QCAA

Queensland Curriculum and Assessment Authority

Mathematical Methods 2019 v1.2

IA1: Sample assessment instrument

This sample has been compiled by the QCAA to assist and support teachers in planning and developing assessment instruments for individual school settings.

Student name

Student number

Teacher

Issued

Due date

Marking summary

Criterion	Marks allocated	Provisional marks
Formulate	4	
Solve	7	
Evaluate and verify	5	
Communicate	4	
Overall	**20**	

Conditions

Technique	Extended response — Problem-solving and modelling task
Unit	Unit 3: Further calculus
Topic/s	Topic 2: Further differentiation and applications 2 Topic 3: Integrals
Duration	4 weeks (including 3 hours of class time)
Mode/length	Written: Up to 10 pages (including tables, figures and diagrams) and a maximum of 2000 words
Individual/group	A unique response must be developed by each student
Other	Use of technology is required and must go beyond simple computation or word processing
Resources	The technology used can include scientific calculator, graphics calculator (CAS or non-CAS), spreadsheet program and/or other mathematical software

Context

Sprint races (100 m, 200 m, and 400 m) are among the most prestigious of Olympic events. Thus, there is considerable effort put into training and strategising to maximise performance. In this task you will create mathematical models of an elite sprinter's race with the aim of identifying the most effective area of improvement for the athlete to focus on.

Task

You will formulate at least two mathematical models to describe the sprint of an elite sprinter in a 100 m, 200 m or 400 m sprint race. You should use non-polynomial models. From these models, you will select the best one and analyse it to make recommendations as to how the sprinter could improve their time.

The World Athletics website (https://worldathletics.org/about-iaaf/documents/research-centre) contains split times from a number of athletics world championships. You may use this, or another source approved by your teacher, upon which to base your model.

To complete this task, you must

- respond with a range of understanding and skills, such as using mathematical language, appropriate calculations, tables of data, graphs and diagrams
- provide a response to the context that highlights the real-life application of mathematics
- respond using a written report format that can be read and interpreted independently of the instrument task sheet
- develop a unique response.

Checkpoints

☐ One week after issue date: Students email evidence of their progress to their teacher.

☐ Two weeks after issue date: Students email a draft for feedback. General feedback on drafts is provided to the class, but no individual corrections are made

☐ Three weeks after issue date: Students email evidence of their progress to their teacher.

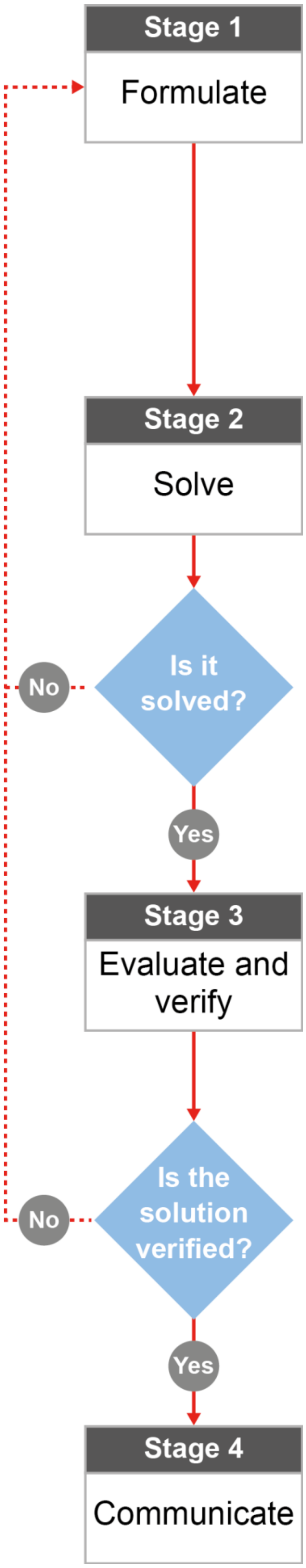
☐ Four weeks after issue date: Students submit their final response.

Authentication strategies

- The teacher will provide class time for task completion.
- Students will each produce a unique response by using individualised data and producing a unique report.
- Students will provide documentation of their progress at indicated checkpoints.
- The teacher will collect copies of the student response and monitor at key junctures.
- Students will use plagiarism-detection software at submission of the response.
- Students must acknowledge all sources.
- The teacher will ensure class cross-marking occurs.

Scaffolding

The approach to problem-solving and mathematical modelling must be used.



Design a plan to translate the problem into a mathematically purposeful representation by first determining the applicable mathematical and/or statistical principles, concepts, techniques and technology that are required to solve the problem. Identify and document appropriate assumptions, variables and observations, based on the logic of the proposed models.

In mathematical modelling, formulating a model involves the process of mathematisation — moving from the real world to the mathematical world.

Select and apply mathematical and/or statistical procedures, concepts and techniques previously learnt to solve the mathematical problem to be addressed through your model. Synthesise and refine existing models, and generate and test hypotheses with secondary data and information, as well as using standard mathematical techniques. Models should satisfy the rules for the final position in the race. Solutions can be found using algebraic, graphic, arithmetic and/or numeric methods, with and/or without technology.

Once you have achieved a possible solution, consider the reasonableness of the solution and/or the utility of the model in terms of the problem. Evaluate your results and make a judgment about the solution/s to the problem in relation to the original issue, statement or question.

This involves exploring the strengths and limitations of your model. Where necessary, this will require you to go back through the process to further refine the model/s. Check that the output of your model provides a valid solution to the real-world problem it has been designed to address. The model should appropriately represent the running of a race.

This stage emphasises the importance of methodological rigour and the fact that problem-solving and mathematical modelling is not usually linear and involves an iterative process.

The development of solutions and models to abstract and real-world problems must be capable of being evaluated and used by others and so need to be communicated clearly and fully. Communicate your findings systematically and concisely using mathematical, statistical and everyday language. Draw conclusions, discussing the key results and the strengths and limitations of the model/s. You could offer further explanation, justification and/or recommendations, framed in the context of the initial problem.

Instrument-specific marking guide (IA1): Problem-solving and modelling task (20%)

Criterion: Formulate

Assessment objectives

1. select, recall and use facts, rules, definitions and procedures drawn from Unit 3 Topics 2 and/or 3
2. comprehend mathematical concepts and techniques drawn from Unit 3 Topics 2 and/or 3
5. justify procedures and decisions by explaining mathematical reasoning

The student work has the following characteristics:	Marks
• documentation of appropriate assumptions • accurate documentation of relevant observations • accurate translation of all aspects of the problem by identifying mathematical concepts and techniques.	3–4
• statement of some assumptions • statement of some observations • translation of simple aspects of the problem by identifying mathematical concepts and techniques.	1–2
• does not satisfy any of the descriptors above.	0

Criterion: Solve

Assessment objectives

1. select, recall and use facts, rules, definitions and procedures drawn from Unit 3 Topics 2 and/or 3
6. solve problems by applying mathematical concepts and techniques drawn from Unit 3 Topics 2 and/or 3

The student work has the following characteristics:	Marks
• accurate use of complex procedures to reach a valid solution • discerning application of mathematical concepts and techniques relevant to the task • accurate and appropriate use of technology.	6–7
• use of complex procedures to reach a reasonable solution • application of mathematical concepts and techniques relevant to the task • use of technology.	4–5
• use of simple procedures to make some progress towards a solution • simplistic application of mathematical concepts and techniques relevant to the task • superficial use of technology.	2–3
• inappropriate use of technology or procedures.	1
• does not satisfy any of the descriptors above.	0

Criterion: Evaluate and verify

Assessment objectives

4. evaluate the reasonableness of solutions
5. justify procedures and decisions by explaining mathematical reasoning

The student work has the following characteristics:	Marks
• evaluation of the reasonableness of solutions by considering the results, assumptions and observations • documentation of relevant strengths and limitations of the solution and/or model • justification of decisions made using mathematical reasoning.	4–5
• statements about the reasonableness of solutions by considering the context of the task • statements about relevant strengths and limitations of the solution and/or model • statements about decisions made relevant to the context of the task.	2–3
• statement about a decision and/or the reasonableness of a solution.	1
• does not satisfy any of the descriptors above.	0

Criterion: Communicate

Assessment objective

3. communicate using mathematical, statistical and everyday language and conventions

The student work has the following characteristics:	Marks
• correct use of appropriate technical vocabulary, procedural vocabulary and conventions to develop the response • coherent and concise organisation of the response, appropriate to the genre, including a suitable introduction, body and conclusion, which can be read independently of the task sheet.	3–4
• use of some appropriate language and conventions to develop the response • adequate organisation of the response.	1–2
• does not satisfy any of the descriptors above.	0