

CAMBRIDGE INTERNATIONAL EXAMINATIONS

International General Certificate of Secondary Education

MARK SCHEME for the November 2003 question papers

0606 ADDITIONAL MATHEMATICS

0606/01 Paper 1, maximum raw mark 80

0606/02 Paper 2, maximum raw mark 80

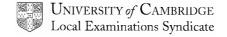
These mark schemes are published as an aid to teachers and students, to indicate the requirements of the examination. They show the basis on which Examiners were initially instructed to award marks. They do not indicate the details of the discussions that took place at an Examiners' meeting before marking began. Any substantial changes to the mark scheme that arose from these discussions will be recorded in the published *Report on the Examination*.

All Examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes must be read in conjunction with the question papers and the Report on the Examination.

CIE will not enter into discussions or correspondence in connection with these mark schemes.

CIE is publishing the mark schemes for the November 2003 question papers for most IGCSE and GCE Advanced Level syllabuses.



Grade thresholds taken for Syllabus 0606 (Additional Mathematics) in the November 2003 examination.

	maximum	minimum	mark required	for grade:
	mark available	Α	E	
Component 1	80	63	31	21
Component 2	80	67	36	26

Grade A* does not exist at the level of an individual component.

Page 1	Mark Scheme	Syllabus
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Mark Scheme Notes

- Marks are of the following three types:
 - M Method mark, awarded for a valid method applied to the problem. Method marks are not lost for numerical errors, algebraic slips or errors in units. However, it is not usually sufficient for a candidate just to indicate an intention of using some method or just to quote a formula; the formula or idea must be applied to the specific problem in hand, e.g. by substituting the relevant quantities into the formula. Correct application of a formula without the formula being quoted obviously earns the M mark and in some cases an M mark can be implied from a correct answer.
 - A Accuracy mark, awarded for a correct answer or intermediate step correctly obtained. Accuracy marks cannot be given unless the associated method mark is earned (or implied).
 - B Mark for a correct result or statement independent of method marks.
- When a part of a question has two or more "method" steps, the M marks are generally independent unless the scheme specifically says otherwise; and similarly when there are several B marks allocated. The notation DM or DB (or dep*) is used to indicate that a particular M or B mark is dependent on an earlier M or B (asterisked) mark in the scheme. When two or more steps are run together by the candidate, the earlier marks are implied and full credit is given.
- The symbol √ implies that the A or B mark indicated is allowed for work correctly following on from previously incorrect results. Otherwise, A or B marks are given for correct work only. A and B marks are not given for fortuitously "correct" answers or results obtained from incorrect working.
- Note: B2 or A2 means that the candidate can earn 2 or 0.
 B2, 1, 0 means that the candidate can earn anything from 0 to 2.
- The following abbreviations may be used in a mark scheme or used on the scripts:
 - AG Answer Given on the question paper (so extra checking is needed to ensure that the detailed working leading to the result is valid)
 - BOD Benefit of Doubt (allowed when the validity of a solution may not be absolutely clear)
 - CAO Correct Answer Only (emphasising that no "follow through" from a previous error is allowed)
 - ISW Ignore Subsequent Working
 - MR Misread
 - PA Premature Approximation (resulting in basically correct work that is insufficiently accurate)
 - SOS See Other Solution (the candidate makes a better attempt at the same question)

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Penalties

- MR –1 A penalty of MR –1 is deducted from A or B marks when the data of a question or part question are genuinely misread and the object and difficulty of the question remain unaltered. In this case all A and B marks then become "follow through √" marks. MR is not applied when the candidate misreads his own figures this is regarded as an error in accuracy.
- OW –1, 2 This is deducted from A or B marks when essential working is omitted.
- PA –1 This is deducted from A or B marks in the case of premature approximation.
- S –1 Occasionally used for persistent slackness.
- EX –1 Applied to A or B marks when extra solutions are offered to a particular equation.



November 2003

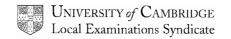
INTERNATIONAL GCSE

MARK SCHEME

MAXIMUM MARK: 80

SYLLABUS/COMPONENT: 0606/01

ADDITIONAL MATHEMATICS
Paper 1



Page 1	Mark Scheme	Syllabus	Paper
	IGCSE EXAMINATIONS – NOVEMBER 2003	0606	1

1. x + 3y = k and y ½=2x + 3 Elimination of x or y		1	T
$ \begin{array}{c} \rightarrow y^2 + 6y - (2k + 3) = 0 \text{ or} \\ \rightarrow x^2 - (2k + 18) x + (k^2 - 27) = 0 \end{array} \\ \rightarrow x^2 - (2k + 18) x + (k^2 - 27) = 0 \end{array} \\ \rightarrow x^2 - (2k + 18) x + (k^2 - 27) = 0 \end{array} \\ \rightarrow x^2 - (2k + 18) x + (k^2 - 27) = 0 \end{array} \\ \rightarrow x^2 - (2k + 18) x + (k^2 - 27) = 0 \end{array} \\ \rightarrow x + (3k + 16) x + (k^2 - 27) = 0 $ $\rightarrow x + (3k + 16) x + (k^2 - 27) = 0 $ $\rightarrow x + (3k + 16) x + (k^2 - 27) = 0 $ $\rightarrow x + (3k + 16) x + (k^2 - 27) = 0 $ $\rightarrow x + (3k + 16) x + (k^2 - 27) = 0 $ $\rightarrow x + (3k + 16) x + (k^2 - 27) = 0 $ $\rightarrow x + (3k + 16) x + (k^2 - 27) = 0 $ $\rightarrow x + (3k + 16) x + (k^2 - 27) = 0 $ $\rightarrow x + (3k + 16) x + (k^2 - 27) = 0 $ $\rightarrow x + (2k + 16) x +$			
$ \begin{array}{c} \rightarrow x^2 - (2k + 18)x + (k^2 - 27) = 0 \\ \text{Uses } b^2 - 4ac \\ \rightarrow k < -6 \\ \end{array} $ $ \begin{array}{c} A1 \\ \text{A1} \\ \text{A1} \\ \text{A1} \\ \text{A1} \\ \text{A1} \\ \text{A2} \\ \end{array} $ $ \begin{array}{c} 2. \ 8^x = 2^{-3k} 4^{2k} = 2^x \\ \text{Attempts to link powers of 2} \\ \rightarrow x - 3 - (-3x) = 5 - (x) \\ \rightarrow x = 1.6 \text{ or } 8/5 \text{ etc} \\ \text{I log } 8^x = -3x\log_2, \log 4^{2/k} = x\log_2 \\ \text{equate coefficients of log 2} \\ \text{3. } x^3 + ax^2 + bx - 3 \\ \text{Puts } x = 3 27 + 9a + 3b - 3 = 0 \\ \text{Puts } x = 2 -8 + 4a - 2b - 3 = 15 \\ \text{(9a + 3b = -24 and } 4a - 2b = 26) \\ \text{Sim equations} \rightarrow a = 1 \text{ and } b = -11 \\ \text{A1} \\ \text{Denominator} = 1 \\ \text{Numerator} = 20 \sqrt{2} - 15 \sqrt{3} + 8 \sqrt{12 - 6} \sqrt{18} \\ \text{But } \sqrt{12} = 2\sqrt{3} \text{and } \sqrt{18} = 3\sqrt{2} \\ \rightarrow 2\sqrt{2} + \sqrt{3} \\ \text{Between 0 and } \pi/4 \\ \rightarrow 2 + \sqrt{2} \text{ or } 3.41 \\ \text{Between 0 and } \pi/4 \\ \rightarrow 2 + \sqrt{2} \text{ or } 3.41 \\ \text{Between 0 and } \pi/4 \\ \rightarrow 3301 - 110] \\ Ewisinity of these of the these o$		M1	
Uses b^2-4ac $\rightarrow k<-6$		A 4	1
$\begin{array}{c} \rightarrow kkcf \\ 2.\ 8^\times = 2^{3^\times} 4^{2^\times} = 2^\times \\ \text{Attempts to link powers of 2} \\ \rightarrow x = 3, -3, -3, -3, -3, -3, -3, -3, -3, -3, $	$\rightarrow X^2 - (2K + 18)X + (K^2 - 27) = 0$	AT	CO
$\begin{array}{c} \rightarrow kkcf \\ 2.\ 8^\times = 2^{3^\times} 4^{2^\times} = 2^\times \\ \text{Attempts to link powers of 2} \\ \rightarrow x = 3, -3, -3, -3, -3, -3, -3, -3, -3, -3, $	Liens $b^2 - 4aa$	N/1	Any use of b^2-4ac even if -0 or >0
4 2. 8" = 2"			1
$ \begin{array}{c} 2. \ 8^{\times} = 2^{3k} \ 4^{19x} = 2^k \\ \text{Attempts to link powers of 2} \\ \rightarrow \ x = 3 - (-3x) = 5 - (x) \\ \rightarrow \ x = 1.6 \text{ or } 8/5 \text{ etc} \\ \hline \{ \begin{array}{c} \log 8^{\times} = -3x \log 2, \log 4^{19x} = x \log 2 \\ \text{equate coefficients of } \log 2 \\ \end{array} \\ \text{Puts } x = 3 \longrightarrow 27 + 9a + 3b - 3 = 0 \\ \text{Puts } x = 3 \longrightarrow 27 + 9a + 3b - 3 = 0 \\ \text{Puts } x = 3 \longrightarrow 27 + 9a + 3b - 3 = 0 \\ \text{Puts } x = 3 \longrightarrow 27 + 9a + 3b - 3 = 0 \\ \text{Puts } x = 3 \longrightarrow 27 + 9a + 3b - 3 = 0 \\ \text{Puts } x = 2 \longrightarrow -8 + 4a - 2b - 3 = 15 \\ (9a + 3b = -24 \text{ and } 4a - 2b = 26) \\ \text{Sim equations} \rightarrow \ a = 1 \text{ and } b = -11 \\ \text{Sim equations} \rightarrow \ a = 1 \text{ and } b = -11 \\ \text{Divides volume by length}^2 \\ 4\sqrt{2} - 3\sqrt{3} \times \frac{5 + 2\sqrt{6}}{5 - 2\sqrt{6}} \times \frac{5 + 2\sqrt{6}}{5 - 2$	→ K < −0		CO
Attempts to link powers of 2 $\rightarrow x < -3 - (-3x) = 5 - (x)$ A1 [4] [1] [1] [2] [1] [2] [1] [2] [3] [3] [2] [4] [2] [3] [3] [4] [4] [4] [5] [8] [1] [8] [1] [1] [8] [1] [1] [8] [1] [1] [8] [8] [1] [1] [8] [1] [1] [8] [1] [1] [8] [1] [8] [1] [8] [1] [1] [8] [8] [1] [1] [8] [8] [1] [8] [8] [1] [1] [8] [8] [1] [8] [8] [8] [8] [8] [8] [8] [8] [8] [8		[4]	
$\begin{array}{c} \rightarrow \text{x} = 1.6 \text{ or } 8/5 \text{ etc} \\ \rightarrow \text{x} = 1.6 \text{ or } 8/5 \text{ etc} \\ \text{[} \log 8^{\times} = -3\text{xlog2}, \log 4^{1/4} = \text{xlog2} \\ \text{equate coefficients of log 2]} \\ 3. x^3 + ax^2 + bx - 3 \\ \text{Puts } x = 3 x^2 + 9a + 3b - 3 = 0 \\ \text{Puts } x = 2 \rightarrow - 8 + 4a - 2b - 3 = 15 \\ (9a + 3b = -24 \text{ and } 4a - 2b = 26) \\ \text{Sim equations} \rightarrow a = 1 \text{ and } b = -11 \\ \text{A1} \\ (9a + 3b = -24 \text{ and } 4a - 2b = 26) \\ \text{Sim equations} \rightarrow a = 1 \text{ and } b = -11 \\ \text{Divides volume by length}^2 \\ \frac{4\sqrt{2} - 3\sqrt{3}}{5 + 2\sqrt{6}} \frac{5 + 2\sqrt{6}}{5 - 2\sqrt{6}} \frac{81}{5 - 2\sqrt{6}} \\ \frac{4\sqrt{2} - 3\sqrt{3}}{5 + 2\sqrt{6}} \frac{5 + 2\sqrt{6}}{5 - 2\sqrt{6}} \frac{81}{5 - 2\sqrt{6}} \\ \text{Denominator } = 1 \\ \text{Numerator} = 20\sqrt{2} - 15\sqrt{3} + 8\sqrt{12} - 6\sqrt{18} \\ \text{But } \sqrt{12} = 2\sqrt{3} \text{and } \sqrt{18} = 3\sqrt{2} \\ \rightarrow 2\sqrt{2} + \sqrt{3} \\ \text{Between 0 and } \pi/4 \\ \rightarrow 2 + \sqrt{2} \text{ or } 3.41 \\ \text{Between 0 and } \pi/4 \\ \rightarrow 2 + \sqrt{2} \text{ or } 3.41 \\ \text{Between 0 and } \pi/4 \\ \rightarrow 330i - 110j \\ \text{tan}^{-1}(110/330) = 18.4^{\circ} \\ \rightarrow \text{Bearing of Q from P = 108}^{\circ} \\ \text{(ii) Resultant speed} = \sqrt{(330^2 + 110^2)} \\ \text{Time} = 273 + \text{resultant speed} = 47 \text{ minutes} \\ \text{Time} = 273 + \text{resultant speed} \\ = 47 \text{ minutes} \\ \text{A1} \\ \text{Co} \\ \text{In any form } $	2. $8^{-x} = 2^{-3x}$ $4^{\frac{1}{2}x} = 2^{x}$	B1 B1	Wherever used
$\begin{array}{c} \rightarrow \text{x} = 1.6 \text{ or } 8/5 \text{ etc} \\ \rightarrow \text{x} = 1.6 \text{ or } 8/5 \text{ etc} \\ \text{[} \log 8^{\times} = -3\text{xlog2}, \log 4^{1/4} = \text{xlog2} \\ \text{equate coefficients of log 2]} \\ 3. x^3 + ax^2 + bx - 3 \\ \text{Puts } x = 3 x^2 + 9a + 3b - 3 = 0 \\ \text{Puts } x = 2 \rightarrow - 8 + 4a - 2b - 3 = 15 \\ (9a + 3b = -24 \text{ and } 4a - 2b = 26) \\ \text{Sim equations} \rightarrow a = 1 \text{ and } b = -11 \\ \text{A1} \\ (9a + 3b = -24 \text{ and } 4a - 2b = 26) \\ \text{Sim equations} \rightarrow a = 1 \text{ and } b = -11 \\ \text{Divides volume by length}^2 \\ \frac{4\sqrt{2} - 3\sqrt{3}}{5 + 2\sqrt{6}} \frac{5 + 2\sqrt{6}}{5 - 2\sqrt{6}} \frac{81}{5 - 2\sqrt{6}} \\ \frac{4\sqrt{2} - 3\sqrt{3}}{5 + 2\sqrt{6}} \frac{5 + 2\sqrt{6}}{5 - 2\sqrt{6}} \frac{81}{5 - 2\sqrt{6}} \\ \text{Denominator } = 1 \\ \text{Numerator} = 20\sqrt{2} - 15\sqrt{3} + 8\sqrt{12} - 6\sqrt{18} \\ \text{But } \sqrt{12} = 2\sqrt{3} \text{and } \sqrt{18} = 3\sqrt{2} \\ \rightarrow 2\sqrt{2} + \sqrt{3} \\ \text{Between 0 and } \pi/4 \\ \rightarrow 2 + \sqrt{2} \text{ or } 3.41 \\ \text{Between 0 and } \pi/4 \\ \rightarrow 2 + \sqrt{2} \text{ or } 3.41 \\ \text{Between 0 and } \pi/4 \\ \rightarrow 330i - 110j \\ \text{tan}^{-1}(110/330) = 18.4^{\circ} \\ \rightarrow \text{Bearing of Q from P = 108}^{\circ} \\ \text{(ii) Resultant speed} = \sqrt{(330^2 + 110^2)} \\ \text{Time} = 273 + \text{resultant speed} = 47 \text{ minutes} \\ \text{Time} = 273 + \text{resultant speed} \\ = 47 \text{ minutes} \\ \text{A1} \\ \text{Co} \\ \text{In any form } $	Attempts to link powers of 2	M1	Needs to use x ^a ÷x ^b =x ^{a-b}
$ \begin{bmatrix} \log 8^{\times} = -3x\log 2, \log 4^{\frac{7}{24}} = x\log 2 \\ \text{equate coefficients of log 2} \end{bmatrix} & \text{IB} 1B \\ \text{IB} 1B \\ \text{IM} 1A1 \end{bmatrix} \\ \end{bmatrix} \\ 3. x^3 + 3x^2 + bx - 3 \\ \text{Puts } x = 3 \\ \text{Puts } x = 2 \\ \text{Puts } $			
$ \begin{bmatrix} \log 8^{x} = -3x\log 2, \log 4^{x/9} = x\log 2 \\ \text{equate coefficients of log 2} \end{bmatrix} \\ \text{equations} \\ \text{Puts } x = 3 \\ \text{\rightarrow 8^{+}4a^{-}2b^{-}3=15$} \\ \text{$(9a+3b=-24$ and $4a^{-}2b=26$)} \end{bmatrix} \\ \text{Sim equations} \\ \text{\rightarrow a = 1$ and $b = -11$} \\ \text{Sim equations} \\ \text{\rightarrow a = 1$ and $b = -11$} \\ \text{Sim equations} \\ \text{\rightarrow a = 1$ and $b = -11$} \\ \text{Sim equations} \\ \text{\rightarrow a = 1$ and $b = -11$} \\ \text{\rightarrow bivides volume by length}^{2} \\ \frac{4\sqrt{2} - 3\sqrt{3}}{5 - 2\sqrt{6}} \\ \text{\times 5 + 2\sqrt{6}$} \\ \text{$\rightarrow$ 4 + 2\sqrt{2} - 3\sqrt{3}$} \\ \frac{4\sqrt{2} - 3\sqrt{3}}{5 - 2\sqrt{6}} \\ \text{\times 5 + 2\sqrt{6}$} \\ \text{$\rightarrow$ 4 + 2\sqrt{2}$} \\ \text{$\rightarrow$ 2 + 2\sqrt{3}$} \\ \text{$\rightarrow$ 3 + 2\sqrt{3}$} \\ \text{$\rightarrow$ 2 + 2\sqrt{3}$} \\ \text{$\rightarrow$ 3 + 2\sqrt{3}$} \\ \text{$\rightarrow$ 2 + 2\sqrt{3}$} \\ \text{$\rightarrow$ 3 + 2\sqrt{3}$} \\ \text{$\rightarrow$ 4 + 2\sqrt{3}$} \\$	\rightarrow x = 1.6 or 8/5 etc	A1	со
equate coefficients of log 2]	.,,		
3. $x^3 + ax^2 + bx - 3$ Puts $x = 3$ → $27 + 9a + 3b - 3 = 0$ Puts $x = -2$ → $-8 + 4a - 2b - 3 = 15$ $(9a + 3b = -24 \text{ and } 4 - 2b - 26)$ Sim equations → $a = 1$ and $b = -11$ 4. $(\sqrt{3} - \sqrt{2})^2 = 5 - 2\sqrt{6}$ or $5 - 2\sqrt{2}\sqrt{3}$ Divides volume by length ² $\frac{4\sqrt{2} - 3\sqrt{3}}{5 - 2\sqrt{6}} \times \frac{5 + 2\sqrt{6}}{5 - 2\sqrt{6}}$ Denominator = 1 Numerator = $20\sqrt{2} - 15\sqrt{3} + 8\sqrt{12} - 6\sqrt{18}$ But $\sqrt{12} = 2\sqrt{3}$ and $\sqrt{18} = 3\sqrt{2}$ $\frac{1}{5}$ $\frac{1}{5}$ $y = 0$ when $3x + \frac{1}{2}\pi = \pi$ $\frac{1}{5}$ Between 0 and $\pi/4$ $\frac{1}{5}$ Between 0 and $\frac{1}{5}$ Betw		[B1B1	
Puts x=3 \rightarrow 27+9a+3b-3=0	equate coefficients of log 2]	M1A1]	
Puts x=3 \rightarrow 27+9a+3b-3=0 Puts x=-2 \rightarrow -8+4a=2b-3=15 (9a+3b=-24 and 4a-2b=26) Sim equations \rightarrow a = 1 and b = -11 4. $(\sqrt{3}-\sqrt{2})^2=5-2\sqrt{6}$ or $5-2\sqrt{2}\sqrt{3}$ Divides volume by length? 4. $(\sqrt{3}-\sqrt{2})^2=5-2\sqrt{6}$ or $\sqrt{3}-2\sqrt{6}$ M1 4. $(\sqrt{3}-\sqrt{2})^2=5-2\sqrt{6}$ or $\sqrt{3}-2\sqrt{6}$ M1 4. $(\sqrt{3}-\sqrt{2})^2=5-2\sqrt{6}$ or $\sqrt{3}-2\sqrt{6}$ M1 5. $(\sqrt{3}-\sqrt{2})^2=5-2\sqrt{6}$ 5. $(\sqrt{3}-\sqrt{2})^2=5-2\sqrt{6}$ 6. $(\sqrt$	2 3 102 162 2		
Puls $x=-2 \rightarrow -8+4a-2b-3=15$ (9a+3b=-24 and 4a-2b-3=15 (9a+3b=-24 and 4a-2b-3e) Sim equations \rightarrow a = 1 and b = -11 4. $(\sqrt{3}-\sqrt{2})^2=5-2\sqrt{6}$ or $5-2\sqrt{2}\sqrt{3}$ Divides volume by length? 4. $(\sqrt{2}-3\sqrt{3}) \times 5+2\sqrt{6}$ M1 Denominator = 1 Numerator = $20\sqrt{2}-15\sqrt{3}+8\sqrt{12-6}\sqrt{18}$ But $\sqrt{12}=2\sqrt{3}$ and $\sqrt{18}=3\sqrt{2}$ M1 $\rightarrow 2\sqrt{2}+\sqrt{3}$ M1 Signification somewhere with either of these co		N/1 A 1	Needs v=2 and =0 for M mark
$(9a+3b=-24 \text{ and } 4a-2b=26)$ $Sim \ \text{equations} \rightarrow \ \text{a} = 1 \ \text{and b} = -11$ $A1 \qquad \text{co}$ $4. \ (\sqrt{3}-\sqrt{2})^2 = 5 - 2\sqrt{6} \text{ or } 5-2\sqrt{2}\sqrt{3}$ $\text{Divides volume by length}^2$ $\frac{4\sqrt{2}-3\sqrt{3}}{5-2\sqrt{6}} \times \frac{5+2\sqrt{6}}{5+2\sqrt{6}}$ $Denominator = 1 \\ \text{Numerator} = 20\sqrt{2}-15\sqrt{3}+8\sqrt{12-6}\sqrt{18}$ $\text{But } \sqrt{12} = 2\sqrt{3} \text{ and } \sqrt{18} = 3\sqrt{2}$ $\rightarrow 2\sqrt{2} + \sqrt{3}$ $A1 \qquad \text{Correct simplification somewhere with either of these co}$ $5 \qquad y=0 \ \text{when } 3x + \frac{1}{4}\pi = \pi$ $\rightarrow x = \frac{1}{4}\pi$ $\text{Between 0 and } \pi/4$ $\rightarrow 2 + \sqrt{2} \text{ or } 3.41$ $6 \text{ Wind } 50i-70j \text{ V(still air)} = 280i-40j$ $(i) \text{ Resultant velocity} = \mathbf{v_{air}} + \mathbf{w}$ $\rightarrow 330i-110j$ $\tan^{-1}(110/330) = 18.4^{\circ}$ $\rightarrow \text{Bearing of Q from P} = 108^{\circ}$ $(ii) \text{ Resultant speed} = \sqrt{(330^2+110^2)}$ $\text{Time} = 273 + \text{resultant speed} = \sqrt{(340^2+10^2)}$ $\text{For } 273 + \sqrt{(a^2+b^2)}$			
Sim equations \rightarrow a = 1 and b = -11 A1 [5] 4. $(\sqrt{3}-\sqrt{2})^2 = 5 - 2\sqrt{6}$ or $5-2\sqrt{2}\sqrt{3}$ Divides volume by length? $\frac{4\sqrt{2}-3\sqrt{3}}{5-2\sqrt{6}} \times \frac{5+2\sqrt{6}}{5+2\sqrt{6}}$ Denominator = 1 Numerator = $20\sqrt{2}-15\sqrt{3}+8\sqrt{12}-6\sqrt{18}$ But $\sqrt{12} = 2\sqrt{3}$ and $\sqrt{18} = 3\sqrt{2}$ $\rightarrow 2\sqrt{2} + \sqrt{3}$ M1 Correct simplification somewhere with either of these co [5] 5 $y=0 \text{ when } 3x + \frac{1}{4}\pi$ B1 Co. Allow 45° Knows to integrate. Needs "cos". All correct, including ± 3 , ± 6 and ± 9 . Between 0 and $\pm 1/4$		WIAI	
$[5] \begin{tabular}{ c c c c c c c c c c c c c c c c c c c$	(9a+3b==24 and 4a=2b=26)		(A marks for unsimplified)
$[5] \begin{tabular}{ c c c c c c c c c c c c c c c c c c c$	Sim equations $x = 1$ and $b = -11$	Λ1	60
4. $(\sqrt{3}-\sqrt{2})^2=5-2\sqrt{6}$ or $5-2\sqrt{2}\sqrt{3}$ Divides volume by length? $\frac{4\sqrt{2}-3\sqrt{3}}{5-2\sqrt{6}}\times\frac{5+2\sqrt{6}}{5+2\sqrt{6}}$ Denominator = 1 Numerator = $20\sqrt{2}-15\sqrt{3}+8\sqrt{12-6}\sqrt{18}$ But $\sqrt{12}=2\sqrt{3}$ and $\sqrt{18}=3\sqrt{2}$ $\rightarrow 2\sqrt{2}+\sqrt{3}$ M1 Correct simplification somewhere with either of these co $[5]$ $\sqrt{5}$ $\sqrt{5}$ $\sqrt{2} \times \sqrt{5} \times \sqrt{5+2\sqrt{6}}$ B1 M1 Correct simplification somewhere with either of these co $\sqrt{5}$ $\sqrt{5}$ $\sqrt{5} \times \sqrt{2} \times \sqrt{3}$ B1 Co. Allow 45° [5] $\sqrt{5}$ $\sqrt{5} \times \sqrt{3} \times \sqrt{3} \times \sqrt{3} \times \sqrt{3} \times \sqrt{3} \times \sqrt{3}$ B1 Co. Allow 45° All correct, including $+3$, $+3$ 0 and -4 0 Uses limits correctly $+ - + + + + + + + + + + + + + + + + + $	Sim equations $\rightarrow a - 1$ and $b11$		CO
Divides volume by length? $\frac{4\sqrt{2}-3\sqrt{3}}{5-2\sqrt{6}} \times \frac{5+2\sqrt{6}}{5+2\sqrt{6}}$ $\frac{4\sqrt{2}-3\sqrt{3}}{5-2\sqrt{6}} \times \frac{5+2\sqrt{6}}{5+2\sqrt{6}}$ $\frac{1}{5} \times \frac{5+2\sqrt{6}}{5+2\sqrt{6}} \times \frac{5+2\sqrt{6}}{5+2\sqrt{6}}$ $\frac{1}{5} \times \frac{1}{5} $		[]	
$\frac{4\sqrt{2}-3\sqrt{3}}{5-2\sqrt{6}} \times \frac{5+2\sqrt{6}}{5+2\sqrt{6}}$ Denominator = 1 Numerator = $20\sqrt{2}-15\sqrt{3}+8\sqrt{12}-6\sqrt{18}$ But $\sqrt{12}=2\sqrt{3}$ and $\sqrt{18}=3\sqrt{2}$ $\rightarrow 2\sqrt{2}+\sqrt{3}$ $\frac{1}{5}$ $y=0 \text{ when } 3x+\frac{1}{4}\pi = \pi$ $\rightarrow x=\frac{1}{4}\pi$ Between 0 and $\pi/4$ $\rightarrow 2+\sqrt{2}$ or 3.41 Between 0 and $\pi/4$ $\rightarrow 2+\sqrt{2}$ or 3.41 Between 0 and $\pi/4$ $\rightarrow 330i-110j$ (i) Resultant velocity = $\mathbf{v}_{air} + \mathbf{w}$ $\rightarrow 330i-110j$ $\rightarrow Bearing of Q from P = 108°$ (ii) Resultant speed = $\sqrt{(330^2+110^2)}$ $Time = 273 + resultant speed = 47 minutes$ M1 \times by denominator with sign changed		B1	Co anywhere
Denominator = 1 Numerator = $20\sqrt{2}-15\sqrt{3}+8\sqrt{12}-6\sqrt{18}$ But $\sqrt{12}=2\sqrt{3}$ and $\sqrt{18}=3\sqrt{2}$ $\rightarrow 2\sqrt{2}+\sqrt{3}$ M1 A1 B1 Correct simplification somewhere with either of these co $ \begin{array}{cccccccccccccccccccccccccccccccccc$	Divides volume by length ²	M1	V÷l² used
Denominator = 1 Numerator = $20\sqrt{2}-15\sqrt{3}+8\sqrt{12}-6\sqrt{18}$ But $\sqrt{12}=2\sqrt{3}$ and $\sqrt{18}=3\sqrt{2}$ $\rightarrow 2\sqrt{2}+\sqrt{3}$ M1 A1 B1 Correct simplification somewhere with either of these co $ \begin{array}{cccccccccccccccccccccccccccccccccc$	$4\sqrt{2} - 3\sqrt{3}$ $5 + 2\sqrt{6}$		
Denominator = 1 Numerator = $20\sqrt{2}-15\sqrt{3}+8\sqrt{12}-6\sqrt{18}$ But $\sqrt{12}=2\sqrt{3}$ and $\sqrt{18}=3\sqrt{2}$ $\rightarrow 2\sqrt{2}+\sqrt{3}$ M1 A1 B1 Correct simplification somewhere with either of these co $ \begin{array}{cccccccccccccccccccccccccccccccccc$	$\frac{1\sqrt{2} + \sqrt{6}}{5 + \sqrt{6}} \times \frac{3 + 2\sqrt{6}}{5 + \sqrt{6}}$	M1	× by denominator with sign changed
Numerator = $20\sqrt{2}-15\sqrt{3}+8\sqrt{12}-6\sqrt{18}$ But $\sqrt{12}=2\sqrt{3}$ and $\sqrt{18}=3\sqrt{2}$ $\rightarrow 2\sqrt{2}+\sqrt{3}$ M1 A1 B1 Correct simplification somewhere with either of these co $ \begin{array}{cccccccccccccccccccccccccccccccccc$	$5-2\sqrt{6}$ $5+2\sqrt{6}$		
Numerator = $20\sqrt{2}-15\sqrt{3}+8\sqrt{12}-6\sqrt{18}$ But $\sqrt{12}=2\sqrt{3}$ and $\sqrt{18}=3\sqrt{2}$ $\rightarrow 2\sqrt{2}+\sqrt{3}$ M1 A1 B1 Correct simplification somewhere with either of these co $ \begin{array}{cccccccccccccccccccccccccccccccccc$			
But $\sqrt{12} = 2\sqrt{3}$ and $\sqrt{18} = 3\sqrt{2}$ $\rightarrow 2\sqrt{2} + \sqrt{3}$ Solution $\sqrt{18} = 3\sqrt{2}$ $\rightarrow 2\sqrt{2} + \sqrt{3}$ But $\sqrt{12} = 2\sqrt{3}$ and $\sqrt{18} = 3\sqrt{2}$			
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	But $\sqrt{12} = 2\sqrt{3}$ and $\sqrt{18} = 3\sqrt{2}$	M1	
$[5] \begin{tabular}{ c c c c c c c c c c c c c c c c c c c$			either of these
$ 5 \qquad \qquad y=0 \text{ when } 3x+1/4\pi=\pi \\ \rightarrow x=1/4\pi \qquad \qquad B1 \qquad \qquad Co. \text{ Allow } 45^\circ $	$\rightarrow 2\sqrt{2} + \sqrt{3}$		СО
$y=0 \text{ when } 3x+\frac{1}{4}\pi=\pi$ $\rightarrow x=\frac{1}{4}\pi$ $B1$ $Co. Allow 45^{\circ}$ $ Gsin(3x+\pi/4)dx=-6\cos(3x+\pi/4)\div 3 $ $Between 0 \text{ and } \pi/4$ $\rightarrow 2+\sqrt{2} \text{ or } 3.41$ $ Gi $ $ Wind 50i-70j $ $ V(still air)=280i-40j$ $ (i) \text{ Resultant velocity}=\mathbf{v_{air}}+\mathbf{w}$ $\rightarrow 330i-110j$ $tan^{-1}(110/330)=18.4^{\circ}$ $\rightarrow Bearing of Q \text{ from } P=108^{\circ}$ $ (ii) \text{ Resultant speed}=\sqrt{(330^2+110^2)}$ $Time=273\div resultant speed=47 \text{ minutes}$ $ A1 \rangle$ $ DM1 \rangle$ $A1 \rangle$ $ Connecting two vectors (allow -)$ $Co (Could get these 2 marks in (ii))$ $ Connecting two vectors (allow -)$ $ Co$		[5]	
$y=0 \text{ when } 3x+\frac{1}{4}\pi=\pi$ $\rightarrow x=\frac{1}{4}\pi$ $B1$ $Co. Allow 45^{\circ}$ $ Gsin(3x+\pi/4)dx=-6\cos(3x+\pi/4)\div 3 $ $Between 0 \text{ and } \pi/4$ $\rightarrow 2+\sqrt{2} \text{ or } 3.41$ $ Gi $ $ Wind 50i-70j $ $ V(still air)=280i-40j$ $ (i) \text{ Resultant velocity}=\mathbf{v_{air}}+\mathbf{w}$ $\rightarrow 330i-110j$ $tan^{-1}(110/330)=18.4^{\circ}$ $\rightarrow Bearing of Q \text{ from } P=108^{\circ}$ $ (ii) \text{ Resultant speed}=\sqrt{(330^2+110^2)}$ $Time=273\div resultant speed=47 \text{ minutes}$ $ A1 \rangle$ $ DM1 \rangle$ $A1 \rangle$ $ Connecting two vectors (allow -)$ $Co (Could get these 2 marks in (ii))$ $ Connecting two vectors (allow -)$ $ Co$	5		
	,		
Between 0 and $\pi/4$ \rightarrow 2 + $\sqrt{2}$ or 3.41 $A1$ $A1$ $A1$ $A1$ $A1$ $A1$ $A1$ $A1$	$\rightarrow x = \frac{1}{4}\pi$	B1	Co. Allow 45°
Between 0 and $\pi/4$ \rightarrow 2 + $\sqrt{2}$ or 3.41 $A1$ $A1$ $A1$ $A1$ $A1$ $A1$ $A1$ $A1$			
Between 0 and $\pi/4$ \rightarrow 2 + $\sqrt{2}$ or 3.41			
Between 0 and $\pi/4$ $\rightarrow 2 + \sqrt{2}$ or 3.41 $A1$ $A1$ $A1$ $A1$ $A1$ $A1$ $A1$ $A1$	$\int 6\sin(3x+\pi/4)dx = -6\cos(3x+\pi/4) \div 3$	M1	Knows to integrate. Needs "cos".
Between 0 and $\pi/4$ $\rightarrow 2 + \sqrt{2}$ or 3.41		A2,1	
	Between 0 and π/4	DM1	
[6] 6 Wind $50\mathbf{i}$ – $70\mathbf{j}$ V(still air) = $280\mathbf{i}$ – $40\mathbf{j}$ (i) Resultant velocity = $\mathbf{v_{air}}$ + \mathbf{w} $\rightarrow 330\mathbf{i}$ – $110\mathbf{j}$ M1 Connecting two vectors (allow –) Co (Could get these 2 marks in (ii)) $\tan^{-1}(110/330) = 18.4^{\circ}$ \rightarrow Bearing of Q from P = 108° (ii) Resultant speed = $\sqrt{(330^2+110^2)}$ Time = $273 \div$ resultant speed = 47 minutes M1 Use of Pythagoras with his components $\tan^{-1}(110/330) = 18.4^{\circ}$ $- \Delta \mathbf{m} \mathbf{m} \mathbf{m} \mathbf{m} \mathbf{m} \mathbf{m} \mathbf{m} \mathbf{m}$	\rightarrow 2 + $\sqrt{2}$ or 3.41	A1	
(i) Resultant velocity = \mathbf{v}_{air} + \mathbf{w} $\rightarrow 330\mathbf{i} - 110\mathbf{j}$		[6]	
(i) Resultant velocity = \mathbf{v}_{air} + \mathbf{w} $\rightarrow 330\mathbf{i} - 110\mathbf{j}$	6 Wind 50i - 70i Watill air) - 290i -40i		
	0 vviilu 301 70j v(Siiii aii) - 2001 -40j		
	(i) Resultant velocity = v · + w	M1	Connecting two vectors (allow –)
tan ⁻¹ (110/330) = 18.4° \rightarrow Bearing of Q from P = 108° (ii) Resultant speed = $\sqrt{(330^2+110^2)}$ Time = 273 ÷ resultant speed = 47 minutes Table 108° DM1 A1 For use of tangent (330/110 ok) co Use of Pythagoras with his components For 273 ÷ $\sqrt{(a^2+b^2)}$			
⇒ Bearing of Q from P = 108° (ii) Resultant speed = $\sqrt{(330^2+110^2)}$ Time = $273 \div \text{resultant speed}$ = 47 minutes A1 Use of Pythagoras with his components $A1$ For $273 \div \sqrt{(a^2+b^2)}$, 000i 110j	/ ' '	Could got those 2 marks in (ii)
⇒ Bearing of Q from P = 108° (ii) Resultant speed = $\sqrt{(330^2+110^2)}$ Time = $273 \div \text{resultant speed}$ = 47 minutes A1 Use of Pythagoras with his components $A1$ For $273 \div \sqrt{(a^2+b^2)}$	$tan^{-1}(110/330) = 18.4^{\circ}$	DM1	For use of tangent (330/110 ok)
(ii) Resultant speed = $\sqrt{(330^2+110^2)}$ Time = 273 ÷ resultant speed = 47 minutes M1 Use of Pythagoras with his components For $273 \div \sqrt{(a^2+b^2)}$			_ ` ` ,
Time = 273 ÷ resultant speed = 47 minutes $A1\sqrt{}$ components For 273 ÷ $\sqrt{(a^2+b^2)}$	- Dealing of Q Holli F - 100	<i>,</i>	
Time = 273 ÷ resultant speed = 47 minutes $A1\sqrt{}$ components For 273 ÷ $\sqrt{(a^2+b^2)}$	(ii) Resultant speed = $\sqrt{(330^2+110^2)}$	M1	Use of Pythagoras with his
= 47 minutes $A1$ For $273 \div \sqrt{(a^2+b^2)}$			
For $273 \div \sqrt{(a^2+b^2)}$		A1√	
[10]	- 47 Hilliutes	,	For $273 \div \sqrt{(a^2+b^2)}$
Codio diawingo die on.	Scale drawings are ok	[6]	
	Coale diawings are oit.	L-J	

Page 2	Mark Scheme	Syllabus	Paper
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$7 (0.6 0.2 0.5) \times \begin{pmatrix} 8 & 6 & 6 & 5 \\ 5 & 4 & 3 & 2 \\ 3 & 3 & 2 & 2 \end{pmatrix} \times \begin{pmatrix} 40 \\ 50 \\ 50 \\ 60 \end{pmatrix}$ $= (7.3 5.9 5.2 4.4) \times \begin{pmatrix} 40 \\ 50 \\ 50 \\ 60 \end{pmatrix}$	B2,1,0 M1 A1	Wherever 3 matrices come – as row or column matrices – as 3 by 4 or 4 by 3 – independent of whether they are compatible for multiplication or not. Correct method for multiplying any 2 of the 3 - co for A mark.
or $(0.6 \ 0.2 \ 0.5) \times \begin{pmatrix} 1220 \\ 670 \\ 490 \end{pmatrix}$ $\rightarrow 1111	M1 B1 [6]	Correct method for remaining two. Co – even if from arithmetic.
(i) d/dx(lnx) = 1/x	B1	Anywhere, even if not used in "u/v"
$\frac{dy}{dx} = \frac{(2x+3) \times \frac{1}{x} - (\ln x) \times 2}{(2x+3)^2}$ (ii) $\delta y = (dy/dx) \times \delta x = 0.2p$ (iii) $dy/dt = dy/dx \times dx/dt$ $\rightarrow dx/dt = 0.6$	M1A1√ M1A1 M1 A1√ [7]	Uses correct formula. All ok. Could use product formula. A mark unsimplified. Allow if δy mixed with dy/dt. M mark given for algebraic dy/dx × p. Allow if dy/dt mixed with δy √ for 0.12 ÷ his dy/dx. Condone use of δx etc
9 (a) Uses $\sec^2 x = 1 + \tan^2 x \rightarrow \text{quad in sec}$ or $x \in \text{c}^2$ then uses $\text{s}^2 + \text{c}^2 = 1 \rightarrow \text{quad in cos}$ $\rightarrow 4 \sec^2 x + 8 \sec x - 5 = 0$ $\rightarrow -5 \cos^2 x + 8 \cos x + 4 = 0$ $\rightarrow \sec x = -2.5 \text{ (or 0.5)}$ or $\cos x = -0.4 \text{ (or 2)}$ $\rightarrow x = 113.6^\circ$ or 246.4° (b) $\tan(2y+1) = 16/5 = 3.2$ Basic angle associated with $3.2 = 1.27$ Next angle $= \pi + 1.27$ and $2\pi + 1.27$ (Value $= 1$) $\Rightarrow 2 \rightarrow 3.28$ (others are 0.134 and 1.705)	B1 M1 A1A1√ B1 M1 M1A1	Co. Sets to 0 and uses correct method for solution of a 3 term quadratic in sec or cos. A1 co. A1√ for 360°−"first ans" only. Anywhere (allow 72.6°) Realising the need to add on π and/or 2π Correct order used ie −1, then ÷2 for any correct value. Allow if all 3 values are given, providing none are over 4. (degrees − max 2/4 B1, M0, M1, A0)

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Logs or calculator $\rightarrow x = 1.02$ (iii) (iii) (1.02, 0) and (0, 2) B1 B1 $$ Shape in 1st quadrant. Both shown or implied by statement. M1 Reasonable attempt $e^{\frac{1}{2}N}$ as the subject. Using logs. All ok, including x, y interchanged. [8] 11 (i) $y = \frac{1}{2}N$ and $y = 3N - 15$ $\rightarrow C(6,3)$ M1 OB=OC+CB $\rightarrow B(8,9)$ M1 Soln of simultaneous eqns Co (or step method if B done first) Vectors, step or soln of $y = \frac{1}{2}N + 5$ and $y = 3N - 15$ From his C M1 Vectors, step or soln of $y = \frac{1}{2}N + 5$ and $y = 3N - 15$ From his C M1 Sol of simultaneous eqns Co (or step method if B done first) Vectors, step or soln of $y = \frac{1}{2}N + 5$ and $y = 3N - 15$ From his C M1 Sol of simultaneous eqns Co (or step method if B done first) Vectors, step or soln of $y = \frac{1}{2}N + 5$ and $y = 3N - 15$ From his C M1 A1 Sol of simultaneous eqns Co (or step method if B done first) Vectors, step or soln of $y = \frac{1}{2}N + 5$ and $y = 3N - 15$ From his C M1 A1 Sol of simultaneous eqns Co (or step method if B done first) Vectors, step or soln of $y = \frac{1}{2}N + 5$ and $y = 3N - 15$ From his C M1 A1 Sol of simultaneous eqns Co (or step method if B done first) Vectors, step or soln of $y = \frac{1}{2}N + 5$ and $y = 3N - 15$ From his C M1 A1 Co – unsimplified. Sol of simultaneous eqns Co (or step method if B done first) M1 Adding OA,AB,BC,CO Co. [111] 12 EITHER (i) 125 = $\pi r + 2x + 2(5r/4)$ $\rightarrow x = \frac{1}{2}(1 + 2N + 1)$ A1 A1 A1 A1 A1 A1 A1 A1 A1 A	10 $f(x) = 5-3e^{\frac{y_2x}{2}}$		
Logs or calculator $\rightarrow x = 1.02$ (iii) (iii) (1.02, 0) and (0, 2) B1 Shape in 1st quadrant. Both shown or implied by statement. M1 Reasonable attempt $e^{3/4}$ as the subject. Using logs. All ok, including x, y interchanged. [8] 11 (i) $y = \frac{1}{2}x$ and $y = 3x - 15$ $\rightarrow C(6,3)$ M1 Soln of simultaneous eqns Co (or step method if B done first) Vectors, step or soln of $y = \frac{1}{2}x + 5$ and $y = 3x - 15$ $\rightarrow B(8,9)$ M1 Sol of simultaneous eqns Co (or step method if B done first) Vectors, step or soln of $y = \frac{1}{2}x + 5$ and $y = 3x - 15$ From his C M1 Vectors, step or soln of $y = \frac{1}{2}x + 5$ and $y = 3x - 15$ From his C M1 Sol of simultaneous eqns Co (or step method if B done first) Vectors, step or soln of $y = \frac{1}{2}x + 5$ and $y = 3x - 15$ From his C M1 A1 Sol of simultaneous eqns Co (or step method if B done first) Vectors, step or soln of $y = \frac{1}{2}x + 5$ and $y = 3x - 15$ From his C M1 A1 Sol of simultaneous eqns Co (or step method if B done first) Vectors, step or soln of $y = \frac{1}{2}x + 5$ and $y = 3x - 15$ From his C M1 A1 Sol of simultaneous eqns Co (or step method if B done first) Vectors, step or soln of $y = \frac{1}{2}x + 5$ and $y = 3x - 15$ From his C M1 A1 Co – unsimplified. Sol of simultaneous eqns Co (or step method if B done first) Vectors, step or soln of $y = \frac{1}{2}x + 5$ and $y = 3x - 15$ From his C M1 A1 Co – unsimplified. Sol of simultaneous eqns Co (or step method if B done first) M1 Adding OA,AB,BC,CO Co. [111] 12 EITHER (i) 125 = $\pi r + 2x + 2(5r/4)$ $\rightarrow x = \frac{1}{2}(1425 - \pi r - 5r/2)$ M1 A1 Anywhere in the question — independent of any other working Use of $\frac{1}{2}x + \frac{1}{2}x $	(i) Range is <5	B1	Allow ≤ or <
$(iv) e^{\frac{2\pi x}{3}} = (5 - y) + 3$ $x/2 = \ln[(5 - y)/3]$ $f^{1}(x) = 2\ln[(5 - x)/3]$ $N1$ $(i) y = \frac{2\pi x}{3} = (5 - y) + 3$ $x/2 = \ln[(5 - y)/3]$ $f^{1}(x) = 2\ln[(5 - x)/3]$ $N1$ $N1$ $N1$ $N2 = 2\ln[(5 - x)/3]$ $N1$ $N1$ $N1$ $N1$ $N1$ $N1$ $N1$ $N1$		M1A1	Normally 2,0 but if working shown, can get M1 if appropriate
$x/2 = \ln[(5-y)/3] \\ f^{1}(x) = 2\ln[(5-x)/3]$ $M1 \\ A1$ $A1$ $M2$ $M3$ $M1 \\ A1$ $M3$ $M4$ $M1 \\ M4$ $M1 \\ M4$ $M3$ $M4$ $M1 \\ M4$ $M5$ $M1 \\ M4$ $M5$ $M1 \\ M4$ $M6$ $M1$ $M1$ $M2$ $M2$ $M1$ $M2$ $M2$ $M3$ $M1$ $M4$ $M1$ $M2$ $M2$ $M3$ $M1$ $M4$ $M1$ $M2$ $M3$ $M4$ $M1$ $M3$ $M4$ $M1$ $M4$ $M4$ $M4$ $M6$ $M1$ $M6$ $M1$ $M1$ $M1$ $M1$ $M1$ $M1$ $M1$ $M1$			
11 (i) $y=\frac{1}{2}x$ and $y=3x-15$ $\rightarrow C(6,3)$ OB=OC+CB $\rightarrow B(8,9)$ M1 A1 Vectors, step or soln of $y=\frac{1}{2}x+5$ and $y=3x-15$ From his C M1 $A1$ We of $A1$ $A1$ $A1$ Note that $A1$	$x/2 = \ln[(5-y)/3]$	M1 A1	Using logs.
$(i) \ y=\frac{1}{2}x \ and \ y=3x-15 \ \rightarrow C(6,3)$ $OB=OC+CB$ $OB=0C+CB$ $OB=0(3)$ $OB=0(3)$ $OB=0(3)$ $OB=0(4)$ $OB=0(4$		[8]	
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	(i) y=½x and y=3x-15		
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	OB=OC+CB	M1	
eqn of AD is $y-6=-2(x-2)$ or $y=-2x+10$ Soln of $y=\frac{1}{2}x$ and eqn of AD \rightarrow D(4,2) (ii) Length OC = $\sqrt{45}$, OA = $\sqrt{40}$ Perimeter of OABC = $2(\sqrt{45}+\sqrt{40})$ \rightarrow 26.1 12 EITHER (i) $125 = \pi r + 2x + 2(5r/4)$ \rightarrow $x = \frac{1}{2}(125 - \pi r - 5r/2)$ M1 Area of triangle = $\frac{1}{2}x \times 2r \times 3r/4 = 3r^2/4$ A = $\frac{1}{2}\pi r^2 + 2rx +$ = $125r - \frac{1}{2}\pi r^2 - 7r^2/4$ (ii) $125 = \pi r + 2x + 2(5r/4)$ \rightarrow M1 Area of triangle = $\frac{1}{2}x \times 2r \times 3r/4 = 3r^2/4$ A = $\frac{1}{2}\pi r^2 + 2rx +$ = $125r - \frac{1}{2}\pi r^2 - 7r^2/4$ Anywhere in the question — independent of any other working Use of $\frac{1}{2}x + 2rx$. Answer given — beware fortuitous ans. (iii) $\frac{1}{2}x + \frac{1}{2}x + \frac{1}$	→ B(8,9)	A 1√	
(ii) Length OC = $\sqrt{45}$, OA = $\sqrt{40}$ Perimeter of OABC = $2(\sqrt{45}+\sqrt{40})$ A1 12 EITHER (i) $125 = \pi r + 2x + 2(5r/4)$ A1 A1 Attempt at $4/5$ lengths. Co. $h = 3r/4$ M1 Area of triangle = $\frac{1}{2} \times 2r \times 3r/4 = 3r^2/4$ M1 Area of triangle = $\frac{1}{2} \times 2r \times 3r/4 = 3r^2/4$ M1 A = $\frac{1}{2}\pi r^2 + 2rx + \dots$ = $125r - \frac{1}{2}\pi r^2 - 7r^2/4$ B1 Anywhere in the question — independent of any other working Use of $\frac{1}{2}$ bh with h as function of r B1 Correct $\frac{1}{2}\pi r^2 + 2rx$. Answer given — beware fortuitous ans. (ii) $dA/dr = 125 - \pi r - 7r/2$ M1A1 Any attempt to differentiate. Co. Solved = 0 to give DM1 Setting his differential to 0.			` ` · · · · · · · · · · · · · · · · · ·
Perimeter of OABC = $2(\sqrt{45}+\sqrt{40})$ $\rightarrow 26.1$ M1 Adding OA,AB,BC,CO Co. [11] Adding OA,AB,BC,CO Co. [11] Attempt at 4/5 lengths. Co. M1 Area of triangle = $\frac{1}{2} \times 2r \times 3r/4 = 3r^2/4$ Area of triangle = $\frac{1}{2} \times 2r \times 3r/4 = 3r^2/4$ M1 Area of triangle = $\frac{1}{2} \times 2r \times 3r/4 = 3r^2/4$ M1 Anywhere in the question — independent of any other working Use of $\frac{1}{2}$ bh with h as function of r A = $\frac{1}{2}\pi r^2 + 2rx +$ = $125r - \frac{1}{2}\pi r^2 - 7r^2/4$ Al Anywhere in the question — independent of any other working Use of $\frac{1}{2}$ bh with h as function of r Answer given — beware fortuitous ans. M1A1 Any attempt to differentiate. Co. Solved = 0 to give DM1 Setting his differential to 0.	Soln of y= $\frac{1}{2}x$ and eqn of AD \rightarrow D(4,2)	M1A1	Sol of simultaneous eqns. co.
12 EITHER (i) $125 = \pi r + 2x + 2(5r/4)$ $\rightarrow x = \frac{1}{2}(125 - \pi r - 5r/2)$ M1 Attempt at $4/5$ lengths. Co. $h = 3r/4$ Area of triangle = $\frac{1}{2} \times 2r \times 3r/4 = 3r^2/4$ M1 Anywhere in the question — independent of any other working Use of $\frac{1}{2}$ bh with h as function of r $A = \frac{1}{2}\pi r^2 + 2rx +$ $= 125r - \frac{1}{2}\pi r^2 - 7r^2/4$ B1 Correct $\frac{1}{2}\pi r^2 + 2rx$. Answer given — beware fortuitous ans. (ii) $dA/dr = 125 - \pi r - 7r/2$ M1A1 Any attempt to differentiate. Co. Solved = 0 to give DM1 Setting his differential to 0.	Perimeter of OABC = $2(\sqrt{45}+\sqrt{40})$	M1	Adding OA,AB,BC,CO
(i) $125 = \pi r + 2x + 2(5r/4)$ $\rightarrow x = \frac{1}{2}(125 - \pi r - 5r/2)$ M1 Attempt at $\frac{4}{5}$ lengths. Co. $h = 3r/4$ M1 Anywhere in the question — independent of any other working Use of $\frac{1}{2}$ bh with h as function of r $A = \frac{1}{2}\pi r^2 + 2rx +$ $= 125r - \frac{1}{2}\pi r^2 - 7r^2/4$ B1 Correct $\frac{1}{2}\pi r^2 + 2rx$. Answer given — beware fortuitous ans. (ii) $dA/dr = 125 - \pi r - 7r/2$ M1A1 Any attempt to differentiate. Co. Solved = 0 to give DM1 Setting his differential to 0.		[11]	
	12 EITHER		
Area of triangle = $\frac{1}{2} \times 2r \times 3r/4 = 3r^2/4$ M1 M2 M1 M2 M1 M1 M1 Lindependent of any other working Use of $\frac{1}{2}$ bh with h as function of r M1 A = $\frac{1}{2}\pi r^2 + 2rx +$ = $125r - \frac{1}{2}\pi r^2 - 7r^2/4$ M1 Correct $\frac{1}{2}\pi r^2 + 2rx$. Answer given – beware fortuitous ans. M1A1 Any attempt to differentiate. Co. Solved = 0 to give DM1 Setting his differential to 0.			
Area of triangle = $\frac{1}{2} \times 2r \times 3r/4 = 3r^2/4$ M1 Use of $\frac{1}{2}$ bh with h as function of r $A = \frac{1}{2}\pi r^2 + 2rx + \dots$ $= 125r - \frac{1}{2}\pi r^2 - 7r^2/4$ B1 Correct $\frac{1}{2}\pi r^2 + 2rx$. Answer given – beware fortuitous ans. (ii) $dA/dr = 125 - \pi r - 7r/2$ M1A1 Any attempt to differentiate. Co. Solved = 0 to give DM1 Setting his differential to 0.	h = 3r/4	M1	
$= 125r - \frac{1}{2}\pi r^2 - 7r^2/4$ A1 Answer given – beware fortuitous ans. (ii) $dA/dr = 125 - \pi r - 7r/2$ M1A1 Any attempt to differentiate. Co. Solved = 0 to give DM1 Setting his differential to 0.	Area of triangle = $\frac{1}{2} \times 2r \times 3r/4 = 3r^2/4$	M1	
Solved = 0 to give DM1 Setting his differential to 0.			
	(ii) $dA/dr = 125 - \pi r - 7r/2$	M1A1	Any attempt to differentiate. Co.
7 - 250 / (2- + 7) or 40 0	Solved = 0 to give	DM1	Setting his differential to 0.
$\rightarrow r = 250 / (2\pi + 1) \text{ or 18.8}$ Any correct form.	\rightarrow r = 250 / (2 π + 7) or 18.8	A1	Any correct form.
[10]		[10]	

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/12	Lies of similar triangles and de 3/
/ 12 M1	Use of similar triangles – needs ¾ lengths correct.
/ 2 A1	Correct in any form – needs h as subject
give M1	Needs correct formula
-5r³/2) A1	Beware fortuitous answers (AG)
M1A1	Any attempt to differentiate. co
DM1	Setting his dV/dr to 0 + attempt.
A1	Correct to 3 or more sig figures
×30 M1	Anywhere
sf) A1 [10]	Exactly 4:9 or 2.25 to 3 sig figures
nd gn.	(2) Factors Sets the equation to 0 Attempts to obtain brackets Solves each bracket to 0.
	o give M1 -5r³/2) A1 -M1A1 -DM1 -A1 -430 -M1 -A1



November 2003

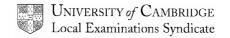
INTERNATIONAL GCSE

MARK SCHEME

MAXIMUM MARK: 80

SYLLABUS/COMPONENT: 0606/02

ADDITIONAL MATHEMATICS
Paper 2



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1 [4]		Eliminate x or y	M1					
		$\Rightarrow y^2 - 8y + 15 = 0 \qquad x^2 - 10x + 9 = 0$						
		Factorise or formula \Rightarrow (1, 3) and (9, 5)	DM1 A1					
		Midpoint is (5, 4)						
2 [4]		$\cos \theta \left(\frac{1 + \sin \theta - (1 - \sin \theta)}{1 - \sin^2 \theta} = \cos \theta \left(\frac{2 \sin \theta}{1 - \sin^2 \theta} \right) = \frac{2 \sin \theta \cos \theta}{1 - \sin^2 \theta}$	M1 A1					
		Use of Pythagoras $\Rightarrow \frac{2\sin\theta\cos\theta}{\cos^2\theta} = 2\tan\theta \Rightarrow k = 2$	B1 A1					
3 [4]		$\log_2 x = 2\log_4 x$ or $\log_4 (x - 4) = \frac{1}{2} \log_2 (x - 4)$	B1					
		$2\log_4 x - \log_4 (x - 4) = 2$ or $\log_2 x - \frac{1}{2} \log_2 (x - 4) = 2$						
		Eliminate logs $\frac{x^2}{x-4} = 16$ or $\frac{x}{\sqrt{x-4}} = 4$	M1 A1					
		Solve for $x \Rightarrow x = 8$	A1					
4 [4]	(i)	a solution of the solution of	B2 B1 B1					
	(ii)	<i>A</i> ∩ <i>B</i> '∩ <i>C</i> '						
	(iii)	$B \cup (A \cap C)$						
5 [5]	(i)	$243x^5 -405x^4 +270x^3$	B1 B1 B1					
	(ii)	Coefficient of $x^4 = (-405 \times 1) + (270 \times 2) = 135$	M1 A1					
6 [6]		At B, $v = 40 (e^{-t} - 0.1) = 0 \implies e^{-t} = 0.1 \implies t = \ln 10 (=2.30)$	M1 A1					
		$\int 40(e^{-t} - 0.1)dt = 40(-e^{-t} - 0.1t)$	M1 A1					
		$AB = \int_{0}^{\log 10} = 40 \left[\left(-\frac{1}{10} - \frac{\ln 10}{10} \right) - (-1) \right] = 4(9 - \ln 10) \approx 26.8$	DM1 A1					

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7 [7]		Dealing with elements $\begin{pmatrix} 1 & -2 \\ -3 & 4 \end{pmatrix}$ and $\begin{pmatrix} 3 & -1 \\ 2 & 2 \end{pmatrix}$	M1							
		$\mathbf{A}^{-1} = -\frac{1}{2} \begin{pmatrix} 1 & -2 \\ -3 & 4 \end{pmatrix} \mathbf{B}^{-1} = \frac{1}{8} \begin{pmatrix} 3 & -1 \\ 2 & 2 \end{pmatrix}$								
	(i)	$\mathbf{C} = \mathbf{B} - 2\mathbf{A}^{-1} = \begin{pmatrix} 2 & 1 \\ -2 & 3 \end{pmatrix} + \begin{pmatrix} 1 & -2 \\ -3 & 4 \end{pmatrix} = \begin{pmatrix} 3 & -1 \\ -5 & 7 \end{pmatrix}$								
	(ii)	$\mathbf{D} = \mathbf{B}^{-1}\mathbf{A} = \frac{1}{8} \begin{pmatrix} 3 & -1 \\ 2 & 2 \end{pmatrix} \begin{pmatrix} 4 & 2 \\ 3 & 1 \end{pmatrix} = \frac{1}{8} \begin{pmatrix} 9 & 5 \\ 14 & 6 \end{pmatrix}$								
8 [7]	(i)	$\frac{10!}{6!4!} = \frac{10 \times 9 \times 8 \times 7}{1 \times 2 \times 3 \times 4} = 210$								
	(ii)	No pink selected i.e. any 6 from (5 + 2) = 7	B1							
	(iii)	All selections contain at least 1 red								
		No yellow selected i.e. any 6 from $(3 + 5) = \frac{8!}{6!2!} = 28$								
		At least 1 of each colour – 120 – (7 + 28) = 175								
9 [8]	(i)	$\frac{d}{dx}\left(\sqrt{4x-3}\right) = \left(4x-3\right)^{-\frac{1}{2}} \times \frac{1}{2} \times 4$								
		$\frac{d}{dx} \left\{ (2x+3)\sqrt{4x-3} \right\} = \left(2x+3)\left(\frac{2}{\sqrt{4x-3}}\right) + 2\sqrt{4x-3}$								
		$=\frac{12x}{\sqrt{4x-3}} \Rightarrow k = 12$	A1							
	(ii)	$\int \frac{x}{\sqrt{4x-3}} \mathrm{d}x = (2x+3)\sqrt{4x-3} \times \frac{1}{12}$	M1	A1						
		$\int_{1}^{7} = \frac{1}{2} (85 - 5) = 6 \frac{2}{3}$	A1							
10 [10]		(i) ∠AOB = 19.2 + 16 = 1.2	M1	A1						
	-4	(ii) $DE = 8 \sin 1.2 \approx 7.46$ (iii) $\angle DOE = \sin^{-1} (7.46 \div 16) \approx 0.485 \text{ (AG)}$	M1 M1							
	16	(iii) $\angle DOE = \sin^{-1}(7.46 \div 16) \approx 0.485 \text{ (AG)}$ (iv) Sector $DOB = \frac{1}{2} \times 16^2 \times 0.485 = 62.08$	M1	Λ1						
	1	Length $OE = \sqrt{(16^2 - 7.46^2)} \approx 14.2$	M1							
	1	$\Delta DOE = \frac{1}{2} \times 7.46 \times 14.2 \approx 52.97$	M1							
		Shaded area ≈ 9.1 – 9.3 (9.275)	A1							

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F 1		1								
11 [10]		V	5	10	15	20	25	(i) Plotting lg R against lg v	M1	
		R	32	96	180	290	420	Accuracy of points: Straight line	A2,	1, 0
		lg v	0.70	1.00	1.18	1.30	1.40	(ii) $R = kv^{\beta} \Rightarrow \lg R = \lg k + \beta \lg v$	B1	
		lg R	1.51	1.98	2.26	2.46	2.61	β = gradient \approx 1.55 - 1.60	M1	A1
						lg <i>k</i> =	= lg <i>R</i> ii	ntercept $\approx 0.4 \Rightarrow k \approx 2.4 - 2.6$	M1	A1
	(iii)	lg R	= Ig 75	i ≈ 1.88	$3 \Rightarrow \text{fro}$	m grapl	n lg <i>v</i> ≈	$0.92 - 0.96 \Rightarrow v \approx 8.3 - 9.1$	M1	A1
		[Or b	y solvi	ng e.g	., 75	$= 2.5v^{1}$	^{.58} or	1.88 = 0.4 + 1.58 lg <i>v</i>]		
12 EITHER [11]	(i)	$gf(x) = \frac{4}{2 - (3x - 2)}$				B1				
		Solve $\frac{4}{4-3x} = 2$ [or solve fg(x) = 3 $\left(\frac{4}{2-x}\right) - 2 = 2$]				M1				
		\Rightarrow x = 2/3					A1			
	(ii)	$f(x) = g(x) \Rightarrow 3x - 2 = \frac{4}{2 - x} \Rightarrow 3x^2 - 8x + 8 = 0$								
		Discriminant = $64 - 96 < 0$ \Rightarrow No real roots				M1	A1			
	(iii)	f ⁻¹ : >	$\alpha \mapsto (x)$	(+ 2) ÷	3				B1	
		y = 4	/ (2 –	<i>x</i>)	\Rightarrow 2	x = 2 - 4	4/ <i>y</i>	$\Rightarrow g^{-1}: x \mapsto 2 - 4/x$	M1	A1
	(iv)		1	-	1 to				B1	B1
		7						Lines intersect at (1, 1)	B1	

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12 OR [11]	(i)	$1 - x^2 + 6x = a - (x + b)^2 = a - x^2 - 2bx - b^2 \Rightarrow a - b^2 = 1 \text{ and } -2b = 6$	M1 .	A1
		[or $1 - x^2 + 6x = 1 - (x^2 - 6x) = 1 - \{(x - 3)^2 - 9\}$]		
		$\Rightarrow b = -3, a = 10$	A1	
	(ii)	$1 - x^2 + 6x = 10 - (x - 3)^2$ \Rightarrow Maximum at (3, 10)		
		∴ Single-valued for $x \ge 3$ and hence for $x \ge 4$	M1 .	A1
	(iii)	$y = 10 - (x - 3)^2$ \Rightarrow $(x - 3)^2 = 10 - y$ \Rightarrow $x - 3 = \sqrt{(10 - x)}$	M1	
		$\Rightarrow f^{-1}: x \mapsto 3 + \sqrt{(10 - x)}$	A1	
	(iv)	When $x = 2$, $g(x) = 9$ and when $x = 7$, $g(x) = -6$	B1	
		Range of g is $-6 \le g \le 10$	B1	
	(v)		В 2,	1, 0