MATTHEW MOSS HIGH SCHOOL
*Learning for Life*

Policy No.: 28

Policy: Numeracy

Review Date: June 2017

Policy Name: Numeracy

Nominated Lead Member of Staff: Deputy Headteacher (Numeracy)

Review Cycle: 1 Year

Authorisation : Headteacher

Review Date: June 2017

# Numeracy Policy

**Mission Statement:** Matthew Moss High School is committed to raising the standards of numeracy of all of its learners, so that they develop the ability to use numeracy skills effectively in all areas of the curriculum and the skills necessary to cope confidently with the demands of further education, employment and adult life.

**The purposes of our whole-school numeracy policy:**

- to develop, maintain and improve standards in numeracy across the school
- to ensure consistency of practice including methods, vocabulary, notation, etc.
- to indicate areas for collaboration between subjects
- to assist the transfer of learners' knowledge, skills and understanding between subjects

**Expectations**

All staff should look for opportunities to promote numeracy either during Form time or on other learning occasions. Instances of numeracy should be made clear and the general principles of this policy should be followed.

**Consistency of Practice**

The Mathematical Association recommend that teachers of Mathematics and teachers of other subjects co-operate on agreed strategies. In particular that:

**Teachers of mathematics should:**

1. Be aware of the mathematical techniques used in other subjects and provide assistance and advice to other departments, so that a correct and consistent approach is used in all subjects.
2. Provide information to other subject teachers on appropriate expectations of learners and difficulties likely to be experienced in various age and ability groups.
3. Through liaison with other teachers, attempt to ensure that learners have appropriate numeracy skills by the time they are needed for work in other subject areas.
4. Seek opportunities to use topics and examination questions from other subjects in mathematics lessons.

**Teachers of subjects other than mathematics should:**

1. Ensure they are familiar with correct mathematical language, notation, conventions and techniques, relating to their own subject, and encourage learners to use these correctly.

2. Be aware of appropriate expectations of learners and difficulties that might be experienced with numeracy skills.

3. Provide information for mathematics teachers on the stage at which specific numeracy skills will be required for particular groups.

4. Provide resources for mathematics teachers to enable them to use examples of applications of numeracy relating to other subjects in mathematics lessons.

**Mental Arithmetic Techniques**

All departments should give every encouragement to learners using mental techniques but must also ensure that they are guided towards efficient methods and do not attempt convoluted mental techniques when a written or calculator method is required.

**Role & Use of Calculators**

In simple terms, each department needs to decide and then plan into each module of work whether calculators are banned, ignored, allowed, encouraged or compulsory.

**Whole School Policy on the use of calculators**

The school expects all learners to bring their own scientific calculator to lessons when required. In deciding when learners use a calculator in lessons we should ensure that:

- learners' first resort should be mental methods
- learners have sufficient understanding of the calculation to decide the most appropriate method: mental, pencil and paper or calculator
- learners have the technical skills required to use the basic facilities of a calculator constructively and efficiently, the order in which to use keys, how to enter numbers as money, measures, fractions, etc.
- learners understand the four arithmetical operations and recognise which to use to solve a particular problem
- when using a calculator, learners are aware of the processes required and are able to say whether their answer is reasonable
- learners can interpret the calculator display in context (e.g. 5.3 is £5.30 in money calculations)
- we help learners, where necessary, to use the correct order of operations – especially in multi-step calculations, such as (3.2 – 1.65) x (15.6 - 5.77)

**Vocabulary**
The following are all important aspects of helping learners with the technical vocabulary of Mathematics:

- Use of Word walls
- Using a variety of words that have the same meaning e.g. add, plus, sum, product
- Encouraging learners to be less dependent on simple words e.g. exposing them to the word multiply as a replacement for times
- Discussion about words that have different meanings in Mathematics from everyday life e.g. take away, volume, product etc
- Highlighting word sources e.g. quad means 4, lateral means side so that learners can use them to help remember meanings. This applies to both prefixes and suffixes to words

Numeracy Across the Curriculum: Examples of underlying maths skills in curriculum areas.

- ART – Symmetry; use of paint mixing as a ratio context
- ENGLISH – comparison of 2 data sets on word and sentence length
- FOOD TECHNOLOGY – recipes as a ratio context, reading scales,
- GEOGRAPHY – representing data, use of Spreadsheets, use of graphs
- HISTORY – timelines, sequencing events
- ICT – representing data; considered use of graphs not just pretty ones!
- MFL – Dates, sequences and counting in other languages; use of basic graphs and surveys to practise foreign language vocabulary and reinforce interpretation of data
- MUSIC – addition of fractions
- PHYSICAL EDUCATION – collection of real data for processing in Maths e.g. Health and Fitness data
- RELIGIOUS EDUCATION – interpretation and comparison of data gathered from secondary sources (internet) on e.g. developing and developed world
- RESISTANT MATERIALS – measuring skills, units of area and volume
- SCIENCE – calculating with formulae, 3 way relationships, use of graphs
- TEXTILES – scale, practical equipment, proportion

Reference: "Numeracy across the Curriculum" ISBN 0 906588 47 2 by Mary Ledwick, published by The Mathematical Association. http://www.m-a.org.uk/index.htm

**Associated Policies:**
**Special Educational Needs**
**Careers Education, Advice and Guidance**
**Pupil Premium**
**Home Learning**
**Marking and Feedback**
**Curriculum**
**Pastoral**
**EAL**

**APPENDIX**
**Numeracy Policy**
**Techniques Library**

## Reading and writing numbers

Learners must be encouraged to write numbers simply and clearly. The symbol for zero with a line through it (⌀), ones which could be mistaken for 7 (1) and continental sevens ( 7) should be discouraged.

Most learners 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 learners 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 learners follow the correct order of operations for arithmetic calculations. Most will be familiar with the mnemonic: **BODMAS**.

**B**rackets, power **O**f, **D**ivision, **M**ultiplication, **A**ddition, **S**ubtraction

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

5 + 3 x 4 = 17 ***NOT*** *5 + 3 x 4 means 8 x 4 = 32* x

**Mental Calculations**

Most learners, at KS3, 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

**Written Calculations**

Learners often use the ' = ' sign incorrectly. The ' = ' sign should only be used when both sides of an operation have the same value.

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

eg 2 378 – 412 ≈ 2 400 – 400
2 400 – 400 = 2 000 ✓

**Pencil & Paper Calculations**

All learners should be able to use some pencil and paper methods involving simple addition, subtraction, multiplication and division. Some learners 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, learners 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 or not their answer is reasonable in the context of the question.

There is no necessity to use a particular method for any of these calculations and any with which the learner is familiar and confident should be used. Many families of schools are now discussing and beginning to agree common methods across schools.
The following methods are some with which learners may be familiar.

**Addition & Subtraction**

| | | Estimate |
|---|---|---|
| **Addition** | 3 456 + 975 | 3 500 + 1 000 = 4 500 |

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

**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
  -2 5 6 9
   5 4 3 4
```

**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.

eg. 46 x 100 = 4 600

The same method is used for decimals.

eg. 5.34 x 10 = 53.4

**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 x 0.3 ≈ 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.

∴ 1.2 x 0.3 = 0.36

**Percentages**

Whilst learners 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 learners 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. Learners should be aware that fractions, decimals and percentages are different ways of representing part of a whole and know the simple equivalents

eg 10% = $^{1}/_{10}$ 12% = 0.12

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

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. Learners 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 into 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)

$$\frac{27 \times 2}{50 \times 2} = \frac{54}{100} = 54\%$$

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

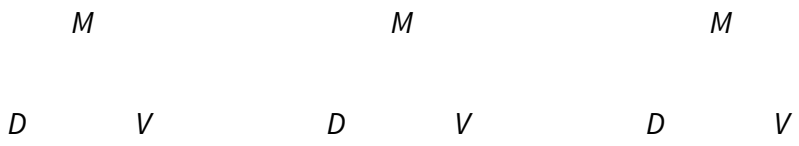
$$\frac{39}{57} = 39 \div 57 = 0.684 \text{ (to 3 d.p.)} = 68.4\%$$

**Algebra**

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

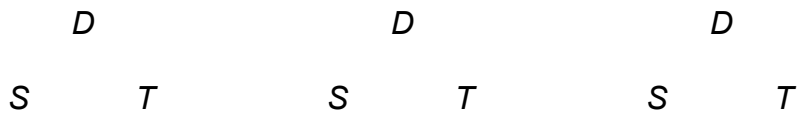
In some cases triangles can be useful for specific cases.

e.g Density = $\frac{\text{Mass}}{\text{Volume}}$




**Density** = $\frac{\textit{Mass}}{\textit{Volume}}$ , **Mass** = *Density x Volume,* **Volume** = $\frac{\textit{Mass}}{\textit{Density}}$

Similarly with **Distance, Speed and Time**




**Speed** = $\frac{\textit{Distance}}{\textit{Time}}$ **Distance** = *Speed x Time,* **Time** = $\frac{\textit{Distance}}{\textit{Speed}}$

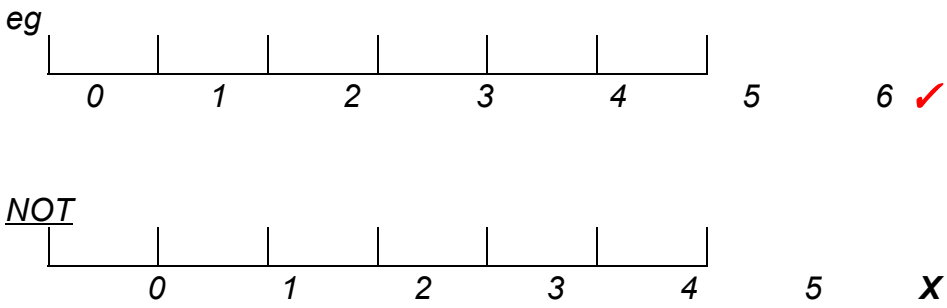
**Data Handling**

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

**Plotting Points**

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




**Axes**

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

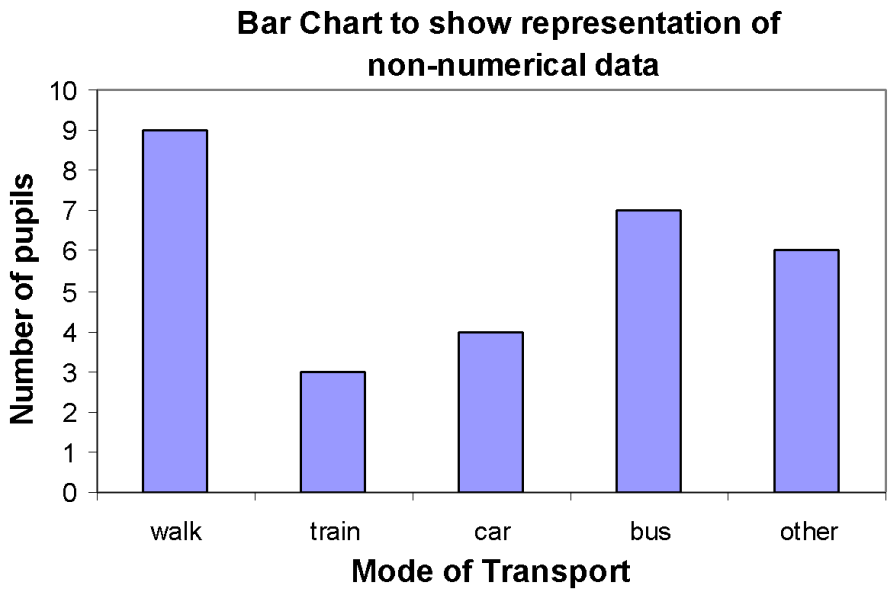
eg In an experiment in which temperature is taken every 5 minutes the horizontal axis would be used for time and the vertical axis for temperature.

Having plotted points learners can sometimes be confused as to whether or not they should join the points. If the results are from an experiment then a 'line of best fit' will usually be needed.

**Bar Charts**

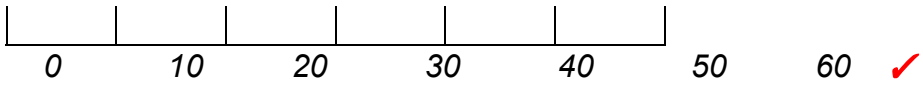
These are the diagrams most frequently used in areas of the curriculum other than mathematics. The way in which the graph is drawn depends on the type of data to be processed.

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. eg.



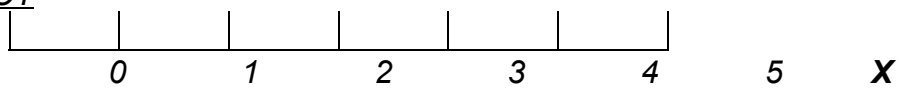

Where the data are continuous, eg. lengths, the horizontal scale should be like the scale used for a graph on which points are plotted.

*eg*

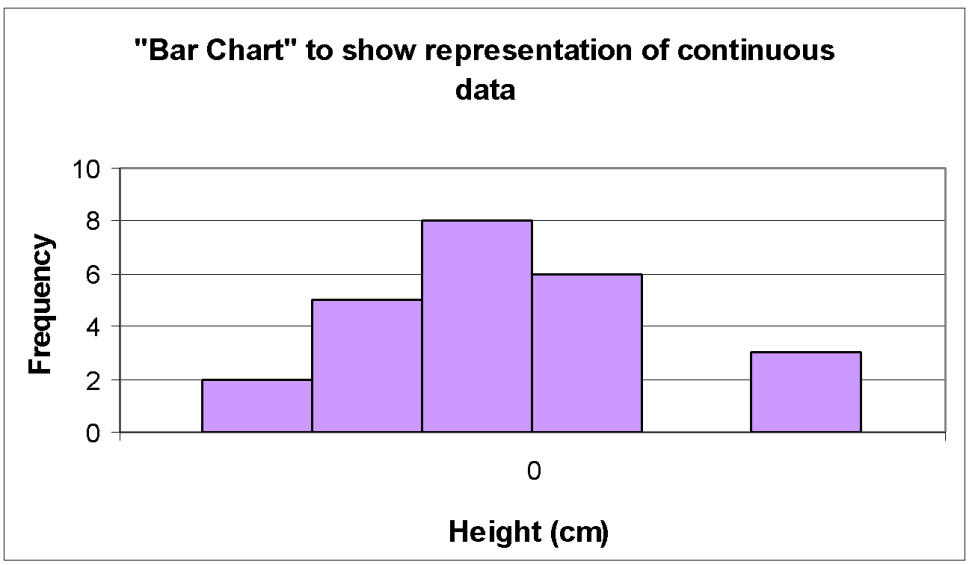



✓

*NOT*

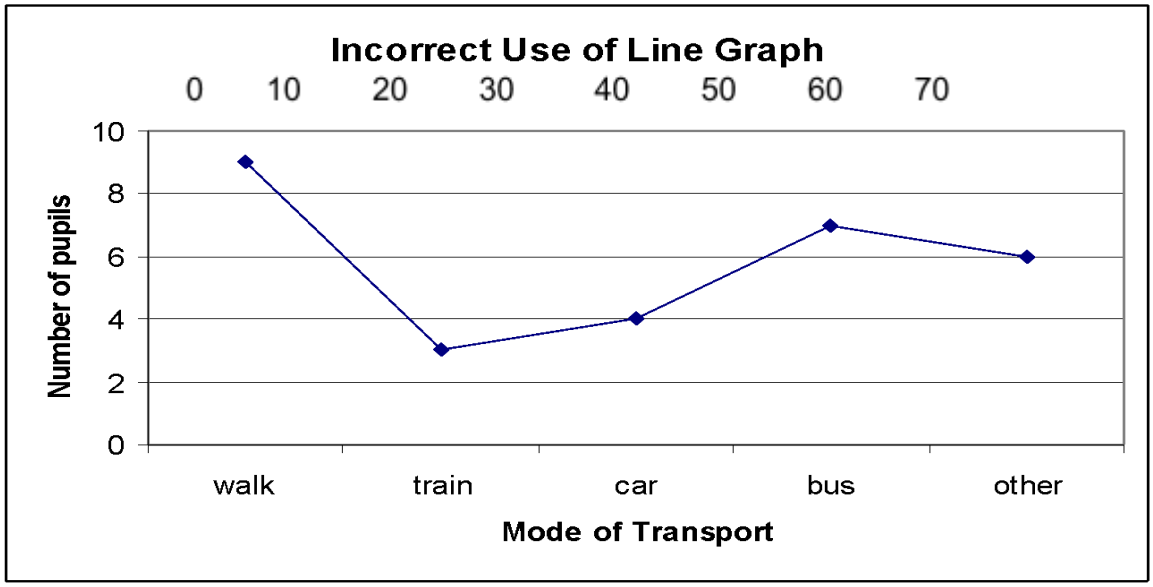



***X***



**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.

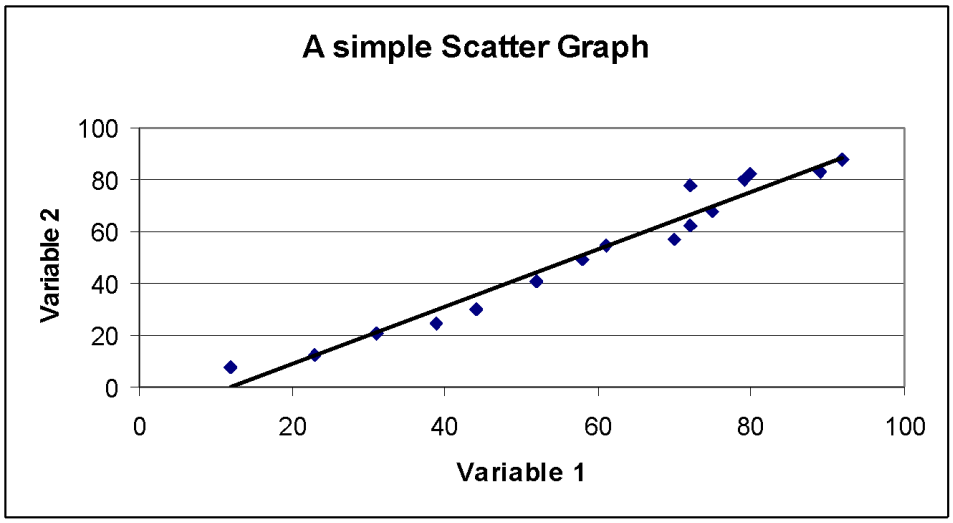



**Computer Drawn Graphs & Diagrams**

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

**Scattergraphs**

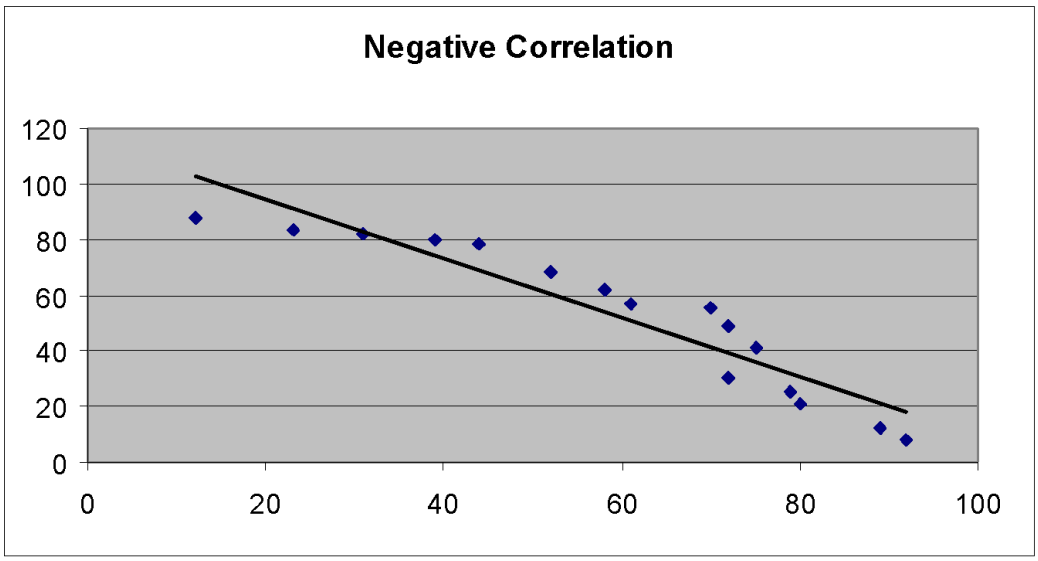
These are used to compare two sets of numerical data. The two values are plotted on two axes labelled as for continuous data. If possible a 'line of best fit ' should be drawn.

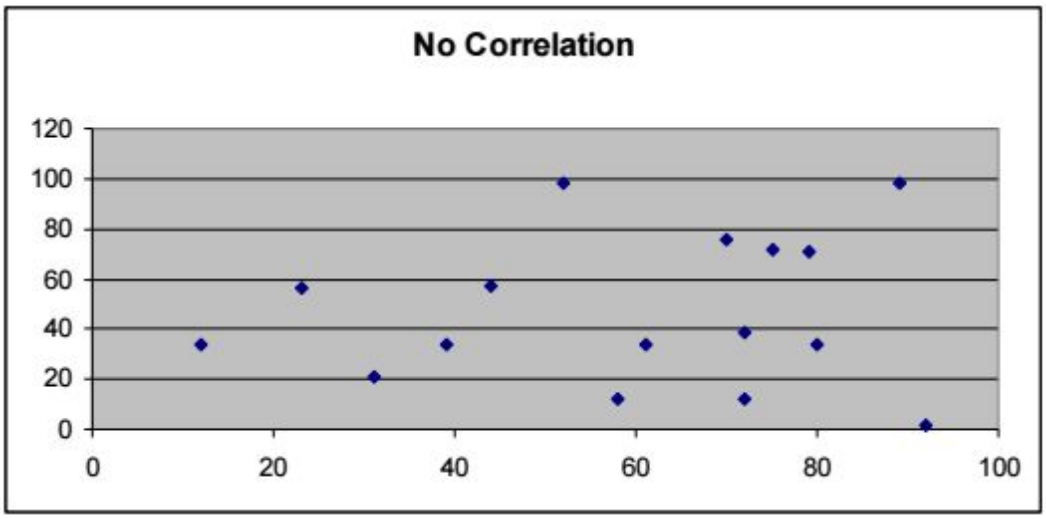



The degree of correlation between the two sets of data is determined by the proximity of the points to the 'line of best fit'

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.

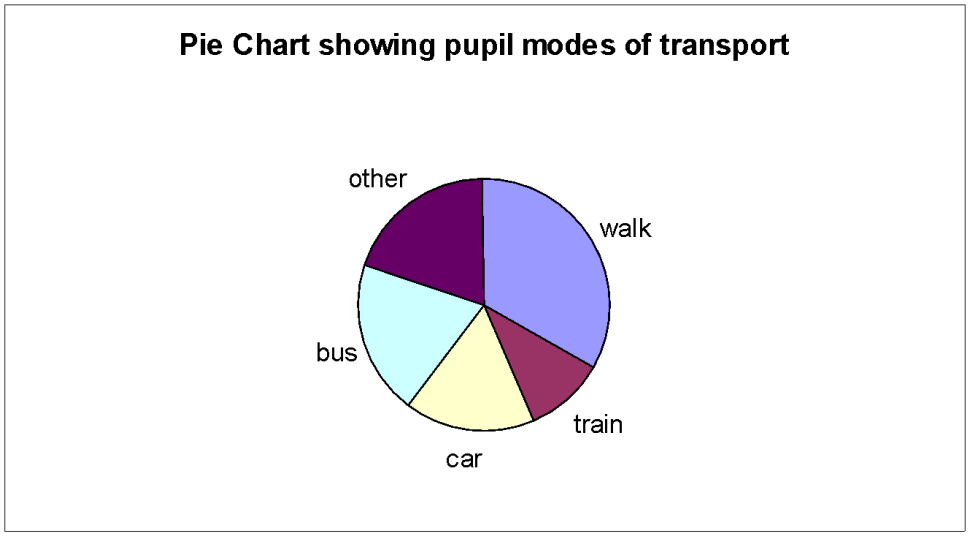





**Pie Charts**

The way in which learners 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°. Eg. The following table shows the results of a survey of 30 learners 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 learners should first work out the share of 360° to be allocated to one item and then multiply this by its frequency. e.g. 180 learners were asked their favourite core subject.

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

| Subject | Number of learners | Pie Chart Angle |
|---|---|---|
| English | 63 | 63 x 2 = 126° |
| Mathematics | 75 | 75 x 2 = 150° |
| Science | 42 | 42 x 2 = 84° |
| Total | 180 | 360° |

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

eg. 43% will be represented by 43 X 3.6 = 154.8°

≈ <u>155°</u>

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 ÷ 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.**

eg. 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,

**Mean =** $\frac{3 + 2 + 5 + 8 + 4 + 3 + 6 + 3 + 2}{9} = \frac{36}{9} = 4$

**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