OCR
Oxford Cambridge and RSA

GCSE

Mathematics B (Linear)

Component **J567/03:** Mathematics Paper 3 (Higher)

General Certificate of Secondary Education

Mark Scheme for November 2016

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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.

OCR will not enter into any discussion or correspondence in connection with this mark scheme.

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 using a correct method and are not lost for purely numerical errors.
A marks are for an accurate answer and depend on preceding **M** (method) marks. Therefore **M0 A1** cannot be awarded.
B marks are independent of **M** (method) marks and are for a correct final answer, a partially correct answer, or a correct intermediate stage.
SC marks are for special cases 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 not from wrong working **full marks** should be awarded.

Do not award the marks if the answer was obtained from an incorrect method, ie incorrect working is seen and 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, eg FT 180 × (*their* '37' + 16), or FT 300 – √(*their* '$5^2 + 7^2$'). Answers to part questions which are being followed through are indicated by eg 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 eg 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.

MARK SCHEME

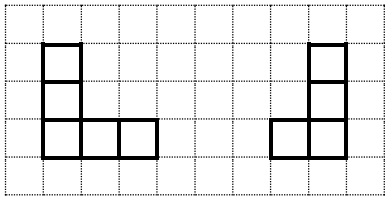
Question			Answer	Marks	Part marks and guidance	
1	(a)		Point (16, 9) indicated	1		
	(b)		Ruled line of best fit 13 to 14	B1 B1		Ruled line of best fit passing between (6, 7) to (6, 10) and (18, 18) and (18, 20), line from (0, 0) to (20, 20) scores B0 Second B1 is independent
2	(a)	(i)	36	1		
		(ii)	–6	2	**M1** for –15 seen or [+]9 seen or for $5 \times -3 + (-3)^2$	
	(b)		$5t(2t + 3q)$ final answer	2	**B1** for $5t(2t + \ldots)$ or $5(2t^2 + 3qt)$ or $t(10t + 15q)$ seen	
	(c)		8	3	**M2** for $7x – 4x = 15 + 9$ or better Or **M1** for $7x – 4x – 9 = 15$ or for $7x = 4x + 15 + 9$ **AND** **M1** for $x = \frac{b}{a}$ after $ax = b$ seen **Max 2 marks if answer incorrect**	Correct collection of x terms Correct collection of constants $b \neq 0$, $a \neq 1$

Question			Answer	Marks	Part marks and guidance	
	(d)		$k = \frac{m-3}{8}$ or $k = \frac{m}{8} - \frac{3}{8}$ final answer	2	**M1** for $8k = m - 3$ or $\frac{m}{8} = k + \frac{3}{8}$ After **M0**, **SC1** for answer $\frac{m-3}{8}$ or $k = \frac{m+3}{8}$ or $k = \frac{m}{8} - 3$ or $k = \frac{3-m}{8}$ or $k = m - 3 \div 8$	Accept $k = (m - 3) \div 8$ for 2 marks
3	(a)		Arc radius 4 cm, centre A Arc radius 5 cm, centre B Correct region shaded	1 1 1	 **FT** intersection of *their* two arcs	For first two marks, allow tolerance of ±2mm Arcs must be at least one quarter circle by eye Condone freehand arcs
	(b)		5.4	3	**B1** for 20 minutes **soi** **M1** for 1.8 ÷ *their* 20 [×60] **soi**	eg award B1 M1 for 1.8 × 3 seen
4	(a)	(i)	2 | 0 1 6 8 9 3 | 1 1 5 6 7 9 4 | 0 1 2 7 8 5 | 3 7 6 | 2 5	3	**M2** for ordered diagram with one error, omission or extra or for unordered diagram with all 20 values in correct rows and no extras OR **M1** for [un]ordered diagram with no more than two errors, omissions or extras	Give bod for unclear numbers if crossed out as part of median calculation If two diagrams, mark better
		(ii)	38	2	**M1** for 37 and/or 39 as answer or identified in table or working or for 8 as answer or **FT** middle value(s) from *their* ordered stem and leaf identified	e.g. accept 7 and/or 9 ringed in 30 row in table for M1 or ordered list of at least first/last 11 values But M0 for 0 1 6 8 9 1 … without further clarification

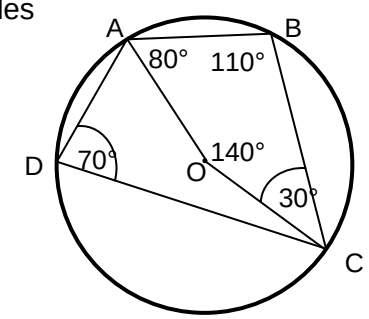
Question			Answer	Marks	Part marks and guidance	
		(iii)	25	2	**M1 FT** for $\frac{\textit{their}\ 5}{20}$ **oe seen**	*Their* 5 is number in first row of *their* stem and leaf
	(b)	(i)	Suitable question with at least 4 option boxes with clear non-overlapping categories covering full range of times from 0600 to 2300	2	**B1** for suitable question with at least 3 option boxes Or **SC1** for at least 4 option boxes with clear non-overlapping categories covering full range of times with no question	For B1 option boxes may be unclear, have overlap or not cover full range of times Allow open end for first/final group eg before 8am/ after 9pm etc
		(ii)	28	2	**M1** for $\frac{280}{500}[\times 50]$ **oe** or for $\frac{50}{500}$ **soi**	Implied by 10% of 280 seen or $\frac{50}{500}$ seen
5	(a)		$-\frac{2}{3}$ **oe**	2	**M1** for attempt to find (change in *y*) ÷ (change in *x*) Or **SC1** for answer $\frac{2}{3}$ **oe** or for answer –1.5 **oe**	Must be integer/integer or 3sf decimal for 2 marks, M1 only for answer $-\frac{3}{4.5}$ Allow $y = -\frac{2}{3}x + 3$ oe for 2 marks
	(b)		Straight line through (–1.5, –4) and (2.5, 4)	3	**B2** for correct short straight line or for two correct pairs of coordinates **soi** Or **B1** for one correct pair of coordinates **soi**	Tolerance 2mm radially by eye for plots Coordinates may be implied by plot or line, other than $x = k$ or $y = k$, passing through correct point

x	–2	–1	0	1	2	3
y	–5	-3	–1	1	3	5

Question			Answer	Marks	Part marks and guidance	
	(c)		(1.5, 2)	**1**	**FT** intersection of their line with L	Tolerance for reading ±0.1
6			19.75	**4**	**B1** for 500g or 2 bags [cashews] **soi** **and** 300g or 3 bags [almonds] **soi** **and** 200g or 2 bags [cranberries]**soi** **M2** for 2 × 4.75 + 3 × 2.15 + 2 × 1.90 **soi** OR **M1** for one of 2 × 4.75 or 3 × 2.15 or 2 × 1.90 **soi**	9.50 + 6.45 + 3.80 Clear attempt to add cost of 2 bags cashews, 3 bags almonds, 2 bags cranberries, may include arithmetic slips 9.50 or 6.45 or 3.80 or may be implied by calculations leading to 17.60 seen
7	**(a)**		$0.\dot{1}$	**1**		Condone 0.111[1111] Allow any clear indication of recurring notation
	(b)		$\frac{8}{15}$ **oe**	**2**	**M1** for $\frac{4}{3} \times \frac{2}{5}$ **oe**	Accept eg $\frac{120}{225}$ for 2 marks and $\frac{20}{15} \times \frac{6}{15}$ for M1 ISW for incorrect cancellation after $\frac{8}{15}$ oe evaluated

Question			Answer	Marks	Part marks and guidance	
8	(a)		$y > 5.5$ final answer	3	**M1** for $2y - 6 > 5$ or $y - 3 > \frac{5}{2}$ AND **M1FT** for $2y > 5 + 6$ or $y > \frac{5}{2} + 3$ AND **M1FT** for $y > \frac{b}{a}$ after $ay > b$ seen **Max 2 marks if answer incorrect** Or **SC2** for answer 5.5 or $y \ldots 5.5$ with = or any incorrect inequality symbol or answer $2(5.5 - 3) > 5$	Condone use of = or incorrect inequality symbol for all method marks Accept any equivalent fraction for 5.5 $b \neq 0$, $a \neq 1$
	(b)		–2, –1, 0, 1	1		
9	(a)			2	**B1** for one correct diagram or for both diagrams correct shape and size, incorrect orientation	Condone unruled and omission of internal lines
	(b)	(i)	(3, 0, 1)	1		
		(ii)	(1, 2, 3)	1		
10	(a)		[SF] 3 [Centre] (–6, –5)	B1 B1	Max **B1** if another transformation mentioned	Condone missing brackets for coordinates but not written as vector

Question			Answer	Marks	Part marks and guidance	
	(b)		Rotation or enlargement 180° or [SF] –1 (–1, 0)	**B1** **B1** **B1**	No other transformation Must be consistent with given transformation Or **SC2** for triangle vertices (0, 4), (1, 2), (1, 4) seen Or **SC1** for triangle vertices (–4, 2), (–4, 3), (–2, 3) seen **Max 2 marks if answer incorrect**	Or for two correct rotations of *their* shape clearly seen Or for correct rotation of *their* shape about origin clearly seen
11			Length = 25, width = 18	**5**	**M1** for $(2x – 5)(x + 3)$ or $2x^2$ **soi** **M1** for expansion of brackets $2x^2 – 5x + 6x – 15$ or better **M1FT** for equating area of rectangle with 2 × area of square and solving to $x =$ *their* 15 **M1FT** for answer for length correctly evaluated using $2x – 5$ using *their x* **M1FT** for answer for width correctly evaluated using $x + 3$ using *their x* **Max 4 marks if answer incorrect** **Alternative method** **M1** for correct length of rectangle linked with square of side *a* **M1** for correct width of rectangle linked with square of side *a* **M1** for area of rectangle **and** square evaluated correctly for square of side *a* **Max 3 marks if answer incorrect**	Accept answer length = 18, width = 25 for 5 marks Accept 3 terms correct in 4-term expression or 2 terms correct in simplified 3-term expression Solving *their* equation involving areas Providing length positive Providing width positive Trial and improvement method

Question	Answer	Marks	Answer
12*	∠OAB = 80° with correct and clearly laid out solution. All required angles clearly identified in working with a correct reason given for each angle found. Correct mathematical terminology and notation throughout For 4 marks: **4a** Correct answer of ∠OAB = 80° with at least two correct reasons related to angles seen **4b** Complete solution with full reasons and maximum one arithmetic slip to reach incorrect value for ∠OAB For 2 marks: **2a** One relevant angle stated with correct reason, allow FT **2b** Two relevant angles found, may be indicated on diagram, allow FT **2c** Two relevant reasons stated, need not be linked with appropriate angles  	5 4-3 2-1	Eg ∠AOC = 140°, angle at centre = twice angle at circumference ∠ABC = 110°, opposite angles in cyclic quad sum to 180° ∠OAB = 80, angles in quadrilateral sum to 360° For 3 marks: **3a** Correct answer of ∠OAB = 80° with insufficient or no reasons seen **3b** At least two relevant angles stated with correct reasons, allow FT **3c** Complete solution with at least one correct reason related to angle seen and maximum one arithmetic slip to reach incorrect value for ∠OAB For 1 mark: **1a** One relevant angle found, may be indicated on diagram, allow FT **1b** One relevant reason stated, need not be linked with appropriate angle Acceptable reasons: [angle] … centre twice …[angle] circumference Opposite angles [in a] cyclic [quad] [add up to] 180 Cyclic quad[rilateral] NB if not spoilt by incorrect reason [angles in a] quadrilateral [is/equals/adds to] 360 Allow [angles at a] point [is/equals/adds to] 360 if linked with correct pair of angles

Question			Answer	Marks	Part marks and guidance	
13	(a)		15 700 000 000	1		Must have 8 zeros, ignore incorrectly positioned dividers
	(b)		1.974×10^{11}	2	**B1** for answer figs 1974 Or **M1** for 2.40 **and** 0.426 **oe** seen Or 24 **and** 4.26 seen Or 240 000 000 000 **and** 42 600 000 000 seen	May be as part of numbers in 'standard form'
	(c)		20	3	**B2** for answer 120[%] OR **B1** for figs 3 and figs 2.5 used **M1** for $\frac{3.038\times10^{11}}{2.543\times10^{11}}[\times100]$ **oe** or $\frac{3.038\times10^{11}-2.543\times10^{11}}{2.543\times10^{11}}[\times100]$	May be using their rounded values, eg $\frac{30}{25}$ or $\frac{5}{25}$ etc
14	(a)		(1, 2)	2	**B1** for one value correct Or **M1** for $\frac{-3+5}{2}$ and $\frac{4+0}{2}$	
	(b)		$4\sqrt{5}$	4	**B1** for triangle sides 8 and 4 **soi** **M1FT** for $\sqrt{8^2+4^2}$ **M1FT** for $\sqrt{80}$	Allow –8, –4 Pythagoras using *their* 8 and *their* 4
15	(a)	(i)	Correct tree diagram $\frac{4}{10}$ on first set of branches $\frac{5}{9}$, $\frac{4}{9}$ and $\frac{4}{10}$ on second set	2	**B1** for two branches completed correctly	

Question			Answer	Marks	Part marks and guidance	
		(ii)	$\frac{1}{3}$ oe	2	**M1FT** for $\frac{6}{10}\times\frac{5}{9}$	Award M1 for answer $\frac{9}{25}$ oe after $\frac{6}{10}$ in place of $\frac{5}{9}$ on tree diagram
	(b)		$\frac{64}{1000}$ oe	2	**M1FT** for $\frac{4}{10}\times\frac{4}{10}\times\frac{4}{10}$	ISW incorrect cancellation of fraction
16	(a)	(i)	$\begin{pmatrix}-8\\12\end{pmatrix}$	1		
		(ii)	$\begin{pmatrix}-3\\7\end{pmatrix}$	1		
	(b)		Vector $\begin{pmatrix}-1\\-6\end{pmatrix}$ drawn on grid	2	**B1** for correct line with no arrow Or **M1** for $\begin{pmatrix}-4\\6\end{pmatrix}+\begin{pmatrix}3\\-12\end{pmatrix}$ or $\begin{pmatrix}-1\\-6\end{pmatrix}$ seen Or for vector $\begin{pmatrix}-4\\6\end{pmatrix}$ or $\begin{pmatrix}3\\-12\end{pmatrix}$ drawn	For 2 marks, vector must have arrow and resultant clearly shown Condone missing vector brackets if intention clear Condone missing arrow on vector for M1 or vector drawn in stages
17			$\frac{3y-2x}{xy}$ final answer	2	**M1** for numerator $3y - 2x$ seen or common denominator xy seen	Common denominator implied by answer with denominator xy
18	(a)	(i)	1	1		
		(ii)	3	2	**B1** for $27^{\frac{1}{3}}$ or $\sqrt[3]{27}$ or $\left(\frac{1}{3}\right)^{-1}$ seen	Condone $\frac{3}{1}$ for 2 marks $\frac{1}{\frac{1}{3}}$ implies M1
	(b)		$11 + 6\sqrt{2}$	2	**M1** for $9+3\sqrt{2}+3\sqrt{2}+\sqrt{2}\sqrt{2}$ or better, at least two terms correct in an expression with three or four terms	Allow M1 for $6\sqrt{2}$ or for $11+a\sqrt{2}$ but not for 11 alone

Question			Answer	Marks	Part marks and guidance	
19			Correct algebraic solution leading to $x = 5, y = 16$ $x = -2, y = 2$	5	**nfww** **M2** for $x^2 - 3x - 10$ [= 0] Or $y^2 - 18y + 32$ [= 0] OR **M1** for attempting to equate eg $x^2 - x - 4 = 2x + 6$ **oe** or $y = \left(\frac{y-6}{2}\right)^2 - \frac{y-6}{2} - 4$ AND **M1FT dep** for factorising *their* quadratic $(x - 5)(x + 2)$ or $(y - 16)(y - 2)$ AND **A1** for $x = 5$, $x = -2$ **A1** for $y = 16$, $y = 2$ After **A0**, allow **SC1** for one pair of x and y values correct Or for both y values correctly FT their x values substituted into $y = 2x + 6$	Accept $-x^2 + 3x + 10$ [= 0] Dependent on at least M1 Or correct FT substitution into formula eg $\frac{3 \pm \sqrt{3^2 - 4 \times 1 \times -10}}{2 \times 1}$ Allow A marks if solutions clear in working and transferred to wrong places on answer lines

OCR (Oxford Cambridge and RSA Examinations)
1 Hills Road
Cambridge
CB1 2EU

OCR Customer Contact Centre

Education and Learning
Telephone: 01223 553998
Facsimile: 01223 552627
Email: general.qualifications@ocr.org.uk

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Head office
Telephone: 01223 552552
Facsimile: 01223 552553