

A-level

Topic : Logarithm and Exponential

May 2013-May 2023

Answers

Question 1

<i>EITHER:</i> State or imply $\ln y = \ln A - kx^2$	B1
Substitute values of $\ln y$ and x^2 , and solve for k or $\ln A$	M1
Obtain $k = 0.42$ or $A = 2.80$	A1
Solve for $\ln A$ or k	M1
Obtain $A = 2.80$ or $k = 0.42$	A1
<i>OR1:</i> State or imply $\ln y = \ln A - kx^2$	B1
Using values of $\ln y$ and x^2 , equate gradient of line to $-k$ and solve for k	M1
Obtain $k = 0.42$	A1
Solve for $\ln A$	M1
Obtain $A = 2.80$	A1
<i>OR2:</i> Obtain two correct equations in k and A and substituting y - and x^2 - values in $y = Ae^{-kx^2}$	B1
Solve for k	M1
Obtain $k = 0.42$	A1
Solve for A	M1
Obtain $A = 2.80$	A1 [5]

Question 2

Use law for the logarithm of a product, quotient or power	M1
Use $\ln e = 1$ or $\exp(1) = e$	M1
Obtain correct equation free of logarithms in any form, e.g. $\frac{y+1}{y} = ex^3$	A1
Rearrange as $y = (ex^3 - 1)^{-1}$, or equivalent	A1 [4]

Question 3

<i>EITHER:</i> State or imply non-modular equation $2^2(3^x - 1)^2 = (3^x)^2$, or pair of equations $2(3^x - 1) = \pm 3^x$	M1
Obtain $3^x = 2$ and $3^x = \frac{2}{3}$ (or $3^{x+1} = 2$)	A1
<i>OR:</i> Obtain $3^x = 2$ by solving an equation or by inspection	B1
Obtain $3^x = \frac{2}{3}$ (or $3^{x+1} = 2$) by solving an equation or by inspection	B1
Use correct method for solving an equation of the form $3^x = a$ (or $3^{x+1} = a$), where $a > 0$	M1
Obtain final answers 0.631 and -0.369	A1 [4]

Question 4

Apply at least one logarithm property correctly

*M1

Obtain $\frac{(x+4)^2}{x} = x+a$ or equivalent **without logarithm** involved

A1

Rearrange to express x in terms of a

M1 d*M

Obtain $\frac{16}{a-8}$ or equivalent

A1 [4]

Question 5

(i) Use law for the logarithm for a product or quotient or exponentiation
AND for a power

M1

Obtain $(4x-5)^2(x+1) = 27$

B1

Obtain given equation correctly $16x^3 - 24x^2 - 15x - 2 = 0$

A1 [3]

(ii) Obtain $x = 2$ is root or $(x-2)$ is a factor, or likewise with $x = -\frac{1}{4}$

B1

Divide by $(x-2)$ to reach a quotient of the form $16x^2 + kx$

M1

Obtain quotient $16x^2 + 8x + 1$

A1

Obtain $(x-2)(4x+1)^2$ or $(x-2), (4x+1), (4x+1)$

A1 [4]

(iii) State $x = 2$ only

A1 [1]

Question 6

Remove logarithms and obtain $5 - e^{-2x} = e^{\frac{1}{2}}$, or equivalent

B1

Obtain a correct value for e^{-2x} , e^{2x} , e^{-x} or e^x , e.g. $e^{2x} = 1/(5 - e^{\frac{1}{2}})$

B1

Use correct method to solve an equation of the form $e^{2x} = a$, $e^{-2x} = a$, $e^x = a$ or $e^{-x} = a$
where $a > 0$. [The M1 is dependent on the correct removal of logarithms.]

M1

Obtain answer $x = -0.605$ only.

A1 4

Question 7

Use law of the logarithm of a quotient or product or $2 = \log_{10} 100$

M1

Remove logarithms and obtain $x + 9 = 100x$, or equivalent

A1

Obtain answer $x = \frac{1}{11}$

A1 3

Question 8

Use law of the logarithm of a power

M1

Obtain a correct linear equation in any form, e.g. $x = (x-2) \ln 3$

A1

Obtain answer $x = 22.281$

A1 [3]

Question 9

- Use law for the logarithm of a power at least once
- Obtain correct linear equation, e.g. $5x \ln 2 = (2x + 1) \ln 3$
- Solve a linear equation for x
- Obtain $x = 0.866$

*M1
A1
M1 dep *M
A1 [4]

Question 10

- Use laws of indices correctly and solve for u
- Obtain u in any correct form, e.g. $u = \frac{16}{16-1}$
- Use correct method for solving an equation of the form $4^x = a$, where $a > 0$
- Obtain answer $x = 0.0466$

M1
A1
M1
A1 [4]

Question 11

- Use law for the logarithm of a product, quotient or power
- Obtain a correct equation free of logarithms, e.g. $\frac{x+4}{x^2} = 4$
- Solve a 3-term quadratic obtaining at least one root
- Obtain final answer $x = 1.13$ only

M1
A1
M1
A1 4

Question 12

- State or imply $1 + u = u^2$
- Solve for u
- Obtain root $\frac{1}{2}(1 + \sqrt{5})$, or decimal in [1.61, 1.62]
- Use correct method for finding x from a positive root
- Obtain $x = 0.438$ and no other answer

B1
M1
A1
M1
A1 [5]

Question 13

- Use law of the logarithm of a power, quotient or product
- Remove logarithms and obtain a correct equation in x , e.g. $x^2 + 4 = 4x^2$
- Obtain final answer $x = 2/\sqrt{3}$, or exact equivalent

M1
A1
A1 [3]

Question 14

- (i) *EITHER*: State or imply non-modular equation $(2(x-1))^2 = (3x)^2$, or pair of linear equations
 $2(x-1) = \pm 3x$ **B1**
 Make reasonable solution attempt at a 3-term quadratic, or solve two linear equations **M1**
 Obtain answers $x = -2$ and $x = \frac{2}{5}$ **A1**
- OR*: Obtain answer $x = -2$ by inspection or by solving a linear equation **(B1)**
 Obtain answer $x = \frac{2}{5}$ similarly **(B2)**
[3]
- (ii) Use correct method for solving an equation of the form $5^x = a$ or $5^{x+1} = a$, where $a > 0$ **M1**
 Obtain answer $x = -0.569$ only **A1**
[2]

Question 15

- Use law of the logarithm of a product, power or quotient **M1***
 Obtain a correct linear equation, e.g. $(3x-1)\ln 4 = \ln 3 + x\ln 5$ **A1**
 Solve a linear equation for x **DM1***
 Obtain answer $x = 0.975$ **A1** [4]

Question 16

- (i) State or imply $y \ln 3 = (2-x)\ln 4$ **B1**
 State that this is of the form $ay = bx + c$ and thus a straight line, or equivalent **B1**
 State gradient is $-\frac{\ln 4}{\ln 3}$, or exact equivalent **B1**
[3]
- (ii) Substitute $y = 2x$ and solve for x , using a log law correctly at least once **M1**
 Obtain answer $x = \ln 4 / \ln 6$, or exact equivalent **A1**
[2]

Question 17

- Solve for 3^x and obtain $3^x = \frac{18}{7}$ **B1**
 Use correct method for solving an equation of the form $3^x = a$, where $a > 0$ **M1**
 Obtain answer $x = 0.860$ 3 d.p. only **A1** [3]

Question 18

- Use law of the logarithm of a quotient **M1**
 Remove logarithms and obtain a correct equation, e.g. $e^z = \frac{y+2}{y+1}$ **A1**
 Obtain answer $y = \frac{2-e^z}{e^z-1}$, or equivalent **A1** [3]

Question 19

Remove logarithm and obtain $1 + 2^x = e^2$	B1
Use correct method to solve an equation of the form $2^x = a$, where $a > 0$	M1
Obtain answer $x = 2.676$	A1
Total:	3

Question 20

(i)	Remove logarithms correctly and obtain $e^x = \frac{1-y}{y}$	B1
	Obtain the given answer $y = \frac{e^{-x}}{1+e^{-x}}$ following full working	B1
	Total:	2
(ii)	State integral $k \ln(1 + e^{-x})$ where $k = \pm 1$	*M1
	State correct integral $-\ln(1 + e^{-x})$	A1
	Use limits correctly	DM1
	Obtain the given answer $\ln\left(\frac{2e}{e+1}\right)$ following full working	A1
	Total:	4

Question 21

Use law of the logarithm of a power or a quotient	M1
Remove logarithms and obtain a correct equation in x . e.g. $x^2 + 1 = ex^2$	A1
Obtain answer 0.763 and no other	A1

Question 22

Rearrange as $3u^2 + 4u - 4 = 0$, or $3e^{2x} + 4e^x - 4 = 0$, or equivalent	B1
Solve a 3-term quadratic for e^x or for u	M1
Obtain $e^x = \frac{2}{3}$ or $u = \frac{2}{3}$	A1
Obtain answer $x = -0.405$ and no other	A1

Question 23

Plot the four points and draw straight line	B1
State or imply that $\ln y = \ln C + x \ln a$	B1
Carry out a completely correct method for finding $\ln C$ or $\ln a$	M1
Obtain answer $C = 3.7$	A1
Obtain answer $a = 1.5$	A1
	5

Question 24

Use law for the logarithm of a power or a quotient on the given equation	M1
Use $\log_2 8 = 3$ or $2^3 = 8$	M1
Obtain $x^2 - 8x - 8 = 0$, or horizontal equivalent	A1
Solve a 3-term quadratic equation	M1
Obtain final answer $x = 8.90$ only	A1
	5

Question 25

Use law for the logarithm of a product, quotient or power	M1
Obtain a correct equation free of logarithms, e.g. $4(x^4 - 4) = x^4$	A1
Solve for x	M1
Obtain answer $x = 1.52$ only	A1
	4

Question 26

State or imply $u^2 = u + 5$, or equivalent in 5^x	B1
Solve for u , or 5^x	M1
Obtain root $\frac{1}{2}(1 + \sqrt{21})$, or decimal in [2.79, 2.80]	A1
Use correct method for finding x from a positive root	M1
Obtain answer $x = 0.638$ and no other answer	A1
Total:	5

Question 27

Rearrange the equation in the form $ae^{2x} = b$ or $ae^x = be^{-x}$	M1
Obtain correct equation in either form with $a = 2$ and $b = 5$	A1
Use correct method to solve for x	M1
Obtain answer $x = 0.46$	A1
	4

Question 28

Substitute and obtain 3-term quadratic $3u^2 + 4u - 1 = 0$, or equivalent	B1
Solve a 3 term quadratic for u	M1
Obtain root $(\sqrt{7} - 2) / 3$, or decimal in [0.21, 0.22]	A1
Use correct method for finding x from a positive value of e^x	M1
Obtain answer $x = -1.536$ only	A1
	5

Question 29

(i)	Use law for the logarithm of a product or quotient	M1
	Use $\log_{10} 100 = 2$ or $10^2 = 100$	M1
	Obtain $x^2 - 4x - 100 = 0$, or equivalent	A1
		3
(ii)	Solve a 3-term quadratic equation	M1
	Obtain answer 12.2 only	A1
		2

Question 30

State or imply $u^2 - u - 12 (= 0)$, or equivalent in 3^x	B1
Solve for u , or for 3^x , and obtain root 4	B1
Use a correct method to solve an equation of the form $3^x = a$ where $a > 0$	M1
Obtain final answer $x = 1.26$ only	A1
	4

Question 31

Use law of the logarithm of a product or quotient	M1
Use law of the logarithm of power twice	M1
Obtain a correct linear equation in x , e.g. $(3 - 2x)\ln 5 = \ln 4 + x\ln 7$	A1
Obtain answer $x = 0.666$	A1
	4

Question 32

State $1 + e^{2y} = e^x$	B1
Make y the subject	M1
Obtain answer $y = \frac{1}{2} \ln(e^x - 1)$	A1
	3

Question 33

Remove logarithms and state $4 - 3^x = e^{1.2}$, or equivalent	B1
Use correct method to solve an equation of the form $3^x = a$, where $a > 0$.	M1
Obtain answer $x = -0.351$ only	A1
	3

Question 34

Reduce the equation to a horizontal equation in 3^{3x} , 3^{3x+1} or 27^x	M1
Simplify and reach $3(3^{3x}) = 5$, $3(27^x) = 5$, or equivalent	A1
Use correct method for finding x from a positive value of 3^{3x} , 3^{3x+1} or 27^x	M1
Obtain answer $x = 0.155$	A1
	4

Question 35

Use law of logarithm of a power and sum and remove logarithms	M1
Obtain a correct equation in any form, e.g. $3(2x + 5) = (x + 2)^2$	A1
Use correct method to solve a 3-term quadratic, obtaining at least one root	M1
Obtain final answer $x = 1 + 2\sqrt{3}$ or $1 + \sqrt{12}$ only	A1
	4

Question 36

Use law of the logarithm of a product or power	M1
Obtain a correct linear inequality in any form, e.g. $\ln 2 + (1 - 2x) \ln 3 < x \ln 5$	A1
Solve for x	M1
Obtain $x > \frac{\ln 6}{\ln 45}$	A1
	4

Question 37

State or imply $2 \ln y = \ln A + kx$	B1
Substitute values of $\ln y$ and x , or equate gradient of line to k , and solve for k	M1
Obtain $k = 0.80$	A1
Solve for $\ln A$	M1
Obtain $A = 3.31$	A1

Question 38

(a)	Remove logarithms correctly and state $1 + e^{-x} = e^{-2x}$, or equivalent	B1
	Show equation is $u^2 + u - 1 = 0$, where $u = e^x$, or equivalent	B1
		2
(b)	Solve a 3-term quadratic for u	M1
	Obtain root $\frac{1}{2}(-1 + \sqrt{5})$, or decimal in $[0.61, 0.62]$	A1
	Use correct method for finding x from a positive root	M1
	Obtain answer $x = -0.481$ only	A1
		4

Question 39

State or imply $\log_{10} 10 = 1$	B1	$\log_{10} 10^{-1} = -1$
Use law of the logarithm of a power, product or quotient	M1	
Obtain a correct equation in any form, free of logs	A1	e.g. $(2x + 1)/(x + 1)^2 = 10^{-1}$ or $10(2x + 1)/(x + 1)^2 = 10^0$ or 1 or $x^2 + 2x + 1 = 20x + 10$
Reduce to $x^2 - 18x - 9 = 0$, or equivalent	A1	
Solve a 3-term quadratic	M1	
Obtain final answers $x = 18.487$ and $x = -0.487$	A1	Must be 3 d.p. Do not allow rejection.
	6	

Question 40

State that $1 + e^{-3x} = e^2$	B1	With no errors seen to that point
Use correct method to solve an equation of the form $e^{-3x} = a$, where $a > 0$, for x or equivalent	M1	($e^{-3x} = 6.389\dots$) Evidence of method must be seen.
Obtain answer $x = -0.618$ only	A1	Must be 3 decimal places

Question 41

State or imply $\log_{10} 10 = 1$	B1	$\log_{10} 10^{-1} = -1$
Use law of the logarithm of a power, product or quotient	M1	
Obtain a correct equation in any form, free of logs	A1	e.g. $(2x + 1)/(x + 1)^2 = 10^{-1}$ or $10(2x + 1)/(x + 1)^2 = 10^0$ or 1 or $x^2 + 2x + 1 = 20x + 10$
Reduce to $x^2 - 18x - 9 = 0$, or equivalent	A1	
Solve a 3-term quadratic	M1	
Obtain final answers $x = 18.487$ and $x = -0.487$	A1	Must be 3 d.p. Do not allow rejection.
	6	

Question 42

Use law of the logarithm of a product or power	M1
Obtain a correct equation free of logarithms, e.g. $3(x^3 - 3) = x^3$	A1
Obtain $x = 1.65$	A1
	3

Question 43

State or imply $u^2 - 3u - 1 = 0$, or equivalent in 4^x	B1
Solve for u or 4^x	M1
Obtain root $\frac{1}{2}(3 + \sqrt{13})$, or decimal in [3.30, 3.31]	A1
Use correct method for finding x from a positive root	M1
Obtain answer $x = 0.862$ and no other	A1
	5

Question 44

(a)	State or imply $\ln x = \ln A - y \ln 3$	B1
	State that the graph of y against $\ln x$ has an equation that is <i>linear</i> in y and $\ln x$, or has an equation of the standard form ' $y = mx + c$ ' and is thus a straight line	B1
	State that the gradient is $-\frac{1}{\ln 3}$	B1
		3
(b)	Substitute $\ln x = 0$, $y = 1.3$ and use correct method to solve for A	M1
	Obtain answer $A = 4.17$ only	A1
		2

Question 45

Reduce to a 3-term quadratic $u^2 + 6u - 1 = 0$ OE	B1
Solve a 3-term quadratic for u	M1
Obtain root $\sqrt{10} - 3$	A1
Obtain answer $x = -1.818$ only	A1
Reject $-\sqrt{10} - 3$ correctly	B1
Alternative method for Question 2	
Rearrange to obtain a correct iterative formula	B1
Use the iterative process at least twice	M1
Obtain answer $x = -1.818$	A1
Show sufficient iterations to at least 4 d.p. to justify $x = -1.818$	A1
Clear explanation of why there is only one real root	B1
	5

Question 46

Use laws of indices correctly and solve for 4^x	M1
Obtain correct solution in any form, e.g. $4^x = \frac{256}{15}$	A1
Use a correct method for solving an equation of the form $4^x = a$, where $a > 0$	M1
Obtain answer 2.047	A1
	4

Question 47

Use law of the logarithm of a product, a quotient or power	*M1	e.g. $\ln(7^x) = x \ln 7$
Obtain a correct linear equation in any form	A1	e.g. $\ln 3 + (1-x) \ln 2 = x \ln 7$
Solve a linear equation for x	DM1	
Obtain answer $x = \frac{\ln 6}{\ln 14}$	A1	Maximum 3 out of 4 available if final answer not in required form e.g. 0.67... ISW once correct answer seen.

Question 48

State or imply $n \ln x + 2 \ln y = \ln C$	B1	
Substitute values of $\ln y$ and $\ln x$, or equate gradient of line to $\pm \frac{1}{2}n$, but not $\pm n$, and solve for n	M1	Using $\ln x$ and $\ln y$ values
Obtain $n = 0.8[0]$ or $0.8[00]$ or $\frac{4}{5}$	A1	
Solve for C	M1	Using $\ln x$ and $\ln y$ values in equation of correct form, that is $\ln C$ not C . Allow $C = e^{2.668}$.
Obtain $C = 14.41$	A1	Must be 2 d.p.
Alternative method for question 3		
Obtain two correct equations in n and C by substituting x and y values in the given equation	B1	$(2.886)^n \times (2.484)^2 = C$ and $(1.363)^n \times (3.353)^2 = C$
Solve for n	M1	Using x and y values
Obtain $n = 0.8[0]$ or $0.8[00]$ or $4/5$	A1	$\left(\frac{2.886}{1.363}\right)^n \times \left(\frac{2.484}{3.353}\right)^2 = 1$ leading to $n = 0.7995$
Solve for C	M1	Using x and y values
Obtain $C = 14.41$	A1	Must be 2 d.p.
	5	

Question 49

(a)	Use law of logarithm of a power	M1	$\log_3(2x + 1) = 1 + \log_3(x - 1)^2$
	Use $\log_3 3 = 1$	B1	$\log_3(2x + 1) = \log_3 3 + 2\log_3(x - 1)$ $\left[\log_3\left(\frac{2x + 1}{(x - 1)^2}\right) = \log_3 3 \text{ or } \left(\frac{2x + 1}{(x - 1)^2}\right) = 3 \right]$ SC For candidates scoring M0 B0 due to combining logs before dealing with coefficient 2, and confusing coefficients, allow $\log_3(\dots) = c$ leading to $(\dots) = 3^c$ B1 .
	Obtain $3x^2 - 8x + 2 = 0$ or $1.5x^2 - 4x + 1 = 0$	A1	OE 3 terms only and = 0 required.
		3	
(b)	Solve 3-term quadratic equation from part 3(a) or restart to find y	M1	$y = \frac{4 \pm \sqrt{10}}{6}$ or $y = 1.1937\dots$ or $y = 0.1396\dots$ $(x = 2.3874 \text{ or } x = 0.2792)$ May solve for x but must find $y = \frac{x}{2}$ to gain M1.
	Obtain answer 1.19	A1	CAO. 2 dp required.
		2	

Question 50

Use law of the logarithm of a product, power or quotient or a law of indices (on an expression that is relevant to the question)	M1	e.g. $\ln(e^{2x} + 3) - \ln 3 = \ln\left(\frac{e^{2x} + 3}{3}\right)$ or $e^{(2x+\ln 3)} = e^{2x}e^{\ln 3}$
State a correct equation without logs (in any form)	A1	e.g. $3 + e^{2x} = 3e^{2x}$
Carry out correct method to solve an equation of the form $e^{2x} = a$, where $a > 0$, or for solving $e^x = b$ ($b > 0$) if they have already taken the square root	M1	Allow for $x = \frac{1}{2}\ln \frac{3}{2}$. M1 can be implied by correct answer.
Obtain answer $x = 0.203$	A1	CAO. The question requires 3 d.p. Answer only with no working shown is 0/4.
	4	

Question 51

Use law of the logarithm of a product or a quotient or a power	*M1	
Obtain a correct linear equation in any form	A1	e.g. $\ln 2 + (2x - 1)\ln 3 = (x + 1)\ln 4$ or $\log_2 2 + (2x - 1)\log_2 3 = (2x + 2)\log_2 2$
Solve for x	DM1	Allow for unsimplified expression $x = \dots$. Allow M1 M1 for $x = 1.45$ from $6^{2x-1} = 4^{x+1}$.
Obtain answer $x = 2.21$	A1	The question asks for 2 dp.

Question 52

Use law for the logarithm of a product, quotient or power	M1
Remove logarithms and state a correct equation, e.g. $x(2x-1) = (x+1)^2$	A1
Solve a 3-term quadratic obtaining at least one root	M1
Obtain answer 3.303 only	A1
	4

Question 53

Use law of the logarithm of a power or product	M1	Ignoring the 3 or the 5 is not a misread.
Obtain a correct linear equation in any form, e.g. $(3x-1)\ln 2 = \ln 5 + (1-x)\ln 3$	A1	Condone invisible brackets if they are used correctly later.
Solve for x	M1	Get as far as $x = \dots$ Condone minor slips in the processing e.g. sign errors and losing a term that had been there, but award M0 for a fundamental error e.g. $3x\ln 2 + x\ln 3 = 3x\ln 6$ or ignoring the 3 or the 5 completely. Condone working in decimals.
Obtain final answer $x = \frac{\ln 30}{\ln 24}$	A1	Do not ISW

Question 54

Use law of the logarithm of a quotient or express x as $\ln e^x$	M1	$x = \ln[(2y-3)/(y+4)]$ or $\ln e^x = \ln(2y-3) - \ln(y+4)$.
Remove logarithms and obtain a correct equation e.g. $e^x = \frac{2y-3}{y+4}$	A1	
Obtain answer $y = \frac{3+4e^x}{2-e^x}$	A1	OE ISW
	3	

Question 55

Use exponentials or law for the logarithm of a product, quotient or power	M1*	$e^{\ln(5+x)} = e^{5+\ln x}$ insufficient. Need e.g. $\ln\left(\frac{x+5}{x}\right) = 5$ or $\ln(x+5) = \ln(e^5) + \ln x$ or $\ln(x+5) = \ln(e^5 x)$ or $x+5 = e^{5+\ln x}$ or $x+5 = e^5 e^{\ln x}$ and others.
Correctly remove logarithms	DM1	
Obtain a correct equation in x	A1	e.g. $\frac{x+5}{x} = e^5$ (or 148.4...) or $x+5 = xe^5$.
Obtain 0.034	A1	CAO Final answer must be 3d.p.
	4	

Question 56

Use law of the logarithm of a power, quotient or product

M1 Must be used correctly on a **correct** term.
 e.g. M1 for $2 \ln x = \ln x^2$
 but M0 for $2 \ln x - \ln 2 = 2 \ln \frac{x}{2}$.
 M0 for $\ln(2x^2 - 3) = \ln 2x^2 - \ln 3$
 $= \ln 2 + 2 \ln x - \ln 3$.

Remove logarithms and obtain a correct equation in x

A1 e.g. $2x^2 - 3 = \frac{x^2}{2}$.

Obtain final answer $x = \sqrt{2}$ only

A1 If $x = -\sqrt{2}$ is mentioned, it must be rejected.

3

Question 57

$$3(e^{2x})^2 - 5(e^{2x}) - 4 = 0$$

B1 OE Form 3 term quadratic in e^{2x} .

$$e^{2x} = \frac{5 \pm \sqrt{73}}{6}, \quad x = \frac{1}{2} \ln \left(\frac{5 + \sqrt{73}}{6} \right)$$

M1 Use correct method to solve for x .

$$x = 0.407$$

A1 Only

3

