OCR
RECOGNISING ACHIEVEMENT

OXFORD CAMBRIDGE AND RSA EXAMINATIONS

Advanced Subsidiary General Certificate of Education
Advanced General Certificate of Education

MEI STRUCTURED MATHEMATICS 4752

Concepts for Advanced Mathematics (C2)

Wednesday **12 JANUARY 2005** Afternoon 1 hour 30 minutes

Additional materials:
Answer booklet
Graph paper
MEI Examination Formulae and Tables (MF2)

TIME 1 hour 30 minutes

INSTRUCTIONS TO CANDIDATES

- Write your name, centre number and candidate number in the spaces provided on the answer booklet.
- There is an **insert** for use in Question **11**.
- Answer **all** the questions.
- You are permitted to use a graphical calculator in this paper.

INFORMATION FOR CANDIDATES

- The number of marks is given in brackets [ ] at the end of each question or part question.
- 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.
- Final answers should be given to a degree of accuracy appropriate to the context.
- The total number of marks for this paper is 72.

This question paper consists of 5 printed pages, 3 blank pages and an insert.

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ERRATUM NOTICE

OXFORD CAMBRIDGE AND RSA EXAMINATIONS

Advanced Subsidiary GCE

MEI STRUCTURED MATHEMATICS **4752**

Concepts for Advanced Mathematics (C2)

Wednesday **12 JANUARY 2005** Afternoon 1 hour 30 minutes

To be opened immediately
For the attention of the Examination Officer and Head of Mathematics

For the January session of examinations, all yellow examination papers beginning 47.. should have the new yellow formulae booklet MF2.
All white papers beginning 26.. should have the blue formulae booklet MF12.

There has been an error when sending out the formulae booklets for C2 (4752) and D1 (4771). The 'legacy' formulae booklet (MF12) has been sent.

For the C2 (4752) examination on Wed 12th January 05, candidates may use the MF2 they used in the C1 (4751) examination.
For the D1 (4771) examination on Fri 14th January 05, the legacy formulae booklet MF12 can be used. This will not disadvantage candidates.

Any enquiry about this notice should be referred to the Information Bureau on 01223 553 998 or helpdesk@ocr.org.uk

Jan05/erratum08

Section A (36 marks)

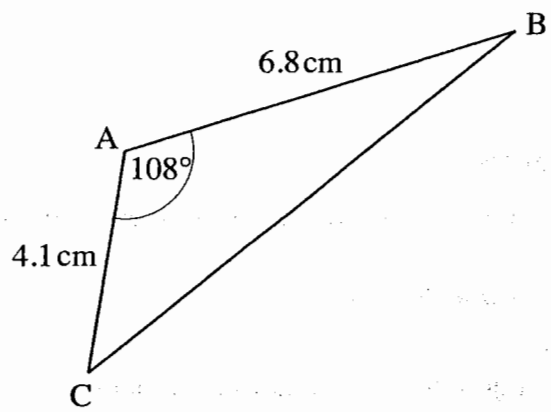
1 Find $\frac{dy}{dx}$ when $y = x^6 + \sqrt{x}$. [3]

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

3 Sketch the graph of $y = \sin x$ for $0° \leqslant x \leqslant 360°$.

Solve the equation $\sin x = -0.2$ for $0° \leqslant x \leqslant 360°$. [4]

4



Not to scale

Fig. 4

For triangle ABC shown in Fig. 4, calculate

(i) the length of BC, [3]

(ii) the area of triangle ABC. [2]

5 The first three terms of a geometric progression are 4, 2, 1.

Find the twentieth term, expressing your answer as a power of 2.

Find also the sum to infinity of this progression. [5]

6 A sequence is given by

$$a_1 = 4,$$

$$a_{r+1} = a_r + 3.$$

Write down the first 4 terms of this sequence.

Find the sum of the first 100 terms of the sequence. [5]

7

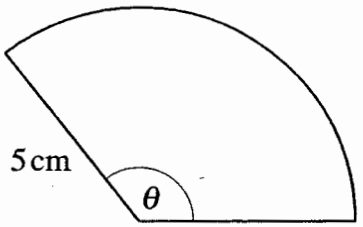


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Fig. 7

Fig. 7 shows a sector of a circle of radius 5 cm which has angle θ radians. The sector has area 30 cm^2.

(i) Find θ. [3]

(ii) Hence find the perimeter of the sector. [2]

8 **(i)** Solve the equation $10^x = 316$. [2]

(ii) Simplify $\log_a\left(a^2\right) - 4\log_a\left(\frac{1}{a}\right)$. [3]

[Turn over

Section B (36 marks)

9 **(i)** A tunnel is 100 m long. Its cross-section, shown in Fig. 9.1, is modelled by the curve

$$y = \tfrac{1}{4}(10x - x^2),$$

where x and y are horizontal and vertical distances in metres.

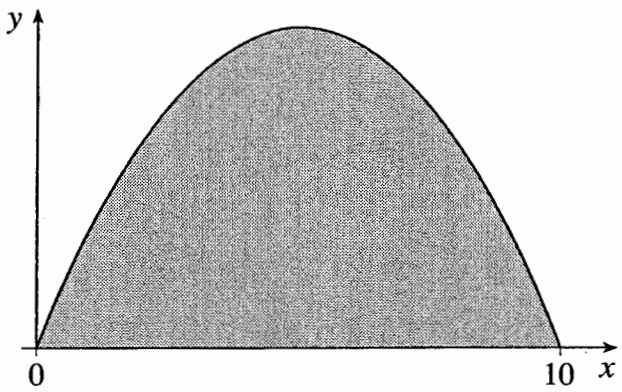

Figure 9.1

Using this model,

(*A*) find the greatest height of the tunnel, [2]

(*B*) explain why $100\int_0^{10} y\,dx$ gives the volume, in cubic metres, of earth removed to make the tunnel. Calculate this volume. [5]

(ii) The roof of the tunnel is re-shaped to allow for larger vehicles. Fig. 9.2 shows the new cross-section.

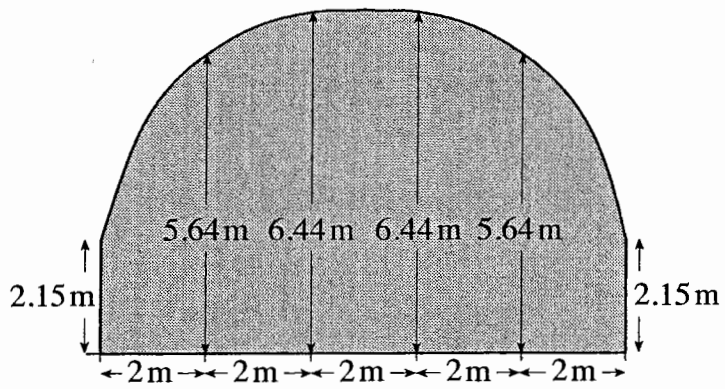

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Fig. 9.2

Use the trapezium rule with 5 strips to estimate the new cross-sectional area.

Hence estimate the volume of earth removed when the tunnel is re-shaped. [5]

10 A curve has equation $y = x^3 - 6x^2 + 12$.

(i) Use calculus to find the coordinates of the turning points of this curve. Determine also the nature of these turning points. [7]

(ii) Find, in the form $y = mx + c$, the equation of the normal to the curve at the point $(2, -4)$. [4]

11 Answer part (iii) of this question on the insert provided.

A hot drink is made and left to cool. The table shows its temperature at ten-minute intervals after it is made.

Time (minutes)	10	20	30	40	50
Temperature (°C)	68	53	42	36	31

The room temperature is 22 °C. The difference between the temperature of the drink and room temperature at time t minutes is z °C. The relationship between z and t is modelled by

$$z = z_0 10^{-kt},$$

where z_0 and k are positive constants.

(i) Give a physical interpretation for the constant z_0. [2]

(ii) Show that $\log_{10} z = -kt + \log_{10} z_0$. [2]

(iii) On the insert, complete the table and draw the graph of $\log_{10} z$ against t.

Use your graph to estimate the values of k and z_0.

Hence estimate the temperature of the drink 70 minutes after it is made. [9]

Candidate Name	Centre Number	Candidate Number

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INSERT

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This insert consists of 2 printed pages.

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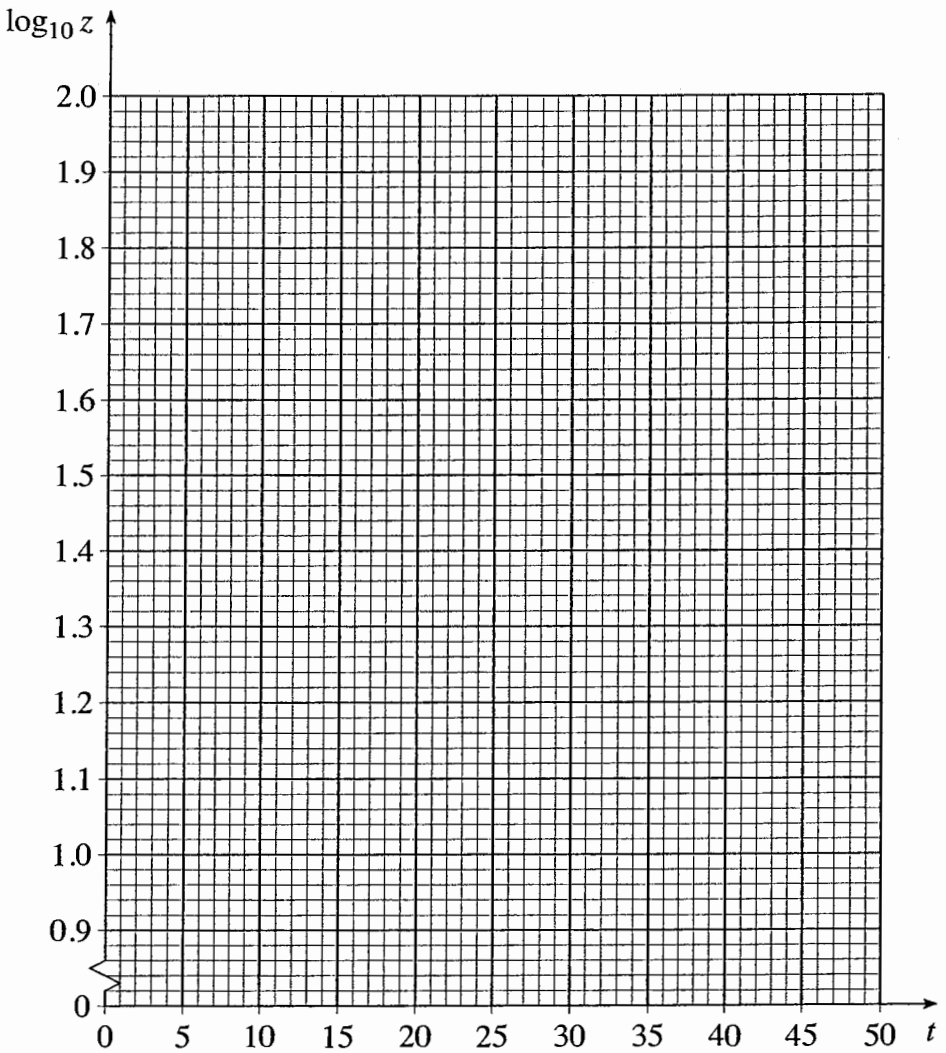
11 (iii)

t	10	20	30	40	50
z	46				
$\log_{10} z$					



Mark Scheme

Section A

1	$6x^5 + \frac{1}{2}x^{-\frac{1}{2}}$ o.e.	B1 B1 B1	$6x^5$ $x^{\frac{1}{2}}$ soi $\frac{1}{2}x^{-\frac{1}{2}}$ isw	3
2	$x^4/4$ $\frac{x^{-2}}{-2}$ c	B1 B2 B1	 B1 for kx^{-2}	4
3	At least 1 period of sine curve Sine curve from 0 to 360 191.537 rot to 3 or more sf 348.463 rot to 3 or more sf	G1 G1 B1 B1	 ± 1 indicated After B1 B1, -1 for extras in the range SC1 for 192.8 and 347.2 (grads) SC1 for 180.2 and 359.8 (radians)	4
4	9.0 or 8.96 or 8.960 13.2577	B3 B2	M1 for $[BC^2=]6.8^2+4.1^2-2\times4.1\times6.8\times\cos108$ A1 for 80.2(8..), 8.37(grads), 6.49 (rads) Correctly rounded to 3 or more sf M1 for $0.5\times4.1\times6.8\times\sin108$ For complete long methods using BC, allow M1 and A1 for 13.2 to 13.3	5 **[16]**
5	a = 4, r = 1/2 identified 2^{-17} 8	B1 T2 S2	Stated or identified by correct use M1 20th term = their(*a*)x(their *r*)^{19} M1 S = their (*a*) / (1–their (*r*))	5
6	4, 7, 10, 13, 16 ignore extras 15250	B1 B4	For showing 1st four or 2nd four terms B1 for d = 3 soi B1 for a = 4 soi M1 for use of 100/2[2a + 99d] o.e.	5
7	(i) 2.4, $2\frac{2}{5}$, $\frac{12}{5}$ (ii) 22	B3 P2	M1 for 30 = ½ × 25 × q o.e. M1 for q = (2 x 30) / 5^2 M1 for (arc =)5 x their 2.4	5
8	(i) 2.5, 2.50, 2.500, 2.499.. (ii) 6 www	B2 B3	M1 for $\log_{10}$ 316 or ln 316/ln 10 B2 for 6 $\log_a a$ or $\log_a(a^6)$ Or B1 for $2\log_a(a)$ or $-\log_a a^{-4}$ SC1 Using a=10 ⇒ 6 SC2 Using numerical a, not 10 ⇒ 6	5 **[20]**
			Total for section A	36

Section B

9	**i*A***	6.25	B2	M1 for $x = 5$ used to find y	2
	i*B*	(V =) area of cross-section × length	E1		
		$(\frac{100}{4})[\frac{10}{2}x^2 - \frac{1}{3}x^3]$ o.e.	M1		
		[val at $x = 10$] – [val at $x = 0$]	M1	Subs of correct limits into their integrand	
		4166 to 4167 or 4170	A2	A1 for 166.6... or 16666.6... or 41.6…rot to 3 sf or more	5
	ii	52.62	B4	M3 for- 2/2×[2.15x2+2(5.64x2+6.44x2)]oe Or M2 if one slip Or M1 if 2 slips or one trap evaluated	5 **[12]**
		Their(5262) – their (4167)	M1	Must be >0	
10	**i**	$y' = 3x^2 - 12x$	B1B1		
		use of $y' = 0$	M1		
		$x = 0$ and 4	A1		
		(0, 12) and (4, –20)	A1	Allow y = 12 and y = -20	
		$y'' = 6x - 12$ used	M1	y' used each side of TP or good sketch	7
		max when $x = 0$, min when $x = 4$	A1	Both stated, only one needs testing	
	ii	when $x = 2$ $y' = -12$	B1		
		grad of normal = 1/12	B1ft	from their y'	
		$y + 4 = 1/12(x - 2)$	M1ft	accept any numerical m Or -4 = their(m) x 2 + c	4 **[11]**
		$y = \frac{1}{12}x - 4\frac{1}{6}$	A1	Any recognisable 25/6, at worst 4.1	
11	**i**	Excess temperature	B1		2
		At t =0 oe	B1		
	ii	$\log z = \log z_0 + \log (10^{-kt})$	B1		
		$= \log z_0 - kt\log 10$	B1	nb AG	2
	iii	Z= 46 31 20 14 9		If z= 68, 53…P1, L1,M1, M1, M1 available	
		log *z* : 1.66 1.49 1.30 1.15 0.95	T1		
		correctly plotted	P1	ft their values, within 2mm	
		line of best fit	L1	Ruled, using their points	
		k = 0.017 to 0.019 or 0.02	G2	M1 for attempting +/- gradient	9
		z_0= 66 to 73	B2	M1 for (log) z_0= 1.82 to 1.86	
		temp of drink = 25 to 27	C2	M1 3 to 5 or their $69 \times 10^{-70 \text{ x their } k}$	**[13]**

Examiner’s Report