OCR
RECOGNISING ACHIEVEMENT

GCSE

Mathematics B (Linear)

General Certificate of Secondary Education

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

Mark Scheme for November 2013

Oxford Cambridge and RSA Examinations

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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.

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

1. **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.

2. 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.

3. 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 – $\sqrt{}$(*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.

4. 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.

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

   - **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 and applies as a default.
   - **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**.

6. In questions with no final answer line, make no deductions for wrong work after an acceptable answer (ie **isw**) unless the mark scheme says otherwise, indicated by the instruction 'mark final answer'.

7. In questions with a final answer line following working space,

   (i) if the correct answer is seen in the body of working and the answer given on the answer line is a clear transcription error allow full marks unless the mark scheme says 'mark final answer'. Place the annotation ✓ next to the correct answer.

   (ii) if the correct answer is seen in the body of working but the answer line is blank, allow full marks. Place the annotation ✓ next to the correct answer.

   (iii) if the correct answer is seen in the body of working but a completely different answer is seen on the answer line, then accuracy marks for the answer are lost. Method marks could still be awarded. Use the M0, M1, M2 annotations as appropriate and place the annotation × next to the wrong answer.

8. In questions with a final answer line:

   (i) If one answer is provided on the answer line, mark the method that leads to that answer.

   (ii) If more than one answer is provided on the answer line and there is a single method provided, award method marks only.

   (iii) If more than one answer is provided on the answer line and there is more than one method provided, award zero marks for the question unless the candidate has clearly indicated which method is to be marked.

9. In questions with no final answer line:

   (i) If a single response is provided, mark as usual.

   (ii) If more than one response is provided, award zero marks for the question unless the candidate has clearly indicated which response is to be marked.

10. 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.

11. 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.

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

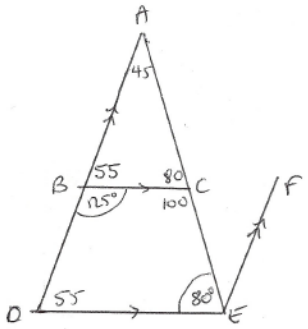
13. For methods not provided for in the mark scheme give as far as possible equivalent marks for equivalent work. If in doubt, consult your Team Leader.

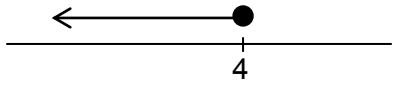
14. Anything in the mark scheme which is in square brackets […] is not required for the mark to be earned, but if present it must be correct.

Question			Answer	Marks	Part Marks and Guidance	
1	(a)	(i)	$2^5 \times 3$ Or $2 \times 2 \times 2 \times 2 \times 2 \times 3$ or better	2	**M1** for correct factor pair or product seen or attempt at factor tree/ladder with at least two steps or answer $2^k \times 3$ **oe** OR **SC1** for 2, 2, 2, 2, 2, 3 identified but not as product	Condone 3^1 for 2 or 1 marks May be part of factor tree or eg $4 \times 8 \times 3$ May contain errors
		(ii)	12 final answer	2	**B1** for 2, 2, 3 clearly identified for both 96 and 108 or answer of 2, 3, 4 or 6 **oe**	e.g. in a Venn diagram e.g. accept 2^2 for B1
	(b)		$5\frac{1}{6}$ final answer	3	**B2** for $5\frac{2}{12}$ or $\frac{62}{12}$ seen or other unsimplified equivalent OR **M1** for $1\frac{3}{4}$ converted to $1\frac{9}{12}$ or $\frac{21}{12}$ AND **M1** for correct addition of *their* two improper fractions/mixed numbers with common denominator AND **M1** for *their* improper fraction/mixed number correctly converted to a mixed number in its lowest terms **max 2 marks if answer incorrect**	M1 may be implied by $\frac{3}{4}$ converted to $\frac{9}{12}$ but not $3\frac{9}{12}$ Or M1 for other conversion to common denominator with at least one correct numerator allow this M1 even if no simplification required
2	(a)		-7 125	1 1		

Question			Answer	Marks	Part Marks and Guidance	
	(b)		21	2	**M1** for 9 from b^2 or + 3 from $-b$ **soi** Or for $2 \times (^{-}3)^2 - {}^{-}3$ seen	e.g. $^{-}36 - {}^{-}3 = {}^{-}33$ implies M1 Condone missing brackets in $(^{-}3)^2$ if result 9 seen
3	**(a)**		97.28 [p]	4	**B3** for 24.32 seen from 12.8 × 1.9 or answer £97.28 or **figs** 9728 OR **M1** for 1.9 × 4 × 12.8 **soi** AND **B1** for **figs** 76, 512, 38, 152, 1152 896, 768, 608, 4608 or 95 seen AND **B1** for answer in range 87 to 104	allow rounding of 97.28 seen for 4 marks May be seen in stages, may be done in any order but not using rounded values. Condone additional multiplication by 7
	(b)	**(i)**	4 | 9 5 | 3 4 7 6 | 0 4 7 8 7 | 0 3 3 4 4 7 8 8 | 6	3	**M2** for table with 4 correct rows Or **M1** for unordered diagram with at most one error or omission	

Question			Answer	Marks	Part Marks and Guidance	
		(ii)	He uses fewer units than average with clear and correct working using appropriate representative value/values e.g. Using median = 69, he uses 276 units per month on average which is less than average household e.g. Using his maximum four weekly values, he uses 315 units per month which is less than the average household e.g. The average household uses 82.5 units per week and his median weekly use is 69 units which is less than the average	4	**B2** for selecting an appropriate representative daily or weekly or monthly or 4-monthly amount making the time period clear Or **B1** for representative amount that is not appropriate or incorrect representative value **M1** for **correct** answer to calculation allowing like with like comparison e.g. for *their* weekly average × 4 Or *their* daily average × 30 Or calculation of *their* monthly average Or average household uses 330 × 4 = 1320 in 4 months Or average household uses 330 ÷ 4 = 82.5 per week **B1** for comparison and conclusion ft *their* values **If their conclusion follows from comparison of incorrect figures, maximum 3 marks may be awarded**	For all marks follow through their stem and leaf diagram e.g. median [weekly] = 69 maximum monthly = 74 + 77 + 78 + 86 [= 315] total in 4 months = 1077 e.g. addition of any four weekly amounts or incorrect addition of all 16 amounts or incorrect median Allow use of e.g. $4\frac{1}{3}$ weeks per month or 28 to 31 days per month Must compare like with like, e.g. Felix weekly with average weekly or Felix monthly with average monthly If choice of values used, mark to the candidate's advantage

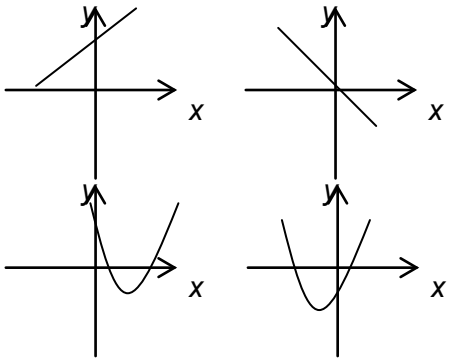
Question			Answer	Marks	Guidance
4*			x = 45° with correct and clearly laid out solution. All required angles clearly identified in working with a correct reason given for each angle found. Correct mathematical terminology and notation throughout **4a** correct answer of x = 45° with at least two correct angles and related reasons stated **4b** complete solution with full reasons and maximum one arithmetic slip to reach incorrect value for x **2a** one relevant angle stated with correct reason, allow **FT** **2b** two relevant angles found, may be indicated in correct position on diagram, allow **FT** **2c** two relevant reasons stated, need not be linked with appropriate angles No correct work seen  	5 4–3 2–1 0	e.g. ∠CED = ∠ACB = 80°, corresponding angles ∠ABC = 180° – 125° = 55°, angles on a line ∠CAB = 180° – 55° – 80° = 45°, angles in a triangle x = 45°, alternate angles equal For the lower mark **3a** correct answer of x = 45° with insufficient solution/reasons seen **3b** at least two relevant angles stated with correct reasons, may **FT** arithmetic slip **3c** at least three relevant angles found, may be indicated in correct position on diagram, may **FT** arithmetic slip For the lower 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:** Alternate angles equal Corresponding angles equal [Co-]interior/allied [angles] = 180 [angles in a] triangle = 180 [angles on a straight] line = 180 [angles in a] quadrilateral = 360 Similar triangles (only if correct angle pairs used) 180 may be implied in above reasons by a correct calculation seen and equal by a correct pair **soi** Condone use of Z (in place of alternate), F (in place of corresponding), C/U (in place of interior/allied) for up to 4 marks Supplementary angles alone is not sufficient, needs some context

Question			Answer	Marks	Part Marks and Guidance	
5	(a)	(i)	$\frac{74}{120}$ **oe**	1	accept 0.616[…] or 0.617 or 61.6[…][%] or 61.7% or better	do not accept ratio as answer **isw** for incorrect cancelling or 74 in 120 or 74 out of 120 etc after correct fraction seen Condone 'likely' after correct fraction seen
		(ii)	600 final answer	2	**M1** for $\frac{30}{120} \times 2400$ **oe** or for 600 seen with 2400	e.g. $\frac{600}{2400}$ or 600 out of 2400
	(b)		50	2	**M1** for $\frac{1500}{2400} \times 80$ **oe**	
6	(a)		$x \leq 4$	2	**M1** for $3x \leq 8 + 4$ or better AND **M1** for $x \leq \frac{b}{a}$ after $ax \leq b$ **seen** **max 1 mark if answer incorrect** OR **SC1** for answer 4 or x … 4 with any incorrect equality or inequality symbol or answer $3 \times 4 - 4 \leq 8$	Condone use of = or incorrect inequality symbol in place of ≤ for all method marks $a \neq 1$, $b \neq 0$ condone e.g. '4 or less' as answer for SC1
	(b)			1	**FT** *their* inequality in **(i)**	Condone any indication at 4 Condone missing arrow at other end but do not accept indication of the line terminating Accept any length line

Question			Answer	Marks	Part Marks and Guidance	
7			Use of 360° at point Or use of symmetry to halve 90°	B1	e.g. 360 – 90 seen or angles summing to 360 seen	implied by 270 seen
			[Angle in each polygon =] 135[°]	B1	or exterior angle is 45	
			Number of sides = 360 ÷ (180 – *their* 135)	B1	or identifying polygon has 8 sides or 180(n – 2) = 135n used	condone poor notation for division e.g. 45 ÷ 360 if intention clear
			Octagon	B1		All marks independent
8	(a)		Triangle B correctly positioned Vertices ($^-$4, $^-$2), ($^-$4, $^-$3), ($^-$1, $^-$2)	4	**B3** for triangle B with two vertices correct Or for correct rotation followed by translation by 5 left or 1 down Or for correct translation following 90° anticlockwise rotation about origin OR **B2** for correct rotation of A clockwise about origin followed by incorrect or no translation Or for 90° anticlockwise rotation about origin followed by translation by 5 left or 1 down OR **B1** for rotation of A 90° anticlockwise about origin followed by incorrect or no translation OR **SC2** for correct translation following 180° rotation about origin OR **SC1** for translation of 5 left or 1 down following 180° rotation about origin	Use overlay Accept intention if triangles not labelled Red triangle scores 4 marks, horizontal or vertical translation of red scores B3, any other translation of red scores B2 Green triangle scores B3, horizontal or vertical translation of green scores B2, any other translation of green scores B1 Blue triangle scores SC2, horizontal or vertical translation of blue scores SC1, any other translation of blue scores SC0

Question			Answer	Marks	Part Marks and Guidance	
	(b)		[Centre] ($^{-}$1, 2) and [scale factor] $^{-}$2 with no other transformation	2	**B1** for ($^{-}$1, 2) Or **B1** for $^{-}$2	Do not accept centre written as vector Condone e.g. 'negative enlargement of 2' for scale factor $^{-}$2
9			[Shortest side =] 7 **nfww**	5	**M4** for $x = 4$ **nfww** OR **M1** for $8x + 2$ or $4x + 18$ seen AND **M1** for *their* '$8x + 2$' = *their* '$4x + 18$' AND **M1** for correctly collecting terms *their* '$8x - 4x$' = *their* '$18 - 2$' AND **M1** for $x = \frac{b}{a}$ after $ax = b$ seen **AND** **M1** for correctly evaluating $11 - x$ using *their* positive x **max 4 marks if answer incorrect**	allow 5 marks for $11 - x$ on answer line if seen evaluated as 7 in working accept unsimplified any equivalent equation **FT** *their* attempts at perimeters **FT** *their* linear equation $a \neq 1$ and $a \neq b$ and $\frac{b}{a} > 0$ $0 < x < 11$ Trial and improvement methods can score 5 for shortest side = 7 or 4 for $x = 4$ only. Answer 7 with no working scores 5
10	**(a)**		5 15 34 48 60	1		

Question			Answer	Marks	Part Marks and Guidance	
	(b)		All points plotted correctly and joined with smooth curve or straight line segments	2	**FT** *their* table **B1** for at least 4 points plotted at correct height within interval	Allow ±1 mm for plotting points and drawing curve, use overlay for guidance Condone starting at (20, 5) Mark curve generously Bar chart only scores 0, bar chart with curve scores max B1
	(c)		14 to 16	2	**B1** for 44 to 46 seen or **FT** reading from *their* line or curve at $s = 75$	FT for *their* reading or '60 – *their* reading', tolerance ±1 no FT from bar chart
11	**(a)**		9 060 000	1		condone dots for commas if digits clear
	(b)		3.4×10^5 or 340 000	2	**B1** for **figs** 34 Or **M1** for 10 100 000 and 9 760 000 seen or 10.1 and 9.76 seen or 1.01 and 0.976 seen	may be as part of numbers in standard form
	(c)		2×10^8 or 1.995×10^8	2	**M1** for $50 \times 4 \times 10^6$ **soi** or $50 \times 3.99 \times 10^6$ **soi** **SC1** for answer **figs** 2 or answer **figs** 1995	e.g. may be implied by correct figs seen in working, and answer truncated but with 10^8 in correct standard form

Question			Answer	Marks	Part Marks and Guidance	
12	(a)	(i)	1.8	2	**M1** for 3 × 0.6 or answer **figs** 18	
		(ii)	1800	1FT	**FT** 1000 × *their* 1.8	strict follow through
	(b)	(i)	0.03 [m^2]	3	**M2** for 0.1^2 **soi** Or **M1** for 100 seen or scale factor 0.1 **soi**	accept answer 300 cm^2 if units clearly stated e.g. M1 implied by answer 0.3
		(ii)	1.8	1FT	**FT** *their* **(a)(ii)** ÷ 1000	strict follow through
13			Correct region R indicated	3	**B2** for region on the correct side of two inequalities **B1** for region on the correct side of one inequality	Do not assume axes are boundaries unless identified by shading i.e. if no shading, assume that the region is bounded by the inequality lines If no label R, assume shading identifies region unless clearly shading out each individual inequality If their region is bounded by lines other than those given maximum B1 may be awarded
14				1 2	both correct, first line any with positive gradient, second line any with negative gradient or horizontal or vertical line both correct, first graph any with two positive solutions, second any with one/no positive solutions Or **B1** for any one parabola seen	accept any clear intention of correct graphs, ie not ruled but attempt at straight line Accept any clear intention of correct graphs, ie attempt at parabola Condone more than one parabola on axes for B1

Question			Answer	Marks	Part Marks and Guidance	
15			$\frac{5}{8}$ **oe**	4	**M3** for sum of at least four of required probabilities seen: DD, DM, MD, DW and WD Or for P(D) + P(MD) + P(WD) Or for 1 - P(no dark) OR **M2** for P(no dark) = $\frac{10}{16} \times \frac{9}{15}$ or $\frac{3}{8}$ Or for correct tree diagram showing probabilities on sufficient branches Or for at least two of the five required probabilities found OR **M1** for at least one correct combined probability seen Or for three correct probabilities for first chocolate seen: M = $\frac{8}{16}$, D = $\frac{6}{16}$ and W = $\frac{2}{16}$ Or for identifying the five required pairs of outcomes: DD, DM, MD, DW and WD OR **SC2** for answer $\frac{27}{28}$ or $\frac{39}{64}$ Or **SC1** for correct tree diagram assuming just 6 dark, 2 white chocolates or correct tree diagram assuming replacement	allow all method marks if correct multiplication seen, even if not evaluated or incorrectly evaluated P(MM) = $\frac{8}{16} \times \frac{7}{15} = \frac{7}{30}$ P(MD) = $\frac{8}{16} \times \frac{6}{15} = \frac{1}{5}$ P(MW) = $\frac{8}{16} \times \frac{2}{15} = \frac{1}{15}$ P(DM) = $\frac{6}{16} \times \frac{8}{15} = \frac{1}{5}$ P(DD) = $\frac{6}{16} \times \frac{5}{15} = \frac{1}{8}$ P(DW) = $\frac{6}{16} \times \frac{2}{15} = \frac{1}{20}$ P(WM) = $\frac{2}{16} \times \frac{8}{15} = \frac{1}{15}$ P(WD) = $\frac{2}{16} \times \frac{6}{15} = \frac{1}{20}$ P(WW) = $\frac{2}{16} \times \frac{1}{15} = \frac{1}{120}$ allow equivalent marks throughout for methods using dark/not dark

Question			Answer	Marks	Part Marks and Guidance	
16	(a)		4.5	3	**nfww** **M1** for eliminating fraction and expanding bracket $3x - 1 = 5x - 10$ AND **M1** for collecting terms **FT** $^-1 + 10 = 5x - 3x$ AND **M1** for $x = \frac{b}{a}$ after $ax = b$ seen **max 2 marks if answer incorrect**	condone $3x - 1 = 5x - 2$ or $3x - 1 = x - 10$ or $0.6x - 0.2 = x - 2$ for M1 correct collection from $ax + b = cx + d$ to $ax - cx = d - b$ $a \neq 1$ or 0 and $a \neq b$ and $b \neq 0$
	(b)		a^8	2	**M1** for $(a^{-4})^{-2}$ or $\left(\frac{1}{a^4}\right)^{-2}$ or $\left(\frac{a^9}{a^5}\right)^2$ or $\frac{a^{-10}}{a^{-18}}$ or $\frac{a^{18}}{a^{10}}$ seen	condone a^{-4-2} for M1
	(c)		$\frac{14 - x}{(x-2)(x+1)}$ or $\frac{14 - x}{x^2 - x - 2}$	3	**M1** for $4(x + 1) - 5(x - 2)$ or $4x + 4 - 5x + 10$ with three terms correct or better seen **M1** for correct common denominator seen as denominator	Mark final answer but **isw** for incorrect expansion of denominator after correct denominator seen May be in two separate fractions condone missing final bracket in denominator
17	(a)		**a** + **b** final answer	1		
	(b)		**b** – **a** final answer	1		Condone **b** + $^-$**a**

Question			Answer	Marks	Part Marks and Guidance	
	(c)		$\frac{1}{3}$ (**a** + **b**) or $\frac{1}{3}$ **a** + $\frac{1}{3}$ **b** final answer	1	**FT** $\frac{1}{3}$ (*their* '**a** + **b**')	
	(d)		$\frac{1}{3}$ (2**b** – **a**) or $\frac{2}{3}$ **b** – $\frac{1}{3}$ **a** final answer	2	**M1** for $-\frac{1}{3}$ (**a** + **b**) + **b** **oe** or for **b** ± *their* '$\frac{1}{3}$ (**a** + **b**)' or for $\overrightarrow{XO}+\overrightarrow{OR}$ or $\overrightarrow{XQ}+\overrightarrow{QR}$ **soi**	
18			$20 + 5\sqrt{3}$	4	**B1** for $\sqrt{5}$ or $\sqrt{15}$ or $\sqrt{75}$ seen **M1** for $[\frac{1}{2}\times]$ $\sqrt{5} \times \sqrt{15}$ **M1** for total area = 15 + 5 + 2 × $\frac{1}{2}\times\sqrt{5}\times\sqrt{15}$ or better **M1** for $5\sqrt{3}$ seen **max 3 marks if answer incorrect**	$\sqrt{75}$ seen implies B1 and M1 may be implied by adding their 'simplified' $\sqrt{5}\times\sqrt{15}$ to 20

Question			Answer	Marks	Part Marks and Guidance	
19			$x = -0.75$, $y = 8$ $x = 2$, $y = -3$	6	**M2** for $4x^2 - 5x - 6$ or $6 + 5x - 4x^2$ **soi** OR **M1** for attempting to equate e.g. $5 - 4x = 4x^2 - 9x - 1$ **oe** **AND** **M2** for correctly factorising *their* quadratic $(4x + 3)(x - 2)$ OR **M1** for $(4x \pm 3)(x \pm 2)$ **AND** **A1** for $x = 2$ and -0.75 **A1** for $y = -3$ and 8 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 $y = 5 - 4x$	Or $y^2 - 5y - 24$ reaching quadratic equation in one variable, need not be simplified dependent on at least M1 e.g. $(y + 3)(y - 8)$ Or for correct **FT** substitution into formula with $\frac{5 \pm \sqrt{25 + 96}}{8}$ or better seen e.g. $\frac{5 \pm 11}{8}$ dependent on at least M1 Or for attempt to use formula with no more than one error allow A marks if solutions clear in working, transferred to wrong places on answer lines

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