GCSE Mathematics · Paper 1 (non-calculator) · Higher tier

Paper code LWF-AQAH1-A · 80 marks. M = method, A = accuracy (depends on the preceding M), B = independent. "oe" = or equivalent; "ft" = follow through. The questions and this mark scheme were written with AI.

Q	Answer	Mark scheme	Marks	Topic
1	B	**B1** 29 circled (B)	1	Order of operations AO1
2	C	**B1** $2a^2$ circled (option C)	1	Multiplying algebraic terms AO1
3	D	**B1** D (16) circled	1	Exterior angles of regular polygons AO1
4	C	**B1** 0.85 circled	1	Probability of an event not happening AO1
5	£10.26	**M1** Complete correct method to multiply 2.85 by 3.6, e.g. 285 × 36 with at most one arithmetic error, or 2.85 × 3 = 8.55 and 2.85 × 0.6 = 1.71 oe **A1** 10.26 (accept 10.260)	2	Multiplying decimals AO1
6	19.2 km	**M1** Identifies that the difference 5 − 3 = 2 parts represents 4.8 km oe **M1** 4.8 ÷ 2 = 2.4 (value of one part) or 3 × 2.4 = 7.2 and 5 × 2.4 = 12 oe **A1** 19.2	3	Ratio: difference between parts AO1
7	£16.40	**M1** 2x + 3(x − 3.5) = 71.5 oe, e.g. 2x + 3x − 10.5 = 71.5 **M1** Collects terms correctly to 5x = 82 oe (ft their linear equation with x terms and constants correctly collected) **A1** 16.40 (accept 16.4). Award full marks for a correct answer from a valid non-algebraic method with working shown	3	Forming and solving linear equations AO1

Q	Answer	Mark scheme	Marks	Topic
8	4.2×10^{10} bytes	**M1** $3.5 \times 12 = 42$ or 42×10^9 or 42 000 000 000 oe **A1** 4.2×10^{10} (must be in correct standard form)	2	Calculating in standard form AO1
9	40.5 m²	**M1** Finds a missing length: $8 - 5 = 3$ or $6 - 3.5 = 2.5$ **M1** Correct complete method for the area, e.g. $8 \times 3.5 + 5 \times 2.5$ or $5 \times 6 + 3 \times 3.5$ or $8 \times 6 - 3 \times 2.5$ oe **A1** 40.5	3	Area of compound shapes AO1
10	£300	**M1** Multipliers 1.2 and 0.85 oe seen (e.g. 120/100, 85/100, or 306 ÷ 85 × 100 method) **M1** $1.2 \times 0.85 = 1.02$ oe, or $306 \div 0.85 = 360$ (last season's price) oe **M1** 306 ÷ 1.02 oe, or their 360 ÷ 1.2 oe (dep on previous M) **A1** £300 cao	4	Reverse percentages AO3
11	$2x^3 + x^2 - 13x + 6$	**M1** Expands one pair of brackets correctly, e.g. $x^2 + x - 6$ or $2x^2 - 5x + 2$ or $2x^2 + 5x - 3$ (may be unsimplified with four correct terms) **M1** Multiplies their quadratic by the remaining bracket with at least 4 of the 6 resulting terms correct (ft their quadratic) **A1** $2x^3 + x^2 - 13x + 6$	3	Expanding three binomials AO1
12	9	**M1** Correct expressions for total oranges and total bags in terms of x, e.g. $95 + 5x$ oe and $16 + x$ oe (allow one arithmetic slip in the products) **M1** Forms and begins to solve equation $(95 + 5x)/(16 + x) = 5.6$ oe, e.g. $95 + 5x = 5.6(16 + x)$ or $95 + 5x = 89.6 + 5.6x$ **A1** $x = 9$ (trial and improvement with correct verification that mean = 5.6 when x = 9 scores full marks; an answer of 9 with no working scores 0)	3	Mean from a frequency table AO3
13	*see scheme*	**M1** Time taken found as 1 h 24 min, 84 min, 1.4 h or 5040 s oe **M1** Correct conversion of distance to metres (126 000) and time to seconds (5040), or speed 90 km/h with an attempt to convert to m/s using ×1000 and ÷3600 oe **A1** Complete correct working leading to 25 m/s, e.g. 126 000 ÷ 5040 = 25 or 90 000 ÷ 3600 = 25	3	Speed and unit conversion AO2

Q	Answer	Mark scheme	Marks	Topic
14	x = 3, y = 3.5	**M1** Correct method to eliminate one variable, e.g. 10x − 4y = 16 and adding to 3x + 4y = 23, or 15x + 20y = 115 and 15x − 6y = 24 and subtracting; condone one arithmetic error **A1** x = 3 or y = 3.5 oe **M1** Substitutes their first value into either original equation and solves for the other variable (ft their value) **A1** x = 3 and y = 3.5 oe (both correct)	4	Simultaneous equations AO1
15	1/3	**M1** 80 − 31 − 12 − 13 = 24 for the non-fiction only region **M1** 12/(their 24 + 12) oe, i.e. 12/36 ft their 24 **A1** 1/3 oe	3	Conditional probability from a Venn diagram AO2
16	15√5 m	**M1** $25^2 - 20^2$ or 625 − 400 oe (uses 30 − 10 = 20 as the horizontal leg) **A1** AB = 15 **M1** (their 15)² + 30² or 225 + 900 or √1125 oe (ft their AB) **A1** 15√5	4	Pythagoras' theorem with surds AO3
17	6 + 4√3	**M1** Multiplies numerator and denominator by (√3 + 1) oe, or writes √12 = 2√3 and attempts to rationalise **M1** Correct expansion of numerator to 12 + 8√3 (or 6 + 2√3 + 6√3 + 6) or correct denominator 2 **A1** 6 + 4√3 oe (a = 6, b = 4)	3	Rationalising the denominator AO1
18	(4.5, 0)	**M1** Rearranges to find gradient of L as −3/2 and states or uses perpendicular gradient 2/3 oe **M1** Forms equation of M using their perpendicular gradient and (6, 1), e.g. 1 = 2/3 × 6 + c leading to y = 2/3 x − 3 oe (e.g. 3y = 2x − 9) **A1** (4.5, 0) oe; accept x = 4.5 with y = 0 clearly indicated	3	Perpendicular lines AO2
19	12.5%	**M1** Reads cumulative frequency at £4500 as a value in the range 69 to 71 (may be indicated on the graph) **M1** 80 − their reading (= 9 to 11) oe; a percentage of the reading itself (e.g. 87.5%) does not score this mark **A1** Answer in the range 11.25 to 13.75 (%); an answer of 10 accounts with no conversion to a percentage scores M1 M1 A0	3	Cumulative frequency graphs AO2
20	4:30 pm	**M1** 6 × 10 = 60 (painter-hours) or 6 × 4 = 24 or 4/10 (2/5) of the job done by noon oe	3	Inverse proportion AO2

Q	Answer	Mark scheme	Marks	Topic
		M1 (60 − 24) ÷ 8 = 4.5 or 36 ÷ 8 or T = 60/n with n = 8 applied to the remaining 3/5 of the job oe **A1** 4:30 pm oe (accept 16:30); ft their remaining time added to 12 noon if both M marks awarded		
21(a)	$2(x - 3)^2 - 13$	**M1** $2(x^2 - 6x) + 5$ oe or $(x - 3)^2$ seen **M1** $2[(x - 3)^2 - 9] + 5$ oe, or $2(x - 3)^2 - 18 + 5$ **A1** $2(x - 3)^2 - 13$	3	Completing the square and turning points AO1
21(b)	(3, −13)	**B1** (3, −13) ft their (b, c) from part (a) provided $a \neq 0$	1	Completing the square and turning points AO1
22	96π cm³	**M1** 216/360 × 2 × π × 10 or 12π seen as the arc length oe **M1** 2πr = their arc length leading to base radius 6 (cm) oe ft their arc length **M1** $\sqrt{(10^2 - \text{their } 6^2)}$ or height = 8 (cm); uses 10 cm as the slant height, ft their radius **A1** 96π (cm³) cao	4	Sectors and cones AO3
23	7/22	**M1** Forms two multiples of x whose decimal parts are identical, e.g. 10x = 3.1818... and 1000x = 318.1818... (oe, e.g. x = 0.31818... and 100x = 31.81818...) **M1** Subtracts to eliminate the recurring part, giving 990x = 315 oe (e.g. 99x = 31.5) **A1** 7/22 (accept correct alternative method, e.g. 3/10 + 18/990 = 35/110 = 7/22, for full marks; 315/990 or 35/110 unsimplified scores M1M1A0)	3	Recurring decimals to fractions AO1
24	85°	**M1** Angle BAD = ½(4x + 30) or (2x + 15)° oe, using angle at centre = 2 × angle at circumference; or angle BCD = ½(360 − (4x + 30)) or (165 − 2x)° oe, using the reflex angle at O **M1** Forms a correct equation in x from the angle facts, e.g. (2x + 15) + (3x − 10) = 180 using opposite angles of a cyclic quadrilateral, or 3x − 10 = 165 − 2x oe (ft their expression for BAD or BCD) **A1** x = 35 and angle BAD = 85° **B1** The reasons for the steps used, stated correctly in words: 'angle at the centre is twice the angle at the circumference' (with 'angles round a point add up to 360°' if the reflex angle is used) and 'opposite angles of a cyclic quadrilateral add up to 180°' (must be attached to the steps where they are used)	4	Circle theorems with algebra AO2

Q	Answer	Mark scheme	Marks	Topic
25	£229.50	**M1** Volume ratio simplified, e.g. 6400 : 21 600 = 8 : 27 or 21 600 ÷ 6400 = 27/8 or 3.375 oe **M1** Length scale factor 3/2 or 1.5 (or 2 : 3) from cube rooting their volume ratio **M1** Area scale factor 9/4 or 2.25 and 12 × 9/4 = 27 (m^2) oe, ft their length scale factor squared **A1** £229.50 cao	4	Similar shapes: area and volume scale factors AO3
26	*see scheme*	**M1** Correct algebraic expressions for two consecutive odd numbers, e.g. 2n + 1 and 2n + 3 (or 2n − 1 and 2n + 1) oe, and forms the sum of their squares. Using n and n + 2 with no statement that they are odd scores M0. **M1** Correct expansion and collection of terms, e.g. $8n^2 + 16n + 10$ (or $8n^2 + 2$ from 2n − 1 and 2n + 1). Dependent on first M1. **A1** Writes in the form $8(n^2 + 2n + 1) + 2$ oe (or $8n^2 + 2 = 8(n^2) + 2$) AND states that the bracketed term is an integer so the first term is a multiple of 8, hence 2 more than a multiple of 8. An unfactorised $8n^2 + 16n + 10$ or $8(n^2 + 2n) + 10$ with no further step scores A0.	3	Algebraic proof AO2
27	15 square units	**M1** Uses the turning point to write $y = (x − 2)^2 − 9$ oe, or states p = −4 from the line of symmetry x = 2 **M1** Expands to $y = x^2 − 4x − 5$ oe (i.e. finds q = −5), or sets $(x − 2)^2 = 9$ to find the roots **A1** Roots x = −1 and x = 5 (from (x + 1)(x − 5) = 0 or x = 2 ± 3), giving BC = 6 **A1** A = (0, −5) stated or height of triangle taken as 5 (ft their q) **A1** Area = 15 (ft ½ × their BC × their |q| provided both M marks earned)	5	Quadratic graphs and completing the square AO3

Model answers

1 $2^3 = 8$, so $8 \times 3 = 24$, then $5 + 24 = 29$. Circle B (29).

2 $4 \times 0.5 = 2$ and $a \times a = a^2$, so $4a \times 0.5a = 2a^2$. Answer C circled.

3 Exterior angles of a polygon sum to 360°, so number of sides = $360 \div 22.5 = 16$.
Answer: D (16)

4 P(not late) = $1 - 0.15 = 0.85$, so circle 0.85

5 2.85×3.6
$285 \times 36 = 285 \times 30 + 285 \times 6 = 8550 + 1710 = 10\,260$
Two decimal places in 2.85 and one in 3.6, so three decimal places: 10.260
Cost = £10.26

6 Difference in parts = $5 - 3 = 2$ parts
2 parts = 4.8 km, so 1 part = $4.8 \div 2 = 2.4$ km
Total parts = $3 + 5 = 8$
Total distance = $8 \times 2.4 = 19.2$ km

7 Child ticket = $x - 3.50$
$2x + 3(x - 3.50) = 71.50$
$2x + 3x - 10.50 = 71.50$
$5x - 10.50 = 71.50$
$5x = 82$
$x = 16.40$
Adult ticket costs £16.40

8 $3.5 \times 10^9 \times 12 = 42 \times 10^9$
$= 4.2 \times 10^{10}$ bytes

9 Missing horizontal length = 8 − 5 = 3 m
Missing vertical length = 6 − 3.5 = 2.5 m
Split into two rectangles:
8 × 3.5 = 28
5 × 2.5 = 12.5
Area = 28 + 12.5 = 40.5 m²

10 Increase of 20% is multiplier 1.2
Decrease of 15% is multiplier 0.85
Overall multiplier = 1.2 × 0.85 = 1.02
Original price = 306 ÷ 1.02 = 30600 ÷ 102 = 300
(Check: 300 × 1.2 = 360, 360 × 0.85 = 306 ✓)
Answer £300

11 $(x + 3)(x - 2) = x^2 - 2x + 3x - 6 = x^2 + x - 6$

$(x^2 + x - 6)(2x - 1) = 2x^3 - x^2 + 2x^2 - x - 12x + 6$

$= 2x^3 + x^2 - 13x + 6$

12 Total oranges = 4 × 3 + 5 × x + 6 × 8 + 7 × 5 = 12 + 5x + 48 + 35 = 95 + 5x
Total bags = 3 + x + 8 + 5 = 16 + x
(95 + 5x)/(16 + x) = 5.6
95 + 5x = 5.6(16 + x) = 89.6 + 5.6x
95 − 89.6 = 5.6x − 5x
5.4 = 0.6x
x = 9
Check: 25 bags, 140 oranges, 140 ÷ 25 = 5.6 ✓
Answer x = 9

13 Time taken: 08:52 to 10:16 = 1 hour 24 minutes = 84 minutes = 84 × 60 = 5040 seconds
Distance: 126 km = 126 000 m
Average speed = 126 000 ÷ 5040 = 25 m/s

(Alternatively: 1 h 24 min = 1.4 h, so 126 ÷ 1.4 = 90 km/h, and 90 ÷ 3.6 = 25 m/s.)

14 Multiply the second equation by 2:
$10x - 4y = 16$
Add to the first equation:
$3x + 4y + 10x - 4y = 23 + 16$
$13x = 39$
$x = 3$
Substitute into $3x + 4y = 23$:
$9 + 4y = 23$
$4y = 14$
$y = 3.5$
Check in $5x - 2y = 8$: $15 - 7 = 8$ ✓

$x = 3$, $y = 3.5$

15 Number who bought non-fiction only = $80 - 31 - 12 - 13 = 24$
Number who bought non-fiction = $24 + 12 = 36$
Probability = $12/36 = 1/3$

16 Horizontal distance from D across to the line BC is $30 - 10 = 20$ m.
In the right-angled triangle with hypotenuse CD:
$AB^2 = 25^2 - 20^2 = 625 - 400 = 225$
AB = 15 m
In triangle ABC (right angle at B):
$AC^2 = 15^2 + 30^2 = 225 + 900 = 1125$
$AC = \sqrt{1125} = \sqrt{(225 \times 5)} = 15\sqrt{5}$
Length of fence = $15\sqrt{5}$ m

17 $\sqrt{12} = 2\sqrt{3}$
$(2\sqrt{3} + 6)/(\sqrt{3} - 1) \times (\sqrt{3} + 1)/(\sqrt{3} + 1)$
Numerator: $(2\sqrt{3} + 6)(\sqrt{3} + 1) = 6 + 2\sqrt{3} + 6\sqrt{3} + 6 = 12 + 8\sqrt{3}$
Denominator: $(\sqrt{3} - 1)(\sqrt{3} + 1) = 3 - 1 = 2$
$(12 + 8\sqrt{3})/2 = 6 + 4\sqrt{3}$
So $a = 6$ and $b = 4$.

18 $3x + 2y = 8 \rightarrow 2y = -3x + 8 \rightarrow y = -3/2\ x + 4$
Gradient of L = −3/2
Gradient of M = 2/3 (since −3/2 × 2/3 = −1)
M: $y = 2/3\ x + c$, through (6, 1): $1 = 2/3 \times 6 + c \rightarrow 1 = 4 + c \rightarrow c = -3$
M: $y = 2/3\ x - 3$
Crosses x-axis when y = 0: $2/3\ x = 3 \rightarrow x = 4.5$
Coordinates (4.5, 0)

19 Reading up from £4500 on the graph gives a cumulative frequency of 70.
Number of accounts with more than £4500 = 80 − 70 = 10
Percentage = 10/80 × 100 = 12.5%

20 Total work = 6 × 10 = 60 painter-hours.
From 8 am to 12 noon is 4 hours, so 6 × 4 = 24 painter-hours done.
Remaining work = 60 − 24 = 36 painter-hours.
Now 8 painters, so time = 36 ÷ 8 = 4.5 hours.
12 noon + 4 h 30 min = 4:30 pm.

21(a) $2x^2 - 12x + 5 = 2(x^2 - 6x) + 5$
$= 2[(x - 3)^2 - 9] + 5$
$= 2(x - 3)^2 - 18 + 5$
$= 2(x - 3)^2 - 13$
Answer: $2(x - 3)^2 - 13$

21(b) Minimum when $(x - 3)^2 = 0$, so x = 3 and y = −13.
Answer: (3, −13)

22 Arc length of sector = 216/360 × 2 × π × 10 = 3/5 × 20π = 12π cm
The arc becomes the circumference of the base of the cone:
$2\pi r = 12\pi$ so r = 6 cm
The radius of the sector becomes the slant height, so l = 10 cm
Height $h = \sqrt{(10^2 - 6^2)} = \sqrt{(100 - 36)} = \sqrt{64} = 8$ cm
Volume = ⅓ × π × 6² × 8 = ⅓ × π × 288 = 96π cm³

23 Let x = 0.3181818...
10x = 3.181818...
1000x = 318.181818...
1000x − 10x = 318.181818... − 3.181818...
990x = 315
x = 315/990 = 63/198 = 21/66 = 7/22

Answer 7/22

24 Angle BAD = ½ × angle BOD = ½(4x + 30) = (2x + 15)°, because the angle at the centre is twice the angle at the circumference subtended by the same arc BD.
ABCD is a cyclic quadrilateral, so opposite angles sum to 180°:
(2x + 15) + (3x − 10) = 180
5x + 5 = 180
5x = 175
x = 35
Angle BAD = 2(35) + 15 = 85°
(Check: angle BCD = 3(35) − 10 = 95°, and 85 + 95 = 180 ✓; angle BOD = 170° = 2 × 85 ✓)

25 Volume scale factor = 21 600 ÷ 6400 = 216/64 = 27/8
Length scale factor = $\sqrt[3]{(27/8)}$ = 3/2
Area scale factor = $(3/2)^2$ = 9/4
Surface area of silo B = 12 × 9/4 = 27 m²
Cost = 27 × £8.50 = £229.50

26 Let the two consecutive odd numbers be 2n + 1 and 2n + 3, where n is an integer.
$(2n + 1)^2 + (2n + 3)^2 = 4n^2 + 4n + 1 + 4n^2 + 12n + 9$
$= 8n^2 + 16n + 10$
$= 8(n^2 + 2n + 1) + 2$
$n^2 + 2n + 1$ is an integer, so $8(n^2 + 2n + 1)$ is a multiple of 8.
Therefore the sum of the squares is always 2 more than a multiple of 8.

27 The coefficient of x^2 is 1 and the turning point is (2, −9), so in completed-square form

$y = (x - 2)^2 - 9$

Expanding: $y = x^2 - 4x + 4 - 9 = x^2 - 4x - 5$

So $p = -4$ and $q = -5$.

At A, $x = 0$ so $y = -5$. A is (0, −5).

At B and C, $y = 0$:

$x^2 - 4x - 5 = 0$

$(x + 1)(x - 5) = 0$

$x = -1$ or $x = 5$

B is (−1, 0) and C is (5, 0), so BC = 6.

Area of triangle ABC = ½ × 6 × 5 = 15 square units.

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