Concrete / Pictorial / Abstract Maths Calculation Policy

This policy has been largely adapted from the White Rose Maths Hub Calculation Policy with furthermaterial added. It is a working document and will be revised and amended as necessary. Many variations have been included to provide teachers with a range of tools to support pupils in their grasp of number and calculation. To ensure consistency for pupils, it is important that that the mathematical language used in maths lessons reflects the vocabulary used throughout this policy.

Recommended practice delivering a mastery approach

True mastery aims to develop all children's mathematical understanding at the same pace. As much as possible, children should be accessing the samelearning. Differentiation should primarily be through support, scaffolding and deepening, not through task.

Consistency in language is essential for pupils to understand the concepts presented in mathematics. If other, 'child-friendly' terminology is used, this must be alongside the current terminology recommended by maths specialists. Using this will support children with their examinations and throughout secondaryschool.

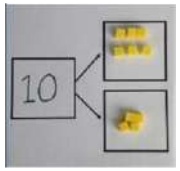
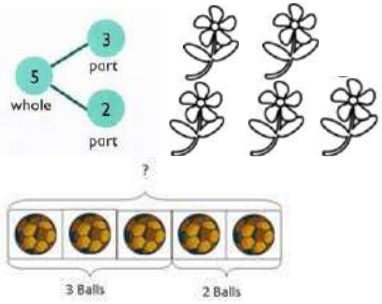
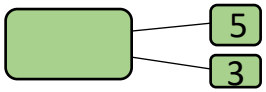
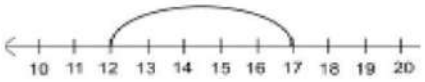
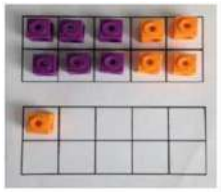
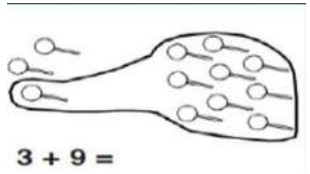
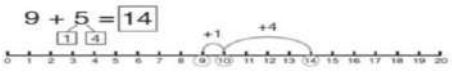
Evidence repeatedly shows that mixed ability seating increases less confident pupils' perception of mathematical capability, which impacts positively upon outcomes. While not a school policy, it is recommended to avoid ability groups. This presents a challenge in ensuring the more confident mathematicians arebeing extended. An extension tasks to deepen understanding is the most simplistic way around this.

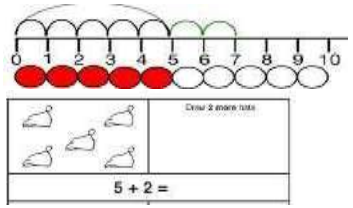
Concrete, pictorial, abstract (CPA) concepts should not be confused as differentiation for lower, middle, higher attaining children. CPA is an approach to beused with the whole class and teachers should promote each area as equally valid. Manipulatives in particular must not be presented as a resource to support the less confident or lower attaining pupils.

Used well, manipulatives can enable pupils to inquire themselves- becoming independent learners and thinkers. They can also provide a common language with which to communicate cognitive models for abstract ideas. Drury, H. (2015)	*Children aged seven to ten years old work in primarily concrete ways and that the abstract notions of mathematics may only be accessible to them through embodiment in practical resources. Jean Piaget's (1951)*	*Real things and structured images enables children to understand the abstract. The concrete and the images are a means for children to understand the symbolic so it's important to move between all modes to allow children to make connections. Morgan, D. (2016)*

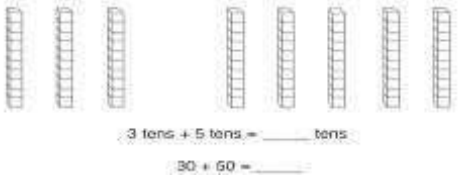
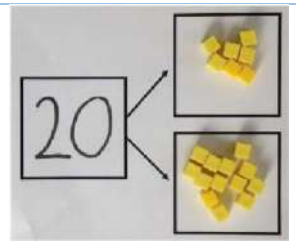
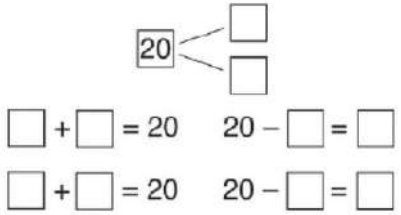
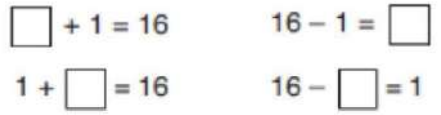
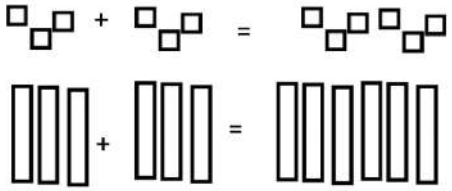
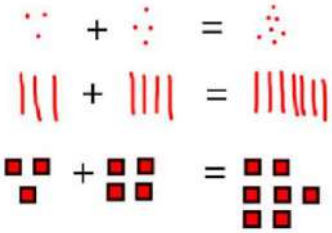
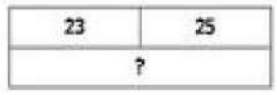
The abstract should run alongside the concrete and pictorial stage as this enables pupils to better understand mathematical statements and concepts.

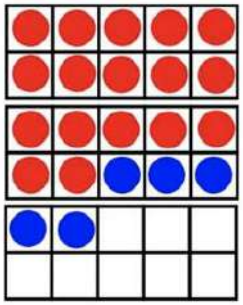
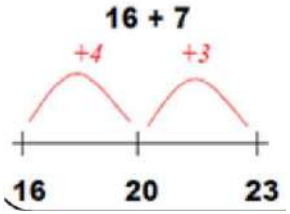
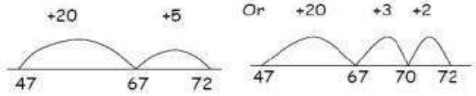
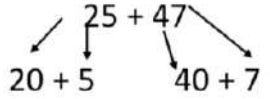
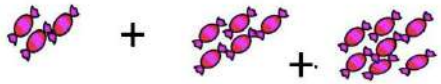
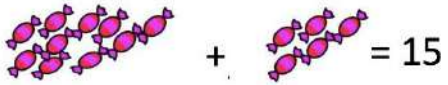
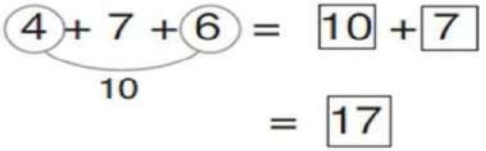
YEAR 1 ADDITION

OBJECTIVE / STRATEGY	CONCRETE	PICTORIAL	ABSTRACT
Combining two parts to make a whole: part-whole model	  Use part, part whole model. Use cubes to add two numbers together as a group or in a bar.  	Use pictures to add two numbers together as a group or in a bar.  	8 = 5 + 3 5 + 3 = 8  Use the part-part-whole diagram as shown above to move into the abstract. Include missing number questions to support varied fluency: 8 = ? + 3 5 + ? = 8
Starting at the bigger number and counting on	 Start with the larger number on the bead string and then count on to the smaller number 1 by 1 to find the answer.	 12 + 5 = 17 Start at the larger number on the number line and count on in ones or in one jump to find the answer.	5 + 12 = 17 Place the larger number in your head and count on the smaller number to find your answer.
Regrouping to make 10 *This is an essential skill for column addition later*	 6 + 5 = 11 Start with the bigger number and use the smaller number to make 10.  Use 10 frames	Use pictures or a number line. Regroup or partition the smaller number using the part, part whole model to make 10.  	7 + 4= 11 If I am at seven, how many more do I need to make 10? How many more do I add on now?

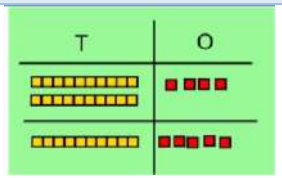
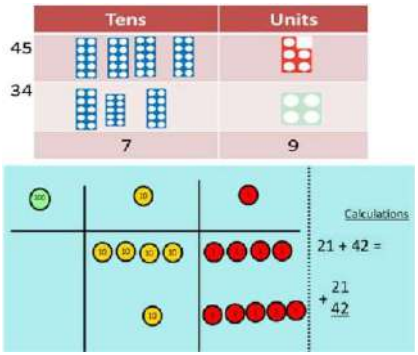
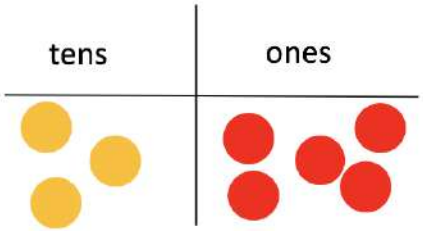
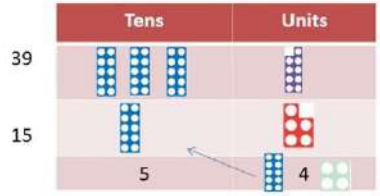
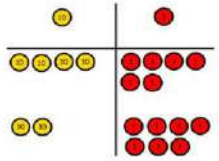
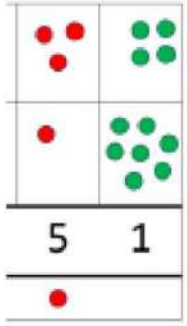
Represent number bonds and related subtraction facts within 20	 2 more than 5		Include missing number questions: 8 = ? + 3 5 + ? = 8 Emphasis should be on the language: *'1 more than 5 is equal to 6.'* *'2 more than 5 is 7.'* *'8 is 3 more than 5.'*

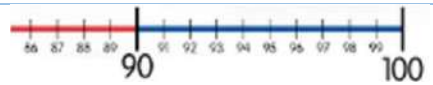
YEAR 2 ADDITION

OBJECTIVE / STRATEGY	CONCRETE	PICTORIAL	ABSTRACT
Adding multiples of 10	50= 30 = 20  Model using dienes and bead strings	 Use representations for Base 10	20 + 30 = 50 70 = 50 + 20 40 + □ = 60
Use known number facts: part-whole model	 Children explore ways of making numbers within 20		Explore commutativity of addition by swapping the addends to build a fact family. Explore the concept of the inverse relationship of addition and subtractions and use this to check calculations. 
Using known facts		 Chn draw representations of HTO	3 + 4 = 7 *leads to* 30 + 40 = 70 *leads to* 300 + 400 = 700
Bar model	 3 + 4 = 7	 7 + 3 = 10	 23 + 25 = 48

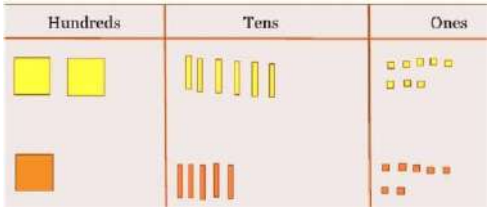
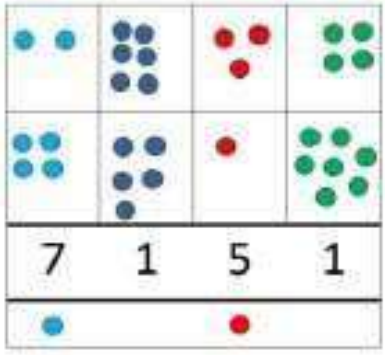
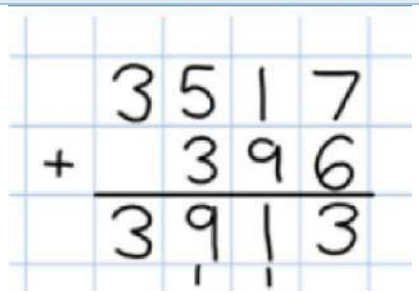
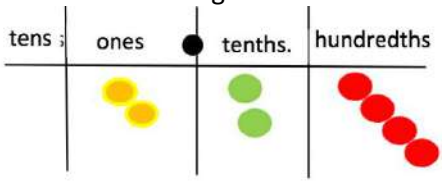
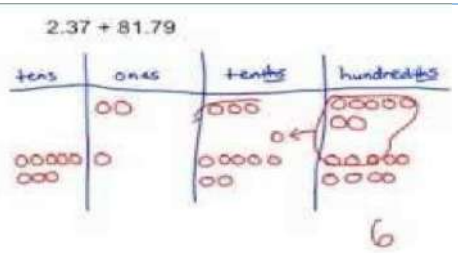
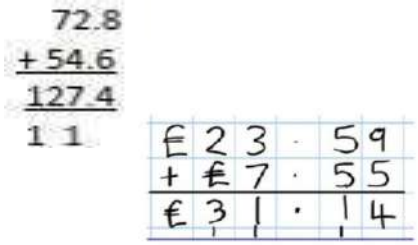
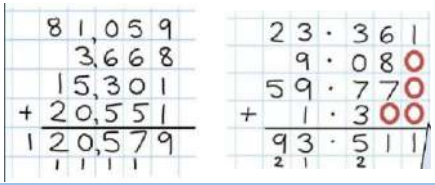
Add a 2-digit number and tens	 17 + 5 = 22 Use tenframe to make‘magic ten. Children explore the pattern. 17 + 5 = 22 27 + 5 = 32	Use number line to model 	27 + 10 = 37 27 + 20 = 47 27 + □ = 57
Add two 2-digit numbers	 Model using dienes, place value counters and numicon	 Use number line and bridge ten using part wholeif necessary.	 20 + 40 = 60 5+ 7 =12 60 + 12 = 72 Lead into recording in column format, to reinforce place value and prepare childrenfor formal written methods with larger values.
Add 3 1-digit numbers	 Combine to make 10 first if possible, or bridge 1o then add third digit	 Regroup and draw representation. 	 Combine the two numbers that make/ bridge ten then add on the third.

YEAR 3 ADDITION

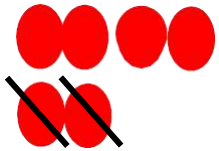
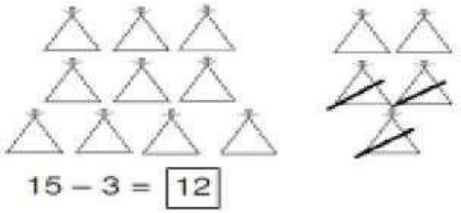
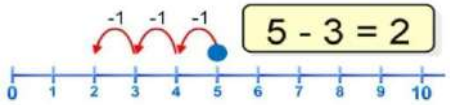
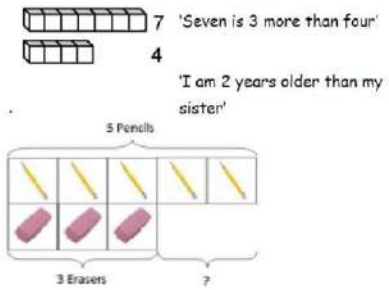
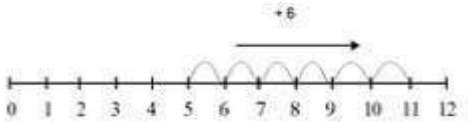
OBJECTIVE / STRATEGY	CONCRETE	PICTORIAL	ABSTRACT
Column addition (no regrouping with friendly numbers). Add two or three 2-digit or 3-digit numbers.	 Dienes or numicon. Add together the ones first, then the tens:  Move to using place value counters	Children move to drawing the counters using a tens and one frame:  	2 2 3 + 1 1 4 3 3 7 Add the ones first, then the tens, then the hundreds.
Column addition (with regrouping)	 Exchange ten ones for a ten. Model using numicon and place value counters.  46 + 27 = 73	 3 4 + 1 7 Children can draw a representation of the grid to further support their understanding, carrying the ten **underneath** the line	20 + 5 40 + 8 60 + 13 = 73 Start by partitioning the numbers before formal column to show the exchange. 536 + 85 621 1 1

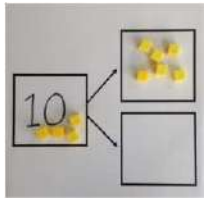
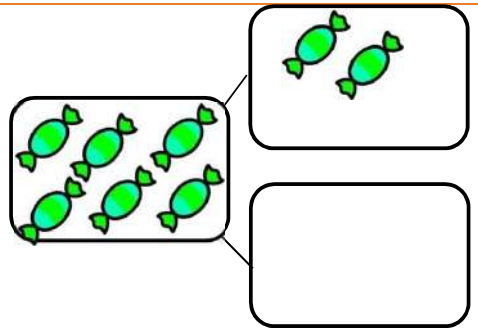
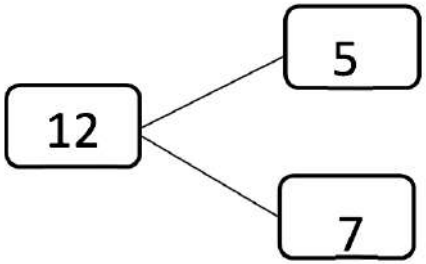
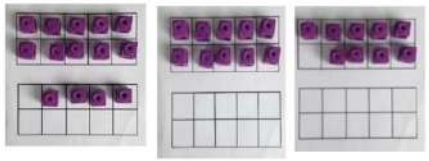
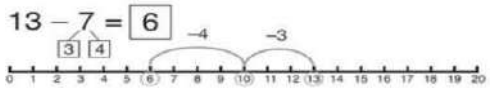
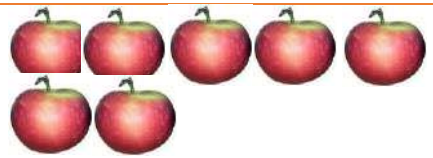
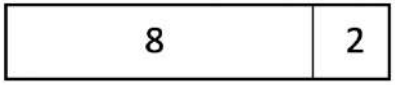
Estimate the answers to questions and use inverse operations to check answers	 Estimating 98 + 17 = ? 100 + 20 = 120	 Use number lines to illustrate estimation.	Building up known facts and using them to illustrate the inverse and to check answers: 98 + 18 = 116 116 – 18 = 98 18 + 98 = 116 116 – 98 = 18

YEARS 4–6 ADDITION

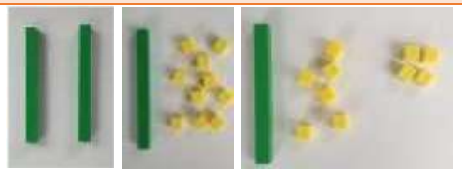
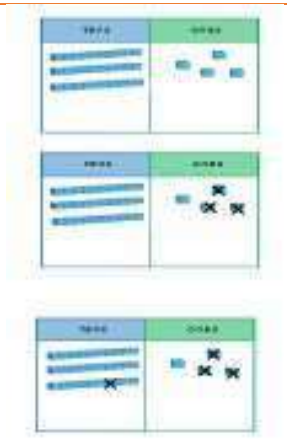
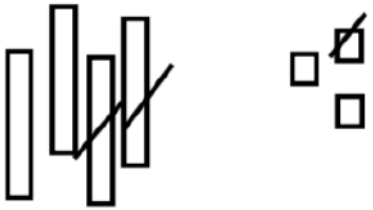
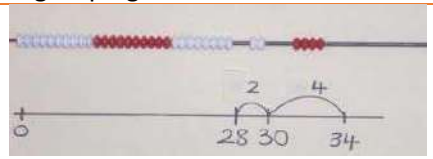
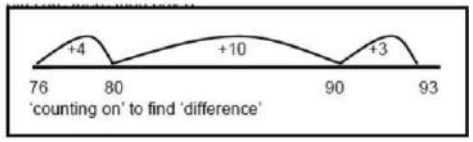
OBJECTIVE / STRATEGY	CONCRETE	PICTORIAL	ABSTRACT
Y4—add numbers with up to 4 digits	 Children continue to use dienes or place value counters to add, exchanging ten ones for a ten and ten tens for a hundred and ten hundreds for a thousand.	 Draw representations using place value grid.	 Continue from previous work to carry hundreds as well as tens. Relate to money and measures.
Y5—add numbers with more than 4 digits. Add decimals with 2 decimal places, including money.	As Year 4 Introduce decimal place value counters and model exchange for addition. 		
Y6—add several numbers of increasing complexity, including adding money, measure and decimals with different numbers of decimal points.	As Year 5	As Year 5	Insert zeros for place holders. 

YEAR 1 SUBTRACTION

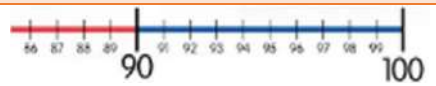
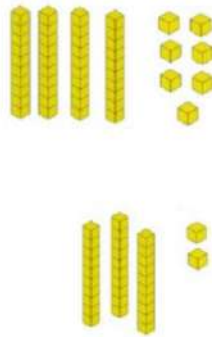
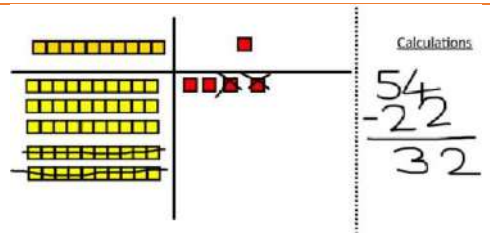
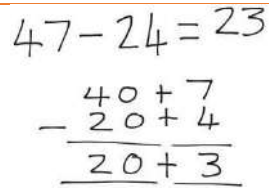
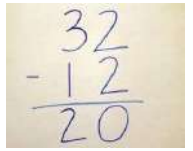
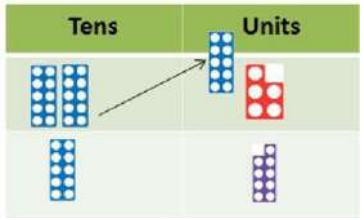
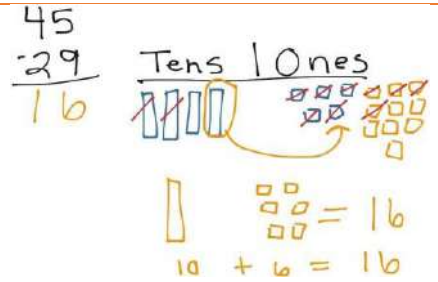
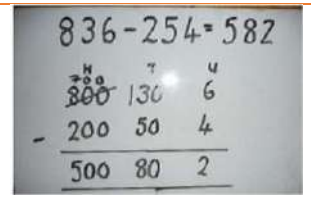
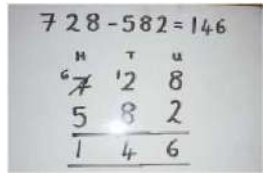
OBJECTIVE / STRATEGY	CONCRETE	PICTORIAL	ABSTRACT
Taking away ones	Use physical objects, counters, cubes etc to show how objects can be taken away. 4 — 2 = 2  6—4 = 2 	Cross out drawn objects to show what has been taken away.  15 – 3 = 12	7 — 4 = 3 16 — 9 = 7
Counting back	 Move objects away from the group, counting backwards.  Move the beads along the bead string as you count backwards	 Count back in ones using a number line.	Put 13 in your head, count back 4. What number are you at?
Find the difference	Compare objects and amounts  Lay objects to represent a bar model	Count on using a number line to find the difference. 	Hannah has 12 sweets and her sister has 5. How many more does Hannah have than her sister?

Represent and use number bonds and related subtraction facts within 20 Include subtracting zero Part part whole model	 Link to addition. Use PPW model to modelthe inverse. If 10 is the whole and 6 is one of the arts,what s the other part? 10—6 = 4	 Use pictorial representations to show the part	Move to using numbers within the part whole model:  Include missing number problems: 12 - ? = 5 7 = 12 - ?
Make 10	14—9  Make 14 on the ten frame. Take 4 away to make ten, then take one more away so that you have taken 5.	 13—7 Jump back 3 first, then another 4. Use ten as the stopping point.	16—8 How many do we take off first to get to 10? How many left to take off?
Bar model Including the inverse operations.	 5—2 = 3		 10 = 8 + 2 10 = 2 + 8 10—2 = 8 10—8 = 2

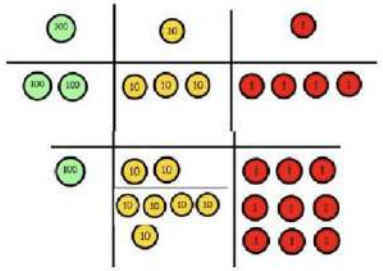
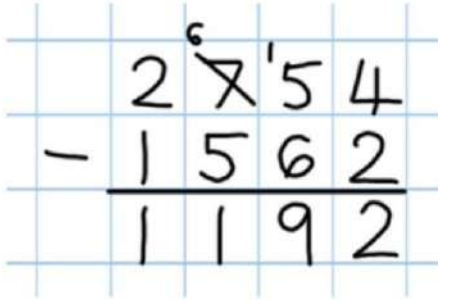
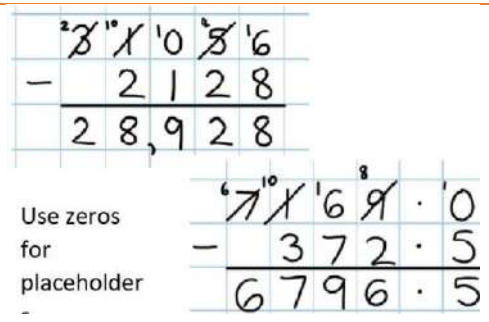
YEAR 2 SUBTRACTION

OBJECTIVE / STRATEGY	CONCRETE	PICTORIAL	ABSTRACT
Regroup a ten into ten ones	 Use a PV chart to show how to change a ten into ten ones, use the term 'take and make'	 20 – 4 =	20—4 = 16
Partitioning to subtract (no regrouping using friendly numbers)	 34 – 13 = 21 Use Dienes to show how to partition the number when subtracting without regrouping	Children draw representations of Dienes and cross off.  43—21 = 22	43—21 = 22
Make ten strategy Progression should be crossing one ten, crossing more than one ten, crossing the hundreds.	 34—28 Use a bead bar or bead strings to model counting to next ten and the rest.	 Use a number line to count on to next ten and then the rest.	93—76 = 17

YEAR 3 SUBTRACTION

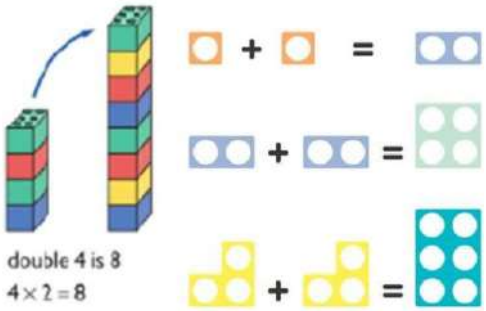
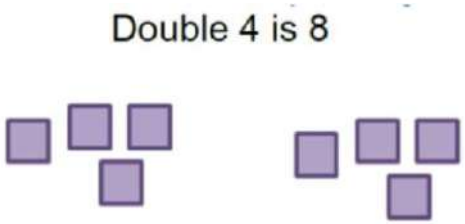
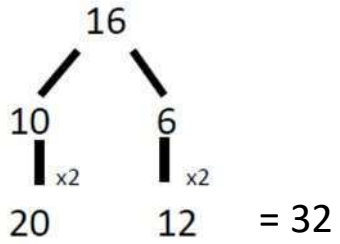
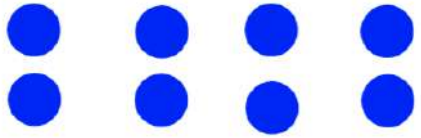
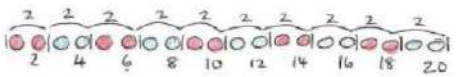
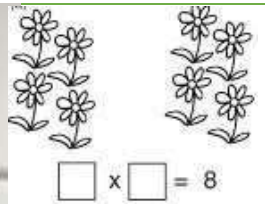
OBJECTIVE / STRATEGY	CONCRETE	PICTORIAL	ABSTRACT
Subtract numbers mentally, including: 3-digit number + ones 3-digit number + tens 3-digit number + hundreds			Vary the position of the answer and question. Expose children to missing number questions and vary the missing part of the calculation: 678 = ? - 1 688 – 10 = ? 678 = ? – 100
Column subtraction without regrouping (friendly numbers)	 47 – 32 Use base 10 or numicon to model	 Draw representations to support understanding	 Intermediate step may be needed to lead to clear subtraction understanding. 
Column subtraction with regrouping	 Begin with base 10 or Numicon. Move to pv counters, modelling the exchange of a ten into ten ones. Use the phrase ‘take and make’ for exchange.	 Children may draw base ten or PV counters and cross off.	 Begin by partitioning into PV columns  Then move on to formal method

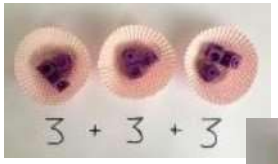
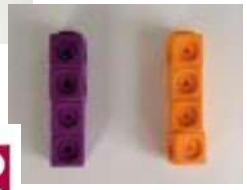
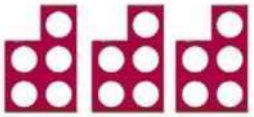
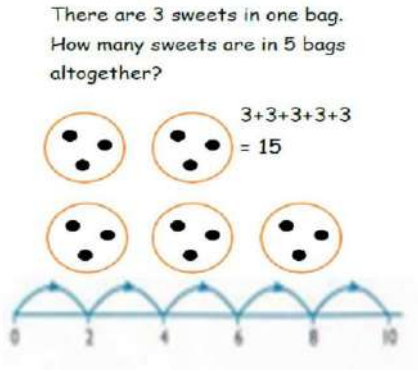
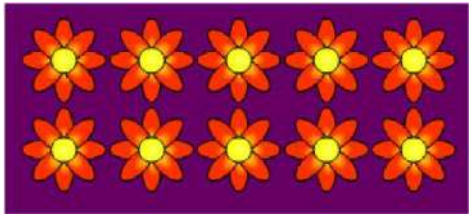
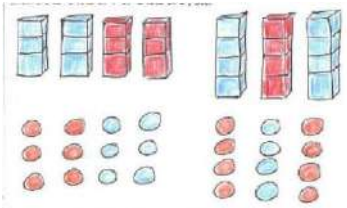
YEARS 4–6 SUBTRACTION

OBJECTIVE / STRATEGY	CONCRETE	PICTORIAL	ABSTRACT
Subtracting tens and ones Y4 – subtract with up to 4 digits (introduce decimal subtraction through context of money)	234 - 179  Model process of exchange using Numicon, base ten and then move to PV counters.	Children to draw PV counters and show their exchange – see Y3	 Use the phrase 'take and make' for exchange
Y5 – subtract with at least 4 digits, including money and measures Subtract with decimal values, including mixtures of integers and decimals and aligning the decimal, up to 3 decimal places	As Year 4	Children to draw PV counters and show their exchange – see Y3	 Use zeros for placeholder
Y6 – subtract with increasingly large and more complex numbers and decimal values, up to 3 decimals places	As Year 4	Children to draw PV counters and show their exchange – see Y3	

YEAR 1 MULTIPLICATION

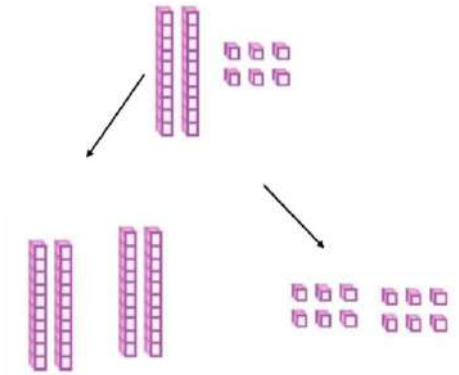
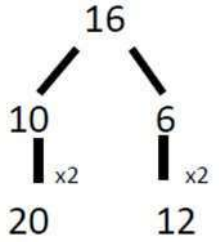
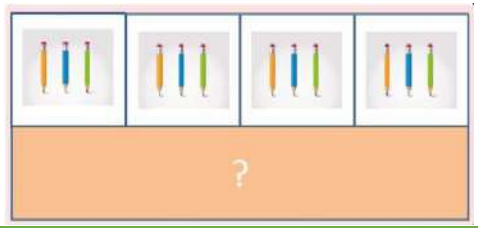
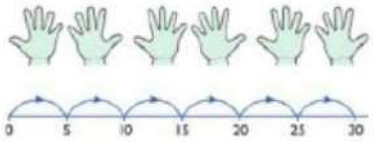
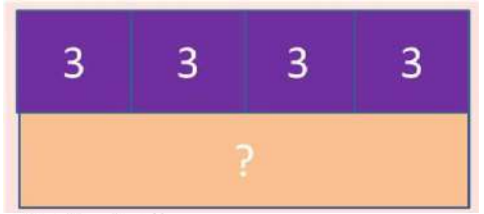
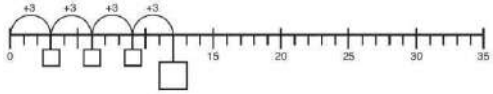
Programme of Study specifies the following objectives but it does not require the explicit teaching of the mathematical symbol of multiplication

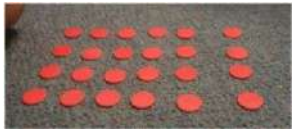
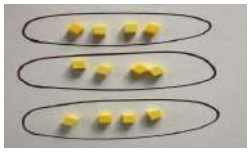
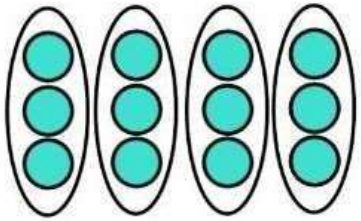
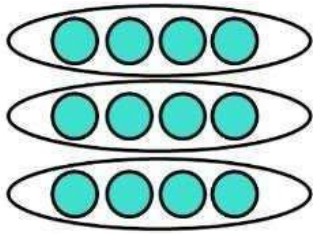
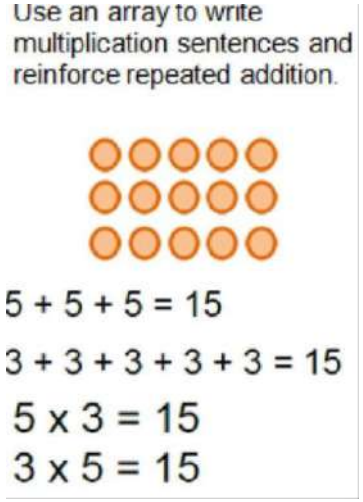
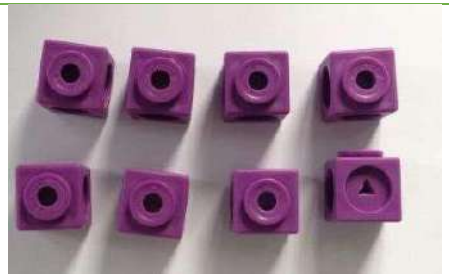
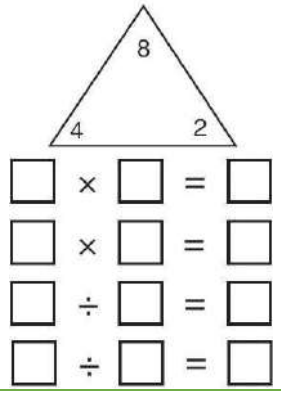
OBJECTIVE / STRATEGY	CONCRETE	PICTORIAL	ABSTRACT
Doubling	Practical activities using manipultives including cubes and Numicon to demonstrate doubling 	Draw pictures to show how to double numbers 	Partition a number and then double each part before recombining it back together 
Counting in multiples (2s, 5s, 10s)	Count the groups as children are skip counting, children may use their fingers as they are skip counting.  	 Children make representations to show counting in multiples 	Count in multiples of a number aloud. Write sequences with multiples of numbers. 2, 4, 6, 8, 10 5, 10, 15, 20, 25, 30 10, 20, 30, 40, 50
Making equal groups and counting the total	  Use manipulatives to create equal groups.	Draw  to show 2 x 3 = 6 Draw and make representations	2 x 4 = 8

Repeated addition	   Use different objects to add equal groups	Use pictorial including number lines to solve problems 	Write addition sentences to describe objects and pictures 
Understanding arrays	Use objects laid out in arrays to find the answers to 2 lots 5, 3 lots of 2 etc. 	Draw representations of arrays to show understanding 	3 x 2 = 6 2 x 5 = 10

YEAR 2 MULTIPLICATION

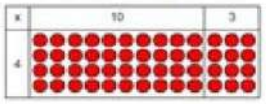
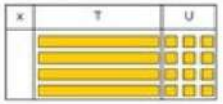
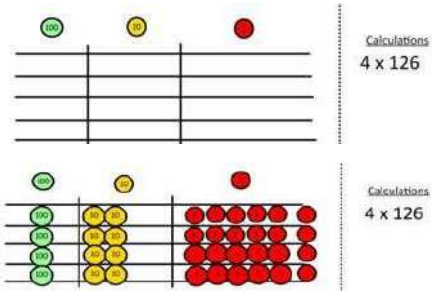
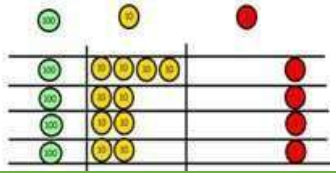
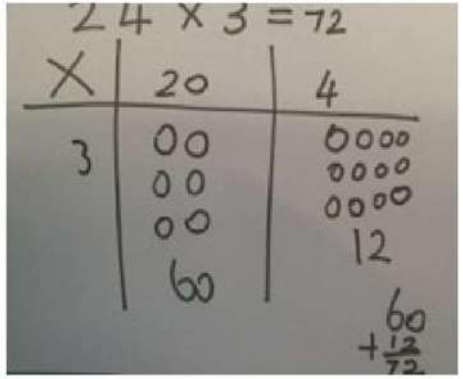
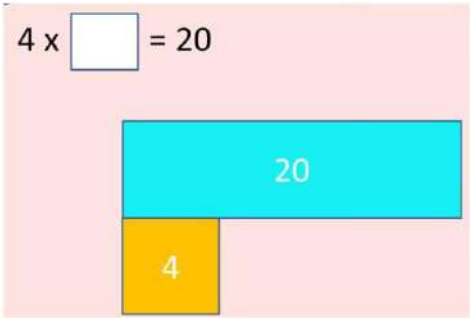
Children should be able to recall and use multiplication and division facts for the 2, 5 and 10 times tables

OBJECTIVE / STRATEGY	CONCRETE	PICTORIAL	ABSTRACT
Doubling	Model doubling using dienes and place value counters.  40 + 12 = 52	Draw pictures and representations to show how to double numbers	Partition a number and then double eachpart before recombining it back together.  = 32
Counting in multiples of 2, 3, 4, 5, 10 from 0 (repeated addition)	Count the groups as children are skip counting, children may use their fingers as they are skip counting. Use bar models. 5 + 5 + 5 + 5 + 5 + 5 + 5 + 5 = 40   	Number lines, counting sticks and bar models should be used to show representation of counting in multiples.   	Count in multiples of a number aloud. Write sequences with multiples of numbers. 0, 2, 4, 6, 8, 10 0, 3, 6, 9, 12, 15 0, 5, 10, 15, 20, 25, 30 $4 \times 3 = \square$

Multiplication is commutative	Create arrays usingcounters and cubes and Numicon    Pupils should understand that an array can represent different equations and that, as multiplication is commutative, the order of the multiplication does not affect the answer 	Use representations of arrays to show differentcalculations and explore commutativity.  	12 = 3 × 4 12 = 4 × 3 
Using the inverse *This should be taught alongside division, so pupils learn how they work alongside each other*			2 x 4 = 8 4 x 2 = 8 8 ÷ 2 = 4 8 ÷ 4 = 2 8 = 2 x 4 8 = 4 x 2 2 = 8 ÷ 4 4 = 8÷ 2 Show all 8 related fact family sentences.

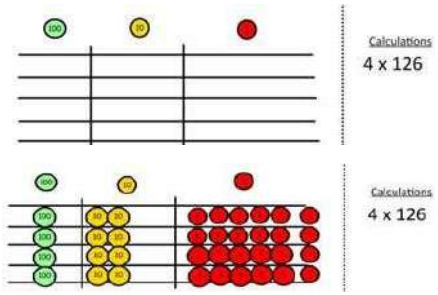
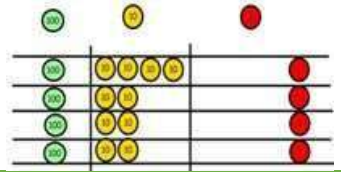
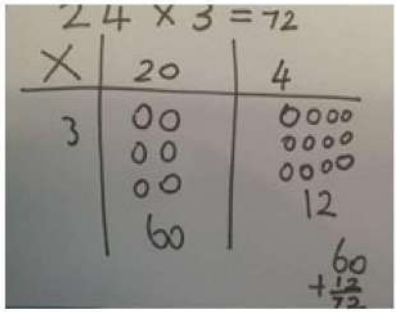
YEAR 3 MULTIPLICATION

Children should be able to recall and use multiplication facts for the 3,4, and 8 times tables

OBJECTIVE / STRATEGY	CONCRETE	PICTORIAL	ABSTRACT
Grid method progressing to the formal method Multiply 2-digit numbers by 1-digit numbers	Show the links with arrays to first introduce the grid method.  4 rows of 10 4 rows of 3 Move onto base ten to move towards a more compact method:  4 rows of 13 Move onto place value counters to show how we are finding groups of a number. We are multiplying by 4 so we need 4 rows:  Calculations 4 x 126 Calculations 4 x 126 Fill each row with 126. Add up each column, starting with the ones making any exchanges needed 	Children can represent their work with place value counters in a way that they understand. They can draw the counters using colours to show different amounts or just use the circles in the different columns to show their thinking as shown below.  24 x 3 = 72 X | 20 | 4 3 | 60 | 12 60 + 12 = 72 Bar model to explore missing numbers  4 x ☐ = 20 20 4	Start with multiplying by 1-digit numbers and showing the clear addition alongside the grid. | × | 30 | 5 | | 7 | 210 | 35 | 210 + 35 = 245 Move forward to the formal written method: 35 X 7 245 3

Solve problems, including missing number problems, integer scaling problems			Three times as high, eight times as long ? x 5 = 20 20 ÷ ? = 5 3 hats and 4 coats, how many different combinations?

YEARS 4–6 MULTIPLICATION

OBJECTIVE / STRATEGY	CONCRETE	PICTORIAL	ABSTRACT
Grid method recap for multiplying 2-digit numbers by 1-digit numbers, moving onto 3-digit by 1-digit (Y4 expectation)	Use place value counters to show how we are finding groups of a number. We are multiplying by 4 so we need 4 rows:  Fill each row with 126. Add up each column, starting with the ones making any exchanges needed 	Children can represent their work with place value counters in a way that they understand. They can draw the counters using colours to show different amounts or just use the circles in the different columns to show their thinking as shown below. 	Start with multiplying by 1-digit numbers and showing the clear addition alongside the grid. | ×	30	5
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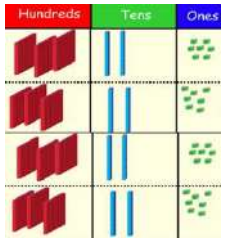
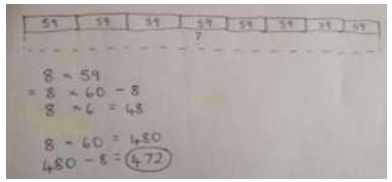
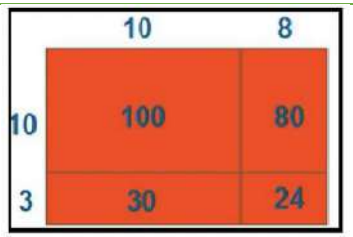
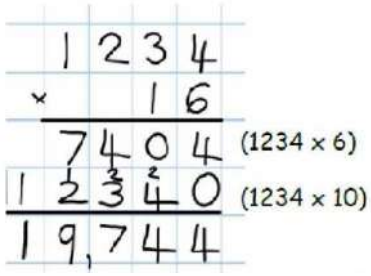
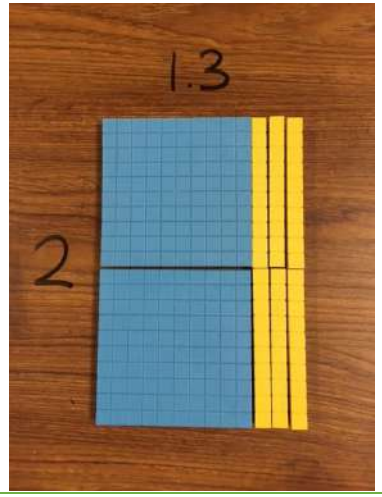
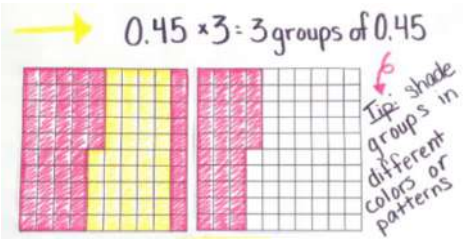
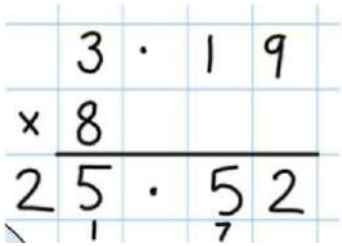
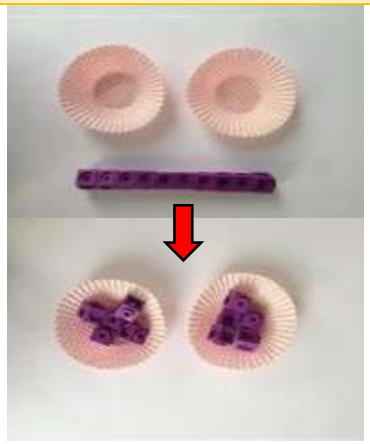
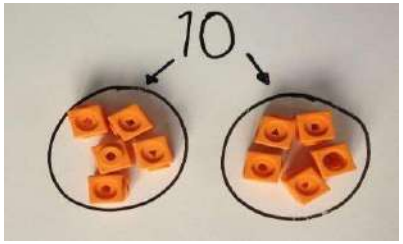
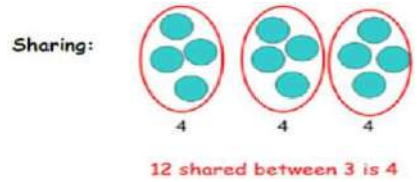
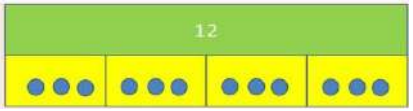
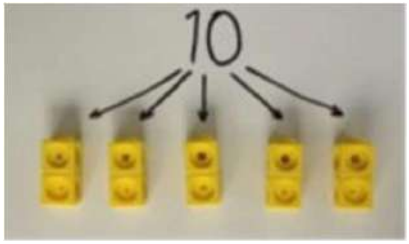
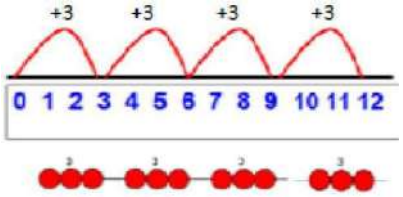
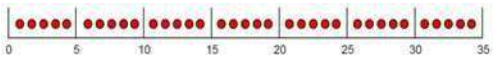
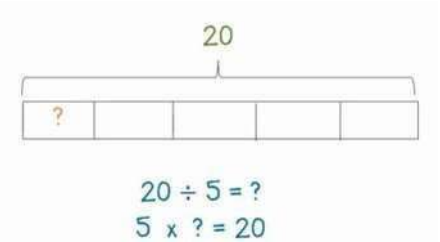
7	210	35	 210 + 35 = 245
Column multiplication	Children can continue to be supported by place value counters at this stage of multiplication. This initially involves no regrouping  It is important at this stage that they always multiply the ones first. The corresponding long multiplication is modelled alongside.	<table><tr><td>×</td><td>300</td><td>20</td><td>7</td></tr><tr><td>4</td><td>1200</td><td>80</td><td>28</td></tr></table> The grid method may be used to show how this relates to a formal written method.  Bar modelling and number lines can support learners when solving multiplication problems	327 x 4 28 80 1200 1308 3 2 7 × 4 1 3 0 8 1 2 This may lead to a compact method.

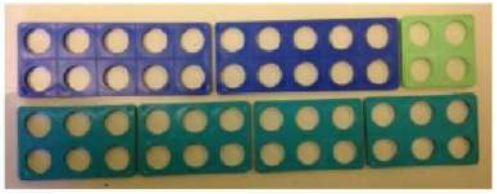
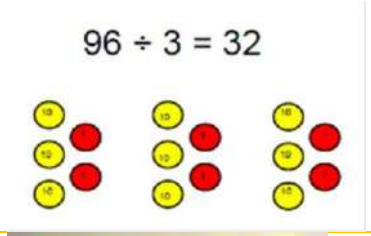
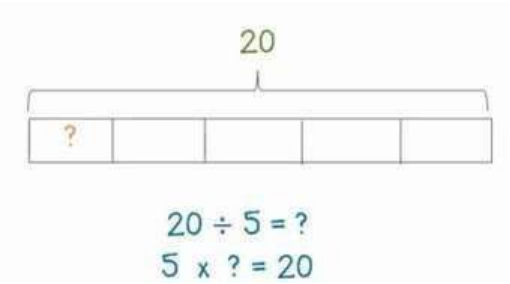
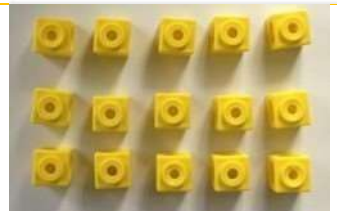
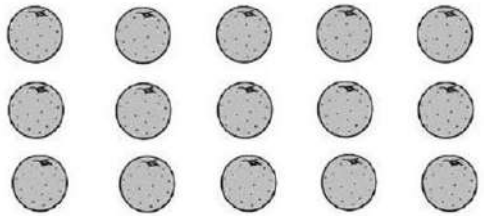
Column multiplication (multiplying by 2-digit numbers)	Manipulatives may still be used with the corresponding long multiplication modelled alongside.	 Continue to use bar modelling to support problem solving	 18 x 3 in the first answer row. 18 x 10 in the second answer row. Show multiplying by 10 by putting a 0 in the ones column first. 
Multiplying decimals (up to 2 decimal places) by a 1-digit number.	Use base 10/dienes (hundred ‘flat’ = whole, ten ‘bar’ = 0.1 and ones ‘cube’ = 0.01) to show grouping/repeated addition: 	Use hundred squares to reinforce idea that multiplying decimals is repeated addition or adding groups of the same amount: 	Remind children that the single digit belongs in the ones column. Line up the decimal points in the question and the answer. 

YEAR 1 DIVISION

OBJECTIVE / STRATEGY	CONCRETE	PICTORIAL	ABSTRACT
Division as sharing	 I have 10 cubes – can you share them equally between two? 	Children use pictures or shapes to share quantities  8 shared between 2 is 4  Children use bar modelling to show and supportunderstanding.  12 ÷ 4 = 3	12 shared between 3 is 4 12 ÷ 3 = 4
Division as grouping	Divide quantities into equal groups using cubes, counters, objects or place value counters to aid understanding. 	Use number lines for grouping  12 ÷ 3 = 4	28 ÷ 7 = 4 Divide 28 into 7 groups. How many are in each group?

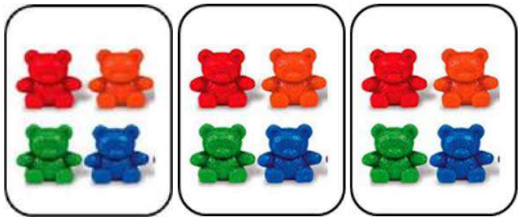
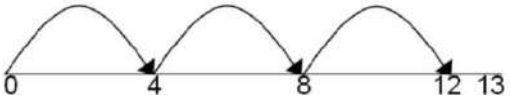
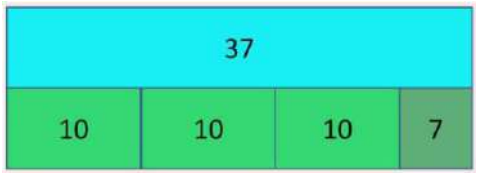
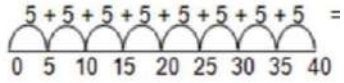
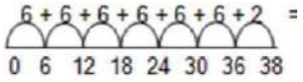
		Think of the bar as a whole. Split it into the number of groups you are dividing by and work out how manywould be within each group. 	

YEAR 2 DIVISION

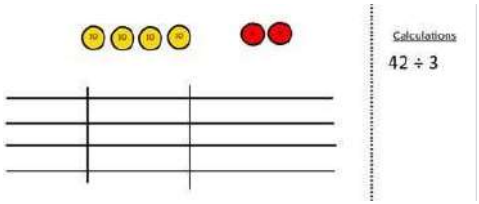
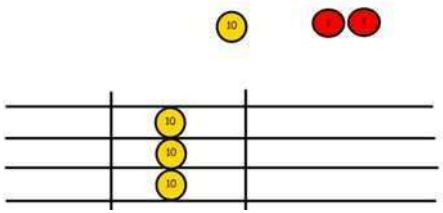
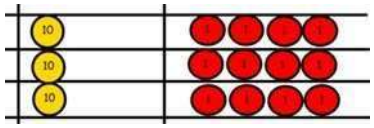
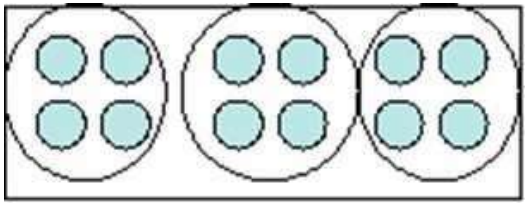
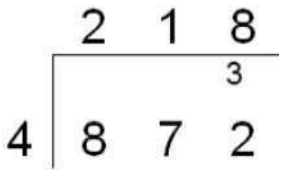
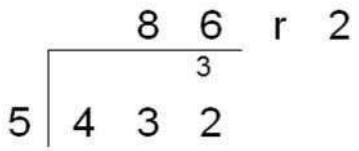
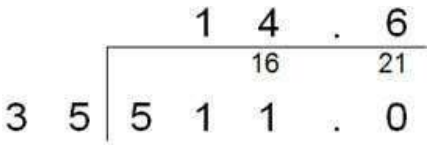
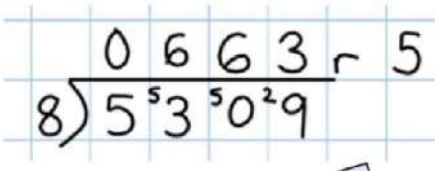
OBJECTIVE / STRATEGY	CONCRETE	PICTORIAL	ABSTRACT
Division as grouping	Use cubes, counters, objects or place valuecounters to aid understanding.  24 divided into groups of 6 = 4 	Continue to use bar modelling to aid solving division problems. 	How many groups of 6 in 24? 24 ÷ 6 = 4
Division with arrays	 Link division to multiplication by creating anarray and thinking about the number sentences that can be created. E.g. 15 ÷ 3 = 5 5 x 3 = 15 15 ÷ 5 = 3 3 x 5 = 15	Draw an array and use lines to split the array into groups to make multiplication and division sentences 	Find the inverse of multiplication and division sentences by creating eight linking number sentences 7 x 4 = 28 4 x 7 = 28 28 ÷ 7 = 4 28 ÷ 4 = 7 28 = 7 x 4 28 = 4 x 7 4 = 28 ÷ 7 7 = 28 ÷ 4

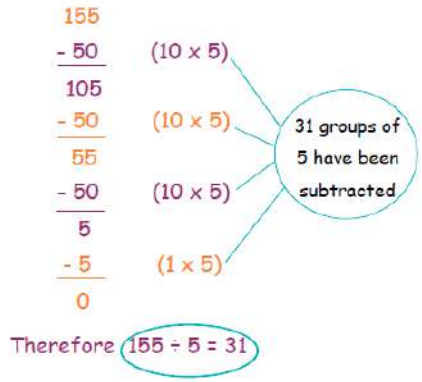
YEAR 3 DIVISION

(Greater Depth Year 2)

OBJECTIVE / STRATEGY	CONCRETE	PICTORIAL	ABSTRACT
Division with remainders	14 ÷ 3 = Divide objects between groups and see how much is left over  	Jump forward in equal jumps on a number line then see how many more you need to jump to find a remainder.  Draw dots and group them to divide an amount and clearly show a remainder.  Use bar models to show division with remainders.    	Complete written divisions and show the remainder using r 

YEARS 4–6 DIVISION

OBJECTIVE / STRATEGY	CONCRETE	PICTORIAL	ABSTRACT
Short Division - divide at least 3-digit numbers by 1 digit.	Use place value counters to divide using the bus stop method alongside 42 ÷ 3=  Start with the biggest place value column, we are sharing 40 into three groups. We can put 1 ten in each group and we have 1 ten left over.  We exchange this ten for ten ones and then share the ones equally among the groups.  We look at the counters in one of the groups - the answer is 14.	Students can continue to use drawn diagrams with dots or circles to help them divide numbers into equal groups.  Encourage them to move towards counting in multiples to divide more efficiently.	Begin with divisions that divide equally with no remainder.  Move onto divisions with a remainder.  Finally move into decimal places to divide the total accurately.  

Long Division (Chunking Method) – for dividing at least 3-digits by 2-digit numbers	Make connection with repeated subtraction. Use place value counters to support. Recognise that repeatedly taking away such a small amount from a large number is not efficient and use this as an introduction to the concept of chunking.	Make connections with repeated subtraction. Show concept on number line.	Laid out like repeated subtraction. Start with calculations that don't have a remainder, e.g.:  Then move on to calculations with remainders: