

Foundation Mathematics Units 3 & 4

Chapter 6 — Representing data

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Theory

Raw data — a long list of values straight from a survey or measurement — is hard to make sense of. The first job in representing data is to **organise** it into a table that shows the pattern at a glance. This section covers the three tables you need: the **frequency table**, the **grouped frequency table**, and the **two-way table**.

Frequency tables.

A **frequency table** records how many times each value occurs. It has a column for the value, a **tally**, the **frequency** f (the count), and often a **relative frequency** column. The **relative frequency** of a value is its share of the whole data set:

$$\text{relative frequency} = \frac{f}{n},$$

where n is the total number of data values. This is a proportion — a decimal between 0 and 1. Multiplying by 100 % gives the **percentage relative frequency**, $\frac{f}{n} \times 100\%$. Relative frequencies always add to 1, or to 100 % when written as percentages (allowing for rounding), so they let you compare data sets of different sizes fairly.

A **cumulative frequency** column gives a running total of the frequencies — the number of values at or below each point. The final cumulative frequency equals n .

Grouped frequency tables.

When numerical data is spread over a wide range (for example, test marks from 0 to 100), listing every separate value is unhelpful. Instead the data is sorted into **class intervals** of equal width (such as 40–49, 50–59, ...) and the frequency of each class is counted. A good grouped table uses **5 to 10 non-overlapping classes** that cover the full range. Grouped tables also carry cumulative frequencies, which show how many values fall below the top of each class.

Two-way tables.

A **two-way table** (or contingency table) organises data classified by **two** categorical variables at once — for example drink choice (coffee/tea) against time of day (morning/afternoon). Each inner cell is the count for one combination; the **row totals** and **column totals** run along the edges, and the grand total n sits in the bottom-right corner. A missing cell can always be found by subtracting from a known total. To express a cell (or a total) as a percentage, divide it by the appropriate total and multiply by 100 % — being careful **which** total the question asks about (the whole group, a row, or a column).

Worked examples

Example 1 — scaffolded

Twenty-five students were asked how many pets they own. The results were

0, 1, 2, 1, 0, 3, 1, 2, 1, 1, 0, 2, 1, 4, 2, 1, 0, 1, 2, 3, 1, 2, 0, 1, 2.

Construct a frequency table showing the frequency and the relative frequency (as a percentage) of each value.

Working

Comment

Count each value: 0 appears 5 times, 1 appears 10, 2 appears 7, 3 appears 2, 4 appears 1.

Tally the raw list; the frequencies must total $n = 25$.

Relative frequency of 0 = $\frac{5}{25} = 0.2$, which is 20 %.

Percentage relative frequency = $\frac{f}{n} \times 100\%$.

Working	Comment
Repeat: $1 \rightarrow 40\%$, $2 \rightarrow 28\%$, $3 \rightarrow 8\%$, $4 \rightarrow 4\%$.	Each frequency divided by 25, times 100.

Pets	Frequency	Percentage relative frequency
0	5	20%
1	10	40%
2	7	28%
3	2	8%
4	1	4%
Total	25	100%

Example 2 — scaffolded

The test marks (out of 100) of 30 students were

52, 63, 71, 48, 85, 67, 59, 73, 66, 55, 78, 62, 70, 81, 49, 58, 64, 72, 69, 76, 53, 88, 61, 57, 74, 66, 68, 79, 51, 60.

Construct a grouped frequency table with classes 40–49, 50–59, ..., 80–89, and include a cumulative frequency column.

Working	Comment
Count how many marks fall in each class: 40–49 has 2 (48, 49).	Sort each mark into its class interval.
50–59 has 7; 60–69 has 10; 70–79 has 8; 80–89 has 3	The frequencies total 30.
.	
Cumulative: 2, then $2 + 7 = 9$, then $9 + 10 = 19$, then 27, then 30.	Each cumulative value is the running total.

Mark	Frequency	Cumulative frequency
40–49	2	2
50–59	7	9
60–69	10	19
70–79	8	27
80–89	3	30

Example 3 — unscaffolded

A cafe recorded the drink orders of 100 customers by time of day. It knows that 35 customers ordered coffee in the morning, 60 ordered coffee altogether, and 55 ordered in the morning altogether. Complete the two-way table, and hence find the percentage of **morning** customers who ordered tea.

Every missing cell comes from subtracting from a known total. Coffee in the afternoon = $60 - 35 = 25$. Tea in the morning = $55 - 35 = 20$. Tea altogether = $100 - 60 = 40$, so tea in the afternoon = $40 - 20 = 20$. The afternoon total is $100 - 55 = 45$.

	Morning	Afternoon	Total
Coffee	35	25	60
Tea	20	20	40
Total	55	45	100

Of the 55 morning customers, 20 ordered tea, so the percentage is

$$\frac{20}{55} \times 100\% = 36.4\% \text{ (to 1 d.p.)}.$$

$\therefore$ 36.4% of morning customers ordered tea.

Example 4 — unscaffolded

A survey of 200 commuters recorded their main mode of transport. The relative frequencies, written as percentages, are shown below.

Transport	Percentage relative frequency
Car	45%
Train	30%
Bus	15%
Bike	10%

How many commuters used each mode, and how many used **public transport** (train or bus)?

Multiply each relative frequency by the total of 200: car = $0.45 \times 200 = 90$, train = $0.30 \times 200 = 60$, bus = $0.15 \times 200 = 30$, bike = $0.10 \times 200 = 20$. Public transport is train plus bus, $60 + 30 = 90$ commuters (which is $30\% + 15\% = 45\%$ of the 200).

$\therefore$ 90 used a car, 60 a train, 30 a bus and 20 a bike; 90 commuters used public transport.

Practice questions

Scaffolded

Q1. Fifteen people named their favourite fruit: apple, banana, apple, orange, banana, apple, banana, apple, orange, banana, apple, grape, banana, apple, orange. (a) Construct a frequency table. (b) Find the relative frequency (as a percentage) of each fruit. (c) State the most common (modal) fruit.

Q2. A frequency table of the number of cars per household is shown.

Cars	0	1	2	3
Frequency	3	8	6	3

- How many households were surveyed?
- Find the relative frequency of 1 car, as a percentage.
- Complete a cumulative frequency column.

Q3. The heights (cm) of 20 plants were

152, 148, 161, 155, 167, 159, 145, 163, 158, 150, 172, 149, 156, 164, 153, 168, 147, 160, 151, 157. (a) Construct a grouped frequency table with classes 145–149, 150–154, ..., 170–174. (b) Add a cumulative frequency column. (c) How many plants were shorter than 160 cm?

Q4. In a survey of 50 households, 30 own a pet and 35 live in a house (the rest in an apartment). Of the pet owners, 22 live in a house. (a) Complete a two-way table of pet ownership against housing type. (b) How many households own no pet and live in an apartment? (c) How many households live in an apartment altogether?

Q5. Using your completed table from **Q4**: (a) What percentage of all households own a pet? (b) What percentage of the households that live in a house own a pet? (c) What percentage of pet owners live in an apartment?

Q6. Refer to the commuter relative-frequency table in Worked example 4. (a) Which mode was used by exactly 30 commuters? (b) What percentage did **not** use a car? (c) Explain why relative frequencies are useful when comparing this survey with a survey of a different-sized city.

Un scaffolded

Q7. The numbers of goals scored in 20 games were 1, 2, 2, 3, 1, 2, 4, 3, 2, 1, 2, 3, 2, 2, 1, 3, 2, 4, 2, 3. Construct a frequency table with a relative-frequency (percentage) column.

Q8. Forty people named a favourite colour: red 14, blue 16, green 7, yellow 3. Find the relative frequency of each colour as a percentage.

Q9. The ages of 20 gym members were 23, 31, 42, 28, 35, 47, 52, 38, 29, 44, 33, 41, 26, 39, 50, 45, 30, 37, 48, 34. Construct a grouped frequency table with classes 20–29, 30–39, 40–49, 50–59, and include cumulative frequencies.

Q10. A shop's daily sales of an item over 20 days were 12, 18, 25, 33, 41, 15, 22, 29, 36, 44, 19, 27, 31, 38, 45, 14, 23, 30, 39, 42. Construct a grouped frequency table (classes 10–19, 20–29, 30–39, 40–49), and state on how many days at least 30 items were sold.

Q11. A survey of 80 students recorded whether they play sport, by gender. There are 48 boys, 54 students play sport, and 30 of the boys play sport. (a) Complete a two-way table. (b) What percentage of all students play sport? (c) What percentage of the girls play sport?

Q12. Of 120 people, 70 travel by bus (the rest by car) and 50 live in the city (the rest in the suburbs). 32 of the bus travellers live in the city. (a) Complete a two-way table of transport against where they live. (b) What percentage travel by bus? (c) What percentage of the city residents travel by bus?

Q13. The shoe sizes of 20 students were 7, 8, 8, 9, 7, 8, 10, 9, 8, 7, 8, 9, 8, 10, 7, 9, 8, 8, 9, 7. Construct a frequency table with frequency and cumulative frequency columns.

Q14. A gym's 200 members are classified by age (under 30 / 30 and over) and membership type (member / non-member of the pool). There are 110 under 30, 90 pool members, and 64 under-30 pool members. (a) Complete a two-way table. (b) What percentage of pool members are under 30?

Q15. A frequency table of the number of children per family in a survey of 25 families is: 0 → 4, 1 → 9, 2 → 7, 3 → 3, 4 → 2. (a) Add a cumulative frequency column. (b) How many families have at most 2 children?

Q16. Using the grouped table from **Q10**, what percentage of days had sales of 30 or more items?

Q17. Using the two-way table from **Q11**, a student is chosen at random. Are they more likely to be a boy who plays sport or a girl who plays sport? Justify with figures.

Q18. A cinema classified 150 visits by day type (weekday/weekend) and ticket type (adult/child). There were 80 weekday visits, 95 adult visits, and 45 weekday adult visits. (a) Complete a two-way table. (b) What percentage of visits were on a weekend? (c) What percentage of adult visits were on a weekday?

Answers

Q1. (a)/(b) apple 6 (40%), banana 5 (33.3%), orange 3 (20%), grape 1 (6.7%). (c) apple. **Q2.** (a) 20. (b) 40%. (c) cumulative 3, 11, 17, 20. **Q3.** (b) frequencies 4, 4, 5, 4, 2, 1; cumulative 4, 8, 13, 17, 19, 20. (c) 13 plants. **Q4.** (a) pet-yes: house 22, apartment 8; pet-no: house 13, apartment 7. (b) 7. (c) 15. **Q5.** (a) 60%. (b) 62.9%. (c) $\frac{8}{30} \times 100\% = 26.7\%$. **Q6.** (a) bus. (b) 55%. (c) relative frequencies (percentages) let you compare the *proportions* even though the two cities have different total numbers of commuters. **Q7.** $1 \rightarrow 4$ (20%), $2 \rightarrow 9$ (45%), $3 \rightarrow 5$ (25%), $4 \rightarrow 2$ (10%). **Q8.** red 35%, blue 40%, green 17.5%, yellow 7.5%. **Q9.** frequencies 4, 8, 6, 2; cumulative 4, 12, 18, 20. **Q10.** frequencies 5, 5, 6, 4; cumulative 5, 10, 16, 20; at least 30 on 10 days. **Q11.** (a) boys: play 30, no 18; girls: play 24, no 8. (b) 67.5%. (c) $\frac{24}{32} \times 100\% = 75\%$. **Q12.** (a) bus: city 32, suburb 38; car: city 18, suburb 32. (b) 58.3%. (c) 64%. **Q13.** $7 \rightarrow 5$ (cum 5), $8 \rightarrow 8$ (cum 13), $9 \rightarrow 5$ (cum 18), $10 \rightarrow 2$ (cum 20). **Q14.** (a) under-30: member 64, non-member 46; 30+: member 26, non-member 64. (b) $\frac{64}{90} \times 100\% = 71.1\%$. **Q15.** (a) cumulative 4, 13, 20, 23, 25. (b) 20 families. **Q16.** 10 of 20 days = 50%. **Q17.** Boy-who-plays 30 vs girl-who-plays 24, so a boy who plays sport is more likely. **Q18.** (a) weekday: adult 45, child 35; weekend: adult 50, child 20. (b) $\frac{70}{150} \times 100\% = 46.7\%$. (c) $\frac{45}{95} \times 100\% = 47.4\%$.

Fully-worked solutions

Q1. Counting the list: apple 6, banana 5, orange 3, grape 1 (total 15). (a)/(b) Percentage relative frequencies: apple $\frac{6}{15} \times 100\% = 40\%$, banana $\frac{5}{15} \times 100\% = 33.3\%$, orange $\frac{3}{15} \times 100\% = 20\%$, grape $\frac{1}{15} \times 100\% = 6.7\%$. (c) Apple has the highest frequency, so it is the most common (modal) fruit.

Q2. (a) $n = 3 + 8 + 6 + 3 = 20$ households. (b) Percentage relative frequency of 1 car = $\frac{8}{20} \times 100\% = 40\%$. (c) Cumulative frequencies: 3, $3 + 8 = 11$, $11 + 6 = 17$, $17 + 3 = 20$.

Q3. (a)/(b) Sorting the heights into classes:

Height	Frequency	Cumulative
145–149	4	4
150–154	4	8
155–159	5	13
160–164	4	17
165–169	2	19
170–174	1	20

(c) “Shorter than 160 cm” means the first three classes: $4 + 4 + 5 = 13$ plants (the cumulative frequency at the top of the 155–159 class).

Q4. (a) Pet owners live in a house 22 times, so pet-owners in an apartment = $30 - 22 = 8$. House dwellers without a pet = $35 - 22 = 13$. Non-pet-owners = $50 - 30 = 20$, so non-pet apartment = $20 - 13 = 7$.

	House	Apartment	Total
Pet	22	8	30
No pet	13	7	20
Total	35	15	50

(b) 7 households own no pet and live in an apartment.

(c) $50 - 35 = 15$ households live in an apartment.

Q5. (a) $\frac{30}{50} \times 100\% = 60\%$ own a pet. (b) Of the 35 house dwellers, 22 own a pet: $\frac{22}{35} \times 100\% = 62.9\%$. (c) Of the 30 pet owners, 8 live in an apartment: $\frac{8}{30} \times 100\% = 26.7\%$.

Q6. (a) 15% of $200 = 30$, which is the **bus**. (b) Not a car $= 100\% - 45\% = 55\%$. (c) Relative frequencies give each mode's **share** of the total, so two surveys with different total numbers of commuters can still be compared fairly, proportion to proportion.

Q7. Counting: $1 \rightarrow 4, 2 \rightarrow 9, 3 \rightarrow 5, 4 \rightarrow 2$ (total 20). Percentage relative frequencies: $\frac{4}{20} \times 100\% = 20\%$, $\frac{9}{20} \times 100\% = 45\%$, $\frac{5}{20} \times 100\% = 25\%$, $\frac{2}{20} \times 100\% = 10\%$.

Q8. $n = 40$. red $\frac{14}{40} \times 100\% = 35\%$, blue $\frac{16}{40} \times 100\% = 40\%$, green $\frac{7}{40} \times 100\% = 17.5\%$, yellow $\frac{3}{40} \times 100\% = 7.5\%$.

Q9. Sorting the ages:

Age	Frequency	Cumulative
20–29	4	4
30–39	8	12
40–49	6	18
50–59	2	20

Q10. Sorting the daily sales:

Sales	Frequency	Cumulative
10–19	5	5
20–29	5	10
30–39	6	16
40–49	4	20

At least 30 sold means the last two classes: $6 + 4 = 10$ days.

Q11. (a) Boys who play $= 30$, so boys who don't $= 48 - 30 = 18$. Students who play $= 54$, so girls who play $= 54 - 30 = 24$. Girls total $= 80 - 48 = 32$, so girls who don't $= 32 - 24 = 8$.

	Play	Don't play	Total
Boys	30	18	48
Girls	24	8	32
Total	54	26	80

(b) $\frac{54}{80} \times 100\% = 67.5\%$.

(c) Of the 32 girls, 24 play sport: $\frac{24}{32} \times 100\% = 75\%$.

Q12. (a) Bus travellers in the city $= 32$, so bus-suburb $= 70 - 32 = 38$. City total $= 50$, so car-city $= 50 - 32 = 18$. Car total $= 120 - 70 = 50$, so car-suburb $= 50 - 18 = 32$.

	City	Suburb	Total
Bus	32	38	70

	City	Suburb	Total
Car	18	32	50
Total	50	70	120

(b) $\frac{70}{120} \times 100\% = 58.3\%$.

(c) Of the 50 city residents, 32 take the bus: $\frac{32}{50} \times 100\% = 64\%$.

Q13. Counting: $7 \rightarrow 5$, $8 \rightarrow 8$, $9 \rightarrow 5$, $10 \rightarrow 2$.

Size	Frequency	Cumulative
7	5	5
8	8	13
9	5	18
10	2	20

Q14. (a) Under-30 members = 64, so under-30 non-members = $110 - 64 = 46$. Members total = 90, so 30+ members = $90 - 64 = 26$. The 30+ total = $200 - 110 = 90$, so 30+ non-members = $90 - 26 = 64$.

	Member	Non-member	Total
Under 30	64	46	110
30 and over	26	64	90
Total	90	110	200

(b) Of the 90 members, 64 are under 30: $\frac{64}{90} \times 100\% = 71.1\%$.

Q15. (a) Cumulative frequencies: 4, $4 + 9 = 13$, $13 + 7 = 20$, $20 + 3 = 23$, $23 + 2 = 25$. (b) “At most 2 children” is the cumulative frequency at 2, which is 20 families.

Q16. From **Q10**, 30 or more items were sold on $6 + 4 = 10$ of the 20 days, which is $\frac{10}{20} \times 100\% = 50\%$.

Q17. From the two-way table in **Q11**, 30 students are boys who play sport and 24 are girls who play sport. Since $30 > 24$, a randomly chosen student is more likely to be a boy who plays sport.

Q18. (a) Weekday adult = 45, so weekday child = $80 - 45 = 35$. Adult total = 95, so weekend adult = $95 - 45 = 50$. Weekend total = $150 - 80 = 70$, so weekend child = $70 - 50 = 20$.

	Adult	Child	Total
Weekday	45	35	80
Weekend	50	20	70
Total	95	55	150

(b) $\frac{70}{150} \times 100\% = 46.7\%$.

(c) Of the 95 adult visits, 45 were on a weekday: $\frac{45}{95} \times 100\% = 47.4\%$.

Chapter 6 Representing data — 6D Common graphs and charts

Theory

A **graph** turns a table of numbers into a picture, making patterns, comparisons and trends easy to see. The skill is twofold: **choosing** the right graph for the data, and **reading** a graph accurately. Which graph suits the data depends on the **type** of data (categorical or numerical — see 5D) and on what you want to show.

Bar and column charts.

A **bar chart** (horizontal bars) or **column chart** (vertical columns) compares **categorical** data. Each bar's length or height shows the frequency or value for that category. The bars are separated by gaps (the categories are separate groups), and the scale must start at 0 so the heights compare fairly.

Line graphs.

A **line graph** shows how a **numerical** quantity changes over time. Points are plotted and joined in order, so the line shows the **trend** — rising, falling or steady — and lets you read values between the marked points.

Pie charts.

A **pie chart** shows how a whole is divided into **parts**. Each category gets a sector whose angle is its fraction of the total turn of 360° :

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

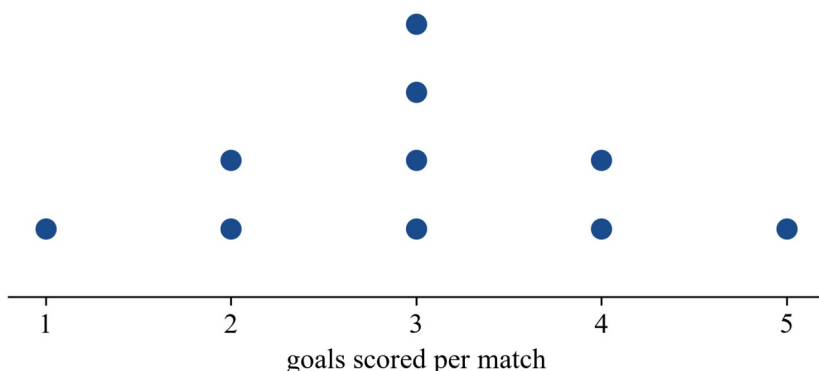
Pie charts show proportions well but make exact values hard to read.

Pictographs.

A **pictograph** uses a repeated symbol to represent a fixed number of items, stated in a **key** (e.g. one symbol = 4 books). The value for a row is the number of symbols times the key value; a part-symbol shows a part of that amount.

Dot plots.

A **dot plot** places one dot for each data value above a number line. It suits small sets of **discrete numerical** data and shows the mode (tallest stack), the spread and any clusters or gaps at a glance.

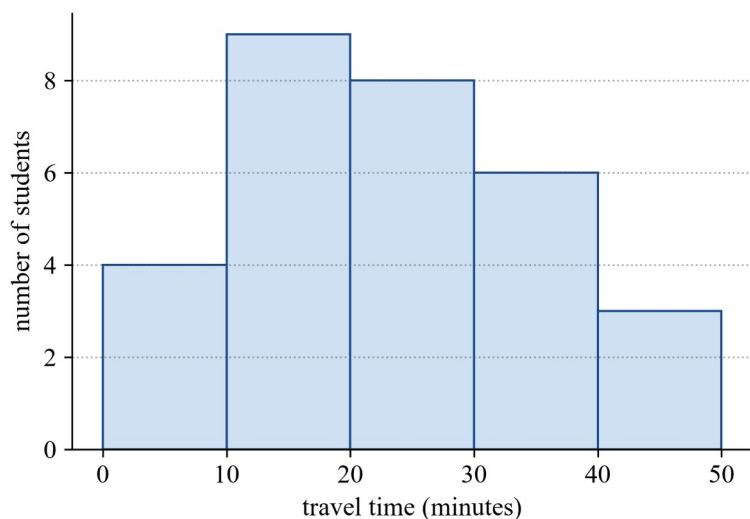


Stem-and-leaf plots.

A **stem-and-leaf plot** keeps every individual value while showing the shape of the data. Each value is split into a **stem** (its leading digit(s)) and a **leaf** (its last digit); leaves are written in order beside their stem. A **key** explains how to read a value. Because the data stays ordered, you can read off the median, the range and every original value.

Histograms.

A **histogram** shows **numerical** data that has been grouped into equal **class intervals**, such as 0–10, 10–20, 20–30 minutes. The height of each column is the frequency of that interval. Unlike a bar chart, the columns sit **side by side with no gaps**, because the horizontal axis is a continuous number scale rather than a list of separate categories. A histogram is the usual display for **continuous** data, or for a numerical data set too large for a dot plot, and it shows the **shape** of the data — where the values bunch up and how they tail off.



Choosing the right graph.

Data / purpose	Best graph
Compare categories	bar or column chart
Show change over time	line graph
Show parts of a whole	pie chart
Small discrete data set	dot plot or stem-and-leaf plot
Continuous data, or a large numerical data set	histogram
Keep the actual values visible	stem-and-leaf plot

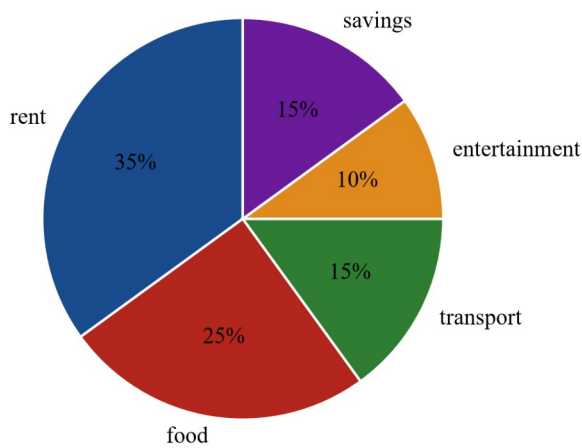
Whatever the graph, always read the **title, axis labels, scale and key** before drawing a conclusion.

Worked examples

Example 1 — scaffolded

A household's monthly budget is: rent \$700, food \$500, transport \$300, entertainment \$200, savings \$300. Find the sector angle and the percentage for each category in a pie chart.

Working	Comment
Total = $700 + 500 + 300 + 200 + 300 = \2000 .	Add all parts to get the whole.
Rent: $\frac{700}{2000} \times 360^\circ = 126^\circ$, and $\frac{700}{2000} \times 100\% = 35\%$.	Sector angle and percentage use the same fraction.
Food: $\frac{500}{2000} \times 360^\circ = 90^\circ$ (25%).	A quarter of the budget.
Transport: 54° (15%); entertainment: 36° (10%); savings: 54° (15%).	Each category in turn.
Check: $126 + 90 + 54 + 36 + 54 = 360^\circ$.	The angles must sum to 360° .



Example 2 — scaffolded

The stem-and-leaf plot shows the test marks (out of 100) of a class.

```

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

```

Key: 5 | 2 = 52 marks

Find (a) how many students sat the test, (b) the median mark, and (c) the range.

Working

Counting all the leaves: $3 + 4 + 4 + 3 + 1 = 15$ students.

The values in order run 52, 55, 58, 61, ..., 90; the median is the 8th value.

The 8th value is 72, so the median = 72 marks.

Range = $90 - 52 = 38$ marks.

Comment

Each leaf is one student.

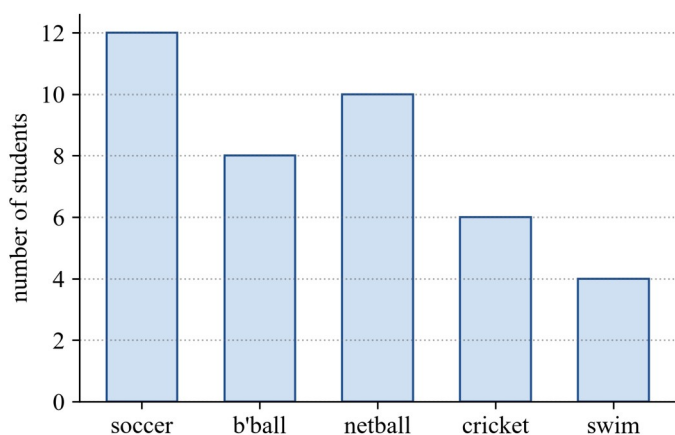
With $n = 15$ (odd), the median is in position $15 + 1/2 = 8$.

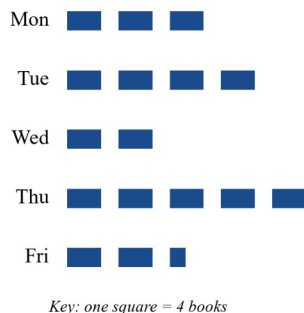
Read the 8th leaf: stem 7, leaf 2.

Highest (9|0) minus lowest (5|2).

Example 3 — unscaffolded

The column chart shows students' favourite sports, and the pictograph shows how many books a library lent each day.





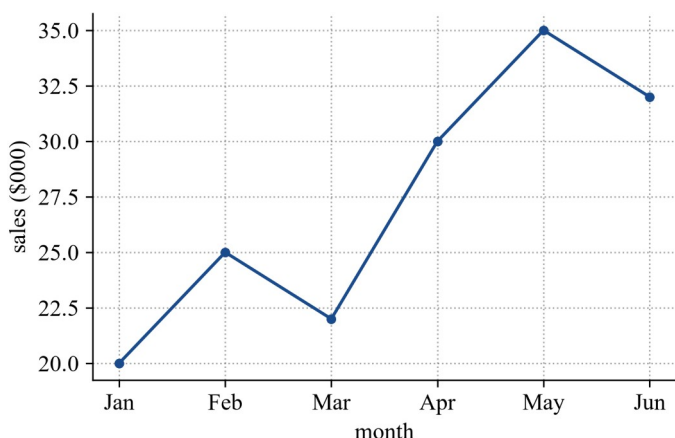
State the most popular sport and how many students chose netball; then find the total books lent for the week and the busiest day.

From the column chart, **soccer** is tallest (12 students), so it is the most popular, and **netball** has 10 students. The total surveyed is $12 + 8 + 10 + 6 + 4 = 40$ students. For the pictograph (one square = 4 books): Mon $3 \times 4 = 12$, Tue 16, Wed 8, Thu 20, Fri $2.5 \times 4 = 10$, a total of $12 + 16 + 8 + 20 + 10 = 66$ books. The most squares are on **Thursday** (20 books).

$\therefore$ soccer is most popular, 10 chose netball, 66 books were lent, and Thursday was busiest.

Example 4 — unscaffolded

The line graph shows a shop's monthly sales.



Describe the overall trend, and find the month with the biggest one-month rise.

The sales rise from \$20,000 in January to \$35,000 in May, dipping slightly in March and again in June, so the **overall trend is upward**. The one-month changes are $+5, -3, +8, +5, -3$ (in \$000), so the biggest single rise is **March to April**, an increase of \$8,000.

$\therefore$ sales trend upward overall, with the largest rise (\$8,000) from March to April.

Practice questions

Scaffolded

Q1. A survey of 2000 people's main news source gave: TV 800, online 700, radio 300, print 200. (a) Find the total (check it is 2000). (b) Find the pie-chart sector angle for "online". (c) Find the percentage for "TV".

Q2. In a dot plot of goals scored, the values are 1, 2, 2, 3, 3, 3, 3, 4, 4, 5. (a) How many matches are shown? (b) What is the mode? (c) What is the range?

Q3. A pictograph uses one symbol = 20 cars. (a) A row with 4 symbols represents how many cars? (b) A row with $2\frac{1}{2}$ symbols represents how many cars? (c) How many symbols represent 70 cars?

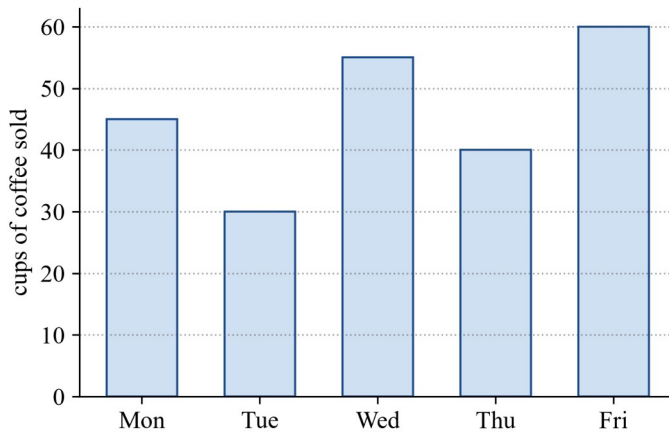
Q4. A class's heights (cm) are shown in a stem-and-leaf plot with stems 14, 15, 16, 17 and 18. The plot has 18 leaves altogether. (a) How many students are in the class? (b) Between what two heights (cm) do all the values lie? (c) Which plot — dot plot or stem-and-leaf — keeps the exact heights visible?

Q5. A pie chart of a \$3600 grant has a “wages” sector of 200° . (a) What fraction of the whole is “wages”? (b) What percentage is “wages”? (c) How many dollars is the “wages” sector?

Q6. For each data set, name the most suitable graph. (a) The percentage of a council budget spent on each of 5 services. (b) A city's rainfall each month for a year. (c) The number of pets (0–5) owned by each of 20 households.

Un scaffolded

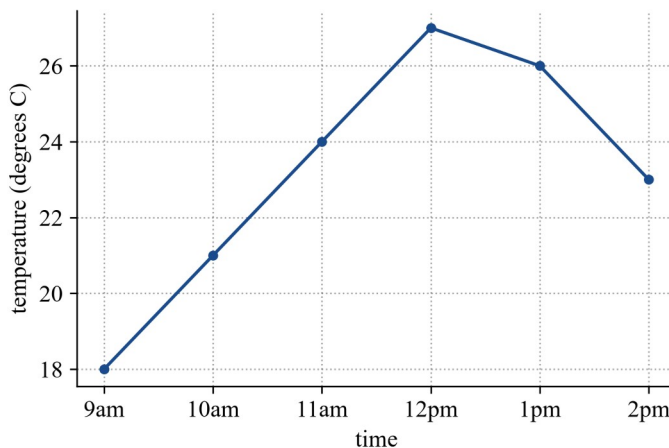
Q7. The column chart shows a cafe's daily coffee sales.



State the busiest day, the quietest day, and the total coffees sold for the five days.

Q8. A pie chart of 720 survey responses shows a “satisfied” sector of 270° . How many people were satisfied, and what percentage is this?

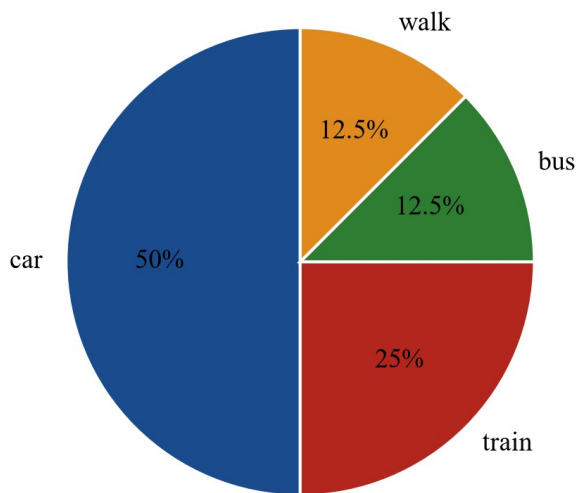
Q9. The line graph shows the temperature at a weather station from 9am to 2pm one day.



State the temperature at 11am, the warmest time shown, and the total rise in temperature from 9am to 12pm.

Q10. A budget of \$1800 is split rent \$720, food \$540, other \$540. Find the pie-chart sector angle for each category.

Q11. The pie chart shows how 360 people travel to work.



Given the sector angles are car 180° , train 90° , bus 45° and walk 45° , find the number of people who travel by each mode.

Q12. A pictograph of weekly sales uses one symbol = 50 units. Week 1 shows 3 symbols, Week 2 shows $4\frac{1}{2}$ symbols and Week 3 shows 2 symbols. Find the total units sold over the three weeks.

Q13. The stem-and-leaf plot shows the masses (kg) of 16 parcels.

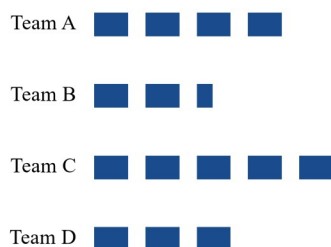
2		3	5	8	
3		1	4	6	6
4		0	2	5	7
5		1	3	5	8
6		2			

Key: 2 | 3 = 23 kg

Find the lightest and heaviest parcels, the range, and the median mass.

Q14. A student draws a column chart of favourite colours but starts the vertical axis at 10 instead of 0. Explain what is misleading about this, and name the correct graph type for showing each colour's share of the whole class instead.

Q15. The pictograph shows goals scored by four teams; one symbol = 10 goals.



Key: one square = 10 goals

Find how many goals each team scored, and the total for all four teams.

Q16. The values 3, 5, 5, 6, 7, 7, 7, 8, 9, 12 are to be displayed. (a) Would a dot plot or a pie chart be more suitable, and why? (b) State the mode and the range.

Q17. A pie chart of how a worker spends a 24-hour day shows sleep 120° , work 135° , and “other” the rest. How many hours does each sector represent? (Hint: 360° represents 24 hours.)

Q18. A company’s yearly profit (\$million) was 2,3,3,5,4,6 over six years. State the most suitable graph to show the change over time, describe the overall trend, and give the year with the largest fall.

Answers

Q1. (a) 2000. (b) 126° . (c) 40%. **Q2.** (a) 10. (b) 3. (c) 4. **Q3.** (a) 80 cars. (b) 50 cars. (c) $3\frac{1}{2}$ symbols. **Q4.** (a) 18. (b) between 140 and 189 cm. (c) the stem-and-leaf plot. **Q5.** (a) $\frac{5}{9}$. (b) $55.\bar{5}\% \approx 55.6\%$. (c) \$2000. **Q6.** (a) pie chart. (b) line graph. (c) dot plot. **Q7.** busiest Friday (60), quietest Tuesday (30), total 230 cups. **Q8.** 540 people; 75%. **Q9.** 24 degrees at 11am; warmest at 12pm (27 degrees); total rise from 9am to 12pm = 9 degrees. **Q10.** rent 144° , food 108° , other 108° . **Q11.** car 180, train 90, bus 45, walk 45. **Q12.** 475 units ($150 + 225 + 100$). **Q13.** lightest 23 kg, heaviest 62 kg, range 39 kg, median 41 kg. **Q14.** starting the axis at 10 exaggerates the differences between the bars (see 7H); a pie chart shows each colour's share of the whole. **Q15.** A 40, B 25, C 50, D 30; total 145 goals. **Q16.** (a) a dot plot, because the data is a small set of individual discrete values (a pie chart is for parts of a whole). (b) mode 7, range 9. **Q17.** sleep 8 h, work 9 h, other 7 h. **Q18.** a line graph; the profit trends upward overall; the largest fall is year 4 to year 5 (\$5m to \$4m).

Fully-worked solutions

Q1. (a) $800 + 700 + 300 + 200 = 2000$. (b) $\text{online} = \frac{700}{2000} \times 360^\circ = 126^\circ$. (c) $\text{TV} = \frac{800}{2000} \times 100\% = 40\%$.

Q2. (a) There are 10 values, so 10 matches. (b) The value 3 appears most often (four times), so the mode is 3. (c) $\text{Range} = 5 - 1 = 4$.

Q3. (a) $4 \times 20 = 80$ cars. (b) $2.5 \times 20 = 50$ cars. (c) $70 \div 20 = 3.5$, so $3\frac{1}{2}$ symbols.

Q4. (a) Each leaf is one student, so 18 students. (b) Stem 14 with the smallest leaf is at least 140; stem 18 with the largest leaf is at most 189; so all heights lie between 140 and 189 cm. (c) The stem-and-leaf plot keeps every exact value.

Q5. (a) $\frac{200}{360} = \frac{5}{9}$. (b) $\frac{5}{9} \times 100\% = 55.\bar{5}\% \approx 55.6\%$. (c) $\frac{5}{9} \times 3600 = \2000 .

Q6. (a) Parts of a whole budget $\rightarrow$ **pie chart**. (b) Change over time $\rightarrow$ **line graph**. (c) A small set of discrete counts $\rightarrow$ **dot plot**.

Q7. Reading the columns: Mon 45, Tue 30, Wed 55, Thu 40, Fri 60. The busiest day is **Friday** (60) and the quietest is **Tuesday** (30). Total = $45 + 30 + 55 + 40 + 60 = 230$ cups.

Q8. Satisfied fraction = $\frac{270}{360} = \frac{3}{4}$, so $\frac{3}{4} \times 720 = 540$ people, which is 75%.

Q9. Reading the line graph: at 11am the temperature is 24 degrees; the highest point is at 12pm (27 degrees). The total rise from 9am (18 degrees) to 12pm (27 degrees) is $27 - 18 = 9$ degrees.

Q10. Total = $720 + 540 + 540 = 1800$. Rent = $\frac{720}{1800} \times 360^\circ = 144^\circ$; food = $\frac{540}{1800} \times 360^\circ = 108^\circ$; other = 108° . (Check: $144 + 108 + 108 = 360^\circ$.)

Q11. Each degree represents $\frac{360 \text{ people}}{360^\circ} = 1$ person per degree, so: car $\frac{180}{360} \times 360 = 180$; train 90; bus 45; walk 45. (Check: $180 + 90 + 45 + 45 = 360$.)

Q12. Week 1 = $3 \times 50 = 150$; Week 2 = $4.5 \times 50 = 225$; Week 3 = $2 \times 50 = 100$. Total = $150 + 225 + 100 = 475$ units.

Q13. The lowest value is $2|3 = 23$ kg and the highest is $6|2 = 62$ kg, so the range = $62 - 23 = 39$ kg. With $n = 16$ (even), the median is the average of the 8th and 9th values, 40 and 42, so median = $\frac{40 + 42}{2} = 41$ kg.

Q14. Starting the vertical axis at 10 rather than 0 cuts off the bottom of every bar, so small differences look much larger than they are — the chart exaggerates the differences (this is the truncated-axis trick of 7H). To show each colour's **share of the whole class**, a **pie chart** is the appropriate graph.

Q15. One symbol = 10 goals: Team A $4 \times 10 = 40$; Team B $2.5 \times 10 = 25$; Team C $5 \times 10 = 50$; Team D $3 \times 10 = 30$.
Total = $40 + 25 + 50 + 30 = 145$ goals.

Q16. (a) A **dot plot** — the data is a small set of individual discrete values, which a dot plot displays directly; a pie chart is only for showing parts of a whole. (b) The value 7 occurs three times (mode = 7); range = $12 - 3 = 9$.

Q17. 360° represents 24 hours, so 1° represents $\frac{24}{360} = \frac{1}{15}$ hour. Sleep = $\frac{120}{360} \times 24 = 8$ h; work = $\frac{135}{360} \times 24 = 9$ h;
other = $24 - 8 - 9 = 7$ h.

Q18. A **line graph** best shows change over time. Plotting 2, 3, 3, 5, 4, 6 shows the profit trending **upward** overall (from \$2m to \$6m). The one-year changes are +1, 0, +2, -1, +2, so the largest fall is from year 4 to year 5 (\$5m down to \$4m).

Theory

Spreadsheet software (such as Excel or Google Sheets) and other technology can turn a table of data into a graph in a few clicks. The skill is no longer *drawing* the graph by hand — it is **choosing the right type of graph**, setting it up so it is honest and clear, and **reading** a technology-generated graph correctly.

Organising data in a spreadsheet.

Data is entered in a grid of **rows** and **columns**, with a **heading** at the top of each column (for example “Month” in one column and “Sales” in the next). To make a chart you **select the data range** — the headings plus the numbers — and insert a chart. The headings become the axis labels and the legend, so clear headings matter.

Choosing the right chart.

The type of data (categorical or numerical — see 5D) decides the sensible chart:

Chart type	Best for	Example
Column or bar chart	comparing categories , or a few separate periods	votes by party, sales by month
Line graph	showing change over time	temperature through a day
Pie chart	parts of a whole (values add to 100%)	how a budget is split
Scatter plot	the relationship between two numerical variables	height vs weight

Data collected over time can take either of the first two. Use a **column chart** when you are **comparing a few separate periods** (six months of sales side by side), and a **line graph** when the point is the **trend** — how the values rise and fall across the period.

For a **pie chart** each category’s sector is a fraction of the whole circle, so

$$\text{sector angle} = \frac{\text{category value}}{\text{total}} \times 360^\circ, \text{sector percentage} = \frac{\text{category value}}{\text{total}} \times 100\%.$$

Reading a technology chart.

Whatever the software, read a chart by checking:

- the **title** — what the chart is about;
- the **axis labels and scale** — what each axis measures and the size of each gridline step;
- the **legend** — which colour or symbol is which data series;
- **data labels** — exact values printed on the bars/points, if shown.

When the default chart is a poor choice.

Software will happily draw *any* chart type from selected data, even a silly one. Watch for:

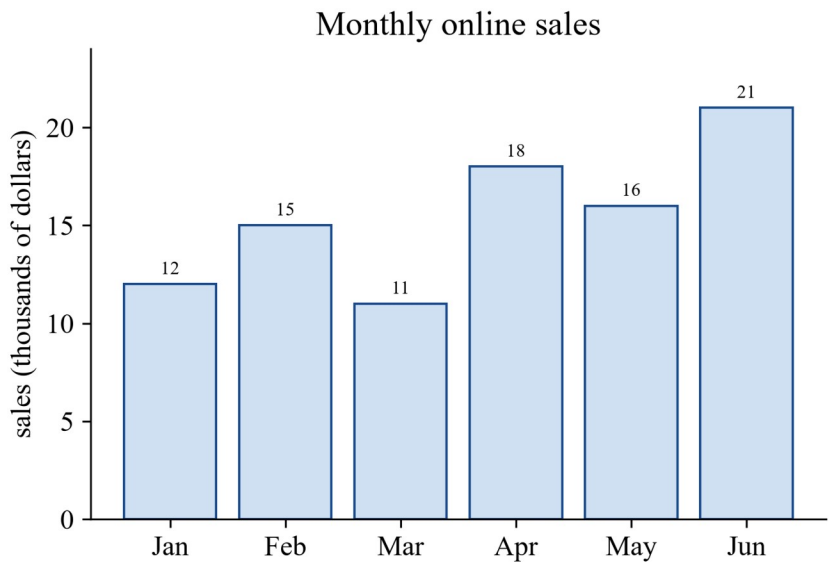
- a **pie chart with many similar slices** (hard to compare) — a bar chart is clearer;
- a **line graph joining unordered categories** (e.g. joining “apples, bananas, cherries”) — lines imply an order/trend that categories do not have, so use a bar chart;
- **3-D or decorative effects** that distort the sizes — keep charts flat and simple;
- a **missing or non-zero axis start** that exaggerates differences (see 7H).

Always ask: *does this chart make the data easy and honest to read?*

Worked examples

Example 1 — scaffolded

A shop records its monthly online sales (in thousands of dollars) in a spreadsheet and makes the column chart below.



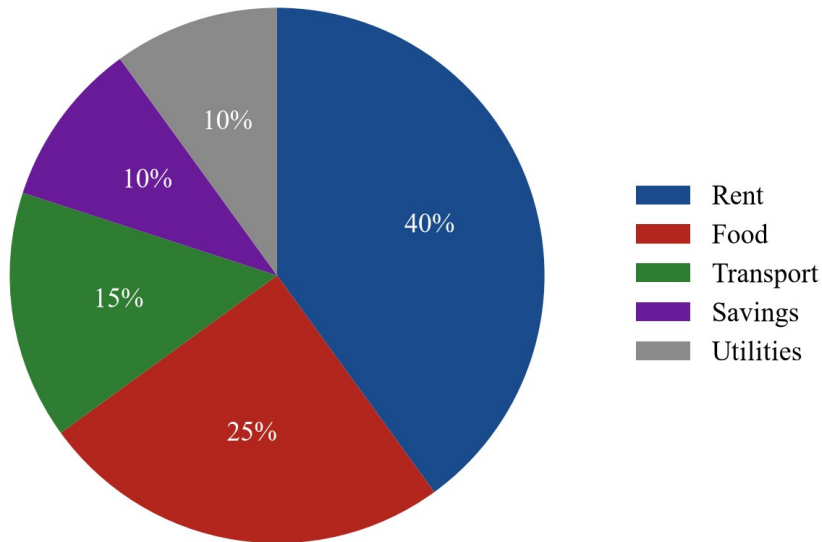
Find (a) the month with the highest sales, (b) the total sales for the six months, (c) how much more was sold in June than in January, and (d) why a column chart suits this data.

Working	Comment
(a) The tallest column is June at 21, so June had the highest sales.	Read the column heights (or the data labels).
(b) Total sales = $12 + 15 + 11 + 18 + 16 + 21 = 93$, i.e. \$ 93 000.	Add the six monthly values (in thousands).
(c) June – January = $21 - 12 = 9$, i.e. \$ 9000 more.	Subtract the two columns.
(d) The six months are separate periods being compared , so a column chart is a good choice.	Columns compare a few separate periods clearly.

Example 2 — scaffolded

A household’s \$4000 monthly budget is shown in the pie chart below.

Household monthly budget (\$4000)



Find (a) the amount spent on food, (b) the sector angle for transport.

Working

Comment

(a) Food is 25 % of \$4000 = $0.25 \times 4000 = \$1000$.

Percentage of the whole.

(b) Transport is 15 %, so its angle = $\frac{15}{100} \times 360^\circ = 54^\circ$.

Sector angle = fraction $\times 360^\circ$.

Check: all sectors $40 + 25 + 15 + 10 + 10 = 100\%$.

The parts of a pie must total 100 %.

Example 3 — unscaffolded

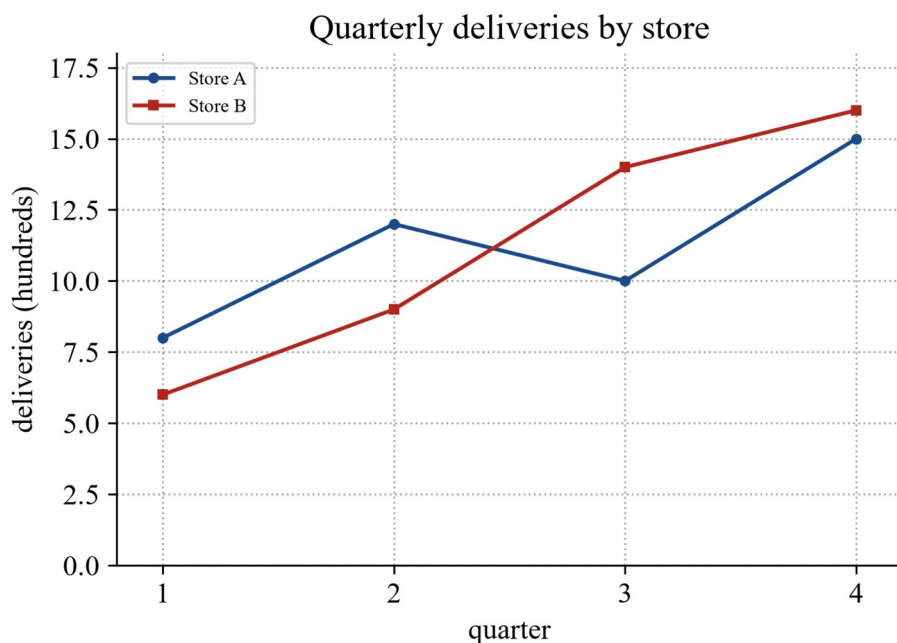
A student wants to compare the number of students who chose each of five different elective subjects. The software has drawn a **line graph** joining the five subjects. Explain why this is a poor choice and state a better chart.

The five subjects are **categories** — they have no natural order and no “in-between” values, so joining them with a line wrongly suggests a trend from one subject to the next. A line graph should be used for change over time, not for separate categories.

$\therefore$ a **column (bar) chart** is the better choice, because it compares the separate subject totals without implying any trend.

Example 4 — unscaffolded

The line graph below shows the quarterly number of deliveries (in hundreds) for two stores.



In which quarter did Store B first overtake Store A, and how many more deliveries did Store B make than Store A in Quarter 4?

Reading the two lines, Store A is above Store B in Quarter 1 (by $8 - 6 = 2$ hundred) and in Quarter 2 (by $12 - 9 = 3$ hundred). The lines cross between Quarter 2 and Quarter 3, and Store B is above Store A from **Quarter 3** onward. In Quarter 4, Store B is at 16 hundred and Store A is at 15 hundred, a difference of 1 hundred.

$\therefore$ Store B first overtook Store A in **Quarter 3**, and made 100 more deliveries than Store A in Quarter 4.

Practice questions

Scaffolded

Q1. State the most appropriate chart type for each data set. (a) The maximum temperature in a town on each day of one week, to show how the temperature rose and fell across the week. (b) The number of students who chose each of four sports. (c) How a \$2000 grant is divided among five clubs.

Q2. Use the monthly sales column chart from Example 1. (a) What were the sales in April? (b) What were the total sales for the first three months (Jan–Mar)? (c) Which month had the lowest sales?

Q3. Use the household budget pie chart from Example 2. (a) What percentage is spent on rent? (b) How many dollars is spent on savings? (c) What is the sector angle for rent?

Q4. A spreadsheet lists a café's daily coffee sales for a fortnight (14 days). (a) Is "number of coffees per day" categorical or numerical data? (b) To show how daily sales changed across the fortnight, what chart type suits best? (c) The café also wants to show what fraction of a day's \$500 takings came from coffee, food and other. What chart type suits that?

Q5. A chart's vertical axis is labelled "Sales (\$)" and its horizontal axis "Week", with a legend showing a blue line "Store 1" and a red line "Store 2". (a) What does the vertical axis measure? (b) What does the legend tell you? (c) If the blue line is higher than the red line in Week 5, what does that mean?

Q6. A pie chart of how 200 people travel to work shows: car 50 %, train 25 %, bus 15 %, walk 10 %. (a) How many people travel by car? (b) What is the sector angle for train? (c) How many people walk?

Un scaffolded

Q7. A council wants a chart to show the proportion of its annual budget spent on roads, parks, libraries and waste. State the most suitable chart type and explain why.

- Q8.** Using the monthly sales column chart (Example 1), find the mean monthly sales.
- Q9.** A pie chart of a \$60 000 salary shows tax 25 %, rent 30 %, living costs 30 % and savings 15 %. Find the dollar amount saved and the sector angle for tax.
- Q10.** A software package draws a 3-D pie chart in which the front slices look much bigger than the back slices. Explain why this is misleading and how to fix it.
- Q11.** A spreadsheet has two columns: “Height (cm)” and “Mass (kg)” for 20 people. To show whether taller people tend to have greater mass, which chart type should be chosen, and why?
- Q12.** In the two-store delivery line graph (Example 4), find the total number of deliveries Store A made across the four quarters.
- Q13.** A student makes a line graph joining the average rainfall for the cities Melbourne, Sydney, Brisbane and Perth. Explain what is wrong with this choice and give a better chart.
- Q14.** A pie chart sector has an angle of 72° . What percentage of the whole does it represent?
- Q15.** A column chart shows quarterly profit with the vertical axis starting at \$90 000 (not \$0), making the differences between quarters look large. What is this technique called, and how should the chart be drawn honestly?
- Q16.** A market stall records sales of four products in a spreadsheet. Give the chart type best suited to (a) comparing the four products’ totals, and (b) showing each product’s share of total sales.
- Q17.** A pie chart of 400 survey responses shows “Yes” as a sector of angle 216° . How many people answered “Yes”?
- Q18.** A weather station stores the daily maximum temperature for a year in a spreadsheet. The manager wants a single chart to show how the temperature changed through the year. State the best chart type and explain why a pie chart would not work here.
-

Answers

Q1. (a) line graph; (b) column/bar chart; (c) pie chart. **Q2.** (a) \$18 000; (b) \$38 000 (12 + 15 + 11 thousand); (c) March. **Q3.** (a) 40%; (b) \$400; (c) 144°. **Q4.** (a) numerical (discrete); (b) line graph; (c) pie chart. **Q5.** (a) sales in dollars; (b) which line is which store (blue = Store 1, red = Store 2); (c) Store 1 had higher sales than Store 2 in Week 5. **Q6.** (a) 100 people; (b) 90°; (c) 20 people. **Q7.** Pie chart — it shows each area's share of the whole budget (the parts add to 100%). **Q8.** \$15 500 (mean of 12, 15, 11, 18, 16, 21 thousand = 15.5). **Q9.** Savings \$9000; tax sector 90°. **Q10.** The 3-D perspective enlarges the front slices, distorting the true proportions; draw a flat 2-D pie (or a bar chart) so slice sizes are accurate. **Q11.** Scatter plot — it shows the relationship between two numerical variables (height and mass). **Q12.** 4500 deliveries (Store A: 8 + 12 + 10 + 15 = 45 hundred). **Q13.** The cities are categories with no order, so a joining line implies a false trend; use a column/bar chart. **Q14.** 20%. **Q15.** A truncated (non-zero) axis; redraw with the vertical axis starting at \$0. **Q16.** (a) column/bar chart; (b) pie chart. **Q17.** 240 people. **Q18.** A line graph — it shows change over time; a pie chart cannot, because the daily temperatures are not parts of a single whole.

Fully-worked solutions

Q1. (a) The question asks how the temperature **changed** across the week, so the trend matters: use a **line graph**. (b) The four sports are **categories**, so a **column/bar chart** compares them. (c) Dividing a fixed \$2000 among clubs is **parts of a whole**, so a **pie chart**.

Q2. From the chart, (a) April = \$18 000. (b) Jan + Feb + Mar = 12 + 15 + 11 = 38, i.e. \$38 000. (c) The shortest column is **March** (\$11 000).

Q3. (a) The rent sector is labelled 40%. (b) Savings is 10% of \$4000 = $0.10 \times 4000 = \$400$. (c) Rent's angle = $\frac{40}{100} \times 360^\circ = 144^\circ$.

Q4. (a) A daily count of coffees is a **number** you count, so **numerical (discrete)**. (b) To show change across the 14 days, use a **line graph**. (c) To show each part's share of one day's takings, use a **pie chart**.

Q5. (a) The vertical axis measures **sales in dollars**. (b) The legend says the **blue line is Store 1 and the red line is Store 2**. (c) A higher blue line in Week 5 means **Store 1 had greater sales than Store 2** that week.

Q6. (a) Car = 50% of 200 = 100 people. (b) Train = 25%, angle = $0.25 \times 360^\circ = 90^\circ$. (c) Walk = 10% of 200 = 20 people.

Q7. A **pie chart** is most suitable: the four spending areas are parts of one whole budget and add to 100%, so their sectors show each area's share at a glance.

Q8. Mean = $\frac{12 + 15 + 11 + 18 + 16 + 21}{6} = \frac{93}{6} = 15.5$, i.e. **\$15 500** per month.

Q9. Savings = 15% of \$60 000 = $0.15 \times 60\,000 = \$9000$. Tax is 25%, so its angle = $0.25 \times 360^\circ = 90^\circ$.

Q10. In a 3-D pie the tilt makes the **front slices appear larger** than back slices of the same value, so the picture no longer matches the real percentages. Fix it by using a **flat 2-D pie chart** (or a bar chart), where each slice's size is proportional to its value.

Q11. Height and mass are **two numerical variables**, and the question is about their **relationship**, so a **scatter plot** is correct — each person is one point, and an upward pattern would show taller people tending to have greater mass.

Q12. Store A's quarterly values are 8, 12, 10, 15 hundred, so the total is $8 + 12 + 10 + 15 = 45$ hundred = 4500 deliveries.

Q13. The four cities are **categories** with no natural order or in-between values, so joining them with a line falsely suggests a trend from one city to the next. A **column/bar chart** compares the cities' rainfall correctly.

Q14. Percentage = $\frac{72}{360} \times 100\% = 20\%$.

Q15. Starting the axis at \$90 000 instead of \$0 is a **truncated (non-zero) axis**, which exaggerates the differences between quarters. Draw it honestly with the **vertical axis starting at \$0**.

Q16. (a) To compare the four products' totals, use a **column/bar chart**. (b) To show each product's share of the total, use a **pie chart**.

Q17. The "Yes" fraction is $\frac{216}{360} = 0.6 = 60\%$, so the number of people is $0.6 \times 400 = 240$.

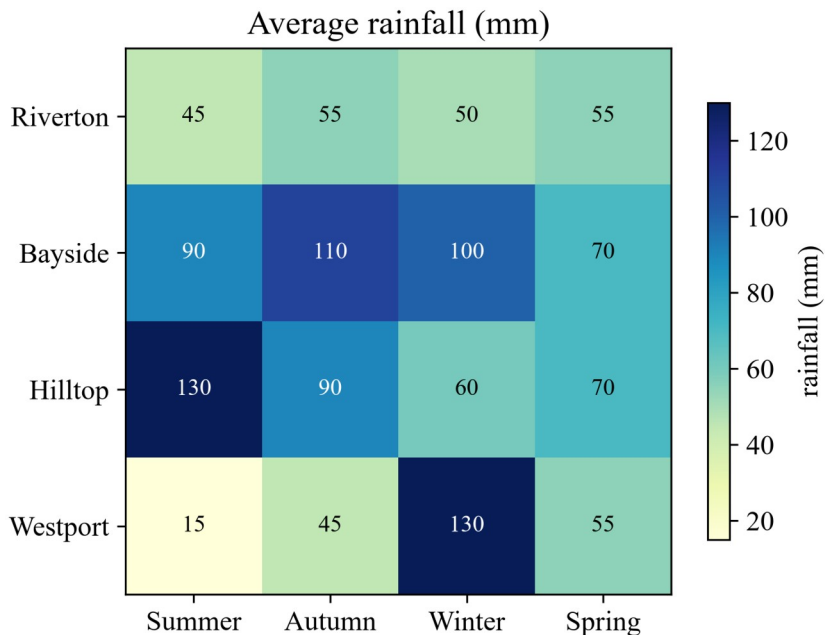
Q18. A **line graph** is best: the daily maximum temperatures form a series **over time**, and a line shows how they rise and fall through the year. A **pie chart** would not work because the daily temperatures are not parts of a single total — you cannot add them into a meaningful "whole".

Theory

Newspapers, websites, business dashboards and apps now show data in ways that go well beyond the bar chart and pie chart. These **contemporary displays** pack a lot of information into one picture. You are not expected to draw them by hand — the skill is to **read and interpret** them, and to judge when each one is a good (or a misleading) choice.

Heat maps.

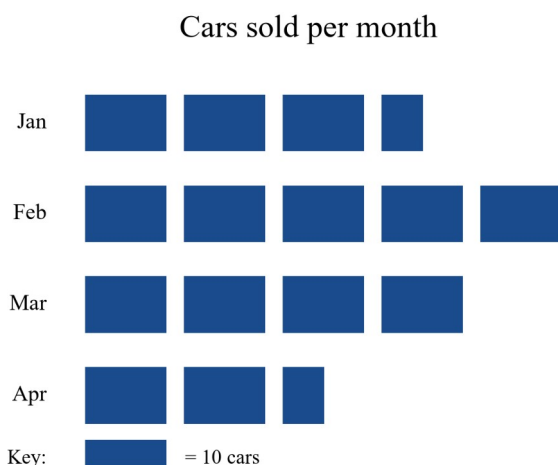
A **heat map** shows values in a grid of coloured cells: the colour (or its darkness) represents the size of the value, so patterns jump out at a glance. It suits data with **two categories** — one along the rows, one along the columns.



To read a heat map, find the cell where the row and column meet and read its value (here the cells are labelled). The darkest cells are the largest values: Hilltop in summer and Westport in winter both had 130 mm, while Westport in summer had the least, 15 mm.

Pictograms.

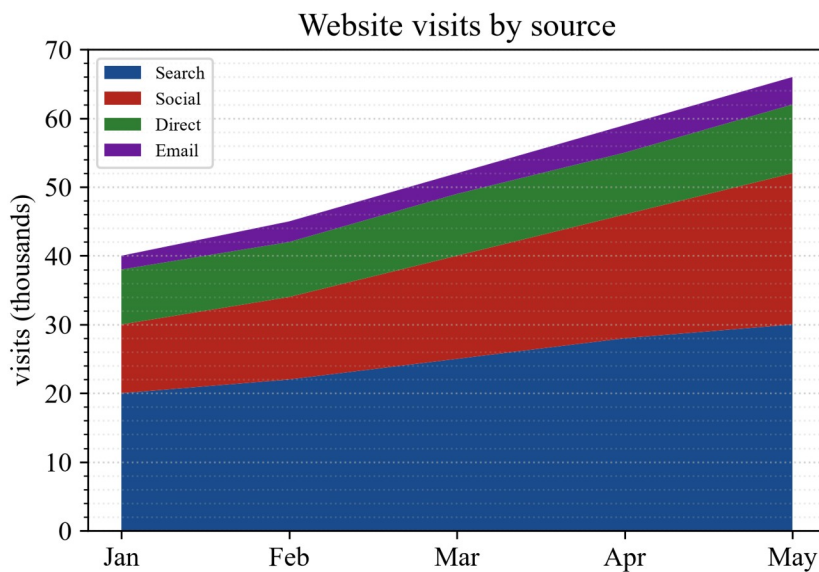
A **pictogram** uses a repeated symbol to show an amount, with a **key** telling you how much one symbol represents. Part-symbols show part-amounts.



Here one symbol = 10 cars, so February's five symbols mean 50 cars and January's three-and-a-half symbols mean 35 cars. **Watch out:** if a pictogram makes a symbol *bigger* (taller *and* wider) to show "more", the area grows much faster than the amount and the picture exaggerates the difference.

Stacked area charts.

A **stacked area chart** shows how the parts of a total change over time. Each coloured band is one category; the height of a band is its value, and the top of the stack is the **total**.



Read a single band by its thickness, and the total by the top edge. Above, website visits grow from 40 thousand in January to 66 thousand in May, with “Search” the biggest source every month.

Radar (spider) charts.

A **radar chart** plots several variables on spokes coming out from a centre, so you can compare a few items across many features at once. A point far from the centre is a high score. They suit comparing **profiles** (e.g. two products across the same features).

Bubble charts.

A **bubble chart** is a scatterplot with a third variable shown by the **size** of each point (bubble). It suits three numerical variables at once.

Sunburst charts.

A **sunburst** is a set of nested rings showing a **hierarchy** — the inner ring is the main categories and each outer ring breaks a category into its parts. The angle of a segment shows its share of the whole.

Marimekko (Mekko) charts.

A **Marimekko** chart is a stacked bar chart in which the **width** of each column also carries meaning (e.g. the size of each market), so both the column width and the coloured heights are data.

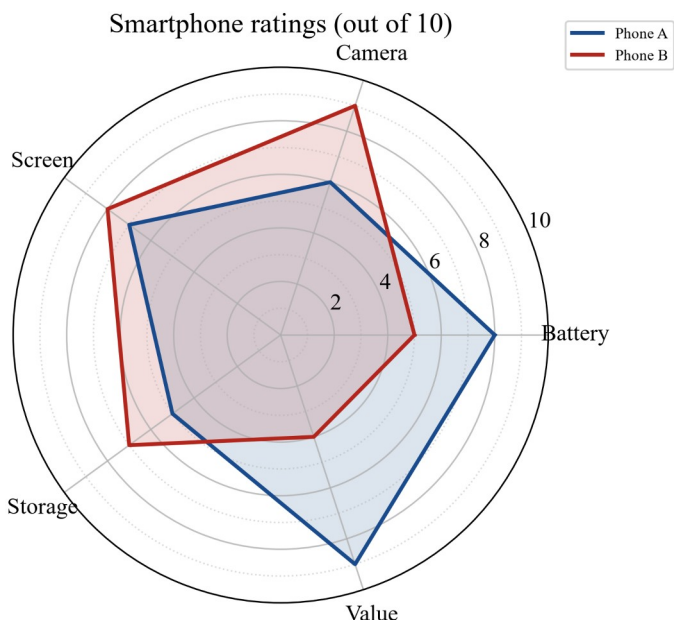
Choosing (and questioning) a display.

Match the display to the data: two categories → heat map; parts of a total over time → stacked area; a profile across features → radar; three numeric variables → bubble; a hierarchy → sunburst. And always ask whether the display is **fair**: are the colours or symbol sizes proportional to the values, or do they exaggerate?

Worked examples

Example 1 — scaffolded

The radar chart compares two smartphones, each rated out of 10 on five features.



Working

Phone A's camera point is on the "6" ring.
 Phone B's camera point is on the "9" ring.
 So Phone B is better for the camera (9 vs 6).
 Phone A's furthest point is on "Value" at 9.
 Phone A beats Phone B on Battery (8 vs 5) and Value (9 vs 4); Phone B beats Phone A on Camera, Screen and Storage.

Comment

Follow the "Camera" spoke out from the centre.
 Phone B's polygon reaches further on that spoke.
 A point further from the centre is a higher score.
 Its highest-scoring feature.
 Compare the two polygons spoke by spoke.

Example 2 — scaffolded

Use the **stacked area chart** of website visits (in the Theory) to answer the following.

Working

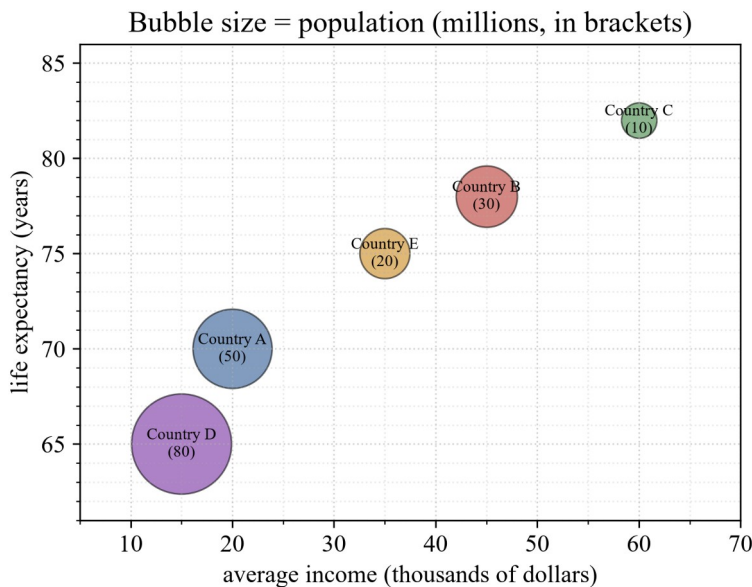
The top of the stack in May is at 66 (thousand).
 The "Search" band in May runs from 0 up to 30.
 "Social" grows from 10 (Jan) to 22 (May), a rise of 12 thousand.
 "Search" is the thickest band in every month, so it is the largest source all year.

Comment

The top edge shows the total.
 The bottom band is read from the axis directly.
 Read the band's thickness in each month.
 Compare band thicknesses across time.

Example 3 — unscaffolded

The bubble chart shows five countries: average income (horizontal), life expectancy (vertical) and population (bubble size).



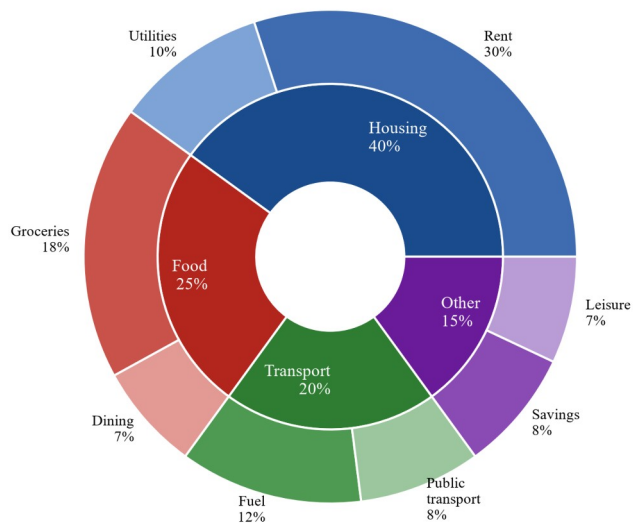
Country C's bubble is the highest, at a life expectancy of 82 years, and it is also the furthest right, so it has the highest average income (\$ 60 thousand). Country D has by far the **largest** bubble, so the biggest population (80 million), yet it sits lowest and furthest left — the lowest life expectancy and income. Reading across the chart, bubbles to the right (higher income) tend to sit higher (higher life expectancy).

∴ higher-income countries here tend to have higher life expectancy, and the largest-population country (D) has the lowest income and life expectancy.

Example 4 — unscaffolded

A household wants to show how its whole budget splits into major categories and then into individual items. Which contemporary display best suits this, and what does it show?

Household budget (% of total)



A **sunburst** is ideal, because the data is a **hierarchy** (categories that break into sub-items). The inner ring shows the four major categories — Housing 40 %, Food 25 %, Transport 20 %, Other 15 % of the total — and the outer ring splits each one, so Rent (30 % of the whole budget) is the single largest item, sitting inside Housing.

∴ a sunburst suits this hierarchical budget; it shows Housing as the biggest category (40 %) and Rent as the biggest single item (30 %).

Practice questions

Scaffolded

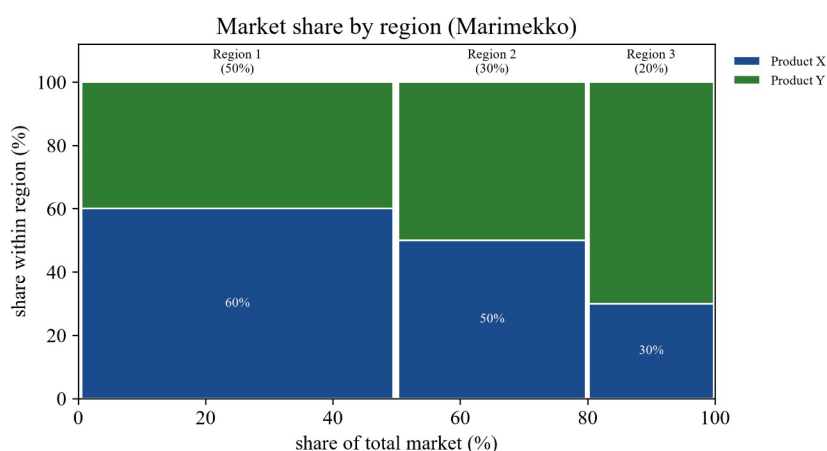
Q1. Use the **pictogram** of cars sold (in the Theory), where one symbol = 10 cars.

- (a) How many cars were sold in March?
- (b) How many cars were sold in April?
- (c) How many cars were sold across all four months?

Q2. Use the **heat map** of rainfall (in the Theory).

- (a) How much rain fell in Bayside in autumn?
- (b) Which city and season had the least rain?
- (c) Which city's rainfall changed the least across the four seasons?

Q3. Use the **Marimekko** chart below, where each column's width is a region's share of the total market and the colours split each region between Product X and Product Y.



- (a) Which region is the largest market?
- (b) What percentage of Region 1 is Product X?
- (c) In which region does Product Y have its largest share?

Q4. Use the **sunburst** budget chart (in Worked example 4).

- (a) What percentage of the total budget is Transport?
- (b) Groceries make up what percentage of the total budget?
- (c) Name the two items that make up the Transport category.

Q5. Use the **stacked area** chart of website visits (in the Theory).

- (a) What was the total number of visits in January?
- (b) How many visits came from "Email" in May?
- (c) Did "Direct" visits change much over the five months?

Q6. For each data set, name the most suitable contemporary display and give a reason.

- (a) Comparing two athletes across six fitness measures.
- (b) Showing how a school's total enrolment splits into year levels and then into classes.
- (c) Rainfall for every month across five different towns.

Un scaffolded

Q7. From the rainfall **heat map**, what was the highest rainfall shown anywhere on the chart, and in which city and season did it occur? (Give one.)

Q8. From the rainfall **heat map**, find Bayside's total rainfall for the whole year.

- Q9.** From the **radar** chart, state each phone's single best feature and its score.
- Q10.** A shopper mainly wants long battery life and good value for money. Using the **radar** chart, which phone should they choose, and why?
- Q11.** From the **stacked area** chart, which source of website visits grew the most from January to May, and by how many thousand?
- Q12.** From the **stacked area** chart, by roughly how many thousand did total visits grow from January to May?
- Q13.** From the **bubble** chart, which country has the largest population, and how can you tell?
- Q14.** From the **bubble** chart, describe the general relationship between a country's income and its life expectancy.
- Q15.** From the **sunburst**, what is the largest single item in the whole budget, and what percentage of the total is it?
- Q16.** A pictogram shows apples picked, with one apple symbol = 20 apples. One row shows four-and-a-half apple symbols. How many apples does that row represent?
- Q17.** From the **Marimekko** chart, Product X has a 60 %, 50 % and 30 % share in Regions 1, 2 and 3, whose market shares are 50 %, 30 % and 20 %. Show that Product X's overall share of the whole market is 51 %.
- Q18.** A company shows its yearly profit for one product over ten years using a **heat map** with a single row of ten coloured cells. Explain why this is a poor choice of display, and name a better one.
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Answers

Q1. (a) 40. (b) 25. (c) 150. **Q2.** (a) 110 mm. (b) Westport in summer (15 mm). (c) Riverton (only 45–55 mm). **Q3.** (a) Region 1 (widest column, 50 % of the market). (b) 60 %. (c) Region 3 (70 %). **Q4.** (a) 20 %. (b) 18 %. (c) Fuel and Public transport. **Q5.** (a) 40 thousand. (b) 4 thousand. (c) No — it stayed near 8–10 thousand. **Q6.** (a) radar chart (compares several features for a few items). (b) sunburst (a hierarchy: levels then classes). (c) heat map (two categories: town and month). **Q7.** 130 mm — Hilltop in summer (or Westport in winter). **Q8.** $90 + 110 + 100 + 70 = 370$ mm. **Q9.** Phone A: Value, 9. Phone B: Camera, 9. **Q10.** Phone A — it scores higher on both Battery (8 vs 5) and Value (9 vs 4). **Q11.** “Social”, by 12 thousand (10 → 22). **Q12.** About 26 thousand (40 → 66). **Q13.** Country D — it has the largest bubble. **Q14.** Higher income tends to go with higher life expectancy (a positive relationship). **Q15.** Rent, 30 % of the total budget. **Q16.** $4.5 \times 20 = 90$ apples. **Q17.** $0.50 \times 60 + 0.30 \times 50 + 0.20 \times 30 = 30 + 15 + 6 = 51$ %. **Q18.** A single row of colours makes it very hard to read exact values or a trend; a line graph shows the year-to-year change clearly.

Fully-worked solutions

Q1. One symbol = 10 cars. (a) March shows four full symbols: $4 \times 10 = 40$ cars. (b) April shows two-and-a-half symbols: $2.5 \times 10 = 25$ cars. (c) Total = $35 + 50 + 40 + 25 = 150$ cars.

Q2. (a) The Bayside row, autumn column, reads 110 mm. (b) The palest (smallest) cell is Westport in summer, 15 mm. (c) Riverton’s four values are 45, 55, 50, 55 — a spread of only 10 mm, the most even of the four cities.

Q3. (a) Region 1 has the widest column, so it is the largest market (50 % of the total). (b) In Region 1 the Product X (lower) band fills 60 % of the column height. (c) Product Y is largest in Region 3, where it takes 70 % (the tallest Y band).

Q4. (a) Transport is the 20 % segment of the inner ring. (b) Groceries is an 18 % slice of the outer ring (part of Food). (c) The Transport category splits into Fuel (12 %) and Public transport (8 %), which add to 20 %.

Q5. (a) In January the top of the stack is at 40, so 40 thousand visits. (b) In May the “Email” band is 4 thick, so 4 thousand visits. (c) “Direct” stayed between 8 and 10 thousand — very little change.

Q6. (a) A **radar chart** compares one item across many features, so it suits two athletes across six fitness measures. (b) A **sunburst** shows a hierarchy — total → year levels → classes. (c) A **heat map** suits two categories at once (town × month) with colour showing the rainfall.

Q7. The darkest cells are the largest values: 130 mm, at Hilltop in summer (Westport in winter is also 130 mm).

Q8. Bayside’s four seasonal values are 90, 110, 100, 70; their sum is $90 + 110 + 100 + 70 = 370$ mm.

Q9. Phone A reaches furthest on the Value spoke, scoring 9. Phone B reaches furthest on the Camera spoke, scoring 9.

Q10. Compare the two spokes that matter. Battery: A = 8, B = 5. Value: A = 9, B = 4. Phone A is higher on both, so the shopper should choose **Phone A**.

Q11. Read each band’s thickness in January and May: Search 20 → 30 (+10), Social 10 → 22 (+12), Direct 8 → 10 (+2), Email 2 → 4 (+2). “Social” grew the most, by 12 thousand.

Q12. The total is the top of the stack: 40 thousand in January and 66 thousand in May, a rise of $66 - 40 = 26$ thousand.

Q13. Bubble size represents population, and Country D has clearly the largest bubble, so it has the largest population (80 million).

Q14. The bubbles to the right (higher income) generally sit higher (higher life expectancy), so there is a **positive** relationship: higher income tends to go with higher life expectancy.

Q15. Every outer segment is a percentage of the whole budget; the largest is Rent at 30 % (inside the Housing category).

Q16. Each symbol is 20 apples, so four-and-a-half symbols represent $4.5 \times 20 = 90$ apples.

Q17. Product X's share of the whole market is its share of each region weighted by that region's market size:

$$0.50 \times 60 \% + 0.30 \times 50 \% + 0.20 \times 30 \% = 30 \% + 15 \% + 6 \% = 51 \%.$$

Q18. A single row of coloured cells forces the reader to judge values from colour alone, which is imprecise, and a trend over time is hard to see. Profit over ten years is a single quantity changing with time, so a **line graph** (or a column graph) shows the year-to-year pattern far more clearly.