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Tasmanian Secondary Assessment Board

Tasmanian Certificate of Education

External Assessment

2002

CH856 CHEMISTRY

CRITERIA 2 AND 7

Time: 45 minutes

On the basis of your performance in this examination, the examiners will provide a rating of A, B, C or D on each of the following criteria taken from the syllabus statement:

Criterion 2 Communicate ideas and information using appropriate chemical language and formats when undertaking chemical investigations.

Criterion 7 Demonstrate an understanding of the fundamental principles and theories of electrochemistry.

Questions: 7
Pages: 6

CANDIDATE INSTRUCTIONS

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NOTE: 1 litre (L) = 1000 millilitres (mL) = $1dm^3$ = 1000 cm^3.

Question 1

Ammonia reacts with oxygen under suitable conditions to produce nitrogen and water.

$$4NH_{3(g)} + 3O_{2(g)} \longrightarrow 2N_{2(g)} + 6H_2O_{(g)}$$

(a) What are the changes in the oxidation states of nitrogen, N? (1 mark)

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(b) What substance has been oxidised, and what has it been oxidised to? (1 mark)

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(c) What substance has been reduced, and what has it been reduced to? (1 mark)

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Question 2

The nitrate ion is a strong oxidiser especially in acidic solution.

(a) Write the half equation for acidified nitrate as an oxidiser, if it is converted to the brown gas nitrogen dioxide, NO_2. (1 mark)

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(b) Nitric acid will oxidise copper metal. Write the oxidation half equation for copper and hence the overall equation for the reaction between copper and nitric acid. (2 marks)

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(c) Explain why hydrochloric acid will not oxidise copper. (2 marks)

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(d) Suggest why the compound iron (II) nitrate is not stable. (1 mark)

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Question 3

In order to construct a simple cell, a student placed a strip of copper into a beaker containing a 1.0 mol L^{-1} of copper (II) sulfate solution. The student then placed a carbon rod into a beaker containing a solution which was 1.00 mol L^{-1} with respect to both iron (III) sulfate and iron (II) sulfate. A salt bridge was used to connect the solutions in the two beakers. In the external circuit, a voltmeter and a switch were added.

(a) Write the anode reaction. (1 mark)

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(b) Write the cathode reaction. (1 mark)

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(c) Hence write the overall equation. (1 mark)

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(d) What is a suitable salt for the salt bridge? Give a reason for your choice. (2 marks)

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(e) Draw a labeled diagram of the cell. Include the anode and cathode, and the charge on each. Indicate on the diagram the direction of electron flow in the external circuit, and the direction of ion flow through the salt bridge. (4 marks)

(f) What is the maximum voltage obtainable from this cell? (1 mark)

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For Marker Only

Questions	Marks
1, 2 & 3	/19

Question 4

Write half equations for the reaction at each electrode for the electrolysis of a 1.00 mol L^{-1} sodium iodide solution, (using platinum electrodes). Explain why each occurs. (4 marks)

Anode: .....

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Cathode: .....

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Question 5

A student standardised a solution of potassium permanganate, $KMnO_4$, by titrating it against a weighed amount of sodium oxalate, $Na_2C_2O_4$, in the presence of sulfuric acid. 0.134 g of sodium oxalate (molar mass = 134 g mol^{-1}), needed 21.5 mL of the potassium permanganate solution to reach the end point of the titration. The oxalate ion is oxidised to CO_2 gas.

(a) Explain how the end point of this titration is determined. (2 marks)

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(b) Write the half equations for oxidation and reduction and hence the overall equation for the titration. (2 marks)

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(c) Calculate the concentration of the potassium permanganate solution. (3 marks)

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Question 6

Explain how you would use electrolysis to coat an object such as a key with nickel in a school laboratory. Include a diagram of the apparatus, showing the chemicals used, the electrodes, the electron flow, and the relevant electrode equation. (4 marks)

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Question 7

(a) Explain why iron poles rust readily on the seashore yet iron canons recovered from shipwrecks in the deep ocean remain relatively uncorroded, even after 50 years. (3 marks)

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(b) Copper statues in parks are often bolted onto steel frames. These frames become badly corroded, although the copper statues do not. Explain with the aid of relevant equations why the steel corrodes and the copper does not. (3 marks)

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For Marker Only

Questions	Marks
4, 5, 6 & 7	/21

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Tasmanian Secondary Assessment Board

Tasmanian Certificate of Education

External Assessment

2002

CH856 CHEMISTRY

CRITERIA 2 AND 8

Time: 45 minutes

On the basis of your performance in this examination, the examiners will provide a rating of A, B, C or D on each of the following criteria taken from the syllabus statement:

Criterion 2 Communicate ideas and information using appropriate chemical language and formats when undertaking chemical investigations.

Criterion 8 Demonstrate an understanding of the principles and theories of thermochemistry, rate of reaction and equilibrium.

Questions: 8
Pages: 7

CANDIDATE INSTRUCTIONS

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NOTE: 1 litre (L) = 1000 millilitres (mL) = $1dm^3$ = 1000 cm^3.

Question 8

The combustion of petrol and the breakdown of carbohydrates in our bodies are both exothermic reactions.

(a) What is an exothermic reaction? (1 mark)

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(b) Explain in terms of breaking and forming bonds why the reactions are exothermic. (2 marks)

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Question 9

The reaction occurring during neutralisation in aqueous solution may be represented by the ionic equation:

$$H^+_{(aq)} + OH^-_{(aq} \longrightarrow H_2O_{(l)} \quad \Delta H = -56.6 \text{ kJ mol}^{-1}.$$

(a) When 1.00 mol of sulfuric acid was neutralised in aqueous solution by sodium hydroxide, 113 kJ of energy was released. Compare the amount of energy evolved with the ΔH value for the neutralisation equation above and explain the difference. (2 marks)

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(b) When 1.00 mol of an organic acid was neutralised in aqueous solution by sodium hydroxide, only 42 kJ of energy was released. Compare the amount of energy evolved with the ΔH value for the neutralisation equation above and explain the difference. (2 marks)

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Question 10

Given the following bond dissociation energies in kJ mol^{-1}:

H–H = 436 F–F = 156 H–F = 567

(a) Determine ΔH for the synthesis of hydrogen fluoride from hydrogen and fluorine. (3 marks)

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(b) Determine the energy released when 10.0 g of hydrogen fluoride is formed. (1 mark)

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Question 11

The combustion of petrol is an exothermic reaction.

(a) Why does this reaction not occur spontaneously at room temperature, but requires a match to start it? (2 marks)

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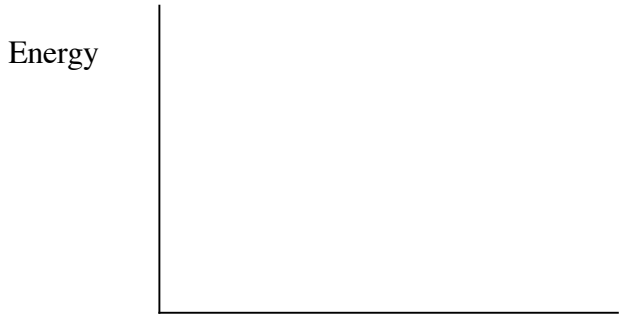
(b) Sketch and label a graph to indicate the energy profile of this reaction. (2 marks)



(c) What feature would be different on a graph of a reaction that was spontaneous at room temperature? Give a reason. (2 marks)

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Question 12

The ionisation constant for water, K_w, is 1.0×10^{-14} at 25°C and about 5×10^{-13} at 90°C.

Write the equilibrium reaction for the ionisation of water and explain how the electrical conductivity of water would change as it is heated. (3 marks)

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For Marker Only

Questions	Marks
8, 9, 10, 11 & 12	/20

Question 13

Consider the equilibrium system in aqueous solution:

$$Cr_2O_7^{2-}{}_{(aq)} + 3H_2O_{(l)} \rightleftharpoons 2CrO_4^{2-}{}_{(aq)} + 2H_3O^+{}_{(aq)}$$

(a) Write an expression for the equilibrium constant. (1 mark)

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(b) Dichromate ions, $Cr_2O_7^{2-}$ are orange and chromate ions, CrO_4^{2-} are yellow. Indicate (with reasons) what the likely colour change would be if an alkaline solution is added to the equilibrium mixture. (3 marks)

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Question 14

Methanol can produce ethene and water using a suitable catalyst at a slightly raised temperature according to the following equation:

$$2CH_3OH_{(g)} \rightleftharpoons C_2H_{4(g)} + 2H_2O_{(g)} + \text{energy}$$

(a) What effect does the catalyst have on the equilibrium? (2 marks)

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(b) Would increasing the pressure by decreasing the volume of the system alter the **position** of the equilibrium? Explain. (2 marks)

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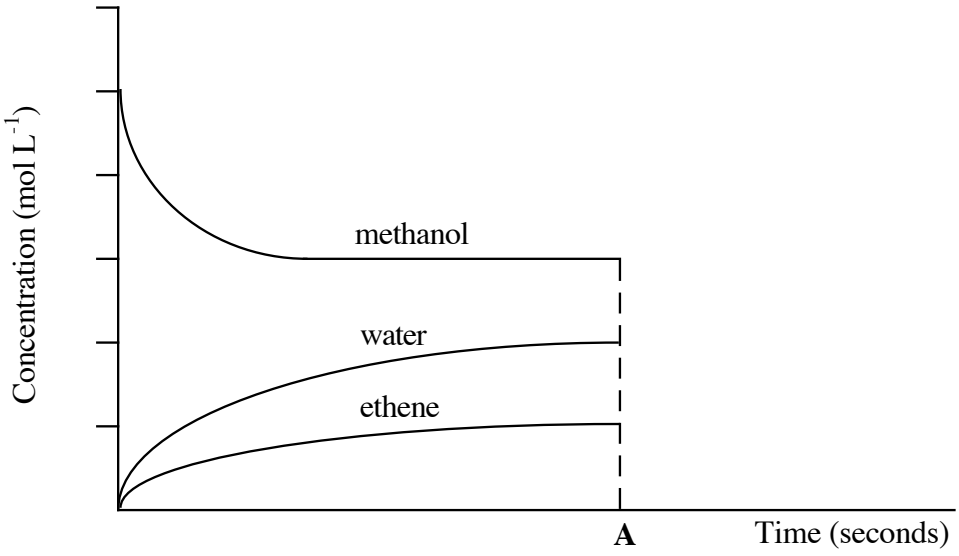
(c) A concentration-time graph for this reaction was determined and is shown below.



At point **A** more methanol is added, indicate on the graph the likely changes to the concentration of each gas until the new equilibrium position is established. (3 marks)

Question 15

The rate at which a chemical reaction proceeds depends on the conditions under which the reaction takes place. Give the major reasons for the change in rate of each of the following reactions.

(a) A wad of steel "wool", glowing in air, bursts into flames when plunged into a jar of oxygen. (2 marks)

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(b) Iron filings react slowly with a cold solution of 2.00 mol L^{-1} hydrochloric acid but reacts rapidly with the same acid when heated. (3 marks)

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(c) Hydrogen peroxide, H_2O_2, decomposes (to water and oxygen) rapidly when a very small quantity of manganese dioxide is added. (2 marks)

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(d) Kindling wood burns much faster than large logs. (2 marks)

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For Marker Only

Questions	Marks
13, 14 & 15	/20

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Tasmanian Secondary Assessment Board

Tasmanian Certificate of Education

External Assessment

2002

CH856 CHEMISTRY

CRITERIA 2 AND 9

Time: 45 minutes

On the basis of your performance in this examination, the examiners will provide a rating of A, B, C or D on each of the following criteria taken from the syllabus statement:

Criterion 2 Communicate ideas and information using appropriate chemical language and formats when undertaking chemical investigations.

Criterion 9 Demonstrate an understanding of properties and reactions of inorganic and organic matter.

Questions: 5
Pages: 6

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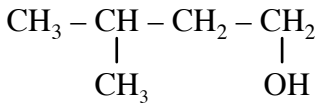
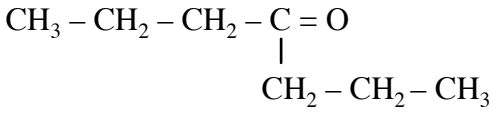
Question 16

Give the systematic names of the following compounds: (2 marks)

Compounds	Names
	
	

Question 17

An organic compound has the following properties: it reacts with sodium metal, it has a neutral pH, and on analysis was found to contain 1 carbon atom per molecule.

(a) What functional group is present? (1 mark)

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(b) (i) What is the structural formula of this compound? (1 mark)

(ii) What is the name of this compound? (1 mark)

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(c) (i) Write the equation for the reaction of ethanol with sodium, showing structural formulae for the organic compounds. (2 marks)

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(ii) Name the salt formed. (1 mark)

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Question 18

(a) Two compounds A and B have the molecular formulae, C_3H_8O and C_3H_6O respectively. They can both be oxidised to a compound with the molecular formula $C_3H_6O_2$. Write their structural formulae, and identify the functional group present in each in the spaces indicated below. (4 marks)

Compound A (molecular formula C_3H_8O)

Structural formula	Functional group

Compound B (molecular formula C_3H_6O)

Structural formula	Functional group

(b) Write a fully balanced equation for the oxidation of compound B with acidified potassium dichromate, $K_2Cr_2O_7$. Name the organic product. (3 marks)

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(c) (i) Give the structural formulae and names for two isomers of C_4H_8O which contain different functional groups. (3 marks)

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(ii) How could the two isomers in (c)(i) be distinguished? Explain. (2 marks)

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For Marker Only

Questions	Marks
16, 17 & 18	/20

Question 19

Chlorine, element 17 and astatine element 85 are halogens

(a) What is the electronic configuration of the chlorine atom? (1 mark)

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(b) Explain with the aid of an electron dot diagram why chlorine forms diatomic molecules. (2 marks)

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(c) Explain why chlorine forms a Cl^- ion. (1 mark)

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(d) Compare how easily chlorine and astatine form ions. Explain the difference. (2 marks)

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(e) Predict the following properties for astatine: (4 marks)

(i) the expected physical state at 25°C and 101.3 kPa.	
(ii) the expected acid-base character of hydrogen astatide.	
(iii) the expected acid-base character of astatine oxide.	
(iv) the expected formula of calcium astatide	

(f) Write and balance the expected equation for the reaction between astatine and rubidium (element 37). (2 marks)

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Question 20

(a) Use the Kinetic Molecular Theory of Gases to explain the following observations:

(i) The air pressure in car tyres increases during a long drive. (2 marks)

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(ii) On a warm day the lid is removed from a petrol can, which contains a small amount of petrol. The lid is replaced two hours later. Overnight the temperature drops to 5°C. Next morning the can is badly dented.

(3 marks)

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(b) Suggest why the General Gas equation cannot be used for the gas carbon dioxide at temperatures less than -20°C. (1 mark)

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(c) Explain why carbon dioxide is not a suitable gas for a weather balloon. (2 marks)

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For Marker Only

Questions	Marks
19 & 20	/20

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2002

CH856 CHEMISTRY

CRITERIA 2 AND 10

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Criterion 2 Communicate ideas and information using appropriate chemical language and formats when undertaking chemical investigations.

Criterion 10 Apply logical processes to solve quantitative chemical problems.

Questions: 7
Pages: 7

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Question 21

The environmentally favoured pesticide, malathion, has the molecular formula $C_{12}H_{23}PS_2O_3$.

(a) Calculate its molecular mass. (1 mark)

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(b) What is the percentage by mass of phosphorous in malathion? (1 mark)

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Question 22

(a) An oxide of chlorine contains 18.4 % of oxygen. Calculate the empirical formula of the oxide. (3 marks)

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(b) Sodium carbonate has several different hydrated forms, which can be represented by the formula $Na_2CO_3.xH_2O$. If the relative formula mass of one of the forms is 232, calculate the formula of the hydrate. (ie. determine the value of x) (3 marks)

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Question 23

An aerosol can of fly spray has a volume of 150mL. The contents of the can exert a pressure of 9.0×10^5 Pa at 27°C.

(a) How many particles are present in the can of fly spray? (4 marks)

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(b) If the contents of the can are transferred to a 200mL container, what will be the temperature in °C, if the pressure drops to 6.00×10^5 Pa? (3 marks)

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Question 24

A "volcano" simulation involved the decomposition of ammonium dichromate, $(NH_4)_2Cr_2O_7$, to produce chromium (III) oxide, water vapour, and nitrogen.

(a) Write a balanced equation to represent this decomposition. (1 mark)

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(b) Calculate the mass of water produced if 52.4 g of ammonium dichromate is decomposed. (3 marks)

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For Marker Only

Questions	Marks
21, 22, 23 & 24	/19

Question 25

The following three hydrochloric acid solutions were mixed together:

10.0 mL of 0.500 mol L^{-1}
140.0 mL of 0.250 mol L^{-1}
100.0 mL of 0.100 mol L^{-1}

(a) What is the concentration of the resulting solution? (3 marks)

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(b) What is the pH of the resulting solution? (1 mark)

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(c) 28.6 ml of a 0.200 mol L^{-1} hydrochloric acid solution is required for neutralisation in a titration with 25.0 mL of an ammonia solution. What is the concentration of the ammonia solution? (4 marks)

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Question 26

It is found experimentally, that the complete combustion of 2.00 g of gaseous ethanol, CH_3CH_2OH, produces 63.0 kJ of heat.

(a) Calculate ΔH for this reaction

$$CH_3CH_2OH_{(g)} + 3O_{2(g)} \longrightarrow 2CO_{2(g)} + 3H_2O_{(g)}.$$

(3 marks)

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(b) The heat of vaporisation of water is 44 kJ mol^{-1}, hence calculate the heat of reaction for

$$CH_3CH_2OH_{(g)} + 3O_{2(g)} \longrightarrow 2CO_{2(g)} + 3H_2O_{(l)}.$$

(3 marks)

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Question 27

A current of 1.20 A is passed through 100 mL of a solution of 0.500 mol L^{-1} zinc sulfate, $ZnSO_{4(aq)}$, for exactly 5 minutes.

(a) What mass of zinc would be deposited on the cathode? (4 marks)

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(b) What is the concentration of the remaining zinc ions? (3 marks)

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For Marker Only

Questions	Marks
25, 26 & 27	/21