2006 HSC Notes from the Marking Centre Mathematics

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2006 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 2006 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. In answering parts of questions candidates should always state the relevant formulae and the information they use to substitute into the formulae. In general, candidates who do this make fewer mistakes and, when mistakes are made, marks are able to be awarded for the working shown. 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. Any rough working should be included in the answer booklet for the question to which it applies.

Question 1

(a) Candidates are reminded to write the calculator display before rounding off. They must also take care to read the question carefully to avoid transcription errors, particularly at the start of the paper.

(b) The majority of candidates were able to factorise the expression and gave a bald answer. A number of candidates solved an equation, found the roots and hence determined the factors of the expression, but many were not able to interpret their answers correctly. Many candidates factorised the expression and continued on to solve an equation.

(c) The majority of candidates recognised that the equation represented a V-shaped graph. However the graph was commonly positioned incorrectly on the number plane, with candidates often sketching $y = |x| + 4$ instead. Candidates are reminded of the need to use a ruler when sketching and to clearly identify intercepts.

(d) Candidates are reminded of the need to know formulae and the importance of being familiar with their calculator. The vast majority of successful answers applied the sine rule showing full setting out. Candidates are reminded to read the question carefully and round off as advised. A number of candidates also wrongly assumed that the triangle was right-angled.

(e) The importance of clear and logical setting out is stressed here as many solutions included confusing setting out, particularly when dividing by a negative number. Candidates whose first line of working was $3 \le 2 + 5x$ avoided dividing by a negative number and did not need to consider the change of inequality sign.

(f) Candidates must be careful when copying from the examination paper to their writing booklet. A number of candidates confused the letters '*a*' and '*r*' when identifying the common ratio, or did not clearly identify '*r*'. Candidates also confused the common ratio with the limiting sum.

Question 2

As a general comment this question illustrated that many candidates still have weaknesses in the algebraic manipulation of expressions and in finding the exact values of trigonometric functions for standard angles such as $\frac{\pi}{3}$ and $\frac{\pi}{6}$.

(a) (i) This part of the question required an application of the product rule and a knowledge of the derivative of $\tan x$. Better responses demonstrated knowledge of the product rule either by writing the rule down explicitly or by setting the answer out in the correct form before writing down the final answer. Candidates are reminded that the derivative of $\tan x$ can be found by using the standard integrals sheet provided as part of the examination paper.

(ii) The majority of candidates attempted this part by using the quotient rule rather than rewriting the integrand as a product and applying the product rule. Again, better responses demonstrated knowledge of the quotient rule before attempting to write down a final answer. A large number of candidates made errors in trying to simplify the expression that they had obtained from substitution into the quotient rule.

(b) (i) The most common error in this part was to differentiate one or both of the terms in the integrand, rather than to integrate them.

(ii) The most common error in this part was not to recognise that the primitive was a logarithmic function. Poor responses included finding the primitive of each term in the numerator and denominator, differentiating the integrand, and incorrect algebraic rearrangements of the integrand. For those candidates who did recognise the primitive as a logarithmic function, common errors included: writing the primitive as $\frac{1}{4}\ln(1+x^2)$, writing the primitive as $4\ln((1+x)^2)$, and using logarithms to the base 10 instead of to the base *e*.

(c) Answering this part of the question entailed three basic steps: finding the slope of the tangent, determining a point that the tangent passes through, and hence determining the equation of the tangent.

The slope of the tangent is given by $f'\left(\frac{\pi}{6}\right)$. Common errors in this step included: not correctly differentiating $\cos 2x$, not substituting $x = \frac{\pi}{6}$ into the derivative, incorrectly evaluating $-2\sin\frac{2\pi}{6}$, using the slope of the normal, or using a slope not obtained from differentiation at all, for example $m = \cos 2$.

The tangent passes through the point $(\frac{\pi}{6}, \cos\frac{2\pi}{6})$. Common errors in this step included: using the point obtained from letting $x = 0$, not substituting $x = \frac{\pi}{6}$ into $\cos 2x$, incorrectly evaluating $\cos\frac{2\pi}{6}$, or using 30 for the abscissa of the point. Even for candidates who correctly completed the first two steps, errors were made in putting the information together to find the equation of the tangent. The majority of these errors seemed to be careless errors, such as writing $\frac{\pi}{3}$ instead of $\frac{\pi}{6}$, or writing $\sqrt{3}$ instead of $-\sqrt{3}$.

Question 3

(a) (i) This question was attempted in a variety of ways. The most common methods used were finding the gradient from the coordinates of *A* and *B* and then substituting into the point-gradient form of a line or substituting directly into the two-point formula. Showing the coordinates of *A* and *B* satisfied the equation of the line also earned full marks and was the most successful method used by candidates who scored few marks in other parts of the question.

(ii) Most candidates answered this part correctly. The most common mistake was to substitute $y = 0$ instead of $x = 0$ into the equation of *AB* to find the coordinates of *D*.

(iii) The perpendicular distance formula was not known by a significant number of candidates and even when it was known the substitutions were often not done correctly, with the denominator causing the most errors. Practice in using this formula correctly should be given a strong emphasis in a candidate's revision. Many students spent considerable time correctly finding the distance using other techniques.

(iv) The better responses to this question used their answer to part (iii) and the distance *AD* to find the area. Again, time was wasted by many candidates who did not use their answer to part (iii) to find the area of the triangle. Others incorrectly assumed that *AC* was perpendicular to *AD* or found the area of the wrong triangle. The fact that triangle *ABD* was an obtuse-angled triangle and the perpendicular height was measured outside the triangle appeared to confuse many candidates.

(b) Candidates who listed the three terms and added them achieved full marks. As there were only three terms the solution could easily be found by adding these terms. Many candidates did not gain marks in this part as they did not write out the expansion of the series and incorrectly assumed it was an arithmetic progression or a geometric progression.

(c) Candidates providing the better responses recognised that the question involved arithmetic progressions and used formulae correctly or carefully listed terms, enabling many to answer all parts of the question correctly. A number of candidates incorrectly assumed that the series was geometric or even that it was exponential decay. It was apparent that solving equations and inequations involving the substitution of a negative into a formula was an area of revision that would have benefited many candidates.

(i) Responses that recognised the common difference was –17 and correctly found the 14th term received full marks.

(ii) Those candidates who found the sum to 14 terms correctly, or correctly applied the sum to *n* terms formula using their result from part (i), received full marks.

(iii) Better responses involved candidates successfully solving $T_n < 60$. The methods used included: solving $T_n = 60$ and then testing the solution to arrive at the conclusion that the required number of days was 31; successfully solving $T_n < 60$ and remembering to change the inequality sign when dividing by a negative; and using a trial-and-error method to find the first term under 60 and then correctly concluding that the number of days was 31.

Question 4

(a) (i) In better responses, candidates gave reasons for the three geometrical steps and used the diagram to illustrate their thought process by marking in the angles. Most candidates worked with radians, though some chose to convert to degrees first before proceeding with their solutions. Candidates using a mixture of radians and degrees in the same equation did not gain the mark.

(ii) Candidates who used the correct cosine rule and substituted correctly usually scored full marks. The sine rule was also used by candidates with the same degree of success. Dividing the isosceles triangle into right-angle triangles for calculation of *BD* was another method used. Loss of marks usually resulted from incorrect use of calculators, a wrong angle, or incorrect cosine rule or sine rule.

(iii) Candidates who knew their formulae were generally successful in obtaining the correct answer. The most common errors were not knowing the sector area formula, and leaving out the $\frac{1}{2}$ in the sector area formula or the formula for the area of the triangle. Another error was the use of 150 instead of $\frac{5\pi}{6}$ in the sector area formula. Some candidates were unable to simplify or work with surds and fractions, resulting in calculation errors in their responses.

(b) Most candidates were able to answer this volume question correctly. Common errors were leaving out the π in the integrand and incorrect limits. Since this volume of rotation is about the *y*-axis, the correct integrand is $V = \pi \int_1^5 (y-1)\, dy$; however, many candidates took the volume of rotation to be about the *x*-axis and ended with an incorrect expression.

(c) (i) Misinterpretation of the question by many candidates assuming there was 'replacement' led to the solution $P(\text{www}) = \frac{1}{2}\times\frac{1}{2}\times\frac{1}{2} = \frac{1}{8}$. However, consistently carrying through this error in part (ii) and part (iii) was not penalised in those parts. Better responses took into account that there was no replacement and most candidates were able to use their calculators to obtain a simple fraction.

(ii) Most candidates doubled the answer from part (i) and received the mark for this part of the question.

(iii) Most candidates used the complement of the event to answer this question. Candidates who drew tree diagrams and then tried to work out the probability were often unsuccessful in obtaining the correct answer.

Question 5

(a) (i) Most candidates understood that $\frac{dy}{dx}$ was required and that stationary points occurred when $\frac{dy}{dx} = 0$. Candidates who attempted the differentiation using the product rule were more likely to make an error than those who wrote the function as a simple polynomial before differentiating. Poor factorising and substitution skills were often evident.

(ii) This part was done well. Almost all candidates knew to equate the second derivative to zero and most successfully tested for the change in concavity.

(iii) The graph did not pose a problem to candidates who had successfully completed parts (i) and (ii). Many did not continue their graph far enough to show the *x*-intercept of 3. Algebraic errors often made it impossible to draw a graph to fit the candidate's incorrect stationary points. Candidates are reminded that the graph of a cubic function is smooth and continuous.

(iv) This part was answered well. Some candidates substituted successfully but were unsure whether the minimum value was the *x*- or *y*-coordinate of the lowest point.

(b) (i) The majority of candidates were successful in this part.

(ii) This part was not done well. Successful candidates recognised the connection between parts (i) and (ii) and were able to place the negative sign correctly.

Question 6

(a) (i) The majority of candidates presented a solution involving $\angle BCA = \angle CAD$ (alternate angles as BC is parallel to AD). However, candidates who did not provide the link $\angle BAC = \angle CAD$ were not awarded any marks.

(ii) Candidates presented a congruence proof that involved three matching equality statements. The better responses gave appropriate reasons for these statements and the correct congruence test. Candidates who provided insufficient justification were awarded one mark.

(iii) Candidates providing better responses to this question presented a correct argument with appropriate reasons to justify their statements. However, many candidates attempted to answer the question by stating the properties of a rhombus only. When presenting a proof candidates need a logical argument with justification.

(b) (i) Most candidates substituted $t = 0$ into the mathematical model $P = 150 + 300e^{-0.05t}$ and obtained the correct answer of 450 birds.

(ii) A significant number of candidates did not calculate $\frac{dP}{dt}$ to determine the rate of change. Most candidates who determined the rate of change obtained the correct answer. Candidates who omitted the negative sign or did not indicate a decreasing rate were awarded one mark.

(iii) Many candidates attempted to use the limiting sum of a geometrical progression to answer this question. Candidates providing better responses understood that $e^{-0.05t} \to 0$ when $t \to \infty$ and obtained the correct answer of 150 birds.

(iv) A pleasing number of candidates obtained full marks for this question. Candidates solved the exponential equation $50 = 300e^{-0.05t}$ using logarithms or obtained the correct answer using a trial-and-error method and their calculator.

Question 7

(a) Most candidates correctly evaluated the product of the roots but then experienced difficulty in the relatively unfamiliar task of using that result to evaluate the sum of the roots. The difficulty arose because the reciprocal relationship between the roots was left for the candidates to discover. This proved to be a demanding task for most candidates.

(b) (i) Candidates were required to show that a graph cut the x-axis at a given point. They needed to realise that this task involved analytical rather than graphical methods.

(ii) The correct shape of a cosine curve was indicated by correct intercepts and correct concavity changes. Three marks were allocated for varying degrees of correctness. The majority of candidates demonstrated a familiarity with the shape of a cosine curve.

(iii) The required calculation to determine the area under the curve was usually set up correctly, and the primitive was also found correctly; however, the correct numerical expression required substituting radian measure rather than degrees. It is apparent from most responses that the table of standard integrals was correctly applied in this question.

(c) (i) This provided the easiest mark of the question, with candidates required simply to write down the discriminant from the given quadratic equation.

(ii) This was perhaps the most challenging part of the question, since it was left to candidates to see a connection between a value of an unknown in the coefficient of a term of the quadratic equation and the intersection of a parabola with a given line. Responses seldom linked this with the discriminant.

Question 8

(a) (i) Candidates are reminded that the concepts of distance and displacement are not interchangeable and marks were lost in part (i) for answers which were positive rather than negative.

(ii) It should be stressed in relation to parts (i) and (ii) that the term 'initial' demands that $t = 0$ (not $x = 0$) whereas 'passing through the origin' implies that $x = 0$ (as opposed to $t = 0$). A common error in this part was to integrate rather than differentiate when producing a velocity formula. Candidates who differentiated correctly often then substituted $t = 0$ instead of the correct $t = 3$.

(iii) Generally, this part was handled well if the correct velocity formula was obtained in part (ii).

(iv) In this part many candidates incorrectly sketched a straight line. Better responses not only displayed a hyperbolic shape but also fully addressed the issue of the horizontal asymptote.

(b) (i) Responses to this part were generally strong. Common errors were to put $A_n = 300$ rather than $A_n = 0$, to use $n = 299$ rather than 300, and finally to claim that 200 000 $(1.06)^n$ = 212 000^n. Many students carefully reconstructed (without reward) the supplied expression for A_n.

(ii) It was common for candidates to use trial and error rather than an algebraic approach in part (ii) and carefully presented responses were accepted. Despite significant algebraic demands, many candidates solved the relevant exponential equation in part (ii) to achieve full marks in part (b).

Question 9

(a) Finding the vertex of the parabola proved difficult for the majority of candidates. Those who had the most success completed the square. Candidates who used the axis of symmetry to find the *x*-value often had problems finding the *y*-coordinate of the vertex. Of those who found the correct vertex, most were then able to find the correct focus.

(b) (i) Most candidates were able to find the initial rate and then write $240 = 120 + 26t - t^2$. Unfortunately many then made careless errors and were unable to factorise correctly. In better responses candidates changed the equation so that the coefficient of t^2 was positive. Candidates are reminded of the importance of basic algebra skills.

(ii) This part was very poorly done. Many candidates correctly integrated and gave $V = 120t + 13t^2 - \frac{t^3}{3} + c$, but then either did not bother to evaluate c or incorrectly said that c was 1500. They did not appear to understand that V was the 'volume of water that has flowed into the tank since the start of the storm'.

(iii) This part was done well. Many candidates who showed their substitution and working were able to gain full marks here even though their function in part (ii) was incorrect.

(c) (i) This part was not done well. Candidates who were most successful drew a diagram and correctly applied Pythagoras' theorem to give $r^2 = a^2 - (x-a)^2$. They were then able to arrive at the correct expression for V.

(ii) Candidates who attempted this part usually did well, demonstrating that they have been well taught in maximum/minimum problems. A significant number gained full marks even though they were unable to do part (i). Candidates are reminded of the key steps in such problems, viz. finding the derivative and setting it to zero, solving this equation, testing the values so found in a clear and well-labelled manner and, finally, drawing a conclusion. The more successful candidates left V, V', V'' in factored form and used the second derivative to test. Common errors included dropping the $\frac{\pi}{3}$ or a, failing to do a test correctly, and not referring to a general principle to make a concluding statement.

Question 10

(a) This part was attempted by the majority of candidates and proved to be the part where most earned their marks. Most candidates seemed to know Simpson's rule well, and had no difficulty in applying it. Some replaced the $(\log_e x)^3$ function incorrectly with $(\log_{10} x)^3$, $3\log_e x$ or $\log_e x^3$. Correct evaluation of $\log_e 1$ was often hard to determine from the written responses. Candidates should be encouraged to show all values in a table before applying Simpson's rule. Often the $4(\log_e 1)^3$ term was left out of the calculations due to its zero value. Since Simpson's rule is often used for area calculation, most candidates converted their answer to a positive value, with some even taking the absolute value of any negative portions of their calculations. Finally, the calculation of $\frac{h}{3}$ or $\frac{b-a}{6}$ proved difficult for some candidates, but one interesting method employed involved the addition of the weightings eg $\frac{1.5-0.5}{1+4+1}$ for one application or $\frac{1.5-0.5}{1+4+2+4+1}$ for two applications.

(b) Having ten marks attached to part (b) seemed to deter a large number of candidates from attempting this part. Candidates are advised to look carefully at the mark value for sub-parts as an indication of the amount of work required to answer them.

(i) Most candidates failed to recognise that $KL = 6 + x$, others going through some elaborate calculations in order to prove it. Having correctly stated the Pythagorean relationship, a large number of candidates had difficulty expanding the terms to show that $QL^2 = 24x$.

(ii) Candidates should be advised to attempt geometry proofs even though they are late in the paper. A large percentage failed to attempt the similarity proof and moved straight to the proportionality section. When proofs were attempted, the demonstration of geometrical reasoning was poor, with some candidates indicating that three angles were 'supplementary' for example, and/or neglecting to state the similarity test used. Again, candidates are advised to make use of their sketched diagram to discover the matched angles required for the similarity.

(iii) The majority of candidates who attempted this part were able to gain the allotted mark. The most common error was that $A = \frac{1}{2}y^2$, while a number of candidates appeared to simply 'fudge' their response by rewriting the statement given. Some candidates recalculated the expression for KL in order to use it in their working.

(iv) The algebra involved in this part proved to be very difficult and even beyond most candidates. Those who looked at it as two distinct equality statements were able to make the best progress, but failure to link the fact that $0 < x < 6$ was prevalent, with $x = \frac{27}{2}$ still being tested and even the interval $6 \leq x \leq 13.5$ being stated as the final answer or part thereof.

(v) In order to gain full marks for this part, candidates were required to draw the link between the domain in part (iv) and their area. A common error was the use of the expression for y from part (ii) instead of the expression for A from part (iii). Candidates are advised to avoid the use of shortcuts when differentiation is involved, for example leaving the denominator out of the quotient rule because it was to be set equal to zero. A significant number of candidates obtained their only mark for part (b) by correctly differentiating. When testing for a minimum, values of the derivative on either side should be used instead of just stating – 0 + or \ _ / in a table.

Mathematics

2006 HSC Examination Mapping Grid

Question	Marks	Content	Syllabus outcomes
1 (a)	2	12.2, 1.1	H3
1 (b)	2	1.3	P4
1 (c)	2	4.2	P4
1 (d)	2	5.5	P4
1 (e)	2	1.4	P3
1 (f)	2	7.3	H5
2 (a) (i)	2	8.8, 13.5	P7, P8, H5
2 (a) (ii)	2	8.8, 13.5	P7, P8, H5
2 (b) (i)	2	11.2, 12.5	P8, H5
2 (b) (ii)	3	11.2, 12.5	P8, H5
2 (c)	3	8.5. 13.5	P2, P7, H6
3 (a) (i)	2	6.2	P4
3 (a) (ii)	1	6.3	P4
3 (a) (iii)	1	6.5	P4
3 (a) (iv)	2	2.3	P4
3 (b)	1	7.0	H5
3 (c) (i)	2	7.5	H5
3 (c) (ii)	1	7.5	H5
3 (c) (iii)	2	7.5	P2, H5
4 (a) (i)	1	2.3, 13.1	P4, H5
4 (a) (ii)	2	5.3, 5.5	P4
4 (a) (iii)	2	13.1	H5
4 (b)	3	11.4	P8, H8
4 (c) (i)	2	3.3	H5
4 (c) (ii)	1	3.2, 3.3	H5
4 (c) (iii)	1	3.3	H5
5 (a) (i)	3	10.2	P5, P6, P7, P8, H6
5 (a) (ii)	1	10.4	P5, P8, H6
5 (a) (iii)	3	10.5	P5, P8, H6, H9
5 (a) (iv)	1	10.6	P5, P8, H6
5 (b) (i)	1	12.5, 13.5	P7, P8, H5
5 (b) (ii)	3	11.4, 12.5, 13.6	P8, H5, H9
6 (a) (i)	1	2.5	H2, H5

Question	Marks	Content	Syllabus outcomes
6 (a) (ii)	2	2.5	H2, H5
6 (a) (iii)	3	2.5	H2, H5
6 (b) (i)	1	14.2	H3
6 (b) (ii)	2	14.2	H3, H5
6 (b) (iii)	1	14.2	H3
6 (b) (iv)	2	14.2	H3, H9
7 (a) (i)	1	9.2	P4
7 (a) (ii)	1	9.2	P4
7 (b) (i)	1	13.3, 5.1	P5, H5, H9
7 (b) (ii)	3	13.3, 5.1	H6, H9
7 (b) (iii)	3	11.4	H8
7 (c) (i)	1	9.2	P4
7 (c) (ii)	2	9.1	P4
8 (a) (i)	1	14.1	H4, H9
8 (a) (ii)	3	14.1, 14.3	H5, H9
8 (a) (iii)	1	14.1, 14.3	H5, H9
8 (a) (iv)	2	10.5, 14.3	H5, H9
8 (b) (i)	3	7.2, 7.5	H5
8 (b) (ii)	2	7.5, 12.3	H3, H5
9 (a)	2	9.5	P4
9 (b) (i)	2	1.4	P3
9 (b) (ii)	1	11.2	H5
9 (b) (iii)	2	14.1	H4, H5
9 (c) (i)	2	2.3	P4
9 (c) (ii)	3	10.6	H5
10 (a)	2	11.3	H5
10 (b) (i)	1	1.1, 2.3	P4
10 (b) (ii)	3	2.4, 2.5	P4, H5
10 (b) (iii)	1	1.1, 2.3	P4
10 (b) (iv)	2	9.1	P4
10 (b) (v)	3	10.2, 10.6	H5, H6, H9

BOARD OF STUDIES
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2006 HSC Mathematics Marking Guidelines

Question 1 (a)

Outcomes assessed: H3

MARKING GUIDELINES

Criteria	Marks
• Correct answer	2
• Correct evaluation or rounding	1

Question 1 (b)

Outcomes assessed: P4

MARKING GUIDELINES

Criteria	Marks
• Correct answer	2
• Demonstrates some knowledge of factorisation	1

Question 1 (c)

Outcomes assessed: P4

MARKING GUIDELINES

Criteria	Marks
• Correct sketch	2
• Demonstrates some knowledge of absolute value graphs	1

Question 1 (d)

Outcomes assessed: P4

MARKING GUIDELINES

Criteria	Marks
• Correct answer	2
• Applies sine rule or equivalent merit	1

Question 1 (e)

Outcomes assessed: P3

MARKING GUIDELINES

Criteria	Marks
• Correct solution	2
• Makes significant progress	1

Question 1 (f)

Outcomes assessed: H5

MARKING GUIDELINES

Criteria	Marks
• Correct solution	2
• Identifies the common ratio or equivalent progress	1

Question 2 (a) (i)

Outcomes assessed: P7, P8, H5

MARKING GUIDELINES

Criteria	Marks
• Correct answer	2
• Demonstrates some knowledge of the product rule or the derivative of $\tan x$	1

Question 2 (a) (ii)

Outcomes assessed: P7, P8, H5

MARKING GUIDELINES

Criteria	Marks
• Correct answer	2
• Demonstrates some knowledge of the quotient rule or equivalent progress	1

Question 2 (b) (i)

Outcomes assessed: P8, H5

MARKING GUIDELINES

Criteria	Marks
• Correct primitive	2
• Correct primitive of either term	1

Question 2 (b) (ii)

Outcomes assessed: P8, H5

MARKING GUIDELINES

Criteria	Marks
• Correct solution	3
• Correct primitive or equivalent merit	2
• Primitive of the form $A\log(1+x^2)$ or equivalent merit	1

Question 2 (c)

Outcomes assessed: P2, P7, H6

MARKING GUIDELINES

Criteria	Marks
• Correct solution	3
• Substantial progress	2
• Calculates the gradient of $y = \cos 2x$ at $x = \frac{\pi}{6}$ or equivalent merit	1

Question 3 (a) (i)

Outcomes assessed: P4

MARKING GUIDELINES

Criteria	Marks
• Correct solution	2
• Calculates the gradient or equivalent merit	1

Question 3 (a) (ii)

Outcomes assessed: P4

MARKING GUIDELINES

Criteria	Marks
• Correct answer	1

Question 3 (a) (iii)

Outcomes assessed: P4

MARKING GUIDELINES

Criteria	Marks
• Correct answer	1

Question 3 (a) (iv)

Outcomes assessed: P4

MARKING GUIDELINES

Criteria	Marks
• Correct answer	2
• Calculates the distance *AD* or equivalent merit	1

Question 3 (b)

Outcomes assessed: H5

MARKING GUIDELINES

Criteria	Marks
• Correct answer	1

Question 3 (c) (i)

Outcomes assessed: H5

MARKING GUIDELINES

Criteria	Marks
• Correct answer	2
• Finds the common difference or equivalent merit	1

Question 3 (c) (ii)

Outcomes assessed: H5

MARKING GUIDELINES

Criteria	Marks
• Correct answer	1

Question 3 (c) (iii)

Outcomes assessed: P2, H5

MARKING GUIDELINES

Criteria	Marks
• Correct answer	2
• Attempts to solve $T_n < 60$ or equivalent merit	1

Question 4 (a) (i)

Outcomes assessed: P4, H5

MARKING GUIDELINES

Criteria	Marks
• Correct solution	1

Question 4 (a) (ii)

Outcomes assessed: P4

MARKING GUIDELINES

Criteria	Marks
• Correct answer	2
• Attempts to apply the cosine rule or equivalent merit	1

Question 4 (a) (iii)

Outcomes assessed: H5

MARKING GUIDELINES

Criteria	Marks
• Correct answer	2
• Finds the area of sector *BCD* or equivalent merit	1

Question 4 (b)

Outcomes assessed: P8, H8

MARKING GUIDELINES

Criteria	Marks
• Correct solution	3
• Correct integral expression in terms of y or equivalent merit	2
• Makes some progress	1

Question 4 (c) (i)

Outcomes assessed: H5

MARKING GUIDELINES

Criteria	Marks
• Correct answer	2
• Multiplies the probability of independent events or equivalent merit	1

Question 4 (c) (ii)

Outcomes assessed: H5

MARKING GUIDELINES

Criteria	Marks
• Correct answer	1

Question 4 (c) (iii)

Outcomes assessed: H5

MARKING GUIDELINES

Criteria	Marks
• Correct answer	1

Question 5 (a) (i)

Outcomes assessed: P5, P6, P7, P8, H6

MARKING GUIDELINES

Criteria	Marks
• Correct solution	3
• Finds the coordinates of the turning points or equivalent merit	2
• Attempts to solve $f'(x) = 0$ or equivalent merit	1

Question 5 (a) (ii)

Outcomes assessed: P5, P8, H6

MARKING GUIDELINES

Criteria	Marks
• Correct answer	1

Question 5 (a) (iii)

Outcomes assessed: P5, P8, H6, H9

MARKING GUIDELINES

Criteria	Marks
• Correct sketch	3
• Shows many of the required features	2
• A graph which is consistent with the shape of a cubic	1

Question 5 (a) (iv)

Outcomes assessed: P5, P8, H6

MARKING GUIDELINES

Criteria	Marks
• Correct answer	1

Question 5 (b) (i)

Outcomes assessed: P7, P8, H5

MARKING GUIDELINES

Criteria	Marks
• Correct solution	1

Question 5 (b) (ii)

Outcomes assessed: P8, H5, H9

MARKING GUIDELINES

Criteria	Marks
• Correct solution	3
• Makes substantial progress	2
• Correct integral expression or equivalent	1

Question 6 (a) (i)

Outcomes assessed: H2, H5

MARKING GUIDELINES

Criteria	Marks
• Correct solution	1

Question 6 (a) (ii)

Outcomes assessed: H2, H5

MARKING GUIDELINES

Criteria	Marks
• Correct solution	2
• Correct argument with insufficient justification or equivalent merit	1

Question 6 (a) (iii)

Outcomes assessed: H2, H5

MARKING GUIDELINES

Criteria	Marks
• Correct solution	3
• Correct argument with insufficient justification or equivalent merit	2
• Makes some progress	1

Question 6 (b) (i)

Outcomes assessed: H3

MARKING GUIDELINES

Criteria	Marks
• Correct answer	1

Question 6 (b) (ii)

Outcomes assessed: H3, H5

MARKING GUIDELINES

Criteria	Marks
• Correct solution	2
• Finds $\frac{dP}{dt}$ or equivalent merit	1

Question 6 (b) (iii)

Outcomes assessed: H3

MARKING GUIDELINES

Criteria	Marks
• Correct answer	1

Question 6 (b) (iv)

Outcomes assessed: H3, H9

MARKING GUIDELINES

Criteria	Marks
• Correct solution	2
• Makes some progress	1

Question 7 (a) (i)

Outcomes assessed: P4

MARKING GUIDELINES

Criteria	Marks
• Correct answer	1

Question 7 (a) (ii)

Outcomes assessed: P4

MARKING GUIDELINES

Criteria	Marks
• Correct answer	1

Question 7 (b) (i)

Outcomes assessed: P5, H5, H9

MARKING GUIDELINES

Criteria	Marks
• Correct solution	1

Question 7 (b) (ii)

Outcomes assessed: H6, H9

MARKING GUIDELINES

Criteria	Marks
• Correct sketch	3
• Correct shape with some intercepts missing	2
• Indicating the 3 intercepts or equivalent merit	1

Question 7 (b) (iii)

Outcomes assessed: H8

MARKING GUIDELINES

Criteria	Marks
• Correct solution	3
• Correct primitive or equivalent merit	2
• Correct integral expression or equivalent merit	1

Question 7 (c) (i)

Outcomes assessed: P4

MARKING GUIDELINES

Criteria	Marks
• Correct answer	1

Question 7 (c) (ii)

Outcomes assessed: P4

MARKING GUIDELINES

Criteria	Marks
• Correct solution	2
• Indicates that $\Delta < 0$ or equivalent merit	1

Question 8 (a) (i)

Outcomes assessed: H4, H9

MARKING GUIDELINES

Criteria	Marks
• Correct answer	1

Question 8 (a) (ii)

Outcomes assessed: H5, H9

MARKING GUIDELINES

Criteria	Marks
• Correct solution	3
• Differentiates and finds the time when the particle passes through the origin or equivalent merit	2
• Finds the time when the particle passes through the origin or equivalent merit	1

Question 8 (a) (iii)

Outcomes assessed: H5, H9

MARKING GUIDELINES

Criteria	Marks
• Correct solution	1

Question 8 (a) (iv)

Outcomes assessed: H5, H9

MARKING GUIDELINES

Criteria	Marks
• Correct sketch	2
• A sketch consistent with parts (i) and (ii)	1

Question 8 (b) (i)

Outcomes assessed: H5

MARKING GUIDELINES

Criteria	Marks
• Correct solution	3
• Applies the formula for the sum of a *GP* and attempts to solve $A_{300} = 0$ or equivalent merit	2
• Attempts to solve $A_{300} = 0$ or equivalent merit	1

Question 8 (b) (ii)

Outcomes assessed: H3, H5

MARKING GUIDELINES

Criteria	Marks
• Correct solution	2
• Evaluates r^n or equivalent merit	1

Question 9 (a)

Outcomes assessed: P4

MARKING GUIDELINES

Criteria	Marks
• Correct solution	2
• Finds the vertex or equivalent progress	1

Question 9 (b) (i)

Outcomes assessed: P3

MARKING GUIDELINES

Criteria	Marks
• Correct solution	2
• Finds the quadratic equation that t satisfies or equivalent merit	1

Question 9 (b) (ii)

Outcomes assessed: H5

MARKING GUIDELINES

Criteria	Marks
• Correct answer	1

Question 9 (b) (iii)

Outcomes assessed: H4, H5

MARKING GUIDELINES

Criteria	Marks
• Correct solution	2
• Some progress	1

Question 9 (c) (i)

Outcomes assessed: P4

MARKING GUIDELINES

Criteria	Marks
• Correct solution	2
• Attempts to use Pythagoras' theorem to obtain r in terms of x or equivalent merit	1

Question 9 (c) (ii)

Outcomes assessed: H5

MARKING GUIDELINES

Criteria	Marks
• Correct solution	3
• Finds the value of x or equivalent merit	2
• Differentiates and attempts to solve $\frac{dV}{dx} = 0$	1

Question 10 (a)

Outcomes assessed: H5

MARKING GUIDELINES

Criteria	Marks
• Correct solution	2
• Shows some understanding of Simpson's rule	1

Question 10 (b) (i)

Outcomes assessed: P4

MARKING GUIDELINES

Criteria	Marks
• Correct solution	1

Question 10 (b) (ii)

Outcomes assessed: P4, H5

MARKING GUIDELINES

Criteria	Marks
• Correct solution	3
• Shows the triangles are similar or equivalent merit	2
• A correct deduction from the similarity or equivalent merit	1

Question 10 (b) (iii)

Outcomes assessed: P4

MARKING GUIDELINES

Criteria	Marks
• Correct solution	1

Question 10 (b) (iv)

Outcomes assessed: P4

MARKING GUIDELINES

Criteria	Marks
• Correct solution	2
• Finds one of the endpoints of the range or equivalent merit	1

Question 10 (b) (v)

Outcomes assessed: H5, H6, H9

MARKING GUIDELINES

Criteria	Marks
• Correct solution	3
• Finds the value of x for which the minimum occurs or equivalent merit	2
• Calculates $\frac{dA}{dx}$ or equivalent merit	1