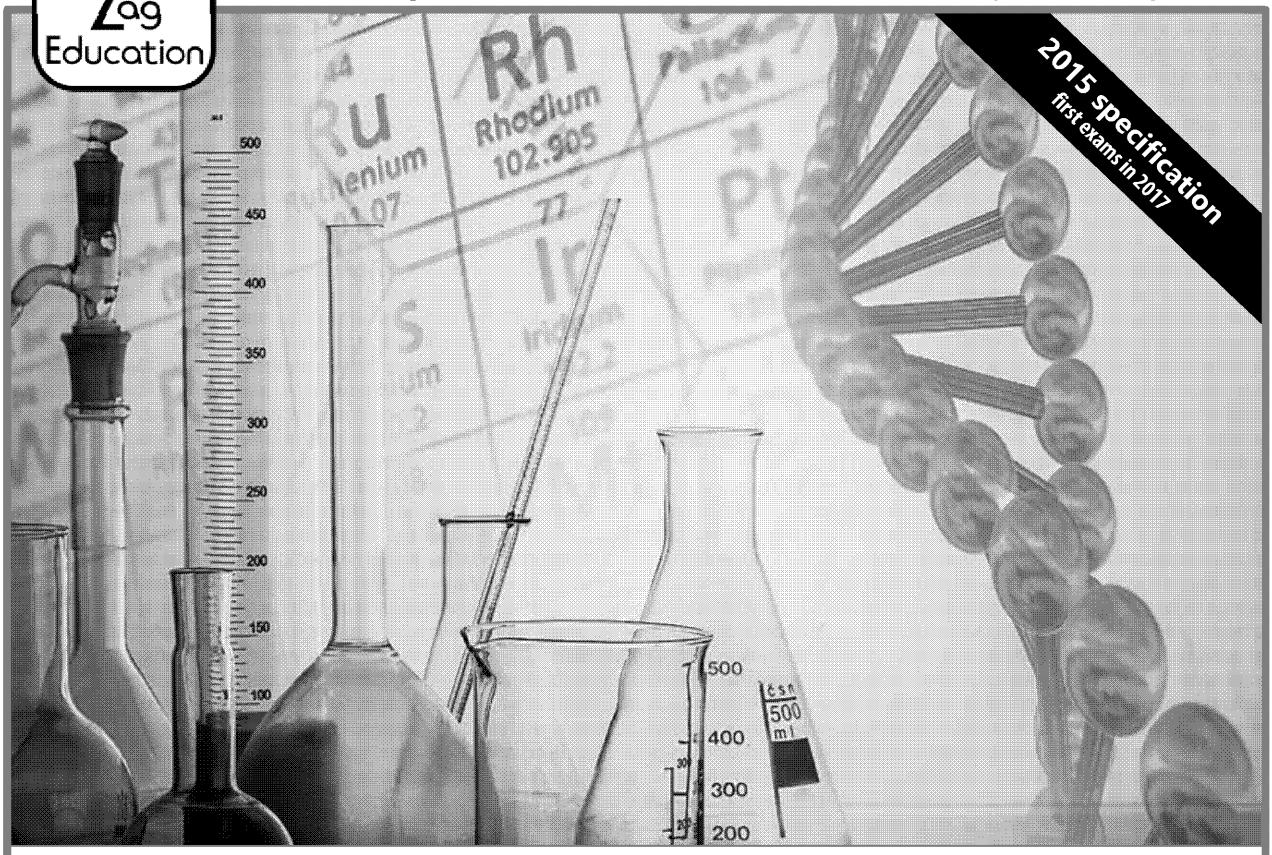
Zig Zag Education

Chemistry

A Level | OCR A | H432



Practice Exams

for A Level OCR Chemistry A

Paper 1

P D Davey

zigzageducation.co.uk

POD 7597

Contents

Teacher's Introduction

This pack contains four Practice Paper 1s for the OCR A Level Chemistry (A) specifi
2017). The papers and corresponding mark schemes in this pack are modelled on
material provided by the board.

Paper 1 is entitled 'Periodic table, elements and physical chemistry' and covers:

- Module 2: Foundations in chemistry
- Module 3: Periodic table and energy
- Module 5: Physical chemistry and transition elements

This paper is designed so it can be used as either a mock examination or a revisio
designed with both students and teachers in mind, allowing students to mark thei
progress. Otherwise, the mark schemes resemble that produced by OCR in their s

Each practice paper contains both short and longer questions in proportion to sample assessment material. This includes factual recall, explanation and discussion questions, with two 6-mark Level of Response questions per paper indicated with an asterisk (*).

Papers have been designed to ensure that the Mathematical Skills and Practical Activity Groups (PAGs) specified in the new syllabus are assessed, as well as 'how science works' aspects of the syllabus

Across the three Practice Paper packs (Papers 1, 2 and 3), coverage of the specific
specification analysis grid is also included, enabling teachers to identify questions
technique activities, or as homework assignments.

The author has aimed to include a spread of material from the relevant topics in e
obtain an overview of their students' knowledge and understanding for each unit.

I hope you and your students find this pack useful.

Mark Distribution across all Pap

		TOTAL	1A	1B	1C	1D	2A
Atoms, Equations & Formulae		13	8	4		6	4
Reacting Masses & Gases		36	3		6	4	3
Acids, bases & redox	Titrations	24		3	7	1	
	Redox	10	1	3	1		
	Structure	31	2	7	2	5	
	Bonding	31	3	3	3	3	1
Periodicity, Group 2 & Group 7	Periodicity	43	5	5	5	15	
Qual Tests		8	1		4	1	
Enthalpy	Enthalpy Calculation	14		1		6	
	Bond Enthalpies	12			1		
	Hess	[illegible]	1	5	1	3	
Rates & Eqm	Rates	[illegible]	6	2	6	1	
	Le Ch[illegible]	11		4		1	
Basic Concepts		19					6
Alk[illegible]		15					
	Properties & Reactions	24					7
	Addition Polymers	13					4
Alcohols & Halogenoalkanes	Alcohols	16					5
	Halogenoalkanes	15					2
Synthesis	Practical Techniques	5					
Analytical Techniques	IR	13					3
	Mass Spec	9					1
Rates & Eqm (quant)	How fast	41	13	11	7	3	
	RDS	13		2	3		
	Arrhenius	13				8	
	Kc	14		3	6		
	Kp	25	6	9	2	5	
	Ka and pH	30	8	6	6	2	
	Buffers	31			6	10	
	Neutralisation & Indicators	9	1	4	1		
Energy	Lattices	12	6		2		
	Born-Haber	25	6	6	4	1	
	Gibbs and Entropy	18	3	1	6	2	
Redox & Electrode Potentials	Redox Titrations	15	6	9			
	Electrode Potential setup	18	4		5		
	Electrode Potential theory	17	4	1	3	2	
	Fuel Cells	13	1			7	
Transition Elements	Complexes	37	7	8	2	9	
	Reactions	20	1	2	6	5	
	Analysis	17		1	5		
Aromatics	Theory	21					6
	Reactions	17					9
	Phenol	9					
Carbonyls	Reactions	14					
	Tests	[illegible]					1
Carboxylic acids		[illegible]					1
Esters & Acyl Chlorides		10					5
Nitrogen Compounds	Amin[illegible]	22					6
	[illegible] acids & Amides	9					2
	Chirality	11					2
Conden[illegible]		12					3
C-C bo[illegible]ion	Nitriles	11					2
Synthesis	Reflux	9					1
	Purification	20					6
	Synthetic Routes	27					3
Analysis	Chromatography	16					2
	Qualitative Tests	12					6
	NMR	29					9
	Combined Techniques	16					
	MATHS		32	31	35	37	8
	PRACTICAL		21	18	15	14	15

Mark Distribution across Pa

		Paper 1A								Paper 1B						
			MC	Q16	Q17	Q18	Q19	Q20	Q21		MC	Q16	Q17	Q18	Q19	Q2
Atoms, Equations & Formulae		8			3	5				4	1	1	2			
Reacting Masses & Gases		3	1			2										
Acids, bases & redox	Titrations									3	2					
	Redox	1	1							3						
Structure and bonding	Structure	2							2	7	1					6
	Bonding	3				3				3		2				1
Periodicity, Group 2 & Group 7	Periodicity	5	2		3					5	2		3			
Qual Tests		1	1													
Enthalpy	Enthalpy Calculation									1	1					
	Bond Enthalpies	4				4										
	Hess	1	1							5	1	4				
Rates & Eqm	Rates	6	2				4			2				2		
	Le Chatelier									4	1	3				
Rates & Eqm (quant)	How fast	13	1				12			11	1			10		
	RDS									2				2		
	Arrhenius															
	Kc									3		3				
	Kp	6				6				9	1	8				
	Ka and pH	8	2		6					6	1		5			
	Buffers															
	Neutralisation and Indicators	1	1							4			4			
Energy	Lattices	6							6							
	Born-Haber	6							6	6						6
	Gibbs and Entropy	3							3	1	1					
Redox & Electrode Potentials	Redox Titrations	6		6						9						
	Electrode Potential Setup	4		4												
	Electrode Potential Theory	4		4						1	1					
	Fuel Cells	1	1													
Transition Elements	Complexes	7	1					6		8					8	
	Reactions	1	1							2					2	
	Analysis									1	1					

	Total	100	15	14	12	20	16	6	17	Total	100	15	21	14	14	10	1
	Maths	32	2		6	9	3	7	5	Maths	31	4	8	5	6		2
	Prac	21	3	6	3	5	4			Prac	18	2	2	2	6	3	

Chemistry A
Unit H432

Practice Paper 1B

Name	

Time allowed
2 hours 15 minutes

Information
- The total marks available for this paper is 100. The number of marks available for each question is shown in brackets.
- Answer all questions and show all working

You will need:
An OCR A Chemistry data sheet

You may use:
- A scientific or graphical calculator
- A pencil for graphs and drawings
- A ruler

Paper 1B

SECTION A

You should aim to finish this section within 20

1 A solution of metal ions formed a precipitate on addition of $NaOH_{(aq)}$ t
an excess of $NaOH_{(aq)}$. Identify the metal ion.

A Fe^{3+}

B Fe^{2+}

C Cr^{3+}

D Cr^{2+}

Your a

2 Which of the following combinations of enthalpy changes could be use
this reaction?

$$2CO_{(g)} + 2NO_{(g)} \rightarrow 2CO_{2(g)} + N_{2(g)}$$

A $2\Delta H_f^e(CO_2) + 2\Delta H_c^e(C) + \Delta H_c^e(N_2)$

B $2\Delta H_c^e(C) - 2\Delta H_f^e(NO) - 2\Delta H_f^e(CO)$

C $2\Delta H_f^e(NO) + \Delta H_f^e(CO) - 2\Delta H_f^e(CO_2)$

D $\Delta H_c^e(N_2) + 2\Delta H_c^e(C) - 2\Delta H_f^e(CO_2)$

Your answer

3 A lumberjack burns a log for warmth. Which of these is true about thi

A $\Delta H > 0$ $\Delta S > 0$

B $\Delta H < 0$ $\Delta S < 0$

C $\Delta H > 0$ $\Delta S < 0$

D $\Delta H < 0$ $\Delta S > 0$

Your answer

4 Which of the following represents the electronic structure of cobalt in a

A $1s^2 2s^2 2p^6 3s^2 3p^6 3d^5$

B $1s^2 2s^2 2p^6 3s^2 3p^6 3d^9$

C $1s^2 2s^2 2p^6 3s^2 3p^6 3d^3 4s^2$

D $1s^2 2s^2 2p^6 3s^2 3p^6 3d^4 4s^2$

Your answer ☐

5 Assuming a complete reaction, how many hydroxide ions are produced when 1 mol of Na_2O and 1 mol of Al_2O_3 react with water?

A 3.01×10^{23}

B 6.02×10^{23}

C 1.20×10^{24}

D 2.41×10^{24}

Your answer ☐

6 6.02 g of $SnCl_2.xH_2O$ were dehydrated to leave 5.10 g of $SnCl_2$. What is x?

A 1

B 2

C 3

D 4

Your answer ☐

7 How do nuclear charge and shielding vary down group 7?

A Nuclear charge stays the same, shielding increases

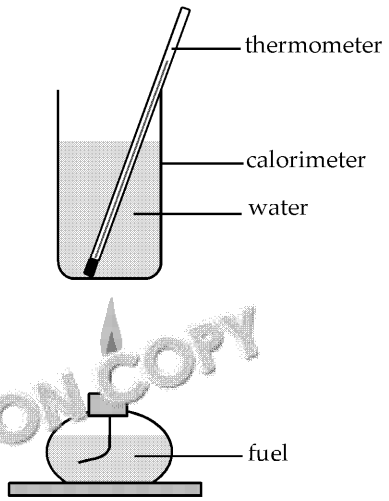
B Nuclear charge stays the same, shielding decreases

C Nuclear charge increases, shielding increases

D Nuclear charge increases, shielding decreases

Your answer ☐

8 A fuel was burned and the enthalpy change calculated using values m
simple set-up:



Which following changes would be most important to ensure th
as possible to a value recorded in a data book?

A Measuring the temperature using a temperature sensor on a data l

B Burning all the fuel

C Insulation of the set-up

D Using a larger quantity of water to minimise percentage error

Your answer ☐

9 Use the following values to identify which of the reactions below is m
according to electrochemical data.

$Li^+_{(aq)} + e^- \rightleftharpoons Li_{(s)}$ $E^\ominus = -3.04$ V

$Yb^{2+}_{(aq)} + 2e^- \rightleftharpoons Yb_{(s)}$ $E^\ominus = -2.76$ V

$Be^{2+}_{(aq)} + 2e^- \rightleftharpoons Be_{(s)}$ $E^\ominus = -1.85$ V

A $Yb_{(s)}$ and $Be^{2+}_{(aq)}$

B $Li^+_{(aq)}$ and $Be_{(s)}$

C $Li_{(s)}$ and $Yb^{2+}_{(aq)}$

D $Li_{(s)}$ and $Be_{(s)}$

Your answer ☐

10 A stud lis that a particular endothermic reaction got faster
these ations explains why?

A The activation energy gets lower at higher temperatures

B The position of equilibrium shifts to the left

C The position of equilibrium shifts to the right

D The rate constant increases

Your answer ☐

11 Identify the conjugate base of the hydrogen carbonate ion, HCO_3^-.

A H_2CO_3

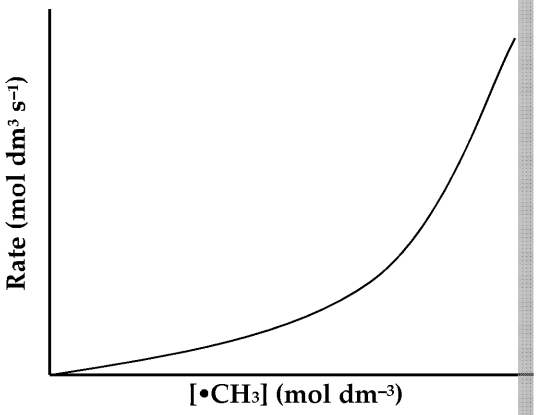
B OH^-

C H^+

D CO_3^{2-}

Your answer ☐

12 The rate of reaction for the formation of C_2H_6 from CH_3 radicals was de
concentrations of CH_3 radical[illegible]y what conclusion can be made



A The reaction is definitely zeroth order with respect to C_2H_6

B The reaction is definitely not zeroth or first order with respect to •

C The reaction could be either first or second order with respect to •

D The overall order is definitely 2

Your answer ☐

13 An agricultural chemist wants to synthesise 700 g of potassium nitrate
moles of nitric acid would be needed if the yield [illegible] %?

A 5.06 mol

B 9.48 mol

C 6.[illegible] l

D 95[illegible]

Your answer ☐

14 The value of K_p for a reaction decreases when the temperature increase is true?

1. The reactants and products are all gases.
2. Less energy is needed to break the bonds in the reactants than is re bonds in the products.
3. The position of equilibrium remains the same.

A Statement 1 only

B Statement 2 only

C Statements 1 and 2 only

D Statements 1, 2 and 3

Your a r ☐

15 A chemist wanted to prepare a 0.100 mol dm^{-3} solution of HCl. The ch cylinder to pour 25.0 cm^3 of 1.00 mol dm^{-3} stock solution of HCl into a distilled water to the volumetric flask up to the 250 cm^3 mark.

Which of the following errors would lead to a lower concentration tha

1. Not washing the measuring cylinder that was used to transfer the make sure all the acid was transferred to the volumetric flask
2. Using an unwashed measuring cylinder that had previously been
3. Filling the volumetric flask up to the top of the meniscus, instead

A 1 only

B 3 only

C 1 and 3 only

D 1 and 2 only

Your answer ☐

SECTION B

16 Sulfur trioxide is an important industrial chemical due to its use in syn
be prepared by the following reversible reaction, which is exothermic i

$$O_{2(g)} + 2\ SO_{2(g)} \rightleftharpoons 2\ SO_{3(g)}$$

a) Explain why SO_2 is a polar molecule, but SO_3 is not.

.....

.....

.....

.....

b) i) the enthalpy of formation data given below to calculate Δ standard conditions.

$\Delta H_f^{\ominus}(SO_{2(g)}) = -296.8\ kJ\ mol^{-1}$ $\Delta H_f^{\ominus}(SO_{3(g)})$

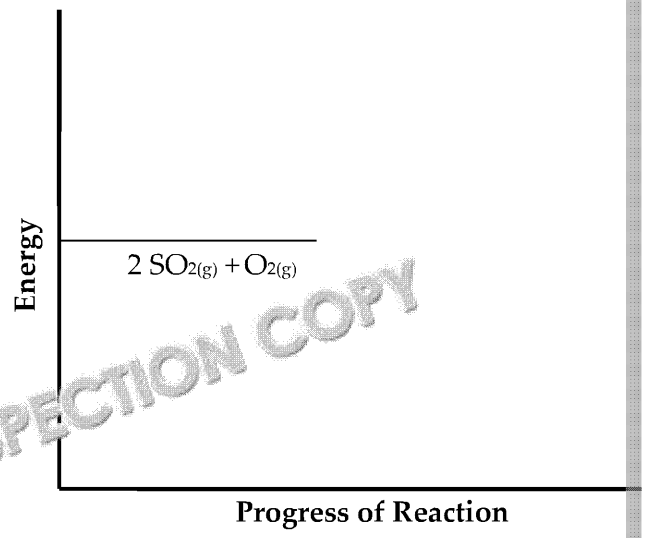
.....

.....

.....

.....

ii) Complete the enthalpy diagram for this reaction, labelling the activation energy.



c) i) In a container at 298 K, 0.160 moles of $SO_{2(g)}$ and 0.160 moles o
equilibrium, at which point the pressure was 500 Pa. From th
sulfur trioxide was isolated, giving 3.443 g of gaseous sulfur t
for this reaction at this temperature and give its unit.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

ii) Explain how the value of K_P remains constant even if the cont
the volume.

.....

.....

.....

.....

.....

.....

d) The industrial conditions for this reaction are 100–200 kPa pressur
vanadium (V) oxide catalyst.

i) Give the formula of the catalyst.

.....

ii) Predict how the value of K_P would differ if no catalyst was pr

.....

.....

.....

.....

iii) Explain the disadvantages of using a temperature higher or lo

.....

.....

.....

.....

.....

.....

17 Chloric (III) acid is a weak monobasic acid with the formula $HClO_2$ tha
reacti... Cl_2 and H_2O. Another product is also formed in this reactio
those t... occurs when chlorine is used in water treatment.

a) Predict the identity of the side product, and hence write a balance

.....

.....

.....

.....

b) Explain why people may be concerned about chlorine's use in wat
the volume of water treated is large enough that pH is unaffected)

.....

.....

c) To check the pH of the water that has been treated, a pH meter ma
the pH meter is added to buffers with known pHs and repeatedly
the purpose of this.

.....

.....

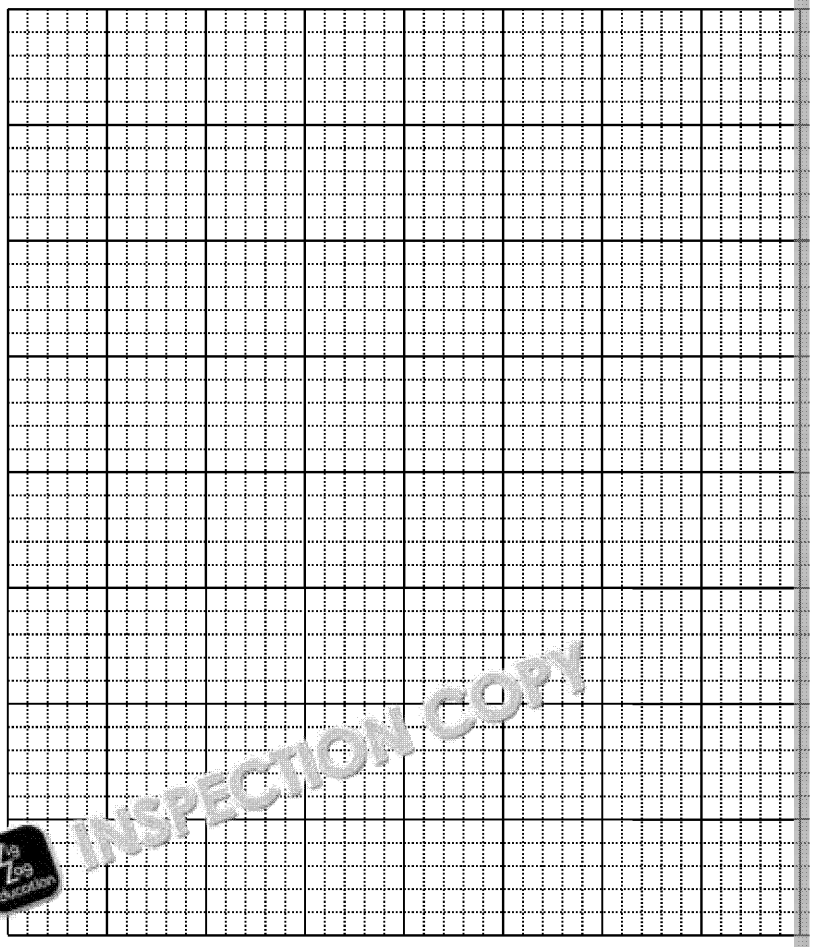
.....

.....

d) To analyse samples of $HClO_2$ it may be titrated against NaOH and
portion of NaOH is added. An environmental scientist carried ou
these results:

Volume of $NaOH_{(aq)}$ added (cm^3)	
0.0	
2.0	
4.0	
6.0	
8.0	
[illegible]	
12.0	
14.0	
16.0	

i) Plot a pH curve using these results.



ii) Explain which of the following indicators would be most appr
equivalence point.

Indicator	pH range of colour cha
Congo red	3.0–5.0
Bromocresol purple	5.2–6.6
Thymolthalein	8.8–10.5

.....

.....

.....

.....

e) The pK_a of $HClO_2$ is 1.94.

i) Calculate the pH of a 0.0100 mol dm^{-3} solution of $HClO_2$.

.....

.....

.....

.....

ii) Calculate the concentration of OH^- ions in a 0.0100 mol dm^{-3} s

.....

.....

iii) Given that more than 5 % of $HClO_2$ is dissociated in solution,
explain why the assumptions used to make the calculation in
effect this has on the answer.

.....

.....

.....

.....

18 Hydrogen peroxide may be decomposed by a variety of organic and in the equation:

$$2\ H_2O_{2(aq)} \rightarrow 2\ H_2O_{(l)} + O_{2(g)}$$

The use of Fe (III) solutions as catalysts is of particular interest to scien the reaction forms intermediate species which are highly reactive radic break down polluting agents. In order to make use of these possibilitie must be understood.

a) Explain why concentration is expected to have an effect on reactio collision theory.

.....

.....

.....

.....

b)* Draw a labelled experimental set-up to show how an initial rates m compare the rates of decomposition of hydrogen peroxide for diffe Fe (III), and explain how the experiment can be performed.

.....

.....

.....

.....

.....

.....

.....

c) Use the data below to determine the order of reaction with respect to
hence the value and unit of the rate constant, k, for reactions at a cert
show your working. You can assume that rate is independent of [Fe

	$[H_2O_2]$ (mol dm^{-3})	Rate (mo
Reaction 1	5.00×10^{-3}	3.65
Reaction 2	1.67×10^{-3}	1.21

.....

.....

.....

.....

.....

.....

.....

.....

d) Use your value of k to determine the time it takes for the concentra
reaction to decrease to 2.50×10^{-3} mol dm^{-3}. If you have not calcul
use a value for k of 1.00×10^{-4}. This is not the correct answer.

.....

.....

.....

.....

e) Under different temperature and pH conditions the rate-determini

$$Fe^{3+} + H_2O_2 \rightleftharpoons [FeHO_2]^{2+} + H^+$$

State the overall order of the reaction under these conditions, justi

.....

.....

.....

.....

19 A key step in the synthesis of cisplatin is the ligand substitution of two of $[PtI_4]^{2-}$ with two NH_3 ligands from an ammonia solution to give a cis precipitate.

a) State the coordination number of platinum in $[PtI_4]^{2-}$.

.....

b) Define the term 'complex ion'.

.....

.....

c) Draw the structure of the cis isomer produced, and explain how it differs from the trans isomer.

.....

.....

.....

d) Write a balanced equation for the ligand substitution equation, including state symbols.

.....

e) When the cisplatin is ultimately made, it can be used as an antican
cisplatin works.

.....

.....

.....

.....

f) Suggest why some patients may choose not t e cisplatin.

.....

.....

20 Magnesium and aluminium are two of the most abundant metals in th
found in period 3 of the periodic table.

a)* Describe and explain how melting point varies across period 3.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

b) The boiling point of aluminium bromide is low and its conductivit
as a solid. Predict the type of structure and bonding seen in liquid

.....

c) Solid magnesium bromide dissolves in water. The following data enthalpy of hydration of a magnesium ion.

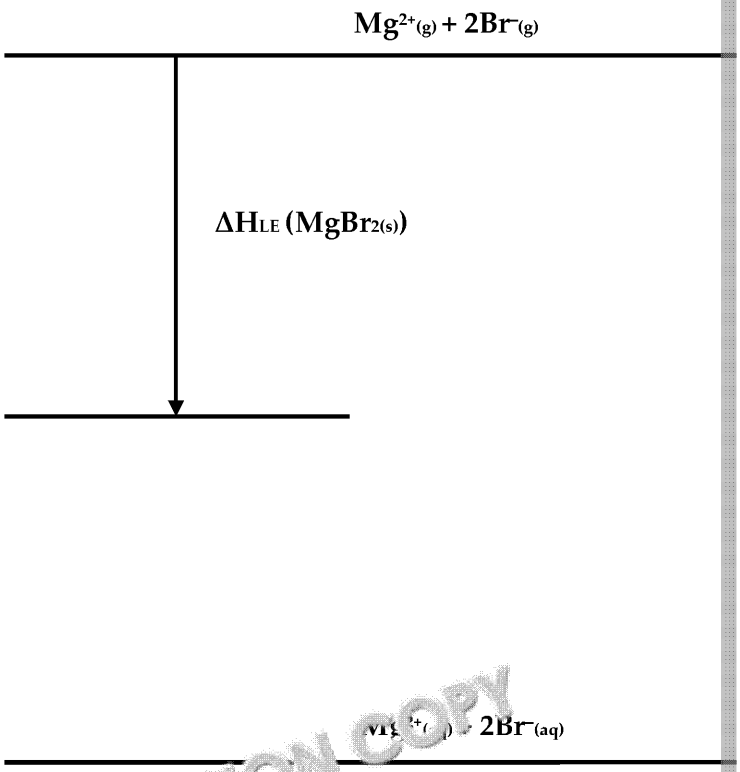
	Experimental valu
ΔH_{LE} ($MgBr_{2(s)}$)	-2432
ΔH_{sol} ($MgBr_{2(s)}$)	-192
ΔH_{hyd} ($Br^-_{(g)}$)	-348

i) Define the term 'enthalpy of hydrati

.....

.....

ii) Use the above data to complete the Born–Haber cycle below a changes, including the enthalpy of hydration of an Mg^{2+} ion.



iii) e t e to calculate the enthalpy of solution.

.....

.....

.....

.....

21 In the presence of acid, zinc can reduce dichromate ions, $Cr_2O_7^{2-}$ to Cr^{3+}

a) Give the oxidation state of chromium in $Cr_2O_7^{2-}$.

.....

b) If the experiment is not done carefully, bubbles of hydrogen gas a

.....

.....

A student wanted to use this rea investigate the percentage of z student carried out the following experiment.

- She grou zinc tablet and added it to a small quantity
- Si a magnetic stirring bar in the flask and placed it on a st we continually stirred.
- Above the flask, she set up a burette containing a solution with a 5 concentration of $Cr_2O_7^{2-}$ ions.
- She placed an indicator in the flask that would turn violet in the p ions, i.e. when all the zinc had reacted.
- She added the $Cr_2O_7^{2-}$ solution from the burette until the solution t the reading.
- She repeated the experiment to achieve a concordant titre.

Her results are shown below.

	Titration 1	Titration 2	Ti
Start reading (cm^3)	0.00	20.90	
End reading (cm^3)	20.90	41.05	
Titre (cm^3)			
Mean titre to 1 d.p. (cm^3)			

c) Co te e above to work out the average titre to 1 decim

d) Deduce the half equations and, therefore, the overall equation for
calculate the percentage by mass of the tablet.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

e) The student reflected that the method assumed that the only subst
with $Cr_2O_7^{2-}$ was the zinc. Explain how this affects the accuracy of
obtained if the assumption is false.

.....

.....

f) The student also reflected that she had not shown that her value fo
zinc in the tablet was reproducible. Explain what is needed to sho
reproducible.

.....

.....

Chemistry A
Unit H432

Practice Paper 1B

Name	

Time allowed
2 hours 15 minutes

Information
- The total marks available for this paper is 100. The number of marks available for each question is shown in brackets.
- Answer all questions and show all working

You will need:
An OCR A Chemistry data sheet

You may use:
- A scientific or graphical calculator
- A pencil for graphs and drawings
- A ruler

Paper 1B

SECTION A

You should aim to finish this section within 20

1 A solution of metal ions formed a precipitate on addition of $NaOH_{(aq)}$ t an excess of $NaOH_{(aq)}$. Identify the metal ion.

A Fe^{3+}
B Fe^{2+}
C Cr^{3+}
D Cr^{2+}

2 Which ... ng combinations of enthalpy changes could be use this re...?

$$2CO_{(g)} + 2NO_{(g)} \rightarrow 2CO_{2(g)} + N_{2(g)}$$

A $2\Delta H_f^e(CO_2) + 2\Delta H_c^e(C) + \Delta H_c^e(N_2)$
B $2\Delta H_c^e(C) - 2\Delta H_f^e(NO) - 2\Delta H_f^e(CO)$
C $2\Delta H_f^e(NO) + \Delta H_f^e(CO) - 2\Delta H_f^e(CO_2)$
D $\Delta H_c^e(N_2) + 2\Delta H_c^e(C) - 2\Delta H_f^e(CO_2)$

3 A lumberjack burns a log for warmth. Which of these is true about thi

A $\Delta H > 0$ $\Delta S > 0$
B $\Delta H < 0$ $\Delta S < 0$
C $\Delta H > 0$ $\Delta S < 0$
D $\Delta H < 0$ $\Delta S > 0$

4 Which of the following represents the electronic structure of cobalt in a

A $1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,3d^5$
B $1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,3d^9$
C $1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,3d^3\,4s^2$
D $1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,3d^4\,4s^2$

5 Assuming a complete reaction, ho... ...ydroxide ions are produce react with water?

A 3.01×10^{23}
B $6.$... 10^{2}...
C 1.2... 10^{24}
D 2.41×10^{24}

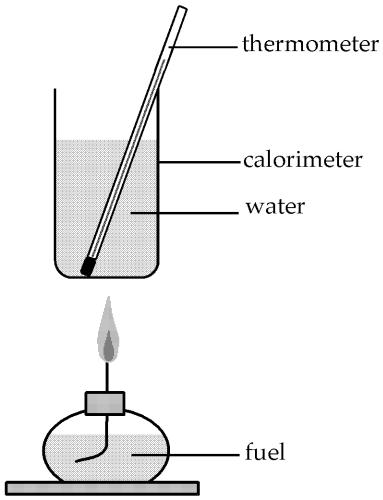
6 6.02 g of $SnCl_2.xH_2O$ were dehydrated to leave 5.10 g of $SnCl_2$. What is

A 1
B 2
C 3
D 4

7 How do nuclear charge and shielding vary down group 7?

A Nuclear charge stays the same, shielding increases
B Nuclear charge stays the same, shielding decreases
C Nuclear charge increases, shielding increases
D Nuclear charge increases, shielding decreases

8 A fuel was burned and the enthalpy change calculated using values m
simpl p:



Which of the following changes would be most important to ensure th
as possible to a value recorded in a data book?

A Measuring the temperature using a temperature sensor on a data l
B Burning all the fuel
C Insulation of the set-up
D Using a larger quantity of water to minimise percentage error

9 Use the following values to identify which of the reactions below is mo
according to electrochemical data

$Li^+_{(aq)} + e^- \rightleftharpoons Li_{(s)}$ $E^\ominus = -3.04$ V
$Yb^{2+}_{(aq)} + 2e^- \rightleftharpoons Yb_{(s)}$ $E^\ominus = -2.76$ V
$Be^{2+}_{(aq)} + 2e^- \rightleftharpoons Be_{(s)}$ $E^\ominus = -1.85$ V

A $Yb_{(s)}$ and $Be^{2+}_{(aq)}$
B $Li^+_{(aq)}$ and $Be_{(s)}$
C $Li_{(s)}$ and $Yb^{2+}_{(aq)}$
D $Li_{(s)}$ and $Be_{(s)}$

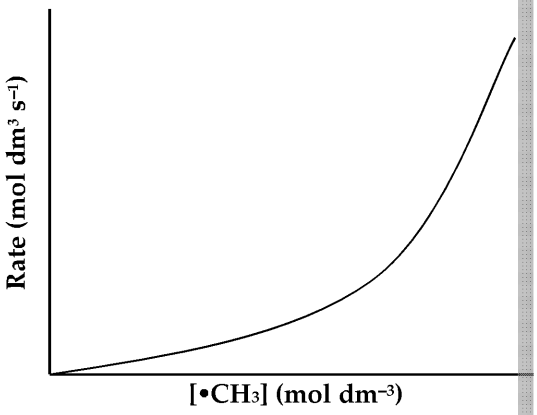
10 A student discovered that a particular endothermic reaction got faster
these explanations explains why?

A The activation energy gets lower at higher temperatures
B The position of equilibrium shifts to the left
C The position of equilibrium shifts to the right
D The rate constant increases

11 Identify the conjugate base of the hydrogen carbonate ion, HCO_3^-.

A H_2CO_3
B OH^-
C H^+
D CO_3^{2-}

12 The ra ea tion for the formation of C_2H_6 from CH_3 radicals was d
concen ons of CH_3 radicals. Identify what conclusion can be made



A The reaction is definitely zeroth order with respect to C_2H_6
B The reaction is definitely not zeroth or first order with respect to •
C The reaction could be either first or second order with respect to •
D The overall order is definitely 2

13 An agricultural chemist wants to synthesise 700 g of potassium nitrate
moles of nitric acid would be needed if the yield is 7 %?

A 5.06 mol
B 9.48 mol
C 6.91 mol
D 95 l

14 The value of K_p for a reaction decreases when the temperature increase
is true?

1. The reactants and products are all gases.
2. Less energy is needed to break the bonds in the reactants than is r
bonds in the products.
3. The position of equilibrium remains the same.

A Statement 1 only
B Statement 2 only
C Statements 1 and 2 only
D Statements 1, 2 and 3

15 A chemist wanted t a 0.100 mol dm^{-3} solution of HCl. The ch
cylinde po 5 cm^3 of 1.00 mol dm^{-3} stock solution of HCl into a
distill er to the volumetric flask up to the 250 cm^3 mark.

Which of the following errors would lead to a lower concentration tha

1. Not washing the measuring cylinder that was used to transfer the
make sure all the acid was transferred to the volumetric flask
2. Using an unwashed measuring cylinder that had previously been
3. Filling the volumetric flask up to the top of the meniscus, instead

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

SECTION B

16 Sulfur trioxide is an important industrial chemical due to its use in syn
be prepared by the following reversible reaction, which is exothermic i

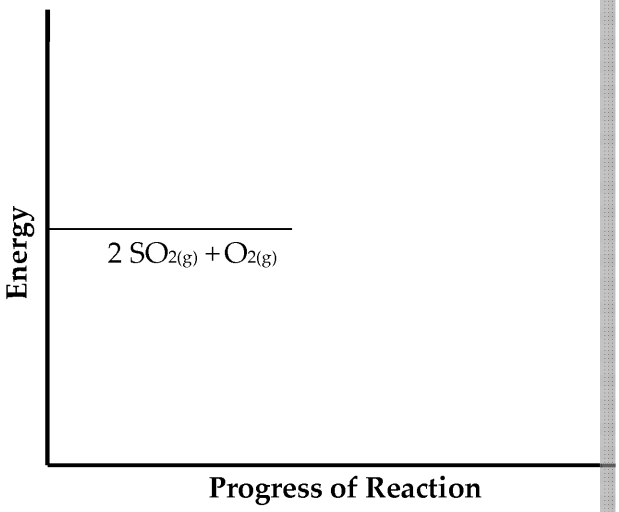
$$O_{2(g)} + 2\ SO_{2(g)} \rightleftharpoons 2\ SO_{3(g)}$$

a) Explain why SO_2 is a polar molecule, but SO_3 is not.

b) i) Use the enthalpy of formation data given below to calculate Δ
standard conditions.

$\Delta H_f^{\ominus}(SO_{2(g)}) = -29(8)$ kJ mol^{-1} $\Delta H_f^{\ominus}(SO_{3(g)})$

ii) Copy and complete the enthalpy diagram for this reaction, lab
the activation energy.



c) i) In a container at 298 K, 0.160 moles of $SO_{2(g)}$ and 0.160 moles o
equilibrium, at which point the pressure was 500 Pa. From th
sulfur trioxide was isolated, giving 3.443 g of gaseous sulfur t
for this reaction at this temperature and give its unit.

ii) Explain how the value of K_p rem[illegible] constant even if the cont
the volume.

d) Th[illegible] conditions for this reaction are 100–200 kPa pressur
va[illegible]m (V) oxide catalyst.

i) Give the formula of the catalyst.

ii) Predict how the value of K_p would differ if no catalyst was pr

iii) Explain the disadvantages of using a temperature higher or lo

17 Chloric (III) acid is a weak monobasic acid with the formula $HClO_2$ tha
reaction of Cl_2 and H_2O. Another product is also formed in this reactio
those that occurs when chlorine is used in water treatment.

a) Predict the identity of the side product, and hence write a balance

b) Explain why people may be concerned about chlorine's use in wat
the volume of water treated is large enough that pH is unaffected)

c) To check the pH of the water that has been [illegible]ed, a pH meter ma
the pH meter is added to buffers wit[illegible] pHs and repeatedly
the purpose of this.

d) T[illegible]ysing samples of $HClO_2$ it may be titrated against NaOH and
pc[illegible]of NaOH is added. An environmental scientist carried ou
these results:

Volume of $NaOH_{(aq)}$ added (cm^3)	
0.0	
2.0	
4.0	
6.0	
8.0	
10.0	
12.0	
14.0	
16.0	

i) Plot a pH curve using these results.

ii) Explain which of the following indicators would be most appr
equivalence point.

Indi[illegible]r	pH range of colour cha
[illegible]ngo red	3.0–5.0
Bromocresol purple	5.2–6.6
Thymolthalein	8.8–10.5

e) The pK_a of $HClO_2$ is 1.94.

i) Calculate the pH of a 0.0100 mol dm^{-3} solution of $HClO_2$.

ii) Calculate the concentration of OH^- ions in a 0.0100 mol dm^{-3} s

iii) Given that more than 5 % of $HClO_2$ is dissociated in solution, explain why the assumptions used to make the calculation in effect this has on the answer.

18 Hydrogen peroxide is decomposed by a variety of organic and in the equation:

$$2\ H_2O_{2(aq)} \rightarrow 2\ H_2O_{(l)} + O_{2(g)}$$

The use of Fe (III) solutions as catalysts is of particular interest to scien the reaction forms intermediate species which are highly reactive radic break down polluting agents. In order to make use of these possibilitie must be understood.

a) Explain why concentration is expected to have an effect on reactio collision theory.

b)* Draw a labelled experimental set-up to show how an initial rates m compare the rates of decomposition of hydrogen peroxide for diffe Fe (III), and explain how the experiment can be performed.

c) Use the data below to determine the order of reaction with respect to hence the value and unit of the rate constant, k, for reactions at a cert show your working. You can assume that rate is independent of [Fe

	$[H_2O_2]$ (mol dm^{-3})	Rate (mo
Reaction 1	5.00 × 10	3.65
Reaction 2	1.00 × 10^{-3}	1.21

d) Use your value of k to determine the time it takes for the concentra re to decrease to 2.50×10^{-3} mol dm^{-3}. If you have not calcul use a value for k of 1.00×10^{-4}. This is not the correct answer.

e) Under different temperature and pH conditions the rate-determin

$$Fe^{3+} + H_2O_2 \rightleftharpoons [FeHO_2]^{2+} + H^+$$

State the overall order of the reaction under these conditions, justi

19 A key step in the synthesis of cisplatin is the ligand substitution of two of $[PtI_4]^{2-}$ with two NH_3 ligands from an ammonia solution to give a cis precipitate.

a) State the coordination number of platinum in $[PtI_4]^{2-}$.

b) Define the term 'complex ion'.

c) Draw the structure of the cis isomer produced, and explain how it trans isomer.

d) Write a balanced e[illegible]tion for the ligand substitution equation, inc

e) W[illegible]e cisplatin is ultimately made, it can be used as an antican cisplatin works.

f) Suggest why some patients may choose not to use cisplatin.

20 Magnesium and aluminium are two of the most abundant metals in th found in period 3 of the periodic table.

a)* Describe and explain how melting point varies across period 3.

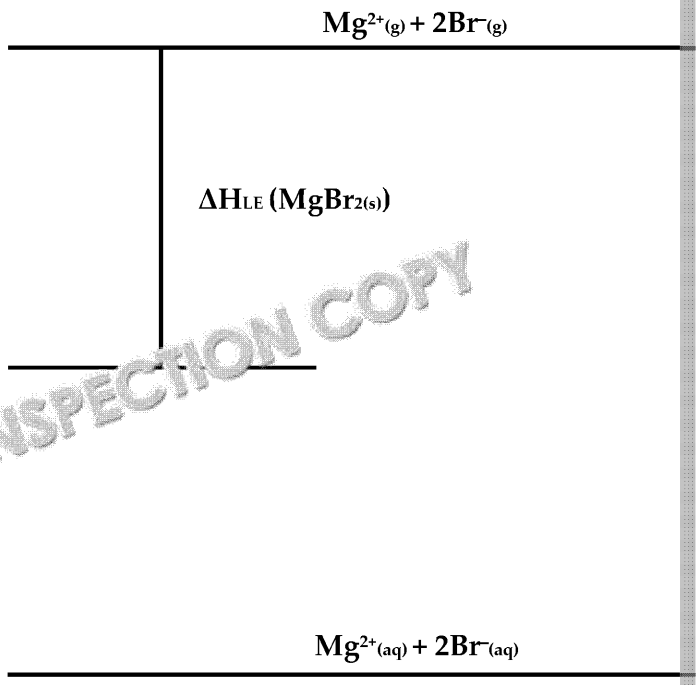
b) The boiling point of aluminium bromide is low and its conductivit as a solid. Predict the type of structure and bonding seen in liquid

c) Solid magnesium bromide dissolves in water. The following data enthalpy of hydration of a magnesium ion.

	xperimental valu
ΔH_{LE} ($MgBr_{2(s)}$)	-2432
ΔH_{iso} ($MgBr_{2(s)}$)	-192
ΔH_{hyd} ($Br^-_{(g)}$)	-348

i) Define the term 'enthalpy of hydration'.

ii) Copy the Born–Haber cycle below. Use the above data to cor
and label all the enthalpy changes, including the enthalpy of



iii) Use the cycle to calculate the enthalpy of solution.

21 In the presence of acid, zinc can reduce dichromate ions, $Cr_2O_7^{2-}$ to Cr^{3+}

a) Give the oxidation state of chromium in $Cr_2O_7^{2-}$.

b) If the experiment is not done carefully, bubbles of hydrogen gas a

A student wanted to use this reaction to investigate the percentage of z
student carried out the following experiment.

- She ground a 25.0 mg zinc tablet and added it to a small quantity
- She placed a magnetic stirring bar in the flask and placed it on a st
were continually stirred.
- Above the flask, she supported a burette containing a solution with a 5
concentration of $Cr_2O_7^{2-}$ ions.
- She added an indicator in the flask that would turn violet in the pr
ions when all the zinc had reacted.
- She added the $Cr_2O_7^{2-}$ solution from the burette until the solution t
the reading.
- She repeated the experiment to achieve a concordant titre.

Her results are shown below.

	Titration 1	Titration 2	Ti
Start reading (cm^3)	0.00	20.90	
End reading (cm^3)	20.90	41.05	
Titre (cm^3)			
Mean titre to 1 d.p. (cm^3)			

c) Copy and complete the table above to work out the average titre to

d) Deduce the half equation and, therefore, the overall equation for t calculate the percentage by mass of the tablet.

e) The student reflected that the method assumed that the only subst with $Cr_2O_7^{2-}$ was the zinc. Explain how this affects the accuracy of obtained if the assumption is false.

f) The student also reflected that she had not shown that her value fo zinc in the tablet was reproducible. Explain what is needed to sho reproducible.

Preview of Questions Ends Here

Mark Schemes

Practice Paper 1A

Section A

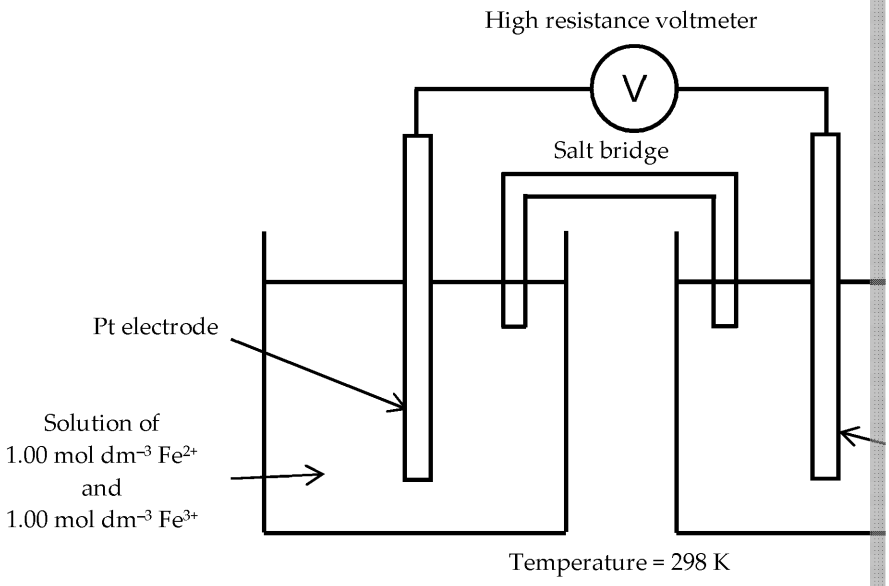
1	A	**6**	C	**11**	A
2	D	**7**	C	**12**	C
3	D	**8**	B	**13**	A
4	A	**9**	B	**14**	D
5	C	**10**	A	**15**	D

Section B

16 a) The best reducing agent is the [metal] losing electrons / has the most nega
Al ✓

b) 0.[illegible] 1.6[illegible] = [illegible] V ✓

c) Aluminium electrode in a solution of Al^{3+} ions ✓
Platinum electrode in a solution of Fe^{2+} and Fe^{3+} ions ✓
1.00 mol dm^{-3} solutions AND temperature = 298 K AND 100 kPa/1 bar pr
Salt bridge AND voltmeter ✓



d) Kinetic barrier / activation energy barrier is too [illegible] to be overcome by a

e)

LEVEL OF RESPONSE QUESTION	
Level 3: (5–6 marks)	Answer is structured in an entirely ordered and details of the method are correct.
Level 2: (3–4 marks)	Answer is mostly well structured. Details fr equipment and reactions are included.
Level 1: (1–2 marks)	Answer has limited structure. Either equipm an equation is not.
0 marks	No creditworthy response.

Indicative Content

- $Fe^{2+} \rightleftharpoons Fe^{3+} + e^-$
- Iron(II) is oxidised
- $MnO_4^- + 8H^+ + 5e^- \rightleftharpoons Mn^{2+} + 4H_2O$
- Potassium permanga[illegible] idising agent
- $5Fe^{2+} + 8H^+ + M[illegible] \rightleftharpoons [illegible] + 4H_2O + 5\ Fe^{3+}$
- Sampl[illegible] into a conical flask / beaker / other suitable containe
- a [illegible]te tile (to see colour)
- [illegible]ette washed with oxidising agent first
- Oxidising agent added to burette
- Open tap to add potassium permanganate to the factory sample
- Swirl
- Slow down addition of potassium permanganate when colour start
- Endpoint is when colour just changes from purple to colourless

17 a) $Ba + 2\ H_2O \rightarrow Ba(OH)_2 + H_2$

Correct species ✓ Balancing ✓ IGNORE state symbols

b) i) ANY THREE FROM:

Dissolve the metals in the same volume of water ✓

Stir ✓

Measure the pH of the solution formed using a pH meter ✓

Record the pH once a constant value has been reached (indicating no

ii) Barium hydroxide will have a higher pH / be more alkaline AND be soluble ✓

c) i) $[H^+] = 10^{-pH} = 10^{-10.94} = 1.15 \times 10^{-11}$ ✓

$[OH^-] = \frac{K_w}{[H^+]} = \frac{1.00\times10^{-14}}{1.15\times10^{-11}}$ (ALLOW ECF)

8.71×10^{-4} (mol dm^{-3}) ✓ (For correct final answer)

ii) Moles $OH^- = 8.71 \times 10^{-4} \times 0.0500$ [illegible] $\times 10^{-5}$ ✓ (ALLOW EC

Moles H^+ = Moles OH^- = [illegible]

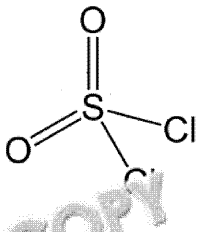
$[H^+] = \frac{\text{Moles}}{\text{Volu}} = \frac{[illegible]}{[illegible]} = 1.74 \times 10^{-3}$ ✓ (ALLOW ECF)

[illegible] $\frac{(1.74\times10^{-3})^2}{4.51\times10^{-4}}$ ✓(ALLOW ECF)

[illegible]$_3$] $= 6.73 \times 10^{-3}$ mol dm^{-3} ✓ (For correct final answer)

18 a) Atom economy is 100 % ✓
No waste products ✓

b) Correct connectivity ✓
Correct shape ✓
Name of shape is tetrahedral AND bond angle is 109.5° (ALLOW 109°) ✓



c) i) Bonds broken = 2 × S=O + Cl–Cl + (2 × 523) + 242 = 1288 (kJ mol⁻¹) (A
Bonds formed = 2 × S–O + 2 × S–Cl = (2 × 523) + (2 × 253) = 1552 (kJ
Enthalpy change = bonds broken – bonds formed = 1288 – 1552 = -26

ii) Values used are average values across a range of molecules, and exa
particular molecule / environment AW ✓ (IGNORE references to cal
reactants and products are gases in the equation)

d) i)

	SO_2	Cl_2
Moles (initial)	0.400	0.400
Moles (eqm)	0.0240	0.0240
Mole Fraction	$\frac{0.0240}{0.024 + 0.024 + 0.376}$	$\frac{0.0240}{0.024 + 0.024 + 0.376}$
	0.05660	0.05660
Partial Pressure	0.05660 × 2	0.05660 × 2
	0.1132	0.1132

$K_p = \frac{p(SO_2Cl_2)}{p(Cl_2) \times p(SO_2)}$ ✓

$K_p = \frac{1.774}{0.1132 \times 0.1132} = 138(.4)$ ✓ Units = $\frac{kPa}{kPa \times kPa} = kPa^{-1}$ ✓

ii) *p(SO₂Cl₂)* is left out OR the equation becomes $\frac{1}{p(Cl_2) \times p(SO_2)}$ ✓

e) i) In case any SO_2 or Cl_2 leaks out AND they are toxic gases ✓

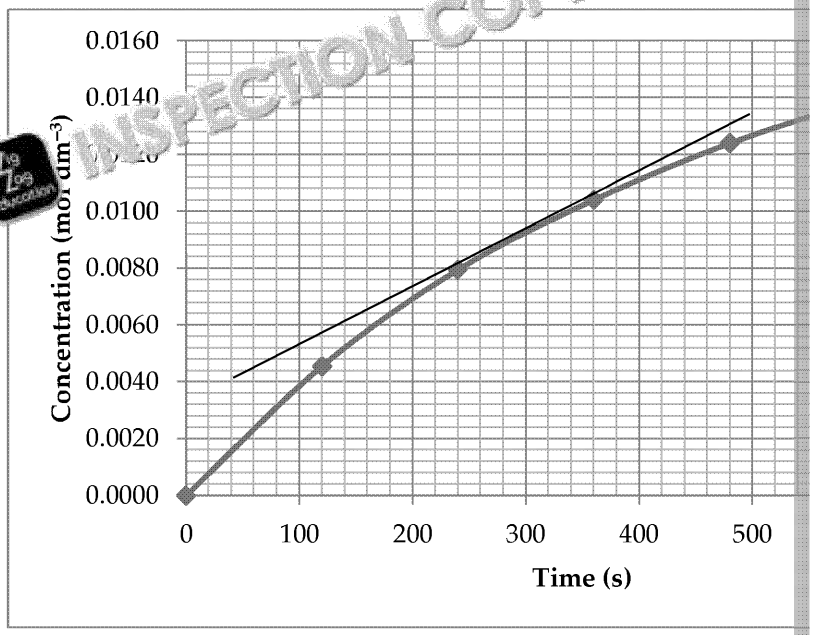
ii) **Reflux** condenser ✓
To ensure reactant vapours condense and are returned to the reactio

iii) To purify the SO_2Cl_2 ✓
Other liquids / impurities with different boiling points will not be co

19 a) i) (Speeds up a reaction by) providing an alternative route for the reac
Which has a lower activation energy ✓

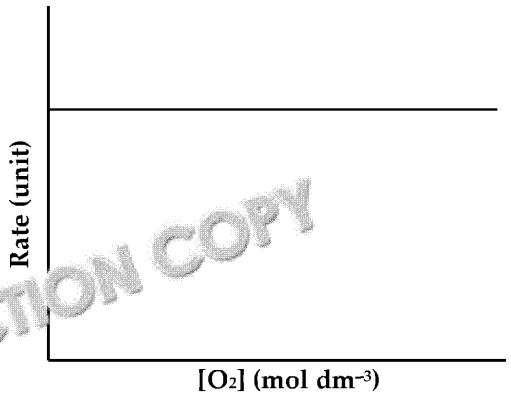
ii) Catalyst may be toxic OR cost of removing the catalyst OR catalysts

b) Even scale AND plot take up more than half the paper in both directions
All points in correct place ✓
Smooth line of best fit ✓
Tangent taken at 300 s ✓
Rate calculated using gradient $\left(\frac{\Delta y}{\Delta x}\right)$ to be between 2.0×10^{-5} and $2.6 \times 10^{-}$
evidence of measuring gradient) ✓
Unit is mol dm^{-3} s^{-1} ✓



c) i) Plot $[Fe(H_2O)_6]^{2+}$ against time and measure several half-lives ✓
Half-lives will be constant if it is first order ✓

ii) ✓ Horizontal line



d) Calibration is needed to give reference values ✓
Record the values given by the colorimeter for known concentrations of
Plot a graph / calibration curve so concentrations can be worked out for
colorimeter ✓

	LEVEL OF RESPONSE QUESTION
Level 3: (5–6 marks)	Answer is structured in an entirely ordered manne described and exemplified. An explanation of the i metals is given in each context.
Level 2: (3–4 marks)	Answer is mostly well structured. Two out of three and exemplified, and one example of how the reac important is given.
Level 1: (1–2 marks)	Answer has limited structure. No examples are giv explained. Descriptions of reactions are vague or o
0 marks	No creditworthy response

Indicative Content

Explanation and examples:

- Ligand substitution involves the replacement of one ligand surrounding
- e.g. $[Cu(H_2O)_6]^{2+} + 4Cl^- \rightleftharpoons [CuCl_4]^{2-} + 6H_2O$
- Redox reactions involve a change in oxidation state of the transition me
- e.g. $[Fe(H_2O)_6]^{2+} + [O] \rightleftharpoons [Fe(H_2O)_6]^{3+}$
- Precipitation reactions involve the formation of a solid from a solution.
- e.g. $Fe^{2+}_{(aq)} + 2OH^-_{(aq)} \rightleftharpoons [Fe(OH)_2]_{(s)}$ (State symbols should be given)

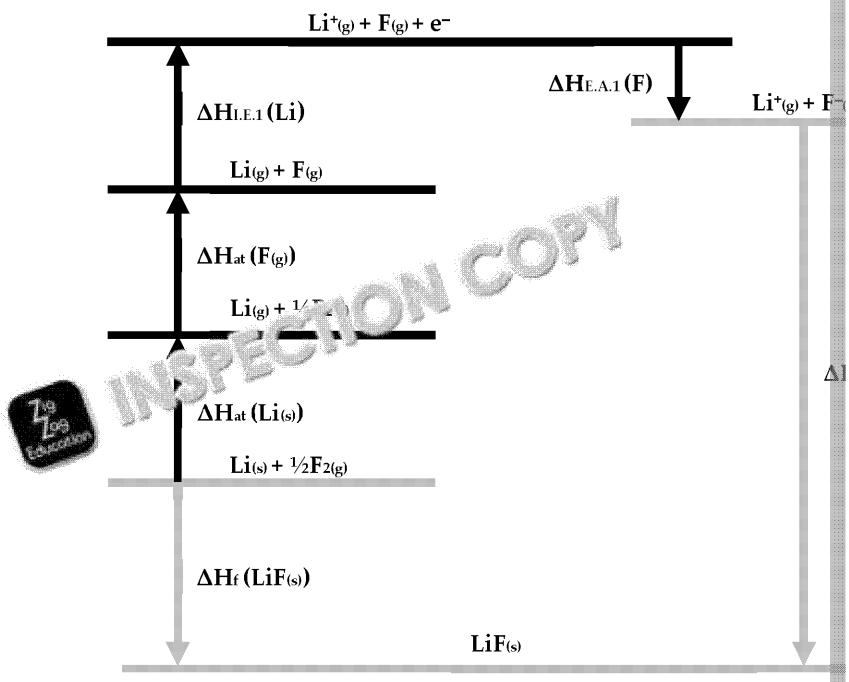
Importance (accept any valid example):

- Ligand substitution reactions are important in, for example, the replace monoxide in haemoglobin.
- Redox reactions are important in, for example, catalytic behaviour such reaction of zinc with acids.
- Precipitation reactions are important in analysis, e.g. Cu^{2+} forms a blue hydroxide.

21 a) **Giant ionic** lattice of many oppositely charged ions ✓
Held together by electrostatic attraction (between the oppositely charged

b) (The enthalpy change when) one mole of a compound is formed ✓
From its gaseous ions ✓

c)

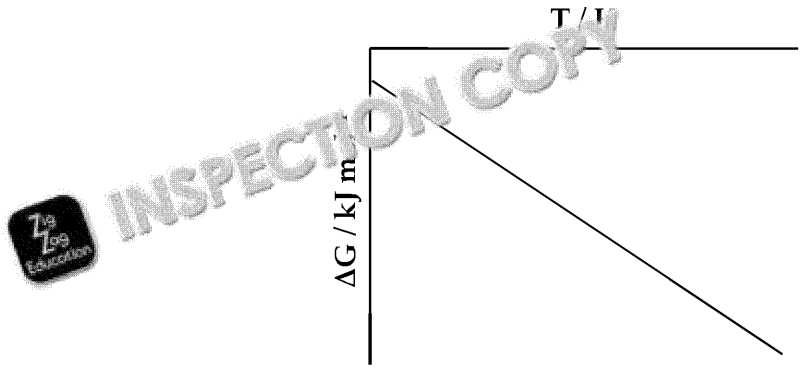


Correct species on lines with correct state symbols (✓for two correct, ✓✓for
order
All arrows correct direction ✓
All labels correct ✓(IGNORE state symbols)
$\Delta H_{LE} = \Delta H_f (LiF_{(s)}) - \Delta H_{at} (Li_{(s)}) - \Delta H_{at} (F_{(g)}) - \Delta H_{I.E.1} (Li) - \Delta H_{E.A.1} (F)$ ✓
$\Delta H_{LE} = -616 - 158 - 79 - 520 - -326 = -1047$ (kJ mol^{-1}) ✓

d) The ions are approximately the same size AND but the ions in beryllium
Electrostatic attraction is greater, meaning more energy is released when

e) Dissolution involves breaking apart the lattice / lattice energy (as well as
Additional energy needed to break apart LiF lattice outweighs more exother

f)



Negative ΔG on graph, starting at origin or below on y-axis
AND because reaction is feasible at all temperatures in range ✓
Negative gradient ✓
Because ΔS is positive for dissolution, so -ΔS, the gradient, is negative ✓

Preview of Answers Ends Here