Aga Khan University Examination Board

Notes from E-Marking Centre on HSSC-I Physics Annual Examination 2023

Introduction

This document has been produced for the teachers and candidates of Higher Secondary School Certificate (HSSC) Part I Physics. It contains comments on candidates' responses to the 2023 HSSC Part 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 which 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.

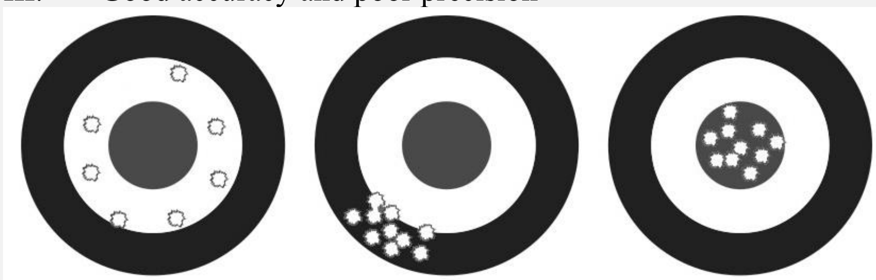
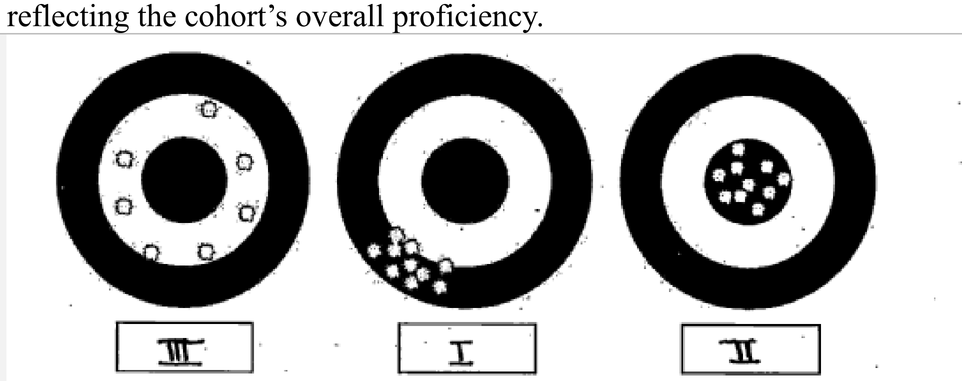
General Observations

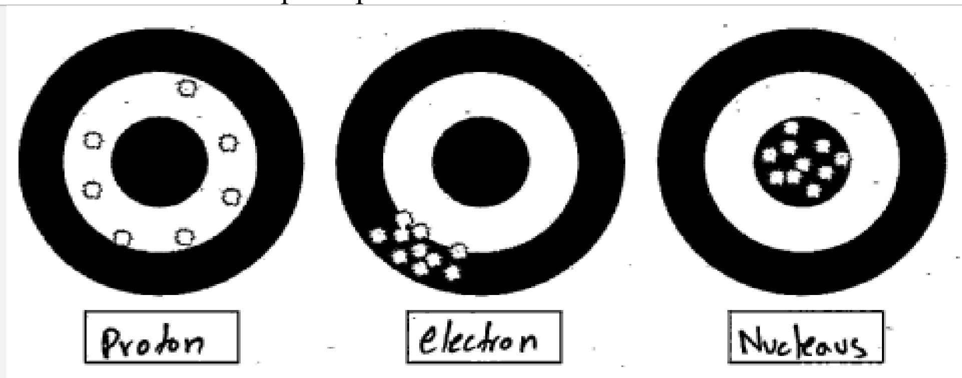
This year, candidates performed well on questions related to precision and accuracy, centripetal acceleration, SHM, optics, work done, and thermodynamics, word problems related to the simple harmonic motion and projectile motion. Whereas low-scoring candidates struggled in questions based on sum of vectors, Bernoulli's equation, sound, and KMT.

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

Detailed Comments

Constructed Response Questions (CRQs)

Question No. 1	
Question Text	Categorise the following dartboards on the given basis. I. Poor accuracy and good precision II. Good accuracy and good precision III. Good accuracy and poor precision  (**Note**: Label the number I, II or III of the selected option in the given boxes.)
SLO No.	1.4.2
SLO Text	Differentiate between precision and accuracy.
Max Marks	03
Cognitive Level	*U
Checking Hints	1 mark for categorising each dartboard (3 required)
Overall Performance	The overall performance of the cohort on this question was highly commendable. Majority of candidates demonstrated a clear understanding of the question's requirements, showcasing their knowledge of precision and accuracy definitions, as well as their practical applications in various contexts. This level of competence indicates a solid grasp of the concepts and their implications, showcasing candidates' proficiency in the subject matter. Moreover, their ability to apply these principles to different scenarios highlights their analytical skills and showcases their commendable performance.
Description of Better Responses	Better responses were evident in correctly showcasing a sound understanding of precision and accuracy concepts. Candidates demonstrated that accuracy relates to the proximity of measured values to the actual value provided in the question, while precision involves the closeness of multiple values to each other. They properly highlighted that better accuracy is represented when all values are close to the central circle, and good precision is indicated by closely grouped darts on any area of the board. These insightful explanations illustrate a good grasp of both precision and accuracy principles in the context of the dartboard scenario, reflecting the cohort's overall proficiency.
Image of Better Response	

Description of Weaker Responses	In weaker responses observed within the cohort, some candidates displayed limited understanding of the concepts of accuracy and precision. They struggled to differentiate between the two and were unable to effectively address the question's requirements, leading to misconceptions. They wrongly identified the differences between precision and accuracy. To foster improvement, it would be beneficial for these candidates to focus on further studying the distinctions between accuracy and precision, along with their practical applications. Encouraging a proactive approach to seeking guidance from educators and engaging in additional practice can aid in enhancing their comprehension and proficiency in these fundamental principles.
Image of Weaker Response	

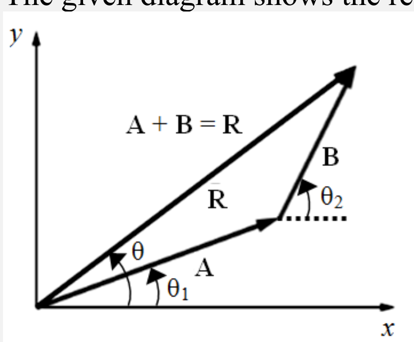
Suggestions for improvement (Tick all that apply)

How to Approach SLO	Pedagogy** Used for that SLO	Assessment Strategies
• Understand the expectations of the command words • Look at the cognitive level • Identify the content that is required to answer that question (both in terms of understanding of concepts and any skills that may be required like analysing or evaluating) • Go through the past paper questions on that particular concept • Refer to the resource guide for extra resources	• Story Board • Cause and Effect • Fish and Bone • Concept Mapping • Audio Visual resources • Think, Pair and Share • Questioning Technique (Socratic approach) • Practical Demonstration ** For description of each pedagogy, refer to Annexure A	• Past paper questions • Discussion on E-Marking Notes • AKU-EB Digital Learning Solution powered by Knowledge Platform https://akueb.knowledgeplatform.com/login

Any Additional Suggestion:

- Subject teachers are suggested to discuss the concepts of accuracy and precision in a physics laboratory can be made simpler and more relatable by explaining that accuracy and precision are crucial aspects of scientific measurements, accuracy refers to how close a measurement is to the true or accepted value, precision refers to how consistent and reproducible measurements are when taken multiple times.
- Relate accuracy to hitting a target with an arrow or ball. If you hit the bullseye, you are accurate. If all your arrows or balls cluster closely together, you are precise.
- Provide practical examples using instruments available in the lab like show them the Vernier callipers that how to measure the diameter of different objects like coins or rods. Discuss how close the measurements are to the actual values, measure the thickness of various objects (coins, books, etc.) by screw gauge and emphasize the importance of consistency in measurements and demonstrate how to measure the radius of a spherical object multiple times by spherometer and calculate precision.
- Introduce the concept of measurement error, emphasizing that even with precision, there can be systematic or random errors that affect accuracy and discuss ways to minimize errors through calibration and careful measurement techniques.

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

Question No. 2	
Question Text	The given diagram shows the resultant vector **R** of two vectors **A** and **B**.  Write the formula for each of the following. a. Magnitude of the vector **A** b. Direction of the resultant vector **R**
SLO No.	2.3.1
SLO Text	Explain the sum of vectors using perpendicular components.
Max Marks	02
Cognitive Level	U
Checking Hints	1 mark for each part (2 required)
Overall Performance	Some candidates within the cohort encountered challenges in comprehending the question's requirements, leading to suboptimal responses. They inaccurately utilised incorrect formulas and overlooked the distinct components asked for: the magnitude of vector **A** and the direction of the resultant vector. A significant number of candidates missed the crucial details in the question, failing to apply the appropriate formulas for both vector **A** and the resultant vector. To enhance overall performance, it is essential for candidates to meticulously analyse and understand all aspects of the question, ensuring accurate application of the required formulas for each component. Encouraging a careful and attentive approach can foster improved results in future assessments.

Description of Better Responses	Better responses demonstrated candidates' expertise in analytically treating vector addition. They accurately applied Pythagoras' theorem to determine vector A's magnitude, showcasing a strong grasp of mathematical concepts. Furthermore, they correctly employed the appropriate trigonometric ratios to find the direction of the resultant vector, highlighting their proficiency in vector calculations. These candidates displayed a comprehensive understanding of vector addition and confidently utilised mathematical tools to arrive at precise solutions. Their skillful handling of the problem reflects their proficiency in the topic and showcases their analytical abilities. Encouraging others to follow these approaches can lead to improved performance and a deeper understanding of vector addition.
Image of Better Response	a. $A = \sqrt{Ax^2 + Ay^2}$. b. $\theta = \tan^{-1} \frac{Ry}{Rx} \Rightarrow \theta = \tan^{-1} \frac{(Ay + By)}{(Ax + Bx)}$
Description of Weaker Responses	Weaker responses were observed where some candidates misunderstood the question, leading to misconceptions and erroneous application of concepts. These candidates often used incorrect or incomplete formula of magnitude of the vector **A** and direction of the resultant vector **R**, resulting in inaccuracies in their answers. To enhance their performance, it is important for these candidates to carefully analyse the question prompt, ensuring a clear understanding of the required concepts before attempting the solution. Encouraging them to review relevant formulas and engage in practice exercises can strengthen their comprehension and promote accurate responses in future assessments. Emphasizing attention to detail and consistent practice can contribute to improved problem-solving abilities for these candidates.
Image of Weaker Response	a. $\lvert A \rvert = \sqrt{x^2 + y^2}$ —— 4 b. Direction of the resultant vector **R** $R = AB \sin\theta \, \hat{n}$ → Tells us about the direction of R.

Suggestions for improvement (Tick all that apply)

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Any Additional Suggestion:

- Teachers are advised to establish a strong foundation for their students in the concepts of vector summation and multiplication and ensure that their classroom instructions include practicals and hands-on experiences in these areas. Like by explaining what vectors are, emphasizing their direction and magnitude, use everyday examples like velocity, force, and displacement to illustrate the concept of vectors, highlight that vectors have both magnitude and direction, unlike scalars that have only magnitude, utilize visual aids such as diagrams, arrows, or vector diagrams to represent vectors visually, show how vector addition and multiplication affect the direction and magnitude of vectors, use a simple example like walking or driving in different directions to introduce vector addition, provide hands-on experiences with physical objects like blocks or toy cars to demonstrate vector addition.
- Use online tools and simulations that allow students to interactively experiment with vector addition.

Question No. 3	
Question Text	A missile is fired with a velocity of 450 m/s at an angle of 45° with the horizontal axis. Calculate a. the range of the projectile. b. the time for which the missile will remain in the air. (**Note**: The acceleration due to gravity as 10 m/s^2.)
SLO No.	3.6.4
SLO Text	Solve word problems related to the a. time of flight, b. maximum height, c. horizontal range of a projectile.
Max Marks	03
Cognitive Level	*A

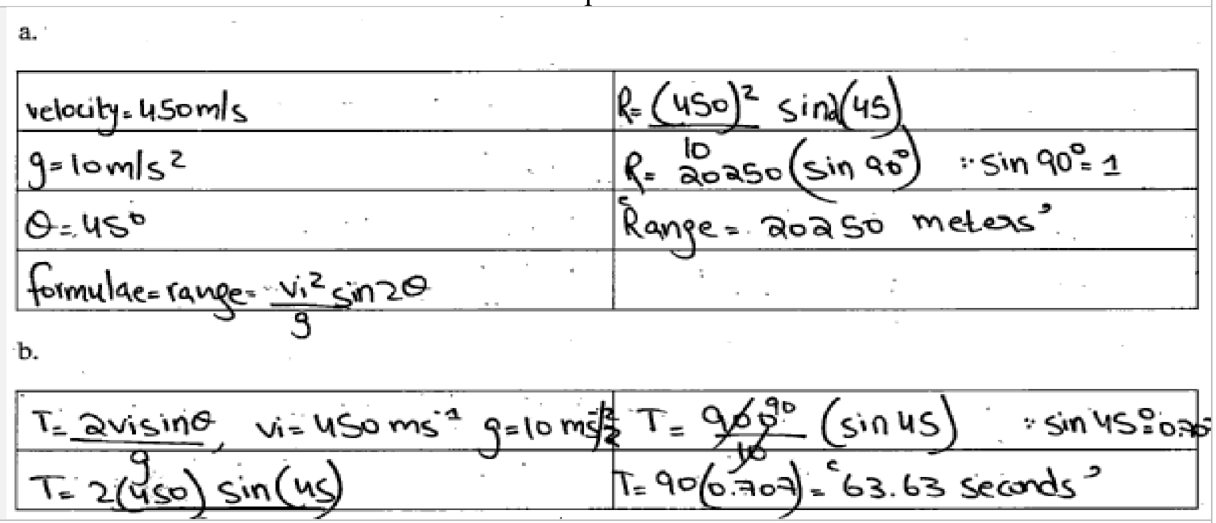
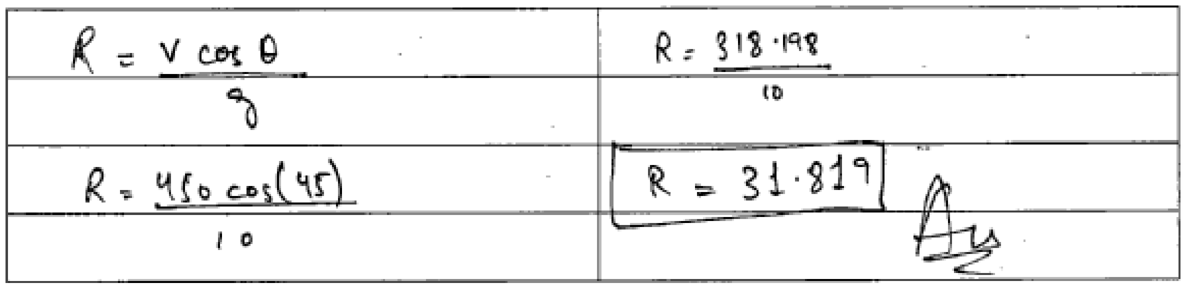
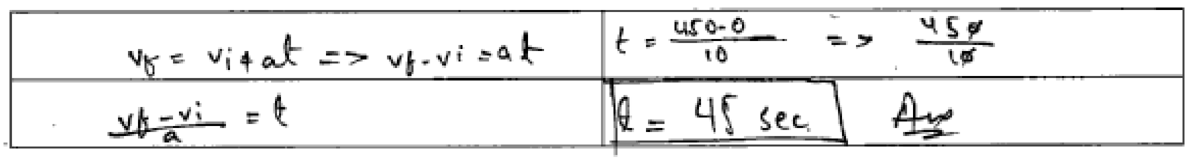
Checking Hints	a. 1 mark for writing the correct formula of each of range or time of missile. 1 mark for writing the correct answer of the time of projectile with SI unit. b. 1 mark for writing the correct answer of the range of projectile with SI unit.
Overall Performance	The performance of the cohort in this question was praiseworthy. Candidates demonstrated a keen ability to identify both cases accurately by thoroughly analysing the given situation. Moreover, the majority of candidates recognised the optimal angle of projection for maximum missile range, which is 45 degrees. This showcases their sound understanding of projectile motion principles and effective application of knowledge. Candidates' proficiency in identifying crucial factors in projectile motion reflects their strong analytical skills. Encouraging continued practice and application of concepts in different contexts will further enhance their problem-solving abilities and ensure continued success in similar scenarios.
Description of Better Responses	Better responses were observed, reflecting candidates' proficiency in extracting relevant data from the question and utilising the correct formula for calculating the range $\mathbf{R} = \frac{\mathbf{v_i}^2 \mathbf{sin2\theta}}{\mathbf{g}}$ and total time of flight $\mathbf{t} = \frac{\mathbf{2v_i sin\theta}}{\mathbf{g}}$. Moreover, these candidates presented their answers in the appropriate SI units, showcasing their attention to detail and accuracy. Their adept execution of calculations demonstrated a strong command of the subject matter. Encouraging all candidates to continue honing their problem-solving skills and ensuring precise application of formulas and units will further enhance their performance in similar scenarios.
Image of Better Response	 a. velocity = 450 m/s ; $R = \frac{(450)^2 \sin 2(45)}{10}$ g = 10 m/s² ; R = 20250 (sin 90°) ∵ sin 90° = 1 θ = 45° ; Range = 20250 meters formulae = range = $\frac{v_i^2 \sin 2\theta}{g}$ b. $T = \frac{2 v_i \sin\theta}{g}$, $v_i = 450\ ms^{-1}$ $g = 10\ ms^{-2}$; $T = \frac{900}{10}(\sin 45)$ ∵ sin 45° = 0.70 $T = \frac{2(450)\sin(45)}{}$; T = 90(0.707) = 63.63 seconds
Description of Weaker Responses	Weaker responses were observed, wherein candidates used incorrect formulas and made erroneous substitutions, leading to inaccurate answers. Specifically, in part B, some candidates mistakenly employed the formula for the time to reach the maximum height instead of the correct formula for the total time of flight. This misunderstanding affected their calculations and resulted in incorrect responses. To enhance their performance, candidates should focus on accurately identifying the appropriate formulas for each part of the problem and ensuring precise substitutions. Encouraging a thorough review of concepts and regular practice in various scenarios can strengthen their problem-solving skills and lead to more accurate outcomes.

Image of Weaker Response

a.



b.

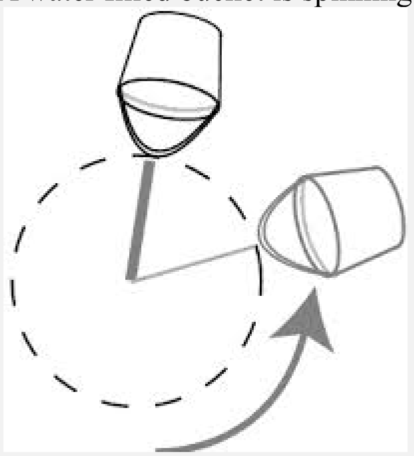
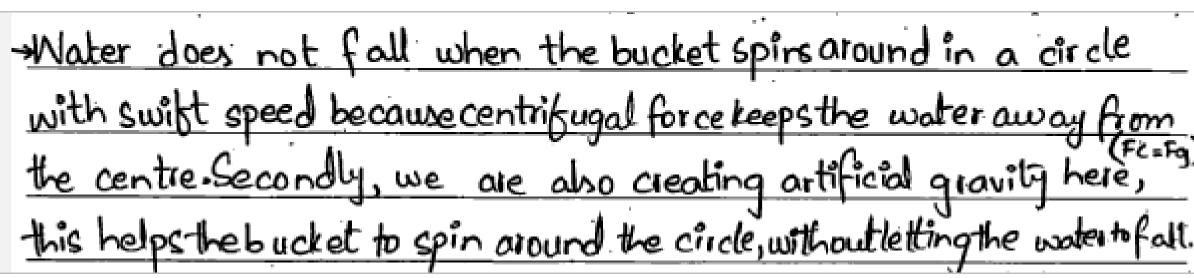


Suggestions for improvement (Tick all that apply)

How to Approach SLO	Pedagogy Used for that SLO	Assessment Strategies
• Understand the expectations of the command words • Look at the cognitive level • Identify the content that is required to answer that question (both in terms of understanding of concepts and any skills that may be required like analysing or evaluating) • Go through the past paper questions on that particular concept • Refer to the resource guide for extra resources	• Story Board • Cause and Effect • Fish and Bone • Concept Mapping • Audio Visual resources • Think, Pair and Share • Questioning Technique (Socratic approach) • Practical Demonstration	• Past paper questions • Discussion on E-Marking Notes • AKU-EB Digital Learning Solution powered by Knowledge Platform https://akueb.knowledgeplatform.com/login

Any Additional Suggestion:

- It is advised to the subject teachers that motion of projectile can be demonstrated practically and discussed with the horizontal and vertical motion separately, giving clear knowledge about the application of gravitation force and its role in the motion of projectile. Like physically demonstrating projectile motion by launching an object, such as a ball, from an inclined surface, use a motion tracker or a simple video analysis tool to track the object's path and velocity.
- Connect the concept of projectile motion to practical applications like sports (e.g., basketball, soccer), astronomy (e.g., planetary motion), and engineering (e.g., missile trajectory).
- Engage students in activities like launching projectiles at different angles and velocities.

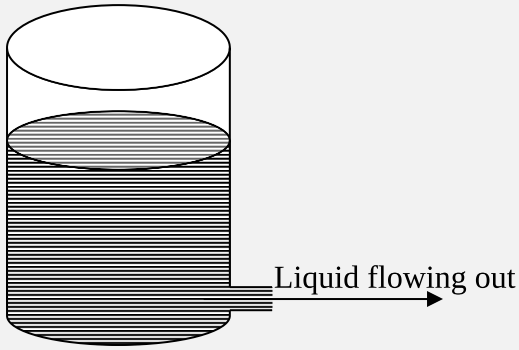
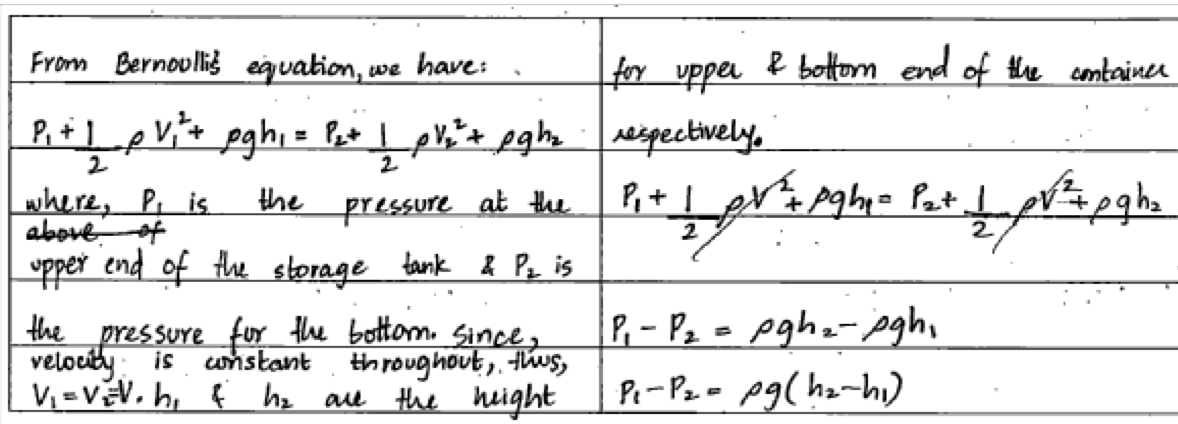
Question No. 4	
Question Text	A water filled bucket is spinning with the help of a rope as shown in the given figure.  Explain why the water does not fall when the bucket spins around in a circle with a swift speed.
SLO No.	5.2.2
SLO Text	Derive centripetal acceleration when speed is uniform.
Max Marks	02
Cognitive Level	U
Checking Hints	1 mark for mentioning weight of water and centripetal force. 1 mark for mentioning its equality.
Overall Performance	In the overall cohort, candidates displayed awareness of centripetal force and centripetal acceleration but encountered challenges in effectively explaining how centripetal force balances the weight of water in the bucket during circular motion. Encouraging candidates to provide more in-depth and reasoned explanations that will showcase a deeper understanding of the concept and its practical application. Emphasising critical thinking and connecting theoretical knowledge to real-world scenarios can improve their ability to deliver well-reasoned answers in future assessments.
Description of Better Responses	Better responses excelled in providing a clear and comprehensive explanation of how the centripetal force balances the weight of water in the bucket during circular motion. These candidates demonstrated a solid understanding by highlighting that the centripetal force acts as an inward force, countering the outward centrifugal force, which prevents the water from spilling. Additionally, some candidates successfully related the scenario to artificial gravity, effectively explaining the force responsible for maintaining the water's position in the bucket. Their ability to connect theoretical concepts to practical examples showcased a higher level of comprehension and critical thinking. These well-structured explanations significantly improved the overall quality of their responses.
Image of Better Response	 →Water does not fall when the bucket spins around in a circle with swift speed because centrifugal force keeps the water away from the centre. Secondly, we are also creating artificial gravity here, (Fc = Fg) this helps the bucket to spin around the circle, without letting the water to fall.

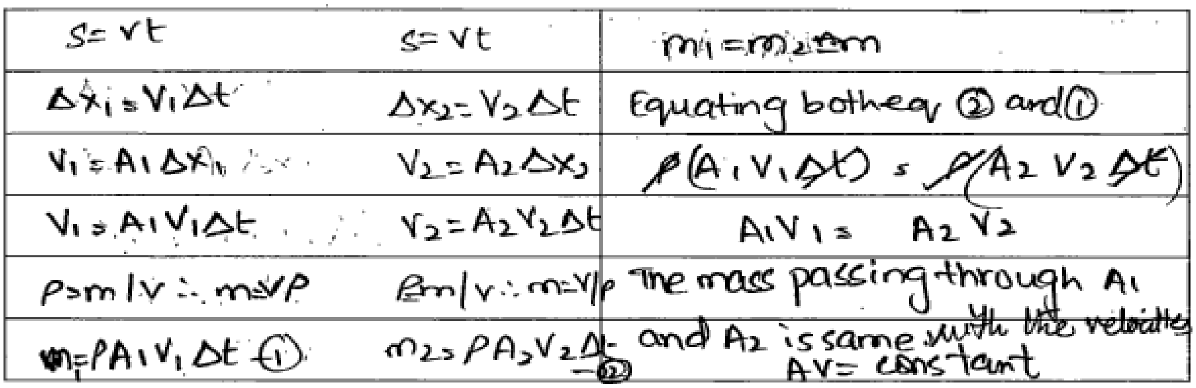
Description of Weaker Responses	In weaker responses within the cohort, some candidates provided answers without proper support or utilised incorrect concepts. While some mentioned centripetal force, they struggled to establish its relationship with balancing the water's weight in the bucket during circular motion. Some of the candidates mentioned that water falls out because of the weight of the water which required to keep it moving in the mentioned circle. To enhance their responses, candidates should aim for a more comprehensive explanation, clarifying how the centripetal force acts as an inward force, countering the outward centrifugal force to maintain equilibrium and prevent water spillage.
Image of Weaker Response	When the bucket Spins around in a circle with a Swift Speed, the water does not fall because the pressure becomes Constant on the behalf of Spinning in a Swift speed.

Suggestions for improvement (Tick all that apply)

How to Approach SLO	Pedagogy Used for that SLO	Assessment Strategies
• Understand the expectations of the command words • Look at the cognitive level • Identify the content that is required to answer that question (both in terms of understanding of concepts and any skills that may be required like analysing or evaluating) • Go through the past paper questions on that particular concept • Refer to the resource guide for extra resources	• Story Board • Cause and Effect • Fish and Bone • Concept Mapping • Audio Visual resources • Think, Pair and Share • Questioning Technique (Socratic approach) • Practical Demonstration	• Past paper questions • Discussion on E-Marking Notes • AKU-EB Digital Learning Solution powered by Knowledge Platform https://akueb.knowledgeplatform.com/login

Any Additional Suggestion:
Teachers are encouraged to address the distinction between uniform and non-uniform circular motion by utilising vector representation to illustrate the velocity at various points on a circle.

Question No. 5	
Question Text	The given figure shows liquid flowing out from the bottom of a storage tank with a constant velocity.  Find an equation for the hydrostatic pressure at the bottom of the tank.
SLO No.	6.3.1
SLO Text	Derive Bernoulli's equation.
Max Marks	03
Cognitive Level	U
Checking Hints	1 mark for writing each mathematical step in the solution (3 required).
Overall Performance	The overall performance of the cohort in this question was challenging. Many candidates struggled to identify the topic accurately and inappropriately applied Torricelli's theorem. Furthermore, they overlooked the command word in the question, leading to incorrect attempts at finding the pressure of a liquid flowing out of the tank or calculating the liquid's velocity instead of determining the pressure at the tank's bottom. However, some better responses successfully derived an equation of pressure using either the formula **P = F/A** or Bernoulli's equation. Encouraging candidates to carefully analyse the question and apply relevant formulas can enhance their performance in similar situations.
Description of Better Responses	Some candidates successfully focused on the command word and derived the correct equation for pressure at the tank's bottom ($\mathbf{P} = \boldsymbol{\rho}\mathbf{g}\mathbf{h}$). Encouraging candidates to develop effective techniques for identifying relevant information will improve their performance.
Image of Better Response	 From Bernoulli's equation, we have: $P_1 + \frac{1}{2}\rho V_1^2 + \rho g h_1 = P_2 + \frac{1}{2}\rho V_2^2 + \rho g h_2$ where, P_1 is the pressure at the ~~above of~~ upper end of the storage tank & P_2 is the pressure for the bottom. Since, velocity is constant throughout, thus, $V_1 = V_2 = V$. h_1 & h_2 are the height for upper & bottom end of the container respectively. $P_1 + \frac{1}{2}\rho V^2 + \rho g h_1 = P_2 + \frac{1}{2}\rho V^2 + \rho g h_2$ $P_1 - P_2 = \rho g h_2 - \rho g h_1$ $P_1 - P_2 = \rho g (h_2 - h_1)$

Description of Weaker Responses	Weaker responses were evident as candidates became distracted by the figure, resulting in the identification of incorrect concepts and errors in comprehending the question. Consequently, they derived inaccurate equations and failed to address the question's core requirements effectively. Some of the candidates were unable to come across the equation $P+\frac{1}{2}\rho v^{2}+\rho gh=\text{constant}$, because of lack of their understanding and they inappropriately connected the demand of the question to the equation of continuity. To enhance their performance, candidates should practice focusing on the command words and essential information while disregarding distractions.
Image of Weaker Response	 $S=vt$ $S=vt$ $m_1=m_2=m$ $\Delta x_1=V_1\Delta t$ $\Delta x_2=V_2\Delta t$ Equating both eq ② and ① $V_1=A_1\Delta x_1$ $V_2=A_2\Delta x_2$ $\rho(A_1V_1\Delta t)=\rho(A_2V_2\Delta t)$ $V_1=A_1V_1\Delta t$ $V_2=A_2V_2\Delta t$ $A_1V_1=A_2V_2$ $\rho=m/V \therefore m=V\rho$ $\rho=m/V \therefore m=V/\rho$ The mass passing through A_1 $m=\rho A_1V_1\Delta t$ ① $m_2=\rho A_2V_2\Delta t$ ② and A_2 is same with the velocities $AV=$ constant

Suggestions for improvement (Tick all that apply)

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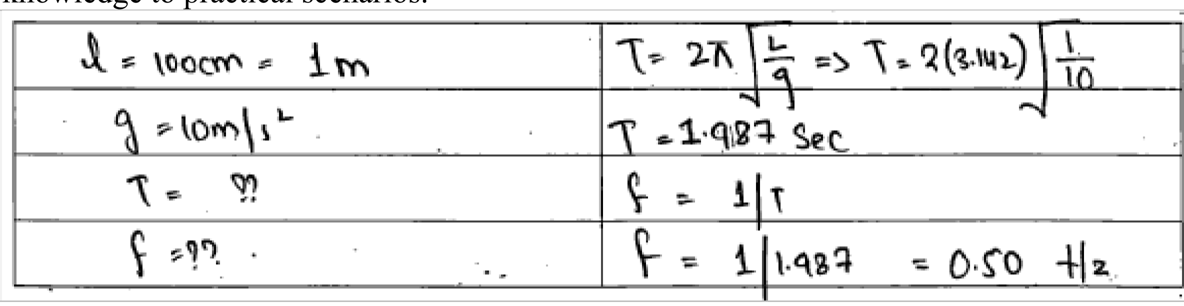
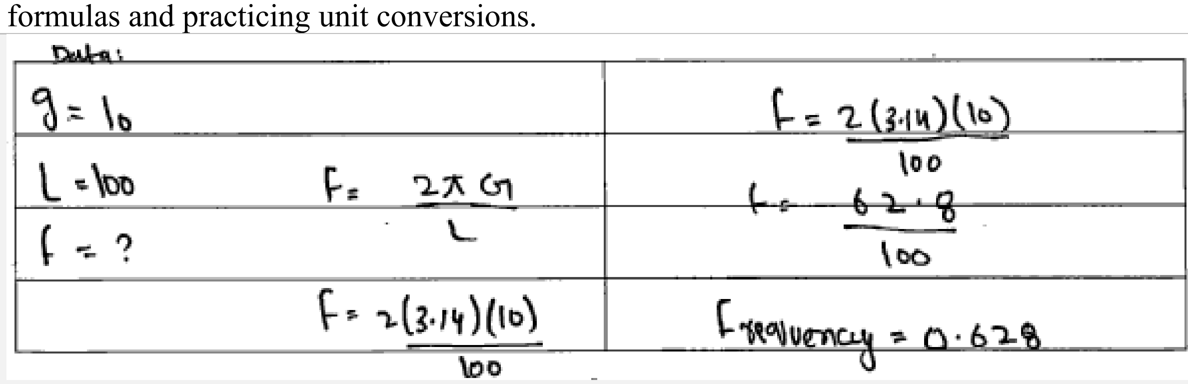
Any Additional Suggestion:

- Teachers can play a crucial role in helping their students enhance their focus on diagrams, question requirements, command words, and phrasing of questions by implementing the steps involve in the break down a question systematically, explain the importance of understanding what the question is asking before attempting an answer, analysing a question using a sample question relevant to the subject.
- Emphasize the importance of diagrams in understanding and answering questionsby observing and analysing diagrams, charts, graphs, or illustrations provided with questions. Provide exercises where students practice paraphrasing question requirements in their own words.
  Encourage students to lead discussions by presenting their interpretations of challenging questions.

Question No. 6	
Question Text	If the length of a simple pendulum is 100 cm, then calculate its frequency. (**Note**: The acceleration due to gravity 'g' as 10 m/s^2.)
SLO No.	7.5.3
SLO Text	Solve word problems using the expression for the time period of a simple pendulum.
Max Marks	02
Cognitive Level	A
Checking Hints	1 mark for formula of the time period or frequency. 1 mark for correct substitution and result.
Overall Performance	Most of the candidates did really well on this question about calculating the frequency of the simple pendulum. They showed that they understood what the question was asking and used the right methods to find the correct answers. Their answers were clear and showed that they have a good grasp of the topic and can solve problems effectively.
Description of Better Responses	Better responses were observed where candidates accurately calculated the frequency of a simple pendulum. They demonstrated proficiency by converting the given length from centimetres (cm) to metres (m) and effectively substituting values into the frequency $T=\frac{1}{f}$ **(or)** $f=\frac{1}{2\pi}\sqrt{\frac{g}{l}}$ formula. Additionally, some candidates successfully derived the frequency using relevant frequency relations. These well-executed calculations illustrate candidates' strong understanding of mathematical concepts and their ability to apply theoretical knowledge to practical scenarios.
Image of Better Response	
Description of Weaker Responses	Weaker responses were evident, as candidates faced challenges in correctly writing the formula for the time period of a simple pendulum and mixed up the formula of frequency and time period. Moreover, they struggled with unit conversions from **(cm to m)** and extracting relevant data from the question, leading to inaccurate calculations and answers. To enhance their performance, candidates should focus on reviewing and understanding the appropriate formulas and practicing unit conversions.
Image of Weaker Response	

Suggestions for improvement (Tick all that apply)

How to Approach SLO	Pedagogy Used for that SLO	Assessment Strategies
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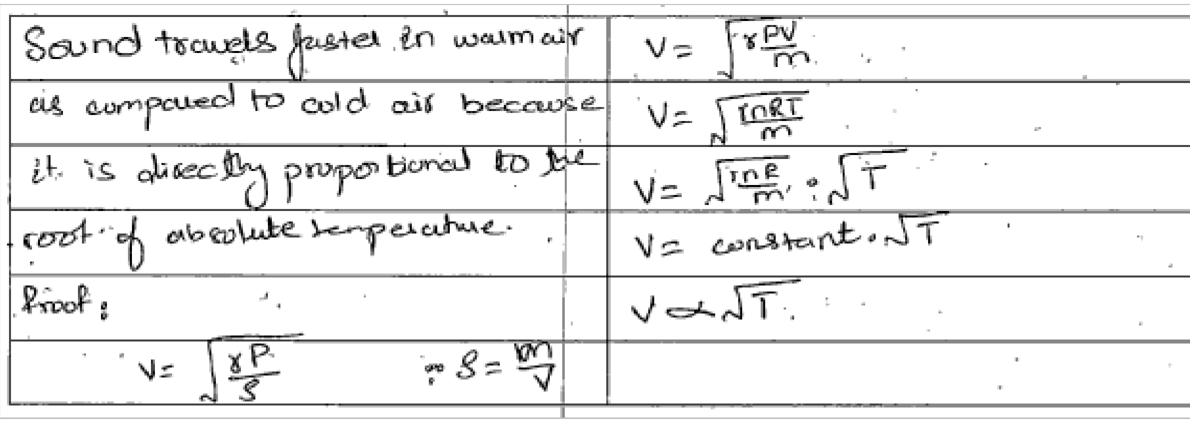
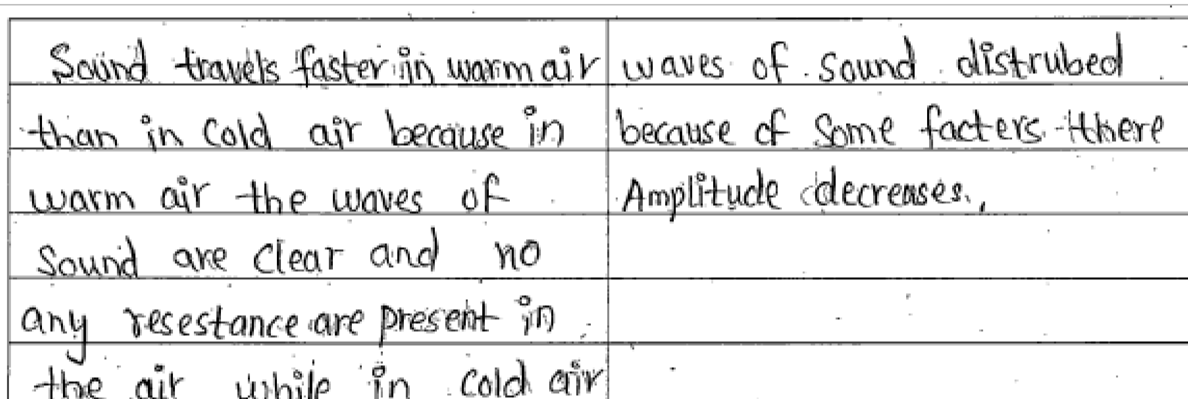
Any Additional Suggestion: Nil		

Question No. 7	
Question Text	Sound travels faster in warm air than in cold air. Explain the given statement with the help of mathematical equations.
SLO No.	8.2.4
SLO Text	Explain the effects of pressure, density and temperature on the speed of sound in air.
Max Marks	03
Cognitive Level	U
Checking Hints	1 mark for each mathematical step used in the explanation (3 required). (OR) 1 mark for mathematical equation. 1 mark for writing each statement in the reason (2 required).
Overall Performance	Overall, the responses of the cohort were of an average standard. Some candidates provided incomplete answers and expressed improper or irrelevant mathematical expressions. Furthermore, a considerable number of candidates struggled to effectively explain the given statement using appropriate mathematical equations and unable to write that with the increase of temperature the volume of a gas increases so the density of an air decreases and hence the velocity of sound in the air increases. To enhance their performance, candidates would benefit from providing more comprehensive answers with relevant mathematical expressions and clear explanations.

Description of Better Responses	Better responses were evident, showcasing candidates' adeptness in establishing the correct mathematical relationship between the speed of sound and temperature that is $V = V_o\sqrt{\frac{T}{273}}$ or $V = V_o + 0.61t$ or $v = \sqrt{\frac{\gamma RT}{M}}$. They confidently utilised equations and provided well-reasoned answers. Moreover, some candidates employed the relation and offered a clear explanation of the impact of temperature on density, followed by how density affects the speed of sound. This comprehensive approach demonstrated their proficiency in illustrating the interrelation of factors influencing the speed of sound. Such well-structured responses, supported by sound reasoning, earned full marks, underscoring the candidates' competence in this subject area.
Image of Better Response	 Sound travels faster in warm air as compared to cold air because it is directly proportional to the root of absolute temperature. Proof: $v = \sqrt{\frac{\gamma P}{\rho}}$ $\because \rho = \frac{m}{V}$ $V = \sqrt{\frac{\gamma PV}{m}}$ $V = \sqrt{\frac{\gamma nRT}{m}}$ $V = \sqrt{\frac{\gamma nR}{m}} \cdot \sqrt{T}$ $V = \text{constant} \cdot \sqrt{T}$ $V \propto \sqrt{T}$.
Description of Weaker Responses	Weaker responses were evident, as candidates provided improper and incomplete answers without sufficient mathematical support. Although some attempted to use mathematical relationships, they struggled to provide proper explanations **and were unable to get the correct equation** $\mathbf{v \alpha \sqrt{T}}$ **and** $V = \sqrt{\frac{E}{\rho}}$. To enhance their performance, candidates should focus on delivering complete and well-supported answers, incorporating relevant mathematical explanations where necessary. Encouraging regular practice in applying mathematical concepts and offering coherent explanations can improve their understanding and reasoning skills.
Image of Weaker Response	 Sound travels faster in warm air than in Cold air because in warm air the waves of Sound are clear and no any resestance are present in the air while in Cold air waves of Sound distrubed because of Some facters there Amplitude decreses.

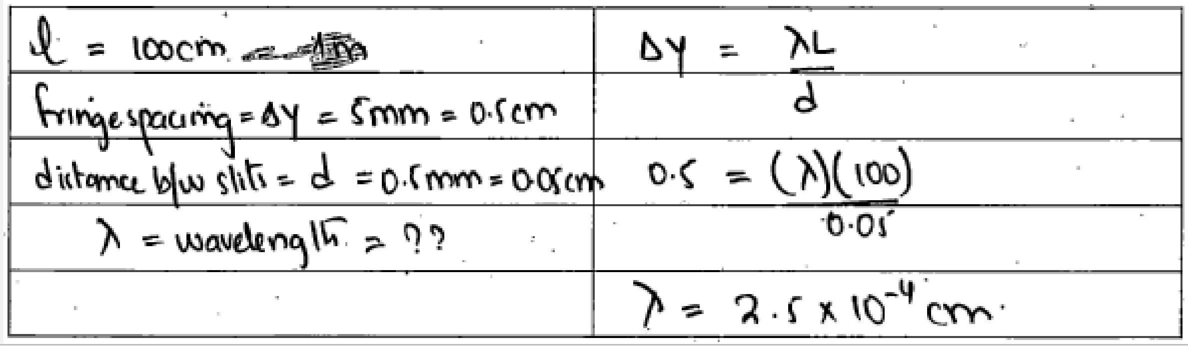
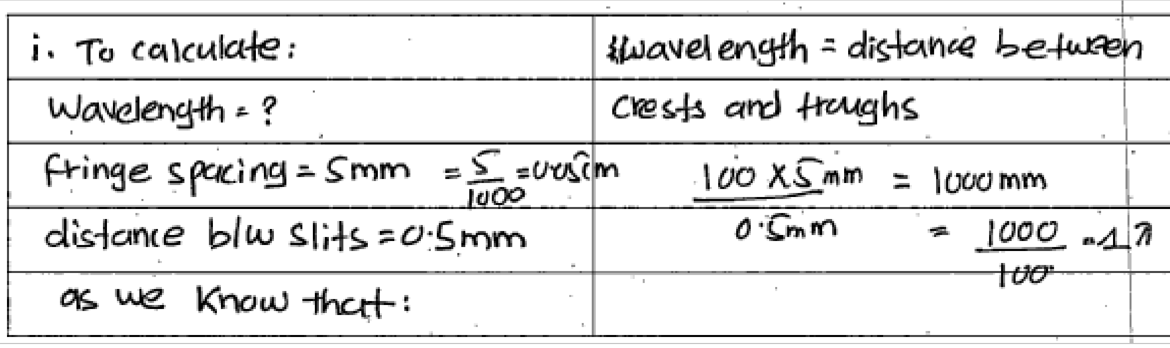
Suggestions for improvement (Tick all that apply)

How to Approach SLO	Pedagogy Used for that SLO	Assessment Strategies
• Understand the expectations of the command words • Look at the cognitive level • Identify the content that is required to answer that question (both in terms of understanding of concepts and any skills that may be required like analysing or evaluating) • Go through the past paper questions on that particular concept • Refer to the resource guide for extra resources	• Story Board • Cause and Effect • Fish and Bone • Concept Mapping • Audio Visual resources • Think, Pair and Share • Questioning Technique (Socratic approach) • Practical Demonstration	• Past paper questions • Discussion on E-Marking Notes • AKU-EB Digital Learning Solution powered by Knowledge Platform https://akueb.knowledgeplatform.com/login

Any Additional Suggestion:

Candidates are required to provide a mathematical explanation that demonstrates a clear understanding of how a statement can be justified using relevant formulas. Additionally, they should be acquainted with the concepts of direct and inverse proportions.

Question No. 8	
Question Text	Interference fringes are produced on a screen 100 cm away from the slits. Calculate the wavelength of light in cm. If the i. fringe spacing is 5 mm. ii. distance between slits is 0.5 mm.
SLO No.	9.2.5
SLO Text	Derive relation for fringe spacing and use the relation in solving word problems.
Max Marks	03
Cognitive Level	A
Checking Hints	1 mark for writing the correct conversion from 'mm to cm'. 1 mark for the correct substitution in the formula OR writing correct formula. 1 mark for the correct answer with SI unit.
Overall Performance	The cohort performed exceptionally well on this question, demonstrating a strong ability to identify the word problem as being related to Young's double-slit experiment. Their adept recognition of the context and specific experiment showcased a commendable understanding of the topic. Such well-attempted responses indicate a solid grasp of relevant concepts and principles.
Description of Better Responses	Candidates exhibited a good command over the subject, accurately extracting data from the question and performing appropriate unit conversions as requested. They used the correct formula to calculate the answer and presented it in centimetres (cm) as specified. This accurate approach showcases their proficiency in handling calculations related to interference of light.

Image of Better Response	
Description of Weaker Responses	Weaker responses were evident, as candidates struggled to understand the question's demands, leading to errors in unit conversions and formula applications. Some candidates even used inappropriate formulas, such as **v = f λ**, for interference of light calculations. To improve their performance, candidates should focus on thoroughly understanding the question and identifying the correct formulas for interference of light. Encouraging them to practice precise unit conversions and accurate substitutions will enhance their problem-solving skills. Providing additional guidance and reinforcing the appropriate application of relevant formulas can support their development in this topic, resulting in more accurate responses in future assessments.
Image of Weaker Response	

Suggestions for improvement (Tick all that apply)

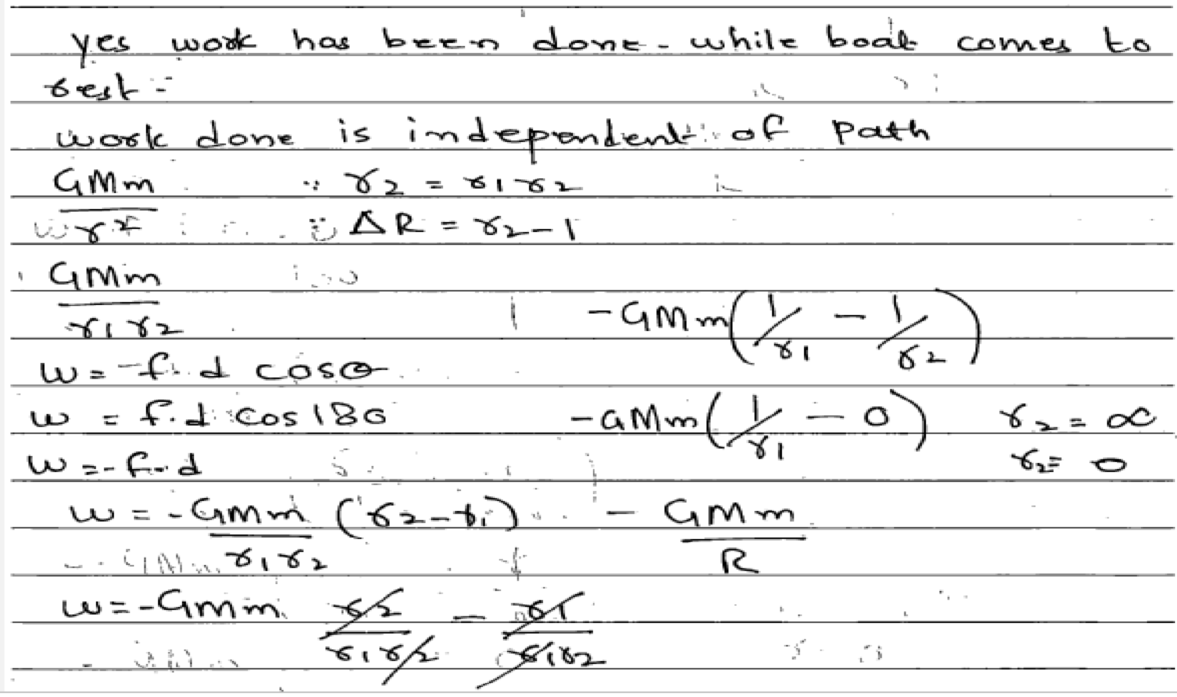
How to Approach SLO	Pedagogy Used for that SLO	Assessment Strategies
• Understand the expectations of the command words • Look at the cognitive level • Identify the content that is required to answer that question (both in terms of understanding of concepts and any skills that may be required like analysing or evaluating) • Go through the past paper questions on that particular concept • Refer to the resource guide for extra resources	• Story Board • Cause and Effect • Fish and Bone • Concept Mapping • Audio Visual resources • Think, Pair and Share • Questioning Technique (Socratic approach) • Practical Demonstration	• Past paper questions • Discussion on E-Marking Notes • AKU-EB Digital Learning Solution powered by Knowledge Platform https://akueb.knowledgeplatform.com/login

Any Additional Suggestion:
Nil

Extended Response Questions (ERQs)

These questions offered a choice between part **a** and **b**.

Question No. 9a	
Question Text	In a river, a man is propelling a boat upstream with the help of paddles. If the boat comes to rest, while the man is still paddling, then explain whether work is being done or not. Give reason to your answer and support it with a mathematical equation.
SLO No.	4.1.5
SLO Text	Describe work done by variable and constant forces.
Max Marks	07
Cognitive Level	U
Checking Hints	1 mark for each point in the reason (5 required). 1 mark for each mathematical equation (2 required).
Overall Performance	Majority of the candidates attempted this part of the question, The overall performance of the candidates in this question was very good. Most of the candidates demonstrated a good understanding that the work done is zero when the displacement is zero. This indicates their grasp of the fundamental concept that work is the product of force and displacement, and when there is no displacement, no work is done.
Description of Better Responses	Candidates displayed a good understanding of the concept of work done and the significance of displacement in its calculation. High-scoring candidates demonstrated a critical analysis of the given situation, providing well-reasoned answers by employing the appropriate mathematical formula for work done. Like they correctly stated that when the displacement is zero and hence no work is done. Additionally, some candidates explained that the work done by the water and the propeller are balanced, resulting in a network of zero.
Image of Better Response	No work is being done because the displacement is zero. Work is dot product of Force and displacement and if either of the two quantities is zero, then work is zero. $W = F \cdot d$ OR $W = Fd\cos\theta$ The value of work depends upon three things. 1. The force 2. The displacement 3. The angle between force and displacement. If force is zero, then work is zero. If displacement is zero the work is zero, and if the angle between force and displacement is 90, then ~~force~~ work is zero. In the above scenerio displacement is ~~W=F.d~~ zero, thus the work will also be zero. $W = F \cdot d$ $W = F \cdot 0$ $W = 0$

Description of Weaker Responses	Weaker responses were evident as candidates provided unsupported answers and utilised irrelevant equations, such as equations of motion, to justify their statements regarding work done. To improve their performance, candidates should focus on using the appropriate formula for work done, which involves the product of force and displacement.
Image of Weaker Response	 yes work has been done - while book comes to rest - work done is independent of path $\frac{GMm}{r}$ ∵ $r_2 = r_1 r_2$ ∵ $\Delta R = r_2 - r_1$ $\frac{GMm}{r_1 r_2}$ $-GMm\left(\frac{1}{r_1} - \frac{1}{r_2}\right)$ $w = -f.d\cos\theta$ $w = f.d\cos 180$ $-GMm\left(\frac{1}{r_1} - 0\right)$ $r_2 = \infty$ $w = -f.d$ $r_2 = 0$ $w = -GMm\frac{(r_2 - r_1)}{r_1 r_2}$ $-\frac{GMm}{R}$ $w = -GMm\left(\frac{r_2}{r_1 r_2} - \frac{r_1}{r_1 r_2}\right)$

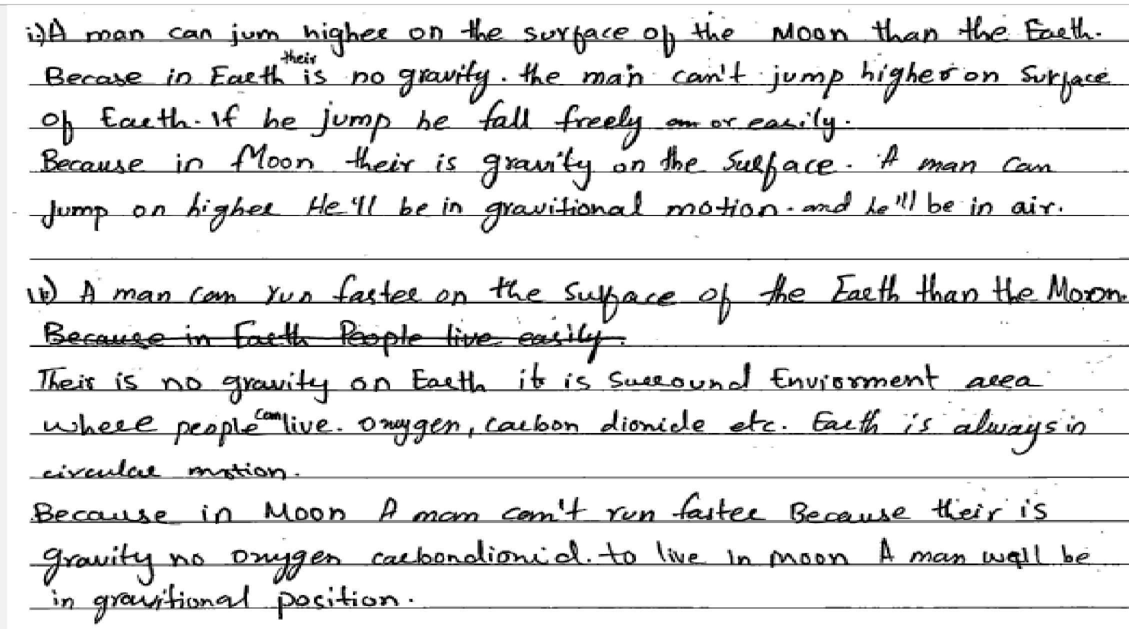
Suggestions for improvement (Tick all that apply)

How to Approach SLO	Pedagogy Used for that SLO	Assessment Strategies
• Understand the expectations of the command words • Look at the cognitive level • Identify the content that is required to answer that question (both in terms of understanding of concepts and any skills that may be required like analysing or evaluating) • Go through the past paper questions on that particular concept • Refer to the resource guide for extra resources	• Story Board • Cause and Effect • Fish and Bone • Concept Mapping • Audio Visual resources • Think, Pair and Share • Questioning Technique (Socratic approach) • Practical Demonstration	• Past paper questions • Discussion on E-Marking Notes • AKU-EB Digital Learning Solution powered by Knowledge Platform https://akueb.knowledgeplatform.com/login

Any Additional Suggestion:

- When learning about work done, teachers can explain to students that the angle between the force and the direction of movement is crucial. If the force and movement are in the same direction, it's like teamwork, and we call it the dot product. If they're at right angles, it's like teamwork at a right angle, which is the cross product. The angle between them tells us how the work is done.
- Providing additional guidance on the correct application of relevant formulas can support their development in this topic and lead to more accurate responses in future assessments.

Question No. 9b	
Question Text	Explain each statement by providing a valid reason. i. A man can jump higher on the surface of the Moon than the Earth. ii. A man can run faster on the surface of the Earth than the Moon.
SLO No.	4.2.1
SLO Text	Explain the work done in a gravitational field.
Max Marks	07
Cognitive Level	U
Checking Hints	1 mark for each highlighted point (Any 7 required).
Overall Performance	The performance of the candidates in this question was generally strong. Most candidates effectively compared the gravitational field strength of the Earth and the Moon, providing well-reasoned answers with logical explanations. This demonstrates a good understanding of gravitational fields and the factors influencing them.
Description of Better Responses	Better responses were evident among high-scoring candidates. They accurately explained each statement by noting the difference in acceleration due to gravity between the Moon and Earth. They highlighted that the Moon has a smaller value, enabling higher jumps and faster running on its surface. Conversely, Earth's greater static friction provides better grip, and action-reaction forces facilitate efficient running. They exemplified this with the concept that a running individual pushes the Earth backward with their foot, and the Earth reacts by pushing the person forward with an equal force. Such well-reasoned and comprehensive responses demonstrate the candidates' proficiency in understanding gravity and motion concepts.
Image of Better Response	i) A man can jump higher of Moon:. Ans=> This happens beacuse The gravitaical pull or The force pulling him down is less as compare to The gravitaical pull of earth hence the force is less to pull him down so he can jump higher. Moon's gravity < Earth's gravity ii) A man can run faster on The earth:. Ans=> While running we need friction to run on a surface. As The gravity of earth is more hence more friction is present between the earth's surface and The runner. More friction means more faster you can run. earth's friction > moon's friction.

Description of Weaker Responses	Weaker responses were observed, indicating a lack of understanding of gravitational fields. Some candidates incorrectly stated that there is no gravity on the Moon's surface. Moreover, irrelevant explanations were provided, such as comparing Earth's and the Moon's atmospheres in terms of density and oxygen content. To enhance their performance, candidates should focus on grasping the fundamental principles of gravitational fields and their effects on celestial bodies. Encouraging them to provide relevant and accurate explanations will improve their understanding and ability to address physics concepts effectively. Offering additional guidance and reinforcing the importance of accurate scientific explanations can support their development in this area of study.
Image of Weaker Response	 i) A man can jum higher on the surface of the Moon than the Earth. Because in Earth their is no gravity. the man can't jump higher on surface of Earth. If he jump he fall freely ~~on~~ or easily. Because in Moon their is gravity on the Sulface. A man can jump on higher He'll be in gravitional motion. and he'll be in air. ii) A man can run faster on the surface of the Earth than the Moon. ~~Because in Earth People live easily.~~ Their is no gravity on Earth it is surround Enviroment area where people can live. oxygen, carbon dionide etc. Earth is always in circular motion. Because in Moon A man can't run faster Because their is gravity no oxygen carbondionid. to live in moon A man wall be in gravitional position.

Suggestions for improvement (Tick all that apply)

How to Approach SLO	Pedagogy Used for that SLO	Assessment Strategies
• Understand the expectations of the command words • Look at the cognitive level • Identify the content that is required to answer that question (both in terms of understanding of concepts and any skills that may be required like analysing or evaluating) • Go through the past paper questions on that particular concept • Refer to the resource guide for extra resources	• Story Board • Cause and Effect • Fish and Bone • Concept Mapping • Audio Visual resources • Think, Pair and Share • Questioning Technique (Socratic approach) • Practical Demonstration	• Past paper questions • Discussion on E-Marking Notes • AKU-EB Digital Learning Solution powered by Knowledge Platform https://akueb.knowledgeplatform.com/login

Any Additional Suggestion:
It is essential to rectify the misconception among candidates that the gravitational field exists only on Earth. Many candidates mistakenly believe that outside of Earth, there is no gravitational field. This misconception should be addressed and corrected during the study of absolute gravitational potential, orbital velocity, and weightlessness in artificial satellites.

Question No. 10a	
Question Text	Why do we reduce pressure in the tyres of an automobile while driving on a motorway? Write your answer in SEVEN points.
SLO No.	10.1.2
SLO Text	Calculate pressure on a gas molecule inside a gas container.
Max Marks	07
Cognitive Level	U
Checking Hints	1 mark for each highlighted statement (Any 7 required).
Overall Performance	Majority of candidates attempted this part of the question, and their performance was below the desired level, as many candidates misunderstood the context and provided explanations that were not based on the kinetic molecular theory or gas pressure inside the container. Instead, they offered general or irrelevant points, which did not address the specific requirements of the question. To improve their performance, candidates should focus on understanding the concepts of the kinetic molecular theory and gas pressure inside a container. Encouraging them to provide relevant and specific explanations will enhance their understanding and ability to address questions effectively. Providing additional practice and guidance in these areas can support their development and lead to more accurate responses in future assessments.
Description of Better Responses	Better responses demonstrated a solid understanding of the topic, providing proper reasoning based on the kinetic molecular theory and supporting their explanations with relevant mathematical expressions, such as the pressure of a gas inside the container ($P = 1/3\ \rho\ v^2$) and kinetic energy ($K.E = 3/2\ k\ T$). In some of the best responses, candidates related the scenario to an automobile being driven on a motorway. They explained that increased friction between the tyres and the road generated heat, raising the gas temperature inside the tyres. This led to an increase in kinetic energies, causing more frequent collisions among gas molecules and with the tyre walls, resulting in higher pressure. To prevent tyre bursts and accidents, it is essential to reduce the gas pressure. Such comprehensive and well-structured explanations highlight the candidates' competence in connecting theoretical concepts with practical situations and effectively applying mathematical expressions to support their reasoning.

Image of Better Response	1- While driving on a motorway, The tyres of the automobile get warm because of frictional force. 2- Because of the frictional force, the temprature inside the tyre gets brigher and the air filled inside gradualy get's warm. 3- Because of increase in temprature of the gas moleiules, they start moving fast. 4- As they move faster they exert more pressure over the ~~su~~ inside surface of the tyre. 5- If there is more volume of gas, that means more pressure will be exerted over the tyre. 6- In this case there can ~~be~~ a tyre burst happen 7- So for getting rid of a tyre burst, so the automobiles tyres are filled with less gas and the pressure is reduced.
Description of Weaker Responses	Weaker responses indicated candidates' difficulty in relating the situation to the kinetic molecular theory or pressure of a gas inside the container. Nature of motorways, causes of road accidents and dealing with emergencies. Some of the candidates' explanations often included irrelevant points or lacked specific connections to the underlying concepts. To improve their responses, candidates should focus on understanding the relevance of the kinetic molecular theory and gas pressure in such scenarios. Encouraging them to provide precise and well-reasoned explanations will strengthen their grasp of physics principles and enhance their ability to tackle similar questions effectively. Offering additional guidance and practice in making connections between theoretical concepts and practical situations can support their development and lead to more accurate responses in future assessments.
Image of Weaker Response	• Because the strick order of motorway member. When we increase pressure they will accident. • Reduce pressure is much better than the increase pressure. • They will be safe and no call for the emergency. • They will see the notice board clearly. • They were peaceful mind. • Know about when much more distance is left? • They Know about the guidence of motoway rules and regulation. • When you were first time travel they will be guide for you. • Everywhere saftey measure are attached.

Suggestions for improvement (Tick all that apply)

How to Approach SLO	Pedagogy Used for that SLO	Assessment Strategies
• Understand the expectations of the command words • Look at the cognitive level • Identify the content that is required to answer that question (both in terms of understanding of concepts and any skills that may be required like analysing or evaluating) • Go through the past paper questions on that particular concept • Refer to the resource guide for extra resources	• Story Board • Cause and Effect • Fish and Bone • Concept Mapping • Audio Visual resources • Think, Pair and Share • Questioning Technique (Socratic approach) • Practical Demonstration	• Past paper questions • Discussion on E-Marking Notes • AKU-EB Digital Learning Solution powered by Knowledge Platform https://akueb.knowledgeplatform.com/login

Any Additional Suggestion:
While discussing kinetic molecular theory or doing derivation of it, it is crucial to establish connections between mathematical statements and real-life examples. This approach will enable students to provide well-reasoned answers by relating theoretical concepts to everyday situations.

Question No. 10b	
Question Text	More work is done when a gas is heated at constant pressure rather than at constant volume. Justify the given statement in SEVEN points.
SLO No.	10.6.3
SLO Text	Show that $C_p - C_v = R$ by using 1st law of thermodynamics.
Max Marks	07
Cognitive Level	U
Checking Hints	1 mark for each highlighted statement (7 required).
Overall Performance	The candidates demonstrated a good performance in this question. They effectively related the statement to the first law of thermodynamics and specific heat capacity at constant pressure and constant volume. This reflects their understanding of thermodynamics principles and their ability to apply them to practical situations. Encouraging candidates to explore and apply these concepts in various contexts will further enhance their comprehension and problem-solving skills. Candidates' performance in this question highlights their competence and proficiency in this aspect of physics. Providing positive reinforcement and encouraging continuous engagement with the subject will foster further improvement in their future assessments.

Description of Better Responses	Better responses were evident as candidates proficiently explained the concepts of isobaric and isochoric processes and skillfully applied the first law of thermodynamics to justify the statement in the question. Moreover, some responses successfully highlighted that the specific heat capacity at constant pressure is greater than the specific heat capacity at constant volume. This indicates a strong understanding of thermodynamics principles and the ability to make relevant connections between theoretical concepts and practical scenarios. Encouraging candidates to further explore and apply such knowledge will enhance their understanding of thermodynamics and improve their problem-solving capabilities. The cohort's adept performance showcases their proficiency and competency in this aspect of physics.
Image of Better Response	(A) When work is done at constant pressure it is an isobaric process. When pressure is constant: $W = PA\Delta y$ $\because A\Delta y = \Delta V \Rightarrow W = P\Delta V$. Hence the constant pressure has little effect on the workdone. If explained through a graph, the area under a P-V graph shows the workdone by the system. Thus an isobar looks like: P, V. The shaded area represents the workdone which is maximum. If we consider a system containing gas at constant pressure (with a frictionless piston). All heat supplied to the system can be utilized to displace the piston and increase the internal energy. $Q = \Delta U + W$ $Q = \Delta U + P\Delta V$. If we consider a system with a gas enclosed in a container, with a fixed immovable piston, no work is done. Such a process is an isochoric process. → lock. Even if heat is supplied to the system, it would cover no displacement ~~on~~ hence, the change in volume will be 0 and $W = 0$ as well. $W = PA\Delta y$ $\because A\Delta y = \Delta V$ ~~⇒ W = PAΔy but~~ since $\Delta y = 0$ so ΔV also equals to zero. $W = P\Delta V \Rightarrow W = P(0) = W = 0$. Thus all the heat which is supplied to an isochoric system is utilized to increase the internal energy. A/c to first law of thermodynamics: $Q = W + \Delta U$, $Q = 0 + \Delta U$, $Q = \Delta U$. An isochor also proves the statement: P, → V, → no area = no W. Moreover, Cp is also greater than Cv because when pressure is constant W is done so more heat is required to perform work. Whereas, at constant volume (Cv) is less because no work is done only ΔU is increased.
Description of Weaker Responses	Weaker responses were observed, as candidates faced challenges in justifying the statement with proper reasoning. Some mistakenly explained Boyle's law and Charles's law, which were not directly relevant to the question. To enhance their responses, candidates should focus on understanding the specific concepts related to the first law of thermodynamics and specific heat capacity at constant pressure and constant volume.

Image of Weaker Response	1) More work is done when a gas is heated at Constant pressure rather than at Constant volume because at constant volume there is more requirement of heat. 2) At Constant volume there is less effective collisions. 3) At constant volume density also varies, density isn't constant. 4) At Constant volume there is low heat of vapourization. 5) At constant volume we need high boiling point. 6) At Constant volume molecules interact with each others which lowers the work done.

Suggestions for improvement (Tick all that apply)

How to Approach SLO	Pedagogy Used for that SLO	Assessment Strategies
• Understand the expectations of the command words • Look at the cognitive level • Identify the content that is required to answer that question (both in terms of understanding of concepts and any skills that may be required like analysing or evaluating) • Go through the past paper questions on that particular concept • Refer to the resource guide for extra resources	• Story Board • Cause and Effect • Fish and Bone • Concept Mapping • Audio Visual resources • Think, Pair and Share • Questioning Technique (Socratic approach) • Practical Demonstration	• Past paper questions • Discussion on E-Marking Notes • AKU-EB Digital Learning Solution powered by Knowledge Platform https://akueb.knowledgeplatform.com/login

Any Additional Suggestion:

Even though 'Thermodynamics' is the last topic in the HSSC-I exam syllabus, it is just as important as the others. So, teachers, please make sure to give it enough time and focus on all the little details and what is needed to understand it well.

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, students 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, students 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, students 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 students' interest and understanding of space.

Pedagogy: Think, Pair, and Share

Description: A collaborative learning technique where students 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. Students 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 students 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. Students 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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