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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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

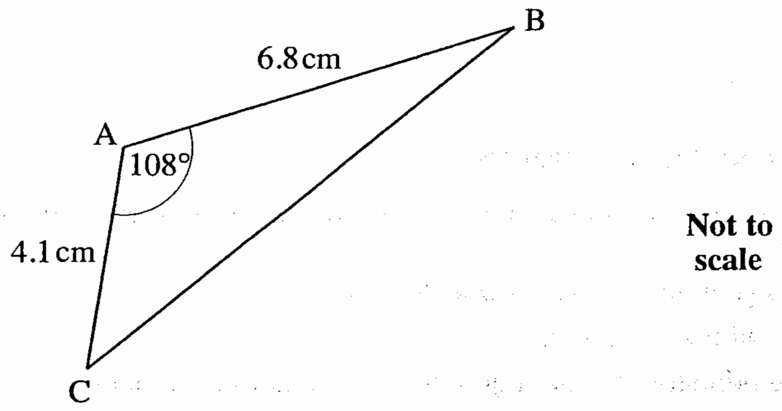


Fig. 4

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

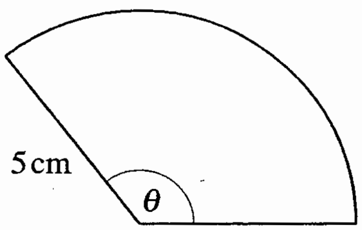
$$a_1 = 4,$$

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

Write down the first 4 terms of this sequence.

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

7



Not to scale

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

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

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

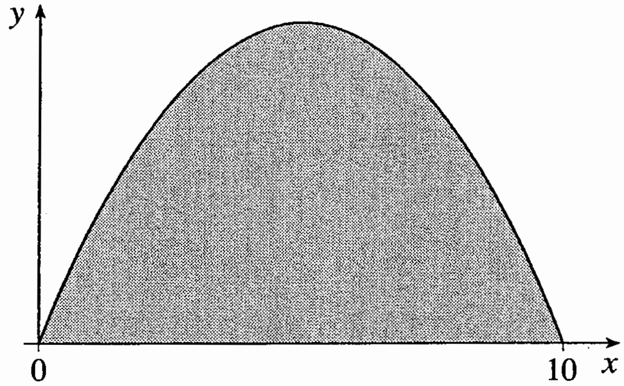


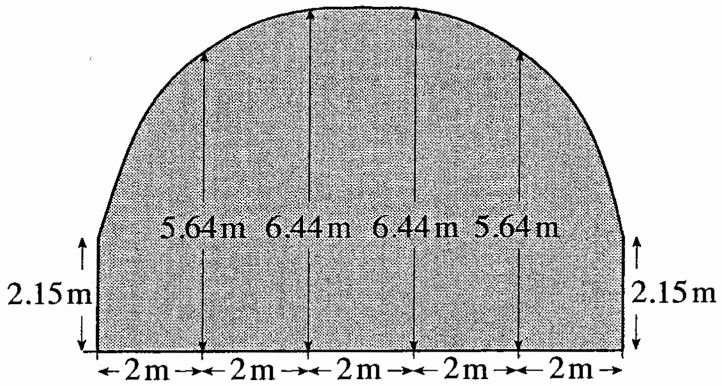
Figure 9.1

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.



Not to scale

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

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)

INSERT

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

INSTRUCTIONS TO CANDIDATES

- This insert should be used in Question **11**.
- Write your name, centre number and candidate number in the spaces provided at the top of this page and attach it to your answer booklet.

This insert consists of 2 printed pages.

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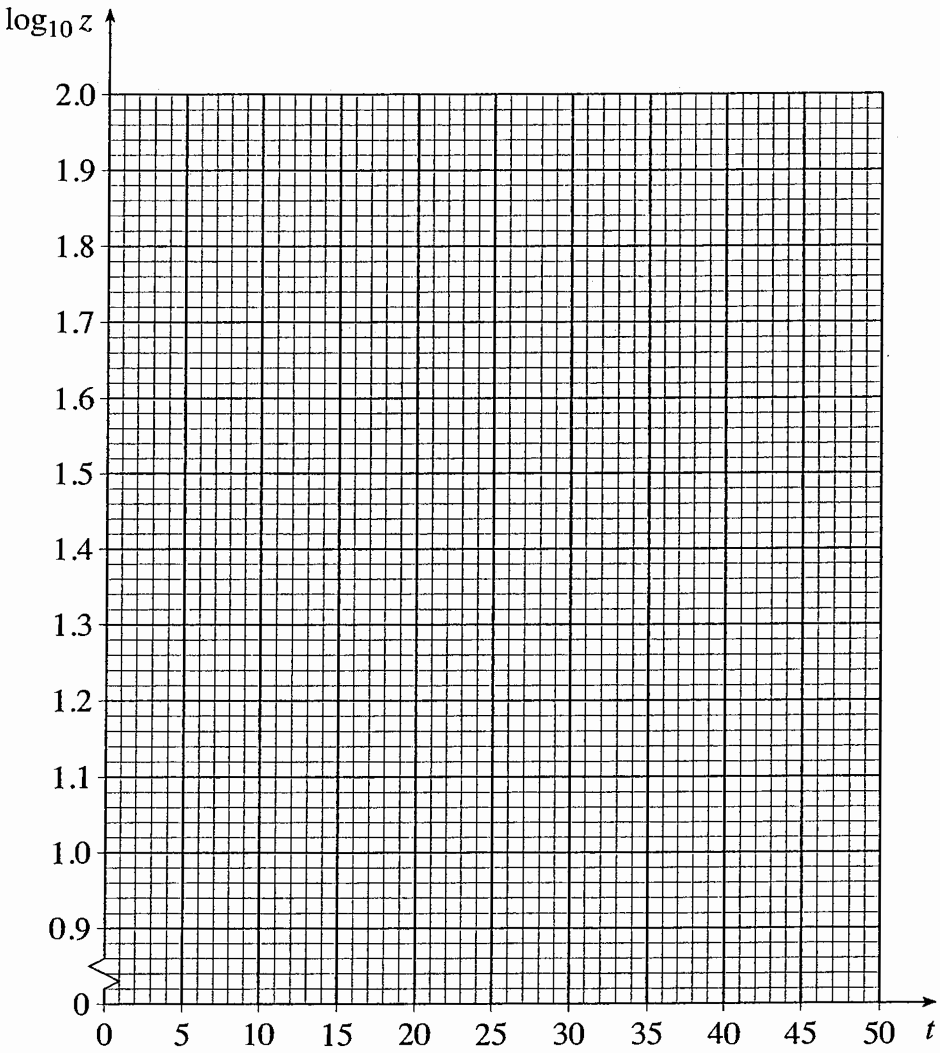
11 (iii)

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



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)

Monday **23 MAY 2005** Morning 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.
- Answer **all** the questions.
- You are permitted to use a graphical calculator in this paper.

INFORMATION FOR CANDIDATES

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Section A (36 marks)

1 Differentiate $x + \sqrt{x^3}$. [4]

2 The nth term of an arithmetic progression is $6 + 5n$. Find the sum of the first 20 terms. [4]

3 Given that $\sin\theta = \frac{\sqrt{3}}{4}$, find in surd form the possible values of $\cos\theta$. [3]

4 A curve has equation $y = x + \frac{1}{x}$.

Use calculus to show that the curve has a turning point at $x = 1$.

Show also that this point is a minimum. [5]

5 (i) Write down the value of $\log_5 5$. [1]

(ii) Find $\log_3\left(\frac{1}{9}\right)$. [2]

(iii) Express $\log_a x + \log_a(x^5)$ as a multiple of $\log_a x$. [2]

6 Sketch the graph of $y = 2^x$.

Solve the equation $2^x = 50$, giving your answer correct to 2 decimal places. [5]

7 The gradient of a curve is given by $\frac{dy}{dx} = \frac{6}{x^3}$. The curve passes through $(1, 4)$.

Find the equation of the curve. [5]

8 (i) Solve the equation $\cos x = 0.4$ for $0° \leqslant x \leqslant 360°$.

(ii) Describe the transformation which maps the graph of $y = \cos x$ onto the graph of $y = \cos 2x$. [5]

Section B (36 marks)

9

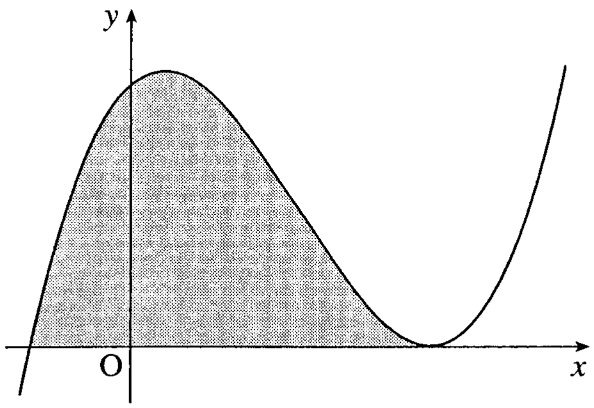


Fig. 9

Fig. 9 shows a sketch of the graph of $y = x^3 - 10x^2 + 12x + 72$.

(i) Write down $\frac{dy}{dx}$. [2]

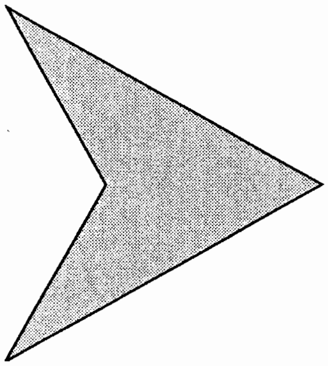
(ii) Find the equation of the tangent to the curve at the point on the curve where $x = 2$. [4]

(iii) Show that the curve crosses the x-axis at $x = -2$. Show also that the curve touches the x-axis at $x = 6$. [3]

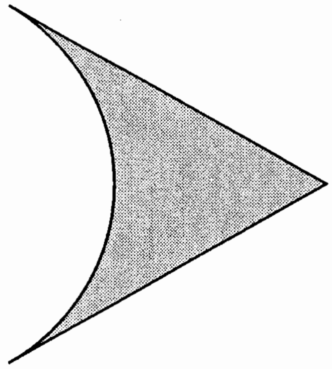
(iv) Find the area of the finite region bounded by the curve and the x-axis, shown shaded in Fig. 9. [4]

PMT

10 *Arrowline Enterprises* is considering two possible logos:



and



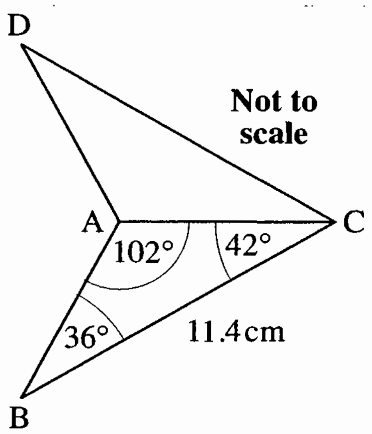


Fig. 10.1

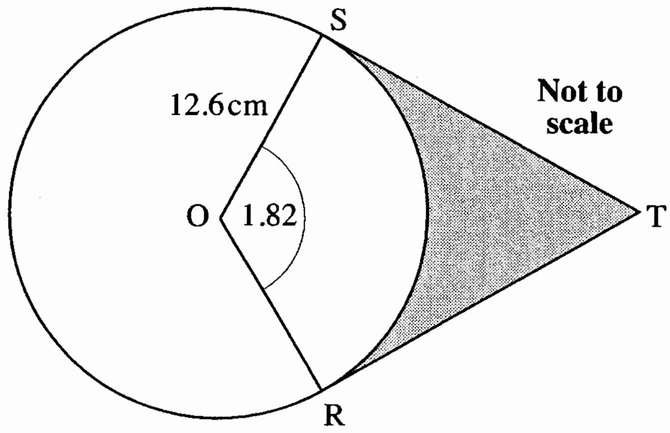


Fig. 10.2

(i) Fig. 10.1 shows the first logo ABCD. It is symmetrical about AC.

Find the length of AB and hence find the area of this logo. [4]

(ii) Fig. 10.2 shows a circle with centre O and radius 12.6 cm. ST and RT are tangents to the circle and angle SOR is 1.82 radians. The shaded region shows the second logo.

Show that ST = 16.2 cm to 3 significant figures.

Find the area and perimeter of this logo. [8]

11 There is a flowerhead at the end of each stem of an oleander plant. The next year, each flowerhead is replaced by three stems and flowerheads, as shown in Fig. 11.

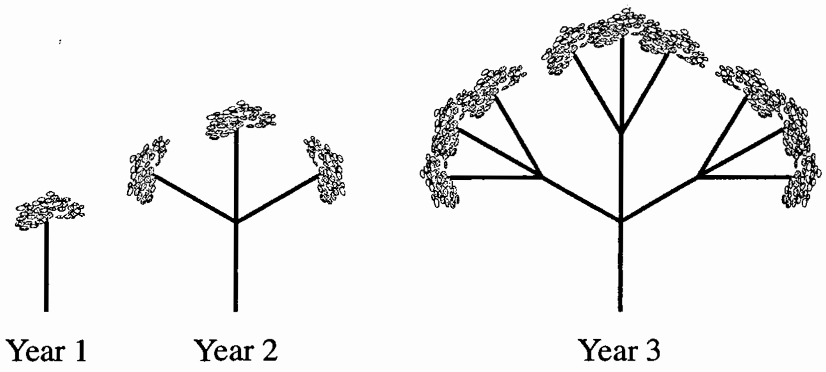


Fig. 11

(i) How many flowerheads are there in year 5? [1]

(ii) How many flowerheads are there in year n? [1]

(iii) As shown in Fig. 11, the total number of stems in year 2 is 4, (that is, 1 old one and 3 new ones). Similarly, the total number of stems in year 3 is 13, (that is, 1 + 3 + 9).

Show that the total number of stems in year n is given by $\frac{3^n - 1}{2}$. [2]

(iv) Kitty's oleander has a total of 364 stems. Find

(A) its age, [2]

(B) how many flowerheads it has. [1]

(v) Abdul's oleander has over 900 flowerheads.

Show that its age, y years, satisfies the inequality $y > \frac{\log_{10} 900}{\log_{10} 3} + 1$.

Find the smallest integer value of y for which this is true. [4]

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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)

Monday **16 JANUARY 2006** Morning 1 hour 30 minutes

Additional materials:
8 page 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.
- Answer **all** the questions.
- You are permitted to use a graphical calculator in this paper.
- Final answers should be given to a degree of accuracy appropriate to the context.

INFORMATION FOR CANDIDATES

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- The total number of marks for this paper is 72.

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

HN/3
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Section A (36 marks)

1 Given that $140° = k\pi$ radians, find the exact value of k. [2]

2 Find the numerical value of $\sum_{k=2}^{5} k^3$. [2]

3

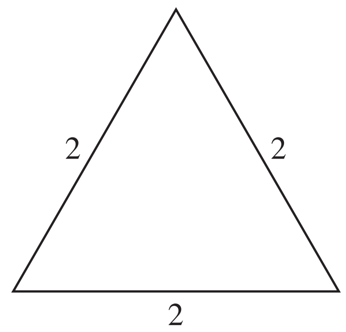


Fig. 3

Beginning with the triangle shown in Fig. 3, prove that $\sin 60° = \frac{\sqrt{3}}{2}$. [3]

4

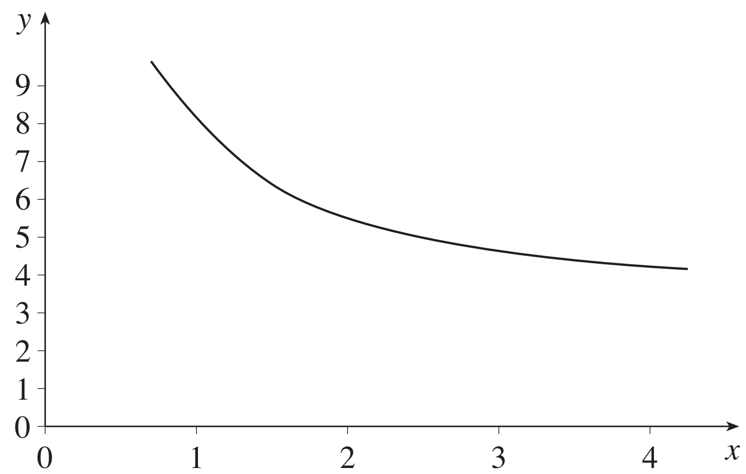


Fig. 4

Fig. 4 shows a curve which passes through the points shown in the following table.

x	1	1.5	2	2.5	3	3.5	4
y	8.2	6.4	5.5	5.0	4.7	4.4	4.2

Use the trapezium rule with 6 strips to estimate the area of the region bounded by the curve, the lines $x = 1$ and $x = 4$, and the x-axis.

State, with a reason, whether the trapezium rule gives an overestimate or an underestimate of the area of this region. [5]

5 **(i)** Sketch the graph of $y = \tan x$ for $0° \leqslant x \leqslant 360°$. [2]

(ii) Solve the equation $4\sin x = 3\cos x$ for $0° \leqslant x \leqslant 360°$. [3]

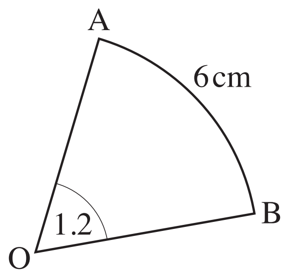
6 A curve has gradient given by $\frac{dy}{dx} = x^2 - 6x + 9$. Find $\frac{d^2y}{dx^2}$.

Show that the curve has a stationary point of inflection when $x = 3$. [4]

7 In Fig. 7, A and B are points on the circumference of a circle with centre O.

Angle AOB = 1.2 radians.

The arc length AB is 6 cm.



Not to scale

Fig. 7

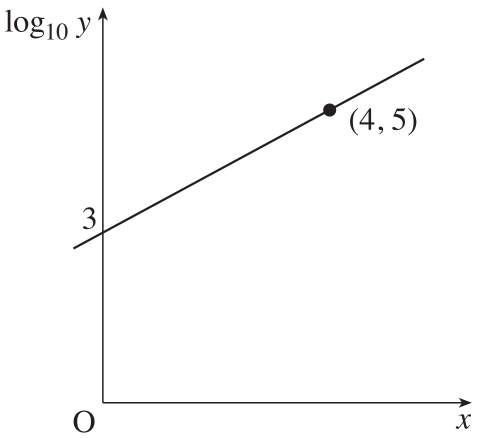
(i) Calculate the radius of the circle. [2]

(ii) Calculate the length of the chord AB. [3]

8 Find $\int \left(x^{\frac{1}{2}} + \frac{6}{x^3} \right) dx$. [5]

[Turn over

9



Not to scale

Fig. 9

The graph of $\log_{10} y$ against x is a straight line as shown in Fig. 9.

(i) Find the equation for $\log_{10} y$ in terms of x. [3]

(ii) Find the equation for y in terms of x. [2]

Section B (36 marks)

10 The equation of a curve is $y = 7 + 6x - x^2$.

(i) Use calculus to find the coordinates of the turning point on this curve.

Find also the coordinates of the points of intersection of this curve with the axes, and sketch the curve. [8]

(ii) Find $\int_1^5 (7 + 6x - x^2)\,dx$, showing your working. [3]

(iii) The curve and the line $y = 12$ intersect at $(1, 12)$ and $(5, 12)$. Using your answer to part **(ii)**, find the area of the finite region between the curve and the line $y = 12$. [1]

11

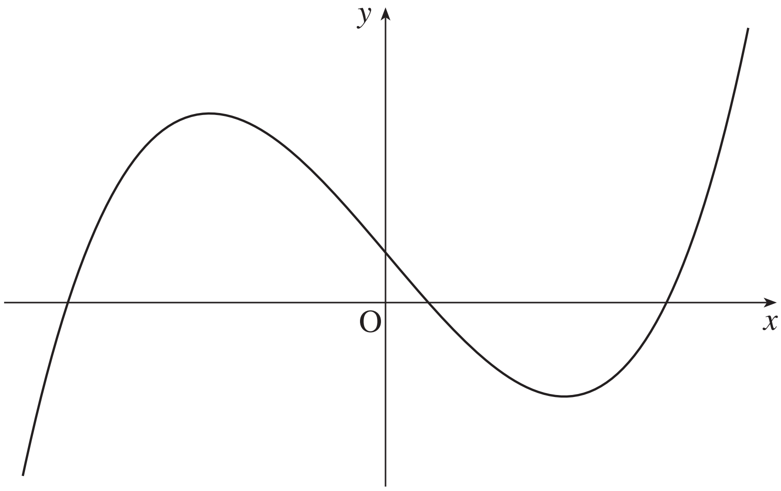


Fig. 11

The equation of the curve shown in Fig. 11 is $y = x^3 - 6x + 2$.

(i) Find $\dfrac{dy}{dx}$. [2]

(ii) Find, in exact form, the range of values of x for which $x^3 - 6x + 2$ is a decreasing function. [3]

(iii) Find the equation of the tangent to the curve at the point $(-1, 7)$.

Find also the coordinates of the point where this tangent crosses the curve again. [6]

12 **(i)** Granny gives Simon £5 on his 1st birthday. On each successive birthday, she gives him £2 more than she did the previous year.

(*A*) How much does she give him on his 10th birthday? [2]

(*B*) How old is he when she gives him £51? [2]

(*C*) How much has she given him **in total** when he has had his 20th birthday present? [2]

(ii) Grandpa gives Simon £5 on his 1st birthday and increases the amount by 10% each year.

(*A*) How much does he give Simon on his 10th birthday? [2]

(*B*) Simon first gets a present of over £50 from Grandpa on his *n*th birthday. Show that

$$n > \frac{1}{\log_{10} 1.1} + 1.$$

Find the value of n. [5]

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)

Tuesday **6 JUNE 2006** Afternoon 1 hour 30 minutes

Additional materials:
8 page 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.
- Answer **all** the questions.
- There is an **insert** for use in Question **12**.
- You are permitted to use a graphical calculator in this paper.
- Final answers should be given to a degree of accuracy appropriate to the context.

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.
- The total number of marks for this paper is 72.

This question paper consists of 4 printed pages and an insert.

HN/4
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Section A (36 marks)

1 Write down the values of $\log_a a$ and $\log_a (a^3)$. [2]

2 The first term of a geometric series is 8. The sum to infinity of the series is 10.

Find the common ratio. [3]

3 θ is an acute angle and $\sin\theta = \frac{1}{4}$. Find the exact value of $\tan\theta$. [3]

4 Find $\int_1^2 \left(x^4 - \frac{3}{x^2} + 1\right) \mathrm{d}x$, showing your working. [5]

5 The gradient of a curve is given by $\frac{\mathrm{d}y}{\mathrm{d}x} = 3 - x^2$. The curve passes through the point $(6, 1)$. Find the equation of the curve. [4]

6 A sequence is given by the following.

$$u_1 = 3$$
$$u_{n+1} = u_n + 5$$

(i) Write down the first 4 terms of this sequence. [1]

(ii) Find the sum of the 51st to the 100th terms, inclusive, of the sequence. [4]

7 **(i)** Sketch the graph of $y = \cos x$ for $0° \leqslant x \leqslant 360°$.

On the same axes, sketch the graph of $y = \cos 2x$ for $0° \leqslant x \leqslant 360°$. Label each graph clearly. [3]

(ii) Solve the equation $\cos 2x = 0.5$ for $0° \leqslant x \leqslant 360°$. [2]

8 Given that $y = 6x^3 + \sqrt{x} + 3$, find $\frac{\mathrm{d}y}{\mathrm{d}x}$ and $\frac{\mathrm{d}^2y}{\mathrm{d}x^2}$. [5]

9 Use logarithms to solve the equation $5^{3x} = 100$. Give your answer correct to 3 decimal places. [4]

Section B (36 marks)

10 **(i)**

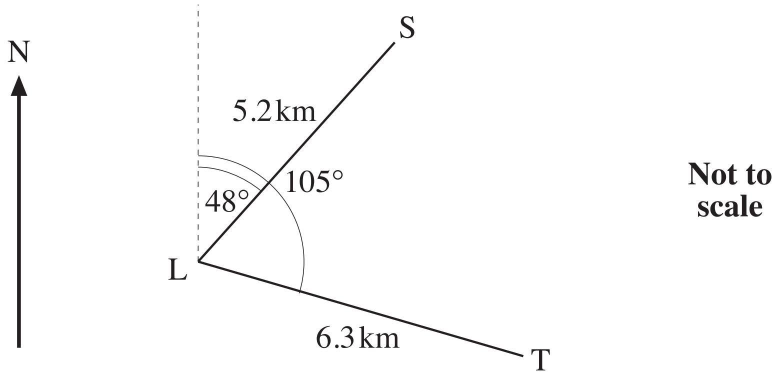

Fig. 10.1

At a certain time, ship S is 5.2 km from lighthouse L on a bearing of 048°. At the same time, ship T is 6.3 km from L on a bearing of 105°, as shown in Fig. 10.1.

For these positions, calculate

(*A*) the distance between ships S and T, [3]

(*B*) the bearing of S from T. [3]

(ii)

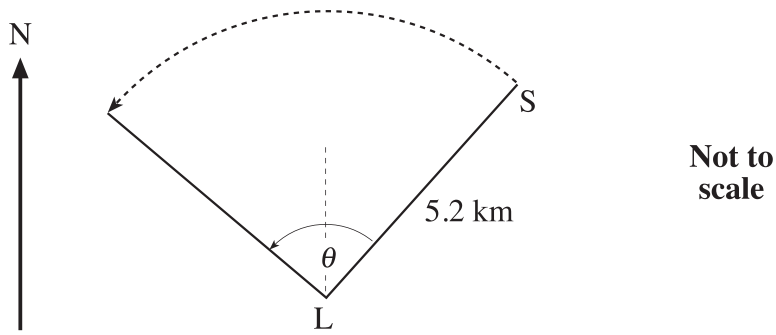

Fig. 10.2

Ship S then travels at $24\,\text{km h}^{-1}$ anticlockwise along the arc of a circle, keeping 5.2 km from the lighthouse L, as shown in Fig. 10.2.

Find, in radians, the angle θ that the line LS has turned through in 26 minutes.

Hence find, in degrees, the bearing of ship S from the lighthouse at this time. [5]

[Turn over

11 A cubic curve has equation $y = x^3 - 3x^2 + 1$.

(i) Use calculus to find the coordinates of the turning points on this curve. Determine the nature of these turning points. [5]

(ii) Show that the tangent to the curve at the point where $x = -1$ has gradient 9.

Find the coordinates of the other point, P, on the curve at which the tangent has gradient 9 and find the equation of the normal to the curve at P.

Show that the area of the triangle bounded by the normal at P and the x- and y-axes is 8 square units. [8]

12 **Answer the whole of this question on the insert provided.**

A colony of bats is increasing. The population, P, is modelled by $P = a \times 10^{bt}$, where t is the time in years after 2000.

(i) Show that, according to this model, the graph of $\log_{10} P$ against t should be a straight line of gradient b. State, in terms of a, the intercept on the vertical axis. [3]

(ii) The table gives the data for the population from 2001 to 2005.

Year	2001	2002	2003	2004	2005
t	1	2	3	4	5
P	7900	8800	10000	11300	12800

Complete the table of values on the insert, and plot $\log_{10} P$ against t. Draw a line of best fit for the data. [3]

(iii) Use your graph to find the equation for P in terms of t. [4]

(iv) Predict the population in 2008 according to this model. [2]

Candidate Name	Centre Number	Candidate Number

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)

INSERT

Tuesday **6 JUNE 2006** Afternoon 1 hours 30 minutes

INSTRUCTIONS TO CANDIDATES

- This **insert** should be used in Question **12.**
- Write your name, centre number and candidate number in the spaces provided at the top of this page and attach it to your answer booklet.

This insert consists of 2 printed pages.

HN/2

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[Turn over

PMT

12 **(i)** ....

....

....

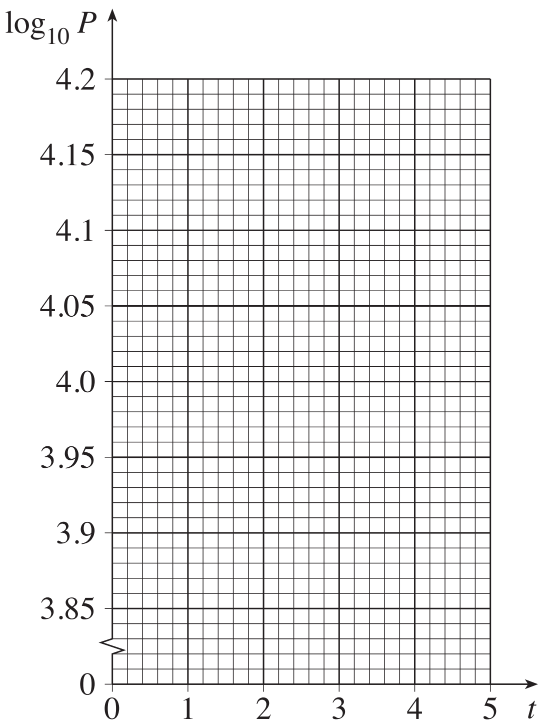
....

....

....

(ii)

Year	2001	2002	2003	2004	2005
t	1	2	3	4	5
P	7900	8800	10 000	11 300	12 800
$\log_{10} P$					



(iii) ....

....

....

(iv) ....

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RECOGNISING ACHIEVEMENT

ADVANCED SUBSIDIARY GCE UNIT

4752/01

MATHEMATICS (MEI)

Concepts for Advanced Mathematics (C2)

TUESDAY 16 JANUARY 2007

Morning
Time: 1 hour 30 minutes

Additional materials:
Answer booklet (8 pages)
Graph paper
MEI Examination Formulae and Tables (MF2)

INSTRUCTIONS TO CANDIDATES

- Write your name, centre number and candidate number in the spaces provided on the answer booklet.
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- The total number of marks for this paper is 72.
- There is an **insert** for use in Question **13**.

ADVICE TO CANDIDATES

- Read each question carefully and make sure you know what you have to do before starting your answer.
- 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.

This document consists of **6** printed pages, **2** blank pages and an insert.

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PMT

Section A (36 marks)

1 Differentiate $6x^{\frac{5}{2}} + 4$. [2]

2 A geometric progression has 6 as its first term. Its sum to infinity is 5.

Calculate its common ratio. [3]

3 Given that $\cos\theta = \frac{1}{3}$ and θ is acute, find the exact value of $\tan\theta$. [3]

4 Sequences A, B and C are shown below. They each continue in the pattern established by the given terms.

A: 1, 2, 4, 8, 16, 32, …

B: 20, –10, 5, –2.5, 1.25, –0.625, …

C: 20, 5, 1, 20, 5, 1, …

(i) Which of these sequences is periodic? [1]

(ii) Which of these sequences is convergent? [1]

(iii) Find, in terms of n, the nth term of sequence A. [1]

5 A is the point $(2, 1)$ on the curve $y = \dfrac{4}{x^2}$.

B is the point on the same curve with x-coordinate 2.1.

(i) Calculate the gradient of the chord AB of the curve. Give your answer correct to 2 decimal places. [2]

(ii) Give the x-coordinate of a point C on the curve for which the gradient of chord AC is a better approximation to the gradient of the curve at A. [1]

(iii) Use calculus to find the gradient of the curve at A. [2]

6 Sketch the curve $y = \sin x$ for $0° \leqslant x \leqslant 360°$.

Solve the equation $\sin x = -0.68$ for $0° \leqslant x \leqslant 360°$. [4]

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PMT

7 The gradient of a curve is given by $\frac{dy}{dx} = x^2 - 6x$. Find the set of values of x for which y is an increasing function of x. [3]

8 The 7th term of an arithmetic progression is 6. The sum of the first 10 terms of the progression is 30.

Find the 5th term of the progression. [5]

9 A curve has gradient given by $\frac{dy}{dx} = 6x^2 + 8x$. The curve passes through the point $(1, 5)$. Find the equation of the curve. [4]

10 **(i)** Express $\log_a x^4 + \log_a\left(\frac{1}{x}\right)$ as a multiple of $\log_a x$. [2]

(ii) Given that $\log_{10} b + \log_{10} c = 3$, find b in terms of c. [2]

[Section B starts on the next page.]

Section B (36 marks)

11 Fig. 11.1 shows a village green which is bordered by 3 straight roads AB, BC and CA. The road AC runs due North and the measurements shown are in metres.

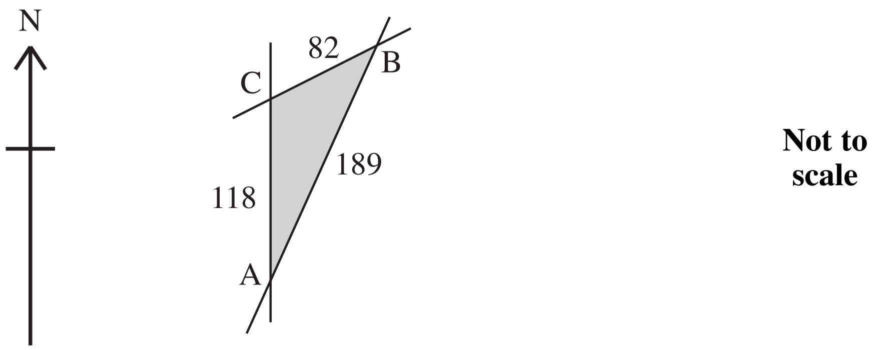

Fig. 11.1

(i) Calculate the bearing of B from C, giving your answer to the nearest 0.1°. [4]

(ii) Calculate the area of the village green. [2]

The road AB is replaced by a new road, as shown in Fig. 11.2. The village green is extended up to the new road.

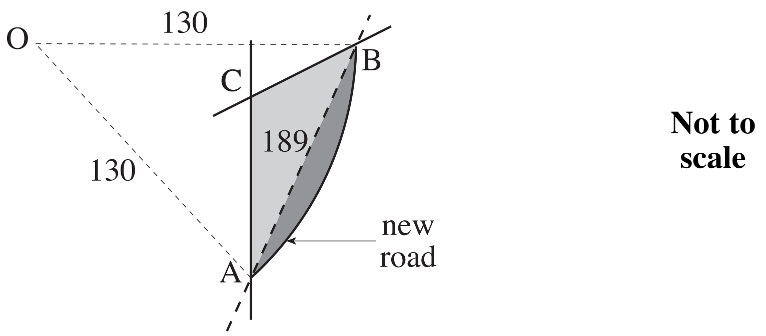

Fig. 11.2

The new road is an arc of a circle with centre O and radius 130 m.

(iii) (*A*) Show that angle AOB is 1.63 radians, correct to 3 significant figures. [2]

(*B*) Show that the area of land added to the village green is 5300 m^2 correct to 2 significant figures. [4]

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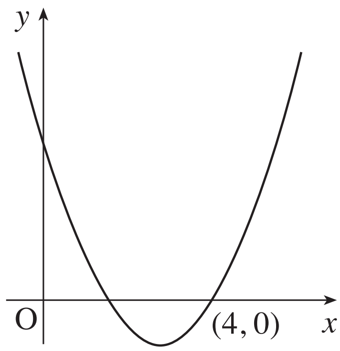
12 Fig. 12 is a sketch of the curve $y = 2x^2 - 11x + 12$.



Not to scale

Fig. 12

(i) Show that the curve intersects the x-axis at $(4, 0)$ and find the coordinates of the other point of intersection of the curve and the x-axis. [3]

(ii) Find the equation of the normal to the curve at the point $(4, 0)$.

Show also that the area of the triangle bounded by this normal and the axes is 1.6 units^2. [6]

(iii) Find the area of the region bounded by the curve and the x-axis. [3]

13 **Answer part (ii) of this question on the insert provided.**

The table gives a firm's monthly profits for the first few months after the start of its business, rounded to the nearest £100.

Number of months after start-up (x)	1	2	3	4	5	6
Profit for this month (£y)	500	800	1200	1900	3000	4800

The firm's profits, £y, for the xth month after start-up are modelled by

$$y = k \times 10^{ax}$$

where a and k are constants.

(i) Show that, according to this model, a graph of $\log_{10} y$ against x gives a straight line of gradient a and intercept $\log_{10} k$. [2]

(ii) **On the insert**, complete the table and plot $\log_{10} y$ against x, drawing by eye a line of best fit. [3]

(iii) Use your graph to find an equation for y in terms of x for this model. [3]

(iv) For which month after start-up does this model predict profits of about £75 000? [3]

(v) State one way in which this model is unrealistic. [1]

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RECOGNISING ACHIEVEMENT

ADVANCED SUBSIDIARY GCE UNIT **4752/01**

MATHEMATICS (MEI)

Concepts for Advanced Mathematics (C2)

INSERT

TUESDAY 16 JANUARY 2007

Morning
Time: 1 hour 30 minutes

Candidate Name	

Centre Number						Candidate Number					

INSTRUCTIONS TO CANDIDATES

- This insert should be used in Question **13(ii)**.
- Write your name, centre number and candidate number in the spaces provided above and **attach the page to your answer booklet**.

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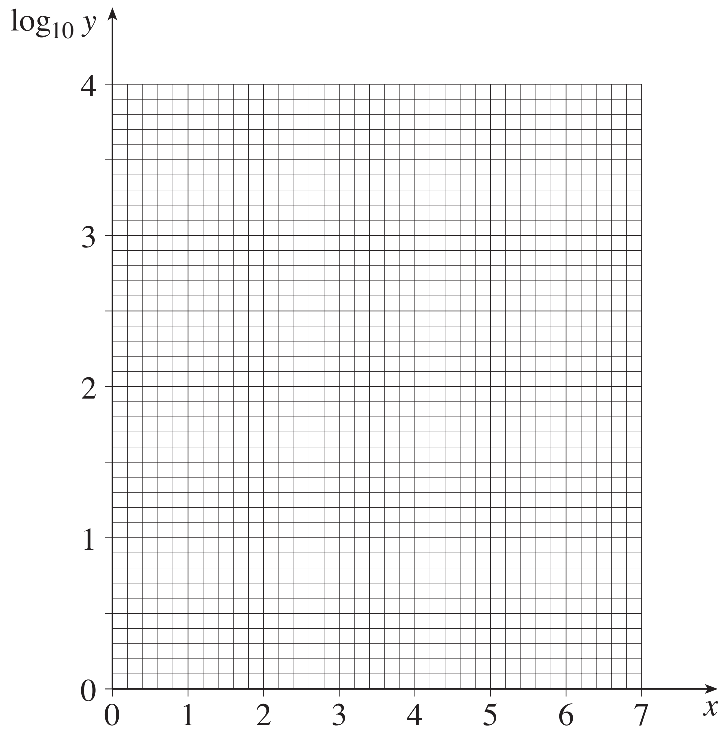
13 (ii)

Number of months after start-up (x)	1	2	3	4	5	6
Profit for this month (£y)	500	800	1200	1900	3000	4800
$\log_{10} y$	2.70					



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RECOGNISING ACHIEVEMENT

ADVANCED SUBSIDIARY GCE UNIT **4752/01**

MATHEMATICS (MEI)

Concepts for Advanced Mathematics (C2)

THURSDAY 7 JUNE 2007

Morning
Time: 1 hour 30 minutes

Additional materials:
Answer booklet (8 pages)
Graph paper
MEI Examination Formulae and Tables (MF2)

INSTRUCTIONS TO CANDIDATES

- Write your name, centre number and candidate number in the spaces provided on the answer booklet.
- Answer **all** the questions.
- You are permitted to use a graphical calculator in this paper.
- Final answers should be given to a degree of accuracy appropriate to the context.

INFORMATION FOR CANDIDATES

- The number of marks is given in brackets [ ] at the end of each question or part question.
- The total number of marks for this paper is 72.

ADVICE TO CANDIDATES

- Read each question carefully and make sure you know what you have to do before starting your answer.
- 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.

This document consists of **6** printed pages and **2** blank pages.

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Section A (36 marks)

1 **(i)** State the exact value of $\tan 300°$. [1]

(ii) Express 300° in radians, giving your answer in the form $k\pi$, where k is a fraction in its lowest terms. [2]

2 Given that $y = 6x^{\frac{3}{2}}$, find $\frac{dy}{dx}$ and $\frac{d^2y}{dx^2}$.

Show, without using a calculator, that when $x = 36$ the value of $\frac{d^2y}{dx^2}$ is $\frac{3}{4}$. [5]

3

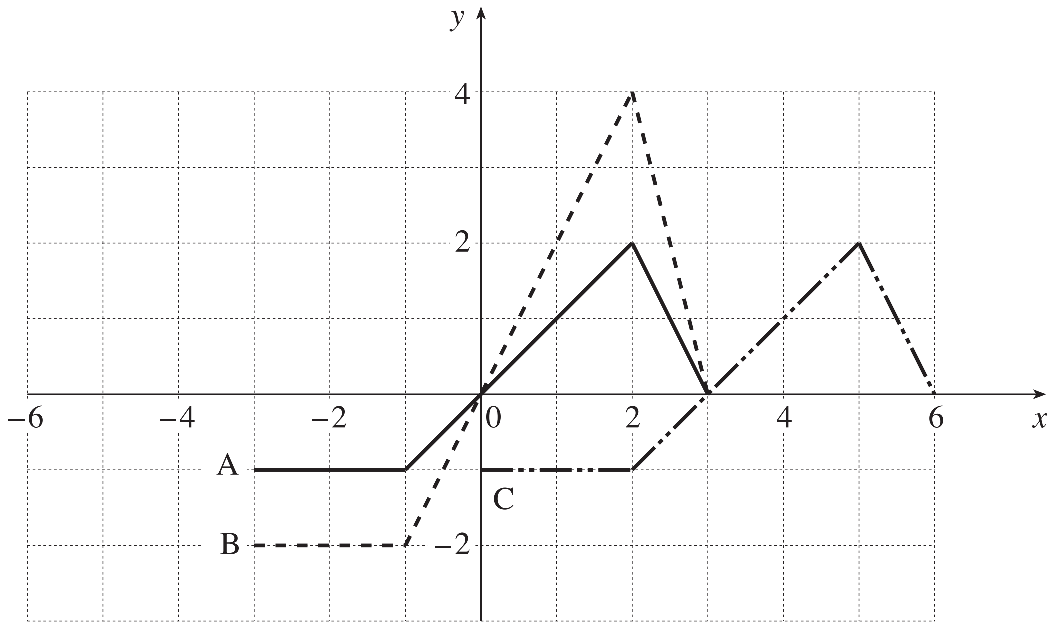

Fig. 3

Fig. 3 shows sketches of three graphs, A, B and C. The equation of graph A is $y = f(x)$.

State the equation of

(i) graph B, [2]

(ii) graph C. [2]

4 **(i)** Find the second and third terms of the sequence defined by the following.

$$t_{n+1} = 2t_n + 5$$
$$t_1 = 3$$ [2]

(ii) Find $\sum_{k=1}^{3} k(k+1)$. [2]

5 A sector of a circle of radius 5 cm has area 9 cm^2.

Find, in radians, the angle of the sector.

Find also the perimeter of the sector. [5]

6 **(i)** Write down the values of $\log_a 1$ and $\log_a a$, where $a > 1$. [2]

(ii) Show that $\log_a x^{10} - 2\log_a\left(\frac{x^3}{4}\right) = 4\log_a(2x)$. [3]

7 **(i)** Sketch the graph of $y = 3^x$. [2]

(ii) Use logarithms to solve the equation $3^x = 20$. Give your answer correct to 2 decimal places. [3]

8 **(i)** Show that the equation $2\cos^2\theta + 7\sin\theta = 5$ may be written in the form

$$2\sin^2\theta - 7\sin\theta + 3 = 0.$$ [1]

(ii) By factorising this quadratic equation, solve the equation for values of θ between 0° and 180°. [4]

Section B (36 marks)

9 The equation of a cubic curve is $y = 2x^3 - 9x^2 + 12x - 2$.

(i) Find $\frac{dy}{dx}$ and show that the tangent to the curve when $x = 3$ passes through the point $(-1, -41)$. [5]

(ii) Use calculus to find the coordinates of the turning points of the curve. You need not distinguish between the maximum and minimum. [4]

(iii) Sketch the curve, given that the only real root of $2x^3 - 9x^2 + 12x - 2 = 0$ is $x = 0.2$ correct to 1 decimal place. [3]

10 Fig. 10 shows the speed of a car, in metres per second, during one minute, measured at 10-second intervals.

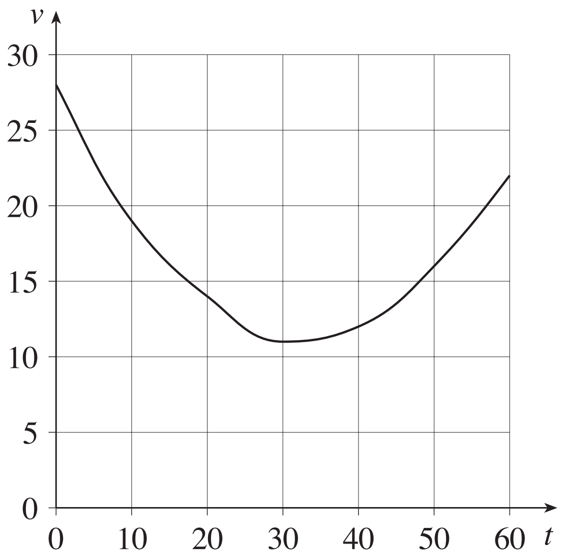

Fig. 10

The measured speeds are shown below.

Time (t seconds)	0	10	20	30	40	50	60
Speed ($v\,\mathrm{m\,s^{-1}}$)	28	19	14	11	12	16	22

(i) Use the trapezium rule with 6 strips to find an estimate of the area of the region bounded by the curve, the line $t = 60$ and the axes. [This area represents the distance travelled by the car.] [4]

(ii) Explain why your calculation in part **(i)** gives an overestimate for this area. Use appropriate rectangles to calculate an underestimate for this area. [3]

The speed of the car may be modelled by $v = 28 - t + 0.015t^2$.

(iii) Show that the difference between the value given by the model when $t = 10$ and the measured value is less than 3% of the measured value. [2]

(iv) According to this model, the distance travelled by the car is

$$\int_0^{60} (28 - t + 0.015t^2)\,dt.$$

Find this distance. [3]

11 **(a)** André is playing a game where he makes piles of counters. He puts 3 counters in the first pile. Each successive pile he makes has 2 more counters in it than the previous one.

(i) How many counters are there in his sixth pile? [1]

(ii) André makes ten piles of counters. How many counters has he used altogether? [2]

(b) In another game, played with an ordinary fair die and counters, Betty needs to throw a six to start.

The probability P_n of Betty starting on her nth throw is given by

$$P_n = \frac{1}{6} \times \left(\frac{5}{6}\right)^{n-1}.$$

(i) Calculate P_4. Give your answer as a fraction. [2]

(ii) The values $P_1, P_2, P_3, \ldots$ form an infinite geometric progression. State the first term and the common ratio of this progression.

Hence show that $P_1 + P_2 + P_3 + \ldots = 1$. [3]

(iii) Given that $P_n < 0.001$, show that n satisfies the inequality

$$n > \frac{\log_{10} 0.006}{\log_{10}\left(\frac{5}{6}\right)} + 1.$$

Hence find the least value of n for which $P_n < 0.001$. [4]

RECOGNISING ACHIEVEMENT

ADVANCED SUBSIDIARY GCE **4752/01**

MATHEMATICS (MEI)

Concepts for Advanced Mathematics (C2)

WEDNESDAY 9 JANUARY 2008 Afternoon

Time: 1 hour 30 minutes

Additional materials: Answer Booklet (8 pages)
MEI Examination Formulae and Tables (MF2)

INSTRUCTIONS TO CANDIDATES

- Write your name, centre number and candidate number in the spaces provided on the answer booklet.
- Read each question carefully and make sure you know what you have to do before starting your answer.
- Answer **all** the questions.
- You are permitted to use a graphical calculator in this paper.
- Final answers should be given to a degree of accuracy appropriate to the context.

INFORMATION FOR CANDIDATES

- The number of marks is given in brackets [ ] at the end of each question or part question.
- The total number of marks for this paper is 72.
- 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.

This document consists of **6** printed pages and **2** blank pages.

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Section A (36 marks)

1 Differentiate $10x^4 + 12$. [2]

2 A sequence begins

1 2 3 4 5 1 2 3 4 5 1 . . .

and continues in this pattern.

(i) Find the 48th term of this sequence. [1]

(ii) Find the sum of the first 48 terms of this sequence. [2]

3 You are given that $\tan\theta = \frac{1}{2}$ and the angle θ is acute. Show, without using a calculator, that $\cos^2\theta = \frac{4}{5}$. [3]

4

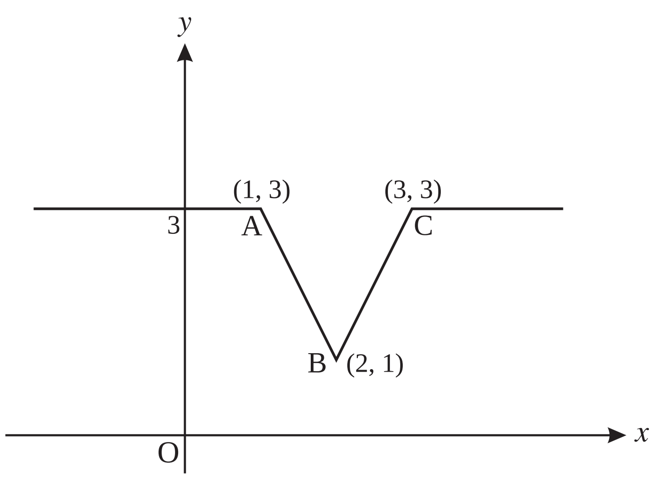

Fig. 4

Fig. 4 shows a sketch of the graph of $y = \mathrm{f}(x)$. On separate diagrams, sketch the graphs of the following, showing clearly the coordinates of the points corresponding to A, B and C.

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

(ii) $y = \mathrm{f}(x + 3)$ [2]

5 Find $\int (12x^5 + \sqrt[3]{x} + 7)\,\mathrm{d}x$. [5]

6 **(i)** Sketch the graph of $y = \sin\theta$ for $0 \leqslant \theta \leqslant 2\pi$. [2]

(ii) Solve the equation $2\sin\theta = -1$ for $0 \leqslant \theta \leqslant 2\pi$. Give your answers in the form $k\pi$. [3]

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7 **(i)** Find $\sum_{k=2}^{5} 2^k$. [2]

(ii) Find the value of n for which $2^n = \frac{1}{64}$. [1]

(iii) Sketch the curve with equation $y = 2^x$. [2]

8 The second term of a geometric progression is 18 and the fourth term is 2. The common ratio is positive. Find the sum to infinity of this progression. [5]

9 You are given that $\log_{10} y = 3x + 2$.

(i) Find the value of x when $y = 500$, giving your answer correct to 2 decimal places. [1]

(ii) Find the value of y when $x = -1$. [1]

(iii) Express $\log_{10}(y^4)$ in terms of x. [1]

(iv) Find an expression for y in terms of x. [1]

Section B (36 marks)

10

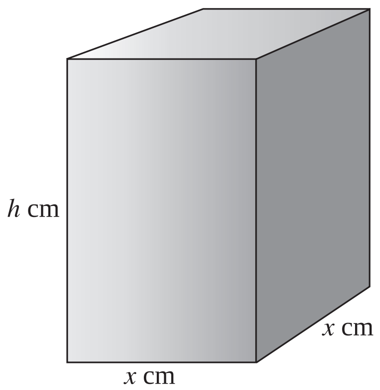

Fig. 10

Fig. 10 shows a solid cuboid with square base of side x cm and height h cm. Its volume is 120 cm^3.

(i) Find h in terms of x. Hence show that the surface area, A cm^2, of the cuboid is given by $A = 2x^2 + \frac{480}{x}$. [3]

(ii) Find $\frac{dA}{dx}$ and $\frac{d^2A}{dx^2}$. [4]

(iii) Hence find the value of x which gives the minimum surface area. Find also the value of the surface area in this case. [5]

PMT

11 **(i)** The course for a yacht race is a triangle, as shown in Fig. 11.1. The yachts start at A, then travel to B, then to C and finally back to A.

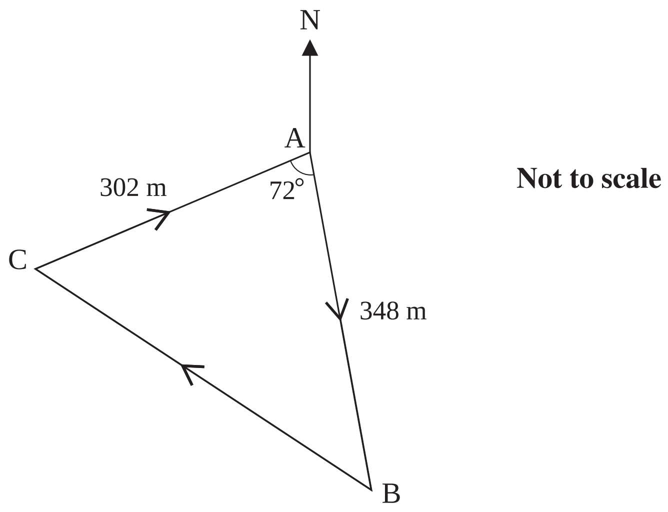

Fig. 11.1

(*A*) Calculate the total length of the course for this race. [4]

(*B*) Given that the bearing of the first stage, AB, is 175°, calculate the bearing of the second stage, BC. [4]

(ii) Fig. 11.2 shows the course of another yacht race. The course follows the arc of a circle from P to Q, then a straight line back to P. The circle has radius 120 m and centre O; angle POQ = 136°.

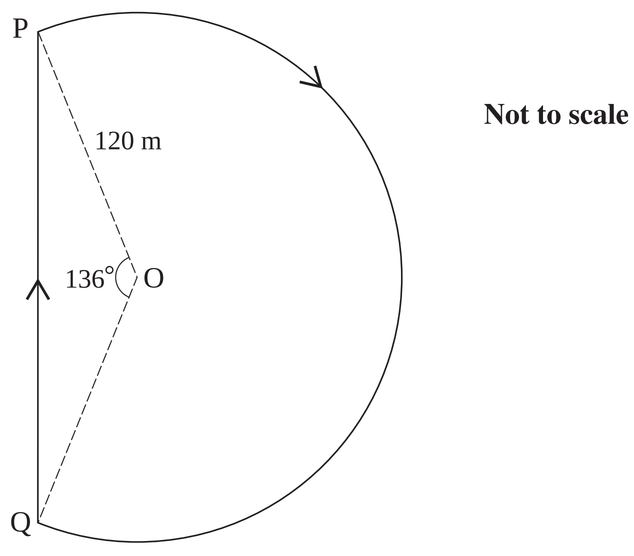

Fig. 11.2

Calculate the total length of the course for this race. [4]

12 **(i)**

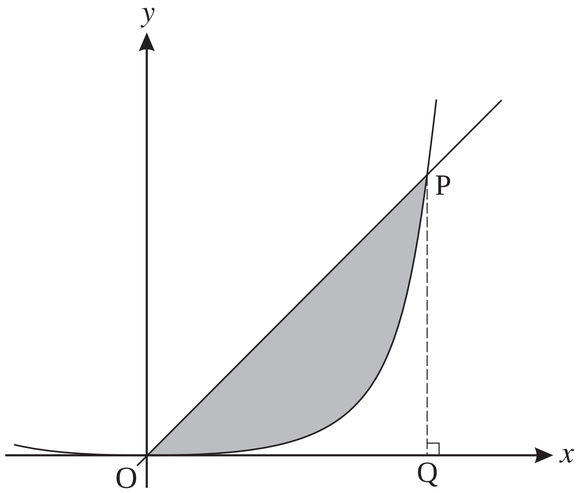

Fig. 12

Fig. 12 shows part of the curve $y = x^4$ and the line $y = 8x$, which intersect at the origin and the point P.

(*A*) Find the coordinates of P, and show that the area of triangle OPQ is 16 square units. [3]

(*B*) Find the area of the region bounded by the line and the curve. [3]

(ii) You are given that $\mathrm{f}(x) = x^4$.

(*A*) Complete this identity for $\mathrm{f}(x + h)$.

$$\mathrm{f}(x+h) = (x+h)^4 = x^4 + 4x^3h + \ \ldots$$ [2]

(*B*) Simplify $\dfrac{\mathrm{f}(x+h) - \mathrm{f}(x)}{h}$. [2]

(*C*) Find $\lim\limits_{h \to 0} \dfrac{\mathrm{f}(x+h) - \mathrm{f}(x)}{h}$. [1]

(*D*) State what this limit represents. [1]

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RECOGNISING ACHIEVEMENT

ADVANCED SUBSIDIARY GCE **4752/01**

MATHEMATICS (MEI)

Concepts for Advanced Mathematics (C2)

THURSDAY 15 MAY 2008 Morning

Time: 1 hour 30 minutes

Additional materials: Answer Booklet (8 pages)
Insert for Question 13
MEI Examination Formulae and Tables (MF2)

INSTRUCTIONS TO CANDIDATES

- Write your name in capital letters, your Centre Number and Candidate Number in the spaces provided on the Answer Booklet.
- Read each question carefully and make sure you know what you have to do before starting your answer.
- Answer **all** the questions.
- There is an **insert** for use in Question **13**.
- You are permitted to use a graphical calculator in this paper.
- Final answers should be given to a degree of accuracy appropriate to the context.

INFORMATION FOR CANDIDATES

- The number of marks is given in brackets [ ] at the end of each question or part question.
- The total number of marks for this paper is 72.
- 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.

This document consists of **7** printed pages, **1** blank page and an insert.

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Section A (36 marks)

1 Express $\frac{7\pi}{6}$ radians in degrees. [2]

2 The first term of a geometric series is 5.4 and the common ratio is 0.1.

(i) Find the fourth term of the series. [1]

(ii) Find the sum to infinity of the series. [2]

3 State the transformation which maps the graph of $y = x^2 + 5$ onto the graph of $y = 3x^2 + 15$. [2]

4 Use calculus to find the set of values of x for which $f(x) = 12x - x^3$ is an increasing function. [3]

5 In Fig. 5, A and B are the points on the curve $y = 2^x$ with x-coordinates 3 and 3.1 respectively.

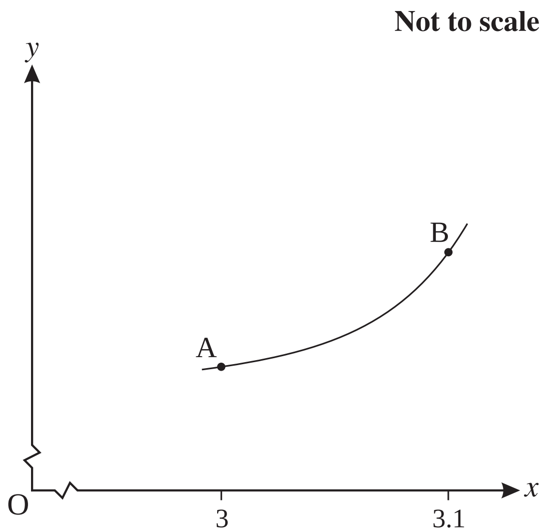

Fig. 5

(i) Find the gradient of the chord AB. Give your answer correct to 2 decimal places. [2]

(ii) Stating the points you use, find the gradient of another chord which will give a closer approximation to the gradient of the tangent to $y = 2^x$ at A. [2]

6 A curve has gradient given by $\frac{dy}{dx} = 6\sqrt{x}$. Find the equation of the curve, given that it passes through the point (9, 105). [4]

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7

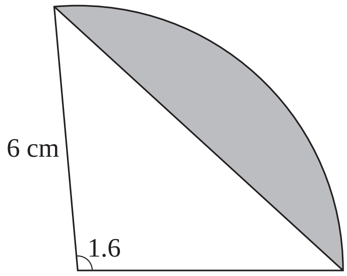

Fig. 7

A sector of a circle of radius 6 cm has angle 1.6 radians, as shown in Fig. 7.

Find the area of the sector.

Hence find the area of the shaded segment. [5]

8 The 11th term of an arithmetic progression is 1. The sum of the first 10 terms is 120. Find the 4th term. [5]

9 Use logarithms to solve the equation $5^x = 235$, giving your answer correct to 2 decimal places. [3]

10 Showing your method, solve the equation $2\sin^2\theta = \cos\theta + 2$ for values of θ between 0° and 360°. [5]

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Section B (36 marks)

11

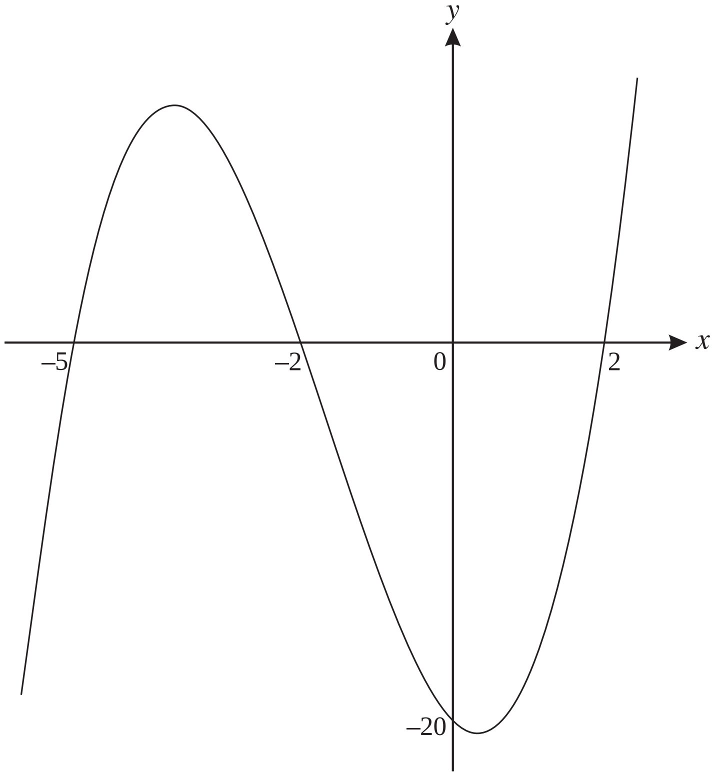

Fig. 11

Fig. 11 shows a sketch of the cubic curve $y = \mathrm{f}(x)$. The values of x where it crosses the x-axis are -5, -2 and 2, and it crosses the y-axis at $(0, -20)$.

(i) Express $\mathrm{f}(x)$ in factorised form. [2]

(ii) Show that the equation of the curve may be written as $y = x^3 + 5x^2 - 4x - 20$. [2]

(iii) Use calculus to show that, correct to 1 decimal place, the x-coordinate of the minimum point on the curve is 0.4.

Find also the coordinates of the maximum point on the curve, giving your answers correct to 1 decimal place. [6]

(iv) State, correct to 1 decimal place, the coordinates of the maximum point on the curve $y = \mathrm{f}(2x)$. [2]

PMT

12

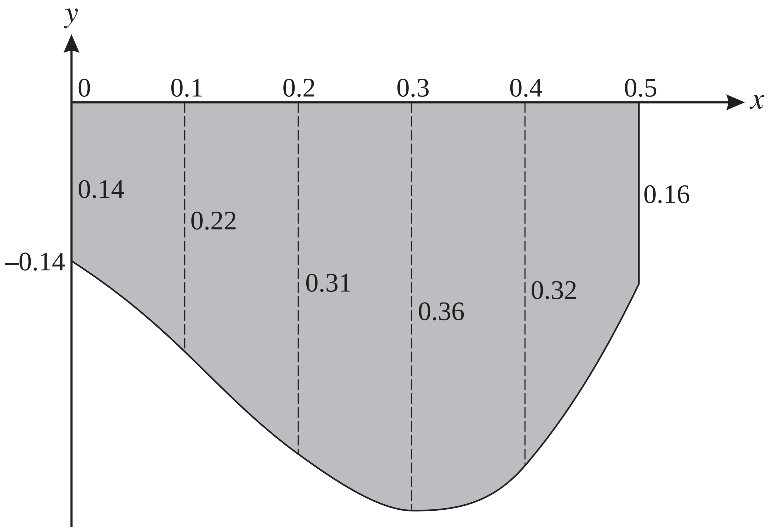

Fig. 12

A water trough is a prism 2.5 m long. Fig. 12 shows the cross-section of the trough, with the depths in metres at 0.1 m intervals across the trough. The trough is full of water.

(i) Use the trapezium rule with 5 strips to calculate an estimate of the area of cross-section of the trough.

Hence estimate the volume of water in the trough. [5]

(ii) A computer program models the curve of the base of the trough, with axes as shown and units in metres, using the equation $y = 8x^3 - 3x^2 - 0.5x - 0.15$, for $0 \leqslant x \leqslant 0.5$.

Calculate $\int_0^{0.5} (8x^3 - 3x^2 - 0.5x - 0.15)\,dx$ and state what this represents.

Hence find the volume of water in the trough as given by this model. [7]

[Question 13 is printed overleaf.]

13 The percentage of the adult population visiting the cinema in Great Britain has tended to increase since the 1980s. The table shows the results of surveys in various years.

Year	1986/87	1991/92	1996/97	1999/00	2000/01	2001/02
Percentage of the adult population visiting the cinema	31	44	54	56	55	57

Source: Department of National Statistics, www.statistics.gov.uk

This growth may be modelled by an equation of the form

$$P = at^b,$$

where P is the percentage of the adult population visiting the cinema, t is the number of years after the year 1985/86 and a and b are constants to be determined.

(i) Show that, according to this model, the graph of $\log_{10} P$ against $\log_{10} t$ should be a straight line of gradient b. State, in terms of a, the intercept on the vertical axis. [3]

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

(ii) Complete the table of values on the insert, and plot $\log_{10} P$ against $\log_{10} t$. Draw by eye a line of best fit for the data. [4]

(iii) Use your graph to find the equation for P in terms of t. [4]

(iv) Predict the percentage of the adult population visiting the cinema in the year 2007/2008 (i.e. when $t = 22$), according to this model. [1]

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RECOGNISING ACHIEVEMENT

ADVANCED SUBSIDIARY GCE **4752/01**

MATHEMATICS (MEI)

Concepts for Advanced Mathematics (C2)

INSERT for Question 13

THURSDAY 15 MAY 2008 Morning

Time: 1 hour 30 minutes

Candidate Forename		Candidate Surname	
Centre Number		Candidate Number	

INSTRUCTIONS TO CANDIDATES

- Write your name in capital letters, your Centre Number and Candidate Number in the boxes above.
- This insert should be used to answer Question **13 (ii)**.
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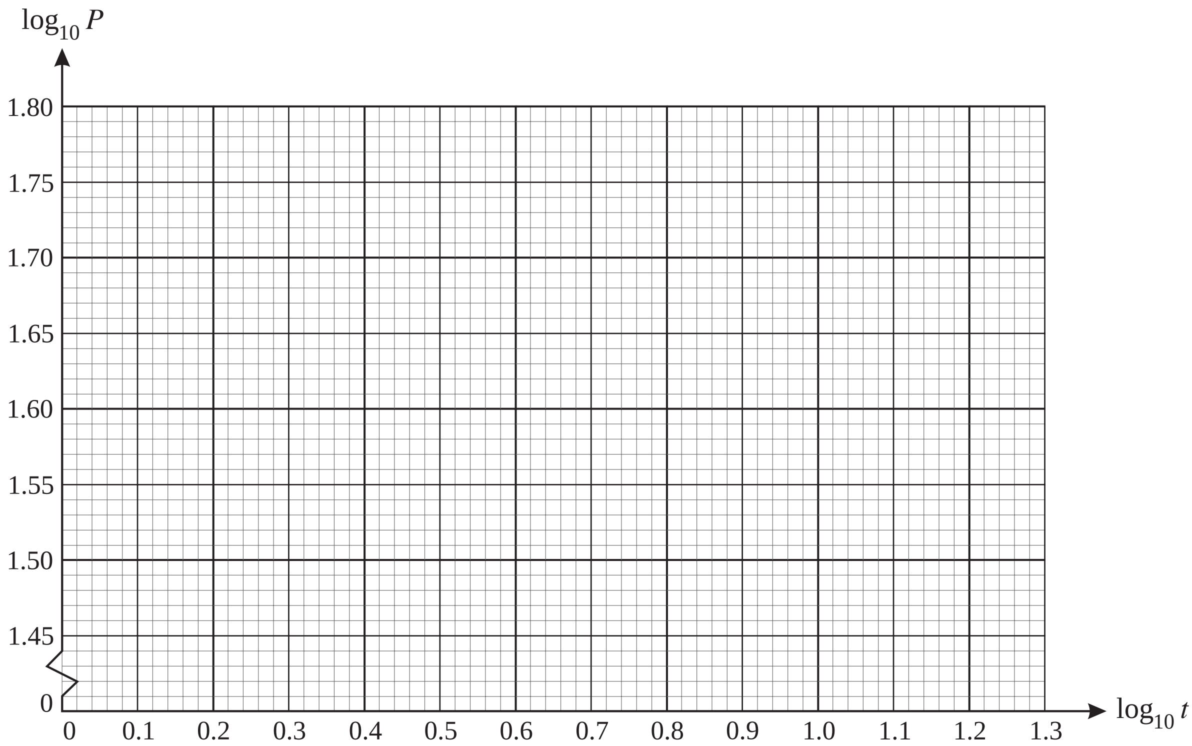
13 (ii)

Year	1986/87	1991/92	1996/97	1999/00	2000/01	2001/02
t	1	6	11	14	15	16
P	31	44	54	56	55	57
$\log_{10} t$			1.04			
$\log_{10} P$			1.73			



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ADVANCED SUBSIDIARY GCE

MATHEMATICS (MEI) 4752

Concepts for Advanced Mathematics (C2)

Candidates answer on the Answer Booklet

OCR Supplied Materials:
- 8 page Answer Booklet
- Insert for Questions 5 and 12 (inserted)
- MEI Examination Formulae and Tables (MF2)

Other Materials Required:
None

Tuesday 13 January 2009
Morning

Duration: 1 hour 30 minutes

INSTRUCTIONS TO CANDIDATES

- Write your name clearly in capital letters, your Centre Number and Candidate Number in the spaces provided on the Answer Booklet.
- Use black ink. Pencil may be used for graphs and diagrams only.
- Read each question carefully and make sure that you know what you have to do before starting your answer.
- Answer **all** the questions.
- Do **not** write in the bar codes.
- There is an **insert** for use in Questions **5** and **12**.
- You are permitted to use a graphical calculator in this paper.
- Final answers should be given to a degree of accuracy appropriate to the context.

INFORMATION FOR CANDIDATES

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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**.
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Section A (36 marks)

1 Find $\int \left(20x^4 + 6x^{-\frac{3}{2}}\right) \mathrm{d}x$. **[4]**

2 Fig. 2 shows the coordinates at certain points on a curve.

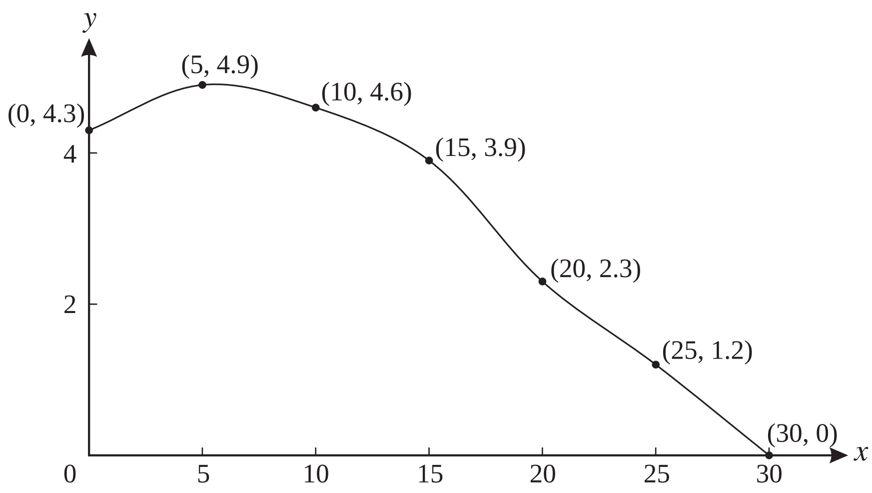

Fig. 2

Use the trapezium rule with 6 strips to calculate an estimate of the area of the region bounded by this curve and the axes. **[4]**

3 Find $\sum_{k=1}^{5} \frac{1}{1+k}$. **[2]**

4 Solve the equation $\sin 2x = -0.5$ for $0° < x < 180°$. **[3]**

5 **Answer this question on the insert provided.**

Fig. 5 shows the graph of $y = \mathrm{f}(x)$.

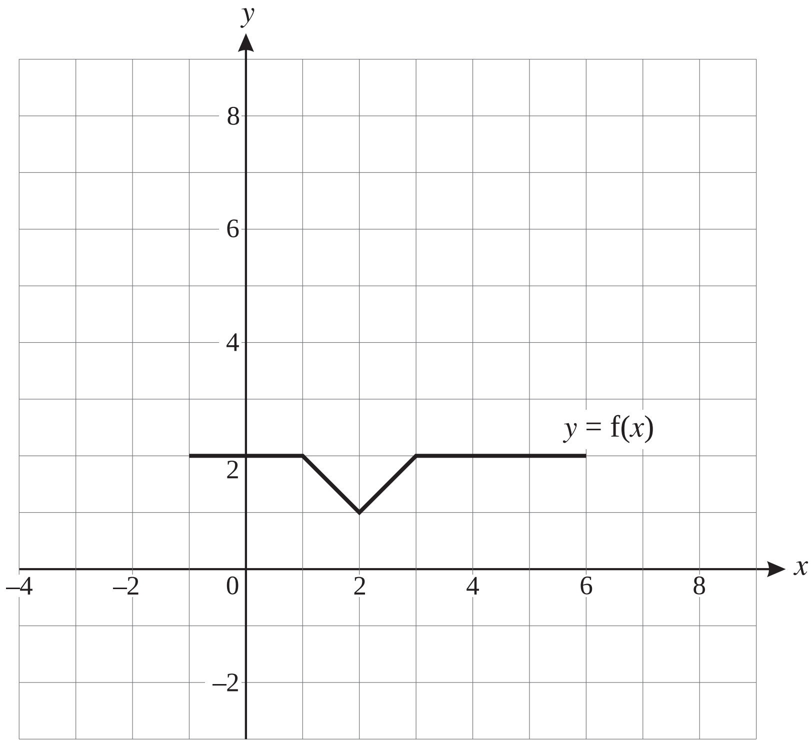

Fig. 5

On the insert, draw the graph of

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

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

6 An arithmetic progression has first term 7 and third term 12.

(i) Find the 20th term of this progression. **[2]**

(ii) Find the sum of the 21st to the 50th terms inclusive of this progression. **[3]**

7 Differentiate $4x^2 + \frac{1}{x}$ and hence find the x-coordinate of the stationary point of the curve $y = 4x^2 + \frac{1}{x}$. **[5]**

8 The terms of a sequence are given by

$$u_1 = 192,$$
$$u_{n+1} = -\tfrac{1}{2}u_n.$$

(i) Find the third term of this sequence and state what type of sequence it is. **[2]**

(ii) Show that the series $u_1 + u_2 + u_3 + \ldots$ converges and find its sum to infinity. **[3]**

9 **(i)** State the value of $\log_a a$. **[1]**

(ii) Express each of the following in terms of $\log_a x$.

(A) $\log_a x^3 + \log_a \sqrt{x}$ **[2]**

(B) $\log_a \dfrac{1}{x}$ **[1]**

Section B (36 marks)

10 Fig. 10 shows a sketch of the graph of $y = 7x - x^2 - 6$.

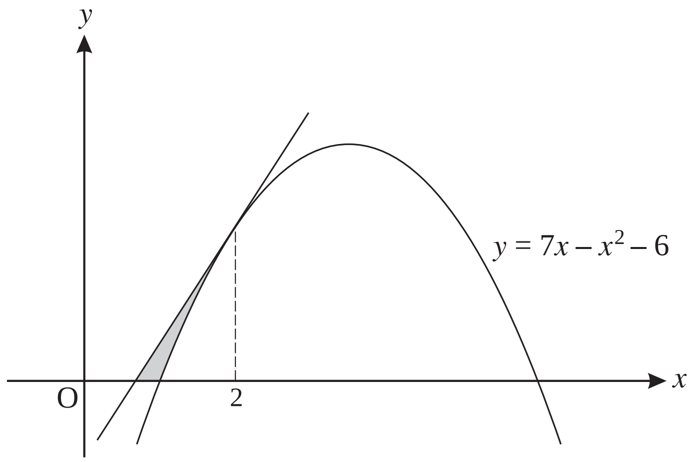

Fig. 10

(i) Find $\dfrac{dy}{dx}$ and hence find the equation of the tangent to the curve at the point on the curve where $x = 2$.

Show that this tangent crosses the x-axis where $x = \frac{2}{3}$. **[6]**

(ii) Show that the curve crosses the x-axis where $x = 1$ and find the x-coordinate of the other point of intersection of the curve with the x-axis. **[2]**

(iii) Find $\displaystyle\int_1^2 (7x - x^2 - 6)\,dx$.

Hence find the area of the region bounded by the curve, the tangent and the x-axis, shown shaded on Fig. 10. **[5]**

11 **(i)**

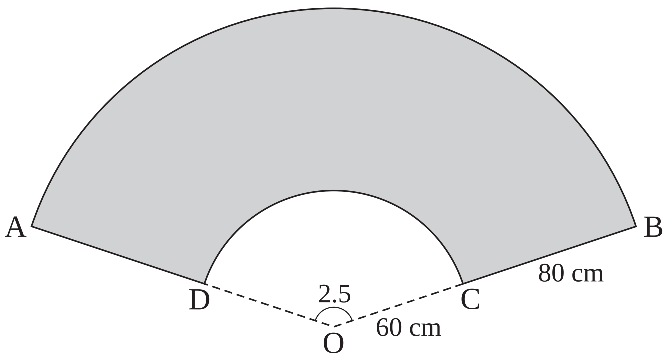

Fig. 11.1

Fig. 11.1 shows the surface ABCD of a TV presenter's desk. AB and CD are arcs of circles with centre O and sector angle 2.5 radians. OC = 60 cm and OB = 140 cm.

(*A*) Calculate the length of the arc CD. **[2]**

(*B*) Calculate the area of the surface ABCD of the desk. **[4]**

(ii) The TV presenter is at point P, shown in Fig. 11.2. A TV camera can move along the track EF, which is of length 3.5 m.

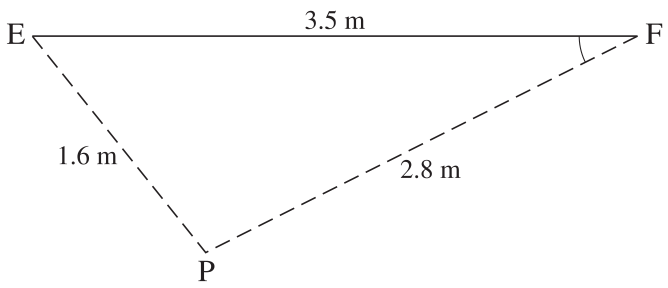

Fig. 11.2

When the camera is at E, the TV presenter is 1.6 m away. When the camera is at F, the TV presenter is 2.8 m away.

(*A*) Calculate, in degrees, the size of angle EFP. **[3]**

(*B*) Calculate the shortest possible distance between the camera and the TV presenter. **[2]**

[Question 12 is printed overleaf.]

12 Answer part (ii) of this question on the insert provided.

The proposal for a major building project was accepted, but actual construction was delayed. Each year a new estimate of the cost was made. The table shows the estimated cost, £y million, of the project t years after the project was first accepted.

Years after proposal accepted (t)	1	2	3	4	5
Cost (£y million)	250	300	360	440	530

The relationship between y and t is modelled by $y = ab^t$, where a and b are constants.

(i) Show that $y = ab^t$ may be written as

$$\log_{10} y = \log_{10} a + t \log_{10} b.$$ **[2]**

(ii) **On the insert**, complete the table and plot $\log_{10} y$ against t, drawing by eye a line of best fit. **[3]**

(iii) Use your graph and the results of part **(i)** to find the values of $\log_{10} a$ and $\log_{10} b$ and hence a and b. **[4]**

(iv) According to this model, what was the estimated cost of the project when it was first accepted? **[1]**

(v) Find the value of t given by this model when the estimated cost is £1000 million. Give your answer rounded to 1 decimal place. **[2]**

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ADVANCED SUBSIDIARY GCE

MATHEMATICS (MEI) 4752

Concepts for Advanced Mathematics (C2)
INSERT for Questions 5 and 12

Tuesday 13 January 2009
Morning

Duration: 1 hour 30 minutes

Candidate Forename		Candidate Surname	
Centre Number		Candidate Number	

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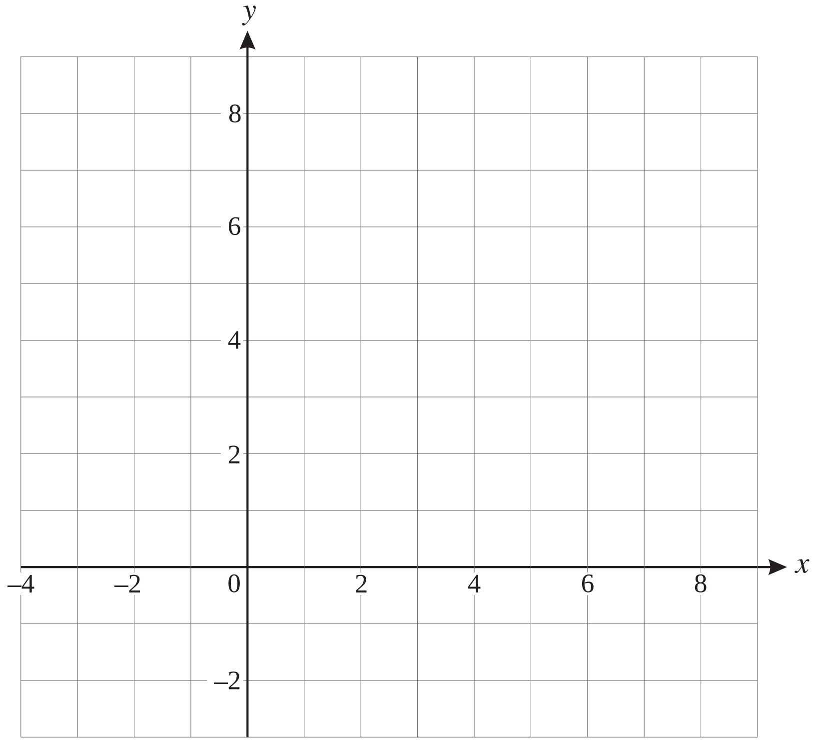
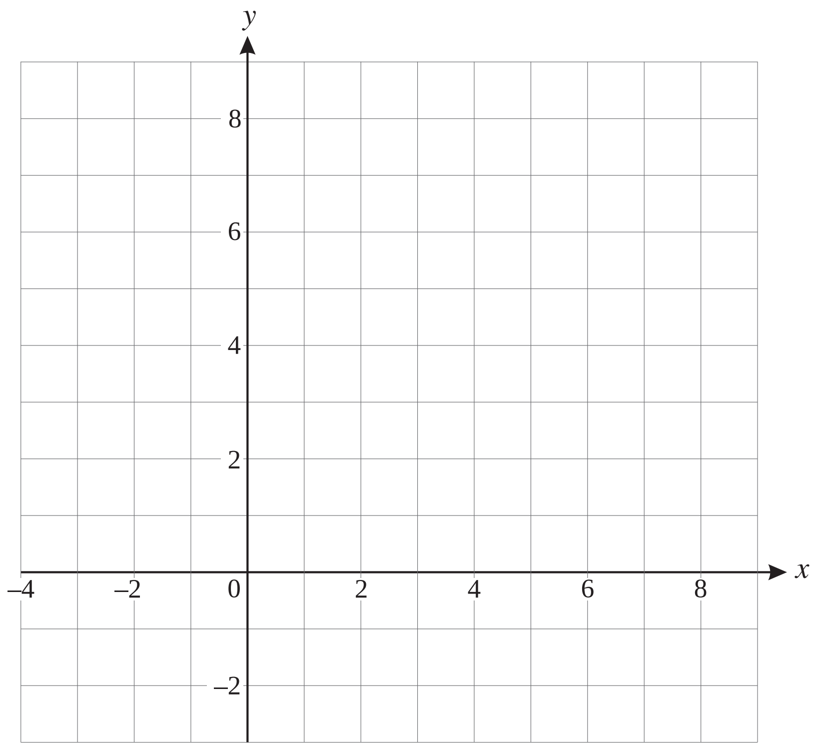
5 **(i)** $y = f(x - 2)$



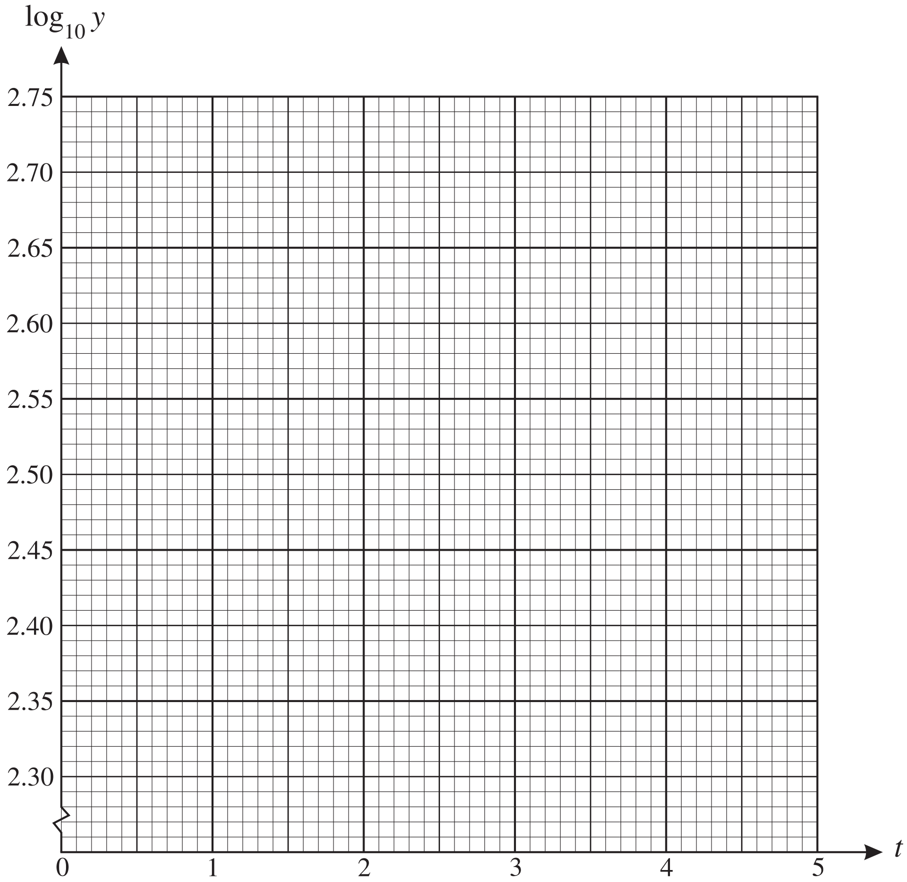
(ii) $y = 3f(x)$



PMT

12 (ii)

Years after proposal accepted (t)	1	2	3	4	5
Cost (£y million)	250	300	360	440	530
$\log_{10} y$	2.398				



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ADVANCED SUBSIDIARY GCE

MATHEMATICS (MEI) 4752

Concepts for Advanced Mathematics (C2)

Candidates answer on the Answer Booklet

OCR Supplied Materials:
- 8 page Answer Booklet
- Insert for Question 10 (inserted)
- MEI Examination Formulae and Tables (MF2)

Other Materials Required:
None

Friday 22 May 2009
Morning

Duration: 1 hour 30 minutes

* 4 7 5 2 *

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Turn over

Section A (36 marks)

1 Use an isosceles right-angled triangle to show that $\cos 45° = \frac{1}{\sqrt{2}}$. **[2]**

2 Find $\int_1^2 (12x^5 + 5)\,dx$. **[4]**

3 **(i)** Find $\sum_{k=3}^{8}(k^2 - 1)$. **[2]**

(ii) State whether the sequence with kth term $k^2 - 1$ is convergent or divergent, giving a reason for your answer. **[1]**

4 A sector of a circle of radius 18.0 cm has arc length 43.2 cm.

(i) Find in radians the angle of the sector. **[2]**

(ii) Find this angle in degrees, giving your answer to the nearest degree. **[2]**

5 **(i)** On the same axes, sketch the graphs of $y = \cos x$ and $y = \cos 2x$ for values of x from 0 to 2π. **[3]**

(ii) Describe the transformation which maps the graph of $y = \cos x$ onto the graph of $y = 3\cos x$. **[2]**

6 Use calculus to find the x-coordinates of the turning points of the curve $y = x^3 - 6x^2 - 15x$.

Hence find the set of values of x for which $x^3 - 6x^2 - 15x$ is an increasing function. **[5]**

7 Show that the equation $4\cos^2\theta = 4 - \sin\theta$ may be written in the form

$$4\sin^2\theta - \sin\theta = 0.$$

Hence solve the equation $4\cos^2\theta = 4 - \sin\theta$ for $0° \leqslant \theta \leqslant 180°$. **[5]**

8 The gradient of a curve is $3\sqrt{x} - 5$. The curve passes through the point (4, 6). Find the equation of the curve. **[5]**

9 Simplify

(i) $10 - 3\log_a a$, **[1]**

(ii) $\dfrac{\log_{10} a^5 + \log_{10}\sqrt{a}}{\log_{10} a}$. **[2]**

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Section B (36 marks)

10 Answer part (i) of this question on the insert provided.

Ash trees grow quickly for the first years of their life, then more slowly. This table shows the height of a tree at various ages.

Age (t years)	4	7	10	15	20	40
Height (h m)	4	9	12	17	19	26

The height, h m, of an ash tree when it is t years old may be modelled by an equation of the form

$$h = a\log_{10} t + b.$$

(i) **On the insert**, complete the table and plot h against $\log_{10} t$, drawing by eye a line of best fit. **[3]**

(ii) Use your graph to find an equation for h in terms of $\log_{10} t$ for this model. **[3]**

(iii) Find the height of the tree at age 100 years, as predicted by this model. **[1]**

(iv) Find the age of the tree when it reaches a height of 29 m, according to this model. **[3]**

(v) Comment on the suitability of the model when the tree is very young. **[2]**

11 **(i)** In a 'Make Ten' quiz game, contestants get £10 for answering the first question correctly, then a further £20 for the second question, then a further £30 for the third, and so on, until they get a question wrong and are out of the game.

(A) Haroon answers six questions correctly. Show that he receives a total of £210. **[1]**

(B) State, in a simple form, a formula for the total amount received by a contestant who answers n questions correctly.

Hence find the value of n for a contestant who receives £10 350 from this game. **[4]**

(ii) In a 'Double Your Money' quiz game, contestants get £5 for answering the first question correctly, then a further £10 for the second question, then a further £20 for the third, and so on doubling the amount for each question until they get a question wrong and are out of the game.

(A) Gary received £75 from the game. How many questions did he get right? **[1]**

(B) Bethan answered 9 questions correctly. How much did she receive from the game? **[2]**

(C) State a formula for the total amount received by a contestant who answers n questions correctly.

Hence find the value of n for a contestant in this game who receives £2 621 435. **[4]**

[Question 12 is printed overleaf.]

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12 **(i)** Calculate the gradient of the chord joining the points on the curve $y = x^2 - 7$ for which $x = 3$ and $x = 3.1$. **[2]**

(ii) Given that $f(x) = x^2 - 7$, find and simplify $\frac{f(3+h) - f(3)}{h}$. **[3]**

(iii) Use your result in part **(ii)** to find the gradient of $y = x^2 - 7$ at the point where $x = 3$, showing your reasoning. **[2]**

(iv) Find the equation of the tangent to the curve $y = x^2 - 7$ at the point where $x = 3$. **[2]**

(v) This tangent crosses the x-axis at the point P. The curve crosses the positive x-axis at the point Q. Find the distance PQ, giving your answer correct to 3 decimal places. **[3]**

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ADVANCED SUBSIDIARY GCE

MATHEMATICS (MEI) 4752

Concepts for Advanced Mathematics (C2)
INSERT for Question 10

Friday 22 May 2009
Morning

Duration: 1 hour 30 minutes

Candidate Forename		Candidate Surname	
Centre Number		Candidate Number	

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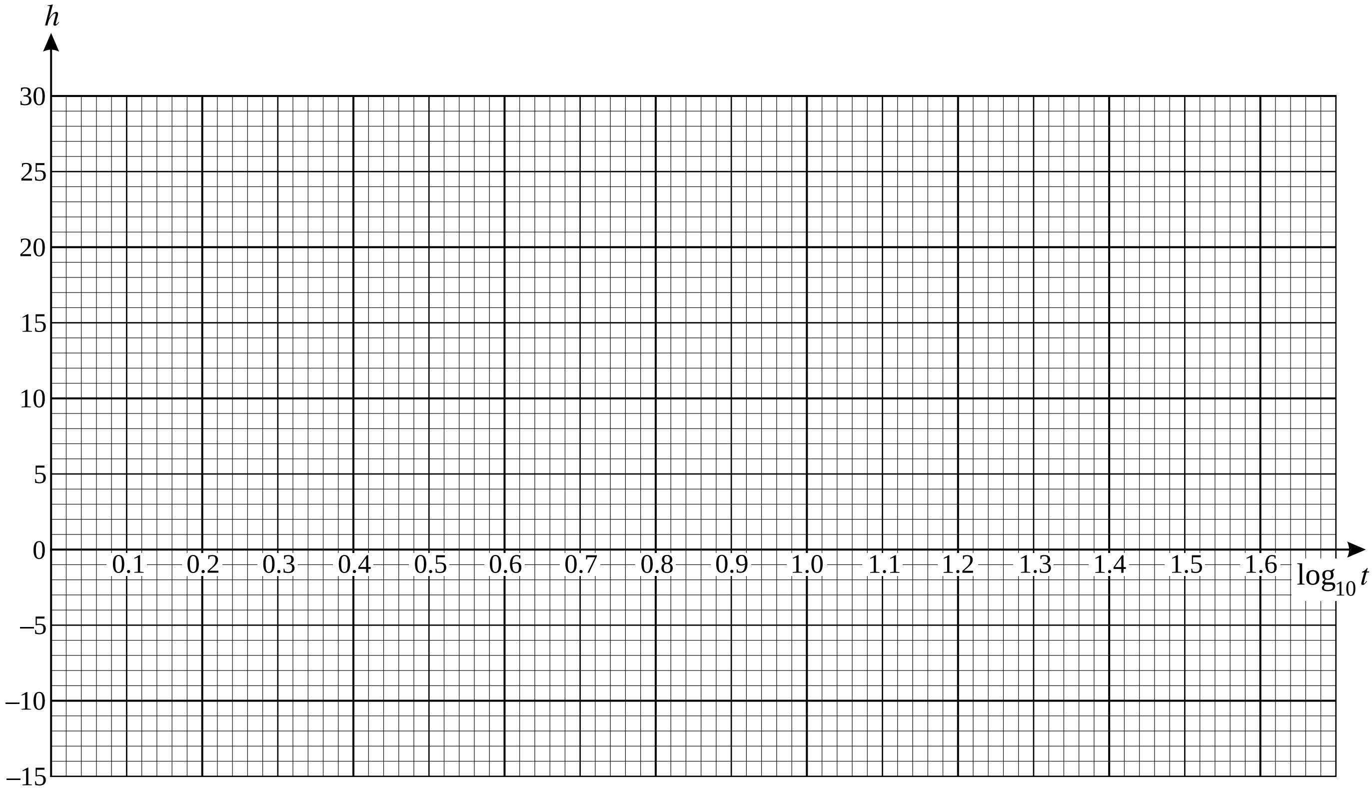
10 (i)

Age (t years)	4	7	10	15	20	40
$\log_{10} t$			1			
Height (h m)	4	9	12	17	19	26



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ADVANCED SUBSIDIARY GCE

MATHEMATICS (MEI) 4752

Concepts for Advanced Mathematics (C2)

Candidates answer on the Answer Booklet

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- 8 page Answer Booklet
- Insert for Question 12 (inserted)
- MEI Examination Formulae and Tables (MF2)

Other Materials Required:
None

Friday 15 January 2010
Afternoon

Duration: 1 hour 30 minutes

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2R–9F25

Section A (36 marks)

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

2 A sequence begins

1 3 5 3 1 3 5 3 1 3 ...

and continues in this pattern.

(i) Find the 55th term of this sequence, showing your method. **[1]**

(ii) Find the sum of the first 55 terms of the sequence. **[2]**

3 You are given that $\sin\theta = \frac{\sqrt{2}}{3}$ and that θ is an acute angle. Find the **exact** value of $\tan\theta$. **[3]**

4 A sector of a circle has area $8.45\,\text{cm}^2$ and sector angle 0.4 radians. Calculate the radius of the sector. **[3]**

5

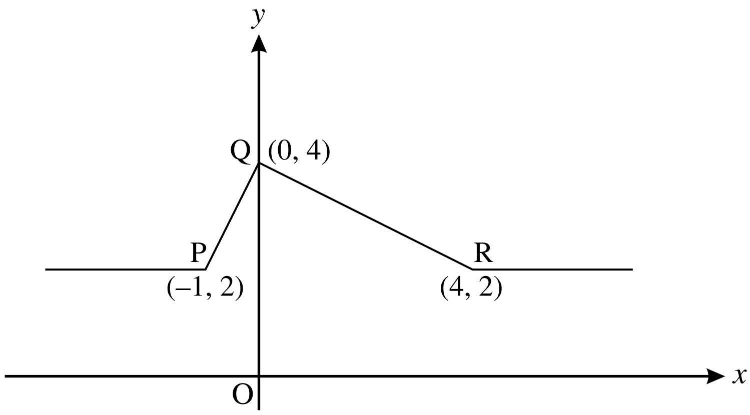

Fig. 5

Fig. 5 shows a sketch of the graph of $y = f(x)$. On separate diagrams, sketch the graphs of the following, showing clearly the coordinates of the points corresponding to P, Q and R.

(i) $y = f(2x)$ **[2]**

(ii) $y = \frac{1}{4}f(x)$ **[2]**

6 **(i)** Find the 51st term of the sequence given by

$$u_1 = 5,$$
$$u_{n+1} = u_n + 4.$$ **[3]**

(ii) Find the sum to infinity of the geometric progression which begins

$$5 \qquad 2 \qquad 0.8 \qquad \ldots\ .$$ **[2]**

7

Not to scale

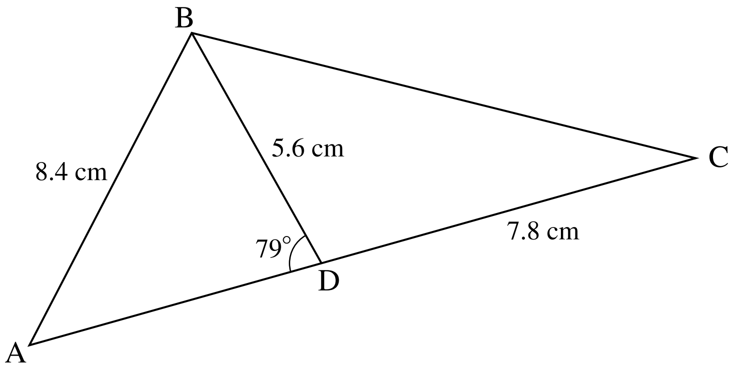

Fig. 7

Fig. 7 shows triangle ABC, with AB = 8.4 cm. D is a point on AC such that angle ADB = 79°, BD = 5.6 cm and CD = 7.8 cm.

Calculate

(i) angle BAD, **[2]**

(ii) the length BC. **[3]**

8 Find the equation of the tangent to the curve $y = 6\sqrt{x}$ at the point where $x = 16$. **[5]**

9 **(i)** Sketch the graph of $y = 3^x$. **[2]**

(ii) Use logarithms to solve $3^{2x+1} = 10$, giving your answer correct to 2 decimal places. **[3]**

Section B (36 marks)

10 **(i)** Differentiate $x^3 - 3x^2 - 9x$. Hence find the x-coordinates of the stationary points on the curve $y = x^3 - 3x^2 - 9x$, showing which is the maximum and which the minimum. **[6]**

(ii) Find, in exact form, the coordinates of the points at which the curve crosses the x-axis. **[3]**

(iii) Sketch the curve. **[2]**

11 Fig. 11 shows the cross-section of a school hall, with measurements of the height in metres taken at 1.5 m intervals from O.

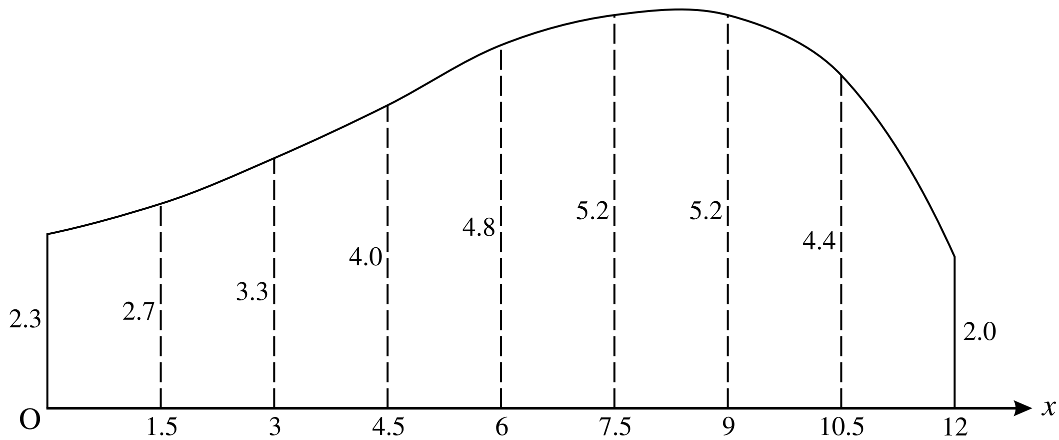

Fig. 11

(i) Use the trapezium rule with 8 strips to calculate an estimate of the area of the cross-section. **[4]**

(ii) Use 8 rectangles to calculate a lower bound for the area of the cross-section. **[2]**

The curve of the roof may be modelled by $y = -0.013x^3 + 0.16x^2 - 0.082x + 2.4$, where x metres is the horizontal distance from O across the hall, and y metres is the height.

(iii) Use integration to find the area of the cross-section according to this model. **[4]**

(iv) Comment on the accuracy of this model for the height of the hall when $x = 7.5$. **[2]**

12 Answer part (ii) of this question on the insert provided.

Since 1945 the populations of many countries have been growing. The table shows the estimated population of 15- to 59-year-olds in Africa during the period 1955 to 2005.

Year	1955	1965	1975	1985	1995	2005
Population (millions)	131	161	209	277	372	492

Source: United Nations

Such estimates are used to model future population growth and world needs of resources. One model is $P = a10^{bt}$, where the population is P millions, t is the number of years after 1945 and a and b are constants.

(i) Show that, using this model, the graph of $\log_{10} P$ against t is a straight line of gradient b. State the intercept of this line on the vertical axis. **[3]**

(ii) **On the insert**, complete the table, giving values correct to 2 decimal places, and plot the graph of $\log_{10} P$ against t. Draw, by eye, a line of best fit on your graph. **[3]**

(iii) Use your graph to find the equation for P in terms of t. **[4]**

(iv) Use your results to estimate the population of 15- to 59-year-olds in Africa in 2050. Comment, with a reason, on the reliability of this estimate. **[3]**

ADVANCED SUBSIDIARY GCE

MATHEMATICS (MEI) 4752

Concepts for Advanced Mathematics (C2)
INSERT for Question 12

Friday 15 January 2010
Afternoon

Duration: 1 hour 30 minutes

Candidate Forename		Candidate Surname	

Centre Number						Candidate Number				

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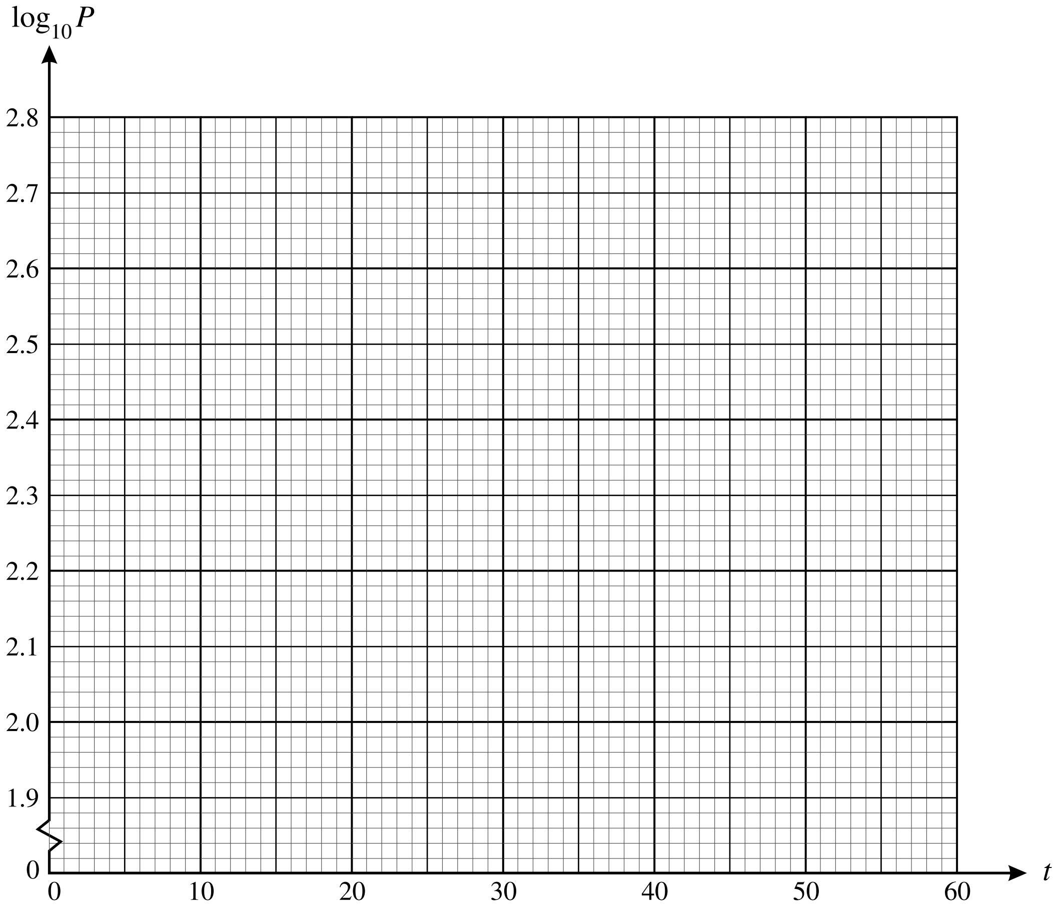
PMT

12 (ii)

Year	1955	1965	1975	1985	1995	2005
t	10	20	30	40	50	60
P	131	161	209	277	372	492
$\log_{10} P$	2.12	2.21				



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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

Thursday 27 May 2010
Morning

Duration: 1 hour 30 minutes

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These instructions are the same on the Printed Answer Book and the Question Paper.

- Write your name clearly in capital letters, your Centre Number and Candidate Number in the spaces provided on the Printed Answer Book.
- **The questions are on the inserted Question Paper.**
- **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 and make sure that 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 graphical calculator in this paper.
- Final answers should be given to a degree of accuracy appropriate to the context.

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- The total number of marks for this paper is **72**.
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3R–0B27
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Section A (36 marks)

1 You are given that

$$u_1 = 1,$$
$$u_{n+1} = \frac{u_n}{1 + u_n}.$$

Find the values of u_2, u_3 and u_4. Give your answers as fractions. **[2]**

2 **(i)** Evaluate $\sum_{r=2}^{5} \frac{1}{r-1}$. **[2]**

(ii) Express the series $2 \times 3 + 3 \times 4 + 4 \times 5 + 5 \times 6 + 6 \times 7$ in the form $\sum_{r=2}^{a} \mathrm{f}(r)$ where $\mathrm{f}(r)$ and a are to be determined. **[2]**

3 **(i)** Differentiate $x^3 - 6x^2 - 15x + 50$. **[2]**

(ii) Hence find the x-coordinates of the stationary points on the curve $y = x^3 - 6x^2 - 15x + 50$. **[3]**

4 In this question, $\mathrm{f}(x) = x^2 - 5x$. Fig. 4 shows a sketch of the graph of $y = \mathrm{f}(x)$.

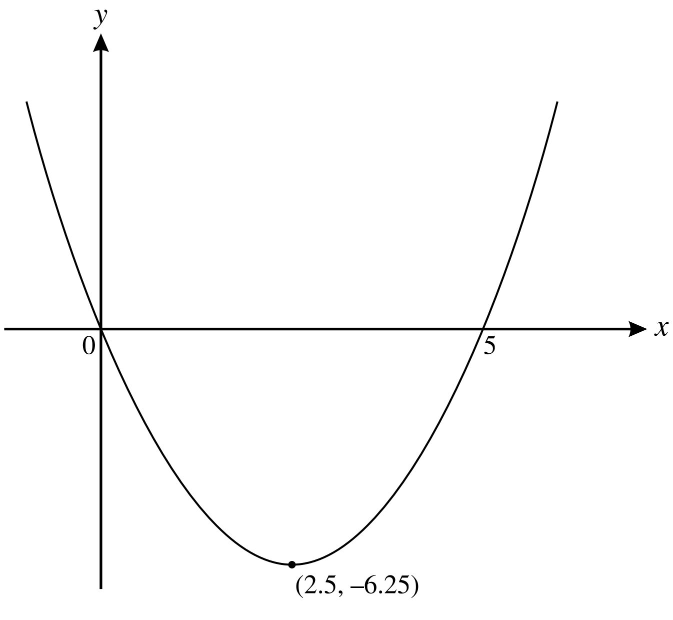

Fig. 4

On separate diagrams, sketch the curves $y = \mathrm{f}(2x)$ and $y = 3\mathrm{f}(x)$, labelling the coordinates of their intersections with the axes and their turning points. **[4]**

5 Find $\int_2^5 \left(1 - \frac{6}{x^3}\right) dx$. **[4]**

6 The gradient of a curve is $6x^2 + 12x^{\frac{1}{2}}$. The curve passes through the point (4, 10). Find the equation of the curve. **[5]**

7 Express $\log_a x^3 + \log_a \sqrt{x}$ in the form $k \log_a x$. **[2]**

8 Showing your method clearly, solve the equation $4\sin^2\theta = 3 + \cos^2\theta$, for values of θ between 0° and 360°. **[5]**

9 The points (2, 6) and (3, 18) lie on the curve $y = ax^n$.

Use logarithms to find the values of a and n, giving your answers correct to 2 decimal places. **[5]**

Section B (36 marks)

10 **(i)** Find the equation of the tangent to the curve $y = x^4$ at the point where $x = 2$. Give your answer in the form $y = mx + c$. **[4]**

(ii) Calculate the gradient of the chord joining the points on the curve $y = x^4$ where $x = 2$ and $x = 2.1$. **[2]**

(iii) (A) Expand $(2 + h)^4$. **[3]**

(B) Simplify $\frac{(2+h)^4 - 2^4}{h}$. **[2]**

(C) Show how your result in part **(iii)** (B) can be used to find the gradient of $y = x^4$ at the point where $x = 2$. **[2]**

11 (a)

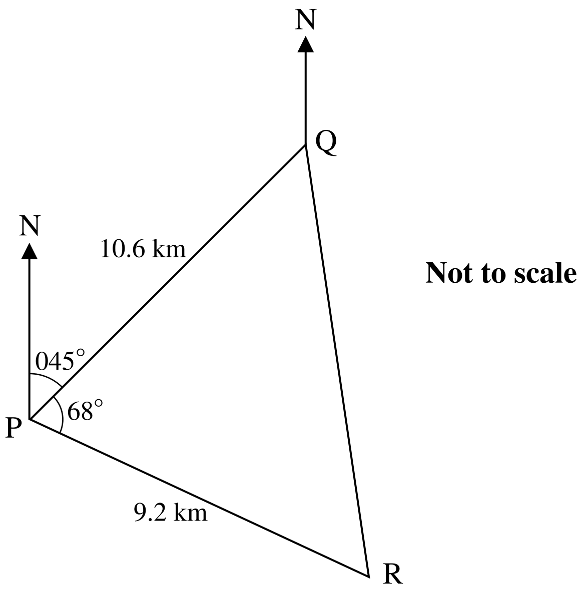

Fig. 11.1

A boat travels from P to Q and then to R. As shown in Fig. 11.1, Q is 10.6 km from P on a bearing of 045°. R is 9.2 km from P on a bearing of 113°, so that angle QPR is 68°.

Calculate the distance and bearing of R from Q. **[5]**

(b) Fig. 11.2 shows the cross-section, EBC, of the rudder of a boat.

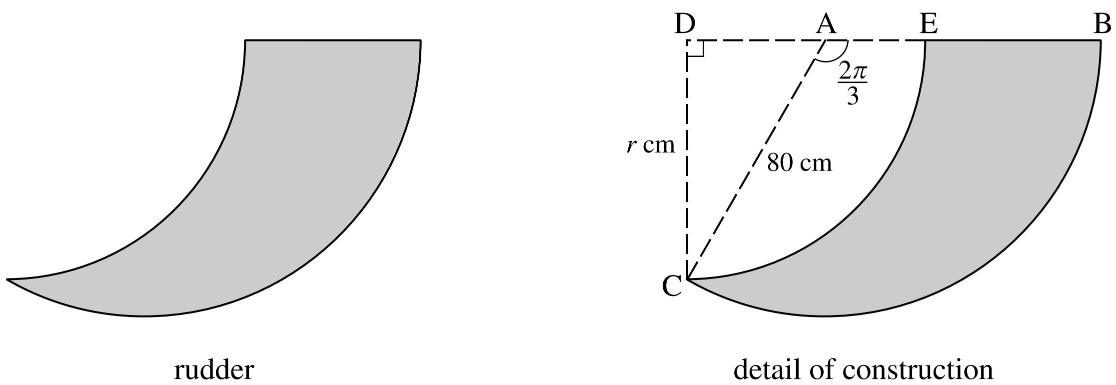

Fig. 11.2

BC is an arc of a circle with centre A and radius 80 cm. Angle CAB = $\frac{2\pi}{3}$ radians.

EC is an arc of a circle with centre D and radius r cm. Angle CDE is a right angle.

(i) Calculate the area of sector ABC. **[2]**

(ii) Show that $r = 40\sqrt{3}$ and calculate the area of triangle CDA. **[3]**

(iii) Hence calculate the area of cross-section of the rudder. **[3]**

12

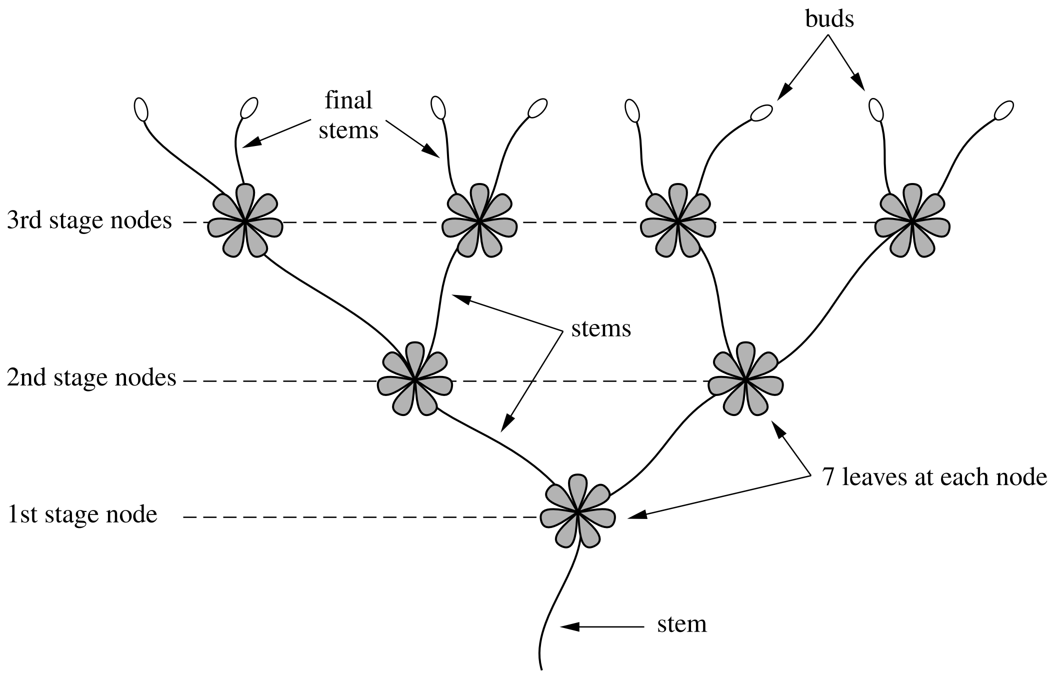

Fig. 12

A branching plant has stems, nodes, leaves and buds.

- There are 7 leaves at each node.
- From each node, 2 new stems grow.
- At the end of each final stem, there is a bud.

Fig. 12 shows one such plant with 3 stages of nodes. It has 15 stems, 7 nodes, 49 leaves and 8 buds.

(i) One of these plants has 10 stages of nodes.

(A) How many buds does it have? **[2]**

(B) How many stems does it have? **[2]**

(ii) (A) Show that the number of leaves on one of these plants with n stages of nodes is

$$7(2^n - 1).$$ **[2]**

(B) One of these plants has n stages of nodes and more than 200 000 leaves. Show that n satisfies the inequality $n > \dfrac{\log_{10} 200\,007 - \log_{10} 7}{\log_{10} 2}$. Hence find the least possible value of n. **[4]**

ADVANCED SUBSIDIARY GCE

MATHEMATICS (MEI) 4752

Concepts for Advanced Mathematics (C2)

QUESTION PAPER

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OCR supplied materials:

- Printed answer book 4752
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Other materials required:

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Friday 14 January 2011
Afternoon

Duration: 1 hour 30 minutes

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Section A (36 marks)

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

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

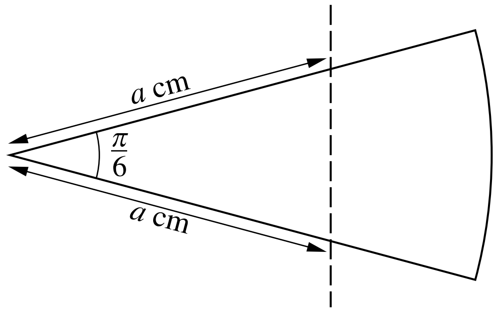

Fig. 9

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

Section B (36 marks)

10

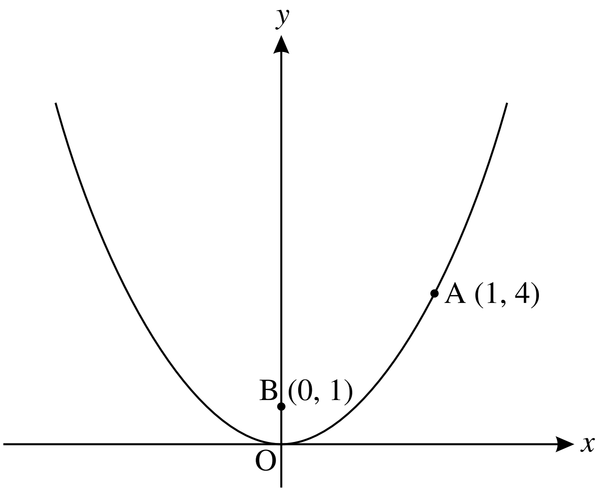

Fig. 10

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

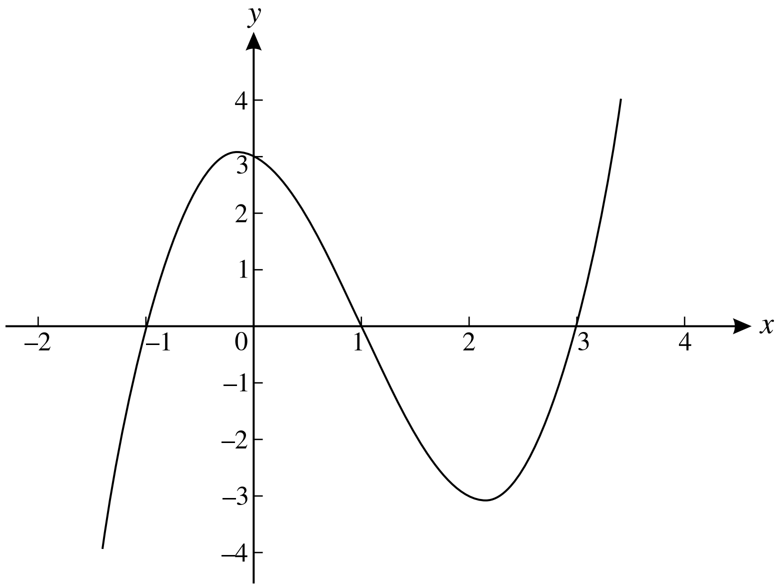

Fig. 11

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]**

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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)

QUESTION PAPER

Candidates answer on the printed answer book.

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- Printed answer book 4752
- MEI Examination Formulae and Tables (MF2)

Other materials required:
- Scientific or graphical calculator

Friday 20 May 2011
Afternoon

Duration: 1 hour 30 minutes

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

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- Write your name, centre number and candidate number in the spaces provided on the printed answer book. Please write clearly and in capital letters.
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Section A (36 marks)

1 Find $\int_2^5 (2x^3 + 3)\,\mathrm{d}x$. **[3]**

2 A sequence is defined by

$$u_1 = 10,$$
$$u_{r+1} = \frac{5}{u_r^2}.$$

Calculate the values of u_2, u_3 and u_4.

What happens to the terms of the sequence as r tends to infinity? **[3]**

3 The equation of a curve is $y = \sqrt{1 + 2x}$.

(i) Calculate the gradient of the chord joining the points on the curve where $x = 4$ and $x = 4.1$. Give your answer correct to 4 decimal places. **[3]**

(ii) Showing the points you use, calculate the gradient of another chord of the curve which is a closer approximation to the gradient of the curve when $x = 4$. **[2]**

4 The graph of $y = ab^x$ passes through the points (1, 6) and (2, 3.6). Find the values of a and b. **[3]**

5 Find the equation of the normal to the curve $y = 8x^4 + 4$ at the point where $x = \frac{1}{2}$. **[5]**

6 The gradient of a curve is given by $\frac{\mathrm{d}y}{\mathrm{d}x} = 6\sqrt{x} - 2$. Given also that the curve passes through the point (9, 4), find the equation of the curve. **[5]**

7 Solve the equation $\tan\theta = 2\sin\theta$ for $0° \leqslant \theta \leqslant 360°$. **[4]**

8 Using logarithms, rearrange $p = st^n$ to make n the subject. **[3]**

9 You are given that

$$\log_a x = \tfrac{1}{2}\log_a 16 + \log_a 75 - 2\log_a 5.$$

Find the value of x. **[3]**

10 The nth term, t_n, of a sequence is given by

$$t_n = \sin(\theta + 180n)°.$$

Express t_1 and t_2 in terms of $\sin\theta°$. **[2]**

Section B (36 marks)

11 **(i)** The standard formulae for the volume V and total surface area A of a solid cylinder of radius r and height h are

$$V = \pi r^2 h \qquad \text{and} \qquad A = 2\pi r^2 + 2\pi rh.$$

Use these to show that, for a cylinder with $A = 200$,

$$V = 100r - \pi r^3.$$ **[4]**

(ii) Find $\frac{dV}{dr}$ and $\frac{d^2V}{dr^2}$. **[3]**

(iii) Use calculus to find the value of r that gives a maximum value for V and hence find this maximum value, giving your answers correct to 3 significant figures. **[4]**

12 Jim and Mary are each planning monthly repayments for money they want to borrow.

(i) Jim's first payment is £500, and he plans to pay £10 less each month, so that his second payment is £490, his third is £480, and so on.

(A) Calculate his 12th payment. **[2]**

(B) He plans to make 24 payments altogether. Show that he pays £9240 in total. **[2]**

(ii) Mary's first payment is £460 and she plans to pay 2% less each month than the previous month, so that her second payment is £450.80, her third is £441.784, and so on.

(A) Calculate her 12th payment. **[2]**

(B) Show that Jim's 20th payment is less than Mary's 20th payment but that his 19th is not less than her 19th. **[3]**

(C) Mary plans to make 24 payments altogether. Calculate how much she pays in total. **[2]**

(D) How much would Mary's first payment need to be if she wishes to pay 2% less each month as before, but to pay the same in total as Jim, £9240, over the 24 months? **[2]**

[Question 13 is printed overleaf.]

13 Fig. 13.1 shows a greenhouse which is built against a wall.

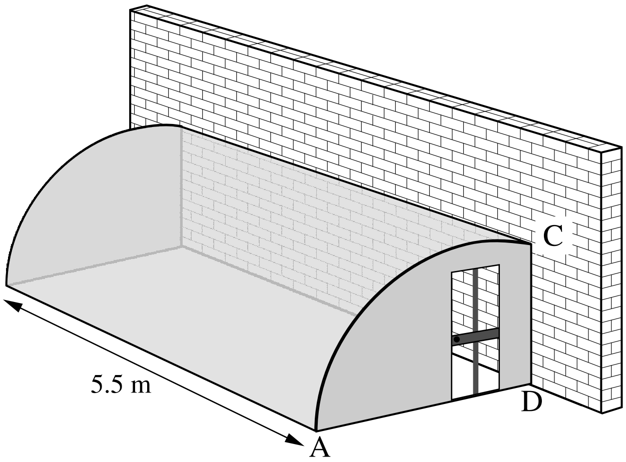

Fig. 13.1

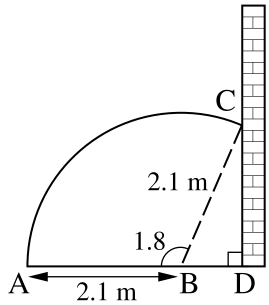

Fig. 13.2

The greenhouse is a prism of length 5.5 m. The curve AC is an arc of a circle with centre B and radius 2.1 m, as shown in Fig. 13.2. The sector angle ABC is 1.8 radians and ABD is a straight line. The curved surface of the greenhouse is covered in polythene.

(i) Find the length of the arc AC and hence find the area of polythene required for the curved surface of the greenhouse. **[4]**

(ii) Calculate the length BD. **[3]**

(iii) Calculate the volume of the greenhouse. **[5]**

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Tuesday 17 January 2012 – Morning

AS GCE MATHEMATICS (MEI)

4752 Concepts for Advanced Mathematics (C2)

QUESTION PAPER

Candidates answer on the Printed Answer Book.

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- Printed Answer Book 4752
- MEI Examination Formulae and Tables (MF2)

Other materials required:
- Scientific or graphical calculator

Duration: 1 hour 30 minutes

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Section A (36 marks)

1 Find $\sum_{r=3}^{6} r(r+2)$. **[2]**

2 Find $\int \left(x^5 + 10x^{\frac{3}{2}}\right) dx$. **[4]**

3 Find the set of values of x for which $x^2 - 7x$ is a decreasing function. **[3]**

4 Given that $a > 0$, state the values of

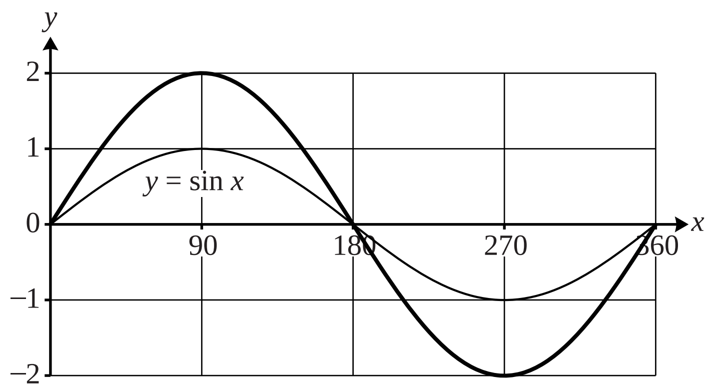
(i) $\log_a 1$, **[1]**

(ii) $\log_a (a^3)^6$, **[1]**

(iii) $\log_a \sqrt{a}$. **[1]**

5 Figs. 5.1 and 5.2 show the graph of $y = \sin x$ for values of x from 0° to 360° and two transformations of this graph. State the equation of each graph after it has been transformed.

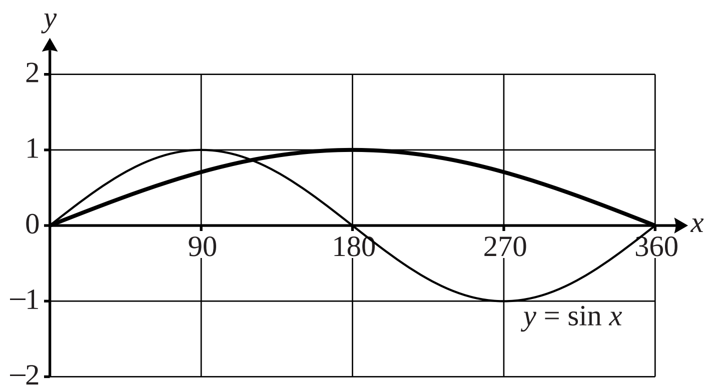
(i)



[1]

Fig. 5.1

(ii)



[2]

Fig. 5.2

6 Use logarithms to solve the equation $235 \times 5^x = 987$, giving your answer correct to 3 decimal places. **[3]**

7 Given that $y = a + x^b$, find $\log_{10} x$ in terms of y, a and b. **[3]**

8 Show that the equation $4\cos^2\theta = 1 + \sin\theta$ can be expressed as

$$4\sin^2\theta + \sin\theta - 3 = 0.$$

Hence solve the equation for $0° \leqslant \theta \leqslant 360°$. **[5]**

9 A geometric progression has a positive common ratio. Its first three terms are 32, b and 12.5.

Find the value of b and find also the sum of the first 15 terms of the progression. **[5]**

10 In an arithmetic progression, the second term is 11 and the sum of the first 40 terms is 3030. Find the first term and the common difference. **[5]**

Section B (36 marks)

11 The point A has x-coordinate 5 and lies on the curve $y = x^2 - 4x + 3$.

(i) Sketch the curve. **[2]**

(ii) Use calculus to find the equation of the tangent to the curve at A. **[4]**

(iii) Show that the equation of the normal to the curve at A is $x + 6y = 53$. Find also, using an algebraic method, the x-coordinate of the point at which this normal crosses the curve again. **[6]**

12 The equation of a curve is $y = 9x^2 - x^4$.

(i) Show that the curve meets the x-axis at the origin and at $x = \pm a$, stating the value of a. **[2]**

(ii) Find $\dfrac{dy}{dx}$ and $\dfrac{d^2y}{dx^2}$.

Hence show that the origin is a minimum point on the curve. Find the x-coordinates of the maximum points. **[6]**

(iii) Use calculus to find the area of the region bounded by the curve and the x-axis between $x = 0$ and $x = a$, using the value you found for a in part **(i)**. **[4]**

13

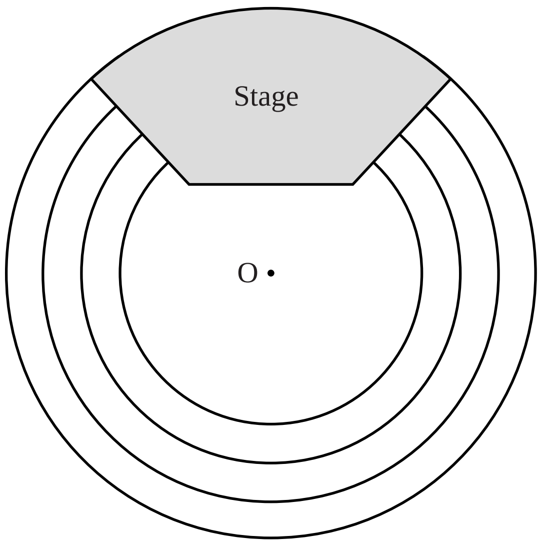


Fig. 13.1

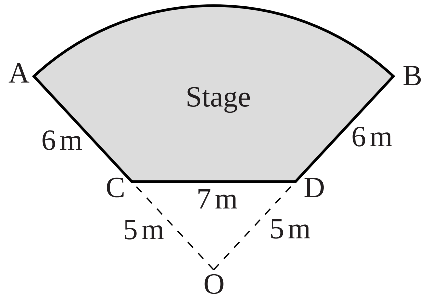


Fig. 13.2

In a concert hall, seats are arranged along arcs of concentric circles, as shown in Fig. 13.1. As shown in Fig. 13.2, the stage is part of a sector ABO of radius 11 m. Fig. 13.2 also gives the dimensions of the stage.

(i) Show that angle COD = 1.55 radians, correct to 2 decimal places. Hence find the area of the stage. **[6]**

(ii) There are four rows of seats, with their backs along arcs, with centre O, of radii 7.4 m, 8.6 m, 9.8 m and 11 m. Each seat takes up 80 cm of the arc.

(*A*) Calculate how many seats can fit in the front row. **[4]**

(*B*) Calculate how many more seats can fit in the back row than the front row. **[2]**

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Friday 18 May 2012 – Morning

AS GCE MATHEMATICS (MEI)

4752 Concepts for Advanced Mathematics (C2)

QUESTION PAPER

4715640612

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

Duration: 1 hour 30 minutes

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- 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.
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- 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.

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Section A (36 marks)

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

2 Find the second and third terms in the sequence given by

$$u_1 = 5,$$
$$u_{n+1} = u_n + 3.$$

Find also the sum of the first 50 terms of this sequence. **[4]**

3

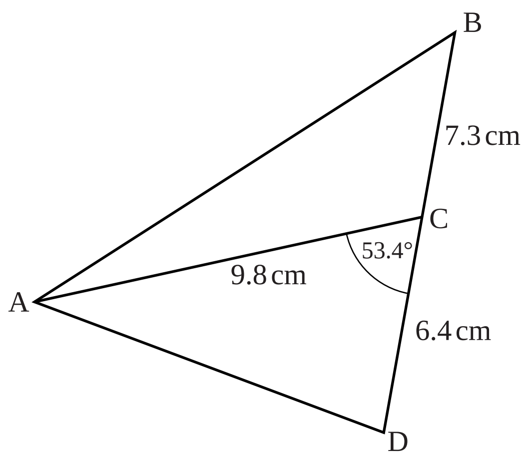

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Fig. 3

In Fig. 3, BCD is a straight line. AC = 9.8 cm, BC = 7.3 cm and CD = 6.4 cm; angle ACD = 53.4°.

(i) Calculate the length AD. **[3]**

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

4 The point P (6, 3) lies on the curve $y = f(x)$. State the coordinates of the image of P after the transformation which maps $y = f(x)$ onto

(i) $y = 3f(x)$, **[2]**

(ii) $y = f(4x)$. **[2]**

5 A sector of a circle has angle 1.6 radians and area 45 cm^2. Find the radius and perimeter of the sector. **[5]**

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6 Fig. 6 shows the relationship between $\log_{10} x$ and $\log_{10} y$.

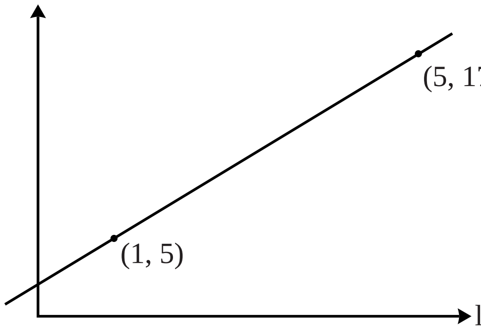

Fig. 6

Find y in terms of x. **[5]**

7 The gradient of a curve is given by $\frac{dy}{dx} = 6x^{\frac{1}{2}} - 5$. Given also that the curve passes through the point (4, 20), find the equation of the curve. **[5]**

8 Solve the equation $\sin 2\theta = 0.7$ for values of θ between 0 and 2π, giving your answers in radians correct to 3 significant figures. **[5]**

Section B (36 marks)

9 A farmer digs ditches for flood relief. He experiments with different cross-sections. Assume that the surface of the ground is horizontal.

(i)

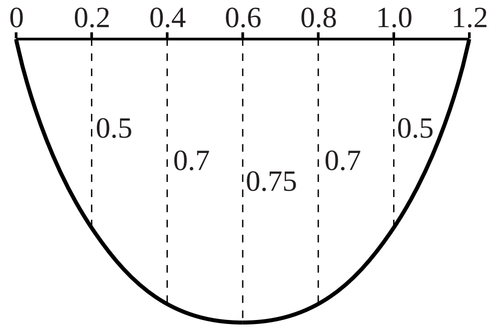

Fig. 9.1

Fig. 9.1 shows the cross-section of one ditch, with measurements in metres. The width of the ditch is 1.2 m and Fig. 9.1 shows the depth every 0.2 m across the ditch.

Use the trapezium rule with six intervals to estimate the area of cross-section. Hence estimate the volume of water that can be contained in a 50-metre length of this ditch. **[5]**

(ii) Another ditch is 0.9 m wide, with cross-section as shown in Fig. 9.2.

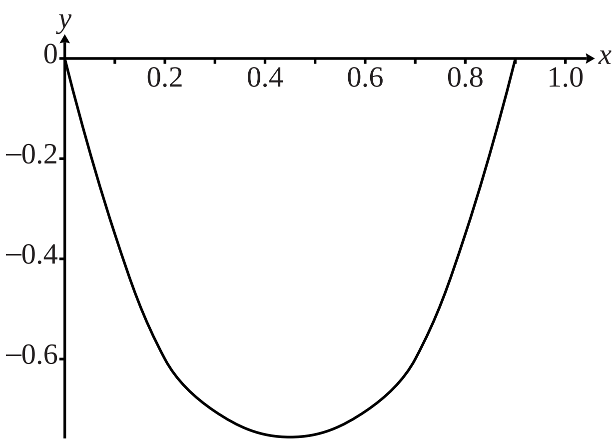

Fig. 9.2

With x- and y-axes as shown in Fig. 9.2, the curve of the ditch may be modelled closely by $y = 3.8x^4 - 6.8x^3 + 7.7x^2 - 4.2x$.

(A) The actual ditch is 0.6 m deep when $x = 0.2$. Calculate the difference between the depth given by the model and the true depth for this value of x. **[2]**

(B) Find $\int (3.8x^4 - 6.8x^3 + 7.7x^2 - 4.2x)\,dx$. Hence estimate the volume of water that can be contained in a 50-metre length of this ditch. **[5]**

10 **(i)** Use calculus to find, correct to 1 decimal place, the coordinates of the turning points of the curve $y = x^3 - 5x$. [You need not determine the nature of the turning points.] **[4]**

(ii) Find the coordinates of the points where the curve $y = x^3 - 5x$ meets the axes and sketch the curve. **[4]**

(iii) Find the equation of the tangent to the curve $y = x^3 - 5x$ at the point (1, –4). Show that, where this tangent meets the curve again, the x-coordinate satisfies the equation

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

Hence find the x-coordinate of the point where this tangent meets the curve again. **[6]**

11 A geometric progression has first term a and common ratio r. The second term is 6 and the sum to infinity is 25.

(i) Write down two equations in a and r. Show that one possible value of a is 10 and find the other possible value of a. Write down the corresponding values of r. **[7]**

(ii) Show that the ratio of the nth terms of the two geometric progressions found in part **(i)** can be written as $2^{n-2} : 3^{n-2}$. **[3]**

Friday 18 January 2013 – Afternoon

AS GCE MATHEMATICS (MEI)

4752/01 Concepts for Advanced Mathematics (C2)

QUESTION PAPER

Candidates answer on the Printed Answer Book.

OCR supplied materials:
- Printed Answer Book 4752/01
- MEI Examination Formulae and Tables (MF2)

Other materials required:
- Scientific or graphical calculator

Duration: 1 hour 30 minutes

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- 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.

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Section A (36 marks)

1 Find $\int 30x^{\frac{3}{2}}\,dx$. **[3]**

2 For each of the following sequences, state with a reason whether it is convergent, periodic or neither. Each sequence continues in the pattern established by the given terms.

(i) $3, \ \frac{3}{2}, \ \frac{3}{4}, \ \frac{3}{8}, \ \dots$ **[1]**

(ii) $3, \ 7, \ 11, \ 15, \ \dots$ **[1]**

(iii) $3, \ 5, \ -3, \ -5, \ 3, \ 5, \ -3, \ -5, \ \dots$ **[1]**

3 **(i)** The point P (4, –2) lies on the curve $y = \mathrm{f}(x)$. Find the coordinates of the image of P when the curve is transformed to $y = \mathrm{f}(5x)$. **[2]**

(ii) Describe fully a single transformation which maps the curve $y = \sin x°$ onto the curve $y = \sin(x - 90)°$. **[2]**

4

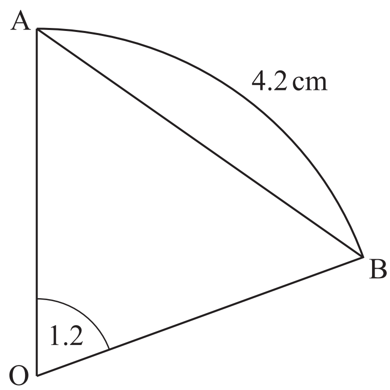

Fig. 4

Fig. 4 shows sector OAB with sector angle 1.2 radians and arc length 4.2 cm. It also shows chord AB.

(i) Find the radius of this sector. **[2]**

(ii) Calculate the perpendicular distance of the chord AB from O. **[2]**

5 A and B are points on the curve $y = 4\sqrt{x}$. Point A has coordinates (9, 12) and point B has x-coordinate 9.5. Find the gradient of the chord AB.

The gradient of AB is an approximation to the gradient of the curve at A. State the x-coordinate of a point C on the curve such that the gradient of AC is a closer approximation. **[3]**

6 Differentiate $2x^3 + 9x^2 - 24x$. Hence find the set of values of x for which the function $\mathrm{f}(x) = 2x^3 + 9x^2 - 24x$ is increasing. **[4]**

7 Fig. 7 shows a sketch of a village green ABC which is bounded by three straight roads. AB = 92 m, BC = 75 m and AC = 105 m.

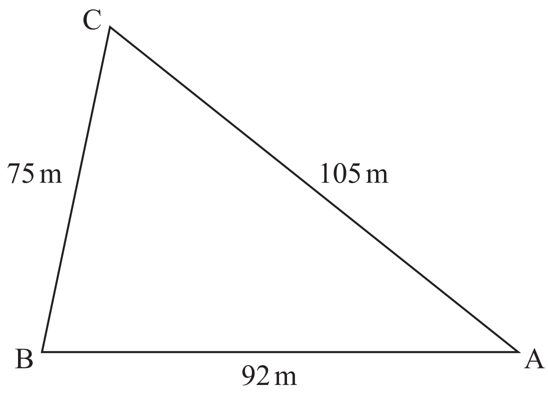

Fig. 7

Calculate the area of the village green. **[5]**

8 **(i)** Sketch the graph of $y = 3^x$. **[2]**

(ii) Solve the equation $3^{5x-1} = 500\,000$. **[3]**

9 **(i)** Show that the equation $\dfrac{\tan\theta}{\cos\theta} = 1$ may be rewritten as $\sin\theta = 1 - \sin^2\theta$. **[2]**

(ii) Hence solve the equation $\dfrac{\tan\theta}{\cos\theta} = 1$ for $0° \leqslant \theta \leqslant 360°$. **[3]**

Section B (36 marks)

10 Fig. 10 shows a sketch of the curve $y = x^2 - 4x + 3$. The point A on the curve has x-coordinate 4. At point B the curve crosses the x-axis.

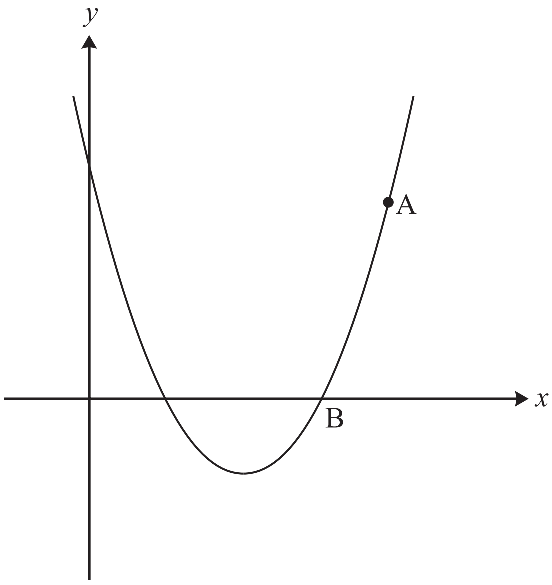

Fig. 10

(i) Use calculus to find the equation of the normal to the curve at A and show that this normal intersects the x-axis at C (16, 0). **[6]**

(ii) Find the area of the region ABC bounded by the curve, the normal at A and the x-axis. **[5]**

11 **(i)** An arithmetic progression has first term A and common difference D. The sum of its first two terms is 25 and the sum of its first four terms is 250.

(A) Find the values of A and D. **[4]**

(B) Find the sum of the 21st to 50th terms inclusive of this sequence. **[3]**

(ii) A geometric progression has first term a and common ratio r, with $r \neq \pm 1$. The sum of its first two terms is 25 and the sum of its first four terms is 250.

Use the formula for the sum of a geometric progression to show that $\dfrac{r^4 - 1}{r^2 - 1} = 10$ and hence or otherwise find algebraically the possible values of r and the corresponding values of a. **[5]**

12 The table shows population data for a country.

Year	1969	1979	1989	1999	2009
Population in millions (p)	58.81	80.35	105.27	134.79	169.71

The data may be represented by an exponential model of growth. Using t as the number of years after 1960, a suitable model is $p = a \times 10^{kt}$.

(i) Derive an equation for $\log_{10} p$ in terms of a, k and t. **[2]**

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

(iii) Use your line of best fit to express $\log_{10} p$ in terms of t and hence find p in terms of t. **[4]**

(iv) According to the model, what was the population in 1960? **[1]**

(v) According to the model, when will the population reach 200 million? **[3]**

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Friday 17 May 2013 – Morning

AS GCE MATHEMATICS (MEI)

4752/01 Concepts for Advanced Mathematics (C2)

QUESTION PAPER

Candidates answer on the Printed Answer Book.

OCR supplied materials:
- Printed Answer Book 4752/01
- MEI Examination Formulae and Tables (MF2)

Other materials required:
- Scientific or graphical calculator

Duration: 1 hour 30 minutes

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Section A (36 marks)

1 Find $\frac{dy}{dx}$ when

(i) $y = 2x^{-5}$, **[2]**

(ii) $y = \sqrt[3]{x}$. **[3]**

2 The nth term of a sequence, u_n, is given by

$$u_n = 12 - \tfrac{1}{2}n.$$

(i) Write down the values of u_1, u_2 and u_3. State what type of sequence this is. **[2]**

(ii) Find $\sum_{n=1}^{30} u_n$. **[3]**

3 The gradient of a curve is given by $\frac{dy}{dx} = \frac{18}{x^3} + 2$. The curve passes through the point $(3, 6)$. Find the equation of the curve. **[5]**

4 **(i)** Starting with an equilateral triangle, prove that $\cos 30° = \frac{\sqrt{3}}{2}$. **[2]**

(ii) Solve the equation $2\sin\theta = -1$ for $0 \leqslant \theta \leqslant 2\pi$, giving your answers in terms of π. **[3]**

5

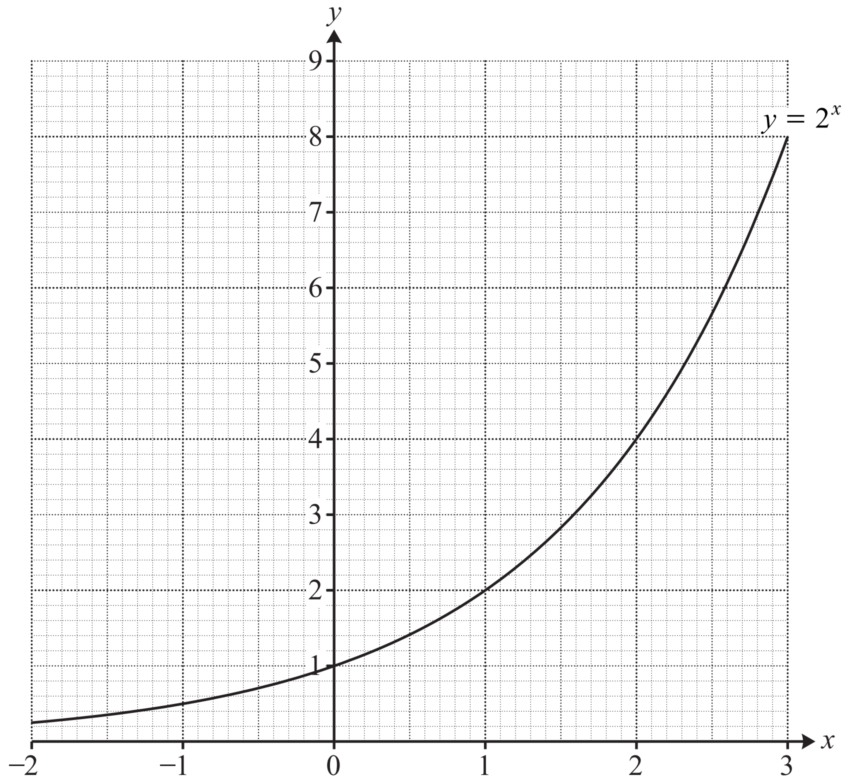

Fig. 5

Fig. 5 shows the graph of $y = 2^x$.

(i) On the copy of Fig. 5, draw by eye a tangent to the curve at the point where $x = 2$. Hence find an estimate of the gradient of $y = 2^x$ when $x = 2$. **[3]**

(ii) Calculate the y-values on the curve when $x = 1.8$ and $x = 2.2$. Hence calculate another approximation to the gradient of $y = 2^x$ when $x = 2$. **[2]**

6 S is the sum to infinity of a geometric progression with first term a and common ratio r.

(i) Another geometric progression has first term $2a$ and common ratio r. Express the sum to infinity of this progression in terms of S. **[1]**

(ii) A third geometric progression has first term a and common ratio r^2. Express, in its simplest form, the sum to infinity of this progression in terms of S and r. **[2]**

7 Fig. 7 shows a curve and the coordinates of some points on it.

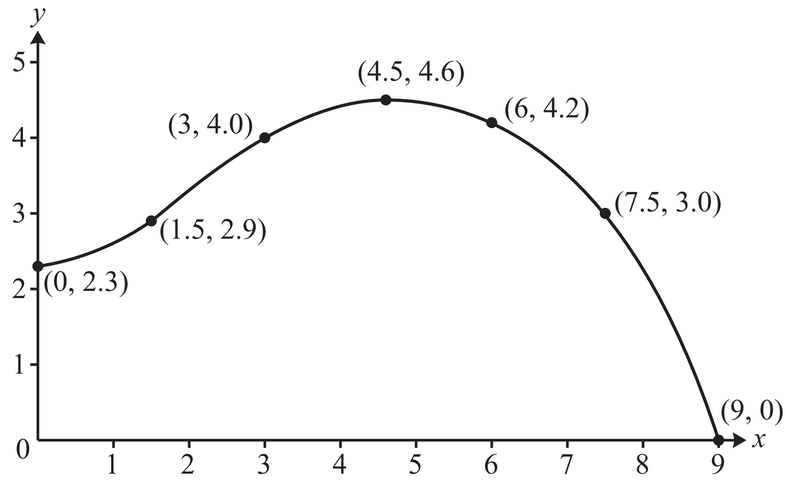

Fig. 7

Use the trapezium rule with 6 strips to estimate the area of the region bounded by the curve and the positive x- and y-axes. **[4]**

8 Fig. 8 shows the graph of $y = \mathrm{g}(x)$.

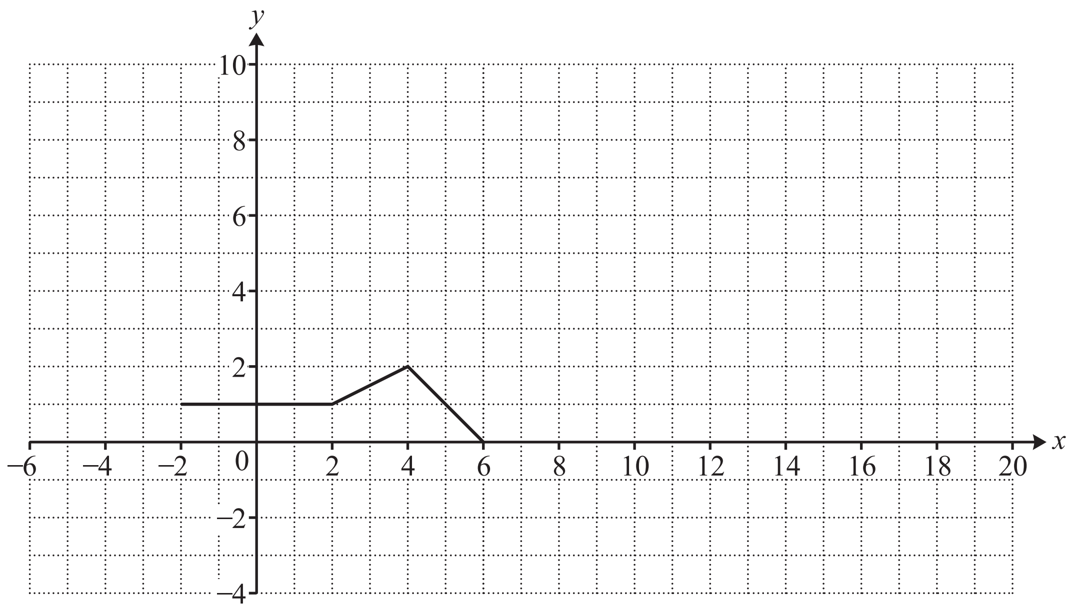

Fig. 8

Draw the graph of

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

(ii) $y = 3\mathrm{g}(x)$. **[2]**

Section B (36 marks)

9 Fig. 9 shows a sketch of the curve $y = x^3 - 3x^2 - 22x + 24$ and the line $y = 6x + 24$.

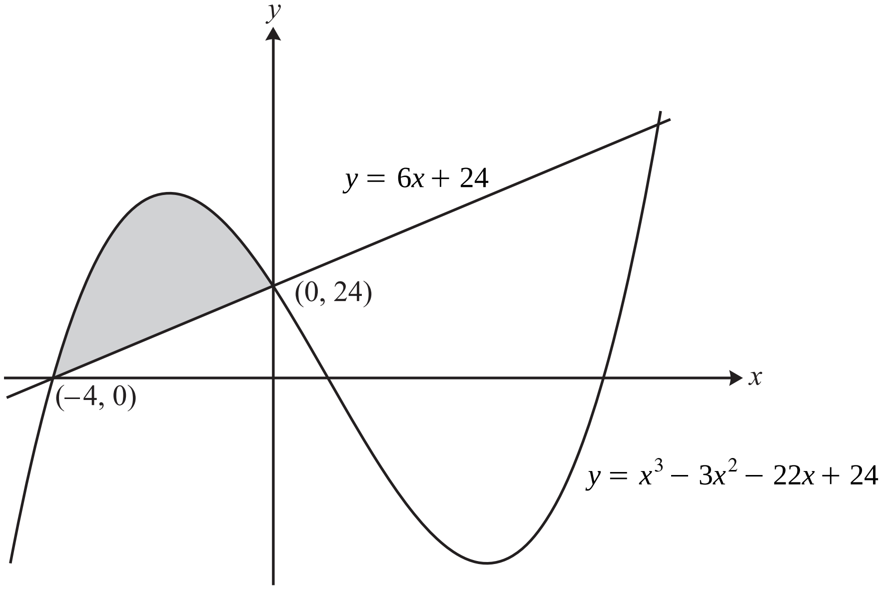

Fig. 9

(i) Differentiate $y = x^3 - 3x^2 - 22x + 24$ and hence find the x-coordinates of the turning points of the curve. Give your answers to 2 decimal places. **[4]**

(ii) You are given that the line and the curve intersect when $x = 0$ and when $x = -4$. Find algebraically the x-coordinate of the other point of intersection. **[3]**

(iii) Use calculus to find the area of the region bounded by the curve and the line $y = 6x + 24$ for $-4 \leqslant x \leqslant 0$, shown shaded on Fig. 9. **[4]**

10 Fig. 10.1 shows Jean's back garden. This is a quadrilateral ABCD with dimensions as shown.

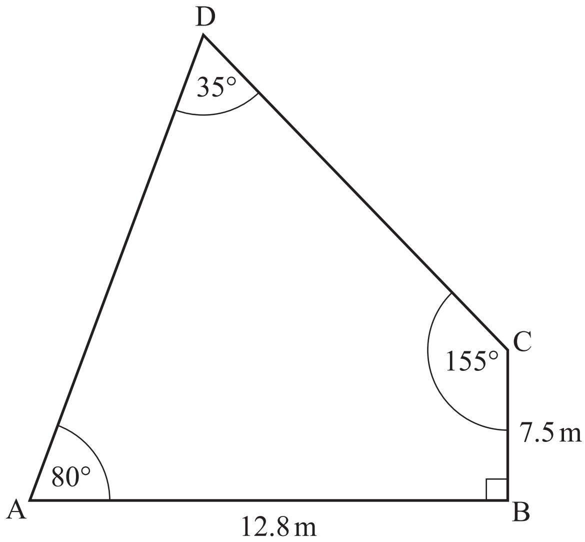

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Fig. 10.1

(i) (*A*) Calculate AC and angle ACB. Hence calculate AD. **[6]**

(*B*) Calculate the area of the garden. **[3]**

(ii) The shape of the fence panels used in the garden is shown in Fig. 10.2. EH is the arc of a sector of a circle with centre at the midpoint, M, of side FG, and sector angle 1.1 radians, as shown. FG = 1.8 m.

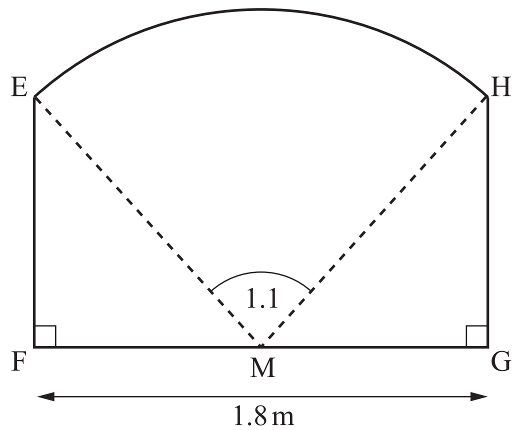

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Fig. 10.2

Calculate the area of one of these fence panels. **[5]**

11 A hot drink when first made has a temperature which is 65°C higher than room temperature. The temperature difference, d °C, between the drink and its surroundings decreases by 1.7% each minute.

(i) Show that 3 minutes after the drink is made, $d = 61.7$ to 3 significant figures. **[2]**

(ii) Write down an expression for the value of d at time n minutes after the drink is made, where n is an integer. **[1]**

(iii) Show that when $d < 3$, n must satisfy the inequality

$$n > \frac{\log_{10}3 - \log_{10}65}{\log_{10}0.983}.$$

Hence find the least integer value of n for which $d < 3$. **[4]**

(iv) The temperature difference at any time t minutes after the drink is made can also be expressed as $d = 65 \times 10^{-kt}$, for some constant k. Use the value of d for 1 minute after the drink is made to calculate the value of k. Hence find the temperature difference 25.3 minutes after the drink is made. **[4]**

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