

Mathematics Key Stage 2 SATs papers : Consideration of the 2017 & 2018 papers

Every teacher in KS2 should complete the end of key stage mathematics test papers and consider the implications for their teaching. It becomes very clear that if teachers in Years 3,4,5 do not secure learning as described by the national curriculum, then the chances of pupils succeeding in Year 6 are significantly reduced. *(When completing the test papers, teachers should be provided with ample time (this is not to test if the teachers are as good as Year 6 pupils or a speed test, but rather an in-depth look at the questions and concepts covered in the papers) and teachers are advised to have with them supporting resources, e.g. pencil and a rubber; the mark scheme; internet access for seeking advice; and mathematics dictionary. As teachers complete the papers, they should note gaps in their own knowledge and understanding, consider what steps they had to take to complete each question, and identify the underlying knowledge that is required in order to be able to answer the question. How does the work in their year group feed into the later success of Year 6 pupils? In addition to completing the papers, it is important to discuss some of the questions, and conclusions teachers have drawn from completing the papers – the points below may aid discussions around key action points. Teachers should then create an action plan as to how they can strengthen elements of teaching now that they have greater knowledge of the standards to be achieved at the end of the key stage).*

All year groups are advised to focus on:

Times tables, place value, multiplying and dividing by 10/100/1000, inverses, and borrowing when subtracting are all topics in which pupils need to be confident and fluent. All pupils need to be confident in dealing with large numbers (take care not to limit lower ability pupils by never having a chance to answer questions that involve large numbers). A central element of all mathematics work should be application and problem solving.

Key reasons why pupils do not perform well on mathematics tests:

- Lower ability pupils have sometimes not covered all of the curriculum or tackled questions in class that are as complex / demanding as the test papers. This means that teachers can virtually put a line through questions pupils will not be able to complete. It is essential that all pupils cover the curriculum to the right standard.
- Lower ability pupils often have issues with fluency in mathematics (e.g. times tables) and often do not see links between elements of mathematics (e.g. the inverse of operations) which slows them down (the test requires speed and efficiency) and makes multistep problems more demanding because the issues tie up more of the child's working memory. For example, being confident in a range of number bonds helps with speed and in checking answer, such as number bonds for 50, for 60, and for ones related to 10, e.g. 100 and 1000.
- Having a sense of number – size of numbers, comparisons, place value, monetary values, lengths and size etc. This type of knowledge and understanding helps mathematics to make sense.

- Pupils are not completing sufficient application and mathematical problem solving questions. In every year group, application should be a significant percentage of the work completed by pupils in class, and a major part of mathematics homework.
- Pupils need to be regularly exposed to the question types they will experience in the examination, not just in Year 6 but across KS2.
- A lack of understanding of mathematics terms – this particularly applied to paper 3.
- A lack of cross curricular mathematics – pupils lack experience in real use of mathematics.

Paper 1 Arithmetic Paper 2017

Essential to completing this paper was excellent knowledge of:

- Place value
- Times tables
- Fraction conversion
- Common dominators of fractions.
- Division and multiplication by 100, 1000, 10000, etc. (Quite a lot of questions needed an underlying knowledge and understanding of this)
- Borrowing and method of subtraction (shown in the appendix of the NC document).

(If a child runs out of time when completing tests – check their fluency with facts such as times tables and check they are using the most efficient processes).

Pupils need a lot of exposure to the trickier elements of the paper in order to build confidence. For example, long multiplication, long division, working out a percentage, and fractions divided by a whole number. Panic can set in and lead to pupils missing out these questions. They also need exposure to the question types that are used in the test paper, e.g. the answer box being at the beginning of a number sentence.

Pupils need to make sure they have learned the processes, e.g. the process of multiplying two fractions, borrowing, brackets first. If they are not confident in the process, they will make mistakes or miss questions that require this knowledge.

Children often find 'cognitive flexibility' a challenge – e.g. switching rapidly between multiplication, division, addition and subtraction, or switching between a question on fractions followed by a question on angles. Therefore, it is useful for pupils to have regular exposure to 'mixed question' activities. Mixed question sets are also good for revisiting topics and keeping past topics 'fresh' in the minds of pupils.

Teachers are advised to regularly complete questions themselves in order to carefully consider the process that is used to arrive at an answer. This can help the teacher to see where the pupils' mistakes have taken place and identify underlying gaps in knowledge and understanding. When looking at a pupil's working out it may be possible to identify the problem, e.g.

- The pupil has an issue with borrowing.
- The pupil has an issue of not inserting a zero in the process of long multiplication.

- The pupil has an issue with place value.
- The pupil does not know the process for a particular type of question, e.g. long division.
- The pupil is making mistakes under time pressure.

Pupils need regular opportunities to complete tests. After each test, the pupil should identify the topic areas for which they need help and support. It might also be useful for them to time themselves on particular questions to see if they need a more efficient method or if they can identify an underlying issues that might be slowing them down, such as times table knowledge. They should also look for where they have made mistakes in reading the question paper.

When questions have been incorrectly answered in a test paper:

- Pupils should try to work out the correct answer (with or without support) before being provided with the answer (it is more likely to lead to improved understanding if they have to work out where they went wrong than simply seeing the teacher work out the correct answer).
- Be supported by illustrated / modelled answers to help bridge gaps in knowledge and understanding. (Or perhaps watch video clips of how such questions are answered).
- Consider what supporting resources they may find useful when trying to correct answers, e.g. mathematics dictionary, practical equipment. Whilst these will not be available in the test, the idea is for the pupils to become competent and confident so that they can complete the questions independently by the time they reach the test.
- Pupils should complete extra questions on the topic areas where they had the most incorrect questions. Simply to correct the questions that were wrong will not be enough to fix the problem. Enable pupils to work in groups on particular mathematics topics. Enable pupils to select their own homework based on the topics they need to study.

Pupils sometimes struggle with test papers because they have forgotten the method. Worked examples at the start of practice exercises can be very good for encouraging struggling learners to complete more study questions.

Time and efficiency is critical. If pupils do not correctly identify between the 'mental' and 'written' questions, they would likely have still struggled to complete the paper in time. However, those who identified the 'mental' questions should have easily been able to complete the full paper within 30 minutes.

The Arithmetic paper has been broadly similar in this regard since its introduction, so we can expect this to stay the same in future years. **Since a high score on the Arithmetic test is a key indicator of pupils meeting the expected standard, it is important that this skill (which again links back to 'true' fluency,) becomes or remains part of your approach to Maths in Year 6.**

Paper 2 (Reasoning)

As in previous years – papers 2 and 3 – focus on ‘the use of’ and ‘confidence with’ mathematics. Can the pupils really use mathematics? Make sure the curriculum reflects this!

Cross curricular mathematics would help pupils to have real reasons to apply and use mathematics which would be good preparation for papers 2 and 3. For many of the questions in paper 2, sheer volume of practice is likely to be advantageous. Schools that provided booklets of questions that pupils can complete outside of the main class time (particularly ones that have worked examples, a mark scheme to check answers and linked to video clips they can use if they are stuck) offer excellent opportunities for pupils to be confident with key topics. Often pupils move on to new topics too quickly, have too little time to revisit previous topics and lack opportunities to work on topics they feel less confident in.

In order to be able to tackle the questions on paper two, pupils need to be confident and fluent in times tables and be able to use this knowledge to help with division. Many of the questions require this type of underlying knowledge.

In addition, pupils need to be able to use quick mental methods to work out the answers rather than always using formal methods. For example, in question 10, if pupils worked out each calculation using a formal method they might gain the 2 marks for the question, but then find themselves running out of time to complete the whole paper.

10

Write the correct symbol in each box to make the statements correct.

11×12	<input style="width: 30px; height: 20px;" type="text"/>	15×10
$90 \div 30$	<input style="width: 30px; height: 20px;" type="text"/>	$60 \div 20$
$120 \div 4$	<input style="width: 30px; height: 20px;" type="text"/>	$160 \div 8$
30×8	<input style="width: 30px; height: 20px;" type="text"/>	100×10


2 marks

Questions where pupils could work out easier methods saved them valuable time, e.g. using 2.5×12 in question 20. (worth 2 marks)

20 The length of an alligator can be estimated by:

- measuring the distance from its eyes to its nose
- then multiplying that distance by 12

What is the difference in the estimated lengths of these two alligators?



Not to scale

There was also an increase in the 2018 paper of asking pupils questions about the methods, e.g.

16 Adam wants to use a mental method to calculate $182 - 97$

He starts from 182

Here are some methods that Adam could use.

Tick the methods that are correct.

add 3 then subtract 90

subtract 100 then add 3

subtract 7 then subtract 90

subtract 3 then subtract 100

2 marks


Place value, again, plays a central role in the paper. Pupils need to be to correctly align figures when turning a word problem into a calculation, multiply and divide by 10, 100, 1000, 10000, etc, with ease. Pupils also need knowledge of place value in order to correctly round the numbers in question 10 (round 84,516 to the nearest 10, nearest 100, nearest 1000).

Pupils need to be able to add and subtract 4 digit numbers, including being comfortable with **borrowing**. Often lower ability pupils are not exposed to large enough numbers and often find the process of borrowing a challenge. Importantly, they also need to be able to turn a word problem into the calculation. For example, in question 8 'At the start of June, there were 1,793 toy cars in the shop. During June 8,728 more cars were delivered and 9,473 were sold.' Requires pupils to turn the question into a calculation. **Many pupils find it difficult to identify the operation**, e.g. equating 'sold' with a *subtraction*, and 'more' toys arriving as an *addition*. Pupils need to be regularly exposed to this type of application

question throughout KS2 and for those who are struggling, plenty of opportunity to work in a group with the teacher to look at many many questions.

Terminology needs to be understood, e.g. 'more', 'combined', 'mass', 'faces', 'vertices', 'ratio', 'mean', 'volume', 'translated'. **Pupils also need factual knowledge, such as knowing kilogram is kg, how many millilitres in a litre.** Pupils need knowledge of measures and time, e.g. number of days in a week, months in a year, degrees in a circle. **There are some knowledge elements that pupils will either know or not know when sitting down to complete the test paper, e.g. how to calculate the radius of a circle or the volume of a cube, and these questions are easy mark questions that will be lost if pupils knowledge is not secure.** There was an increase in the 2018 paper as to the number of questions pupils would not be able to complete if they did not have this type of knowledge, e.g. (3 marks)

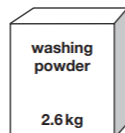
17 There are 28 pupils in a class.
The teacher has 8 litres of orange juice.
She pours 225 millilitres of orange juice for every pupil.



How much orange juice is left over?

This type of question was also a feature in Paper 3:

13 A box contains 2.6 kg of washing powder.



Jack uses 65 grams of powder for each wash.

He uses all the powder.

How many washes did Jack do?

Show your method

	washes
--	--------

2 marks

There are quite a few questions where pupils are provided with some information and have to work out from this information the **missing numbers**. It would be helpful for pupils to play logic and number games to familiarise themselves with the idea that from partial information, full information can be derived.

There are quite a lot of **working memory demands**, and therefore some children would benefit from making notes on the paper, e.g. in question 9 they first had to work out $\frac{3}{4}$ of each shape and then consider if the number of shaded squares matched this.

There are some questions which are clearly a **'staple' question, such as put the decimals into order, round a number to the nearest 10, 100, 1000, circle the number that is 10 times greater (e.g. ten times greater than nine hundred and seven)**. Pupils should not be getting these questions incorrect. As these are common questions, pupils should be exposed to these lots and lots of these across Year 6 (and prior to this) and therefore these should be confidently answered – if not, teachers need to look at the quantity of practice pupils have undertaken.

Fraction questions required pupils to understand **mixed number questions, top heavy fractions and be confident with alternatives**, e.g. tick the box for two numbers equivalent to $\frac{1}{4}$. One very notable theme that was tested in the KS2 Sats papers 2018 was mixed numbers. These played a heavier role in the calculations paper than previously (with 4 questions involving mixed numbers), and also made a significant appearance in Paper 2 (see Q13 & Q19 & Q23 below). There were 8 marks in total across the papers involved mixed numbers in some way, shape or form.

7 Tick the two numbers that are equivalent to $\frac{1}{4}$

Tick two.

0.25	<input type="checkbox"/>
0.75	<input type="checkbox"/>
$\frac{25}{100}$	<input type="checkbox"/>
0.5	<input type="checkbox"/>
$\frac{2}{5}$	<input type="checkbox"/>

1 mark

13 Circle the improper fraction that is equivalent to $6\frac{7}{8}$

$\frac{67}{8}$	$\frac{48}{8}$	$\frac{62}{8}$	$\frac{55}{8}$	$\frac{76}{8}$	1 mark
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19

Layla wants to estimate the answer to this calculation.

$$3\frac{9}{10} - 2\frac{1}{8} + 1\frac{4}{5}$$

Tick the calculation below that is the best estimate.

Tick **one**.

3 - 2 + 2

4 - 2 + 1

4 - 2 + 2

3 - 2 + 1

1 mark

23

The length of a day on Earth is 24 hours.

The length of a day on Mercury is $58\frac{2}{3}$ times the length of a day on Earth.

What is the length of a day on Mercury, in **hours**?

Show
your
method

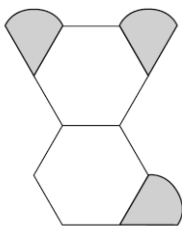
2 marks

Pupils who had learnt how to use the bar method could apply it to question 21.

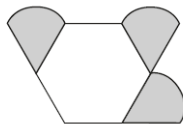
21

Amina is making designs with two different shapes.

She gives each shape a value.




Total value is 147




Total value is 111

Calculate the value of each shape.

 =

1 mark

 =

1 mark

Paper 3 reasoning

Terminology: Translate, factors, radius, diameter, litre, millilitre, digit, names of different types of angles, names of shapes (e.g. pentagon), parallel, perpendicular, square number, prime number, difference, area, volume, factors, vertices. **In 2017 paper 3 was heavier on mathematical terminology - which means pupils cannot answer the questions if they don't know these terms. In 2018 terminology was perhaps more heavily weighted in paper 2.** (Obviously, there could be different terms in future papers, so teachers are advised to check the national curriculum document and make sure that in every lesson terms are explained and documented).

Factual information and conversions: 24 hour clock conversion, number of millilitres in a litre (and therefore what half a litre is), working out the radius when given the diameter, fraction to decimal conversion, the ability to work out area and volume. **Some of the factual knowledge questions are easy and quick to complete as long as you know the facts and how to use them, e.g. conversions from millilitres to litres– there were quite a few of this type of question in 2017, in 2018 there was more 'use of this knowledge' and if pupils do not know the factual information it will be difficult for them to attempt the question.**

In this paper, MANY of the questions require the pupils to consider the most efficient way to reach the answer – not just the use of a formal method. For example, in question 5 (The children at Farmfield school are collecting money for charity. Their target is to collect £360. So far they have collected 57.73. How much do they still need to collect?), the pupil needs to spot that rather than completing the formal method of subtraction, they can isolate the £300, and then simply subtract £57.73 from £60 – a much easier and faster way of arriving at the answer. Pupils may run out of time to complete the paper unless they can be efficient with methods. If pupils are really struggling with a question, they should move on and come back to it, e.g. question 19 in the 2018 paper could hold up some struggling pupils.

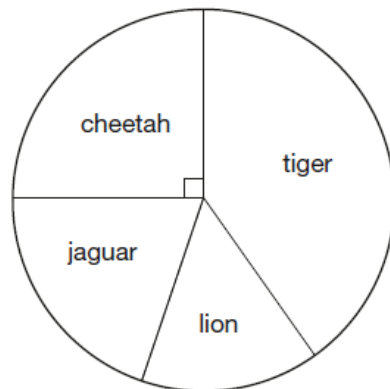
In addition to its being a useful skill in performing quick calculations, **rounding up and down** was a feature of both paper 2 and 3. Therefore, it is advisable that pupils become fluent in rounding (and a pre-cursor to this is number bonds!)

There is more emphasis in the 2018 paper 3 on 'use' of knowledge, e.g. fractions. Consider the following questions (all of which were 2 marks):

6

This chart shows the number of different types of big cat in a zoo.

There are **20** big cats in the zoo altogether.



Here are some statements about the chart.

Tick the statements that are **true**.

There are more cheetahs than jaguars.

The total number of lions and tigers is 10

One-quarter of the big cats are cheetahs.

There are more than 5 jaguars.

2 marks

16

A book has 276 pages.

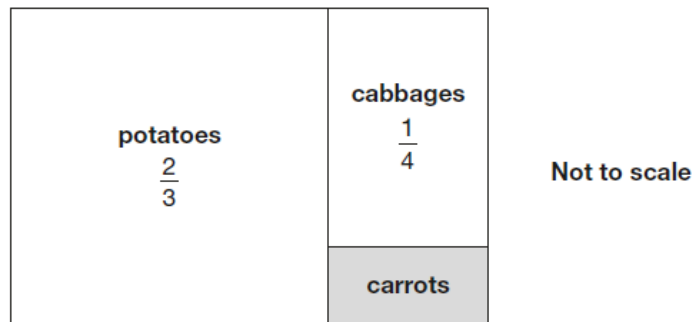
Amina has read $\frac{1}{3}$ of the book.

How many pages are **left** for Amina to read?

18

This is a diagram of a vegetable garden.

It shows the fractions of the garden planted with potatoes and cabbages.



The remaining area is planted with carrots.

What fraction of the garden is planted with carrots?

Negative numbers featured in paper 2 and do so again in paper 3. Again, pupils need to be able to calculate with positive and negative numbers and also be able to plot them on graph quadrants. Plenty of practise of this is advised, along with mapping it into cross curricula topics.

There were quite a few questions that involved **money** – being confident in using money would be an advantage. Similarly, there were questions that required pupils to be confident in **calculations involving time**.

There are quite a few questions where logical working through of a range of alternative possible answers is required, e.g. question 8 ‘write three factors of 30 that are not factors of 15’.

In both paper 2 and paper 3, pupils were asked ‘**explain it**’ or ‘**prove it**’ questions. Pupils need to be exposed to this type of questions in order to be able to logically work through the steps and learn how to record their thinking.

Working carefully and reading the question more than once is advisable. It is easy to read the question incorrectly and therefore carryout the calculation incorrectly.

There are a couple of algebra questions at the end of the paper in the 2017 paper. The 2018 paper 3 was easier than in 2017 – no algebra questions at the end.

Building up to Year 6

Each year, half the marks are drawn from the domains covered in Year 3-5.

To what extent are Year 6 teachers able to deliver the Year 6 curriculum because pupils' knowledge, skill and understanding is at the right point as they enter the final year? How much time are they focused to devote to earlier concepts? How is knowledge and understanding tested in Y3-5? How many opportunities are there for revisiting topics, plugging gaps, revising past concepts in all year groups as well as in Y6? How can teachers ensure that learning is secure and pupils are confident with the elements of mathematics as appropriate for their year group? How skilled are TAs in the aspects of mathematics that are being delivered and the prior concepts that might be not have been mastered?

Progression	Of particular significance when looking at the past papers.
Across ALL year groups	Application and problem solving questions, including missing number problems and using number facts, multi-step problems. Times tables. Number sense / size of numbers. Cross curricula opportunities.
Year 3	Find 10 more / 10 less and dividing by 10. Find 100 more / 100 less Recognising the place value of 3 digit numbers and starting to understand the idea of size comparisons up to 1000. Write and read numerals up to 1000 in numbers and in words, e.g. nine hundred and twenty-six. Use the inverse, e.g. to check answers. Formal methods of addition and subtraction (adding and subtracting 3 digit numbers). Multiplication 2 digits by 1 digit. Fractions, including adding and subtracting fractions and fractions of objects and shapes. Degrees in a turn. Topic of time, e.g. Number of days in a week, year, estimating time, measuring time, etc. Using graphs and charts.
Year 4	1000 more / 1000 less. Place value 4 digit numbers. Rounding. 4 digit addition and subtraction. Formal multiplication methods (2 digits and 3 digit numbers by 1 digit) Fractions, including decimal conversions. Converting measurements. Perimeter and area. Plotting co-ordinates. Angles. Negative numbers. Quite a lot in Year 4 about derived facts, inverses and approaches to efficiency in mental calculation.

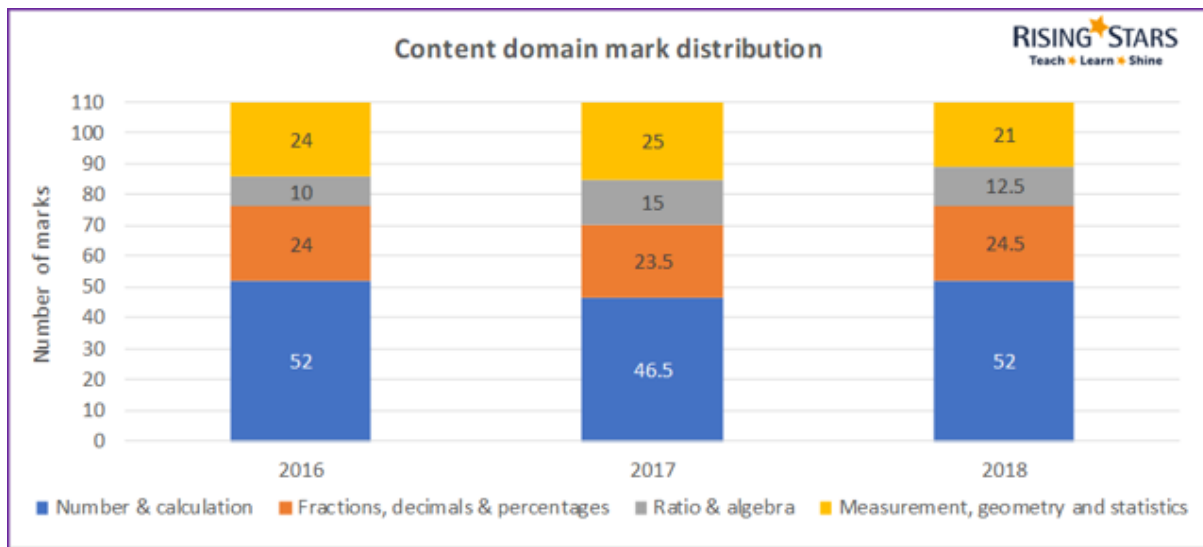
Year 5	<p>Dealing with very large numbers.</p> <p>Add and subtract 4 digit numbers using formal methods.</p> <p>multiply numbers up to 4 digits by a one- or two-digit number</p> <p>divide numbers up to 4 digits by a one-digit</p> <p>multiply and divide whole numbers and those involving decimals by 10, 100 and 1000.</p> <p>Factors, including mixed number and improper fractions, decimals and percentages, adding and subtracting fractions.</p> <p>Square and cube numbers.</p> <p>Rotation and angles.</p> <p>Measurements. Use all four operations to solve problems involving measure [for example, length, mass, volume, money] using decimal notation, including scaling.</p> <p>Plotting 2 quadrants (negative and positive numbers)</p>
Year 6	<p>Long division</p> <p>Long multiplication</p> <p>Fractions, including multiplying and dividing fractions.</p> <p>Calculations with decimals</p> <p>Percentages</p> <p>Ratio and scaling (and reflection)</p> <p>Area of parallelograms and triangles, cubes and cuboids.</p> <p>Radius, diameter and circumference of circles.</p> <p>Angles, including angles on a line, opposite angles, calculating angles.</p> <p>Missing numbers, number patterns, algebra</p> <p>All four quadrants – plotting co-ordinates negative and positive</p>

A teacher posted their analysis of the SATs questions based on the NC for specific year groups (as seen below).

KS2 Maths SATs papers
Percentage of questions from each year group curriculum (rounded)
[change from previous year] @_MissieBee

Year group	2016	2017	2018
3	16%	7% [-9%]	9% [+2%]
4	14%	26% [+12%]	18% [-8%]
5	27%	25% [-2%]	26% [+1%]
6	43%	41% [-2%]	47% [+6%]

Rising Stars have also provided a graph showing the distribution of domains in the tests:



It is essential that Mathematics leaders and Year 6 teachers use the ASP system to compare national performance in these topic areas against the school's performance. This will then help teachers to consider the effectiveness of teaching for particular domains and can then action plan how to improve mathematics units, rather than trying to rethink the whole year.