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Tasmanian Certificate of Education

CHEMISTRY

Senior Secondary 5C

Subject Code: CHM5C

External Assessment

2004

Part 1

Time: 36 minutes

On the basis of your performance in this examination, the examiners will provide a result on the following criterion taken from the syllabus statement:

Criterion 4 Develop and evaluate experiments.

Pages: 7
Questions: 3

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CANDIDATE INSTRUCTIONS

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For Marker Use Only

Question 1

A sodium hydroxide solution was standardized against a 0.0100 mole L^{-1} solution of hydrochloric acid. It was then available for use in another titration.

(a) Explain why it is necessary to standardize sodium hydroxide prior to use. (2 marks)

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(b) An acid-base titration experiment can be used to determine the molar mass of a solid, soluble organic acid. Briefly outline the steps that you would follow. (5 marks)

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(c) Outline the calculations necessary to obtain the molar mass of the acid, given that the acid is monoprotic. (4 marks)

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For Marker Use Only

Question 2

A year 12 class was trying to identify two unknown metal samples. All of the class observed that neither of the metals reacted with water.

(a) Sanjay added some 1.00 mole L^{-1} hydrochloric acid to the metal labeled A and observed that a colourless gas was produced and the metal disappeared forming a solution. He identified the gas as hydrogen.

(i) Using the standard reduction potentials on the Information Sheet, list the metals that A could be. (1 mark)

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(ii) Explain why lead should not be included. (1 mark)

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(b) His partner, Daniel, noticed that the reaction was vigorous and that the solution formed was colourless.

(i) Explain why tin could be eliminated from the possibilities. (1 mark)

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(ii) Explain why iron and chromium could be eliminated from the possibilities. (1 mark)

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(iii) Samantha and her partner used more specific oxidation-reduction experiments to specifically identify metal A. Outline what these experiments could have been. Include the chemicals they would need and explain how they would know what metal A was. (5 marks)

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For Marker Use Only

Question 3

The heat of combustion of candle wax is to be determined.

(a) Draw and label a diagram of the necessary equipment set up for the experiment. (3 marks)

(b) What is the scientific principle that the experiment is based on? (1 mark)

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(c) List the measurements you need to take. (4 marks)

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Question 3 continues opposite.

Question 3 (continued)

For Marker Use Only

(d) Comment on some of the sources of error present in this experiment and explain how you could have tried to eliminate them. (2 marks)

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TASMANIAN QUALIFICATIONS AUTHORITY

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Tasmanian Certificate of Education

CHEMISTRY

Senior Secondary 5C

Subject Code: CHM5C

External Assessment

2004

Part 2

Time: 36 minutes

On the basis of your performance in this examination, the examiners will provide a result on the following criterion taken from the syllabus statement:

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

Pages: 11
Questions: 5

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For Marker Use Only

Question 4

(a) What is the oxidation state of nitrogen in:

(i) ammonium chloride, NH_4Cl? (1 mark)

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(ii) sodium nitrite, $NaNO_2$? (1 mark)

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(b) The nitrite ion can be oxidized to nitrate ion under suitable conditions. Write a half equation for the oxidation. (1 mark)

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For Marker Use Only

Question 5

(a) Bromine, $Br_{2(\ell)}$, is added to a fresh 1 mole L^{-1} solution of tin (II) nitrate, $SnSO_{4(aq)}$.

Write half equations and a balanced overall equation for the chemical changes expected. (3 marks)

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(b) Would you expect any reaction between bromine and iron (III) chloride? Give reasons. (2 marks)

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(c) If iron metal was added to bromine what would be the expected reaction(s)? (3 marks)

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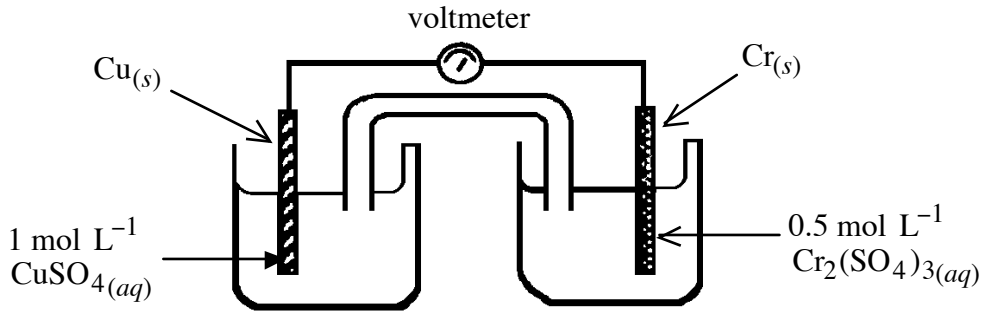
For Marker Use Only

Question 6

An electrochemical cell is assembled as shown in the diagram below.



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

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

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(c) Write the overall cell reaction. (1 mark)

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(d) What voltage would be obtained under standard conditions? (1 mark)

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(e) Describe the movement of ions as the cell operates and explain why they move. (3 marks)

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Question 6 continues opposite.

Question 6 (continued)

For Marker Use Only

(f) Suggest a suitable substance for the salt bridge. Indicate why you chose this substance. (1 mark)

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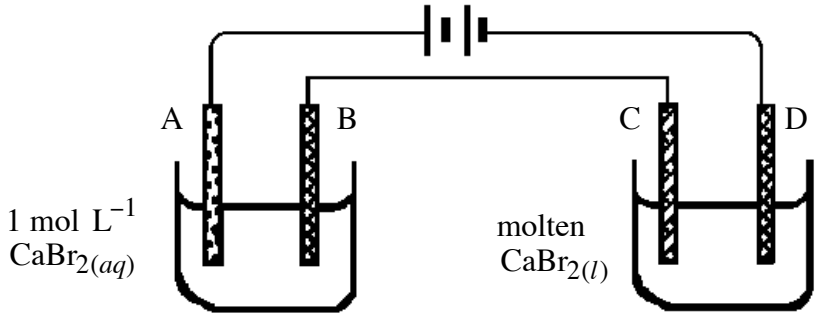
For Marker Use Only

Question 7

The diagram below shows two electrolytic cells connected in series. All of the electrodes A, B, C and D are inert.



(a) Identify the two anodes. (1 mark)

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(b) Write an equation for the expected reaction at electrode A. Explain why this reaction is expected. (2 marks)

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(c) Write an equation for the expected reaction at electrode B. Explain why this reaction is expected. (2 marks)

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(d) Write an equation for the expected reaction at electrode C. (1 mark)

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(e) Write an equation for the expected reaction at electrode D. (1 mark)

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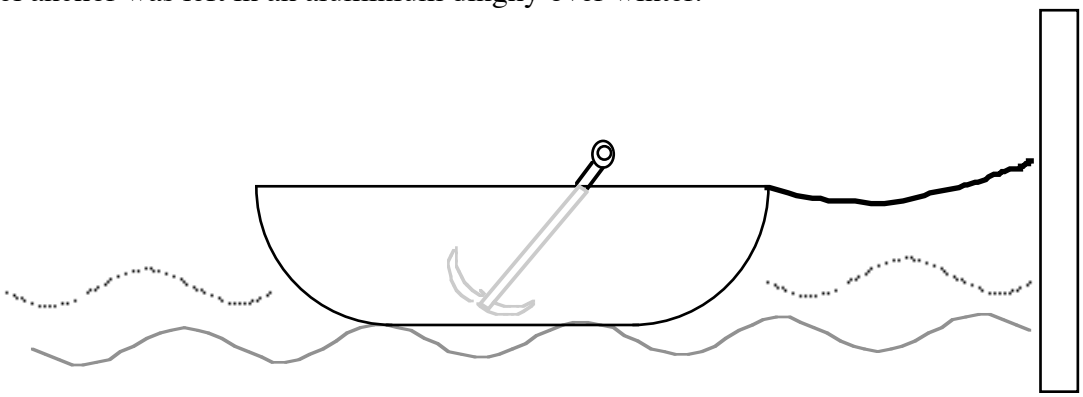
For Marker Use Only

Question 8

A steel anchor was left in an aluminium dinghy over winter.



(a) Explain why the aluminium underneath the anchor corroded. Include appropriate equations. (3 marks)

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(b) How could the anchor have been stored in the boat without it causing corrosion? (1 mark)

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Tasmanian Certificate of Education

CHEMISTRY

Senior Secondary 5C

Subject Code: CHM5C

External Assessment

2004

Part 3

Time: 36 minutes

On the basis of your performance in this examination, the examiners will provide a result on the following criterion taken from the syllabus statement:

Criterion 8 Demonstrate knowledge and understanding of the principles and theories of thermochemistry, kinetics and equilibrium.

Pages: 11
Questions: 6

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CANDIDATE INSTRUCTIONS

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For Marker Use Only

Question 9

(a) Write a balanced thermochemical equation to illustrate the combustion reaction of one mole of methane producing carbon dioxide gas and water vapour and releasing 802 kJ of heat. (1 mark)

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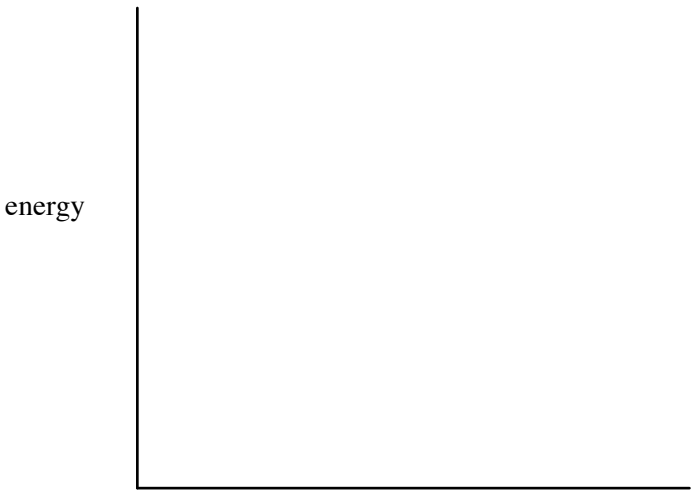
(b) Draw and label the energy diagram for this reaction, taking into account that a methane and oxygen mixture is stable at room temperature but reacts vigorously when a burning match is introduced. (2 marks)



(c) Explain the shape of the diagram. (2 marks)

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Question 10

Consider the following information:

$H_{2(g)} + I_{2(s)} \rightarrow 2HI_{(g)}$ $\Delta H = 52.5$ kJ at 25°C.

$H_{2(g)} + I_{2(g)} \rightarrow 2HI_{(g)}$ $\Delta H = -10.9$ kJ at 375°C.

Give one reason for the change in sign of ΔH between 25°C and 375°C. (2 marks)

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For Marker Use Only

Question 11

Consider the following gaseous reaction:

$$CH_{4(g)} + 2Cl_{2(g)} \rightarrow CH_2Cl_{2(g)} + 2HCl_{(g)}$$

(a) If the rate of appearance of hydrogen chloride, $HCl_{(g)}$ is 0.100 mol L^{-1} S^{-1} what is the rate of disappearance of methane $CH_{4(g)}$? (1 mark)

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(b) Use the following bond energies to predict the heat of reaction in kJ mol^{-1} for the reaction, and clearly indicate whether the reaction is endothermic or exothermic.

Bond energies (kJ mol^{-1}) for gases:

C-H = 414, H-Cl = 431, C-Cl = 327, Cl-Cl = 243 (3 marks)

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For Marker Use Only

Question 12

Lead (II) nitrate, $Pb(NO_3)_2$ and potassium iodide, KI, will react to form a yellow precipitate of lead (II) iodide, PbI_2.

In one experiment some solid lead (II) nitrate is placed in a test tube and solid potassium iodide is carefully added. After several minutes a yellow line appeared at the junction of the two solids.

In another test tube solutions of lead (II) nitrate and potassium iodide were added. The reaction forming a thick yellow precipitate appeared instantaneous.

Explain why the rates of the two reactions were so different. (3 marks)

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For Marker Use Only

Question 13

Two identical flasks, A and B, containing 10.0 g of powdered calcium carbonate, $CaCO_3$, were set up. A was placed on the bench and kept at room temperature, while B was placed in a bucket of iced water. 100 mL of 2.00 mol L^{-1} hydrochloric acid, HCl, was poured into both. (The acid for B had been in iced water for 10 minutes to ensure that it was the same temperature as the flask B.).

(a) Explain why the rate of the reaction in B is less than in A. (3 marks)

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(b) Give one way other than by decreasing the temperature that the reaction rate in A could be slowed. Explain why the change suggested would slow the rate. (2 marks)

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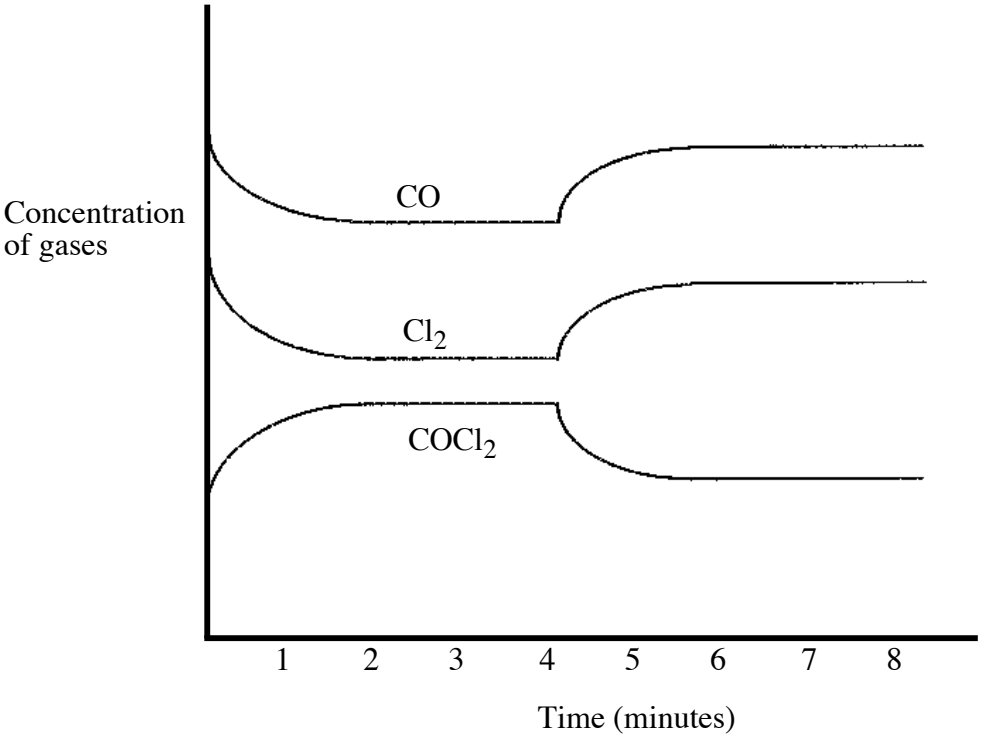
For Marker Use Only

Question 14

Phosgene is prepared according to the following reversible reaction:

$$CO_{(g)} + Cl_{2(g)} \rightleftharpoons COCl_{2(g)}$$

A mixture containing these three gases is introduced into a closed system in the presence of a catalyst. The following graph shows how the concentration of each of these gases varies with time.



(a) Describe the system three minutes after mixing and comment on the rates of reactions occurring in the system. (2 marks)

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(b) Write an expression for the equilibrium constant of this reaction. (1 mark)

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Question 14 continues opposite.

Question 14 (continued)

For Marker Use Only

(c) Four minutes after mixing, the temperature of the system is increased to a higher constant value. From the system's response shown on the graph above, deduce whether the reaction is endothermic or exothermic. Explain. (3 marks)

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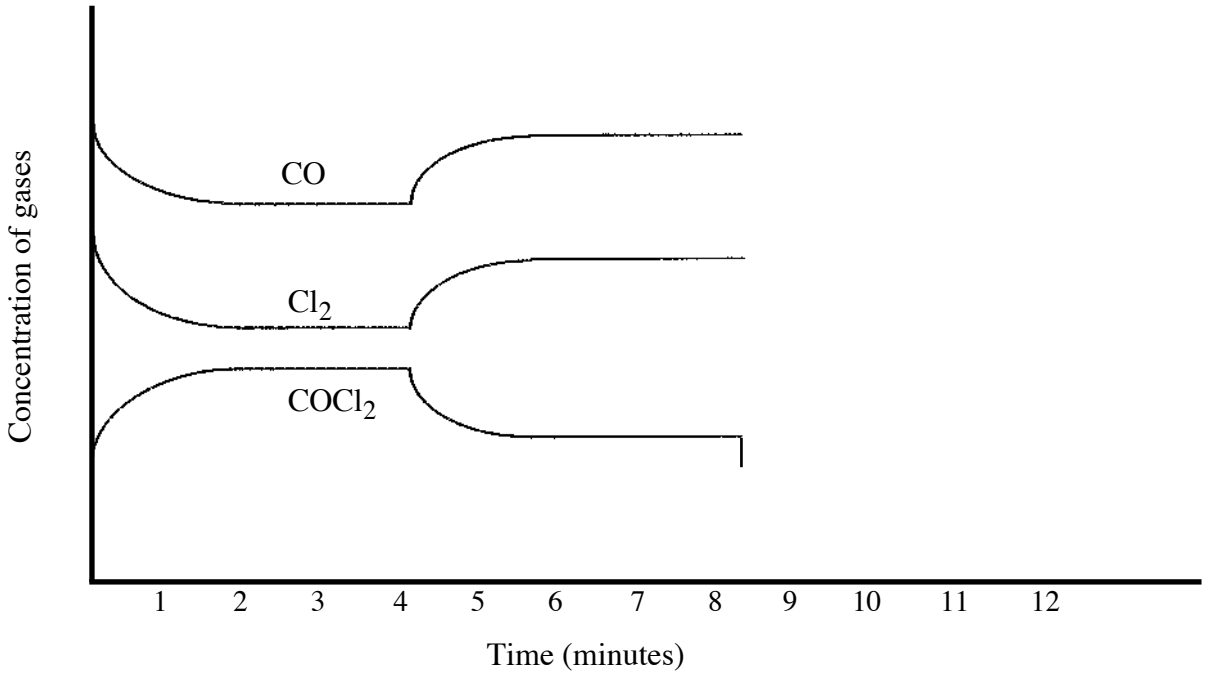
(d) At 8 minutes some $COCl_{2(g)}$ is removed. Show on the graph below how the concentrations of all the species would change over the next 4 minutes. (3 marks)



(e) What effect does the presence of a catalyst have on the system? Explain. (2 marks)

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Tasmanian Certificate of Education

CHEMISTRY

Senior Secondary 5C

Subject Code: CHM5C

External Assessment

2004

Part 4

Time: 36 minutes

On the basis of your performance in this examination, the examiners will provide a result on the following criterion taken from the syllabus statement:

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

Pages: 11
Questions: 7

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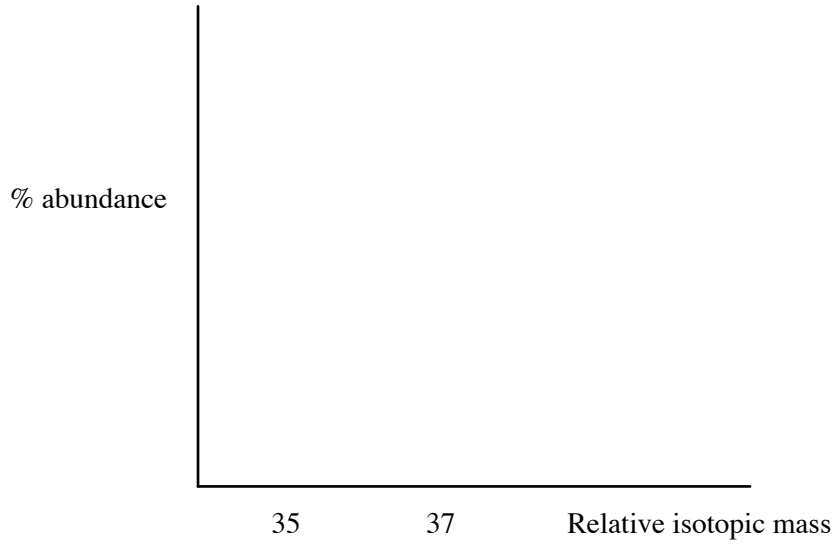
For Marker Use Only

Question 15

Chlorine consists of two isotopes, chlorine-35 and chlorine-37. The relative percentages are:

chlorine-35	75.8%,	$A_r = 34.969$
chlorine-37	24.2%	$A_r = 36.966$

(a) Sketch the mass spectrum of Chlorine. (2 marks)



(b) Calculate the average relative atomic mass of chlorine. (2 marks)

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For Marker Use Only

Question 16

Consider the oxides Na_2O and SO_2.

Explain the acid/base nature of these oxides, including relevant equations. (4 marks)

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For Marker Use Only

Question 17

Four unknown elements, A, B, C and D have the properties described below.

Element	First ionisation energy (relative)	Number of valence electrons
A	Medium	4
B	Low	1
C	High	7
D	High	6

Identify the element that best fits the description given. Include reasons. (4 marks)

(a) The element most likely to be a metal.

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(b) The element most likely to form ions with a –1 oxidation number.

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(c) The element whose atoms could bond by single covalent bonds to form diatomic molecules.

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(d) The element forming a covalent network structure.

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For Marker Use Only

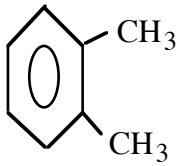
Question 18

Give the type of compound and IUPAC names for the following compounds:

(a) $CH_3CH_2COOCH_3$. (1 mark)

Type of compound: .....

Name: .....

(b) 

(1 mark)

Type of compound: .....

Name: .....

Question 19

For Marker Use Only

Ethane, C_2H_6, ethene, C_2H_4, and benzene, C_6H_6, all react with chlorine, Cl_2 under different conditions.

(a) Write equations (showing structural formulae) for these reactions and indicate the type of reaction. (6 marks)

ethane:

Type of reaction: .....

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ethene:

Type of reaction: .....

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benzene:

Type of reaction: .....

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(b) Rank the three in order of speed of reaction. (1 mark)

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Question 20

For Marker Use Only

(a) Alcohols react with sodium metal. Write the equation showing the reaction of sodium with methyl propan-1-ol, $CH_3CH(CH_3)CH_2OH$. (1 mark)

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(b) Methyl propan-1-ol can be oxidised. The product depends on the oxidising agent. Name the two organic compounds that methyl propan-1-ol can be oxidised to. (1 mark)

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(c) Why is it not possible to oxidise methyl propan-2-ol? (1 mark)

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(d) Methyl propan-1-ol will react with methanoic acid, HCOOH, in the presence of hydrogen ions. Give the name and structural formula of the organic product. (1 mark)

Name: .....

Structural formule:

(e) Write an equation for the incomplete combustion of methylpropane, molecular formula C_4H_{10}. (1 mark)

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For Marker Use Only

Question 21

But-1-ene is a relatively reactive hydrocarbon. Complete the following relating to but-1-ene and its reactions. (4 marks)

Reaction with but-1-ene	Product structural formulae	Name of type of product
hydrogen		
ammonia gas, NH_3	Or	
itself under certain conditions		

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Tasmanian Certificate of Education

CHEMISTRY

Senior Secondary 5C

Subject Code: CHM5C

External Assessment

2004

Part 5

Time: 36 minutes

On the basis of your performance in this examination, the examiners will provide a result on the following criterion taken from the syllabus statement:

Criterion 10 Apply logical processes to solve quantitative chemical problems.

Pages: 11
Questions: 7

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For Marker Use Only

Question 22

A climber in Nepal was sitting inside his tent waiting for a blizzard to end. The temperature was –15°C and air pressure 42.0 kPa. If he breathed in 6.00 L of air, what volume would this occupy at standard laboratory conditions (S.L.C.)? (3 marks)

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Question 23

The characteristic odour of pineapple is largely due to an organic compound containing the elements carbon, hydrogen and oxygen. A 3.433 g sample of this compound was analysed and found to contain 2.130 g of carbon and 0.3575 g of hydrogen.

(a) Determine the empirical formula of the compound. (4 marks)

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(b) The molar mass was determined to be 116 g mol^{-1}. What is the molecular formula of the compound? (1 mark)

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For Marker Use Only

Question 24

The solubility of sodium hydroxide at 25°C is 109g per 100 mL of solution. What is the maximum pH obtainable from a sodium hydroxide solution at 25°C? (4 marks)

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Question 25

An electrolytic cell is used to reduce indium, In, from a molten salt. A current of 1.55 A was used for 95.0 minutes and produced 3.50 g of indium metal.

Using this information and the known molar mass of indium, determine its oxidation state in the molten salt. (4 marks)

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For Marker Use Only

Question 26

Silicon carbide, SiC, commonly known as carborundum is the very hard, black substance used on many abrasive papers. It can be made by heating a mixture of quartz, SiO_2 and carbon, C, to a high temperature.

$$SiO_{2(s)} + 2C_{(s)} \rightarrow SiC_{(s)} + CO_{2(g)}$$

(a) What is the maximum amount of carborundum that can be produced when 1.00 kg of solid SiO_2 reacts with 1.00 kg of solid carbon? (4 marks)

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(b) What mass of the excess reagent would be left over in the above reaction? (2 marks)

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For Marker Use Only

Question 27

The reaction of carbon and oxygen to form carbon monoxide is difficult to control, but the following two reactions are readily controlled.

$C_{(graphite)} + O_{2(g)} \rightarrow CO_{2(g)}$ $\quad \Delta H = -395$ kJ

$CO_{(g)} + \frac{1}{2}O_{2(g)} \rightarrow CO_{2(g)}$ $\quad \Delta H = -284$ kJ

Use these reactions to calculate ΔH for the reaction:

$C_{(graphite)} + \frac{1}{2}O_{2(g)} \rightarrow CO_{(g)}$ (3 marks)

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For Marker Use Only

Question 28

Jillian, a chemistry student was investigating the concentration of sulfuric acid, H_2SO_4, in the electrolyte of various car batteries. To do this she pipetted out 20.00 mL of the electrolyte from one of the cells and diluted it to 250mL in a volumetric flask.

She placed the diluted acid in a burette and titrated it with 20.00 mL samples of 0.290 mol L^{-1} sodium hydroxide solution. On average she used 17.35 mL of the diluted solution for the end point.

(a) Write an equation between the sulfuric acid and the sodium hydroxide. (1 mark)

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(b) Calculate the concentration of the sulfuric acid in the diluted solution. (3 marks)

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(c) Hence calculate the concentration of the sulfuric acid in the car battery electrolyte. (1 mark)

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