Mark Scheme (Results)

Summer 2013

GCE Core Mathematics 1 (6663/01R)

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General Marking Guidance

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.

EDEXCEL GCE MATHEMATICS

General Instructions for Marking

1. The total number of marks for the paper is 75.

2. The Edexcel Mathematics mark schemes use the following types of marks:

- **M** marks: method marks are awarded for 'knowing a method and attempting to apply it', unless otherwise indicated.
- **A** marks: accuracy marks can only be awarded if the relevant method (M) marks have been earned.
- **B** marks are unconditional accuracy marks (independent of M marks)
- Marks should not be subdivided.

3. Abbreviations

These are some of the traditional marking abbreviations that will appear in the mark schemes:

- bod – benefit of doubt
- ft – follow through
- the symbol $\sqrt{}$ will be used for correct ft
- cao – correct answer only
- cso - correct solution only. There must be no errors in this part of the question to obtain this mark
- isw – ignore subsequent working
- awrt – answers which round to
- SC: special case
- oe – or equivalent (and appropriate)
- dep – dependent
- indep – independent
- dp decimal places
- sf significant figures
- ∗ The answer is printed on the paper
- ⌐ The second mark is dependent on gaining the first mark

4. All A marks are 'correct answer only' (cao.), unless shown, for example, as A1 ft to indicate that previous wrong working is to be followed through. After a misread however, the subsequent A marks affected are treated as A ft, but manifestly absurd answers should never be awarded A marks.

5. For misreading which does not alter the character of a question or materially simplify it, deduct two from any A or B marks gained, in that part of the question affected.

6. If a candidate makes more than one attempt at any question:
    - If all but one attempt is crossed out, mark the attempt which is NOT crossed out.
    - If either all attempts are crossed out or none are crossed out, mark all the attempts and score the highest single attempt.

7. Ignore wrong working or incorrect statements following a correct answer.

8. In some instances, the mark distributions (e.g. M1, B1 and A1) printed on the candidate's response may differ from the final mark scheme.

General Principles for Core Mathematics Marking

(But note that specific mark schemes may sometimes override these general principles).

Method mark for solving 3 term quadratic:

1. Factorisation

$(x^2 + bx + c) = (x + p)(x + q)$, where $|pq| = |c|$, leading to x =

$(ax^2 + bx + c) = (mx + p)(nx + q)$, where $|pq| = |c|$ and $|mn| = |a|$, leading to x =

2. Formula

Attempt to use correct formula (with values for *a*, *b* and *c*).

3. Completing the square

Solving $x^2 + bx + c = 0$: $\left(x \pm \frac{b}{2}\right)^2 \pm q \pm c$, $q \neq 0$, leading to x =...

Method marks for differentiation and integration:

1. Differentiation

Power of at least one term decreased by 1. $(x^n \to x^{n-1})$

2. Integration

Power of at least one term increased by 1. $(x^n \to x^{n+1})$

Use of a formula

Where a method involves using a formula that has been learnt, the advice given in recent examiners' reports is that the formula should be quoted first.
Normal marking procedure is as follows:
Method mark for quoting a correct formula and attempting to use it, even if there are mistakes in the substitution of values.
Where the formula is not quoted, the method mark can be gained by implication from correct working with values, but may be lost if there is any mistake in the working.

Exact answers

Examiners' reports have emphasised that where, for example, an exact answer is asked for, or working with surds is clearly required, marks will normally be lost if the candidate resorts to using rounded decimals.

Answers without working

The rubric says that these may not gain full credit. Individual mark schemes will give details of what happens in particular cases. General policy is that if it could be done "in your head", detailed working would not be required.

Question Number	Scheme	Notes	Marks
1.	$y = x^3 + 4x + 1 \Rightarrow \frac{dy}{dx} = 3x^2 + 4(+0)$	M1: $x^n \rightarrow x^{n-1}$ including $1 \rightarrow 0$ A1: Correct differentiation (Do not allow $4x^0$ unless $x^0 = 1$ is implied by later work)	M1A1
	substitute $x = 3 \Rightarrow$ gradient = 31	M1: Substitutes $x = 3$ into their $\frac{dy}{dx}$ (not y) Substitutes $x = 3$ into a "changed" function. They may even have integrated. A1: cao	M1A1
			[4]

Question Number	Scheme	Notes	Marks
2.	$\frac{15}{\sqrt{3}} = \frac{15}{\sqrt{3}} \times \frac{\sqrt{3}}{\sqrt{3}} = 5\sqrt{3}$	M1: Attempts to multiply numerator and denominator by √3. This may be implied by a correct answer. A1: $5\sqrt{3}$	M1A1
	$\sqrt{27} = 3\sqrt{3}$		B1
	$\frac{15}{\sqrt{3}} - \sqrt{27} = 2\sqrt{3}$		A1
	Correct answer only scores full marks		
			[4]
Way 2	$\frac{15}{\sqrt{3}} - \sqrt{27} = \frac{15 - \sqrt{81}}{\sqrt{3}} \left(= \frac{6}{\sqrt{3}}\right)$	Terms combined correctly with a common denominator (Need not be simplified)	B1
	$\frac{6}{\sqrt{3}} \times \frac{\sqrt{3}}{\sqrt{3}} = \frac{6\sqrt{3}}{3}$	M1: Attempts to multiply numerator and denominator by √3. This may be implied by a correct answer. A1: $\frac{6\sqrt{3}}{3}$	M1A1
	$\frac{15}{\sqrt{3}} - \sqrt{27} = 2\sqrt{3}$		A1
			[4]
	Note that $\frac{15}{\sqrt{3}} - \sqrt{27} = \frac{15\sqrt{3}}{3} - 3\sqrt{3} = 15\sqrt{3} - 9\sqrt{3} = 6\sqrt{3}$ is quite common and scores M1A0B1A0 (i.e. $5\sqrt{3}$ is never seen)		

Question Number	Scheme	Notes	Marks
3.	$\int 3x^2 - \frac{4}{x^2}\text{d}x = 3\frac{x^3}{3} - 4\frac{x^{-1}}{-1}$	M1: $x^n \to x^{n+1}$ for either term. If they write $\frac{4}{x^2}$ *as* $4x^2$ allow $x^2 \to x^3$ here.	M1,A1,A1
		A1: $3\frac{x^3}{3}$ **or** $-4\frac{x^{-1}}{-1}$ (one correct term which may be un-simplified)	
		A1: $3\frac{x^3}{3}$ **and** $-4\frac{x^{-1}}{-1}$ (both terms correct which may be un-simplified)	
	Note that M1A0A1 is not possible		
	$= x^3 + \frac{4}{x} + c$ or $x^3 + 4x^{-1} + c$	Fully correct simplified answer with + c all appearing on the same line.	A1
			[4]

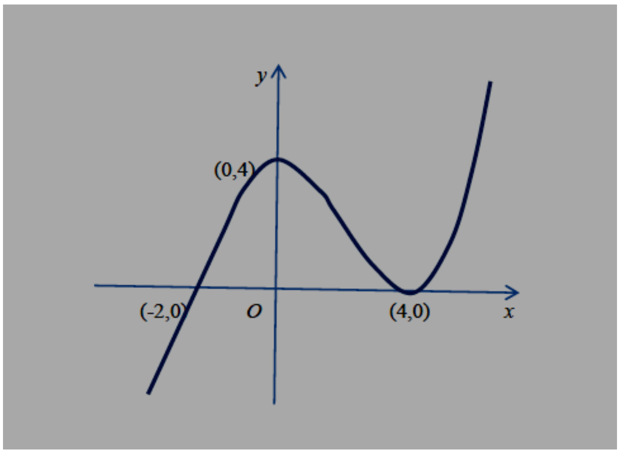
Question Number	Scheme	Notes	Marks
4.(a)	$4x+2y-3=0 \Rightarrow y=-2x+\frac{3}{2}$	Attempt to write in the form $y=$	M1
	$\Rightarrow$ gradient $=-2$	Accept any un-simplified form and allow even with an incorrect value of "c"	A1
(a) Way 2	Alternative: $4+2\frac{dy}{dx}=0$	Attempt to differentiate Allow $p \pm q\frac{dy}{dx}=0,\ p,q \neq 0$	M1
	$\Rightarrow$ gradient $=-2$	Accept any un-simplified form	A1
	Answer only scores M1A1		
			[2]
(b)	Using $m_N = -\frac{1}{m_T}$	Attempt to use $m_N = -\frac{1}{gradient\ from\ (a)}$	M1
	$y-5='\frac{1}{2}'(x-2)$ or Uses $y = mx + c$ in an attempt to find c	Correct straight line method using a 'changed' gradient and the point (2, 5)	M1
	$y=\frac{1}{2}x+4$	Cao (Isw)	A1
			(3)
			[5]

Question Number	Scheme	Notes	Marks
5.(a)	$2^y = 8 \Rightarrow y = 3$	Cao (Can be implied i.e. by 2^3)	B1
	(Alternative: Takes logs base 2: $\log_2 2^y = \log_2 8 \Rightarrow y\log_2 2 = 3\log_2 2 \Rightarrow y = 3$)		
			(1)
(b)	$8 = 2^3$	Replaces 8 by 2^3 (May be implied)	M1
	$4^{x+1} = (2^2)^{x+1}$ or $(2^{x+1})^2$	Replaces 4 by 2^2 **correctly.**	M1
	$2^{3x+2} = 2^3 \Rightarrow 3x + 2 = 3 \Rightarrow x = \frac{1}{3}$	M1: Adds their powers of 2 on the lhs and puts this equal to 3 leading to a solution for *x*. A1: $x = \frac{1}{3}$ or $x = 0.\dot{3}$ or awrt 0.333	M1A1
			(4)
(b) Way 2	$4^{x+1} = 4 \times 4^x$	Obtains 4^{x+1} in terms of 4^x **correctly**	M1
	$2^x \times 4^x = 8^x$	Combines their 2^x and 4^x **correctly**	M1
	$4 \times 8^x = 8 \Rightarrow 8^x = 2 \Rightarrow x = \frac{1}{3}$	M1: Solves $8^x = k$ leading to a solution for *x*. A1: $x = \frac{1}{3}$ or $x = 0.\dot{3}$ or awrt 0.333	M1A1
			[5]

Question Number	Scheme	Notes	Marks
6.(a)	$x_2 = 1 - k$	Accept un-simplified e.g. 1^2 - 1k	B1
			(1)
(b)	$x_3 = (1-k)^2 - k(1-k)$	Attempt to substitute their x_2 into $x_3 = (x_2)^2 - kx_2$ with their x_2 in terms of k.	M1
	$= 1 - 3k + 2k^2$ *	Answer given	A1*
			(2)
(c)	$1 - 3k + 2k^2 = 1$	Setting $1 - 3k + 2k^2 = 1$	M1
	$\left(2k^2 - 3k = 0\right)$		
	$k(2k-3) = 0 \Rightarrow k = ..$	Solving their quadratic to obtain a value for k. **Dependent on the previous M1.**	dM1
	$k = \frac{3}{2}$	Cao and cso (ignore any reference to k = 0)	A1
			(3)
(d)	$\sum_{n=1}^{100} x_n = 1 + \left(-\frac{1}{2}\right) + 1 + ...$ Or $= 1 + \left(1 - 'k'\right) + 1 + ...$		M1
	Writing out at least 3 terms with the third term equal to the first term. Allow in terms of k as well as numerical values. Evidence that the sequence is oscillating between 1 and 1 – k. This may be implied by a correct sum.		
	$50 \times \frac{1}{2}$ or $50 \times 1 - 50 \times \frac{1}{2}$ or $\frac{1}{2} \times 50 \times (1 - \frac{1}{2})$	An attempt to combine the terms correctly. Can be in terms of k here e.g 100 – 50k	M1
	= 25	Allow an equivalent fraction, e.g. 50/2 or 100/4	A1
	Note that the use of $\frac{1}{2}n(a+l)$ is acceptable here but $\frac{1}{2}n(2a+(n-1)d)$ is not.		
			(3)
	Allow correct answer only		
			[9]

Question Number	Scheme	Notes	Marks
7.(a)	$U_{10} = 500 + (10-1) \times 200$	Uses $a + (n-1)d$ with a=500, d=200 and n = 9,10 or 11	M1
	=(£)2300		A1
	If the term formula is not quoted and the numerical expression is incorrect score M0. **A correct answer with no working scores full marks.**		**(2)**
(b)	**Mark parts (b) and (c) together**		
	$\frac{n}{2}\{2 \times 500 + (n-1) \times 200\} = 67200$	M1: Attempt to use $S = \frac{n}{2}\{2a + (n-1)d\}$ with , $S_n = 67200$, $a = 500$ *and* $d = 200$ A1: Correct equation	M1A1
	If the sum formula is not quoted and the equation is incorrect score M0.		
	$n^2 + 4n - 672 = 0$	M1: An attempt to remove brackets and collect terms. **Dependent on the previous M1** A1: A correct **three term** equation in any form	dM1A1
	E.g. allow $n^2 + 4n = 672$, $n^2 = 672 - 4n$, $672 - 4n - n^2 = 0$, $200n^2 + 800n = 134400$ etc.		
	$n^2 + 4n - 24 \times 28 = 0$ *	Replaces 672 with 24×28 with the equation **as printed** (including = 0) with no errors. (= 0 may not appear on the last line but must be seen at some point)	A1
			(5)
(c)	$(n-24)(n+28) = 0 \Rightarrow n = ..$ or $n(n+4) = 24 \times 28 \Rightarrow n = ..$	Solves the **given** quadratic in an attempt to find n. They may use the quadratic formula.	M1
	24	States that n = 24, or the number of years is 24	A1
	Allow correct answer only in (c)		
			(2)
			[9]

Question Number	Scheme	Notes	Marks
	Ignore any references to the units in this question		
8.(a)	length is '$x + 4$'	May be implied	B1
	$x+x+x+4+x+4>19.2 \Rightarrow x>..$	$2x+2(x\pm 4)>19.2$ and proceeds to $x >$ ..... (Accept 'invisible' brackets) Attempts 2 widths + 2 lengths > 19.2 leading to $x >$	M1
	E.g. $x+x+4x+4x>19.2 \Rightarrow x>1.92$ scores B0M1A0		
	$x > 2.8$ *	Achieves $x > 2.8$ with no errors	A1(*)
			(3)
	Mark parts (b) and (c) together		
(b)(i)	$x(x+4)<21$	Cao	B1
b(ii)	$x^2+4x-21<0$ $(x+7)(x-3)<0 \Rightarrow x=...$	Multiply out lhs, produce 3TQ = 0 and attempt to solve leading to x =... according to general guidelines	M1
	Either -7 < x < 3 **or** 0 < x < 3	M1: Attempts the 'inside' for their critical values (may be from a 2TQ here) A1: Accept either -7 < x < 3 or 0 < x < 3 or (x > -7 **and** x < 3) or (x > 0 **and** x < 3) but not e.g. (x > -7, x < 3) or (x > -7 **or** x < 3) (There is no specific need for them to realise x > 0)	M1A1
	Note that <u>many</u> candidates stop here		
			(4)
(c)	2.8 < x < 3	Follow through their answers to (a) and (b) Provided "their 3" > 2.8	B1ft
			(1)
			[8]
	Examples		
	$x(x-4)<21 \Rightarrow x^2-4x-21<0$ $(x-7)(x+3)<0,\ x=7, x=-3$ $-3<x<7\ or\ 0<x<7$ $2.8<x<7$ Scores B0M1M1A0B1ft	$x\times 4x<21 \Rightarrow 4x^2-21<0$ $(2x-\sqrt{21})(2x+\sqrt{21})<0,\ x=\pm\frac{\sqrt{21}}{2}$ $-\frac{\sqrt{21}}{2}<x<\frac{\sqrt{21}}{2}\ or\ 0<x<\frac{\sqrt{21}}{2}$ $2.8<x<\frac{\sqrt{21}}{2}$ Scores B0M0M1A0B0	

Question Number	Scheme	Notes	Marks
9.(a)	$f(x) = (x+1)(x-2)^2$	M1: Either stating or writing down that (x ± 1) **or** (x ± 2) is a factor – may be implied by their f(x)	M1A1B1
		A1: **Both** (x + 1) **and** (x - 2) are factors - may be implied by their f(x)	
		B1: y or f(x)= (x + 1)(x - 2)^2	
	$= (x+1)(x^2-4x+4) = x^3-3x^2+4$	M1: Multiplying out a quadratic to get 3 terms and then multiplying by the linear term to form a cubic.	M1A1
		A1: x^3-3x^2+4 or a = -3, b = 0, c = 4	
			(5)
(b)		Same shape and position (ignore any coordinates) with the maximum on the y-axis	B1
		y intercept = 4 or their 'c'	B1ft
		x coordinates at -2 and 4 or marked as coordinates. Allow (0, -2) and (0, 4) if they are marked in the correct position. The curve must cross or at least stop at x = -2	B1
			(3)
			[8]
(a) Way 2	$x=0, y=4 \Rightarrow c=4$	Uses (0, 4) to obtain c = 4 (can be just stated)	B1
	$x=-1, y=0 \Rightarrow -1+a-b+c=0$ $x=2, y=0 \Rightarrow 8+4a+2b+c=0$	Uses both (-1, 0) and (2, 0) in $y = x^3+ax^2+bx+c$ to form 2 simultaneous equations. Allow the equations to contain c here.	M1
	$a-b=-3$ $4a+2b=-12$ $\Rightarrow a = ..\ or\ b = ...$	Solves simultaneously with a value for c to obtain a value for a or a value for b	M1
	Either a = -3 **or** b = 0		A1
	Both a = -3 **and** b = 0		A1

Question Number	Scheme	Notes	Marks
9.(a) Way 3	$\frac{dy}{dx} = 3x^2 + 2ax + b$	M1: $x^n \to x^{n-1}$ at least once including c → 0	M1
	$x = 0 \Rightarrow \frac{dy}{dx} = 0 \Rightarrow b = 0$	Correct value for *b*	A1
	$x = 0, y = 4 \Rightarrow c = 4$	Uses (0, 4) to obtain $c = 4$ (can be just stated)	B1
	$3(2)^2 + 2a(2) + b = 0$ or $(-1)^3 + a(-1)^2 + b(-1) + 4 = 0$	Obtains an equation in *a*	M1
	$a = -3$	Correct value for *a*	A1
			(5)
	Special case: A common incorrect approach is to assume the cubic is of the form e.g. $f(x) = x(x \pm 1)(x \pm 2) + 4$ This scores B1 only for $c = 4$		
			[8]

Question Number	Scheme	Notes	Marks
10.(a)	$\mathrm{f}'(x)=\frac{x+9}{\sqrt{x}}=\frac{x}{\sqrt{x}}+\frac{9}{\sqrt{x}}=x^{\frac{1}{2}}+9x^{-\frac{1}{2}}$	M1: Correct attempt to split into 2 separate terms or fractions. May be implied by one correct term. Divides by $x^{\frac{1}{2}}$ or multiplies by $x^{-\frac{1}{2}}$. A1: $x^{\frac{1}{2}}+9x^{-\frac{1}{2}}$ or equivalent	M1A1
	$\mathrm{f}(x)=\frac{x^{\frac{3}{2}}}{\frac{3}{2}}+9\frac{x^{\frac{1}{2}}}{\frac{1}{2}}(+c)$	M1: Independent method mark for $x^n \rightarrow x^{n+1}$ **on separate terms** A1: Allow un-simplified answers. No requirement for + c here	M1A1
	$\frac{(9)^{\frac{3}{2}}}{\frac{3}{2}}+9\frac{(9)^{\frac{1}{2}}}{\frac{1}{2}}+c=0\Rightarrow c=...$	Substitutes x = 9 and y = 0 into their integrated expression leading to a value for c. If no c at this stage M0A0 follows unless their method implies that they are correctly finding a constant of integration.	M1
	$\mathrm{f}(x)=\frac{2}{3}x^{\frac{3}{2}}+18x^{\frac{1}{2}}-72$	There is no requirement to simplify their f(x) so accept any correct un-simplified form.	A1
			(6)
(b)	$\mathrm{f}'(x)=\frac{x+9}{\sqrt{x}}=10\Rightarrow x+9=10\sqrt{x}$	Sets $\mathrm{f}'(x)=\frac{x+9}{\sqrt{x}}=10$ and multiplies by $\sqrt{x}$. The terms in x must be in the numerator. E.g. allow $\frac{x+9}{10}=\sqrt{x}$	M1
	They must be setting either the **original** $\mathrm{f}'(x)=10$ or an equivalent **<u>correct</u>** expression = 10		
	$(\sqrt{x}-9)(\sqrt{x}-1)=0\Rightarrow\sqrt{x}=...$	Correct attempt to solve a relevant 3TQ in $\sqrt{x}$ leading to solution for $\sqrt{x}$. **Dependent on the previous M1.**	dM1
	x = 81, x = 1	Note that the x = 1 solution could be just written down and is B1but must come from a <u>correct</u> equation.	A1, B1
			(4)
			[10]
Alternative to part (b)	$(\frac{x+9}{\sqrt{x}})^2=10^2\Rightarrow x^2+18x+81=100x$	Sets $\frac{x+9}{\sqrt{x}}=10$, squares and multiplies by x. They must be setting either the original $\mathrm{f}'(x)=10$ or an equivalent **<u>correct</u>** expression = 10	M1
	$(x-81)(x-1)=0\Rightarrow x=..$	Correct attempt to solve a relevant 3TQ leading to solution for x. **Dependent on the previous M1.**	dM1
	x = 81, x = 1	Note that the x = 1 solution could be just written down and is B1but must come from a <u>correct</u> equation.	A1, B1

Question Number	Scheme	Notes	Marks
11. (a)	$y = x + 2 \Rightarrow x^2 + 4(x+2)^2 - 2x = 35$	Substitute $y = \pm x \pm 2$ into $x^2 + 4y^2 - 2x = 35$ to obtain an equation in x only.	M1
	Alternative: $\frac{2x - x^2 + 35}{4} = (x+2)^2$ or $\sqrt{\frac{2x - x^2 + 35}{4}} = (x+2)$		
	$5x^2 + 14x - 19 = 0$	Multiply out and collects terms producing 3 term quadratic in any form.	M1
	$(5x + 19)(x - 1) = 0 \Rightarrow x = ..$	Solves their quadratic, usual rules, as far as x = ... **Dependent on the first M1** i.e. a correct method for eliminating y (or x – see below)	dM1
	$x = -\frac{19}{5}, x = 1$	Both correct	A1 for both
	$y = -\frac{9}{5}, y = 3$	M1: Substitutes back into either given equation to find a value for y	M1
	Coordinates are ($-\frac{19}{5}, -\frac{9}{5}$) and (1, 3)	Correct matching pairs. Coordinates need not be given explicitly but it must be clear which x goes with which y	A1
			(6)
Alternative to part (a)	$x = y - 2 \Rightarrow (y-2)^2 + 4y^2 - 2(y-2) =$	Substitutes $x = \pm y \pm 2$ into $x^2 + 4y^2 - 2x = 35$	M1
	$5y^2 - 6y - 27 = 0$	Multiply out, collect terms producing 3 term quadratic in any form.	M1
	$(5y + 9)(y - 3) = 0 \Rightarrow y = ..$	Solves their quadratic, usual rules, as far as y = ... **Dependent on the first M1** i.e. a correct method for eliminating x	dM1
	$y = -\frac{9}{5}, y = 3$	Both correct	A1 for both
	$x = -\frac{19}{5}, x = 1$	M1: Substitutes back into either given equation to find a value for x	M1
	Coordinates are ($-\frac{19}{5}, -\frac{9}{5}$) and (1,3)	Correct matching pairs as above.	A1
(b)	$d^2 = (1 - -\frac{19}{5})^2 + (3 - -\frac{9}{5})^2$ or $d = \sqrt{(1 - -\frac{19}{5})^2 + (3 - -\frac{9}{5})^2}$	M1: Use of $d^2 = (x_1 - x_2)^2 + (y_1 - y_2)^2$ or $d = \sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2}$ where neither $(x_1 - x_2)$ nor $(y_1 - y_2)$ are zero. A1ft: Correct ft expression for d or d^2 (may be un-simplified)	M1A1ft
	$d = \frac{24}{5}\sqrt{2}$	Allow $4.8\sqrt{2}$	A1cao
			(3)
			[9]

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