Maths Level 2

Chapter 6
Working with data and averages

Maths Level 2

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Chapter 6: Working with data and averages

Use these free pilot resources to help build your learners' skill base

We are delighted to continue to make available our free pilot learner resources and teacher notes, to help teach the skills learners need to pass Edexcel FS Mathematics, Level 2.

But use the accredited exam material and other resources to prepare them for the real assessment

We developed these materials for the pilot assessment and standards and have now matched them to the final specification in the table below. They'll be a useful interim measure to get you started but the assessment guidance should no longer be used and you should make sure you use the accredited assessments to prepare your learners for the actual assessment.

New resources available for further support

We're also making available new learner and teacher resources that are completely matched to the final specification and assessment – and also providing access to banks of the actual live papers as these become available. We recommend that you switch to using these as they become available.

Coverage of accredited specification and standards

The table below shows the match of the accredited specification to the unit of pilot resources. This table supersedes the pilot table within the teacher notes.

Coverage and Range	Exemplification	Learner Unit
Collect and represent discrete and continuous data, using ICT where appropriate	• Collecting data • Tally charts • Frequency tables • Pie charts • Bar charts • Line graphs • Grouped frequency tables • Scatter graphs	I1 Types of data I2 Extracting and interpreting information from tables I3 Extracting and interpreting information from bar charts I4 Extracting and interpreting information from charts and graphs I5 Collecting data I6 Representing data in bar charts, pie charts, line graphs and scatter graphs I7 Using spreadsheets to draw statistical diagrams Grouped frequency tables are covered in our new publishing (see below)
		I8 Remember what you have learned
Use and interpret statistical measures, tables and diagrams, for discrete and continuous data, using ICT where appropriate	• Mean, median, mode and range for discrete data • Modal class for grouped data	J1 Mean J2 Median and mode J3 Using average and the range
	• Positive and negative correlation and line of best fit	I6 Representing data in bar charts, pie charts, line graphs and scatter graphs
Use statistical methods to investigate situations	• Comparison of two groups using measures of average and range	J3 Using averages and the range
	• Use line of best fit	I6 Representing data in bar charts, pie charts, line graphs and scatter graphs
	• Compare proportions in a pie chart	I4 Extracting and interpreting information from charts and graphs
		I6 Representing data in bar charts, pie charts, line graphs and scatter graphs
		J4 Remember what you have learned

Where to find the final specification, assessment and resource material

Visit our website **www.edexcel.com/fs** then:
- **for the specification and assessments:** under **Subjects**, click on **Mathematics (Levels 1–2)**
- **for information about resources:** under **Support**, click on **Published resources**.

Pilot material only – see introduction before use

Working with data

You should already know how to:

✔ extract and interpret information, for example, in tables, diagrams, charts and line graphs

✔ collect, organise and represent discrete data in tables, charts, diagrams and line graphs.

By the end of this section you will know how to:

▶ extract discrete and continuous data from tables, charts and line graphs

▶ interpret information given by data in tables, charts and line graphs

▶ collect and represent discrete and continuous data, using ICT where appropriate.

1 Types of data

Learn the skill

There are two general types of data:

■ **qualitative** data - non-numerical data such as colours of hair, makes of car

■ **quantitative** data - numerical data such as marks in a test, waiting time in a doctor's surgery.

Quantitative data may be either **discrete** or **continuous**.

▷ **Discrete data** can only take particular values.

Shoe sizes, such as 5, $5\frac{1}{2}$, 6, $6\frac{1}{2}$ are discrete data. There are no values in between. The shoe size $5\frac{1}{4}$ does not exist!

▷ **Continuous data** can take any value.

Weight does not suddenly jump from 66 kg to 67 kg. It goes through all the values in between such as 66.723 145… kg.

> **Tip**
> Each item of discrete data has an exact value.

> **Tip**
> Continuous data cannot be measured exactly. The accuracy depends on the measuring device.

Try the skill

Decide whether each of the following types of data is quantitative or qualitative. If it is quantitative data, identify whether it is also discrete or continuous.

1 height of a tree

2 favourite tv programme

3 your weight

4 time to wait for a bus

5 type of tree

6 temperature of an oven

7 number of goals scored in a football match

8 distance between two towns

2 Extracting and interpreting information from tables

📖 *Learn the skill*

You need to be able to extract information from tables.

Example 1: A woman wants to buy a new computer. She chooses from the models in this table. She wants a computer with at least 2 GB of memory and more than 350 GB hard drive capacity. She wants to pay less than £600. Which model should she buy?

Model	Memory	Hard drive capacity	Price
T9608	1 GB	250 GB	£399.99
B3413	2 GB	360 GB	£599.99
A6332	3 GB	320 GB	£589.99
P2613	3 GB	500 GB	£699.99

Look at the amounts of memory for each model.

T9608 does not have enough.

Look at the hard drive capacity. A6332 is too small.

P2613 costs more than £600. So only B3413 satisfies all the requirements.

Tip

Work through the requirements systematically.

Answer: B3413

➡️ *Try the skill*

1. Here is an extract from a holiday brochure giving prices per person for a holiday in Palma, Majorca.

    a Work out the cost for one person to stay for two weeks in Sunny Chalets, arriving on 1 July.

    _____

    b Work out the cost for two people to stay for one week in Bay View Hotel, arriving on 17 June.

    _____

Arrival date	Cost per person at Sunny Chalets		Cost per person at Bay View Hotel	
	7 days	additional 7 days	7 days	additional 7 days
1.6 to 16.6	£240	£80	£380	£140
17.6 to 30.6	£270	£80	£420	£150
1.7 to 16.7	£300	£100	£450	£150
17.7 to 31.7	£280	£100	£435	£135

2. The table gives the results of a survey into the way some students travel to college.

	Bus	Train	Car	Total
Males	20	15	8	
Females	22	13	5	
Total				

   a how many students travel to college by train?

   b how many male students were surveyed?

   c how many more female students travel to college by bus than by train?

   d how many students were surveyed altogether?

Pilot material only – see introduction before use

Extracting and interpreting information from bar charts

🔖 *Learn the skill*

▷ **Bar charts** use bars to show patterns in data.

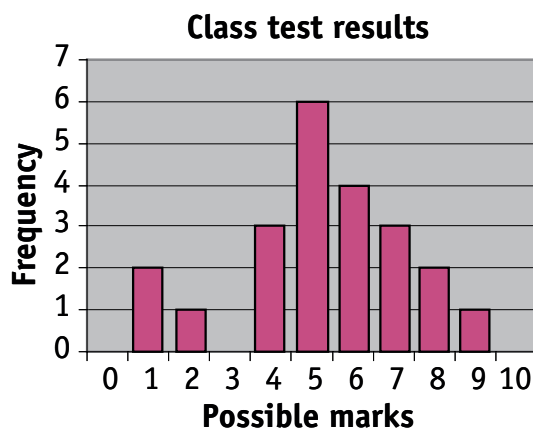The bars may be horizontal or vertical.

Both axes should have labels and the chart should have a title.

This bar chart shows some students' marks in a maths test.

The bar chart shows how many students achieved each score.

This is called the **frequency**.

▷ You use a **dual bar chart** to compare two sets of data.

Class test results

> **Tip**
>
> For continuous data there are no gaps between the bars.

> **Tip**
>
> The vertical scale should start at 0 otherwise the differences between amounts appear larger than they are. This can be misleading.

⏩ *Try the skill*

1. This bar chart was produced by Freshco to compare the cost of a certain brand of cat food.

   a Why is the bar chart misleading?

   _____

   b What is the difference between the highest and lowest cost of the cat food?

   _____

Cost of cat food

2. This chart shows a shop's sales in May and June this year.

Sales in May and June
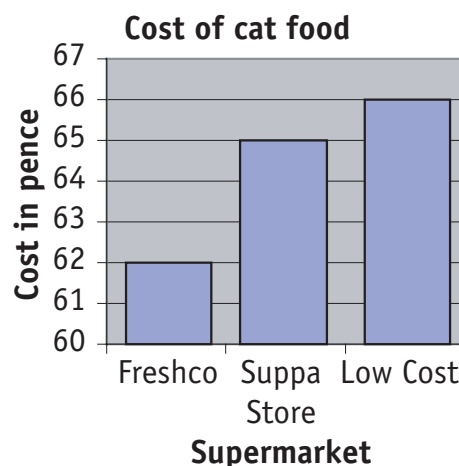
> **Tip**
>
> The key shows what the different coloured bars mean.
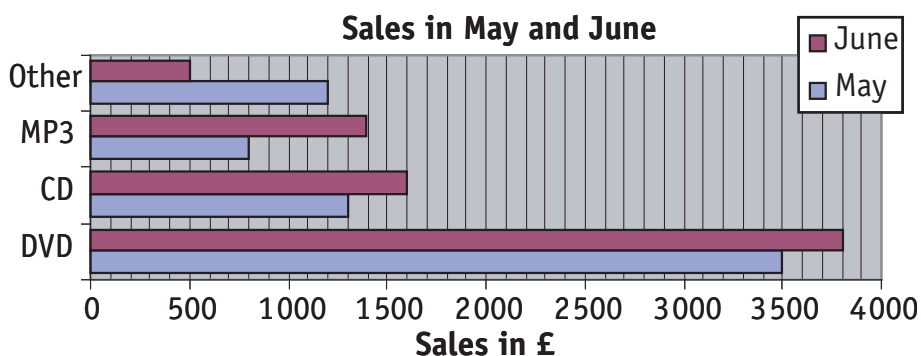
   a What is the difference between the total sales in May and the total sales in June?

   b Which item has the biggest difference between the sales in May and the sales in June?

4 Extracting and interpreting information from charts and graphs

Pie charts

📖 *Learn the skill*

Pie charts show the proportion of the data that is in each category. A pie chart is split into 'slices' called sectors.

There are 360º in a circle. To extract information from a pie chart you need to find the connection between the angles and the data.

Example 1: A tour operator conducted a survey of its customers' favourite holiday destinations. The pie chart displays the results of the survey.
Spain was chosen by 150 people, which was $\frac{1}{3}$ of the customers surveyed.
a How many customers were surveyed?
b How many customers chose Greece?

a $\frac{1}{3}$ of the customers surveyed is 150 people
The total number surveyed is $\frac{3}{3}$
So the total number of customers surveyed = 3 × 150 = 450

Answer: 450 customers

b You need to use a protractor to measure the angle of the sector representing Greece. The angle is 88º
360º represents 450 customers
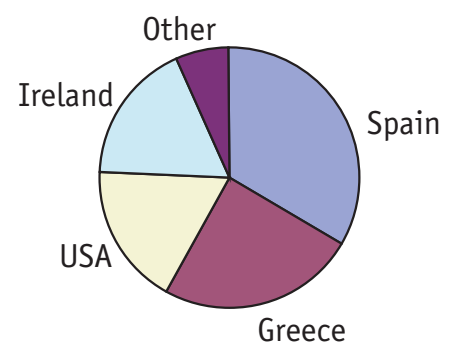1º represents $\frac{450}{360}$ customers
So 88º represents 88 × $\frac{450}{360}$ = 110 customers

Answer: 110 customers

> **Remember**
>
> A pie chart does not give data values.

Favourite holiday destinations

> **Tip**
>
> $\frac{450}{360}$ = 1.25, but you can't have 1.25 customers. Work out the whole calculation 88 × $\frac{450}{360}$ in one go on your calculator.

Line graphs

> ▷ **Line graphs** are used to display **continuous data**.

Points plotted on the graph are joined up with straight lines.

Example 2: This line graph shows the temperatures in Manchester for the first five days in July. What is the difference between the highest and lowest temperatures?

First identify the scale. Five small squares represent 5°C, so one small square is 1°C.

From the graph, the highest temperature is 22°C and the lowest temperature is 15°C.

The difference is 22 – 15 = 7.

Answer: 7°C

Temperature in July

Pilot material only – see introduction before use
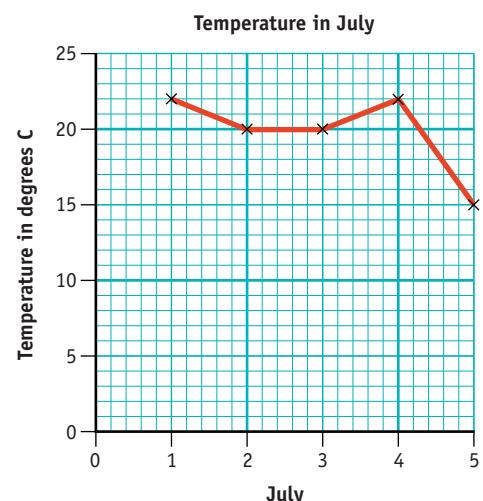
Scatter graphs

▷ **Scatter graphs** show any connection between two sets of data.

The scatter graph shows the marks of 18 students in a maths test and a physics test.

A point is plotted for each of the 18 students.

Test marks in maths and physics

The points are grouped in a band that slopes generally 'uphill' from left to right, showing a connection between the marks in maths and physics.

This indicates that students who scored higher marks in maths also tended to score higher marks in physics.
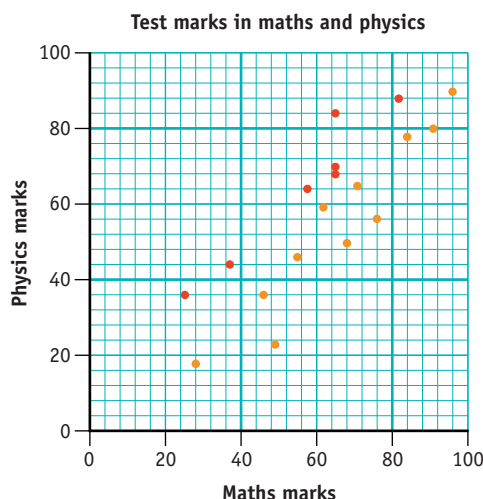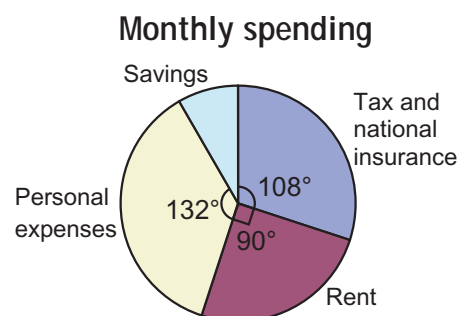
Tip

When the trend is 'uphill' this is called **positive correlation**. If the trend is 'downhill' this is called **negative correlation**.

⇨ *Try the skill*

1. The pie chart shows how a woman spends her wages. She earns £960 a month.

   a How much of the woman's wages is spent on tax and national insurance?

   _____

   b What fraction of her wages is the woman saving?

   _____

Monthly spending

2. A student heats up water as part of an experiment. He records the temperature every 10 seconds as shown in the table.

Temperature (°C)	40	52	65	79	85	92	100
Time (seconds)	0	10	20	30	40	50	60

Which type of chart would you use to present this information?

_____

3. This graph shows the sales of CDs and DVDs by a company in the first six months of 2006.

Sales of CDs and DVDs in 2006
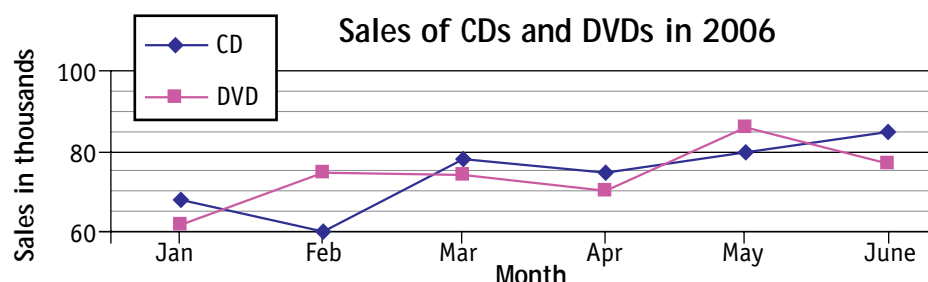
   a In which months were the sales of CDs greater than the sale of DVDs?

   b In which month did the biggest difference in sales of CDs and DVDs occur?

Tip

You often need to compare line graphs that have been drawn on the same set of axes.

Tip

It is not always possible to work out exact values from a line graph. In this question, some of the points are not plotted exactly on the horizontal lines so you need to approximate the sales for the month.

5 Collecting data

Learn the skill

You may need to collect data as part of an investigation or a survey.

Data which is collected by **observation** can be recorded on a data collection sheet using a tally. For example, the data collection sheet on the right might be used by a restaurant manager to find public opinion on their favourite nationality of food in a local area.

Nationality of Food	Tally	Frequency
Indian		
Italian		
etc		

Data can also be collected in a survey by using a **questionnaire**. In a questionnaire each question should have a set of response boxes which cover all possible answers to the questions with no overlap. The questions should be clear and unbiased.

The sample of people you choose to take part in a survey must also be unbiased. For example, a suitable question to survey a random selection of students on the number of hours they spend on homework would be:

How many hours do you spend each week on homework?

☐ Less than 5 hours   ☐ 5 but less than 10 hours   ☐ 10 but less than 15 hours

☐ 15 but less than 20 hours   ☐ more than 20 hours

Data may also be collected by **experiment**. For example, a factory may be interested in the lifetime of their lightbulbs and could carry out an experiment to find the number of days each of a sample of lightbulbs produce light before they burn out.

Data which is collected by observation or by experiment is called **primary** data.

Other research may require using data which has been collected and recorded by someone else. This is called **secondary** data. For example, an insurance company would be interested in National statistics recording the number of accidents for different occupations when working out insurance policy payments.

Tip

An **Actuary** assesses financial risk and calculates insurance premiums.

Try the skill

1. A travel agent wants to survey customers' favourite holiday destinations. What would he use to collect the data? Is this primary or secondary data?

2. Design a suitable question for a restaurant manager to survey how much local people are prepared to pay for a meal out.

3. The manager of a new supermarket wants to survey customer opinion of the restaurant facilities. He asks customers who visit the supermarket one Monday morning to fill in a questionnaire.

    a Why will the survey be biased?

    b Describe how he could change the way he carries out his survey to make it less biased.

6 Representing data in bar charts, pie charts, line graphs and scatter graphs

Bar charts

When drawing bar charts, make sure you:

- use a ruler and a sharp pencil, and draw the bar chart on squared or graph paper
- choose a scale which is easy to use e.g. 1 small square as 1, 2, 5, 10, 20, 50, 100, 200, 500, 1000 etc
- give the bar chart a title and label both axes, with units if appropriate
- draw bars with an equal width
- for discrete or qualitative data leave a fixed gap in-between the bars.

Example 1: Draw a bar chart to show the results of the survey into student travel to college:

	Bus	Train	Car
Males	20	15	8
Females	22	13	5

Remember
A bar chart can have vertical or horizontal bars.

Remember
A dual bar chart is used to compare 2 sets of data.
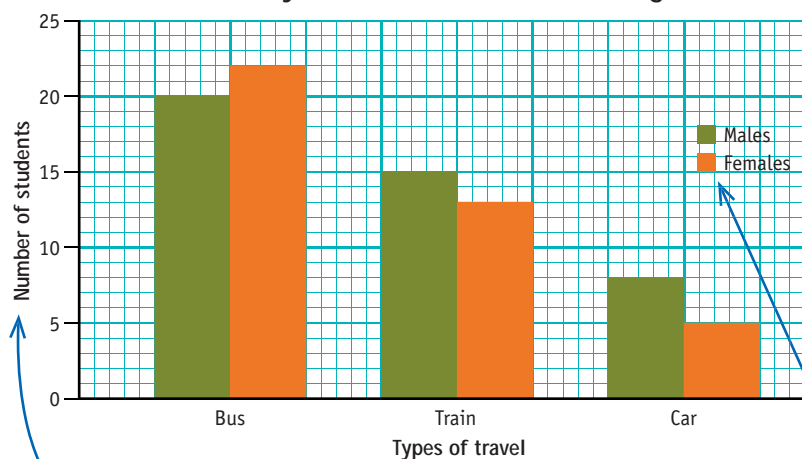
Tip
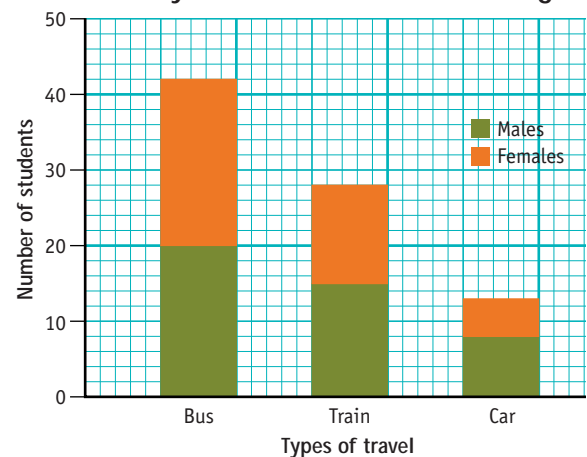The data can also be represented in a **component** bar chart.

Tip
Try to use a scale that will allow for a large bar chart which is esay to read

Survey of student travel to college

the vertical axis is the frequency

this is the **key** for the bar chart

Survey of student travel to college

Pilot material only – see introduction before use

Pie charts

To draw a pie chart:

■ find the total frequency for the categories

■ divide 360° by the total frequency

■ multiply the result by the individual frequencies for each category

■ check the sum of the angles for each category is 360°

■ give the pie chart a title

■ use a compass and protractor to draw the circle and measure the angles

■ label each sector of the pie chart or use a key for each category.

Tip

In assessment questions the circle will usually be drawn for you.

Example 2: The table shows the results of a survey into people's favourite television soap.

Soap	Number of people
Coronation Street	55
Emmerdale	24
Eastenders	48
Neighbours	34
Hollyoaks	19
Total	**180**

Draw a pie chart to illustrate this information.

Total frequency = 180 = $\frac{360}{180}$ = 2° per person

Soap	Number of people	No. of degrees
Coronation Street	55	55 × 2 = 110
Emmerdale	24	24 × 2 = 48
Eastenders	48	48 × 2 = 96
Neighbours	34	34 × 2 = 68
Hollyoaks	19	19 × 2 = 38
		Total = 360

Survey into favourite television soap

Tip

If the sum of the frequencies does not divide exactly into 360°, you need to write each angle correct to one decimal place. If the sum of the angles then works out to be more than 360°, subtract 1° from the largest angle.

Tip

A key can also be used to indicate what each sector represents in a pie chart.
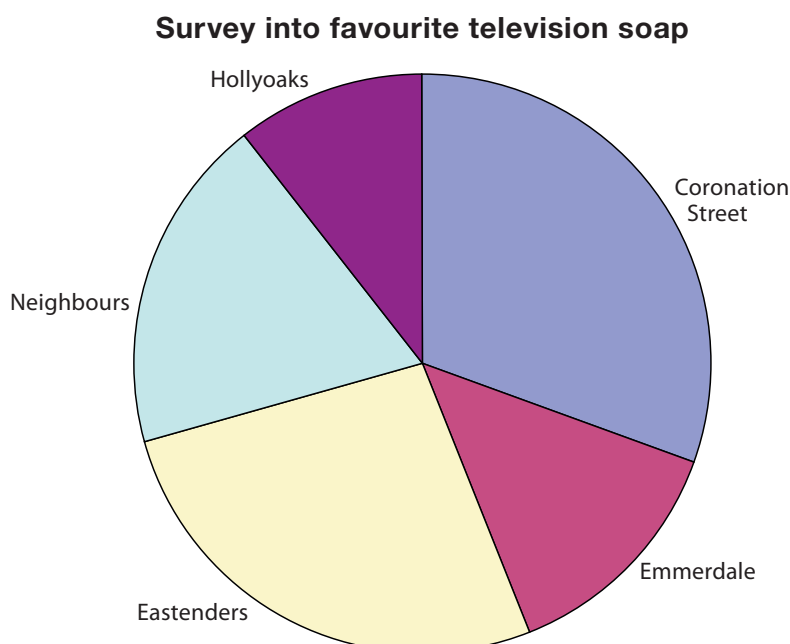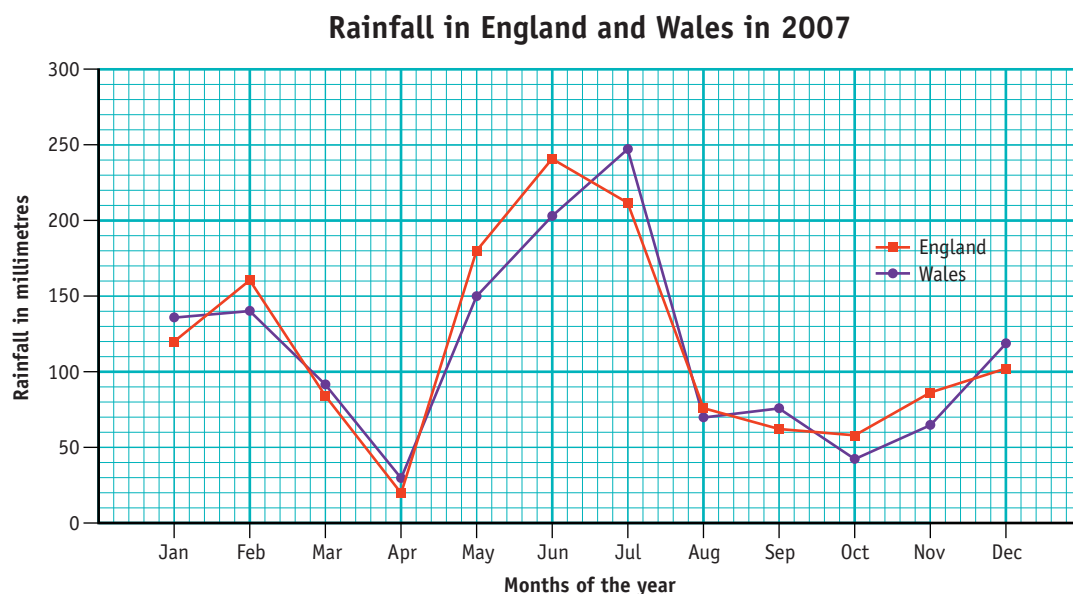
Line graphs

To draw a line graph:

■ use a ruler and a sharp pencil, and draw the line graph on squared or graph paper

■ choose a scale which is easy to use e.g. 1 small square as 1, 2, 5, 10, 20, 50, 100, 200, 500, 1000 etc

■ give the line graph a title and label both axes, with units if appropriate

■ if the line graph has more than one line, label each line or use a key to distinguish between them.

Example 3: The table shows the average rainfall in England and Wales in 2007 in millimetres.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
England	119	161	84	19	179	241	212	76	62	58	86	102
Wales	135	139	91	29	149	202	246	69	75	42	64	118

Source: www.met-office.gov.uk

Draw a line graph to compare the rainfall in England and Wales in 2007.

Rainfall in England and Wales in 2007

Tip

The key identifies the difference between the two line graphs.

Scatter graphs

To draw a scatter graph:

■ use a ruler and a sharp pencil, and draw the scatter graph on graph paper

■ choose a scale which is easy to use e.g. 1 small square as 1, 2, 5, 10, 20, 50, 100, 200, 500, 1000 etc

■ give the scatter graph a title and label both axes, with units if appropriate

■ plot each pair of points and look to see if there is a general pattern or trend.

Example 4: The table shows the number of millimetres of rainfall and the number of hours of sunshine in England in 2007.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rainfall in mm	119	161	84	19	179	241	212	76	62	58	86	102
Sunshine in hours	126	107	148	151	88	81	99	116	113	112	116	117

Source: www.met-office.gov.uk

Draw a scatter graph to see if there is any correlation between the number of millimetres of rainfall and the number of hours of sunshine in England in 2007.

Rainfall and sunshine in England in 2007
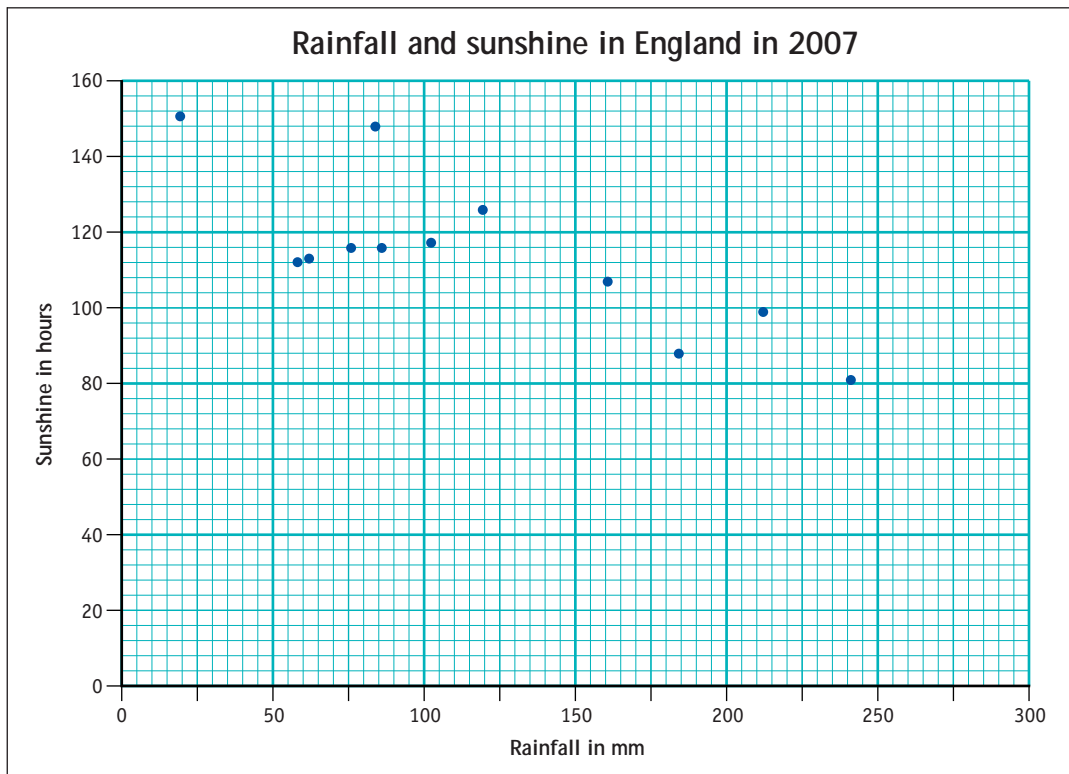
The scatter graph shows negative correlation. This means that the more mm of rainfall the less hours of sunshine.

Remember

The scales do not need to be the same on the two axes.

Scatter graphs and lines of best fit

If there is correlation between two sets of data, then it is possible to draw a **line of best fit**.

A line of best fit represents the trend or slope of the points that are plotted. It should pass near most of the points on the scatter graph, although there may be anomalies, sometimes called 'rogue values'. The line of best fit need not necessarily pass through any of the points plotted on the scatter graph, but it should have roughly equal numbers of points on either side of the line.

A line of best fit can be drawn on the scatter graph showing correlation between millimetres of rainfall and the number of hours of sunshine in England in 2007. The line of best fit can then be used to make predictions.

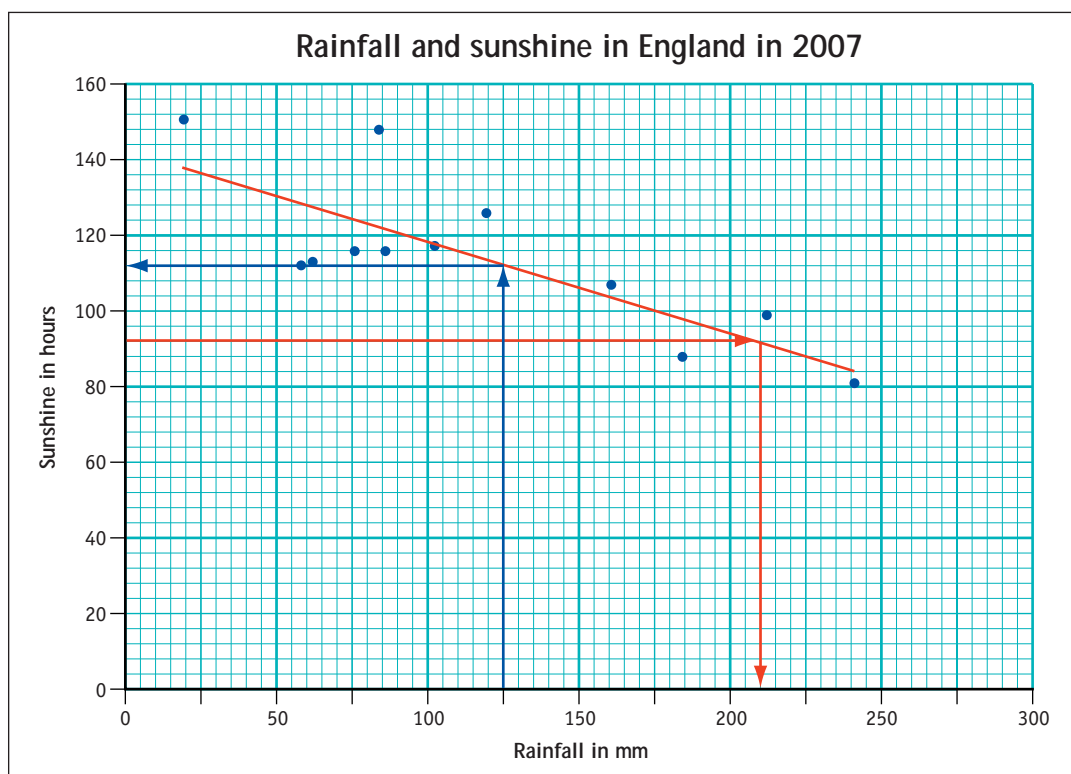**Example 5:** Draw a line of best fit on the scatter graph for rainfall and sunshine and use it to predict:
a the number of hours of sunshine you would expect in a month when there is 130 mm of rainfall
b the number of mm of rainfall you would expect in a month when there are 92 hours of sunshine.

Rainfall and sunshine in England in 2007

a draw a line up from 130 mm to the line of best fit and across to the hours of sunshine axis. The blue line shows 112 hours of sunshine

Answer: 112 hours

b draw a line across from 92 hours to the line of best fit and down to the rainfall axis. The red line shows 210 mm of rainfall.

Answer: 210 mm

Note this line of best fit only passes through one of the plotted points. First check the scale on each axis:

Vertical axis
5 small squares = 20 hours
1 small square = $\frac{20}{5}$ = 4 hours
Horizontal axis
5 small squares = 50 mm
1 small square = $\frac{50}{5}$ = 10 mm

➡ *Try the skill*

1. The table gives the life expectancy of males and females in six different countries.

   a Draw a dual bar chart to illustrate the data.

   b Which country has the highest female life expectancy?

   c Which country has the lowest male life expectancy?

   d Which country has the greatest difference between male and female life expectancy?

Country	Males	Females
Afghanistan	41.7	42.3
Australia	79.0	83.7
China	70.8	74.1
India	61.8	64.2
Russia	58.7	72.4
UK	76.6	81.1

Source: World Health Organisation

2. The table shows the **percentage** of Adult, Children, and Concession tickets sold at a cinema in the afternoon during half-term. This information can be shown on a **component** bar chart. Complete the bar chart below. The the first two bars have been done for you.

	Mon	Tue	Wed	Thur	Fri
Adults	42	38	40	43	33
Children	46	48	42	41	45
Concessions	12	14	18	16	22

People attending the cinema
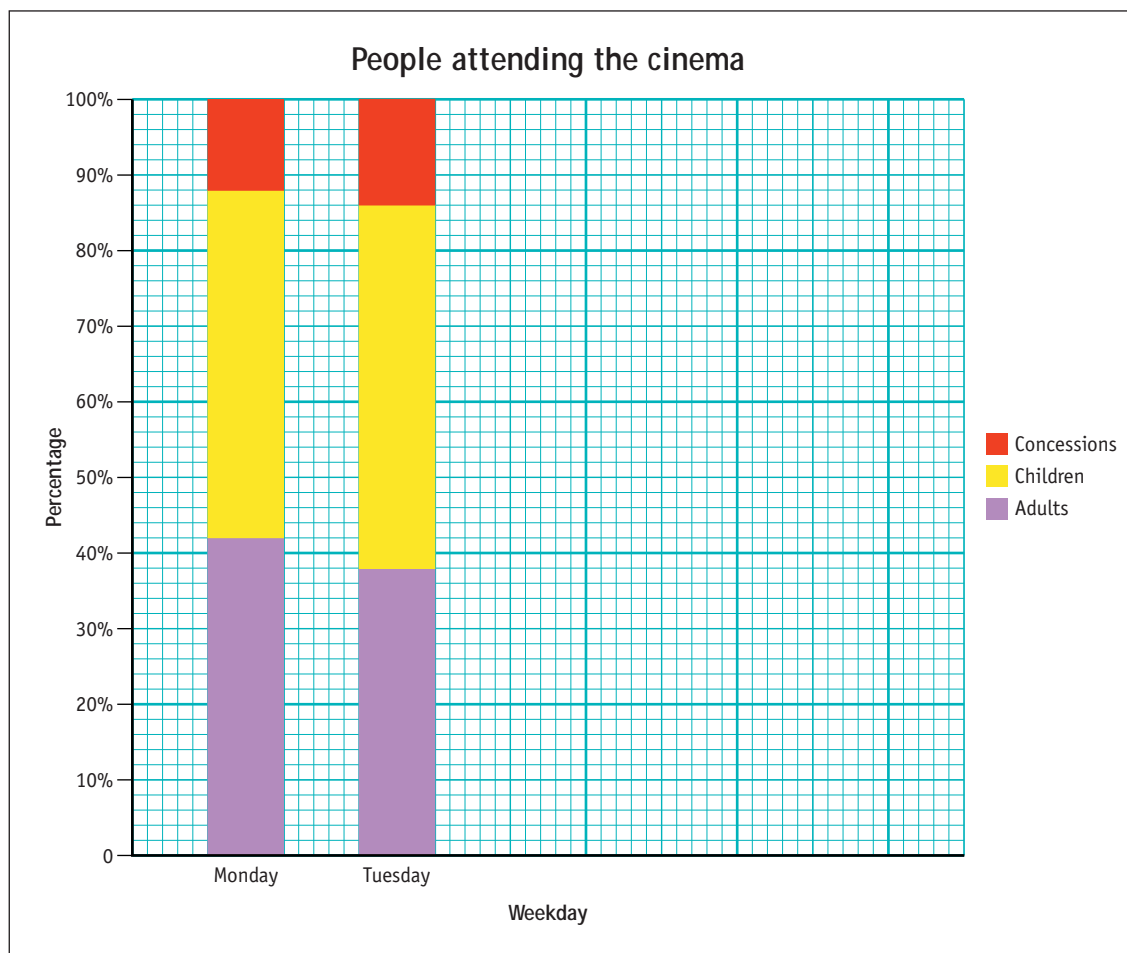
3. A student records how he spends his time in one 24-hour weekday period.

Activity	Number of hours	Number of degrees
sleeping	8	
eating	2	
travelling	2	
working	9	
relaxing	3	
Total		

Complete the table to find the number of degrees to use in a pie chart to represent each activity. Draw a pie chart to illustrate this information.

4. The table shows the number of overseas visitors to the UK in thousands in 2006 and 2007.

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2006	2260	1790	2300	2920	2840	2720	3530	3710	3060	2510	2570	2510
2007	2350	2050	2470	2930	3000	2760	3360	3360	2870	2740	2520	2480

Source: National Statistics Online

a Draw a line graph to compare the number of overseas visitors to the UK in 2006 and 2007.

b In which month was the difference between the number of visitors (i) greatest (ii) least?

5 The table shows the percentage of households in the United Kingdom that owned mobile phones and computers from 1996 to 2005.

	Percentage of UK households	
Year	Mobile phone	Home computer
1996	17	27
1997	21	29
1998	27	33
1999	44	38
2000	47	44
2001	65	50
2002	70	55
2003	76	58
2004	78	62

Source: National Statistics Online

> **Tip**
> You usually plot the values in the first column on the horizontal axis.

a Draw a scatter graph to illustrate this information.

b Draw a line of best fit and use it to predict the percentage of households that:

  i owned a computer in 2005 if 79% of households owned mobile phones

  ii owned a mobile phone when 20% of households owned a computer.

7 Using spreadsheets to draw statistical diagrams

📖 *Learn the skill*

Although you do need to be able to draw statistical diagrams by hand, a spreadsheet is a useful way to draw statistical diagrams and can be used to confirm that the results of your calculations are correct.

When producing work electronically, you should always make use of the header/footer facility to demonstrate ownership of your work.
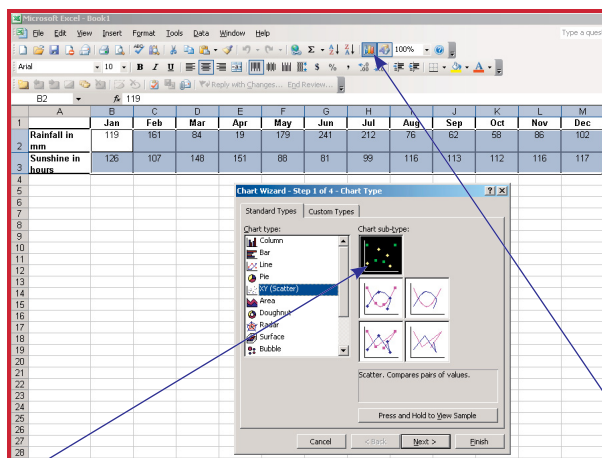
Graphs should be made to look as if they have been drawn on graph paper. Graph paper usually has a white background. Excel graphs have a grey background which is called the 'Plot Area'. Step 6 shows how to change the background from grey to white.

Graph paper has darker lines which are the 'major' gridlines and lighter lines which are the 'minor' gridlines. In Excel, the major gridlines are the ones with numbers at the end of them. Step 7 below shows how to select a lighter shade for the minor gridlines.
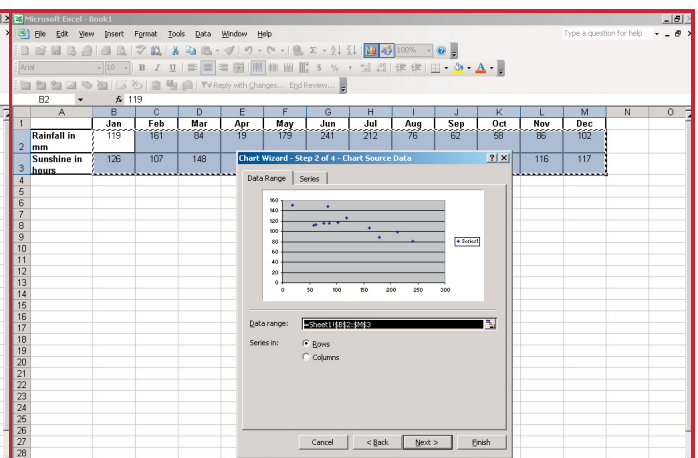
It is also very important that when using spreadsheets you follow the main rules for drawing charts and graphs:

■ give the chart or graph a title saying what it is about

■ label the axes stating the units used if relevant.

> **Example 1:** Use an Excel spreadsheet to draw a scatter graph for the rainfall and sunshine data used in Example 3 and 4 above. Use Excel to draw a line of best fit on your scatter graph.

Transfer the data into an Excel worksheet as shown. Highlight the rainfall and sunshine data and click on the chart wizard icon 📊 Select XY (Scatter) and the chart sub-type highlighted above. Click 'Next'.

The next page shows the points plotted on the scatter graph. Click 'Next'.
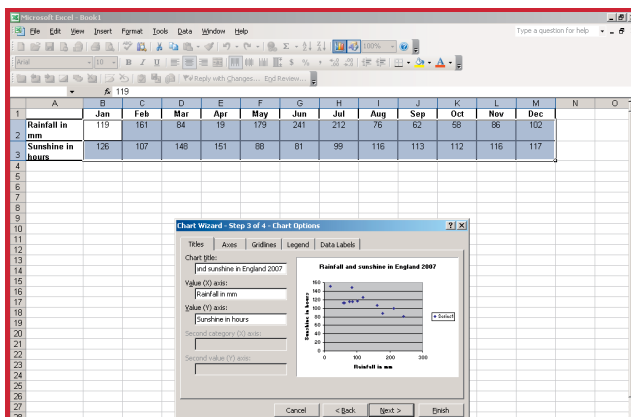
Type in a suitable title and labels for the x and y axes, remembering to include the units. Click on the 'Gridlines' tab.
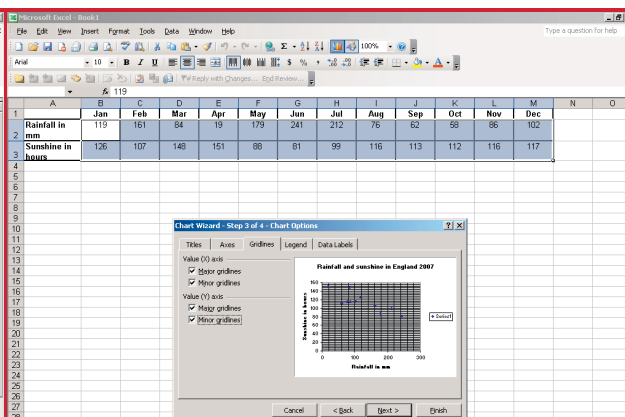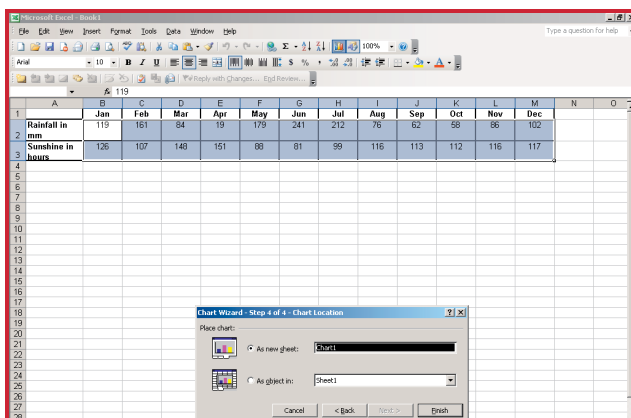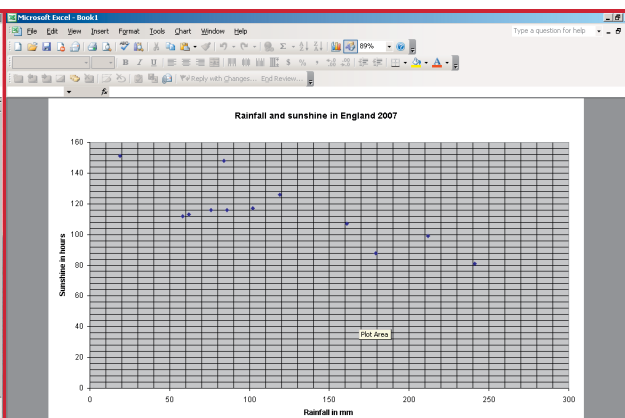

Tick 'Major gridlines', 'Minor gridlines' for both the x and y axes. Click on the 'Legend' tab and untick 'Show legend'. Click on 'Next'.

On the final page click on Place chart 'As new sheet' and click 'Finish'.

As you move your cursor around the screen you will see it pick up different statements. When you see 'Plot Area', right click and choose the 'Clear' option.
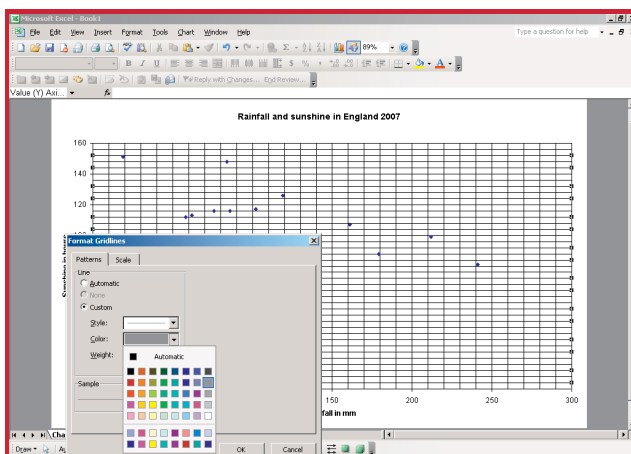
When the cursor picks up 'Value (Y) Axis Minor Gridlines' right click, select 'Format gridlines' and choose 'Gray-50%' for the colour. Click OK. Then do the same for 'Value (X) Axis Minor Gridlines'. Then click 'OK'.
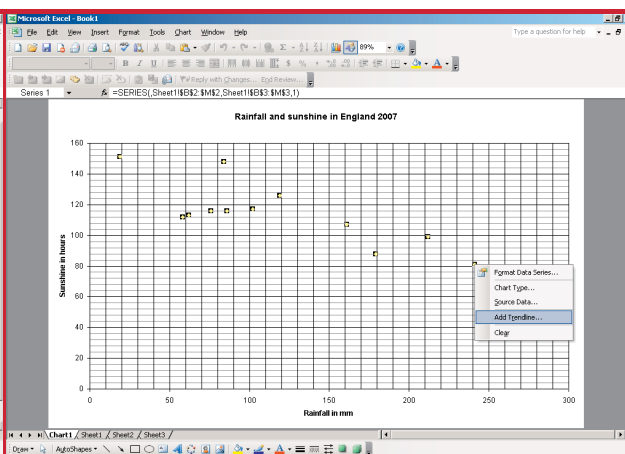
Right click on one of the plotted points, select 'Add Trendline'. Linear will be highlighted, click 'OK' and the line of best fit will be added to the scatter graph.

▶ *Try the skill*

Use Excel and the chart wizard for questions 1, 3, 4 and 5 in the last **Try the skill** exercise. Remember to make use of the header/footer facility and look at the print preview before printing out your charts and graphs.

8 Remember what you have learned

🔖 *First complete this …*

▷ _____ data can only take particular values.

▷ _____ data can take any value.

▷ _____ _____ use bars to show patterns in data.

▷ You use double bar charts to _____ two sets of data.

▷ Pie charts show the _____ of different types of data in a set of results.

▷ Line graphs are used to display _____ data.

▷ _____ _____ show any connection between two sets of data.

⏩ *Use the skill*

1. Here are the results of a survey on the number of TVs per house.

   How many houses had more than three TVs?

Number of TVs in the house	Number of houses
0	1
1	21
2	38
3	84
4	29
5	6
6	1

A ☐ 36
B ☐ 60
C ☐ 84
D ☐ 120

2. A travel company compares the number of visitors to major capital cities in June 2005 and June 2006.

Number of visitors to European capitals in June

What is the difference between the numbers visiting Paris and Rome in 2006, to the nearest thousand?
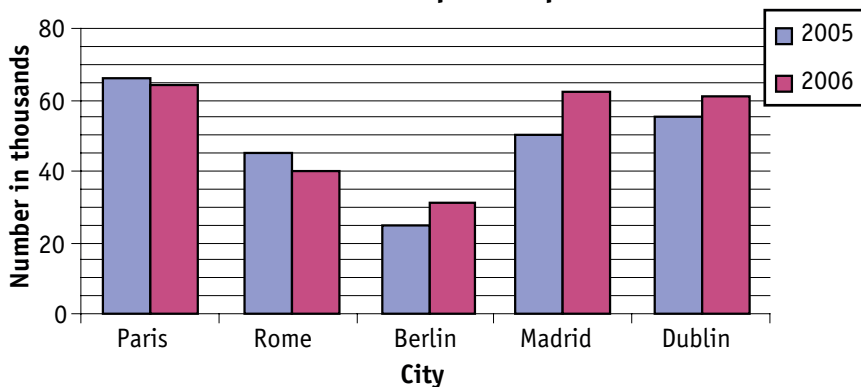
A ☐ 22 500
B ☐ 25 000
C ☐ 63 000
D ☐ 61 000

3. Which city showed the highest increase in visitors from 2005 to 2006?

A ☐ Rome

B ☐ Berlin

C ☐ Madrid

D ☐ Dublin

4. The graph shows the sales for a shop in one year.

Monthly sales

Which of these statements about the graph is correct?

A ☐ the value of photocopying sales is lower than computer sales every month

B ☐ the value of the stationery sales is higher than photocopying sales every month

C ☐ the value of all sales fell and rose again in April and August

D ☐ the value of all sales increased in June and November

5. The heights of 30 sunflowers were recorded. The results are shown in this table.

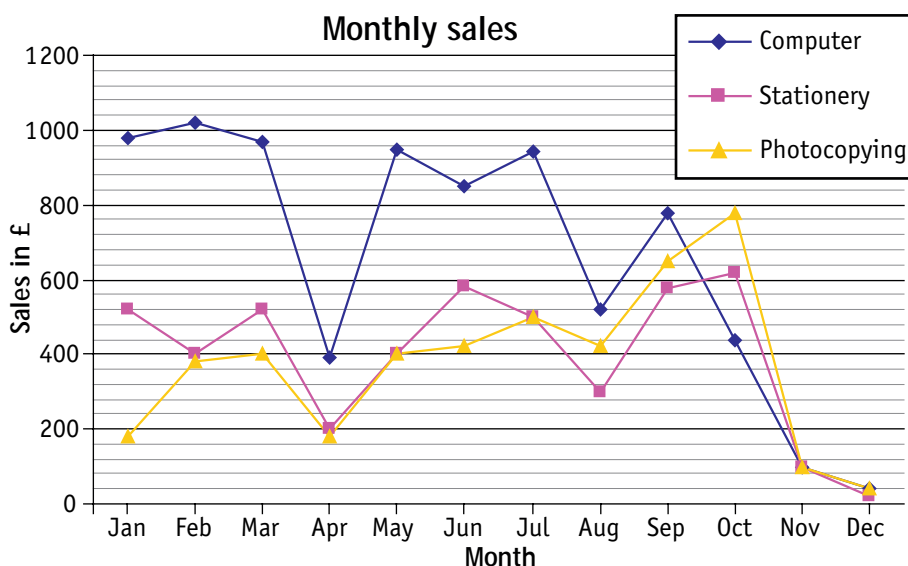| Height (cm)	13–15	16–18	19–21	22–24	25–27	28–30
Frequency	1	2	11	10	5	1

Which of these is the best way to present this information?

A ☐ line graph

B ☐ bar chart

C ☐ scatter graph

D ☐ pie chart

6. A company's profits for the first four months in 2006 are shown in the table.

Month	Jan	Feb	March	April
Profit (£)	1 790	1 840	1 735	1 720

The information is presented in a bar chart.

Company profit per month
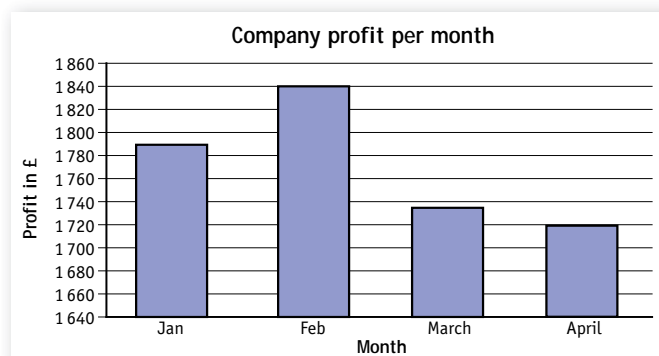
Why is this bar chart misleading?

A ☐ The title is incorrect.

B ☐ The axis labels are incorrect.

C ☐ The vertical scale does not start at zero.

D ☐ Some of the bars are incorrect.

Pilot material only – see introduction before use

J Working with averages

You should already know how to:

✔ find the mean and range for a set of data.

By the end of this section you will know how to:

▶▶ find the mean, median and mode and use them to compare two sets of data

▶▶ find the range and use it to describe the spread within sets of data.

---

1 Mean

Learn the skill

▷ An **average** is a value that is used to represent a set of data.

The **mean** of a set of data is the most widely used average.

▷ Mean = $\dfrac{\text{sum of values}}{\text{number of values}}$

Example 1: A student scores the following marks in her maths tests:
75% 77% 75% 48% 73% 80% 76%
Her friend has a mean mark of 75%. What is the difference between their mean marks?

Student's mean mark

$= \dfrac{75 + 77 + 75 + 48 + 73 + 80 + 76}{7} = \dfrac{504}{7} = 72\%$

Difference between the student's mean and her friend's mean

$= 75 - 72 = 3\%$

Answer: 3%

You can also work out the **mean** of the data in a **frequency distribution table**.

Example 2: The table shows the number of pets owned by the occupiers of 25 houses in a street.

What is the mean number of pets per house?

mean = $\dfrac{\text{total number of pets}}{\text{total number of houses}}$

To work out the total number of pets, look at each category.

4 houses had 0 pets, this is 4 × 0 = 0 pets in total.

x	f
Number of pets	Number of houses
0	4
1	7
2	9
3	3
4	2
5	0

Tip
An average gives a 'typical value' for the data.

Tip
The mean may not work out to be one of the actual data values. Here, 72% is not one of the student's test scores.

Tip
Create an fx column by multiplying each of the x values by the corresponding f value. Then mean = $\dfrac{\Sigma fx}{\Sigma f}$
Σ means 'sum of'.

Pilot material only – see introduction before use

7 houses had 1 pet, this is 7 × 1 = 7 pets in total …

The total number of pets

= 4 × 0 + 7 × 1 + 9 × 2 + 3 × 3 + 2 × 4 + 0 × 5

=   0   +   7   +   18   +   9   +   8   +   0   = 42

The total number of houses is the sum of the frequencies = 25

Mean = $\frac{42}{25}$ $\overset{\times 4}{\underset{\times 4}{=}}$ $\frac{168}{100}$ = 1.68

Answer: 1.68

⏩ Try the skill

1. The heights of four boys are 151 cm, 154 cm, 162 cm and 153 cm. What is the mean height of the boys?

2. A man's journey times to work one week were 14 minutes, 18 minutes, 21 minutes, 13 minutes and 19 minutes. What was his mean journey time for the week?

3. Five friends save £12, £10, £15, £11 and £16 respectively in a month. The following month, the mean amount the friends save is £13.40. What is the difference in the mean amounts of money saved for the two months?

4. A student has a mean test result of 65% for her first five tests. She scores 71% in the next test. What is her mean test result for all six tests?

5. The table gives the ages of students on a Diploma course.

Age in years	Number of students
16	4
17	8
18	12
19	10
20	2

What is the mean age of the students on the course?

2 Median and mode

▷ The **mode** of a set of data is the value that occurs most often.

▷ The **median** of a set of data is the middle value when the data values are placed in order.

Tip

mode = most often
median = middle

To find the position of the median value in a set of data add 1 to the number of values and divide by 2.

If the number of values is n, then median = $\frac{(n+1)^{th}}{2}$ value

Example 1: A student sits seven maths tests. Her marks for the tests are 75%, 77%, 75%, 48%, 73%, 80% and 76%.
The student sits another test and scores 78%.
a What is her modal mark?
b What is her median mark for the eight tests?

a The modal mark, or mode = 75%

Answer: 75%

b The test marks for the eight tests, in order, are:

↓
48%, 73%, 75%, 75%, 76%, 77%, 78%, 80%

As there are eight test marks the median is in the $\frac{8+1}{2}$ = 4.5th position.

So the median test mark is the mean of the 4th and 5th marks, 75% and 76%.

Median mark = $\frac{75+76}{2}$ = 75.5%

Answer: 75.5%

Tip

Remember to place the data in order to find the median.

Tip

If there is an even number of values, the median will not be one of the actual data values. The mode will always be one of the data values.

You can also work out the **median** and **mode** of data in a **frequency table**.

Example 2: The table shows a group of students' marks scored out of 6 in a test.
a What is the modal mark?
b What is the median?

Mark	Number of students
0	0
1	2
2	1
3	5
4	3
5	4
6	4

a The modal mark is the mark with the highest frequency.

The highest frequency is 5 so the modal mark is 3.

Answer: The modal mark is 3.

b There are 19 values.

The median is the $\frac{(19+1)^{th}}{2}$ value = 10th value.

This is in the category where the mark is 4.

Answer: The median is 4.

1. The number of chocolates in 7 tubes of Smarties was counted: 45, 46, 46, 45, 47, 48, 45.

   a What is the median number of Smarties in a tube?

   _____

   b What is the modal number of Smarties?

   _____

2. A survey of petrol prices recorded the following prices in pence per litre for unleaded petrol:

103.9	107.9	106.9	107.9	107.9	104.9	103.9
107.9	103.9	109	107.9	107.9	105.9	106.9

   a What is the median price of petrol in pence per litre?

   _____

   b What is the modal price of petrol in pence per litre?

   _____

3. The table shows the number of letters received by 40 households in one particular day.

   a What is the median number of letters received?

   _____

   b What is the modal number of letters received?

   _____

Number of letters	Number of households
0	1
1	5
2	9
3	15
4	8
5	2

4. The table shows the results of a survey into the number of parking tickets people had received in a city centre.

   a What is the median number of parking tickets for:

      i men _____

      ii women? _____

   b What is the modal number of parking tickets received for:

      i men _____

      ii women? _____

   c Use your answers to compare parking in the city centre by men and women.

   _____

   _____

Number of tickets	Men	Women
0	2	3
1	3	11
2	10	5
3	4	1
4	1	0

Tip

In a grouped frequency table, the interval with the highest frequency is called the 'modal class'. For example:

Mark	Frequency
1 – 10	2
11 – 20	8
21 – 30	12
31 – 40	10
41 – 50	5

Modal class is 21 – 30 marks as this has highest frequency of 12.

Tip

Remember that the mode is one of the values, either 0, 1, 2, 3 or 4, **not** the frequency.

3 Using averages and the range

📙 Learn the skill

You should choose the best average to use to represent data.

The table gives the pros and cons of each average:

Average	Advantages	Disadvantages
Mean	Takes all the data values into account	Is affected by extreme values
Median	Is not affected by extreme values	Does not take all the data values into account
Mode	Is not affected by extreme values	Does not take all the data values into account

Here are some common ways each average is used:

■ To find the typical number of goods produced per month in a factory, the **mean** is often the best average to use.

■ To find the most typical salary in an office, the **median** is often the best average to use, as it will not be affected by a few high wages.

■ For a clothes shop wanting to reorder stock, the **mode** is often the most useful average, as it will identify the items that are most likely to sell.

Test tip

You may be asked to **compare** sets of data using average values.

The **range** is a measure of the spread of the data. The range of a set of data is the difference between the highest value and the lowest value.

Tip

The bigger the range, the more spread out the data values are.
The smaller the range, the more consistent the results.

▷ Range = highest value – lowest value

Example 1: What is the range for this student's test marks?
75%   77%   75%   48%   73%   80%   76%

The highest mark is 80% and the lowest mark is 48%.

Range = 80 – 48 = 32%

Answer: 32%

⏩ Try the skill

1. The numbers of cars per hour driving through a village during daylight hours in a two-week period were:
    12, 11, 12, 13, 15, 10, 14, 17, 16, 7, 9, 15, 12, 11.

    Find:
    a the median _____
    b the mode _____
    c the range _____

2. A student records the number of cars of different colours in a car park. The results are shown in the bar chart. What is:

a the modal colour of car

_____

b the range in the number of cars of each colour?

_____

3. Which of mean, median or mode is the best average to use in these situations?

a Witnesses to a robbery gave statements about the number of thieves who took part. Their answers were: 1, 2, 2, 3, 3, 3, 3.

_____

b Students were asked how long they spent watching TV at the weekend. Their answers, in hours, were: 3, 4, 3, 4, 4, 5, 10, 4, 3.

_____

c A manufacturer wants to know the typical number of sweets in a packet. Six packets had 102, 103, 104, 101, 102 and 105 sweets respectively.

_____

Cars in a car park

(bar chart: White 6, Black 4, Red 10, Blue 8, Silver 15, Green 2, Other 5; y-axis 0 to 16; x-axis labelled Colour)

Tip

There may be more than one possible answer.

4. The range in the weights of the male babies in a nursery is 1.8 kg. The range in the weights of the female babies is 0.7 kg. Decide which of these statements is correct.

A Male babies are heavier than female babies.

B The weights of male babies are more varied than the weights of female babies.

C The heaviest male baby weighed more than the heaviest female baby.

_____

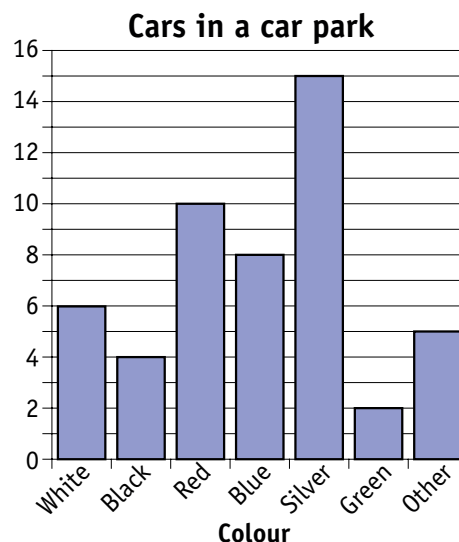**5.** A researcher counted the number of peas in pods, as shown in the table.

Calculate:

a the mean _____

_____

b the median _____

c the mode _____

d the range _____

of the number of peas in a pod.

Number of peas	Number of pods
3	6
4	9
5	25
6	40
7	20

4 Remember what you have learned

First complete this …

▷ An _____ is a value that is used to represent a set of data.

▷ _____ = $\dfrac{\text{sum of values}}{\text{number of values}}$

▷ The _____ of a set of data is the middle value when the data are placed in order.

▷ The _____ of a set of data is the value that occurs most often.

▷ _____ = highest value − lowest value.

Use the skill

1. A baby's birth weight was 3.4 kg. In the tenth week, the baby weighed 5.3 kg.

   What was the baby's mean weight gain per week?

A		0.19 kg
B		0.53 kg
C		0.87 kg
D		1.9 kg

2. The table shows the mean monthly temperatures in England and Wales, in 2004 and 2005, in degrees Celsius.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2004	4.9	5.1	6.2	9.2	11.7	15.1	15.5	17.1	14.4	10.4	7.5	5.3
2005	5.7	4.0	6.8	8.6	11.0	15.1	16.3	15.9	14.8	12.7	6.0	4.3

   What was the mean temperature for the year in 2004, to one decimal place?

A		9.8 °C
B		15.3 °C
C		10.2 °C
D		12.3 °C

3. What is the difference in the range of temperature in England and Wales for 2004 and 2005?

A		0.1 degrees
B		0.2 degrees
C		0.3 degrees
D		0.5 degrees

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4. A café manager recorded the number of different flavour packets of crisps sold in one particular week. The results are recorded in the table below:

	Ready Salted	Cheese & Onion	Salt & Vinegar	Smoky Bacon	Total
Monday	11	16	12	5	44
Tuesday	8	6	5	3	22
Wednesday	12	18	11	4	45
Thursday	9	17	8	2	36
Friday	20	8	6	1	35
Total	60	65	42	15	182

What is the mean number of sales of cheese and onion crisps per weekday?

A ☐ 3
B ☐ 8
C ☐ 12
D ☐ 13

5. Using the data from question 4, what is the range in the number of different flavour packets of crisps sold on Wednesday?

A ☐ 11
B ☐ 14
C ☐ 15
D ☐ 19

6. The marks out of 25 for twenty students in a test are as follows: 19, 6, 20, 21, 18, 22, 12, 15, 19, 13, 15, 11, 10, 8, 14, 21, 20, 5, 16, 12.

What is the median mark?

A ☐ 14
B ☐ 15
C ☐ 15.5
D ☐ 16

7. Fifty people were surveyed about the maximum amount they would be prepared to spend on a holiday.

The table shows the results.

What is the mean amount the people surveyed would be prepared to spend on a holiday?

Amount of money	Number of people
£5 000	2
£4 000	4
£3 000	6
£2 500	12
£2 000	16
£1 500	10

A ☐ £2420
B ☐ £2500
C ☐ £2750
D ☐ £3000

8. Sixty people were surveyed about the number of pieces of fruit or vegetables they had eaten the previous day. The results are recorded in the table below:

Number of pieces of fruit or vegetables	0	1	2	3	4	5	6
Number of people	2	4	6	10	8	22	8

What is the modal number of pieces of fruit or vegetables eaten by the people surveyed?

A ☐ 3
B ☐ 5
C ☐ 8
D ☐ 22