TASMANIAN QUALIFICATIONS AUTHORITY

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Tasmanian Certificate of Education

CHEMISTRY

Senior Secondary 5C

Subject Code: CHM5C

External Assessment

2005

Part 1

Time: approximately 45 minutes

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

Criterion 4 Develop and evaluate experiments.

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

Criterion	Mark
7	/32
4	/8

Pages: 11
Questions: 7

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CANDIDATE INSTRUCTIONS

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The last question in each part is used in the assessment of Criterion 4.

For Marker Use Only

Question 1

This question assesses Criterion 7.

(a) What is the oxidation state of sulfur in: (1 mark)

(i) $SO_4^{2-}(aq)$ .....

(ii) $SO_3^{2-}(aq)$ .....

(b) Would the sulphur in $SO_4^{2-}(aq)$ have to be oxidised or reduced to produce $SO_3^{2-}(aq)$? Explain. (2 marks)

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Question 2

This question assesses Criterion 7.

Iodine $\left(I_{2(s)}\right)$ makes brown stains on plastic surfaces it comes into contact with. To remove these stains the iodine needs to be reacted to become $I^-(aq)$ ions. One aqueous ion that is able to do this is thiosulfate $\left(S_2O_3^{2-}(aq)\right)$ which when reacted produces $S_4O_6^{2-}(aq)$.

(a) Write the half and net equations for this reaction; label the oxidation and reduction components. (3 marks)

Oxidation: .....

Reduction: .....

Net: .....

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(b) The addition of lead (II) nitrate $\left(Pb(NO_3)_{2(aq)}\right)$ to a solution containing $I^-(aq)$ ions such as the one in (a) produces a bright yellow precipitate $PbI_{2(s)}$. Is this a redox reaction? Explain. (2 marks)

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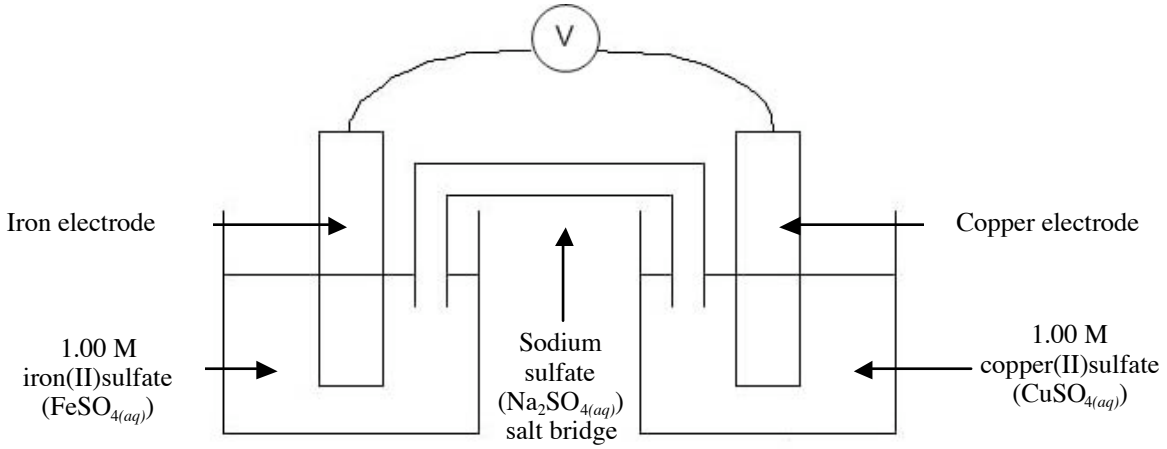
For Marker Use Only

Question 3

This question assesses Criterion 7.

An electrochemical cell is constructed with half cells made up of an iron electrode in a 1.00 M iron(II)sulfate solution and a copper electrode in a 1.00 M copper(II)sulfate solution with a sodium sulfate salt bridge.



(a) Identify the anode and cathode. (1 mark)

Anode: .....

Cathode: .....

(b) What is the overall equation for the cell reaction? (2 marks)

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(c) Which electrode do the electrons flow towards? (1 mark)

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(d) Aqueous copper(II)sulfate has a distinctive blue colour during this reaction. Would you expect this colour to become more or less intense? Explain. (2 marks)

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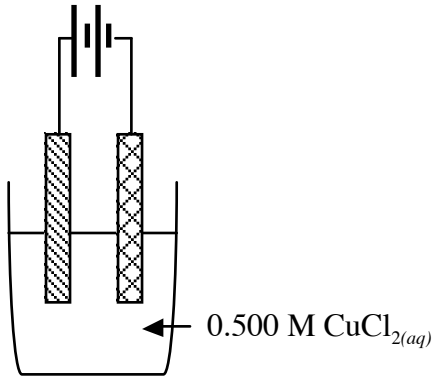
For Marker Use Only

Question 4

This question assesses Criterion 7.

The diagram below shows an electrolysis cell in which the electrolyte consists of a dilute copper(II)chloride solution. Both electrodes are platinum (Pt).



(a) Using the electrochemical series, predict what half reactions would occur at the anode and cathode. (2 marks)

Anode: .....

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Cathode: .....

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(b) After some time a gas starts to be produced at the cathode. What is the most likely half reaction occurring to produce this gas? Explain. (2 marks)

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(c) It is suspected that the $CuCl_{2(aq)}$ solution has been contaminated with aqueous sodium chloride $NaCl_{(aq)}$. Explain any differences, if any, that contamination would make to your answers in (a) and (b) of this question. (2 marks)

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For Marker Use Only

Question 5

This question assesses Criterion 7.

A sample of an unknown salt, of either silver or chromium, is given to you as a chemist. Electrolysis of a molten sample of this salt for 1.50 hours with a 10.0 amp current deposits 9.71 grams of a metal on the cathode. Demonstrate with the Faraday Law which metal it must be. (6 marks)

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Question 6

For Marker Use Only

This question assesses Criterion 7.

Many older-style houses have painted iron-work on their front verandas is exposed to the weather.

(a) Using half equations and a diagram, explain what would happen if the iron-work had not been painted. (4 marks)

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(b) What does the paint prevent from happening? (1 mark)

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(c) Give one other practical alternative to painting the ironwork? (1 mark)

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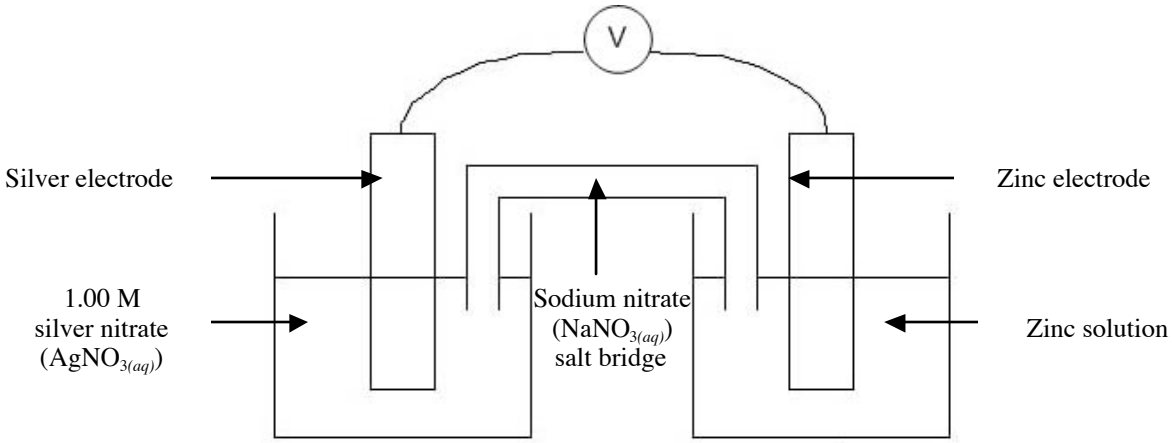
For Marker Use Only

Question 7

This question assesses ***Criterion 4.***

Three cells were set up using different zinc solutions each cell was set up as follows:



The results collected were:

Cell number	1	2	3
Zinc solution	$Zn(NO_3)_{2(aq)}$	$ZnSO_{4(aq)}$	$ZnCl_{2(aq)}$
Concentration of $AgNO_{3(aq)}$	1.00 M	1.00 M	1.00 M
Concentration of zinc solution	1.00 M	1.00 M	1.00 M
Potential difference (across cell)	1.40 V	1.41 V	1.39 V

(a) Explain why the potential difference was so similar for each cell. (2 marks)

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(b) Why is the salt bridge necessary? (1 mark)

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Question 7 continues over the page.

Question 7 (continued)

For Marker Use Only

(c) What would you expect to happen to the potential of cell number 1 if the zinc were replaced with a hydrogen electrode, and the zinc nitrate solutions were replaced with hydrochloric acid solutions $\left(HCl_{(aq)}\right)$? Explain. (2 marks)

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(d) If in cell 1 of the original experiment, by mistake, you placed the silver electrode in the zinc nitrate solution and the zinc electrode in the silver nitrate solution:

(i) How would this affect the results? Explain. (2 marks)

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(ii) What other observations could you make to confirm that you had made this mistake? (1 mark)

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CHEMISTRY

Senior Secondary 5C

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External Assessment

2005

Part 2

Time: approximately 45 minutes

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

Criterion 4 Develop and evaluate experiments.

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

Criterion	Mark
8	/32
4	/8

Pages: 11
Questions: 8

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For Marker Use Only

Question 8

This question assesses Criterion 8.

Heat energy needs to be continually applied for water to boil. At constant pressure, the temperature of boiling water remains constant. Explain why. (1 mark)

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Question 9

This question assesses Criterion 8.

Sodium thiosulfate dissolves readily in water. When sodium thiosulfate is dissolved in water, the temperature drops.

(a) What type of thermochemical reaction is this? (1 mark)

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(b) Explain in terms of bond breaking and bond formation why the temperature drops when sodium thiosulfate is dissolved in water. (2 marks)

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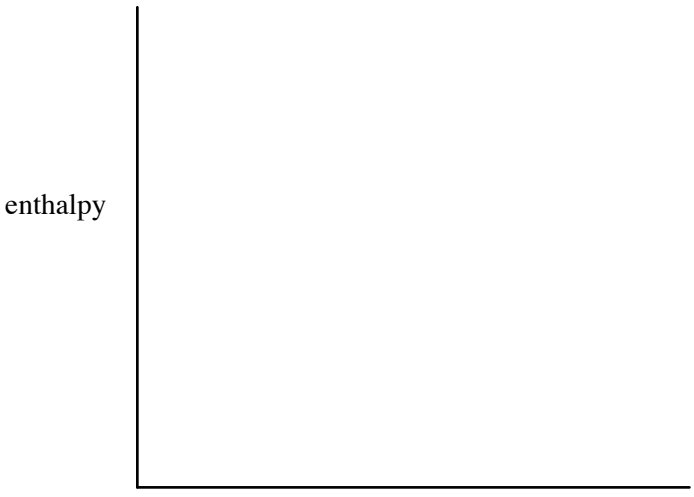
(c) Sketch an enthalpy diagram for the process of dissolving sodium thiosulfate in water. (2 marks)



For Marker Use Only

Question 10

This question assesses Criterion 8.

How much energy is required to heat 250 g of water from 15°C to 99°C? The specific heat capacity of water is 4.184 J g^{-1} °C^{-1}. (2 marks)

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Question 11

This question assesses Criterion 8.

Consider the following equations:

$C_{(graphite)}$	+	$O_{2(g)}$	→	$CO_{2(g)}$		ΔH = -394 kJ
$2CO_{(g)}$	+	$O_{2(g)}$	→	$2CO_{2(g)}$		ΔH = -564 kJ
		$O_{2(g)}$	→	$2O_{(g)}$		ΔH = +490 kJ
		$CO_{(g)}$	→	$C_{(g)}$	+ $O_{(g)}$	ΔH = +964 kJ

Calculate ΔH for the sublimation reaction of graphite:

$$C_{(graphite)} \rightarrow C_{(g)}$$

(4 marks)

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For Marker Use Only

Question 12

This question assesses Criterion 8.

Hydrochloric acid reacts with a zinc according to the equation:

$$2HCl_{(aq)} + Zn_{(s)} \rightarrow ZnCl_{2(aq)} + H_{2(g)}$$

(a) Explain why the rate of appearance of hydrogen decreases as the reaction proceeds. (1 mark)

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(b) Two beakers each contain 200 mL of 2 mol L^{-1} hydrochloric acid. One beaker is kept at room temperature (about 18˚C) and the other one is warmed on a hot plate and maintained at 50˚C. A 2.00 g lump of zinc is put in each at the same time. (Note: There is an excess of hydrochloric acid.)

In which beaker will the zinc disappear first? Explain in terms of collision of particles. (3 marks)

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(c) Wrapping copper wire around a block of zinc is found to increase the reaction rate of a lump of zinc in hydrochloric acid. Suggest why this occurs. (1 mark)

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For Marker Use Only

Question 13

This question assesses Criterion 8.

A solution of copper (II) chloride, $CuCl_2$, and a solution of potassium hydroxide, KOH, form a precipitate of copper (II) hydroxide, $Cu(OH)_2$, almost instantaneously when mixed. The reaction between copper (II) chloride solution and silver metal is very slow.

(a) Explain why the precipitation reaction is much faster than the reaction between the copper (II) chloride and silver. (3 marks)

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(b) Give two ways that the rate of the silver and copper (II) chloride solution reaction could be increased at room temperature, without introducing a catalyst. (2 marks)

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For Marker Use Only

Question 14

This question assesses Criterion 8.

Calcium carbonate, $CaCO_3$, decomposes when heated.

$$CaCO_{3(s)} \rightarrow CaO_{(s)} + CO_{2(g)}$$

(a) Explain why this reaction does not go to completion in a closed container. (1 mark)

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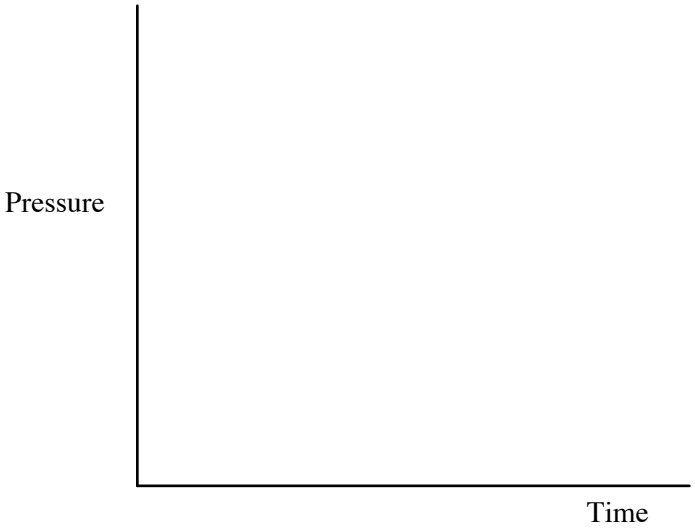
(b) The temperature of the closed container was kept constant and the pressure recorded for several hours as the calcium carbonate was heated. Sketch a graph indicating how the pressure would be expected to change with time. Label any significant feature of the sketch. (2 marks)



(c) The volume of the closed container can be readily altered. Explain what changes would occur immediately, and over a period of time, if the volume were suddenly increased at constant temperature. Give reasons. (4 marks)

Immediate change: .....

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Change over a period of time: .....

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Question 14 continues opposite.

Question 14 (continued)

For Marker Use Only

(d) What other data are needed to predict the effect of a temperature increase on the reaction? (1 mark)

$$CaCO_{3(s)} \rightarrow CaO_{(s)} + CO_{2(g)}$$

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(e) What would be the effect of adding some unreactive nitrogen to the closed container while the calcium carbonate was being heated? The temperature and volume of the container are kept constant. Explain. (2 marks)

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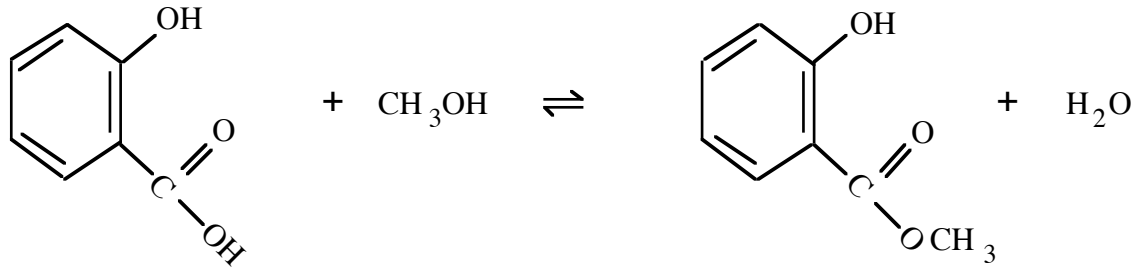
For Marker Use Only

Question 15

This question assesses ***Criterion 4****.*

The ester methyl salicylate can be prepared in a two step process:

Step 1: Salicylic acid and methanol and a small amount of concentrated sulfuric acid are refluxed together for some time.



Step 2: The ester is extracted, purified and weighed and the percentage yield calculated.

Briefly explain four ways you can change the conditions in step 1 to increase the percentage yield. (8 marks)

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CHEMISTRY

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External Assessment

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Part 3

Time: approximately 45 minutes

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

Criterion 4 Develop and evaluate experiments.

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

Criterion	Mark
9	/32
4	/8

Pages: 11
Questions: 9

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Question 16

For Marker Use Only

This question assesses Criterion 9.

Non-metals nitrogen, oxygen and fluorine are neighbours in the periodic table.

(a) Compare and explain their relative reactivity. (3 marks)

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(b) Explain why this trend is different to the metals in the same period. (1 mark)

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(c) The metals of this period have a significantly higher melting point compared to the non-metals in (a). Explain this observation. (2 marks)

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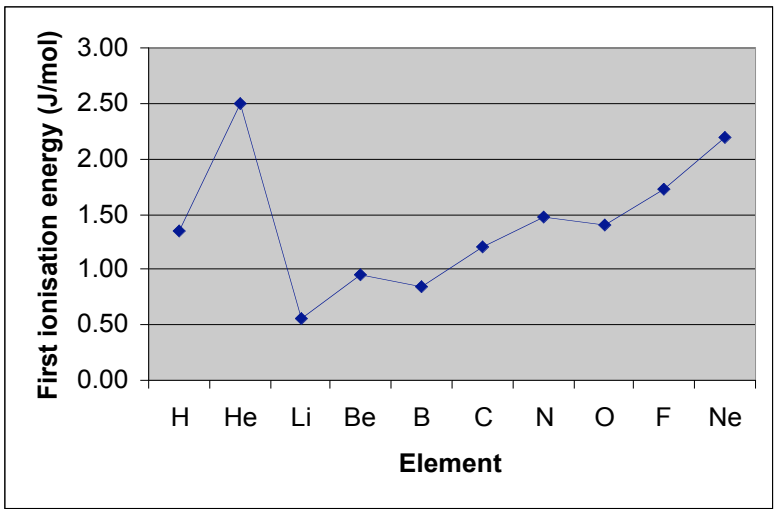
For Marker Use Only

Question 17

This question assesses Criterion 9.

Below is a graph showing the ionisation energy of the first ten elements.



Explain the significance of:

(a) The major peak for helium. (1 mark)

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(b) The minor peak for beryllium. (1 mark)

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For Marker Use Only

Question 18

This question assesses Criterion 9.

(a) What is the electronic configuration of: (1 mark)

(i) Neon

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(ii) Xenon

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(b) Both of these gases are considered inert under normal conditions. Explain why this is so in terms of their electron configuration. (1 mark)

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(c) Explain why it is possible, under extreme conditions, to oxidise xenon but not neon. (2 marks)

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Question 19

This question assesses Criterion 9.

Explain why a bunsen burner flame is sooty when the air hole is closed. (2 marks)

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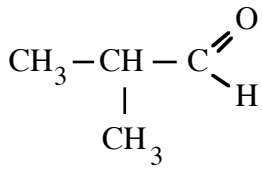
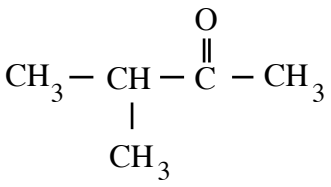
For Marker Use Only

Question 20

This question assesses Criterion 9.

Complete the following table. (4 marks)

Name of compound	Structural formula	Type of compound
		
5-methyl-2-hexanol		
		
2-ethyl-4,4-dimethylpentanoic acid		

For Marker Use Only

Question 21

This question assesses Criterion 9.

Give the balanced chemical equation, the type of reaction and name of the organic product for the following reactions:

(a) but-2-ene $\left(C_4H_{8(l)}\right)$ and steam $\left(H_2O_{(g)}\right)$. (2 marks)

Equation: .....

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Type of reaction: .....

Product name: .....

(b) benzene $\left(C_6H_{6(l)}\right)$ and chlorine $\left(Cl_{2(g)}\right)$. (2 marks)

Equation: .....

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Type of reaction: .....

Product name: .....

For Marker Use Only

Question 22

This question assesses Criterion 9.

(a) Give the molecular formula and name of the alcohol used to produce the ester:

$CH_3(CH_2)_4COO(CH_2)_5CH_3$ (1 mark)

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(b) What other organic reactant is required to make the ester? (Give the name and formula.) (1 mark)

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(c) Write a balanced equation for the formation of the ester. (1 mark)

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(d) Explain how the reactant in (b) can be produced from the alcohol in (a). Include all relevant balanced equations. (3 marks)

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Question 23

This question assesses Criterion 9.

With a named example of each, what are the structural differences between primary, secondary and tertiary alcohols? (4 marks)

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For Marker Use Only

Question 24

This question assesses ***Criterion 4****.*

When presented with three reagents you are told they are primary, secondary and tertiary alcohols that share the same molecular formula (C_4H_9OH). When added to acidified potassium dichromate solution $(K_2Cr_2O_{7(aq)})$ the following results were observed:

Alcohol A	As the alcohol was added, the dichromate solution changed from orange to green.
Alcohol B	Dichromate solution remained orange as the alcohol was added.
Alcohol C	As the alcohol was added, the dichromate solution changed from orange to green.

(a) Name alcohol B and give reasons for your answer. (2 marks)

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(b) From these results it can be determined that alcohol A is one of three possible alcohols, what are these three possibilities? Explain with reference to the results. (2 marks)

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(c) Acidified potassium permanganate $(KMnO_{4(aq)})$ is also available for you to use as a reagent.

(i) What products would you expect from the reaction of the **four** alcohols with acidified potassium permanganate? (2 marks)

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Question 24 continues opposite.

Question 24 (continued)

For Marker Use Only

(ii) Explain whether the use of potassium permanganate could assist in being able to distinguish between alcohol A and alcohol C. (2 marks)

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Part 4

Time: approximately 45 minutes

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Criterion 4 Develop and evaluate experiments.

Criterion 10 Apply logical processes to solve quantitative chemical problems.

Criterion	Mark
10	/32
4	/8

Pages: 11
Questions: 8

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Question 25

This question assesses Criterion 10.

At 400˚C, phosphorous vapour exists in the form of P_4 molecules. What is the density of this vapour at 400˚C if the pressure is 96.0 kPa? (3 marks)

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Question 26

This question assesses Criterion 10.

Aluminium is produced by electrolytic reduction of bauxite.

(a) What is the maximum mass of aluminium that could be obtained by the reduction of 459 tonnes of bauxite ore containing 66.7% aluminium oxide, Al_2O_3, by mass. (3 marks)

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(b) Calculate the number of electrons required to produce 900 kg of aluminium by electrolytic reduction of a molten mixture containing aluminium oxide. (3 marks)

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For Marker Use Only

Question 27

This question assesses Criterion 10.

Hydrogen sulfide burns in oxygen to produce water and sulfur dioxide. When 3.00 g of gaseous hydrogen sulfide is burnt in excess oxygen 5650 J of heat is evolved at 50˚C.

Calculate ΔH at 50˚C for the reaction:

$$2H_2S_{(g)} + 3O_{2(g)} \rightarrow 2H_2O_{(\ell)} + 2SO_{2(g)}$$

(3 marks)

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Question 28

This question assesses Criterion 10.

An underground iron pipeline is protected from corrosion by attaching a 10.0 kg lump of magnesium to it with a copper wire. If an average current of 0.20 A flows along the copper wire, how many years would be required for the magnesium to be completely consumed?

(3 marks)

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For Marker Use Only

Question 29

This question assesses Criterion 10.

A small piece of sodium reacted with 4.50 L of water.

$$2Na_{(s)} + 2H_2O_{(l)} \rightarrow 2Na^+_{(aq)} + 2OH^-_{(aq)} + H_{2(g)}$$

The pH of the resulting solution was measured as 9.26.

Calculate the mass of the sodium used. (4 marks)

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For Marker Use Only

Question 30

This question assesses Criterion 10.

A solution containing 1.42 g of sodium sulfate, Na_2SO_4, is added to 45.0 mL of a 2.00 mol L^{-1} solution of barium chloride, $BaCl_2$.

(a) Write an equation for the precipitation reaction that occurred. (1 mark)

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(b) Calculate the mass of the precipitate formed. (4 marks)

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(c) Calculate the mass of the excess reactant. (1 mark)

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(d) If the total volume of the mixture after reaction is 80.0 mL, calculate the concentration of the sodium ions. (2 marks)

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For Marker Use Only

Question 31

This question assesses Criterion 10.

4.00 g of impure iron was dissolved in excess dilute sulfuric acid, H_2SO_4 and the solution made up to 500 mL. 25.0 mL of this solution required 19.8 mL of 0.0305 mol L^{-1} potassium permanganate solution for complete oxidation.

(a) Write the ionic equation for the reaction of the iron and sulfuric acid. (1 mark)

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(b) The ionic equation for the oxidation reaction with the potassium permanganate is:

$$MnO_4^-(aq) + 8H^+(aq) \quad 5Fe^{2+}(aq) \rightarrow Mn^{2+}(aq) + 5Fe^{3+}(aq) + 4H_2O(aq)$$

Calculate the percentage purity of the iron sample. (4 marks)

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For Marker Use Only

Question 32

*This question assesses **Criterion 4**.*

Solutions of potassium permanganate, $KMnO_4$, can be standardised by titrating against oxalic acid, $(COOH)_2$.

(a) How is the end point observed? (1 mark)

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(b) The reaction is slow at room temperature. Explain why this could present a problem in the titration and how it could be overcome. (2 marks)

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(c) You are given the potassium permanganate solution and a known mass of oxalic acid. Explain how you would proceed next. (3 marks)

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(d) The burette readings from a titration experiment were:

22.43 mL, 22.49 mL, 20.65 mL and 22.54 mL.

Comment on these and indicate the best estimate for use in calculations. Give reasons. (2 marks)

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