Write-on

Chemistry A
Unit H432

Practice Paper 1C

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

Question	Mark
MCQs	
16	
17	
18	
19	
20	
21	
Total	

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Paper 1C

SECTION A

You should aim to finish this section within 20 minutes.

1 ΔH for which of the following equations formally represents a ΔH of neutralisation?

A $H_2SO_4 + Ca(OH)_2 \rightarrow CaSO_4 + 2H_2O$

B $HCl + NH_3 \rightarrow NH_4Cl$

C $2HCl + MgCO_3 \rightarrow MgCl_2 + CO_2 + H_2O$

D $[Fe(H_2O)_6]^{2+} + 2OH^- \rightarrow [Fe(OH)_2] + 6H_2O$

Your answer ☐

2 A burette with 0.1 cm^3 divisions is used to measure 22.5 cm^3. Calculate the percentage uncertainty.

A 0.2 %

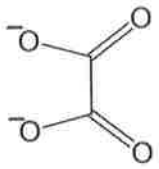
B 0.4 %

C 0.9 %

D 1.8 %

Your answer ☐

3 A pale pink manganese hexaaqua complex undergoes a series of ligand replacement reactions, such that the water ligands are replaced by two ammonia ligands, two iodide ligands and the ligand shown. What is the charge on the complex formed?



A 0

B 2–

C 2+

D 1–

Your answer ☐

4 Which of the following statements explains the drop in first ionisation energy between beryllium and boron?

A Boron's outer electron is removed from the next shell.

B There is p orbital repulsion between the electrons in boron's outer shell.

C Beryllium has only half-filled orbitals, giving it extra stability.

D A p subshell has a slightly higher energy than an s subshell.

Your answer ☐

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5 At 100 °C, pure water has a pH of 6.14. Calculate the value of K_w at this temperature.

A 1.00×10^{-14}

B 5.25×10^{-13}

C 8.51×10^{-4}

D 6.21×10^{-1}

Your answer ☐

6 Which of the following represents iodic (V) acid?

A HIO_2

B HIO_3

C HIO_4

D HIO_5

Your answer ☐

7 How many electrons are in a mole of hydrogen gas, made from two atoms of ^2H?

A 6.02×10^{-23}

B 1.20×10^{-22}

C 2.41×10^{-22}

D 4.82×10^{-22}

Your answer ☐

8 Which of the following is related to the conductivity of graphene?

A Carbon does not form a full outer shell in graphene.

B It is a network of carbon ions.

C Graphene is in a rigidly bonded network.

D Graphene exists as a single layer.

Your answer ☐

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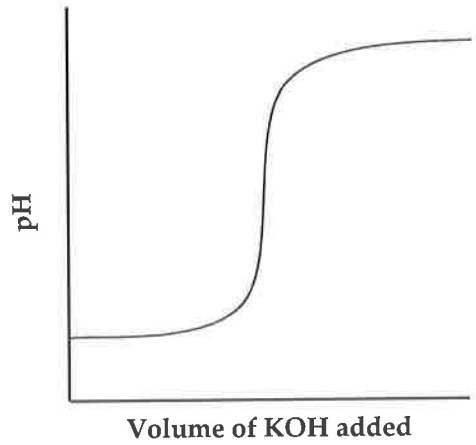
9 Which of the following could represent the shape of a titration curve if KOH is added to a roughly similar concentration of CH_3COOH?

A



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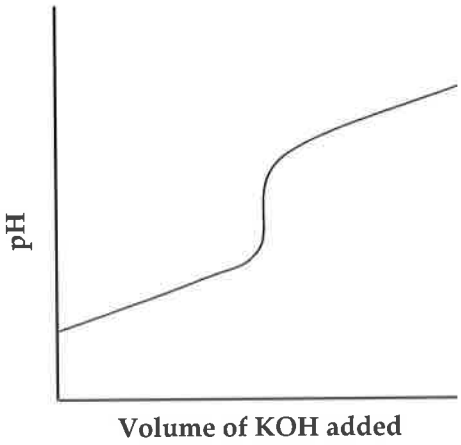

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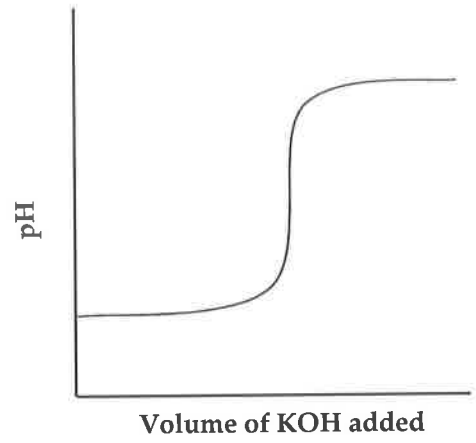

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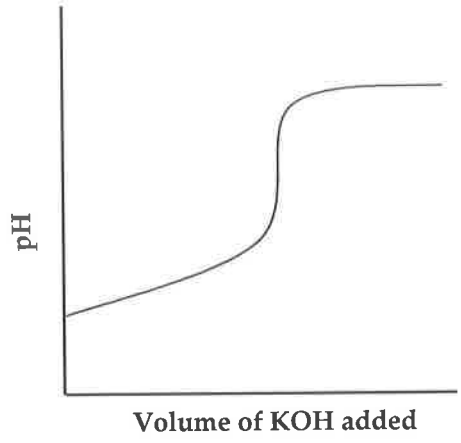

Your answer ☐

10 Use the following information to calculate the NO bond enthalpy in nitrogen monoxide:

- The N=O bond enthalpy in NO_2 is 469 kJ mol^{-1}
- The O=O bond enthalpy is 495 kJ mol^{-1}

$$2NO + O_2 \rightleftharpoons 2NO_2 \qquad \Delta H_r = +821 \text{ kJ mol}^{-1}$$

A 1101 kJ mol^{-1}

B 1264 kJ mol^{-1}

C 634 kJ mol^{-1}

D 2202 kJ mol^{-1}

Your answer ☐

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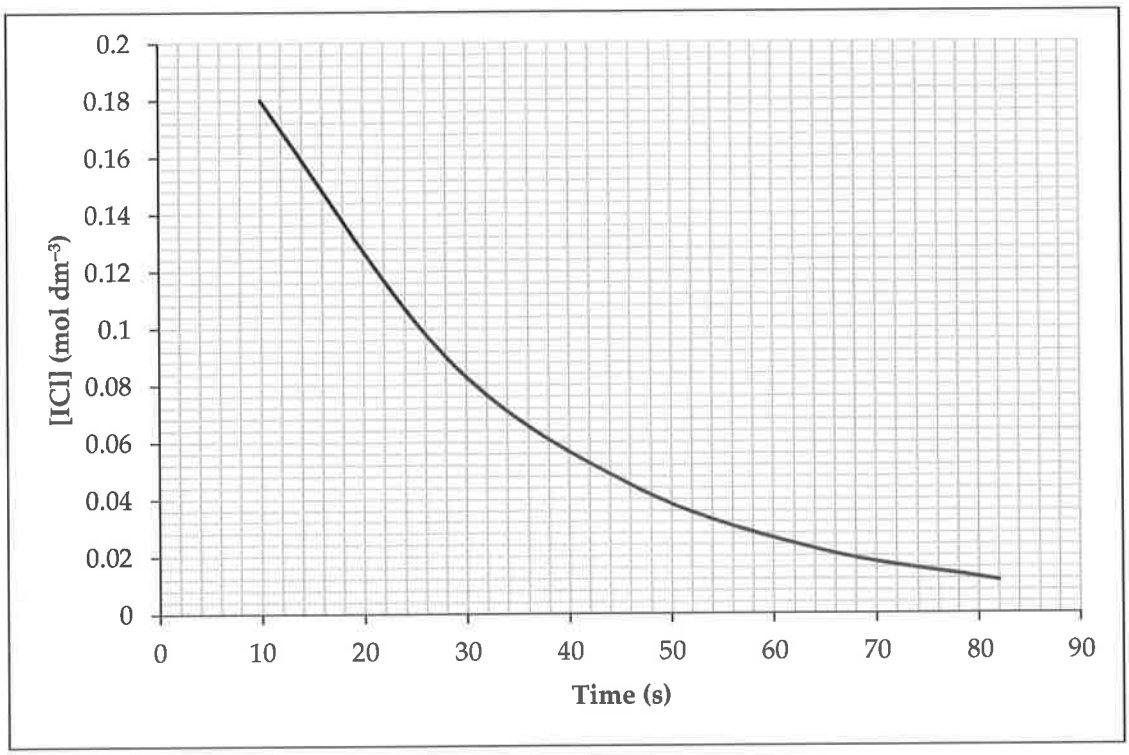
11 Use the graph below to calculate the half-life of this first order reaction of the compound ICl.



A 32 s

B 98 s

C 18 s

D 24 s

Your answer ☐

12 Identify the electron configuration of a Cu^+ ion.

A $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10}$

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

C $1s^2 2s^2 2p^6 3s^2 3p^6 4s^1 3d^9$

D $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10}$

Your answer ☐

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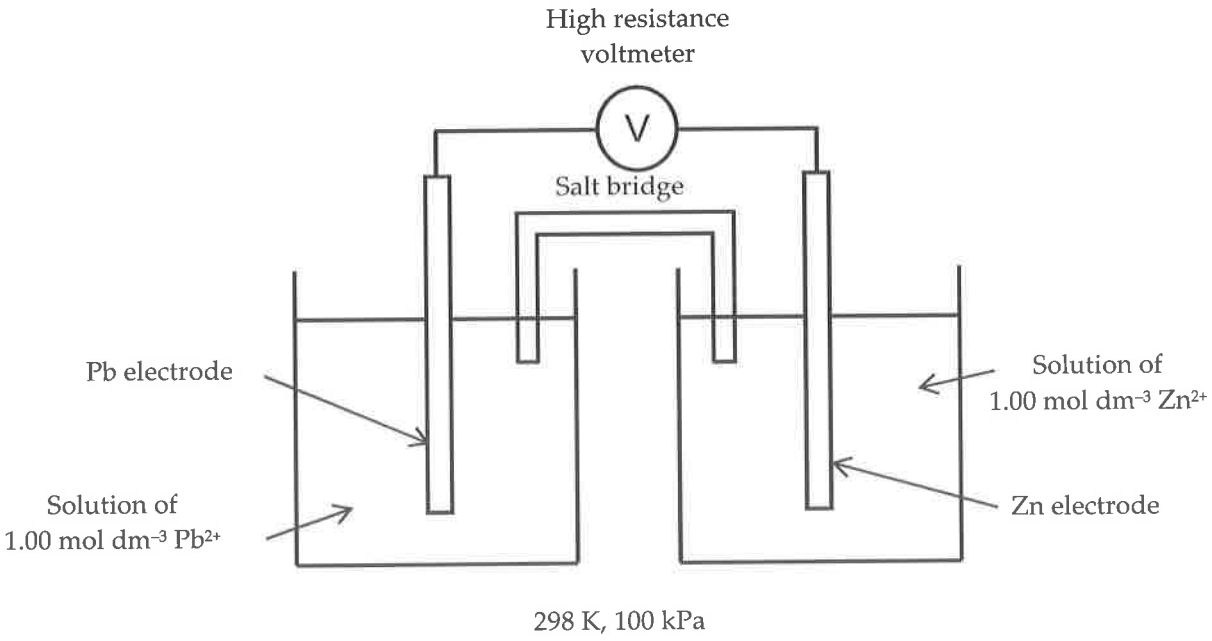
13 Zinc reacts with aqueous lead (II) ions in a redox reaction. What can definitely be concluded from this?

1. $Pb^{2+}_{(aq)} + 2e^- \rightleftharpoons Pb_{(s)}$ has a positive value for $E^\ominus$
2. $Pb^{2+}_{(aq)} + 2e^- \rightleftharpoons Pb_{(s)}$ has a negative value for $E^\ominus$
3. The following circuit would record a positive voltage



A 1 and 3

B 2 and 3

C 1 only

D None of 1, 2 or 3

Your answer ☐

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14 The following reaction was at equilibrium in a 1 dm^3 container:

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

The following expression is used to describe the partial pressures of reactants and products:

$$\frac{p(SO_3)^2}{p(SO_2)^2 p(O_2)}$$

A force was exerted on the walls of the container, expanding the container's volume to 2 dm^3.

Which of the following describes the situation after the expansion?

1. The value of the expression is initially increased
2. The value of the expression is initially decreased
3. The value of the expression returns to its original value
4. The value of the expression is unchanging
5. The position of equilibrium shifts left

A 1 only

B 2 and 3 only

C 1, 3 and 5 only

D 4 and 5 only

Your answer ☐

15 Which of the following is true of the compound $[Ni(NH_2CH_2CH_2NH_2)_3]^{2+}$?

1. It can exist as cis-trans isomers
2. It has a coordination number of 3
3. It contains nickel in a +II oxidation state

A Only 3

B 1 and 3

C 2 and 3

D 1 and 2

Your answer ☐

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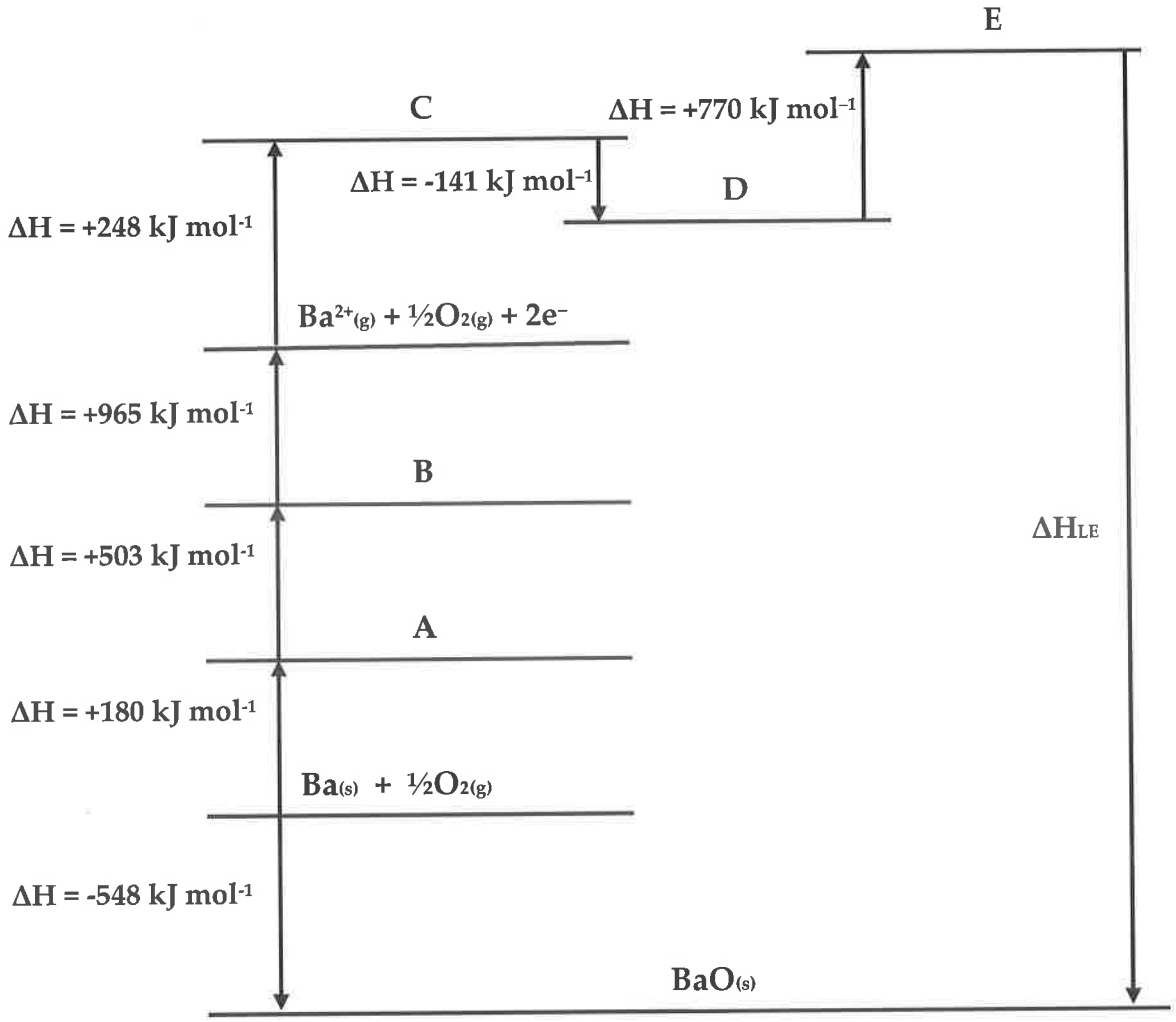
SECTION B

16 Born–Haber cycles are a useful means of determining quantities that are hard to measure experimentally. The Born–Haber cycle below can be used to calculate the lattice energy of barium oxide from the enthalpy of formation and other data.



a) Identify the species formed at:

i) A

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[1]

ii) B

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[1]

b) Name the enthalpy change from C to D.

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[1]

c) Explain why D to E is endothermic.

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[1]

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d) Calculate the lattice enthalpy of barium oxide.

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[2]

e) Explain whether the value for 1st ionisation energy would have a larger or smaller value in the Born–Haber cycle for strontium oxide formation.

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[2]

QUESTION TOTAL: 8 MARKS

17 Many insects produce the weak acid methanoic acid (HCOOH), as either a defence, a weapon or a means of digestion.

a)* Titrations can be used to compare the concentration of methanoic acid in samples from different insects.

0.100 mol dm^{-3} NaOH was added to a burette ready for titration. Describe how solutions of samples that have already been obtained from different insects could be prepared to allow comparisons between the insects.

Ensure your answer includes both equipment and procedures. You do not need to include details of calculations.

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b) i) A sample from one species of ant had a pH of 2.54. What is the concentration of H^+ ions in this sample?

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ii) Methanoic acid has a pK_a of 3.75 at 298 K. Calculate the concentration of methanoic acid that would have a pH of 2.54.

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iii) Why does the answer to ii) rely upon negligible dissociation of water?

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c) Methanoic acid can be used in conjunction with NaOH to make a buffer.

i) Explain what is meant by the term 'buffer'.

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ii) Explain how this buffer would be made.

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[1]

d) A buffer may also be formed from 20.0 cm^3 of 0.250 mol dm^{-3} methanoic acid and 20.0 cm^3 of 0.200 mol dm^{-3} sodium methanoate. Calculate the pH of this buffer to one decimal place.

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[3]

QUESTION TOTAL: 17 MARKS

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18 The nitrosyl halides are a class of chemicals made from nitrogen, oxygen and a halogen. They decompose reversibly to form the halogen and nitrogen monoxide. For nitrosyl bromide this process is represented as follows:

$$2NOBr_{(g)} \rightleftharpoons 2NO_{(g)} + Br_{2(g)}$$

a) Draw a dot-and-cross diagram of the molecule NOBr showing outer electrons only (you will need to decide on the arrangement of the elements in the structure) and use it to predict the shape and bond angle in NOBr.

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[3]

b) The reaction may be followed by allowing the additional gas produced to bubble out of the reaction container through a liquid and into a gas syringe.

i) Explain how this set-up could allow the initial rate of reaction to be determined at different temperatures.

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[3]

ii) Why would dynamic equilibrium not be reached in this set-up?

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[1]

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c) At room temperature, a number of moles, Y, of NOBr decomposed in a sealed 2.00 dm^3 container to form 0.0890 moles of NO at equilibrium. Given that K_c at this temperature is 0.0143 mol dm^{-3}, calculate Y and work out the mole fraction of NOBr at dynamic equilibrium in the container.

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d) i) Predict the sign for ΔS for the decomposition of $NOBr_{(g)}$, justifying your prediction.

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[2]

ii) As the temperature is increased, the partial pressures of NO and Br_2 at equilibrium increases. Using Le Chatelier's principle, deduce the sign of ΔH and explain why this confirms your prediction for the sign of ΔS for the decomposition of nitrosyl bromide.

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QUESTION TOTAL: 19 MARKS

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19 The electrochemical series is a table of standard electrode potentials that can be used to predict the emfs of different electrochemical cells.

a) Draw the full experimental set-up, indicating any relevant conditions, needed to determine the standard electrode potential of the following half equation:

$$Pd^{2+}_{(aq)} + 2e^- \rightleftharpoons Pd_{(s)}$$

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(4)

b) The value recorded for the standard electrode potential of this half cell is +0.92 V. Explain, in terms of equilibrium, how the pH of the solution at the other electrode will change as current flows, and, therefore, why the experiment will not give the standard electrode potential for the above half equation several hours after the experiment has started.

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(3)

QUESTION TOTAL: 7 MARKS

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20 ClO^- ions are very reactive ions that can disproportionate on warming to form ClO_3^- ions and Cl^- ions.

$$3ClO^-_{(aq)} \rightarrow 2Cl^-_{(aq)} + ClO_3^-{}_{(aq)}$$

a) Use oxidation numbers to explain why this is a disproportionation reaction.

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b) Using collision theory, explain why reactions occur more readily at higher temperatures.

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[2]

c) Maxwell–Boltzmann curves represent the distribution of molecular energies at different temperatures.

i) Label the axes below, and draw two labelled curves to show how the Maxwell–Boltzmann distribution changes with temperature.

[3]

ii) How is the total number of particles represented on a Maxwell–Boltzmann curve?

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[1]

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d)* At a certain temperature, the following data was measured.

$[ClO^-]$ (mol dm^{-3})	Rate (mol dm^{-3} s^{-1})
3.60×10^{-4}	8.1
1.08×10^{-3}	72.3
3.24×10^{-3}	650.7

Show how this data can be used to determine the order of reaction and the rate equation, and hence propose a two-step mechanism for the reaction, explaining your reasoning.

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[6]

e) When ClO^- is heated, a second reaction may occur at the same time which produces 0.5 moles of oxygen gas for every one mole of ClO^- reacting.

i) At a temperature of 197 °C, and a pressure of 0.500 kPa, 100 cm^3 of a 0.0100 mol dm^{-3} solution of $ClO^-_{(aq)}$ produced 720 cm^3 of $O_{2(g)}$.

Assuming all the ClO^- decomposed by one of the two pathways, how many moles of $ClO_3^-{}_{(aq)}$ are produced?

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[5]

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c) From 10 g of the rock, the compound W obtained was dissolved in water and NaOH carefully added to form a precipitate.

The dry precipitate was obtained and then heated to several hundred degrees for 10 minutes. 0.400 g of precipitate remained.

i) By working out the identity of W, calculate the percentage by mass of the original compound that was compound W, assuming it is made up of one type of positive ion and one type of negative ion.

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[5]

ii) Why was it important that NaOH was not added in excess?

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QUESTION TOTAL: 11 MARKS

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ii) $AgNO_{3(aq)}$ does not form a precipitate with either ClO^- or ClO_3^- ions. Suggest how this fact can allow the moles of Cl^- ions produced to be confirmed experimentally.

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[4]

QUESTION TOTAL: 23 MARKS

21 At a geological dig, a rock was unearthed that contained a mixture of different ionic compounds. Three main compounds were isolated and analytical tests performed on them.

These three compounds – compound A, compound I and compound W – accounted for > 99 % of the mass of the rock.

Compound A was analysed using mass spectrometry and found to contain isotopes of the metal cobalt.

Compound I was dissolved in water, forming a complex, K, of the metal ion in compound I. On addition of ammonia, compound L was formed – a blue precipitate. On addition of further ammonia, a complex M formed.

Compound W was also dissolved in water. On addition of H_2O_2/OH^-, a yellow solution was formed. On addition of $HCl_{(aq)}$ followed by $BaCl_2$, a white precipitate formed.

a) Explain how mass spectrometry would have shown that compound A contained isotopes of cobalt.

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[1]

b) i) By deducing their identities, write an equation for the formation of compound L from complex K.

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[2]

ii) Describe what is observed when M is formed from L, and give the formula for M.

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[2]

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