**UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS**

GCE Advanced Subsidiary Level

# MARK SCHEME for the November 2004 question paper

## 9709 MATHEMATICS

**9709/02** **Paper 2, maximum raw mark 50**

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*.

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

CIE is publishing the mark schemes for the November 2004 question papers for most IGCSE and GCE Advanced Level syllabuses.

**Grade thresholds** taken for Syllabus 9709 (Mathematics) in the November 2004 examination.

| | maximum mark available | minimum mark required for grade: | | |
|---|---|---|---|---|
| | | A | B | E |
| Component 2 | 50 | 33 | 29 | 15 |

The thresholds (minimum marks) for Grades C and D are normally set by dividing the mark range between the B and the E thresholds into three. For example, if the difference between the B and the E threshold is 24 marks, the C threshold is set 8 marks below the B threshold and the D threshold is set another 8 marks down. If dividing the interval by three results in a fraction of a mark, then the threshold is normally rounded down.

**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 marks indicated in the scheme may not be subdivided. If there is genuine doubt whether a candidate has earned a mark, allow the candidate the benefit of the doubt. Unless otherwise indicated, marks once gained cannot subsequently be lost, e.g. wrong working following a correct form of answer is ignored.

- Wrong or missing units in an answer should not lead to the loss of a mark unless the scheme specifically indicates otherwise.

- For a numerical answer, allow the A or B mark if a value is obtained which is correct to 3 s.f., or which would be correct to 3 s.f. if rounded (1 d.p. in the case of an angle). As stated above, an A or B mark is not given if a correct numerical answer arises fortuitously from incorrect working. For Mechanics questions, allow A or B marks for correct answers which arise from taking *g* equal to 9.8 or 9.81 instead of 10.

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

AEF Any Equivalent Form (of answer is equally acceptable)

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)

SR Special Ruling (detailing the mark to be given for a specific wrong solution, or a case where some standard marking practice is to be varied in the light of a particular circumstance)

**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. An MR-2 penalty may be applied in particular cases if agreed at the coordination meeting.

PA -1 This is deducted from A or B marks in the case of premature approximation. The PA -1 penalty is usually discussed at the meeting.

**November 2004**

GCE AS LEVEL

| MARK SCHEME |
|---|
| MAXIMUM MARK: 50 |
| **SYLLABUS/COMPONENT: 9709/02**<br><br>**MATHEMATICS**<br>**Paper 2 (Pure Mathematics 2)** |

| | | | |
|---|---|---|---|
| 1 | *EITHER:* State or imply non-modular inequality $(x + 1)^2 > x^2$ or corresponding quadratic equation or linear equation $x + 1 = -x$ | B1 | |
| | Obtain critical value $-\frac{1}{2}$ | B1 | |
| | State answer $x > -\frac{1}{2}$ | B1 | |
| | *OR:* Obtain critical value $-\frac{1}{2}$ by solving a linear inequality or by graphical method or inspection | B2 | |
| | State answer $x > -\frac{1}{2}$ | B1 | 3 |
| | [For $2x + 1 > 0$, $x > +\frac{1}{2}$, or similar reasonable method] | M1 | |
| 2 | Use logarithms to obtain an equation in $\ln x$ | M1 | |
| | Obtain $\ln x = \frac{\ln 11}{(3.9 - 3.2)}$, or equivalent | A1 | |
| | Obtain answer $x = 31$ (accept 30.7, 30.74) | A1 | 3 |
| 3 | At any stage, state answer $x = 90°$ (c.w.o) | B1 | |
| | Write the equation in the form $6\sin x \cos x = \cos x$ | B1 | |
| | Remove factor of $\cos x$ and solve an equation in $\sin x$ for $x$ | M1 | |
| | Obtain answer $x = 9.59°$ and no others in the range (9.6° OK: rubric) (Ignore answers outside the given range.) | A1 | 4 |
| 4 | State or obtain $16 - 20 + 2a + b = 0$ | B1 | |
| | Substitute $x = -1$ and equate to $-6$ | M1 | |
| | Obtain a 3-term equation in any correct form | A1 | |
| | Solve a relevant pair of equations, obtaining $a$ or $b$ | M1 | |
| | Obtain $a = 1$ and $b = 2$ | A1 | 5 |
| 5 (i) | Use the product rule to obtain the first derivative (must involve 2 terms) | M1 | |
| | Obtain derivative $2x \ln x + x^2 \frac{1}{x}$ or equivalent | A1 | |
| | Equate derivative to zero and solve for $x$ | M1 | |
| | Obtain answer $x = e^{-0.5}$ or $\frac{1}{\sqrt{e}}$ or equivalent (e.g. 0.61) | A1 | 4 |
| (ii) | Determine nature of stationary point using correct second derivative ($3 + 2\ln x$) or correct first derivative or equation of the curve (3 $y$-values, central one $y(\exp(-0.5))$) | M1 | |
| | Show point is a minimum completely correctly | A1 | 2 |
| 6 (i) | Make recognisable sketch of an appropriate trig curve, e.g. $y = \cot x$, for $0 < x < \frac{1}{2}\pi$ | B1 | |
| | Sketch the appropriate second curve e.g. $y = x$ correctly and justify the given statement | B1 | 2 |

| | | | |
|---|---|---|---|
| **(ii)** | Consider sign of cot $x - x$ at $x = 0.8$ and $x = 0.9$, or equivalent | M1 | |
| | Complete the argument correctly with appropriate calculations | A1 | **2** |
| **(iii)** | Show, using cot $x \equiv \frac{1}{\tan x}$, that cot $x = x$ is equivalent to $x = \arctan\left(\frac{1}{x}\right)$ (or vice versa) | B1 | **1** |
| **(iv)** | Use the iterative formula correctly at least once | M1 | |
| | Obtain final answer 0.86 | A1 | |
| | Show sufficient iterations to justify its accuracy to 2 decimal places, or show that there is a sign change in (0.855, 0.865) | B1 | **3** |
| **7 (i)** | State coordinates (0, 5) | B1 | **1** |
| **(ii)** | State first derivative of the form $k\,e^{x} + m\,e^{-2x}$, where $km \neq 0$ | M1 | |
| | Obtain correct first derivative $2\,e^{x} - 6\,e^{-2x}$ | A1 | |
| | Substitute $x = 0$, obtaining gradient of $-4$ | A1√ | |
| | Form equation of line through $A$ with this gradient (NOT the normal) | M1 | |
| | Obtain equation in any correct form e.g. $y - 5 = -4x$ | A1 | |
| | Obtain coordinates (1.25, 0) or equivalent | A1 | **6** |
| **(iii)** | Integrate and obtain $2\,e^{x} - \frac{3}{2}e^{-2x}$, or equivalent | B1 + B1 | |
| | Use limits $x = 0$ and $x = 1$ correctly | M1 | |
| | Obtain answer 4.7 | A1 | **4** |
| **8 (i)** | State answer $R = \sqrt{2}$ | B1 | |
| | Use trigonometric formulae to find $\alpha$ | M1 | |
| | Obtain answer $\alpha = \frac{1}{4}\pi$ (NOT 45°, unless $45° = {}^{\pi}\!/_{4}{}^{c}$ somewhere, later) | A1 | **3** |
| **(ii)** | Use $\cos\theta + \sin\theta = \sqrt{2}\cos(\theta - \frac{1}{4}\pi)$ to justify the given answer | B1 | **1** |
| **(iii)** | Differentiate using the quotient or product rule | M1 | |
| | Obtain derivative in any correct form | A1 | |
| | Obtain the given answer correctly | A1 | **3** |
| **(iv)** | Convert integrand to give $\int \frac{1}{2}\sec^2(\theta - {}^{\pi}\!/_{4})\,d\theta$ | B1 | |
| | Integrate, to obtain function $\frac{1}{2}\tan(\theta - {}^{\pi}\!/_{4})$ | M1 | |
| | Substitute (correct) limits correctly, to obtain given result | A1 | **3** |