

TOPICAL PAST PAPER QUESTIONS

IGCSE Additional Mathematics (0606)

Paper 1

Exam Series: February/March 2017 – October/November 2024

Format Type A:

Answers to all questions are provided as an appendix



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Introduction

Each Topical Past Paper Questions Compilation contains a comprehensive collection of hundreds of questions and corresponding answer schemes, presented in worksheet format. The questions are carefully arranged according to their respective chapters and topics, which align with the latest IGCSE or AS/A Level subject content. Here are the key features of these resources:

1. The workbook covers a wide range of topics, which are organized according to the latest syllabus content for Cambridge IGCSE or AS/A Level exams.
2. Each topic includes numerous questions, allowing students to practice and reinforce their understanding of key concepts and skills.
3. The questions are accompanied by detailed answer schemes, which provide clear explanations and guidance for students to improve their performance.
4. The workbook's format is user-friendly, with worksheets that are easy to read and navigate.
5. This workbook is an ideal resource for students who want to familiarize themselves with the types of questions that may appear in their exams and to develop their problem-solving and analytical skills.

Overall, Topical Past Paper Questions Workbooks are a valuable tool for students preparing for IGCSE or AS/A level exams, providing them with the opportunity to practice and refine their knowledge and skills in a structured and comprehensive manner. To provide a clearer description of this book's specifications, here are some key details:

- Title: Cambridge IGCSE Additional Mathematics (0606) Paper 1 Topical Past Papers
- Subtitle: Exam Practice Worksheets With Answer Scheme
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- Subject code: 0606
- Years covered: February/March 2017 – October/November 2024
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Contents

1	Functions	7
2	Quadratic functions	23
3	Equations, inequalities and graphs	39
4	Indices and surds	61
5	Factors of polynomials	79
6	Simultaneous equations	95
7	Logarithmic and exponential functions	99
8	Straight line graphs	147
9	Circular measure	183
10	Trigonometry	219
11	Permutations and combinations	305
12	Series	341
13	Vectors in two dimensions	399
14	Differentiation and integration	449
A	Answers	643

Chapter 1

Functions

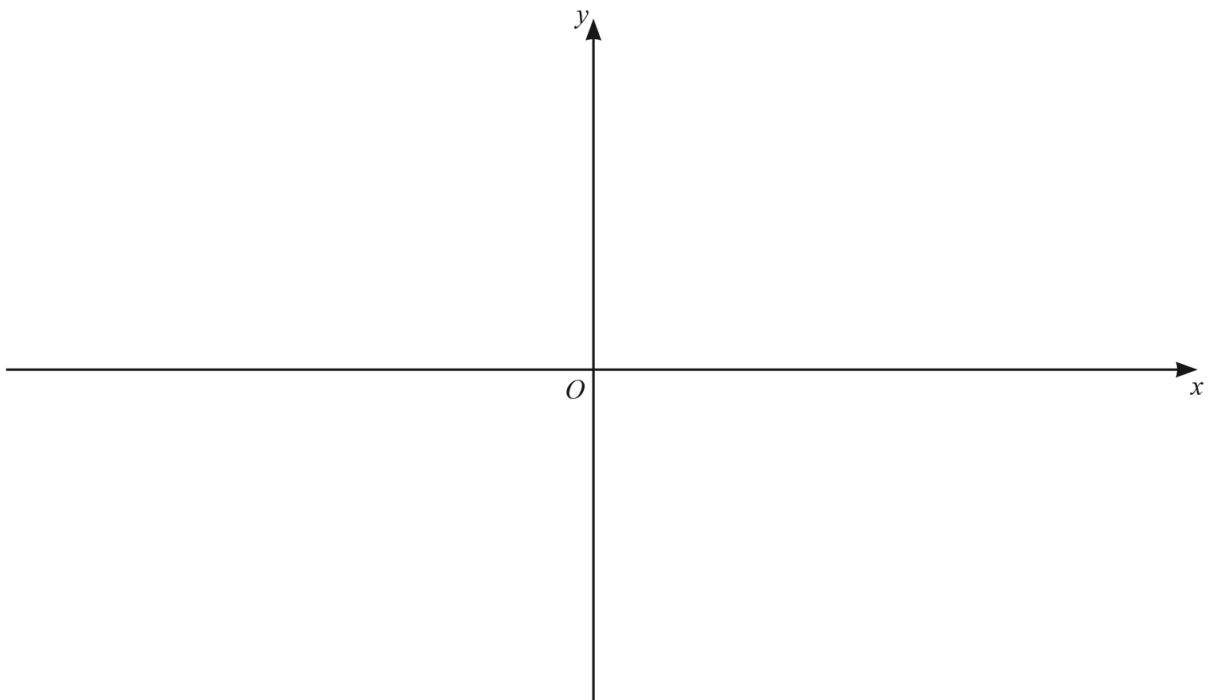
1. 0606_m24_qp_12 Q: 4

A function f is such that $f(x) = 2 + e^{-3x}$, $x \in \mathbb{R}$.

(a) Write down the range of f . [1]

(b) Find an expression for f^{-1} . [2]

(c) On the axes, sketch the graphs of $y = f(x)$ and $y = f^{-1}(x)$, stating the coordinates of the points where the curves meet the coordinate axes. State the equations of any asymptotes. Label your curves. [4]



A function g is such that $g(x) = x^{\frac{3}{2}} + 4$, $x \geq 0$.

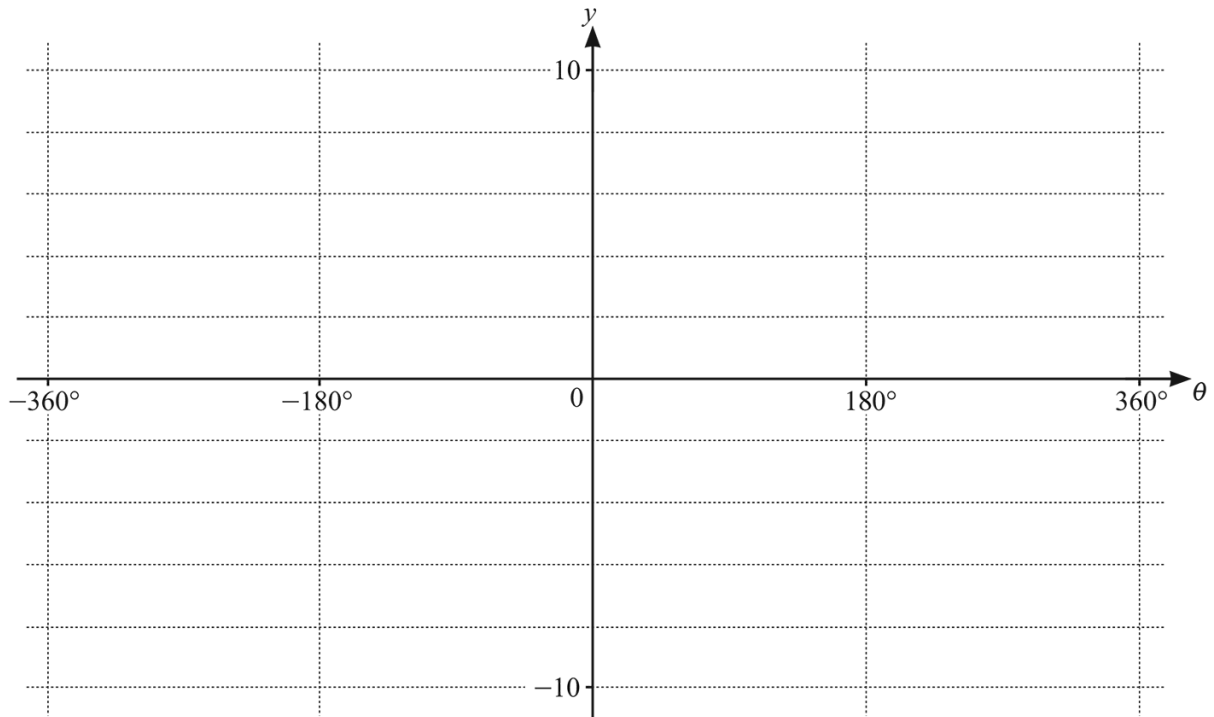
(d) Find the exact solution of the equation $gf(x) = 12$.

[4]



2. 0606_w24_qp_13 Q: 2

On the axes, sketch the graph of $y = 4 + 5 \sin \frac{\theta}{2}$, for $-360^\circ \leq \theta \leq 360^\circ$. State the intercept with the y-axis. [4]



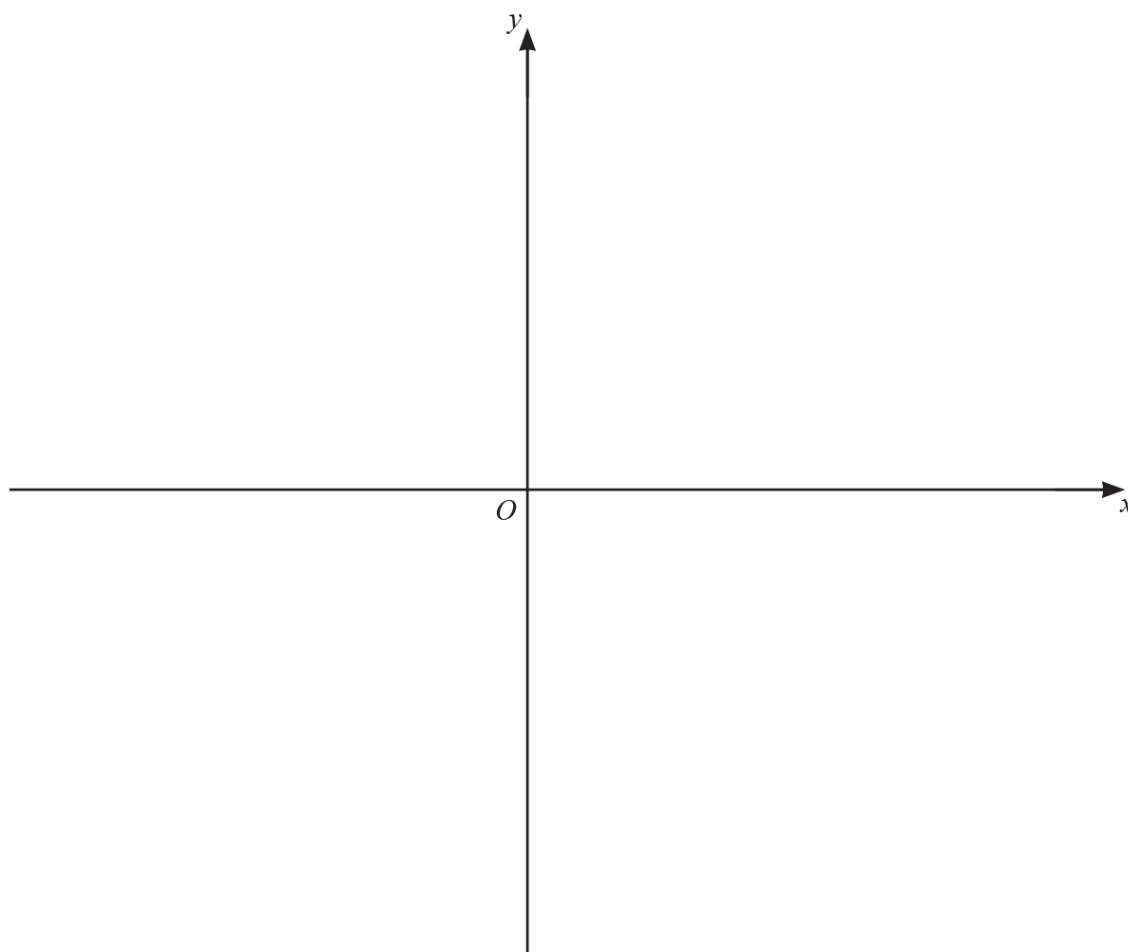
3. 0606_s23_qp_12 Q: 8

It is given that $f(x) = 2\ln(3x-4)$ for $x > a$.

(a) Write down the least possible value of a . [1]

(b) Write down the range of f . [1]

(c) It is given that the equation $f(x) = f^{-1}(x)$ has two solutions. (You do not need to solve this equation). Using your answer to **part (a)**, sketch the graphs of $y = f(x)$ and $y = f^{-1}(x)$ on the axes below, stating the coordinates of the points where the graphs meet the axes. [4]



It is given that $g(x) = 2x - 3$ for $x \geq 3$.

(d) (i) Find an expression for $g(g(x))$. [1]

(ii) Hence solve the equation $fg(g(x)) = 4$ giving your answer in exact form. [3]

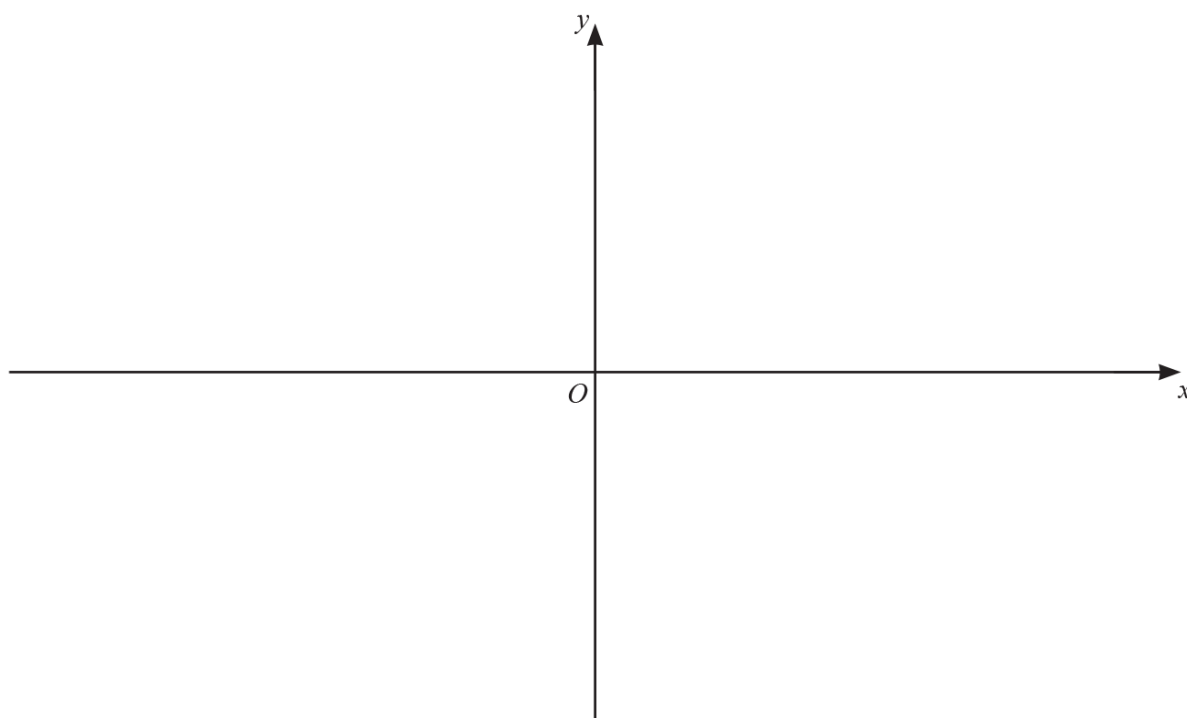
4. 0606_w23_qp_12 Q: 8

(a) It is given that $f : x \rightarrow (3x+1)^2 - 4$ for $x \geq a$, and that f^{-1} exists.

(i) Find the least possible value of a . [1]

(ii) Using this value of a , write down the range of f . [1]

(iii) Using this value of a , sketch the graphs of $y = f(x)$ and $y = f^{-1}(x)$ on the axes, stating the intercepts with the coordinate axes. [4]



(b) It is given that $g(x) = \ln(2x^2 + 5)$ for $x \geq 0$,

$$h(x) = 3x - 2 \text{ for } x \geq 0.$$

Solve the equation $hg(x) = 4$ giving your answer in exact form.

[3]

5. 0606_s21_qp_11 Q: 5

The functions f and g are defined as follows.

$$f(x) = x^2 + 4x \quad \text{for } x \in \mathbb{R}$$

$$g(x) = 1 + e^{2x} \quad \text{for } x \in \mathbb{R}$$

(a) Find the range of f . [2]

(b) Write down the range of g . [1]

(c) Find the exact solution of the equation $fg(x) = 21$, giving your answer as a single logarithm. [4]

6. 0606_w21_qp_13 Q: 2

A particle moves in a straight line such that its velocity, $v \text{ ms}^{-1}$, at time t seconds after passing through a fixed point O , is given by $v = e^{3t} - 25$. Find the speed of the particle when $t = 1$. [2]

7. 0606_s20_qp_12 Q: 5

$$f : x \mapsto (2x+3)^2 \text{ for } x > 0$$

(a) Find the range of f . [1]

(b) Explain why f has an inverse. [1]

(c) Find f^{-1} . [3]

(d) State the domain of f^{-1} . [1]

(e) Given that $g : x \mapsto \ln(x+4)$ for $x > 0$, find the exact solution of $fg(x) = 49$. [3]

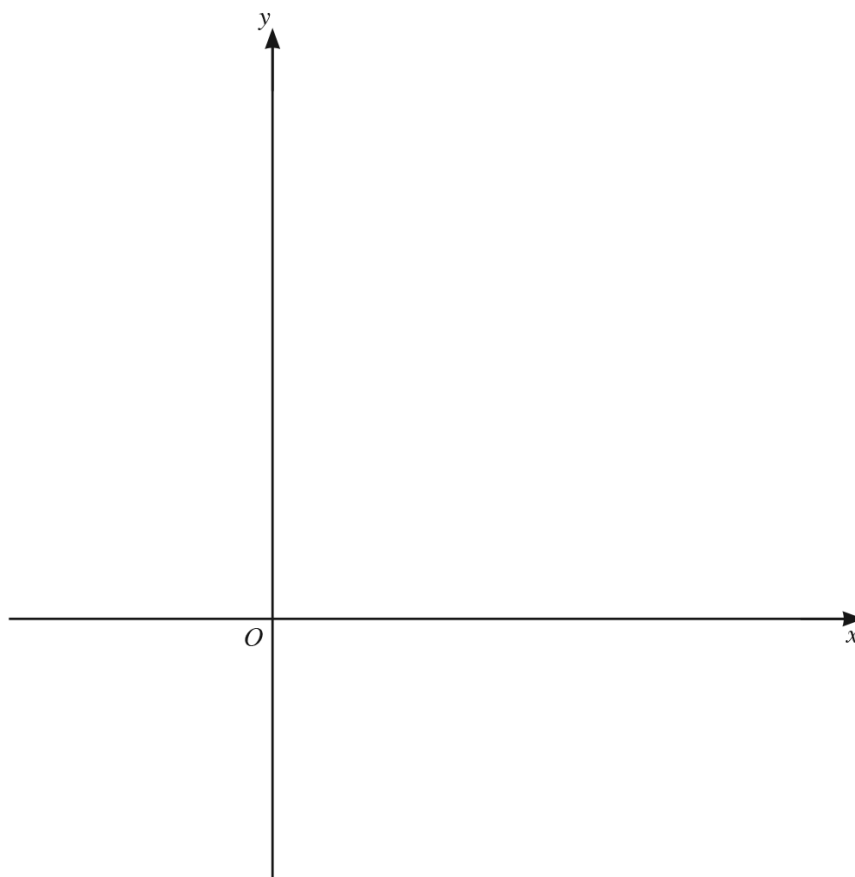
8. 0606_w20_qp_11 Q: 7

It is given that $f(x) = 5 \ln(2x+3)$ for $x > -\frac{3}{2}$.

(a) Write down the range of f . [1]

(b) Find f^{-1} and state its domain. [3]

(c) On the axes below, sketch the graph of $y = f(x)$ and the graph of $y = f^{-1}(x)$. Label each curve and state the intercepts on the coordinate axes.



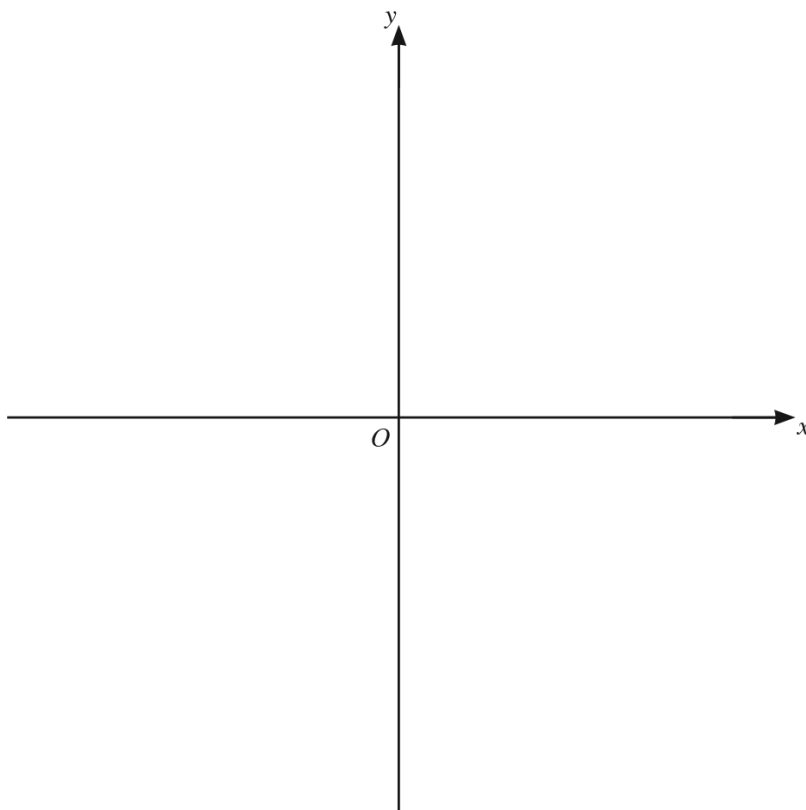
[5]

9. 0606_w20_qp_12 Q: 6

$$f(x) = x^2 + 2x - 3 \quad \text{for } x \geq -1$$

- (a) Given that the minimum value of $x^2 + 2x - 3$ occurs when $x = -1$, explain why $f(x)$ has an inverse. [1]

- (b) On the axes below, sketch the graph of $y = f(x)$ and the graph of $y = f^{-1}(x)$. Label each graph and state the intercepts on the coordinate axes.



[4]

10. 0606_w20_qp_13 Q: 3

(a) $f(x) = 4 \ln(2x - 1)$

(i) Write down the largest possible domain for the function f . [1]

(ii) Find $f^{-1}(x)$ and its domain. [3]

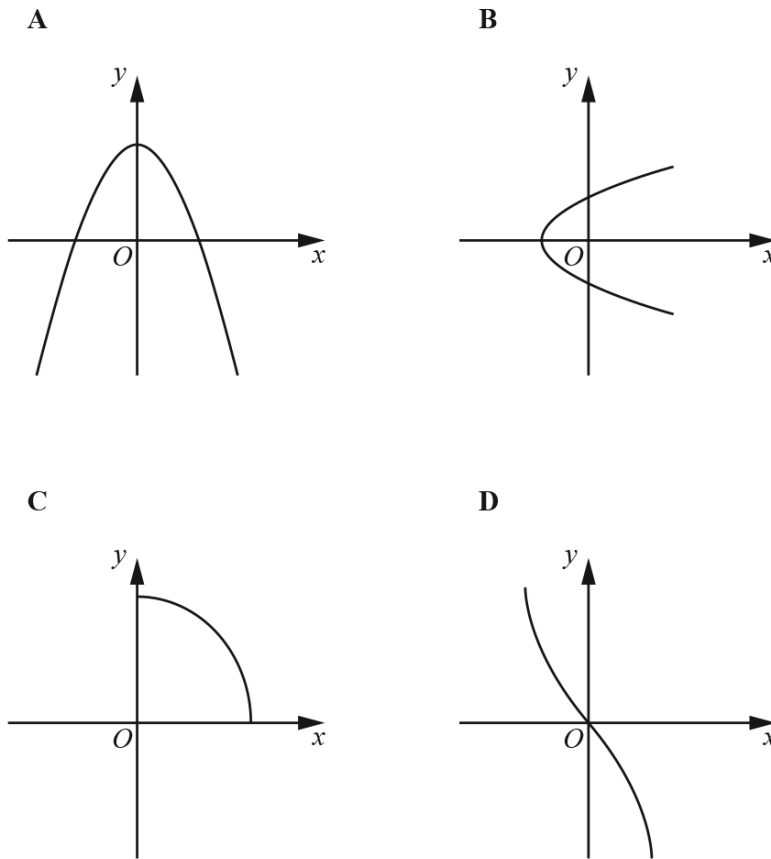
(b) $g(x) = x + 5$ for $x \in \mathbb{R}$

$$h(x) = \sqrt{2x - 3} \text{ for } x \geq \frac{3}{2}$$

Solve $gh(x) = 7$. [3]

11. 0606_s18_qp_11 Q: 3

Diagrams **A** to **D** show four different graphs. In each case the whole graph is shown and the scales on the two axes are the same.



Place ticks in the boxes in the table to indicate which descriptions, if any, apply to each graph. There may be more than one tick in any row or column of the table. [4]

	A	B	C	D
Not a function				
One-one function				
A function that is its own inverse				
A function with no inverse				

12. 0606_w17_qp_11 Q: 6

(a) Functions f and g are such that, for $x \in \mathbb{R}$,

$$f(x) = x^2 + 3,$$

$$g(x) = 4x - 1.$$

(i) State the range of f . [1]

(ii) Solve $fg(x) = 4$. [3]

(b) A function h is such that $h(x) = \frac{2x+1}{x-4}$ for $x \in \mathbb{R}$, $x \neq 4$.

(i) Find $h^{-1}(x)$ and state its range. [4]

(ii) Find $h^2(x)$, giving your answer in its simplest form. [3]

Chapter 2

Quadratic functions

13. 0606_w24_qp_13 Q: 3

Find the values of k for which the equation $4x^2 - k = 4kx - 2$ has no real roots. [4]

14. 0606_s23_qp_13 Q: 2

(a) Write $2x^2 + 5x + 3$ in the form $2(x+a)^2 + b$, where a and b are rational numbers. [2]

(b) Hence write down the coordinates of the stationary point on the curve $y = 2x^2 + 5x + 3$. [2]

(c) Solve the inequality $2x^2 + 5x + 3 < \frac{15}{8}$. [3]

15. 0606_w23_qp_12 Q: 9

Solve the equation $12x^{\frac{2}{3}} - 5x^{-\frac{2}{3}} - 11 = 0$ for $x > 0$. Give your answer correct to one decimal place. [4]

16. 0606_m22_qp_12 Q: 1

Find the values of k such that the line $y = 9kx + 1$ does not meet the curve $y = kx^2 + 3x(2k + 1) + 4$.
[5]

17. 0606_m22_qp_12 Q: 2

DO NOT USE A CALCULATOR IN THIS QUESTION.

Solve the equation $(3 - 5\sqrt{3})x^2 + (2\sqrt{3} + 5)x - 1 = 0$, giving your solutions in the form $a + b\sqrt{3}$,
where a and b are rational numbers.
[6]

18. 0606_w22_qp_11 Q: 4

DO NOT USE A CALCULATOR IN THIS QUESTION.

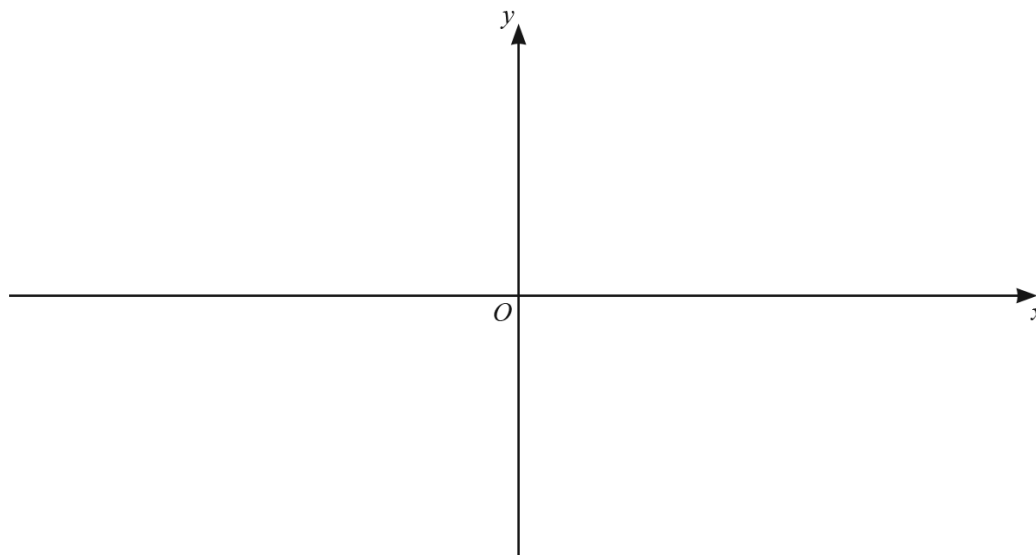
Solve the equation $(\sqrt{5} - 1)x^2 - 2x - (\sqrt{5} + 1) = 0$, giving your answers in the form $a + b\sqrt{5}$, where a and b are constants. [6]

19. 0606_m21_qp_12 Q: 4

(a) Show that $2x^2 + 5x - 3$ can be written in the form $a(x+b)^2 + c$, where a , b and c are constants. [3]

(b) Hence write down the coordinates of the stationary point on the curve with equation $y = 2x^2 + 5x - 3$. [2]

(c) On the axes below, sketch the graph of $y = |2x^2 + 5x - 3|$, stating the coordinates of the intercepts with the axes. [3]



(d) Write down the value of k for which the equation $|2x^2 + 5x - 3| = k$ has exactly 3 distinct solutions. [1]

20. 0606_s21_qp_13 Q: 1

Find the possible values of the constant k such that the equation $kx^2 + 4kx + 3k + 1 = 0$ has two different real roots. [4]

21. 0606_m20_qp_12 Q: 2

Find the values of k for which the line $y = kx + 3$ is a tangent to the curve $y = 2x^2 + 4x + k - 1$. [5]

22. 0606_s20_qp_11 Q: 4

DO NOT USE A CALCULATOR IN THIS QUESTION.

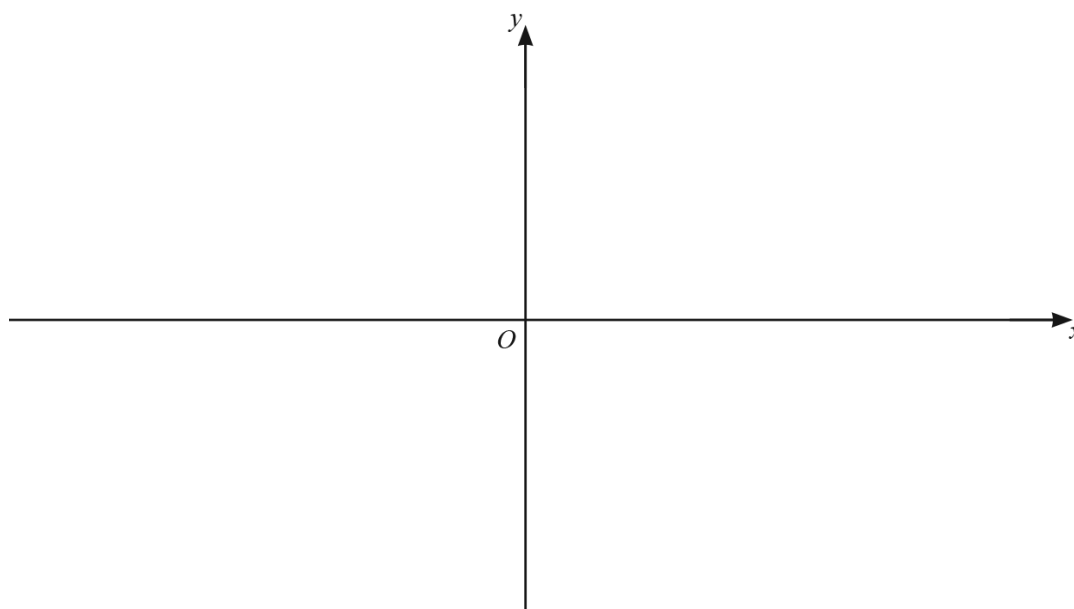
Find the positive solution of the equation $(5 + 4\sqrt{7})x^2 + (4 - 2\sqrt{7})x - 1 = 0$, giving your answer in the form $a + b\sqrt{7}$, where a and b are fractions in their simplest form. [5]

23. 0606_s20_qp_13 Q: 4

(a) Write $2x^2 + 3x - 4$ in the form $a(x + b)^2 + c$, where a , b and c are constants. [3]

(b) Hence write down the coordinates of the stationary point on the curve $y = 2x^2 + 3x - 4$. [2]

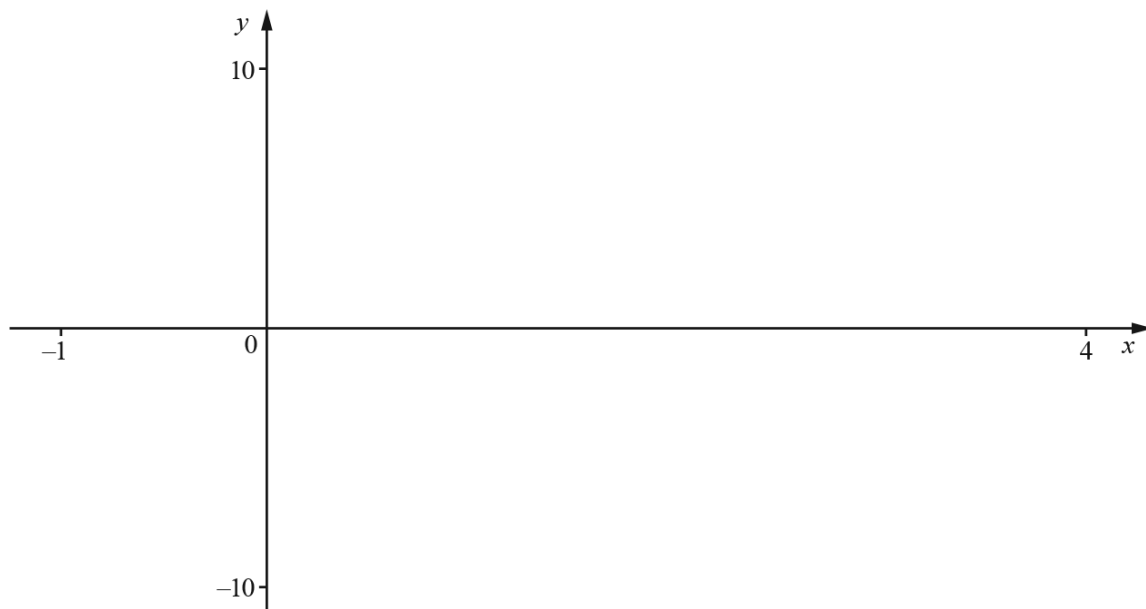
(c) On the axes below, sketch the graph of $y = |2x^2 + 3x - 4|$, showing the exact values of the intercepts of the curve with the coordinate axes. [3]



(d) Find the value of k for which $|2x^2 + 3x - 4| = k$ has exactly 3 values of x . [1]

24. 0606_m19_qp_12 Q: 2

On the axes below, sketch the graph of the curve $y = |2x^2 - 5x - 3|$, stating the coordinates of any points where the curve meets the coordinate axes.



[4]

25. 0606_s19_qp_12 Q: 2

Do not use a calculator in this question.

Find the coordinates of the points of intersection of the curve $y = (2x+3)^2(x-1)$ and the line $y = 3(2x+3)$.

[5]

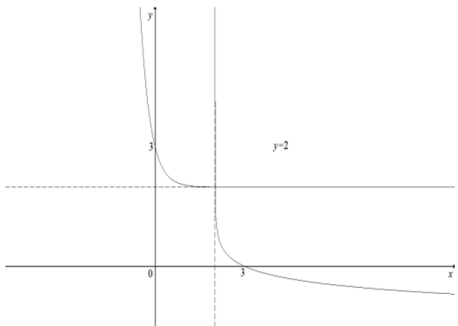


Appendix A

Answers

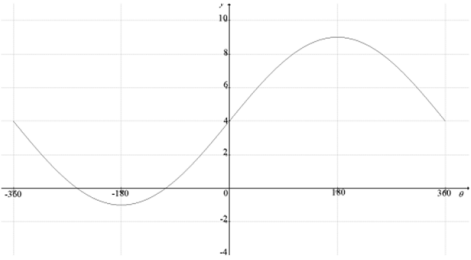
1. 0606_m24_ms_12 Q: 4

Question	Answer	Marks	Guidance
(a)	$f > 2$	B1	
(b)	$f^{-1}(x) = -\frac{1}{3}\ln(x-2)$ or $\frac{1}{3}\ln\left(\frac{1}{x-2}\right)$ isw	2	M1 for a complete attempt at inverse, allow sign slip but brackets must be used correctly.

Question	Answer	Marks	Guidance
(c)		4	<p>B1 for correct $y = f(x)$ with y-intercept of 3. Must have correct asymptotic behaviour and be in the first and second quadrant.</p> <p>B1dep for correct reflection of $y = f(x)$ to obtain $y = f^{-1}(x)$ with x-intercept of 3. Must have correct asymptotic behaviour and be in the first and fourth quadrant.</p> <p>B1 for asymptote of $y = 2$ stated or drawn through $y = 2$, must have a correctly shaped $y = f(x)$</p> <p>B1 for asymptote of $x = 2$ stated or drawn or drawn through $x = 2$, must have a correctly shaped $y = f^{-1}(x)$</p>
(d)	$(2 + e^{-3x})^{\frac{3}{2}} + 4$ soi	B1	For correct order
	$2 + e^{-3x} = 4$	M1	For forming an equation, must be correct order
	$x = -\frac{1}{3}\ln 2$	2	M1 dep for correct attempt to solve for x .

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2. 0606_w24_ms_13 Q: 2

Question	Answer	Marks	Guidance
		4	<p>B1 for correct shape must be a curve with one min in 3rd quadrant and one max in first quadrant and correct endpoints $(-360, 4)$ and $(360, 4)$ Ignore labelling of their maximum point if incorrect coordinates.</p> <p>depB1 for intercept of 4 on y-axis. Must have the correct shape</p> <p>depB1 for max in correct position of $(180^\circ, 9)$. Must have the correct shape</p> <p>depB1 for min in correct position of $(-180^\circ, -1)$. Must have the correct shape</p>

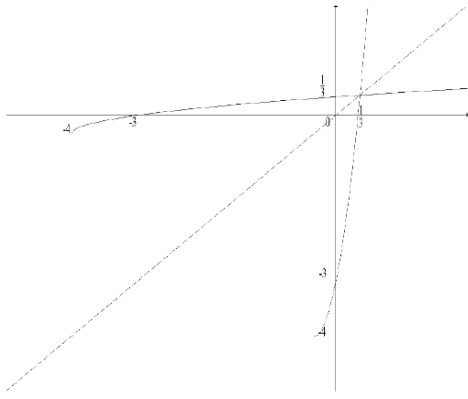
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3. 0606_s23_ms_12 Q: 8

Question	Answer	Marks	Guidance
(a)	$(a =) \frac{4}{3}$ or $1.\dot{3}$	B1	Allow a recurring decimal Must not be an inequality in terms of a Allow $x > \frac{4}{3}$
(b)	$f \in \mathbb{R}$ or $-\infty < f < \infty$ or \mathbb{R}	B1	Allow y or $f(x)$ but not x .
(c)		4	B1 for a correct shape for $y = f(x)$ in quadrants 1 and 4 B1 for $(\frac{5}{3}, 0)$, must have a correct shape in either quadrant 1 or quadrant 4 B1 for $y = f^{-1}(x)$, must be a correct shape in quadrants 1 and 2 and intersect twice. B1 for $(0, \frac{5}{3})$, must have a reasonable shape for $y = f^{-1}(x)$ in either the first quadrant or the second quadrant
(d)(i)	$g(g(x)) = 4x - 9$	B1	Must be simplified
(d)(ii)	$fg(g(x)) = 2\ln(12x - 31)$	M1	allow unsimplified, using <i>their</i> answer to (i)
	$2\ln(12x - 31) = 4$ $x = \frac{e^2 + 31}{12}$	2	Dep M1 for correct order of operations to solve <i>their</i> equation, to get as far as $x = \dots$ Implied by decimal answer of awrt 3.2 A1 Must be exact form.

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4. 0606_w23_ms_12 Q: 8

Question	Answer	Marks	Guidance
(a)(i)	$a = -\frac{1}{3}$ or $x \geq -\frac{1}{3}$	B1	Allow -0.333 or better Allow a correct recurring decimal
(a)(ii)	$f \geq -4$	B1	
(a)(iii)		4	B1 for $y = f(x)$, must have a correct shape (right hand side from the vertex of a quadratic curve), must be a 1:1 function, intersecting each of the x and y axes once, in quadrants 1, 3 and 4. B1, dependent on previous B for passing through $(0, -3)$ and $(\frac{1}{3}, 0)$. B1 dependent on first B1 for $y = f^{-1}(x)$, being a correct reflection of <i>their</i> $y = f(x)$, intersecting each of the x and y axes and $y = f(x)$ once. B1 dependent on previous B for passing through $(-3, 0)$ and $(0, \frac{1}{3})$.
(b)	$3(\ln(2x^2 + 5)) - 2 (= 4)$	M1	For correct order
	$x = \sqrt{\frac{e^2 - 5}{2}}$ or exact equivalent	2	M1 dep for a correct attempt to deal with logarithms and obtain $x = \dots$ Allow one arithmetic or sign slip.

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5. 0606_s21_ms_11 Q: 5

Question	Answer	Marks	Guidance
(a)	$f \geq -4$	2	M1 for a valid method to find the least value of $x^2 + 4x$ A1 for $f \geq -4, y \geq -4$ or $f(x) \geq -4$
(b)	$g > 1$	B1	Allow $y > 1$ or $g(x) > 1$
(c)	$(1 + e^{2x})^2 + 4(1 + e^{2x}) [= 21]$	M1	
	$e^{4x} + 6e^{2x} - 16 = 0$ $(e^{2x} + 8)(e^{2x} - 2) = 0$	M1	Dep for quadratic in terms of e^{2x} and attempt to solve to obtain $e^{2x} = k$
	$e^{2x} = 2$ $x = \frac{1}{2} \ln k$	M1	Dep on both previous M marks, for attempt to solve $e^{2x} = k$
	$x = \ln \sqrt{2}$ or $\ln 2^{\frac{1}{2}}$	A1	

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6. 0606_w21_ms_13 Q: 2

Question	Answer	Marks	Guidance
	$v = -4.91$ soi	B1	
	Speed = 4.91	B1	

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7. 0606_s20_ms_12 Q: 5

Question	Answer	Marks	Partial Marks
(a)	$f > 9$	B1	Allow y but not x
(b)	It is a one-one function because of the restricted domain	B1	

Question	Answer	Marks	Partial Marks
(c)	$x = (2y + 3)^2$ or equivalent	M1	For a correct attempt to find the inverse
	$y = \frac{\sqrt{x} - 3}{2}$	M1	For correct rearrangement
	$f^{-1} = \frac{\sqrt{x} - 3}{2}$	A1	Must have correct notation
(d)	$x > 9$	B1	FT on <i>their</i> (a)
(e)	$f(\ln(x + 4)) = 49$	M1	For correct order
	$(2\ln(x + 4) + 3)^2 = 49$ $\ln(x + 4) = 2$	M1	For correct attempt to solve, dep on previous M mark, as far as $x =$
	$x = e^2 - 4$	A1	

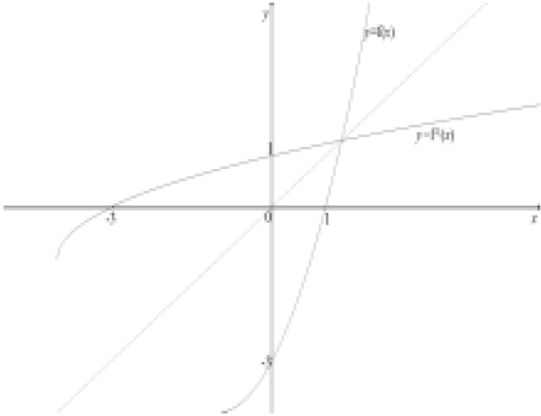
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8. 0606_w20_ms_11 Q: 7

Question	Answer	Marks	Guidance
(a)	$f \in \mathbb{R}$	B1	Allow y but not x
(b)	$x = 5 \ln(2y + 3)$ $e^{\frac{x}{5}} = 2y + 3$	M1	For a complete attempt to obtain inverse
	$f^{-1}(x) = \frac{e^{\frac{x}{5}} - 3}{2}$	A1	Must be using correct notation
	Domain $x \in \mathbb{R}$	B1	FT on <i>their</i> (a). Must be using correct notation
(c)		5	B1 for shape of $y = f(x)$ B1 for shape of $y = f^{-1}(x)$ B1 for $5 \ln 3$ or 5.5 and -1 on both axes for $y = f(x)$ B1 for $5 \ln 3$ or 5.5 and -1 on both axes for $y = f^{-1}(x)$ B1 All correct, with apparent symmetry which may be implied by previous 2 B marks or by inclusion of $y = x$, and implied asymptotes, may have one or two points of intersection

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9. 0606_w20_ms_12 Q: 6

Question	Answer	Marks	Guidance
(a)	It is a one-one function because of the given restricted domain or because $x \geq -1$	B1	
(b)		4	<p>B1 for $y = f(x)$ for $x > -1$ only</p> <p>B1 for 1 on x-axis and -3 on y-axis for $y = f(x)$</p> <p>B1 for $y = f^{-1}(x)$ as a reflection of $y = f(x)$ in the line $y = x$, maybe implied by intercepts with axes</p> <p>B1 for 1 on y-axis and -3 on x-axis for $y = f^{-1}(x)$</p>

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10. 0606_w20_ms_13 Q: 3

Question	Answer	Marks	Guidance
(a)(i)	$x > \frac{1}{2}$	B1	Must be using x

Question	Answer	Marks	Guidance
(a)(ii)	$x = 4 \ln(2y - 1)$ $e^{\frac{x}{4}} = 2y - 1$ $y = \frac{1}{2} \left(1 + e^{\frac{x}{4}} \right)$	M1	For full method for inverse using correct order of operations
	$f^{-1}(x) = \frac{1}{2} \left(1 + e^{\frac{x}{4}} \right)$ or $f^{-1}(x) = \frac{1}{2} \left(1 + \sqrt[4]{e^x} \right)$	A1	Must be using correct notation
	$x \in \mathbb{R}$	B1	
(b)	$\sqrt{2x - 3} + 5 = 7$	M1	For correct order
	$x = \frac{2^2 + 3}{2}$	M1	Dep on previous M mark, for obtaining x by simplifying and solving using correct order of operations, including squaring
	$x = \frac{7}{2}$ or 3.5	A1	

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11. 0606_s18_ms_11 Q: 3

<table border="1"> <thead> <tr> <th>A</th> <th>B</th> <th>C</th> <th>D</th> </tr> </thead> <tbody> <tr> <td></td> <td>✓</td> <td></td> <td></td> </tr> <tr> <td></td> <td></td> <td>✓</td> <td>✓</td> </tr> <tr> <td></td> <td></td> <td>✓</td> <td></td> </tr> <tr> <td>✓</td> <td></td> <td></td> <td></td> </tr> </tbody> </table>	A	B	C	D		✓					✓	✓			✓		✓				<p>4 B1 for either each row correct or each column correct – mark to candidate's advantage.</p>
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12. 0606_w17_ms_11 Q: 6

(a)(i)	$f \geq 3$	B1	must be using a correct notation
(a)(ii)	$(4x-1)^2 + 3 = 4$	M1	correct order
	solution of resulting quadratic equation	DM1	
	$x = 0, x = \frac{1}{2}$	A1	both required
(b)(i)	$xy - 4y = 2x + 1$	M1	'multiplying out'
	$x(y-2) = 4y+1$ $x = \frac{4y+1}{y-2}$	M1	collecting together like terms
	$h^{-1}(x) = \frac{4x+1}{x-2}$	A1	correct answer with correct notation
	Range $h^{-1} \neq 4$	B1	must be using a correct notation
(b)(ii)	$h^2(x) = h\left(\frac{2x+1}{x-4}\right)$ $= \frac{2\left(\frac{2x+1}{x-4}\right)+1}{\left(\frac{2x+1}{x-4}\right)-4}$	M1	dealing with h^2 correctly
	dealing with fractions within fractions	M1	
	$= \frac{5x-2}{17-2x}$ oe	A1	

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13. 0606_w24_ms_13 Q: 3

Question	Answer	Marks	Guidance
	$4x^2 - 4kx - k + 2 = 0$	B1	soi
	$k^2 + k - 2$ Critical values $-2, 1$	2	M1 for use of discriminant on <i>their</i> three-term quadratic equation to obtain two critical values
	$-2 < k < 1$	A1	Strict inequality

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14. 0606_s23_ms_13 Q: 2

Question	Answer	Marks	Guidance
(a)	$2\left(x + \frac{5}{4}\right)^2 - \frac{1}{8}$ oe	2	B1 for $2\left(x + \frac{5}{4}\right)^2$ B1 for $-\frac{1}{8}$
(b)	$\left(-\frac{5}{4}, -\frac{1}{8}\right)$ oe	2	B1 FT for each on <i>their</i> (a).

Question	Answer	Marks	Guidance
(c)	Use of <i>their</i> (a) or expansion to 3 term quadratic (= 0), to obtain two critical values.	M1	
	$-\frac{9}{4}, -\frac{1}{4}$	A1	For both critical values
	$-\frac{9}{4} < x < -\frac{1}{4}$	A1	

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15. 0606_w23_ms_12 Q: 9

Question	Answer	Marks	Guidance
	$12\left(x^{\frac{2}{3}}\right)^2 - 11\left(x^{\frac{2}{3}}\right) - 5 = 0$	B1	For recognition of a 3-term quadratic equation in terms of $x^{\frac{2}{3}}$ or a suitable substitution
	$\left(3x^{\frac{2}{3}} + 1\right)\left(4x^{\frac{2}{3}} - 5\right) = 0$ $x^{\frac{2}{3}} = -\frac{1}{3}, x^{\frac{2}{3}} = \frac{5}{4}$	2	M1 for attempt to solve a 3-term quadratic equation in the form $12u^2 \pm 11u \pm 5 = 0$ to obtain at least one solution in the form $x^{\frac{2}{3}} = \dots$ or 'u' = ... A1 for at least one correct solution.
	$x = 1.4$ only	A1	

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16. 0606_m22_ms_12 Q: 1

Question	Answer	Marks	Guidance
	$9kx + 1 = kx^2 + 3(2k + 1)x + 4$, leading to $kx^2 + x(3 - 3k) + 3 [= 0]$	M1	For equating the two equations and attempt to obtain a 3 term quadratic equation equated to zero.
	$(3 - 3k)^2 - (4 \times 3k)$ oe	M1	Dep on previous M mark for attempt to use the discriminant in any form
	$3k^2 - 10k + 3$ oe	M1	Dep on previous M mark for simplification to a 3 term quadratic expression in terms of k
	Critical values 3 and $\frac{1}{3}$	A1	For both
	$\frac{1}{3} < k < 3$	A1	Mark the final answer

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17. 0606_m22_ms_12 Q: 2

Question	Answer	Marks	Guidance
	$x = \frac{-(2\sqrt{3} + 5) \pm \sqrt{(2\sqrt{3} + 5)^2 - 4(3 - 5\sqrt{3})(-1)}}{2(3 - 5\sqrt{3})}$	M1	For the use of the quadratic formula
	$x = \frac{-(2\sqrt{3} + 5) \pm \sqrt{12 + 20\sqrt{3} + 25 + 12 - 20\sqrt{3}}}{2(3 - 5\sqrt{3})}$	M1	For expansion of the square root, must see at least 4 terms
	$x = \frac{-12 - 2\sqrt{3}}{2(3 - 5\sqrt{3})} \text{ oe, } x = \frac{2 - 2\sqrt{3}}{2(3 - 5\sqrt{3})} \text{ oe}$	A1	For both
	$x = \frac{-12 - 2\sqrt{3}}{2(3 - 5\sqrt{3})} \times \frac{3 + 5\sqrt{3}}{3 + 5\sqrt{3}} \text{ oe}$ <p>or</p> $x = \frac{2 - 2\sqrt{3}}{2(3 - 5\sqrt{3})} \times \frac{3 + 5\sqrt{3}}{3 + 5\sqrt{3}} \text{ oe}$ <p>with an attempt to simplify</p>	M1	For attempt to rationalise at least one of <i>their</i> solutions (must be similar structure) Sufficient detail must be seen, at least 3 terms in the numerator
	$\frac{1}{2} + \frac{\sqrt{3}}{2}$	A1	Must have sufficient detail shown
	$\frac{2}{11} - \frac{\sqrt{3}}{33}$	A1	Must have sufficient detail shown

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18. 0606_w22_ms_11 Q: 4

Question	Answer	Marks	Guidance
	$x = \frac{2 \pm \sqrt{4 + 4(\sqrt{5} - 1)(\sqrt{5} + 1)}}{2(\sqrt{5} - 1)}$	M1	For a correct use of the quadratic formula with sufficient detail
	$x = \frac{2 \pm 2\sqrt{5}}{2(\sqrt{5} - 1)}$ or $x = \frac{1 \pm \sqrt{5}}{(\sqrt{5} - 1)}$	2	Dep M1 for attempt to simplify to obtain 2 real roots A1 for either
	$x = \frac{(\sqrt{5} + 1)}{(\sqrt{5} - 1)} \times \frac{(\sqrt{5} + 1)}{(\sqrt{5} + 1)}$	M1	For attempt at rationalisation
	$x = \frac{3}{2} + \frac{\sqrt{5}}{2}$	A1	
	$x = -1$	B1	

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19. 0606_m21_ms_12 Q: 4

Question	Answer	Marks	Guidance
(a)	$2\left(x + \frac{5}{4}\right)^2 - \frac{49}{8}$	3	B1 for $b = \left(x + \frac{5}{4}\right)^2$ or $(x + 1.25)^2$ B1 for $c = -\frac{49}{8}$ or -6.125

Question	Answer	Marks	Guidance
(b)	$\left(-\frac{5}{4}, -\frac{49}{8}\right)$ oe	2	<p>B1 for $-\frac{5}{4}$ as part of a set of coordinates or $x = -\frac{5}{4}$,</p> <p>FT on <i>their b</i></p> <p>B1 for $-\frac{49}{8}$ as part of a set of coordinates or $y = -\frac{49}{8}$ FT on <i>their c</i></p> <p>Need to be using <i>their</i> answer to (a) and not using differentiation as 'Hence'.</p> <p>B1 for $-\frac{5}{4}, -\frac{49}{8}$</p>
(c)		3	<p>B1 for correct shape, with maximum in the second quadrant and cusps on the x-axes and reasonable curvature for $x < -3$ and $x > 0.5$.</p> <p>B1 for $(-3, 0)$ and $(0.5, 0)$ either seen on the graph or stated, must have attempted a correct shape</p> <p>B1 for $(0, 3)$ either seen on the graph or stated, must have attempted a correct shape</p>
(d)	$\frac{49}{8}$ oe	B1	<p>FT on <i>their c </i> from (a)</p> <p>Allow $\frac{49}{8}$ from other methods</p>

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20. 0606_s21_ms_13 Q: 1

Question	Answer	Marks	Guidance
	$(4k)^2 - 4k(3k+1)$	M1	For use of the discriminant to obtain a two term quadratic expression.
	$4k^2 - 4k = 0$	M1	Dep to find critical values, allow if only one is found
	$k = 0, k = 1$	A1	For both critical values
	$k < 0 \quad k > 1$	A1	

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21. 0606_m20_ms_12_Q: 2

$2x^2 + 4x + k - 1 = kx + 3$ $2x^2 + (4 - k)x + (k - 4) = 0$	2	M1 for attempt to equate the line and curve and simplify to a 3 term quadratic equation = 0 A1 for a correct equation, allow equivalent form
$(4 - k)^2 = 4 \times 2 \times (k - 4)$	M1	Use of discriminant in any form
$k^2 - 16k + 48 = 0$ $k = 12, k = 4$ Do not isw	2	Dep M1 on previous M mark, for attempt to solve a quadratic equation in k A1 for both
Alternative 1		
$2x^2 + 4x + k - 1 = kx + 3$ $2x^2 + (4 - k)x + (k - 4) = 0$	(2	M1 for attempt to equate the line and curve and simplify A1 for a correct equation, allow equivalent form
$k = 4x + 4$ $2\left(\frac{k-4}{4}\right)^2 + (4-k)\left(\frac{k-4}{4}\right) + (k-4) = 0$	M1	Equating gradients and substitution to obtain a quadratic equation in terms of k
$k^2 - 16k + 48 = 0$ $k = 12$ and $k = 4$ Do not isw	2)	Dep M1 on previous M mark, for attempt to solve a quadratic equation in k A1 for both
Alternative 2		
$2x^2 + 4x + k - 1 = kx + 3$ $2x^2 + (4 - k)x + (k - 4) = 0$	(2	M1 for attempt to equate the line and curve and simplify A1 for a correct equation, allow equivalent form
$k = 4x + 4$ $2x^2 - 4x = 0$ $x = 0, 2$	M1	Equating gradients and substitution to obtain a quadratic equation in terms of x and solution of this equation to obtain 2 x values
$k = 4x + 4$ $k = 12$ and $k = 4$ Do not isw	2)	Dep M1 on previous M mark, for substitution of their x values to obtain k values A1 for both

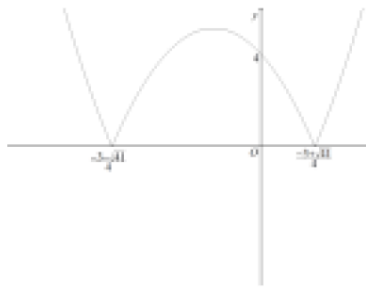
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22. 0606_s20_ms_11 Q: 4

Question	Answer	Marks	Partial Marks
	$x = \frac{-(4-2\sqrt{7}) + \sqrt{(4-2\sqrt{7})^2 - 4(5+4\sqrt{7})(-1)}}{2(5+4\sqrt{7})}$	M1	For correct use of quadratic formula, allow inclusion of \pm until final answer
	$x = \frac{-(4-2\sqrt{7}) + \sqrt{16+28-16\sqrt{7}+20+16\sqrt{7}}}{2(5+4\sqrt{7})}$ $x = \frac{-(4-2\sqrt{7})+8}{2(5+4\sqrt{7})}$	M1	For attempt to simplify discriminant, must see attempt at expansion and subsequent simplification
	$x = \frac{4+2\sqrt{7}}{2(5+4\sqrt{7})} \quad \text{or} \quad x = \frac{2+\sqrt{7}}{(5+4\sqrt{7})}$	A1	For either
	$x = \frac{2+\sqrt{7}}{(5+4\sqrt{7})} \times \frac{5-4\sqrt{7}}{5-4\sqrt{7}}$ $x = \frac{10+5\sqrt{7}-8\sqrt{7}-28}{25-112}$	M1	For attempt to rationalise, must see attempt at expansion and subsequent simplification
	$x = \frac{6}{29} + \frac{\sqrt{7}}{29}$	A1	


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23. 0606_s20_ms_13 Q: 4

Question	Answer	Marks	Partial Marks
(a)	$2\left(x + \frac{3}{4}\right)^2 - \frac{41}{8}$	B3	B1 for 2 B1 for $\frac{3}{4}$ B1 for $-\frac{41}{8}$
(b)	$\left(-\frac{3}{4}, -\frac{41}{8}\right)$	B2	B1 for $-\frac{3}{4}$ or FT on <i>their</i> $-b$ B1 for $-\frac{41}{8}$ or FT on <i>their</i> c
(c)		B1	For shape with max in 2 nd quadrant
		B1	For x-intercepts $\frac{-3 \pm \sqrt{41}}{4}$
		B1	For y-intercept of 4 and cusps
(d)	$\frac{41}{8}$	B1	FT on <i>their</i> c

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24. 0606_m19_ms_12 Q: 2

	4	B1 for general shape with maximum point in 1st quadrant B1 for $\left(-\frac{1}{2}, 0\right)$ and $(3, 0)$ soi B1 for $(0, 3)$ soi B1 dep on first B1, with cusps and correct shape for $x < -\frac{1}{2}$ and $x > 3$
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25. 0606_s19_ms_12 Q: 2

Either: $(2x+3)^2(x-1)=3(2x+3)$ $(2x+3)(2x^2+x-6)(=0)$	M1	For attempt to equate line and curve and attempt to simplify to $2x+3 \times$ a quadratic factor or cancelling $2x+3$ and obtaining a quadratic factor
$(2x+3)(2x^2+x-6)=0$ $(2x+3)(2x-3)(x+2)=0$	M1	Dep for attempt at 3 linear factors from a linear term and a quadratic term
$\left(-\frac{3}{2}, 0\right)$	B1	
$\left(\frac{3}{2}, 18\right)$	A1	Dep on first M mark only
$(-2, -3)$	A1	Dep on first M mark only
Or: $(2x+3)^2(x-1)=3(2x+3)$ $4x^3+8x^2-9x-18(=0)$	M1	For attempt to equate line and curve and attempt to simplify to a cubic equation, by collecting like terms
$(x+2)(4x^2-9)$ $(2x-3)(2x^2+7x+6)$ $(2x+3)(2x^2+x-6)$ $(2x+3)(2x-3)(x+2)(=0)$	M1	Dep For attempt to find a factor from a 4 term cubic equation (usually $x+2$), do long division or to obtain a quadratic factor and factorise this quadratic factor
$\left(-\frac{3}{2}, 0\right)$	A1	
$\left(\frac{3}{2}, 18\right)$	A1	
$(-2, -3)$	A1	

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