Numeracy
Rhifedd

across the curriculum

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LEARNING STYLES

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Section 1 - Numbers

Reading and writing numbers

Most pupils can read, write and say numbers up to a thousand, but they often have difficulties with larger numbers. It is now common practice to use a space rather than a comma between groups of three figures - e.g. 34 000 not 34,000 - however, the latter is still common in many textbooks and is easier for pupils to read and write, therefore the practice of using a comma is encouraged.

When reading large numbers, pupils should know that the final three figures should be read in the same way that they are written, i.e., in ***hundreds, tens and units.*** Reading from right to left, the next three figures are ***thousands*** while the next group of three figures is ***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 when making numeracy calculations. Remember **BODMAS.**

Brackets, Orders, Division, Multiplication, Addition, Subtraction

This shows the correct order for completing operations, e.g.

$5 + 3 \times 4$ NOT $5 + 3 \times 4$

means $5 + 12$ means 8×4

$= 17$ ✓ $= 32$ ✗

The important facts to remember are that Brackets must be calculated first, followed by Orders, Multiplication and Division and, finally, Addition and Subtraction. Pupils must also remember to **work down the page** when answering these types of questions.

e.g. (i) $(5 + 3) \times 4$

$= 8 \times 4$

$= \underline{32}$

e.g. (ii) $5 + 6^2 \div 3 - 4$

$= 5 + 36 \div 3 - 4$

$= 5 + 12 - 4$

$= \underline{13}$

Care must be taken when subtracting

e.g. (iii) $5 - 12 + 4$

$= -7 + 4$

$= 3$ ✓

but $5 - 12 + 4$

$= 5 - 16$

$= \underline{-11}$ ✗

Calculators

Some pupils are over-reliant on calculators to do simple calculations. Whenever possible, pupils should be encouraged to do mental arithmetic or use pen and paper. However, the pupil's ability and the objectives of the task at hand need to be considered. In order to complete a task successfully, it may be essential for a pupil to use a calculator for a calculation which appears simple to you. This should be allowed in order to make progress within the subject area.

Before completing the calculation, pupils should be encouraged to provide an estimation. After completing the calculation with a calculator, they should consider whether the answer is rational in the context of the question.

Mental Arithmetic

Most pupils should be able to complete the following processes in their heads, although the speed at which they do so will vary significantly.

1. Recall addition and subtraction facts up to 20
2. Recall multiplication and division facts for times tables up to 10 x 10.

Pupils should be encouraged to do mental arithmetic using a variety of strategies, but there will be significant differences in their ability to do so. It would be beneficial if teachers talked to pupils about how they completed the calculation. Any method which leads to the correct answer is acceptable.

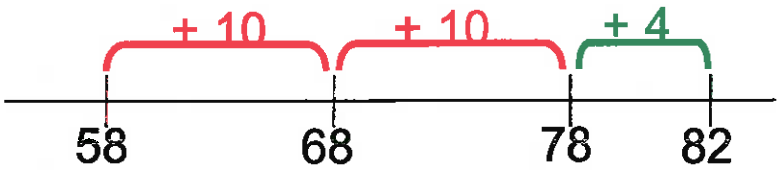
e.g. $53+19 = 53 + 20-1$

$284 - 56 = 284 - 60 + 4$

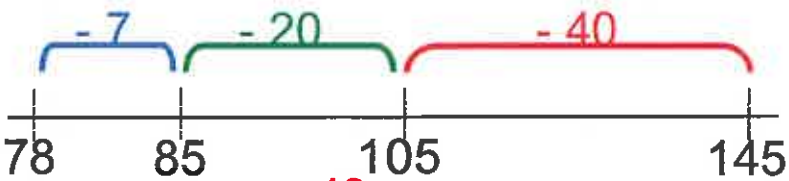
$76 \div 4 = (76 \div 2) \div 2$

or using the language line:

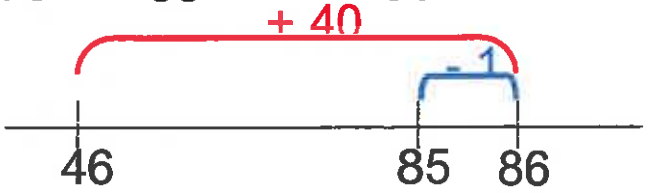
58 + 24



145 - 67



46 + 39



Written calculations

Pupils often misuse the '=' symbol. During a series of operations, they sometimes write incorrect mathematical sentences.

e.g. **5 x 4** = 20 + 3 = 23 - 8 = **15** as 5 x 4 ≠ 15 (≠ means not equal)

It is important for every teacher to encourage pupils to write such calculations correctly and neatly. The need to work down the page should be emphasised.

e.g. 5 x 4 = 20
20 + 3 = 23
23 - 8 = 15 ✓

The '≈' (approximately) symbol should be used when providing estimations.

e.g. 2,3478 - 412

≈ 2,400 - 400
= 2,400 - 400
= 2000 ✓

Calculations using Paper and Pencil

All pupils should be able to use some paper and pencil styles when completing simple addition, subtraction, multiplication and division. Some less able pupils will find it difficult to remember multiplication facts in order to complete such calculations successfully. In those circumstances, it may be more beneficial to use a calculator in order to complete the task.

Before completing any calculation, pupils should be encouraged to provide a rough estimation. This should be done by rounding off numbers and calculating the rough answer in their heads.

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

The columns must be kept neat when using the written method.

356 + 78

$$\begin{array}{rrr} & 3 & 5 & 6 \\ + & & 7 & 8 \\ \hline & 4 & 3 & 4 \\ & {\scriptstyle 1} & {\scriptstyle 1} & \end{array}$$

23.4 – 5.2

$$\begin{array}{rrcr} & {\scriptstyle 4}\not{5} & {\scriptstyle 13} & . & 4 \\ - & & 5 & . & 2 \\ \hline & 4 & 8 & . & 2 \end{array}$$

Subtraction by 'counting forward'

e.g. 8,003 - 2,569

Start	Add
2569	1
2570	30
2600	400
3000	5000
8000	3
Total	5434

Multiplying and Dividing by 10,100,1000...

When a number is multiplied by 10 its value increases ten times and all the numbers move one place to the left on the place value grid. When multiplying by 100, all the numbers move two places to the left, and so on. Any empty columns will be filled with a zero in order to maintain their value when the numbers are written without the column headings. WE DO NOT SAY THAT WE ADD A ZERO WHEN MULTIPLYING BY 10!

PLACE VALUE GRIDS

One million	Hundred Thousand	Ten Thousand	One thousand	One hundred	Ten	Unit	.	Tenth	Hundredth	Thousandth

MULTIPLICATION ← DIVISION →

e.g. 46 x 100 = 4600

M	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	

The empty spaces after the decimal point have not been filled with zero. The place value of the numbers are not affected by these gaps.

When dividing by 10, each number moves one place to the right and its value decreases.

e.g. 350 ÷ 10 = 35

H	T	U	·	t	h
3	5	0	·		
	3	5	·		

e.g. 53 ÷ 100 = 0.53

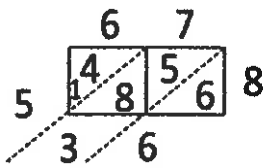
H	T	U	·	t	h
	5	3	·		
		0	·	5	3

When the calculation provides a decimal, the 'units' column must be filled with a zero in order to support the place value of the numbers

Short Multiplication

67 x 8

```
  6 7
X   8
5 3 6
  5
```



60 x 8 = 480
7 X 8 = 56
536

Long Multiplication

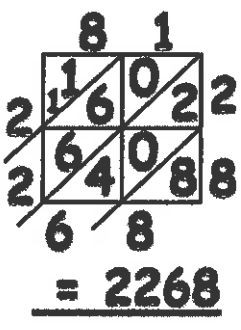
81 x 28

```
  8 1
x 2 8
  6 4 8   (x units)
1 6 2 0   (x tens)
2 2 6 8
1
```

THIS IS OUR PREFERRED METHOD

80	1	
1600	20	20
640	8	8

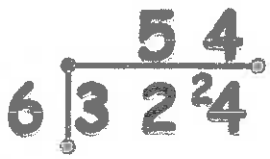
1600
640
20
8
2268



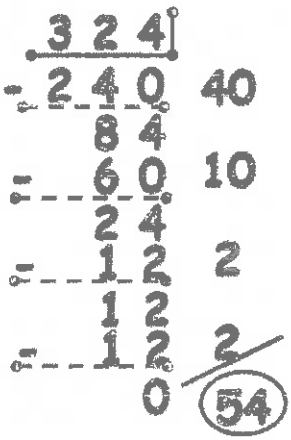
Division

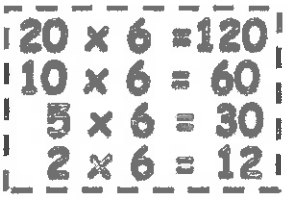
e.g. 324 ÷ 6

Traditional Method



Chunking



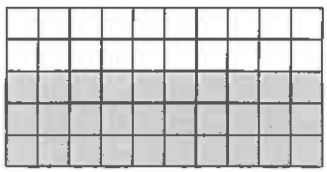


Percentages

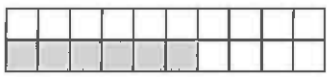
Whilst pupils should be familiar with a number of operations relating to percentages in mathematics lessons, we do not intend to elaborate on them in this booklet. The following are examples of operations that pupils should be expected to use in other areas.

Calculating the percentages of numbers

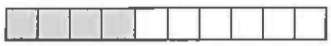
A percentage is a fraction out of 100



30 out of 50
(50 x **2** = 100)
60 out of 100
60%



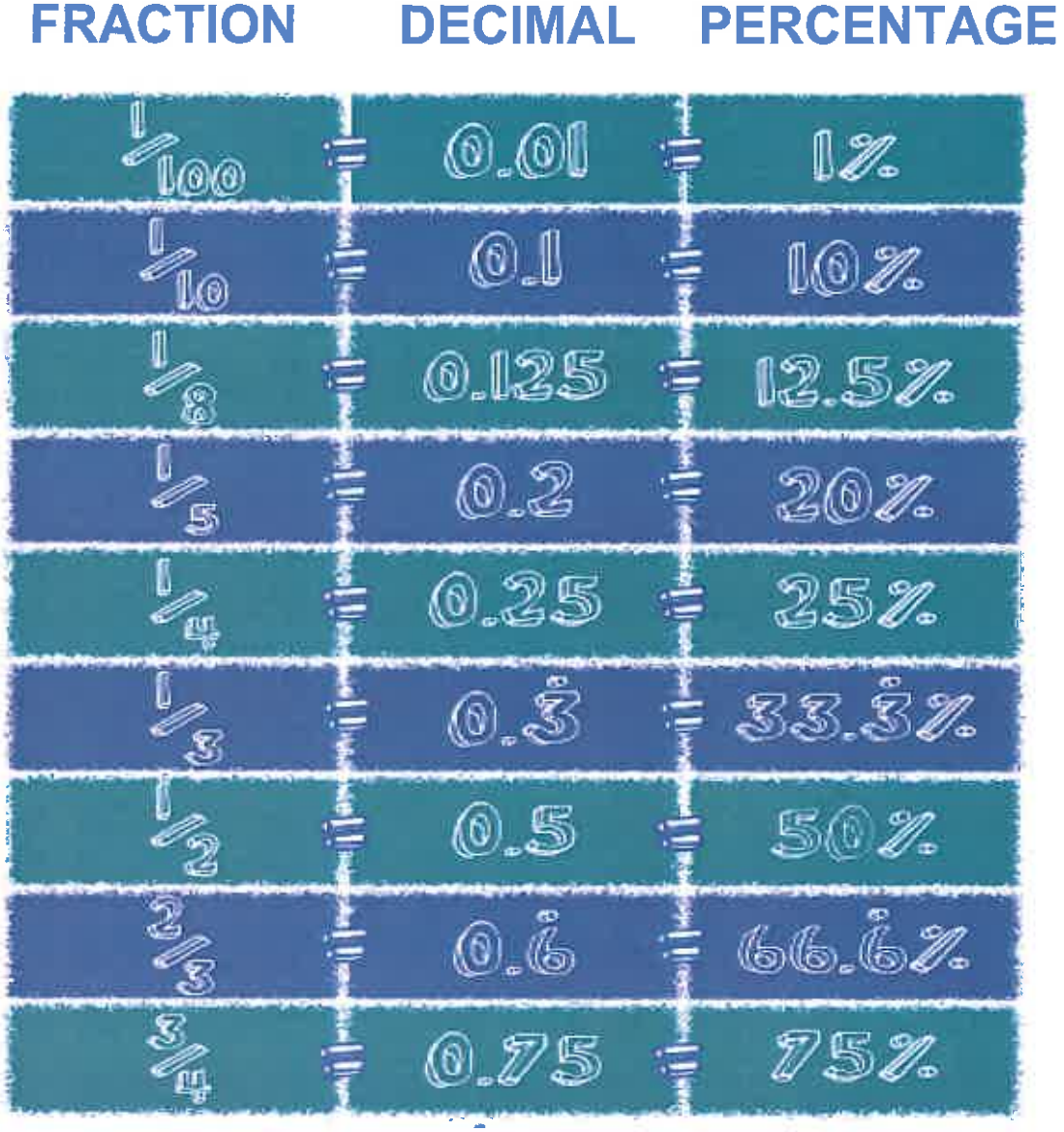
6 out of 20
(20 x **5** = 100)
30 out of 100
30%



4 out of 10
(10 x **10** = 100)
40 out of 100
40%

The methods for calculating the percentages of numbers vary, depending on the percentage required. Pupils should be aware that fractions, decimals and percentages represent a part of a sum differently, and they should know what is equivalent.

On the whole, pupils can deal with **fractions of a number/amount** and, therefore, it would benefit pupils to be able to **change** from a **percentage to a fraction,** which is equivalent.



e.g.
75% of $240

$\frac{3}{4}$ of 240

240 ÷ 4 = 60 **(divide the bottom)**
60 x 3 = $180 **(multiply the top)**

Most other percentages can be calculated by finding 10% (1/10, one tenth) by dividing by 10, then multiplying or finding fractions of that amount.
Similarly: 5% = half of 10%
15% = 10% + 5%

Most other percentages can be calculated using this method.

When **using a calculator,** the percentage is usually considered a decimal. Pupils should be encouraged to turn the question into a sentence which includes mathematical symbols (where **'of' stands for multiplication**)

e.g. Finding 27% of £350 is
0.27 x 350 = £94.50

and that is how it should be entered into a calculator.

For **less able pupils**, this can be changed into a fraction again (using a calculator)

e.g. 27% of £350 is
$\frac{27}{100}$ of 350
350 ÷ 100 = 3.5
3.5 x 27 = 94.50

Calculating the amount as a percentage

In every case, the amount should be expressed as a fraction of the original amount, then changed into a percentage in one of the following ways:

i) What is 15 as a percentage of 60?
(simplifying the fraction first)

$$\frac{15}{60} = \frac{1}{4} = 25\%$$

ii) What is 27 as a percentage of 50?
(using equivalent fractions and remembering that a percentage is a fraction out of 100)

$$\frac{27}{50} = \frac{54}{100} = 54\%$$

iii) What is 39 as a percentage of 57?
(using a calculator)

$$\frac{39}{57} = 39 \div 57$$

$$= 0.684 \times 100$$

$$= 68.4\% \text{ (1 decimal place)}$$

Improper Fractions / Mixed Numbers / Decimals

Pupils should be able to switch between improper fractions, mixed numbers and decimals. Again, this goes back to knowing the equivalent fractions, decimals and percentages (e.g. ¼ = 0.25 = 25%).

There will be several occasions where pupils will come across improper fractions (e.g. mean, speed, time etc), therefore a calculator will not need to be used necessarily.

e.g. $\frac{13}{4}$ = 4 1/4 = 4.25

$\frac{28}{10}$ = 2 8/10 = 2.8

When a calculator is required, it is important for pupils to write it as an improper fraction first.

e.g. $\frac{14.7}{5}$ = 2.94

Rounding

Pupils are often expected to round up in all subjects. Pupils are happy to round up to the nearest whole number, 10, 100 and 1000. Care must be taken when rounding up to decimal places, especially significant numbers.

e.g. i) round up 5.67 seconds to the nearest **tenth** of a second (**1 decimal place**)

5.67 → 5.7

ii) round up 0.015 to **2 decimal places** (nearest **hundredth**)

0.015 → 0.02

iii) round up the population of Wales, from 3,095,233 to **2 significant numbers**

3,155,233 → 3,200,000

Being able to round up numbers to **1 significant number** will be beneficial when **estimating** calculations.

e.g. estimating 52 x 8.7

≈ 50 x 9

= 450

Section 2 - Displaying Data

Drawing Graphs and Charts

Simple rules for drawing graphs:

- use a PENCIL and a RULER
- use GRAPH PAPER or squared paper
- include a title which describes the content of the graph
- label axes correctly
- keep the scale consistent (similar spacing)

Remember to use SALTU when marking work on graphs and charts

S – scale
A – axis
L – labelling
T – titles
U - units

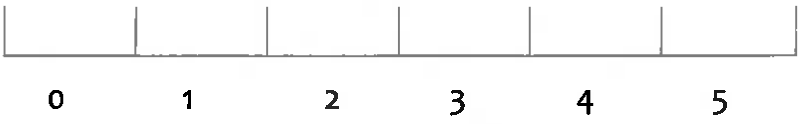
Plotting Points

When drawing a diagram where points need to be plotted, some pupils will need to be reminded that the numbers on the axis need to be on the lines rather than in the spaces. Pupils need to be reminded to think of **multiples** when drawing the scale e.g. multiples of 5: 5,10,15,20
multiples of 0.2: 0.2, 0.4, 0.6, 0.8, 1.0 1.2 etc

e.g.

✓

Not



✘

Axis

When drawing graphs to represent experimental data, the horizontal axis is normally used for the regular variable.

e.g. In an experiment where the temperature is measured every 5 minutes, the horizontal axis would always be used to represent time and the vertical axis used for temperature.

After plotting points, pupils can sometimes get confused about whether they should join up the points or not. If the results are from an experiment, then a 'best fit line' is usually needed. Further details on Drawing Graphs and

Charts can be found in the next section.

Choosing a graph or chart which is appropriate for the data

Discrete Data or Continuous Data?

When choosing which kind of graph or chart to use to represent the data learners need to consider the type of data in question.

Discrete data:
Data which results from calculating separate items or events, e.g. number of people.

Continuous data:
This data is collected by measuring something specific, e.g. length, temperature, weight. Continuous data can have any value between two values. It can be measured to some extent from accuracy alone. Continuous data is usually represented by a line.

Here are some examples of both discrete and continuous data:

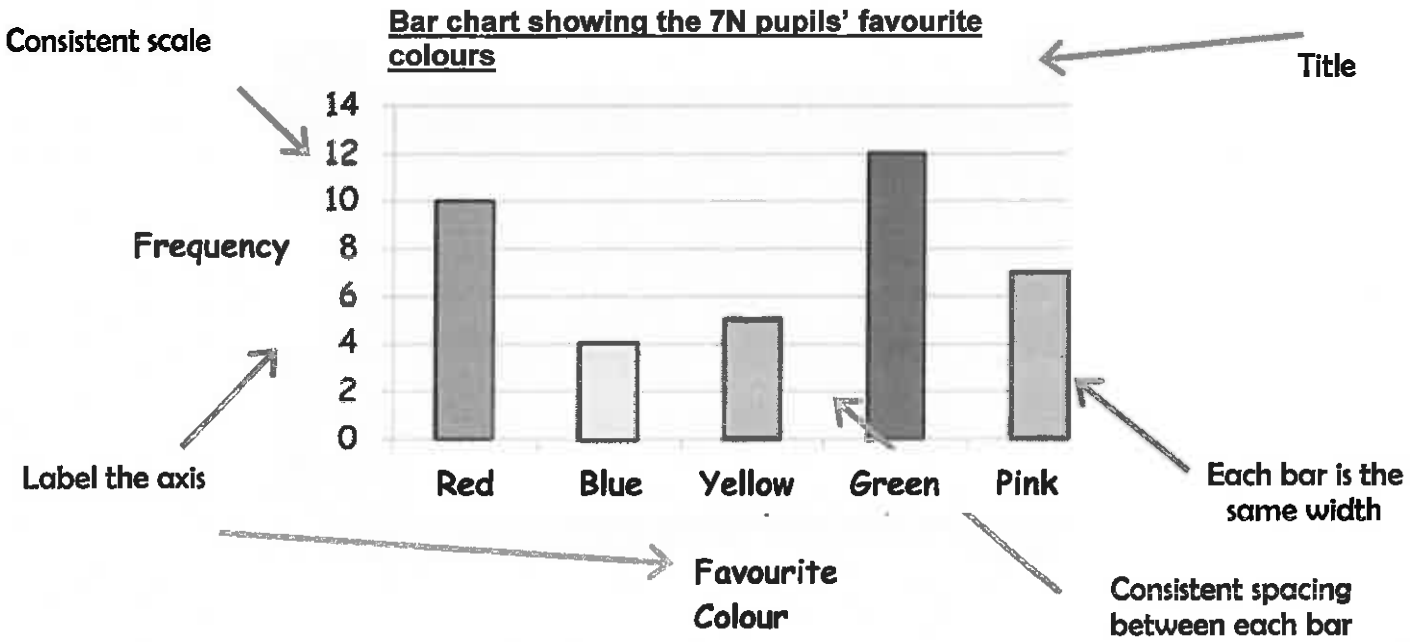
Discrete	Continuous
Shoe size	Foot length
Type of car	Time from 0-60mph
Type of fish	Weight of salmon
Number of sunny days	Hours of sunshine
What kind of transport is used to go shopping	Distance from home to shops

1. Bar Chart

These are diagrams which are mostly used in curricular areas outside of mathematics. The method of drawing the graph depends on the type of data that needs to be processed.

a) Ungrouped Data – **Discrete Data**

Graphs should be drawn **with spaces between the bars** unless the data categories include numbers (colours, types of cars, names of pop stars, etc). Spaces should also be included if the data includes numbers of a specific value (shoe size, KS3 level etc.) Where there are spaces in the graph, the horizontal axis will be labelled **under** the columns.



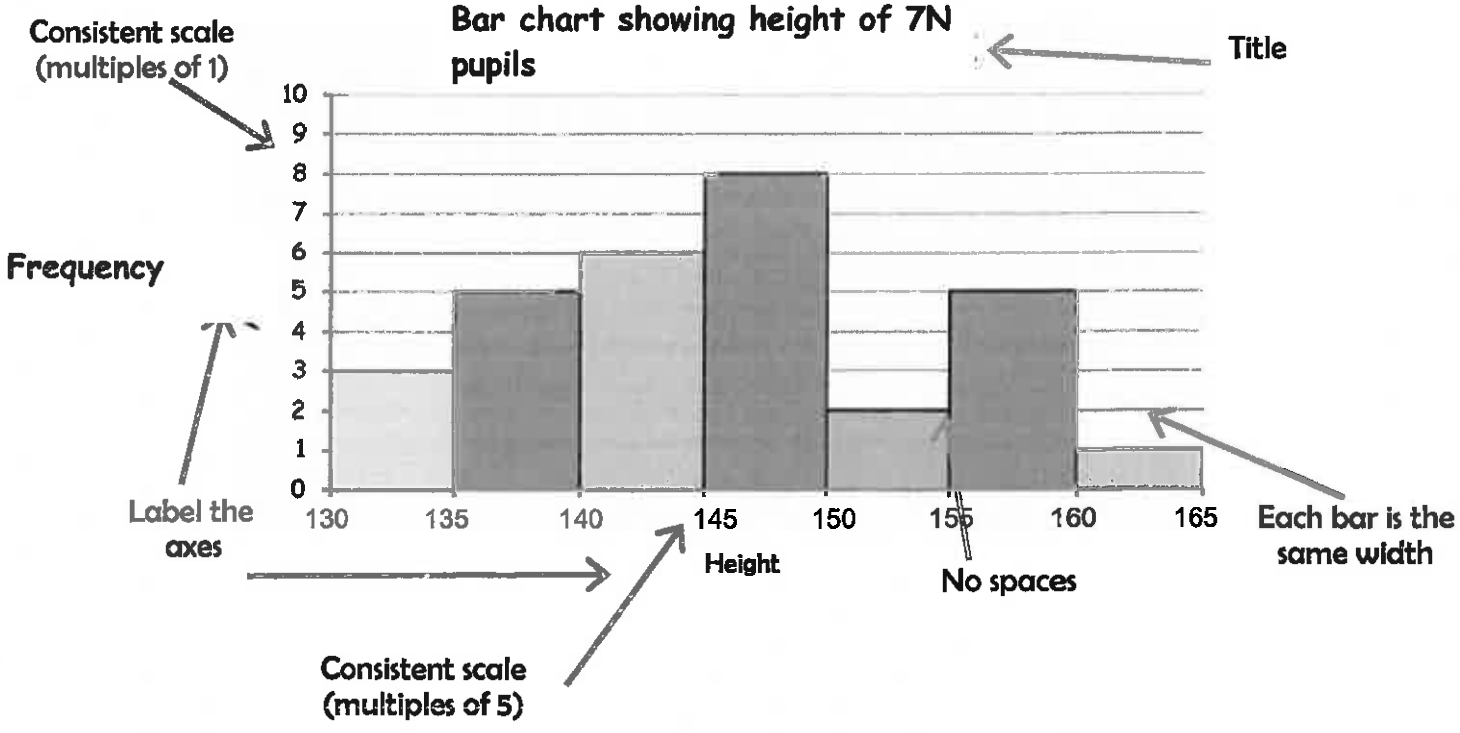
b) Grouped Data – Continuous Data

If the data is continuous, e.g. length, weight, money the horizontal axis should show the scale for plotting points on the graph. There should be no space between the bars as the data is continuous.

The following notation can be used:
130 ≤ x < 135
Data which is 130 or more but less than 135 and that every class interval is equal e.g. groups of 5

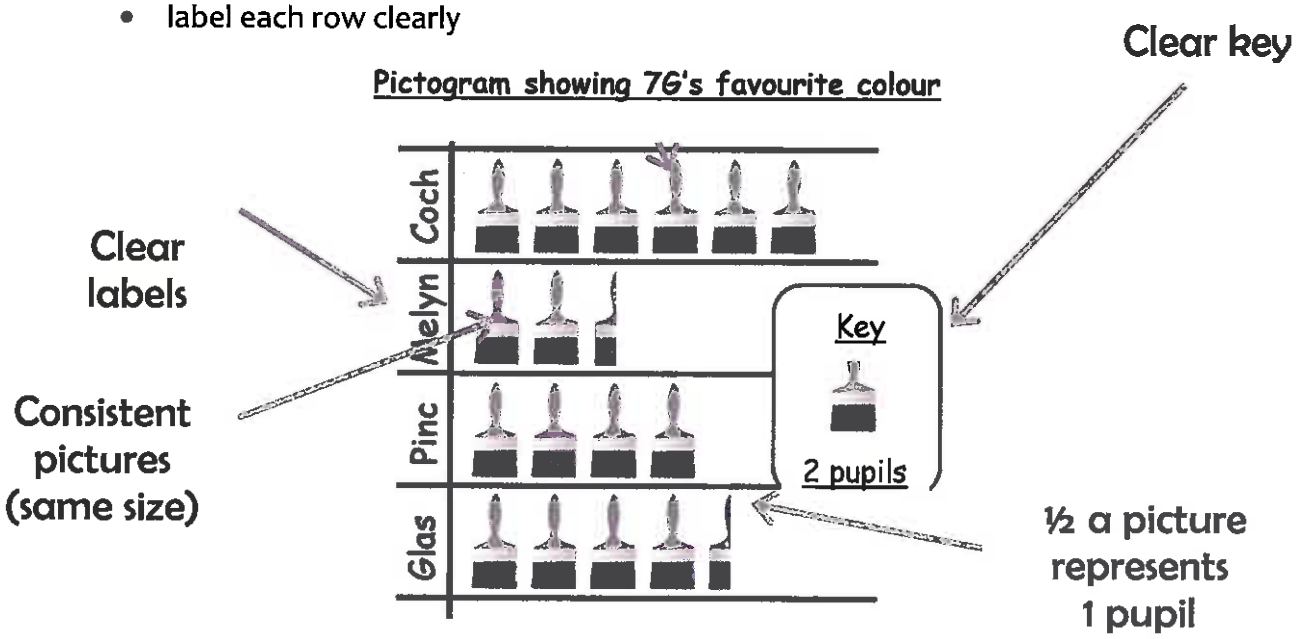
Height (cm)	Frequency
130 ≤ x < 135	3
135 x 140 = 100	5
140 x 145 = 100	6
145 x 150 = 100	8
150 x 155 = 100	2
155 x 160 = 100	5
160 x 165 = 100	1

Frequency table showing th results



2. Pictogram

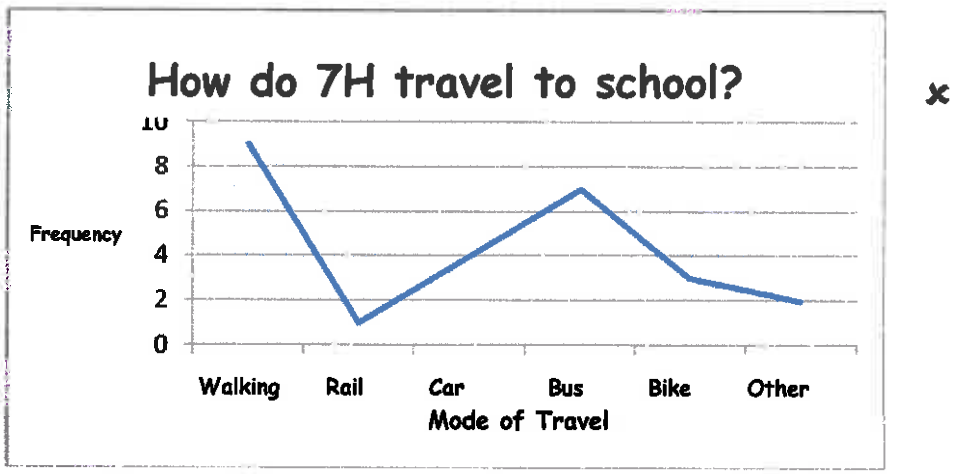
- include a clear key which shows what every picture represents
- choose a suitable picture (a simple picture which is connected to the subject of the data)
- use one picture only
- keep the picture consistent (always the same size)
- label each row clearly



3. Line Graphs

Line graphs should only be used where the order in which categories are written is significant.
The points will be connected if the graph shows a tendency or if it makes sense to include the values of the data between the plotted points e.g. measuring a patient's temperature at regular intervals.
It is important that pupils are able to interpret line graphs.

Incorrect Use of Line Graphs:



x

4. Pie Chart

The way in which pupils are expected to calculate the angles of a pie chart depends on the complexity of the question. If the numbers in question are simple, then it is possible to calculate simple fractions of 360°.

e.g. Frequency table showing how 7A pupils travel to school.

Mode of travel	Frequency
Bus	25
Walking	6
Car	4
Rail	1

Step 1: Count how many people took part in the survey:

$25 + 6 + 4 + 1 = \underline{36}$

Step 2: Count as a **fraction of a number** (360°) for each option.

e.g. Bus $\frac{25}{36}$ of 360

$360 \div 36 = 10°$

$10° \times 25 = \mathbf{250°}$

Step 3: Calculate the size of the angle of each category

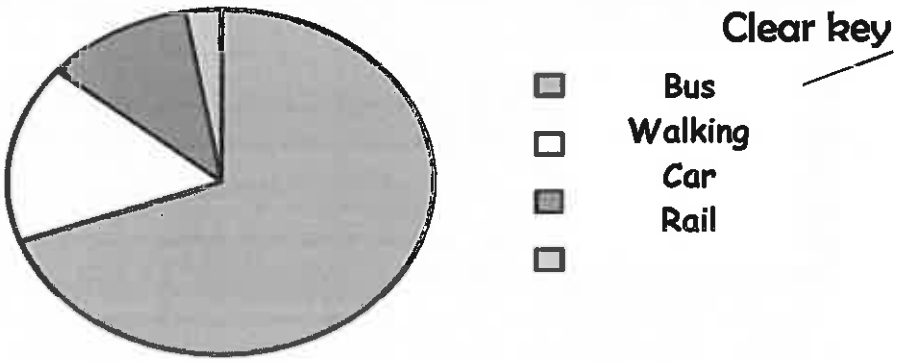
Bus:	25 people:		=	250°
Walking:	6 people:	$\frac{6}{36} \times 10\ 360°$	=	60°
Car:	4 people:	$\frac{4}{36} \times 360°$	=	40°
Train:	1 people	$\frac{1}{36} \times 360°$	=	10°

Each angle adds up to 360

Step 4: Draw the pie chart starting with the radius as a northern line

Title →

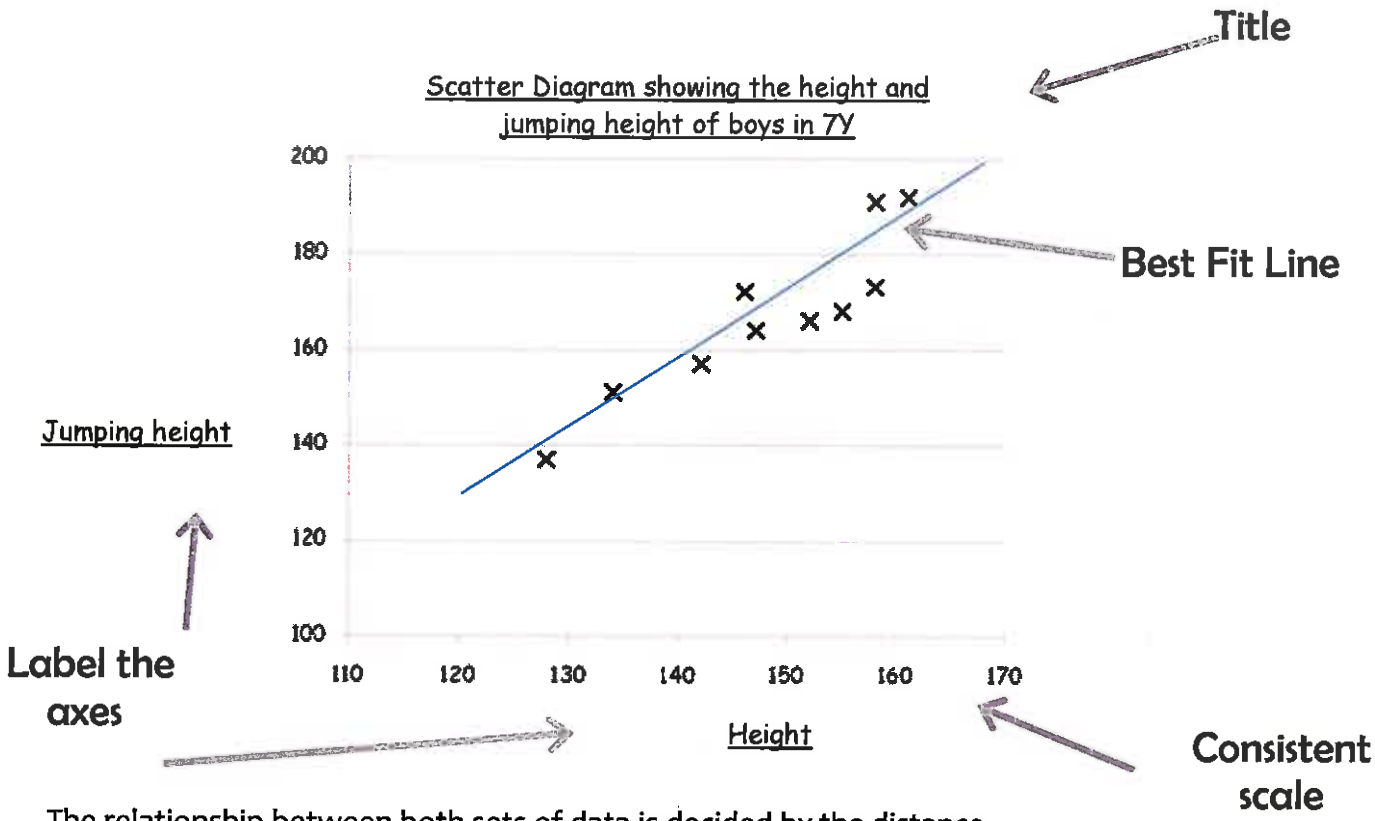
Pie chart showing how 7A pupils travel to school



5. Scatter Diagram

These are used to compare two sets of numeric data. Both values are plotted on two labelled axes, in the same way as continuous data. If possible, a 'best fit line' should be drawn.

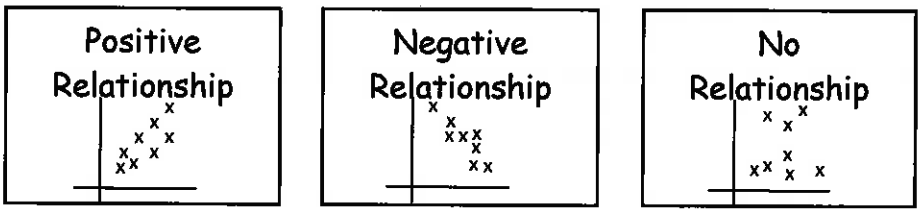
Height (cm)	128	158	155	134	161	152	142	158	147	146
Jumping height (cm)	137	191	168	151	192	166	157	173	164	172



The relationship between both sets of data is decided by the distance between the points and the 'best fit line'.

The above graph shows a positive relationship between both variables. However, you must ensure that there is a rational link between the two e.g. the sales of ice cream and temperature. Plotting the use of mobile phones against the cost of houses would produce two sets of increasing data, but is there a link between them?

A negative relationship shows one variable increasing as the other decreases. There is no relationship between points that have been randomly scattered. See the diagrams below.



6. Data Analysis

When comparing two sets of data, it is beneficial to use different averages to support the argument. The three different types of averages are mean, median and mode.

(1) MODE

The most popular data value.

e.g. Teacher travelling times (to the nearest minute)

25 40 30 40 40 30 20

The mode time is **40**

(2) MEDIAN

The middle data value after placing them in order.

e.g. Hours of homework that pupils have every week

5 4 8 4 6 5 8

Arrange the numbers: 4 4 5 5 6 8 8

Median: 5 hours

If there is repeating data, the point between the two middle numbers must be calculated.

e.g. Hours of homework that pupils have every week

5 4 8 4 6 5 8 8

Arrange the numbers: 4 4 5 5 6 8 8 8

Median: $\frac{5+6}{2} = \frac{11}{2} = 5.5$ hours

(3) MEAN

$$\frac{\text{The total of all the data values}}{\text{Number of data values}}$$

e.g. Foot length of 10 newborn babies (to the nearest cm)

7 8 6 8.5 7 5 8 7.5 6 8 9

Total data values = $7 + 8 + 6 + 8.5 + 7 + 5 + 8 + 7.5 + 6 + 8 + 9$
$= 80$

Number of data values = 10

Mean = $\frac{80}{10}$
$= 8$ cm

(4) RANGE

Highest data value - Lowest data value

The range must be used to decide how consistent the data is.
Small range - the data is close together and therefore consistent.
Large range - the data is scattered and is therefore inconsistent.

e.g. Foot length of 10 newborn babies (to the nearest cm)

7 8 6 8.5 7 5 8 7.5 6 8 9

Range
$= 9 - 5$
$= 4$ cm

Table

Eye colour	Number of pupils
Blue	
Green	
Brown	

Time (minutes)	Temperature of water (°C) Turn 1	Turn 2	Turn 3	Mean
0				
10				
20				

Note

- Neat columns and rows.
- Independent variable in the first column.
- Dependent variable in the second/other columns.
- Appropriate headings and units above each column.
- The first column is filled with the independent variable.

How to draw a Table

Step 1- Decide how many colums and rows are needed.

You need a row for every independent variable and an additional row for headings.

You need one column for the independent variable, e.g Eye colour.

You need one column for the dependent variable, e.g Number of pupils.

Eye Colour	Number of pupils

Sometimes you will need more than one column for the dependent variable, e.g when repeating a scientific experement.

Time (minutes)	Temperature of water (°C) Turn 1	Turn 2	Turn 3	Mean

Remember- You need to use a ruler to draw neat rows and columns.

Step 2 - Give clear headings and units to each coloumn.

Step 3 – List the claues of the independent variable in the first column.

Eye Colour	Number of pupils
Blue	
Green	
Brown	

Example of a table in Science

Time (minutes)	Temperature of water (°C) Turn 1	Turn 2	Turn 3	Mean
0				
10				
20				

Step 4 - The table is now ready to collect data to fill the colums.

How to choose appropriate scales.

Step 1 – What is the greatest value for the dependent variable?
e.e.

Eye Colou	Number of pupils
Blue	5
Green	10
Brown	20

Step 2- Use the scale selector to choose an appropriate scale that goes up to your greatest number.
e.g. 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20.

Step 3- Calculate the value of every little square on your graph paper.

e.e. If every big square is worth 2,

and there are 10 little squares in one big square.

$2 \div 10 = 0.2$

Each little square is worth 0.2.