## FAST TRACK CHEMISTRY EXAMINATION, 2011

## QUESTION/ANSWER BOOKLET

# CHEMISTRY

**NAME:** _____

**TEACHER:**_____

### 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 Booklet
Separate Multiple Choice Answer Sheet
Separate Chemistry Data Sheet

*TO BE PROVIDED BY THE CANDIDATE*

*Standard Items:* Pens, pencils, eraser or correction fluid, ruler

*Special Items:* Calculators satisfying the conditions set by the Curriculum Council.

### 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 PAPER**

| Part | Format | No. of Questions Set | No. of Questions to be Attempted | Marks Allocated | Recommended Time (Approx /Minutes |
|---|---|---|---|---|---|
| 1 | Multiple choice | 30 | ALL | 60 (30%) | 55 |
| 2 | Short answer | 12 | ALL | 70 (35%) | 60 |
| 3 | Calculations | 5 | ALL | 50 (25%) | 45 |
| 4 | Extended answers | 3 | 1 | 20 (10%) | 20 |

Total marks for paper = 200 (100%)

## INSTRUCTIONS TO CANDIDATES

**Reading Time:** The examiners recommend that candidates spend the reading time mainly reading the Instructions to Candidates and Parts 2, 3 and 4

**Part 1 – Multiple Choice**

On the separate answer sheet, place a cross (X) in the box that corresponds to the correct answer.

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**

Use a ballpoint or ink pen. **Do not** answer in pencil. Write your answers in this Question/Answer Booklet.

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.

## 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 $BaSO_4(s)$, $Cu(s)$, $Na_2CO_3(s)$].

**SEE NEXT PAGE**

**PART 1 (60 marks = 30% of paper)**

Answer ALL questions in Part 1 on the separate Multiple Choice Answer Sheet provided. Each question in this part is worth 2 marks.

---

1. The atoms of Group 6 elements have, in their ground state,

   (a) Two electrons in the first shell

   (b) Six electrons in the first shell

   (c) Two electrons in the outer shell

   (d) Eight electrons in the outer shell

2. Which of the following bonds would have the greatest ionic character?

   (a) O:O

   (b) Rb:F

   (c) Na:Cl

   (d) Mg:Mg

3. Which one of the following molecules contains a triple covalent bond?

   (a) propyne, $C_3H_4$

   (b) sulfur trioxide, $SO_3$

   (c) phosphorous (III) trichloride, $PCl_3$

   (d) carbonate ion, $CO_3^{2-}$

4. In straight chain alkanes,

   (a) the boiling point increases as the length of the carbon chain increases because there are more covalent bonds

   (b) the boiling point increases as the length of the carbon chain increases because the dispersion forces are larger

   (c) the boiling point decreases as the length of the carbon chain increases because the covalent bonds are less electronegative

   (d) the boiling point decreases as the length of the carbon chain increases because the dispersion forces become insignificant

**SEE NEXT PAGE**

5. Dry ice is solid carbon dioxide. If 44.01 kg of dry ice is sublimed at 25.0ºC and 101.3 kPa, what volume of carbon dioxide vapour is produced?

   (a) $1.077 \times 10^3$ L

   (b) 107.7 L

   (c) 10.77 $m^3$

   (d) $1.077 \times 10^6$ L

6. 0.0100 mole of an iodide of an element "X" is dissolved in 500.0 mL of distilled water. 50.00 mL of this solution was required to react completely with 300.00 mL of 0.0100 mol $L^{-1}$ $Pb(NO_3)_2$ solution, forming lead iodide precipitate. What is the likely formula of the iodide?

   (a) XCl

   (b) $XCl_2$

   (c) $XCl_3$

   (d) $XCl_4$

7. Copper wire may be easily bent without breaking. The best explanation for this is that

   (a) the forces between the copper atoms are weak, this allows the copper atoms to move around easily.

   (b) slight changes in relative positions of adjacent copper particles do not break the bonds as they are equally strong in all directions.

   (c) copper particles are strongly bonded in layers, but the bonding between the layers is relatively weak.

   (d) all of the above.

8. A chemist dissolved a sample of an unknown metal in sufficient hydrochloric acid to completely dissolve the sample. She then added sodium hydroxide solution sparingly and noticed a that a white precipitate formed. Upon adding excess sodium hydroxide solution she noticed that the precipitate re-dissolved. The metal was most likely

   (a) silver.

   (b) magnesium.

   (c) gold.

   (d) zinc.

**SEE NEXT PAGE**

9. The table below shows the first six ionisation energies for an element "Z".

| *Ionisation Energy* | *Value (kJ mol$^{-1}$* |
|---|---|
| 1$^{st}$ | 510 |
| 2$^{nd}$ | 973 |
| 3$^{rd}$ | 3416 |
| 4$^{th}$ | 4512 |
| 5$^{th}$ | 5789 |
| 6$^{th}$ | 6734 |

The formula for a phosphate of X would be

(a) $XPO_4$

(b) $X_2(PO_4)_3$

(c) $X_3PO_4$

(d) $X_3(PO_4)_2$

**The next two items refer to the following information.**

Some of the properties of the pure substances *W, X, Y* and *Z* are given below.

| Substance | Hardness Of solid | Melting Point (º C) | Electrical conductivity of solid | Electrical conductivity of solution |
|---|---|---|---|---|
| W | Soft | -120 | Negligible | High |
| X | Soft | 20 | Negligible | Negligible |
| Y | Hard | 800 | Negligible | High |
| Z | Hard | 2850 | Negligible | Not measured (insoluble) |

10. The substance most likely to be a covalent network substance is

(a) *W*

(b) *X*

(c) *Y*

(d) *Z*

11. The substance most likely to be an ionic network substance is

(a) *W*

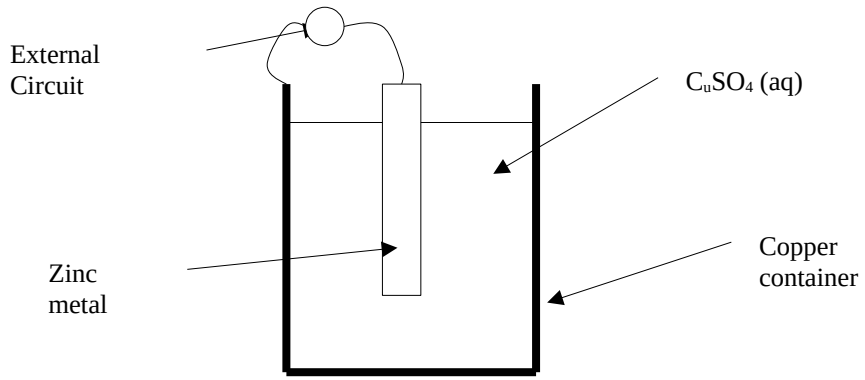
(b) *X*

(c) *Y*

(d) *Z*

**SEE NEXT PAGE**

12. The diagram below shows a zinc rod immersed in a solution of copper sulfate which is in a copper container. An external conducting circuit links the zinc and copper.




Which of the following statements about the circuit is **not** true?

(a) The half-equation at the zinc rod is: $Cu^{2+}_{(aq)} + 2e^- \longrightarrow Cu_{(s)}$

(b) Electrons flow from the zinc, through the external circuit into the copper container.

(c) Reduction occurs on the surface of the copper container.

(d) The zinc rod will slowly dissolve.

13. Consider the following reaction:

$TiO_{2(s)} + 2Cl_{2(g)} + 2C_{(graphite)} \longrightarrow TiCl_{4(g)} + 2CO_{(g)}$ , $\Delta H = -78$ kJ $molL^{-1}$

Which of the following will increase the rate of reaction?

| | |
|---|---|
| I | Powdering the $TiO_2$ and C |
| II | Increasing the temperature |
| III | Adding a suitable catalyst |

(a) I only

(b) II only

(c) III only

(d) All of I, II and III

14. In a reversible reaction, equilibrium is reached when

(a) reactants stop changing into products

(b) the activation energy of the forward and reverse reactions is equal

(c) the concentrations of reactants and products are equal

(d) the concentrations of reactants and products are constant

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15. A student has an approximately 2 mol $L^{-1}$ solution of ethanoic acid ($CH_3COOH$), which she adds via a burette into a 25.0 mL sample of 2.00 mol $L^{-1}$ NaOH solution.
The equation for the reaction is:

$$CH_3COOH + NaOH \longrightarrow H_2O + CH_3COONa$$

The indicator used changes colour at a pH of 7.3, while the pH of a 1 mol $L^{-1}$ solution of $CH_3COONa$ is 8.5
The equivalence point of the titration will occur

(a) after the end point has been reached

(b) before the end point is reached

(c) at the end point

(d) either before or after the end point, but additional information is needed to decide this

16. Which of the following solutions would have a pH greater than 7.0 at 25 ºC?

(a) 1.00 mol $L^{-1}$ potassium chloride solution

(b) 1.00 mol $L^{-1}$ potassium ethanoate solution

(c) 1.00 mol $L^{-1}$ ammonium chloride solution

(d) 1.00 mol $L^{-1}$ hydrogen chloride solution

17. Just before using a pipette in a titration, it must be rinsed with

(a) a non-alkaline detergent, then distilled water

(b) a standard solution, then distilled water

(c) a little of the solution to be used in it

(d) distilled water only

18. Which one of the following species is the strongest oxidising agent at 25 ºC?

(a) $F_2(g)$

(b) $F^-(aq)$

(c) $Na(s)$

(d) $Na^+(aq)$

19. Consider the following equation, which represents a reaction in the extraction of chromium from its ore

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$$2Fe_2O_3.Cr_2O_3 + 4Na_2CO_3 + 3O_2 \longrightarrow 2Fe_2O_3 + 4Na_2CrO_4 + 4CO_2$$

Which of the following statements about the oxidation states of the substances is correct?

(a) The iron has been reduced from a +3 to a +2 oxidation state

(b) The chromium has been oxidised from a +3 to a +6 state

(c) The carbon has been oxidised from a +2 to a +4 state

(d) The reaction is not a REDOX reaction and no species have changed oxidation state

20. Which of the following will **not** decolourise an acidified solution of potassium permanganate?

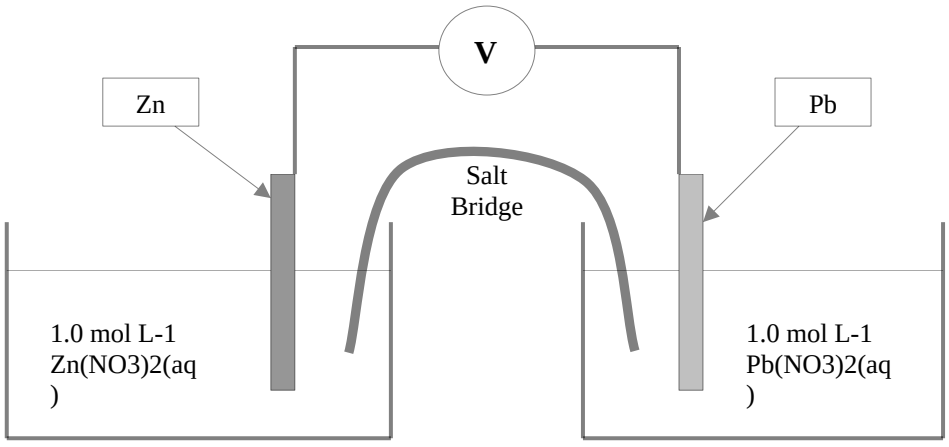
(a) $CH_3CH_2CH_2OH$

(b) $(CH_3)_3COH$

(c) $(CH_3)_2CHOH$

(d) $CH_3CH_2CH_2CHO$

**The following Diagram relates to questions 21, 22 and 23**




21. Assuming standard conditions, what would be the voltage produced by this cell?

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(a) 0.76 volts

(b) 0.89 volts

(c) 0.63 volts

(d) - 0.13 volts

22. 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.

23. 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.

21.

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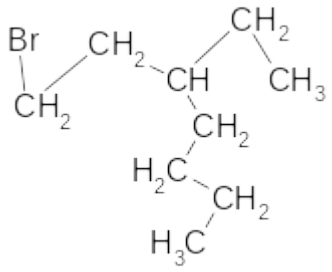
24. What is the name of the compound whose structural formula is given below?



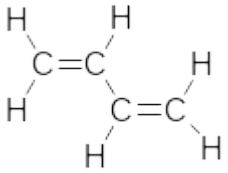

(a) 1-bromo-3-butylpentane

(b) 1-bromo-3-ethylheptane

(c) 1-bromo-3-propylheptane

(d) 7-bromo-5-ethylheptane

25. Butadiene, whose structural formula is below, is used in the production of synthetic rubber. It is classified as *unsaturated* because




(a) the molecules are unstable and react easily

(b) butadiene has fewer hydrogen atoms than butane

(c) each carbon in butadiene shares three electron pairs, not four

(d) each molecule of butadiene contains double bonds

26. The figure below shows the structure of aspirin

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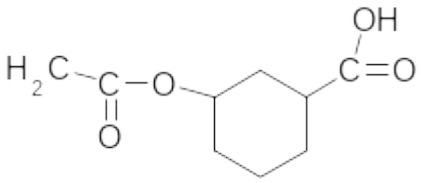

The structure contains

(a) an acid and an ester

(b) an acid and a ketone

(c) an ester and a ketone

(d) a ketone and an alcohol

27. Naphthalene, $C_{10}H_8$, is an unsaturated hydrocarbon. Which of the following species would be most abundant when naphthalene reacts with limited $Br_2$ solution?

(a) $C_{10}H_8Br$

(b) $C_{10}H_8Br_2$

(c) HBr

(d) $H_2$

28. 2-butanol is shaken with warm solution of acidified potassium dichromate. The organic product is

(a) propanoic acid

(b) butanoic acid

(c) butanal

(d) butanone

29. A metal can be extracted from its oxide by heating a mixture of the metal oxide with carbon powder. In an experiment, oxides of iron, copper, aluminium and sodium were mixed together and combined with carbon powder. The Mixture was then heated. As the reactions proceeded, the first metal to appear would be

(a) iron

(b) copper

(c) aluminium

(d) sodium

30. Which of the names below is correct for the molecule shown here?

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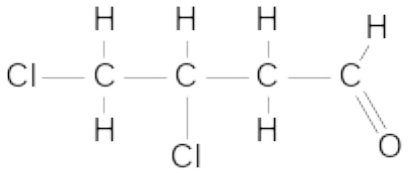

(a) 1,2-dichloro-4-butanone

(b) 3,4-dichlorobutanal

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

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

**END OF PART 1**

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**PART 2**

Answer ALL questions in Part 2 in the spaces provided below. This part carries 70 marks (35% of total).

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 a reaction occurs and the change is not visible, you should write this.

   (a) Potassium bromide is added to silver nitrate solution.

   **Equation** _____

   **Observation** _____

   [3 marks]

   (b) Copper (II) chloride solution is mixed with ammonia solution.

   **Equation** _____

   **Observation** _____

   [3 marks]

   (c) A little concentrated sulfuric acid is added to a mixture of ethanol and propanoic acid and the mixture is heated.

   **Equation** _____

   **Observation** _____

   [3 marks]

   (d) Excess acidified potassium permanganate solution is added to hydrogen peroxide solution.

   **Equation** _____

   **Observation** _____

   [3 marks]

**SEE NEXT PAGE**

2. The electron configuration of a boron atom can be written as $1s^2 2s^2 2p^1$. Using the same notation, give the electron configuration of

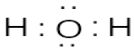
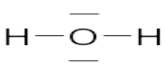
   (a) a sulfide ion $S^{2-}$ _____

   (b) a magnesium ion $Mg^{2+}$ _____

   [2 marks]

3. For each species listed in the table below

   (a) draw the structural formula, representing **all** valence shell electron pairs as : or as -
   (b) indicate the shape of the species by either a sketch or a name.

   [for example water  or  and so on]

| **Species** | **Structural formula (showing all valence shell electrons)** | **Shape (sketch or name)** |
|---|---|---|
| sulfur dioxide, $SO_2$ | | |
| Sulfate ion, $SO_4^{2-}$ | | |
| Nitrogen trichloride, $NCl_3$ | | |

[6 marks]

**SEE NEXT PAGE**

4. The table below shows some physical and chemical properties of the chlorides of some Period 3 elements.

| | NaCl | $MgCl_2$ | $PCl_3$ | $SCl_2$ |
|---|---|---|---|---|
| *Melting point (°C)* | 800 | 710 | -90 | -80 |
| *Boiling point (°C)* | 1470 | 1420 | 80 | 60 |
| *Electrical conductivity of solid* | Poor | Poor | Poor | Poor |
| *Electrical conductivity of liquid* | Good | Good | Poor | Poor |
| *PH of water solution* | 7 | 7 | <7 | <7 |

(a) Explain the large difference in the melting points of $MgCl_2$ and $SCl_2$.

(b) Explain the difference in electrical conductivity of solid and liquid $MgCl_2$.

(c) Would you expect each of these to be an electrical conductor? Explain in each case.

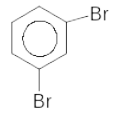
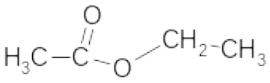
(i) a water solution of NaCl

(ii) a water solution of $PCl_3$

[6 marks]

**SEE NEXT PAGE**

5. Complete the table below.

| **Name of Compound** | **Molecular Formula** | **Empirical Formula** | **Structural Formula** |
|---|---|---|---|
| | | |  |
| 2-methyl-3-pentanol | $C_6H_{14}O$ | | |
| 2,2-dimethylcyclopentanone | | | |
| | | |  |
| ethylcyclobutane | | | |

[7 marks]

6. Name the organic products for the following reactions.

   (a) Methanol is oxidised by acidified potassium dichromate solution.

   _____

   (b) 2-butanol is oxidised by acidified potassium permanganate solution.

   _____

   (c) Sodium metal is added to ethanol

   _____

[3 marks]

7. For each of the following pairs of substances, describe a **chemical test** that could be used to distinguish between the two substances. You must predict your observation for the same test with each substance.

   (a) solutions of magnesium chloride and zinc chloride.

   **Description of Test**

   **Observation with magnesium chloride**

   **Observation with zinc chloride**

   (b) samples of ammonia gas and nitrogen gas.

   **Description of Test**

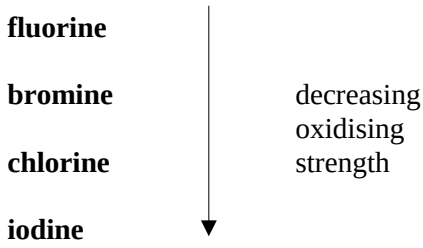
   **Observation with ammonia gas**

   **Observation with nitrogen gas**

[8 marks]

**SEE NEXT PAGE**

8. A student, while preparing for her TEE Chemistry Examination, studies the table of Standard Reduction Potentials provided in your data sheet. In her notes, she lists the ***halogens*** in order of oxidising strength. This is her list:




(a) Which two halogens are wrongly placed? _____

(b) Show by equation, chlorine acting as an oxidising agent with a metal.

_____

(c) ***Halide*** ions can act as *reducing agents*. List the halide ions in order of ***decreasing*** strength as reducing agents.

_____

(d) Show by equation, a halide ion acting as an reducing agent with a metal ion.

_____

(e) If fluorine gas was bubbled through a solution containing a mixture of chloride, bromide and iodide ions, what effect would this have? Equations are not necessary.

_____

(f) When fluorine is bubbled through the solution described in part (e), it is also found that oxygen gas is evolved. Use equations to explain this observation.

_____

_____

_____

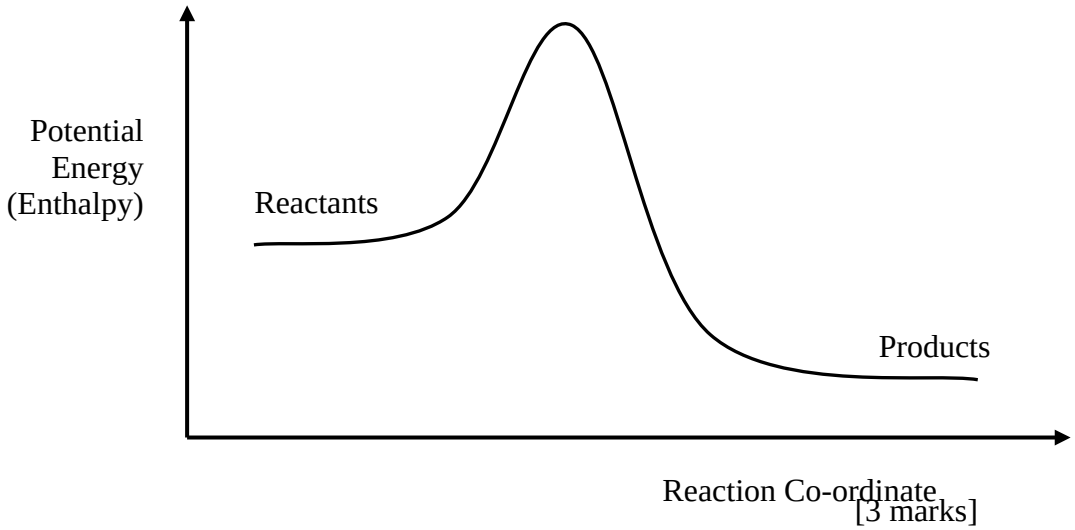
_____

[8 marks]

**SEE NEXT PAGE**

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

(i) The activation energy for the forward reaction as **$E_A$**
(ii) The enthalpy change for the reverse reaction as **ΔH**
(iii) An energy pathway for the catalysed reaction as **CAT**




[3 marks]

(b). Write the electron configuration for the following species:

(i) A Neon atom

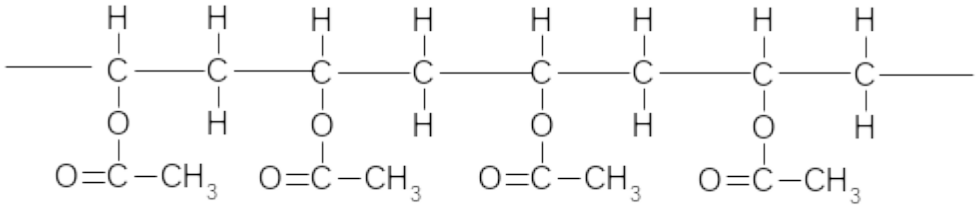
_____

(ii) A Potassium ion

_____

[4 marks]

10. Polyvinyl acetate, PVA, is a woodworking glue which consists of a polymer chain, part of which is represented below:



(a) Draw the formula of the repeating unit in the above structure

(b) Draw the structural formula for the *monomer* molecule used in the production of PVA.

(c) What is the name of the type of polymerisation used in the manufacture of PVA?

_____

(d) How could a chemist test a reaction mixture to ensure that polymerisation was complete?

_____

_____

_____

_____

[6 marks]

11.

The dissociation of carbonyl chloride is represented by the following equation:

$$COBr_{2(g)} \rightleftharpoons CO_{(g)} + Br_{2(g)}$$

(a) Write an expression for the equilibrium constant *k*, for the above reaction

(b) Complete the table below, indicating how the following changes would affect the number of moles of carbonyl bromide present at equilibrium.

| **CHANGE** | **EFFECT ON NUMBER OF MOLES OF $COBr_2$** | **REASON** |
|---|---|---|
| Bromine gas is rapidly introduced to the reaction flask at a constant volume and temperature. | | |
| Ethene gas is rapidly introduced to the reaction flask at a constant volume and temperature. | | |
| The volume of the system is allowed to expand at a constant temperature | | |

[7 marks]

**END OF PART 2**

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**PART 3**

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 equations and clear setting out, even if you can't complete the problem. When questions are divided into sections, working for each section must be clearly distinguished using (a), (b) and so on. You **MUST** correct final numerical answers to three (3) significant figures where appropriate, and you **MUST** provide units where applicable. Information which may be necessary for solving the problems is located on the separate Chemistry Data Sheet. You **MUST** show clear reasoning, and failure to do so will result in loss of marks. This part carries 50 marks (25% of the total).

---

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**

**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 200ºC 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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**SEE NEXT PAGE**

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: $MnO_4^-{}_{(aq)} + 8H^+{}_{(aq)} + 5e^- \rightarrow Mn^{2+}{}_{(aq)} + 4H_2O_{(l)}$

$Fe^{2+}{}_{(aq)} \rightarrow Fe^{3+}{}_{(aq)} + e^-$

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 acidification is this not required in this experiment?

[2 marks]

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4. An 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. Sulfuric acid has been found to be a major contributor to pollution in our waterways near mining operations. The sulfuric acid results from the oxidation of Iron Pyrites ($FeS_2$) in water. The iron pyrites is often found in coal deposits and in regions where iron is mined.

In the presence of water, iron pyrites ($FeS_2$) is oxidised by air to form Iron (III) oxide and sulfuric acid:

$$4FeS_{2(s)} + 15O_{2(g)} + 8H_2O_{(l)} \longrightarrow 8H_2SO_{4(aq)} + 2Fe_2O_{3(s)}$$

On one particular day, 9.00 tonnes of iron pyrites dissolved in a freshwater lake of volume $3.00 \times 10^7$ L. In the following calculation, you may assume that the $H_2SO_4$ is completely dissociated.

(a) Find the $H^+$ ion concentration in the water.

[3marks]

(b) Find the pH of the water.

[2marks]

To treat the acidity problem, the local mining company dissolved 9.00 tonnes of solid sodium hydroxide into the lake.

(c) Was the amount of sodium hydroxide added sufficient to neutralise the lake? Support your answer with calculations.

[3 marks]

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**PART 4 (20 marks - 10% of paper)**

Answer the following extended answer questions. 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, but you will lose marks if what you write is unclear or lacks coherence.
Your answer should be presented in about 1½ to 2 pages. Begin your essay on the next page.

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1. The tables below show the electrical conductivity of various aqueous compounds at a concentration of 0.01 $molL^{-1}$.

   By analysing the data, it is possible to make comparisons between similar compounds and identify trends. Referring to ***specific*** data from the table, write an essay on any trends indicated, carefully explaining the *chemistry* involved.

## MOLAR CONDUCTIVITIES OF AQUEOUS SOLUTIONS AT 25ºc

Molar conductivity = the electrical conductivity of a solution containing 1 mole placed between electrodes 1 metre apart.

| **SOLUTE** | CONDUCTIVITY ($\Lambda$/mS $m^2$ $mol^{-1}$) |
|---|---|
| $AgNO_3$ | 10.91 |
| $BaCl_2$ | 23.85 |
| $CH_3COOH$ | 1.60 |
| $CH_3COONa$ | 8.38 |
| HBr | 41.37 |
| HCl | 41.19 |
| HF | 9.61 |
| HI | 41.28 |
| $HNO_3$ | 40.60 |
| $H_2SO_4$ | 61.60 |
| KBr | 14.32 |
| KCl | 14.13 |
| KI | 14.22 |
| $KNO_3$ | 13.58 |
| $NH_4Cl$ | 14.13 |
| NaCl | 11.85 |
| NaOH | 23.80 |
| $Na_2S0_4$ | 21.35 |

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