AQUINAS COLLEGE

Year 12 Final Examination, 2007

Question/Answer Booklet

CHEMISTRY

Name:	

Part	Mark
1	/60
2	/70
3	/50
4	/20
Total	/200
	%

Time allowed for this paper

Reading time before commencing work: Ten minutes
Working time for paper: Three hours

Materials required/recommended for this paper

To be provided by the supervisor

This Question/Answer Paper
Separate Multiple Choice Answer Sheet
Chemistry Data Sheet

To be provided by the candidate

Standard Items: Pens, pencils, eraser or correction fluid and ruler
Special Items: A 2B, B or HB pencil for the separate Multiple Choice Answer Sheet and Calculators satisfying the conditions set by the Curriculum Council for this subject.

Important note to candidates

No other items may be taken into the examination room. It is **your** responsibility to ensure that you do not have any unauthorised notes or other items of a non-personal nature in the examination room. If you have any unauthorised material with you, hand it to the supervisor **before** reading any further.

Structure of this paper

Part	Number of questions available	Number of questions to be attempted	Suggested working time	Marks available
1 Multiple choice	30	30	55	60 (30%)
2 Short answer	10	10	60	70 (35%)
3 Calculations	5	5	45	50 (25%)
4 Extended answers	1	1	20	20 (10%)
			Total marks	200 (100%)

Instructions to candidates

1. Answer the questions according to the following instructions:

Part 1 Answer **all** questions, using a 2B, B or HB pencil on the separate Multiple Choice Answer Sheet. **Do not** use a ballpoint or ink pen.

If you consider that two or more of the alternative responses are correct, choose the one you think is best. If you think you know an answer, mark it even if you are not certain you are correct. Marks will **not** be deducted for incorrect answers.

Feel free to write or do working on the question paper; many students who score high marks on the Multiple Choice Section do this.

Parts 2, 3 and 4 Write your answers in the spaces provided in this Question/Answer Booklet. A blue or black ball point or ink pen should be used.

Questions containing specific instructions to show working should be answered with a complete, logical, clear sequence of reasoning showing how the final answer was arrived at; correct answers which do not show working will not be awarded full marks.

2. It is recommended that you spend your reading time mainly reading the Instructions to Candidates and Parts 2, 3 and 4.

3. At the end of the examination make sure that your name is on your Question/Answer Booklet and on your separate Multiple Choice Answer Sheet.

4. **Chemical Equations**
For full marks, chemical equations should refer only to those specific species consumed in the reaction and the new species produced. These species may be **ions** [for example $Ag^{+}_{(aq)}$], **molecules** [for example $NH_{3(g)}$, $CH_3COOH_{(l)}$, $CH_3COOH_{(aq)}$] or **solids** [for example $BaSO_{4(s)}$, $Cu_{(s)}$, $Na_2CO_{3(s)}$].

PART 1 (60 marks = 30% of paper)

Answer ALL questions in Part 1 on the separate Multiple Choice Answer Sheet provided, using a 2B, B or HB pencil. Each question in this part is worth 2 marks.

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1. Which of the following is **not** a ground state electron configuration?

   (a) $1s^2\,2s^2 2p^4$

   (b) $1s^2\,2s^2 2p^6$

   (c) $1s^2\,2s^2 3p^6\,4s^2$

   (d) $1s^2\,2s^2 2p^6\,3s^2$

2. Which of the following is the shape of boron trihydride?

   (a) Pyramidal

   (b) Tetrahedral

   (c) Linear

   (d) Triangular planar

3. Which of the following correctly explains the trend in first ionisation energies as you go across period 3 from Na to C*l*?

   (a) It decreases because the atomic radii are increasing.

   (b) It increases because the nuclear charges are increasing.

   (c) It increases because the number of energy levels is increasing.

   (d) It decreases because the atoms are becoming less metallic in their character.

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4. Which of the following species contains a total of 8 valence electrons?

   (a) CH_4

   (b) I_2

   (c) BeH_2

   (d) He

5. Which of the following substances is an alkanal (aldehyde)?

   (a) $CH_3CH_2CH_2OH$

   (b) CH_3CH_2COOH

   (c) $CHOCH_2CH_2CH_3$

   (d) CH_3COCH_3

6. Which of the following substances will not cause a colour change from orange to green if added to an acidified solution of potassium dichromate and warmed.

   (a) Butanoic acid

   (b) Butanal

   (c) 1-Butanol

   (d) 2-Butanol

7. Which of the following is the empirical formula of propylmethanoate?

   (a) $C_2H_4O_2$

   (b) C_2H_4O

   (c) $C_4H_8O_2$

   (d) CH_2O

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8. Which of the following pairs of substances are **not** isomers of each other.

(a) 1-butene and cyclobutane

(b) pentanal and 2-pentanone

(c) 3-hexanone and hexanol

(d) propanoic acid and methylethanoate

9. Which one of the following molecules is polar?

(a) BCl_3

(b) SO_2

(c) CO_2

(d) C_4H_{10}

10. In which of the following pure substances would you **not** encounter hydrogen bonding between the molecules?

(a) CH_3CH_2OH

(b) H_2O

(c) CH_3NH_2

(d) HCl

11. Which of the following puts the elements in the correct order of **increasing** electronegativity?

(a) C → Si → Ge

(b) K → Ca →Rb

(c) P → N → O

(d) S → Cl → Br

12. Which of the reasons below best explains why the first ionisation energy of aluminium is lower than the first ionisation energy of magnesium?

    (a) Aluminum has a higher nuclear charge due to more protons in the aluminium atom.

    (b) In the aluminium atom the electron is being lost from a different sub-shell than the electron in magnesium.

    (c) Aluminium has a greater number of principal energy levels than magnesium so the electron is not as strongly attracted to the nucleus.

    (d) In aluminium atoms the distance between the outer electron and the nucleus is greater than in magnesium so it is easier to remove the electron from the atom.

13. The values for the first two ionisation energies for Aluminium are:

    1^{st} 584 $kJmol^{-1}$ 2^{nd} 1 823 $kJmol^{-1}$

    The next two ionization energies are most likely to be:

    (a) 3^{rd} 9 876 $kJmol^{-1}$ 4^{th} 10 234 $kJmol^{-1}$

    (b) 3^{rd} 2 713 $kJmol^{-1}$ 4^{th} 3 489 $kJmol^{-1}$

    (c) 3^{rd} 2 845 $kJmol^{-1}$ 4^{th} 11 654 $kJmol^{-1}$

    (d) 3^{rd} 9 777 $kJmol^{-1}$ 4^{th} 43 657 $kJmol^{-1}$

14. Which one of the following substances exists as a covalent network?

    (a) $SiCl_{4(s)}$

    (b) $I_{2(s)}$

    (c) $SiO_{2(s)}$

    (d) $H_2O_{(s)}$

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Questions 15 - 17 relate to the following equation:

$$2PbSO_{4(s)} + H_2O_{(l)} \rightleftarrows Pb_{(s)} + PbO_{2(s)} + 2SO_4^{2-}{}_{(aq)} + 4H^+{}_{(aq)}$$

15. Which of the following is an oxidation state of lead that is **not** exhibited in the reactants or products of this reaction?

(a) 0

(b) + 2

(c) + 3

(d) + 4

16. Which of the following is the equilibrium constant expression for this reaction?

(a) $K = \dfrac{[PbSO_4]}{[H^+]^4[SO_4^{2-}]^2}$

(b) $K = \dfrac{[H_2O]}{[H^+]^4[SO_4^{2-}]^2}$

(c) $K = [H^+]^4[SO_4^{2-}]^2$

(d) $K = \dfrac{1}{[H^+]^2[SO_4^{2-}]}$

17. Assuming equilibrium has been established, which of the following will cause an increase in the concentration of $H^+{}_{(aq)}$ ions?

(a) Adding more solid lead.

(b) Adding sodium sulphate.

(c) Adding water.

(d) Adding barium nitrate solution.

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18. What is the pH of a solution of 1.50×10^{-2} mol L^{-1} nitric acid?

(a) 1.82

(b) 0.82

(c) ─ 1.82

(d) 1.3

19. Which of the following roles does zinc play in the Leclanché cell (dry cell)

I It is the reducing agent.

II It provides the casing for the cell.

III It is the cathode.

IV It is a source of electrons for the reaction.

(a) **I, II** and **IV** only

(b) **I, II** and **III** only

(c) **II** and **III** only

(d) **I** and **IV** only

20. Which of the following has the substances listed in the correct order of **increasing** strength of the intermolecular forces within the substance?

(a) $H_2 < HCl < CO_2 < NH_3$

(b) $H_2 < CO_2 < NH_3 < HCl$

(c) $H_2 < CO_2 < HCl < NH_3$

(d) $CO_2 < HCl < NH_3 < H_2$

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21. During the carbon-in-pulp process used for the extraction of gold, the $[Au(CN)_2]^-$ ion is removed from the pulp by reacting with:

(a) O_2

(b) NaCN/NaOH

(c) HCN

(d) HCl

22. Potassium dichromate can be used as an oxidising agent in redox titrations. When a student tried to use dichromate to analyse the chloride ion concentration in a solution of hydrochloric acid, the titration was unsuccessful. The reaction he was expecting was as follows:

$$6Cl^- + Cr_2O_7^{2-} + 14H^+ \rightarrow 2Cr^{3+} + 7H_2O + 3Cl_2$$

The most likely reason for this is:

(a) There was no clear colour change at the end point due to the colour of the chlorine produced.

(b) He didn't acidify the dichromate solution before adding to the hydrochloric acid.

(c) The dichromate isn't a strong enough oxidising agent.

(d) It is impossible to obtain a standard solution of potassium dichromate.

23. Which of the following correctly describes the substances produced at the electrodes during the electrolysis of 1.0 mol L^{-1} copper(II) sulfate solution with inert electrodes.

	Anode	**Cathode**
(a)	Hydrogen gas	Oxygen gas
(b)	Hydrogen gas	Copper metal
(c)	Copper metal	Sulfur dioxide gas
(d)	Oxygen gas	Copper metal

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Questions 24 - 25 relate to the following equation:

In an experiment to investigate the corrosion of iron, three steel nails were set up as follows:

Nail 1: Loosely wrapped in copper foil.
Nail 2: Loosely wrapped in zinc foil.
Nail 3: No other metal present.

The nails were left in a damp, warm atmosphere for three days.

24. Which of the sets of results below would be expected?

	Relative amount of corrosion of nail		
	Nail 1	**Nail 2**	**Nail 3**
(a)	extensive corrosion	no corrosion	some corrosion
(b)	least corrosion	some corrosion	extensive corrosion
(c)	some corrosion	extensive corrosion	least corrosion
(d)	extensive corrosion	some corrosion	least corrosion

25. Which of the following best describes the reasons for carrying out the test in warm conditions.

(a) The extra heat lowers the activation energy, which enables the corrosion reactions to occur more readily.

(b) The increased temperature increases the solubility of oxygen in the water, which enables more oxygen to react with the iron.

(c) The average kinetic energy of the particles involved in the reactions increases, increasing the frequency of collisions.

(d) Greater heat allows electrons to flow through the iron between the anodic and cathodic regions more quickly, which allows the corrosion to occur more readily.

26. Assuming standard conditions, what would be the cell potential (E.M.F.) for the disproportionation of hydrogen peroxide as shown:

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

(a) + 1.10 V

(b) − 2.46 V

(c) + 2.46 V

(d) − 1.10 V

27. Which of the following 1.0 mol L^{-1} solutions will be acidic?

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I sodium hydrogencarbonate

II ammomium chloride

III sodium ethanoate

IV iron(III) nitrate

(a) **II, III** and **IV** only

(b) **III** only

(c) **I** and **III** only

(d) **II** and **IV** only

28. Tests were done on an unknown solid X, which was known to be a mixture of two compounds. The results are given below:

Test	Description	Observation
1	Add the solid to distilled water and filter the resulting mixture.	White solid and green solution formed
2	Add dilute hydrochloric acid to the residue from Test 1.	Gas released on addition of the acid.
3	Add silver nitrate solution to the filtrate from Test 1.	White precipitate formed

Which of the following could be the compounds in X?

(a) Nickel(II) carbonate and sodium sulfate

(b) Iron(II) chloride and magnesium hydroxide

(c) Zinc carbonate and nickel(II) chloride

(d) Chromium(III) nitrate and zinc chloride

29. Which of the following statements about sodium hydroxide is false?

(a) It is used in the manufacture of soaps.

(b) It is used as a primary standard in acid-base titrations.

(c) It is used in the purification of bauxite.

(d) It is a strong base.

30. The structural formula of a stearate ion is $CH_3(CH_2)_{16}COO^-$.

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Which of the following is the best explanation of why this ion can act as a surfactant, and therefore help to remove grease from a surface.

(a) The long chain within the ion enables them to form a layer on the surface preventing the grease from attaching to the surface.

(b) The stearate ion acts a catalyst for the chemical breakdown of the molecules that make up the grease.

(c) The stearate ion contains separate polar and non-polar sections.

(d) The sterate group is able to form an ester linkage to the molecules in the grease and hence they can be removed when the stearate ion is washed away.

END OF PART 1

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PART 2 (70 marks = 35% of paper)

Answer ALL questions in Part 2 in the spaces provided below.

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1. Write equations for any reactions that occur in the following procedures. If no reaction occurs write 'no reaction'.

   In each case describe **in full** what you would observe; including any
   - colours
   - odours
   - precipitates (give the colour)
   - gases evolved (give the colour or describe as colourless).

   If no change is observed, you should state this.

   (a) Dilute sulfuric acid is added to solid chromium(III) carbonate.

   Equation _____

   Observation _____

   _____

   [3 marks]

   (b) Dilute sodium hydroxide is added to nickel(II) sulfate solution.

   Equation _____

   Observation _____

   _____

   [3 marks]

   (c) Concentrated nitric acid is added to copper metal.

   Equation _____

   Observation _____

   _____

   [3 marks]

   (d) Magnesium metal is added to copper(II) sulfate solution.

   Equation _____

   Observation _____

   _____

   [3 marks]

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2. Aluminium salts are acidic due to the presence of the hexaaqualuminate ion, $[Al(H_2O)_6]^{3+}$ which is formed when a soluble aluminium salt is dissolved in water. This ion undergoes hydrolysis as follows:

$$[Al(H_2O)_6]^{3+}_{(aq)} + H_2O_{(l)} \rightleftarrows [Al(OH)(H_2O)_5]^{2+}_{(aq))} + H_3O^{+}_{(aq)}$$

(a) Write the equilibrium constant (K) expression for this reaction.

[1 mark]

(b) A solution of an aluminium nitrate had a pH of 5.6.

(i) Using the above equilibrium reaction, explain how the pH of the solution would change when more solid aluminium nitrate was dissolved into the solution.

[2 marks]

(ii) When more water was added to the original solution, the pH initially rose from 5.6 to 6.0, and then dropped to 5.8. Explain these observations.

[3 marks]

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(c) It was found that when the aluminium nitrate solution was warmed, the pH of the solution decreased. From this information, deduce whether the forward reaction in the above equilibrium is endothermic or exothermic. Explain your reasoning.

[3 marks]

(d) Draw an electron dot diagram to show the bonding present in the H_3O^+ ion.

[2 marks]

(e) In the complex ion: $[Al(OH)(H_2O)_5]^{2+}$ what is:

(i) The oxidation number of the Al. _____

(ii) The shape of the complex ion. _____

[2 marks]

3. From the following list of ions, chose one that best fits the description below.
You are allowed to use each ion more than once.

Chloride	**Ni^{2+}**	**Au^{+}**	**Hydroxide**
Sulfate	**Permanganate**	**ClO_2^-**	**H^+**
ClO^-	**Fluoride**	**Oxide**	**Carbonate**
Potassium	**Hydrogensulfate**	**I^-**	**Fe^{2+}**

Description	**Name or Formula**
Will form a precipitate when mixed with a solution containing Lead(IV) ions, but not with Tin(IV) ions	
Hydrolyses in water to form an acidic solution.	
Forms green solutions that will turn brown in the presence of oxygen.	
The conjugate base of water.	
Has the ability to oxidise bromide ions to bromine.	
Is formed from oxygen in the first stage of the corrosion of iron.	
Contains chlorine with an oxidation number of +3.	

[7 marks]

4. For each species listed in the table below draw the structural formula, representing **all** valence shell electron pairs as : or as – indicate the shape of the species by either a sketch or a name.

Species	Structural formula	Shape
Carbon Monoxide CO		
Carbonate ion, CO_3^{2-}		

[4 marks]

5. Write the ground state electron configuration (using s, p, d notation) for the following species:

(a) P _____

(b) S^{2-} _____

[2 marks]

6. Using three examples of your choice, explain the following statement. Use relevant bonding diagrams in your answer.

There is a continuum from pure covalent bonding, through polar covalent bonding, to ionic bonding"

[6 marks]

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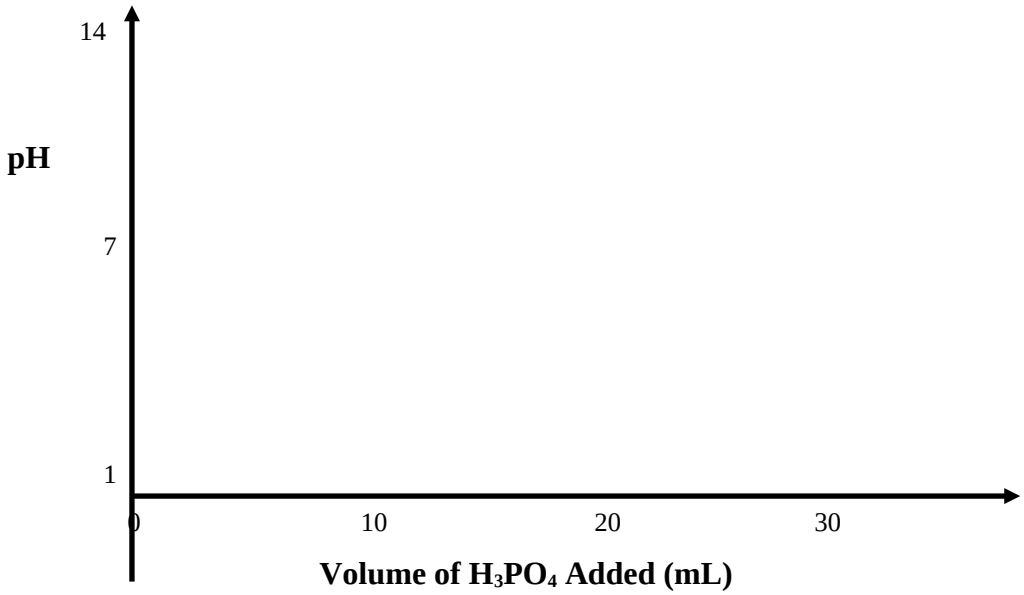
7. Phosphoric acid is a weak, triprotic acid. In a volumetric analysis experiment, a solution of approximately 0.2 mol L^{-1} phosphoric acid (H_3PO_4) is titrated with a standard solution of 0.200 mol L^{-1} sodium hydroxide in order to calculate the accurate concentration of the acid. 30.00 mL of the sodium hydroxide solution was pipetted into a conical flask, and the phosphoric acid added from the burette.

(a) Write an ionic equation, including state symbols, for the reaction occurring.

[2 marks]

(b) On the axis below, sketch a graph showing how the pH would be expected to change during the titration, until an excess of the acid was added.

[3 marks]



(c) On the graph above, label the equivalence point for this reaction.

[1 mark]

(d) What should the pipette be rinsed with, immediately prior to use?

[1 mark]

(e) Give the name of an indicator that would be suitable for use in this titration.

[1 mark]

8. Explain how you could distinguish between the following pairs of compounds using a single chemical test for each pair. Give equations for any reactions that would occur.

Compounds	Description of Test	Expected Observations
Zinc Hydroxide and **Magnesium Hydroxide**		
Equation(s):		

Compounds	Description of Test	Expected Observations
1-pentene and **pentane**		
Equation(s)		

[6 marks]

9. (a) The structure of a polymer is shown below:

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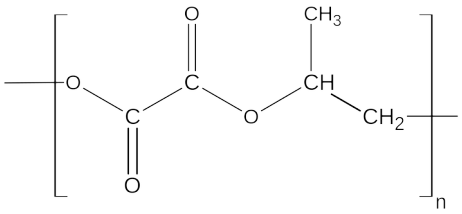
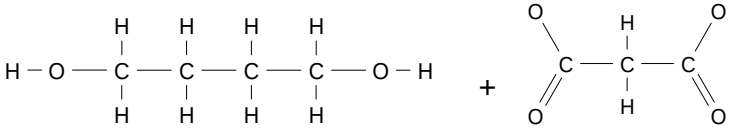


What type of reaction is used to synthesise this polymer?

[1 mark]

(b) In the same style as in part (a) draw the structure of the polymer formed from the combination of the two monomers below:



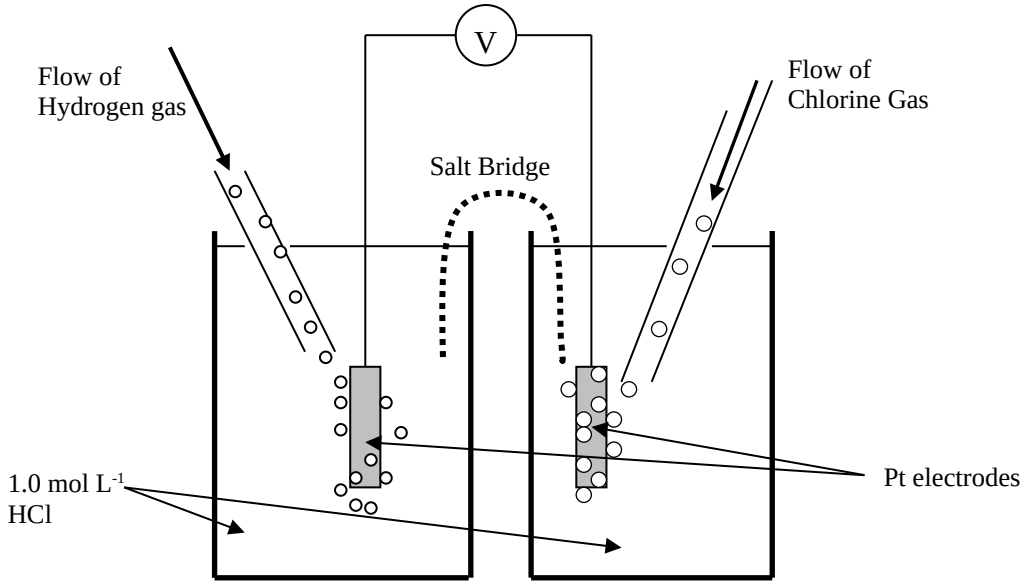
[2 marks]

(c) Draw the structure of the molecule 2-methyl-2-butene, and give the structure of the polymer formed from this monomer.

Monomer:	Polymer:

[3 marks]

10. Below is a representation of an electrochemical cell, which involves the reaction of hydrogen and chlorine:



(a) Give the half equation for the reactions occurring at the anode and at the cathode and write an overall redox equation for the reaction occurring in the cell.

Anode half-equation:
Cathode half-equation:
Overall equation:

[3 marks]

(b) Calculate the maximum voltage (e.m.f.) that could be produced by this cell.

[1 mark]

(c) Show the direction of flow of electrons in the external circuit by means of an arrow on the above diagram

[1 mark]

(d) Suggest a reason why platinum is used for the electrodes.

[1 mark]

END OF PART 2

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PART 3 (50 marks = 25% of the paper)

Answer ALL questions in Part 3. The calculations are to be set out in detail in this Question/Answer Booklet. Marks will be allocated for correct answers and clear setting out, even if you cannot complete the problem. When questions are divided into sections, clearly distinguish each section using (a), (b) and so on. Express your final numerical answers to three (3) significant figures where appropriate, and provide units where applicable. Information which may be necessary for solving the problems is located on the separate Chemistry Data Sheet. Show clear reasoning: if you don't, you will lose marks.

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1. Carbon dioxide is prepared by reacting hydrochloric acid with marble chips (calcium carbonate)

   If 3.125 g of marble chips were mixed with 20.0 mL of 2.00 mol L^{-1} $HCl_{(aq)}$

   (a) Write an equation for the reaction occurring.

   [1 mark]

   (b) Determine the limiting reagent, and calculate the number of moles of the excess reagent remaining after the reaction is completed.

   [5 marks]

   (c) What would be the volume of carbon dioxide produced at 25°C and 1.00 atm?

   [2 marks]

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2. An experiment was carried out to determine the alcohol (ethanol) content in white wine. 5.00 mL samples of wine were acidified with 10 mL of 2.0 mol L^{-1} H^2SO^4 and titrated against 0.450 mol L^{-1} sodium dichromate. It was was found that 17.85 mL of the dichromate was required for the complete reaction.

The equation for the reaction is:

$$2Cr^2O^{7\,2-} + 3CH^3CH^2OH + 16H^+ \rightarrow 4Cr^{3+} + 3CH^3COOH + 11H^2O$$

(a) Calculate the concentration of the ethanol in the wine in mol L^{-1}.

[4 marks]

(b) Assuming the density of the wine is 1.06 g mL^{-1}, calculate the concentration of ethanol in the wine as a percentage (%) by mass.

[3 marks]

(c) What colour change would be seen at the end point of each titration?

[1 mark]

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3. The blue-green pigment Chrysocolla, is a hydrated salt that contains copper, silicon and oxygen:

$$Cu_wSi_xO_y \,.\, \boldsymbol{Z}H_2O$$

A 10.00 g sample was carefully heated to remove water and the resulting solid had a mass of 7.21g.

To calculate the amount of silicon present, this 7.21g was roasted at high temperature in the presence of oxygen and 3.10g of SiO_2 was produced.

In a separate analysis, it was found that the original hydrated salt was found to contain 32.8% copper.

(a) Determine the empirical formula of Chrysocolla by calculating the values of ***w, x, y*** *and* ***Z***.

[9 marks]

(b) Based on the colour of the pigment, state the oxidation number of the copper, and calculate the oxidation state of silicon in the compound.

[2 marks]

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4. The manufacture of aluminium consists of two stages:

A. The purification of bauxite ($Al(OH)_3$)

Heating with hot aqueous NaOH: $Al(OH)_{3\,(s)} + OH^-_{(aq)} \rightarrow [Al(OH)_4]^-_{(aq)}$
Cooling and crystallizing: $[Al(OH)_4]^-_{(aq)} \rightarrow Al(OH)_{3\,(s)} + OH^-_{(aq)}$
Heating to remove water: $2\,Al(OH)_{3\,(s)} \rightarrow Al_2O_{3\,(s)} + 3H_2O_{(l)}$

B. The electrolytic reduction of Alumina (Al_2O_3)

Anode Reaction: $C_{(s)} + 2O^{2-}_{(aq)} \rightarrow CO_{2\,(g)} + 4e^-$

Cathode Reaction: $Al^{3+}_{(aq)} + 3e^- \rightarrow Al_{(s)}$

The bauxite used in the process has a purity of 87.0%.
The current in the electrolytic cell is 40 000 amps.
(1.00 tonne = 1.00 x 10^6 g 1.00 hour = 3 600 seconds)

In order to produce 1.00 tonne of pure Aluminium from bauxite, calculate:

(a) The time in hours that the current must pass through the electrolytic cell.
[5 marks]

(b) The original mass of the impure bauxite required.
[3 marks]

(c) The volume of carbon dioxide at STP produced as a by-product.
[2 marks]

(d) The minimum volume of 8.00 mol L^{-1} sodium hydroxide required in the purification process.
[2 marks]

5. An experiment was carried out to calculate the purity of a sample of calamine ($ZnCO_3$).

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4.54 g of impure calamine was added to 50.0 mL of 2.00 mol L^{-1} HCl.

The resulting solution was filtered into a volumetric flask and made up to 250.0 mL. 25.00 mL aliquots of this solution were then titrated against 0.105 mol L^{-1} of NaOH solution and the results shown below:

Burette readings (mL)	Titrations		
	1	2	3
Final volume	32.50	37.25	43.15
Initial volume	0.00	5.50	11.30
Titre			

(a) Complete the table and calculate the titration volume.

[2 marks]

(b) Calculate the number of moles of hydrochloric acid present in the 25.00 mL aliquots.

[2 marks]

(c) Calculate the total number of moles of hydrochloric acid present in the 250.0 mL flask and hence calculate the % purity of the calamine.

[7 marks]

END OF PART 3

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PART 4 (20 marks = 10% of paper)

Answer the following extended answer question. Where applicable use equations, diagrams and illustrative examples of the chemistry you are describing.

Marks are awarded principally for the relevant chemical content of your answer, and also for coherence and clarity of expression. Your answer should be presented in about 1½ to 2 pages on the lined paper after the questions.

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1. Oxygen plays a major role in many of the processes studied in TEE Chemistry. The reactions listed below involve elemental oxygen and are just **one part** of an overall process:

   For each of the three reactions, A, B and C:

   (a) Briefly outline the role that the given reaction plays in the overall process listed.

   (b) Identify the reducing agent in each reaction and describe how the bonding in the reducing agent changes during the reaction.

   (c) Explain one method of increasing the rate of production of the products in each reaction shown.

   *(You must choose a **different** method for all 3 reactions)*

	Overall Process	Reaction involving O_2
A.	Corrosion of Iron	$O_{2(g)} + 2H_2O_{(l)} + 4e^- \rightarrow 4OH^-_{(aq)}$
B.	Production of Sulfuric Acid	$2SO_{2(g)} + O_{2(g)} \rightleftarrows 2SO_{3(g)}$
C.	Oxidation of Ethanol to Ethanoic Acid	$2CH_3CH_2OH_{(aq)} + O_{2(g)} \rightarrow 2CH_3CHO_{(aq)} + 2H_2O_{(l)}$

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END OF EXAM