2005 HSC Notes from the Marking Centre Mathematics Extension 1

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2005 HSC NOTES FROM THE MARKING CENTRE MATHEMATICS EXTENSION 1

Introduction

This document provides candidates and teachers with feedback in relation to the quality of responses provided by candidates to the 2005 Mathematics Extension 1 HSC examination paper. It should be read in conjunction with the 2005 HSC Mathematics Extension 1 examination paper, the marking guidelines and the *Mathematics Stage 6 Syllabus*.

Question 1

a) The main errors included omitting the $\frac{1}{7}$, writing $\tan x$ rather than $\tan^{-1} x$, and omitting the constant.

(b) This part was poorly done. Many candidates drew an X-shaped rather than V-shaped graph or just drew one line. Of those who drew the correct graph, a large proportion did not shade the section below the x-axis or did not make clear whether the area below the x-axis was included. Many candidates did not indicate an x-intercept or y-intercept. Very few candidates indicated a test point to indicate how they found the correct region.

(c) A common error was: $-1 \le \frac{x}{4} \le 1 \Rightarrow -4 \le x \le 1$.

A number of candidates either left the range out completely or did not know the correct range.

(d) This part was reasonably well attempted, but many candidates did not substitute back, writing the answer in terms of u rather than x. Candidates who attempted to make x the subject before substituting into the integral either did not find the differential or made an arithmetic error. Very few candidates managed to do the integral successfully using this method. Some candidates did not know how to simplify $\frac{1}{4}\frac{(2x^2+1)^{\frac{9}{4}}}{\frac{9}{4}}$.

(e) This part was done well by most candidates. The most common errors included not understanding the direction and which were the end points of the interval being divided, using an incorrect formula, bringing in negative values inappropriately, and incorrectly solving basic algebraic equations.

(f) This part was done poorly. Many candidates did not provide the correct formula. Common errors included $4m = 2 \Rightarrow m = 2$, or $-4 = 2m \Rightarrow m = -\frac{1}{2}$.

Candidates who solved the absolute value equation by using ± 1 (rather than squaring the equation) more often produced the correct answer. A few candidates had the correct initial equation but then used 45 rather than tan 45°.

Question 2

(a) This question was generally not done well. It required knowledge of the derivative of the inverse sine function and a simple chain rule application. A very common error was to not multiply by $\frac{d}{dx}(5x)$. Using the product rule made the solution unnecessarily complicated.

(b) This question was challenging for many candidates. Although most candidates demonstrated knowledge of the general term of a binomial expansion, many were not able to successfully apply it to this question. Common errors included poor handling of indices; failure to use brackets appropriately; and neglecting the minus sign in the expansion. Several candidates gave the position of the independent term in the expansion rather than the actual term.

(c) (i) Most candidates demonstrated correct usage of the product rule and correct differentiation of trigonometric and exponential functions. However, candidates who did not simplify their expression or simplified it incorrectly could then not complete part (ii) correctly.

(ii) Candidates who correctly simplified part (i) and related it to part (ii) generally produced the correct answer. A common error was $\int e^{3x} \sin x \; dx = \frac{e^{3x}}{3} - \cos x + C$.
Some candidates tried to use integration by parts to do this question. However, very few were successful using this method. Candidates are advised to use their time efficiently and to check for a link to the previous part(s) and observe the mark value.

(d) (i) This part was done well, with many candidates correctly stating $\frac{dT}{dt} = -kAe^{-kt}$ and then substituting into the differential equation to prove the result. There were several who chose to do the proof by integrating.

(ii) This question was very well done by many candidates. A common error was to use $A = 25$, which was the initial temperature.

Question 3

(a) (i) A statement that indicated a change in sign from g(0.7) to g(0.9) was required, and not just the function values. A few candidates used the *log* key on their calculators and were not able to show that a zero existed.

(ii) This part was done very poorly. Most candidates evaluated g(0.8) = 0.052… and wrote that the zero occurred at 0.8. Some candidates who used two or more applications of halving the interval stated that the zero was between 0.7 and 0.75, close to 0.75, and so rounded to 0.8. A considerable number used Newton's method.

(b) (i) This question was done well. However, a significant number of candidates made careless errors such as omitting 5's, 4's, x's.

(ii) Generally this part was done reasonably well. Some candidates did not see any connection with the expression given in (i); others assumed that the expansion found in (i) was the integral; others did not recognise the need to find $\frac{1}{2}$ of the expression in (i) before integrating; and others assumed that $\sin 9x + \sin x = \sin 10x$.

(c) This part was answered well, but the setting out was generally poor. The omission of the limit was a concern. Some omitted *lim* throughout their answer, while others only included it in the very last line. A number of candidates realised that they needed a $-5x$ instead of a $+5x$ and tried to change the + by writing a – more heavily over it.

(d) (i) An explanation was required with $x(\ell - x) = 12$. Candidates need to take care that the correct letters are used when writing statements such as AE.EB = CE.ED.

(ii) The majority of candidates who attempted this part did not realise that ℓ was a variable and they attempted to differentiate the quadratic equation with respect to x. A few candidates differentiated the equation implicitly. Candidates who made ℓ the subject of the formula, then solved $\frac{d\ell}{dx} = 0$, were usually successful.

Very few candidates perceived the elegant result that for x to be real $\Delta = \ell^2 - 48 \geq 0$.

Question 4

Many of the candidates chose an incorrect approach in some parts of the question, which did not allow them to reach the correct solution. Candidates are reminded to show all necessary working, particularly when substituting into expressions.

(a) This part was done very poorly. Candidates who made the substitution $u = \sin x$ were generally successful. Once candidates had found the correct primitive they were mostly successful in evaluating the integral. Many did not correctly simplify $\frac{1}{3}\left(\frac{1}{\sqrt{2}}\right)^3$.

(b) This part was done poorly. Many candidates were unable to correctly recall or work out expressions for $\sin\theta$ or $\tan\theta$ in terms of t or $\frac{\theta}{2}$. Right-angled triangles indicated confusion as to whether the angle was θ or $\frac{\theta}{2}$ and what the lengths of the sides should be, with the hypotenuse sometimes not being the longest side. Some candidates also incorrectly gave $\text{cosec}\,\theta = \frac{1}{\cos\theta}$. Candidates who wrote the trigonometric expression in terms of $\frac{\theta}{2}$ were generally successful.

(c) (i) Most candidates attempted this part by simultaneous solution of the equations. A significant number of candidates wasted time by first deriving the equations of the normals. Most candidates were able to successfully solve their simultaneous equations. However, some were not convincing in their factorisation, particularly of $p^3 - q^3$.

Candidates are reminded that in a 'show that' question it is important to show the logical connection from step to step ie to not 'fudge' results. Few candidates used the approach of substituting the coordinates of R into the equations of the normals. Those who used this approach were usually both successful and efficient, with the exception of the candidates who only substituted into one of the normals or stated that the point R would also satisfy the other equation rather than 'showing' this.

(ii) Most candidates were able to substitute the coordinates $(0, a)$ correctly into the equation of the chord.

(iii) A significant number of candidates appeared to be confused as to how to approach this part, with some candidates obviously having no idea of what was meant by 'the equation of a locus'. A significant number of candidates substituted the coordinates of R into either the equation of the chord or the equation of the parabola. Many candidates who approached the question correctly were unable to manipulate the parametric equations to eliminate p and q successfully, or made careless algebraic errors.

(d) Candidates were required to use the principle of mathematical induction to show that an inequality was true. Although an inequality involving an exponential proved to be challenging for some candidates, many candidates demonstrated that they understood the structure of mathematical induction proofs. In substituting into the left-hand side of the inequality, many candidates made careless arithmetic or transcription errors. Presentation and notation were often unclear with candidates who used S_k, $S(k)$ etc. Most candidates were unable to logically follow through the proof, or if they were able to do so, were not able to sufficiently justify their final inequality as being true because $k \geq 2$.

Question 5

(a) This part was correctly answered by many candidates. In the best responses candidates showed that they were able to use $\sin^2 2x = \frac{1}{2}(1 - \cos 4x)$ correctly and were then able to proceed with the integral and find the required volume. Candidates who had memorised the result $\int \sin^2 x \, dx = \frac{1}{2}x - \frac{1}{4}\sin 2x$ and then tried to apply it generally made errors, particularly with coefficients. Other common errors included $(\sin 2x)^2 = \sin^2 4x$ and/or changing the limits of the integral.

(b) This part of the question consisted of three parts all related to the same diagram. Candidates are reminded that unless the diagram is copied into the answer booklet (and angles labelled) it is meaningless to make statements such as $\angle PAD = 90° - \alpha$ if α has not been specified. All statements need to be supported by correctly stated reasons.

(i) This part was generally answered well, although there was some confusion between the meanings of the terms ‘supplementary’ and ‘complementary’. Careless naming of angles, leading to the wrong angles being stated as supplementary, was also common.

(ii) The better responses included clear statements that both of the angles were equal to $\angle ADE$ and clearly cited appropriate reasons related to ‘angles at the circumference’ or ‘angles in the same segment’. Other correct methods using equiangular triangles were possible but these responses were more prone to contain errors.

(iii) There were a number of ways to complete this part successfully. Most candidates proved triangles PAE and QBE similar. Many candidates used the wrong triangles and thus were unable to complete the proof. Using the result of part (ii) to show that PAQB was also cyclic was unusual but well done when it was attempted.

(c) (i) In this part, most candidates were able to find correct values for both R and α. A common error was to use $\alpha = -\frac{\pi}{6}$, and others occurred due to careless arithmetic.

(ii) Often candidates were able to write values for both the amplitude and centre of motion from inspection of the result of part (i). Although the question specified simple harmonic motion a number of candidates wasted time proving this and then finding the amplitude. Some confusion about the meaning of the terms was apparent and many candidates stated the centre of motion as a time value.

(iii) Many candidates were able to find a time for maximum speed although some were unable to find the first time after $t = 0$. Candidates need to solve completely for t before discarding any values. There was often a lack of consistency between the answers given in parts (ii) and (iii). Some candidates calculated a time for the centre of motion in part (ii) and then found a different answer in part (iii). Again in this part, misunderstanding of the meaning of terms was evident. A common error was to state that maximum speed occurs when $v = 0$.

Question 6

Candidates are reminded to copy given equations carefully from the examination paper, to show all necessary working, to take care with notation and setting out, and clearly indicate the part of the question being attempted.

(a) (i) Most candidates showed an understanding of the sum of $P(3)$, $P(4)$ and $P(5)$ and working involving the use of the binomial expansion. Candidates using $1 - [P(0) + P(1) + P(2)]$ often did not include $P(0)$ or had difficulty correctly expanding the brackets.

(ii) This part was generally done well.

(iii) Use of the complementary result was the most efficient method for solving this part. Some had difficulty with 'at most', incorrectly including $P(16)$ in their use of the complementary result. Correct expansion of brackets and use of the binomial expansion caused problems for some candidates.

(b) (i) The majority of candidates were successful, evaluating t when $\dot{y} = 0$ and then substituting the resulting value for t into the equation for y. Use of parametric equations was more effective, as the use of Cartesian equations or time of flight and maximum height results involved more working and caused problems for some.

(ii) Some candidates realised that the earliest time occurred when t was twice the answer to (b)(i), while very few showed an understanding that the gradient of the projectile after reaching the highest point was negative. Candidates using Cartesian equations often had difficulty correctly evaluating both values for t due to algebraic or arithmetic errors.

(iii) Candidates who attempted this part of the question generally used Pythagoras' theorem but struggled to solve the ensuing equation correctly.

Question 7

(a) Clearly candidates had difficulty interpreting the 3D diagram, with some seeing it as 2D. Candidates are reminded to draw and label a diagram, as many referred to sides but it was unclear which side they were referring to.

(i) Many candidates did not calculate PT. If they did, they often assumed that it was equal to the lengths from P to the edges of the slick, consequently using the cosine rule to find the diameter. Many candidates intended to use the cosine or sine rules correctly by finding expressions for these lengths in terms of r, 450 and 2000, but in most cases made errors along the way. Some candidates converted the angle to degrees instead of putting their calculators in radian mode. Others simply did not use radians.

(ii) While many candidates could write the relevant chain rule, most were not able to proceed from this to find the growth rate of the radius.

(b) Candidates, overall, were not able to clearly communicate their reasoning and their intentions. This could have been overcome by the drawing of a graph to assist explanations, but there were very few graphs drawn for this part.

(i) Most candidates were able to do this quite easily even though there were still a considerable number of basic errors in solving an equation.

(ii) Some candidates reasoned correctly that for there to be one zero both stationary points should be above the axis. Some implied this by sketching such a possible cubic. However, the effect of $A>0$ was either not noted or simply not known. Having stated this, many did not show how this led to $A < \frac{3\sqrt{3}}{2}$. Many candidates wrongly evaluated $f(\frac{3\sqrt{3}}{2})$ or substituted $\frac{3\sqrt{3}}{2}$ for A and could not proceed with a valid argument.

(iii) This was not well done, with many candidates simply stating that since $f(1) = f(-1) = 1$, $f(x)$ has no roots as there is no sign change. Again because they overlooked the significance of $A>0$, the candidates were not able to state that the only zero would occur when $x<-1$.

(iv) Many candidates could differentiate the given trigonometric function. However, in most cases they did not see the link with part (iii), and so could not proceed with this question. Those who did were not always able to explain clearly the link with reference to the domain. Some candidates attempted to sketch $g(\theta)$, but not sufficiently convincingly; others sketched $2\sin\theta$ and $\sec^2\theta$, showing there were no points of intersection and thus no solutions for $g'(\theta) = 0$.

(v) This was generally done well with most candidates scoring the mark, even if they had not attempted part (iv), by realising that since there were no stationary points the function had an inverse.

Mathematics Extension 1

2005 HSC Examination Mapping Grid

Question	Marks	Content	Syllabus outcomes
1 (a)	1	15.5	HE6
1 (b)	2	6.4	P4
1 (c)	2	15.2	HE4, P5
1 (d)	3	11.5	HE6
1 (e)	2	6.7E	P3, P4
1 (f)	2	6.6	P4
2 (a)	2	15.5	HE4
2 (b)	3	17.3	HE3
2 (c) (i)	2	12.5, 13.5	H3, H5
2 (c) (ii)	1	11.2	H5, H8
2 (d) (i)	1	14.2E	HE3
2 (d) (ii)	3	14.2E	HE3
3 (a) (i)	1	16.4	PE3, H3
3 (a) (ii)	2	16.4	PE3, H3, HE7
3 (b) (i)	1	5.7	P4
3 (b) (ii)	2	11.2	H5, H8
3 (c)	2	8.5	P7, P8, PE6
3 (d) (i)	2	2.10	P3, P4
3 (d) (ii)	2	9.2, 2.10	P4
4 (a)	2	13.6E	HE6, H8, H5
4 (b)	2	1.3, 5.1, 5.8	P4
4 (c) (i)	2	9.6	PE3, PE6
4 (c) (ii)	1	9.6	PE3
4 (c) (iii)	2	9.6	PE2, PE3
4 (d)	3	7.4E	HE2

Question	Marks	Content	Syllabus outcomes
5 (a)	3	11.4, 13.7	HE6, H8
5 (b) (i)	1	2.9	PE2, PE3
5 (b) (ii)	2	2.10	PE2, PE3
5 (b) (iii)	1	2.10	PE2, PE3
5 (c) (i)	2	5.9	P4, H5
5 (c) (ii)	2	14.4	HE3
5 (c) (iii)	1	14.4	HE3
6 (a) (i)	2	18.2	HE3
6 (a) (ii)	1	18.2	HE3
6 (a) (iii)	2	18.2	HE3
6 (b) (i)	2	14.3E	HE3
6 (b) (ii)	3	14.3E	HE3
6 (b) (iii)	2	14.3E	HE3
7 (a) (i)	2	5.6, 13.1	H5
7 (a) (ii)	2	14.1	H5, HE7
7 (b) (i)	1	10.2	H5
7 (b) (ii)	2	10.5	H5, H6, PE3
7 (b) (iii)	1	10.5	H5, H6
7 (b) (iv)	3	5.9, 10.2	H5, H6, H9, HE7
7 (b) (v)	1	15.1	HE4, HE7

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2005 HSC Mathematics Extension 1
Marking Guidelines

Question 1 (a)

Outcomes assessed: HE6

MARKING GUIDELINES

Criteria	Marks
• Correct primitive	1

Question 1 (b)

Outcomes assessed: P4

MARKING GUIDELINES

Criteria	Marks
• Correct sketch	2
• Correct boundary or equivalent merit	1

Question 1 (c)

Outcomes assessed: HE4, P5

MARKING GUIDELINES

Criteria	Marks
• Correct answer	2
• Correct domain or range	1

Question 1 (d)

Outcomes assessed: HE6

MARKING GUIDELINES

Criteria	Marks
• Correct solution	3
• Makes substantial progress	2
• Some understanding of the method of substitution	1

Question 1 (e)

Outcomes assessed: P3, P4

MARKING GUIDELINES

Criteria	Marks
• Correct solution	2
• Obtains one correct coordinate or divides AP internally in the ratio 3:2 or 2:3	1

Question 1 (f)

Outcomes assessed: P4

MARKING GUIDELINES

Criteria	Marks
• Correct solution	2
• One value of m or equivalent merit	1

Question 2 (a)

Outcomes assessed: HE4

MARKING GUIDELINES

Criteria	Marks
• Correct answer	2
• Answer which displays some knowledge of the derivate of the inverse sine of $5x$	1

Question 2 (b)

Outcomes assessed: HE3

MARKING GUIDELINES

Criteria	Marks
• Correct solution	3
• The answer involves $\binom{12}{4}$ or $\binom{12}{8}$ or equivalent merit	2
• Evidence of the application of the binomial theorem	1

Question 2 (c) (i)

Outcomes assessed: H3, H5

MARKING GUIDELINES

Criteria	Marks
• Correct answer	2
• Shows understanding of the product rule	1

Question 2 (c) (ii)

Outcomes assessed: H5, H8

MARKING GUIDELINES

Criteria	Marks
• Correct primitive	1

Question 2 (d) (i)

Outcomes assessed: HE3

MARKING GUIDELINES

Criteria	Marks
• Correct solution	1

Question 2 (d) (ii)

Outcomes assessed: HE3

MARKING GUIDELINES

Criteria	Marks
• Correct solution	3
• Evaluates k or equivalent merit	2
• Evaluates A or equivalent merit	1

Question 3 (a) (i)

Outcomes assessed: PE3, H3

MARKING GUIDELINES

Criteria	Marks
• Correct solution	1

Question 3 (a) (ii)

Outcomes assessed: PE3, H3, HE7

MARKING GUIDELINES

Criteria	Marks
• Correct solution	2
• Applies the method of halving the interval	1

Question 3 (b) (i)

Outcomes assessed: P4

MARKING GUIDELINES

Criteria	Marks
• Correct solution	1

Question 3 (b) (ii)

Outcomes assessed: H5, H8

MARKING GUIDELINES

Criteria	Marks
• Correct primitive	2
• Solution recognises the connection with part (i)	1

Question 3 (c)

Outcomes assessed: P7, P8, PE6

MARKING GUIDELINES

Criteria	Marks
• Correct solution	2
• Correctly substitutes into the definition or equivalent merit	1

Question 3 (d) (i)

Outcomes assessed: P3, P4

MARKING GUIDELINES

Criteria	Marks
• Correct solution	2
• Attempts to apply the theorem of the length of intersecting chords	1

Question 3 (d) (ii)

Outcomes assessed: P4

MARKING GUIDELINES

Criteria	Marks
• Correct solution	2
• Considers the discriminant of the quadratic OR expresses ℓ in terms of x and attempts to find the minimum	1

Question 4 (a)

Outcomes assessed: HE6, H8, H5

MARKING GUIDELINES

Criteria	Marks
• Correct solution	2
• Correct primitive or equivalent merit	1

Question 4 (b)

Outcomes assessed: P4

MARKING GUIDELINES

Criteria	Marks
• Correct solution	2
• Correctly expresses $\operatorname{cosec}\theta$ or $\cot\theta$ in terms of t	1

Question 4 (c) (i)

Outcomes assessed: PE3, PE6

MARKING GUIDELINES

Criteria	Marks
• Correct solution	2
• Attempts to solve the equations simultaneously OR • Verifies that R satisfies one of the equations	1

Question 4 (c) (ii)

Outcomes assessed: PE3

MARKING GUIDELINES

Criteria	Marks
• Correct solution	1

Question 4 (c) (iii)

Outcomes assessed: PE2, PE3

MARKING GUIDELINES

Criteria	Marks
• Correct solution	2
• Attempts to eliminate the parameters using $pq = -1$	1

Question 4 (d)

Outcomes assessed: HE2

MARKING GUIDELINES

Criteria	Marks
• Correct proof	3
• Correctly proves the inductive step OR • Verifies the first case and attempts to prove the inductive step	2
• Verifies $n = 2$ correctly	1

Question 5 (a)

Outcomes assessed: HE6, H8

MARKING GUIDELINES

Criteria	Marks
• Correct solution	3
• Correctly integrates $\sin^2 2x$ using the double angle formula or equivalent merit	2
• Correct expression for the volume OR • An attempt to integrate an expression involving $\sin^2 2x$ using the double angle formula	1

Question 5 (b) (i)

Outcomes assessed: PE2, PE3

MARKING GUIDELINES

Criteria	Marks
• Correct solution	1

Question 5 (b) (ii)

Outcomes assessed: PE2, PE3

MARKING GUIDELINES

Criteria	Marks
• Correct solution	2
• Proves that one angle is equal to $\angle ADE$ or equivalent merit	1

Question 5 (b) (iii)

Outcomes assessed: PE2, PE3

MARKING GUIDELINES

Criteria	Marks
• Correct solution	1

Question 5 (c) (i)

Outcomes assessed: P4, H5

MARKING GUIDELINES

Criteria	Marks
• Correct solution	2
• A correct value of R OR • A correct value of α	1

Question 5 (c) (ii)

Outcomes assessed: HE3

MARKING GUIDELINES

Criteria	Marks
• Correct answer	2
• One correct value	1

Question 5 (c) (iii)

Outcomes assessed: HE3

MARKING GUIDELINES

Criteria	Marks
• Correct answer	1

Question 6 (a) (i)

Outcomes assessed: HE3

MARKING GUIDELINES

Criteria	Marks
• Correct solution	2
• Understands that Megan earns a point if she picks 3, 4 or 5 winners and calculates at least one of these probabilities correctly	1

Question 6 (a) (ii)

Outcomes assessed: HE3

MARKING GUIDELINES

Criteria	Marks
• Correct solution	1

Question 6 (a) (iii)

Outcomes assessed: HE3

MARKING GUIDELINES

Criteria	Marks
• Correct solution	2
• Calculates the probability that Megan earns 17 points OR • Attempts to calculate the probability by using the complementary event	1

Question 6 (b) (i)

Outcomes assessed: HE3

MARKING GUIDELINES

Criteria	Marks
• Correct solution	2
• Correct height or time	1

Question 6 (b) (ii)

Outcomes assessed: HE3

MARKING GUIDELINES

Criteria	Marks
• Correct solution	3
• Correctly calculates the latest time or equivalent merit	2
• Finds the earliest time or equivalent merit	1

Question 6 (b) (iii)

Outcomes assessed: HE3

MARKING GUIDELINES

Criteria	Marks
• Correct solution	2
• Recognises that $v^2 = (\dot{x})^2 + (\dot{y})^2$ or equivalent merit	1

Question 7 (a) (i)

Outcomes assessed: H5

MARKING GUIDELINES

Criteria	Marks
• Correct solution	2
• Attempts to apply an appropriate technique	1

Question 7 (a) (ii)

Outcomes assessed: H5, HE7

MARKING GUIDELINES

Criteria	Marks
• Correct solution	2
• Attempts to apply the chain rule	1

Question 7 (b) (i)

Outcomes assessed: H5

MARKING GUIDELINES

Criteria	Marks
• Correct solution	1

Question 7 (b) (ii)

Outcomes assessed: H5, H6, PE3

MARKING GUIDELINES

Criteria	Marks
• Correct solution	2
• Attempts to find a condition for the value of the function at the local minimum to be positive	1

Question 7 (b) (iii)

Outcomes assessed: H5, H6

MARKING GUIDELINES

Criteria	Marks
• Correct solution	1

Question 7 (b) (iv)

Outcomes assessed: H5, H6, H9, HE7

MARKING GUIDELINES

Criteria	Marks
• Correct solution	3
• Calculating $g'(\theta)$ and attempting to apply the result in part (iii)	2
• Calculating $g'(\theta)$	1

Question 7 (b) (v)

Outcomes assessed: HE4, HE7

MARKING GUIDELINES

Criteria	Marks
• Correct solution	1