

Guide for Number – MAC Calculation policy

Reading and writing numbers

Most pupils are able to read, write and say numbers up to a thousand, but often have difficulty with larger numbers. It is now common practice to use spaces rather than commas between each group of three figures. eg. 34 000 not 34,000 though the latter will still be found in many text books and cannot be considered incorrect.

In reading large figures pupils should know that the final three figures are read as they are written as **hundreds, tens** and **units**.

Reading from the left, the next three figures are **thousands** and the next group of three are **millions**.

eg. 3 027 251 is three million, twenty seven thousand and fifty one.

Order of Operations

It is important that pupils follow the correct order of operations for arithmetic calculations. Most will be familiar with the mnemonic: **BIDMAS**.

Brackets, **I**ndices, **D**ivision, **M**ultiplication, **A**ddition, **S**ubtraction

Note: Indices is another word for powers. It includes squares, cubes, roots, and other higher, fractional and negative powers.

This shows the order in which calculations should be completed. eg

$$5 + 3 \times 4$$

means

$$5 + 12 \\ = \underline{17} \quad \checkmark$$

NOT $5 + 3 \times 4$
means 8×4
 $= \underline{32} \quad \times$

The important facts to remember are that the **B**rackets are done first, then the **I**ndices, **M**ultiplication and **D**ivision and finally, **A**ddition and **S**ubtraction.

eg(i) $(5 + 3) \times 4$
 $= 8 \times 4$
 $= \underline{32}$

eg (ii) $5 + 6^2 \div 3 - 4$
 $= 5 + 36 \div 3 - 4$
 $= 5 + 12 - 4$
 $= 17 - 4$

$$= \underline{13}$$

Care must be taken with Subtraction.

eg	$5 + 12 - 4$	or	$5 + 12 - 4$
	$= 17 - 4$		$= 5 + 8$
	$= \underline{13}$ ✓		$= \underline{13}$ x

eg	$5 - 12 + 4$	but	$5 - 12 + 4$ ¹
	$= -7 + 4$		$= 5 - 16$
	$= \underline{-3}$ ✓		$= \underline{-11}$ x

For this to be correct it would have to be written: $5 - (12 + 4)$ so that the bracket is worked out first.

Calculators

Some pupils are over-dependent on the use of calculators for simple calculations. **Wherever possible pupils should be encouraged to use mental or pencil and paper methods.** It is, however, necessary to give consideration to the ability of the pupil and the objectives of the task in hand. In order to complete a task successfully it may be necessary for pupils to use a calculator for what you perceive to be a relatively simple calculation. This should be allowed if progress within the subject area is to be made. **Before completing the calculation pupils should be encouraged to make an estimate of the answer.** Having completed the calculation on the calculator they should consider whether the answer is reasonable in the context of the question.

Mental Calculations

Most pupils should be able to carry out the following processes mentally though the speed with which they do it will vary considerably.

- recall addition and subtraction facts up to 20
- recall multiplication and division facts for tables up to 12 x 12.

Pupils should be encouraged to carry out other calculations mentally using a variety of strategies but there will be significant differences in their ability to do so. It is helpful if teachers discuss with pupils how they have made a calculation. Any method which produces the correct answer is acceptable.

eg $53 + 19 = 53 + 20 - 1$

$$284 - 56 = 284 - 60 + 4$$

$$32 \times 8 = 32 \times 2 \times 2 \times 2$$

$$76 \div 4 = (76 \div 2) \div 2$$

Written Calculations

Pupils often use the '=' sign incorrectly. When doing a series of operations they sometimes write mathematical sentences which are untrue.

eg $5 \times 4 = 20 + 3 = 23 - 8 = 15$ ✗ since $5 \times 4 \neq 15$

It is important that all teachers encourage pupils to write such calculations correctly.

eg $5 \times 4 = 20$
 $20 + 3 = 23$
 $23 - 8 = \underline{15}$ ✓

The '=' sign should only be used when both sides of an operation have the same value. There is no problem with a calculation such as:

$$43 + 57 = 40 + 3 + 50 + 7 = 90 + 10 = \underline{100}$$
 ✓

since each part of the calculation has the same value.

The '≈' (approximately equal to) sign should be used when estimating answers.

eg $2\,378 - 412 \approx 2\,400 - 400$

$$2\,400 - 400 = \underline{2\,000}$$
 ✓

All pupils should be able to use some pencil and paper methods involving simple addition, subtraction, multiplication and division.

Before completing any calculation, pupils should be encouraged to estimate a rough value for what they expect the answer to be. This should be done by rounding the numbers to one significant figure and mentally calculating the approximate answer.

After completing the calculation they should be asked to consider whether or not their answer is reasonable in the context of the question.

The following methods are examples of the agreed methods for addition, subtraction, multiplication and division that are taught at Key Stage 1-2 that students should be fluent in when entering KS3.

Addition and subtraction

789 + 642 becomes

$$\begin{array}{r} 789 \\ + 642 \\ \hline 1431 \\ \hline \end{array}$$

Answer: 1431

874 - 523 becomes

$$\begin{array}{r} 874 \\ - 523 \\ \hline 351 \\ \hline \end{array}$$

Answer: 351

932 - 457 becomes

$$\begin{array}{r} 8 \quad 12 \quad 1 \\ 932 \\ - 457 \\ \hline 475 \\ \hline \end{array}$$

Answer: 475

932 - 457 becomes

$$\begin{array}{r} 1 \quad 1 \\ 932 \\ - 457 \\ \hline 475 \\ \hline \end{array}$$

Answer: 475

Addition and subtraction of decimals is completed in the same way but reminders may be needed to maintain place value by keeping decimal points in line underneath each other.

Multiplication and Division by 10,100,1000...

When a number is multiplied by 10 its value has increased tenfold and each digit will move one place to the left so multiplying its value by 10. When multiplying by 100 each digit moves two places to the left, and so on... Any empty columns will be filled with zeros so that place value is maintained when the numbers are written without column headings.

The decimal point does not move - the numbers do.

eg. $46 \times 100 = 4\,600$

Th	H	T	U
		4	6
4	6	0	0

The same method is used for decimals.

eg. $5.34 \times 10 = 53.4$

H	T	U	.	t	h
		5	.	3	4
5	3	.	4		

Empty spaces after the decimal point are not filled with zeros. The place value of the numbers is unaffected by these spaces.

When dividing by 10 each digit is moved one place to the right so making it smaller.

eg. $350 \div 10 = 35$

H	T	U	.	t	h
3	5	0	.		
	3	5	.		

eg. $53 \div 100 = 0.534$

H	T	U	.	t	h
	5	3	.		
		0	.	5	3

When the calculation results in a decimal the units column must be filled with a zero to maintain the place value of the numbers.

Multiplication

Short multiplication

24×6 becomes

$$\begin{array}{r} 24 \\ \times 6 \\ \hline 144 \\ 2 \end{array}$$

Answer: 144

342×7 becomes

$$\begin{array}{r} 342 \\ \times 7 \\ \hline 2394 \\ 21 \end{array}$$

Answer: 2394

2741×6 becomes

$$\begin{array}{r} 2741 \\ \times 6 \\ \hline 16446 \\ 42 \end{array}$$

Answer: 16 446

Long multiplication

24×16 becomes

$$\begin{array}{r} 2 \\ 24 \\ \times 16 \\ \hline 240 \\ 144 \\ \hline 384 \end{array}$$

Answer: 384

124×26 becomes

$$\begin{array}{r} 12 \\ 124 \\ \times 26 \\ \hline 2480 \\ 744 \\ \hline 3224 \\ 11 \end{array}$$

Answer: 3224

124×26 becomes

$$\begin{array}{r} 12 \\ 124 \\ \times 26 \\ \hline 744 \\ 2480 \\ \hline 3224 \\ 11 \end{array}$$

Answer: 3224

Multiplication – alternative method

Conventional multiplication as set out above may not suit all pupils and teachers should be aware that other methods that may be employed by some pupils.

eg(i) 327×53

Estimate: $300 \times 50 = 15\,000$

X	300	20	7	Total
50	15 000	1000	350	16 350
3	900	60	21	981
Total	15 900	1060	371	17331

eg(ii) 456×24

Estimate: $450 \times 20 = 9\,000$

$$\begin{array}{r}
 456 \\
 \times 20 \\
 \hline
 9120 \\
 \text{1 1}
 \end{array}
 +
 \begin{array}{r}
 456 \\
 \times 4 \\
 \hline
 1824 \\
 \text{2 2}
 \end{array}
 +
 \begin{array}{r}
 9120 \\
 + 1824 \\
 \hline
 10\,924
 \end{array}$$

Multiplying Decimals

- As always, estimate the answer.
- Complete the calculation as if there were no decimal points.
- In the answer insert a decimal point so that there are the same number of decimal places in the answer as there were in the original question.
- Check to see if the answer is reasonable

eg (i) $1.2 \times 0.3 \approx 1 \times 0.3 = 0.3$

Ignoring the decimal points, this will be calculated as $12 \times 3 = 36$ and will now need two decimal places in the answer.

$$\therefore 1.2 \times 0.3 = 0.36$$

Similarly:

eg (ii) $43.14 \times 3.5 \approx 40 \times 4 = 160$

$$\begin{array}{r}
 43.14 \quad (2 \text{ decimal places}) \\
 \times 3.5 \quad (1 \text{ decimal place}) \\
 \hline
 21570 \\
 129420 \\
 \hline
 150.990 \quad (3 \text{ dp needed in the answer})
 \end{array}$$

Division

Short division

98 ÷ 7 becomes

$$\begin{array}{r} 14 \\ 7 \overline{) 98} \\ \underline{7 } \\ 28 \\ \underline{28} \\ 0 \end{array}$$

Answer: 14

432 ÷ 5 becomes

$$\begin{array}{r} 86 \text{ r } 2 \\ 5 \overline{) 432} \\ \underline{40 } \\ 32 \\ \underline{30} \\ 2 \end{array}$$

Answer: 86 remainder 2

496 ÷ 11 becomes

$$\begin{array}{r} 45 \text{ r } 1 \\ 11 \overline{) 496} \\ \underline{44 } \\ 56 \\ \underline{55} \\ 1 \end{array}$$

Answer: $45 \frac{1}{11}$

Long division

432 ÷ 15 becomes

$$\begin{array}{r} 28 \text{ r } 12 \\ 15 \overline{) 432} \\ \underline{30 } \\ 132 \\ \underline{120} \\ 12 \end{array}$$

Answer: 28 remainder 12

432 ÷ 15 becomes

$$\begin{array}{r} 28 \\ 15 \overline{) 432} \\ \underline{30 } \quad 15 \times 20 \\ 132 \\ \underline{120} \quad 15 \times 8 \\ 12 \end{array}$$

$$\frac{12}{15} = \frac{4}{5}$$

Answer: $28 \frac{4}{5}$

432 ÷ 15 becomes

$$\begin{array}{r} 28.8 \\ 15 \overline{) 432.0} \\ \underline{30 } \\ 132 \\ \underline{120} \\ 120 \\ \underline{120} \\ 0 \end{array}$$

Answer: 28.8

Chunking

A method for Long Division with which some pupils will be familiar and is based on recall of multiplication of numbers by 5, 10, 20 etc. followed by continuous subtraction.

eg 351 ÷ 13

$$\begin{array}{r} 27 \\ 13 \overline{) 351} \\ \underline{- 130} \quad 10 \\ 221 \\ \underline{- 130} \quad 10 \\ 91 \\ \underline{- 52} \quad 4 \\ 39 \\ \underline{- 39} \quad 3 \\ 0 \quad 27 \end{array}$$

Any remainders in this type of calculation should be written as a fraction by dividing the remainder by the number by which the calculation has been divided.