Problem solving guidance

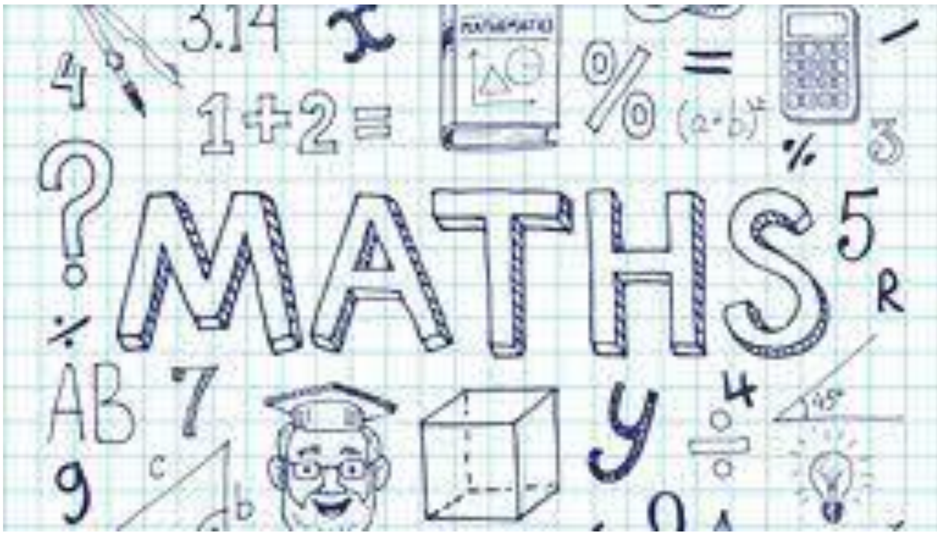
Patterns and rules

EYFS KS1

Lower KS2

Upper KS2

Spring 1



Mathematics Intent

At Teagues Bridge, our intention is **ambitious.** We aim to create strong mathematicians who have the necessary skills and understanding to tackle mathematical challenges in varying contexts, including the ability to reason and apply their knowledge to solving problems. This should mean that children are able to apply their knowledge to everyday life and can **aspire** to achieve anything that they want. We want our pupils to have strong mental manipulation and to use written strategies when appropriate.

Our philosophy for mathematics is replacing an idea that maths is lots of rules and numbers with a study of patterns and connected ideas. In early years they will build a foundation of number understanding and representation through mainly concrete and pictorial representations. The approach will be supported by in depth questioning, throughout the school to develop mastery.

Use of CPA is encouraged to ensure the curriculum is accessible for all children and that they all have the **opportunity** and are able to demonstrate their understanding in a variety of ways. This will enable them to have a good understanding of maths and not just the ability to follow a procedure. We want to **empower** them to want to ask questions and want to find the answers.

Aims: The national curriculum for mathematics aims to ensure that all pupils:

- become fluent in the fundamentals of mathematics, including through varied and frequent practice with increasingly complex problems over time, so that pupils develop conceptual understanding and the ability to recall and apply knowledge rapidly and accurately.
- reason mathematically by following a line of enquiry, conjecturing relationships and generalisations, and developing an argument, justification or proof using mathematical language
- can solve problems by applying their mathematics to a variety of routine and nonroutine problems with increasing sophistication, including breaking down problems into a series of simpler steps and persevering in seeking solutions.

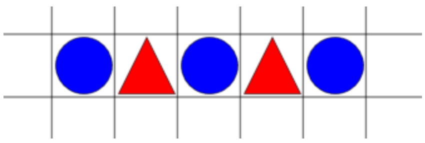
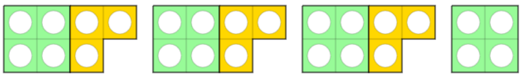
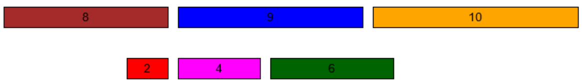
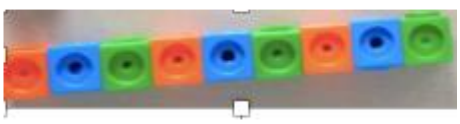
Mathematics is an interconnected subject in which pupils need to be able to move fluently between representations of mathematical ideas. The programmes of study are, by necessity, organised into apparently distinct domains, but pupils should make rich connections across mathematical ideas to develop fluency, mathematical reasoning and competence in solving increasingly sophisticated problems. They should also apply their mathematical knowledge to science and other subjects.

The expectation is that the majority of pupils will move through the programmes of study at broadly the same pace. However, decisions about when to progress should always be based on the security of pupils' understanding and their readiness to progress to the next stage. Pupils who grasp concepts rapidly should be challenged through being offered rich and sophisticated problems before any acceleration through new content. Those who are not sufficiently fluent with earlier material should consolidate their understanding, including through additional practice, before moving on.

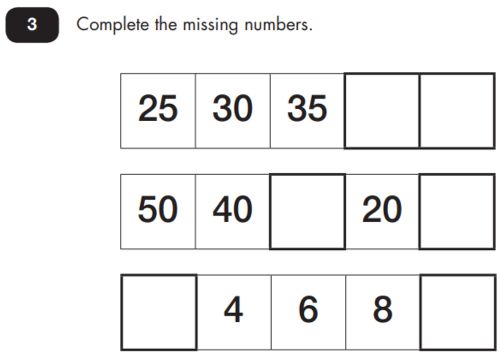
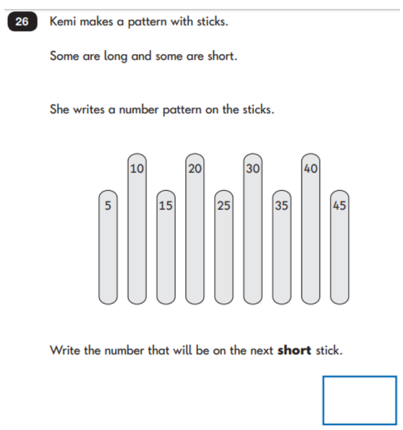
Our lessons are structured to enable all children to achieve and have an **opportunity** to make progress with their learning. Each lesson begins with a **CLIC maths** activity, where they have chance to develop their mental strategies, secure number facts and number manipulation. They then **develop** their mathematical fluency with the teacher modelling and explaining before they have a go themselves. Children then have a **reasoning/ problem solving** activity which is a variation of the previous work to demonstrate they have mastered the objective. Children who are ready can then **challenge** themselves with a task that requires applying the learning to a greater depth. We have our own programme of study which is supported with schemes like White Rose to support.

EYFS and Key Stage one – Patterns and rules

Patterns & Rules	EYFS (conditional)	KSI (conditional)
I know how to spot the pattern/rule and describe it mathematically. I know how to design a process or arithmetic strategy using the rules.	I know what comes next. I know how to make a repeating pattern.	I know what a repeating pattern is. I know how to find the step size, following a rule. I know how to describe patterns mathematically using signs and symbols. I know how to use the inverse.

Key Skills and Strategy Development EYFS	Question stems
Spot the pattern/rule and describe it using colours or shapes for example.	Is this a repeating pattern? Is this a step size, following a rule? Can you describe it?
Follow a rule, such as adding one more each time.	What arithmetic knowledge will you use?
Example problems	Model answers
  	**Conditional Knowledge** Early years Use combinations of number facts, shape facts, pattern facts, methods of counting, addition and subtraction to ⇒ play games ⇒ sing songs ⇒ answer questions ⇒ talk about everyday objects ⇒ solve problems using objects within continuous provision
	

Keystage 1 ~ Patterns and Rules

<table>
<tr><th>Key Skills and Strategy Development KS1</th><th>Question stems</th></tr>
<tr><td>Spot the pattern/rule and describe it mathematically.</td><td>Is this a repeating pattern?
Is this a step size, following a rule?
Can you describe it mathematically?</td></tr>
<tr><td>Design a process or arithmetic strategy using the rules</td><td>What arithmetic knowledge will you use?</td></tr>
<tr><td>Prove mathematically</td><td>What will the proof look like?</td></tr>
<tr><td>Declarative knowledge</td><td>Procedural knowledge</td></tr>
<tr><td>Key Stage 1 Concepts, representations and associated vocabulary: ⇒ simple fractions ⇒ basic arithmetic: the numbering system and its symbols, place value, conventions for expressions and equations, counting, addition, subtraction, equal sharing, doubling, balancing simple arithmetic equations, classifying numbers (odd, even, teens), inverse operations, estimation, numerical patterns ⇒ basic measurement: length; capacity; time; position; relative size, position, direction, motion, quantity ⇒ Currency and coinage ⇒ Basic geometry: 2D and 3D shapes, geometric patterns</td><td>Key Stage 1 Efficient and accurate methods: ⇒ counting up and down in 1s, 2, 5s, 10s and 1/2s; addition; subtraction, equal sharing, division, and multiplication ⇒ reading, writing of the digits/symbols, vocabulary and phrases required for working with simple fractions, arithmetic expressions and equations ⇒ measuring length, capacity, time and monetary value ⇒ presentation and layout of calculations ⇒ using a ruler ⇒ spotting and making geometric and numerical patterns.</td></tr>
<tr><td>Example problems</td><td>Model answers</td></tr>
<tr><td></td><td>Y1 -count, read and write numbers to 100 in numerals; count in multiples of twos, fives and tens</td></tr>
<tr><td></td><td>Y1 - count, read and write numbers to 100 in numerals, count in multiples of twos, fives and tens.
Y2 - count in steps of 2, 3, and 5 from 0, and in tens from any number, forward and backward</td></tr>
</table>

5 Kim is counting in 2s. She starts counting at 32 **32 …** Circle the numbers that Kim will say. **45 36 44**	Y2 – count in steps of 2, 3, and 5 from 0, and in tens from any number, forward and backward
32 Here is part of a number pattern. The numbers increase by **five** each time. 2 7 12 17 22 Write the next **even** number in the pattern. ☐ 1 mark	Y1 – count, read and write numbers to 100 in numerals, count in multiples of twos, fives and tens.
I think of a number and add 3. The answer is 15. What is my number? ? → +3 → 15 12 ← -3 ← 15	Y2- recognise and use the inverse relationship between addition and subtraction and use this to check calculations and solve missing number problems.
20 Write the missing numbers to continue the number pattern. 7 + 3 = 10 17 + 3 = 20 ☐ + 3 = 30 ☐ + 3 = ☐ 47 + 3 = 50 1 mark	Y2 – numbers to develop further their recognition of patterns within the number system

Lower Key Stage 2 – Patterns and rules

Patterns & Rules	EYFS (conditional)	KS1	LKS2
I know how to spot the pattern/rule and describe it mathematically. I know how to design a process or arithmetic strategy using the rules.	I know what comes next. I know how to make a repeating pattern.	I know what a repeating pattern is. I know how to find the step size, following a rule. I know how to describe patterns mathematically using signs and symbols.	I know what a repeating pattern is. I know how to follow a rule. I know when the pattern increases or decreases. I know how to apply inverse relationships. I know how to describe rules mathematically using signs and symbols.

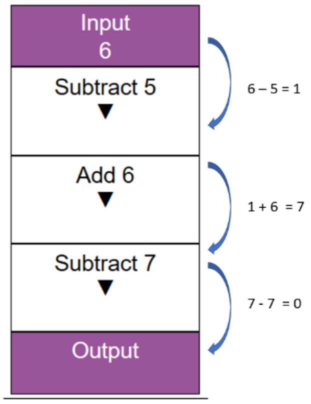
Key Skills and Strategy Development LKS2	Question stems
Spot the pattern/rule and describe it mathematically.	Is this a repeating pattern? Is this a step size, following a rule? Is it increasing or decreasing? Can you describe it mathematically?
Design a process or arithmetic strategy using the rules	What arithmetic knowledge will you use? What inverse relationships will you use?
Prove mathematically	What will the proof look like? Are there other examples that satisfy the rule?

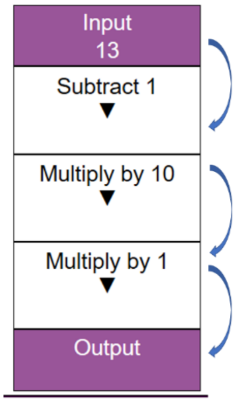
Declarative knowledge	**Procedural knowledge**
Lower Key Stage 2 Concepts, representations, and associated vocabulary: ⇒ Arithmetic: enhanced knowledge of the code for number (to 1000s) including patterns and associated rules for addition and subtraction of numbers, decimal numbers, place value, negative numbers, associative and distributive laws ⇒ Maths facts: all multiplication facts for the 3, 4, 6, 7, 8, 9, 11, 12 multiplication tables, decimal equivalents of key fractions ⇒ equivalent fractions.	Lower Key Stage 2 Efficient and accurate methods: ⇒ counting up and down in multiples of 3, 4, 6, 7, 8, 9, 11, 12, 25, 50, 100, 1000, in tenths, in ones through to negative numbers ⇒ Column addition and subtraction ⇒ Mental addition and subtraction using patterns and rules of number ⇒ Short division and multiplication ⇒ Mental multiplication using derived fact

<table>
<tr><td></td><td></td></tr>
<tr><th>Example problems</th><th>Model answers</th></tr>
<tr><td>1 The numbers in this sequence increase by 14 each time.
Write the missing numbers.<table><tr><td></td><td>82</td><td>96</td><td></td><td>124</td><td>138</td><td></td></tr></table>2 marks</td><td>Y3 – add and subtract numbers with up to three digits, in a sequence</td></tr>
<tr><td>Fill in the missing numbers.
1 ten + 3 ones = 13
2 tens + ___ ones = 23
3 tens + 3 ones = ___
___ tens + 3 ones = 43
Can you see a pattern?
What will the next number sentence be?</td><td>Y3 – add and subtract numbers with up to three digits, in a sequence</td></tr>
<tr><td>1 Write the next two numbers in each sequence.<table><tr><td>6</td><td>12</td><td>18</td><td></td><td></td></tr><tr><td>21</td><td>28</td><td>35</td><td></td><td></td></tr><tr><td>90</td><td>81</td><td>72</td><td></td><td></td></tr></table></td><td>Y3 – add and subtract numbers with up to three digits, in a sequence.</td></tr>
<tr><td>1 Complete the sequences.<table><tr><td>2,000</td><td>3,000</td><td></td><td>5,000</td></tr></table><table><tr><td></td><td>5,400</td><td>4,400</td><td>3,400</td></tr></table></td><td>Y4 – pupils become fluent in the order and place value of numbers beyond 1000, including counting in tens, and hundreds and thousands.</td></tr>
<tr><td>Complete the number track.<table><tr><td>0</td><td>25</td><td>50</td><td></td><td></td><td></td><td>150</td></tr></table></td><td>Y4 – counting in sequences</td></tr>
<tr><td></td><td>Y3 – add and subtract numbers mentally.</td></tr>
</table>

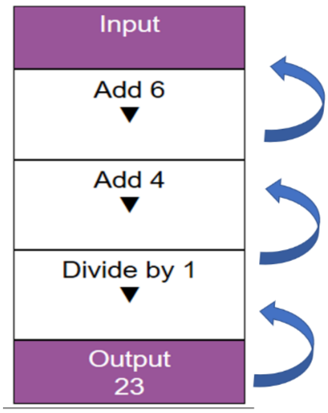
1 Complete the sequences.

0	50	100			250	
44		36	32			20





Y4 – estimate and use inverse operations to check answers to a calculation



Y4 - estimate and use inverse operations to check answers to a calculation

Upper Key Stage 2 – Patterns and rules

Patterns & Rules	EYFS (conditional)	KS1	LKS2	UKS2
I know how to spot the pattern/rule and describe it mathematically. I know how to design a process or arithmetic strategy using the rules.	I know what comes next. I know how to make a repeating pattern.	I know what a repeating pattern is. I know how to find the step size, following a rule. I know how to describe patterns mathematically using signs and symbols.	I know what a repeating pattern is. I know how to follow a rule. I know when the pattern increases or decreases. I know how to apply inverse relationships. I know how to describe rules mathematically using signs and symbols.	I know what a repeating pattern is and can predict sequences. I know how to apply a rule including more than one step. I know when the rule increases or decreases or is incremental. I know how to apply inverse relationships and reverse strategies. I know how to describe rules mathematically using signs and symbols including expressions.

Key Skills and Strategy Development LKS2	Question stems
Spot the pattern/rule and describe it mathematically.	What is the rule in the sequence? Is it increasing or decreasing in regular step sizes? Can you describe it mathematically?
Design a process or arithmetic strategy using the rules	What arithmetic knowledge will you use? What inverse relationships will you use?
Prove mathematically	What will the proof look like? Are there other examples that satisfy the rule? Is there an expression for the rule? The nth term?

Declarative knowledge	**Procedural knowledge**
Upper Key Stage 2 Concepts, representations, and associated vocabulary: ⇒ Enhanced knowledge of the code for number: up to and within 1 000 000, multiples, factors, decimals, prime number facts to 100, composite numbers, indexation Conversion facts metric to imperial measurements and vice versa ⇒ Key circle, quadrilateral and triangle facts and formulae (e.g. angles on a straight line sum to 180 degrees) Rules and principles governing order of	Upper Key Stage 2 Efficient and accurate methods ⇒ Scaling, coordinate geometry in all four quadrants ⇒ Division with remainders as fractions, decimals and where rounding is needed ⇒ Fractions: conversion mixed to improper and vice versa, add, subtract and multiply ⇒ Finding percentages of amounts ⇒ ⇒

operations for square and cubed numbers ⇒ Properties of linear sequences Rules and principles governing order of operations.	Use of order of operations ⇒ Convert between fractions, decimals and percentages. Linear algebra.
Example problems	**Model answers**
7 Here is a number sequence. 75 50 25 ☐ ☐ 1 mark Write the next two numbers in the sequence.	Y5 – count forwards or backwards in steps of powers of 10 for any given number up to 1 000 000
4 Write the next **two** numbers in this sequence. 1,780 1,880 1,980 ☐ ☐ 1 mark	Y5 – count forwards or backwards in steps of powers of 10 for any given number up to 1 000 000
21 The numbers in this sequence increase by the same amount each time. Write the missing numbers. ☐ 1 $1\frac{5}{8}$ $2\frac{1}{4}$ ☐	Y6 – compare and order fractions, including fractions > 1.
23 Here is a pattern of number pairs. a | b 1 | 9 2 | 19 3 | 29 4 | 39 Complete the **rule** for the number pattern. $b = \square \times a - \square$ 1 mark	Y6 – use simple formulae.
	Y6 – find pairs of numbers that satisfy an equation with two unknowns

17

$$x + 2y = 20$$

x and y are whole numbers **less than 10**

What could x and y be?

x =

y =

---

10 Ken thinks of a number.

He divides it by 3

The answer is 72

What number was Ken thinking of?

1 mark

Y5 - solve addition and subtraction multi-step problems in contexts, deciding which operations and methods to use and why.

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22 Megan uses these number machines to calculate how many diagonals different shapes have.

	number of vertices			number of diagonals
triangle	3	× 0	÷ 2	0
quadrilateral	4	× 1	÷ 2	2
pentagon	5	× 2	÷ 2	5

Complete the number machine for the **octagon**.

octagon				

1 mark

Y6 - use simple formulae.

Y6 - use simple formulae

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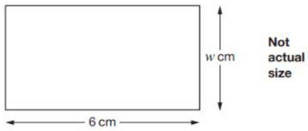
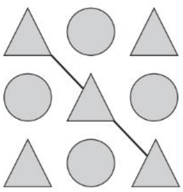
<tr>
<td>
20 The length of this rectangle is 6 cm.
The width is w cm.


Circle all the methods below that can be used to work out the perimeter of the rectangle.
$w \times 6$ $w \times 2 + 12$
$2 \times (w + 6)$ $6 + w + 6 + w$
2 marks
</td>
<td></td>
</tr>
<tr>
<td>
21

Each shape stands for a number.
The total of the shapes on the diagonal line is 48
The total of all the shapes is 200
Calculate the value of each shape.
 =
1 mark
 =
1 mark
</td>
<td>
Y5 – solve addition and subtraction multi-step problems in contexts, deciding which operations and methods to use and why.

Y6 – express missing number problems algebraically
</td>
</tr>
</table>