Pupils should be taught to:	As outcomes, Year 7 pupils should, for example:
Discuss a problem that can be addressed by statistical methods, and identify related questions to explore	Use, read and write, spelling correctly: *survey, questionnaire, experiment, data, statistics...* *grouped data, class interval...* *tally, table, frequency, data collection sheet... database...* **Given a problem that can be addressed by statistical methods, suggest possible answers,** in mathematics or other subjects. For example: • *Problem* What method of transport do pupils use to travel to school, and why? *Possible answers* Most pupils catch a bus because it's quicker. Few pupils cycle to school because of the busy roads. Pupils who walk to school have less distance to travel. A bus journey is quicker than walking the same distance. Some pupils must leave home before 7:30 a.m. • *Problem* Do different types of newspaper use words (or sentences) of different lengths? If so, why? *Possible answers* Tabloid newspapers use shorter words (or sentences) so that they are easier to read and so appeal to a wider audience. There is not likely to be much difference in the use of two- and three-letter words. There may be more difference in sentence length between newspapers of different types than in word length. • *Cross-curricular problem with geography* How will the population of a typical MEDC (more economically developed country) change over the next 50 years as compared with an LEDC (less economically developed country)? *Possible answers* The large number of younger people in the LEDC will lead to an explosion in the population in the future. The smaller number of younger people in the MEDC may lead to a population decline. Future changes may be difficult to predict because improvements in factors such as health care and nutrition, for example, are unknown.

As outcomes, Year 8 pupils should, for example:

Use vocabulary from previous year and extend to:
sample... primary source, secondary source, data log... two-way table... discrete, continuous...

Discuss a problem that can be solved by statistical methods; identify related questions to explore, in mathematics or other subjects. For example:

- *Problem*
  At what time during a football match is there most likely to be a goal?
  Related questions
  Where could you find the necessary data?
  Are there differences between football divisions?
  When is the best time to buy a snack if you don't want to miss a goal or to queue at half-time?
  What is the likelihood of missing a goal if you leave 10 minutes early?

- *Problem*
  A neighbour tells you that the local bus service is not as good as it used to be.
  How could you find out if this is true?
  Related questions
  How can 'good' be defined? Frequency of service, cost of journey, time taken, factors relating to comfort, access...?
  How does the frequency of the bus service vary throughout the day/week?

- *Problem*
  How much TV do pupils and adults watch?
  Related questions
  What factors affect TV viewing habits? Hours of work per week, hours of sleep per week, weekly travelling distance...?

- *Cross-curricular problem with geography*
  How do modes of transport to an out-of-town shopping centre compare with those to a town centre?
  Related questions
  Are there variations at different times of the day/ week? If so, are they linked to variations in the number of visitors at each location?

- *Cross-curricular problem with science*
  What are the factors affecting invertebrate communities in freshwater habitats?
  Related questions
  What data could be collected?
  What is the variation in light intensity at different depths of the water?

- *Cross-curricular problem with science*
  Why do penguins huddle together to keep warm?
  Related questions
  Can the process be modelled by comparing the cooling of a single warm test-tube with that of one surrounded by other similarly warm tubes?

As outcomes, Year 9 pupils should, for example:

Use vocabulary from previous years and extend to:
raw data... representative, bias... census...

Suggest a problem to explore using statistical methods, frame questions and raise conjectures, in mathematics or other subjects. For example:

- *Cross-curricular problem with physical education*
  How far can people jump from a standing start?
  To what extent does a run-up help?
  Does practice improve the distance?
  Are Year 9 pupils able to jump or throw further than Year 7 pupils of the same height?
  Conjectures
  Your height and the length of your run-up are likely to affect how far you can jump.
  A moderate run-up is useful, but the effect will diminish after a certain point.

- *Cross-curricular problem with science*
  What effect does engine size have on the acceleration of a car?
  Conjecture
  In general more powerful engines produce the greatest acceleration.

- *Cross-curricular problem with science*
  What factors affect the distribution of grass and non-grass plants on the school field?
  Conjecture
  The direction that the field faces in relation to the school building will affect the distribution.

- *Cross-curricular problem with geography*
  Are development indicators, such as GNP, and measures of development, such as educational attainment, telephones per 1000 people, energy consumption per capita, life expectancy... consistent with each other?
  Which are the most closely connected?
  Conjecture
  The measure of development that will show the greatest contrast between MEDCs (more economically developed countries) and LEDCs (less economically developed countries) is energy consumption per capita.

- *Cross-curricular problem with PSHE*
  How available are fairly-traded goods in local shops? What sort of organisations promote these goods and why?
  Conjecture
  People with experience of or links with LEDCs are more likely to be aware of and to buy fairly-traded goods.

Pupils should be taught to:	As outcomes, Year 7 pupils should, for example:
Decide which data to collect and identify possible sources	**Decide which data would be relevant to the enquiry and possible sources.** Relevant data might be obtained from: • a survey of a sample of people; • an experiment involving observation, counting or measuring; • secondary sources such as tables, charts or graphs, from reference books, newspapers, **websites**, **CD-ROMs** and so on. For example: • *How do pupils travel to school?* Data needed for each individual pupil: the method of travel, why that method is used, how long the journey takes, the distance to school. • *Do different types of newspaper use words (or sentences) of different lengths?* Data needed from each newspaper: a count of an agreed number of words (or sentences) from each paper. • *How does the population vary from one country to another?* Data needed for each country: population figures, e.g. from books, **websites** or **CD-ROMs**. • *Can taller people hold their breath longer than shorter people?* Data needed for each person: height, time that they can hold their breath. Determine the sample size and type, e.g. who to ask, how many to ask, where and when the sample should be taken. Decide what units to use for measurements such as pupils' heights, distances travelled, times of journeys...

As outcomes, Year 8 pupils should, for example:

Decide which data to collect to answer a question, and the degree of accuracy needed; identify possible sources.

Relevant data might be obtained from:

- a questionnaire or survey of a sample of people;
- an experiment involving the use of hand-held technology such as **data-loggers** with **graphic calculators** or **computers**;
- secondary sources, such as reference materials, including **websites**, **CD-ROMs**, newspapers, directories, historical records...

For example:

- Plan a questionnaire to find out how often and how people travel to shopping centres, or what their TV viewing habits are.
- Plan an experiment using hand-held data-logging equipment to measure light intensity in different parts of a stream, or to measure cooling rates.
- Plan how to research sports results on the **Internet**, including what to look for and what to record.

Recognise that data from primary sources may take more time and resources to collect than from secondary sources but may give more insight and address more precisely the problem being explored.

Determine the sample size and type, e.g. who and how many to ask, how, where and when the sample should be taken. Recognise that too small a sample may give unrepresentative results, while too large a sample may be expensive in resources and time.

As outcomes, Year 9 pupils should, for example:

Discuss how data relate to the enquiry and identify possible sources, including primary and secondary sources.

Relevant data might be obtained from:

- a questionnaire or survey of a sample of people;
- printed tables and lists;
- the **Internet**;
- other **computer databases**.

For example:

- Plan how to conduct a survey into long jumps or throws with different lengths of run-up.
- Identify magazines and books with information on engine sizes of cars and acceleration times for 0–60 mph.
- *Determine a range of countries with different sizes of population, development and income. Search the **Internet**, **CD-ROMs** or printed sources of information for relevant information.*
- *Visit the library to access census data for the local area, relating to a study of housing.*
- *Construct a questionnaire to explore attitudes to fairly-traded goods and a survey for shops.*

Identify possible sources of bias and plan how to minimise it. *For example:*

- *When investigating pupils' aptitudes in PE activities, aim to reduce possible bias due to selection, non-response and timing of the enquiry, by:*
  a. *choosing pupils from a range of year groups and with a range of heights;*
  b. *making sure that there are equal numbers of girls and boys;*
  c. *choosing pupils from the full range of athletic prowess.*
- *When designing a questionnaire for a survey:*
  a. *ensure the sample is representative by choosing it randomly and/or selecting people from particular categories;*
  b. *phrase questions in a neutral manner so that they do not bias results by encouraging a particular response.*
- *When conducting an experiment, vary one factor at a time, keeping other factors constant.*

Pupils should be taught to:

Plan how to collect and organise the data and design suitable data collection sheets and tables

As outcomes, Year 7 pupils should, for example:

Decide how to collect and organise the data needed; design a data collection sheet or questionnaire to use in a simple survey.
For example:

- *Survey of ways of travelling to school*

Name	Class	Age	Form of travel	Distance (m)	Depart time	Arrival time	Duration

- *Survey of lengths of words (or sentences) in newspapers*
  Decide:
  sample size, where in the newspaper to collect the words, what to do with data such as numbers, hyphenated words, abbreviations and other exceptional data.

- *Investigation of populations of different countries*
  In geography, design a table to collect population data.

Construct frequency tables for sets of data, grouped where appropriate in equal class intervals. Know that the final or initial interval may be open, e.g. for ages 'over 80'.
For example:

- *How do pupils travel to school?*
  Intervals of 5 minutes are likely to be more useful than intervals of 1 minute or 1 hour.
  Discuss where to put a journey time such as 15 minutes.

Journey time in minutes	0–5	5–10	10–15	15–20	20–25	25–30	30–35	35+
No. of pupils								

- *How easy are newspapers to read?*
  Take the first 100 words from a front-page story of a newspaper. Record the number of letters in each word.
  Record the data in intervals of 4 letters.

No. of letters (n)	1–4	5–8	9–12	13–16	17–20
Express					
Mail					
Telegraph					

  Record the data again in intervals of 3 letters.
  Which are more useful: intervals of 3 letters or intervals of 4 letters? Why?

- *Which is your better catching hand?*
  Place 10 centimetre cubes on the back of your writing hand. Toss them gently upwards, turn your hand round quickly, and catch as many as you can.
  Repeat for the non-writing hand.
  Record the results of the whole class in a frequency table.

Cubes caught (c)	0	1	2	3	4	5	6	7	8	9	10
Writing hand											
Non-writing hand											

As outcomes, Year 8 pupils should, for example:

Decide how to collect the data (e.g. a survey or experiment), including sample size. Plan a simple survey or experiment, and design a suitable data collection sheet. For example:

- *Survey of the price of second-hand cars*

Vendor	Price band <£2000	£2000–£3999	£4000–£5999	£6000–£7999	£8000–£9999	£10 000+
Private						
Dealer						

- *Comparison of invertebrate communities in two contrasting sections of a stream*

Invertebrate indicator animals	No. at site A	No. at site B
Bloodworm		
Caddis fly larva		
Freshwater shrimp		
Mayfly nymph		
Rat tailed maggot		
Sludge worm		
Stonefly nymph		
Water louse		

Construct frequency tables for sets of continuous data, with given equal class intervals. Know that class intervals should be continuous with no gaps or overlaps; the last group may be open. For example:

- *Timing of goals scored in Premier League matches on one Saturday*
  Discuss how and where to record a goal scored after, say, 60 minutes, emphasising that the choice must be consistent for each similar occurrence.

Time (minutes)	Frequency
$0 < T \leq 15$	4
$15 < T \leq 30$	5
$30 < T \leq 45$	6
$45 < T \leq 60$	1
$60 < T \leq 75$	4
$75 < T \leq 90$	7

As outcomes, Year 9 pupils should, for example:

Design a survey or experiment to capture relevant data from one or more sources; determine sample size and degree of accuracy needed; design, trial and if necessary refine data collection sheets. For example:

- *Investigation of jumping or throwing distances*
  Check that the data collection sheet is designed to record all factors that may have a bearing on the distance jumped or thrown, such as age or height. Decide the degree of accuracy needed for each factor. Recognise that collecting too much information will slow down the experiment; too little may limit its scope.

- *Survey of acceleration data for popular cars*
  Check that the published data contain what is expected. Round published engine sizes to the nearest 0.1 litre to eliminate unnecessary accuracy in data such as 1428 cc and 1964 cc.

- *Study of the distribution of grass*
  Use a quadrat or points frame to estimate the numbers of grass and non-grass plants growing in equal areas at regular intervals from a north-facing building. Repeat next to a south-facing building. Increase accuracy by taking two or more independent measurements.

- *Questionnaire on attitudes to fairly-traded goods*
  Test questions on a small sample before refining them for a larger sample.

Construct tables for large sets of raw data, discrete and continuous, choosing suitable class intervals. Know that to group data loses information but grouping is necessary to ensure that large data sets are manageable. For example:

- Group long jump distances initially in intervals of 5 cm or 10 cm, recognising that the number of groups created may be too few for further analysis, or too many to reveal key features.

When organising large data sets, find suitable class intervals to fit the full range of the data. For example:

- *Population distribution data for the UK 1999*

Ages	Population
0–9	3 890 782
10–19	4 088 469
20–29	4 172 971
30–39	5 042 082
40–49	4 818 389
50–59	3 454 277
60–69	2 374 917
70–79	1 777 692
80–89	744 780
90+	126 935

Ages	Population
0–14	5 917 365
15–29	6 234 857
30–44	7 608 956
45–59	5 705 792
60–74	3 364 102
75–89	1 533 287
90+	126 935

Ages	Population
0–19	7 979 251
20–39	9 215 053
40–59	8 272 666
60–79	4 152 609
80+	871 715

Pupils should be taught to:	As outcomes, Year 7 pupils should, for example:
Plan how to collect and organise the data and design suitable data collection sheets and tables (continued)	
Collect and record data from primary and secondary sources	**Collect and record small sets of data as planned from surveys and experiments or secondary sources.**

For plans, see pages 248–53.

As outcomes, Year 8 pupils should, for example:

Design and use simple two-way tables. For example, design, read and compare the cells in two-way tables such as:

- Method of transport to different shopping centres

	Car	Bus	Train	Walk	Coach	Other
Local centre						
Town centre						
Out-of-town development						

- Method of transport and distance to school

Distance (km)	Car	Bus	Train	Walk	Coach	Other
0–0.5						
0.5–1						
1–1.5						
1.5–2						
2–2.5						
2.5–3						
3+						

Collect data as planned from secondary sources or by carrying out a survey or experiment, involving observation, data-logging using ICT, or questionnaire.

For plans, see pages 248–53.

As outcomes, Year 9 pupils should, for example:

Design and use two-way tables. For example:

- Use a two-way table to highlight the difference between male and female smoking patterns in the UK in different age groups, and any trends visible over time.

1996

Age	Male %	Female %
16–19	25	32
20–24	43	37
25–34	38	33
35–49	30	30
50–59	27	26
60+	17	18

1986

Age	Male %	Female %
16–19	30	31
20–24	41	38
25–34	37	35
35–49	37	33
50–59	34	34
60+	28	22

1976

Age	Male %	Female %
16–19	38	35
20–24	48	44
25–34	48	41
35–49	49	44
50–59	49	45
60+	40	42

UK smoking and age distribution 1976–1996

- The cost of an old Barbie doll depends on both its condition and whether or not it is in the original box. The table shows what percentage of the original cost the secondhand value retains.

Condition	Boxed	Not boxed
Excellent	100%	65%
Good	80%	32%
Poor	50%	15%

By considering the percentage lost by not having its original box, examine the claim that the importance of the box increases with the doll's condition.

Gather data as planned from specified secondary sources, including printed tables and lists from ICT-based sources. *Identify what extra information may be required to pursue a further line of enquiry.*

For example:

- *As part of a study in science of car engine sizes, discuss whether the published value for bhp or 'torque' may be a better measure of 'power' than engine size.*
- *When designing a questionnaire about fairly-traded goods, include some questions on social or moral attitudes for later analysis.*
- *As part of a study of development indicators, discuss whether:*
  - *features relating to development are particular to the countries selected or are representative of wider trends;*
  - *some measures appear not to vary as much as others, and may be less useful as indicators of development.*

Respond to problems of unavailable data, or data that relate to different dates, or that are organised in different ways (e.g. some appearing in tabular form, some in graphical form, some in summarised form), for example, by estimating the required comparable value.

Pupils should be taught to:

Calculate statistics from data, using ICT as appropriate

As outcomes, Year 7 pupils should, for example:

Use, read and write, spelling correctly:
statistic, interval...
range, mean, median, mode, modal class/group, average...

Know that:
- The mode is the only statistic appropriate for data based on non-numeric categories, e.g. the most common way of travelling to school.
- The mean is often referred to as '*the* average'.

Find the mode of a small set of discrete data.

Know that the mode of a set of numbers is the number that occurs most often in the set. For example:

- For 1, 2, 3, 3, 4, 6, 9, the mode is 3.
  For 3, 4, 4, 4, 7, 7, 8, the mode is 4.
  For 2, 2, 3, 5, 6, 9, 9, there are two modes, 2 and 9.

In a grouped frequency distribution, the group that contains the most members is called the modal class or modal group.

Calculate the mean for a small set of discrete data, using a **calculator** for a larger number of items.

The mean of a set of numbers is the sum of all the numbers divided by the number of numbers in the set. For example:

- The mean of 2, 6, 8, 9 and 12 is:

$$\frac{2 + 6 + 8 + 9 + 12}{5} = \frac{37}{5} = 7.4$$

- For this data set for 100 words in a newspaper passage:

No. of letters:	1	2	3	4	5	6	7	8	9	10	11	12	13
No. of words:	5	15	31	12	7	6	14	5	3	0	2	0	0
Total letters:	5	30	93	48	35	36	98	40	27	0	22	0	0

the mean number of letters in a word is:

$$\frac{5 + 30 + 93 + 48 + 35 + 36 + 98 + 40 + 27 + 22}{100} = \frac{434}{100} = 4.34$$

As outcomes, Year 8 pupils should, for example:

Use vocabulary from previous year and extend to:
distribution...
stem-and-leaf diagram...

Know when it is appropriate to use the mode (or modal class), mean, median and range:

- The median is useful for comparing with a middle value, e.g. half the class swam more than 500 m.
- The range gives a simple measure of spread.
- The mode indicates the item or class that occurs most often and is useful in reporting opinion polls.
- The mean gives an idea of what would happen if there were 'equal shares'.

Find the modal class of a set of continuous data, i.e. the group with the most members. For example:

- London marathon times: top 100 women

Time (hours:minutes)	Frequency
2:20 ≤ *T* < 2:25	0
2:25 ≤ *T* < 2:30	7
2:30 ≤ *T* < 2:35	3
2:35 ≤ *T* < 2:40	5
2:40 ≤ *T* < 2:45	8
2:45 ≤ *T* < 2:50	4
2:50 ≤ *T* < 2:55	12
2:55 ≤ *T* < 3:00	10
3:00 ≤ *T* < 3:05	33
3:05 ≤ *T* < 3:10	18

Source: www.london-marathon.co.uk

The modal class is a marathon time, *T* hours:minutes, of 3:00 ≤ *T* < 3:05.

Calculate the mean for a large set of data, using a **calculator** or **spreadsheet**. For example:

- Calculate the mean score thrown by a dice.

	A	B	C	D	E	F	G	H
1	Score	1	2	3	4	5	6	
2	No. of throws	26	30	28	32	31	29	=SUM(B2:G2)
3	Total	=B1*B2	=C1*C2	=D1*D2	=E1*E2	=F1*F2	=G1*G2	=SUM(B3:G3)/H2

	A	B	C	D	E	F	G	H
1	Score	1	2	3	4	5	6	
2	No. of throws	26	30	28	32	31	29	176
3	Total	26	60	84	128	155	174	3.56

The mean score for 176 throws is 3.56 (to 2 d.p.).

Calculate a mean using an assumed mean. For example:

- Find the mean of 28.7, 28.4, 29.1, 28.3 and 29.5.

  Use 29.0 as the assumed mean.
  The differences are ⁻0.3, ⁻0.6, 0.1, ⁻0.7 and 0.5, giving a total difference of ⁻1.0.
  The actual mean is 29.0 – (1.0 ÷ 5) = 28.8.

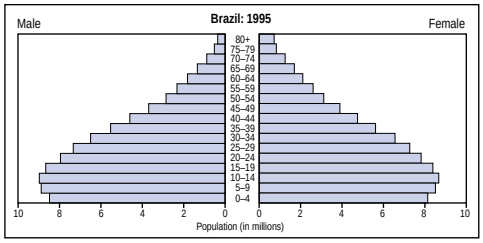
As outcomes, Year 9 pupils should, for example:

Use vocabulary from previous years and extend to:
raw data, estimate of the mean/median, cumulative frequency...

Select statistics most appropriate to the problem.
Decide which statistics are most suitable in a particular case, choosing between the median and the mean partly on the basis of whether extreme or chance values will influence the measure unduly. Be aware that the difference will be most significant in skew distributions, where both may need to be quoted.

Find the modal class of a large set of data.
For example:

- Use a population pyramid to find that there are more teenagers in Brazil than other age groups.



Source: US Census Bureau, International Data Base

Recognise that if the Brazilian population were grouped in 15-year intervals, data would be easier to plot and may show general trends just as clearly.

Calculate an estimate of the mean of a large set of grouped data *to a suitable degree of accuracy.*

Choose suitable mid-points for class intervals, justifying decisions, e.g. that a suitable mid-interval of the range 10–19 years is 15 years, and of an open interval such as '80+ years' is 90 years. For example:

- *Using the data in the table, estimate the mean time spent on homework.*

Time spent on homework (minutes)	Frequency
0 ≤ time ≤ 30	6
30 < time ≤ 60	14
60 < time ≤ 90	21
90 < time ≤ 120	9
Total	50

The mean time is approximately:

$$\frac{(15 \times 6) + (45 \times 14) + (75 \times 21) + (105 \times 9)}{50} = 64.8 \text{ min}$$

- *Estimate the mean age of a head of household in Brazil from this table, using a* ***spreadsheet*** *or the statistical facilities on a* ***calculator****.*

Age group	10–19	20–29	30–39	40–49	50–59	60–69	70–79	80+	Totals
Mid-range (*x*)	15	25	35	45	55	65	75	90	
Frequency (*f*)	232 813	5 395 646	8 080 436	6 185 652	4 192 554	2 766 020	1 255 301	335 960	28 444 382
f × *x*	3 492 195	134 891 150	282 815 260	278 354 340	230 590 470	179 791 300	94 147 575	30 236 400	1 234 318 690

The mean age is approximately:
1 234 318 690 ÷ 28 444 382 = 43.3941, or 43.4 years

Pupils should be taught to:	As outcomes, Year 7 pupils should, for example:
Calculate statistics from data, using ICT as appropriate, finding the mode, mean, median and range (continued)	**Find and use the range of a small set of discrete data.** The range of a set of values is the difference between the largest and smallest numbers in the set. For example, for 2, 3, 4, 7, 9, 10, 12, 15, the range is 15 – 2 = 13. **Find the median of a small set of discrete data.** The median of a set of numbers is the value of the middle number when they are arranged in ascending order. For example, 2, 5, 8, 3, 1, 7, 6 becomes 1, 2, 3, 5, 6, 7, 8, and the median is 5. If there is no single middle number, the mean of the two middle numbers is taken. For example, the set 1, 5, 7, 8, 9, 10 has a median of (7 + 8)/2 = 7.5.

As outcomes, Year 8 pupils should, for example:

Find the range of a set of continuous data, calculating this as the highest rounded-off figure minus the lowest rounded-off figure. For example:

- Calculate the range of temperatures recorded at a weather station over a 24-hour period. Compare with the range of data from weather stations at different sites.

Range of temperatures at Snowdon on 10 May 2000

	Min.	Max.	Range
Summit	6.8 °C	13.8 °C	7 degrees
Llanberis	9.3 °C	15.5 °C	6.2 degrees
Clogwyn Station	9.3 °C	22.0 °C	12.7 degrees

Source: Snowdonia Weather Stations Project

Know that it can be helpful to state the range of a set of data as well as the mean, mode or median.

Find the median of a large set of data.
For example, find the median of:

- the time taken to run the London marathon;
- marks in a test taken by Year 8 pupils;
- the cost of a particular chocolate bar from various retailers.

Use a stem-and-leaf diagram to help find the median, range and mode. For example:

- Hours of sunshine for UK weather stations 10/05/00

Hours of sunshine for UK weather stations: 10/05/00

(stem = hours, leaves = tenths)

0	6	9
1	6	9
2	2	2 5 6 6 7 9
3	0	0 0 0 1 2 2 5 5 5 7 8 9
4	0	1 5 5 6 6 6 7 9
5	0	1 5 5 6 8 9 9
6	1	2 2 2 3 6 6 7 8 8 9 9 9 9 9
7	0	0 1 6 7 8 8
8	0	0

There are 65 items of data.
The median is the 33rd item, 4.9 hours (4 hours and 54 minutes) of sunshine.
The range is 8.0 – 0.6 = 7.4 hours.
The mode is 6.9 hours.

As outcomes, Year 9 pupils should, for example:

Estimate the range of a large set of grouped data.
For example:

- *Estimate the range of the distances jumped by 67 pupils, from the data in this table.*

Distance jumped (cm)	No. of pupils
$180 \le d < 190$	2
$190 \le d < 200$	6
$200 \le d < 210$	9
$210 \le d < 220$	7
$220 \le d < 230$	15
$230 \le d < 240$	18
$240 \le d < 250$	8
$250 \le d < 260$	2

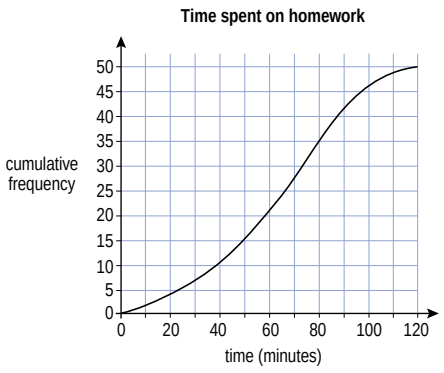
The first class is 180–189 cm, then 190–199 cm, and so on. The last class is 250–259 cm.
An estimate of the range is calculated by using the lowest class value in the first class (or 179.5 cm) and the highest class value in the last class (or 259.5 cm), giving an estimate of the range to be
259.5 – 179.5 = 80 cm.

Estimate the median and interquatile range of a large set of grouped data, *where the original data are not available. For example:*

- *Estimate the median distance jumped by 67 pupils, from the data in the table above.*

  There are 67 pupils; the middle pupil is the 34th. The median must lie in the interval $220 \le d < 230$, representing 15 pupils, from the 25th to 39th pupils. The 34th pupil is estimated to be 10/15 of the way along the interval of 10 cm, so an estimate of the median is 227 cm to the nearest centimetre.

- *Estimate the median and quartiles from a cumulative frequency diagram, e.g. by reading data for the 25th pupil from a graph showing the time that 50 pupils spent on homework.*



Pupils should be taught to:

Calculate statistics from data, using ICT as appropriate, finding the mode, mean, median and range (continued)

As outcomes, Year 7 pupils should, for example:

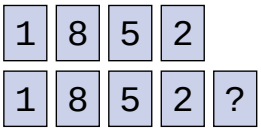
Calculate statistics. For example:

- A competition has three different games.
  Jane has played two of the games.

	Game A	Game B	Game C
Score	62	53	

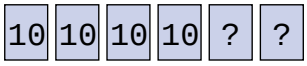
  To win, Jane needs a mean score of 60.
  How many points does she need to score in game C?

- Phil has these four cards.
  The mean is 4.

  Phil takes another card. The mean of the five cards is still 4.
  What number is on his new card?

- Rajshree has six cards.

  The six cards have a mean of 10 and a range of 6.
  What are the numbers on the other two cards?

- I can catch either a Direct bus or a Transit bus to go home.
  For my last five journeys on each bus, this is how long I had to wait:

Direct bus	10 min	8 min	5 min	9 min	8 min
Transit bus	16 min	1 min	2 min	15 min	1 min

  Calculate the mean of the waiting time for each bus.
  Decide which bus it would be more sensible to catch.
  Explain why.

- Five careful measurements were made to find the mass of a nugget of gold. The five measurements were:
  2.003 2.012 1.998 2.000 1.989 ounces.
  Find the mean of the five measurements.

See Y456 examples (pages 116–17).

As outcomes, Year 8 pupils should, for example:

Calculate statistics. For example:

- Imran and Nia play three games.
  Their scores have the same mean.
  The range of Imran's scores is twice the range of Nia's scores.
  Write the missing scores in the table below.

Imran's score		40	
Nia's score	35	40	45

- John has three darts scores with a mean of 30 and a range of 20.
  His first dart scored 26.
  What were his other two scores?

- Collect data from weather stations over a 24-hour period.

Wind speed (mph) Snowdon 10/05/00

Location/time	Summit (1085 m)	Clogwyn (770 m)	Llanberis (105 m)
00:00	1	6	2
01:00	2	8	3
02:00	3	7	8
03:00	3	8	9
04:00	5	6	11
05:00	3	7	9
06:00	5	5	21
07:00	8	10	15
08:00	6	12	11
09:00	3	9	10
10:00	3	4	10
11:00	3	5	12
12:00	8	3	18
13:00	8	2	17
14:00	10	2	17
15:00	10	2	24
16:00	12	5	30
17:00	15	9	30
18:00	17	11	33
19:00	20	12	38
20:00	27	12	41
21:00	35	14	47
22:00	36	14	57
23:00	34	13	45

Source: Snowdonia Weather Stations Project

Calculate the mean and median wind speeds and the range.

	Summit	Clogwyn	Llanberis
Mean	11.54	7.75	21.58
Median	8	7.5	17
Range	35	12	55

Which place had the least reliable weather?

As outcomes, Year 9 pupils should, for example:

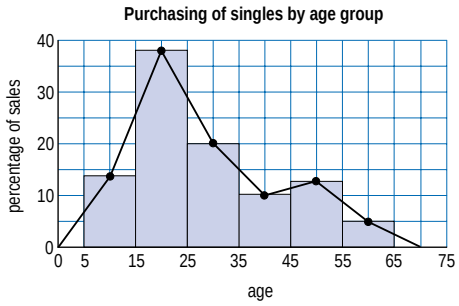
Calculate statistics. For example:

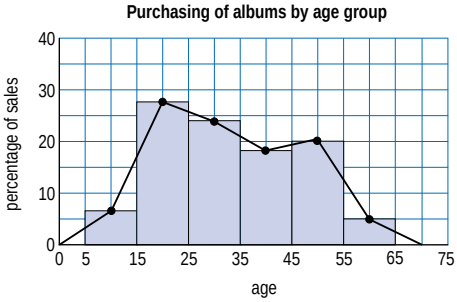
- Three people have a median age of 30 and a mean age of 36. The range of their ages is 20.
  How old is each person?

- Three children have a mean age of 10.
  The range of their ages is 6.
  What is the lowest possible age:
  a. of the youngest child?
  b. of the oldest child?

- Amrita has five cards numbered in the range 0 to 20. She says:
  'The range of my cards is 4, the mode is 6 and the mean is 5.'
  Is this possible?

- *Look at these two frequency diagrams.*



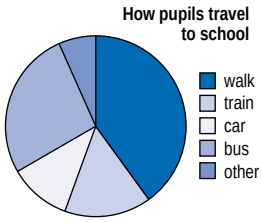


a. *Estimate the mean age of people buying singles.*
b. *Estimate the median age of people buying singles.*
c. *Estimate the mean age of people buying albums.*
d. *Estimate the median age of people buying albums.*

What conclusions can you draw from your answers?

Pupils should be taught to:	As outcomes, Year 7 pupils should, for example:
Construct graphs and diagrams to represent data, on paper and using ICT	Use, read and write, spelling correctly: *frequency diagram, bar chart, bar-line graph, pie chart...* **Construct graphs and diagrams to represent data, on paper and using ICT, and identify key features.** For example:

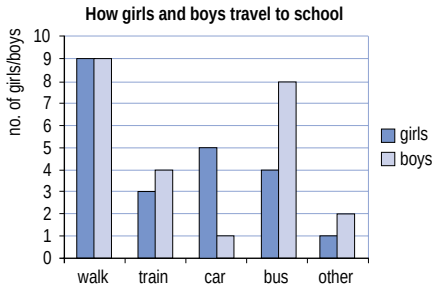
- **Pie charts** generated by **ICT**, for example:



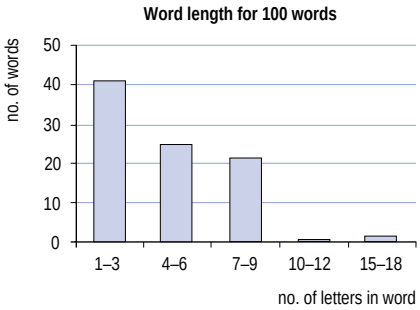
Know that the sizes of sectors of the chart represent the proportions in each category.

Link to percentages (pages 70–7).

- **Bar charts** for categorical data, for example:



- **Bar charts** for grouped discrete data, for example:



Choose suitable class intervals.
Know that the bars may be labelled with the range that they represent, but not the divisions between the bars.

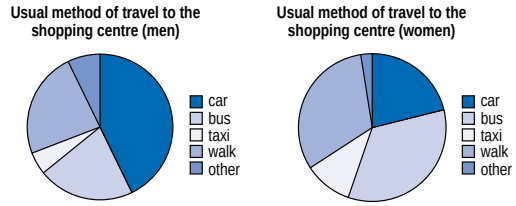
Know the conventions for marking the axes when the scale does not start from zero (see **page 172**).

As outcomes, Year 8 pupils should, for example:

Use vocabulary from previous year and extend to: *population pyramid, scatter graph, distance–time graph, line graph...*

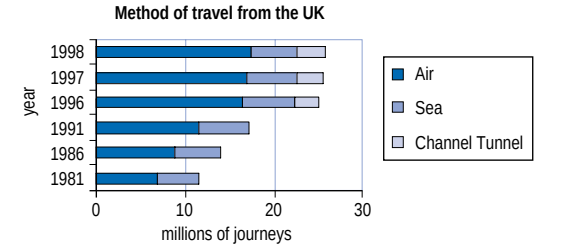
Construct graphs and diagrams to represent data, on paper and using ICT, and identify key features.

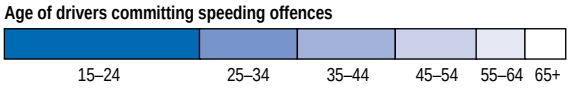
- **Pie charts:** Understand that pie charts are mainly suitable for categorical data. Draw pie charts using **ICT** and by hand, usually using a **calculator** to find the angles. For example, draw these graphs to compare shopping travel habits.



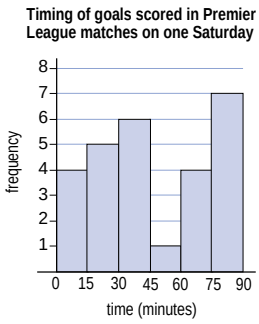
Link to percentages (pages 70–7).

- **Bar charts:** Compound bar charts allow both overall trends and changes in subcategories to be shown, for example:





- **Frequency diagrams** for a continuous variable, for example:



Choose suitable class intervals.
The bars in this graph represent intervals of $0 \le t < 15$ minutes, $15 \le t < 30$ minutes, etc.

Know that for continuous data the divisions between the bars should be labelled.

As outcomes, Year 9 pupils should, for example:

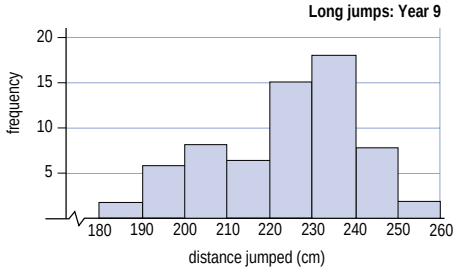
Use vocabulary from previous years and extend to: *line of best fit, cumulative frequency graph...*

Construct graphs and diagrams to represent data, on paper and using ICT, and identify key features.

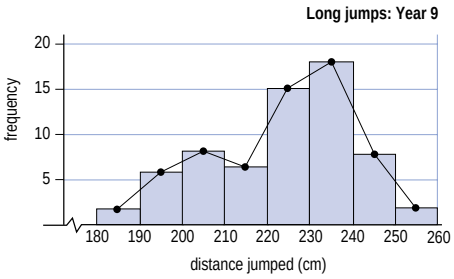
Appreciate that:

- A table usually gives all the data that can be retrieved.
- A graph, chart or diagram representing the data highlights particular features that a table does not.
- Data shown in a graph, chart or diagram are often in an aggregated form that does not allow the original data to be extracted.
- Calculated statistics are representative values of data sets.

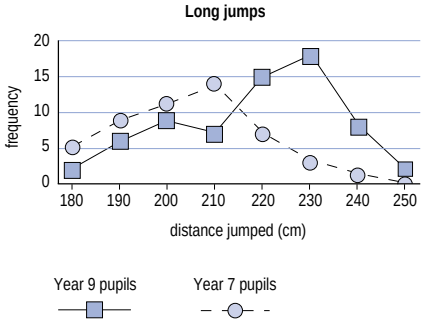
- **Frequency diagrams and polygons,** e.g. in this graph bars represent intervals of $180 \le d < 190$, etc.



Use frequency polygons, for example:



Use superimposed frequency polygons rather than bar charts to compare results, for example the distances jumped by pupils in Year 7 and pupis in Year 9.

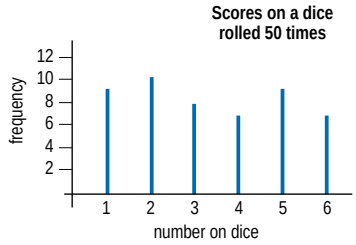


Pupils should be taught to:

Construct graphs and diagrams to represent data, on paper and using ICT (continued)

As outcomes, Year 7 pupils should, for example:

- **Bar-line graphs** for a discrete variable, for example:

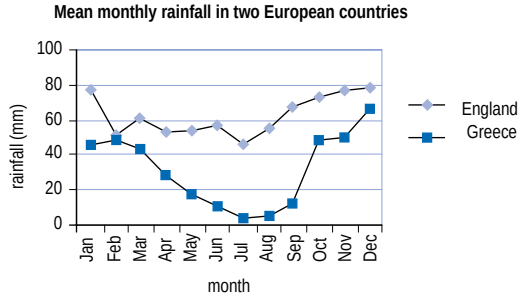


Know that:
- The length of the bar represents the frequency.
- What is being counted or measured (the independent variable) is placed on the horizontal axis, and the count or measure (the dependent variable) on the vertical axis.
- It is not appropriate to join the tops of the bars.

See Y456 examples (pages 114–17).

As outcomes, Year 8 pupils should, for example:

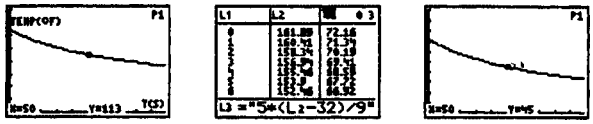
- **Line graphs** comparing two sets of data, for example:



Know that it can be appropriate to join the points on the graph in order to compare trends over time.

- **Line graphs** comparing continuous data, for example:

Use a **temperature probe** and **graphical calculator** to compare cooling rates, e.g. to model the problem 'Why do penguins huddle together to keep warm?'

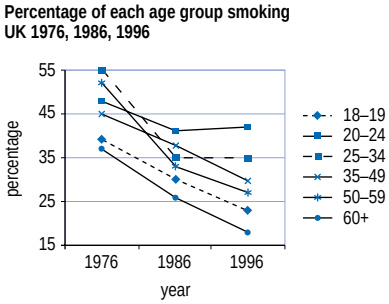


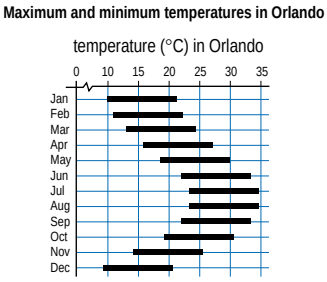
Understand that every point on the cooling curve has a meaning.

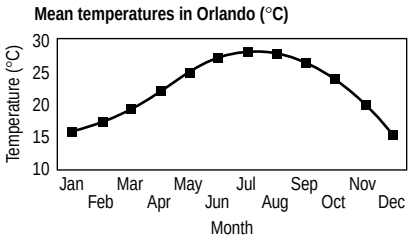
Link to graphs of functions, including distance–time graphs (pages 172–7).

As outcomes, Year 9 pupils should, for example:

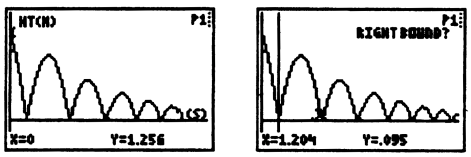
- **Line graphs** comparing several sets of data, for example:







Distance–time graph for a bouncing ball recorded on a **graphical calculator** using a **motion detector**

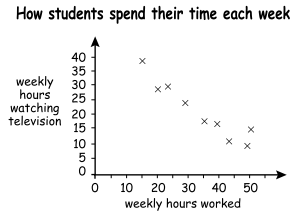


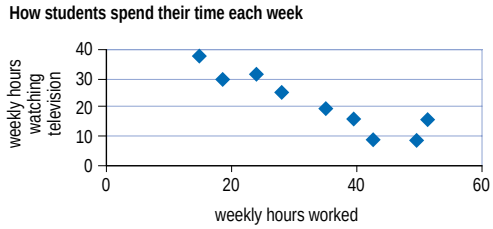
Link to graphs of functions, including distance–time graphs (pages 172–7).

Pupils should be taught to:	As outcomes, Year 7 pupils should, for example:
Construct graphs and diagrams to represent data, on paper and using ICT (continued)	

As outcomes, Year 8 pupils should, for example:

- **Scatter graph** for continuous data, two variables, for example to show weekly hours worked against hours of TV watched (plotted by hand and using **ICT**).

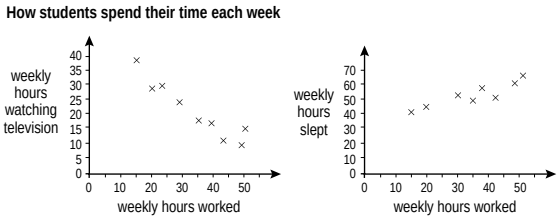




Link to two-way tables (page 254–5).

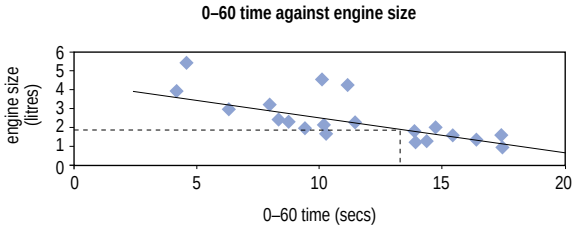
As outcomes, Year 9 pupils should, for example:

- **Scatter graphs**, for example:



Use the two scatter graphs above to suggest a relationship between the amount of TV a pupil watches and the number of hours he or she sleeps.

- ***Draw a line of best fit,*** *by eye or using a* ***graphical calculator*** *or* ***spreadsheet****, e.g. engine size against 0–60 mph acceleration times.*



Find the mean point through which the line should pass.

Predict a 0–60 mph time of about 13 seconds for a new car with a 1.8 litre engine.

- *This table shows the heights jumped in a field test by different BMX bikes, each carrying the same rider.*

Mass (kg)	Height (cm)
8.0	26.8
8.5	26.4
9.0	26.1
9.5	25.7
10.0	25.0
10.5	24.8
11.0	24.3

a. *Draw a scatter graph to show the results.*
b. *Draw a line of best fit.*
c. *Estimate the height jumped by a bike weighing 9.7 kg.*

Understand that:
- *A prediction based on a line of best fit is an estimate and may be subject to substantial error.*
- *A line of best fit indicates an estimated relationship which may not mean anything in practice.*

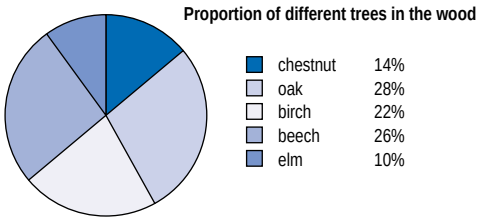
Pupils should be taught to:

Interpret diagrams and graphs, and draw inferences

As outcomes, Year 7 pupils should, for example:

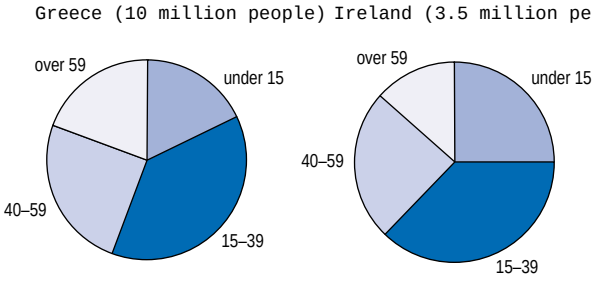
Interpret diagrams, graphs and charts, and draw inferences based on the shape of graphs and simple statistics for a single distribution. Relate these to the initial problem. For example:

- Interpret data in a pie chart from a newspaper, or generated by a **computer**. For example:
  a. Which species of trees grow best in the local wood?



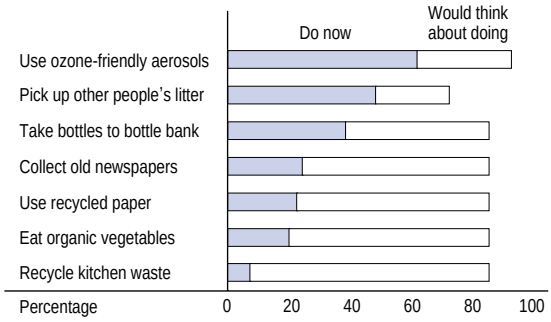
How many of each species of tree would there be in the wood if it had 600 trees?
Why do you think there are fewer elm trees in the wood than other species?

  b. These pie charts show some information about the ages of people in Greece and in Ireland. Roughly what percentage of people in Greece are aged 40–59?



Dewi says: 'The charts show that there are more people under 15 in Ireland than in Greece.'
Dewi is wrong. Explain why the charts do not show this.

- Interpret data in a simple compound bar chart.
For example:
In a survey people were asked about the things they did to help make the environment better. The bar chart below shows what people do now and what they would think about doing in the future.

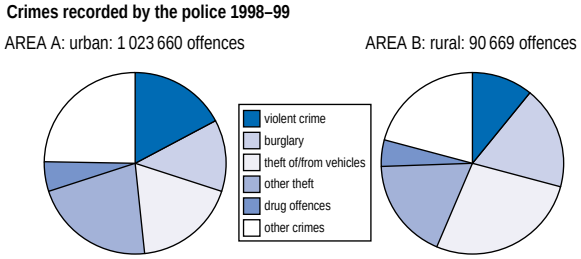


You are going to make a television advert about the environment. Choose two issues to be in your advert using the information in the chart. Explain how you chose each issue using *only* the information in the chart.

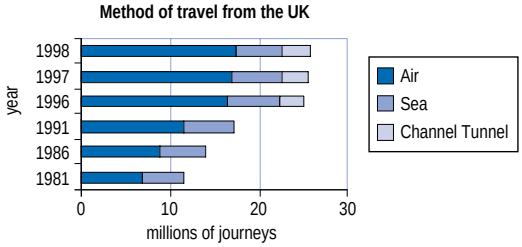
As outcomes, Year 8 pupils should, for example:

Interpret tables, graphs and diagrams, and draw inferences related to the problem; relate summarised data to the questions being explored. For example:

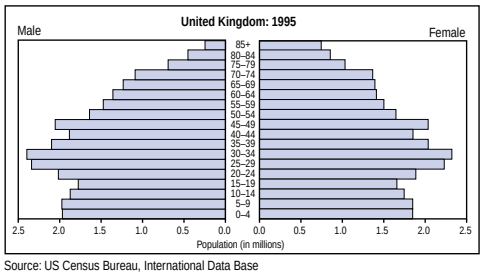
- Interpret pie charts. For example, discuss differences in crime patterns between two areas.



- Interpret data in a compound bar chart. For example:
  How has the method of travel changed over the last 20 years? Using the data in the graph, predict what the results will look like for this year.
  What about next year? In 10 years?



- Interpret data in a population pyramid. For example, discuss differences in the male and female populations of different countries.



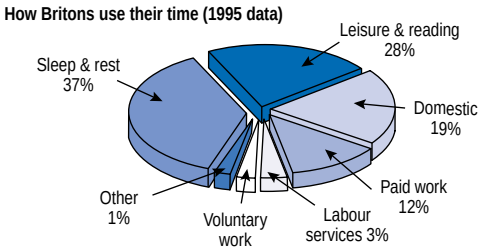
Source: US Census Bureau, International Data Base

Calculate simple statistics, such as the percentage of men and women over 70, to illustrate observations.

As outcomes, Year 9 pupils should, for example:

Interpret graphs and diagrams, and draw inferences from data representations to support and to cast doubt on initial conjectures. For example:

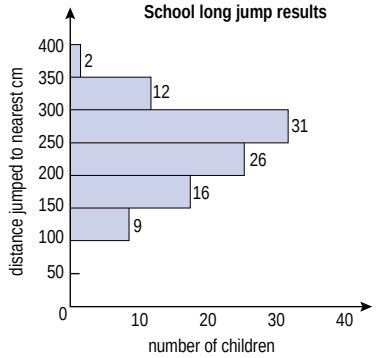
- Interpret pie charts, e.g. showing how British adults spend their time.



Source: *Economic Trends*, Office for National Statistics 1998

Criticise a claim that the pie chart shows that Britons spend too little time working. Argue that paid work amounts to 12% of $24 \times 7 = 20.16$ hours per week, which suggests that 1 in 2 British adults works about 40 hours a week, about right.

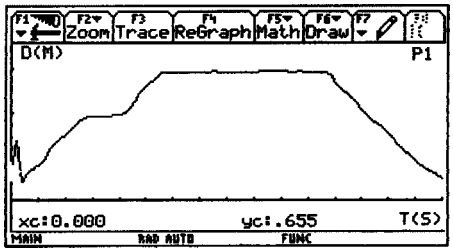
- Interpret frequency diagrams. For example:
  Here are the long jump results for a school.
  They are measured to the nearest centimetre, and classified in intervals $0 \leq d < 50$, $50 \leq d < 100$, etc.



a. Steve jumped 315 cm.
He says: 'Only two people jumped further than me.' Could he be correct? Tick the correct box, then explain your answer.
☐ Yes ☐ No

b. Ruby says: 'The median jump was 275 cm.'
She is not correct. Explain how the graph shows she is not correct.

- Interpret a distance–time graph, e.g. generated on a **graphical calculator** using a **CBR** (calculator-based ranger).



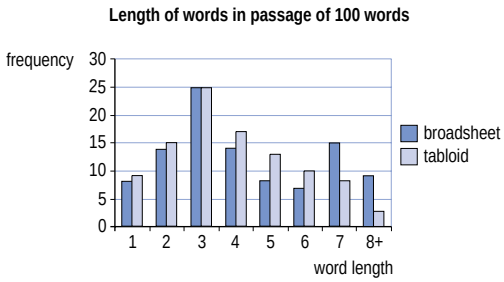
Pupils should be taught to:

Interpret diagrams and graphs, and draw inferences (continued)

As outcomes, Year 7 pupils should, for example:

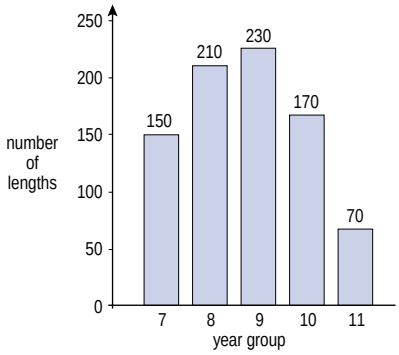
- Interpret a bar chart (discrete data). For example:

a. This chart shows the lengths of 100 words in two different newspaper passages. Compare the two distributions.



Observe that the differences are not great, but there may be slightly greater word length and variety of word length in the broadsheet newspaper.

b. A school has five year groups.
Eighty pupils took part in a sponsored swim.
Lara drew this graph.



Look at the graph.
Did Year 10 have fewer pupils taking part than Year 7?
Tick the correct box.

☐ Yes ☐ No ☐ Cannot tell

Explain your answer.

See Y456 examples (pages 114–17).

As outcomes, Year 8 pupils should, for example:

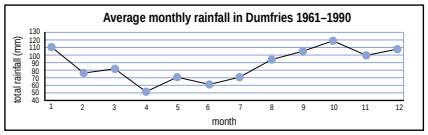
- Interpret data in a table from a secondary source. For example, describe the relationship between the number of cigarettes smoked and when smokers have their first cigarette of the day.

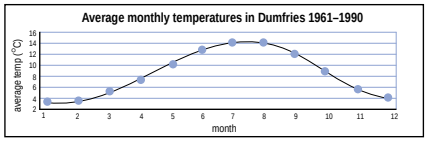
Time after waking first cigarette smoked	No. of cigarettes smoked per day		
	20 or more	10–19	0–9
Less than 5 minutes	31	12	2
5–14 minutes	28	16	3
15–29 minutes	19	17	6
30 minutes to 1 hour	14	23	12
1–2 hours	6	18	15
More than 2 hours	2	15	63

Source: *Smoking Statistics: who smokes and how much*, ASH

- Interpret line graphs, e.g. weather data.

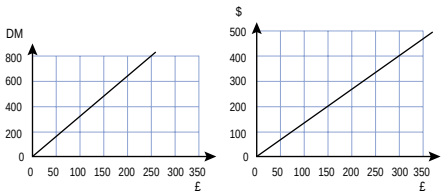
a.





When would you visit Dumfries? Why?
The driest month in Dumfries is normally April, when temperatures are around 7 °C. June is considerably warmer, and only a little wetter.

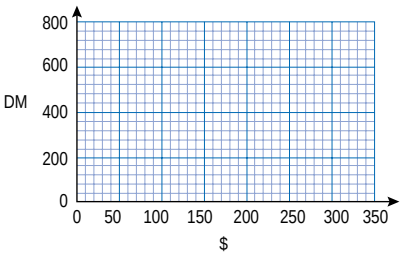
b. These two graphs convert pounds (£) to Deutschmarks (DM) and pounds (£) to dollars ($).



Use the graphs to complete the table.

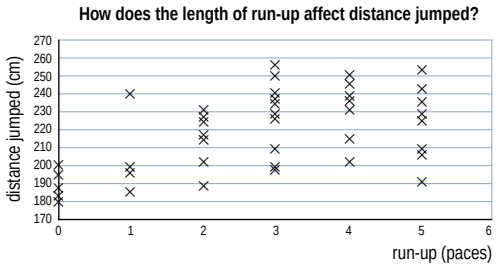
Number of £	Approximate number of DM	Approximate number of $
0	0	0
200		

Use the information in your table to draw a conversion graph for $ into DM.



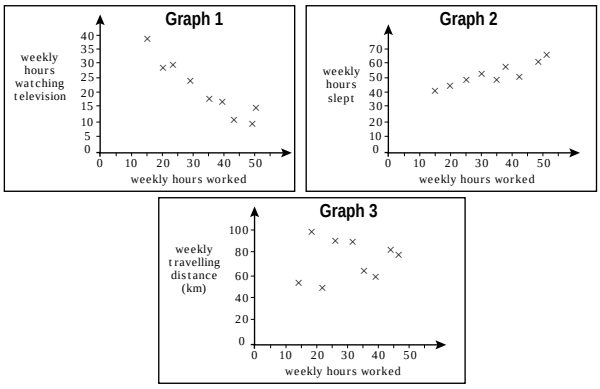
As outcomes, Year 9 pupils should, for example:

- Interpret scatter graphs, e.g. showing the effect of length of run-up on long jump distance.



Is there enough evidence to show that increasing the number of paces before take-off improves the distance jumped?

- Develop basic understanding of correlation. For example, some students plotted three scatter graphs.



a. What does graph 1 show about the relationship between the weekly hours spent watching TV and the weekly hours worked?
b. What does graph 2 show about the relationship between the weekly hours slept and the weekly hours worked?
c. What does graph 3 show about the relationship between the weekly travelling distance and the weekly hours worked?
d. One student works for 30 hours a week or more. Estimate the weekly hours spent watching TV and the weekly hours slept by this student. Explain how you decided on your estimates.

Analyse data to find patterns and exceptions, look for cause and effect, and try to explain anomalies.

- *In a study of engine size and acceleration times, observe that in general a larger engine size leads to greater acceleration. However, particular cars do not fit the overall pattern, perhaps because they are much heavier than average, or are built for rough terrain rather than normal roads.*

Recognise that in controlled scientific conditions it may be possible to deduce cause and effect, but that in statistical situations establishing a connection does not necessarily imply causality.

Pupils should be taught to:	As outcomes, Year 7 pupils should, for example:
Compare two simple distributions using the range, mode, mean or median	**Compare the distributions of two sets of data, and the relationships between them, using the range and one of the mode, mean or median.** For example: • *How do pupils travel to school?* Compare the median and range of the times taken to travel to school for two groups of pupils, such as those who travel by bus and those who travel by car. • *Which newspaper is easiest to read?* In a newspaper survey of the numbers of letters in 100-word samples, compare the mean and the range. Newspaper type — Mean — Range tabloid — 4.3 — 10 broadsheet — 4.4 — 14 • *Which is your better catching hand?* Use data from practical experiments to compare results for the writing hand with the non-writing hand, e.g. the mode and range for the number of cubes caught. • *Do First Division or Second Division teams score more goals?* Use data from secondary sources to compare goals scored in a season by teams in the First Division and teams in the Second Division. Calculate the range, mean, median and mode. Write two sentences comparing the results, using the range and the mean, median or mode.
Communicate methods and results	**Write a short report of a statistical enquiry.** Illustrate with diagrams, graphs and charts, using **ICT** as appropriate; justify the choice of what is presented. For example: • *How do pupils travel to school?* Draw conclusions based on the original questions and the data analysis. Indicate which diagrams and statistics have proved informative and why. Note difficulties or ambiguities that arose and how they were dealt with. Summarise conclusions: for example, 80% of pupils who live within one mile walk to school; many of those that travel by car do so because it fits in with a parent's journey to work. • *Do newspapers use words or sentences of different length? If so, why?* Explain why the analysis might be misleading. Does the use of technical vocabulary, names of people, conjunctions and pronouns... have an effect in making word length similar? • *How will the population of different countries change over the next 50 years?* Write an account based on population pyramids. Use terms such as *birth rate*, *death rate* and *natural increase*.

As outcomes, Year 8 pupils should, for example:

Compare two distributions using the range and one or more of the mode, mean or median.
For example:

- *Which type of battery lasts longer?*
  Use data from an experiment to calculate the range, median and mean of each type.
  Conclude, for example, that one brand is generally of higher quality, and one has less consistent manufacturing standards, as evidenced by a greater range.

- *Compare and contrast weather patterns in England and Greece.*
  Use secondary data to calculate the range, mean, mode, median of temperature, rainfall, hours of sunshine… in each country. Conclude, for example, that Greece is warmer on average, but also experiences a greater variety in weather patterns.

- *Compare and contrast TV viewing patterns for different age groups.*
  Compare teenagers with an adult sample. Infer, for example, that teenagers watch more TV, but adults have more consistent viewing patterns.

Communicate the results of a statistical enquiry and the methods used, using **ICT** as appropriate; justify the choice of what is presented. For example:

- Prepare and present a statistical report comparing the methods of transport to an out-of-town shopping centre and a town centre. Indicate the types of shopping customers use each centre for and their reasons.

- As part of a cross-curricular project with science, produce and present a report on how the communities in two habitats differ. Compare relevant factors such as light intensity and plant or animal diversity.

- After an experiment to simulate the cooling rates of penguins, present information that establishes the result: the two graphs plotted on the same diagram, or selected temperature values at the same times.

As outcomes, Year 9 pupils should, for example:

Compare two or more distributions, using the shape of the distributions and appropriate statistics.
For example:

- *Compare long jump performance*
  Use frequency diagrams to compare the overall performance of Year 7 and Year 9 pupils.
  Conclude, for example, that because the two distributions are similar in shape and range, there is a similar pattern of good, average and poor jumpers in each year.
  Calculate the means of Year 7 and Year 9 pupils' jumps to be, say, 217 cm and 234 cm. Conclude that Year 9 pupils generally jump between 15 cm and 20 cm further than Year 7 pupils.

- *Compare the populations of the UK and Brazil*
  Conclude, for example, that the similar range indicates that at least some parts of the Brazilian population live as long as people do in the UK.
  Use the median age to explain that whereas half the population of the UK is over the age of 35, in Brazil half the population is under the age of 24.

- *Investigate the contents of 25 gram bags of crisps*

	Mean mass (g)	Range (g)
Jones crisps		
Strollers crisps		

  From a table of summarised data, conclude that bags of Jones crisps are on average marginally lighter than bags of Strollers crisps, but that the greater range of the Jones crisps bags means that there will be quite a few heavy bags as well as quite a few light bags.

Communicate interpretations and results of a statistical enquiry using selected tables, graphs and diagrams from primary and secondary sources in support. For example:

- Describe the current incidence of male and female smoking in the UK, using frequency diagrams to demonstrate the peak age groups.
  Show how the position has changed over the past 20 years, using line graphs.
  Conclude that the only group of smokers on the increase is females aged 15–25 years.
  Suggest possible reasons, based on results from your own questionnaire.

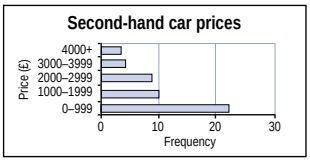
- *As a joint project with geography, write about development, showing an understanding of the difficulty of defining the term, given anomalies between the various measures. Evaluate the usefulness of the indicators from scatter graphs. Refer to tables of data for particular countries to suggest reasons for differences in development on different scales and in different contexts.*

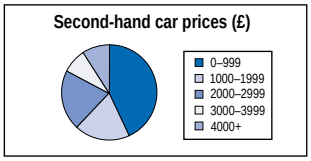
Pupils should be taught to:	As outcomes, Year 7 pupils should, for example:
Communicate methods and results (continued)	

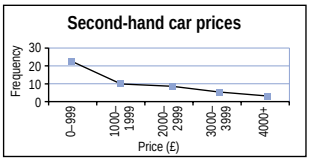
As outcomes, Year 8 pupils should, for example:

As outcomes, Year 9 pupils should, for example:

Select tables, graphs and charts to support findings. For example, choose a bar chart to represent second-hand car prices, because it conveys the progression in value (unlike the pie chart) and has a stronger visual image than the line graph, where the joining of points to show trends could mislead.







Identify misleading graphs and statistics, such as:

- incomplete diagrams;
- inappropriate use of scale or breaking the scale on the axes to magnify differences;
- treating discrete data as continuous data, and vice versa, or joining up points with lines for a discrete distribution;
- general conclusions from very small samples, e.g. '9 out of 10 cats prefer...';
- misinterpreting lines of best fit on scatter diagrams.

Recognise that graphs produced by popular **ICT packages** often suffer from some of these faults.

Examine results critically, and justify choice of statistical representation in written presentations, recognising the limitations of any assumptions and their effect on the conclusions drawn. *For example:*

- *Study of populations of the UK and Brazil*
  Conclude that the 'bottom-heavy' shape of the Brazilian population distribution could be due to a number of factors. Observe that a significant difference between the mean and median gives a measure of the skew of the distribution.

  Note that the 'bottom-heavy' effect could be due to a rising birth rate (giving an increasing number of younger people) or to a significant death rate at all ages (reducing the number of people still alive at each higher age group). Use the high population growth rate to indicate the former, but the high infant mortality and low life expectancy to support the latter.

  Use the roughly uniform population distribution, and high life expectancy, of the UK to argue that both mortality figures and the birth rate are low.

- *Study of distribution of grass and non-grass plants*
  Having examined the effect of moisture content of soil on the distribution of grass, recognise that other factors may be significant.