QCATs
Queensland Comparable Assessment Tasks

9

2009

MATHEMATICS

TEACHER GUIDELINES

Rainwater

These guidelines provide important information to support administration and implementation of the QCATs.

SECTIONS IN THIS BOOKLET:

Queensland Government

Queensland Studies Authority
Partnership and innovation

Contact information:

Information about the QCATs is available on the QSA website <www.qsa.qld.edu.au>. Select Assessment > Queensland Comparable Assessment Tasks.

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Section 1: Understanding QCATs

Queensland Comparable Assessment Tasks (QCATs)

QCATs aim to provide:

- a model of authentic, performance-based assessment aligned to a selection of Ess*ential Learnings* and to the *Standards*
- resources to support consistency in the way teachers make judgments about the qualities in student work
- information for teachers and students relevant to a selection of *Essential Learnings* about what students know, understand and can do, what is working well and what needs attention.

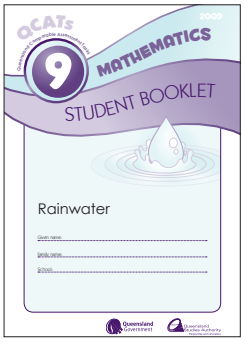
QCATs are assessments that encourage and rely upon interaction between teachers and students. They ask students to use relevant knowledge and skills to respond to a meaningful problem.

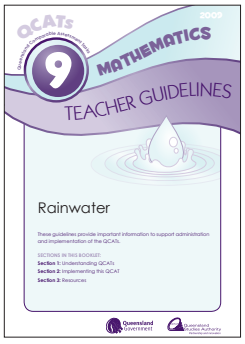
These assessments are resources that provide teachers, students and parents/carers with information to contribute to discussions about student learning and to plan for future learning. The effectiveness of these assessments in providing helpful information will depend on the level of interaction teachers have with their students before, during and after implementation.

Teacher preparation

- Check that you have the appropriate number of:
  - *Student booklets* — the assessment to be presented to students (one per student)
  - *Teacher guidelines* (one per teacher).
- Check for any defective *Student booklets*.
- Contact the QSA if any additional booklets are required.
- Read all the materials provided.
- Review the selected *Essential Learnings* listed in Section 3.
- Work through the assessment yourself so that you understand what students are required to do.
- Plan implementation with your colleagues:
  - Set times and dates for implementation.
  - Discuss how you will achieve consistency of teacher judgment.
  - Decide how to select five samples that are representative of the A to E grades for the QSA's random sampling process.

Note: *Sample responses* are available for download from the QSA Assessment Bank <https://qcar.qsa.qld.edu.au/assessmentbank>.





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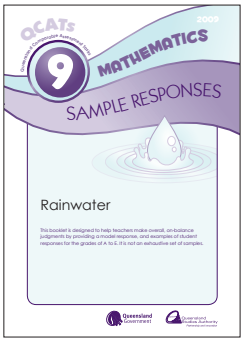


Found online in the QSA Assessment Bank

Student orientation

It is important to set conditions that provide students with the opportunity to do their best work.

- Students should have had opportunities to engage with the selected *Essential Learnings* well in advance of participating in QCATs. Review and consolidation may be necessary before implementing the QCAT, which assesses students' performance in applying knowledge and understanding in a new context.
- Allow some time to familiarise students with the expectations of the assessment. The time required will depend upon the needs of students.
- Begin each assessment with a teacher-facilitated discussion about the context of the assessment and the problem posed. It is vital that all students are engaged in this discussion.
- Ensure that preparation activities do not involve rehearsal of the actual assessment or a similar one.
- Explain what is being assessed by introducing the students to the assessable elements. These are provided in the *Guide to making judgments* located on the back page of both the *Teacher guidelines* and the *Student booklet*.
- Discuss with students ways in which this assessment can provide them with information and insight into their strengths and areas for improvement.

QCAT conditions

- You have the flexibility to implement the assessment at any time across the eight school weeks of the nominated implementation period, to suit school timetabling.
- Students need not complete the assessment in a single session. If you choose to implement the assessment over more than one session, ensure that the *Student booklets* are kept in a secure location between sessions.
- All responses must be recorded in the *Student booklet*. Extra paper may be provided to students for drafting purposes.
- *Student booklets* have clearly marked sections with prompts to indicate when students should await further instructions.
- Students should not be disadvantaged because they do not understand the instructions or questions — you may read and clarify the instructions and questions but it is important that you use professional judgment, and do not provide the information required in the response. Responses to individual student questions may be shared with the whole class.
- You may point out to a student if you notice that they have missed a question.
- Take advantage of the opportunity to interact with students during the assessment. This will enable you to gather information about future learning needs while the assessment is being implemented.
- Students absent during the administration of the QCATs should be given an opportunity to complete the assessment upon returning to school.
- Collect all *Student booklets* from students on completion of the assessment.
- Schools are responsible for the safe storage of *Student booklets* until the end of the school year.

Making judgments

- Use the *Guide to making judgments* to grade student responses. Additional resources for your reference are:
  - *Guide to making judgments* explained (Section 3)
  - model response (Section 3)
  - *Sample responses*, graded A to E and annotated to explain how they demonstrate the qualities described in the *Guide to making judgments*. *Sample responses* are available for download from the QSA Assessment Bank <https://qcar.qsa.qld.edu.au/assessmentbank>.
- The model response and *Sample responses* are provided for reference purposes only. They each demonstrate possible responses and should be used to support the *Guide to making judgments*.
- Making judgments is **not** about determining whether one student's work is better than that of another. Rather, make standards-based judgments by matching student responses to the *Guide to making judgments*.
- Read and consider all of the evidence in the *Student booklet* before making and recording a judgment about the quality of the performance for each assessable element.

The judgment process

Making a judgment about the quality of a student's response to the assessment is a two-stage process.

Stage 1: Make a judgment about the evidence related to each assessable element

- Read the purpose statement at the top of the *Guide to making judgments*. This statement describes the focus of the QCAT.
- Read the task-specific assessable elements in the *Guide to making judgments*. These identify significant and discrete aspects that you will look for in student responses.
- Identify the evidence in the *Student booklet* as indicated in the *Guide to making judgments*.
- Match the evidence from the *Student booklet* with a task-specific descriptor. Begin at the bottom of each continuum. As you move up the continuum, each task-specific descriptor signposts a discernable difference in the quality of the student performance.
- Consider all the task-specific descriptors on the continuum.
- Record a judgment on the continuum for each assessable element. A judgment may be recorded anywhere along the length of the continuum.

  Note: Refer to the model response and *Sample responses* to support the process of matching student responses to task-specific descriptors in the *Guide to making judgments*.

Stage 2: Make an overall on-balance judgment

- Reread the purpose of the assessment as stated at the top of the *Guide to making judgments*.
- Consider the judgments recorded for each assessable element. Sometimes the on-balance judgment will be an easy fit over one of the A to E grades. However, where there is uneven performance across the assessable elements, an overall on-balance judgment must be made by considering the significance of each assessable element in relation to the purpose of the assessment.
- Record the overall grade by circling the relevant letter (A to E) on the *Guide to making judgments*.
- A nil award of "N" is to be recorded only when there is insufficient evidence to inform a judgment for an overall grade. In some circumstances students completing only part of the task may have their assessment considered complete if there is sufficient evidence of student performance across the assessable elements to inform an overall on-balance judgment.

Consistency of teacher judgment

- The process of achieving consistency of teacher judgment is integral to making judgments about the quality of student responses. This involves teachers consistently applying a shared understanding of those qualities that characterise the *Standards*.
- Consistency of teacher judgment is achieved through engaging in professional conversations about the quality of evidence in student responses using *Standards*, assessable elements and task-specific descriptors as a common language. There are various ways of achieving teacher consensus. Three approaches to professional conversations are outlined in Section 3. Schools may also develop their own processes for achieving consensus.
- Teacher consensus will facilitate the process of selecting five student responses considered to be representative of the overall A to E grades. Schools may be required to provide samples as part of the QSA's random sampling process, which is carried out after implementation.

Providing feedback

- Effective feedback to students would include reference to the:
  - student responses
  - *Guide to making judgments*
  - *Essential Learnings* and *Standards*
  - model and *Sample responses*.
- Work with students and discuss information about what they were expected to know, understand and do, and how their responses were judged using the *Guide to making judgments*. Focus this discussion on developing strategies to improve learning.
- Consider strategies that could be used to cater to the needs of students who experienced either low or high levels of success in completing the assessment.

Special consideration

Schools are responsible for determining which students require special provisions. Students should have the opportunity to participate in school-based assessment.

The QCATs are designed to be part of a classroom assessment program, and principles of participation and equity apply. The QSA offers this general advice about including all students:

- Students who have been identified as having specific educational needs may be assisted using those adjustments and supports usually available in the classroom. To make participation possible in all or part of the assessment task, such help may be in the form of assistive technologies, teacher-aide time or reading support.
- Students for whom English is not their first language, and who are assessed as not achieving a reading level appropriate to complete the task, may be assisted by an interpreter or educational devices (e.g. pictures, electronic whiteboards, interactive devices) to allow participation in all or part of the task.
- In exceptional circumstances where undertaking the task may be a traumatic experience for a student, the principal (in consultation with specialist and support staff and parents/carers) may make a decision regarding the participation of that student in the task.

Important dates

24 August 2009	• QCATs arrive in schools.
24 August – 2 November 2009	• Implement QCATs. **Note:** Schools have the flexibility to implement at any time across the eight school weeks of this period. • Submit student data. • Select five student samples that are representative of grades awarded. Where a school is unable to select student samples representative of all grades (A to E), they are to select five student samples representing the awarded range of grades.
2 November 2009	• Final day to submit student data. • Schools notified if they have been randomly selected to submit their five representative samples.
December 2009	• Schools retain all *Student booklets* until the end of the school year.

Section 2: Implementing this QCAT

Read this section in conjunction with the *Student booklet*.

The purpose of this QCAT is to use mathematical reasoning to develop an appropriate local plan for storage and use of rainwater.

Getting ready

Section 2 of this assessment requires students to use rainfall data for your local area. To provide this data, the teacher will need to obtain 30-year mean and median rainfall data for the school's location from the Bureau of Meteorology website.

- Go to the following web page: <www.bom.gov.au/climate/averages/tables/ca_qld_names.shtml>.
- Select the monthly statistics for the location nearest to your school.
- Select the period 1971–2000 from the Period drop-down list above the table. If data for this period is unavailable at your selected location, choose an alternative nearby location.
- Look at the "Rainfall" section in the displayed statistics table.
- Copy the row labelled "Decile 5 (median) rainfall (mm)" into a table like the one below.
- Prepare sufficient copies for all students.

Median rainfall data for Longreach Aero, 1971 to 2000												
Month	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Median rainfall (mm)	57.0	85.0	47.8	6.6	19.4	4.5	4.1	4.5	3.1	13.2	16.5	39.9

Source: Commonwealth of Australia 2009, Bureau of Meteorology, <www.bom.gov.au>

- If students are skilled in the use of appropriate technologies, teachers may wish to give them the opportunity to use those technologies to complete some sections of the assessment.
  - A calculator's statistical functions could be used to determine mean and median in Question 1, with students showing working by providing the appropriate formula.
  - A spreadsheet program could be used for repetitive calculations in Section 2.
- Work through the assessment task yourself. You may wish to prepare a spreadsheet that will calculate possible values for questions based on student answers to previous questions. For example, you could create a table that calculated values for Question 9 based on students' answers to Question 8.

On the day

This section describes the organisation and procedures that teachers are expected to follow in the administration of this QCAT.

Setting the scene: Group discussion *Suggested time: 20 minutes*		
Teacher	**Student**	**Materials**
Engage students in a whole-class discussion to focus their thinking on the context and the problem of identifying an appropriately sized rainwater tank in relation to water use and water availability. The following steps are suggested: • Read with the class "Setting the scene: Group discussion" (*Student booklet*, page 3). • Discuss the issues which need to be considered before installing a rainwater tank. • Explain, in student-friendly terms, the assessable elements against which student work will be judged. Assessable elements are found in the *Guide to making judgments* on the back page of these guidelines and of the *Student booklet*.	Students listen to task expectations, discuss the context and issues, and ask clarifying questions.	*Student booklet*

Section 1: How much rain? *Suggested time: 40 minutes* *Allow 5 minutes to read and clarify requirements of the task.*		
Teacher	**Student**	**Materials**
Briefly explain that the purpose of this section of the assessment is to apply mathematical reasoning in predicting and measuring rainfall. Advise students to read all information and questions carefully and to take their time to respond thoughtfully. Provide sufficient support to enable all students to produce their best work. Students should not be disadvantaged because they do not understand terms, instructions or questions. Discuss with students the information about measuring rainfall on page 6. Clarify if required. Supervise completion of Questions 1 to 7, ensuring students attempt all questions.	Students listen to expectations and ask clarifying questions if necessary. Students work independently to read the relevant information and answer Questions 1 to 7. Students may seek clarification at any time.	*Student booklet* Calculator Pens, pencils

Section 2: Planning a rainwater supply *Suggested time: 50 minutes* *Allow 5 minutes to read and clarify the requirements of the task.*		
Teacher	**Student**	**Materials**
Briefly explain that the purpose of this section of the assessment is to calculate the amount of rainwater that could be collected by a house roof and to plan how to store and use it. Supply each student with a copy of the table: Median rainfall data for your location. See "Getting ready" on page 9 for help in preparing data. Some students may find the unstructured nature of Question 10 challenging, and should be encouraged to use the check boxes on page 12 to break the task into achievable parts. Supervise completion of the section, ensuring students attempt all questions.	Students listen to expectations and ask clarifying questions if necessary. Students work independently to read the relevant information and answer Questions 8 to 10. Students may seek clarification at any time.	*Student booklet* Calculator Pens, pencils

Grading student responses

Students should not be penalised for consequential errors. For example, if a student incorrectly calculates the rainwater volume in Question 8, credit should be given for subsequent correct use of this volume in Questions 9 and 10.

As there will be a number of possible correct responses to Question 9, a spreadsheet version of Table 3 (*Student booklet*, page 11) will be useful for checking the accuracy of student responses.

Feedback from trials

This QCAT has been trialled at a number of schools across Queensland. Feedback from the trials showed these areas as common points for follow-up with students:

- manipulating and rearranging algebraic expressions
- analysing situations to identify strategies and procedures to generate a solution
- communicating thinking and reasoning.

Section 3: Resources

The selected *Essential Learnings*

The 2009 QCATs will assess what students know, understand and can do. The following selection of Year 9 Mathematics *Essential Learnings* form the basis of this assessment.

Mathematics *Essential Learnings* by the end of Year 9

Ways of working

Ways of working describe processes students use to develop and demonstrate their *knowledge and understanding*.

Students are able to:

- analyse situations to identify the key mathematical features and conditions, strategies and procedures that may be relevant in the generation of a solution
- select and use mental and written computations, estimations, representations and technologies to generate solutions and to check for reasonableness of the solution
- communicate thinking, and justify and evaluate reasoning and generalisations, using mathematical language, representations and technologies.

Knowledge and understanding

Knowledge and understanding describes essential concepts, facts and procedures.

Number

Number properties and operations and a range of strategies can be applied when working with integers and rational numbers.

- Problems can be interpreted and solved using rational and irrational numbers, including integers, simple powers and square roots, and conventions of the four operations to generate solutions using mental, written and technology-assisted strategies.

Algebra

Variables, algebraic expressions and equations, relationships and functions can be described, represented and interpreted.

- Variables and constants are represented using words and symbols when writing expressions and equations.
- Inverse, associative, commutative and distributive properties can be used to manipulate and rearrange algebraic expressions that involve the four operations, reciprocals, whole-number powers and square roots.

Measurement

Units of measure, instruments, formulas and strategies can be used to estimate and calculate measurement and consider reasonable error.

- Instruments, technologies, strategies and formulas are used to estimate, compare and calculate measures and derived measures, including rate, area, duration and Australian time zone differences.
- Lengths and angles that cannot be measured directly can be investigated using scale, similarity or trigonometry.

Chance and data

Judgments can be based on theoretical or experimental probability. Data can be displayed in various ways and analysed to make inferences and generalisations.

Simple measures of spread and centre, distribution of responses, and the effect of bias and outliers on the measures of location are used to make inferences.

Assessable elements

Assessable elements identify the valued features of the key learning area about which evidence of learning is collected and assessed.

- Knowledge and understanding
- Thinking and reasoning
- Communicating

Standards

Standards are integral to the alignment of curriculum, assessment and reporting. For teachers, parents and students, they provide a shared language for describing the quality of student achievement.

The *Standards* are achievement standards linked to the *Essential Learnings*. Using a five-point scale, the *Standards* describe how well a student has demonstrated their learning based on a collection of evidence. They can also be used to report student progress and achievement.

Standards

Standards describe how well a student has demonstrated their learning based on a collection of evidence.

A standard
Evidence in a student's work typically demonstrates a very high level of knowledge and understanding of concepts, facts and procedures, and application of processes.

B standard
Evidence in a student's work typically demonstrates a high level of knowledge and understanding of concepts, facts and procedures, and application of processes.

C standard
Evidence in a student's work typically demonstrates a sound level of knowledge and understanding of concepts, facts and procedures, and application of processes.

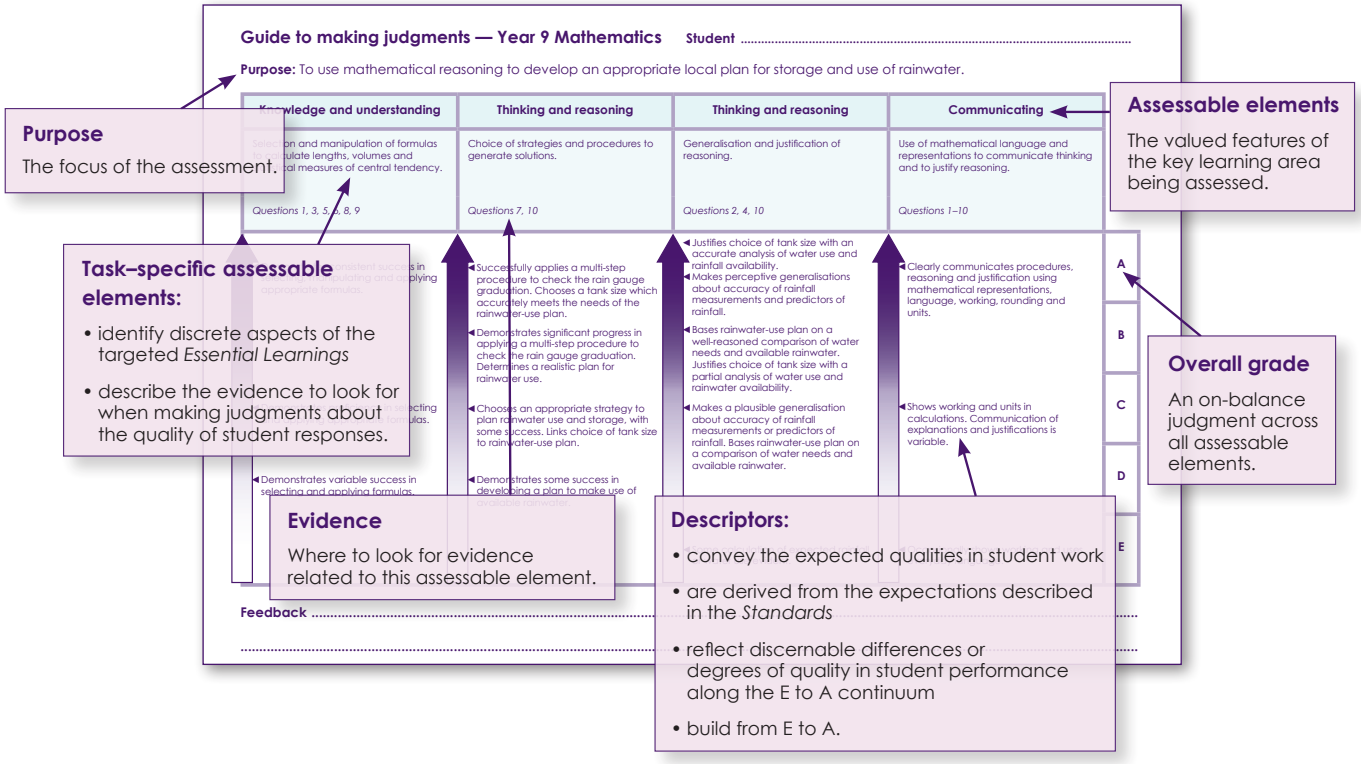
D standard
Evidence in a student's work typically demonstrates a limited level of knowledge and understanding of concepts, facts and procedures, and application of processes.

E standard
Evidence in a student's work typically demonstrates a very limited level of knowledge and understanding of concepts, facts and procedures, and application of processes.

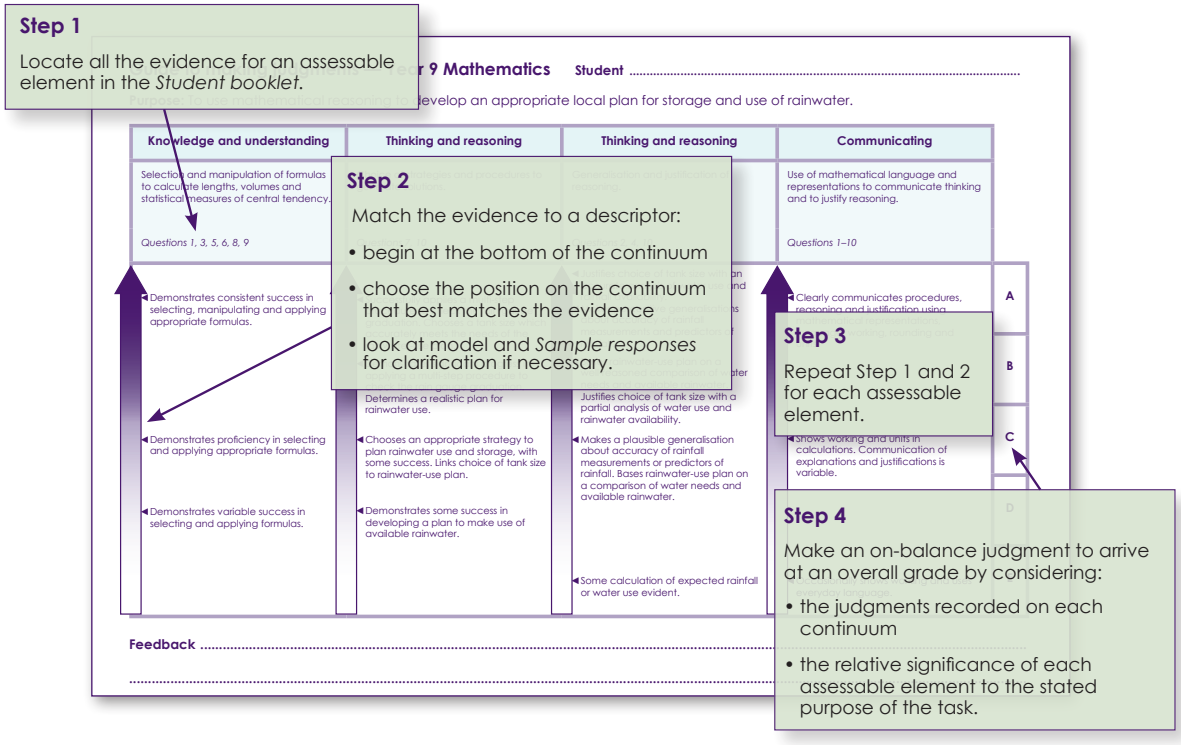
Guide to making judgments (GTMJ) explained

This QCAT uses a continua-style GTMJ, where descriptors are placed along a continuum for each assessable element. The diagrams below show the different parts of the GTMJ continua model, and how to use the GTMJ when grading student responses.

Understanding the GTMJ



Using the GTMJ



Three approaches for consistency of teacher judgment

Calibration model

A facilitator selects samples deemed to be of a certain standard to be used in the calibration process. Teachers individually grade the samples and then compare their judgment with the grade nominated for the sample. Task-specific descriptors are used as the basis for common and explicit language for teachers to use in their discussions about the quality of student performance. These discussions are based on evidence provided in student responses.

Through this professional dialogue, teachers aim to adjust their interpretation and application of the *Standards* to reach consensus about the quality of the sample. This process is repeated for all the student samples. Teachers then individually grade all student responses, applying the shared understanding achieved through this calibration process.

Advantage — Saves time because it focuses on establishing a common understanding of the *Standards* in context, before marking all of the student responses.

Disadvantage — Making the initial quality judgments in isolation can be difficult.

Conferencing model

Teachers grade student responses individually and then select student samples that are representative of their application or understanding of the A to E qualities.

A meeting is convened in which a conferencing process is employed to enable teachers to share samples and discuss their judgments. Task-specific descriptors are used as the basis for a common and explicit language for teachers to use during discussions about the quality of student performance. These discussions are based on the evidence provided in student responses.

Through professional dialogue, teachers aim to reach consensus on the interpretation and application of the *Standards*. Teachers review judgments about their previously graded student responses, applying the shared understanding achieved through this conferencing process.

Advantage — Teachers are involved in professional dialogue with other teachers to reach consensus.

Disadvantage — Establishes a common interpretation and application of the *Standards* after student work has been allocated a grade. Extra time is needed to review and adjust previously graded work.

Expert model

Teachers grade all student responses and then submit selected samples that are representative of their application or understanding of the A to E qualities to an expert. Advice is provided by the expert confirming whether there is consistency in the way the *Standards* are interpreted and applied, or whether teachers need to adjust their understanding, and why. This advice is used by teachers when reviewing judgments about their previously graded student responses.

Advantage — Imposes a common school-based view of the interpretation and application of the *Standards*.

Disadvantage — Teachers are not involved in the rich professional dialogue of reaching consensus with other teachers. This model can be used to reach consistency within a school, but does not best support consistency of teacher judgments across the state.

Model response

1. **Calculate Birdsville's mean and median April rainfall for the period 1997 to 2006.**

Show all working

52.8
2.0
86.6
1.0
6.7
1.0 +
150.1

$$\text{Mean} = \frac{150.1}{10}$$

$$= 15.0 \text{ mm}$$

Mean April rainfall = 15.0 mm

Show all working

86.6
52.8
6.7
2.0
*1.0
*1.0
0.0
0.0
0.0
0.0

$$\text{Median} = \frac{1.0 + 1.0}{2}$$

$$= 1.0$$

Median April rainfall = 1.0 mm

2. **The median is a more useful predictor of typical monthly rainfall than the mean. Use the April data for Birdsville to explain why.**

For 7 out of 10 years, the April rainfall was within 1 mm of the median. In none of the years is the April rainfall near the mean as it is skewed by two very wet years (outliers).

STOP HERE: WAIT FOR YOUR TEACHER'S DIRECTIONS

Measuring rainfall

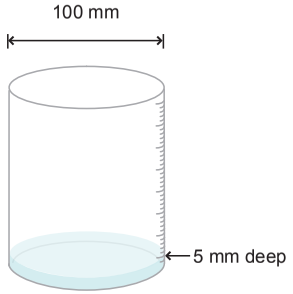
A rain gauge is used to measure rainfall (usually in millimetres).

The level in the gauge represents the depth of rainwater that would build up on a flat horizontal surface if it didn't run off or soak in.

Any open container with straight vertical sides can be used as a simple rain gauge. The depth of water collected is a measure of the amount of rain.

Rain gauges A and B both measure the same amount of rainfall, even though A collects a greater volume of water because of its larger opening.

3. **If 5 mm of rain falls and is collected in a 100 mm diameter rain gauge, calculate the volume of rainwater in the gauge.**



Volume of a cylinder
$= \pi r^2 h$

Show all working

$V = \pi r^2 h$

$= \pi \times 50^2 \times 5$

$= 39\,269.9 \text{ mm}^3$

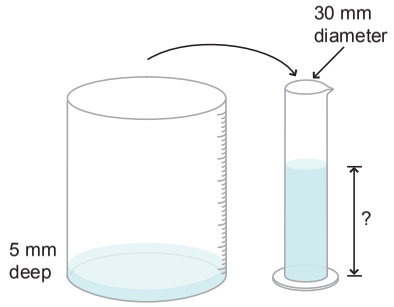
Volume of rainwater = 39 270 mm^3

Model response

To improve the accuracy of rainfall measurement, the collected rainwater can be poured into a narrower cylinder.

4. How is the accuracy of rainfall measurements improved by pouring the collected rainwater into a narrower cylinder?

In a narrower cylinder, the 5 mm of rain is spread over a greater depth, so the graduations are further apart and easier to read.



5. Calculate the depth of the rainwater collected in Question 3 after it is poured into a narrow, 30 mm diameter cylinder.

Show all working

$V = \pi r^2 h$

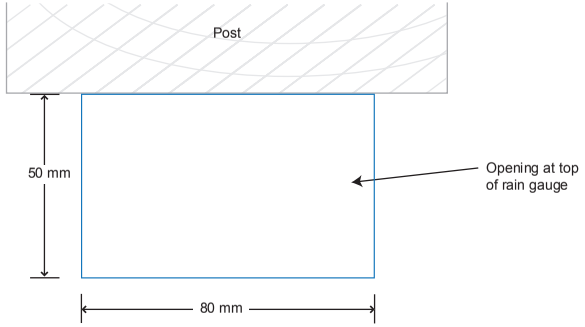
$h = \frac{V}{\pi r^2}$ $\quad h = \frac{39\ 270}{\pi \times 15^2}$

$= 55.56$

Depth of water in the narrow cylinder = 55.6 mm

Not all rain gauges are cylinders.

The diagram below shows the top view of a rain gauge attached to a post.



Not to scale

6. If 5 mm of rain falls, calculate the volume of water collected in the rain gauge above.

Show all working

$V = \text{area} \times \text{height}$

$= l \times w \times h$

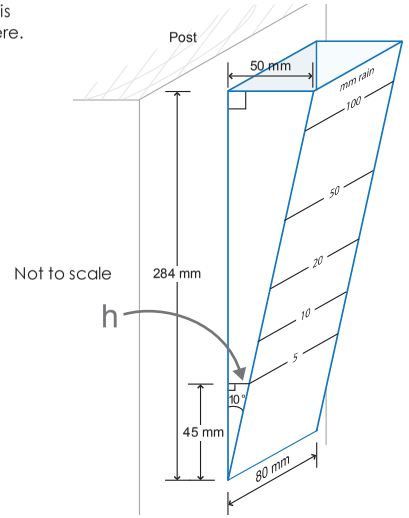
$= 80 \times 50 \times 5$

$= 20\ 000\ mm^3$

Volume of rainwater collected = 20 000 mm^3

Model response

The rain gauge from page 8 is wedge-shaped, as shown here.



7. Use the volume calculated in Question 6 to check if the 5 mm graduation on the rain gauge is in the correct place.

Show all working

$$\frac{h}{50} = \frac{45}{284}$$

$$h = \frac{45 \times 50}{284}$$

$$= 7.9 \text{ mm}$$

$$V = \text{area} \times \text{height}$$

$$= \frac{b \times h \times 80}{2}$$

$$= \frac{45 \times 7.9 \times 80}{2}$$

$$= 14\,220 \text{ mm}^3$$

Note: This is one of several methods that could be used to solve this problem.

Volume at marked 5 mm graduation is only 14 220 mm^3.

Actual volume should be 20 000 mm^3, so it is too low.

Tick the correct answer.

The 5 mm graduation is:

- ☐ in the correct place
- ☐ too high
- ☑ too low.

STOP HERE: WAIT FOR YOUR TEACHER'S DIRECTIONS

Section 2: Planning a rainwater supply

Table 2 below shows typical roof areas for homes of different sizes.

Table 2

Typical roof areas	
Home type	**Roof area (m^2)**
2 bedroom home	100
3 bedroom home	150
4 bedroom home	200
5 bedroom home	250

Assume the roof is flat.

(This makes little difference to the amount of rain collected.)

From the table, choose a home that most closely matches the one you live in (or would like to live in).

My choice of home: 3 bedroom

8. Calculate the amount of rainwater in litres (L) collected by the roof of your chosen home when one millimetre (1 mm) of rain falls.

Show all working

1 mm = 0.001 m
1 m^3 holds 1000 L

$$V = \text{area} \times \text{height}$$

$$= 150 \times 0.001$$

$$= 0.15 \text{ m}^3$$

$$\text{Amount} = 0.15 \times 1000 \text{ L}$$

$$= 150 \text{ L}$$

Amount of rainwater collected by the roof when 1 mm of rain falls = 150 L

Model response

Your teacher has supplied you with median monthly rainfall data for:

…… Longreach Aero …… (location).

9 a. Copy the median rainfall values for each month into column A of Table 3.

b. Using your answer to Question 8, calculate the expected amount of rainwater collected from your chosen roof during each month. Write these values in column B of Table 3.

Table 3

Expected rainwater collected		
Month	**A** Median rainfall (mm)	**B** Rainwater collected by the roof (L)
Jan	57.0	8550
Feb	85.0	12750
Mar	47.8	7170
Apr	6.6	990
May	19.4	2910
Jun	4.5	675
Jul	4.1	615
Aug	4.5	675
Sep	3.1	465
Oct	13.2	1980
Nov	16.5	2475
Dec	39.9	5985

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10. Explain how you could make the best use of the collected rainwater (Table 3) to reduce your need to use water from the local supply.

In your answer:

- ☑ record the number of people living in the house
- ☑ work out approximately how much water your household uses each month (refer to Table 4 below)
- ☑ compare the expected amount of rainwater collected (Table 3) to your monthly usage
- ☑ explain how you could use the collected rainwater to supply some or all of your needs
- ☑ select an appropriately sized tank to store rainwater for use in drier months (refer to Table 5 below)
- ☑ justify all your reasoning and show all calculations.

Answer on the following pages.
Check the box next to each point above as you complete it.

Table 4

Careful water use (using water wisely)	
Use	**Litres *per person* per month**
Drinking, cooking	**300**
Dish washing	**150**
Bathroom and toilet	**2500**
Washing clothes	**200**
A garden hose uses about 700 litres ***per hour***	

Table 5

Rainwater tank sizes and prices										
Tank capacity (litres)	500	1000	1500	2000	2500	3000	5000	10000	20000	50000
Installed cost	$500	$700	$750	$800	$1000	$1100	$1400	$2000	$3000	$7000

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Model response

Note: This is one of many possible solutions to this question.

Monthly usage for my household
Per person:

	300
	150
	2500
	200
Subtotal	3150 L

My household (three people):
3 x 3150 = 9450 L

Add allowance for hose:
If we water for about 30 minutes per week, that's about 2 hours per month
2 x 700 = 1400 L

Total monthly water usage for my household:

	9450
	1400
	10850 L

The monthly mean amount of expected rainwater (from table 3) is 3770 L (45 240 ÷ 12), so I won't be able to use rainwater for all my needs.

If I could store excess rainwater from the wet months to use in the dry months, I could use 3700 L of rainwater a month for:

- drinking and cooking 900 L
- dishwashing 450 L
- washing clothes 600 L
- watering the garden (2½ hrs) 1750 L

I've allowed a little extra water for hosing for a vegetable garden.
I would have to use council water for bathroom and toilet.

Have you checked all the boxes in Question 10?
Continue your answer over the page if necessary.

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I will need to use some tank water from April to November, as in these months I will use more than I collect from my roof.

Rainwater, Apr to Nov

Use 3700 x 8 = 29 600 L

Collected (from table 3) = 10 785 L

Shortfall 29 600 – 10 785 = 18 815 L

So I need to have about 19 000 L rainfall stored at the end of March.

Rainwater, Dec to Mar

Use 3700 x 4 = 14 800 L

Collected (from table 3) = 34 455 L

Extra 34 455 – 14 800 = 19 665 L

If I can store the extra rainfall from December to March, I should have enough for the dry months.

I would install a 20 000 L tank at a cost of $3000.

In a very dry year I may run out of tank water and have to use more council water.

Have you checked all the boxes in Question 10?
Continue your answer over the page if necessary.

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Notes

Notes

Notes

Guide to making judgments — Year 9 Mathematics

Student .....

Purpose: To use mathematical reasoning to develop an appropriate local plan for storage and use of rainwater.

Knowledge and understanding	Thinking and reasoning	Thinking and reasoning	Communicating	
Selection and manipulation of formulas to calculate lengths, volumes and statistical measures of central tendency.	Choice of strategies and procedures to generate solutions.	Generalisation and justification of reasoning.	Use of mathematical language and representations to communicate thinking and to justify reasoning.	
Questions 1, 3, 5, 6, 8, 9	*Questions 7, 10*	*Questions 2, 4, 10*	*Questions 1–10*	
◀ Demonstrates consistent success in selecting, manipulating and applying appropriate formulas.	◀ Successfully applies a multi-step procedure to check the rain gauge graduation. Chooses a tank size which accurately meets the needs of the rainwater-use plan.	◀ Justifies choice of tank size with an accurate analysis of water use and rainfall availability. ◀ Makes perceptive generalisations about accuracy of rainfall measurements and predictors of rainfall.	◀ Clearly communicates procedures, reasoning and justification using mathematical representations, language, working, rounding and units.	**A**
	◀ Demonstrates significant progress in applying a multi-step procedure to check the rain gauge graduation. Determines a realistic plan for rainwater use.	◀ Bases rainwater-use plan on a well-reasoned comparison of water needs and available rainwater. Justifies choice of tank size with a partial analysis of water use and rainwater availability.		**B**
◀ Demonstrates proficiency in selecting and applying appropriate formulas.	◀ Chooses an appropriate strategy to plan rainwater use and storage, with some success. Links choice of tank size to rainwater-use plan.	◀ Makes a plausible generalisation about accuracy of rainfall measurements or predictors of rainfall. Bases rainwater-use plan on a comparison of water needs and available rainwater.	◀ Shows working and units in calculations. Communication of explanations and justifications is variable.	**C**
◀ Demonstrates variable success in selecting and applying formulas.	◀ Demonstrates some success in developing a plan to make use of available rainwater.			**D**
		◀ Some calculation of expected rainfall or water use evident.	◀ Occasionally shows working and uses everyday language.	**E**

Feedback .....

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