Paper Reference(s)

6664/01

Edexcel GCE

Core Mathematics C2

Bronze Level B2

Time: 1 hour 30 minutes

Materials required for examination	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 10 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
74	69	63	57	49	42

1. Find the first 4 terms, in ascending powers of x, of the binomial expansion of

$$\left(1+\frac{3x}{2}\right)^8$$

giving each term in its simplest form.

(4)

May 2016 (R)

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2. (a) Find the remainder when

$$x^3 - 2x^2 - 4x + 8$$

is divided by

(i) $x - 3$,

(ii) $x + 2$.

(3)

(*b*) Hence, or otherwise, find all the solutions to the equation

$$x^3 - 2x^2 - 4x + 8 = 0.$$

(4)

January 2008

3.

$$y = \sqrt{(10x - x^2)}.$$

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

x	1	1.4	1.8	2.2	2.6	3
y	3	3.47			4.39	

(2)

(*b*) Use the trapezium rule, with all the values of y from your table, to find an approximation for the value of $\int_1^3 \sqrt{(10x - x^2)}\ \mathrm{d}x$.

(4)

January 2009

4.

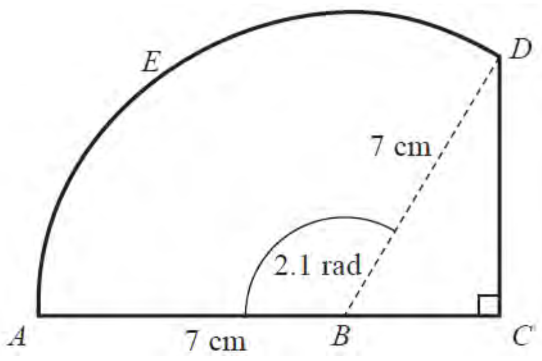

Figure 1

Figure 1 shows the shape *ABCDEA* which consists of a right-angled triangle *BCD* joined to a sector *ABDEA* of a circle with radius 7 cm and centre *B*.

A, *B* and *C* lie on a straight line with *AB* = 7 cm.

Given that the size of angle *ABD* is exactly 2.1 radians,

(*a*) find, in cm, the length of the arc *DEA*,

(2)

(*b*) find, in cm, the perimeter of the shape *ABCDEA*, giving your answer to 1 decimal place.

(4)

May 2014 (R)

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5. The third term of a geometric sequence is 324 and the sixth term is 96.

(*a*) Show that the common ratio of the sequence is $\frac{2}{3}$.

(2)

(*b*) Find the first term of the sequence.

(2)

(*c*) Find the sum of the first 15 terms of the sequence.

(3)

(*d*) Find the sum to infinity of the sequence.

(2)

June 2009

6.

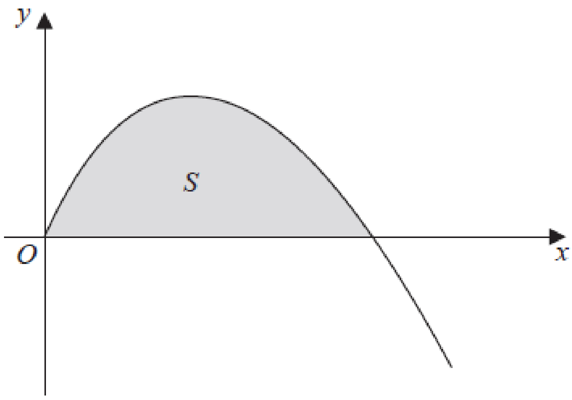

Figure 2

Figure 2 shows a sketch of part of the curve with equation

$$y = 3x - x^{\frac{3}{2}} \qquad x \geq 0\,.$$

The finite region S, bounded by the x-axis and the curve, is shown shaded in Figure 2.

(a) Find

$$\int \left(3x - x^{\frac{3}{2}}\right) \mathrm{d}x\,.$$

(3)

(b) Hence find the area of S.

(3)

May 2016

7.

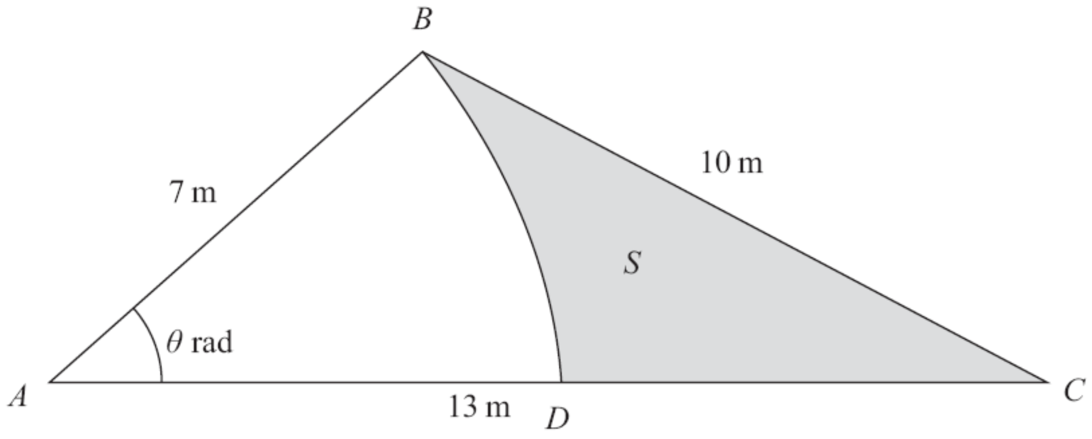

Figure 3

Figure 3 shows the design for a triangular garden ABC where AB = 7 m, AC = 13 m and BC = 10 m.

Given that angle $BAC = \theta$ radians,

(*a*) show that, to 3 decimal places, $\theta = 0.865$

(3)

The point D lies on AC such that BD is an arc of the circle centre A, radius 7 m.

The shaded region S is bounded by the arc BD and the lines BC and DC. The shaded region S will be sown with grass seed, to make a lawned area.

Given that 50 g of grass seed are needed for each square metre of lawn,

(*b*) find the amount of grass seed needed, giving your answer to the nearest 10 g.

(7)

May 2013 (R)

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8. (*a*) Show that the equation

$$4 \sin^2 x + 9 \cos x - 6 = 0$$

can be written as

$$4 \cos^2 x - 9 \cos x + 2 = 0.$$

(2)

(*b*) Hence solve, for $0 \leq x < 720°$,

$$4 \sin^2 x + 9 \cos x - 6 = 0,$$

giving your answers to 1 decimal place.

(6)

January 2009

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9. The curve C has equation $y = 6 - 3x - \dfrac{4}{x^3}$, $x \neq 0$.

(*a*) Use calculus to show that the curve has a turning point P when $x = \sqrt{2}$.

(4)

(*b*) Find the x-coordinate of the other turning point Q on the curve.

(1)

(*c*) Find $\dfrac{d^2y}{dx^2}$.

(1)

(*d*) Hence or otherwise, state with justification, the nature of each of these turning points P and Q.

(3)

January 2013

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10. The points A and B have coordinates (–2, 11) and (8, 1) respectively.

Given that AB is a diameter of the circle C,

(*a*) show that the centre of C has coordinates (3, 6),

(1)

(*b*) find an equation for C.

(4)

(*c*) Verify that the point (10, 7) lies on C.

(1)

(*d*) Find an equation of the tangent to C at the point (10, 7), giving your answer in the form $y = mx + c$, where m and c are constants.

(4)

January 2011

TOTAL FOR PAPER: 75 MARKS

END

Question number	Scheme	Marks
1	$\left(1+\frac{3x}{2}\right)^8$	
	$1+12x$	B1
	$\ldots+\frac{8(7)}{2!}\left(\frac{3x}{2}\right)^2+\frac{8(7)(6)}{3!}\left(\frac{3x}{2}\right)^3+\ldots$	M1
	$\ldots+{}^8C_2\left(\frac{3x}{2}\right)^2+{}^8C_3\left(\frac{3x}{2}\right)^3+\ldots$	
	$\ldots+63x^2+189x^3+\ldots$	A1A1
		[4]
2 (a)(i)	f (3) = $3^3 - 2\times3^2 - 4\times3+8$; = 5	M1; A1
	f (−2) = (−8 − 8 + 8 + 8) = 0	A1
	M1 is for attempt at **either** f (3) or f (−3) in (i) **or** f (2) or f(−2) in (ii)	**(3)**
(b)	[$(x+2)$] (x^2-4x+4) (= 0 not required) [must be seen or used in (b)]	M1 A1
	$(x+2)(x-2)^2$ (= 0) (can imply previous 2 marks)	M1
	Solutions: x = 2 or −2 (both) or (−2, 2, 2) **[no wrong working seen]**	A1
		(4)
		[7]
3 (a)	3.84, 4.14, 4.58 (Any one correct B1 B0. All correct B1 B1)	B1 B1
		(2)
(b)	$\frac{1}{2}\times0.4,\ \left\{(3+4.58)+2\left(3.47+3.84+4.14+4.39\right)\right\}$	B1, M1 A1ft
	= 7.852 (awrt 7.9)	A1
		(4)
		[6]

Question number	Scheme	Marks
4 (a)	Length $DEA = 7(2.1) = 14.7$	M1A1 **(2)**
(b)	Angle $CBD = \pi - 2.1$	M1
	Both $7\cos(\pi - 2.1)$ **and** $7\sin(\pi - 2.1)$ or **Both** $7\cos(\pi - 2.1)$ **and** $\sqrt{7^2 - \left(7\cos(\pi - 2.1)\right)^2}$ or **Both** $7\sin(\pi - 2.1)$ **and** $\sqrt{7^2 - \left(7\sin(\pi - 2.1)\right)^2}$ **Or equivalents to these**	dM1
	$P = 7\cos(\pi - 2.1) + 7\sin(\pi - 2.1) + 7 + 14.7$	ddM1
	$= 31.2764...$ Awrt 31.3	A1 **(4)**
		[6]
5 (a)	$324r^3 = 96$ or $r^3 = \frac{96}{324}$ or $r^3 = \frac{8}{27}$	M1
	$r = \frac{2}{3}$ (*)	A1cso **(2)**
(b)	$a\left(\frac{2}{3}\right)^2 = 324$ or $a\left(\frac{2}{3}\right)^5 = 96$ $a = ...,$ 729	M1; A1 **(2)**
(c)	$S_{15} = \frac{729\left(1 - \left[\frac{2}{3}\right]^{15}\right)}{1 - \frac{2}{3}}, \quad = 2182.00\ldots$ (AWRT 2180)	M1A1ft **(3)**
(d)	$S_\infty = \frac{729}{1 - \frac{2}{3}}, \quad = 2187$	M1, A1 **(2)**
		[9]

Question number	Scheme	Marks
6 (a)	$\left\{\int\left(3x - x^{\frac{3}{2}}\right)\mathrm{d}x\right\} = \frac{3x^2}{2} - \frac{x^{\frac{5}{2}}}{\left(\frac{5}{2}\right)}\ \{+c\}$	M1 A1 A1 **(3)**
(b)	$0 = 3x - x^{\frac{3}{2}} \Rightarrow 0 = 3 - x^{\frac{1}{2}}$ or $0 = x\left(3 - x^{\frac{1}{2}}\right) \Rightarrow x = ...$	M1
	$\left\{\text{Area}(S) = \left[\frac{3x^2}{2} - \frac{2}{5}x^{\frac{5}{2}}\right]_0^9\right\}$	
	$= \left(\frac{3(9)^2}{2} - \left(\frac{2}{5}\right)(9)^{\frac{5}{2}}\right) - \{0\}$	ddM1
	$\left\{= \left(\frac{243}{2} - \frac{486}{5}\right) - \{0\}\right\} = \frac{243}{10}$ or 24.3	A1 oe
		(3)
		[6]
7 (a)	$10^2 = 7^2 + 13^2 - 2\times7\times13\cos\theta$ or $\cos\theta = \frac{7^2+13^2-10^2}{2\times7\times13}$	M1
	$\cos\theta = \frac{59}{91}$ or $\cos\theta = \frac{7^2+13^2-10^2}{2\times7\times13}$ or $\cos\theta = 0.6483$ or 0.8644	A1 o.e
	(θ = 0.8653789549…) = 0.865 * (to 3 dp)	A1* cso
		(3)
(b)	Area triangle $ABC = \frac{1}{2}\times13\times7\sin0.865$ or $\frac{1}{2}\times13\times7\sin49.6$ or $20\sqrt{3}$	M1
	Area sector $ABD = \frac{1}{2}\times7^2\times0.865$ or $\frac{49.6}{360}\times\pi\times7^2$	M1
	=34.6 (triangle) **or** 21.2 (Sector)	A1
	Area of $S = \frac{1}{2}\times13\times7\sin0.865 - \frac{1}{2}\times7^2\times0.865\quad(=13.4)$	M1 A1
	(Amount of seed =) 13.4 x 50 = 670g or 680g (need one of these two answers)	M1 A1
		(7)
		[10]

Question number	Scheme		Marks
8 (a)	$4(1-\cos^2 x)+9\cos x-6=0$ $\quad$ $4\cos^2 x-9\cos x+2=0$		M1 A1
			(2)
(b)	$(4\cos x-1)(\cos x-2)=0$ $\quad$ $\cos x=\ldots,\ \frac{1}{4}$		M1 A1
	$x=75.5 \quad (\alpha)$		B1
	$360-\alpha,\quad 360+\alpha$ or $720-\alpha$		M1, M1
	284.5, 435.5, 644.5		A1
			(6)
			[8]
9 (a)	$y=6-3x-\frac{4}{x^3}$		
	$\frac{dy}{dx}=-3+\frac{12}{x^4}$ *or* $-3+12x^{-4}$	M1: $x^n \to x^{n-1}$ ($x^1 \to x^0$ or $x^{-3} \to x^{-4}$ or $6 \to 0$) A1: Correct derivative	M1 A1
	$\frac{dy}{dx}=0 \Rightarrow -3+\frac{12}{x^4}=0 \Rightarrow x=\ldots$ **or** $\frac{dy}{dx}=-3+\frac{12}{\sqrt{2}^4}$	$y'=0$ and attempt to solve for x May be implied by $\frac{dy}{dx}=-3+\frac{12}{x^4}=0 \Rightarrow \frac{12}{x^4}=3 \Rightarrow x=\ldots$ **or** Substitutes $x=\sqrt{2}$ into their y'	M1
	So $x^4=4$ and $x=\sqrt{2}$ **or** $\frac{dy}{dx}=-3+\frac{12}{\left(\sqrt{2}\right)^4}$ or $-3+12\left(\sqrt{2}\right)^{-4}=0$	Correct completion to answer with no errors by solving their $y'=0$ or substituting $x=\sqrt{2}$ into their y'	A1
			(4)
(b)	$x=-\sqrt{2}$	Awrt -1.41	B1
			(1)
(c)	$\frac{d^2y}{dx^2}=\frac{-48}{x^5}$ or $-48x^{-5}$	Follow through their first derivative from part (a)	B1ft
			(1)
(d)	An appreciation that either $y''>0 \Rightarrow$ a minimum or $y''<0 \Rightarrow$ a maximum		B1
	Maximum at P as $y''<0$		B1 cso
	Minimum at Q as $y''>0$		B1 cso
			(3)
			[9]

Question number	Scheme		Marks
10 (a)	$C\left(\frac{-2+8}{2}, \frac{11+1}{2}\right) = C(3, 6)$ **AG**	Correct method (no errors) for finding the mid-point of AB giving $(3, 6)$	B1*
			(1)
(b)	$(8-3)^2 + (1-6)^2$ or $\sqrt{(8-3)^2 + (1-6)^2}$ or	Applies distance formula in order to find the radius.	M1
	$(-2-3)^2 + (11-6)^2$ or $\sqrt{(-2-3)^2 + (11-6)^2}$	Correct application of formula.	A1
	$(x-3)^2 + (y-6)^2 = 50 \left(\text{or } \left(\sqrt{50}\right)^2 \text{ or } \left(5\sqrt{2}\right)^2\right)$	$(x \pm 3)^2 + (y \pm 6)^2 = k$, k is a positive value.	M1
	$(x-3)^2 + (y-6)^2 = 50$ (Not 7.07^2)		A1
			(4)
(c)	{For $(10, 7)$,} $\underline{(10-3)^2 + (7-6)^2 = 50}$, {so the point lies on C.}		B1
			(1)
(d)	{Gradient of radius} $= \frac{7-6}{10-3}$ or $\frac{1}{7}$	This must be seen in part (d).	B1
	Gradient of tangent $= \frac{-7}{1}$	Using a perpendicular gradient method.	M1
	$y - 7 = -7(x - 10)$	$y - 7 = (\text{their gradient})(x - 10)$	M1
	$y = -7x + 77$	$y = -7x + 77$ or $y = 77 - 7x$	A1 cao
			(4)
			[10]

Examiner reports

Question 1

This question was generally well answered and responses showed that students could work confidently with binomial expansions. Although the majority of responses gained full marks the error of not squaring the denominator in the x term when expanding the bracket was seen occasionally, leading to an incorrect expansion of $1+12x+126x^2+756x^3$.

Since the bracket did not contain a negative term, sign errors were all but eliminated, increasing the likelihood of maximum marks.

Question 2

The fact that $(x + 2)$ and $(x – 2)$ were both factors of the cubic was unfortunate and examiners needed to be eagle-eyed in marking part (a); some candidates clearly evaluated f(2) in answering (a)(ii). There were often arithmetic errors in evaluating f(–2), with 16 being a common answer, and consequently many candidates had not found a factor in (a) and needed to start from scratch in part (b).

Of those candidates who chose to use long division in (a), there was a considerable number who produced $(x + 2)(x^2 – 4)$ in (ii) and then went on to use this in part (b). Although the solutions $x = 2$ and $x = –2$ were then often still found, this was fortuitous and M1A0M1A0 was a common outcome. The most frequent loss of the final mark, however, was for giving the factors, not the solutions, to the cubic equation.

Question 3

On the whole this question was also well answered with most students gaining more than just the two marks for completion of the table in part (a).

As in previous sessions the most frequent error was in finding h, with 2/6 being the most usual wrong answer. Many candidates used h = (b – a)/n and put n as 6. It is clear that what this formula represents is not fully understood. It was rare to see the simple method of subtracting one x value from the next one to get h.

There were not as many bracketing errors in the application of the formula this time as in previous examinations. Errors in substituting values inside the curly brackets included putting (0 + 4.58) + 2(3 + 3.47 + . . . + 4.39) as well as several instances of the first bracket correct but 3 also appearing in the second bracket. There was also some use of x values instead of y values in the trapezium formula.

Question 4

Part (a) was extremely well done. Most problems occurred because students were not comfortable using radians and changed 2.1 radians to degrees before making an attempt at the arc length *DEA*.

In part (b), to find the width and height of triangle *BCD* many students resorted to using the sine rule instead of basic trigonometry. This then caused problems for some who wrote down equations such as $\dfrac{7}{\sin 90}=\dfrac{DC}{\sin\left(\pi-2.1\right)}$ and then proceeded to work in radians, including using 90 degrees as a radian measure. There were some cases where students did not appreciate what was meant by the perimeter and included *BD* in their total. There were also a significant number of cases where students rounded prematurely which meant that the final A mark was lost.

Question 5
There were many excellent solutions to this question. When problems did occur, these were frequently in part (a), where some candidates showed insufficient working to establish the given common ratio and others confused common ratio and common difference, treating the sequence as arithmetic.

Most of those who were confused in part (a) seemed to recover in part (b). In both part (a) and part (b), some candidates used the formula ar^{n-1} and others successfully used the method of repeatedly multiplying or dividing by the common ratio.

Formulae and methods for the sum to 15 terms and the sum to infinity were usually correct in parts (c) and (d). Just a few candidates found the 15th term instead of the sum in part (c) and just a few resorted to finding all 15 terms and adding.

Question 6
This was a very accessible question where only a very small minority failed to achieve at least half marks.

In part (a), although the vast majority had a completely correct integration, a few slips were evident, usually with the $x^{\frac{3}{2}}$ term. Incorrect simplification leading to $-\frac{5}{2}x^{\frac{3}{2}}$ was often seen and penalised if a correct unsimplified expression had not been shown previously.

Weaker candidates often made no attempt at part (b) of the question, which was largely due to their inability to determine the upper limit. Many candidates had difficulty in solving the equation $3x - x^{\frac{3}{2}} = 0$ as they were unable to deal with the indices. A variety of methods were used with factorisation being the most popular. Attempts at solving the equation by squaring both sides or approaches using logarithms were less successful. Many candidates were able to deduce $x = 9$ by inspection. A common mistake was to proceed to $x = \sqrt{3}$ from $x^{\frac{1}{2}} = 3$.

Question 7
In part (a) most used the cosine rule correctly. A number of solutions were given in degrees and then changed to radians. A value for $\cos\theta$ was needed as an intermediate step to showing the printed answer, that θ was 0.865.

In part (b) a majority used the correct formulae for both the areas of triangles *ABC* and sector *ABD*. Some attempted the triangle area by using base x height divided by 2 so had to work out the height first. The area of the sector formula was not always correct; sometimes the half was lost and sometimes the arc length formula was used instead. Asked to find the amount of grass seed, 670g was most common response although a few gave 680g. Both of these answers received the mark and the units were not required for the mark. Rare errors were students who divided by 50 to get their final answer. Most multiplied, as required. Some left their final answer rounded to the nearest whole number (not the nearest 10).

Question 8
In part (a) most candidates correctly substituted for (sinx)^2 but some lost the A mark through incorrect signs or a failure to put their expression equal to zero.

For part (b) most factorised or used the formula correctly and earned the B1. Unfortunately some who failed to achieve the given answer in a) carried on with their own version of the equation. There were many completely accurate solutions, but others stopped after 360 – 75.5 or did just 360 + 75.5 and some candidates tried combinations of 180 +/- 75.5 or 270 +/- 75.5. A few candidates mixed radians and degrees.

This question was answered well by a majority of candidates.

Question 9
In Q9(a) the majority of candidates differentiated correctly and then either chose to solve $\frac{dy}{dx} = 0$ or substituted $x = \sqrt{2}$ to establish the turning point at P.

In Q9(b) many wrote down $x = -\sqrt{2}$ but also a significant number of candidates went back to the original equation in Q8(a) and attempted to find the other solution, with varying degrees of success.

The differentiation in Q9(c) was answered well and recovery was allowed from an incorrect derivative in Q9(a). There was a clear demand to establish the nature of the turning points at P and Q with justification. There were many cases where candidates made no reference to the fact that the sign of the second derivative was the determining factor and simply evaluated the second derivative at P and Q and stated whether they thought they were a maximum or minimum.

Question 10
This question was answered more successfully by candidates than similar ones in the past. It was pleasing to see that a significant number of candidates used diagrams to help them to answer this question.

In part (a), most candidates were able to verify that (3, 6) was the centre of the circle, usually by finding the midpoint of A and B, although other acceptable methods were seen.

In part (b), most candidates were able to write down an expression for the radius of the circle (or the square of the radius). A significant number of candidates found the length of the diameter AB and halved their result to find the radius correctly. Most candidates were also familiar with the form of the equation of a circle, although some weaker candidates gave equations of straight lines. The most common error in this part was confusion between the diameter and radius of a circle leading to the incorrect result of $(x-3)^2+(y-6)^2=50$.

In part (c), the majority of those candidates who had found a correct equation in part (b) were able to substitute both $x=10$ and $y=7$ into the left-hand side of their circle equation and show that this gave a result of 50. Other candidates successfully substituted $x=10$ (or $y=7$) into the circle equation, solved the resulting quadratic and showed that one resulting y (or x) value was correct. Those candidates who gave an incorrect answer in part (b) were usually unable to gain any credit in part (c).

In part (d), many candidates knew the method for finding the equation of the tangent at $(10, 7)$. Typical mistakes here included candidates finding the gradient of the radius AB or finding a line parallel to the radius or finding a line through the centre of the circle. A few candidates attempted to find the gradient of the line by differentiating their circle equation. This method was rarely successful, as most candidates were not able to apply the method of implicit differentiation correctly.

Statistics for C2 Practice Paper Bronze Level B2

				Mean score for students achieving grade:							
Qu	**Max score**	**Modal score**	**Mean %**	**ALL**	**A***	**A**	**B**	**C**	**D**	**E**	**U**
1	4		90.8	3.63	3.92	3.95	3.73	3.68	3.69	3.43	2.03
2	7		86	6.05		6.80	6.53	6.08	5.50	5.01	3.74
3	6		81	4.88		5.68	5.24	4.69	4.09	3.60	2.74
4	6		84.0	5.04	5.96	5.72	5.52	4.96	4.42	3.56	2.25
5	9		81	7.30		8.75	8.35	7.86	7.12	6.29	3.96
6	6	6	81	4.86	5.92	5.80	5.47	5.06	4.60	4.06	3.06
7	10		85	8.54	9.77	9.67	9.26	8.06	7.51	6.28	2.59
8	8		74	5.89		7.60	6.82	5.68	3.94	2.63	1.05
9	9	9	73	6.53	8.81	8.32	7.25	6.22	5.10	3.98	2.26
10	10		71	7.11	9.74	9.25	7.95	6.27	4.93	3.46	1.70
	75		**79.77**	**59.83**	**44.12**	**71.54**	**66.12**	**58.56**	**50.90**	**42.30**	**25.38**