *isomers of alcohol*.

Explain whether this is a correct statement.

....

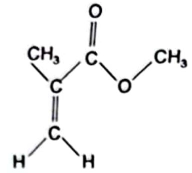
....

.... [1]

[Total: 5]

[Turn over

A7 **(a)** Poly(methyl methacrylate), PMMA, is a member of a family of polymers known as acrylics. It is a clear plastic and is often used as a shatterproof replacement for glass. It is formed from a single monomer, methyl methacrylate, that has the following structure:



methyl methacrylate

(i) Methyl methacrylate is made from an alcohol and a carboxylic acid.

Draw the displayed formula of the alcohol and carboxylic acid, and state the conditions for this reaction.

conditions: ....

alcohol	carboxylic acid

[3]

(ii) Draw the structure of an isomer of methyl methacrylate which

- is a straight chain molecule and
- produces a colourless gas on addition of magnesium.

[1]

(iii) Draw the structure of PMMA with three repeat units.

[2]

(b) State two differences between the polymerisation process of PMMA and nylon

....

....

....

....

.... [2]

[Total: 8]

---- End of Section A ----

Section B (30 marks)

Answer all **three** questions in this section in the spaces provided. The last question is in the form of an either/or and only one of the alternatives should be attempted.

B8 The standard reduction potential (E°) of a substance measures the likelihood that a substance is reduced. Table 8.1 shows the E° values of some substances. The more negative the E° value, the more easily the substance is reduced. Whereas the more positive the E° value, the more easily the substance is oxidised.

Table 8.1

electrode reaction	E° / V
$Cu^{2+} + 2e^- \rightleftharpoons Cu$	+0.34
$Fe^{3+} + 3e^- \rightleftharpoons Fe$	-0.04
$Mg^{2+} + 2e^- \rightleftharpoons Mg$	-2.38
$Ni^{2+} + 2e^- \rightleftharpoons Ni$	-0.25
$Na^+ + e^- \rightleftharpoons Na$	-2.71
$Zn^{2+} + 2e^- \rightleftharpoons Zn$	-0.76

Another way to determine the reactivity of metals is through heating of the metal carbonates. The metal carbonates were heated strongly and the time taken for 50 cm^3 of carbon dioxide gas to be collected was measured. Some results of the thermal decomposition are shown in Table 8.2.

Table 8.2

metal carbonate	time taken to collect 50 cm^3 of carbon dioxide gas / s
copper(II) carbonate	44
iron(III) carbonate	85
magnesium carbonate	221
nickel(II) carbonate	
sodium carbonate	no gas produced
zinc carbonate	153

(a) (i) State the relationship between the standard electrode potential and reactivity of metals.

....

.... [1]

(ii) Hence, arrange the metals in Table 8.1 in order of increasing reactivity.

.... [1]

(iii) Some E° values are given below.

-2.55 V   -0.44 V   +0.16 V   +0.80 V

Select the most suitable E° value for silver. Explain your answer.

....

.... [2]

(b) (i) Predict the time taken to collect 50 cm^3 of gas for nickel(II) carbonate.

.... [1]

(ii) State and explain whether the results in Table 8.2 agree with the order of reactivity stated in **(a)(ii)**.

Support your answer using relevant information from the question.

....

....

.... [2]

(c) Table 8.3 shows the E° values for some group VII halogens.

Table 8.3

electrode reaction	E° / V
$Br_2 + 2e^- \rightleftharpoons 2Br^-$	+1.07
$Cl_2 + 2e^- \rightleftharpoons 2Cl^-$	+1.36
$F_2 + 2e^- \rightleftharpoons 2F^-$	+2.87
$I_2 + 2e^- \rightleftharpoons 2I^-$	+0.54

(i) State and explain the relationship between the standard electrode potential and reactivity down Group VII.

....

....

.... [2]

[Turn over

(ii) State the observations when aqueous chlorine is added to a solution of potassium iodide.

....

.... [1]

(d) Suggest and explain the E° value for neon.

....

.... [2]

[Total: 12]

B9 Figure 9.1 shows the stages for the industrial manufacture of sulfuric acid.

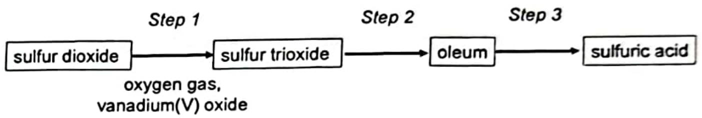


Figure 9.1

(a) In Step 1, explain, in terms of the collision theory, how vanadium(V) oxide increases the rate of reaction.

....

....

.... [2]

(b) Explain whether Step 1 is a redox reaction.

....

....

....

....[2]

(c) Figure 9.2 shows the percentage yield of sulfur trioxide at different temperatures.

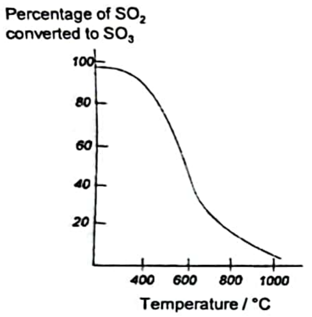


Figure 9.2

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

....

.... [1]

(ii) Hence, suggest why the optimum operating temperature is 450 °C instead of 250 °C.

....

.... [1]

(d) The flue gases of this process usually contain a mixture of sulfur dioxide and sulfur trioxide. Desulfurisation of the flue gases is important to reduce air pollution in the surrounding areas.

State the reactant used for flue gas desulfurisation and explain how it helps to reduce air pollution.

....

....

.... [2]

[Total: 8]

[Turn over

B10 EITHER

The ozone depletion potential (ODP) of a compound is a measure of its ability to destroy ozone. Table 10.1 shows the ODP of some substances. These substances can be classified as chlorofluorocarbons (CFCs), hydrochlorofluorocarbons (HCFCs) and hydrofluorocarbons (HFCs), and the names indicate the elements present in them.

Table 10.1

class	compound	ozone depletion potential (ODP)
CFC	CCl_3F	1.0
CFC	CCl_2F_2	1.0
HCFC	$CHClF_2$	0.05
HCFC	$CHCl_2CF_3$	0.02
HFC	CH_2FCF_3	0

Table 10.2 shows the bond energies for some of the bonds in chlorofluorocarbons.

Table 10.2

bond	bond energy / kJ/mol
C-F	485
C-Cl	350
C-H	413

(a) A student suggested that compounds such as HFCs are better alternatives to CFCs.

State and explain whether the student's statement is correct.

....

.... [1]

(b) Draw the dot-and-cross diagram to show the bonding in $CHClF_2$. Show outer electrons only.

[2]

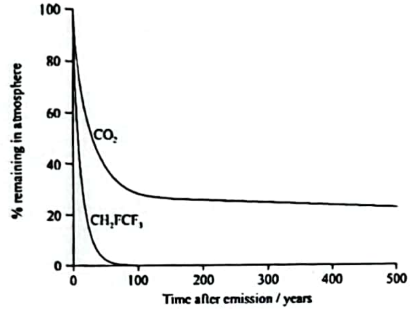
(c) Explain why $CHClF_2$ is decomposed by UV light to form chlorine atoms rather than fluorine or hydrogen atoms.

....

....

.... [2]

(d) The graph shows the changes in levels over time of equal masses of CO_2 and CH_2FCF_3 introduced in the atmosphere.



Given that both CO_2 and CH_2FCF_3 are greenhouse gases, state and explain which gas has a greater impact on global warming.

....

....

.... [2]

(e) (i) Nitrogen oxides are also able to destroy ozone as seen in the equations below.

$$NO + O_3 \rightarrow NO_2 + O_2$$
$$O_3 + NO_2 \rightarrow NO + 2O_2$$

Using the equations, state and explain the role of nitrogen monoxide in the breakdown of ozone.

....

....

.... [2]

(ii) State another effect of oxides of nitrogen on the environment.

....

.... [1]

[Total: 10]

The melting points of oxides of the elements in Period 3 of the Periodic Table are given in Table 10.3.

One mole of each of the oxides were added to water separately and the pH of the resulting solutions were measured and shown in Table 10.3 as well.

Table 10.3

oxides	Na_2O	MgO	Al_2O_3	SiO_2	P_4O_{10}	SO_2	Cl_2O_7
melting point / °C	1132	2852	2072	1710	340	- 72	- 92
pH of solution	13	9			1	1	1

(a) Using Table 10.3, describe and explain the trend in the melting point of the oxides of Period 3 elements of the Periodic Table, in terms of their structure and bonding.

....

....

....

....

....

....

....

....

.... [3]

(b) The strength of bonds in sodium oxide (Na_2O) and magnesium oxide (MgO) is dependent on two factors – the charge of the ions, q, and the ionic radius, r.

$$\textit{strength of bond} \propto \frac{(q_+)(q_-)}{(r_+)(r_-)}$$

Legend:

q_+ numerical value of the charge of the cation

q_- numerical value of the charge of the anion

r_+ ionic radii of the cation

r_- ionic radii of the anion

Using the relationship given, state and explain why the melting point of MgO is different from that of Na_2O.

....

....

....

.... [2]

(c) (i) State and explain the pH obtained when aluminium oxide (Al_2O_3) and silicon dioxide (SiO_2) were added to water.

....

.... [1]

(ii) Hence, describe a test which you can do to distinguish between a sample of aluminium oxide and silicon dioxide.

Include the expected observations for both substances.

....

....

.... [2]

(iii) The last three oxides in Table 10.3, P_4O_{10}, SO_2, and Cl_2O_7, produce a solution of pH 1 when added to water.

State and explain the observation(s) when a piece of magnesium strip was added to each of these solutions formed.

....

....

.... [2]

[Total: 10]

---- End of Section B ----

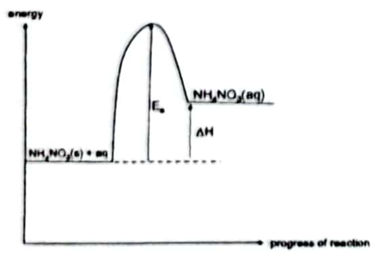
---- End of paper ----

V	VI	VII	0
			2 He helium 4
7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40
33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
83 Bi bismuth 209	84 Po polonium –	85 At astatine –	86 Rn radon –
	116 Lv livermorium –		

68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
100 Fm fermium –	101 Md mendelevium –	102 No nobelium –	103 Lr lawrencium –

Prelim 4Ex Chem 2023 – mark scheme

P2 Section A

	Suggested answers		marks	Remarks
A1	(a)	carbon monoxide and nitrogen dioxide	[1]	
	(b)	potassium nitrate	[1]	
	(c)	nitrogen dioxide	[1]	
	(d)	calcium oxide	[1]	
	(e)	graphite	[1]	
A2	(a)	No. of moles of NH_4NO_3 = 5 ÷ (14+4+14+3(16)) = 0.0625 mol [1m] 1380J of energy is absorbed when 0.0625 mol of ammonium nitrate is dissolved Enthalpy change = 1380 ÷ 0.0625 = +22080 J/mol = +22.1 kJ/mol [1m for value + 1m for sign]	[3]	
	(b)	The **energy absorbed for bond breaking** between ions in ammonium nitrate is **greater** than the **energy released for bond forming between water molecules and the ions**. Thus the overall energy change is positive.	[2]	
	(c)	When ammonium nitrate dissolves in water, the particles change from being closely packed in an orderly manner, to being less closely packed in a disorderly manner. [1m] The particles change from only vibrating about their fixed positions to being able to slide freely past each other. [1m]	[2]	
	(d)	 1m – labelled product 1m – E_a 1m - ΔH	[3]	
A3	(a)(i)	It is a reducing agent.	[1]	

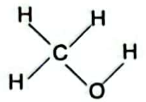
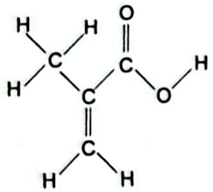
A3 (a)(ii) [2]

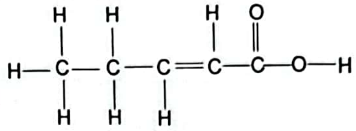
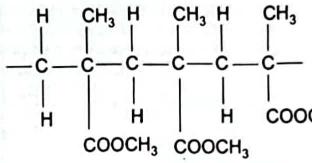
Element	S	O
Mass / g	40	60
Number of moles	40 ÷ 32 = 1.25	60 ÷ 16 = 3.75
Simplest mole ratio	1	3

[1m]

Empirical formula: SO_3 [1m]

	(a)(iii)	H_2O	[1]	
	(b)	$Fe^{3+}(aq) + 3OH^-(aq) \rightarrow Fe(OH)_3(s)$	[2]	
A4	(a)	Wires: electrons [1m] Electrolyte: ions [1m]	[2]	
	(b)	Cryolite lowers the melting point of the aluminium oxide [1m], thus electrolysis can be done at a lower temperature, which reduces the energy costs.	[1]	
	(c)	Anode: $2O^{2-}(l) \rightarrow O_2(g) + 4e^-$ [1m] Cathode: $Al^{3+}(l) + 3e^- \rightarrow Al(l)$ [1m]	[2]	
	(d)	Oxygen formed at the anode will react with graphite to produce carbon dioxide [1m], causing the anode to gradually wear away.	[1]	
	(e)	For concentrated aluminium chloride, hydrogen gas is formed at the cathode and at the anode, chlorine gas is formed. [1m] In contrast, for molten aluminium chloride, aluminium is formed at the cathode, and oxygen gas is formed at the anode. [1m]	[2]	
A5	(a)(i)	UV light	[1]	
	(a)(ii)	Method 1 gives a higher yield as it only produces one product. [1m] Method 2 is a substitution process, and may produce a mixture of products, with varying degree of substitution and position of chlorine atoms. [1m]	[2]	
	(b)(i)	$CH_2CH_2 + H_2O \rightarrow CH_3CH_2OH$ Steam Phosphoric acid as catalyst, 300°C, 60 atm	[2]	

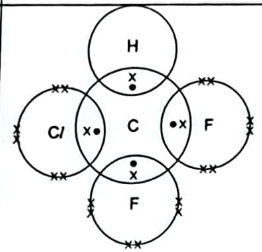
	(b)(ii)	Fermentation can only produce 15% ethanol, while hydration is able to produce 100% ethanol. OR Fermentation requires a longer period of time to produce ethanol, while hydration is faster.	[1]	
	(b)(iii)	Fractional distillation	[1]	
	(b)(iv)	Bioethanol is a renewable source of energy as sugarcane can be grown, whereas petrol is a non-renewable source of energy. Or The combustion of bioethanol is more environmentally sustainable as sugarcane absorbs carbon dioxide during photosynthesis which offsets the carbon dioxide produced during combustion.	[1]	
A6	(a)	The members have the same general formula, $C_nH_{2n+1}CHO$. The members show a gradual gradation in the physical property - boiling point increases as the number of carbon atoms increases.	[2]	
	(b)	Molecular formula: C_4H_8O Predicted boiling point: 75°C (value between 49 – 103)		
	(c)	Incorrect. The molecular formulae of alcohol and aldehydes are different, hence they are not isomers.	[1]	
A7	(a)	Conditions: a few drops of concentrated sulfuric acid [1m] [1m] for each structure, all bonds to be shown Alcohol:  Carboxylic acid: 	[3]	

	(b)(i)		[1]	
	(a)(ii)	addition polymerisation	[1]	
	(a)(iii)		[1]	
	(b)(ii)	Nylon is formed from condensation polymerisation while poly(methyl methacrylate) is formed from addition polymerisation. Any 2 points: poly(methyl methacrylate) is formed from monomers with C=C bonds/ are unsaturated, while nylon is formed from monomers with 2 different functional groups (e.g. O-H, COOH). poly(methyl methacrylate) involves no elimination of small molecules / formation of a single product while nylon involves elimination of small molecules like H_2O and HC*l*.	[2]	

P2 Section B

B8	(a)i	The more reactive the metal, the more negative the standard electrode potential.	[1]	
	(a)(ii)	Copper, iron, nickel, zinc, magnesium, sodium	[1]	Common errors: - Reversed order of metals - Metal ions instead of metals given
	(a)(iii)	+0.80V Silver is less reactive than copper, thus its E° value must be more positive than +0.34V.	[1]	
	(b)(i)	(accept values between 86s to 152s)	[1]	
	(b)(ii)	Yes, it agrees. The less reactive the metal, the less thermally stable the metal carbonate, hence the shorter the time taken for 50cm³ to be collected. [1m]	[2]	

		Eg copper is the least reactive metal, thus copper(II) carbonate is the least thermally stable and takes the shortest time 44s to collect 50 cm^3. (any relevant data) [1m]		
	(c)(i)	Down the group, the E° value become less positive as reactivity decreases. [1m] Down the group, the valence electron is further away from the positively charged nucleus, thus it is more difficult to attract electron during reactions and undergo reduction. [1m]	[2]	
	(c)(ii)	The colourless solution turns brown.	[1]	
	(d)	0V. [1m] Neon is a noble gas with fully filled valence shell, thus there is no tendency to gain or lose electrons. [1m]	[2]	
B9	(a)	Vanadium(V) oxide is a catalyst which provides an alternative pathway of lower activation energy. A greater proportion of particles have energy greater than or equal to the activation energy. [1m] Hence frequency of effective collisions increases, and increases the speed of reaction. [1m]	[2]	
	(b)	The oxidation state of S from +4 in SO_2 to +6 in SO_3 and undergoes oxidation. [1m] The oxidation state of O decreases from 0 in O_2 to -2 in SO_3 and undergoes reduction. [1m] Since both oxidation and reduction occurs at the same time, this is a redox reaction.	[2]	Many failed to identify the reduction process occurring.
	(c)(i)	The yield decreases as temperature increases.	[1]	
	(c)(ii)	Although yield increases when temperature is lowered, the rate of reaction will be slower when a lower temperature of 250 °C is used. Thus 450 °C is a compromise between the yield and speed of reaction.	[1]	
	(d)	Calcium oxide [1m] or calcium carbonate It is a basic oxide which can react with the acidic gases SO_2 and SO_3 to remove them from the flue gases. [1m] $CaO + SO_2 \rightarrow CaSO_3$ $CaCO_3 + SO_2 \rightarrow CaSO_3 + CO_2$		

B10	Either			
	(a)	As the number of chlorine atoms in the compound increased, the ozone depletion potential value also increased. Hence good alternatives to CFCs such as HFCs which do not have chlorine atoms, have less impact on ozone depletion. [1m]	[1]	
	(b)	 1m – correct number of electrons shared 1m – correct number of valence electrons	[2]	Common mistakes: missing out valence electrons of F and Cl.
	(c)	The bond energy of C-*Cl* is lower than that of C-H and C-F [1m]. Thus less energy is needed to break the C-Cl bond, leading to more chlorine atoms being formed. [1m]	[2]	
	(d)	CO_2 has the greater impact. Even after 100 years, the percentage of CO_2 left is still 30%, whereas CH_2FCF_3 has almost being completely removed from the atmosphere. [1m] Thus CO_2 emissions have a longer lifetime to cause global warming. [1m]	[2]	
	(e)(i)	It is acting as a catalyst. [1m] Nitrogen monoxide is used up in step 1 to react with ozone, however, it will be regenerated in Step 2. Thus each molecule of nitrogen monoxide can go on to react with another ozone molecule, destroying thousands of ozone molecules. [1m]	[2]	
	(e)(ii)	Oxides of nitrogen can react with water in the atmosphere to form acid rain. Acid rain corrodes metal and limestone structures, make water bodies and soils too acidic for plants and aquatic life.	[1]	

B10	OR			
	(a)	Metallic oxides Na_2O, MgO and Al_2O_3 have giant ionic lattice structures. A lot of energy is needed to overcome the strong electrostatic forces of attraction between the oppositely charged ions. Thus they have high melting points. [1m] SiO_2 has a giant molecular structure. A lot of energy is needed to overcome the numerous number of strong covalent bonds in the three dimensional structure. Thus it has a high melting point. [1m] Non-metallic oxides, P_4O_{10}, SO_2, and Cl_2O_7, have simple molecular structures. Little amount of energy is needed to overcome the weak intermolecular forces of attraction between the molecules. Thus their melting points are low. [1m]	[3]	Common mistakes: incorrect terms for the particles involved (eg in ionic compounds, students mentioned bonding between atoms etc)
	(b)	MgO and Na_2O only differ in their cations. The charge of Mg^{2+} (2+) is twice than that of Na^+(+1), [1m] while the ionic radius of Mg^{2+} is smaller than that of Na^+. [1m] Thus the strength of bonds in MgO is stronger than that of Na_2O and requires more energy to overcome. Thus the melting point of MgO is higher than that of Na_2O.	[2]	
	(c)(i)	Al_2O_3 and SiO_2 are insoluble in water, thus a pH of 7 is obtained when they are added to water.	[1]	Poorly done. Many failed to recognise these two solids are insoluble in water.
	(c)(ii)	Add dilute nitric acid to both samples. [1m] Al_2O_3, being an amphoteric oxide, will react and give a colourless solution. While SiO_2, being an acidic oxide, will not react and remain as a white solid. [1m]	[2]	
	(c)(iii)	They are non-metal oxides and are acidic oxides. Thus, they dissolve in water to produce acidic solutions. [1] Effervescence of a colourless, odourless gas which extinguishes lighted splint is observed. Mg metal dissolves. [1m]	[2]	