GCSE
MATHEMATICS
8300/3H

Higher Tier Paper 3 Calculator

Mark scheme

November 2018

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18BG83003H/MS

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.
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.
ft	Follow through marks. Marks awarded for correct working following a mistake in an earlier step.
SC	Special case. Marks awarded for a common misinterpretation which has some mathematical worth.
M dep	A method mark dependent on a previous method mark being awarded.
B dep	A mark that can only be awarded if a previous independent mark has been awarded.
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
Use of brackets	It is not necessary to see the bracketed work to award the marks.

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

Questions which ask students to show working

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

Questions which do not ask students to show working

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

Misread or miscopy

Students often copy values from a question incorrectly. If the examiner thinks that the student 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 student intended it to be a decimal point.

Question	Answer	Mark	Comments
1	up	B1	
	Additional Guidance		
2	$\frac{5}{2}$	B1	
	Additional Guidance		
3	$8n - 5$	B1	
	Additional Guidance		
4	120	B1	
	Additional Guidance		
5	109.5 in the correct position	B1	oe
	110.5 in the correct position	B1	oe Allow $110.4\dot{9}$ answers reversed score B0B1
	Additional Guidance		
	110.4999…		B1
	110.4999		B0

Question	Answer	Mark	Comments
6(a)	Plots at least 3 points correctly	M1	Plots within the correct 2 mm vertical square
	Fully correct with all points joined	A1	
	Additional Guidance		

6(b)	[4200, 4500]	B2	B1 Any indication the 2018 figure is being increased for 2019 eg a point plotted for 2019 that is greater than 3780
	Additional Guidance		
	Answer in range with or without working		B2
	4300 – 4350 on answer line (both values in range)		B2
	4400 – 4600 on answer line (one value in range)		B1
	Answer outside of range but between 3780 and 4200		B1
	Answer outside of range but greater than 4500		B1

Question	Answer	Mark	Comments
7	Any correct value	M1	11, 23, 37, 53, 71, 91, 113, 137, 163
	Selects 91 as the only incorrect value with no errors in values given	A1	oe eg stops at 91
	91 and 13 (is a factor) or 91 and 7 (is a factor) or 91 and 13 × 7	A1	oe eg 91 ÷ 7 = 13
	Additional Guidance		
	Ignore incorrect evaluations for first mark		
	Ignore all values for n greater than 9		
	Do not allow 11 within a list of prime numbers eg 2, 3, 5, 7, 11…		
	Error in list eg 12, 23, 37, 53, 71, 91, 113, 137, 163 with 12 and 91 selected as not prime (not valid as incorrect)		M1A0A0
	Error in list eg 12, 23, 37, 53, 71, 91, 113, 137, 163 with only 91 selected as not prime (not valid as incorrect conclusion from their list)		M1A0A0
	$9^2 + 9 + 1 = 91$ is incorrect working		M0A0A0

Question	Answer	Mark	Comments
8	**Alternative method 1**		
	(600 ×) 0.8 or 480	M1	oe
	600×0.8^2 or 384 or 600×0.8^3 or 307.2(0) or 600×0.8^4 or 245.76 or 600×0.8^5 or [196, 197]	M1dep	
	[196, 197] and incorrect	A1	oe eg 196.61 and no 196.61 still owed
	Alternative method 2		
	600 × 0.2 or 120	M1	oe
	120 × 0.8 or 96 or 96 × 0.8 or 76.8(0) or 76.8(0) × 0.8 or 61.44 or 61.44 × 0.8 or [49.15, 49.16]	M1dep	oe eg (600 – 120) × 0.2 or 480 × 0.2
	[403, 404] and incorrect	A1	oe eg paid off 403.39(2)
	Alternative method 3		
	0.8	M1	
	0.8^5 or 0.327 68 or 0.3277 or 0.328 or 0.33	M1dep	
	0.327 68 (or 0.3277 or 0.328 or 0.33) and incorrect	A1	oe
	Additional Guidance		
	Ignore units		
	Full marks can be awarded for a correct explanation eg 120 and 96 calculated with a comment 'as soon as the payment is below 120 a month it cannot be paid off in five months'		

Question	Answer	Mark	Comments
9	0.9 × π ÷ 2 or 0.9π ÷ 2 or 0.45π or 0.9 × [3.14, 3.142] ÷ 2 or [2.82, 2.83] ÷ 2 or 2.8 ÷ 2 or 1.4…	M1	Large semicircle
	0.9 ÷ 3 × π ÷ 2 or 0.3π ÷ 2 or 0.15π or 0.9 ÷ 3 × [3.14, 3.142] ÷ 2 or 0.94… ÷ 2 or 0.47…	M1	Small semicircle May be implied from using 1.4… for three small semicircles in next mark
	their 1.4… + 3 × their 0.47… + 2 × 0.75 or 0.9π + 2 × 0.75 or 2 × their 1.4… + 2 × 0.75 or 4.3…	M1dep	oe dep on both marks
	305 ÷ their 4.3… or [70.4, 70.94]	M1dep	dep on previous mark
	71 with working	A1	
	Additional Guidance		
	0.9π or 2.8… with no evidence of incorrect method		M1M1
	0.45π ÷ 2		M0

Question	Answer	Mark	Comments
10	**Alternative method 1**		
	$\frac{1}{2}x > 3 - 8$ or $\frac{1}{2}x > -5$ or $8 - 3 > -\frac{1}{2}x$ or $5 > -\frac{1}{2}x$ or $8 + \frac{1}{2}x > 3$	M1	oe
	$x > -10$	A1	oe $-10 < x$
	Alternative method 2		
	$16 > 6 - x$ or $16 - 6 > -x$ or $10 > -x$ or $x > 6 - 16$ or $16 + x > 6$	M1	oe
	$x > -10$	A1	oe $-10 < x$
	Additional Guidance		
	Answer using incorrect sign eg $x < -10$ or $x = -10$		M1A0

Question	Answer	Mark	Comments
11	$\cos x = \frac{9}{10}$	M1	oe eg $\sin x = \frac{\sqrt{10^2 - 9^2}}{10}$ $\tan x = \frac{\sqrt{10^2 - 9^2}}{9}$
	25.8… or 26	A1	
	Additional Guidance		
	$\cos = \frac{9}{10}$ $x = 25.8$ (recovered)		M1A1
	$\cos = \frac{9}{10}$		M0A0
12	Graph should be a curve	B1	oe eg Should not be straight lines Not a curve Not smooth Too straight Need more points plotted
	Additional Guidance		
13	200	B1	
	Additional Guidance		

Question	Answer	Mark	Comments
14	19×82 or 1558	M1	
	$\frac{\text{their } 1558 + 93}{20}$ or $\frac{1651}{20}$	M1dep	oe
	82.55 or 82.6	A1	
	Additional Guidance		
15	$2 \times \pi \times 8 \times 22$ or 352π or [1105, 1106]	M1	Area of lampshade A oe $2 \times \pi \times 0.08 \times 0.22$ or 0.0352π or [0.1105, 0.1106]
	$4 \times \frac{1}{2} \times 15 \times 24$ or 720	M1	Area of lampshade B oe $4 \times \frac{1}{2} \times 0.15 \times 0.24$ or 0.072
	their $352\pi \div 100^2 \times 400$ or 14.08π or [44.2, 44.24]	their $720 \div 100^2 \times 400$ or 28.8(0)	M1dep their $0.0352\pi \times 400$ or 14.08π or [44.2, 44.24] dep on 1st M1
			their 0.072×400 or 28.8(0) dep on 2nd M1
	their $14.08\pi + 3.50$ or [47.7, 47.74] and their 28.8(0) + 7.5(0) or 36.3(0)	M1dep	dep on M3 and method for fabric cost for both lampshades correct
	1.3(1…) : 1 or 1.32 : 1	A1	
	Additional Guidance		
	1 : 1.3(1…) or 1 : 1.32		M4A0

Question	Answer	Mark	Comments
16	**Alternative method 1**		
	0.38 × 50 or 19	M1	oe
	0.6 × 80 or 48	M1	oe
	$\frac{\text{their } 19 + \text{their } 48}{50 + 80}$ or $\frac{67}{130}$	M1dep	oe
	0.51(5…) or 0.52 or $\frac{67}{130}$ and (67 × 2 =) 134 or $\frac{67}{130}$ and (130 ÷ 2 =) 65	A1	oe
	Alternative method 2		
	0.38 × 50 or 19	M1	oe
	0.6 × 80 or 48	M1	oe
	0.5 × (50 + 80) or 65	M1dep	oe
	65 and 67	A1	
	Alternative method 3		
	0.38 × 50 or 19	M1	oe
	0.5 × (50 + 80) or 65	M1	oe
	$\frac{\text{their } 65 - \text{their } 19}{80}$ or $\frac{46}{80}$	M1dep	oe
	0.575	A1	

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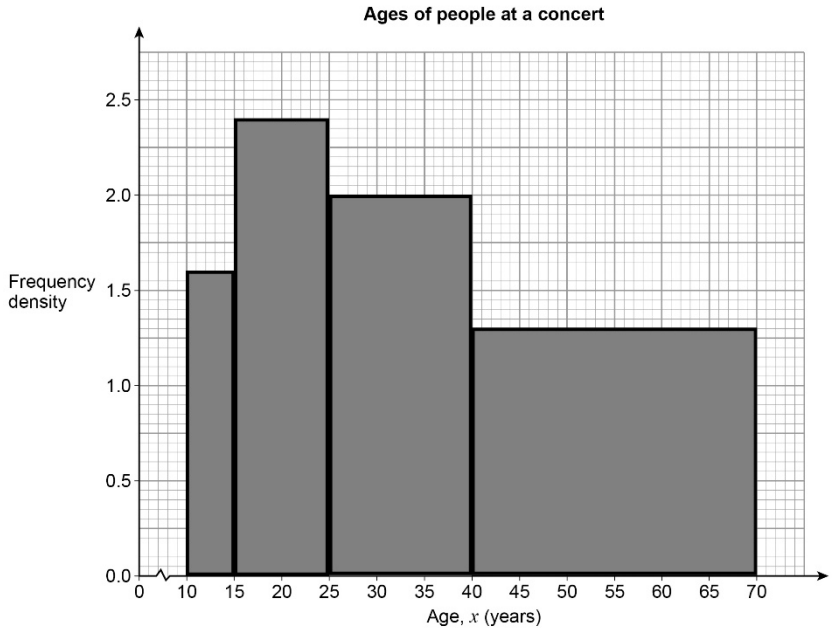
Question	Answer	Mark	Comments
16 cont	**Alternative method 4**		
	0.6 × 80 or 48	M1	oe
	0.5 × (50 + 80) or 65	M1	oe
	$\frac{\text{their } 65 - \text{their } 48}{50}$ or $\frac{17}{50}$	M1dep	oe
	0.34	A1	
	Alternative method 5		
	$\frac{50}{130}$ × 0.38 or 0.14… or 0.15	M1	oe
	$\frac{80}{130}$ × 0.6 or 0.36… or 0.37	M1	oe
	their 0.14… + their 0.36…	M1dep	oe
	0.51(5…) or 0.52	A1	
	Additional Guidance		
17	$\frac{9}{25x}$	B1	
	Additional Guidance		

Question	Answer	Mark	Comments
18	Any one of $8 \div 5$ or 1.6 or $24 \div 10$ or 2.4 or $30 \div 15$ or 2 or $39 \div 30$ or 1.3	M1	Implied by a correct bar
	At least three of 1.6 and 2.4 and 2 and 1.3	M1dep	Implied by three correct bars
	Fully correct histogram	A1	Tolerance $\pm\frac{1}{2}$ square ignore frequency polygon if drawn
	Additional Guidance		
			3 marks

Question	Answer	Mark	Comments
19	30.25 or 29.75 or 5.85 or 5.75	B1	
	their 30.25 – their 5.75	M1	Must be their max roll – their min cut their max must be (30, 30.5] their min must be [5.5, 5.8)
	24.5	A1	
	Additional Guidance		
	30.5 – 5.75 = 24.75		B1M1A0
20	**Alternative method 1**		
	$2(-x-1)^2-5$	M1	oe Replacing x with $-x$
	$2(x^2+x+x+1)-5$ or $2x^2+4x+2-5$ or $2x^2+4x-3$	M1dep	oe expansion
	$y=2x^2+4x-3$	A1	
	Alternative method 2		
	$2(x^2-x-x+1)-5$ or $2x^2-4x+2-5$ or $2x^2-4x-3$	M1	oe expansion Multiplying out original expression
	$2(-x)^2-4(-x)-3$ or $2x^2+4x-3$	M1dep	oe Replacing x with $-x$
	$y=2x^2+4x-3$	A1	
	Additional Guidance		
	Using symmetry in y axis, $y=2(x+1)^2-5 \rightarrow y=2x^2+4x-3$		M1M1A1

Question	Answer	Mark	Comments
21	1(h) 20 (min) and 50 (min) or $1\frac{20}{60}$ (h) or $1\frac{1}{3}$ (h) or 1.33…(h) or $\frac{50}{60}$ (h) or $\frac{5}{6}$ (h) or 0.83…(h)	B1	oe Journey time(s) at 10.20 am
	6 × their $1\frac{1}{3}$ or 8	M1	oe Priya's distance at 10.20 am
	their 8 ÷ their $\frac{50}{60}$ or 9.6 or 16.8 ÷ 8 or 2.1	M1dep	oe Joe's speed in km/h Multiplier for distance comparison
	16.8 ÷ their 9.6 or 1.75(h) or 1(h) 45 (min) or 105 (min) or 16.8 ÷ 8 × 50 (÷ 60) or $\frac{16.8 - \text{their } 8}{\text{their } 9.6}$ or $\frac{8.8}{\text{their } 9.6}$ or 0.91(6…)(h) or 0.917(h) or 0.92(h) or 55(min)	M1dep	oe Joe's total journey time Joe's journey time after overtaking Priya
	11.15 (am)	A1	oe eg quarter past 11 (in the morning)
	Additional Guidance		
	If 11.15 comes from correct method but with premature rounding eg 8 ÷ 0.83 = 9.64 16.8 ÷ 9.64 = 1.743 h 1.743 × 60 = 104.58 minutes ie 11 : 14 : 58 so 11 : 15		B1M3A0
	8 km implies		B1M1
	16.8 ÷ 6 or 2.8 with no further valid working		B0M0

Question	Answer	Mark	Comments
22(a)	–0.3 or $-\frac{3}{10}$	B1	
	–0.2027 or $-\frac{2027}{10\,000}$	B1ft	ft their –0.3
	Additional Guidance		
	ft answer must be to at least 4 decimal places		
	Note: if their –0.3 is –0.2027, then ft answer is –0.200 832 8…		
22(b)	–0.20081	B1	
	Additional Guidance		
	Answer must be to exactly 5 decimal places		
	–0.20083		B0
23	**Alternative method 1**		
	48 ÷ 2 × 3 or 72	M1	oe
	their 72 ÷ 2 or 36	M1dep	$\cos^{-1}\left(\frac{36}{141}\right)$ or 75.2
	141^2 – their 36^2 or 18 585	M1dep	ft their base ÷ 2 sin (their 75.2) = $\frac{h}{141}$ or tan (their 75.2) = $\frac{h}{\text{their } 36}$
	$\sqrt{141^2 - \text{their } 36^2}$ or $\sqrt{18\,585}$	M1dep	141 × sin (their 75.2) or their 36 × tan (their 75.2)
	[136.2, 136.4] or 136	A1	

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Question	Answer	Mark	Comments
23 cont	**Alternative method 2**		
	141 ÷ 3 or 47	M1	oe
	24 and their 47 × 2 or 24 and 94 or 12 and their 47	M1dep	$\cos^{-1}\left(\frac{24}{94}\right)$ or 75.2
	their $94^2 - 24^2$ or 8260 or $\sqrt{8260}$ or 90.88… or their $47^2 - 12^2$ or 2065 or $\sqrt{2065}$ or 45.44…	M1dep	sin (their 75.2) = $\frac{h}{\text{their } 94}$ or tan (their 75.2) = $\frac{h}{24}$
	$\sqrt{\text{their } 94^2 - 24^2}$ × 3 ÷ 2 or $\sqrt{8260}$ × 3 ÷ 2 or 90.88… × 3 ÷ 2 or $\sqrt{\text{their } 47^2 - 12^2}$ × 3 or $\sqrt{2065}$ × 3 or 45.44… × 3	M1dep	their 94 × sin (their 75.2) × 3 ÷ 2 or 24 × tan (their 75.2) × 3 ÷ 2
	[136.2, 136.35] or 136	A1	
	Additional Guidance		
	Values may be seen on diagram in correct positions		

Question	Answer	Mark	Comments
24	$\frac{4}{3}\pi(2x)^3$ or $\frac{1}{3}\pi(3x)^2h$	M1	oe
	$\frac{4}{3}\pi(2x)^3 = \frac{1}{3}\pi(3x)^2h$ or $\frac{4}{3}\pi 8x^3 = \frac{1}{3}\pi 9x^2h$	M1dep	oe Sets up equation
	$32x = 9h$ or $x = \frac{9}{32}h$ or $h = \frac{32}{9}x$ or $\frac{32}{3}r = 9h$ or $r = \frac{27}{32}h$ or $h = \frac{32}{27}r$ or $27h = 32r$ or $\frac{27}{32}h : h$ or $3x : \frac{32}{9}x$ or $\frac{27}{32} : 1$ or $3 : \frac{32}{9}$ or 0.84… : 1 or 3 : 3.55…	M1dep	oe linear equation or ratio
	27 : 32	A1	
	Additional Guidance		
	32 : 27		M1M1M1A0
	Note $\frac{4}{3}\pi(2)^3$ = [33.49, 33.52] $\frac{1}{3}\pi(3)^2h$ = [9.42h, 9.43h]		

Question	Answer	Mark	Comments
25	*B* and *C*	B1	
	Additional Guidance		
26	$y(x - 4) = 2x + 3$	M1	$x(y - 4) = 2y + 3$
	$yx - 4y = 2x + 3$	M1dep	$xy - 4x = 2y + 3$
	$yx - 2x = 4y + 3$ or $x(y - 2) = 4y + 3$ or $x = \frac{4y + 3}{y - 2}$	M1dep	$xy - 2y = 4x + 3$ or $y(x - 2) = 4x + 3$
	$\frac{4x+3}{x-2}$	A1	oe Must be in terms of x
	Additional Guidance		
	Ignore any attempt to give the domain of f^{-1}		
27(a)	$x^2 + (3x + p)^2 = 53$	M1	oe
	$9x^2 + 3xp + 3xp + p^2$ or $9x^2 + 6xp + p^2$	M1	Expands $(3x + p)^2$ correctly
	$x^2 + (3x + p)^2 = 53$ and $x^2 + 9x^2 + 3xp + 3xp + p^2 = 53$ and $10x^2 + 6px + p^2 - 53 = 0$ or $x^2 + (3x + p)^2 = 53$ and $x^2 + 9x^2 + 6xp + p^2 = 53$ and $10x^2 + 6px + p^2 - 53 = 0$	A1	
	Additional Guidance		

Question	Answer	Mark	Comments
27(b)	$7 = 3 \times 2 + p$ or $7 = 6 + p$ or $p = 1$	M1	oe Substitutes $x = 2$ into given equation $10(2)^2 + 6p(2) + p^2 - 53 = 0$ or $p^2 + 12p - 13 = 0$ or $(p - 1)(p + 13)$ or $p = 1$ (and $p = -13$)
	$10x^2 + 6x + 1 - 53$ (= 0) or $10x^2 + 6x - 52$ (= 0) or $5x^2 + 3x - 26$ (= 0)	M1dep	oe equation Substitutes their p into given equation
	$(5x + 13)(x - 2)$ or $\frac{-3 \pm \sqrt{3^2 - 4 \times 5 \times -26}}{2 \times 5}$ or $-\frac{3}{10} \pm \sqrt{\frac{529}{100}}$	M1	oe Correct factorisation of their 3-term quadratic or correct substitution in formula for their 3-term quadratic or correct completion of square to expression for x
	(x =) –2.6	A1	oe
	(–2.6, –6.8)	A1	oe
	Additional Guidance		
	After scoring first M1, they substitute $p = -13$ $(p - 1)(p + 13)$ or $p = 1$ (and $p = -13$)		M1
	$10x^2 - 78x + 169 - 53 = 0$ or $10x^2 - 78x + 116 = 0$ or $5x^2 - 39x + 58 = 0$		M1dep
	$(5x - 29)(x - 2)$ or $\frac{--39 \pm \sqrt{(-39)^2 - 4 \times 5 \times 58}}{2 \times 5}$ or $\frac{39}{10} \pm \sqrt{\frac{361}{100}}$		M1dep A0 A0

Question	Answer	Mark	Comments
28	gradient is negative	B1	
	Additional Guidance		