

Statistical charts and scatter diagrams

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Read first: [Fractions, decimals, ordering and the four operations](#), [Averages and measures of spread](#)

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What you need to know

The Core and Extended syllabuses are the same for this topic. By the end of it you should be able to draw and interpret:

1. **Bar charts**, including **dual** bar charts (two bars side by side for each category) and **composite** or stacked bar charts (one bar split into parts).
2. **Pie charts**: work out sector angles from frequencies, draw the sectors with a protractor, and turn angles back into frequencies, fractions or percentages.
3. **Pictograms**: use the key, including parts of a symbol.
4. **Stem-and-leaf diagrams**, with the leaves in order and a key.
5. **Simple frequency distributions**: tally tables and frequency tables.
6. **Scatter diagrams**: plot points (as small crosses), and describe what the pattern shows.
7. **Correlation**: know what positive, negative and zero correlation mean.
8. **Lines of best fit**: draw one by eye as a single ruled straight line, and use it to estimate one value from another.

Finding the mean, median, mode and range from these charts is in the note on averages and measures of spread. Histograms and cumulative frequency diagrams have their own note.

Understand it

Tally charts and frequency tables

A **frequency** is how many times something happens. To count a list of results, go through it once, in order, and make a tally mark for each result in its row. Draw marks in **gates** of five: four upright strokes and the fifth across them, so the counts are easy to add up. Then write each total in the frequency column and check the frequencies add up to the number of results.

Fruit	Tally	Frequency
Apple		7
Banana		9
Mango		5
Orange		4
Total		25

A frequency table is a **simple frequency distribution**: it shows how the results are spread over the categories. Every chart below is just a different picture of a table like this one.

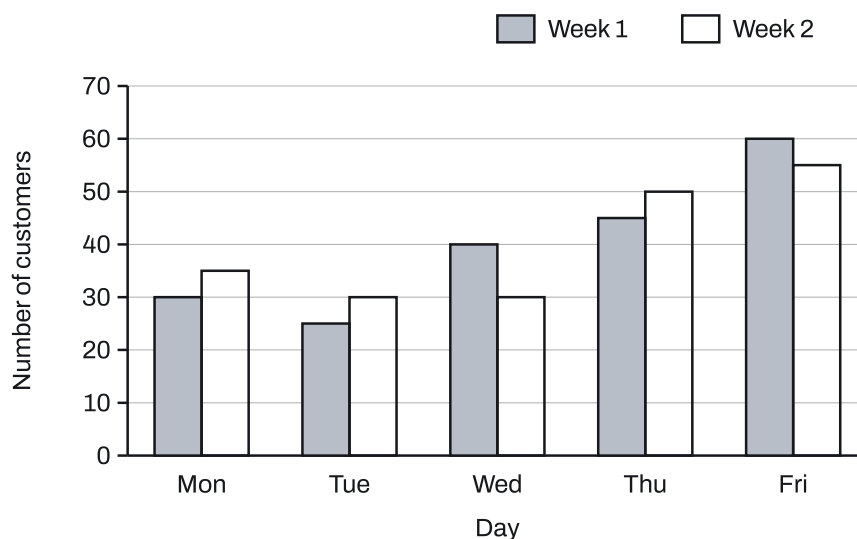
Bar charts

A bar chart shows each category as a bar whose **height** is its frequency. A good bar chart has:

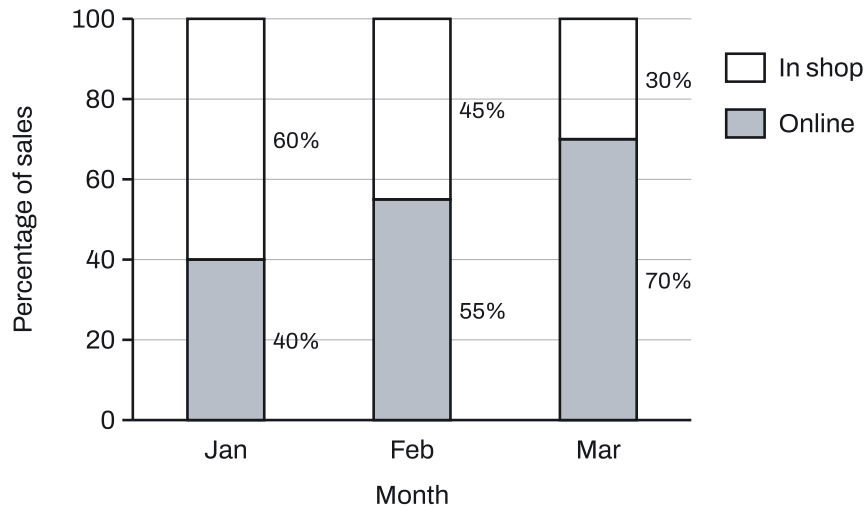
- bars of **equal width** with **equal gaps** (for categories such as colours or days);
- a frequency axis with a **linear scale** starting at 0 (equal steps for equal numbers);
- both axes labelled.

To draw a bar, find its value on the frequency axis and rule the top of the bar at that height. To read one, go across from the top of the bar to the scale, and work out what each small square is worth first (on a scale where 10 is five squares, one square is 2).

A **dual bar chart** puts two bars side by side for each category, with a **key**, so two groups can be compared category by category.



A **composite** (stacked) bar chart splits each bar into parts. Often each bar is 100% tall and the parts are percentages, so you can compare proportions. In the chart below, 70% of March's sales were online and the rest, $100\% - 70\% = 30\%$, were in the shop. If the shop's sales in March were \$2 million, the shop part was 30% of \$2 million, which is $0.3 \times 2 = 0.6$, so \$0.6 million.

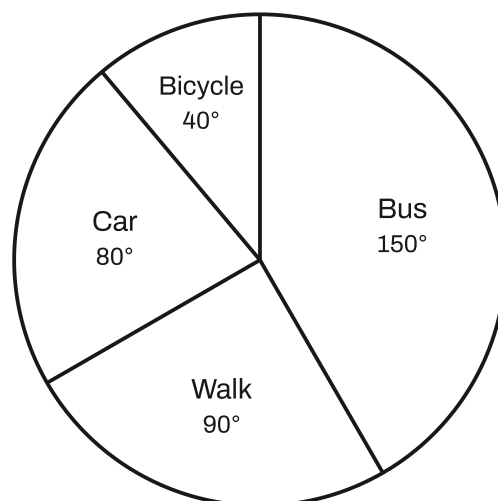


Pie charts

A pie chart shows how a whole is shared out. The whole circle, 360° , stands for the total frequency, so each item gets the same share of 360° :

$$\text{sector angle} = \frac{\text{frequency}}{\text{total frequency}} \times 360^\circ.$$

For 72 students, one student is worth $360 \div 72 = 5^\circ$. So 30 bus users get $30 \times 5 = 150^\circ$, and 18 walkers get 90° .



Drawing it: draw a radius (usually straight up from the centre). Put the protractor's centre on the centre of the circle and its zero line on the radius, measure the first angle and draw the next radius. Measure each new angle from the line you just drew. The last sector is whatever is left, so check it measures what you worked out. Label every sector.

Reading it backwards: a sector is the same fraction of the circle as its group is of the total:

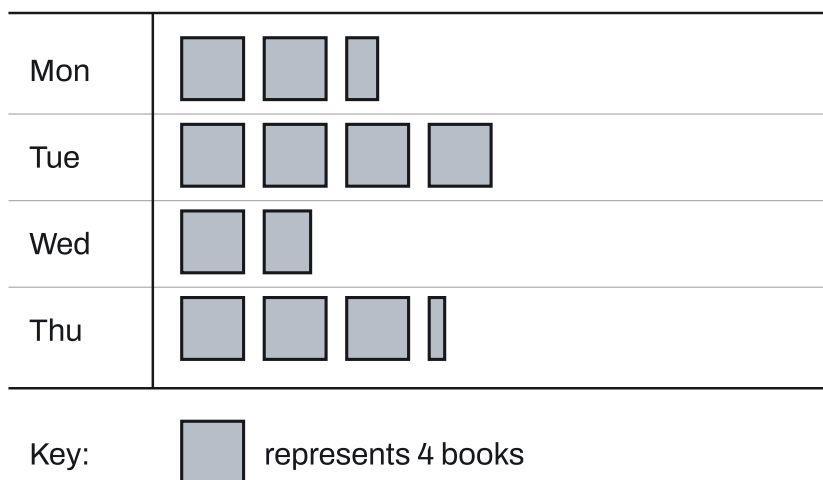
$$\text{frequency} = \frac{\text{angle}}{360^\circ} \times \text{total}, \quad \text{fraction} = \frac{\text{angle}}{360^\circ}, \quad \text{percentage} = \frac{\text{angle}}{360^\circ} \times 100\%.$$

A 90° sector is a quarter, 25%. If you know one sector's frequency and angle, you know how much each degree is worth: 15 people shown by 60° means $\frac{15}{60} = 0.25$ people per degree, so the whole pie is $360 \times 0.25 = 90$ people.

A pie chart shows **proportions**: which share is biggest. It does not show the actual numbers unless you are told the total. A bar chart shows the actual frequencies.

Pictograms

A pictogram uses a symbol for a fixed number of items, given by the **key**. A part of a symbol is that fraction of the key: with one square for 4 books, half a square is 2 books and a quarter is 1 book.



Monday is $2\frac{1}{2} \times 4 = 10$ books. To draw 13 books you need $13 \div 4 = 3\frac{1}{4}$ squares.

Stem-and-leaf diagrams

A stem-and-leaf diagram keeps every value but groups them. Each value is split into a **stem** (for two-digit numbers, the tens digit) and a **leaf** (the last digit). The **key** shows how to join them again. For the ages 23, 31, 18, 27, 35, 22, 19, 30, 26:

Stem	Leaves
1	8 9
2	2 3 6 7

Stem	Leaves
3	0 1 5

Key: 2 | 3 represents 23 years.

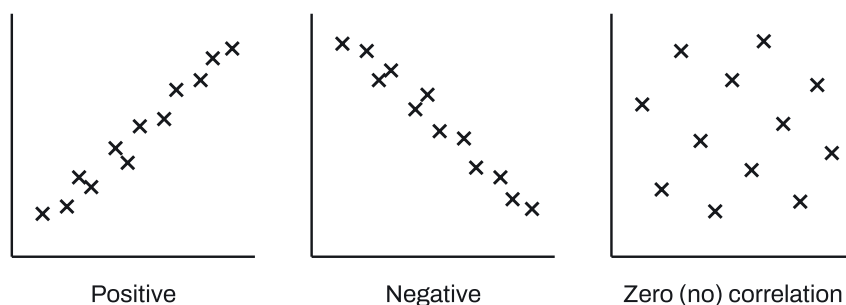
The leaves are **single digits** in **order**, smallest next to the stem, and lined up in columns so the rows' lengths act like a bar chart on its side. For decimals the stem can be the whole number: a key 2 | 7 represents 2.7 kg.

Scatter diagrams and correlation

A scatter diagram compares **two** measurements taken from each person or thing, such as hours of revision and test score. Each pair is one point, (x, y) , marked with a small cross.

Correlation describes the pattern:

- **Positive correlation:** as one quantity increases, the other tends to increase. The points go up from left to right.
- **Negative correlation:** as one increases, the other tends to decrease. The points go down from left to right.
- **Zero (no) correlation:** there is no pattern; knowing one value tells you nothing about the other.



You can describe correlation from a sentence too: "the higher the temperature, the fewer hot drinks sold" is negative correlation.

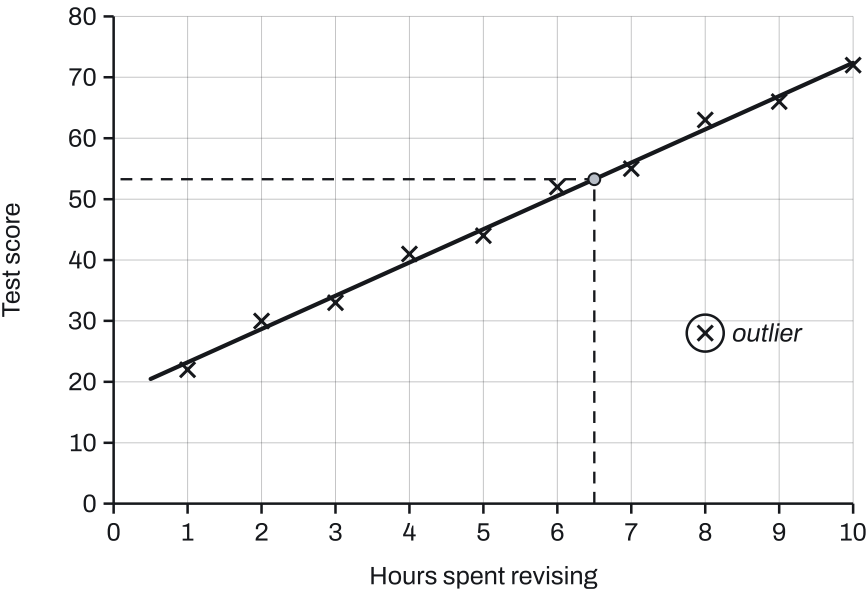
Lines of best fit

When there is correlation, a **line of best fit** sums up the trend. Draw it **by eye**:

- a single **ruled straight** line, not a curve and not dot-to-dot;
- it follows the direction of the points and runs across the whole spread of the data;
- it need not go through any particular point (nor through the origin), but about as many points should lie above it as below, all along its length.

To **estimate** from the line, go from the value you know to the line, then across (or down) to the other axis. Both directions are asked.

A point far from the rest of the pattern is an **outlier**. For a question such as "which score was lower than expected", find the point well **below** the trend.



Key facts and formulas

None of these is on the List of formulas printed in the exam paper, so you must know them all.

Formula	Status
Sector angle = $\frac{\text{frequency}}{\text{total}} \times 360^\circ$	Learn it
Frequency = $\frac{\text{angle}}{360^\circ} \times \text{total}$	Learn it
Total = frequency $\div \frac{\text{angle}}{360^\circ} = \frac{\text{frequency}}{\text{angle}} \times 360^\circ$	Learn it
Percentage of the whole = $\frac{\text{angle}}{360^\circ} \times 100\%$	Learn it
The angles in a pie chart add up to 360° ; the parts of a composite percentage bar add up to 100%	Learn it
Missing frequency = total – sum of the other frequencies	Learn it
Pictogram value = number of symbols $\times$ key	Learn it
Positive correlation: both increase; negative: one increases as the other decreases; zero: no pattern	Learn it

How to do it

We have tagged 83 different questions on this topic from Papers 1–4, 2021–2025 (89 counting questions repeated on two papers). The types came up this often. 38 of the 83 questions mix two or more types, so the counts add up to more than 83.

Question type	Questions
Calculate pie chart sector angles and draw or complete a pie chart	24
State the type of correlation or describe the relationship	23
Plot points, draw a line of best fit and estimate from it	18
Complete or read a stem-and-leaf diagram	18
Read, complete or draw a bar chart (including dual and composite)	17
Read a pie chart: find a frequency, total, fraction or percentage	14
Criticise, compare or explain charts in words	7
Complete a tally or frequency table	6
Identify an outlier on a scatter diagram	5
Read or complete a pictogram	4

1. Calculate sector angles and draw or complete a pie chart (24 questions)

1. **Find the total** if it isn't given: add the frequencies.
2. **Work out each angle:** $\frac{\text{frequency}}{\text{total}} \times 360$. It is often quicker to find $360 \div \text{total}$ (degrees per person) once and multiply.
3. **Check** the angles add up to 360° .
4. **Draw** each sector from the last line you drew, with the protractor centred on the centre of the circle. Label every sector with its name.

Variations you will meet:

- **A table with a "sector angle" column** to complete first, then the pie chart.
- **Some sectors already drawn.** Measure or read them, draw only the missing ones, and check the last one is what is left of 360° .
- **"The rest" category.** Find its frequency by subtraction (total minus the others), or its angle as 360° minus the other angles.
- **The total comes from somewhere else:** another chart, or a percentage (for example 60% of the circle is $0.6 \times 360 = 216^\circ$).
- **A single angle** on its own: for example, 3 blue cars out of 20 need $\frac{3}{20} \times 360 = 54^\circ$.

2. State the type of correlation or describe the relationship (23 questions)

1. Look at the overall direction of the points, ignoring any single odd point.
2. Answer with one word: **positive**, **negative** or **zero** (none). You don't need "strong" or "weak".

Variations you will meet:

- **From a sentence**, with no diagram: "as the temperature increases, more people swim" is **positive**; "fewer bowls of soup are sold when it is hotter" is **negative**.
- **"Describe the relationship"** wants a sentence **in context** using both quantities: "the higher the temperature, the more people on the beach". Just "positive" does not answer it.
- **Choose the correct statement** from several, or say whether a claim about the diagram is true and why.

3. Plot points, draw a line of best fit and estimate from it (18 questions)

1. **Read the scale** on both axes before plotting: work out what one small square is worth (for example \$0.01 when five squares are \$0.05).
2. **Plot** each new point as a small cross exactly at (x, y) . The first value in the table goes on the axis it belongs to; check the axis labels.
3. **Draw the line of best fit**: one ruled straight line along the trend, across the full range of the points, with points spread evenly on both sides. Don't force it through the origin or through the first and last points.
4. **Estimate**: draw a line from the known value to your line of best fit, then to the other axis, and read the value. Mark schemes accept a range of answers, and follow your own line if it slopes the right way.

Variations you will meet:

- **Either axis can be the one you know**. Given a y -value, go across to the line, then down to the x -axis.
- **Read or count points**: the value for one point, or how many points are below a given value (read the scale carefully: \$53 000 on a scale in thousands of dollars is 53).
- **Choose the best line** from several drawn: the one that follows the trend with points balanced either side.
- **Large scales**: a value such as \$54 000 on a grid with steps of \$10 000 lies $\frac{4}{10}$ of the way from 50 000 to 60 000.

4. Complete or read a stem-and-leaf diagram (18 questions)

1. **Read the key** to see what a stem and a leaf stand for.
2. **Cross each value off** the list as you place it, so none is missed or used twice. Count: the number of leaves must equal the number of values.
3. **Put the leaves in order** in each row, smallest first, one digit per leaf, spaced evenly. Write the key if the question asks for it.
4. **Read the diagram** by counting leaves: how many values are above or below a value, the mode (most common value), or the range (last value minus first value).

Variations you will meet:

- **Decimal data**: a key such as $0 \mid 3$ represents 0.3 kg, so the stem is the whole number and the leaf is the tenths digit.
- **Units change**: "over 2 years old" with ages in months means over 24 months.

- **The median** from the diagram: with n values, the median is the $\frac{n+1}{2}$ th value, counted along the ordered leaves. With an **even** number of values it falls between two: with 12 values it is halfway between the 6th and 7th, so if they are 12 and 13 the median is $\frac{12+13}{2} = 12.5$. For "show that", write down both middle values and the calculation.
- **Missing values** from given facts, such as the range or the lowest score needed for the top 75%.

5. Read, complete or draw a bar chart (17 questions)

1. **Read each bar** carefully against the scale.
2. **For a missing bar**, find its value first, usually total — (sum of the other bars), or from a ratio. Then draw it with the same width and gap as the others, to the right height.
3. **For a whole chart**, choose a linear frequency scale starting at 0, label both axes, and make the bars equal widths with equal gaps.
4. Answer the follow-on: a difference, the mode (tallest bar), the mean (total $\div$ number of bars), a fraction or a percentage.

Variations you will meet:

- **Dual bar chart**: use the key to tell the two groups apart, and draw a missing bar in the right position with the right shading.
- **Composite percentage bar chart**: draw the bar by marking the split at the right percentage; each part's value is that percentage of the bar's total (for example 40% of \$3.5 million is \$1.4 million).
- **Grouped classes** such as "1 to 20", "21 to 40": the bars stand for groups of values, not single values.

6. Read a pie chart: find a frequency, total, fraction or percentage (14 questions)

1. **Measure** the angle with a protractor if it isn't marked (to the nearest degree).
2. **Frequency** = $\frac{\text{angle}}{360} \times \text{total}$. For "show that", write this calculation out in full.
3. **Fraction** = $\frac{\text{angle}}{360}$ in its simplest form; **percentage** = $\frac{\text{angle}}{360} \times 100$.

Variations you will meet:

- **Total from one sector**: 45 people shown by 120° means the total is $\frac{45}{120} \times 360 = 135$.
- **Using a difference**: "45 more people chose wind than rain" with sectors 95° and 80° . The difference, 15° , stands for 45 people, so each degree is 3 people. Then find what the question asks, for example another sector's frequency (angle $\times$ 3).
- **Ratio of two sectors** is the ratio of their angles.

7. Criticise, compare or explain charts in words (7 questions)

- **What is wrong with this bar chart?** Look for bars of different widths, uneven gaps, a frequency scale that is not linear (unequal steps) or does not start at 0, and missing axis labels. Give each reason as a separate clear statement.

- **Advantage of a bar chart over a pie chart:** you can read the actual frequencies from a bar chart; a pie chart only shows each group's share of the whole.
- **Compare two distributions:** make two different comments, such as one about an average and one about the range, in context ("week 2 had a higher mean number of customers").
- **Explain without calculating:** if one category gets more people, the total changes, so **every** sector angle changes, not just that one.

8. Complete a tally or frequency table (6 questions)

1. Go through the data **in order**, making one tally mark per result and crossing the result off.
2. Group marks in gates of five.
3. Write each total in the **frequency** column (not in the tally column), and check they add up to the number of results.

Variation: a missing row from a total, for example days not open = 30 – days open.

9. Identify an outlier on a scatter diagram (5 questions)

1. Find the trend (or picture the line of best fit).
2. Ring the **one** point that is furthest from it in the direction the question describes: "less than expected" or "cheaper than expected" is well **below** the trend; "more than expected" is well **above**.

10. Read or complete a pictogram (4 questions)

1. Use the key: count whole symbols, then add the part symbols (half a symbol is half the key).
2. For a missing row, find its frequency (often total minus the other rows), divide by the key and draw that many symbols, with a clear part symbol for any fraction.

Worked examples

The bold codes show where marks are earned, as in Cambridge mark schemes. The number is how many marks.

- **M1** method mark: for a correct method, even if the numbers slip.
 - **A1** accuracy mark: for a correct answer; it needs the M mark before it.
 - **B1** mark for a correct result on its own, with no method needed.
-

Example 1

Sixty people choose their favourite drink.

Drink	Tea	Coffee	Juice	Water
Frequency	21	15	9	15

(a) Work out the sector angle for each drink. [2]

(b) Draw the pie chart. [2]

(c) In a pie chart for a different group of people, the sector for water is 72° and represents 30 people. How many people are in this group? [2]

(a) Each person is worth $360 \div 60 = 6^\circ$. **M1** for $\frac{\text{frequency}}{60} \times 360$ with any frequency.

Tea $21 \times 6 = 126^\circ$, coffee $15 \times 6 = 90^\circ$, juice $9 \times 6 = 54^\circ$, water $15 \times 6 = 90^\circ$. **A1**

Check: $126 + 90 + 54 + 90 = 360$.

(b) Draw a radius, then measure 126° , 90° and 54° in turn, each from the last line drawn; the last sector should measure 90° . Label each sector. **B2** for a fully correct, labelled pie chart (**B1** for at least one correct sector).

(c) 30 people are shown by 72° , so the whole group is

$$\frac{30}{72} \times 360 = 150 \text{ people.}$$

M1 for $\frac{30}{72} \times 360$ or $30 \div \frac{72}{360}$, **A1** for 150.

Example 2

These are the masses, in kg, of 14 parcels.

1.2 3.4 2.7 0.9 1.8 2.3 3.1 1.5 2.7 0.6 2.0 1.1 3.6 2.9

(a) Complete an ordered stem-and-leaf diagram, with the key $1 \mid 5$ represents 1.5 kg. [2]

(b) How many parcels have a mass of more than 2.5 kg? [1]

(c) What fraction of the parcels have a mass of more than 2.5 kg? Give your answer in its simplest form. [1]

(d) Write down the mode. [1]

(a)

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

Key: 1 | 5 represents 1.5 kg. Check: $2 + 4 + 5 + 3 = 14$ leaves. **B2** (**B1** for one error, or for a correct diagram with the leaves not in order).

(b) 2.7, 2.7, 2.9, 3.1, 3.4, 3.6: **6** parcels. **B1**

(c) $\frac{6}{14} = \frac{3}{7}$. **B1**

(d) 2.7 kg, the only value that appears twice. **B1**

Example 3

A cinema is drawing a bar chart of the number of tickets it sold on four days. The table gives the heights of the bars drawn so far. The bar for Saturday is missing.

Day	Thursday	Friday	Saturday	Sunday
Tickets sold	48	64	?	72

(a) The numbers of tickets sold on Saturday and Sunday are in the ratio 4 : 3. Work out the height of the bar for Saturday. **[2]**

(b) What percentage of the tickets for the four days were sold on Friday? Give your answer correct to 1 decimal place. **[2]**

(c) 40 of Sunday's tickets were for children and the rest were for adults. The cinema draws a dual bar chart with one bar for children and one for adults on each day. Write down the heights of Sunday's two bars. **[1]**

(a) Sunday's 72 tickets are 3 parts, so one part is $72 \div 3 = 24$ and Saturday is $4 \times 24 = 96$. **M1** for $72 \div 3 \times 4$, **A1** for 96. Draw the bar to height 96, the same width as the others and with an equal gap.

(b) Total = $48 + 64 + 96 + 72 = 280$. **M1** for $\frac{64}{280} \times 100$.

$$\frac{64}{280} \times 100 = 22.857 \dots = 22.9\% \text{ (1 d.p.)}$$

A1

(c) Children 40, adults $72 - 40 = 32$. **B1**

Example 4

The table shows the hours spent revising and the test score of 11 students.

Hours	1	2	3	4	5	6	7	8	8	9	10
Score	22	30	33	41	44	52	55	63	28	66	72

They are plotted on the last scatter diagram in "Understand it".

(a) What type of correlation does the diagram show? **[1]**

- (b) One student scored much less than expected for the time they spent revising. Ring this point. **[1]**
- (c) Draw a line of best fit. **[1]**
- (d) Use your line to estimate the score of a student who revises for 6.5 hours. **[1]**
- (e) Use your line to estimate how long a student who scored 60 revised for. **[1]**
- (a)** Positive: students who revise for longer tend to score higher. **B1**
- (b)** The point (8, 28): it is far below the trend of the others. **B1**
- (c)** One ruled straight line, from about (0.5, 20) to (10, 72), with the other points balanced on both sides. Ignore the outlier. **B1**
- (d)** Go up from 6.5 to the line and across: about 53. **B1** (a range such as 50 to 56 is accepted, following your line).
- (e)** Go across from 60 to the line and down: about 7.7 hours. **B1** (again a range, following your line).

Common mistakes

- **Using frequencies as angles.** A group of 30 people in a total of 72 is 150° , not 30° . Work out every angle before drawing, and check they add up to 360° .
- **Confusing degrees with percentages.** A 90° sector is 25%, not 90%. Divide by 360, not 100.
- **Forgetting the sectors already drawn.** When completing a pie chart, the last sector is 360° minus **all** the others, including the ones printed.
- **Drawing inaccurately.** Measure each angle from the line just drawn, with the protractor's centre on the circle's centre. An angle a few degrees out loses the mark.
- **Unordered or wrongly split stem-and-leaf diagrams.** Leaves must be single digits in order; writing "27" as a leaf, or leaving the rows unsorted, loses marks. Missing out one value is the other common slip: count the leaves.
- **Joining the dots on a scatter diagram,** or drawing a line that is too steep or too flat, or only across part of the data. A line of best fit is one ruled line along the middle of the whole cloud of points.
- **Words that aren't correlation types.** "Increasing", "direct" or "proportional" are not accepted: say **positive, negative or zero**.
- **Misreading scales.** Check what each small square is worth before plotting or reading, especially when the scale goes up in fives, 0.05s or thousands.
- **Counting pictogram symbols as whole ones.** A half symbol is worth half the key.
- **Writing frequencies in the tally column.** Tally marks go in the tally column; numbers go in the frequency column.

How to get the marks

- **Show the calculation** for each sector angle ($\frac{16}{90} \times 360$) or frequency ($\frac{120}{360} \times 90$). A method mark is given for one correct calculation even if later ones slip.
- **Drawing marks follow your angles.** If your angles are wrong but add up to 360° and are drawn accurately, you still get credit, so always draw what you calculated.
- **"Show that"** (for example "show that 75 students chose the museum") means writing the full calculation that leads to the given number.
- **Correlation** needs only the one word. **"Describe the relationship"** needs a sentence in context about both quantities.
- **Lines of best fit** must be ruled and straight; estimates are marked against a range and follow your own line, so draw it neatly and read it carefully.
- **Plotted points** are marked on position: a small cross exactly on the right spot.
- **Stem-and-leaf:** full marks need every value, in order, with the key if asked; one error still earns a mark.
- **"Give reasons"** or **"give one advantage"**: each reason should be a separate, specific statement ("the bars are different widths"), not a general comment such as "it is wrong".

Quick check

1. In a survey of 45 students, 12 chose swimming. Work out the sector angle for swimming in a pie chart.
2. "As the number of hours of sunshine increases, the number of umbrellas sold decreases." What type of correlation does this describe?
3. In a pictogram, one symbol represents 6 cars. (a) Tuesday has three and a half symbols. How many cars is this? (b) How many symbols show 15 cars?
4. Draw an ordered stem-and-leaf diagram, with a key, for 34, 51, 27, 45, 38, 52, 29, 41, 36, and find the range.
5. A pie chart shows how some people voted. The sector for Adam is 100° and the sector for Beth is 70° . 60 more people voted for Adam than for Beth. How many people voted in total?

Answers

1. $\frac{12}{45} \times 360 = 96^\circ$.
2. Negative correlation.
3. (a) $3.5 \times 6 = 21$ cars. (b) $15 \div 6 = 2.5$, so two and a half symbols.
4. Stem 2: 7 9; stem 3: 4 6 8; stem 4: 1 5; stem 5: 1 2. Key: 2 | 7 represents 27. Range = $52 - 27 = 25$.
5. The difference is $100^\circ - 70^\circ = 30^\circ$, which stands for 60 people, so 1° is 2 people. Total = $360 \times 2 = 720$ people.

Past questions to try

- **0580/31/O/N/25 Q12**: show a frequency from a pie chart, then complete it.
- **0580/23/O/N/25 Q6**: ring an outlier, plot a point, count points and state the correlation.
- **0580/31/M/J/25 Q1**: read and complete a pictogram.
- **0580/33/O/N/25 Q7**: give two reasons a bar chart is wrong.