

**MARK SCHEME for the October/November 2012 series**

**0606 ADDITIONAL MATHEMATICS**

**0606/22**

Paper 2, 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 should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

Cambridge will not enter into discussions about these mark schemes.

Cambridge is publishing the mark schemes for the October/November 2012 series for most IGCSE, GCE Advanced Level and Advanced Subsidiary Level components and some Ordinary Level components.

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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  $\nabla$  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)

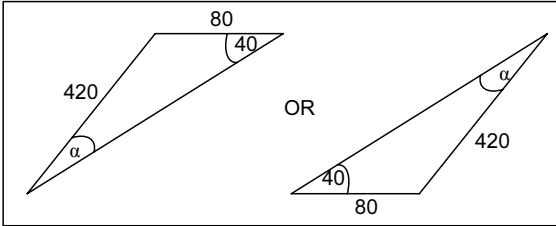
### Penalties

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” 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</b> <math>7x + 5 = 3x - 13</math>  <math>x = -4.5</math> o.e.  <math>7x + 5 = 3x + 13</math>  <math>x = 0.8</math> o.e.  OR  Square and Equate  <math>10x^2 + 37x - 36 (= 0)</math> o.e.  <math>(5x - 4)(2x + 9) [= 0]</math>  <math>x = 0.8</math> and <math>x = -4.5</math>  OR  Plot <math>y =  7x + 5 </math>  Plot <math>y =  3x - 13 </math>  <math>x = 0.8</math>  <math>x = -4.5</math></p>	<p>M1  A1  M1  A1  [4]  M1  A1  M1  A1  M1  M1  A1  A1</p>	<p>Equate and attempt to solve  Equate  Mark final answers  Both expressions must have 3 terms  Three terms  Factorise or formula of three term quadratic.  Shape and intercepts must be correct  Shape and intercepts must be correct</p>
<p><b>2</b> <math>\left(\frac{dA}{dr}\right)4\pi r + 10\pi</math>  Use <math>\frac{dA}{dt} = \frac{dA}{dr} \times \frac{dr}{dt}</math> with <math>r = 6</math>  6.8</p>	<p>B1,B1  M1  A1  [4]</p>	<p>Their <math>\frac{dA}{dr}</math>  Rounds to 6.8</p>
<p><b>3</b> Rearrange to <math>ax^2 + bx + c [= 0]</math>  <math>(2x - 1)(2x - 7) [&lt; 0]</math>  0.5 and 3.5  <math>0.5 &lt; x &lt; 3.5</math></p>	<p>M1  M1  A1  A1  [4]</p>	<p>Factorise or formula  not <math>\leq</math> mark final statement.</p>
<p><b>4</b> (i) <math>8(2^3)</math> or 56  <math>-448(x^5)</math>  (ii) <math>1120(x^4)</math>  <math>2 \times</math> their 1120 and their <math>-448</math> used  <math>1792(x^5)</math></p>	<p>B1  B1  [2]  B1  M1  A1  [3]</p>	<p>Mark final answer</p>
<p><b>5</b> (i) Evidence of 6, 5, 4, and 3 only  360  (ii) Evidence of <math>2 \times 3</math> for outside digits  Evidence of <math>4 \times 3</math> for inside digits  72</p>	<p>M1  A1  [2]  B1  B1  B1  [3]</p>	<p>Numbers listed but not added.  <math>{}^4P_2</math> used correctly.</p>
<p><b>6</b> (i) Express as powers of 2  Correctly reaches <math>3x + 2y = 6</math>  (ii) Express as powers of 5  <math>y = 3x - 4</math> o.e.  Attempt to solve simultaneous equations  <math>x = \frac{14}{9}</math> and <math>y = \frac{2}{3}</math></p>	<p>M1  A1 AG  [2]  M1  A1  M1  A1  [4]</p>	<p>At least one : <math>2^{6y-9}</math> or <math>2^{4x-4y}</math> o.e.  Both correct <math>5^2</math> and <math>5^{3x-6}</math> o.e.  Three terms  Equations must be linear  Accept decimals that round to correct 3sf</p>

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<p>7 (i) <math>\sec^2 4x</math> <math>\times 4</math></p> <p>(ii) <math>x + \tan 4x</math> <math>\div 4</math></p> <p>(iii) Correct use of limits</p> $k = \frac{1}{8}$	<p>M1 A1 [2]</p> <p>B1 M1 A1 [3]</p> <p>M1</p> <p>A1 [2]</p>	<p>One term only</p> <p>No additional terms isw</p> <p>Expression must have 2 integrated terms in <math>x</math> from (ii).</p> <p>Rounds to 0.125. Accept <math>\frac{\pi}{8}</math> or <math>0.125\pi</math></p>
<p>8 (i) <math>(b =) \frac{7-4}{8-2} = \left[ \frac{1}{2} \right]</math></p> <p><math>(\lg a) = 3</math></p> <p><math>\lg y = \lg a + b \lg x</math> or <math>\lg y - 4 = b(\lg x - 2)</math> or <math>\lg y = 3 + 0.5 \lg x</math></p> <p><math>a = 1000</math> or <math>10^3</math></p> <p><math>y = 1000x^{0.5}</math> or <math>1000\sqrt{x}</math></p> <p>(ii) <math>m = 1</math></p> <p>(iii) <math>c = 6</math></p>	<p>B1 M1</p> <p>M1</p> <p>A1 A1 [5]</p> <p>B1 [1]</p> <p>B1 [1]</p>	<p>Finding gradient Finding <math>y</math> intercept</p> <p><math>\lg y = c + m \lg x</math> is sufficient</p>
<p>9 (i)</p>  <p><math>\frac{\sin \alpha}{80} = \frac{\sin 40}{420}</math></p> <p><math>\alpha = 7.03</math> or <math>7</math></p> <p>Bearing 223 (<math>230 - \alpha</math>)</p> <p>(ii) <math>\frac{v}{\sin 133} = \frac{420}{\sin 40}</math></p> <p><math>v = 478</math></p> <p>Use time <math>\frac{1000}{v}</math></p> <p>2.09 hours or 2 hours 5 minutes</p>	<p>B1</p> <p>M1 A1 A1 [4]</p> <p>M1</p> <p>A1</p> <p>M1</p> <p>A1 [4]</p>	<p>Correct triangle</p> <p>Use of sine or cosine rule in any triangle with some of 80, 420, their <math>v</math> and an angle.</p> <p>Use of sine or cosine rule in any triangle with 80 or 420 or both.</p> <p><math>v</math> calculated from a triangle</p> <p>Units required</p>

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<p><b>10 (i)</b> Integrate to find <math>v</math>  <math>v = 4t - t^2 (+ c)</math>            Use <math>t = 0, v = 12</math> to find <math>c = 12</math>  <math>v = 4t - t^2 + 12</math>  <math>t = 6</math></p> <p><b>(ii)</b> Integrate to find <math>s</math>  <math>s = 2t^2 - \frac{t^3}{3} + 12t</math>  <math>s = 72</math></p>	<p>M1 A1 B1 M1 A1 [5] M1 A1✓ A1 [3]</p>	<p>Increase of powers seen at least once</p> <p>Solve three term quadratic Do not penalize <math>t = -2</math>.</p> <p>Increase of powers on at least 2 terms 3 terms cao</p>
<p><b>11 (a)</b> <math>\tan x = -2.25</math> 114 294</p> <p><b>(b)</b> Uses <math>\operatorname{cosec} y = \frac{1}{\sin y}</math>  Forms quadratic in <math>\sin y : 12\sin^2 y + \sin y - 1 = 0</math>  <math>(4\sin y - 1)(2\sin y + 1) = 0</math> 14.5 and 199.5 165.5 and 340.5</p> <p><b>(c)</b> <math>\cos\left(\frac{z}{3}\right) = \frac{3}{5}</math>  <math>\frac{z}{3} = 0.927</math> <math>z = 2.78</math> to <math>2.79</math> inc <math>z = 16.1</math></p>	<p>B1 B1 B1✓ [3] B1  M1  M1 A1 A1 [5] B1  M1 A1 A1 [4]</p>	<p>Rounds to 114.0 isw Their 114 + 180 from tan function isw</p> <p>Seen anywhere</p> <p>Must be 3 terms</p> <p>Factorise or formula of 3 term quadratic. Any 2 values isw The other 2 values isw</p> <p>Solves their equation in radians isw Rounds to isw</p>
<p><b>12 EITHER</b></p> <p><b>(i)</b> <math>y A e^{-\frac{1}{4}x} (+ c)</math> <math>A = -4</math> Substitute (0, 10) <math>y = 14 - 4e^{-\frac{1}{4}x}</math> 14 - 4e</p> <p><b>(ii)</b> Tangent at A is <math>y - 10 = x</math> Gradient tangent at B is e  Tangent at B is <math>y + 4e - 14 = ex + 4e</math> Solve equations of tangents <math>x = \frac{4}{1-e}</math> o.e.</p>	<p>M1 A1 DM1  A1 A1 [5] B1 B1  B1✓ M1 A1 [5]</p>	<p>Integrate : <math>e^{-\frac{x}{4}}</math> seen</p> <p>With their gradient and answer to (i) Two linear equations</p>

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<p><b>12 OR</b></p> <p><b>(i)</b> <math>\frac{dy}{dx} = -\frac{1}{3}e^{-\frac{1}{3}x}</math>  at (0, 9) <math>\frac{dy}{dx} = -\frac{1}{3}</math>  Grad normal = 3  Point Q is (-3, 0)</p> <p><b>(ii)</b> Area rectangle 24 + 3e (32.1)  <math>\int_{-3}^0 8 + e^{-\frac{x}{3}} dx</math>  <math>= \left[ 8x - 3e^{-\frac{x}{3}} \right]_{-3}^0</math>  21 + 3e (29.1)  Shaded area = 3</p>	M1  A1 M1 A1 [4] M1 M1  A1  M1 A1 A1 [6]	$Ae^{-\frac{x}{3}}$ only one term  Use of $m_1 m_2 = -1$ Condone $x = -3$  Their $3 \times$ their $(8 + e)$ Integrate: $8x$ and $e^{-\frac{x}{3}}$ seen  Correct use of limits their $-3$ and $0$
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