

MARK SCHEME for the May/June 2010 question paper
for the guidance of teachers

0606 ADDITIONAL MATHEMATICS

0606/12

Paper 12, maximum raw mark 80

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began, which would have considered the acceptability of alternative answers.

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 May/June 2010 question papers for most IGCSE, GCE Advanced Level and Advanced Subsidiary Level syllabuses and some Ordinary Level syllabuses.

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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 Accuracy 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 \surd 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.

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The following abbreviations may be used in a mark scheme or used on the scripts:

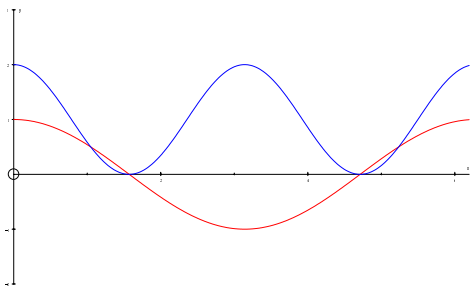
AG	Answer Given on the question paper (so extra checking is needed to ensure that the detailed working leading to the result is valid)
BOD	Benefit of Doubt (allowed when the validity of a solution may not be absolutely clear)
CAO	Correct Answer Only (emphasising that no “follow through” from a previous 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)

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 – usually discussed at a meeting.
EX –1	Applied to A or B marks when extra solutions are offered to a particular equation. Again, this is usually discussed at the meeting.

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<p>1 $24x^2 - 6x = 0$</p> <p>(or $y^2 + 3y + 2 = 0$)</p> <p>leading to $(0, 1)$ and $\left(\frac{1}{4}, -2\right)$</p>	<p>M1</p> <p>M1</p> <p>DM1 A1,A1 [5]</p>	<p>M1 for attempt to get an equation in one variable.</p> <p>M1 for attempt to get 2 or 3 term quadratic = 0</p> <p>DM1 for attempt to solve A1 for each pair of values</p>
<p>2 $6(-2)^3 + a(-2)^2 - (a+1)(-2) + b = 15$</p> <p>$6a + b = 61$</p> <p>when $x = -1$, $2a + b = 29$</p> <p>leading to $a = 8$ and $b = 13$</p>	<p>M1</p> <p>A1 A1 M1 A1 [5]</p>	<p>M1 for substitution of $x = -2$ or -1, or verification</p> <p>A1 for each correct (allow unsimplified)</p> <p>M1 for attempt to solve A1 for $a = 8$, $b = 13$</p>
<p>3 (i) $\overline{AB} = \begin{pmatrix} 4 \\ 5 \end{pmatrix} - \begin{pmatrix} -17 \\ 25 \end{pmatrix}$</p> <p>$= \begin{pmatrix} 21 \\ -20 \end{pmatrix}$</p> <p>unit vector = $\begin{pmatrix} \frac{21}{29} \\ -\frac{20}{29} \end{pmatrix}$ or equivalent</p> <p>(ii) $\overline{OC} - \begin{pmatrix} -17 \\ 25 \end{pmatrix} = 3 \begin{pmatrix} 21 \\ -20 \end{pmatrix}$</p> <p>$\overline{OC} = \begin{pmatrix} 46 \\ -35 \end{pmatrix}$</p>	<p>B1</p> <p>M1, A1 [3]</p> <p>M1</p> <p>A1 [2]</p>	<p>B1 for \overline{AB}</p> <p>M1 for magnitude of \overline{AB}</p> <p>M1 for $\begin{pmatrix} -17 \\ 25 \end{pmatrix} + 3\overline{AB}$</p>
<p>4 (i) gradient = -2</p> <p>$y^2 = -2\sec x + c$</p> <p>leading to $y^2 = -2\sec x + 6.4$</p> <p>(ii) when $y = 2$, $\cos x = \frac{5}{6}$</p>	<p>B1</p> <p>M1</p> <p>A1 [3]</p> <p>DM1</p> <p>A1 [2]</p>	<p>B1 for gradient</p> <p>M1 for correct attempt to link y^2 and $\sec x$</p> <p>DM1 for attempt to solve their equation using $y = 2$</p>
<p>5 $\frac{dy}{dx} = \frac{3}{x^2}$,</p> <p>gradient at $A = \frac{1}{3}$,</p> <p>normal grad = -3</p> <p>coords of $A (3, 5)$</p> <p>normal $y - 5 = -3(x - 3)$</p> <p>when $y = 0$, $x = \frac{14}{3}$</p>	<p>M1</p> <p>DM1</p> <p>B1</p> <p>DM1</p> <p>A1 [5]</p>	<p>M1 for attempt to differentiate</p> <p>DM1 for use of perp grads</p> <p>DM1 for attempt at normal</p>

<p>6 (a) (i)</p>  <p>(ii) 4</p> <p>(b) (i) 5</p> <p>(ii) $\frac{2\pi}{3}$</p>	<p>B1 B1 B1 [3] B1 [1] B1 [1] B1 [1]</p>	<p>B1 for $y = \cos x$ B1 for either a translation of $\begin{pmatrix} 0 \\ 1 \end{pmatrix}$ or 2 cycles B1 for correct curve</p>										
<p>7 (i)</p> <table border="1" data-bbox="245 891 697 1025"> <tr> <td>lgv</td> <td>1</td> <td>1.70</td> <td>2.04</td> <td>2.36</td> </tr> <tr> <td>lgp</td> <td>3.15</td> <td>2.18</td> <td>1.72</td> <td>1.28</td> </tr> </table> <p>(ii) gradient = n = -1.37 (allow 1.32 to 1.42)</p> <p>(iii) $p = 30$ (allow 28 to 32)</p>	lgv	1	1.70	2.04	2.36	lgp	3.15	2.18	1.72	1.28	<p>M1 A2,1,0 [3] M1 A1 [2] M1 A1 [2]</p>	<p>M1 for attempt to take logs and plot graph -1 for each error either in table or on graph. M1 for use of gradient M1 for use of graph or their equation</p>
lgv	1	1.70	2.04	2.36								
lgp	3.15	2.18	1.72	1.28								
<p>8 (i) $\begin{pmatrix} 16 & 9 \\ 1 & -2 \end{pmatrix}$</p> <p>(ii) $\frac{1}{8-3} \begin{pmatrix} 2 & -3 \\ -1 & 4 \end{pmatrix}$</p> <p>(iii) $\mathbf{X} = \mathbf{AB}$ = $\begin{pmatrix} -5 & 12 \\ 0 & 8 \end{pmatrix}$</p>	<p>B1 B1 [2] B1 B1 [2] M1 A2,1,0 [3]</p>	<p>B1 at least 2 correct B1 all correct B1 for determinant B1 for matrix M1 for attempt at valid method -1 each error</p>										

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<p>9 (i) $5 + 5 + 3\theta + 8\theta = 15.5$ $\theta = 0.5$</p> <p>(ii) $\frac{1}{2}(3)^2 \theta : \frac{1}{2}(8)^2 \theta - \frac{1}{2}(3)^2 \theta$ $= 9 : 55$</p>	<p>M1, DM1 A1 [3]</p> <p>M1 DM1 DM1, A1 [4]</p>	<p>M1 for use of arc length DM1 for attempt to find perimeter</p> <p>M1 for a sector area M1 for attempt to find area of $XABY$ M1 for attempt to obtain ratio</p>
<p>10 (i) ${}^{10}C_7 = 120$</p> <p>(ii) ${}^6C_5 \times {}^4C_2 = 36$</p> <p>(iii) Need $(6C + 1M) + (5C + 2M) + (4C + 3M)$ $4 + \text{(ii)} + ({}^6C_4 \times {}^4C_3)$ $= 100$</p>	<p>B1 [1]</p> <p>B1, B1 [2]</p> <p>M1 B1, B1 A1 [4]</p>	<p>B1 for ${}^6C_5 \times {}^4C_2$, B1 for 36</p> <p>M1 for a correct method B1 for 4, B1 for 60</p>
<p>11 (i) $48 = 12 \ln(2t + 3)$ $2t + 3 = e^4$ $t = 25.8$</p> <p>(ii) $x = 12 \ln(2t + 3)$ $v = \frac{24}{2t + 3}$ when $t = 1$, $v = 4.8$</p> <p>(iii) $a = -\frac{48}{(2t + 3)^2}$ when $t = 1$, $a = -1.92$</p>	<p>M1 DM1 A1 [3]</p> <p>B1 B1 B1 [3]</p> <p>B1 $\sqrt{B1}$ B1 [3]</p>	<p>M1 for attempt to deal with logs DM1 for attempt to solve</p> <p>B1 $\frac{1}{2t + 3}$ B1 24 B1 for 4.8</p> <p>B1 for $\frac{1}{(2t + 3)^2}$ $\sqrt{B1}$ on '24' B1 for -1.92</p>

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<p>12 EITHER</p> <p>(i) $y = 4 \sin 2x + c$ passes through $\left(\frac{\pi}{4}, 7\right)$, $c = 3$</p> <p>(ii) $5 = 4 \sin 2x + 3$ $0.5 = \sin 2x$ $x = \frac{\pi}{12}, \frac{5\pi}{12}$</p> <p>(iii) $\int_{\frac{\pi}{12}}^{\frac{5\pi}{12}} 4 \sin 2x + 3 dx$ $\left[-2 \cos 2x + 3x\right]_{\frac{\pi}{12}}^{\frac{5\pi}{12}}$ $= \pi + 2\sqrt{3}$ Shaded area $= \pi + 2\sqrt{3} - \frac{5\pi}{3}$ (= 1.37)</p>	<p>M1 M1 A1 [3]</p> <p>M1 M1 A1 √A1 [4]</p> <p>M1 A1 DM1</p> <p>M1 A1 [5]</p>	<p>M1 for attempt to integrate M1 for attempt to get c provided a function of $\sin 2x$ is used</p> <p>M1 for attempt to equate to 5 and solve M1 for a correct method to find x</p> <p>√A1 on first solution</p> <p>M1 for attempt to integrate</p> <p>DM1 for correct use of limits</p> <p>M1 for area of rectangle</p>
<p>12 OR</p> <p>(i) $y = 2e^{3x} - 12x + c$ Passes through (0, 1), so $c = -1$</p> <p>(ii) $6e^{3x} - 12 = 0$ leading to $x = \frac{1}{3} \ln 2$ and $y = 3 - 4 \ln 2$ (allow (0.231, 0.227))</p> <p>(iii) $\frac{d^2y}{dx^2} = 18e^{3x}$, always +ve so min</p> <p>(iv) at (0, 1), gradient = -6 tangent : $y - 1 = -6(x - 0)$ when $y = 0$, $x = \frac{1}{6}$</p>	<p>M1, A1 M1, A1 [4]</p> <p>M1 A1, A1 [3]</p> <p>M1, A1 [2]</p> <p>M1 DM1 A1 [3]</p>	<p>M1 for attempt to integrate, condone omission of c M1 for attempt to obtain c</p> <p>M1 for attempt to solve</p> <p>M1 for a complete, correct method</p> <p>M1 for attempt to get equation of tangent at (0, 1) DM1 for substitution of $y = 0$</p>