Numeracy across the Curriculum (supporting document)

Date Reviewed: January 2019

Date Ratified by Governors: January 2019

Date due for renewal: January 2020

The skills of a numerate Year 6 pupil

Year 6 Pupils should:

- have a sense of the size of a number and where it fits into the number system;
- know number bonds off by heart e.g. tables, doubles and halves;
- use their numeracy skills to work out answers mentally;
- calculate accurately and efficiently using a variety of strategies, both written and mental;
- recognise when AND when not to use a calculator; using it efficiently if needs be;
- make sense of number problems, including non-routine problems, and recognise the operations needed to solve them;
- explain their methods and reasoning using correct mathematical terms;
- judge whether their answers are reasonable, and develop strategies for checking;
- suggest suitable units for measuring;
- make sensible estimates for measurements;
- explain and interpret graphs, diagrams, charts and tables;
- use the numbers in graphs, diagrams, charts and tables to predict….

The skills of a numerate Year 9 pupil

Year 9 pupils should:

- have a sense of the size of a number and where it fits into the number system;
- recall mathematical facts confidently;
- calculate accurately and efficiently, both mentally and with pencil and paper, drawing upon a range of calculation strategies;
- use proportional reasoning to simplify and solve problems;
- use calculators and other ICT resources appropriately and effectively to solve mathematical problems, and select from the display the number of figures appropriate to the context of a calculation;
- use simple formulae and substitute numbers in them;
- measure and estimate measurements, choosing suitable units and reading numbers correctly from a range of meters, dials and scales;
- calculate simple perimeters, areas and volumes, recognising the degree of accuracy that can be achieved;
- understand and use measures of time and speed, and rates such as £ per hour or miles per litre;
- draw plane figures to given specifications and appreciate the concept of scale in geometrical drawings and maps;
- understand the difference between the mean, median and mode and the purpose for which each is used;
- collect data, discrete and continuous, and draw, interpret and predict from graphs, diagrams, charts and tables;
- have some understanding of the measurement of probability and risk;
- explain their methods, reasoning and conclusions, using correct mathematical terms;
- judge the reasonableness of solutions and check them when necessary;
- give their results to a degree of accuracy appropriate to the context.

Areas of Collaboration.
Section 1 – Number

Reading and writing numbers

Pupils must be encouraged to write numbers simply and clearly.
Most pupils can 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. e.g. 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.***

e.g. 3 027 251 is three million, twenty-seven thousand, two hundred 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.**

e.g. (i) (5 + 3) x 4
= 8 x 4
= 32

e.g. (ii) $5 + 6^2 \div 3 - 4$
$= 5 + 36 \div 3 - 4$
$= 5 + 12 - 4$
$= 17 - 4$
$= 13$

Care must be taken with **S**ubtraction.

eg	5 + 12 – 4 = 17 – 4 = 13 ✓	**or**	5 + 12 – 4 = 5 + 8 **=** 13 **x**
eg	5 –12 + 4 = -7 + 4 = -3 ✓	**but**	5 –12 + 4 [1] = 5 – 16 **=** -11 **x**

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 consider the ability of the pupil and the objectives of the task in hand. 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 10 x 10.

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.

e.g. $53 + 19 = 53 + 20 - 1$ $\quad$ $284 - 56 = 284 - 60 + 4$

$32 \times 8 = 32 \times 2 \times 2 \times 2$ $\quad$ $76 \div 4 = (76 \div 2) \div 2$

Pencil & Paper Calculations

All pupils should be able to use some pencil and paper methods involving simple addition, subtraction, multiplication and division. Some less able pupils will find difficulty in recalling multiplication facts to complete successfully such calculations. In these circumstances, it may be more useful to use a calculator in your subject to complete the task.

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 and mentally calculating the approximate answer.

After completing the calculation, they should be asked to consider whether their answer is reasonable in the context of the question.

There is no necessity to use a method for any of these calculations and any with which the pupil is familiar and confident should be used.

The following methods are some with which pupils may be familiar.

Addition & Subtraction

Estimate

Addition 3 456 + 975 3 500 + 1 000 = 4 500

```
  3 456
+   975
  4 431
  1  11
```

Subtraction by 'counting on'

Estimate

eg 8 003 – 2 569 8 000 – 3 000 = 5 000

Start	**Add**
2 569	1
2 570	30
2 600	400
3 000	5 000
8 000	3
Total	5 434

Subtraction by decomposition

Estimate

8 000 – 3 000 = 5000

```
    7 9 9 1
eg  8 0 0 3   (8, 0, 0 crossed out)
   -2 5 6 9
    5 4 3 4
```

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 unit 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.

e.g. 46 x 100 = 4 600

Th	**H**	**T**	**U**
		4	6
4	6	0	0

The same method is used for decimals.

e.g. 5.34 x 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 ÷ 10 = 35

H	T	U	.	T	H
3	5	0	.		
	3	5	.		

eg. 53 ÷ 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

3 2 7
x 5 3
9 8_2 1 ← 327 x 3
1 $6_1 3_3$ 5 0 ← 327 x 50
1 7 3 3 1

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

e.g. (i) 327 x 53 Estimate: 300 x 50 = 15 000

X	300	20	7	**Total**
50	15 000	1000	350	16 350
3	900	60	21	981
Total	15900	1060	371	**17331**

e.g. (ii) 456 X 24 Estimate: 450 x 20 = 9 000

```
  456          456        9120
 x 20         x  4     + 1824
 9120    +    1824      10 924
 1 1             2 2
```

Division

```
          2  7
 1  3 | 3  5  1
    -   2  6  0
           9  1
    -      9  1
              0
```

Chunking

Chunking is 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

```
          2  7
 1  3 | 3  5  1
    -   1  3  0 | 1  0
        2  2  1
    -   1  3  0 | 1  0
           9  1
       -   5  2 |    4
           3  9
       -   3  9 |    3
              0 | 2  7
```

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.

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:

e.g. (i) 1.2 x 0.3 $\approx$ 1 x 0.3 = 0.3

Ignoring the decimal points, this will be calculated as 12 x 3 = 36 and will now need two decimal places in the answer:

$\therefore$ 1.2 x 0.3 = 0.36

Similarly:

e.g. (ii) 43.14 x 3.5 ≈ 40 x 4 = 160

	4	3	.	1	4	(2 decimal places)
x			3	.	5	(1 decimal place)
	2	1	5	7	0	
1	2	9	4	2	0	
1	5	0.	9	9	0	(3 dp needed in the answer)

Percentages

Whilst pupils should be familiar with many operations involving percentages in mathematics lessons it is not proposed to elaborate on all of them in this booklet. The following is a sample of operations which pupils will be expected to use in other areas.

Calculating percentages of a quantity

Methods for calculating percentages of a quantity vary depending upon the percentage required. Pupils should be aware that fractions, decimals and percentages are different ways of representing part of a whole and know the simple equivalents

e.g. 10% = $^{1}/_{10}$ 12% = 0.12

Where percentages have simple fraction equivalents, fractions of the amount can be calculated:

e.g. i) To find 50% of an amount, halve the amount.
ii)To find 75% of an amount, find a quarter by dividing by four and then multiply it by three

.

Most other percentages can be found by finding 10%, by dividing by 10, and then finding multiples or fractions of that amount:

e.g. To find 30% of an amount first find 10% by dividing the amount by 10 and then multiply this by three.
30% = 3x10%

Similarly: 5% = half of 10% and 15% = 10% + 5%

Most other percentages can be calculated in this way.

When using the calculator it is usual to think of the percentage as a decimal. Pupils should be encouraged to convert the question to a sentence containing mathematical symbols: ('of' means X)

eg. Find 27% of £350 becomes
0.27 X £350 =

and this is how it should be entered in the calculator.

Calculating the amount as a percentage

In every case the amount should be expressed as a fraction of the original amount and then converted to a percentage in one of the following ways:

i) What is 15 as a percentage of 60?
(using simple fractions)
$\frac{15}{60} = \frac{1}{4} = 25\%$

ii) What is 27 out of 50 as a percentage?
(using equivalent fractions)
$\frac{27\times2}{50\times2} = \frac{54}{100} = 54\%$

iii) What is 39 as a percentage of 57?
(Using a calculator)
$\frac{39}{57} = 39 \div 57 = 0.684 = 68.4\%$

Section 2 – Algebra

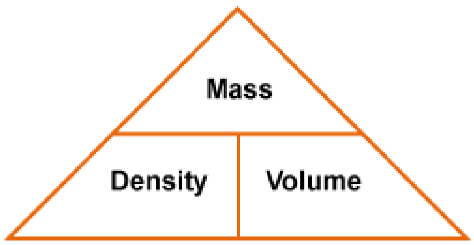
The most common use of algebra across the curriculum will be in the use of formulae.

When transforming formulae pupils will be taught to use the 'balancing' method where they do the same to both sides of an equation:

eg (i)	A = lb	Make b the subject of the formula
	[÷l]	$\frac{A}{l} = b$

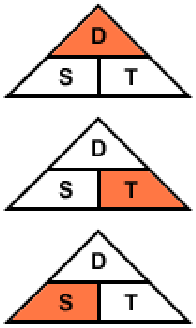
However, in some cases triangles can be useful for specific cases.

$Density = \frac{Mass}{Volume}$



$Density = \frac{Mass}{Volume}$ $Mass = Density \times Volume$ $Volume = \frac{Mass}{Density}$

Similarly with **Distance, Speed and Time**



Distance = Speed x Time

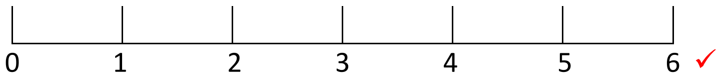
$$\text{Time} = \frac{\text{Distance}}{\text{Speed}}$$

$$\text{Speed} = \frac{\text{Distance}}{\text{Time}}$$

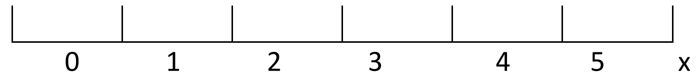
Plotting Points

When drawing a diagram on which points must be plotted some pupils will need to be reminded that the numbers written on the axes must be on the lines not in the spaces:

e.g.



NOT



Axis

When drawing graphs to represent experimental data it is usual to use the horizontal axis for the variable which has a regular class interval:

eg In an experiment in which temperature is taken every 5 minutes the horizontal axis would be used

for time and the vertical axis for temperature.

Having plotted points, pupils can sometimes be confused as to whether or not thy should join the points. If the results are from an experiment then a 'line of best fit' will usually be needed. Further details appear in the following section on Data Handling.

Section 3 – Data Handling

It is important that graphs and diagrams are drawn on the appropriate paper:

- bar charts and line graphs on squared or graph paper;
- pie charts on plain paper.

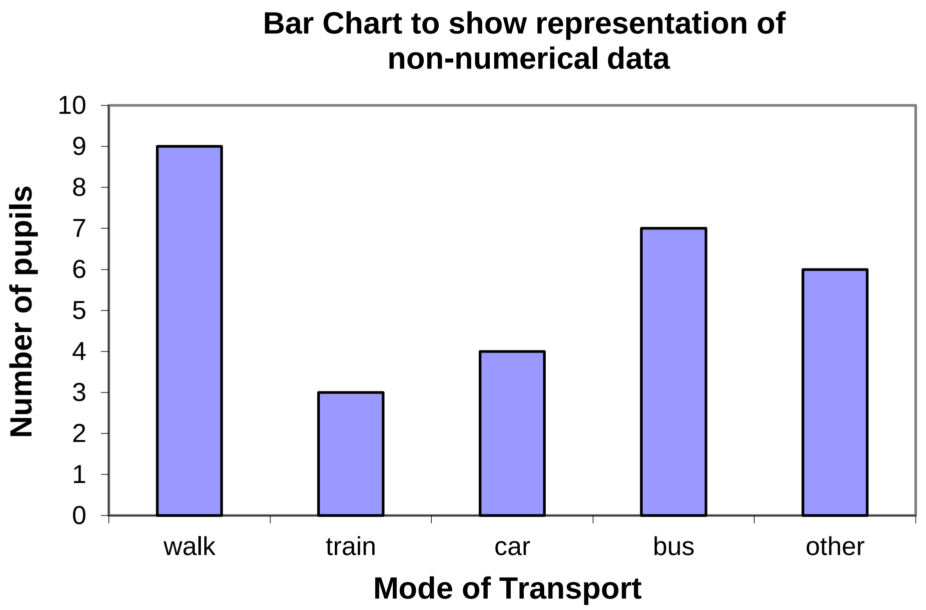
Bar Charts

These are the diagrams most frequently used in areas of the curriculum other than mathematics. The way in which the graph is drawn depends on the type of data being used.

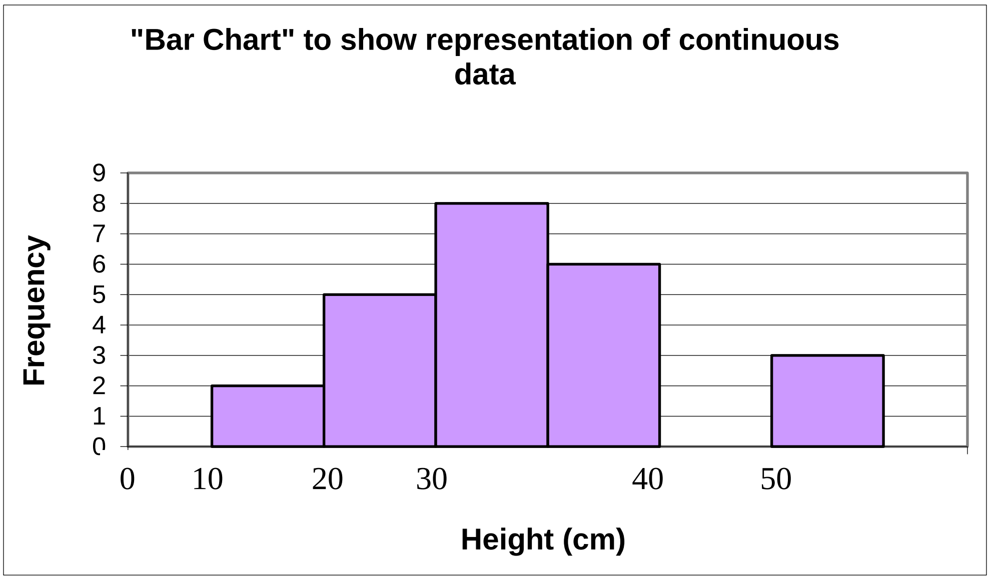
Graphs should be drawn with **gaps between the bars** if the data categories are not numerical (colours, makes of car, names of pop star, etc). There should also be gaps if the data is numeric but can only take a particular value (shoe size, KS3 level, etc). In cases where there are gaps in the graph the horizontal axis will be labelled beneath the columns.

The labels on the vertical axis should be on the lines.

e.g.



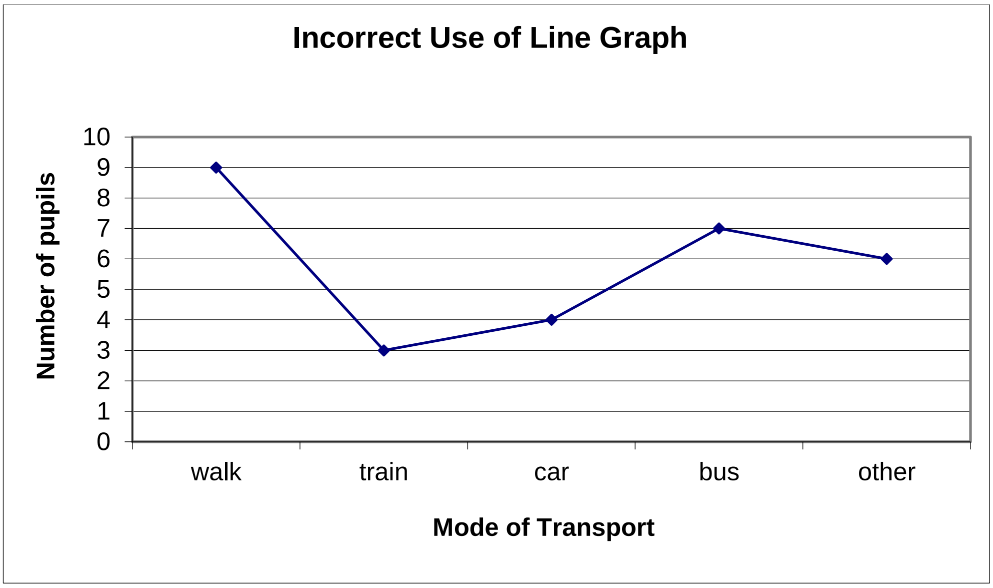
Where the data is continuous, e.g. lengths, the horizontal scale should be like the scale used for a graph on which points are plotted:



Line Graphs

Line graphs should only be used with data in which the order in which the categories are written is significant.

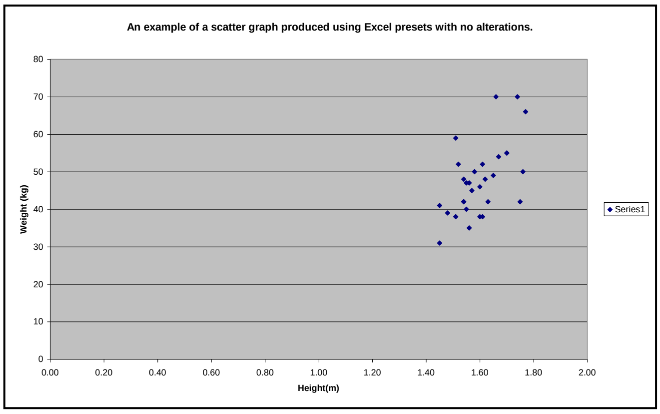
Points are joined if the graph shows a trend or when the data values between the plotted points make sense to be included. For example, the measure of a patient's temperature at regular intervals shows a pattern but not a definitive value.

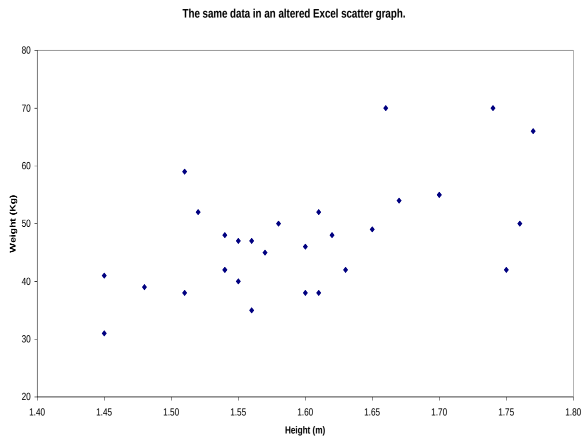


Computer Drawn Graphs & Diagrams

Pupils throughout the school should be able to use **Excel** or other spreadsheets to draw graphs to represent data. As it is easy to produce a wide variety of graphs there is a tendency to produce diagrams that have little relevance. Pupils should always be encouraged to write a comment explaining their observations from the graph.

For coursework any graphs produced using ICT should not have gridlines on them and the background should be white. This is because the gridlines and grey background are presets and they do not add any mathematical value. Pupils should however, be encouraged to alter axis scales where appropriate.
The two examples below show the difference quite well. The first is produced with a few clicks of the mouse. The second required slightly more thought about the data being looked at and was altered to obtain a better interpretation of the data.



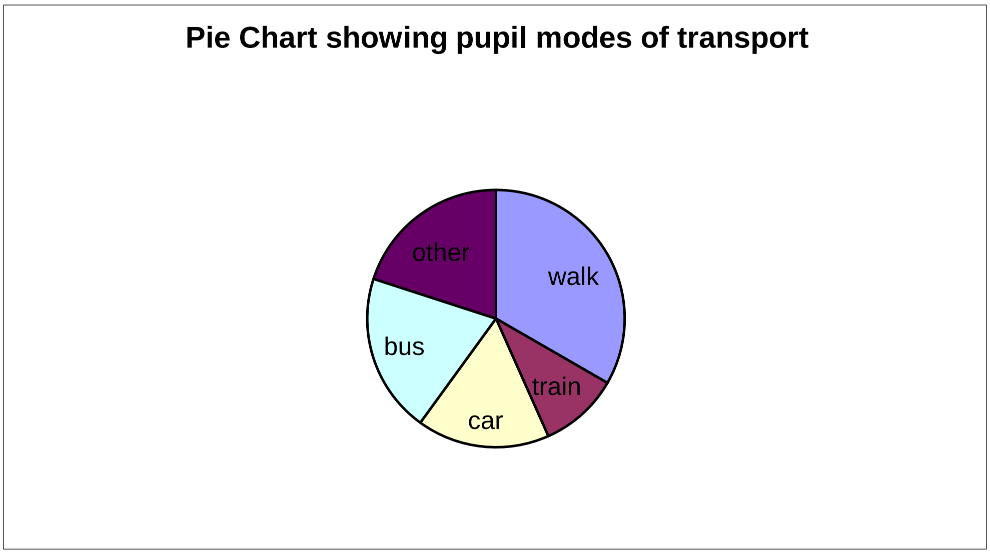


Pie Charts

The way in which pupils should be expected to work out angles for a pie chart will depend on the complexity of the question. If the numbers involved are simple it will be possible to calculate simple fractions of 360°.

The following table shows the results of a survey of 30 pupils travelling to school. Show this information on a pie chart.

Mode of Transport	Frequency	Fraction	Angle
Walk	10	$\frac{1}{3}$	120º
Train	3	$\frac{1}{10}$	36º
Car	5	$\frac{1}{6}$	60º
Bus	6	$\frac{1}{5}$	72º
Other	6	$\frac{1}{5}$	72º
Total	**30**	**1**	**360º**



However, with more difficult numbers which do not readily convert to a simple fraction, pupils should first work out the share of 360° to be allocated to **one** item and then multiply this by its frequency:
e.g. 180 pupils were asked their favourite core subject.

Each pupil has 360 ÷ 180 = 2° of the pie chart.

Subject	Number of pupils	Pie Chart Angle
English	63	63 x 2 = 126º
Mathematics	75	75 x 2 = 150º
Science	42	42 x 2 = 84º
Total	180	360º

If the data is in percentage form each item will be represented by 3.6° on the pie. To calculate the angle pupils will need to multiply the frequency by 3.6:

e.g. 43% will be represented by $43 \times 3.6 = 154.8°$

$\approx \underline{155°}$

Any calculations of angles should be rounded to the nearest degree only at the **final stage of the calculation.** If the number of items to be shown is 47 each item will need:

$360 \div 47 = 7.659574468°$

This complete number should be used when multiplying by the frequency and then rounded to the nearest degree.

Using Data

Range

The range of a set of data is the difference between the highest and the lowest data values.

e.g. If in an examination the highest mark is 80% and the lowest mark is 45%, the range is 35% because 80% - 45% = 35%

The range is always a **single number**, so it is **NOT** 45% - 80%

Averages

Three different averages are commonly used:

Mean – is calculated by adding up all the values and dividing by the number of values**;**

Median – is the middle value when a set of values has been arranged in order;

Mode - is the most common value. It is sometimes called the **modal group.**

eg. for the following values: **3, 2, 5, 8, 4, 3, 6, 3, 2,**

$$\boldsymbol{mean = \frac{3+2+5+8+4+3+6+3+2}{9} = \frac{36}{9}}$$

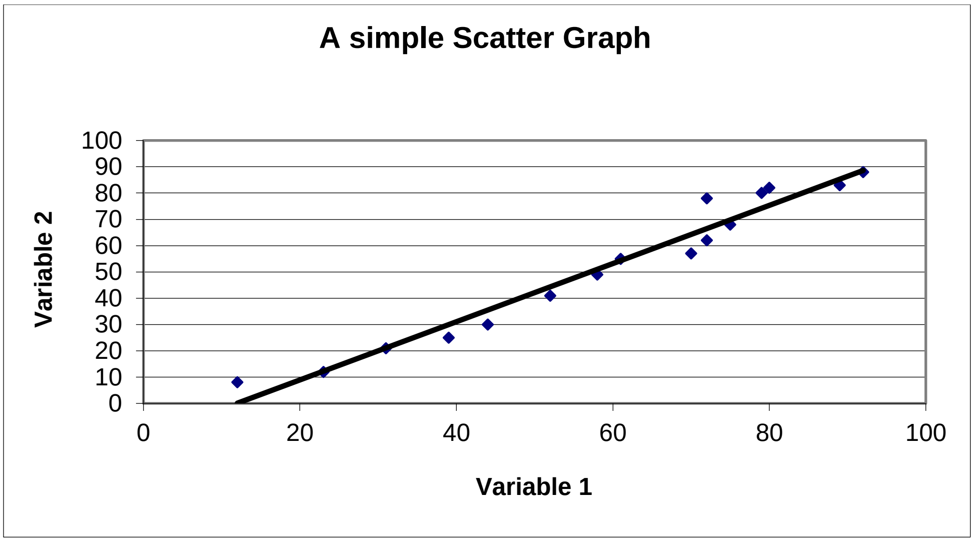
$\boldsymbol{median}$ is 3 because 3 is in the middle when the values are put in order

2, 2, 3, 3, 3, 4, 5, 6, 8

$\boldsymbol{mode}$ is 3 because 3 is the value which occurs most often.

Scatter graphs

These are used to compare two sets of numerical data. The two values are plotted on two axes labelled as for continuous data. If possible a ‘line of best fit ‘should be drawn.



The degree of correlation between the two sets of data is determined by the proximity of the points to the 'line of best fit'

The above graph shows a positive correlation between the two variables. However, you need to ensure that there is a reasonable connection between the two, e.g. ice cream sales and temperature. Plotting use of mobile phones against cost of houses will give two increasing sets of data but are they connected?

Negative correlation depicts one variable increasing as the other decreases, no correlation comes from a random distribution of points. See diagrams below.