Paper Reference(s)

6664/01

Edexcel GCE

Core Mathematics C2
Silver Level S2

Time: 1 hour 30 minutes

Materials required for examination papers	**Items included with question papers**
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	56	49	42	35

1. Find the first 3 terms, in ascending powers of x, of the binomial expansion of

$$(2 - 3x)^5,$$

giving each term in its simplest form.

(4)

May 2012

2.
$$f(x) = 3x^3 - 5x^2 - 58x + 40.$$

(a) Find the remainder when f (x) is divided by ($x - 3$) .

(2)

Given that ($x - 5$) is a factor of f(x) ,

(b) find all the solutions of f(x) = 0 .

(5)

June 2010

3.
$$f(x) = 2x^3 - 5x^2 + ax + 18$$

where a is a constant.

Given that ($x - 3$) is a factor of f(x),

(a) show that $a = -9$,

(2)

(b) factorise f(x) completely.

(4)

Given that

$$g(y) = 2(3^{3y}) - 5(3^{2y}) - 9(3^y) + 18,$$

(c) find the values of y that satisfy g(y) = 0, giving your answers to 2 decimal places where appropriate.

(3)

May 2013

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4. (*a*) Show that the equation

$$3\sin^2\theta - 2\cos^2\theta = 1$$

can be written as

$$5\sin^2\theta = 3.$$

(2)

(*b*) Hence solve, for $0° \leq \theta < 360°$, the equation

$$3\sin^2\theta - 2\cos^2\theta = 1,$$

giving your answer to 1 decimal place.

(7)

January 2008

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5. The circle C has equation

$$x^2 + y^2 - 20x - 24y + 195 = 0.$$

The centre of C is at the point M.

(*a*) Find

(i) the coordinates of the point M,

(ii) the radius of the circle C.

(5)

N is the point with coordinates (25, 32).

(*b*) Find the length of the line MN.

(2)

The tangent to C at a point P on the circle passes through point N.

(*c*) Find the length of the line NP.

(2)

January 2013

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6. $$f(x) = x^4 + 5x^3 + ax + b,$$

where a and b are constants.

The remainder when $f(x)$ is divided by $(x - 2)$ is equal to the remainder when $f(x)$ is divided by $(x + 1)$.

(a) Find the value of a.

(5)

Given that $(x + 3)$ is a factor of $f(x)$,

(b) find the value of b.

(3)

January 2009

7.

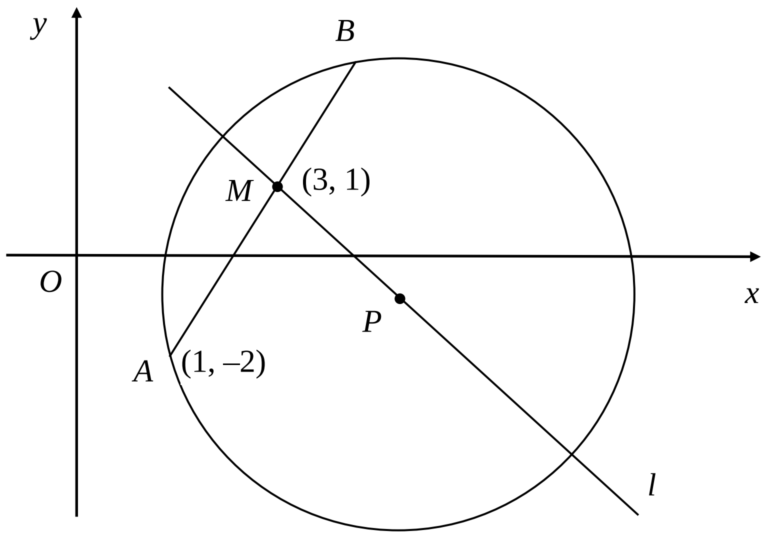

Figure 3

The points A and B lie on a circle with centre P, as shown in Figure 3.
The point A has coordinates $(1, -2)$ and the mid-point M of AB has coordinates $(3, 1)$.
The line l passes through the points M and P.

(a) Find an equation for l.

(4)

Given that the x-coordinate of P is 6,

(b) use your answer to part (a) to show that the y-coordinate of P is -1,

(1)

(c) find an equation for the circle.

(4)

May 2007

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8. (*a*) Sketch the graph of $y = 7^x$, $x \in \mathbb{R}$, showing the coordinates of any points at which the graph crosses the axes.

(2)

(*b*) Solve the equation

$$7^{2x} - 4(7^x) + 3 = 0,$$

giving your answers to 2 decimal places where appropriate.

(6)

January 2011

9.

Figure 4

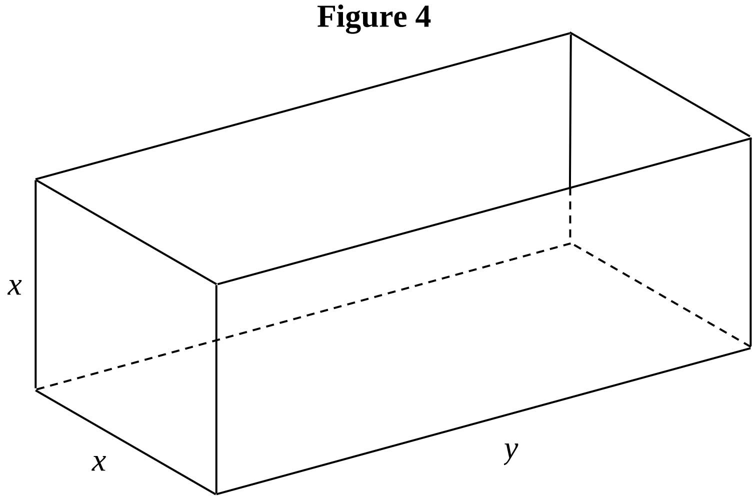


Figure 4 shows an open-topped water tank, in the shape of a cuboid, which is made of sheet metal. The base of the tank is a rectangle x metres by y metres. The height of the tank is x metres.

The capacity of the tank is 100 m^3.

(*a*) Show that the area $A \text{ m}^2$ of the sheet metal used to make the tank is given by

$$A = \frac{300}{x} + 2x^2.$$

(4)

(*b*) Use calculus to find the value of x for which A is stationary.

(4)

(*c*) Prove that this value of x gives a minimum value of A.

(2)

(*d*) Calculate the minimum area of sheet metal needed to make the tank.

(2)

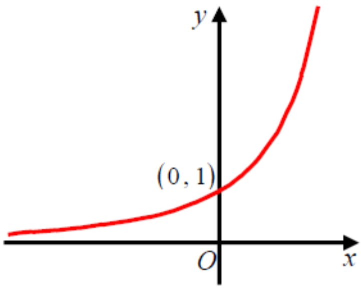
January 2008

TOTAL FOR PAPER: 75 MARKS

END

Question Number	Scheme	Marks
1.	$\left[(2-3x)^5\right] = \ ... \quad + \binom{5}{1}2^4(-3x) + \binom{5}{2}2^3(-3x)^2 + .., \quad ......$	M1
	$= 32, \ -240x, \ +720x^2$	B1 A1 A1 **[4]**
2. (a)	Attempting to find $f(3)$ or $f(-3)$	M1
	$f(3) = 3(3)^3 - 5(3)^2 - (58\times 3) + 40 = 81 - 45 - 174 + 40 = -98$	A1 (2)
(b)	$\{3x^3 - 5x^2 - 58x + 40 = (x-5)\}\ (3x^2 + 10x - 8)$	M1 A1
	Attempt to <u>factorise</u> 3-term quadratic, or to use the quadratic formula (see general principles at beginning of scheme). This mark may be implied by the correct solutions to the quadratic.	M1
	$(3x-2)(x+4) = 0 \qquad x = ...$ <u>or</u> $x = \dfrac{-10 \pm \sqrt{100+96}}{6}$	A1 ft
	$\dfrac{2}{3}$ (or exact equiv.), -4, 5	A1 (5) **[7]**
3. (a)	Attempt $f(3)$ or $f(-3)$	M1
	$f(3) = 54 - 45 + 3a + 18 = 0 \Rightarrow 3a = -27 \Rightarrow a = -9$	A1* cso (2)
(b)	$f(x) = (x-3)(2x^2 + x - 6)$	M1A1
	$= (x-3)(2x-3)(x+2)$	M1A1 (4)
(c)	$\{3^y = 3 \Rightarrow\}\ \underline{y = 1}$ or g(1) = 0	B1
	$\{3^y = 1.5 \Rightarrow\}\log(3^y) = \log 1.5$ or $y = \log_3 1.5$	M1
	$\{y = 0.3690702...\} \Rightarrow y =$ awrt 0.37	A1 (3) **[9]**

Question Number	Scheme	Marks
4. (a)	$3\sin^2\theta - 2\cos^2\theta = 1$	
	$3\sin^2\theta - 2(1-\sin^2\theta) = 1$	M1
	$3\sin^2\theta - 2 + 2\sin^2\theta = 1$	
	$5\sin^2\theta = 3$ cso	A1
		(2)
(b)	$\sin^2\theta = \frac{3}{5}$, so $\sin\theta = (\pm)\sqrt{0.6}$	M1
	Attempt to solve both $\sin\theta = +\ldots$ and $\sin\theta = -\ldots$	M1
	$\theta = 50.7685°$ awrt $\theta = 50.8°$	A1
	$\theta\ (= 180° - 50.7685_c°)$; $= 129.23\ldots°$ awrt $129.2°$	M1; A1
	$\sin\theta = -\sqrt{0.6}$	
	$\theta = 230.785°$ and $309.23152°$ awrt $230.8°$, $309.2°$	M1A1
		(7) **[9]**
5. (a)(i)	The centre is at (10, 12)	B1 B1
(ii)	Uses $(x-10)^2 + (y-12)^2 = -195 + 100 + 144 \Rightarrow r = \ldots$	M1
	Completes the square for both x and y in an attempt to find r. $(x \pm "10")^2 \pm a$ and $(y \pm "12")^2 \pm b$ and $+195 = 0, (a, b \neq 0)$	
	$r = \sqrt{10^2 + 12^2 - 195}$	A1
	$r = 7$	A1
		(5)
(b)	$MN = \sqrt{(25 - "10")^2 + (32 - "12")^2}$	M1
	$MN\left(= \sqrt{625}\right) = 25$	A1
		(2)
(c)	$NP = \sqrt{("25"^2 - "7"^2)}$	M1
	$NP\left(= \sqrt{576}\right) = 24$	A1
		(2) **[9]**
6. (a)	$f(2) = 16 + 40 + 2a + b$ **or** $f(-1) = 1 - 5 - a + b$	M1 A1
	Finds 2nd remainder and equates to 1st $\Rightarrow 16 + 40 + 2a + b = 1 - 5 - a + b$	M1 A1
	$a = -20$	A1cso
		(5)
(b)	$f(-3) = (-3)^4 + 5(-3)^3 - 3a + b = 0$	M1 A1ft
	$81 - 135 + 60 + b = 0$ gives $b = -6$	A1 cso
		(3) **[8]**

Question Number	Scheme	Marks
7. (a)	Gradient of *AM*: $\frac{1-(-2)}{3-1}=\frac{3}{2}$	B1
	Gradient of *l*: $=-\frac{2}{3}$	M1
	$y-1=-\frac{2}{3}(x-3)$ or $\frac{y-1}{x-3}=-\frac{2}{3}$ $\quad [3y=-2x+9]$	M1 A1
		(4)
(b)	$x = 6$: $\quad 3y = -12 + 9 = -3 \quad y = -1$	B1
		(1)
(c)	$(r^2=)\ (6-1)^2+(-1-(-2))^2$	M1 A1
	$(x\pm 6)^2+(y\pm 1)^2=k, \quad k\neq 0$	M1
	$(x-6)^2+(y+1)^2=26$ (oe)	A1
		(4) **[9]**
8. (a)	Graph of $y = 7^x$, $x \in \mathbb{R}$ and solving $7^{2x} - 4(7^x) + 3 = 0$	
		
	At least two of the three criteria correct.	B1
	All three criteria correct.	B1
		(2)
(b)	$y^2 - 4y + 3$ {= 0}	M1 A1
	{ $(y-3)(y-1)=0$ or $(7x-3)(7x-1)=0$ }	A1
	$y = 3, \quad y = 1$ or $7x = 3, \quad 7x = 1$	A1
	$\{7^x=3\Rightarrow\}\ x\log 7=\log 3$	
	or $x=\frac{\log 3}{\log 7}$ or $x=\log_7 3$	dM1
	$x = 0.5645\ldots$	A1
	$x = 0$	B1
		(6) **[8]**

Question Number	Scheme	Marks
9. (a)	(Total area) = $3xy + 2x^2$	B1
	(Vol:) $x^2y = 100$ $\quad (y = \frac{100}{x^2}, xy = \frac{100}{x})$	B1
	Deriving expression for area in terms of x only	M1
	(Area =) $\frac{300}{x} + 2x^2$	A1 cso
		(4)
(b)	$\frac{\mathrm{d}A}{\mathrm{d}x} = -\frac{300}{x^2} + 4x$	M1A1
	Setting $\frac{\mathrm{d}A}{\mathrm{d}x} = 0$ and finding a correct power of x	M1
	$x = 4.2172$ awrt 4.22	A1
		(4)
(c)	$\frac{\mathrm{d}^2A}{\mathrm{d}x^2} = \frac{600}{x^3} + 4$ = positive, > 0; therefore minimum	M1;A1
		(2)
(d)	Substituting found value of x into (a)	M1
	[$y = \frac{100}{4.2172^2} = 5.6228$]	
	Area = 106.707 awrt 107	A1
		(2)
		[12]

Examiner reports

Question 1

This was a straightforward starter question allowing candidates to settle into the paper, with 59% of candidates achieving full marks and only 14% failing to gain at least half marks. Students confidently applied the binomial series and had no problem with binomial coefficients which were usually found using a formula though some candidates simply quoted the 5th line of Pascal's triangle. The most common error was in missing out the brackets around the term in x^2, leading to an incorrect coefficient for this term. Some did not simplify $+ -240x$, and a small proportion of candidates complicated the expansion by taking out a factor of 2^5, which introduced fractions and then involved further simplification at the end. This latter method frequently led to errors. A few wrote the expansion in descending order but most of these gave all the terms and so managed to score full marks.

Question 2

Although many candidates opted for long division rather than the remainder theorem in part (a), most scored the method mark and many accurately achieved the correct value for the remainder.

Long division in part (b) often led to the correct quadratic, which most candidates factorised correctly. Correct factorisation by inspection was seen occasionally, but attempting (by trial and error) to find further solutions by using the factor theorem was rarely successful. Some candidates, having found factors, thought they had finished and did not proceed to give any solutions to the equation. The 'obvious' solution $x = 5$ was sometimes omitted. 'Implicit' solutions such as $f(5) = 0$ were generously allowed on this occasion.

Question 3

The first two parts of this question were very familiar and the vast majority of candidates answered them well, but part (c) was less familiar and proved very challenging for all but the very good candidates.

Part (a) was accessible to almost all students with most taking the route of setting $f(3) = 0$ and solving to get $a = -9$. Very few slips were seen in the evaluation of $f(3)$ and most students who started with this approach gained both marks. The common error of failing to equate the expression to zero explicitly led to many students losing a mark. We saw very few students erroneously using $f(-3)$. Some candidates chose to assume the value $a = -9$ and proceeded to show that $f(3)$ did indeed equate to zero, or by long division showed that the result was a three termed quadratic. However, often such candidates lost the A mark because there was no suitable concluding statement, such as "so $(x - 3)$ is a factor". There were relatively few attempts using "way 3" in the mark scheme, dividing $f(x)$ by $(x - 3)$ to give a remainder in terms of a, and full marks by this approach were rare.

In part (b) students were generally well rehearsed in the methods for fully factorising the cubic equation, with many preferring the long division approach. Some slips were observed in the signs, particularly with the x term. More students remembered to factorise their quadratic compared to previous papers, with most achieving three factors in their final expression. The most common error seen was with the signs when factorising the three-term quadratic. It was rare to see a factor theorem only approach.

In part (c) the question presented real challenge and was a useful tool for differentiating between the weaker and more able students. Those more able who had spotted the link between this part and the previous part of the question generally answered it well, using logs effectively, although a significant number lost the last mark by giving a solution for $3^y = –2$.

However, a large number of candidates did not spot the link between f(x) and g(y) and hence attempted to solve g(y) = 0 by many inappropriate and ineffectual methods, and poor simplification such as $2(3^{3y}) = 6^{3y}$ was often seen. One mark was often salvaged for the solution $y = 1$, found usually by spotting that g(1) = 0, although it sometimes emerged from wrong work, such as $3y = 3$, rather than $3^y = 3$.

Question 4

For the majority of candidates part (a) produced 2 marks, but part (b) was variable. Good candidates could gain full marks in part (b) in a few lines but the most common solution, scoring a maximum of 4 marks, did not consider the negative value of sin θ. There were many poorly set out solutions and in some cases it was difficult to be sure that candidates deserved the marks given; a statement such as $5\sin^2\theta = 3 \Rightarrow \sin\theta = \frac{\sqrt{3}}{\sqrt{5}}$, so $\theta = 50.8^\circ, 309.2^\circ$, could be incorrect thinking, despite having two of the four correct answers.

Question 5

Many candidates were successful in finding the centre and radius of a circle in part (a). Completing the square was often done accurately leading to the correct centre and radius. Errors that were seen involved centres of, (–10, –12) or (20, 24) and some errors in the rearrangement in attempting to find the radius.

Part (b) was probably equally well answered with the majority of candidates able to use Pythagoras successfully.

Part (c) was found more challenging by candidates. Candidates who drew a diagram were more successful and spotted the need to use Pythagoras again although many had *NP* as the hypotenuse.

Question 6

In part (a) most who used the remainder theorem correctly used f(2) and f(–1) and scored M1A1 usually for $16 + 40 + 2a + b$, the (–1)^4 often causing problems. A large number of candidates then mistakenly equated each to zero and solved the equations simultaneously, obtaining $a = –20$ and ignoring $b = –16$ so that they could go on in part (b) to use f(–3) = 0 to obtain $b = –6$.

Those who equated f(2) to f(–1), as required, usually completed to find a although there were many careless errors here. Some candidates worked with f(2) – f(–1) and then equated to zero but not always very clearly.

The candidates using long division often made a small error, which denied most of the marks available:

- Omission of the "$0x^2$" term as a place-holder from the dividend resulted in much confusion.
- Failure to pursue the division until they had reached the constant term gave equations of the "remainders" still containing x.
- The almost inevitable habit of subtracting negative terms wrongly (e.g. $5x^2 – (–2x^2) = 3x^2$).

They usually made little progress, and penalised themselves by the excessive time taken to do the complicated algebra required.

In part (b) again the remainder theorem method scored better than the long division method. Most candidates who reached $a = -20$ obtained the correct value for b, but there was some poor algebra, with the powers of -3 causing problems for some. A few used f(3) instead of f(–3) and a number did not set their evaluation equal to zero.

Question 7

In general, this question was very well done with many candidates scoring full marks.

Part (a) was usually correct, with most candidates realising that the required straight line l had to be perpendicular to the given chord. Some candidates unnecessarily found the coordinates of the point B, using a mid-point formula. Others, again unnecessarily, found the equation of the line AB. For most, part (b) provided useful verification of the accuracy of their equation of l, but a few persisted with a wrong y-coordinate for P despite $y = -1$ being given.

Those who failed in the first two parts of the question were still able to attempt the equation of the circle in part (c). This part was, however, where many lost marks. A common mistake was to calculate the length of PM and to use this as the radius of the circle, and even those who correctly identified PA as the radius sometimes made careless sign errors in their calculations. Some candidates knew the formula $(x-a)^2 + (y-b)^2 = r^2$ but seemed unsure of how to use it, while others gave a wrong formula such as $(x-a)^2 - (y-b)^2 = r^2$ or $(x-a)^2 + (x-b)^2 = r^2$ or $(x-a) + (y-b) = r^2$. The point (3, 1) was sometimes used as the 'centre'.

Question 8

Many good sketches were seen in part (a), with a significant number of candidates constructing a table of x and y-values in order to help them sketch the correct curve. Some candidates had little idea of the shape of the curve, whilst others omitted this part completely and a significant number failed to show the curve for $x < 0$. For $x < 0$, some candidates believed the curve levelled off to give $y = 1$, whilst others showed the curve cutting through the x-axis. Many candidates were able to state the correct y-intercept of $(0, 1)$, but a few believed the intercept occurred at $(0, 7)$.

Responses to part (b) varied considerably with a number of more able candidates unable to produce work worthy of any credit. A significant number of candidates incorrectly took logs of each term to give the incorrect result of $2x\log 7 - x\log 28 + \log 3 = 0$. Some candidates provided many attempts at this part with many of them failing to appreciate that 7^{2x} is equivalent to $(7^x)^2$ and so they were not able to spot the quadratic equation in 7^x. Those candidates who wrote down the correct quadratic equation of $y^2 - 4y + 3 = 0$ proceeded to gain full marks with ease, but sometimes final answers were left as 3 and 1. Some candidates wrote down incorrect quadratic equations such as $7y^2 - 4y + 3 = 0$ or $7y^2 - 28y + 3 = 0$. Notation was confusing at times, especially where the substitution $x = 7^x$ appeared.

Question 9

For the better candidates this was a very good source of marks, but it proved quite taxing for many of the candidates who were able to spend time on the question. In part (a) the $2x^2$ term in the given answer was usually produced but the work to produce $\frac{300}{x}$ was often unconvincing, and it was clear that the given answer, which was an aid for subsequent parts, enabled many candidates to gain marks that otherwise would have been lost. It was common to see steps retraced to correct an initial wrong statement, such as $A = 2x^2 + 4xy$, but sometimes the resulting presentation was not very satisfactory and often incomplete, and the ability to translate "the capacity of the tank is 100m^3" into an algebraic equation was quite often lacking.

In part (b) the two most common errors were in differentiating $\frac{300}{x}$, often seen as 300 or –300, and in solving the correct equation $-\frac{300}{x^2} + 4x = 0$. It was surprising, too, to see so many candidates who, having successfully reached the stage $4x^3 = 300$, gave the answer $x = 8.66$, i.e. $\sqrt{75}$.

In part (c) the most common approach, by far, was to consider $\frac{d^2A}{dx^2}$, and although the mark scheme was kind in some respects, it was expected that the sign, rather than just the value, of $\frac{d^2A}{dx^2}$ was commented upon.

The method mark in the final part was usually gained although there was a significant minority of candidates who substituted their value of $\frac{d^2A}{dx^2}$, rather than their answer to part (b), into the expression for A.

Statistics for C2 Practice Paper Silver Level S2

Qu	Max score	Modal score	Mean %	ALL	A*	A	B	C	D	E	U
				Mean score for students achieving grade:							
1	4		80	3.21	3.95	3.82	3.62	3.41	3.13	2.76	1.76
2	7		79	5.50	6.89	6.70	6.37	6.02	5.39	4.61	2.59
3	9		69	6.23	8.75	8.12	7.12	6.43	5.81	5.10	3.34
4	9		65	5.87		7.83	6.59	5.89	4.84	3.68	1.88
5	9		72	6.52	8.90	8.28	7.15	6.07	5.18	3.94	1.76
6	8		71	5.69		7.30	6.20	5.29	4.32	3.53	2.23
7	9		66	5.97		8.44	7.50	6.44	5.10	3.71	1.43
8	8		64	5.09	7.74	7.12	5.65	4.41	3.29	2.45	1.32
9	12		63	7.57		11.29	9.21	6.64	4.33	3.09	1.20
	75		**69**	**51.65**		**68.90**	**59.41**	**50.60**	**41.39**	**32.87**	**17.51**