AQA Qualifications

GCSE

Mathematics

Unit 3: Higher 43603H

Mark scheme

43603H
June 2016

Version: 1.0 Final

Mark schemes are prepared by the Lead Assessment Writer and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation events which all associates participate in and is the scheme which was used by them in this examination. The standardisation process ensures that the mark scheme covers the students' responses to questions and that every associate understands and applies it in the same correct way. As preparation for standardisation each associate analyses a number of students' scripts: alternative answers not already covered by the mark scheme are discussed and legislated for. If, after the standardisation process, associates encounter unusual answers which have not been raised they are required to refer these to the Lead Assessment Writer.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of students' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

Further copies of this Mark Scheme are available from aqa.org.uk

Glossary for Mark Schemes

GCSE examinations are marked in such a way as to award positive achievement wherever possible. Thus, for GCSE Mathematics papers, marks are awarded under various categories.

If a student uses a method which is not explicitly covered by the mark scheme the same principles of marking should be applied. Credit should be given to any valid methods. Examiners should seek advice from their senior examiner if in any doubt.

M	Method marks are awarded for a correct method which could lead to a correct answer.
M dep	A method mark dependent on a previous method mark being awarded.
A	Accuracy marks are awarded when following on from a correct method. It is not necessary to always see the method. This can be implied.
B	Marks awarded independent of method.
B dep	A mark that can only be awarded if a previous independent mark has been awarded.
ft	Follow through marks. Marks awarded following a mistake in an earlier step.
SC	Special case. Marks awarded within the scheme for a common misinterpretation which has some mathematical worth.
oe	Or equivalent. Accept answers that are equivalent. eg, accept 0.5 as well as $\frac{1}{2}$
[*a*, *b*]	Accept values between *a* and *b* inclusive.
[*a*, *b*)	Accept values $a \leq$ value $< b$
3.14…	Accept answers which begin 3.14 eg 3.14, 3.142, 3.1416

Examiners should consistently apply the following principles

Diagrams

Diagrams that have working on them should be treated like normal responses. If a diagram has been written on but the correct response is within the answer space, the work within the answer space should be marked. Working on diagrams that contradicts work within the answer space is not to be considered as choice but as working, and is not, therefore, penalised.

Responses which appear to come from incorrect methods

Whenever there is doubt as to whether a candidate has used an incorrect method to obtain an answer, as a general principle, the benefit of doubt must be given to the candidate. In cases where there is no doubt that the answer has come from incorrect working then the candidate should be penalised.

Questions which ask candidates to show working

Instructions on marking will be given but usually marks are not awarded to candidates who show no working.

Questions which do not ask candidates to show working

As a general principle, a correct response is awarded full marks.

Misread or miscopy

Candidates often copy values from a question incorrectly. If the examiner thinks that the candidate has made a genuine misread, then only the accuracy marks (A or B marks), up to a maximum of 2 marks are penalised. The method marks can still be awarded.

Further work

Once the correct answer has been seen, further working may be ignored unless it goes on to contradict the correct answer.

Choice

When a choice of answers and/or methods is given, mark each attempt. If both methods are valid then M marks can be awarded but any incorrect answer or method would result in marks being lost.

Work not replaced

Erased or crossed out work that is still legible should be marked.

Work replaced

Erased or crossed out work that has been replaced is not awarded marks.

Premature approximation

Rounding off too early can lead to inaccuracy in the final answer. This should be penalised by 1 mark unless instructed otherwise.

Continental notation

Accept a comma used instead of a decimal point (for example, in measurements or currency), provided that it is clear to the examiner that the candidate intended it to be a decimal point.

Q	Answer	Mark	Comments
1 Alt 1 of 2	**Alternative method 1**		
	$\frac{15}{100}$ × 49.8(0) or 7.47	49.8(0) ÷ 5 or 9.96	M1	oe 0.85 seen
	49.8(0) – their 7.47 or 42.33	$\frac{15}{100}$ × their 9.96 or 1.49(4)	M1dep	oe 49.8(0) × 0.85 or 42.33
	their 42.33 ÷ 5 or their 9.96 – their 1.49 or 8.466 or 8.46 or 8.47		M1dep	
	8.466 or 8.46 or 8.47 and 5 litres		Q1ft	Strand (iii) ft only for M1M1M0

Q	Answer	Mark	Comments

1 Alt 2 of 2	**Alternative method 2**			
	$\frac{15}{100}$ × 49.8(0) or 7.47	49.8(0) ÷ 5 or 9.96	M1	oe 8.75 × 5 or 43.75 or 1 ÷ 8.75 or 0.114… or 0.11
	49.8(0) – their 7.47 or 42.33	$\frac{15}{100}$ × their 9.96 or 1.49(4)	M1dep	oe
	49.8(0) – their 7.47 or 42.33 and 43.75	8.75 + their 1.49(4) or 10.24(4)	M1dep	1 ÷ 8.75 or 0.114… or 0.11 and 5 ÷ their 42.33 or 0.118… or 0.12
	42.33 and 43.75 and 5 litres	9.96 and 10.24(4) and 5 litres	Q1ft	0.114… and 0.118… and 5 litres or 0.11 and 0.12 and 5 litres Strand (iii) ft only for M1M1M0
	Additional Guidance			
	Allow £49.80 or £42.33 or large can or second can or B for Q mark			
	Do not accept £50 for £49.80 unless recovered			

2(a)	*a* and *b*	B1	

2(b)	*b* and *c*	B1	

2(c)	*a* and *c*	B1	

Q	Answer	Mark	Comments
3	*AED* = 100 or *E* = 100 or *ADE* = 40 or *D* = 40 or *DAE* = 40 or *A* = 40	B1	May be on diagram in the correct place
	(*BAD* =) 180 – 117 or 63 seen or implied	M1	oe May be on diagram in the correct place
	103	A1	
	Additional Guidance		
	Beware of contradictions between diagram and working shown *BAD* shown as 63 on diagram in correct position 180 – 117 with nothing marked on diagram and no contradiction 180 – 117 = 63, 63 only marked at *C* on diagram		 M1 M1 M0
	Condone assumption for symmetry of trapezium (360 – 2 × 117) ÷ 2		M1

Q	Answer	Mark	Comments
4	**Alternative method 1**		
	A pair of intersecting arcs of radii 4 cm	M1	
	A pair of intersecting arcs of radii 8 cm	M1	
	Fully correct kite drawn with all arcs shown	A1	SC1 for a complete kite within tolerance
	Alternative method 2 (perpendicular bisector)		
	Two pairs of intersecting arcs of equal radii greater than 3 cm	M1	
	Perpendicular bisector constructed	M1dep	
	Fully correct kite drawn with at least one arc of radius 4 cm and one arc of radius 8 cm	A1	SC1 for a complete kite within tolerance
	Additional Guidance		
	Kite may be drawn inverted		
5	95 ÷ 38 or 2.5(0)	M1	oe
	7 + their 2.5(0) or 9.5(0) or 2 hours 30 minutes seen	M1dep	oe Allow 2.30 or 2:30
	9.30 (am) or 0930	A1	oe
	Additional Guidance		
	Answer 9 hours 30 minutes		M1M1A0
	9.30 pm or 2130		M1M1A0

Q	Answer	Mark	Comments
6(a)	$c^2 = a^2 + b^2$ and $c = \sqrt{a^2 + b^2}$	B2	B1 for 1 correct or 1 correct and 1 incorrect or 2 correct and 1 incorrect
6(b)	22^2 and 8^2 seen or 484 and 64 or 420	M1	oe
	$\sqrt{22^2 - 8^2}$ or $\sqrt{484 - 64}$ or $\sqrt{420}$ or $2\sqrt{105}$	M1dep	
	20.4(9…)	A1	
	20.5	B1ft	ft any 2 dp or better SC2 for final answer of 23.4 only from incorrect use of Pythagoras' theorem
	Additional Guidance		
	20.5 on its own		4 marks
	Trigonometry method could gain marks: M1 for gaining an equation in terms of y, M1dep for full method that would lead to an answer of 20.4(9…)		

Q	Answer	Mark	Comments
7 Alt 1 of 4	**Alternative method 1**		
	$4x + 10 + 6x - 15 + 60 = 180$ or $4x + 10 + 6x - 15 = 120$	M1	oe
	$(x =)12.5$	A1	oe
	4 × their 12.5 + 10 or 6 × their 12.5 – 15	M1dep	Dependent on M1
	60	A1	
	4 × 12.5 + 10 = 60 and 6 × 12.5 – 15 = 60 or 4 × 12.5 + 10 = 60 and 180 – 60 – 60 = 60 or 6 × 12.5 – 15 = 60 and 180 – 60 – 60 = 60	Q1	Strand (ii) Accept 60, 60, 60 with 12.5 seen

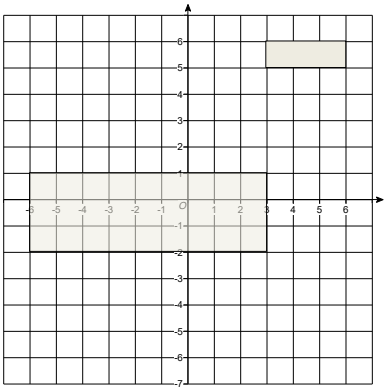
Q	Answer	Mark	Comments
7 Alt 2 of 4	**Alternative method 2**		
	$6x - 15 = 4x + 10$ or $2x = 25$	M1	oe
	$(x =)12.5$	A1	oe
	4 × their 12.5 + 10 or 6 × their 12.5 – 15	M1dep	Dependent on M1
	60	A1	
	4 × 12.5 + 10 = 60 and 6 × 12.5 – 15 = 60 or 4 × 12.5 + 10 = 60 and 180 – 60 – 60 = 60 or 6 × 12.5 – 15 = 60 and 180 – 60 – 60 = 60	Q1	Strand (ii) Accept 60, 60, 60 with 12.5 seen

Q	Answer	Mark	Comments
7 Alt 3 of 4	**Alternative method 3**		
	$6x$ – 15 = 60 or $4x$ + 10 = 60	M1	oe
	(x =)12.5	A1	oe
	6 × their 12.5 – 15 or 4 × their 12.5 + 10	M1dep	Dependent on M1
	60	A1	
	4 × 12.5 + 10 = 60 and 6 × 12.5 – 15 = 60 or 4 × 12.5 + 10 = 60 and 180 – 60 – 60 = 60 or 6 × 12.5 – 15 = 60 and 180 – 60 – 60 = 60	Q1	Strand (ii) Accept 60, 60, 60 with 12.5 seen

Q	Answer	Mark	Comments
7 Alt 4 of 4	**Alternative method 4**		
	$6x$ – 15 = 60	M1	oe
	(x =)12.5	A1	oe
	$4x$ + 10 = 60	M1	Dependent on M1
	(x =)12.5	A1	oe
	Valid statement or 4 × 12.5 + 10 = 60 and 6 × 12.5 – 15 = 60 or 4 × 12.5 + 10 = 60 and 180 – 60 – 60 = 60 or 6 × 12.5 – 15 = 60 and 180 – 60 – 60 = 60	Q1	Strand (ii) eg Since both x values are 12.5 then all angles are 60 Accept 60, 60, 60 with both A marks awarded
	Additional Guidance		

Q	Answer	Mark	Comments
8	diameter = 10 (cm) seen or implied or width of rectangle = 10 (cm) seen or implied	B1	May be on diagram
	radius = 5 (cm) seen or implied	B1dep	May be on diagram
	10 × 10 or 100 or 20 × 10 or 200	M1	oe
	$\pi \times 5^2$ or 25π or [78.5, 78.6] or 79 or $2 \times \pi \times 5^2$ or 50π or [157, 157.2] or 158	M1	oe
	100 – their 25π or [21.4, 21.5] or 200 – 2 × their 25π	M1dep	oe Dependent on M1 M1
	[42.8, 43] or $200 - 50\pi$ or $50(4 - \pi)$ or 42	A1	oe
	Additional Guidance		
	$200 - 50\pi = 150\pi$ does not score final A mark		5 marks
	20 × 10 or 200 implies		B1M1
	$2 \times \pi \times 5$ implies		B1B1
	$\pi d = 10\pi$ implies		B1
	10π on its own		B0

Q	Answer	Mark	Comments
9	Correctly evaluated trial	M1	eg $2^6 - 30 = 34$ 4.1 → –12.(8…) or –12.9 or –13 4.2 → –11.(6…) or –12 4.3 → –10.(3…) 4.4 → –8.(8…) or –8.9 or –9 4.5 → –7.(…) 4.6 → –5.(7…) or –6 4.7 → –4.(…) 4.8 → –2.(…) 4.9 → –0.1(…)
	Obtains $4 < x \leq 5$ or better	M1dep	eg $2^5 - 30 = 2$ 4.95 → 0.9… or 1
	Obtains $4.9 \leq x \leq 5$ or better or two correct trials [4.85, 4.95] which bracket 0	A1	4.85 → –1.(1…) or –1.2
	Tests 4.95 and concludes 4.9 or two correct trials [4.85, 4.95] which bracket 0 and concludes 4.9	Q1	Strand (ii) Using 2 dp to ensure 1 dp
	Additional Guidance		
	Correct answer with no working		M0M0A0Q0

Q	Answer	Mark	Comments
10	 Fully correct enlargement centre (3, 4) Vertices (3, 1), (3, –2), (–6, –2), (–6, 1)	B3	B2 for enlargement SF –2, –1 or $-\frac{1}{3}$ with correct centre or 4 correct vertices plotted but shape not drawn B1 for enlargement SF $\frac{1}{3}$ with correct centre or enlargement SF3 with correct orientation
	Additional Guidance		

Q	Answer		Mark	Comments
11 Alt 1 of 4	**Alternative method 1**			
	$x + y + 70 = 180$ or $x + 2y + 40 = 180$		M1	oe
	$x + y = 110$ and $x + 2y = 140$	$2x + 2y = 220$ and $x + 2y = 140$	M1dep	oe Collects terms and equates coefficients Equations may be implied from 110 or 140 on diagram in correct place
	$x = 80$ or $y = 30$		A1	
	$x = 80$ and $y = 30$		A1	
11 Alt 2 of 4	**Alternative method 2**			
	$x + y + 70 = 180$ or $x + y + 70 + x + 2y + 40 = 360$		M1	oe
	$2x + 2y = 220$ and $2x + 3y = 250$	$3x + 3y = 330$ and $2x + 3y = 250$	M1dep	oe Collects terms and equates coefficients Equations may be implied from 110 or 140 on diagram in correct place
	$x = 80$ or $y = 30$		A1	
	$x = 80$ and $y = 30$		A1	

Q	Answer	Mark	Comments
11 Alt 3 of 4	**Alternative method 3**		
	$x + 2y + 40 = 180$ or $x + y + 70 + x + 2y + 40 = 360$	M1	oe
	$2x + 4y = 280$ and $2x + 3y = 250$ / $3x + 6y = 420$ and $4x + 6y = 500$	M1dep	oe Collects terms and equates coefficients Equations may be implied from 110 or 140 on diagram in correct place
	$x = 80$ or $y = 30$	A1	
	$x = 80$ and $y = 30$	A1	
	Alternative method 4		
11 Alt 4 of 4	$x + y + 70 = 180$ or $x + 2y + 40 = 180$	M1	oe
	$2y + 40 – (y + 70) = 0$ or $2x + 140 – (x + 40) = 360 – 180$	M1dep	oe Eliminates a variable
	$x = 80$ or $y = 30$	A1	
	$x = 80$ and $y = 30$	A1	
	Additional Guidance		
	$y = 30$ must come from correct equations not from $x + 2y = 70$ and $x + y = 40$		M0 M0 A0

Q	Answer	Mark	Comments
12	Graph 1 = *D* Graph 2 = *A* Graph 3 = blank Graph 4 = *B* Graph 5 = blank Graph 6 = *C*	B4	B1 for each correct letter in the correct position
	Additional Guidance		
	Choice of answers eg *A* in every position *A* in two positions, *D B* and *C* correct		B0 B3
13(a)	$\frac{1}{2} \times (2x - 8)(4x + 6) \times \sin 30$	M1	oe
	$8x^2 - 32x + 12x - 48$ or $4x^2 - 16x + 6x - 24$ or $2x^2 - 8x + 3x - 12$ (= 14)	M1	oe $8x^2 - 20x - 48$ or $4x^2 - 10x - 24$ or $2x^2 - 5x - 12$
	$2x^2 - 5x - 12 = 14$ or $2x^2 - 5x - 12 - 14 = 0$ or $2x^2 - 8x + 3x - 12 - 14 = 0$ or $2x^2 - 8x + 3x - 26 = 0$ and $2x^2 - 5x - 26 = 0$	A1	
	Additional Guidance		
	$\frac{1}{2} \times (2x - 8)(4x + 6) = 4x^2 - 16x + 6x - 24$ not recovered		M0M1A0

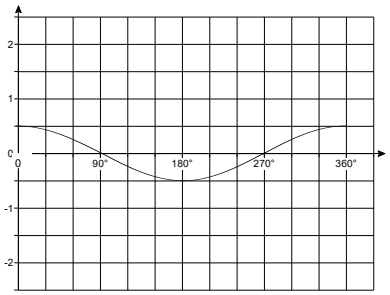
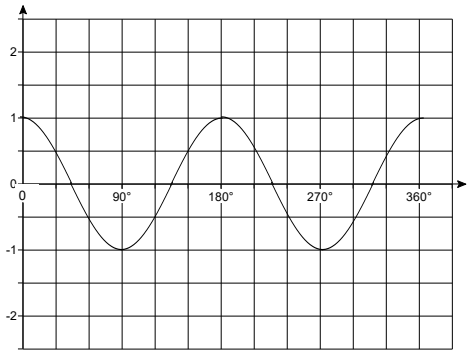
Q	Answer	Mark	Comments
13(b)	$\frac{--5 \pm \sqrt{(-5)^2 - (4 \times 2 \times -26)}}{2 \times 2}$	M1	Allow one error
	$\frac{--5 \pm \sqrt{(-5)^2 - (4 \times 2 \times -26)}}{2 \times 2}$ or $\frac{5 \pm \sqrt{25 + 208}}{4}$ or $\frac{5 \pm \sqrt{233}}{4}$	A1	Fully correct oe
	5.06… (and –2.56…)	A1	Allow 5.07
	5.1	A1	Must ignore negative answer
	Additional Guidance		
	5.1 without working		4 marks

Q	Answer	Mark	Comments
14	use of tan	M1	
	$\tan x = \frac{5}{10}$ or $\tan x = \frac{10}{5}$	M1dep	oe
	26.5(6…) or 26.57 or 26.6 or 27 / 63.4… or 63	A1	
	153.(…)	A1	SC3 for 333.(…)
	Additional Guidance		
	Scale drawing with answer 153.(…)		4 marks
	Scale drawing giving angle of 27 or 63		3 marks
	154 on its own		M0
	26 on its own		M0
	Use of Pythagoras' theorem giving 11.18 or 11.2 and use of sin x or cos x		M1
	Use of Pythagoras' theorem giving 11.18 or 11.2 on its own		M0

Q	Answer	Mark	Comments
15	**Alternative method 1**		
	$\frac{x}{15}$ or $\frac{x + 20}{17}$	M1	oe $x = 15t$ or $x + 20 = 17t$
	$\frac{x}{15} = \frac{x + 20}{17}$	M1dep	oe $15t + 20 = 17t$
	$17x = 15(x + 20)$ or $17x = 15x + 300$ or $17x - 15x = 300$ or $2x = 300$	M1dep	oe $20 = 17t - 15t$ or $20 = 2t$ or $t = 10$
	150	A1	
	Alternative method 2		
	(relative velocity =) 17 – 15 or 2 (m/s)	M1	
	(relative displacement =) 20 (metres)	M1dep	
	(time taken =) 20 ÷ 2 or 10	M1dep	
	150	A1	
	Additional Guidance		

Q	Answer	Mark	Comments
16(a)	($\overrightarrow{AB}$ =) **b** – **a** or ($\overrightarrow{BA}$ =) **a** – **b**	M1	oe
	$\mathbf{a} + \frac{1}{2}(\mathbf{b} - \mathbf{a})$ or $\mathbf{b} - \frac{1}{2}(\mathbf{b} - \mathbf{a})$	M1dep	oe
	$\frac{1}{2}\mathbf{a} + \frac{1}{2}\mathbf{b}$ or $\frac{1}{2}(\mathbf{a} + \mathbf{b})$	A1	Do not ignore fw
	Additional Guidance		
	a – **b** or **b** – **a** as final answer with no working shown		M0 M0 A0

16(b)	$-\frac{1}{2}\mathbf{a} - \frac{1}{2}\mathbf{b}$ or $-\frac{1}{2}(\mathbf{a} + \mathbf{b})$	B1ft	ft their answer in part (a), even if unsimplified. Answer must be a valid vector
	Additional Guidance		
	Do not condone missing brackets eg **b** – **a** ÷ 2 in part (a) followed by **a** – **b** ÷ 2 in part (b)		

Q	Answer	Mark	Comments
17(a)	60 and 300	B1	Either order
	Additional Guidance		
17(b)		B1	Smooth curve through (0°, 0.5) (90°, 0) (180°, –0.5) (270°, 0) (360°, 0.5)
	Additional Guidance		
	Mark intention		
17(c)		B1	Smooth curve through (0°, 1) (90°, –1) (180°, 1) (270°, –1) (360°, 1)
	Additional Guidance		
	Mark intention Must cross x-axis in the correct square for the four intercepts		

Q	Answer	Mark	Comments
18	**Alternative method 1**		
	$\frac{1}{3}\pi (r + 2)^2 r$	M1	
	$\frac{4}{3}\pi r^3 = \frac{1}{3}\pi (r + 2)^2 r$	M1dep	oe
	$3r^2 – 4r – 4 (= 0)$ or $3r^2 – 4r = 4$	M1dep	oe Reduces to three term quadratic
	$(3r + 2)(r – 2) (= 0)$	M1dep	
	2	A1	must discard $r = -\frac{2}{3}$ SC2 Answer 2 with no working
	Alternative method 2		
	$\frac{1}{3}\pi (r + 2)^2 r$	M1	
	$\frac{4}{3}\pi r^3 = \frac{1}{3}\pi (r + 2)^2 r$	M1dep	oe
	$4r^2 = (r + 2)^2$	M1dep	
	$2r = r + 2$	M1dep	
	2	A1	SC2 Answer 2 with no working
	Additional Guidance		
	Answer $r = 2$ and $r = -\frac{2}{3}$		M4 A0
	If there is incorrect working, unless recovered, apply the scheme even if $r = 2$ is seen		

Q	Answer	Mark	Comments
19	$5^2 + 3^2 - 2 \times 5 \times 3 \times \cos 120$	M1	
	49 or $\sqrt{5^2 + 3^2 - 2 \times 5 \times 3 \times \cos 120}$	M1dep	
	7	A1	
	Angle *ACB* = angle *DCE* stated or implied	B1	May be on diagram
	SAS	Q1	oe Dependent on M1 M1 A1 B1 Strand (i)
	Additional Guidance		
	Note: Angle *ACB* = 21.7… or 21.8 or 22 Note: Cosine rule must be seen for the complete proof eg *AC* = 7 without method shown followed by *ACB* = *DCE* and SAS		B1 only
	Calculations using sine rule or cosine rule giving answers of *AC* = 7 cm and *DE* = 3 cm followed by eg SSS is fully correct		5 marks