Paper Reference(s)

6664/01

Edexcel GCE

Core Mathematics C2
Bronze Level B4

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
71	64	57	50	44	38

1. The first three terms of a geometric series are

$$18, 12 \text{ and } p$$

respectively, where p is a constant.

Find

(*a*) the value of the common ratio of the series,

(1)

(*b*) the value of p,

(1)

(*c*) the sum of the first 15 terms of the series, giving your answer to 3 decimal places.

(2)

May 2013

2. A circle C has centre $(-1, 7)$ and passes through the point $(0, 0)$. Find an equation for C.

(4)

January 2012

3.
$$y = \sqrt{(5^x + 2)}$$

(*a*) Copy and complete the table below, giving the values of y to 3 decimal places.

x	0	0.5	1	1.5	2
y			2.646	3.630	

(2)

(*b*) Use the trapezium rule, with all the values of y from your table, to find an approximation for the value of $\int_0^2 \sqrt{(5^x + 2)} \ \mathrm{d}x$.

(4)

June 2008

4. (*a*) Find the first 4 terms of the binomial expansion, in ascending powers of *x*, of

$$\left(1+\frac{x}{4}\right)^8,$$

giving each term in its simplest form.

(4)

(*b*) Use your expansion to estimate the value of $(1.025)^8$, giving your answer to 4 decimal places.

(3)

January 2012

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5. (*a*) Complete the table below, giving values of $\sqrt{(2^x + 1)}$ to 3 decimal places.

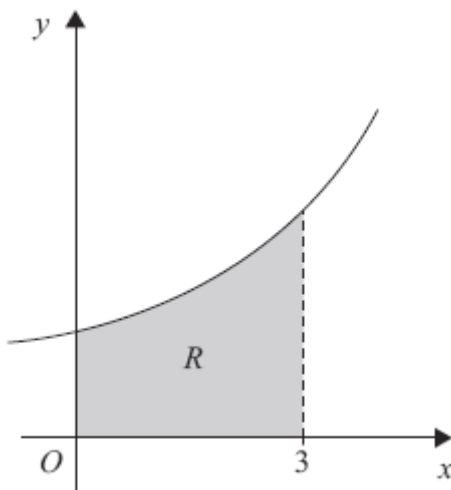| *x*	0	0.5	1	1.5	2	2.5	3
$\sqrt{(2^x + 1)}$	1.414	1.554	1.732	1.957			3

(2)

Figure 1

Figure 1 shows the region *R* which is bounded by the curve with equation $y = \sqrt{(2^x + 1)}$, the *x*-axis and the lines $x = 0$ and $x = 3$

(*b*) Use the trapezium rule, with all the values from your table, to find an approximation for the area of *R*.

(4)

(*c*) By reference to the curve in Figure 1 state, giving a reason, whether your approximation in part (*b*) is an overestimate or an underestimate for the area of *R*.

(2)

June 2009

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6. Given that $\begin{pmatrix} 40 \\ 4 \end{pmatrix} = \dfrac{40!}{4!\,b!}$,

(*a*) write down the value of *b*.

(1)

In the binomial expansion of $(1 + x)^{40}$, the coefficients of x^4 and x^5 are *p* and *q* respectively.

(*b*) Find the value of $\dfrac{q}{p}$.

(3)

January 2011

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7. The second and third terms of a geometric series are 192 and 144 respectively.

For this series, find

(*a*) the common ratio,

(2)

(*b*) the first term,

(2)

(*c*) the sum to infinity,

(2)

(*d*) the smallest value of *n* for which the sum of the first *n* terms of the series exceeds 1000.
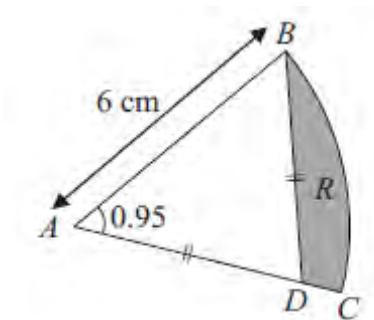
(4)

May 2011

4

8.

Figure 2

Figure 2 shows ABC, a sector of a circle of radius 6 cm with centre A. Given that the size of angle BAC is 0.95 radians, find

(*a*) the length of the arc BC,

(2)

(*b*) the area of the sector ABC.

(2)

The point D lies on the line AC and is such that $AD = BD$. The region R, shown shaded in Figure 2, is bounded by the lines CD, DB and the arc BC.

(*c*) Show that the length of AD is 5.16 cm to 3 significant figures.

(2)

Find

(*d*) the perimeter of R,

(2)

(*e*) the area of R, giving your answer to 2 significant figures.

(4)

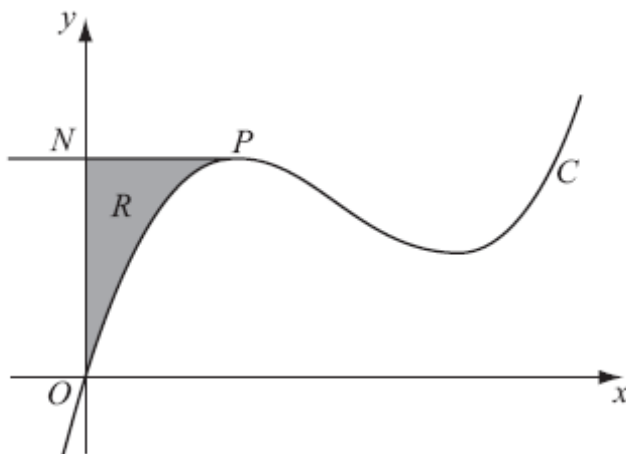**January 2012**

9.

Figure 3

Figure 3 shows a sketch of part of the curve C with equation

$$y = x^3 - 10x^2 + kx,$$

where k is a constant.

The point P on C is the maximum turning point.

Given that the x-coordinate of P is 2,

(a) show that $k = 28$.

(3)

The line through P parallel to the x-axis cuts the y-axis at the point N.
The region R is bounded by C, the y-axis and PN, as shown shaded in Figure 3.

(b) Use calculus to find the exact area of R.
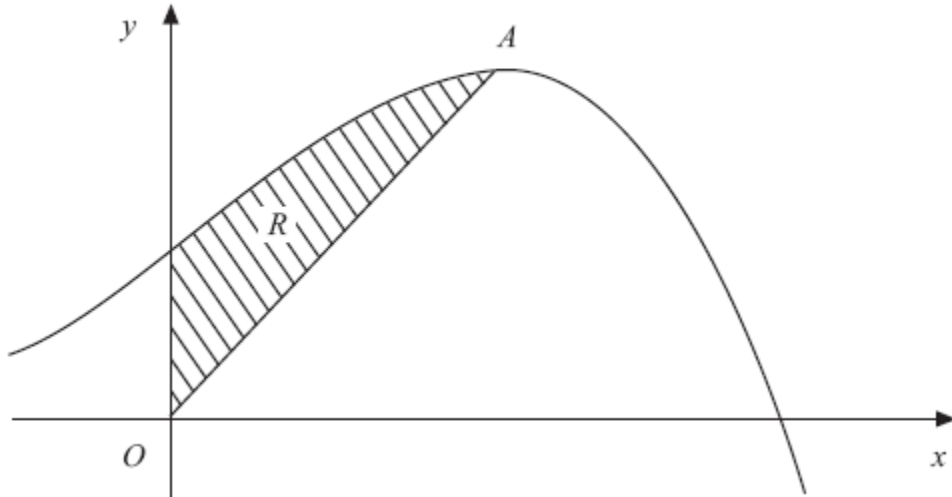
(6)

June 2010

10.

Figure 4

Figure 4 shows a sketch of part of the curve with equation $y = 10 + 8x + x^2 - x^3$.

The curve has a maximum turning point A.

(a) Using calculus, show that the x-coordinate of A is 2.

(3)

The region R, shown shaded in Figure 4, is bounded by the curve, the y-axis and the line from O to A, where O is the origin.

(b) Using calculus, find the exact area of R.

(8)

June 2008

TOTAL FOR PAPER: 75 MARKS

END

Question Number	Scheme	Marks
1. (a)	$\{r =\} \dfrac{2}{3}$	B1 (1)
(b)	$\{p =\} 8$	B1 cao (1)
(c)	$\{S_{15} =\} \dfrac{18\left(1 - \left(\frac{2}{3}\right)^{15}\right)}{1 - \frac{2}{3}}$	M1
	$\{S_{15} = 53.87668...\} \Rightarrow S_{15} = $ awrt 53.877	A1 (2) **[4]**
2.	The equation of the circle is $(x+1)^2 + (y-7)^2 = (r^2)$	M1 A1
	The radius of the circle is $\sqrt{(-1)^2 + 7^2} = \sqrt{50}$ or $5\sqrt{2}$ or $r^2 = 50$	M1
	So $(x+1)^2 + (y-7)^2 = 50$ or equivalent	A1 **[4]**
3. (a)	$1.732, \ 2.058, \ 5.196$ awrt	B1 B1 (2)
(b)	$\dfrac{1}{2} \times 0.5 \ ......$	B1
	$......\{(1.732 + 5.196) + 2(2.058 + 2.646 + 3.630)\}$	M1 A1 ft
	$= 5.899$	A1 (4) **[6]**
4. (a)	$(1 + \frac{x}{4})^8 = 1 + 2x + .., ...$	B1
	$+ \dfrac{8 \times 7}{2}(\frac{x}{4})^2 + \dfrac{8 \times 7 \times 6}{2 \times 3}(\frac{x}{4})^3,$	M1 A1
	$= \quad + \frac{7}{4}x^2 + \frac{7}{8}x^3 \quad$ or $\quad = \quad + 1.75x^2 + 0.875x^3$	A1 (4)
(b)	States or implies that $x = 0.1$	B1
	Substitutes their value of x (provided it is <1) into series obtained in part (a)	M1
	i.e. $1 + 0.2 + 0.0175 + 0.000875, \ = 1.2184$	A1 cao (3) **[7]**

Question Number	Scheme	Marks
5. (a)	$x = 2$ gives 2.236 (allow AWRT) Accept $\sqrt{5}$	B1
	$x = 2.5$ gives 2.580 (allow AWRT) Accept 2.58	B1
		(2)
(b)	$\left(\dfrac{1}{2} \times \dfrac{1}{2} \right)$, $\big[(1.414 + 3) + 2(1.554 + 1.732 + 1.957 + 2.236 + 2.580) \big]$	B1 M1 A1ft
	$= 6.133$ (AWRT 6.13, even following minor slips)	A1
		(4)
(c)	Overestimate	B1
	'Since the trapezia lie <u>above the curve</u>', or an equivalent explanation, or sketch of (one or more) trapezia above the curve on a diagram (or on the given diagram, in which case there should be reference to this).	dB1
		(2)
		[8]
6. (a)	$\dbinom{40}{4} = \dfrac{40!}{4!\,b!}$; $(1 + x)^n$ coefficients of x^4 and x^5 are p and q respectively	
	$b = 36$	B1
		(1)
(b)	Term 1: $\dbinom{40}{4}$ or $^{40}C_4$ or $\dfrac{40!}{4!36!}$ or $\dfrac{40(39)(38)(37)}{4!}$ or 91 390	M1
	Term 2: $\dbinom{40}{5}$ or $^{40}C_5$ or $\dfrac{40!}{5!35!}$ or $\dfrac{40(39)(38)(37)(36)}{5!}$ or 658 008	A1
	Hence, $\dfrac{q}{p} = \dfrac{658008}{91390} \left\{ = \dfrac{36}{5} = 7.2 \right\}$	A1 oe cso
		(3)
		[4]

Question Number	Scheme	Marks
7. (a)	$\{ ar = 192 \quad \text{and} \quad ar^2 = 144 \}$	
	$r = \dfrac{144}{192}$	M1
	$r = \frac{3}{4}$ or 0.75	A1
		(2)
(b)	$a(0.75) = 192$	M1
	$a\left\{ = \dfrac{192}{0.75} \right\} = 256$	A1
		(2)
(c)	$S_\infty = \dfrac{256}{1 - 0.75}$	M1
	So, $\{ S_\infty = \}$ 1024	A1 cao
		(2)
(d)	$\dfrac{256(1 - (0.75)^n)}{1 - 0.75} > 1000$	M1
	$(0.75)^n < 1 - \dfrac{1000(0.25)}{256} \left\{ = \dfrac{6}{256} \right\}$	M1
	$n\log(0.75) < \log\left(\dfrac{6}{256} \right)$	M1
	$n > \dfrac{\log\left(\frac{6}{256} \right)}{\log(0.75)} = 13.0471042... \Rightarrow n = 14$	A1 cso
		(4)
		[10]
8. (a)	$r\theta = 6 \times 0.95, = 5.7 \quad$ (cm)	M1, A1
		(2)
(b)	$\dfrac{1}{2} r^2 \theta = \dfrac{1}{2} \times 6^2 \times 0.95, = 17.1 \; \left(\text{cm}^2 \right)$	M1, A1
		(2)
(c)	Let $AD = x$ then $\dfrac{x}{\sin 0.95} = \dfrac{6}{\sin 1.24}$ so $x = 5.16$ \qquad *	
	OR $\quad x = 3 / \cos 0.95$ OR so $x = 3/ \sin 0.62 \quad$ so $x = 5.16 \quad$ *	M1 A1
	OR $x^2 = 6^2 + x^2 - 12x\cos 0.95$ leading to $x = \quad$, so $x = 5.16 \quad$ *	
		(2)
(d)	Perimeter = '5.7'+5.16 +6 − 5.16= "11.7" $\quad$ **or 6 + their 5.7**	M1A1 ft
		(2)
(e)	Area of triangle $ABD = \frac{1}{2} \times 6 \times 5.16 \times \sin 0.95 = 12.6$ or	
	$\frac{1}{2} \times 6 \times 3 \times \tan 0.95 = 12.6$ (½ base x height) or	
	$\frac{1}{2} \times 5.16 \times 5.16 \times \sin 1.24 = 12.6$	M1 A1
	So Area of R = '17.1' − '12.6' = 4.5	M1 A1
		(4)
		[12]

Question Number	Scheme	Marks
9. (a)	$\dfrac{dy}{dx} = 3x^2 - 20x + k$	M1 A1
	At $x = 2$, $\dfrac{dy}{dx} = 0$, so $12 - 40 + k = 0$ $\qquad k = 28$ $\qquad$ (*)	A1 cso
	N.B. The '= 0' must be seen at some stage to score the final mark.	
		(3)
(b)	$\displaystyle\int (x^3 - 10x^2 + 28x)\, dx = \dfrac{x^4}{4} - \dfrac{10x^3}{3} + \dfrac{28x^2}{2}$	M1 A1
	$\left[\dfrac{x^4}{4} - \dfrac{10x^3}{3} + 14x^2 \right]_0^2 = ... \qquad \left(= 4 - \dfrac{80}{3} + 56 = \dfrac{100}{3} \right)$	M1
	y-coordinate of $P = 8 - 40 + 56 = 24$ $\qquad$ <u>Allow if seen in part (a)</u>	B1
	Area of rectangle $= 2 \times (\text{their } y\text{-coordinate of } P)$	
	Area of $R = (\text{their } 48) - \left(\text{their } \dfrac{100}{3} \right) \qquad = \dfrac{44}{3} \left(14\dfrac{2}{3} \text{ or } 14.\dot{6} \right)$	M1 A1
		(6)
		[9]
10. (a)	$\left(\dfrac{dy}{dx} = \right) 8 + 2x - 3x^2$	M1 A1
	$3x^2 - 2x - 8 = 0 \quad (3x + 4)(x - 2) = 0 \quad x = 2$	A1 cso
		(3)
(b)	Area of triangle $= \qquad \dfrac{1}{2} \times 2 \times 22$	M1 A1
	$\displaystyle\int 10 + 8x + x^2 - x^3\, dx = 10x + \dfrac{8x^2}{2} + \dfrac{x^3}{3} - \dfrac{x^4}{4}$	M1 A1 A1
	$\left[10x + \dfrac{8x^2}{2} + \dfrac{x^3}{3} - \dfrac{x^4}{4} \right]_0^2 = ... \left(= 20 + 16 + \dfrac{8}{3} - 4 \right)$	M1
	Area of $R = 34\dfrac{2}{3} - 22 = \dfrac{38}{3} \left(= 12\dfrac{2}{3} \right)$ (Or $12.\dot{6}$)	M1 A1
		(8)
		[11]

Examiner reports

Question 1

Candidates displayed a good knowledge of Geometric Series and generally applied formulae successfully to gain maximum marks in most responses.

A small number of candidates attempted a common difference rather than ratio, yielding $r = -6$ and $p = 6$, but usually went on to use the geometric series sum formula in (c). One error that caused a few candidates to lose marks was to give $r = 3/2$ instead of $r = 2/3$, though they often then obtained $p = 8$ in (b). Some students also lost marks due to incorrect rounding, for example by giving r as 0.6, though many obtained the mark in (a), having written 12/18 or 2/3 previously, but then lost marks later by using 0.6 or some other approximation in their calculations.

In part (c), most students used the correct formula for the sum of a geometric progression, although some candidates were unable to use their calculators efficiently to obtain an accurate answer. Other mistakes were to give the sum as $\dfrac{18(1-(\frac{2}{3})^{14})}{1-\frac{2}{3}}$ or to attempt to use the formula for the sum to infinity or the formula for the sum of an arithmetic series. Attempts to find and then add all 15 terms were very rare. A significant minority went straight from a correct formula in part (c) to an answer rounded to 3 significant figures rather than 3 decimal places, losing the last mark (just one of a number of occasions where candidates were failing to read the detail of the question properly).

Question 2

This question was also well answered (71% with full marks). For those who did not obtain a completely correct solution, most began with $(x+1)^2 + (y-7)^2 = r^2$. However, errors were common, with incorrect signs within and between the brackets, missing indices, or 1 and –7 in the wrong bracket. Most were able to find the radius although a significant minority appeared to be confused between radius and diameter. Some candidates had difficulty with $(-1)^2$ and made $r = \sqrt{48}$ whilst others made $r^2 = \dfrac{d^2}{2}$. Others substituted the correct radius into their equation without squaring it. Although not penalised, many candidates did not simplify their r^2 leaving it as $(\sqrt{50})^2$ or $(2\sqrt{5})^2$. Only very few candidates expanded the brackets to give the answer in the form $x^2 + 2x + y^2 - 14y = 0$. (This expanded answer was not required by the question). There were a number of weaker candidates who did not use the circle formula at all and instead attempted some form of straight line equation, gaining no marks.

Question 3

Part (a) was answered correctly by the vast majority of candidates. Where an error did occur it was frequently $\sqrt{5^0 + 2} = \sqrt{0 + 2} = 1.414$. The values were almost always given to the requested degree of accuracy.

Use of the trapezium rule in part (b) was often clear and accurate, but the common mistake in the value of h $\left(h = \dfrac{2}{5} \text{ instead of } h = \dfrac{2}{4} \right)$ was frequently seen. Bracketing mistakes were less common but there were some candidates who left out the main brackets and only multiplied the first two terms by $0.5h$.

A few candidates used the equivalent method of adding the areas of separate trapezia, which was acceptable and was usually successful.

Question 4

There were many completely correct solutions (39.5%) but a sizeable minority of candidates who obtained a fully correct answer in (a) had little idea how to answer (b).

Part (a): The majority of candidates were able to obtain the binomial expansion. There were the usual mistakes with terms in just x rather than $\dfrac{x}{4}$ and omission of brackets around this fraction, which often meant incorrect powers of 4 were used. Many candidates failed to simplify all of their terms hence losing the final A mark and there were some who did not simplify their $\dfrac{8x}{4}$, losing the first B mark.

In part (b), most candidates were able to use their expansion correctly and many were able to gain marks even from incorrect answers to (a). In general they used 0.1 and showed their results clearly. However some used 1.025, 3.1 or even 1, with no consideration as to whether their result was a sensible answer. A few restarted with 0.025 as in the special case and achieved the correct result. Those who just used their calculator to evaluate $(1.025)^8$ were not answering the question and gained no credit.

Question 5

Part (a) was answered correctly by the majority of candidates, although $\sqrt{2^{2.5}+1}$ was sometimes evaluated as $\sqrt{2.5^2+1}$.

The trapezium rule was often accurately used in part (b), but the common mistake in the value of h $\left(h = \dfrac{3}{7} \text{ instead of } h = \dfrac{3}{6} \right)$ was frequently seen. Some candidates had confused bracketing, leaving out the main brackets and multiplying only the first two terms by $0.5h$. The equivalent method of adding the areas of separate trapezia was occasionally seen.

In part (c), some of the candidates' responses clearly indicated a lack of understanding of why the trapezium rule gave an overestimate in this case. To score the final mark, a convincing explanation (with reference to trapezia) was required. Those candidates who supported their reasoning with a simple sketch were usually more successful.

Question 6

A significant number of candidates failed to answer part (a) correctly, due to the unfamiliarity with the formula for $\dbinom{n}{r}$. Common incorrect answers for b included 1, 4, 10, 36! or 91390.

In part (b), most candidates were able to write down the binomial expansion of $(1 + x)^n$. Although a minority of candidates picked out wrong terms, most commonly terms in x^3 and x^4 rather than x^4 and x^5, the majority of candidates were able to to give $\dfrac{q}{p}$ as $\dfrac{36}{5}$. Other common errors included finding $\dfrac{p}{q}$ or giving $\dfrac{q}{p}$ as 7.2x, which is not independent of x.

Question 7

Most candidates were able to answer parts (a), (b) and (c) and gain full marks. A small minority found the common difference in part (a), used it in part (b) and attempted to use it with the correct formula in part (c). These candidates obviously did not recognise that $|r| < 1$ was a requirement for the sum to infinity. The same was true for the relatively few candidates who found $r = \dfrac{4}{3}$ in part (a).

Most candidates used the correct summation formula in part (d). Although many of these candidates arrived at the correct answer of $n = 14$, they lost the final mark for incorrect inequality work. A significant number of these candidates were not able to deal with the sign reversals when multiplying $-(0.75)^n$ by -1 or when dividing by $\log 0.75$ which many failed to realise was negative. Those candidates using equalities throughout were generally more successful in gaining full marks. Common errors in this part included candidates who combined $256(0.75)^n$ to give 192^n, and candidates who tried to take the log of a negative number. Some candidates gave their final answer n as a decimal, failing to realise that it had to be an integer.

In part (d), a number of candidates used the formula for the nth term starting from $n = 1$, and continued to add each term until arriving at 1000 whilst others used a method "trial and improvement" by using the summation formula. A number of these solutions, however, were incomplete without both the sum of the first 13 terms and the first 14 terms being given.

Question 8

Most candidates were able to display their knowledge of trigonometry and circles here and a substantial group (44%) achieved full marks. Among the others, greater clarity in their responses would have helped their own working and not led to lost marks. A few were reluctant to work in radians, particularly in part (c), but generally worked correctly in degrees.

Parts (a) and (b) were almost always correct, though some candidates lost the $\frac{1}{2}$ in the formula for area.

Part (c) was attempted in a wide variety of ways. The most common approach was to use the Sine rule, having first found that the third angle of triangle ADB is 1.24 radians. This was generally successful. However there were a few cases seen of angle $(2\pi - 2x) \times 0.95$ and there was some confusion as to which were the equal angles of the isosceles triangle.

Others used trigonometry in the right-angled triangle which is half of triangle *ADB*, getting a successful result from $AD = \dfrac{3}{\cos 0.95}$. Those who attempted the cosine rule in triangle *ADB* could achieve a correct answer but sometimes attempted a verification method. Answers to part (c) were often disappointing, partly from poor algebra and from a lack of clarity in the symbols used and confusion about the equal sides. As this was a 'show that' question, there appeared to be a temptation for some to hope that the examiner would not notice incorrect working.

In part (d), where perimeter was needed, a few slips were seen, but most were able to achieve the required result. Many were able to find the correct area in part (e) by using the difference between the area of the sector and of the triangle *ADB*. Lack of clarity was a problem where errors occurred, since scripts mostly said 'the area of the triangle' and it was not always clear whether *ADB* or *ABC* was intended. Some approached the problem by using area of the segment + area of triangle *BDC*. This was usually successful. Errors sometimes occurred

when finding angles in triangle *BDC*. Lack of clarity again caused difficulties. A minority of candidates assumed that this was a normal 'area of segment' question, without looking properly at the question, but this was fairly rare.

Question 9

To establish the *x*-coordinate of the maximum turning point in part (a), it was necessary to differentiate and to use $\frac{dy}{dx} = 0$. Most candidates realised the need to differentiate, but the use of the zero was not always clearly shown.

Methods for finding the area in part (b) were often fully correct, although numerical slips were common. Weaker candidates often managed to integrate and to use the limits 0 and 2, but were then uncertain what else (if anything) to do. There were some attempts using *y* coordinates as limits. While the most popular method was to simply subtract the area under the curve from the area of the appropriate rectangle, integrating $24 - (x^3 - 10x^2 + 28x)$ between 0 and 2 was also frequently seen. Occasional slips included confusing 24 (the *y*-coordinate of *P*) with 28, subtracting 'the wrong way round' and failing to give the final answer as an exact number.

Question 10

In general, this was very well done, showing that many candidates know when to differentiate and when to integrate.

In part (a), most candidates successfully differentiated the equation then presented evidence that they understood that $\frac{dy}{dx} = 0$ at a turning point. A significant number went on to find the second derivative to establish the nature of the turning point (although this was not required here, given the graph).

Most candidates integrated correctly in part (b) and a majority subtracted the area of the triangle correctly. Those who found the equation of the straight line ($y = 11x$) and then proceeded to find the area of the triangle by integration (or to subtract $11x$ from the equation of the curve and then integrate) were more likely to make mistakes than those who simply used $\frac{1}{2}bh$ for the triangle. It was disappointing to see the final mark being lost by candidates who did not give an *exact* final answer, as specified in the question. A few candidates who appeared to have no correct overall strategy for answering the question were still able to earn marks for their integration.

Statistics for C2 Practice Paper Bronze Level B4

Qu	Max score	Modal score	Mean %	Mean score for students achieving grade:							
				ALL	A*	A	B	C	D	E	U
1	4		83	3.33	3.94	3.89	3.76	3.61	3.41	3.04	1.98
2	4		79	3.17	3.96	3.83	3.49	3.19	2.61	2.10	0.94
3	6		79	4.73		5.80	5.44	4.97	4.42	3.77	2.54
4	7		71	5.00	6.97	6.45	5.50	4.66	3.78	3.35	2.13
5	8		71	5.67		6.98	6.38	5.95	5.38	4.78	3.26
6	4		75	2.99	3.80	3.59	3.19	2.87	2.59	2.13	1.16
7	10		74	7.41	9.61	9.24	8.57	7.95	7.15	6.09	3.13
8	12		77	9.26	11.53	11.31	10.29	9.00	7.44	5.87	3.42
9	9		66	5.92	8.89	8.53	7.66	6.50	5.03	3.41	1.24
10	11		68	7.46		10.62	9.57	8.15	6.11	4.04	1.32
	75		**73**	**54.94**		**70.24**	**63.85**	**56.85**	**47.92**	**38.58**	**21.12**