OCR
RECOGNISING ACHIEVEMENT

ADVANCED SUBSIDIARY GCE

MATHEMATICS (MEI) 4752

Concepts for Advanced Mathematics (C2)

QUESTION PAPER

Candidates answer on the printed answer book.

OCR supplied materials:
- Printed answer book 4752
- MEI Examination Formulae and Tables (MF2)

Other materials required:
- Scientific or graphical calculator

Friday 14 January 2011
Afternoon

Duration: 1 hour 30 minutes

INSTRUCTIONS TO CANDIDATES

These instructions are the same on the printed answer book and the question paper.

- The question paper will be found in the centre of the printed answer book.
- Write your name, centre number and candidate number in the spaces provided on the printed answer book. Please write clearly and in capital letters.
- **Write your answer to each question in the space provided in the printed answer book.** Additional paper may be used if necessary but you must clearly show your candidate number, centre number and question number(s).
- Use black ink. Pencil may be used for graphs and diagrams only.
- Read each question carefully. Make sure you know what you have to do before starting your answer.
- Answer **all** the questions.
- Do **not** write in the bar codes.
- You are permitted to use a scientific or graphical calculator in this paper.
- Final answers should be given to a degree of accuracy appropriate to the context.

INFORMATION FOR CANDIDATES

This information is the same on the printed answer book and the question paper.

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- You are advised that an answer may receive **no marks** unless you show sufficient detail of the working to indicate that a correct method is being used.
- The total number of marks for this paper is **72**.
- The printed answer book consists of **12** pages. The question paper consists of **8** pages. Any blank pages are indicated.

INSTRUCTION TO EXAMS OFFICER / INVIGILATOR

- Do not send this question paper for marking; it should be retained in the centre or destroyed.

Section A (36 marks)

1 Calculate $\sum_{r=3}^{6} \frac{12}{r}$. **[2]**

2 Find $\int \left(3x^5 + 2x^{-\frac{1}{2}}\right) dx$. **[4]**

3 At a place where a river is 7.5 m wide, its depth is measured every 1.5 m across the river. The table shows the results.

Distance across river (m)	0	1.5	3	4.5	6	7.5
Depth of river (m)	0.6	2.3	3.1	2.8	1.8	0.7

Use the trapezium rule with 5 strips to estimate the area of cross-section of the river. **[3]**

4 The curve $y = \mathrm{f}(x)$ has a minimum point at (3, 5).

State the coordinates of the corresponding minimum point on the graph of

(i) $y = 3\mathrm{f}(x)$, **[2]**

(ii) $y = \mathrm{f}(2x)$. **[2]**

5 The second term of a geometric sequence is 6 and the fifth term is –48.

Find the tenth term of the sequence.

Find also, in simplified form, an expression for the sum of the first n terms of this sequence. **[5]**

6 The third term of an arithmetic progression is 24. The tenth term is 3.

Find the first term and the common difference.

Find also the sum of the 21st to 50th terms inclusive. **[5]**

7 Simplify

(i) $\log_{10} x^5 + 3\log_{10} x^4$, **[2]**

(ii) $\log_a 1 - \log_a a^b$. **[2]**

8 Showing your method clearly, solve the equation

$$5\sin^2\theta = 5 + \cos\theta \qquad \text{for } 0° \leqslant \theta \leqslant 360°.$$ **[5]**

9 Charles has a slice of cake; its cross-section is a sector of a circle, as shown in Fig. 9. The radius is r cm and the sector angle is $\frac{\pi}{6}$ radians.

He wants to give half of the slice to Jan. He makes a cut across the sector as shown.

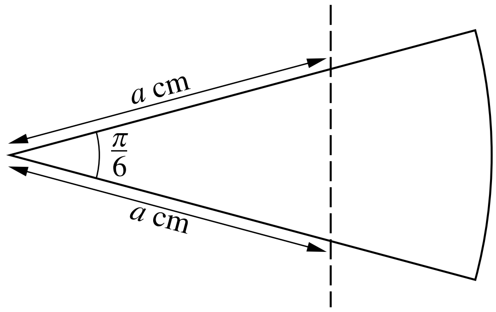

Fig. 9

Show that when they each have half the slice, $a = r\sqrt{\frac{\pi}{6}}$. **[4]**

Section B (36 marks)

10

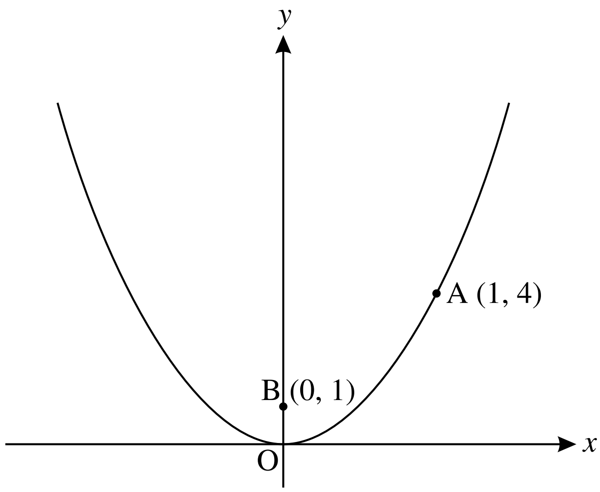

Fig. 10

A is the point with coordinates (1, 4) on the curve $y = 4x^2$. B is the point with coordinates (0, 1), as shown in Fig. 10.

(i) The line through A and B intersects the curve again at the point C. Show that the coordinates of C are $\left(-\frac{1}{4}, \frac{1}{4}\right)$. **[4]**

(ii) Use calculus to find the equation of the tangent to the curve at A and verify that the equation of the tangent at C is $y = -2x - \frac{1}{4}$. **[6]**

(iii) The two tangents intersect at the point D. Find the y-coordinate of D. **[2]**

11

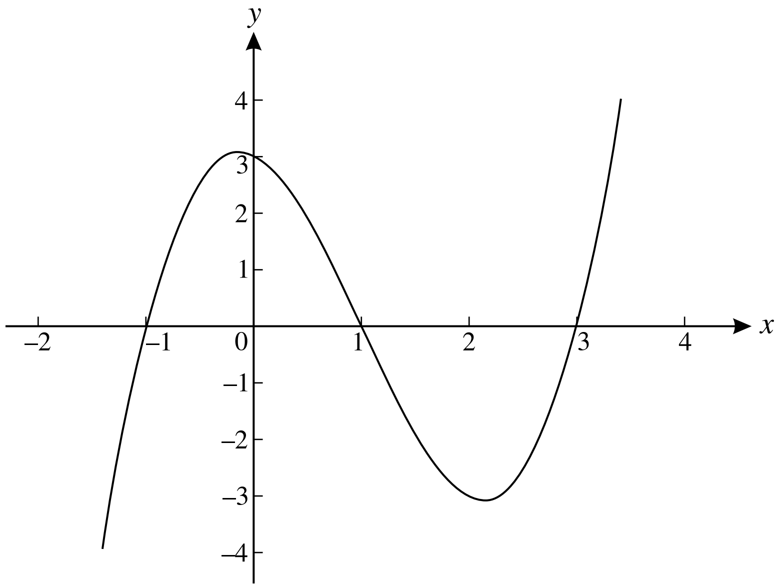

Fig. 11

Fig. 11 shows the curve $y = x^3 - 3x^2 - x + 3$.

(i) Use calculus to find $\int_1^3 (x^3 - 3x^2 - x + 3)\,dx$ and state what this represents. **[6]**

(ii) Find the x-coordinates of the turning points of the curve $y = x^3 - 3x^2 - x + 3$, giving your answers in surd form. Hence state the set of values of x for which $y = x^3 - 3x^2 - x + 3$ is a decreasing function. **[5]**

12 The table shows the size of a population of house sparrows from 1980 to 2005.

Year	1980	1985	1990	1995	2000	2005
Population	25 000	22 000	18 750	16 250	13 500	12 000

The 'red alert' category for birds is used when a population has decreased by at least 50% in the previous 25 years.

(i) Show that the information for this population is consistent with the house sparrow being on red alert in 2005. **[1]**

The size of the population may be modelled by a function of the form $P = a \times 10^{-kt}$, where P is the population, t is the number of years after 1980, and a and k are constants.

(ii) Write the equation $P = a \times 10^{-kt}$ in logarithmic form using base 10, giving your answer as simply as possible. **[2]**

(iii) Complete the table and draw the graph of $\log_{10} P$ against t, drawing a line of best fit by eye. **[3]**

(iv) Use your graph to find the values of a and k and hence the equation for P in terms of t. **[4]**

(v) Find the size of the population in 2015 as predicted by this model.

Would the house sparrow still be on red alert? Give a reason for your answer. **[3]**

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ADVANCED SUBSIDIARY GCE

MATHEMATICS (MEI) 4752

Concepts for Advanced Mathematics (C2)

PRINTED ANSWER BOOK

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OCR supplied materials:
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• MEI Examination Formulae and Tables (MF2)
Other materials required:
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Friday 14 January 2011
Afternoon

Duration: 1 hour 30 minutes

Candidate forename		Candidate surname	

Centre number						Candidate number				

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Section A (36 marks)

1

2

3

4 (i)	
4 (ii)	
5	

6	
7 (i)	
7 (ii)	

8	
9	

Section B (36 marks)

10 (i)	
10 (ii)	

10 (iii)	

11 (i)

11 (ii)

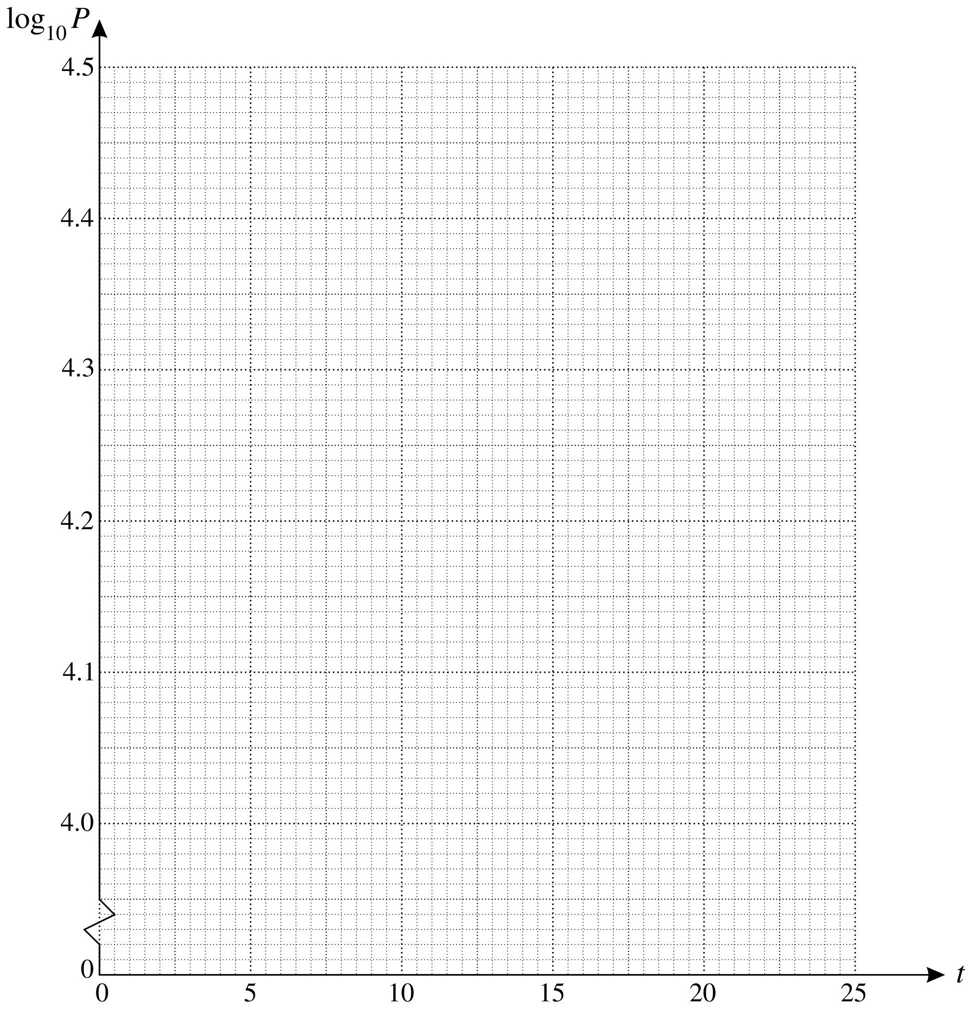
12 (i)

12 (ii)

12 (iii)

Year	1980	1985	1990	1995	2000	2005
Population (P)	25 000	22 000	18 750	16 250	13 500	12 000
Years after 1980 (t)	0	5	10	15	20	25
$\log_{10} P$	4.40	4.34				

12 (iii) **(continued)**



12 (iv)

12 (v)	

GCE

Mathematics (MEI)

Advanced Subsidiary GCE

Unit **4752:** Concepts for Advanced Mathematics

Mark Scheme for January 2011

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E-mail: publications@ocr.org.uk

SECTION A

1	11.4 o.e.	**2**	**M1** for 12/3 + 12/4 + 12/5 + 12/6 o.e.	**M0** unless four terms summed
2	$\frac{1}{2}x^6 + 4x^{\frac{1}{2}} + c$	**4**	**B1** for $\frac{1}{2}x^6$, **M1** for $kx^{\frac{1}{2}}$, **A1** for $k = 4$ or $\frac{4}{1}$, **B1** for + c dependent on at least one power increased	allow $\frac{3}{6}x^6$ isw,
3	½ × 1.5 × (0.6 + 0.7 + 2(2.3+3.1+2.8+1.8)) = 15.975 rounded to 2 s.f. or more	**M2** **A1**	**M1** if one error or **M2** for sum of 5 unsimplified individual trapezia: 2.175, 4.05, 4.425, 3.45, 1.875	basic shape of formula must be correct. Must be 5 strips. **M0** if pair of brackets omitted or h = 7.5 or 1. allow recovery of brackets omitted to obtain correct answer. **M0** for other than 5 trapezia isw only if 15.975 clearly identified as cross-sectional area
4	(i) (3, 15)	**B2**	**B1** for each coordinate	s.c. **B0** for (3, 5)
4	(ii) (1.5, 5)	**B2**	**B1** for each coordinate	s.c. **B0** for (3, 5)
5	$ar = 6$ and $ar^4 = -48$ $r = -2$ tenth term = 1536 $\frac{-3(1-(-2)^n)}{1-(-2)}$ o.e. $(-2)^n - 1$	**M1** **M1** **A1** **M1** **A1**	**B2** for r = -2 www **B3** for 1536 www allow **M1** for a = 6÷their r and substitution in GP formula with their a and r c.a.o.	ignore incorrect lettering such as d =-2 condone the omission of the brackets round "-2" in the numerator and / or the denominator

6	$a+2d = 24$ and $a + 9d = 3$ $d = -3$; $a = 30$ $S_{50} - S_{20}$ -2205 cao	M1 A1 A1 M1 A1	if **M0** , **B2** for either, **B3** for both ft their a and d; **M1** for $S_{30} = \frac{30}{2}(u_{21} + u_{50})$ o.e. **B2** for -2205 www	do not award **B2** or **B3** if values clearly obtained fortuitously $S_{50} = -2175$; $S_{20} = 30$ $u_{21} = 30 - 20 \times 3 = -30$ $u_{50} = 30 - 49 \times 3 = -117$
7	(i) $17 \log_{10} x$ or $\log_{10} x^{17}$	B2	**M1** for $5\log_{10} x$ or $12 \log_{10} x$ or $\log_{10} x^{12}$ as part of the first step	condone omission of base
7	(ii) $-b$	B2	**M1** for $\log_a 1 = 0$ or $\log_a a = 1$ soi	allow $0 - b$
8	substitution of $\sin^2 \theta = 1 - \cos^2 \theta$ $-5\cos^2 \theta = \cos \theta$ $\theta = 90$ and 270, 102 258 101 *and* 259	M1 A1 A1 A1 A1 SC 1	soi or better accept 101.5(…) and 258.(46…) rounded to 3 or more sf; if **M0,** allow **B1** for both of 90 and 270 and **B1** for 102 and **B1** for 258 (to 3 or more sf)	if the 4 correct values are presented, ignore any extra values which are outside the required range, but apply a penalty of minus 1 for extra values in the range if given in radians deduct 1 mark from total awarded (1.57, 1.77, 4.51, 4.71)

9	area sector = $\frac{1}{2}\times r^2\times\frac{\pi}{6}\left[=\frac{\pi r^2}{12}\right]$	**M1**	soi	
	area triangle = $\frac{1}{2}\times a^2\times\sin\frac{\pi}{6}\left[=\frac{a^2}{4}\right]$	**M1**	soi	allow sin30
	$\frac{1}{2}a^2\times\frac{1}{2}=\frac{1}{2}\times r^2\times\frac{\pi}{6}\times\frac{1}{2}$	**M1**	soi	no follow through marks available
	$\frac{a^2}{4}=\frac{\pi r^2}{24}$ o.e. and completion to given answer	**A1**		at least one correct intermediate step required, and no wrong working to obtain given answer

Section A Total: 36

SECTION B

10	(i) eqn of AB is $y = 3x + 1$ o.e. their "$3x + 1$" $= 4x^2$ $(4x + 1)(x - 1) = 0$ o.e. so $x = -1/4$ at C, $x = -1/4$, $y = 4 \times (-1/4)^2$ or $3 \times (-1/4) + 1$[=1/4 as required]	**M1** **M1** **M1** **A1**	or equiv in y: $y = 4\left(\frac{y-1}{3}\right)^2$ or rearranging and deriving roots $y = 4$ or ¼ condone verification by showing lhs = rhs o.e. or y = ¼ implies x = ± ¼ so at C x = − ¼	**SC3** for verifying that A, B and C are collinear and that C also lies on the curve **SC2** for verifying that A, B and C are collinear by showing that gradient of AB = AC (for example) or showing C lies on AB solely verifying that C lies on the curve scores 0
10	(ii) $y' = 8x$ at A $y' = 8$ eqn of tgt at A $y - 4$ = their"8"$(x - 1)$ $y = 8x - 4$ at C $y' = 8 \times -1/4$ [=−2] y − ¼ = −2(x − (− ¼)) or other unsimplified equivalent to obtain given result. allow correct verification that (-¼,¼) lies on given line	**M1** **A1** **M1** **A1** **M1** **A1**	ft their gradient NB if m = -2 obtained from given answer or only showing that (− ¼, ¼) lies on given line $y = -2x$ − ¼ then 0 marks.	gradient must follow from evaluation of $\frac{dy}{dx}$ condone unsimplified versions of $y = 8x - 4$ dependent on award of first **M1** **SC2** if equation of tangent and curve solved simultaneously to correctly show repeated root
10	(iii) their "$8x - 4$" $= -2x$ − ¼ $y = -1$ www	**M1** **A1**	or $\frac{y+4}{8} = \frac{y+\frac{1}{4}}{-2}$	o.e. [$x = 3/8$]

11	(i) $\frac{x^4}{4} - x^3 - \frac{x^2}{2} + 3x$ their integral at 3 − their integral at 1 [= −2.25 − 1.75] = −4 isw represents area between curve and x axis between x = 1 and 3 negative since below x-axis	M2 M1 A1 B1 B1	**M1** if at least two terms correct dependent on integration attempted	ignore $+c$ M0 for evaluation of $x^3 - 3x^2 - x + 3$ or of differentiated version **B0** for area *under* or above curve between x = 1 and 3
11	(ii) $y' = 3x^2 - 6x - 1$ their $y' = 0$ soi $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$ with $a = 3$, $b = -6$ and $c = -1$ isw $x = \frac{6 \pm \sqrt{48}}{6}$ or better as final answer $\frac{6-\sqrt{48}}{6} < x < \frac{6+\sqrt{48}}{6}$ or ft their final answer	M1 M1 M1 A1 B1	dependent on differentiation attempted or $3(x-1)^2$ - 4 [= 0] or better eg **A1** for $1 \pm \frac{2}{3}\sqrt{3}$ allow ≤ instead of <	no follow through; NB $\frac{6 \pm \sqrt{48}}{6}$ or better stated without working implies use of correct method **A0** for incorrect simplification, eg 1 ± √48 allow **B1** if *both* inequalities are stated separately and it's clear that both apply allow **B1** if the terms and the signs are in reverse order
12	(i) 50% of 25 000 is 12 500 and the population [in 2005] is 12 000 [so consistent]	B1	or 12 000 is 48% of 25 000 so less than 50%[so consistent]	
12	(ii) $\log_{10} P = \log_{10} a - kt$ or $\log_{10} \frac{P}{a}$ = -kt o.e. www	B2	condone omission of base; **M1** for $\log_{10} P = \log_{10} a + \log_{10} 10^{-kt}$ or better www	

12	(iii) 4.27, 4.21, 4.13, 4.08 plots ruled line of best fit drawn	**B1** **B1** **B1**	accept 4.273…, 4.2108…, 4.130…, 4.079… rounded to 2 or more dp 1 mm tolerance ft their values if at least 4 correct values are correctly plotted	 f.t. if at least two calculated values correct must have at least one point on or above and at least one point on or below the line and must cover $0 \le t \le 25$
12	(iv) a = 25000 to 25400 $0.01 \le k \le 0.014$ $P = a \times 10^{-kt}$ or $P = 10^{\log a - kt}$ with values in acceptable ranges	**B1** **B2** **B1**	allow $10^{4.4..}$ **M1** for $-k = \frac{\Delta y}{\Delta x}$ using values from table or graph; condone $+k$ **B0** if left in logarithmic form	**M1** for a correct first step in solving a pair of valid equations in either form **A1** for k **A1** for a **A1** for $P = a \times 10^{-kt}$
12	(v) $P = a \times 10^{-35k}$ 8600 to 9000 comparing their value with 9375 o.e. and reaching the correct conclusion for their value	**M1** **A1** **A1**	T heir a and k f.t.	allow $\log P = \log a - 35k$

Section B Total: 36

4752 Concepts for Advanced Mathematics

General Comments

In general the candidates seemed well prepared for this examination, and the paper was accessible to the overwhelming majority. That said, a surprising number of candidates lost easy marks through a failure to handle routine algebra, and some candidates presented their work so poorly that it was not always possible to tell whether an answer deserved credit or not. For example, was a multiplication sign changed into an addition sign – or vice versa? Centres are reminded of the importance of crossing out work clearly and replacing it clearly. A few candidates made life difficult for examiners by doing a small amount of extra work in the middle of a large supplementary answer book.
Centres are reminded that with a request to "show that", candidates are expected to work towards the given answer for full credit, rather than *verify* the result (by substitution, for example). A verification approach is unlikely to attract full credit when the demand is "show that". Many candidates still do not seem to recognise when an answer they have found is clearly not sensible (for example in Q5 $-1 < r < 1$, Q6 a large positive value for d, Q12 (v) a huge increase in the number of sparrows.)

Comments on Individual Questions

1) The overwhelming majority of candidates scored full marks on this question. A few made a slip with the arithmetic, and lost a mark. The small minority who had extra terms or too few terms did not score. Neither did the small number of candidates who thought it was a geometric progression.

2) This question was done very well, with most candidates obtaining full marks. Careless mistakes included the omission of "+ c", 2 ÷ ½ = 1 and 3 ÷ 6 = 2 (the latter was not penalised.) A few candidates differentiated the second term instead of integrating.

3) Most candidates scored full marks. A few slipped up with the arithmetic, and some used the wrong value for h. Some of the catastrophic errors which resulted in no marks being awarded were $h = 7.5$, the omission of the outer brackets and the substitution of x values instead of y values.

4) (i) Most candidates gained full marks here, but (3, 8), (3, 5/3) and (9,15) were seen from time to time.

4) (ii) Candidates were even more successful with this part. (6,5) was by far the most common error, although (3/2, 5) was occasionally seen.

5) A small number of candidates either could not make a start or thought this was an arithmetic progression. However, most candidates recognised the geometric progression, and many were able to find r correctly – usually by solving the correct equations simultaneously, but occasionally by trial and error. u_n was found correctly by most, but those who made sign errors with a and r did not earn full credit. Many recognised the appropriate formula for the sum of the first n terms, but only the best candidates were able to manipulate the brackets correctly and present the right answer.

6) Most candidates wrote down two correct equations and solved them correctly to find a and d. However, some surprising errors were seen – usually involving division or addition instead of subtraction. A few successfully used a trial and error approach. The last two marks were only obtained by the stronger candidates. The most common errors were to find $S_{50} – S_{21}$, or to find S_{29} (instead of S_{30}).

7) (i) Most candidates successfully obtained the correct answer. The following errors were commonly seen: $5 \log x + 12 \log x = 60 \log x$ (or $17 \log x^2$), $3 \log x^4 = \log x^7$ and $\log x^5 + 3 \log x^4 = 3 \log x^{5+4}$.

7)(ii) Most candidates correctly identified at least one of the terms, and most went on to score full marks. Only a few candidates clearly did not understand what was going on, and tried to combine the two terms.

8) A significant minority failed to score any marks at all on this question, either because they did not know how to start, or because their initial step was either $\cos\theta = 1 - \sin\theta$, or $\sin^2\theta = 1 - \cos\theta$. After a correct initial step, errors in expanding the brackets were often seen, usually resulting in $\cos^2\theta + \cos\theta = 0$ or $5\cos^2\theta - \cos\theta = 0$. At this point many candidates divided by $\cos\theta$ and missed the roots 90° and 270°. Those who obtained 101.5° often failed to appreciate that there was another root connected with this, or simply added 180 to obtain 281.5°. A surprising number of candidates found $\cos^{-1}(0.2)$ after earning the first two marks. Only a few then went on to obtain the correct values.

9) Many candidates earned a mark by stating correctly the area of the sector. A few were able to also give the correct formula for the area of the triangle (but a surprisingly large number could not), but only the best were able to deal with $\sin(\pi/6)$ and equate this with half the area of the sector. There were many fruitless attempts to "fudge" the given answer, often based on using the length *a* as the area.

10) (i) Only a few candidates failed to score on this question. Most successfully obtained the equation of the line, and then equated it to the equation of the curve. Marks were then sometimes lost through a failure to solve the resulting quadratic successfully, or for merely stating that at $x = -\frac{1}{4}$, $y = \frac{1}{4}$, instead of actually substituting the value in an appropriate formula. Those who adopted a verification approach incurred a small penalty, as detailed in the mark scheme.

10) (ii) This part was done very well indeed. Some candidates lost marks by showing insufficient working in the last part, and a very few thought the gradient of the tangent at A was -1/8.

10) (iii) Most candidates obtained full marks, but a few equated $3x + 1$ with $-2x - \frac{1}{4}$, and some candidates made mistakes with the algebra and obtained $y = 7$ (or 1).

11) (i) Nearly all candidates integrated at least two terms correctly to obtain one method mark, and nearly all obtained the third mark for evaluating F(3) – F(1). The most frequent errors in the integration were the omission of the denominator of 2 in the third term, or the complete omission of the fourth term. Many made errors with the arithmetic and lost the fourth mark. Many of the responses to the last part were too vague to earn full credit.

11) (ii) There were many very good attempts at this question, although a surprising number of candidates were unable to use the (correct) quadratic formula or complete the square correctly for the third mark. Many candidates lost the accuracy mark through an incorrect simplification of correctly obtained surds. Most candidates were familiar with decreasing functions and were rewarded accordingly.

12) (i) The overwhelming majority of candidates used the given data appropriately and earned the mark for this question.

12) (ii) A disappointingly high number of candidates seemed to be unfamiliar with this standard piece of work, and presented an incorrect equation, or incorrect working to "derive" the correct equation. $\log P = \log a \times \log 10^{-kt}$ was frequently seen.

12) (iii) This was done very well by nearly all the candidates. Only a few lost the first mark (usually for giving the last value as 4.07 or 4.1, but sometimes all the values were incorrect), and even fewer lost the second mark for correctly plotting their values. A small number of candidates failed to use a ruler and lost the last mark.

12)(iv) Most connected the gradient of the line with *k* and many obtained a value within the specified range. Some made a sign error and lost a mark. Nearly all those who attempted the question connected log*a* with the intercept, and obtained a value within the specified range. Only a few candidates interchanged *k* and *a* and thus failed to score. Even some strong candidates ignored the request for a statement of the equation in the required form and lost an easy mark accordingly.

12) (v) A good number of candidates failed to score. Most candidates who attempted the question realised that a substitution of t = 35 was required, and often went on to score at least one more mark. Some candidates substituted t = 2015 or t = 30. Most related their answer to 9375 and gave a sensible interpretation, thus earning the third mark even if the second had been lost. A very small number of candidates tried to work directly from their graph, usually because they realised their formula was wrong.

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