Problem solving guidance

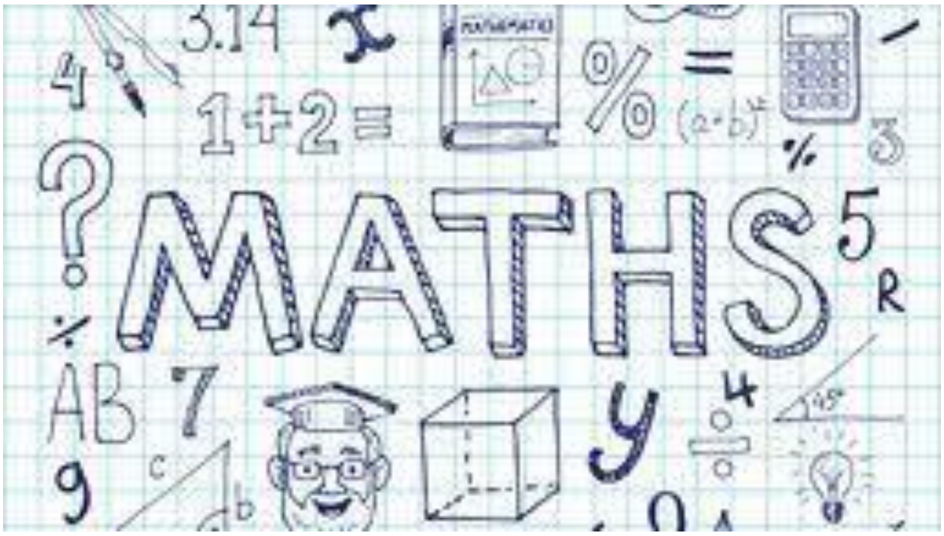
Logic problems

EYFS KS1

Lower KS2

Upper KS2

Autumn 2



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.

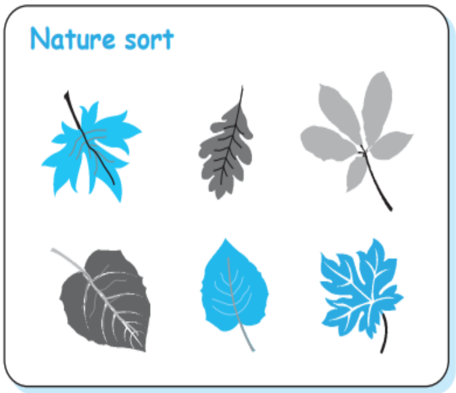
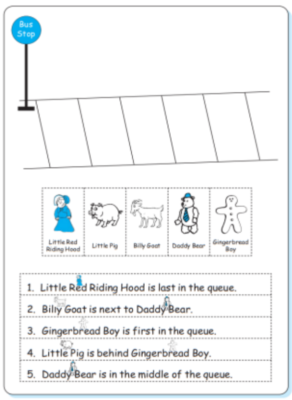
The expectation is that the majority of pupils will move through the programmes of study at broadly the same pace. However, decisions about when to progress should always be based on the security of pupils' understanding and their readiness to progress to the next stage. Pupils who grasp concepts rapidly 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 – Logic

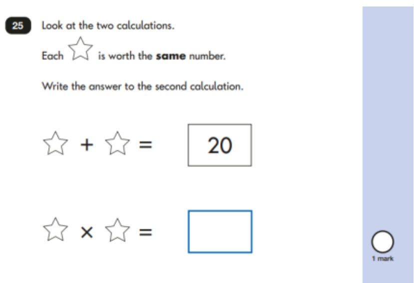
Logic	**EYFS (conditional)**	**KS1 (conditional)**
I know how to identify the starting point by generalising or classifying. I know to check solutions to match the criteria.	I know how and when to find a starting point. I know what I should do next.	I know where the starting point is. I know that I must find the best clue. I know what is true and when I can be certain.

Key Skills and Strategy Development EYFS	Question stems
Work systematically.	How will I put my objects in order? What resources shall we choose?
Follow a set of instructions.	What am I allowed to do?
I know when items/objects are the same.	Have I solved the problem?

Example problems	Declarative and procedural knowledge
	Early years: numbers and number bonds to 10; concepts and vocabulary for talking about maths and mathematical patterns (size, weight, capacity, quantity, position, distance, time) Early years: accurate counting, single digit addition and subtraction, halving doubling and sharing. Sorting and matching
	Following clues.

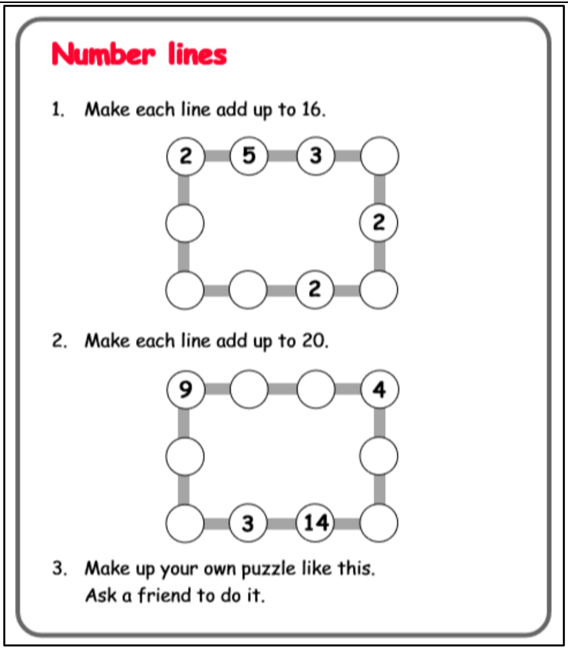
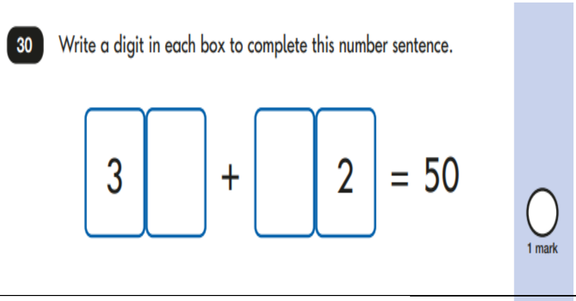
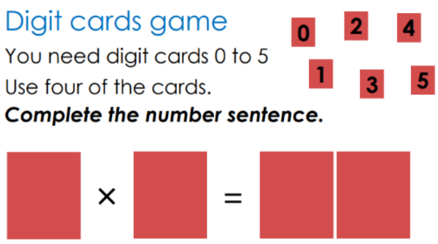
Keystage 1 ~ Logic

Key Skill and Strategy Development KS1	Question stems
Identify the starting point by generalising or classifying.	Where is your starting point? Which is the best clue? What do you know is true?
Check solutions match the criteria.	Have I answered the question?

<table>
<tr><th>Declarative knowledge</th><th>Procedural knowledge</th></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 pattern</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</td></tr>
<tr><th>Example problems</th><th>Model answers</th></tr>
<tr><td>
</td><td>Y2 -recall and use addition and subtraction facts to 20 fluently, and derive and use related facts up to 100</td></tr>
<tr><td>1 2 3 4 5 6 7 8 9
Use the clues to write the digits 1 to 9 in the grid.

A: This digit is odd.
B: This digit is less than 2.
C: This digit is half of 12.
D: This digit is 1 more than E.
E: This digit is equal to 3 + 4.
F: This digit is 2 more than B.
G: This digit is between 1 and 3
H: This digit is even.
I: This is the largest digit.</td><td><table><tr><td>A</td><td>5</td><td>B</td><td>1</td><td>C</td><td>6</td></tr><tr><td>D</td><td>8</td><td>E</td><td>7</td><td>F</td><td>3</td></tr><tr><td>G</td><td>2</td><td>H</td><td>4</td><td>I</td><td>9</td></tr></table>
Y1- read, write and interpret mathematical statements involving addition (+), subtraction (–) and equals (=) signs ♣</td></tr>
</table>

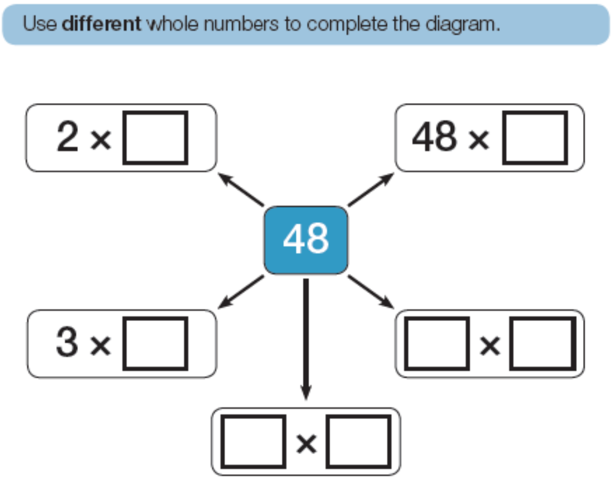
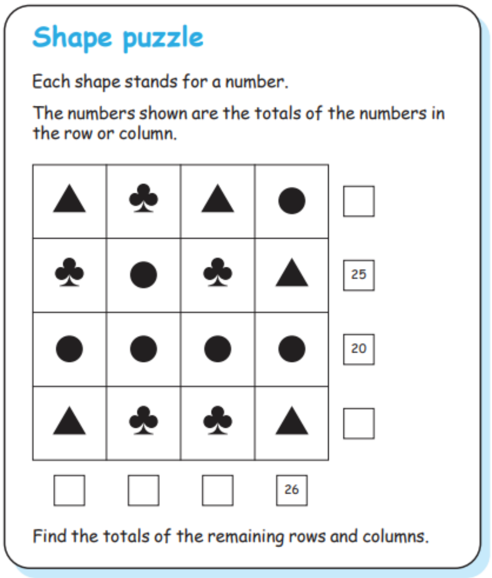
<table>
<tr><td></td><td>represent and use number bonds and related subtraction facts within 20
Y2 - recall and use addition and subtraction facts to 20 fluently, and derive and use related facts up to 100</td></tr>
<tr><td>Use four different number cards to complete the number sentences below.
5 15 25 35 45 55
$\square + \square = 60$
$\square + \square = 60$</td><td>Y2 - add and subtract numbers using concrete objects, pictorial representations, and mentally, including: ♣ a two-digit number and ones</td></tr>
<tr><td>5
$\square \times \square = 25$</td><td>Y2 -recall and use multiplication and division facts for the 2, 5 and 10 multiplication tables, including recognising odd and even numbers.</td></tr>
<tr><td>11 Junaid has sorted some numbers in the table below.
The numbers must be greater than 10 but less than 50
Circle the number that is in the wrong place in the table.
<table>
<tr><th>Odd numbers</th><th>Even numbers</th></tr>
<tr><td>45 17 28 23 15</td><td>32 64 16 44 20</td></tr>
</table>
Put one more number in each group in the table.</td><td>Y1 - They practise counting as reciting numbers and counting as enumerating objects, and counting in twos, fives and tens from different multiples to develop their recognition of patterns in the number system (for example, odd and even numbers), including varied and frequent practice through increasingly complex questions.</td></tr>
</table>

 	Y1 - read, write and interpret mathematical statements involving addition (+), subtraction (–) and equals (=) signs ♣ represent and use number bonds and related subtraction facts within 20
 	Y2 -show that addition of two numbers can be done in any order (commutative) and subtraction of one number from another cannot. recognise and use the inverse relationship between addition and subtraction and use this to check calculations and solve missing number problems
 	Y2 -recall and use multiplication and division facts for the 2, 5 and 10 multiplication tables, including recognising odd and even numbers.

Lower Key Stage 2 – Logic

Logic	EYFS (conditional)	KS1 (conditional)	LKS2 (conditional)
I know how to identify the starting point by generalising or classifying. I know to check solutions to match the criteria.	I know how and when to find a starting point. I know what I should do next.	I know where the starting point is. I know that I must find the best clue. I know what is true and when I can be certain.	I know where the starting point is. I know how to find the best clue. I know when I can place information with certainty. I know when my deduction accurate. I know how to present the solution.

Key Skill and Strategy Development LKS2	Question stems
Identify the starting point by generalising or classifying.	Where is your starting point? Which is the best clue? What can you place with certainty? Is your deduction accurate?
Check solutions match the criteria.	Have I answered the entire question?
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. Geometry facts: right angles, acute and obtuse angles, right angles in whole and half turns, symmetry, triangle, and quadrilateral classifications; horizontal, perpendicular, parallel and per	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 facts. Draw 2D and 3D shapes .
Example problems	Model answers

	Y3 – recall and use multiplication and division facts for the 3, 4 and 8 multiplication tables. Y4 –use place value, known and derived facts to multiply and divide mentally
	Y4 – solve addition and subtraction deciding which operations and methods to use and why

Here are six number cards.

They are all factors of the same number.

3	4	6
8	12	16

Use the cards to complete 3 factor pairs.

□ × □

□ × □

□ × □

Write one more factor pair for this number.

□ × □

Y3 – recall and use multiplication and division facts for the 3, 4 and 8 multiplication tables.
Y4 –use place value, known and derived facts to multiply and divide mentally

Numbers of boys and girls

Use these clues to find the number of boys and girls in each class.

- There are a total of 114 children in the school.
- There are 14 girls in Class 2.
- Class 4 has twice as many girls as class 2.
- No class has the same number of children.
- There are 52 boys in the school in total.
- In class 1 there are half as many boys as in class 2.
- In class 2 there are a total of 30 children.
- In class 3 there are an equal number of girls and boys.
- In class 4 there are 10 boys.
- There are a different number of boys and girls in the school.

Numbers of boys and girls

	Class 1	Class 2	Class 3	Class 4	Total
Girls					
Boys					
Total					

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

Use four **different** whole numbers to complete the sentences.

□ × □ = 24

□ × □ = 24

Y3 – recall and use multiplication and division facts for the 3, 4 and 8 multiplication tables.

<table><tr><td>Ryan thinks of a 4-digit whole number where every digit is different. Use the clues to work out Ryan's number.</td><td>All digits are even.</td><td>Ryan's number is smaller than 4500.</td></tr><tr><td>The third digit is not 8.</td><td>Ryan's number is a multiple of 5.</td><td>Ryan's number is between 4000 and 5000.</td></tr></table>	Y4- order and compare numbers beyond 1000. Look for all or every first.
<table><tr><td>Megan thinks of a sequence of four 2-digit numbers. Use the clues to work out the numbers in the sequence.</td><td>The first number in the sequence is an odd number.</td><td>All of the numbers are multiples of 5.</td></tr><tr><td>The last number in the sequence is less than 50.</td><td>The sequence goes up in regular steps.</td><td>9 is a factor of the last number in the sequence.</td></tr></table>	Y3 - Y3 - recall and use multiplication and division facts for 5 x multiplication tables.

Upper Key Stage 2 – Logic

Logic	EYFS (conditional)	KS1	LKS2	UKS2
I know how to identify the starting point by generalising or classifying. I know to check solutions to match the criteria.	I know how and when to find a starting point. I know what I should do next.	I know where the starting point is. I know that I must find the best clue. I know what is true and when I can be certain.	I know where the starting point is. I know how to find the best clue. I know when I can place information with certainty. I know when my deduction accurate. I know how to present the solution.	I know where the most useful information is. I know how to find the generalisations and rules. I know that some information can be eliminated. I know the best way present the solution. I know when I have answered the question fully.

Key Skill and Strategy Development LKS2	Question stems
Identify the starting point by generalising or classifying. Manage positive and negative information.	Where is the most useful information? What are the generalisations and rules? What can you place with certainty? Can you eliminate information?
Check solutions match the criteria.	How shall I present the solution? In a table? Have I answered the entire question?
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 for square and cubed numbers Rules and principles governing order of operations.	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 ⇒ Convert between fractions, decimals and percentages Linear algebra, basic trigonometry.
Example problems	Model answers

<table>
<tr>
<td>Put three whole numbers less than 10 to make this equation true.

☐ x ☐ x ☐ = 105</td>
<td>Y5 -identify multiples and factors, including finding all factor pairs of a number, and common factors of two numbers

5 x 3 x 7 = 105</td>
</tr>
<tr>
<td>Here are four number cards.

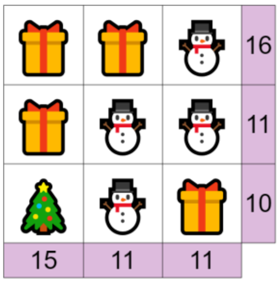
2 3 4 7

Layla uses each card once to make a four-digit number.
She places:
• 4 in the tens column
• 2 so that it has a higher value than any of the other digits
• the remaining two digits so that 7 has the higher value.

Write a digit in each box to show Layla's number.

☐☐☐☐</td>
<td>Y5 - read, write, order and compare numbers to at least 1 000 000 and determine the value of each digit</td>
</tr>
<tr>
<td>10 Write the missing square number to make this addition correct.

$8^2 + \_\_\_\_^2 = 73$

1 mark</td>
<td>Y6 - use their knowledge of the order of operations to carry out calculations involving the four operations</td>
</tr>
<tr>
<td>
Simultaneous Grids (mathsbot.com)</td>
<td>Y6 – finding all possibilities for logic</td>
</tr>
<tr>
<td>1 Use each of the digit cards once to fill in the boxes.

-3 -7 0

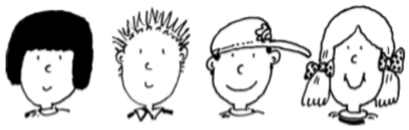
☐ < ☐ < ☐</td>
<td>Y5 - interpret negative numbers in context, count forwards and backwards with positive and negative whole numbers, including through zero .
Y6 -use negative numbers in context, and calculate intervals across zero.</td>
</tr>
<tr>
<td></td>
<td><table>
<tr><th></th><th>Ross</th><th>Tim</th><th>Sam</th></tr>
<tr><td>Strawberry</td><td>✓</td><td>x</td><td>✓</td></tr>
<tr><td>Vanilla</td><td>x</td><td>✓</td><td>✓</td></tr>
<tr><td>Banana</td><td>✓</td><td>✓</td><td>x</td></tr>
</table></td>
</tr>
</table>

<table>
<tr>
<td>Ross, Sam and Tim are brothers.
The shop sells three kinds of ice cream, strawberry, vanilla and banana.
Each brother only likes two flavours and each ice cream flavour is only liked by two of the brothers.
Sam said " Ross likes strawberry and I don't like banana."
Which ice cream does Tim like?
</td>
<td>Y6 – solve practical problems that involve all of the above.</td>
</tr>
<tr>
<td>Sarah, Jenny, Ranjit and Paul each choose a sandwich filling. They can choose from:
◆ tuna,
◆ salad,
◆ cheese, or
◆ chicken.

Each child chooses a different filling.

Clues
◆ Sarah doesn't like fish.
◆ Jenny cannot eat dairy products.
◆ Ranjit does not eat meat or fish.
◆ Jenny doesn't like tuna or chicken.

Which sandwich filling does each child choose?</td>
<td>Y6 – solve practical problems that involve all of the above</td>
</tr>
<tr>
<td>Nick-names

Dawn, Mark, Josh and Tina are friends.

They each have a nick-name.
Their nick-names are Spider, Curly, Ace and Fudgy, but not in that order.

What is the nick-name of each of the friends?

Clues
◆ Josh plays tennis with Curly and goes swimming with Ace.
◆ Tina has been on holiday with Curly but travels to school with Fudgy.
◆ Spider, Curly and Dawn play in the football team.
◆ Spider sometimes goes to tea with Josh.</td>
<td>Y6 – solve practical problems that involve all of the above</td>
</tr>
</table>