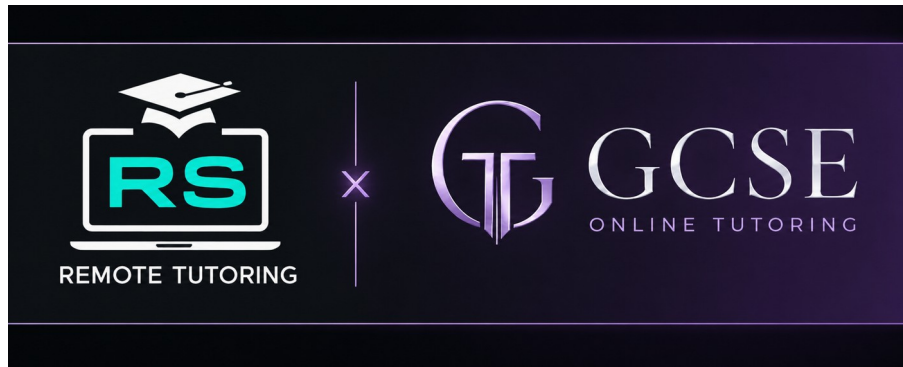




GCSE MATHEMATICS

HIGHER TIER

UNIT 2: RATIO, PROPORTION AND RATES OF CHANGE

Modules 1-7 | 315 original questions | Formula guides, full methods and marking guidance

FREE WEBSITE EDITION

Student name: _____

Target grade: _____ Start date: _____ Completion date: _____

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Unit 2 Contents and Study Plan

MODULES 1-7 • FREE WEBSITE EDITION

HIGHER TIER • SHOW CLEAR WORKING • KEEP EXACT VALUES WHERE REQUIRED

Name: _____ Date: _____ Score: ____ / ____

Begin with the short fluency check, then move through Standard Higher, Multi-step Higher and Grade 7-9 Challenge. Formula guides and all worked answers are collected at the end.

Module	Topic	Specification	Score
1	Ratio, Sharing and Fractions	R3-R8	___ / ___
2	Scale Factors, Similarity and Proportional Relationships	R2, R6, R8, R12	___ / ___
3	Direct and Inverse Proportion	R7, R10, R13, R14	___ / ___
4	Percentages, Growth and Decay	R9, R16	___ / ___
5	Compound Measures and Unit Conversions	R1, R11	___ / ___
6	Rates of Change and Gradients	R14, R15	___ / ___
7	Mixed Higher Ratio and Proportion Problems	R1-R16 review	___ / ___

Book structure

- 8 purposeful fluency questions per module
- 12 Standard Higher questions per module
- 15 multi-step Higher exam questions per module
- 10 Grade 7-9 challenge questions per module
- Formula and method bank for every module
- All answers, formulas and worked methods at the end



Unit 2 Specification Coverage Map

INDEPENDENTLY AUTHORED PRACTICE MAP

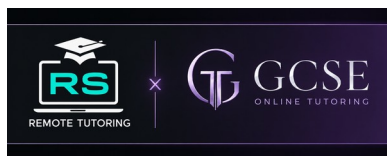
HIGHER TIER • SHOW CLEAR WORKING • KEEP EXACT VALUES WHERE REQUIRED

Name: _____ Date: _____ Score: _____ / _____

Every question is independently authored. This map identifies the GCSE Mathematics skills covered by each module. It is not a reproduction or adaptation of an AQA question paper, mark scheme, examiner report or other assessment material.

Module	Specification alignment	Design guidance
M1	R3-R8	ratio, sharing, linked/changing ratios, fractions and mixtures
M2	R2, R6, R8, R12	scale drawings, similarity, area/volume scaling and proportional relationships
M3	R7, R10, R13-R14	construct direct/inverse equations, powered and combined proportion, graphs
M4	R9, R16	reverse percentages, compound growth/decay and iteration
M5	R1, R11	units, speed, density, pressure, average rates and comparisons
M6	R14-R15	average rate, tangent gradient and instantaneous change
M7	R1-R16	multi-strand AO2/AO3 modelling and proof

Specification references above identify curriculum coverage only. All questions, diagrams, solutions and marking guidance in this resource are independently authored.



How to Use and Check Your Work

STUDENT ROUTINE AND QUALITY STANDARD

HIGHER TIER • SHOW CLEAR WORKING • KEEP EXACT VALUES WHERE REQUIRED

Name: _____ Date: _____ Score: _____ / _____

1 Attempt Work without notes first. Translate the context into a ratio, multiplier, formula or graph before calculating.

2 Mark Use the worked answer. Credit a method only when its mathematical setup is visible.

3 Repair Identify whether the error was modelling, units, algebra, arithmetic or interpretation; then redo from blank.

4 Retest Repeat a similar question after 2-7 days without support.

5 Present Give exact values where appropriate, sensible accuracy, units and a concluding statement.

Higher answer standard

- Define the variables and governing relationship
- Show constants of proportionality and multipliers
- Convert all units before using compound-measure formulas
- Distinguish average rates (chords) from instantaneous rates (tangents)
- Check whether a result is physically and mathematically reasonable



Ratio, Sharing and Fractions

FLUENCY CHECK

HIGHER TIER • SHOW CLEAR WORKING • KEEP EXACT VALUES WHERE REQUIRED

Name: _____ Date: _____ Score: ____ / ____

A short prerequisite check. Work accurately, then move promptly to Higher demand.

1. Write the ratio 12 red counters to 18 blue counters in its simplest form. [1 mark]

2. Simplify the ratio 35:49. [1 mark]

3. Simplify 1.2:0.8. [2 marks]

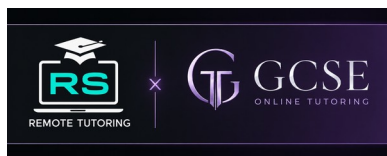
4. Simplify 250 g : 1 kg. [2 marks]

5. A bag contains 8 green and 20 yellow beads. Write green:yellow in simplest form. [1 mark]

6. The ratio of adults to children is 3:7. There are 21 adults. Find the number of children. [2 marks]

7. The ratio of boys to girls is 5:4. There are 36 pupils altogether. Find the number of girls. [2 marks]

8. Share £45 in the ratio 2:3. [2 marks]



Ratio, Sharing and Fractions

STANDARD HIGHER • PART A

HIGHER TIER • SHOW CLEAR WORKING • KEEP EXACT VALUES WHERE REQUIRED

Name: _____ Date: _____ Score: ____ / ____

Higher-tier application. Show the governing relationship and exact working.

1. Share 84 sweets in the ratio 3:4. [2 marks]

2. A length is divided in the ratio 5:2. The shorter part is 14 cm. Find the longer part. [2 marks]

3. Orange and apple juice are mixed in the ratio 2:5. Find the amount of apple juice needed for 300 ml of orange juice. [2 marks]

4. Write the ratio 3:5 as the fraction of the total that is the first part. [1 mark]

5. In a class, the ratio of left-handed to right-handed pupils is 1:9. What fraction are left-handed? [1 mark]

6. Write the ratio $\frac{2}{5} : \frac{3}{10}$ as a ratio of whole numbers in simplest form. [2 marks]



Ratio, Sharing and Fractions

STANDARD HIGHER • PART B

HIGHER TIER • SHOW CLEAR WORKING • KEEP EXACT VALUES WHERE REQUIRED

Name: _____ Date: _____ Score: ____ / ____

Continue the Higher set. Interpret each result in context.

7. Red, blue and white paint are mixed in the ratio 2:3:5. There are 40 litres altogether. Find each amount. [3 marks]

8. $A:B=3:5$ and $B:C=4:7$. After £46 is transferred from C to A, A and C are equal. Find the original total. [5 marks]

9. Red:blue=5:8. After 20% of the red counters are removed, the ratio is 1:2. Find the original total if 16 red counters were removed. [4 marks]

10. Two alloys have copper:zinc ratios 7:3 and 4:1. Equal masses are mixed. Find the copper:zinc ratio of the mixture. [5 marks]

11. A, B and C share money. $A:B=2:5$ and $B:C=3:4$. C receives £196 more than A. Find each share. [5 marks]

12. The ratio of adults to children is 4:9. After 12 adults leave and 18 children arrive, the ratio is 2:5. Find the original numbers. [5 marks]



Ratio, Sharing and Fractions

MULTI-STEP HIGHER • PART A

HIGHER TIER • SHOW CLEAR WORKING • KEEP EXACT VALUES WHERE REQUIRED

Name: _____ Date: _____ Score: ____ / ____

Original multi-step exam-style questions. Show every connected stage.

1. The ratio of cats to dogs at a rescue centre is 7:5. There are 60 animals. How many are cats? [3 marks]

2. A recipe uses flour, sugar and butter in the ratio 5:2:3. Mia uses 450 g of flour. Find the mass of butter. [3 marks]

3. A prize of £960 is shared between Ali and Beth in the ratio 5:3. Find the difference between their shares. [4 marks]

4. A drink is made with squash and water in the ratio 1:6. Sam makes 2.1 litres. Find the volume of squash. [3 marks]

5. The angles in a triangle are in the ratio 2:3:4. Find all three angles. [4 marks]



Ratio, Sharing and Fractions

MULTI-STEP HIGHER • PART B

HIGHER TIER • SHOW CLEAR WORKING • KEEP EXACT VALUES WHERE REQUIRED

Name: _____ Date: _____ Score: ____ / ____

Continue the multi-step set. Explain decisions where requested.

6. Two numbers are in the ratio 4:7. Their sum is 99. Find the two numbers. [3 marks]

7. Two numbers are in the ratio 3:8. Their difference is 35. Find the two numbers. [4 marks]

8. A school has boys:girls = 6:7. There are 84 girls. After 12 boys leave, show that the new ratio is 5:7. [3 marks]

9. A bag contains red:blue:green counters in the ratio 4:5:3. There are 24 green counters. Find the total number of counters. [3 marks]

10. Paint A mixes red:white = 3:2. Paint B mixes red:white = 7:5. Which mixture has the greater fraction of red? [3 marks]



Ratio, Sharing and Fractions

MULTI-STEP HIGHER • PART C

HIGHER TIER • SHOW CLEAR WORKING • KEEP EXACT VALUES WHERE REQUIRED

Name: _____ Date: _____ Score: ____ / ____

Complete the multi-step set. Check units, accuracy and reasonableness.

11. Shop A sells 6 notebooks for £8.10. Shop B sells 10 for £13.20. Which is better value? [4 marks]

12. A 750 g cereal box costs £3.15. A 1.2 kg box costs £4.80. Compare the cost per 100 g. [4 marks]

13. The ratio $x:y$ is $2:5$ and $y:z$ is $3:4$. Find $x:y:z$ in whole numbers. [4 marks]

14. The ratio $a:b$ is $4:9$. The ratio $b:c$ is $6:5$. Find $a:b:c$. [4 marks]

15. A jar contains £1 and 50p coins in the ratio $3:5$. There are 64 coins. Find their total value. [4 marks]



Ratio, Sharing and Fractions

GRADE 7-9 CHALLENGE • PART A

HIGHER TIER • SHOW CLEAR WORKING • KEEP EXACT VALUES WHERE REQUIRED

Name: _____ Date: _____ Score: ____ / ____

Extended reasoning. Plan the model before calculating.

1. A sum is shared between A, B and C in the ratio 2:3:7. C receives £210 more than A. Find the total sum. [4 marks]

2. The ratio of red to blue counters is 3:5. After 6 red counters are added, the ratio becomes 3:4. There were initially 40 blue counters. Find the initial number of red counters and check the new ratio. [4 marks]

3. A rectangle has length:width = 7:4 and perimeter 88 cm. Find its area. [5 marks]

4. A class has boys:girls = 5:7. Four boys join and two girls leave. The numbers then become equal. Find the original class size. [5 marks]

5. A drink contains juice and water in the ratio 2:7. After 300 ml of water is added, the ratio becomes 1:4. Find the original volume of the drink. [5 marks]



Ratio, Sharing and Fractions

GRADE 7-9 CHALLENGE • PART B

HIGHER TIER • SHOW CLEAR WORKING • KEEP EXACT VALUES WHERE REQUIRED

Name: _____ Date: _____ Score: ____ / ____

Complete the challenge set. Present a clear mathematical argument.

6. A and B share money in the ratio 4:7. B gives £45 to A and they then have equal amounts. Find the original total. [5 marks]

7. The ratio of adults to children at an event is 3:8. After 18 adults arrive, the ratio is 3:5. There are 80 children. Find the original number of adults. [4 marks]

8. A bag contains red, blue and green beads. Red:blue=2:3 and blue:green=4:5. There are 75 green beads. Find the total number. [4 marks]

9. Two alloys contain copper:zinc in ratios 3:2 and 5:3. Which has the larger copper percentage, and by how many percentage points? [4 marks]

10. Red and blue counters are in the ratio 4:7. After 18 blue counters are removed, the ratio is 2:3. Find the original number of each colour. [5 marks]



Scale Factors, Similarity and Proportional Relationships

FLUENCY CHECK

HIGHER TIER • SHOW CLEAR WORKING • KEEP EXACT VALUES WHERE REQUIRED

Name: _____ Date: _____ Score: ____ / ____

A short prerequisite check. Work accurately, then move promptly to Higher demand.

1. y is directly proportional to x . When $x=2$, $y=8$. Find y when $x=5$. [2 marks]

2. y is directly proportional to x . When $x=3$, $y=18$. Find y when $x=7$. [2 marks]

3. y is directly proportional to x . When $x=4$, $y=20$. Find y when $x=9$. [2 marks]

4. y is directly proportional to x . When $x=5$, $y=15$. Find y when $x=8$. [2 marks]

5. y is directly proportional to x . When $x=7$, $y=14$. Find y when $x=11$. [2 marks]

6. A recipe for 4 people uses 240 g of flour. Find the flour needed for 10 people. [2 marks]

7. A recipe for 6 people uses 330 g of flour. Find the flour needed for 15 people. [2 marks]

8. A recipe for 5 people uses 275 g of flour. Find the flour needed for 12 people. [2 marks]



MODULE 02 / R2, R6, R8, R12

Scale Factors, Similarity and Proportional Relationships

STANDARD HIGHER • PART A

HIGHER TIER • SHOW CLEAR WORKING • KEEP EXACT VALUES WHERE REQUIRED

Name: _____ Date: _____ Score: ____ / ____

Higher-tier application. Show the governing relationship and exact working.

- 1. On a map, 2 cm represents 5 km. Find the real distance represented by 7 cm. [2 marks]**

- 2. On a map, 3 cm represents 12 km. Find the real distance represented by 8 cm. [2 marks]**

- 3. On a map, 4 cm represents 18 km. Find the real distance represented by 11 cm. [2 marks]**

- 4. A map scale is 1:50,000. A route measures 3.6 cm. Find the real distance in metres. [3 marks]**

- 5. A map scale is 1:25,000. A route measures 8.4 cm. Find the real distance in metres. [3 marks]**

- 6. Complete the proportion $6:15 = x:35$. [2 marks]**



Scale Factors, Similarity and Proportional Relationships

STANDARD HIGHER • PART B

HIGHER TIER • SHOW CLEAR WORKING • KEEP EXACT VALUES WHERE REQUIRED

Name: _____ Date: _____ Score: _____ / _____

Continue the Higher set. Interpret each result in context.

7. Eight identical machines make a batch in 6 hours. Assuming inverse proportion, find the time for 12 machines. [3 marks]

8. A map has scale 1:25 000. A triangular field has map base 8.4 cm and perpendicular height 5.6 cm. Find its actual area in hectares. [5 marks]

9. Two similar solids have surface-area ratio 25:49. The smaller volume is 375 cm³. Find the larger volume. [5 marks]

10. A model is built to scale 1:n. Its volume is 216 cm³ and the actual volume is 27 m³. Find n. [5 marks]

11. Twelve machines make 5400 items in 7.5 hours. Eight machines work for 6 hours at 15% greater individual rate. Find the number made. [5 marks]

12. A recipe is scaled from 18 to 30 portions. The original uses flour:sugar=7:3 and 420 g flour. During scaling, 10% extra sugar is added. Find the new sugar mass. [5 marks]



MODULE 02 / R2, R6, R8, R12

Scale Factors, Similarity and Proportional Relationships

MULTI-STEP HIGHER • PART A

HIGHER TIER • SHOW CLEAR WORKING • KEEP EXACT VALUES WHERE REQUIRED

Name: _____ Date: _____ Score: _____ / _____

Original multi-step exam-style questions. Show every connected stage.

1. A recipe for 6 uses 420 g of rice. Work out the amount for 14 people. [3 marks]

2. A recipe for 8 uses 600 g of pasta. Work out the amount for 20 people. [3 marks]

3. A recipe for 5 uses 350 g of fruit. Work out the amount for 18 people. [3 marks]

4. A map has scale 1:40,000. A path is 6.5 cm long. Find its actual length in kilometres. [3 marks]

5. A map has scale 1:125,000. A path is 4.8 cm long. Find its actual length in kilometres. [3 marks]



MODULE 02 / R2, R6, R8, R12

Scale Factors, Similarity and Proportional Relationships

MULTI-STEP HIGHER • PART B

HIGHER TIER • SHOW CLEAR WORKING • KEEP EXACT VALUES WHERE REQUIRED

Name: _____ Date: _____ Score: _____ / _____

Continue the multi-step set. Explain decisions where requested.

6. A map has scale 1:20,000. A path is 9.2 cm long. Find its actual length in kilometres. [3 marks]

7. y is directly proportional to x . $y=30$ when $x=4$. Find y when $x=11$. [3 marks]

8. y is directly proportional to x . $y=42$ when $x=6$. Find y when $x=15$. [3 marks]

9. y is directly proportional to x . $y=52$ when $x=8$. Find y when $x=18$. [3 marks]

10. 5 workers take 12 hours at the same rate. How long would 8 workers take? [3 marks]



MODULE 02 / R2, R6, R8, R12

Scale Factors, Similarity and Proportional Relationships

MULTI-STEP HIGHER • PART C

HIGHER TIER • SHOW CLEAR WORKING • KEEP EXACT VALUES WHERE REQUIRED

Name: _____ Date: _____ Score: _____ / _____

Complete the multi-step set. Check units, accuracy and reasonableness.

11. 6 workers take 15 hours at the same rate. How long would 10 workers take? [3 marks]

12. 4 workers take 21 hours at the same rate. How long would 7 workers take? [3 marks]

13. A photograph 8 cm wide is enlarged in the ratio 5:2. Find the new width. [2 marks]

14. A model car is 18 cm long at scale 1:24. Find the actual length in metres. [3 marks]

15. The cost C is directly proportional to mass m. 3.5 kg costs £8.40. Find the cost of 6 kg. [4 marks]



MODULE 02 / R2, R6, R8, R12

Scale Factors, Similarity and Proportional Relationships

GRADE 7-9 CHALLENGE • PART A

HIGHER TIER • SHOW CLEAR WORKING • KEEP EXACT VALUES WHERE REQUIRED

Name: _____ Date: _____ Score: _____ / _____

Extended reasoning. Plan the model before calculating.

1. A recipe uses flour:sugar:butter = 5:2:3. A baker has 1.8 kg of butter. Find the maximum total mass of mixture. [4 marks]

2. A map scale is 1:50,000. A rectangular park is 4.2 cm by 3.6 cm on the map. Find its actual area in hectares. [5 marks]

3. y is directly proportional to x . When $x=12$, $y=7.5$. Find x when $y=18.75$. [4 marks]

4. p is inversely proportional to q . $p=18$ when $q=4$. Find p when $q=10$. [4 marks]

5. A journey takes 6 hours at 50 mph. Assuming time is inversely proportional to speed, find the time at 75 mph. [4 marks]



MODULE 02 / R2, R6, R8, R12

Scale Factors, Similarity and Proportional Relationships

GRADE 7-9 CHALLENGE • PART B

HIGHER TIER • SHOW CLEAR WORKING • KEEP EXACT VALUES WHERE REQUIRED

Name: _____ Date: _____ Score: _____ / _____

Complete the challenge set. Present a clear mathematical argument.

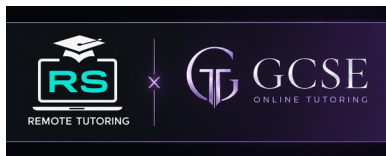
6. A plan uses scale 1:200. A room has actual area 48 m^2 and plan length 6 cm. Find its plan width. [5 marks]

7. Twelve pumps empty a tank in 35 minutes. After 10 minutes, 5 pumps stop. Find the total time, assuming equal rates. [5 marks]

8. A recipe for 8 uses 300 ml milk. Priya has 1.65 litres. What is the greatest number of complete portions she can make? [4 marks]

9. A scale drawing is enlarged by scale factor 1.5. Its area was 32 cm^2 . Find the new area. [4 marks]

10. Two quantities are directly proportional. Increasing x by 20% changes y from 45 to what value? [3 marks]



Direct and Inverse Proportion

FLUENCY CHECK

HIGHER TIER • SHOW CLEAR WORKING • KEEP EXACT VALUES WHERE REQUIRED

Name: _____ Date: _____ Score: ____ / ____

A short prerequisite check. Work accurately, then move promptly to Higher demand.

1. y is directly proportional to x^2 . Write an equation connecting y and x . [1 mark]

2. y is inversely proportional to x . Write an equation. [1 mark]

3. $y \propto x^3$ and $y=16$ when $x=2$. Find k . [2 marks]

4. $p \propto 1/q^2$ and $p=5$ when $q=2$. Find k . [2 marks]

5. State the shape of a graph of $y=kx$ for $k>0$. [1 mark]

6. If $y \propto x^2$, state the factor change in y when x triples. [2 marks]

7. If $y \propto 1/x$, state the factor change in y when x is halved. [2 marks]

8. Given $y=18/x$, find y when $x=12$. [2 marks]



Direct and Inverse Proportion

STANDARD HIGHER • PART A

HIGHER TIER • SHOW CLEAR WORKING • KEEP EXACT VALUES WHERE REQUIRED

Name: _____ Date: _____ Score: ____ / ____

Higher-tier application. Show the governing relationship and exact working.

1. y is directly proportional to x^2 . $y=20$ when $x=2$. Find y when $x=5$. [4 marks]

2. y is directly proportional to x^2 . $y=54$ when $x=3$. Find y when $x=7$. [4 marks]

3. y is directly proportional to x^2 . $y=48$ when $x=4$. Find y when $x=10$. [4 marks]

4. y is directly proportional to x^2 . $y=75$ when $x=5$. Find y when $x=8$. [4 marks]

5. y is inversely proportional to x^2 . $y=32$ when $x=2$. Find y when $x=4$. [4 marks]

6. y is inversely proportional to x^2 . $y=12$ when $x=3$. Find y when $x=6$. [4 marks]



Direct and Inverse Proportion

STANDARD HIGHER • PART B

HIGHER TIER • SHOW CLEAR WORKING • KEEP EXACT VALUES WHERE REQUIRED

Name: _____ Date: _____ Score: ____ / ____

Continue the Higher set. Interpret each result in context.

7. y is inversely proportional to x^2 . $y=20$ when $x=5$. Find y when $x=10$. [4 marks]

8. y is inversely proportional to x^2 . $y=45$ when $x=4$. Find y when $x=6$. [4 marks]

9. $y \propto x^n$. When x doubles, y is multiplied by 8. Find n . [3 marks]

10. $p \propto q^n$. p changes from 12 to 192 when q doubles. Find n . [3 marks]

11. A graph of y against x^2 is a straight line through (0,0) and (9,45). Find y when $x=5$. [4 marks]

12. Explain how plotting y against $1/x$ tests whether y is inversely proportional to x . [3 marks]



Direct and Inverse Proportion

MULTI-STEP HIGHER • PART A

HIGHER TIER • SHOW CLEAR WORKING • KEEP EXACT VALUES WHERE REQUIRED

Name: _____ Date: _____ Score: _____ / _____

Original multi-step exam-style questions. Show every connected stage.

1. The braking distance d is proportional to speed squared. At 40 km/h, $d=18$ m. Find d at 100 km/h and state the multiplier. [5 marks]

2. The braking distance d is proportional to speed squared. At 60 km/h, $d=30$ m. Find d at 150 km/h and state the multiplier. [5 marks]

3. The braking distance d is proportional to speed squared. At 80 km/h, $d=50$ m. Find d at 200 km/h and state the multiplier. [5 marks]

4. The braking distance d is proportional to speed squared. At 50 km/h, $d=24$ m. Find d at 120 km/h and state the multiplier. [5 marks]

5. The braking distance d is proportional to speed squared. At 30 km/h, $d=14$ m. Find d at 90 km/h and state the multiplier. [5 marks]



Direct and Inverse Proportion

MULTI-STEP HIGHER • PART B

HIGHER TIER • SHOW CLEAR WORKING • KEEP EXACT VALUES WHERE REQUIRED

Name: _____ Date: _____ Score: ____ / ____

Continue the multi-step set. Explain decisions where requested.

6. The time T to complete a task is inversely proportional to the number n of identical machines. Six machines take 14 h. After 5 h, two machines fail. Find the total completion time. [5 marks]

7. The intensity I is inversely proportional to d^2 . $I=72$ when $d=5$. Find d when $I=8$. [5 marks]

8. The mass m of similar spheres is proportional to r^3 . A sphere of radius 4 cm has mass 320 g. Find the radius of a sphere of mass 1080 g. [5 marks]

9. y is directly proportional to x^2 and inversely proportional to z . $y=24$ when $x=4, z=2$. Find y when $x=10, z=5$. [5 marks]

10. p is proportional to $\sqrt{q}$. $p=18$ when $q=16$. Find q when $p=45$. [4 marks]



Direct and Inverse Proportion

MULTI-STEP HIGHER • PART C

HIGHER TIER • SHOW CLEAR WORKING • KEEP EXACT VALUES WHERE REQUIRED

Name: _____ Date: _____ Score: ____ / ____

Complete the multi-step set. Check units, accuracy and reasonableness.

11. The cost C consists of a fixed fee plus an amount directly proportional to time t . $C = £38$ at $t = 3$ and $£68$ at $t = 8$. Find the equation and cost at 12 h. [5 marks]

12. A graph representing inverse proportion passes through (3,20). Show that (12,5) lies on it and find its equation. [4 marks]

13. For $y = k/x^2$, $y = 7.2$ at $x = 5$. Find the two x -values for which $y = 20$. [5 marks]

14. The period T is proportional to $\sqrt{L}$. Increasing L by 44% changes T by what percentage? [4 marks]

15. A quantity is inversely proportional to x^3 . By what percentage must x increase to halve the quantity? [5 marks]



Direct and Inverse Proportion

GRADE 7-9 CHALLENGE • PART A

HIGHER TIER • SHOW CLEAR WORKING • KEEP EXACT VALUES WHERE REQUIRED

Name: _____ Date: _____ Score: ____ / ____

Extended reasoning. Plan the model before calculating.

1. $y \propto x^n$ and $y=6$ at $x=2$, $y=486$ at $x=6$. Find n and k . [5 marks]

2. $p \propto x^2/y^3$. $p=10$ when $x=6, y=3$. Find p when $x=15, y=5$. [5 marks]

3. A and B work at rates in ratio 3:5. Together they finish in 12 h. Find the time each would take alone. [5 marks]

4. The surface area S of similar solids is proportional to $V^{(2/3)}$. If volume rises by 72.8%, find percentage increase in S . [5 marks]

5. x is inversely proportional to y^2 . Increasing y by $p\%$ reduces x by 36%. Find p . [5 marks]



Direct and Inverse Proportion

GRADE 7-9 CHALLENGE • PART B

HIGHER TIER • SHOW CLEAR WORKING • KEEP EXACT VALUES WHERE REQUIRED

Name: _____ Date: _____ Score: _____ / _____

Complete the challenge set. Present a clear mathematical argument.

6. A curve $y=k/x$ passes through A(2,18). Point B has x-coordinate 8. Find the gradient of chord AB. [5 marks]

7. A cylinder family has fixed volume. Show h is inversely proportional to r^2 and find h when r doubles from a height of 30 cm. [5 marks]

8. Given $y=kx^3$, points (a,16) and (3a,432) lie on the graph. Verify consistency and find k in terms of a . [4 marks]

9. The energy $E \propto v^2$. A 12% increase in v changes E by what percentage? [4 marks]

10. For positive x , $y=ax^2$ and $z=b/x$. If $y=z$ at $x=2$, find the x -coordinate where $y=8z$. [5 marks]



Percentages, Growth and Decay

FLUENCY CHECK

HIGHER TIER • SHOW CLEAR WORKING • KEEP EXACT VALUES WHERE REQUIRED

Name: _____ Date: _____ Score: ____ / ____

A short prerequisite check. Work accurately, then move promptly to Higher demand.

1. Increase £240.00 by 15%. [2 marks]

2. Increase £360.00 by 8%. [2 marks]

3. Increase £1250.00 by 12%. [2 marks]

4. Increase £84.00 by 25%. [2 marks]

5. Increase £560.00 by 35%. [2 marks]

6. Decrease £180.00 by 20%. [2 marks]

7. Decrease £450.00 by 12%. [2 marks]

8. Decrease £96.00 by 15%. [2 marks]



Percentages, Growth and Decay

STANDARD HIGHER • PART A

HIGHER TIER • SHOW CLEAR WORKING • KEEP EXACT VALUES WHERE REQUIRED

Name: _____ Date: _____ Score: ____ / ____

Higher-tier application. Show the governing relationship and exact working.

1. Decrease £720.00 by 5%. [2 marks]

2. Decrease £250.00 by 32%. [2 marks]

3. A price rises from £80 to £92. Find the percentage increase. [2 marks]

4. A population falls from 640 to 560. Find percentage decrease. [2 marks]

5. After a 20% discount, a coat costs £56. Find original price. [3 marks]

6. After a 15% increase, a bill is £138. Find original amount. [3 marks]



Percentages, Growth and Decay

STANDARD HIGHER • PART B

HIGHER TIER • SHOW CLEAR WORKING • KEEP EXACT VALUES WHERE REQUIRED

Name: _____ Date: _____ Score: ____ / ____

Continue the Higher set. Interpret each result in context.

7. Find simple interest on £900 at 4% per year for 3 years. [3 marks]

8. After a 12% increase followed by a p% decrease, a value is 0.952 times its original value. Find p. [4 marks]

9. An investment grows from £8000 to £10,648.80 in 5 years at a fixed annual compound rate. Find the rate. [5 marks]

10. A population falls by 8% annually. After n years it first falls below 60% of its initial value. Find n. [5 marks]

11. A shop marks up cost by 35%, then discounts the marked price by 18%. Find the profit percentage on cost. [4 marks]

12. A machine worth £48,000 loses 22% in year 1 and 14% in each later year. Find its value after 4 years. [5 marks]



Percentages, Growth and Decay

MULTI-STEP HIGHER • PART A

HIGHER TIER • SHOW CLEAR WORKING • KEEP EXACT VALUES WHERE REQUIRED

Name: _____ Date: _____ Score: ____ / ____

Original multi-step exam-style questions. Show every connected stage.

1. £500.00 is invested at 4% compound interest for 3 years. Find the final amount. [4 marks]

2. £1200.00 is invested at 3% compound interest for 5 years. Find the final amount. [4 marks]

3. £850.00 is invested at 6% compound interest for 2 years. Find the final amount. [4 marks]

4. £2000.00 is invested at 2.5% compound interest for 4 years. Find the final amount. [4 marks]

5. A value of £24000.00 depreciates by 12% each year for 3 years. Find its value. [4 marks]



Percentages, Growth and Decay

MULTI-STEP HIGHER • PART B

HIGHER TIER • SHOW CLEAR WORKING • KEEP EXACT VALUES WHERE REQUIRED

Name: _____ Date: _____ Score: ____ / ____

Continue the multi-step set. Explain decisions where requested.

6. A value of £1800.00 depreciates by 18% each year for 2 years. Find its value. [4 marks]

7. A value of £650.00 depreciates by 9% each year for 4 years. Find its value. [4 marks]

8. A shop increases £160 by 25% then discounts the result by 20%. Find the final price. [4 marks]

9. A salary of £28,000 rises by 3.5%. Find the increase and new salary. [3 marks]

10. A £72 item has VAT of 20% added. Find total. [2 marks]



Percentages, Growth and Decay

MULTI-STEP HIGHER • PART C

HIGHER TIER • SHOW CLEAR WORKING • KEEP EXACT VALUES WHERE REQUIRED

Name: _____ Date: _____ Score: ____ / ____

Complete the multi-step set. Check units, accuracy and reasonableness.

11. A sale price after 30% off is £91. Find original. [3 marks]

12. A town grows from 48,000 to 52,320. Find percentage growth. [3 marks]

13. An amount gains 5% then 8%. Find the overall percentage increase. [4 marks]

14. An item loses 10% then 15%. Find overall percentage decrease. [4 marks]

15. Simple interest makes £150 on £750 over 5 years. Find annual rate. [4 marks]



Percentages, Growth and Decay

GRADE 7-9 CHALLENGE • PART A

HIGHER TIER • SHOW CLEAR WORKING • KEEP EXACT VALUES WHERE REQUIRED

Name: _____ Date: _____ Score: ____ / ____

Extended reasoning. Plan the model before calculating.

1. A value increases by 20% then decreases by 20%. Explain the net change. [3 marks]

2. After two annual increases of 5%, an investment is £2205. Find the starting amount. [4 marks]

3. A car is worth £14,580 after two years of 10% depreciation. Find its original value. [4 marks]

4. A population grows 3% yearly from 80,000. Find first year it exceeds 90,000. [5 marks]

5. An account pays 4% compound interest. How much must be invested to have £5000 after 6 years? [5 marks]



Percentages, Growth and Decay

GRADE 7-9 CHALLENGE • PART B

HIGHER TIER • SHOW CLEAR WORKING • KEEP EXACT VALUES WHERE REQUIRED

Name: _____ Date: _____ Score: _____ / _____

Complete the challenge set. Present a clear mathematical argument.

6. A shop marks up cost by 40% then gives 15% discount. Cost is £75. Find profit percentage. [5 marks]

7. A machine loses 18% value yearly. After 3 years it is worth £13,778.08. Find original. [5 marks]

8. A number is increased by $p\%$ using multiplier 1.32. Find p . [2 marks]

9. Two offers: 25% off £240, or £55 off £240. Which is cheaper and by how much? [4 marks]

10. A bank offers 3.8% compound or 4% simple for 5 years on £3000. Which gives more? [5 marks]



Compound Measures and Unit Conversions

FLUENCY CHECK

HIGHER TIER • SHOW CLEAR WORKING • KEEP EXACT VALUES WHERE REQUIRED

Name: _____ Date: _____ Score: _____ / _____

A short prerequisite check. Work accurately, then move promptly to Higher demand.

1. Travel 150 km in 3 hours. Find average speed. [2 marks]

2. Travel 84 km in 1.4 hours. Find average speed. [2 marks]

3. Travel 225 km in 4.5 hours. Find average speed. [2 marks]

4. Travel 96 km in 1.5 hours. Find average speed. [2 marks]

5. Travel 42 km in 0.7 hours. Find average speed. [2 marks]

6. A substance has mass 540 g and volume 60 cm³. Find density. [2 marks]

7. A substance has mass 1260 g and volume 140 cm³. Find density. [2 marks]

8. A substance has mass 875 g and volume 125 cm³. Find density. [2 marks]



Compound Measures and Unit Conversions

STANDARD HIGHER • PART A

HIGHER TIER • SHOW CLEAR WORKING • KEEP EXACT VALUES WHERE REQUIRED

Name: _____ Date: _____ Score: _____ / _____

Higher-tier application. Show the governing relationship and exact working.

1. A force of 480 N acts over 60 m². Find pressure. [2 marks]

2. A force of 735 N acts over 105 m². Find pressure. [2 marks]

3. A force of 960 N acts over 120 m². Find pressure. [2 marks]

4. Convert 72 km/h to m/s. [2 marks]

5. Convert 15 m/s to km/h. [2 marks]

6. A tap fills 18 litres in 2.5 minutes. Find litres per minute. [2 marks]



Compound Measures and Unit Conversions

STANDARD HIGHER • PART B

HIGHER TIER • SHOW CLEAR WORKING • KEEP EXACT VALUES WHERE REQUIRED

Name: _____ Date: _____ Score: _____ / _____

Continue the Higher set. Interpret each result in context.

7. A pack of 750 g costs £3.60. Find cost per 100 g. [2 marks]

8. A journey consists of 120 km at 80 km/h and 180 km at v km/h. The overall average speed is 75 km/h. Find v . [5 marks]

9. A hollow metal cuboid has external dimensions 12 by 9 by 7 cm and uniform wall thickness 1 cm. Its mass is 3.336 kg. Find density. [5 marks]

10. A force of 4.8 kN acts on a circular area of radius 3.5 cm. Find pressure in N/m^2 to 3 significant figures. [5 marks]

11. A tank fills at 18 L/min while leaking at a rate directly proportional to the water depth. At the stated depth the leak is 5.5 L/min. Find the time for a further 625 L, assuming that leak rate remains constant. [4 marks]

12. A car uses 7.2 L per 100 km. Fuel costs £1.56/L. It travels 425 km and shares the cost in ratio 3:2. Find both shares. [5 marks]



Compound Measures and Unit Conversions

MULTI-STEP HIGHER • PART A

HIGHER TIER • SHOW CLEAR WORKING • KEEP EXACT VALUES WHERE REQUIRED

Name: _____ Date: _____ Score: _____ / _____

Original multi-step exam-style questions. Show every connected stage.

1. A vehicle travels at 68 km/h for 2.75 hours. Find the distance. [3 marks]

2. A vehicle travels at 52 km/h for 3.5 hours. Find the distance. [3 marks]

3. A vehicle travels at 75 km/h for 1.8 hours. Find the distance. [3 marks]

4. A journey of 315 km is made at 70 km/h. Find the time. [3 marks]

5. A journey of 264 km is made at 48 km/h. Find the time. [3 marks]



Compound Measures and Unit Conversions

MULTI-STEP HIGHER • PART B

HIGHER TIER • SHOW CLEAR WORKING • KEEP EXACT VALUES WHERE REQUIRED

Name: _____ Date: _____ Score: _____ / _____

Continue the multi-step set. Explain decisions where requested.

6. A journey of 187.5 km is made at 62.5 km/h. Find the time. [3 marks]

7. A metal block has density 7.8 g/cm^3 and volume 45 cm^3 . Find its mass. [3 marks]

8. A liquid has mass 1.26 kg and density 0.9 g/cm^3 . Find its volume in cm^3 . [4 marks]

9. A pressure of 2400 N/m^2 acts on area 0.35 m^2 . Find the force. [3 marks]

10. A force of 1500 N creates pressure 6000 N/m^2 . Find area. [3 marks]



Compound Measures and Unit Conversions

MULTI-STEP HIGHER • PART C

HIGHER TIER • SHOW CLEAR WORKING • KEEP EXACT VALUES WHERE REQUIRED

Name: _____ Date: _____ Score: _____ / _____

Complete the multi-step set. Check units, accuracy and reasonableness.

11. A 1.5 kg bag costs £4.35 and a 900 g bag costs £2.70. Which is better value per kg? [4 marks]

12. A pipe carries 480 litres in 16 minutes. How many litres in 1 hour at this rate? [3 marks]

13. A cyclist travels 18 km in 45 minutes. Find speed in km/h. [3 marks]

14. A car travels 120 km at 60 km/h then 180 km at 90 km/h. Find average speed. [5 marks]

15. A printer produces 840 pages in 12 minutes. Find pages per second. [3 marks]



Compound Measures and Unit Conversions

GRADE 7-9 CHALLENGE • PART A

HIGHER TIER • SHOW CLEAR WORKING • KEEP EXACT VALUES WHERE REQUIRED

Name: _____ Date: _____ Score: _____ / _____

Extended reasoning. Plan the model before calculating.

1. A runner covers 5 km at 12 km/h and 3 km at 9 km/h. Find average speed. [5 marks]

2. A solid cuboid 8 cm by 5 cm by 3 cm has mass 936 g. Find density. [4 marks]

3. A hollow object has outer volume 250 cm^3 , inner empty volume 70 cm^3 and mass 1.44 kg. Find material density. [5 marks]

4. A force of 18 kN acts on a rectangle 0.6 m by 0.25 m. Find pressure. [4 marks]

5. A car goes 150 km at 75 km/h and returns at 50 km/h. Find average speed for the whole journey. [5 marks]



Compound Measures and Unit Conversions

GRADE 7-9 CHALLENGE • PART B

HIGHER TIER • SHOW CLEAR WORKING • KEEP EXACT VALUES WHERE REQUIRED

Name: _____ Date: _____ Score: _____ / _____

Complete the challenge set. Present a clear mathematical argument.

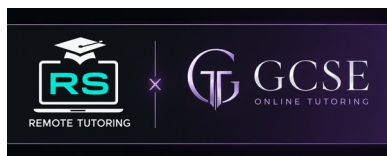
6. Fuel costs £1.52 per litre. A car travels 47 miles per gallon. Use 1 gallon=4.5 L. Find fuel cost for 235 miles. [5 marks]

7. A tank fills at 28 L/min but leaks at 3.5 L/min. It starts empty. How long to reach 980 L? [4 marks]

8. Two taps fill 6 L/min and 9 L/min. A drain empties 2 L/min. Find time for 520 L. [4 marks]

9. A block density is 2.7 g/cm^3 . Its mass is 5.4 kg. It has base 20 cm by 15 cm. Find height. [5 marks]

10. A machine produces 375 items in 2.5 h. After improvement its rate rises by 12%. Find items in 8 h. [4 marks]



Rates of Change and Gradients

FLUENCY CHECK

HIGHER TIER • SHOW CLEAR WORKING • KEEP EXACT VALUES WHERE REQUIRED

Name: _____ Date: _____ Score: ____ / ____

A short prerequisite check. Work accurately, then move promptly to Higher demand.

1. Find the gradient between (2,5) and (8,23). [2 marks]

2. A distance rises from 40 m to 115 m in 5 s. Find average speed. [2 marks]

3. State what the gradient of a distance-time graph represents. [1 mark]

4. State what the gradient of a velocity-time graph represents. [1 mark]

5. A tangent rises 24 units for a run of 6. Find its gradient. [1 mark]

6. Find the average rate of change of $y=x^2$ from $x=2$ to $x=6$. [3 marks]

7. A population changes by -360 over 12 years. Find average rate. [2 marks]

8. Explain why a steeper distance-time graph means greater speed. [2 marks]



Rates of Change and Gradients

STANDARD HIGHER • PART A

HIGHER TIER • SHOW CLEAR WORKING • KEEP EXACT VALUES WHERE REQUIRED

Name: _____ Date: _____ Score: ____ / ____

Higher-tier application. Show the governing relationship and exact working.

1. Find the average rate of change of $f(x)=x^2$ from $x=1$ to $x=5$. [4 marks]

2. Find the average rate of change of $f(x)=x^2$ from $x=2$ to $x=7$. [4 marks]

3. Find the average rate of change of $f(x)=x^2$ from $x=3$ to $x=9$. [4 marks]

4. Find the average rate of change of $f(x)=x^2$ from $x=4$ to $x=10$. [4 marks]

5. A tangent to a curve at $x=4$ passes through (2,7) and (7,27). Estimate the gradient at $x=4$. [3 marks]

6. A car speed rises from 12 to 28 m/s in 8 s. Find average acceleration. [3 marks]



Rates of Change and Gradients

STANDARD HIGHER • PART B

HIGHER TIER • SHOW CLEAR WORKING • KEEP EXACT VALUES WHERE REQUIRED

Name: _____ Date: _____ Score: ____ / ____

Continue the Higher set. Interpret each result in context.

7. A reservoir volume falls from 8.2×10^6 to 6.5×10^6 L in 20 days. Find average daily change. [3 marks]

8. On a distance-time graph a chord joins (15,240) and (45,1050), with time in seconds. Find average speed. [3 marks]

9. A tangent has gradient -3.5 on a temperature-time graph. Interpret this. [3 marks]

10. The gradient of y against time changes from positive to zero. Interpret this for y. [3 marks]

11. Find the average rate of change of $V = \frac{4}{3}\pi r^3$ from $r=2$ to $r=5$. [4 marks]

12. A curve passes through (1,9),(3,17),(5,33). Compare average gradients on the two intervals. [4 marks]



Rates of Change and Gradients

MULTI-STEP HIGHER • PART A

HIGHER TIER • SHOW CLEAR WORKING • KEEP EXACT VALUES WHERE REQUIRED

Name: _____ Date: _____ Score: _____ / _____

Original multi-step exam-style questions. Show every connected stage.

1. A cyclist travels 300 m in 20 s, rests 10 s, then travels 900 m in 30 s. Find the average speed for the whole journey. [4 marks]

2. A car accelerates uniformly from 8 to 26 m/s in 9 s. Find acceleration and distance travelled using average velocity. [5 marks]

3. The tangent to $y=x^2$ at $x=3$ is estimated using points (2.9,8.41) and (3.1,9.61). Find the estimate. [4 marks]

4. Estimate the gradient of $y=x^3$ at $x=2$ using $x=1.9$ and 2.1 . [5 marks]

5. A tank contains $V=5000-40t^2$ litres after t minutes. Find average outflow rate from $t=3$ to $t=7$. [4 marks]



Rates of Change and Gradients

MULTI-STEP HIGHER • PART B

HIGHER TIER • SHOW CLEAR WORKING • KEEP EXACT VALUES WHERE REQUIRED

Name: _____ Date: _____ Score: ____ / ____

Continue the multi-step set. Explain decisions where requested.

6. A ball height is $h=20t-5t^2$. Find average velocity from $t=1$ to $t=3$ and interpret the sign. [4 marks]

7. A tangent drawn at $t=6$ on a volume-time curve passes through (4,900) and (9,525). Estimate instantaneous flow rate. [4 marks]

8. A population $P=2000 \times 1.04^t$. Find average annual increase from $t=3$ to $t=8$. [5 marks]

9. A runner covers first half of a distance at 8 m/s and second half at 12 m/s. Find average speed. [5 marks]

10. A graph of mass against volume has gradient 7.8. Explain the physical meaning and predict mass at 45 cm^3 if it passes through origin. [4 marks]



Rates of Change and Gradients

MULTI-STEP HIGHER • PART C

HIGHER TIER • SHOW CLEAR WORKING • KEEP EXACT VALUES WHERE REQUIRED

Name: _____ Date: _____ Score: ____ / ____

Complete the multi-step set. Check units, accuracy and reasonableness.

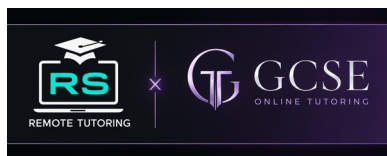
11. Pressure $P=1200/A$. Find average rate of change from $A=4$ to $A=10$. [4 marks]

12. A tangent gradient to a distance-time curve is 22 at $t=10$. A chord from $t=8$ to 12 has gradient 19. Explain the difference. [4 marks]

13. A rectangle has fixed perimeter 40, so area $A=x(20-x)$. Find average rate of change from $x=4$ to $x=9$. [4 marks]

14. A cooling curve falls 18°C in the first 5 min and 12°C in the next 10 min. Compare average cooling rates. [4 marks]

15. The gradient of a tangent is estimated using a triangle with run 0.4 and fall 3.2. State the estimate and why a large triangle is preferred. [4 marks]



Rates of Change and Gradients

GRADE 7-9 CHALLENGE • PART A

HIGHER TIER • SHOW CLEAR WORKING • KEEP EXACT VALUES WHERE REQUIRED

Name: _____ Date: _____ Score: ____ / ____

Extended reasoning. Plan the model before calculating.

1. For $f(x)=x^2$, show the chord gradient from $x=a$ to $x=b$ is $a+b$. [5 marks]

2. For $f(x)=x^3$, find the chord gradient from a to b in factorised form. [5 marks]

3. A car travels equal times at 40, 60 and 80 km/h. Find average speed and explain why arithmetic mean works here. [4 marks]

4. A car travels equal distances at 40, 60 and 80 km/h. Find average speed. [5 marks]

5. A curve has tangent gradient zero at $x=3$, positive before and negative after. Describe the point. [4 marks]



Rates of Change and Gradients

GRADE 7-9 CHALLENGE • PART B

HIGHER TIER • SHOW CLEAR WORKING • KEEP EXACT VALUES WHERE REQUIRED

Name: _____ Date: _____ Score: _____ / _____

Complete the challenge set. Present a clear mathematical argument.

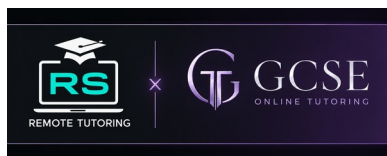
6. The radius of a sphere grows at 0.2 cm/s. Explain why its volume does not grow at a constant rate. [4 marks]

7. Average rate of change of $f(x)=1/x$ from 2 to k is $-1/12$. Find $k>2$. [5 marks]

8. A tangent to $y=k/x$ at $x=4$ is estimated by chord endpoints $x=3.9, 4.1$. With $k=80$, calculate the estimate. [5 marks]

9. A tank drains so $V=t^3-12t^2+36t+100$. Find average rate from $t=2$ to 6. [5 marks]

10. Explain how reducing the chord interval around a point improves an instantaneous-gradient estimate. [4 marks]



Mixed Higher Ratio and Proportion Problems

FLUENCY CHECK

HIGHER TIER • SHOW CLEAR WORKING • KEEP EXACT VALUES WHERE REQUIRED

Name: _____ Date: _____ Score: ____ / ____

A short prerequisite check. Work accurately, then move promptly to Higher demand.

1. Share £540 in ratio 4:5. [2 marks]

2. Convert 54 km/h to m/s. [2 marks]

3. Increase 320 by 12.5%. [2 marks]

4. If $y \propto x^2$ and x doubles, state y factor. [1 mark]

5. Density formula. [1 mark]

6. Find gradient through (2,7),(8,25). [2 marks]

7. Scale 1:50000: 3 cm represents how many km? [2 marks]

8. A 20% decrease uses which multiplier? [1 mark]



Mixed Higher Ratio and Proportion Problems

STANDARD HIGHER • PART A

HIGHER TIER • SHOW CLEAR WORKING • KEEP EXACT VALUES WHERE REQUIRED

Name: _____ Date: _____ Score: ____ / ____

Higher-tier application. Show the governing relationship and exact working.

1. $A:B=4:7$ and $B:C=5:6$. If C exceeds A by £132, find the total. [5 marks]

2. A drink has syrup:water= $3:11$. After 400 ml water evaporates the ratio is $1:3$. Find the original volume. [5 marks]

3. A plan scale is $1:400$. A room area is 56 m^2 and plan length 3.5 cm. Find plan width. [5 marks]

4. Similar solids have volume ratio $216:343$. Their surface areas differ by 127 cm^2 . Find both surface areas. [5 marks]

5. A price rises by 18% then falls by 10%. Find the overall percentage change. [4 marks]

6. A value is £756 after three years of 5% compound growth. Find the original value. [5 marks]



Mixed Higher Ratio and Proportion Problems

STANDARD HIGHER • PART B

HIGHER TIER • SHOW CLEAR WORKING • KEEP EXACT VALUES WHERE REQUIRED

Name: _____ Date: _____ Score: _____ / _____

Continue the Higher set. Interpret each result in context.

7. A trip is 90 km at 45 km/h and 160 km at 80 km/h. Find average speed. [4 marks]

8. A block of density 7.5 g/cm^3 has mass 2.7 kg and base area 40 cm^2 . Find height. [4 marks]

9. A recipe uses two ingredients in mass ratio 5:3. Both ingredients cost the same price per kilogram. A 2.4 kg batch costs £18. Find the cost of the first ingredient in a 4 kg batch. [4 marks]

10. A map area is 18 cm^2 at scale 1:20 000. Find actual area in hectares. [5 marks]

11. A value rises 10% yearly while a comparison value is directly proportional to its square. Find comparison multiplier after 3 years. [5 marks]

12. A liquid density is 0.84 g/cm^3 . A mixture has liquid:water mass ratio 3:2. Find volume of liquid in 1.26 kg mixture. [5 marks]



Mixed Higher Ratio and Proportion Problems

MULTI-STEP HIGHER • PART A

HIGHER TIER • SHOW CLEAR WORKING • KEEP EXACT VALUES WHERE REQUIRED

Name: _____ Date: _____ Score: _____ / _____

Original multi-step exam-style questions. Show every connected stage.

1. A car travels 150 km at 60 km/h then 210 km at a speed 20% higher. Find average speed. [5 marks]

2. A model tank scale is 1:25. Its volume is 320 cm³. The actual liquid has density 0.8 g/cm³. Find mass when full. [5 marks]

3. Two investments are in ratio 3:5. First grows 8%, second falls 4%. Find new ratio and overall percentage change. [5 marks]

4. A workforce rises in ratio 5:6 and individual rate rises 10%. Find percentage change in output per hour. [4 marks]

5. A sphere radius is enlarged in ratio 2:3. Density falls by 20%. Find mass ratio old:new. [5 marks]



Mixed Higher Ratio and Proportion Problems

MULTI-STEP HIGHER • PART B

HIGHER TIER • SHOW CLEAR WORKING • KEEP EXACT VALUES WHERE REQUIRED

Name: _____ Date: _____ Score: ____ / ____

Continue the multi-step set. Explain decisions where requested.

6. A road gradient is 1:12. A map scale is 1:25000 and horizontal map length 7.2 cm. Find vertical rise. [4 marks]

7. A population P is proportional to area A and grows 3% yearly. Area increases in ratio 4:5. Find population multiplier after 2 years. [5 marks]

8. A pump rate is inversely proportional to time. Six pumps fill 9000 L in 50 min. One fails after 20 min. Find total time. [5 marks]

9. A substance mass is 2.4 kg, density 1.2 g/cm³. It is recast into similar solids with length scale 1:2. How many small solids? [4 marks]

10. A price is increased p% then reduced p%, leaving 91% of original. Find p. [5 marks]



Mixed Higher Ratio and Proportion Problems

MULTI-STEP HIGHER • PART C

HIGHER TIER • SHOW CLEAR WORKING • KEEP EXACT VALUES WHERE REQUIRED

Name: _____ Date: _____ Score: ____ / ____

Complete the multi-step set. Check units, accuracy and reasonableness.

11. A curve $y=k/x$ has average gradient -2 from $x=3$ to $x=9$. Find k . [5 marks]

12. A car value decays 15% yearly. Its mass-to-value ratio is initially 0.06 kg/£. Assuming mass constant, find ratio after 4 years. [5 marks]

13. A recipe is scaled by 1.6, then 5% is wasted. Find usable-amount percentage change. [4 marks]

14. A distance-time tangent has gradient 18 m/s. On a map scale 1:100000, how far in cm represents 25 minutes at that instantaneous speed? [5 marks]

15. Two similar cones have volume ratio 64:125. The smaller height is 12 cm. The cones are filled so that they take equal times to fill, and the larger fills at 30 cm^3/s . Find the larger height and the smaller fill rate. [5 marks]



Mixed Higher Ratio and Proportion Problems

GRADE 7-9 CHALLENGE • PART A

HIGHER TIER • SHOW CLEAR WORKING • KEEP EXACT VALUES WHERE REQUIRED

Name: _____ Date: _____ Score: _____ / _____

Extended reasoning. Plan the model before calculating.

1. $A:B=2:3$. A grows 25% and B falls $p\%$, after which the amounts are equal. Find p . [5 marks]

2. A cyclist goes uphill at v and downhill at $2v$ over equal distances. Average speed is 24 km/h. Find v . [5 marks]

3. A quantity $y \propto x^2$ and its instantaneous rate against time is considered while x grows linearly. Explain why y -time graph curves upward. [4 marks]

4. A cone is enlarged so surface area rises 44%. Density falls 25%. Find mass percentage change. [5 marks]

5. An investment must double in 9 years. Find the required annual compound rate to 3 significant figures. [5 marks]



Mixed Higher Ratio and Proportion Problems

GRADE 7-9 CHALLENGE • PART B

HIGHER TIER • SHOW CLEAR WORKING • KEEP EXACT VALUES WHERE REQUIRED

Name: _____ Date: _____ Score: _____ / _____

Complete the challenge set. Present a clear mathematical argument.

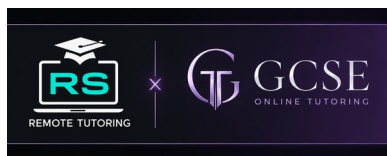
6. A tank cross-sectional area is proportional to depth. Explain why constant inflow does not give constant depth increase. [4 marks]

7. Two mixtures 2:3 and 5:7 are combined in mass ratio 4:5. Find overall first:second component ratio. [5 marks]

8. A pressure is inversely proportional to area. Radius of a circular contact patch rises 10%. Find pressure percentage change. [5 marks]

9. For $y=k/x$, show average gradient from a to b is $-k/(ab)$. [5 marks]

10. A value grows 6% yearly but is reduced by a fixed £500 at each year end. Starting £10,000, find value after 3 years. [5 marks]



Ratio, Sharing and Fractions

FORMULAS AND METHOD BANK

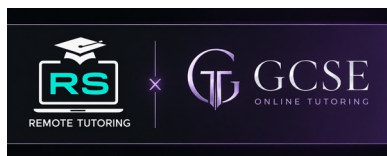
HIGHER TIER • SHOW CLEAR WORKING • KEEP EXACT VALUES WHERE REQUIRED

Name: _____ Date: _____ Score: ____ / ____

Use these methods before checking the answer tables. Write the setup first, substitute values, calculate, then give a final answer with units.

When to use it	Formula / method
Simplify a ratio	Put both quantities in the same units. Divide every part by their highest common factor (HCF).
Scale a ratio	Find the multiplier: known amount $\div$ matching ratio part. Multiply every other part by the same multiplier.
Share a total in a ratio	1. Add the ratio parts. 2. One part = total $\div$ total parts. 3. Each share = one part $\times$ its ratio part.
First part as a fraction	first fraction = first ratio part $\div$ total ratio parts. For a:b, first fraction = $a/(a+b)$.
Difference given	Difference in ratio parts = larger part $-$ smaller part. One part = stated difference $\div$ difference in parts.
Three-part ratio	For a:b:c, total parts = $a+b+c$. One part = total $\div$ ($a+b+c$).
Combine two ratios	Make the shared quantity equal using a common multiple, then join the remaining parts. Example 2:5 and 3:4 $\rightarrow$ 6:15:20.
Compare mixtures	Convert the chosen part to a fraction of the total, then compare fractions, decimals or percentages.
Best value	unit cost = total cost $\div$ number of items, mass or volume. The lower unit cost is better value.
Changing-ratio problem	Let the original amounts be ratio part $\times k$. Form an equation after the stated change, solve for k, then check the new ratio.
Fraction or percentage to ratio	Convert every part to the same form, then remove fractions/decimals and simplify. Example 35%:65% = 35:65 = 7:13.
Ratio with different item values	Find the number in each ratio part first. Multiply each number by its item value, then add or compare the resulting values.

Marking reminder: a correct setup can earn method marks even when a later arithmetic error occurs.



Scale Factors, Similarity and Proportional Relationships

FORMULAS AND METHOD BANK

HIGHER TIER • SHOW CLEAR WORKING • KEEP EXACT VALUES WHERE REQUIRED

Name: _____ Date: _____ Score: _____ / _____

Use these methods before checking the answer tables. Write the setup first, substitute values, calculate, then give a final answer with units.

When to use it	Formula / method
Direct proportion	$y=kx$; $k=y/x$.
Inverse proportion	$y=k/x$; $k=xy$.
Recipe scaling	new amount = original amount $\times$ new servings $\div$ original servings.
Scale 1:n	actual length = drawing length $\times$ n, in the same units.
Unitary method	Find one unit by division, then multiply by the required number of units.
Inverse work	workers $\times$ time = constant, when all workers have equal rates.
Length enlargement	new length = original length $\times$ scale factor.
Area enlargement	new area = original area $\times$ scale factor ² .
Volume enlargement	new volume = original volume $\times$ scale factor ³ .

Marking reminder: a correct setup can earn method marks even when a later arithmetic error occurs.



Direct and Inverse Proportion

FORMULAS AND METHOD BANK

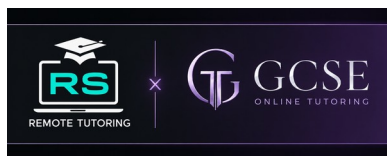
HIGHER TIER • SHOW CLEAR WORKING • KEEP EXACT VALUES WHERE REQUIRED

Name: _____ Date: _____ Score: ____ / ____

Use these methods before checking the answer tables. Write the setup first, substitute values, calculate, then give a final answer with units.

When to use it	Formula / method
Direct proportion	$y=kx^n$; determine k from one pair of values.
Inverse proportion	$y=k/x^n$; equivalently $yx^n=k$.
Proportion graphs	y against x^n , or y against $1/x^n$, is linear through the origin.
Scaling powers	If x changes by factor a , x^n changes by factor a^n .
Combined proportion	Translate each statement into factors before finding k .
Model check	Substitute the original data and check units and reasonableness.

Marking reminder: a correct setup can earn method marks even when a later arithmetic error occurs.



Percentages, Growth and Decay

FORMULAS AND METHOD BANK

HIGHER TIER • SHOW CLEAR WORKING • KEEP EXACT VALUES WHERE REQUIRED

Name: _____ Date: _____ Score: ____ / ____

Use these methods before checking the answer tables. Write the setup first, substitute values, calculate, then give a final answer with units.

When to use it	Formula / method
Percentage change	$\text{change} \div \text{original} \times 100\%$.
Increase multiplier	$1 + \text{percentage}/100$.
Decrease multiplier	$1 - \text{percentage}/100$.
Reverse percentage	$\text{original} = \text{final} \div \text{multiplier}$.
Simple interest	$\text{interest} = \text{principal} \times \text{annual rate} \times \text{time}$.
Compound growth	$\text{final} = \text{original} \times \text{growth multiplier}^{\text{number of periods}}$.
Repeated depreciation	$\text{final} = \text{original} \times \text{decay multiplier}^{\text{number of periods}}$.
Overall repeated change	multiply the successive multipliers; convert the final multiplier back to a percentage.
Find time	test integer powers or solve by systematic trial at Foundation level.

Marking reminder: a correct setup can earn method marks even when a later arithmetic error occurs.



Compound Measures and Unit Conversions

FORMULAS AND METHOD BANK

HIGHER TIER • SHOW CLEAR WORKING • KEEP EXACT VALUES WHERE REQUIRED

Name: _____ Date: _____ Score: _____ / _____

Use these methods before checking the answer tables. Write the setup first, substitute values, calculate, then give a final answer with units.

When to use it	Formula / method
Speed	$\text{speed} = \text{distance} \div \text{time}.$
Distance	$\text{distance} = \text{speed} \times \text{time}.$
Time	$\text{time} = \text{distance} \div \text{speed}.$
Density	$\text{density} = \text{mass} \div \text{volume}.$
Mass	$\text{mass} = \text{density} \times \text{volume}.$
Volume	$\text{volume} = \text{mass} \div \text{density}.$
Pressure	$\text{pressure} = \text{force} \div \text{area}.$
Force	$\text{force} = \text{pressure} \times \text{area}.$
Area from pressure	$\text{area} = \text{force} \div \text{pressure}.$
Rate	$\text{rate} = \text{quantity} \div \text{time}.$
Conversions	$\text{km/h} \div 3.6 = \text{m/s}; \text{m/s} \times 3.6 = \text{km/h}.$
Average speed	total distance $\div$ total time; do not average two speeds directly.

Marking reminder: a correct setup can earn method marks even when a later arithmetic error occurs.



Rates of Change and Gradients

FORMULAS AND METHOD BANK

HIGHER TIER • SHOW CLEAR WORKING • KEEP EXACT VALUES WHERE REQUIRED

Name: _____ Date: _____ Score: ____ / ____

Use these methods before checking the answer tables. Write the setup first, substitute values, calculate, then give a final answer with units.

When to use it	Formula / method
Average rate	change in output $\div$ change in input; gradient of a chord.
Instantaneous rate	gradient of the tangent at the point.
Units	output units per input unit, e.g. m/s or $^{\circ}\text{C}/\text{min}$.
Distance-time	gradient is speed; horizontal means stationary.
Velocity-time	gradient is acceleration.
Reliable tangent	use a large triangle on the tangent, not two nearby curve points.

Marking reminder: a correct setup can earn method marks even when a later arithmetic error occurs.



Mixed Higher Ratio and Proportion Problems

FORMULAS AND METHOD BANK

HIGHER TIER • SHOW CLEAR WORKING • KEEP EXACT VALUES WHERE REQUIRED

Name: _____ Date: _____ Score: _____ / _____

Use these methods before checking the answer tables. Write the setup first, substitute values, calculate, then give a final answer with units.

When to use it	Formula / method
Mixed modelling	Name each relationship, write its formula, then connect the stages.
Multipliers	Translate ratios, percentages and scale factors into multipliers.
Compound measures	Convert units before substituting.
Similarity	Length k , area k^2 , volume k^3 .
Rates	Average uses total change/total input; instantaneous uses tangent gradient.
Validation	Check dimensions, magnitude and whether conditions are consistent.

Marking reminder: a correct setup can earn method marks even when a later arithmetic error occurs.



Ratio, Sharing and Fractions

FLUENCY CHECK - ANSWERS

HIGHER TIER • SHOW CLEAR WORKING • KEEP EXACT VALUES WHERE REQUIRED

Name: _____ Date: _____ Score: ____ / ____

Use the formula/method guides in the consolidated solutions section. Award method marks where the setup is correct.

Q	Answer / concise method	Mark s	Check
1	12:18; divide both parts by 6 → 2:3.	1	B1: correct result or statement.
2	HCF(35,49)=7; 35:49 = 5:7.	1	B1: correct result or statement.
3	Multiply both parts by 10: 12:8; divide by 4 → 3:2.	2	M1 method; A1 answer.
4	Convert 1 kg=1000 g. 250:1000 = 1:4.	2	M1 method; A1 answer.
5	8:20; divide by 4 → 2:5.	1	B1: correct result or statement.
6	Scale factor $21 \div 3 = 7$; children = $7 \times 7 = 49$.	2	M1 method; A1 answer.
7	Total parts=9; one part = $36 \div 9 = 4$; girls = $4 \times 4 = 16$.	2	M1 method; A1 answer.
8	Total parts=5; $\pounds 45 \div 5 = \pounds 9$; shares $\pounds 18$ and $\pounds 27$.	2	M1 method; A1 answer.



Ratio, Sharing and Fractions

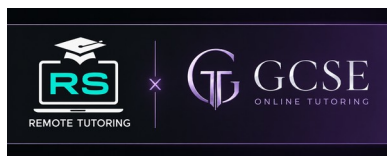
STANDARD HIGHER • PART A - ANSWERS

HIGHER TIER • SHOW CLEAR WORKING • KEEP EXACT VALUES WHERE REQUIRED

Name: _____ Date: _____ Score: ____ / ____

Use the formula/method guides in the consolidated solutions section. Award method marks where the setup is correct.

Q	Answer / concise method	Mark s	Check
1	Total parts=7; $84 \div 7 = 12$; shares 36 and 48.	2	M1 method; A1 answer.
2	One part= $14 \div 2 = 7$ cm; longer= $5 \times 7 = 35$ cm.	2	M1 method; A1 answer.
3	Scale factor= $300 \div 2 = 150$; apple= $5 \times 150 = 750$ ml.	2	M1 method; A1 answer.
4	Total parts=8; first fraction= $\frac{3}{8}$.	1	B1: correct result or statement.
5	Total parts=10; fraction= $\frac{1}{10}$.	1	B1: correct result or statement.
6	Multiply both parts by 10: 4:3.	2	M1 method; A1 answer.



Ratio, Sharing and Fractions

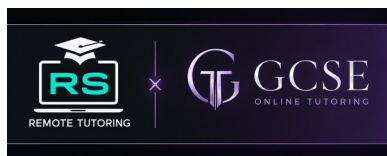
STANDARD HIGHER • PART B - ANSWERS

HIGHER TIER • SHOW CLEAR WORKING • KEEP EXACT VALUES WHERE REQUIRED

Name: _____ Date: _____ Score: ____ / ____

Use the formula/method guides in the consolidated solutions section. Award method marks where the setup is correct.

Q	Answer / concise method	Mark s	Check
7	Total parts=10; one part=4 L; red=8 L, blue=12 L, white=20 L.	3	M1 setup; M1 process; A1 conclusion.
8	A:B:C=12:20:35. Let amounts be 12k, 20k, 35k. Then $12k+46=35k-46$, so $23k=92$ and $k=4$. Total= $67k=£268$.	5	M1 setup; M2-M4 development; A1 conclusion.
9	16 is 20% of red, so red=80. One ratio part=16, blue=128. Total=208; after removal $64:128=1:2$.	4	M1 setup; M1 development; A1 accuracy; A1 conclusion.
10	Copper fractions are $\frac{7}{10}$ and $\frac{4}{5}=\frac{8}{10}$. For equal masses, copper= $\frac{15}{10}$ units and zinc= $\frac{5}{10}$ units, so ratio=3:1.	5	M1 setup; M2-M4 development; A1 conclusion.
11	A:B:C=6:15:20. Difference=14 parts=£196, so one part=£14. Shares: A=£84, B=£210, C=£280.	5	M1 setup; M2-M4 development; A1 conclusion.
12	Let amounts 4k and 9k. $(4k-12)/(9k+18)=2/5$. $20k-60=18k+36$, so $k=48$. Adults=192, children=432.	5	M1 setup; M2-M4 development; A1 conclusion.



Ratio, Sharing and Fractions

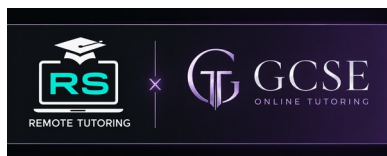
MULTI-STEP HIGHER • PART A - ANSWERS

HIGHER TIER • SHOW CLEAR WORKING • KEEP EXACT VALUES WHERE REQUIRED

Name: _____ Date: _____ Score: ____ / ____

Use the formula/method guides in the consolidated solutions section. Award method marks where the setup is correct.

Q	Answer / concise method	Mark s	Check
1	Total parts=12; one part= $60 \div 12 = 5$; cats= $7 \times 5 = 35$.	3	M1 setup; M1 process; A1 conclusion.
2	One part= $450 \div 5 = 90$ g; butter= $3 \times 90 = 270$ g.	3	M1 setup; M1 process; A1 conclusion.
3	Total parts=8; one part=£120; shares £600 and £360; difference £240.	4	M1 setup; M1 development; A1 accuracy; A1 conclusion.
4	Total parts=7; $2.1 \div 7 = 0.3$ L squash.	3	M1 setup; M1 process; A1 conclusion.
5	Total parts=9; $180 \div 9 = 20^\circ$; angles 40° , 60° , 80° .	4	M1 setup; M1 development; A1 accuracy; A1 conclusion.
6	Total parts=11; one part=9; numbers 36 and 63.	3	M1 setup; M1 process; A1 conclusion.
7	Difference=5 parts; one part= $35 \div 5 = 7$; numbers 21 and 56.	4	M1 setup; M1 development; A1 accuracy; A1 conclusion.
8	One part= $84 \div 7 = 12$; initial boys= $6 \times 12 = 72$. After 12 leave: 60:84; divide by 12 $\rightarrow$ 5:7.	3	M1 setup; M1 process; A1 conclusion.



Ratio, Sharing and Fractions

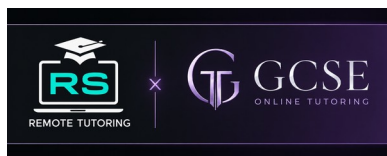
MULTI-STEP HIGHER • PART B - ANSWERS

HIGHER TIER • SHOW CLEAR WORKING • KEEP EXACT VALUES WHERE REQUIRED

Name: _____ Date: _____ Score: ____ / ____

Use the formula/method guides in the consolidated solutions section. Award method marks where the setup is correct.

Q	Answer / concise method	Mark s	Check
9	3 parts=24, so one part=8; total parts=12; total=96.	3	M1 setup; M1 process; A1 conclusion.
10	A red fraction= $\frac{3}{5}=0.6$; $B=\frac{7}{12}\approx 0.583$; Paint A.	3	M1 setup; M1 process; A1 conclusion.
11	A unit cost= $\pounds 8.10\div 6=\pounds 1.35$; $B=\pounds 13.20\div 10=\pounds 1.32$; Shop B by 3p each.	4	M1 setup; M1 development; A1 accuracy; A1 conclusion.
12	$\pounds 3.15\div 7.5=\pounds 0.42$ per 100 g; $\pounds 4.80\div 12=\pounds 0.40$; 1.2 kg box is better value.	4	M1 setup; M1 development; A1 accuracy; A1 conclusion.
13	LCM for y is 15. $x:y=6:15$ and $y:z=15:20$; $x:y:z=6:15:20$.	4	M1 setup; M1 development; A1 accuracy; A1 conclusion.
14	LCM for b is 18. $a:b=8:18$ and $b:c=18:15$; ratio 8:18:15.	4	M1 setup; M1 development; A1 accuracy; A1 conclusion.
15	Total parts=8; one part=8; $\pounds 1$ coins=24, 50p coins=40; value= $\pounds 24+\pounds 20=\pounds 44$.	4	M1 setup; M1 development; A1 accuracy; A1 conclusion.



Ratio, Sharing and Fractions

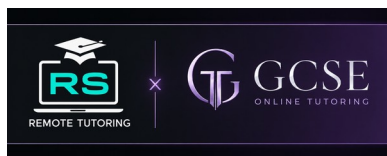
GRADE 7-9 CHALLENGE - ANSWERS

HIGHER TIER • SHOW CLEAR WORKING • KEEP EXACT VALUES WHERE REQUIRED

Name: _____ Date: _____ Score: ____ / ____

Use the formula/method guides in the consolidated solutions section. Award method marks where the setup is correct.

Q	Answer / concise method	Mark s	Check
1	Difference $C-A=5$ parts= $\pounds 210$; one part= $\pounds 42$; total 12 parts= $\pounds 504$.	4	M1 setup; M1 development; A1 accuracy; A1 conclusion.
2	5 parts=40, so one part=8; initial red=24. New red=30; $30:40=3:4$.	4	M1 setup; M1 development; A1 accuracy; A1 conclusion.
3	$2(L+W)=88$, so $L+W=44$. 11 parts=44; one part=4; $L=28$, $W=16$; area= 448 cm^2 .	5	M1 setup; M2-M4 development; A1 conclusion.
4	Let one part= k : boys= $5k$, girls= $7k$. $5k+4=7k-2$; $2k=6$; $k=3$. Original total= $12k=36$.	5	M1 setup; M2-M4 development; A1 conclusion.
5	Let amounts $2k$ and $7k$. $2k/(7k+300)=1/4$; $8k=7k+300$; $k=300$. Original= $9k=2700 \text{ ml}$.	5	M1 setup; M2-M4 development; A1 conclusion.
6	Amounts $4k$ and $7k$. $4k+45=7k-45$; $3k=90$; $k=30$. Total= $11k=\pounds 330$.	5	M1 setup; M2-M4 development; A1 conclusion.
7	8 parts=80, one part=10; original adults=30. Check: $30+18=48$ and $48:80=3:5$.	4	M1 setup; M1 development; A1 accuracy; A1 conclusion.
8	Combine: red:blue=8:12 and blue:green=12:15, so 8:12:15. One part= $75 \div 15=5$; total= $35 \times 5=175$.	4	M1 setup; M1 development; A1 accuracy; A1 conclusion.
9	First= $3/5=60\%$; second= $5/8=62.5\%$; second by 2.5 percentage points.	4	M1 setup; M1 development; A1 accuracy; A1 conclusion.
10	Let red= $4k$ and blue= $7k$. $4k/(7k-18)=2/3$; $12k=14k-36$; $k=18$. Red=72, blue=126. Check $72:108=2:3$.	5	M1 setup; M2-M4 development; A1 conclusion.



Scale Factors, Similarity and Proportional Relationships

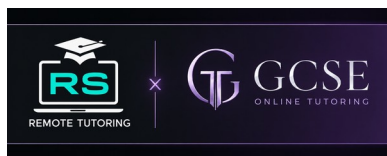
FLUENCY CHECK - ANSWERS

HIGHER TIER • SHOW CLEAR WORKING • KEEP EXACT VALUES WHERE REQUIRED

Name: _____ Date: _____ Score: _____ / _____

Use the formula/method guides in the consolidated solutions section. Award method marks where the setup is correct.

Q	Answer / concise method	Marks	Check
1	Constant $k=8 \div 2=4$; $y=4 \times 5=20$.	2	M1 method; A1 answer.
2	Constant $k=18 \div 3=6$; $y=6 \times 7=42$.	2	M1 method; A1 answer.
3	Constant $k=20 \div 4=5$; $y=5 \times 9=45$.	2	M1 method; A1 answer.
4	Constant $k=15 \div 5=3$; $y=3 \times 8=24$.	2	M1 method; A1 answer.
5	Constant $k=14 \div 7=2$; $y=2 \times 11=22$.	2	M1 method; A1 answer.
6	Per person $=240 \div 4=60$ g; for 10: 600 g.	2	M1 method; A1 answer.
7	Per person $=330 \div 6=55$ g; for 15: 825 g.	2	M1 method; A1 answer.
8	Per person $=275 \div 5=55$ g; for 12: 660 g.	2	M1 method; A1 answer.



MODULE 02 / R2, R6, R8, R12

Scale Factors, Similarity and Proportional Relationships

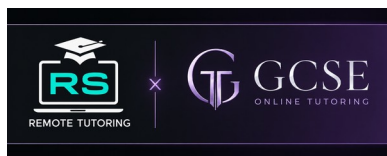
STANDARD HIGHER • PART A - ANSWERS

HIGHER TIER • SHOW CLEAR WORKING • KEEP EXACT VALUES WHERE REQUIRED

Name: _____ Date: _____ Score: _____ / _____

Use the formula/method guides in the consolidated solutions section. Award method marks where the setup is correct.

Q	Answer / concise method	Marks	Check
1	Per cm = $5 \div 2 = 2.5$ km; distance = $7 \times 2.5 = 17.5$ km.	2	M1 method; A1 answer.
2	Per cm = $12 \div 3 = 4$ km; distance = $8 \times 4 = 32$ km.	2	M1 method; A1 answer.
3	Per cm = $18 \div 4 = 4.5$ km; distance = $11 \times 4.5 = 49.5$ km.	2	M1 method; A1 answer.
4	Actual = $3.6 \times 50,000 = 180,000$ cm; $\div 100 = 1800$ m.	3	M1 setup; M1 process; A1 conclusion.
5	Actual = $8.4 \times 25,000 = 210,000$ cm; $\div 100 = 2100$ m.	3	M1 setup; M1 process; A1 conclusion.
6	$6/15 = x/35$; $x = 35 \times 6 \div 15 = 14$.	2	M1 method; A1 answer.



Scale Factors, Similarity and Proportional Relationships

STANDARD HIGHER • PART B - ANSWERS

HIGHER TIER • SHOW CLEAR WORKING • KEEP EXACT VALUES WHERE REQUIRED

Name: _____ Date: _____ Score: _____ / _____

Use the formula/method guides in the consolidated solutions section. Award method marks where the setup is correct.

Q	Answer / concise method	Mark s	Check
7	Machines $\times$ time constant: $8 \times 6 = 48$; time $= 48 \div 12 = 4$ hours.	3	M1 setup; M1 process; A1 conclusion.
8	Actual base $= 2100$ m and height $= 1400$ m. Area $= \frac{1}{2} \times 2100 \times 1400 = 1,470,000 \text{ m}^2 = 147 \text{ ha}$.	5	M1 setup; M2-M4 development; A1 conclusion.
9	Length ratio $= 5:7$, so volume ratio $= 125:343$. Larger volume $= 375 \times 343 / 125 = 1029 \text{ cm}^3$.	5	M1 setup; M2-M4 development; A1 conclusion.
10	$27 \text{ m}^3 = 27,000,000 \text{ cm}^3$. Volume factor $= 27,000,000 / 216 = 125,000 = 50^3$, so $n = 50$.	5	M1 setup; M2-M4 development; A1 conclusion.
11	Original rate per machine-hour $= 5400 / (12 \times 7.5) = 60$. New rate $= 69$. Output $= 8 \times 6 \times 69 = 3312$.	5	M1 setup; M2-M4 development; A1 conclusion.
12	Original sugar $= 420 \times \frac{3}{7} = 180 \text{ g}$. Scale by $30/18 = 5/3$ gives 300 g ; add 10% gives 330 g .	5	M1 setup; M2-M4 development; A1 conclusion.



Scale Factors, Similarity and Proportional Relationships

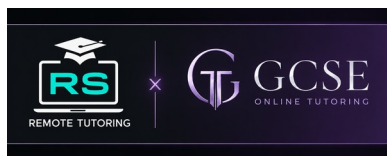
MULTI-STEP HIGHER • PART A - ANSWERS

HIGHER TIER • SHOW CLEAR WORKING • KEEP EXACT VALUES WHERE REQUIRED

Name: _____ Date: _____ Score: ____ / ____

Use the formula/method guides in the consolidated solutions section. Award method marks where the setup is correct.

Q	Answer / concise method	Mark s	Check
1	Amount= $420 \times 14/6 = 980$ g.	3	M1 setup; M1 process; A1 conclusion.
2	Amount= $600 \times 20/8 = 1500$ g.	3	M1 setup; M1 process; A1 conclusion.
3	Amount= $350 \times 18/5 = 1260$ g.	3	M1 setup; M1 process; A1 conclusion.
4	$6.5 \times 40,000 = 260,000$ cm; $\div 100,000 = 2.6$ km.	3	M1 setup; M1 process; A1 conclusion.
5	$4.8 \times 125,000 = 600,000$ cm; $\div 100,000 = 6$ km.	3	M1 setup; M1 process; A1 conclusion.
6	$9.2 \times 20,000 = 184,000$ cm; $\div 100,000 = 1.84$ km.	3	M1 setup; M1 process; A1 conclusion.
7	$k = y/x = 30 \div 4 = 7.5$; $y = kx = 7.5 \times 11 = 82.5$.	3	M1 setup; M1 process; A1 conclusion.
8	$k = y/x = 42 \div 6 = 7$; $y = kx = 7 \times 15 = 105$.	3	M1 setup; M1 process; A1 conclusion.



Scale Factors, Similarity and Proportional Relationships

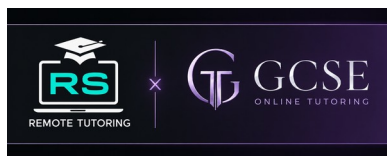
MULTI-STEP HIGHER • PART B - ANSWERS

HIGHER TIER • SHOW CLEAR WORKING • KEEP EXACT VALUES WHERE REQUIRED

Name: _____ Date: _____ Score: ____ / ____

Use the formula/method guides in the consolidated solutions section. Award method marks where the setup is correct.

Q	Answer / concise method	Marks	Check
9	$k=y/x=52\div8=6.5$; $y=kx=6.5\times18=117$.	3	M1 setup; M1 process; A1 conclusion.
10	Inverse proportion: total worker-hours= $5\times12=60$; time= $60\div8=7.5$ hours.	3	M1 setup; M1 process; A1 conclusion.
11	Inverse proportion: total worker-hours= $6\times15=90$; time= $90\div10=9$ hours.	3	M1 setup; M1 process; A1 conclusion.
12	Inverse proportion: total worker-hours= $4\times21=84$; time= $84\div7=12$ hours.	3	M1 setup; M1 process; A1 conclusion.
13	Scale factor= $5/2=2.5$; width= $8\times2.5=20$ cm.	2	M1 method; A1 answer.
14	$18\times24=432$ cm=4.32 m.	3	M1 setup; M1 process; A1 conclusion.
15	Unit cost= $\pounds8.40\div3.5=\pounds2.40/\text{kg}$; cost= $6\times\pounds2.40=\pounds14.40$.	4	M1 setup; M1 development; A1 accuracy; A1 conclusion.



Scale Factors, Similarity and Proportional Relationships

GRADE 7-9 CHALLENGE - ANSWERS

HIGHER TIER • SHOW CLEAR WORKING • KEEP EXACT VALUES WHERE REQUIRED

Name: _____ Date: _____ Score: ____ / ____

Use the formula/method guides in the consolidated solutions section. Award method marks where the setup is correct.

Q	Answer / concise method	Mark s	Check
1	3 parts=1.8 kg; one part=0.6 kg; total 10 parts=6 kg.	4	M1 setup; M1 development; A1 accuracy; A1 conclusion.
2	Sides=2100 m and 1800 m; area=3,780,000 m ² =378 ha.	5	M1 setup; M2-M4 development; A1 conclusion.
3	$k=7.5/12=0.625$; $x=18.75/0.625=30$.	4	M1 setup; M1 development; A1 accuracy; A1 conclusion.
4	$pq=72$; $p=72/10=7.2$.	4	M1 setup; M1 development; A1 accuracy; A1 conclusion.
5	Distance constant= $50 \times 6=300$ miles; time= $300 \div 75=4$ hours.	4	M1 setup; M1 development; A1 accuracy; A1 conclusion.
6	Actual length=12 m. Width= $48 \div 12=4$ m=400 cm; plan width= $400 \div 200=2$ cm.	5	M1 setup; M2-M4 development; A1 conclusion.
7	Work= $12 \times 35=420$ pump-min. Done=120; left=300. Seven pumps take $300/7=42 \frac{6}{7}$ min; total= $52 \frac{6}{7}$ min ≈ 52.9 .	5	M1 setup; M2-M4 development; A1 conclusion.
8	Milk per portion= $300/8=37.5$ ml; $1650/37.5=44$ portions.	4	M1 setup; M1 development; A1 accuracy; A1 conclusion.
9	Area scale factor= $1.5^2=2.25$; new area= $32 \times 2.25=72$ cm ² .	4	M1 setup; M1 development; A1 accuracy; A1 conclusion.
10	Same multiplier 1.20; $y=45 \times 1.2=54$.	3	M1 setup; M1 process; A1 conclusion.



Direct and Inverse Proportion

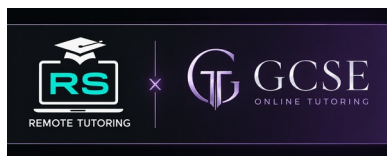
FLUENCY CHECK - ANSWERS

HIGHER TIER • SHOW CLEAR WORKING • KEEP EXACT VALUES WHERE REQUIRED

Name: _____ Date: _____ Score: ____ / ____

Use the formula/method guides in the consolidated solutions section. Award method marks where the setup is correct.

Q	Answer / concise method	Mark s	Check
1	$y=kx^2$.	1	B1: correct result or statement.
2	$y=k/x$.	1	B1: correct result or statement.
3	$16=k \times 8$, so $k=2$.	2	M1 method; A1 answer.
4	$p=k/q^2$, so $k=pq^2=20$.	2	M1 method; A1 answer.
5	A straight line through the origin with positive gradient k .	1	B1: correct result or statement.
6	y changes by $3^2=9$.	2	M1 method; A1 answer.
7	y doubles.	2	M1 method; A1 answer.
8	$y=18/12=1.5$.	2	M1 method; A1 answer.



Direct and Inverse Proportion

STANDARD HIGHER • PART A - ANSWERS

HIGHER TIER • SHOW CLEAR WORKING • KEEP EXACT VALUES WHERE REQUIRED

Name: _____ Date: _____ Score: ____ / ____

Use the formula/method guides in the consolidated solutions section. Award method marks where the setup is correct.

Q	Answer / concise method	Mark s	Check
1	$y=kx^2$; $k=20/4=5$. Hence $y=5 \times 25=125$.	4	M1 setup; M1 development; A1 accuracy; A1 conclusion.
2	$y=kx^2$; $k=54/9=6$. Hence $y=6 \times 49=294$.	4	M1 setup; M1 development; A1 accuracy; A1 conclusion.
3	$y=kx^2$; $k=48/16=3$. Hence $y=3 \times 100=300$.	4	M1 setup; M1 development; A1 accuracy; A1 conclusion.
4	$y=kx^2$; $k=75/25=3$. Hence $y=3 \times 64=192$.	4	M1 setup; M1 development; A1 accuracy; A1 conclusion.
5	$y=k/x^2$; $k=32 \times 2^2=128$. Hence $y=128/16=8$.	4	M1 setup; M1 development; A1 accuracy; A1 conclusion.
6	$y=k/x^2$; $k=12 \times 3^2=108$. Hence $y=108/36=3$.	4	M1 setup; M1 development; A1 accuracy; A1 conclusion.



Direct and Inverse Proportion

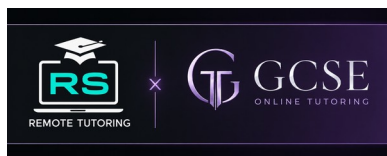
STANDARD HIGHER • PART B - ANSWERS

HIGHER TIER • SHOW CLEAR WORKING • KEEP EXACT VALUES WHERE REQUIRED

Name: _____ Date: _____ Score: ____ / ____

Use the formula/method guides in the consolidated solutions section. Award method marks where the setup is correct.

Q	Answer / concise method	Mark s	Check
7	$y=k/x^2$; $k=20 \times 5^2=500$. Hence $y=500/100=5$.	4	M1 setup; M1 development; A1 accuracy; A1 conclusion.
8	$y=k/x^2$; $k=45 \times 4^2=720$. Hence $y=720/36=20$.	4	M1 setup; M1 development; A1 accuracy; A1 conclusion.
9	$2^n=8=2^3$, so $n=3$.	3	M1 setup; M1 process; A1 conclusion.
10	$192/12=16=2^4$, so $n=4$.	3	M1 setup; M1 process; A1 conclusion.
11	Gradient $k=45/9=5$, so $y=5x^2=125$.	4	M1 setup; M1 development; A1 accuracy; A1 conclusion.
12	If $y=k/x$, then $y=k(1/x)$; the plot is a straight line through the origin.	3	M1 setup; M1 process; A1 conclusion.



Direct and Inverse Proportion

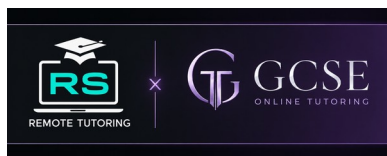
MULTI-STEP HIGHER • PART A - ANSWERS

HIGHER TIER • SHOW CLEAR WORKING • KEEP EXACT VALUES WHERE REQUIRED

Name: _____ Date: _____ Score: ____ / ____

Use the formula/method guides in the consolidated solutions section. Award method marks where the setup is correct.

Q	Answer / concise method	Mark s	Check
1	$d = kv^2$. Multiplier $= (10/4)^2 = 25/4$; $d = 18 \times 25/4 = 225/2$ m.	5	M1 setup; M2-M4 development; A1 conclusion.
2	$d = kv^2$. Multiplier $= (15/6)^2 = 25/4$; $d = 30 \times 25/4 = 375/2$ m.	5	M1 setup; M2-M4 development; A1 conclusion.
3	$d = kv^2$. Multiplier $= (20/8)^2 = 25/4$; $d = 50 \times 25/4 = 625/2$ m.	5	M1 setup; M2-M4 development; A1 conclusion.
4	$d = kv^2$. Multiplier $= (12/5)^2 = 144/25$; $d = 24 \times 144/25 = 3456/25$ m.	5	M1 setup; M2-M4 development; A1 conclusion.
5	$d = kv^2$. Multiplier $= (9/3)^2 = 9$; $d = 14 \times 9 = 126$ m.	5	M1 setup; M2-M4 development; A1 conclusion.
6	Total work $= 6 \times 14 = 84$ machine-hours. Work done $= 30$; remaining $= 54$. Four machines need 13.5 h; total $= 18.5$ h.	5	M1 setup; M2-M4 development; A1 conclusion.
7	$ld^2 = k = 72 \times 25 = 1800$. $8d^2 = 1800$, so $d^2 = 225$ and $d = 15$.	5	M1 setup; M2-M4 development; A1 conclusion.
8	Mass ratio $= 1080/320 = 27/8 = (3/2)^3$, so radius factor $= 3/2$ and radius $= 6$ cm.	5	M1 setup; M2-M4 development; A1 conclusion.



Direct and Inverse Proportion

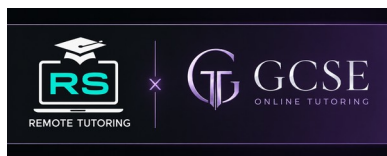
MULTI-STEP HIGHER • PART B - ANSWERS

HIGHER TIER • SHOW CLEAR WORKING • KEEP EXACT VALUES WHERE REQUIRED

Name: _____ Date: _____ Score: ____ / ____

Use the formula/method guides in the consolidated solutions section. Award method marks where the setup is correct.

Q	Answer / concise method	Mark s	Check
9	$y=kx^2/z$. $k=24 \times 2/16=3$. Then $y=3 \times 100/5=60$.	5	M1 setup; M2-M4 development; A1 conclusion.
10	$p=k\sqrt{q}$; $k=18/4=4.5$. $\sqrt{q}=45/4.5=10$, so $q=100$.	4	M1 setup; M1 development; A1 accuracy; A1 conclusion.
11	Gradient $=(68-38)/(8-3)=6$; $C=6t+20$. At 12 h, $C=£92$.	5	M1 setup; M2-M4 development; A1 conclusion.
12	$xy=60$ at both points; equation $y=60/x$.	4	M1 setup; M1 development; A1 accuracy; A1 conclusion.
13	$k=7.2 \times 25=180$. $20=180/x^2$, so $x^2=9$ and $x=\pm 3$.	5	M1 setup; M2-M4 development; A1 conclusion.
14	T multiplier $=\sqrt{1.44}=1.2$, so T increases by 20%.	4	M1 setup; M1 development; A1 accuracy; A1 conclusion.
15	Need new x factor a with $1/a^3=1/2$, so $a=\sqrt[3]{2} \approx 1.2599$; increase $\approx 26.0\%$.	5	M1 setup; M2-M4 development; A1 conclusion.



Direct and Inverse Proportion

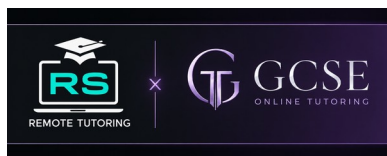
GRADE 7-9 CHALLENGE - ANSWERS

HIGHER TIER • SHOW CLEAR WORKING • KEEP EXACT VALUES WHERE REQUIRED

Name: _____ Date: _____ Score: ____ / ____

Use the formula/method guides in the consolidated solutions section. Award method marks where the setup is correct.

Q	Answer / concise method	Mark s	Check
1	$486/6=81=(6/2)^n=3^n$, so $n=4$. $k=6/2^4=3/8$.	5	M1 setup; M2-M4 development; A1 conclusion.
2	Ratio multiplier $= (15/6)^2(3/5)^3 = 25/4 \times 27/125 = 27/20$. $p=13.5$.	5	M1 setup; M2-M4 development; A1 conclusion.
3	Combined 8 parts completes $1/12$ job/h, so one part $= 1/96$. A rate $= 1/32$, B $= 5/96$; times 32 h and $96/5 = 19.2$ h.	5	M1 setup; M2-M4 development; A1 conclusion.
4	Volume multiplier $= 1.728 = 1.2^3$. Multiplier $= (1.728)^{(2/3)} = 1.2^2 = 1.44$; increase $= 44\%$.	5	M1 setup; M2-M4 development; A1 conclusion.
5	New x multiplier $= .64 = 1/a^2$, so $a = 1/0.8 = 1.25$; $p = 25\%$.	5	M1 setup; M2-M4 development; A1 conclusion.
6	$k=36$; B $= (8, 4.5)$. Gradient $= (4.5-18)/(8-2) = -13.5/6 = -2.25$.	5	M1 setup; M2-M4 development; A1 conclusion.
7	$V = \pi r^2 h$ fixed, so $h = V/(\pi r^2) \propto 1/r^2$. Doubling r divides h by 4: 7.5 cm.	5	M1 setup; M2-M4 development; A1 conclusion.
8	$432/16 = 27 = 3^3$, consistent. $k = 16/a^3$.	4	M1 setup; M1 development; A1 accuracy; A1 conclusion.
9	Multiplier $= 1.12^2 = 1.2544$, so increase $= 25.44\%$.	4	M1 setup; M1 development; A1 accuracy; A1 conclusion.
10	At $x=2$, $4a=b/2$, so $b=8a$. $ax^2=8(8a/x)$; $x^3=64$, so $x=4$.	5	M1 setup; M2-M4 development; A1 conclusion.



Percentages, Growth and Decay

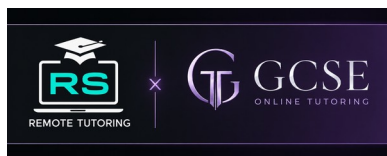
FLUENCY CHECK - ANSWERS

HIGHER TIER • SHOW CLEAR WORKING • KEEP EXACT VALUES WHERE REQUIRED

Name: _____ Date: _____ Score: ____ / ____

Use the formula/method guides in the consolidated solutions section. Award method marks where the setup is correct.

Q	Answer / concise method	Mark s	Check
1	Multiplier= $1+15/100=1.15$; new= $240 \times 1.15 = £276.00$.	2	M1 method; A1 answer.
2	Multiplier= $1+8/100=1.08$; new= $360 \times 1.08 = £388.80$.	2	M1 method; A1 answer.
3	Multiplier= $1+12/100=1.12$; new= $1250 \times 1.12 = £1400.00$.	2	M1 method; A1 answer.
4	Multiplier= $1+25/100=1.25$; new= $84 \times 1.25 = £105.00$.	2	M1 method; A1 answer.
5	Multiplier= $1+35/100=1.35$; new= $560 \times 1.35 = £756.00$.	2	M1 method; A1 answer.
6	Multiplier= $1-20/100=0.8$; new= $180 \times 0.8 = £144.00$.	2	M1 method; A1 answer.
7	Multiplier= $1-12/100=0.88$; new= $450 \times 0.88 = £396.00$.	2	M1 method; A1 answer.
8	Multiplier= $1-15/100=0.85$; new= $96 \times 0.85 = £81.60$.	2	M1 method; A1 answer.



Percentages, Growth and Decay

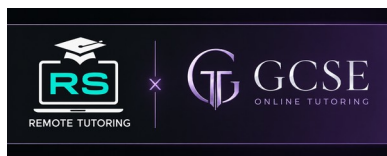
STANDARD HIGHER • PART A - ANSWERS

HIGHER TIER • SHOW CLEAR WORKING • KEEP EXACT VALUES WHERE REQUIRED

Name: _____ Date: _____ Score: ____ / ____

Use the formula/method guides in the consolidated solutions section. Award method marks where the setup is correct.

Q	Answer / concise method	Mark s	Check
1	Multiplier = $1 - 5/100 = 0.95$; new = $720 \times 0.95 = \text{£}684.00$.	2	M1 method; A1 answer.
2	Multiplier = $1 - 32/100 = 0.68$; new = $250 \times 0.68 = \text{£}170.00$.	2	M1 method; A1 answer.
3	Change = 12; percentage = $12/80 \times 100 = 15\%$.	2	M1 method; A1 answer.
4	Change = 80; $80/640 \times 100 = 12.5\%$.	2	M1 method; A1 answer.
5	Original = $56 \div 0.80 = \text{£}70$.	3	M1 setup; M1 process; A1 conclusion.
6	Original = $138 \div 1.15 = \text{£}120$.	3	M1 setup; M1 process; A1 conclusion.



Percentages, Growth and Decay

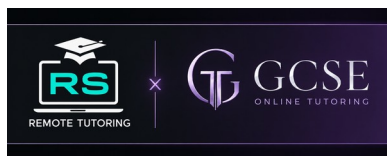
STANDARD HIGHER • PART B - ANSWERS

HIGHER TIER • SHOW CLEAR WORKING • KEEP EXACT VALUES WHERE REQUIRED

Name: _____ Date: _____ Score: ____ / ____

Use the formula/method guides in the consolidated solutions section. Award method marks where the setup is correct.

Q	Answer / concise method	Mark s	Check
7	Interest = $900 \times 0.04 \times 3 = \text{£}108$.	3	M1 setup; M1 process; A1 conclusion.
8	$1.12(1-p/100) = 0.952$, so $1-p/100 = 0.85$ and $p = 15$.	4	M1 setup; M1 development; A1 accuracy; A1 conclusion.
9	Solve $8000(1+r)^5 = 10648.80$. The ratio is $1.3311 = 1.1^3$? Testing gives $(10648.8/8000)^{(1/5)} \approx 1.0588$, so rate $\approx 5.88\%$.	5	M1 setup; M2-M4 development; A1 conclusion.
10	Need $0.92^n < 0.60$. $0.92^6 \approx 0.6064$ and $0.92^7 \approx 0.5578$, so $n = 7$.	5	M1 setup; M2-M4 development; A1 conclusion.
11	Multiplier = $1.35 \times 0.82 = 1.107$. Final is 110.7% of cost, so profit = 10.7%.	4	M1 setup; M1 development; A1 accuracy; A1 conclusion.
12	Value = $48000 \times 0.78 \times 0.86^3 = \text{£}23,813.94$ (nearest penny).	5	M1 setup; M2-M4 development; A1 conclusion.



Percentages, Growth and Decay

MULTI-STEP HIGHER • PART A - ANSWERS

HIGHER TIER • SHOW CLEAR WORKING • KEEP EXACT VALUES WHERE REQUIRED

Name: _____ Date: _____ Score: ____ / ____

Use the formula/method guides in the consolidated solutions section. Award method marks where the setup is correct.

Q	Answer / concise method	Mark s	Check
1	Final = $500 \times 1.04^3 = £562.43$.	4	M1 setup; M1 development; A1 accuracy; A1 conclusion.
2	Final = $1200 \times 1.03^5 = £1391.13$.	4	M1 setup; M1 development; A1 accuracy; A1 conclusion.
3	Final = $850 \times 1.06^2 = £955.06$.	4	M1 setup; M1 development; A1 accuracy; A1 conclusion.
4	Final = $2000 \times 1.025^4 = £2207.63$.	4	M1 setup; M1 development; A1 accuracy; A1 conclusion.
5	Value = $24000 \times 0.88^3 = £16355.33$.	4	M1 setup; M1 development; A1 accuracy; A1 conclusion.
6	Value = $1800 \times 0.82^2 = £1210.32$.	4	M1 setup; M1 development; A1 accuracy; A1 conclusion.
7	Value = $650 \times 0.91^4 = £445.74$.	4	M1 setup; M1 development; A1 accuracy; A1 conclusion.
8	$160 \times 1.25 \times 0.80 = £160$; the changes cancel for this pair of multipliers.	4	M1 setup; M1 development; A1 accuracy; A1 conclusion.



Percentages, Growth and Decay

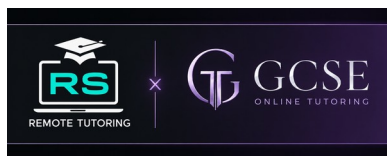
MULTI-STEP HIGHER • PART B - ANSWERS

HIGHER TIER • SHOW CLEAR WORKING • KEEP EXACT VALUES WHERE REQUIRED

Name: _____ Date: _____ Score: ____ / ____

Use the formula/method guides in the consolidated solutions section. Award method marks where the setup is correct.

Q	Answer / concise method	Mark s	Check
9	Increase= $28000 \times 0.035 = \pounds 980$; new= $\pounds 28,980$.	3	M1 setup; M1 process; A1 conclusion.
10	$72 \times 1.20 = \pounds 86.40$.	2	M1 method; A1 answer.
11	$91 \div 0.70 = \pounds 130$.	3	M1 setup; M1 process; A1 conclusion.
12	Change= 4320 ; $4320/48000 \times 100 = 9\%$.	3	M1 setup; M1 process; A1 conclusion.
13	Multiplier= $1.05 \times 1.08 = 1.134$; increase= 13.4% .	4	M1 setup; M1 development; A1 accuracy; A1 conclusion.
14	Multiplier= $0.90 \times 0.85 = 0.765$; decrease= 23.5% .	4	M1 setup; M1 development; A1 accuracy; A1 conclusion.
15	rate= $150/(750 \times 5) = 0.04 = 4\%$.	4	M1 setup; M1 development; A1 accuracy; A1 conclusion.



Percentages, Growth and Decay

GRADE 7-9 CHALLENGE - ANSWERS

HIGHER TIER • SHOW CLEAR WORKING • KEEP EXACT VALUES WHERE REQUIRED

Name: _____ Date: _____ Score: ____ / ____

Use the formula/method guides in the consolidated solutions section. Award method marks where the setup is correct.

Q	Answer / concise method	Mark s	Check
1	Multiplier= $1.2 \times 0.8 = 0.96$; final is 96% of original, a 4% decrease.	3	M1 setup; M1 process; A1 conclusion.
2	Start= $2205 \div 1.05^2 = \text{£}2000$.	4	M1 setup; M1 development; A1 accuracy; A1 conclusion.
3	Original= $14580 \div 0.9^2 = \text{£}18,000$.	4	M1 setup; M1 development; A1 accuracy; A1 conclusion.
4	$80000 \times 1.03^4 \approx 90040.7$; first exceeds after 4 years.	5	M1 setup; M2-M4 development; A1 conclusion.
5	Principal= $5000 \div 1.04^6 \approx \text{£}3951.57$.	5	M1 setup; M2-M4 development; A1 conclusion.
6	Selling= $75 \times 1.4 \times 0.85 = \text{£}89.25$; profit= $\text{£}14.25$; $14.25/75 \times 100 = 19\%$.	5	M1 setup; M2-M4 development; A1 conclusion.
7	Original= $13778.08 \div 0.82^3 \approx \text{£}24,988.90$.	5	M1 setup; M2-M4 development; A1 conclusion.
8	$1 + p/100 = 1.32$; $p = 32$.	2	M1 method; A1 answer.
9	25% off gives $\text{£}180$; $\text{£}55$ off gives $\text{£}185$; first is cheaper by $\text{£}5$.	4	M1 setup; M1 development; A1 accuracy; A1 conclusion.
10	Compound= $3000 \times 1.038^5 \approx \text{£}3615.00$; simple= $3000 + 3000 \times 0.04 \times 5 = \text{£}3600$; compound by $\text{£}15.00$.	5	M1 setup; M2-M4 development; A1 conclusion.



Compound Measures and Unit Conversions

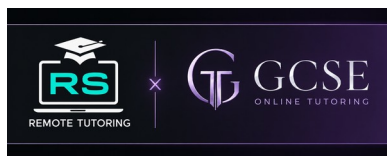
FLUENCY CHECK - ANSWERS

HIGHER TIER • SHOW CLEAR WORKING • KEEP EXACT VALUES WHERE REQUIRED

Name: _____ Date: _____ Score: _____ / _____

Use the formula/method guides in the consolidated solutions section. Award method marks where the setup is correct.

Q	Answer / concise method	Mark s	Check
1	speed=distance÷time=150÷3=50 km/h.	2	M1 method; A1 answer.
2	speed=distance÷time=84÷1.4=60 km/h.	2	M1 method; A1 answer.
3	speed=distance÷time=225÷4.5=50 km/h.	2	M1 method; A1 answer.
4	speed=distance÷time=96÷1.5=64 km/h.	2	M1 method; A1 answer.
5	speed=distance÷time=42÷0.7=60 km/h.	2	M1 method; A1 answer.
6	density=mass÷volume=540÷60=9 g/cm ³ .	2	M1 method; A1 answer.
7	density=mass÷volume=1260÷140=9 g/cm ³ .	2	M1 method; A1 answer.
8	density=mass÷volume=875÷125=7 g/cm ³ .	2	M1 method; A1 answer.



Compound Measures and Unit Conversions

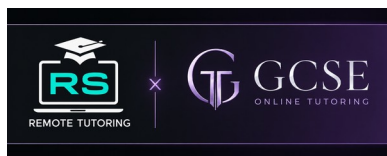
STANDARD HIGHER • PART A - ANSWERS

HIGHER TIER • SHOW CLEAR WORKING • KEEP EXACT VALUES WHERE REQUIRED

Name: _____ Date: _____ Score: _____ / _____

Use the formula/method guides in the consolidated solutions section. Award method marks where the setup is correct.

Q	Answer / concise method	Marks	Check
1	pressure=force÷area=480÷60=8 N/m ² .	2	M1 method; A1 answer.
2	pressure=force÷area=735÷105=7 N/m ² .	2	M1 method; A1 answer.
3	pressure=force÷area=960÷120=8 N/m ² .	2	M1 method; A1 answer.
4	72÷3.6=20 m/s.	2	M1 method; A1 answer.
5	15×3.6=54 km/h.	2	M1 method; A1 answer.
6	18÷2.5=7.2 L/min.	2	M1 method; A1 answer.



Compound Measures and Unit Conversions

STANDARD HIGHER • PART B - ANSWERS

HIGHER TIER • SHOW CLEAR WORKING • KEEP EXACT VALUES WHERE REQUIRED

Name: _____ Date: _____ Score: _____ / _____

Use the formula/method guides in the consolidated solutions section. Award method marks where the setup is correct.

Q	Answer / concise method	Mark s	Check
7	$\pounds 3.60 \div 7.5 = \pounds 0.48$ per 100 g.	2	M1 method; A1 answer.
8	Total time = $300/75 = 4$ h. First time = 1.5 h, so second time = 2.5 h. $v = 180/2.5 = 72$ km/h.	5	M1 setup; M2-M4 development; A1 conclusion.
9	Metal volume = $12 \times 9 \times 7 - 10 \times 7 \times 5 = 756 - 350 = 406$ cm ³ . Mass = 3336 g. Density = $3336/406 \approx 8.22$ g/cm ³ .	5	M1 setup; M2-M4 development; A1 conclusion.
10	Force = 4800 N; radius = 0.035 m; area = $\pi(0.035)^2$. Pressure = $4800/[\pi(0.035)^2] \approx 1.25 \times 10^6$ N/m ² .	5	M1 setup; M2-M4 development; A1 conclusion.
11	Net rate = $18 - 5.5 = 12.5$ L/min. Time = $625/12.5 = 50$ min.	4	M1 setup; M1 development; A1 accuracy; A1 conclusion.
12	Fuel = $7.2 \times 4.25 = 30.6$ L. Cost = $30.6 \times 1.56 = \pounds 47.736 \approx \pounds 47.74$. Shares before penny adjustment: $\pounds 28.6416$ and $\pounds 19.0944$, so $\pounds 28.64$ and $\pounds 19.10$.	5	M1 setup; M2-M4 development; A1 conclusion.



Compound Measures and Unit Conversions

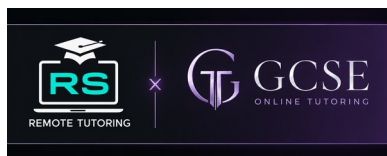
MULTI-STEP HIGHER • PART A - ANSWERS

HIGHER TIER • SHOW CLEAR WORKING • KEEP EXACT VALUES WHERE REQUIRED

Name: _____ Date: _____ Score: ____ / ____

Use the formula/method guides in the consolidated solutions section. Award method marks where the setup is correct.

Q	Answer / concise method	Mark s	Check
1	distance=speed×time=68×2.75=187 km.	3	M1 setup; M1 process; A1 conclusion.
2	distance=speed×time=52×3.5=182 km.	3	M1 setup; M1 process; A1 conclusion.
3	distance=speed×time=75×1.8=135 km.	3	M1 setup; M1 process; A1 conclusion.
4	time=distance÷speed=315÷70=4.5 hours.	3	M1 setup; M1 process; A1 conclusion.
5	time=distance÷speed=264÷48=5.5 hours.	3	M1 setup; M1 process; A1 conclusion.
6	time=distance÷speed=187.5÷62.5=3 hours.	3	M1 setup; M1 process; A1 conclusion.
7	mass=density×volume=7.8×45=351 g.	3	M1 setup; M1 process; A1 conclusion.
8	1.26 kg=1260 g; volume=mass÷density=1260÷0.9=1400 cm ³ .	4	M1 setup; M1 development; A1 accuracy; A1 conclusion.



Compound Measures and Unit Conversions

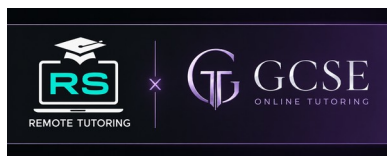
MULTI-STEP HIGHER • PART B - ANSWERS

HIGHER TIER • SHOW CLEAR WORKING • KEEP EXACT VALUES WHERE REQUIRED

Name: _____ Date: _____ Score: _____ / _____

Use the formula/method guides in the consolidated solutions section. Award method marks where the setup is correct.

Q	Answer / concise method	Mark s	Check
9	force=pressure $\times$ area=2400 $\times$ 0.35=840 N.	3	M1 setup; M1 process; A1 conclusion.
10	area=force $\div$ pressure=1500 $\div$ 6000=0.25 m ² .	3	M1 setup; M1 process; A1 conclusion.
11	£4.35 $\div$ 1.5=£2.90/kg; £2.70 $\div$ 0.9=£3/kg; 1.5 kg bag.	4	M1 setup; M1 development; A1 accuracy; A1 conclusion.
12	Rate=30 L/min; in 60 min=1800 L.	3	M1 setup; M1 process; A1 conclusion.
13	45 min=0.75 h; speed=18 $\div$ 0.75=24 km/h.	3	M1 setup; M1 process; A1 conclusion.
14	Times 2 h and 2 h; total 300 km/4 h=75 km/h.	5	M1 setup; M2-M4 development; A1 conclusion.
15	840 $\div$ 12=70 pages/min; 70 $\div$ 60=7/6 $\approx$ 1.17 pages/s.	3	M1 setup; M1 process; A1 conclusion.



Compound Measures and Unit Conversions

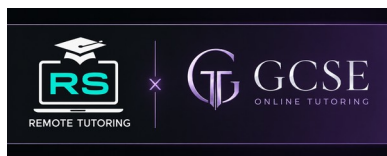
GRADE 7-9 CHALLENGE - ANSWERS

HIGHER TIER • SHOW CLEAR WORKING • KEEP EXACT VALUES WHERE REQUIRED

Name: _____ Date: _____ Score: ____ / ____

Use the formula/method guides in the consolidated solutions section. Award method marks where the setup is correct.

Q	Answer / concise method	Mark s	Check
1	Times= $5/12$ h and $3/9=1/3$ h; total= $3/4$ h; average= $8 \div 0.75=10 \frac{2}{3}$ km/h.	5	M1 setup; M2-M4 development; A1 conclusion.
2	Volume= 120 cm^3 ; density= $936 \div 120=7.8 \text{ g/cm}^3$.	4	M1 setup; M1 development; A1 accuracy; A1 conclusion.
3	Material volume= 180 cm^3 ; mass= 1440 g ; density= 8 g/cm^3 .	5	M1 setup; M2-M4 development; A1 conclusion.
4	$18 \text{ kN}=18000 \text{ N}$; area= 0.15 m^2 ; pressure= 120000 N/m^2 .	4	M1 setup; M1 development; A1 accuracy; A1 conclusion.
5	Times= 2 h and 3 h; total distance= 300 ; average= $300/5=60 \text{ km/h}$.	5	M1 setup; M2-M4 development; A1 conclusion.
6	Gallons= $235/47=5$; litres= 22.5 ; cost= $22.5 \times 1.52=\text{£}34.20$.	5	M1 setup; M2-M4 development; A1 conclusion.
7	Net rate= 24.5 L/min ; time= $980/24.5=40 \text{ min}$.	4	M1 setup; M1 development; A1 accuracy; A1 conclusion.
8	Net= 13 L/min ; time= $520/13=40 \text{ min}$.	4	M1 setup; M1 development; A1 accuracy; A1 conclusion.
9	Mass= 5400 g ; volume= $5400/2.7=2000 \text{ cm}^3$; height= $2000/(300)=6 \frac{2}{3} \text{ cm}$.	5	M1 setup; M2-M4 development; A1 conclusion.
10	Old rate= $150/\text{h}$; new= $168/\text{h}$; in $8 \text{ h}=1344 \text{ items}$.	4	M1 setup; M1 development; A1 accuracy; A1 conclusion.



Rates of Change and Gradients

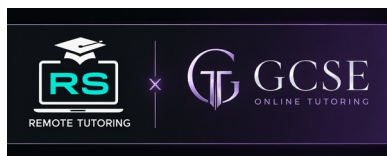
FLUENCY CHECK - ANSWERS

HIGHER TIER • SHOW CLEAR WORKING • KEEP EXACT VALUES WHERE REQUIRED

Name: _____ Date: _____ Score: ____ / ____

Use the formula/method guides in the consolidated solutions section. Award method marks where the setup is correct.

Q	Answer / concise method	Mark s	Check
1	$(23-5)/(8-2)=3.$	2	M1 method; A1 answer.
2	$75/5=15 \text{ m/s.}$	2	M1 method; A1 answer.
3	Speed.	1	B1: correct result or statement.
4	Acceleration.	1	B1: correct result or statement.
5	4.	1	B1: correct result or statement.
6	$(36-4)/(6-2)=8.$	3	M1 setup; M1 process; A1 conclusion.
7	-30 per year.	2	M1 method; A1 answer.
8	Gradient=change in distance/change in time, so steeper means more distance per unit time.	2	M1 method; A1 answer.



Rates of Change and Gradients

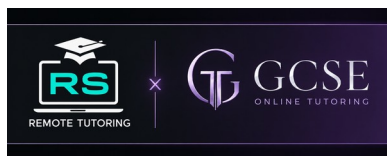
STANDARD HIGHER • PART A - ANSWERS

HIGHER TIER • SHOW CLEAR WORKING • KEEP EXACT VALUES WHERE REQUIRED

Name: _____ Date: _____ Score: ____ / ____

Use the formula/method guides in the consolidated solutions section. Award method marks where the setup is correct.

Q	Answer / concise method	Mark s	Check
1	$[f(5)-f(1)]/(5-1)=(25-1)/(4)=6.$	4	M1 setup; M1 development; A1 accuracy; A1 conclusion.
2	$[f(7)-f(2)]/(7-2)=(49-4)/(5)=9.$	4	M1 setup; M1 development; A1 accuracy; A1 conclusion.
3	$[f(9)-f(3)]/(9-3)=(81-9)/(6)=12.$	4	M1 setup; M1 development; A1 accuracy; A1 conclusion.
4	$[f(10)-f(4)]/(10-4)=(100-16)/(6)=14.$	4	M1 setup; M1 development; A1 accuracy; A1 conclusion.
5	Tangent gradient= $(27-7)/(7-2)=4.$	3	M1 setup; M1 process; A1 conclusion.
6	$(28-12)/8=2 \text{ m/s}^2.$	3	M1 setup; M1 process; A1 conclusion.



Rates of Change and Gradients

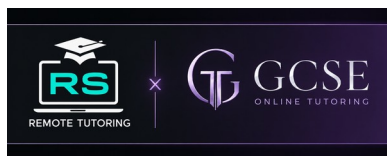
STANDARD HIGHER • PART B - ANSWERS

HIGHER TIER • SHOW CLEAR WORKING • KEEP EXACT VALUES WHERE REQUIRED

Name: _____ Date: _____ Score: ____ / ____

Use the formula/method guides in the consolidated solutions section. Award method marks where the setup is correct.

Q	Answer / concise method	Mark s	Check
7	$(6.5-8.2) \times 10^6 / 20 = -85,000 \text{ L/day.}$	3	M1 setup; M1 process; A1 conclusion.
8	$(1050-240)/(45-15) = 810/30 = 27 \text{ m/s.}$	3	M1 setup; M1 process; A1 conclusion.
9	At that instant, temperature is decreasing at 3.5 degrees per unit time.	3	M1 setup; M1 process; A1 conclusion.
10	y was increasing; when gradient is zero it is instantaneously stationary/at a turning or flat point.	3	M1 setup; M1 process; A1 conclusion.
11	$[500\pi/3 - 32\pi/3]/3 = 52\pi.$	4	M1 setup; M1 development; A1 accuracy; A1 conclusion.
12	1 to 3:4; 3 to 5:8. The rate of increase is greater on the second interval.	4	M1 setup; M1 development; A1 accuracy; A1 conclusion.



Rates of Change and Gradients

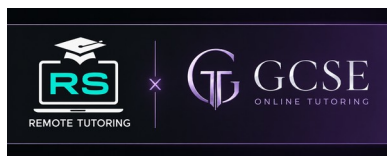
MULTI-STEP HIGHER • PART A - ANSWERS

HIGHER TIER • SHOW CLEAR WORKING • KEEP EXACT VALUES WHERE REQUIRED

Name: _____ Date: _____ Score: ____ / ____

Use the formula/method guides in the consolidated solutions section. Award method marks where the setup is correct.

Q	Answer / concise method	Mark s	Check
1	Total distance=1200 m; total time=60 s; average=20 m/s.	4	M1 setup; M1 development; A1 accuracy; A1 conclusion.
2	$a=(26-8)/9=2 \text{ m/s}^2$. Average velocity= $(8+26)/2=17 \text{ m/s}$; distance=153 m.	5	M1 setup; M2-M4 development; A1 conclusion.
3	Gradient= $(9.61-8.41)/0.2=6$.	4	M1 setup; M1 development; A1 accuracy; A1 conclusion.
4	Values 6.859 and 9.261. Gradient= $(9.261-6.859)/0.2=12.01$.	5	M1 setup; M2-M4 development; A1 conclusion.
5	$V(3)=4640, V(7)=3040$. Change= -1600 over 4 min= -400 L/min .	4	M1 setup; M1 development; A1 accuracy; A1 conclusion.
6	$h(1)=15, h(3)=15$; average= 0 m/s . Net height change is zero though the ball moved.	4	M1 setup; M1 development; A1 accuracy; A1 conclusion.
7	Gradient= $(525-900)/(9-4)=-75 \text{ units/time}$.	4	M1 setup; M1 development; A1 accuracy; A1 conclusion.
8	$[2000(1.04^8)-2000(1.04^3)]/5 \approx 104.2 \text{ people/year}$.	5	M1 setup; M2-M4 development; A1 conclusion.



Rates of Change and Gradients

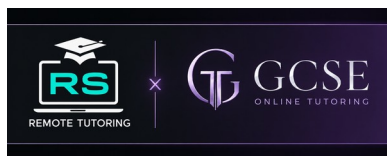
MULTI-STEP HIGHER • PART B - ANSWERS

HIGHER TIER • SHOW CLEAR WORKING • KEEP EXACT VALUES WHERE REQUIRED

Name: _____ Date: _____ Score: ____ / ____

Use the formula/method guides in the consolidated solutions section. Award method marks where the setup is correct.

Q	Answer / concise method	Mark s	Check
9	For distance $2d$, time $=d/8+d/12=5d/24$. Average $=2d/(5d/24)=48/5=9.6$ m/s.	5	M1 setup; M2-M4 development; A1 conclusion.
10	Gradient is density 7.8 g/cm ³ . Mass $=7.8 \times 45 = 351$ g.	4	M1 setup; M1 development; A1 accuracy; A1 conclusion.
11	P values 300 and 120. Rate $=(120-300)/6=-30$ pressure units per area unit.	4	M1 setup; M1 development; A1 accuracy; A1 conclusion.
12	22 is instantaneous speed at $t=10$; 19 is average speed over the interval. Varying speed makes them differ.	4	M1 setup; M1 development; A1 accuracy; A1 conclusion.
13	$A(4)=64, A(9)=99$; rate $=35/5=7$.	4	M1 setup; M1 development; A1 accuracy; A1 conclusion.
14	First $=-3.6^\circ\text{C}/\text{min}$; second $=-1.2^\circ\text{C}/\text{min}$. Cooling is three times as fast initially.	4	M1 setup; M1 development; A1 accuracy; A1 conclusion.
15	Gradient $=-3.2/0.4=-8$. A large triangle reduces reading/rounding error.	4	M1 setup; M1 development; A1 accuracy; A1 conclusion.



Rates of Change and Gradients

GRADE 7-9 CHALLENGE - ANSWERS

HIGHER TIER • SHOW CLEAR WORKING • KEEP EXACT VALUES WHERE REQUIRED

Name: _____ Date: _____ Score: ____ / ____

Use the formula/method guides in the consolidated solutions section. Award method marks where the setup is correct.

Q	Answer / concise method	Mark s	Check
1	$(b^2 - a^2)/(b - a) = (b - a)(a + b)/(b - a) = a + b.$	5	M1 setup; M2-M4 development; A1 conclusion.
2	$(b^3 - a^3)/(b - a) = a^2 + ab + b^2.$	5	M1 setup; M2-M4 development; A1 conclusion.
3	Equal times make distances proportional to speeds; average = $(40 + 60 + 80)/3 = 60$ km/h.	4	M1 setup; M1 development; A1 accuracy; A1 conclusion.
4	For distance d each, time = $d(1/40 + 1/60 + 1/80) = 13d/240$. Average = $3d/(13d/240) = 720/13 \approx 55.4$ km/h.	5	M1 setup; M2-M4 development; A1 conclusion.
5	A local maximum: curve increases, is horizontal, then decreases.	4	M1 setup; M1 development; A1 accuracy; A1 conclusion.
6	$V = 4/3\pi r^3$; equal increases in r produce increasingly large volume changes, so the gradient of V against time increases.	4	M1 setup; M1 development; A1 accuracy; A1 conclusion.
7	$(1/k - 1/2)/(k - 2) = -1/(2k) = -1/12$, so $k = 6$.	5	M1 setup; M2-M4 development; A1 conclusion.
8	$[80/4.1 - 80/3.9]/0.2 \approx -5.003$, about -5.	5	M1 setup; M2-M4 development; A1 conclusion.
9	$V(2) = 132, V(6) = 100$; rate = $-32/4 = -8$.	5	M1 setup; M2-M4 development; A1 conclusion.
10	As both endpoints approach the point, the chord approaches the tangent, so its gradient approaches the instantaneous rate.	4	M1 setup; M1 development; A1 accuracy; A1 conclusion.



Mixed Higher Ratio and Proportion Problems

FLUENCY CHECK - ANSWERS

HIGHER TIER • SHOW CLEAR WORKING • KEEP EXACT VALUES WHERE REQUIRED

Name: _____ Date: _____ Score: ____ / ____

Use the formula/method guides in the consolidated solutions section. Award method marks where the setup is correct.

Q	Answer / concise method	Marks	Check
1	£240 and £300.	2	M1 method; A1 answer.
2	15 m/s.	2	M1 method; A1 answer.
3	360.	2	M1 method; A1 answer.
4	4.	1	B1: correct result or statement.
5	density=mass/volume.	1	B1: correct result or statement.
6	3.	2	M1 method; A1 answer.
7	1.5 km.	2	M1 method; A1 answer.
8	0.8.	1	B1: correct result or statement.



Mixed Higher Ratio and Proportion Problems

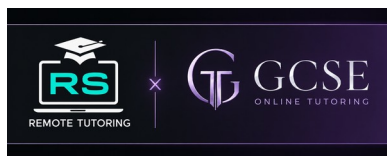
STANDARD HIGHER • PART A - ANSWERS

HIGHER TIER • SHOW CLEAR WORKING • KEEP EXACT VALUES WHERE REQUIRED

Name: _____ Date: _____ Score: ____ / ____

Use the formula/method guides in the consolidated solutions section. Award method marks where the setup is correct.

Q	Answer / concise method	Mark s	Check
1	A:B:C=20:35:42. Difference=22 parts=£132, so one part=£6 and total=97×6=£582.	5	M1 setup; M2-M4 development; A1 conclusion.
2	Let amounts 3k, 11k. $3k/(11k-400)=1/3$; $9k=11k-400$; $k=200$. Original 14k=2800 ml.	5	M1 setup; M2-M4 development; A1 conclusion.
3	Actual length=14 m, width=4 m=400 cm. Plan width=1 cm.	5	M1 setup; M2-M4 development; A1 conclusion.
4	Length ratio 6:7, area ratio 36:49. Difference 13 parts=127, so areas=127×36/13 and 127×49/13 cm ² .	5	M1 setup; M2-M4 development; A1 conclusion.
5	Multiplier=1.18×.90=1.062, so increase 6.2%.	4	M1 setup; M1 development; A1 accuracy; A1 conclusion.
6	Original=756/1.05 ³ ≈£653.06.	5	M1 setup; M2-M4 development; A1 conclusion.



Mixed Higher Ratio and Proportion Problems

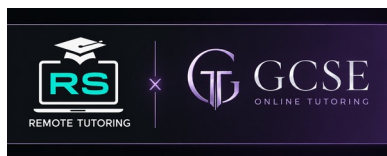
STANDARD HIGHER • PART B - ANSWERS

HIGHER TIER • SHOW CLEAR WORKING • KEEP EXACT VALUES WHERE REQUIRED

Name: _____ Date: _____ Score: ____ / ____

Use the formula/method guides in the consolidated solutions section. Award method marks where the setup is correct.

Q	Answer / concise method	Marks	Check
7	Times 2 h and 2 h; total 250 km in 4 h = 62.5 km/h.	4	M1 setup; M1 development; A1 accuracy; A1 conclusion.
8	Volume = $2700/7.5 = 360 \text{ cm}^3$; height = $360/40 = 9 \text{ cm}$.	4	M1 setup; M1 development; A1 accuracy; A1 conclusion.
9	The common unit price is $\pounds 18 \div 2.4 = \pounds 7.50$ per kg. First-ingredient mass = $5/8 \times 4 = 2.5 \text{ kg}$, so its cost is $2.5 \times \pounds 7.50 = \pounds 18.75$.	4	M1 setup; M1 development; A1 accuracy; A1 conclusion.
10	Area factor = 20000^2 . Actual = $18 \times 400,000,000 \text{ cm}^2 = 720,000 \text{ m}^2 = 72 \text{ ha}$.	5	M1 setup; M2-M4 development; A1 conclusion.
11	Original value factor = $1.1^3 = 1.331$; comparison factor = $1.331^2 = 1.771561$.	5	M1 setup; M2-M4 development; A1 conclusion.
12	Liquid mass = $3/5 \times 1260 = 756 \text{ g}$; volume = $756/0.84 = 900 \text{ cm}^3$.	5	M1 setup; M2-M4 development; A1 conclusion.



Mixed Higher Ratio and Proportion Problems

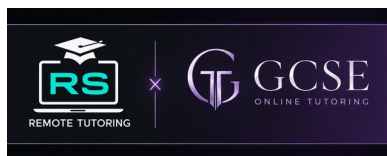
MULTI-STEP HIGHER • PART A - ANSWERS

HIGHER TIER • SHOW CLEAR WORKING • KEEP EXACT VALUES WHERE REQUIRED

Name: _____ Date: _____ Score: ____ / ____

Use the formula/method guides in the consolidated solutions section. Award method marks where the setup is correct.

Q	Answer / concise method	Mark s	Check
1	Second speed=72; times=2.5 and $210/72=35/12$. Total distance 360, time $65/12$; average= $864/13 \approx 66.5$ km/h.	5	M1 setup; M2-M4 development; A1 conclusion.
2	Actual volume= $320 \times 25^3 = 5,000,000 \text{ cm}^3$; mass=4,000,000 g=4000 kg.	5	M1 setup; M2-M4 development; A1 conclusion.
3	Let 3k, 5k. New amounts 3.24k, 4.8k; ratio=27:40. Total changes 8k to 8.04k, increase 0.5%.	5	M1 setup; M2-M4 development; A1 conclusion.
4	Output factor= $6/5 \times 1.1 = 1.32$; increase 32%.	4	M1 setup; M1 development; A1 accuracy; A1 conclusion.
5	Volume factor= $27/8$; density factor= $.8 = 4/5$; mass factor= $27/10$, so ratio old:new=10:27.	5	M1 setup; M2-M4 development; A1 conclusion.
6	Horizontal actual=1800 m. Rise= $1800/12 = 150$ m.	4	M1 setup; M1 development; A1 accuracy; A1 conclusion.
7	Multiplier= $5/4 \times 1.03^2 = 1.326125$, increase 32.6125%.	5	M1 setup; M2-M4 development; A1 conclusion.
8	Work= $6 \times 50 = 300$ pump-min. Done=120; remaining 180 with 5 pumps=36 min. Total 56 min.	5	M1 setup; M2-M4 development; A1 conclusion.



Mixed Higher Ratio and Proportion Problems

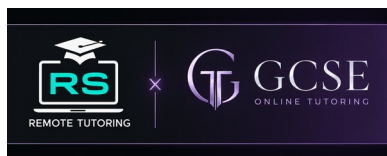
MULTI-STEP HIGHER • PART B - ANSWERS

HIGHER TIER • SHOW CLEAR WORKING • KEEP EXACT VALUES WHERE REQUIRED

Name: _____ Date: _____ Score: ____ / ____

Use the formula/method guides in the consolidated solutions section. Award method marks where the setup is correct.

Q	Answer / concise method	Mark s	Check
9	Volume total = $2400/1.2 = 2000 \text{ cm}^3$. Each length half means volume $1/8$, so 8 identical small solids.	4	M1 setup; M1 development; A1 accuracy; A1 conclusion.
10	$(1+p)(1-p) = 0.91$ with p decimal. $1-p^2 = .91$; $p = .3$, so 30%.	5	M1 setup; M2-M4 development; A1 conclusion.
11	$(k/9 - k/3)/6 = (-2k/9)/6 = -k/27 = -2$, so $k = 54$.	5	M1 setup; M2-M4 development; A1 conclusion.
12	Value factor = $.85^4 = .52200625$; ratio factor reciprocal. New ratio = $.06/.52200625 \approx 0.11494 \text{ kg/£}$.	5	M1 setup; M2-M4 development; A1 conclusion.
13	Multiplier = $1.6 \times .95 = 1.52$, so usable amount rises 52%.	4	M1 setup; M1 development; A1 accuracy; A1 conclusion.
14	Distance = $18 \times 1500 = 27000 \text{ m} = 2,700,000 \text{ cm}$. Map length = 27 cm.	5	M1 setup; M2-M4 development; A1 conclusion.
15	Length ratio = 4:5, so larger height = $12 \times 5/4 = 15 \text{ cm}$. Equal fill times make rates proportional to volumes, so smaller rate = $30 \times 64/125 = 15.36 \text{ cm}^3/\text{s}$.	5	M1 setup; M2-M4 development; A1 conclusion.



Mixed Higher Ratio and Proportion Problems

GRADE 7-9 CHALLENGE - ANSWERS

HIGHER TIER • SHOW CLEAR WORKING • KEEP EXACT VALUES WHERE REQUIRED

Name: _____ Date: _____ Score: ____ / ____

Use the formula/method guides in the consolidated solutions section. Award method marks where the setup is correct.

Q	Answer / concise method	Mark s	Check
1	New A=2.5k. Set $2.5k=3k(1-p)$, so $1-p=5/6$ and $p=1/6=16\frac{2}{3}\%$.	5	M1 setup; M2-M4 development; A1 conclusion.
2	Average $=2/(1/v+1/(2v))=4v/3=24$, so $v=18$ km/h.	5	M1 setup; M2-M4 development; A1 conclusion.
3	Equal time intervals give equal x increases, but x^2 increments grow; tangent gradients increase, so the graph is concave upward.	4	M1 setup; M1 development; A1 accuracy; A1 conclusion.
4	Length factor $=\sqrt{1.44}=1.2$; volume factor $=1.728$; density factor $=.75$; mass factor $=1.296$, increase 29.6% .	5	M1 setup; M2-M4 development; A1 conclusion.
5	$(1+r)^9=2$; $r=2^{(1/9)}-1\approx 0.0801$, so 8.01% .	5	M1 setup; M2-M4 development; A1 conclusion.
6	Volume gained per depth unit grows as area grows, so the same volume raises the level by progressively less; depth-time gradient decreases.	4	M1 setup; M1 development; A1 accuracy; A1 conclusion.
7	First component $=4\times 2/5+5\times 5/12=8/5+25/12=221/60$. Second $=4\times 3/5+5\times 7/12=12/5+35/12=319/60$. Ratio $221:319$.	5	M1 setup; M2-M4 development; A1 conclusion.
8	Area factor $=1.1^2=1.21$; pressure factor $=1/1.21\approx .826446$, decrease $\approx 17.4\%$.	5	M1 setup; M2-M4 development; A1 conclusion.
9	$(k/b-k/a)/(b-a)=k(a-b)/[ab(b-a)]=-k/(ab)$.	5	M1 setup; M2-M4 development; A1 conclusion.
10	Iterate: $10000\times 1.06-500=10100$; then 10206 ; then 10318.36 . Value $\pounds 10,318.36$.	5	M1 setup; M2-M4 development; A1 conclusion.