MathsHUBS Resources

National Centre for Excellence in the Teaching of Mathematics

# Mastery Professional Development

*Multiplication and Division*


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## *Year 1*

### 2.1 Counting, unitising and coins

Explore the concept of unitising by counting in units of two, five or ten; investigate how objects can be counted efficiently by counting in units other than one; apply unitising in the context of the low-denomination coins (1 p, 2 p, 5 p and 10 p).

- **Teaching point 1:** We can count efficiently by counting in groups of two.
- **Teaching point 2:** We can count efficiently by counting in groups of ten.
- **Teaching point 3:** We can count efficiently by counting in groups of five.
- **Teaching point 4:** A coin has a value which is independent of its size, shape, colour or mass.
- **Teaching point 5:** The *number* of coins in a set is different from the *value* of the coins in a set; knowledge of counting in groups of two, five or ten can be used to work out the value of a set of identical low-denomination coins.
- **Teaching point 6:** Knowledge of counting in groups of two, five or ten can be used to work out how many identical low-denomination coins are needed to make a given value. We can count efficiently by counting in groups of two.

## *Year 2*

### 2.2 Structures: multiplication representing equal groups

Explore how objects can be arranged in equal groups, and how the number of groups and the size of the groups can be described; represent equally grouped objects with addition and multiplication expressions, connecting multiplication to repeated addition.

- **Teaching point 1:** Objects can be grouped into equal or unequal groups.
- **Teaching point 2:** When describing equally grouped objects, the number of groups and the size of the groups must both be defined.
- **Teaching point 3:** Equal groups can be represented with a repeated addition expression.
- **Teaching point 4:** Equal groups can be represented with a multiplication expression.
- **Teaching point 5:** Multiplication expressions can be written for cases where the groups each contain zero items, and for cases where the groups each contain one item.

### 2.3 Times tables: groups of 2 and commutativity (part 1)

Build up the two times table by combining children's experience of counting in units of two and of representing equal groups; explore how, in a multiplication equation, the factors can appear in either order and the product remains the same.

- **Teaching point 1:** For equally grouped objects, the number of groups is a factor, the group size is a factor, and the overall number of objects is the product; this can be represented with a multiplication equation. Counting in multiples of two can be used to find the product when the group size is two.
- **Teaching point 2:** Counting in multiples of two can be represented by the two times table. Adjacent multiples of two have a difference of two. Facts from the two times table can be used to solve problems about groups of two.
- **Teaching point 3:** Factor pairs can be written in either order, with the product remaining the same (commutativity).

## 2.4 Times tables: groups of 10 and of 5, and factors of 0 and 1

Build up the ten and five times tables, combining children's experience of counting in units of five or ten and of representing equal groups; explore patterns in the ten and five times tables, and generalise about the product when one factor is zero or one.

- **Teaching point 1:** Counting in multiples of ten can be represented by the ten times table. Adjacent multiples of ten have a difference of ten. Facts from the ten times table can be used to solve problems about groups of ten.
- **Teaching point 2:** Counting in multiples of five can be represented by the five times table. Adjacent multiples of five have a difference of five. Facts from the five times table can be used to solve problems about groups of five.
- **Teaching point 3:** Skip counting and grouping can be used to explore the relationship between the five times table and the ten times table.
- **Teaching point 4:** When zero is a factor, the product is zero. When one is a factor, the product is equal to the other factor (if there are only two factors).

## 2.5 Commutativity (part 2), doubling and halving

Explore how one multiplication equation can have two different grouping interpretations (e.g., an equation from the two times table can be interpreted in terms of groups of two, or two equal groups); make connections between the two times table, doubling and halving.

- **Teaching point 1:** The same multiplication equation can have two different grouping interpretations. Problems about two/five/ten equal groups can be solved using facts from the two/five/ten times table (commutativity).
- **Teaching point 2:** If two is a factor, knowledge of doubling facts can be used to find the product; problems about doubling can be solved using facts from the two times table.
- **Teaching point 3:** Halving is the inverse of doubling; problems about halving can be solved using facts from the two times table and known doubling facts.
- **Teaching point 4:** Products in the ten times table are double the products in the five times table; products in the five times table are half of the products in the ten times table.

## 2.6 Structures: quotitive and partitive division

Introduce the quotitive and partitive structures of division; skip count using the divisor, or use known multiplication facts, to find the quotient; generalise about the quotient when dividend = 0, dividend = divisor, or divisor = 1.

- **Teaching point 1:** Objects can be grouped equally, sometimes with a remainder.
- **Teaching point 2:** Division equations can be used to represent 'grouping' problems, where the total quantity (dividend) and the group size (divisor) are known; the number of groups (quotient) can be calculated by skip counting in the divisor. (quotitive division)
- **Teaching point 3:** Division equations can be used to represent 'sharing' problems, where the total quantity (dividend) and the number we are sharing between (divisor) are known; the size of the shares (quotient) can be calculated by skip counting in the divisor.
(partitive division)
- **Teaching point 4:** Strategies for finding the quotient, that are more efficient than skip counting, include using known multiplication facts and, when the divisor is two, using known halving facts.

- **Teaching point 5:** When the dividend is zero, the quotient is zero; when the dividend is equal to the divisor, the quotient is one; when the divisor is equal to one, the quotient is equal to the dividend.

## *Year 3*

### 2.7 Times tables: 2, 4 and 8, and the relationship between them

Build up the four/eight times table; using different structures/interpretations of multiplication and division, solve problems related to these tables; explore connections between the two, four and eight times tables.

- **Teaching point 1:** Counting in multiples of four can be represented by the four times table. Adjacent multiples of four have a difference of four. Facts from the four times table can be used to solve multiplication and division problems with different structures.
- **Teaching point 2:** Products in the four times table are double the products in the two times table; products in the two times table are half of the products in the four times table.
- **Teaching point 3:** Counting in multiples of eight can be represented by the eight times table. Adjacent multiples of eight have a difference of eight. Facts from the eight times table can be used to solve multiplication and division problems with different structures.
- **Teaching point 4:** Products in the eight times table are double the products in the four times table; products in the four times table are half of the products in the eight times table. Products that are in the two, four and eight times tables share the same factors.
- **Teaching point 5:** Divisibility rules can be used to find out whether a given number is divisible (to give a whole number) by two, four or eight.

### 2.8 Times tables: 3, 6 and 9, and the relationship between them

Build up the three/six/nine times table; using different structures/interpretations of multiplication and division, solve problems related to these tables; explore connections between the three, six and nine times tables.

- **Teaching point 1:** Counting in multiples of three can be represented by the three times table. Adjacent multiples of three have a difference of three. Facts from the three times table can be used to solve multiplication and division problems with different structures.
- **Teaching point 2:** Counting in multiples of six can be represented by the six times table. Adjacent multiples of six have a difference of six. Facts from the six times table can be used to solve multiplication and division problems with different structures.
- **Teaching point 3:** Products in the six times table are double the products in the three times table; products in the three times table are half of the products in the six times table.
- **Teaching point 4:** Counting in multiples of nine can be represented by the nine times table. Adjacent multiples of nine have a difference of nine. Facts from the nine times table can be used to solve multiplication and division problems with different structures.
- **Teaching point 5:** Products in the nine times table are triple the products in the three times table. Products that are in the three, six and nine times tables share the same factors.
- **Teaching point 6:** Divisibility rules can be used to find out whether a given number is divisible (to give a whole number) by three, six or nine.

## 2.9 Times tables: 7 and patterns within/across times tables

Build up the seven times table and solve associated multiplication and division problems; explore times table patterns including generalising about the product in terms of odd/even factors, reviewing divisibility rules, and exploring square numbers.

- **Teaching point 1:** Counting in multiples of seven can be represented by the seven times table. Adjacent multiples of seven have a difference of seven. Facts from the seven times table can be used to solve multiplication and division problems with different structures.
- **Teaching point 2:** When both factors are odd numbers, the product is an odd number; when one factor is an odd number and the other is an even number, the product is an even number; when both factors are even numbers, the product is an even number.
- **Teaching point 3:** When both factors have the same value, the product is called a square number; square numbers can be represented by objects arranged in square arrays.
- **Teaching point 4:** Divisibility rules can be used to find out whether a given number is divisible (to give a whole number) by particular divisors.

# *Year 4*

## 2.10 Connecting multiplication and division, and the distributive law

Explore why multiplication is commutative while division is not. Build on understanding of the difference between adjacent multiples to explore the distributive law, and apply it to derive multiplication facts.

- **Teaching point 1:** Multiplication is commutative; division is not commutative.
- **Teaching point 2:** Multiplication is distributive: multiplication facts can be derived from related known facts by partitioning one of the factors, and this can be interpreted as partitioning the number of groups; two-part problems that involve addition/subtraction of products with a common factor can be efficiently solved by applying the distributive law.
- **Teaching point 3:** The distributive law can be used to derive multiplication facts beyond known times tables.

## 2.11 Times tables: 11 and 12

Build up the eleven and twelve times tables using the distributive law, and solve associated multiplication and division problems. Combine known six times table facts with doubling facts and strategies to multiply by twelve.

- **Teaching point 1:** The distributive law can be used to build up the 11 times table by partitioning 11 into 10 and 1. Adjacent multiples of 11 have a difference of 11.
- **Teaching point 2:** The distributive law can be used to build up the 12 times table by partitioning 12 into 10 and 2. Adjacent multiples of 12 have a difference of 12.
- **Teaching point 3:** Products in the 12 times table are double the products in the six times table; products in the six times table are half of the products in the 12 times table.
- **Teaching point 4:** Divisibility rules can be used to find out whether a given number is divisible (to give a whole number) by 11 or 12.

## 2.12 Division with remainders

Explore how some quantities can be split into equal groups with a remainder, and express this using mathematical notation; practise interpreting the meaning of the remainder in different contexts.

- **Teaching point 1:** Objects can be divided into equal groups, sometimes with a remainder; objects can be shared equally, sometimes with a remainder; a remainder can be represented as part of a division equation.
- **Teaching point 2:** If the dividend *is* a multiple of the divisor, there is *no* remainder; if the dividend *is not* a multiple of the divisor, there *is* a remainder. The remainder is always less than the divisor.
- **Teaching point 3:** When solving contextual problems involving remainders, the answer to a division calculation must be interpreted carefully to determine how to make sense of the remainder.

## 2.13 Calculation: multiplying and dividing by 10 or 100

Use place-value knowledge to develop strategies for multiplying/dividing by 10 and 100. Generalise about the product or quotient when a factor or the dividend is made 10 or 100 times bigger/smaller.

- **Teaching point 1:** Finding 10 times as many is the same as multiplying by 10 (for positive numbers); to multiply a whole number by 10, place a zero after the final digit of that number.
- **Teaching point 2:** To divide a multiple of 10 by 10, remove the final zero digit (in the ones place) from that number.
- **Teaching point 3:** Finding 100 times as many is the same as multiplying by 100 (for positive numbers); to multiply a whole number by 100, place two zeros after the final digit of that number.
- **Teaching point 4:** To divide a multiple of 100 by 100, remove the final two zero digits (in the tens and ones places) from that number.
- **Teaching point 5:** Multiplying a number by 100 is equivalent to multiplying by 10, and then multiplying the product by 10. Dividing a multiple of 100 by 100 is equivalent to dividing by 10, and then dividing the quotient by 10.
- **Teaching point 6:** If one factor is made 10 times the size, the product will be 10 times the size. If the dividend is made 10 times the size, the quotient will be 10 times the size.
- **Teaching point 7:** If one factor is made 100 times the size, the product will be 100 times the size. If the dividend is made 100 times the size, the quotient will be 100 times the size.

## 2.14 Multiplication: partitioning leading to short multiplication

Introduce the short multiplication algorithm, using it to multiply two-/three-digit numbers by single-digit numbers; explore regrouping where necessary.

- **Teaching point 1:** The distributive law can be applied to multiply any two-digit number by a single-digit number, by partitioning the two-digit number into tens and ones, multiplying the parts by the single-digit number, then adding the partial products.
- **Teaching point 2:** Any two-digit number can be multiplied by a single-digit number using an algorithm called '*short multiplication*'; the digits of the factors must be aligned correctly; the algorithm is applied working from the least significant digit (on the right) to the most significant digit (on the left); if the product in any column is ten or greater, we must '*regroup*'.

- **Teaching point 3:** The distributive law can be applied to multiply any three-digit number by a single-digit number, by partitioning the three-digit number into hundreds, tens and ones, multiplying the parts by the single-digit number, then adding the partial products.
- **Teaching point 4:** Any three-digit number can be multiplied by a single-digit number using the short multiplication algorithm.

## 2.15 Division: partitioning leading to short division

Introduce the short division algorithm, using it to divide two-/three-digit numbers by single-digit numbers; explore exchange where necessary.

- **Teaching point 1:** Any two-digit number can be divided by a single-digit number, by partitioning the two-digit number into tens and ones, dividing the parts by the single-digit number, then adding the partial quotients; if dividing the tens gives a remainder of one or more tens, we must exchange the remaining tens for ones before dividing the resulting ones value by the single-digit number.
- **Teaching point 2:** Any two-digit number can be divided by a single-digit number using an algorithm called '*short division*'; the algorithm is applied working from the most significant digit (on the left) to the least significant digit (on the right); if there is a remainder in the tens column, we must '*exchange*'.
- **Teaching point 3:** Any three-digit number can be divided by a single-digit number, by partitioning the two-digit number into hundreds, tens and ones, dividing the parts by the single-digit number, then adding the partial quotients; if dividing the hundreds gives a remainder of one or more hundreds, we must exchange the remaining hundreds for tens before dividing the resulting tens value by the single-digit number.
- **Teaching point 4:** Any three-digit number can be divided by a single-digit number using the short-division algorithm.

## 2.16 Multiplicative contexts: area and perimeter 1

Use addition and multiplication to solve problems about the perimeter of irregular and regular 2D shapes, and to find the area of rectilinear and composite rectilinear shapes; use division to solve associated inverse problems.

- **Teaching point 1:** Perimeter is the distance around the edge of a two-dimensional (2D) shape.
- **Teaching point 2:** Perimeter is measured in units of length and can be calculated by adding together the lengths of the sides of a 2D shape.
- **Teaching point 3:** Multiplication can be used to calculate the perimeter of a regular polygon; when the perimeter is known, side-lengths can be calculated using division.
- **Teaching point 4:** Area is the measurement of the surface of a flat item.
- **Teaching point 5:** Area is measured in square units, such as square centimetres ($cm^2$) and square metres ($m^2$).
- **Teaching point 6:** The area of a rectangle can be calculated using multiplication; the area of a composite rectilinear shape can be found by splitting the shape into smaller rectangles.

### 2.17 Structures: using measures and comparison to understand scaling

Build on segment 2.13 to introduce the scaling structure of multiplication and division; use known multiplication and division strategies to solve problems about scaling/comparison problems.

- **Teaching point 1:** A longer length can be described in terms of a shorter length using the language of 'times'; the longer length can be calculated, if the shorter length is known, using multiplication.
- **Teaching point 2:** A shorter length can be described in terms of a longer length using the language of fractions; the shorter length can be calculated, if the longer length is known, using division.
- **Teaching point 3:** Other measures can be compared using the language of 'times' and fractions, and calculated using multiplication or division.

## *Year 5*

### 2.18 Using equivalence to calculate

Develop efficiency in calculation by using equivalence, through adjusting the factors (in multiplication) and the dividend and divisor (in division).

- **Teaching point 1:** For multiplication, if there is a multiplicative *increase* to one factor and a corresponding *decrease* to the other factor, the product stays the same.
- **Teaching point 2:** For division, if there is a multiplicative change to the dividend and a corresponding change to the divisor, the quotient stays the same.

### 2.19 Calculation: ×/÷ decimal fractions by whole numbers

Develop strategies for multiplying and dividing decimal fractions by whole numbers, including combining known facts with unitising, multiplying and dividing by 10 and 100, and using adjusting strategies.

- **Teaching point 1:** Decimal fractions (with a whole number of tenths or hundredths) can be multiplied by a whole number by using known multiplication facts and unitising.
- **Teaching point 2:** Multiplying by 0.1 is equivalent to dividing by 10; multiplying by 0.01 is equivalent to dividing by 100. Understanding of place value can be used to divide a number by 10/100: when a number is divided by 10, the digits move one place to the right; when a number is divided by 100, the digits move two places to the right.
- **Teaching point 3:** To multiply a single-digit number by a decimal fraction with up to two decimal places, convert the decimal fraction to an integer by multiplying by 10 or 100, perform the resulting calculation using an appropriate strategy, then adjust the product by dividing by 10 or 100.
- **Teaching point 4:** If the multiplier is less than one, the product is less than the multiplicand; if the multiplier is greater than one, the product is greater than the multiplicand.
- **Teaching point 5:** To divide any decimal fraction with up to two decimal places by a single-digit number, convert the decimal fraction to an integer by multiplying by 10 or 100, perform the resulting calculation using an appropriate strategy, then adjust the quotient by dividing by 10 or 100.

## 2.20 Multiplication with three factors and volume

Use multiplication to calculate the volume of cuboids and shapes comprised of several cuboids; use division to solve associated inverse problems. Use associativity and commutativity to solve abstract multiplication problems with three factors.

- **Teaching point 1:** Volume is the amount of space that something occupies.
- **Teaching point 2:** Volume is measured in cubic units, such as cubic centimetres ($cm^3$) and cubic metres ($m^3$).
- **Teaching point 3:** The volume of a cuboid can be calculated by multiplying the length, width and height.
- **Teaching point 4:** Both the commutative law and the associative law can be applied when multiplying three or more numbers.
- **Teaching point 5:** The choice of which order to multiply in can be made according to the simplest calculation.

## 2.21 Factors, multiples, prime numbers and composite numbers

Identify properties of factors and multiples including square and prime numbers, composite numbers, common and prime factors, and common multiples. Use factor pairs to solve problems efficiently.

- **Teaching point 1:** Factors are positive integers that can be multiplied together to equal a given number.
- **Teaching point 2:** Systematic methods can be used to find all factors of a number; factors come in pairs; all positive integers have an even number of factors apart from square numbers, which have an odd number of factors; numbers with more than two factors are called composite numbers.
- **Teaching point 3:** Prime numbers are positive integers that have exactly two factors.
- **Teaching point 4:** A common factor is a factor that is shared by two or more numbers. A prime factor is a factor that is also a prime number.
- **Teaching point 5:** A multiple of a number is the product of that number and an integer; a common multiple is a multiple that is shared by two or more numbers.
- **Teaching point 6:** The factor pairs of '100' can be used to support efficient calculation.

## 2.22 Combining multiplication with addition and subtraction

Learn to combine multiplication with addition or subtraction. Learn to use brackets to change the order of operations. Build on knowledge of the distributive law.

- **Teaching point 1:** Multiplication can be combined with addition and subtraction; when there are no brackets, multiplication is completed before addition or subtraction; when there are brackets, the calculation within the brackets is completed first.
- **Teaching point 2:** When adding or subtracting multiplication expressions that have a common factor, the distributive law can be applied.

*Year 6*

## 2.23 Multiplication strategies for larger numbers and long multiplication

Develop strategies for multiplying two numbers with two or more digits, including adjusting strategies when multiplying by a power of ten, partitioning followed by multiplication and addition of partial products, and long multiplication.

- **Teaching point 1:** When multiplying two numbers that are multiples of 10, 100 or 1,000, multiply the number of tens, hundreds or thousands and then adjust the product using place value.
- **Teaching point 2:** When multiplying two numbers where one number is a multiple of 10, 100 or 1,000, use short multiplication and adjust the product using place value.
- **Teaching point 3:** Two two-digit numbers can be multiplied by partitioning one of the factors, calculating partial products and then adding these partial products. This method can be extended to multiplication of three-digit numbers by two-digit numbers.
- **Teaching point 4:** *'Long multiplication'* is an algorithm involving multiplication, then addition of partial products, which supports multiplication of two numbers with two or more digits.
- **Teaching point 5:** Multiplication where one of the factors is a composite number can be carried out by multiplying one factor and then the other factor.

## 2.24 Division: dividing by two-digit divisors

Learn to divide by two-digit divisors, recording calculations using either the short or long division algorithm. Represent remainders in an appropriate way, according to the context, including using the short or long division algorithm to express remainders as decimal fractions.

- **Teaching point 1:** Any two- or three-digit dividend can be divided by a two-digit divisor by skip counting in multiples of the divisor (quotient < 10); these calculations can be recorded using the short or long division algorithms.
- **Teaching point 2:** Any three- or four-digit dividend can be divided by a two-digit divisor using the short or long division algorithms (including quotient ≥ 10).
- **Teaching point 3:** When there is a remainder, the result can be expressed as a whole-number quotient and a whole-number remainder, as a whole-number quotient and a proper-fraction remainder, or as a decimal-fraction quotient.

## 2.25 Using compensation to calculate

Learn how multiplication and division calculations are affected when one element of the calculation is multiplied or divided by a scale factor.

- **Teaching point 1:** For multiplication, if there is a multiplicative change to one factor, the product changes by the same scale factor.
- **Teaching point 2:** For division, if there is a multiplicative change to the dividend and the divisor remains the same, the quotient changes by the same scale factor.
- **Teaching point 3:** For division, if there is a multiplicative increase to the divisor and the dividend remains the same, the quotient decreases by the same scale factor; if there is a multiplicative decrease to the divisor and the dividend remains the same, the quotient increases by the same scale factor.

## 2.26 Mean average and equal shares

Understand the concept of mean average and learn how to find the mean of a set of data. Use the mean to compare sets of data and learn when it is appropriate to use the mean.

- **Teaching point 1:** The mean is the size of each part when a quantity is shared equally.
- **Teaching point 2:** The mean is defined as the sum of all the numbers in a set of data divided by the number of numbers/values that make up the set of data. If we know the mean of a set of data and the number of numbers/values in that set, we can calculate the total of the set. The mean of a set changes if the total value of the set changes or if the number of numbers/values in the set changes.
- **Teaching point 3:** The mean can be used to compare data.
- **Teaching point 4:** The mean is not always an appropriate representation of a set of data.

## 2.27 Scale factors, ratio and proportional reasoning

Use bar modelling and ratio grids to reason about multiplicative relationships between two or more cardinal quantities, and explore correspondence problems. Extend understanding of scaling measures to make and interpret maps and scale/compare the dimensions of similar shapes.

- **Teaching point 1:** Multiplication and division can be used to calculate unknown values in correspondence (cardinal comparison) problems.
- **Teaching point 2:** Multiplication and understanding of correspondence can be used to calculate the number of possible combinations of items.
- **Teaching point 3:** Scaling can be used to make and interpret maps.
- **Teaching point 4:** There is a proportional relationship between the dimensions of similar shapes; if the scale factor and the dimensions of one of the shapes is known, the dimensions of the similar shape can be calculated; if the dimensions of both of the shapes are known, the scale factor can be calculated.

## 2.28 Combining division with addition and subtraction

Learn to combine division with addition or subtraction. Revisit the use of brackets to change the order of operations. Build on knowledge of the distributive law.

- **Teaching point 1:** Division can be combined with addition and subtraction; when there are no brackets, division is completed before addition or subtraction; when there are brackets, the calculation within the brackets is completed first.
- **Teaching point 2:** When adding or subtracting division expressions that have a common divisor, the distributive law can be applied.

## 2.29 Decimal place-value knowledge, multiplication and division

Develop efficient calculation strategies, and connect knowledge of multiplying and dividing by 10/100/1,000 to understanding of place value, including application to conversion between metric units of measure.

- **Teaching point 1:** To multiply a number by 10/100/1,000, move the digits one/two/three places to the left; to divide a number by 10/100/1,000, move the digits one/two/three places to the right.
- **Teaching point 2:** Measures can be converted from one unit to another using knowledge of multiplication and division by 10/100/1,000.

## 2.30 Multiplicative contexts: area and perimeter 2

Build on earlier knowledge of area and perimeter. Learn to find the area of parallelograms and triangles by identifying the perpendicular height. Compare areas and perimeters and apply scale factors to side-length, perimeter and area.

- **Teaching point 1:** The area of a parallelogram can be calculated by multiplying the base by the perpendicular height; all parallelograms with the same base and perpendicular height will have the same area.
- **Teaching point 2:** The area of a triangle can be calculated by multiplying the base by the perpendicular height and then dividing by two.
- **Teaching point 3:** Shapes with the same area can have different perimeters; shapes with the same perimeter can have different areas.
- **Teaching point 4:** When a shape has been transformed by a scale factor, the perimeter is also transformed by the same scale factor.