

**MARK SCHEME for the October/November 2008 question paper**

**0606 ADDITIONAL MATHEMATICS**

**0606/01**

Paper 1, 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.

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 October/November 2008 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  $\checkmark$  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.

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

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| 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><b>1 (i)</b> correct diagram</p> <p><b>(ii)</b> correct diagram</p> <p><b>(iii)</b> correct diagram</p>  | <p>B1</p> <p>B1</p> <p>B1 [3]</p>                                |   |
| <p><b>2</b> <math>(2x + 1)^2 &gt; 8x + 9</math><br/> <math>4x^2 - 4x - 8 &gt; 0</math><br/> <math>x^2 - x - 2 &gt; 0</math><br/> <math>(x + 1)(x - 2) &gt; 0</math><br/> Leads to critical values <math>x = -1, 2</math><br/> <math>x &lt; -1</math> and <math>x &gt; 2</math></p>                                      | <p>M1</p> <p>DM1</p> <p>A1</p> <p><math>\sqrt{A1}</math> [4]</p> | <p>M1 for simplification to 3 term quadratic</p> <p>DM1 for factorisation</p> <p>A1 for critical values</p> <p>Follow through on their critical values.</p>   |
| <p><b>3</b></p> $\text{LHS} = \frac{\sin^2 A + 1 + \cos^2 A + 2 \cos A}{(1 + \cos A) \sin A}$ $= \frac{2 + 2 \cos A}{(1 + \cos A) \sin A}$ $= \frac{2}{\sin A} \text{ leading to } 2 \cos ecA$  | <p>M1</p> <p>A1</p> <p>M1</p> <p>A1 [4]</p>                      | <p>M1 for attempt to deal with fractions and attempt to obtain numerator</p> <p>A1 correct</p> <p>M1 for use of <math>\sin^2 A + \cos^2 A = 1</math></p>  |
| <p><b>4</b> Substitution of <math>x = 1</math><br/> leading to <math>a + b + 4 = 0</math></p> <p>Substitution of <math>x = -\frac{1}{2}</math> leading to<br/> <math>-a + 2b - 28 = 0</math></p> <p>Leading to <math>a = -12, b = 8</math></p>  | <p>M1</p> <p>M1</p> <p>A1</p> <p>M1</p> <p>A1 [5]</p>            | <p>M1 for substitution of <math>x = 1</math> and equated to 3</p> <p>M1 for substitution of <math>x = -\frac{1}{2}</math> and equated to 6</p> <p>A1 for both correct</p> <p>M1 for solution</p> <p>A1 for both</p>                                   |
| <p><b>5 (i)</b> <math>\mathbf{a} = \frac{1}{13} (5\mathbf{i} - 12\mathbf{j})</math></p> <p><b>(ii)</b> <math>q(5\mathbf{i} - 12\mathbf{j}) + p\mathbf{i} + \mathbf{j} = 19\mathbf{i} - 23\mathbf{j}</math><br/> <math>5q + p = 19</math><br/> <math>-12q + 1 = -23</math><br/> Leading to <math>q = 2, p = 9</math></p> | <p>M1, A1 [2]</p> <p>M1</p> <p>M1</p> <p>A1 [3]</p>              | <p>M1 for a valid attempt to obtain magnitude.</p> <p>M1 for equating like vectors</p> <p>M1 for solution of (simultaneous) equations</p> <p>A1 for both</p>  |
| <p><b>6 (i)</b> <math>2t^2 - 9t - 5 = 0</math><br/> <math>(2t + 1)(t - 5) = 0</math><br/> <math>t = \frac{1}{2}, t = 5</math></p> <p><b>(ii)</b> <math>x^{\frac{1}{2}} = -0.5, 5</math><br/> <math>x = 0.25, 25</math></p>  | <p>M1</p> <p>DM1</p> <p>A1 [3]</p> <p>M1</p> <p>A1, A1 [3]</p>   | <p>M1 for attempting to form a quadratic in <math>t</math></p> <p>DM1 for attempt to solve a 3 term quadratic</p> <p>A1 for both</p> <p>M1 for realising that <math>x^{0.5}</math> is equivalent to <math>t</math> (or valid attempt at solution)</p> |

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| <p>7 (i) <math>y = 4x^2 - 12x + 3</math><br/><math>y = (2x - 3)^2 - 6</math></p> <p>(ii) <math>\left(\frac{3}{2}, -6\right)</math></p> <p>(iii) <math>f \geq -6</math></p>   | <p>B1<br/>B1<br/>B1 [3]</p> <p><math>\sqrt{B1}</math>,<br/><math>\sqrt{B1}</math> [2]</p> <p><math>\sqrt{B1}</math> [1]</p> | <p>B1 for 2 (part of linear factor)<br/>B1 for -3 (part of linear factor)<br/>B1 for -6</p> <p>Follow through on their <math>a</math>, <math>b</math> and <math>c</math><br/>Allow calculus method.</p> <p>Follow through on their <math>c</math></p>  |
| <p>8 <math>\frac{dy}{dx} = -2e^{-2x} (+c)</math></p> <p>When <math>\frac{dy}{dx} = 3, x = 0, \therefore c_1 = 5</math></p> <p><math>\frac{dy}{dx} = -2e^{-2x} + 5</math></p> <p><math>y = e^{-2x} + 5x(+c_2)</math></p> <p>When <math>x = 2, y = e^{-4} \therefore c_2 = -10</math></p> <p><math>y = e^{-2x} + 5x - 10</math></p>  | <p>B1</p> <p>M1<br/>A1</p> <p>B1</p> <p>M1<br/><math>\sqrt{A1}</math> [6]</p>   | <p>B1 for <math>-2e^{-2x}</math></p> <p>M1 for attempt to find <math>c_1</math></p> <p>B1 for <math>-2e^{-2x}</math></p> <p>M1 for attempt to find <math>c_2</math><br/><math>\sqrt{-2}</math> times their <math>c_1</math></p>  |
| <p>9 (i) <math>2^5 + {}^5C_1 2^4(-3x) + {}^5C_2 2^3(-3x)^2</math><br/><math>32 - 240x + 720x^2</math></p> <p>(ii) <math>32a = 64, \quad a = 2</math><br/><math>32b - 240a = -192,</math><br/><math>b = 9</math><br/><math>-240b + 720a = c</math><br/><math>c = -720</math></p>  | <p>B1<br/>B1<br/>B1 [3]</p> <p>B1<br/>M1<br/>A1<br/>M1<br/>A1 [5]</p>   | <p>B1 for 32 or <math>2^5</math><br/>B1 for -240<br/>B1 for 720.</p> <p>B1 for <math>a = 2</math><br/>M1 for equation in <math>a</math> and <math>b</math> equated to <math>\pm 192</math><br/>A1 for <math>b = 9</math><br/>M1 for equation in <math>a</math> and <math>b</math> equated to <math>c</math><br/>A1 for <math>c = -720</math></p> |
| <p>10 (a) (i) <math>fg(x) = f\left(\frac{x}{x+2}\right)</math><br/><math>= 3 - \frac{x}{x+2}</math></p> <p>(ii) <math>3 - \frac{x}{x+2} = 10</math><br/>leading to <math>x = -1.75</math></p> <p>(b) (i) <math>h(x) &gt; 4</math></p> <p>(ii) <math>h^{-1}(x) = e^{x-4}</math><br/><math>h^{-1}(9) = e^5 \quad (\approx 148)</math><br/>or <math>4 + \ln x = 9,</math><br/>leading to <math>x = e^5</math></p> <p>(iii) correct graphs</p> | <p>M1</p> <p>A1 [2]</p> <p>DM1<br/>A1 [2]</p> <p>B1 [1]</p> <p>M1<br/>A1 [2]</p> <p>B1<br/>B1<br/>B1 [3]</p>                | <p>M1 for order</p> <p>DM1 for dealing with fractions sensibly</p> <p>M1 for attempting to obtain inverse function</p> <p>B1 for each curve<br/>B1 for idea of symmetry</p>  |

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| <p><b>11 (i)</b> <math>\tan^2 2x = 3</math><br/> <math>\tan 2x = (\pm)\sqrt{3}</math><br/> <math>2x = 60^\circ, 120^\circ, 240^\circ, 300^\circ</math><br/> <math>x = 30^\circ, 60^\circ, 120^\circ, 150^\circ</math></p> <p><b>(ii)</b> <math>2\operatorname{cosec}^2 y + \operatorname{cosec} y - 3 = 0</math><br/> <math>(2\operatorname{cosec} y + 3)(\operatorname{cosec} y - 1) = 0</math><br/> <math>\operatorname{cosec} y = -\frac{3}{2}, 1</math><br/> <math>\sin y = -\frac{2}{3}, 1</math><br/> <math>y = 221.8^\circ, 318.2^\circ, y = 90^\circ</math></p> <p><b>(iii)</b> <math>\cos\left(z + \frac{\pi}{2}\right) = -\frac{1}{2}</math><br/> <math>z + \frac{\pi}{2} = \frac{2\pi}{3}, \frac{4\pi}{3}</math><br/> <math>z = \frac{\pi}{6}, \frac{5\pi}{6}</math>, allow 0.52, 2.62 rads</p> | <p>M1<br/>DM1<br/>A1, A1<br/>[4]</p> <p>M1, A1<br/>M1</p> <p>A1, A1<br/>[5]</p> <p>M1</p> <p>A1, A1<br/>[3]</p>                            | <p>M1 for an equation in <math>\tan^2 2x</math><br/>M1 for attempt to solve using <math>2x</math> correctly<br/>A1 for any pair</p> <p>M1 for correct use of identity or other valid method<br/>A1 for a correct quadratic<br/>M1 for solution of quadratic and attempt to solve correctly</p> <p>A1 for <math>221.8^\circ, 318.2^\circ</math>, A1 for <math>90^\circ</math></p> <p>M1 for dealing with sec and order of operations</p> <p>A1 for each</p>                |
| <p><b>12 EITHER</b></p> <p><b>(i)</b> <math>\frac{dy}{dx} = \frac{(x+1)2x - x^2}{(x+1)^2}</math><br/> <math>= \frac{x(x+2)}{(x+1)^2}</math><br/> <math>\frac{dy}{dx} = 0, x = 0, -2</math><br/> <math>y = 0, -4</math></p> <p><b>(ii)</b> gradient of normal = <math>-\frac{4}{3}</math><br/> normal <math>y = -\frac{4}{3}x + \frac{11}{6}</math>, leads to<br/> M (1.375, 0)<br/> N (0, -4)<br/> Area = 2.75</p>   | <p>M1<br/>A1</p> <p>DM1<br/>A1, A1<br/>[5]</p> <p>M1<br/>A1<br/><math>\sqrt{B1}</math><br/>B1</p> <p>M1<br/><math>\sqrt{A1}</math> [6]</p> | <p>M1 for attempt to differentiate a quotient<br/>A1 correct allow unsimplified</p> <p>DM1 for equating to zero and an attempt to solve<br/>A1 for each pair (could be <math>x = 0</math> and <math>x = -2</math>)</p> <p>M1 for attempt to obtain gradient of the normal<br/>A1 for a correct (unsimplified) normal equation<br/>Follow through on their normal<br/>B1 for N</p> <p>M1 for attempt to get area of triangle<br/>Ft on their M and N (must be on axes)</p> |

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| <p><b>12 OR</b></p> <p>(i) <math>\frac{dy}{dx} = e^{x-2} - 2</math></p> <p><math>\frac{dy}{dx} = 0, e^{x-2} = 2</math></p> <p><math>x = 2 + \ln 2</math><br/>(2.69)</p> <p><math>y = 4 - 2\ln 2</math><br/>(2.61)</p> <p><math>\frac{d^2y}{dx^2} = e^{x-2}</math>, always +ve <math>\therefore</math> min</p> <p>(ii)</p> <p><math>\int_0^3 (e^{x-2} - 2x + 6) dx = [e^{x-2} - x^2 + 6x]_0^3</math></p> <p><math>= (e - 9 + 18) - (e^{-2})</math></p> <p><math>= e - e^{-2} + 9</math></p> <p><math>k = 9</math></p> | <p>B1</p> <p>B1</p> <p>M1</p> <p>A1</p> <p>A1</p> <p>B1 [6]</p> <p>M1, A1</p> <p>M1</p> <p>A1</p> <p>B1 [5]</p> | <p>B1 for <math>e^{x-2}</math></p> <p>B1 for <math>-2</math> only</p> <p>M1 for equating to zero and attempt to solve</p> <p>A1 for <math>x</math></p> <p>A1 for <math>y</math></p> <p>B1 for conclusion from a valid method</p> <p>M1 for attempt to integrate</p> <p>M1 for correctly applying limits</p> <p>A1 for <math>e - e^{-2}</math></p> <p>B1 for <math>k</math></p> |
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