Charts, diagrams and time series

S2, S4 · Statistics · revision notes

Reading, drawing and interpreting the charts and diagrams used for data: pictograms, bar charts, vertical line charts, two-way tables, pie charts, stem-and-leaf diagrams, frequency polygons and time series graphs. You also need to choose a suitable diagram and explain why a diagram is misleading. These questions come up on both tiers: often early on Foundation papers, and as pie chart comparison problems on Higher papers.

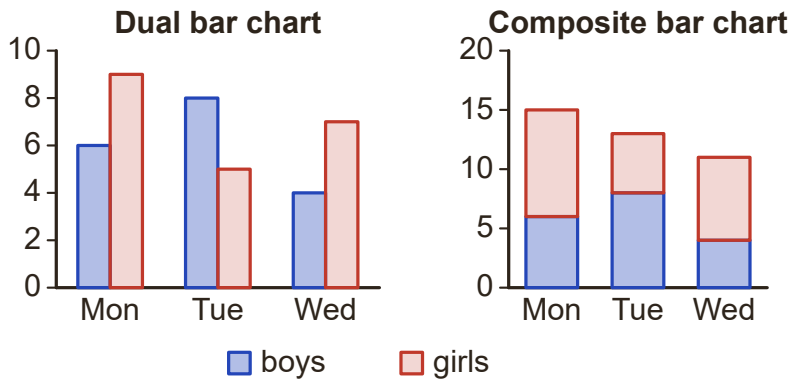
Key facts

- Angles in a pie chart add up to 360°
- Frequency from a pie chart = angle ÷ 360° × total
- Frequency polygon: plot (midpoint, frequency) and join with straight lines
- Time series: trend = general direction; seasonal pattern = repeats each year
- Sector angle = frequency ÷ total × 360°
- Midpoint of a class = (lower end + upper end) ÷ 2
- Stem-and-leaf: leaves in order, plus a key such as 3 | 7 = 37
- Bar chart: equal widths, equal gaps, frequency axis starting at 0

Notes

Charts for counts and categories

- A **pictogram** uses symbols to show frequencies. Read the key: if one symbol stands for 4 people, half a symbol stands for 2.
- A **bar chart** has bars of equal width with equal gaps, and a frequency axis that starts at 0.
- A **dual bar chart** puts bars for two groups side by side. A **composite bar chart** stacks the parts of each total in one bar.



Dual: side by side, to compare groups. Composite: stacked, so each bar shows the total too.

- A **vertical line chart** shows ungrouped discrete data, such as the number of goals in each match.
- In a **two-way table**, every row and every column adds up to its total.

Pie charts

- The angles in a pie chart add up to 360°.
- To draw one, find the angle for one item (360° ÷ total), then multiply it by each frequency.
- To read one, frequency = angle ÷ 360° × total.
- A pie chart shows **proportions**, not numbers. When two pie charts have different totals, a bigger angle does not mean a bigger number.

Stem-and-leaf diagrams

- The stem shows the first digit(s) and each leaf is the last digit of one value, e.g. the key 3 | 7 means 37.
- The leaves must be in order and you must give a key.

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

Key: 3 | 1 means 31 (leaves in order)

13 values: 15, 18, 20, 23, 23, 27, 31, 34, 36, 36, 39, 42, 45.

- Every value is kept, so you can find the median (the $\frac{n+1}{2}$th value), the mode and the range.
- A back-to-back diagram puts two groups either side of one stem, so you can compare them.

Frequency polygons and time series

- A **frequency polygon** plots each frequency at the **midpoint** of its class. Join the points in order with straight lines, but do not join the last point back to the first.
- A **time series graph** plots values in time order (e.g. every quarter) and joins the points with straight lines.
- The **trend** is the general direction: increasing or decreasing. A **seasonal pattern** repeats at the same time each year.

Choosing and criticising diagrams

- Categories: bar chart, pictogram or pie chart. Ungrouped discrete data: vertical line chart. Grouped data: frequency polygon. Data over time: time series graph.
- A diagram is misleading if the frequency axis does not start at 0, the scale is uneven, labels are missing, or a picture is enlarged in both height and width (so its area grows much faster than the number).

How to answer each type of question

M = method mark, A = answer mark, B = a mark on its own, C = a communication mark.

Draw a pie chart

3 marks **Grade 4**

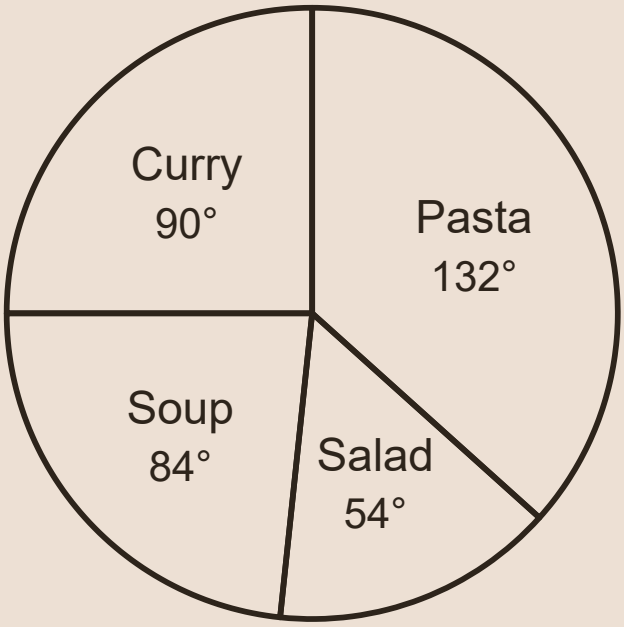
1. Add up the frequencies to find the total.
2. Work out 360° ÷ total: the angle for one item.
3. Multiply each frequency by this angle, and check that the angles add up to 360°.
4. Draw each sector accurately with a protractor and label it.

Example. 60 students each chose one lunch option. The table shows their choices.

Lunch	Frequency
Pasta	22
Salad	9
Soup	14
Curry	15

Draw an accurate pie chart for this information.

Model answer.



360 ÷ 60 = 6° for each student (M1)

Pasta 22 × 6 = 132°, Salad 9 × 6 = 54°, Soup 14 × 6 = 84°, Curry 15 × 6 = 90° (A1 for all four angles; check: 132 + 54 + 84 + 90 = 360)

A pie chart with all four sectors drawn to within 2° and labelled (C1)

Work out a frequency from a pie chart

2 to 3 marks | **Grade 4**

1. If an angle is not given, subtract the other angles from 360°.
2. Write the angle as a fraction of 360°.
3. Multiply this fraction by the total frequency.

Example. A pie chart shows how 240 people travel to work.
The angles of the sectors are: car 150°, walk 45°, train 60°. The rest of the pie chart is for bus.
Work out the number of people who travel to work by bus.

Model answer.

Bus angle = 360 − (150 + 45 + 60) = 105° (M1)

$$\frac{105}{360} \times 240$$ (M1)

= 70 people (A1)

Draw a frequency polygon

2 to 3 marks **Grade 4**

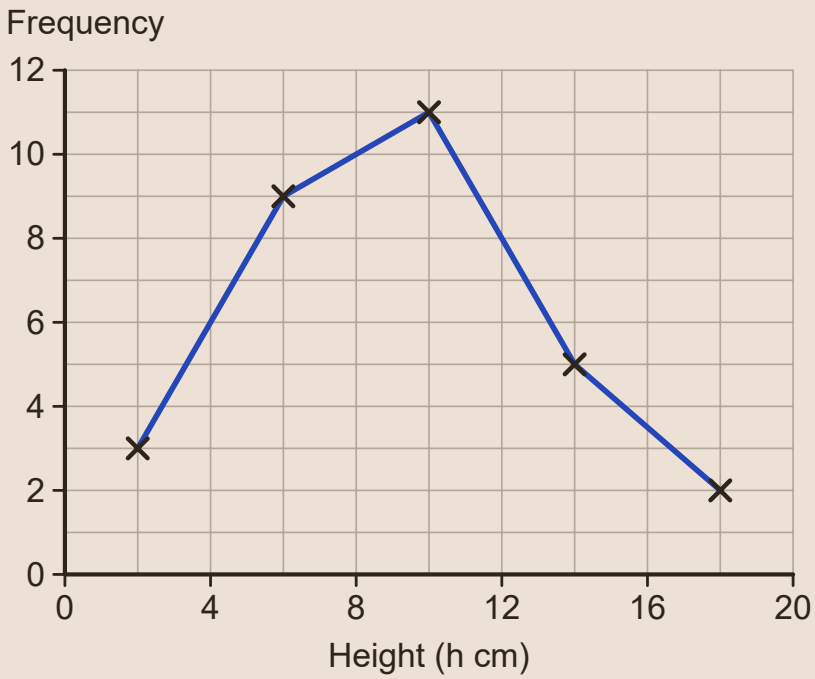
1. Work out the midpoint of each class.
2. Plot each point at (midpoint, frequency).
3. Join the points in order with straight lines, using a ruler.
4. If asked, the modal class is the class with the highest frequency.

Example. The table shows information about the heights, h cm, of 30 seedlings.

Height (h cm)	Frequency
$0 < h \leq 4$	3
$4 < h \leq 8$	9
$8 < h \leq 12$	11
$12 < h \leq 16$	5
$16 < h \leq 20$	2

(a) Draw a frequency polygon for this information.
(b) Write down the modal class.

Model answer.



(a) Points plotted at (2, 3), (6, 9), (10, 11), (14, 5) and (18, 2) (B1)

The points joined in order with straight lines (B1)

(b) $8 < h \leq 12$ (B1)

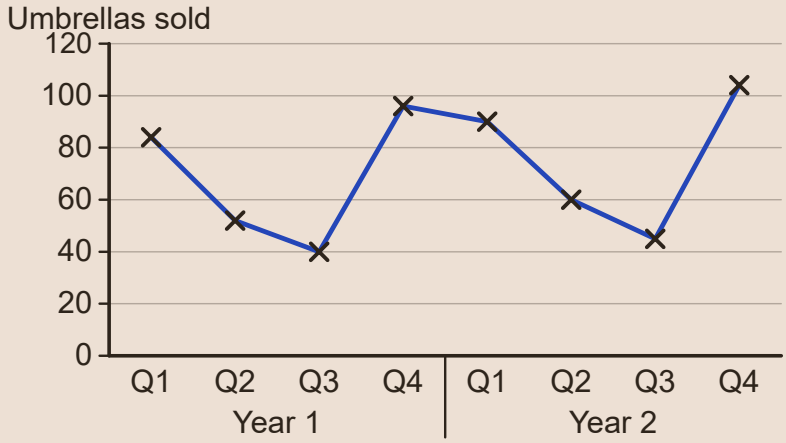
Describe a time series

1 to 3 marks **Grade 4**

1. For the trend, compare the same season in different years, or describe the overall direction.
2. For the seasonal pattern, say when the values are highest and lowest each year.
3. If asked for a reason, give one that fits the context.

Example. A shop records the number of umbrellas it sells in each quarter (Q1 is January to March).

	Q1	Q2	Q3	Q4
Year 1	84	52	40	96
Year 2	90	60	45	104



(a) Describe the trend in the sales.
(b) Describe the seasonal pattern and give a possible reason for it.

Model answer.

(a) The sales are increasing: every quarter in Year 2 is higher than the same quarter in Year 1 (B1)

(b) Each year the sales are highest in Q4 and lowest in Q3 (B1), for example because there is more rain in autumn and winter than in summer (C1)

Compare two pie charts with different totals 3 marks **Grade 5**

1. Do not compare the angles directly when the totals are different.
2. Work out the actual number for each pie chart: angle ÷ 360° × total.
3. Compare the numbers and give a clear conclusion that answers the question.

Example. Club A has 90 members. In a pie chart of the members' favourite sports, the football sector has an angle of 120°.
Club B has 180 members. In its pie chart, the football sector has an angle of 80°.
Jo says, “More members of Club A than of Club B chose football, because 120° is bigger than 80°.”
Is Jo correct? You must show your working.

Model answer.

Club A: $\frac{120}{360} \times 90 = 30$ (M1)

Club B: $\frac{80}{360} \times 180 = 40$ (M1)

No: 40 members of Club B chose football but only 30 members of Club A. The angles show fractions of each club, not numbers, and Club B has twice as many members (C1)

Don’t lose marks

- Leaving out the key in a pictogram or stem-and-leaf diagram, or leaving the leaves unordered.
- Plotting a frequency polygon at the ends of the classes instead of the midpoints, or joining the last point back to the first.
- Comparing the angles in two pie charts with different totals as if they were numbers.
- Drawing bars of different widths, or using a frequency scale with uneven steps.
- Giving the highest frequency instead of the value when asked for the mode from a chart.
- Describing a time series as just 'it goes up and down'. Say whether it is increasing or decreasing overall, and when it peaks.

More tips

Memory tricks

- Pie chart check: your angles must add up to exactly 360°. If they do not, find the slip before you draw.
- Friendly totals: for 60 items each one is 6°, for 90 items 4°, for 120 items 3° and for 180 items 2°.
- Midpoint trick: add the two ends of the class and halve, e.g. 12 and 16 give 14.
- Stem-and-leaf check: count the leaves. There must be one leaf for every data value.
- Time series: compare like with like (Q1 with Q1) so that the seasonal pattern does not hide the trend.

Exam technique

- Use a sharp pencil, a ruler and a protractor. Pie chart angles need to be accurate to within about 2°.
- In pie chart questions, write down the angle for one item (360 ÷ total). It is often the first method mark.
- For 'Is ... correct?', work out the numbers, then write Yes or No with a reason that uses your numbers.
- Check the scale on each axis before reading values: one small square might be worth 2, 5 or 10.
- When you explain why a graph is misleading, name the feature (e.g. 'the vertical axis does not start at 0') and say what effect it has.

What each grade needs

What you need to be able to do, from the first marks up to the top grade.

Grade 1 — **Read pictograms, bar charts and tables**
Use the key of a pictogram (for example, one symbol stands for 4 people) and read bar heights carefully against the scale.

Grade 2 — **Draw a bar chart or vertical line chart**
Label both axes, start the frequency scale at 0 and make the bars the same width with equal gaps.

Grade 3 — **Complete and use a two-way table**
Use the fact that each row and each column adds up to its total to fill in the missing values.

Grade 3 — **Draw and read a stem-and-leaf diagram**
Put the leaves in order, include a key, and use the diagram to find the median and the range.

Grade 4 — **Draw and interpret a pie chart**
Work out each angle as frequency ÷ total × 360°, and each frequency as angle ÷ 360° × total.

Grade 4 — **Draw and interpret a frequency polygon**
Plot each frequency at the midpoint of its class and join the points with straight lines.

Grade 4 — **Describe trends and patterns in time series**
Say whether the values are generally rising or falling, and describe any pattern that repeats each year.

Grade 5 — **Compare pie charts and criticise misleading diagrams**
Work out actual numbers when the totals are different, and spot axes that do not start at 0 or scales that are uneven.

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