Physics subject report

2023 cohort

January 2024

Queensland Government | QCAA Queensland Curriculum & Assessment Authority

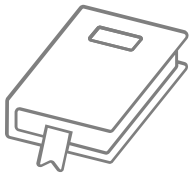
240037

Queensland Curriculum & Assessment Authority
PO Box 307 Spring Hill QLD 4004 Australia

Phone: (07) 3864 0299
Email: office@qcaa.qld.edu.au
Website: www.qcaa.qld.edu.au

Contents

Introduction



Throughout 2023, schools and the Queensland Curriculum and Assessment Authority (QCAA) continued to improve outcomes for students in the Queensland Certificate of Education (QCE) system. These efforts were consolidated by the cumulative experience in teaching, learning and assessment of the current General and General (Extension) senior syllabuses, and school engagement in QCAA endorsement and confirmation processes and external assessment marking. The current evaluation of the QCE system will further enhance understanding of the summative assessment cycle and will inform future QCAA subject reports.

The annual subject reports seek to identify strengths and opportunities for improvement of internal and external assessment processes for all Queensland schools. The 2023 subject report is the culmination of the partnership between schools and the QCAA. It addresses school-based assessment design and judgments, and student responses to external assessment for this subject. In acknowledging effective practices and areas for refinement, it offers schools timely and evidence-based guidance to further develop student learning and assessment experiences for 2024.

The report also includes information about:

- how schools have applied syllabus objectives in the design and marking of internal assessments
- how syllabus objectives have been applied in the marking of external assessments
- patterns of student achievement.

The report promotes continuous improvement by:

- identifying effective practices in the design and marking of valid, accessible and reliable assessments
- recommending where and how to enhance the design and marking of valid, accessible and reliable assessment instruments
- providing examples that demonstrate best practice.

Schools are encouraged to reflect on the effective practices identified for each assessment, consider the recommendations to strengthen assessment design and explore the authentic student work samples provided.

Audience and use

This report should be read by school leaders, subject leaders and teachers to:

- inform teaching and learning and assessment preparation
- assist in assessment design practice
- assist in making assessment decisions
- help prepare students for internal and external assessment.

The report is publicly available to promote transparency and accountability. Students, parents, community members and other education stakeholders can use it to learn about the assessment practices and outcomes for senior subjects.

Report preparation

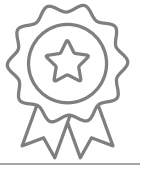
The report includes analyses of data and other information from endorsement, confirmation and external assessment processes. It also includes advice from the chief confirmer, chief endorser and chief marker, developed in consultation with and support from QCAA subject matter experts.

Subject highlights

396
schools offered Physics

86.46%
of students completed 4 units

99.09%
of students received a C or higher



Subject data summary

Subject completion

The following data includes students who completed the General subject or Alternative Sequence (AS).

Note: All data is correct as at January 2024. Where percentages are provided, these are rounded to two decimal places and, therefore, may not add up to 100%.

Number of schools that offered Physics: 396.

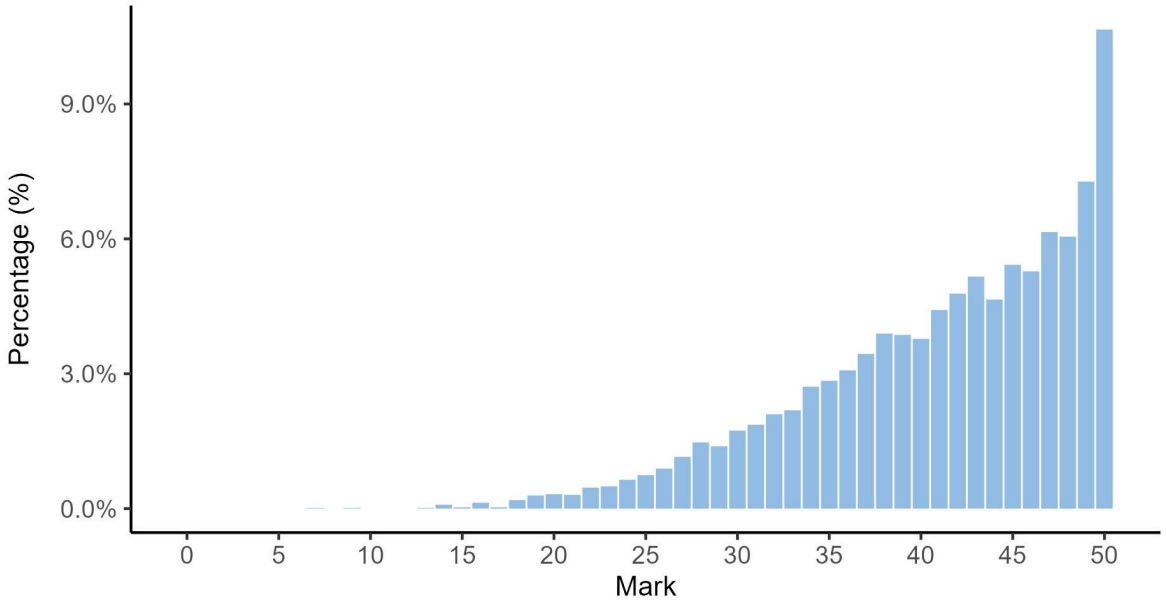
Completion of units	Unit 1	Unit 2	Units 3 and 4
Number of students completed	7,904	7,449	6,834

Units 1 and 2 results

Number of students	Satisfactory	Unsatisfactory
Unit 1	7,479	425
Unit 2	6,925	524

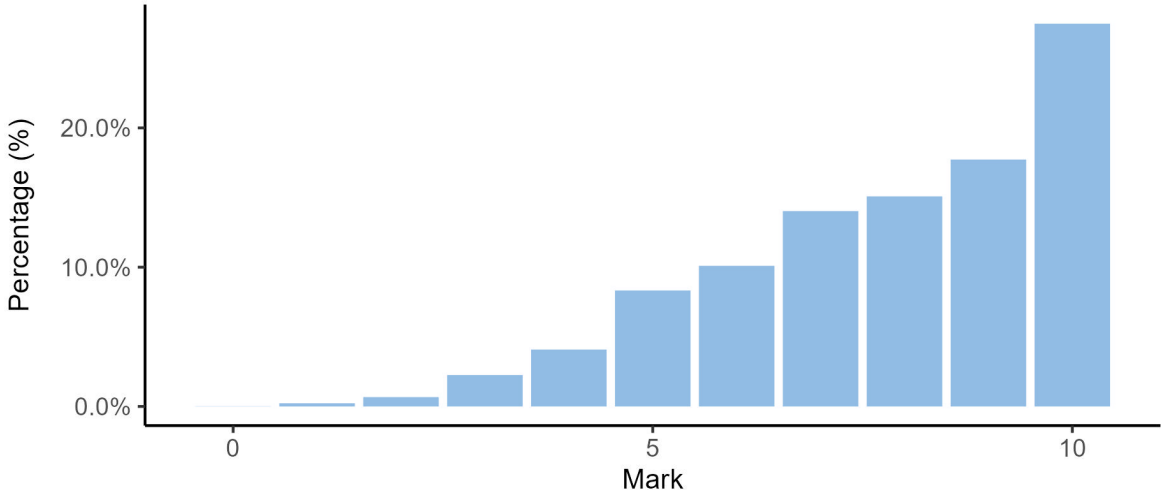
Units 3 and 4 internal assessment (IA) results

Total marks for IA

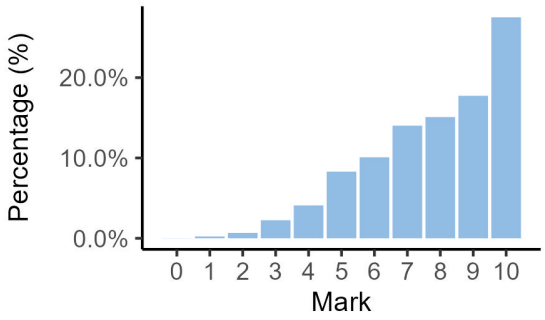


IA1 marks

IA1 total

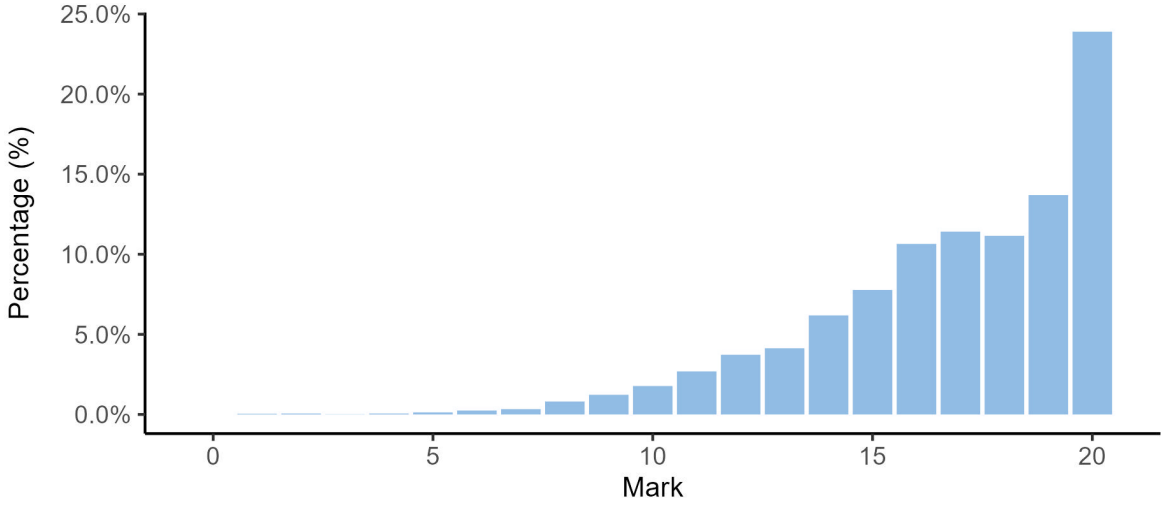


IA1 Criterion: Data test

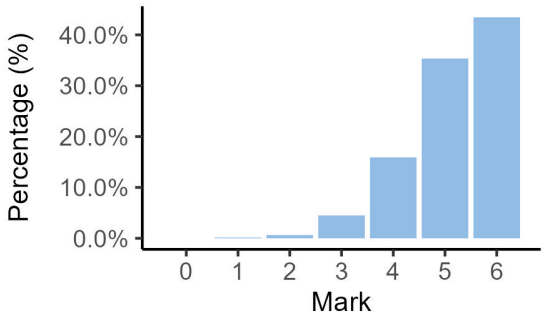


IA2 marks

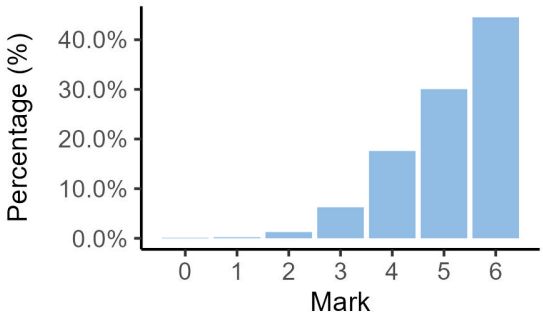
IA2 total



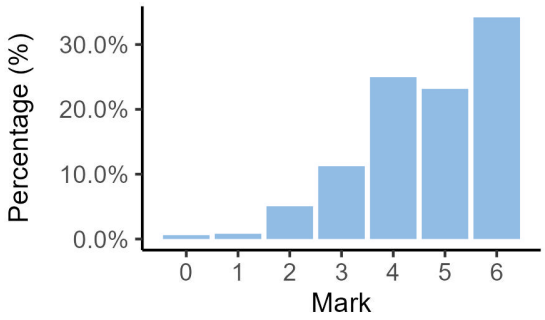
IA2 Criterion: Researching and planning



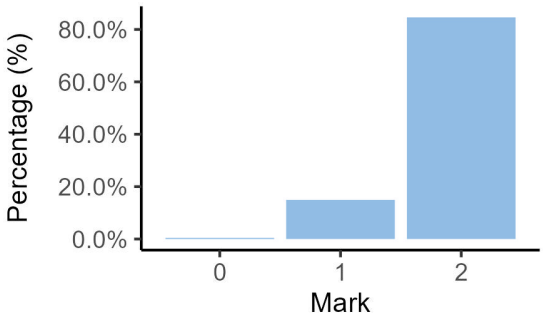
IA2 Criterion: Analysis of evidence



IA2 Criterion: Interpretation and evaluation

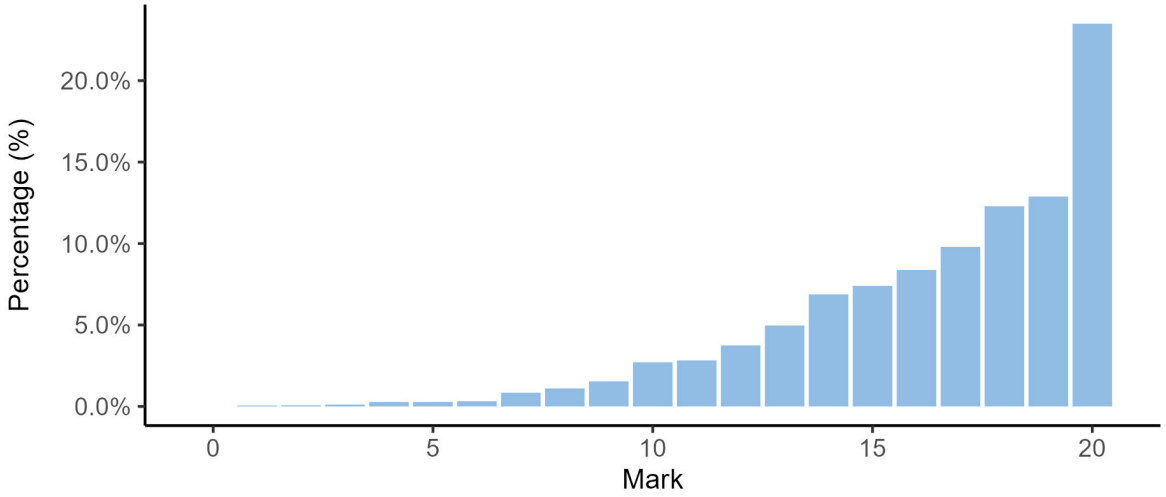


IA2 Criterion: Communication

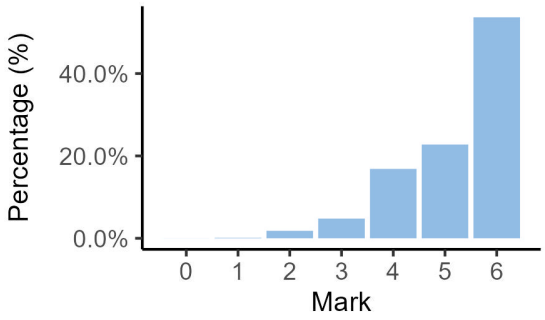


IA3 marks

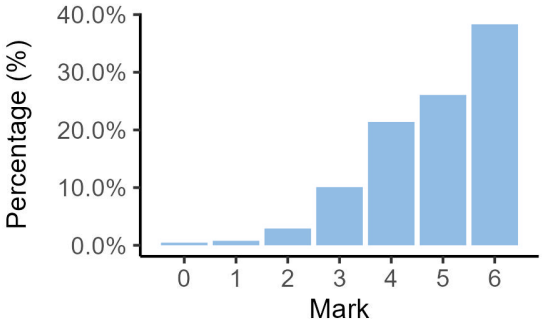
IA3 total



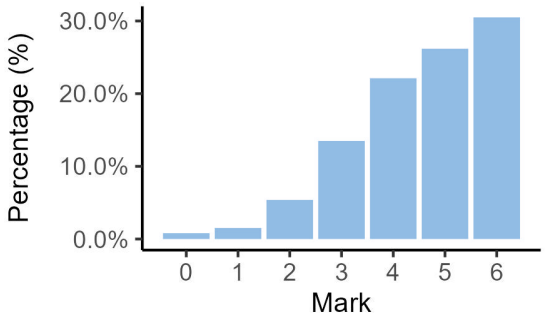
IA3 Criterion: Researching and planning



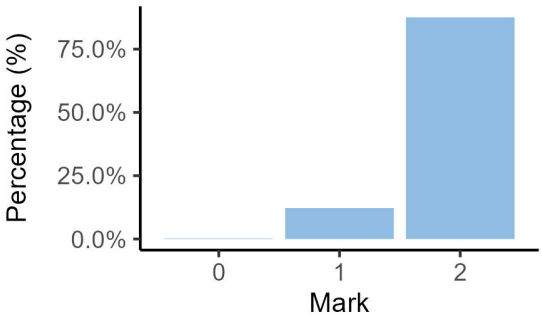
IA3 Criterion: Analysis and interpretation



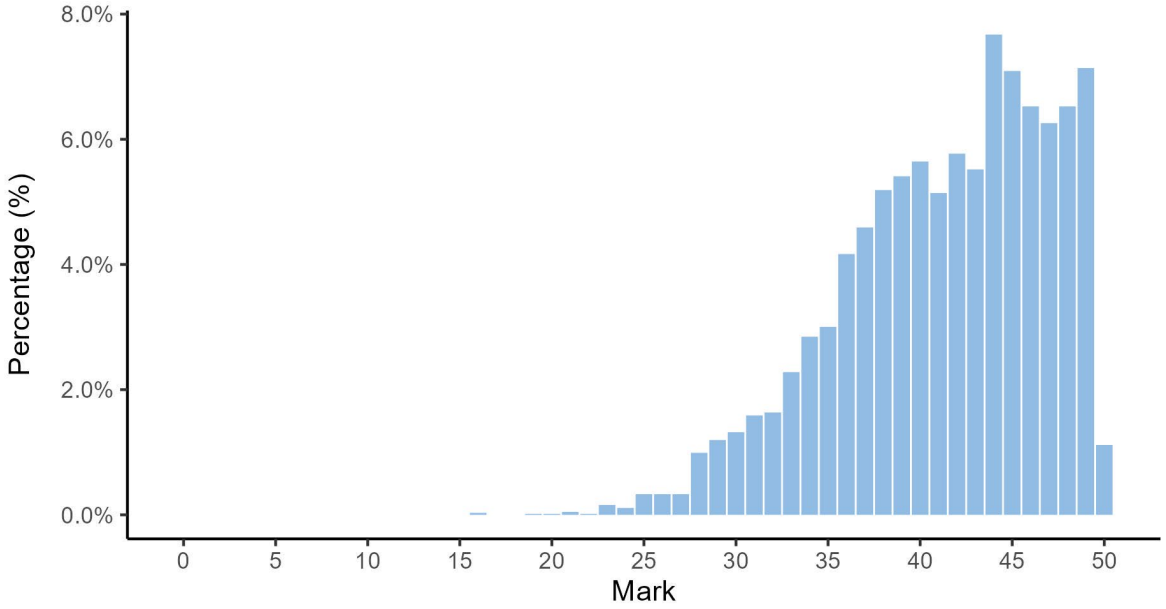
IA3 Criterion: Conclusion and evaluation



IA3 Criterion: Communication

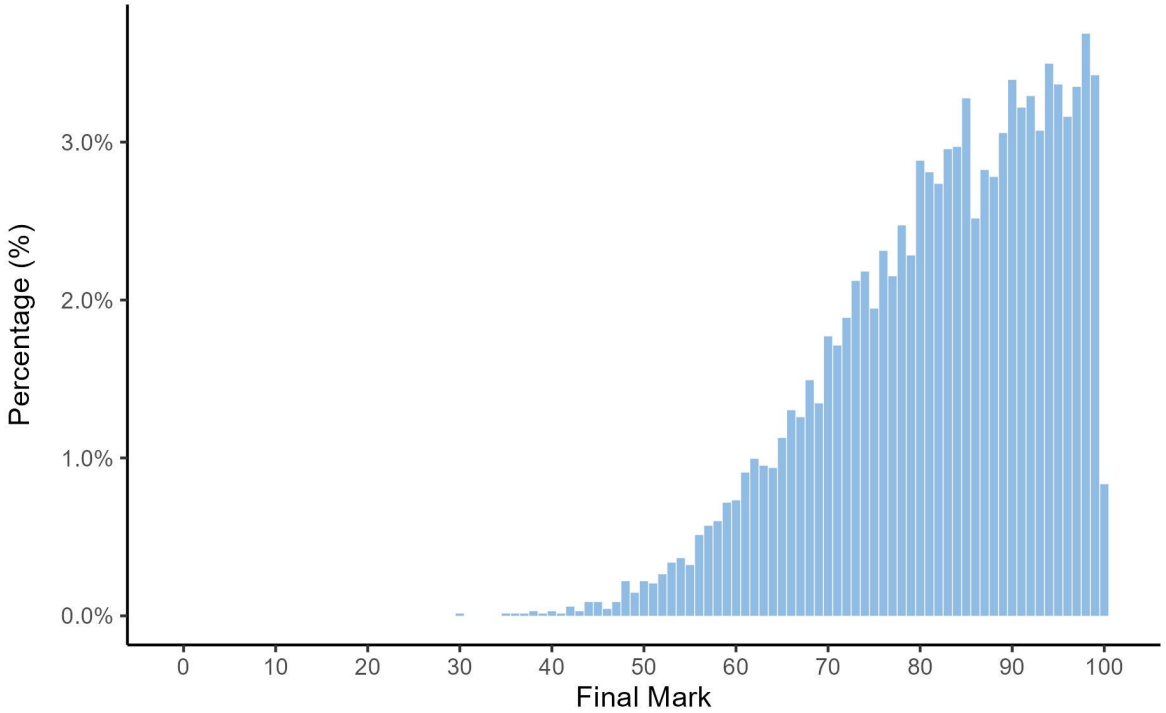


External assessment (EA) marks



Final subject results

Final marks for IA and EA



Grade boundaries

The grade boundaries are determined using a process to compare results on a numeric scale to the reporting standards.

Standard	A	B	C	D	E
Marks achieved	100–87	86–72	71–50	49–19	18–0

Distribution of standards

The number of students who achieved each standard across the state is as follows.

Standard	A	B	C	D	E
Number of students	2,936	2,563	1,273	62	0

Internal assessment

The following information and advice relate to the assessment design and assessment decisions for each IA in Units 3 and 4. These instruments have undergone quality assurance processes informed by the attributes of quality assessment (validity, accessibility and reliability).

Endorsement

Endorsement is the quality assurance process based on the attributes of validity and accessibility. These attributes are categorised further as priorities for assessment, and each priority can be further broken down into assessment practices.

Data presented in the Assessment design section identifies the reasons why IA instruments were not endorsed at Application 1, by the priority for assessments. An IA may have been identified more than once for a priority for assessment, e.g. it may have demonstrated a misalignment to both the subject matter and the assessment objective/s.

Refer to *QCE and QCIA policy and procedures handbook v5.0*, Section 9.6.

Percentage of instruments endorsed in Application 1

Number of instruments submitted	IA1	IA2	IA3
Total number of instruments	393	394	392
Percentage endorsed in Application 1	56%	90%	83%

Confirmation

Confirmation is the quality assurance process based on the attribute of reliability. The QCAA uses provisional criterion marks determined by teachers to identify the samples of student responses that schools are required to submit for confirmation.

Confirmation samples are representative of the school's decisions about the quality of student work in relation to the instrument-specific marking guide (ISMG), and are used to make decisions about the cohort's results.

Refer to *QCE and QCIA policy and procedures handbook v5.0*, Section 9.7.

The following table includes the percentage agreement between the provisional marks and confirmed marks by assessment instrument. The Assessment decisions section of this report for each assessment instrument identifies the agreement trends between provisional and confirmed marks by criterion.

Number of samples reviewed and percentage agreement

IA	Number of schools	Number of samples requested	Number of additional samples requested	Percentage agreement with provisional marks
1	391	2,025	0	99.74%
2	391	2,596	0	85.93%
3	391	2,580	0	89.51%

Internal assessment 1 (IA1)

Data test (10%)

This assessment focuses on the application of a range of cognitions to multiple provided items.

Student responses must be completed individually, under supervised conditions, and in a set timeframe.

Assessment design

Validity

Validity in assessment design considers the extent to which an assessment item accurately measures what it is intended to measure and that the evidence of student learning collected from an assessment can be legitimately used for the purpose specified in the syllabus.

Reasons for non-endorsement by priority of assessment

Validity priority	Number of times priority was identified in decisions*
Alignment	90
Authentication	0
Authenticity	6
Item construction	41
Scope and scale	13

*Each priority might contain up to four assessment practices.

Total number of submissions: 393.

Effective practices

Validity priorities were effectively demonstrated in assessment instruments that:

- featured datasets derived from Unit 3 (or AS Unit 1) subject matter that could be interpreted objectively, e.g. a graph of experimental data from a practical investigating the average speed of an object undergoing centripetal motion
- used mark values for each item that reflected the number of steps or cognitions required in the item's response, i.e. each step was allocated a whole mark rather than a part mark
- contained a suitable number of questions for students to demonstrate their breadth of knowledge within a 60-minute test.

Practices to strengthen

It is recommended that assessment instruments:

- align the objective and cognitive verb to the nature of the expected response in the marking scheme, e.g. calculating a measure of uncertainty aligns to Objective 2 (Mark allocations table, Syllabus section 4.5.1 or AS section 4.6.1)
- include marking schemes to demonstrate alignment between the marks awarded and the cognition/s required to answer the question, e.g. avoid allocating marks for the number of

decimal places or significant figures as these are related to Objective 7, which is not assessed in this instrument

- include questions that require a unique response that does not follow on from another question, i.e. all questions should be answered independently of other questions.

Accessibility

Accessibility in assessment design ensures that no student or group of students is disadvantaged in their capacity to access an assessment.

Reasons for non-endorsement by priority of assessment

Accessibility priority	Number of times priority was identified in decisions*
Bias avoidance	13
Language	43
Layout	13
Transparency	25

*Each priority might contain up to four assessment practices.

Total number of submissions: 393.

Effective practices

Accessibility priorities were effectively demonstrated in assessment instruments that:

- provided a consistent layout with clearly legible datasets, including legends, labelled axes, correct units and figure labels
- followed appropriate communication conventions, including the use of bolding only where relevant
- included succinct cues that clearly prompted students to demonstrate the appropriate requirements in their response, e.g. ‘Calculate the time taken for the object’s total flight using data from Figure 1. Show all working’ (see Syllabus glossary).

Practices to strengthen

It is recommended that assessment instruments:

- contain symbols that are correct for the context of the dataset, e.g. ±
- provide all the data required to answer the question in the dataset. Students should not be relying on prior knowledge to answer the questions.

Additional advice

- Schools should
  - use the ‘Print preview’ function to ensure the layout of the task is appropriate (see *Developing summative internal assessment instruments,* pages 20–25, available in the Endorsement application (app) on the QCAA Portal)
  - ensure internal quality assurance processes are carried out before submitting instruments for endorsement (*QCE and QCIA policy and procedures handbook v5.0*, Section 9.6.1*)*.

Assessment decisions

Reliability

Reliability is a judgment about the measurements of assessment. It refers to the extent to which the results of assessments are consistent, replicable and free from error.

Agreement trends between provisional and confirmed marks

Criterion number	Criterion name	Percentage agreement with provisional	Percentage less than provisional	Percentage greater than provisional	Percentage both less and greater than provisional
1	Data test	99.74%	0%	0.26%	0%

Effective practices

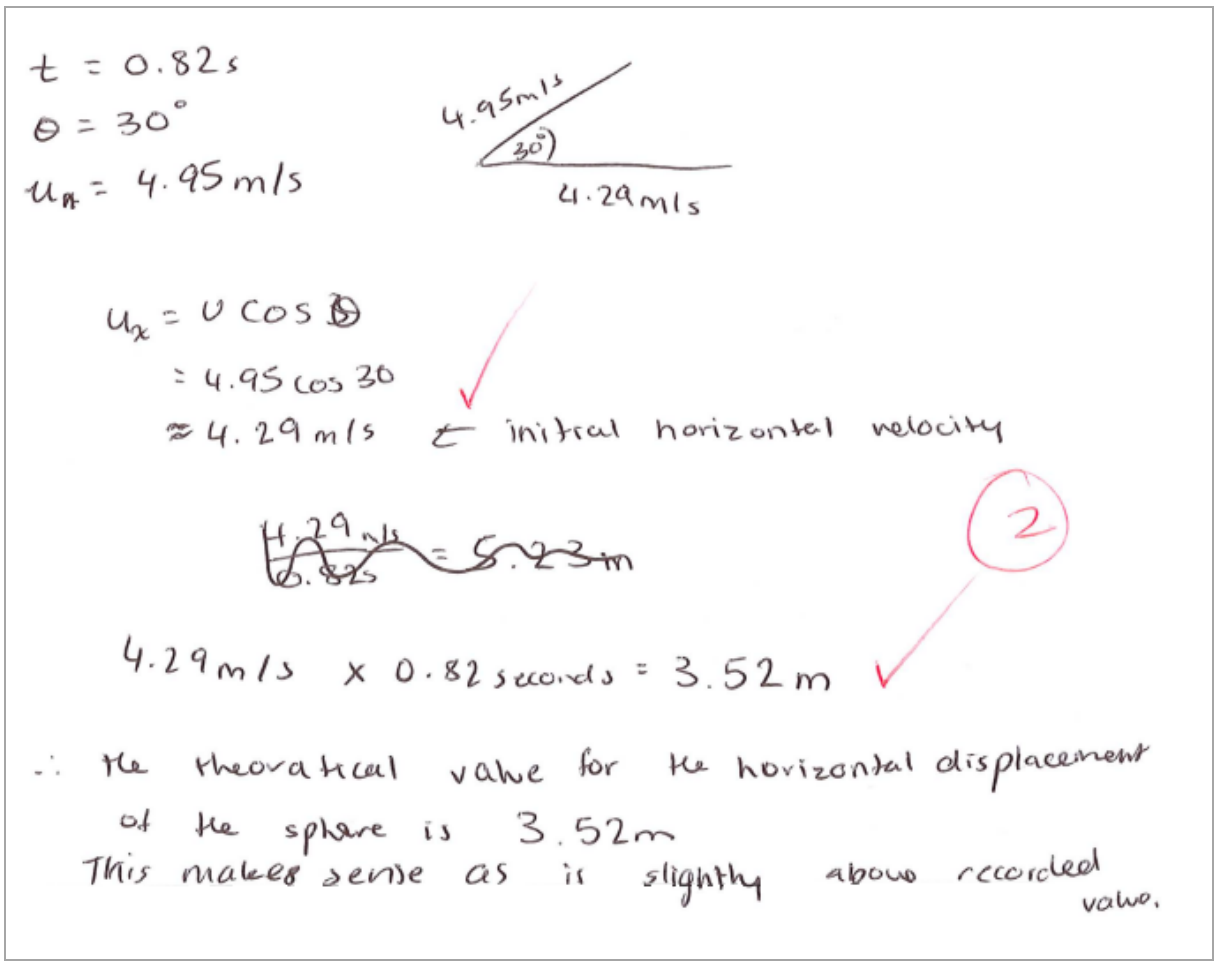
Accuracy and consistency of the application of the ISMG for this IA was most effective when:

- marking schemes demonstrated the expected responses and the required skills, and outlined how marks were awarded for them
- marking schemes allowed for flexibility in student responses when appropriate
- provisional marks were accurately calculated by correctly converting the awarded marks to a percentage using the total possible marks, and then applying the percentage cut-offs in the ISMG, e.g. award a mark of 10 only where the percentage achieved on the data test was greater than 90% (see the *Making judgments* webinar in the Syllabuses app on the QCAA Portal).

Samples of effective practices

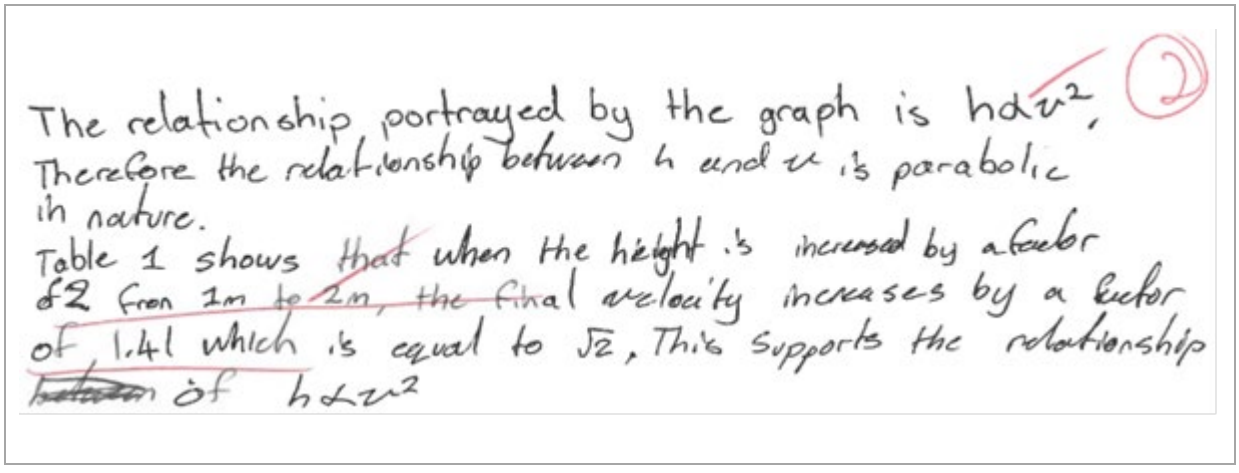
The following excerpt demonstrates clear annotations indicating a match between the marking guide and a student response to an Objective 2 item that requires the application of understanding of projectile motion to calculate an unknown theoretical value, based on values from the dataset.

Note: The characteristic/s identified may not be the only time the characteristic/s has occurred throughout a response.



The following excerpt demonstrates appropriate application of the marking guide to a student response to an Objective 3 item that demonstrates a comprehensive analysis of the dataset to determine the relationship between the variables, including reference to specific data to support the analysis.

Note: The characteristic/s identified may not be the only time the characteristic/s has occurred throughout a response.



Practices to strengthen

To further ensure accuracy and consistency of the application of the ISMG for this IA, it is recommended that:

- correct and accurate marking schemes for comparable assessments be consistently applied and submitted for confirmation. Comparable assessments should be developed in the Endorsement app to ensure the correct examination and its matching marking scheme are available for confirmation (*QCE and QCIA policy and procedures handbook v5.0*, Section 7.4).

Internal assessment 2 (IA2)

Student experiment (20%)

This assessment requires students to research a question or hypothesis through collection, analysis and synthesis of primary data. A student experiment uses investigative practices to assess a range of cognitions in a particular context. Investigative practices include locating and using information beyond students' own knowledge and the data they have been given.

Research conventions must be adhered to. This assessment occurs over an extended and defined period of time. Students may use class time and their own time to develop a response.

Assessment design

Validity

Validity in assessment design considers the extent to which an assessment item accurately measures what it is intended to measure and that the evidence of student learning collected from an assessment can be legitimately used for the purpose specified in the syllabus.

Reasons for non-endorsement by priority of assessment.

Validity priority	Number of times priority was identified in decisions*
Alignment	21
Authentication	12
Authenticity	4
Item construction	6
Scope and scale	0

*Each priority might contain up to four assessment practices.

Total number of submissions: 394.

Effective practices

Validity priorities were effectively demonstrated in assessment instruments that:

- included a clear authentication statement indicating that feedback was limited to a single complete or near-complete draft, which must have been in the mode required by the syllabus (*QCE and QCIA policy and procedures handbook v5.0*, Section 8.2.5)
- offered students the chance to select from a variety of practical activities that were derived from the teaching and learning of Unit 3 (or AS Unit 1), to form the foundation of their methodology and research question.

Practices to strengthen:

It is recommended that assessment instruments:

- clearly indicate students may not use a sample research question (if one was provided)
- include all the specifications for the assessment task listed in the syllabus (section 4.5.2, AS section 2.5.2)

- clearly identify the task elements to be completed individually and those to be completed as a group, e.g. using asterisks in the task specifications
- contain appropriate authentication strategies to ensure students are producing unique responses, e.g. observation of students during class work, interviews with students.

Accessibility

Accessibility in assessment design ensures that no student or group of students is disadvantaged in their capacity to access an assessment.

Reasons for non-endorsement by priority of assessment

Accessibility priority	Number of times priority was identified in decisions*
Bias avoidance	0
Language	2
Layout	0
Transparency	0

*Each priority might contain up to four assessment practices.

Total number of submissions: 394.

Effective practices

Accessibility priorities were effectively demonstrated in assessment instruments that:

- showed an indication of the time available to students in the checkpoints (e.g. Week 4: Select experiment and identify proposed modifications) rather than specific dates
- avoided repeating elements of the task in different sections, e.g. repeating task descriptions in the conditions.

Practices to strengthen

There were no significant issues identified for improvement.

Additional advice

- Checkpoints provide opportunities for students to practise self-assessment and for teachers to check students are on track for both content and assessment conditions. Drafts are an opportunity to provide focused feedback on a preliminary response and to authenticate student work (*QCE and QCIA policy and procedures handbook v5.0*, Sections 8.2.4 and 8.2.5).

Assessment decisions

Reliability

Reliability is a judgment about the measurements of assessment. It refers to the extent to which the results of assessments are consistent, replicable and free from error.

Agreement trends between provisional and confirmed marks

Criterion number	Criterion name	Percentage agreement with provisional	Percentage less than provisional	Percentage greater than provisional	Percentage both less and greater than provisional
1	Research and planning	91.82%	6.91%	1.28%	0%
2	Analysis of evidence	94.12%	5.37%	0.51%	0%
3	Interpretation and evaluation	93.09%	5.88%	1.02%	0%
4	Communication	98.47%	0.51%	1.02%	0%

Effective practices

Accuracy and consistency of the application of the ISMG for this IA was most effective when:

- for the Analysis of evidence criterion,
  - *sufficient* and *relevant* raw data was systematically and effectively analysed using *correct* and *relevant* processes, e.g. calculation of percentage uncertainty or linearisation of data including correlation coefficients (r^2)
  - uncertainty and limitations were
    - *thoroughly* identified through analysis of the evidence from the experimental data rather than discussing problems relating to methodology
    - *appropriately* related to the correct and relevant processing of data
- for the Interpretation and evaluation criterion,
  - *logically* derived improvements and extensions to the experiment identified how
    - random error can be reduced to improve the reliability of the data, e.g. repeating measurements
    - measurement uncertainty can be reduced by using more precise measuring equipment, e.g. an instrument with a finer-grained scale
    - modifying the methodology improved the accuracy of the data and the validity of the conclusions drawn e.g. by identifying and rectifying any systematic error in the measurement process
  - *justified* conclusions referred to the trends, patterns or relationships identified in the analysis of evidence to indicate how the evidence matched with the theoretical concepts identified in the rationale
  - *justified* discussions of
    - validity were made with reference to the accepted/constant values from the rationale

- reliability of the experimental process considered the uncertainties identified in the analysis of errors.

Samples of effective practices

The following excerpts demonstrate research questions that specifically identified the independent and dependent variables, and relevant alignment to Unit 3 subject matter.

Note: The characteristic/s identified may not be the only time the characteristic/s has occurred throughout a response.

Excerpt 1

What is the relationship between the horizontal and vertical displacement of a launched ball bearing, fired using a projectile launcher mounted to the different heights 0.6, 0.7, 0.8, 0.9 and 1 meter at a constant angle of 0° on a scaffold?

Excerpt 2

What is the effect of changing the magnetic field strength (0.001510 T, 0.003000 T and 0.004325 T) on the force acting on a 0.015 m copper wire at 90° angle to the magnetic field with different currents (0.1 A, 0.2 A, 0.3 A, 0.4 A and 0.5 A) flowing through it?

The following excerpts demonstrate justified modifications to the methodology by explaining the expected effect of each.

Note: The characteristic/s identified may not be the only time the characteristic/s has occurred throughout a response.

Excerpt 1

Modification	Justification
Redirect: Investigate the relationship between the horizontal and vertical displacements instead of the relationship between horizontal displacement and the firing angle. This is achieved by changing the height of the projectile launcher while keeping the angle constant	As the method that was used to investigate the relationship between the horizontal displacement and the angle the projectile was fired proved to be invalid, due to the initial velocity constantly changing, the experiment had to be redirected to not include change in angles. Therefore, the modified experiment will use a constant angle with a change in height.
Refinement: Ensure that the initial velocity is kept constant by using photogates, a reliable instrument that can accurately measure velocity.	As the initial experiment was greatly impacted by the unintended change in velocity, photogates can ensure that velocity stays constant, with any outliers being removed.
Refinement: Increase the number of trials for each height, from 4 to 5.	More trials will create a more accurate representation of the average range at the displacement.

Excerpt 2

REFINED BY

Table 2: Refinements

Limitations of the original experiment	Refinements
The lack of sample size increases the margin of error, affecting the reliability and precision.	Increasing the number of trials from 2 to 5. Random errors can be reduced and more reliable results can be produced.

Practices to strengthen

To further ensure accuracy and consistency of the application of the ISMG for this IA, it is recommended that:

- for the Research and planning criterion,
  - a *specific* research question explicitly states the relationship between an independent and dependent variable, with relevant controlled variables included where appropriate, to inform the rationale and lead to a justified conclusion
  - the impacts of risks associated with the investigation and their subsequent management are *considered* with regard to how the methodology is carried out
  - *justified* modifications to the methodology clearly state how each modification will improve the reliability and/or validity of the evidence.

Additional advice

- Teachers should review advice about how to determine provisional marks when applying the best-fit model to make decisions (see *Using ISMGs For General Science syllabuses* under Resources in the Syllabuses app on the QCAA Portal).
- Marked ISMGs should indicate the characteristics evident in the student response and the mark awarded for each criterion (*QCE and QCIA policy and procedures handbook v5.0*, Section 9.7.1).
- School internal quality assurance processes and/or communities of practice may allow a deeper understanding of judgments made using ISMGs.

Internal assessment 3 (IA3)

Research investigation (20%)

This assessment requires students to evaluate a claim. They will do this by researching, analysing and interpreting secondary evidence from scientific texts to form the basis for a justified conclusion about the claim. A research investigation uses research practices to assess a range of cognitions in a particular context. Research practices include locating and using information beyond students' own knowledge and the data they have been given.

Research conventions must be adhered to. This assessment occurs over an extended and defined period of time. Students may use class time and their own time to develop a response.

Assessment design

Validity

Validity in assessment design considers the extent to which an assessment item accurately measures what it is intended to measure and that the evidence of student learning collected from an assessment can be legitimately used for the purpose specified in the syllabus.

Reasons for non-endorsement by priority of assessment.

Validity priority	Number of times priority was identified in decisions*
Alignment	21
Authentication	13
Authenticity	1
Item construction	15
Scope and scale	14

*Each priority might contain up to four assessment practices.

Total number of submissions: 392.

Effective practices

Validity priorities were effectively demonstrated in assessment instruments that:

- featured claims that could generate multiple research questions relevant to Unit 4: Revolutions in modern physics (or AS Unit 2: Einstein's famous equation), e.g. 'the speed of light is the ultimate speed limit of the universe'
- contained a sufficient number of claims for the size of the cohort, so that students could formulate unique responses to the task.

Practices to strengthen

It is recommended that assessment instruments:

- include all syllabus task specifications in the task description (Syllabus section 5.6.1, AS section 3.6.1)
- include appropriate information in the scaffolding section to support the development of unique student responses, e.g. 'the sample research question cannot be used'.

Accessibility

Accessibility in assessment design ensures that no student or group of students is disadvantaged in their capacity to access an assessment.

Reasons for non-endorsement by priority of assessment

Accessibility priority	Number of times priority was identified in decisions*
Bias avoidance	0
Language	13
Layout	0
Transparency	0

*Each priority might contain up to four assessment practices.

Total number of submissions: 392.

Effective practices

Accessibility priorities were effectively demonstrated in assessment instruments that:

- showed an indication of the time available to students in the checkpoints (e.g. Week 4: Analyse and evaluate evidence) rather than specific dates
- included claims written using clear, succinct language and accurate spelling and grammar.

Practices to strengthen

It is recommended that assessment instruments:

- include each task specification as a unique dot point and not combined with another point (Syllabus section 5.6.1; AS section 3.6.1).

Additional advice

- Prior to including a claim in the task, teachers should verify the availability of adequate and pertinent evidence from secondary sources that students can access when preparing their response.

Assessment decisions

Reliability

Reliability is a judgment about the measurements of assessment. It refers to the extent to which the results of assessments are consistent, replicable and free from error.

Agreement trends between provisional and confirmed marks

Criterion number	Criterion name	Percentage agreement with provisional	Percentage less than provisional	Percentage greater than provisional	Percentage both less and greater than provisional
1	Research and planning	95.14%	3.84%	1.02%	0%
2	Analysis and interpretation	96.42%	3.07%	0.51%	0%

Criterion number	Criterion name	Percentage agreement with provisional	Percentage less than provisional	Percentage greater than provisional	Percentage both less and greater than provisional
3	Conclusion and evaluation	94.88%	4.86%	0%	0.26%
4	Communication	98.21%	0.51%	1.28%	0%

Effective practices

Accuracy and consistency of the application of the ISMG for this IA was most effective when:

- for the Analysis and interpretation criterion, *thorough* identification of *relevant* trends, patterns or relationships in the evidence were used to develop the *justified* scientific arguments
- for the Communication criterion, the *appropriate* use of genre conventions was consistent throughout the student response, e.g. in a report, it was evident through the consistent use of labels for diagrams and figures.

Samples of effective practices

The following excerpts demonstrate a specific and relevant research question that allows the student to develop an answer within the scale of the task and that relates directly to the subject matter, i.e. AS Unit 2: Einstein's famous equation and General syllabus Unit 4: Revolutions in modern physics.

Note: The characteristic/s identified may not be the only time the characteristic/s has occurred throughout a response.

Excerpt 1

Does Hydrogen-Boron[11] laser fusion have theoretical potential to create a chain reaction to produce unlimited energy?

Excerpt 2

1.1 Rationale

The first segment investigates **the minimum velocity required for a spaceship carrying one human being to reach the closest star to the Earth in one human lifetime.** Taking the weight of the heaviest human being to ever live, Jon Brower Minnoch (635kg), accounts for the weight of any human being - up to present day - to travel into space (Glenday, 2018). Also taking the weight of the heaviest spaceship, the International Space Station (~420,000kg), accounts for any spaceship – up to present day – to travel to Proxima Centauri (NASA, n.d.). The average human life expectancy in the world is 72.98 years old (macrotrends, 2022).

The second segment investigates **the laws of special relativity on a spaceship and any human being/s within the spaceship.** In terms of special relativity, the spaceship and person/s on the spaceship will undergo time dilation and length contraction (Art of Life, 2021).

1.2 Research Question

From the claim, the following research question was developed:

Aligning with the laws of special relativity, what is the minimum velocity required for a spaceship (420,000kg) carrying one human being (635kg) to reach Proxima Centauri in 72.98 years?

The following excerpts have been included to demonstrate insightful discussion of the quality of evidence by identifying how agreement between several sources strengthens the ability to make a valid conclusion, despite limitations inherent in some of the sources.

Note: The characteristic/s identified may not be the only time the characteristic/s has occurred throughout a response.

Excerpt 1

All three of the sources directly support each other, where the equilibrium model by Scheffer et al (2006) was supported by the data collected by UC San Diego (2023), which was further supported by the temperature measurements by NOAA (2023). As all 3 sources corroborated with each other, the evidence's reliability in answering the RQ is increased. Both source 1 and 3 are long term studies which use independent analysis and evaluation prior to publication, where statistically anomalous data is discarded, ensuring the data used is a reliable representation of global trends. As such, the reliability of the evidence in answering the RQ within their respective locations is high.

Excerpt 2

Reliability and Validity

The conclusion developed in this report is accurate based on the information collected and the assumptions made, however this information may not necessarily be correct. Because Star Wars is a fictional universe with many spin-offs and fandoms that have been created in the years since its release, it was difficult to find reliable sources. This meant that the majority of sources used were fandom websites which may not be correct. When trying to determine the velocities of the different hyperdrive classes, many contradicting sources were found. For instance, a fan page on VS Battles stated that Class 2 ships travelled ≈28.5 million times the speed of light (Blue, 2018), which was faster than the other velocities found for the Class 0.5 and 1 hyperdrives. The velocity calculations were based on the most accurate report, however this was found on a fan-page which reduces the reliability of the information. In this report, it was assumed that the space vessels moved very quickly, and that space-time did not fold and teleportation did not occur. Folding space-time refers to the act of overlaying two destinations at different locations in the universe so that no distance is actually travelled (Barr, 2015). Teleportation describes moving between locations using special technology to remove the factor of distance (Merriam-Webster, 2023). The types of spaceships used were collected from the movies, and care was taken to ensure the correct ships were identified, but this could not be verified with the limited resources available. In addition to this, the distances and velocities used were scaled down significantly to account for the known laws of physics, however there is no way to know if this understanding of physics is applicable in the Star Wars universe. The processes used to develop the conclusion were consistent and reasonable, meaning this report is accurate relative to the sources, however the sources may not be reliable.

Insightful discussion

Practices to strengthen

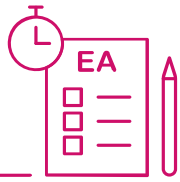
To further ensure accuracy and consistency of the application of the ISMG for this IA, it is recommended that:

- for the Research and planning criterion,
  - research questions are
    - *specific* to a particular aspect of the claim so a response may be developed within the response conditions of the syllabus
    - *relevant* to subject matter from Unit 4 (or AS Unit 2)
  - *sufficient* sources of evidence are used to ensure there is enough evidence to form *justified* scientific arguments
- for the Conclusion and evaluation criterion for the top performance level, *insightful* discussions of the quality of evidence make valid conclusions clearly linked to the limitations of evidence.

Additional advice

- Schools should review advice about how to determine provisional marks using the best-fit model (see *Using ISMGs For General Science syllabuses* under Resources in the Syllabuses app on the QCAA Portal). Further information about making judgments using an ISMG is also accessible in the Assessment Literacy app (*Module 3 — Making reliable judgments*).
- Strategies identified in the *QCE and QCIA policy and procedures handbook v5.0* (Section 8.2.6) should be administered to manage response length to ensure that student responses meet the conditions of the syllabus.

External assessment



External assessment (EA) is developed and marked by the QCAA. The external assessment for a subject is common to all schools and administered under the same conditions, at the same time, on the same day.

Examination (50%)

Assessment design

The assessment instrument was designed using the specifications, conditions and assessment objectives described in the summative external assessment section of the syllabus.
The examination consisted of two papers:

- Paper 1, Section 1 consisted of multiple choice questions (20 marks)
- Paper 1, Section 2 consisted of short response questions (26 marks)
- Paper 2, Section 1 consisted of short response questions (44 marks).

The examination assessed subject matter from Units 3 and 4. Questions were derived from the context of Gravity and motion, Electromagnetism, Special relativity, Quantum theory, and The Standard Model.

The assessment required students to respond to multiple choice and short response questions.

The AS assessment instrument was designed using the specifications, conditions and assessment objectives described in the summative external assessment section of the AS.
The AS examination consisted of two papers:

- Paper 1, Section 1 consisted of multiple choice questions (20 marks)
- Paper 1, Section 2 consisted of short response questions (24 marks)
- Paper 2, Section 1 consisted of short response questions (45 marks).

The AS examination assessed subject matter from AS Units 1 and 2. Questions were derived from the context of Linear motion and force, Gravity and motion, Special relativity, Ionising radiation and nuclear reactions, and The Standard Model.

The AS assessment required students to respond to multiple choice and short response questions.

Assessment decisions

Assessment decisions are made by markers by matching student responses to the external assessment marking guide (EAMG). The external assessment papers and the EAMG are published in the year after they are administered.

Multiple choice question responses

There were 20 multiple choice questions in Paper 1.

Percentage of student responses to each option

Note:

- The correct answer is **bold** and in a blue shaded table cell.
- Some students may not have responded to every question.

Physics General

Question	A	B	C	D
1*	2.07	12.14	**78.88**	6.72
2	**79.39**	9.91	6.05	4.47
3	**55.87**	24.43	11.15	8.17
4*	9.6	8.52	18.01	**63.62**
5	11.89	**67.61**	12.38	7.95
6*	24.63	**52.76**	13.56	8.42
7*	8.74	7.95	**77.95**	5.23
8	**41.34**	9.29	41.9	7.23
9	6.75	**67.85**	8.55	16.13
10	**48.42**	10.4	29.56	10.9
11	19.27	31.8	3.22	**45.5**
12*	**47.1**	12.89	31.94	7.82
13	14.53	**63**	18.22	3.96
14*	25.49	10.31	5.42	**58.57**
15*	9.22	**58.79**	20.9	10.91
16*	13.83	0.86	5.41	**79.79**
17*	16.53	3.45	**74.78**	5.06
18*	**65.54**	18.47	8.04	7.61
19	10.05	19.69	**58.92**	10.72
20	12.19	7.74	16.58	**63.21**

Physics AS

Question	A	B	C	D
1*	3.79	24.42	**59.79**	11.37
2	11.37	**82.11**	5.05	1.05
3	**83.37**	3.58	5.89	6.74
4*	13.26	11.37	19.58	**54.95**
5	6.11	21.89	**43.58**	27.79
6*	22.11	**45.89**	20.84	9.89
7*	16.63	10.32	**65.26**	7.37

8	16	**46.11**	23.16	13.47
9	5.89	5.05	8.63	**79.79**
10†	**34.95**	**27.37**	**22.95**	**12.63**
11	37.26	7.37	**39.79**	15.16
12*	**36.42**	14.95	36	12
13	**19.58**	19.16	26.11	33.89
14*	27.16	14.53	8.63	**49.26**
15*	14.32	**44.42**	29.47	10.95
16*	13.89	1.47	5.89	**77.89**
17*	22.11	4.84	**67.37**	5.26
18*	**58.53**	21.89	10.11	8.21
19	20.63	**45.89**	22.53	10.32
20	16.84	28.84	**44.42**	8.42

* Questions were common to both General and AS examinations.

† Subject matter that formed the basis for Question 10 in Paper 1 on the AS examination was identified as outside the scope of AS Unit 1 and Unit 2. The QCAA conducted a review of the question and all students were awarded 1 mark for this question.

Effective practices

Overall, students responded well when they:

- ensured they had completely solved the multiple choice problem before choosing an option that was a step in their solution
- were confident with the meaning of a range of cognitive verbs, e.g. 'describe' and 'discuss'
- appropriately used technology to effectively solve mathematical problems.

Samples of effective practices

Short response

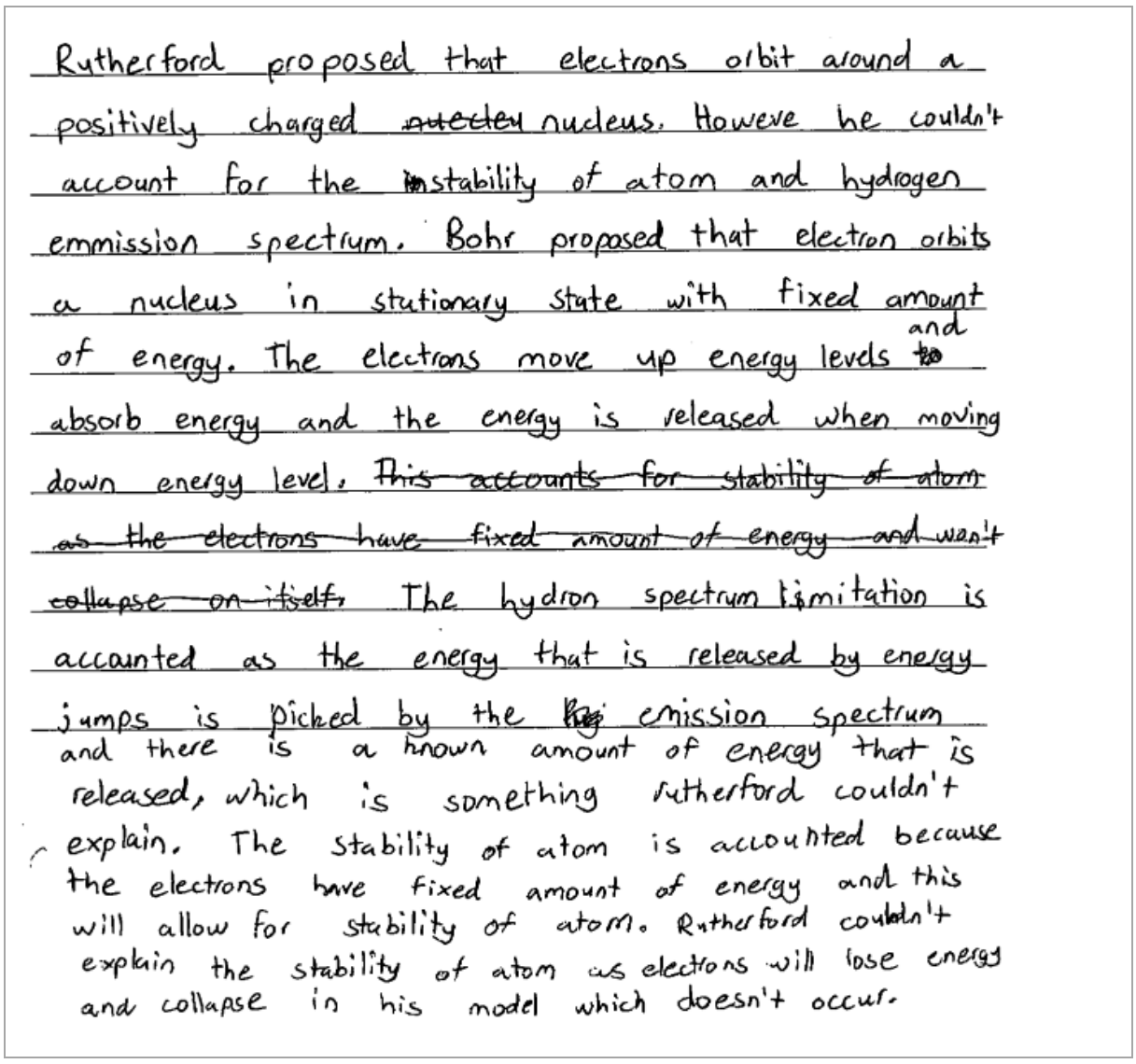
The following excerpt is from Question 21 in Paper 1 of both the Physics General and Physics AS examinations. It required students to describe how the atomic model proposed by Bohr addressed the limitation of Rutherford's model.

Effective student responses:

- gave an account of the key features of each model (Bohr and Rutherford)
- identified a limitation of Rutherford's model
- expressed the significance of the Bohr model that addressed the limitation.

This excerpt has been included:

- to demonstrate the description of the atomic models as it provides evidence of the significance of Bohr's model having quantised energy levels.



Rutherford proposed that electrons orbit around a positively charged ~~nucleus~~ nucleus. Howeve he couldn't account for the ~~in~~stability of atom and hydrogen emmission spectrum. Bohr proposed that electron orbits a nucleus in stationary state with fixed amount of energy. The electrons move up energy levels ~~to~~ and absorb energy and the energy is released when moving down energy level. ~~This accounts for stability of atom as the electrons have fixed amount of energy and won't collapse on itself.~~ The hydron spectrum ~~l~~limitation is accounted as the energy that is released by energy jumps is picked by the ~~Bo~~ emission spectrum and there is a known amount of energy that is released, which is something rutherford couldn't explain. The stability of atom is accounted because the electrons have fixed amount of energy and this will allow for stability of atom. Rutherford couldn't explain the stability of atom as electrons will lose energy and collapse in his model which doesn't occur.

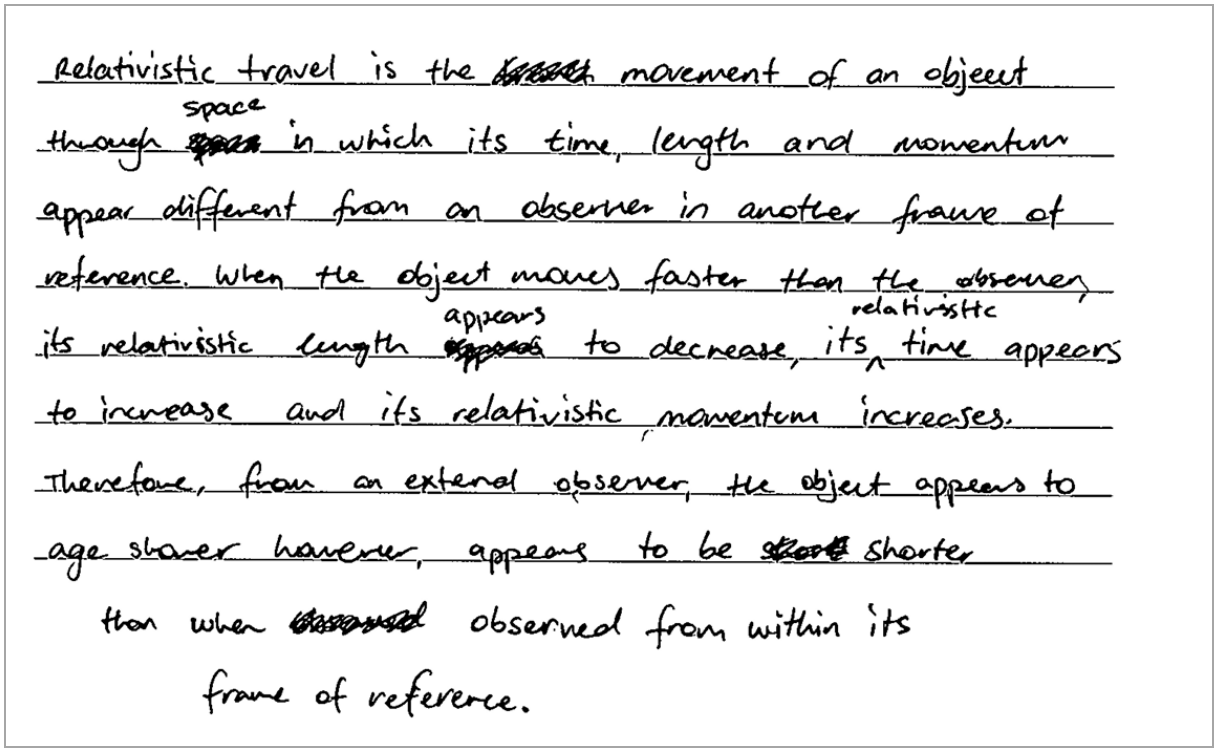
The following excerpt is from Question 1 in Paper 2 of both the Physics General and Physics AS examinations. It required students to describe the effects of relativistic travel on an object.

Effective student responses:

- identified the three characteristics of relativistic travel, i.e. time dilation, length contraction and relativistic momentum
- gave an account of each of these effects on the object that was experiencing time travel, e.g. objects travelling near the speed of light will experience time *slower* compared to an observer in a non-relativistic frame of reference.

This excerpt has been included:

- to demonstrate a response that describes the consequence of the relativistic travel on the object, rather than only identifying the features.


Relativistic travel is the movement of an object through space in which its time, length and momentum appear different from an observer in another frame of reference. When the object moves faster than the observer, its relativistic length appears to decrease, its relativistic time appears to increase and its relativistic momentum increases. Therefore, from an external observer, the object appears to age slower however, appears to be shorter than when observed from within its frame of reference.

The following excerpt is from Question 3b) in Paper 2 of both the Physics General and Physics AS examinations. It required students to determine a unit of distance between a series of charges in a straight line.

Note: Following administration of the examination, a minor error for this question was identified, with the net force arrow pointing in the wrong direction. All other information in the question was correct and was sufficient for students to arrive at the correct answer. The marking operation and marking guide were adjusted to ensure all students were marked validly and reliably. This included:

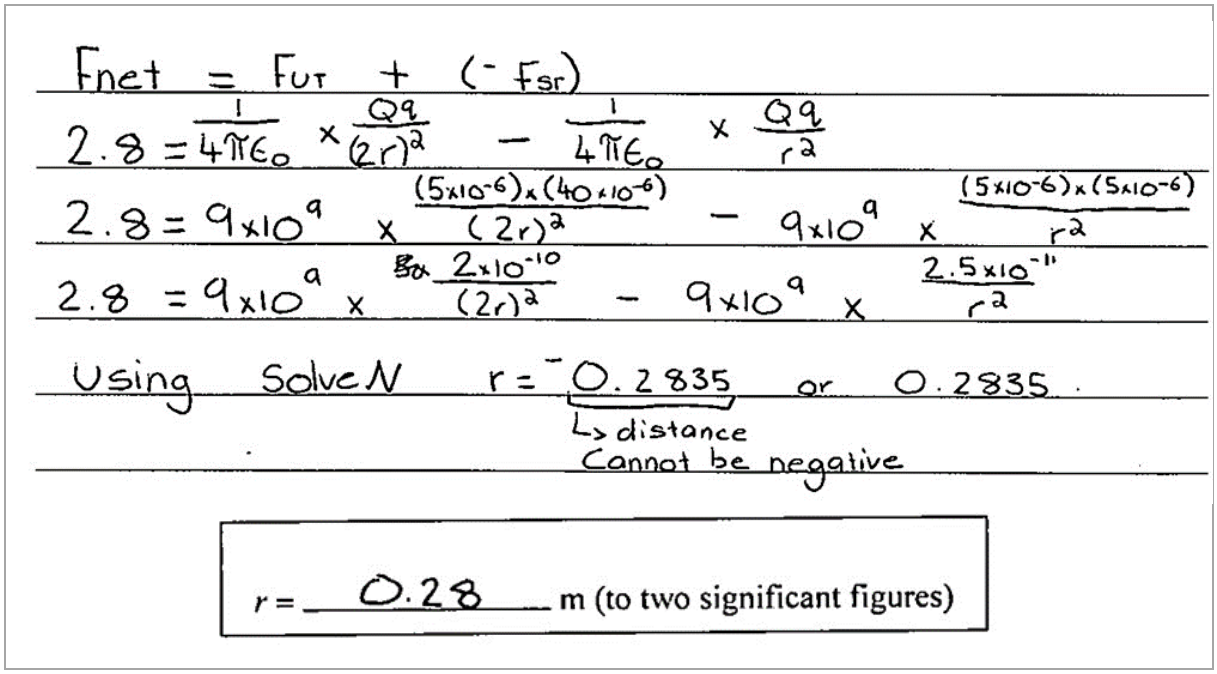
- additional quality assurance of the marking of this question by chief and lead markers, and further review by QCAA subject matter experts
- analysis of student performance across the examination by QCAA measurement experts
- endorsement of the adjusted marking processes and the student performance analysis by the QCAA Ratification Committee (which includes independent technical experts).

Effective student responses:

- recognised the correct formulas to apply when solving the question
- identified the relationship between force and distance between each pair of charges
- identified the correct vector relationship between the forces
- provided appropriate mathematical reasoning and correctly determined the unit value.

This excerpt has been included:

- to demonstrate a solution obtained using technology and correct understanding of the answer's magnitude.



The following excerpt is from Question 7 in Paper 2 of both the Physics General and Physics AS examinations. It required students to discuss the nature of light by describing evidence from two key experiments.

Effective student responses:

- identified the nature of light comes from two different experiments, e.g. Young's double slit experiment and the photoelectric effect/black-body radiation
- described evidence for the wave nature of light and evidence for photons from these experiments
- concluded that light has properties of both waves and particles.

This excerpt has been included:

- to demonstrate an effective way of discussing a concept by describing two different considerations and then forming a conclusion.

In Young's Double Slit Experiment, monochromatic light was shone through two slits producing a pattern of periodic light and dark stripes. Although particles would not produce this, this was consistent with the behaviour of mechanical transverse waves undergoing regular constructive/destructive interference. Also, in the photoelectric effect, light was shown to be quantised, as when shining light on a metal cathode, photoelectrons were only ejected if the light exceeded a threshold frequency with kinetic energy equal to the difference in the light's energy and the work function. This was not consistent with light as a wave, but was consistent with the expected behaviour of a quantised particle of light. These two experiments showed the nature of light could be considered as both a particle and a wave.

The following excerpt is from Question 5a) in AS Paper 2. It required students to calculate an object's displacement from a velocity–time graph.

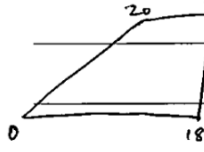
Effective student responses:

- identified a suitable mathematical strategy and showed relevant stages of working.

This excerpt has been included:

- to demonstrate calculation of displacement by determining the area under the slope on a velocity–time graph and reaching a numerical answer.

To find displacement, find the Area under graph between $t = 0$ and $t = 180$ s.



$a = 60$
$b = 180$
$h = 20$

$A = \frac{(a+b)}{2} h$

$= \frac{(60+180)}{2} \times 20$

$= 2400$ m

Displacement = 2400 m (to the nearest whole number)

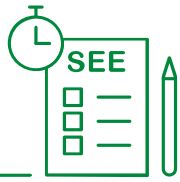
Practices to strengthen

When preparing students for external assessment, it is recommended that:

- calculations performed for multiple choice questions consider the units associated with each option to ensure the appropriate unit conversions are made
- when *describing* concepts,

  - teachers ensure students are giving an account of the characteristics and features (simply stating the phenomenon is not sufficient to receive full marks)
  - responses should be clear and succinct, as incorrect or contradictory information may result in a mark not being awarded
- opportunities for teaching and learning of the cognitive verb *discuss* be included, with responses including two different considerations and a conclusion
- attention to numeracy skills is considered as part of the teaching and learning of physics, for instance use of common denominators when adding/subtracting fractions or correctly squaring expressions within brackets, e.g. $(2r)^2 = 4r^2$.

Senior External Examination



The Physics Senior External Examination (SEE) is a standalone examination offered to eligible Year 12 students and adult learners. It contributes 100% to a student's final subject result.

Assessment design

The assessment was designed using the specifications, conditions and assessment objectives described in the summative external assessment section of the Physics Senior External Examination syllabus.

The SEE consisted of two assessments:

- SEE 1 contributed 50% of the marks
- SEE 2 contributed 50% of the marks.

Note: The SEE information should be read in conjunction with the rest of the subject report.

Number of students who completed the Physics Senior External Examination: 9.

There were insufficient student enrolments in this subject to provide useful analytics.

Assessment decisions

Effective practices

Overall, students responded well to:

- short response items when they justified their decisions by referring to data
- extended response items when they evaluated the experimental process by
  - identifying aspects of the process that could lead to an error
  - justifying how these aspects may have decreased the reliability/validity of the data.

This subject will no longer be offered after 2023.