Cambridge Assessment International Education

Curriculum Framework

Cambridge Lower Secondary Mathematics 0862

Published in September 2020 for first teaching in September 2021.
Cambridge Lower Secondary Progression Tests will be available from 2022.
Cambridge Lower Secondary Checkpoint tests will be available from 2023.

Version 3.0

Cambridge Pathway

Why choose Cambridge International?

Cambridge International prepares school students for life, helping them develop an informed curiosity and a lasting passion for learning. We are part of the University of Cambridge.

Our Cambridge Pathway gives students a clear path for educational success from age 5 to 19. Schools can shape the curriculum around how they want students to learn – with a wide range of subjects and flexible ways to offer them. It helps students discover new abilities and a wider world, and gives them skills they need for life so they can thrive throughout their schooling work and life.

Our programmes and qualifications set the global standard for international education. They are created by subject experts, rooted in academic rigour and reflect the latest educational research. They provide a strong platform for students to progress from one stage to the next, and are well supported by teaching and learning resources.

Our mission is to provide educational benefit through provision of international programmes and qualifications for school education and to be the world leader in this field. Together with schools, we develop Cambridge learners who are confident, responsible, reflective, innovative and engaged – equipped for success in the modern world.

Every year, nearly a million Cambridge students from 10 000 schools in 160 countries prepare for their future with the Cambridge Pathway.

Quality management
Cambridge International is committed to providing exceptional quality. In line with this commitment, our quality management system for the provision of international qualifications and education programmes for students aged 5 to 19 is independently certified as meeting the internationally recognised standard, ISO 9001:2015. Learn more at **www.cambridgeinternational.org/ISO9001**

Contents

Changes to this curriculum framework

For information about changes to this curriculum framework, go to page 35.

The latest curriculum framework is version 3.0, published August 2021.

1 Why choose this curriculum framework?

Key benefits

Cambridge Lower Secondary Mathematics encourages lifelong enthusiasm for analytical and rational thinking. Learners develop a holistic understanding of the subject, focusing on principles, patterns, systems, functions and relationships. Cambridge Lower Secondary learners become mathematically competent and fluent in computation which they can apply to everyday situations.

A unique feature of Cambridge Lower Secondary Mathematics is 'Thinking and Working Mathematically'. The process of thinking and working mathematically encourages learners to talk with others, challenge ideas and to provide evidence that validates conjectures and solutions. When learners are thinking and working mathematically they actively seek to make sense of ideas and build connections between different facts, procedures and concepts. This supports higher order thinking that assists learners in viewing the world in a mathematical way.

The structure of the *Cambridge Lower Secondary Mathematics Curriculum Framework* is designed to support clear progression of mathematics knowledge and skills within and across the lower secondary stages. Learners will systematically develop their mathematical skills in Number, Algebra, Geometry and Measure, and Statistics and Probability. They recognise the interconnections of mathematical concepts.

The Number strand is the foundation of the mathematics curriculum. Learners explore the number system and develop fundamental calculation skills enabling them to compute increasingly complex calculations. Learners develop knowledge and skills in the Number strand that they can apply in the other strands of the mathematics curriculum.

The Algebra strand builds on pre-algebra concepts in the primary stages to strengthen learners reasoning and their ability to find and generalise patterns and rules. Learners use algebra and graphical techniques to describe and model mathematical relationships, and to solve real-life problems.

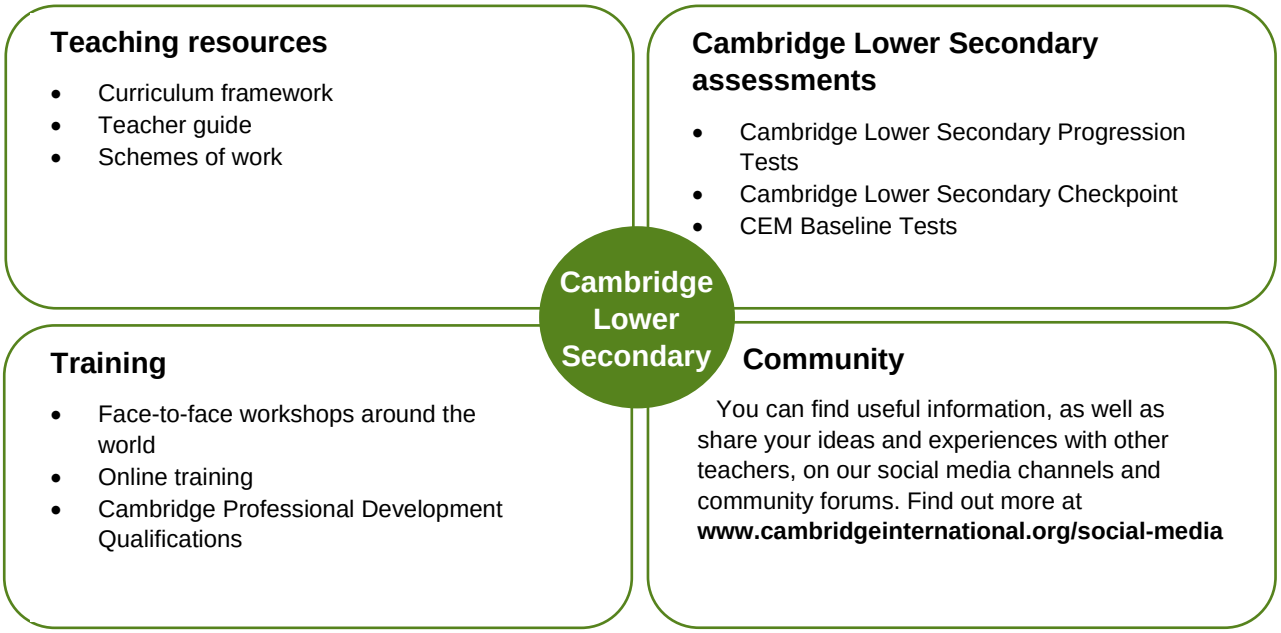
In the Geometry and Measure strand learners develop spatial awareness and explore various contexts in which they must apply number skills. They learn to visualise real-life problems and use mathematical instruments and digital technology to produce accurate geometric representations.

Within the Statistics and Probability strand there is emphasis on the statistical enquiry cycle. This allows learners to understand the data they encounter in their daily lives, which may be presented in unfamiliar ways, and to recognise where the presentation of data is misleading, such as in the media or advertisements.

Supporting teachers

We provide a wide range of practical resources, detailed guidance, innovative training and professional development so that you can give your learners the best possible experience of Cambridge Lower Secondary Mathematics.

You will find most of these resources on the Cambridge Lower Secondary support site (**lowersecondary.cambridgeinternational.org**). Ask the Cambridge coordinator or exams officer in your school if you do not already have a log-in for this support site.



Progression through the Cambridge Pathway

Our lower secondary programme is part of the Cambridge Pathway. This pathway leads seamlessly from primary to secondary and pre-university years. Each step of the pathway builds on the learners' development from the previous one or from other educational systems. This curriculum framework is typically for learners aged 11 to 14, but it may be appropriate to use it for slightly different ages to suit your context.

You can download more information on progression from the Cambridge Lower Secondary support site.

Teaching time

For guidance, this curriculum framework is based on learners having 4 to 5 hours of Mathematics per week (or about 120 to 150 hours per stage). Your actual number of teaching hours may vary according to your context.

Assessment

We provide assessments designed to complement this curriculum framework for Stages 7 to 9. You can find more information on assessing Cambridge Lower Secondary Mathematics on the Cambridge Lower Secondary support site.

2 Curriculum overview

Aims

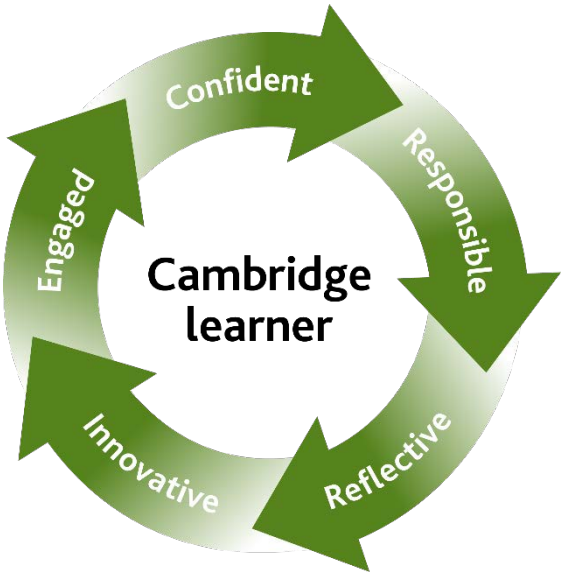
Following the Cambridge Lower Secondary programme helps learners to lay the foundations for lifelong learning, including:

- curiosity about the world around them and enthusiasm for learning
- knowledge, understanding and skills that can be applied in and across subjects
- effective and confident communication skills, including in English
- understanding of their personal and local context, as well as having global awareness.

In Cambridge Lower Secondary Mathematics, learners:

- engage in creative mathematical thinking to generate elegant solutions
- improve numerical fluency and knowledge of key mathematical concepts to make sense of numbers, patterns, shapes, measurements and data
- develop a variety of mathematical skills, strategies and a way of thinking that will enable them to describe the world around them and play an active role in modern society
- communicate solutions and ideas logically in spoken and written language using appropriate mathematical symbols, diagrams and representations
- understand that technology provides a powerful way of communicating mathematics, one which is particularly important in an increasingly technological and digital world.

The Cambridge approach encourages learners to be:



Cambridge Lower Secondary Mathematics supports learners to become:

Responsible – They understand how principles of mathematics can be applied to real life problems in a responsible way.

Innovative – They solve new and unfamiliar problems using innovative mathematical thinking. They can select their own preferred mathematical strategies and can suggest alternative routes to develop efficient solutions.

Confident – They are confident and enthusiastic mathematical practitioners, able to use appropriate techniques without hesitation, uncertainty or fear. They are keen to ask mathematical questions in a structured, systematic, critical and analytical way. They are able to present their findings and defend their strategies and solutions as well as critique and improve solutions of others.

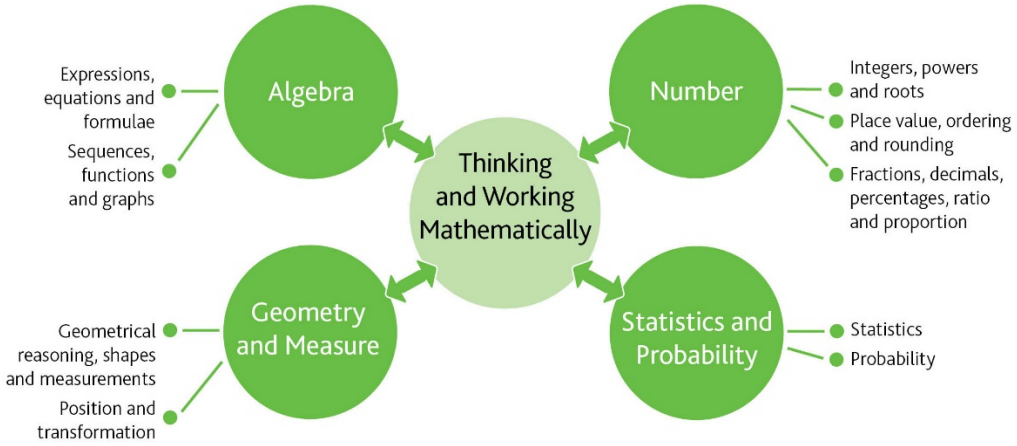
Engaged – They are curious and engage intellectually to deepen their mathematical understanding. They are able to use mathematics to participate constructively in society and the economy by making informed mathematical choices.

Reflective – They reflect on the process of thinking and working mathematically as well as mastering mathematics concepts. They are keen to make conjectures by asking sophisticated questions and develop higher order thinking skills.

Overview of the strands

This curriculum framework provides a comprehensive set of learning objectives for Cambridge Lower Secondary Mathematics. These give a structure for teaching and learning and a reference against which learners' attainment and skills development can be checked.

We have divided the learning objectives into four main areas called 'strands' which run through every lower secondary stage: Number, Algebra, Geometry and Measure, and Statistics and Probability. Although each strand is presented separately, it is intimately connected to the other strands. Each strand is divided into 'sub-strands' and these sub-strands are listed in the diagram below.



Thinking and Working Mathematically is not an independent strand, instead it is embedded within and across the other curriculum strands. Thinking and Working Mathematically brings awareness to learners' mathematical actions and assists them in finding elegant mathematical solutions. You can find out more about Thinking and Working Mathematically in the Overview of teaching approaches section below.

The curriculum framework has been designed to provide balanced coverage of mathematics skills and knowledge at the lower secondary level. Although the curriculum framework is divided into strands, they are interrelated and should be taught in conjunction with each other. In particular, the Thinking and Working Mathematically characteristics should be integrated into the teaching of the other strands.

Below is a brief description of each strand:

Number

In the Number strand, learners discover the differences between rational and irrational numbers. They learn concepts such as lowest common multiple and highest common factor, direct and inverse proportion and indices. Learners round numbers to a given number of decimal places or significant figures, and apply their understanding of rounding to find upper and lower limits. They explore terminating and recurring decimals and their relationship with fractions and percentages. Learners use knowledge of the laws of arithmetic, order of operations, inverse operations and equivalence of fractions, decimals and percentages to simplify calculations. They are encouraged to use mental strategies to estimate before formally calculating answers.

Algebra

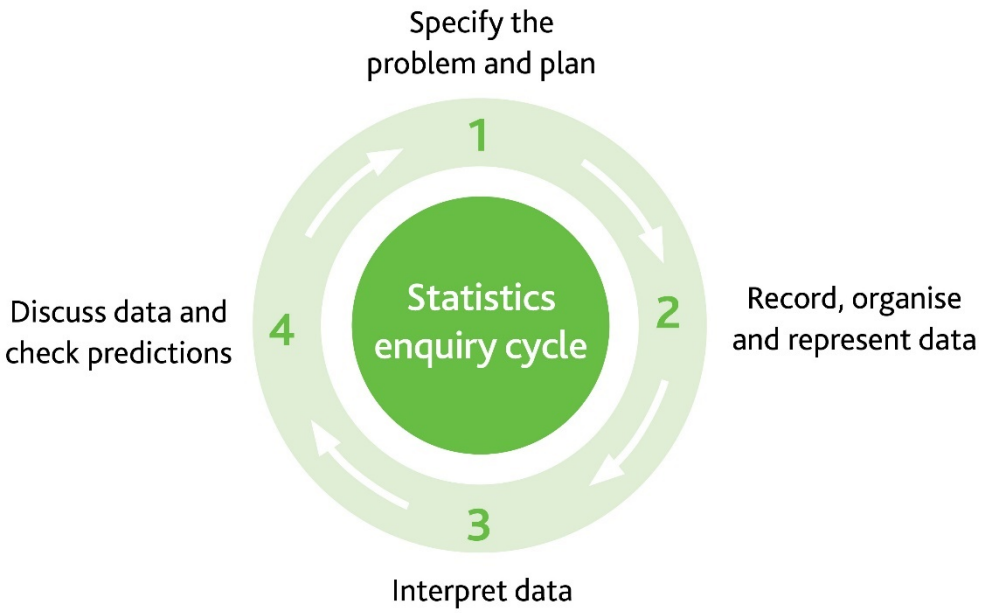
Learners use mathematical language to discuss the differences between expressions, formulae and equations and use these concepts to model real-life situations. Learners explore term-to-term and n^{th} term rules of numerical and spatial patterns, and linear and quadratic sequences. Learners are introduced to linear and simple quadratic functions and produce graphs of functions using the Cartesian plane. Learners also use algebra and graphical techniques to find solutions to simultaneous equations and inequalities.

Geometry and Measure

In the Geometry and Measure strand learners explore regular and irregular polygons and circles. Learners use knowledge of rectangles, squares, triangles and circles to investigate the area of 2D shapes, and surface area and volume of 3D shapes. Learners investigate the properties of angles in polygons, on parallel lines and on intersecting lines. Learners use a ruler and compass or digital technology to construct triangles, regular polygons and line and angle bisectors. Learners use knowledge of scale and bearings to interpret positions on maps and plans. Using precise mathematical language, learners describe transformations of points and 2D shapes. From Stage 9, learners know and use Pythagoras' theorem to understand the relationships between the sides of a right-angled triangle.

Statistics and Probability

Learners conduct simple statistics investigations as part of a four-part statistical enquiry cycle:



Learners use a variety of data collection methods and consider whether to collect categorical, discrete or continuous data. They review advantages and disadvantages of different sampling methods when conducting investigations. Learners interpret data, identifying patterns, trends and relationships, within and between data sets. They discuss conclusions, make inferences and generalisations to check their predictions.

When learners explore probability they use language associated with mutually exclusive outcomes and complementary, combined and independent events. They recognise the difference between experimental and theoretical probabilities and compare expected frequencies with observed outcomes.

Overview of teaching approaches

Cambridge advocates an active learning approach where teaching and learning is student-centred so that it is aligns with the experiences and needs of individuals. Learners are encouraged to work both individually and collaboratively to find solutions to mathematical problems.

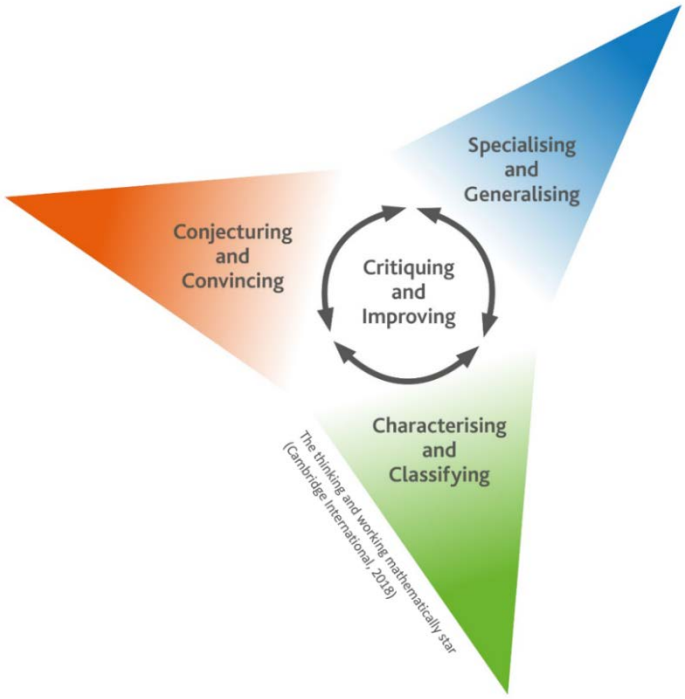
Thinking and Working Mathematically

Thinking and Working Mathematically supports the mathematical concepts and skills in all strands of the Cambridge Lower Secondary Mathematics curriculum. When learners think and work mathematically, they actively engage with their learning of mathematics. They try to make sense of ideas and build connections between different facts, procedures and concepts. Learners who do not think and work mathematically can carry out processes that their teacher has shown them, but they may not understand why the processes work or what the results mean. Noticing inconsistencies, patterns and particular representations encourages learners to think and work mathematically. Practice, reflection and questioning will help them to improve.

Thinking and Working Mathematically comprises eight characteristics that are presented in four pairs:

- Specialising and Generalising
- Conjecturing and Convincing
- Characterising and Classifying
- Critiquing and Improving.

The four pairs of characteristics are represented in the Thinking and Working Mathematically Star.



The characteristics are intertwined and are interdependent, and a high-quality mathematics task may draw on one or more of them.

Thinking and Working Mathematically should not be taught as a separate special activity but instead it should be embedded throughout the curriculum.

The eight Thinking and Working Mathematically characteristics provide the language required to make decisions about what mathematical knowledge, procedures and strategies might be used in order to gain a deeper understanding of mathematical questions.

Thinking and Working Mathematically characteristic	**Definition**
Specialising	Choosing *an example* and checking to see if it satisfies or does not satisfy specific mathematical criteria
Generalising	Recognising an underlying pattern by identifying *many* examples that satisfy the same mathematical criteria
Conjecturing	Forming mathematical questions or ideas
Convincing	Presenting evidence to *justify or challenge* a mathematical idea or solution
Characterising	Identifying and describing the mathematical properties of an object
Classifying	Organising objects into groups according to their mathematical properties
Critiquing	Comparing and evaluating mathematical ideas, representations or solutions to identify advantages and disadvantages
Improving	Refining mathematical ideas or representations to develop a more effective approach or solution

All of the characteristics that form Thinking and Working Mathematically are based on extensive research by Professor John Mason.

Mental strategies are important skills of mathematics and are at the core of developing learners' mathematical understanding. However, this curriculum does not require learners to follow or practise specific strategies. Allowing greater flexibility in teaching mental strategies means learners can view mental strategies as a more personal and a less formal choice. Learners then have greater ownership over which mental strategies they chose to develop in order to achieve a deeper conceptual understanding of mathematics.

You can find more information and ideas for teaching and learning activities in the *Cambridge Lower Secondary Mathematics Teacher Guide* and schemes of work available on the Lower Secondary support site (**lowersecondary.cambridgeinternational.org**).

The teacher guide will support you to plan and deliver lessons using effective teaching and learning approaches.

The scheme of work for each stage of Cambridge Lower Secondary Mathematics contains:

- suggested units showing how the learning objectives in the curriculum framework can be grouped and ordered
- at least one suggested teaching activity for each learning objective
- a list of subject-specific language that will be useful for your learners
- common misconceptions
- sample lesson plans
- links to relevant NRICH activities to enrich learners' mathematical experiences (**nrich.maths.org**).

You do not need to use the ideas in the schemes of work to teach Cambridge Lower Secondary Mathematics. They are designed to indicate the types of activities you might use, and the intended depth and breadth of each learning objective. These activities are not designed to fill all the teaching time for each lower secondary stage. You should use other activities with a similar level of difficulty, for example, those from endorsed resources.

We work with a range of publishers to provide high-quality endorsed resources to support our curriculum frameworks. In order to provide choice for Cambridge International Schools, we encourage publishers to develop resources with varying approaches. There is no requirement for endorsed textbooks to follow the teaching order suggested in the Cambridge Lower Secondary schemes of work. If a resource is endorsed, you can be confident that all the learning objectives are covered.

3 Learning objectives by stage

Overview of learning objectives

Separate learning objectives are provided for the mathematics content in each of the lower secondary Stages 7 to 9. It may be appropriate to introduce this framework at slightly different ages to suit your particular circumstances.

All the learning objectives in each stage provide clear progression from the previous stage and to the subsequent stage.

The characteristics for Thinking and Working Mathematically apply to all of the lower secondary stages. You can find out more about these characteristics on the next page.

To enable effective progression in your teaching, you need to be familiar with the progression of skills across stages. This will help you to build on prior learning in every stage. The progression of learning objectives across Stages 7 to 9 is available on the Lower Secondary support site (**lowersecondary.cambridgeinternational.org**).

Learning objective codes

Each learning objective has a unique code, e.g. **7Nf.05**. These codes appear in the schemes of work, teacher guide and other Cambridge Lower Secondary resources. Each learning objective code includes:

- the stage number, e.g. **7**
- a reporting code that appears in the feedback reports for tests and reflects the sub-strand titles, e.g. **Nf** (see below)
- a number reflecting the order of the learning objectives in the sub-strand for the stage, e.g. **05** is the fifth learning objective.

Thinking and Working Mathematically

TWM	**Specialising**
	Generalising
	Conjecturing
	Convincing
	Characterising
	Classifying
	Critiquing
	Improving

Number

Nf	**Fractions, decimals, percentages, ratio and proportion**
Ni	**Integers, powers and roots**
Np	**Place value, ordering and rounding**

Algebra

Ae	**Expressions, equations and formulae**
As	**Sequences, functions and graphs**

Geometry and Measure

Gp	**Position and transformation**
Gg	**Geometrical reasoning, shapes and measurements**

Statistics and Probability

Sp	**Probability**
Ss	**Statistics**

Stage 7

Thinking and Working Mathematically

- **TWM.01** Specialising
- **TWM.02** Generalising
- **TWM.03** Conjecturing
- **TWM.04** Convincing
- **TWM.05** Characterising
- **TWM.06** Classifying
- **TWM.07** Critiquing
- **TWM.08** Improving

Number

Integers, powers and roots

- **7Ni.01** Estimate, add and subtract integers, recognising generalisations.
- **7Ni.02** Understand that brackets, positive indices and operations follow a particular order.
- **7Ni.03** Estimate, multiply and divide integers including where one integer is negative.
- **7Ni.04** Understand lowest common multiple and highest common factor (numbers less than 100).
- **7Ni.05** Use knowledge of tests of divisibility to find factors of numbers greater than 100.
- **7Ni.06** Understand the relationship between squares and corresponding square roots, and cubes and corresponding cube roots.

Place value, ordering and rounding

- **7Np.01** Use knowledge of place value to multiply and divide whole numbers and decimals by any positive power of 10.
- **7Np.02** Round numbers to a given number of decimal places.

Fractions, decimals, percentages, ratio and proportion

- **7Nf.01** Recognise that fractions, terminating decimals and percentages have equivalent values.
- **7Nf.02** Estimate and add mixed numbers, and write the answer as a mixed number in its simplest form.
- **7Nf.03** Estimate, multiply and divide proper fractions.
- **7Nf.04** Use knowledge of common factors, laws of arithmetic and order of operations to simplify calculations containing decimals or fractions.
- **7Nf.05** Recognise percentages of shapes and whole numbers, including percentages less than 1 or greater than 100.
- **7Nf.06** Understand the relative size of quantities to compare and order decimals and fractions, using the symbols =, ≠, > and <.
- **7Nf.07** Estimate, add and subtract positive and negative numbers with the same or different number of decimal places.
- **7Nf.08** Estimate, multiply and divide decimals by whole numbers.
- **7Nf.09** Understand and use the unitary method to solve problems involving ratio and direct proportion in a range of contexts.
- **7Nf.10** Use knowledge of equivalence to simplify and compare ratios (same units).
- **7Nf.11** Understand how ratios are used to compare quantities to divide an amount into a given ratio with two parts.

Algebra

Expressions, equations and formulae

- **7Ae.01** Understand that letters can be used to represent unknown numbers, variables or constants.
- **7Ae.02** Understand that the laws of arithmetic and order of operations apply to algebraic terms and expressions (four operations).
- **7Ae.03** Understand how to manipulate algebraic expressions including:
  - collecting like terms
  - applying the distributive law with a constant.
- **7Ae.04** Understand that a situation can be represented either in words or as an algebraic expression, and move between the two representations (linear with integer coefficients).
- **7Ae.05** Understand that a situation can be represented either in words or as a formula (single operation), and move between the two representations.
- **7Ae.06** Understand that a situation can be represented either in words or as an equation. Move between the two representations and solve the equation (integer coefficients, unknown on one side).
- **7Ae.07** Understand that letters can represent an open interval (one term).

Sequences, functions and graphs

- **7As.01** Understand term-to-term rules, and generate sequences from numerical and spatial patterns (linear and integers).
- **7As.02** Understand and describe nth term rules algebraically (in the form $n \pm a$, $a \times n$ where a is a whole number).
- **7As.03** Understand that a function is a relationship where each input has a single output. Generate outputs from a given function and identify inputs from a given output by considering inverse operations (linear and integers).
- **7As.04** Understand that a situation can be represented either in words or as a linear function in two variables (of the form $y = x + c$ *or* $y = mx$), and move between the two representations.
- **7As.05** Use knowledge of coordinate pairs to construct tables of values and plot the graphs of linear functions, where y is given explicitly in terms of x ($y = x + c$ *or* $y = mx$).
- **7As.06** Recognise straight-line graphs parallel to the x- or y-axis.
- **7As.07** Read and interpret graphs related to rates of change. Explain why they have a specific shape.

Geometry and Measure

Geometrical reasoning, shapes and measurements

- **7Gg.01** Identify, describe and sketch regular polygons, including reference to sides, angles and symmetrical properties.
- **7Gg.02** Understand that if two 2D shapes are congruent, corresponding sides and angles are equal.
- **7Gg.03** Know the parts of a circle:
  - centre
  - radius
  - diameter
  - circumference
  - chord
  - tangent.
- **7Gg.04** Understand the relationships and convert between metric units of area, including hectares (ha), square metres (m^2), square centimetres (cm^2) and square millimetres (mm^2).
- **7Gg.05** Derive and know the formula for the area of a triangle. Use the formula to calculate the area of triangles and compound shapes made from rectangles and triangles.
- **7Gg.06** Identify and describe the combination of properties that determine a specific 3D shape.
- **7Gg.07** Derive and use a formula for the volume of a cube or cuboid. Use the formula to calculate the volume of compound shapes made from cuboids, in cubic metres (m^3), cubic centimetres (cm^3) and cubic millimetres (mm^3).
- **7Gg.08** Visualise and represent front, side and top view of 3D shapes.
- **7Gg.09** Use knowledge of area, and properties of cubes and cuboids to calculate their surface area.
- **7Gg.10** Identify reflective symmetry and order of rotational symmetry of 2D shapes and patterns.
- **7Gg.11** Derive the property that the sum of the angles in a quadrilateral is 360°, and use this to calculate missing angles.
- **7Gg.12** Know that the sum of the angles around a point is 360º, and use this to calculate missing angles.
- **7Gg.13** Recognise the properties of angles on:
  - parallel lines and transversals
  - perpendicular lines
  - intersecting lines.
- **7Gg.14** Draw parallel and perpendicular lines, and quadrilaterals.

Position and transformation

- **7Gp.01** Use knowledge of scaling to interpret maps and plans.
- **7Gp.02** Use knowledge of 2D shapes and coordinates to find the distance between two coordinates that have the same *x* or *y* coordinate (without the aid of a grid).
- **7Gp.03** Use knowledge of translation of 2D shapes to identify the corresponding points between the original and the translated image, without the use of a grid.
- **7Gp.04** Reflect 2D shapes on coordinate grids, in a given mirror line (*x*- or *y*-axis), recognising that the image is congruent to the object after a reflection.
- **7Gp.05** Rotate shapes 90° and 180° around a centre of rotation, recognising that the image is congruent to the object after a rotation.
- **7Gp.06** Understand that the image is mathematically similar to the object after enlargement. Use positive integer scale factors to perform and identify enlargements.

Statistics and Probability

Statistics

- **7Ss.01** Select and trial data collection and sampling methods to investigate predictions for a set of related statistical questions, considering what data to collect (categorical, discrete and continuous data).
- **7Ss.02** Understand the effect of sample size on data collection and analysis.
- **7Ss.03** Record, organise and represent categorical, discrete and continuous data. Choose and explain which representation to use in a given situation:
  - Venn and Carroll diagrams
  - tally charts, frequency tables and two-way tables
  - dual and compound bar charts
  - waffle diagrams and pie charts
  - frequency diagrams for continuous data
  - line graphs
  - scatter graphs
  - infographics.
- **7Ss.04** Use knowledge of mode, median, mean and range to describe and summarise large data sets. Choose and explain which one is the most appropriate for the context.
- **7Ss.05** Interpret data, identifying patterns, within and between data sets, to answer statistical questions. Discuss conclusions, considering the sources of variation, including sampling, and check predictions.

Probability

- **7Sp.01** Use the language associated with probability and proportion to describe, compare, order and interpret the likelihood of outcomes.
- **7Sp.02** Understand and explain that probabilities range from 0 to 1, and can be represented as proper fractions, decimals and percentages.
- **7Sp.03** Identify all the possible mutually exclusive outcomes of a single event, and recognise when they are equally likely to happen.
- **7Sp.04** Understand how to find the theoretical probabilities of equally likely outcomes.
- **7Sp.05** Design and conduct chance experiments or simulations, using small and large numbers of trials. Analyse the frequency of outcomes to calculate experimental probabilities.

Stage 8

Thinking and Working Mathematically

- **TWM.01** Specialising
- **TWM.02** Generalising
- **TWM.03** Conjecturing
- **TWM.04** Convincing
- **TWM.05** Characterising
- **TWM.06** Classifying
- **TWM.07** Critiquing
- **TWM.08** Improving

Number

Integers, powers and roots

- **8Ni.01** Understand that brackets, indices (square and cube roots) and operations follow a particular order.
- **8Ni.02** Estimate, multiply and divide integers, recognising generalisations.
- **8Ni.03** Understand factors, multiples, prime factors, highest common factors and lowest common multiples.
- **8Ni.04** Understand the hierarchy of natural numbers, integers and rational numbers.
- **8Ni.05** Use positive and zero indices, and the index laws for multiplication and division.
- **8Ni.06** Recognise squares of negative and positive numbers, and corresponding square roots.
- **8Ni.07** Recognise positive and negative cube numbers, and the corresponding cube roots.

Place value, ordering and rounding

- **8Np.01** Use knowledge of place value to multiply and divide integers and decimals by 0.1 and 0.01.
- **8Np.02** Round numbers to a given number of significant figures.

Fractions, decimals, percentages, ratio and proportion

- **8Nf.01** Recognise fractions that are equivalent to recurring decimals.
- **8Nf.02** Estimate and subtract mixed numbers, and write the answer as a mixed number in its simplest form.
- **8Nf.03** Estimate and multiply an integer by a mixed number, and divide an integer by a proper fraction.
- **8Nf.04** Use knowledge of the laws of arithmetic and order of operations (including brackets) to simplify calculations containing decimals or fractions.
- **8Nf.05** Understand percentage increase and decrease, and absolute change.
- **8Nf.06** Understand the relative size of quantities to compare and order decimals and fractions (positive and negative), using the symbols =, ≠, >, <, ≤ and ≥.
- **8Nf.07** Estimate and multiply decimals by integers and decimals.
- **8Nf.08** Estimate and divide decimals by numbers with one decimal place.
- **8Nf.09** Understand and use the relationship between ratio and direct proportion.
- **8Nf.10** Use knowledge of equivalence to simplify and compare ratios (different units).
- **8Nf.11** Understand how ratios are used to compare quantities to divide an amount into a given ratio with two or more parts.

Algebra

Expressions, equations and formulae

- **8Ae.01** Understand that letters have different meanings in expressions, formulae and equations.
- **8Ae.02** Understand that the laws of arithmetic and order of operations apply to algebraic terms and expressions (four operations, squares and cubes).
- **8Ae.03** Understand how to manipulate algebraic expressions including:
  - applying the distributive law with a single term (squares and cubes)
  - identifying the highest common factor to factorise.
- **8Ae.04** Understand that a situation can be represented either in words or as an algebraic expression, and move between the two representations (linear with integer or fractional coefficients).
- **8Ae.05** Understand that a situation can be represented either in words or as a formula (mixed operations), and manipulate using knowledge of inverse operations to change the subject of a formula.
- **8Ae.06** Understand that a situation can be represented either in words or as an equation. Move between the two representations and solve the equation (integer or fractional coefficients, unknown on either or both sides).
- **8Ae.07** Understand that letters can represent open and closed intervals (two terms).

Sequences, functions and graphs

- **8As.01** Understand term-to-term rules, and generate sequences from numerical and spatial patterns (including fractions).
- **8As.02** Understand and describe nth term rules algebraically (in the form $n \pm a$, $a \times n$, or $an \pm b$, where a and b are positive or negative integers or fractions).
- **8As.03** Understand that a function is a relationship where each input has a single output. Generate outputs from a given function and identify inputs from a given output by considering inverse operations (including fractions).
- **8As.04** Understand that a situation can be represented either in words or as a linear function in two variables (of the form $y = mx + c$), and move between the two representations.
- **8As.05** Use knowledge of coordinate pairs to construct tables of values and plot the graphs of linear functions, where y is given explicitly in terms of x ($y = mx + c$).
- **8As.06** Recognise that equations of the form $y = mx + c$ correspond to straight-line graphs, where m is the gradient and c is the y-intercept (integer values of m).
- **8As.07** Read and interpret graphs with more than one component. Explain why they have a specific shape and the significance of intersections of the graphs.

Geometry and Measure

Geometrical reasoning, shapes and measurements

- **8Gg.01** Identify and describe the hierarchy of quadrilaterals.
- **8Gg.02** Understand π as the ratio between a circumference and a diameter. Know and use the formula for the circumference of a circle.
- **8Gg.03** Know that distances can be measured in miles or kilometres, and that a kilometre is approximately $\frac{5}{8}$ of a mile or a mile is 1.6 kilometres.
- **8Gg.04** Use knowledge of rectangles, squares and triangles to derive the formulae for the area of parallelograms and trapezia. Use the formulae to calculate the area of parallelograms and trapezia.
- **8Gg.05** Understand and use Euler's formula to connect number of vertices, faces and edges of 3D shapes.
- **8Gg.06** Use knowledge of area and volume to derive the formula for the volume of a triangular prism. Use the formula to calculate the volume of triangular prisms.
- **8Gg.07** Represent front, side and top view of 3D shapes to scale.
- **8Gg.08** Use knowledge of area, and properties of cubes, cuboids, triangular prisms and pyramids to calculate their surface area.
- **8Gg.09** Understand that the number of sides of a regular polygon is equal to the number of lines of symmetry and the order of rotation.
- **8Gg.10** Derive and use the fact that the exterior angle of a triangle is equal to the sum of the two interior opposite angles.
- **8Gg.11** Recognise and describe the properties of angles on parallel and intersecting lines, using geometric vocabulary such as alternate, corresponding and vertically opposite.
- **8Gg.12** Construct triangles, midpoint and perpendicular bisector of a line segment, and the bisector of an angle.

Position and transformation

- **8Gp.01** Understand and use bearings as a measure of direction.
- **8Gp.02** Use knowledge of coordinates to find the midpoint of a line segment.
- **8Gp.03** Translate points and 2D shapes using vectors, recognising that the image is congruent to the object after a translation.
- **8Gp.04** Reflect 2D shapes and points in a given mirror line on or parallel to the x- or y-axis, or $y = \pm x$ on coordinate grids. Identify a reflection and its mirror line.
- **8Gp.05** Understand that the centre of rotation, direction of rotation and angle are needed to identify and perform rotations.
- **8Gp.06** Enlarge 2D shapes, from a centre of enlargement (outside or on the shape) with a positive integer scale factor. Identify an enlargement and scale factor.

Statistics and Probability

Statistics

- **8Ss.01** Select, trial and justify data collection and sampling methods to investigate predictions for a set of related statistical questions, considering what data to collect (categorical, discrete and continuous data).
- **8Ss.02** Understand the advantages and disadvantages of different sampling methods.
- **8Ss.03** Record, organise and represent categorical, discrete and continuous data. Choose and explain which representation to use in a given situation:
  - Venn and Carroll diagrams
  - tally charts, frequency tables and two-way tables
  - dual and compound bar charts
  - pie charts
  - frequency diagrams for continuous data
  - line graphs and time series graphs
  - scatter graphs
  - stem-and-leaf diagrams
  - infographics.
- **8Ss.04** Use knowledge of mode, median, mean and range to compare two distributions, considering the interrelationship between centrality and spread.
- **8Ss.05** Interpret data, identifying patterns, trends and relationships, within and between data sets, to answer statistical questions. Discuss conclusions, considering the sources of variation, including sampling, and check predictions.

Probability

- **8Sp.01** Understand that complementary events are two events that have a total probability of 1.
- **8Sp.02** Understand that tables, diagrams and lists can be used to identify all mutually exclusive outcomes of combined events (independent events only).
- **8Sp.03** Understand how to find the theoretical probabilities of equally likely combined events.
- **8Sp.04** Design and conduct chance experiments or simulations, using small and large numbers of trials. Compare the experimental probabilities with theoretical outcomes.

Stage 9

Thinking and Working Mathematically

- **TWM.01** Specialising
- **TWM.02** Generalising
- **TWM.03** Conjecturing
- **TWM.04** Convincing
- **TWM.05** Characterising
- **TWM.06** Classifying
- **TWM.07** Critiquing
- **TWM.08** Improving

Number

Integers, powers and roots

- **9Ni.01** Understand the difference between rational and irrational numbers.
- **9Ni.02** Use positive, negative and zero indices, and the index laws for multiplication and division.
- **9Ni.03** Understand the standard form for representing large and small numbers.
- **9Ni.04** Use knowledge of square and cube roots to estimate surds.

Place value, ordering and rounding

- **9Np.01** Multiply and divide integers and decimals by 10 to the power of any positive or negative number.
- **9Np.02** Understand that when a number is rounded there are upper and lower limits for the original number.

Fractions, decimals, percentages, ratio and proportion

- **9Nf.01** Deduce whether fractions will have recurring or terminating decimal equivalents.
- **9Nf.02** Estimate, add and subtract proper and improper fractions, and mixed numbers, using the order of operations.
- **9Nf.03** Estimate, multiply and divide fractions, interpret division as a multiplicative inverse, and cancel common factors before multiplying or dividing.
- **9Nf.04** Use knowledge of the laws of arithmetic, inverse operations, equivalence and order of operations (brackets and indices) to simplify calculations containing decimals and fractions.
- **9Nf.05** Understand compound percentages.
- **9Nf.06** Estimate, multiply and divide decimals by integers and decimals.
- **9Nf.07** Understand the relationship between two quantities when they are in direct or inverse proportion.
- **9Nf.08** Use knowledge of ratios and equivalence for a range of contexts.

Algebra

Expressions, equations and formulae

- **9Ae.01** Understand that the laws of arithmetic and order of operations apply to algebraic terms and expressions (four operations and integer powers).
- **9Ae.02** Understand how to manipulate algebraic expressions including:
  - expanding the product of two algebraic expressions
  - applying the laws of indices
  - simplifying algebraic fractions.
- **9Ae.03** Understand that a situation can be represented either in words or as an algebraic expression, and move between the two representations (including squares, cubes and roots).
- **9Ae.04** Understand that a situation can be represented either in words or as a formula (including squares and cubes), and manipulate using knowledge of inverse operations to change the subject of a formula.
- **9Ae.05** Understand that a situation can be represented either in words or as an equation. Move between the two representations and solve the equation (including those with an unknown in the denominator).
- **9Ae.06** Understand that the solution of simultaneous linear equations:
  - is the pair of values that satisfy both equations
  - can be found algebraically (eliminating one variable)
  - can be found graphically (point of intersection).
- **9Ae.07** Understand that a situation can be represented either in words or as an inequality. Move between the two representations and solve linear inequalities.

Sequences, functions and graphs

- **9As.01** Generate linear and quadratic sequences from numerical patterns and from a given term-to-term rule (any indices).
- **9As.02** Understand and describe nth term rules algebraically (in the form $an \pm b$, where a and b are positive or negative integers or fractions, and in the form $\frac{n}{a}$, n^2, n^3 or $n^2 \pm a$, where a is a whole number).
- **9As.03** Understand that a function is a relationship where each input has a single output. Generate outputs from a given function and identify inputs from a given output by considering inverse operations (including indices).
- **9As.04** Understand that a situation can be represented either in words or as a linear function in two variables (of the form $y = mx + c$ or $ax + by = c$), and move between the two representations.
- **9As.05** Use knowledge of coordinate pairs to construct tables of values and plot the graphs of linear functions, including where y is given implicitly in terms of x ($ax + by = c$), and quadratic functions of the form $y = x^2 \pm a$.
- **9As.06** Understand that straight-line graphs can be represented by equations. Find the equation in the form $y = mx + c$ or where y is given implicitly in terms of x (fractional, positive and negative gradients).
- **9As.07** Read, draw and interpret graphs and use compound measures to compare graphs.

Geometry and Measure

Geometrical reasoning, shapes and measurements

- **9Gg.01** Know and use the formulae for the area and circumference of a circle.
- **9Gg.02** Know and recognise very small or very large units of length, capacity and mass.
- **9Gg.03** Estimate and calculate areas of compound 2D shapes made from rectangles, triangles and circles.
- **9Gg.04** Use knowledge of area and volume to derive the formula for the volume of prisms and cylinders. Use the formula to calculate the volume of prisms and cylinders.
- **9Gg.05** Use knowledge of area, and properties of cubes, cuboids, triangular prisms, pyramids and cylinders to calculate their surface area.
- **9Gg.06** Identify reflective symmetry in 3D shapes.
- **9Gg.07** Derive and use the formula for the sum of the interior angles of any polygon.
- **9Gg.08** Know that the sum of the exterior angles of any polygon is 360°.
- **9Gg.09** Use properties of angles, parallel and intersecting lines, triangles and quadrilaterals to calculate missing angles.
- **9Gg.10** Know and use Pythagoras' theorem.
- **9Gg.11** Construct 60°, 45° and 30° angles and regular polygons.

Position and transformation

- **9Gp.01** Use knowledge of bearings and scaling to interpret position on maps and plans.
- **9Gp.02** Use knowledge of coordinates to find points on a line segment.
- **9Gp.03** Transform points and 2D shapes by combinations of reflections, translations and rotations.
- **9Gp.04** Identify and describe a transformation (reflections, translations, rotations and combinations of these) given an object and its image.
- **9Gp.05** Recognise and explain that after any combination of reflections, translations and rotations the image is congruent to the object.
- **9Gp.06** Enlarge 2D shapes, from a centre of enlargement (outside, on or inside the shape) with a positive integer scale factor. Identify an enlargement, centre of enlargement and scale factor.
- **9Gp.07** Analyse and describe changes in perimeter and area of squares and rectangles when side lengths are enlarged by a positive integer scale factor.

Statistics and Probability

Statistics

- **9Ss.01** Select, trial and justify data collection and sampling methods to investigate predictions for a set of related statistical questions, considering what data to collect, and the appropriateness of each type (qualitative or quantitative; categorical, discrete or continuous).
- **9Ss.02** Explain potential issues and sources of bias with data collection and sampling methods, identifying further questions to ask.
- **9Ss.03** Record, organise and represent categorical, discrete and continuous data. Choose and explain which representation to use in a given situation:
  - Venn and Carroll diagrams
  - tally charts, frequency tables and two-way tables
  - dual and compound bar charts
  - pie charts
  - line graphs, time series graphs and frequency polygons
  - scatter graphs
  - stem-and-leaf and back-to-back stem-and-leaf diagrams
  - infographics.
- **9Ss.04** Use mode, median, mean and range to compare two distributions, including grouped data.
- **9Ss.05** Interpret data, identifying patterns, trends and relationships, within and between data sets, to answer statistical questions. Make informal inferences and generalisations, identifying wrong or misleading information.

Probability

- **9Sp.01** Understand that the probability of multiple mutually exclusive events can be found by summation and all mutually exclusive events have a total probability of 1.
- **9Sp.02** Identify when successive and combined events are independent and when they are not.
- **9Sp.03** Understand how to find the theoretical probabilities of combined events.
- **9Sp.04** Design and conduct chance experiments or simulations, using small and large numbers of trials. Calculate the expected frequency of occurrences and compare with observed outcomes.

4 Glossary

This glossary is provided to support your understanding of the content of this curriculum framework. The definitions are intended to be sufficient to guide an informed reader.

Brackets – a mathematical notation that are used to denote grouping. Brackets are also commonly referred to as parentheses.

Constant – $3x$ is an expression where 3 is a constant as it has a fixed value. Letters can also be used to represent constants. For example, the mathematical constant π is used to represent the number approximately equal to 3.14159265…

Draw – using mathematical instruments, such as rulers, pair of compasses and protractors, to accurately represent lines and shapes. See **Sketch**.

Index/Indices – the plural of index is indices. Indices are numbers that show how often a number is multiplied by itself. Indices are also commonly referred to as exponents or powers.

Infographic – a representation of information in a graphic format designed to make the data more accessible.

Irrational number – a number that cannot be expressed as a common fraction with a non-zero denominator.

Integer – any positive or negative whole number and zero. (Example: …-2, -1, 0, +1, +2…). See **Whole number**.

Learning objective – statements from the curriculum framework of the expectations of knowledge, understanding and skills that learners will develop; they provide a structure for teaching and learning, and a reference against which to check learners' ability and skills development.

Limit – a value that is less than, more than or equal to every element of a set of data. Limits are also commonly referred to as bounds.

Rational number – a number that can be expressed as a common fraction with a non-zero denominator.

Scheme of work – support materials for each stage of Cambridge Lower Secondary Mathematics. Each scheme of work contains a suggested long-term plan, a medium-term plan with suggested activities and sample short-term (lesson) plans.

Sketch – illustrate lines and shapes without mathematical instruments so they be representative only and may not be precise. See **Draw**.

Sources of variation – reasons for differences in data e.g. sampling variability.

Standard form – a way of expressing very large or very small numbers in a simplified format. Standard form is also commonly referred to as scientific notation.

Statistical question – a question that will have variable answers. (Example: Which fruits do people in this class like?)

Strand – a collection of learning objectives in the curriculum framework that forms an area of learning.

Surd – an irrational number with a value that cannot be precisely determined. (Example: an infinite recurring decimal such as $\sqrt{2}$. Surd is also commonly referred to as radical.)

Teacher guide – the document providing support in using the curriculum framework to plan and deliver lessons using effective teaching and learning approaches.

Trapezium/Trapezia – a quadrilateral with one pair of parallel sides.

Unknown number – if the expression $3x$ is equal to 12, then the variable x is also an unknown number as the value of x can be found. In this case x has a value of 4.

Variable – $3x$ is an expression where x is a variable as x represents an unspecified number and can have various values.

Whole number – positive whole numbers and zero (when *dividing* by a whole number, this does not include zero). (Example: 0, 1, 2, 3 etc.) See **Integer**.

5 Changes to this curriculum framework

This curriculum framework has been amended. The latest curriculum framework is version 3.0, published August 2021.

- We have made changes in order to make the curriculum framework digitally accessible. For example, we have increased the font size and spacing and added alternative text to images and tables.

There may be other minor changes that do not affect teaching and learning.

The changes made in version 2.0, published January 2021, were:

- 8Gg.02: Removed ‘Strands’.
- 8Ss.03: Removed ‘waffle diagrams and’. Added ‘and time series graphs’. Added ‘stem-and-leaf diagrams’.
- 9Ss.03: Removed ‘waffle diagrams and’. Removed ‘frequency diagrams for continuous data’. Added ‘time series graphs and frequency polygons’. Added ‘stem-and-leaf and back-to-back stem-and-leaf diagrams’.

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