2002 HSC Notes from the Marking Centre Mathematics

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2002 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 2002 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.

Question 1

This question was generally well done. Candidates should be encouraged to set out their work clearly and show all necessary working, particularly when manipulating algebraic expressions.

(a) Many misread the question and evaluated 3.1^2 instead of 3.1^3, and there was much confusion between 3 significant figures and 3 decimal places. Candidates are advised to write down the full calculator display before rounding.

(b) Generally well done.

(c) The most common error was dividing both sides of the quadratic equation by x, thus losing the solution $x = 0$. Candidates who used the quadratic formula or tried to complete the square did not have as much success as those who factorised.

(d) Many candidates did not realise that the integral involved a log function, and of those who did a substantial number could not handle the '3' correctly.

(e) Poor algebra skills and setting out were evident in many responses. The main source of error was a failure to handle the implicit brackets in the $\frac{2x-5}{2}$ term.

(f) This question was generally well done. Candidates who used the substitution method often fared better than those who tried to add/subtract equations. A significant number of candidates only found one variable.

Question 2

This question tested basic calculus with one part based on the sine rule.

(a) Common errors were $y' = \{2xe^{2x} \;, \frac{e^{2x}}{2}, 2e^{x}\}$. It was disappointing to see many otherwise strong candidates claiming that the equation of the tangent was $(y-1) = 2e^{2x}(x-0)$.

(b) (i) This part was well done. A common error was $\frac{d}{dx}\sin x = -\cos x$. It was also clear that some candidates viewed sin x as the product of two functions, sin and x.

(ii) This straightforward quotient rule question was tackled effectively by most candidates. Common mistakes were errors in sign and transposition of terms in the numerator. Some candidates opted to use the product rule on $\ln x(x^{-2})$ and usually proceeded correctly to full marks.

(c) Many candidates correctly applied the sine rule but were seemingly confused by the term 'ratio' and did not proceed to an expression for $\frac{x}{y}$.

(d) (i) This elementary question was well done, however some candidates still seem reluctant to use the table of standard integrals.

(ii) Most candidates managed to obtain the correct primitive for this integral. Those that did not obtain full marks generally had trouble with the evaluation step.

Question 3

This question contained three parts including plane geometry and coordinate geometry. Multiple answer booklets were common. It is important that candidates label parts correctly and indicate if the answer to a part continues into another booklet.

(a) This was a term deposit question with interest compounded annually over 20 years. Unfortunately many candidates treated the question as though it was about superannuation, depreciation or time payment. Converting the interest from a percentage to a decimal was generally well done.

(b) This part involved plane geometry and deductive reasoning to justify a numerical answer. It was pleasing to find the majority of candidates correctly labelling angles. Very few candidates arrived at the wrong numerical value. A logical sequence of reasoning was expected. Some candidates confused the following: straight angle, alternate angles, co-interior angles, and corresponding angles.

(c) A sketch, not to scale, was provided, but those candidates who used their own reasonably accurate sketch employed the most time efficient ways to finish the question. Some candidates seemed unaware that the five sub-sections of part (c) were related.

(i) Almost all candidates found the coordinates of M.

(ii) The most successful candidates were those who used substitution of gradient and midpoint to show that the given equation was the perpendicular bisector of the given interval. It was unfortunate that so many candidates decided to use a locus technique to find the perpendicular bisector. Some of these people made arithmetic mistakes and could not see that their answer was incorrect.

(iii) This part was not handled well.

(iv) Generally well done.

(v) It was gratifying that most candidates realized that the area of the triangle could be found easily from a reasonable sketch using half the base times the height. A common error in the surd work was $\sqrt{\frac{45}{2}} = \frac{\sqrt{45}}{2}$ which may have resulted from sloppy writing of the radical sign.

Question 4

Overall, this question was very well done with many losing no more than two marks. It is important to check that calculators are in the correct angle mode before beginning a trigonometry question. Also rounding should be discouraged until the final stage of any calculation.

(a) In the algebraic solution, while most candidates recognised that there were two cases to be considered, many could not manipulate the simple inequalities. A common error was to treat the expression as a single inequality leading to an expression like $-2 \geq x \geq 4$ and then graphing the answer incorrectly as the section between –2 and 4. Attention must be drawn to the need to draw a neat straight line, to show points as clear dots (solid in this case) on the line, to label them with numbers and to draw rays going outwards from each dot.

(b) Generally well done.

(c) (i) Surprisingly, some candidates did not know the cosine rule. Candidates should show the substitution step, the calculator answer and the rounded answer.

(ii) This should have been a very easy exercise but some candidates insisted on using the sine rule to find perpendicular heights etc. Hardly any of these attempts were successful and most were certainly hindered by the lack of a diagram.

(d) (i) Most candidates solved the equations simultaneously but the question could have been answered by substitution of the coordinates into both equations.

(ii) Very well done, even by weaker candidates. Many did omit the *'dx'* when specifying the integral. The most common error was the use of 0 to 6 or 0 to 8 as the limits of integration.

Question 5

The responses overall were encouraging, with most candidates tending to score more than 6 out of the 12 marks available.

(a) (i) Fairly well handled, even by those candidates who wrote out all the distances. Most candidates attempted to use an arithmetic series formula, although $(32–2) \div 2 = 20$ was fairly common. Any non-integer value for n was awarded zero.

(ii) Most candidates attempted to use a formula for summing an arithmetic series but many forgot to double their answer for the return distance. Using $n = 32$ was surprisingly common and only a very small proportion attempted to use a geometric series.

(b) Most candidates attempted to use the arc length formula and could get $\theta = 1.9$ to earn 2 marks. The third mark was for converting radians to degrees and this was poorly done, common answers being $1°54'$ or $1.9\pi \rightarrow 342°$.

(c) (i) The most common approaches to find the vertex were by the axis of symmetry or by using calculus. Candidates had great difficulty in using the completing the square method and some even tried to find the x-intercepts using the quadratic formula. A common error was $x(x–8) = y–4 \rightarrow$ vertex (8,4).

(ii) This part was poorly handled because of the inability to complete the square. A graphical approach that showed understanding of the location of the focus gained recognition. Relatively few candidates thought that the focus was still at $(0, a)$.

Question 6

(a) This proved to be a reasonably difficult 2 marks for many candidates. To gain the mark for the sketch, candidates needed to indicate on their semicircle that the radius was 2 units by marking 2 and/or –2 on the x-axis and 2 on the y-axis.

(b) (i) This was generally well done although algebraic errors in expanding the product often occurred.

(ii) Many candidates wasted time finding the derivative of the cubic found in part (i) before attempting to sketch the curve. Candidates should be encouraged to give at least a half-page sketch and to label points clearly. Many still think that any point of inflexion is a horizontal point of inflexion.

(iii) This part was missed by many candidates. The most common response was $x \geq 1$.

(c) The volume of revolution was poorly done. A great deal of confusion existed about whether to rotate about the x-axis or the y-axis and what limits to use in each case. Those who simplified the integrand to $2\sqrt{y}$ were more likely to successfully complete the integration step. Most remembered to include π in their formula.

Question 7

(a) (i) An easy mark for the minority who observed that $|r| < 1$, with many of those unsuccessful in gaining the mark claiming $|r| \leq 1$ or $r < 0$. The majority attempted to describe the behaviour of the series, but all too often in an imprecise or contradictory way in which ‘it’ was used to represent several different quantities in the same sentence. Of these responses, some were restricted to saying what a limiting sum is, or why it is calculated, rather than citing the conditions for its existence.

(ii) A significant number of those who could correctly quote the formula for the limiting sum then got into trouble in the denominator through either incorrect signs or failing to reduce it to a binomial before attempting its rationalisation. Relatively few candidates ignored the requirement of an ‘exact’ answer and used decimal approximations.

(b) (i) The vast majority of candidates answered correctly.

(ii) Common false starts included taking V to be $\frac{1}{4}, \frac{3}{4} \times 25$ and $\frac{1}{4} \times 60$. Of the candidates who attempted to expand in order to arrive at a quadratic equation, the majority made algebraic or arithmetic errors. Expanding $(1 - \frac{t}{60})^2$ to give $1 - \frac{t^2}{3600}$ still occurred all too often. Of those who attempted to take the square root of each side, many made errors, while those who did not frequently omitted any mention of the negative root. Some candidates ignored the restriction $0 \le t \le 60$, while a significant number seemed to suddenly chance upon $t = 30$, and, with or without further explanation, gave this as the answer. This was the most troublesome part of the question, with some candidates gaining full credit in 3 or 4 lines, while some others struggled for more than a page to little avail.

(iii) Most candidates recognised the need to find the derivative and then substitute the appropriate value of t. For every candidate who was successful there was another who correctly applied the chain rule, apart from taking the derivative of $1 - \frac{t}{60}$ to be $\frac{1}{60}$.

(c) (i) Most candidates were unable to explain simply that there were 7 socks left of which 6 did not match the first sock. Elaborate diagrams of coloured socks, tables and tree diagrams were common, as were recalculations of the probability rather than an explanation of how it was obtained. Interestingly, many of the candidates who scored poorly over the whole question were successful here.

(ii) This part was poorly done with $\frac{6}{7} \times \frac{5}{6}$ as the most common response. Many candidates did not see the link with part (i), while others seemed to be thinking of 3 further selections with answers of the form $\frac{6}{7} \times \frac{5}{6} \times \frac{4}{5}$, which inadvertently led to a correct result.

(iii) The majority of candidates used the concept of complementary events to obtain their answer, but a large number did not and started the problem all over again.

Question 8

(a) This part was handled well by many candidates, with a good number scoring full marks.

(i) A surprising number of candidates did not know that Q_o was the initial value. Fortunately, they were able to continue using $\frac{1}{2} Q = Qe^{-15t}$. A small number still had trouble solving this equation. It was pleasing though that very few candidates used $\log_{10}$.

(ii) The most common error was to ignore the minus sign on the power. This occurred more often when a candidate had incorrectly calculated the value of k to be a negative number. This apparent carelessness resulted in the loss of a mark. A number of candidates correctly obtained their answer using the half-life process.

(b) This part was not handled as well by the candidates.

(i) Many of the graphs drawn were carelessly sketched or drawn in a hurry. Some graphs had straight-line sections or sharp points. Candidates were careless with the labels and the scales used on the axes. Those candidates who used a template often had trouble labelling their axes correctly. This was most evident on the vertical axis, where the lines on the page often led to some confusion as to whether the candidate knew what the amplitude was. Some did not read the question carefully and consequently did not sketch the graph in the required domain. To gain full marks candidates had to show the correct sine curve, with correct period, amplitude and translation.

(ii) Candidates who did well on this part used the graph to get their answers. Candidates who used calculus generally only obtained 2 solutions. Again, candidates did not read the question carefully enough as a large number of candidates only gave answers to 't' and not 'x'.

(iii) Many candidates did this part of the question poorly. Descriptions required some mention of the oscillation of the particle (ie it moves backwards and forwards) and some simple aspects of the motion of the particle. Many candidates earned their marks in the first few lines and then proceeded to elaborate about increasing and decreasing accelerations, changing velocities and turning points, often writing two pages. A significant number reiterated the answer in part (ii). Information about where the particle was at rest was not sufficient to gain marks in part (iii). Poor expression and poor writing hampered candidates' attempts. Many had difficulty expressing the 'motion' in words. A significant number were in fact simply describing the 'graph' as opposed to the 'motion' of the particle.

Question 9

(a) (i) The essential features of the log function were the asymptote, the x-intercept and the shape of the graph.

(ii) Care needed to be taken when substituting the x-values into $\ln(x-1)$. Candidates who provided a table showing the function values were generally more successful than those who did not.

(b) Nearly all candidates achieved some marks in this section. Candidates who showed the ability to generate a formula had a higher chance of achieving part marks than those who relied on a memorised formula. Calculator skills in evaluating the amount were very good. Care needs to be taken in counting the number of terms in the series and in deciding what is the first term.

(c) (i) A number were able to answer this question from the graph. They realised the velocity was linear and quickly calculated the gradient of the line through the origin.

(ii) This is a question where it is essential that candidates present their working in a clear manner. This enables part marks to be awarded for a correct approach and it also reduces the chance that candidates will misread their own working.

(iii) Displacement functions had to be equated and solved to answer this part. Many candidates incorrectly equated the velocity functions.

Question 10

Most candidates had great difficulty in attempting this question. The easiest marks to gain were in the first two parts while only the very best candidates successfully answered the remaining parts.

(a) (i) Candidates needed to start with $\cos\frac{\theta}{2} = \frac{10}{r}$ or (at the very least) $\sec\frac{\theta}{2} = \frac{r}{10}$. Many of the more capable candidates perceived that they were required to 'prove' that the altitude of the isosceles triangle bisected the chord (by congruent triangles). This used much extra time and effort for the first 2 marks of a question. Candidates who used the third side of the right triangle with sides 10 and *r*, needed to provide a diagram with the sides and angles labelled. Unfortunately, many candidates did not realise that the answer involved a simple trigonometric expression and attempted to find sector areas etc.

(ii) Similar comments apply to part (ii). In both parts, candidates were also able to use the cosine and sine rules but were prone to error or did not provide enough detail, for example, going from $r = \dfrac{10}{\sin(\frac{\pi}{2} - \frac{\theta}{2})}$ directly to $r = 10\sec\frac{\theta}{2}$.

(iii) Graphs should be at least half a page in size, using a constant scale on both axes, and be drawn using a ruler. It is advisable to use the answer booklet's ruled lines for the horizontal axis and to denote the scale on the vertical axis. Many candidates did not understand the concept of domain and graphed each 'function' for $0 < \theta < \pi$ on the same graph or two separate graphs. Candidates who plotted several points often produced very acceptable graphs. Others, however, because of problems with scale or the accuracy of their plotting, failed to show the correct concavity or any concavity at all. Many did not realise that the graphs had a common endpoint.

(b) Poor algebraic and arithmetic skills often let down candidates who had at least some idea of what was needed in part (b).

(i) Candidates who used either the chain or quotient rule often gained marks, while those who started by reorganising *I* so that it had a common denominator made the differentiation much more difficult. Common mistakes were $\frac{d}{dx}\left(b^2\right) = 2b$ or b^2, and the use of (or lack of) parentheses and brackets was very poor.

(ii) Many candidates did not realise that $b = 15$ needed to be substituted into the expression for *I*. Additionally, for the few who managed to equate the numerator of the derivative in factored form to zero ie [A] $-4x\left(x^2 + 561\right)\left(x^2 + 17\right) = 0$ or [B] $-4x\left(x^2 - 60\right)\left(x^2 + 260\right) = 0$, many then made crucial mistakes, namely $x = \pm\sqrt{561}$ or $x = \sqrt{-561}$ as well as $x = \sqrt{60}$ only. Having been told that there is a maximum when $x = 0$, candidates needed to provide numerical information for $\frac{dI}{dx}$ on both sides of $x = 0$, if equation [A] was not provided. Also,0 candidates who equated $P = 0$ for their stationary point often incorrectly used *P* (rather than –*P*) to determine the nature of the stationary point.

(iii) Some candidates, who managed to find the three stationary points in part (iii), assumed that a maximum turning point occurred at $x = 0$, even though their obtained values for the derivative indicated a minimum.

Mathematics

2002 HSC Examination Mapping Grid

Question	Marks	Content	Syllabus outcomes
1(a)	2	Basic arithmetic and algebra	P3
1(b)	2	The tangent to a curve and the derivative of a function	P7, P8
1(c)	2	Basic arithmetic and algebra	P4
1(d)	1	Integration	P8, H8
1(e)	3	Basic arithmetic and algebra	P4
1(f)	2	Basic arithmetic and algebra	P4
2(a)	2	The tangent to a curve and the derivative of a function Geometrical applications of differentiation	P6, H3, H5, H6
2(b)(i)	2	The tangent to a curve and the derivative of a function The trigonometric functions	P7, H5
2(b)(ii)	2	The tangent to a curve and the derivative of a function Logarithmic and exponential functions	P7, H3
2(c)	3	Trigonometric ratios	P4
2(d)(i)	1	Integration; The trigonometric functions	H5, H8
2(d)(ii)	2	Integration; Logarithmic and exponential functions	H3, H8
3(a)	2	Series and applications	H4
3(b)	3	Plane geometry	P2, P4
3(c)(i)	1	Linear functions and lines	P4
3(c)(ii)	2	Linear functions and lines	P4
3(c)(iii)	1	Linear functions and lines	P4
3(c)(iv)	1	Linear functions and lines	P4
3(c)(v)	2	Linear functions and lines	H5
4(a)	2	Basic arithmetic and algebra	P4
4(b)	2	Trigonometric ratios	P4
4(c)(i)	2	Trigonometric ratios	P4
4(c)(ii)	2	Trigonometric ratios	P4
4(d)(i)	1	Real functions of a real variable and their geometrical representation	P4
4(d)(ii)	3	Integration	H8
5(a)(i)	2	Series and applications	H5
5(a)(ii)	3	Series and applications	H5
5(b)	3	The trigonometric functions	H4, H5
5(c)(i)	2	The quadratic polynomial and the parabola	P4
5(c)(ii)	2	The quadratic polynomial and the parabola	P4
6(a)	2	Real functions of a real variable and their geometrical representation	P4
6(b)(i)	2	Geometrical applications of differentiation	H5, H8

Question	Marks	Content	Syllabus outcomes
6(b)(ii)	3	Geometrical applications of differentiation	H6
6(b)(iii)	1	Geometrical application of differentiation	H6
6(c)	4	Integration	H8
7(a)(i)	1	Series and applications	H2, H5
7(a)(ii)	2	Series and applications	P3, H5
7(b)(i)	1	Applications of calculus to the physical world	H5
7(b)(ii)	2	Applications of calculus to the physical world	H5
7(b)(iii)	2	Applications of calculus to the physical world	H5
7(c)(i)	1	Probability	H2, H5
7(c)(ii)	2	Probability	H5
7(c)(iii)	1	Probability	H5
8(a)(i)	3	Applications of calculus to the physical world	H3, H4, H5
8(a)(ii)	2	Applications of calculus to the physical world	H3, H4, H5
8(b)(i)	3	The trigonometric functions Applications of calculus to the physical world	H5, H9
8(b)(ii)	2	The trigonometric functions Applications of calculus to the physical world	H5, H7, H9
8(b)(iii)	2	The trigonometric functions	H4
9(a)(i)	2	Logarithmic and exponential functions	H3, H9
9(a)(ii)	2	Logarithmic and exponential functions; Integration	H8, H9
9(b)	4	Series and applications	H5
9(c)(i)	1	Applications of calculus to the physical world	H4, H5, H9
9(c)(ii)	2	Applications of calculus to the physical world	H4, H5
9(c)(iii)	1	Applications of calculus to the physical world	H5
10(a)(i)	2	Trigonometric ratios	P4
10(a)(ii)	1	Trigonometric ratios	P4
10(a)(iii)	3	The trigonometric functions	H5, H9
10(b)(i)	2	Geometrical applications of differentiation	H5, H9
10(b)(ii)	2	Geometrical applications of differentiation	H2, H5, H6, H9
10(b)(iii)	2	Geometrical applications of differentiation	H2, H5, H6, H9

BOARD OF STUDIES
NEW SOUTH WALES

2002 HSC Mathematics
Marking Guidelines

Question 1 (a)

Outcomes assessed: P3

MARKING GUIDELINES

Criteria	Marks
• Gives correct answer	2
EITHER • Gives correct value but rounds incorrectly OR • Correctly rounds incorrect simplification	1

Question 1 (b)

Outcomes assessed: P7, P8

MARKING GUIDELINES

Criteria	Marks
• Gives correct answer	2
• Correctly differentiates either of x^3 or 2	1

Question 1 (c)

Outcomes assessed: P4

MARKING GUIDELINES

Criteria	Marks
• Gives both correct values of x	2
• Attempts to solve as a quadratic but makes subsequent error OR • Gives only one correct value of x	1

Question 1 (d)

Outcomes assessed: P8, H8

MARKING GUIDELINES

Criteria	Marks
• Gives correct answer (Ignore constant of integration)	1

Question 1 (e)

Outcomes assessed: P4

MARKING GUIDELINES

Criteria	Marks
• Gives correct answer	3
• Attempts a sensible solution and makes one error	2
• Attempts a sensible solution and makes two errors	1

Question 1 (f)

Outcomes assessed: P4

MARKING GUIDELINES

Criteria	Marks
• Finds correct values of x and y	2
• Attempts a method of solution to isolate x or y OR • Correctly solves for only one of x and y	1

Question 2 (a)

Outcomes assessed: P6, H3, H5, H6

MARKING GUIDELINES

Criteria	Marks
• Correct equation of tangent	2
• Correct derivative or correct substitution into the equation for a tangent following a mistake in calculating the gradient	1

Question 2 (b) (i)

Outcomes assessed: P7, H5

MARKING GUIDELINES

Criteria	Marks
• Gives correct expression	2
• Attempts the use of the product rule but makes one error (eg incorrect sign) OR • Differentiates $\sin x$ and x correctly	1

Question 2 (b) (ii)

Outcomes assessed: P7, H3

MARKING GUIDELINES

Criteria	Marks
• Gives correct expression	2
• Attempts the use of the quotient rule but makes one error (eg incorrect sign) OR • Differentiates ln x and x^2 correctly	1

Question 2 (c)

Outcomes assessed: P4

MARKING GUIDELINES

Criteria	Marks
• Gives a correct solution, showing reasons	3
• Attempts a correct solution method, but makes one error	2
• Gives $\sin 60° = \frac{\sqrt{3}}{2}$ and $\sin 45° = \frac{1}{\sqrt{2}}$, or equivalent	1

Question 2 (d) (i)

Outcomes assessed: H5, H8

MARKING GUIDELINES

Criteria	Marks
• Gives correct answer (Ignore constant of integration)	1

Question 2 (d)(ii)

Outcomes assessed: H3, H8

MARKING GUIDELINES

Criteria	Marks
• Gives correct answer	2
• Correct integration OR • Correct evaluation of a wrong integral, provided integral not too trivial	1

Question 3 (a)

Outcomes assessed: H4

MARKING GUIDELINES

Criteria	Marks
• Gives a numerical answer between \$1989 and \$1990	2
• Uses the compound interest formula OR • Correctly identifies the interest rate as 0.035	1

Question 3 (b)

Outcomes assessed: P2, P4

MARKING GUIDELINES

Criteria	Marks
• Gives correct answer with appropriate reasons	3
• Makes one numerical error or misses an appropriate reason	2
• Gives correct answer with no reasons	1

Question 3 (c) (i)

Outcomes assessed: P4

MARKING GUIDELINES

Criteria	Marks
• Gives correct answer	1

Question 3 (c) (ii)

Outcomes assessed: P4

MARKING GUIDELINES

Criteria	Marks
• Correctly substitutes their mid-point from (i) and correct gradient into an appropriate straight-line formula	2
• Correctly identifies the perpendicular bisector passes through the mid-point or finds the correct gradient of AB	1

Question 3 (c) (iii)

Outcomes assessed: P4

MARKING GUIDELINES

Criteria	Marks
• Gives correct answer consistent with previous working	1

Question 3 (c) (iv)

Outcomes assessed: P4

MARKING GUIDELINES

Criteria	Marks
• Gives correct coordinates of D	1

Question 3 (c) (v)

Outcomes assessed: H5

MARKING GUIDELINES

Criteria	Marks
• Gives correct answer or correct answer from previous working	2
• Finds the base length OR • Finds the perpendicular height of ΔABD, using any base or perpendicular height	1

Question 4 (a)

Outcomes assessed: P4

MARKING GUIDELINES

Criteria	Marks
• Gives both algebraic and graphical solution	2
• Gives only one of the algebraic and graphical solution OR • Draws graph with open circles, but algebra correct	1

Question 4 (b)

Outcomes assessed: P4

MARKING GUIDELINES

Criteria	Marks
• Gives both correct answers (No penalty if answers not rounded to the nearest degree)	2
• Gives acute angle only OR • Gives two answers where the acute value of θ is incorrect, but second value is consistent with acute value	1

Question 4 (c) (i)

Outcomes assessed: P4

MARKING GUIDELINES

Criteria	Marks
• Correctly uses cosine rule (Ignore units and rounding errors)	2
• Attempts to use cosine rule, and substitutes correctly	1

Question 4 (c) (ii)

Outcomes assessed: P4

MARKING GUIDELINES

Criteria	Marks
• Gives correct answer (Ignore units and rounding errors)	2
• Substitutes correctly into a formula for the area	1

Question 4 (d) (i)

Outcomes assessed: P4

MARKING GUIDELINES

Criteria	Marks
• Gives a correct justification	1

Question 4 (d) (ii)

Outcomes assessed: H8

MARKING GUIDELINES

Criteria	Marks
• Gives correct solution (Ignore units)	3
• Correctly integrates an appropriate expression or correctly evaluates an incorrect expression of similar difficulty	2
• Writes integral $\int_0^4 \left(6x - x^2 - 2x\right) dx$ or equivalent	1

Question 5 (a) (i)

Outcomes assessed: H5

MARKING GUIDELINES

Criteria	Marks
• Gives correct answer	2
• Sets up arithmetic series but makes an error	1

Question 5 (a) (ii)

Outcomes assessed: H5

MARKING GUIDELINES

Criteria	Marks
• Uses the sum of an arithmetic series, and finds correct answer	3
• Gives answer one half correct answer OR • Makes a mistake in evaluating sum of arithmetic series, but realises dog runs twice the distance the stick is thrown	2
• Recognises sum of an arithmetic series is required and attempts a substitution	1

Question 5 (b)

Outcomes assessed: H4, H5

MARKING GUIDELINES

Criteria	Marks
• Finds correct answer (Answer must be in degrees, but need not be rounded correctly)	3
• Finds answer in radians	2
• Attempts to use a proportion method, or formula for arc length OR • Changes incorrectly derived answer in radians correctly to degrees	1

Question 5 (c) (i)

Outcomes assessed: P4

MARKING GUIDELINES

Criteria	Marks
• Gives correct coordinates	2
• Attempts, using a correct technique, to find the x value OR • Finds consistent y value for incorrect x value	1

Question 5 (c) (ii)

Outcomes assessed: P4

MARKING GUIDELINES

Criteria	Marks
• Gives correct coordinates	2
• Finds the focal length OR • Sketches the graph and marks the focus on the line $x = 4$ within the parabola with statement indicating focus is (4, …), or gives answer consistent with incorrect answer to (i)	1

Question 6 (a)

Outcomes assessed: P4

MARKING GUIDELINES

Criteria	Marks
• Draws correct semicircle and gives correct range	2
• Gives correct range OR • Gives correct sketch OR • Draws circle centre O, radius 2 units AND states range is $-2 \le y \le 2$	1

Question 6 (b) (i)

Outcomes assessed: H5, H8

MARKING GUIDELINES

Criteria	Marks
• Finds correct equation	2
• Integrates correctly but does not include a constant OR • Expands incorrectly but then integrates correctly and includes constant	1

Question 6 (b) (ii)

Outcomes assessed: H6

MARKING GUIDELINES

Criteria	Marks
• Draws correct graph (or correct graph for cubic answer to (b)(i)), marking turning points and y– intercept	3
• Identifies y– intercept, and each of the turning points OR • Draws graph of correct shape and correctly labels one turning point	2
• Draws graph of correct shape but does not label any points OR • Correctly identifies and labels one turning point	1

Question 6 (b) (iii)

Outcomes assessed: H6

MARKING GUIDELINES

Criteria	Marks
• Gives correct solution ($x > 1$) OR • Gives solution consistent with incorrect answer to (i) OR (ii) provided function given in (ii) is a cubic	1

Question 6 (c)

Outcomes assessed: H8

MARKING GUIDELINES

Criteria	Marks
• Finds correct volume (Ignore units)	4
• Correctly integrates correct integral but does not evaluate OR • Evaluates integral correctly, following a mistake in integration OR • Evaluates correct integral with incorrect limits	3
• Obtains correct integral in terms of y for the volume OR • Evaluates $\pi \int_0^2 y^2 dx$ correctly	2
• Gives correct expression for the volume OR • Gives correct integrand in terms of y but with incorrect limits OR • Gives correct expression for volume of solid rotated about x axis with correct limits	1

Question 7 (a) (i)

Outcomes assessed: H2, H5

MARKING GUIDELINES

Criteria	Marks
• Give correct explanation	1

Question 7 (a) (ii)

Outcomes assessed: P3, H5

MARKING GUIDELINES

Criteria	Marks
• Gives correct answer	2
• Correctly substitutes into correct formula OR • Rationalises the denominator of an expression of equivalent difficulty (eg $\frac{1}{r} = \frac{1}{\sqrt{5}-2}$)	1

Question 7 (b) (i)

Outcomes assessed: H5

MARKING GUIDELINES

Criteria	Marks
• Gives correct answer (Ignore units)	1

Question 7 (b) (ii)

Outcomes assessed: H5

MARKING GUIDELINES

Criteria	Marks
• Gives correct answer	2
• Makes substantial progress towards solving for t	1

Question 7 (b) (iii)

Outcomes assessed: H5

MARKING GUIDELINES

Criteria	Marks
• Finds correct answer consistent with their answer to (b) (ii)	2
• Correctly differentiates V(t) OR • Substitutes answer from (ii) into an incorrect derivative	1

Question 7 (c) (i)

Outcomes assessed: H2, H5

MARKING GUIDELINES

Criteria	Marks
• Gives a correct explanation	1

Question 7 (c) (ii)

Outcomes assessed: H5

MARKING GUIDELINES

Criteria	Marks
• Gives correct answer	2
• Gives $\frac{6}{7} \times$ an expression for the probability that the third sock drawn does not match previous socks	1

Question 7 (c) (iii)

Outcomes assessed: H5

MARKING GUIDELINES

Criteria	Marks
• Gives correct probability or probability consistent with previous answer	1

Question 8 (a) (i)

Outcomes assessed: H3, H4, H5

MARKING GUIDELINES

Criteria	Marks
• Gives correct values for Q_0 and k	3
• Finds Q_0 and gives correct equation for k	2
• Finds Q_0 OR • Obtains $3 = Q_0 e^{-15k}$	1

Question 8 (a) (ii)

Outcomes assessed: H3, H4, H5

MARKING GUIDELINES

Criteria	Marks
• Gives correct answer	2
• Obtains a correct expression for the time t	1

Question 8 (b) (i)

Outcomes assessed: H5, H9

MARKING GUIDELINES

Criteria	Marks
• Sketches a graph with all of the following features correct: • shape • amplitude • period • y–values	3
• Three of the above features correct	2
• Two of the above features correct	1

Question 8 (b) (ii)

Outcomes assessed: H5, H7, H9

MARKING GUIDELINES

Criteria	Marks
• Gives correct values for t and x OR • Gives a correct interpretation from incorrect graph in (i), provided the graph has at least two turning points	2
• Obtains $\dot{x} = 2\cos 2t = 0$ at rest and gives, say, 2 correct solutions out of 4 for t and x OR • Gives correct values for only t OR x	1

Question 8 (b) (iii)

Outcomes assessed: H4

MARKING GUIDELINES

Criteria	Marks
• Describes backwards and forwards motion, giving bounds and centre OR • Describes oscillatory motion specifying two features from amplitude, range, centre and period	2
• Notes that the particle oscillates OR • Notes two features of the motion from amplitude, range, centre and period	1

Question 9 (a) (i)

Outcomes assessed: H3, H9

MARKING GUIDELINES

Criteria	Marks
• Sketches graph showing: correct asymptote, shape and x–intercept	2
• Sketches graph with any 2 of: correct asymptote, shape and x–intercept	1

Question 9 (a) (ii)

Outcomes assessed: H8, H9

MARKING GUIDELINES

Criteria	Marks
• Correctly applies and evaluates Simpson's Rule	2
• Correctly applies Simpson's Rule	1

Question 9 (b)

Outcomes assessed: H5

MARKING GUIDELINES

Criteria	Marks
• Gives correct answer or correct answer for $n = 20$ (Ignore rounding)	4
• Obtains correct expression (including correct expression for sum of geometric series) but does not evaluate	3
• Sets up sum of a geometric series with correct rate OR • Sets up geometric series with a correct expression for the sum	2
• Sets up sum of a geometric series OR • Gives rate as 0.0875	1

Question 9 (c) (i)

Outcomes assessed: H4, H5, H9

MARKING GUIDELINES

Criteria	Marks
• Gives correct answer	1

Question 9 (c) (ii)

Outcomes assessed: H4, H5

MARKING GUIDELINES

Criteria	Marks
• Gives correct distance	2
• Obtains correct expression for either the distance travelled by the car or the jet after t seconds OR • Gives answer consistent with an incorrect response to (i)	1

Question 9 (c) (iii)

Outcomes assessed: H5

MARKING GUIDELINES

Criteria	Marks
• Gives correct answer or answer with inconsistent with working in (ii)	1

Question 10 (a) (i)

Outcomes assessed: P4

MARKING GUIDELINES

Criteria	Marks
• Gives correct derivation	2
• Gives correct trigonometric expression for $\frac{\theta}{2}$ in terms of 20 and r	1

Question 10 (a) (ii)

Outcomes assessed: P4

MARKING GUIDELINES

Criteria	Marks
• Gives correct derivation	1

Question 10 (a) (iii)

Outcomes assessed: H5, H9

MARKING GUIDELINES

Criteria	Marks
• Sketches graph showing correct concavity and indicating height of curve at $\theta = 0, \frac{\pi}{2}$ and π (Ignore whether endpoints at $\theta = 0, \pi$ are omitted or not)	3
• Sketches correct graph with one essential feature missing (such as endpoints or scale on y–axis)	2
• Sketches graph of either $r = 10\sec\frac{\theta}{2}$ or $r = 20\sin\frac{\theta}{2}$	1

Question 10 (b) (i)

Outcomes assessed: H5, H9

MARKING GUIDELINES

Criteria	Marks
• Derives expression for $\frac{dI}{dx}$	2
• Correctly differentiates one term in the expression for I OR • Makes simple error when differentiating I	1

Question 10 (b) (ii)

Outcomes assessed: H2, H5, H6, H9

MARKING GUIDELINES

Criteria	Marks
• Gives a correct argument	2
• Shows that $\frac{dI}{dx} = 0$ only at $x = 0$	1

Question 10 (b) (iii)

Outcomes assessed: H2, H5, H6, H9

MARKING GUIDELINES

Criteria	Marks
• Gives valid argument for change in brightness	2
• Identifies x–values of turning points	1