

Stretch and challenge · teacher answers

GCSE Mathematics 1MA1 · L001–L108 · Review draft

Keep this copy private. Accept equivalent correct methods and require an independent explanation before treating a response as secure. These optional activities can replace further scaffolded practice within a 60-minute lesson.

L001 Signed numbers

Stretch

Calculate $-18+27-35$ and check by grouping in a second way.

Answer: -26 ; for example $(-18+27)-35=9-35=-26$.

Deep challenge

A learner claims subtracting a negative always gives a positive answer. Test the claim with a counterexample.

Answer: False: $-8-(-3)=-5$, still negative.

L002 Multiplication, division and order

Stretch

Calculate $48 \div (-6) \times (-2) + 5$, showing equal-priority operations left to right.

Answer: $-8 \times -2 + 5 = 21$.

Deep challenge

Insert brackets in $6 + 2 \times 5 - 4$ to make 36 and explain your choice.

Answer: $(6 + 2) \times 5 - 4 = 36$.

L003 Place value, decimals and estimation

Stretch

Round 0.004976 to two significant figures and estimate 397×0.049 .

Answer: 0.0050; estimate $400 \times 0.05 = 20$.

Deep challenge

A number rounds to 3.50 to two decimal places. Give its interval and explain the excluded endpoint.

Answer: $3.495 \leq x < 3.505$; 3.505 rounds to 3.51.

L004 Number diagnostic and repair

Stretch

A learner calculates $-7 - (-12) = -19$. Locate the first error and repair it.

Answer: Subtracting -12 means add 12, so $-7 + 12 = 5$.

Deep challenge

Create an independent check for $35 \times 0.8 = 28$ that does not simply repeat the multiplication.

Answer: $0.8 = 4/5$, and $35 \div 5 \times 4 = 28$; or 80% of $35 = 28$.

L005 Factors multiples and primes

Stretch

Find the HCF and LCM of 84 and 126 using prime factors.

Answer: $84=2^2 \times 3 \times 7$; $126=2 \times 3^2 \times 7$; HCF=42, LCM=252.

Deep challenge

Two numbers have HCF 6, LCM 180 and one number 30. Find the other.

Answer: Product of numbers=HCF $\times$ LCM=1080; other=1080/30=36.

L006 Fractions and equivalent forms

Stretch

Simplify $42/70$ and give two different fractions equivalent to it.

Answer: $3/5$; examples $6/10$ and $9/15$.

Deep challenge

A fraction is equivalent to $5/8$ and its numerator is 35. Find its denominator and justify.

Answer: Multiplier 7, so denominator 56.

L007 Fraction operations

Stretch

Calculate $\frac{5}{6} - \frac{3}{8}$ and $\frac{2}{3} \times \frac{9}{10}$, simplifying each.

Answer: $\frac{11}{24}$ and $\frac{3}{5}$.

Deep challenge

A learner says $\frac{3}{4} \div \frac{2}{5} = \frac{6}{20}$. Explain and correct.

Answer: Division by $\frac{2}{5}$ multiplies by $\frac{5}{2}$: $\frac{3}{4} \times \frac{5}{2} = \frac{15}{8}$.

L008 Fraction reasoning and retrieval

Stretch

Without notes, calculate $7/12 + 5/18$ and explain the common denominator.

Answer: $21/36 + 10/36 = 31/36$.

Deep challenge

Is $2/3 + 3/4$ greater than 1? Show a method without decimals.

Answer: $8/12 + 9/12 = 17/12 > 1$.

L009 Fractions decimals and percentages

Stretch

Convert $\frac{7}{20}$ into a decimal and percentage, then order it with 0.3 and 32%.

Answer: $\frac{7}{20}=0.35=35\%$; order 0.3, 32%, $\frac{7}{20}$.

Deep challenge

A learner claims $0.125=12.5/10$ percent. Correct the conversion.

Answer: $0.125 \times 100 = 12.5\%$, not 1.25%.

L010 Fractions and percentages of amounts

Stretch

Find 35% of £240 using 10%, 5% and a combination.

Answer: 10%=£24, 5%=£12, so 35%=£84.

Deep challenge

A class has 18 of 24 learners present. Express attendance as a simplified fraction and percentage.

Answer: $18/24=3/4=75\%$.

L011 Percentage change and reverse percentages

Stretch

A coat costs £68 after a 15% reduction. Find its original price.

Answer: $0.85 \times \text{original} = 68$, so $\text{original} = £80$.

Deep challenge

A price rises 20% and then falls 20%. Explain the net change using multipliers.

Answer: $1.2 \times 0.8 = 0.96$, so the final price is 4% lower.

L012 Number checkpoint and feedback

Stretch

Solve $\frac{3}{5}$ of $x=42$ and $0.2x=18$.

Answer: $x=70$ and $x=90$.

Deep challenge

Diagnose why 50% increase followed by 50% decrease does not restore the start.

Answer: Multipliers $1.5 \times 0.5 = 0.75$, a 25% net decrease.

L013 Ratio and sharing

Stretch

Split £126 in ratio 2:3:4 and check the parts total.

Answer: Nine parts at £14: £28, £42, £56; total £126.

Deep challenge

A sum is split $A:B=3:5$ and $B:C=2:3$. Find $A:B:C$ in whole numbers.

Answer: Equalise B at 10: $A:B=6:10$ and $B:C=10:15$, so 6:10:15.

L014 Scale and proportion

Stretch

A scale drawing is 1:25,000. What actual distance does 8 cm represent?

Answer: 200,000 cm=2 km.

Deep challenge

Similar shapes have length factor 1.5. Compare their area factor and explain.

Answer: Area factor $1.5^2=2.25$, since both dimensions scale.

L015 Unit rates and best buys

Stretch

A 750 g pack costs £2.40 and a 1.2 kg pack costs £3.60. Which is better value per kg?

Answer: £3.20/kg versus £3.00/kg, so 1.2 kg pack.

Deep challenge

A 20% discount applies to the 750 g pack. Does the best buy change?

Answer: 750 g pack becomes £1.92, or £2.56/kg; it is now cheaper per kg.

L016 Proportion problems and repair

Stretch

Four workers complete a job in 15 hours at constant rate. How long would six workers take?

Answer: $4 \times 15 / 6 = 10$ hours.

Deep challenge

Explain why doubling workers may fail to halve time in a real job.

Answer: The inverse model assumes equal productivity and no coordination limits; those assumptions may fail.

L017 Algebraic language and substitution

Stretch

If $a=-2$ and $b=5$, evaluate $3a^2-2b$ and $2(a+b)$.

Answer: $12-10=2$; $2\times 3=6$.

Deep challenge

A learner interprets $3x^2$ as $(3x)^2$. Use $x=2$ to expose the error.

Answer: $3x^2=12$ while $(3x)^2=36$.

L018 Collect expand and factorise

Stretch

Expand and simplify $3(2x-5)-2(x+4)$.

Answer: $6x-15-2x-8=4x-23$.

Deep challenge

Factorise $6x^2+9x$ fully and check by expansion.

Answer: $3x(2x+3)$.

L019 Linear equations

Stretch

Solve $5(2x-1)=3x+16$ and check.

Answer: $10x-5=3x+16$, so $7x=21$, $x=3$; both sides 25.

Deep challenge

Explain why dividing $3x+6=12$ by 3 gives $x+6=4$ incorrectly.

Answer: Divide every term: $x+2=4$, so $x=2$.

L020 Equations in contexts

Stretch

A taxi charges £3.50 plus £1.80 per mile. Find miles travelled for a £21.50 fare.

Answer: $3.50 + 1.80m = 21.50$, so $m = 10$.

Deep challenge

A rectangle's perimeter is 38 cm and its length is 3 cm more than width. Find dimensions.

Answer: $2w + 2(w + 3) = 38$, $w = 8$; length = 11 cm.

L021 Formulae and rearranging

Stretch

Rearrange $A = \pi r^2$ for positive r , then find r when $A = 49\pi \text{ cm}^2$.

Answer: $r = \sqrt{A/\pi}$, so $r = 7 \text{ cm}$.

Deep challenge

Rearrange $v = u + at$ for t and identify when the rearrangement is invalid.

Answer: $t = (v - u)/a$, provided $a \neq 0$.

L022 Inequalities and number lines

Stretch

Solve $3-2x < 11$ and show the solution in words.

Answer: $-2x < 8$, so $x > -4$; all numbers greater than -4 .

Deep challenge

Why does dividing $-3x \geq 12$ by -3 reverse the sign? Give a numerical check.

Answer: $x \leq -4$; multiplying an inequality by a negative reverses order, e.g. $-3 \times -4 = 12$ and $x = -5$ gives $15 \geq 12$.

L023 Sequences and nth terms

Stretch

Find nth term of 4,9,14,19,... and its 25th term.

Answer: $5n-1$; 124.

Deep challenge

Can 7,11,15,19,... contain 100? Justify algebraically.

Answer: nth term $4n+3$; $4n+3=100$ gives $n=24.25$, not a whole-number position.

L024 Cumulative checkpoint and feedback

Stretch

Solve $2x+5=17$, then give the third term of $3n+2$.

Answer: $x=6$; third term $=11$.

Deep challenge

A learner extends 2,5,8,11 with 15. Diagnose and find the 20th term.

Answer: Common difference is 3, next 14; nth term $3n-1$ gives term 20 $=59$.

L025 Angle facts and parallel lines

Stretch

Two parallel lines have co-interior angles $3x+10$ and $2x+20$. Find x .

Answer: $5x+30=180$, so $x=30^\circ$.

Deep challenge

A student says alternate angles always add to 180° . Correct the claim.

Answer: Alternate angles on parallel lines are equal; co-interior angles add to 180° .

L026 Triangles and polygons

Stretch

Find each interior angle of a regular 15-sided polygon.

Answer: Exterior angle= $360/15=24^\circ$, interior= 156° .

Deep challenge

A regular polygon has interior angle 165° . Find its number of sides.

Answer: Exterior= 15° , sides= $360/15=24$.

L027 Congruence and geometric reasoning

Stretch

State a valid congruence test for sides 5,7,8 cm in two triangles and explain.

Answer: SSS: all three corresponding sides equal.

Deep challenge

Two triangles have equal side lengths 5 and 7 cm and a non-included equal angle. Must they be congruent?

Answer: No. SSA is generally insufficient; more than one triangle may fit.

L028 Constructions and loci

Stretch

Construct the perpendicular bisector of an 8 cm segment. How far is its midpoint from either endpoint?

Answer: 4 cm; every point on the bisector is equidistant from endpoints.

Deep challenge

A point is 3 cm from A and 4 cm from B. Describe the intersection of its loci.

Answer: Intersections of circles centred A radius 3 cm and B radius 4 cm, if the circles meet; up to two points.

L029 Coordinates and transformations

Stretch

Translate $(-3,4)$ by $(5,-7)$ and reflect the result in the x-axis.

Answer: Translation gives $(2,-3)$; reflection gives $(2,3)$.

Deep challenge

Do reflection and translation always commute? Use a point and transformations as a counterexample.

Answer: No. Reflect $(1,1)$ in y-axis then translate $(2,0)$ gives $(1,1)$; reverse order gives $(-3,1)$.

L030 Enlargement and scale factors

Stretch

Enlarge a rectangle 3 cm by 5 cm by factor 2.5. Find new area.

Answer: New sides 7.5 and 12.5 cm; area=93.75 cm².

Deep challenge

An enlargement factor is -2 about the origin. Where does (3,-4) map, and what happens to orientation?

Answer: (-6,8); it lies opposite the centre and lengths double.

L031 Bearings and scale drawings

Stretch

A map scale is 1 cm:4 km. Two points are 7.5 cm apart. Find actual distance.

Answer: 30 km.

Deep challenge

The bearing of B from A is 065° . Find the bearing of A from B.

Answer: 245° .

L032 Geometry checkpoint and feedback

Stretch

A regular hexagon has side 6 cm. Find perimeter and each exterior angle.

Answer: Perimeter=36 cm; exterior angle=60°.

Deep challenge

A shape is enlarged by factor 3 and its original perimeter is 18 cm. A learner says new area is three times. Correct the reasoning.

Answer: Perimeter becomes 54 cm; area factor is $3^2=9$, not 3.

L033 Perimeter and compound area

Stretch

A rectangle 12 cm by 8 cm has a 3 cm by 2 cm corner cut out. Find area and perimeter.

Answer: Area = $96 - 6 = 90 \text{ cm}^2$; perimeter remains 40 cm for a corner notch.

Deep challenge

Two shapes each have area 36 cm^2 . Must their perimeters be equal? Give a counterexample.

Answer: No. A 6×6 square has perimeter 24 cm; a 4×9 rectangle has perimeter 26 cm.

L034 Circles arcs and sectors

Stretch

A sector has radius 9 cm and angle 80° . Find arc length and area exactly.

Answer: Arc= $\frac{80}{360} \times 18\pi = 4\pi$ cm; area= $\frac{80}{360} \times 81\pi = 18\pi$ cm².

Deep challenge

A learner finds the perimeter of a semicircle of radius 5 cm as 5π cm. Explain the missing part.

Answer: 5π is curved arc only; full perimeter includes diameter 10, so $5\pi + 10$ cm.

L035 Prisms and cylinders

Stretch

A prism has a trapezium cross-section with parallel sides 4 cm and 8 cm and height 3 cm. Its length is 11 cm. Find the volume.

Answer: Cross-section = $(4+8) \times 3 / 2 = 18 \text{ cm}^2$; volume = 198 cm^3 .

Deep challenge

A cylinder and a triangular prism both have cross-sectional area 24 cm^2 and length 7 cm. Compare their volumes and explain.

Answer: Both volumes are $24 \times 7 = 168 \text{ cm}^3$; the cross-section shape does not change the prism rule.

L036 Surface area and volume

Stretch

A closed cuboid has volume 120 cm^3 and dimensions 4 cm by 5 cm by h. Find h and surface area.

Answer: $h=6 \text{ cm}$; $SA=2(20+24+30)=148 \text{ cm}^2$.

Deep challenge

A cylinder has radius r and height 2r. Express its total surface area and volume in terms of r.

Answer: $SA=2\pi r^2+4\pi r^2=6\pi r^2$; $V=2\pi r^3$.

L037 Plans elevations and measures

Stretch

A scale plan measures 6 cm by 4 cm at 1:100. Find the real floor area in m^2 .

Answer: 6 m by 4 m, so 24 m^2 .

Deep challenge

Two solids have identical front and side elevations. Must their plans be identical? Explain with an example.

Answer: No. Different depth arrangements can produce the same elevations; a plan reveals the arrangement from above.

L038 Pythagoras in two dimensions

Stretch

A rectangle is 9 cm by 12 cm. Find its diagonal and the perimeter of one of the right triangles formed by that diagonal.

Answer: Diagonal=15 cm; triangle perimeter=9+12+15=36 cm.

Deep challenge

A triangle has sides 8, 15 and 17 cm. Prove it is right-angled and find its area.

Answer: $8^2+15^2=17^2$; area= $8 \times 15 / 2 = 60 \text{ cm}^2$.

L039 Trigonometry in right triangles

Stretch

A right triangle has adjacent side 8 cm and an angle of 35° . Find the opposite side to 2 d.p.

Answer: $8 \tan 35^\circ \approx 5.60$ cm.

Deep challenge

Two right triangles share angle 30° but have hypotenuses 10 cm and 25 cm. Compare their opposite sides.

Answer: Opposites are 5 cm and 12.5 cm, ratio 2:5, matching the hypotenuse ratio.

L040 Cumulative checkpoint 2 and feedback

Stretch

A cylinder has radius 4 cm and height 5 cm. Find its volume exactly, then state the units of surface area.

Answer: $80\pi \text{ cm}^3$; surface area uses cm^2 .

Deep challenge

A learner uses $8^2+15^2=17$ in a Pythagoras check. Identify and repair the error.

Answer: $8^2+15^2=289=17^2$, not 17; the hypotenuse is $\sqrt{289}=17$.

L041 Coordinates gradient and intercept

Stretch

A line passes through $(-3, 4)$ and $(3, -2)$. Find gradient and y-intercept.

Answer: Gradient= $(-2-4)/6=-1$; y-intercept=1.

Deep challenge

Can two distinct parallel lines have different gradients? Explain using $y=mx+c$.

Answer: No. Parallel non-vertical lines share m and have different c values.

L042 Straight line equations

Stretch

Find the equation of the line through (2,-1) and (6,7).

Answer: $m=2$; $-1=2(2)+c$ gives $c=-5$, so $y=2x-5$.

Deep challenge

The lines $y=3x-4$ and $6x-2y=8$ are claimed to intersect. Test the claim.

Answer: Rearranging the second gives $y=3x-4$; they are the same line, so there is no single intersection.

L043 Distance time and speed graphs

Stretch

A runner covers 400 m in 80 s, rests for 20 s, then covers 200 m in 40 s. Find average speed for the whole journey.

Answer: $600 \text{ m} / 140 \text{ s} = 30/7 \approx 4.29 \text{ m/s}$.

Deep challenge

A distance-time graph has a downward segment. Explain what the vertical axis must represent if the graph is valid.

Answer: It can represent distance from a fixed starting point, which decreases on the return; cumulative distance travelled cannot decrease.

L044 Graph problems and repair

Stretch

A journey has two equal 30 km legs at 30 km/h and 60 km/h. Find overall average speed.

Answer: Times 1 h and 0.5 h; $60/1.5=40$ km/h.

Deep challenge

Explain why the mean of 30 and 60 is not the overall speed for equal distances.

Answer: The slower leg takes longer; total distance divided by total time gives 40 km/h.

L045 Sampling and data quality

Stretch

A school has 800 learners, 200 in Year 11. How many Year 11 learners belong in a proportional sample of 64?

Answer: $64 \times 200 / 800 = 16$.

Deep challenge

A survey about canteen food is sent only to the school's sports team. Give two distinct sources of bias and improve selection.

Answer: The team may differ in diet and schedules, and excludes other learners; sample randomly across year groups or strata.

L046 Tables charts and time series

Stretch

A pie chart represents 72 people. A sector angle is 135° . Find its frequency.

Answer: $135/360 \times 72 = 27$.

Deep challenge

A time-series graph starts its vertical axis at 90 instead of 0. Does this make the data wrong?

Explain the risk.

Answer: Values can be correct, but the truncated scale may exaggerate apparent variation; read labelled values.

L047 Averages and spread

Stretch

Five numbers have mean 12. Four are 8, 11, 13 and 15. Find the fifth and the range.

Answer: Total=60; fifth=13; range=15-8=7.

Deep challenge

A data set has mean 10. One new value of 100 is added. Must the median increase?

Answer: No. A high outlier increases the mean, but the middle ordered value may stay the same.

L048 Statistical comparisons

Stretch

Class A has median 14 and IQR 3; class B median 16 and IQR 9. Compare typical score and consistency.

Answer: B has higher median; A has smaller middle-half spread and is more consistent by IQR.

Deep challenge

Two groups share mean 20. One has range 2 and the other 30. What can and cannot be concluded?

Answer: The mean is the same and total spread differs; neither group is necessarily better in every observation.

L049 Probability and expected frequency

Stretch

A biased coin shows heads 78 times in 120 tosses. Estimate heads in the next 400 tosses.

Answer: Estimated $P(H)=78/120=0.65$; expected count=260.

Deep challenge

Why is an expected frequency of 26 not a guarantee of exactly 26 successes?

Answer: It is a long-run prediction; random variation means the observed count may differ.

L050 Sample spaces and systematic lists

Stretch

Two fair dice are rolled. Count the outcomes with a sum of 9 and find the probability.

Answer: (3,6),(4,5),(5,4),(6,3): $4/36=1/9$.

Deep challenge

A learner lists (1,3) and (3,1) as one outcome when two distinct dice are rolled. Explain the effect.

Answer: The outcomes are distinct ordered pairs; merging them undercounts the total and can distort probability.

L051 Venn diagrams and set notation

Stretch

Of 50 learners, 24 study art, 22 music and 8 both. Find how many study exactly one.

Answer: Art only 16; music only 14; exactly one=30.

Deep challenge

If $P(A)=0.6$, $P(B)=0.5$ and $P(A \cap B)=0.2$, find $P(\text{neither})$.

Answer: $P(A \cup B)=0.6+0.5-0.2=0.9$; neither=0.1.

L052 Cumulative checkpoint 3 and feedback

Stretch

A line has equation $y = -3x + 4$. Find its gradient and y when $x = -2$.

Answer: Gradient -3 ; $y = 10$.

Deep challenge

A student says a probability of 1.2 is possible because it came from a frequency table. Diagnose the error.

Answer: Probabilities lie from 0 to 1 ; the favourable frequency or total, or arithmetic, is wrong.

L053 Powers roots and index laws

Stretch

Simplify $(3x^2y^3)(2x^4y)$ and state any assumptions.

Answer: $6x^6y^4$; multiplication needs no non-zero assumption.

Deep challenge

Is $x^5 + x^3 = x^8$? Show why or give a counterexample.

Answer: No; index laws apply to products, not sums. At $x=2$, $32+8=40$, not 256.

L054 Standard form

Stretch

Write 0.00000056 in standard form, then multiply it by 3×10^5 .

Answer: 5.6×10^{-7} ; product = 1.68×10^{-1} .

Deep challenge

Explain why 12×10^4 is not in standard form and rewrite it.

Answer: Coefficient must be at least 1 and less than 10; $12 \times 10^4 = 1.2 \times 10^5$.

L055 Rounding error intervals and bounds

Stretch

A rectangle is 8.2 cm by 5.6 cm to the nearest 0.1 cm. Find its lower area bound.

Answer: $8.15 \times 5.55 = 45.2325 \text{ cm}^2$.

Deep challenge

A rounded length is 10 cm to nearest cm. Is 10.5 cm included? Explain.

Answer: No; interval is $9.5 \leq L < 10.5$. 10.5 rounds to 11 under the standard convention.

L056 Number accuracy pathway

Stretch

Estimate 398×0.051 to one significant figure, then calculate exactly.

Answer: Estimate $400 \times 0.05 = 20$; exact 20.298.

Deep challenge

A measurement rounds to 1.20 to two decimal places. State the interval and explain why 1.205 is excluded.

Answer: $1.195 \leq x < 1.205$; the upper endpoint rounds to 1.21.

L057 Quadratic expressions

Stretch

Factorise $2x^2+7x+3$ and check by expansion.

Answer: $(2x+1)(x+3)$.

Deep challenge

A learner writes $(x-4)(x+2)=x^2-8$. Find the missing terms.

Answer: x^2-2x-8 ; cross terms are $2x-4x=-2x$.

L058 Quadratic graphs and roots

Stretch

For $y=x^2-4x+3$, find both roots and the turning point.

Answer: Roots 1 and 3; $y=(x-2)^2-1$, turning point (2,-1).

Deep challenge

A quadratic has roots -1 and 5. Write a monic equation and state its axis of symmetry.

Answer: $y=(x+1)(x-5)=x^2-4x-5$; axis $x=2$.

L059 Solving quadratics

Stretch

Solve $3x^2 - 12x = 0$ and check both roots.

Answer: $3x(x-4)=0$, so $x=0$ or 4 .

Deep challenge

Explain why dividing $x^2=9$ by x can lose a solution.

Answer: Dividing by x is unsafe if $x=0$ in general; here taking only $x=3$ loses $x=-3$. Factor x^2-9 or use $\pm\sqrt{9}$.

L060 Algebra pathway and repair

Stretch

Solve $2(x+4)=3x-5$ and check by substitution.

Answer: $2x+8=3x-5$, $x=13$; both sides 34.

Deep challenge

A learner cancels x from $x^2+x=0$ and gets $x=-1$ only. Find every solution.

Answer: $x(x+1)=0$ gives $x=0$ or -1 ; division by x lost $x=0$.

L061 Simultaneous equations

Stretch

Solve $3x+2y=16$ and $x-2y=0$.

Answer: Add to get $4x=16$, $x=4$; $y=2$.

Deep challenge

Can $x+y=5$ and $2x+2y=12$ have a solution? Justify.

Answer: No. Doubling the first gives $2x+2y=10$, contradicting 12.

L062 Equations from situations

Stretch

Three adult tickets and two child tickets cost £37. Adults cost £9 each. Find child price.

Answer: $27+2c=37$, $c=£5$.

Deep challenge

A rectangle's length is twice its width and its area is 50 cm^2 . Find positive dimensions.

Answer: $2w^2=50$, $w=5 \text{ cm}$ and length= 10 cm .

L063 Cubic reciprocal and other graphs

Stretch

For $y=12/x$, find points when $x=-3$ and $x=4$, and identify the missing x -value.

Answer: $(-3,-4)$ and $(4,3)$; $x=0$ excluded.

Deep challenge

Compare $y=x^3$ and $y=-x^3$ at $x=-2$ and $x=2$. What symmetry relates them?

Answer: Values are $(-8,8)$ and $(8,-8)$; reflection in the x -axis maps one graph to the other.

L064 Cumulative checkpoint 4 and feedback

Stretch

Solve $x^2+2x-15=0$ and $2a^3 \times 3a^2$.

Answer: $x=3$ or -5 ; product $6a^5$.

Deep challenge

A student obtains $x=2, y=3$ from $x+y=5$ and $x-y=1$. Test and repair.

Answer: Sum fits but difference is -1 ; correct $x=3, y=2$.

L065 Direct and inverse proportion

Stretch

y is inversely proportional to x^2 . If $y=12$ at $x=2$, find y at $x=4$.

Answer: $y=k/x^2$, $k=48$; $y=3$.

Deep challenge

A graph through the origin appears curved upward. Can y be directly proportional to x ? Explain.

Answer: Direct proportion $y=kx$ is a straight line through the origin; a curved graph does not fit.

L066 Speed density and pressure

Stretch

A solid has density 7.8 g/cm^3 and volume 25 cm^3 . Find mass.

Answer: $m = \rho V = 195 \text{ g}$.

Deep challenge

Pressure doubles while force is constant. What happened to contact area? Explain algebraically.

Answer: $P = F/A$; to double P at fixed F , halve A .

L067 Growth decay and compound interest

Stretch

£1,000 grows 4% annually for three years. Find final value to the nearest penny.

Answer: $1000 \times 1.04^3 = £1,124.86$.

Deep challenge

A price rises 20% then falls 20%. Prove it does not return to the starting price.

Answer: Multipliers $1.2 \times 0.8 = 0.96$; final price is 96% of original, 4% lower.

L068 Rates pathway and repair

Stretch

A car uses 18 litres over 240 km. Express fuel use in litres per 100 km.

Answer: $18/240 \times 100 = 7.5$ L per 100 km.

Deep challenge

A distance is fixed. If speed increases by 25%, what happens to journey time?

Answer: Time factor = $1/1.25 = 0.8$, so time falls by 20%.

L069 Similarity and lengths

Stretch

Similar triangles have corresponding sides 6 cm and 15 cm. A 9 cm side corresponds to what length?

Answer: Scale factor $15/6=2.5$, so 22.5 cm.

Deep challenge

Are triangles with side sets 3,4,5 and 6,8,11 similar? Explain.

Answer: No. Ratios 2,2,2.2 are not constant.

L070 Area and volume scale factors

Stretch

Two similar solids have lengths ratio 3:4 and smaller surface area 54 cm^2 . Find larger area.

Answer: Area ratio 9:16; $54 \times 16/9 = 96 \text{ cm}^2$.

Deep challenge

Volume ratio of similar solids is 27:64. Find length and area ratios.

Answer: Length ratio 3:4; area ratio 9:16.

L071 Triangle problems and bearings

Stretch

A traveller goes north 12 km and east 5 km. Find distance and bearing from start to nearest degree.

Answer: Distance 13 km; bearing $\arctan(5/12) \approx 23^\circ$.

Deep challenge

A bearing from A to B is 315° . State reverse bearing and explain the 180° change.

Answer: 135° from B to A; reverse direction differs by 180° modulo 360° .

L072 Cumulative checkpoint 5 and feedback

Stretch

A similar shape has length factor 1.5. Its original area is 80 cm^2 . Find new area.

Answer: $80 \times 1.5^2 = 180 \text{ cm}^2$.

Deep challenge

A learner uses a length factor of 3 to triple volume. Correct the claim.

Answer: Volume factor is $3^3 = 27$, so volume is 27 times as large.

L073 Probability trees and combined events

Stretch

Two independent events have probabilities 0.4 and 0.7. Find $P(\text{both})$ and $P(\text{neither})$.

Answer: Both=0.28; neither= $0.6 \times 0.3 = 0.18$.

Deep challenge

Toss a biased coin with $P(H)=0.7$ three times. Find $P(\text{exactly two heads})$.

Answer: $3 \times 0.7^2 \times 0.3 = 0.441$.

L074 Dependent events and assumptions

Stretch

A bag holds 5 red and 4 blue. Find $P(\text{two blue without replacement})$.

Answer: $4/9 \times 3/8 = 1/6$.

Deep challenge

A bag has 4 red and 1 blue. Given the first draw was red, find $P(\text{second red without replacement})$.

Answer: After a red, 3 red remain of 4 counters, so $3/4$.

L075 Frequency trees and probability models

Stretch

Of 80 people, 45 cycle. Of those who cycle, 27 are adults. Find the conditional proportion of adults among cyclists.

Answer: $27/45=3/5$.

Deep challenge

A frequency tree has root 60 and first branches 28 and 31. Diagnose the issue and state a possible repair.

Answer: Branches total 59, so one person is unaccounted for; verify data and correct one count or add an unknown branch of 1.

L076 Probability pathway and repair

Stretch

Two fair dice are rolled. Find $P(\text{at least one six})$.

Answer: $1 - P(\text{no six}) = 1 - (5/6)^2 = 11/36$.

Deep challenge

A bag with 3 red and 2 blue is drawn twice without replacement. Are the events independent? Show with probabilities.

Answer: No. $P(\text{red first}) = 3/5$, while $P(\text{red second given red first}) = 2/4 = 1/2$.

L077 Scatter graphs and correlation

Stretch

A trend line predicts 45 at $x=8$ from data spanning $x=2$ to 10. Is this interpolation or extrapolation?

Answer: Interpolation, because 8 lies within the observed x -range.

Deep challenge

A scatter graph shows strong negative correlation between screen time and sleep. Can it prove screen time causes less sleep?

Answer: No. Correlation alone cannot establish causation; confounding factors or reverse direction may exist.

L078 Statistical graphs pathway

Stretch

A histogram class 10–14 has frequency 20 and width 4; class 14–24 has frequency 30 and width 10. Compare densities.

Answer: Densities 5 and 3, so the narrower class has taller bar despite lower frequency.

Deep challenge

Why must a histogram use area rather than bar height for frequency when widths differ?

Answer: Frequency density=frequency/width, so area=width×density=frequency.

L079 Comparing distributions pathway

Stretch

Group A has $Q1=7, Q3=19$; group B has $Q1=10, Q3=17$. Compare IQRs.

Answer: A IQR=12, B IQR=7; B has less middle-half spread.

Deep challenge

Can one distribution have both a higher median and a larger IQR than another? Explain the practical interpretation.

Answer: Yes. Its typical value is higher but its middle half is more variable.

L080 Cumulative checkpoint 6 and feedback

Stretch

A class interval width 6 has frequency 27. Find density, then expected frequency for width 10 at the same density.

Answer: Density=4.5; frequency=45.

Deep challenge

Explain why a single experimental probability estimate may change when more trials are added.

Answer: Relative frequency varies with outcomes; more trials can refine but do not guarantee the same estimate.

L081 Circle geometry pathway

Stretch

A central angle is 146° . Find the circumference angle subtending the same arc.

Answer: 73° .

Deep challenge

In a cyclic quadrilateral, opposite angles are $2x+10$ and $3x-5$. Find x and both angles.

Answer: $5x+5=180$, $x=35$; angles 80° and 100° .

L082 Vectors and translations

Stretch

A triangle has vertices $(0,0)$, $(2,1)$, $(1,4)$. Translate by $(-3,2)$. State all new vertices.

Answer: $(-3,2)$, $(-1,3)$, $(-2,6)$.

Deep challenge

A translation maps $A=(-2,5)$ to $A'=(4,-1)$. Show where $B=(3,3)$ maps.

Answer: Vector $= (6, -6)$; $B' = (9, -3)$.

L083 Vector reasoning pathway

Stretch

If $a=(4,-1)$ and $b=(-2,5)$, find $3a+2b$.

Answer: $(12,-3)+(-4,10)=(8,7)$.

Deep challenge

Prove vector $AB+BC=AC$ for $A=(1,1), B=(4,3), C=(7,-2)$.

Answer: $AB=(3,2), BC=(3,-5)$; $\text{sum}=(6,-3)=AC$.

L084 Geometry connections and repair

Stretch

A circle has centre O, tangent at T and chord through T. Explain the right angle between OT and tangent.

Answer: Radius to point of tangency is perpendicular to tangent, so 90° .

Deep challenge

A translated quadrilateral keeps all side lengths. Explain why translation also preserves parallel sides.

Answer: Every vertex moves by the same vector, so displacement between corresponding vertices remains unchanged; side vectors stay equal.

L085 Functions pathway

Stretch

If $f(x)=x^2+2x$, find $f(-3)$ and solve $f(x)=0$.

Answer: $f(-3)=9-6=3$; $x(x+2)=0$ gives $x=0$ or -2 .

Deep challenge

Let $f(x)=2x+1$ and $g(x)=x^2$. Compare $f(g(3))$ and $g(f(3))$.

Answer: $f(9)=19$; $g(7)=49$; composition order matters.

L086 Graph transformations pathway

Stretch

Describe transformations from $y=x^2$ to $y=(x+3)^2+2$ and state turning point.

Answer: Left 3 and up 2; turning point $(-3,2)$.

Deep challenge

A learner says $y=(x-4)^2$ moves left 4. Correct using a point on the original graph.

Answer: It moves right 4; original vertex $(0,0)$ becomes $(4,0)$.

L087 Equation-solving pathway

Stretch

Solve $3x^2-15x=0$ and check both solutions.

Answer: $3x(x-5)=0$; $x=0$ or 5 .

Deep challenge

Solve $x+y=11$ and $2x-y=4$, then show both checks.

Answer: Add $3x=15$, $x=5$, $y=6$; sums 11 and $10-6=4$.

L088 Cumulative checkpoint 7 and feedback

Stretch

A line $y=2x-3$ and a quadratic $y=x^2-4x+1$ intersect. Form the equation for their x-coordinates.

Answer: $2x-3=x^2-4x+1$, so $x^2-6x+4=0$.

Deep challenge

Why is substituting a found root back into the original equations stronger than repeating the same algebra?

Answer: It checks the solution against both original relationships and can reveal a transformation error.

L089 Rates from graphs pathway

Stretch

A velocity increases uniformly from 4 to 16 m/s in 6 s. Find acceleration and distance.

Answer: $a = (16 - 4) / 6 = 2 \text{ m/s}^2$; trapezium area $= (4 + 16) / 2 \times 6 = 60 \text{ m}$.

Deep challenge

A velocity-time graph dips below the time axis. What does negative area mean?

Answer: Displacement in the opposite chosen direction, not negative distance travelled.

L090 Circle equations pathway

Stretch

A circle has equation $x^2+y^2=49$. Find y-values when $x=0$ and when $x=5$.

Answer: $x=0$ gives $y=\pm 7$; $x=5$ gives $y=\pm\sqrt{24}=\pm 2\sqrt{6}$.

Deep challenge

Can $(7,7)$ lie on the circle $x^2+y^2=49$? Justify by substitution.

Answer: No, $7^2+7^2=98$, not 49.

L091 Proof and algebraic structure

Stretch

Prove the product of two consecutive integers is even.

Answer: $n(n+1)$; one of the consecutive factors is even, so the product is even.

Deep challenge

Prove the sum of three consecutive integers is divisible by 3.

Answer: $(n-1)+n+(n+1)=3n$.

L092 Mixed modelling and checking

Stretch

A phone plan costs £12 plus 8p per text. Write a formula and find the cost for 125 texts.

Answer: $C=12+0.08t$; $C(125)=£22$.

Deep challenge

A rectangle has perimeter 40 cm. Express area in terms of width x and find width for length 12 cm.

Answer: Length= $20-x$, area= $x(20-x)$; if length 12, width=8 cm.

L093 Number and ratio consolidation

Stretch

Split £96 in ratio 1:3:4 and check the total.

Answer: Eight parts at £12: £12, £36, £48; total £96.

Deep challenge

A price increases 10% then 10%. Explain why total increase is 21%, not 20%.

Answer: $1.1^2=1.21$; second 10% acts on the larger amount.

L094 Algebra consolidation

Stretch

Solve $x^2 - x - 20 = 0$ and verify by expansion.

Answer: $(x-5)(x+4)=0$; $x=5$ or -4 .

Deep challenge

Find k so that $x^2 + kx + 12 = (x+3)(x+4)$.

Answer: Expand $\text{RHS} = x^2 + 7x + 12$, so $k=7$.

L095 Geometry probability and statistics consolidation

Stretch

A fair spinner has sectors 1,2,3,4. Find mean score over one spin and $P(\text{score} \geq 3)$.

Answer: Mean = $(1+2+3+4)/4 = 2.5$; probability = $2/4 = 1/2$.

Deep challenge

A radius doubles. Compare the circle's area and circumference multipliers.

Answer: Area $\times 4$; circumference $\times 2$, because πr^2 and $2\pi r$ scale differently.

L096 Coverage diagnostic and repair

Stretch

Find area of a triangle with base 14 cm and height 9 cm, and P(red) from 7 red and 5 blue.

Answer: Area=63 cm²; P(red)=7/12.

Deep challenge

An error log shows repeated percentage and equation mistakes. Propose two different fresh checks and what they test.

Answer: A new multiplier problem tests percentage method; a new equation verified by substitution tests algebra and checking.

L097 Mock paper 1 non-calculator

Stretch

Without a calculator, find $\frac{7}{12}$ of 84 and show a division-first method.

Answer: $84 \div 12 \times 7 = 49$.

Deep challenge

A learner gets 49 but writes only the answer on a two-mark question. Explain what evidence of method to add.

Answer: Show $84 \div 12 = 7$ and $7 \times 7 = 49$ or an equivalent clear fraction calculation.

L098 Mock paper 2 calculator

Stretch

Using a calculator, find 13.5% of £780 and round currency correctly.

Answer: $0.135 \times 780 = \text{£}105.30$.

Deep challenge

A display shows 6.999999 after a calculation expected to be whole. What should the learner check before rounding?

Answer: Check the entered expression, units and expected exact value; display approximation alone is not proof.

L099 Mock paper 3 calculator

Stretch

A cylinder of radius 2.5 cm and height 12 cm has what volume to 1 d.p.?

Answer: $75\pi \approx 235.6 \text{ cm}^3$.

Deep challenge

A learner rounds π to 3 before multiplying in a multistep question. Explain the risk and repair.

Answer: Early rounding loses precision; retain π or full display until the final rounding instruction.

L100 Paper 1 feedback and repair

Stretch

Rework $5/6 - 1/4$ without a calculator and simplify.

Answer: $10/12 - 3/12 = 7/12$.

Deep challenge

A learner adds denominators in $2/3 + 1/4$ to get $3/7$. Explain and correct.

Answer: Use common denominator 12: $8/12 + 3/12 = 11/12$.

L101 Paper 2 feedback and repair

Stretch

£420 grows 7% for two years. Find value to nearest penny.

Answer: $420 \times 1.07^2 = £480.86$.

Deep challenge

A calculator input $420 \times 1 + 0.07^2$ is used for growth. Identify the bracket error.

Answer: Correct input is $420 \times (1.07)^2$; the wrong expression does not apply the multiplier twice.

L102 Paper 3 feedback and repair

Stretch

A solid enlarges by length factor 2.5. Find surface area and volume factors.

Answer: $2.5^2=6.25$; $2.5^3=15.625$.

Deep challenge

A learner uses the area factor for volume. Explain why this fails with dimensions.

Answer: Area has two length dimensions (k^2); volume has three (k^3).

L103 Delayed reassessment

Stretch

Solve $x^2 - 8x + 15 = 0$ after a one-week delay and check roots.

Answer: $(x-3)(x-5)=0$; $x=3$ or 5 .

Deep challenge

Why does copying a corrected example immediately after feedback give weaker retention evidence than a delayed fresh problem?

Answer: It may reflect short-term recall of the example; a new delayed item tests independent retrieval and transfer.

L104 Non-calculator number and algebra

Stretch

Calculate $\frac{5}{8} - \frac{1}{6}$ exactly and simplify.

Answer: $\frac{15}{24} - \frac{4}{24} = \frac{11}{24}$.

Deep challenge

Solve $2(3x-1)=4x+10$ without a calculator and check.

Answer: $6x-2=4x+10$, $x=6$; both sides 34.

L105 Calculator fluency and accuracy

Stretch

Find the value of 250×1.035^4 to the nearest penny.

Answer: Approximately £286.88.

Deep challenge

A result is 0.00048372. Round to three significant figures and explain the first significant digit.

Answer: 0.000484; the first non-zero digit 4 begins the significant figures.

L106 Reasoning and multi-step problems

Stretch

A £120 item is discounted 15% then its new price increases 10%. Find final price.

Answer: $120 \times 0.85 \times 1.10 = \text{£}112.20$.

Deep challenge

Explain why the order of two percentage multipliers does not affect the final number, but the story still matters.

Answer: Multiplication commutes, so factors give the same product; the context determines what each change means and whether it applies.

L107 Paper readiness

Stretch

A learner spends 18 minutes on a 6-mark question. At 90 minutes for 80 marks, how many minutes above proportional allocation is that?

Answer: Proportional allocation = $6 \times 90 / 80 = 6.75$ min; excess = 11.25 min.

Deep challenge

Give a practical paper strategy after finding an unfamiliar question.

Answer: Record known facts and an attempt, leave space, move on and return after securing accessible marks; check timing.

L108 Personal revision plan and flexible repair

Stretch

Plan three short spaced checks for fractions over two weeks, with one fresh question in each.

Answer: For example day 0, day 4 and day 14 with different fraction items; correct and record errors each time.

Deep challenge

A learner can answer only when following a model. What evidence would justify removing the scaffold?

Answer: Success on fresh independent questions, including a delayed one, with a valid method and a check.