NSW GOVERNMENT Education Public Schools

Teaching Measurement

STAGE 2 - STAGE 3

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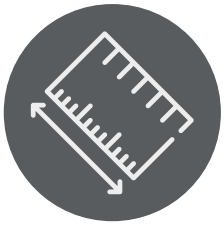

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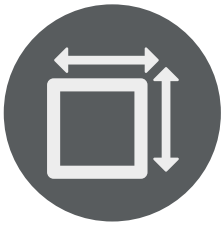

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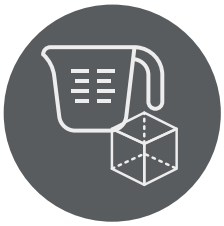

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ABOUT THIS RESOURCE

Teaching Measurement: Stage 2 and Stage 3 is a resource designed to help teachers to plan practical, meaningful programs in the mathematics strand of measurement. Important components of this resource are its emphasis on knowledge of units and their structure (for spatially-organised units), practical activities, recording, estimation and questioning.

The material in this resource are based on a conceptual framework that reinforces the similarity of the measurement processes across the different quantities, especially those quantities where the units are spatially organized (length, area and volume).

The measurement framework is organised into six levels of increasing difficulty, each focusing on a different aspect of learning about measurement. This resource describes Levels 4, 5 and 6 of the framework, but also includes an outline of Levels 1, 2 and 3 to provide a background in the development of early measurement concepts. The activities which accompany each level of the framework are designed to develop students' knowledge of the ideas of measurement, as well as the procedures and skills involved in measuring. The first three levels of the framework, together with lesson ideas and lesson plans, are described in the resource *Teaching Measurement: Early Stage 1 and Stage 1*.

Teaching Measurement: Stage 2 and Stage 3 is organized into an introductory section, followed by four main sections: Length, Area, Volume and Mass.

The introductory section provides:

- **Information about teaching and learning measurement**
  Fundamental measurement processes (knowledge of attributes, conservation, identification of units and unit iteration) and important aspects of teaching measurement (estimation, recording and questioning) are described.
- **A detailed overview of the measurement framework**
  The organization of the measurement framework into six levels, which are similar for the measurement of each quantity, is shown. Each level is divided into two subsections and these describe the development of each attribute.

The main sections related to Length, Area, Volume and Mass each contain:

- **An information section**
  The knowledge and strategies to look for when students engage in the measuring activities related to each attribute.
- **Lesson ideas**
  Classroom activities that are designed to develop the knowledge and strategies for Levels 4, 5 and 6 of the measurement framework. Not all lesson ideas at each level have to be completed if most students in the class have demonstrated the understanding and skills listed for that level. A variety of activities are included to provide opportunities for consolidation and assessment. Each activity is referenced to the measurement and working mathematically outcomes of the NSW Mathematics K–10 Syllabus.
- **Lesson plans**
  One complete lesson plan for each subsection and attribute is provided as a model. The lesson plan includes examples of the types of questions that might be asked to assess students' knowledge of key concepts.

TEACHING AND LEARNING ABOUT MEASUREMENT

Measurement enables continuous quantities, those which are not separately countable, to be compared and ordered. A fundamental difference between measuring and counting a discrete quantity is that in measurement the units are not visible unless “concrete” units are used or the units are constructed or drawn. The items in discrete quantities, such as a box of apples or a group of children, can be individually counted. To measure a continuous quantity, such as the length of a desk, the length has to be partitioned into units that can be counted by either repeating the unit along the length, or subdividing the length into units of a given size.

This resource focuses on length, area, volume and capacity, and mass. Measurement of some of these quantities is spatially organized. In length, area and volume, the units fit together in a spatial pattern, whereas in measurement of capacity and mass the spatial arrangement of the units does not matter. Learning how spatially organised units fit together, and how they may be counted systematically, is basic to understanding the measurement of length, area, and volume. To obtain a precise measurement, units must be aligned or packed so that there are no gaps or overlaps. Although capacity (fluid measure) is a measure of volume, finding the capacity of a container by filling it with liquid or material such as rice or sand is different from packing a container with cubic units, which must be organised spatially.

When informal or non-standard units such as hand spans, paperclips or popsticks are used to measure a length, the units have to be either aligned along the length, or one unit has to be repeated and the endpoint of each length marked in some way. However, when formal units are used to measure length, the measurement can usually be read from a scale on a ruler or tape, which shows units of a particular size. If students are not shown the relationship between the informal and formal measurement procedures, they may not understand the principle underlying the use of a ruler. Similarly, measuring areas and volumes with informal units assists students to understand the calculation formulae when these are taught, providing the principles underlying the informal and formal processes are understood.

FUNDAMENTAL MEASUREMENT IDEAS

There are a number of fundamental ideas that students need to learn to apply to all the measurement concepts they will encounter in the primary school syllabus. These ideas include an understanding of attributes and conservation, and knowledge of units and unit iteration.

Identification of the attribute being measured

The first step in teaching measurement is to compare quantities directly. For example, two students might stand back-to-back and decide who is taller. Comparing quantities directly helps students to identify what attribute is being measured.

Students learn what a length is by comparing it with other lengths and they develop the concept and associated language together. For example, "This stick is long but this one is short. This one is shorter." As students compare quantities directly and order them they learn to identify each attribute and to see how they differ. However, what is being measured is not always clear —students may confuse length and area because they are not sure which part of an object or surface is being measured. Similarly, students may think that the larger the volume of an object, the more mass it will have because they do not know the difference between mass and volume. Foam packaging can be used to show that a large volume of material can have a small mass.

Knowledge of units is fundamental to the process of measuring

Once students are able to identify what is being measured, and can directly compare and order quantities, the next step is to learn to use measurement units. Units enable us to measure and compare quantities that are physically separated in time or space and to give numerical values to quantities. Once a number is associated with a quantity, that quantity can be compared with other quantities and ordered more easily than by using direct comparison. Theoretically, the quantity has to be subdivided into identical parts (units) and the number of units used gives a measurement of quantity. However, when students begin to measure they do not subdivide the length, instead they align units until they have made the required length. This process is conceptually quite different from subdivision.

A fundamental principle of measurement is that quantities can only be compared if the units used to measure each quantity are identical. Students can be assisted to develop this principle through discussion of results when different-sized units are used. Another important idea about units is that use of smaller units gives increased precision.

Any measurement is always approximate, because continuous quantities can theoretically be partitioned into smaller and smaller units, such as from metres to centimetres to millimetres and even finer units. The accuracy of a measurement can be affected by the precision of the measuring instrument, the experience of the person who is measuring as well as other factors related to the quantity being measured.

The principle of conservation is fundamental to understanding measurement

As students begin to measure with units they gradually learn an important principle of measurement, that the quantity is unchanged if it is rearranged (conservation). Students who do not understand the conservation principle may think that string is not the same length when it is curled up as when it is stretched out, or that a cup of water poured into a tall, thin glass is more than when it is poured into a short, wide glass. Nor will they realize that if a square is cut into two pieces to make a long rectangle, then the two shapes have the same area.

While an understanding of conservation is fundamental to the measuring process, this concept seems to develop from activities involving measuring, rather than being a prerequisite to measurement. For volume, conservation may not be established until later because of the complexity of volume measurement. Some students will need more experience than others in measuring quantities before they are convinced that a length, area, volume or mass measurement remains the same after the quantity is rearranged. If students measure inaccurately or use different units, their measurements will differ, making it even more difficult to grasp the principle of conservation.

Knowledge of unit iteration is fundamental to the process of measuring spatially organised quantities

A key measurement understanding for spatially organised quantities, such as length, area and volume, is an awareness of the structure or pattern of the units. Identical units are repeated or iterated so that they do not overlap and there are no gaps between them. Units may be aligned along a length, constructed in an array to measure the area of a rectangle, or packed into a container to find its volume.

Knowledge of the spatial structure of the unit iteration may help students to link concrete, pictorial and symbolic representations of measurement concepts. Once students have realised that the process of exhaustively filling a space with units is a form of partitioning that space, they may be able to re-conceptualise the space in different ways. When students think of measurement as a process of subdivision, they are no longer dependent on concrete representations of the units. They can visualise and work with abstract quantities, enabling them to manipulate fractional units and use the power of the formulae.

Rectangular shapes or containers are used when covering shapes or packing containers with units. It is important that students develop an understanding of the structure of unit covering in area and unit packing in volume. Rectangular shapes or containers assist students to see the structural relationships and usually avoid the complexity of fractional units. However, measurement provides a rich context in which to develop fractional ideas.

IMPORTANT COMPONENTS OF TEACHING MEASUREMENT

The activities in this book are based on familiar experiences and contexts. They provide the basis for understanding the measurement process so that mathematical generalisations can be made. An important aspect of such activities is reflection, so in many of the activities students are encouraged to estimate, then measure, and finally to record their results and describe the measuring procedure. The questions that teachers ask to encourage students to describe, explain and justify their results are crucial.

Estimation

Estimation is seen as an essential part of measurement, because it assists students to develop a sense of the size and structure of the units. The process of estimating may also assist students to understand measurement variability and that measurement is a process of increasing precision.

Students need to share estimation strategies and to discuss ways to obtain more accurate estimates. These include:

- using a referent or known quantity as a comparison measure, e.g. “the dog is shorter than me” or “the seat is about twice as long as me”;
- chunking or breaking a quantity into more manageable parts by estimating a distance as several shorter sections (the distance from the floor to the top of the door is about … and the distance from the top of the door to the ceiling is about…)
- ‘unitising’ or subdividing a quantity into smaller equal parts, such as estimating the height of a ten-story building as ten times the estimate for one story.

Sharing strategies for making estimates encourages students to think of an estimate as an informed, but informal, form of measurement rather than a “guess”. If students predict before they measure, they will learn to judge the relative size of the quantity and the units. Estimation of two- and three-dimensional quantities (area and volume) is more difficult than estimating length.

Recording

As well as encouraging reflection, the recording process is essential as a form of assessment and as an incentive for students to develop the precise language, they need to discuss measurement concepts. Common text types (procedures, recounts and explanations) can be consolidated and extended by asking students to write about what they did in measurement.

In addition to writing about their findings, students may be asked to draw their method of measuring. Drawing is seen as a bridge to link the practical activities to diagrams and plans. Drawing the array structure for the tessellation of area units appears to assist students to perceive the rows (and columns) as composite units and it is this perception that enables them to connect side length and area. If students have drawn and talked about the structure of an array, then the structure of three-dimensional packing may be grasped more easily.

Questioning

A crucial part of a teacher's role is to develop students' ability to think about mathematics. To develop thinking processes teachers need to ask higher order questions that require students to interpret, apply, analyse and evaluate information, rather than questions that simply require students to recall facts. There are a number of strategies that teachers might use.

- Before giving a lesson, decide what the students are to learn and the key questions that will indicate if they have learnt the concept, skill or strategy that was taught.
- Ask probing questions that help students to clarify their responses, to see the relevance to other ideas, to be more accurate or to explain or justify why it is so.
- Encourage students to ask questions of each other so that they begin to develop independence and maturity of thought. Before students ask questions they need to consider what they may not understand or what they do not agree with in an explanation.

THE MEASUREMENT FRAMEWORK

The key levels in the measurement framework are organized into a progression that is similar for measurement of each quantity. Each level is divided into two subsections and these provide the organizing framework for the development of each attribute. The conceptual levels are:

- **Identification of the attribute to be measured**
  Students recognize the quantity to be measured and make direct comparisons of size.
- **Informal measurement**
  Students choose and measure with informal units (given as many as they need) to compare quantities.
- **Structure of the iterated unit**
  Students are given only ONE unit with which to measure. Students construct the unit iteration and describe the spatial structure of length, area and volume.
- **Measure using conventional units**
  Students measure and record quantities with formal units, including centimetres, metres, litres, square metres and square centimetres, cubic centimetres and kilograms.
- **Relationships between formal measurement units**
  Students investigate the calculation of perimeter, area, volume and capacity and mass.
- **Knowing and representing large units**
  Students calculate and record measurements in kilometres, square kilometres and hectares, cubic metres and tonnes. Students use a simple scale to calculate length and area on maps or diagrams.

The six levels in the measurement framework provide a conceptual sequence for teaching length, area, volume and capacity and mass. However, students are not expected to be at the same level in each strand. Measurement of area and volume would be expected to develop later than measurement of length, as length is the basis for measurement of area and volume.

THE MEASUREMENT FRAMEWORK

Level	Length	Area	Volume & Capacity	Mass
	Identification of the attribute			
1.1	Make direct comparisons of length	Make direct comparisons of area	Make direct comparisons of volume or capacity	1.1 Make direct comparisons of mass
1.2	Order two or more lengths by direct comparison	Order two or more areas by direct comparison	Order two or more quantities by direct comparison	1.2 Compare and order objects by hefting 1.3 Compare masses using an equal arm balance
	Informal Measurement			
2.1	Choose and use appropriate units for measuring length	Choose and use appropriate units for measuring area.	Choose and use appropriate units for measuring volume and capacity	Choose appropriate units and use them to measure a mass
2.2	Compare and order lengths by using identical units for each length	Compare and order areas by covering each area with identical units	Compare and order volumes and capacities by filling or packing with identical units	Compare and order masses using identical units for each mass
	Structure of repeated units			**Relationship between units**
3.1	Use one unit to work out how many will be needed altogether when making indirect comparisons	Use one unit to work out how many will be needed altogether when making direct comparisons	Use one unit or composite unit to work out how many will be needed altogether when making indirect comparisons	
3.2	Explain the relationship between unit size and the number of units used to measure length	Explain the relationship between unit size and the number of units used to measure area	Explain the relationship between unit size and the number of units required to fill or pack a container	Explain the relationship between unit size and the number of units required to balance a mass
	Measure using conventional units			
4.1	Measure and record 1 m	Measure 1 m^2	Measure and record 1 L	Measure and record 1 kg
4.2	Measure and record in cm	Measure and record area in m^2 or cm^2 using the structure of repeated units	Measure and record volume in cm^3 by packing	Measure quantities less than 1 kg, in grams
	Relationships between formal measurement units			
5.1	Measure lengths and perimeters in m and cm	Measure and record area in cm^2 or m^2	Measure and record capacity in L and mL	Measure and record mass in kg and gm
5.2	Measure and calculate lengths and perimeters in m, cm and mm	Measure and calculate area in cm^2 or m^2	Measure and calculate volume in cm^3	Measure and calculate mass in kg and gm
	Knowing and representing large units			
6.1	Calculate lengths, distances and perimeters in km Interpret a simple scale	Calculate area in km^2 and ha Interpret a simple scale	Calculate volume in m^3	Calculate mass in tonnes
6.2	Convert units of length to calculate and compare lengths, distances and perimeters Use a simple scale	Convert units of area to calculate and compare areas Use a scale	Convert units of volume and capacity to calculate and compare quantities	Convert units of mass to calculate and compare quantities

Level 1 Identification of the attribute

At Level 1, non-numerical comparisons are made to focus attention on the attribute being measured. Knowing what defines the attribute being measured is complex for young students. For example, students may think of length as an attribute of an object, but not as the distance between two points. They may focus on one dimension (length) when comparing areas or volumes or they may confuse quantities, such as length and area, or volume and mass.

At Level 1 when quantities are introduced they are compared directly to enable students to clarify the attribute, to discuss relative size and to practise specific terminology. The words "bigger" and "smaller" are not precise terms and can contribute to students' confusion about quantities. "Bigger" could mean an object was longer than another, one of its surfaces had more area, or that it had a greater volume or a larger mass than another object. In addition, students measure lengths and areas as parts of three-dimensional objects, so the students have to be clear about which part they are measuring.

The concept that lengths can only be compared if the ends are aligned (establishing a "baseline") is also important at this level, as is superimposition of areas to compare size.

Level 2 Informal units

At Level 2, students choose as many informal units as they need and use them to measure and compare quantities. It is important to establish the procedure of aligning, covering or packing units of length, area and volume, and to continue to develop language and recording skills.

Informal units are used for two reasons. The first is to emphasise that different units can be used to measure the same quantity but that identical units must be used when quantities are compared. The second reason is a practical one: standard units, such as centimetres and metres, are difficult for young students to manipulate.

When measuring with informal units, the attribute of the unit that is being used to measure should be emphasised. If three-dimensional shapes, such as cubes, are used to measure a length, students need to know which part of the cube is being used as the linear unit because the cube itself is a measure of volume and its faces are units of area. If cubes are used, the teacher should highlight an edge as the unit of length.

Level 3 Structure of iterated units

At this level students are given only ONE unit with which to measure so they have to construct the pattern (or structure) of the units by drawing or visualizing. Tracing units is not sufficient for Level 3 understanding because students can trace units without having knowledge of the spatial structure of the units. This level does not seem to have been included previously in measurement teaching programs.

As students construct the unit iteration they learn to describe the spatial structure of length, area and volume. For example, they may construct composite units of area (rows and columns) or volume (layers). Students are also introduced to standard units of length (decimetre) and area (a 10cm x 10cm tile). Because of the complexity of volume concepts, the emphasis is on developing the structure of rows, columns and layers. However, a 100-millilitre scoop is introduced to lead into formal units of capacity. In this book, capacity is used for liquid measure (ml and L) while volume is used for interior space and the space an object takes up (exterior volume and displacement).

In addition to the structure of how units fill space, the relationship between unit size and the number of units required is developed. For example, twice as many new length units (5 cm long) will be required if the original length unit (of 10 cm) is halved. Such relationships are more complex for area and volume than for length, and will need to be built up using practical experiences with concrete materials.

Level 4 Measure using conventional units

At this level students measure and record in the formal units which form the basis of the many common measuring activities in everyday life. These include metres, centimetres, square metres, square centimetres, litres, cubic centimetres, kilograms and grams. It is important that students have practical experiences which assist them to develop an understanding of the relative size of each unit. In addition, students should nominate the most practical unit of measure for specific tasks, to record measurements accurately and to interpret measurements on a diagram or given in instructions.

Activities in area and volume continue the emphasis on identifying and using the array or layer structure of repeated units to count the total number of units used.

Knowledge of how to select and use appropriate instruments is critical to accurate and efficient measuring. Students should be encouraged to estimate before measuring, and to explain their estimation strategy.

In level 4 and level 5, volume and capacity are described separately, so that capacity is referred to in 4.1 and 5.1, and volume is described in 4.2 and 5.2.

Level 5 Relationships between formal measurement units

At this level, students investigate the calculation of perimeter, area, volume and capacity and mass. Students extend their measuring skills and understanding of how to use repeated units to include the measurement of perimeter and area. Learning activities at this level focus on developing an understanding of how attributes are measured, rather than memorisation and application of formulas or rules. Activities involving drawing, cutting and comparing assist students to investigate the area of triangles. The emphasis on packing in layers to measure volume in level 4, is continued in level 5, with greater use of counting in multiples to calculate the total volume of all layers.

Tasks which include converting between units, such as converting centimetres to metres, or millilitres to litres, provide a link with number concepts of division and multiplication. The familiarity with the names, abbreviations, and relative sizes of measurement units which was established during practical activities in Level 4, will assist students to read and record measurements in decimal notation at Level 5.

Level 6 Knowing and representing large units

At this level, students extend their knowledge of standard units of measure to include larger units such as kilometres, square kilometres, hectares, cubic metres and tonnes. Activities focus on practical situations in which these units of measure are used.

Students investigate and describe the relationship between cubic centimetres and millilitres through displacement activities. Simple scales are used to calculate length and area in kilometres , square kilometres and hectares. Students use their understanding of attributes and appropriate units of measure to calculate, convert and record measurements.

GETTING STARTED

You might like to start by looking at the knowledge and strategies described in the framework. Make an estimate of what your students already know and try a lesson at that level. The results will indicate if the level is too easy or too difficult or your intuition was correct.

Check that students understand how to use and record the formal units of measure which are appropriate to the quantity being measured. Students also need to understand how to convert units of measure, and to express measurements to two and three decimal places.

It is important that students have access to a variety of measuring instruments, so they can choose and use equipment which is suitable for the task. You may need to organise groupwork around different activities if your school does not have sufficient equipment for all students to engage in the same measurement tasks.

When appropriate, ask students to demonstrate how they will measure. Sharing approaches is valuable as strengths and weaknesses of different methods can be discussed. You might demonstrate an inaccurate or impractical method and ask students how they could improve it.

Programming

It is suggested that you plan and present a block of three or four lessons based on one substrand, before moving on to a second or third substrand. This programming strategy will assist students to consolidate the essential knowledge of attributes, correct terminology and measurement techniques for each quantity. You should ensure that students are familiar with the concepts of measuring length before the activities for area and volume are commenced. When using the measurement framework as a guide to sequence lessons, remember that students are not expected to be at the same level in each substrand.

Assessing students' understanding of measurement

The Lesson ideas provide several different but related activities at each Level. This enables assessment of similar concepts as students complete different activities. Students in one group could be individually questioned on one day as they work on one activity; with a different group of students completing one of the related activities becoming the focus for observation in another lesson. Encourage students to record and describe their findings. These make excellent work samples for explaining and sharing methods, reporting back, student portfolios and displays, or they can be taken home to share with parents.

GLOSSARY

Area

Part of a two-dimensional surface (plane or curved) enclosed within a specified boundary or geometric figure The measure or extent of such a surface, or part of it (measured in square units)

Array

A set of elements arranged in a pattern of rows and columns

Attributes

Properties or characteristics

Capacity

A term used for a measure of internal volume (often used for liquid measure and given in litres or millilitres)

Conservation

The principle that a quantity (length, area, volume, mass) remains constant during rearrangement or reorganisation

Discrete

Individual parts or items

Displacement

The volume or the mass of fluid displaced by a floating or submerged object is equal to the volume or the mass of the submerged body

Estimate

An approximate judgment or calculation of an amount of something

Iteration

The act of doing something repeatedly; repeated application of a procedure

Layer

A thickness of material spread on or placed on a surface

Length

A measure of a line segment that is unaffected by changing the orientation of the line

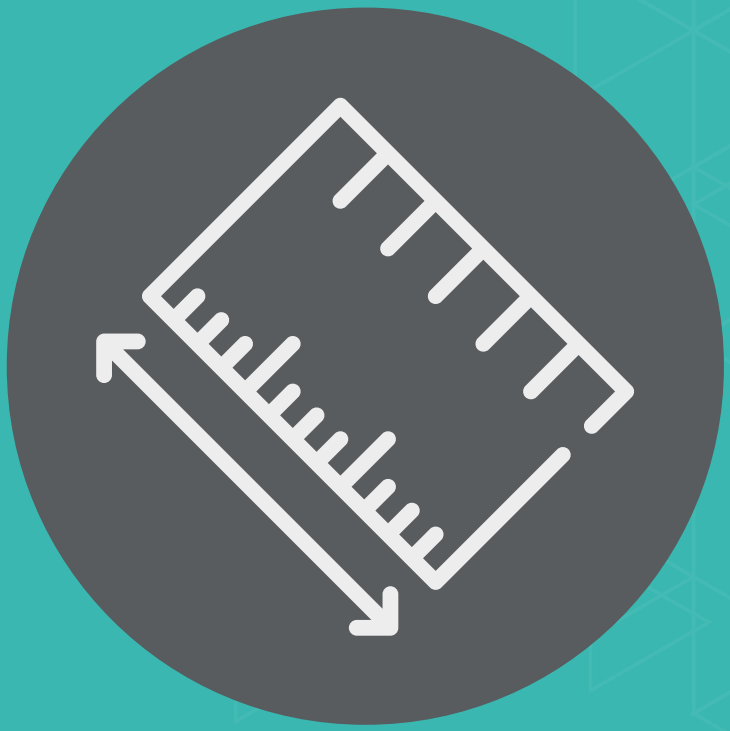
Row or column

An arrangement of objects in a straight line (the convention for an array or grid is that rows are horizontal and columns are vertical)

Tessellation

A covering of a surface with identical shapes (paving). The shapes fit together without gaps or overlap and can be extended infinitely in any direction

Teaching Measurement
LENGTH



LEVEL DESCRIPTIONS FOR LENGTH

Level 1	Knowledge and strategies
L1.1 Identification of the attribute Make direct comparisons of length	1. use length vocabulary, *e.g. long, high, tall; short or low; the same as* 2. put two lengths side by side to compare their lengths 3. straighten a curved or bent length to check if two lengths are the same
L1.2 Identification of the attribute Order two or more lengths by direct comparison	1. use comparative language, *e.g. longer, higher, taller than; shorter or lower than; the same as; shortest, longest* 2. ensure that ends are aligned for comparison by establishing a baseline 3. compare lengths systematically and explain why a length fits into a particular ordering
Level 2	**Knowledge and strategies**
L2.1 Informal measurement Choose and use appropriate units for measuring length	1. align identical units end to end along a given line without overlapping or leaving gaps 2. state or record that the length is the number and type of units used 3. use approximate language to explain parts of units, *e.g. about half a unit* 4. measure a circumference using string or paper strips, without overlapping ends
L2.2 Informal measurement Compare and order lengths by using identical units for each length	1. choose identical units to measure lengths 2. know that the longer line has more units 3. estimate the number of units and explain the estimation strategy 4. know that length is conserved if rearranged
Level 3	**Knowledge and strategies**
L3.1 Structure of repeated units Use one unit to measure length	1. measure precisely by repeating one unit 2. know that lengths (not marks or spaces) are counted 3. use a 10 cm strip as a unit to measure length
L3.2 Structure of repeated units Explain the relationship between unit size and number of units used to measure length	1. explain the relationship between unit size and number of units 2. use the metre as a unit to measure lengths 3. know that measurement techniques must be consistent and precise
Level 4	**Knowledge and strategies**
L4.1 Measure using conventional units Measure and record 1 metre	1. identify lengths which are approximately 1 metre 2. use a ruler to accurately make a length of 1 metre 3. label and record lengths using the abbreviation m
L4.2 Measure using conventional units Measure and record in centimetres	1. measure lengths to the nearest centimetre 2. estimate lengths in centimetres 3. label and record lengths using the abbreviation cm
Level 5	**Knowledge and strategies**
L5.1 Relationships between formal measurement units Measure lengths and perimeters in metres and centimetres	1. choose an appropriate measuring device 2. use measuring devices accurately (trundle wheel, ruler and tape measure) 3. measure the perimeter of two dimensional shapes in metres and centimetres
L5.2 Relationships between formal measurement units Measure and calculate lengths and perimeters in metres, centimetres and millimetres	1. calculate and record lengths and perimeters of rectangles and triangles in centimetres and millimetres 2. convert between metres and centimetres, and centimetres and millimetres 3. calculate and record lengths and perimeters of rectangles and triangles in metres using decimal notation to two decimal places
Level 6	**Knowledge and strategies**
L6.1 Knowing and representing large units Calculate lengths, distances and perimeters in kilometres Interpret a simple scale	1. calculate and record length, distance and perimeter in kilometres 2. use the abbreviation km 3. read and interpret a simple scale
L6.2 Knowing and representing large units Convert units of length to calculate and compare lengths, distances and perimeters Use a simple scale	1. convert units of length 2. use length in calculations using decimal notation to three decimal places 3. develop and use a simple scale to calculate length or distance

LENGTH

Length is usually one of the first measurement concepts students encounter. An understanding of length is crucial, as it is the foundation for building concepts of area and volume. Sometimes students can measure lengths without really understanding what a length is. Length can be a property of an object or shape, as in the lengths of the sides of a triangle or the edges of a desk. Length can be a height of a tree or a student, or it can be a distance, such as from the desk to the door, or from the school to the station.

The three-dimensional nature of the object being measured may obscure the linear nature of length. If the height of a tree or a person is being measured, what is really being measured is an imaginary line, which is perpendicular to the floor, and joins a point on the floor to a point on the top of the tree or the top of the person's head. Using a string pulled taut to measure heights or distance may help students imagine such a line. In most real-life contexts, the line that is being measured has to be imagined and the person measuring has to decide where and how length will be measured.

Teachers can model how to measure length so that students understand the need to take care when they align units, particularly when using one unit. Discussing which methods of measuring are more precise than others will emphasise the importance of keeping the size of the unit the same. Common errors made by students include putting finger spaces between the units or moving the unit without marking the end of each move carefully.

Some students learn a procedure to measure lengths by aligning one end of the ruler with the object and reading the number that corresponds to the other end of the object. In this way, students can use a ruler without knowing how its scale is constructed. Students may not be sure whether to measure from 0 or 1 on the ruler. Frequently students think that the marks, instead of the distance between the marks, are the units of measure. The experience of making a ruler by choosing, marking and numbering the informal units may assist students to understand how a ruler works.

An understanding of geometrical properties can be important in length measurement. When students measure a table or a desk, they usually measure along one edge. Some students may not realize that the length of a rectangular desk will be the same if it is measured along any imaginary line parallel to the edge.

Lengths can be added together and when measuring a length that is not in a straight line, such as the perimeter of a shape, each part can be measured separately and the lengths added together. Longer distances may be measured with a trundle wheel but students may need to be convinced that one rotation of the wheel is the same length as a metre ruler.

LENGTH LESSON IDEAS

Length 4.1

Concertina metre
Towering metres (lesson plan)
The human tape measure
Snakes alive
Ready set go!

Length 4.2

How to use a ruler
Any three items (lesson plan)
Draw it to fit
Measure and design
Bottle measures

Length 5.1

Trundle wheels (lesson plan)
Introduction to perimeter
Shapes to order
Room for elbows
Cut in half

Length 5.2

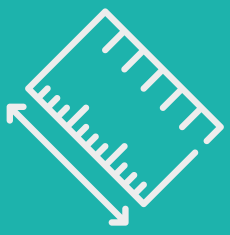
Body parts (lesson plan)
String triangles
Kathys and Kyles
Centimetres, centimetres, centimetres!
Make an envelope

Length 6.1

How far is a kilometre? (lesson plan)
Desks over the horizon
How long?
Introduce scale
Finding the detail

Length 6.2

Design a cross country track (lesson plan)
Walk for 1 kilometre
Marathon
Mystery Flight
Plan a trip



LENGTH 4.1
Lesson ideas

Measure using conventional units
Measure and record 1 metre

Knowledge and strategies
1. identify lengths which are approximately 1 metre
2. use a ruler to accurately make a length of 1 metre
3. label and record lengths using the abbreviation m

Concertina metre

Groups of students make a metre strip using 10 centimetre strips which are taped together, end to end. Students check that their metre length is correct with a metre ruler. Group members fold the strip backwards and forwards in a concertina fashion at the 10 centimetre marks. Students record the estimate and then the count of how many 10 centimetre strips were needed and why.

Outcomes
MA2-2WM
MA2-9MG

Materials
- photocopy of 10 cm strips, tape, scissors, metre rulers

Knowledge and strategies
1. identify lengths which are approximately 1 metre
2. use a ruler to accurately make a length of 1 metre
3. label and record lengths using the abbreviation m

Towering metres (see lesson plan)

Students work in small groups to build a tower that is 1 metre high. Students estimate when their tower has reached 1 metre, then measure to check. Students make adjustments to the height of the tower, if necessary. The group reports back to the class on how close their estimate was to 1 metre. Individual students record how the estimate was made, and the measured result.

Outcomes
MA2-3WM
MA2-9MG

Materials
- building objects or materials for tower, metre rulers, paper and pencils

Knowledge and strategies
1. identify lengths which are approximately 1 metre
2. use a ruler to accurately make a length of 1 metre
3. label and record lengths using the abbreviation m

The human tape measure

Students each make a paper streamer 1 metre long. Students compare the length of their streamer with three other students to ensure an accurate length.

Additional whole-class activity: students estimate, then measure, the distance of about 20 m. Students stand in a line, each holding an end of their own metre, end-to-end with the next student's streamer, until the total is 20 metres.

Outcomes

MA2-3WM
MA2-9MG

Materials

- paper streamers, metre rulers, scissors, pencils

Knowledge and strategies

1. identify lengths which are approximately 1 metre
2. use a ruler to accurately make a length of 1 metre

Rolling metres

Use a paint roller, brush or chalk to make a line or curve which measures approximately 1 metre. Check with a metre length (string or paper) to find if the estimate was more than, less than or exactly 1 metre.

Discuss and record how the metre length was estimated, and the final measure recorded.

Outcomes

MA2-3WM
MA2-9MG

Materials

- 1 metre length, paint roller, chalk or brush, pencils and paper

Knowledge and strategies

1. identify lengths which are approximately 1 metre
2. use a ruler to accurately make a length of 1 metre

Ready set go!

Students examine a plastic drink bottle and predict which length will be the greater – the height or the measurement around the bottle (circumference), by estimating the two lengths in centimetres. Students record their estimates on a labeled drawing, then measure the bottle and record the final measurements in centimetres.

Outcomes

MA2-1WM
MA2-9MG

Materials

- selection of rulers, tape measures, string, streamers, bottles, pencils and paper

Knowledge and strategies

1. measure lengths to the nearest centimetre
2. estimate lengths in centimetres
3. label and record lengths using the abbreviation cm

LENGTH 4.1
Lesson plan

Measure using conventional units
Measure and record 1 metre

TOWERING METRES

Students work in small groups to build a tower that is 1 metre high. Students estimate when their tower has reached 1 metre, then measure to check. Students make adjustments to the height of the tower, if necessary. The group reports back to the class on how close their estimate was to 1 metre. Individual students record how the estimate was made, and the measured result.

Students should

1. identify lengths which are approximately 1 metre
2. use a ruler to accurately make a length of 1 metre
3. label and record lengths using the abbreviation m

Outcomes

MA2-3WM checks the accuracy of a statement and explains the reasoning used

MA2-9MG measures, records, compares and estimates lengths, distances and perimeters in metres, centimetres and millimetres, and measures, compares and records temperatures

Grouping

Step 1: whole-class introduction

Step 2: working in small groups

Step 3: whole-class discussion

Materials

building objects or materials for tower, metre rulers, paper and pencils

Step 1

Discuss why a standard unit is used to measure lengths or distances.

List the names of units used to measure length and ask students to demonstrate the approximate size of the units.

Discuss the tools which are used to measure length.

Introduce or revise the metre as a standard unit to measure length.

Use a metre ruler to demonstrate the length or height of a metre.

Demonstrate 1 m height by holding the metre ruler upright against a student.

Demonstrate 1 m width by placing the metre ruler across the classroom doorway.

Introduce the task: small groups will construct a tower 1 metre high.

Questioning

Why is it important to have an accurate unit of measure?

What are the units that we use to measure how long, how high, or how far?How long would each of these units be?

What equipment do we use to measure length?

What is the name of this unit of length?

Can you see things in the room that may be about 1 metre wide or high?

Where would 1 metre reach on your body, if we measured from the floor?

Step 2

Have your students work in groups to:

- discuss the material to be used in the tower, including stacking materials, or building materials such as rolled paper or sticks
- build the tower until group members estimate it is 1 metre high
- check the height of the tower with a metre ruler and correct if necessary
- individually record the building and measuring processes with a labeled drawing and explanation of estimate and correction.

Check that students

- make a reasonable estimation of 1 metre
- measure the height accurately
- use the abbreviation m in their recording and labeling.

Step 3

Groups display their towers.

Discuss the difficulty of estimating 1 metre.

Compare the strategies used to build towers and the stability of the towers.

Discussion

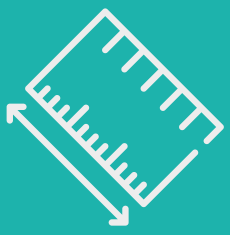
How close was your estimation to

1 metre?

What could you use to help you to estimate 1 metre?

Which is the strongest or most stabile tower?

How would you build a tower next time?



LENGTH 4.2
Lesson ideas

Measure using conventional units
Measure and record in centimetres

Knowledge and strategies
1. measure lengths to the nearest centimetre
2. estimate lengths in centimetres
3. label and record lengths using the abbreviation cm

How to use a ruler

Begin the lesson with a whole-class discussion of how to use a ruler to draw and measure lines which have a length of a whole number of centimetres. Students check their rulers to see where the zero is marked, and practise drawing and measuring a line by starting at this point.

Students work in pairs, student A and student B. Student A draws five lines for student B, each line to be an exact number of centimetres and a length of less than 30 cm. Student B estimates the length of each line, records the estimate, then measures and labels each line. The roles are then reversed.

Outcomes
MA2-2WM
MA2-9MG

Materials
- 30 cm rulers, pencils and paper

Knowledge and strategies
1. measure lengths to the nearest centimetre
2. estimate lengths in centimetres
3. label and record lengths using the abbreviation cm

Any three items (see lesson plan)

Students work in pairs to find three items in the classroom which have a total length of 25 centimetres. Students record their findings by drawing the items, labeling with the measurements in centimetres, and showing how the three lengths were added to make a total of 25 centimetres.

Outcomes
MA2-3WM
MA2-5NA
MA2-9MG

Materials
- access to objects to measure, 30 cm rulers, pencils and paper

Knowledge and strategies
1. measure lengths to the nearest centimetre
2. estimate lengths in centimetres
3. label and record lengths using the abbreviation cm

Draw it to fit

Students choose a rectangular object and measure the edges of one face. Students draw the face, using the measured dimensions, and label with the measurements. Students superimpose the object on the drawing to see if the drawing is correct.

Variation: cut out the drawing and match to the face of the object.

Outcomes
MA2-3WM
MA2-9MG

Materials
- rectangular objects to measure, 30 cm rulers, pencils and paper

Knowledge and strategies
1. measure lengths to the nearest centimetre
2. label and record lengths using the abbreviation cm

Measure and design

Pairs of students work with strips of material such as streamers, ribbons, cardboard or wallpaper. Each student measures, cuts and labels six strips in lengths specified by the teacher. Lengths may include 12 cm, 15 cm, 20 cm, 5 cm, 3 cm, 10 cm, 26 cm, etc.

Students check that their lengths are correct by comparing each strip with their partner's corresponding strip, and measuring with a ruler if necessary. Students incorporate the strips into a design or picture.

Outcomes
MA2-2WM
MA2-9MG

Materials
- streamers, straws, ribbons, cardboard strips, 30 cm rulers, scissors, pencils, paste, backing paper for design

Knowledge and strategies
1. measure lengths to the nearest centimetre
2. estimate lengths in centimetres
3. label and record lengths using the abbreviation cm

Bottle measures

Students examine a plastic drink bottle and predict which length will be the greater – the height or the measurement around the bottle (circumference), by estimating the two lengths in centimetres. Students record their estimates on a labeled drawing, then measure the bottle and record the final measurements in centimetres.

Outcomes
MA2-1WM
MA2-9MG

Materials
- selection of rulers, tape measures, string, streamers, bottles, pencils and paper

Knowledge and strategies
1. measure lengths to the nearest centimetre
2. estimate lengths in centimetres
3. label and record lengths using the abbreviation cm

LENGTH 4.2
Lesson plan

Measure using conventional units
Measure and record in centimetres

ANY THREE ITEMS

Students work in pairs to find three items in the classroom which have a total length of 25 centimetres. Students record their findings by drawing the items, labeling with the measurements in centimetres, and showing how the three lengths were added to make a total of 25 centimetres.

Students should

1. measure lengths to the nearest centimetre
2. estimate lengths in centimetres
3. label and record lengths using the abbreviation cm

Outcomes

MA2-3WM checks the accuracy of a statement and explains the reasoning used

MA2-5NA uses mental and written strategies for addition and subtraction involving two-, three-, four- and five-digit numbers

MA2-9MG measures, records, compares and estimates lengths, distances and perimeters in metres, centimetres and millimetres, and measures, compares and records temperatures

Grouping

Step 1: whole-class introduction

Step 2: working in pairs

Step 3: whole-class discussion

Materials

access to objects to be measured, 30 cm rulers, pencils and paper

Step 1

Revise the important techniques of using a ruler: measuring centimetres from the zero point and reading whole centimetres.

Discuss how long 25 centimetres is and demonstrate a length of 25 centimetres to the students.

Explain to the students that they need to find three objects that have a combined length of 25 cm. Ask students to suggest how this could be achieved.

Discuss different objects that are suitable for measuring.

Explain that the students will need to draw and label the three objects accurately so that they total 25 centimetres.

Questioning

How do I use a ruler to measure a length? What mistakes could I make?

What does 25 cm mean?

What objects would be shorter than 25 centimetres?

How will you make a total length of 25 centimetres?

How will you draw and record your measurements?

What units of measure will you use?

Step 2

Have your students work in pairs to:

- find three objects or items which will measure a total length of 25 centimetres
- measure the objects with their rulers
- draw the objects and label the length of each one
- demonstrate that the total length is 25 centimetres.

Check that students

- estimate before they measure
- commence their measurement from the zero point on the ruler
- measure accurately with the rulers
- record and label the lengths correctly.

Step 3

Selected pairs of students display their labeled drawings and explain the process of identifying and measuring three suitable objects.

Discussion

Tell us how you found your three objects. How did you solve your problems? What advice would you give to someone doing this task?

LENGTH 5.1
Lesson ideas

Relationships between formal measurement units
Measure lengths and perimeters in metres and centimetres

Knowledge and strategies
1. choose an appropriate measuring device
2. use measuring devices accurately (trundle wheel, ruler and tape measure)
3. measure the perimeter of two dimensional shapes in metres and centimetres

Trundle wheels (see lesson plan)
Small groups of students investigate the length measured by one rotation of the trundle wheel. Students can either: (1) draw a chalk line along the ground as the wheel rotates once, (2) draw a line one metre long, or place the 1 metre ruler on the ground and rotate the wheel along the line, (3) cut a piece of string 1 metre long and place it around the wheel or (4) place a tape measure around the wheel.

Students record the procedure used to measure the length and report on the accuracy of their group's trundle wheel.

Extension: students measure and record the perimeter of playground markings or pathways. Groups compare their measurements and report on any differences.

Outcomes
MA2-3WM
MA2-9MG

Materials
- trundle wheels, metre rulers, string, tape measures, pencils and paper

Knowledge and strategies
1. choose an appropriate measuring device
2. use measuring devices accurately (trundle wheel, ruler and tape measure)

Introduction to perimeter
Pairs of students find the perimeter of a rectangle or square by measuring, recording and then adding each side. Examples may include rectangular cards or drawings with sides which measure a whole number of centimetres.

Students discuss the possible methods of finding the perimeter of a rectangle, and report on whether it is necessary to measure all four sides of a rectangle or square.

Variation: measure and record the perimeter of a desk or two desks joined together, by measuring one edge at a time. Record the perimeter in metres and centimetres. Check by using a long tape measure or piece of string.

Outcomes
MA2-2WM
MA2-9MG

Materials
- 2D shapes or small cards, pencils, paper, 30 cm rulers, tape measures, pencils and paper

Knowledge and strategies
1. choose an appropriate measuring device
2. use measuring devices accurately (trundle wheel, ruler and tape measure)
3. measure the perimeter of two dimensional shapes in metres and centimetres

Shapes to order

Students draw and label rectangles and squares which have specified perimeters, e.g. 20 cm, 36 cm, 1 m 20 cm, 3.6 m.

Students work in groups to record as many different rectangles as possible in a set time.

Note: 1 cm grid paper may assist students who have difficulty in drawing lines.

Outcomes
MA2-2WM
MA2-9MG
MA2-5NA

Materials
- rulers, measuring tapes, chalk for drawing on asphalt, pencils and paper

Knowledge and strategies
1. choose an appropriate measuring device
2. use measuring devices accurately (trundle wheel, ruler and tape measure)
3. measure the perimeter of two dimensional shapes in metres and centimetres

Room for elbows

Students design a dinner table which will seat four students along each side, with enough space to eat comfortably. Students draw a diagram of the table with listed reasons for the dimensions.

Outcomes
MA2-1WM
MA2-9MG
MA2-5NA

Materials
- rulers, tape measures, table and chairs, pencils and paper

Knowledge and strategies
1. choose an appropriate measuring device
2. use measuring devices accurately (trundle wheel, ruler and tape measure)
3. measure the perimeter of two dimensional shapes in metres and centimetres

Cut in half

Students choose a large, rectangular picture from a magazine. Students measure and record the perimeter. The picture is cut in half and the perimeter measured and recorded again. Students cut the picture in half again and measure the perimeter.

Students record results with labeled diagrams and comment on how the measurements are changing.

Extension: present the results in a table and graph.

Outcomes
MA2-1WM
MA2-9MG

Materials
- selection of rulers, tape measures, string, streamers, bottles, pencils and paper

Knowledge and strategies
1. measure lengths to the nearest centimetre
2. estimate lengths in centimetres
3. label and record lengths using the abbreviation cm

LENGTH 5.1
Lesson plan

Relationships between formal measurement units
Measure lengths and perimeters in metres and centimetres

TRUNDLE WHEELS

Small groups of students investigate the length measured by one rotation of the trundle wheel. Students either: (1) draw a chalk line along the ground as the wheel rotates once, (2) draw a line 1 metre long, or place the 1 metre ruler on the ground and rotate the wheel along the line, (3) cut a piece of string 1metre long and place it around the wheel or (4) place a tape measure around the wheel.

Students record the procedure used to measure the length and report on the accuracy of their group's trundle wheel.

Extension: students measure and record the perimeter of playground markings or pathways. Groups compare their measurements and report on any differences.

Students should

1. choose an appropriate measuring device
2. use measuring devices accurately (trundle wheel, ruler and tape measure)

Outcomes

MA2-3WM checks the accuracy of a statement and explains the reasoning used

MA2-9MG measures, records, compares and estimates lengths, distances and perimeters in metres, centimetres and millimetres, and measures, compares and records temperatures

Grouping

Step 1: whole-class introduction

Step 2: working in small groups

Step 3: whole-class discussion

Materials

trundle wheel, metre ruler, string, tape measure, pencils and paper

Step 1

Introduce the lesson as an investigation of the accuracy of trundle wheels for measuring length or distance in metres.

Ask a student to demonstrate how a trundle wheel works, and explain how it is used to measure length.

Ask students to describe when it would be appropriate to use a trundle wheel to measure.

Introduce the task: students will report on the accuracy of their trundle wheel as a tool for measuring 1 metre.

Discuss the strategies that students may choose, and list these on the chalkboard (see description of lesson).

Discuss how the students' reports should indicate exactly how close to 1 metre their trundle wheel will measure.

Questioning

How does this tool work? What is it measuring?

When are trundle wheels the best tools to use? Why not use lots of 1 metre rulers? Why is it important to check the accuracy of tools?

What methods could you use to test the accuracy. How close to 1 metre is "close enough" when measuring in metres? Why?

Step 2

Have your students work in small groups to:

- discuss and decide upon a method of testing
- measure the distance covered in one rotation of the wheel as accurately as possible
- record the measurement and report on any variations from the ideal length of 1 metre.

Check that students

- participate in the group investigation
- understand how and when to use a trundle wheel
- measure 1 metre accurately
- understand the need for accurate equipment.

Step 3

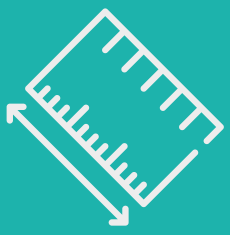
Discuss the errors that may occur when using a trundle wheel, and how to avoid these.

Discuss which methods of checking the trundle wheels may be more accurate.

Discussion

What advice would you give to a student who wants to measure very accurately with a trundle wheel?

Which methods were more accurate than others? Why?



LENGTH 5.2
Lesson ideas

Relationships between formal measurement units

Measure and calculate lengths and perimeters in metres, centimetres and millimetres

Knowledge and strategies

1. calculate and record lengths and perimeters of rectangles and triangles in centimetres and millimetres
2. convert between metres and centimetres, and centimetres and millimetres
3. calculate and record lengths and perimeters of rectangles and triangles in metres using decimal notation to two decimal places

Body parts (see lesson plan)

Students work in groups of five or six to measure, record and compare body parts, e.g. height, head size, wrist and ankles measurement, total length of fingernails, circumference or total length of fingers on one hand. Students record their measurements and comment on relationships between body parts, such as length of arms and length of fingers, or length of feet and height.

Extension: students present the group members' measurements in a graph.

Outcomes

MA2-1WM
MA2-2WM
MA2-9MG
MA2-7NA

Materials

- tape measures, 30 cm rulers, string or streamers, pencils and paper

Knowledge and strategies

1. calculate and record lengths and perimeters of rectangles and triangles in centimetres and millimetres
2. convert between metres and centimetres, and centimetres and millimetres
3. calculate and record lengths and perimeters of rectangles and triangles in metres using decimal notation to two decimal places

String Triangles

Students use a piece of string 1 metre long to experiment with making triangles. Students measure the lengths of the sides of the triangles in centimetres and millimetres. Students record and label the triangles as right-angled, isosceles, equilateral, or scalene. Students check the measurements on the drawn triangles to ensure that each triangle has a perimeter of 1 metre.

Extension: experiment with other shapes.

Outcomes

MA2-2WM
MA2-9MG
MA2-5NA

Materials

- 1 metre length of string for each student or pair of students, 30 cm rulers

Knowledge and strategies

1. calculate and record lengths and perimeters of rectangles and triangles in centimetres and millimetres
2. convert between metres and centimetres, and centimetres and millimetres
3. calculate and record lengths and perimeters of rectangles and triangles in metres using decimal notation to two decimal places

Kathys and Kyles

Students work in small groups to estimate how far they can run in ten seconds. Students measure the distance in metres and record using decimal notation to two decimal places. **Extension:** students calculate their running speed in km/h.

Outcomes

MA2-2WM
MA3-13MG
MA2-9MG

Materials

- stop watches, or watches, trundle wheels, measuring tapes, rulers, paper and pencils

Knowledge and strategies

1. convert between metres and centimetres, and centimetres and millimetres
2. calculate and record lengths and perimeters of rectangles and triangles in metres using decimal notation to two decimal places

Centimetres, centimetres, centimetres!

Students work in pairs or small groups to measure, cut and label lengths of streamer:

- one 1 m strip
- two 0.5 m (1/2 m) strips
- four 0.25 m (1/4 m) strips
- five 0.2 m (1/5 m) strips
- ten 0.1 m (1/10 m) strips

On a large piece of paper at least 1 m x 20 cm, students paste the smaller strips under the 1 m strip, so that each line is equal to 1 metre. Label each line, e.g. 50 cm + 50 cm = 1 m or 0.5 m + 0.5 m = 1 m

Note: the finished product may look more attractive if students are able to select a different colour for each line.

Outcomes

MA2-1WM
MA2-9MG
MA2-7NA

Materials

- streamers, scissors, rulers, paste, pencils, large sheet of paper

Knowledge and strategies

1. convert between metres and centimetres, and centimetres and millimetres
2. calculate and record lengths and perimeters of rectangles and triangles in metres using decimal notation to two decimal places

Make an envelope

Students design a greeting card approximately 12 cm by 18 cm. Students make a simple envelope for the card, ensuring there is enough space around the card so that it will fit into the envelope. Students draw diagrams of how to cut and fold the envelope and label with the correct measurements.

Outcomes

MA2-1WM
MA2-2WM
MA2-9MG

Materials

- light card, paper for envelopes, scissors, sticky tape, paste, 30 cm rulers, pencils and paper

Knowledge and strategies

1. calculate and record lengths and perimeters of rectangles and triangles in centimetres and millimetres
2. convert between metres and centimetres, and centimetres and millimetres

LENGTH 5.2
Lesson plan

Relationships between formal measurement units
Measure and calculate lengths and perimeters in metres, centimetres and millimetres

BODY PARTS

Students work in groups of five or six to measure, record and compare body parts, e.g. height, head size, wrist and ankles measurement, total length of fingernails, circumference or total length of fingers on one hand. Students record their measurements and comment on relationships between body parts, such as length of arms and length of fingers, or length of feet and height.

Extension: students present the group members' measurements in a graph.

Students should

1. calculate and record lengths and perimeters of rectangles and triangles in centimetres and millimetres
2. convert between metres and centimetres, and centimetres and millimetres
3. calculate and record lengths and perimeters of rectangles and triangles in metres using decimal notation to two decimal places

Outcomes

MA2-1WM uses appropriate terminology to describe, and symbols to represent, mathematical ideas

MA2-2WM selects and uses appropriate mental or written strategies, or technology, to solve problems

MA2-9MG measures, records, compares and estimates lengths, distances and perimeters in metres, centimetres and millimetres, and measures, compares and records temperatures

MA2-7NA represents, models and compares commonly used fractions and decimals

Grouping

Step 1: whole-class introduction

Step 2: working in small groups

Step 3: whole-class discussion.

Materials

tape measures, 30 cm rulers, string or streamers, pencils and paper

Step 1

Introduce the task as the measurement and comparison of the length of different parts of the body .

Discuss using measuring equipment to obtain accurate measurements when measuring different body parts.

Discuss the units of measure which will be appropriate (centimetres and millimetres for fingernails, metres for height).

Ask students to suggest measurements which can be taken and compared.

Discuss the possibility that some body lengths are related, such as fingers and feet, or height and feet.

Introduce the task.

Questioning

What measuring device would you use to measure the length of body parts?

Which units of measure will you use, and how will these be recorded?

How are you going to ensure that the different body parts are measured in the same way for the different group members?

What could your group measure sensibly and accurately?

Do you think there will be a relationship between any body parts?

How are you going to work this out?

Step 2

Have your students work in small groups to:

- decide what body parts they are going to measure and what measuring eqipment they will use
- measure and record different body parts
- compare the results from members of the group
- discuss the relationship between two selected sets of measurements.

Check that students

- measure accurately
- choose appropriate measuring tools
- record results systematically
- record using appropriate units of measure.

Step 3

Groups report on their findings.

Discuss measurements which varied within groups.

Discuss the relationships between body parts.

Discussion

Tell us one interesting fact about your group's measurements.

Were there some measurements which had very big differences? Why?

Describe some interesting relationships that you found between the measurements.

LENGTH 6.1
Lesson ideas

Knowing and representing large units
Calculate lengths, distances and perimeters in kilometres; interpret a simple scale

Knowledge and strategies
1. calculate and record length, distance and perimeter in kilometres
2. use the abbreviation km
3. read and interpret a simple scale

How far is a kilometre? (see lesson plan)
Students discuss how kilometres are used as a unit to measure distance, and the relationship between metres and kilometres. Students discuss the distance represented by 1 kilometre, in terms of distance to local landmarks or walking routes in the school grounds, and the possible time taken to walk 1 kilometre.

Students discuss how to measure 1 kilometre in the school grounds, possibly by measuring 100 metres and multiplying by 10. Students estimate, then measure to see how long it takes them to walk 1 kilometre, e.g. by walking the 100 metres 10 times.

Variations: students estimate, then measure, how many steps they would take when walking 1 kilometre, or time taken by different age groups of students, or time taken to ride a bicycle or skateboard for 1 kilometre.

Outcomes
MA3-3WM
MA3-9MG
MA3-13MG

Materials
- trundle wheels, tape measures, watches or stop watches, pencils and paper

Knowledge and strategies
1. calculate and record length, distance and perimeter in kilometres
2. use the abbreviation km

Desks over the horizon
Students estimate, then calculate how many desks aligned end to end would fit into a line 1 kilometre long. Students record measurements and calculations.

Variation: students calculate how many times their body length would need to be repeated to measure 1 kilometre or how many times the length of a pair of students would need to be repeated.

Outcomes
MA3-1WM
MA3-9MG
MA3-6NA
MA3-7NA

Materials
- desks, measuring tapes, 30 cm and 1 m rulers, calculators, pencils and paper

Knowledge and strategies

1. calculate and record length, distance and perimeter in kilometres
2. use the abbreviation km

How long?

Students work in small groups to answer: How long is the wool in a ball of wool?Students may need to discuss a range of strategies before commencing to measure. Students express the measurement in kilometres, and in metres.

Outcomes

MA3-2WM
MA3-9MG
MA3-6NA
MA3-7NA

Materials

- balls of wool, measuring devices, pencils, paper

Knowledge and strategies

1. calculate and record length, distance and perimeter in kilometres
2. use the abbreviation km

Introduce scale

Students investigate how the representation of an object is reduced, when the object is drawn to scale.

Small groups of students photocopy an object such as a pencil. The pencil is photocopied again, reduced to 50% of the original size (1:2). The pencil is photocopied a third time, reduced to 25% of its original size (1:4). Students discuss the length of the pencil in the second and third photocopies, compared with the original length.

Students measure the length of an object (watch, pencil case, strip of paper) and predict the length when the object is drawn to a scale of 1:4. Check by cutting a strip of paper the predicted length, folding, and using this to measure the object.

Whole class discusses why and how maps are drawn to scale, and the units of measure which are commonly cited on a scale.

Outcomes

MA3-2WM
MA3-9MG
MA3-7NA

Materials

- different objects, 30 cm and 1 m rulers, photocopier, strips of paper, pencils

Knowledge and strategies

1. read and interpret a simple scale

Finding the detail

Whole class discusses how to use a scale to represent kilometres or metres on a street map.

Students are given a map of the local area, showing the location of the school. Students use the scale and a drawing compass to mark the area within 500 metres of the school in all directions. Students list the street names or landmarks within this area.

Outcomes

MA3-2WM
MA3-9MG
MA3-7NA

Materials

- local maps, grid paper, 30 cm rulers, pencils, paper

Knowledge and strategies

1. calculate and record length, distance and perimeter in kilometres
2. use the abbreviation km
3. read and interpret a simple scale

LENGTH 6.1
Lesson plan

Knowing and representing large units
Calculate lengths, distances and perimeters in kilometres; interpret a simple scale

HOW FAR IS A KILOMETRE?

Students discuss how kilometres are used as a unit to measure distance, and the relationship between metres and kilometres. Students discuss the distance represented by 1 kilometre, in terms of distance to local landmarks or walking routes in the school grounds, and the possible time taken to walk 1 kilometre.

Students discuss how to measure 1 kilometre in the school grounds, possibly by measuring 100 metres and multiplying by 10. Students estimate, then measure to see how long it takes them to walk 1 kilometre, e.g. by walking the 100 metres 10 times.

Variations: students estimate, then measure, how many steps they would take when walking 1 kilometre, or time taken by different age groups of students, or time taken to ride a bicycle or skateboard for 1 kilometre.

Students should

1. calculate and record length, distance and perimeter in kilometres
2. use the abbreviation km

Outcomes

MA3-3WM gives a valid reason for supporting one possible solution over another

MA3-9MG selects and uses the appropriate unit and device to measure lengths and distances, calculates perimeters, and converts between units of length

MA3-13MG uses 24-hour time and am and pm notation in real-life situations, and constructs timelines

Grouping

Step 1: whole-class introduction

Step 2: working in small groups

Step 3: whole-class discussion

Materials

trundle wheels, tape measures, watches or stop watches, pencils and paper

Step 1

Introduce the lesson as the measurement of distance, in kilometres.

Ask students to describe a kilometre in terms of a distance and the time taken to walk a kilometre.

Revise or introduce the relationship between metres and kilometres.

Show students how to use the abbreviation km.

Discuss how the students could measure 1 kilometre. Students may decide to use a 50 m, 100 m or 200 m length.

Discuss how students will calculate time taken to walk a kilometre. Encourage students to think carefully if they suggest walking briskly for 50 m or 100 m and then multiplying the time taken by 20 or 10.

Questioning

What is the unit which we use to measure distances, such as from the school to the next suburb or town, or from here to the city? Where do you see these distances recorded?

How far is a kilometre and how long would it take you to walk a kilometre?

How could you measure 1 kilometre in the school grounds?

What equipment will you use?

How will you calculate the time taken to walk 1 kilometre?

Think carefully about the distance. How would you expect the distance of 1 kilometre to affect your overall walking speed?

Step 2

Have your students work in pairs or small groups to:

- measure and mark the chosen length
- measure and record the time taken to walk the marked length
- calculate and record the time taken to walk 1 kilometre
- present results with a map of the marked length.

Check that students

- select and use appropriate measuring equipment
- measure accurately
- understand the relationship between metres and kilometres
- calculate and record the time taken to walk 1 kilometre.

Step 3

Discuss methods used by students to measure 1 kilometre.

Discuss differences in students' results of time taken.

Ask students to suggest variations which could be measured, such as the number of steps taken in 1 kilometre, the difference between Kindergarten walkers and Year 5 walkers, or the time taken to ride a bicycle or skate board for 1 kilometre.

Discussion

What strategy did you use to identify a distance of 1 kilometre?

Why do we have some slightly different answers?

What else could we measure and compare, in the time taken to walk or travel 1 kilometre?

LENGTH 6.2
Lesson ideas

Knowing and representing large units

Convert units of length to calculate and compare lengths, distances and perimeters; use a simple scale

Knowledge and strategies

1. convert units of length
2. use length in calculations using decimal notation to three decimal places
3. develop and use a simple scale to calculate length or distance

Design a Cross Country track (see lesson plan)

Students work in pairs or small groups to design a 3 kilometre cross country course for their school. Students draw the course to scale and label their plan with the scale used and the length of each part of the course.

Outcomes

MA3-2WM
MA3-9MG
MA3-5NA

Materials

- grid paper, 30 cm rulers, trundle wheels, pencils and paper

Knowledge and strategies

1. convert units of length
2. use length in calculations using decimal notation to three decimal places
3. develop and use a simple scale to calculate length or distance

Walk for 1 kilometre

Students use a street map and its scale to mark routes 1 km from the school. Each route of 1 km must follow streets on the map.

Outcomes

MA3-2WM
MA3-9MG
MA3-7NA

Materials

- street maps, 30 cm rulers, pencils and paper, paper strips

Knowledge and strategies

1. convert units of length
2. use length in calculations using decimal notation to three decimal places
3. develop and use a simple scale to calculate length or distance

Marathon

Students use a local street map to plan a marathon route of 42 km.

Extension: Compare the geographical and weather conditions on the designed route with the Sydney 2000 Olympic route and predict a winning time to complete the marathon

Outcomes

MA3-1WM
MA3-9MG
MA3-7NA

Materials

- local maps, paper, grid paper, pencils, paper

Knowledge and strategies

1. convert units of length
2. use length in calculations using decimal notation to three decimal places
3. develop and use a simple scale to calculate length or distance

Mystery Flight

Students use the scale on an atlas map of NSW (teachers may have to enlarge a map and its scale). Students plan a mystery flight of 1000 kilometres (for example), which commences from the nearest airport and includes up to four take-offs and landings.

Outcomes

MA3-2WM
MA3-9MG
MA3-7NA

Materials

- atlas map of NSW or Australia, 30 cm rulers, pencils and paper

Knowledge and strategies

1. convert units of length
2. use length in calculations using decimal notation to three decimal places
3. develop and use a simple scale to calculate length or distance

Plan a Trip

Students use a website to complete an itinerary for a trip. On the site www.Travelmate.com.au students can click on *Smart Trip* and enter trip details, e.g. from Sydney to Bathurst for a detailed itinerary. From the driving directions, students will need to convert units to calculate time and distance. Students could complete a timeline of their trip using 24 hour time. Students can use www.qantas.com.au to plan a holiday with a flight.

Outcomes

MA3-2WM
MA3-9MG
MA3-13MG
MA3-7NA

Materials

- access to websites, pencils and paper

Knowledge and strategies

1. convert units of length
2. use length in calculations using decimal notation to three decimal places
3. develop and use a simple scale to calculate length or distance

LENGTH 6.2
Lesson plan

Knowing and representing large units
Convert units of length to calculate and compare lengths, distances and perimeters; use a simple scale

DESIGN A CROSS COUNTRY TRACK

Students work in pairs or small groups to design a 3 kilometre cross country course for their school. Students draw the course to scale and label their plan with the scale used and the length of each part of the course.

Students should

1. convert units of length
2. use length in calculations using decimal notation to three decimal places
3. develop and use a simple scale to calculate length or distance

Outcomes

MA3-2WM selects and applies appropriate problem-solving strategies, including the use of digital technologies, in undertaking investigations

MA3-9MG selects and uses the appropriate unit and device to measure lengths and distances, calculates perimeters, and converts between units of length

MA3-5NA selects and applies appropriate strategies for addition and subtraction with counting numbers of any size

Grouping

Step 1: whole-class introduction

Step 2: working in small groups

Step 3: whole-class discussion

Materials

Plan of school grounds drawn to scale or map of local area, 30 cm rulers, trundle wheels, pencil and paper

Step 1

Discuss the length and components of a cross country track, including hill-climbs, uneven ground and natural obstacles such as trees.

Discuss how the route may be repeated a number of times, when the venue has limited space, so the track is still 3 km long. Take students into the school grounds or park to identify areas and features suitable for a cross country track.

Discuss how to record the track and the need to draw the track to scale.

Demonstrate on the chalkboard how to draw the track to scale and label with important features, distances and scale.

Questioning

What is the unit which we use to measure distances, such as from the school to the next suburb or town, or from here to the city? Where do you see these distances recorded?

How far is a kilometre and how long would it take you to walk a kilometre?

How could you measure 1 kilometre in the school grounds?

What equipment will you use?

How will you calculate the time taken to walk 1 kilometre?

Think carefully about the distance. How would you expect the distance of 1 kilometre to affect your overall walking speed?

Step 2

Have your students work in pairs or small groups to:

- decide on the different lengths or parts of the track they are designing
- use the trundle wheel or a long measuring tape to measure distances they will include in the track
- draw the track freehand while outside designing it but ensuring the correct measurements of the different sections are marked
- decide on a scale to use when drawing the final track.
- mark in the measurements
- add all of the measurements together to ensure their track is 3 kilometres long.

Check that students

- select and use appropriate measuring equipment
- measure accurately
- understand the relationship between metres and kilometres
- calculate and record the time taken to walk 1 kilometre.

Step 3

Ask students to share their cross country track designs with the class.

Have students explain how they selected and used a scale to record their tracks.

Discuss which tracks would provide difficulty for competitors.

Discussion

What strategy did you use to identify a distance of 1 kilometre?

Why do we have some slightly different answers?

What else could we measure and compare, in the time taken to walk or travel 1 kilometre?

Teaching Measurement
AREA

LEVEL DESCRIPTIONS FOR AREA

Level 1	Knowledge and strategies
L1.1 Identification of the attribute Make direct comparisons of area	1. use area vocabulary, *e.g. surface, inside, outside, shape, area, boundary, large area, small area* 2. make closed shapes; indicate the space enclosed by the boundary 3. superimpose shapes to compare their size (large differences) 4. indicate the surface they are referring to
L1.2 Identification of the attribute Order two or more areas by direct comparison	1. use comparative language, *e.g. larger area, smaller area, largest area, smallest area, the same area as* 2. superimpose same shapes to compare them 3. compare areas systematically and explain how an area fits into a particular ordering
Level 2	**Knowledge and strategies**
L2.1 Informal measurement Choose and use appropriate units for measuring area	1. structure identical units in rows or columns (no gaps or overlaps) to cover an area 2. state or record that the area is the number and type of units used 3. use approximate language for parts of units *about half a tile* 4. choose appropriate units and explain why one shape is better than another to use as a covering tile
L.2.2 Informal measurement Compare and order areas by covering each area with identical units	1. choose identical units and cover each area 2. know that the larger area has more units 3. estimate the number of units and explain the estimation strategy 4. know that area is conserved if rearranged
Level 3	**Knowledge and strategies**
L.3.1 Structure of repeated units Use one unit to measure area	1. move and align the unit in a systematic way to preserve size 2. represent rows and columns by extending or drawing lines (rectangular units) 3. explain and use the structure of rectangular unit tessellation
L3.2 Structure of repeated units Explain the relationship between unit size and number of units used to measure area	1. explain the relationship between unit size and the number of units 2. express the same area in terms of different sized units 3. know that measurement techniques must be consistent and precise
Level 4	**Knowledge and strategies**
L4.1 Measure using conventional units Measure 1 square metre	1. identify areas which are approximately 1 square metre 2. use an array structure to calculate how many tiles of a given size will be needed to cover an area of 1 square metre
L4.2 Measure using conventional units Measure and record area in square metres or square centimetres using the structure of repeated units	1. use the square metre as a unit to measure area 2. use the square centimetre as a unit to measure area 3. record area using the abbreviations m^2 and cm^2
Level 5	**Knowledge and strategies**
L5.1 Relationships between formal measurement units Measure and record area in square metres or square centimetres	1. select and use appropriate measuring devices 2. explain the relationship between length and breadth and area of rectangles 3. use the length and breadth of a rectangle to calculate area
L5.2 Relationships between formal measurement units Measure and calculate area in square metres or square centimetres	1. select and use the appropriate unit to measure area 2. calculate areas which are a combination of rectangles or squares 3. investigate the area of triangles
Level 6	**Knowledge and strategies**
L6.1 Knowing and representing large units Calculate area in hectares and square kilometres Interpret a simple scale	1. identify situations where hectares and square kilometres are used to measure areas 2. express the relationships between square kilometres and hectares and square metres and hectares 3. read and interpret a simple scale
L6.2 Knowing and representing large units Convert units of area to calculate and compare areas Use a simple scale	1. convert units of area 2. use the hectare as a unit to measure area 3. develop and use a simple scale to calculate area

AREA

Area, or the amount of surface, is a two-dimensional quantity and has to be identified as a property of a three-dimensional object. The three-dimensional nature of the object being measured may obscure the two-dimensional nature of area. For example, the surface of a student's desk or the floor can be measured by overlaying it with square units. However, students may think that they are measuring the size of the desk itself because the concept of a surface with length and breadth but no width is difficult to imagine. Students may also gain the impression that areas are horizontal or vertical flat surfaces because such surfaces are most commonly measured. Students are likely to measure the area of the top of their desk, but not the areas of its sides, underneath surface, or legs. The areas of these surfaces are usually not measured, nor are other hard to measure areas, such as curved or irregular surfaces.

Students are usually introduced to the concept of area by superimposing areas and later, by measuring areas with informal units. In covering activities, rectangular areas are used so that students develop an understanding of the structure of the unit covering (array) in area. Knowledge of array structure is important for an understanding of area measurement as it enables the area of a rectangle to be linked to the lengths of its sides, and is fundamental to an understanding of the formula for the area of a rectangle. The array structure also provides the basis for rectangular area to be calculated using multiplication.

When young students draw the covering of a rectangle with unit squares, some will draw each individual square while others will draw a combination of individual squares and lines. Some students will draw lines to represent rows and then mark off squares individually while others will draw an array using lines. In general, these different methods appear to mirror students' understanding of the array structure and indicate if students have constructed rows (and/or columns) as composite units. Thus, drawing the covering appears to be an effective way of focusing students' attention on the array structure. However, tracing may not help students, as some of them will be able to trace an accurate array, yet not understand its structure. Drawing or visualizing accurate arrays suggests that students can represent covering a region with rectangular units, without gaps or overlap.

AREA LESSON IDEAS

Area 4.1

Make a square metre (lesson plan)
Estimate a square metre
Bigfoot
Designer squares
Cut in halves

Area 4.2

Square letters (lesson plan)
Hopscotch
Handball courts
Measuring areas in the playground
How much?

Area 5.1

Length x Breadth (lesson plan)
Sistine Chapel
Playground areas
Check all faces
Yes/No

Area 5.2

Fractured areas
Cut and compare (lesson plan)
Total area
Bits and pieces
Cutaways

Area 6.1

Believe it or not! (lesson plan)
School in a square
Village green
On our desk
Design a package

Area 6.2

Largest area or longest borders?
Plans for a dog pen
Drawing areas (lesson plan)
Design a school block
Design a park

AREA 4.1
Lesson ideas

Measure using conventional units
Measure 1 square metre

Knowledge and strategies
1. identify areas which are approximately 1 square metre, using a paper or cardboard square metre
2. use an array structure to calculate how many tiles of a given size will be needed to cover an area of 1 square metre

Introductory lesson: Make a square metre (see lesson plan)
Teacher outlines a square metre on the floor with chalk or masking tape. Students discuss the length of each side and predict what the area of the shape would be called. Several students are asked to place 10 cm square tiles in rows starting at one side. The class estimates, then counts how many will fit along each side. The class discusses how many tiles will be needed to cover the square metre, and how many square centimetres this would be. Individual students record the array of tiles and label with length and area measurements.

Outcomes
MA2-1WM
MA2-10MG
MA2-6NA

Materials
- metre ruler, chalk or masking tape, 10 cm square tiles, pencils and paper

Knowledge and strategies
1. identify areas which are approximately 1 square metre, using a paper or cardboard square metre
2. use an array structure to calculate how many tiles of a given size will be needed to cover an area of 1 square metre

Estimate a square metre
Students work in pairs or small groups to make a square metre template from paper. (Teacher may need to demonstrate using a metre ruler). Students use the paper template to find and record surfaces which have an area of about 1 square metre.

Whole class discusses how the area can be measured for checking, perhaps using 10 cm square tiles or 10 cm strips from previous activities.

Note: the square metre templates should be kept for later activities.

Outcomes
MA2-2WM
MA2-10MG

Materials
- 10 cm square tiles or 10 cm strips, paper, scissors, sticky tape, 1 m rulers

Knowledge and strategies
1. identify areas which are approximately 1 square metre, using a paper or cardboard square metre
2. use an array structure to calculate how many tiles of a given size will be needed to cover an area of 1 square metre

Bigfoot

Students are given the outline of an adult's shoe and asked to find how many pairs of shoes would be needed to cover a square metre. Students should use two shoe outlines to make a tile, and measure with the tile. Record how the number of tiles was predicted then measured.

Extension or second lesson: groups of students choose the smallest and the largest shoe in their group to find the number of shoes needed to cover a square metre. Discuss the difference in the number of units used.

Outcomes

MA2-3WM
MA2-10MG
MA2-6NA

Materials

- outlines of an adult's foot, scissors, square metre templates, pencils and paper

Knowledge and strategies

1. identify areas which are approximately 1 square metre, using a paper or cardboard square metre
2. use an array structure to calculate how many tiles of a given size will be needed to cover an area of 1 square metre

Designer squares

Each student cuts out and decorates a 20 cm square using a technique such as paper weaving, printing, or splatter painting. Students predict how many of their squares will be needed to cover 1 square metre, and how many will be left over. Individual students record their predicted number and array of squares.

The class makes a square metre with their combined paper squares and checks the number of tiles used.

Outcomes

MA2-3WM
MA2-10MG
MA2-6NA

Materials

- 20 cm squares, paint or materials to decorate squares, square metre template, scissors, pencils and paper

Knowledge and strategies

1. identify areas which are approximately 1 square metre, using a paper or cardboard square metre
2. use an array structure to calculate how many tiles of a given size will be needed to cover an area of 1 square metre

Cut in halves

Students cut their square metre templates into halves, and put the pieces together to make a different shape. Students predict, then measure the area of the new shape using 10 cm tiles, 10 cm strips, or rulers. The new shape is recorded together with details of how it was measured.

Extension: cut the square metre into quarters; make irregular shapes; cut the square metre diagonally.

Outcomes

MA2-2WM
MA2-10MG
MA2-6NA

Materials

- square metre templates, scissors, rulers, 10 cm tiles or strips, pencils, paper

Knowledge and strategies

1. identify areas which are approximately 1 square metre, using a paper or cardboard square metre
2. use an array structure to calculate how many tiles of a given size will be needed to cover an area of 1 square metre

AREA 4.1
Lesson plan

Measure using conventional units
Measure 1 square metre

MAKE A SQUARE METRE

Teacher outlines a square metre on the floor with chalk or masking tape. Students discuss the length of each side and predict what the area of the shape would be called. Several students are asked to place 10 cm square tiles in rows starting at one side. The class estimates, then counts how many will fit along each side. The class discusses how many tiles will be needed to cover the square metre, and how many square centimetres this would be. Individual students record the array of tiles and label with length and area measurements.

Students should

1. identify areas which are approximately 1 square metre, using a paper or cardboard square metre
2. use an array structure to calculate how many tiles of a given size will be needed to cover an area of 1 square metre

Outcomes

MA2-1WM uses appropriate terminology to describe, and symbols to represent, mathematical ideas

MA2-10MG measures, records, compares and estimates areas using square centimetres and square metres

MA2-6NA uses mental and informal written strategies for multiplication and division

Grouping

Step 1: whole-class introduction

Step 2: working individually

Step 3: whole-class discussion

Materials

metre ruler, chalk or masking tape, 10 cm square tiles, pencils, paper

Step 1

Teacher outlines a square with sides of

1 metre on the floor.

Students discuss the length of each side and predict what the area of the square would be called.

To measure the square metre, several students are asked to begin placing 10 cm tiles along one side of the shape.

Class estimates, then counts how many tiles will be needed along adjoining sides.

Discuss how to use the array structure to calculate the total number of tiles needed to cover the square metre.

Discuss how to calculate the total number of square centimetres in 1 square metre, if each of the tiles has an area of 100 cm^2.

Discuss how to record and label the array of tiles used to cover the square metre.

Questioning

What is the area of this shape?

Can you think of other shapes or surfaces that have an area of 1 square metre?

Can you describe to us what a square metre looks like?

How could I measure the area of this square metre?

How many tiles will be needed for each row?

How many rows will there be? How did you work that out?

How many tiles altogether?

If each of these tiles has an area of 100 cm^2, how could we work out the area of the square in square centimetres?

How could I draw the square with its tiles?

What measurements should I include?

Step 2

Have your students work individually to:

- record the array and the number of tiles used
- label the drawing with length and area measurements.

Check that students

- draw an array which has tiles of a consistent size, in rows and columns
- understand how to use the array structure to calculate the total number of tiles.

Step 3

Students report back to the class to explain how they recorded the array pattern.

Discussion

Is there a quick way of drawing the pattern of the tiles? What is this pattern called?

Does an area of 1 square metre have to be shaped like a square?

AREA 4.2
Lesson ideas

Measure using conventional units
Measure and record area in square metres or square centimetres using the structure of repeated units

Knowledge and strategies
1. use the square metre as a unit to measure area
2. use the square centimetre as a unit to measure area
3. record area using the abbreviations m^2 and cm^2

Square letters (see lesson plan)

Students work in small groups to design an alphabetic letter on 1 cm grid paper. The letter should have a maximum area of 12 cm^2. Students trace the letter on the playground using a square metre template and convert the square centimetres to square metres. Students find and record the area of their playground letter in square metres.

Extension: groups of students draw simple words and determine the total area of the words in square centimetres.

Outcomes
MA2-2WM
MA2-10MG

Materials
- 1 cm grid paper, square metre templates, chalk, asphalt, pencils and paper

Knowledge and strategies
1. use the square metre as a unit to measure area
2. use the square centimetre as a unit to measure area
3. record area using the abbreviations m^2 and cm^2

Hopscotch

Students in pairs make a 50 cm square and discuss how many will be needed to make 1 m^2.

Using the 50 cm x 50 cm tile, students design a hopscotch grid that has a maximum total area of 3 m^2.

Record the design and the total area.

Outcomes
MA2-2WM
MA2-10MG
MA2-5NA

Materials
- 50 cm squares, chalk, asphalt, pencils, paper

Knowledge and strategies
1. use the square metre as a unit to measure area
2. use the square centimetre as a unit to measure area
3. record area using the abbreviations m^2 and cm^2

Handball courts

Students design and draw a diagram of a handball court. Use a metre ruler or measuring tape to draw the handball court in the playground. Estimate the area and check by measuring with paper square metres.

Extension: how many tiles with sides of 50 cm would be needed to cover the same area? Record in words and diagrams.

Outcomes
MA2-3WM
MA2-10MG
MA2-6NA

Materials
- pencils, paper, 1 m rulers, measuring tapes, 1 m^2 paper, chalk, asphalt, 50 cm tiles

Knowledge and strategies
1. use the square metre as a unit to measure area
2. record area using the abbreviations m^2 and cm^2

Measuring areas in playground

Students measure defined areas in the playground using the paper square metre templates.

Record the measurements and the array. Allow for "left over" area when measuring with the square metre.

Check the measured dimensions of the area with a trundle wheel or tape measure.

Outcomes
MA2-3WM
MA2-10MG
MA2-6NA

Materials
- 1 m^2 templates, tape measures, 1 m rulers, pencils, paper

Knowledge and strategies
1. use the square metre as a unit to measure area
2. record area using the abbreviations m^2 and cm^2

How much?

Students use 1 cm grid paper to design their name plates.

Students calculate the cost of reproducing the name plates if colouring costs $5.00 per cm^2.

Extension: Find the total area of the numerals in a telephone number by drawing the numbers on 1 cm grid paper. Use the patterns from calculator numbers to draw.

Find the total in cm^2 and record.

Outcomes
MA2-2WM
MA2-10MG
MA2-6NA

Materials
- 1 cm grid paper, coloured pencils or pens, recording paper

Knowledge and strategies
1. use the square centimetre as a unit to measure area
2. record area using the abbreviations m^2 and cm^2

AREA 4.2
Lesson plan

Measure using conventional units
Measure and record area in square metres or square centimetres using the structure of repeated units

SQUARE LETTERS

Students work in small groups to design an alphabetic letter on 1 cm grid paper. The letter should have a maximum area of 12 cm^2. Students trace the letter on the playground using a square metre template and converting the square centimetres to square metres. Students find and record the area of their playground letter in square metres.

Extension: groups of students draw simple words and determine the total area of the words in square centimetres.

Students should

1. use the square metre as a unit to measure area
2. use the square centimetre as a unit to measure area
3. record area using the abbreviations m^2 and cm^2

Outcomes

MA2-2WM selects and uses appropriate mental or written strategies, or technology, to solve problems

MA2-10MG measures, records, compares and estimates areas using square centimetres and square metres

Grouping

Step 1: whole-class introduction

Step 2: working in small groups

Step 3: whole-class discussion

Materials

1 cm grid paper, pencil, chalk, asphalt, square metre templates

Step 1

Introduce the lesson as working with units used to measure area, square centimetres and square metres.

Discuss how students will use 1 cm grid paper to design an alphabetic letter that has an area of less than 12 cm^2.

Discuss how to draw curved letters on grid paper so the area of the letter can be measured precisely. Students may suggest using whole squares only, or drawing diagonals to cut the squares into halves.

Discuss how the area of the letter will change if it is drawn on the asphalt by tracing a square metre template. Each square centimetre square on the grid paper will be represented by 1 square metre on the asphalt. Organise students into groups to commence designing the letters.

Questioning

How could I design a letter so that I could work out its area?

Would the area of the letter be accurate if I used curved edges? How can I avoid curves on some letters?

What does area of the letter mean?

How could I calculate the area of the letter on the asphalt?

Step 2

Have your students work in small groups to:

- design a letter on grid paper
- draw the letter on the asphalt using the square metre template
- find the area of the letter in square metres and record the area on the design sheet.

Check that students

- design the letter correctly
- use the square metre template accurately when drawing on the asphalt
- explain how they worked out the area of the letter.

Step 3

Discuss different letters that had the same area.

Discuss difficulty in drawing some letters.

Discussion

Which letters would have been the most difficult to draw?

What advice would you give to someone who has to use a template to draw a square metre?

AREA 5.1
Lesson ideas

Relationships between formal measurement units
Measure and record area in square metres or square centimetres

Knowledge and strategies
1. select and use appropriate measuring devices
2. explain the relationship between length and breadth and area of rectangles
3. use the length and breadth of a rectangle to calculate area

Length x Breadth (see lesson plan)

Students use 1 cm grid paper to draw different rectangles, each with an area of 24 cm². Students label the lengths of the sides in centimetres and discuss the relationship between the lengths of the sides and the area of the rectangles.

The investigation can be extended by considering areas such as 36 cm², 20 cm², or students' own choices. Some students may wish to experiment with fractional units.

Extension: students draw different rectangles which have one pair of opposite sides a constant length. Students vary the breadth of each rectangle and calculate and record the area of each example. Explain the relationship between the areas.

Outcomes
MA3-2WM
MA3-10MG
MA3-6NA

Materials
- 1 cm grid paper, pencils and paper

Knowledge and strategies
1. explain the relationship between length and breadth and area of rectangles
2. use the length and breadth of a rectangle to calculate area

Sistine Chapel

Students find the area of the classroom ceiling by measuring the length and breadth of the floor to the nearest metre. Students calculate the area of the ceiling and find how many tins of paint would be needed for two coats if each four litre can covers 100 m².

Outcomes
MA3-2WM
MA3-10MG
MA3-6NA

Materials
- trundle wheels, tape measures, pencils and paper

Knowledge and strategies
1. select and use appropriate measuring devices
2. explain the relationship between length and breadth and area of rectangles
3. use the length and breadth of a rectangle to calculate area

Playground areas

Students choose a large area to be measured, such as the football field, pathway or covered outdoor area. Students select an appropriate measuring device and calculate the area by taking the dimensions to the nearest metre.

Outcomes

MA3-2WM
MA3-9MG
MA3-10MG
MA3-6NA

Materials

- trundle wheels, tape measures, pencils and paper

Knowledge and strategies

1. select and use appropriate measuring devices
2. explain the relationship between length and breadth and area of rectangles
3. use the length and breadth of a rectangle to calculate area

Check all faces

Students select two small rectangular prisms (boxes or blocks). Students estimate and record which box has the greater surface area. Students measure, calculate and record the area of each face and the total surface areas. Recording should demonstrate that all faces have been accounted for.

Some students may need to use 1 cm grid paper to complete the activity.

Hint to students: does every face have to be measured individually?

Outcomes

MA3-3WM
MA3-10MG
MA3-6NA
MA3-14MG

Materials

- boxes or blocks, rulers, pencils and paper

Knowledge and strategies

1. select and use appropriate measuring devices
2. explain the relationship between length and breadth and area of rectangles
3. use the length and breadth of a rectangle to calculate area

Yes/No

Class game. One student chooses and measures a surface in the classroom, and calculates the area in square centimetres or square metres. The class is told the area measurement and has to guess which object or surface was chosen. Students selected to be “in” may have to measure their area during a break when the class is not in the room.

Outcomes

MA3-2WM
MA3-10MG
MA3-6NA

Materials

- ruler, tape for measuring

Knowledge and strategies

1. select and use appropriate measuring devices
2. explain the relationship between length and breadth and area of rectangles
3. use the length and breadth of a rectangle to calculate area

AREA 5.1
Lesson plan

Relationships between formal measurement units
Measure and record area in square metres or square centimetres

LENGTH X BREADTH

Students use 1 cm grid paper to draw different rectangles, each with an area of 24 cm². Students label the lengths of the sides in centimetres and discuss the relationship between the lengths of the sides and the area of the rectangles.

The investigation can be extended by considering areas such as 36 cm², 20 cm², or students' own choices. Some students may wish to experiment with fractional units.

Extension: students draw different rectangles which have one pair of opposite sides a constant length. Students vary the breadth of each rectangle and calculate and record the area of each example. Explain the relationship between the areas.

Students should

1. explain the relationship between length and breadth and area of rectangles
2. use the length and breadth of a rectangle to calculate area

Outcomes

MA3-2WM selects and applies appropriate problem-solving strategies, including the use of digital technologies, in undertaking investigations

MA3-10MG selects and uses the appropriate unit to calculate areas, including areas of squares, rectangles and triangles

MA3-6NA selects and applies appropriate strategies for multiplication and division, and applies the order of operations to calculations involving more than one operation

Grouping

Step 1: whole-class introduction

Step 2: individual or paired working

Step 3: whole-class discussion

Materials

1 cm grid paper, pencils and paper

Step 1

Using a 1 cm grid on an overhead projector or an enlarged grid on the chalkboard, ask several students to demonstrate how they would draw a rectangle with an area of 24 units.

Ask students to describe how they would check the area, without counting individual units.

Discuss methods which students could use to identify other rectangles which have an area of 24 units.

Introduce the task as using 1 cm grid paper to design, draw and label rectangles which have an area of 24 cm^2.

Ask the students to write a description of how to find the area of a rectangle.

Questioning

How would you use this grid to draw a rectangle with an area of 24 units?

How many different answers do you think there might be?

How would you check the area without counting all of the squares?

How could you work out other possibilities for rectangles with an area of 24 units?

Step 2

Have your students work individually or in pairs to:

- use 1 cm grid paper to draw different rectangles with an area of 24 cm^2
- label the length of the sides and the areas of the rectangles
- describe how to find the area of a rectangle.

Check that students

- explain the relationship between length and breadth and area of rectangles
- use the length and breadth of a rectangle to calculate area.

Step 3

Discuss how the students determined the dimensions of the rectangles.

Discuss the relationship between the lengths of the sides and the area of the rectangles.

Ask students whether the class has identified all possible rectangles that have an area of 24 cm^2.

Discussion

How did you check that every rectangle was the correct size?

How can you work out the area of a rectangle?

What was the same and what was different about the rectangles which you measured?

How can we be sure that you have found all of the rectangles?

AREA 5.2
Lesson ideas

Relationships between formal measurement units
Measure and calculate area in square metres or square centimetres

Knowledge and strategies
1. select and use the appropriate unit to measure area
2. calculate areas which are a combination of rectangles or squares
3. investigate the area of triangles

Fractured areas
Students discuss how to break alphabetic shapes which have been drawn on a 1 cm grid, into different areas to measure. The letter T could be broken into a long rectangle and two squares or three squares and a rectangle.

Pairs of students draw letters or shapes on 1 cm grid paper, and find two different ways of breaking up each shape. Record the area of each shape in cm^2 and the total area of the letter.

Outcomes
MA3-2WM
MA3-10MG
MA3-15MG

Materials
- 1 cm grid paper, pencils

Knowledge and strategies
1. select and use the appropriate unit to measure area
2. calculate areas which are a combination of rectangles or squares

Cut and compare (see lesson plan)
Pairs or individual students commence by taking a rectangle such as an A4 sheet of paper or smaller. Students draw and cut along one diagonal and investigate whether the two triangles which have been made are the same size. Students continue with different-sized rectangles to see if they can find a rectangle where the two triangles are not the same.

Students select one of their rectangles and use the area of the rectangle to calculate the area of each triangle.

Whole class discusses how to find the area of a right-angled triangle.

Outcomes
MA3-2WM
MA3-10MG
MA3-15MG

Materials
- rulers, pencils, paper, scissors

Knowledge and strategies
1. select and use the appropriate unit to measure area
2. investigate the area of triangles

Total area

Students work individually or in pairs with geoboards to design an irregular shape comprised of five rectangles. Students transfer the outline of the shape onto grid paper and calculate the area of the total shape by measuring and recording the area of each rectangle.

Extension: students calculate and then design a different pattern of rectangles that has the same area.

Outcomes

MA3-2WM
MA3-10MG
MA3-15MG

Materials

- geoboards and elastic bands, grid paper, pencils, paper

Knowledge and strategies

1. select and use the appropriate unit to measure area
2. calculate areas which are a combination of rectangles or squares

Bits and pieces

Students work with a partner to use two or three cardboard templates of different rectangles and squares to make a composite shape. Students trace around the outline of the composite shape and mark and label the lengths of all sides. Students swap their drawing with another pair of students, who must find the area of the composite shape from the given dimensions. Students check their answer by comparing with the areas of the cardboard templates.

Outcomes

MA3-2WM
MA3-10MG
MA3-15MG

Materials

- cardboard templates in a variety of shapes and sizes

Knowledge and strategies

1. select and use the appropriate unit to measure area
2. calculate areas which are a combination of rectangles or squares

Cutaways

Students draw and cut out a 20 cm square. Students draw and cut out a square or rectangle inside the 20 cm square, ensuring that the sides of the cut-out measure a whole number of centimetres (not fractional parts). Students give the sheet to a partner who has to find the area of the remaining paper and the area of the cut-out shape.

Outcomes

MA3-3WM
MA3-10MG
MA3-6NA

Materials

- paper to cut to 20 cm square, scissors, pencils, rulers

Knowledge and strategies

1. select and use the appropriate unit to measure area
2. calculate areas which are a combination of rectangles or squares

AREA 5.2
Lesson plan

Relationships between formal measurement units
Measure and calculate area in square metres or square centimetres

CUT AND COMPARE

Pairs or individual students commence by taking a rectangle such as an A4 sheet of paper or smaller. Students draw and cut along one diagonal and investigate whether the two triangles which have been made are the same size. Students continue with different-sized rectangles to see if they can find a rectangle where the two triangles are not the same.

Students select one of their rectangles and use the area of the rectangle to calculate the area of each triangle.

Whole class discusses how to find the area of a right-angled triangle.

Students should

1. select and use the appropriate unit to measure area
2. investigate the area of triangles

Outcomes

MA3-2WM selects and applies appropriate problem-solving strategies, including the use of digital technologies, in undertaking investigations

MA3-10MG selects and uses the appropriate unit to calculate areas, including areas of squares, rectangles and triangles

MA3-15MG manipulates, classifies and draws two-dimensional shapes, including equilateral, isosceles and scalene triangles, and describes their properties

Grouping

Step 1: whole-class introduction

Step 2: individual or paired working

Step 3: whole-class discussion

Materials

rulers, pencils, paper, scissors, paste

Step 1

Discuss how to calculate the area of a rectangle.

Ask the students to predict the shape and size of the pieces when a rectangle is cut diagonally. Ask the students if the result could ever be different.

Discuss how students could prove that two triangles cut diagonally from a rectangle or square will always have the same area, or will never have the same area. Introduce the task and suggest that students may also be able to may a statement about how to find the area of a triangle.

Questioning

What does area of this rectangle mean?

What happens when you cut a rectangle in half, diagonally?

What will you make?

Will this always happen?

Are the triangles always the same size if I use different-sized rectangles?

How could you work out the area of one of these two triangles?

Step 2

Have your students work individually or in pairs to:

- draw, measure and cut rectangles of different sizes
- compare the triangles formed by cutting the rectangles diagonally
- record their findings
- choose one rectangle, find the area and calculate the area of each triangle
- make a statement about the areas of the triangles and rectangles that were investigated.

Check that students

- draw, measure and cut accurately
- experiment with a range of rectangles
- calculate the area of one triangle.

Step 3

Discuss the results of the investigations, and how the area of a right-angled triangle may be calculated.

Discussion

What happened when you changed the size and shape of the rectangles?

What would happen with a square?

Would this work with any other shapes?

Can you explain how to find the area of a triangle?

Will this work for all triangles?

AREA 6.1
Lesson ideas

Knowing and representing large units
Calculate area in square kilometres and hectares; interpret a simple scale

Knowledge and strategies
1. identify situations where hectares and square kilometres are used to measure areas
2. express the relationships between square kilometres and hectares and square metres and hectares
3. read and interpret a simple scale

Believe it or not! (see lesson plan)
How many Year 5 or Year 6 students could stand, shoulder to shoulder, in a hectare?

How many Year 5 or Year 6 students could stand, shoulder to shoulder, in a square kilometre?

Extension: if the world's population was standing shoulder to shoulder, what area would be covered?

Outcomes
MA3-2WM
MA3-10MG
MA3-6NA

Materials
- metre rule or metre measure, pencils and paper, calculators

Knowledge and strategies
1. identify situations where hectares and square kilometres are used to measure area
2. express the relationships between square kilometres and hectares and square metres and hectares

School in a square
Students use a locality map and the scale on the map to mark a square kilometre with the school in the centre. Students describe the interesting features included in the square kilometre.

Outcomes
MA3-2WM
MA3-10MG
MA3-6NA

Materials
- local map, pencils and paper, ruler

Knowledge and strategies
1. identify situations where hectares and square kilometres are used to measure area
2. read and interpret a simple scale

Village green

Students investigate: How many sheep, cows, or horses could be kept on the local oval?

Students will need to find information about grazing livestock in a given area, to complete the task.

Extension: students calculate how many items would cover a hectare. Suggestions include: picnic rugs, school backpacks, exercise books, sheets of newspaper.

Outcomes

MA3-3WM
MA3-10MG
MA3-6NA

Materials

- trundle wheels or tape measures, pencils and paper, calculators

Knowledge and strategies

1. identify situations where hectares and square kilometres are used to measure area
2. express the relationships between square kilometres and hectares and square metres and hectares

On our desk

Two students place up to five objects on their desk. Students draw a plan of the items on the desk, to a scale of 1 cm:10 cm. Students should measure the positions of objects as precisely as possible. Students should have access to grid paper.

Students swap their plan with another pair, and recreate their friends' desktop on an empty desk, using the given plan.

Outcomes

MA3-3WM
MA3-9MG
MA3-10MG
MA3-6NA

Materials

- objects, 30 cm rulers, pencils, paper, grid paper

Knowledge and strategies

1. read and interpret a simple scale

Design a package

Students select and copy a picture or design such as a cereal packet or a CD cover. Students rule a 1 centimetre grid on the picture. On a separate piece of A3 paper, students rule up, using faint lines, a grid using a selected scale, e.g. a 2 cm grid to enlarge the picture or a 5 mm grid to reduce the picture. Students transfer details from the selected picture to the new grid.

Extension: students experiment with various scales and calculate the difference in area when different scales are used.

Outcomes

MA3-3WM
MA3-10MG
MA3-7NA

Materials

- copied pictures or designs, 30 cm rulers, pencils and paper

Knowledge and strategies

1. read and interpret a simple scale

AREA 6.1
Lesson plan

Knowing and representing large units
Calculate area in square kilometres and hectares; interpret a simple scale

BELIEVE IT OR NOTi

How many Year 5 or Year 6 students could stand, shoulder to shoulder, in a hectare?

How many Year 5 or Year 6 students could stand, shoulder to shoulder, in a square kilometre?

Extension: if the world's population was standing shoulder to shoulder, what area would be covered?

Students should

1. identify situations where hectares and square kilometres are used to measure area
2. express the relationships between square kilometres and hectares and square metres and hectares

Outcomes

MA3-2WM selects and applies appropriate problem-solving strategies, includingthe use of digital technologies, in undertaking investigations

MA3-10MG selects and uses the appropriate unit to calculate areas, including areas of squares, rectangles and triangles

MA3-6NA selects and applies appropriate strategies for multiplication and division, and applies the order of operations to calculations involving more than one operation

Grouping

Step 1: whole-class introduction

Step 2: working in small groups

Step 3: whole-class discussion

Materials

metre rule or metre measure, pencils and paper, calculators

Step 1

Introduce the hectare and square kilometre as units of area measure.

Explain that the hectare is 10 000 square metres and a square kilometre is 100 hectares.

Discuss strategies which students might use to calculate how many students will fit into a hectare and a square kilometre. Students will probably decide to work with 1 m^2, but other strategies may be suggested and evaluated.

Questioning

What units of measure are used to measure large areas?

Do you know how many square metres are equal to 1 hectare?

How many hectares are in a square kilometre?

How could we calculate the number of students that would fit in a hectare and square kilometre?

Step 2

Have your students work in pairs or small groups to discuss and implement a chosen strategy that the student may:

- calculate the number of students that could stand shoulder to shoulder in a square metre
- calculate the number of students that would fit in a hectare
- calculate the number of students that would fit in a square kilometre.

Check that students

- understand the relationship between metres, hectares and square kilometres
- calculate the number of students in a hectare
- calculate the number of students in a square kilometre.

Step 3

Groups report on their findings and suggest reasons why some groups may have different results.

Discuss any difficulties encountered with calculations.

Discussion

What strategies did you use to calculate the number of students that would fit in a hectare?

Why do we have different results?

AREA 6.2
Lesson ideas

Knowing and representing large units
Convert units of area to calculate and compare areas; use a scale

Knowledge and strategies
1. convert units of area
2. use the hectare as a unit to measure area
3. develop and use a simple scale to calculate area

Largest area or longest borders?

Students investigate:

Which Australian state has the largest area? Can you compare this with the state that has the smallest area? Which state has the longest borders? Students explain how they calculated their answers.

Outcomes
MA3-1WM
MA3-9MG
MA3-10MG
MA3-6NA

Materials
- scaled map of Australia, rulers, grid paper, pencils and paper

Knowledge and strategies
1. convert units of area
2. use the hectare as a unit to measure area
3. develop and use a simple scale to calculate area

Plans for a dog pen

Students design a dog pen that can be made from a 32 m length of wire fencing. Students record the measurements of the run on a diagram which has been drawn to scale and explain how the shape would give a dog the greatest area for exercise.

Extension: Would it be possible to design a pen which is a combination of shapes?

Outcomes
MA3-2WM
MA3-3WM
MA3-10MG
MA3-6NA

Materials
- rulers, paper, pencils

Knowledge and strategies
1. convert units of area
2. develop and use a simple scale to calculate area

Drawing areas (see lesson plan)

Small groups of students use grid paper to design and draw to scale, shapes that have a given area, such as 12 m².

Students draw the shapes on the playground in their finished size. The students' designs do not have to be regular shapes.

Outcomes

MA3-2WM
MA3-10MG
MA3-6NA

Materials

- chalk, rulers, grid paper, pencils, asphalt

Knowledge and strategies

1. convert units of area
2. develop and use a simple scale to calculate area

Design a school block

Students design and draw a school block which contains two classrooms, a verandah, a storeroom, hat room and office for each class. Draw to scale. Ensure that all lengths are labelled and add correctly to a total length. Find the area of each space and the total area.

Outcomes

MA3-2WM
MA3-10MG
MA3-6NA

Materials

- grid paper, rulers, tape measures, pencils, paper

Knowledge and strategies

1. convert units of area
2. develop and use a simple scale to calculate area

Design a Park

Students design a new park and playground area. The total area of the park is 1 hectare. Discuss the scale chosen to design the park, e.g.1 cm² is equal to 25 m².

The following features may be included in the plan:

A car park measuring 1000 m², a playing field of half a hectare, a children's playground area of 500 m², a sand pit of 50 m², a toilet block of 250 m², paths for bike riding and walking that should be 2.5 metres wide, picnic and barbeque areas that take up 200 m² each. The rest of the park should be landscaped with lawn and creative designs for gardens. A water feature could be added.

Outcomes

MA3-2WM
MA3-10MG
MA3-6NA

Materials

- 1 cm grid paper in size (20 cm x 20 cm), pencils

Knowledge and strategies

1. convert units of area
2. use the hectare as a unit to measure area
3. develop and use a simple scale to calculate area

AREA 6.2
Lesson plan

Knowing and representing large units
Convert units of area to calculate and compare areas; use a scale

DRAWING AREAS

Small groups of students use grid paper to design and draw to scale, shapes that have a given area, such as 12 m^2.

Students draw the shapes on the playground in their finished size. The students' designs do not have to be regular shapes.

Students should

1. convert units of area
2. develop and use a simple scale to calculate area

Outcomes

MA3-2WM selects and applies appropriate problem-solving strategies, including the use of digital technologies, in undertaking investigations

MA3-10MG selects and uses the appropriate unit to calculat eareas, including areas of squares, rectangles and triangles

MA3-6NA selects and applies appropriate strategies for multiplication and division, and applies the order of operations to calculations involving more than one operation

Grouping

Step 1: whole-class introduction

Step 2: working in small groups

Step 3: whole-class discussion

Materials

chalk, rulers, tape measures, grid paper, pencils

Step 1

Discuss what is meant by scale and why scale is used.

Explain that the students are going to draw a shape with a given area to scale.

Explain that the students will be drawing the shape to the finished size out in the playground.

Questioning

Why is it important to be able to develop and use a scale? What scale could you use when you are designing a shape with a given area?

Step 2

Have your students work in small groups to:

- design a shape with a given area, to scale
- mark the scale they are using on their drawing
- measure an area accurately on the playground
- use the scale and check that the measurements are accurate.

Check that students

- choose and record the scale for their design
- draw their shape to the correct size.

Step 3

Students compare the scales they used for their shapes.

Students describe how they measured their shape and drew it in the playground.

Discuss examples of the use of scale in everyday life, and the importance of being able to interpret a scale.

Discussion

How did you choose a scale?

What difficulties did you encounter when you were drawing the shape in the playground?

Where might you see a scale and how will the scale assist you to measure and plan?

Teaching Measurement
VOLUME & CAPACITY

LEVEL DESCRIPTIONS FOR VOLUME & CAPACITY

Level 1	Knowledge and strategies
L1.1 Identification of the attribute Make direct comparisons of volume and capacity	1. use the terms, pack, pour, fill, full and empty, nearly full 2. recognise when a container is full and not full 3. pour or pack material into a container
L1.2 Identification of the attribute Order two or more quantities by direct comparison	1. be familiar with the terms volume and capacity and use comparative language, e.g. larger, smaller, biggest, smallest, the same as 2. use compensation strategies, e.g. one container is higher, but the other is wider so the two might hold about the same 3. compare volume or capacity systematically and explain why volume or capacity fits into a particular ordering
Level 2	**Knowledge and strategies**
L2.1 Informal measurement Choose and use appropriate units for measuring volume and capacity	1. pack a box with blocks and count the blocks; structure the packing in layers 2. fill a container by pouring and count the number of units used 3. state or record the number and type of units used to measure volume and capacity 4. suggest appropriate units and explain why one is better than another
L2.2 Informal measurement Compare and order volumes and capacities by filling or packing with identical units	1. compare capacities or volumes by filling or packing with identical units 2. know that the greater capacity or volume has more units 3. estimate the number of units and explain the estimation strategy 4. explain that the volume of fluid does not change when poured into containers of different sizes or shapes (conservation)
Level 3	**Knowledge and strategies**
L3.1 Structure of repeated units Use one unit or composite unit to work out how many will be needed altogether when making direct comparisons	1. estimate then calculate the capacity of a container based on one unit (cups and 100 mL scoops) 2. explain the structure of cubic units packed into rectangular containers or packed to make a rectangular prism (e.g. three layers of six blocks) 3. explain that the volume of material does not change when units are rearranged (conservation) 4. use change in level to compare the volume of objects (introduction to displacement)
L3.2 Structure of repeated units Explain the relationship between unit size and the number of units required to fill or pack a container	1. explain the relationship between unit size and number of units 2. express the same volume or capacity in different size units 3. know that measurement techniques must be consistent and precise
Level 4	**Knowledge and strategies**
L4.1 Measure using conventional units Measure and record 1 litre	1. estimate and measure to the nearest litre 2. calculate the number of given units to fill a litre 3. record measures of capacity using the abbreviation L
L4.2 Measure using conventional units Measure and record volume in cubic centimetres by packing	1. estimate and measure the volume of small rectangular containers in cubic centimetres by packing 2. identify the array structure of each layer 3. record measures of volume using the abbreviation cm^3
Level 5	**Knowledge and strategies**
L5.1 Relationships between formal measurement units Measure and record capacity in litres and millilitres	1. measure and record capacities in millilitres and litres 2. record capacity using decimal notation to three decimal places 3. convert between mL and litres, e.g. 1600 mL = 1 litre 600 millilitres 4. use overflow or change in level as a measure of volume to the nearest 100 mL
L5.2 Relationships between formal measurement units Measure and calculate volume in cubic centimetres	1. estimate then calculate the volume of a rectangular prism in cubic centimetres, given the volume of one layer and the number of layers 2. explain the relationship between 1 cubic centimetre and 1 millilitre (using displacement)
Level 6	**Knowledge and strategies**
L6.1 Knowing and representing large units Calculate volume in cubic metres	1. identify situations where cubic metres are used to measure volume 2. estimate and use cubic metres to measure volume 3. identify the relationship between the length, breadth, height and volume of rectangular prisms
L6.2 Knowing and representing large units Convert units of volume and capacity to calculate and compare quantities	1. express the relationships between volume and capacity: cubic centimetres and millilitres, cubic centimetres and litres 2. convert measures to calculate volume and capacity

VOLUME & CAPACITY

Volume is an extremely complex concept because of its different forms and the different ways of measuring it. The complexity of volume concepts means that many students are unlikely to develop conservation of volume until they have had experiences of measuring volume in a range of contexts, and with both types of units (liquid and cubic).

One aspect of volume is capacity (the term usually used for liquids measured in kilolitres, litres and millilitres) and means the amount a container can hold. The capacity of a jug might be measured in cups, millilitres or litres. The capacity of a large container, like a swimming pool could be measured in kilolitres or could be calculated in cubic metres from the internal dimensions of the pool if it is rectangular and its depth is consistent. Liquid measure may be judged on the basis of length. For example, if students add cups of water to a cylindrical container and predict how much the water level will rise each time, they usually base their judgments on a change in height. Capacity is similar to mass because the spatial structure of liquid measurement units is not important. For this reason, measuring capacity is easier than measuring volume where the spatial organisation of three-dimensional units must be considered.

A second aspect of volume is the volume of a model made with blocks. This aspect enables comparisons to be made easily —which model has more or fewer blocks—by counting the blocks. However, students may focus on counting and not associate this activity with volume. Nevertheless, it provides practice with stacking and layering, and may assist students to consider that not all blocks are visible when a model is built.

A third aspect of volume is the capacity (interior volume) of containers, when measured in cubic centimetres. The cubic units make this aspect of volume measurement more difficult than liquid measure. Students have to first learn to pack rectangular containers systematically. For example, students could measure and compare the volumes of their lunchboxes using informal cubic units, such as blocks. Packing activities develop knowledge of how the units are packed. This structure provides the basis for later development of the formula for the volume of a rectangular prism. In upper primary, students learn that one cubic centimetre is equal to one millilitre so they can see that both methods, packing or filling, give the same volume.

A fourth aspect of volume is exterior volume, or the amount of space a container takes up. Cosmetics containers are a good example. The amount the container holds (its interior volume) is often far less than the volume of the container (its exterior volume). Exterior volume of an object or irregularly shaped container is quite difficult to determine and would usually be found by displacement.

The fifth aspect of volume is that of displacement. This concept is difficult because it is not obvious that the amount of water displaced by an object is the volume of the object. However, experiences with displacement will assist students to develop this idea over time, especially if they measure identical objects so that the change in level, or the amount of water displaced is the same each time.

Working out the volume based on the number of blocks in a row or column of blocks and the number of rows in a layer depends on systematic packing. Knowledge of the structure of rows and columns in two dimensions, learnt as part of the area concept, will assist students to learn about the structure of three-dimensional packing. They might also use blocks connected together to make a “stick” to be equivalent to a row. The “sticks” can be used to form layers. Each “stick” would be a composite unit and so can be linked to repeated addition and multiplication. Students may be surprised at the large number of blocks in a container and they may need to check the number of layers and the number of blocks in each layer.

Experience with packing units, then drawing diagrams of these concrete situations, will help students perceive connections between textbook representations and practical situations. In the activities involving volume, rectangular containers are used so that students develop an understanding of the structure of the unit packing in volume. When focusing on the unit structure, fractional units should be avoided if possible, as they may obscure the structural relationships.

Tasks can be made more challenging for students by changing the way that information is recorded or by asking them to estimate before measuring. For example, asking students to draw a three-dimensional array of cubes increases the difficulty of the task of packing a clear plastic container with cubes. Drawings may assist the teacher to see if students have grasped the structure of packing volume units.

Such experiences prepare students to learn at a later stage, that the three dimensions, length, width, and height, of a rectangular container can be measured, and then multiplied together to find its volume. This strategy is a sophisticated one, because students have to perceive the relation between side lengths of a rectangular prism and volume to understand the basis for the formula.

VOLUME & CAPACITY LESSON IDEAS

Volume and capacity 4.1

One litre exactly (lesson plan)
Make a litre measure
How many litres
How many to the litre?
Choose me

Volume and capacity 4.2

Layer count (lesson plan)
Plan a prism
Twins
Side views
Copy this!

Volume and capacity 5.1

Calibrations (lesson plan)
ising levels
Dripping tap
Sprinkler patterns
Water for a day

Volume and capacity 5.2

Copy my model
Five different ways to model 36 cm^3
Group therapy
Grid prisms (lesson plan)
Investigating displacement to measure volume

Volume and capacity 6.1

Make a cubic metre
How big is the classroom?
Claustrophobia (lesson plan)
Green thumbs
Loaves to the cubic metre

Volume and capacity 6.2

Mouthfuls
What went in? (lesson plan)
It's all garbage
Fill the fish tank
How deep?

VOLUME & CAPACITY 4.1
Lesson ideas

Measure using conventional units
Measure and record 1 litre

Knowledge and strategies
1. estimate and measure to the nearest litre
2. calculate the number of given units to fill a litre
3. record measures of capacity using the abbreviation L

One litre exactly (see lesson plan)

Students estimate, measure and record how many 100 mL cups or scoops are required to fill a litre.

Students repeat this process with another small container, using the previous measure to assist in estimating before measuring.

Extension: students calculate the capacity of their measuring cup by dividing 1000 mL by the number of cupfuls in one litre, using a calculator.

Outcomes
MA2-1WM
MA2-11MG

Materials
- litre measure, container of water, small cups, mugs, scoops, funnels, pencils and paper, calculator for extension activity

Knowledge and strategies
1. estimate and measure to the nearest litre
2. calculate the number of given units to fill a litre
3. record measures of capacity using the abbreviation L

Make a litre measure

Students make a litre measure by pouring 1 L of water from a 500 mL or 1 L jug, into an empty, plastic soft drink bottle. Mark the water level on the bottle with a waterproof marker.

Note: if different bottles are used, students could compare the heights and shapes of their litre measures and discuss the results.

Outcomes
MA2-2WM
MA2-11MG

Materials
- plastic bottles greater than 1 L capacity, marker pens, water, funnels

Knowledge and strategies
1. estimate and measure to the nearest litre

How many litres?

Students work in small groups to estimate and measure the capacity of four large containers (bucket, large ice cream container, tote tray, bin) using a 1 L measure.

Students record their results and explain how the capacity was estimated.

Note: it may be easier if students commence by filling and measuring their largest container, then use the water to measure the remaining containers.

Outcomes

MA2-3WM
MA2-11MG

Materials

- water, 1 L measures, buckets, bins, tote trays, funnels, pencils and paper

Knowledge and strategies

1. estimate and measure to the nearest litre
2. record measures of capacity using the abbreviation L

How many to the litre?

Students collect containers which have a labelled capacity of less than 1 L, e.g. 500 mL, 250 mL.

Students calculate how many times each container will have to be filled to make 1 L, record and then check by filling with water and pouring into the 1 L measure.

Note: students may need to be reminded to keep an accurate tally of the number of times they filled their container.

Outcomes

MA2-3WM
MA2-11MG

Materials

- 1 L measures, variety of labelled containers, water, funnels, pencils and paper

Knowledge and strategies

1. estimate and measure to the nearest litre
2. calculate the number of given units to fill a litre
3. record measures of capacity using the abbreviation L

Choose me

Students are presented with a large group of containers of various sizes and shapes. Students choose a container which they estimate will have a capacity of one litre.

Students measure the capacity of their chosen container by using a litre measure, and record as more than 1 L, exactly 1 L, less than 1 L.

Note: a wide variety of containers, such as plastic drink bottles, lunch boxes, take-away food or margarine containers should be used for estimating.

Outcomes

MA2-1WM
MA2-11MG

Materials

- 1 L measures, variety of containers, pencils and paper, water

Knowledge and strategies

1. estimate and measure to the nearest litre
2. record measures of capacity using the abbreviation L

VOLUME & CAPACITY 4.1
Lesson plan

Measure using conventional units
Measure and record 1 litre

ONE LITRE EXACTLY (see lesson plan)

Students estimate, measure and record how many 100 mL cups or scoops are required to fill a litre.

Students repeat this process with another small container, using the previous measure to assist in estimating before measuring.

Extension: students calculate the capacity of their measuring cup by dividing 1000 mL by the number of cupfuls in one litre, using a calculator.

Students should

1. estimate and measure to the nearest litre
2. calculate the number of given units to fill a litre
3. record measures of capacity using the abbreviation L

Outcomes

MA2-1WM uses appropriate terminology to describe, and symbols to represent, mathematical ideas

MA2-11MG measures, records, compares and estimates volumes and capacities using litres, millilitres and cubic centimetres

Grouping

Step 1: whole-class introduction

Step 2: working individually

Step 3: whole-class discussion

Materials

litre measure, container of water, small cups, mugs, scoops, funnels, pencils and paper, calculator for extension activity

Step 1

Introduce the litre as a formal unit for measuring the capacity of large containers.

Display a 100 mL scoop or small container and ask students to estimate how many cupfuls would be necessary to fill the litre container.

Demonstrate filling, pouring and counting the cupfuls.

Discuss how the tally of the cupfuls can be recorded. Stop when the large container is about one-third full and ask students if they would like to revise their estimates. Continue pouring and counting, then ask a student to record the number of cupfuls on the chalkboard.

Introduce the activity to be completed by small groups.

Questioning

How could I measure the capacity of this large container?

How many of these small cupfuls will be needed to fill the litre container?

How did you work out your estimate?

How will you remember the number of cupfuls?

You can see how full the litre container now is. Would you like to change your estimate of the number of cupfuls?

How would I record this measure?

How do I write the abbreviation for litre?

Step 2

Have your students work in pairs or small groups to:

- estimate the number of cupfuls required to fill the litre container
- discuss and record their estimates
- measure and record the number of cupfuls required using SI abbreviation L
- select a different scoop or small cup and estimate, measure and record the number of cupfuls needed to fill a litre container.

Check that students

- make reasonably accurate estimates
- revise their estimate, if they find that their estimate is inaccurate after commencing measuring
- measure and count accurately and record findings.

Step 3

Students compare the results obtained from their two different cups or scoops and discuss the reasons for the variations in results.

Discussion

What do your measurements tell you about your cupfuls or scoops?

How did you make sure that your measurements were accurate?

VOLUME & CAPACITY 4.2
Lesson ideas

Measure using conventional units
Measure and record volume in cubic centimetres by packing

Knowledge and strategies
1. estimate and measure the volume of small rectangular containers in cubic centimetres by packing
2. identify the array structure of each layer
3. record measures of volume using the abbreviation cm^3

Layer count (see lesson plan)

Pairs of students make a rectangular prism with centimetre blocks. Students commence with a base which has twelve blocks. Students record the number of blocks and the array pattern in the first layer. Two more layers are added and the total number of blocks and volume in cubic centimetres are recorded. Students look at the number pattern of the layers to predict how many blocks will be needed for five layers.

Note: wooden or plain centimetre blocks, rather than interlocking blocks, may be easier to build into a prism; if blocks in different colours are available, layers made in different colours may assist students to identify the layers.

Extension: students draw their prisms, ensuring that the correct number of blocks is indicated.

Outcomes
MA2-2WM
MA2-11MG
MA2-6NA

Materials
- centimetre blocks, pencils and paper

Knowledge and strategies
1. estimate and measure the volume of small rectangular containers in cubic centimetres by packing
2. identify the array structure of each layer
3. record measures of volume using the abbreviation cm^3

Plan a prism

Pairs of students discuss what size and shape to make a rectangular prism built from 1 cm blocks. Students draw the front, side and top views of their planned prism on grid paper, estimate how many centimetre blocks will be required to build the prism and the volume of the model in cubic centimetres. Students make the planned prism and compare the model with their plans and estimated volume.

Outcomes
MA2-3WM
MA2-11MG
MA2-6NA

Materials
- centimetre blocks, 1 cm grid paper, paper and pencils

Knowledge and strategies
1. estimate and measure the volume of small rectangular containers in cubic centimetres by packing

2. identify the array structure of each layer
3. record measures of volume using the abbreviation cm^3

Twins

Students find the volume of two identical boxes by packing with centimetre blocks from two different directions (or pack the same box in two different ways by commencing at a different face). Record the number of blocks in each layer, the number of layers and the volume of the packed blocks, in cubic centimetres. **Extension:** experiment with building the same number of blocks into a different rectangular prism.

Outcomes

MA2-3WM
MA2-11MG
MA2-6NA

Materials

- small boxes, centimetre blocks, pencils and paper

Knowledge and strategies

1. estimate and measure the volume of small rectangular containers in cubic centimetres by packing
2. identify the array structure of each layer
3. record measures of volume using the abbreviation cm^3

Side views

Students work in pairs to build a rectangular prism from interlocking blocks or centimetre blocks. Students draw plans of three faces – top, front and side and record the volume of the model in cubic centimetres. Students give their plans to another pair, who build the rectangular prism to the given plan, then compare their new model with the original model.

Variation 1: groups of students display their finished rectangular prisms and plans. The teacher rearranges the order of the plans. The group moves to another display of models and matches the rectangular prisms and correct plans.

Variation 2: pairs of students make a prism and draw a plan. The prism is covered and left on the desk, and the students move to another desk. Students use the plan at the new desk to build a prism and then compare this with the original model.

Outcomes

MA2-1WM
MA2-11MG

Materials

- centimetre blocks or interlocking blocks, pencils and paper

Knowledge and strategies

1. estimate and measure the volume of small rectangular containers in cubic centimetres by packing
2. identify the array structure of each layer
3. record measures of volume using the abbreviation cm^3

Copy this!

Students work in pairs of A and B. Student A makes rectangular prism from cubes of side length of 1 cm, without showing Student B. Student A describes the model to Student B, who makes the model after following the directions. Student A checks the model and both students use the layer structure of the prism to calculate and record the volume of the model in cubic centimetres. The students reverse roles and build a second prism.

Outcomes

MA2-1WM
MA2-3WM
MA2-11MG

Materials

- interlocking centimetre cubes, pencils and paper

Knowledge and strategies

1. estimate and measure the volume of small rectangular containers in cubic centimetres by packing
2. identify the array structure of each layer
3. record measures of volume using the abbreviation cm^3

VOLUME & CAPACITY 4.2
Lesson plan

Measure using conventional units
Measure and record volume in cubic centimetres by packing

LAYER COUNT

Pairs of students make a rectangular prism with centimetre blocks. Students commence with a base which has twelve blocks. Students record the number of blocks and the array pattern in the first layer. Two more layers are added and the total number of blocks is recorded. Students look at the number pattern of the layers to predict how many blocks will be needed for five layers.

Note: wooden or plain centimetre blocks, rather than interlocking blocks, may be easier to build into a prism; if blocks in different colours are available, layers made in different colours may assist students to identify the layers.

Extension: students draw their prisms, ensuring that the correct number of blocks is indicated.

Students should

1. estimate and measure the volume of small rectangular containers in cubic centimetres by packing
2. identify the array structure of each layer
3. record measures of volume using Standard SI abbreviation cm^3

Outcomes

MA2-2WM selects and uses appropriate mental or written strategies, or technology, to solve problems

MA2-11MG measures, records, compares and estimates volumes and capacities using litres, millilitres and cubic centimetres

MA2-6NA uses mental and informal written strategies for multiplication and division

Grouping

Step 1: whole-class introduction

Step 2: working in small groups

Step 3: whole-class discussion

Materials

centimetre blocks, pencils and paper

Step 1

Introduce the lesson as the calculation of the volume of a rectangular prism.

Explain how the students will build a rectangular prism using centimetre blocks.

Ask a student to demonstrate how to build a rectangular prism, commencing with a base layer of eight blocks.

Discuss how the number of centimetre blocks on the first layer can be calculated, either by skip counting in rows or by multiplying the number of rows by the number of blocks in each row.

Ask the students to predict how many blocks will be needed for a total of four layers.

Discuss how to make the calculation, using the term *multiples*.

Add the remaining layers to complete the prism, confirm the number of blocks used and record the total measurement in cubic centimetres (cm^3). Introduce the small group activity.

Questioning

What could I measure about this prism?

What measuring tools and units would I need to use?

How could I measure the volume of a rectangular prism?

How many blocks are in this first layer?

How many blocks will we need for four layers?

What is the volume of this prism?

How will you record your measurements?

Step 2

Have your students work in pairs or small groups to:

- make a base of the rectangular prism using twelve blocks
- record the structure of the array and the number of blocks in the first layer
- add two more layers and record the number of blocks in each layer
- predict how many blocks will be needed for five layers.
- check by building two more layers and recording the number of blocks used.
- record the volume of the model in cubic centimetres.

Check that students

- pack the blocks accurately in layers
- use multiplication facts to determine the number of blocks in each layer
- record the volume of the model in cubic centimetres.

Step 3

Discuss how students calculated the volume of their prisms.

Discuss how to build a prism with the same volume, but different dimensions

Discussion

How did you calculate the volume of the rectangular prism?

How would you make a prism which had the same volume but different dimensions?

VOLUME & CAPACITY 5.1
Lesson ideas

Relationships between formal measurement units
Measure and record capacity in litres and millilitres

Knowledge and strategies
1. measure and record capacities in millilitres and litres
2. record capacity using decimal notation to three decimal places
3. convert between mL and litres, e.g. 1600 mL=1 litre 600 millilitres
4. use overflow or change in level as a measure of volume to the nearest 100 mL

Calibrations (see lesson plan)
Students mark 100 mL gradations on an empty plastic container, using water poured from a measuring jug. Students use their calibrated container to identify single or multiple objects which displace 100 mL (marbles, golf balls, bolts, scissors or rocks)

Variation: students use their calibrated container to estimate, measure and record the capacity of a variety of containers to the nearest 100 mL.

Outcomes
MA2-2WM
MA2-11MG

Materials
- measuring jugs, clear plastic containers (e.g. 2 L fruit juice bottle with the neck cut off) to be made into measures, marking pens, drip trays, a variety of small objects to be submersed in the plastic container. **Note:** the unmarked container should have a capacity of at least 500 mL.

Knowledge and strategies
1. record capacity using decimal notation to three decimal places
2. convert between mL and litres, e.g. 1600 mL = 1 litre 600 millilitres
3. use overflow or change in level as a measure of volume to the nearest 100 mL

Rising levels
Students use small drink bottles filled with water, or unopened bottles of water or juice. Students immerse the bottles, one at a time, in a large calibrated container of water and note the changing water level. Students estimate then measure how many bottles will be needed to displace 500 mL and 1 L of water. Record results.

Outcomes
MA2-1WM
MA2-3WM
MA2-11MG

Materials
- small drink bottles which have lids, large calibrated container, water, funnels, pencils and paper

Knowledge and strategies

1. record capacity using decimal notation to three decimal places
2. convert between mL and litres, e.g. 1600 mL=1 litre 600 millilitres
3. use overflow or change in level as a measure of volume to the nearest 100 mL

Dripping tap

Pairs or small groups of students estimate then measure the volume in litres of water wasted by a dripping tap in 24 hours.

Compare results with another group, and comment on any differences between results.

Variation: measure the volume of water wasted when a tap is left on for two hours.

Outcomes

MA2-1WM
MA2-3WM
MA2-11MG
MA2-13MG

Materials

- access to taps, stop watches or watches, measuring jugs, pencils and paper

Knowledge and strategies

1. measure and record capacities in millilitres and litres
2. record capacity using decimal notation to three decimal places
3. convert between mL and litres, e.g. 1600 mL = 1 litre 600 millilitres

Sprinkler patterns

Students investigate the effectiveness of a lawn sprinkler in distributing water evenly over an area.

Ice cream containers are placed at different points in the watered area. The volume of water which accumulates in each container is monitored after 5, 10 and 15 minutes. Students estimate the volume of water in each container before measuring. Students present the information clearly (may include a graph).

Outcomes

MA2-1WM
MA2-11MG

Materials

- hose and sprinkler, ice cream containers, millilitre measures, pencils and paper

Knowledge and strategies

1. measure and record capacities in millilitres and litres
2. record capacity using decimal notation to three decimal places
3. convert between mL and litres, e.g. 1600 mL=1 litre 600 millilitres

Water for a day

Pairs or small groups of students calculate how much water they use in one day. A suggested procedure is to commence by listing activities that require water, then estimate what the total may be. Students confirm as many measurements as practical, before calculating the total volume of water in litres.

Information: new toilet cisterns have a 3 L half flush and 6 L full flush; older style toilet cisterns have a 15 L flush; each minute under a normal shower can use 23 L of water.

Outcomes

MA2-2WM
MA2-11MG

Materials

- measuring jugs, cups or glasses, basins for measuring water during hand washing, pencils, paper, calculators

Knowledge and strategies

1. measure and record capacities in millilitres and litres
2. record capacity using decimal notation to three decimal places
3. convert between mL and litres, e.g. 1600 mL=1 litre 600 millilitres

VOLUME & CAPACITY 5.1
Lesson plan

Relationships between formal measurement units
Measure and record capacity in litres and millilitres

CALIBRATIONS

Students mark 100 mL gradations on an empty plastic container, using water poured from a measuring jug. Students use their calibrated container to identify single or multiple objects which displace 100 mL (marbles, golf balls, bolts, scissors or rocks)

Variation: students use their calibrated container to estimate, measure and record the capacity of a variety of containers to the nearest 100 mL.

Students should

1. record capacity using decimal notation to three decimal places
2. convert between mL and litres, e.g. 1600 mL=1 litre 600 millilitres
3. use overflow or change in level as a measure of volume to the nearest 100 mL

Outcomes

MA2-2WM selects and uses appropriate mental or written strategies, or technology, to solve problems

MA2-11MG measures, records, compares and estimates volumes and capacities using litres, millilitres and cubic centimetres

Grouping

Step 1: whole-class introduction

Step 2: individual or paired working

Step 3: whole-class discussion

Materials

measuring jugs, clear plastic containers (e.g. 2 L fruit juice bottle with the neck cut off) to be made into measures, marking pens, drip trays, a variety of small objects to be submersed in the plastic container

Note: the unmarked container should have a capacity of at least 500 mL.

Step 1

Introduce the lesson by explaining that students will make their own instrument for measuring the volume of water in a container.

Revise the use of litres and millilitres and discuss how to record measurements, and how to convert between units.

Display several measuring jugs, examine the markings and discuss a useful unit of measure, such as 50 mL or 100 mL.

Discuss how an unmarked container can be marked to measure in gradations of 100 mL. Ensure that students understand the importance of accuracy – pouring exactly 100 mL each time, marking the container carefully and viewing their markings at eye-level.

Discuss the term *displace*, and how *displacement* can be used to measure volume.

Ask students to suggest an item or items which displace 100 mL of water.

Have a student demonstrate how to record findings, using correct abbreviations.

Questioning

How could I use this container to make an instrument for measuring capacity?

What units are used to measure the volume of an amount of liquid?

How do you record those units? What would be a useful measure to mark on the container?

How could you make a measuring device which will measure to the nearest 100 mL?

What could give you an inaccurate measure?

What does displace mean?

Can you suggest an item which will displace 100 mL of water in your measuring container? What will your recording include?

Step 2

Have your students work in small groups to:

- prepare a container as a measuring instrument
- investigate items which displace 100 mL of water
- record the trials and results.

Check that students

- prepare their measuring instrument as accurately as possible
- make reasonable predictions of items which will displace 100 mL water
- record their results.

Step 3

Discuss how students selected items to trial, and the final results.

Compare the items which displace 100 mL.

Discussion

How did you choose your first items?How did the results from the first items help you to select a second item?

How can we be sure that you have found all of the rectangles?

VOLUME & CAPACITY 5.2
Lesson ideas

Relationships between formal measurement units
Measure and calculate volume in cubic centimetres

Knowledge and strategies
1. estimate then calculate the volume of a rectangular prism in cubic centimetres, given the volume of one layer and the number of layers
2. explain the relationship between 1 cubic centimetre and 1 mL (using displacement)

Copy my model
Students examine the teacher's model of a rectangular prism built from centimetre cubes, and estimate the volume of the model in cubic centimetres. Teacher dismantles the rectangular prism, one layer at a time and explains that rectangles of 1 cm grid paper have been cut to the same size as the base of the model, and placed on the top of each layer. Students may revise their estimate. The class discusses how the volume can be calculated, in terms of each layer and the number of layers. Pairs of students replicate the rectangular prism (including the grid paper at each layer) and record the volume in cubic centimetres.

Extension: students work in pairs. Student A builds a model from 1 cm cubes while Student B averts eyes. Student B examines the model without touching it, calculates the volume in cubic centimetres and explains to Student A how the calculations were made.

Outcomes
MA3-3WM
MA3-11MG

Materials
- centimetre blocks, 1 cm grid paper, scissors, pencils and paper

Knowledge and strategies
1. estimate then calculate the volume of a rectangular prism in cubic centimetres, given the volume of one layer and the number of layers

Five different ways to model 36 cm³
The class discusses how a rectangular prism with a volume of 36 cubic centimetres could be built from centimetre blocks (e.g. 3x4x3, 2x6x3, 4x9x1, 12x1x3). Pairs of students design and construct their 36 cm³ rectangular prism.

Students display their diagrams, calculations and models and the class discusses the variations in rectangular prisms.

Outcomes
MA3-1WM
MA3-11MG

Materials
- centimetre blocks, pencils and paper

Knowledge and strategies
1. estimate then calculate the volume of a rectangular prism in cubic centimetres, given the volume of one layer and the number of layers

Group therapy (barrier game)

Individual students in a small group make a rectangular prism described by the leader, using centimetre blocks. Instructions may include the structure of the array for the base and the number of layers.

Group members record calculations of the volume of the prism in cubic centimetres. Students check their model against the completed prism.

Outcomes

MA3-1WM
MA3-11MG

Materials

- centimetre blocks, pencils, paper

Knowledge and strategies

1. estimate then calculate the volume of a rectangular prism in cubic centimetres, given the volume of one layer and the number of layers

Grid prisms (see lesson plan)

Pairs of students or individual students design and make rectangular prisms by folding, cutting and taping the nets of prisms drawn on 1 cm grid paper. Students find the volume of the prism in cubic centimetres, and record how the volume was calculated or counted.

Variation: students make a prism with a volume of 120 cm^3, from 1 cm grid paper. Students record how they chose the dimensions of their prism and how the volume was calculated.

Outcomes

MA3-3WM
MA3-11MG
MA3-14MG

Materials

- 1 cm grid paper, scissors, sellotape, pencils, paper

Knowledge and strategies

1. estimate then calculate the volume of a rectangular prism in cubic centimetres, given the volume of one layer and the number of layers

Investigating displacement to measure volume

Step 1: students use a calibrated container of water (measuring glass or similar) and drop in one centimetre block at a time.

Students record what happens to the water level, and comment on the relationship between 1 cm^3 and 1 mL.

Step 2: students make a small rectangular prism from centimetre cubes and calculate and record the volume.

Students find the volume of water displaced when the model is dropped into a calibrated container of water. Students read the new water level and record in millilitres.

Step 3: students retrieve the model and construct a model which has the same volume, but different dimensions. Students find the volume by displacement and record the results. The process is repeated and students make a written or verbal report on the results.

Outcomes

MA3-2WM
MA3-11MG

Materials

- interlocking centimetre blocks which sink, calibrated measures, water, pencils and paper

Knowledge and strategies

1. estimate then calculate the volume of a rectangular prism in cubic centimetres, given the volume of one layer and the number of layers
2. explain the relationship between 1 cubic centimetre and 1 mL (using displacement)

VOLUME & CAPACITY 5.2
Lesson plan

Relationships between formal measurement units
Measure and calculate volume in cubic centimetres

GRID PRISMS (see lesson plan)

Pairs of students or individual students design and make rectangular prisms by folding, cutting and taping the nets of prisms drawn on 1 cm grid paper. Students find the volume of the prism in cubic centimetres, and record how the volume was calculated or counted.

Variation: students use 1 cm grid paper to make a prism with a volume of 120 cm^3. Students record how they chose the dimensions of their prism and how the volume was calculated.

Students should

1. estimate then calculate the volume of a rectangular prism in cubic centimetres, given the volume of one layer and the number of layers

Outcomes

MA3-3WM gives a valid reason for supporting one possible solution over another

MA3-11MG selects and uses the appropriate unit to estimate, measure and calculate volumes and capacities, and converts between units of capacity

MA3-14MG identifies three-dimensional objects, including prisms and pyramids, on the basis of their properties, and visualises, sketches and constructs them given drawings of different views

Grouping

Step 1: whole-class introduction

Step 2: individual or paired working

Step 3: whole-class discussion

Materials

1 cm grid paper, scissors, sellotape, pencils and paper, model made from 1 cm blocks for teacher's demonstration

Step 1

Display a rectangular prism made from 1 cm blocks (suggested size of the prism is approximately 6 cm x 5 cm x 3 cm).

Ask students how the prism could be measured.

Discuss how to measure the edges, area of each face, volume and mass.

Ask students to explain how they would make a paper model of the prism, using 1 cm grid paper.

Discuss the number of faces and the size of each face. Note that parallel faces are the same size and have the same array pattern.

Discuss how a net of the prism could be drawn. Ask students to draw different versions of the net on the chalkboard. Have students explain how their net will fold to make a 3D shape.

Discuss how the volume of the prism can be calculated by multiplying the volume of one layer by the number of layers.

Calculate the total volume of the prism by commencing with a different layer. Introduce the task – students design and make their own rectangular prisms.

Note: some students may prefer to work from a model, drawing six separate faces, and taping these together.

Questioning

How could I measure this prism? Are there any other measurements I could make?

How would you make a paper model of this prism – how would you begin?

How many faces will your model have?

What do you notice about parallel or opposite faces?

What would a net of this prism look like?

How do you check that the net will fold correctly, before you cut it out?

How would you calculate the volume of this prism?

What is another way of calculating the volume?

Step 2

Have your students work in pairs or small groups to:

- design and draw the net of a rectangular prism on 1 cm grid paper
- cut, fold and tape the make a 3D model
- calculate the volume of the prism.

Check that students

- decide on the dimensions of their prism and draw the net
- construct the paper model
- explain how to calculate the volume of the model.

Step 3

Discuss different ways of calculating the volume of a rectangular prism after finding the volume of one layer – by skip counting, repeated addition, or multiplication.

Compare models which have a similar volume, but different dimensions.

Discussion

What are the different methods you could use to calculate the volume of a rectangular prism?

Why does each of these methods work?Do we have some prisms which have the same volume, but are different shapes?How has this happened?

VOLUME & CAPACITY 6.1
Lesson ideas

Knowing and representing large units
Calculate volume in cubic metres

Knowledge and strategies
1. identify situations where cubic metres are used to measure volume
2. estimate and use cubic metres to measure volume
3. identify the relationship between the length, breadth, height, and volume of rectangular prisms

Make a cubic metre

Students discuss what a cubic metre is, and what is measured in cubic metres.

Small groups make a skeleton model of a cubic metre with wooden dowel or plastic sticks, rolled newspaper or a commercial kit. Students check all dimensions with a metre rule or tape measure.

Extension: collect MAB blocks and flats from other classrooms, to make a model of a cubic metre. If possible, make one layer and at least one vertical column from blocks or ten flats placed together as a block. Students discuss how many cubic centimetres are in one layer, and how many cubic centimetres are in ten layers. The availability of materials may restrict this activity to a whole class demonstration and discussion, or a task completed by one small group at a time.

Outcomes
MA3-2WM
MA3-11MG

Materials
- material to build model (dowel, plastic or paper) or commercial kit, pencils, paper

Knowledge and strategies
1. identify situations where cubic metres are used to measure volume
2. estimate and use cubic metres to measure volume
3. identify the relationship between the length, breadth, height, and volume of rectangular prisms

How big is the classroom?

Students use their models of cubic metres, together with diagrams and measurements to the nearest metre, to calculate the volume of the classroom in cubic metres.

Note: some students may find the calculation of volume easier to visualise if the furniture is pushed aside and cubic metre models are placed across the room.

Outcomes
MA3-2WM
MA3-11MG

Materials
- cubic metre models, tape measures, pencils and paper, calculators

Knowledge and strategies

1. identify situations where cubic metres are used to measure volume
2. estimate and use cubic metres to measure volume
3. identify the relationship between the length, breadth, height, and volume of rectangular prisms

Claustrophobia (see lesson plan)

Students use the cubic metre models to estimate then measure how many students can fit into a cubic metre. Small groups investigate how many students could fit into the classroom, if students were packed to the ceiling.

Extension: how many rooms would be required for all of the students and teachers in the school?

Outcomes

MA3-2WM
MA3-3WM
MA3-11MG

Materials

- cubic metre models, tape measures, pencils and paper, calculators

Knowledge and strategies

1. identify situations where cubic metres are used to measure volume
2. estimate and use cubic metres to measure volume
3. identify the relationship between the length, breadth, height, and volume of rectangular prisms

Green thumbs

Pairs or small groups of students calculate the cost of laying mulch on the school garden, to a depth of 10 cm. Students may need to be given dimensions of a garden if there is no school garden to measure.

The cost of mulch per cubic metre, plus delivery, can be requested from local garden supplies.

Alternative: pairs or small groups of students calculate the cost of putting a 20 cm layer of sand in the long jump pit. Local builders suppliers may be contacted for cost per cubic metre, plus delivery.

Outcomes

MA3-2WM
MA3-11MG

Materials

- trundle wheels, tape measures, pencils and paper, calculators

Knowledge and strategies

1. identify situations where cubic metres are used to measure volume
2. estimate and use cubic metres to measure volume
3. identify the relationship between the length, breadth, height, and volume of rectangular prisms

Loaves to the cubic metre

Students investigate how many loaves of bread can be packed into 1 cubic metre.

Suggestion: students make a scale drawing of one layer of loaves of bread, to find how the loaves can be arranged to fit 1 square metre, then calculate the number of layers.

Outcomes

MA3-2WM
MA3-11MG

Materials

- sample loaf of bread, rulers, grid paper, pencils, calculators, paper

Knowledge and strategies

1. identify situations where cubic metres are used to measure volume
2. estimate and use cubic metres to measure volume
3. identify the relationship between the length, breadth, height, and volume of rectangular prisms

VOLUME & CAPACITY 6.1
Lesson plan

Knowing and representing large units
Calculate volume in cubic metres

CLAUSTROPHOBIA

Students use cubic metre models from a previous lesson to estimate then measure how many students can fit into a cubic metre. Small groups investigate how many students could fit into the classroom, if students were packed to the ceiling.

Extension: how many rooms would be required for all of the students and teachers in the school?

Students should

1. identify situations where cubic metres are used to measure volume
2. estimate and use cubic metres to measure volume

Outcomes

MA3-2WM selects and applies appropriate problem-solving strategies, includingthe use of digital technologies, in undertaking investigations

MA3-3WM gives a valid reason for supporting one possible solution over another

MA3-11MG selects and uses the appropriate unit to estimate, measure and calculate volumes and capacities, and converts between units of capacity

Grouping

Step 1: whole-class introduction

Step 2: working in small groups

Step 3: whole-class discussion

Materials

cubic metre models, tape measures, pencils, paper, calculators

Step 1

Introduce the cubic metre and discuss how the measurement unit is used.

Explain that the students will calculate how many students fit into a cubic metre and discuss how groups may calculate this.

Encourage students to trial several methods of arranging themselves within the cubic metre, before final results are recorded.

Discuss how to calculate the number of cubic metres in the classroom and the total number of students which could be fitted into a classroom.

Questioning

How big is a cubic metre?

How many students do you think would fit into a cubic metre?

How will I work out how many students could be fitted into a classroom, from the floor to the ceiling and from wall to wall?

How do I calculate the volume of the classroom to the nearest cubic metre?

Step 2

Have your students work in pairs or small groups to:

- estimate then work out how many students will fit in a cubic metre (several groups may need to join together to count the number of students in one cubic metre)
- measure the length, breadth and height of the classroom to calculate its volume.
- calculate the number of students who will occupy the volume of the classroom
- record the results.

Check that students

- have an understanding of a cubic metre
- accurately measure the volume of the classroom
- understand how to calculate the possible number of students to fill the room.

Step 3

Groups report on their findings.

Discuss variations and possible reasons for the differences between results.

Extension: Discuss how to calculate the number of rooms needed for all of the students and teachers in the school.

Discussion

How close was your first estimate of how many students would fit into one room, and how did you change your estimate as you continued?

Why do we have some different results?

What else could we do with these measurements?

VOLUME & CAPACITY 6.2
Lesson ideas

Knowing and representing large units
Convert units of volume and capacity to calculate and compare quantities

Knowledge and strategies
1. express the relationships between volume and capacity: cubic centimetres and millilitres, cubic centimetres and litres
2. convert measures to calculate volume and capacity

Mouthfuls
Students work in small groups to find which group member has the largest mouth. The volume of water which can fit into a mouth may be measured in several ways. Students could take a large gulp from a container which has the level of water marked, and then calculate how much was taken. The mouthful can be calculated by reading a marked scale on the container, or by adding centimetre blocks to the container until the original level is reached. Students express the volume in cubic centimetres and millilitres.

Outcomes
MA3-2WM
MA3-11MG

Materials
- disposable cups, water, marking pens, centimetre blocks, calibrated containers, pencils and paper

Knowledge and strategies
1. express the relationships between volume and capacity: cubic centimetres and millilitres, cubic centimetres and litres
2. convert measures to calculate volume and capacity

What went in? (see lesson plan)
Students in pairs mark the water level on a container and then add a model built from centimetre blocks. The new level is marked and the model removed. Students calculate the volume of the model in cubic centimetres and the volume of water displaced in millilitres. The container is given to a second pair of students who estimate the volume of blocks that were added, and check by building and adding a model. The students compare their results with the original measurements.

Note: students may need to be reminded to read the water level accurately and to drop the blocks into the water without splashing.

Outcomes
MA3-2WM
MA3-11MG

Materials
- calibrated containers, water, marking pens, centimetre blocks, pencils and paper

Knowledge and strategies
1. express the relationships between volume and capacity: cubic centimetres and millilitres, cubic centimetres and litres
2. convert measures to calculate volume and capacity

It's all garbage

Students work in small groups to investigate and report on the volume of rubbish which is generated at the school each week. Students may need to use information concerning the volume and number of garbage bins, and the frequency of emptying. Issues which may be investigated include:

Where does most of the rubbish come from?

Is recycling a sensible option?

What does the school pay for rubbish removal?

What are the broader issues around the disposal of rubbish in the local community?

Outcomes

MA3-3WM
MA3-11MG

Materials

- pencils, paper, access to School Assistants and General Assistant to answer questions

Knowledge and strategies

1. express the relationships between volume and capacity: cubic centimetres and millilitres, cubic centimetres and litres
2. convert measures to calculate volume and capacity

Fill the fish tank

Students investigate how long it would take to fill a large fish tank, using a hose attached to the school tap. The tank has dimensions of 1 m x 50 cm. The tank is 70 cm high.

Students may like to discuss:

A sensible height for the water level;

How to calculate the volume of water required;

How to measure the rate of flow of water from the school tap;

The conversion of cubic centimetres or cubic metres to millilitres and litres.

Students need to record all of their measurements and their calculations.

Outcomes

MA3-2WM
MA3-11MG
MA3-13MG

Materials

- bucket, litre measure, stopwatch, access to a school tap, pencils and paper, calculators

Knowledge and strategies

1. express the relationships between volume and capacity: cubic centimetres and millilitres, cubic centimetres and litres
2. convert measures to calculate volume and capacity

How deep?

Students calculate the depth of water in containers when 1 litre of water has been poured into:

a container with a base of 10 cm x 5 cm and height 30 cm

a container with a base of 20 cm x 10 cm and height of 10 cm a container with a base of 30 cm x 7 cm and height of 10 cm.

Extension: students work in pairs to set problems for each other, increasing the volume of water and the dimensions of the containers.

Outcomes

MA3-2WM
MA3-11MG

Materials

- pencils and paper

Knowledge and strategies

1. express the relationships between volume and capacity: cubic centimetres and millilitres, cubic centimetres and litres
2. convert measures to calculate volume and capacity

VOLUME & CAPACITY 6.2
Lesson plan

Knowing and representing large units
Convert units of volume and capacity to calculate and compare quantities

WHAT WENT IN?

Students in pairs mark the water level on a container and then add a model built from centimetre blocks. The new level is marked and the model removed. Students calculate the volume of the model in cubic centimetres and the volume of water displaced in millilitres. The container is given to a second pair of students who estimate the volume of blocks that were added, and check by building and adding a model. The students compare their results with the original measurements.

Note: students may need to be reminded to read the water level accurately and to drop the blocks into the water without splashing.

Students should

1. express the relationships between volume and capacity, cubic centimetres and millilitres, cubic centimetres and litres
2. convert measures to calculate volume and capacity

Outcomes

MA3-2WM selects and applies appropriate problem-solving strategies, including the use of digital technologies, in undertaking investigations

MA3-11MG selects and uses the appropriate unit to estimate, measure and calculate volumes and capacities, and converts between units of capacity

Grouping

Step 1: whole-class introduction

Step 2: working in small groups

Step 3: whole-class discussion

Materials

calibrated containers, water, marking pens, centimetre blocks, pencils and paper

Step 1

Introduce the activity as the measurement of volume by displacement.

Show the students a model built from 1 cm blocks and a calibrated container partially filled with water. Ask the students how the volume of the model can be measured.

Discuss how to mark the water level, drop the model carefully into the water, and mark the new water level on the container.

Calculate and record the volume of water displaced and compare with the volume measured by counting the blocks in the model.

Discuss the relationship between the units of measure used – cubic centimetres and millilitres – and how to record the measures. Introduce the task.

Questioning

What is the volume of my model?

How can I measure the volume, and what units will I use?

What will happen to the water level on the container after we have added the blocks?

How much water has been displaced?

What is the relationship between the number of blocks and the number of millilitres? How could we prove this?

Step 2

Have your students work in pairs to:

- build a model from 1 cm blocks , measure the volume of the model by displacement and record the results
- swap the marked container with another pair of students
- estimate and record the volume of the model that was added to the container which they have just received
- check the estimated volume by building a model and measuring by displacement
- check the results with the students who marked the water level.

Check that students

- understand why they need to mark the water levels before and after the blocks are added
- take care not to remove an excessive amount of water when the blocks are retrieved
- accurately measure the volume
- discuss the relationship between cubic centimetres and millilitres.

Step 3

Pairs of students discuss their results and compare with the original measurements. Whole-class discuss why results may be slightly different. Revise the relationship between a cube of side 1 cm and 1 mL of water.

Discussion

If the same number of blocks was joined to make a different model, would it still have the same volume?

Why is there a match between your displacement measures and the number of blocks in your models?

Why could these be different?

Teaching Measurement
MASS

LEVEL DESCRIPTIONS FOR MASS

Level 1	Knowledge and strategies
L1.1 Identification of the attribute Make direct comparisons of mass	1. use mass vocabulary such as *light, heavy, hard to push or lift* 2. identify materials that are light and heavy 3. identify objects that have about the same mass 4. heft or push objects and decide which is heavier or lighter
L1.2 Identification of the attribute Compare and order objects by hefting or by making intuitive judgements	1. use comparative language: *heavier than, lighter than, heaviest, lightest* 2. predict which object would be heavier than, lighter than, about the same and explain reasoning. 3. compare masses systematically and explain why a mass fits into a particular ordering
Level 2	**Knowledge and strategies**
L2.1 Informal measurement Compare masses using an equal arm balance	1. know that an identical object on each side will balance 2. know that the side that goes down has the greater mass 3. demonstrate how to use an equal arm balance to compare three or more objects and report the results
L2.2 Informal measurement Choose appropriate units and use them to measure a mass	1. find out how many identical units will balance a given mass. 2. suggest appropriate units and explain why some units would be better than others 3. explain that spatial structure is not important for mass and that round objects such as marbles are suitable for measuring mass
Level 3	**Knowledge and strategies**
L3.2 Structure of units Explain the relationship between unit size and number of units required to balance a mass	1. explain the relationship between unit size and the number of units 2. express the same mass in terms of different sized units 3. know that measurement techniques must be consistent and precise
Level 4	**Knowledge and strategies**
L4.1 Measure using conventional units Measure and record 1 kilogram	1. identify a mass which is approximately 1 kilogram 2. use a measuring instrument to make a 1 kilogram mass 3. record mass using the abbreviation kg
L4.2 Measure using conventional units Measure quantities less than1 kg in grams	1. measure mass to the nearest 10 grams 2. estimate masses to the nearest 100 grams 3. use measuring devices accurately 4. record mass using the abbreviation gm
Level 5	**Knowledge and strategies**
L5.1 Relationships between formal measurement units Measure and record mass in kilograms and grams	1. select and use an appropriate measuring device 2. measure and record mass in kilograms and grams
L 5.2 Relationships between formal measurement units Measure and calculate mass in kilograms and grams	1. measure and record masses in kilograms using decimal notation to three decimal places 2. convert from kilograms to grams, and grams to kilograms 3. calculate mass in grams and kilograms
Level 6	**Knowledge and strategies**
L6.1 Knowing and representing large units Calculate mass in tonnes	1. identify situations where the tonne is used to measure mass 2. calculate mass in tonnes 3. use the abbreviation t
L6.2 Knowing and representing large units Convert units of mass to calculate and compare mass	1. convert units of mass 2. use mass in calculations using decimal notation to three decimal places

MASS

Mass is defined as the amount of matter in an object but, like time and temperature, it cannot be seen. Students may confuse mass and volume because objects with a larger volume will often have more mass than with a smaller volume. However, if two contrasting materials are compared, for example, foam packaging and iron, students will quickly realize that the larger volume does not necessarily have the larger mass.

Mass may also be confused with weight. Students may have some awareness of the difference between these two concepts now that space travel has been widely reported and astronauts have been shown to weigh less on the moon because the moon's gravitational field is not as strong as that of earth. Weight is a force that is affected by gravity and so as gravity changes, the weight of an object will change. So scientifically, it is incorrect to say an object weighs one kilogram because weight is measured in units of force (Newton's, named after Sir Isaac Newton who formulated the law of gravity). The correct expression is that an object has a mass of one kilogram. Use of precise language by teachers will assist students to distinguish between these two concepts when they encounter them in secondary school.

The measurement framework for mass is slightly different from length, area and volume as units of mass are not spatially organized. Students learn to use an equal-arm balance to measure mass in Level 1.3 and then progress to the use of informal units in Level 2. The only concept at Level 3 is that of the relationship between the size of the unit and the number of units. For example, if four-block units are used to balance an object, then four times as many will be needed if one-block units are substituted.

In levels 4, 5 and 6, students are progressively introduced to using and recording the formal units of measure, grams, kilograms and tonnes. As with length, area, and volume and capacity, it is important that students be given ample opportunities to select the units of measure and the measuring instruments which are appropriate to the task.

MASS LESSON IDEAS

Mass 4.1

On the case
Make a kilo (lesson plan)
Kilogram ball
Treasure hunt
Make a shot putt

Mass 4.2

By the cupful (lesson plan)
Make 50 grams
Massive model
Pass the parcel
Calibrated elastic band

Mass 5.1

How heavy are my books?
Which scales?
Toy story
Fruit salad (lesson plan)
Aussies abroad

Mass 5.2

Lunchtime
Litterbugs
The average lunch (lesson plan)
Accurate?
Investigation

Mass 6.1

Which unit would you use? (lesson plan)
School bags full
How many kids to the elephant
Largest?
Cars

Mass 6.2

Cool!
Towering tins
Follow that jellybean (lesson plan)
Tonnes of tables
A wet week

MASS 4.1
Lesson ideas

Measure using conventional units
Measure and record 1 kilogram

Knowledge and strategies
1. identify masses which are approximately 1 kilogram
2. use a measuring instrument to make a 1 kilogram mass
3. label and record masses using the abbreviation kg

On the case
Organise students into groups and provide each group with a kilogram weight. Students heft the weight to support their concept of a mass of 1 kilogram. Students heft their pencil cases (including contents), and sort the cases from lightest to heaviest. Students discuss which pencil cases would make a combined mass of about 1 kilogram. Weigh the predicted combinations and record the results stating if the mass of the pencil cases was less than 1 kilogram, equal to 1 kilogram or more than 1 kilogram.

Outcomes
MA2-3WM
MA2-12MG

Materials
- scales, packing material, pencils and paper

Knowledge and strategies
1. identify masses which are approximately 1 kilogram
2. use a measuring instrument to make a 1 kilogram mass
3. label and record masses using the abbreviation kg

Make a kilo (see lesson plan)
Students examine a number of small items and estimate how many of each item will measure 1 kilogram. Students are given a limited range of items so that results can be compared and checked easily. Students record their estimates and results using the abbreviation kg.

Note: the mass of some items that might appear to be the same, may vary. Examples include different brands of DD batteries and wooden *longs*.

Outcomes
MA2-2WM
MA2-3WM
MA2-12MG

Materials
- 1 kg mass, samples of food or other materials in 1 kg packages, scales or equal arm balances, different items to weigh such as marbles, batteries, blocks, pencils and paper

Knowledge and strategies

1. identify masses which are approximately 1 kilogram
2. use a measuring instrument to make a 1 kilogram mass
3. label and record masses using the abbreviation kg

Kilogram ball

Pairs of students make a 1 kilogram ball of modelling clay, potter's clay or playdough. As they build the ball, the students keep weighing to make an accurate mass of 1 kilogram.

Outcomes

MA2-2WM
MA2-12MG

Materials

- modelling clay or playdough, scales

Knowledge and strategies

1. identify masses which are approximately 1 kilogram
2. use a measuring instrument to make a 1 kilogram mass
3. label and record masses using the abbreviation kg

Treasure hunt

Students find items in the classroom or playground that have a mass of about 1 kilogram. Students record items which are estimated to be 1 kilogram, then measure and record the mass as 1 kilogram, more than 1 kilogram, less than 1 kilogram. Ensure that a range of items that have a mass of about 1 kilogram is available before commencing the activity.

Outcomes

MA2-1WM
MA2-12MG

Materials

- scales, different items to weigh such as sporting equipment, containers, plastic bottles of water

Knowledge and strategies

1. identify masses which are approximately 1 kilogram
2. label and record masses using the abbreviation kg

Make a shot putt

Students make a 1 kilogram shot by putting sand in a piece of fabric or old pillow case and tying very firmly with string.

Students putt the 1 kilogram shot and estimate then measure the distance thrown. Having a metre ruler available as a visual support may assist students to estimate distance.

Extension: students predict, then measure, how far a 2 kilogram shot can be thrown.

Outcomes

MA2-2WM
MA2-9MG
MA2-12MG

Materials

- fabric, string, sand, tape measure, measuring scales, pencils and paper

Knowledge and strategies

1. identify masses which are approximately 1 kilogram
2. use a measuring instrument to make a 1 kilogram mass
3. label and record masses using the abbreviation kg

MASS 4.1
Lesson plan

Measure using conventional units
Measure and record 1 kilogram

MAKE A KILO

Students examine a number of small items and estimate how many of each item will measure 1 kilogram. Students are given a limited range of items so that results can be compared and checked easily. Students record their estimates and results using the abbreviation kg.

Note: the mass of some items that might appear to be the same, may vary. Examples include different brands of DD batteries and wooden *longs*.

Students should

1. identify masses which are approximately 1 kilogram
2. use a measuring instrument to make a 1 kilogram mass
3. label and record masses using the abbreviation kg

Outcomes

MA2-2WM selects and uses appropriate mental or written strategies, or technology, to solve problems

MA2-3WM checks the accuracy of a statement and explains the reasoning used

MA2-12MG measures, records, compares and estimates the masses of objects using kilograms and grams

Grouping

Step 1: whole-class introduction

Step 2: working individually

Step 3: whole-class discussion

Materials

1 kg mass, samples of food or other materials in 1 kg packages, scales or equal arm balances, different items to weigh such as marbles, batteries, blocks, pencils and paper

Step 1

Introduce the lesson as the measurement of mass in kilograms.

Discuss what can be bought by the kilogram, and what is measured in kilograms. If possible, display a variety of 1 kg weights and 1 kg packages of food or other materials and allow students to handle these.

Explain how the students are going to estimate and then check how many objects (of one kind) have a total mass of one kilogram.

Demonstrate how to record the result using the abbreviation kg.

Questioning

How is mass measured?

What can we buy by the kilogram?

What materials or objects are measured in kilograms?

How many of these books do you estimate would have a mass of

1 kilogram?

How would I record my answer?

Step 2

Have your students work in pairs or small groups to:

- estimate how many objects will have a mass of 1 kilogram
- record the estimate
- check the estimate by finding the mass of the collection and checking it against 1 kilogram
- record the results.

Check that students

- estimate before measuring
- use measuring devices accurately
- record results correctly.

Step 3

Discuss students' results. Encourage students to report surprising results, or materials that were heavier or lighter than expected.

Discuss how the number of items in a kilogram is affected by the mass of each item.

Discussion

How did you estimate? Which objects were difficult to estimate?

How could you explain a mass of 1 kilogram to a friend?

Why is it that I could have more apples in a kilogram of apples, than I would have rockmelons in a kilogram of rockmelons?

MASS 4.2
Lesson ideas

Measure using conventional units
Measure quantities less than 1 kilogram, in grams

Knowledge and strategies
1. measure mass to the nearest 10 grams
2. estimate masses to the nearest 100 grams
3. use measuring devices accurately

By the cupful (see lesson plan)

Students measure and compare the mass of cupfuls of different materials. Students estimate first by hefting, and then measure the cupfuls to find the heaviest cupful and the lightest cupful. Students order and record their measurements to the nearest 10 grams.

Extension: students graph the results.

Outcomes
MA2-1WM
MA2-12MG

Materials
- cups, different materials to compare such as rice, flour, beads or other material readily available at the school, scales, pencils and paper

Knowledge and strategies
1. measure mass to the nearest 10 grams
2. estimate masses to the nearest 100 grams
3. use measuring devices accurately

Make 50 grams

Students estimate how many of each object is needed to make a mass of 50 grams. Students select objects, record their estimate, then measure and record the actual number of objects needed to make a mass of 50 grams. Materials to weigh can include blocks, dice and counters from the classroom, as well as small food items such as peanuts or crackers, and household items including nails, bolts and batteries.

Outcomes
MA2-3WM
MA2-12MG

Materials
- objects to weigh such as pencils, tiles or small blocks, scales, pencils and paper or appropriate household or food items

Knowledge and strategies
1. measure mass to the nearest 10 grams
2. estimate masses to the nearest 100 grams
3. use measuring devices accurately

Massive model

Students work in pairs to make a model from 1 centimetre interlocking cubes. Students estimate the mass of their model before measuring and recording. Students combine with another two pairs of students, to estimate measure and record the combined mass of the three models.

Outcomes
MA2-2WM
MA2-12MG

Materials
- interlocking cubes, scales, pencil, paper

Knowledge and strategies
4. measure mass to the nearest 10 grams
5. estimate masses to the nearest 100 grams
6. use measuring devices accurately

Pass the parcel

Students sit in a whole-class circle and pass around 4 or 5 closed containers that contain small items, to music. When the music stops, the students holding the containers write their estimate of the mass of the container and its contents on the chalkboard. After several estimates for the different objects have been recorded, students weigh the items to determine who had the closest estimate. Access to labelled masses may assist student to estimate the containers, by hefting a known mass and a container.

Outcomes
MA2-3WM
MA2-12MG

Materials
- items in closed containers, music, scales, chalk, chalkboard

Knowledge and strategies
7. measure mass to the nearest 10 grams
8. estimate masses to the nearest 100 grams
9. use measuring devices accurately

Calibrated elastic band

Students work in a small group to hang known masses (in grams) from a large, thick elastic band. Masses will need to be large enough to stretch the elastic band or use thinner elastic bands for smaller masses. Students calibrate the stretch by marking and labelling the levels on a backboard of cardboard or paper. Students use the scale to measure and record the mass of other objects from the classroom. It may be necessary to have a supply of elastic bands available as the elastic band may not return to its original length if used repeatedly or with objects of a large mass. Check the mass of the objects by measuring with a set of scales.

Outcomes
MA2-2WM
MA2-12MG

Materials
- large elastic band, nail or hook, chalkboard, paper clips for hooks, objects to be compared, pencils and paper

Knowledge and strategies
1. measure mass to the nearest 10 grams
2. use measuring devices accurately

MASS 4.2
Lesson plan

Measure using conventional units
Measure quantities less than 1 kilogram, in grams

BY THE CUPFUL

Students measure and compare the mass of cupfuls of different materials. Students estimate first by hefting, and then measure the cupfuls to find the heaviest cupful and the lightest cupful. Students order and record their measurements to the nearest 10 grams.

Extension: students graph the results.

Students should

1. measure mass to the nearest 10 grams
2. estimate masses to the nearest 100 grams
3. use measuring devices accurately

Outcomes

MA2-1WM uses appropriate terminology to describe, and symbols to represent, mathematical ideas

MA2-12MG measures, records, compares and estimates the masses of objects using kilograms and grams

Grouping

Step 1: whole-class introduction

Step 2: working in small groups

Step 3: whole-class discussion

Materials

cups, different materials to compare such as rice, flour, beads or other material readily available at the school, scales, pencils and paper

Step 1

Discuss the need for a measure smaller than the kilogram to obtain accurate measurements.

Discuss materials or food which are measured in grams.

Introduce the task. Students order the mass of cupfuls of different materials by hefting. Students use scales to find the mass of each cupful to the nearest

10 grams and record the results.

Discuss the need to handle materials carefully, especially if substances such as rice or flour are used.

Questioning

When might I want a unit of measure that is smaller than a kilogram?

What can I buy or measure in grams?

What is your estimate of the mass of a cupful?

What else do you need to know before estimating?

Step 2

Have your students work in small groups to:

- estimate the weight of a cupful of flour or other material
- weigh the cupful and record the estimate and actual weight
- repeat with a cupful of sugar or other materials
- record the results.

Check that students

- estimate before weighing the cupfuls
- measure accurately to the nearest 10 grams
- record measurements accurately.

Step 3

Discuss students' results and the differences between materials.

Discussion

What did you find when you weighed the different materials?

Which material was the heaviest or lightest? How do you know?

MASS 5.1
Lesson ideas

Relationships between formal measurement units
Measure and record mass in kilograms and grams

Knowledge and strategies
1. select and use an appropriate measuring device
2. estimate masses in grams and kilograms
3. measure and record masses in kilograms or grams

How heavy are my books?
Students work individually or in pairs to select six books and estimate the mass of the books in kilograms and grams. Students select appropriate scales to weigh the books. Students find and record the mass of each individual book and then calculate the mass of the six books by adding the six results. Students check their calculation by weighing the six books and commenting on any variation from their calculation. The final report should include the reasons for the selection of the measuring device.

Outcomes
MA2-1WM
MA2-12MG

Materials
- assorted scales, exercise books, pencils and paper

Knowledge and strategies
4. select and use appropriate measuring device
5. estimate masses in grams and kilograms
6. measure and record masses in kilograms or grams

Which scales?
Students work in small groups to trial and record the smallest and largest masses that can be accurately measured on various measuring devices. The devices may include bathroom scales, kitchen scales, balances etc. Ensure that the students are conversant in how to read the scale on each measuring device and that the scales are set at zero. Students may need reminding to handle the equipment carefully and to check that scales have been placed on a firm, flat surface.

Outcomes
MA2-2WM
MA2-12MG

Materials
- different measuring devices, different objects to weigh, pencils and paper

Knowledge and strategies
1. select and use appropriate measuring device
2. measure and record masses in kilograms or grams

Toy story

Students bring a toy from home to be weighed. In small groups, students weigh and record the mass of each toy. Students find the total mass of all toys in the group by weighing, but also by adding the masses.

Extension: students graph the mass of each toy in the group.

Outcomes

MA2-1WM
MA2-12MG
MA2-18SP

Materials

- toys, scales, pencils and paper

Knowledge and strategies

1. measure and record masses in kilograms or grams

Fruit salad (see lesson plan)

Students work in pairs or small groups to select a measuring device and then measure the mass of individual pieces of fruit, or vegetables. Students estimate then calculate how many pieces would be needed to make a kilogram. Students check their calculations by working with other groups to weigh and count 1 kilogram of the fruit or vegetables.

Note: the fruit could be used after the lesson to make a healthy fruit salad for the class to eat. Discuss the need for food hygiene and ensure that hands are washed carefully, or gloves are worn, and that preparation surfaces are clean.

Outcomes

MA2-3WM
MA2-12MG

Materials

- fruit, vegetables, kitchen scales, pencils and paper

Knowledge and strategies

1. select and use appropriate measuring device
2. estimate masses in grams and kilograms
3. measure and record masses in kilograms or grams

Aussies abroad

Students work in small groups to investigate the gross and net weights of small plastic jars and large glass containers of vegemite. If several different examples are used, each container can be examined by a small group and then rotated to the next group. Students determine which containers would hold the greater volume of Vegemite and find how many of each container would fit into a 10 kilogram carton (students may choose to use a calculator).

Extension: compare the vegemite containers by finding the best value-for-money.

Outcomes

MA2-1WM
MA2-12MG

Materials

- different-sized jars of vegemite, scales, calculators, pencils and paper

Knowledge and strategies

1. select and use appropriate measuring device
2. measure and record masses in kilograms or grams

MASS 5.1
Lesson plan

Relationships between formal measurement units
Measure and record mass in kilograms and grams

FRUIT SALAD

Students work in pairs or small groups to select a measuring device and then measure the mass of individual pieces of fruit, or vegetables. Students estimate then calculate how many pieces would be needed to make a kilogram. Students check their calculations by working with other groups to weigh and count 1 kilogram of the fruit or vegetables.

Note: the fruit could be used after the lesson to make a healthy fruit salad for the class to eat. Discuss the need for food hygiene and ensure that hands are washed carefully, or gloves are worn, and that preparation surfaces are clean.

Students should

1. select and use appropriate measuring device
2. estimate masses in grams and kilograms
3. measure and record masses in grams and kilograms

Outcomes

MA2-3WM checks the accuracy of a statement and explains the reasoning used

MA2-12MG measures, records, compares and estimates the masses of objects using kilograms and grams

Grouping

Step 1: whole-class introduction

Step 2: individual or paired working

Step 3: whole-class discussion

Materials

fruit, vegetables, kitchen scales, pencils and paper (knives and chopping boards, bowls or cups, spoons, if fruit salad is to be made and eaten)

Step 1

Commence the lesson by discussing the need to use various measuring devices to find the mass of different materials or objects.

Introduce the task and discuss how students will find the mass of one piece of fruit or a vegetable and then calculate the number of pieces which make a total of 1 kilogram.

Discuss the units of measure which will be used, and how to convert from grams to kilograms.

Demonstrate how to estimate, then measure, the mass of one piece of fruit.

Revise the need to measure and record accurately.

Discuss how the fruit or vegetables will be collected and weighed at the end of the group activity, to find the mass of 1 kilogram.

Questioning

What scales would I use to measure quantities such as 50 gm or 200 gm in the kitchen?

How do I measure my body mass? How is food weighed in the supermarket or shop?

How will you find the mass of one piece of fruit?

What unit of measure will you use?

How will you calculate the number of pieces of fruit which make a kilogram?

What is your estimate of the mass of this piece of fruit? What could you compare it with, to make an estimate?

How will you make sure that you have measured accurately?

Step 2

Have your students work in small groups to:

- select a measuring device
- estimate, measure and record the mass of one piece of fruit or a vegetable
- calculate how many pieces would make 1 kilogram.

Check that students

- choose an appropriate measuring device
- estimate, measure and record accurately, using correct abbreviations
- calculate the number of pieces in 1 kilogram.

Step 3

Students report back on their reasons for selecting measuring devices. Collect the fruit or vegetables, measure how many pieces total 1 kilogram and compare with the students' calculations.

Discussion

Were the measuring devices suitable for measuring the mass of the fruit?

Why could your group's calculation be different from another groups?

MASS 5.2
Lesson ideas

Relationships between formal measurement units
Measure and calculate mass in kilograms and grams

Knowledge and strategies
1. measure and record masses in kilograms and grams using decimal notation
2. convert from kilograms to grams, and grams to kilograms
3. use mass in calculations (grams and kilograms)

Lunchtime
Students weigh and record each item in their lunch box. Express each item in grams. Total the number of grams of their lunch. Compare with other students.

Note: ensure the students have access to scales that can accurately measure small masses in grams; lunches which have been ordered at the school canteen will need to be collected early to be available for the activity.

Extension: ask students to use kitchen scales at home to find the mass of their breakfast and dinner, then calculate the total mass of food eaten in a day.

Outcomes
MA3-2WM
MA3-12MG

Materials
- lunches, scales, pencils and paper

Knowledge and strategies
1. measure and record masses in kilograms and grams using decimal notation
2. use mass in calculations (grams and kilograms)

Litterbugs
Students collect and sort the litter found in the school playground and place it into garbage bags that have been labelled with categories of litter suggested during a class discussion. Groups weigh individual garbage bags and determine the total mass for each category of litter, and then the total mass of litter.

Note: it may take more than one day to collect a significant quantity of litter.

Variation: weigh empty garbage bins, and then the full garbage bins. Subtract the mass of the bin from the total mass to find the mass of litter.

Outcomes
MA3-1WM
MA3-12MG

Materials
- school litter, garbage bags, devices for weighing, pencils and paper

Knowledge and strategies

1. measure and record masses in kilograms and grams using decimal notation
2. convert from kilograms to grams, and grams to kilograms
3. use mass in calculations (grams and kilograms)

The average lunch (see lesson plan)

Students find the average mass of lunch eaten by the students in their small group, including fruit and drinks. Students use the measurement of each group's lunch mass, to calculate the total mass of all lunches for the class for one day. Express the total in kilograms and grams. Students then find how many 5 kg crates would be needed for carrying the lunches from the whole class.

Extension: discuss which group member is the closest to the "average" height and weight for students in the class. Using this student's mass, calculate how many lunches would have to be eaten to equal the mass.

Outcomes

MA3-2WM
MA3-12MG

Materials

- kitchen scales, pencils and paper, student's lunches

Knowledge and strategies

1. measure and record masses in kilograms and grams using decimal notation
2. convert from kilograms to grams, and grams to kilograms
3. use mass in calculations (grams and kilograms)

Accurate?

Students work in pairs or small groups to check the accuracy of kitchen and bathroom scales by using mass pieces. Students draw a table to record the measure of each mass, and comment on the accuracy of each instrument. Note: ensure the kitchen scales used are able to measure a mass of more than two kilograms.

Extension: if the scales are inaccurate, predict and measure what happens when the mass is increased.

Outcomes

MA3-3WM
MA3-12MG

Materials

- 500 gm, 1 kg, 2 kg mass, kitchen and bathroom scales, pencils and paper

Knowledge and strategies

1. measure and record masses in kilograms and grams using decimal notation

Investigation

Students place each leg of a table on a bathroom scale. Record the mass shown on each scale. Explain why/why not the combined mass shown will be a true measure of the table's mass. Find a way of checking the mass of the table.

Predict what will happen if 10 kg was placed on the table top. Trial and record the results.

Note: ensure that all four bathroom scales are at the same height.

Outcomes

MA3-3WM
MA3-12MG

Materials

- small table, four bathroom scales, 10 kg mass for each group, pencils and paper

Knowledge and strategies

1. measure and record masses in kilograms and grams using decimal notation
2. use mass in calculations (grams and kilograms)

MASS 5.2
Lesson plan

Relationships between formal measurement units
Measure and calculate mass in kilograms and grams

THE AVERAGE LUNCH

Students find the average mass of lunch eaten by the students in their small group, including fruit and drinks. Students use the measurement of each group's lunch mass, to calculate the total mass of all lunches for the class for one day. Express the total in kilograms and grams. Students then find how many 5 kg crates would be needed for carrying the lunches from the whole class.

Extension: discuss which group member is the closest to the "average" height and weight for students in the class. Using this student's mass, calculate how many lunches would have to be eaten to equal the mass.

Students should

1. measure and record masses in kilograms and grams using decimal notation
2. convert from kilograms to grams and grams to kilograms
3. use mass in calculations

Outcomes

MA3-2WM selects and applies appropriate problem-solving strategies, including the use of digital technologies, in undertaking investigations

MA3-12MG measures, records, compares and estimates the masses of objects using kilograms and grams

Grouping

Step 1: whole-class introduction

Step 2: individual or paired working

Step 3: whole-class discussion

Materials

kitchen scales, pencils and paper, students' lunches

Step 1

Discuss the task and list the strategies which students will use to find the average mass of lunches in their group.

Revise the units used to measure mass, how to convert from grams to kilograms, and the need for accuracy in measuring and recording.

Discuss how to convert the mass of individual lunches in grams to kilograms and grams in the total mass. Introduce the task.

Questioning

How would you calculate the average lunch for your group?

What would you do first?

Which units of measure will you use?

How will you calculate the average from your measures?

How do I calculate the total mass of lunches for the class?

How do I convert grams to kilograms?

Step 2

Have your students work in groups to:

- measure and record the mass of each lunch
- make individual recordings of each mass, find the total mass and check with other group members
- calculate the average mass of the group's lunches
- nominate a student from the group to write the group's average mass and total lunch mass on the blackboard.

Check that students

- measure and record accurately
- convert grams to kilograms
- record their masses using decimal notation.

Step 3

Discuss the students' strategies and measurements. Use the list of groups' lunch masses to calculate the total mass of lunches in the class.

Calculate how many 5 kg crates would be needed to carry the lunches.

Compare the average lunch from each group, and find the heaviest and lightest mass.

Discussion

How did your group solve problems as you worked?

How many 5 kg crates do you think we will need to pack all these lunches?

How can we order the average masses?

MASS 6.1
Lesson ideas

Knowing and representing large units
Calculate area in square kilometres and hectares; interpret a simple scale

Knowledge and strategies
1. identify situations where the tonne is used to measure mass
2. express a tonne as 1000 kilograms
3. use tonnes in calculations

Which unit would you use? (see lesson plan)
Students think of ten different animals, from very large, to small, and record this list.

Beside each animal name, students write the unit of mass which may be used to measure each one.

Students research the mass of several of the listed animals and record the results.

Extensions: students find the difference between the lightest animal and the heaviest animal; students find the number of small animals required to balance the mass of the largest animal.

Note: students may need to be reminded that resource material can refer to both imperial and metric measurements such as ton or tonne.

Outcomes
MA3-3WM
MA3-12MG

Materials
- access to research material on animals, pencils and paper

Knowledge and strategies
1. identify situations where the tonne is used to measure mass
2. express a tonne as 1000 kilograms

School bags full
Students in groups of four or five find the average mass of their full school bags. This measurement is used to calculate the mass of all bags in the class. Students predict the mass of all bags in the school.

Extension: how many teachers' bags or baskets make a tonne?

Outcomes
MA3-2WM
MA3-12MG
MA3-7NA
MA3-18SP

Materials
- school bags, scales, calculators, pencils and paper

Knowledge and strategies

1. identify situations where the tonne is used to measure mass
2. express a tonne as 1000 kilograms
3. use tonnes in calculations

How many kids to the elephant?

Students find the mass of the "average" student in the class. Students estimate and then calculate, how many students would have the same mass as an elephant (average 4 tonne).

Outcomes

MA3-1WM
MA3-12MG
MA3-7NA
MA3-18SP

Materials

- bathroom scales, calculators, pencils and paper

Knowledge and strategies

1. identify situations where the tonne is used to measure mass
2. express a tonne as 1000 kilograms
3. use tonnes in calculations

Largest?

Students work in pairs or small groups to investigate:

Were dinosaurs the largest living creatures ever? Students research the question and order the animals that they had studied, from heaviest to lightest. Calculate the difference in mass between the heaviest and lightest animals in the list.

Outcomes

MA3-1WM
MA3-12MG

Materials

- access to research material on very heavy animals, pencils and paper

Knowledge and strategies

1. identify situations where the tonne is used to measure mass
2. express a tonne as 1000 kilograms
3. use tonnes in calculations

Cars

Students use car handbooks or brochures to find the mass of a small car. Collect information from the local bus company to find the mass of full and empty buses.

Estimate and then calculate how many small cars have the equivalent mass of a full bus.

Outcomes

MA3-1WM
MA3-12MG
MA3-4NA

Materials

- car brochures, access to the local bus company, calculators, pencils and paper

Knowledge and strategies

1. identify situations where the tonne is used to measure mass
2. express a tonne as 1000 kilograms
3. use tonnes in calculations

MASS 6.1
Lesson plan

Knowing and representing large units
Calculate area in square kilometres and hectares; interpret a simple scale

WHICH UNIT WOULD YOU USE?

Students think of ten different animals, from very large, to small, and record this list.

Beside each animal name, students write the unit of mass which may be used to measure each one.

Students research the mass of several of the listed animals and record the results.

Extensions: students find the difference between the lightest animal and the heaviest animal; students find the number of small animals required to balance the mass of the largest animal.

Note: students may need to be reminded that resource material can refer to both imperial and metric measurements such as ton or tonne.

Students should

1. identify situations where the tonne is used to measure mass
2. express a tonne as 1000 kilograms

Outcomes

MA3-3WM gives a valid reason for supporting one possible solution over another

MA3-12MG selects and uses the appropriate unit and device to measure the masses of objects, and converts between units of mass

Grouping

Step 1: whole-class introduction

Step 2: working in small groups

Step 3: whole-class discussion

Materials

access to research material on animals, pencils, paper

Step 1

Revise grams and kilograms as units of mass and discuss the need to use kilograms rather than grams for some objects.

Discuss how to convert between grams and kilograms, and how to express grams in decimal notation.

Discuss the need for a larger unit of mass than the kilogram, introduce the tonne and express 1 tonne = 1000 kg.

Brainstorm objects or a group of objects with a mass of 1 tonne or multiples of 1 tonne.

Brainstorm a list of animals with different masses.

Introduce the task.

Questioning

When would grams be an appropriate unit of measure? Why?

When would kilograms be an appropriate unit of measure? Why?

How are kilograms and grams recorded?

What unit is used to measure very large items, such as a car, a ship, a load of building materials?

What is the relationship between a kilogram and a tonne?

Which animals would have a mass of a tonne?

Step 2

Have your students work in groups to:

- select from the class list five to ten animals ranging in size from very small to very large
- research the mass of each of their selected animals
- display the information in a table indicating the animal, unit of measure and mass.

Check that students

- select a range of animals to enable them to record masses in grams, kilograms and tonnes
- record accurately and use correct abbreviations
- understand how to convert kilograms to tonnes.

Step 3

Discuss the results and use them to arrange the original brainstormed list in order of mass.

Discussion

What unexpected or unusual results did you find?

MASS 6.2
Lesson ideas

Knowing and representing large units
Convert units of mass to calculate and compare mass

Knowledge and strategies
1. convert units of mass
2. use mass in calculations (grams, kilograms and grams) using decimal notation

Cool!
Using ice cube trays, find how many ice cubes would be needed to make a tonne of ice.

Outcomes
MA3-1WM
MA3-12MG
MA3-11MG

Materials
- ice cube trays, litre measures, calculators, pencils and paper

Knowledge and strategies
1. convert units of mass
2. use mass in calculations (grams, kilograms and grams) using decimal notation

Towering tins
Students calculate the height of a tower of items where the tower has a total mass of 1 tonne.

Examples of items may include: drink cans (full or empty), books, bricks, an “average” Year 5 or Year 6 student.

Outcomes
MA3-3WM
MA3-9MG
MA3-12MG

Materials
- kitchen scales or bathroom scales, calculators, pencils and paper

Knowledge and strategies
1. convert units of mass
2. use mass in calculations (grams, kilograms and grams) using decimal notation

Follow that jellybean (see lesson plan)

Students investigate the length of a line of jellybeans, if 0.5 t of jellybeans were placed end-to-end. How long would the line be?

Outcomes

MA3-2WM
MA3-3WM
MA3-9MG
MA3-12MG

Materials

- kitchen scales, small packets of jellybeans (at least 60 gm), rulers or tape measures, calculators, pencils and paper

Knowledge and strategies

1. convert units of mass
2. use mass in calculations (grams, kilograms and grams) using decimal notation

Tonnes of tables

Students work in pairs or small groups to find the mass of all of the desks in the school.

Variation: students nominate objects or materials to measure.

Outcomes

MA3-2WM
MA3-12MG

Materials

- bathroom scales, pencils and paper, calculators

Knowledge and strategies

1. convert units of mass
2. use mass in calculations (grams, kilograms and grams) using decimal notation

A wet week

Students calculate the mass of rainwater that would fall on a football field in a wet week.

Either, measure rainfall, or select reports of rainfall from the newspaper or television weather reports. Calculate by finding the volume of water on the football field and then converting to units of mass.

Extension: Students compare the mass of water on a football field and a netball court.

Outcomes

MA3-2WM
MA3-10MG
MA3-11MG
MA3-12MG

Materials

- rain gauge, weather reports, calculators, tape measures or trundle wheels, pencils and paper

Knowledge and strategies

1. convert units of mass
2. use mass in calculations (grams, kilograms and grams) using decimal notation

MASS 6.2
Lesson plan

Knowing and representing large units
Convert units of mass to calculate and compare mass

FOLLOW THAT JELLYBEAN

Students investigate the length of a line of jellybeans, if 0.5 t of jellybeans were placed end-to-end. How long would the line be?

Students should

1. convert units of mass
2. use mass in calculations (grams, kilograms and grams) using decimal notation

Outcomes

MA3-2WM selects and applies appropriate problem-solving strategies, including the use of digital technologies, in undertaking investigations

MA3-3WM gives a valid reason for supporting one possible solution over another

MA3-9MG selects and uses the appropriate unit and device to measure lengths and distances, calculates perimeters, and converts between units of length

MA3-12MG selects and uses the appropriate unit and device to measure the masses of objects, and converts between units of mass

Grouping

Step 1: whole-class introduction

Step 2: working in small groups

Step 3: whole-class discussion

Materials

kitchen scales, small packets of jellybeans (at least 60 gm), rulers or tape measures, calculators, pencils and paper

Step 1

Present the task to students and discuss how to break the question into steps. Students may suggest taking

50 gm of jellybeans, placing them in a line, and measuring the length of the line. The length of 0.5 t jellybeans would be: the length of the line x 20 x 1000.

An alternative method would involve finding the mass of a line of jellybeans which is 50 cm long, and then finding how many 50 cm lines would be required to bring the total mass to 0.5 t.

Discuss how to convert the units of measure which students may need for the calculation (convert grams to kilograms and tonnes, convert centimetres to metres and kilometres)

Questioning

What is this question asking you to do?

What sort of measurements will you have to make? What would be the best way to start?

Which measurement units will you have to use?

Is there another way to solve this problem?

How do I convert tonnes to grams, and centimetres to kilometres? Are there some steps to help you?

Step 2

Have your students work in pairs or small groups to:

- choose a strategy to solve the problem
- collect and use measuring devices to find the mass of the jelly beans and the length of a line
- convert units of measure where necessary, to calculate the total length.

Check that students

- decide which strategy to use
- make accurate measurements
- convert between units of measure
- record results using decimal notation.

Step 3

Ask students to explain their working and present their results. Discuss how different methods of measuring may have produced differences in results.

Discussion

How did you solve the problem?

What has caused the differences in these results?

Can you think of a simpler way to answer this question?