2003 HSC Notes from the Marking Centre Mathematics

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2003 HSC NOTES FROM THE MARKING CENTRE MATHEMATICS

Introduction

This document has been produced for the teachers and candidates of the Stage 6 course, Mathematics. It is based on comments provided by markers on each of the questions from the Mathematics paper. The comments outline common sources of error and contain advice on examination technique and how best to present answers for certain types of questions.

It is essential for this document to be read in conjunction with the relevant syllabus, the 2003 Higher School Certificate Examination, the Marking Guidelines and other support documents that have been developed by the Board of Studies to assist in the teaching and learning of the Mathematics course.

As a general comment candidates need to read the questions carefully and set out their working clearly. It is unwise to do working on the question paper and if a question part is worth more than 1 mark the examiners expect more than just a bald answer.

Question 1

Candidates generally attempted all parts of this question. Areas that caused some problems were:

- Significant Figures: approximately forty percent of candidates did not know how to write their answer correct to 3 significant figures.
- Changing radians to degrees.
- Solving simple equations. A large number of candidates were able to find the correct equation in various parts but then tried to solve it mentally, making basic mistakes. Examples of these common mistakes included: $x = 11$ from $x - 3 = 7$, $\theta = \frac{3}{5}$ from $5 = 3\theta$, $x = 4$ from $-x + 3 = 7$, $x = 87.5\%$ of \$135 from '$x + 12.5\%$ of $x = 135$'.
  It is generally felt that candidates should show even the most basic steps in their working to avoid such errors, especially early in the examination as they settle down.

(a) Nearly all candidates performed the calculation correctly, but many could not write their answer correct to three significant figures.

(b) This question was generally answered correctly. The most common mistake was to try and apply the product rule. A number of candidates did not know that $\sec^2 x$ is the derivative of $\tan x$.

(c) Nearly all candidates correctly applied the formula $\ell = r\theta$. Many had problems solving the resulting equation or changing $\frac{5}{3}$ radians to degrees.

(d) While most candidates answered this question correctly there was still a large number who tried to reduce \$315 by 12.5% or even increase \$315 by 12.5%, receiving no marks. Successful candidates began with the step that $1.125x = \$315$, or $(x + 12.5\%x) = \$315$, and then went on to solve this.

(e) Candidates answered this part very well, over 90% receiving full marks. The most common mistake was to differentiate rather than integrate.

(f) Most candidates correctly realised that two cases needed to be considered. It was surprising to see the number of apparently simple mistakes made by candidates, as noted previously. Other mistakes were to include the absolute value sign in solutions and to think that $|x - 3| = x + 3$.

Question 2

Overall this question was fairly well done. The vast majority of candidates obviously felt comfortable working with exact values rather than rounded-off values.

(a) Those candidates who correctly differentiated the function generally went on to obtain full marks from well set out working.
Common errors were to treat $2\log_e x$ as linear and having a gradient of 2ln or just 2. Others simply found the equation of the tangent with no regard for the normal. Many also left their answer for the normal without having substituted the point $(e, 2)$ into the gradient

ie $y - 2 = \frac{-x}{2}(x - e)$

(b) Candidates should be encouraged to redraw the diagram accurately, including information on it and making use of it in their working out.

(i) Generally well done.

(ii) Generally well done.

(iii) Most who got this incorrect failed to recognise the obtuse angle was required (45° and – 45° were common answers). In a number of cases the cosine rule, with lengthy calculations, was used to solve this simple problem. Candidates should take note of the mark value for each part, as an indication of the amount of working out required.

(iv) A large percentage of candidates failed to see the connection between the gradients of *OA* and *BC*, making up the coordinates of *C* and then using them to determine the gradient of *BC*, not parallel to *OA*. Common errors included: on finding that at $y = 0$, $x = 10$, writing $C(0,10)$; and incorrectly expanding $y - 6 = -(x - 4)$, leading to an incorrect *C*.

(v) Errors in (iv) lead to problems with identifying the perpendicular distance as $5\sqrt{2}$. A neat solution involved simple, justified trigonometry.

The failure to write $y = -x + 10$ in the correct general form for use in the perpendicular distance formula was a common error.

(vi) A number of candidates did not know the formula for the area of a trapezium, while others used the non-parallel sides *OC* and *AB* in their formula. Dissections were often used but not always explained. Treating the area as a rhombus and using AC and OB was a common error.

Question 3

(a) (i) This part of the question was well answered and most candidates scored full marks. The most common errors were the failure to differentiate $(2e^x - 4)$ correctly and missing the index when writing out the chain rule.

(ii) This was the best answered part of the question. Most candidates were able to apply the product rule correctly. The most common error was the incorrect differentiation of $\sin x$, giving the result $-\cos x$.

(b) Most candidates were able to find the angle of 89° but did not score full marks, as reasons were missing, or if given, were either incorrect or poorly stated. Many candidates wrote out correct numerical expressions or calculations but failed to include the reason 'angle sum of a triangle'. Confusing alternate angles with corresponding or co-interior angles was a common error.

(c) Candidates who managed to sketch the graphs normally went on to score two or more marks. More attention needs to be paid to the use of scales and labelling. Using a dotted line to draw the line $y = x - 2$ was poorly done. Poor interpretation of the inequalities and incorrect shading of the required region were common and resulted in candidates failing to score full marks for this part of the question.

(d) (i) Most candidates who recognised the integral as a log function scored full marks. Failure to do so in some cases resulted in unsuccessful lengthy algebraic attempts, which wasted time and gained no marks. Omission of the brackets when writing log $(x^2 + 5)$ was another common error.

(ii) Most candidates were able to integrate to get $\tan x$ but were not able to evaluate $\tan\frac{\pi}{3} - \tan\frac{\pi}{4}$ correctly. Many candidates obviously did not change their calculator to radian mode and thus failed to evaluate correctly.

Question 4

(a) (i) Generally not well done. Many candidates did not understand bearings, particularly the significance of the word 'from', taking the angle to be at R rather than Q.

(ii) This was generally well done with the sine rule used appropriately. Most candidates did not copy the diagram, making it hard to award marks when they used their own labels. Poor understanding of bearings prevented many candidates from finding the final bearing.

(b) (i) Candidates who drew a tree diagram or table or listed outcomes did very well. Some candidates did not read the question, using 1, 2, 3, 4 for spinner 2.

(ii) Again, candidates with outcomes listed were generally correct. The most common error was an answer of $\frac{7}{12}$. Some candidates did not demonstrate awareness of the impossibility of a probability greater than 1.

(c) (i) Most candidates scored full marks. Some candidates made errors in simplification and/or factorisation.

(ii) This question was generally well done, though many candidates did not show an understanding of the correct use of absolute value signs. A number of candidates did not see the link between parts (i) and (ii). A common mistake was to use incorrect limits, particularly 0 to 4 for the parabola. Integration was well done; most mistakes in evaluation resulted from not showing the first line of substitution and/or not using brackets around expressions.

Question 5

(a) (i) Generally well done.

(ii) The question asked for the coordinates of the stationary points. This required finding both the x and the y coordinates. Many candidates did not find the y values. The nature of the stationary points can be determined by looking at the gradient to the left and right of the point in question and this method is to be encouraged. Many candidates missed the stationary point at $x = 0$ and a large number did not successfully justify that it was a point of inflexion. A common oversight was the failure to say that the points were a horizontal point of inflexion and a minimum turning point, after performing various checks.

(iii) Overall the sketches were poor. Many candidates made no attempt to draw the inflexion at the origin as a horizontal part of the curve, even after describing it as one.

(iv) This part was poorly done. Those who knew to test $f''(x) < 0$ often could not solve the inequality.

(b) (i) Most candidates correctly obtained the answer, 63.

(ii) This part was poorly answered. Many answers were out by 1 because the candidates used 63 as the number of blocks in row 21 (instead of 62 blocks in row 21). Many candidates also failed to include the first 20 rows in the total number of rows.

(iii) Most candidates knew to calculate two separate sums and used the correct formulae. Candidates should always show their substitution into a formula.

Question 6

(a) Candidates were required to solve an equation involving logarithms to base 2. Many candidates could not convert to a linear equation by exponentiation. Of those who did, some began unnecessarily with a change of base, to base e or base 10. Of the candidates who took the direct approach, some transposed the number with the base.

(b) A majority of candidates correctly labelled angles. Those who did not, seldom earned any marks. Of the correct solutions, there was one direct and several longer methods. Some candidates preferred to refer to angles with a symbol such as a dot, rather that a label. This practice is not recommended because ambiguous statements often result.

(i) Reasons to justify statements were often omitted or incorrect. A logical sequence of reasoning was expected. Some candidates could not recall the geometrical reason but proceeded to make up a reason. They were unsuccessful unless they used key words such as ‘angle sum’ or ‘straight line’. Some candidates confused alternate angles, co-interior angles and corresponding angles. Incorrect reasons such as ‘alternating angles’ or ‘alternative angles’ were not accepted.

(ii) Generally well done.

(iii) Many candidates did not appreciate the meaning of the word ‘hence’ and treated this part without reference to the previous parts. The proportion statement confused a significant number of candidates who claimed that two triangles were similar when they were not.

(c) A significant number of candidates scored all their marks for Question 6 in this part. Some candidates lost a minus sign early in their solution and ended up with negative time. Some of these candidates then backtracked to find their mistake. Not all were successful. The question also clearly required candidates to evaluate the constant *k*. Some solved part (c) without evaluating the constant.

Question 7

(a) There was some similarity in content with the corresponding question in last year’s paper, so it was interesting to note that although problems still remain, there was improvement noted in the general standard of explanation.

(i) This part provided an easy 2 marks for the many candidates who could observe the exact value of r and insert it into the appropriate formula. The most common error was stating the value of the common ratio as $\sqrt{2}+1$ rather than its reciprocal. Many candidates had trouble simplifying the result, and relatively few used the simplified expression $\sqrt{2}-1$ as their substitution. With predictable consequences, far too many candidates wrote $1/\sqrt{2}+1$ rather than $1/(\sqrt{2}+1)$ or $\dfrac{1}{\sqrt{2}+1}$. The vast majority of candidates did work with exact values rather than using their calculator.

(ii) Most candidates correctly observed that $|r|>1$ meant there could not be a limiting sum. Equivalently, a few candidates showed that the (positive) terms were getting larger. Failure to obtain the mark usually stemmed from incorrect identification of the ratio or citing criteria like $|r|>0$ or that the $\text{Sum} \to 0$.

(b) (i) The vast majority of candidates correctly used $v=0$ to show that $\cos t = \dfrac{1}{2}$, but of these a large minority then either made mistakes, found only one value of *t,* gave an answer in degrees, or simply stopped.

(ii) This part provided the greatest diversity of answers – ranging from a bald answer of 6, to candidates spending a page trying to show that the answers to part (ii) were the times at which the maximum velocity occurred. Relatively few candidates gave a sound calculus-based explanation, many relied on a ‘from the graph’ approach or the observation that a maximum would occur when $\cos t = -1$. Most puzzling of all was the enormous number of candidates who failed to understand what the question required – their answer being when the maximum velocity occurred rather than finding its magnitude.

(iii) Albeit with varying degrees of detail, accuracy and presentation, sketching this graph was a good source of marks for most candidates. It was again puzzling that a large number of candidates failed to reconcile their fully correct answer to this part with an incomplete or inaccurate response to part (ii).

(iv) A majority of candidates managed a single mark here as a result of finding a (sometimes convoluted) primitive of v. It was surprising that few recognised the significance of the sign of the integral in the two sub-domains and of those who did, many were unable to carry the computation to a successful conclusion.

Question 8

(a) Most candidates could determine that the focal length was 2, however many did not gain the mark for this part as they wrote directrix = 2, instead of $y = 2$.

(b) Most candidates attempted to write down a volume of revolution integral. Common errors were: revolving around the *x*-axis instead of the *y*-axis; not being able to determine *x* as a function of *y*; not finding the correct limits (many used 'l' as a numerical value); not using the volume of revolution formula correctly (for example, omitting π, leaving out *dy* or using *dx* instead of *dy*).

Many candidates simplified $(\ln(y))^2$ to $2\ln(y)$ and a number attempted to evaluate their integral, which was contrary to the given instructions.

(c) Generally this part was well done. Common errors were: using 5 or 7 function values instead of 3; determining the wrong value of *h*; applying incorrect weightings; using $\frac{f(a)+f(b)}{2}$ instead of $f\left(\frac{a+b}{2}\right)$; using the *x* values instead of the $f(x)$ values.

Many candidates did not show sufficient working and it was impossible for markers to tell what values had been used. Also, several candidates used logarithms to base 10 as opposed to natural logarithms.

(d) Many candidates did not understand this part.

(i) Most candidates correctly started to find the intersection of the parabola and the line by eliminating *y* from the equations. However, only a very few managed to find the roots of this equation and to interpret their result consistent with the question.

(ii) This part was generally well done. The most common mistake was incorrectly factorising the resulting quadratic equation in *m*.

(iii) Most candidates did not make the link between parts (i) and (ii). Many candidates who attempted this part did not realise that the point (5,2) was not on the parabola and so wanted to use differentiation to find the tangents.

Question 9

This question covered the syllabus areas of solving trigonometric equations, areas of sectors and segments and applications of calculus to the real world. The question demanded higher order algebraic skills for candidates to score well.

(a) Many candidates failed to recognise that the equation was a quadratic and so could go no further. Others could not factorise correctly, with common errors being $\sin x(2\sin x - 3) = 2 \rightarrow \sin x = 2$, or changing to $\cos x$. Once factorised, candidates got recognition for $\sin x = 2$ having no solution, or for both solutions to $\sin x = -\frac{1}{2}$. Finally, for full marks, candidates needed to recognise that the domain was in radians not degrees.

(b) (i) Common errors included using an incorrect 'cosine rule' or using $\angle BOA$. Candidates often did not eliminate r from their expression which was often left as $\frac{3r^2}{2r^2\sqrt{3}}$. Candidates who chose 'or otherwise' tried to work geometrically using the assumption that triangles *AOB, AOC* and *BOC* were congruent.

(ii) Many candidates who had $\angle BAO = 30°$ in (i), did not realise it had to be changed to radians and/or doubled. Otherwise, candidates answered this part reasonably well, except for those who confused sector with segment.

(iii) Most candidates who were correct in (ii) scored the mark in (iii) also. Others did this part independently as the fraction of the circle. Many candidates tried to find the area using angles that still involved r.

(iv) Many candidates appeared to have difficulty visualising the two circles and simply found the difference between their answers for (ii) and (iii). Recognition was given for correctly finding the area of either segment.

(c) (i) Candidates manipulated either of the given equations for E. Few could clearly use $t = \frac{L}{v-u}$.

(ii) Poor use of notation made it unclear as to whether candidates were differentiating with respect to v, t, u or L. Poor algebra skills made the differential equation $\frac{dE}{dv} = 0$ difficult to solve. Of those who did get through to $v = 0$ or $v = \frac{3u}{2}$, a large proportion did not attempt to justify that the minimum occurs for $v = \frac{3u}{2}$. Of those who did, most used the first derivative test rather than the second derivative.

Question 10

(a) Most candidates either ignored or did not correctly address the central issue of there being k regular payments per year. Candidates often worked with (1.06) or $\left(\frac{1.06}{k}\right)$ instead of the correct $\left(1+\frac{0.06}{k}\right)$. Many candidates recovered from poor proofs in (i) and (ii) to gain marks in the calculations of (iii) and (iv); however once again the use of incorrect rates and number of repayments corrupted most attempts. Candidates who attempted to attack the question by invoking memorised general formulae for loan repayments generally did poorly.

(b) (i) Many candidates appreciated that this part involved multiple uses of Pythagoras' theorem but had difficulty in providing a coherent proof of the formula for l.

(ii) Most candidates were unclear how to apply the usual rules of calculus to this situation, however those who differentiated the two square root terms correctly often gained a full two marks by correctly bringing the terms together over a common denominator.

(iii) The majority of candidates who attempted this part were drawn to the simple but physically impossible answer of $x = 1$ as opposed to the correct $x = \frac{r^2 + r\sqrt{r^2 + 8}}{4}$. Candidates needed to reach a unique solution of $x = \frac{r^2 + r\sqrt{r^2 + 8}}{4}$ and provide a proof that the point was indeed a local maximum. Simply stating a test to do this was insufficient.

Mathematics

2003 HSC Examination Mapping Grid

Question	Marks	Content	Syllabus outcomes
1 (a)	2	12.1	P3, H3
1 (b)	2	8.7, 13.5	P7, H5
1 (c)	2	13.1	H5
1 (d)	2	1.1	P4
1 (e)	2	10.8	H8
1 (f)	2	1.4	P4
2 (a)	3	10.7	P6, H3
2 (b) (i)	1	6.5	P4
2 (b) (ii)	1	6.2	P4
2 (b) (iii)	1	6.2	P4
2 (b) (iv)	2	6.2	P4, H5
2 (b) (v)	2	6.5	P4, H5
2 (b) (vi)	2	2.3	P4, H5
3 (a) (i)	2	8.9	P7, H3
3 (a) (ii)	2	12.5	P7, H5
3 (b)	2	2.4	P4
3 (c)	3	4.4	P4
3 (d) (i)	1	12.5	P8, H5
3 (d (ii)	2	13.6	P8, H5
4 (a) (i)	1	5.4	P4
4 (a) (ii)	3	5.5, 5.4	P4, H5
4 (b) (i)	2	3.2	H5
4 (b) (ii)	1	3.1, 3.2	H5
4 (c) (i)	2		P4
4 (c) (ii)	3	11.4	H8
5 (a) (i)	1	8.7, 1.3	P4

Question	Marks	Content	Syllabus outcomes
5 (a) (ii)	3	10.2, 10.4	H6
5 (a) (iii)	1	10.5	H3
5 (a) (iv)	2	10.4	P2, P4, H2, H5
5 (b) (i)	2	7.5	H5
5 (b) (ii)	1	7.5	H5
5 (b) (iii)	2	7.5	H5
6 (a)	2	12.3, 1.1, 1.4	H3
6 (b) (i)	1	2.5	P2, P4, H2, H5
6 (b) (ii)	2	2.5	P2, P4, H2, H5
6 (b) (iii)	2	2.5	P2, P4, H2, H5
6 (c) (i)	2	14.2	H3
6 (c) (ii)	2	14.2	H3, H5
7 (a) (i)	2	7.3	P3, H5
7 (a) (ii)	1	7.3	P2, P3, H2, H5
7 (b) (i)	2	14.3	H5
7 (b) (ii)	2	14.3	H5
7 (b) (iii)	2	14.3	H5, H9
7 (b) (iv)	3	14.3	H5
8 (a)	1	9.5	P4
8 (b)	3	11.4	H3, H5, H9
8 (c)	3	11.3	H8, H9
8 (d) (i)	2	10.7	P4
8 (d) (ii)	2	1.4	P3, P4
8 (d) (iii)	1	10.7	H5

Question	Marks	Content	Syllabus outcomes
9 (a)	2	5.2, 13	P3, H5
9 (b) (i)	1	5.5, 13	P4, H9
9 (b) (ii)	1	13.1	H5, H9
9 (b) (iii)	1	13.1	H5, H9
9 (b) (iv)	2	13.1, 5.5	H5, H9
9 (c) (i)	1	14.3	H5, H9
9 (c) (ii)	4	10.6	H2, H5, H9
10 (a) (i)	1	7.5	H5
10 (a) (ii)	2	7.5	H5
10 (a) (iii)	2	7.5	H5
10 (a) (iv)	2	7.5	H2, H5
10 (b) (i)	1	2.3	H5, H9
10 (b) (ii)	2	8.9	H5
10 (b) (iii)	2	10.6	H2, H5

BOARD OF STUDIES
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2003 HSC Mathematics
Marking Guidelines

Question 1 (a)

Outcomes assessed: P3, H3

MARKING GUIDELINES

Criteria	Marks
• Correct answer	2
• Clearly correct computation or clear correct rounding to 3 significant figures of incorrect computation	1

Question 1 (b)

Outcomes assessed: P7, H5

MARKING GUIDELINES

Criteria	Marks
• Correct answer	2
• Partially correct eg $3x + \sec^2 x$	1

Question 1 (c)

Outcomes assessed: H5

MARKING GUIDELINES

Criteria	Marks
• Correct answer (ignoring rounding)	2
• Evidence of application of $\ell = r\theta$	1

Question 1 (d)

Outcomes assessed: P4

MARKING GUIDELINES

Criteria	Marks
• Correct answer	2
• Gives evidence of understanding that \$315 is $112\frac{1}{2}\%$ of cost of meal without the tip	1

Question 1 (e)

Outcomes assessed: H8

MARKING GUIDELINES

Criteria	Marks
• Correct answer	2
• Partially correct	1

Question 1 (f)

Outcomes assessed: P4

MARKING GUIDELINES

Criteria	Marks
• Correct answer	2
• Obtains one correct solution or working shows understanding of the two cases	1

Question 2 (a)

Outcomes assessed: P6, H3

MARKING GUIDELINES

Criteria	Marks
• Correct solution. Equation of normal can be in any form	3
• Demonstrates a clear understanding of what is required, but working contains a single error (eg equation of tangent, or omits the – sign in slope of normal or line through wrong point)	2
• Makes some relevant progress on the question (eg finds slope of tangent, finds slope of normal from incorrect slope of tangent)	1

Question 2 (b) (i)

Outcomes assessed: P4

MARKING GUIDELINES

Criteria	Marks
• Correct answer	1

Question 2 (b) (ii)

Outcomes assessed: P4

MARKING GUIDELINES

Criteria	Marks
• Correct answer	1

Question 2 (b) (iii)

Outcomes assessed: P4

MARKING GUIDELINES

Criteria	Marks
• Correct answer	1

Question 2 (b) (iv)

Outcomes assessed: H5, P4

MARKING GUIDELINES

Criteria	Marks
• Correct answer. Equation of line can be any form. Accept $x = 10$ for C	2
• Either correct equation or appropriate C from incorrect equation	1

Question 2 (b) (v)

Outcomes assessed: H5, P4

MARKING GUIDELINES

Criteria	Marks
• Correct solution	2
• Finds point where perpendicular through *O* meets *BC* or equivalent substantial progress	1

Question 2 (b) (vi)

Outcomes assessed: H5, P4

MARKING GUIDELINES

Criteria	Marks
• Correct solution	2
• Correctly calculates $\left\|BC\right\|$ or equivalent progress	1

Question 3 (a) (i)

Outcomes assessed: P7, H3

MARKING GUIDELINES

Criteria	Marks
• Correct answer. Simplification not required	2
• Clearly shows an attempt to apply the chain rule	1

Question 3 (a) (ii)

Outcomes assessed: P7, H5

MARKING GUIDELINES

Criteria	Marks
• Correct answer. Simplification not required	2
• Clearly shows an attempt to apply the product rule	1

Question 3 (b)

Outcomes assessed: P4

MARKING GUIDELINES

Criteria	Marks
• Correct answer with reasons. Reasons need to be clear, but do not need to be precisely stated	2
• Correct answer without reasons or makes progress by finding another relevant angle with reasons	1

Question 3 (c)

Outcomes assessed: P4

MARKING GUIDELINES

Criteria	Marks
• Correct region (including boundaries). Ignore behaviour at (6, 4) and (6, 0)	3
• Sketch shows lines $x = 6$ and $y = x - 2$ and shaded region is consistent with at least one inequality	2
• Sketch shows line $x = 6$ or $y = x - 2$	1

Question 3 (d) (i)

Outcomes assessed: P8, H5

MARKING GUIDELINES

Criteria	Marks
• Correct answer. C may be omitted	1

Question 3 (d) (ii)

Outcomes assessed: P8, H5

MARKING GUIDELINES

Criteria	Marks
• Correct answer, not involving references to tan	2
• Correct primitive or equivalent	1

Question 4 (a) (i)

Outcomes assessed: P4

MARKING GUIDELINES

Criteria	Marks
• Correct answer	1

Question 4 (a) (ii)

Outcomes assessed: P4, H5

MARKING GUIDELINES

Criteria	Marks
• Correct bearing	3
• Computes $\angle RPQ$ correctly or gives bearing consistent with an incorrect $\angle RPQ$ obtained from an application of the sine rule	2
• Correct application of the sine rule or gives bearing consistent with incorrect $\angle RPQ$	1

Question 4 (b) (i)

Outcomes assessed: H5

MARKING GUIDELINES

Criteria	Marks
• Correct answer. Evaluation is not required	2
• Identifies the two possibilities or correctly computes probability of one of them	1

Question 4 (b) (ii)

Outcomes assessed: H5

MARKING GUIDELINES

Criteria	Marks
• Correct answer. Evaluation is not required	1

Question 4 (c) (i)

Outcomes assessed: P4

MARKING GUIDELINES

Criteria	Marks
• Correct solution	2
• Uses a correct approach	1

Question 4 (c) (ii)

Outcomes assessed: H8

MARKING GUIDELINES

Criteria	Marks
• Correct solution. Errors in simplifying the final numerical expression may be ignored	3
• Correct process with a single minor error eg errors which lead to wrong sign, minor mistake in integration	2
• Relates the area to appropriate definite integral(s)	1

Question 5 (a) (i)

Outcomes assessed: P4

MARKING GUIDELINES

Criteria	Marks
• Correct derivative before factorising	1

Question 5 (a) (ii)

Outcomes assessed: H6

MARKING GUIDELINES

Criteria	Marks
• Both points with nature correctly determined NB (0, 0) inflection because $f''(0) = 0$ is not acceptable	3
• Coordinates of both stationary points found and one point correctly classified. (y-coordinates may be shown in answer to part (iii))	2
• x coordinates of both stationary points found or one point found and correctly classified	1

Question 5 (a) (iii)

Outcomes assessed: H3

MARKING GUIDELINES

Criteria	Marks
• Graph through two stationary points found in (ii) with claimed nature and no additional stationary points	1

Question 5 (a) (iv)

Outcomes assessed: P2, P4, H2, H5

MARKING GUIDELINES

Criteria	Marks
• Indicates concave down between 0 and 2	2
• Work which shows that candidate relates concavity to the sign of the 2nd derivative	1

Question 5 (b) (i)

Outcomes assessed: H5

MARKING GUIDELINES

Criteria	Marks
• Correct solution	2
• Finds number of blocks in row 1 or correct computation based on incorrect number of blocks in row 1	1

Question 5 (b) (ii)

Outcomes assessed: H5

MARKING GUIDELINES

Criteria	Marks
• Correct answer appropriate to answer to (i)	1

Question 5 (b) (iii)

Outcomes assessed: H5

MARKING GUIDELINES

Criteria	Marks
• Correct answer. Mistakes in numerical evaluation should be ignored	2
• Correct application of a formula for the sum of an *AP* to either section or equivalent	1

Question 6 (a)

Outcomes assessed: H3

MARKING GUIDELINES

Criteria	Marks
• Correct solution	2
• Converts to a linear equation by exponentiation	1

Question 6 (b) (i)

Outcomes assessed: P2, P4, H2, H5

MARKING GUIDELINES

Criteria	Marks
• Gives an appropriate reason. Reason must be clear, but need not be precisely stated	1

Question 6 (b) (ii)

Outcomes assessed: P2, P4, H2, H5

MARKING GUIDELINES

Criteria	Marks
• Correct proof with full justification. Students may rely on the theorem that Δ's with equal base angles are isosceles	2
• Shows $\angle DCB = \angle ABE$ (or equivalent) with reasons, or provides a proof without the required level of justification	1

Question 6 (b) (iii)

Outcomes assessed: P2, P4, H2, H5

MARKING GUIDELINES

Criteria	Marks
• Correct argument with reasons. Students who have not shown that $BC = BD$ in (ii) must give a reason here	2
• Substantial progress such as showing $\Delta AEB \,|||\, \Delta ADC$ or an argument which omits the required reasons	1

Question 6 (c) (i)

Outcomes assessed: H3

MARKING GUIDELINES

Criteria	Marks
• Correct solution. Numerical evaluation of k is not required	3
• Establishes that $C_0 = 5$ and $e^{-k} = \dfrac{2.8}{5}$ or makes equivalent progress	2
• Evaluates C_0 or makes equivalent progress	1

Question 6 (c) (ii)

Outcomes assessed: H3, H5

MARKING GUIDELINES

Criteria	Marks
• Establishes that $t = -\ln(0.04)/k$ or equivalent. Do not penalise incorrect rounding, but an answer of 6 years without intermediate working is not acceptable	2
• Obtains $e^{-kt} = \dfrac{0.2}{5}$ or equivalent or obtains an answer of 6 years by considering the GP 5, 2.8, $5\left(\dfrac{2.8}{5}\right)^2, \ldots$	1

Question 7 (a) (i)

Outcomes assessed: P3, H5

MARKING GUIDELINES

Criteria	Marks
• Correct solution. Simplification is not required	2
• Identifies a and r, or uses the correct formula with one of these values incorrectly obtained	1

Question 7 (a) (ii)

Outcomes assessed: P2, P3, H2, H5

MARKING GUIDELINES

Criteria	Marks
• Must refer to the common ratio being greater than 1	1

Question 7 (b) (i)

Outcomes assessed: H5

MARKING GUIDELINES

Criteria	Marks
• Correct answer	2
• Reasonable attempt to solve $2-4\cos t=0$	1

Question 7 (b) (ii)

Outcomes assessed: H5

MARKING GUIDELINES

Criteria	Marks
• Correct answer	2
• Deduces that $4\sin t=0$ or equivalent	1

Question 7 (b) (iii)

Outcomes assessed: H5, H9

MARKING GUIDELINES

Criteria	Marks
• Correct shape showing information obtained in (i) and (ii). Sketch does not have to be drawn to scale, but only ignore extension beyond one period if 2π is shown	2
• Graph has inverted cosine shape and correct period, or equivalent merit	1

Question 7 (b) (iv)

Outcomes assessed: H5

MARKING GUIDELINES

Criteria	Marks
• Correct solution (consistent with answers in (i)). Do not penalise students who are clearly calculating total distance between 0 and 2π	3
• Minor error in computation, or correct computation of displacement	2
• Working which shows an understanding that distance/displacement is related to the integral of the velocity	1

Question 8 (a)

Outcomes assessed: P4

MARKING GUIDELINES

Criteria	Marks
• Correct answer	1

Question 8 (b)

Outcomes assessed: H3, H5, H9

MARKING GUIDELINES

Criteria	Marks
• Correct answer	3
• An answer which is almost correct, but which omits the π, or has incorrect limits of integration or equivalent	2
• Obtains an integral involving (ln y) or equivalent	1

Question 8 (c)

Outcomes assessed: H8, H9

MARKING GUIDELINES

Criteria	Marks
• Correct substitution into Simpson's rule to obtain $\frac{2}{3}\left(\frac{2}{\ln 2}+\frac{16}{\ln 4}+\frac{6}{\ln 6}\right)$ or equivalent	3
• Applies Simpson's rule to 3 equally spaced points with incorrect h or equivalent	2
• Exhibits knowledge of the shape of the Simpson's rule formula in the context of this question	1

Question 8 (d) (i)

Outcomes assessed: P4

MARKING GUIDELINES

Criteria	Marks
• Establishes that the line and parabola have only 1 point of intersection	2
• Substitutes $y = mx - 3m^2$ into equation of parabola or finds the point on the parabola with slope m	1

Question 8 (d) (ii)

Outcomes assessed: P3, P4

MARKING GUIDELINES

Criteria	Marks
• Correct solution	2
• Uses the fact that $y = mx - 3m^2$ passes through (5, 2) to obtain $2 = 5m - 3m^2$	1

Question 8 (d) (iii)

Outcomes assessed: H5

MARKING GUIDELINES

Criteria	Marks
• Correct answer from (ii)	1

Question 9 (a)

Outcomes assessed: P3, H5

MARKING GUIDELINES

Criteria	Marks
• Correct solution	2
• Deduces that $\sin x = -\frac{1}{2}$ or finds both solutions of $\sin x = k$, where $-1 < k < 1$ is one of the incorrect solutions to the quadratic in $\sin x$	1

Question 9 (b) (i)

Outcomes assessed: P4, H9

MARKING GUIDELINES

Criteria	Marks
• Correct solution	1

Question 9 (b) (ii)

Outcomes assessed: H5, H9

MARKING GUIDELINES

Criteria	Marks
• Correct answer	1

Question 9 (b) (iii)

Outcomes assessed: H5, H9

MARKING GUIDELINES

Criteria	Marks
• Correct answer	1

Question 9 (b) (iv)

Outcomes assessed: H5, H9

MARKING GUIDELINES

Criteria	Marks
• Correct solution	2
• Calculates area of ΔAOB or equivalent	1

Question 9 (c) (i)

Outcomes assessed: H5, H9

MARKING GUIDELINES

Criteria	Marks
• Must be apparent from working that $t = \dfrac{L}{v-u}$	1

Question 9 (c) (ii)

Outcomes assessed: H2, H5, H9

MARKING GUIDELINES

Criteria	Marks
• Correct solution, including justification for the claim that it minimises E	4
• Finds $v = \dfrac{3u}{2}$, but does not show that it corresponds to minimum E	3
• Deduces that $2aLv^3 - 3aLuv^2 = 0$ or equivalent	2
• Computes $\dfrac{dE}{dv}$ correctly or attempts to solve $\dfrac{dE}{dv} = 0$	1

Question 10 (a) (i)

Outcomes assessed: H5

MARKING GUIDELINES

Criteria	Marks
• Correct solution. Need not be simplified	1

Question 10 (a) (ii)

Outcomes assessed: H5

MARKING GUIDELINES

Criteria	Marks
• A solution which shows the development of the *GP* and applies formula for sum of *GP* with convincing detail	2
• Correctly develops the GP with the correct number of terms, or correctly sums an equivalent GP developed in the course of the answer $\left(\text{eg } 1+\alpha+\ldots+\alpha^n\right)$	1

Question 10 (a) (iii)

Outcomes assessed: H5

MARKING GUIDELINES

Criteria	Marks
• Correct answer. Evaluation is required	2
• Attempt to solve $\dfrac{kF\left(\alpha^n-1\right)}{0.06}=120000\alpha^n$ with $\alpha = 1.015$ and $n = 100$, $k = 4$, or equivalent	1

Question 10 (a) (iv)

Outcomes assessed: H2, H5

MARKING GUIDELINES

Criteria	Marks
• Correct answer. Evaluation is required	2
• Finds repayment when $k = 12$, $n = 300$, or makes arithmetic errors in correct process	1

Question 10 (b) (i)

Outcomes assessed: H5, H9

MARKING GUIDELINES

Criteria	Marks
• Correct answer	1

Question 10 (b) (ii)

Outcomes assessed: H5

MARKING GUIDELINES

Criteria	Marks
• Correctly differentiates l and expresses the result with a common denominator. Rationalising the numerator need not be shown explicitly	2
• Correctly differentiates l	1

Question 10 (b) (iii)

Outcomes assessed: H2, H5

MARKING GUIDELINES

Criteria	Marks
• Finds $x = r\left(r + \frac{\sqrt{r^2+8}}{4}\right)$ with justification that this minimises l	2
• Determines that $x = r\left(\frac{r+\sqrt{r^2+8}}{4}\right)$ is the only solution of $\frac{dl}{dx} = 0$ satisfying $0 \le x \le r$ $\left[\text{ie must reject } x = 1, \text{ but is not required to reject } x = r\left(\frac{r-\sqrt{r^2+8}}{4}\right)\right]$	1