**UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS**

International General Certificate of Secondary Education

# MARK SCHEME for the November 2005 question paper

## 0606 ADDITIONAL MATHEMATICS

0606/01          Paper 1     maximum raw mark 80

This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. It shows the basis on which Examiners were initially instructed to award marks. It does 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*.

The minimum marks in these components needed for various grades were previously published with these mark schemes, but are now instead included in the Report on the Examination for this session.

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

CIE is publishing the mark schemes for the November 2005 question papers for most IGCSE and GCE Advanced Level and Advanced Subsidiary Level syllabuses and some Ordinary Level syllabuses.

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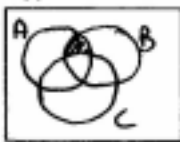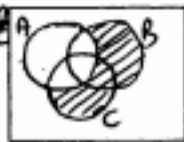
The following abbreviations may be used in a mark scheme or used on the scripts:

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)

CWO    Correct Working Only – often written by a 'fortuitous' answer

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.
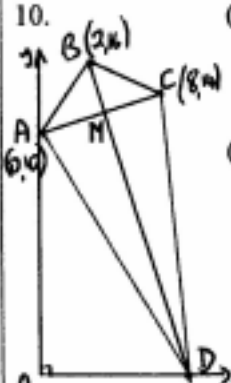
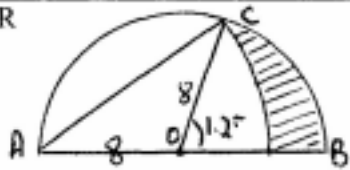| | | |
|---|---|---|
| **1**<br>(a) Squares and sets to 0<br>→ $x^2 - 13x + 36$<br>→ $x = 4$ and $9$<br>→ $x < 4$ and $x > 9$ | M1<br>A1<br>A1<br><br>[3] | Condone alg errors in squaring but eqn must be set to 0 and attempt at solution.<br>Independent of <,= or ><br>Co – not for ≤ or ≥. |
| **2** (a) (i) $A' \cap B$,<br>(ii) $A' \cup B$ or $(A \cap B')'$<br><br>(b) (i)       (ii)<br> | B1<br>B1<br>  [2]<br><br>B1  [1]<br>B1  [1] | Co<br>Co<br><br>Co<br>Co |
| **3**<br>$2(2x + 6/x) = x + c$ →<br>$3x^2 - cx + 12 = 0$<br>Use of $b^2 - 4ac = 0$<br>→ $c = 12$ and<br>→ $c = -12$ | M1<br>M1<br>A1<br>A1√<br>[4] | Eliminates $y$ and forms a quadratic eqn.<br>Uses $b^2 - 4ac = 0$ on quadratic=0.<br>Co<br>For the −ve root of $c^2 = k$. |
| **4**<br>Length = $2 - \sqrt{3}$.<br>Area = $(2 - \sqrt{3})^2 = 7 - 4\sqrt{3}$<br>Height = volume ÷ area<br>= $(2\sqrt{3} - 3) \div (7 - 4\sqrt{3})$<br>× top and bottom by $7 + 4\sqrt{3}$<br>→ height = $3 + 2\sqrt{3}$<br><br>(or $(7 - 4\sqrt{3})(a + b\sqrt{3}) = 2\sqrt{3} - 3$ Sim eqns<br>B1 M1( as before) M1 forming + sol A1) | B1<br><br>M1<br>M1<br>A1<br>[4] | Co<br><br>Used with volume and area<br>Technique correct<br>Co but beware decimal answers leading to correct answer – this gets 0/4 |
| **5** F($i + 12j$) at ($3i + 2j$). S ($85i + 5j$) at $-5i + kj$<br><br>At time $t$, $r_F = (1 + 3t)i + (12 + 2t)j$<br>         $r_S = (85 - 5t)i + (5 + kt)j$<br>Equate i's $1 + 3t = 85 - 5t$   $t = 10.5$<br>Equate j's $12 + 2t = 5 + kt$     $k = 2\frac{2}{3}$ | M1<br>A1<br>M1 A1<br>M1A1√<br>[6] | M1 for one $x$ or $y$ component.<br>A1 for both $x$ components correct.<br>M1 for equating $x$ components. A1 Co<br>M1 for equating $y$ components. A1√ for his $t$ and his components. |

| 6 $v = 6 - 6e^{-3t}$ | | |
|---|---|---|
| (i) $a = dv/dt = 18e^{-3t}$ | M1 A1 | Attempt at differentiation. Co. |
| $t = \ln 2 \ e^t = 2 \rightarrow e^{-3t} = 1/8$ | | |
| $\rightarrow a = 18/8$ or 2.25 | A1 [3] | Co. |
| (ii) $s = \int v dt = 6t + 2e^{-3t}$ [+c] | M1 A1 | Attempt at integration. Co. (ignore c) |
| but $t=0$ when $s=0$, $\rightarrow c = -2$ | DM1 | Don't allow if c automatically = 0. |
| Put $t = \ln 2 \rightarrow 2.41$ | A1 [4] | Co. |

| 7 | | |
|---|---|---|
| (a) $2 = \log_7 49$ | B1 | Anywhere |
| Combines two logs correctly | M1 | Allow even if first B1 not given |
| Forms equation and solves | DM1 | Needs to have got rid of all logs |
| $\rightarrow y = 2$ | A1 [4] | correctly. Co |
| | | Nb change to lg is same scheme –same work needed. |
| (b) $\log_p 8 \times \log_{16} p$ | | |
| $\log_p 8 = \log_2 8 \div \log_2 p = 3/\log_2 p$ | M1 | Change of base once |
| $\log_{16} p = \frac{1}{4}\log_2 p$ | M1 | Same base – 2,8,16,10 – so that $p$ cancels. |
| $\rightarrow \frac{3}{4}$ or 0.75 | A1 [3] | Co. |

| 8 $y = (x + 2)\sqrt{(x-1)}$ | | |
|---|---|---|
| (i) $dy/dx = \sqrt{x-1} + (x + 2) \times \frac{1}{2}(x - 1)^{-\frac{1}{2}}$ | B1 | B1 for correct diff of $\sqrt{x-1}$ |
| $= (x - 1 + \frac{1}{2}x + 1) \div \sqrt{x-1}$ | M1 | Use of "uv" for M. co |
| | M1 | Reasonable attempt at algebra |
| $= \frac{3x}{2\sqrt{x-1}}$ $\quad k = 1.5$ or $1\frac{1}{2}$ | A1 [4] | co |
| (ii) $\int_2^5 \frac{x dx}{\sqrt{x-1}} = \frac{2}{3} \times \sqrt{(x-1)}(x+2)$ | M1 | Use of $\int$ = reverse of differentiation. |
| | A1√ | For $1 \div$ "his $k$" |
| evaluated from 2 to 5 $= \frac{2}{3} \times (14 - 4)$ | DM1 A1 | Value at 25" – "value at 2". Co for A. |
| $\rightarrow 20/3$ | [4] | |

| 9 (a) $3\cos x = 8\tan x = 8\sin x/\cos x$ | M1 | Use of t=s/c |
|---|---|---|
| $\rightarrow 3\cos^2 x = 8\sin x = 3(1 - \sin^2 x)$ | M1 | Use of $s^2+c^2=1$ |
| $\rightarrow 3s^2 + 8s - 3 = 0$ | DM1 | Correct attempt at quadratic = 0 |
| $\rightarrow s = -3$ or $\frac{1}{3}$ | | |
| $\rightarrow x = 19.5°$ or $160.5°$ | A1 A1√ [5] | Co. for $180° - 1^{st}$ answer. |
| (b) $\cos(\frac{2}{3}y) = -\sqrt{3}/2$ | M1 | For $\cos^{-1} (\pm\sqrt{3}/2 )$ |
| $\rightarrow \frac{2}{3}y = 5\pi/6$ or $2\pi - $(answer) | DM1 | For $2\pi - $ answer |
| $\rightarrow y = 5.50$ or $7\pi/4$ | A1 [3] | Allow if other answer (3.93) is given. |

**10.**



(i) Pythagoras →
$AB=\sqrt{40}.\ BC=\sqrt{40}$

M1 A1 [2]

Or by vectors

(ii) $m$ of $AC = \frac{1}{2}$.
$m$ of $BD = -2$
eqn $BD \rightarrow y+2x=20$
$\rightarrow D(10, 0)$

or $M(4,12) \rightarrow m = -2$

B1
M1
M1
A1 [4]

Anywhere
Use of $m_1m_2 = -1$
Not necessary to have eqn since $y=0$ may be used.

Finds $M \rightarrow m$ of $-2$ equivalent to B1M1.

(iii) Area of $ABC$ : Area of $ACD$

$BM : MD$
$= \sqrt{20} : \sqrt{180} = 1:3$

(or finds each area by "matrix" or $\frac{1}{2}bh$)

M1
M1 A1 [3]

Realises that only heights are needed.
Pythagoras – any form ok for A mark.

M1 $ABC$ (40) M1 $ACD$ (120) A1 1:3.

**11**

$f : x \rightarrow |2x-3|-4 \quad -2 \le x \le 3$

(i)



B2,1 [2]

Must be "V" shaped to get any marks.
Must cross −ve $x$ and −ve $y$ axes.
Endpoint −ve $y$. Start point + ve $y$.

(ii) Range of $f$    $-4$ to $3$

B1 B1 [2]

Independent of graph. $-4$ on own ok.
3 on its own.

(iii) $2x - 3 = 2 \rightarrow x = 2\frac{1}{2}$ or $2.5$
$2x - 3 = -2 \rightarrow x = \frac{1}{2}$ or $0.5$

B1
M1A1 [3]

Co – answer only
Correct method of other solution. co

(iv) Largest value is $x$ value at "V" $= 1\frac{1}{2}$

B1√ [1]

From his graph – or any other method

(v) Equation of left hand part of "V".
$m = -2 \rightarrow -2x - 1$.

M1 A1 [2]

Realises that one line only is needed + correct method ($y=mx+c$ etc).
Or $-(2x-3) - 4 = -2x - 1$
Doesn't need $a$ or $b$ implicitly mentioned

**12 EITHER**

| x | 1.5 | 2 | 2.5 | 3 | 3.5 |
|---|---|---|---|---|---|
| y | 7.3 | 3.5 | 2.0 | 1.3 | 0.9 |
| lgx | 0.18 | 0.30 | 0.40 | 0.48 | 0.54 |
| lgy | 0.86 | 0.54 | 0.30 | 0.11 | −0.05 |

(i) Draws graph of lgy against lgx.    M1    Knows what to do.
Accuracy of points and line.    A2,1,0    Within ½ square.
     **[3]**

(ii)    $n = 2.45$ to $2.60$    M1 A1    Needs $m = ±n$ for M. Co for +ve only.
     $a = 19.5$ to $21.0$    M1 A1    Needs $\lg a$ = intercept on $y$ axis.
       **[4]**

(iii)    $y = x^2 \rightarrow \lg y = 2\lg x$.    M1    Allow M1 for statement in log form.
     $\rightarrow$ Line of gradient 2.    A1    Reasonable attempt at line of $m = 2$
     $y = x^2$ intersects $yx^n = a$ where the    through $(0,0)$.
     lines meet. $\rightarrow x = 1.90$ to $2.00$    A1    Co.
       **[3]**

(or solves $y = x^2$ with $yx^{2.5} = 20$ alg)

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**12 OR**



(i) Area sector $COB = \frac{1}{2} \times 8^2 \times 1.2 = 38.4$    M1 A1    Use of $\frac{1}{2}r^2\theta$ with radians.
       **[2]**

(ii) $AOC = \pi - 1.2$ rad or $OAC = 0.6$rad    B1    Anywhere.
     $AC^2 = 8^2 + 8^2 - 2 \times 8 \times 8 \times \cos(\pi - 1.2)$    M1 A1    Cosine rule or splitting into two 90°
     or $AC = 2 \times 8 \times \cos 0.6 = 13.2$      triangles.
     area $= \frac{1}{2} \times 13.2^2 \times 0.6 = 52.27$    M1 A1√    Use of $\frac{1}{2}r^2\theta$ with radians.
       **[5]**

(iii) Sector $ACD$ + Shaded = $AOC$ +    M1    Plan mark linking the 4 regions.
     Sector $OBC$
     Triangle $AOC = \frac{1}{2} \times 8 \times 8 \times \sin(\pi - 1.2)$    M1    Independent mark –for triangle $AOC$.
       $= 29.8(3)$
     Shaded $= 29.83 + 38.4 - 52.27 = 15.9$    A1    Co for either 15.9 or 16.0.
       (allow 16.0)    **[3]**

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DM1 for quadratic equation. Equation must be set to 0 if using formula or factors.

Formula.                 Factors
Must be correct           Must attempt to put quadratic into 2 factors.
– ignore arithmetic and algebraic slips.    Each factor then equated to 0.