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IGCSE

Further Pure Mathematics

Sample Assessment Materials (SAMs)

Edexcel IGCSE in Further Pure Mathematics (4PM0)

First examination 2011

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Acknowledgements

This document has been produced by Edexcel on the basis of consultation with teachers, examiners, consultants and other interested parties. Edexcel acknowledges its indebtedness to all those who contributed their time and expertise to its development.

Authorised by Roger Beard
Prepared by Ali Melville

Contents

Introduction

These sample assessment materials have been prepared to support the specification.

The aim of these materials is to provide students and centres with a general impression and flavour of the actual question papers and mark schemes in advance of the first operational examinations.

Sample assessment papers

Centre No.						Paper Reference							Surname	Initial(s)
Candidate No.						4	P	M	0	/	0	1	Signature	

Paper Reference(s)

4PM0/01

Edexcel IGCSE

Further Pure Mathematics

Paper 1

Examiner's use only

Team Leader's use only

Question Number	Leave Blank
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
Total	

Sample Assessment Material

Time: 2 hours

Materials required for examination
Nil

Items included with question papers
Nil

Candidates are expected to have an electronic calculator when answering this paper.

Instructions to Candidates

In the boxes above, write your centre number, candidate number, your surname, initials and signature.
Check that you have the correct question paper.
You must write your answer for each question in the space following the question.
If you need more space to complete your answer to any question, use additional answer sheets.

Information for Candidates

Full marks may be obtained for answers to ALL questions.
The marks for individual questions and the parts of questions are shown in round brackets: e.g. **(2)**.
There are 10 questions in this question paper. The total mark for this paper is 100.
There are 20 pages in this question paper. Any blank pages are indicated.

Advice to Candidates

Write your answers neatly and legibly.

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Leave blank

1. Solve the equations

$$x^2 + 4x - xy = 10$$

$$2x - y = 3$$

(6)

Q1

(Total 6 marks)

Leave blank

2.

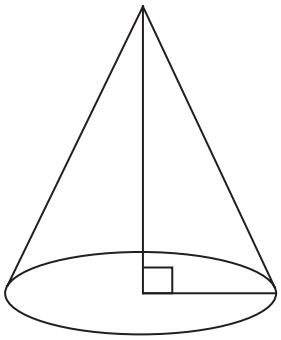


Figure 1

The volume of a right circular cone is increasing at the rate of 45 $cm^3 s^{-1}$.
The height of the cone is always three times the radius of the base of the cone.
Find the rate of increase of the radius of the base, in $cm\,s^{-1}$, when the radius of the cone is 4 cm.
Give your answer correct to 3 significant figures.

(6)

Q2

(Total 6 marks)

Leave blank

3. A curve has equation $y = 2 + \frac{1}{x+1}$, $x \neq -1$

(a) Find an equation of the asymptote to the curve which is parallel to

(i) the x-axis, (ii) the y-axis.

(2)

(b) Find the coordinates of the points where the curve crosses the coordinate axes.

(2)

(c) Sketch the curve, showing clearly the asymptotes and the coordinates of the points where the curve crosses the coordinate axes.

(3)

Leave blank

Question 3 continued

Q3

(Total 7 marks)

Leave blank

4. The sum of the first four terms of an arithmetic series is 34
The sum of the first six terms of the series is 69

Find,

(a) the common difference of the series,

(4)

(b) the first term of the series.

(1)

The sum of the first p terms of this series is 650

(c) Find the value of p.

(3)

Another arithmetic series is formed.
The sum of the first four terms of the new series is 54
The sum of the first six terms of this new series is 99

Find, for the new series,

(d) the common difference,

(1)

(e) the first term.

(1)

Leave blank

Question 4 continued

Q4

(Total 10 marks)

Leave blank

5.

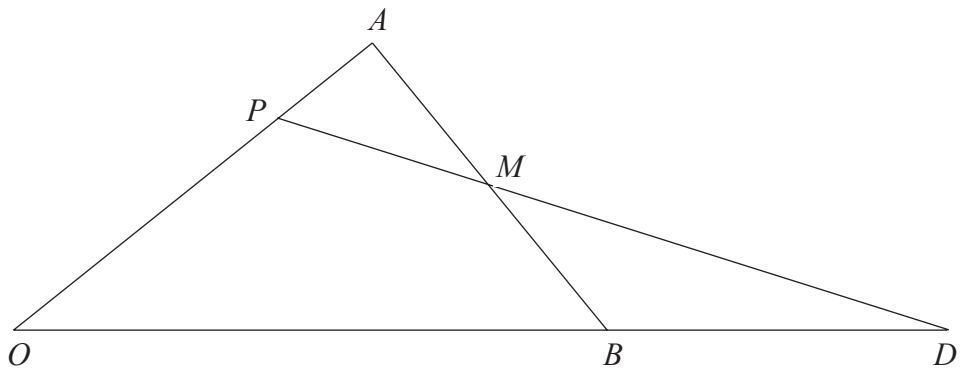


Figure 2

In Figure 2, $\overrightarrow{OA} = \mathbf{a}$, $\overrightarrow{OB} = \mathbf{b}$ and M is the midpoint of AB.
The point P divides OA in the ratio 2:1, and PM produced meets OB produced at D.

(a) Find, in terms of **a** and **b**,

(i) $\overrightarrow{AB}$,

(ii) $\overrightarrow{PA}$,

(iii) $\overrightarrow{PM}$.

(4)

Given that $\overrightarrow{PD} = \mu\overrightarrow{PM}$ and $\overrightarrow{OD} = \lambda\overrightarrow{OB}$,

(b) find the value of μ and the value of λ.

(4)

Leave blank

Question 5 continued

Q5

(Total 8 marks)

Leave blank

6. (a) Complete the table below of values for $y = e^{-\frac{1}{2}x} + 1$, giving your values of y to 2 decimal places.

x	–1	0	1	2	3	4	5
y		2	1.61		1.22	1.14	

(2)

(b) Draw the graph of $y = e^{-\frac{1}{2}x} + 1$ for $-1 \leqslant x \leqslant 5$

(2)

(c) Use your graph to estimate, to 2 significant figures, the solution of the equation

$$e^{-\frac{1}{2}x} = 0.8$$

showing your method clearly.

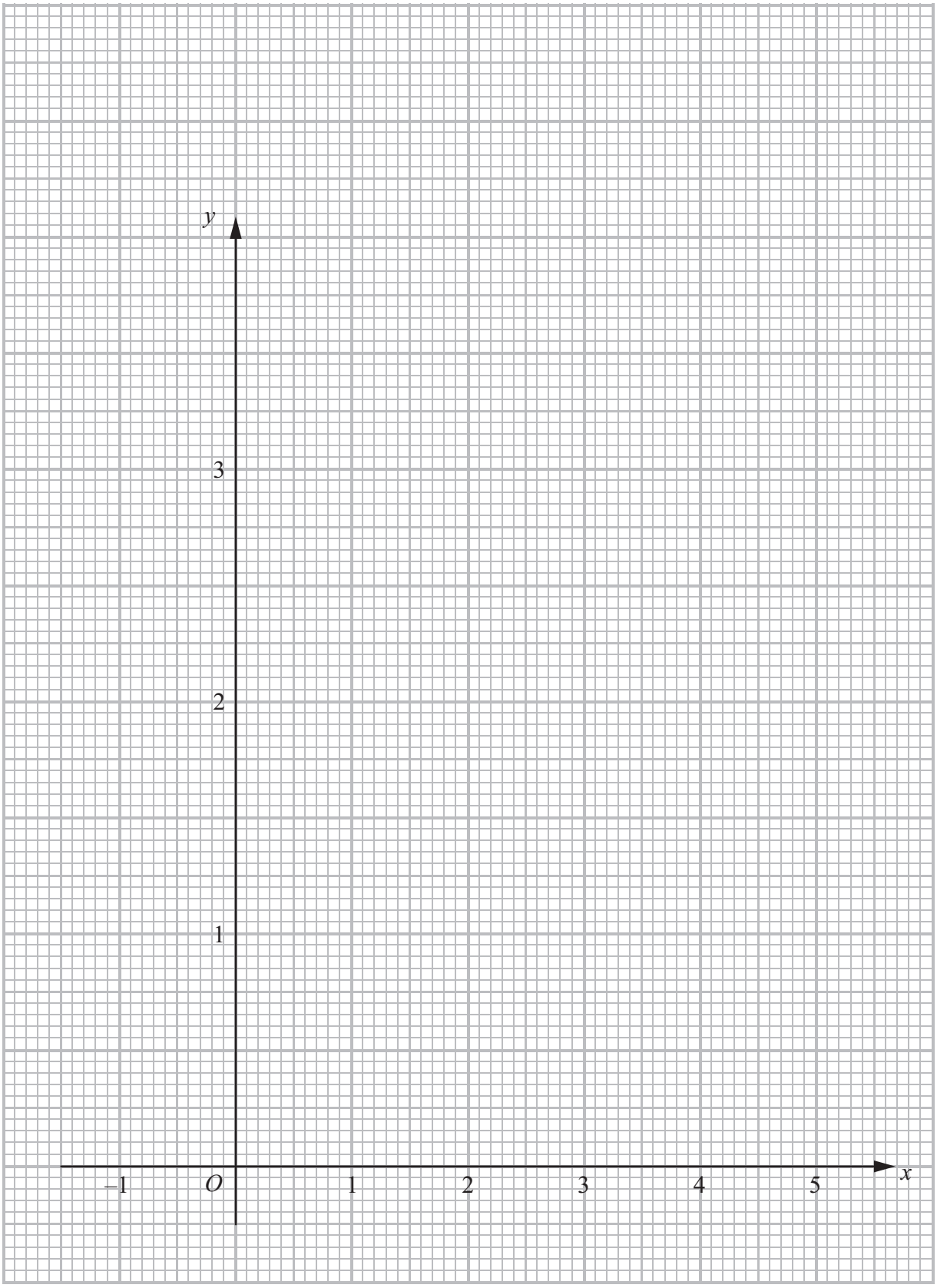
(2)

(d) By drawing a straight line on your graph, estimate, to 2 significant figures, the solution of the equation $x = -2\ln(2x - 7)$.

(4)

Leave blank

Question 6 continued



Q6

(Total 10 marks)

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7.

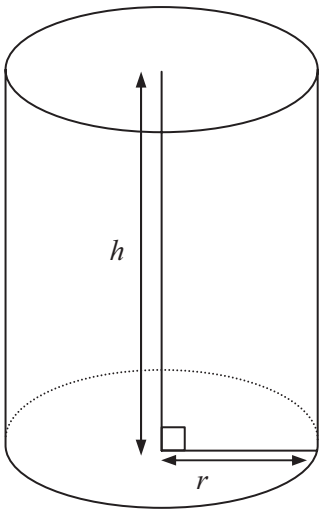

Figure 3

A water tank is in the shape of a right circular cylinder with no lid.
The base of the cylinder is a circle of radius r cm and the height is h cm.
The total external surface area of the tank is A cm^2.
The capacity of the tank is $50\,000\pi$ cm^3.

(a) Show that $A = \left(\frac{100\,000}{r} + r^2\right)\pi$.

(4)

(b) Find, to the nearest whole number, the minimum value of A.
Verify that the value you have found is a minimum.

(6)

Leave blank

Question 7 continued

Q7

(Total 10 marks)

Leave blank

8. The equation $x^2 + 2tx + t = 0$, where t is a non-zero constant, has roots α and β, where $\alpha > \beta$.

(a) Find, in terms of t,

(i) $\alpha^2 + \beta^2$, (ii) $\alpha^2\beta^2$.

(5)

Given that $10\alpha^2\beta^2 = 3(\alpha^2 + \beta^2)$,

(b) find the value of t.

(3)

Using your value of t,

(c) find the exact value of $\alpha - \beta$, giving your answer in the form $p\sqrt{q}$, where p and q are integers and $p \neq 1$.

(3)

Leave blank

Question 8 continued

Q8

(Total 11 marks)

Leave blank

9. Using $\cos(A + B) = \cos A \cos B - \sin A \sin B$,

(a) show that

(i) $\sin^2\theta = \frac{1}{2}(1 - \cos 2\theta)$,

(ii) $\cos^2\theta = \frac{1}{2}(\cos 2\theta + 1)$.

(4)

Given

$$f(\theta) = 1 + 10\sin^2\theta - 16\sin^4\theta$$

(b) Show that $f(\theta) = 3\cos 2\theta - 2\cos 4\theta$

(4)

(c) Solve the equation

$$1 + 10\sin^2\theta° - 16\sin^4\theta° + 2\cos 4\theta° = 0.25 \text{ for } 0 \leqslant \theta \leqslant 180,$$

giving your solutions to 1 decimal place.

(4)

Given that $\int_0^{\frac{\pi}{8}} f(\theta)\mathrm{d}\theta = q + p\sqrt{2}$,

(d) find the value of p and the value of q.

(5)

Leave blank

Question 9 continued

Q9

(Total 17 marks)

Leave blank

10. The points A and B have coordinates (1, 6) and (6, –4) respectively.
The point K divides AB internally in the ratio 2:3

(a) Show that the coordinates of K are (3, 2).

(2)

The line l passes through K and is perpendicular to AB.

(b) Find an equation, with integer coefficients, for l.

(4)

The point E, with coordinates (7, e) lies on l.

(c) Find the value of e.

(1)

The line EK is produced to D so that $EK = KD$.

(d) Find the coordinates of D.

(2)

(e) Find the area of the kite $AEBD$.

(3)

The circle C passes through A, D and K.

(f) Find (i) the coordinates of the centre of C,

(ii) the exact value of the radius of C,

(iii) the area of C, giving your answer in terms of π.

(3)

Leave blank

Question 10 continued

Leave blank

Question 10 continued

Q10

(Total 15 marks)

TOTAL FOR PAPER: 100 MARKS

END

Centre No.						Paper Reference							Surname	Initial(s)
Candidate No.						4	P	M	0	/	0	2	Signature	

Paper Reference(s)

4PM0/02

Edexcel IGCSE

Further Pure Mathematics

Paper 2

Sample Assessment Material

Time: 2 hours

Examiner's use only

Team Leader's use only

Question Number	Leave Blank
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
Total	

Materials required for examination
Nil

Items included with question papers
Nil

Candidates are expected to have an electronic calculator when answering this paper.

Instructions to Candidates

In the boxes above, write your centre number, candidate number, your surname, initials and signature.
Check that you have the correct question paper.
You must write your answer for each question in the space following the question.
If you need more space to complete your answer to any question, use additional answer sheets.

Information for Candidates

Full marks may be obtained for answers to ALL questions.
The marks for individual questions and the parts of questions are shown in round brackets: e.g. **(2)**.
There are 11 questions in this question paper. The total mark for this paper is 100.
There are 24 pages in this question paper. Any blank pages are indicated.

Advice to Candidates

Write your answers neatly and legibly.

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1.

Diagram **NOT** accurately drawn

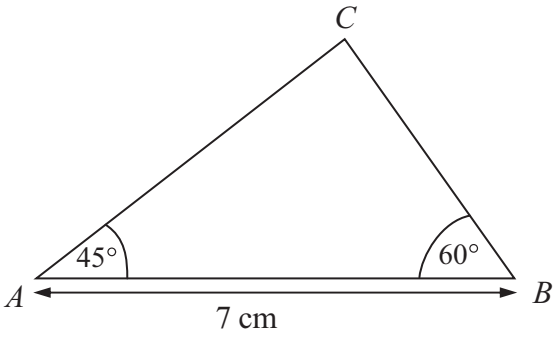

Figure 1

In $\triangle ABC$, $\angle A = 45°$, $\angle B = 60°$ and $AB = 7$ cm.

Calculate, to 3 significant figures, the length of BC.

(3)

Q1

(Total 3 marks)

Leave blank

2. A particle P is moving in a straight line.
At time t seconds, the displacement, s metres, of P from a fixed point O of the line is given by $s = 2t^2 - 9t + 4$

The velocity of P at time t seconds is $v\,\text{m}\,\text{s}^{-1}$.

Find

(a) an expression for v in terms of t,

(2)

(b) the time when P is instantaneously at rest.

(2)

Q2

(Total 4 marks)

Leave blank

3. $f(x) = x^3 + x^2 + px + q$, where p and q are constants.

$f(x)$ has a factor $(x - 4)$

When $f(x)$ is divided by $(x - 2)$ the remainder is -16

(a) Form a pair of simultaneous equations in p and q.

(3)

(b) Find the value of p and the value of q.

(3)

Q3

(Total 6 marks)

Leave blank

4. Given that $(1 + ax)^n = 1 + 18x + 135x^2 + \ldots$, where a and n are constants, find the value of a and the value of n.

(6)

Q4

(Total 6 marks)

Leave blank

5. Differentiate with respect to x

(a) $y = (5x^2 - 2)e^{2x}$

(3)

Leave blank

Question 5 continued

Differentiate with respect to x

(b) $y = \dfrac{x^3 + 2}{x - x^2}$, simplifying your answer.

(4)

Q5

(Total 7 marks)

Leave blank

6.

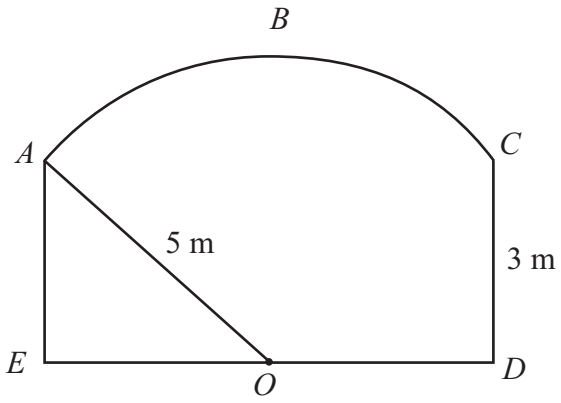

Figure 2

Figure 2 shows the cross-section of a tunnel in which $ACDE$ is a rectangle and ABC is an arc of a circle.

The centre of the circle is at the midpoint, O, of ED.

The radius of the arc is 5 m and $CD = 3$ m.

(a) Find, in radians, the size of angle AOC.
Give your answer correct to 3 significant figures.

(2)

(b) Find, in m^2, the area of the cross-section of the tunnel.
Give your answer correct to 3 significant figures.

(5)

Leave blank

Question 6 continued

Q6

(Total 7 marks)

Leave blank

7.

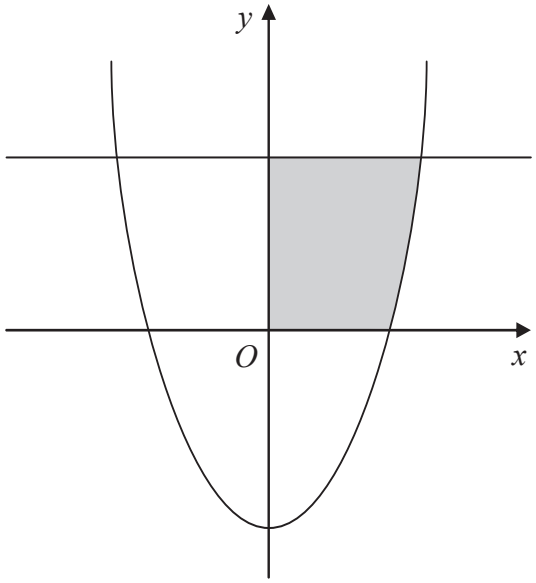

Figure 3

Figure 3 shows the curve with equation $y = x^2 - 4$ and the line with equation $y = 5$

The shaded region is rotated through 360° about the x-axis.

Find the volume of the solid generated.

Give your answer correct to 3 significant figures.

(9)

Leave blank

Question 7 continued

Q7

(Total 9 marks)

Leave blank

8. The sum of the first and third terms of a geometric series is 50
The sum of the second and third terms is 30

(a) Find the two possible values of the common ratio of the series.

(5)

Given that the series is convergent when $|r| < 1$,

(b) find the least number of terms of the series for which the sum exceeds 79.9

(6)

Leave blank

Question 8 continued

Q8

(Total 11 marks)

Leave blank

9. Solve

(a) $\log_2 128 = x$,

(2)

(b) $\log_5 (3y - 1) = 3$

(2)

Given that $p \neq q$, solve the simultaneous equations

(c) $\log_p q + 4 \log_q p = 5$

$pq = 32$

(5)

(d) (i) Factorise $6x \ln x + 4 \ln x - 2 - 3x$

(ii) Hence find the exact solution of the equation

$6x \ln x + 4 \ln x - 2 - 3x = 0$

(5)

Leave blank

Question 9 continued

Q9

(Total 14 marks)

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10.

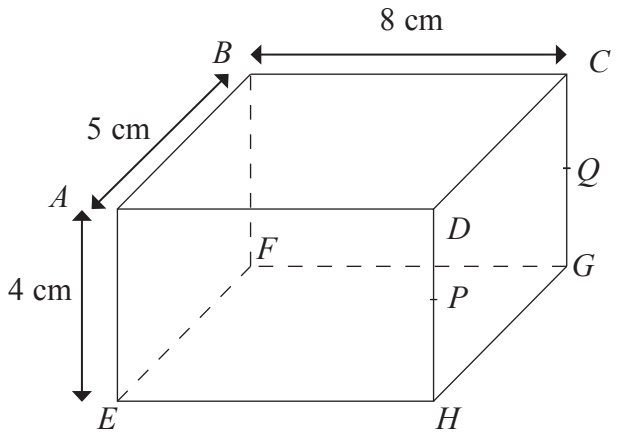

Figure 4

Figure 4 shows a cuboid with a rectangular top $ABCD$.

$AB = 5$ cm, $BC = 8$ cm and $AE = 4$ cm.

The midpoint of DH is P and the midpoint of CG is Q.

(a) Find the length of AG.
Give your answer correct to 3 significant figures.

(2)

Calculate, in degrees to one decimal place, the **acute** angle

(b) between AG and the plane $EFGH$,

(3)

(c) between the plane $ABQP$ and the plane $EFQP$,

(3)

(d) between the plane BCH and the plane $EFGH$,

(3)

(e) between AG and CE.

(4)

Leave blank

Question 10 continued

Leave blank

Question 10 continued

Leave blank

Question 10 continued

Q10

(Total 15 marks)

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11.

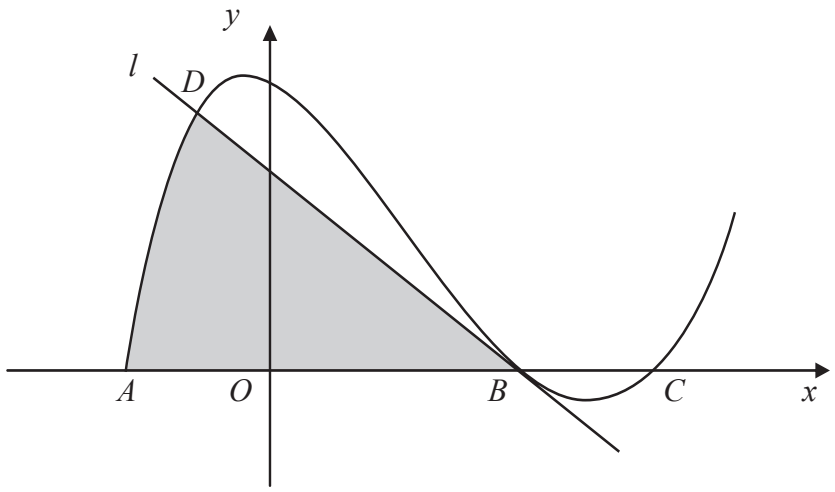

Figure 5

Figure 5 shows the curve with equation $y = x^3 - 5x^2 - 2x + 24$.
The curve meets the x-axis at the points A, B and C.
The line l is the tangent to the curve at B.

(a) Verify that the coordinates of A are $(-2, 0)$.

(2)

(b) Find the coordinates of B and the coordinates of C.

(4)

(c) Find an equation for l.

(4)

The line l intersects the curve at the point D.

(d) Verify that the coordinates of D are $(-1, 20)$.

(2)

(e) Find the area of the shaded region in Figure 5.

(6)

Leave blank

Question 11 continued

Leave blank

Question 11 continued

Leave blank

Question 11 continued

Q11

(Total 18 marks)

TOTAL FOR PAPER: 100 MARKS

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Sample mark schemes

General Marking Guidance

- All candidates must receive the same treatment.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.
- **Types of mark**
  - M marks: method marks
  - A marks: accuracy marks
  - B marks: unconditional accuracy marks (independent of M marks)

- **Abbreviations**
  - cao – correct answer only
  - ft – follow through
  - isw – ignore subsequent working
  - SC - special case
  - oe – or equivalent (and appropriate)
  - dep – dependent
  - indep - independent

- **No working**

  If no working is shown then correct answers normally score full marks
  If no working is shown then incorrect (even though nearly correct) answers score no marks.

- **With working**

  If there is a wrong answer indicated on the answer line always check the working in the body of the script (and on any diagrams), and award any marks appropriate from the mark scheme.
  If it is clear from the working that the "correct" answer has been obtained from incorrect working, award 0 marks.
  Any case of suspected misread loses A (and B) marks on that part, but can gain the M marks.
  If working is crossed out and still legible, then it should be given any appropriate marks, as long as it has not been replaced by alternative work.

- **Follow through marks**

  Follow through marks which involve a single stage calculation can be awarded without working since you can check the answer yourself, but if ambiguous do not award.
  Follow through marks which involve more than one stage of calculation can only be awarded on sight of the relevant working, even if it appears obvious that there is only one way you could get the answer given.

- **Ignoring subsequent work**

  It is appropriate to ignore subsequent work when the additional work does not change the answer in a way that is inappropriate for the question: eg. incorrect cancelling of a fraction that would otherwise be correct
  It is not appropriate to ignore subsequent work when the additional work essentially makes the answer incorrect eg algebra.

- **Linear equations**

  Full marks can be gained if the solution alone is given, or otherwise unambiguously indicated in working (without contradiction elsewhere). Where the correct solution only is shown substituted, but not identified as the solution, the accuracy mark is lost but any method marks can be awarded.

- **Parts of questions**

  Unless allowed by the mark scheme, the marks allocated to one part of the question CANNOT be awarded in another

Paper 1

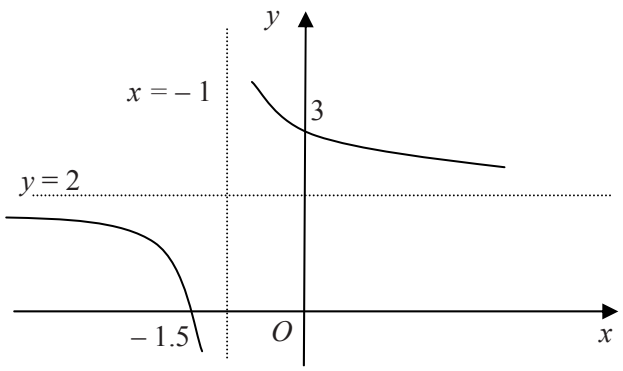
Question Number	Working	Notes
1	$y = 2x - 3$ $x^2 + 4x - x(2x - 3) = 10$ $x^2 - 7x + 10 = 0$ $(x - 2)(x - 5) = 0$ $x = 2, y = 1$ $x = 5, y = 7$	 M1 Equation in one variable M1A1 3 term quadratic – any order M1Factorise or use formula (correct) A1 cao A1 cao **6**

Question Number	Working	Notes
2	$\frac{dV}{dt} = 45$ $h = 3r$ $V = \frac{1}{3}\pi r^2 h = \pi r^3,$ $\frac{dV}{dr} = 3\pi r^2$ $\frac{dr}{dt} = \frac{dr}{dV} \times \frac{dV}{dt} = \frac{1}{3\pi r^2} \times 45$ $r = 4$ cm $\frac{dr}{dt} = \frac{15}{16\pi} = 0.2984\ldots.$ 0.298 cm/s	 B1 correct volume formula with one variable M1 differentiating M1 chain rule used A1 correct terms in chain rule M1 using $r = 4$ A1 correct answer to 3 sf **6**

Question Number	Working	Notes
3 (a)(i)	$y = 2$	B1 **1**

Question Number	Working	Notes
3(a)(ii)	$x = -1$	B1 **1**

Question Number	Working	Notes
3 (b)	(0, 3) $(-\frac{3}{2}, 0)$	B1 B1 **2**

Question Number	Answer	Notes
3 (c)		B1 2 branches in correct quadrants B1 asymptotes B1 3, – 1.5 shown **3**

Question Number	Working	Notes
4 (a)	$S_4 = 34 = \frac{4}{2}(2a + 3d)$ $S_6 = 69 = \frac{6}{2}(2a + 5d)$ $2a + 3d = 17$ $2a + 5d = 23$ $2d = 6$ $d = 3$	M1 either equation attempted with correct formula A1 both equations fully correct M1 solve the equations A1 cso **4** **(Alternative solution)** $S_4 = 34 = a + a + d + a + 2d + a + 3d$ $34 = 4a + 6d$ $S_6 = 69 = a + a + d + \ldots\ldots a + 5d$ $69 = 6a + 15d$ M1, A1, award as above Then as main scheme

Question Number	Working	Notes
4 (b)	$a = \frac{23 - 15}{2}$ $a = 4$	A1 ($a = 4$ cso) **1**

Question Number	Working	Notes
4 (c)	$S_p = \frac{p}{2}(8 + 3p - 3)$ $650 = \frac{p}{2}(5 + 3p)$ $3p^2 + 5p - 1300 = 0$ $(3p + 65)(p - 20)$ $p = 20$	M1 using a correct summation formula for S_p M1 Solve quadratic (any method) A1 cso **3**

Question Number	Working	Notes
4 (d)	$d = 3$	B1 **1**

Question Number	Working	Notes
4 (e)	$a = 9$	B1 **1**

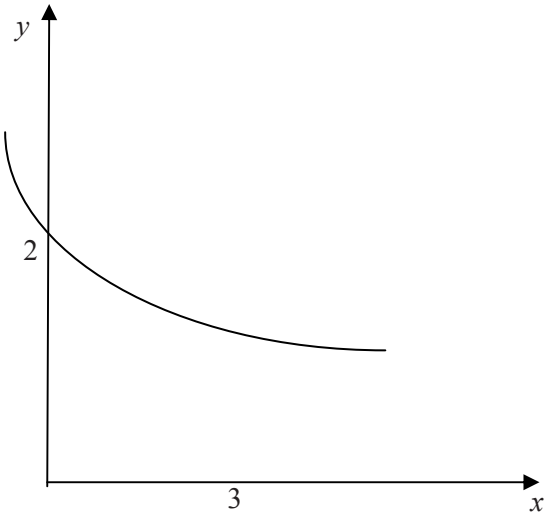
Question Number	Working	Notes
5 (a)(i)	$\overrightarrow{AB} = \mathbf{b} - \mathbf{a}$	B1 **1**

Question Number	Working	Notes
5 (a)(ii)	$\overrightarrow{PA} = \frac{1}{3}\mathbf{a}$	B1 **1**

Question Number	Working	Notes
5 (a)(iii)	$\overrightarrow{PM} = \frac{1}{3}\mathbf{a} + \frac{1}{2}(\mathbf{b} - \mathbf{a})$ $\frac{1}{2}\mathbf{b} - \frac{1}{6}\mathbf{a}$	M1 A1 **2**

Question Number	Working	Notes
5 (b)	$\overrightarrow{OD} = \frac{2}{3}\mathbf{a} + \mu(\frac{1}{2}\mathbf{b} - \frac{1}{6}\mathbf{a})$ $\frac{2}{3} - \frac{1}{6}\mu = 0$ $\mu = 4$ $\lambda = 2$	M1 $\overrightarrow{OD}$ in terms of **a, b** M1 make **a** term zero A1 for $\mu = 4$ A1 for $\lambda = 2$ **4**

Question Number	Answer	Notes
6 (a)	<table><tr><td>x</td><td>–1</td><td>0</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td></tr><tr><td>y</td><td>**2.65**</td><td>2</td><td>1.61</td><td>**1.37**</td><td>1.22</td><td>1.14</td><td>**1.08**</td></tr></table>	B2 B1 B0 B2 all correct B1 two correct **2**

Question Number	Answer	Notes
6 (b)		 B1 axes B1 curve **2**

Question Number	Working	Notes
6 (c)	$e^{\frac{-1}{2}x} + 1 = 1.8$ $x = 0.45$	 M1 rearrange eq^{n}. A1 For $x = 0.45$ cso **2**

Question Number	Working	Notes
6 (d)	$x = -2\ln(2x - 7)$ $-\frac{1}{2}x = \ln(2x - 7)$ $e^{\frac{-1}{2}x} + 1 = 2x - 7 + 1$ Draw $y = 2x - 6$ $x = 3.6$	M1 rearrange equation A1 M1 draw line A1 $x = 3.6$ **4**

Question Number	Working	Notes
7 (a)	$V = \pi r^2 h = 50000\pi$ $r^2 h = 50000$ $A = 2\pi rh + \pi r^2$ $=2\pi r \times \dfrac{500000}{r^2} + \pi r^2$ $= \left(\dfrac{100000}{r} + r^2\right)\pi$	B1 M1 M1 A1 **4**

Question Number	Working	Notes
7 (b)	$\dfrac{dA}{dr} = \left(-100000r^{-2} + 2r\right)\pi$ $\dfrac{dA}{dr} = 0$ $2r = \dfrac{100000}{r^2}$, $r^3 = 50000$ $r = 36.84$ $\dfrac{d^2A}{dr^2} = (200000r^{-3} + 2)\pi > 0 \quad \therefore$ minimum $A_{\min} = 12791$	M1 differentiate M1A1 equate to zero and solve M1 establish minimum A1 conclusion B1 **6**

Question Number	Working	Notes
8 (a)(i) and (ii)	$\alpha + \beta = -2t$ $\alpha\beta = t$ $\alpha^2 + \beta^2 = (\alpha + \beta) - 2\,\alpha\beta$ $= 4t^2 - 2t$ $\alpha^2\beta^2 = t^2$	B1 B1 M1 A1 B1 **5**

Question Number	Working	Notes
8 (b)	$10t^2 = 3(4t^2 - 2t)$ $10t^2 = 12t^2 - 6t$ $0 = t(t - 3)$ $t \neq 0, \therefore$	M1 form equation M1A1 solve quadratic **3**

Question Number	Working	Notes
8 (c)	$(\alpha - \beta)^2 = \alpha^2 - 2\,\alpha\beta + \beta^2$ $= (4 \times 9 - 6) - 2 \times 3 = 24$ $(\alpha - \beta) = \sqrt{24}$ $= 2\sqrt{6}$	 M1 correct algebra for $(\alpha - \beta)^2$ A1 $\sqrt{24}$ A1 **3**

Question Number	Working	Notes
9 (a)(i) and (ii)	$\cos 2\theta = \cos^2\theta - \sin^2\theta$ $= 1 - 2\sin^2\theta$ $= 2\cos^2\theta - 1$ $\sin^2\theta = \frac{1}{2}(1 - \cos 2\theta)$ $\cos^2\theta = \frac{1}{2}(1 + \cos 2\theta)$	M1 using given formula M1 using $\sin^2\theta + \cos^2\theta = 1$ A1 rearrange A1 rearrange **4**

Question Number	Working	Notes
9 (b)	$1 + 10\sin^2\theta - 16\sin^2\theta$ $= 1 + 10 \times \frac{1}{2}(1 - \cos 2\theta) - 16 \times$ $\frac{1}{4}(1 - \cos 2\theta)^2$ $= 1 + 5 - 5\cos 2\theta - 4(1 - 2\cos 2\theta + \cos^2 2\theta)$ $= 2 + 3\cos 2\theta - 4 \times \frac{1}{2}(1 + \cos 4\theta)$ $= 3\cos 2\theta - 2\cos 4\theta$	M1 use formulae from (a) M1 square $(1 - \cos 2\theta)^2$ M1 use formula from (a) A1 cso **4**

Question Number	Working	Notes
9 (c)	$3\cos 2\theta - 2\cos 4\theta + 2\cos 4\theta = 0.25$ $\cos 2\theta = \frac{0.25}{3}$ $2\theta = 85.21°, 274.78°$ $\theta = 42.6°, 137.4°$	M1 use result in (b) M1 obtain either value of 2θ A1 A1 values of θ **4**

Question Number	Working	Notes
9 (d)	$\int_0^{\frac{\pi}{8}} (3\cos 2\theta - 2\cos 4\theta) d\theta$ $= \left[\frac{3}{2}\sin 2\theta - \frac{1}{2}\sin 4\theta\right]_0^{\frac{\pi}{8}}$ $= \frac{3}{2}\sin\frac{\pi}{4} - \frac{1}{2}\sin\frac{\pi}{2} - 0$ $= \frac{3}{2}\times\frac{1}{\sqrt{2}} - \frac{1}{2}$ $= \frac{3\sqrt{2}}{4} - \frac{1}{2}$ $p = \frac{3}{4}\ \ q = -\frac{1}{2}$	 M1A1 integrate M1 use limits M1 surd values A1 correct final answer. **5**

Question Number	Working	Notes
10 (a)	$x_k = \frac{1\times 3 + 6\times 2}{5}$ $y_k = \frac{6\times 3 - 4\times 2}{5}$ $x_k = 3, y_k = 2$	M1 using ratio formula for either coordinate A1 both correct **2**

Question Number	Working	Notes
10 (b)	Grad $AB = \frac{6+4}{1-6} = -2$ Grad perpendicular $= \frac{1}{2}$ Eqn l: $y - 2 = \frac{1}{2}(x - 3)$ $2y = x + 1$ o.e.	B1 B1 M1 any valid method for eq^n of line A1 must have integer coefficients **4**

Question Number	Working	Notes
10 (c)	$x = 7$ $y = \frac{7+1}{2} = 4$ $4 = e$	 B1 **1**

Question Number	Working	Notes
10 (d)	D is (–1, 0)	B1 B1 **2**

Question Number	Working	Notes
10 (e)	$AB^2 = 5^2 + 10^2 = 125$ EK^2 (= KD^2) = $4^2 + 2^2$ Area $AEBD$ = $\sqrt{125} \times \sqrt{20}$ = 50	M1 using (correct) length of line A1 both correct B1 for 50 **3**

Question Number	Working	Notes
10(f) (i)	(0, 3)	B1 **1**

Question Number	Working	Notes
10(f) (ii)	$AD^2 = 2^2 + 6^2 = 40$ Radius = $\frac{1}{2}\sqrt{40}$ (Or find length centre $\rightarrow K$)	B1 **1**

Question Number	Working	Notes
10(f) (iii)	The area of $C = 10\pi$	B1 **1**

Paper 2

Question Number	Working	Notes
1	$\frac{a}{\sin A} = \frac{c}{\sin C}$ $\frac{a}{\sin 45} = \frac{7}{\sin 75}$ $a = \frac{7 \sin 45}{\sin 75}$ $A = 5.12$ cm	M1 sine rule A1 correct nos in sine rule A1 **3**

Question Number	Working	Notes
2 (a)	$v = 4t - 9$	M1 differentiating A1 cao **2**

Question Number	Working	Notes
2 (b)	"$4t - 9$ "$= 0$ $t = 2.25$	M1 ft from their (a) A1 cao **2**

Question Number	Working	Notes
3 (a)	$x = 4$: $64 + 16 + 4p + q = 0$ $4p + q = -80$ $x = 2$: $8 + 4 + 2p + q = -16$ $2p + q = -28$	M1 for correct substitution into f(x) A1 correct rearrangement A1 for correct rearrangement **Alternative method: division by (x –2) and (x – 4)** **3**

Question Number	Working	Notes
3 (b)	$2p = -52$ $p = -26$ $q = -28 + 52$ $q = 24$	M1 Solving simultaneous equations A1 A1 **3**

Question Number	Working	Notes
4	$(1+ax)^n = 1 + anx + \frac{a^2n(n-1)}{2!}x^2 + \ldots$ $an = 18$ $\frac{a^2n(n-1)}{2!} = 135$ $a^2n^2 - a^2n = 135 \times 2$ $18^2 - 18a = 270$ $a = \frac{18^2 - 270}{18} = 3$ $n = 6$	M1 attempting binomial expansion A1 for a fully correct expansion M1 for equating coefficients A1 for both correct M1 solving the equations A1 for $a = 3$, $n = 6$ **6**

Question Number	Working	Notes
5 (a)	$\frac{dy}{dx} = 10xe^{2x} + 2(5x^2 - 2)e^{2x}$	M1 attempt to use product rule A1,A1 for each term correct (ignore any simplification) **3**

Question Number	Working	Notes
5 (b)	$\frac{dy}{dx} = \frac{3x^2(x-x^2) - (x^3+2)(1-2x)}{(x-x^2)^2}$ $\frac{dy}{dx} = \frac{2x^3 - x^4 + 4x - 2}{(x-x^2)^2}$	M1 attempt to use quotient rule inc. denominator correct A1, A1 each numerator term A1 correct simplification **4**

Question Number	Working	Notes
6 (a)	$\cos(EAO) = \frac{3}{5}$ $\angle AOC = 2 \times \angle EAO$ $= 1.854\ldots$	M1 any valid method A1 must be radians **2**

Question Number	Working	Notes
6 (b)	Area sector $AOC = \frac{1}{2} r^2\theta$ $= \frac{1}{2} \times 25 \times 1.854\ldots \text{m}^2$ Area $\Delta AEO = \frac{1}{2} \times 3 \times 4$ $= 6\ \text{m}^2$ Total area $= \frac{1}{2} \times 25 \times 1.854 + 12$ $= 35.18\ldots.$ $35.3\ \text{m}^2$	M1 use of correct formula A1 cao B1 M1 add two parts A1 cao **5**

Question Number	Working	Notes
7	$y = 5 \quad x^2 = 9 \qquad x = \pm 3$ Volume of cylinder $= \pi \times 25 \times 3 = 75\pi$ Crosses x-axis at $x = \pm 2$ Volume of revolution $= \int_2^3 \pi y^2 dx$ $= \int_2^3 \pi (x^2 - 4)^2 dx$ $= \int_2^3 \pi (x^4 - 8x^2 + 16) dx$ $= \pi \left[\frac{x^5}{5} - \frac{8x^3}{3} + 16x \right]_2^3$ $= \pi \left[\frac{3^5}{5} - \frac{8}{3} \times 3^3 + 48 - \left(\frac{32}{5} - \frac{64}{3} + 32 \right) \right]$ $= 7.53\pi$ Required volume $= 75\pi - 7.53\pi$ $= 211.9\ldots.$ 212	M1 A1 B1 M1 use of $\int_2^3 \pi y^2 dx$ M1 square and integrate A1 correct result M1 substitute limits A1 A1 f.t. **9**

Question Number	Working	Notes
8 (a)	$ar + ar^2 = 30$ $a + ar^2 = 50$ $\frac{r + r^2}{1 + r^2} = \frac{3}{5}$ $5r + 5r^2 = 3 + 3r^2$ $2r^2 + 5r - 3 = 0$ $(2r - 1)(r + 3) = 0$ $r = \frac{1}{2}$ $r = -3$	M1 either equation A1 both correct M1 eliminate a M1 solve quadratic, any valid method A1 both values of r **5**

Question Number	Working	Notes
8 (b)	$r = \frac{1}{2}$ $a(\frac{1}{2} + \frac{1}{4}) = 30$ $a = 40$ $S_n = a\frac{\left(1 - \left(\frac{1}{2}\right)^n\right)}{1 - r}$ $= 80(1 - (\frac{1}{2})^n)$ $80(1 - (\frac{1}{2})^n) > 79.9$ $1 - (\frac{1}{2})^n > \frac{79.9}{80}$ $(\frac{1}{2})^n < \frac{1}{800}$ $n = 10$	M1 substitute $r = \frac{1}{2}$ A1 M1 use of summation formula A1 cao M1 form and attempt to solve inequality A1 ($n = 10$) **6**

Question Number	Working	Notes
9 (a)	$2^x = 128$ $x = 7$	M1 "undo" log A1 $x = 7$ **2**

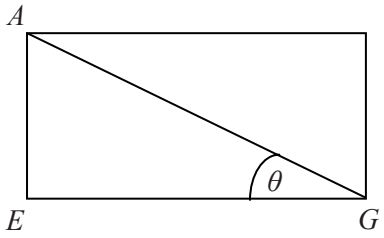
Question Number	Working	Notes
9 (b)	$3y - 1 = 5^3 = 125$ $3y = 126$ $y = 42$	M1 "undo" log and solve linear equation A1 cao **2**

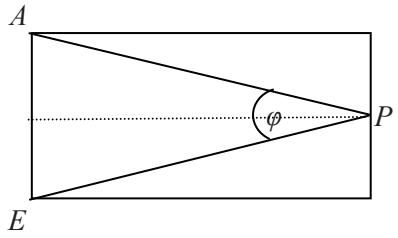
Question Number	Working	Notes
9 (c)	$\log_p q + 4\ \dfrac{\log_p p}{\log_p q} = 5$ $(\log_p q)^2 - 5\log_p q + 4 = 0$ $(\log_p q - 4)(\log_p q - 1)=0$ $\log_p q = 4$ $p^4 = q$ $\log_p q = 1$ $p = q$ (not acceptable) $pq = 32$ $p^5 = 32$ $p = 2$ and $q = 16$	M1 change base M1 solve quadratic A1 M1 find p, q A1 cao **5**

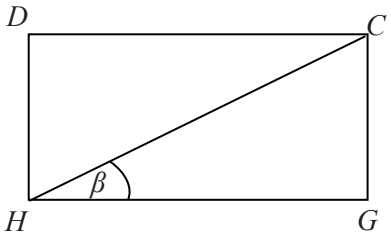
Question Number	Working	Notes
9 (d)(i)	$(3x + 2)\ (2\ \ln x - 1)$	M1A1 **2**

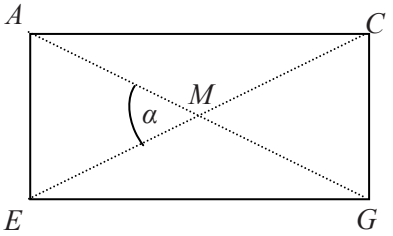
Question Number	Working	Notes
9 (d)(ii)	$(3x + 2)\ (2\ \ln x - 1) = 0$ $x = -\dfrac{2}{3}$ (not possible) $\ln x = \dfrac{1}{2}$ $x = e^{\frac{1}{2}}$	 M1 solve (factorised) quadratic A1 $(x = -\dfrac{2}{3})$ A1 $x = e^{\frac{1}{2}}$ **3**

Question Number	Working	Notes
10 (a)	$AG^2 = \sqrt{(4^2 + 5^2 + 8^2)} = \sqrt{105}$ $= 10.24\ldots$ 10.2 cm	M1 use Pythagoras theorem A1 (10.2) **2**

Question Number	Working	Notes
10 (b)	 $\sin\theta = \frac{4}{AG}$ $\theta = 22.97\ldots$ $\theta = 23.0°$	B1 identify required angle M1 A1 (23.0° or 23°) **3**

Question Number	Working	Notes
10 (c)	 $\tan\frac{1}{2}\varphi = \frac{2}{8}$ $\varphi = 28.1°$	B1 identify angle M1 A1 (must be 3sf) **3**

Question Number	Working	Notes
10 (d)	 $\tan\beta = \frac{4}{5}$ $\beta = 38.7°$	B1 identify angle M1 A1 **3**

Question Number	Working	Notes
10 (e)	 $AM = \frac{1}{2}\sqrt{105}$ $\sin\frac{1}{2}\alpha = \frac{2}{\frac{1}{2}\sqrt{105}}$ $\alpha = 45.95\ldots..$ $\alpha = 46.0°$	B1 identify angle M1 A1 A1 **4**

Question Number	Working	Notes
11 (a)	$f(-2) = -8 - 20 + 4 + 24 = 0$ $A = (-2, 0)$	M1 substitute $x = -2$ A1 conclusion **2**

Question Number	Working	Notes
11 (b)	$x^3 - 5x^2 - 2x + 24$ $= (x + 2)(x^2 - 7x + 12)$ $= (x + 2)(x - 3)(x - 4)$ B is (3, 0) C is (4, 0)	 M1 factorise by inspection or divide M1 factorise quadratic A1 A1 for B, C **4**

Question Number	Working	Notes
11 (c)	$y = x^3 - 5x^2 - 2x + 24$ $\frac{dy}{dx} = 3x^2 - 10x - 2$ $x = 3 \quad \frac{dy}{dx} = 27 - 30 - 2$ $= -5$ Tangent: $y = -5(x - 3)$ oe	 M1 differentiate M1 substitute $x = 3$ A1 B1 **4**

Question Number	Working	Notes
11 (d)	$(-1, 20) \quad x = -1$ $y = -5(-1 - 3) = 20 \ \therefore$ on line Curve: $-1 - 5 + 2 + 24 = 20$ $\therefore$ on curve	M1 check point on curve or line A1 both correct **2**

Question Number	Working	Notes
11 (e)	$\int_2^1 (x^3 - 5x^2 - 2x + 24)dx + \frac{1}{2} \times 4 \times 20$ $= \left[\frac{x^4}{4} - \frac{5x^3}{3} - x^2 + 24\right]_{-2}^{-1} + 40$ $= (\frac{1}{4} + \frac{5}{3} - 1 - 24) - (4 + \frac{40}{3} - 4 - 48) + 40$ $51\frac{7}{12}$	M1 split into parts M1 integrate A1 correct integration B1 40 M1 substitute correct limits A1 cao **6**

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