

Semester 2 Examination

Question/Answer Booklet

CHEMISTRY

NAME: _____

CLASS: _____

Time allowed for this paper

Reading time before commencing work: Ten minutes

Working time for paper: Three 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	30	30	55	60 (30%)
2 Short Answers	11	11	60	70 (35%)
3 Calculations	5	5	45	50 (25%)
4 Extended Answers	1	1	20	20 (10%)
Total marks				200 (100%)

Instructions to candidates

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.

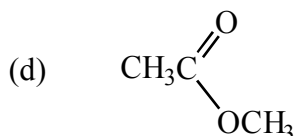
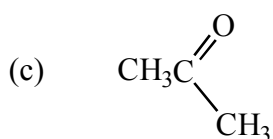
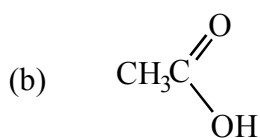
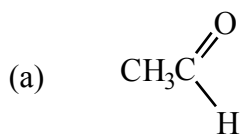
4. **Chemical equations**

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 $\text{Ag}^+(\text{aq})$], **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 (60 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 2 marks.

- An unknown metal, X, forms a selenide with a formula X_2Se_3 . The correct formula for its bromide is
 - XBr
 - XBr_2
 - XBr_3
 - X_2Br_3
- Which of the following reactions does **not** occur in the processes of producing alumina from bauxite?
 - $Al(OH)_3(s) + OH^-(aq) \rightarrow [Al(OH)_4]^-(aq)$
 - $Al(OH)_3(s) + 3H^+(aq) \rightarrow Al^{3+}(aq) + 3H_2O(l)$
 - $2Al(OH)_3(s) \rightarrow Al_2O_3(s) + 3H_2O$
 - $[Al(OH)_4]^-(aq) \rightarrow Al(OH)_3(s) + OH^-(aq)$
- Which one of the following may have 16 protons, 17 neutrons and 18 electrons?
 - Ar
 - Cl
 - S
 - S^{2-}
- Which one of the following represents an ester?



5. Which of the following elements exhibit more than one oxidation state in compounds?
- I sulfur
 - II potassium
 - III chromium
 - IV lead
- (a) I and III only.
(b) I and IV only.
(c) II and III only.
(d) I, III and IV only.
6. Which one of the following statements is **not** correct.
- (a) Both the first and second ionisation energy for magnesium are equal as both involve the removal of an electron from the same orbital.
(b) The third ionisation energy for calcium is much higher than its second ionisation energy because the third electron must be removed from a lower energy level than the second.
(c) The first ionisation energy for calcium is higher than the first ionisation energy for potassium because the electron is held more strongly by the larger positive charge on the calcium nucleus.
(d) The first ionisation energy for potassium is lower than the first ionisation energy for argon because, despite the large positive charge on the potassium nucleus the outermost potassium electron is in a higher energy level.
7. Which one of the following represents elements in order of increasing electronegativity?
- (a) $S > O > Ga > Ca$
(b) $O > S > Ga > Ca$
(c) $Ca > Ga > S > O$
(d) $Ca > Ga > O > S$
8. A sample of wine was found to contain 3.63 ppm of sulphur dioxide. Calculate the mass of sulfur dioxide that would be found in a 150 g glass of the wine.
- (a) 5.45×10^2 g
(b) 5.45×10^{-1} g
(c) 5.45×10^{-3} g
(d) 5.45×10^{-4} g
9. Which one of the following will oxidise I^- to I_2 but not Br^- to Br_2 at concentrations of 1.00 mol L^{-1} in aqueous solution?
- (a) Fe^{2+}
(b) Ag^+
(c) Sn^{2+}
(d) MnO_2

10. Four electrolytic cells with carbon electrodes were set up each with a different electrolyte. The electrolytes used, all with a concentration of 1.00 mol L^{-1} in water, are listed.

I	Cell 1	NaOH
II	Cell 2	$\text{Sn}(\text{NO}_3)_2$
III	Cell 3	NaCl
IV	Cell 4	HBr

For which of the solutions would hydrogen gas be produced at the cathode and oxygen gas at the anode?

- (a) I only.
(b) I and II only.
(c) I, III and IV only.
(d) I, II, III and IV only.
11. The overall reaction in an electrochemical cell may be represented by
- $$2\text{Fe}^{3+}(\text{aq}) + \text{Cu}(\text{s}) \rightarrow 2\text{Fe}^{2+}(\text{aq}) + \text{Cu}^{2+}(\text{aq})$$
- If the concentration of ions is 1.00 mol L^{-1} , the anode is made of copper and the cathode of platinum, the cell potential would be
- (a) 1.11 V
(b) 0.61 V
(c) 0.43 V
(d) none of the above.
12. Which one of the following ionic substances would be unstable, that is, in which would the two ions present react with one another?
- (a) FeI_3
(b) MgI_2
(c) KI
(d) AlI_3
13. In which one of the following reactions is the hydrogencarbonate ion acting as an acid?
- (a) $\text{HCO}_3^- + \text{H}_3\text{O}^+ \rightarrow \text{CO}_2 + 2\text{H}_2\text{O}$
(b) $\text{HCO}_3^- + \text{H}_2\text{O} \rightarrow \text{H}_2\text{CO}_3 + \text{OH}^-$
(c) $\text{HCO}_3^- + \text{PO}_4^{3-} \rightarrow \text{CO}_3^{2-} + \text{HPO}_4^{2-}$
(d) $\text{HCO}_3^- + \text{CH}_3\text{COOH} \rightarrow \text{H}_2\text{O} + \text{CO}_2 + \text{CH}_3\text{COO}^-$
14. Which one of the following is true about the compound formed between radium and iodine?
- (a) The compound is ionic with formula Ra_2I
(b) The compound is ionic with formula RaI_2
(c) The compound is covalent molecular with formula Ra_2I
(d) The compound is covalent molecular with formula RaI_2

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15. A student made a series of observations when a colourless liquid was tested with a number of reagents.

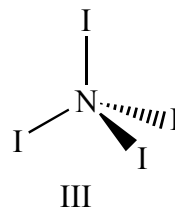
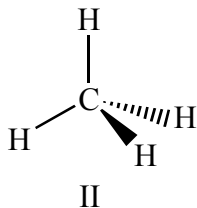
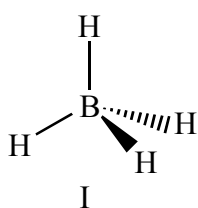
Test	Observation
Sodium metal was added to the liquid.	Colourless, odourless gas evolved very slowly, the solid dissolved.
Acidified potassium permanganate was added to the liquid.	No visible change occurred.
Ethanoic acid and sulfuric acid were mixed with the liquid and heated.	A pleasant fruity smell was detected.

The liquid tested is most likely

- (a) methyl-2-propanol
(b) 2-butanol
(c) butanoic acid
(d) butanal
16. Methanamine ionises according to the equation
- $$\text{CH}_3\text{NH}_2(\text{aq}) + \text{H}_2\text{O}(\ell) \rightleftharpoons \text{CH}_3\text{NH}_3^+(\text{aq}) + \text{OH}^-(\text{aq}) + \text{Heat}$$
- which of the following would increase the concentration of the CH_3NH_3^+ ion at equilibrium.
- (a) adding a strong base
(b) adding a weak base
(c) adding a strong acid
(d) increasing the temperature.
17. Ammonium chloride is added to water. Which one of the following statements best describes what happens?
- (a) The pH increases because the ammonium ion reacts with water to produce ammonia.
(b) The pH increases because the chloride ion reacts with water to produce hydroxide ions.
(c) The pH decreases because the ammonium ion reacts with water to produce hydronium ions.
(d) The pH decreases because the chloride ion reacts with water to produce hydrochloric acid.
18. Organic acids are classified as weak electrolytes because they
- (a) have low solubility in water so the concentration of ions is low.
(b) have high solubility in water but only a few molecules ionise.
(c) have high solubility in water and so are fully ionised.
(d) are molecular compounds that do not ionise at all.

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19. In which one of the following lists will each compound form a solution with a pH less than 7 when mixed with water?
- Sulfur dioxide, hydrogen sulphide, ammonia, sodium ethanoate.
 - Carbon dioxide, ammonium chloride, sodium chloride, ethanoic acid.
 - Sodium sulfide, calcium oxide, potassium carbonate, barium hydroxide.
 - Phosphorous pentoxide, sulfur trioxide, ammonium nitrate, hydrogen sulfide.
20. Consider the following structures

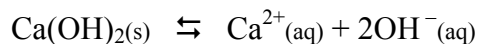


Which of the following statements is true?

- I and II are neutral molecules
 - II and III are neutral molecules
 - II is a neutral molecule
 - None of the structures are neutral molecules
21. How many non-bonding valence electrons are there on the sulfur atom in a sulfur dioxide molecule?
- none
 - 2
 - 4
 - 6
22. How many valence electrons are there in a sulfite ion, SO_3^{2-} ?
- 2
 - 24
 - 26
 - 32
23. Which one of the following compounds is likely to have the highest melting point?
- CO
 - NO
 - CaO
 - SO₂

24. Which one of the following is **not** a property of aluminium
- (a) It reacts with dilute hydrochloric acid to produce hydrogen.
 - (b) It reacts with sodium hydroxide solution to produce hydrogen.
 - (c) It is resistant to corrosion as it does not react with oxygen.
 - (d) It displaces zinc from a solution of zinc ions.
25. Which of the following compounds are isomers of ethyl ethanoate
- I $\text{CH}_3\text{OCH}_2\text{CH}_2\text{OCH}_3$
- II $\text{CH}_3\text{CH}_2\text{C} \begin{array}{l} \text{=O} \\ \text{OCH}_3 \end{array}$
- III $\text{CH}_3\overset{\text{O}}{\parallel}\text{CCH}_2\text{CH}_2\text{OH}$
- (a) I only
 - (b) II only
 - (c) III only
 - (d) II and III only
26. How many aliphatic isomers have the molecular formula $\text{C}_3\text{H}_5\text{Br}$.
- (a) 2
 - (b) 3
 - (c) 4
 - (d) 5
27. Which one of the following attractive forces between atoms results in substances that have the highest melting point?
- (a) dispersion forces
 - (b) covalent bonding
 - (c) metallic bonding
 - (d) hydrogen bonding
28. Which of the following statements about dispersion forces is correct?
- (a) An increase in the mass of a molecule causes an increase in the strength of dispersion forces.
 - (b) An increase in the difference of the electronegativity between atoms in a molecule causes an increase in the strength of dispersion forces.
 - (c) Dispersion forces only exist in molecules that do not have a dipole or the ability to form a hydrogen bond.
 - (d) An increase in the number of protons and electrons leads to stronger dispersion forces.

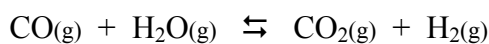
29. Consider the following equilibrium



Which one of the following is the equilibrium constant expression for this reaction?

- (a) $K = [\text{Ca}^{2+}] [\text{OH}^{-}]$
- (b) $K = [\text{Ca}^{2+}] [\text{OH}^{-}]^2$
- (c) $K = \frac{[\text{Ca}^{2+}][\text{OH}^{-}]}{[\text{Ca(OH)}_2]}$
- (d) $K = \frac{[\text{Ca}^{2+}][\text{OH}^{-}]^2}{[\text{Ca(OH)}_2]}$

30. Consider the equilibrium



At 25 °C the equilibrium constant is equal to 100. Which of the following statements is correct for the system at equilibrium.

- (a) The concentration of reactants is significantly greater than the concentration of products.
- (b) The concentration of products is significantly greater than the concentration of reactants.
- (c) The concentration of reactants and products is the same.
- (d) The rate of the forward reaction is greater than the rate of the reverse reaction.

END OF PART I

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PART 2 (70 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) An aqueous solution of ethanal is mixed with an aqueous solution of potassium dichromate and sulfuric acid.

Equation: _____

Observation: _____

- (b) Solid chromium III oxide is mixed with a hot hydrochloric acid solution.

Equation: _____

Observation: _____

- (c) Nickel metal is placed into a solution of copper II sulfate.

Equation: _____

Observation: _____

- (d) A solution of sodium ethanoate is mixed with dilute hydrochloric acid.

Equation: _____

Observation: _____

[12 marks]

2. Draw electron dot diagrams of the following species and estimate the bond angles. Bond angles should be described as equal to, slightly less than or slightly greater than a particular angular value.

Species	Electron dot diagram	Bond angles
EXAMPLE: beryllium difluoride (BeF ₂)		<i>equal to 180°</i>
Selenium dioxide (SeO ₂)		
molecular aluminium bromide (AlBr ₃)		
tellurate ion (TeO ₄ ²⁻)		

[6 marks]

3. Draw the shape of the following species and indicate the direction of the polarity of each bond and then the net polarity of the molecules. If the molecule is non polar write "non-polar" for the net polarity.

Species	Shape and Polarity of Bonds	Net Polarity
EXAMPLE Water		
dichloromethane		
Arsenic tribromide		

[7 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.

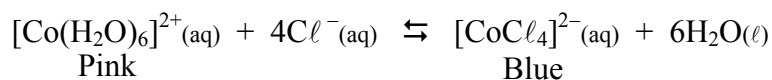
Substances	Chemical Test	Observations
Solid potassium nitrate and Solid magnesium nitrate		For potassium nitrate
		For magnesium nitrate
Solid sodium sulfide and Solid sodium nitrate		For sodium sulfide
		For sodium nitrate

[6 marks]

5. Equal volumes of two solutions are mixed. One has a pH of 8.50 and the other a pH of 3.60. What is the pH of the final solution?

[3 marks]

6. Consider the equilibrium



The forward reaction as written is endothermic. The concentration of the chloride ion is adjusted so that at equilibrium the concentration of each of the two complex ions is equal giving the solution a purple colour, that is an equal mixture of pink and blue.

Some of the solution was placed into each of three test tubes, each of which was treated in one of the three ways described below. Write observations for each test tube and write an explanation where required

Test Tube 1.

A concentrated solution of hydrochloric acid was added.

Describe what you would observe.

Test Tube 2.

The solution was cooled in an ice bath.

(a) Describe what you would observe.

(b) Explain your observations in terms of Le Chatelier's principle.

Test Tube 3.

Water was added.

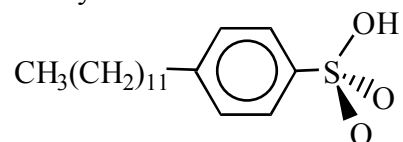
(a) Describe what you would observe.

(b) Explain your observations in terms of changes in concentration of aqueous species and the resulting changes in reaction rates.

[7 marks]

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7. The structure of dodecalalkylbenzene sulfonic acid is shown.



This substance is typically used to make detergent. It itself also behaves as a surfactant and can be used to make cleaning solutions because it interacts with water and oils in the same way as soaps and detergents.

- (a) In terms of intermolecular forces explain how this molecule can interact strongly with water and oil.

- (b) Explain how these interactions lead to the removal of oils from clothing washed in water containing this molecule. Use diagrams to help with your explanation.

[5 marks]

8. (a) Sketch a diagram representing an electrolytic cell containing a cobalt cathode and a carbon anode. The electrolyte is a 1.00 mol L^{-1} cobalt II sulfate solution.
- (b) On your diagram show the direction in which the electrons and ions move during its operation.



- (c) Write equations to show the reactions occurring at each electrode.

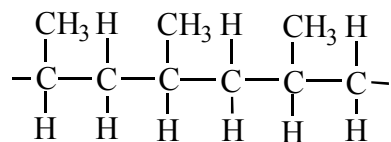
Electrode	Equation
Cathode	
Anode	

- (d) Describe what you would observe during the cell's operation. Include **all** observations and indicate where in the cell these would be observed.



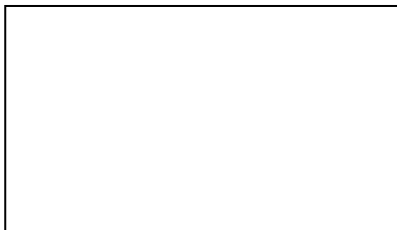
[9 marks]

9. A small section of polymer is shown



(a) Draw the structure of the monomer used to make this polymer and write its name.

Structure:



Name: _____

(b) What is the name of the polymer drawn above?

Name: _____

(c) What type of polymer is it?

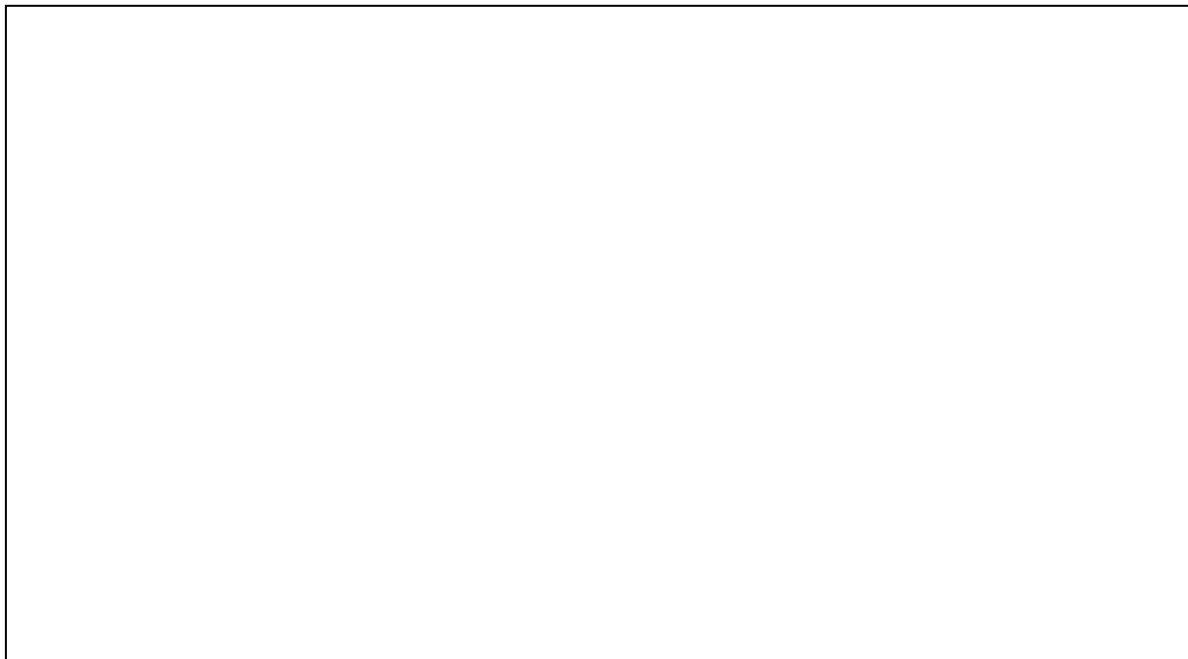
Type of Polymer: _____

[5 marks]

10. A chemist was given the task of extracting pure zinc oxide from a mixture of oxides containing iron oxide, calcium oxide and silicon dioxide in addition to the zinc oxide. Clearly explain, using equations where appropriate, how the chemist was able to obtain pure zinc oxide.

[6 marks]

11. Draw all the structural and geometric isomers of the aliphatic hydrocarbons having the formula C_4H_8 .



[4 marks]

END OF PART 2

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PART 4 (20 marks)

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.

The process of cleaning objects involves either the removal of substances from the surface of the object by dissolving it or changing it by reaction to something soluble then washing it away, or changing the dirt from a coloured substance to a colourless one. The following are some examples of cleaning processes.

1. Mortar and concrete can be removed from clay brickwork using hydrochloric acid then water. Mortar and concrete contain a number of solid hydroxides and carbonates that bind other inert particles such as sand and crushed rock to one another to produce a hard rock-like material. The most common hydroxides and carbonates present are those formed with calcium, magnesium and aluminium ions. Clay bricks are made up of complex minerals that are extremely unreactive.
2. Dry cleaning clothing involves the removal of fats and oils using an organic solvent. This is most often tetrachloroethene, a rather toxic substance. It has been suggested that liquid carbon dioxide could also be used as a dry cleaning liquid.
3. Concentrated sodium hydroxide solution or paste is often used to clean fat from ovens. This usually involves painting the solution or paste onto the dirty surface and allowing it to stand for some considerable time then washing it away with water.
4. The whiteness of white clothing can be restored by treating the article with a solution of sodium hypochlorite in a process call bleaching.
5. Rust stains are usually as a result of an object being contaminated with iron III ions, usually in the form of Fe_2O_3 . This can often be removed using a solution containing oxalic acid and sulfuric acid.
 - (a) For each of the processes described
 - (i) Write a clear explanation of how the process works.
 - (ii) Comment on how you would make sure that the process proceeds as quickly as possible.
 - (b) When you used potassium permanganate in your volumetric analysis you may have noticed that when a drop of this solution was accidentally spilt onto your report page it quickly turned into a brown stain. The brown substance is manganese IV oxide. Describe fully how you could remove the stain from your page.

END OF QUESTIONS

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