

MARK SCHEME for the May/June 2009 question paper
for the guidance of teachers

9709/01

9709 MATHEMATICS

Paper 1, maximum raw mark 75

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 must be read in conjunction with the question papers and the report on the examination.

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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 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 \surd 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.

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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 \surd " 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.

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<p>1 $\frac{s}{1-s} - \frac{s}{1+s} = \frac{2s^2}{1-s^2}$</p> <p>Use of $1 - s^2 = c^2$</p> <p>$\rightarrow \frac{2s^2}{c^2}$</p> <p>$\rightarrow 2t^2$</p>	<p>B1</p> <p>M1</p> <p>A1</p> <p>[3]</p>	<p>Correct algebra</p> <p>Use of this formula.</p> <p>Evidence of tan=sin/cos and everything completed accurately.</p>
<p>2 $kx - 4 = x^2 - 2x \rightarrow x^2 - (2+k)x + 4 = 0$</p> <p>Use of $b^2 - 4ac$</p> <p>$(2+k)^2 = 16 \quad k = 2 \text{ or } -6$</p> <p>$k > 2 \text{ or } k < -6$</p>	<p>M1</p> <p>M1</p> <p>A1</p> <p>A1</p> <p>[4]</p>	<p>Complete elimination of y (or x)</p> <p>Any use ($=0, <0, >0$)</p> <p>For the values of k, however used</p> <p>Correct only.</p>
<p>3 (i) $(2+3x)^5 = 32 + 240x + 720x^2$</p> <p>(ii) $(1+ax)(2+3x)^5$</p> <p>$\rightarrow (1 \times 720) + (a \times 240) = 0$</p> <p>$\rightarrow a = -3$</p>	<p>3 × B1</p> <p>[3]</p> <p>M1</p> <p>A1√</p> <p>[2]</p>	<p>All co.</p> <p>Must be considering exactly 2 terms.</p> <p>√ for ($- \text{coeff } x^2 \div \text{coeff } x$).</p>
<p>4 (i) $a = 6$</p> <p>$b = 2$</p> <p>$c = 3$</p> <p>(ii) $6\sin 2x + 3 = 0$</p> <p>$\rightarrow \sin 2x = -\frac{1}{2}$</p> <p>Works with “2x” first</p> <p>$x = \frac{7\pi}{12}$ or 1.83.</p>	<p>B1</p> <p>B1</p> <p>B1</p> <p>[3]</p> <p>M1</p> <p>M1</p> <p>A1</p> <p>[3]</p>	<p>co</p> <p>co</p> <p>co</p> <p>Setting to 0 and attempt at making sinbx the subject.</p> <p>Must be evidence of $\div b$</p> <p>Co (radians only)</p>
<p>5 (i) Perimeter of $R_1 = r + r + r\theta$</p> <p>Major arc length = $2\pi r - r\theta$</p> <p>Equated and solved $\rightarrow \theta = \pi - 1$</p> <p>(ii) $\frac{1}{2}r^2\theta$ with $\theta = \pi - 1$, equated to 30</p> <p>$\rightarrow r^2 = 60/(\pi - 1) \quad (r = 5.29)$</p> <p>$R_2 = \frac{1}{2}r^2(\pi + 1) \rightarrow 58.0$</p> <p>or</p> <p>[Reflex = $\pi + 1$.</p> <p>$R_2 = 30(\pi + 1) \div (\pi - 1)$</p> <p>[M1 A1 M1 A1]</p>	<p>B1</p> <p>B1</p> <p>B1</p> <p>[3]</p> <p>M1</p> <p>A1</p> <p>M1A1</p> <p>[4]</p>	<p>co answer was given</p> <p>Use of correct formula once</p> <p>Any correct form for r or r²</p> <p>Attempt at r (or r²) and at area of R₂</p> <p>co (could be full circle – sector)</p>

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<p>6</p> <p>(i) $\mathbf{OA} \cdot \mathbf{OB} = 14 - 16 - 4 = -6$ This is $-ve \rightarrow$ Obtuse angle.</p> <p>(ii) $\mathbf{AB} = 5\mathbf{i} + 10\mathbf{j} - 5\mathbf{k}$ $\mathbf{AX} = \frac{2}{5}(\mathbf{AB})$ $\mathbf{OX} = \mathbf{OA} + \mathbf{AX}$ $\mathbf{OX} = 4\mathbf{i} - 4\mathbf{j} + 2\mathbf{k}$</p> <p>Divides by the modulus Unit vector = $\frac{1}{6}(4\mathbf{i} - 4\mathbf{j} + 2\mathbf{k})$</p>	<p>M1 A1 B1√ [3]</p> <p>M1 A1</p> <p>M1 A1√ [4]</p>	<p>Must be scalar from correct method. co. Correct deduction from his scalar.</p> <p>Needs \mathbf{AB} and \mathbf{OX} attempting. co</p> <p>Must finish with a vector, not a scalar. Correct for his \mathbf{OX}.</p>
<p>7</p> <p>(a) $a = 0.5, r = 0.5^2$ Uses correct formula = $0.5 \div 0.75$ $\rightarrow S_{\infty} = \frac{2}{3}$ (or 0.667)</p> <p>(b) $a = 5, d = 4$ Uses $200 = a + (n - 1)d$ or T.I. 50 terms in the progression Use of correct Sum formula $\rightarrow 5150$</p>	<p>B1 M1 A1 [3]</p> <p>M1 A1 M1 A1 [4]</p>	<p>For both a and r. Uses correct formula with some a, r. co.</p> <p>Attempt at finding the number of terms. co. Correct formula (could use the last term (201)). co.</p>
<p>8</p> <p>m of $AC = \frac{1}{2}$ Perpendicular gradient = -2 Eqn BD $y + 3 = -2(x - 10)$ (or $y + 2x = 17$)</p> <p>Sim. eqns BD with given eqn. $\rightarrow B(6, 5)$</p> <p>Vector move (step) $\rightarrow C(12, 8)$</p>	<p>M1 M1 A1</p> <p>M1 A1</p> <p>M1 A1√ [7]</p>	<p>Use of $m_1 m_2 = -1$ Correct method for eqn of line In any form.</p> <p>Correct method of solution. co.</p> <p>Any valid method. √ for his B.</p>
<p>9</p> <p>(i) $dy/dx = -6(3x - 2)^{-2} \times 3$ If $x = 2, m = -1\frac{1}{8}$ (-1.125)</p> <p>(ii) $\text{Vol} = \int \frac{36}{(3x - 2)^2} dx$ $[\frac{-36}{(3x - 2)} \div 3]$</p> <p>Use of limits $[2] - [1] \rightarrow 9\pi$</p>	<p>B1 M1 A1 [3]</p> <p>B1</p> <p>B1 B1</p> <p>M1 A1 [5]</p>	<p>B1 (without the $\times 3$). Use of chain rule. co.</p> <p>Attempt at $\pi \int y^2$ - even if π missing.</p> <p>No need for π here.</p> <p>Correct use of correct limits. co.</p>

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<p>10</p> <p>(i) $2x^2 - 12x + 13 = 2(x - 3)^2 - 5$</p> <p>(ii) Symmetrical about $x = 3$. $A = 6$.</p> <p>(iii) One limit is -5 Other limit is 13</p> <p>(iv) Inverse since 1:1 ($4 > 3$).</p> <p>(v) Makes x the subject of the equation Order of operations correct</p> $\rightarrow \sqrt{\frac{x+5}{2}} + 3$	<p>$3 \times B1$ [3]</p> <p>$B1\sqrt{}$ [1]</p> <p>$B1\sqrt{}$ $B1$ [2]</p> <p>$B1$ [1]</p> <p>$M1$ $DM1$</p> <p>$A1$ [3]</p>	<p>Allow even if a, b, c not specifically quoted.</p> <p>For $2 \times$ his ($-b$).</p> <p>For his c. co.</p> <p>Valid argument.</p> <p>Attempts to change the formula. “+5”, $\div 2$, $\sqrt{}$, $+3$. Allow for simple algebraic slips such as -5 for $+5$ etc.</p> <p>co – as a function of x, not y. condone \pm.</p>
<p>11</p> <p>(i) $\frac{dy}{dx} = 3x^2 - 12x + 9$ Solves $\frac{dy}{dx} = 0$ $\rightarrow A(1, 4), B(3, 0)$.</p> <p>(ii) If $x = 2, m = -3$ Normal has $m = \frac{1}{3}$ Eqn $y - 2 = \frac{1}{3}(x - 2)$ or $3y = x + 4$.</p> <p>(iii) area under curve – integrate y. $\rightarrow \frac{1}{4}x^4 - 2x^3 + \frac{9}{2}x^2$ Limits 2 to “his 3” $\rightarrow \frac{3}{4}$ (0.75) Area of trapezium = $\frac{1}{2} \times 1 \times (2 + 2\frac{1}{3})$ $= 2\frac{1}{6}$ Subtract \rightarrow shaded area of $1\frac{5}{12}$</p>	<p>$B1$</p> <p>$M1$</p> <p>$A1$ [3]</p> <p>$M1$</p> <p>$M1 A1$ [3]</p> <p>$B2,1$ $M1$</p> <p>$M1$</p> <p>$A1$ [5]</p>	<p>co (can be given in part (ii))</p> <p>Attempt to solve $dy/dx = 0$.</p> <p>Both needed.</p> <p>Use of $m_1 m_2 = -1$. needs calculus.</p> <p>Correct form of equation – needs calculus. $A1$ any form.</p> <p>For the 3 terms. -1 for each error. Using 2 to “his 3” with integration.</p> <p>Any correct method for trapezium.</p> <p>co</p>