

## Semester 1 Examination, 2003

### 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*

- 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.
- 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.

- The examiners recommend that you spend your reading time mainly reading the instructions to candidates and Parts 2, 3 and 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  $\text{Ag}^+(\text{aq})$ ], **molecules** [for example  $\text{NH}_3(\text{g})$ ,  $\text{NH}_3(\text{aq})$ ,  $\text{CH}_3\text{COOH}(\ell)$ ,  $\text{CH}_3\text{COOH}(\text{aq})$ ] or **solids** [for example  $\text{BaSO}_4(\text{s})$ ,  $\text{Cu}(\text{s})$ ,  $\text{Na}_2\text{CO}_3(\text{s})$ ].

SEE NEXT PAGE

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

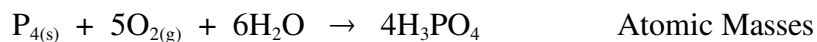
Answer ALL questions in Part 1 on the Separate Multiple Choice Answer Sheet provided, using a 2B, B, or HB pencil. Each question in this part is worth 1½ marks.

1. On going down a column of the periodic table which one of the following statements is TRUE?
- (a) Atomic size generally decreases.
  - (b) Ionisation energy usually decreases.
  - (c) The number of valence electrons increases.
  - (d) The number of valence electrons decreases.

Questions 2 and 3 concern the element magnesium (Mg) which has atomic mass 24.32 and atomic number 12. Magnesium has three naturally-occurring isotopes having mass numbers 24, 25 and 26.

2. Which of the following statements about magnesium is WRONG?
- (a) Isotope 24 is the most abundant.
  - (b) All atoms of Mg have 12 protons.
  - (c) All atoms of Mg have identical nuclei.
  - (d) The three isotopes of Mg have similar properties except mass.
3. A magnesium **ion** ( $\text{Mg}^{+2}$ ) may have which one of the following combinations of particles?
- (a) 10 electrons, 12 protons and 14 neutrons.
  - (b) 10 electrons, 14 protons and 12 neutrons.
  - (c) 10 electrons, 14 protons and 10 neutrons.
  - (d) 12 electrons, 12 protons and 12 neutrons.
4. The  $\text{CO}_2$  molecule is linear and the  $\text{SO}_2$  molecule is bent or V-shaped. If both carbon to oxygen and sulfur to oxygen bonds are polar, which one of the following is true?
- (a) Both  $\text{CO}_2$  and  $\text{SO}_2$  are polar, but  $\text{CO}_2$  is more polar than  $\text{SO}_2$ .
  - (b) Both  $\text{CO}_2$  and  $\text{SO}_2$  are polar, but  $\text{SO}_2$  is more polar than  $\text{CO}_2$ .
  - (c) The shapes allow neither molecule to be polar.
  - (d)  $\text{SO}_2$  is polar, but  $\text{CO}_2$  is not.

Question 5 and 6 refer to the preparation of phosphoric acid by the following reaction:



Atomic Masses

$$\text{H} = 1.0$$

$$\text{O} = 16.0$$

$$\text{P} = 31.0$$

5. The volume of oxygen gas ( $\text{O}_{2(\text{g})}$ ) measured at STP, required to produce 784 g of  $\text{H}_3\text{PO}_4$  is:

- (a) 10.0 L
- (b) 112 L
- (c) 179.2 L
- (d) 224 L

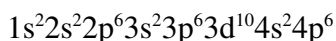
6. The weight of  $\text{H}_3\text{PO}_4$  which could be produced from 124 g of  $\text{P}_4$  is

- (a) 98.0 g
- (b) 124 g
- (c) 392 g
- (d) 496 g

7. Which one of the following properties would be possible for both strongly acidic and strongly basic solutions?

- (a) Solution has a hydrogen ion concentration of  $1.0 \times 10^{-7} \text{ mol L}^{-1}$
- (b) Solution turns blue litmus red.
- (c) Solution tastes sour.
- (d) Solution is a very good conductor of electricity.

8. Which of the following species could have the following electron configuration?



- (a)  $\text{Br}^-$
- (b)  $\text{Rb}^+$
- (c) Kr
- (d) All of the above

9. Which of the following would conduct an electric current?
1. a crystal of sodium chloride
  2. molten silver nitrate
  3. an aqueous solution of ammonium sulfate
  4. magnesium metal
- (a) 1, 2 and 3 only.  
 (b) 2, 3 and 4 only.  
 (c) 2 and 3 only.  
 (d) 2 and 4 only.
10. When  $1.0 \text{ mol L}^{-1}$  aqueous solutions of the substances in each of the following pairs are mixed, in which cases will precipitates be formed?
1.  $\text{AgNO}_3$  and  $\text{NaCl}$
  2.  $\text{CaCl}_2$  and  $(\text{NH}_4)_2\text{CO}_3$
  3.  $\text{Ba}(\text{NO}_3)_2$  and  $\text{K}_2\text{SO}_4$
  4.  $\text{KNO}_3$  and  $\text{MgCl}_2$
- (a) 1, 2 and 3 only.  
 (b) 1 and 3 only.  
 (c) 2 and 4 only.  
 (d) 1 and 2 only.
11. Which substance involves bonding that is mainly ionic?
- (a) ice,  $\text{H}_2\text{O}(\text{s})$   
 (b) liquid ammonia,  $\text{NH}_3(\ell)$   
 (c) solid silicon dioxide,  $\text{SiO}_2(\text{s})$   
 (d) solid cesium fluoride,  $\text{CsF}(\text{s})$
12. Which, if any, of the following representations of valence electrons, could be expected to form a network solid?

	s	p		
(a)	<div style="border: 1px solid black; padding: 2px; display: inline-block;">↑</div>	<div style="border: 1px solid black; width: 40px; height: 20px; display: inline-block;"></div>	<div style="border: 1px solid black; width: 40px; height: 20px; display: inline-block;"></div>	<div style="border: 1px solid black; width: 40px; height: 20px; display: inline-block;"></div>
(b)	<div style="border: 1px solid black; padding: 2px; display: inline-block;">↑↓</div>	<div style="border: 1px solid black; padding: 2px; display: inline-block;">↑</div>	<div style="border: 1px solid black; width: 40px; height: 20px; display: inline-block;"></div>	<div style="border: 1px solid black; width: 40px; height: 20px; display: inline-block;"></div>
(c)	<div style="border: 1px solid black; padding: 2px; display: inline-block;">↑↓</div>	<div style="border: 1px solid black; padding: 2px; display: inline-block;">↑</div>	<div style="border: 1px solid black; padding: 2px; display: inline-block;">↑</div>	<div style="border: 1px solid black; width: 40px; height: 20px; display: inline-block;"></div>
(d)	<div style="border: 1px solid black; padding: 2px; display: inline-block;">↑↓</div>	<div style="border: 1px solid black; padding: 2px; display: inline-block;">↑↓</div>	<div style="border: 1px solid black; padding: 2px; display: inline-block;">↑</div>	<div style="border: 1px solid black; padding: 2px; display: inline-block;">↑</div>

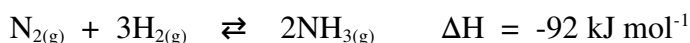
13. In which of the following reactions is water behaving as an acid?

- (a)  $\text{H}_2\text{O}_{(\text{g})} + \text{C}_{(\text{s})} \rightleftharpoons \text{H}_{2(\text{g})} + \text{CO}_{(\text{g})}$   
 (b)  $\text{H}_2\text{O}_{(\text{l})} + \text{NH}_{3(\text{g})} \rightleftharpoons \text{NH}_4^+_{(\text{aq})} + \text{OH}^-_{(\text{aq})}$   
 (c)  $\text{HCO}_3^-_{(\text{aq})} + \text{H}_2\text{O}_{(\text{l})} \rightleftharpoons \text{CO}_3^{2-}_{(\text{aq})} + \text{H}_3\text{O}^+_{(\text{aq})}$   
 (d)  $\text{H}_2\text{O}_{(\text{l})} + \text{HCl}_{(\text{g})} \rightleftharpoons \text{H}_3\text{O}^+_{(\text{aq})} + \text{Cl}^-_{(\text{aq})}$

14. The reaction  $\text{A} + \text{B} \rightleftharpoons \text{C} + \text{D}$  may be said to be at equilibrium when

- (a) all four species A, B, C and D can be detected in the reaction mixture.  
 (b) the molar ratios A:B and C:D are both 1.00.  
 (c) the concentrations of A, B, C and D are separately constant with time.  
 (d) the sum of the concentrations of A and B is equal to the sum of the concentrations of C and D

15. A closed vessel contains nitrogen and hydrogen in equilibrium with  $\text{NH}_3$ , as shown by the equation below.



Which one of the following procedures will shift the equilibrium position to the right, that is produce more  $\text{NH}_3$ ?

- (a) Increasing the pressure of the system.  
 (b) Increasing the temperature of the system.  
 (c) Introduction of an inert gas into the system.  
 (d) Addition of a catalyst to the system.

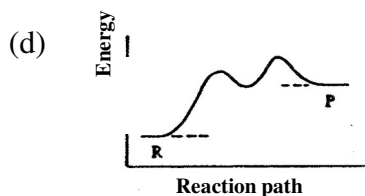
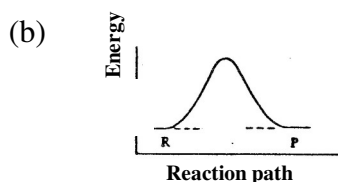
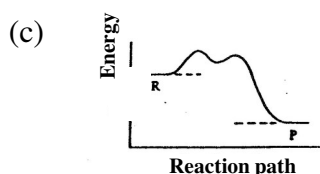
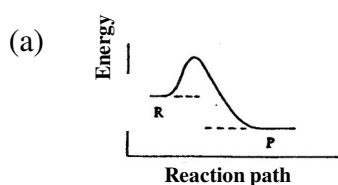
16. In which one of the following reactions will the equilibrium position be **unaffected** by a change in volume?

- (a)  $\text{N}_{2(\text{g})} + \text{O}_{2(\text{g})} \rightleftharpoons 2\text{NO}_{(\text{g})} \quad \Delta H = + 180 \text{ kJ mol}^{-1}$   
 (b)  $\text{N}_{2(\text{g})} + 3\text{H}_{2(\text{g})} \rightleftharpoons 2\text{NH}_{3(\text{g})} \quad \Delta H = - 92 \text{ kJ mol}^{-1}$   
 (c)  $2\text{SO}_{3(\text{g})} \rightleftharpoons 2\text{SO}_{2(\text{g})} + \text{O}_{2(\text{g})} \quad \Delta H = + 380 \text{ kJ mol}^{-1}$   
 (d)  $\text{C}_2\text{H}_{6(\text{g})} \rightleftharpoons \text{C}_2\text{H}_{4(\text{g})} + \text{H}_{2(\text{g})} \quad \Delta H = + 138 \text{ kJ mol}^{-1}$

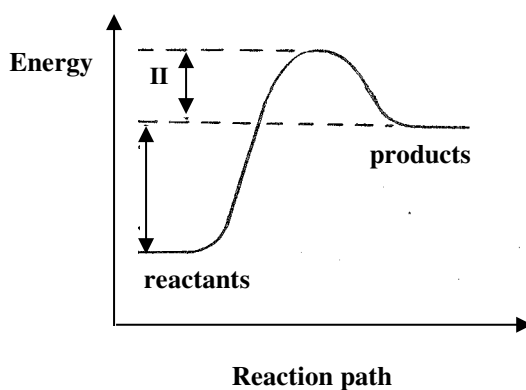
17. What volume of  $0.500 \text{ mol L}^{-1}$  barium bromide would contain  $0.100 \text{ mol}$  of bromide ion?

- (a)  $1.00 \times 10^2 \text{ mL}$   
 (b)  $2.00 \times 10^2 \text{ mL}$   
 (c)  $5.00 \times 10^1 \text{ mL}$   
 (d)  $4.00 \times 10^2 \text{ mL}$

18. 5.0 mL of  $0.60 \text{ mol L}^{-1}$  sodium chloride solution has 15 mL of water added to it. The new concentration of the solution is
- (a)  $0.20 \text{ mol L}^{-1}$   
(b)  $2.4 \text{ mol L}^{-1}$   
(c)  $0.60 \text{ mol L}^{-1}$   
(d)  $0.15 \text{ mol L}^{-1}$
19. Which of the following reaction path represents an endothermic reaction?  
R denotes reactants,  
P denotes products



20. The change in energy during a chemical reaction is shown below. Energy changes I and II are also shown.



The effect of adding a positive catalyst to the system is to

- (a) increase the size of II only.  
(b) decrease the size of II only.  
(c) increase the size of I and decrease the size of II.  
(d) decrease the size of I and increase the size of II.

**END OF PART 1**

**SEE NEXT PAGE**

**PART 2 (30 marks = 30% of paper)**

Answer ALL questions in Part 2 in the spaces provided below. This part is worth 30 marks (30% of the total).

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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) Chromium metal is added to a solution of sodium hydroxide

**Equation** \_\_\_\_\_

**Observation** \_\_\_\_\_

[2 marks]

- (b) A strip of magnesium is added to a solution of copper (II) sulfate

**Equation** \_\_\_\_\_

**Observation** \_\_\_\_\_

[2 marks]

- (c) Solutions of lead (II) nitrate and rubidium iodide (RbI) are mixed:

**Equation** \_\_\_\_\_

**Observation** \_\_\_\_\_

[2 marks]



2. Write the **name** or **formula** of a substance whose properties match those described:
- (a) A highly polar molecular substance that is very soluble in water. Individual molecules are described as having a pyramidal shape.
- \_\_\_\_\_
- (b) Combines with another element by sharing one pair of valence electrons. When combined with hydrogen it forms molecules that exhibit hydrogen bonding and are acidic.
- \_\_\_\_\_
- (c) Has a very high first ionisation energy, a very low boiling point and does not form bonds with the two elements immediately before or after it in the periodic table.
- \_\_\_\_\_
- (d) In its pure form it is very malleable and ductile and reacts vigorously with water (although most other elements of the same group are more reactive); salts containing this ion are always soluble.
- \_\_\_\_\_

[4 marks]

3. An important chemical reaction is the combustion of petrol in the cylinder of a motor of a vehicle.



Use the collision theory to **explain** 4 ways by which the rate of this reaction could be increased.

- (a) \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
- (b) \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
- (c) \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
- (d) \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

[4 marks]

4. Give a **chemical** test and observations that could be used to distinguish between the following pairs of substances. You need to clearly state the expected observation for each substance tested. No equations need be given.

(a)  $2 \text{ mol L}^{-1} \text{ H}_2\text{SO}_4$  and  $2 \text{ mol L}^{-1} \text{ HNO}_3$

TEST: \_\_\_\_\_

OBSERVATION:

\_\_\_\_\_

(b) Two white powders: magnesium hydroxide and aluminium hydroxide

TEST: \_\_\_\_\_

OBSERVATION:

\_\_\_\_\_

(c) Two colourless solutions: potassium ethanoate and potassium chloride.

TEST: \_\_\_\_\_

OBSERVATION:

\_\_\_\_\_

[6 marks]

5. Use ticks (✓) in the appropriate spaces to classify each of the following solutions

Solutions	Strong Electrolyte	Weak Electrolyte	Non Electrolyte	Strong Conductor	Weak Conductor	Non Conductor
Calcium Hydroxide						
Nitric Acid						
Sugar						
Ammonia						

SEE NEXT PAGE

[4 marks]

6. Draw electron dot diagrams for the following species and describe the shape. Indicate if the species would be polar or not.

Use dots (•) to show all valence electrons

Species	Electron dot diagram	Name of shape	Polar or Not?
hydrogen sulfite ion $\text{HSO}_3^-$			
beryllium difluoride $\text{BeF}_2$			
tellurium dihydride $\text{TeH}_2$			

[6 marks]

**END OF PART 2****SEE NEXT PAGE**

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. This part carries 30 marks (30% of the total)

- [2 marks]

[illegible]

[illegible]

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- (a) What mass of precipitate would be formed?

(b) Calculate the concentration of all ions which remain in the final solution after filtering.

[4 marks]

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- Calculate the percentage by mass of copper in the sample of copper ore.

[8 marks]

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- $$(\text{NH}_4)_2\text{CO}_{3(s)} \rightarrow \text{NH}_{3(g)} + \text{CO}_{2(g)} + \text{H}_2\text{O}_{(g)}$$

Calculate

- [2 marks]

- [3 marks]

- [2 marks]

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## END OF PART 3

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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.

1. Hydrogen chloride gas is a covalent molecular substance yet, when it dissolves in water, it completely ionises to form hydrochloric acid. Heat is released as it dissolves.

Explain fully the principles of chemistry involved in this process. Your answer should consider bonding, solubility, acidic properties and energy changes.

**OR**

- The halogens are a group of elements that have similar properties but they also have differences. Select three similar properties and three different properties of the halogens and clearly explain how these similarities and differences are caused. The properties you select may be physical or chemical properties.

**END OF QUESTIONS**

**Begin your answer to Part 4 here**

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**END OF PAPER**

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