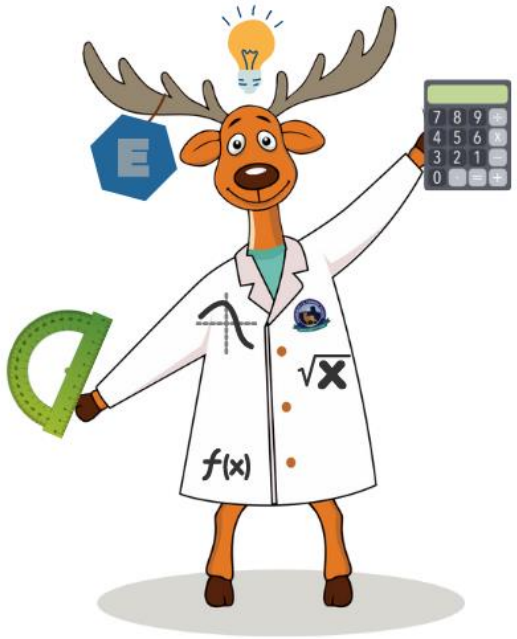
Staindrop CE Primary School

Calculations & Procedures Policy



We want all children at Staindrop CE Primary to...

GO PLACES, MEET PEOPLE MAKE THINGS HAPPEN:

Enjoy & Appreciate the power of Maths in the real world

KNOW MORE

Knowledge

Develop a d**eep understanding of mathematical concepts**, make **connections and spot patterns** across key areas in Maths and relate this to **real life contexts**.

DO MORE

Skills

Learn how to **solve problems** and calculations, **reason mathematically** and **justify** those solutions with mathematical vocabulary and increased confidence.

REMEMBER MORE

Fluency

Become **fluent** in the fundamentals of Mathematics so that they can **instantly recall number facts** and **apply** them with automaticity when solving problems.

Barriers to Mathematical learning for Staindrop CE pupils:

- Socio-economic divide (bridging gap for ALL)
- Above national average for PP in some cohorts
- Above national average for SEND in some cohorts
- Lack of independence (applying knowledge and skills to approach problems/calculations)
- Children struggle to retain facts and recall them with automaticity

THROUGH GOD'S LOVE, WE ARE THE RICH SOIL WHERE ROOTS GROW AND SEEDS FLOURISH (Luke 8: 4-15)

The following calculations and procedures policy has been devised to meet the requirements of the National Curriculum (2014) for the teaching and learning of Mathematics. It outlines the different calculations and strategies that could be taught and used by children from Reception to Year 6.

The policy is designed to give pupils a consistent and smooth progression of learning in calculations across our school. This guidance is also to make teachers and parents aware of the progression of strategies that pupils are formally taught that will support them with their mental and written calculations. In addition, it will help support teachers in identifying appropriate pictorial representations and concrete materials to help develop understanding. It is important to remember that it may sometimes be necessary to revisit strategies from previous year groups if children are working below age related expectations.

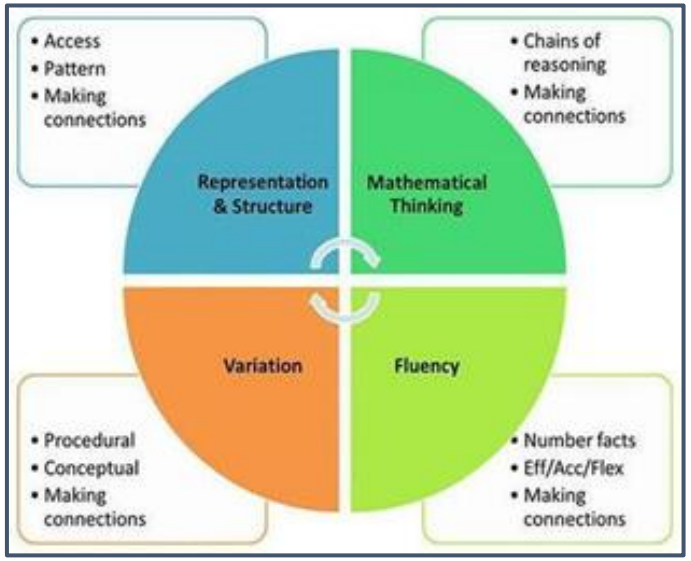
This policy is research based, and must be used alongside our Mathematics Curriculum which includes year group specific coverage, progression of knowledge and skills and key instant recall facts.

Children are taught to use the following processes when deciding on an 'appropriate' and 'efficient' approach to calculation:

Can I do it in my head using a mental strategy?

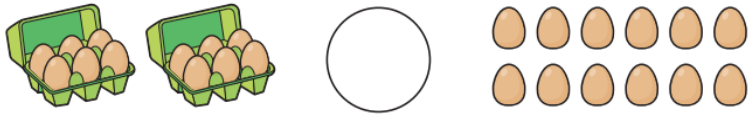
Can I use some jottings (pictorial representations) to help me?

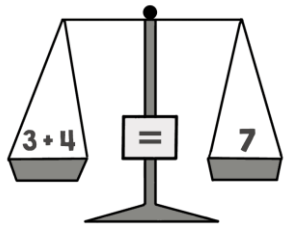
Should I use a formal written method to find the answer?

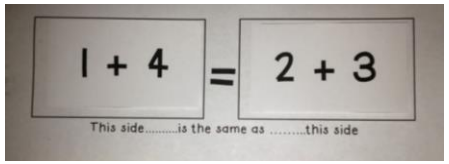


Teaching Equality:

It is important that when teaching the 4 operations that equality (=) is also taught appropriately. Misconceptions that = means that children must 'do something' and that it indicates that an answer is needed are common and must be addressed early on. Teachers should present children with number sentences and problems which place the = sign in different positions, different context and include missing box problems . For example, ?+4=7; 7=3+?; , or = 5+6__ 7+4. In the concrete phase scales and Numicon provide a useful resource to demonstrate equality. Pictorial representations and abstract examples of equality can be used as shown below:







b) 22 + 1 = ☐

c) 54 + 1 = ☐

f) 33 + ☐ = 34

g) 18 = 19 − ☐

Importance of vocabulary:

The 2014 National Curriculum places great emphasis on the importance of pupils using the correct mathematical language as a central part of their learning. Children will be unable to articulate their mathematical reasoning if they lack the mathematical vocabulary required to do so. It is therefore essential that teaching using the strategies outlined in this policy is accompanied by the use of appropriate mathematical vocabulary (See vocabulary progression document).

New vocabulary should be introduced in a suitable context (for example, with relevant real objects, apparatus, pictures or diagrams) and explained carefully. High expectations of the mathematical language used are essential, with teachers modelling and only accepting what is correct.

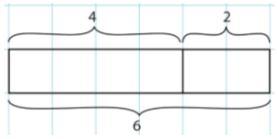
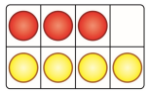
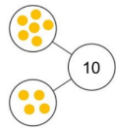
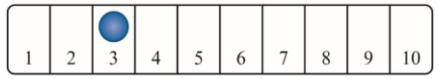
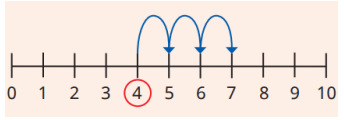
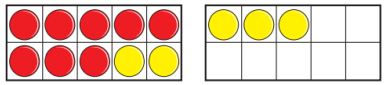
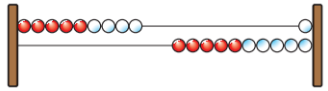
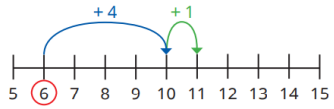
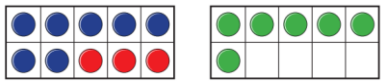
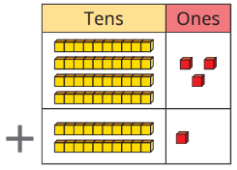
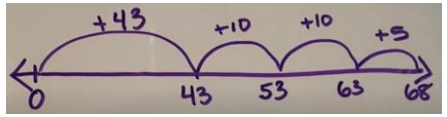
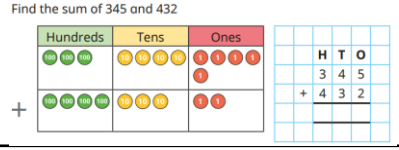
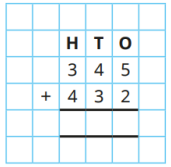
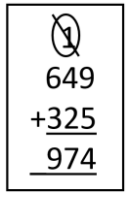
Progression in Calculations...

Reception	Year 1	Year 2
• count reliably with numbers from one to 20. • place numbers in order. • say which number is one more or one less than a given number. • using quantities and objects, they add two single-digit numbers and combine/count on to find the answer. • using quantities and objects, they subtract two single-digit numbers and count back to find the answer. • recall number bonds within 5 and someone to 10 • solve problems practically, including doubling, halving and sharing.	• given a number, identify one more and one less • read, write and interpret mathematical statements involving addition (+), subtraction (–) and equals (=) signs • represent and use number bonds and related subtraction facts within 20 • add and subtract one-digit and two-digit numbers to 20, including zero • solve one-step problems that involve addition and subtraction, using concrete objects and pictorial reprs, and missing number problems such as 7 = – 9. • solve one-step problems involving multiplication and division, by calculating the answer using concrete objects, pictorial representations and arrays with the support of the teacher	• solve problems with addition and subtraction: using concrete objects and pictorial representations, including those involving numbers, quantities and measures applying their increasing knowledge of mental and written methods • recall and use addition and subtraction facts to 20 fluently • derive and use related facts up to 100 • add and subtract numbers using concrete objects, pictorial representations, and mentally, including: a two-digit number and ones, a two-digit number and tens, two two-digit numbers • adding three one-digit numbers • 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 • recall and use multiplication and division facts for the 2, 5 and 10 multiplication tables, including recognising odd and even numbers • calculate mathematical statements for multiplication and division within the multiplication tables and write them using the multiplication (×), division (÷) and equals (=) signs • show that multiplication of two numbers can be done in any order (commutative) and division of one number by another cannot • solve problems involving multiplication and division, using materials, arrays, repeated addition, mental methods, and multiplication and division facts, including problems in contexts

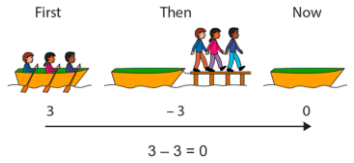
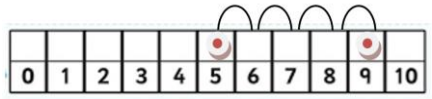
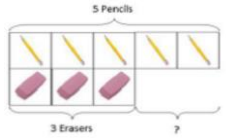
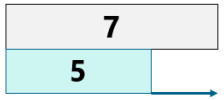
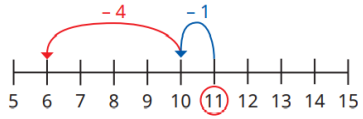
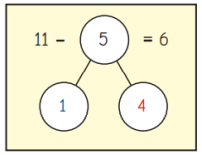
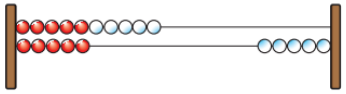
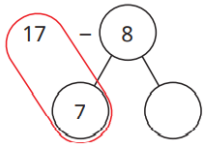
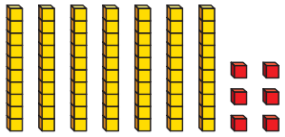
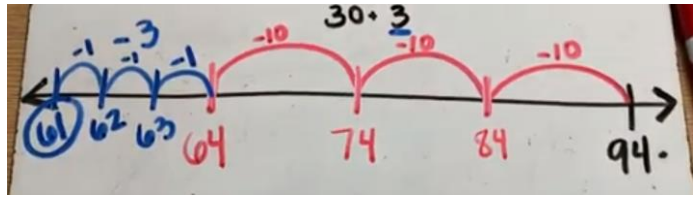
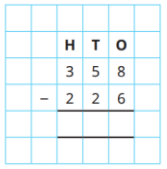
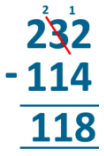
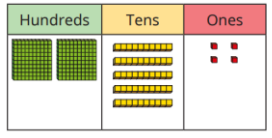
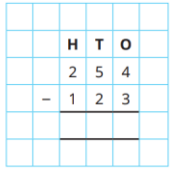
Progression in Calculations...

Year 3	Year 4	Year 5	Year 6
• add and subtract numbers mentally, including: a three-digit number and ones, a three-digit number and tens, a three-digit number and hundreds • add and subtract numbers with up to three digits, using formal written methods • estimate the answer to a calculation and use inverse operations to check answers • solve problems, including missing number problems, using number facts, place value, and more complex addition and subtraction. • recall and use multiplication and division facts for the 3, 4 and 8 multiplication tables • write and calculate mathematical statements for multiplication and division using the multiplication tables that they know, including for two-digit numbers times one-digit numbers, using mental and progressing to formal written methods • solve problems, including missing number problems, involving multiplication and division, including positive integer scaling problems and correspondence problems in which n objects are connected to m objects	• add and subtract numbers with up to 4 digits using the formal written methods of columnar addition and subtraction where appropriate • estimate and use inverse operations to check answers to a calculation • solve addition and subtraction two-step problems in contexts, deciding which operations and methods to use and why • recall multiplication and division facts for multiplication tables up to 12 × 12 • use place value, known and derived facts to multiply and divide mentally, including: multiplying by 0 and 1; dividing by 1; multiplying together three numbers • multiply two-digit and three-digit numbers by a one-digit number using formal written layout • solve problems involving multiplying and adding, including using the distributive law to multiply two digit numbers by one digit, integer scaling problems and harder correspondence problems such as n objects are connected to m objects.	• add and subtract whole numbers with more than 4 digits, including using formal written methods • use rounding to check answers to calculations and determine, in the context of a problem, levels of accuracy • solve addition and subtraction multi-step problems in contexts, deciding which operations and methods to use and why. • multiply numbers up to 4 digits by a one- or two-digit number using a formal written method, including long multiplication for two-digit numbers • multiply and divide numbers mentally drawing upon known facts • divide numbers up to 4 digits by a one-digit number using the formal written method of short division and interpret remainders appropriately for the context • multiply and divide whole numbers and those involving decimals by 10, 100 and 1000 • solve problems involving multiplication and division including using their knowledge of factors and multiples, squares and cubes • solve problems involving addition, subtraction, multiplication and division and a combination of these, including understanding the meaning of the equals sign • solve problems involving multiplication and division, including scaling by simple fractions and problems involving simple rates.	• multiply multi-digit numbers up to 4 digits by a two-digit whole number using the formal written method of long multiplication • divide numbers up to 4 digits by a two-digit whole number using the formal written method of long division, and interpret remainders as whole number remainders, fractions, or by rounding, as appropriate for the context • divide numbers up to 4 digits by a two-digit number using the formal written method of short division where appropriate, interpreting remainders according to the context • perform mental calculations, including with mixed operations and large numbers • identify common factors, common multiples and prime numbers • use their knowledge of the order of operations to carry out calculations involving the four operations • solve addition and subtraction multi-step problems in contexts, deciding which operations and methods to use and why • solve problems involving addition, subtraction, multiplication and division use estimation to check answers to calculations and determine, in the context of a problem, an appropriate degree of accuracy.

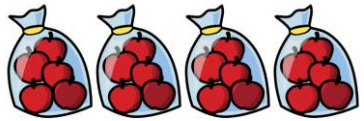
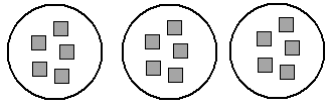
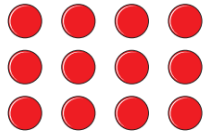
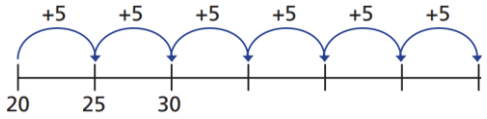
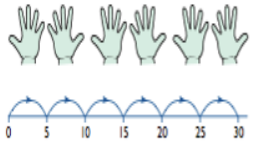
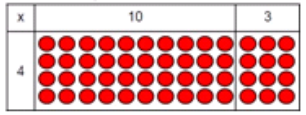
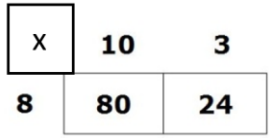
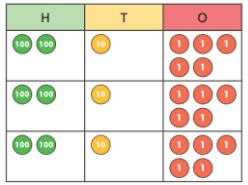
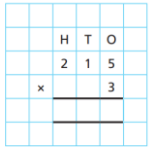
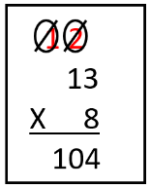
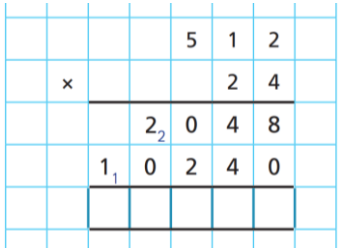
Addition

Stage	Strategy/Method (inc concrete and pictorial representations to expose concept)	Mental strategies
Stage 1	**Counting a set of objects (1-1 correspondence) and combining 2 groups to make a whole (Aggregation)**   There is 3 red and 4 yellow. There are 7 altogether.  	-Subitising -Number patterns (stampolines)
Stage 2	 **Finding a total by adding more (Augmentation)**  "3… 4, 5"  4 + 3 = 7	-Counting on from the largest/group number -Recalling number bonds
Stage 3	The counters show that 8 + 5 = 10 + 3  **1-digit + 1-digit (regrouping to make 10)**  Here is Jo's method for working out 6 + 5 	-Known facts -Near doubles
Stage 4	 7 + 3 + 6 = 16 **Adding 3 1-digit numbers** Fay is working out 9 + 4 + 1 Here are her workings.  9 + 1 = 10 10 + 4 = 14	-Look for known facts e.g doubles, bonds -Make 10
Stage 5	**2-digit and 1-digit and then 2-digit + 2-digit** Using/d*rawing 10s and 1s*  *Number line addition, partitioning smaller number* 	-Counting on from the larger group/number -Partitioning addend and then counting on (tens and ones) -Bridging 10 (using known bonds)
Stage 6	*Column method (show alongside pictorial)* *Start with the ones and move up place value* **Column method (no regrouping)**  	-Counting on from the larger group/number -Partitioning addend and then counting on (tens and ones) -Bridging 10 (using known bonds) -Estimation/Adjusting augend/addend
Stage 7	**Column method (regrouping)** • Start with the ones • Regroup above • Circle regrouped number • Cross out when added 	e.g 2,999 + 300 (add 1 to make 3,000 and subtract 1 from answer)

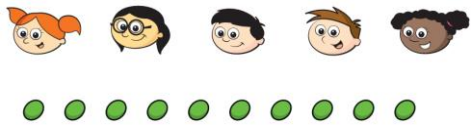
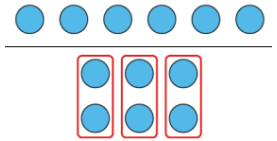
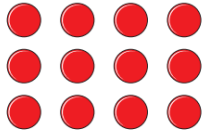
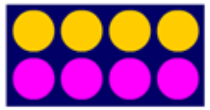
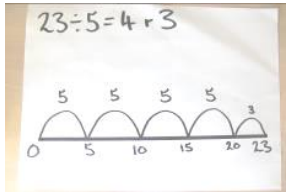
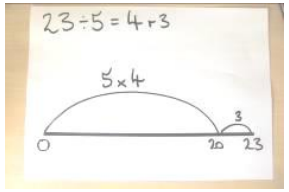
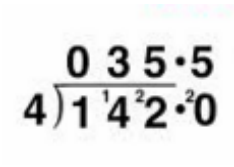
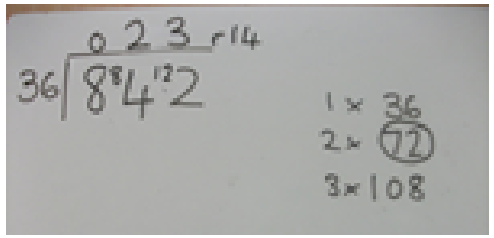
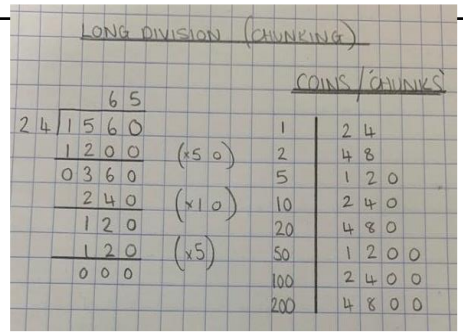
Subtraction

Stage	Strategy/Method (inc concrete/pictorialrepresentations to expose concept)	Mental strategies
Stage 1	 **Removing objects from a group (reduction)**  *"How many left?"* 	-Subitising -Number patterns (stampolines) -Counting backward
Stage 2	  **Finding the difference/ a part** "5… 6, 7" "5 and **2 more** = 7"  6 - 2 = 4 "4 ice-creams do not have flakes"	-Counting on from the largest/group number to find the difference -Recalling number bonds
Stage 3	  **1-digit – 1-digit (crossing 10)**  	-Known facts -Partitioning numbers within 10
Stage 4	**2-digit - 1-digit and then 2-digit - 2-digit** *Drawing 10s and 1s to subtract*  *Number line subtraction, partitioning smaller number* 	-Counting on from the larger group/number to find the difference -Partitioning addend and then counting back (tens and ones) -Bridging 10 (using known bonds)
Stage 5	**Column method (no exchanging)** • *Column method (use alongside PV chart if needed)* • *Start with the ones and move up place value*  	-Counting on from the larger group/number -Partitioning addend and then counting on (tens and ones) -Bridging 10 (using known bonds) -Estimation/Adjusting subtrahend/minuend e.g 4,001 – 3,500 (subtract 1 to make 4,000 and add 1 to answer)
Stage 6	**Column method (exchanging)** • Start with the ones • If the value at the top is not large enough to subtract, exchange from the next place value E.G 232 – 114 = 118 "We can't take 4 ones away from 2 ones, so we exchange a 10 for 10 ones. "We now have 12 – 4 = 8"   	

Multiplication

Stage	Strategy/Method (inc concrete/pictorial representations to expose concept)	Mental Strategies
Stage 1	**Counting in groups of 2's, 5s, and 10s using songs, number fans, counting sticks**  *"Real life representations"* 	*Counting in multiples* *Known x table facts* *Using known facts/doubles etc* **Use rounding as to check answers and level of accuracy**
Stage 2	**Making and counting equal groups of 2, 5 and 10 etc…**   *Repeat addition* *arrays* 	
Stage 3	**Counting in groups of an equal number**  "6 x 5 = 30 "6 lots of 5 = 30"  	
Stage 4	**Multiplying 2-digit and 3-digit by 1-digit** 1. Grid Method 13 x 8 =     2. Short multiplication Start with the ones -Regroup above and circle -Cross off when added. 	
Stage 5	 **Multiplying 3 or more digits by 2-digit numbers** • Multiply by the ones digit • Regroup below • Hold place value with a 0 • Multiply by the tens digit • Regroup below • Add the products using formal addition	

Division

Stage	Strategy/Method (inc concrete/pictorial representations to expose concept)	Mental Strategies
Stage 1	 **Dividing by sharing** *"Real life representations"* *5 balloons shared between 5 children*  	*Skip counting in multiples* *Known x table facts* *Using known facts/doubles etc* *Division using factors* **Use rounding as to check answers and level of accuracy**
Stage 2	 "9 split into groups of 3" **Dividing by grouping**    *Moving on to more organised arrays to recognise groups, and find ½ and ¼ of whole numbers.*	
Stage 3	 *23 ÷ 5 = 4 r3* *"How many 5s in 23?"* **Division through chunking/grouping inc remainders**  *Using known facts*	
Stage 4	*968 ÷ 7 = 137 r5*  **Short division (inc remainders)** • Divide the largest number in the dividend first • Record 'groups above' or place value holder if needed • Exchange any remainders into the next place value column  *Decimal remainders*	
Stage 5	 **Long Division (using coins and given facts to help with larger multiples)** • Write down the 'chunks'/multiples of the divisor • Subtract the largest 'chunk'/multiple • Write the 'chunk'/multiple in brackets • Repeat subtraction until there is no dividend 	

Whole School Approach to Problem Solving

Problem solving is a key component of our Maths Curriculum and is highly valued by teachers and pupils. It is used daily in lessons and challenges pupils to independently seek solutions, explore and discuss patterns and make sense of mathematical problems within different concepts.

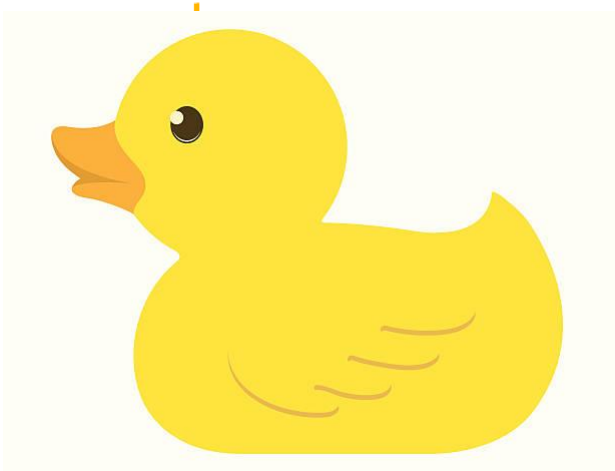
Our whole school approach to problem solving is underpinned by Polya's 4 stages of problem solving. It provides a simplified way for pupils to solve a problem and works in a variety of contexts and types of problem solving questions.

Throughout our Maths curriculum, pupils will be exposed to different types of problem solving questions including:

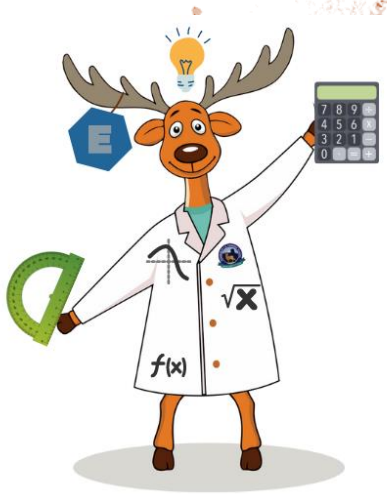
- Closed (routine) problems
- Open-ended (non-routine) problems
- Reasoning questions (e.g true of false)

QUACK

- **Q** Question – read it carefully
- **U** Understand – underline or circle key elements
- **A** Approximate – think about the size of your answer
- **C** Calculate
- **K** Know if the answer is sensible or not



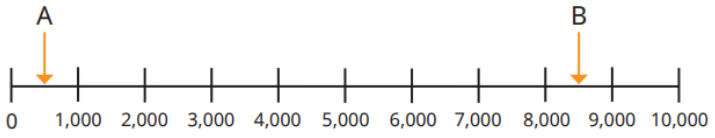
Procedures in Key Areas of Mathematics



Place Value

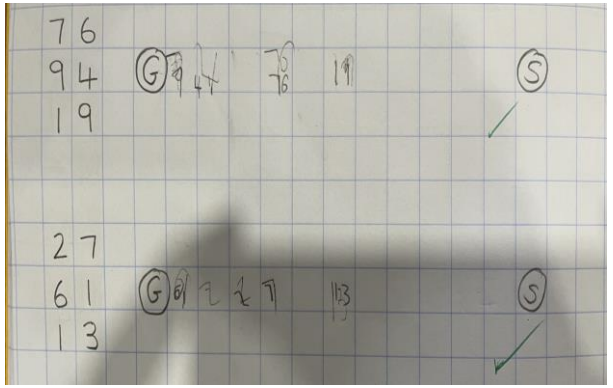
Estimating value/position of numbers on a number line (Y2+)

- Identify the start and end points (intervals)
- Find and label the value at the mid-point or other suitable points e.g ¼ or ¾ of the way along
- Consider a numbers position relative to identified points



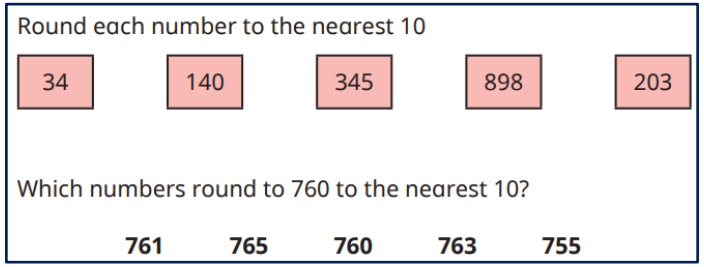
Ordering Numbers (Y2+)

- Read aloud all given numbers
- Re-write the numbers by stacking them vertically (one underneath the other) to expose place value
- Start by looking at the digit with the highest place value
- If two numbers have the same value, look to the next PV digit
- Order according to statement e.g ascending or descending



Rounding Numbers (Y4+)

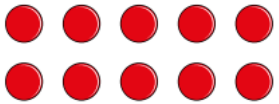
- Write the number to be rounded clearly
- Circle the digit in the PV column that you are rounding to e.g 10s
- Identify the multiple before and after e.g previous and next multiple of 10 if rounding to nearest 10
- Underline the digit to the right and identify it's position within interval e.g 3 in 13 is closer to 10 than it is 20.

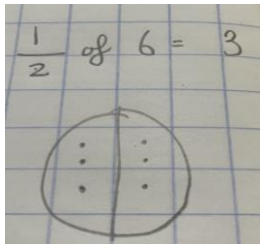


Fractions

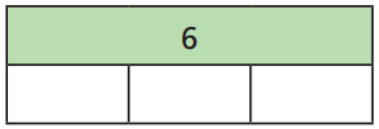
Finding fractions of amounts (Y2+)

Step 1 – Use drawings, arrays or shapes to support.



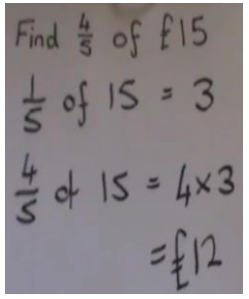


Step 2 – Use bar model, division,



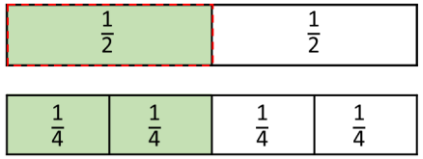
$\frac{1}{3}$ of 6 = ☐

- Find 1 part of the whole by dividing by the denominator
- Multiply the quotient by the numerator to find the given fraction



Find Equivalent Fractions (Y2+)

Step 1 – Recognising equivalence using bar models and pictures (Y2/3)



Step 2 – Find equivalent fractions

- Multiply the numerator and denominator by the same number
- Work systematically starting with the smallest factor

$$\frac{2}{9} \overset{\times 3}{=} \frac{6}{27}$$

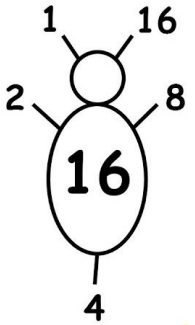
$$\frac{1}{4} \overset{\times 2 \times 3 \times 5 \times 10}{=} \frac{2}{8} = \frac{3}{12} = \frac{5}{20} \overset{\times 2 \times 3 \times 5 \times 10}{=} \frac{10}{40}$$

$\times 4$ on the left, $\div 4$ on the right

Simplifying Fractions (Y6)

Step 1 – Simplify a fraction

- Find a common factor of both the numerator and denominator by using x table knowledge or factor bugs
- Divide the numerator and denominator by the factor



$$\frac{6}{9} \overset{\div 3}{=} \frac{2}{3}$$

Factors of 6: 1, 2, 3, 6

Factors of 9: 1, 3, 9

Step 2 – Simplify a mixed number fraction

- Keep the whole number the same and simplify the fraction by finding the common factor as above

$$2\frac{4}{10} = 2\frac{2}{5}$$

Fractions cont...

Converting improper fractions to mixed number (Y4+)

- Write out the improper fraction
- Divide the numerator by the denominator using x table knowledge or short division if necessary
- Record the amount of wholes
- Any remainders should be written as a fraction with the original denominator

Converting mixed number to improper fractions (Y4+)

- Write out the mixed number fraction
- Multiply the whole number by the denominator
- Add the product to the numerator

Comparing and Ordering fractions

Step 1 –With the same denominator

- Write out the fractions
- Check the denominator is the same
- Use number lines/bar models if needed for conceptual understanding
- Order the fractions accordingly

Step 2 – with different denominators *(mainly Y6, Y5 use equivalence/multiples of same number to help)*

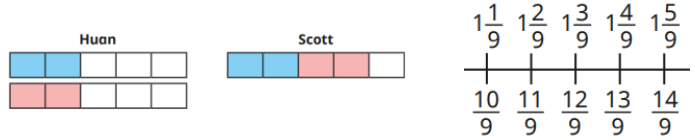
- Write out the fractions
- Find the lowest common multiple
- Multiply each numerator by the same as you did the denominator
- Order/compare the fractions accordingly

< > = symbols will be used here

Add & Subtract Fractions

Step 1 –With the same denominator (proper fractions)

- Check the denominator is the same
- Use bar models/num lines if needed for conceptual understanding
- Add/subtract the numerators
- If the total is an improper fraction, convert/simplify



Step 2 –With different denominators

- Check the denominators
- If they are different, find the lowest common denominator and multiply the numerator and denominator to get like denominators.
- Add/subtract the numerators of both fractions together
- Write your answer as a fraction and make sure its in its simplest form.

Fractions cont...

Multiply fractions

Step 1 - Multiply a fraction by an integer

- Multiply the numerator by the integer *(bar model to show repeat addition)*
- The denominator remains the same (integer over 1)
- Write the fraction in its simplest form

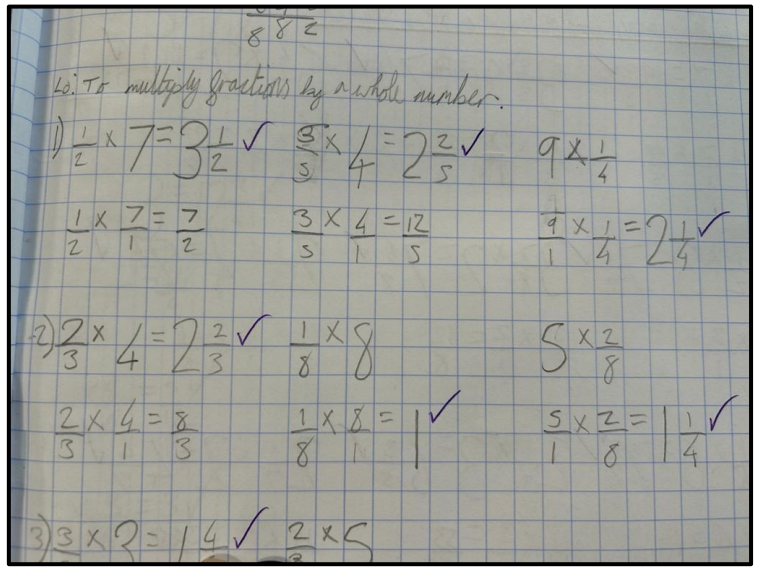
Step 2 – Multiply a mixed number fraction by an integer

- Partition the fraction into wholes and parts
- Multiply each by the integer
- OR convert to improper fraction before multiplying the numerator.

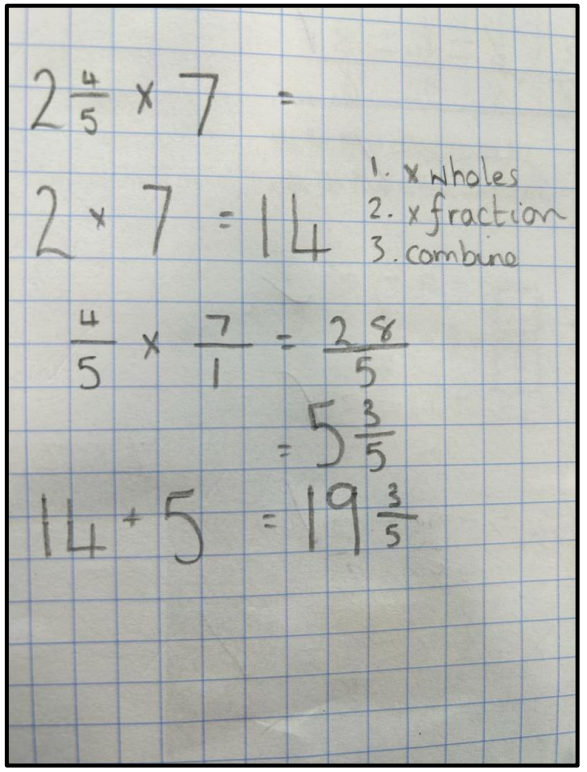
Step 3 – Find the product of 2 fractions

- Multiply the numerators
- Multiply the denominators
- Find the greatest common factor by writing the fractions out at the side
- Divide both the numerator and denominator by the common factor to write your answer in the simplest form.

Step 1..



Step 2..



Fractions cont...

Divide fractions

Step 1 – Divide a fraction by an integer

- Divide the numerator by the integer *(bar model as representation)*

If the numerator is divisible by the integer

e.g 10/11 ÷ 5 =

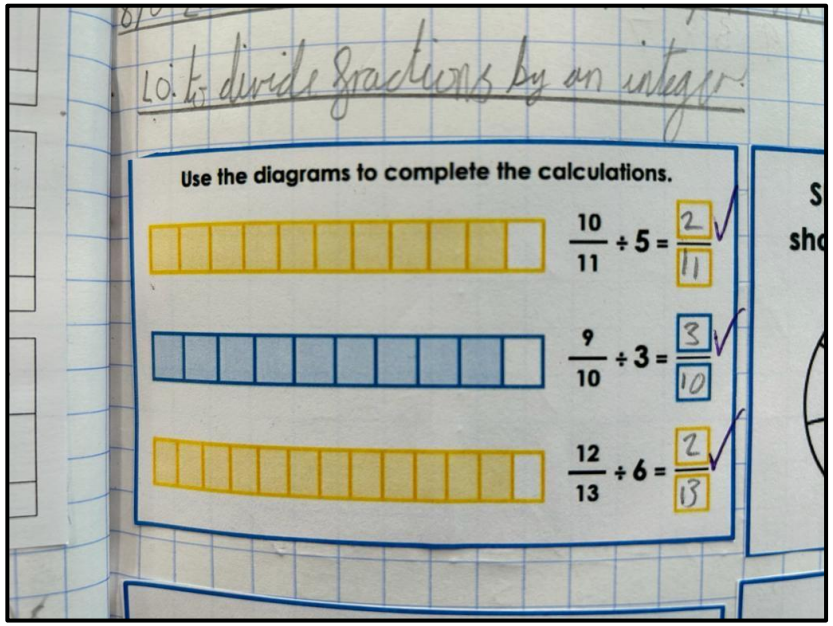
Step 2 – Divide any fraction by an integer

- Multiply the denominator by the integer
- Keep the numerator the same
- Simplify if needed*

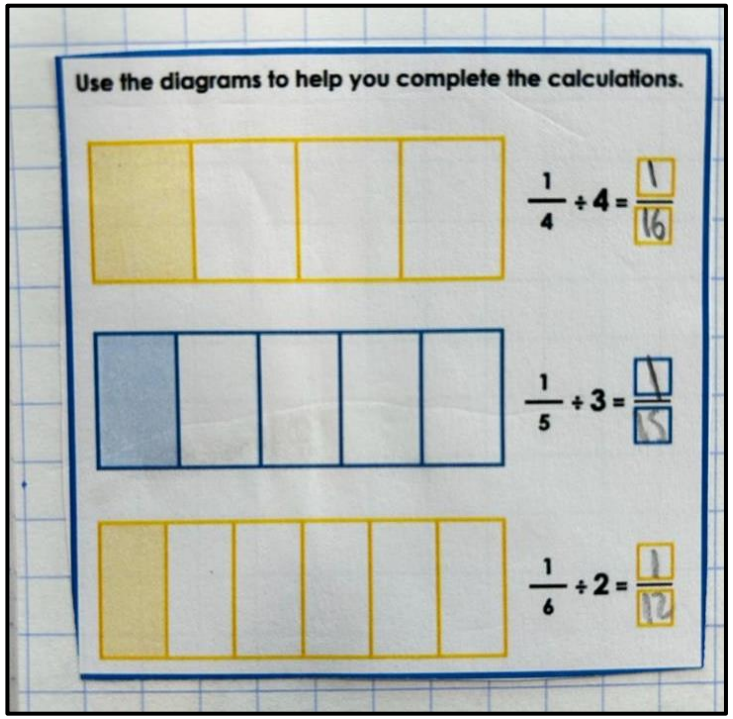
Bar models used to model 'equal parts' being divided

Inverse operation discussed

Step 1...



Step 2...



Decimals & Percentages

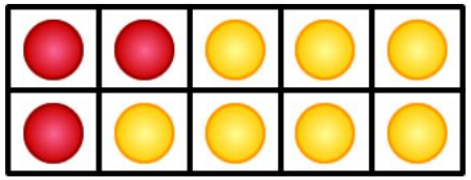
Decimals

Divide whole numbers by 10/100/1,000 etc

- Use counters/PV charts to model all digits moving however many places to the right
- Children know how many places digits must move using the divisor

Making wholes with tenths and hundredths

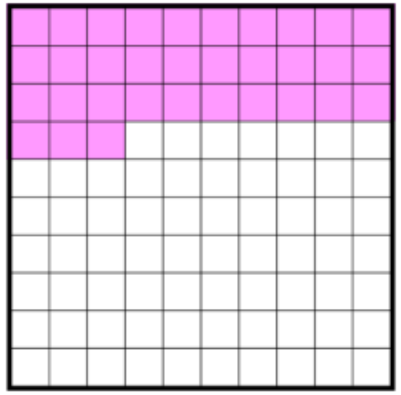
- Use known facts e.g bonds to 10/100



How many tenths are red? **3 tenths are red**

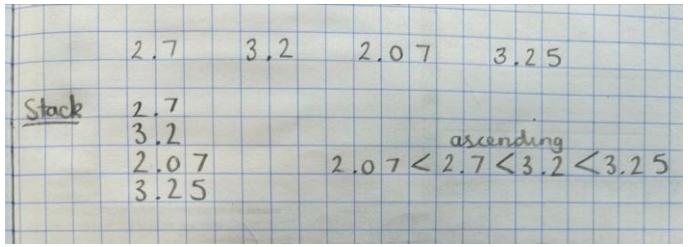
How many tenths are yellow? **7 tenths are yellow**

3 tenths + 7 tenths = 1 whole



Order/Compare decimals

- Read numbers and re-write them by stacking them vertically (one underneath the other) to expose place value
- Start by looking at the digit with the highest place value (e.g tenths)
- If two numbers have the same value, look to the next PV digit (e.g hundredths)
- Order according to statement e.g ascending or descending



Round decimals

- Write the number to be rounded clearly
- Circle the digit in the PV column that you are rounding to e.g tenths
- Identify the multiple before and after e.g previous and next tenth if rounding to nearest tenth
- Underline the digit to the right and identify it's position within interval e.g 3 in 0.63 is closer to 0.6 than it is 0.7.

Percentages

Understand that per cent means number of parts per 100

Converting percentages to fractions

- Fractions, decimals and percentages can be represented as the same value
- Write the percentage over 100
- Write it in the simplest of forms by dividing both the numerator and denominator by the highest common factor

Converting fractions to percentages

The denominator is always divisible by 100

- Use equivalents and relationships to convert e.g ¼ = 25% so ¾ = 75%

ALL CONVERSIONS ARE TAUGHT AS PART OF OUR KIRFS

Decimals & Percentages

Percentages

Understand that per cent means number of parts per 100

Percentage of an amount

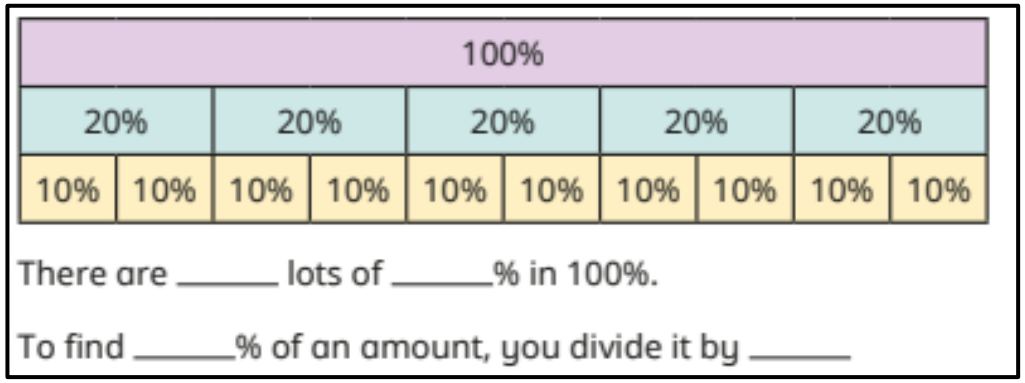
Step 1 - Finding common percentages e.g 1% 10% 20% 25% 50%

Step 2 – Children use knowledge of above percentages:

For example, to find 75% they can find 25% and multiply it by 3; to find 60% they can find 10% and multiply it by 6.
They then move on to more complex percentages.

Allow children time to explore different ways of making percentages without actually calculating the percentages of amounts, for example 45% can be made from 25% + 10% + 10%, 5% × 9, 1% × 45, 50% – 5%.

Step 1..



Step 2..