Centre No.						Paper Reference	Surname	Initial(s)
Candidate No.						6 6 6 3 / 0 1	Signature	

Paper Reference(s)

6663/01

Edexcel GCE

Core Mathematics C1

Advanced Subsidiary

Wednesday 16 May 2012 – Morning

Time: 1 hour 30 minutes

Examiner's use only

Team Leader's use only

Question Number	Leave Blank
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
Total	

Materials required for examination	Items included with question papers
Mathematical Formulae (Pink)	Nil

Calculators may NOT be used in this examination.

Instructions to Candidates

In the boxes above, write your centre number, candidate number, your surname, initials and signature.
Check that you have the correct question paper.
Answer ALL the questions.
You must write your answer for each question in the space following the question.

Information for Candidates

A booklet 'Mathematical Formulae and Statistical Tables' is provided.
Full marks may be obtained for answers to ALL questions.
The marks for individual questions and the parts of questions are shown in round brackets: e.g. **(2)**.
There are 10 questions in this question paper. The total mark for this paper is 75.
There are 24 pages in this question paper. Any blank pages are indicated.

Advice to Candidates

You must ensure that your answers to parts of questions are clearly labelled.
You should show sufficient working to make your methods clear to the Examiner.
Answers without working may not gain full credit.

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1. Find

$$\int \left(6x^2 + \frac{2}{x^2} + 5\right) \mathrm{d}x$$

giving each term in its simplest form.

(4)

Q1

(Total 4 marks)

Summer 2012
6663 Core Mathematics C1
Mark Scheme

Question Number	Scheme	Marks
1.	$\left\{\int\left(6x^2+\dfrac{2}{x^2}+5\right)\mathrm{d}x\right\} = \dfrac{6x^3}{3}+\dfrac{2x^{-1}}{-1}+5x\ (+c)$	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 $\dfrac{2}{x^2}\to\pm\mu x^{-1}$ or $5\to 5x$ is M1. **1st A1**: for a correct un-simplified x^3 or x^{-1} $\left(\text{or } \dfrac{1}{x}\right)$ term. **2nd A1:** for both x^3 and x^{-1} terms correct and simplified on the same line. Ie. $2x^3-2x^{-1}$ or $2x^3-\dfrac{2}{x}$. **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.	

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2. (a) Evaluate $(32)^{\frac{3}{5}}$, giving your answer as an integer.

(2)

(b) Simplify fully $\left(\frac{25x^4}{4}\right)^{-\frac{1}{2}}$

(2)

Q2

(Total 4 marks)

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)	$\left\{\left(\frac{25x^4}{4}\right)^{-\frac{1}{2}}\right\} = \left(\frac{4}{25x^4}\right)^{\frac{1}{2}}$ or $\left(\frac{5x^2}{2}\right)^{-1}$ or $\frac{1}{\left(\frac{25x^4}{4}\right)^{\frac{1}{2}}}$ ***See notes below***	M1
	$= \frac{2}{5x^2}$ or $\frac{2}{5}x^{-2}$ ***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 $\frac{1}{2}$ OR use of -1 **Use of $\frac{1}{2}$:** Candidate needs to demonstrate the they have rooted all three elements in their bracket. **Use of -1:** Either Candidate has $\frac{1}{\text{Bracket}}$ or $\left(\frac{Ax^C}{B}\right)$ becomes $\left(\frac{B}{Ax^C}\right)$. Allow M1 for... • $\left(\frac{4}{25x^4}\right)^{\frac{1}{2}}$ or $\left(\frac{5x^2}{2}\right)^{-1}$ or $\frac{1}{\left(\frac{25x^4}{4}\right)^{\frac{1}{2}}}$ or $\sqrt{\left(\frac{4}{25x^4}\right)}$ or $\frac{1}{\sqrt{\left(\frac{25x^4}{4}\right)}}$ or $\left(\frac{\frac{1}{25x^4}}{\frac{1}{4}}\right)^{\frac{1}{2}}$ or $\frac{\frac{1}{5x^2}}{\frac{1}{2}}$ or $\frac{\frac{1}{5}x^{-2}}{\frac{1}{2}}$ or $-\left(\frac{5x^2}{2}\right)$ or $\left(\frac{-5x^{-2}}{-2}\right)$ or $-\left(\frac{5x^{-2}}{2}\right)$ or $\frac{5x^{-2}}{2}$ • $\left(\frac{4}{25x^4}\right)^K$ or $\left(\frac{5x^2}{2}\right)^C$ where K, C are any powers including 1. **A1:** for either $\frac{2}{5x^2}$ or $\frac{2}{5}x^{-2}$ or $0.4x^{-2}$ or $\frac{0.4}{x^2}$. **Note:** $\left(\sqrt{\left(\frac{25x^4}{4}\right)}\right)^{-1}$ is not enough work by itself for the method mark. **Note:** A final answer of $\frac{1}{\frac{5}{2}x^2}$ or $\frac{1}{2\frac{1}{2}x^2}$ or $\frac{1}{2.5x^2}$ is A0. **Note**: Also allow $\pm\frac{2}{5x^2}$ or $\pm\frac{2}{5}x^{-2}$ or $\pm 0.4x^{-2}$ or $\pm\frac{0.4}{x^2}$ for A1.	

Leave blank

3. Show that $\frac{2}{\sqrt{(12)}-\sqrt{(8)}}$ can be written in the form $\sqrt{a} + \sqrt{b}$, where a and b are integers.
(5)

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.

Alternative 1 solution

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

Alternative 2 solution

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

with no incorrect working seen is awarded M1A1B1B1A1.

Leave blank

4.

$$y = 5x^3 - 6x^{\frac{4}{3}} + 2x - 3$$

(a) Find $\frac{dy}{dx}$ giving each term in its simplest form.

(4)

(b) Find $\frac{d^2y}{dx^2}$

(2)

Question Number	Scheme	Marks
	$y = 5x^3 - 6x^{\frac{4}{3}} + 2x - 3$	
4. (a)	$\left\{\frac{\mathrm{d}y}{\mathrm{d}x} =\right\}$ $5(3)x^2 - 6\left(\frac{4}{3}\right)x^{\frac{1}{3}} + 2$	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	

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5. A sequence of numbers a_1, a_2, a_3 ... is defined by

$$a_1 = 3$$

$$a_{n+1} = 2a_n - c \qquad (n \geqslant 1)$$

where c is a constant.

(a) Write down an expression, in terms of c, for a_2

(1)

(b) Show that $a_3 = 12 - 3c$

(2)

Given that $\sum_{i=1}^{4} a_i \geqslant 23$

(c) find the range of values of c.

(4)

Question Number	Scheme	Marks
	$a_1 = 3,\ a_{n+1} = 2a_n - c\ ,\quad n \geq 1\ ,\ c$ 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	

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6. A boy saves some money over a period of 60 weeks. He saves 10p in week 1, 15p in week 2, 20p in week 3 and so on until week 60. His weekly savings form an arithmetic sequence.

(a) Find how much he saves in week 15
(2)

(b) Calculate the total amount he saves over the 60 week period.
(3)

The boy's sister also saves some money each week over a period of m weeks. She saves 10p in week 1, 20p in week 2, 30p in week 3 and so on so that her weekly savings form an arithmetic sequence. She saves a total of £63 in the m weeks.

(c) Show that

$$m(m + 1) = 35 \times 36$$

(4)

(d) Hence write down the value of m.
(1)

Question Number	Scheme	Marks
	Boy's Sequence: $10, 15, 20, 25, \ldots$	
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: $10, 20, 30, 40, \ldots$	
(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 £0.80p 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.

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7. The point P (4, –1) lies on the curve C with equation $y = \text{f}(x)$, $x > 0$, and

$$\text{f}'(x) = \frac{1}{2}x - \frac{6}{\sqrt{x}} + 3$$

(a) Find the equation of the tangent to C at the point P, giving your answer in the form $y = mx + c$, where m and c are integers.

(4)

(b) Find f(x).

(4)

Question Number	Scheme	Marks
	$P(4, -1)$ lies on C where $\mathrm{f}'(x) = \frac{1}{2}x - \frac{6}{\sqrt{x}} + 3, \quad x > 0$	
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
	$\{4 - 24 + 12 + c = -1 \quad \Rightarrow \quad c = 7\}$	
	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 $\mathrm{f}(x) = \ldots$ or $y = \ldots$ then you can give credit for this working in part (b).	

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8. $$4x - 5 - x^2 = q - (x + p)^2$$

where p and q are integers.

(a) Find the value of p and the value of q.

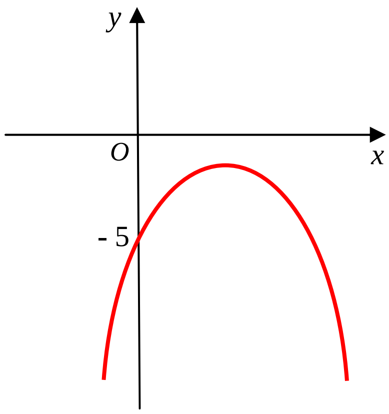
(3)

(b) Calculate the discriminant of $4x - 5 - x^2$

(2)

(c) On the axes on page 17, sketch the curve with equation $y = 4x - 5 - x^2$ showing clearly the coordinates of any points where the curve crosses the coordinate axes.

(3)

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.
	Alternative 1 to (a)
	$\{4x-5-x^2 =\}\ -\left[x^2-4x\right]-5 = -\left[(x-2)^2-4\right]-5 = -(x-2)^2+4-5 = -1-(x-2)^2$
	Alternative2 to (a)
	$q-(x+p)^2 = q-(x^2+2px+p^2) = -x^2-2px+q-p^2$
	Compare x terms: $-2p=4 \Rightarrow \underline{p=-2}$
	Compare constant terms: $q-p^2=-5 \Rightarrow q-4=-5 \Rightarrow \underline{q=-1}$
	M1: Either $\pm 2p=4$ or $q\pm p^2=-5$; **1st A1:** for $p=-2$; **2nd A1:** for $q=-1$

	<u>Alternative 3 to (a)</u> 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).

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9. The line L_1 has equation $4y + 3 = 2x$

The point A $(p, 4)$ lies on L_1

(a) Find the value of the constant p.

(1)

The line L_2 passes through the point C $(2, 4)$ and is perpendicular to L_1

(b) Find an equation for L_2 giving your answer in the form $ax + by + c = 0$, where a, b and c are integers.

(5)

The line L_1 and the line L_2 intersect at the point D.

(c) Find the coordinates of the point D.

(3)

(d) Show that the length of CD is $\frac{3}{2}\sqrt{5}$

(3)

A point B lies on L_1 and the length of $AB = \sqrt{(80)}$

The point E lies on L_2 such that the length of the line CDE = 3 times the length of CD.

(e) Find the area of the quadrilateral $ACBE$.

(3)

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	
	$=\frac{1}{2}\times\frac{3}{2}\sqrt{5}\times\sqrt{80}+\frac{1}{2}\times3\sqrt{5}\times\sqrt{80}$ Finding the area of any triangle.	M1
	$=\frac{3}{4}\sqrt{5}\times4\sqrt{5}+\frac{3}{2}\sqrt{5}\times4\sqrt{5}$	
	$=\frac{3}{4}(20)+\frac{3}{2}(20)$	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, $\lambda\neq0$. 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. ***Alternatives part (d): Final accuracy*** **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. ***Alternative 1 to part (e):*** 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. ***Alternative 2 to part (e):*** 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. ***Alternative 3 to part (e):*** $\left\{CE = CD + DE = \frac{3}{2}\sqrt{5} + 3\sqrt{5} = \frac{9}{2}\sqrt{5}\right\}$, $\left\{BD = DA + \underline{AB} = 3\sqrt{5} + \underline{4\sqrt{5}} = 7\sqrt{5}\right\}$ 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.

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10.

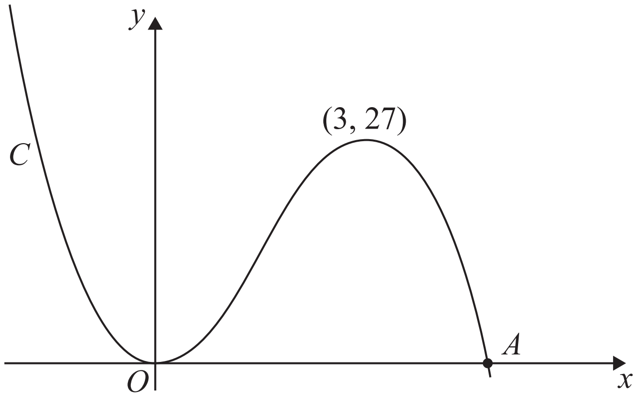


Figure 1

Figure 1 shows a sketch of the curve C with equation $y = \text{f}(x)$ where

$$\text{f}(x) = x^2(9 - 2x)$$

There is a minimum at the origin, a maximum at the point (3, 27) and C cuts the x-axis at the point A.

(a) Write down the coordinates of the point A.

(1)

(b) On separate diagrams sketch the curve with equation

(i) $y = \text{f}(x + 3)$

(ii) $y = \text{f}(3x)$

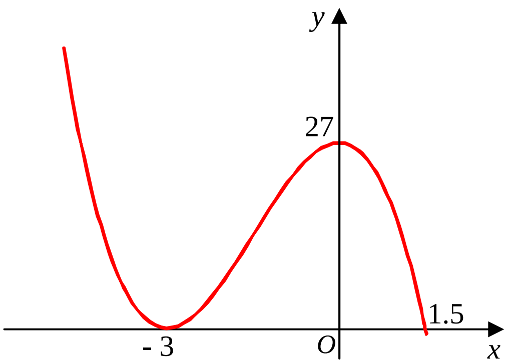
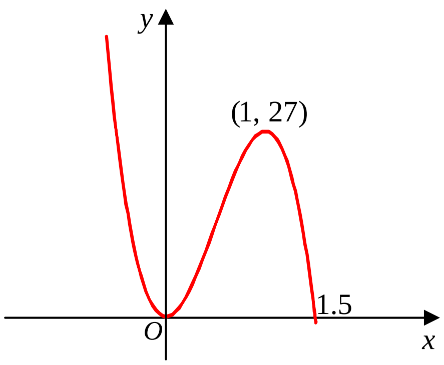
On each sketch you should indicate clearly the coordinates of the maximum point and any points where the curves cross or meet the coordinate axes.

(6)

The curve with equation $y = \text{f}(x) + k$, where k is a constant, has a maximum point at (3, 10).

(c) Write down the value of k.

(1)

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.