Semester 1 Examination, 2007

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, highlighter

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	Number of questions available	Number of questions to be attempted	Suggested working time (Minutes)	Marks available
1 Multiple Choice	20	ALL	35	30 (30%)
2 Short Answers	6	ALL	40	35 (35%)
3 Calculations	3	ALL	30	25 (25%)
4 Extended Answers	1	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 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 space 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 candidates spend the 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)

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 of the following solids would you expect hydrogen bonding to play a significant role in determining the melting temperature?

   (a) solid H_2S
   (b) solid CO_2
   (c) solid $(NH_2)_2CO$
   (d) solid CH_3F

2. Cyclohexene has the molecular formula C_6H_{10}. The percentage by mass of hydrogen in cyclohexene is approximately

   (a) $\frac{10}{10+72}\times 100$
   (b) $\frac{10+72}{10}\times 100$
   (c) $\frac{10\times 2}{10+72}\times 100$
   (d) $\frac{10\times 2}{(10\times 2)+72}\times 100$

3. Seawater contains 8.44×10^{-4} mol L^{-1} of Br^-.
   If all the Br^- could be extracted as Br_2 from 1.00 L of seawater, the yield would be

   (a) 0.0674 g
   (b) 0.135 g
   (c) 33.7 g
   (d) 66.4 g

4. The number of neutrons, protons and electrons respectively in $^{33}_{16}S^{2-}$ is

   (a) 33, 16, 18
   (b) 17, 16, 16
   (c) 17, 16, 18
   (d) 16, 17, 14

SEE NEXT PAGE

Use the following information to answer questions 5 to 7.

The diagram below represents the groups and rows of the Periodic Table, but the elements in it are not given their normal symbols.

A																	
D												E	G		J		
	L										M						
	Q				R						T						
X													Z				

5. The formula of the compound formed between element J and element Q is.

   (a) Q_2J
   (b) Q_2J_2
   (c) QJ
   (d) QJ_2

6. Which one of the following statements regarding the position of the elements D and X in the periodic table is correct?

   (a) They are in the same period and exhibit similar chemical properties.
   (b) They are in the same group and exhibit similar chemical properties.
   (c) They are in the same group and have identical electronic configurations.
   (d) They are in the same period and have the same number of electrons in the outermost energy level.

7. The element that is most likely to form coloured compounds is

   (a) D
   (b) M
   (c) Q
   (d) R

8. A 2.63 sample of an organic compound containing only carbon and hydrogen was found, on analysis, to contain 2.15 g of carbon. The empirical formula of the compound is

   (a) CH_3
   (b) C_3H_7
   (c) C_3H_8
   (d) C_6H_{16}

SEE NEXT PAGE

9. Which one of the following 0.10 mol L^{-1} solutions would form a precipitate when added to a 0.10 mol L^{-1} solution of sodium hydroxide?

   (a) barium nitrate
   (b) iron(II) chloride
   (c) potassium sulfide
   (d) ammonium hydrogencarbonate

10. Two processes that result in the formation of ions in solution are dissociation and ionisation. Which one of the following equations represents the process of dissociation?

   (a) $HC\ell_{(aq)} + H_2O_{(\ell)} \rightleftarrows H_3O^+_{(aq)} + C\ell^-_{(aq)}$
   (b) $HC\ell_{(aq)} \rightleftarrows H^+_{(aq)} + C\ell^-_{(aq)}$
   (c) $Ca(OH)_{2(s)} \rightarrow Ca^{2+}_{(aq)} + 2OH^-_{(aq)}$
   (d) $Ca^{2+}_{(aq)} + 2OH^-_{(aq)} \rightarrow Ca(OH)_{2(s)}$

11. A catalyst is used in the industrial production of NH_3 from H_2 and N_2. The best description of the effect of the catalyst is that it

   (a) increases the proportion of NH_3 in the mixture at equilibrium.
   (b) increases the rate of production of H_2 and N_2.
   (c) increases both the rate of production of H_2 and N_2 and the rate of production of NH_3.
   (d) decreases the rate of production of NH_3.

Question 12 refers to the following information.

The element silicon is becoming increasingly important in our technological society. It is used for computer chips and for ceramics such as the heat resistant tiles on the space shuttle. The element is produced commercially by heating silica with carbon in an electric arc furnace at 2000 K, according to the equation.

$SiO_{2(\ell)} + 2C_{(s)} \rightarrow 2CO_{(g)} + Si_{(\ell)}$.

In a particular furnace, 300 kg of SiO_2 is heated with 180 kg of carbon.

12. When the reaction is completed the amount of excess reagent is

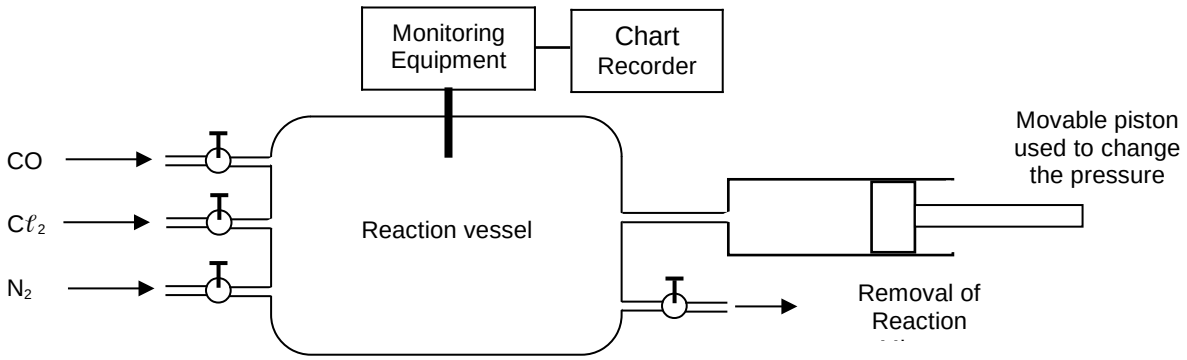
   (a) 120 kg of SiO_2
   (b) 60 kg of SiO_2
   (c) 120 kg of carbon
   (d) 60 kg of carbon.

Questions 13 to 16 refer to the following information.

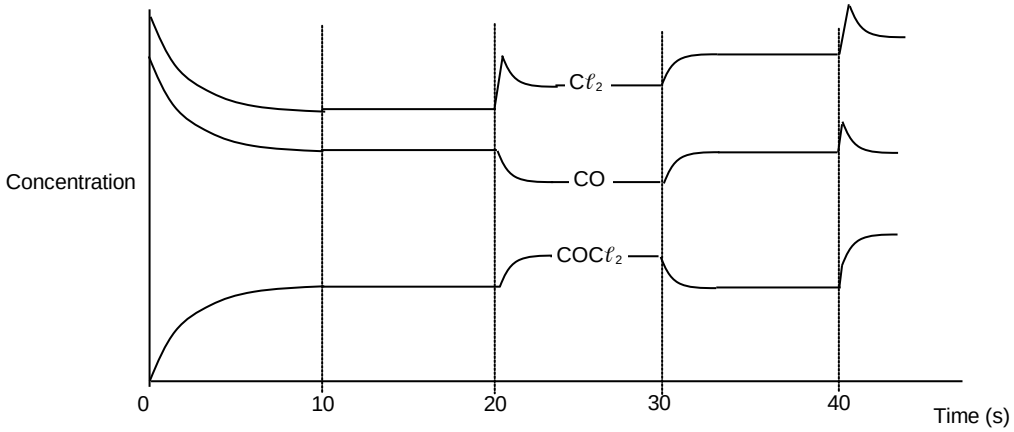
The manufacture of the insecticide carbaryl requires the production of phosgene, $COC\ell_2$, from carbon monoxide and chlorine. The reaction is represented by the equation

$CO_{(g)} + C\ell_{2(g)} \rightleftharpoons COC\ell_{2(g)} \qquad \Delta H = -110 \text{ kJ mol}^{-1}$

The reaction takes place in a vessel where the pressure can be changed, It can be connected to supplies of CO, $C\ell_2$ and N_2. The reaction mixture can be removed by opening a valve. Monitoring equipment continuously measures the concentration of CO, $C\ell_2$, and $COC\ell_2$.



The change in concentrations of $C\ell_2$, and CO and $COC\ell_2$ in the vessel are recorded on a chart, part of which is shown below.



13. The correct equilibrium expression for the reaction is

(a) $\dfrac{[CO][C\ell_2]}{[COC\ell_2]}$

(b) $\dfrac{[COC\ell_2][C\ell_2]}{[CO]}$

(c) $\dfrac{[COC\ell_2]}{[C\ell_2][CO]}$

(d) $\dfrac{[COC\ell_2]}{[C\ell_2]^2[CO]}$

14. At which time was the addition of nitrogen, which does not react with any of the other compounds, the only change made to the contents of the reaction vessel?

    (a) 10 s
    (b) 20 s
    (c) 30 s
    (d) 40 s

15. What was the only change made to the contents of the reaction vessel at 30 s?

    (a) an increase in pressure.
    (b) addition of N_2, which does not react with any of the other compounds.
    (c) a rise in temperature.
    (d) addition of $C\ell_2$.

16. What was the only change made to the contents of the reaction vessel at 40 s?

    (a) an increase in pressure.
    (b) addition of N_2, which does not react with any of the other compounds.
    (c) a rise in temperature.
    (d) addition of $C\ell_2$.

17. A mixture is prepared by mixing 100.0 mL portions of 0.010 mol L^{-1} $NaC\ell$, 0.010 mol L^{-1} $CaC\ell_2$, and 0.010 mol L^{-1} $A\ell C\ell_3$. The minimum volume of 0.020 mol L^{-1} $AgNO_3$ required to precipitate all of the chloride ions in the mixture is

    (a) 1.5×10^2 mL
    (b) 2.0×10^2 mL
    (c) 3.0×10^2 mL
    (d) 6.0×10^2 mL

18. A certain neutral atom has the electronic configuration $1s^2 2s^2 2p^6 3s^2$. The electronic configuration of the next atom in the same group of the periodic table would be

    (a) $1s^2 2s^2 2p^6 3s^2 3p^1$
    (b) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2$
    (c) $1s^2 2s^2 2p^6 3s^2 3p^6 3d^2 4s^2$
    (d) $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2$

SEE NEXT PAGE

19. The energy to remove each of the first eight electrons from an atom is listed in the table.

Electron removed	Energy (kJ mol^{-1})
1^{st}	999
2^{nd}	2251
3^{rd}	3356
4^{th}	4555
5^{th}	7003
6^{th}	8495
7^{th}	27103
8^{th}	31715

The atom is

(a) sulfur
(b) fluorine
(c) sodium
(d) phosphorus

20. 0.20 g of an unknown gas occupies a volume of 70 mL at S.T.P. The unknown gas could be.

(a) O_2
(b) SO_2
(c) NO
(d) C_4H_{10}

END OF PART I

SEE NEXT PAGE

PART 2 (35 marks)

Answer ALL questions in Part 2 in the spaces provided, using blue or black ballpoint or ink pen.

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.

1. (a) Sulfuric acid solution is added to chromium(III) oxide powder.

Equation: _____

Observation: _____

_____

(b) Nickel(II) sulfate solution is added to a solution of potassium phosphate

Equation: _____

Observation: _____

_____

(c) Excess ammonia solution is added to solid copper(II) hydroxide.

Equation: _____

Observation: _____

_____

(d) Hydrochloric acid is added to a solution of sodium chromate

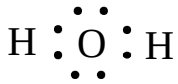
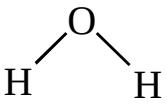
Equation: _____

Observation: _____

_____

[8 marks]

2. (a) For the species in the table draw the structural formula representing all valence electron pairs as **:**
   (b) Sketch and name the shape of the molecule or ion.

Species	**Structural formula (showing all valence electrons)**	**Sketch and name the shape**
EXAMPLE: Water (H_2O)		 Name of shape Bent
Arsine (AsH_3)		Name of shape_____
Nitrite ion (NO_2^-)		Name of shape_____
Germane (GeH_4)		Name of shape_____

[6 marks]

3. Many ionic compounds are soluble in water. Use diagrams to show how the ions interact with water in a solution of potassium iodide.

[2 marks]

4. Using a chemical test, distinguish between the following pairs of substances. Describe the test and what you observe when each substance is tested.

Substances	**Chemical Test**	**Observations**
Solid zinc nitrate and Solid magnesium nitrate		For zinc nitrate
		For magnesium nitrate

[3 marks]

5. Hydrogen chloride and ammonia are both very soluble in water. They also readily react with one another. The reaction can be represented by the equation

$$HC\ell_{(g)} + NH_{3(g)} \rightarrow NH_4C\ell_{(s)}$$

The product is also readily soluble in water.

Describe as 'high', 'low' or 'none' the electrical conductivity you would observe for 0.100 mol L^{-1} aqueous solutions of the three substances. In each case explain fully the observed conductivity. Support your explanation with equations.

Compound	Electrical conductivity	Explanation
$HC\ell_{(aq)}$		
$NH_{3(aq)}$		
$NH_4C\ell_{(aq)}$		

[6 marks]

SEE NEXT PAGE

6. (a) Explain what Le Chatelier's Principle is used for.

[1 marks]

(b) In the manufacture of sulfuric acid, sulfur dioxide is oxidised in the presence of a catalyst to sulfur trioxide according to the equation.

$$2SO_{2(g)} + O_{2(g)} \rightleftarrows 2SO_{3(g)} \qquad \Delta H = -198 \text{ kJ mol}^{-1}$$

(b) **Before** equilibrium is reached a number of changes were made to the reaction conditions. For each of the following changes describe the rate at which equilibrium is reached as increased, unchanged or decreased?

(i) Increasing the pressure _____

(ii) Increasing the temperature _____

(iii) Removing the catalyst _____

[3 marks]

(c) **After** equilibrium has been established a number of separate changes were made to the reaction mixture and equilibrium allowed to re-establish. Would the amount of sulphur dioxide present in the reaction mixture increase, remain unchanged or decrease?

(i) Increasing the pressure _____

(ii) Increasing the temperature _____

(iii) Removing the catalyst _____

[3 marks]

SEE NEXT PAGE

(d) With the reaction mixture at equilibrium some sulfur dioxide is added to the reaction vessel. Describe all the changes that occur to the rates of the forward and reverse reactions until a new equilibrium has been established.

[3 marks]

END OF PART 2

PART 3 (25 marks)

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. 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.

Answer all Part 3 questions using a blue or black ball point or ink pen.

1. The chemical process for the production of the insecticide lindane, $C_6H_6C\ell_6$, results in a reaction mixture that contains lindane and unused reactants. A 1.00 g sample of this mixture was burnt in excess oxygen to produce gaseous carbon dioxide and hydrogen chloride as the only products. Lindane was the only compound in the mixture that contained chlorine. The hydrogen chloride formed all reacted when it was bubbled through 250.0 mL of 0.200 mol L^{-1} silver nitrate solution. It produced a white precipitate which was filtered and dried. The mass of the precipitate was found to be 2.32 g.

   Calculate the

   (a) volume of hydrogen chloride gas produced at 98.0 kPa and 25.0 °C.

   (b) concentration of silver ions left in solution.

   (c) percentage purity of the insecticide

   [8 marks]

SEE NEXT PAGE

SEE NEXT PAGE

2. The analytical chemist working for a mining company routinely analysed ore samples containing copper using the following method. A 5.00 g sample of a copper ore containing only copper(II) carbonate and unreactive silicates is reacted with 25.0 mL of 1.25 mol L^{-1} sulfuric acid solution until all the copper(II) carbonate has reacted, leaving some unreacted acid in the solution. All dissolved CO_2 is then driven from the solution by heating. The resulting solution is then reacted with a 0.250 mol L^{-1} solution of sodium hydroxide and it was found that exactly 17.60 mL of the NaOH solution is required to just react with the remaining acid.

   Assuming that copper(II) carbonate is the only substance present that reacts with acid, calculate the mass of copper in every tonne (1000 kg) of ore.

   [8 marks]

SEE NEXT PAGE

3. The reactions involved in the manufacture of nitric acid can be represented as follows:

$N_2 + 3H_2 \rightarrow 2NH_3$
$4NH_3 + 5O_2 \rightarrow 4NO + 6H_2O$
$2NO + O_2 \rightarrow 2NO_2$
$4NO_2 + 2H_2O + O_2 \rightarrow 4HNO_3$

Calculate the mass of nitric acid that could be produced from reacting 1.16 m^3 of nitrogen with 2.85 m^3 of hydrogen, both measured at 300 atmospheres pressure and a temperature of 500 °C. Assume that equilibrium was never allowed to become established in any of the steps. (1.00 m^3 = 1000 L)

[9 marks]

SEE NEXT PAGE

END OF PART 3

PART 4 (10 marks)

SEE NEXT PAGE

Answer the following extended answer question using a blue or black ball point or ink pen. 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, and also for coherence and clarity of expression. Your answer should be presented in about 1½ - 2 pages. Begin your answer on the lined page following the end of the question.

---

1. The table shows some physical properties of some oxides.

Property	$A\ell_2O_3$	PbO	H_2O	SO_2	O_3
Melting Point (°C)	2045	888	0	-73	-192
Electrical conductivity of solid	Poor	Poor	Poor	Poor	Poor
Electrical conductivity of Liquid	Poor	Good	Poor	Poor	Poor
Hardness	Very Hard	Hard	Soft	Very Soft	Very Soft

Use the data to write an extended answer explaining the differences and similarities in the properties of these oxides. Explanations should be in terms of the forces that exist between the particles. A detailed explanation of how these forces keep the particles together must be part of your answer.

END OF QUESTIONS

SEE NEXT PAGE

Write your response to Part 4 below.

SEE NEXT PAGE

SEE NEXT PAGE

SEE NEXT PAGE

END OF PAPER