



آغا خان یونیورسٹی ایگزامینیشن بورڈ
AGA KHAN UNIVERSITY EXAMINATION BOARD

Notes from E-Marking Centre on HSSC-I Chemistry Annual Examinations 2024

Introduction

This document has been produced for the teachers and candidates of Higher Secondary School Certificate (HSSC) Part I Chemistry. It contains comments on candidates' responses to the 2024 HSSC-I Examination indicating the quality of the responses and highlighting their relative strengths and weaknesses.

E-Marking Notes

This includes overall comments on candidates' performance on every question and *some* specific examples of candidates' responses that support the mentioned comments. Please note that the descriptive comments represent an overall perception of the better and weaker responses as gathered from the e-marking session. However, the candidates' responses shared in this document represent some specific example(s) of the mentioned comments.

Teachers and candidates should be aware that examiners may ask questions that address the Student Learning Outcomes (SLOs) in a manner that requires candidates to respond by integrating knowledge, understanding and application skills they have developed during the course of study. Candidates are advised to read and comprehend each question carefully before writing the response to fulfil the demand of the question.

Candidates need to be aware that the marks allocated to the questions are related to the answer space provided on the examination paper as a guide to the length of the required response. A longer response will not in itself lead to higher marks. Candidates need to be familiar with the command words in the SLOs which contain terms commonly used in examination questions. However, candidates should also be aware that not all questions will start with or contain one of the command words. Words such as 'how', 'why' or 'what' may also be used.

General Observations

The candidates' performance demonstrated a strong understanding of various chemistry concepts, as evidenced by their responses. Many candidates showed a clear grasp of topics such as hybridisation and molecular geometry, limiting reagents and the properties of solutions and suspensions. However, certain areas need improvement to ensure a more comprehensive understanding and better performance next year:


- Properties of cathode rays
- Principles of electronic configuration
- Calculations involving reaction quotients, order of reaction, initial rates, calorimetry and enthalpy changes
- Precise use of scientific vocabulary and concepts for accurate justification of explanations
- Balancing of redox reactions using the oxidation number change method
- The Lewis concept of acids and bases
- Structured answer presentation, particularly in tabular format

Note: Candidates' responses shown in this report have not been corrected for grammar, spelling, format, or information.

DETAILED COMMENTS
Constructed Response Questions (CRQs)

Question No. 1a	
Question Text	What will be observed if a small paddle wheel is placed in the path of cathode rays? Write the property of cathode rays that supports your answer.
SLO No.	2.1.2
SLO Text	Describe the properties of: a. cathode rays b. positive rays;
Max Marks	2
Cognitive Level	U*
Checking Hints	1 mark for mentioning the observation 1 mark for writing the property in support of the stated observation
Overall Performance	Candidates generally showed a good grasp of the fundamental concepts related to cathode rays, with a significant portion accurately identifying the behaviour and properties of these rays. While many provided clear and accurate responses, a few candidates had misconceptions regarding the experimental details and the nature of cathode rays.
Description of Better Responses	<i>Better responses</i> effectively demonstrated a clear understanding of cathode rays by correctly identifying that the paddle wheel placed in the path of cathode rays would move due to the momentum of the rays. These candidates accurately described the property of cathode rays as material particles, showing an understanding that the movement of the paddle wheel is a result of the impact of these particles. This indicates a solid grasp of the experimental details and the properties of cathode rays.
Image of Better Response	<p style="text-align: center;">Cathode rays can drive a small paddle wheel placed in their path. This shows that cathode rays are material particle having definite mass and velocity. It shows that these rays carry momentum.</p>
Description of Weaker Responses	<i>Weaker responses</i> struggled to accurately describe the effect of cathode rays on the paddle wheel. Some candidates incorrectly stated that the paddle wheel would produce a shadow due to the straight-line movement of cathode rays. This reflects a misunderstanding of the experimental setup and the nature of cathode rays, indicating confusion about the differences between the effects of rays and opaque objects.
Image of Weaker Response	<p style="text-align: center;">A sharp shadow of the object placed in the path of cathode rays will occur.</p>

Suggestions for improvement (Highlight all that apply)

Maximising SLO Achievement	Preferred Pedagogy** Used for this SLO	Assessment Strategies
<ul style="list-style-type: none"> Identify the expectation of command words (use Command Word Guide) Ensure the content is taught at the relevant cognitive level Identify necessary content required (skills + concepts) Review past paper questions on the concept Utilise the resource guide for additional materials 	<ul style="list-style-type: none"> Story Board Cause and Effect Fish and Bone Concept Mapping Audio Visual Resources Think, Pair and Share Knowledge Platform videos Questioning Technique (Socratic approach) Practical Demonstration <p>** For description of each Pedagogy, refer to Annexure A</p>	<ul style="list-style-type: none"> Past paper questions Discussion on E-Marking Notes AKU-EB Digital Learning Solution powered by Knowledge Platform <p>https://akueb.knowledgeplatform.com/login</p> 

Any Additional Suggestion: Utilise interactive demonstrations, simulations, or diagrams to illustrate the behaviour of cathode rays and their interaction with objects such as paddle wheels. Engage candidates in discussions about the nature of cathode rays and the experiments used to study them, addressing common misconceptions and reinforcing correct interpretations.


*K = Knowledge U = Understanding A = Application and other higher-order cognitive skills

Question No. 1b

Question Text	Write the electronic configuration of an element X with atomic number 15 using the following rules: i. Aufbau principle ii. Hund's rule
SLO No.	2.7.2
SLO Text	Determine electronic configuration of elements based on Aufbau principle, Hund's rule and Pauli's exclusion principle;
Max Marks	2
Cognitive Level	A
Checking Hints	i. 1 mark for writing the correct electronic configuration according to the Aufbau principle ii. 1 mark for writing the correct electronic configuration according to the Hund's rule
Overall Performance	Candidates generally showed a satisfactory grasp of the concepts related to electronic configuration. Majority of the candidates demonstrated a clear understanding of the rules for writing electronic configurations using both the Aufbau principle and Hund's rule. However, there were notable discrepancies in how candidates differentiated between the two rules and applied them in practice.
Description of Better Responses	<i>Better responses</i> clearly demonstrated an understanding of electronic configuration by correctly applying both the Aufbau principle and Hund's rule. These candidates accurately represented the configurations of degenerate orbitals as per Hund's rule and used the Aufbau principle to determine the order of filling orbitals. Their responses reflected a strong grasp of the concepts and the ability to apply the rules accurately.

Images of Better Responses	<p>i. Aufbau principle (1 Mark)</p> <p>$1s^2, 2s^2, 2p^6, 3s^2, 3p^3$</p> <hr/> <p>ii. Hund's rule (1 Mark)</p> <p>$1s \quad 2s \quad 2p \quad 3s \quad 3p$</p> <p>$\uparrow\downarrow \quad \uparrow\downarrow \quad \uparrow\downarrow \uparrow\downarrow \uparrow\downarrow \quad \uparrow\downarrow \quad \uparrow\downarrow \uparrow\downarrow \uparrow\downarrow$</p>
Description of Weaker Responses	<p><i>Weaker responses</i> revealed a lack of understanding in distinguishing between the Aufbau principle and Hund's rule. Some candidates provided the same configuration for both rules, indicating confusion between the two approaches. Others merely wrote the statements of each rule without applying them to determine the electronic configuration, showing a weaker conceptual understanding of the topic.</p>
Images of Weaker Responses	<p>i. Aufbau principle (1 Mark)</p> <p>$X^{15} = 1s^2, 2s^2, 2p_x^2, 2p_y^2, 2p_z^2, 3p_x^2, 3p_y^2, 3p_z^1$</p> <hr/> <p>ii. Hund's rule (1 Mark)</p> <p>$X^{15} = 1s^2, 2s^2, 2p_x^1, 2p_y^1, 2p_z^1, 3p_x^1, 3p_y^1, 3p_z^1$</p>

Suggestions for improvement (Highlight all that apply)

Maximising SLO Achievement	Preferred Pedagogy Used for this SLO	Assessment Strategies
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Any Additional Suggestion: Teachers should incorporate interactive exercises and practice problems that require candidates to write electronic configurations using both rules to reinforce their understanding. Regular quizzes with immediate feedback should be implemented to address common misconceptions and reinforce correct application, leading to improved performance and confidence in their knowledge.

Question No. 2

Question Text	Compare the given attributes of a bond in the following gas molecules.											
	Attribute	O₂	N₂									
	Bond Energy											
	Bond Strength											
SLO No.	3.1.2											
SLO Text	Relate bond energy with bond strength;											
Max Marks	2											
Cognitive Level	U											
Checking Hints	1 mark for each correct comparison (2 required)											
Overall Performance	The question was challenging for the candidates. Many candidates were unclear about the basis of bond energy and the strength of bonds, often failing to relate these concepts correctly. This impacted the overall performance, as only a few candidates demonstrated a correct and thorough understanding.											
Description of Better Responses	<i>Better responses</i> accurately related bond energy and bond strength to the presence of multiple bonds in oxygen and nitrogen molecules. These candidates correctly identified that the bond strength increases with the number of bonds, leading to higher bond energy. Their answers demonstrated a clear understanding of the concepts and their application to different molecules.											
Images of Better Responses	<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 20%;">Attribute</th> <th style="width: 40%;">O₂</th> <th style="width: 40%;">N₂</th> </tr> </thead> <tbody> <tr> <td style="text-align: center;">Bond Energy</td> <td style="text-align: center;">lowest bond energy</td> <td style="text-align: center;">greatest bond energy</td> </tr> <tr> <td style="text-align: center;">Bond Strength</td> <td style="text-align: center;">weaker than N₂ because there are less no. of bonds between atoms. O=O</td> <td style="text-align: center;">Stronger than O₂ because there are more no. of bonds than O₂. N≡N</td> </tr> </tbody> </table>			Attribute	O ₂	N ₂	Bond Energy	lowest bond energy	greatest bond energy	Bond Strength	weaker than N ₂ because there are less no. of bonds between atoms. O=O	Stronger than O ₂ because there are more no. of bonds than O ₂ . N≡N
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Bond Energy	lowest bond energy	greatest bond energy										
Bond Strength	weaker than N ₂ because there are less no. of bonds between atoms. O=O	Stronger than O ₂ because there are more no. of bonds than O ₂ . N≡N										
Description of Weaker Responses	<i>Weaker responses</i> revealed significant misconceptions. Many candidates incorrectly linked bond strength and bond energy to electronegativity, rather than the number of bonds. This indicates a misunderstanding of the fundamental attributes of covalent bonds. These candidates were unable to accurately explain the relationship between bond energy and bond strength and the factors that affect them, highlighting a need for clearer instruction and reinforcement of these concepts.											
Images of Weaker Responses	<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 20%;">Attribute</th> <th style="width: 40%;">O₂</th> <th style="width: 40%;">N₂</th> </tr> </thead> <tbody> <tr> <td style="text-align: center;">Bond Energy</td> <td style="text-align: center;">Bond energy is greater than the N₂</td> <td style="text-align: center;">N₂ has less bond energy as compared to O₂</td> </tr> <tr> <td style="text-align: center;">Bond Strength</td> <td style="text-align: center;">Bond strength of O₂ is greater than the N₂</td> <td style="text-align: center;">N₂ has less bond strength is compared to O₂</td> </tr> </tbody> </table>			Attribute	O ₂	N ₂	Bond Energy	Bond energy is greater than the N ₂	N ₂ has less bond energy as compared to O ₂	Bond Strength	Bond strength of O ₂ is greater than the N ₂	N ₂ has less bond strength is compared to O ₂
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Suggestions for improvement (Highlight all that apply)

Maximising SLO Achievement	Preferred Pedagogy Used for this SLO	Assessment Strategies
<ul style="list-style-type: none"> Identify the expectation of command words (use Command Word Guide) 	<ul style="list-style-type: none"> Story Board Cause and Effect Fish and Bone 	<ul style="list-style-type: none"> Past paper questions Discussion on E-Marking Notes

- Ensure the content is taught at the relevant cognitive level
- Identify necessary content required (skills + concepts)
- Review past paper questions on the concept
- Utilise the resource guide for additional materials

- Concept Mapping
- Audio Visual Resources
- Think, Pair and Share
- Knowledge Platform videos
- Questioning Technique (Socratic approach)
- Practical Demonstration

- AKU-EB Digital Learning Solution powered by Knowledge Platform <https://akueb.knowledgeplatform.com/login>

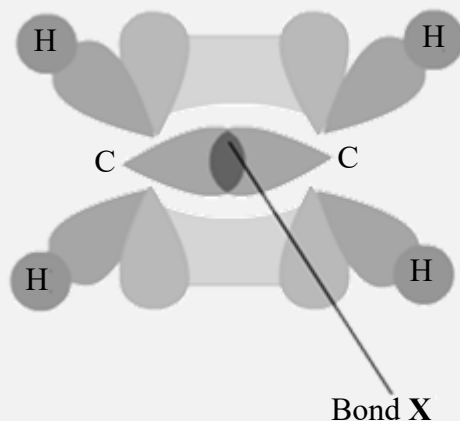


Any Additional Suggestion: Utilise interactive methods, such as molecular models and simulations, to visually demonstrate the concepts of bond energy and bond strength. Incorporate reasoning exercises that require candidates to explain the basis of bond energy and strength in various molecules. Reinforce correct concepts by providing immediate feedback and addressing common misconceptions, particularly the incorrect association of bond energy and strength with electronegativity, through targeted teaching and examples.

Question No. 3

Question Text

Consider the orbital shape of a molecule.



Identify the following in the given diagram.

- Hybridisation: _____
- Geometry: _____
- Bond X: _____

SLO No.

3.3.4 (3.3.2)

SLO Text

Describe the shapes of simple molecules using orbital hybridisation (sp , sp^2 , sp^3); (Describe the features of sigma and pi bonds;)

Max Marks

3

Cognitive Level

U

Checking Hints

1 mark for each correct identification (3 required)
Candidates will receive zero marks if they identify a carbon-carbon double bond instead of a sigma bond.

Overall Performance


Majority of the cohort successfully demonstrated a clear understanding of the concepts assessed by the question. However, there were some candidates who struggled with these concepts, revealing specific areas that require further attention.

Description of Better Responses

Better responses showcased a thorough and clear understanding of hybridisation and molecular geometry. These candidates accurately identified the type of hybridisation, the geometry of the molecule, and the type of bond highlighted. Their answers reflected a strong

	grasp of the theories of covalent bonding, such as the Valence Shell Electron Pair Repulsion (VSEPR) model and the hybrid orbital model.						
Images of Better Responses	<table border="1"> <tr> <td>a. Hybridisation:</td> <td><u>sp² hybridization</u></td> </tr> <tr> <td>b. Geometry:</td> <td><u>Trigonal planar</u></td> </tr> <tr> <td>c. Bond X:</td> <td><u>Sigma bond</u></td> </tr> </table>	a. Hybridisation:	<u>sp² hybridization</u>	b. Geometry:	<u>Trigonal planar</u>	c. Bond X:	<u>Sigma bond</u>
a. Hybridisation:	<u>sp² hybridization</u>						
b. Geometry:	<u>Trigonal planar</u>						
c. Bond X:	<u>Sigma bond</u>						
Description of Weaker Responses	<i>Weaker responses</i> indicated a lack of understanding of the concepts. Some candidates were either unaware of or only partially understood the concept of molecular geometry, particularly the VSEPR model and the hybrid orbital model. These responses highlighted the incorrect identification of the type of bond as simply covalent without distinguishing between sigma and pi bonds, reflecting a significant misconception regarding the nature of bonds formed during hybridisation. Additionally, many candidates identified the geometry mostly as tetrahedral with sp ³ hybridisation, demonstrating a limited grasp of more complex geometries and hybridisation types.						
Images of Weaker Responses	<table border="1"> <tr> <td>a. Hybridisation:</td> <td><u>sp³</u></td> </tr> <tr> <td>b. Geometry:</td> <td><u>Tetrahedral.</u></td> </tr> <tr> <td>c. Bond X:</td> <td><u>Covalent Double Bond (σ, π)</u></td> </tr> </table>	a. Hybridisation:	<u>sp³</u>	b. Geometry:	<u>Tetrahedral.</u>	c. Bond X:	<u>Covalent Double Bond (σ, π)</u>
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Suggestions for improvement (Highlight all that apply)

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Any Additional Suggestion: Assign group activities where candidates use molecular model kits to construct models of molecules with different types of hybridization, such as methane (CH₄), ethene (C₂H₄), and ethyne (C₂H₂). Encourage the use of colour-coded stickers or markers to differentiate between various orbitals (s, p, and hybridised orbitals like sp³, sp², sp) in their models. Facilitate group discussions where candidates explain how atomic orbitals hybridise to form different molecular geometries and types of bonds. Moreover, use visual aids and diagrams to illustrate the VSEPR model and hybrid orbital theory, aiding in the visualisation of molecular spatial arrangements.

Question No. 4

Question Text	<p>In a closed container at 900 K, 6.0×10^{-3} M of $\text{CH}_4(\text{g})$ reacts with 4.0×10^{-3} M of $\text{H}_2\text{O}(\text{g})$ to produce 8.0×10^{-3} M of $\text{CO}(\text{g})$ and 3.0×10^{-3} M of $\text{H}_2(\text{g})$. The equation for the reversible reaction is as under.</p> $\text{CH}_4(\text{g}) + \text{H}_2\text{O}(\text{g}) \rightleftharpoons \text{CO}(\text{g}) + 3\text{H}_2(\text{g}) \quad K_c = 2.4 \times 10^{-4}$ <p>a. Calculate the value of Q_c. b. Determine the direction in which the reaction will proceed.</p>
SLO No.	7.1.6
SLO Text	Predict the direction of a reaction by relating equilibrium constant with the ratio between concentration of products and reactants;
Max Marks	4
Cognitive Level	A
Checking Hints	<p>a. 1 mark for the formula/ substitution 1 mark for the correct value of Q_c</p> <p>b. 1 mark for comparing the value of Q_c and K_c, i.e. $Q_c < K_c$ 1 mark for determining the correct direction of reaction</p>
Overall Performance	Candidates generally showed better understanding of K_c and the prediction of the reaction's direction. While some candidates struggled with calculating accurate Q_c value, they were often able to predict the correct direction of the reaction based on their calculations. Generally, the question was well-attempted.
Description of Better Responses	<i>Better responses</i> highlighted the correct reaction quotient expression for the given reaction and accurate calculations of the Q_c value. These candidates effectively related the Q_c value to the given K_c value and correctly predicted the direction of the reaction, demonstrating a strong understanding of the relationship between Q_c and K_c and how it determines the reaction's direction.
Images of Better Responses	<div style="border: 1px solid black; padding: 5px;"> <p>a. Calculate the value of Q_c. (2 Marks)</p> $Q_c = \frac{[\text{CO}][\text{H}_2]^3}{[\text{CH}_4][\text{H}_2\text{O}]}$ $Q_c = \frac{(8.0 \times 10^{-3})(3.0 \times 10^{-3})^3}{(6.0 \times 10^{-3})(4.0 \times 10^{-3})}$ $Q_c = \frac{2.16 \times 10^{-10}}{2.4 \times 10^{-5}}$ $Q_c = 9 \times 10^{-6}$ <p>b. Determine the direction in which the reaction will proceed. (2 Marks)</p> <p>The reaction will proceed in forward direction b/c Q_c value is less than K_c.</p> </div>
Description of Weaker Responses	<i>Weaker responses</i> struggled with calculations involving exponential values and often failed to correctly relate the Q_c value to the given K_c value, leading to incorrect predictions about the direction of the reaction. Additionally, some candidates were unable to write the correct Q_c expression, indicating misconceptions about the expressions for the reaction quotient, equilibrium constant, and their applications.

Images of Weaker Responses

a. Calculate the value of Q_c . (2 Marks)

$$K_c = \frac{[CO] + [H_2]^3}{[CH_4] + [H_2O]}$$

$$2.4 \times 10^{-4} = \frac{[8 \times 10^{-3}] + [3 \times 10^{-3}]^3}{[6 \times 10^{-3}] + [4 \times 10^{-3}]}$$


$$2.4 \times 10^{-4} \{8.000027 \times 10^{-3}\} = \frac{8.000027 \times 10^{-3}}{2.4 \times 10^{-6}}$$

$$Q_c = 3.33 \times 10^{-9}$$

b. Determine the direction in which the reaction will proceed. (2 Marks)

The reaction will proceed in backward direction.

Suggestions for improvement (Highlight all that apply)

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Any Additional Suggestion: Begin by reviewing the concept of chemical equilibrium and the equilibrium constant (K_c). Explain the reaction quotient (Q_c), which is like K_c but can be calculated at any point during a reaction. Divide students into small groups and assign each group an example equilibrium reaction. Have them:

- Write down the balanced chemical equation for their assigned reaction.
- Calculate Q_c using the given initial concentrations or pressures.
- Compare Q_c to K_c (if provided) or predict whether the system is at equilibrium, and if not, in which direction the reaction will proceed to reach equilibrium.
- Discuss the implications of their findings within their groups.

Facilitate class discussions to reinforce the relationship between Q_c and K_c and the steps for predicting the direction of a reaction. Use real-life examples and visual aids to illustrate these concepts.

Question No. 5a

Question Text X and Y react to form a product Z. In the first experiment (first run), the concentration of X is doubled while Y is held constant, and the initial rate doubles. In the second experiment (second run), the concentration of Y is doubled while the concentration of X remains constant, and the initial rate quadruples. Deduce the order of the reaction with respect to X and Y. (Note: Assume that the term 'constant' represents a concentration of 1 mol dm⁻³.)

SLO No. 9.2.4

SLO Text Deduce the order of reaction using the method of initial rate;

Max Marks 2

Cognitive Level A

Checking Hints 1 mark for deducing each order of reaction (TWO required)

Overall Performance Candidates generally demonstrated a satisfactory understanding of reaction order concepts. However, many struggled to identify the order of reaction from the given experimental data. While some were able to provide the correct rate law equation and determine the overall reaction order as third order, others had difficulty interpreting the data accurately.

Description of Better Responses Better responses clearly identified the order of reaction with respect to each reactant and correctly stated the overall order of reaction as third order. These candidates also provided the correct rate law equation, demonstrating a solid understanding of how the concentration of reactants influences the reaction rate.

Image of Better Response

Image i:

According to the first experiment if we increase/double "X" rate doubles, that means it's a "first order" reaction, [X]. In the second run if "Y" doubles the rate double 4 times, meaning it's a "2nd order reaction", [Y²]. The rate expression for this will be rate = k [X][Y]²

Image ii:


	X	Y	Rate	For X: (obs 1 and 2)	For Y: (obs 1 and 3)	Overall order of reaction:
1	1	1	0.12	rate ₂ = (conc ₂) ^y rate ₁ = (conc ₁) ^y	rate ₃ = (conc ₃) ^x rate ₁ = (conc ₁) ^x	1 + 2 = 3
2	2	1	0.24	$\frac{0.24}{0.12} = \left(\frac{2}{1}\right)^y$	$\frac{0.48}{0.12} = \left(\frac{2}{1}\right)^x$	III rd order
3	1	2	0.48	y = 1 (w.r.t X)	x = 2 (w.r.t Y)	

Description of Weaker Responses Weaker responses revealed misconceptions regarding the order of reaction for each reactant. These candidates struggled to interpret the experimental data and often failed to predict the effect of changing reactant concentrations on the reaction rate. Some responses incorrectly adjusted the number of moles of reactants in different experiments and were unable to predict the order of reaction accurately.

Image of Weaker Response

X	Y	Z	1	$\frac{2x}{x} \div \frac{y}{x} = 2:1$
1) x	x	x		x : y
2) 2x	x	2x	2	$\frac{2x}{x} \div \frac{4x}{x} = 1:4$
3) x	2x	4x		

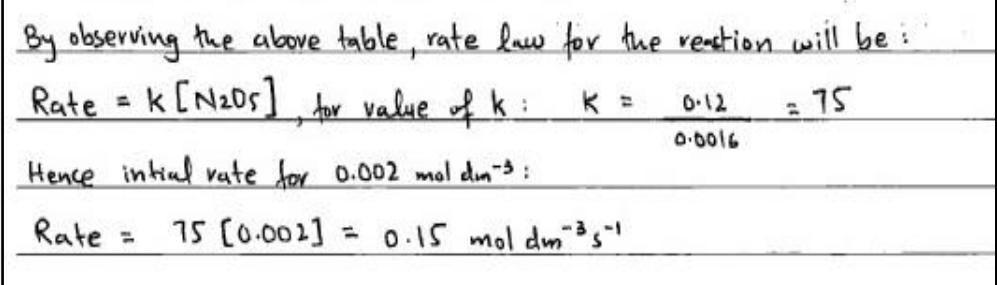
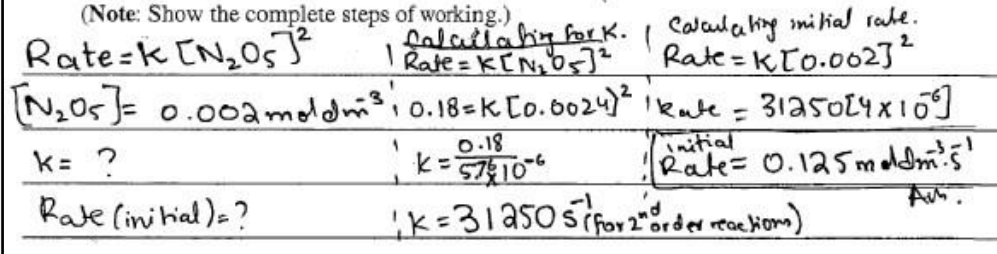
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Any Additional Suggestion: Explain the order of reaction with relatable analogies, such as baking cookies. The rate at which we mix ingredients, bake, and cool the cookies determines how quickly they are ready. Similarly, in chemistry, the reaction rate indicates how fast reactants turn into products. The order of reaction is like understanding how each ingredient affects baking time. For instance, if adding more flour speeds up baking (like a first-order reaction), or if adding more chocolate chips doesn't change baking time (like a zero-order reaction). Similarly, graphs can also be used to illustrate zero-order, first-order, and second-order reactions, showing how reaction rates change with varying reactant concentrations. Incorporate hands-on examples and practice problems where candidates calculate reaction orders from experimental data. Encourage group discussions and collaborative problem-solving to share thought processes and correct misconceptions.

Question No. 5b

Question Text	<p>Consider the following results for the decomposition of dinitrogen pentaoxide.</p> $2\text{N}_2\text{O}_{5(g)} \rightarrow 4\text{NO}_{2(g)} + \text{O}_{2(g)}$ <table border="1" data-bbox="347 1245 1066 1498"> <thead> <tr> <th>Concentration of N_2O_5 (mol dm^{-3})</th> <th>Initial Rate ($\text{mol dm}^{-3} \text{s}^{-1}$)</th> </tr> </thead> <tbody> <tr> <td>0.0016</td> <td>0.12</td> </tr> <tr> <td>0.0024</td> <td>0.18</td> </tr> <tr> <td>0.0032</td> <td>0.24</td> </tr> </tbody> </table> <p>Calculate the initial rate of reaction when the concentration of N_2O_5 is $0.002 \text{ mol dm}^{-3}$. (Note: Show the complete steps of working.)</p>	Concentration of N_2O_5 (mol dm^{-3})	Initial Rate ($\text{mol dm}^{-3} \text{s}^{-1}$)	0.0016	0.12	0.0024	0.18	0.0032	0.24
Concentration of N_2O_5 (mol dm^{-3})	Initial Rate ($\text{mol dm}^{-3} \text{s}^{-1}$)								
0.0016	0.12								
0.0024	0.18								
0.0032	0.24								
SLO No.	9.3.2								
SLO Text	Calculate the initial rate using concentration data of given reactions;								
Max Marks	2								
Cognitive Level	A								
Checking Hints	1 mark for calculating the rate constant 1 mark for calculating initial rate								
Overall Performance	The overall responses to this question indicated that it was challenging for many candidates. However, those who performed well demonstrated a deep understanding of reaction kinetics processes and concepts, showing a high level of proficiency in interpreting experimental data and applying the principles of chemical kinetics to solve the problem.								

Description of Better Responses	<i>Better responses</i> indicated a strong grasp of the order of reaction and the rate law when provided with data. Candidates correctly calculated the rate constant (k) by substituting appropriate values into the rate law equation. Utilising the unitary method and other relevant mathematical techniques, they successfully determined the initial rate of reaction. Their logical and well-structured responses reflected a solid comprehension of the relationship between concentration and reaction rate, with methodical and precise calculations demonstrating a clear understanding of the associated units and concepts involved.
Image of Better Response	 <p>By observing the above table, rate law for the reaction will be:</p> $\text{Rate} = k[\text{N}_2\text{O}_5], \text{ for value of } k: k = \frac{0.12}{0.0016} = 75$ <p>Hence initial rate for $0.002 \text{ mol dm}^{-3}$:</p> $\text{Rate} = 75 [0.002] = 0.15 \text{ mol dm}^{-3} \text{ s}^{-1}$
Description of Weaker Responses	<i>Weaker responses</i> showed a lack of clarity or partial understanding of fundamental concepts such as the rate law and order of reaction. These candidates struggled to interpret the provided data accurately, resulting in incorrect calculations and conclusions. Many candidates cited the rate law expression as $\text{Rate} = k[\text{N}_2\text{O}_5]^2$, incorrectly identifying the reaction as second order with respect to N_2O_5 . Hence, their calculations, based on the square of the concentration of N_2O_5 , were incorrect, leading to invalid answers.
Image of Weaker Response	 <p>(Note: Show the complete steps of working.)</p> <p>Rate = $k[\text{N}_2\text{O}_5]^2$ Calculating for k. Calculating initial rate. Rate = $k[\text{N}_2\text{O}_5]^2$ Rate = $k[0.002]^2$</p> <p>$[\text{N}_2\text{O}_5] = 0.002 \text{ mol dm}^{-3}$ $0.18 = k[0.0024]^2$ $k_{\text{rate}} = 31250 [4 \times 10^{-6}]$</p> <p>$k = ?$ $k = \frac{0.18}{576 \times 10^{-6}}$ $\text{initial Rate} = 0.125 \text{ mol dm}^{-3} \text{ s}^{-1}$</p> <p>Rate (initial) = ? $k = 31250 \text{ s}^{-1}$ (for 2nd order reaction) Avh.</p>

Suggestions for improvement (Highlight all that apply)

Maximising SLO Achievement	Pedagogy Used for that SLO	Assessment Strategies
<ul style="list-style-type: none"> Identify the expectation of command words (use Command Word Guide) Ensure the content is taught at the relevant cognitive level Identify necessary content required (skills + concepts) Review past paper questions on the concept Utilise the resource guide for additional materials 	<ul style="list-style-type: none"> Story Board Cause and Effect Fish and Bone Concept Mapping Audio Visual Resources Think, Pair and Share Knowledge Platform videos Questioning Technique (Socratic approach) Practical Demonstration 	<ul style="list-style-type: none"> Past paper questions Discussion on E-Marking Notes AKU-EB Digital Learning Solution powered by Knowledge Platform <p>https://akueb.knowledgeplatform.com/login</p> 

Any Additional Suggestion: Use everyday examples to clarify reaction order and rate law concepts, making them more tangible. For instance, compare changing the amount of an ingredient in baking to altering reactant concentrations and its impact on baking time (reaction rate). Break down finding the initial rate of a reaction into clear, manageable steps to help candidates follow the process systematically. Engage students in

interactive activities and practice problems to reinforce these concepts. Encourage group discussions and collaborative problem-solving to facilitate peer learning and address misconceptions effectively.

Question No. 6

Question Text Consider a 16 g sample of methanol (CH_3OH) is burnt in the presence of excess oxygen in a bomb calorimeter containing 4,000 g of water. The temperature of the water increases from 22°C to 27°C .
If the heat capacity of the calorimeter is $2,657 \text{ J}^\circ\text{C}$ and the specific heat of water is $4.2 \text{ J/g}^\circ\text{C}$, then calculate the enthalpy of combustion of methanol in kJ mol^{-1} .
(**Note:** Molar mass of methanol is 32 g mol^{-1} .)

SLO No. 11.4.2

SLO Text Calculate the heat of reaction in a calorimeter from given experimental data;

Max Marks 4

Cognitive Level A

Checking Hints
1 mark for calculating ΔT
1 mark for calculating the correct number of moles of methanol
1 mark for the correct formula of calculating enthalpy of combustion
1 mark for the correct answer from substituted values in kJ mol^{-1}

Overall Performance Overall, candidates found this question to be difficult. While a few candidates demonstrated a clear understanding of enthalpy and calorimetric calculations, many struggled with applying these concepts accurately.

Description of Better Responses *Better responses* showed a strong understanding of the enthalpy of reaction and calorimetric calculations. These candidates accurately used the concepts of specific heat capacity, heat capacity, and molar enthalpy for exothermic reactions. They correctly applied the formula: $q_{\text{total}} = (q_{\text{water}} = m \cdot c \cdot \Delta T) + (q_{\text{calorimeter}} = C_{\text{calorimeter}} \cdot \Delta T)$ followed by $\Delta H_c = -\frac{q_{\text{total}}}{n}$.
Their responses included clear, precise calculations and the correct use of negative signs for exothermic reactions, with answers provided in kJ mol^{-1} .

Image of Better Response

Mass = 16g	Heat absorbed by water	
Molar mass = 32	$q = m \cdot c \cdot \Delta T$	Heat of combustion
Moles = $\frac{16}{32} = 0.5 \text{ mol}$	$q = 4000 \times 4.2 \times 5$	= $\frac{97.285}{0.5}$
	$q = 84000 \text{ J}$	
$m_w = 4000 \text{ g} = 4 \text{ kg}$	Heat absorbed by calorimeter	$= 194.57 \text{ kJ mol}^{-1}$
$\Delta T = 27 - 22 = 5^\circ\text{C}$	$q = c \Delta T$	
$C_c = 2657 \text{ J}^\circ\text{C}$	$q = 2657 \times 5$	
$C_w = 4.2 \text{ J/g}^\circ\text{C}$	$q = 13285 \text{ J}$	
$H_{\text{comb}} = ?$	Total = $84000 + 13285$	
	$= 97285 = 97.285 \text{ kJ}$	

Description of Weaker Responses *Weaker responses* often demonstrated partial or unclear understanding of fundamental concepts related to enthalpy and calorimetry. Many candidates accurately calculated the change in temperature and the number of moles of methanol but struggled with applying the correct formula for determining the enthalpy of combustion. Additionally, some failed to recognise that the enthalpy of exothermic reactions should be represented with a negative sign, and many did not convert their results to kJ mol^{-1} . These issues indicate a lack of thorough understanding or an incomplete grasp of the topic.

Image of Weaker Response

$$q_v = ? \therefore C = 2657 + 4.2 = 2661.2 \text{ J/g}^\circ\text{C}$$

$$\Delta T = 27^\circ\text{C} - 22^\circ\text{C} = 4^\circ\text{C} \text{ or } 4 \text{ K}$$

$$q = C \Delta T$$

$$q = 2661.2 \times 4$$

$$q = 10644.8 \text{ J}$$

$$\Delta H_{\text{com}} = ?$$


$$\text{moles} = 16 \text{ g} / 32 \text{ g/mol} = 0.5 \text{ moles of } \text{CH}_3\text{OH}$$

$$\Delta H_{\text{com}} = 10644.8 / 0.5 = 21289.6 \text{ J/mol}$$

$$\text{Convert to kJ/mol} : 21289.6 / 1000 = 21.28 \text{ kJ/mol}$$

Hence, ΔH_{com} of methanol is 21.28 kJ/mol.

Suggestions for improvement (Highlight all that apply)

Maximising SLO Achievement	Pedagogy Used for that SLO	Assessment Strategies
<ul style="list-style-type: none"> Identify the expectation of command words (use Command Word Guide) Ensure the content is taught at the relevant cognitive level Identify necessary content required (skills + concepts) Review past paper questions on the concept Utilise the resource guide for additional materials 	<ul style="list-style-type: none"> Story Board Cause and Effect Fish and Bone Concept Mapping Audio Visual Resources Think, Pair and Share Knowledge Platform videos Questioning Technique (Socratic approach) Practical Demonstration 	<ul style="list-style-type: none"> Past paper questions Discussion on E-Marking Notes AKU-EB Digital Learning Solution powered by Knowledge Platform <p>https://akueb.knowledgeplatform.com/login</p> 

Any Additional Suggestion: To strengthen candidates' understanding and application of enthalpy and calorimetry concepts, provide them with a range of challenging numerical problems. These problems should involve various formulas and scenarios to enhance their problem-solving skills. Teach candidates a step-by-step approach to solving these problems, breaking down each part of the calculation process clearly. Include worked examples and detailed solutions to illustrate complex problem-solving techniques. Emphasise the importance of correctly interpreting the signs (positive or negative) in enthalpy changes, especially for exothermic and endothermic reactions, to ensure accurate calculations and understanding.

Extended Response Questions (ERQs)

Extended response questions offered a choice between parts 'a' and 'b'

Question No. 7a

Question Text	<p>According to the following equation, 96 g of sulphur reacts with 36 g of carbon to produce carbon disulphide.</p> $2\text{S}_{(s)} + \text{C}_{(s)} \xrightarrow{\text{heat}} \text{CS}_{2(l)}$ <p>Calculate the following and identify the limiting reagent in this reaction.</p> <p>i. The mass of carbon disulphide produced</p> <p>ii. The excess amount of the reactant in grams that is left un-reacted</p> <p>(Note:</p> <ul style="list-style-type: none"> • $^{12}_6\text{C}$ and $^{32}_{16}\text{S}$ • Show the complete steps of working.) 																		
SLO No.	1.4.2																		
SLO Text	Calculate maximum amount of product produced and amount of any unreacted excess reagent, with the help of limiting reagent in a chemical reaction;																		
Max Marks	7																		
Cognitive Level	A																		
Checking Hints	<p>1 mark for calculating the correct moles of sulphur</p> <p>1 mark for calculating the correct moles of carbon</p> <p>1 mark for calculating the molar mass of carbon disulphide</p> <p>1 mark for identifying the limiting reagent</p> <p>1 mark for calculating the correct mass of carbon disulphide</p> <p>1 mark for the comparison of moles of sulphur and carbon</p> <p>1 mark for calculating the amount of the reagent in excess (in grams)</p>																		
Overall Performance	Overall, candidates demonstrated strong performance in calculating both the mass of carbon disulphide produced and the amount of excess reagent remaining unreacted, based on the identified limiting reagent. This proficiency was evident from the high attempt rate for this question. However, some weaker responses showed confusion with molar masses and the subsequent calculations for products and excess reagent.																		
Description of Better Responses	<i>Better responses</i> accurately calculated the number of moles of each reactant and correctly identified the limiting reagent by comparing the moles of the product formed with each reactant. These candidates also correctly determined the amount of product formed and the mass of the unreacted excess reagent, demonstrating a solid grasp of stoichiometric calculations.																		
Image of Better Response	<div style="border: 1px solid black; padding: 5px;"> <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 50%; border-bottom: 1px solid black;">Mass of sulphur = 96 g</td> <td style="width: 50%; border-bottom: 1px solid black;">Molar mass of sulphur = 32 g</td> </tr> <tr> <td style="border-bottom: 1px solid black;">Mass of carbon = 36 g</td> <td style="border-bottom: 1px solid black;">Molar mass of carbon = 12 g</td> </tr> <tr> <td colspan="2" style="border-bottom: 1px solid black;">Moles = Mass / Molar mass</td> </tr> <tr> <td style="border-bottom: 1px solid black;">Moles of sulphur = $96/32$</td> <td style="border-bottom: 1px solid black;">Moles of carbon = $36/12$</td> </tr> <tr> <td style="border-bottom: 1px solid black;">= 3 moles of S</td> <td style="border-bottom: 1px solid black;">= 3 moles of C</td> </tr> <tr> <td style="border-bottom: 1px solid black;">S : CS₂</td> <td style="border-bottom: 1px solid black;">C : CS₂</td> </tr> <tr> <td style="border-bottom: 1px solid black;">2 : 1</td> <td style="border-bottom: 1px solid black;">1 : 1</td> </tr> <tr> <td style="border-bottom: 1px solid black;">= $3 \times \frac{1}{2} = 1.5$ moles of CS₂</td> <td style="border-bottom: 1px solid black;">= $3 \times \frac{1}{1} = 3$ moles of CS₂</td> </tr> <tr> <td style="border-bottom: 1px solid black;">So, limiting reagent = Sulphur</td> <td style="border-bottom: 1px solid black;">∴ M.M = 76 g</td> </tr> </table> </div>	Mass of sulphur = 96 g	Molar mass of sulphur = 32 g	Mass of carbon = 36 g	Molar mass of carbon = 12 g	Moles = Mass / Molar mass		Moles of sulphur = $96/32$	Moles of carbon = $36/12$	= 3 moles of S	= 3 moles of C	S : CS ₂	C : CS ₂	2 : 1	1 : 1	= $3 \times \frac{1}{2} = 1.5$ moles of CS ₂	= $3 \times \frac{1}{1} = 3$ moles of CS ₂	So, limiting reagent = Sulphur	∴ M.M = 76 g
Mass of sulphur = 96 g	Molar mass of sulphur = 32 g																		
Mass of carbon = 36 g	Molar mass of carbon = 12 g																		
Moles = Mass / Molar mass																			
Moles of sulphur = $96/32$	Moles of carbon = $36/12$																		
= 3 moles of S	= 3 moles of C																		
S : CS ₂	C : CS ₂																		
2 : 1	1 : 1																		
= $3 \times \frac{1}{2} = 1.5$ moles of CS ₂	= $3 \times \frac{1}{1} = 3$ moles of CS ₂																		
So, limiting reagent = Sulphur	∴ M.M = 76 g																		

$$\begin{aligned} \text{Mass of Carbon disulphide produced} &= \text{Moles} \times \text{Molar mass} \\ &= 1.5 \times 76 \\ &= 114 \text{ g of CS}_2 \end{aligned}$$

S : C

2 : 1

$$\text{So, } n = 3 \times \frac{1}{2} = 1.5 \text{ moles of Carbon}$$

If there were 3 moles of C ; then,

$$= 3 - 1.5 = 1.5 \text{ moles of Carbon left unreacted}$$

$$\text{Mass left unreacted} = \text{Moles} \times \text{Molar mass}$$

$$= 1.5 \times 12$$

$$= 18 \text{ g of carbon left unreacted}$$

Description of Weaker Responses

Weaker responses had difficulty in accurately calculating the number of moles, which led to incorrect determinations of the product mass and the identification of limiting and excess reagents. This misunderstanding of molar masses and stoichiometric relationships, which are crucial for accurate calculations, resulted in errors in determining the mass of the excess reagent.

Image of Weaker Response

PART A

1) To find out limiting reactant first calculate its moles

$$\text{moles} = \frac{\text{mass}}{\text{m.mass}} \quad \text{moles of S} = \frac{96}{32} = 3, \quad \text{moles of C} = \frac{36}{12} = 3$$

moles of S and C is equal so we check through the balanced chemical equation

2 moles of S is used to make CS₂ then = 2 × 3 = 6 moles

1 mole of C is used to make CS₂ then = 1 × 3 = 3 moles

Here, C is the limiting reactant because it use less amount of moles and it is completely consumed in the reaction

$$\text{mass} = (\text{moles} \times \text{molecular mass})$$

$$\text{mass} = 6 \times 44$$

$$\text{Mass} = 264 \text{ g}$$

Mass of Carbon disulphide produced 264 g

The excess amount of reactant in gram that is left unreacted is calculated by

$$= \text{Calculated mass} + \text{Total mass}$$


$$= 264 + 132$$

$$= 396 \text{ g}$$

$$\text{Now, to find unreacted} = 396 - 132$$

$$= 264 \text{ g left unreacted}$$

Suggestions for improvement (Highlight all that apply)


Maximising SLO Achievement	Preferred Pedagogy Used for this SLO	Assessment Strategies
<ul style="list-style-type: none"> Identify the expectation of command words (use Command Word Guide) Ensure the content is taught at the relevant cognitive level Identify necessary content required (skills + concepts) Review past paper questions on the concept Utilise the resource guide for additional materials 	<ul style="list-style-type: none"> Story Board Cause and Effect Fish and Bone Concept Mapping Audio Visual Resources Think, Pair and Share Knowledge Platform videos Questioning Technique (Socratic approach) Practical Demonstration 	<ul style="list-style-type: none"> Past paper questions Discussion on E-Marking Notes AKU-EB Digital Learning Solution powered by Knowledge Platform <p>https://akueb.knowledgeplatform.com/login</p> 

Any Additional Suggestion: To address the weaknesses observed, offer candidates a range of challenging numerical problems focused on stoichiometry and limiting reagents to enhance their calculation skills. Teach a systematic approach to problem-solving by breaking down each step of the calculation process. Provide detailed worked examples and practice problems to help candidates navigate through complex scenarios and reinforce their understanding.

Question No. 7b

Question Text	Balance the following reaction using the oxidation number method. $\text{MnO}_4^{1-} + \text{Fe}^{2+} + \text{H}^{1+} \rightarrow \text{Mn}^{2+} + \text{Fe}^{3+} + \text{H}_2\text{O}$ (Note: Show the complete steps of working.)
SLO No.	12.1.4
SLO Text	Balance a chemical equation using oxidation number change method;
Max Marks	7
Cognitive Level	A
Checking Hints	1 mark for showing the change in oxidation state of manganese 1 mark for showing the change in oxidation state of iron 1 mark for balancing manganese on both sides of the equation 1 mark for balancing iron on both sides of the equation 1 mark for balancing oxygen on both sides of the equation 1 mark for balancing hydrogen ions on both sides of the equation 1 mark for writing the final balanced equation
Overall Performance	Overall, the question was attempted by few candidates. Those who performed well demonstrated proficiency in balancing redox reactions, accurately identifying oxidation state changes, and correctly using the oxidation number change method to balance equations. In contrast, weaker responses revealed misconceptions and difficulties with this method, often improperly balancing electrons, oxygen, and hydrogen atoms, indicating a need for further practice and understanding.
Description of Better Responses	<i>Better responses</i> exhibited a strong grasp of redox reactions and the balancing process. These candidates accurately identified oxidised and reduced species by tracking changes in oxidation numbers. They skilfully balanced electrons in redox equations using the oxidation number change method, including the correct balancing of oxygen atoms by adding water molecules and hydrogen atoms by adding hydrogen ions. Their responses reflected a thorough understanding and ample practice of this method.

Suggestions for improvement (Highlight all that apply)

Maximising SLO Achievement	Preferred Pedagogy Used for this SLO	Assessment Strategies
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Any Additional Suggestion: Teach a structured method for balancing redox reactions, starting with detailed, step-by-step explanations on assigning oxidation numbers and tracking changes during the reactions. Emphasise the importance of balancing electrons to ensure accurate redox equations. Provide a range of practice problems with increasing difficulty to help students master the method. Offer detailed feedback on these problems to address misunderstandings and reinforce correct techniques.

Question No. 8a

Question Text	When silver chloride dissolves in a solution of ammonia, it results in the formation of a complex ion, $\text{Ag}(\text{NH}_3)_2^+$. Explain $\text{Ag}(\text{NH}_3)_2^+$ as a Lewis acid-base adduct by including the following in your answer. i. Classification of reactants along with the justification for each classification ii. Balanced equation for the dissolution of AgCl in a solution of NH_3 iii. Lewis structure of $\text{Ag}(\text{NH}_3)_2^+$ with the identification of the type of bond present in it
SLO No.	8.4.2
SLO Text	Classify compounds (e.g. NH_3 , AlCl_3 , BF_3 , etc.) as Lewis acids or bases;
Max Marks	7
Cognitive Level	U
Checking Hints	1 mark for classifying the silver ion as Lewis acid 1 mark for the correct reason 1 mark for classifying ammonia as Lewis base 1 mark for the correct reason 1 mark for the balanced chemical equation showing the dissolution of silver chloride in ammonia 1 mark for the Lewis structure of the complex ion 1 mark for identifying the bond formed in the adduct
Overall Performance	Overall, the question was attempted by few candidates. The candidates' responses to this question highlighted their general difficulty with Lewis's acid and base. Many candidates displayed misconceptions about identifying Lewis acids and bases, often confusing lone pair donors and acceptors with proton donors and acceptors. However, those who performed well demonstrated a strong understanding of the Lewis concept, accurately depicting the interactions involved.

Description of Better Responses

Candidates who provided *better responses* clearly identified ammonia as a Lewis base and lone pair donor, and silver ion as a Lewis acid and lone pair acceptor. They accurately depicted the Lewis structure of the complex ion (adduct), showing two molecules of ammonia attached to one silver ion, and included a balanced chemical equation. Additionally, they correctly identified the type of bond formed during lone pair transfer as a coordinate covalent bond.

Image of Better Response

ii) Balance Equation

$$\text{AgCl} + 2\text{NH}_3 \longrightarrow \text{Ag}(\text{NH}_3)_2^+ + \text{Cl}^-$$

i) AgCl is a Lewis acid as it has an incomplete octet and has a tendency to have 1 electron pair. whereas NH₃ is a Lewis base because it has one lone pair. As Lewis base is a substance that donates a pair of electrons so NH₃ here is donating its lone pair. Lewis acid is a substance that gains electron pair. If AgCl breaks into ions Ag⁺ and Cl⁻, Ag⁺ will have an incomplete octet thus is able to gain electron pair.

iii) Lewis Structure:

$$\text{AgCl} \longrightarrow \text{Ag}^+ + \text{Cl}^-$$

- One-sided sharing by NH₃.
- The type of bonding between them is coordinate covalent bond as there is sharing of electron pairs between them. Where one shares the electron, the other doesn't take part in it. [Ag].

$\text{[NH}_3\text{]}$

- The product is called adduct.

Description of Weaker Responses

Weaker responses revealed misconceptions regarding the Lewis theory of acids and bases. Candidates struggled to identify Lewis acids and bases with appropriate justification, often relying on the concept of proton donors and acceptors rather than lone pair donors and acceptors. They were unable to draw the Lewis structure using two molecules of ammonia and incorrectly identified the type of bond in the complex ion as either ionic or covalent.

Image of Weaker Response


(i) AgCl is a Lewis acid because it donates the proton.

ii) NH₃ is a Lewis base because it accepts the proton.

(ii) $\text{AgCl} + 2\text{NH}_3 \longrightarrow \text{Ag}(\text{NH}_3)_2^+ + \text{Cl}^-$

(iii) Covalent bond is present in it

Suggestions for improvement (Highlight all that apply)

Maximising SLO Achievement	Pedagogy Used for that SLO	Assessment Strategies
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Any Additional Suggestion:

To enhance candidates' performance on questions related to the Lewis theory of acids and bases, teachers can use diagrams and visual aids to illustrate how Lewis acids and bases interact through electron pairs. It is important to differentiate between Lewis acids and bases and Bronsted-Lowry acids and bases, clarifying the distinctions between proton donors/acceptors and electron pair donors/acceptors. Incorporate interactive simulations and tools to help students visualise Lewis structures and bonding interactions more effectively. Provide targeted practice problems that focus on drawing Lewis structures for various molecules and complex ions. Finally, use feedback sessions to review common mistakes and reinforce correct concepts, ensuring that candidates gain a deeper and more accurate understanding of the Lewis theory.

Question No. 8b

Question Text	Compare true solutions with suspensions based on the given attributes. (Note: Write the points of comparison in tabular form.) i. Nature of the solutions ii. External appearance iii. Size of the particles (in diameter) iv. Diffusion of the solution through parchment and filter paper v. Sedimentation vi. Visibility of particles vii. Brownian movements
SLO No.	10.1.3
SLO Text	Compare the characteristics of colloids and suspension that distinguish these from solution;
Max Marks	7
Cognitive Level	U
Checking Hints	1 mark for each correct comparison (7 required)
Overall Performance	Majority of the candidates preferred to attempt part b over part a. They displayed varying levels of understanding regarding the differences between solutions and suspensions in their responses. While many effectively distinguished solutions as homogeneous and suspensions as heterogeneous, providing detailed insights into particle sizes, appearance, and separation methods, others struggled with these concepts. Additionally, many responses were poorly

organised, leading to confusion between the two types of mixtures. Overall, this indicates a need for improved understanding and clearer presentation of the properties of solutions and suspensions.

Description of Better Responses

Better responses showed a clear understanding of the distinctions between solutions and suspensions. These candidates accurately characterised solutions as homogeneous and suspensions as heterogeneous. They provided detailed information about particle sizes, often in nanometres, and demonstrated excellent observational skills in describing differences in external appearance, particle visibility, and separation techniques like filtration and sedimentation. Additionally, they explained the movement of particles, including Brownian motion, in both solutions and suspensions. This reflects a strong grasp of the molecular-level characteristics of both types of mixtures.

Images of Better Responses

Characteristics	Solutions (true)	Suspension
• Nature of the Solution	Homogeneous	Heterogeneous
• External appearance	clear mixture, transparent	opaque, solute particles suspended in solution or at the bottom due to influence of gravity.
• Size of particles	Particles ranging from 0.1 → 1 nm	Particles having diameter more than 1000 nm.
• Diffusion through parchment and filter paper	Diffuse through both parchment and filter paper.	Don't diffuse through parchment or filter paper.
• Sedimentation	Do not sediment down under the influence of gravity.	sediment down due to the influence of gravity.
• Visibility of particles	Not visible with naked eyes, electron microscope or ordinary microscope	Visible to naked eyes.
• Brownian Movement	Show or exhibit random motion or brownian motion.	Hindered brownian motion.

Description of Weaker Responses

Weaker responses revealed misconceptions about the properties of solutions and suspensions. Although some candidates correctly identified the nature of both solutions and suspensions, they struggled to clearly explain differences in external appearance and molecular movement. Many described particle sizes as simply small or large, without providing specific measurements for the diameter. Additionally, the lack of a well-organised tabular presentation led to confusion between the characteristics of solutions and suspensions. Candidates often wrote a simple one-liner under each heading without specifying whether it referred to a suspension or a solution. These issues highlighted a fundamental misunderstanding of the properties and distinctions between solutions and suspensions.

Image of Weaker Response

b

Nature of solution:
 some solution are acidic & some are ~~was~~ used as base because of their natural properties

Usability of particles:
 some particles are easy to see because of their shape & chemical structure.


External appearance:
 External appearance of different particles are different.

Size of particles:
 The size of the particles are very small.

Diffusion of the solution through particle & Altopaper:
 Some particles which are very small in size they easily pass through but some do not

Brownian movement:
 Only negative particles do this type of movement.

Suggestions for improvement (Highlight all that apply)

Maximising SLO Achievement	Preferred Pedagogy Used for this SLO	Assessment Strategies
<ul style="list-style-type: none"> Identify the expectation of command words (use Command Word Guide) Ensure the content is taught at the relevant cognitive level Identify necessary content required (skills + concepts) Review past paper questions on the concept Utilise the resource guide for additional materials 	<ul style="list-style-type: none"> Story Board Cause and Effect Fish and Bone Concept Mapping Audio Visual Resources Think, Pair and Share Knowledge Platform videos Questioning Technique (Socratic approach) Practical Demonstration 	<ul style="list-style-type: none"> Past paper questions Discussion on E-Marking Notes AKU-EB Digital Learning Solution powered by Knowledge Platform <p>https://akueb.knowledgeplatform.com/login</p> 

Any Additional Suggestion:

Teachers should use comparison charts or graphic organisers to clearly contrast the properties of solutions and suspensions. Provide detailed explanations of their external appearance and molecular movement and emphasise the importance of specifying particle sizes with precise measurements rather than vague terms like 'small' or 'large.' Incorporate structured, well-organised tabular presentations into lessons to help candidates effectively distinguish between the two types of mixtures. To reinforce understanding, include practical demonstrations that visually illustrate these concepts, enhancing accurate comprehension.

Annexure A: Pedagogies Used for Teaching the SLOs

Pedagogy: Storyboard

Description: A visual pedagogy that uses a series of illustrated panels to present a narrative, encouraging creativity and critical thinking. It helps learners organise ideas, sequence events, and comprehend complex concepts through storytelling.

Example: In a Literature class, candidates are tasked with creating storyboards to visually retell a novel. They draw key scenes, write captions, and present their stories to the class, enhancing their reading comprehension and fostering their imagination.

Pedagogy: Cause and Effect

Description: This pedagogy explores the relationships between actions and consequences. By analysing cause-and-effect relationships, learners develop a deeper understanding of how events are interconnected and how one action can lead to various outcomes.

Example: In a History class, candidates study the causes and effects of the Industrial Revolution. They research and discuss how technological advancements in manufacturing led to significant societal changes, such as urbanisation and labour reform movements.

Pedagogy: Fish and Bone

Description: A method that breaks down complex topics into main ideas (the fish) and supporting details (the bones). This visual approach enhances comprehension by highlighting essential concepts and their relevant explanations.

Example: During a Biology class on human anatomy, the teacher uses the fish and bone technique to teach about the human skeletal system. Teacher presents the main components of the human skeleton (fish) and elaborates on each bone's structure and function (bones).

Pedagogy: Concept Mapping

Description: An effective way to visually represent relationships between ideas. Learners create diagrams connecting key concepts, aiding in understanding the overall structure of a subject and fostering retention.

Example: In a Psychology assignment, candidates use concept mapping to explore the various theories of personality. They interlink different theories, such as Freud's psychoanalysis, Jung's analytical psychology, and Bandura's social-cognitive theory, to see how they relate to each other.

Pedagogy: Audio Visual Resources

Description: Incorporating multimedia elements like videos, images, and audio into lessons. This approach caters to different learning styles, making educational content more engaging and memorable.

Example: In a General Science class, the teacher uses a documentary-style video to teach about the solar system. The video includes stunning visual animations of the planets, interviews with astronomers, and background music, enhancing candidates' interest and understanding of space.

Pedagogy: Think, Pair, and Share

Description: A collaborative learning technique where candidates ponder a question or problem individually, then discuss their thoughts in pairs or small groups before sharing with the entire class. It fosters active participation, communication skills, and diverse perspectives.

Example: In a Literature in English class, the teacher poses a thought-provoking question about a novel's moral dilemma. Candidates first reflect individually, then pair up to exchange their opinions, and finally participate in a lively class discussion to explore different viewpoints.

Pedagogy: Questioning Technique (Socratic Approach)

Description: Based on Socratic dialogue, this method stimulates critical thinking by posing thought-provoking questions. It encourages learners to explore ideas, justify their reasoning, and discover knowledge through a process of inquiry.

Example: In an Ethics class, the instructor uses the Socratic approach to lead a discussion on the meaning of justice. By asking a series of probing questions, the candidates engage in a deeper exploration of ethical principles and societal values.

Pedagogy: Practical Demonstration

Description: A hands-on approach where learners observe real-life applications of theories or skills. Practical demonstrations enhance comprehension, skill acquisition, and problem-solving abilities by bridging theoretical concepts with real-world scenarios.

Example: In a Food and Nutrition class, the instructor demonstrates the proper technique for filleting a fish. Candidates observe and then practice the skill themselves, learning the practical application of knife skills and culinary precision.

(Note: The examples provided in this annexure serve as illustrations of various pedagogies. It is important to understand that these pedagogies are versatile and can be applied across subjects in numerous ways. Feel free to adapt and explore these techniques creatively to enhance learning outcomes in your specific context.)

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