

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 mark available | minimum mark required for grade: | | |
|-------------|------------------------------|----------------------------------|----|----|
| | | A | C | 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.

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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 \checkmark 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 $\sqrt{}$ " 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.

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MARK SCHEME

MAXIMUM MARK: 80

SYLLABUS/COMPONENT: 0606/01

ADDITIONAL MATHEMATICS
Paper 1



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| | | |
|---|--|---|
| 1. $x + 3y = k$ and $y^2 = 2x + 3$ Elimination of x or y $\rightarrow y^2 + 6y - (2k+3) = 0$ or $\rightarrow x^2 - (2k + 18)x + (k^2 - 27) = 0$ Uses $b^2 - 4ac$ $\rightarrow k < -6$ | M1 A1 M1 A1 [4] | x or y must go completely, but allow for simple arithmetic or numeric slips co Any use of $b^2 - 4ac$, even if $=0$ or >0 co |
| 2. $8^{-x} = 2^{-3x}$ $4^{\frac{1}{2}x} = 2^x$ Attempts to link powers of 2 $\rightarrow x - 3 - (-3x) = 5 - (x)$ $\rightarrow x = 1.6$ or $8/5$ etc [$\log 8^{-x} = -3x \log 2$, $\log 4^{\frac{1}{2}x} = x \log 2$ equate coefficients of $\log 2$] | B1 B1 M1 A1 [4] [B1B1 M1A1] | Wherever used Needs to use $x^a \div x^b = x^{a-b}$ co |
| 3. $x^3 + ax^2 + bx - 3$ 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 $b = -11$ | M1A1 M1A1 A1 [5] | Needs $x=3$ and $=0$ for M mark Needs $x=-2$ and $=15$ for M mark (A marks for unsimplified) co |
| 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 $\sqrt{18} = 3\sqrt{2}$ $\rightarrow 2\sqrt{2} + \sqrt{3}$ | B1 M1 M1 M1 A1 [5] | Co anywhere $V \div l^2$ used \times by denominator with sign changed Correct simplification somewhere with either of these co |
| 5 $y=0$ when $3x + \frac{1}{4}\pi = \pi$ $\rightarrow x = \frac{1}{4}\pi$ $\int 6\sin(3x+\pi/4)dx = -6 \cos(3x+\pi/4) \div 3$ Between 0 and $\pi/4$ $\rightarrow 2 + \sqrt{2}$ or 3.41 | B1 M1 A2,1 DM1 A1 [6] | Co. Allow 45° Knows to integrate. Needs "cos". All correct, including $\div 3$, $\times 6$ and $-ve$ Uses limits correctly – must use $x=0$ In any form – at least 3sf |
| 6 Wind $50i - 70j$ $V(\text{still air}) = 280i - 40j$ (i) Resultant velocity = $\mathbf{v_{air} + w}$ $\rightarrow 330i - 110j$ $\tan^{-1}(110/330) = 18.4^\circ$ \rightarrow Bearing of Q from P = 108° (ii) Resultant speed = $\sqrt{(330^2 + 110^2)}$ Time = $273 \div$ resultant speed = 47 minutes Scale drawings are ok. | M1 A1 DM1 A1 M1 A1 [6] | Connecting two vectors (allow $-$) Co (Could get these 2 marks in (ii)) For use of tangent (330/110 ok) co Use of Pythagoras with his components For $273 \div \sqrt{(a^2+b^2)}$ |

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| $7 \begin{pmatrix} 0.6 & 0.2 & 0.5 \end{pmatrix} \times \begin{pmatrix} 8 & 6 & 6 & 5 \\ 5 & 4 & 3 & 2 \\ 3 & 3 & 2 & 2 \end{pmatrix} \times \begin{pmatrix} 40 \\ 50 \\ 50 \\ 60 \end{pmatrix}$ $= \begin{pmatrix} 7.3 & 5.9 & 5.2 & 4.4 \end{pmatrix} \times \begin{pmatrix} 40 \\ 50 \\ 50 \\ 60 \end{pmatrix}$ $\text{or } \begin{pmatrix} 0.6 & 0.2 & 0.5 \end{pmatrix} \times \begin{pmatrix} 1220 \\ 670 \\ 490 \end{pmatrix}$ <p>→ \$1111</p> | <p>B2,1,0</p> <p>M1 A1</p> <p>M1</p> <p>B1</p> <p>[6]</p> | <p>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.</p> <p>Correct method for multiplying any 2 of the 3 - co for A mark.</p> <p>Correct method for remaining two.</p> <p>Co – even if from arithmetic.</p> |
| <p>8</p> <p>(i) $d/dx(\ln x) = 1/x$</p> $\frac{dy}{dx} = \frac{(2x+3) \times \frac{1}{x} - (\ln x) \times 2}{(2x+3)^2}$ <p>(ii) $\delta y = (dy/dx) \times \delta x = 0.2p$</p> <p>(iii) $dy/dt = dy/dx \times dx/dt$</p> <p>→ $dx/dt = 0.6$</p> | <p>B1</p> <p>M1A1√</p> <p>M1A1</p> <p>M1</p> <p>A1√</p> <p>[7]</p> | <p>Anywhere, even if not used in “u/v”</p> <p>Uses correct formula. All ok. Could use product formula. A mark unsimplified.</p> <p>Allow if δy mixed with dy/dt. M mark given for algebraic $dy/dx \times p$.</p> <p>Allow if dy/dt mixed with δy √ for $0.12 \div \text{his } dy/dx$. Condone use of δx etc</p> |
| <p>9 (a) Uses $\sec^2 x = 1 + \tan^2 x \rightarrow$ quad in sec or $\times c^2$ then uses $s^2 + c^2 = 1 \rightarrow$ quad in cos → $4\sec^2 x + 8\sec x - 5 = 0$ → $-5\cos^2 x + 8\cos x + 4 = 0$ → $\sec x = -2.5$ (or 0.5) or $\cos x = -0.4$ (or 2) → $x = 113.6^\circ$ or 246.4°</p> <p>(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) $\div 2 \rightarrow 3.28$ (others are 0.134 and 1.705)</p> | <p>B1</p> <p>M1</p> <p>A1A1√</p> <p>B1</p> <p>M1</p> <p>M1A1</p> <p>[8]</p> | <p>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.</p> <p>Anywhere (allow 72.6°) Realising the need to add on π and/or 2π Correct order used ie -1, then $\div 2$ for any correct value. Allow if all 3 values are given, providing none are over 4. (degrees – max 2/4 B1, M0, M1, A0)</p> |

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| <p>10 $f(x) = 5 - 3e^{\frac{1}{2}x}$</p> <p>(i) Range is < 5</p> <p>(ii) $5 - 3e^{\frac{1}{2}x} = 0 \rightarrow e^{\frac{1}{2}x} = 5/3$ Logs or calculator $\rightarrow x = 1.02$</p> <p>(iii) $(1.02, 0)$ and $(0, 2)$</p> <p>(iv) $e^{\frac{1}{2}x} = (5 - y) \div 3$ $x/2 = \ln[(5-y)/3]$ $f^{-1}(x) = 2\ln[(5-x)/3]$</p> | <p>B1</p> <p>M1A1</p> <p>B1 B1✓</p> <p>M1 M1 A1</p> <p>[8]</p> | <p>Allow \leq or $<$</p> <p>Normally 2,0 but if working shown, can get M1 if appropriate</p> <p>Shape in 1st quadrant. Both shown or implied by statement.</p> <p>Reasonable attempt $e^{\frac{1}{2}x}$ as the subject. Using logs. All ok, including x, y interchanged.</p> |
| <p>11</p> <p>(i) $y = \frac{1}{2}x$ and $y = 3x - 15$ $\rightarrow C(6, 3)$</p> <p>OB = OC + CB</p> <p>$\rightarrow B(8, 9)$</p> <p>m of OC = $\frac{1}{2}$, m of AD = -2 eqn of AD is $y - 6 = -2(x - 2)$ or $y = -2x + 10$</p> <p>Soln of $y = \frac{1}{2}x$ and eqn of AD $\rightarrow D(4, 2)$</p> <p>(ii) Length OC = $\sqrt{45}$, OA = $\sqrt{40}$ Perimeter of OABC = $2(\sqrt{45} + \sqrt{40})$ $\rightarrow 26.1$</p> | <p>M1 A1</p> <p>M1 A1✓</p> <p>M1 A1</p> <p>M1A1</p> <p>M1 M1 A1</p> <p>[11]</p> | <p>Soln of simultaneous eqns Co (or step method if B done first)</p> <p>Vectors, step or soln of $y = \frac{1}{2}x + 5$ and $y = 3x - 15$ From his C</p> <p>use of $m_1 m_2 = -1$ (M0 if perp to $y = 3x$) Co – unsimplified.</p> <p>Sol of simultaneous eqns. co.</p> <p>Once. Adding OA, AB, BC, CO Co.</p> |
| <p>12 EITHER</p> <p>(i) $125 = \pi r + 2x + 2(5r/4)$ $\rightarrow x = \frac{1}{2}(125 - \pi r - 5r/2)$</p> <p>$h = 3r/4$</p> <p>Area of triangle = $\frac{1}{2} \times 2r \times 3r/4 = 3r^2/4$</p> <p>$A = \frac{1}{2}\pi r^2 + 2rx + \dots$ $= 125r - \frac{1}{2}\pi r^2 - 7r^2/4$</p> <p>(ii) $dA/dr = 125 - \pi r - 7r/2$</p> <p>Solved = 0 to give</p> <p>$\rightarrow r = 250 / (2\pi + 7)$ or 18.8</p> | <p>M1 A1</p> <p>M1</p> <p>M1</p> <p>B1 A1</p> <p>M1A1</p> <p>DM1</p> <p>A1</p> <p>[10]</p> | <p>Attempt at 4/5 lengths. Co.</p> <p>Anywhere in the question – independent of any other working Use of $\frac{1}{2}bh$ with h as function of r</p> <p>Correct $\frac{1}{2}\pi r^2 + 2rx$. Answer given – beware fortuitous ans.</p> <p>Any attempt to differentiate. Co.</p> <p>Setting his differential to 0.</p> <p>Any correct form.</p> |

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| 12 OR (i) | $h / (12-r) = 30 / 12$ | M1 | Use of similar triangles – needs $\frac{3}{4}$ lengths correct. |
| | $\rightarrow h = 5(12-r) / 2$ | A1 | Correct in any form – needs h as subject |
| | Uses $V = \pi r^2 h$ to give | M1 | Needs correct formula |
| | $\rightarrow V = \pi(30r^2 - 5r^3/2)$ | A1 | Beware fortuitous answers (AG) |
| | (ii) $dV/dr = \pi(60r - 15r^2/2)$ | M1A1 | Any attempt to differentiate. co |
| | $= 0$ when $r = 8 \rightarrow h = 10$ | DM1 | Setting his dV/dr to 0 + attempt. |
| | $\rightarrow V = 640\pi$ or 2010 | A1 | Correct to 3 or more sig figures |
| | Volume of cone = $\frac{1}{3}\pi \times 12^2 \times 30$ | M1 | Anywhere |
| | $\rightarrow 1440\pi$ or 4520 | A1 | Exactly 4:9 or 2.25 to 3 sig figures |
| | Ratio of 4 : 9 or 1 : 2.25 (3 sf) | [10] | |
| DM1 for quadratic equation | | | |
| (1) Formula. Sets the equation to 0 Formula must be correct and correctly used. Condone simple slips in sign. | | | (2) Factors Sets the equation to 0 Attempts to obtain brackets Solves each bracket to 0. |

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MAXIMUM MARK: 80

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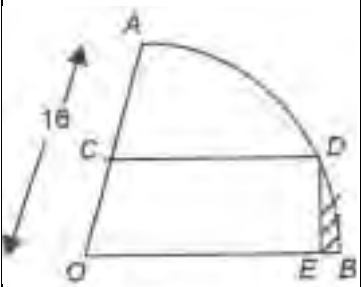
**ADDITIONAL MATHEMATICS
Paper 2**



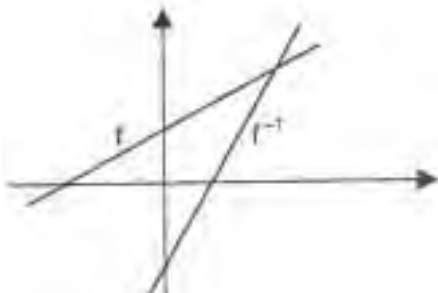
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| 1 [4] | | <p>Eliminate x or y</p> $\Rightarrow y^2 - 8y + 15 = 0 \quad x^2 - 10x + 9 = 0$ <p>Factorise or formula \Rightarrow (1, 3) and (9, 5)</p> <p>Midpoint is (5, 4)</p> | <p>M1</p> <p>DM1 A1</p> <p>B1 ✓</p> |
| 2 [4] | | $\cos \theta \left(\frac{1 + \sin \theta - (1 - \sin \theta)}{1 - \sin^2 \theta} \right) = \cos \theta \left(\frac{2 \sin \theta}{1 - \sin^2 \theta} \right) = \frac{2 \sin \theta \cos \theta}{1 - \sin^2 \theta}$ <p>Use of Pythagoras $\Rightarrow \frac{2 \sin \theta \cos \theta}{\cos^2 \theta} = 2 \tan \theta \Rightarrow k = 2$</p> | <p>M1 A1</p> <p>B1 A1</p> |
| 3 [4] | | $\log_2 x = 2 \log_4 x \quad \text{or} \quad \log_4 (x - 4) = \frac{1}{2} \log_2 (x - 4)$ $2 \log_4 x - \log_4 (x - 4) = 2 \quad \text{or} \quad \log_2 x - \frac{1}{2} \log_2 (x - 4) = 2$ <p>Eliminate logs $\frac{x^2}{x-4} = 16$ or $\frac{x}{\sqrt{x-4}} = 4$</p> <p>Solve for x $\Rightarrow x = 8$</p> | <p>B1</p> <p>M1 A1</p> <p>A1</p> |
| 4 [4] | <p>(i)</p>  <p>(ii) $A \cap B' \cap C'$</p> <p>(iii) $B \cup (A \cap C)$</p> | | <p>B2 B1 B1</p> |
| 5 [5] | <p>(i)</p> $243x^5 - 405x^4 + 270x^3$ <p>(ii)</p> <p>Coefficient of $x^4 = (-405 \times 1) + (270 \times 2) = 135$</p> | | <p>B1 B1 B1</p> <p>M1 A1</p> |
| 6 [6] | | <p>At B, $v = 40(e^{-t} - 0.1) = 0 \Rightarrow e^{-t} = 0.1 \Rightarrow t = \ln 10 (=2.30)$</p> $\int 40(e^{-t} - 0.1) dt = 40(-e^{-t} - 0.1t)$ $AB = \int_0^{\log 10} = 40 \left[\left(-\frac{1}{10} - \frac{\ln 10}{10} \right) - (-1) \right] = 4(9 - \ln 10) \approx 26.8$ | <p>M1 A1</p> <p>M1 A1</p> <p>DM1 A1</p> |

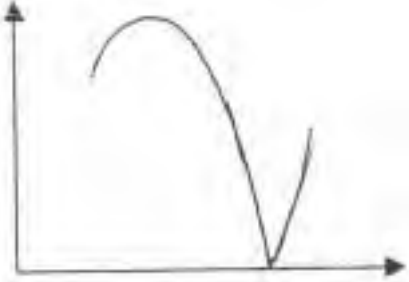
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| 7 [7] | <p>Dealing with elements $\begin{pmatrix} 1 & -2 \\ -3 & 4 \end{pmatrix}$ and $\begin{pmatrix} 3 & -1 \\ 2 & 2 \end{pmatrix}$</p> <p>$\mathbf{A}^{-1} = -\frac{1}{2} \begin{pmatrix} 1 & -2 \\ -3 & 4 \end{pmatrix}$ $\mathbf{B}^{-1} = \frac{1}{8} \begin{pmatrix} 3 & -1 \\ 2 & 2 \end{pmatrix}$</p> <p>(i) $\mathbf{C} = \mathbf{B} - 2\mathbf{A}^{-1} = \begin{pmatrix} 2 & 1 \\ -2 & 3 \end{pmatrix} + \begin{pmatrix} 1 & -2 \\ -3 & 4 \end{pmatrix} = \begin{pmatrix} 3 & -1 \\ -5 & 7 \end{pmatrix}$</p> <p>(ii) $\mathbf{D} = \mathbf{B}^{-1}\mathbf{A} = \frac{1}{8} \begin{pmatrix} 3 & -1 \\ 2 & 2 \end{pmatrix} \begin{pmatrix} 4 & 2 \\ 3 & 1 \end{pmatrix} = \frac{1}{8} \begin{pmatrix} 9 & 5 \\ 14 & 6 \end{pmatrix}$</p> | M1 A1 A1 M1 A1 M1 A1 |
| 8 [7] | <p>(i) $\frac{10!}{6!4!} = \frac{10 \times 9 \times 8 \times 7}{1 \times 2 \times 3 \times 4} = 210$</p> <p>(ii) No pink selected i.e. any 6 from $(5 + 2) = 7$</p> <p>(iii) All selections contain at least 1 red</p> <p>No yellow selected i.e. any 6 from $(3 + 5) = \frac{8!}{6!2!} = 28$</p> <p>At least 1 of each colour – $120 - (7 + 28) = 175$</p> | M1 A1 B1 M1 A1 M1 A1 |
| 9 [8] | <p>(i) $\frac{d}{dx}(\sqrt{4x-3}) = (4x-3)^{-\frac{1}{2}} \times \frac{1}{2} \times 4$</p> <p>$\frac{d}{dx}\{(2x+3)\sqrt{4x-3}\} = (2x+3)\left(\frac{2}{\sqrt{4x-3}}\right) + 2\sqrt{4x-3}$</p> <p>$= \frac{12x}{\sqrt{4x-3}} \Rightarrow k = 12$</p> <p>(ii) $\int \frac{x}{\sqrt{4x-3}} dx = (2x+3)\sqrt{4x-3} \times \frac{1}{12}$</p> <p>$\int_1^7 = \frac{1}{2}(85-5) = 6\frac{2}{3}$</p> | M1 A1 M1 A1 ✓ A1 M1 A1 A1 |
| 10 [10] |  <p>(i) $\angle AOB = 19.2 + 16 = 1.2$</p> <p>(ii) $DE = 8 \sin 1.2 \approx 7.46$</p> <p>(iii) $\angle DOE = \sin^{-1}(7.46 \div 16) \approx 0.485$ (AG)</p> <p>(iv) Sector $DOB = \frac{1}{2} \times 16^2 \times 0.485 = 62.08$</p> <p>Length $OE = \sqrt{16^2 - 7.46^2} \approx 14.2$</p> <p>$\triangle DOE = \frac{1}{2} \times 7.46 \times 14.2 \approx 52.97$</p> <p>Shaded area $\approx 9.1 - 9.3$ (9.275)</p> | M1 A1 M1 A1 M1 A1 M1 M1 M1 A1 |

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| 11 [10] | | v 5 10 15 20 25 (i) Plotting $\lg R$ against $\lg v$ R 32 96 180 290 420 Accuracy of points: Straight line $\lg v$ 0.70 1.00 1.18 1.30 1.40 (ii) $R = kv^\beta \Rightarrow \lg R = \lg k + \beta \lg v$ $\lg R$ 1.51 1.98 2.26 2.46 2.61 $\beta = \text{gradient} \approx 1.55 - 1.60$ $\lg k = \lg R \text{ intercept} \approx 0.4 \Rightarrow k \approx 2.4 - 2.6$ | M1 A2, 1, 0 B1 M1 A1 M1 A1 |
| | (iii) | $\lg R = \lg 75 \approx 1.88 \Rightarrow \text{from graph } \lg v \approx 0.92 - 0.96 \Rightarrow v \approx 8.3 - 9.1$ [Or by solving e.g., $75 = 2.5v^{1.58}$ or $1.88 = 0.4 + 1.58 \lg v$] | M1 A1 |
| 12 EITHER [11] | (i) | $gf(x) = \frac{4}{2 - (3x - 2)}$ Solve $\frac{4}{4 - 3x} = 2$ [or solve $fg(x) = 3 \left(\frac{4}{2 - x} \right) - 2 = 2$] $\Rightarrow x = 2/3$ | B1 M1 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) | $f^{-1}: x \mapsto (x + 2) \div 3$ $y = 4 / (2 - x) \Rightarrow x = 2 - 4/y \Rightarrow g^{-1}: x \mapsto 2 - 4/x$ | B1 M1 A1 |
| | (iv) |  | B1 B1 |
| | | Lines intersect at (1, 1) | B1 |

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