Using Itemised Data Capture Reports to Improve Assessment Design in Physical Sciences

Leveraging educational assessment data for decision-making and accountability

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About the Independent Examinations Board

Mission

- To advance quality teaching and learning through the design, delivery, and promotion of innovative and relevant assessments and services.
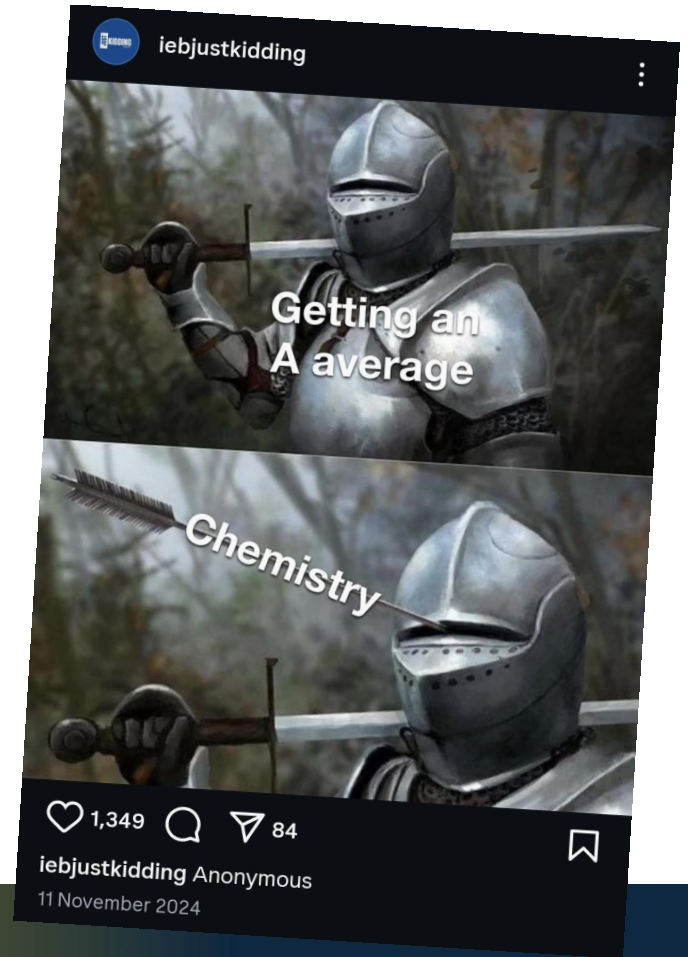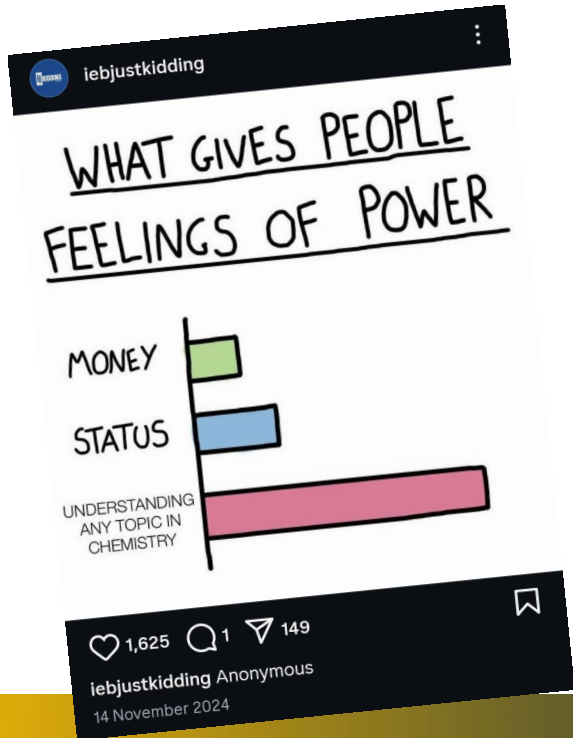
National Senior Certificate

- This qualification is assessed by three different assessment bodies in South Africa, all quality assured by UMALUSI.
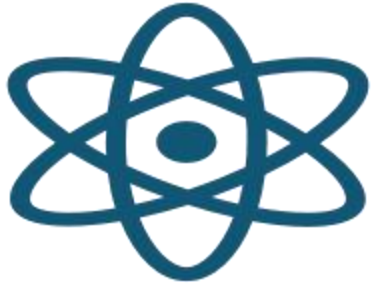
Pre-testing

- None of the items in the final examinations are pre-tested.

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assessment matters

news24
BREAKING
NEWS

This follows complaints over two questions in the Physical Science Paper 2 set by another assessment body, the Independent Examinations Board (IEB), for pupils attending the majority of the country's private schools.

iebjustkidding

WHAT GIVES PEOPLE FEELINGS OF POWER

MONEY

STATUS

UNDERSTANDING ANY TOPIC IN CHEMISTRY

1,625   1   149

iebjustkidding Anonymous
14 November 2024

iebjustkidding

Getting an A average

Chemistry

1,349   84

iebjustkidding Anonymous
11 November 2024

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Physical Sciences

Single subject consisting of two components: Physics and Chemistry

In most schools both components are taught by the same teachers, who form part of a stable teaching community

All candidates have to write both papers during the final examinations – set by the IEB
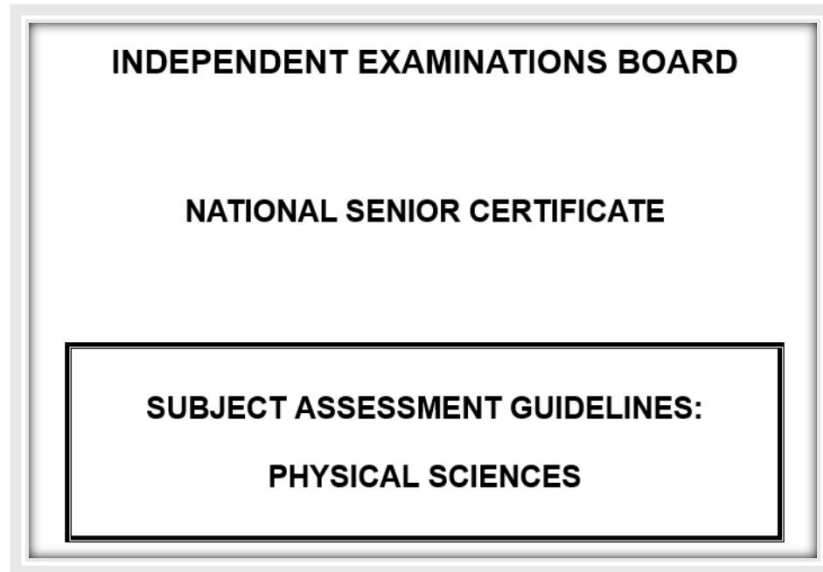
- Counts 75% of the candidate's final mark

School Based Assessments (SBA) are based on both components – set by the schools.

- Counts 25% of the candidate's final mark

Specification Tables for Content & Cognitive Taxonomy

INDEPENDENT EXAMINATIONS BOARD

NATIONAL SENIOR CERTIFICATE

SUBJECT ASSESSMENT GUIDELINES:

PHYSICAL SCIENCES

Cognitive Taxonomy

Level	Description	Paper I Physics (%)	Paper II Chemistry (%)
1	Knowledge and Recall	15	15
2	Comprehensions and Routine Exercises	35	40
3	Application and Analysis	40	35
4	Synthesis and Evaluation	10	10

Leong's Factors of Difficulty

Complexity of the Task

Familiarity of the Task

Independence Required

Abstractness

Language Complexity

Information Processing

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Design Tool

NATIONAL SENIOR CERTIFICATE: PHYSICAL SCIENCES: PAPER I – ANALYSIS GRID

Item	Content							Cognitive Level				Difficulty Level			
Question / Task	Kinematics (Motion in 1D)	Newton's Laws & Applications of Newton's Laws	Momentum, Impulse, Work, Energy and Power	Gravitational & Electric Fields	Electric Circuits	Electrodynamics	Photons and Electrons	Knowledge and recall	Comprehension, routine exercises	Application and analysis	Synthesis and Evaluation	Easy for G12 learner to answer	Moderately challenging	Difficult for a G12 learner to answer	Very difficult for a G12 learner to answer
								1	2	3	4	1	2	3	4
1.1	2							2				2			
1.2	2									2			2		
1.3		2									2			2	
1.4			2							2		2			
1.5			2							2				2	
1.6			2							2				2	
1.7				2						2				2	
1.8					2					2				2	
1.9						2					2				2
1.10						2			2			2			

Cohort Performance

Physics	2021		2022		2023		2024	
	Average	CL ; DL	Average	CL ; DL	Average	CL ; DL	Average	CL ; DL
	57	2,4 ; 2,3	63	2,5 ; 2,3	64	2,5 ; 2,2	67	2,5 ; 2,2

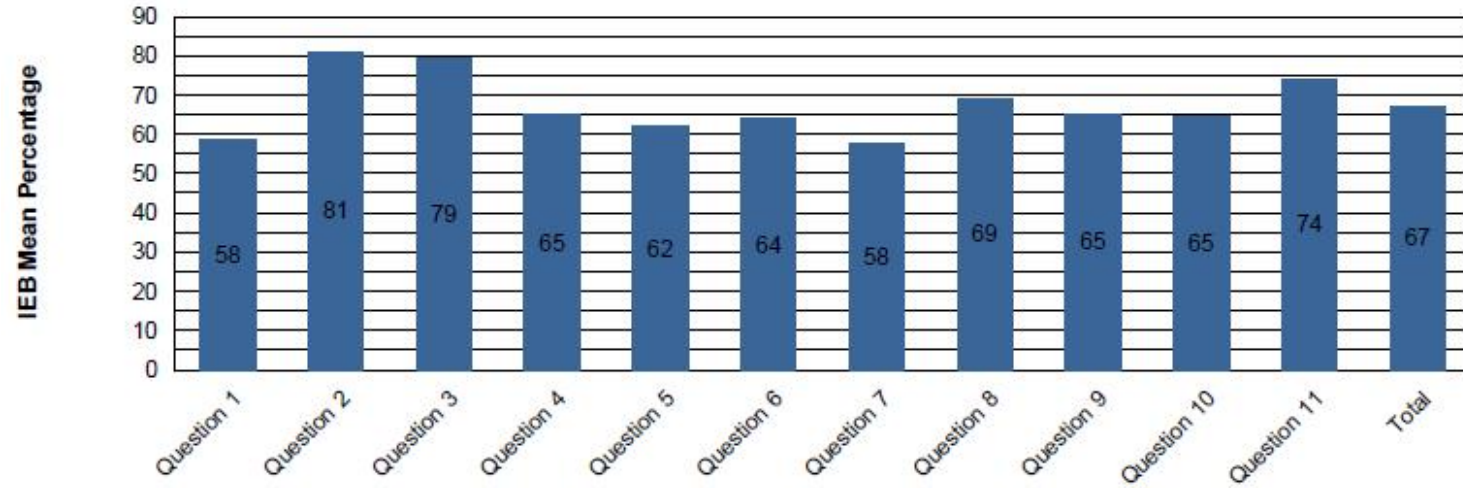| Chemistry	2021		2022		2023		2024	
	Average	CL ; DL	Average	CL ; DL	Average	CL ; DL	Average	CL ; DL
	57	2,4 ; 2,4	53	2,5 ; 2,3	58	2,4 ; 2,1	51	2,4 ; 2,0

Examination Panels:
- Physics: Examiner, Internal Moderator & External Moderator have not changed
- Chemistry: Same External Moderator since 2021 and same Examiner since 2022

Post Examination Analysis (PEA):
- Done by an independent panel after the examination was written
- Their findings of the standard of the paper was comparable to that of the Examination Panel

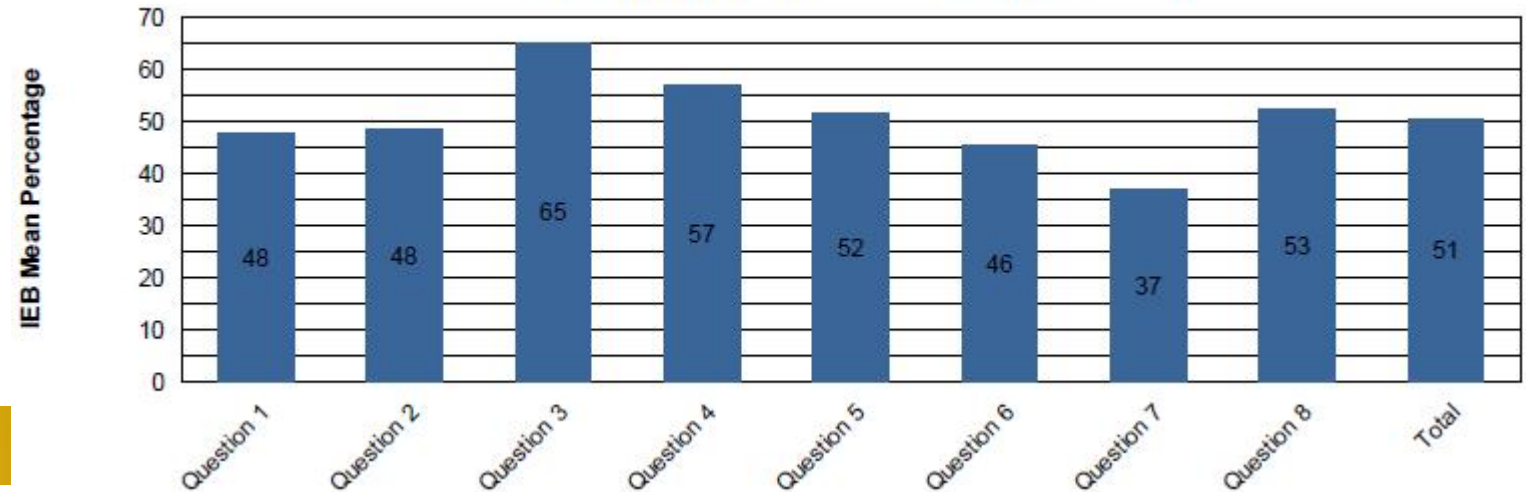# Post Analysis Tool: Itemised Data Capturing (IDC)

**IEBMeanPerc / QuestionCode**

Physics

IEBMeanPerc / QuestionCode

Chemistry

Itemised Data Capturing: Chemistry

	2021	2022	2023	2024
	CL ; DL	CL ; DL	CL ; DL	CL ; DL
Chemical Equilibrium	2,8 ; 2,9	3,0 ; 2,7	3,1 ; 3,0	2,9 ; 2,5
Acids and Bases	2,7 ; 2,9	2,3 ; 2,2	2,4 ; 2,2	2,3 ; 2,2
Organic Chemistry	2,5 ; 2,5	2,4 ; 2,2	2,0 ; 1,6	2,1 ; 1,5

Averages per year

	Chemical Equilibrium	Acids and Bases	Organic Chemistry
2021	50	58	66
2022	58	58	50
2023	53	56	65
2024	57	52	53
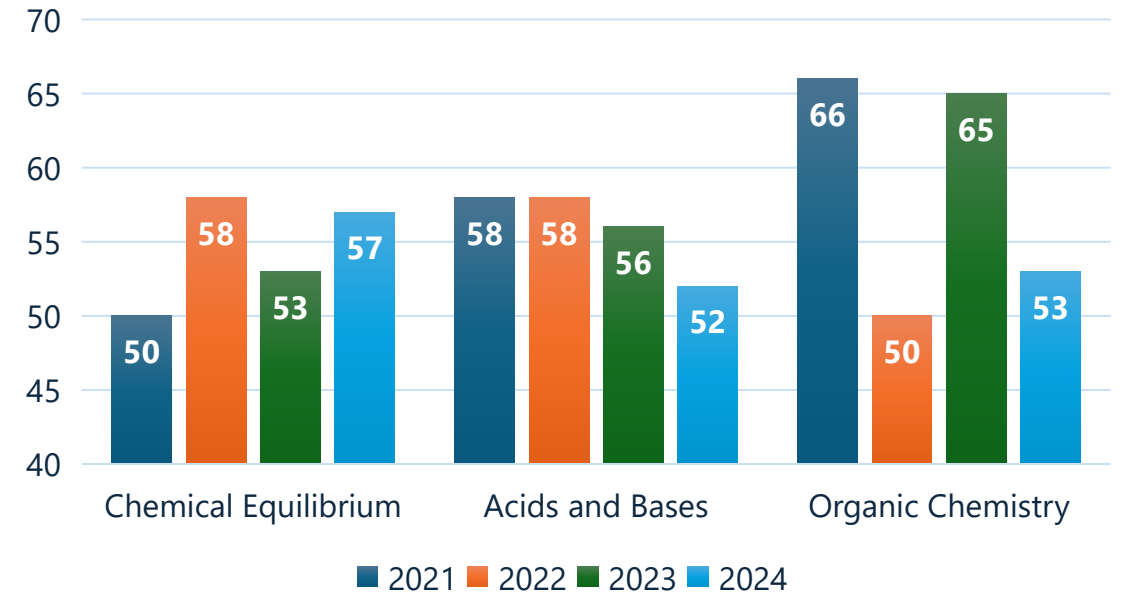
Itemised Data Capturing: Physics

Averages per year
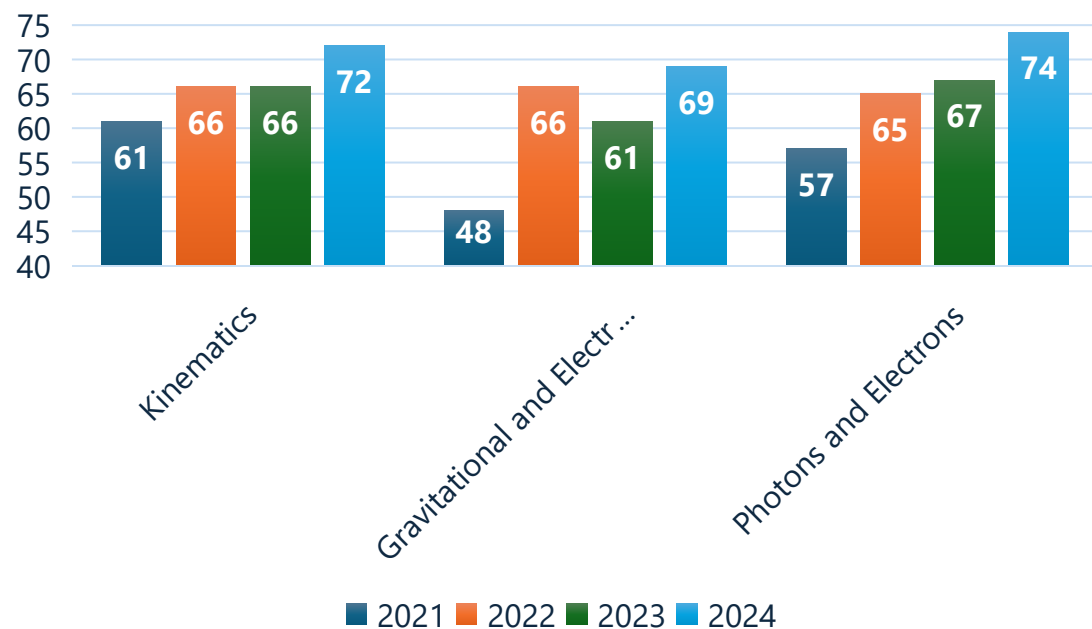
|	2021	2022	2023	2024
	CL ; DL	CL ; DL	CL ; DL	CL ; DL
Kinematics	2,5 ; 2,2	2,2 ; 1,9	2,6 ; 2,1	2,1 ; 2,2
Gravitational and Electric Fields	2,9 ; 3,0	2,5 ; 2,7	2,2 ; 2,1	2,1 ; 1,7
Photons and Electrons	2,3 ; 1,9	2,4 ; 2,2	2,8 ; 2,9	2,8 ; 2,6

Number of Items per Question Paper
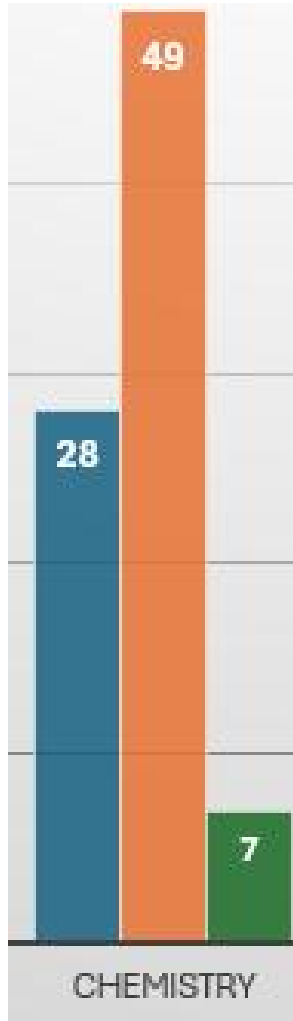
Number of Items
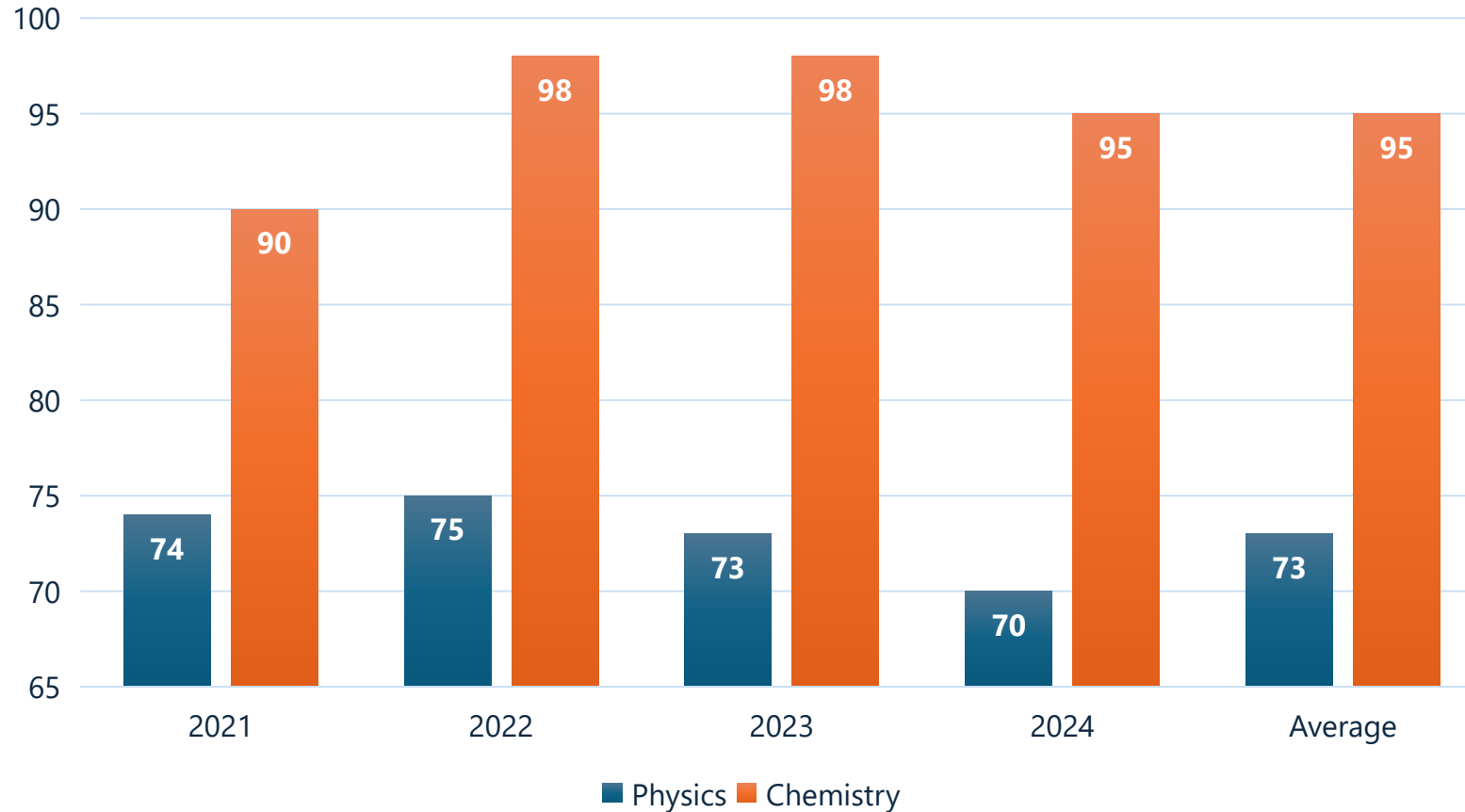
- **Average marks per item:**
  Physics: 2,7
  Chemistry: 2,1
- **Physics:** Lower item count, greater weight per item
- **Chemistry:** Higher item count, less weight per item
- In both cases the item count is still sufficient to ensure sampling across Bloom's Taxonomy and all four difficulty levels

Item Comparison (N)

Items per mark allocation
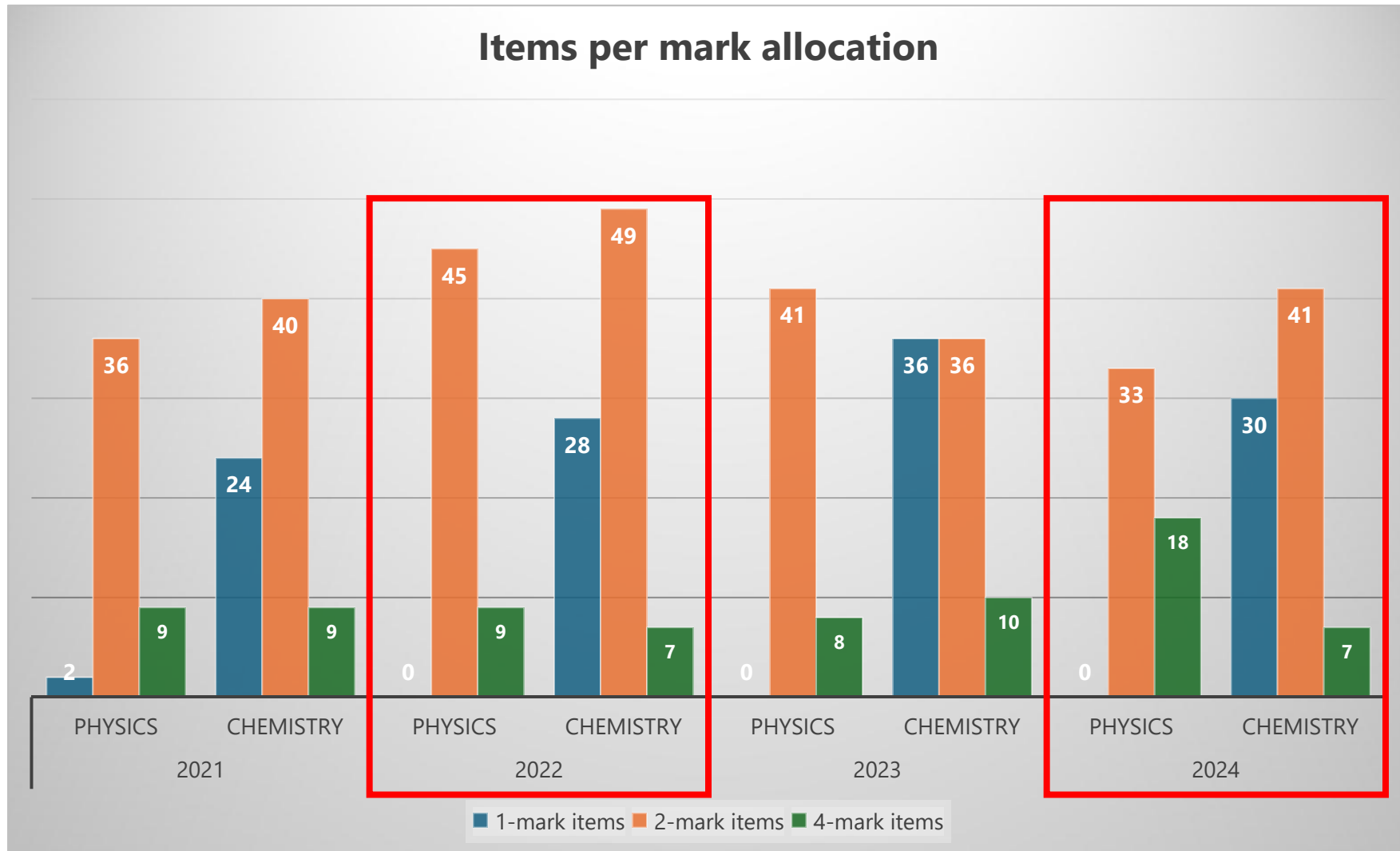
Chemistry: Item Comparison

2-mark items	Cognitive Level ; Difficulty Level				Total
	3 ; 2	3 ; 3	4 ; 3	4 ; 4	
2021	4	4	1	0	9
2022	2	10	3	7	22
2023	4	6	1	3	14
2024	6	3	2	0	11

Chemistry Observations:

• In 2022 there was a very high number of 2-mark items

• 22 of these items were set to cognitive level groupings three (Application and Analysis) and four (Synthesis and Evaluation) – 20 of which was rated as difficulties three and four

• The mark allocation were mostly split between answer and reason, but no continuous accuracy could be applied if the candidate's original statement was incorrect (Science marking convention)

Chemistry: Item Comparison
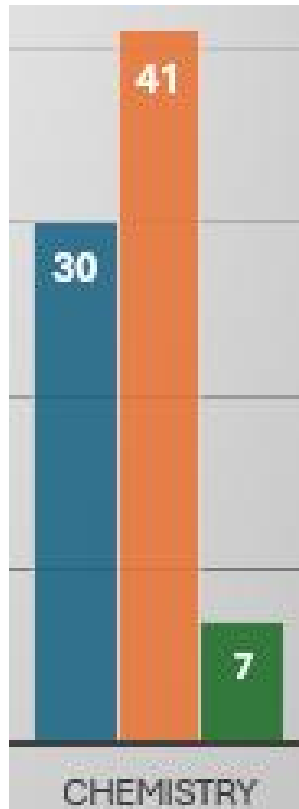
2-mark items	Cognitive Level ; Difficulty Level				Total
	1 ; 1	1 ; 2	2 ; 1	2 ; 2	
2021	9	5	5	8	27
2022	5	1	9	11	26
2023	9	1	6	6	22
2024	8	0	12	10	30

Chemistry Observations:

- In 2024 the total number of 1- and 2-mark items were comparable to 2023

- 22 of the 2-mark items were set to cognitive level grouping two (Comprehension and Routine Exercises) in 2024

- Less 2-mark items under cognitive grouping one (definitions). The stating of definitions early in questions enable candidates to align their thoughts for the questions that follow

Physics: Item Comparison

4-mark items	Cognitive Level ; Difficulty Level							Total
	2 ; 1	2 ; 2	2 ; 3	3 ; 2	3 ; 3	4 ; 3	4 ; 4	
2021	0	2	1	0	4	0	2	9
2022	0	2	1	1	5	0	0	9
2023	0	3	1	0	2	0	2	8
2024	4	4	1	3	4	1	1	18

Physics Observations:

- In 2024 the total number of 4-mark items were doubled compared to the years before

- It was also the first year where 4-mark items were assessed at lower difficulty levels within similar cognitive levels to the years before

- This seems to have led to improved results as greater differentiation could happen within sub-questions as part marks could be obtained in these items – this was made possible by the majority of these items being calculation type questions

Key Observations

Overall cognitive level (CL) and difficulty level (DL) of a question paper is not sufficient to predict outcomes/performance – it is imperative to look into the combination of CL and DL, together with how it is asked in the paper

Number of items, together with their mark allocation and the marking principles applied, could affect candidate performance

Sufficient scaffolding (definitions), where appropriate, is necessary to ensure reliable testing

Way Forward

National Senior Certificate

Operates without pre-testing

Live-data insight:

The functional utility of Bloom's Taxonomy

The predictive reliability of item difficulty classifications

Assessment literacy in action:

Enables dynamic post hoc analysis

Evidence-based item design

By embracing this complexity, we become not just users of taxonomies, but critical examiners of their lived truth in high-stakes environments.