

# Brockwell Junior School

## Progression in Calculation

### 2022



This policy supports the Teaching for Mastery approach that is taught throughout the school. The school uses White Rose Maths as its core scheme for Years 3 -6, alongside the NCETM PD materials and MathShed. Doodle Maths and TTRock Stars are used to maintain fluency in multiplication facts from Year 3. This calculation policy gives examples of a range of representations, models and images that demonstrate how maths in our school is taught. Each representation is from one of the schemes stated above and is key to supporting children to develop a deep understanding of number and calculation. Teachers use these to model calculations through a concrete, pictorial and abstract (CPA) approach.

- **Concrete** is the “doing” stage. During this stage, students use concrete objects to model problems.
- **Pictorial** is the “seeing” stage. Here, visual representations of concrete objects are used to model problems. This stage encourages children to make a mental connection between the physical object they just handled and the abstract pictures, diagrams or models that represent the objects from the problem.
- **Abstract** is the “symbolic” stage, where children use abstract symbols to model problems. Students will not progress to this stage until they have demonstrated that they have a solid understanding of the concrete and pictorial stages of the problem.

**Lesson design:** When planning a lesson, teachers consider:

- **Cohesion:** small steps are taken, with all children beginning with the same problem. The teacher plans for misconceptions that might arise, or have arisen in previous learning and supports these through the use of carefully structured oral and written questions that the children work on and discuss as a whole group before proceeding to individual or paired work.
- **Mathematical Thinking:** children are supported by the use of Stem Sentences within a lesson, which give scaffolding for support and allow the teacher to consider extension questions. Children are given time to consider the ‘in focus’ task at the beginning of the lesson and to establish efficient ways of solving the problem.
- **Representations and Structure:** children are given a range of similar models and images from Reception to Year 6 that progressively build on their knowledge and understanding (eg, the whole: part-part diagram or bar models)
- **Variation and Intelligent Practise:** teachers use the representations shown in the policy and vary them within a lesson in small steps until the objective has been achieved. Teachers encourage the children to look for and discuss patterns within their thinking and make connections with previous learning.
- **Fluency:** efficient calculation requires having a variety of mental strategies. Children are encouraged to use retrieval skills and to make comparisons, for example by answering ‘what is the same and what is different between the 3 and 6  $\times$  tables?’. As the children develop instant recall alongside conceptual understanding, they begin to see patterns and work more systematically.

**Mental and written methods:** Children are taught strategies that establish a secure understanding of place value, such as counting forwards and backwards in ones, tens and hundreds. Children are given opportunities to explain and reason why they have chosen a strategy and whether it is the most efficient. Formal written methods are introduced when children demonstrate understanding with concrete apparatus, proving that their knowledge of place value is secure. Calculations that require a written method are presented to children with apparatus alongside models and images, such as dienes apparatus or place value counters. This ensures that they have a conceptual understanding of the written method and that it is not a process that the children use for every type of calculation.

# Year 3 Addition and Subtraction

# Representations and Images

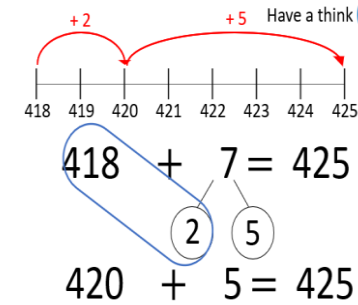
Add and subtract numbers mentally, including 3-digit numbers - ones, tens, hundreds

Add and subtract numbers with up to 3- digits, using formal written methods of columnar addition and subtraction

+	0	1	2	3	4	5	6	7	8	9	10
0	0+0	0+1	0+2	0+3	0+4	0+5	0+6	0+7	0+8	0+9	0+10
1	1+0	1+1	1+2	1+3	1+4	1+5	1+6	1+7	1+8	1+9	1+10
2	2+0	2+1	2+2	2+3	2+4	2+5	2+6	2+7	2+8	2+9	2+10
3	3+0	3+1	3+2	3+3	3+4	3+5	3+6	3+7	3+8	3+9	3+10
4	4+0	4+1	4+2	4+3	4+4	4+5	4+6	4+7	4+8	4+9	4+10
5	5+0	5+1	5+2	5+3	5+4	5+5	5+6	5+7	5+8	5+9	5+10
6	6+0	6+1	6+2	6+3	6+4	6+5	6+6	6+7	6+8	6+9	6+10
7	7+0	7+1	7+2	7+3	7+4	7+5	7+6	7+7	7+8	7+9	7+10
8	8+0	8+1	8+2	8+3	8+4	8+5	8+6	8+7	8+8	8+9	8+10
9	9+0	9+1	9+2	9+3	9+4	9+5	9+6	9+7	9+8	9+9	9+10
10	10+0	10+1	10+2	10+3	10+4	10+5	10+6	10+7	10+8	10+9	10+10

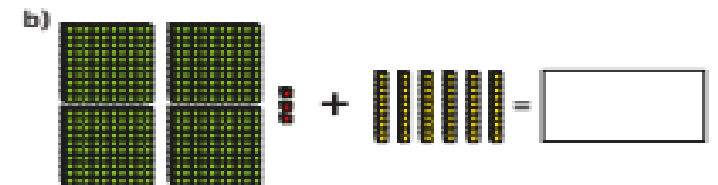
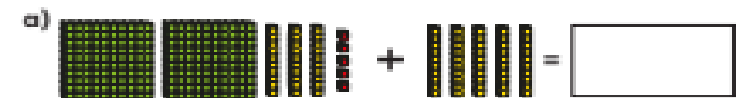
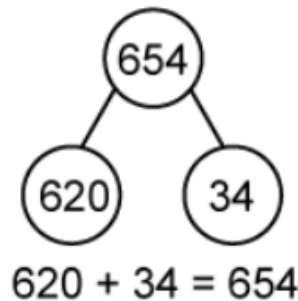
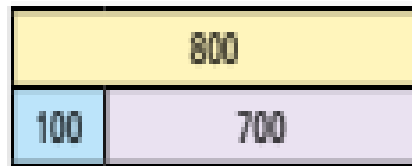
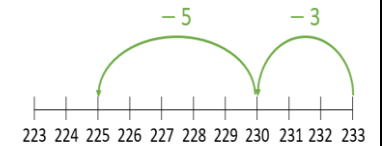


Bridging



$$233 - 8 = 225$$

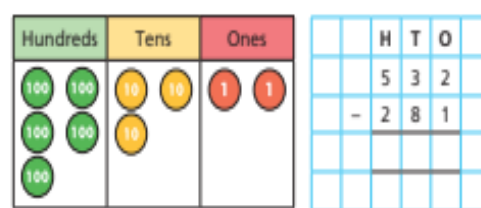
Use 2 jumps on the number line



a) 235 + 157



b) 532 - 281



Estimate the answer to a calculation and use inverse operations to check answers.

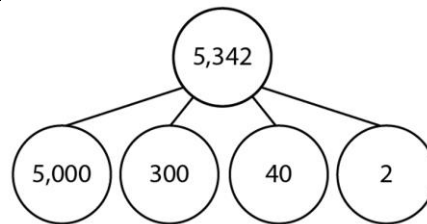
Solve problems, including missing number problems, using number facts, place value, and more complex addition and subtraction

# Year 4 Addition and Subtraction

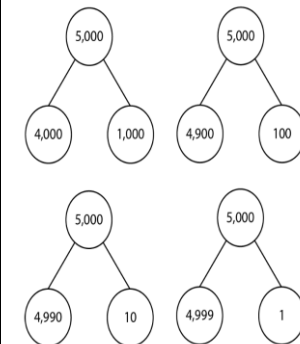
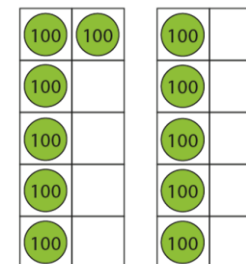
# Representations and Images

Add and subtract numbers mentally, including 4-digit numbers - ones, tens, hundreds and thousands

+	0	1	2	3	4	5	6	7	8	9	10
0	0+0	0+1	0+2	0+3	0+4	0+5	0+6	0+7	0+8	0+9	0+10
1	1+0	1+1	1+2	1+3	1+4	1+5	1+6	1+7	1+8	1+9	1+10
2	2+0	2+1	2+2	2+3	2+4	2+5	2+6	2+7	2+8	2+9	2+10
3	3+0	3+1	3+2	3+3	3+4	3+5	3+6	3+7	3+8	3+9	3+10
4	4+0	4+1	4+2	4+3	4+4	4+5	4+6	4+7	4+8	4+9	4+10
5	5+0	5+1	5+2	5+3	5+4	5+5	5+6	5+7	5+8	5+9	5+10
6	6+0	6+1	6+2	6+3	6+4	6+5	6+6	6+7	6+8	6+9	6+10
7	7+0	7+1	7+2	7+3	7+4	7+5	7+6	7+7	7+8	7+9	7+10
8	8+0	8+1	8+2	8+3	8+4	8+5	8+6	8+7	8+8	8+9	8+10
9	9+0	9+1	9+2	9+3	9+4	9+5	9+6	9+7	9+8	9+9	9+10
10	10+0	10+1	10+2	10+3	10+4	10+5	10+6	10+7	10+8	10+9	10+10

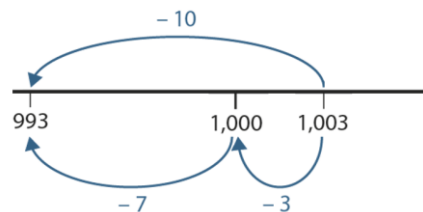


$$600 + 500 = 1,100$$



Estimate and use inverse operations to check answers to a calculation

$$1,003 - 10 = 993$$

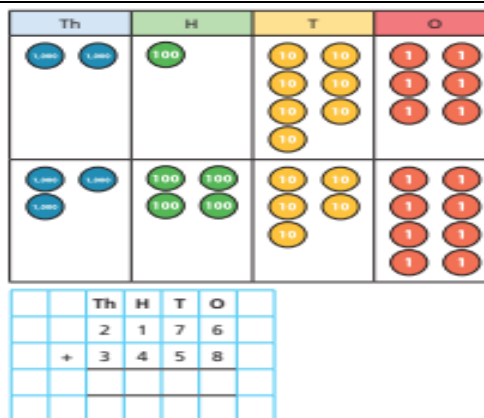


$$£3.45 + 99p = £4.44$$



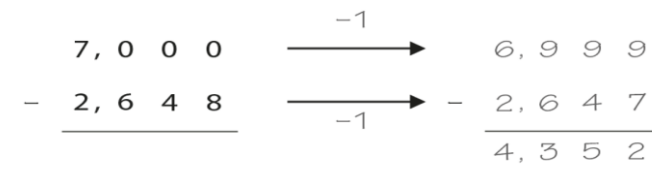
Solve addition and subtraction 2 - step problems, deciding which operations and methods to use and why.

Add and subtract numbers with up to 4 digits using the formal written methods of columnar addition and subtraction



Compensating

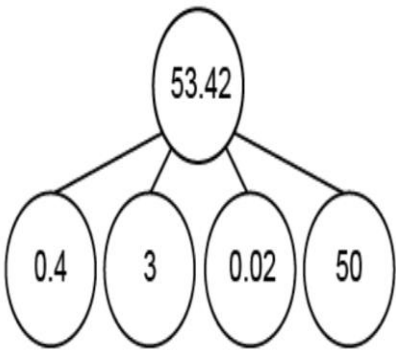
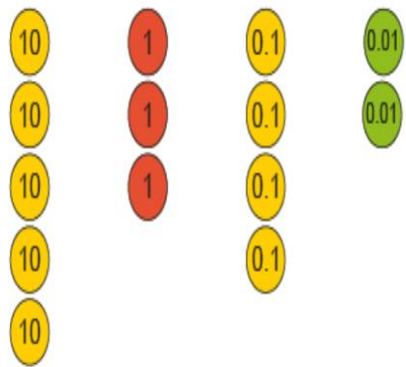
$$7,000 - 2,648 = 6,999 - 2,647 = 4,352$$



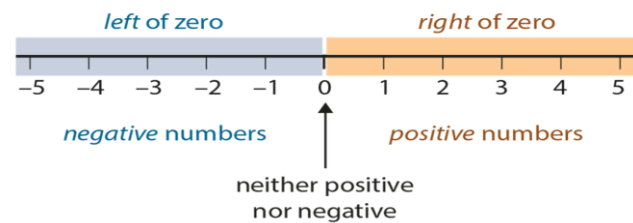
Year 5 Addition and Subtraction

Representations and Images

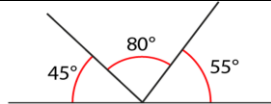
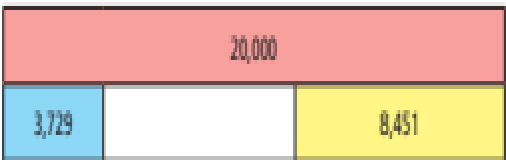
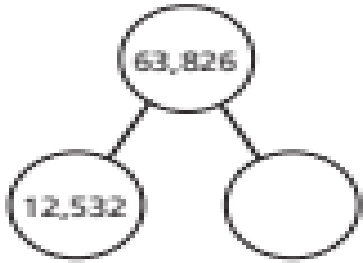
I can add and subtract increasingly large numbers mentally.



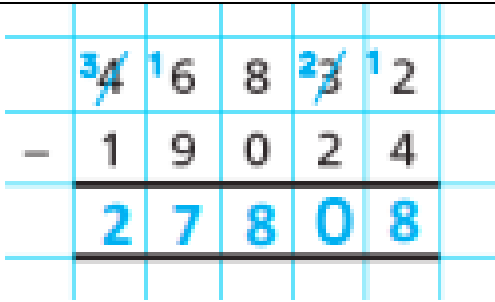
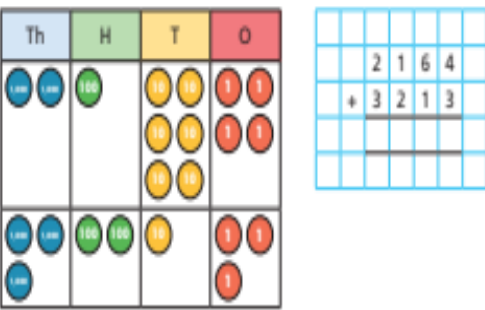
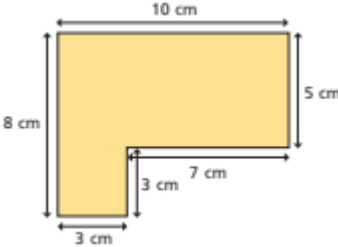
?		
1.5	2.1	0.9



I can add and subtract whole numbers with more than 4 digits using formal written methods.



180		
45	80	55



Solve addition and subtraction multi-step problems in contexts, deciding which operations and methods to use and why

I can use rounding to check answers to calculations.

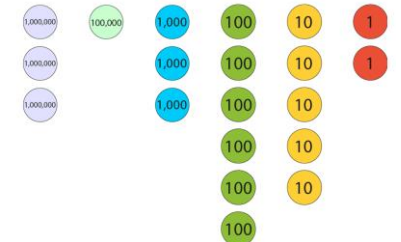
## Year 6 Addition and Subtraction

## Representations and Images

Perform mental calculation including with mixed operations and large numbers.

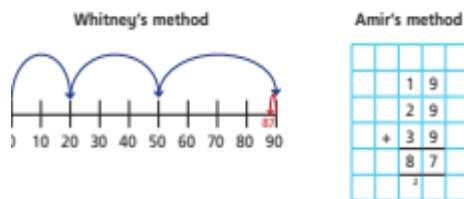
Add and subtract whole numbers with more than 4 digits using formal written methods.

10,000,000	20,000,000	30,000,000	40,000,000	50,000,000	60,000,000	70,000,000	80,000,000	90,000,000
1,000,000	2,000,000	3,000,000	4,000,000	5,000,000	6,000,000	7,000,000	8,000,000	9,000,000
100,000	200,000	300,000	400,000	500,000	600,000	700,000	800,000	900,000
10,000	20,000	30,000	40,000	50,000	60,000	70,000	80,000	90,000
1,000	2,000	3,000	4,000	5,000	6,000	7,000	8,000	9,000
100	200	300	400	500	600	700	800	900
10	20	30	40	50	60	70	80	90
1	2	3	4	5	6	70	8	9
0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09



3,103,652

Whitney and Amir are working out  $19 + 29 + 39$ .  
Talk about each method, and explore how they work.



Which method do you think is most efficient? Why?


Cars for sale: price list	
Car A	£2,750
Car B	£19,500
Car C	£24,999
Car D	£45,000

a) What is the total price of all four cars?


Mo has £1,000 to spend. He buys a TV and a games console.



Does Mo have enough money left to buy the phone? \_\_\_\_\_  
Show your workings.

Compensating





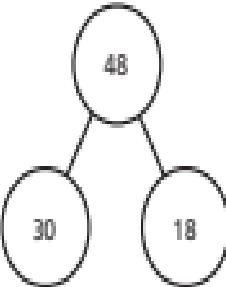
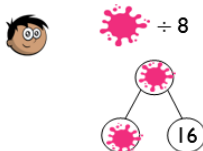
$$200,000 - 158,436 = 41,564$$

$$\begin{array}{r} 200,000 \\ - 158,436 \\ \hline \end{array} \xrightarrow{-1} \begin{array}{r} 199,999 \\ - 158,435 \\ \hline \end{array}$$

Use knowledge of the order of operations to carry out calculations involving the four operations.

Solve addition and subtraction multi-step problems in contexts, deciding which operations and methods to use and why.

Use informal and formal methods to solve problems involving decimals.

Year 3 Multiplication and Division	Representations and Images	
<p>Write and calculate mathematical statements for multiplication and division using known multiplications tables, including for 2- digit numbers times 1-digit numbers using mental and formal written methods.</p>	<p>Equal Groups (<math>4 \times 5 = 5 + 5 + 5 + 5</math>)</p> 	<p>Arrays <math>2 \times 10 = 10 \times 2</math></p> 
	<p>Division by grouping</p>  <p>Arrange the coins into 3 equal groups. How many coins are there in each group? <span style="border: 1px solid black; padding: 2px;">2</span></p>	<p>Division by sharing</p> <p>4 30 flowers are shared equally between 5 vases.</p> 
<p>Recall and use multiplication and division facts for the 2,5,10, 3,4 and 8 multiplication tables.</p>	<p>a) <math>48 \div 3 = </math> <span style="border: 1px solid black; padding: 2px;">16</span></p>  <div style="display: flex; justify-content: space-around;"> <div> <math>30 \div 3 = </math> <span style="border: 1px solid black; padding: 2px;">10</span>  <math>18 \div 3 = </math> <span style="border: 1px solid black; padding: 2px;">6</span>  <math>48 \div 3 = </math> <span style="border: 1px solid black; padding: 2px;">16</span> </div> </div>	<p>Bus Stop Method</p> <p>How many groups of 2 tens can we make?</p> <p>Are there any remaining tens?</p> <p>How many groups of 2 ones can we make?</p> <div style="border: 1px solid black; padding: 10px; margin: 10px auto; width: fit-content;"> <math display="block">76 \div 2 = 38</math> <math display="block">\begin{array}{r} 38 \\ 2 \overline{) 76} \end{array}</math> </div>
		<p>Amir partitioned a number to help him divide by 8</p> <p>Some of his working out has been covered with paint.</p> <p>What number could Amir have started with?</p>  <p>Solve problems, including multiplication and division including scaling problems.</p>



## Year 4 Multiplication and Division

## Representations and Images

Recall multiplication and division facts and tables up to  $12 \times 12$ .

Use place value and facts to multiply and divide mentally.

Multiply 2-digit numbers by a 1-digit number using a formal written layout.

Recognise and use factor pairs in mental calculations.

10 000	1000	100	10	1	$\frac{1}{10}$	$\frac{1}{100}$	$\frac{1}{1000}$

### Multiplying

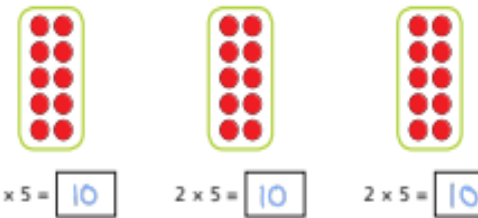
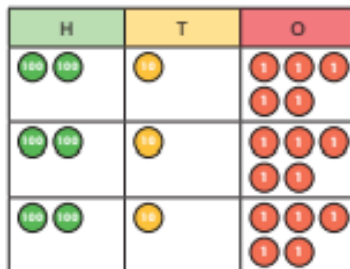
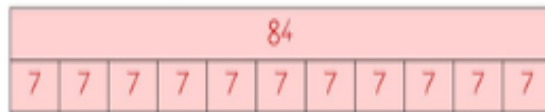
X 10  
X 100

digits move LEFT 1 space  
digits move LEFT 2 spaces

### Dividing

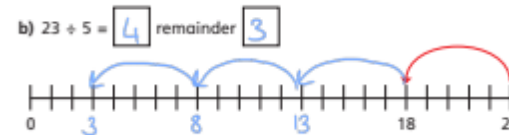
$\div 10$   
 $\div 100$

digits move RIGHT 1 space  
digits move RIGHT 2 spaces



Use your answer to part a) to complete the multiplication.

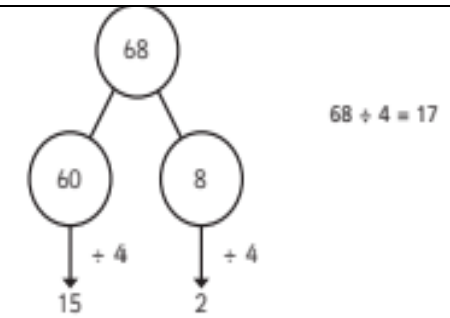
$$3 \times 2 \times 5 = 6 \times 5 = 30$$



### Bus Stop Method

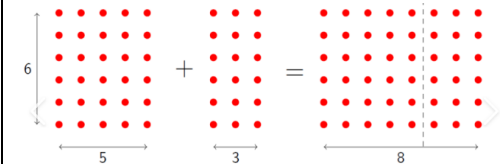
How many groups of 8 hundreds can we make? How many groups of 8 tens can we make? How many groups of 8 ones can we make?

$$\begin{array}{r} 045 \\ 8 \overline{) 360} \end{array}$$



### Distributive law

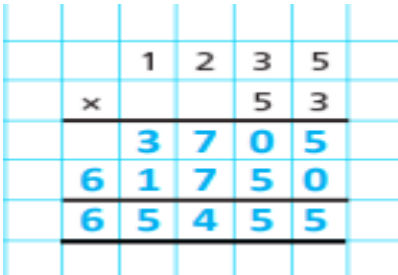
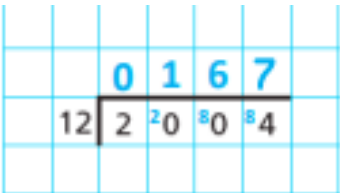
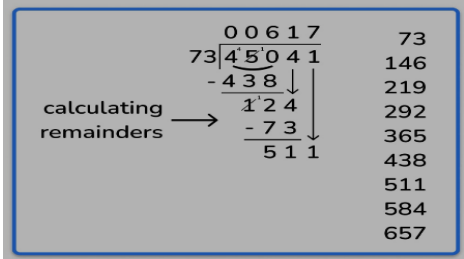
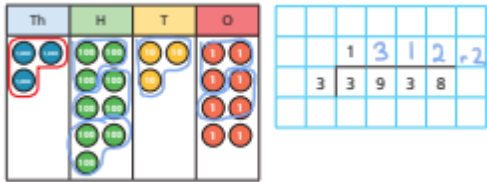
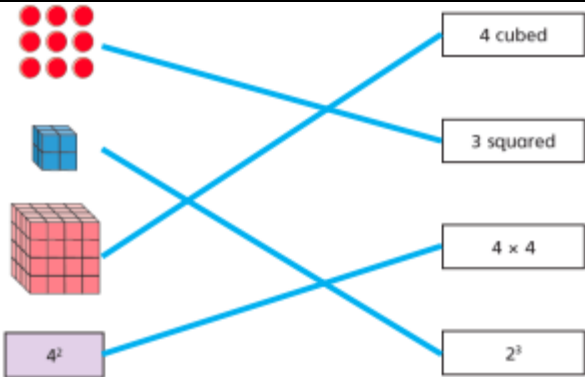
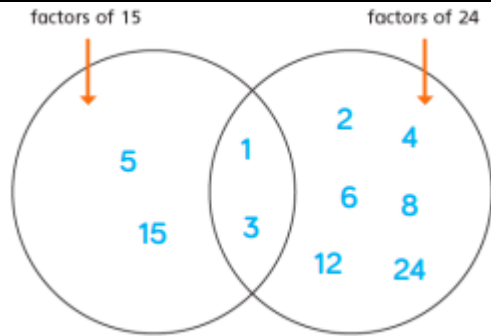
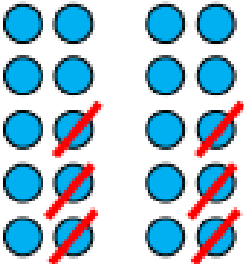
$$5 \times 6 + 3 \times 6 = 8 \times 6$$

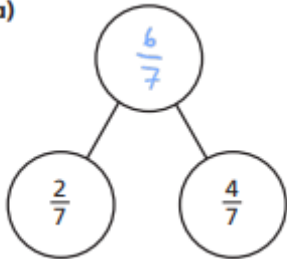
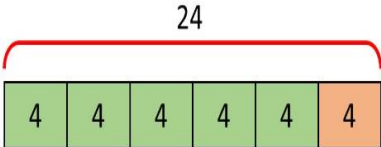
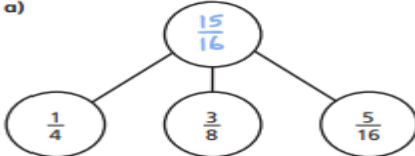
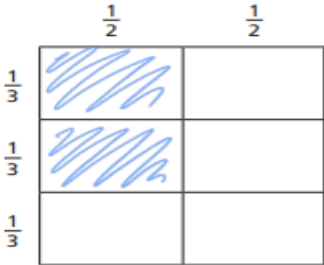





I can solve problems involving multiplying and adding, including the distributive law, integer scaling problems and harder correspondence problems.



Year 5 Multiplication and Division		Representations and Images																																																														
Multiply and divide mentally and multiply and divide numbers involving decimals.  Multiply whole numbers and those involving decimals by 10, 100 and 1000.  Multiply and divide numbers up to 4 -digits by a 1 - or 2 -digit number using formal written	<table><tr><td>10 000</td><td>1000</td><td>100</td><td>10</td><td>1</td><td>●</td><td><math>\frac{1}{10}</math></td><td><math>\frac{1}{100}</math></td><td><math>\frac{1}{1000}</math></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td>●</td><td></td><td></td></tr></table> <div><div>Multiplying</div><div>X 10 X 100</div><div>digits move LEFT 1 space digits move LEFT 2 spaces</div></div> <div><div>Dividing</div><div>÷ 10 ÷ 100</div><div>digits move RIGHT 1 space digits move RIGHT 2 spaces</div></div>	10 000	1000	100	10	1	●	$\frac{1}{10}$	$\frac{1}{100}$	$\frac{1}{1000}$						●			Identify multiples and factors, including finding all factor pairs of a number and common factors between numbers.  Know and use the vocabulary of prime numbers, prime factors and composite numbers.  Establish whether a number up to 100 is a prime and recall and recognise prime numbers and recognise and use square numbers.	<div><div>13</div><div>1 13</div><div>13 has only two factors - itself and 1. So it is a prime number.</div></div> <div><div>4</div><div>1 2 4</div><div>4 has three factors - itself, 1 and 2. So it is NOT a prime number.</div></div>																																												
	10 000	1000	100	10	1	●	$\frac{1}{10}$	$\frac{1}{100}$	$\frac{1}{1000}$																																																							
						●																																																										
<div><div>4</div><div></div><div>2<sup>2</sup> or 2 x 2 = 4</div></div> <div><div>9</div><div></div><div>3<sup>2</sup> or 3 x 3 = 9</div></div> <div><div>16</div><div></div><div>4<sup>2</sup> or 4 x 4 = 16</div></div>	The factors of 12 are: 1, 2, 3, 4, 6 and 12  The factors of 8 are: 1, 2, 4 and 8  1, 2 and 4 are factors of 12 and 8	Calculating cube numbers <div><div>30 6</div><div>6 30 x 6 = 180 6 x 6 = 36</div><div>180 + 36 = 216</div></div>																																																														
<table><tr><th>Th</th><th>H</th><th>T</th><th>O</th></tr><tr><td>4</td><td>4</td><td>4</td><td>4</td></tr><tr><td>4</td><td>4</td><td>4</td><td>4</td></tr><tr><td>4</td><td>4</td><td>4</td><td>4</td></tr><tr><td>4</td><td>4</td><td>4</td><td>4</td></tr></table> <table><tr><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td>2</td><td>2</td><td>1</td><td>4</td></tr><tr><td></td><td>x</td><td></td><td></td><td></td><td>4</td></tr><tr><td></td><td></td><td>8</td><td>8</td><td>5</td><td>6</td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td></tr></table>	Th	H	T	O	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4									2	2	1	4		x				4			8	8	5	6							Bus Stop Method <table><tr><td></td><td></td><td>1</td><td>5</td><td>6</td><td>1</td></tr><tr><td>3</td><td>4</td><td>6</td><td>8</td><td>3</td><td></td></tr></table>			1	5	6	1	3	4	6	8	3		Solve problems using knowledge of factors, multiples, squares and cubes.  5) Which is larger? 4 <sup>3</sup> or 9 <sup>2</sup> ? 3 <sup>4</sup> or 6 <sup>2</sup> ?
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Year 6 Multiplication and Division		Representations and Images	
<p>Identify common factors, common multiples and prime numbers.</p> <p>Multiply and divide multi-digit numbers up to 4 - digits by a 2 -digit whole number.</p> <p>Interpret remainders as whole number remainders, fractions or by rounding.</p> <p>Use knowledge of the order of operations to carry out calculations involving the 4 operations.</p>	<p>Use the formal method for multiplication</p> 	<p>Use the formal method of short division.</p> 	<p>Use the formal method of long division</p> 
	<p>Remainders</p> 		
	<p><math>(10 - 3) \times 2</math></p> 	<p> <math>85 \times 50 = 4,250</math>  <math>85 \times 500 = 42,500</math>  <math>85 \times 5,000 = 425,000</math> </p>	<p>Solve mixed multiplication and division number sentences and number problems.</p>

Fractions		Representations and images	
Year 3	Year 4	Year 5	Year 6
Add and subtract fractions with the same denominator.	I can add and subtract fractions with the same denominator and solve problems involving harder fractions to calculate and divide quantities.	Add and subtract fractions with the same denominator and denominators with multiples of the same number.  Multiply proper fractions and mixed numbers by whole numbers	I can compare, order, add and subtract fractions with different denominators and mixed numbers, using the concept of equivalent fractions.  I can multiply simple pairs of proper fractions, writing the answer in the simplest form.  I can divide proper fractions by whole numbers.
<p>a)</p> 	<p>Hannah &amp; Sal share 24 sweets.</p> <p>Hannah gets <math>\frac{5}{6}</math> of them. Sal gets <math>\frac{1}{6}</math> of them.</p> <p>How many sweets do they each get?</p> 	<p>a)</p> 	<p>b) <math>\frac{1}{2} \times \frac{2}{3} = \boxed{\frac{2}{6}} = \frac{1}{3}</math></p> 
<p>b)</p>  <p><math>\frac{4}{5} - \frac{2}{5} = \boxed{\frac{2}{5}}</math></p>	<p>f) <math>\frac{1}{8}</math> of 80 = <math>\boxed{10}</math></p> 	 <p><math>\frac{1}{7} + \frac{1}{7} + \frac{1}{7} + \frac{1}{7} = \boxed{\frac{4}{7}}</math></p> <p><math>4 \times \frac{1}{7} = \boxed{\frac{4}{7}}</math></p>	<p>a) <math>\frac{1}{3} \div 2 = \boxed{\frac{1}{6}}</math></p> 