

VCE VM Numeracy Units 3 & 4

Chapter 10 — Systematics

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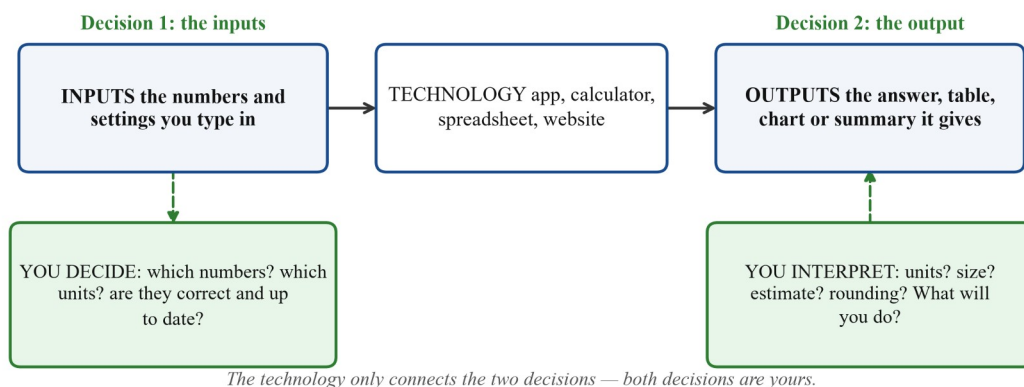
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Theory

Every time you use a digital tool — a calculator, an app, a spreadsheet, a website — the same thing happens. You type numbers **in**, the tool works on them, and it hands numbers **back**. The tool is fast and it is confident, but it is not checking anything. It cannot know that you typed centimetres where it asked for metres, or last year's price, or a depth ten times too big. It multiplies whatever you typed and shows you the result, neatly formatted. So a technology answer is only ever as good as two decisions the technology cannot make for you: **what goes in**, and **what the output actually means**. This section is about making those two decisions on purpose.

Every tool is an input–output chain.



Inputs, technology, outputs — and the two decisions that stay yours

The middle box is the part you never have to think about: the app or calculator does its arithmetic correctly, every time. The two green boxes are the part you do. **Inputs** are the numbers and settings you type in — measurements, prices, rates, dates, choices. **Outputs** are what comes back — a single answer, a table, a chart, a quote, a fare. Between those two boxes sits every possible mistake, and not one of them produces an error message.

Decision 1: which numbers go in — relevant and appropriate.

A tool often shows you more boxes than the calculation needs, and asks for numbers in units you did not measure in. Two words keep this straight. Information is **relevant** if the calculation actually uses it. It is **appropriate** if it is in the units the tool wants, up to date (this week's price, not last year's), and measured rather than guessed — or, if it must be guessed, guessed honestly.

Carly is about to paint one wall and opens a paint app, PaintMate. The screen asks her for eight things; the paint calculation needs four of them (below). The colour name, the roller brand, her phone number and the room's name are all perfectly real information — and not one of them changes how many litres of paint the wall needs.

Inputs the paint app NEEDS (relevant: the calculation uses them)	Inputs it does NOT need (irrelevant: they change nothing in the working)
✓ wall length: 5.4 m	✗ wall colour: Sage Green
✓ wall height: 250 cm (change to 2.5 m!)	✗ brand of roller you own
✓ number of coats: 2	✗ your phone number
✓ coverage from the can: 12 m ² per litre	✗ the name of the room

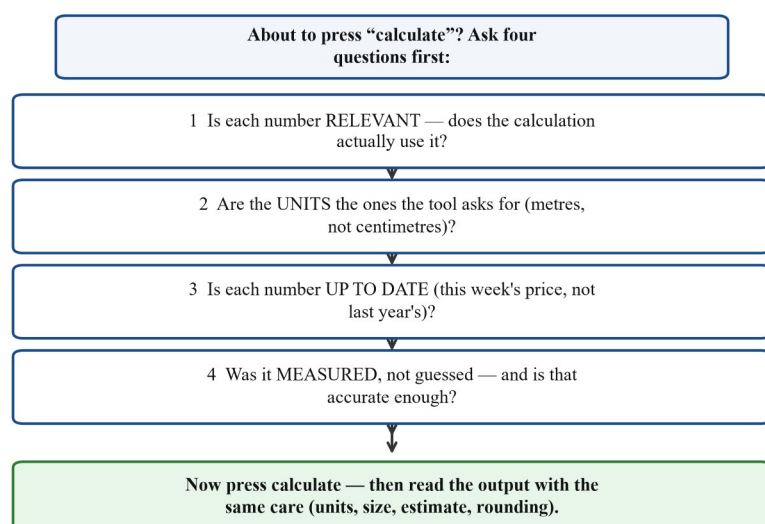
Colour matters when you BUY the paint — but it does not change how many litres the wall needs.

The four inputs the paint calculation needs, and the four it does not

Made-up data: the app's name and every value on the screen are made up for this section.

Notice the second row of the green panel. Carly's tape measure says the wall is 250 cm high, but the app asks for metres, so the appropriate input is $250 \div 100 = 2.5$ m. Typing 250 would not crash anything. It would simply return an answer 100 times too big, politely.

Four questions to ask before you press calculate.



*The tool never warns you that an input is wrong.
It multiplies whatever you typed, confidently.*

About to press calculate? Ask four questions first

The four questions are small and quick — relevant? right units? up to date? measured? — and a minute of asking catches exactly the mistakes that no error message will ever catch.

A worked model: reading a fare screen.

Tuan opens a ride app, QuickRide, and types in his trip: 12 km. The app shows two fares, one for now (peak) and one for after 9 pm (off-peak), and prints how each one is built:

- Peak: a \$3.50 starting fee plus \$2.10 per km.
- Off-peak: a \$3.50 starting fee plus \$1.80 per km.

Check both screens by hand. Peak: the distance charge is $12 \times 2.10 = \$25.20$, and adding the starting fee gives $25.20 + 3.50 = \$28.70$. Off-peak: the distance charge is $12 \times 1.80 = \$21.60$, and adding the starting fee gives

$21.60 + 3.50 = \$25.10$. Both screens match the hand calculation, so the outputs are believable — and the difference between them, $28.70 - 25.10 = \$3.60$, tells Tuan exactly what waiting until after 9 pm is worth.

QuickRide fare estimate	
Trip length	12 km
Time of day	5:15 pm (peak)
Flagfall	\$3.50
Cost per km	\$2.10
Fare: \$28.70	

QuickRide fare estimate	
Trip length	12 km
Time of day	9:30 pm (off-peak)
Flagfall	\$3.50
Cost per km	\$1.80
Fare: \$25.10	

Same trip, same app — one different input (the time) changes the output.
Travelling after peak saves \$3.60.

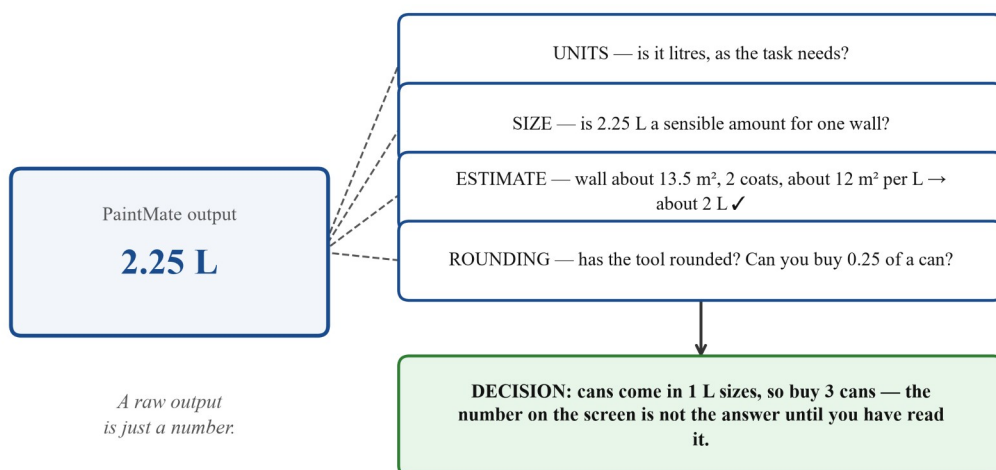
Two QuickRide screens for the same 12 km trip

Made-up data: the app's name and every fare on the two screens are made up for this section.

About the data in this section. The ride fares, paint and potting-mix calculators, electricity and water readings, print quotes, library loans, step counts and fridge energy figures in this section are **made up** (not real): pretend businesses and pretend numbers, built for this book so you can practise the maths. Nothing here is real data about a real business or person.

Decision 2: reading the output mathematically.

An output is not an answer yet. It is a number waiting for you to read it, and four checks do the reading. Using Carly's paint screen (below): **units** — is the output in litres, the thing she actually buys? **size** — is 2.25 L a sensible amount for one wall? **estimate** — the wall is about 13.5 m^2 per coat, 2 coats is about 27 m^2 , and at about 12 m^2 per litre that is a bit over 2 L, so 2.25 sits right beside the estimate; **rounding** — has the tool rounded anything, and can she actually buy 0.25 of a can? Cans come in 1 L sizes, so the screen's 2.25 L becomes a decision: buy 3 cans.



Four checks on one output: 2.25 L of paint

Made-up data: the app's name and every number on the screen are made up for this section.

Rounding: name the precision, then keep full precision until the end.

Every rounded answer in this book states its precision — “to the nearest cent”, “to 1 decimal place” — because a rounded number is a choice, and someone has to make that choice on purpose. Money is counted to the nearest cent: a mean of 36.557142857... dollars is \$36.56 to the nearest cent, and saying so is part of the answer. The other half of

the rule is to round at the **end**, not along the way. Round that mean to \$36.56 first and then multiply by 30 days and you get \$1 096.80; carry the full display through and you get \$1 096.71. That is nine cents of drift created purely by rounding early. Example 2 walks both paths.

When the output is a table or a chart.

The same four checks apply, plus one extra habit: read the title, the column headings and the units **before** you read a single number, so you know what you are looking at. Then look for the shape of the data — a total row to check against your own addition, a trend across the rows, and any single value that does not fit the pattern at all (one month double every other, one day far above the mean). That odd value is usually the most interesting number on the page: either something really happened, or something was typed wrong. You will practise all of it on a water-use chart in Q10 and a library loans table in Q13.

Worked examples

Example 1 — scaffolded

Carly's wall is 5.4 m long and 250 cm high. She will paint it 2 coats. The paint she likes covers about 12 m² per litre and sells in 1 L cans at \$26 each; a 4 L can of the same paint costs \$79. She types length 5.4, height 2.5, coats 2 and coverage 12 into PaintMate, and the screen shows 2.25 L. Check the screen, and turn its output into a buying decision.

Working	Comment
Height in the units the app wants: $250 \div 100 = 2.5$ m.	Her tape said 250 cm; the app asks for metres.
Area of one coat: $5.4 \times 2.5 = 13.5$ m ² .	Length times height.
Area to cover, 2 coats: $13.5 \times 2 = 27$ m ² .	Every square metre of wall gets painted twice.
Paint needed: $27 \div 12 = 2.25$ L — the screen agrees.	The paint covers 12 m ² per litre.
Estimate: $24 \div 12 = 2$ and $36 \div 12 = 3$, so $27 \div 12$ must land between 2 and 3, nearer 2.	The screen's 2.25 is believable.
Cans: 2.25 L means 3 cans, since nobody sells a quarter can; $3 \times 26 = \$78$.	Round up to the next whole can.
\$78 is less than the \$79 a single 4 L can costs, so three 1 L cans it is.	The output 2.25 L has become a decision: buy 3 cans.

Example 2 — scaffolded

Julia's electricity app, MeterMate, shows what each day of last week cost her (table below). She wants the week's total and mean, checked against an estimate, and then a 30-day cost figure to test against her \$1 100 monthly budget. State money answers to the nearest cent.

Day	Mon	Tue	Wed	Thu	Fri	Sat	Sun
Cost (\$)	34.20	38.75	35.60	40.15	36.90	39.80	30.50

Made-up data: Julia's name and every daily cost in the table are made up for this section.

Working	Comment
Total: $34.20 + 38.75 + 35.60 + 40.15 + 36.90 + 39.80 + 30.50 =$.	Add the seven daily outputs; the app's total row agrees.
Estimate: a typical day looks like \$36 to \$37, so the week should sit between $7 \times 36 = \$252$ and $7 \times 37 = \$259$.	\$255.90 is inside that window, so the total is believable.
Mean: $255.90 \div 7 = 36.557142857 \dots$, i.e. \$36.56 to the nearest cent.	Money stops at cents — say so. Keep the full display for the next step.
30 days at full precision:	Round once, at the very end.

$36.557142857 \dots \times 30 = 1\,096.7142857 \dots$, i.e. \$1 096.71 to the nearest cent.

From the rounded mean instead:

$36.56 \times 30 = \$1\,096.80$ — nine cents higher.

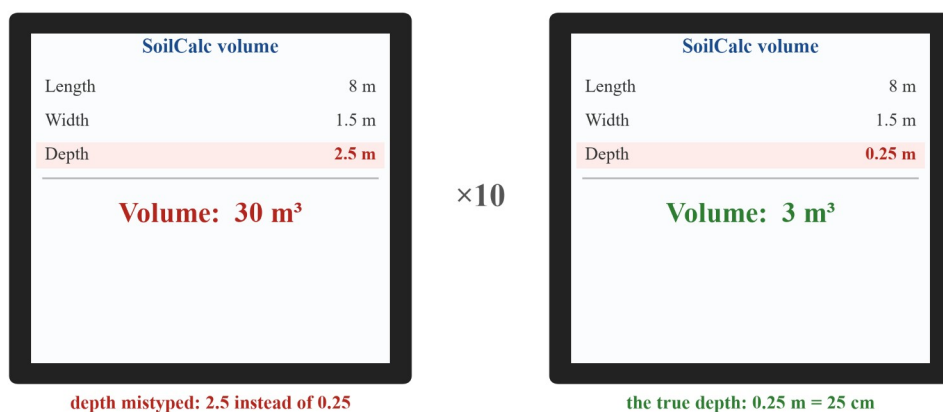
Budget: \$1 096.71 is under \$1 100, by
 $1\,100 - 1\,096.71 = \$3.29$.

Rounding early drifts the answer; carry full precision through.

The output becomes a decision: the budget just holds.

Example 3 — unscaffolded

Gus is filling a raised garden bed 8 m long, 1.5 m wide and 25 cm deep with potting mix. He types length 8, width 1.5 and depth 2.5 into a potting-mix calculator, SoilCalc, and the screen (left, below) reports 30 m³. Potting mix costs \$38.50 per m³. Should Gus order 30 m³?



one missed decimal point
 makes the output 10 times too big

Two SoilCalc screens for the same garden bed

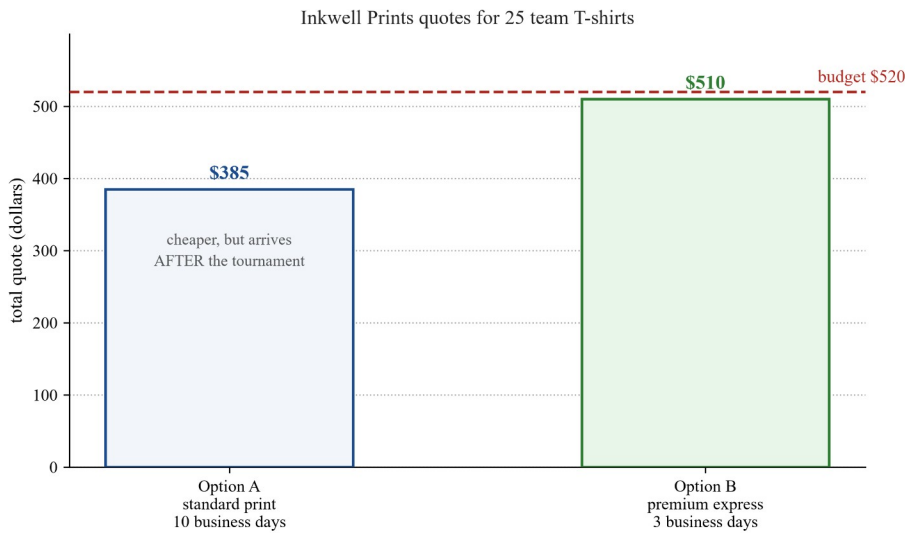
Made-up data: the calculator's name and every number on the two screens are made up for this section.

The input to check first is the depth. The bed is 25 cm deep and the calculator asks for metres, so the appropriate input is $25 \div 100 = 0.25$ m — Gus typed 2.5, ten times too big. With the true depth the volume is $8 \times 1.5 \times 0.25 = 3$ m³ (right screen), while Gus's inputs give $8 \times 1.5 \times 2.5 = 30$ m³: his output is exactly 10 times the truth, and the screen warns him about nothing. At \$38.50 per m³ the true volume costs $3 \times 38.50 = \$115.50$, while ordering from the wrong screen would cost $30 \times 38.50 = \$1\,155.00$ — an overquote of $1\,155.00 - 115.50 = \$1\,039.50$ for soil that would not fit in the bed.

$\therefore$ the screen's 30 m³ is wrong: the bed needs 3 m³, costing \$115.50, and Gus must fix the depth input before he orders anything.

Example 4 — unscaffolded

Sione's team needs 25 T-shirts printed in time for a tournament in 5 business days, and his club's budget is \$520. Inkwell Prints quotes two options (below). Option A, standard print: \$14 per shirt plus a \$35 setup fee, 10 business days. Option B, premium express: \$18 per shirt plus a \$60 setup fee, 3 business days. Which option should Sione choose?



Inkwell Prints' two quotes for 25 team T-shirts

Made-up data: the printer's name and both quotes are made up for this section.

Option A costs $25 \times 14 = \$350$ of printing plus the \$35 setup fee, so $350 + 35 = \$385$ — but 10 business days is after the tournament, so the shirts would arrive too late to wear. Option B costs $25 \times 18 = \$450$ plus the \$60 setup fee, so $450 + 60 = \$510$, which fits the \$520 budget, and 3 business days meets the deadline with time to spare. Option A is the cheaper quote by $510 - 385 = \$125$, but a cheaper quote that arrives after the tournament is not cheaper — it is useless.

$\therefore$ Sione chooses Option B: \$510 sits inside the \$520 budget and 3 business days meets the 5-day deadline, while Option A's \$385 arrives too late to use.

Practice questions

Scaffolded

Q1. Taj's parcel weighs 2.6 kg, and a postage app charges \$3.25 per kg of parcel mass. The same screen also shows an estimated delivery time of 3 days.

- Which two numbers on the screen does the cost calculation actually use, and which shown number does it not use at all?
- Work out the cost of posting the parcel, to the nearest cent.
- Check your answer with an estimate: 2.6 kg lies between 2 kg and 3 kg. What two costs does that put your answer between, and does your (b) sit between them?

Q2. A baking app scales recipes up and down. Lucy's recipe needs 1.5 kg of flour, and the app's input box is labelled "grams".

- How many grams is 1.5 kg?
- Lucy types 1.5 into the grams box. The app's output is now how many times smaller than the flour the recipe actually needs?
- In one sentence: what was wrong with her input, and what should she have typed?

Q3. Freda's beading app tracks her usual supplier's price per packet of beads: \$1.80 per packet last month, \$1.95 per packet this month. Freda buys 12 packets.

- What would 12 packets have cost at last month's price?
- What do 12 packets cost at this month's price?
- How much more is your (b) than your (a)?

Q4. Nikhil's club must raise \$1 250 for new gear, and a fundraiser app offers to split the target equally between the 18 club members.

- (a) What is each member's share, to the nearest cent?
- (b) Check by multiplying: what do 18 shares of exactly that size add up to?
- (c) How far short of \$1 250 is that total, and what does it tell you about rounding a share down to the nearest cent?

Q5. A cleaning app works out rug areas from two typed lengths. Alice's rug measures 2.9 m by 1.9 m, and the app's screen shows 5.51 m².

- (a) Estimate the rug's area first, by rounding each side to the nearest metre.
- (b) Work out the exact area.
- (c) Does the screen agree with your exact answer, and does it sit near your estimate?

Q6. A grocery app shows Kurt two packs of the same coffee: 750 g for \$4.20, and 1 kg for \$5.45.

- (a) What is the 750 g pack's price per kilogram?
- (b) Which pack is cheaper per kilogram?
- (c) How much does the cheaper pack save per kilogram?

Unscaffolded

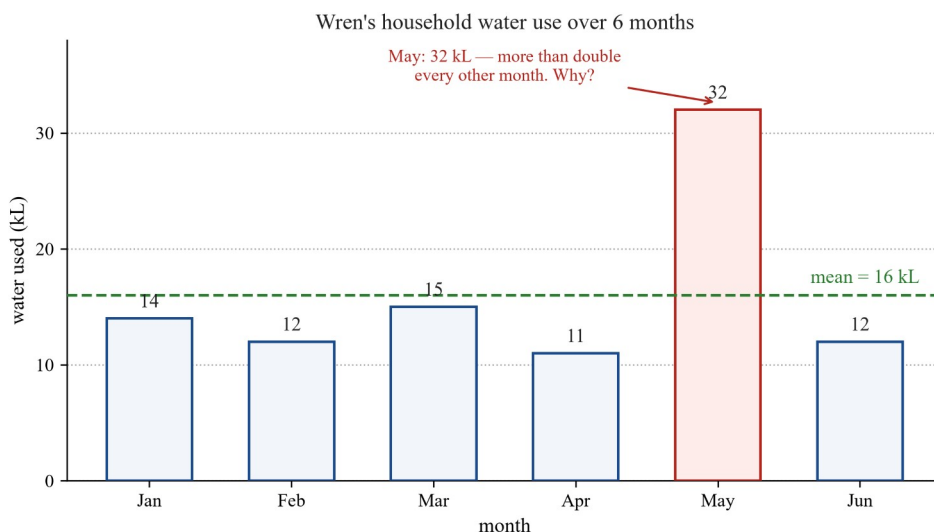
Q7. An online booking site quotes Ivan \$45 an hour for hall hire, plus a \$60 cleaning fee on every booking. He books the hall for 6 hours, and his event budget is \$300. Will the booking fit the budget? Show the quote and the gap either way.

Q8. Ash's shade-cloth calculator asks for lengths in metres. His garden patch measures 3.6 m by 2.4 m, but Ash types 360 and 240 — his tape measure's centimetre readings — and the screen reports 86 400. Work out the true area, then work out how many times too big the screen's output is, and why it is exactly that many times.

Q9. Two pool apps quote Eva a membership. Coast Pool: \$18 per week, no fees. AquaPass: \$65 per 4 weeks, plus a \$30 one-off card fee. Compare the two over 12 weeks and again over 24 weeks: which is cheaper each time, and by how much? Why does the winner change?

Q10. Wren’s water app charts her household’s water use for six months (below).

- What is the six-month total, and the mean use per month to 1 decimal place?
- One month does not fit the pattern at all. Which month, and what makes it stand out?
- Which month used the least water?



Wren’s household water use over six months

Made-up data: Wren’s name and every reading in the chart are made up for this section.

Q11. Rafiq’s electricity app says his home uses about 145 kWh a week. His current price is 26.4 c per kWh, and a retailer’s offer is 29.8 c per kWh. What would a week cost at each price, to the nearest cent, and what is the difference per week?

Q12. A fencing calculator quotes Vince \$85 per metre of fence. His run of fence measures 24.6 m, but “to be safe” he types 30 m, and the screen quotes \$2 550. Work out the quote the true measurement gives, and how much the rounded-up input adds to the quote.

Q13. A library’s borrowing app summarises last week’s loans (table below).

- How many items were loaned out across the six days?
- What is the mean number of loans per day, to 1 decimal place?
- On which days were loans above that mean?

Day	Mon	Tue	Wed	Thu	Fri	Sat
Loans	132	98	145	110	165	240

Made-up data: the library’s name and every count in the table are made up for this section.

Q14. A mowing app estimates job time at 40 minutes per yard. Yusuf knows that yards on his block take him 55 minutes on average. For a Saturday of 12 yards, what time does the app predict (in hours), what time should he really expect (in hours), and by how much does the app understate his day?

Q15. Tilda’s recipe app scales ingredient lists. Her cake serves 4 and needs 300 g of flour and 120 g of butter; she wants 10 servings. Work out the scale factor the app should use, and the flour and butter it should then show. Tilda then notices she typed the servings as 6, not 10: work out the factor the app actually used, the flour it showed, and how many grams of flour short of the true 10-serving amount that leaves her.

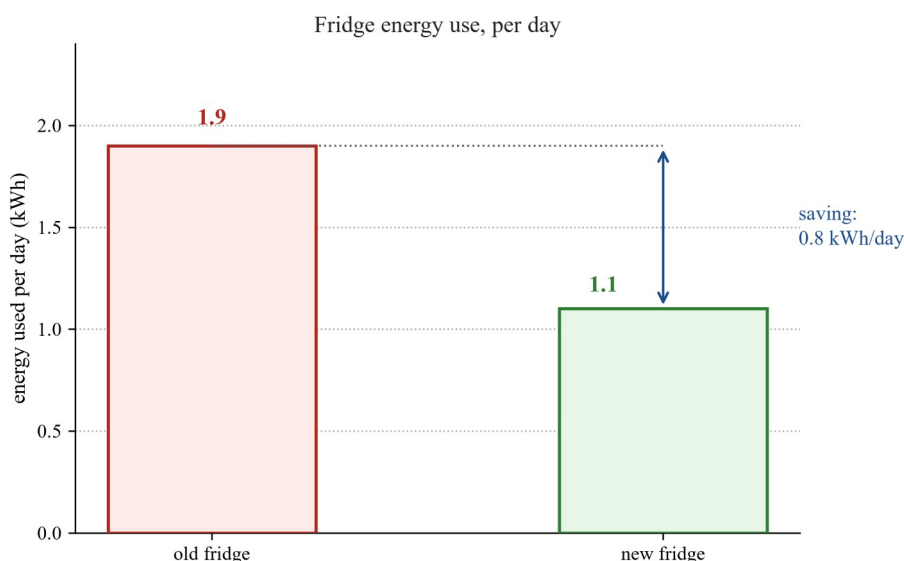
Q16. Marta’s party app quotes a venue at \$180 plus catering at \$9.50 a head. For 25 guests the total comes out over her \$400 budget. Work out the total for 25 guests and the amount by which it is over, then the total for 23 guests, and say whether 23 guests fits the budget.

Q17. Dex’s phone counts 8 450 steps in a day and turns steps into distance using a step length of 0.8 m. His watch, set to a step length of 0.7 m, counts the same steps.

- What distance does the phone report, in km?
- What distance does the watch report, in km to 1 decimal place?
- Using the watch’s unrounded distance, how much shorter is it than the phone’s, to 2 decimal places?

Q18. Olive’s energy app charts her old fridge at 1.9 kWh per day and a new efficient model at 1.1 kWh per day (below). Electricity costs 28 c per kWh, and the new fridge costs \$1 249.

- How much energy would the new fridge save per day, and how much per week for each fridge?
- How many kWh is that saving over a year of 365 days, and what is the year’s saving in dollars, to the nearest cent?
- How many years of savings, to 1 decimal place, would cover the fridge’s \$1 249 price — and does 15 whole years of savings quite reach it?



Fridge energy use per day, old versus new

Made-up data: both energy readings and the fridge price are made up for this section.

Answers

- Q1.** (a) the mass 2.6 kg and the rate \$3.25 per kg; the 3-day delivery estimate is not used. (b) \$8.45. (c) between $2 \times 3.25 = \$6.50$ and $3 \times 3.25 = \$9.75$; yes, \$8.45 sits between them.
- Q2.** (a) 1 500 g. (b) 1 000 times smaller. (c) the box is labelled grams, so her 1.5 was read as 1.5 g; she should have typed 1500.
- Q3.** (a) \$21.60. (b) \$23.40. (c) \$1.80 more.
- Q4.** (a) \$69.44. (b) \$1 249.92. (c) \$0.08 short — rounding a share down always undershoots the target, so the club should round the share up instead.
- Q5.** (a) about $3 \times 2 = 6 \text{ m}^2$. (b) 5.51 m^2 . (c) yes — the screen matches the exact area, and 5.51 sits near the estimate of 6.
- Q6.** (a) \$5.60 per kg. (b) the 1 kg pack, at \$5.45 per kg. (c) \$0.15 per kg.
- Q7.** Hire $45 \times 6 = \$270$, plus the \$60 fee: \$330. No — the \$300 budget is \$30 short.
- Q8.** True area 8.64 m^2 . The screen's 86 400 is 10 000 times too big, because each side was typed 100 times too long and area multiplies both sides: $100 \times 100 = 10\,000$.
- Q9.** 12 weeks: Coast \$216 against AquaPass \$225 — Coast, by \$9. 24 weeks: Coast \$432 against AquaPass \$420 — AquaPass, by \$12. The \$30 card fee is paid once only, so it weighs half as much per week over 24 weeks as over 12.
- Q10.** (a) 96 kL; mean 16.0 kL. (b) May, at 32 kL — more than double every other month. (c) April, at 11 kL.
- Q11.** \$38.28 at 26.4 c per kWh; \$43.21 at 29.8 c per kWh; a difference of \$4.93 a week.
- Q12.** \$2 091.00 from the true measurement; the rounded-up input adds \$459.00.
- Q13.** (a) 890 loans. (b) 148.3 loans per day. (c) Friday and Saturday.
- Q14.** App: 480 minutes = 8 h. Real: 660 minutes = 11 h. The app understates the day by 3 h.
- Q15.** Factor 2.5; flour 750 g and butter 300 g. Mistyped factor 1.5; flour 450 g; that is 300 g of flour short.
- Q16.** 25 guests: \$417.50, over the budget by \$17.50. 23 guests: \$398.50 — that fits.
- Q17.** (a) 6.76 km. (b) 5.9 km. (c) 0.85 km (the unrounded gap is 0.845 km).
- Q18.** (a) 0.8 kWh per day; 13.3 kWh against 7.7 kWh per week. (b) 292 kWh; \$81.76. (c) 15.3 years; no — 15 years of savings is \$1 226.40, still under \$1 249.
-

Fully-worked solutions

- Q1.** (a) The cost is mass times rate, so the calculation uses 2.6 kg and \$3.25 per kg; the delivery estimate changes nothing in the cost. (b) $2.6 \times 3.25 = \$8.45$. (c) $2 \times 3.25 = \$6.50$ and $3 \times 3.25 = \$9.75$; \$8.45 lies between the two, so the screen is believable.
- Q2.** (a) $1.5 \times 1000 = 1500 \text{ g}$. (b) The app read her 1.5 as 1.5 g; $1500 \div 1.5 = 1000$, so the output is 1 000 times smaller than the flour the recipe needs. (c) The input box is labelled grams, so the number had to be typed in grams: 1500, not 1.5.
- Q3.** (a) $12 \times 1.80 = \$21.60$. (b) $12 \times 1.95 = \$23.40$. (c) $23.40 - 21.60 = \$1.80$.
- Q4.** (a) $1250 \div 18 = 69.444444\dots$, so \$69.44 to the nearest cent. (b) $18 \times 69.44 = \$1\,249.92$. (c) $1250 - 1249.92 = \$0.08$ short: rounding every share down always leaves the target short, so here the share should be rounded up, not down.

- Q5.** (a) Rounding the sides to 3 m and 2 m gives about $3 \times 2 = 6 \text{ m}^2$. (b) $2.9 \times 1.9 = 5.51 \text{ m}^2$. (c) The screen's 5.51 m^2 matches the exact area, and it sits near the estimate of 6 m^2 , so the output is believable.
- Q6.** (a) 750 g is 0.75 kg, so $4.20 \div 0.75 = \$5.60$ per kg. (b) The 1 kg pack costs \$5.45 per kg, which is under \$5.60 per kg, so the 1 kg pack is cheaper. (c) $5.60 - 5.45 = \$0.15$ saved per kilogram.
- Q7.** Hire: $45 \times 6 = \$270$. Quote: $270 + 60 = \$330$. His budget is \$300, so the booking does not fit: $330 - 300 = \$30$ short.
- Q8.** True area: $3.6 \times 2.4 = 8.64 \text{ m}^2$. Entered: $360 \times 240 = 86\,400$. The ratio is $86\,400 \div 8.64 = 10\,000$, so the output is 10 000 times too big. The reason: each side was typed in centimetres, i.e. 100 times too long, and an area multiplies both sides together, $100 \times 100 = 10\,000$.
- Q9.** 12 weeks is three 4-week blocks: Coast $18 \times 12 = \$216$; AquaPass $65 \times 3 + 30 = \$225$; Coast is cheaper by $225 - 216 = \$9$. 24 weeks is six blocks: Coast $18 \times 24 = \$432$; AquaPass $65 \times 6 + 30 = \$420$; AquaPass is cheaper by $432 - 420 = \$12$. The \$30 card fee is paid once only, so spread over 24 weeks it costs half as much per week as over 12 — that is why the winner changes.
- Q10.** (a) $14 + 12 + 15 + 11 + 32 + 12 = 96 \text{ kL}$; mean $96 \div 6 = 16.0 \text{ kL}$. (b) May, at 32 kL — more than double the next-highest month (15 kL), so either something unusual happened or a reading was misread. (c) April, at 11 kL.
- Q11.** Current price: $145 \times 0.264 = \$38.28$. Offer: $145 \times 0.298 = \$43.21$. Difference: $43.21 - 38.28 = \$4.93$ per week.
- Q12.** Measured: $24.6 \times 85 = \$2\,091.00$. Guess: $30 \times 85 = \$2\,550$. The rounded-up input adds $2\,550 - 2\,091 = \$459.00$ to the quote — his “safety margin” is \$459.00 of fence that does not exist.
- Q13.** (a) $132 + 98 + 145 + 110 + 165 + 240 = 890$ loans. (b) $890 \div 6 = 148.3333\dots$, i.e. 148.3 loans per day to 1 decimal place. (c) Above 148.3: Friday (165) and Saturday (240) — the two busiest days, heading into the weekend.
- Q14.** App: $12 \times 40 = 480$ minutes, and $480 \div 60 = 8 \text{ h}$. Real: $12 \times 55 = 660$ minutes, and $660 \div 60 = 11 \text{ h}$. The app understates his Saturday by $11 - 8 = 3 \text{ h}$.
- Q15.** True factor: $10 \div 4 = 2.5$; flour $300 \times 2.5 = 750 \text{ g}$; butter $120 \times 2.5 = 300 \text{ g}$. With 6 typed: factor $6 \div 4 = 1.5$; flour $300 \times 1.5 = 450 \text{ g}$; shortfall $750 - 450 = 300 \text{ g}$ of flour — enough to notice in a cake.
- Q16.** 25 guests: catering $25 \times 9.50 = \$237.50$; total $180 + 237.50 = \$417.50$; over the \$400 budget by $417.50 - 400 = \$17.50$. 23 guests: catering $23 \times 9.50 = \$218.50$; total $180 + 218.50 = \$398.50$, which fits under \$400. The venue fee is fixed, so cutting two guests saves exactly $2 \times 9.50 = \$19.00$ — just enough.
- Q17.** (a) $8\,450 \times 0.8 = 6\,760 \text{ m}$, i.e. 6.76 km. (b) $8\,450 \times 0.7 = 5\,915 \text{ m}$, i.e. 5.915 km, which the watch shows as 5.9 km to 1 decimal place. (c) $6.76 - 5.915 = 0.845 \text{ km}$, i.e. 0.85 km to 2 decimal places: the shorter step length quietly deletes about 850 m of Dex's walking every day.
- Q18.** (a) $1.9 - 1.1 = 0.8 \text{ kWh}$ saved per day; per week the old fridge uses $1.9 \times 7 = 13.3 \text{ kWh}$ and the new one $1.1 \times 7 = 7.7 \text{ kWh}$. (b) $0.8 \times 365 = 292 \text{ kWh}$ in a year; at 28 c per kWh that is $292 \times 0.28 = \$81.76$ saved per year. (c) $1\,249 \div 81.76 = 15.2764\dots$, i.e. 15.3 years to 1 decimal place. Fifteen whole years saves $15 \times 81.76 = \$1\,226.40$, which is still under \$1 249 — so no, 15 years of savings does not quite reach the price.

Theory

Every day at work and at home, information arrives in a mess: handwriting on a clip-board, prices on a sign, times called out across a yard, answers phoned in. Turning that mess into something you can add up, put in order and learn from is a skill in its own right. This section is about the tools that help — and about recording data so those tools can actually use it.

By the end of this section you can:

- name computational tools and applications that collect, record, organise, sort and interpret data, and choose one that suits the job
- set out a table of records with one field per column, so the data stays usable
- sort and filter a table without breaking it, and read it with COUNT, SUM, AVERAGE, MAX and MIN
- say how online forms and workplace systems (tills, scanners, time clocks) record data for you, and check recorded data for mistakes

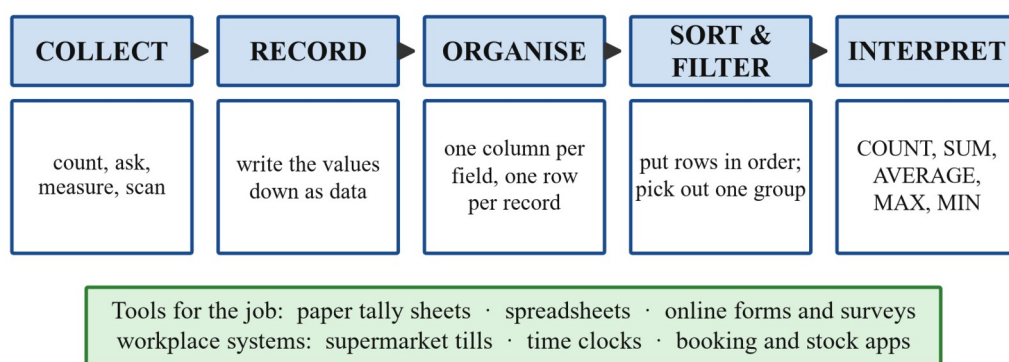
About the data in this section. Every table, form and figure here is **made up** (not real): pretend gardens, shops, clubs, teams and workplaces with pretend numbers, built for this book so you can practise the skills. Nothing here is real data about a real person, business or place.

One house rule before we start: **nothing in this section needs a machine to answer it.** Every question can be done with pen, paper and a basic calculator. The technology is shown because it is what workplaces use — it is a helper, never a requirement. (Section 1F taught your first spreadsheet steps — cells, formulas and the SUM, AVERAGE, MAX and MIN functions — and Section 8A looked at types of data and ways of collecting it. Section 10A looks at inputs and outputs of technology in general. This section builds on all three.)

What is a data tool?

A **data tool** is any tool or application that helps you collect, record, organise, sort or interpret information. The job usually runs in five steps, and different tools suit different steps.

One job, five steps — and a data tool can help with each



A chain of five boxes: collect, record, organise, sort and filter, interpret, with a strip below naming paper tally sheets, spreadsheets, online forms and workplace systems

Four families of data tool come up again and again:

- **Paper tally sheets** — a ruled sheet you mark by hand as things happen. Cheap, tough, works in the rain, and fine for counting one thing on the spot.
- **Spreadsheet programs** — a grid of cells on a computer or tablet. Best when the numbers need totals, means, sorting or filtering, and when the table will grow or change.

- **Online forms and surveys** — questions on a screen that people answer from their own phone or computer. Each answer arrives already typed into its own field, as one record.
- **Workplace systems** — supermarket tills and barcode scanners, time clocks, booking apps, stock counters. These record data automatically as a side effect of doing the job.

Choosing the tool comes down to three questions: Who is giving the information? What will you do with it afterwards? And where are you when you collect it? Counting bikes past a post for two hours is a tally sheet. Asking 200 members two questions each is an online form. Keeping twelve months of power bills so you can total and average them is a spreadsheet.

Fields and records

However you collect data, it ends up in a table sooner or later, and every well-built table has the same two parts:

- a **field** is one kind of information — one **column**, named in the **header row**;
- a **record** is everything about one person, thing or event — one **row**.

Rivergum Community Garden — week 3 harvest (made-up data)

	A	B	C	D	
1	Bed	Crop	Mass (kg)	Week	header row (row 1): names each field, carries the unit
2	1	Potatoes	6.4	3	
3	2	Carrots	3.8	3	
4	1	Silverbeet	2.5	3	

each row is a **RECORD**
(everything about one harvest) →

↑
each column is a **FIELD**
(one kind of information)

A small spreadsheet of a community garden harvest with arrows labelling the header row, one column as a field and one row as a record

Two habits make a table like this work. Put the **unit in the header** — Mass (kg), Fee (\$) — so the cells underneath hold plain numbers. And keep **one fact per cell**: a cell holding “2 tables \$20 each” holds two facts, and no tool can sort or total either of them.

Recording data so it stays usable

Data is only as useful as the way it was written down. Four rules keep data usable:

1. **One fact per cell.** Split “2 tables \$20 each” into a Tables cell holding 2 and a Fee each cell holding 20.00.
2. **Numbers as numbers.** Type 6.4, not “6.4 kg”. A cell holding text cannot be added, averaged or sorted as a number.
3. **One spelling for one thing.** If a town is spelled two ways, a sort or a filter sees two different towns and splits your group in half.

4. **Units in the header**, never in the cells (rule 2 again).

Same sign-up, recorded two ways

Hard for a data tool to use

Name	What they want (and cost)	From
Marta	2 tables \$20 each	Geelong
Ali	3 tables \$25 each	Geelong

two facts in one cell — you cannot sort or total either of them

Easy to sort, filter and total

Name	Tables	Fee each (\$)	Town
Marta	2	20.00	Geelong
Ali	3	25.00	Geelong

one fact per cell; the unit sits in the header; the town is spelled one way

The same market sign-up recorded two ways: a messy table with two facts in one cell and a misspelled town, beside a clean table with one fact per cell

Sorting

To **sort** is to put rows in order by one column — the **sort key**. **Ascending** means smallest to largest (A to Z for words); **descending** means largest to smallest (Z to A). The one rule that matters: **whole rows move together**. The sort key decides the order, but every other cell travels with its own row.

Sorting the job list by Hours quoted, largest first

Before: as typed in

	Job	Customer	Suburb	Hours quoted
1				
2	Replace alternator	Silva	Echuca	3.5
3	Battery and charging test	O'Brien	Bendigo	1.0
4	New starter motor	Kaur	Echuca	2.5
5	Find wiring fault	Costa	Huntly	4.5
6	Air-con service	Ibrahim	Bendigo	2.0

↓ sort by Hours quoted,
descending — whole rows
move together

After: sorted

	Job	Customer	Suburb	Hours quoted
1				
2	Find wiring fault	Costa	Huntly	4.5
3	Replace alternator	Silva	Echuca	3.5
4	New starter motor	Kaur	Echuca	2.5
5	Air-con service	Ibrahim	Bendigo	2.0
6	Battery and charging test	O'Brien	Bendigo	1.0

*The top row answers the boss's question:
the longest job is Find wiring fault, 4.5 hours.*

A job list before and after sorting by hours quoted, largest first, with the whole rows moved together

Sort the key column **on its own** and the records scramble: the numbers end up in order but beside the wrong names, and the table quietly lies to you.

The sort mistake: one column sorted on its own

The table as it started

1	Player	Goals
2	Ash	8
3	Bo	12
4	Cy	5
5	Dee	10

WRONG — records scrambled

1	Player	Goals
2	Ash	12
3	Bo	10
4	Cy	8
5	Dee	5

only the Goals
column sorted



Bo scored 12 goals,
not 10: the numbers
moved without their
players.

Always sort the
WHOLE TABLE, so each
row stays together.

A players-and-goals table before, and after sorting only the goals column, so each goal total sits beside the wrong player

Before you sort, select the **whole table** (or let the program extend the selection for you). If a sorted table looks wrong, check one row you know by heart — it is the fastest way to catch a scramble.

Filtering

To **filter** is to show only the rows that match a rule — Paid? = No, Town = Colac, Delivery day = Thursday — and hide the rest. Filtering **hides rows; it never deletes them**. Clear the filter and every row comes back. This is why a filter is safe for looking at one group, and why totals taken while a filter is on are totals of the *shown* rows only.

Filter on: Paid? = No — only unpaid invoices show

1	Club	Round	Amount (\$)	Paid?
2	Mildura	4	\$120.00	Yes
3	Red Cliffs	4	\$95.00	No
4	Irymple	4	\$120.00	Yes
5	Merbein	5	\$95.00	No
6	Red Cliffs	5	\$95.00	Yes
7	Merbein	4	\$120.00	No
8	Irymple	5	\$95.00	No

← hidden,
not deleted

*4 rows show. Their amounts add to \$405.00.
Clear the filter and all 7 rows come back.*

An invoice table filtered to unpaid invoices, with the three paid rows that do not match greyed out and labelled hidden, not deleted

Interpreting with functions

Once data sits in a column, five functions read it and report back. Section 1F met four of them; COUNT joins them here.

Five functions that read a column of data

	A	B				
1	Job	Hours quoted				
2	Alternator	3.5	▶	=COUNT(B2:B6)	5	how many numbers are in the block
3	Battery test	1.0	▶	=SUM(B2:B6)	13.5	adds the block — the total hours
4	Starter motor	2.5				
5	Wiring fault	4.5	▶	=AVERAGE(B2:B6)	2.7	the mean hours per job
6	Air-con service	2.0	▶	=MAX(B2:B6)	4.5	the largest value — longest job
			▶	=MIN(B2:B6)	1.0	the smallest value — shortest job

The data never changes — functions just read it and report back.

A column of hours beside the five functions COUNT, SUM, AVERAGE, MAX and MIN with the value each one returns

Read aloud on that column: **five** jobs, **13.5** hours in total, a mean of **2.7** hours per job, the longest **4.5** hours and the shortest **1.0** hour. The data never changes — functions only read it. That is also what makes them good checkers: a COUNT tells you how many records arrived, and a MIN or MAX shows up a value that cannot be right.

Online forms and workplace systems

An **online form** collects and records in one move. Each question is already a field, each submitted answer is already a record, and nobody retypes anything — so the typing errors never happen.

An online form collects; the answers arrive already organised

Valley Sports Club survey

1. Which sport do you play?
☐ soccer ☐ netball
☐ footy ☐ other

2. Best training night?
☐ Mon ☐ Wed ☐ Fri

3. Years played: [____]

Sport	Night	Years played
Soccer	Mon	3
Netball	Wed	1
Footy	Mon	5
Soccer	Fri	2

*No retyping, so no typing errors — each Submit adds one record, and each question is already its own field.
 Made-up survey: the club, the questions and every answer are made up for this section.*

An online club survey form beside the table of response records it builds, one record per submission

Workplace systems go one step further and record data **automatically**, as a side effect of the job being done. A supermarket scanner enters the barcode, the item name, the unit price from the store's price list, the quantity, the time and the checkout number — no handwriting, no retyping, no misread digits. Time clocks, booking apps and stock counters work the same way. Automatic recording removes whole families of human error; it does not remove the need to check (below).

Checking data

Recorded data can still be wrong, and a spreadsheet will total a mistake just as happily as a truth. Three quick checks catch most problems:

- **COUNT against what you expect.** Five deliveries went out; COUNT says 4 records. One is missing.
- **MIN and MAX against common sense.** A column of adult heights in cm whose MIN is 1 . 69 has a metres value hiding in it.

- **A sum estimate against SUM.** Round the column in your head; if the function's answer is a different shape, something was typed wrong.

And remember the direction of trust: a total is only as good as the records under it. Garbage in, garbage out — the tool computes what you gave it, not what you meant.

Worked examples

Example 1 — scaffolded

Anh volunteers at the Rivergum Community Garden. Each week Anh writes the harvest on paper, then types it into a spreadsheet so the committee can see it. This week's notes say: *Bed 1, potatoes, 6.4 kg, week 3; Bed 2, carrots, 3.8 kg, week 3; Bed 1, silverbeet, 2.5 kg, week 3.* Set the table up and read it.

Working	Comment
Choose the fields: Bed, Crop, Mass (kg), Week.	One column per kind of information. The unit lives in the header, so every cell below it stays a plain number.
Row 1 is the header row. Then one record per row: 1, Potatoes, 6.4, 3; 2, Carrots, 3.8, 3; 1, Silverbeet, 2.5, 3.	Three harvests, so three records. Type 6.4, not "6.4 kg" — a text cell cannot be added or sorted as a number.
Bed 1 mass: $6.4 + 2.5 = 8.9$ kg. Bed 2 mass: 3.8 kg.	By hand, or filter on Bed = 1 and the two Bed 1 records are the only rows showing, ready to add.
=COUNT on the Mass column returns 3.	A check: three records were entered, three are in the table.

∴ The table has 4 fields and 3 records, and Bed 1 grew 8.9 kg in week 3.

Made-up data: the garden, the beds and every mass in this example are made up for this section.

Example 2 — scaffolded

Grace, an auto electrician in Echuca, keeps her quoted jobs in a spreadsheet. Her boss asks: *which job is quoted for the most hours, and how many hours are quoted altogether?*

Working	Comment
Sort key: Hours quoted, descending (largest first).	The boss wants the biggest at the top. Select the whole table first, so rows stay together.
Order after sorting: Find wiring fault 4.5; Replace alternator 3.5; New starter motor 2.5; Air-con service 2.0; Battery and charging test 1.0.	The hours decide the order; each customer and suburb travels with its own job.
Top row: Find wiring fault, 4.5 hours.	The sort puts the answer in row 2, where you can read it off.
Total: $3.5 + 1.0 + 2.5 + 4.5 + 2.0 = 13.5$ hours, so =SUM returns 13.5. =COUNT returns 5 jobs; =AVERAGE returns 2.7 hours per job.	Functions read the column without changing it — the same column answers all three questions.

∴ The longest quoted job is the wiring fault at 4.5 hours, and the five jobs carry 13.5 quoted hours in total.

Made-up data: the jobs, customers, suburbs and hours in this example are made up for this section.

Example 3 — unscaffolded

Theo manages the Sunrise Op Shop and keeps weekly takings in a spreadsheet. Column B holds items sold, column C the average price in dollars, and column D the takings.

Sunrise Op Shop — weekly takings (made-up data)			
	A	B	C
1	Week	Items sold	Average price (\$)
2	1	240	\$3.25
3	2	315	\$3.40
4	3	190	\$4.10
5	4	265	\$3.60
6	5	300	\$3.90
7	Total		

D2 holds the formula $=B2*C2$; every other takings cell holds a copy of it.

A spreadsheet of five weeks of op shop takings with a multiplication formula in D2 and a SUM formula in the total row

Takings are items sold multiplied by the average price, so D2 holds the formula $=B2*C2$, and the same formula copied down gives $240 \times 3.25 = \$780.00$, $315 \times 3.40 = \$1071.00$, $190 \times 4.10 = \$779.00$, $265 \times 3.60 = \$954.00$ and $300 \times 3.90 = \$1170.00$. Reading the takings column with functions: $=SUM(D2:D6)$ adds to \$4754.00; $=AVERAGE(D2:D6)$ gives \$950.80 per week (correct to the nearest cent); and $=MAX(D2:D6)$ returns \$1170.00, which sits in week 5's row, so week 5 was the best week. Then Theo finds a mistake: week 3 sold 200 items, not 190. Retyping 200 into B4 is the whole fix — D4 recomputes to $200 \times 4.10 = \$820.00$ and the SUM climbs to \$4795.00 by itself, because a formula always means “whatever is in these cells now”.

$\therefore$ D2 holds $=B2*C2$; the five weeks took $\$780.00 + \$1071.00 + \$779.00 + \$954.00 + \$1170.00 = \$4754.00$, averaging \$950.80 per week with week 5 best at \$1170.00; and after the correction week 3 shows \$820.00 and the total becomes \$4795.00.

Made-up data: the shop and every number in this example and its figure are made up for this section.

Example 4 — unscaffolded

Ines is the treasurer of a netball association and tracks club invoices in a spreadsheet: which club, which round, the amount, and whether it has been paid.

Club	Round	Amount (\$)	Paid?
Mildura	4	120.00	Yes
Red Cliffs	4	95.00	No
Irymple	4	120.00	Yes
Merbein	5	95.00	No
Red Cliffs	5	95.00	Yes
Merbein	4	120.00	No
Irymple	5	95.00	No

Filtering on Paid? = No hides the three paid invoices and shows the four unpaid ones: Red Cliffs round 4 (\$95.00), Merbein round 5 (\$95.00), Merbein round 4 (\$120.00) and Irymple round 5 (\$95.00). Their amounts add to $95.00 + 95.00 + 120.00 + 95.00 = \$405.00$ still owing. Sorting the shown rows by amount, descending, puts the largest unpaid invoice on top: Merbein's \$120.00 from round 4. Clearing the filter brings all 7 rows back — filtering hid nothing forever — and the whole column sums to $120.00 + 95.00 + 120.00 + 95.00 + 95.00 + 120.00 + 95.00 = \$740.00$ invoiced for the season so far.

$\therefore$ Four invoices totalling \$405.00 are unpaid, the largest being Merbein's \$120.00 for round 4, out of \$740.00 invoiced in all.

Practice questions

Scaffolded

Q1. The school canteen keeps its wholesale order in a spreadsheet.

School canteen order form (made-up data)			
	A	B	C
1	Item	Qty	Price (\$)
2	Sandwich roll	24	\$3.20
3	Muesli bar	36	\$1.80
4	Juice	40	\$2.10

A spreadsheet order form for the school canteen with a multiplication formula in D2

- Which cell holds the price of a muesli bar?
- Write the formula in D2, and find the value it shows (correct to the nearest cent).
- Write a function that adds the three totals in column D, and find its value.

Q2. A gym keeps this list of members.

Member	Plan	Visits this month	Monthly fee (\$)
Omar	Pay-per-visit	6	75.00
Tegan	20-visit	14	120.00
Winnie	Unlimited	21	160.00

- How many fields does the table have?
- How many records does it have?
- Why does the fee column keep (\$) in the header instead of typing "\$" inside each cell?

Q3. Five friends record their fun-run times, in minutes: 42, 38, 51, 35, 47.

- Write the times sorted ascending.
- Write the times sorted descending.
- The winner is the smallest time. Which sort puts the winner in the top row, and what is the winning time?

Q4. Zoe babysits after school and lists what she earned each night last week: \$12, \$18, \$7, \$25, \$13.

- Which function counts how many nights she worked?
- Which function gives her total for the week, and what does it return?
- Which functions give her best night and her mean night, and what do they return?

Q5. Kiran's pay sheet multiplies hours by the hourly rate.

	A	B	C	D
1	Day	Hours	Rate (\$)	Pay (\$)
2	Mon	4	26.00	
3	Tue	5.5	26.00	
4	Wed	6.5	28.40	

- Find the values D2 and D3 show (correct to the nearest cent).
- D2's formula $=B2 * C2$ is copied into D4. Write the formula as it appears in D4.
- Find the value D4 shows, and the value of $=SUM(D2 : D4)$.

Q6. A vet clinic lists this week's patients.

Pet	Owner	Town	Vaccination due?
Biscuit	Tran	Colac	Yes
Rex	Okafor	Camperdown	No
Misty	Halliday	Colac	No
Buddy	Petrov	Camperdown	Yes
Coco	Delaney	Colac	Yes
Dash	Ahmed	Skipton	No

- Filter on `Town = Colac`. Which rows show?
- Clear the filter. How many rows show now, and why?
- With the Colac filter on: how many shown pets are due for vaccination, and which pet is in the top row after sorting `Pet` from A to Z?

Un scaffolded

Q7. Choose the better data tool for each job — *paper tally sheet*, *online survey form* or *spreadsheet* — and say why in one sentence.

- Counting riders past the trail head between 8 am and 10 am on Sunday.
- Asking all 200 club members two questions about next season.
- Keeping twelve months of power bills so you can total them and find the mean.

Q8. A market stall sign-up sheet was typed into a spreadsheet exactly as people wrote it.

Name	What they want (and cost)	From
Marta	2 tables \$20 each	Geelong
Ali	1 stall 3 m wide	Geliong
Soo-Young	1 table, 2 chairs, \$35 total	Geelong

- Name two things about this table that will stop a data tool using it well.
- Ali's town is a misspelling of Geelong. Explain what goes wrong when the table is sorted or filtered by town.
- Rewrite Marta's row so each fact has its own cell, and find what Marta owes (correct to the nearest cent).

Q9. A tradesperson lists this week's quotes.

Job	Quote (\$)	Hours
Deck reseal	680.00	6
Gutter replacement	1 240.00	10
Fence repaint	975.00	12
Tree trimming	520.00	4
Shed repair	1 860.00	15

- Write the jobs in order of quote, descending.
- Find the total of the five quotes (correct to the nearest cent).
- Which column, sorted which way, puts the shortest job in the top row — and which job is that?

Q10. The Rivergum Bakery records its Friday market sales in a spreadsheet.

Rivergum Bakery — Friday market sales (made-up data)

	A	B	C	D
1	Product	Sold	Price (\$)	Takings (\$)
2	Sourdough loaf	38	\$6.50	=B2*C2
3	Lamington	45	\$3.20	\$144.00
4	Sausage roll	60	\$4.40	\$264.00
5	Custard tart	25	\$5.20	\$130.00
6	Total			=SUM(D2:D5)

A spreadsheet of Friday market sales for four products with a multiplication formula in D2 and a SUM formula in the total row

- Find the four takings values in D2:D5 (correct to the nearest cent).
- Find the value of =SUM (D2 : D5) and of =AVERAGE (D2 : D5) (correct to the nearest cent).
- The bakery actually sold 40 custard tarts, not 25. Find the new value of D5 and the new value of the SUM.

Q11. A class records heights in centimetres in one column: 168, 172, 165, 181, 176, 1.69, 170.

- Which function shows up the value that cannot be right, and what does it return?
- Explain the most likely mistake behind that value.
- With the value corrected, find the sum of the seven heights and their mean, correct to 1 decimal place.

Q12. A coach sorts only the Goals column of this table, leaving the names where they were.

Player	Goals
Ayoub	14
Baker	9
Chen	21
Doyle	6
Ellis	11

- Write the rows exactly as they now appear.
- The coach knows Chen scored 21. Explain how that alone proves the sorted table is wrong.
- Write the correct descending sort of the whole table, find the total goals, and say what the coach should have selected before sorting.

Q13. A delivery firm filters its orders on `Delivery day = Thursday`.

Order	Town	Amount (\$)	Delivery day
1041	Echuca	84.50	Wednesday
1042	Moama	120.00	Thursday
1043	Deniliquin	63.20	Thursday
1044	Echuca	45.90	Thursday
1045	Moama	210.75	Wednesday
1046	Deniliquin	38.40	Wednesday
1047	Echuca	96.10	Thursday
1048	Moama	55.00	Thursday

- How many rows show, and what do their amounts add to (correct to the nearest cent)?
- The hidden rows are the Wednesday deliveries. What do their amounts add to?
- Clear the filter. How many rows show, and what is the grand total?

Q14. A fundraiser's donations for the week sit in cells B2:B9: 45, 62, 38, 75, 54, 62, 91, 41 (dollars).

- What does `=COUNT (B2 : B9)` return, and what does that number mean?
- Find the values of `=SUM (B2 : B9)` and `=AVERAGE (B2 : B9)` (correct to the nearest cent).
- Find the values of `=MAX (B2 : B9)` and `=MIN (B2 : B9)`, and count how many days took more than the mean.

Q15. The canteen committee runs an online survey: *Which day do you usually buy lunch?* and *Rate the canteen from 1 (poor) to 5 (great)*. The first five responses arrive as five records.

A canteen survey: five responses arrive as five records

Canteen survey

1. Which day do you usually buy lunch?

Mon · Tue · Wed

2. Rate the canteen:

1 (poor) to 5 (great)

Response	Favourite day	Rating (1–5)
1	Wed	4
2	Mon	5
3	Wed	3
4	Wed	4
5	Tue	4

Made-up survey: every answer in the table is made up for this section.

A canteen survey form beside the five response records it collected

- Which of the two fields holds categories (words) rather than numbers?
- How many of the five responses name Wednesday?
- Find the mean of the five ratings, correct to 1 decimal place, and give one reason the answers are less error-prone than if the committee had copied them off paper.

Q16. At the supermarket checkout, scanning an item records one sale automatically.

- List six fields a till record like this could hold.
- What is one record in this table? How many records does a basket of three scanned items make?
- Give two reasons automatic recording like this carries fewer errors than writing prices down by hand.

Q17. A club fundraiser washes cars on Saturday mornings and keeps the numbers in a spreadsheet. Every car costs \$12.

	A	B	C	D
1	Saturday	Cars	Price (\$)	Takings (\$)
2	3 May	32	12	
3	10 May	45	12	
4	17 May	28	12	
5	24 May	51	12	
6	31 May	40	12	

- Find the five takings values (correct to the nearest cent), and write the formula in D2 with the value it shows.
- Find the value of `=SUM(D2:D6)`, and say which Saturday took the most money.
- Find the total number of cars washed and the mean per Saturday, to the nearest whole number.

Q18. An electrician keeps job notes in a paper notebook and is thinking of moving to a spreadsheet on a tablet.

- Give two ways the spreadsheet would make the notes more useful.
- Give one situation where the paper notebook is still the better tool.
- The spreadsheet totals every column perfectly. Explain why the totals can still be wrong, and name one check from this section that would catch a mistake.

Answers

Q1. a) C3. b) $=B2 * C2$, showing \$76.80. c) $=SUM(D2 : D4) = \$225.60$. **Q2.** a) 4 fields. b) 3 records. c) So the cells hold plain numbers that can be added, averaged and sorted; the unit is said once, in the header. **Q3.** a) 35, 38, 42, 47, 51. b) 51, 47, 42, 38, 35. c) Ascending; the winning time is 35 minutes. **Q4.** a) COUNT (returns 5 nights). b) SUM, returning \$75.00. c) MAX returns \$25.00; AVERAGE returns \$15.00. **Q5.** a) $D2 = \$104.00$, $D3 = \$143.00$. b) $=B4 * C4$. c) $D4 = \$184.60$; $=SUM(D2 : D4) = \$431.60$. **Q6.** a) Biscuit, Misty and Coco (3 rows). b) 6 rows — a filter hides rows, it never deletes them. c) 2 pets due; Biscuit is top after the A-to-Z sort. **Q7.** a) Paper tally sheet — one counter, on the spot, nothing to power. b) Online survey form — 200 people answer from wherever they are and each answer arrives as a record. c) Spreadsheet — the numbers need a total and a mean, month after month. **Q8.** a) Any two: two facts in one cell; no units named; a misspelled town; costs written as words and symbols mixed with numbers. b) Sorting or filtering sees “Geliong” as a different town from Geelong, so Ali’s row lands in a group of its own. c) Name = Marta, Tables = 2, Fee each (\$) = 20.00, Town = Geelong; Marta owes $2 \times 20.00 = \$40.00$. **Q9.** a) Shed repair, Gutter replacement, Fence repaint, Deck reseal, Tree trimming. b) \$5 275.00. c) Sort Hours ascending; Tree trimming (4 hours). **Q10.** a) \$247.00, \$144.00, \$264.00, \$130.00. b) SUM = \$785.00; AVERAGE = \$196.25. c) $D5 = \$208.00$; new SUM = \$863.00. **Q11.** a) MIN, returning 1.69. b) One height was typed in metres (1.69 m) instead of centimetres; it should be 169. c) Sum = 1201 cm; mean = 171.6 cm. **Q12.** a) Ayoub 21, Baker 14, Chen 11, Doyle 9, Ellis 6. b) The top row says Ayoub scored 21, but the coach knows those 21 goals are Chen’s — the numbers moved without their players. c) Chen 21, Ayoub 14, Ellis 11, Baker 9, Doyle 6; total 61 goals; select the whole table before sorting. **Q13.** a) 5 rows, adding to \$380.20. b) \$333.65. c) 8 rows, grand total \$713.85. **Q14.** a) 8 — eight donation days were recorded. b) SUM = \$468.00; AVERAGE = \$58.50. c) MAX = \$91.00, MIN = \$38.00; 4 days above the mean. **Q15.** a) Favourite day. b) 3 responses. c) Mean rating 4.0; answers arrive already typed as records, so nobody retypes (or misreads) them. **Q16.** a) Any six of: time, barcode, item name, unit price (\$), quantity, checkout number. b) One scanned item sale; 3 records. c) Any two: no handwriting to misread, no retyping, prices come straight from the store’s price list, nothing is forgotten at the end of a shift. **Q17.** a) \$384.00, \$540.00, \$336.00, \$612.00, \$480.00; $D2$ holds $=B2 * C2$, showing \$384.00. b) \$2 352.00; Saturday 24 May. c) 196 cars; mean 39 cars per Saturday. **Q18.** a) Any two: totals and means appear instantly; jobs sort and filter by customer, suburb or date; a corrected number updates every total; the notes are searchable and backed up. b) Any one: no signal or flat battery on a roof or in a crawlspace; wet or gloved hands; a one-off scribble faster than opening a file. c) A total is only as good as the records under it — a mistyped number or a formula pointing at the wrong cell is totalled perfectly; a COUNT against the expected number of records, or a MIN/MAX sanity check, catches it.

Fully-worked solutions

Q1. a) Prices sit in column C, one row per item: the muesli bar is row 3, so its price is in C3. b) A total is quantity times price, so $D2$ holds $=B2 * C2$, which shows $24 \times 3.20 = \$76.80$. c) $=SUM(D2 : D4)$ adds $76.80 + 64.80 + 84.00 = \$225.60$.

Q2. a) One column per field: Member, Plan, Visits this month, Monthly fee (\$) — **4 fields**. b) One row per member: Omar, Tegan, Winnie — **3 records**. c) With (\$) in the header, each fee cell holds a plain number like 120.00, so the column can be added, averaged and sorted; typing “\$120.00” into the cell would make it text.

Q3. a) Ascending (smallest first): **35, 38, 42, 47, 51**. b) Descending: **51, 47, 42, 38, 35**. c) In a race the smallest time wins, so the **ascending** sort puts the winner in the top row: **35 minutes**.

Q4. a) $=COUNT$ counts the numbers in the list: 5 nights. b) $=SUM$ adds $12 + 18 + 7 + 25 + 13 = \$75.00$. c) $=MAX$ returns the best night, **\$25.00**; $=AVERAGE$ returns $75.00 \div 5 = \$15.00$ per night.

Q5. a) $D2: 4 \times 26.00 = \$104.00$. $D3: 5.5 \times 26.00 = \$143.00$. b) Copying moves the references down with the formula, so $D4$ reads $=B4 * C4$. c) $D4: 6.5 \times 28.40 = \$184.60$. The week’s pay is $104.00 + 143.00 + 184.60 = \$431.60$.

Q6. a) The Colac rows are **Biscuit, Misty and Coco** — 3 rows show. b) All **6** rows: filtering hides the rows that do not match, it never deletes them, so clearing the filter restores the full table. c) Of the three shown pets, Biscuit and Coco are due — **2**. Sorting Pet A to Z puts **Biscuit** (top of B, C, M) in the first shown row.

Q7. a) Paper tally sheet: one person counting one thing for two hours needs marks, not a login — total the tallies afterwards. **b) Online survey form:** 200 members answer from their own phones, and every submission arrives as one record with no retyping. **c) Spreadsheet:** twelve rows of bills want a SUM and an AVERAGE, and next month's bill slots straight in.

Q8. a) Any two of: “2 tables \$20 each” packs two facts into one cell, so neither can be sorted or totalled; no column says what the numbers mean or their units; the same town is spelled two ways; costs mix words and symbols so they are text, not numbers. **b)** A sort or filter compares the town cells as text: “Geliong” does not match “Geelong”, so Ali's record is treated as a different town and drops out of (or splits) the Geelong group. **c)** Clean row: Name = Marta, Tables = 2, Fee each (\$) = 20.00, Town = Geelong. Marta owes $2 \times 20.00 = \$40.00$.

Q9. a) Descending by quote: **Shed repair (\$1 860.00), Gutter replacement (\$1 240.00), Fence repaint (\$975.00), Deck reseal (\$680.00), Tree trimming (\$520.00).** **b)** $680.00 + 1\,240.00 + 975.00 + 520.00 + 1\,860.00 = \$5\,275.00$. **c)** The shortest job is the smallest Hours value, so sort **Hours ascending**; the top row is then **Tree trimming, 4 hours**.

Q10. a) $38 \times 6.50 = \$247.00$; $45 \times 3.20 = \$144.00$; $60 \times 4.40 = \$264.00$; $25 \times 5.20 = \$130.00$. **b)** $\text{SUM}(D2:D5) = 247.00 + 144.00 + 264.00 + 130.00 = \$785.00$; $\text{AVERAGE}(D2:D5) = 785.00 \div 4 = \$196.25$. **c)** With 40 tarts, $D5 = 40 \times 5.20 = \$208.00$, and the SUM recomputes to $785.00 - 130.00 + 208.00 = \$863.00$.

Q11. a) =MIN returns **1.69** — far below every other height, so it is the odd value. **b)** 1.69 is a height in **metres** typed into a centimetre column; it should read 169. **c)** Corrected column: $168 + 172 + 165 + 181 + 176 + 169 + 170 = 1201$ cm. Mean = $1201 \div 7 = 171.571\dots$, i.e. **171.6 cm** correct to 1 decimal place.

Q12. a) Sorting only the Goals column gives the goals 21, 14, 11, 9, 6 down the unchanged name column: **Ayoub 21, Baker 14, Chen 11, Doyle 9, Ellis 6.** **b)** The top row now claims Ayoub scored 21 goals, but the coach knows Chen scored 21 — a number has ended up beside the wrong player, so the records are scrambled. **c)** Sorting the whole table descending: **Chen 21, Ayoub 14, Ellis 11, Baker 9, Doyle 6.** Total goals = $14 + 9 + 21 + 6 + 11 = 61$. The fix: select the **whole table** (both columns) before sorting, so each row moves together.

Q13. a) Five rows show: 1042, 1043, 1044, 1047, 1048. Their amounts add to $120.00 + 63.20 + 45.90 + 96.10 + 55.00 = \$380.20$. **b)** The three hidden Wednesday rows: $84.50 + 210.75 + 38.40 = \$333.65$. **c)** Clearing the filter shows all **8** rows; the grand total is $380.20 + 333.65 = \$713.85$.

Q14. a) COUNT returns **8**: eight donation days were recorded — a check that no day went missing. **b)** $\text{SUM} = 45 + 62 + 38 + 75 + 54 + 62 + 91 + 41 = \$468.00$; $\text{AVERAGE} = 468.00 \div 8 = \$58.50$. **c)** MAX = **\$91.00**, MIN = **\$38.00**. Days above the \$58.50 mean: 62, 75, 62, 91 — **4 days**.

Q15. a) Favourite day — its answers are words (Mon, Tue, Wed), while the rating is a number. **b)** Wednesday appears in responses 1, 3 and 4: **3 responses**. **c)** Ratings sum to $4 + 5 + 3 + 4 + 4 = 20$; mean = $20 \div 5 = 4.0$. The form is safer because each answer arrives already typed into its own field as a record — there is no handwriting to misread and no retyping to get wrong.

Q16. a) Any six of: **time of sale, barcode, item name, unit price (\$), quantity, checkout number.** **b)** One record is **one scanned item sale** — everything the till stored about that one line. Three scanned items make **3 records**. **c)** Any two of: there is no handwriting to misread; nothing is retyped by a human; the price comes straight from the store's price list instead of a keyed-in number; sales cannot be forgotten at the end of a busy shift.

Q17. a) Takings are cars times \$12: $32 \times 12 = \$384.00$; $45 \times 12 = \$540.00$; $28 \times 12 = \$336.00$; $51 \times 12 = \$612.00$; $40 \times 12 = \$480.00$. D2 holds =B2*C2, showing **\$384.00**. **b)** $\text{SUM}(D2:D6) = 384.00 + 540.00 + 336.00 + 612.00 + 480.00 = \$2\,352.00$. The best taking, \$612.00, is **Saturday 24 May**. **c)** Cars: $32 + 45 + 28 + 51 + 40 = 196$. Mean = $196 \div 5 = 39.2$, i.e. **39 cars** per Saturday to the nearest whole number.

Q18. a) Any two of: totals, means and counts appear the moment they are asked for; jobs can be sorted or filtered by customer, suburb or week; fixing one typed number updates every total that uses it; the records can be searched, copied and backed up, unlike a notebook. b) Any one of: a roof, a crawlspace or a site with no signal or a flat battery; wet or gloved hands over a screen; a one-off note that is quicker to scribble than to open a file. c) A function computes exactly what is in the cells — a mistyped value, a missed record or a formula aimed at the wrong cells is totalled just as confidently as good data. Checks from this section: COUNT against the number of jobs expected, or MIN/MAX against common sense, or a quick rounded sum in your head against SUM.

Theory

Section 10A looked at the inputs and outputs of technology, and section 10B looked at spreadsheets that collect and sort data. This section puts those ideas to work on something you do every week: deciding **what** has to happen, in **what order**, and **when**. Section 10D covers maps, journey planners and online calculators; section 10E covers adjusting settings to get better outputs.

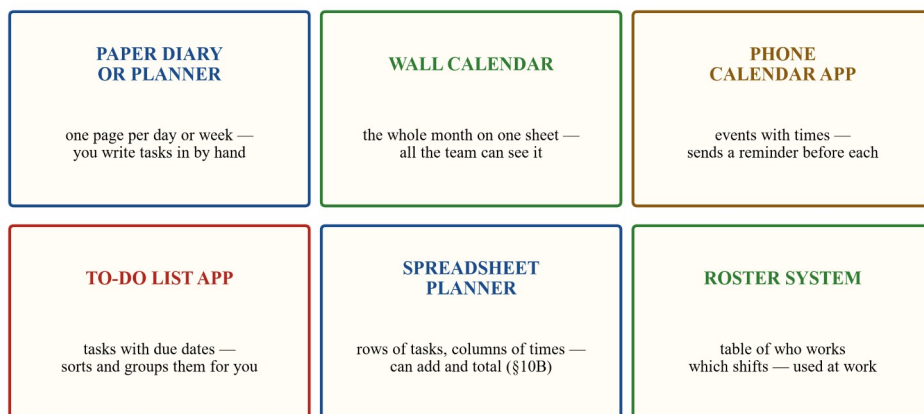
What is planning? What is scheduling?

- A **task** is one job that needs doing: mow the lawn, collect a cake, set out chairs.
- A **plan** is the list of all the tasks, in the order they should happen.
- A **schedule** is a plan with times attached — every task gets a start time and a finish time.
- The **duration** of a task is how long it takes (§4D).
- A **deadline** is a time by which something must be finished.

Planning answers “what must be done, and in what order?”. Scheduling answers “when will each part happen?”. Good plans do both, and then get checked with maths.

Systems for planning and scheduling.

A **system** is a fixed way of doing things, where every part has its place. A wall calendar with the week’s jobs written on it is a system. A phone app that stores tasks and pops up reminders is a system. Lots of systems plan and schedule; the six below are the ones you will meet most.



six systems for planning and scheduling

- A **paper diary or planner** — one page per day or per week; you write tasks in by hand.
- A **wall calendar** — the whole month on one sheet; good for a family or a team, because everyone can see it.
- A **phone calendar app** — events with times; it sends a **reminder** (an alert) before each one.
- A **to-do list app** — tasks with due dates; it can sort them and group them into categories.
- A **spreadsheet planner** — rows of tasks with columns for times (§10B); the spreadsheet can add and total for you.
- A **roster system** — used at work: a table of who works which shifts.

The best system is the one you actually look at. The maths is the same in all of them: times, durations, totals and checks. Technology stores the plan and reminds you about it — but the adding, the backward planning and the checking are yours, and everything in this section can be done with pen, paper and a basic calculator.

Collate, organise, categorise.

You met these words with data in §8A. Here you do them with tasks.

- **Collate** — gather every task into one place: one list, one app, one page. A task written on three receipts and remembered in your head will get lost.
- **Organise** — put the tasks in the order they will happen.
- **Categorise** — sort tasks into groups: by who does them, by where they happen, or by how urgent they are.

The task table.

A **task table** is the planner you will use most in this section. It has five columns:

Column	What it holds
Task	what has to be done
Duration	how long it takes
Depends on	the task that must finish first (if any)
Start	when the task begins
Finish	when the task ends

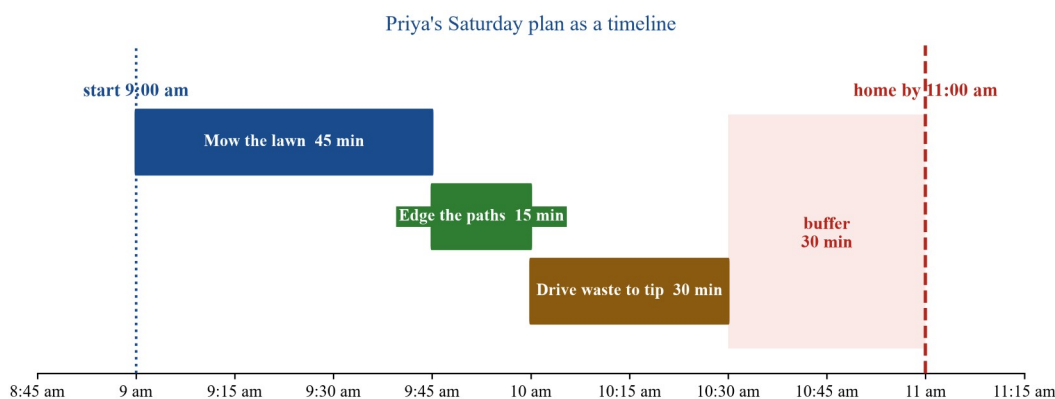
Two rules do all the work:

- going forward: $\text{finish} = \text{start} + \text{duration}$
- going backward: $\text{start} = \text{finish} - \text{duration}$

Each task starts when the one before it finishes, so the Start column is just the Finish column moved down one row. Priya is planning a Saturday morning of garden work. She must be home by 11:00 am.

Task	Duration	Depends on	Start	Finish
Mow the lawn	45 min	—	9:00 am	9:45 am
Edge the paths	15 min	Mow the lawn	9:45 am	10:00 am
Drive the green waste to the tip	30 min	Edge the paths	10:00 am	10:30 am

Check the plan by adding the durations: $45 + 15 + 30 = 90$ minutes = 1 h 30 min, and $9:00 \text{ am} + 1 \text{ h } 30 \text{ min} = 10:30 \text{ am}$ ✓. The two ways of finding the finish must agree — that is the built-in check, like a Total row (§8A).



Made-up data: Priya and every time in this model are made up for this section.

Timelines.

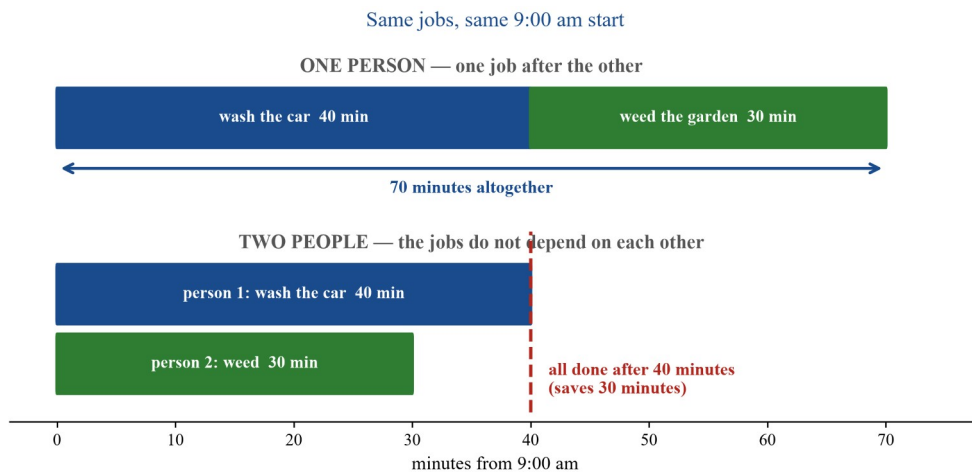
A **timeline** draws the schedule as bars along a time axis. Each bar starts at its task's start time and ends at its finish time, so a longer bar means a longer task. The model above is drawn as a timeline in the figure. When two bars sit at the same time but on different rows, those tasks run **at the same time**. Timelines make a plan easy to see — which is why apps and spreadsheet planners draw them.

Order matters: depends on.

Some tasks cannot start until another task finishes. You cannot edge the paths while the mower is still going around them; you cannot pour concrete before the site is level. When one task must wait for another, we say it **depends on** that task, and the “Depends on” column records it.

Tasks that do **not** depend on each other can be done in any order — or at the same time, if different people do them. Washing the car takes 40 minutes and weeding the garden takes 30 minutes, and neither job needs the other:

- one person does both one after the other: $40 + 30 = 70$ minutes;
- two people start together at 9:00 am: the weeding finishes at 9:30 am and the washing at 9:40 am, so everything is done in 40 minutes — the length of the **longest** task.



Two people save $70 - 40 = 30$ minutes. Sharing tasks this way is the fastest fix when a plan will not fit the time available.

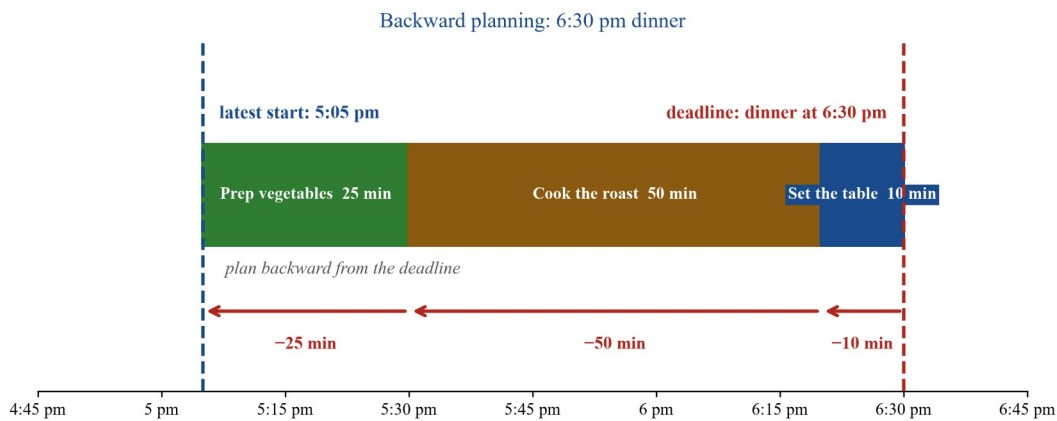
Backward planning from a deadline.

When the finish time is fixed — dinner must be on the table at 6:30 pm — you plan **backward** from the deadline:

1. Write the tasks in the order they will be done.
2. Start at the deadline.
3. Subtract the last task's duration to get its start time. That start is the finish of the task before it.
4. Keep subtracting until you reach the first task. Its start time is the **latest start** for the whole job.
5. Check forward: latest start + total duration must land back on the deadline.

Dinner model: prep the vegetables (25 min), then cook the roast (50 min), then set the table (10 min), finishing exactly at 6:30 pm.

Step backward	Time
Dinner on the table (deadline)	6:30 pm
Set the table takes 10 min, so it starts at 6:30 pm – 10 min	6:20 pm
Cooking takes 50 min, so it starts at 6:20 pm – 50 min	5:30 pm
Prep takes 25 min, so it starts at 5:30 pm – 25 min	5:05 pm



Check forward: $25 + 50 + 10 = 85$ minutes = 1 h 25 min, and 5:05 pm + 1 h 25 min = 6:30 pm ✓. The latest start is **5:05 pm**.

Buffer time.

Real life runs late. A **buffer** is spare time left between your planned finish and the deadline:

$$\text{buffer} = \text{deadline} - \text{planned finish}$$

Priya finishes at 10:30 am and must be home by 11:00 am, so her plan carries a buffer of 30 minutes — if the mowing runs long, the plan still works. The dinner plan has **zero** buffer: start at 5:05 pm and anything that goes wrong makes dinner late. To build in a 15-minute buffer, start 15 minutes earlier, at 4:50 pm. A plan with no buffer is not wrong — it is just fragile.

Categories and priorities.

To **prioritise** is to put the most important or most urgent tasks first. An **urgent** task needs action soon. Diaries and to-do apps sort tasks by their due dates into categories like these:

- **Overdue** — the due date has already passed.
- **Today** — it must happen today.
- **Coming up** — it is due later in the week.
- **Can wait** — no fixed due date; nothing breaks if it slips.

Categorising is not just tidiness. When a plan will not fit the time available, the “can wait” tasks are the ones you move first.

Rosters and repeating schedules.

A **roster** is a table that shows who works when. One stretch of work is called a **shift**. Many rosters repeat a fixed **pattern** — for example 3 days on, then 2 days off — and timetables repeat every week.

Rosters usually use 24-hour time and decimal hours (§4D). A shift from 16:00 to 20:00 lasts 4 hours. A shift from 9:00 to 15:00 with a 30-minute unpaid lunch is $6 - 0.5 = 5.5$ hours of work. To find a week’s total hours, add the shift durations; to find pay, multiply hours by the hourly rate (§5B).

Checking the plan fits.

Before starting anything, add up the durations and compare with the time you have:

- total needed $\leq$ time available → the plan fits; the leftover time is your buffer;
- total needed $>$ time available → the plan does **not** fit. Your options: start earlier, move a “can wait” task, or share the tasks so some run at the same time.

Checking first beats discovering the problem at the deadline.

About the data in this section. The rosters, timetables, bookings, tasks and numbers here are **made up** (not real): pretend people, pretend businesses and pretend numbers, built for this book so you can practise the maths. Nothing here is real data about a real business, person or place.

Worked examples

Example 1 — scaffolded

A volunteer repair café is opening for the Saturday morning. Three tasks must run one after the other, starting at 8:40 am: set up the tables and tools (20 min), check the repair tools work (25 min), then the first booking — fixing a toaster (45 min).

- (a) Find the finish time of each task. (b) Find the total time from 8:40 am to the end of the last task. (c) The first booking runs 15 minutes late. Find its new finish time.

Made-up data: the repair café and every time in this example are made up for this section.

Working	Comment
List the tasks in order: set up (20 min) → check tools (25 min) → first repair (45 min).	Each task starts when the one before it finishes.
Set up: $8:40 \text{ am} + 20 \text{ min} = 9:00 \text{ am}$.	$40 + 20 = 60$ min, and 60 min is exactly 1 hour, so the time rolls over to 9:00 (§4D).
Check tools: $9:00 \text{ am} + 25 \text{ min} = 9:25 \text{ am}$.	Start with the previous finish, not with 8:40.
First repair: $9:25 \text{ am} + 45 \text{ min} = 10:10 \text{ am}$.	Jump 35 min to 10:00, then 10 more: 10:10 am.
(b) Total: 8:40 am to 10:10 am is 1 h 30 min (90 min).	Check by adding durations: $20 + 25 + 45 = 90$ min ✓ — both ways agree.
(c) Late finish: $10:10 \text{ am} + 15 \text{ min} = 10:25 \text{ am}$.	A task that runs long pushes its finish — and everything after it — back by the same amount.

Example 2 — scaffolded

A community film night starts at 7:30 pm. Before the film can start, three jobs must run in this order: put up the signs (20 min), set out the chairs (25 min), set up the projector and sound (15 min).

- (a) What is the latest time the sound setup can start? (b) What is the latest time the whole job can start, and what is the total preparation time?
 (b) The organiser wants a 10-minute buffer. What time should the work start?

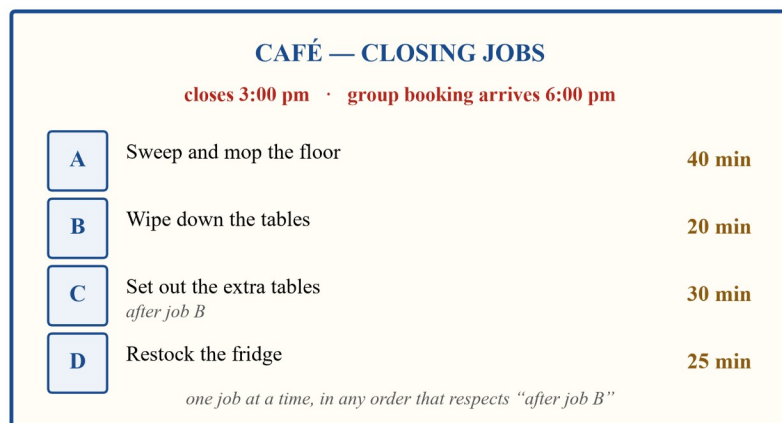
Made-up data: the film night and every time in this example are made up for this section.

Working	Comment
Write the jobs in work order: signs → chairs → sound.	Backward planning reads the list in reverse.
Start at the deadline: the film starts at 7:30 pm.	The deadline is the fixed finish time.
Sound: finishes 7:30 pm, takes 15 min, so it starts at $7:30 \text{ pm} - 15 \text{ min} = 7:15 \text{ pm}$.	$\text{start} = \text{finish} - \text{duration}$. That answers (a).
Chairs: finish 7:15 pm, take 25 min, so they start at $7:15 \text{ pm} - 25 \text{ min} = 6:50 \text{ pm}$.	Each job finishes exactly when the next one starts.
Signs: finish 6:50 pm, take 20 min, so they start at $6:50 \text{ pm} - 20 \text{ min} = 6:30 \text{ pm}$.	This is the latest start for the whole job.

Working	Comment
(b) Total: $20 + 25 + 15 = 60$ min; latest start 6:30 pm .	Check forward: $6:30 \text{ pm} + 1 \text{ h} = 7:30 \text{ pm}$ ✓ — the check catches any backward slip.
(c) With a 10-minute buffer: $6:30 \text{ pm} - 10 \text{ min} = 6:20 \text{ pm}$.	The buffer sits between your finish and the deadline, so start earlier by that much.

Example 3 — unscaffolded

A café closes at 3:00 pm. A group booking arrives at 6:00 pm, and the café must be ready before then. The closing jobs are on the card below.



Made-up data: the café, its jobs and every time are made up for this section.

- (a) One staff member does all four jobs, one after the other. Find the total time needed. (b) Starting at 3:00 pm, when does the staff member finish, and what is the buffer before the 6:00 pm booking? (c) A second staff member helps: one does job A then job D, the other does job B then job C, both starting at 3:00 pm. When is everything finished now, and how much bigger is the buffer?

Step 1. (a) Add the four durations: $40 + 20 + 30 + 25 = 115$ minutes = 1 h 55 min.

Step 2. (b) Finish = $3:00 \text{ pm} + 1 \text{ h } 55 \text{ min} = 4:55 \text{ pm}$. The buffer is the time from the finish to the deadline: $6:00 \text{ pm} - 4:55 \text{ pm} = 65$ minutes.

Step 3. (c) Schedule the two people. Job C depends on job B, and person 2 does B before C, so the order is safe.

Person	Job	Start	Finish
Person 1	A — sweep and mop (40 min)	3:00 pm	3:40 pm
Person 1	D — restock the fridge (25 min)	3:40 pm	4:05 pm
Person 2	B — wipe down tables (20 min)	3:00 pm	3:20 pm
Person 2	C — set out extra tables (30 min)	3:20 pm	3:50 pm

Step 4. Everything is finished at the later of the two finish times: 4:05 pm. The new buffer is $6:00 \text{ pm} - 4:05 \text{ pm} = 115$ minutes (1 h 55 min), which is $115 - 65 = 50$ minutes bigger than before.

∴ one person needs 115 minutes (1 h 55 min) and finishes at 4:55 pm with a 65-minute buffer; with two people everything is finished at 4:05 pm and the buffer grows by 50 minutes to 115 minutes.

Example 4 — unscaffolded

Jordan works at a youth club. This week's roster is below. Jordan is paid \$24.80 per hour.



Day	Shift
Monday	16:00–20:00
Wednesday	17:30–21:30
Saturday	09:00–15:00 (includes a 30-minute unpaid lunch break)

Made-up data: Jordan, the youth club, the roster and the pay rate are made up for this section.

- (a) Find the length of each shift, in hours. (b) Find Jordan's total hours for the week. (c) Find Jordan's pay for the week, correct to the nearest cent.

Step 1. (a) Find each duration (§4D). Monday: 16:00 to 20:00 is 4 hours. Wednesday: 17:30 to 21:30 is 4 hours. Saturday: 09:00 to 15:00 is 6 hours, and the 30-minute lunch is unpaid, so $6 - 0.5 = 5.5$ hours (decimal hours).

Step 2. (b) Add the shifts: $4 + 4 + 5.5 = 13.5$ hours. As a check, $13.5 \text{ h} = 13 \text{ h } 30 \text{ min}$, and the minutes add the same way: $240 + 240 + 330 = 810 \text{ min} = 13.5 \text{ h}$ ✓.

Step 3. (c) Pay = rate $\times$ hours (§5B): $13.5 \times \$24.80 = \$334.80$ — the working lands exactly on a cent, so to the nearest cent the pay is \$334.80.

$\therefore$ the shifts are 4 h, 4 h and 5.5 h; the week totals 13.5 hours; and the pay is \$334.80, correct to the nearest cent.

Practice questions

Scaffolded

Q1. Find the finish time in each case. (a) A bus leaves at 7:45 am and the ride takes 35 minutes. What time does it arrive? (b) A cake goes into the oven at 1:50 pm and bakes for 40 minutes. What time does it come out? (c) A work session starts at 20:45 and runs for 1 h 55 min. What time does it finish, in 24-hour time?

Q2. Find the start time in each case. (a) Training ends at 5:15 pm and lasts 1 h 20 min. What time did it start? (b) A loaf must come out of the oven at 11:00 am and bakes for 45 minutes. What time must it go in? (c) A shift ends at 23:00 and is 7.5 hours long with no breaks. What time does it start? Give your answer in 24-hour time and in 12-hour time.

Q3. Here are the steps for making a smoothie, mixed up: *blend everything, pour into a glass, wash the fruit, chop the fruit*. (a) Write the four steps in the correct order. (b) Which step depends on “chop the fruit”? (c) Can you pour the smoothie into a glass before blending? Give a reason.

Q4. A market stall opens at 9:30 am on Saturday. The jobs, in order, are: set up the stall (30 min), lay out the goods (20 min, after the stall is up), make the sign and price cards (15 min, after the goods are out). Work starts at 8:15 am and runs one job after the other.

- (a) Copy and complete the task table.

Task	Duration	Start	Finish
Set up the stall	30 min	8:15 am	?
Lay out the goods	20 min	?	?
Make the sign and price cards	15 min	?	?

- (b) Find the total time for the three jobs.
(c) Find the buffer between the last finish and the 9:30 am opening.

Made-up data: the stall and every time in this question are made up for this section.

Q5. Nikhil must upload his homework by 4:00 pm. His plan finishes typing at 3:35 pm. (a) Find the buffer in his plan. (b) The typing runs 15 minutes over. What time does he finish? Does he still meet the deadline, and what buffer is

left? (c) Nikhil adds one more 25-minute task after the typing, before the upload. What is his planned finish now, what is the new buffer, and why is a buffer that size risky?

Q6. Roster times. (a) A roster shows a shift starting at 0630. Write this time in 12-hour time. (b) A shift ends at 8:05 pm. Write this time in 24-hour time. (c) An overnight security shift runs from 22:30 to 06:15 the next day. Find its duration.

Un scaffolded

Q7. A community hall opens at 9:00 am for a morning tea. The jobs are: unlock and turn on the lights (10 min), set out 40 chairs (30 min), test the microphone (15 min), and set up the tea and coffee (20 min). The chairs, the microphone and the tea can only start after the hall is unlocked.

- One person does all four jobs, one after the other. Find the total time needed and the finish time.
- After the unlock, which jobs could run at the same time?
- Three people help: one unlocks the hall, then the three each take one of the other jobs and start together at the same time. Find the finish time, and how many minutes are saved compared with part (a).

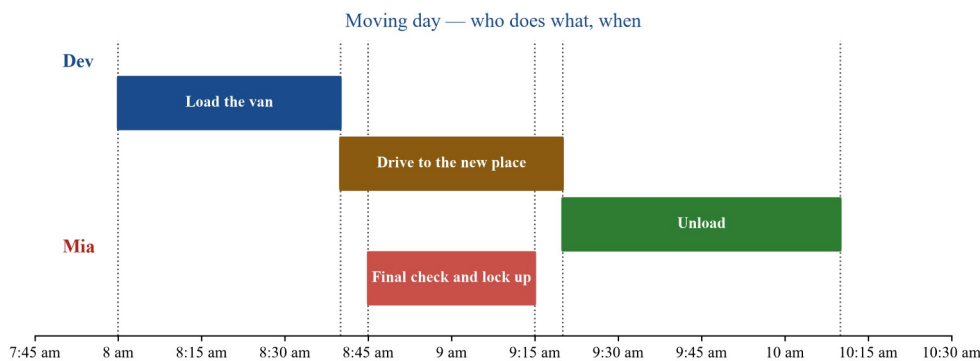
Made-up data: the hall, the jobs and every time are made up for this section.

Q8. A band night has doors opening at 7:00 pm, and everything must be ready by then. Before doors, in this order: load in the gear (25 min), set up the drums and amps (40 min), sound check (30 min).

- Find the total preparation time.
- Find the latest start time that still has everything ready for doors.
- The band arrives at 5:00 pm and starts straight away. What time do they finish, and what is the buffer before doors?

Made-up data: the band night and every time are made up for this section.

Q9. Dev and Mia are moving house on Saturday. Their jobs are drawn on the timeline below.



Made-up data: Dev, Mia and every time on the timeline are made up for this section.

- Which two tasks run at the same time? How can you tell from the bars?
- Find the duration of the unload.
- What time is everything finished?

Q10. Sam works at a plant nursery on a repeating pattern: 3 days on, then 2 days off. The pattern starts on a Monday, and day 1 is a work day. The grid below shows 14 days (two full weeks) to fill in.

THE PATTERN

W	W	W	O	O
---	---	---	---	---

3 days on, then 2 days off
— the pattern repeats

Day 1 is a work day.

Two weeks — 14 days: mark each day W (work) or O (off)

M	T	W	T	F	S	S	M	T	W	T	F	S	S
1	2	3	4	5	6	7	8	9	10	11	12	13	14

W = work day O = off day

Made-up data: Sam, the nursery and the roster grid are made up for this section.

- Mark each of the 14 days as Work or Off. How many days does Sam work?
- Each work day is a 6-hour shift. Find Sam's total hours over the 14 days.
- Find the percentage of the 14 days that Sam works, to the nearest whole percentage.

Q11. Le's weekly timetable at TAFE is summarised below.

Day	Timetabled hours	Of which: work placement
Monday	5	0
Tuesday	4.5	0
Wednesday	5	5
Thursday	4	0
Friday	3.5	3.5

Made-up data: Le, the timetable and every number in it are made up for this section.

- Find the total timetabled hours in the week.
- Find the total work placement hours in the week.
- Find the work placement hours as a percentage of the total week, correct to 1 decimal place.

Q12. Today is Wednesday. A to-do app holds these seven tasks.

Task	Due
Return library book	Tuesday
Pay phone bill	Wednesday
Water the plants	Wednesday
Buy a birthday present	Thursday
Hand in the assignment	Friday
Clean the bedroom	Saturday
Renew the car registration	next Monday

Made-up data: the tasks and due dates are made up for this section.

- How many tasks are overdue?
- How many tasks are due today?
- Find the percentage of the 7 tasks that are due after today, correct to 1 decimal place.

Q13. A bakery plans its morning in a spreadsheet. The Finish column is calculated from the Start and Duration columns; two cells show “?”.

	Task	Start	Duration (min)	Finish
2	Preheat the oven	5:30 am	15	5:45 am
3	First bake	5:45 am	40	6:25 am
4	Ice the cakes	6:25 am	30	?
5	Set out the counter	6:55 am	25	?

The Start times are typed in. The Finish column is calculated.

Two calculated cells show ? — find them.

Made-up data: the bakery and every entry in the sheet are made up for this section.

- Which columns hold inputs the baker types, and which column holds the output the spreadsheet calculates (§10A)?
- Find the two missing finish times (the “?” cells).
- The baker changes the icing duration from 30 min to 45 min. Find the new finish time for the icing, and explain why that change breaks the plan as written.

Q14. A caterer plans four jobs before an event, then records how long each job actually took. Work starts at 9:00 am and the food must arrive by 11:30 am.

Job	Planned (min)	Actual (min)
Make the sandwiches	40	50
Make the drinks	25	20
Load the van	30	35
Drive to the event	45	45

Made-up data: the caterer and every number in the table are made up for this section.

- Find the total planned time and the total actual time.
- Find the planned finish time and the planned buffer before the 11:30 am deadline.
- Find the actual finish time. Does the caterer still meet the deadline, and what buffer is left?

Q15. Grace has a free block of 150 minutes before footy training. Her to-do list: revise for the test (45 min), tidy her room (30 min), walk the dog (25 min), bake for tomorrow’s fete (60 min).

Made-up data: Grace, her list and every time are made up for this section.

- Find the total time needed to do all four tasks.
- By how many minutes is the list too long for the 150-minute block?
- Grace categorises the baking as “can wait” and does it tomorrow morning instead. Do the remaining three tasks fit in the block? How many spare minutes does she have?

Q16. A physio clinic takes 30-minute appointments on Tuesday morning, from 9:00 am to 12:00 pm. The booking sheet is below.

Physio clinic — Tuesday bookings

30-minute appointments, 9:00 am to 12:00 pm

9:00 am	BOOKED — Ana
9:30 am	BOOKED — Ben
10:00 am	
10:30 am	BOOKED — Carla
11:00 am	
11:30 am	BOOKED — Dan

Made-up data: the clinic, the patients and the booking sheet are made up for this section.

- How many slots are free, and at what times?
- Find the total number of booked minutes.
- Find the percentage of the morning that is booked, to the nearest whole percentage.

Q17. Deadlines across the calendar. April has 30 days and March has 31. (a) A project starts on Monday 28 April and is due on Friday 2 May. How many days after the start date is the due date? (b) A library book is borrowed on 12 March on a 21-day loan. What is its due date? (c) A bill due on 15 May is paid on 23 May. How many days late is it?

Q18. Ava is planning a birthday picnic in the park. Guests arrive at 12:30 pm and everything must be ready by then. Ava can start at 9:00 am. Her task card is below.

PARK PICNIC — TASK CARD		
guests arrive 12:30 pm · Ava can start at 9:00 am		
P1	Set up the table and the shade	30 min
P2	Blow up balloons and decorate <i>waits for P1</i>	25 min
P3	Collect the cake from the bakery	35 min
P4	Make the sandwiches	30 min
P5	Pack the esky with drinks and ice	15 min
P6	Set out the food and final tidy <i>waits for P2, P4 and P5</i>	20 min

Made-up data: Ava, the picnic and every time on the card are made up for this section.

- Ava does all six tasks herself, one after the other, in an order that respects every “waits for”. Find the total time needed.
- Starting at 9:00 am, what time does Ava finish, and what is the buffer before 12:30 pm?
- Ava’s brother offers to do tasks P3, P4 and P5 while Ava does P1, P2 and P6. Both start at 9:00 am, and Ava starts P6 as soon as everything it waits for is finished. Find the new finish time and the new buffer.
- How many minutes does the brother’s help save?

Answers

Q1. (a) 8:20 am. (b) 2:30 pm. (c) 22:40. **Q2.** (a) 3:55 pm. (b) 10:15 am. (c) 15:30 (3:30 pm). **Q3.** (a) wash → chop → blend → pour. (b) blend everything. (c) no — there is no smoothie to pour until blending is done; pouring depends on blending. **Q4.** (a) 8:45 am; 8:45 am–9:05 am; 9:05 am–9:20 am. (b) 65 min (1 h 5 min). (c) 10 min. **Q5.** (a) 25 min. (b) 3:50 pm; yes, on time; 10 min left. (c) 4:00 pm; buffer 0 min — risky because any task that runs even a little over makes the upload late. **Q6.** (a) 6:30 am. (b) 2005. (c) 7 h 45 min. **Q7.** (a) 75 min; 10:15 am. (b) chairs, microphone and tea — all only wait for the unlock, so any of them can run together. (c) 9:40 am; 35 min saved. **Q8.** (a) 95 min (1 h 35 min). (b) 5:25 pm. (c) 6:35 pm; 25 min. **Q9.** (a) the drive and Mia's final check — their bars overlap between 8:45 and 9:15. (b) 50 min. (c) 10:10 am. **Q10.** (a) Work: days 1, 2, 3, 6, 7, 8, 11, 12, 13 — 9 days. (b) 54 h. (c) 64 % to the nearest whole percentage. **Q11.** (a) 22 h. (b) 8.5 h. (c) 38.6 % to 1 d.p. **Q12.** (a) 1 (library book). (b) 2 (phone bill, plants). (c) 57.1 % to 1 d.p. **Q13.** (a) inputs: Task, Start, Duration; output: Finish. (b) icing 6:55 am; counter 7:20 am. (c) 7:10 am — the counter is scheduled to start at 6:55 am, before the icing has finished, so the two now overlap and the plan breaks. **Q14.** (a) planned 140 min; actual 150 min. (b) 11:20 am; 10 min. (c) 11:30 am; yes, exactly on the deadline; buffer 0 min. **Q15.** (a) 160 min. (b) 10 min too long. (c) yes — 100 min fits; 50 min spare. **Q16.** (a) 2 free: 10:00 am and 11:00 am. (b) 120 min. (c) 67 % to the nearest whole percentage. **Q17.** (a) 4 days. (b) 2 April. (c) 8 days. **Q18.** (a) 155 min (2 h 35 min). (b) 11:35 am; buffer 55 min. (c) 10:40 am; buffer 110 min (1 h 50 min). (d) 55 min.

Fully-worked solutions

Q1. (a) 7:45 am + 35 min: jump 15 min to 8:00 am, then 20 more → **8:20 am**. (b) 1:50 pm + 40 min: jump 10 min to 2:00 pm, then 30 more → **2:30 pm**. (c) 20:45 + 1 h 55 min: jump 15 min to 21:00, then 1 h 40 min → **22:40**. Check: all three used finish = start + duration (§4D jumping).

Q2. (a) 5:15 pm – 1 h 20 min: back 15 min to 5:00 pm, back 1 h to 4:00 pm, back 5 more → **3:55 pm**. (b) \$11{:}00 - 45 = \$ **10:15 am**. (c) 7.5 h = 7 h 30 min; 23:00 – 7:30 = 15:30, so the shift starts at **15:30**, which is **3:30 pm**. Check (c): 15:30 + 7:30 = 23:00 ✓.

Q3. (a) The fruit must be clean before it is chopped, chopped before it is blended, and blended before it is poured: **wash the fruit → chop the fruit → blend everything → pour into a glass**. (b) **Blend everything** — you cannot blend fruit that has not been washed and chopped first. (c) **No** — pouring depends on blending; before blending there is no smoothie in the jug to pour.

Q4. (a) Each job starts when the one before finishes:

Task	Duration	Start	Finish
Set up the stall	30 min	8:15 am	8:45 am
Lay out the goods	20 min	8:45 am	9:05 am
Make the sign and price cards	15 min	9:05 am	9:20 am

(b) Total = 30 + 20 + 15 = 65 minutes (1 h 5 min). Check: 8:15 am + 1 h 5 min = 9:20 am ✓ — matches the table.

(c) Buffer = opening – planned finish = 9{:}30 - 9{:}20 = \$ **10 minutes**.

Q5. (a) Buffer = 4{:}00 - 3{:}35 = \$ **25 minutes**. (b) New finish = 3{:}35 + 15 = \$ **3:50 pm**. 3:50 < 4:00, so he **still meets the deadline**, with 4{:}00 - 3{:}50 = \$ **10 minutes** of buffer left. (c) Finish = 3{:}35 + 25 = \$ **4:00 pm** — exactly the deadline, so the new buffer is **0 minutes**. A zero buffer is risky: if any task runs even a little over, the upload is late. This is why plans usually keep some spare time.

Q6. (a) 0630 has an hour under 12, so it is an am time (§4D): **6:30 am**. (b) 8:05 pm is a pm time, so add 12 to the hour: 8 + 12 = 20 → **2005**. (c) Split at midnight: 22:30 to midnight is 1 h 30 min; midnight to 06:15 is 6 h 15 min. Duration = 1{:}30 + 6{:}15 = \$ **7 h 45 min** (465 min).

Q7. (a) All four jobs done one after the other: $10 + 30 + 15 + 20 = 75$ minutes. Finish $\$ = 9\{: \}00 + 1\ 15 = \$ 10:15$ am. (b) The chairs, the microphone and the tea each wait **only** for the unlock — none of them waits for another — so **all three can run at the same time** once the hall is open. (c) One person unlocks: $9:00 \text{ am} + 10 \text{ min} = 9:10 \text{ am}$. Then the three work in parallel, so they all finish by the longest job: the chairs, 30 min. Finish $\$ = 9\{: \}10 + 30 = \$ 9:40$ am. Minutes saved $\$ = 10\{: \}15 - 9\{: \}40 = \$ 35$ minutes. Check: the parallel stretch takes 30 min instead of $30 + 15 + 20 = 65$ min, and $65 - 30 = 35$ ✓ — the same saving.

Q8. (a) Total $= 25 + 40 + 30 = 95$ minutes (1 h 35 min). (b) Plan backward from doors at 7:00 pm: sound check starts at $7:00 - 0:30 = 6:30$ pm; set-up starts at $6:30 - 0:40 = 5:50$ pm; load-in starts at $5\{: \}50 - 0\{: \}25 = \$ 5:25$ pm. Check forward: $5:25 \text{ pm} + 1 \text{ h } 35 \text{ min} = 7:00 \text{ pm}$ ✓. (c) Start 5:00 pm: finish $\$ = 5\{: \}00 + 1\ 35 = \$ 6:35$ pm. Buffer $\$ = 7\{: \}00 - 6\{: \}35 = \$ 25$ minutes.

Q9. (a) Mia's **final check and lock-up** (8:45–9:15) runs while Dev is **driving** (8:40–9:20) — their bars overlap. You can tell because the two bars cover some of the same time: 8:45 to 9:15 sits inside 8:40 to 9:20. No other pair overlaps: the load finishes at 8:40, before 8:45, and the unload starts at 9:20, after 9:15. (b) Unload: 9:20 to 10:10 is **50 minutes** (jump 40 min to 10:00, then 10 more). (c) The last task to end is the unload, so everything is finished at **10:10 am**.

Q10. (a) The pattern repeats every 5 days: Work, Work, Work, Off, Off. Filling the 14-day grid from Monday:

Da														
y	1	2	3	4	5	6	7	8	9	10	11	12	13	14
	W	W	W	O	O	W	W	W	O	O	W	W	W	O

Work days: 1, 2, 3, 6, 7, 8, 11, 12, 13 — that is **9 days**. Check: 14 days = 2 full patterns (10 days, 6 work) plus the first 4 days of a pattern (W W W O, 3 work): $6 + 3 = 9$ ✓. (b) Hours $\$ = 9 = \$ 54$ hours. (c) $\frac{9}{14} \times 100 = 64.285\dots$, which is 64 % to the nearest whole percentage.

Q11. (a) Total $\$ = 5 + 4.5 + 5 + 4 + 3.5 = \$ 22$ hours. (b) Placement = Wednesday + Friday $\$ = 5 + 3.5 = \$ 8.5$ hours. (c) $\frac{8.5}{22} \times 100 = 38.636\dots$, which is 38.6 % correct to 1 decimal place. Check: 8.5 is a little more than a third of 22, and 38.6 % is a little more than 33 % ✓.

Q12. Today is Wednesday. Sort the seven tasks by due date:

- **Overdue** (due before today): return library book (Tuesday) — **1 task**.
- **Today** (due Wednesday): pay phone bill, water the plants — **2 tasks**.
- **After today**: present (Thu), assignment (Fri), bedroom (Sat), registration (next Mon) — **4 tasks**.

(c) $\frac{4}{7} \times 100 = 57.142\dots$, which is 57.1 % correct to 1 decimal place. Check: $1 + 2 + 4 = 7$ ✓ — every task is in exactly one category.

Q13. (a) The baker types the **Task**, **Start** and **Duration** columns — those are the **inputs**. The spreadsheet calculates the **Finish** column from them — that is the **output** (§10A). (b) Icing: $6\{: \}25 + 30 = \$ 6:55$ am. Counter: $6\{: \}55 + 25 = \$ 7:20$ am. (c) New icing finish $\$ = 6\{: \}25 + 45 = \$ 7:10$ am. The plan has the counter starting at 6:55 am, but the icing now runs until 7:10 am — the counter task starts **before its kitchen is free**, so the two overlap and the schedule breaks. Changing one input changes the output, and the rest of the plan must be checked again (this is parameter thinking — see §10E).

Q14. (a) Planned total $\$ = 40 + 25 + 30 + 45 = \$ 140$ minutes. Actual total $\$ = 50 + 20 + 35 + 45 = \$ 150$ minutes. (b) Planned finish $\$ = 9\{: \}00 + 140 = 9\{: \}00 + 2\ 20 = \$ 11:20$ am. Planned buffer $\$ = 11\{: \}30 - 11\{: \}20 = \$ 10$ minutes. (c) Actual finish $\$ = 9\{: \}00 + 150 = 9\{: \}00 + 2\ 30 = \$ 11:30$ am — exactly the deadline, so **yes, the caterer makes it**, but the buffer left is $11\{: \}30 - 11\{: \}30 = \$ 0$ minutes. The 10-minute buffer absorbed the 10-minute overrun with nothing to spare.

Q15. (a) Total \$ = $45 + 30 + 25 + 60 = \$ 160$ **minutes**. (b) $\$160 - 150 = \$ 10$ **minutes** — the list is 10 minutes too long, so it cannot all fit. (c) Without the baking: $45 + 30 + 25 = 100$ minutes, and $100 \leq 150$, so **yes, the rest fits**, with $\$150 - 100 = \$ 50$ **spare minutes**. Categorising (“can wait”) turned a plan that did not fit into one that did.

Q16. (a) The morning holds 6 half-hour slots: 9:00, 9:30, 10:00, 10:30, 11:00, 11:30. Booked: 9:00 (Ana), 9:30 (Ben), 10:30 (Carla), 11:30 (Dan). Free: **2 slots — 10:00 am and 11:00 am**. (b) Booked minutes \$ = 4 = \$ **120 minutes**. (c)

The morning is 9:00 am to 12:00 pm = 180 minutes. $\frac{120}{180} \times 100 = 66.666\dots$, which is 67 % to the nearest whole

percentage. Check: 120 of 180 minutes is two-thirds, and 67 % is close to $66\frac{2}{3}\%$ ✓.

Q17. (a) Count in two parts (§4D): 28 April to 30 April is 2 days (29th, 30th), then 2 more days into May (1st, 2nd): $\$2 + 2 = \$ 4$ **days**. (b) 12 March to 31 March is $31 - 12 = 19$ days; the loan still needs $21 - 19 = 2$ days into April, so the due date is **2 April**. (c) $\$23 - 15 = \$ 8$ **days late**.

Q18. (a) One person does every task, so the total is the sum of all six durations (an order that respects the “waits for” notes is $P1 \rightarrow P2 \rightarrow P3 \rightarrow P4 \rightarrow P5 \rightarrow P6$): $30 + 25 + 35 + 30 + 15 + 20 = 155$ minutes \$ = \$ **2 h 35 min**. (b) Finish \$ = $9\{:\}00 + 2\ 35 = \$ 11:35$ **am**. Buffer \$ = $12\{:\}30 - 11\{:\}35 = \$ 55$ **minutes**. (c) Schedule the two people. Brother: P3 9:00–9:35 am, P4 9:35–10:05 am, P5 10:05–10:20 am. Ava: P1 9:00–9:30 am, P2 9:30–9:55 am. P6 waits for P2 (done 9:55 am), P4 (done 10:05 am) and P5 (done 10:20 am), so the earliest it can start is the latest of those: **10:20 am**. P6: 10:20–10:40 am, so everything is finished at **10:40 am**. New buffer = $12:30 - 10:40 = 110$ minutes \$ = \$ **1 h 50 min**. (d) Minutes saved \$ = $11\{:\}35 - 10\{:\}40 = \$ 55$ **minutes**. Check: with help, the day runs $9:00 \rightarrow 10:40 = 100$ minutes of clock time; the tasks still total 155 minutes of work, but two people were working for much of it — the clock time is shorter even though the work is the same ✓.

Theory

Section 10A looked at the inputs and outputs of technology: what you put in, and what you get back. Section 10C used technology to plan and schedule tasks. This section takes the same input–output idea and uses it on three tools you will meet outside class: **interactive maps**, **journey planners** and **online calculators**. Section 7B covered paper maps, compass directions and bearings; here the map lives on a screen and does some of the maths for you. Section 10E covers changing a tool’s settings to get a better output.

Tools that plan for you.

- An **interactive map** is a map on a screen that answers questions. You type a start and an end, pick how you are travelling, and it gives back a distance, a travel time and a route.
- A **journey planner** joins public transport timetables into a door-to-door trip. In Victoria the planner and the timetables behind it are published by **Public Transport Victoria (PTV)**, the government body that runs the train, tram, bus and coach services.
- An **online calculator** is a website or app that does one kind of sum for you: a trip-fuel calculator, a paint calculator, a fare calculator.

Each of these tools is a black box with inputs and outputs (§10A). The maths in this section is what lets you *use* those outputs: turn them into speeds, arrival times and totals, check they make sense, and choose between the options a tool offers.

Demonstrated, never required.

Every map screen, planner result, timetable and calculator in this section is printed on the page in front of you. You never need a phone, an app or the internet to answer anything here: pen, paper and a basic calculator are enough. The tools are shown because they are part of the study and part of life — and because an output you cannot check is an output you cannot trust.

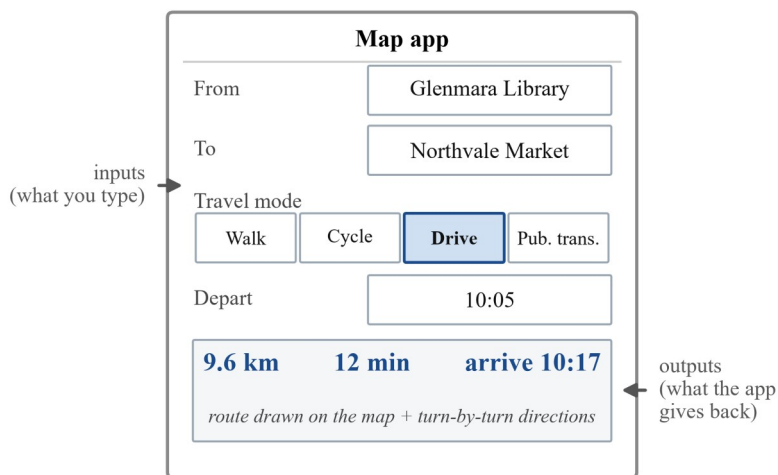
Times in this section.

Planners and timetables write times with the 24-hour clock, so this section does too: 08:12, 14:40, 16:25. The afternoon hours keep counting past 12, so 3:45 pm is written 15:45 (§4D). Departures, arrivals and durations still obey the two rules from §10C: going forward, arrival = departure + duration; going backward, departure = arrival – duration.

Interactive maps: inputs and outputs.

Tool	Inputs you give	Outputs it gives back
Interactive map	start, destination, way of travelling, departure time	distance, travel time, arrival time, route
Journey planner	start, destination, day and time	the legs (walk, wait, ride, change), arrival time, fare
Trip-fuel calculator	distance, fuel use per 100 km, fuel price per litre	fuel used, fuel cost

The panel below is a typical interactive-map result: a drive from Glenmara Library to Northvale Market, leaving at 10:05.



Made-up data: the app screen and every place and number on it are made up for this section.

The outputs are 9.6 km, 12 min and an arrival of 10:17. Check the arrival yourself with the forward rule:
 $10:05 + 12 \text{ min} = 10:17$ ✓ — the screen agrees with the clock maths.

Worked model — average speed from a map output. Twelve minutes as a fraction of one hour is $\frac{12}{60} = \frac{1}{5} = 0.2 \text{ h}$.

So the average speed on that drive is $9.6 \div 0.2 = 48 \text{ km/h}$. Forty-eight km/h is an ordinary speed for town driving, so the output passes the sense check.

Worked model — arrival time. A planner says: depart 15:48, journey 37 min. Going forward:
 $15:48 + 37 \text{ min} = 16:25$.

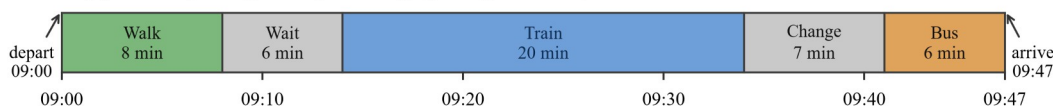
Worked model — duration from a timetable. A timetable row reads: departs 13:42, arrives 14:17. The duration is
 $14:17 - 13:42 = 35 \text{ min}$.

Journey planners: legs, changes and timetables.

A journey planner splits a trip into **legs**: the pieces that run without stopping. Walking to a stop is a leg, waiting is a leg, each ride is a leg, and a **change** — getting off one service and on another — shows up as a wait or a short walk between services. A **service** is one scheduled run of a bus, train, tram or coach. A **timetable** lists the departure and arrival times of every service on a route. A **fare** is the price of a ticket.

Journey planner result — Glenmara Station to Harbourside Park (made-up journey)

Every part of a trip is a leg. Waiting and changing are legs too — they all count in the total time.



Made-up data: the journey, the services and every time shown are made up for this section.

The total door-to-door time is the sum of **all** the legs, waiting and changing included: $8 + 6 + 20 + 7 + 6 = 47 \text{ min}$. Leaving at 09:00, the arrival is $09:00 + 47 \text{ min} = 09:47$, exactly as the planner shows. The wait and the change are legs too — leave them out and the total, and the arrival, are wrong.

Reading a timetable backward. Often you know the time you must *arrive*, and you need the latest service that gets you there. Read the arrival column, pick the last arrival that is not later than your deadline, then read across to its departure. Questions 4 and 9 practise this.

Online calculators.

An online calculator takes a few numbers and returns the sum you could have done by hand — only faster, and with no keying slips. Three kinds turn up in this section:

Calculator	Inputs	Outputs
Trip-fuel calculator	distance, fuel use in L/100 km, fuel price per litre	fuel used in L, fuel cost in \$
Paint calculator	area to paint in m ² , coverage in m ² per litre	litres needed, tins to buy
Fare calculator	start, destination, ticket type	fare in \$

The screen below is a trip-fuel calculator with its three inputs filled in.

Fuel-cost calculator

Distance: 120 km

Fuel use: 8.0 L/100 km

Fuel price: \$1.65 per litre

Calculate

Fuel used: 9.6 L

Cost: \$15.84

Made-up data: the calculator screen and every number on it are made up for this section.

Check the outputs by hand. Fuel used: $120 \times 8.0 \div 100 = 9.6$ L. Cost: $9.6 \times \$1.65 = \$15.84$. Both match the panel, so the panel can be trusted — and if they had not matched, one of the inputs was wrong.

Units first. Every input box carries a unit: km, L/100 km, dollars per litre, m². Type a number in the wrong unit and the output is wrong by exactly the factor between the units — metres typed into a kilometres box makes every answer 1000 times too big (Q11). Read the unit before you type the number.

Deciding with numbers.

The point of reading outputs mathematically is usually a **choice**: drive or catch the train, take the short slow route or the long fast one, buy the big tin or the small one. Compare the options on the things that matter, and put a number on each:

- door-to-door time — every leg, including the walks, the waits and the changes;
- total cost — fuel **and** parking, or the fares for **every** person travelling;
- what can go wrong — a missed connection, a full car park, a late service.

Then choose, and give your reason in one sentence with a number in it. Example 3 and Questions 10, 13 and 18 all have this shape.

Rounding and sensible answers.

Carry full precision through the working and round only where the question says to — “to the nearest cent”, “to 1 decimal place” — then state that precision in your answer. Money is normally given to the nearest cent; the speeds in this section to 1 d.p. Before you finish, run a **sense check**: compare the output with something you already know. A person walks at about 5 km/h, so a “walk” output that implies 45 km/h cannot be right (Q17); the 48 km/h found above is what town driving looks like. If an output fails the sense check, go back to the inputs — the unit, the travel mode, the departure time — before you trust it.

About the data in this section. The map screens, journey planner results, timetables, fares, fuel prices and every other number in this section are **made up** (not real): pretend towns, pretend services and pretend numbers, built for this book so you can practise the maths. Nothing here is real data about a real business, person or place. The tools themselves — interactive maps, journey planners such as PTV’s, and online calculators — are real kinds of tool; every screen shown is a made-up example of one.

Worked examples

Example 1 — scaffolded

A worker checks the drive from Glenmara to Stringybark Lookout on a map app before leaving. The app’s card is shown below.

Map app — driving route	
From	Glenmara
To	Stringybark Lookout
Depart	14:40
Distance: 18.5 km Estimated time: 25 min	

Made-up data: the app card and every number on it are made up for this section.

- (a) Write the estimated time of 25 min as a fraction of an hour, and as a decimal to 4 d.p.
- (b) Use the distance and the time on the card to find the average speed in km/h.
- (c) The driver departs at 14:40. Find the arrival time the app is predicting.

Working	Comment
(a) 25 min as a fraction of an hour is $\frac{25}{60} = \frac{5}{12}$.	There are 60 min in one hour (§4D).
As a decimal, $\frac{5}{12} = 0.4167$ to 4 d.p.	$5 \div 12 = 0.41666\dots$; the fourth decimal place rounds up.
(b) Average speed = $18.5 \div \frac{5}{12} = 44.4$ km/h.	Speed = distance $\div$ time, with the time in hours (§5B).
(c) $14:40 + 25 \text{ min} = 15:05$.	Jump 20 min to 15:00, then 5 min more.

Example 2 — scaffolded

A journey planner result for Glenmara to Harbourside Park, departing at 08:12, is shown below.

Journey planner — Glenmara to Harbourside Park

Depart 08:12

Trip distance: 6.8 km

Legs of the journey

	Walk to station	7 min
	Train	14 min
	Change	5 min
	Tram	9 min

Made-up data: the planner result and every number on it are made up for this section.

- Find the total door-to-door time of the journey, in minutes.
- Find the arrival time.
- The planner says the trip covers 6.8 km. Find the average speed for the whole journey in km/h, to 1 d.p.

Working	Comment
(a) $7 + 14 + 5 + 9 = 35$ min.	Every leg counts, the change included.
(b) $08:12 + 35 \text{ min} = 08:47$.	Forward rule: arrival = departure + duration.
(c) $35 \text{ min} = \frac{35}{60} \text{ h} = \frac{7}{12} \text{ h}$.	The time must be in hours to give km/h.
$6.8 \div \frac{7}{12} = \frac{408}{35} \approx 11.7$ km/h, to 1 d.p.	Dividing by a fraction: multiply by its reciprocal.

The average is low because the walks and the change are in it — that is what “door-to-door” means.

Example 3 — unscaffolded

Mara travels from Glenmara to her job at the Northvale Market and back. Driving: 24 km each way, the car uses 8.5 L per 100 km, fuel is \$1.72 per litre, parking is \$14 for the day, and each way is a 35 min drive plus a 10 min walk from the car park. Public transport: the fare is \$5.60 each way and the trip takes 52 min door-to-door each way.

- Find the fuel cost for one way, to the nearest cent.
- Find the total cost of a day of driving, to the nearest cent: fuel there and back, plus the parking.
- Compare driving with public transport for the day, on cost and on time. Which would you choose, and why?
- Fuel for one way: $24 \times 8.5 \div 100 = 2.04$ L. At \$1.72 a litre that is $2.04 \times \$1.72 = \$3.5088$, which is \$3.51 to the nearest cent.

- (e) Fuel for the return: $\$3.5088 \times 2 = \$7.0176$. Add the day's parking: $\$7.0176 + \$14 = \$21.0176$, which is \$21.02 to the nearest cent. The unrounded \$3.5088 is carried through; rounding happens once, at the end.
- (f) Public transport for the day: $2 \times \$5.60 = \$11.20$. Driving costs $\$21.0176 - \$11.20 = \$9.8176$ more, which is \$9.82 to the nearest cent. On time: driving is $2 \times (35 + 10) = 90$ min door-to-door and public transport is $2 \times 52 = 104$ min, so driving saves $104 - 90 = 14$ min.

$\therefore$ a day of driving costs \$21.02 against \$11.20 by public transport — \$9.82 dearer to the nearest cent — but saves 14 min of travel time. Either choice can be defended once the trade is named: pay \$9.82 for the 14 min and the car at lunchtime, or save the money and read on the train. The numbers are what turn a guess into a decision.

Example 4 — unscaffolded

A courier checks a 340 km run on a trip-fuel calculator. The screen is shown below.

Trip fuel calculator	
Distance	340 km
Fuel use	7.8 L/100 km
Fuel price	\$1.689 per litre
Calculate	
Fuel used: 26.52 L Fuel cost: \$44.79	

Made-up data: the calculator screen and every number on it are made up for this section.

- (a) Check both outputs by hand: the fuel used, and the fuel cost to the nearest cent.
- (b) A different calculator asks for the distance in metres instead of kilometres. What number should be typed for the same trip?
- (c) The run grows to 420 km. Find the new fuel used and the new cost, to the nearest cent.
- (d) Fuel used: $340 \times 7.8 \div 100 = 26.52$ L, which matches the screen. Cost: $26.52 \times \$1.689 = \$44.79228$, which is \$44.79 to the nearest cent — the screen again. Two methods agreeing means the output can be trusted.
- (e) One kilometre is 1000 m, so $340 \times 1000 = 340\,000$ m. The number to type is 340 000.
- (f) Fuel: $420 \times 7.8 \div 100 = 32.76$ L. Cost: $32.76 \times \$1.689 = \$55.33164$, which is \$55.33 to the nearest cent.

$\therefore$ the screen's 26.52 L and \$44.79 both check out; the same trip typed into a metres box is 340 000; and at 420 km the run uses 32.76 L and costs \$55.33 to the nearest cent.

Practice questions

Scaffolded

Q1. Time basics for planners. (a) Write 3:45 pm in 24-hour time. (b) A planner shows a journey from 08:12 to 08:47. How many minutes is that? (c) A planner says: depart 14:05, journey 38 min. Find the arrival time.

Q2. Speed, distance and time from map outputs. (a) How long, in minutes, does 12 km at an average speed of 48 km/h take? (b) How far does a car travelling at 60 km/h go in 15 min? (c) A map says a route covered 9 km in 12 min. Find the average speed in km/h.

Q3. Legs of a journey. A planner result lists these legs: walk 5 min, wait 3 min, bus 18 min, walk 4 min. The departure is 16:20. (a) Find the total door-to-door time, in minutes. (b) Find the arrival time. (c) Which leg is the longest, and how long is it?

Q4. This bus timetable runs Monday to Friday, Glenmara to Harbourside Park.

Departs Glenmara	Arrives Harbourside Park
08:05	08:37
08:20	08:55
08:35	09:05
08:50	09:28

Made-up data: this timetable is made up for this section.

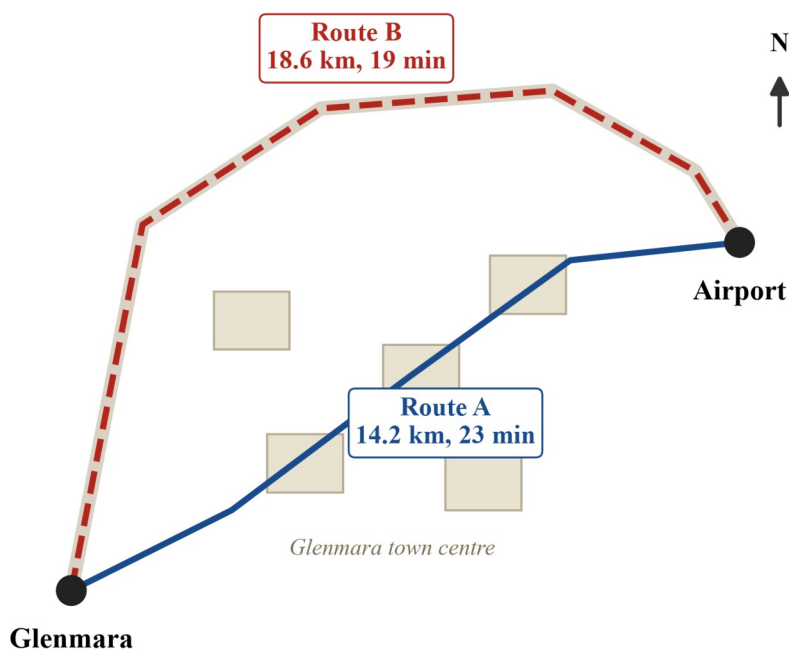
- How many minutes does the 08:20 service take?
- The services depart every how many minutes?
- You must be at the park by 09:10. Find the latest service you can catch: give its departure time and its arrival time.

Q5. Fuel basics. A trip is 150 km, the car uses 8 L per 100 km, and fuel is \$1.70 per litre. (a) Find the fuel used, in litres. (b) Find the fuel cost. (c) The trip doubles to 300 km. Find the new fuel used and the new cost, and say what you notice.

Q6. Inputs, outputs and units. (a) A trip-fuel calculator has three input boxes. What goes in them? (b) Look at the map-app panel in the Theory figures. Name two inputs you give the app and two outputs it gives back. (c) A walking calculator wants its distance in metres. Write 2.4 km in metres.

Un scaffolded

Q7. A map app offers two driving routes from Glenmara to the airport.



Schematic map — not to scale (made-up places)

Made-up data: the map is a schematic of made-up places, and the distances and times are made up for this section.

- How much longer is Route B than Route A, in km?
- You leave at 09:50 and take Route B. Find your arrival time.
- Find the average speed on Route A in km/h, to 1 d.p.

Q8. A journey planner result lists these legs: walk 6 min, wait 4 min, train 22 min, change 8 min, bus 12 min. The departure is 07:41 and the trip covers 13.5 km. (a) Find the total door-to-door time, in minutes. (b) Find the arrival time. (c) Find the average speed for the whole journey in km/h, to 1 d.p.

Q9. Mara must be at work in Northvale by 08:15. The weekday train timetable is shown below.

Weekday timetable — Glenmara to Northvale (train)

Departs Glenmara	Arrives Northvale
07:06	07:38
07:24	07:55
07:42	08:13
08:00	08:34
08:18	08:52

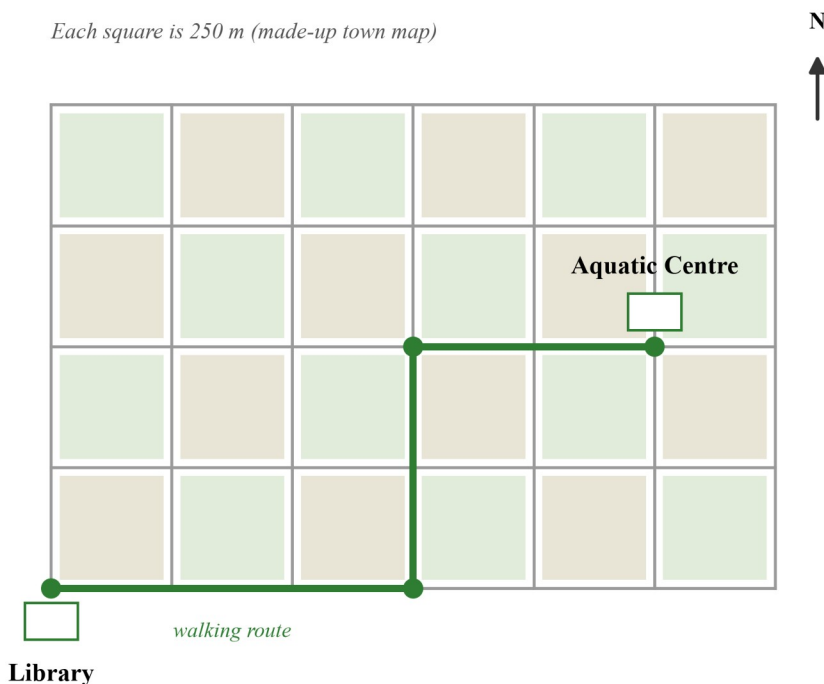
Made-up timetable for this section.

- Find the latest train that arrives by 08:15.
- Give its arrival time, and how many minutes early that is.
- How many minutes does that service take?

Q10. Dee travels from Glenmara to work at Harbourside Park 5 days a week. Driving: 12 km each way, the car uses 7.5 L per 100 km, fuel is \$1.66 per litre, and parking is \$6 a day. Public transport: \$6.40 a day in fares. (a) Find the cost of driving for one week, to the nearest cent. (b) Find the cost of public transport for one week. (c) Find the difference between the two, per week and over 4 weeks.

Q11. A trip-fuel calculator is given: distance 275 km, fuel use 9.2 L per 100 km, fuel price \$1.712 per litre. (a) Find the fuel used and the fuel cost, to the nearest cent. (b) The distance box is labelled km, but 275 000 is typed in by mistake. What fuel does the calculator return, and how many times too big is it? (c) The fuel price rises to \$1.799 per litre. Find the new cost of the 275 km trip, to the nearest cent.

Q12. On this walking map of a made-up town grid, every square is 250 m on a side. The green line is the walking route from the Library to the Aquatic Centre.

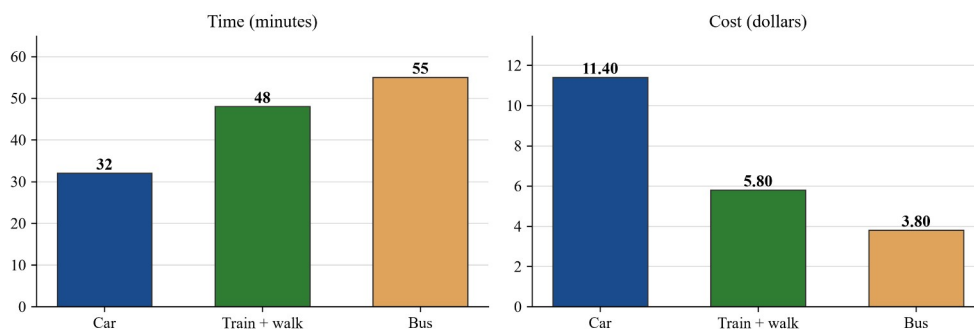


Made-up data: the town map and the route are made up for this section.

- Find the length of the walk, in km.
- At 5 km/h, how many minutes does the walk take?
- The walker leaves at 10:15. Find the arrival time.

Q13. A planner compares three ways for one person to get to the match at Northvale Oval.

Three ways to get to the match at Northvale Oval (made-up data)



Made-up data: the three options and every number in the charts are made up for this section.

- Which option is the cheapest, and what does it cost?
- Which option is the fastest, and how long does it take?
- Compare the car with the bus: how many minutes does the car save, and how much more does it cost?

Q14. A paint calculator is given: wall area 86 m², paint coverage 12 m² per litre, and the paint is sold in 4 L tins at \$68.50 a tin. (a) Find the litres of paint needed, to 2 d.p. (b) Find the number of tins to buy. Tins are sold whole. (c) Find the cost of those tins, and the paint left over when the job is done, in litres to 2 d.p.

Q15. A map app estimates that a drive of 87.5 km will take 1 h 30 min. Show that the average speed it implies is 58.3 km/h, to 1 d.p.

Q16. A delivery van based in Glenmara uses 11 L per 100 km, and fuel is \$1.64 per litre. Monday's runs are: X, 46 km; Y, 52 km; Z, 43 km. (a) Find the fuel used on run Z, in litres. (b) Find the fuel cost of run Z, to the nearest cent. (c) Run Y is cancelled and run Z is done in its place. How much fuel money is saved, to the nearest cent?

Q17. A map app in walk mode shows this for a walk from Glenmara Library to Northvale Shops.

Map app

Walk
Cycle
Drive
Pub. trans.

From

Glenmara Library

To

Northvale Shops

3 km 4 min

Does this output make sense?

Made-up data: the app screen is made up for this section.

A person walks at about 5 km/h. (a) How far does a 5 km/h walker go in 4 min? Give your answer in km to 2 d.p. (b) How many minutes should a 3 km walk take at 5 km/h? (c) What average speed does the app's "3 km in 4 min" imply? Comment on the output.

Q18. A family of 2 adults and 2 children in Glenmara is choosing how to get to the Expo. The information panel is shown below.

Getting to the Expo from Glenmara — 2 adults and 2 children

Drive 36 km each way car uses 8.2 L/100 km fuel price \$1.74 per litre parking \$18 for the day 40 min drive + 5 min walk each way	Train adult return fare \$9.80 child return fare \$4.90 each way: 8 min walk + 5 min wait + 22 min train + 5 min walk
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Made-up fares and numbers for this section.

- (a) Find the total cost of driving for the day, to the nearest cent: fuel both ways plus the parking.
- (b) Find the total train fares for the family.
- (c) Find the door-to-door time for the return trip by each option. Which option is faster, and by how much? Which option is cheaper, and by how much to the nearest cent?

Answers

Q1. (a) 15:45. (b) 35 min. (c) 14:43. **Q2.** (a) 15 min. (b) 15 km. (c) 45 km/h. **Q3.** (a) 30 min. (b) 16:50. (c) the bus leg, 18 min. **Q4.** (a) 35 min. (b) 15 min. (c) departs 08:35, arrives 09:05. **Q5.** (a) 12 L. (b) \$20.40. (c) 24 L and \$40.80 — doubling the distance doubles the fuel and the cost. **Q6.** (a) the distance, the fuel use per 100 km, and the fuel price per litre. (b) inputs: any two of From, To, travel mode, departure time; outputs: any two of 9.6 km, 12 min, arrive 10:17. (c) 2400 m. **Q7.** (a) 4.4 km. (b) 10:09. (c) 37.0 km/h, to 1 d.p. **Q8.** (a) 52 min. (b) 08:33. (c) 15.6 km/h, to 1 d.p. **Q9.** (a) 07:42. (b) 08:13, which is 2 min early. (c) 31 min. **Q10.** (a) \$44.94. (b) \$32.00. (c) \$12.94 a week; \$51.76 over 4 weeks. **Q11.** (a) 25.3 L; \$43.31 to the nearest cent. (b) 25 300 L — 1000 times too big. (c) \$45.51 to the nearest cent. **Q12.** (a) 1.75 km. (b) 21 min. (c) 10:36. **Q13.** (a) the bus, \$3.80. (b) the car, 32 min. (c) 23 min saved; \$7.60 more. **Q14.** (a) 7.17 L, to 2 d.p. (b) 2 tins. (c) \$137.00; 0.83 L left over, to 2 d.p. **Q15.** $87.5 \div 1.5 = 58.333\dots$, which is 58.3 km/h to 1 d.p. **Q16.** (a) 4.73 L. (b) \$7.76. (c) \$1.62. **Q17.** (a) 0.33 km, to 2 d.p. (b) 36 min. (c) 45 km/h — far above walking speed, so the output fails the sense check. **Q18.** (a) \$28.27. (b) \$29.40. (c) train 80 min against driving 90 min, so the train is 10 min faster; driving is \$1.13 cheaper, to the nearest cent.

Fully-worked solutions

Q1. (a) Add 12 to the afternoon hour: $3 + 12 = 15$, so 3:45 pm is **15:45**. (b) $08:47 - 08:12 = 35$ min. (c) $14:05 + 38 \text{ min} = 14:43$: jump 55 min to 15:00 is too far, so jump 38 min straight — $5 + 38 = 43$ minutes past 14.

Q2. (a) $12 \div 48 = \frac{1}{4} \text{ h}$, and $\frac{1}{4} \text{ h} = 15 \text{ min}$. (b) $60 \times \frac{15}{60} = 15 \text{ km}$. (c) $9 \div \frac{12}{60} = 9 \times 5 = 45 \text{ km/h}$.

Q3. (a) $5 + 3 + 18 + 4 = 30$ min. (b) $16:20 + 30 \text{ min} = 16:50$. (c) The bus leg, at 18 min — longer than both walks and the wait put together ($5 + 3 + 4 = 12$ min).

Q4. (a) $08:55 - 08:20 = 35$ min. (b) $08:20 - 08:05 = 15$ min, and the later pairs agree ($08:35 - 08:20 = 15$, $08:50 - 08:35 = 15$): every 15 min. (c) The arrivals are 08:37, 08:55, 09:05 and 09:28. The last arrival not later than 09:10 is 09:05, whose service departs at **08:35**.

Q5. (a) $150 \times 8 \div 100 = 12 \text{ L}$. (b) $12 \times \$1.70 = \$20.40$. (c) $300 \times 8 \div 100 = 24 \text{ L}$, and $24 \times \$1.70 = \$40.80$. Double the distance gives double the fuel and double the cost, because fuel use is proportional to distance.

Q6. (a) The distance, the fuel use in L per 100 km, and the fuel price per litre. (b) Inputs: any two of From (Glenmara Library), To (Northvale Market), travel mode (Drive), departure time (10:05). Outputs: any two of 9.6 km, 12 min, arrive 10:17. (c) $2.4 \times 1000 = 2400 \text{ m}$.

Q7. (a) $18.6 - 14.2 = 4.4 \text{ km}$. (b) $09:50 + 19 \text{ min} = 10:09$. (c) $14.2 \div \frac{23}{60} = \frac{852}{23} = 37.043\dots$, which is 37.0 km/h to 1 d.p. Route A is shorter but slower: it threads through the town centre.

Q8. (a) $6 + 4 + 22 + 8 + 12 = 52$ min. (b) $07:41 + 52 \text{ min} = 08:33$. (c) $13.5 \div \frac{52}{60} = \frac{810}{52} = 15.576\dots$, which is 15.6 km/h to 1 d.p.

Q9. (a) Read the arrival column: 07:38, 07:55, 08:13, 08:34, 08:52. The last arrival not later than 08:15 is 08:13, so the latest train Mara can catch departs at **07:42**. (b) It arrives at 08:13, and $08:15 - 08:13 = 2$ min early. (c) $08:13 - 07:42 = 31$ min.

Q10. (a) Fuel one way: $12 \times 7.5 \div 100 = 0.9 \text{ L}$. Fuel cost one way: $0.9 \times \$1.66 = \$1.494$. A day of driving: $2 \times \$1.494 + \$6 = \$8.988$. A week: $\$8.988 \times 5 = \$44.94$ — the working keeps full precision and the answer lands on an exact cent. (b) $\$6.40 \times 5 = \$32.00$. (c) $\$44.94 - \$32.00 = \$12.94$ a week. Over 4 weeks: $\$12.94 \times 4 = \$51.76$.

Q11. (a) $275 \times 9.2 \div 100 = 25.3 \text{ L}$. Cost: $25.3 \times \$1.712 = \$43.3136$, which is \$43.31 to the nearest cent. (b) $275\,000 \times 9.2 \div 100 = 25\,300 \text{ L}$. No van holds 25 300 L: the output is $25\,300 \div 25.3 = 1000$ times too big — exactly

the factor between metres and kilometres, which is how the mistake is spotted. (c) $25.3 \times \$1.799 = \$45.5147$, which is \$45.51 to the nearest cent.

Q12. (a) The route runs $3 + 2 + 2 = 7$ squares, each 250 m: $7 \times 250 = 1750$ m = 1.75 km. (b) $1.75 \div 5 = 0.35$ h, and $0.35 \times 60 = 21$ min. (c) $10:15 + 21$ min = 10:36.

Q13. (a) The lowest cost bar is the bus, at \$3.80. (b) The shortest time bar is the car, at 32 min. (c) Time: $55 - 32 = 23$ min saved by car. Cost: $\$11.40 - \$3.80 = \$7.60$ more by car. Whether 23 min is worth \$7.60 is the decision, and now it is an informed one.

Q14. (a) $86 \div 12 = 7.1666\dots$, which is 7.17 L to 2 d.p. (b) One tin holds 4 L — not enough. Two tins hold 8 L — enough. So **2 tins**: round up, because tins are sold whole. (c) $2 \times \$68.50 = \$137.00$. Leftover paint: $8 - 7.1666\dots = 0.8333\dots$, which is 0.83 L to 2 d.p.

Q15. 1 h 30 min is 1.5 h. $87.5 \div 1.5 = 58.333\dots$. Rounded to 1 d.p. that is 58.3 km/h, as required. ✓

Q16. (a) $43 \times 11 \div 100 = 4.73$ L. (b) $4.73 \times \$1.64 = \$7.7572$, which is \$7.76 to the nearest cent. (c) Run Y would use $52 \times 11 \div 100 = 5.72$ L, costing $5.72 \times \$1.64 = \$9.3808$. The saving is $\$9.3808 - \$7.7572 = \$1.6236$, which is \$1.62 to the nearest cent.

Q17. (a) $5 \times \frac{4}{60} = \frac{1}{3} = 0.333\dots$, which is 0.33 km to 2 d.p. — about a third of a kilometre, not 3 km. (b) $3 \div 5 = 0.6$ h, and $0.6 \times 60 = 36$ min. (c) $3 \div \frac{4}{60} = 45$ km/h. Nobody walks at 45 km/h, so the output fails the sense check: something is wrong with the input or the app. The believable figure is the 36 min from (b).

Q18. (a) Return distance: $2 \times 36 = 72$ km. Fuel: $72 \times 8.2 \div 100 = 5.904$ L. Fuel cost: $5.904 \times \$1.74 = \$10.27296$. Add the parking: $\$10.27296 + \$18 = \$28.27296$, which is \$28.27 to the nearest cent. (b) $2 \times \$9.80 + 2 \times \$4.90 = \$19.60 + \$9.80 = \$29.40$. (c) Driving each way: $40 + 5 = 45$ min, so the return is $2 \times 45 = 90$ min. Train each way: $8 + 5 + 22 + 5 = 40$ min, so the return is $2 \times 40 = 80$ min. The train is $90 - 80 = 10$ min faster. Driving is $\$29.40 - \$28.27296 = \$1.12704$ cheaper, which is \$1.13 to the nearest cent. Either choice can be defended: the train is 10 min faster for only \$1.13 more and no car park to find, while the car costs barely a dollar less and leaves the family with the car at the Expo.

Theory

Every process takes inputs, does something to them, and hands you an output. Some inputs you cannot touch — the price per litre, the weather, the speed limit — but some inputs are yours to choose: how many tables to hire, how many minutes to run the sprinkler, which route to drive, how many hours to run the heater. A **parameter** is an input you get to set before the process runs. **Setting and adjusting parameters** means choosing those numbers on purpose so the output lands where you want it — as cheap as possible, as early as possible, under a limit — and then moving them when the situation changes. This section builds one habit: pick a value, work out the output, compare it with your goal, and adjust.

About the data in this section. Every business, team, person and number in this section is **made up** (not real). They are built for this book so you can practise setting and adjusting parameters. Nothing here is real data about a real person, business or place.

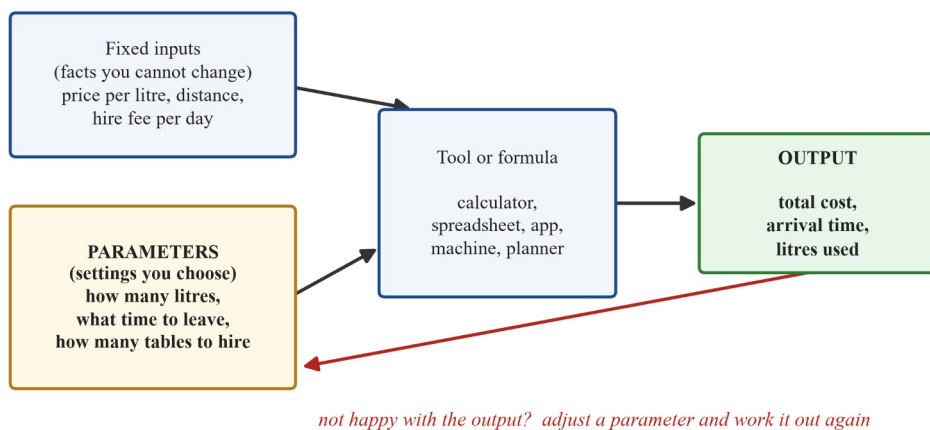
Parameters, inputs and outputs.

A process turns inputs into an output through its steps. The output depends on the inputs, and the inputs you control are the parameters. Picture a morning drive: the departure time is a parameter — you choose it — while the driving time and the breaks are fixed for the day. The output is the arrival time:

$$\text{arrival} = \text{departure} + \text{driving time} + \text{breaks}$$

Leave at 8:10 am with 2 h 25 min of driving and one 20-minute break and you arrive at 10:55 am. Run the same rule backwards — “I must be there by 10:30 am” — and you adjust the parameter: 10:30 am minus 2 h 45 min is a departure of 7:45 am. One rule, used forwards to predict an output and backwards to set a parameter.

Inputs, parameters and outputs

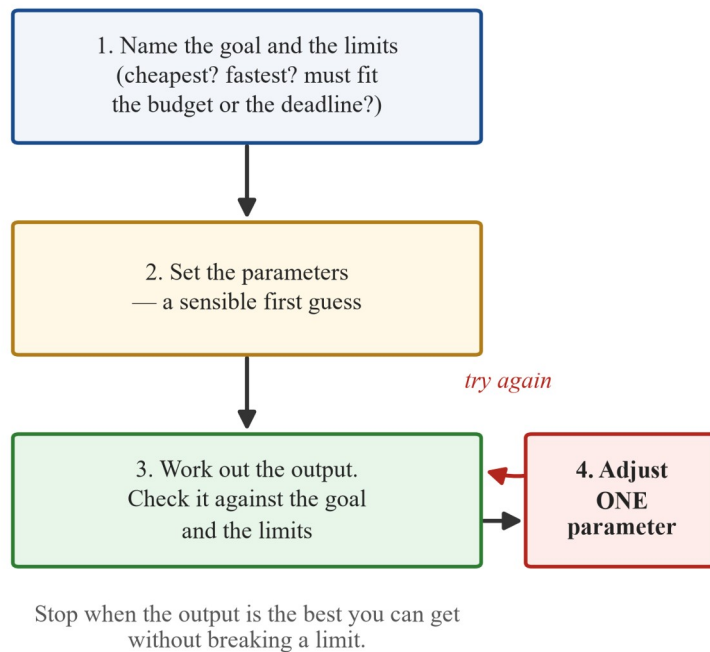


Made-up data: the trip and every time in this picture are made up for this section.

The set–test–adjust loop.

Setting a parameter well is rarely a single calculation. It is a loop: **set** a value, **work out** the output, **compare** it with your goal or your limit, then **adjust** and go around again. Two habits keep the loop honest. Change **one** parameter at a time, so you know exactly what caused the change in the output. And keep a small table of tries — value in, output out, verdict — so you can watch the pattern and stop the moment the output meets the goal.

The set-and-adjust loop



Made-up data: this picture describes the method of this section, not real data.

Comparing options: where the best choice flips.

Often there is not one rule but two or three ways to do a job, and the best one depends on the parameter. Suppose option A costs $\$10 + \$2$ per item and option B costs $\$20 + \$1$ per item. At 5 items, A costs $\$20$ and B costs $\$25$ — A wins. At 20 items, A costs $\$50$ and B costs $\$40$ — B wins. Somewhere between, the two costs are equal: at 10 items both cost $\$30$. That meeting point is the **crossover**. Below it one option is cheaper, above it the other is, so finding the crossover is often the whole job — it tells you the one question worth asking first (“how many items, exactly?”).

Limits, budgets and whole-number answers.

Goals usually arrive as limits: a budget the cost must not pass, a target the profit must reach, a deadline the time must beat. Parameters, meanwhile, usually arrive as whole numbers — whole tables, whole runs, whole days. So the best value of a parameter is often the **last whole number that still meets the limit**, and division alone will not hand it to you. A stall’s cost rule of $\$20 + \$7$ per table against a $\$50$ budget gives $(50 - 20) \div 7 = 4.2857\dots$, but nobody hires 0.2857 of a table. Test the whole numbers either side: 4 tables costs $\$48$ (fits), 5 tables costs $\$55$ (breaks the budget), so 4 is the answer — here you round **down**, because a budget is a ceiling. For a target you must reach, a floor, you round **up** instead. The direction of the limit decides the direction of the rounding.

Sensitivity: which parameter moves the output most?

Before adjusting anything, ask which parameter the output listens to most. The sprinkler of Example 4 delivers 8 L per minute and is set to 30 minutes per run over 5 runs a day: $30 \times 5 \times 8 = 1\,200$ L a day. Add 5 minutes to every run and the day becomes $35 \times 5 \times 8 = 1\,400$ L — a rise of 200 L. Add one extra run instead and the day becomes $30 \times 6 \times 8 = 1\,440$ L — a rise of 240 L. Same-sized tweak, different parameter, different size of move. When you need a big move, adjust the parameter with the biggest lever; when you need a fine tune, adjust the one with the smallest.

Rounding and checking.

When an answer needs rounding, the question tells you how far — to one decimal place, to the nearest cent, to the nearest whole number. Keep the full value in your working and round only at the end, then say in your answer how far you rounded. For parameters the direction of rounding is part of the answer too: down under a ceiling, up towards a floor, and always test the whole numbers either side of the boundary so your verdict is a calculation rather than a

guess. Afterwards, sanity-check: the output should move the way the rule says it moves, and your final choice should still satisfy the limit when you substitute it back in.

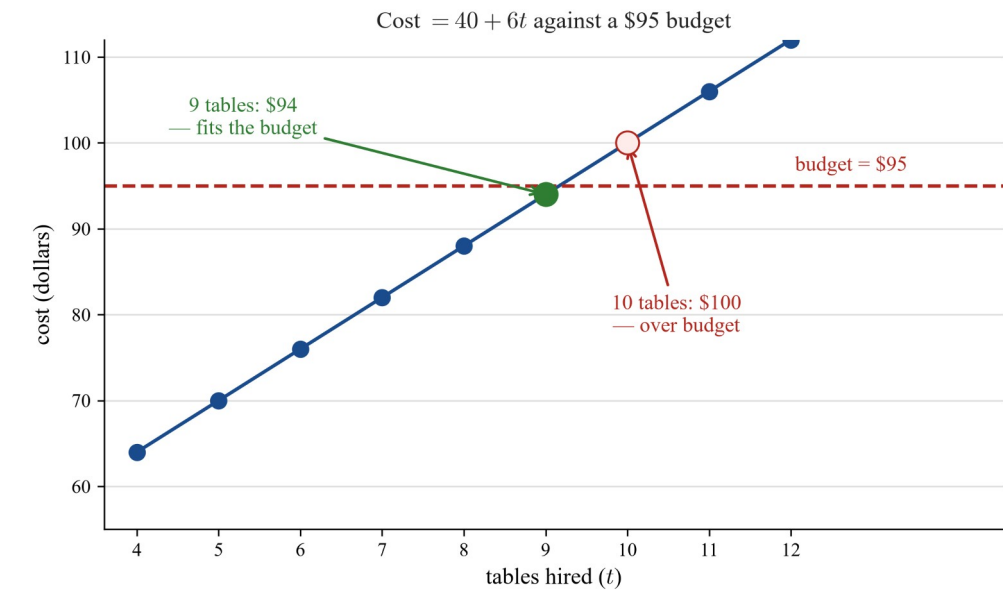
Tools that help.

A spreadsheet is a natural bench for this work: put the parameter in one cell and the rule in another, and the output recalculates the instant you change the input — a whole table of tries in seconds. A graph does the same job for crossovers, drawing both rules until they meet. Use either when you have one; nothing in this section needs more than pen, paper and a calculator. And no tool can choose the goal or read the limit for you — those judgements stay yours.

Worked examples

Example 1 — scaffolded

A hire company delivers trestle tables: a \$ 40 delivery fee plus \$ 6 per table, so the cost rule is $C = 40 + 6t$ dollars for t tables. A group has a budget of \$ 95 for table hire.



Made-up data: the hire company and every cost in this picture are made up for this section.

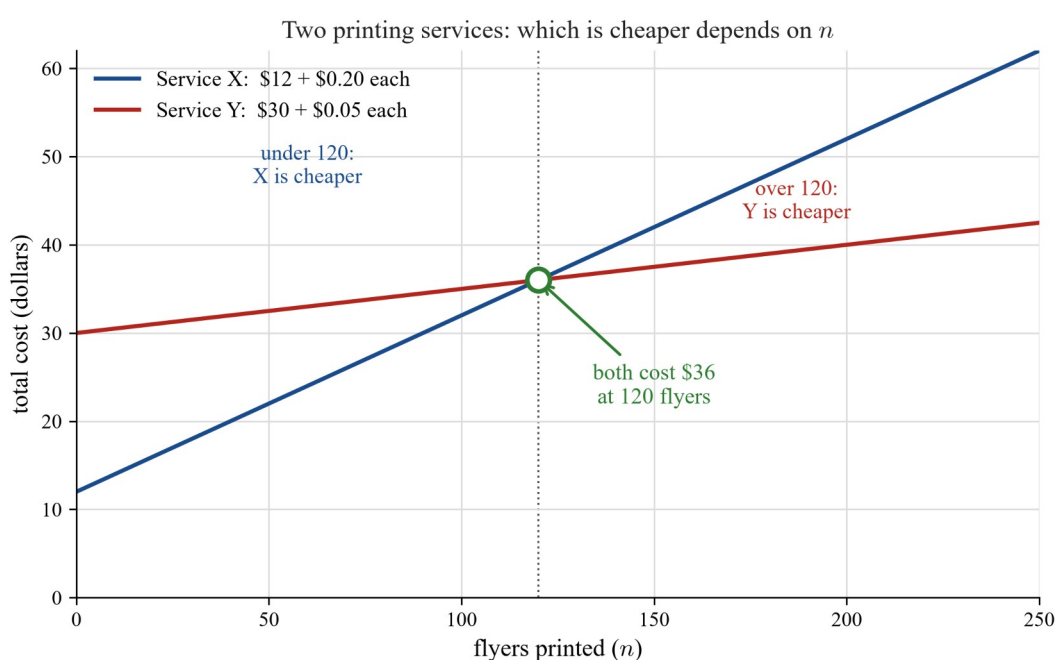
- (a) Find the cost of hiring 8 tables.
- (b) Find the cost of hiring 10 tables, and say whether it fits the \$ 95 budget.
- (c) Find the greatest whole number of tables the group can hire within the budget, and check that the next number up fails.

Working	Comment
Rule: $C = 40 + 6t$, with t the number of tables.	Write the rule and say what each letter means.

Working	Comment
(a) $t = 8$: $C = 40 + 6 \times 8 = 40 + 48 = \$88$.	Substitute the chosen value into the rule.
(b) $t = 10$: $C = 40 + 6 \times 10 = 40 + 60 = \$100$.	Same rule, new value of the parameter.
$\$100 > \$95$: over the budget by $\$100 - \$95 = \$5$.	Compare the output with the limit.
(c) Try $t = 9$: $C = 40 + 6 \times 9 = 40 + 54 = \$94$, and $\$94 \leq \$95$ — fits.	Adjust down one whole table and test again.
$t = 10$ gives $\$100$ (over), so 9 tables is the most that fits.	The last whole value that still meets the limit.
Check: $\$95 - \$94 = \$1$ left over — positive, so 9 tables is affordable.	Substitute back into the limit to confirm.

Example 2 — scaffolded

A club is printing flyers. Service X charges a \$12 set-up plus \$0.20 per flyer; Service Y charges a \$30 set-up plus \$0.05 per flyer. The cost rules are $X = 12 + 0.20n$ and $Y = 30 + 0.05n$ dollars for n flyers.



Made-up data: the printing services and every cost in this picture are made up for this section.

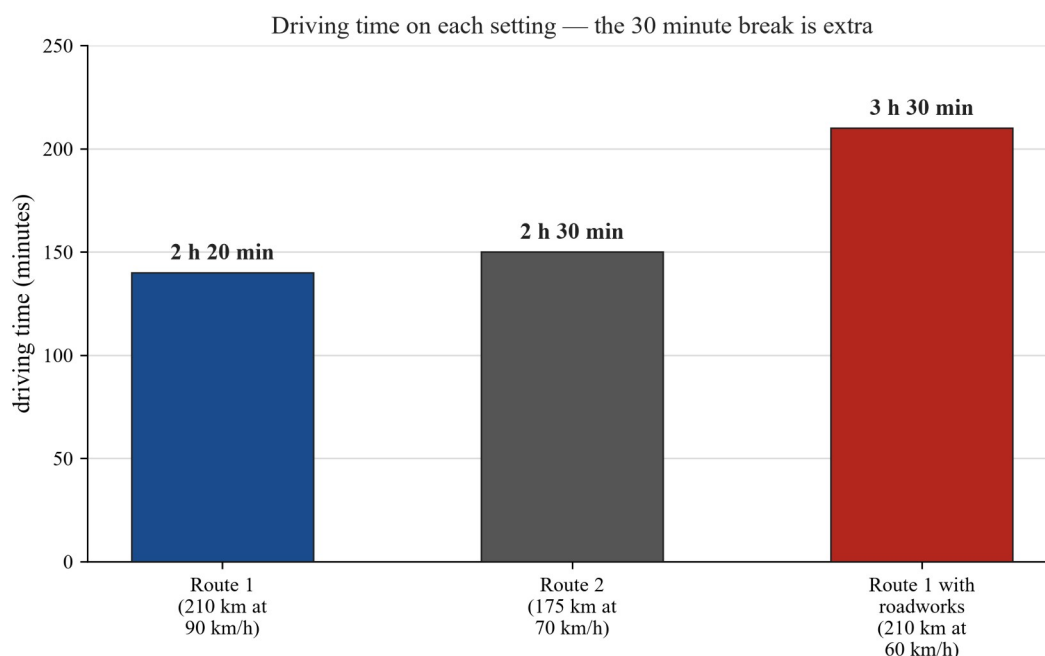
- Find the cost at each service for 80 flyers. Which is cheaper?
- Find the cost at each service for 200 flyers. Which is cheaper?
- Find the number of flyers at which the two services cost the same, and the cost at that number.

Working	Comment
Rules: $X = 12 + 0.20n$ and $Y = 30 + 0.05n$.	Two options, one shared parameter n .

Working	Comment
(a) $n = 80$: $X = 12 + 0.20 \times 80 = 12 + 16 = \$28$; $Y = 30 + 0.05 \times 80 = 30 + 4 = \$34$.	Substitute 80 into both rules.
At 80 flyers, X is cheaper by $\$34 - \$28 = \$6$.	Compare the two outputs at the same parameter value.
(b) $n = 200$: $X = 12 + 40 = \$52$; $Y = 30 + 10 = \$40$.	Same rules, a new value of n .
At 200 flyers, Y is cheaper by $\$52 - \$40 = \$12$ — the best choice has flipped.	A larger n favours the smaller per-flyer price.
(c) Set the rules equal: $12 + 0.20n = 30 + 0.05n$, so $0.15n = 18$, so $n = 120$.	Solve, or test values until the gap closes.
Cost at $n = 120$: $X = 12 + 24 = \$36$ and $Y = 30 + 6 = \$36$.	Both rules give the same output — the crossover.

Example 3 — unscaffolded

A delivery driver leaves the depot at 9:45 am, must allow one 30-minute break on the road, and must reach the delivery by 1:00 pm. Route 1 is 210 km of highway driven at 90 km/h. Route 2 is 175 km of local road driven at 70 km/h.



Made-up data: the routes and every time in this picture are made up for this section.

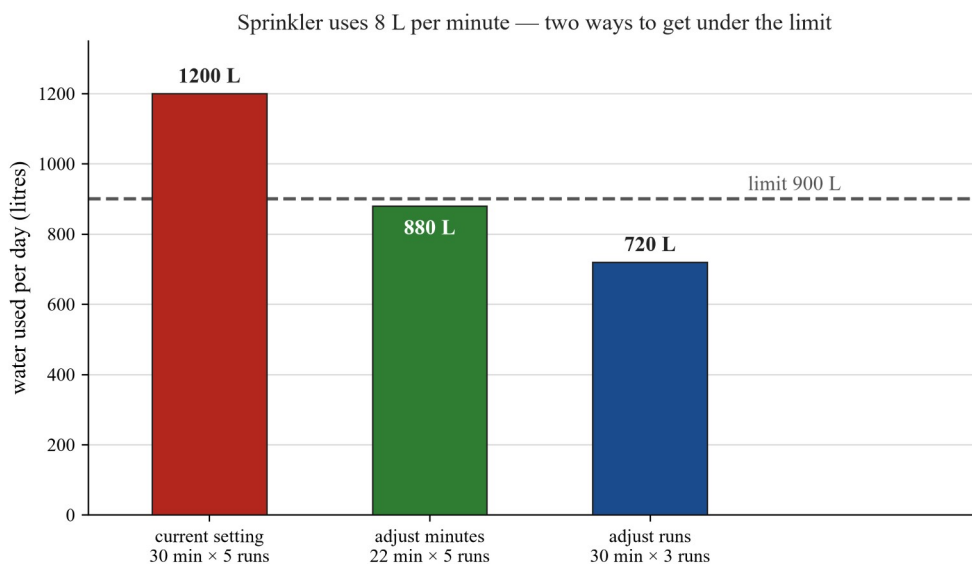
- Find the driving time of each route, and the arrival time at the delivery for each (departure 9:45 am plus the 30-minute break).
- How much spare time does each route leave before the 1:00 pm deadline?
- On the day, roadworks cut Route 1's speed to 60 km/h. Recalculate Route 1's arrival time and decide which route the driver should choose, with a reason.
- Route 1: $210 \div 90 = 2.333\dots$ hours, which is 2 h 20 min of driving; with the 30-minute break that is 2 h 50 min on the road, so leaving at 9:45 am arrives at 12:35 pm. Route 2: $175 \div 70 = 2.5$ hours, which is 2 h 30 min of driving; with the break that is 3 h 0 min on the road, arriving at 12:45 pm.
- The deadline is 1:00 pm. Route 1 arrives 25 min before it and Route 2 arrives 15 min before it. Both settings fit the limit, and Route 1 leaves the bigger margin.
- At 60 km/h, Route 1's driving time becomes $210 \div 60 = 3.5$ hours, which is 3 h 30 min; with the break that is 4 h 0 min on the road, arriving at 1:45 pm — 45 min after the deadline. Route 2 is untouched by the

roadworks and still arrives at 12:45 pm with 15 min to spare. The driver adjusts to Route 2: slower on paper today, but the only route that meets the deadline.

∴ on clear roads Route 1 is the better setting (12:35 pm, 25 min spare), but once roadworks cut it to 60 km/h it arrives 45 min late, so the choice flips to Route 2 (12:45 pm, 15 min spare).

Example 4 — unscaffolded

A garden sprinkler delivers 8 L of water per minute. It is set to run 30 minutes per run, 5 runs per day. The water rule for the garden allows at most 900 L per day.



Made-up data: the sprinkler and every volume in this picture are made up for this section.

- Find the water the current setting uses in a day, and how far over the 900 L limit that is.
- Keeping 5 runs, find the greatest whole number of minutes per run that stays within the limit, and check that one more minute fails.
- Keeping 30-minute runs, find the greatest whole number of runs per day that stays within the limit, and check that one more run fails. Which of the two adjustments makes better use of the allowed water?
- One run uses $8 \times 30 = 240$ L, so 5 runs use $240 \times 5 = 1200$ L in a day. That is $1200 - 900 = 300$ L over the 900 L limit.
- With 5 runs kept, each run may use at most $900 \div 5 = 180$ L, and $180 \div 8 = 22.5$ minutes. Minutes come in whole numbers, so test either side: 22 min uses $22 \times 8 \times 5 = 880$ L, which fits; 23 min uses $23 \times 8 \times 5 = 920$ L, which is over. The greatest whole number of minutes per run is 22.
- With 30-minute runs kept, each run uses 240 L, and $900 \div 240 = 3.75$ runs. Test either side: 3 runs use $3 \times 240 = 720$ L, which fits; 4 runs use $4 \times 240 = 960$ L, which is over. So 3 runs is the most. Of the two adjustments, 22 min over 5 runs uses 880 L of the allowed 900 L while 30 min over 3 runs uses only 720 L, so adjusting the minutes keeps more of the watering the garden already gets.

∴ the current setting uses 1200 L, which is 300 L over the limit; the best whole-number adjustments are 22 min × 5 runs (880 L) or 30 min × 3 runs (720 L), and the 22-minute setting uses the allowance best.

Practice questions

Scaffolded

Q1. A car park charges $C = 5 + 3n$ dollars, where n is the number of hours parked. (a) Find the cost of parking for 4 hours. (b) Find the cost of parking for 10 hours. (c) A driver paid \$26. How many hours did they park?

Q2. A pizza night costs a \$5 delivery fee plus \$12 per pizza. (a) Which number is the parameter you choose, and which numbers are fixed? (b) Find the cost of 3 pizzas. (c) The group has exactly \$65 to spend. How many pizzas can they order so that the money is spent exactly? Check that one more pizza would go over.

Q3. A training room needs 10 min of set-up before the first session, then each session runs 40 min: $T = 10 + 40n$ minutes for n sessions. The room is booked for 240 min (4 h) altogether, set-up included. (a) Find the time needed for 3 sessions, in hours and minutes. (b) Find the time needed for 5 sessions, in hours and minutes. (c) Find the greatest whole number of sessions that fits the 240-minute booking, and check that one more session fails.

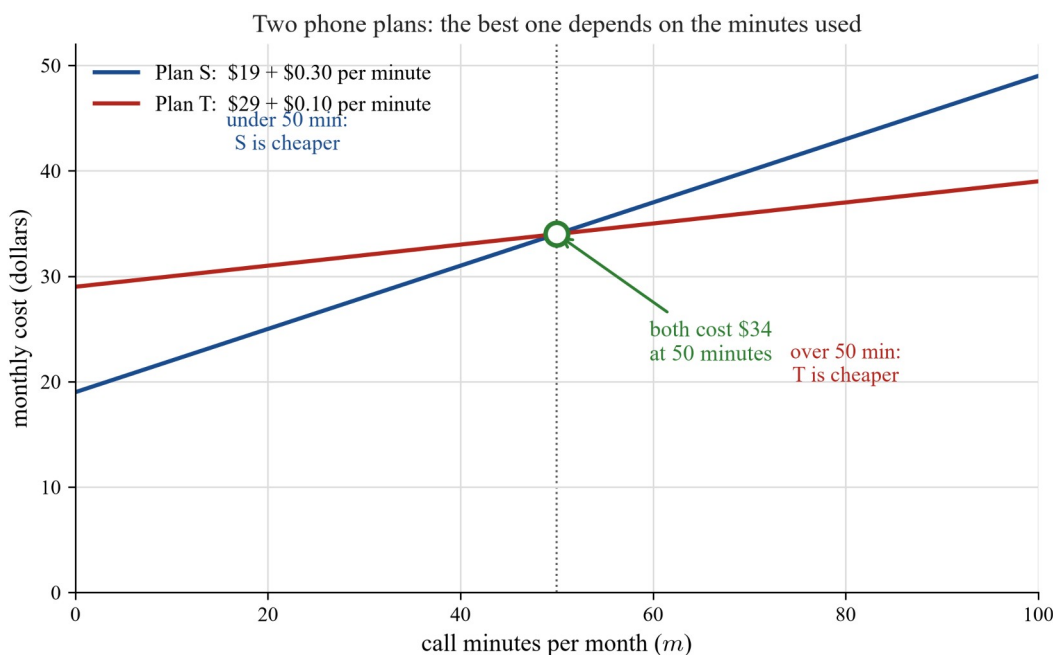
Q4. A spreadsheet works out a party cost. Cell B1 holds the number of guests and cell B3 holds the formula $B3 = B1 \times 14 + 60$, giving the cost in dollars. (a) Find the cost shown in B3 for 20 guests. (b) Find the cost shown in B3 for 25 guests. (c) Changing B1 from 20 to 25 changes B3 by \$70. What does that say the cost per guest is? Show the calculation.

Q5. Two printing sites quote for n prints: Site P charges $P = 4.50 + 0.30n$ dollars and Site Q charges $Q = 8.50 + 0.20n$ dollars. (a) Find each site's cost for 20 prints. Which is cheaper? (b) Find each site's cost for 60 prints. Which is cheaper? (c) Find the number of prints at which the two sites cost the same, and the cost at that number.

Q6. A cordial recipe mixes 1 part syrup with 5 parts water. (a) If you use 100 mL of syrup, how much water do you add? (b) If you use 150 mL of syrup, how much water do you add? (c) A bottle holds 720 mL of mixed cordial. How much of it is water?

Un scaffolded

Q7. Two phone plans charge $S = 19 + 0.30m$ and $T = 29 + 0.10m$ dollars per month, where m is the call minutes used.

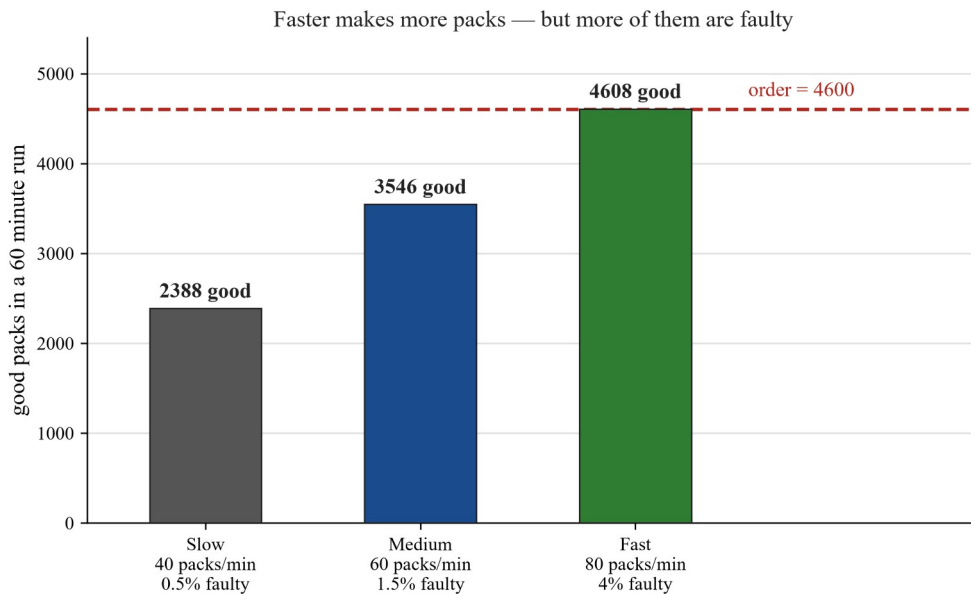


Made-up data: the phone plans and every cost in this picture are made up for this section.

- Find each plan's cost for 30 minutes. Which is cheaper?
- Find each plan's cost for 80 minutes. Which is cheaper?
- Find the number of minutes at which both plans cost the same, and that cost. Write a one-line rule saying which plan is cheaper below and above that number.

Q8. A market stall's profit for a day is \$11 per shirt sold, minus \$80 for the site and the stock: $\text{profit} = 11n - 80$ dollars for n shirts. The stall's goal is a profit of at least \$300. (a) Find the profit on 30 shirts. (b) Find the smallest whole number of shirts that reaches the goal, and check that one fewer shirt misses it. (c) The boundary in (b) is not a whole number. Explain why the answer rounds up here rather than down.

Q9. A packing machine can run at three speeds for a 60-minute run. Slow: 40 packs per minute with 0.5 % faulty. Medium: 60 packs per minute with 1.5 % faulty. Fast: 80 packs per minute with 4 % faulty. An order needs 4 600 good packs from one run.



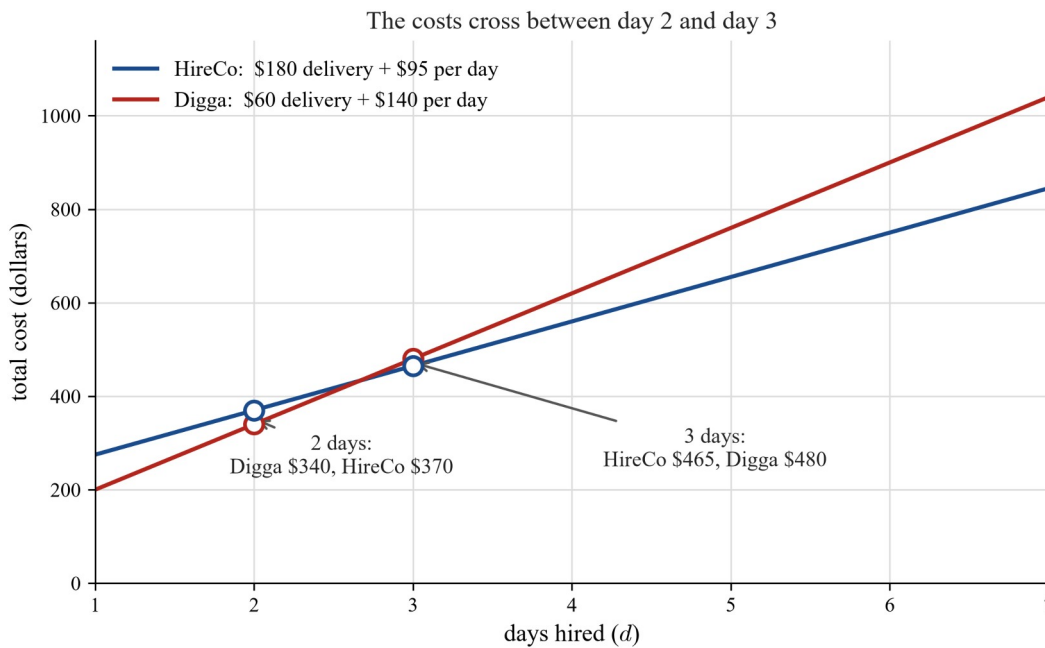
Made-up data: the machine and every count in this picture are made up for this section.

- At Medium speed, find the good packs per minute, to one decimal place.
- Find the good packs produced in a full 60-minute run at each of the three speeds.
- Which speed settings meet the 4 600-pack order in one run? At the setting you choose, how many faulty packs does the run produce?

Q10. A house's electricity use per day is 14 kWh of base load, plus 1.5 kWh for each hour the heater runs and 0.8 kWh for each hour the pool pump runs. Electricity costs \$0.32 per kWh. Today the heater runs 3 h and the pump 2 h. (a) Find today's energy use in kWh and its cost, to the nearest cent. (b) Find the energy use and the cost (to the nearest cent) if the heater runs one extra hour, and the rise in the cost. (c) Find the energy use and the cost (to the nearest cent) if instead the pump runs one extra hour, and the rise in the cost (to the nearest cent). Which single extra hour moves the bill more?

Q11. A bakery's morning jobs run in order: mixing 25 min, proving 50 min, baking 40 min, then cooling and decorating 35 min. (a) Find the total time from the start of mixing to the end of decorating, in hours and minutes. (b) The first loaves must be finished by 10:30 am. Find the latest start time for mixing. (c) A warmer proving cupboard cuts the proving step from 50 min to 35 min. Find the new total time and the new latest start time for 10:30 am.

Q12. Two companies hire out the same scaffold. HireCo: \$ 180 delivery plus \$ 95 per day. Digga: \$ 60 delivery plus \$ 140 per day.



Made-up data: the hire companies and every cost in this picture are made up for this section.

- Find each company's cost for 2 days. Which is cheaper, and by how much?
- Find each company's cost for 3 days. Which is cheaper, and by how much?
- For which whole numbers of days is Digga the cheaper company? Give the crossover in days and explain what it tells you.

Q13. A recipe for 12 serves uses 300 g of flour, 4 eggs and 600 mL of milk. (a) Find the flour, eggs and milk needed for 30 serves. (b) You have 6 eggs and plenty of everything else. How many serves can you make? (c) Find the flour and the milk needed for the number of serves in (b).

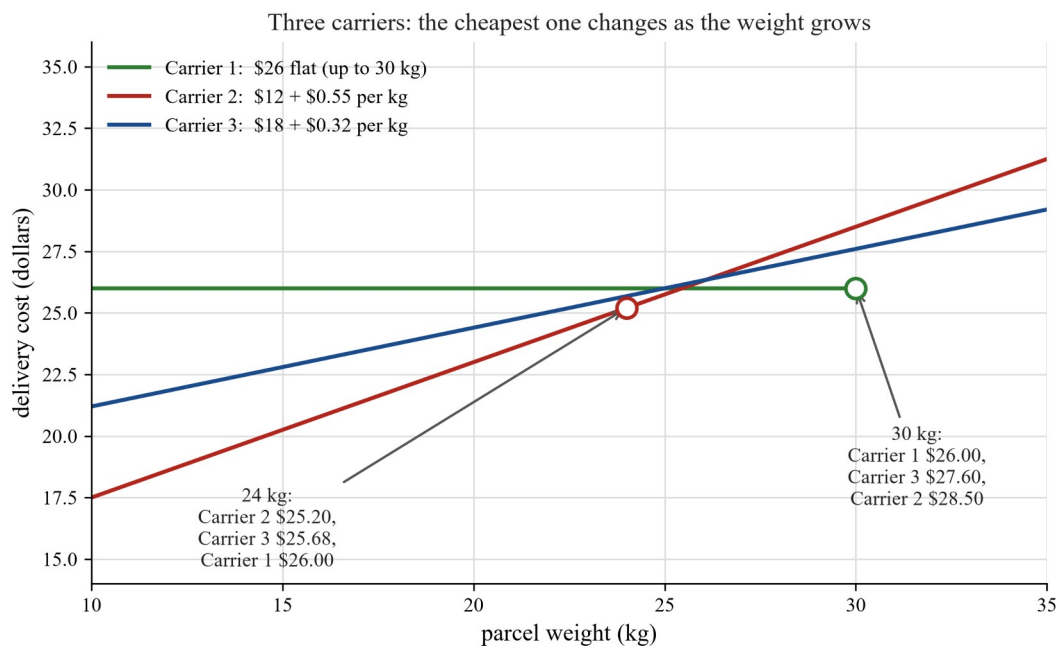
Q14. Kay saves \$ 45 a week from her wage. Her goal is at least \$ 1 200 for a course. (a) Find how much Kay has saved after 20 weeks. (b) Find the smallest whole number of weeks that reaches the goal, and check that one fewer week misses it. (c) If Kay lifts her saving to \$ 50 a week, in how many weeks does she reach the goal exactly?

Q15. An old washing machine uses 90 L per load; a new model uses 65 L per load. Water costs \$ 2.40 per kL (1 000 L). A household runs 5 loads a week for 52 weeks a year. (a) Find the water cost of one load for each machine, to the nearest cent. (b) Find the saving in water cost over a whole year with the new machine. (c) An advertisement claims the new machine "saves more than \$ 80 a year" in water. Use your answer to (b) to say whether the claim is true.

Q16. A trip is 460 km. The car uses 8.5 L of fuel per 100 km, and fuel costs \$ 1.78 per L. (a) Find the fuel the trip needs, to one decimal place. (b) Find the cost of that fuel, to the nearest cent. (c) Smoother driving adjusts the fuel use to 7.4 L per 100 km. Find the new fuel amount and its cost (to the nearest cent), and the saving on the trip (to the nearest cent).

Q17. A video recorder has 12 GB of free space. High definition (HD) video uses 1.6 GB per hour; standard definition (SD) video uses 0.7 GB per hour. (a) Find the greatest whole number of hours of HD video that fits the empty recorder, and check that one more hour fails. (b) Find the greatest whole number of hours of SD video that fits the empty recorder. (c) The recorder first stores 5 h of HD video, then records SD video into whatever space is left. Find the greatest whole number of SD hours that fit, and the space left spare.

Q18. A parcel weighs 24 kg. Three carriers quote: Carrier 1, \$26 flat for any parcel up to 30 kg; Carrier 2, \$12 plus \$0.55 per kg; Carrier 3, \$18 plus \$0.32 per kg.



Made-up data: the carriers and every cost in this picture are made up for this section.

- Find each carrier's cost for the 24 kg parcel.
- Which carrier is cheapest for the 24 kg parcel?
- The parcel is repacked with extra goods and now weighs 30 kg. Find each carrier's cost again, say which is cheapest, and explain why the cheapest carrier changed.

Answers

Q1. (a) \$17. (b) \$35. (c) 7 hours. **Q2.** (a) the number of pizzas is the parameter; the \$5 fee and the \$12 per pizza are fixed. (b) \$41. (c) 5 pizzas, which costs \$65 exactly (6 pizzas would be \$77). **Q3.** (a) 130 min = 2 h 10 min. (b) 210 min = 3 h 30 min. (c) 5 sessions (6 would need 250 min). **Q4.** (a) \$340. (b) \$410. (c) \$14 per guest ($\$70 \div 5$ guests). **Q5.** (a) P \$10.50, Q \$12.50 — P is cheaper. (b) P \$22.50, Q \$20.50 — Q is cheaper. (c) 40 prints, \$16.50 at each site. **Q6.** (a) 500 mL of water. (b) 750 mL of water. (c) 600 mL (with 120 mL of syrup). **Q7.** (a) S \$28, T \$32 — S is cheaper. (b) S \$43, T \$37 — T is cheaper. (c) 50 minutes, \$34; under 50 min S is cheaper, over 50 min T is cheaper. **Q8.** (a) \$250. (b) 35 shirts (profit \$305; 34 shirts gives \$294). (c) the goal is a floor: 34 shirts misses it, so the boundary rounds up to the next whole shirt. **Q9.** (a) 59.1 good packs per minute (to one decimal place). (b) Slow 2388, Medium 3546, Fast 4608 good packs. (c) Fast only; that run produces 192 faulty packs. **Q10.** (a) 20.1 kWh, \$6.43 (to the nearest cent). (b) 21.6 kWh, \$6.91; a rise of \$0.48. (c) 20.9 kWh, \$6.69; a rise of \$0.26 (to the nearest cent); the extra heater hour moves the bill more. **Q11.** (a) 150 min = 2 h 30 min. (b) 8:00 am. (c) 135 min = 2 h 15 min; latest start 8:15 am. **Q12.** (a) HireCo \$370, Digga \$340 — Digga by \$30. (b) HireCo \$465, Digga \$480 — HireCo by \$15. (c) Digga for 1 and 2 days; the costs cross at $8 \div 3 = 2.666\dots$ days, so from 3 days up HireCo is cheaper. **Q13.** (a) 750 g flour, 10 eggs, 1500 mL milk. (b) 18 serves. (c) 450 g flour and 900 mL milk. **Q14.** (a) \$900. (b) 27 weeks (\$1215; 26 weeks is only \$1170). (c) 24 weeks. **Q15.** (a) old \$0.22 per load, new \$0.16 per load (to the nearest cent). (b) \$15.60 a year. (c) false — the saving is \$15.60, nowhere near \$80. **Q16.** (a) 39.1 L (to one decimal place). (b) \$69.60 (to the nearest cent). (c) 34.04 L and \$60.59; a saving of \$9.01 (to the nearest cent). **Q17.** (a) 7 h (11.2 GB; 8 h would need 12.8 GB). (b) 17 h (11.9 GB). (c) 5 h of SD (3.5 GB into the 4 GB left), with 0.5 GB spare. **Q18.** (a) Carrier 1 \$26.00, Carrier 2 \$25.20, Carrier 3 \$25.68. (b) Carrier 2. (c) Carrier 1 \$26.00, Carrier 2 \$28.50, Carrier 3 \$27.60 — Carrier 1; Carrier 3 passes \$26 at 25 kg and Carrier 2 at about 25.5 kg (to one decimal place), so beyond there the flat fee is cheapest.

Fully-worked solutions

Q1. (a) $C = 5 + 3 \times 4 = 5 + 12 = \$17$. (b) $C = 5 + 3 \times 10 = 5 + 30 = \$35$. (c) $5 + 3n = 26$ gives $3n = 21$, so $n = 7$; check $5 + 3 \times 7 = \$26$, which is what the driver paid.

Q2. (a) The number of pizzas is the parameter — it is the input you choose. The \$5 delivery fee and the \$12 per pizza are fixed: they stay the same whatever you order. (b) $5 + 12 \times 3 = 5 + 36 = \$41$. (c) 5 pizzas: $5 + 12 \times 5 = 5 + 60 = \$65$, exactly the money available. One more pizza gives $5 + 12 \times 6 = \$77$, which is over, so 5 is the answer.

Q3. (a) $T = 10 + 40 \times 3 = 130$ min, which is 2 h 10 min. (b) $T = 10 + 40 \times 5 = 210$ min, which is 3 h 30 min. (c) The booking is a ceiling of 240 min. 5 sessions need 210 min (fits); 6 sessions need $10 + 40 \times 6 = 250$ min (over). So 5 sessions is the greatest whole number that fits — the boundary $(240 - 10) \div 40 = 5.75$ rounds down because the limit is a ceiling.

Q4. (a) $B3 = 20 \times 14 + 60 = 280 + 60 = \$340$. (b) $B3 = 25 \times 14 + 60 = 350 + 60 = \$410$. (c) Five extra guests add $\$410 - \$340 = \$70$, so each guest adds $70 \div 5 = \$14$ — the 14 in the formula is the cost per guest, while the 60 is a fixed cost that never changes.

Q5. (a) $P = 4.50 + 0.30 \times 20 = 4.50 + 6 = \$10.50$; $Q = 8.50 + 0.20 \times 20 = 8.50 + 4 = \$12.50$. Site P is cheaper. (b) $P = 4.50 + 0.30 \times 60 = 4.50 + 18 = \$22.50$; $Q = 8.50 + 0.20 \times 60 = 8.50 + 12 = \$20.50$. Site Q is cheaper — the best choice flips as n grows, because Q's per-print price is smaller. (c) Set $4.50 + 0.30n = 8.50 + 0.20n$: then $0.10n = 4$, so $n = 40$ prints, and the cost is $4.50 + 0.30 \times 40 = \$16.50$ (check Q: $8.50 + 0.20 \times 40 = \$16.50$).

Q6. (a) Water is 5 parts to 1 part syrup: $100 \times 5 = 500$ mL. (b) $150 \times 5 = 750$ mL. (c) Mixed cordial is $1 + 5 = 6$ parts, so one part is $720 \div 6 = 120$ mL of syrup and the water is 5 parts, $120 \times 5 = 600$ mL.

Q7. (a) $S = 19 + 0.30 \times 30 = 19 + 9 = \$28$; $T = 29 + 0.10 \times 30 = 29 + 3 = \$32$. Plan S is cheaper. (b) $S = 19 + 0.30 \times 80 = 19 + 24 = \$43$; $T = 29 + 0.10 \times 80 = 29 + 8 = \$37$. Plan T is cheaper. (c) Set $19 + 0.30m = 29 + 0.10m$: then $0.20m = 10$, so $m = 50$ minutes, and both plans cost $19 + 0.30 \times 50 = \$34$. The rule: under 50 minutes a month, S is cheaper; over 50 minutes a month, T is cheaper.

Q8. (a) $11 \times 30 - 80 = 330 - 80 = \$250$. (b) The goal needs $11n - 80 \geq 300$, so $11n \geq 380$ and $n \geq 380 \div 11 = 34.545\dots$. Test the whole shirts either side: 34 shirts give $11 \times 34 - 80 = \$294$ (misses the goal); 35 shirts give $11 \times 35 - 80 = \$305$ (reaches it). The smallest whole number of shirts is 35. (c) Because the goal is a floor, not a ceiling: 34.545... shirts is not possible, and the whole number below it (34) leaves the profit short of \$300, so the boundary must round **up** to 35. Rounding down would answer a different question — “the most shirts I can afford” — not “the fewest that reach the target”.

Q9. (a) Medium makes 60 packs per minute with 1.5 % faulty, so the good share is 98.5 %: $60 \times 0.985 = 59.1$ good packs per minute (to one decimal place). (b) A 60-minute run makes $40 \times 60 = 2400$ packs at Slow, $60 \times 60 = 3600$ at Medium and $80 \times 60 = 4800$ at Fast. Good packs: Slow $2400 \times 0.995 = 2388$; Medium $3600 \times 0.985 = 3546$; Fast $4800 \times 0.96 = 4608$. (c) Only Fast meets the order: $4608 \geq 4600$, while 2388 and 3546 both fall short. At Fast the run makes $4800 - 4608 = 192$ faulty packs — the price of the speed that gets the order done in one run.

Q10. (a) $14 + 1.5 \times 3 + 0.8 \times 2 = 14 + 4.5 + 1.6 = 20.1$ kWh. Cost: $20.1 \times 0.32 = 6.432$, so \$6.43 to the nearest cent. (b) One extra heater hour: $14 + 1.5 \times 4 + 1.6 = 21.6$ kWh, costing $21.6 \times 0.32 = 6.912$, so \$6.91 to the nearest cent; the rise is $6.912 - 6.432 = \$0.48$ exactly. (c) One extra pump hour instead: $14 + 4.5 + 0.8 \times 3 = 20.9$ kWh, costing $20.9 \times 0.32 = 6.688$, so \$6.69 to the nearest cent; the rise is $6.688 - 6.432 = 0.256$, so \$0.26 to the nearest cent. The extra heater hour moves the bill more (\$0.48 against \$0.26), because the heater draws 1.5 kWh per hour against the pump’s 0.8 kWh — the heater is the bigger lever, so it is the parameter to adjust first when cutting the bill.

Q11. (a) $25 + 50 + 40 + 35 = 150$ min, which is 2 h 30 min. (b) Count back 150 min from 10:30 am: 10:30 am minus 2 h 30 min is 8:00 am. (c) With proving at 35 min the total is $25 + 35 + 40 + 35 = 135$ min, which is 2 h 15 min. Counting back 2 h 15 min from 10:30 am gives a latest start of 8:15 am — adjusting one step of the process by 15 min moves the whole morning’s start by 15 min.

Q12. (a) HireCo: $180 + 95 \times 2 = \$370$. Digga: $60 + 140 \times 2 = \$340$. Digga is cheaper by $\$370 - \$340 = \$30$. (b) HireCo: $180 + 95 \times 3 = \$465$. Digga: $60 + 140 \times 3 = \$480$. HireCo is cheaper by $\$480 - \$465 = \$15$. (c) Digga is cheaper at 1 day (\$200 against \$275) and at 2 days, but not from 3 days up. The costs cross where $180 + 95d = 60 + 140d$, so $45d = 120$ and $d = 120 \div 45 = 8 \div 3 = 2.666\dots$ days. Days are whole, so Digga wins for 1–2 days and HireCo wins from 3 days up: Digga’s lower delivery fee leads early, then its higher daily rate takes over.

Q13. (a) 30 serves is $30 \div 12 = 2.5$ times the recipe: flour $300 \times 2.5 = 750$ g, eggs $4 \times 2.5 = 10$, milk $600 \times 2.5 = 1500$ mL. (b) 4 eggs make 12 serves, so 1 egg makes $12 \div 4 = 3$ serves, and 6 eggs make $6 \times 3 = 18$ serves. (c) 18 serves is $18 \div 12 = 1.5$ times the recipe: flour $300 \times 1.5 = 450$ g and milk $600 \times 1.5 = 900$ mL.

Q14. (a) $45 \times 20 = \$900$. (b) The goal needs $45w \geq 1200$, so $w \geq 1200 \div 45 = 26.666\dots$. Test either side: 26 weeks give $45 \times 26 = \$1170$ (short); 27 weeks give $45 \times 27 = \$1215$ (reached). The smallest whole number of weeks is 27 — rounded up, because the goal is a floor. (c) At \$50 a week: $1200 \div 50 = 24$ weeks exactly; check $50 \times 24 = \$1200$. Lifting the weekly parameter by \$5 cuts three weeks off the wait.

Q15. (a) One load is 90 L = 0.090 kL, costing $0.090 \times 2.40 = 0.216$, so \$0.22 to the nearest cent; the new machine’s load is 65 L = 0.065 kL, costing $0.065 \times 2.40 = 0.156$, so \$0.16 to the nearest cent. (b) Each load saves $90 - 65 = 25$ L, and a year is $5 \times 52 = 260$ loads, so the year saves $25 \times 260 = 6500$ L = 6.5 kL, worth $6.5 \times 2.40 = \$15.60$. (c) False. The true saving is \$15.60 a year — less than a quarter of the advertised “\$80”, so the claim does not survive the calculation.

Q16. (a) $460 \div 100 = 4.6$ lots of 100 km, so the fuel is $4.6 \times 8.5 = 39.1$ L (to one decimal place). (b) $39.1 \times 1.78 = 69.598$, so \$69.60 to the nearest cent. (c) At 7.4 L per 100 km the fuel is $4.6 \times 7.4 = 34.04$ L, costing $34.04 \times 1.78 = 60.5912$, so \$60.59 to the nearest cent. The saving is $69.598 - 60.5912 = 9.0068$, so \$9.01 to the nearest cent — adjusting one parameter (fuel use per 100 km) by 1.1 L saves about nine dollars on a single trip.

Q17. (a) $12 \div 1.6 = 7.5$, so test the whole hours either side: 7 h use $7 \times 1.6 = 11.2$ GB (fits); 8 h use $8 \times 1.6 = 12.8$ GB (over the 12 GB). The greatest whole number of HD hours is 7. (b) $12 \div 0.7 = 17.142\dots$; 17 h use $17 \times 0.7 = 11.9$ GB (fits) while 18 h use 12.6 GB (over), so 17 h of SD. (c) 5 h of HD use $5 \times 1.6 = 8$ GB, leaving $12 - 8 = 4$ GB. Then $4 \div 0.7 = 5.714\dots$; 5 h of SD use $5 \times 0.7 = 3.5$ GB (fits) while 6 h use 4.2 GB (over). So 5 h of SD fit, with $4 - 3.5 = 0.5$ GB left spare.

Q18. (a) Carrier 1: \$ 26.00 flat. Carrier 2: $12 + 0.55 \times 24 = 12 + 13.20 = \$ 25.20$. Carrier 3: $18 + 0.32 \times 24 = 18 + 7.68 = \$ 25.68$. (b) Carrier 2, at \$ 25.20 — \$ 0.48 under Carrier 3 and \$ 0.80 under the flat fee. (c) At 30 kg: Carrier 1 is still \$ 26.00; Carrier 2 is $12 + 0.55 \times 30 = 12 + 16.50 = \$ 28.50$; Carrier 3 is $18 + 0.32 \times 30 = 18 + 9.60 = \$ 27.60$. Carrier 1 is now cheapest. The cheapest carrier changed because the per-kg rules keep climbing while the flat fee stands still: Carrier 3 reaches \$ 26 at exactly 25 kg ($(26 - 18) \div 0.32 = 25$) and Carrier 2 reaches it at $(26 - 12) \div 0.55 = 25.4545 \dots$ kg, about 25.5 kg to one decimal place. Past those crossovers both per-kg carriers cost more than the flat \$ 26, so the best choice flips from Carrier 2 to Carrier 1 as the weight grows.

Chapter 10 — Test A (multiple choice)

Chapter 10 (Systematics), sections 10A to 10E. Materials: pen, paper and a basic calculator. Test A: 12 multiple-choice questions (12 marks). Approximate time: 25 minutes.

About the data in this test. The app outputs, spreadsheets, rosters, timetables, prices, times and other numbers in this test are **made up** (not real): pretend people, pretend businesses and pretend numbers, built for this book so you can practise the maths. Nothing here is real data about a real business, person or place, and nothing here is medical or financial advice.

Choose the response that is correct for the question.

Question 1

A parcel-delivery app works out the cost of a delivery as **\$6.80 per kilogram** of parcel mass, **plus \$0.50 per kilometre** of distance. Its confirmation screen shows five numbers: mass 4.5 kg, rate per kg 6.80, rate per km 0.50, distance 18 km, and estimated delivery 2 days.

Which one of these numbers does the cost calculation **not** use?

- A. 4.5
- B. 0.50
- C. 18
- D. 2

Question 2

A garden-supply website asks customers to type the length of each plank into a box labelled **metres**. Cora measures a plank and her tape reads 275 cm.

What number should Cora type into the metres box?

- A. 2.75
- B. 27.5
- C. 275
- D. 0.275

Question 3

A catering calculator tells Leah she needs 47 mini-sandwiches for an event. The sandwiches arrive on trays of 12, and whole trays are the only thing Leah can order.

What is the **least** number of whole trays Leah can order so that she has enough sandwiches?

- A. 3
- B. 4
- C. 3.9
- D. 5

Question 4

A charity records four donations in cells B2 to B5 of a spreadsheet: \$ 55, \$ 40, \$ 65 and \$ 48. The committee wants to know **how many** donations were recorded.

Which function gives them that number?

- A. =SUM (B2 : B5)
- B. =AVERAGE (B2 : B5)
- C. =COUNT (B2 : B5)
- D. =MAX (B2 : B5)

Question 5

Nina, Joel and Rosa each keep their trivia-night points in one row of a spreadsheet: Nina has 18, Joel has 12 and Rosa has 25. The team captain sorts **only the points column** in descending order; the name column stays where it is.

After the sort, what does the **top row** of the table show?

- A. Rosa, 25 points
- B. Nina, 12 points
- C. Joel, 18 points
- D. Nina, 25 points

Question 6

A tradie's spreadsheet holds 7 invoices. A filter on Status = Unpaid shows 3 rows. The tradie then **clears** the filter.

How many invoice rows are visible now?

- A. 7
- B. 4
- C. 3
- D. 0

Question 7

Erin has exactly 2 **hours** free and four jobs she must do **on her own**, one after another. The jobs take 35, 40, 25 and 30 minutes.

Which one of the following is correct?

- A. All four jobs fit, because no single job takes longer than 2 hours.
- B. The jobs do not fit: they need 130 minutes in total, which is 10 minutes more than the 120 minutes Erin has.
- C. All four jobs fit, because they need exactly 120 minutes in total.
- D. All four jobs fit, because 130 minutes is less than 2 hours.

Question 8

Marcus's revision plan finishes at 2:40 pm. His assignment is due online at 3:25 pm.

What is the buffer, in minutes, in Marcus's plan?

- A. 15
- B. 35
- C. 45
- D. 85

Question 9

A map app set to walking mode says a 3.6 **km** walk will take 6 **minutes**. A person walks at about 5 **km/h**.

Which one of the following applies the sense check to this output correctly?

- A. The output passes the sense check: 36 km/h is a normal walking speed.
- B. The output fails the sense check: it implies a speed of 36 km/h, far above the walking speed of about 5 km/h.
- C. The output fails the sense check: it implies a speed of 0.36 km/h, far below the walking speed of about 5 km/h.
- D. The output passes the sense check: a walker at 5 km/h covers 3.6 km in about 6 minutes.

Question 10

Elliot types these values into a trip-fuel calculator: distance 260 **km**, fuel use 7.5 **litres per 100 km**, and fuel price **\$1.62 per litre**.

What is the fuel cost for the trip, **to the nearest cent**?

- A. \$ 12.15
- B. \$ 32.40
- C. \$ 42.12
- D. \$ 31.59

Question 11

A parking app charges $C = 6 + 4n$ dollars, where n is the number of hours parked. Hana has **\$30** to spend on parking.

What is the **greatest** whole number of hours Hana can park for without going over \$30?

- A. 8
- B. 5
- C. 7
- D. 6

Question 12

Two copy shops price by the job. **Shop J** charges a **\$15** set-up fee plus **\$0.25** per copy. **Shop K** charges a **\$25** set-up fee plus **\$0.15** per copy.

At how many copies do the two shops cost **the same**?

- A. 40
- B. 250
- C. 100
- D. 400

End of Test A

Test A — Answers

Question	1	2	3	4	5	6	7	8	9	10	11	12
Answer	D	A	B	C	D	A	B	C	B	D	D	C

Test A — Fully-worked solutions

Question	Answer	Working
1	D	The cost rule uses the mass with its rate, and the distance with its rate: $4.5 \times 6.80 + 18 \times 0.50 = 30.60 + 9.00$. The estimated delivery of 2 days never enters that rule — it is extra information the app shows, not an input it uses. Options A (4.5), B (0.50) and C (18) are all numbers the calculation does use.
2	A	The box wants metres and the tape reads 275 cm. There are 100 cm in 1 m, so divide by 100: $275 \div 100 = 2.75$ m. Option C leaves the reading in centimetres; option B divides by 10 instead of 100; option D divides by 1000 — each is the wrong power of ten.
3	B	The raw output is $47 \div 12 = 3.9166\dots$, about 3.9 trays (option C), but only whole trays can be ordered. Option A: $3 \times 12 = 36$, which is fewer than 47 — short. Option B: $4 \times 12 = 48 \geq 47$ — enough, and the least whole number of trays that is enough. Option D: 5 trays (60 sandwiches) would also feed everyone, but it is more than the event needs.
4	C	COUNT reports how many records are in the range: <code>=COUNT (B2 : B5)</code> = 4. The other functions give different numbers: SUM gives 208 (the total donated), AVERAGE gives \$52.00 (a typical donation) and MAX gives 65 (the largest donation), so only option C answers “how many donations”.
5	D	Sorting only the points column reorders the points to 25, 18, 12 while the names stay put: Nina, Joel, Rosa. The top row then pairs the first name with the first sorted points: Nina, 25 points — a scrambled table in which nobody’s points are right. Option A (Rosa, 25 points) is what a proper sort, where whole rows move together, would show; option B is the top row of an ascending key-only sort; option C is the middle row.
6	A	A filter hides rows; it never deletes

Question	Answer	Working
7	B	them. Clearing the filter brings the 4 hidden rows back, so all 7 rows are visible again. Option B (4) assumes filtering deleted the hidden rows ($7 - 3 = 4$); option C is the count while the filter is still on; option D assumes clearing wipes the table. Erin works alone, one job after another, so the times add: $35 + 40 + 25 + 30 = 130$ minutes. She has 2 hours = 120 minutes. Since $130 > 120$, the jobs do not fit — they are over by $130 - 120 = 10$ minutes. Option A compares only the longest job (40 minutes) with the 2 hours and ignores the other three; option C adds the times incorrectly; option D is false because 2 hours is 120 minutes, and 130 minutes is more than that, not less.
8	C	Buffer = deadline – planned finish. Count from 2:40 pm to 3:00 pm: 20 minutes; then from 3:00 pm to 3:25 pm: 25 minutes. Buffer $= 20 + 25 = 45$ minutes. Option A is the borrow slip ($40 - 25 = 15$); option B counts 2:40 pm to 3:00 pm as 10 minutes; option D treats clock minutes as if they were in hundreds ($125 - 40 = 85$).
9	B	Speed = distance $\div$ time in hours. Since 6 minutes = 0.1 h, the app's output implies $3.6 \div 0.1 = 36$ km/h. People walk at about 5 km/h, so 36 km/h fails the sense check — the time the app shows cannot be right. Option A calls 36 km/h a normal walking speed, which it is not; option C multiplies instead of dividing ($3.6 \times 0.1 = 0.36$); option D is false because at 5 km/h a walker covers only $5 \times 0.1 = 0.5$ km in 6 minutes, not 3.6 km.
10	D	Fuel used = $260 \times 7.5 \div 100 = 19.5$ L. Cost = $19.5 \times \\$1.62 = \\$31.59$ exactly, so to the nearest cent the fuel costs \$31.59. Option A (\$12.15) is the fuel cost for only 100 km ($7.5 \times \\$1.62$); option B (\$32.40) rounds 19.5 L up to 20 L too early; option C (\$42.12) skips

Question	Answer	Working
11	D	the fuel-use rate ($26 \times \\$1.62$). Test whole numbers of hours: $n = 5$ gives $6 + 4 \times 5 = \\$26$ — fits, but perhaps more hours fit too; $n = 6$ gives $6 + 24 = \\$30$ — exactly Hana's cap, so it fits; $n = 7$ gives $6 + 28 = \\$34$ — over \$30. The greatest whole number of hours that fits is 6. Option A comes from ignoring the \$6 flat fee: $30 \div 4 = 7.5$, rounded up to 8; option C (\$34) and option A (\$38) both go over \$30.
12	C	Set the two costs equal: $15 + 0.25n = 25 + 0.15n$. Subtract $0.15n$ from both sides: $15 + 0.10n = 25$. Subtract 15: $0.10n = 10$. Divide: $n = 100$. Check: Shop J = $15 + 0.25 \times 100 = \\$40.00$ and Shop K $= 25 + 0.15 \times 100 = \\$40.00$ — equal, as required. Option A (40) divides the fee gap by Shop J's rate only ($10 \div 0.25$); option B (250) uses Shop K's fee alone ($25 \div 0.10$); option D (400) adds the fees instead of finding their gap ($40 \div 0.10$).

Chapter 10 — Test B (written response)

Chapter 10 (Systematics), sections 10A to 10E. Materials: pen, paper and a basic calculator. Test B: seven questions (37 marks). Approximate time: 50 minutes. Answer all questions in the spaces provided. In all questions where a numerical answer is required, you should only round when instructed to do so, and then to the precision stated. Where more than one mark is available, appropriate working must be shown.

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Question 1 (5 marks)

Rani orders bulk mulch through a garden-supply online calculator. The screen asks for four inputs: garden **length** (in metres), garden **width** (in metres), **depth** (in metres) and **delivery distance** (in kilometres). The output is the **volume** of mulch needed, in cubic metres (m^3).

Rani's garden bed is a rectangle 5.4 m long and 2.2 m wide, and she wants the mulch 15 cm deep. Her delivery distance is 12 km. The mulch costs **\$45 per m^3** .

a. Which one of the four inputs does not affect the volume of mulch the calculator works out? 1 mark

b. What number should Rani type for the **depth**? Give the units. 1 mark

c. Show that the volume of mulch Rani needs is 1.782 m^3 . 2 marks

d. Find the cost of the mulch, **to the nearest cent**. 1 mark

Question 2 (5 marks)

The school fete committee keeps its takings in a spreadsheet. Column A holds the **item**, column B holds the **number sold**, column C holds the **price (\$)** and column D holds the **takings (\$)**. The sheet is set out like this:

	A	B	C	D
1	Item	Number sold	Price (\$)	Takings (\$)
2	Sausage-sizzle plates	46	4.50	
3	Jars of jam	38	3.20	
4	Cans of drink	60	1.50	
5	Raffle tickets	120	2.00	

a. Write the formula that belongs in cell **D2**, and state the value it shows, **to the nearest cent**. 2 marks

b. Find the values shown by **=SUM (D2 : D5)** and **=AVERAGE (D2 : D5)** , to the nearest cent.

2 marks

c. The committee wants to see **only** the items that sold more than 50, without losing any rows. Name the spreadsheet feature they should use.

1 mark

Question 3 (5 marks)

A community theatre group must be fully set up before its **6:30 pm** show. Four jobs have to be done, one after another, in this order:

- unlock the hall and set up the ticket desk — 15 minutes
- set out the chairs — 40 minutes
- hang the banners — 30 minutes
- test the sound — 20 minutes

a. Find the total preparation time needed, in minutes.

1 mark

b. Find the **latest start time** that still has everything ready by 6:30 pm.

2 marks

c. The group starts at **4:10 pm** and runs the jobs one after another with no gaps. Find the finish time, and the **buffer** before the show.

2 marks

Question 4 (5 marks)

Talia's roster for one week at a food truck is shown below. She is paid **\$23.60 per hour**. On the Thursday and Saturday shifts, the 30-minute lunch break is **unpaid**.

Day	Shift
Tuesday	15:00–19:30
Thursday	09:00–14:00 (includes a 30-minute unpaid lunch break)
Saturday	10:30–16:00 (includes a 30-minute unpaid lunch break)

a. Find the length of **each** of Talia's shifts, in **decimal hours**.

3 marks

b. Find Talia's total number of hours for the week.

1 mark

c. Find Talia's pay for the week, **to the nearest cent**.

1 mark

Question 5 (6 marks)

Mei catches public transport to college tomorrow. Her journey planner splits the trip into these legs:

Leg	Time (minutes)
Walk to the station	8
Wait for the train	6
Train ride	25
Change to the bus	5
Bus ride	10

Mei leaves home at **07:46**, and the whole trip covers **14.4 km**.

For the trip home, the evening bus timetable is:

Departs college	Arrives home
16:20	17:02
16:50	17:32
17:20	18:02
17:50	18:32

a. Find the **door-to-door** time of Mei's morning trip, in minutes.

1 mark

b. Find the time Mei arrives at college.

1 mark

c. Find the average speed of the whole morning trip, in km/h, **to one decimal place**.

2 marks

d. In the evening, Mei must be home by **18:15**. Find the **latest** bus she can catch, giving both its departure and arrival times, and state how many minutes early she gets home.

2 marks

Question 6 (6 marks)

A pottery studio has two ways to pay. **Casual** visitors pay **\$14 per session**. **Members** pay a once-off **\$20** joining fee and then **\$8 per session**. Let n be the number of sessions a person attends.

a. Find the cost of each option for 3 sessions, and state which option is cheaper at 3 sessions.

2 marks

b. Find the cost of each option for 6 sessions, and state which option is cheaper at 6 sessions.

2 marks

c. Find the **smallest** whole number of sessions at which the member option becomes cheaper. **Test** the number of sessions one lower to confirm your answer.

2 marks

Question 7 (5 marks)

The Nguyen family is going to a show 45 **km** away and is deciding whether to **drive** or catch the **train**.

- **Driving:** their car uses 9 **litres** of fuel per 100 km, fuel costs **\$1.68 per litre**, and parking at the showground costs **\$12** for the day. Door to door, the drive takes 70 **minutes** each way.
- **Train:** the family's tickets cost **\$21.60** in total for the return trip. Door to door, the train takes 85 **minutes** each way.

a. Find the total distance driven on the return trip, and the number of litres of fuel used. 1 mark

b. Find the total cost of driving for the day — fuel **and** parking — **to the nearest cent**. 2 marks

c. Find how much **more** driving costs than the train, **to the nearest cent**. 1 mark

d. Find the total door-to-door time, in minutes, for the return trip by each option. 1 mark

End of Test B

Test B — Answers

Q1. a. the delivery distance (12 km) **b.** 0.15 m **c.** 1.782 m³ (working below) **d.** \$80.19 to the nearest cent

Q2. a. $=B2 * C2$; \$207.00 to the nearest cent **b.** SUM: \$658.60; AVERAGE: \$164.65, both to the nearest cent **c.** a filter (filtering)

Q3. a. 105 minutes (1 h 45 min) **b.** 4:45 pm **c.** finishes at 5:55 pm; buffer 35 minutes

Q4. a. Tuesday 4.5 h; Thursday 4.5 h; Saturday 5 h **b.** 14 hours **c.** \$330.40 to the nearest cent

Q5. a. 54 minutes **b.** 08:40 **c.** 16.0 km/h to one decimal place **d.** departs 17:20, arrives 18:02; 13 minutes early

Q6. a. member \$44, casual \$42 — casual is cheaper **b.** member \$68, casual \$84 — member is cheaper **c.** 4 sessions (testing 3 sessions shows the member option is not yet cheaper)

Q7. a. 90 km; 8.1 litres **b.** \$25.61 to the nearest cent **c.** \$4.01 to the nearest cent **d.** car 140 minutes; train 170 minutes

Test B — Fully-worked solutions

Question 1.

- a. The volume is worked out from the length, the width and the depth. The **delivery distance (12 km)** never enters that calculation, so it is the input that does not affect the volume.
- b. The depth box asks for metres, and Rani measured 15 cm. There are 100 cm in 1 m, so divide by 100:
 $15 \div 100 = 0.15$. Rani types **0.15 m**.
- c. Area of the bed: $5.4 \times 2.2 = 11.88 \text{ m}^2$. Volume = area $\times$ depth: $11.88 \times 0.15 = 1.782 \text{ m}^3$. So the volume of mulch needed is 1.782 m^3 , as required.
- d. Cost = volume $\times$ price per $\text{m}^3 = 1.782 \times \$45 = \$80.19$ exactly. To the nearest cent, the mulch costs **\$80.19**.

Question 2.

- a. Takings = number sold $\times$ price, so D2 needs **=B2*C2**. It shows $46 \times 4.50 = 207.00$, which is **\$207.00** to the nearest cent (the working lands exactly on a cent).
- b. **=SUM(D2:D5)** adds the four takings: $207.00 + 121.60 + 90.00 + 240.00 = \$658.60$. **=AVERAGE(D2:D5)** divides that total by the 4 rows: $658.60 \div 4 = \$164.65$ exactly. To the nearest cent, the two values are **\$658.60** and **\$164.65**.
- c. A **filter** (filtering) on Number sold greater than 50. The sheet then shows only the two matching rows — cans of drink (60) and raffle tickets (120) — and the other rows are hidden, never deleted.

Question 3.

- a. $15 + 40 + 30 + 20 = 105$ **minutes** (that is, 1 hour 45 minutes).
- b. Plan backwards from the show: $6:30 \text{ pm} - 45 \text{ min} = 5:45 \text{ pm}$; $5:45 \text{ pm} - 1 \text{ h} = 4:45 \text{ pm}$. The latest start time is **4:45 pm**. Check forwards: $4:45 \text{ pm} + 1 \text{ h } 45 \text{ min} = 6:30 \text{ pm}$ ✓.
- c. Finish: $4:10 \text{ pm} + 1 \text{ h} = 5:10 \text{ pm}$; $5:10 \text{ pm} + 45 \text{ min} = 5:55 \text{ pm}$ — they finish at **5:55 pm**. Buffer = $6:30 \text{ pm} - 5:55 \text{ pm} = 35$ **minutes**.

Question 4.

- a. Tuesday: 15:00 to 19:30 is 4 hours 30 minutes = **4.5 hours**. Thursday: 09:00 to 14:00 is 5 hours; subtract the 30-minute (0.5 hour) unpaid lunch: $5 - 0.5 = 4.5$ **hours**. Saturday: 10:30 to 16:00 is 5 hours 30 minutes = 5.5 hours; subtract the lunch: $5.5 - 0.5 = 5$ **hours**.
- b. $4.5 + 4.5 + 5 = 14$ **hours** for the week.
- c. Pay = hours $\times$ rate = $14 \times \$23.60 = \$330.40$ exactly. To the nearest cent, Talia's pay for the week is **\$330.40**.

Question 5.

- a. Door-to-door means **every** leg — the walking and waiting count too: $8 + 6 + 25 + 5 + 10 = 54$ **minutes**.
- b. $07:46 + 14 \text{ min} = 08:00$; $08:00 + 40 \text{ min} = 08:40$. Mei arrives at college at **08:40**.
- c. Time in hours = $54 \div 60 = 0.9 \text{ h}$. Speed = distance $\div$ time = $14.4 \div 0.9 = 16$ exactly. To one decimal place, the average speed is **16.0 km/h**.
- d. Find the latest arrival that is still at or before 18:15. The 17:50 bus arrives 18:32 — too late. The 17:20 bus arrives **18:02**, which is the latest arrival in time, so Mei catches the bus that **departs 17:20** and **arrives 18:02**. Early time = $18:15 - 18:02 = 13$ **minutes** early.

Question 6.

- a. Member: $20 + 8 \times 3 = 20 + 24 = \$44$. Casual: $14 \times 3 = \$42$. At 3 sessions the **casual** option is cheaper, since $\$42 < \$44$.
- b. Member: $20 + 8 \times 6 = 20 + 48 = \$68$. Casual: $14 \times 6 = \$84$. At 6 sessions the **member** option is cheaper, since $\$68 < \$84$.
- c. The switch happens somewhere between 3 and 6 sessions, so test whole numbers. Test $n = 4$: member $20 + 32 = \$52$; casual $14 \times 4 = \$56$ — the member option is cheaper. Test one lower, $n = 3$: member $\$44$, casual $\$42$ — the member option is **not** cheaper yet. So the smallest whole number of sessions at which membership is cheaper is 4. (As a check, the two rules cross at $20 \div 6 = 3.33\dots$ sessions, so the flip to whole sessions is at 4.)

Question 7.

- a. Return distance $= 45 \times 2 = 90$ **km**. Fuel $= \text{distance} \times \text{rate} \div 100 = 90 \times 9 \div 100 = 8.1$ **litres**.
- b. Fuel cost $= 8.1 \times \$1.68 = \$13.608$ — keep the full precision while working. Total $= 13.608 + 12 = 25.608$. To the nearest cent, driving for the day costs $\$25.61$.
- c. Difference $= 25.608 - 21.60 = 4.008$. To the nearest cent, driving costs $\$4.01$ **more** than the train.
- d. Car: $70 \times 2 = 140$ **minutes**. Train: $85 \times 2 = 170$ **minutes**. The train is $\$4.01$ cheaper but takes 30 minutes longer on the day — the family weighs the saving against the extra time and decides; no tool makes that choice for them.