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Mark Scheme (Results)

Summer 2012

GCE Core Mathematics C1 (6663) Paper 1

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Summer 2012
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Summer 2012
6663 Core Mathematics
C1 Mark Scheme

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.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- 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 and can be used if you are using the annotation facility on ePEN.

- 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.

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

$(x^2 + bx + c) = (x + p)(x + q),\ \text{where} |pq| = |c|$, leading to x = ...

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

2. Formula

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

3. Completing the square

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

Summer 2012
6663 Core Mathematics C1
Mark Scheme

Question Number	Scheme	Marks
1.	$\left\{\int\left(6x^2+\frac{2}{x^2}+5\right)\mathrm{d}x\right\} = \frac{6x^3}{3}+\frac{2x^{-1}}{-1}+5x\,(+c)$	M1 A1
	$= 2x^3-2x^{-1}\;;+5x+c$	A1; A1
		4
	Notes	
	M1: for some attempt to integrate a term in x: $x^n \to x^{n+1}$ So seeing either $6x^2 \to \pm\lambda x^3$ or $\frac{2}{x^2} \to \pm\mu x^{-1}$ or $5 \to 5x$ is M1. **1st A1**: for a correct un-simplified x^3 or x^{-1} $\left(\text{or } \frac{1}{x}\right)$ term. **2nd A1:** for both x^3 and x^{-1} terms correct and simplified on the same line. Ie. $2x^3-2x^{-1}$ or $2x^3-\frac{2}{x}$. **3rd A1:** for $+5x+c$. Also allow $+5x^1+c$. This needs to be written on the same line. **Ignore the incorrect use of the integral sign in candidates' responses.** **Note:** If a candidate scores M1A1A1A1 and their answer is NOT ON THE SAME LINE then withhold the final accuracy mark.	

Question Number	Scheme		Marks
2. (a)	$\left\{(32)^{\frac{3}{5}}\right\} = \left(\sqrt[5]{32}\right)^3$ or $\sqrt[5]{(32)^3}$ or 2^3 or $\sqrt[5]{32768}$		M1
	$= 8$		A1
			[2]
(b)	$\left\{\left(\dfrac{25x^4}{4}\right)^{-\frac{1}{2}}\right\} = \left(\dfrac{4}{25x^4}\right)^{\frac{1}{2}}$ or $\left(\dfrac{5x^2}{2}\right)^{-1}$ or $\dfrac{1}{\left(\dfrac{25x^4}{4}\right)^{\frac{1}{2}}}$	***See notes below***	M1
	$= \dfrac{2}{5x^2}$ or $\dfrac{2}{5}x^{-2}$	***See notes for other alternatives***	A1
			[2] **4**

Notes

(a)

M1: for a full correct interpretation of the fractional power. **Note:** $5\times(32)^3$ is M0.

A1: for 8 only.

Note: Award M1A1 for writing down 8.

(b)

M1: For use of $\dfrac{1}{2}$ OR use of -1

Use of $\dfrac{1}{2}$: Candidate needs to demonstrate the they have rooted all three elements in their bracket.

Use of -1: Either Candidate has $\dfrac{1}{\text{Bracket}}$ or $\left(\dfrac{Ax^C}{B}\right)$ becomes $\left(\dfrac{B}{Ax^C}\right)$.

Allow M1 for...

- $\left(\dfrac{4}{25x^4}\right)^{\frac{1}{2}}$ or $\left(\dfrac{5x^2}{2}\right)^{-1}$ or $\dfrac{1}{\left(\dfrac{25x^4}{4}\right)^{\frac{1}{2}}}$ or $\sqrt{\left(\dfrac{4}{25x^4}\right)}$ or $\dfrac{1}{\sqrt{\left(\dfrac{25x^4}{4}\right)}}$ or $\left(\dfrac{\frac{1}{25x^4}}{\frac{1}{4}}\right)^{\frac{1}{2}}$ or $\dfrac{\frac{1}{5x^2}}{\frac{1}{2}}$ or $\dfrac{\frac{1}{5}x^{-2}}{\frac{1}{2}}$

  or $-\left(\dfrac{5x^2}{2}\right)$ or $\left(\dfrac{-5x^{-2}}{-2}\right)$ or $-\left(\dfrac{5x^{-2}}{2}\right)$ or $\dfrac{5x^{-2}}{2}$
- $\left(\dfrac{4}{25x^4}\right)^K$ or $\left(\dfrac{5x^2}{2}\right)^C$ where K, C are any powers including 1.

A1: for either $\dfrac{2}{5x^2}$ or $\dfrac{2}{5}x^{-2}$ or $0.4x^{-2}$ or $\dfrac{0.4}{x^2}$.

Note: $\left(\sqrt{\left(\dfrac{25x^4}{4}\right)}\right)^{-1}$ is not enough work by itself for the method mark.

Note: A final answer of $\dfrac{1}{\frac{5}{2}x^2}$ or $\dfrac{1}{2\frac{1}{2}x^2}$ or $\dfrac{1}{2.5x^2}$ is A0.

Note: Also allow $\pm\dfrac{2}{5x^2}$ or $\pm\dfrac{2}{5}x^{-2}$ or $\pm 0.4x^{-2}$ or $\pm\dfrac{0.4}{x^2}$ for A1.

Question Number	Scheme	Marks
3.	$\left\{\frac{2}{\sqrt{12}-\sqrt{8}}\right\} = \frac{2}{(\sqrt{12}-\sqrt{8})} \times \frac{(\sqrt{12}+\sqrt{8})}{(\sqrt{12}+\sqrt{8})}$ Writing this is sufficient for M1.	M1
	$= \frac{\{2(\sqrt{12}+\sqrt{8})\}}{12-8}$ For $12-8$. This mark can be implied.	A1
	$= \frac{2(2\sqrt{3}+2\sqrt{2})}{12-8}$	B1 B1
	$= \sqrt{3}+\sqrt{2}$	A1 **cso**
		5
	Notes	

M1: for a correct method to rationalise the denominator.

1st A1: $(\sqrt{12}-\sqrt{8})(\sqrt{12}+\sqrt{8}) \to 12-8$ or $(\sqrt{3}+\sqrt{2})(\sqrt{3}-\sqrt{2}) \to 3-2$

1st B1: for $\sqrt{12} = 2\sqrt{3}$ or $\sqrt{48} = 4\sqrt{3}$ seen or implied in candidate's working.

2nd B1: for $\sqrt{8} = 2\sqrt{2}$ or $\sqrt{32} = 4\sqrt{2}$ seen or implied in candidate's working.

2nd A1: for $\sqrt{3}+\sqrt{2}$. Note: $\frac{\sqrt{3}+\sqrt{2}}{1}$ as a final answer is A0.

Note: The first accuracy mark is dependent on the first method mark being awarded.

Note: $\frac{1}{2}\sqrt{12}+\frac{1}{2}\sqrt{8} = \sqrt{3}+\sqrt{2}$ with no intermediate working implies the B1B1 marks.

Note: $\sqrt{12} = \sqrt{4}\sqrt{3}$ or $\sqrt{8} = \sqrt{4}\sqrt{2}$ are not sufficient for the B1 marks.

Note: A candidate who writes down (by misread) $\sqrt{18}$ for $\sqrt{8}$ can potentially obtain M1A0B1B1A0, where the 2nd B1 will be awarded for $\sqrt{18} = 3\sqrt{2}$ or $\sqrt{72} = 6\sqrt{2}$

Note: The final accuracy mark is for a correct solution only.

<u>Alternative 1 solution</u>

$\left\{\frac{2}{\sqrt{12}-\sqrt{8}}\right\} = \frac{2}{(2\sqrt{3}-2\sqrt{2})}$ B1 B1

$= \frac{1}{(\sqrt{3}-\sqrt{2})} \times \frac{(\sqrt{3}+\sqrt{2})}{(\sqrt{3}+\sqrt{2})}$ M1

$= \frac{\{(\sqrt{3}+\sqrt{2})\}}{3-2}$ A1 for $3-2$

$= \sqrt{3}+\sqrt{2}$ A1

Please record the marks in the relevant places on the mark grid.

<u>Alternative 2 solution</u>

$\left\{\frac{2}{\sqrt{12}-\sqrt{8}}\right\} = \frac{2}{(2\sqrt{3}-2\sqrt{2})} = \frac{1}{(\sqrt{3}-\sqrt{2})} = \sqrt{3}+\sqrt{2}$, or $\frac{2}{(2\sqrt{3}-2\sqrt{2})} = \sqrt{3}+\sqrt{2}$

with no incorrect working seen is awarded M1A1B1B1A1.

Question Number	Scheme	Marks
4. (a)	$y = 5x^3 - 6x^{\frac{4}{3}} + 2x - 3$	
	$\left\{\frac{\mathrm{d}y}{\mathrm{d}x} =\right\}\ 5(3)x^2 - 6\left(\frac{4}{3}\right)x^{\frac{1}{3}} + 2$	M1
	$= 15x^2 - 8x^{\frac{1}{3}} + 2$	A1 A1 A1
		[4]
(b)	$\left\{\frac{\mathrm{d}^2y}{\mathrm{d}x^2} =\right\}\ 30x - \frac{8}{3}x^{-\frac{2}{3}}$	M1 A1
		[2]
		6
	Notes	
(a)	**M1**: for an attempt to differentiate $x^n \to x^{n-1}$ to one of the first three terms of $y = 5x^3 - 6x^{\frac{4}{3}} + 2x - 3$. So seeing either $5x^3 \to \pm\lambda x^2$ or $-6x^{\frac{4}{3}} \to \pm\mu x^{\frac{1}{3}}$ or $2x \to 2$ is M1. **1st A1**: for $15x^2$ only. **2nd A1:** for $-8x^{\frac{1}{3}}$ or $-8\sqrt[3]{x}$ only. **3rd A1:** for $+2$ ($+c$ included in part (a) loses this mark). **Note:** $2x^0$ is A0 unless simplified to 2.	
(b)	**M1:** For differentiating $\frac{\mathrm{d}y}{\mathrm{d}x}$ again to give **either** • a correct follow through differentiation of their x^2 term • **or** for $\pm\alpha x^{\frac{1}{3}} \to \pm\beta x^{-\frac{2}{3}}$. **A1:** for any ***correct*** expression ***on the same line*** (accept un-simplified coefficients). For powers: $30x^{2-1} - \frac{8}{3}x^{\frac{1}{3}-1}$ is A0, but writing powers as one term eg: $(15\times 2x) - \frac{8}{3}x^{-\frac{4}{6}}$ is ok for A1. **Note:** Candidates leaving their answers as $\left\{\frac{\mathrm{d}y}{\mathrm{d}x} =\right\} 15x^2 - \frac{24}{3}x^{\frac{1}{3}} + 2$ and $\left(\frac{\mathrm{d}^2y}{\mathrm{d}x^2} =\right)\ 30x - \frac{24}{9}x^{-\frac{2}{3}}$ are awarded M1A1A0A1 in part (a) and M1A1 in part (b). **Be careful:** $30x - \frac{8}{3}x^{-\frac{1}{3}}$ will be A0. **Note:** For an extra term appearing in part (b) on the same line, ie $30x - \frac{8}{3}x^{-\frac{2}{3}} + 2$ is M1A0 **Note:** If a candidate writes in part (a) $15x^2 - 8x^{\frac{1}{3}} + 2 + c$ and in part (b) $30x - \frac{8}{3}x^{-\frac{2}{3}} + c$ then award (a) M1A1A1A0 (b) M1A1	

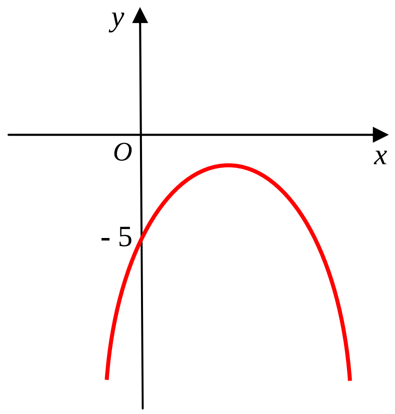
Question Number	Scheme	Marks
	$a_1 = 3,\ a_{n+1} = 2a_n - c\ ,\ \ n \geq 1\ ,\ c$ is a constant	
5. (a)	$\{a_2 =\}\ \ 2 \times 3 - c$ or $2(3) - c$ or $6 - c$	B1 **[1]**
(b)	$\{a_3 =\}\ \ 2 \times (\text{"}6 - c\text{"}) - c$	M1
	$= 12 - 3c$ **(*)**	A1 cso **[2]**
(c)	$a_4 = 2 \times (\text{"}12 - 3c\text{"}) - c \qquad \{= 24 - 7c\}$	M1
	$\left\{\sum_{i=1}^{4} a_i =\right\}\ \ 3 + (6 - c) + (12 - 3c) + (24 - 7c)$	M1
	$\text{"}45 - 11c\text{"} \geq 23$ or $\text{"}45 - 11c\text{"} = 23$	M1
	$c \leq 2$ or $2 \geq c$	A1 cso **[4]**
		7
	Notes	
(a)	The answer to part (a) cannot be recovered from candidate's working in part (b) or part (c). Once the candidate has achieved the correct result you can ignore subsequent working in this part.	
(b)	**M1:** For a correct substitution of ***their*** a_2 ***which must include term(s) in c*** into $2a_2 - c$ giving a result for a_3 in terms of only *c*. Candidates must use correct bracketing for this mark. **A1:** for correct solution only. No incorrect working/statements seen. (**Note**: the answer is given!)	
(c)	**1st M1:** For a correct substitution of a_3 ***which must include term(s) in c*** into $2a_3 - c$ giving a result for a_4 in terms of only *c*. Candidates must use correct bracketing (can be implied) for this mark. **2nd M1:** for an attempt to sum their a_1, a_2, a_3 and a_4 only. **3rd M1:** for their sum (of 3 or 4 or 5 consecutive terms) $=$ or $\geq$ or $>$ 23 to form a linear inequality or equation in *c*. **A1:** for $c \leq 2$ or $2 \geq c$ from a correct solution only. **Beware:** $-11c \geq -22 \Rightarrow c \geq 2$ is A0. **Note:** $45 - 11c \geq 23 \Rightarrow -11c \leq -22 \Rightarrow c \leq 2$ would be A0 cso. **Note:** Applying either $S_n = \frac{n}{2}(2a + (n-1)d)$ or $S_n = \frac{n}{2}(a + l)$ is 2nd M0, 3rd M0. **Note:** If a candidate gives a numerical answer in part (a); they will then get M0A0 in part (b); but if they use the printed result of $a_3 = 12 - 3c$ they could potentially get M0M1M1A0 in part (c) **Note:** If a candidate only adds numerical values (not in terms of *c*) in part (c) then they could potentially get only M0M0M1A0. **Note:** For the 3rd M1 candidates will usually sum a_1, a_2, a_3 and a_4 or a_2, a_3 and a_4 or a_2, a_3, a_4 and a_5 or a_1, a_2, a_3, a_4 and a_5	

Question Number	Scheme	Marks
	Boy's Sequence: $10, 15, 20, 25, ...$	
6. (a)	$\{a=10,\ d=5 \Rightarrow T_{15}=\}\ a+14d = 10+14(5); = 80$ or $0.1+14(0.05); = £0.80$	M1; A1 **[2]**
(b)	$\{S_{60}=\}\ \frac{60}{2}\left[2(10)+59(5)\right]$	M1 A1
	$= 30(315) = 9450$ or $£94.50$	A1 **[3]**
	Boy's Sister's Sequence: $10, 20, 30, 40, ...$	
(c)	$\{a=10,\ d=10 \Rightarrow S_m=\}\ \frac{m}{2}\left(2(10)+(m-1)(10)\right)$ $\left(\text{or } \frac{m}{2}\times 10(m+1) \text{ or } 5m(m+1)\right)$	M1 A1
	63 or $6300 = \frac{m}{2}\left(2(10)+(m-1)(10)\right)$	dM1
	$6300 = \frac{m}{2}(10)(m+1)$ or $12600 = 10m(m+1)$	
	$1260 = m(m+1)$	
	$35 \times 36 = m(m+1)$ **(*)**	A1 **cso** **[4]**
(d)	$\{m=\}\ 35$	B1 **[1]**
		10

	Notes
(a)	**M1:** for using the formula $a+14d$ with either a or d correct. **A1:** for 80 or 80p or $£0.80$ or $£0.80$p and apply ISW. Otherwise, $£80$ or 0.80 or 0.80p would be A0. Award M0 if candidate applies $a+59d$. Listing the first 15 terms and highlighting that the 15th term is 80 or listing 15 terms with the final 15th term aligned with 80 will then be awarded all two marks of M1A1. Writing down 80 with no working is M1A1.
(b)	**M1**: for use of correct $\frac{60}{2}\left[2(10)+59(5)\right]$ or $\frac{15}{2}\left(2(10)+14(5)\right)$ with $a=10,\ d=5$ and $n=60$ or $a=10,\ d=5$ and $n=15$. If a candidate uses $\frac{n}{2}(a+l)$ with $n=60$ or 15, there must be a full method of finding or stating l as either $a+59d\ (=305)$ or $a+14d\ (=80)$, respectively. **1st A1:** for a correct expression for S_{60}. ie. $\frac{60}{2}\left[2(10)+59(5)\right]$ or $\frac{60}{2}\left[2(0.1)+59(0.05)\right]$ or $\frac{60}{2}\left[10+305\right]$ or $\frac{60}{2}\left[0.10+3.05\right]$. This mark can be implied by later working. **2nd A1:** for 9450 or 9450p or $£94.50$ and apply ISW. Otherwise, $£9450$ or 94.50 without £ sign is A0. **Note**: the bracketing error of $\frac{60}{2}\ 2(10)+59(5)$ is A0 unless recovered from later working. Adding together the first 60 terms to obtain 9450 will then be awarded all three marks of M1A1A1.

(c)	**1st M1:** for correct use of S_m formula with one of *a* or *d* correct. **1st A1:** for a correct expression for S_m. Eg: $\frac{m}{2}\left(2(10)+(m-1)(10)\right)$ or $\frac{m}{2}\times 10(m+1)$ or $5m(m+1)$ **2nd M1:** for forming a suitable equation using 63 or 6300 and their S_m. **Dependent on 1st M1.** **2nd A1cso:** for ***reaching the printed result*** with no incorrect working seen. Long multiplication is not necessary for the final accuracy mark. **Note:** $\frac{m}{2}\left(2(10)+(m-1)(10)\right)=630$ and not either 6300 or 63 is dM0. **<u>Beware</u>:** Some candidates will try and fudge the result given on the question paper. **<u>Notes for awarding 2nd A1</u>** Going from $m(m+1)=1260$ straight to $m(m+1)=35\times 36$ is 2nd A1. Going from $m(m+1)=$ some factor decomposition of 6300 straight to $m(m+1)=35\times 36$ is 2nd A1. Going from $10m(m+1)=12600$ straight to $m(m+1)=35\times 36$ is 2nd A0. Going from $m(m+1)=\frac{6300}{5}$ straight to $m(m+1)=35\times 36$ is 2nd A0. ***<u>Alternative: working in an different letter, say n or p.</u>*** **M1A1:** for $\frac{n}{2}\left(2(10)+(n-1)(10)\right)$ (although mixing letters eg. $\frac{n}{2}\left(2(10)+(m-1)(10)\right)$ is M0A0). **dM1:** for 63 or $6300=\frac{n}{2}\left(2(10)+(n-1)(10)\right)$ Leading to $6300=\frac{n}{2}(10)(n+1)\Rightarrow 1260=n(n+1)\Rightarrow 35\times 36=n(n+1)$ The candidate then needs to write either $35\times 36=m(m+1)$ or $m\equiv n$ or $m=n$ to gain the final A1.
(d)	**B1:** for 35 only.

Question Number	Scheme	Marks
	$P(4, -1)$ lies on C where $\mathrm{f}'(x) = \frac{1}{2}x - \frac{6}{\sqrt{x}} + 3,\ \ x > 0$	
7. (a)	$\mathrm{f}'(4) = \frac{1}{2}(4) - \frac{6}{\sqrt{4}} + 3\ ;= 2$	M1; A1
	T: $y - -1 = 2(x-4)$	dM1
	T: $y = 2x - 9$	A1
		[4]
(b)	$\mathrm{f}(x) = \frac{x^{1+1}}{2(2)} - \frac{6x^{-\frac{1}{2}+1}}{(\frac{1}{2})} + 3x\ (+c)$ or equivalent.	M1 A1
	$\{\mathrm{f}(4) = -1 \Rightarrow\}\ \frac{16}{4} - 12(2) + 3(4) + c = -1$	dM1
	$\{4 - 24 + 12 + c = -1 \quad \Rightarrow\ c = 7\}$	
	So, $\{\mathrm{f}(x) =\}\ \frac{x^2}{2(2)} - \frac{6x^{\frac{1}{2}}}{(\frac{1}{2})} + 3x + 7$	A1 cso
	$\left\{\text{NB: } \mathrm{f}(x) = \frac{x^2}{4} - 12\sqrt{x} + 3x + 7\right\}$	**[4]**
		8
	Notes	
(a)	**1st M1:** for clear attempt at $\mathrm{f}'(4)$. **1st A1:** for obtaining 2 from $\mathrm{f}'(4)$. **2nd dM1:** for $y - -1 = (\text{their } \mathrm{f}'(4))(x-4)$ or $\frac{y - -1}{x-4} = (\text{their } \mathrm{f}'(4))$ or full method of $y = mx + c$, with $x = 4,\ y = -1$ and their $\mathrm{f}'(4)$ to find a value for c. **Note:** this method mark is dependent on the first method mark being awarded. **2nd A1:** for $y = 2x - 9$ or $y = -9 + 2x$ **Note:** This work needs to be contained in part (a) only.	
(b)	**1st M1**: for a clear attempt to integrate $\mathrm{f}'(x)$ with at least one correct application of $x^n \to x^{n+1}$ on $\mathrm{f}'(x) = \frac{1}{2}x - \frac{6}{\sqrt{x}} + 3$. So seeing either $\frac{1}{2}x \to \pm\lambda x^{1+1}$ or $-\frac{6}{\sqrt{x}} \to \pm\mu x^{-\frac{1}{2}+1}$ or $3 \to 3x^{0+1}$ is M1. **1st A1:** for correct un-simplified coefficients and powers (or equivalent) with or without $+c$. **2nd dM1:** for use of $x = 4$ and $y = -1$ in an integrated equation to form a linear equation in c equal to -1. ie: applying $\mathrm{f}(4) = -1$. This mark is dependent on the first method mark being awarded. **A1:** For $\{\mathrm{f}(x) = \}\ \frac{x^2}{2(2)} - \frac{6x^{\frac{1}{2}}}{(\frac{1}{2})} + 3x + 7$ stated on one line where coefficients can be un-simplified or simplified, but must contain one term powers. Note this mark is for **correct solution only.** **<u>Note: For a candidate attempting to find f(x) in part (a)</u>** If it is clear that they understand that they are finding $\mathrm{f}(x)$ in part (a); ie. by writing $\mathrm{f}(x) = ...$ or $y = ...$ then you can give credit for this working in part (b).	

Question Number	Scheme	Marks
	$4x - 5 - x^2 = q - (x - p)^2$, p, q are integers.	
8. (a)	$\{4x - 5 - x^2 =\} \; -\left[x^2 - 4x + 5\right] = -\left[(x-2)^2 - 4 + 5\right] = -\left[(x-2)^2 + 1\right]$	M1
	$= -1 - (x-2)^2$	A1 A1
		[3]
(b)	$\{"b^2 - 4ac" = \} \; 4^2 - 4(-1)(-5) \quad \{= 16 - 20\}$	M1
	$= -4$	A1
		[2]
(c)		
	Correct $\cap$ shape	M1
	Maximum **within** the 4th quadrant	A1
	Curve cuts through -5 or $(0, -5)$ marked on the y-axis	B1
		[3]
		8

Notes

(a)

M1: for an attempt to complete the square eg: $\pm(\pm x \pm 2)^2 \pm k - 5,\; k \neq 0$ or $\pm(\pm x \pm 2)^2 \pm \lambda,\; \lambda \neq -5$ seen or implied in working.

1st A1: for $p = -2$ or for $\pm\alpha - (x-2)^2$, α can be 0.

2nd A1: for $q = -1$

Note: Allow M1A1A1 for a correct written down expression of $-1 - (x-2)^2$ Ignore $-1 - (x-2)^2 = 0$.

Note: If a candidate states either $p = -2$ or $q = -1$ or writes $\pm k - (x-2)^2$ then imply the M1 mark.

Note: A candidate who writes down with no working $p = 2,\; q = ($a value which is not $-1)$ gets M0A0A0.

Note: Writing $(x-2)^2 - 1$, followed by $p = -2,\; q = -1$ is M1A1A0.

<u>Alternative 1 to (a)</u>

$\{4x - 5 - x^2 =\} \; -\left[x^2 - 4x\right] - 5 = -\left[(x-2)^2 - 4\right] - 5 = -(x-2)^2 + 4 - 5 = -1 - (x-2)^2$

<u>Alternative2 to (a)</u>

$q - (x+p)^2 = q - (x^2 + 2px + p^2) = -x^2 - 2px + q - p^2$

Compare x terms: $\quad -2p = 4 \Rightarrow \underline{p = -2}$

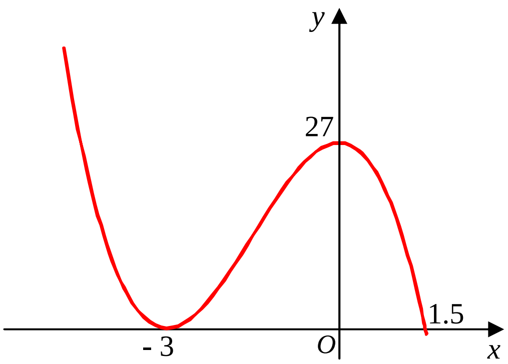
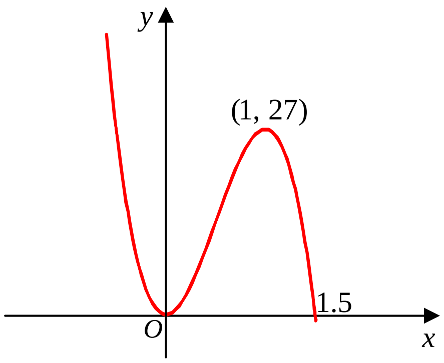
Compare constant terms: $\quad q - p^2 = -5 \Rightarrow q - 4 = -5 \Rightarrow \underline{q = -1}$

M1: Either $\pm 2p = 4$ or $q \pm p^2 = -5$; **1st A1:** for $p = -2$; **2nd A1:** for $q = -1$

	Alternative 3 to (a) Negating $4x - 5 - x^2$ gives $x^2 - 4x + 5$ So, $x^2 - 4x + 5 = (x-2)^2 - 4 + 5 \; \{= (x-2)^2 + 1\}$ **M1** for $\pm(\pm x \pm 2)^2 \pm k + 5$ then stating $p = -2$ is **1st A1** and/or $q = -1$ is **2nd A1**. or writing $-1 - (x-2)^2$ is A1A1. **Special Case for part (a):** $q - (x+p)^2 = q - (x^2 + 2px + p^2) = -x^2 - 2px + q - p^2 = 4x - 5 - x^2$ $\Rightarrow -2px + q - p^2 = 4x - 5 \;\Rightarrow\; q - p^2 + 5 = 4x + 2px \;\Rightarrow\; q - p^2 + 5 = x(4 + 2p)$ $\Rightarrow x = \dfrac{q - p^2 + 5}{4 + 2p} \;\Rightarrow\; p \neq -2$ scores Special Case M1A1A1 **only once** $p \neq -2$ achieved.
(b)	**M1:** for correctly substituting any two of $a = -1, b = 4, c = -5$ into $b^2 - 4ac$ if this is quoted. If $b^2 - 4ac$ is not quoted then the substitution must be correct. Substitution into $b^2 < 4ac$ or $b^2 = 4ac$ or $b^2 > 4ac$ is M0. **A1:** for -4 only. If they write $-4 < 0$ treat the < 0 as ISW and award A1. If they write $-4 \geq 0$ then score A0. So substituting into $b^2 - 4ac < 0$ leading to $-4 < 0$ can score M1A1 **Note:** Only award marks for use of the discriminant in part (b). **Note:** Award M0 if the candidate uses the quadratic formula UNLESS they later go on to identify that the discriminant is the result of $b^2 - 4ac$. **Beware: A number of candidates are writing up their solution to part (b) at the bottom of the second page. So please look!**
(c)	**M1:** Correct $\cap$ shape in any quadrant. **A1:** The maximum must be ***within*** the fourth quadrant to award this mark. **B1:** Curve ***(and not line!)*** cuts through -5 or $(0, -5)$ marked on the y-axis Allow $(-5, 0)$ rather than $(0, -5)$ if marked in the "correct" place on the y-axis. If the curve cuts through the negative y-axis and this is not marked, then you can recover $(0, -5)$ from the candidate's working in part (c). You are not allowed to recover this point, though, from a table of values. **Note:** Do not recover work for part (a) in part (c).

Question Number	Scheme	Marks
	$L_1: \ 4y + 3 = 2x \ \Rightarrow y = \frac{1}{2}x - \frac{3}{4}$; $A(p, 4)$ lies on L_1.	
9. (a)	$\{p =\} \ 9\frac{1}{2}$ or $\frac{19}{2}$ or 9.5	B1
		[1]
(b)	$\{4y + 3 = 2x\} \Rightarrow y = \frac{2x-3}{4} \Rightarrow m(L_1) = \frac{1}{2}$ or $\frac{2}{4}$	M1 A1
	So $m(L_2) = -2$	B1ft
	$L_2: \ y - 4 = -2(x-2)$	M1
	$L_2: \ 2x + y - 8 = 0$ or $L_2: \ 2x + 1y - 8 = 0$	A1
		[5]
(c)	$\{L_1 = L_2 \Rightarrow\} \ 4(8-2x) + 3 = 2x$ or $-2x + 8 = \frac{1}{2}x - \frac{3}{4}$	M1
	$x = 3.5, \ y = 1$	A1, A1 cso
		[3]
(d)	$CD^2 = ("3.5" - 2)^2 + ("1" - 4)^2$	"M1"
	$CD = \sqrt{("3.5" - 2)^2 + ("1" - 4)^2}$	A1 ft
	$= \sqrt{1.5^2 + 3^2} = 1.5\sqrt{1^2 + 2^2} = 1.5\sqrt{5}$ or $\frac{3}{2}\sqrt{5}$ **(*)**	A1 **cso**
		[3]
(e)	Area = triangle ABC + triangle ABE	
	$= \frac{1}{2} \times \frac{3}{2}\sqrt{5} \times \sqrt{80} + \frac{1}{2} \times 3\sqrt{5} \times \sqrt{80}$ Finding the area of any triangle.	M1
	$= \frac{3}{4}\sqrt{5} \times 4\sqrt{5} + \frac{3}{2}\sqrt{5} \times 4\sqrt{5}$	
	$= \frac{3}{4}(20) + \frac{3}{2}(20)$	B1
	$= 45$	A1
		[3]
		15
	Notes	
9. (a)	**B1:** 9.5 oe.	
(b)	**1st M1:** for an attempt to rearrange $4y + 3 = 2x$ into $y = mx + c$. This mark can be implied by the correct gradient of L_1 or L_2.	
	1st A1: for gradient of $L_1 = \frac{1}{2}$ or $\frac{2}{4}$. Stating $m(L_1) = \frac{1}{2}$ without working is M1A1.	
	B1ft: for applying $m(L_2) = \frac{-1}{\text{their } m(L_1)}$. Need not be simplified.	
	Note: Writing down $m(L_2) = -2$ with ***no earlier incorrect working*** gains M1A1B1	
	2nd M1: for applying $y - 4 = \pm\lambda(x-2)$ where λ is a numerical value, $\lambda \neq 0$. or full method of $y = mx + c$, with $x = 2$, $y = 4$ and (their $\pm\lambda$) to find c.	
	2nd A1: $2x + y - 8 = 0$ or $-2x - y + 8 = 0$ or $y + 2x - 8 = 0$ or $4x + 2y - 16 = 0$ or $2x + 1y - 8 = 0$ etc. Must be " = 0". So do not allow $2x + y = 8$ etc.	
	Note: Condone the error of incorrectly rearranging L_1 to give $y = \frac{1}{2}x - 3 \Rightarrow m(L_1) = \frac{1}{2}$.	

(c)	**M1:** for an attempt to solve. Must form a linear equation in one variable. **1st A1:** for $x = 3.5$ (correct solution only). **2nd A1:** for $y = 1$ (correct solution only). **Note:** If $x = 3.5,\ y = 1$ is found from no working, then send to review. **Note:** Use of trial and error to find one of *x* or *y* and then substitution into one of L_1 or L_2 can achieve M1A1A1.
(d)	**M1:** for an attempt at CD^2 - ft their point *D*. Eg: $("3.5"-2)^2 + ("1"-4)^2$ or simplified. This mark can be implied by finding *CD*. **1st A1ft:** for finding their *CD* - ft their point *D*. Eg: $\sqrt{("3.5"-2)^2 + ("1"-4)^2}$ or correctly simplified. **2nd A1:cso** for no incorrect working seen. **Note:** A candidate initially writing down $\sqrt{1.5^2+3^2}$ can be awarded M1A1. ***<u>Alternatives part (d): Final accuracy</u>*** **1.** $\left\{\sqrt{1.5^2+3^2} = \right\}\ \sqrt{\frac{9}{4}+9} = \sqrt{\frac{9}{4}+\frac{36}{4}} = \sqrt{\frac{45}{4}} = \frac{3\sqrt{5}}{2}$ **2.** $\left\{\sqrt{1.5^2+3^2} = \right\}\ \sqrt{11.25} = \sqrt{2.25}\sqrt{5} = 1.5\sqrt{5}$
(e)	**M1:** for an attempt at finding the area of either triangle *ABC* or triangle *ABE*. **B1:** Correct method for removing a square root. Eg: $\sqrt{80}\sqrt{5} = \sqrt{400} = 20$ or $\sqrt{5}\times 4\sqrt{5} = 20$ **Note:** This mark can be implied. **A1:** for 45 only. ***<u>Alternative 1 to part (e):</u>*** Area $= \frac{1}{2}\left(\frac{3}{2}\sqrt{5} + 3\sqrt{5}\right)\left(\sqrt{80}\right) = \frac{1}{2}(30+60) = 45$ **M1:** $\frac{1}{2}(AB)(CE)$. **B1:** Evidence of correct surd removal. **A1:** for 45. **Note:** Multiplying the diagonals (usually to find 90) is M0, B1 if surds are removed correctly, A0. ***<u>Alternative 2 to part (e):</u>*** Area = triangle DAC + triangle DCB + triangle DEA + triangle DBE $= \left(\frac{1}{2}\times\frac{3}{2}\sqrt{5}\times\sqrt{45}\right) + \left(\frac{1}{2}\times\frac{3}{2}\sqrt{5}\times\left(\sqrt{80}-\sqrt{45}\right)\right) + \left(\frac{1}{2}\times 3\sqrt{5}\times\sqrt{45}\right) + \left(\frac{1}{2}\times 3\sqrt{5}\times\left(\sqrt{80}-\sqrt{45}\right)\right)$ $= \left(\frac{1}{2}\times\frac{3}{2}(15)\right) + \left(\frac{1}{2}\times\frac{3}{2}(5)\right) + \left(\frac{1}{2}\times 3\,(15)\right) + \left(\frac{1}{2}\times 3(5)\right)$ $= \left(\frac{45}{4}\right) + \left(\frac{15}{4}\right) + \left(\frac{45}{2}\right) + \left(\frac{15}{2}\right)$ $= 45$ **M1:** For finding the area of one of the four triangles. **B1:** Evidence of correct surd removal. **A1:** for 45. ***<u>Alternative 3 to part (e):</u>*** $\left\{CE = CD + DE = \frac{3}{2}\sqrt{5} + 3\sqrt{5} = \frac{9}{2}\sqrt{5}\right\},\ \left\{BD = DA + \underline{AB} = 3\sqrt{5} + \underline{4\sqrt{5}} = 7\sqrt{5}\right\}$ Area = triangle BCE − triangle ACE $= \frac{1}{2}(CE)(BD) - \frac{1}{2}(CE)(BD)$ $= \frac{1}{2}\times\frac{9}{2}\sqrt{5}\times 7\sqrt{5} - \frac{1}{2}\times\frac{9}{2}\sqrt{5}\times 3\sqrt{5}$ **M1:** for an attempt at the area of triangle *BCE* or triangle *ACE*. $= \frac{63(5)}{4} - \frac{27(5)}{4} = \frac{36(5)}{4} = 9(5)$ **B1:** Evidence of correct surd removal. $= 45$ **A1:** for 45 only.

Question Number	Scheme	Marks
10. (a)	{Coordinates of A are} $(4.5, 0)$ See notes below	B1
		[1]
(b)(i)		
	Horizontal translation	M1
	-3 and their ft 1.5 on postitive x-axis	A1 ft
	Maximum at 27 marked on the y-axis	B1
		[3]
(ii)		
	Correct shape, minimum at $(0, 0)$ and a maximum within the first quadrant.	M1
	1.5 on x-axis	A1 ft
	Maximum at $(1, 27)$	B1
		[3]
(c)	$\{k =\}\ -17$	B1 **[1]**
		8
	Notes	
(a)	**B1:** For stating either $x = 4.5$ or $\frac{9}{2}$ or $\frac{18}{4}$ etc. or $A = 4.5$ or $\frac{9}{2}$ or $(4.5, 0)$. Can be written on graph. Allow $(0, 4.5)$ marked on curve for B1. Otherwise $(0, 4.5)$ without reference to any of the above is B0.	
(b)(i)	**M1:** for any horizontal (left-right) translation where minimum is still **on** x-axis not at $(0, 0)$. Ignore any values. **A1ft:** for -3 **(NOT 3)** and 1.5 (or their x in part (a) – 3) ***evaluated*** and marked on the positive x-axis. Allow $(0, -3)$ and/or $(0, \text{ft } 1.5)$ rather than $(-3, 0)$ and $(\text{ft } 1.5, 0)$ if marked in the "correct" place on the x-axis. **Note:** Candidate ***cannot*** gain this mark if their x in part (a) is less than 3. **B1:** Maximum at 27 marked on the y-axis. **Note**: the maximum must be on the y-axis for this mark.	
(ii)	**M1:** for correct shape with minimum still at $(0, 0)$ and a maximum within the first quadrant. Ignore values. **A1ft:** for $\dfrac{\text{their } x \text{ in part } (a)}{3}$; as intercept on x-axis eg: $\dfrac{4.5}{3}$ or 1.5 or $\dfrac{3}{2}$ or $\dfrac{9}{6}$ **Note:** a generalised $\dfrac{A}{3}$ is A0. Allow $(0, \text{ft } 1.5)$ rather than $(\text{ft } 1.5, 0)$ if marked in the "correct" place on the x-axis. **B1:** Maximum at $(1, 27)$ or allow 1 marked on the x-axis and the corresponding 27 marked on the y-axis. **Note: Be careful to look at the correct graph. The candidate may draw another graph to help them to answer part (c).** **Note:** You can recover (b)(i) $(-3, 0)$ and $(\text{ft } 1.5, 0)$ or in (b)(ii) $(\text{ft } 1.5, 0)$ as ***correct coordinates only*** in candidate's working if these are not marked on their sketch(es).	
(c)	**B1:** for $(k =)\ -17$ only. **BEWARE**: This could be written in the middle or at the bottom of a page.	

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