GCSE

Mathematics (9-1)

Unit **J560/06:** Paper 6 (Higher Tier)

General Certificate of Secondary Education

Mark Scheme for November 2018

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This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. It shows the basis on which marks were awarded by examiners. It does not indicate the details of the discussions which took place at an examiners' meeting before marking commenced.

All examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes should be read in conjunction with the published question papers and the report on the examination.

1.   Annotations used in the detailed Mark Scheme.

Annotation	Meaning
✓	Correct
✗	Incorrect
BOD	Benefit of doubt
FT	Follow through
ISW	Ignore subsequent working (after correct answer obtained), provided method has been completed
M0	Method mark awarded 0
M1	Method mark awarded 1
M2	Method mark awarded 2
A1	Accuracy mark awarded 1
B1	Independent mark awarded 1
B2	Independent mark awarded 2
MR	Misread
SC	Special case
∧	Omission sign

These should be used whenever appropriate during your marking.

The **M**, **A, B** etc. annotations must be used on your standardisation scripts for responses that are not awarded either 0 or full marks.
It is vital that you annotate these scripts to show how the marks have been awarded.
It is not mandatory to use annotations for any other marking, though you may wish to use them in some circumstances.

Subject-Specific Marking Instructions

2.   **M** marks are for <u>using a correct method</u> and are not lost for purely numerical errors.
    A marks are for an <u>accurate</u> answer and depend on preceding **M** (method) marks. Therefore **M0 A1** cannot be awarded.
    B marks are <u>independent</u> of **M** (method) marks and are for a correct final answer, a partially correct answer, or a correct intermediate stage.
    SC marks are for <u>special cases</u> that are worthy of some credit.

3.   Unless the answer and marks columns of the mark scheme specify **M** and **A** marks etc., or the mark scheme is 'banded', then if the correct answer is clearly given and is <u>not from wrong working</u> **full marks** should be awarded.

    Do <u>not</u> award the marks if the answer was obtained from an incorrect method, i.e. incorrect working is seen <u>and</u> the correct answer clearly follows from it.

4. Where follow through (**FT**) is indicated in the mark scheme, marks can be awarded where the candidate's work follows correctly from a previous answer whether or not it was correct.

Figures or expressions that are being followed through are sometimes encompassed by single quotation marks after the word *their* for clarity, e.g. FT 180 × (*their* '37' + 16), or FT 300 – √(*their* '5² + 7²'). Answers to part questions which are being followed through are indicated by e.g. FT 3 × *their* (a).

For questions with FT available you must ensure that you refer back to the relevant previous answer. You may find it easier to mark these questions candidate by candidate rather than question by question.

5. Where dependent (**dep**) marks are indicated in the mark scheme, you must check that the candidate has met all the criteria specified for the mark to be awarded.

6. The following abbreviations are commonly found in GCSE Mathematics mark schemes.

   - **cao** means **correct answer only**.
   - **figs 237**, for example, means any answer with only these digits. You should ignore leading or trailing zeros and any decimal point e.g. 237000, 2.37, 2.370, 0.00237 would be acceptable but 23070 or 2374 would not.
   - **isw** means **ignore subsequent working** (after correct answer obtained).
   - **nfww** means **not from wrong working**.
   - **oe** means **or equivalent**.
   - **rot** means **rounded or truncated**.
   - **seen** means that you should award the mark if that number/expression is seen anywhere in the answer space, including the answer line, even if it is not in the method leading to the final answer.
   - **soi** means **seen or implied**.

7. Make no deductions for wrong work after an acceptable answer unless the mark scheme says otherwise, indicated for example by the instruction 'mark final answer'.

8. As a general principle, if two or more methods are offered, mark only the method that leads to the answer on the answer line. If two (or more) answers are offered, mark the poorer (poorest).

9. When the data of a question is consistently misread in such a way as not to alter the nature or difficulty of the question, please follow the candidate's work and allow follow through for **A** and **B** marks. Deduct 1 mark from any **A** or **B** marks earned and record this by using the MR annotation. **M** marks are not deducted for misreads.

10. Unless the question asks for an answer to a specific degree of accuracy, always mark at the greatest number of significant figures even if this is rounded or truncated on the answer line. For example, an answer in the mark scheme is 15.75, which is seen in the working. The candidate then rounds or truncates this to 15.8, 15 or 16 on the answer line. Allow full marks for the 15.75.

11. If the correct answer is seen in the body and the answer given in the answer space is a clear transcription error allow full marks unless the mark scheme says 'mark final answer' or 'cao'. Place the annotation ✓ next to the correct answer.

    If the answer space is blank but the correct answer is seen in the body allow full marks. Place the annotation ✓ next to the correct answer.

    If the correct answer is seen in the working but a completely different answer is seen in the answer space, then accuracy marks for the answer are lost. Method marks would still be awarded. Use the M0, M1, M2 annotations as appropriate and place the annotation ✗ next to the wrong answer.

12. Ranges of answers given in the mark scheme are always inclusive.

13. For methods not provided for in the mark scheme give as far as possible equivalent marks for equivalent work. If in doubt, consult your Team Leader.

14. Anything in the mark scheme which is in square brackets […] is not required for the mark to be earned, but if present it must be correct.

Question			Answer	Marks	Part marks and guidance	
1	(a)		Points plotted at (21, 18) and (7, 8)	1		Tolerance ±1 mm
	(b)		1 : 3	3	**B2** for 3 : 9 oe or answer 3 : 1 or **B1** for 3 [dancers] or 9 [dancers] identified If 0 scored then **SC1** for 4 : 8 seen **and** simplified to 1 : 2	NOT from 4 : 12 May be on graph 4 : 12 simplified to 1 : 3 scores 0
	(c)		The wedges at the front look bigger than those at the back oe	1		Comments should refer to the 3D nature of the pie chart e.g. It's tilted, slanted, seen from an angle etc. Ignore all references to missing angles, not being joined, etc. Mark the best bit unless contradicted

Question			Answer	Marks	Part marks and guidance	
2	(a)		47.5	4	**B1** for at least four of 10, 30, 45, 55, 70	May be implied by four correct products or 4750
					M1 FT for Σ*mf* where *m* is a value within each group 10×5 + 30×8 + 45×37 + 55×47 + 70×3 soi by 50+240+1665+2585+210 or 4750	FT their "midpoints" seen. M1 may be implied by Lower: 0+160+1480+2350+180 (4180) Upper: 100+320+1850+2820+240 (5330) Allow one error in calculation. Expect 100
					M1 FT dep on **M1** for *their* 4750 ÷ *their* (5+8+37+47+3)	
	(b)		Exact speeds for each vehicle are not recorded oe	1		Do not accept, "Because the mid-point is used" or comments on the method used. Accept e.g.: Specific speeds not given or We don't know the speeds The exact speed isn't given

Question	Answer	Marks	Part marks and guidance	
3	1.3×10^{14}	5	**B4** for 1.30×10^{14} or $1.29[6…] \times 10^{14}$ or 130 000 000 000 000 as final answers or **B3** for 1.3×10^n ($n \neq 0$) or $1.29[6…] \times 10^{14}$ written in full or **M3** for $3500 \div (2.7 \times 10^{-11})$ oe or **B2** for $1.29[6...] \times 10^n$ ($n \neq 0$) or figs 13 OR **M1** for figs 35 ÷ figs 27 soi by figs 129[6…] **B1** for 3500 or 2.7×10^{-14} oe or 3.5×10^3 seen	For 5 marks and M marks, condone use of correctly rounded values in correct calculations E.g. 129 600 000 000 000 0.000 000 000 000 027
4	$(4.7) \leq (x) < (4.8)$	2	**B1** for each symbol	

	Question		Answer	Marks	Part marks and guidance	

5	**(a)**		180 ÷ 3.5 × 11.2 = 576
			or
			180 ÷ 3.5 = 51.4[…]
			and
			576 ÷ 11.2 = 51.4[…]
			or
			576 ÷ 180 = 3.2
			and
			11.2 ÷ 3.5 = 3.2
				3	**M2** for 180 ÷ 3.5 × 11.2
					   or 180 ÷ 3.5 **and** 576 ÷ 11.2
					   or 576 ÷ 180 **and** 11.2 ÷ 3.5
					
					or
					
					M1 for
					   180 ÷ 3.5 soi 51.4[…]
					   or 576 ÷ 11.2 soi 51.4[…]
					   or 576 ÷ 180 soi 3.2
					   or 11.2 ÷ 3.5 soi 3.2
						For M marks allow figs used
						eg **M2** for 18 ÷ 350 × 112
						If in two stages:
						For full marks, condone premature rounding if accurate and answer is stated as 576.
						E.g. **3** marks for 180 ÷ 3.5 = 51.4 and 51.4 × 11.2 [= 575.68 or 575.7] **= 576 (required)**
						eg **M2** for 180 ÷ 3.5 = 51.5 and 51.5 × 11.2 = 576
						Accept equivalent methods eg divisions inverted or correct use of lengths in other units.

	(b)		No oe and correct explanation	**2**	**B1** for 180 ÷ *k* × 11.2 where *k* > 3.5 leading to answer <576 or [180 ÷ 3.5 =] 51.4… **and** 180 ÷ *k, k* > 3.5 leading to answer <51.4(…) or Each cm on the map will be worth fewer km in real life oe	For full marks, clear conclusion and an explanation earning **B1** is needed [180 ÷ 3.5 =] may be referred to in (a)
	(c)		7500 cao	**2**	**M1** for figs 18 ÷ figs 24 soi figs 75	If units included in answer max **M1**

Question			Answer	Marks	Part marks and guidance	
6			375	**4**	**M3** for 1025 ÷ (5k + 15k + 21k) × 15k oe or **M2** for 1025 ÷ (5k + 15k + 21k) oe or **M1** for two ratios with a common number of cashews implied by 5k (almonds) **and** 21k (peanuts) seen, k>0 or for 5 : 15 [: 21] or [5 :] 15 : 21 or 41 seen	**M3** implied by 125, 375, 525 with 375 not selected
7	**(a)**		9	**2**	**M1** for 15 × 0.62, possibly soi by 9.3 If **0** scored, then **SC1** for 15 × 0.41 leading to 6 as final answer	Condone "9 or 10" as final answer for **2** marks if correct working is shown.
	(b)	**(i)**		**2**	**B1** for 0.38 and at least one 0.59 seen on correct branches	
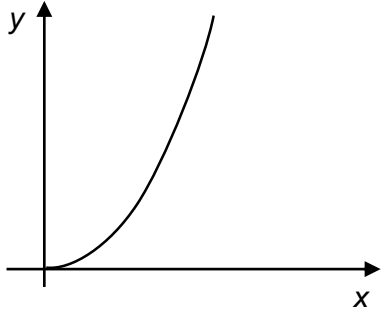
Question			Answer	Marks	Part marks and guidance	
		(ii)	0.5216 or $\dfrac{326}{625}$	3	**M2FT** for $(0.62 \times$ *their* $0.59) + ($*their* $0.38 \times 0.41)$ oe or **M1FT** for $(0.62 \times$ *their* $0.59)$ soi by 0.3658 oe or ($their$ $0.38 \times 0.41)$ soi by 0.1558 oe	Condone 0.52 or 0.522 as final answer provided nfww
8	(a)	(i)	2	2	**M1** for 'rise' ÷ 'run' e.g. 8 ÷ 4	
		(ii)	0	1		
	(b)		150	4	**M3** for complete area$\left[\dfrac{4 \times 8}{2} + (10 \times 8) + \dfrac{(8+10) \times 6}{2} \right]$ or **M2** for two areas $\dfrac{4 \times 8}{2}$ oe, (10×8) oe, or $\dfrac{(8+10) \times 6}{2}$ oe or **M1** for one area $\dfrac{4 \times 8}{2}$ oe, (10×8) oe, or $\dfrac{(8+10) \times 6}{2}$ oe	For **M2** combining a triangle and a rectangle into a trapezium $\dfrac{(14+10) \times 8}{2}$ counts as "two areas" Look for answers of 16, 80 and 54. Allow **M** marks for calculations from other suitable splitting of the areas

Question			Answer	Marks	Part marks and guidance	
9	(a)		A	1		
	(b)		C	1		
10				2	**B1** for a generally increasing graph through (0, 0) or for correct shape not through (0, 0)	Condone straight line with positive gradient through (0,0) for **B1**

Question	Answer	Marks	Part marks and guidance
11	12 nfww	5	**B1** for $5x$ and x soi and **M1** for $6x = 180$ oe and **A1** for $x = 30$ and **M1** for $[n =] \dfrac{360}{their\,30}$ Alternative **M1** for $xn = 360$ oe and **M1** for $5xn = 180(n-2)$ oe and **M1** for $5 \times 360 = 180(n-2)$ oe and **M1** for $10 = n-2$ Alternative **M2** for use of two of $\qquad$ [exterior angle =] $360/n$ $\qquad$ [interior angle =] $180(n-2)/n$ $\qquad$ interior + exterior = 180 or **M1** for use of one of the above AND **M1dep** for checking interior = 5 × exterior **A1** for interior = 150 and exterior = 30 identified	<table><tr><td>sides</td><td>interior</td><td>exterior</td></tr><tr><td>5</td><td>108.0</td><td>72.0</td></tr><tr><td>6</td><td>120.0</td><td>60.0</td></tr><tr><td>7</td><td>128.6</td><td>51.4</td></tr><tr><td>8</td><td>135.0</td><td>45.0</td></tr><tr><td>9</td><td>140.0</td><td>40.0</td></tr><tr><td>10</td><td>144.0</td><td>36.0</td></tr><tr><td>11</td><td>147.3</td><td>32.7</td></tr><tr><td>12</td><td>150.0</td><td>30.0</td></tr><tr><td>13</td><td>152.3</td><td>27.7</td></tr><tr><td>14</td><td>154.3</td><td>25.7</td></tr><tr><td>15</td><td>156.0</td><td>24.0</td></tr></table> For first **M1** allow exterior = $360/n$ but not just $360/n$ Eliminates x Can be implied from a seen calculation or a list showing results of at least two trials (see above) Dependent on **M2** For full marks allow 12 as final answer from trial and improvement, provided interior angle = 150 and exterior angle = 30 are identified in working

Question	Answer	Marks	Part marks and guidance	
12	7.17 to 7.18 or 7.2 nfww	6	**M3** for $x^2 - 3x - 30 = 0$ or **M2** for $\dfrac{6}{2}(10 + x) = x^2$ oe or **M1** for $\dfrac{6}{2}(10 + x)$ oe AND **M2FT** for $\dfrac{3 + \sqrt{(-3)^2 - 4 \times (-30)}}{2}$ or better or 7.17 to 7.18 and -4.18 to -4.17 or **M1FT** for either formula with at most two errors	Condone missing brackets for **M1** **FT** from *their* 3 term quadratic Allow **M2FT** for $\dfrac{3 \pm \sqrt{(-3)^2 - 4 \times (-30)}}{2}$ or better Alternative by completing the square: **M2FT** for $1.5 + \sqrt{32.25}$ or $1.5 \pm \sqrt{32.25}$ or 7.17 to 7.18 and -4.18 to -4.17 or **M1FT** for $(x - 1.5)^2 - 32.25$
13	$8\pi + t\pi + 16 - 2t$ oe including unsimplified expressions	3	**B2** for two of $\dfrac{16\pi}{2}$ oe, $\dfrac{2t\pi}{2}$ oe, or $16 - 2t$ oe seen or **B1** for one of $\dfrac{16\pi}{2}$ oe, $\dfrac{2t\pi}{2}$ oe, or $16 - 2t$ oe seen	Mark final answer Equivalent simplified expressions include: $\pi(8 + t) + 16 - 2t$ or $t(\pi - 2) + 8(\pi + 2)$ Penalise use of 3.14 once e.g. 25.1… and 3.14t scores **B1**

Question			Answer	Marks	Part marks and guidance	
14	(a)		$x = 0.191919\ldots$ $100x = 19.191919\ldots$ $99x = 19$ $x = \dfrac{19}{99}$	3	**M1** for $100x = 19.191919\ldots$ and **M1** for $100x - x = 19.191919\ldots -$ $0.191919\ldots$ or better	For full marks, clear step by step process must be evident Apply marks in a similar way to other methods e.g. **M1** and **M1** for $10000x - 100x$ $= 1919.1919\ldots - 19.1919\ldots$
	(b)		$0.\overline{19} \div 10$ or "divide by 10" $= 0.0\overline{19}$	1 1 dep	 Dependent on first mark	 Answer only scores **0**
15			2.2667 and 2.3882	3	**B2** for 2.2667 or for $2.2666\ldots$ or $\dfrac{34}{15}$ **and** $2.388\ldots$ or **M1** for $\dfrac{2^3}{30} + 2$ soi by $2.2666\ldots$ or $2.2\dot{6}$ or $\dfrac{34}{15}$	For 3 marks, answers must be on answer line or correctly identified as x_2 and x_3

Question	Answer	Marks	Part marks and guidance
16	There could be £301 e.g. because 2635 ÷ 8.745 = 301[.3…]	3	**M2** for a calculation of (2625 to 2635) ÷ (8.745 to 8.755) oe correctly evaluated to an answer of 301(….) or for a calculation of (2632.245 to 2635) ÷ 301 oe correctly evaluated to an answer of 8.745 to 8.755 or for a calculation of 301 × (8.745 to 8.7541528…) oe correctly evaluated to an answer of 2625 to 2635 or **M1** for any further calculation of (2625 to 2635) ÷ (8.745 to 8.755) or (2625 to 2635) ÷ 301 or 301 **×** (8.745 to 8.755) but not 2625 ÷ 8.755 or 2630 ÷ 8.75 or **B1** for 2635, 2.635, 8.745 or 8745 seen	For full marks, their conclusion must follow from a relevant calculation which shows that 301 is a possible answer (either use of 301 and two weights in range, or an answer of more than 301 rounded **down**, and **not** an answer of less than 301 rounded **up**) Calculations may be done in grams as shown, or converted to kg. Common calculations for at least **M2** include: 2635 ÷ 8.75 = 301.1(…) 2635 ÷ 8.745 = 301.3(…) Common calculations scoring only **M1** include: 2625 ÷ 8.75 (= 300) 2630 ÷ 8.745 = 300.7(…)

Question			Answer	Marks	Part marks and guidance	
17			$(\sqrt{6}, 2\sqrt{6})$ and $(^-\sqrt{6}, ^-2\sqrt{6})$	5	**B4** for $(x=) \pm\sqrt{6}$ or one intersection or **M3** for $x^2 = 6$ or **M2** for $x^2 + 4x^2 = 30$ or $5x^2 = 30$ or **M1** for $x^2 + (2x)^2$	 Condone missing brackets for **M1**
18	(a)			3	**B1** for general shape **B1** for max at +2, minimum at 0 **B1** for max at $x = 0, 360, 720$	Starting at max above the x axis, and completing at least one full cycle For full marks, it must be a curve and have correct curvature
	(b)		The maximum value of $\cos x + 1$ is 2 and 2.7 is greater than 2 oe	1		More 'work' may be correctly done before an equivalent conclusion, e.g. $\cos x = 1.7$, and max value of $\cos x$ is 1 and 1.7 is greater than 1.

Question	Answer	Marks	Part marks and guidance	
19	32.2 to 32.3	**6**	**M2** for $x^2 - 10x + 19 = 0$ oe or **M1** for $9^2 = 10^2 + x^2 - 2 \times 10 \times x \times \cos 60$ AND **M1FT** for $\dfrac{10 \pm \sqrt{10^2 - 4 \times 1 \times 19}}{2}$ **A1** for $x = 7.45$ or $5 + \sqrt{6}$ AND **M1** for $\dfrac{1}{2} \times 10 \times their\,7.45 \times \sin 60$ oe Alternative **M1** for $\dfrac{\sin 60}{9} = \dfrac{\sin B}{10}$ oe **M1** for $\sin B = \dfrac{10}{9} \sin 60$ or better **A1** for $B = 74.2(\ldots)$ AND **M1** for $A = 180 - 60 - their\,74.2$ soi by 45.8 AND **M1** for $\dfrac{1}{2} \times 9 \times 10 \times their\,\sin 45.8$	Accept 32 after full correct method Use of cosine rule **FT** their quadratic = 0 <u>Alternative</u>: **M1** for $(x - 5)^2 - 6 = 0$ Ignore 2.55 or $5 - \sqrt{6}$ *Their* 7.45 should be from cosine rule followed by quadratic (not from measuring etc.) Use of sine rule Isolates $\sin B$ *Their* 45.8 should be from sine rule followed by 180 – *their* sine rule answer (not from measuring etc.)

Mark Scheme

Question			Answer	Marks	Part marks and guidance	
20	**(a)**		eg. $\begin{pmatrix} 1 \\ 1 \end{pmatrix}$ and $\begin{pmatrix} 3 \\ 2 \end{pmatrix}$	3	**B2** for one correct answer or **M1** for any multiple of $\begin{pmatrix} 2 \\ 1 \end{pmatrix}$ seen	Other correct answers include: $\begin{pmatrix} 5 \\ 3 \end{pmatrix}$, $\begin{pmatrix} -1 \\ 0 \end{pmatrix}$, $\begin{pmatrix} -3 \\ -1 \end{pmatrix}$, $\begin{pmatrix} -7 \\ -3 \end{pmatrix}$, $\begin{pmatrix} -9 \\ -4 \end{pmatrix}$, $\begin{pmatrix} -11 \\ -5 \end{pmatrix}$, $\begin{pmatrix} -13 \\ -6 \end{pmatrix}$ and $\begin{pmatrix} -15 \\ -7 \end{pmatrix}$ For others, check that top + 5 is double bottom + 2
	(b)		$m = {}^-2, n = 4$	5	**B1** for $\begin{pmatrix} 4m \\ m \end{pmatrix}$ or $\begin{pmatrix} 5n \\ 2n \end{pmatrix}$ soi and **M1** for $4m + 5n = 12$ or $m + 2n = 6$ and **M1** for multiplication by scalar(s) to equate coefficients in m or n or reduction to one variable by substitution e.g. $4(6 - 2n) + 5n = 12$ and **M1** for elimination or simplification to $3m = {}^-6$ or $3n = 12$ oe	

Question	Answer	Marks	Part marks and guidance	
21	5 nfww and after $\dfrac{5(x+5)(x-7)}{(x+5)(x-7)}$ seen	6	**B1** for $(x+5)(x-7)$ or $x^2 + 5x - 7x - 35$ or better seen as a common denominator of the first two fractions AND **B3** for numerator $5x^2 - 10x - 175$ or **B2** for numerator $5x^2 - 10x + 125$ or **M1** for $5x(x-7)$ and $25(x+5)$ AND **M1** for $5(x^2 - 2x - 35)$ or $(5x + 25)(x - 7)$ or $(x+5)(5x-35)$ or $5(x+5)(x-7)$	Condone missing final bracket. Condone numerators written without any denominators or with an incorrect common denominator

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