



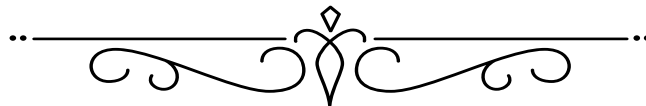
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Maths


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A. Introduction

1. Rationale

Mathematics is an excellent vehicle for the development and improvement of a person's intellectual competence in logical reasoning, spatial visualization, analysis and abstract thought. Students develop numeracy, reasoning, thinking skills, and problem solving skills through the learning and application of mathematics. The development of a highly skilled scientifically- and technologically-based manpower requires a strong grounding in mathematics. Peace Schools aim at the holistic development of a child and identify the need to integrate 21st Century Skills in Mathematics teaching.

Mathematics is also a subject of enjoyment and excitement, which offers students opportunities for creative work and moments of enlightenment and joy. When ideas are discovered and insights gained, students are spurred to pursue mathematics beyond the classroom walls.

2. Aims of Mathematics Education in Schools

Developing children's abilities for mathematisation is the main goal of mathematics education. The narrow aim of school mathematics is to develop 'useful' capabilities, particularly those relating to numeracy—numbers, number operations, measurements, decimals and percentages. The higher aim is to develop the child's resources to think and reason mathematically, to pursue assumptions to their logical conclusion and to handle abstraction. It includes a way of doing things, and the ability and the attitude to formulate and solve problems.

3. Vision for School Mathematics

- Children learn to enjoy mathematics rather than fear it.
- Children learn important mathematics: Mathematics is more than formulas and mechanical procedures.
- Children see mathematics as something to talk about, to communicate through, to discuss among them, to work together on.
- Children pose and solve meaningful problems.
- Children use abstractions to perceive relationships, to see structures, to reason out things, to argue the truth or falsity of statements.
- Children understand the basic structure of Mathematics: Arithmetic, algebra, geometry and trigonometry, the basic content areas of

School Mathematics, all offer a methodology for abstraction, structuration and generalization.

- Teachers engage every child in class with the conviction that everyone can learn mathematics.

4. Mathematics Framework

Mathematical problem solving is central to mathematics learning. It involves the acquisition and application of mathematics concepts and skills in a wide range of situations, including non-routine, open-ended and real-world problems.

The development of mathematical problem solving ability is dependent on five inter-related components, namely, Concepts, Skills, Processes, Attitudes and Meta cognition.

a) Concepts

Mathematical concepts cover numerical, algebraic, geometrical, statistical, probabilistic, and analytical concepts. Students should develop and explore the mathematics ideas in depth, and see that mathematics is an integrated whole, not merely isolated piece of knowledge. They should be given a variety of learning experiences to help them develop a deep understanding of mathematical concepts, and to make sense of various mathematical ideas, as well as their connections and applications, in order to participate actively in learning mathematics and to become more confident in exploring and applying mathematics. The use of manipulative (concrete materials), practical work, and use of technological aids should be part of the learning experiences of the students.

b) Skills

Mathematical skills include procedural skills for numerical calculation, algebraic manipulation, spatial visualization, data analysis, measurement, use of mathematical tools, and estimation. The development of skill proficiencies in students is essential in the learning and application of mathematics. Although students should become competent in the various mathematical skills, over-emphasizing procedural skills without understanding the underlying mathematical principles should be avoided. Skill proficiencies include the ability to use technology confidently, where appropriate, for exploration and problem solving. It is important also to incorporate the use of thinking skills and heuristics in the process of developing skill proficiencies.

c) Processes

Mathematical processes refer to the knowledge skills (or process skills) involved in the process of acquiring and applying mathematical knowledge. This includes reasoning, communication and connections, thinking skills and heuristics, and application and modeling.

Reasoning, Communication and Connections: Mathematical reasoning refers to the ability to analyze mathematical situations and construct logical arguments. It is a

habit of mind that can be developed through the applications of mathematics in different contexts.

Communication refers to the ability to use mathematical language to express mathematical ideas and arguments precisely, concisely and logically. It helps students develop their own understanding of mathematics and sharpen their mathematical thinking.

Connections refer to the ability to see and make linkages among mathematical ideas, between mathematics and other subjects, and between mathematics and everyday life. This helps students make sense of what they learn in mathematics.

Mathematical reasoning, communication and connections should pervade all levels of mathematics learning, from the primary to A-levels.

Thinking skills and heuristics: Students should use various thinking skills and heuristics to help them solve mathematical problems. Thinking skills are skills that can be used in a thinking process, such as classifying, comparing, sequencing, analyzing parts and wholes, identifying patterns and relationships, induction, deduction and spatial visualization.

Some examples of heuristics are listed below and grouped in four categories according to how they are used:

To give a representation, e.g. draw a diagram, make a list, and use equations

To make a calculated guess, e.g. guess and check, look for patterns, make suppositions

To go through the process, e.g. act it out, work backwards, before-after

To change the problem, e.g. restate the problem, simplify the problem, solve part of the problem

Application and modeling: Application and modeling play a vital role in the development of mathematical understanding and competencies. It is important that students apply mathematical problem-solving skills and reasoning skills to tackle a variety of problems, including real-world problems.

Mathematical modeling is the process of formulating and improving a mathematical model to represent and solve real-world problems. Through mathematical modeling, students learn to use a variety of representations of data, and to select and apply appropriate mathematical methods and tools in solving real-world problems. The opportunity to deal with empirical data and use mathematical tools for data analysis should be part of the learning at all levels.

d) Attitudes

Attitudes refer to the affective aspects of mathematics learning such as:

Beliefs about mathematics and its usefulness

Interest and enjoyment in learning mathematics

Appreciation of the beauty and power of mathematics

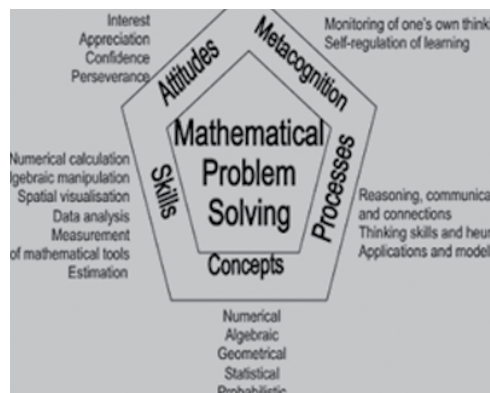
- # Confidence in using mathematics
- # Perseverance in solving a problem

Students' attitudes towards mathematics are shaped by their learning experiences. Making the learning of mathematics fun, meaningful and relevant goes a long way to inculcating positive attitudes towards the subject. Care and attention should be given to the design of the learning activities, to build confidence in and develop appreciation for the subject.

e) Meta cognition

Meta cognition, or “thinking about thinking”, refers to the awareness of, and the ability to control one's thinking processes, in particular the selection and use of problem-solving strategies. It includes monitoring of one's own thinking, and self-regulation of learning. The provision of Meta cognitive experience is necessary to help students develop their problem solving abilities. The following activities may be used to develop the Meta cognitive awareness of students and to enrich their Meta cognitive experience:

- # Expose students to general problem solving skills, thinking skills and heuristics, and how these skills can be applied to solve problems.
- # Encourage students to think aloud the strategies and methods they use to solve particular problems.
- # Provide students with problems that require planning (before solving) and evaluation (after solving).
- # Encourage students to seek alternative ways of solving the same problem and to check the appropriateness and reasonableness of the answer.
- # Allow students to discuss how to solve a particular problem and to explain the different methods that they use for solving the problem.



B. The Curriculum:

1. Curricular Areas and Stages

At the pre-primary stage, all learning occurs through play rather than through didactic communication. Rather than the rote learning of the number sequence, children need to learn and understand, in the context of small sets, the connection between

word games and counting, and between counting and quantity. Making simple comparisons and classifications along one dimension at a time and identifying shapes and symmetries are appropriate skills to acquire at this stage. Encouraging children to use language to freely express one's thoughts and emotions, rather than in predetermined ways, is extremely important at this and at later stages.

Having children developed a positive attitude towards, and a liking for, Mathematics at **the primary stage** is as important, if not more than the cognitive skills and concepts that they acquire. Mathematical games, puzzles and stories help in developing a positive attitude and in making connections between mathematics and everyday thinking. It is important to note that mathematics is not just arithmetic. Besides numbers and number operations, due importance must be given to shapes, spatial understanding, patterns, measurement and data handling. The curriculum must explicitly incorporate the progression that learners make from the concrete to the abstract while acquiring concepts. Apart from computational skills, stress must be laid on identifying, expressing and explaining patterns, on estimation and approximation in solving problems, on making connections, and on the development of skills of language in communication and reasoning.

At the **upper primary stage**, students get the first taste of the power of Mathematics through the application of powerful abstract concepts that compress previous learning and experience. This enables them to revisit and consolidate basic concepts and skills learnt at the primary stage, which is essential from the point of view of achieving universal mathematical literacy. Students are introduced to algebraic notation and its use in solving problems and in generalization, to the systematic study of space and shapes, and for consolidating their knowledge of measurement. Data handling, representation and interpretation form a significant part of the ability of dealing with information in general, which is an essential 'life skill'. The learning at this stage also offers an opportunity to enrich students' spatial reasoning and visualization skills.

At the **secondary stage**, students begin to perceive the structure of Mathematics as a discipline. They become familiar with the characteristics of mathematical communication: carefully defined terms and concepts, the use of symbols to represent them, precisely stated propositions, and proofs justifying propositions. These aspects are developed particularly in the area of geometry. Students develop their facility with algebra, which is important not only in the application of mathematics, but also within mathematics in providing justifications and proofs. At this stage, students integrate the many concepts and skills that they have learnt into a problem-solving ability. Mathematical modeling, data analysis and interpretation taught at this stage can consolidate a high level of mathematical literacy. Individual and group exploration of connections and patterns, visualization and generalization, and making and proving conjectures are important at this stage, and can be encouraged through the use of appropriate tools that include concrete models as in Mathematics laboratories and computers.

Curriculum Standards

Grade I

Stage 1

Strand: Number

Sub strand: Numbers and the number system

- Recite numbers in order (forwards from 1 to 100, backwards from 20 to 0).
- Read and write numerals from 0 to 20.
- Count objects up to 20, recognizing conservation of number.
- Count on in tens from zero or a single-digit number to 100 or just over.
- Count on in twos, beginning to recognize odd/even numbers to 20 as ‘every other number’.
- Begin partitioning two-digit numbers into tens and ones and reverse.
- Within the range 0 to 30, say the number that is 1 or 10 more or less than any given number.
- Use more or less to compare two numbers, and give a number which lies between them.
- Order numbers to at least 20 positioning on a number track; use ordinal numbers.
- Use the = sign to represent equality.
- Give a sensible estimate of some objects that can be checked by counting, e.g. to 30.
- Find halves of small numbers and shapes by folding, and recognize which shapes are halved.

Sub Strand: Calculation

Mental strategies

- Know all number pairs to 10 and record the related addition/subtraction facts.
- Begin to know number pairs to 6, 7, 8, 9 and 10.
- Add more than two small numbers, spotting pairs to 10, e.g. $4 + 3 + 6 = 10 + 3$.
- Begin using pairs to 10 to bridge 10 when adding/subtracting, e.g. $8 + 3$, add 2, then 1.
- Know doubles to at least double 5.
- Find near doubles using doubles already known, e.g. $5 + 6$.
- Begin to recognize multiples of 2 and 10.

Addition and subtraction

- Understand addition as counting on and combining two sets; record related addition sentences.
- Understand subtraction as counting back and ‘take away’; record related subtraction sentences.
- Understand difference as ‘how many more to make?’
- Add/subtract a single-digit number by counting on/back.
- Find two more or less than a number to 20, recording the jumps on a number line.
- Relate counting on and back in tens to finding 10 more/less than a number (< 100).
- Begin to use the +, – and = signs to record calculations in number sentences.
- Understand that changing the order of addition does not change the total.
- Add a pair of numbers by putting the larger number first and counting on.
- Recognize the use of a sign such as || to represent an unknown, e.g. $6 + || = 10$.
- Begin to add single- and two-digit numbers.

Multiplication and division

- Double any single-digit number.
- Find halves of even numbers of objects up to 10.
- Try to share numbers to 10 to find which are even and which are odd.
- Share objects into two equal groups in a context.

Strand: Geometry

Sub Strand: Shapes and geometric reasoning

- Name and sort common 2D shapes (e.g. circles, squares, rectangles and triangles) using features such as number of sides, curved or straight. Use them to make patterns and models.
- Name and sort common 3D shapes (e.g. cube, cuboids, cylinder, cone and sphere) using features such as number of faces, flat or curved faces. Use them to make patterns and models.
- Recognize basic line symmetry.

Sub Strand: Position and movement

- Use everyday language of direction and distance to describe movement of objects.

Strand: Measure

Sub Strand: Money

- Recognize all coins and work out how to pay an exact sum using smaller coins.

Sub strand: Length, mass and capacity

- Compare lengths and weights by direct comparison, then by using uniform non-standard units.

- Estimate and compare capacities by direct comparison, then by using uniform non-standard units.
- Use comparative language, e.g. longer, shorter, heavier, lighter.

Sub Strand: Time

- Begin to understand and use some units of time, e.g. minutes, hours, days, weeks, months and years.
- Read the time to the hour (o'clock) and know key times of day to the nearest hour.
- Order the days of the week and other familiar events.

Strand: Handling data

Sub Strand: Organizing, categorizing and representing data

- Answer a question by sorting and organizing data or objects in a variety of ways, e.g. – using block graphs and pictograms with practical resources; discussing the results
 - In lists and tables with practical resources; discussing the results
 - In Venn or Carroll diagrams giving different criteria for grouping the same objects

Strand: Problem solving

Sub Strand: Using techniques and skills in solving mathematical problems

- Choose appropriate strategies to carry out calculations, explaining working out.
- Explore number problems and puzzles.
- Find many combinations, e.g. combinations of three pieces of different colored clothing.
- Decide to add or subtract to solve a simple word problem (oral), and represent it with objects.
- Check the answer to an addition by adding the numbers in a different order.
- Check the answer to a subtraction by adding the answer to the smaller number in the question.
- Describe and continue patterns such as count on and back in tens, e.g. 90, 80, 70.
- Identify simple relationships between numbers and shapes, e.g. this number is ten bigger than that number.
- Make a sensible estimate of a calculation, and consider whether an answer is reasonable.

Grade II

Strand: Number

Sub Strand: Numbers and the number system

- Count, read and write numbers to at least 100 and back again.
- Count up to 100 objects, e.g. beads on a bead bar.
- Count on in ones and tens from single- and two-digit numbers and back again.
- Count in twos, fives and tens, and use grouping in twos, fives or tens to count larger groups of objects.
- Begin to count on in small constant steps such as threes and fours.
- Know what each digit represents in two-digit numbers; partition into tens and ones.
- Find 1 or 10 more/less than any two-digit number.
- Round two-digit numbers to the nearest multiple of 10.
- Say a number between any given neighboring pairs of multiples of 10, e.g. 40 and 50.
- Place a two-digit number on a number line marked off in multiples of ten.
- Recognize and use ordinal numbers up to at least the 10th number and beyond.
- Order numbers to 100; compare two numbers using the $>$ and $<$ signs.
- Give a sensible estimate of up to 100 objects, e.g. choosing from 10, 20, 50 or 100.
- Understand even and odd numbers and recognize these up to at least 20.
- Sort numbers, e.g. odd/even, multiples of 2, 5 and 10.
- Recognize that we write one half $\frac{1}{2}$ one quarter $\frac{1}{4}$ and three quarters $\frac{3}{4}$
- Recognize that $\frac{2}{2}$ or $\frac{4}{4}$ makes a whole and $\frac{1}{2}$ and $\frac{2}{4}$ are equivalent.
- Recognize which shapes are divided in halves or quarters and which are not.
- Find halves and quarters of shapes and small numbers of objects.

Sub Strand: Calculation

Mental strategies

- Find and learn by heart all number pairs to 10 and pairs with a total of 20.
- Partition all numbers to 20 into pairs and record the related addition and subtraction facts.

- Find all pairs of multiples of 10 with a total of 100 and record the related addition and subtraction facts.
- Learn and recognize multiples of 2, 5 and 10 and derive the related division facts.
- Find and learn doubles for all numbers up to 10 and also 15, 20, 25 and 50.

Addition and subtraction

- Relate counting on/back in tens to finding 10 more/less than any two-digit number and then to adding and subtracting other multiples of 10, e.g. $75 - 30$.
- Use the = sign to represent equality, e.g. $16 + 4 = 17 + 3$.
- Add four or five small numbers together.
- Recognize the use of a symbol such as \square or Δ to represent an unknown, e.g. $\Delta + \square = 10$.
- Solve number sentences such as $27 + \square = 30$.
- Add and subtract a single digit to and from a two-digit number.
- Add pairs of two-digit numbers.
- Find a small difference between pairs of two-digit numbers.
- Understand that addition can be done in any order, but subtraction cannot.
- Understand subtraction as both difference and take away.

Multiplication and division

- Understand multiplication as repeated addition and use the \times sign.
- Understand multiplication as describing an array.
- Understand division as grouping and use the \div sign.
- Use counting in twos, fives or tens to solve practical problems involving repeated addition.
- Find doubles of multiples of 5 up to double 50 and corresponding halves.
- Double two-digit numbers.
- Work out multiplication and division facts for the 3x and 4x tables.
- Understand that division can leave some left over.

Strand: Geometry

Sub Strand: Shapes and geometric reasoning

- Sort, name, describe, visualize and draw 2D shapes (e.g. squares, rectangles, circles, regular and irregular pentagons and hexagons) referring to their properties; recognize common 2D shapes in different positions and orientations.
- Sort, name, describe and make 3D shapes (e.g. cubes, cuboids, cones, cylinders, spheres and pyramids) referring to their properties; recognize 2D drawings of 3D shapes.
- Identify reflective symmetry in patterns and 2D shapes; draw lines of symmetry.

-
- Find examples of 2D and 3D shape and symmetry in the environment.

Sub Strand: Position and movement

- Follow and give instructions involving position, direction and movement.
- Recognize whole, half and quarter turns, both clockwise and anti-clockwise.
- Recognize that a right angle is a quarter turn.

Strand: Measure**Sub Strand: Money**

- Recognize all coins and notes.
- Use money notation.
- Find totals and the coins and notes required paying a given amount; working out change.

Sub Strand: Length, mass and capacity

- Estimate, measure and compare lengths, weights and capacities, choosing and using suitable uniform non-standard and standard units and appropriate measuring instruments.
- Compare lengths, weights and capacities using the standard units: centimeter, meter, 100 g, kilogram, and liter

Sub Strand: Time

- Know the units of time (seconds, minutes, hours, days, weeks, months and years).
- Know the relationships between consecutive units of time.
- Read the time to the half hour on digital and analogue clocks.
- Measure activities using seconds and minutes.
- Know and order the days of the week and the months of the year.

Strand: Handling data**Sub Strand: Organizing, categorizing and representing data**

- Answer a question by collecting and recording data in lists and tables, and representing it as block graphs and pictograms to show results.
- Use Carroll and Venn diagrams to sort numbers or objects using one criterion; begin to sort numbers and objects using two criteria; explain choices using appropriate language, including 'not'.

Strand: Problem solving**Sub Strand: Using techniques and skills in solving mathematical problems**

- Choose appropriate mental strategies to carry out calculations and explain how they worked out the answer.
- Explain methods and reasoning orally.
- Explore number problems and puzzles.

- Make sense of simple word problems (single and easy two step), decide what operations (addition or subtraction, simple multiplication or division) are needed to solve them and, with help, represent them, with objects or drawings or on a number line.
- Make up a number story to go with a calculation, including in the context of money.
- Check the answer to an addition by adding the numbers in a different order or by using a different strategy, e.g. $35 + 19$ by adding 20 to 35 and subtracting 1, and by adding $30 + 10$ and $5 + 9$.
- Check a subtraction by adding the answer to the smaller number in the original subtraction.
- Describe and continue patterns which count on in twos, threes, four or five to 30 or more.
- Identify simple relationships between numbers and shapes, e.g. this number are double ...; these shapes all have ... sides.
- Make a sensible estimate for the answer to a calculation.
- Consider whether an answer is reasonable.

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Grade III

Strand: Number

Sub strand: Numbers and the number system

- Recite numbers 100 to 200 and beyond.
- Read and write numbers to at least 1000.
- Count on and back in ones, tens and hundreds from two- and three-digit numbers.
- Count on and back in steps of 2, 3, 4 and 5 to at least 50.
- Understand what each digit represents in three-digit numbers and partition into hundreds, tens and units.
- Find 1, 10, 100 more/less than two- and three-digit numbers.
- Multiply two-digit numbers by 10 and understand the effect.
- Round two-digit numbers to the nearest 10 and round three digit numbers to the nearest 100.
- Place a three-digit number on a number line marked off in multiples of 100.
- Place a three-digit number on a number line marked off in multiples of 10.
- Compare three-digit numbers, use $<$ and $>$ signs, and find a number in between.
- Order two- and three-digit numbers.
- Give a sensible estimate of a number as a range (e.g. 30 to 50) by grouping in tens.
- Find half of odd and even numbers to 40
- Understand and use fraction notation recognizing that fractions are several parts of one whole
 - Recognize equivalence between and using diagrams.
 - Recognize simple mixed fractions
 - Order simple or mixed fractions on a number line
 - Begin to relate finding fractions to division.
 - Find halves, thirds, quarters and tenths of shapes and numbers (whole number answers).

Sub strand: Calculation***Mental strategies***

- Know addition and subtraction facts for all numbers to 20.
- Know the following addition and subtraction facts:
 - Multiples of 100 with a total of 1000
 - Multiples of 5 with a total of 100
- Know multiplication/division facts for $2\times$, $3\times$, $5\times$, and $10\times$ tables.
- Begin to know $4\times$ tables.
- Recognize two- and three-digit multiples of 2, 5 and 10.
- Work out quickly the doubles of numbers 1 to 20 and derive the related halves.
- Work out quickly the doubles of multiples of 5 (< 100) and derive the related halves.
- Work out quickly the doubles of multiples of 50 to 500.

Addition and subtraction

- Add and subtract 10 and multiples of 10 to and from two- and three-digit numbers.
- Add 100 and multiples of 100 to three-digit numbers.
- Use the = sign to represent equality, e.g. $75 + 25 = 95 + 5$.
- Add several small numbers.
- Find complements to 100, solving number equations such as $78 + 11 = 100$.
- Add and subtract pairs of two-digit numbers.
- Add three-digit and two-digit numbers using notes to support.
- Re-order an addition to help with the calculation, e.g. $41 + 54$, by adding 40 to 54, then 1.
- Add/subtract single-digit numbers to/from three-digit numbers.
- Find 20, 30, ... 90, 100, 200, 300 more/less than three-digit numbers.

Multiplication and division

- Understand the relationship between halving and doubling.
- Understand the effect of multiplying two-digit numbers by 10.
- Multiply single-digit numbers and divide two-digit numbers by 2, 3, 4, 5, 6, 9 and 10.
- Multiply teens numbers by 3 and 5.
- Begin to divide two-digit numbers just beyond $10\times$ tables, e.g. $60 \div 5$, $33 \div 3$.
- Understand that division can leave a remainder (initially as ‘some left over’).
- Understand and apply the idea that multiplication is commutative.

- Understand the relationship between multiplication and division and write connected facts.

Strand: Geometry**Sub strand: Shapes and geometric reasoning**

- Identify, describe and draw regular and irregular 2D shapes including pentagons, hexagons, octagons and semi-circles.
- Classify 2D shapes according to the number of sides, vertices and right angles.
- Identify, describe and make 3D shapes including pyramids and prisms; investigate which nets will make a cube.
- Classify 3D shapes according to the number and shape of faces, number of vertices and edges.
- Draw and complete 2D shapes with reflective symmetry and draw reflections of shapes (mirror line along one side).
- Relate 2D shapes and 3D solids to drawings of them.
- Identify 2D and 3D shapes, lines of symmetry and right angles in the environment.
- Identify right angles in 2D shapes.

Sub strand: Position and movement

- Use the language of position, direction and movement, including clockwise and anti-clockwise.
- Find and describe the position of a square on a grid of squares where the rows and columns are labeled.
- Use a set square to draw right angles.
- Compare angles with a right angle and recognize that a straight line is equivalent to two right angles.

Strand: Measure**Sub strand: Money**

- Consolidate using money notation.
- Use addition and subtraction facts with a total of 100 to find change.

Sub strand: Length, mass and capacity

- Choose and use appropriate units and equipment to estimate, measure and record measurements.
- Know the relationship between kilometers and meters, meters and centimeters, kilograms and grams, liters and milliliters.
- Read to the nearest division or half division, use scales that are numbered or partially numbered.
- Use a ruler to draw and measure lines to the nearest centimeter.

- Solve word problems involving measures.

Sub strand: Time

- Suggest and use suitable units to measure time and know the relationships between them (second, minute, hour, day, week, month, year).
- Read the time on analogue and digital clocks, to the nearest 5 minutes on an analogue clock and to the nearest minute on a digital clock.
- Begin to calculate simple time intervals in hours and minutes.
- Read a calendar and calculate time intervals in weeks or days.

Strand: Handling data

Organizing, categorizing and representing data

- Answer a real-life question by collecting, organizing and interpreting data, e.g. investigating the population of mini-beasts in different environments.
- Use tally charts, frequency tables, pictograms (symbol representing one or two units) and bar charts (intervals labeled in ones or twos).
- Use Venn or Carroll diagrams to sort data and objects using two criteria.

Strand: Problem solving

Sub strand: Using techniques and skills in solving mathematical problems

- Choose appropriate mental strategies to carry out calculations.
- Begin to understand everyday systems of measurement in length, weight, capacity and time and use these to make measurements as appropriate.
- Make sense of and solve word problems, single (all four operations) and two-step (addition and subtraction), and begin to represent them, e.g. with drawings or on a number line.
- Check the results of adding two numbers using subtraction, and several numbers by adding in a different order.
- Check subtraction by adding the answer to the smaller number in the original calculation.
- Check multiplication by reversing the order, e.g. checking that $6 \times 4 = 24$ by doing 4×6 .
- Check a division using multiplication, e.g. check $12 \div 4 = 3$ by doing 4×3 .
- Recognize the relationships between different 2D shapes.
- Identify the differences and similarities between different 3D shapes.
- Estimate and approximate when calculating, and check working.
- Make a sensible estimate for the answer to a calculation, e.g. using rounding.
- Consider whether an answer is reasonable.

Sub strand: Using understanding and strategies in solving problems

- Make up a number story to go with a calculation, including in the context of money.
- Explain a choice of calculation strategy and show how the answer was worked out.
- Explore and solve number problems and puzzles, e.g. logic problems.
- Use ordered lists and tables to help to solve problems systematically.
- Describe and continue patterns which count on or back in steps of 2, 3, 4, 5, 10, or 100.
- Identify simple relationships between numbers, e.g. each number is three more than the number before it.
- Identify simple relationships between shapes, e.g. these shapes all have the same number of lines of symmetry.
- Investigate a simple general statement by finding examples which do or do not satisfy it, e.g. when adding 10 to a number, the first digit remains the same.
- Explain methods and reasoning orally, including initial thoughts about possible answers to a problem.

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Grade IV

Strand: Number

Sub strand: Numbers and the number system

- Read and write numbers up to 10 000.
- Count on and back in ones, tens, hundreds and thousands from four-digit numbers.
- Understand what each digit represents in a three- or four-digit number and partition into thousands, hundreds, tens and units.
 - Use decimal notation and place value for tenths and hundredths in context, e.g. order amounts of money; convert a sum of money such as \$13.25 to cents, or a length such as 125 cm to metres; round a sum of money to the nearest pound.
 - Understand decimal notation for tenths and hundredths in context, e.g. length.
 - Find multiples of 10, 100, 1000 more/less than numbers of up to four digits, e.g. $3407 + 20 = 3427$.
 - Multiply and divide three-digit numbers by 10 (whole number answers) and understand the effect; begin to multiply numbers by 100 and perform related divisions.
 - Recognize multiples of 5, 10 and 100 up to 1000.
 - Round three- and four-digit numbers to the nearest 10 or 100.
 - Position accurately numbers up to 1000 on an empty number line or line marked off in multiples of 10 or 100.
 - Estimate where three- and four-digit numbers lie on empty 0–1000 or 0–10 000 lines.
 - Compare pairs of three-digit or four-digit numbers, using the $>$ and $<$ signs, and find a number in between each pair.
 - Use negative numbers in context, e.g. temperature.
 - Recognize and extend number sequences formed by counting in steps of constant size, extending beyond zero when counting back.
 - Recognize odd and even numbers.
 - Make general statements about the sums and differences of odd and even numbers.
 - Order and compare two or more fractions with the same denominator (halves,

quarters, thirds, fifths, eighths or tenths).

- Recognize the equivalence between: $\frac{1}{2}$, $\frac{4}{8}$ and $\frac{5}{10}$; $\frac{1}{4}$ and $\frac{2}{8}$; $\frac{1}{5}$ and $\frac{2}{10}$.
- Use equivalence to help order fractions, e.g. $\frac{7}{10}$ and $\frac{3}{4}$
- Understand the equivalence between one-place decimals and fractions in tenths.
- Understand that $\frac{1}{2}$ is equivalent to 0.5 and also to $\frac{5}{10}$
- Recognize the equivalence between the decimal fraction and vulgar fraction forms of halves, quarters, tenths and hundredths.
- Recognize mixed numbers, e.g. $5\frac{3}{4}$ and order these on a number line.
- Relate finding fractions to division.
- Find halves, quarters, thirds, fifths, eighths and tenths of shapes and numbers

Sub strand: Calculation

Mental strategies

- Derive quickly pairs of two-digit numbers with a total of 100, e.g. $72 + 28 = 100$.
- Derive quickly pairs of multiples of 50 with a total of 1000, e.g. $850 + 150 = 1000$.
- Identify simple fractions with a total of 1, e.g. $\frac{1}{4} + \frac{3}{4} = 1$.
- Know multiplication for $2\times$, $3\times$, $4\times$, $5\times$, $6\times$, $9\times$ and $10\times$ tables and derive division facts.
- Recognize and begin to know multiples of 2, 3, 4, 5 and 10, up to the tenth multiple.
- Add three or four small numbers, finding pairs that equal 10 or 20.
- Add three two-digit multiples of 10, e.g. $40 + 70 + 50$.
- Add and subtract near multiples of 10 or 100 to or from three digit numbers, e.g. $367 - 198$ or $278 + 49$.
- Add any pair of two-digit numbers, choosing an appropriate strategy.
- Subtract any pair of two-digit numbers, choosing an appropriate strategy.
- Find a difference between near multiples of 100, e.g. $304 - 296$.
- Subtract a small number crossing 100, e.g. $304 - 8$.
- Multiply any pair of single-digit numbers together.
- Use knowledge of commutativity to find the easier way to multiply.
- Understand the effect of multiplying and dividing three-digit numbers by 10.
- Derive quickly doubles of all whole numbers to 50, doubles of multiples of 10 to 500, doubles of multiples of 100 to 5000, and corresponding halves.

Addition and subtraction

- Add pairs of three-digit numbers.
- Subtract a two-digit number from a three-digit number.
- Subtract pairs of three-digit numbers.

Multiplication and division

- Double any two-digit number.
- Multiply multiples of 10 to 90 by a single-digit number.
- Multiply a two-digit number by a single-digit number.
- Divide two-digit numbers by single digit-numbers (answers no greater than 20).
- Decide whether to round up or down after division to give an answer to a problem.
- Understand that multiplication and division are the inverse function of each other.
- Begin to understand simple ideas of ratio and proportion, e.g. a picture is one fifth the size of the real dog. It is 25 cm long in the picture, so it is 5×25 cm long in real life

Strand: Geometry

Sub strand: Shapes and geometric reasoning

- Identify, describe, visualize, draw and make a wider range of 2D and 3D shapes including a range of quadrilaterals, the heptagon and tetrahedron; use pin boards to create a range of polygons. Use spotty paper to record results.
- Classify polygons (including a range of quadrilaterals) using criteria such as the number of right angles, whether or not they are regular and their symmetrical properties.
- Identify and sketch lines of symmetry in 2D shapes and patterns.
- Visualize 3D objects from 2D nets and drawings and make nets of common solids.
- Find examples of shapes and symmetry in the environment and in art.

Sub strand: Position and movement

- Describe and identify the position of a square on a grid of squares where rows and columns are numbered and/or lettered.
- Know that angles are measured in degrees and that one whole turn is 360° or four right angles; compare and order angles less than 180° .
- Devise the directions to give to follow a given path.

Strand: Measure

Sub strand: Length, mass and capacity

- Choose and use standard metric units and their abbreviations (km, m, cm, mm, kg, g, l and ml) when
- Estimating, measuring and recording length, weight and capacity.
- Know and use the relationships between familiar units of length, mass and capacity; know the meaning of ‘kilo’, ‘centi’ and ‘milli’.
- Where appropriate, use decimal notation to record measurements, e.g. 1.3 m, 0.6 kg, 1.2 l.
- Interpret intervals/divisions on partially numbered scales and record readings ac-

curately.

Sub strand: Time

- Read and tell the time to nearest minute on 12-hour digital and analogue clocks.
- Use AM, PM and 12-hour digital clock notation.
- Read simple timetables and use a calendar.
- Choose units of time to measure time intervals.

Sub strand: Area and perimeter

- Draw rectangles, and measure and calculate their perimeters.
- Understand that area is measured in square units, e.g. cm².
- Find the area of rectilinear shapes drawn on a square grid by counting squares.

Strand: Handling data**Sub strand: Organizing, categorizing and representing data**

- Answer a question by identifying what data to collect, organizing, presenting and interpreting data in tables, diagrams, tally charts, frequency tables, pictograms (symbol representing 2, 5, 10 or 20 units) and bar charts (intervals labeled in twos, fives, tens or twenties).
- Compare the impact of representations where scales have different intervals.
- Use Venn diagrams or Carroll diagrams to sort data and objects using two or three criteria.

Strand: Problem solving**Sub strand: Using techniques and skills in solving mathematical problems**

- Choose appropriate mental or written strategies to carry out calculations involving addition or subtraction.
- Understand everyday systems of measurement in length, weight, capacity and time and use these to solve simple problems as appropriate.
- Check the results of adding numbers by adding them in a different order or by subtracting one number from the total.
- Check subtraction by adding the answer to the smaller number in the original calculation.
- Check multiplication using a different technique, e.g. check $6 \times 8 = 48$ by doing 6×4 and doubling.
- Check the result of a division using multiplication, e.g. multiply 4 by 12 to check $48 \div 4$.
- Recognize the relationships between 2D shapes and identify the differences and similarities between 3D shapes.
- Estimate and approximate when calculating, and check working.

Sub strand: Using understanding and strategies in solving problems

- Make up a number story for a calculation, including in the context of measures.
- Explain reasons for a choice of strategy when multiplying or dividing.
- Choose strategies to find answers to addition or subtraction problems; explain and show working.
- Explore and solve number problems and puzzles, e.g. logic problems.
- Use ordered lists and tables to help to solve problems systematically.
- Describe and continue number sequences, e.g. 7, 4, 1, -2 ... identifying the relationship between each number.
- Identify simple relationships between shapes, e.g. these polygons are all regular because ...
- Investigate a simple general statement by finding examples which do or do not satisfy it.
- Explain methods and reasoning orally and in writing; make hypotheses and test them out.

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Grade V

It is important that learners become confident users of calculators. They need to recognize that the calculator is a tool of which they are in control and to understand how it can help them to develop their mathematics. Learners can be taught how to use a calculator effectively and to recognize how and when it is appropriate to do so; by first deciding if mental and pencil-and-paper methods are quicker or more reliable. Note that to use a calculator effectively requires a secure knowledge of number, which has to be the prime aim.

Strand: Number

Sub strand: Numbers and the number system

- Count on and back in steps of constant size, extending beyond zero.
- Know what each digit represents in five- and six-digit numbers.
- Partition any number up to one million into thousands, hundreds, tens and units.
- Use decimal notation for tenths and hundredths and understand what each digit represents.
- Multiply and divide any number from 1 to 10 000 by 10 or 100 and understand the effect.
- Round four-digit numbers to the nearest 10, 100 or 1000.
- Round a number with one or two decimal places to the nearest whole number.
- Order and compare numbers up to a million using the $>$ and $<$ signs.
- Order and compare negative and positive numbers on a number line and temperature scale.
- Calculate a rise or fall in temperature.
- Order numbers with one or two decimal places and compare using the $>$ and $<$ signs.
- Recognize and extend number sequences.
- Recognize odd and even numbers and multiples of 5, 10, 25, 50 and 100 up to 1000.
- Make general statements about sums, differences and multiples of odd and even numbers.
- Recognize equivalence between: $\frac{1}{2}$, $\frac{1}{4}$ and $\frac{1}{8}$; $\frac{1}{3}$ and $\frac{1}{6}$; $\frac{1}{5}$ and $\frac{1}{10}$

- Recognize equivalence between the decimal and fraction forms of halves, tenths and hundredths and use this to help order fractions, e.g. 0.6 is more than 50% and less than $\frac{7}{10}$
- Change an improper fraction to a mixed number, e.g. $\frac{7}{4}$ into $1\frac{3}{4}$; order mixed numbers and place between whole numbers on a number line.
- Relate finding fractions to division and use to find simple fractions of quantities.
- Understand percentage as the number of parts in every 100 and find simple percentages of quantities.
- Express halves, tenths and hundredths as percentages.
- Use fractions to describe and estimate a simple proportion, e.g. 51 of the beads are yellow.
- Use ratio to solve problems, e.g. to adapt a recipe for 6 people to one for 3 or 12 people.

Sub strand: Calculation

Mental strategies

- Know by heart pairs of one-place decimals with a total of 1, e.g. $0.8 + 0.2$.
- Derive quickly pairs of decimals with a total of 10, and with a total of 1.
- Know multiplication and division facts for the $2\times$ to $10\times$ tables.
- Know and apply tests of divisibility by 2, 5, 10 and 100.
- Recognize multiples of 6, 7, 8 and 9 up to the 10th multiple.
- Know squares of all numbers to 10×10 .
- Find factors of two-digit numbers.
- Count on or back in thousands, hundreds, tens and ones to add or subtract.
- Add or subtract near multiples of 10 or 100, e.g. $4387 - 299$.
- Use appropriate strategies to add or subtract pairs of two- and three-digit numbers and numbers with one decimal place, using jottings where necessary.
- Calculate differences between near multiples of 1000, e.g. $5026 - 4998$, or near multiples of 1, e.g. $3.2 - 2.6$.
- Multiply multiples of 10 to 90, and multiples of 100 to 900, by a single-digit number.
 - Multiply by 19 or 21 by multiplying by 20 and adjusting.
 - Multiply by 25 by multiplying by 100 and dividing by 4.
 - Use factors to multiply, e.g. multiply by 3, then double to multiply by 6.
 - Double any number up to 100 and halve even numbers to 200 and use this to double and halve numbers with one or two decimal places, e.g. double 3.4 and half of 8.6.
 - Double multiples of 10 to 1000 and multiples of 100 to 10 000, e.g. double 360 or

double 3600, and derive the corresponding halves.

Addition and subtraction

- Find the total of more than three two- or three-digit numbers using a written method.
- Add or subtract any pair of three- and/or four-digit numbers, with the same number of decimal places, including amounts of money.

Multiplication and division

- Multiply or divide three-digit numbers by single-digit numbers.
- Multiply two-digit numbers by two-digit numbers.
- Multiply two-digit numbers with one decimal place by single digit numbers, e.g. 3.6×7 .
- Divide three-digit numbers by single-digit numbers, including those with a remainder (answers no greater than 30).
- Start expressing remainders as a fraction of the divisor when dividing two-digit numbers by single-digit numbers.
- Decide whether to group (using multiplication facts and multiples of the divisors) or to share (halving and quartering) to solve divisions.
- Decide whether to round an answer up or down after division, depending on the context.
- Begin to use brackets to order operations and understand the relationship between the four operations and how the laws of arithmetic apply to multiplication.

Strand: Geometry

Sub strand: Shapes and geometric reasoning

- Identify and describe properties of triangles and classify as isosceles, equilateral or scalene.
- Recognize reflective and rotational symmetry in regular polygons.
- Create patterns with two lines of symmetry, e.g. on a pegboard or squared paper.
- Visualize 3D shapes from 2D drawings and nets, e.g. different nets of an open or closed cube.
- Recognize perpendicular and parallel lines in 2D shapes, drawings and the environment.
- Understand and use angle measure in degrees; measure angles to the nearest 5° ; identify, describe and estimate the size of angles and classify them as acute, right or obtuse.
- Calculate angles in a straight line.

Sub strand: Position and movement

- Read and plot co-ordinates in the first quadrant.

- Predict where a polygon will be after reflection where the mirror line is parallel to one of the sides, including where the line is oblique.
- Understand translation as movement along a straight line, identify where polygons will be after a translation and give instructions for translating shapes.

Strand: Measure

Sub strand: Length, mass and capacity

- Read, choose, use and record standard units to estimate and measure length, mass and capacity to a suitable degree of accuracy.
- Convert larger to smaller metric units (decimals to one place), e.g. change 2.6 kg to 2600 g.
- Order measurements in mixed units
- Round measurements to the nearest whole unit
- Interpret a reading that lies between two unnumbered divisions on a scale.
- Compare readings on different scales.
- Draw and measure lines to the nearest centimeter and millimeter.

Sub strand: Time

- Recognize and use the units for time (seconds, minutes, hours, days, months and years).
- Tell and compare the time using digital and analogue clocks using the 24-hour clock.
- Read timetables using the 24-hour clock.
- Calculate time intervals in seconds, minutes and hours using digital or analogue formats.
- Use a calendar to calculate time intervals in days and weeks (using knowledge of days in calendar months).
- Calculate time intervals in months or years.

Sub strand: Area and perimeter

- Measure and calculate the perimeter of regular and irregular polygons.
- Understand area measured in square centimeters (cm²).
- Use the formula for the area of a rectangle to calculate the rectangle's area.

Strand: Handling data

Sub strand: Organizing, categorizing and representing data

- Answer a set of related questions by collecting, selecting and organizing relevant data; draw conclusions from their own and others' data and identify further questions to ask.
- Draw and interpret frequency tables, pictograms and bar line charts, with the ver-

tical axis labeled for example in twos, fives, tens, twenties or hundreds. Consider the effect of changing the scale on the vertical axis.

- Construct simple line graphs, e.g. to show changes in temperature over time.
- Understand where intermediate points have and do not have meaning, e.g. comparing a line graph of temperature against time with a graph of class attendance for each day of the week.
- Find and interpret the mode of a set of data.

Sub strand: Probability

- Describe the occurrence of familiar events using the language of chance or likelihood.

Strand: Problem solving

Sub strand: Using techniques and skills in solving mathematical problems

- Understand everyday systems of measurement in length, weight, capacity, temperature and time and use these to perform simple calculations.
- Solve single and multi-step word problems (all four operations); represent them, e.g. with diagrams or a number line.
- Check with a different order when adding several numbers or by using the inverse when adding or subtracting a pair of numbers.
- Use multiplication to check the result of a division, e.g. multiply 3.7×8 to check $29.6 \div 8$.
- Recognize the relationships between different 2D and 3D shapes, e.g. a face of a cube is a square.
- Estimate and approximate when calculating, e.g. using rounding, and check working.
- Consider whether an answer is reasonable in the context of a problem.

Sub strand: Using understanding and strategies in solving problems

- Understand everyday systems of measurement in length, weight, capacity, temperature and time and use these to perform simple calculations.
- Choose an appropriate strategy for a calculation and explain how they worked out the answer.
- Explore and solve number problems and puzzles, e.g. logic problems.
- Deduce new information from existing information to solve problems.
- Use ordered lists and tables to help to solve problems systematically.
- Describe and continue number sequences, e.g. $-30, -27, \square, \square, -18\dots$; identify the relationships between numbers.
- Identify simple relationships between shapes, e.g. these triangles are all isosceles because ...

- Investigate a simple general statement by finding examples which do or do not satisfy it, e.g. the sum of three consecutive whole numbers is always a multiple of three.
- Explain methods and justify reasoning orally and in writing; make hypotheses and test them out.
- Solve a larger problem by breaking it down into sub-problems or represent it using diagrams.

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Grade VI

As in Stage 5, it is important that learners become confident users of calculators. They need to recognize that the calculator is a tool of which they are in control and to understand how it can help them to develop their mathematics. Learners can be taught how to use a calculator effectively and to recognize how and when it is appropriate to do so; by first deciding if mental and pencil-and-paper methods are quicker or more reliable. Note that to use a calculator effectively requires a secure knowledge of number, which has to be the prime aim.

Strand: Number

Sub strand: Numbers and the number system

- Count on and back in fractions and decimals, and repeated steps of whole numbers (and through zero).
- Know what each digit represents in whole numbers up to a million.
- Know what each digit represents in one- and two-place decimal numbers.
- Multiply and divide any whole number from 1 to 10 000 by 10, 100 or 1000 and explain the effect.
- Multiply and divide decimals by 10 or 100 (answers up to two decimal places for division).
- Find factors of two-digit numbers.
- Find some common multiples, e.g. for 4 and 5.
- Round whole numbers to the nearest 10, 100 or 1000.
- Round a number with two decimal places to the nearest tenth or to the nearest whole number.
- Make and justify estimates and approximations of large numbers.
- Order and compare positive numbers to one million, and negative integers to an appropriate level.
- Use the $>$, $<$ and $=$ signs correctly.
- Estimate where four-digit numbers lie on an empty 0 –10 000 line.
- Order numbers with up to two decimal places (including different numbers of places).

- Recognize and extend number sequences.
- Recognize and use decimals with up to three places in the context of measurement.
- Recognize odd and even numbers and multiples of 5, 10, 25, 50 and 100 up to 1000.
- Make general statements about sums, differences and multiples of odd and even numbers.
- Recognize prime numbers up to 20 and find all prime numbers less than 100.
- Recognize the historical origins of our number system and begin to understand how it developed.
- Compare fractions with the same denominator and related denominators,
- Recognize equivalence between fractions
- Recognize and use the equivalence between decimal and fraction forms.
- Order mixed numbers and place between whole numbers on a number line.
- Change an improper fraction to a mixed number
- Reduce fractions to their simplest form
- Begin to convert a vulgar fraction to a decimal fraction using division.
- Understand percentage as parts in every 100 and express as percentages.
- Find simple percentages of shapes and whole numbers.
- Solve simple problems involving ratio and direct proportion.

Sub strand: Calculation

Mental strategies

- Recall addition and subtraction facts for numbers to 20 and pairs of one-place decimals with a total of 1, e.g. $0.4 + 0.6$.
- Derive quickly pairs of one-place decimals totaling 10, e.g. 7.8 and 2.2, and two-place decimals totaling 1, e.g. $0.78 + 0.22$.
- Know and apply tests of divisibility by 2, 4, 5, 10, 25 and 100.
- Use place value and number facts to add or subtract two-digit whole numbers and to add or subtract three-digit multiples of 10 and pairs of decimals, e.g. $560 + 270$; $2.6 + 2.7$; $0.78 + 0.23$.
- Add/subtract near multiples of one when adding numbers with one decimal place, e.g. $5.6 + 2.9$; $13.5 - 2.1$.
- Add/subtract a near multiple of 10, 100 or 1000, or a near whole unit of money, and adjust, e.g. $3127 + 4998$; $5678 - 1996$.
- Use place value and multiplication facts to multiply/divide mentally, e.g. 0.8×7 ; $4.8 \div 6$.
- Multiply pairs of multiples of 10, e.g. 30×40 , or multiples of 10 and 100, e.g. 600×40 .

-
- Double quickly any two-digit number, e.g. 78, 7.8, 0.78 and derive the corresponding halves.
 - Divide two-digit numbers by single-digit numbers, including leaving a remainder.

Addition and subtraction

- Add two- and three-digit numbers with the same or different numbers of digits/decimal places.
- Add or subtract numbers with the same and different numbers of decimal places, including amounts of money.
- Find the difference between a positive and negative integer, and between two negative integers in a context such as temperature or on a number line

Multiplication and division

- Multiply pairs of multiples of 10, e.g. 30×40 , or multiples of 10 and 100, e.g. 600×40
- Multiply near multiples of 10 by multiplying by the multiple of 10 and adjusting.
- Multiply by halving one number and doubling the other, e.g. calculate 35×16 with 70×8 .
- Use number facts to generate new multiplication facts, e.g. the $17 \times$ table from $10 \times + 7 \times$ tables.
- Multiply two-, three- or four-digit numbers (including sums of money) by a single-digit number and two- or three-digit numbers by two-digit numbers.
- Divide three-digit numbers by single-digit numbers, including those leaving a remainder and divide three-digit numbers by two-digit numbers (no remainder) including sums of money.
- Give an answer to division as a mixed number, and a decimal (with divisors of 2, 4, 5, 10 or 100).
- Relate finding fractions to division and use them as operators to find fractions including several tenths and hundredths of quantities.
- Know and apply the arithmetic laws as they apply to multiplication (without necessarily using the terms commutative, associative or distributive).

Strand: Geometry

Sub strand: Shapes and geometric reasoning

- Classify different polygons and understand whether a 2D shape is a polygon or not.
- Visualize and describe the properties of 3D shapes, e.g. faces, edges and vertices.
- Identify and describe properties of quadrilaterals (including the parallelogram, rhombus and trapezium), and classify using parallel sides, equal sides, equal angles.
- Recognize and make 2D representations of 3D shapes including nets.
- Estimate, recognize and draw acute and obtuse angles and use a protractor to meas-

ure to the nearest degree.

- Check that the sum of the angles in a triangle is 180° , for example, by measuring or paper folding; calculate angles in a triangle or around a point.

Sub strand: Position and movement

- Read and plot co-ordinates in all four quadrants.
- Predict where a polygon will be after one reflection, where the sides of the shape are not parallel or perpendicular to the mirror line, after one translation or after a rotation through 90° about one of its vertices.

Strand: Measure

Sub strand: Length, mass and capacity

- Select and use standard units of measure. Read and write to two or three decimal places.
- Convert between units of measurement (kg and g, l and ml, km, m, cm and mm), using decimals to three places, e.g. recognizing that 1.245 m is 1 m 24.5 cm.
- Interpret readings on different scales, using a range of measuring instruments.
- Draw and measure lines to the nearest centimeter and millimeter.
- Know imperial units still in common use, e.g. the mile, and approximate metric equivalents.

Time

- Recognize and understand the units for measuring time (seconds, minutes, hours, days, weeks, months, years, decades and centuries); convert one unit of time into another.
- Tell the time using digital and analogue clocks using the 24-hour clock.
- Compare times on digital and analogue clocks, e.g. realize quarter to four is later than 3:40.
- Read and use timetables using the 24-hour clock.
- Calculate time intervals using digital and analogue times.
- Use a calendar to calculate time intervals in days, weeks or months.
- Calculate time intervals in days, months or years.
- Appreciate how the time is different in different time zones around the world.

Sub strand: Area and perimeter

- Measure and calculate the perimeter and area of rectilinear shapes.
- Estimate the area of an irregular shape by counting squares.
- Calculate perimeter and area of simple compound shapes that can be split into rectangles.

Strand: Handling data**Sub strand: Organizing, categorizing and representing data**

- Solve a problem by representing, extracting and interpreting data in tables, graphs, charts and diagrams, e.g. line graphs for distance and time; a price ‘ready-reckoner’ for currency conversion; frequency tables and bar charts with grouped discrete data.
- Find the mode and range of a set of data from relevant situations, e.g. scientific experiments.
- Begin to find the median and mean of a set of data.
- Explore how statistics are used in everyday life.

Sub strand: Probability

- Use the language associated with probability to discuss events, to assess likelihood and risk, including those with equally likely outcomes.

Strand: Problem solving**Sub strand: Using techniques and skills in solving mathematical problems**

- Choose appropriate and efficient mental or written strategies to carry out a calculation involving addition, subtraction, multiplication or division.
- Understand everyday systems of measurement in length, weight, capacity, temperature and time and use these to perform simple calculations.
- Check addition with a different order when adding a long list of numbers; check when subtracting by using the inverse.
- Recognize 2D and 3D shapes and their relationships, e.g. a cuboid have a rectangular cross-section.
- Estimate and approximate when calculating, e.g. use rounding, and check working.

Sub strand: Using understanding and strategies in solving problems

- Explain why they chose a particular method to perform a calculation and show working.
- Deduce new information from existing information and realize the effect that one piece of information has on another.
- Use logical reasoning to explore and solve number problems and mathematical puzzles.
- Use ordered lists or tables to help solve problems systematically.
- Identify relationships between numbers and make generalized statements using words, then symbols and letters, e.g. the second number is twice the first number plus 5 ($n, 2n + 5$); all the numbers are multiples of 3 minus 1 ($3n - 1$); the sum of angles in a triangle is 180° .
- Make sense of and solve word problems, single and multi-step (all four operations), and represent them, e.g. with diagrams or on a number line; use brackets to show the

series of calculations necessary.

- Solve simple word problems involving ratio and direct proportion.
- Solve simple word problems involving percentages, e.g. find discounted prices.
- Make, test and refine hypotheses, explain and justify methods, reasoning, strategies, results or conclusions orally.

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Grade VII

Strand: Number System

Sub strand: Knowing our Numbers: Integers

- Multiplication and division of integers (through patterns). Division by zero is meaningless
- Properties of integers (including identities for addition & multiplication, commutative, associative, distributive) (through patterns). These would include examples from whole numbers as well. Involve expressing commutative and associative properties in a general form; construction of counter examples, including some by children. Counter examples like
 - Subtraction is not commutative.
 - Word problems including integers (all operations)

Sub strand: Fractions and rational numbers:

- Multiplication of fractions
- Fraction as an operator
- Reciprocal of a fraction
- Division of fractions
- Word problems involving mixed fractions
- Introduction to rational numbers (with representation on number line)
- Operations on rational numbers (all operations)
- Representation of rational number as a decimal.
- Word problems on rational numbers (all operations)
- Multiplication and division of decimal fractions
- Conversion of units (length & mass)
- Word problems (including all operations)

Sub strand: Powers:

- Exponents only natural numbers.
- Laws of exponents (through observing patterns to arrive at generalization.)

Strand: Algebra

Sub strand: Algebraic Expressions

- Generate algebraic expressions (simple) involving one or two variables
- Identifying constants, coefficient, powers
- Like and unlike terms, degree of expressions e.g., x^2y etc. (exponent ≤ 3 , number of variables)
- Addition, subtraction of algebraic expressions (coefficients should be integers).
- Simple linear equations in one variable (in contextual problems) with two operations (avoid complicated coefficients)

Strand: Ratio and Proportion

- Ratio and proportion (revision)
- Unitary method continued, consolidation, general expression.
- Percentage- an introduction.
- Understanding percentage as a fraction with denominator 100
- Converting fractions and decimals into percentage and vice-versa.
- Application to profit and loss (single transaction only)
- Application to simple interest (time period in complete years).

Strand: Geometry

Sub strand: Understanding shapes:

- Pairs of angles (linear, supplementary, complementary, adjacent, vertically opposite) (verification and simple proof of vertically opposite angles)
- Properties of parallel lines with transversal (alternate, corresponding, interior, exterior angles)

Sub strand: Properties of triangles:

- Angle sum property (with notions of proof & verification through paper folding, proofs using property of parallel lines, difference between proof and verification.)
- Exterior angle property
- Sum of two sides of a triangle
- Pythagoras Theorem (Verification only)

Sub strand: Symmetry

- Recalling reflection symmetry
- Idea of rotational symmetry, observations of rotational symmetry of 2-D objects. (900, 1200, 1800)
- Operation of rotation through 900 and 1800 of simple figures.
- Examples of figures with both rotation and reflection symmetry (both operations)
- Examples of figures that have reflection and rotation symmetry and vice-versa

Sub strand: Representing 3-D in 2-D:

- Drawing 3-D figures in 2-D showing hidden faces.
- Identification and counting of vertices, edges, faces, nets (for cubes cuboids, and cylinders, cones).
- Matching pictures with objects (Identifying names)
- Mapping the space around approximately through visual estimation.

Sub strand: Congruence

- Congruence through superposition (examples-blades, stamps, etc.)
- Extend congruence to simple geometrical shapes e.g. triangles, circles.
- Criteria of congruence (by verification) SSS, SAS, ASA, RHS

Sub strand: Construction (Using scale, protractor, compass)

- Construction of a line parallel to a given line from a point outside it. (Simple proof as remark with the reasoning of alternate angles)
- Construction of simple triangles, given three sides, given a side and two angles on it, given two sides and the angle between them.

Strand: Mensuration

- Revision of perimeter, Circumference of Circle

Sub strand: Area

Concept of measurement using a basic unit area of a square, rectangle, triangle, parallelogram and circle, area between two rectangles and two concentric circles

Strand: Data handling

- Collection and organization of data – choosing the data to collect for a hypothesis testing.
- Mean, median and mode of ungrouped data – understanding what they represent
- Constructing bar graphs
- Feel of probability using data through experiments. Notion of chance in events like tossing coins, dice etc. Tabulating and counting occurrences of 1 through 6 in a number of throws. Comparing the observation with that for a coin, observing strings of throws, notion of randomness.

Grade VIII

Strand: Number System

Sub strand: Rational Numbers:

- Properties of rational numbers (including identities) Using general form of expression to describe properties
- Consolidation of operations on rational numbers.
- Representation of rational numbers on the number line
- Between any two rational numbers there lies another rational number (Making children see that if we take two rational numbers then unlike for whole numbers, in this case you can keep finding more and more numbers that lie between them.)
- Word problem (higher logic, two operations, including ideas like area)

Sub strand: Powers

- Integers as exponents.
- Laws of exponents with integral powers

Sub strand: Squares, Square roots, Cubes, Cube roots.

- Square and Square roots
- Square roots using factor method and division method for numbers containing (a) no more than total 4 digits and (b) no more than 2 decimal places
- Cubes and cubes roots (only factor method for numbers containing at most 3 digits)
- Estimating square roots and cube roots. Learning the process of moving nearer to the required number

Sub strand: Playing with numbers

- Writing and understanding a 2 and 3 digit number in generalized form ($100a + 10b + c$, where a, b, c can be only digit 0-9) and engaging with various puzzles concerning this. (Like finding the missing numerals represented by alphabets in sums involving any of the four operations.) Children to solve and create problems and puzzles
- Number puzzles and games
- Deducing the divisibility test rules of 2, 3, 5, 9, 10 for a two or three-digit number expressed in the general form

Strand: Algebra**Sub strand: Algebraic Expressions**

- Multiplication and division of algebraic exp.(Coefficient should be integers)
- Some common errors (e.g. $2 + x \neq 2x$, $7x + y \neq 7xy$)
- Identities $(a + b)^2 = a^2 + 2ab + b^2$, $a^2 - b^2 = (a - b)(a + b)$
- Factorization (simple cases only) as examples the following types $a(x + y)$, $(x + y)^2$, $a^2 - b^2$,
- $(x + a)(x + b)$
- Solving linear equations in one variable in contextual problems involving multiplication and division (word problems) (avoid complex coefficient in the equations)

Strand: Ratio and Proportion

- Slightly advanced problems involving applications on percentages, profit & loss, overhead expenses, Discount, tax.
- Difference between simple and compound interest (compounded yearly up to 3 years or half-yearly up to 3 steps only), Arriving at the formula for compound interest through patterns and using it for simple problems.
- Direct variation – Simple and direct word problems
- Inverse variation – Simple and direct word problems
- Time & work problems– Simple and direct word problems

Strand: Geometry**Sub strand: Understanding shapes:**

- Properties of quadrilaterals –Sum of angles of a quadrilateral is equal to 3600 (By verification)
- Properties of parallelogram (By verification)
 - (i) Opposite sides of a parallelogram are equal,
 - (ii) Opposite angles of a parallelogram are equal,
 - (iii) Diagonals of a parallelogram bisect each other [Why (iv), (v) and (vi) follow from (ii)]
 - (iv)Diagonals of a rectangle are equal and bisect each other.
 - (v) Diagonals of a rhombus bisect each other at right angles.
 - (vi)Diagonals of a square are equal and bisect each other at right angles.

Sub strand: Representing 3-D in 2-D

- Identify and Match pictures with objects [more complicated e.g. nested, joint 2-D and 3-D shapes (not more than 2)].
- Drawing 2-D representation of 3-D objects (Continued and extended)
- Counting vertices, edges & faces & verifying Euler's relation for 3-D figures with

flat faces

- (cubes, cuboids, tetrahedrons, prisms and pyramids)

Sub strand: Construction:

Construction of Quadrilaterals:

- Given four sides and one diagonal
- Three sides and two diagonals
- Three sides and two included angles
- Two adjacent sides and three angles

Strand: Mensuration

(i) Area of a trapezium and a polygon.

(ii) Concept of volume, measurement of volume using a basic unit, volume of a cube, cuboid and cylinder

(iii) Volume and capacity (measurement of capacity)

(iv) Surface area of a cube, cuboid, cylinder

Strand: Data handling

(i) Reading bar-graphs, ungrouped data, arranging it into groups, representation of grouped data through bar-graphs, constructing and interpreting bar-graphs.

(ii) Simple Pie charts with reasonable data numbers

(iii) Consolidating and generalizing the notion of chance in events like tossing coins, dice etc; relating it to chance in life events. Visual representation of frequency outcomes of repeated throws of the same kind of coins or dice throwing a large number of identical dice/coins together and aggregating the result of the throws to get large number of individual events. Observing the aggregating numbers over a large number of repeated events; comparing with the data for a coin. Observing strings of throws, notion of randomness

Strand: Introduction to graphs

Sub strand: Preliminaries:

(i) Axes (Same units), Cartesian plane

(ii) Plotting points for different kind of situations (perimeter vs length for squares, area as a function of side of a square, plotting of multiples of different numbers, simple interest vs number of years etc.)

- Reading off from the graphs
- Reading of linear graphs
- Reading of distance vs time graph

1. Conclusion:

The Curriculum is ambitious, coherent and teaches important principles of mathe-

matics. It is ambitious in the sense that it seeks to achieve the higher aim, rather than only the narrower aim. It is coherent in the sense that the variety of methods and skills available (in arithmetic, algebra, geometry) cohere into an ability to address problems that come from other domains such as science and social studies in high school. It is important in the sense that students feel the need to solve such problems, that teachers and students find it worth their time and energy to address these problems.

The twin concerns of the Mathematics curriculum, “what can mathematics education do to engage the mind of every student, and how can it strengthen the student's resources” are addressed.

C. Assessment and Evaluation

1. The Purpose of Assessment:

- To give credible feedback on the extent to which we have been successful in achieving the goals of mathematics teaching.
- To improve the teaching-learning process and materials
- To review the objectives
- To set standards for students to strive forward
- To inform parents about the quality of learning and the development and progress of their wards
- To provide a report or certify the completion of a course of study
- To identify the student's attitudes to learning, interest, and the ability to learn independently

2. Design and Conduct of Assessment

- Assessment and evaluation are credible
- The tests in knowledge based subject area are able to gauge what children have learned and their ability to use this knowledge for problem solving and application in the real world.
- They test the process of thinking to gauge if the learner also learnt where to find information, how to use new information and to analyze & evaluate the same
- Types of questions set go beyond what is given in the text book.
- Questions that are open-ended and challenging are used.
- Question papers are designed graded for difficulty in order to permit all children to experience a level of success and to gain confidence in their ability to answer and solve problems
- After giving corrected papers, children rewrite the answers and these are again reviewed by the teacher to ensure that children have learnt and gained something
- In classes I and II, assessment is purely qualitative judgments of children's activities in various domains.

- From classes III to VIII grades/marks along with qualitative judgment and areas requiring attention.
- Student's self evaluation reports are also considered from class V onwards.
- Criterion based short tests are conducted from time to time.
- Term-wise exams from class VII onwards

3. Assessment Tools

- Data handling and analysis
- Group projects
- Problem solving
- Math lab activities
- Quiz/oral questions
- Experiments
- Presentations
- Chart, model making
- Visual representation
- Simple and interesting assignments
- Mathematical puzzles based on various theorems

It is suggested that at least one activity out of 4 should be used for assessing performances in math lab activity.

Formative Assessment Tools
Objective type
Short answer
Long answers
Questions
Observation schedule
Interview schedule
Checklist
Rating scale
Anecdotal records
Document analysis tests and inventories
Portfolio analysis

Assessment Techniques
Tests
Assignments
Quizzes and competitions
Projects
Debates
Elocution
Group discussions
Club activities

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