

SEMESTER 1 EXAMINATION 2002

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: Calculators satisfying the conditions set by the Curriculum Council and a 2B, B or HB pencil for the Separate Multiple Choice Answer Sheet.

**** 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 | 20 | ALL | 30 (30%) | 35 |
| 2 | Short Answers | 8 | ALL | 35 (35%) | 40 |
| 3 | Calculations | 4 | ALL | 25 (25%) | 30 |
| 4 | Extended Answers | 2 | 1 | 10 (10%) | 15 |

Total marks for paper = 100 (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

Use a 2B, B or HB pencil to answer 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

Use a ball point 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.

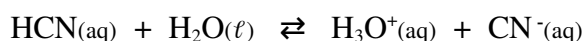
CHEMICAL EQUATIONS

For full marks, chemical equations should refer only to those 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 $\text{BaSO}_4(\text{s})$, $\text{Cu}(\text{s})$, $\text{Na}_2\text{CO}_3(\text{s})$].

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. Which of the following is a characteristic property of an **ionic** compound?
 - (a) Dissolves in non-polar solvents
 - (b) Very low melting point
 - (c) Malleable and ductile
 - (d) Conducts electricity when molten but not when solid
2. Which of the following is non-polar but consists of molecules in which there are polar covalent bonds?
 - (a) Boron trifluoride, BF_3
 - (b) Nitrogen, N_2
 - (c) Water, H_2O
 - (d) Ammonia, NH_3
3. A few drops of sodium hydroxide are added to copper II sulfate solution. A pale blue precipitate is formed. Which one of the following equations best represents the reaction that has occurred?
 - (a) $\text{Cu}^{2+}(\text{aq}) + \text{SO}_4^{2-}(\text{aq}) + 2\text{Na}^+(\text{aq}) + 2\text{OH}^-(\text{aq}) \rightarrow 2\text{Na}^+(\text{aq}) + \text{SO}_4^{2-}(\text{aq}) + \text{Cu}(\text{OH})_2(\text{s})$
 - (b) $\text{Cu}^{2+}(\text{aq}) + 2\text{OH}^-(\text{aq}) \rightarrow \text{Cu}(\text{OH})_2(\text{s})$
 - (c) $\text{CuSO}_4(\text{aq}) + 2\text{NaOH}(\text{aq}) \rightarrow \text{Na}_2\text{SO}_4(\text{aq}) + \text{Cu}(\text{OH})_2(\text{s})$
 - (d) $2\text{Na}^+(\text{aq}) + \text{SO}_4^{2-}(\text{aq}) \rightarrow \text{Na}_2\text{SO}_4(\text{aq})$
4. In which of the following solutions is the TOTAL concentration of ions (in mol L^{-1}) the greatest?
 - (a) 0.3 mol L^{-1} sodium chloride solution
 - (b) 0.3 mol L^{-1} calcium chloride solution
 - (c) 0.2 mol L^{-1} sodium sulfate solution
 - (d) 0.2 mol L^{-1} aluminium chloride solution
5. Consider the following reversible reaction:



Which of the species in the equation shown are acting as bases?

- (a) $\text{HCN}(\text{aq})$ and $\text{H}_2\text{O}(\ell)$
- (b) $\text{HCN}(\text{aq})$ and $\text{H}_3\text{O}^+(\text{aq})$
- (c) $\text{HCN}(\text{aq})$ and $\text{CN}^-(\text{aq})$
- (d) $\text{H}_2\text{O}(\ell)$ and $\text{CN}^-(\text{aq})$

6. Consider the following statements.

1. All hydrocarbons have polar molecules.
2. All acids yield solutions with pH values less than 7.
3. The only common sulfates which are not readily soluble in water are those of lead and magnesium.
4. No ammonium salts are readily soluble in water.
5. Pure water is classified as a very weak electrolyte.

Of these statements the only ones that are TRUE are:

- (a) 1 and 3.
- (b) 2, 4 and 5.
- (c) 2 and 5.
- (d) 1, 3 and 4.

7. Consider the system at equilibrium represented by the following:



Which of the following statements is correct?

- (a) At equilibrium, equal amounts of products and reactants are present.
- (b) The reverse reaction is endothermic.
- (c) Adding helium gas to the system will increase the rate of the forward reaction.
- (d) Reducing the volume of the system will result in a greater concentration of reactants.

8. Solution A is prepared by mixing dilute solutions of sodium nitrate and ammonium chloride together. Solution B is made by mixing dilute solutions of hydrochloric acid and calcium nitrate together. Which of the following gives the correct observation when Solution A and Solution B are mixed?

- (a) No precipitate is formed, but bubbles of a colourless gas will be evolved.
- (b) A white precipitate will be formed.
- (c) A characteristic pungent smell (of ammonia gas) is detected.
- (d) No visible changes are observed, but the temperature of the final solution may change.

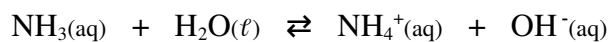
9. Which of the following statements about the third row of the periodic table is correct?

- (a) The metallic nature of the elements decreases from left to right.
- (b) The bonding of the elements changes from covalent molecular to covalent network to metallic from left to right.
- (c) The ionisation energy generally decreases from left to right.
- (d) The valence electrons are in increasingly higher energy levels from left to right.

10. A rise in **temperature** of gaseous reactants results in an increase in the rate of the reaction. This is due mainly to an increase in
- (a) The activation energy of the reaction.
 - (b) The proportion of molecules with energies greater than the activation energy.
 - (c) The proportion of molecules which dissociate into their constituent atoms.
 - (d) The frequency of collision between reactant molecules.
11. An atomic species contains 10 electrons, 11 protons and 12 neutrons. Its electron configuration is most probably
- (a) $1s^2 2s^2 2p^6$
 - (b) $1s^2 2s^2 2p^6 3s^1$
 - (c) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 4p^1$
 - (d) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^1$
12. Which one of the following best describes the halogens. (Group VII elements?)
- (a) They are monatomic molecules that form X^{2-} ions.
 - (b) They are diatomic molecules that form X^- ions.
 - (c) They are monatomic molecules that form X^- ions.
 - (d) They are diatomic molecules that form X^{2+} ions..
13. The following UNBALANCED equation represents the combustion of butane gas in air:
- $$C_4H_{10(g)} + O_{2(g)} \rightarrow CO_{2(g)} + H_2O_{(g)} + \text{heat}$$
- Balance the equation, then choose the correct alternative below:
- Which of the following statements is **correct**?
- (a) In the balanced equation, 2 g of butane reacts with 13 g of oxygen.
 - (b) Measured at 0 °C and 101.3 kPa pressure, the products occupy less volume than the reactants.
 - (c) The number of molecules is conserved during the reaction.
 - (d) The reaction is endothermic.
14. Which one of the following statements is TRUE for the d block elements of the Periodic Table?
- (a) They are all non-metals.
 - (b) They all have relatively high ionisation energies.
 - (c) They generally have partially occupied d sub levels.
 - (d) They form covalent compounds with themselves and non-metals.

15. 50.0 mL of a 0.360 mol L^{-1} sodium chloride solution is mixed with 150 mL of distilled water. What is the new concentration of the solution?
- (a) 0.12 mol L^{-1}
(b) 0.09 mol L^{-1}
(c) 0.36 mol L^{-1}
(d) 1.44 mol L^{-1}
16. Above 19°C , HF exists as a gas containing HF molecules. The bonding between hydrogen and fluorine within these HF molecules is best described as:
- (a) ionic bonding
(b) hydrogen bonding
(c) non-polar covalent bonding
(d) polar covalent bonding
17. Consider the following compounds
- | | | | | |
|---------------|------------------------|--------------------------|-----------------|----------------|
| CH_4 | CH_3Cl | CH_2Cl_2 | CHCl_3 | CCl_4 |
| I | II | III | IV | V |
- Which of the above molecules are polar?
- (a) All compounds I to V
(b) I, III and V
(c) II and IV
(d) II, III and IV
18. Which of the following statements is **LEAST** likely to be true of catalysts?
- (a) Catalysts can reduce the activation energy of a reaction by providing an alternative reaction pathway.
(b) Catalysts differ from reactants in that they are not finally consumed in the reaction.
(c) Catalysts can sometimes provide more favourable geometry for the reaction, especially when gaseous reactants are involved.
(d) Catalysts increase the rate of a chemical reaction by increasing the energy of collisions between reactant molecules.
19. An atom of an isotope of manganese may be represented as $^{56}_{25}\text{Mn}$. Which one of the following is correct?
- (a) the relative atomic mass of manganese is 81.
(b) the atomic number of manganese is 31
(c) the nucleus of an atom of manganese contains 25 protons
(d) the nucleus of an atom of manganese contains 25 neutrons

20. Consider the following equilibrium reaction which is set up in a dilute solution of ammonia in water:



Which of the following statements is correct about the above?

- (a) The addition of 2.0 mol L^{-1} NaOH solution will increase the concentration of NH_3 .
- (b) The equilibrium constant, K , for the above reaction is very large.
- (c) The ammonium ions are acting as a base in the above reaction.
- (d) The addition of a little 2.0 mol L^{-1} ammonium nitrate solution to the above will increase the concentration of hydroxide ions.

END OF PART 1

SEE NEXT PAGE

PART 2 (35 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 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) Iron wire is added to diluted sulfuric acid.

Equation _____

Observation _____

[1½ marks]

- (b) Solid nickel carbonate is added to 1 mol L⁻¹ hydrochloric acid.

Equation _____

Observation _____

[1½ marks]

- (c) Manganese sulfate solution is added to sodium hydroxide solution.

Equation _____

Observation _____

[1½ marks]

- (d) 2 mol L⁻¹ sodium hydroxide solution is added to solid zinc hydroxide .

Equation _____

Observation _____

[1½ marks]

SEE NEXT PAGE

2. Complete the following table.

| Species | Electron dot diagram | Draw the shape showing all atoms |
|---|----------------------|----------------------------------|
| Ortho silicate ion SiO_4^{2-} | | |
| Sulfur dioxide SO_2 | | |

[5 marks]

3. Explain the difference between the following terms.

(a) the **end point** and the **equivalence point** of an acid/base titration.

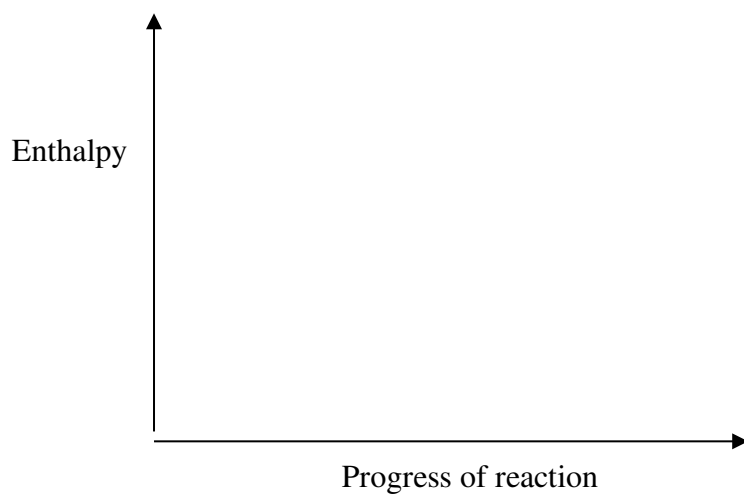
[2 marks]

(b) **dilute acids** and **weak acids**.

[2 marks]

4. Using the axes provided make a simple sketch of the following:

- (a) A potential energy diagram for an exothermic reaction which has an activation energy about four times the value of the heat of reaction.

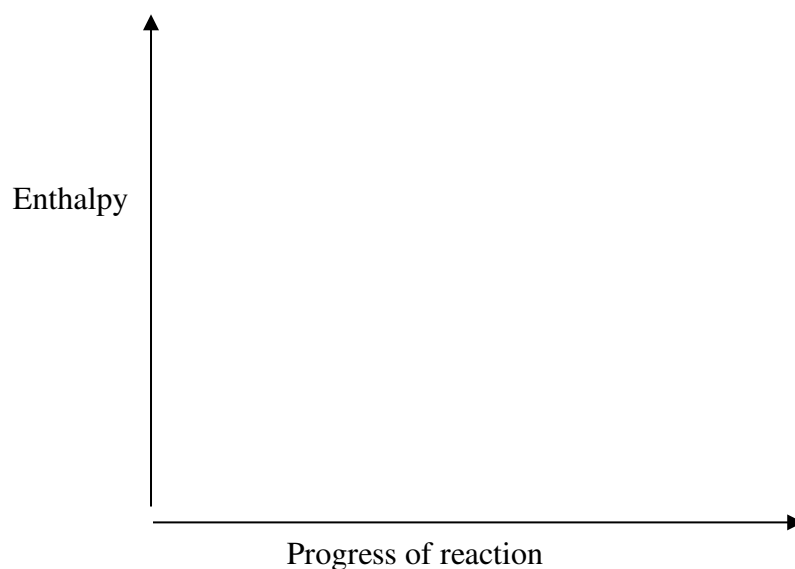


[2 marks]

- (b) A potential energy diagram showing an endothermic reaction for a change in enthalpy of 120 kJ mol^{-1} .

Show on the diagram

- (i) the uncatalysed reaction path.
- (ii) a possible catalysed reaction path.
- (ii) the enthalpy change (ΔH).



[3 marks]

5. A student used the following procedure to prepare a standard hydrochloric acid solution with a concentration of about 0.1 mol L^{-1} .

Step 1: Prepare a solution of hydrochloric acid with a concentration of approximately 0.1 mol L^{-1} .

Step 2: Standardise the hydrochloric acid by titration against a standard solution of sodium carbonate made by dissolving an accurate mass of anhydrous sodium carbonate and making the solution up to an accurate volume.

- (a) Explain why the hydrochloric acid was standardised using the sodium carbonate solution instead of a sodium hydroxide solution made in the same way.

[2 marks]

- (b) Name a suitable indicator for the titration and state the colour change.

Name: _____

[1 mark]

Colour change: From _____ to _____

[1 mark]

- (c) Explain why the student chose this particular indicator for this titration.

[2 marks]

6. Complete the following table.

| Compound name | Formula | Aqueous solution would be Acidic/Basic/Neutral? |
|-------------------|---------------------------|--|
| Potassium sulfate | | |
| | NH_4Cl | |
| Sulfur dioxide | | |
| | CH_3COONa | |

[4 marks]

7. Classify each of the following solids as covalent molecular (**CM**), ionic (**I**), covalent network (**CN**) or metallic (**M**) by writing the correct abbreviation in the second column:

| Name of solid | Bonding type |
|-------------------|--------------|
| graphite | |
| lead | |
| calcium carbonate | |
| ice | |

[2 marks]

8. Classify the following solutions as strong, weak, or non-electrolytes by placing a **tick** in the correct column:

| Aqueous Solution | strong electrolyte | weak electrolyte | non electrolyte |
|--------------------|--------------------|------------------|-----------------|
| Sodium carbonate | | | |
| ethanoic acid | | | |
| barium chloride | | | |
| ammonium ethanoate | | | |
| sucrose (sugar) | | | |
| water | | | |

[3 marks]

END OF PART 2**SEE NEXT PAGE**

This page has been left blank intentionally

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. 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. The amount of salt in a particular brand of soup was found using gravimetric analysis. A 14.962 g sample of powdered chicken soup was mixed with water and stirred thoroughly. The mixture was filtered and the residue washed with more water. The filtrate was made up to 250.0 mL in a volumetric flask. A 20.00 mL sample of this stock solution was pipetted into a conical flask. An excess of silver nitrate was added. The precipitate was filtered, dried and massed. The mass of silver chloride precipitated was 0.246 g.
- (a) Calculate the amount, in moles, of silver chloride precipitated. [1 mark]
- (b) Determine the number of moles of sodium chloride in a 20.00 mL sample of the stock solution. [2 marks]
- (c) Calculate the number of moles of sodium chloride in 250.0 mL of stock solution. [1 mark]
- (d) What mass of sodium chloride was present in the sample of powdered chicken soup? [1 mark]
- (e) Calculate the percentage by mass of sodium chloride in the powdered chicken soup. [2 marks]

[illegible]

- Another 1.322 g sample of the same gaseous compound occupied 0.1453 L at STP.

- [3 marks]

- [3 marks]

[illegible]

This image shows a single sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

SEE NEXT PAGE

- $$\text{CO}_{2(\text{g})} + \text{Ca(OH)}_{2(\text{aq})} \rightleftharpoons \text{CaCO}_{3(\text{s})} + \text{H}_2\text{O}(\ell)$$

From the above information calculate:

- [3 marks]

- [3 marks]

This image shows a single sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

[illegible]

SEE NEXT PAGE

- (a) Calculate the number of moles of sodium carbonate and copper II nitrate used in the initial reaction and determine which is the limiting reagent.

(b) Calculate the mass of precipitate produced.

(c) Calculate the mass of $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ assuming 90.0% recovery

[2 marks]

This image shows a single sheet of white paper with horizontal blue or grey ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

[illegible]

SEE NEXT PAGE

END OF PART 3

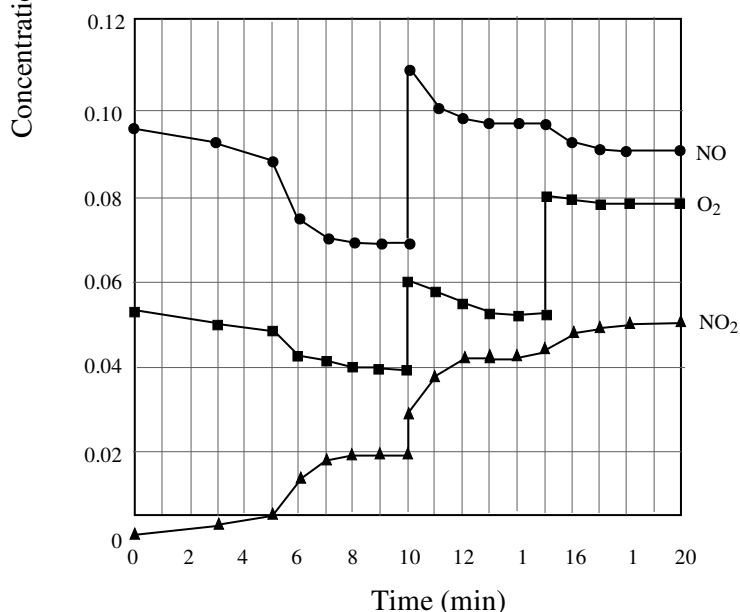
SEE NEXT PAGE

PART 4 (10 marks)

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. The graphs show the changes in the concentration of three gases (nitric oxide, NO, oxygen, O₂, and nitrogen dioxide, NO₂) with time over a 20 minute period in a 2.00 L closed reaction vessel. The temperature is held constant for the 20 minutes.



The reaction occurring is $2\text{NO}(\text{g}) + \text{O}_2(\text{g}) \rightleftharpoons 2\text{NO}_2(\text{g})$

- (a) With reference to this reaction and the graphs, describe and explain two (2) properties of the reaction mixture that would suggest to you when the system was in equilibrium.
- (b) At times of 5 mins, 10 mins, 15 mins explain clearly
- What** could have been done to the system to cause the changes in gas concentration.
 - Why** the concentrations of the gases have changed as they have at these times.

OR

2. Ammonia (NH₃) and phosphine (PH₃) are two compounds that have many similarities.
- (a) Select and explain clearly 2 (two) similarities making sure you describe **why** both compounds have those properties.
- (b) A third compound with similar properties is arsine, AsH₃. Compare the boiling points of these three compounds. List them from highest to lowest boiling point and explain clearly **why** you have placed them in this order.

SEE NEXT PAGE

This image shows a single page of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

SEE NEXT PAGE

[illegible]

SEE NEXT PAGE

This image shows a full page of blank, lined paper. It features approximately 20 evenly spaced horizontal grey lines across its entire width, providing a guide for handwriting or typing. The paper itself is a clean, off-white color. There are no margins, text, or other markings present on the page.

[illegible]

SEE NEXT PAGE

END OF PAPER

SEE NEXT PAGE