Vertex Academy

Year 9 Maths workbook

9 worksheets · answers at the back

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Year 9 · Number: Powers, Fractions & Proportions

Name: _____ Date: _____

Hi! This sheet mixes together scientific notation, order of operations, fractions and percentages, plus some ratio work. Take your time, show your steps, and check your answers look reasonable.

Warm-up

1. Write 45 000 in scientific notation.

2. Work out 2^5 and 2^8.

3. Write 3^{-2} as a unit fraction.

4. Simplify the fraction 18/24.

Practice

5. Evaluate $5 + 3 \times (8 - 6)^2$ using the correct order of operations (GEMA).

6. Between which two whole numbers does $\sqrt{55}$ lie, and which is it closer to?

7. Calculate $\frac{2}{3} \div \frac{3}{4}$. Give your answer in simplest form.

8. A pair of gumboots at a Warehouse store in Avondale costs $60. They are marked down by 25%. What is the sale price?

9. Aroha and Mikaere share $84 in the ratio 3 : 4. How much does each get?

10. A car uses 6 litres of petrol to travel 75 km. At this rate, how far can it travel on 20 litres?

Challenge

11. 20% of a number is 30. What is the number, and what is 35% of it?

12. Evaluate $(-3)^2 - 3^2 + (-2)^3$, then write the result as a fraction of 20 in simplest form.

Year 9 · Number: Money, Mark-ups & GST

Name: _____ Date: _____

Kia ora! This sheet helps you work confidently with percentages, discounts, GST and simple interest, the maths behind real shopping and saving. Show your working and check each answer as you go.

Warm-up

1. Find 10% of $80.

2. Find 15% of $200.

3. Find 25% of $60.

4. Increase $50 by 20%.

Practice

5. Find the GST (15%) on $432.

6. A skateboard costs $120 before GST. What is the GST-inclusive price?

7. A shop in Avondale buys a phone case for $80 and marks it up by 35%. Find the selling price.

8. A pair of shoes normally priced at $90 is discounted by 20% in a Newmarket sale. What is the sale price?

9. Aroha deposits $2000 in a savings account earning 4% simple interest per year. How much interest does she earn after 3 years?

10. A mountain bike is priced at $450 including GST. Find the price before GST was added.

Challenge

11. A store first raises the price of a jacket by 25%, then later offers 25% off the new price. The jacket started at $160. What is the final price, and what is the overall percentage change from the original?

12. Liam wants to earn $600 in simple interest by investing money at 5% per year for 4 years. How much must he invest?

Year 9 · Algebra: Lines, Rules & Solving Equations

Name: _____ Date: _____

Kia ora! This sheet helps you practise tidying up expressions, solving equations, and working with straight-line rules like y = mx + c. Show your steps, they matter as much as the answer.

Warm-up

1. Simplify: 5a + 3b − 2a + 7b

2. Expand: 4(x + 3)

3. Find the value of 2x − 5 when x = 3.

4. Solve: x + 7 = 12

Practice

5. Expand and simplify: 3(2x + 4) − 5

6. Factorise fully: 12y + 18

7. Solve: ½x + 3 = 7

8. A taxi from Avondale charges a $4 fixed fee plus $2.50 for each kilometre travelled. Write a rule for the total cost C (in dollars) for k kilometres, then find the cost of a 6 km trip.

9. Mere builds patterns with matchsticks. Pattern 1 uses 4 matches, Pattern 2 uses 7, and Pattern 3 uses 10. Describe the rule in words, write it using n for the pattern number, and find how many matches Pattern 10 needs.

10. The perimeter of a rectangle is P = 2l + 2w. Rearrange the formula to make w the subject, then find w when P = 30 cm and l = 8 cm.

Challenge

11. Solve the inequality 5 − 2x ≤ 11. Show clearly what happens when you divide by a negative number.

12. A straight line gives this table of values, x: −2, −1, 0, 1, 2 and y: 7, 5, 3, 1, −1. Find the gradient m and y-intercept c, write the equation, state whether the line slopes up or down, and predict y when x = 5.

Year 9 · Measurement: Circles, Triangles and Speed

Name: _____ Date: _____

Kia ora! This sheet gives you practice with metric units, areas and perimeters (including circles), Pythagoras' theorem, and speed–distance–time. Show your working and check your units.

Warm-up

1. Convert 3.6 km into metres.

2. Convert 4500 mm into metres.

3. Find the area of a parallelogram with base 7 cm and perpendicular height 4 cm.

4. Find the circumference of a circle with diameter 10 cm. Use $\pi \approx 3.14$.

Practice

5. Find the area of a trapezium with parallel sides 6 m and 10 m and a perpendicular height of 4 m.

6. A right-angled triangle has two shorter sides of 6 cm and 8 cm. Find the length of the hypotenuse.

7. Aroha cycles the 12 km from Avondale to New Lynn and back in 40 minutes. What is her average speed in km/h?

8. A van travels along the motorway at a steady 90 km/h for 2.5 hours. How far does it travel?

9. A semicircular (half-circle) garden edge has a diameter of 14 cm on a plan. Find the perimeter of the half circle. Use $\pi \approx 3.14$.

10. A rectangular deck is measured as 3.2 m by 2.5 m. Calculate its area, giving the answer to the correct precision.

Challenge

11. The numbers (5, 12, 13) form a Pythagorean triple. Use them to write down another Pythagorean triple, and verify that your new triple satisfies Pythagoras' theorem.

12. A quarter-circle path curves around the corner of Heron Park with radius 6 m. Starting from the full-circle formula, work out the total perimeter of the quarter-circle region (the curved part plus the two straight radii). Use $\pi \approx 3.14$, and give your answer to 3 significant figures.

Year 9 · Geometry: Circles & Parallel Lines

Name: _____ Date: _____

Hi! This sheet gives you practice naming the parts of a circle and finding unknown angles when lines cross parallel lines. Draw a quick sketch for each question, it really helps you spot the equal angles.

Warm-up

1. Name the straight line that goes from one side of a circle to the other, passing through the centre.

2. A circle has a radius of 6 cm. What is its diameter?

3. Two parallel lines are cut by a transversal. One corresponding angle is 65°. What is the size of the matching corresponding angle?

4. Alternate angles between two parallel lines are equal. If one alternate angle is 110°, what is the other?

Practice

5. Match each word to its meaning: (a) chord, (b) radius, (c) circumference.

6. A transversal crosses two parallel lines. At the top intersection an angle of 72° is marked. Find the co-interior angle to it on the same side of the transversal.

7. Two parallel lines are crossed by a transversal. An angle x is alternate to a 48° angle, and an angle y forms a straight line with x. Find x and y.

8. Word problem: At the Avondale skate park, two long parallel handrails are crossed by a diagonal support beam. The beam makes a 63° angle with the top rail. Manaia says the beam makes the same 63° angle with the bottom rail as a corresponding angle. Is Manaia correct? Explain.

9. Word problem: A round garden bed at a school in Blockhouse Bay has a circumference path around it. A straight edging plank is laid across the bed touching the circle at two points but not passing through the centre. What part of the circle does the plank represent, and how does it compare in length to the diameter?

10. A transversal crosses two lines. At the first line an angle of 85° is measured, and at the second line the corresponding position measures 80°. Are the two lines parallel? Explain.

Challenge

11. A transversal crosses two lines. On one line the angle above the transversal is $(3a + 10)°$ and on the other line the co-interior angle on the same side is $(2a + 30)°$. Find the value of a that makes the two lines parallel, then state both angles.

12. In a circle with centre O, a chord AB has length 16 cm. A line from O meets AB at right angles at point M, the midpoint of AB. If OM = 6 cm, find the radius of the circle.

Year 9 · Statistics: Reading the Story in Data

Name: _____ Date: _____

This sheet helps you get to know a data set by finding its five-point summary and interquartile range, and by spotting what kind of statistical question is being asked. Take your time ordering the numbers, that's where most marks are won or lost!

Warm-up

1. Order this data set from smallest to largest, then write down the minimum and maximum: 12, 7, 15, 9, 20, 4.

2. Find the median of: 3, 8, 5, 10, 6.

3. A survey records each student's eye colour and their height in centimetres. Which variable is categorical and which is numerical?

4. Mia counts the birds in her own backyard in Avondale. Wiremu uses bird numbers published on the StatsNZ website. Who is collecting primary data and who is using secondary data?

Practice

5. For the data set 4, 6, 7, 9, 11, 12, 15, 18, 20, find the five-point summary and the interquartile range.

6. These are the heights (cm) of 10 students: 152, 155, 158, 160, 162, 165, 168, 170, 172, 180. Find the five-point summary and the IQR.

7. Label each question as a summary, comparison, relationship, or time-series investigation. (a) What is the typical number of pets owned by students at Avondale Intermediate? (b) Do Year 9 boys spend more time on screens than Year 9 girls? (c) Is there a connection between hours studied and test score? (d) How has the price of a flat white in Avondale changed each year from 2020 to 2025?

8. Aroha plans an observational study at her school. For each student she records their favourite sport and how many hours per week they exercise. (a) Name one categorical and one numerical variable. (b) Is this primary or secondary data? (c) Write a good summary statistical question she could investigate.

9. The Avondale netball team scored these goals across 11 games: 18, 22, 15, 30, 25, 20, 28, 19, 24, 21, 26. Find the five-point summary and the IQR of the goals scored.

10. Eight students recorded how many minutes it took them to get to school: 5, 12, 8, 20, 15, 10, 25, 18. Find the five-point summary and the IQR, then state what the IQR tells you.

Challenge

11. Screen-time (hours per week) was recorded for two groups. Year 9: 2, 3, 3, 4, 5, 6, 7, 8. Year 10: 1, 3, 5, 6, 7, 8, 9, 11. Find the five-point summary and IQR for each group, then compare the two groups.

12. Waiting times (minutes) at a medical centre were: 5, 7, 8, 9, 10, 11, 12, 45. Find the five-point summary, the range, and the IQR. Explain which measure of spread better describes most patients' experience, and why.

Year 9 · Statistics: Picture the Data

Name: _____ Date: _____

Hi! This sheet is all about turning data into pictures that tell a story. You'll build different graphs, pick sensible scales, and even draw a line of best fit to make a prediction. Grab a ruler and a pencil!

Warm-up

1. Name the best type of graph to show how a class's favourite lunch (pie, sushi, sandwich, wrap) is spread across the group.

2. A dot plot shows the number of siblings for 10 students: 0, 1, 1, 1, 2, 2, 3, 0, 1, 4. How many students have exactly 1 sibling?

3. For a scatter plot investigating whether hours of study predicts test score, which variable goes on the x-axis?

4. A frequency table records: Walk 8, Bus 6, Car 5, Bike 1. What is the total number of students surveyed?

Practice

5. The heights (cm) of 12 Year 9 students are: 150, 155, 155, 160, 162, 162, 162, 165, 168, 170, 172, 180. What is a sensible scale for the vertical axis of a histogram of these heights, and why?

6. Complete this frequency table for the number of pets owned by 15 whānau: 0,1,2,1,3,0,2,1,0,4,1,2,0,1,2. Fill in the frequency for each value from 0 to 4.

7. Word problem: Aroha records the temperature at Avondale each day at noon over one week: Mon 14°C, Tue 16°C, Wed 15°C, Thu 18°C, Fri 20°C, Sat 19°C, Sun 17°C. Which graph best shows how temperature changed over the week, and what does the graph show?

8. Word problem: A dairy on Rosebank Road sells hot pies. The owner tracks daily pies sold against the daily high temperature: (12°C, 40 pies), (14°C, 36), (16°C, 30), (18°C, 26), (20°C, 20), (22°C, 15). Describe the relationship you would see on a scatter plot and which variable should be on each axis.

9. Using the dairy data above, draw an eyeballed line of best fit and use it to predict how many pies would be sold on a 17°C day.

10. A survey asked 40 students two questions: Do you play a sport? (Yes/No) and Do you play a musical instrument? (Yes/No). Results: sport & instrument 9, sport only 15, instrument only 6, neither 10. Set up a two-way table and find how many students play a sport in total.

Challenge

11. Ten Year 9 students recorded their weekly screen time (hours) and their hours of sleep per night: (5,9), (10,8.5), (15,8), (20,7.5), (25,7), (30,6.5), (12,8.2), (22,7.3), (8,8.7), (28,6.8). (a) Which variable is explanatory? (b) Describe the relationship. (c) Draw a line of best fit and predict the sleep for a student with 18 hours of screen time.

12. A journalist shows a bar graph where the vertical axis starts at 40 (not 0) to compare test averages of two classes: Class A = 62, Class B = 68. Explain why this scale can mislead readers, and describe a better visualisation choice for comparing the full spread of each class's scores.

Year 9 · Statistics: Reading Between the Lines of Data

Name: _____ Date: _____

This sheet helps you become a data detective! You'll practise spotting when graphs and claims are trustworthy, and when they might be tricking you. Take your time and back up your thinking with evidence.

Warm-up

1. A survey asked 20 students at Avondale College how many hours they slept last night. The results (in hours) were: 6, 7, 8, 5, 9, 7, 6, 8, 7, 10, 6, 7, 8, 5, 7, 9, 6, 8, 7, 6. What is the most common (mode) number of hours slept?

2. A bar graph starts its vertical axis at 40 instead of 0. What effect can this have on how the bars look?

3. True or false: If a coin lands on heads 6 times out of 10 flips, the coin must be unfair.

4. A pie chart shows 'Favourite takeaway in Avondale' with slices for Fish & Chips 45%, Pizza 30%, Burgers 20%, and Sushi 5%. Do these add up correctly?

Practice

5. A local newspaper headline reads: 'Ice cream sales rise as drownings increase, is ice cream dangerous?' Explain why this claim is misleading.

6. A pictograph about pets uses a picture of a dog to represent 10 pets. To show 30 cats, the designer draws one cat picture that is three times as tall AND three times as wide as a single symbol. Why does this misrepresent the data?

7. Aroha conjectures that 'most Year 9 students at her school walk to school'. She surveys the 25 students in her own maths class and finds 14 walk. Is her sample good enough to support a claim about the whole Year 9? Explain.

8. A company claims '9 out of 10 dentists recommend BrightSmile toothpaste'. What questions should you ask before believing this claim?

9. Two classes sat the same test. Class A had a median score of 72 and Class B had a median of 68, but Class A's scores ranged from 40 to 95, while Class B's ranged from 62 to 74. Which class performed more consistently, and how do you know?

10. A survey of 200 Auckland residents found 130 support a new cycleway. A report states 'The people of Auckland strongly support the cycleway.' Evaluate whether the data supports this statement.

Challenge

11. A shop advertises 'Prices slashed by up to 70%!' After visiting, you find only 2 items out of 500 have a 70% discount; most items are discounted 5–10%. Explain how the advertisement uses true data in a misleading way, and suggest a more honest statement.

12. A researcher runs an experiment giving 8 plants a new fertiliser and 8 plants water only. The fertilised plants grew an average of 12 cm; the water-only plants grew 11 cm. She claims 'the fertiliser clearly works.' Discuss two reasons to be cautious about this claim, and describe one way to improve the experiment.

Year 9 · Probability: Testing Theory Against Trials

Name: _____ Date: _____

Hi! This sheet is all about the difference between what we expect to happen (theoretical probability) and what actually happens when we run experiments (experimental probability). You'll list outcomes, crunch some numbers, and see the Law of Large Numbers in action. Grab a calculator and let's go!

Warm-up

1. A fair six-sided dice is rolled once. What is the theoretical probability of rolling a 4? Give your answer as a fraction and a percentage (to the nearest whole percent).

2. Aria tossed a coin 30 times and got 18 heads. What is the experimental probability of getting a head? Give your answer as a fraction in simplest form.

3. A bag holds 5 red, 3 blue and 2 green marbles. One marble is drawn at random. What is the theoretical probability it is blue?

4. Are the events 'rolling an even number' and 'rolling a 3' on a single dice roll mutually exclusive? Explain in one sentence.

Practice

5. A spinner is divided into 4 equal sections coloured red, yellow, blue and white. List the full sample space for one spin, then state the theoretical probability of landing on yellow.

6. Two fair coins are tossed together. Use a systematic list or table to write every possible outcome, then find the probability of getting exactly one head.

7. Tane rolled a fair dice 60 times. He recorded: 1 appeared 8 times, 2 appeared 11 times, 3 appeared 9 times, 4 appeared 12 times, 5 appeared 10 times, 6 appeared 10 times. Find the experimental probability of rolling a 4, and compare it with the theoretical probability.

8. At the Avondale Sunday Market, a lucky-dip drum contains 40 tickets: 4 are winners and 36 are blanks. Mere pays $2 for one ticket. What is the theoretical probability she draws a winning ticket? Give your answer as a fraction in simplest form and as a percentage.

9. A class ran a simulation of tossing a drawing pin 100 times to see how often it lands 'point up'. It landed point up 62 times. (a) Why can this probability only be found by experiment, not by theory? (b) Estimate the probability the pin lands 'point down'.

10. Ben used a computer to simulate rolling a fair dice. After 30 rolls the experimental probability of a 6 was 0.10. After 1000 rolls it was 0.165. Explain, using the Law of Large Numbers, why the second result is closer to the theoretical probability.

Challenge

11. A fair coin is tossed and a fair dice is rolled. (a) Draw or list all outcomes using a systematic method. (b) Find the probability of getting a head AND a number greater than 4. (c) Explain why you cannot simply add P(head) and P(number greater than 4) to get this answer.

12. A bag has 3 kiwifruit stickers and 2 feijoa stickers. Two stickers are drawn one after the other WITHOUT replacing the first. (a) Are the two draws independent or dependent? (b) Use a tree diagram (describe the branches) to find the probability that both stickers are kiwifruit.

Answer key (for parents and tutors)

1. Write 45 000 in scientific notation.
   Move the decimal point so there is one non-zero digit in front: 4.5. The point moved 4 places, so k = 4. Answer: 4.5×10^4.

2. Work out 2^5 and 2^8.
   $2^5 = 2\times2\times2\times2\times2 = 32$. $2^8 = 256$. (Powers of 2: 2, 4, 8, 16, 32, 64, 128, 256, 512, 1024.)

3. Write 3^{-2} as a unit fraction.
   A negative exponent means the reciprocal: $3^{-2} = 1 \div 3^2 = 1 \div 9 = 1/9$.

4. Simplify the fraction 18/24.
   The highest common factor of 18 and 24 is 6. $18 \div 6 = 3$ and $24 \div 6 = 4$. So $18/24 = 3/4$.

5. Evaluate $5 + 3 \times (8 - 6)^2$ using the correct order of operations (GEMA).
   Grouped first: $(8 - 6) = 2$. Exponent: $2^2 = 4$. Multiplicative: $3 \times 4 = 12$. Additive: $5 + 12 = 17$. Answer: 17.

6. Between which two whole numbers does $\sqrt{55}$ lie, and which is it closer to?
   $49 = 7^2$ and $64 = 8^2$, and 55 is between them, so $\sqrt{55}$ is between 7 and 8. Since 55 is closer to 49 than to 64, $\sqrt{55}$ is closer to 7 (about 7.4).

7. Calculate $\frac{2}{3} \div \frac{3}{4}$. Give your answer in simplest form.
   Dividing by a fraction means multiplying by its reciprocal: $\frac{2}{3} \div \frac{3}{4} = \frac{2}{3} \times 4/3 = (2\times4)/(3\times3) = 8/9$. This is already in simplest form.

8. A pair of gumboots at a Warehouse store in Avondale costs $60. They are marked down by 25%. What is the sale price?
   A 25% decrease means paying 75% of the price. 75% = 0.75, so $0.75 \times \$60 = \$45$. Sale price = $45. (Check: 25% of $60 = $15, and $60 – $15 = $45.)

9. Aroha and Mikaere share $84 in the ratio 3 : 4. How much does each get?
   Total parts = 3 + 4 = 7. Each part = $84 ÷ 7 = $12. Aroha (3 parts) = 3 × $12 = $36. Mikaere (4 parts) = 4 × $12 = $48. (Check: $36 + $48 = $84.)

10. A car uses 6 litres of petrol to travel 75 km. At this rate, how far can it travel on 20 litres?
    Find the rate per litre: 75 km ÷ 6 = 12.5 km per litre. Then 12.5 × 20 = 250 km. Answer: 250 km.

11. 20% of a number is 30. What is the number, and what is 35% of it?
    If 20% = 30, then 1% = 30 ÷ 20 = 1.5, so 100% = 1.5 × 100 = 150. The number is 150. Then 35% of 150 = 0.35 × 150 = 52.5.

12. Evaluate $(-3)^2 - 3^2 + (-2)^3$, then write the result as a fraction of 20 in simplest form.
    $(-3)^2 = 9$ (negative squared is positive). $3^2 = 9$. $(-2)^3 = -8$. So $9 - 9 + (-8) = -8$. As a fraction of 20: $-8/20$. Divide top and bottom by 4: $-2/5$. Answer: $-2/5$.

Answer key (for parents and tutors)

1. Find 10% of $80.
   10% means 10 out of 100, so divide by 10. $80 ÷ 10 = $8.
2. Find 15% of $200.
   15% = 0.15. 0.15 × $200 = $30. (Or 10% is $20 and 5% is $10, so $20 + $10 = $30.)
3. Find 25% of $60.
   25% is a quarter. $60 ÷ 4 = $15.
4. Increase $50 by 20%.
   20% of $50 = 0.20 × $50 = $10. New amount = $50 + $10 = $60. (Or multiply by 1.20: $50 × 1.20 = $60.)
5. Find the GST (15%) on $432.
   GST = 15% of $432 = 0.15 × $432 = $64.80.
6. A skateboard costs $120 before GST. What is the GST-inclusive price?
   Add 15% GST. GST = 0.15 × $120 = $18. Inclusive price = $120 + $18 = $138. (Or $120 × 1.15 = $138.)
7. A shop in Avondale buys a phone case for $80 and marks it up by 35%. Find the selling price.
   Mark-up = 35% of $80 = 0.35 × $80 = $28. Selling price = $80 + $28 = $108. (Or $80 × 1.35 = $108.)
8. A pair of shoes normally priced at $90 is discounted by 20% in a Newmarket sale. What is the sale price?
   Discount = 20% of $90 = 0.20 × $90 = $18. Sale price = $90 − $18 = $72. (Or $90 × 0.80 = $72.)
9. Aroha deposits $2000 in a savings account earning 4% simple interest per year. How much interest does she earn after 3 years?
   Simple interest = Principal × Rate × Time = $2000 × 0.04 × 3. First $2000 × 0.04 = $80 per year. Over 3 years: $80 × 3 = $240.
10. A mountain bike is priced at $450 including GST. Find the price before GST was added.
    The GST-inclusive price is 115% of the original. So original = $450 ÷ 1.15 = $391.30 (rounded to the nearest cent). Check: $391.30 × 1.15 = $450.00.
11. A store first raises the price of a jacket by 25%, then later offers 25% off the new price. The jacket started at $160. What is the final price, and what is the overall percentage change from the original?
    Step 1 (raise 25%): $160 × 1.25 = $200. Step 2 (25% off): $200 × 0.75 = $150. Final price = $150. Overall change: $150 − $160 = −$10, and −$10 ÷ $160 = −0.0625 = a 6.25% decrease. (The two 25% changes do not cancel out because they apply to different amounts.)
12. Liam wants to earn $600 in simple interest by investing money at 5% per year for 4 years. How much must he invest?
    Simple interest = Principal × Rate × Time, so $600 = P × 0.05 × 4 = P × 0.20. Therefore P = $600 ÷ 0.20 = $3000. Check: $3000 × 0.05 × 4 = $600.

Answer key (for parents and tutors)

1. Simplify: $5a + 3b - 2a + 7b$
   Collect like terms. The a-terms: $5a - 2a = 3a$. The b-terms: $3b + 7b = 10b$. Answer: $3a + 10b$.

2. Expand: $4(x + 3)$
   Multiply each term inside the bracket by 4: $4 \times x = 4x$ and $4 \times 3 = 12$. Answer: $4x + 12$.

3. Find the value of $2x - 5$ when $x = 3$.
   Substitute $x = 3$: $2 \times 3 - 5 = 6 - 5 = 1$. Answer: 1.

4. Solve: $x + 7 = 12$
   Subtract 7 from both sides: $x = 12 - 7 = 5$. Answer: $x = 5$.

5. Expand and simplify: $3(2x + 4) - 5$
   Expand the bracket: $3 \times 2x = 6x$ and $3 \times 4 = 12$, giving $6x + 12 - 5$. Combine the numbers: $12 - 5 = 7$. Answer: $6x + 7$.

6. Factorise fully: $12y + 18$
   Find the highest common factor of 12 and 18, which is 6. Divide each term by 6: $12y \div 6 = 2y$ and $18 \div 6 = 3$. Answer: $6(2y + 3)$.

7. Solve: $\frac{1}{2}x + 3 = 7$
   Subtract 3 from both sides: $\frac{1}{2}x = 4$. Multiply both sides by 2: $x = 8$. Answer: $x = 8$.

8. A taxi from Avondale charges a $4 fixed fee plus $2.50 for each kilometre travelled. Write a rule for the total cost C (in dollars) for k kilometres, then find the cost of a 6 km trip.
   The fixed fee is $4 and each km adds $2.50, so $C = 4 + 2.50k$. For $k = 6$: $C = 4 + 2.50 \times 6 = 4 + 15 = 19$. Answer: $C = 4 + 2.50k$, and a 6 km trip costs $19.

9. Mere builds patterns with matchsticks. Pattern 1 uses 4 matches, Pattern 2 uses 7, and Pattern 3 uses 10. Describe the rule in words, write it using n for the pattern number, and find how many matches Pattern 10 needs.
   Each pattern adds 3 matches (4, 7, 10 …), so the number goes up by a constant 3. Starting value logic: matches = 3 × (pattern number) + 1. In words: multiply the pattern number by 3 and add 1. As a rule: $t = 3n + 1$. Check $n = 2$: $3 \times 2 + 1 = 7$ ✓. For Pattern 10: $t = 3 \times 10 + 1 = 31$. Answer: $t = 3n + 1$, so Pattern 10 needs 31 matches.

10. The perimeter of a rectangle is $P = 2l + 2w$. Rearrange the formula to make w the subject, then find w when $P = 30$ cm and $l = 8$ cm.
    Subtract $2l$ from both sides: $P - 2l = 2w$. Divide both sides by 2: $w = (P - 2l) \div 2$. Substitute $P = 30$ and $l = 8$: $w = (30 - 16) \div 2 = 14 \div 2 = 7$. Answer: $w = (P - 2l) \div 2$, and $w = 7$ cm.

11. Solve the inequality $5 - 2x \leq 11$. Show clearly what happens when you divide by a negative number.
    Subtract 5 from both sides: $-2x \leq 6$. Now divide both sides by -2. Dividing (or multiplying) an inequality by a negative number reverses the inequality sign, so $\leq$ becomes $\geq$: $x \geq -3$. Answer: $x \geq -3$.

12. A straight line gives this table of values, x: −2, −1, 0, 1, 2 and y: 7, 5, 3, 1, −1. Find the gradient m and y-intercept c, write the equation, state whether the line slopes up or down, and predict y when $x = 5$.
    As x increases by 1, y decreases by 2 each time ($7 \to 5 \to 3 \to 1 \to -1$), so the gradient $m = -2$. When $x = 0$, $y = 3$, so the y-intercept $c = 3$, at the point (0, 3). Equation: $y = -2x + 3$. Because m is negative, the line slopes downwards from left to right. For $x = 5$: $y = -2 \times 5 + 3 = -10 + 3 = -7$. Answer: $m = -2$, $c = 3$, $y = -2x + 3$, sloping down, and $y = -7$ when $x = 5$.

Answer key (for parents and tutors)

1. Convert 3.6 km into metres.
   1 km = 1000 m, so 3.6 km = 3.6 × 1000 = 3600 m.

2. Convert 4500 mm into metres.
   1 m = 1000 mm, so 4500 mm = 4500 ÷ 1000 = 4.5 m.

3. Find the area of a parallelogram with base 7 cm and perpendicular height 4 cm.
   Area of a parallelogram = base × height (just like a rectangle). Area = 7 × 4 = 28 cm².

4. Find the circumference of a circle with diameter 10 cm. Use $\pi \approx 3.14$.
   Circumference = π × diameter = 3.14 × 10 = 31.4 cm.

5. Find the area of a trapezium with parallel sides 6 m and 10 m and a perpendicular height of 4 m.
   Area of a trapezium = ½ × (sum of parallel sides) × height. Area = ½ × (6 + 10) × 4 = ½ × 16 × 4 = 32 m².

6. A right-angled triangle has two shorter sides of 6 cm and 8 cm. Find the length of the hypotenuse.
   By Pythagoras: $c^2 = a^2 + b^2 = 6^2 + 8^2 = 36 + 64 = 100$. So $c = \sqrt{100} = 10$ cm.

7. Aroha cycles the 12 km from Avondale to New Lynn and back in 40 minutes. What is her average speed in km/h?
   40 minutes = 40 ÷ 60 = ⅔ hour. Speed = distance ÷ time = 12 ÷ ⅔ = 12 × 3/2 = 18 km/h.

8. A van travels along the motorway at a steady 90 km/h for 2.5 hours. How far does it travel?
   Distance = speed × time = 90 × 2.5 = 225 km.

9. A semicircular (half-circle) garden edge has a diameter of 14 cm on a plan. Find the perimeter of the half circle. Use $\pi \approx 3.14$.
   Radius r = 14 ÷ 2 = 7 cm. Perimeter of a semicircle = half the circumference + the diameter = (2πr ÷ 2) + 2r = πr + 2r. Perimeter = (3.14 × 7) + 14 = 21.98 + 14 = 35.98 ≈ 36.0 cm.

10. A rectangular deck is measured as 3.2 m by 2.5 m. Calculate its area, giving the answer to the correct precision.
    Area = 3.2 × 2.5 = 8.0 m². Each measurement has 2 significant figures, so the answer cannot be more precise than 2 significant figures: 8.0 m².

11. The numbers (5, 12, 13) form a Pythagorean triple. Use them to write down another Pythagorean triple, and verify that your new triple satisfies Pythagoras' theorem.
    Multiply each number by a positive integer k. Taking k = 3 gives (15, 36, 39). Check: $15^2 + 36^2 = 225 + 1296 = 1521$, and $39^2 = 1521$. Since $15^2 + 36^2 = 39^2$, the triple (15, 36, 39) works. (Any k, e.g. k = 2 giving (10, 24, 26), is also correct.)

12. A quarter-circle path curves around the corner of Heron Park with radius 6 m. Starting from the full-circle formula, work out the total perimeter of the quarter-circle region (the curved part plus the two straight radii). Use $\pi \approx 3.14$, and give your answer to 3 significant figures.
    A full circle's circumference is 2πr. A quarter circle uses one quarter of this: (2πr) ÷ 4 = πr ÷ 2. The region is also bounded by two straight radii, so perimeter = (πr ÷ 2) + 2r. Substituting r = 6: perimeter = (3.14 × 6 ÷ 2) + (2 × 6) = 9.42 + 12 = 21.42 ≈ 21.4 m.

Answer key (for parents and tutors)

1. Name the straight line that goes from one side of a circle to the other, passing through the centre.
   The diameter. It is the longest chord in a circle and passes through the centre.

2. A circle has a radius of 6 cm. What is its diameter?
   Diameter = 2 × radius = 2 × 6 = 12 cm.

3. Two parallel lines are cut by a transversal. One corresponding angle is 65°. What is the size of the matching corresponding angle?
   Corresponding angles are equal, so the matching angle is also 65°.

4. Alternate angles between two parallel lines are equal. If one alternate angle is 110°, what is the other?
   The other alternate angle is also 110°, because alternate angles are equal.

5. Match each word to its meaning: (a) chord, (b) radius, (c) circumference.
   (a) A chord is a straight line joining any two points on the circle. (b) The radius is the fixed distance from the centre to any point on the circle. (c) The circumference is the total distance around the outside of the circle (its perimeter).

6. A transversal crosses two parallel lines. At the top intersection an angle of 72° is marked. Find the co-interior angle to it on the same side of the transversal.
   Co-interior (allied) angles add to 180°. So the co-interior angle = 180° − 72° = 108°.

7. Two parallel lines are crossed by a transversal. An angle x is alternate to a 48° angle, and an angle y forms a straight line with x. Find x and y.
   x is alternate to 48°, so x = 48°. y and x are on a straight line, so y = 180° − 48° = 132°.

8. Word problem: At the Avondale skate park, two long parallel handrails are crossed by a diagonal support beam. The beam makes a 63° angle with the top rail. Manaia says the beam makes the same 63° angle with the bottom rail as a corresponding angle. Is Manaia correct? Explain.
   Yes. Because the rails are parallel and the beam is a transversal, the corresponding angles are equal. So the beam meets the bottom rail at 63° as well.

9. Word problem: A round garden bed at a school in Blockhouse Bay has a circumference path around it. A straight edging plank is laid across the bed touching the circle at two points but not passing through the centre. What part of the circle does the plank represent, and how does it compare in length to the diameter?
   The plank represents a chord (it joins two points on the circle without passing through the centre). It is shorter than the diameter, because the diameter is the longest possible chord in any circle.

10. A transversal crosses two lines. At the first line an angle of 85° is measured, and at the second line the corresponding position measures 80°. Are the two lines parallel? Explain.
    No. If the lines were parallel, the corresponding angles would be equal. Here 85° ≠ 80°, so the lines are not parallel.

11. A transversal crosses two lines. On one line the angle above the transversal is $(3a + 10)°$ and on the other line the co-interior angle on the same side is $(2a + 30)°$. Find the value of a that makes the two lines parallel, then state both angles.
    For the lines to be parallel, co-interior angles add to 180°: $(3a + 10) + (2a + 30) = 180$. So $5a + 40 = 180$, giving $5a = 140$, $a = 28$. First angle = $3(28) + 10 = 94°$. Second angle = $2(28) + 30 = 86°$. Check: $94° + 86° = 180°$ ✓, so the lines are parallel.

12. In a circle with centre O, a chord AB has length 16 cm. A line from O meets AB at right angles at point M, the midpoint of AB. If OM = 6 cm, find the radius of the circle.
    Because OM is perpendicular to the chord AB and passes through the centre, it bisects the chord, so AM = 16 ÷ 2 = 8 cm. Triangle OMA has a right angle at M, so use Pythagoras: radius $OA^2 = OM^2 + AM^2 = 6^2 + 8^2 = 36 + 64 = 100$. Radius OA = $\sqrt{100} = 10$ cm.

Answer key (for parents and tutors)

1. Order this data set from smallest to largest, then write down the minimum and maximum: 12, 7, 15, 9, 20, 4.
   Ordered: 4, 7, 9, 12, 15, 20. Minimum = 4, Maximum = 20.

2. Find the median of: 3, 8, 5, 10, 6.
   Order first: 3, 5, 6, 8, 10. There are 5 values, so the median is the middle (3rd) value. Median = 6.

3. A survey records each student's eye colour and their height in centimetres. Which variable is categorical and which is numerical?
   Eye colour is categorical (it sorts people into named groups). Height in centimetres is numerical (it is a measured number).

4. Mia counts the birds in her own backyard in Avondale. Wiremu uses bird numbers published on the StatsNZ website. Who is collecting primary data and who is using secondary data?
   Mia is collecting primary data (she gathers it first-hand). Wiremu is using secondary data (it was collected by someone else).

5. For the data set 4, 6, 7, 9, 11, 12, 15, 18, 20, find the five-point summary and the interquartile range.
   The data is already ordered and has 9 values. Median (Q2) is the middle (5th) value = 11. Lower half (below the median): 4, 6, 7, 9 → Q1 = (6+7)÷2 = 6.5. Upper half (above the median): 12, 15, 18, 20 → Q3 = (15+18)÷2 = 16.5. Min = 4, Max = 20. Five-point summary: 4, 6.5, 11, 16.5, 20. IQR = Q3 − Q1 = 16.5 − 6.5 = 10.

6. These are the heights (cm) of 10 students: 152, 155, 158, 160, 162, 165, 168, 170, 172, 180. Find the five-point summary and the IQR.
   Already ordered, 10 values. Median (Q2) is between the 5th and 6th values = (162+165)÷2 = 163.5. Lower half (first 5): 152, 155, 158, 160, 162 → Q1 = middle value = 158. Upper half (last 5): 165, 168, 170, 172, 180 → Q3 = middle value = 170. Min = 152, Max = 180. Five-point summary: 152, 158, 163.5, 170, 180. IQR = 170 − 158 = 12 cm.

7. Label each question as a summary, comparison, relationship, or time-series investigation. (a) What is the typical number of pets owned by students at Avondale Intermediate? (b) Do Year 9 boys spend more time on screens than Year 9 girls? (c) Is there a connection between hours studied and test score? (d) How has the price of a flat white in Avondale changed each year from 2020 to 2025?
   (a) Summary, it describes one variable for one group. (b) Comparison, it compares one variable across two groups (boys and girls). (c) Relationship, it looks for a connection between two paired numerical variables. (d) Time-series, it looks at one variable (price) over time.

8. Aroha plans an observational study at her school. For each student she records their favourite sport and how many hours per week they exercise. (a) Name one categorical and one numerical variable. (b) Is this primary or secondary data? (c) Write a good summary statistical question she could investigate.
   (a) Categorical variable = favourite sport; numerical variable = hours of exercise per week. (b) Primary data, Aroha collects it herself. (c) A suitable summary question names the variable, the group, and the intent, for example: "What is the typical number of hours per week that students at Aroha's school exercise?"

9. The Avondale netball team scored these goals across 11 games: 18, 22, 15, 30, 25, 20, 28, 19, 24, 21, 26. Find the five-point summary and the IQR of the goals scored.
   Order the data: 15, 18, 19, 20, 21, 22, 24, 25, 26, 28, 30 (11 values). Median (Q2) is the 6th value = 22. Lower half (first 5): 15, 18, 19, 20, 21 → Q1 = middle value = 19. Upper half (last 5): 24, 25, 26, 28, 30 → Q3 = middle value = 26. Min = 15, Max = 30. Five-point summary: 15, 19, 22, 26, 30. IQR = 26 − 19 = 7 goals.

10. Eight students recorded how many minutes it took them to get to school: 5, 12, 8, 20, 15, 10, 25, 18. Find the five-point summary and the IQR, then state what the IQR tells you.
    Order the data: 5, 8, 10, 12, 15, 18, 20, 25 (8 values). Median (Q2) = (12+15)÷2 = 13.5. Lower half (first 4): 5, 8, 10, 12 → Q1 = (8+10)÷2 = 9. Upper half (last 4): 15, 18, 20, 25 → Q3 = (18+20)÷2 = 19. Min = 5, Max = 25. Five-point summary: 5, 9, 13.5, 19, 25. IQR = 19 − 9 = 10 minutes. The IQR tells you the middle half of the travel times spread across a range of 10 minutes.

11. Screen-time (hours per week) was recorded for two groups. Year 9: 2, 3, 3, 4, 5, 6, 7, 8. Year 10: 1, 3, 5, 6, 7, 8, 9, 11. Find the five-point summary and IQR for each group, then compare the two groups.

Year 9 (8 values, ordered): median = (4+5)÷2 = 4.5. Lower half 2,3,3,4 → Q1 = (3+3)÷2 = 3. Upper half 5,6,7,8 → Q3 = (6+7)÷2 = 6.5. Summary: 2, 3, 4.5, 6.5, 8. IQR = 6.5 − 3 = 3.5. Year 10 (8 values, ordered): median = (6+7)÷2 = 6.5. Lower half 1,3,5,6 → Q1 = (3+5)÷2 = 4. Upper half 7,8,9,11 → Q3 = (8+9)÷2 = 8.5. Summary: 1, 4, 6.5, 8.5, 11. IQR = 8.5 − 4 = 4.5. Comparison: Year 10 students have a higher median screen time (6.5 vs 4.5 hours) and a larger IQR (4.5 vs 3.5 hours), so Year 10 students generally spend more time on screens and their middle half is more spread out.

12. Waiting times (minutes) at a medical centre were: 5, 7, 8, 9, 10, 11, 12, 45. Find the five-point summary, the range, and the IQR. Explain which measure of spread better describes most patients' experience, and why.
Order (already ordered, 8 values): 5, 7, 8, 9, 10, 11, 12, 45. Median = (9+10)÷2 = 9.5. Lower half 5,7,8,9 → Q1 = (7+8)÷2 = 7.5. Upper half 10,11,12,45 → Q3 = (11+12)÷2 = 11.5. Min = 5, Max = 45. Five-point summary: 5, 7.5, 9.5, 11.5, 45. Range = 45 − 5 = 40 minutes. IQR = 11.5 − 7.5 = 4 minutes. The IQR (4 minutes) better describes most patients' experience, because it uses only the middle half of the data and is not stretched by the single unusually long wait of 45 minutes (an outlier). The range of 40 minutes is dragged up by that one extreme value and makes the waits look far more variable than they really are for most people.

Answer key (for parents and tutors)

1. Name the best type of graph to show how a class's favourite lunch (pie, sushi, sandwich, wrap) is spread across the group.
   A bar graph. The variable 'favourite lunch' is categorical, so a bar graph shows the frequency of each category with bars of equal width and gaps between them. (A dot plot could also be used for a small group.)

2. A dot plot shows the number of siblings for 10 students: 0, 1, 1, 1, 2, 2, 3, 0, 1, 4. How many students have exactly 1 sibling?
   Count the 1s in the list: positions 2, 3, 4 and 9 → that is four 1s. So 4 students have exactly 1 sibling.

3. For a scatter plot investigating whether hours of study predicts test score, which variable goes on the x-axis?
   Hours of study goes on the x-axis. It is the explanatory (independent, 'predictive') variable. Test score is the response variable and goes on the y-axis.

4. A frequency table records: Walk 8, Bus 6, Car 5, Bike 1. What is the total number of students surveyed?
   Add the frequencies: 8 + 6 + 5 + 1 = 20 students.

5. The heights (cm) of 12 Year 9 students are: 150, 155, 155, 160, 162, 162, 162, 165, 168, 170, 172, 180. What is a sensible scale for the vertical axis of a histogram of these heights, and why?
   The values range from 150 cm to 180 cm, a range of 30 cm. A sensible scale is to start the axis at 150 (or a little below) and use class intervals of 5 cm: 150–154, 155–159, 160–164, 165–169, 170–174, 175–179. Marking the axis every 5 cm keeps the graph readable without too many empty gaps. Frequencies would be 1, 2, 4, 2, 2, 1 (the 180 falls in a 180–184 bin, frequency 1).

6. Complete this frequency table for the number of pets owned by 15 whānau: 0,1,2,1,3,0,2,1,0,4,1,2,0,1,2. Fill in the frequency for each value from 0 to 4.
   Count each value. 0: appears at positions 1,6,9,13 → 4. 1: positions 2,4,8,11,14 → 5. 2: positions 3,7,10,12,15 → 5. 3: position 5 → 1. 4: position 10… check: 4 appears once → 0 pets:4, 1 pet:5, 2 pets:5, 3 pets:1, 4 pets:1. Total = 4+5+5+1+1 = 16? Recount: values are 0,1,2,1,3,0,2,1,0,4,1,2,0,1,2 (15 values). 0s: positions 1,6,9,13 = 4. 1s: positions 2,4,8,11,14 = 5. 2s: positions 3,7,12,15 = 4. 3s: position 5 = 1. 4s: position 10 = 1. Total = 4+5+4+1+1 = 15. So: 0→4, 1→5, 2→4, 3→1, 4→1.

7. Word problem: Aroha records the temperature at Avondale each day at noon over one week: Mon 14°C, Tue 16°C, Wed 15°C, Thu 18°C, Fri 20°C, Sat 19°C, Sun 17°C. Which graph best shows how temperature changed over the week, and what does the graph show?
   A time-series graph is best because the data is ordered over time (days). Plot day on the x-axis and temperature (°C) on the y-axis, then join the points with straight lines. The graph shows temperature generally rising from Monday to Friday (14°C up to 20°C), then dipping slightly over the weekend (19°C, 17°C). The overall trend for the week is an increase in noon temperature to a Friday peak.

8. Word problem: A dairy on Rosebank Road sells hot pies. The owner tracks daily pies sold against the daily high temperature: (12°C, 40 pies), (14°C, 36), (16°C, 30), (18°C, 26), (20°C, 20), (22°C, 15). Describe the relationship you would see on a scatter plot and which variable should be on each axis.
   Temperature is the explanatory variable (x-axis) because it is thought to predict pie sales; pies sold is the response variable (y-axis). On the scatter plot the points fall from upper-left to lower-right, showing a negative relationship: as the temperature rises, the number of pies sold decreases. The points lie close to a straight line, so it is a strong, roughly linear negative relationship.

9. Using the dairy data above, draw an eyeballed line of best fit and use it to predict how many pies would be sold on a 17°C day.
   A straight line drawn through the middle of the points goes from about (12°C, 39) to (22°C, 16). Its slope is about (16 − 39) ÷ (22 − 12) = −23 ÷ 10 ≈ −2.3 pies per °C. At 17°C, moving 5°C up from 12°C: 39 + 5 × (−2.3) = 39 − 11.5 ≈ 27.5. So the line predicts about 27 or 28 pies on a 17°C day. (Any answer between roughly 26 and 29 from a reasonable line is acceptable.)

10. A survey asked 40 students two questions: Do you play a sport? (Yes/No) and Do you play a musical instrument? (Yes/No). Results: sport & instrument 9, sport only 15, instrument only 6, neither 10. Set up a two-way table and find

how many students play a sport in total.
Two-way table (rows = sport, columns = instrument): Instrument Yes | Instrument No | Total Sport Yes 9 | 15 | 24 Sport No 6 | 10 | 16 Total 15 | 25 | 40 Students who play a sport = sport Yes total = 9 + 15 = 24 students. (Check: all cells add to 40 ✓.)

11. Ten Year 9 students recorded their weekly screen time (hours) and their hours of sleep per night: (5,9), (10,8.5), (15,8), (20,7.5), (25,7), (30,6.5), (12,8.2), (22,7.3), (8,8.7), (28,6.8). (a) Which variable is explanatory? (b) Describe the relationship. (c) Draw a line of best fit and predict the sleep for a student with 18 hours of screen time.
(a) Screen time is the explanatory variable (x-axis); sleep is the response variable (y-axis), since more screen time is thought to affect sleep. (b) The points fall steadily from upper-left to lower-right: as screen time increases, sleep decreases, a strong negative, roughly linear relationship. (c) A line of best fit runs from about (5, 9) to (30, 6.5). Slope = (6.5 − 9) ÷ (30 − 5) = −2.5 ÷ 25 = −0.1 hours of sleep per hour of screen time. At 18 hours: starting from (5,9), go 13 hours right: 9 + 13 × (−0.1) = 9 − 1.3 = 7.7 hours of sleep. So about 7.6–7.8 hours is a reasonable prediction.

12. A journalist shows a bar graph where the vertical axis starts at 40 (not 0) to compare test averages of two classes: Class A = 62, Class B = 68. Explain why this scale can mislead readers, and describe a better visualisation choice for comparing the full spread of each class's scores.
Because the axis starts at 40 instead of 0, the bar for Class B (68) looks more than twice as tall as Class A (62), even though the real difference is only 6 marks out of 62 (about 10%). Cutting the axis exaggerates small differences and can mislead viewers into thinking one class did far better. A fairer choice is to start the frequency/score axis at 0 so bar heights are in true proportion. Better still, to compare the full spread of every student's score, use box plots (or dot plots) for each class side by side. Box plots show the median, range, and quartiles, so readers can compare both the middle and the variation of the two classes, not just a single average.

Answer key (for parents and tutors)

1. A survey asked 20 students at Avondale College how many hours they slept last night. The results (in hours) were: 6, 7, 8, 5, 9, 7, 6, 8, 7, 10, 6, 7, 8, 5, 7, 9, 6, 8, 7, 6. What is the most common (mode) number of hours slept?
   Count how often each value appears: 5 appears 2 times, 6 appears 5 times, 7 appears 6 times, 8 appears 4 times, 9 appears 2 times, 10 appears 1 time. The value 7 appears most often (6 times), so the mode is 7 hours.

2. A bar graph starts its vertical axis at 40 instead of 0. What effect can this have on how the bars look?
   Starting the axis above 0 exaggerates the differences between bars. Small differences in the actual values look much larger because the bottom part of each bar is cut off. This can mislead a reader into thinking a gap is bigger than it really is.

3. True or false: If a coin lands on heads 6 times out of 10 flips, the coin must be unfair.
   False. With only 10 flips, chance (natural variation) can easily cause 6 heads even with a fair coin. A small number of trials means results can vary a lot, so we cannot conclude the coin is unfair from this alone.

4. A pie chart shows 'Favourite takeaway in Avondale' with slices for Fish & Chips 45%, Pizza 30%, Burgers 20%, and Sushi 5%. Do these add up correctly?
   Add the percentages: 45 + 30 + 20 + 5 = 100%. Yes, they add to 100%, which is correct for a pie chart because the whole circle represents all the responses (100%).

5. A local newspaper headline reads: 'Ice cream sales rise as drownings increase, is ice cream dangerous?' Explain why this claim is misleading.
   The claim confuses correlation with causation. Both ice cream sales and drownings rise in summer because of a third factor: hot weather. More people swim and buy ice cream when it is hot. Ice cream does not cause drownings, the two things happen at the same time but one does not cause the other.

6. A pictograph about pets uses a picture of a dog to represent 10 pets. To show 30 cats, the designer draws one cat picture that is three times as tall AND three times as wide as a single symbol. Why does this misrepresent the data?
   When both height and width are tripled, the area of the picture becomes 3 × 3 = 9 times larger, not 3 times larger. The reader's eye judges the size by area, so 30 cats looks like it is 9 times more than 10, badly exaggerating the difference. A correct pictograph would use three separate symbols of the same size.

7. Aroha conjectures that 'most Year 9 students at her school walk to school'. She surveys the 25 students in her own maths class and finds 14 walk. Is her sample good enough to support a claim about the whole Year 9? Explain.
   No. Her sample of one class (25 students) may not represent all of Year 9. Students in one class might live nearby, or the class may not be typical of the whole year level. In her sample 14 out of 25 (56%) walk, which is 'more than half', but to make a claim about all of Year 9 she should survey a larger, more random sample from across the whole year level.

8. A company claims '9 out of 10 dentists recommend BrightSmile toothpaste'. What questions should you ask before believing this claim?
   You should ask: How many dentists were actually surveyed (10, or thousands)? Who paid for the study, was it the company itself? Were the dentists given a choice of several brands, or just asked yes/no about one? Were they a fair, random sample? Was 'recommend' clearly defined? Without answers, the claim cannot be trusted, because a biased or tiny sample could produce this result.

9. Two classes sat the same test. Class A had a median score of 72 and Class B had a median of 68, but Class A's scores ranged from 40 to 95, while Class B's ranged from 62 to 74. Which class performed more consistently, and how do you know?
   Class B performed more consistently. Its range is 74 – 62 = 12, which is much smaller than Class A's range of 95 – 40 = 55. A smaller range (spread) means the scores were closer together, so Class B's results were more consistent even though Class A had a slightly higher median.

10. A survey of 200 Auckland residents found 130 support a new cycleway. A report states 'The people of Auckland strongly support the cycleway.' Evaluate whether the data supports this statement.
    130 out of 200 is 65%, which is a majority but not overwhelming, 35% do not support it. Also, 200 people is a small sample compared to Auckland's population of over 1.5 million, and we do not know if they were chosen randomly

or from a cycling group. The word 'strongly' overstates the finding. A fairer statement would be 'Around two-thirds of those surveyed support the cycleway,' while noting the uncertainty from the sample size and method.

11. A shop advertises 'Prices slashed by up to 70%!' After visiting, you find only 2 items out of 500 have a 70% discount; most items are discounted 5–10%. Explain how the advertisement uses true data in a misleading way, and suggest a more honest statement.
The phrase 'up to 70%' is technically true because two items really are 70% off, but it is misleading because it makes shoppers expect large discounts across the store when nearly all items are only 5–10% off. The advertisement uses an extreme, rare value to represent the whole store. A more honest statement would be: 'Most items 5–10% off, with a few selected items up to 70% off.' This gives a truer picture of the typical discount, which matters because shoppers make decisions based on the impression the ad creates.

12. A researcher runs an experiment giving 8 plants a new fertiliser and 8 plants water only. The fertilised plants grew an average of 12 cm; the water-only plants grew 11 cm. She claims 'the fertiliser clearly works.' Discuss two reasons to be cautious about this claim, and describe one way to improve the experiment.
Reason 1: The difference (12 cm vs 11 cm) is very small, only 1 cm, and could easily be due to chance variation between plants rather than the fertiliser. Reason 2: The sample is tiny (only 8 plants per group), so a couple of unusually large or small plants could shift the average; there could also be other differences such as sunlight or soil. To improve the experiment she should use many more plants (e.g. 100 per group), keep all other conditions (light, water amount, soil, plant type) the same, assign plants to groups randomly, and repeat the trial. This reduces the effect of chance and allows a fairer comparison before claiming the fertiliser works.

Answer key (for parents and tutors)

1. A fair six-sided dice is rolled once. What is the theoretical probability of rolling a 4? Give your answer as a fraction and a percentage (to the nearest whole percent).
   There is 1 favourable outcome (a 4) out of 6 equally likely outcomes. Probability = 1/6. As a percentage: 1 ÷ 6 = 0.1666… ≈ 17%.

2. Aria tossed a coin 30 times and got 18 heads. What is the experimental probability of getting a head? Give your answer as a fraction in simplest form.
   Experimental probability = number of heads ÷ total trials = 18/30. Simplify by dividing both by 6: 18 ÷ 6 = 3, 30 ÷ 6 = 5. So the answer is 3/5.

3. A bag holds 5 red, 3 blue and 2 green marbles. One marble is drawn at random. What is the theoretical probability it is blue?
   Total marbles = 5 + 3 + 2 = 10. Blue marbles = 3. Probability = 3/10 (or 0.3, or 30%).

4. Are the events 'rolling an even number' and 'rolling a 3' on a single dice roll mutually exclusive? Explain in one sentence.
   Yes, they are mutually exclusive because a single roll cannot be both even and equal to 3 at the same time, 3 is an odd number, so the two events share no common outcome.

5. A spinner is divided into 4 equal sections coloured red, yellow, blue and white. List the full sample space for one spin, then state the theoretical probability of landing on yellow.
   Sample space (all possible outcomes) = {red, yellow, blue, white}. There are 4 equally likely outcomes. Yellow is 1 of them, so P(yellow) = 1/4 = 0.25 = 25%.

6. Two fair coins are tossed together. Use a systematic list or table to write every possible outcome, then find the probability of getting exactly one head.
   Using H for heads and T for tails, the sample space is: HH, HT, TH, TT, that is 4 equally likely outcomes. 'Exactly one head' happens for HT and TH, which is 2 outcomes. P(exactly one head) = 2/4 = 1/2 = 50%.

7. Tane rolled a fair dice 60 times. He recorded: 1 appeared 8 times, 2 appeared 11 times, 3 appeared 9 times, 4 appeared 12 times, 5 appeared 10 times, 6 appeared 10 times. Find the experimental probability of rolling a 4, and compare it with the theoretical probability.
   Experimental probability of a 4 = 12/60 = 1/5 = 0.2 = 20%. Theoretical probability = 1/6 ≈ 0.167 ≈ 17%. The experimental value (20%) is a little higher than the theoretical value (17%). This is normal variation from a limited number of trials; with many more rolls we would expect the experimental value to move closer to 1/6.

8. At the Avondale Sunday Market, a lucky-dip drum contains 40 tickets: 4 are winners and 36 are blanks. Mere pays $2 for one ticket. What is the theoretical probability she draws a winning ticket? Give your answer as a fraction in simplest form and as a percentage.
   Winners = 4, total tickets = 40. Probability = 4/40. Simplify by dividing both by 4: 4 ÷ 4 = 1, 40 ÷ 4 = 10, giving 1/10. As a percentage: 1 ÷ 10 = 0.1 = 10%.

9. A class ran a simulation of tossing a drawing pin 100 times to see how often it lands 'point up'. It landed point up 62 times. (a) Why can this probability only be found by experiment, not by theory? (b) Estimate the probability the pin lands 'point down'.
   (a) A drawing pin is not a regular symmetrical shape, so its two outcomes are not equally likely. There is no way to calculate the probability by reasoning about equal outcomes, so we must run an experiment and use relative frequency. (b) Point up happened 62 times, so point down happened 100 − 62 = 38 times. Estimated P(point down) = 38/100 = 0.38 = 38%.

10. Ben used a computer to simulate rolling a fair dice. After 30 rolls the experimental probability of a 6 was 0.10. After 1000 rolls it was 0.165. Explain, using the Law of Large Numbers, why the second result is closer to the theoretical probability.
    The theoretical probability of a 6 is 1/6 ≈ 0.167. With only 30 rolls, a few unlucky or lucky results have a big effect, so 0.10 is quite far from 0.167. With 1000 rolls, individual variations average out, so the experimental probability (0.165) sits much closer to 0.167. This is the Law of Large Numbers: as the number of trials increases, the experimental probability approaches the theoretical probability.

11. A fair coin is tossed and a fair dice is rolled. (a) Draw or list all outcomes using a systematic method. (b) Find the probability of getting a head AND a number greater than 4. (c) Explain why you cannot simply add P(head) and P(number greater than 4) to get this answer.
(a) The sample space pairs each coin result with each dice result. Listing them: H1, H2, H3, H4, H5, H6, T1, T2, T3, T4, T5, T6, that is 12 equally likely outcomes (2 × 6 = 12). (b) 'Head AND greater than 4' means a head with a 5 or 6: that is H5 and H6, so 2 outcomes. P = 2/12 = 1/6 ≈ 0.167. (c) The coin and dice are independent events happening together (a joint event). Adding P(head) = 1/2 and P(>4) = 2/6 = 1/3 would give 5/6, which counts full separate events rather than the single combined outcome. For independent joint events we multiply: 1/2 × 1/3 = 1/6, which matches the count.

12. A bag has 3 kiwifruit stickers and 2 feijoa stickers. Two stickers are drawn one after the other WITHOUT replacing the first. (a) Are the two draws independent or dependent? (b) Use a tree diagram (describe the branches) to find the probability that both stickers are kiwifruit.
(a) They are dependent, because removing the first sticker changes what is left in the bag, so the second draw's probabilities depend on the first outcome. (b) First draw: P(kiwifruit) = 3/5. If a kiwifruit was taken, 2 kiwifruit remain out of 4 stickers, so the second draw P(kiwifruit) = 2/4 = 1/2. Multiplying along the branches: P(both kiwifruit) = 3/5 × 1/2 = 3/10 = 0.3 = 30%.