**SEMESTER 1 EXAMINATION 2004**

**QUESTION/ANSWER BOOKLET**

# CHEMISTRY

**NAME:** _____

**CLASS:** _____

***TIME ALLOWED FOR THIS PAPER***

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

***MATERIAL REQUIRED/RECOMMENDED FOR THIS PAPER***

TO BE PROVIDED BY THE SUPERVISOR

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

TO BE PROVIDED BY THE CANDIDATE

Standard Items: Pens, pencils, eraser or correction fluid, 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 PAPER

| Part | Format | No of Questions Set | No of Questions to be Attempted | Recommended Time (Approx) /Minutes | Marks Allocated |
|---|---|---|---|---|---|
| 1 | Multiple Choice | 20 | ALL | 35 | 30 (30%) |
| 2 | Short Answers | 6 | ALL | 40 | 30 (30%) |
| 3 | Calculations | 4 | ALL | 30 | 30 (30%) |
| 4 | Extended Answers | 2 | 1 | 15 | 10 (10%) |
| | | | | Total marks | 100 (100%) |

## *INSTRUCTIONS TO CANDIDATES*

1. The rules for the conduct of the Tuart College Semester Examinations are the same as those for the conduct of the Tertiary Entrance Examinations and are detailed in the booklet *TEE Handbook*. Sitting this examination implies that you agree to abide by these rules.

2. 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 in the Multiple Choice Section do this.

   **Part 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.

3. The examiners recommend that you spend your reading time mainly reading the instructions to candidates and Parts 2, 3 and 4.

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

**SEE NEXT PAGE**

**PART 1 (30 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 1½ marks.

1. In which region of the Periodic Table are the elements whose **halides** (compounds with elements of Group VII) are covalent at room temperature?

   (a) The top left hand region

   (b) The lower left hand region

   (c) The top right hand region

   (d) The lower right hand region

2. Which of the following lists contains exactly one compound which is soluble in water?

   (a) sodium sulfate, ammonium nitrate, calcium carbonate.

   (b) aluminium chloride, lead (II) sulfate, barium nitrate.

   (c) magnesium carbonate, silver chloride, ammonium carbonate.

   (d) barium sulfate, calcium carbonate, lead (II) chloride.

3. Which one of the following liquids will have the highest electrical conductivity?

   (a) Pure ethanol.

   (b) Tap water.

   (c) Concentrated sugar solution.

   (d) 0.1 mol $L^{-1}$ sodium hydroxide solution.

4. The molar mass of a metal hydroxide is 92.95 g. The metal is most likely

   (a) Cobalt

   (b) Iron

   (c) Calcium

   (d) Nickel

5. A flour mill is especially prone to explosions unless suitable precautions are taken. The best explanation for this is that the fine particles of flour

   (a) have a very large surface area causing combustion reactions to proceed much faster

   (b) have a high translational vibration which is easily converted to heat energy

   (c) have a higher kinetic energy than the activation energy required for reaction

   (d) can produce a fast chain reaction by collision of one particle with another.

**SEE NEXT PAGE**

6. Measured at constant temperature, the rates of some chemical reactions decrease as the reactions proceed because

   (a) the reaction concentrations decrease with time

   (b) absorption of heat by the reaction diminishes the reaction rate

   (c) a catalyst is needed to maintain a constant rate of reaction

   (d) the fraction of reactant molecules with energies in excess of the activation energy decreases as the reaction proceeds

7. A rise in temperature of gaseous reactants results in an increase in the reaction rate of a reaction. This is due mainly to an increase in

   (a) the activation energy of the reaction

   (b) the proportion of collisions with energies greater than the activation energy

   (c) the proportion of molecules which dissociate into their constituent atoms

   (d) the frequency of collisions between reactant molecules

8. Chemical equilibrium is the state in which

   (a) the forward reaction stops and the reverse reaction begins.

   (b) the rate of the forward reaction decreases and the rate of the reverse reaction increases.

   (c) the rate of the forward reaction equals the rate of the reverse reaction.

   (d) the chemical reaction stops.

9. Consider the following system to be in equilibrium:

   $Fe^{3+}$ + $SCN^-$ ⇄ $[Fe(SCN)]^{2+}$
   (yellow) (colourless) (red)

   The red colour can be made more intense by adding a solution of

   (a) $AgNO_3$ to precipitate AgSCN.

   (b) $Fe(NO_3)_3$

   (c) NaCl

   (d) $K_2CO_3$

10. The formation of methanol from hydrogen and carbon monoxide can be represented by

$$CO + 2H_2 \rightleftarrows CH_3OH \qquad \Delta H = +90.97 \text{ kJ}$$

Increasing the temperature will

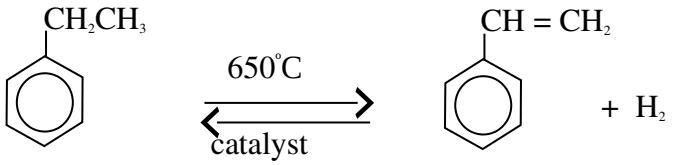
(a) increase the forward reaction rate to a larger extent than the reverse reaction.

(b) decrease the forward reaction rate.

(c) decrease the amount of $CH_3OH$ at equilibrium.

(d) increase the backward reaction rate to a larger extent than the forward reaction.

11. Styrene, which is used extensively as a plastics intermediate, is produced by the dehydrogenation of ethylbenzene.




ethylbenzene styrene

The reaction is endothermic and all reactant and products are gases. The conditions which should give a maximum equilibrium yield are

(a) reduced temperature, reduced pressure.

(b) reduced temperature, elevated pressure.

(c) elevated temperature, reduced pressure.

(d) elevated temperature, elevated pressure.

12. X is an element in Group II of the Periodic Table. It is a solid with high melting point.

Y is an element in Group VII of the Periodic Table. It is a gas at room temperature.

Which of the following indicates the expected electrical conductivity of the compound formed between X and Y in the solid and liquid states.

| | solid | liquid |
|---|---|---|
| (a) | negligible | negligible |
| (b) | negligible | good |
| (c) | good | negligible |
| (d) | good | good |

Question 13 – 15 use the information in the Table below.

| Substance | Melting Point (°C) | Boiling Point (°C) |
|---|---|---|
| helium | –269.7 | –268.9 |
| sodium chloride | 800.4 | 1413 |
| Carbon dioxide | forms a liquid only under pressure | –78.5 |
| silicon dioxide | 1425 | 2230 |
| diamond | above 3500 | about 4200 |
| methane | –182.5 | –161.5 |
| potassium hydroxide | 380 | 1320 |
| hydrogen fluoride | –83 | 19.4 |
| water | 0 | 100 |

13. Which of the substances in the Table, if any, form solids held together by bonds that are mainly ionic?

(a) helium, carbon dioxide and methane only.

(b) water and hydrogen fluoride only.

(c) sodium chloride and potassium hydroxide only.

(d) diamond and silicon dioxide only.

14. In which of the substances in the Table, if any, is the intermolecular force of attraction mainly due to Van der Waals' forces?

(a) helium, carbon dioxide and methane only.

(b) water and hydrogen fluoride only.

(c) sodium chloride and potassium hydroxide only.

(d) diamond and silicon dioxide only.

15. Which of the substances in the table, when in the solid state, are composed of polar molecules?

(a) helium, carbon dioxide and methane only.

(b) water and hydrogen fluoride only.

(c) carbon dioxide and methane.

(d) carbon dioxide, water and hydrogen fluoride.

**SEE NEXT PAGE**

16. The property of metals which enables them to conduct an electric current is that

(a) the outer electrons of metal atoms are not firmly bound to the atom

(b) electrons of metal atoms are better suited as charge carriers than those from non-metal atoms.

(c) ions in the metal are able to move freely through the metallic lattice

(d) metal atoms are not as firmly bonded to each other as are non-metallic atoms

17. Generally, covalent compounds have low melting points because:

(a) they consist of oppositely charged ions linked by strong electrostatic attraction force.

(b) they consist of oppositely charged ions linked by weak electrostatic attraction force.

(c) they consist of molecules linked by weak Van der Waals' force.

(d) they consist of molecules linked by strong covalent bonds.

18. In which of the following examples is the underlined substance acting as a base?

(a) $\underline{NH_3}\ (aq) + H_2O\ (l) \rightarrow NH_4^+\ (aq) + OH^-\ (aq)$

(b) $\underline{H_2O}\ (l) + O^{2-}\ (aq) \rightarrow 2OH^-\ (aq)$

(c) $\underline{2K}(s) + 2H_2O\ (l) \rightarrow 2K^+\ (aq) + 2OH^-\ (aq) + H_2\ (g)$

(d) $\underline{H_2O}\ (l) + CO_3^{2-}\ (aq) \rightarrow OH^-\ (aq) + HCO_3^-(aq)$

19. In a titration experiment, 100.00 mL of stock solution of hydrochloric acid solution was diluted to 500.00 mL in a volumetric flask. A 20.00 mL sample of the diluted solution required 100.00 mL of a 0.200 mol $L^{-1}$ sodium carbonate solution for neutralisation. The concentration of hydrogen ions in the stock solution was

(a) 2.00 mol $L^{-1}$

(b) 5.00 mol $L^{-1}$

(c) 10.0 mol $L^{-1}$

(d) 12.0 mol $L^{-1}$

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20. For the titration between ethanoic acid and standardised sodium hydroxide, which of the following would be **incorrect**.

(a) Add a few drops of phenolphthalein indicator to the ethanoic acid in the burette

(b) Prior to adding the acid to the burette, rinse the burette with distilled water and then a small portion of the acid solution

(c) Pipette out 20.00 mL samples of the sodium hydroxide solution into three separate conical flasks which have each been rinsed with distilled water.

(d) Rinse the pipette with standardised sodium hydroxide solution before transferring the first sample to the conical flask

**END OF PART 1**

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**PART 2 (30 marks = 30% 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 observe, including any
   * colours
   * odours
   * precipitates (give the colour)
   * gases evolved (give the colour or describe as colourless)

   If a reaction occurs but the change is not visible, you should state this.

   (a) Barium hydroxide solution is added to dilute hydrochloric acid.

   **Equation** _____

   **Observation** _____

   _____

   [2 marks]

   (b) Copper (II) sulfate solution is added to sodium hydroxide solution

   **Equation** _____

   **Observation** _____

   _____

   [2 marks]

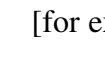
   (c) Manganese dioxide pellets are added to hydrogen peroxide solution.

   **Equation** _____

   **Observation** _____

   _____

   [2 marks]

2. (a) For each of the following species draw the structural formula, representing **all** valence shell electron pairs as
[for example, water  ]

(b) Classify each as polar or non polar.

| Methanamine, $CH_3NH_2$ | Polar of Non Polar? |
|---|---|
| | |
| Carbonate ion, $CO_3^{2-}$ | Polar or Non Polar? |
| | |

[5 marks]

3. Using the information in the table, identify the substances A, B, C, and D from the following list:

aluminium carbonate
candle wax
cobalt nitrate
copper
gold
silicon dioxide
sodium chloride
sucrose (cane sugar)
sulphur

| Substance | Electrical conductivity | | | Solubility in water | Colour of solid | Name of substance |
|---|---|---|---|---|---|---|
| | Solid | Liquid | Water solution | | | |
| A | nil | conducts | conducts | soluble | white | |
| B | nil | nil | nil | soluble | white | |
| C | conducts | conducts | — | insoluble | pink | |
| D | nil | conducts | — | insoluble | white | |

[4 marks]

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4. (a) Perchloric acid, $HClO_4$, is a strong acid. Calculate the pH of 0.0500 mol $L^{-1}$ perchloric acid.

Ans _____

[2 marks]

(b) Calculate the pH of 0.0500 mol $L^{-1}$ barium hydroxide

Ans _____

[3 marks]

5. Classify the following acids by **ticking** <u>two</u> boxes for each acid:

| SUBSTANCE | STRONG ACID | WEAK ACID | DILUTE ACID | CONCENTRATED ACID |
|---|---|---|---|---|
| 0.05 mol $L^{-1}$ $H_2CO_3$ | | | | |
| 10 mol $L^{-1}$ $HCl$ | | | | |
| 10 mol $L^{-1}$ $CH_3COOH$ | | | | |
| 1.0 mol $L^{-1}$ $H_2SO_4$ | | | | |

[4 marks]

6. Consider the following system at equilibrium in a closed container.

$H_{2(g)} + CO_{(g)} \rightleftarrows C_{(s)} + H_2O_{(g)} \qquad \Delta H = +131kJ$

(a) The equilibrium is disturbed by increasing the volume of the container. After a new equilibrium is established, is the amount of $CO_{(g)}$ more, less or the same as before? Explain using reaction rates.

Ans _____

Explanation _____

_____

_____

_____

[2 marks]

(b) If the original equilibrium was disturbed by cooling the container, would the amount of $CO_{(g)}$ be more, less or the same as before? Explain using reaction rates.

Ans _____

Explanation _____

_____

_____

_____

[2 marks]

(c) If solid carbon was added to the system at equilibrium would the amount of $CO_{(g)}$ be more, less or the same as before? Explain using reaction rates.

Ans _____

Explanation _____

_____

_____

_____

[2 marks]

**END OF PART 2**

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**PART 3 (30 marks = 30% of 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 equations 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. Correct 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 chemist finds the calcium content of a rock by dissolving a sample in an acid solution and precipitating the $Ca^{2+}$ ions as the hydrated salt $CaC_2O_4.H_2O$ using an excess of potassium oxalate solution.

$$K_2C_2O_4.H_2O_{(aq)} + Ca^{2+}_{(aq)} \rightarrow CaC_2O_4.H_2O_{(s)} + 2K^+_{(aq)}$$

In a particular analysis, 0.4367 g of rock yielded a precipitate of $CaC_2O_4.H_2O$ with a mass of 0.2920 g.

(a) What is the percentage by mass of calcium in the rock?

[5 marks]

(b) If another ion were present in the rock sample that formed a precipitate with oxalate ions, how would this affect the calculated result?

[2 marks]

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2. A poisonous gas is known to be a compound of carbon, oxygen and chlorine. A 3.55 g sample of the gas was burned in excess oxygen and produced 0.8032 L of carbon dioxide gas at STP.

A further sample of the gas weighing 4.26 g had all its chlorine converted to chloride ions, and when treated with excess silver nitrate solution, yielded 12.34 g of pure dry silver chloride.

Finally, a third sample of the gas was found to have a density of 4.42 g $L^{-1}$ at STP.

(a) By finding the percentages by weight of each element in the compound, calculate the empirical formula.

[5 marks]

(b) From the third sample, find the molecular formula of the gas.

[3 marks]

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3. 100 mL of an oxalic acid ($H_2C_2O_4$) solution is first diluted with distilled water to 1.00 L. Then 20.0 mL samples of this diluted solution are titrated against 0.103 mol. $L^{-1}$ barium hydroxide solution. The volume of barium hydroxide solution required for neutralisation was 14.3 mL.

(a) Calculate the concentration of the original oxalic acid solution.

[5 marks]

(b) What mass of pure oxalic acid was dissolved in each litre of the original solution?

[2 marks]

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4. In an experiment, 150 mL of 0.200 mol $L^{-1}$ lead (II) nitrate solution was added to 350 mL of 0.500 mol $L^{-1}$ potassium chloride solution. A white solid was precipitated.

(a) Write the ionic equation for the above reaction.

[2 marks]

(b) Determine the mass of the white solid which is formed.

[3 marks]

(c) Calculate the concentrations of each of the three ions which remain in the final solution.

[3 marks]

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**END OF PART 3**

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**PART 4 (10 marks = 10% of paper)**

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

Marks are awarded 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 1 to 1½ pages. Begin your answer on the next page.

1. Most chemical reactions start more rapidly and go more slowly as the reactants are used up. The reaction between acidified permanganate solution and oxalic acid seems to be different in that the rate of the reaction increases as time goes by. The equation for the reaction is as follows.

$$\underset{\text{(Purple)}}{2MnO_4^-(aq)} + 5H_2C_2O_4(aq) + 6H^+(aq) \rightarrow 10CO_2(g) + \underset{\text{(Colourless)}}{2Mn^{2+}(aq)} + 8H_2O(l)$$

To investigate this a student dissolved oxalic acid crystals in water and added acidified potassium permanganate solution. The mixture turned purple and took some time to become colourless, but as more purple permanganate solution was added the purple colour disappeared more rapidly.

Suggest and explain four possible reasons for the increase in reaction rate and for each suggestion outline how you could test your idea.

OR

2. Two isotopes of nitrogen are $^{14}_{7}N$ and $^{15}_{7}N$. In order to prove which pure samples of $NH_4Cl$ actually contained the $^{14}_{7}N$ or $^{15}_{7}N$ the following experiments were suggested.

   (a) Titrate a solution of each sample with standard sodium hydroxide solution.

   (b) Change the nitrogen in each sample to ammonia. React the ammonia with excess standard acid - and then back titrate any unreacted acid with a standard sodium hydroxide solution.

   (c) Dissolve known masses of each sample in water, add excess silver nitrate solution to both and then wash, dry and weigh the precipitate.

   (d) Heat known masses of each sample with excess sodium hydroxide. Collect and dry the ammonia and measure its volume, temperature and pressure. Calculate its molecular mass.

**SEE NEXT PAGE**

Comment on <u>each</u> of the suggested experiments by explaining the chemistry involved. Your answer should clearly indicate if the experiment would prove the existence of the two isotopes or not.

**END OF QUESTIONS**

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**END OF PAPER**