Topical Past Paper Questions Workbook

IGCSE Additional Mathematics (0606)
Paper 1

Exam Series: May/June 2012 – Oct/Nov 2022

Format Type B:
Each question is followed by its answer scheme

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Introduction

Each Topical Past Paper Questions Workbook 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 workbooks:

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 Paper Questions Workbook
- Subtitle: Exam Practice Worksheets With Answer Scheme
- Examination board: Cambridge Assessment International Education (CAIE)
- Subject code: 0606
- Years covered: May/June 2012 – Oct/Nov 2022
- Paper: 1
- Number of pages: 1382
- Number of questions: 680

Contents

Chapter 1

Functions

1. 0606_s22_qp_13 Q: 6

(a) It is given that $\mathrm{f} : x \to 2x^2$ for $x \geqslant 0$,

$\mathrm{g} : x \to 2x+1$ for $x \geqslant 0$.

Each of the expressions in the table can be written as one of the following.

f' f'' g' g'' fg gf f^2 g^2 f^{-1} g^{-1}

Complete the table. The first row has been completed for you. [5]

Expression	Function notation
2	g'
0	
$4x$	
$8x^2+8x+2$	
$4x+3$	
$\frac{x-1}{2}$	

(b) It is given that $\mathrm{h}(x) = (x-1)^2 + 3$ for $x \geqslant a$. The value of a is as small as possible such that h^{-1} exists.

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

(ii) Write down the range of h. [1]

(iii) Find $\mathrm{h}^{-1}(x)$ and state its domain. [3]

Answer:

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th><th>Guidance</th></tr>
<tr><td>(a)</td><td><table><tr><th>Expression</th><th>Function notation</th></tr><tr><td>0</td><td>g''</td></tr><tr><td>$4x$</td><td>f'</td></tr><tr><td>$8x^2+8x+2$</td><td>fg</td></tr><tr><td>$4x+3$</td><td>g^2</td></tr><tr><td>$\frac{x-1}{2}$</td><td>g^{-1}</td></tr></table></td><td>5</td><td>B1 for each one correct</td></tr>
<tr><td>(b)(i)</td><td>$a=1$</td><td>B1</td><td></td></tr>
<tr><td>(b)(ii)</td><td>$h(x)\geqslant 3$</td><td>B1</td><td></td></tr>
<tr><td rowspan="3">(b)(iii)</td><td>$x=(y-1)^2+3$
$y=1+\sqrt{x-3}$</td><td>M1</td><td>For a correct attempt to find the inverse, allow one sign error</td></tr>
<tr><td>$h^{-1}(x)=1+\sqrt{x-3}$</td><td>A1</td><td>Must be using correct notation</td></tr>
<tr><td>$x\geqslant 3$</td><td>B1</td><td>Must be using correct notation</td></tr>
</table>

2. 0606_s21_qp_11 Q: 5

The functions f and g are defined as follows.

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

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

(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]

Answer:

Question	Answer	Marks	Guidance
(a)	$f \geqslant -4$	2	**M1** for a valid method to find the least value of $x^2 + 4x$ **A1** for $f \geqslant -4$, $y \geqslant -4$ or $f(x) \geqslant -4$
(b)	$g > 1$	**B1**	Allow $y > 1$ or $g(x) > 1$
(c)	$\left(1+e^{2x}\right)^2 + 4\left(1+e^{2x}\right)[=21]$	**M1**	
	$e^{4x} + 6e^{2x} - 16 = 0$ $\left(e^{2x}+8\right)\left(e^{2x}-2\right) = 0$	**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**	

3. 0606_w21_qp_13 Q: 2

A particle moves in a straight line such that its velocity, v 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]

Answer:

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

4. 0606_s20_qp_12 Q: 5

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

(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]

Answer:

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
	$y=\dfrac{\sqrt{x}-3}{2}$	**M1**	For correct rearrangement
	$\mathrm{f}^{-1}=\dfrac{\sqrt{x}-3}{2}$	**A1**	Must have correct notation
(d)	$x>9$	**B1**	**FT** on *their* (a)
(e)	$\mathrm{f}(\ln(x+4))=49$	**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 $x=$
	$x=\mathrm{e}^2-4$	**A1**	

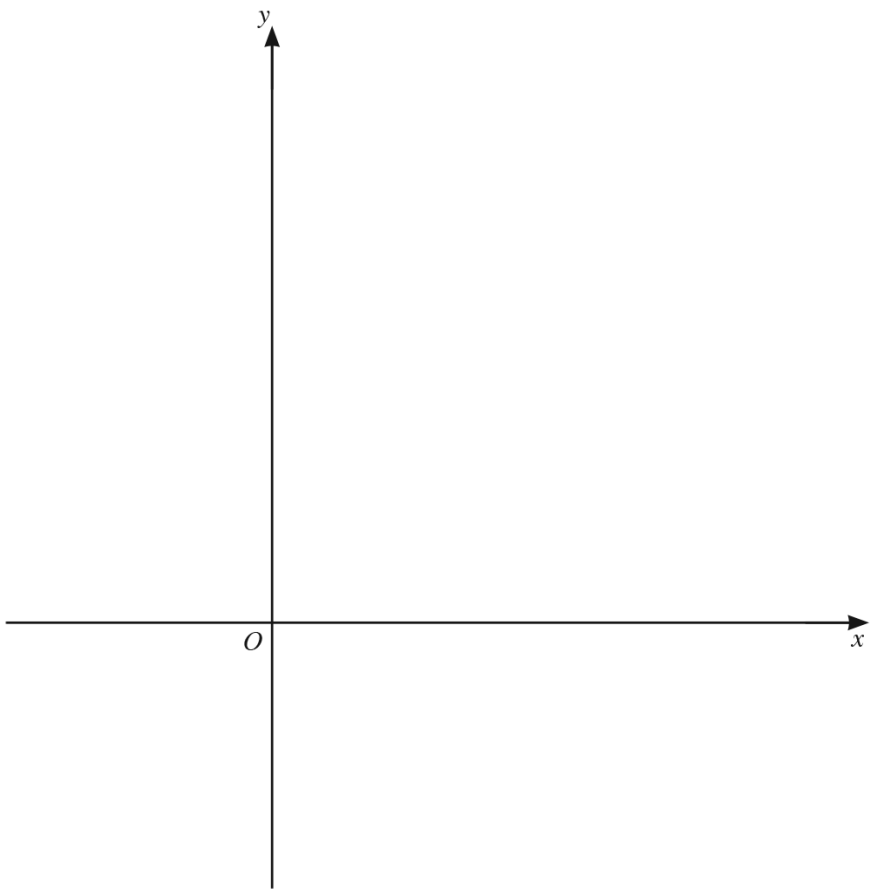
5. 0606_w20_qp_11 Q: 7

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

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

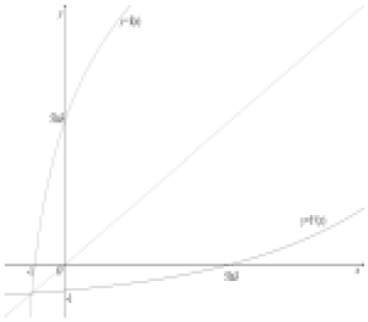
(b) Find f^{-1} and state its domain. [3]

(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]

Answer:

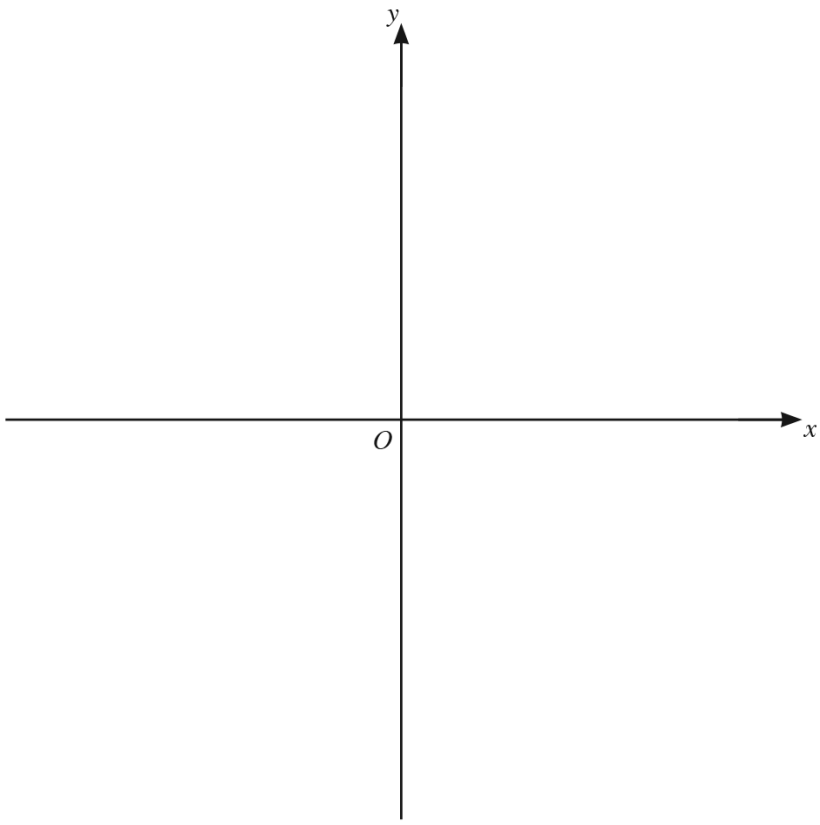
Question	Answer	Marks	Guidance
(a)	$f \in \mathbb{R}$	**B1**	Allow y but not x
(b)	$x = 5\ln(2y+3)$ $e^{\frac{x}{5}} = 2y+3$	**M1**	For a complete attempt to obtain inverse
	$f^{-1}(x) = \dfrac{e^{\frac{x}{5}} - 3}{2}$	**A1**	Must be using correct notation
	Domain $x \in \mathbb{R}$	**B1**	**FT** on *their* **(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 be previous 2 B marks or by inclusion of $y = x$, and implied asymptotes, may have one or two points of intersection

6. 0606_w20_qp_12 Q: 6

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

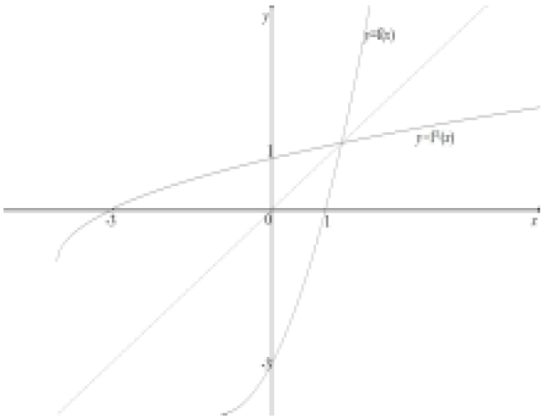
(a) Given that the minimum value of $x^2 + 2x - 3$ occurs when $x = -1$, explain why $f(x)$ has an inverse. [1]

(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]

Answer:

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

7. 0606_w20_qp_13 Q: 3

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

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

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

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

$\mathrm{h}(x) = \sqrt{2x-3}$ for $x \geqslant \frac{3}{2}$

Solve $\mathrm{gh}(x) = 7$. [3]

Answer:

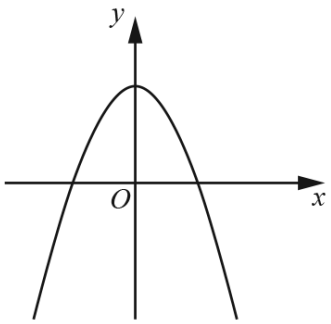
Question	Answer	Marks	Guidance
(a)(i)	$x > \frac{1}{2}$	**B1**	Must be using x

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**	

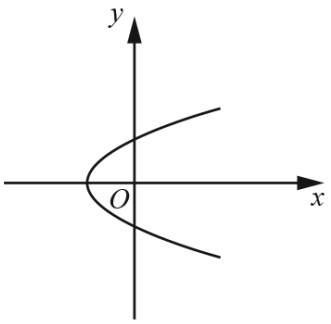
8. 0606_s18_qp_11 Q: 3

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.

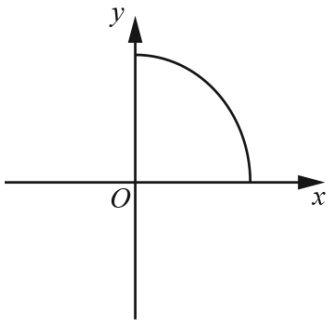
A



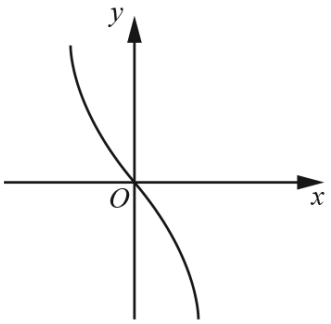
B



C



D



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				

Answer:

	<table><tr><th>A</th><th>B</th><th>C</th><th>D</th></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><tr><td>✓</td><td></td><td></td><td></td></tr></table>	**4**	**B1** for either each row correct or each column correct – mark to candidate's advantage.

9. 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 $h(x) = \dfrac{2x+1}{x-4}$ 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]

Answer:

(a)(i)	$f \geqslant 3$	**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**	

10. 0606_s16_qp_11 Q: 6

The function f is defined by $f(x) = 2 - \sqrt{x+5}$ for $-5 \leqslant x < 0$.

(i) Write down the range of f. [2]

(ii) Find $f^{-1}(x)$ and state its domain and range. [4]

The function g is defined by $g(x) = \frac{4}{x}$ for $-5 \leqslant x < -1$.

(iii) Solve $fg(x) = 0$. [3]

Answer:

(i)	$2-\sqrt{5}<\mathrm{f}(x)\leqslant 2$	**B2**	**B1** for $\leqslant 2$ **B1** for $2-\sqrt{5}<$ or awrt –0.24 Must be using f, f(x) or y, $2-\sqrt{5}<$, if not then **B1** max
(ii)	$\mathrm{f}^{-1}(x)=(2-x)^2-5$ Domain $2-\sqrt{5}<x\leqslant 2$ Range y or $-5\leqslant \mathrm{f}^{-1}(x)<0$	**M1** **A1** **B1** **B1**	for a correct method to find the inverse Must be using the correct variables for the B marks
(iii)	$\mathrm{fg}(x)=\mathrm{f}\left(\frac{4}{x}\right)$ $=2-\sqrt{\frac{4}{x}+5}$ leading to $x=-4$	**M1** **DM1** **A1**	for correct order of functions for solution of equation

11. 0606_w12_qp_11 Q: 9

A function g is such that $g(x) = \dfrac{1}{2x-1}$ for $1 \leqslant x \leqslant 3$.

(i) Find the range of g. [1]

(ii) Find $g^{-1}(x)$. [2]

(iii) Write down the domain of $g^{-1}(x)$. [1]

(iv) Solve $g^2(x) = 3$. [3]

Answer:

(i) $0.2 \leqslant y \leqslant 1$	B1 [1]	Must be using correct notation
(ii) $g^{-1}(x) = \dfrac{1+x}{2x}$	M1 A1 [2]	M1 for a valid method to find inverse A1 must have correct notation
(iii) $0.2 \leqslant x \leqslant 1$	√B1 [1]	Follow through on their **(i)**
(iv) $g^2 = \dfrac{1}{2\left(\dfrac{1}{2x-1}\right)-1} = 3$	M1 DM1	M1 for correct attempt to find g^2 DM1 for equating to 3 and attempt to solve.
$\dfrac{2x-1}{3-2x} = 3$ leading to $x = 1.25$	A1 [3]	

Chapter 2

Quadratic functions

12. 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]

Answer:

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

13. 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]

Answer:

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

14. 0606_w22_qp_11 Q: 4

DO NOT USE A CALCULATOR IN THIS QUESTION.

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

Answer:

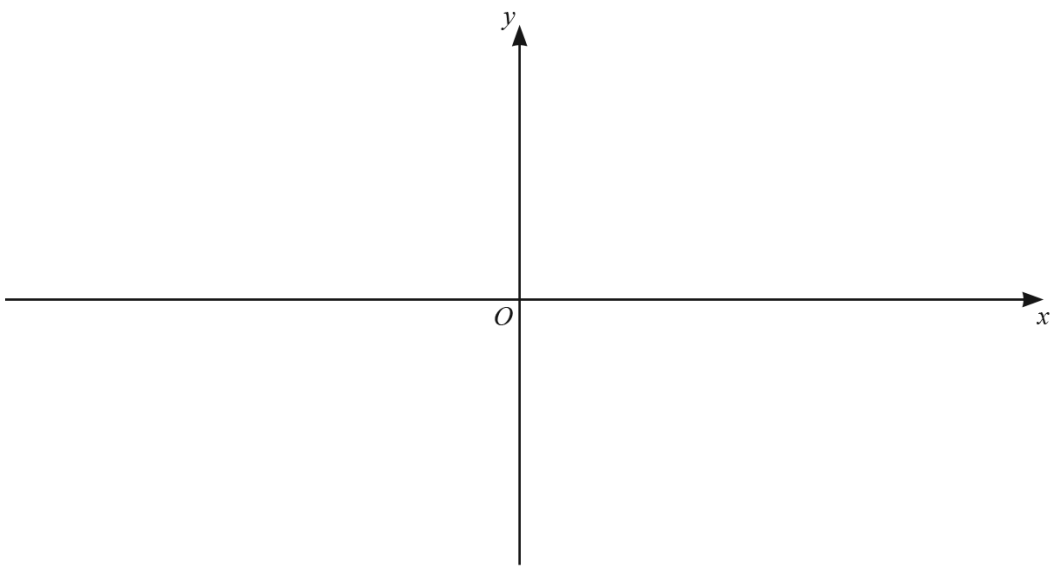
Question	Answer	Marks	Guidance
	$x=\dfrac{2\pm\sqrt{4+4\left(\sqrt{5}-1\right)\left(\sqrt{5}+1\right)}}{2\left(\sqrt{5}-1\right)}$	**M1**	For a correct use of the quadratic formula with sufficient detail
	$x=\dfrac{2\pm2\sqrt{5}}{2\left(\sqrt{5}-1\right)}$ or $x=\dfrac{1\pm\sqrt{5}}{\left(\sqrt{5}-1\right)}$	**2**	**Dep M1** for attempt to simplify to obtain 2 real roots **A1** for either
	$x=\dfrac{\left(\sqrt{5+1}\right)}{\left(\sqrt{5-1}\right)}\times\dfrac{\left(\sqrt{5+1}\right)}{\left(\sqrt{5+1}\right)}$	**M1**	For attempt at rationalisation
	$x=\dfrac{3}{2}+\dfrac{\sqrt{5}}{2}$	**A1**	
	$x=-1$	**B1**	

15. 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]

Answer:

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

16. 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]

Answer:

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**	

17. 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]

Answer:

	$2x^2+4x+k-1=kx+3$ $2x^2+(4-k)x+(k-4)=0$	**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
	$(4-k)^2=4\times2\times(k-4)$	**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

18. 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]

Answer:

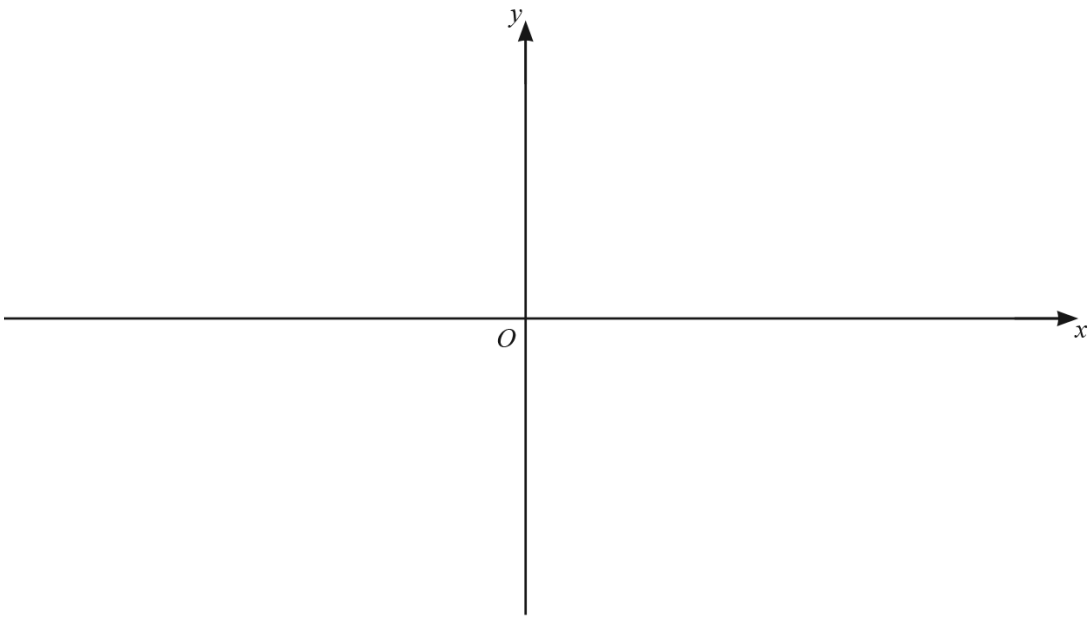
Question	Answer	Marks	Partial Marks
	$x=\dfrac{-(4-2\sqrt{7})+\sqrt{(4-2\sqrt{7})^2-4(5+4\sqrt{7})(-1)}}{2(5+4\sqrt{7})}$	**M1**	For correct use of quadratic formula, allow inclusion of $\pm$ until final answer
	$x=\dfrac{-(4-2\sqrt{7})+\sqrt{16+28-16\sqrt{7}+20+16\sqrt{7}}}{2(5+4\sqrt{7})}$ $x=\dfrac{-(4-2\sqrt{7})+8}{2(5+4\sqrt{7})}$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

19. 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]

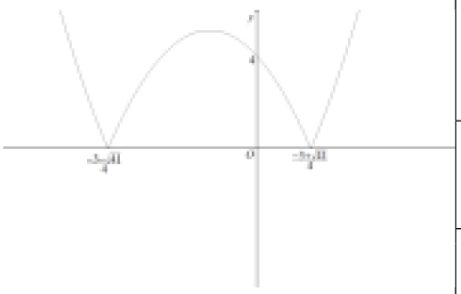
(b) Hence write down the coordinates of the stationary point on the curve $y=2x^2+3x-4$. [2]

(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]

Answer:

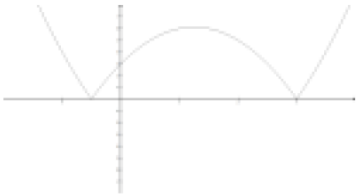
Question	Answer	Marks	Partial Marks
(a)	$2\left(x+\frac{3}{4}\right)^2-\frac{41}{8}$	**B3**	**B1** for 2 **B1** for $\frac{3}{4}$ **B1** for $-\frac{41}{8}$
(b)	$\left(-\frac{3}{4},\ -\frac{41}{8}\right)$	**B2**	**B1** for $-\frac{3}{4}$ or **FT** on *their* $-b$ **B1** for $-\frac{41}{8}$ or **FT** on *their* c
(c)		**B1**	For shape with max in 2nd 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 *their* c

20. 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]

Answer:

		**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 $x>3$

21. 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]

Answer:

	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 oe 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**	

22. 0606_s19_qp_13 Q: 3

Show that the line $y = mx + 4$ will touch or intersect the curve $y = x^2 + 3x + m$ for all values of m.

[4]

Answer:

	$x^2 + (3-m)x + m - 4 = 0$	**M1**	For equating line and curve and attempting to obtain a quadratic equation equated to zero
	Discriminant: $(3-m)^2 - 4(m-4)$	**M1**	**Dep** For use of $b^2 - 4ac$, could be implied by use of quadratic formula
	$(m-5)^2$	**A1**	
	Always positive or zero for any m, so line and curve will always touch or intersect	**A1**	For a suitable comment/conclusion

23. 0606_w19_qp_11 Q: 2

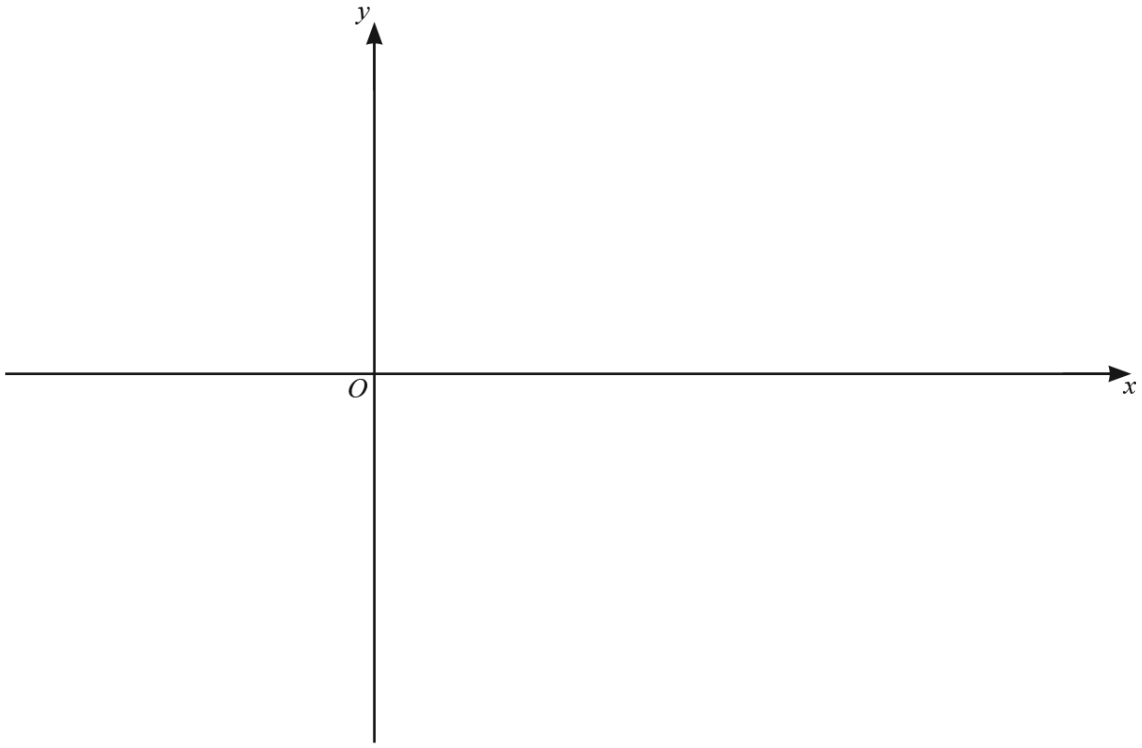
Find the values of k for which the line $y = kx - 3$ and the curve $y = 2x^2 + 3x + k$ do not intersect. [5]

Answer:

	$2x^2 + 3x + k = kx - 3$	**M1**	For an attempt to equate and simplify to a 3 term quadratic equation, allow an error in one term
	$2x^2 + (3-k)x + (k+3) = 0$	**A1**	
	$(3-k)^2 - 4 \times 2 \times (k+3)$	**M1**	For attempt to use the discriminant, allow previous error, leading to a quadratic equation in terms of k
	$k^2 - 14k - 15 = 0$ giving critical values of -1 and 15	**A1**	For critical values
	$-1 < k < 15$	**A1**	

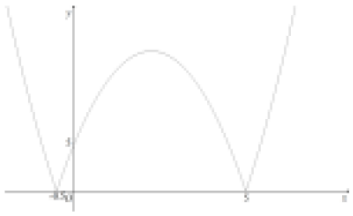
24. 0606_w19_qp_12 Q: 4

(i) On the axes below, sketch the graph of $y = |2x^2 - 9x - 5|$ showing the coordinates of the points where the graph meets the axes. [4]



(ii) Find the values of k for which $|2x^2 - 9x - 5| = k$ has exactly 2 solutions. [3]

Answer:

(i)		**B4**	**B1** for shape, with max in first quadrant **B1** for $(-0.5,0)$ and $(5,0)$ **B1** for $(0,5)$ **B1** all correct, with cusps and correct curvature for $x<0.5$ and $x>5$
(ii)	$k=0$	**B1**	Not from incorrect work
	Stationary point when $y=\pm\frac{121}{8}$ or ± 15.125	**M1**	For attempt to find y-coordinate of stationary point, must be a complete method i.e. Use of calculus Use of discriminant, Use of completing the square Use of symmetry Allow if seen in part (i), but must be used in (ii)
	$k>\frac{121}{8}$	**A1**	cao

25. 0606_s18_qp_12 Q: 2

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

Answer:

	For an attempt to obtain an equation in x only	**M1**	
	$9x^2 - (k+1)x + 4 = 0$	**A1**	correct 3 term equation
	$(k+1)^2 - (4 \times 9 \times 4)$	**M1**	**M1dep** for correct use of $b^2 - 4ac$ oe
	Critical values $k = 11,\ k = -13$	**A1**	
	$-13 < k < 11$	**A1**	For the correct range