

CAMBRIDGE INTERNATIONAL EXAMINATIONS

Cambridge International Advanced Subsidiary Level

MARK SCHEME for the May/June 2015 series

9709 MATHEMATICS

9709/21

Paper 2 maximum raw mark 50

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Mark Scheme Notes

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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.
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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.
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- 1 (i) State or imply equation $(3x + 4)^2 = (3x - 11)^2$ or $3x + 4 = -(3x - 11)$ B1
 Attempt solution of 'quadratic' equation or linear equation M1
 Obtain $x = \frac{7}{6}$ or equivalent (and no other solutions) A1 [3]
- (ii) Use logarithms to solve equation of form $2^y =$ their answer to (i) (must be + ve) M1
 Obtain 0.222 (and no other solutions) A1 [2]
- 2 State or imply that $\ln y = \ln A + p(x - 1)$ B1
 Equate gradient to p or obtain two equations for $\ln A$ and p M1
 Obtain $p = 0.44$ A1
 Substitute values correctly, to find value of $\ln A$ DM1
 Obtain $A = 3.2$ A1 [5]
- Alternative:
 Obtain an equation either $e^{1.6} = Ae^p$ or $e^{2.92} = Ae^{4p}$ M1
 Obtain both equations correctly A1
 Solve to obtain $p = 0.44$ A1
 Substitute value correctly to find A DM1
 Obtain $A = 3.2$ A1 [5]
- 3 Differentiate to obtain form $p \cos x + q \sin 2x$ or equivalent M1
 Obtain correct $6 \cos x + 4 \sin 2x$ or equivalent A1
 Substitute $\frac{1}{6}\pi$ to obtain derivative equal to $5\sqrt{3}$ or 8.66 A1
 Form equation of tangent (not normal) using numerical value of gradient obtained by differentiation M1
 Obtain $y = 8.66x - 2.53$ cao A1 [5]
- 4 (i) Substitute $x = -2$ in $f(x)$ and equate to zero to obtain $-8 + 4a + b = 0$ or equiv B1
 Substitute $x = -1$ in $g(x)$ and equate to -18 M1
 Obtain $-1 + b - a = -18$ or equivalent A1
 Solve a pair of linear equations for a or b DM1
 Obtain $a = 5$, $b = -12$ A1 [5]
- (ii) Simplify $g(x) - f(x)$ to obtain form $kx^2 + c$ where $k < 0$ M1
 Obtain $-17x^2 + 7$ and state 7, following their value of c A1✓ [2]

Page 5	Mark Scheme	Syllabus	Paper
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- 5 (i) Obtain integral of form $ke^{\frac{1}{2}x} + mx$ M1
Obtain correct $6e^{\frac{1}{2}x} + x$ A1
Apply limits and obtain correct $6e^{\frac{1}{2}a} + a - 6$ A1
Equate to 10 and introduce natural logarithm correctly DM1
Obtain given answer $a = 2\ln\left(\frac{16-a}{6}\right)$ correctly A1 [5]
- (ii) Use the iterative formula correctly at least once M1
Obtain final answer 1.732 A1
Show sufficient iterations to justify accuracy to 3 d.p. or show sign change in interval (1.7315, 1.7325) A1 [3]
- 6 (i) State or imply $\operatorname{cosec} 2\theta = \frac{1}{\sin 2\theta}$ B1
Express left-hand side in terms of $\sin \theta$ and $\cos \theta$ M1
Obtain given answer $\sec^2 \theta$ correctly A1 [3]
- (ii) (a) State or imply $\cos \theta = \frac{1}{\sqrt{5}}$ or $\tan \theta = 2$ at least B1
Obtain 1.11 or awrt 1.11, allow 0.353π B1
Obtain 2.03 or awrt 2.03, allow 0.648π and no other values between 0 and π B1 [3]
- (b) State integrand as $\sec^2 2x$ B1
Integrate to obtain expression of form $k \tan mx$ M1
Obtain correct $\frac{1}{2} \tan 2x$ A1
Obtain $\frac{1}{2}\sqrt{3}$ or exact equivalent A1 [4]
- 7 (i) Obtain $3y^2 \frac{dy}{dx}$ as derivative of y^3 B1
Obtain $4y + 4x \frac{dy}{dx}$ as derivative of $4xy$ B1
Equate derivative of left-hand side to zero and solve for $\frac{dy}{dx}$, must be from implicit differentiation M1
Confirm given answer $\frac{dy}{dx} = -\frac{4y}{3y^2 + 4x}$ correctly A1 [4]
- (ii) State or imply $y = 0$ B1
Substitute in equation of curve and show contradiction B1 [2]
- (iii) State or imply $3y^2 + 4x = 0$ B1
Eliminate one variable from equation of curve using $3y^2 + 4x = 0$ M1
Obtain $y = -2$ A1
Obtain $x = -3$ A1 [4]

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Obtain $x = 21.6$ M1
A1 [2]
- (ii) Obtain or imply -21.6 or -21 as lower value
State 43 B1
B1 [2]
- 2 (i) Substitute $x = -2$ into expression and equate to zero
Obtain $-32 + 4a + 2(a + 1) - 18 = 0$ or equivalent
Obtain $a = 8$ M1
A1
A1 [3]
- (ii) Attempt to find quadratic factor by division, inspection, ...
Obtain $4x^2 - 9$ M1
A1
State $(x + 2)(2x - 3)(2x + 3)$ A1 [3]
- 3 (i) Use identity $\sec^2 \theta = 1 + \tan^2 \theta$
Solve three-term quadratic equation in $\tan \theta$ B1
M1
Obtain at least $\tan \theta = \frac{5}{2}$ A1 [3]
- (ii) Substitute numerical values into $\tan(A + B)$ identity M1
Obtain $\frac{\frac{5}{2} + (-1)}{1 - \frac{5}{2}(-1)}$ or equivalent, following their positive answer from part (i) A1^{ft}
Obtain $\frac{3}{7}$ or exact equivalent and no other answers A1 [3]
- 4 (i) Differentiate to obtain $e^x - 8e^{-2x}$ B1
Use correct process to solve equation of form $ae^x + be^{-2x} = 0$ M1
Confirm given answer $\ln 2$ correctly A1 [3]
- (ii) Integrate to obtain expression of form $pe^x + qe^{-2x}$ M1
Obtain correct $e^x - 2e^{-2x}$ A1
Apply both limits correctly M1 depM
Confirm given answer $\frac{5}{2}$ A1 [4]

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- 5 (i) Draw recognisable sketch of $y = 16 - x^4$ B1
 Draw recognisable sketch of $y = |3x|$ B1
 Indicate in some way the two points of intersection B1 depBB [3]
- (ii) Use iterative process correctly at least once M1
 Obtain final answer 1.804 A1
 Show sufficient iterations to justify answer or show sign change in the interval (1.8035, 1.8045) A1 [3]
- (iii) State (1.804, 5.412) B1
 State $(-1.804, 5.412)$, following their first point B1^h [2]
- 6 (i) Solve three-term quadratic equation for $\sin x$ M1
 Obtain at least $\sin x = -\frac{1}{2}$ and no errors seen A1
 Obtain $x = \frac{7}{6}\pi$ A1 [3]
- (ii) State $\sin^2 x = \frac{1}{2} - \frac{1}{2}\cos 2x$ B1
 Obtain given $5 + 8\sin x - 2\cos 2x$ with necessary detail seen B1
 Integrate to obtain expression of form $ax + b\cos x + c\sin 2x$ M1
 Obtain correct $5x - 8\cos x - \sin 2x$ A1
 Apply limits 0 and their x -value correctly M1 depM
 Obtain $\frac{35}{6}\pi + \frac{7}{2}\sqrt{3} + 8$ or exact equivalent A1 [6]
- 7 (a) Differentiate $4\ln y$ to obtain $\frac{4}{y} \times \frac{dy}{dx}$ B1
 Differentiate $6xy$ to obtain $6y + 6x\frac{dy}{dx}$ B1
 Substitute 1 and 1 and solve for $\frac{dy}{dx}$ M1
 Obtain $-\frac{9}{10}$ or equivalent A1 [4]
- (b) Obtain $\frac{dx}{dt} = -10t^{-2} - 1$ B1
 Obtain derivative of form $k(2t-1)^{-\frac{1}{2}}$ for $\frac{dy}{dt}$ M1
 Obtain correct $(2t-1)^{-\frac{1}{2}}$ A1
 Identify value of t as 5 B1
 Obtain expression for $\frac{dy}{dx}$ correctly, with numerical value of t substituted M1
 Obtain $-\frac{5}{21}$ or exact equivalent A1 [6]

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