FSMQ

Additional Mathematics

6993/01: Additional Mathematics: Paper 1

Free Standing Mathematics Qualification

Mark Scheme for June 2022

OCR (Oxford Cambridge and RSA) is a leading UK awarding body, providing a wide range of qualifications to meet the needs of candidates of all ages and abilities. OCR qualifications include AS/A Levels, Diplomas, GCSEs, Cambridge Nationals, Cambridge Technicals, Functional Skills, Key Skills, Entry Level qualifications, NVQs and vocational qualifications in areas such as IT, business, languages, teaching/training, administration and secretarial skills.

It is also responsible for developing new specifications to meet national requirements and the needs of students and teachers. OCR is a not-for-profit organisation; any surplus made is invested back into the establishment to help towards the development of qualifications and support, which keep pace with the changing needs of today's society.

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.

MARKING INSTRUCTIONS

PREPARATION FOR MARKING
RM ASSESSOR

1. Make sure that you have accessed and completed the relevant training packages for on-screen marking: *RM Assessor Assessor Online Training*; *OCR Essential Guide to Marking*.

2. Make sure that you have read and understood the mark scheme and the question paper for this unit. These are posted on the RM Cambridge Assessment Support Portal http://www.rm.com/support/ca

3. Log-in to RM Assessor and mark the **required number** of practice responses ("scripts") and the **number of required** standardisation responses.

YOU MUST MARK 5 PRACTICE AND 10 STANDARDISATION RESPONSES BEFORE YOU CAN BE APPROVED TO MARK LIVE SCRIPTS.

MARKING

1. Mark strictly to the mark scheme.

2. Marks awarded must relate directly to the marking criteria.

3. The schedule of dates is very important. It is essential that you meet the RM Assessor 50% and 100% (traditional 40% Batch 1 and 100% Batch 2) deadlines. If you experience problems, you must contact your Team Leader (Supervisor) without delay.

4. If you are in any doubt about applying the mark scheme, consult your Team Leader by telephone or the RM Assessor messaging system, or by email.

5. **Crossed Out Responses**
   Where a candidate has crossed out a response and provided a clear alternative then the crossed out response is not marked. Where no alternative response has been provided, examiners may give candidates the benefit of the doubt and mark the crossed out response where legible.

   Contradictory Responses
   When a candidate provides contradictory responses, then no mark should be awarded, even if one of the answers is correct.

6. Always check the pages (and additional objects if present) at the end of the response in case any answers have been continued there. If the candidate has continued an answer there, then add a tick to confirm that the work has been seen.

7. Award No Response (NR) if:
   - there is nothing written in the answer space

   Award Zero '0' if:
   - anything is written in the answer space and is not worthy of credit (this includes text and symbols).

   Team Leaders must confirm the correct use of the NR button with their markers before live marking commences and should check this when reviewing scripts.

8. The RM Assessor **comments box** is used by your team leader to explain the marking of the practice responses. Please refer to these comments when checking your practice responses. **Do not use the comments box for any other reason.**
   If you have any questions or comments for your team leader, use the phone, the RM Assessor messaging system, or e-mail.

9. A*ssistant Examiners will send a brief report on the performance of candidates to their Team Leader (Supervisor) via email by the end of the marking period. The report should contain notes on particular strengths displayed as well as common errors or weaknesses. Constructive criticism of the queson paper/mark scheme is also appreciated.*

10. Annotations and abbreviations

Annotation in RM Assessor	**Meaning**
BP	Blank Page – this annotation **must** be used on all blank pages within an answer booklet (structured or unstructured) and on each page of an additional object where there is no candidate response.
✓and ✘	
BOD	Benefit of doubt
FT	Follow through
ISW	Ignore subsequent working
M0, M1	Method mark awarded 0, 1
A0, A1	Accuracy mark awarded 0, 1
B0, B1	Independent mark awarded 0, 1
SC	Special case
^	Omission sign
MR	Misread
Other abbreviations in mark scheme	**Meaning**
AG	Answer given
DM1	M mark dependent on previous M mark
DB1	B mark dependent on previous B mark(s)
Cao	Correct answer only
Oe	Or equivalent
Soi	Seen or implied
www	Without wrong working

11. **Marking Instructions**

a Annotations should be used whenever appropriate during your marking.

The A, M and B 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 standardisation scripts fully to show how the marks have been awarded.

For subsequent marking you must make it clear how you have arrived at the mark you have awarded.

b An element of professional judgement is required in the marking of any written paper. Remember that the mark scheme is designed to assist in marking incorrect solutions. Correct *solutions* leading to correct answers are awarded full marks but work must not be judged on the answer alone, and answers that are given in the question, especially, must be validly obtained; key steps in the working must always be looked at and anything unfamiliar must be investigated thoroughly.

Correct but unfamiliar or unexpected methods are often signalled by a correct result following an *apparently* incorrect method. Such work must be carefully assessed. When a candidate adopts a method which does not correspond to the mark scheme, award marks according to the spirit of the basic scheme; if you are in any doubt whatsoever (especially if several marks or candidates are involved) you should contact your Team Leader.

c The following types of marks are available.

M
A suitable method has been selected and *applied* in a manner which shows that the method is essentially understood. Method marks are not usually lost for numerical errors, algebraic slips or errors in units. However, it is not usually sufficient for a candidate just to indicate an intention of using some method or just to quote a formula; the formula or idea must be applied to the specific problem in hand, eg by substituting the relevant quantities into the formula. In some cases the nature of the errors allowed for the award of an M mark may be specified.

A
Accuracy mark, awarded for a correct answer or intermediate step correctly obtained. Accuracy marks cannot be given unless the associated Method mark is earned (or implied). Therefore M0 A1 cannot ever be awarded.

B
Mark for a correct result or statement independent of Method marks.

d When a part of a question has two or more 'method' steps, the M marks are in principle independent unless the scheme specifically says otherwise; and similarly where there are several B marks allocated. (The notation 'dep *' is used to indicate that a particular mark is dependent on an earlier, asterisked, mark in the scheme.) Of course, in practice it may happen that when a candidate has once gone wrong in a part of a question, the work from there on is worthless so that no more marks can sensibly be given. On the other hand, when two or more steps are successfully run together by the candidate, the earlier marks are implied and full credit must be given.

e The abbreviation **ft i**mplies that the A or B mark indicated is allowed for work correctly following on from previously incorrect results. Otherwise, A and B marks are given for correct work only — differences in notation are of course permitted. A (accuracy) marks are not given for answers obtained from incorrect working. When A or B marks are awarded for work at an intermediate stage of a solution, there may be various alternatives that are equally acceptable. In such cases, exactly what is acceptable will be detailed in the mark scheme rationale. If this is not the case please consult your Team Leader.

Sometimes the answer to one part of a question is used in a later part of the same question. In this case, A marks will often be 'follow through'. In such cases you must ensure that you refer back to the answer of the previous part question even if this is not shown within the image zone. You may find it easier to mark follow through questions candidate-by-candidate rather than question-by-question.

f Wrong or missing units in an answer should not lead to the loss of a mark unless the scheme specifically indicates otherwise. Candidates are expected to give numerical answers to an appropriate degree of accuracy, with 3 significant figures often being the norm. Small variations in the degree of accuracy to which an answer is given (e.g. 2 or 4 significant figures where 3 is expected) should not normally be penalised, while answers which are grossly over- or under-specified should normally result in the loss of a mark. The situation regarding any particular cases where the accuracy of the answer may be a marking issue should be detailed in the mark scheme rationale. If in doubt, contact your Team Leader.

g Rules for replaced work

If a candidate attempts a question more than once, and indicates which attempt he/she wishes to be marked, then examiners should do as the candidate requests.

If there are two or more attempts at a question which have not been crossed out, examiners should mark the better attempt and ignore the others.

h For a *genuine* misreading (of numbers or symbols) which is such that the object and the difficulty of the question remain unaltered, mark according to the scheme but following through from the candidate's data. A penalty is then applied; 1 mark is generally appropriate, though this may differ for some units. This is achieved by withholding one A mark in the question.

Note that a miscopy of the candidate's own working is not a misread but an accuracy error.

Question			Answer	Marks	AO	Guidance
1			$-3 < 2(x+1) < 7$ $\Rightarrow -3 < 2x + 2 < 7$ $\Rightarrow -5 < 2x < 5$ $\Rightarrow -\frac{5}{2} < x < \frac{5}{2}$ If answer is given as two inequalities then they must be separated by "and" for last nark	**M1** **A1** **A1**	1 1 1	Correct first operation on at least one side to solve inequality For a correct inequality on both sides involving $2x$ or $x + 1$ **soi** Accept $\lvert x \rvert < 2.5$ **isw** (SC3 correct answer with no wrong working- allow use of = providing the answer is correct)
				[3]		

Question			Answer	Marks	AO	Guidance
2	(a)		e.g. $18^2 = 3^2 + 2a175$ $\Rightarrow a = \frac{18^2 - 3^2}{350} = 0.9$	**M1** **A1**	1 1	Use of suvat formulae to find a Ignore units
				[2]		
	(b)		e.g. $v = u + at$ with $u = 0$, $v = 18$, and *their a* $\Rightarrow t = \frac{18}{0.9} = 20$ Time taken is 20 seconds.	**M1** **A1**	1 1	Use of suvat formulae to find t. **FT** *their a*
				[2]		

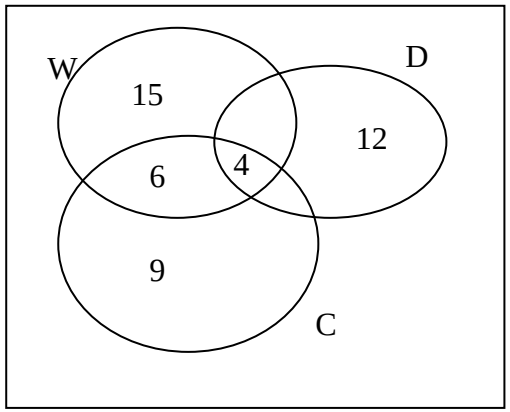
Take care: using $s = 175$ and a different suvat formula give $t = 19.4$. In fact $s = 180$

Question			Answer	Marks	AO	Guidance
3			There are 7 people to be arranged: so 7! The vice-captain can stand on either side. So ×2 =10080	**B1** **B1** **B1**	3 3 1	Sight of 7! **soi** by correct answer (or 5040 or ${}^7P_7$) For multiplying *their initial value* by 2 **soi** Answer
				[3]		

Question			Answer	Marks	AO	Guidance
4	(a)		$\left(\mathrm{f}(1)\right)=1+6+5-12=0$	**B1**	1	Numbers must be seen. Accept 1^3 etc
				[1]		
	(b)		**DR** $\mathrm{f}(x)=(x-1)(x^2+7x+12)$ $=(x-1)(x+4)(x+3)$ $\Rightarrow \mathrm{f}(x)=0$ $\Rightarrow x=1,-3,-4$	**M1*** **A1** **M1dep** **A1**	2 2 1 1	Factorise or long division using $(x-1)$ to give a three term quadratic. Quadratic correct. Must be seen *Their* quadratic correctly factorised or solved
			Alternative method: Use of factor theorem to find all roots	 **M1** **A1** **M1** **A1**		 Attempt to find one other root Root found Attempt to find remaining root All 3 stated
				[4]		

Question			Answer	Marks	AO	Guidance
5	(a)		**DR** $\cos 2\theta = 0.6 \Rightarrow 2\theta = 53.1 \Rightarrow \theta = 26.6$ Also, $2\theta = 306.9 \Rightarrow \theta = 153.4$ Also add to $180 \Rightarrow \theta = 206.6,\ 333.4$	**B1** **B1** **B1**	1 2 1	awrt26.6 For one other value **FT** wrt 1 d.p. For all 4 correct to 1 d.p (but not if there are extra values)
				[3]		
	(b)		**DR** $\Rightarrow 12\left(1-\sin^2\theta\right)+\sin\theta = 11$ $\Rightarrow 12\sin^2\theta - \sin\theta - 1 = 0$ $\Rightarrow \left(4\sin\theta+1\right)\left(3\sin\theta-1\right)=0$ $\Rightarrow \sin\theta = \frac{1}{3}$ and $\sin\theta = -\frac{1}{4}$ $\Rightarrow \theta = 19.5,\ 345.5$ and $\theta = 160.5,\ 194.5$	**M1** **A1** **M1** **A1** **A1**	1 1 1 2 1	Use of Pythagoras Correct quadratic Factorising. i.e. two linear factors, coeffs of *s* multiply to give 12 and the constants to give – 1 or use formula. Awrt 19.5 and one other, awrt 1d.p. For the other two correct to 1 d.p.
				[5]		

Question			Answer	Marks	AO	Guidance
6	(a)		3 events, each with two branches Probabilities of 0.5 on first set, 0.6 and 0.4 on second set and 0.7 and 0.3 on the third All correct	**B1** **B1** **B1**	3 2 2	Some branches may be missing or not labelled At least one set of probabilities seen for each Completed tree- all labels and probabilities
				[3]		
	(b)		$= 0.5\times0.6\times0.3 + 0.5\times0.4\times0.7 + 0.5\times0.4\times0.3$ $= 0.09 + 0.14 + 0.06$ $= 0.29$	**B1** **B1** **B1**	3 1 1	Any one correct product of three probabilities **soi** Three terms added, at least two correct **soi**
				[3]		

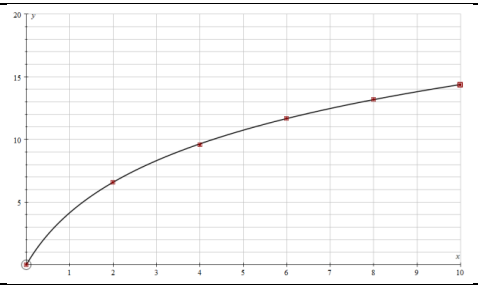
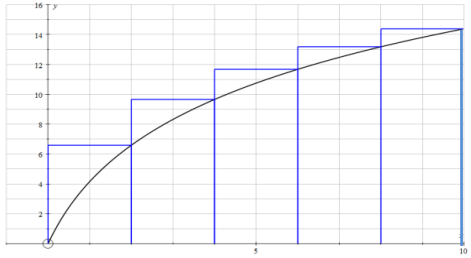
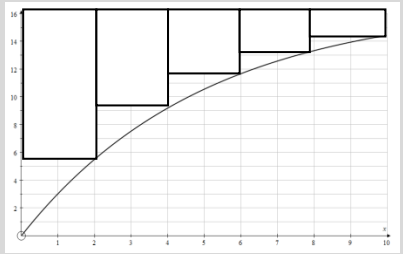
Question			Answer	Marks	AO	Guidance
7	(a)			**B1** **B1** **B1**	3 2 2	Diagram with 3 overlapping regions (rectangle not needed) 15, 12, 9 seen in correct place 6 and 4 in the correct place Ignore anything in the other regions
				[3]		
	(b)		12 + 15 + 4 + 6 + 9 =46 (Two regions left sum to 60 – 46 = 14)/2 So 7	**M1** **M1** **A1**	3 3 1	Add *their* 5 regions **soi** Subtract *their* result from 60 and divide by 2 Mark last answer
				[3]		

Question			Answer	Marks	AO	Guidance
8			$\frac{dy}{dx} = 2 + 4x - 3x^2$	**M1**	1	Integrate, At least two powers increased by 1
			$\Rightarrow (y =) 2x + 2x^2 - x^3 + c$	**A1**	1	Correct including *c*
			Substitute (1, 2) $\Rightarrow 2 = 2 + 2 - 1 + c$ $\Rightarrow c = -1$	**M1**	1	Substitute correct values in all terms into *their* integrated function
			$\Rightarrow y = 2x + 2x^2 - x^3 - 1$	**A1**	1	
				[4]		

Question			Answer	Marks	AO	Guidance
9	(a)		**DR** $y = 4\log_3 x$ $\Rightarrow \log_3 x = \frac{y}{4} \quad \Rightarrow x = 3^{y/4}$	 **B1** **B1**	 1 1	
			Alternative Method $y = 4\log_3 x$ $\Rightarrow y = \log_3 x^4$ $\Rightarrow x = \sqrt[4]{3^y}$	 **B1** **B1**		 Implied by $x^4 = 3^y$
				[2]		
	(b)		**DR** $2\log_{10} 5 + \frac{1}{2}\log_{10} 16$ $= \log_{10} 25 + \log_{10} 4 = \log_{10} 100$ $= 2$	 **M1** **M1** **A1**	 1 1 1	 Dealing with powers Adding logs
				[3]		
	(c)		**DR** $a^x = 17 \Rightarrow x \log a = \log 17$ $\Rightarrow \log a = \frac{\log 17}{2.58} \quad \Rightarrow a = 3$	 **M1** **A1**	 1 1	 Take logs and divide Any base acceptable (e.g.. e or 2.58) i.e. $\log_{2.58}17$ gets M1 Has to be 3 – QP says an integer
			Alternative method $a = \sqrt[2.58]{17}$ $= 3$ **Alternative method** Try a = 2, 3 and choose a = 3	**M1** **A1** **M1** **A1**		 Sc B1 for claiming 3 without checking below
				[2]		

Question			Answer	Marks	AO	Guidance
10	(a)		**DR** $x^2-4x+4=-x^2+8x-6$ $\Rightarrow 2x^2-12x+10=0$ $\Rightarrow x^2-6x+5=0$ $\Rightarrow (x-1)(x-5)=0$ $\Rightarrow x=1,5$ $\Rightarrow (1,1)$ and $(5,9)$ or $x=1, y=1$ and $x=5, y=9$	**M1** **A1** **M1** **A1**	1 1 1 1	Equate and put in form of quadratic Correct 3 term quadratic **oe** Solve quadratic Both pairs
				[4]		
	(b)		**DR** Area $=\int_1^5\left(\left(-x^2+8x-6\right)-\left(x^2-4x+4\right)\right)\mathrm{d}x$ $=\int_1^5\left(-2x^2+12x-10\right)\mathrm{d}x$ $=\left[-\frac{2}{3}x^3+6x^2-10x\right]_1^5$ $=104-\frac{248}{3}=\frac{64}{3}$ **oe**	**M1** **A1** **M1** **M1** **A1**	3 1 1 3 1	Subtract in either order Correct function(s) to be integrated. A0 if divided by 2 (ignore = 0) Integrate. Ignore limits Substitute limits from part (a) and use correctly Allow $-\frac{64}{3}$ with neg sign discarded

			Alternative method $\text{Area}_1 = \int\left(-x^2+8x-6\right)\text{d}x$ $=\left[\frac{-x^3}{3}+4x^2-6x\right]_1^5=\frac{92}{3}$ $\text{Area}_2 = \int\left(x^2-4x+4\right)\text{d}x$ $=\left[\frac{x^3}{3}-2x^2+4x\right]_1^5=\frac{28}{3}$ $=\frac{92}{3}-\frac{28}{3}=\frac{64}{3}$ **oe**	**M1** **A1** **M1** **M1** **A1**		Integrate separately For both Apply limits by substitution of *their* intersections Subtract
				[5]		

Question			Answer	Marks	AO	Guidance
11	(a)			**B1** **B1**	3 3	Points seen on grid which has a clear scale shown by at least one value given on each axis. Point plotted must be within an integer range. i.e. 14.4 in range [14,15] Smooth curve through (0,0) and (10,14.4) and at least 1 other point. The "curve" must be curved in [0,2]
				[2]		
	(b)		 Distance = Area = 2(6.6+9.6+11.7+13.2+14.4) = 111	**B1** **M1** **M1** **A1**	3 3 3 3	Rectangles seen as in diagram; could be totally above the curve Attempt to find area under curve. Sum of heights of rectangles doubled
			Alternative method for rectangles totally above curve  Sum of heights = 9.4+6.4+4.3+2.8+1.6=24.5 Area under curve =2(16×5 – 24.5) = 111	**B1** **M1** **M1** **A1**		Rectangles totally above curve as shown in diagram Attempt to find area Heights of rectangles taken from the top value (e.g. 14.4 or 16), summed and doubled
				[4]		

	(c)		More rectangles or Take lower set and find mean (82.2 giving mean of 96.6) Or use trapezia	**B1**	2	
				[1]		

Question			Answer	Marks	AO	Guidance
12	(a)		$y = 0.5x^2 - 2x$ $\Rightarrow \frac{dy}{dx} = x - 2$ When $x = 0, \frac{dy}{dx} = -2$ $\Rightarrow$ Tangent has equation $y = -2x$	**M1** **A1** **A1**	1 1 1	Diffn (i.e. powers reduced by 1)
				[3]		
	(b)		A has coordinates (4, 0) When $x = 4, \frac{dy}{dx} = 2$ $\Rightarrow$ Gradient of normal = $-\frac{1}{2}$ $\Rightarrow$ Normal has equation $y - y_1 = m(x - x_1)$ $\Rightarrow y = -\frac{1}{2}x + 2$	**B1** **B1** **M1*** **A1** **M1dep** **A1**	2 2 2 2 1 1	Gradient of tangent at A = 2. Can be embedded in equation Negative reciprocal of *their* gradient for tangent at A (which must be seen) Use of eqn of line with *their m*, x_1 and y_1**soi** 3 terms only
				[6]		
	(c)		$-\frac{1}{2}x + 2 = -2x$ $\Rightarrow \frac{3}{2}x = -2 \quad \Rightarrow x = -\frac{4}{3}$ $\Rightarrow y = \frac{8}{3}$	**M1** **A1** **A1**	1 1 1	Solve *their* linear equations simultaneously *x* *y*
				[3]		

Question			Answer	Marks	AO	Guidance
13	(a)		**AG** $\frac{TC}{BC}=\tan\beta,\quad \frac{TC}{AC}=\tan\alpha$	**B1**	3	2 tan ratios
			$\Rightarrow TC = BC\tan\beta = AC\tan\alpha$ $\Rightarrow BC(\tan\beta-\tan\alpha) = AB\tan\alpha$	**M1**	3	Equate correct ratios. AC could be written AB + BC
			$\Rightarrow BC = \frac{AB\tan\alpha}{(\tan\beta-\tan\alpha)}$	**A1**	3	Correct completion **AG**
				[3]		
	(b)	(i)	$BC = \frac{AB\tan\alpha}{(\tan\beta-\tan\alpha)}$ $= \frac{25\tan 15}{(\tan 20-\tan 15)} = 69.8$	**M1** **A1**	3 1	Substitutions Awrt 69.8
			Alternative method not using the formula in (a) **Use of sin rule** $\frac{BT}{\sin 15}=\frac{AT}{\sin 160}=\frac{25}{\sin 5}$ and e.g. BC = BTcos20 or BC = ATcos15 $\Rightarrow$ BC = 69.8	**M1** **A1**		Use of sin rule andrt angled triangle
				[2]		
		(ii)	$TC = BC\tan\beta$ $= 69.8\tan\beta = 25.4$ **OR** $TC = AC\tan\alpha$ $= 94.8\tan\alpha = 25.4$ Height of tower is 25.4 m	**M1** **A1**	1	Awrt 25.4
				[2]		

Question			Answer	Marks	AO	Guidance
14	(a)	(i)	Because intervals are unequal e.g. 1.4 is not the midpoint or you will get the gradient at 1.5	**B1**	2	Anything that implies lack of symmetry
				[1]		
		(ii)	$\frac{3.1447-1.5358}{1.8-1.4}$ $=4.02$	**M1** **A1**	1 1	 Awrt 4.02
				[2]		
		(iii)	$\frac{1.5358-1.0732}{1.4-1.2}=2.31$	**B1**	1	Awrt 2.31
				[1]		
	(b)		$\frac{1.3132-0.6899}{1.6-1.2}$ $=1.56$	**M1** **A1** **A1**	3 1 1	Using central difference method Correct values Awrt 1.56
			Alternative Methods Backward difference: $\frac{0.9518-0.6899}{0.2}$ $=1.31$ Forward difference $\frac{1.3132-0.9518}{0.2}$ $=1.81$ Average = 1.55 or 1.56	 **M1** **A1** **A1**		 For either of these methods Awrt 1.31 or 1.81 If central difference method is there then mark the one that earns the most marks Isw e.g. 1.55825 gives 1.6 should earn the mark
				[3]		

Question			Answer	Marks	AO	Guidance
15	(a)	(i)	Points in correct place	B1	1	The points do not need to be labelled
				[1]		
		(ii)	Line with negative gradient passing between A and B	B1	2	
			Line correct	B1	2	Seen by passing through at least (2,6), (8,3) SC B1 for line through (0,7) with positive gradient
				[2]		
	(b)		Through midpoint	M1	2	Attempt to show that *l* goes through midpoint (4,5)
				A1	2	Substitution into eqn of line correct
			Gradients perpendicular	M1	2	Finding both gradients (can be embedded in equations)
				A1	2	Statement that gradients satisfy $m_1 m_2 = -1$ or equivalent. i.e. one is the negative reciprocal of the other.
				[4]		
	(c)		$(x-4)^2+(y-5)^2$	M1	1	Use of circle formula with correct midpoint. Ignore rhs
			$=5$ **oe**	A1	1	May be left in this form **isw**
			Alternative Method $(x-3)(x-5)+(y-3)(y-7)=0$	M1		May be left in non-expanded form
			$x^2+y^2-8x-10y+36=0$	A1		
				[2]		

	(d)		$x^2+y^2-8x-10y+36=0$ $x+2y=14$ $\Rightarrow\left(\frac{14-x}{2}\right)^2+x^2-8x-10\left(\frac{14-x}{2}\right)+36=0$ $\Rightarrow\left(\frac{196-28x+x^2}{4}\right)+x^2-8x-(70-5x)+36=0$ $\Rightarrow x^2-8x+12=0$ $\Rightarrow(x-2)(x-6)=0$ $\Rightarrow x=2$ giving $y=6$ and $x=6$ giving $y=4$ i.e. (6, 4) and (2, 6)	**M1** **A1** **A1**	3 3 1	Sight of substitution of linear eqn into *their* circle eqn (can be the unsimplified eqn for circle) Or, if eqn is in *y;* $y^2-10y+24=0$ Sc B3 correct coordinates given
			Alternative method Vector from A to centre is $\begin{pmatrix}1\\2\end{pmatrix}$ So P is $\begin{pmatrix}-2\\1\end{pmatrix}$ from Centre i.e. (2,6) and Q is $\begin{pmatrix}2\\-1\end{pmatrix}$ i.e. (6, 4) Similarly, other point is (2, 6)	**M1** **A1** **A1**		
				[3]		

Guidelines for solving quadratic equations

Find.
No working needs to be seen.
For both when the function factorises and when it does not

- Full marks if both roots are correct
- No marks if one or both are incorrect.

Determine.
Justification of the result must be given which in this situation means working must be seen

When the function $ax^2+bx+c=0$ factorises, for the M1

- The modulus of the product of the first two terms in the brackets must equal $|a|x^2$
- The modulus of the product of the second two terms in the brackets must equal $|c|$.

When the formula is needed to find roots of the equation $ax^2+bx+c=0$
Correct substitutions into the formula must be seen. Allow one sign error

$x=\dfrac{-b\pm\sqrt{b^2-4ac}}{2a}$ with the appropriate values substituted M1

$x = p, q$ A1

If completion of square is required, or used.

$ax^2+bx+c=0 \Rightarrow a\left(x^2+\dfrac{b}{a}+\dfrac{b^2}{4a^2}\right)=\dfrac{b^2}{4a}-c$ M1

$\Rightarrow\left(x+\dfrac{b}{2a}\right)=\pm\sqrt{\dfrac{b^2-4ac}{4a^2}}$

$\Rightarrow x=-\dfrac{b}{2a}\pm\sqrt{\dfrac{b^2-4ac}{4a^2}}$ A1

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