Physics subject report

2022 cohort

February 2023

Queensland Government
QCAA
Queensland Curriculum & Assessment Authority

For all Queensland schools

ISBN

Electronic version: 978-1-74378-239-2

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Introduction

Throughout 2022, schools and the QCAA worked together to further consolidate the new Queensland Certificate of Education (QCE) system. The familiar challenges of flood disruption and pandemic restrictions were managed, and the system continued to mature regardless.

We have now accumulated three years of assessment information, and our growing experience of the new system is helping us to deliver more authentic learning experiences for students. An independent evaluation will commence in 2023 so that we can better understand how well the system is achieving its goals and, as required, make strategic improvements. The subject reports are a good example of what is available for the evaluators to use in their research.

This report analyses the summative assessment cycle for the past year — from endorsing internal assessment instruments to confirming internal assessment marks, and marking external assessment. It also gives readers 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, including those 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 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 General subjects (including alternative sequences (AS) and Senior External Examination (SEE) subjects, where relevant) and General (Extension) 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 data summary

Subject completion

The following data includes students who completed the General subject or AS.

Note: All data is correct as at 31 January 2023. Where percentages are provided, these are rounded to two decimal places and, therefore, may not add up to 100%.

Number of schools that offered the subject: 397.

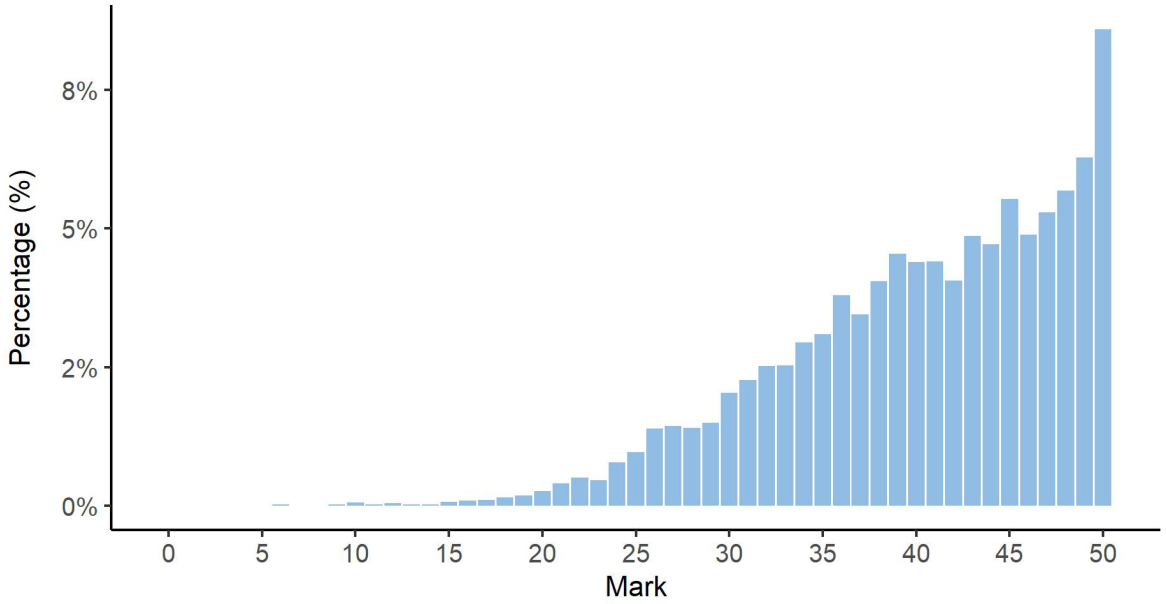
Completion of units	Unit 1	Unit 2	Units 3 and 4
Number of students completed	7447	7096	6429

Units 1 and 2 results

Number of students	Satisfactory	Unsatisfactory
Unit 1	7085	362
Unit 2	6604	492

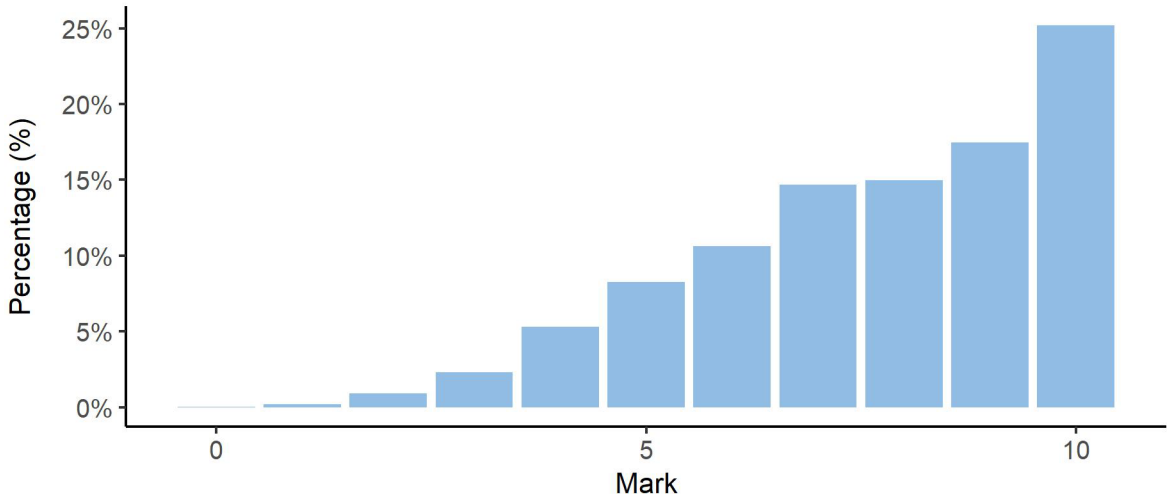
Units 3 and 4 internal assessment (IA) results

Total marks for IA

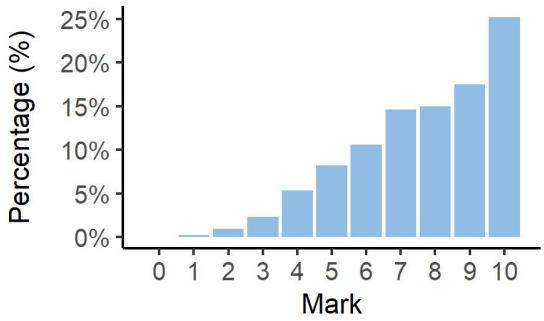


IA1 marks

IA1 total

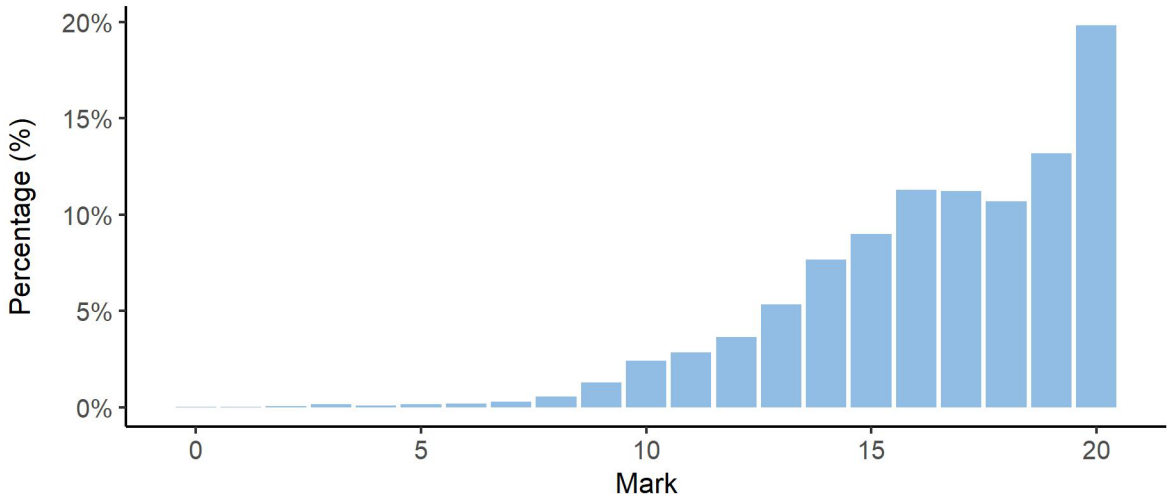


IA1 Criterion: Data test

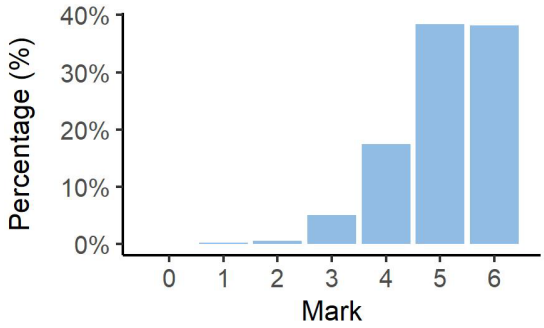


IA2 marks

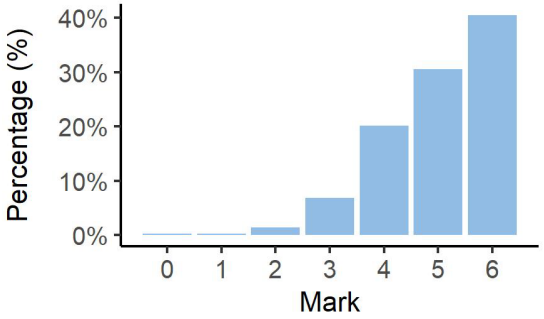
IA2 total



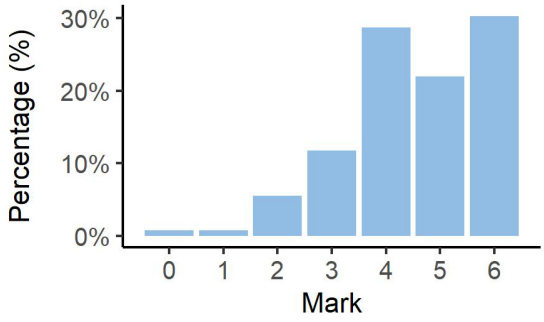
IA2 Criterion: Research and planning



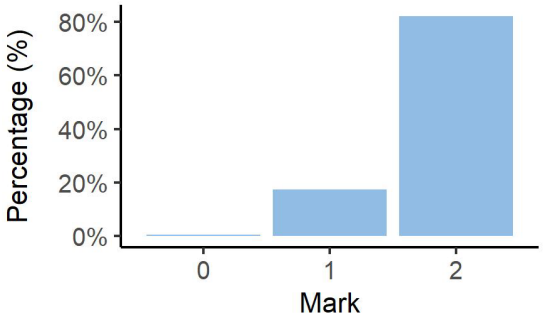
IA2 Criterion: Analysis of evidence



IA2 Criterion: Interpretation and evaluation

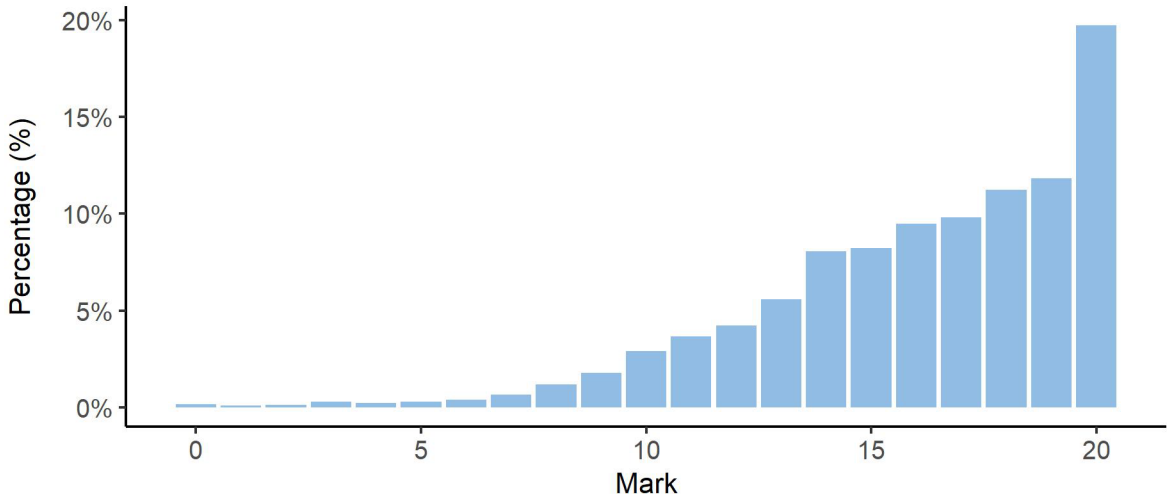


IA2 Criterion: Communication

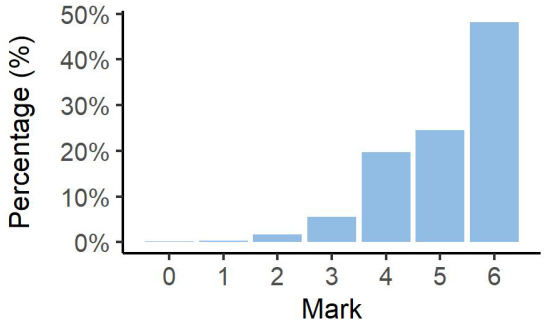


IA3 marks

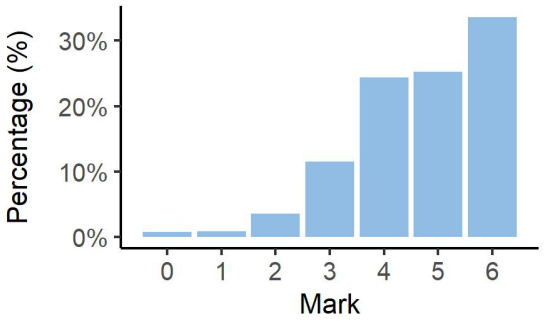
IA3 total



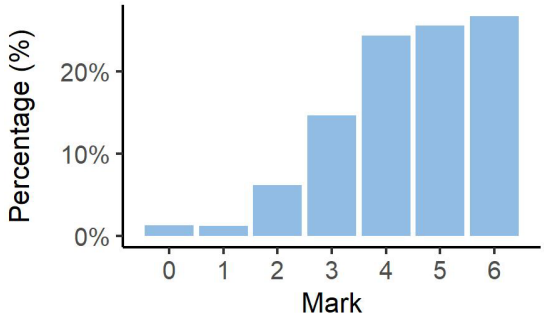
IA3 Criterion: Research and planning



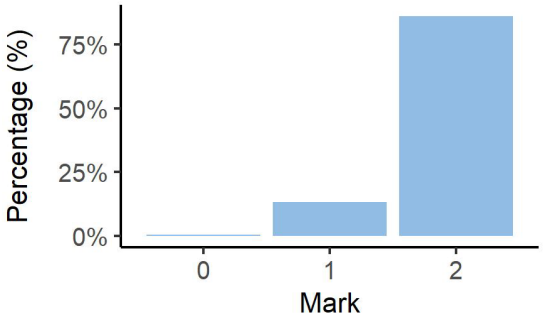
IA3 Criterion: Analysis and interpretation



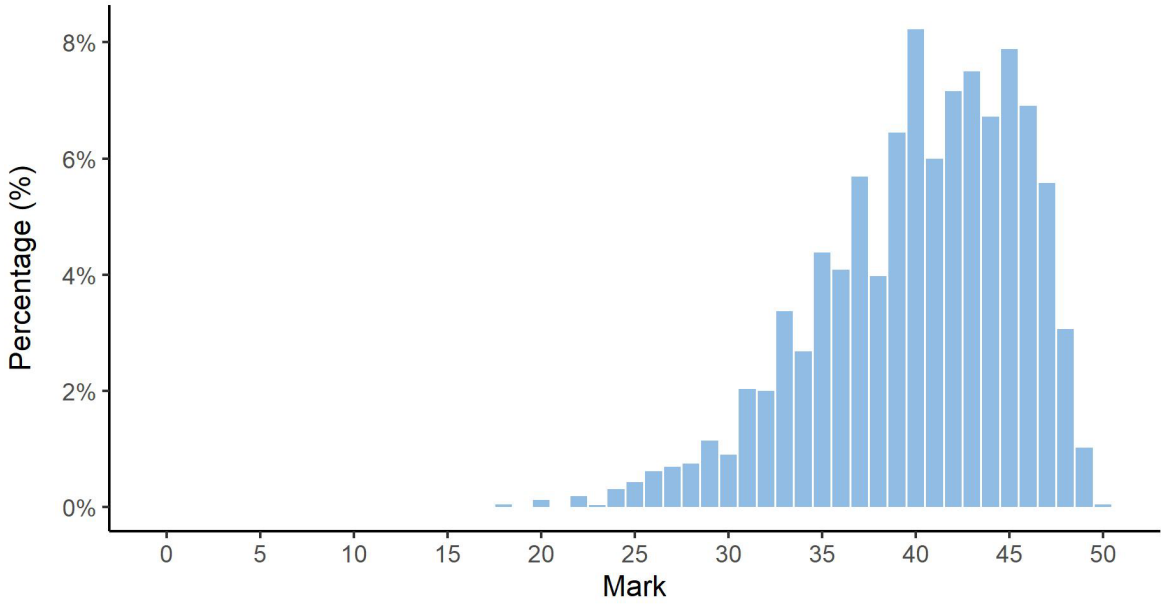
IA3 Criterion: Conclusion and evaluation



IA3 Criterion: Communication

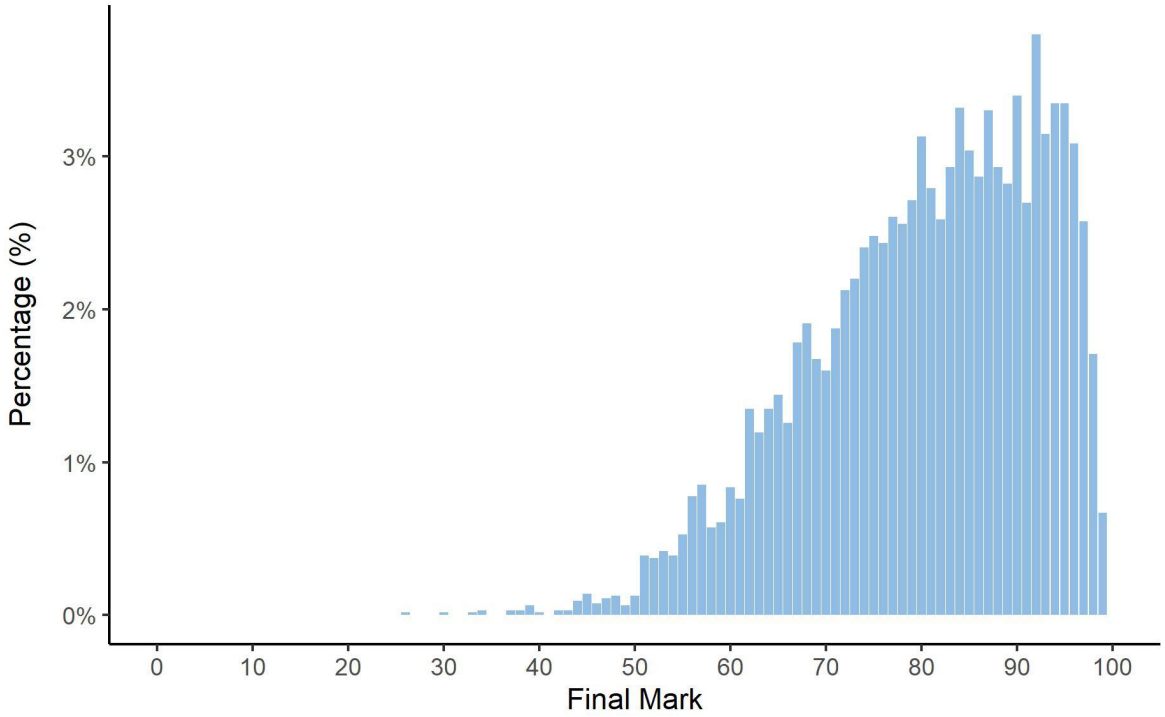


External assessment (EA) marks



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	100–86	85–71	70–49	48–19	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	2560	2519	1297	53	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 v4.0*, Section 9.5.

Percentage of instruments endorsed in Application 1

Number of instruments submitted	IA1	IA2	IA3
Total number of instruments	395	395	397
Percentage endorsed in Application 1	48%	83%	81%

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 v4.0*, Section 9.6.

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	395	2348	0	98.23%
2	394	2355	90	84.26%
3	393	2327	114	86.51%

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	132
Authentication	0
Authenticity	12
Item construction	29
Scope and scale	39

*Each priority might contain up to four assessment practices.

Total number of submissions: 395.

Effective practices

Validity priorities were effectively demonstrated in assessment instruments that:

- used datasets clearly drawn from the teaching and learning of Unit 3 subject matter, e.g. data from experiments used to determine the acceleration due to gravity
- contained only relevant data that students would need to respond to the given questions
- used separate questions to assess cognitions independently, e.g. ‘a) Identify the relationship between average range and projection angle’ and ‘b) Draw a conclusion about the effect of complementary angles on the horizontal range of the projectile’.

Practices to strengthen

It is recommended that assessment instruments:

- use the correct cognitions for each objective assessed, e.g. the cognitive verb 'calculate' needs to be placed with a question that assesses the apply understanding objective, refer to the Mark allocation table (General Syllabus section 4.5.1, Alternative Sequence section 4.6.1)
- show stimulus in the datasets that correlates to the question and expected response, e.g. if a question refers to 'Graph 2', ensure there is a Graph 2 clearly labelled in the dataset
- feature questions that require students to respond to quantitative or qualitative data in the dataset.

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	21
Language	50
Layout	15
Transparency	45

*Each priority might contain up to four assessment practices.

Total number of submissions: 395.

Effective practices

Accessibility priorities were effectively demonstrated in assessment instruments that:

- contained a succinct commentary accompanying each dataset that avoided unnecessary details or complexity
- were formatted using the page break tool in the Endorsement application to ensure datasets, figure labels, questions and response space are not separated across pages
- used appropriate communication conventions, including use of bolding only where relevant.

Practices to strengthen

It is recommended that assessment instruments:

- are checked for common spelling and grammatical errors within questions and datasets, e.g. 'decent' instead of 'descent', 'sum of mass' instead of 'sum of masses'
- provide question cues that are succinct and clearly prompt the requirements of the student response, e.g. 'Justify your response'
- are developed using the print preview function in the Endorsement application to ensure that the layout of the task and the response spaces are appropriate (see *Developing summative internal assessment instruments — Endorsement user guide*, pp. 20–25).

Additional advice

- Marking schemes should clearly demonstrate the scope and scale of the expected student response for each question, including the allocation of each mark to be awarded.

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	98.23%	0.76%	0.76%	0.25%

Effective practices

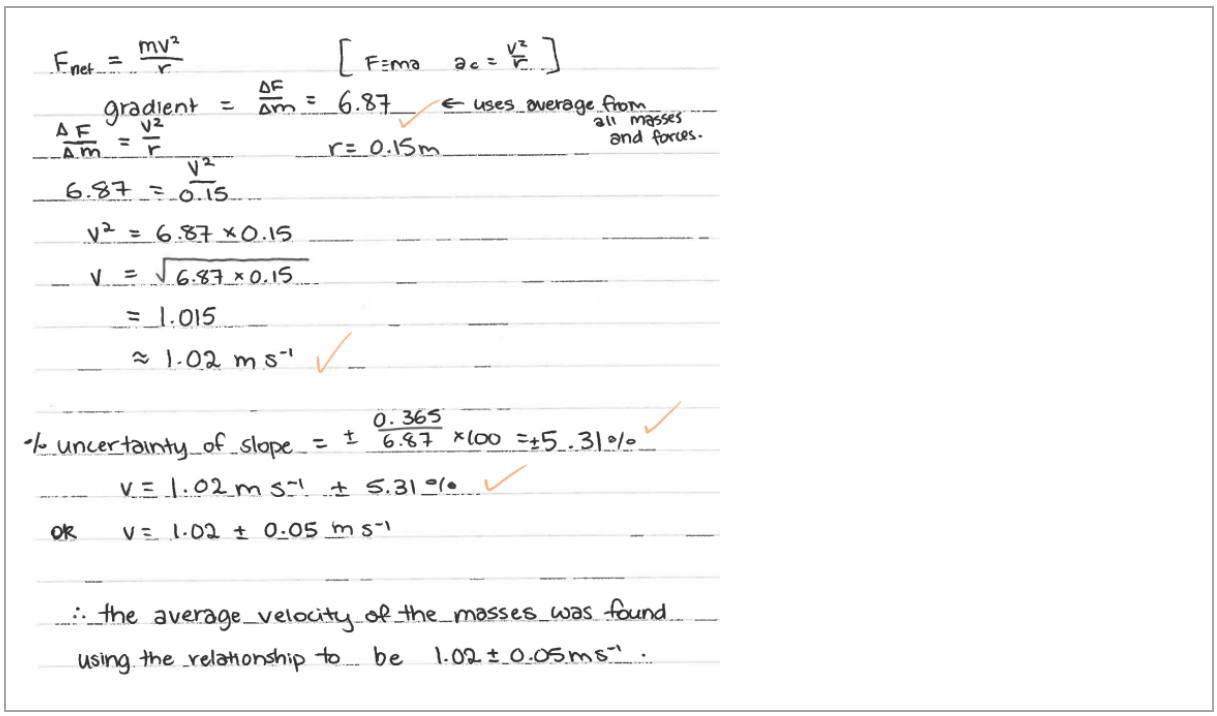
Accuracy and consistency of the application of the ISMG for this IA was most effective when:

- marking schemes were correct and showed the full breakdown of mark allocations awarded to questions to support consistent and accurate intra- and inter-marker decision-making
- student responses were clearly annotated to indicate how they were marked against the marking scheme (*QCE and QCIA policy and procedures handbook v4.0*, Section 9.6.1)
- percentage cut-offs were used appropriately to determine marks (Making judgments webinar).

Samples of effective practices

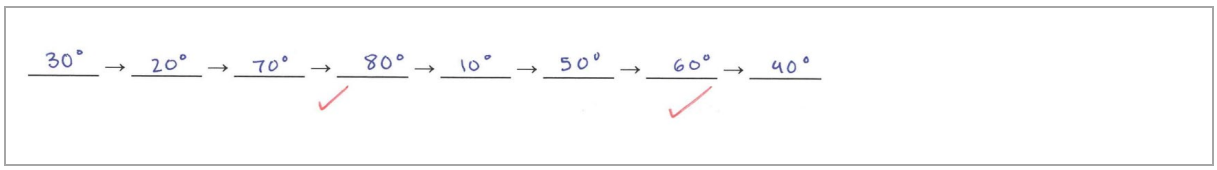
The following excerpt demonstrates suitable annotations, matching aspects of the marking guide, on a student response to an objective 4 item that requires determination of the velocity of a mass using data from a graph.

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



The following excerpt demonstrates suitable annotations, matching aspects of the marking guide, on a student response to an objective 3 item that requires sequencing of data based on the reliability of measurements.

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:

- marking guides are updated at confirmation to ensure errors are corrected and alternative student responses are captured for quality assurance processes.

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	32
Authentication	9
Authenticity	4
Item construction	18
Scope and scale	0

*Each priority might contain up to four assessment practices.

Total number of submissions: 395.

Effective practices

Validity priorities were effectively demonstrated in assessment instruments that:

- contained clear communication of the genre to be used, e.g. scientific report or multimodal presentation
- provided an opportunity for students to choose from a range of practicals derived from the teaching and learning of Unit 3 as the basis for their methodology and research question
- featured checkpoints to monitor student progress through the task, e.g. select modifications, complete risk assessment, collect and analyse data, submit draft, submit final response.

Practices to strengthen

It is recommended that assessment instruments:

- include all the specifications for the assessment task listed in the syllabus (General Syllabus section 4.5.2, Alternative Sequence section 4.6.2)
- ensure stages of the task that may be completed in groups are clearly identified, e.g. 'Develop a research question to be investigated*'
- ensure that examples provided in scaffolding cannot be used by students as a basis for their enquiry.

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	7
Layout	2
Transparency	6

*Each priority might contain up to four assessment practices.

Total number of submissions: 395.

Effective practices

Accessibility priorities were effectively demonstrated in assessment instruments that:

- included clear communication of task elements, using succinct language and accurate spelling and grammar
- contained clear communication of the genre to be used, e.g. scientific report or multimodal presentation
- avoided leading students to a predetermined response by providing appropriate scaffolding to support development of the research question.

Practices to strengthen

There were no significant issues identified for improvement.

Additional advice

- In the authentication strategies, schools should
  - clearly outline strategies that are appropriate to their context, e.g. interviews with students, written or oral feedback, observation of students during class work
  - clearly indicate that feedback will be provided on one draft only.
- In the scaffolding, schools should provide an indication of the time available to students (e.g. Week 4: Submission of complete draft for feedback) rather than specific dates.

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	90.86%	6.85%	1.78%	0.51%
2	Analysis of evidence	90.36%	7.61%	1.78%	0.25%
3	Interpretation and evaluation	92.13%	6.09%	1.78%	0%
4	Communication	98.73%	0.25%	1.02%	0%

Effective practices

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

- in the Analysis of evidence criterion, *sufficient* raw data was collected to allow *thorough* identification of trends, patterns and relationships, and uncertainties in the data
- in the Interpretation and evaluation criterion
  - discussions of validity and reliability were *justified* by referring to data, systematic and random errors in datasets and, where appropriate, accepted values for constants
  - improvements and extensions to an experiment were *logically* derived from analysis of experimental evidence by referring to a *thorough* identification of uncertainty and limitations of the evidence
- in the Communication criterion
  - *appropriate* genre conventions (e.g. the use of passive voice) were demonstrated consistently through the report
  - *appropriate* referencing conventions were used consistently to acknowledge sources of information and maintain academic integrity.

Samples of effective practices

The following excerpt demonstrates considered management of risks and ethical or environmental issues.

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

1) 1.4 Management of Risks:

The overall experiment was given a low-medium risk due to several safety hazards. An over-heating power supply may cause melting to outer-plastic and can shut-down – affecting connected outlets to the supply(Hill 2021). Consequently, the power-supply was shut off every 2-minutes and was placed over a heat-resistant mat to eliminate heat-transfer and to allow a risk-free 8V supply. Furthermore, many power-cables were connected to walls, computers, and other equipment throughout the procedure, hence a safety hazard for a potential "*trips and falls*" in the laboratory-safety-procedure section(Safety, 2013). Thereby, chairs were placed over all wires – to caution to anyone in near premises. Finally, gloves and sanitization of equipment were also utilized for COVID-19 regulations to prevent cross-contamination.

The following excerpt demonstrates collection of sufficient and relevant raw data.

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

Results – Tables: collection of sufficient and relevant raw data

Velocity (±0.001m/s)	Displacement (±0.0005m) Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Mean Displacement	Absolute Uncertainty (±m)
4.8258	2.412*	2.431	2.434	2.434	2.434	2.43325	0.0015
5.1642	2.784	2.78	2.771	2.788	2.789	2.7824	0.009
5.4432	3.083	3.098	3.1	3.086	3.099	3.0932	0.0085
5.8098	3.513	3.521	3.504	3.524	3.521	3.5166	0.01
6.0198	3.782	3.792	3.792	3.772	3.753*	3.7845	0.01

Table 3. Raw Data Table
**used to denote anomalies*

The following excerpt demonstrates suggested improvements and extensions to the experiment that are logically derived from the analysis of evidence.

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

Evaluation and Improvements: justified discussion logically derived

Limitations of Evidence	Effects of Limitations	Improvements
Projectile launcher would sometimes move between trials.	This affected the reliability of the experiment because this meant the initial horizontal displacement would be inconsistent between trials. This random error is likely the cause of the absolute and percentage uncertainties like ±0.32% in the 5.16m/s trials (Table 4).	Fixating the launcher with screws would prevent the launcher from moving between trials. This would reduce random error and consequently increase the precision of the data.

Practices to strengthen

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

- in the Research and planning criterion
  - a *considered* rationale
    - documents the development of the research question from the original experiment
    - links the research question to the justification of modifications

- the impacts of risks associated with the investigation and their subsequent management are *considered* with regard to how the methodology is carried out.

Additional advice

- Teachers should provide students with opportunities to engage with a variety of inquiry skills and analytical process (e.g. collect, process, analyse, interpret and evaluate data) as part of their ongoing teaching and learning to enable student success.
- Marked ISMGs must clearly indicate the characteristics evident in the student response and the mark awarded for each criterion (*QCE and QCIA policies and procedures handbook v4.0*, Section 9.6.3).
- Schools should review advice about how to determine provisional marks when applying the best-fit model to decisions about marks awarded on the ISMG (Making judgments webinar).

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	29
Authentication	15
Authenticity	1
Item construction	16
Scope and scale	8

*Each priority might contain up to four assessment practices.

Total number of submissions: 397.

Effective practices

Validity priorities were effectively demonstrated in assessment instruments that:

- contained enough claims to allow students to develop unique responses to the task
- provided scaffolding that directed students to address all components of the task
- featured claims that could be used to develop multiple specific and relevant research questions, e.g. 'Interstellar travel is impossible as the travel time is beyond that of a human lifespan'.

Practices to strengthen

It is recommended that assessment instruments:

- contain claims that are clearly derived from Unit 4 subject matter, e.g. 'Astronauts on the International Space Station age more slowly than people on Earth'
- feature all the task specifications in the task description (General Syllabus section 5.6.1 and Alternative Sequence section 5.5.1)
- present claims as assertions, i.e. statements without accompanying evidence.

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	10
Layout	7
Transparency	29

*Each priority might contain up to four assessment practices.

Total number of submissions: 397.

Effective practices

Accessibility priorities were effectively demonstrated in assessment instruments that:

- modelled accurate spelling, grammar, punctuation and other textual features
- contained instructions that avoid specialist language or jargon outside the scope of the syllabus.

Practices to strengthen

It is recommended that assessment instruments:

- provide clear instructions using cues that align to the specifications, objectives and ISMG.

Additional advice

- In the authentication strategies, schools should
  - clearly outline strategies that are appropriate to their context, e.g. interviews with students, written or oral feedback, observation of students during class work
  - clearly indicate that feedback will be provided on one draft only.
- In the scaffolding, schools should provide an indication of the time available to students (e.g. Week 4: Submission of complete draft for feedback) rather than specific dates.

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	93.64%	5.09%	1.27%	0%
2	Analysis and interpretation	92.37%	6.11%	1.53%	0%
3	Conclusion and evaluation	91.09%	8.14%	0.51%	0.25%
4	Communication	98.22%	0.25%	1.53%	0%

Effective practices

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

- in the Research and planning criterion
  - a *considered* rationale demonstrated an understanding of subject matter from Unit 4 and applied this to the development of the research question from the claim
  - *relevant* sources were identified from a variety of scientifically credible outlets and not limited to peer-reviewed journal articles
- in the Analysis and interpretation criterion, the trends, patterns and relationships identified in the evidence were used to *justify* the scientific arguments presented.

Samples of effective practices

The following excerpt demonstrates a considered rationale identifying clear development of the research question from the claim.

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

Rationale

Particle accelerators, invented in 1930, play an important role in particle and nuclear physics. Using electric and magnetic fields, they produce beams of high-speed, charged atomic or subatomic particles (CERN, n.d.). The world's largest and most powerful particle accelerator is the Large Hadron Collider (LHC) at CERN in Switzerland, however there are numerous accelerators with diverse uses worldwide (Dutfield, 2022). The claim to be investigated in this report is that "particle accelerators are an expensive and unnecessary technology, without any real-world application." Particle accelerators are a very expensive technology- the LHC cost an estimated $4.75 billion to construct, not including operation and maintenance costs (Knapp, 2012). However, they have numerous applications including research, medicine, industrial processes, and security (Dotson, 2014). Therefore, the claim "without any real-world application" can be argued against, thus it was decided to investigate the necessity of particle accelerators in different applications. The most notable achievement of the LHC was the discovery of the Higgs Boson in 2012 (Castelvecchi, 2021). However, the existence of this particle had been theorised for almost 50 years prior to its discovery, so why was the LHC given so much credit in 2012? To further investigate, the following research question was posed: To what extent were particle accelerators a necessary technology for the discovery and confirmation of the Higgs Boson?

The following excerpts demonstrate a thorough identification of relevant trends, patterns or relationships leading to a justified scientific argument concerning the effects of time dilation and a conclusion that is justified by linking this evidence to the research question.

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

Excerpt 1

The study found that Scott's telomeres lengthened in space, indicating a 'reverse aging' process. However, upon re-entry to Earth, his telomeres shortened back with a higher number of "signal-free chromosome ends" than before flight (Garrat-Bakelman et al., 2019). This is predicted to have a long-term consequence of "accelerated aging or associated age-related pathologies" (Wanjek, 2019). Telomeres are regarded as a "robust biomarker of aging" and are key markers for disease (Garrat-Bakelman et al., 2019). Through cell division, telomeres shorten until reaching the Hayflick limit, initiating cells apoptosis. When telomeres become too short, they can no longer protect chromosomal DNA from degradation and the chromosome begins folding, increasing DNA mutations (Bartlett, 2014). Therefore, while Mark's theoretically an additional five milliseconds older than Scott from the travel, biologically Scott's shortened telomere lengths indicate higher aging and pathological risk (Wall, 2016).

Excerpt 2

It has been accepted that Einstein's theory of special relativity is true and a travelling twin should age slower than a sedentary twin from the Earth's reference frame. The results from the Kelly Twin Investigation did not model this statement, but Nwanaji-Enwerem et al.'s findings predict the Kelly Twin's converse results are a result of radiation, microgravity, and the small-time dilation difference of five milliseconds. Nwanaji-Enwerem et al. demonstrated slowed aging could be observed in the decreased epigenetic marker, PhenoAge. However, this justification and link between studies requires further investigation to prove true; with current research, there is conflicting evidence about the validity of Einstein's claim.

Practices to strengthen

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

- in the Conclusion and evaluation criterion, *justified* conclusions discuss how the trends, patterns and relationships identified in the analysis of evidence link back to the research question.

Additional advice

- Teachers should guide students through the research investigation to support the development of a research question that allows successful completion of the task within the scope of Unit 4 (IA3 effective processes and practices resource).
- Marked ISMGs must clearly indicate the characteristics evident in the student response and the mark awarded for each criterion (*QCE and QCIA policies and procedures handbook v4.0*, Section 9.6.3).
- Schools should review advice about how to determine provisional marks when applying the best-fit model to decisions about marks awarded on the ISMG (Making judgments webinar).

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 (28 marks)
- Paper 2, Section 1 consisted of short response questions (50 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 (35 marks)
- Paper 2, Section 1 consisted of short response questions (46 marks).

The AS examination assessed subject matter from AS units 3 and 4. Questions were derived from the context of Heating processes, Waves, Electrical circuits, Electromagnetism and Quantum theory.

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	64.44	**25.14**	6.96	3.21
2	18.32	8.66	**63.1**	9.62
3	**52.23**	37.61	7.66	2.33
4	13.87	**66.88**	13.02	5.63
5	3.33	**85.35**	6.39	4.71
6	**86.95**	2.33	5.98	4.55
7	4.41	5.98	**79.75**	9.56
8	6.26	21.35	**63.12**	8.23
9	39.98	**57.79**	1.2	0.8
10	**72.91**	7.44	9.16	10.19
11	8.56	12.75	33.17	**45.17**
12	**83.62**	8.51	3.91	3.58
13	7.54	22.79	**28.62**	39.81
14	4.16	22.71	**63.75**	9.06
15	41.21	13.85	16	**28.55**
16	11.87	4.43	10.42	**72.83**
17	**45.62**	20.95	14.54	18.17
18	8.06	**48.57**	28.87	14.19
19	7.93	12.94	6.94	**71.83**
20	11.97	15.37	24.14	**48.12**

Physics Alternative Sequence

Question	A	B	C	D
1	66.21	**17.17**	11.72	4.09
2	25.61	13.62	**48.77**	11.72
3	**35.15**	7.36	3.54	53.41
4	17.98	31.34	24.52	**23.98**
5	10.63	**81.47**	6.27	1.63
6	**75.48**	5.72	10.08	8.72
7	6.54	10.35	**70.03**	12.81
8	16.35	32.7	**37.87**	10.9
9	8.72	9.54	47.14	**34.6**
10	**62.67**	13.62	12.81	10.63
11	16.89	17.44	36.51	**29.16**
12	6.27	5.18	**43.32**	45.23
13	8.72	32.43	**31.88**	24.25
14	54.22	11.17	**31.34**	2.72
15	**63.49**	6.54	19.07	10.9
16	15.53	**41.42**	21.25	21.25
17	**21.25**	24.25	24.25	29.7
18	17.44	**43.6**	24.8	13.9
19	10.9	16.89	13.62	**58.58**
20	14.71	**56.13**	13.62	15.53

Effective practices

Overall, students responded well to:

- opportunities to describe their understanding of familiar scenarios, e.g. describing particle interactions in known Feynman diagrams
- opportunities to demonstrate their understanding and application of circular and projectile motion
- short response items requiring them calculate a numerical value from one or two steps.

Samples of effective practices

Short response

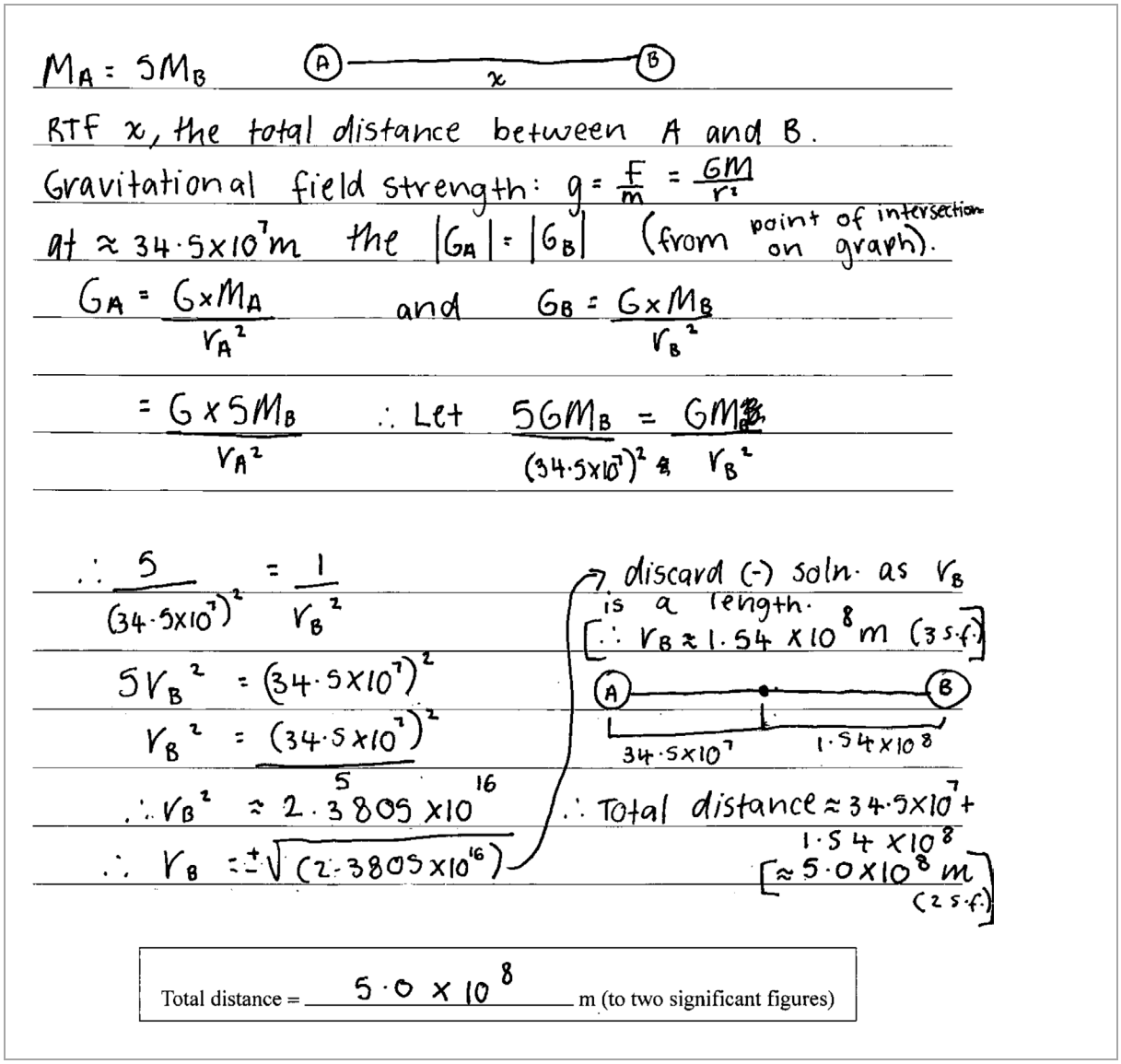
The following excerpt is from Question 27 from Paper 1 (General). It required students to determine the distance between two objects experiencing a gravitational force between them through analysis of graphical data.

Effective student responses:

- recognised the scenario related to gravitational field strength
- identified the distance on the graph where net gravitational field strength was zero
- constructed an equation to solve for the distance between the two objects
- provided appropriate mathematical reasoning
- determined the distance between the two objects.

This excerpt has been included:

- to demonstrate analysis of graphical data to identify the position where the net gravitational field strength was zero.



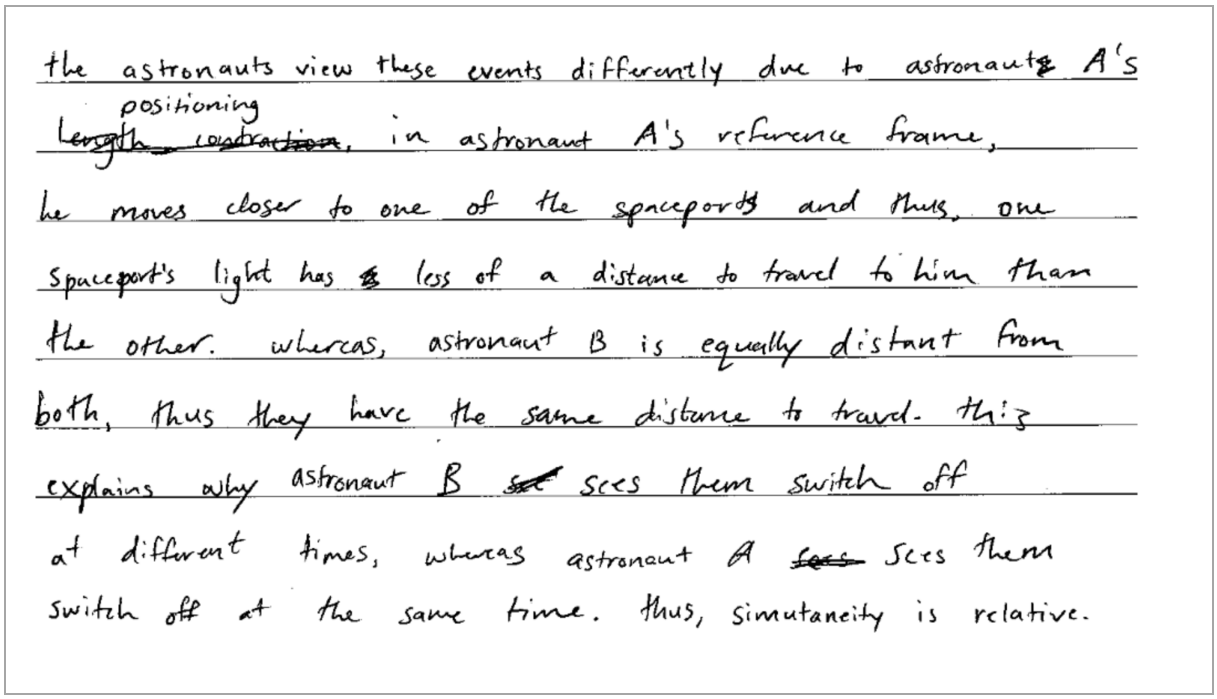
The following excerpt is from Question 1 from Paper 2 (General). It required students to explain a scenario relating to simultaneity experienced by two astronaut observers.

Effective student responses:

- explained simultaneity from the perspective of astronaut A
- explained the loss of simultaneity for astronaut B.

This excerpt has been included:

- to demonstrate an explanation of simultaneity using the context of the scenario.



the astronauts view these events differently due to astronaut A's positioning. Length ~~contraction~~, in astronaut A's reference frame, he moves closer to one of the spaceports and thus, one spaceport's light has less of a distance to travel to him than the other. whereas, astronaut B is equally distant from both, thus they have the same distance to travel. this explains why astronaut B ~~see~~ sees them switch off at different times, whereas astronaut A ~~sees~~ sees them switch off at the same time. thus, simultaneity is relative.

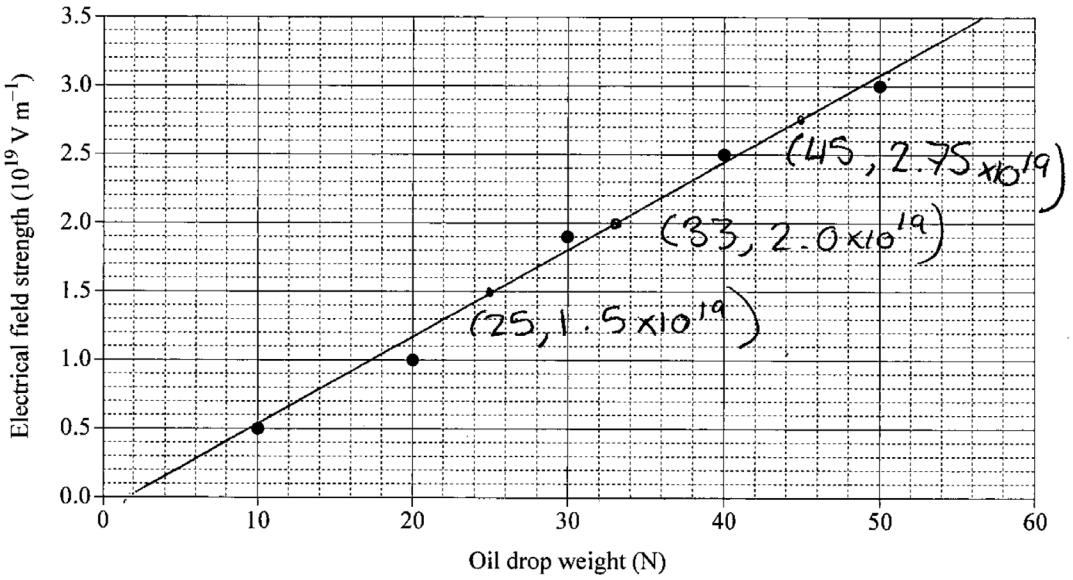
The following excerpt is from Question 3a from Paper 2 (General and Alternative Sequence). It required students to determine the average charge on an oil drop through analysis of graphical data.

Effective student responses:

- recognised the scenario related to electric field strength and electron charge
- provided appropriate mathematical reasoning
- determined the gradient of the slope of a line of best fit for the data
- determined the average charge on the oil drops.

This excerpt has been included:

- to demonstrate mathematical reasoning using an appropriate line of best fit.



$E \propto F \rightarrow E = \frac{F}{q}$

$\therefore$ gradient $= \frac{1}{q}$

gradient $= \frac{y_2 - y_1}{x_2 - x_1}$

$\frac{1}{q} = \frac{2.75 \times 10^{19} - 1.5 \times 10^{19}}{45 - 25}$

$\frac{1}{q} = 6.25 \times 10^{17}$

$\therefore q = 1.6 \times 10^{-18}$ C

Average charge = 1.6×10^{-18} C (to two significant figures)

Practices to strengthen

It is recommended that when preparing students for external assessment, teachers consider:

- reminding students that a line of best fit should match the data provided and not necessarily be assumed to pass through the origin
- encouraging students to provide explanations that consider the context of the scenario and go beyond a simple restatement of concepts
- exposing students to questions that require them to make connections between different syllabus topics and units
- exposing students to multiple choice questions with options that contain variations on the exact wording of the definitions in the syllabus glossary.

Additional advice

- Schools should prepare students to use perusal time to review all pages of the examination booklet to ensure no questions are missed.

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:

- opportunities to demonstrate their understanding and application of the photoelectric effect
- extended response questions.

Practices to strengthen

It is recommended that when preparing students for the Senior External Examination, teachers consider:

- teaching students how to use evidence to evaluate experimental processes and claims
- providing opportunities for students to practise identifying relationships within graphical data.