Paper Reference(s)

6664/01

Edexcel GCE

Core Mathematics C2
Silver Level S4

Time: 1 hour 30 minutes

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

Candidates may use any calculator allowed by the regulations of the Joint Council for Qualifications. Calculators must not have the facility for symbolic algebra manipulation, differentiation and integration, or have retrievable mathematical formulas stored in them.

Instructions to Candidates

Write the name of the examining body (Edexcel), your centre number, candidate number, the unit title (Core Mathematics C2), the paper reference (6664), your surname, initials and signature.

Information for Candidates

A booklet 'Mathematical Formulae and Statistical Tables' is provided.
Full marks may be obtained for answers to ALL questions.
There are 11 questions in this question paper. The total mark for this paper is 75.

Advice to Candidates

You must ensure that your answers to parts of questions are clearly labelled.
You must show sufficient working to make your methods clear to the Examiner. Answers without working may gain no credit.

Suggested grade boundaries for this paper:

A*	A	B	C	D	E
70	63	55	47	39	32

1. $$y = 3^x + 2x.$$

(*a*) Complete the table below, giving the values of y to 2 decimal places.

x	0	0.2	0.4	0.6	0.8	1
y	1	1.65				5

(2)

(*b*) Use the trapezium rule, with all the values of y from your table, to find an approximate value for $\int_0^1 (3^x + 2x)\ \mathrm{d}x$.

(4)

June 2010

2.

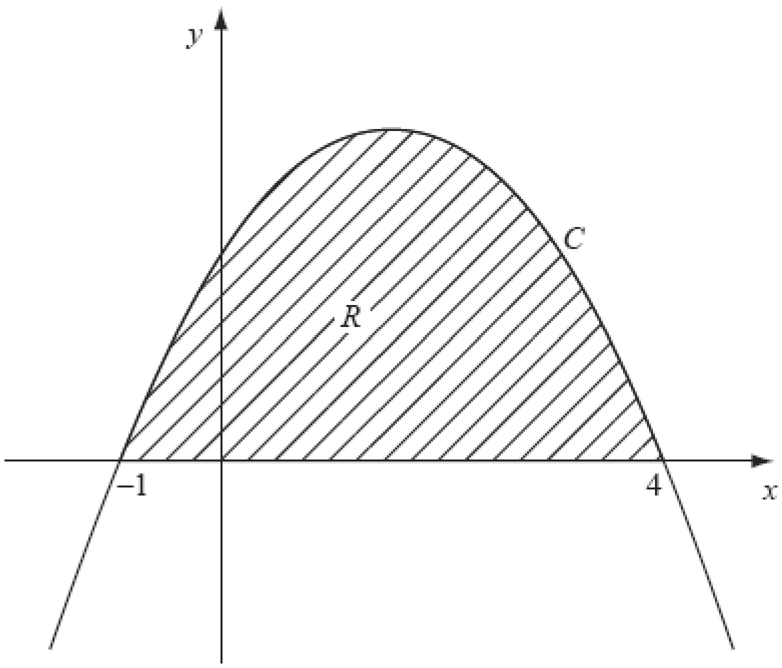

Figure 1

Figure 1 shows part of the curve C with equation $y = (1 + x)(4 - x)$.

The curve intersects the x-axis at $x = -1$ and $x = 4$. The region R, shown shaded in Figure 1, is bounded by C and the x-axis.

Use calculus to find the exact area of R.

(5)

January 2009

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3. A company predicts a yearly profit of £120 000 in the year 2013. The company predicts that the yearly profit will rise each year by 5%. The predicted yearly profit forms a geometric sequence with common ratio 1.05.

(*a*) Show that the predicted profit in the year 2016 is £138 915.

(1)

(*b*) Find the first year in which the yearly predicted profit exceeds £200 000.

(5)

(*c*) Find the total predicted profit for the years 2013 to 2023 inclusive, giving your answer to the nearest pound.

(3)

January 2013

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4. The circle C has equation

$$x^2 + y^2 + 4x - 2y - 11 = 0.$$

Find

(*a*) the coordinates of the centre of C,

(2)

(*b*) the radius of C,

(2)

(*c*) the coordinates of the points where C crosses the y-axis, giving your answers as simplified surds.

(4)

May 2011

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5. The circle C has centre (3, 1) and passes through the point P(8, 3).

(*a*) Find an equation for C.

(4)

(*b*) Find an equation for the tangent to C at P, giving your answer in the form $ax + by + c = 0$, where a, b and c are integers.

(5)

June 2008

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6. (*a*) Find, to 3 significant figures, the value of x for which $8^x = 0.8$.

(2)

(*b*) Solve the equation

$$2 \log_3 x - \log_3 7x = 1.$$

(4)

May 2007

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7. (*a*) Given that

$$2 \log_3 (x - 5) - \log_3 (2x - 13) = 1,$$

show that $x^2 - 16x + 64 = 0$.

(5)

(*b*) Hence, or otherwise, solve $2 \log_3 (x - 5) - \log_3 (2x - 13) = 1$.

(2)

June 2010

8.

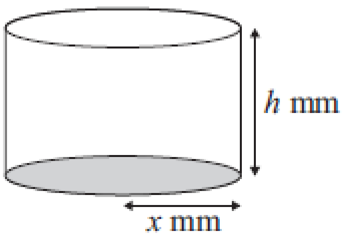

Figure 2

A manufacturer produces pain relieving tablets. Each tablet is in the shape of a solid circular cylinder with base radius x mm and height h mm, as shown in Figure 2.

Given that the volume of each tablet has to be 60 mm^3,

(*a*) express h in terms of x,

(1)

(*b*) show that the surface area, A mm^2, of a tablet is given by $A = 2\pi x^2 + \dfrac{120}{x}$.

(3)

The manufacturer needs to minimise the surface area A mm^2, of a tablet.

(*c*) Use calculus to find the value of x for which A is a minimum.

(5)

(*d*) Calculate the minimum value of A, giving your answer to the nearest integer.

(2)

(*e*) Show that this value of A is a minimum.

(2)

January 2012

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9. (i) Solve, for $0 \leq \theta < 180°$

$$\sin(2\theta - 30°) + 1 = 0.4$$

giving your answers to 1 decimal place.

(5)

(ii) Find all the values of x, in the interval $0 \leq \theta < 360°$, for which

$$9\cos^2 x - 11\cos x + 3\sin^2 x = 0$$

giving your answers to 1 decimal place.

(7)

You must show clearly how you obtained your answers.

May 2013 (R)

TOTAL FOR PAPER: 75 MARKS

END

Question Number	Scheme	Marks
1. (a)	2.35, 3.13, 4.01	B1 B1 (2)
(b)	$\frac{1}{2}\times 0.2$	B1
	$k\{(1+5)+2(1.65+p+q+r)\}$, k constant, $k\neq 0$	M1 A1
	= 2.828 (awrt 2.83)	A1 (4) **[6]**
2.	$y=(1+x)(4-x)=4+3x-x^2$	M1
	$\int(4+3x-x^2)\mathrm{d}x=4x+\frac{3x^2}{2}-\frac{x^3}{3}$	M1 A1
	$=[..............]_{-1}^{4}=\left(16+24-\frac{64}{3}\right)-\left(-4+\frac{3}{2}+\frac{1}{3}\right)=\frac{125}{6}$ $\left(=20\frac{5}{6}\right)$	M1 A1 **[5]**
3. (a)	$120000\times(1.05)^3=138915*$	B1 (1)
(b)	$120000\times(1.05)^{n-1}>200000$	M1
	$\log 1.05^{n-1}>\log\left(\frac{5}{3}\right)$	M1
	$(n-1>)\frac{\log\left(\frac{5}{3}\right)}{\log 1.05}$ or equivalent	A1
	2024	M1 A1 (5)
(c)	$\frac{a(1-r^n)}{1-r}=\frac{120000(1-1.05^{11})}{1-1.05}$	M1 A1
	1704814	A1 (3) **[9]**

Question Number	Scheme	Marks
4. (a)	$x^2 + y^2 + 4x - 2y - 11 = 0$	
	$\left\{\underline{(x+2)^2 - 4} + \underline{\underline{(y-1)^2 - 1}} - 11 = 0\right\}$	M1
	Centre is $(-2, 1)$.	A1 cao
		(2)
(b)	$(x+2)^2 + (y-1)^2 = 11 + 1 + 4$	M1
	So $r = \sqrt{11+1+4} \Rightarrow r = 4$	A1
		(2)
(c)	When $x = 0$, $y^2 - 2y - 11 = 0$	M1 A1 aef
	$y = \dfrac{2 \pm \sqrt{(-2)^2 - 4(1)(-11)}}{2(1)}$ $\left\{ = \dfrac{2 \pm \sqrt{48}}{2} \right\}$	M1
	So, $y = 1 \pm 2\sqrt{3}$	A1 cao cso
		(4) **[8]**
5. (a)	$(8-3)^2 + (3-1)^2$ or $\sqrt{(8-3)^2 + (3-1)^2}$	M1 A1
	$(x \pm 3)^2 + (y \pm 1)^2 = k$ or $(x \pm 1)^2 + (y \pm 3)^2 = k$ (k a positive <u>value</u>)	M1
	$(x-3)^2 + (y-1)^2 = 29$	A1
		(4)
(b)	Gradient of radius = $\dfrac{2}{5}$ (or exact equivalent)	B1
	Gradient of tangent = $\dfrac{-5}{2}$	M1
	$y - 3 = \dfrac{-5}{2}(x - 8)$	M1 A1 ft
	$5x + 2y - 46 = 0$ or equivalent	A1
		(5) **[9]**

Question Number	Scheme	Marks
6. (a)	$x = \frac{\log 0.8}{\log 8}$ or $\log_8 0.8$, $= -0.107$	M1 A1
		(2)
(b)	$2\log x = \log x^2$	B1
	$\log x^2 - \log 7x = \log \frac{x^2}{7x}$	M1
	"Remove logs" to form equation in *x*, using the base correctly:	
	$\frac{x^2}{7x} = 3$	M1
	$x = 21$	A1cso
		(4)
		[6]
7. (a)	$2\log_3(x-5) = \log_3(x-5)^2$	B1
	$\log_3(x-5)^2 - \log_3(2x-13) = \log_3 \frac{(x-5)^2}{2x-13}$	M1
	$\log_3 3 = 1$ seen or used correctly	B1
	$\log_3\left(\frac{P}{Q}\right) = 1 \Rightarrow P = 3Q$ $\left\{\frac{(x-5)^2}{2x-13} = 3 \Rightarrow (x-5)^2 = 3(2x-13)\right\}$	M1
	$x^2 - 16x + 64 = 0$ (*)	A1 cso
		(5)
(b)	$(x-8)(x-8) = 0 \Rightarrow x = 8$	M1 A1
		(2)
		[7]

Question Number	Scheme	Marks
8. (a)	$(h=)\dfrac{60}{\pi x^2}$ or exact equivalent	B1
		(1)
(b)	$(A=)2\pi x^2+2\pi xh$ or $(A=)2\pi r^2+2\pi rh$ or $(A=)2\pi r^2+\pi dh$	B1
	Either $(A)=2\pi x^2+2\pi x\left(\dfrac{60}{\pi x^2}\right)$ or As $\pi xh=\dfrac{60}{x}$	M1
	then $(A=)2\pi x^2+2\left(\dfrac{60}{x}\right)$	
	$A=2\pi x^2+\left(\dfrac{120}{x}\right)$ *	A1 cso
		(3)
(c)	$(\dfrac{dA}{dx})=4\pi x-\dfrac{120}{x^2}$ or $=4\pi x-120x^{-2}$	M1 A1
	$4\pi x-\dfrac{120}{x^2}=0$ implies $x^3=$	M1
	$x=\sqrt[3]{\dfrac{120}{4\pi}}$	dM1 A1
		(5)
(d)	$A=2\pi(2.12)^2+\dfrac{120}{2.12}$, $=85$	M1 A1
		(2)
(e)	$\dfrac{d^2A}{dx^2}=4\pi+\dfrac{240}{x^3}$ and sign considered	M1
	which is > 0 and therefore minimum	A1
		(2)
		[11]

Question Number	Scheme	Marks
9. (a)	$\sin(2\theta-30)=-0.6$ or $2\theta-30=-36.9$ or implied by 216.9	B1
	$2\theta-30=216.87$ = (180 + 36.9)	M1
	$\theta=\dfrac{216.87+30}{2}=123.4$ or 123.5	A1
	$2\theta-30=360-36.9$ or 323.1	M1
	$\theta=\dfrac{323.1+30}{2}=176.6$	A1
		(5)
(b)	$9\cos^2 x-11\cos x+3(1-\cos^2 x)=0$ or $6\cos^2 x-11\cos x+3(\sin^2 x+\cos^2 x)=0$	M1
	$6\cos^2 x-11\cos x+3=0$ {as $(\sin^2 x+\cos^2 x)=1$}	A1
	$(3\cos x-1)(2\cos x-3)=0$ implies cos x =	M1
	$\cos x=\dfrac{1}{3},\ \left(\dfrac{3}{2}\right)$	A1
	$x=70.5$	B1
	$x=360-\text{"}70.5\text{"}$	M1
	$x=289.5$	A1cao
		(7) **[12]**

Examiner reports

Question 1

Part (a) was answered correctly by the majority of candidates, although 4.00 (or 4) was sometimes given instead of 4.01 as the third missing value in the table.

The trapezium rule was often accurately used in part (b), although using n in $\left(\dfrac{b-a}{n}\right)$ as the number of ordinates instead of the number of intervals was again a common mistake. Some candidates left out the main brackets and multiplied only the first two terms by $0.5h$. Others wrongly included 1 and/or 5 in the bracket to be doubled. Just a few ignored the demand for the trapezium rule and attempted the integration by 'calculus'.

Question 2

Most candidates expanded the brackets correctly and most collected to three terms although a significant number then reversed the signs before integrating. A few candidates differentiated or tried to integrate without expanding first but the majority scored the M mark here. Most substituted the correct limits and subtracted correctly, although those who evaluated f(4) and f(–1) separately often made errors in subtracting. A common mistake was the substitution of 1 instead of –1. A few split the area into two parts –1 to 0 and 0 to 4. The fraction work and the inability to cope with a negative raised to a power (here and in other questions) is quite a concern. Many candidates completed correctly and this question was reasonably well done.

Question 3

Part (a) was well answered with most candidates gaining the mark for establishing the profit in 2016 correctly. The majority used the nth term although some listed the first 4 terms to show the result.

In part (b), many candidates adopted a correct approach using logarithms and established a value for their n or $n - 1$ but then did not give an answer in the context of the question, i.e. did not use their value of n to establish a calendar year. Those who did go on to find a year were sometimes confused as to which year their value of n implied. A significant number of candidates opted to take a 'trial and improvement' approach by experimenting with different values of n. While such methods can gain credit, candidates must be aware that they must show evidence of sufficient work to earn the marks. In this case, examiners would be expecting to see a value of n that gave the year before the profit exceeded £200 000 together with the value of n that gave the year after the profit exceeded £200 000 along with the associated profits. For this kind of approach, if the candidate then went on to identify the correct calendar year, full marks are possible. In this part, some candidates misinterpreted the question as requiring the year when the **sum** of the profits exceeded £200 000.

In part (c), a large number of candidates used the incorrect value of n in the correct sum formula. The use of $n = 10$ was the most common incorrect value.

Question 4

Most candidates attempted this question with varying degrees of success. Those candidates who completed the square correctly tended to gain full marks in parts (a) and (b). Some candidates who arrived at the correct equation for the circle then gave the coordinates of the centre with the signs the wrong way round i.e. $(2, -1)$.

Some candidates realised that they needed to have $(x+2)^2$ and $(y-1)^2$ but failed to subtract a constant term when completing the square. These candidates usually gave $\sqrt{11}$ as the radius. Others added the constants when completing the square and obtained $r=\sqrt{6}$, or did not square the constants and obtained either $r=\sqrt{14}$ or $r=\sqrt{8}$. Some candidates incorrectly squared the 1 from the *y* bracket to give $1^2=2$.

Some candidates failed to complete the square correctly and factorised *x* and *y* to get $x(x+4)+y(y-2)=11$ leading to answers of $(-4, 2)$ for centre and $\sqrt{11}$ for radius.

A small minority of candidates who compared $x^2+y^2+4x-2y-11=0$ with $x^2+y^2+2gx+2fy+c=0$ were usually successful in answering parts (a) and (b).

In some instances, part (c) was completed more successfully than parts (a) and (b). A notable number of candidates achieved full marks in (c) by using the equation given on the question paper having gained no marks in parts (a) and (b). Many candidates understood that intersections with the *y*-axis can be found by substituting $x=0$, although a significant minority substituted $y=0$ into their circle equation. When substituting $x=0$ it was preferable for candidates to use the original form of the equation - thus avoiding any errors they had introduced in manipulation for parts (a) and (b). Those that used the squared form of the equation of the circle on occasion substituted $(x+2)^2$ as 0 rather than just *x*.

Many candidates solved the resulting equation either by use of the formula or by completing the square, although a number of those who completed the square omitted one of the two exact solutions. A minority of candidates did not give their answer in a simplified surd form.

A very small minority of candidates attempted part (c) by drawing a diagram showing the circle in relation to the axes, followed by a solution involving Pythagoras.

Question 5

In part (a), most candidates were able to gain the first two marks for attempting to find the radius. The form of equation for a circle was generally well known, but occasionally radius and diameter were confused. A few candidates felt that a mid-point calculation was required at some stage of the working and a few offered $(x-3)^2+(x-1)^2=29$ as the circle equation.

Part (b) was less well done than part (a) but most candidates made some progress. There were a few who could not accurately calculate the gradient of the radius, then others who did not seem to realise that the tangent was perpendicular to the radius. Candidates would have found a simple sketch beneficial here. Those who tried to find the gradient by differentiating the equation of the circle were almost always unsuccessful, since methods such as implicit differentiation were not known. The final mark was often lost through careless arithmetical errors or failure to understand the term integer. Good candidates, however, often produced concise, fully correct solutions to this question.

Question 6

Answers to part (a) were usually correct, although a surprising number of candidates seemed to think that –0.11 (rather than –0.107) was a 3 significant figure answer.

Part (b) caused many problems and highlighted the fact that the theory of logarithms is often poorly understood at this level. While many candidates scored a mark for expressing 2log *x* as

$\log x^2$, some wrote $2\log x - \log 7x = 2\log\left(\frac{x}{7x}\right)$. A very common mistake was to proceed from the correct equation $\log_3\left(\frac{x^2}{7x}\right) = 1$ to the equation $\frac{x^2}{7x} = 1$, using the base incorrectly.

Candidates who resorted to changing the base sometimes lost accuracy by using their calculator. Weaker candidates frequently produced algebra that was completely unrecognisable in the context of logarithms, and even good candidates were seen to jump from $\log x^2 - \log 7x = 1$ to the quadratic equation $x^2 - 7x - 1 = 0$. Amongst those who scored full marks, it was rare but gratifying to see a justification of the invalidity of the 'solution' $x = 0$.

Question 7

In part (a), while some candidates showed little understanding of the theory of logarithms, others produced excellent solutions. The given answer was probably helpful here, giving confidence in a topic that seems to be demanding at this level. It was important for examiners to see full and correct logarithmic working and incorrect statements such as $\log(x-5)^2 - \log(2x-13) = \frac{\log(x-5)^2}{\log(2x-13)}$ were penalised, even when there was apparent 'recovery' (helped by the given answer). The most common reason for failure was the inability to deal with the 1 by using $\log_3 3$ or an equivalent approach.

From $\log_3 \frac{(x-5)^2}{(2x-13)} = 1$, it was good to see candidates using the base correctly to obtain $\frac{(x-5)^2}{(2x-13)} = 3^1$, from which the required equation followed easily.

Even those who were unable to cope with part (a) often managed to understand the link between the parts and solve the quadratic equation correctly in part (b). It was disappointing, however, that some candidates launched into further logarithmic work.

Question 8

Numerous candidates found this question difficult but 18% achieved full marks. Weaker candidates sometimes managed no more than 2 marks (for differentiation). 28% achieved only zero, one or two marks out of the thirteen available.

In part (a) most candidates knew the formula for the volume of a cylinder but some were unable to make *h* the subject.

In part (b), those candidates who were able to write down an expression for the surface area in terms of two circles and a rectangle (of length equal to the circumference) were usually able to go on to gain all 3 marks. However, many candidates did not realise that this was the way to approach this part of the question, often seemingly trying to work back from the answer, but then showing insufficient working to convince that they were using the area of the two circles and the rectangle as required. The formula $S = 2\pi r^2 + \frac{2V}{r}$ was sometimes seen, but this was only accepted if it had been properly derived as the $\frac{2V}{r}$ is not obvious and the answer was printed. Some also started from an incorrect formula, $S = 2\pi x^2 + (2)\pi x^2 h$ being seen quite frequently, followed by mistakes in cancellations to achieve the required result.

Presentation was sometimes a problem, especially for those who confused a multiplication sign with the letter x.

Part (c) required the use of calculus and no marks were available for correct answers obtained by trial and error or by graphical means. Given the formula for the surface area, most candidates were able to differentiate it and equate it to zero. The negative power in the resulting equation caused some candidates problems but many were able to end with an equation in x cubed which they cube- rooted to obtain x, the radius. Two common errors at this stage were to find the cube root of 30π instead of $\frac{30}{\pi}$ and to square root rather than cube root. Some candidates used inequalities as their condition for a stationary value rather than equating their derivative to zero, and could only score two of the marks available for part (c). Other candidates differentiated twice and solved $\frac{\mathrm{d}^2A}{\mathrm{d}x^2}$ = 0, which was also an incorrect method.

Part (d) was omitted by quite a few candidates. A high number of candidates however successfully substituted their value for x into their equation for the surface area although a number lost the final mark because they did not give the correct value as an integer. For some candidates, this was the only mark they lost on this question.

Almost all candidates attempted part (e), with most sensibly choosing to demonstrate that the second differential was positive, rather than other acceptable methods such as considering the gradient. Of the candidates using the second derivative method, those who lost marks on this part had usually differentiated the second term incorrectly although there was sometimes confusion over exactly what had to be positive for a minimum. Some weaker candidates considered the sign of A here, "85 > 0, therefore minimum" being quite often seen. Others confused the 85 with the value for x and substituted $x = 85$ into their second derivative. Some stronger candidates could see that the second derivative was positive for all values of x and made a clear conclusion to show the minimum.

Question 9

The majority of candidates were able to make a good attempt at this question and many gained full marks. Where candidates were less successful, part (a) was less well done that part (b).

Several candidates did not realise that they needed to obtain sin $(2\theta - 30) = -0.6$ to start this question. Some candidates expanded the bracket in (a) and others solved to find θ as –3.4 but then made no further progress. Occasionally candidates who had correct values for $(2\theta - 30)$ made the common error of dividing by 2 before adding 30. Of those who only found one of the two solutions, it was most common for them to find 176.6, often not using the method on the mark scheme, but obtaining the –3.4 before using the sine graph or a CAST diagram.

In part (b) candidates regularly obtained the correct quadratic but there were some errors is factorising and solving, with cos $x = \frac{2}{3}$ and $\frac{1}{3}$ being the most common incorrect answer. A few candidates gave just one value of x as 70.5 without calculating the second value, whilst a few gave extra answers of $180 - x$ and $180 + x$, or of $270 + x$ and $270 - x$. It was interestingly very rare for candidates to work in radians in this question.

Statistics for C2 Practice Paper Silver Level S4

Qu	Max score	Modal score	Mean %	Mean score for students achieving grade: ALL	A*	A	B	C	D	E	U
1	6		80	4.81	5.89	5.75	5.48	5.11	4.72	4.09	2.81
2	5		78	3.90		4.65	4.23	3.87	3.27	2.76	1.54
3	9		68	6.16	8.48	7.56	6.47	5.91	5.06	4.38	2.94
4	8		59	4.70	7.77	7.25	5.99	4.71	3.46	2.29	0.77
5	9		62	5.61		8.25	7.10	5.90	4.35	2.76	0.93
6	6		62	3.72		5.43	4.45	3.68	2.95	2.29	1.20
7	7		61	4.30	6.86	6.55	5.61	4.48	3.27	2.15	0.79
8	13		54	7.04	12.59	11.74	9.37	6.76	4.50	2.79	0.92
9	12		80	9.61	11.93	11.52	10.54	8.98	7.36	4.56	2.21
	75		**66**	**49.85**		**68.70**	**59.24**	**49.40**	**38.94**	**28.07**	**14.11**