Mt Lawley SHS

Year 12 Semester Two Examination, 2006

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	ALL	55	60 (30%)
2 Short answer	11	ALL	60	70 (35%)
3 Calculations	5	ALL	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.

The following information refers to questions 1-3

An element **X** contains atoms that have a ground state configuration of $1s^2\,2s^2 2p^6\,3s^2 3p^4$

1.   In which block of the periodic table will element **X** be found?

        (a)   s block

        (b)   p block

        (c)   d block

        (d)   f block

2.   The ions of element **X** would most likely have a charge of:

        (a)   4+

        (b)   2+

        (c)   2-

        (d)   6+

3.   The bonds present in the compound H_2**X** are most likely to be:

        (a)   Single covalent bonds.

        (b)   Double covalent bonds.

        (c)   Ionic bonds.

        (d)   Hydrogen bonds.

4.   Which of the following has the highest electronegativity?

        (a)   Li

        (b)   Be

        (c)   N

        (d)   O

5.   Which of the following species will be linear in shape?

      (a) NH_3

      (b) H_2O

      (c) C_2H_2

      (d) SO_2

6.   Which of the following substances would **not** react with acidified potassium dichromate solution?

      (a)   1-propanol

      (b)   methyl-2-propanol

      (c)   propanal

      (d)   2-butanol

7.   In which of the following substances is the empirical formula the same as the molecular formula?

      (a) CH_3COOH

      (b) CH_3COOCH_3

      (c) $CH_3COOCH_2CH_3$

      (d) $CH_3(CH_2)_4CH_3$

8.   Which of the following is the best definition of a condensation polymer?

      (a)   It is a long saturated molecule formed when two unsaturated molecules combine in a chain reaction.

      (b)   It is a polymer that is formed when two gaseous molecules react to form a substance that is liquid at room temperature.

      (c)   It is a long chain molecule formed in a reaction that produces water as one of the products.

      (d)   It is a polymer containing non-polar and polar sections, which allow it to act as a surfactant.

9.   Which of the following correctly describes the dominant intermolecular forces occurring in the following substances?

|	C_8H_{18}	NH_3	CCl_4
(a)	Dispersion Forces	Hydrogen Bonding	Dipole-Dipole
(b)	Hydrogen Bonding	Dipole-Dipole	Dispersion Forces
(c)	Hydrogen Bonding	Dipole-Dipole	Dipole-Dipole
(d)	Dispersion Forces	Hydrogen Bonding	Dispersion Forces

10.   The first five Ionisation Energies for an element are given below:

1st 506   kJ mol^{-1}
2nd 2 583 kJ mol^{-1}
3rd 3 832 kJ mol^{-1}
4th 4 493 kJ mol^{-1}
5th 5 126 kJ mol^{-1}

Which of the following could be this element?

(a)   Si

(b)   Li

(c)   Ca

(d)   Na

11.   Which of the following is the conjugate base of the hydrogencarbonate ion?

(a) HCO_3^-

(b) CO_3^{2-}

(c) H_2CO_3

(a) OH^-

SEE NEXT PAGE

12. The following reaction is one of the reactions required for the rusting of iron to occur.

$$O_{2(g)} + 2H_2O_{(l)} + 4e^- \rightleftharpoons 4OH^-_{(aq)}$$
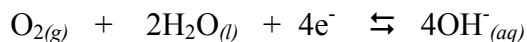
Which of the following would cause the reverse reaction to be favoured?

(a) Adding more water.

(b) Adding $Fe^{2+}_{(aq)}$ ions to form a precipitate of $Fe(OH)_2$.

(c) Reducing the concentration of oxygen gas.

(d) Adding dilute acid.

13. Which of the following is the pH of a 0.0100 mol L^{-1} solution of barium hydroxide?

(a) 12.3

(b) 2.0

(c) 1.7

(d) 13.0

14. A student measured the pH of two solutions. One solution was 1.00×10^{-4} mol L^{-1} nitric acid and the other was 1.00 mol L^{-1} oxalic acid. She found that both had similar pH values. Which of the following is the best explanation for this result?

(a) They are both strong acids so they will give similar pH readings.

(b) The oxalic acid is a diprotic acid, which increases the acidity of the solution of oxalic acid.

(c) There must have been an error in her recording.

(d) The nitric acid solution was a low concentration of a strong acid.

15. In which of the following species listed below does iodine have an oxidation state of $+3$?

(a) FeI_3

(b) IO_3^-

(c) HIO_2

(d) I_2

SEE NEXT PAGE

16.   Which of the following is likely to have the most acidic oxide?

(a)   Ca

(b)   Cr

(c)   Cu

(d)   Cl

17.   As you go down Group II from Be to Ra, which of the options below correctly describes the trends in the characteristics of the elements?

	Electronegativity	1st Ionisation Energy	Electrical Conductivity
(a)	Decreases	Decreases	Increases
(b)	Increases	Decreases	Decreases
(c)	Decreases	Increases	Increases
(d)	Increases	Increases	Decreases

18.   Nitrogen is required for plant growth and can be added to the soil by adding aqueous ammonia ($NH_{3(aq)}$), or fertilisers such as potassium nitrate ($KNO_{3(s)}$). Which of the following is a correct reason to use potassium nitrate instead of ammonia?

(a)   Potassium nitrate is insoluble, so pollution caused by excess fertiliser is reduced.

(b)   Potassium nitrate also contains potassium, which is helpful for plant growth.

(c)   Potassium nitrate is an acidic salt, which keeps the pH of the soil low.

(d)   Aqueous ammonia is hard to prepare because ammonia is only slightly soluble in water.

19.   Which of the following reactions will not occur spontaneously?

(a) $2Br^-_{(aq)} + Cl_{2(aq)} \rightarrow 2Cl^-_{(aq)} + Br_{2(aq)}$

(b) $Hg_{(l)} + 2HCl_{(aq)} \rightarrow HgCl_{2(aq)} + H_{2(aq)}$

(c) $Mg_{(s)} + Cu^{2+}_{(aq)} \rightarrow Mg^{2+}_{(aq)} + Cu_{(s)}$

(d) $H_2O_{2(aq)} + 2H^+_{(aq)} + 2Br^-_{(aq)} \rightarrow 2H_2O_{(l)} + Br_{2(aq)}$

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20. Water will ionise according to the following reaction:

$$H_2O_{(l)} \leftrightharpoons H^+_{(aq)} + OH^-_{(aq)}$$
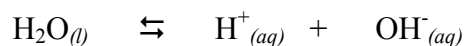
The equilibrium constant for this process is given by: $K = [H^+][OH^-]$

Which of the following statements concerning this process is true?

(a) Adding a soluble base to water will cause the forward reaction to be favoured.

(b) If the concentration of hydrogen ions increases, the value of K will increase.

(c) At $25^\circ C$ the value of $[H^+]$ is 1.00×10^{-14} mol L^{-1}.

(d) If: $[H^+] = [OH^-]$, then the solution is said to be neutral.

21. Ethanol (CH_3CH_2OH) is oxidised by reacting it with acidified potassium dichromate solution. Which of the following could **not** be a product of this reaction?

(a) Cr^{3+}

(b) CH_3CHO

(c) CrO_4^{2-}

(d) CH_3COOH

22. Which of the following salt solutions would have the lowest pH?

(a) $NaCH_3COO_{(aq)}$

(b) $NH_4Cl_{(aq)}$

(c) $NH_4CH_3COO_{(aq)}$

(d) $Na_3PO_{4(aq)}$

23. Which of these is the correct equation for the reaction occurring at the cathode of a dry cell (Leclanché cell)?

(a) $Mn_2O_{3(s)} + H_2O_{(l)} \rightarrow 2MnO_{2(s)} + 2H^+_{(aq)} + 2e^-$

(b) $Zn_{(s)} \rightarrow Zn^{2+}_{(aq)} + 2e^-$

(c) $NH_{3(aq)} + H^+_{(aq)} \rightarrow NH_4^+_{(aq)}$

(d) $2MnO_{2(s)} + 2H^+_{(aq)} + 2e^- \rightarrow Mn_2O_{3(s)} + H_2O_{(l)}$

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The following Diagram relates to questions 24, 25 and 26
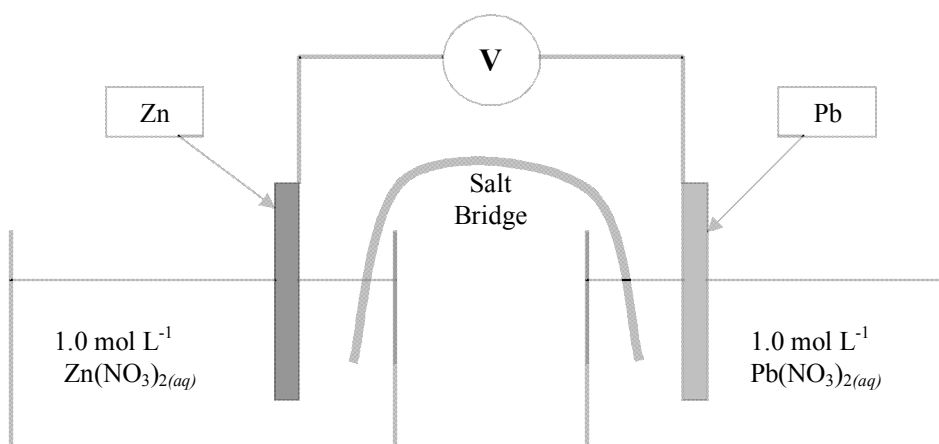
24. Assuming standard conditions, what would be the voltage produced by this cell?

    (a) 0.76 volts

    (b) 0.89 volts

    (c) 0.63 volts

    (d) - 0.13 volts

25. Which of the following is the best description of the purpose of the salt bridge?

    (a) To allow the flow of electrons between the two solutions.

    (b) To increase the concentration of the ions and therefore allow the reaction to occur more quickly.

    (c) To complete the aqueous section of the circuit.

    (d) To allow zinc ions to come into contact with the lead metal so that a reaction can occur.

26. Which statement is false?

    (a) The zinc electrode is being oxidised.

    (b) The electrons in the external circuit flow towards the lead electrode.

    (c) The lead electrode is the anode.

    (d) Positive ions in the salt bridge move towards the lead electrode.

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27. Which of the following molecules is the *trans* form of a pair of geometric isomers?

(a)

(b)

(c)

(d)
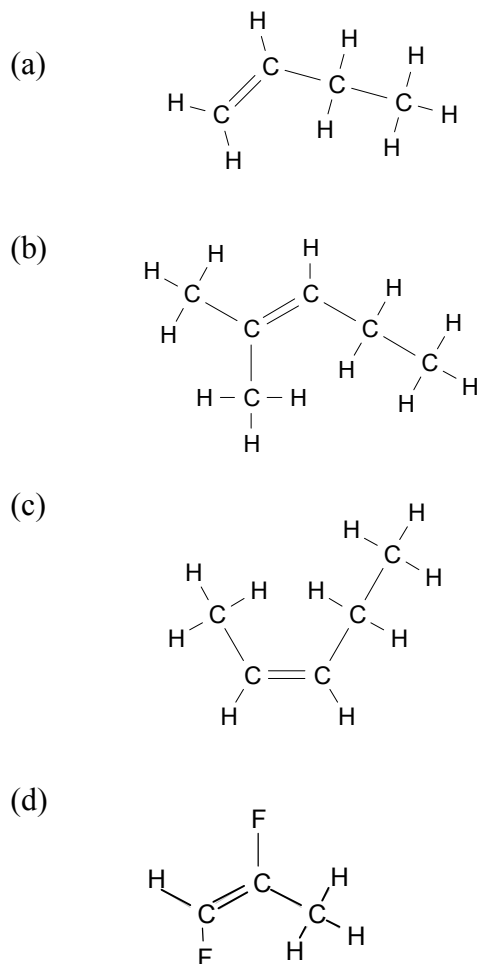
28. Which of the names below is correct for the molecule shown here?
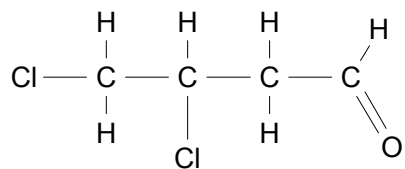
(a) 1,2-dichloro-4-butanone

(b) 3,4-dichlorobutanal

(c) 1,2-chloro-4-butanal

(d) 3,4-dichloro-1-butanol

SEE NEXT PAGE

29. Which of the following is **not** used as a raw material in the manufacture of sulfuric acid?

    (a) Water

    (b) Hydrogen Sulfide

    (c) Sulfur

    (d) Air

30. A student had 100.0 mL of 1.00 mol L^{-1} hydrochloric acid and was asked to reduce the concentration to 0.200 mol L^{-1}. What volume of distilled water would she need to add to her solution?

    (a) 400.0 mL

    (b) 500.0 mL

    (c) 300.0 mL

    (d) 20.0 mL.

END OF PART 1

SEE NEXT PAGE

PART 2   **(70 marks = 35% of paper)**

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

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)   Nickel metal is added to a solution of copper(II) nitrate.

Equation _____

Observation _____

_____
                                                                                                                [3 marks]

(b)   Solid sodium carbonate is added to dilute ethanoic acid.

Equation _____

Observation _____

_____
                                                                                                                [3 marks]

(c)   Hydrogen peroxide solution is added to an acidified solution of iron(II) sulfate.

Equation _____

Observation _____

_____
                                                                                                                [3 marks]

(d)   Sodium hydroxide solution is added to solid zinc hydroxide.

Equation _____

Observation _____

_____
                                                                                                                [3 marks]

SEE NEXT PAGE

2. For each of the species listed in the table below:
   - draw the structural formula (electron dot diagram), showing **all** valence shell electron pairs,
   - indicate the shape of the species by either a sketch or a name and
   - state the polarity of the molecule

Molecules	Structural formula	Shape	Polar or Non-polar?
Carbon Dioxide CO_2			
Ozone O_3			
Dichlorodi-fluoromethane CCl_2F_2			

[9 marks]

3. An energy profile diagram for a chemical reaction is shown below, draw and label:

   (a) The activation energy for the forward reaction as E_A
   (b) The enthalpy change for the reverse reaction as ΔH
   (c) An energy pathway for the catalysed reaction as **CAT**

Potential Energy (Enthalpy)

Reactants

Products

Reaction Co-ordinate
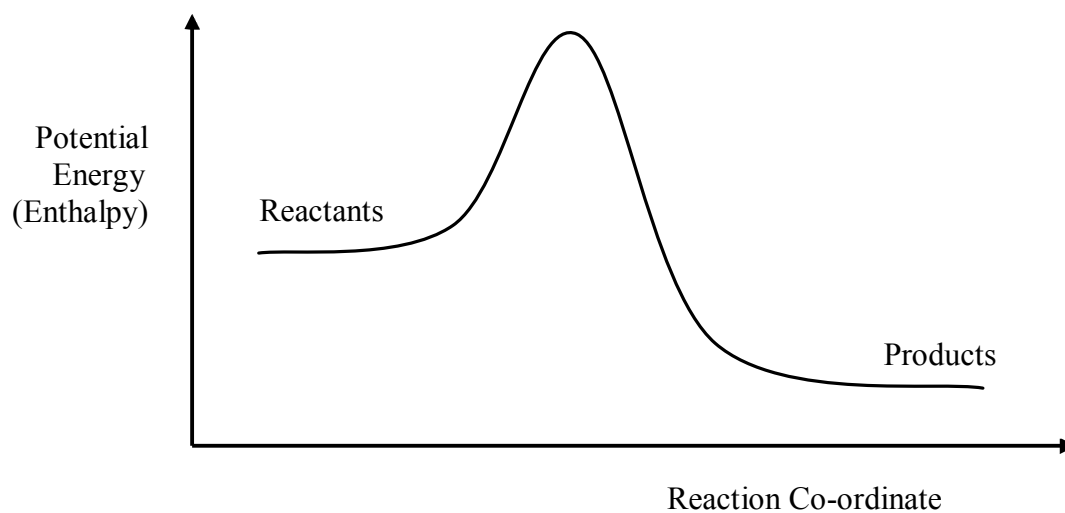
[3 marks]

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4.   Shown below is a laboratory version of a Lead-Acid Accumulator Cell in the process of being **recharged**.
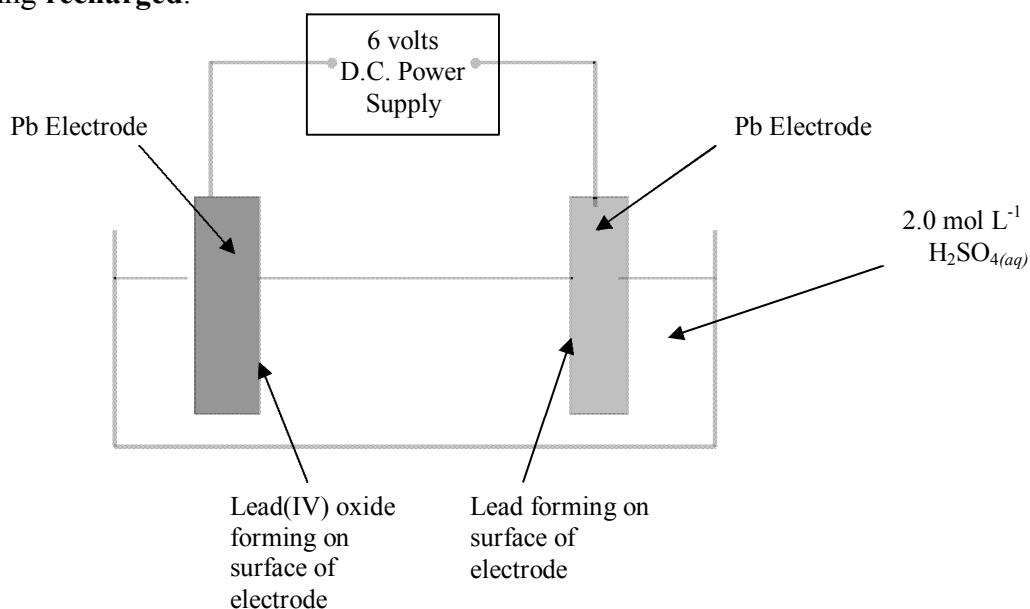
(a)   Label the anode on the above diagram.

[1 mark]

(b)   Write the half equation, for the reaction occurring at the anode during the **recharging** process.

[1 mark]

(c)   After a short while, the cell was disconnected and connected to a globe, which glowed for a few minutes, then dimmed and eventually went out.

(i)   Write the overall redox reaction for the discharging reaction.

[2 marks]

(ii)   With reference to this equation, explain why the bulb went out after a few minutes.

_____

_____

_____

_____

[2 marks]

SEE NEXT PAGE

(d)   A student suggested trying to recharge the lead-acid cell by connecting it to one dry (Leclanché) cell. Explain why this would not work.

_____

_____

_____

[1 mark]

(e)   In a car battery the lead electrodes are constructed in the form of grid or mesh structures. Suggest a reason for this.

_____

_____

[1 mark]

5.   Write an equation for the production of the soap Sodium Stearate, ($CH_3(CH_2)_{16}COONa$) from a triglyceride and sodium hydroxide.

[2 marks]

SEE NEXT PAGE

6.   A student reacted solid copper(II) hydroxide with aqueous ammonia to investigate the following reversible reaction:

$$Cu(OH)_{2(s)} \quad + \quad 4NH_{3(aq)} \quad \rightleftarrows \quad [Cu(NH_3)_4]^{2+}_{(aq)} \quad + \quad 2OH^-_{(aq)}$$
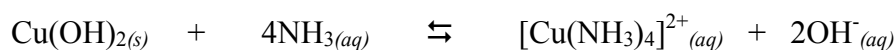
(a)   Write the Equilibrium constant (K) expression for the reaction.

[1 mark]

(b)   Complete the table showing expected observations, and explain the reasons for these changes using your knowledge of equilibrium where appropriate. *(One has been partly done for you)*

Procedure: (a) Add solid copper(II) hydroxide to aqueous ammonia solution.	
Observation: Some of the pale blue solid dissolves to form a deep blue solution.	*Explanation:*
Procedure: (b) To half of the solution produced in (a), add sodium hydroxide solution.	
Observation:	*Explanation:*
Procedure: (c) To the other half of the solution from (a), add magnesium nitrate solution.	
Observation:	*Explanation:*

[8 marks]

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7. From the following list of substances, chose two that fit the descriptions below.

H_3PO_4 $Cr(NO_3)_3$ Cl_2 HNO_3 $CH_3CH_2CH_2COOH$

$Cr(OH)_3$ $K_2Cr_2O_7$ C_2H_4 Br_2 CH_3CHO

C_3H_8 CH_3CH_2OH H_2 CH_4 $HOOCCOOH$
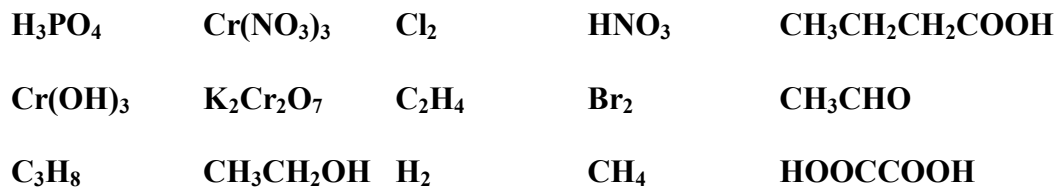
Description	Substance 1	Substance 2
Two green substances that are both soluble in water.		
Two monoprotic acids.		
Two substances that can react together to produce ethanoic acid		
Two substances that can be used as monomers in polymerization reactions		
Two substances with the same empirical formula.		

[10 marks]

8. Write the electron configuration for the following species:

(a)   A Neon atom   _____

(b)   A Potassium ion   _____

[2 marks]

SEE NEXT PAGE

9.   This question relates to the ester molecule shown below:
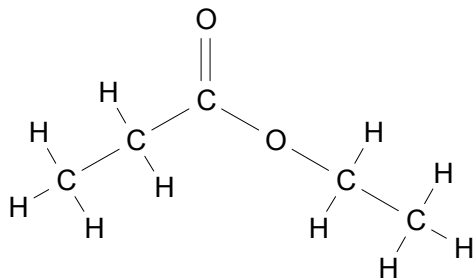
(a)   Draw the structures and give the names of the two organic molecules that would be required to synthesise this compound.

1.
Name:

2.
Name:

[4 marks]

(b)   The ester was found to be only slightly soluble in water. Showing your reasoning, briefly explain what that suggests about the polarity of the molecule.

_____

_____

_____

_____

_____

[2 marks]

SEE NEXT PAGE

10.   A student was required to standardise a solution of sulfuric acid by titrating it with a sodium carbonate solution made up from an accurately weighed mass of pure sodium carbonate. The sulfuric acid was placed in the burette. The sodium carbonate solution was pipetted into the conical flask with a few drops of methyl orange indicator added.

(a)   Explain why sodium carbonate was chosen for this experiment.

_____

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                                                                    [2 marks]

(b)   Explain why methyl orange was chosen as the indicator?

_____

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                                                                    [2 marks]

SEE NEXT PAGE

11. The two initial reactions involved in the corrosion of iron are:

Anode: $Fe_{(s)} \rightarrow Fe^{2+}_{(aq)} + 2e^-$

Cathode: $O_{2(g)} + 2H_2O_{(l)} + 4e^- \rightarrow 4OH^-_{(aq)}$
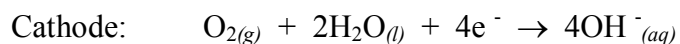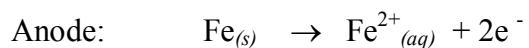
(a)   With the aid of a diagram, explain how these two processes can occur at different areas of the iron.

[2 marks]

(b)   Hot water tanks in homes are made of steel, and can be protected from corrosion by a sacrificial anode made of magnesium. With reference to the standard reduction potentials on your data sheet, the equations given above and your diagram in part (a), explain how this reduces the corrosion of iron in the tank.

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[3 marks]

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.

___

1.   A student was asked to to produce a sample of aluminium carbonate $Al_2(CO_3)_3$ by a precipitation reaction. She added 250.0 mL of 1.00 mol L^{-1} aluminium nitrate solution to 500.0 mL of 0.500 mol L^{-1} sodium carbonate solution.

      (a)   Calculate the mass of aluminium carbonate precipitated.

                                                      [6 marks]

      (b)   What would be the concentration of carbonate ions in the final solution?

                                                      [2 marks]

SEE NEXT PAGE

2.   An unknown organic compound **X,** which was known to contain hydrogen, carbon and chlorine was analysed to find its formula. A 10.15g sample was combusted in air and produced 4.40g of water.

    A separate 5.48g of **X** underwent a substitution reaction to convert the chlorine atoms to chloride ions. On addition of excess silver nitrate solution to the resulting solution, 12.54g of silver chloride was precipitated.

    A third 5.00g sample of X was vapourised and found to occupy 1.05 L at 200°C and 150 kPa.

    (a)   Calculate the empirical formula of **X**.

                [8 marks]

    (b)   Calculate the molar mass of **X**, and hence work out the molecular formula.

                [4 marks]

    (c)   Draw and name a possible structure for **X** that would react readily with aqueous bromine but would not form geometric *(cis/trans)* isomers

                [2 marks]

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3.   Invar is an alloy of iron and nickel that is used for the manufacture surveyors' tapes as it has a low rate of expansion when subjected to high temperatures. The following experiment was carried out in order to determine the % of iron in the alloy. It can be assumed that the nickel present in the alloy will not react with the sulfuric acid.

1.   Weigh out an accurately measured sample of approximately 5 g of Invar alloy.
2.   Add to 200.0 mL 4.00 mol L^{-1} sulfuric acid and warm whilst stirring for 5 minutes.
3.   Filter resulting solution into a 250.0 mL volumetric flask and make up to the mark with distilled water.
4.   Pipette 20.00 mL of this solution into a conical flask and titrate with 0.0345 mol L^{-1} potassium permanganate.

Relevant equations: $MnO_4^{-}{}_{(aq)}$ + $8H^+{}_{(aq)}$ + $5e^-$ → $Mn^{2+}{}_{(aq)}$ + $4H_2O_{(l)}$
                                    $Fe^{2+}{}_{(aq)}$ → $Fe^{3+}{}_{(aq)}$ + e^-

Results: Mass of Invar used: 4.910 g
                     Average Titration volume: 24.68 mL

(a)   Calculate the % of iron by mass in the Invar sample.

[7 marks]

(b)   In titrations potassium permanganate normally needs to be acidified. Explain why is this the case and give a reason why addition of acid is not required in this experiment?

[2 marks]

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4. A experiment was set up to calculate the amount of citric acid present in lemon juice. Citric acid has a formula of $C_6H_8O_7$ and is a weak triprotic acid. 8.00g of the lemon juice was mixed with 50.00 mL of 0.500 mol L^{-1} $NaOH_{(aq)}$ and stirred thoroughly.

The resulting solution was filtered and immediately titrated against 1.05 mol L^{-1} $HCl_{(aq)}$.

The whole experiment was carried out 3 times and the results shown below:

	Titrations		
	1	2	3
Final Reading (mL)	15.90	31.75	47.65
Initial Reading (mL)	0.00	15.90	31.75
Titre (mL)			

(a) By calculating the average number of moles of NaOH remaining in the experiment, calculate the % (by mass) of citric acid in the lemon juice.

[11 marks]

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5.   The steel hull of a ship is protected from corrosion by being connected to a 20.0kg block of zinc metal. The zinc reacts as shown:

$$Zn_{(s)} \rightarrow Zn^{2+}_{(aq)} + 2e^-$$
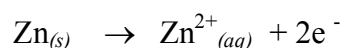
This sacrificial anode will protect the hull from corrosion for 200 days. (1 day = 86 400 seconds)

(a)   Calculate the average current that would flow between the zinc block and the hull of the ship during this period of time.

                                                         [5 marks]

(b)   After this time the block was replaced with of aluminium. Assuming the same current was flowing, calculate the mass (in kg) of aluminium required to protect the ship for the same length of time (200 days).

                                                         [2 marks]

(c)   Give a reason why zinc is more commonly used than aluminium for this purpose.

                                                                   [1 mark]

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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.

1.

<div style="border:1px solid black; padding:10px">

'Isomers are a substances that possess the same molecular formula but have a different molecular structure'

Isomerism exists in a number of different types of organic molecules. The different arrangement or orientation of the atoms often leads to a difference in the properties of the various isomers of the substance.

These differences include physical properties such as melting point, volatility, and solubility in water, which depend mainly on the intermolecular forces acting in the substance.

The chemical properties, such as reactivity, acid/base behaviour and types of reaction that the substance is involved in are often also affected by the different arrangements of the atoms. The different structure of the isomer can also affect the structure and type of product formed in reactions of the isomer.

</div>

Using the descriptions above as a guide, compare and contrast the chemistry of the following 3 pairs of Isomers:

cyclopropane and **propene**

propanal and **propanone (acetone)**

propanoic acid and **methyl ethanoate**

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END OF EXAM