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Surname		Other names	
Pearson Edexcel International Idvanced Level	Centre Number	Cand	idate Number
Coro Math	som of		フィ
Core Math Advanced Tuesday 19 June 2018 – Aft Time: 2 hours 30 minutes	ternoon	Fics C	34 Reference 1A02/01

Candidates may use any calculator allowed by the regulations of the Joint Council for Qualifications. Calculators must not have the facility for symbolic algebra manipulation, differentiation and integration, or have retrievable mathematical formulae stored in them.

Instructions

- Use **black** ink or ball-point pen.
- If pencil is used for diagrams/sketches/graphs it must be dark (HB or B). Coloured pencils and highlighter pens must not be used.
- Fill in the boxes at the top of this page with your name, centre number and candidate number.
- Answer **all** questions and ensure that your answers to parts of questions are clearly labelled.
- Answer the questions in the spaces provided - there may be more space than you need.
- You should show sufficient working to make your methods clear. Answers without working may not gain full credit.
- When a calculator is used, the answer should be given to an appropriate degree of accuracy.

Information

- The total mark for this paper is 125.
- The marks for **each** question are shown in brackets - use this as a guide as to how much time to spend on each guestion.

Advice

- Read each question carefully before you start to answer it.
- Try to answer every question.
- Check your answers if you have time at the end.

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ast Paper	This resource was created and owned by Pearson Edexcel		WMA02
			Leave blank
1. (i) Find			
	$\int \frac{2x^2 + 5x + 1}{4x} dx x > 0$		
	$\int x^2 \mathrm{d}x, x > 0$		
		(3)	
(ii) Find			
	ſ		
	$\int x \cos 2x \mathrm{d}x$		
		(3)	
2			

Summer	2018 www.mystud	ybro.com Mathemat	ics C34
Question Number	Scheme	Notes	Marks
1. (i)	$\left\{\int \frac{2x^2+5x+1}{x^2}\mathrm{d}x =\right.$	$\int 2 + \frac{5}{x} + \frac{1}{x^2} dx \bigg\}$	
		At least one of either $\pm \frac{A}{x} \to \pm \alpha \ln kx$ or $\pm \frac{B}{x^2} \to \pm \beta x^{-1}$; A, B, α , β non zero.	M1
	$= 2x + 5\ln kx - \frac{1}{x} \{+c\}$	At least 2 out of the 3 terms are correct. e.g. 2 of $2x, -\frac{1}{x}, 5 \ln kx$	A1
	Where $k \neq 0$ (k is usually 1)	$2x + 5\ln kx - \frac{1}{x}$ with or without + c all on one line and apply isw once seen. Do not allow + $\frac{1}{x}$ for $-\frac{1}{x}$	A1
			[3]
	(i) Alternative	by parts I:	
	$\left\{ \int \left(2x^2 + 5x + 1 \right) x^{-2} \mathrm{d}x = -\frac{1}{x} \left(2x^2 + 5x + $	$x^2+5x+1\Big)+\int\frac{1}{x}(4x+5)\mathrm{d}x\bigg\}$	
	$= -2x - 5 - \frac{1}{2} + 4x + 5\ln kx \ \{+c\}$	At least one of either $\pm \frac{A}{x} \to \pm \alpha \ln kx$ or $\pm \frac{B}{x^2} \to \pm \beta x^{-1}$; A, B, α , β non zero.	M1
	x	At least 2 out of the 3 terms are correct. At least 2 of $2x, -\frac{1}{x}, 5 \ln kx$	A1
	$= 2x - 5 - \frac{1}{x} + 5 \ln kx \ \{+c\}$ Where $k \neq 0$ (k is usually 1)	$2x - 5 - \frac{1}{x} + 5 \ln kx \text{ with or without } + c$ Or $2x + 5 \ln kx - \frac{1}{x}$ with or without $+ c$ all on one line and apply isw once seen. Do not allow $+ \frac{1}{-x}$ for $-\frac{1}{x}$	A1

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(i) Alternative by parts II:			
$\left\{ \int \left(2x^2 + 5x + 1 \right) x^{-2} \mathrm{d}x = x^{-2} \left(\frac{2x^3}{3} + \frac{5x^2}{2} + x \right) + \int 2x^{-3} \left(\frac{2x^3}{3} + \frac{5x^2}{2} + x \right) \mathrm{d}x \right\}$			
$=\frac{2x}{2}+\frac{5}{2}+\frac{1}{2}+\frac{4x}{2}+5\ln kx-\frac{2}{2}\left\{+c\right\}$	At least one of either $\pm \frac{A}{x} \rightarrow \pm \alpha \ln kx$ or $\pm \frac{B}{x^2} \rightarrow \pm \beta x^{-1}$; A, B, α , β non zero.	M1	
3 2 x 3 x 1	At least 2 out of the 3 terms are correct. At least 2 of $2x, -\frac{1}{x}, 5 \ln kx$	A1	
$= 2x + \frac{5}{2} - \frac{1}{x} + 5\ln kx \ \{+c\}$ Where $k \neq 0$ (k is usually 1)	$2x + \frac{5}{2} - \frac{1}{x} + 5\ln kx \text{ with or without } + c$ or $2x + 5\ln kx - \frac{1}{x}$ with or without $+ c$ all on one line and apply isw once seen. Do not allow $+ \frac{1}{-x}$ for $-\frac{1}{x}$	A1	
(i) Altornat	tivo:		
$\int \frac{2x^2 + 5x + 1}{x^2} \mathrm{d}x = \int 2 + \frac{5x + 1}{x^2} \mathrm{d}x = \int 2 + (x^2 + 1) \mathrm{d}x$	$5x+1)x^{-2} dx = 2x - \frac{1}{x}(5x+1) + \int \frac{5}{x} dx$		
	At least one of either $\pm \frac{A}{x} \to \pm \alpha \ln kx$ or $\pm \frac{B}{x^2} \to \pm \beta x^{-1}$; A, B, α , β non zero.	M1	
1 ()	At least 2 out of the 3 terms are correct. At least 2 of $2x, -\frac{1}{x}, 5 \ln kx$	A1	
$-2x - 5 - \frac{1}{x} + 5 \ln x \left\{ \frac{1}{x} \right\}$	$2x - 5 - \frac{1}{x} + 5 \ln kx \{+c\} \text{ with or without } + c$ or $2x + 5 \ln kx - \frac{1}{x}$ with or without $+c$ all on one line and apply isw once seen. Do not allow $+ \frac{1}{-x}$ for $-\frac{1}{x}$	A1	

Summer	⁻ 2018	www.mystudy	ybro.com	Mathematics C34
Past Baper	(Mark Schen	This resource was created and c $ \left\{ I = \int x \cos 2x dx \right\}, \begin{cases} u = x \\ \frac{dv}{dx} = cc \end{cases} $	$\Rightarrow \frac{du}{dx} = 1$ $\Rightarrow v = \frac{1}{2}\sin 2x$	WMA02
			$\pm \lambda x \sin 2x \pm \mu \int \sin 2x \{ dx \}$ BUT if the parts formula is q incorrectly score M0	uoted M1
		$=\frac{1}{2}x\sin 2x - \int \frac{1}{2}\sin 2x \left\{ dx \right\}$	$\frac{1}{2}x\sin 2x - \int \frac{1}{2}\sin 2x \{dx\}$ simplified or un-simplified	A1
		$= \frac{1}{2}x\sin 2x + \frac{1}{4}\cos 2x \ \{+\ c\}$	$\frac{1}{2}x\sin 2x + \frac{1}{4}\cos 2x \text{ with or w}$ $\frac{1}{2}x\sin 2x - \left(-\frac{1}{4}\cos 2x\right) \text{ is A0}$	without $+ c$, A1
				[3]
				6
		Quest	ion 1 Notes	1 11 1 1 1
	Note	The $5\ln x$ can appear in different correct e.g. $5\ln kx $	torms e.g. $5\ln 5x$ or $2.5\ln x^2$ etc. a	and allow modulus signs
(i)	Note	There are no marks for attempts at $\int 2$.	$\frac{x^2 + 5x + 1 \mathrm{d}x}{\int x^2 \mathrm{d}x}$	
(ii)	Note	There are no marks for attempts at $\int x c$	$\cos x \mathrm{d}x$	

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2. A curve *C* has parametric equations

$$x = \frac{3}{2}t - 5, \quad y = 4 - \frac{6}{t} \qquad t \neq 0$$

- (a) Find the value of $\frac{dy}{dx}$ at t = 3, giving your answer as a fraction in its simplest form. (3)
- (b) Show that a cartesian equation of C can be expressed in the form

$$y = \frac{ax+b}{x+5} \qquad x \neq k$$

where *a*, *b* and *k* are integers to be found.

(4)

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Question Number	Scheme	Scheme Notes					
2.	$x = \frac{3}{2}t - 5, y = 4 - \frac{6}{t}, t \neq 0$						
(a)	$\frac{\mathrm{d}x}{\mathrm{d}t} = \frac{3}{2}, \frac{\mathrm{d}y}{\mathrm{d}t} = 6t^{-2}$	Both $\frac{dx}{dt} = \frac{3}{2}$ or $\frac{dt}{dx} = \frac{2}{3}$ and $\frac{dy}{dt} = 6t^{-2}$ $\frac{dy}{dt}$ can be simplified or un-simplified. Note: This mark can be implied.	B1				
	So, $\frac{dy}{dx} = \frac{6t^{-2}}{\left(\frac{3}{2}\right)} \left\{ = 4t^{-2} \right\}$	Their $\frac{dy}{dt}$ divided by their $\frac{dx}{dt}$ or their $\frac{dy}{dt}$ multiplied by their $\frac{dt}{dx}$	M1				
	$\left\{ \text{When } t = 3, \right\} \frac{\mathrm{d}y}{\mathrm{d}x} = \frac{4}{9}$	$\frac{4}{9}$	A1 cao				
			[3]				
(b)	• $t = \frac{x+5}{\left(\frac{3}{2}\right)} \implies y = 4 - \frac{6}{\left(\frac{x+5}{\left(\frac{3}{2}\right)}\right)}$	An attempt to eliminate <i>t</i> .	M1				
	• $t = \frac{6}{4 - y} \implies x = \frac{3}{2} \left(\frac{6}{4 - y}\right) - 5$ • $\frac{6}{4 - y} = \frac{2}{3} (x + 5)$	Achieves a correct equation in <i>x</i> and <i>y</i> only.	A1 o.e.				
	$\implies y = 4 - \frac{9}{x+5}$						
	$\Rightarrow y = \frac{4(x+5)-9}{x+5}$						
	$\implies y = \frac{4x + 11}{x + 5}$	$\underline{a=4}$ and $\underline{b=11}$ or $\frac{4x+11}{x+5}$	A1				
	$x \neq -5$ or $k = -5$	Do not is so if they have $x \neq -5$, $k \neq -5$ score B0 i.e. penalise contradictory statements.	B1				
			[4]				
	Alternative 1	IOF (D):					
	$y = \frac{ax+b}{x+5} \Longrightarrow 4 - \frac{6}{t} =$	$=\frac{a(1.5t-5)+b}{1.5t-5+5}$					
	$\Rightarrow 4 - \frac{6}{t} = \frac{1.5at - 5a + b}{1.5t} \Rightarrow 6t - 9 = 1.5at - 5a + b$ $\Rightarrow 6t = 1.5at \text{ or } -9 = -5a + b$	Substitutes for <i>x</i> and <i>y</i> and "compares coefficients" for term in <i>t</i> or constant term	M1				
	$a = 4$ or $b = 1\overline{1}$	Correct value for <i>a</i> or <i>b</i>	A1				
	$a = 4$ and $b = \overline{11}$	Correct values for <i>a</i> and <i>b</i>	A1				
	$x \neq -5$ or $k = -5$	Do not isw so if they have $x \neq -5$, $k \neq -5$ score B0 i.e. penalise contradictory statements.	B1				
			[4]				
			7				

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		Alternative 2	for (b):		
	$y = \frac{4t-6}{t} = \frac{3(4t-6)}{2\frac{3t}{2}} = \frac{3(4t-6)}{2(x+5)} = \frac{4 \times \frac{3t}{2} - 9}{(x+5)} = \frac{4(x+5) - 9}{(x+5)}$ M1: Obtains y in terms of x A1: Correct unsimplified expression				
		$\Rightarrow y = \frac{4x + 11}{x + 5}$	$\underline{a=4}$ and $\underline{b=11}$ or $\frac{4x+11}{x+5}$	A1	
		$x \neq -5$ or $k = -5$	Do not isw so if they have $x \neq -5$, $k \neq -5$ score B0 i.e. penalise contradictory statements.	B1	
				[4]	
		Quest	ion 2 Notes		
2. (a)	Note	M1 can also be obtained by substituting	$t = 3$ into both their $\frac{dy}{dt}$ and their $\frac{dx}{dt}$ and the	n dividing	
		their values the correct way round.	esian form in (a) possibly having done (b) first	Fα	
	Note Note Note Note Some candidates may use the Cartesian form in (a) possibly having done (b) first. E $y = \frac{4x + 11}{x + 5} \Rightarrow \frac{dy}{dx} = \frac{4(x + 5) - 4x - 11}{(x + 5)^2} \left(= \frac{9}{(x + 5)^2} \right) t = 3 \Rightarrow x = \frac{9}{2} - 5 = -\frac{1}{2}$ $\Rightarrow \frac{dy}{dx} = \frac{9}{\left(-\frac{1}{2} + 5\right)^2} = \frac{4}{9}$ This would require a complete method to find the Cartesian equation and then B1 for the derivative. Then M1 for a complete method attempting the derivative and substituting for and A1 for 4/9 as in the main scheme. The marks for obtaining the Cartesian equation can score in (b) provided their Cartesian equation is seen or used in (b). (i.e. if they do (a) first)				
			•		

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3.	$\mathbf{f}(x) = 2^{x-1} - 4 + 1.5x \qquad x \in \mathbb{R}$	orank
(a)	a) Show that the equation $f(x) = 0$ can be written as	
	$x = \frac{1}{2}(8-2^{x})$	
	3	(2)
Tł	The equation $f(x) = 0$ has a root α , where $\alpha = 1.6$ to one decimal place.	
(b	b) Starting with $x_0 = 1.6$, use the iteration formula	
	$x_{n+1} = \frac{1}{3} \left(8 - 2^{x_n} \right)$	
	to calculate the values of x , x , and x , giving your answers to 3 decimal pla	ces.
	x_1, x_2 and $x_3, gring four anothers to 5 account pro-$	(3)
(c)	c) By choosing a suitable interval, prove that $\alpha = 1.633$ to 3 decimal places.	(2)
8		

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Question Number	Scheme		Notes			
3.	$f(x) = 2^{x-1} - 4 + 1.5x, x \in \mathbb{I}$	$\mathbb{R}; x$	$\mathbb{R}; x_{n+1} = \frac{1}{3} (8 - 2^{x_n}), \ x_0 = 1.6$			
(a)	$0 = 2^{x-1} - 4 + 1.5x \implies 1.5x = 4 - 2^{x-1} \text{ or } $	Sets $f(x) = 0$ and makes $1.5x$ (or kx) the subject of the formula using correct processing so allow sign errors only.	M1			
	$\Rightarrow x = \frac{2}{3} (4 - 2^{x-1}) \Rightarrow x = \frac{1}{3} (8 - 2^x) (*)$ or $\Rightarrow x = \frac{(4 - 2^{x-1})}{1.5} \Rightarrow x = \frac{1}{3} (8 - 2^x) (*)$ $x = \frac{1}{3} (8 - 2^x) (*)$					
	Special case: Starts with $1.5x = 4 - 2^{x-1}$ a	and cor	npletes m	ethod with no $f(x) = 0$ is M1A0		
					[2]	
	Alternative working backwards:					
	$x = \frac{1}{3} (8 - 2^{x}) \Rightarrow 3x = 8 - 2^{x} \Rightarrow 2^{x} - 8 + 3x = 0$ $x - \frac{1}{3} (8 - 2^{x}) = 0 \Rightarrow 3x - 8 + 2^{x} = 0$ Multiplies by 3 and collects terms to one side or collects terms to one side and multiplie by 3				M1	
	$2^{x} - 8 + 3x = 0 \Longrightarrow 2^{x-1} - 4 + 1.5x =$	=0		Obtains $2^{x-1} - 4 + 1.5x = 0$ by cso.	A1	
					[2]	
(b)	$x_1 = \frac{1}{3} \left(8 - 2^{1.6} \right)$	For su This n	bstituting hark can be	$x_0 = 1.6 \text{ into } \frac{1}{3} \left(8 - 2^{x_0} \right).$ e implied by $x_1 = \text{awrt } 1.66$	M1	
	$x_1 = 1.656$, $x_2 = 1.616$	$x_1 = a$	wrt 1.656	and $x_2 = awrt 1.616$	A1	
	<i>x</i> ₃ = 1.645	<i>x</i> ₃ = 1	.645 only	(not awrt)	A1 cao	
	Mark their values in the order given i.e	e. assun	ne their fi	rst calculated value is <i>x</i> ₁ etc.	[2]	
(c)	f(1.6325) = -0.00100095				[3]	
	$\begin{array}{c} \text{or awrt} - 1 \times 10^{-3} \\ \text{f}(1.6335) = 0.00157396 \end{array}$ Chooses a suitable interval for <i>x</i> , which is within 1.633 ± 0.0005 and either side of 1.63288 and ettempts to evaluate f(<i>x</i>) for both values			ble interval for <i>x</i> , which is within		
				and either side of 1.63288 and	M1	
	or awrt 1×10^{-3} or awrt 2×10^{-3}	anemp	ns to evalu			
	Sign change (negative, positive) (and $f(x)$ is continuous) therefore root ($\alpha = 1.633$)Both values correct awrt (or truncated) 1 sf, sign change and a conclusion			correct awrt (or truncated) nange and a conclusion	A1 cso	
					[2]	
					7	

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		Question 3 Notes					
3. (a)	M1	11 There are other methods for obtaining the printed equation but the M1 scores for setting $f(x) = 0$ and making <i>kx</i> the subject of the formula using correct processing e.g.					
		$0 = 2^{x-1} - 4 + 1.5x \implies \frac{2^x}{2} - 4 + 1.5x = 0 \implies 3x = 8 - 2^x \text{ M1}$					
		$\Rightarrow x = \frac{1}{3} \left(8 - 2^x \right) (*) \qquad \text{A1}$					
		$0 = 2^{x-1} - 4 + 1.5x \implies 2^x - 8 + 3x = 0 \implies 3x = 8 - 2^x \text{ M1}$					
		$\Rightarrow x = \frac{1}{3} \left(8 - 2^x \right) (*) \qquad \text{A1}$					
3 (c)	A 1	Correct solution only					
5. (0)	111	Candidate needs to state both of their values for $f(x)$ to awrt (or truncated) 1sf along with					
		a reason and conclusion. Reference to change of sign or $f(1, 6325) \times f(1, 6335) < 0$ or					
		a diagram $\mathbf{or} < 0$ and > 0 or one positive, one negative are sufficient reasons. There must be a					
		conclusion, e.g. $a = 1.633 (3 \text{ dp})$. Ignore the presence or absence of any reference to continuity.					
		A minimal acceptable reason and conclusion could be "change of sign, so true"					
	Note	In part (c), candidates can construct their proof using a narrower range than [1.6325, 1.6335] which contains the root 1.632888767					

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(3)

4. (a) Find the binomial expansion of

$$(1 + px)^{-4}, |px| < 1$$

in ascending powers of x, up to and including the term in x^3 , giving each coefficient as simply as possible in terms of the constant p.

$$f(x) = \frac{3+4x}{(1+px)^4}$$
 $|px| < 1$

where p is a positive constant.

In the series expansion of f(x), the coefficient of x^2 is twice the coefficient of x.

(b) Find the value of *p*.

(c) Hence find the coefficient of x^3 in the series expansion of f(x), giving your answer as a simplified fraction.

(2)

(5)



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Rast Paper Question Number	(Mark Sch	eme) This resource was created and owne Scheme	ed by	Pearson Edexcel Not	es	WMA02 Marks
4. (a)	(1 + px)	$\frac{1}{-4} = 1 + (-4)(px) + \frac{(-4)(-5)}{2!}(px)^2 + \frac{(-4)(-5)}{3!}$)(-6)	$(px)^3 +$	see notes	M1
		$= 1 - 4px + 10p^2x^2 - 20p^3x^3 + \dots$	Th	ree of the four tern	ns correct and	A1
		or	Al	four terms correct	t and simplified and	
		$= 1 - 4(px) + 10(px)^2 - 20(px)^3 + \dots$	isw Mi	once a correct and	swer is seen.	A1
			IVIC	ist be seen in part ((u).	[3]
(b)		$\left\{ f(x) = \frac{3+4x}{(1+px)^4} = \right\} (3+4x)(1-4px+x)(1-4px) = 0$	- 10 <i>p</i> ²	$x^{2}x^{2} - 20p^{3}x^{3} +)$	=	M1
	There	Attempts to expand $(3 + 4x) \times$ the should be evidence of at least $(3 \times \text{one term from } x)$	eir pa m par	rt (a) expansion. t (a)) + $(4x \times \text{ one te})$	erm from part (a))	
		Note: $f(x) = 3 + (4 - 12p)x + (30p^2 - 10p^2)$	$(6p)x^2$	$(40p^2 - 60p^3)$	$x^3 +$	
	= 3 -	$\frac{12 m + 30 n^2 r^2 - 60 n^3 r^3 + 4 r - 16 m^2 + 40 n^2}{12 m r^2 + 40 n^2}$	r^3	Dependent on the	e previous M	
		$\frac{12px + 50p x}{2} \text{oop } x + \frac{14x}{10px} + \frac{10px}{10px} + \frac{10px}{10px}$	л	mark Multiplies of	but to give exactly	
		$"30p^2 - 16p" = 2"(4 - 12p)"$		x^2 and attempts of	ne coefficient =	dM1
		Or		twice the other. Th	nis mark can be	
		or $2"(30p^2 - 16p)" = "(4 - 12p)"$		implied by later w to be present for the	orking. Allow <i>x</i> 's nis mark	
		$30p^2 - 16p = 2(4 - 12p)$	Cor	rect equation with	n no x 's	A1
	$\Rightarrow (10p)$	$30p^2 + 8p - 8 = 0$ (2-4)(3p+2) = 0 or (5p-2)(6p+4) = 0 $\Rightarrow p$	o =	Dependent on the Correct method is leading to at lease	he 1st M mark for solving a 3TQ st one value.	
	1.5	or		If working is sho guidance for solv working is show	own see general ving 3TQs. If no n then you may see if their 3TO	dM1
	15p	$p^{+}+4p-4=0 \Rightarrow (5p-2)(3p+2)=0 \Rightarrow p=$		solves correctly.	see in their 51Q	
		$\left\{p = \frac{2}{5}, -\frac{2}{3} \Rightarrow \text{As } p > 0, \text{ then}\right\} p = \frac{2}{5}$	<i>p</i> =	$\frac{2}{5}$ only.		A1
						[5]
(c)		$40\left(\frac{2}{5}\right)^2 - 60\left(\frac{2}{5}\right)^3$	Subs their	stitutes their $p = \frac{2}{5}$ coefficient of x^3	from part (b) into (which comes from	M1
			exac	$\frac{1}{64}$ $\frac{1}{4}$	eir expansion)	
			Allo	w $\frac{64}{25}$ or $2\frac{14}{25}$. C	ondone 2.56.	
		Coefficient of x^3 is $\frac{64}{25}$	Allo	w $\frac{64}{25}x^3$, $2\frac{14}{25}x^3$,	$2.56x^3$	A1
			Ι	f 2 answers are of	fered. score A0	
						[2]
			4 27			10
4 (2)	M1	Question Uses the binomial expansion with $n = -4$ and	4 No1 d 'x':	tes = px.		
 (<i>a</i>)	Note	M1 can be given for either $1 + (-4)(px)$ or $\frac{(-4)}{2}(px)$	- 4)(- - 21	$(-5)(px)^2$ or (-4)	$\frac{(-5)(-6)}{2!}(px)^3$	
(b)	Note	Allow recovery in part (h) from missing has a	<u> </u>	\mathbf{p} part (c) $\mathbf{a} = -\mathbf{r}^2$	J!	2
	TIOLE	Anow recovery in part (0) noin missing brack	cets II	i pari (a). c.g. <i>px</i>	now becoming $p x$	•

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5. (i)	The functions f and g are defined by	
	$f: x \to e^{2x} - 5, \qquad x \in \mathbb{R}$	
	$g: x \to \ln(3x-1), \qquad x \in \mathbb{R}, \ x > \frac{1}{3}$	
	(a) Find f^{-1} and state its domain.	
		(3)
	(b) Find fg(3), giving your answer in its simplest form.	(2)
(**)		(-)
(11)	(a) Sketch the graph with equation	
	y = 4x - a	
	where a is a positive constant. State the coordinates of each point	t where the
	graph cuts or meets the coordinate axes.	(2)
	Given that	
	4x-a =9a	
	where a is a positive constant,	
	(b) find the possible values of	
	x-6a +3 x	
	giving your answers, in terms of <i>a</i> , in their simplest form.	(5)



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Question Number	(Mark Scheme)	This resource was created an Scheme	d owned by Pearson Edexcel Notes	WMA02 Marks
5.		$f: x \to e^{2x} - 5, x \in \mathbb{R}; g: x$	$x \to \ln(3x-1), x \in \mathbb{R}, x > \frac{1}{3}$	
(i) (a)	$y = e^{2x} - x + 5 = e^{2y}$	$5 \Rightarrow x = e^{2y} - 5$ $\Rightarrow \ln(x+5) = 2y$	Attempt to make <i>x</i> (or swapped <i>y</i>) the subject using correct processing so allow sign errors only.	M1
	$\left(y=\right)\frac{1}{2}\ln(x+5)$	$\left\{ \left(\mathbf{f}^{-1} : x \to \right) \frac{1}{2} \ln(x+5) \right\}$	$\frac{1}{2}\ln(x+5) \text{ or } \frac{1}{2}\ln x+5 \text{ or } \ln(x+5)^{\frac{1}{2}}.$ Correct expression ignoring how it is referenced but must be in terms of x. Do not allow $\ln(x+5).\frac{1}{2}$ or e.g. $\ln x + 5$ or $\ln(x+5)$ unless the correct answer is seen previously or subsequently.	A1
	Domain: x	$x > -5$ or $(-5, \infty)$	$x > -5$ or $(-5, \infty)$ Condone domain > -5	B1
				[3]
(b)	fg(3) = (NB fg(2)	$= e^{2\ln(3(3) - 1)} - 5$ (x) =9x ² - 6x - 4)	g goes into f and $x = 3$ is substituted into the result or finds g(3) $\{= \ln 8\}$ and substitutes into f	M1
	$= e^{2\ln 8} - $	$5 = 64 - 5 \} = 59$	59 cao	A1
		-		[2]
(11)(a)	y a 0 <u>1</u> 4	x a	A vishape with the vertex on the positive <i>x</i> -axis (with no significant asymmetry about the vertical through the vertex). The left hand branch must extend into the second quadrant. Do not allow a "y" shape unless the part below the <i>x</i> -axis is dotted or "crossed out" States $(0, a)$ and $(\frac{1}{4}a, 0)$ or $\frac{1}{4}a$ marked in the correct position on the <i>x</i> -axis and <i>a</i> marked in the correct position on the <i>y</i> -axis. Other points marked on the axes can be ignored.	B1 B1
(b)			10a $9a+a$ $5a$	[#]
	$\begin{cases} 4x - a = 9a \implies \\ \hline \\ \hline \\ \hline \\ \hline \\ \\ \hline \\ \\ \hline \\ \\ \hline \\$	$\Rightarrow x = \frac{10a}{4} \left\{ \text{or } x = \frac{5a}{2} \right\}$	$x = \frac{10\pi}{4} \text{ or } x = \frac{5\pi}{4} \text{ or } x = \frac{5\pi}{2}$ (may be implied)	B1
	- (4 <i>x</i> - <i>a</i>) =	9a or 4x - a = -9a	Attempt at the "second" solution. Accept - $(4x - a) = 9a$ or $4x - a = -9a$ or $-4x = 8a$. Do not condone (unless recovered) invisible brackets in this case.	M1
		x = -2a	x = -2a	A1
	$\left\{ x = \frac{5}{2}a \Longrightarrow \right\}$ $\left\{ x = -2a \Longrightarrow \right\}$	$\left \frac{5}{2}a - 6a\right + 3\left \frac{5}{2}a\right ; = 11a$ $-2a - 6a + 3 - 2a ; = 14a$	Substitutes at least one of their x values from solutions of $ 4x - a = 9a$ where x < 6a into $ x - 6a + 3 x $ and finds at least one value for $ x - 6a + 3 x $ Must apply the modulus.	M1
			Both $11a$ and $14a$ and no other answers	A1
				[5]
				12

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		Question 5 Notes
(b)		The values of x might be found by squaring:
		$ 4x - a = 9a \Rightarrow 16x^2 - 8ax + a^2 = 81a^2 \Rightarrow 16x^2 - 8ax - 80a^2 = 0$
	Note	$16x^2 - 8ax - 80a^2 = 0 \Longrightarrow x = \frac{5a}{2}, -2a$
		Score as follows: B1 for a correct 3 term quadratic (terms collected after squaring)
		M1: Solves their 3 term quadratic (usual rules)
		A1: $x = \frac{5a}{2}, -2a$

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6. (a) Express $\sqrt{5}\cos\theta - 2\sin\theta$ in the form $R\cos(\theta + \alpha)$, where R > 0 and $0 < \alpha < \frac{\pi}{2}$

State the value of *R* and give the value of α to 4 significant figures.

(3)

(4)

(b) Solve, for $-\pi < \theta < \pi$,

 $\sqrt{5}\cos\theta - 2\sin\theta = 0.5$

giving your answers to 3 significant figures. [Solutions based entirely on graphical or numerical methods are not acceptable.]

 $f(x) = A(\sqrt{5}\cos\theta - 2\sin\theta) + B \qquad \theta \in \mathbb{R}$

where *A* and *B* are constants.

Given that the range of f is

$$-15 \leqslant f(x) \leqslant 33$$

(c) find the value of B and the possible values of A.

(4)

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Question Number	Scheme		Notes		Ma
6.	$\sqrt{5}\cos q - 2\sin q \circ R\cos(q + a)$				
(a)	<i>R</i> = 3		$R = 3$, cao (±3 is B0) ($\sqrt{9}$ is B0)	B1	
	$\tan \alpha = \pm \frac{2}{\sqrt{5}}$ (Also allow $\cos \alpha = \pm \frac{\sqrt{5}}{3}$ or $\pm \frac{2}{3}$, sin	$\tan \alpha = \pm \frac{2}{3}$	$= \pm \frac{\sqrt{5}}{2} \implies \alpha = \dots$ For $\pm \frac{\sqrt{5}}{3} \implies \alpha = \dots$, where "3" is their <i>R</i> .)	M1	
	$\alpha = 0.7297276562 \Rightarrow \alpha = 0.7297$ (4 sf)	Anything that rounds to 0.7297 (Degrees is 41.81 and scores A0)	A1	
	{ Note: $\sqrt{5}\cos q$	- 2sin <i>q</i>	$y = 3\cos(q + 0.7297)$	[3]	
(b)	√5 cd	psq - 2s	$\sin q = 0.5$		
	Attempts to use part (a) "3" $\cos(\theta \pm "0.7297") = 0.5$ $3\cos(\theta + 0.7297) = 0.5$ $\Rightarrow \cos(\theta + 0.7297) = \frac{0.5}{3}$ Attempts to use part (a) "3" $\cos(\theta \pm "0.7297") = 0.5$ 9and proceeds to $\cos(\theta \pm "0.7297") = K$, $ K < 1$ May be implied by $\theta \pm "0.7297" = 1.4033$ or $\theta \pm "0.7297" = \cos^{-1}\left(\frac{0.5}{\text{their } 3}\right)(=1.4033)$				
	$\theta_1 = 0.673648 \Rightarrow \theta_1 = 0.674 (3 \text{ sf})$	Anything that rounds to 0.674		A1	
	$\theta_2 + "0.7297" = "-1.4033" \Longrightarrow \theta_2 = \dots$	dependent on the previous M mark Correct attempt at a second solution in the range. Usually given for: θ_2 + their 0.7297 = - their 1.4033 $\Rightarrow \theta_2$ =			
	$\theta_2 = -2.133048 \Rightarrow \theta_2 = -2.13 (3 \mathrm{sf})$	Anythi	ng that rounds to -2.13	A1	
	For solutions in (b) that are otherwise	fully con	rect, if there are extra answers in the range,		
	For candidates who work consistently in a	degrees i	in (a) and (b) allow awrt 38.6° and $awrt - 122^{\circ}$		_
	in part (b) as the	A mark	will be lost in part (a)		_
(c)		(\cdot, \cdot)	$\mathbf{D} = \mathbf{D} = 1 \mathbf{C} + \mathbf{C} \mathbf{C} + \mathbf{C} \mathbf{C}$	[4]	-
	$f(x) = A(\sqrt{5}\cos\theta - 2)$	$\sin\theta$ +	$B, \theta \in \mathbb{R}; -15 \leq 1(x) \leq 33$		
	$\Rightarrow -15 \leqslant 3.$	$A\cos(\theta - \frac{1}{2})$	$+0./30) + B \leq 33$		-
	Note that part (c)	IS NOW I		B1	_
	<i>B</i> = 9		Correct value for <i>B</i>		_
	3A + B = 33-3A + B = -15 or $3A + B = -13A + B = 32$	15 3	Writes down at least one pair of simultaneous equations (or inequalities) of the form $\begin{array}{c} RA + B = 33 \\ -RA + B = -15 \end{array} \text{ or } \begin{array}{c} RA + B = -15 \\ -RA + B = 33 \end{array}$ and finds at least one value for A	M1	
	A = 8 or $A = -8$		One correct value for A	A1	
	A = 8 and $A = -8$		Both values correct	A1	
				[4]	
				11	

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(C)	B = 9	Correct value for <i>B</i>	B1
	(2)(A)(3) = 33	315 (2)(A)(their R) = $3315 \Rightarrow A =$	M1
	A = 8 or A	=-8 One correct value for A	A1
	A = 8 and A	A = -8 Both values correct	A1
			[4]
(c) Alt 2	$B = \frac{33 - 15}{2}$	=9 Correct value for B	B1
	$3A = 33 - 9 \Longrightarrow$	$A = 8$ (their R)A = 33 - their B \Rightarrow A =	M1
	A = 8 or A	=-8 One correct value for A	A1
	A = 8 and A	A = -8 Both values correct	A1
			[4]
		Question 6 Notes	
(c)	Note The M mark may	y be implied by correct answers so obtaining $A = 8$ implies M1A	A1



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Question Number		Scheme	Notes	Marks
7.		$V = \frac{1}{3}\rho h^2 (90 - h) = 30\rho h^2 -$	$\frac{1}{3}\rho h^3; \ \frac{\mathrm{d}V}{\mathrm{d}t} = 180$	
	$\frac{\mathrm{d}V}{\mathrm{d}h} = 60\rho h - \rho h^2$		$\left\{\frac{\mathrm{d}V}{\mathrm{d}h}=\right\}\pm\partial h\pm bh^2,\ \partial\neq0,\ b\neq0$	M1
			$60\rho h - \rho h^2$ Can be simplified or un-simplified.	A1
	$\left\{\frac{\mathrm{d}V}{\mathrm{d}h}\times\right.$	$\frac{\mathrm{d}h}{\mathrm{d}t} = \frac{\mathrm{d}V}{\mathrm{d}t} \Longrightarrow \bigg\} \Big(60\rho h - \rho h^2\Big)\frac{\mathrm{d}h}{\mathrm{d}t} = 180$	$\left(\text{their } \frac{\mathrm{d}V}{\mathrm{d}h} \right) \times \frac{\mathrm{d}h}{\mathrm{d}t} = 180$	
	$\left\{\frac{\mathrm{d}h}{\mathrm{d}t}=\frac{\mathrm{d}t}{\mathrm{d}t}\right\}$	$\frac{V}{V} \div \frac{dV}{W} \Rightarrow \left\{ \frac{dh}{V} = 180 \times \frac{1}{(0 - 1)^2} \right\}$	or $180 \div \text{their } \frac{dV}{dh}$ This is for a correct application of the	M1
		$dt dh \int dt 60\pi h - \pi h^2$	chain rule and not for just quoting a correct chain rule.	
	When $h = 15$, $\left\{ \frac{dh}{dt} = \right\} \frac{1}{60\rho(15) - \rho(15)^2} \times 180 \left\{ = \frac{4}{15\rho} \right\}$		Dependent on the previous M mark. Substitutes $h = 15$ into an expression which is a result of a quotient (or their	D.41
			rearranged quotient) of their $\frac{dV}{dh}$ and 180. May be implied by awrt 0.08 or	ani i
	$\begin{cases} \frac{\mathrm{d}h}{\mathrm{d}t} = 0.0 \end{cases}$	$0848826 \Rightarrow \left\{ \frac{dh}{dt} = \underline{0.085} (\text{cm s}^{-1}) (2 \text{sf}) \right\}$	Awrt 0.085 or allow $\frac{4}{15\pi}$ oe (and isw if	A1 cao
				[5]
				5
		Alternative Method for t	he first M1A1	
		Product rule: $\begin{cases} u = \frac{1}{3}\rho h^2 \end{cases}$	v = 90 - h	
		$\left \frac{\mathrm{d}u}{\mathrm{d}h} = \frac{2}{3}\rho h\right $	$\frac{\mathrm{d}v}{\mathrm{d}h} = -1$	
	$\frac{\mathrm{d}V}{\mathrm{d}h} = \frac{2}{3}\rho h(90 - h) + \frac{1}{3}\rho h^2(-1)$ $\frac{\left\{\frac{\mathrm{d}V}{\mathrm{d}h} = \frac{2}{3}\rho h(90 - h) + \frac{1}{3}\rho h^2(-1)\right\}}{\left[\frac{2}{3}\rho h(90 - h) + \frac{1}{3}\rho h^2(-1)\right]}$		$= \begin{cases} \pm \alpha h(90 - h) \pm \beta h^{2}(-1), \ \alpha \neq 0, \ \beta \neq 0 \\ \text{e simplified or un-simplified.} \end{cases}$	M1
			$90 - h$) + $\frac{1}{3}ph^2(-1)$	A1
				+
		Question	7 Notes	<u>I</u>
7.	Note	$\frac{dV}{dh}$ does not have to be explicitly stated for that they are differentiating their V.	or the 1 st M1 and/or the 1 st A1 but it should be	be clear
	Note	$V = \frac{1}{3}\pi h^2(90 - h) \Rightarrow \frac{dV}{dh} = \frac{2}{3}\pi h(90 - h)$ conditions for the derivative	(h) scores M0A0 even though it satisfies the	ie

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8. With respect to a fixed origin O, the lines l_1 and l_2 are given by the equations

$$l_1: \mathbf{r} = \begin{pmatrix} 1\\ -3\\ 2 \end{pmatrix} + \lambda \begin{pmatrix} 1\\ 2\\ 3 \end{pmatrix}, \qquad l_2: \mathbf{r} = \begin{pmatrix} 6\\ 4\\ 1 \end{pmatrix} + \mu \begin{pmatrix} 1\\ 1\\ -1 \end{pmatrix}$$

where λ and μ are scalar parameters.

(a) Show that l_1 and l_2 do not meet.

(4)

The point *P* is on l_1 where $\lambda = 0$, and the point *Q* is on l_2 where $\mu = -1$

(b) Find the acute angle between the line segment PQ and l_1 , giving your answer in degrees to 2 decimal places.

(5)

(c) Find the shortest distance from the point Q to the line l_1 , giving your answer to 3 significant figures.

(2)



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Question Number	Scheme	Notes	Marks	
8.	$l_1: \mathbf{r} = \begin{pmatrix} 1 \\ -3 \\ 2 \end{pmatrix} + \lambda \begin{pmatrix} 1 \\ 2 \\ 3 \end{pmatrix}, \ l_2: \mathbf{r} = \begin{pmatrix} 6 \\ 4 \\ 1 \end{pmatrix} + \mu \begin{pmatrix} 1 \\ 1 \\ -1 \end{pmatrix}; \text{ Let } \theta = \text{acute angle between } PQ \text{ and } l_1.$			
(a)	$i: 1+\lambda$	$=6+\mu$ (1)		
	$\mathbf{j}: -3 + 2\lambda$	$= 4 + \mu$ (2)		
	$\mathbf{k}: 2 + 3\lambda =$	$=1-\mu$ (3)		
	(1) and (2) yields $/ = 2$, $m = -3$ Attempts to solve a pair of equations to find at		N/1	
	(1) and (3) yields $\lambda = 1$, $\mu = -4$	least one of either $/ = \dots$ or $m = \dots$	M1	
	(2) and (3) yields $/ = 1.2, m = -4.6$	/ and <i>m</i> are both correct	A1	
	Checking (3): $8 \neq 4$ Checking (2): $-1 \neq 0$	Attempts to show a contradiction	M1	
	Checking (1): $2.2 \neq 1.4$	Correct comparison and a conclusion. Accept		
	l_1 and l_2 do not intersect.	"do not meet" and accept "are skew".	A1	
	1 2	Requires an previous work to be correct.		
	Allow a calculation that gives " $8 = 4$ so the lines do not meet"			
			[4]	
	Alternative for part (a):			
		Attempts to solve a pair of equations	M1	
		to find at least one of either $/ = \dots$ or $m = \dots$	1111	
		Shows any two of		
		(1) and (2) yielding $/ = 2$		
	(1) and (2) yields $/ = 2, m = -3$	(1) and (3) yielding $/ = 1$		
	(1) and (3) yields $/ = 1, m = -4$	(2) and (3) yielding $/ = 1.2$		
	(2) and (3) yields $/ = 1.2, m = -4.6$	or shows any two of	A1	
		(1) and (2) yielding $M = -3$		
		(1) and (3) yielding $m = -4$		
		(2) and (3) yielding $m = -4.6$		
		Attempts to show a contradiction	M1	
	E.g. So 2≠1	Correct comparison and a conclusion. Accept		
	l_1 and l_2 do not intersect.	"do not meet" and accept "are skew".	A1	
		Requires all previous work to be correct.		
			F / 1	

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(b) $\overrightarrow{OP} = \begin{pmatrix} 1 \\ -3 \\ 2 \end{pmatrix}, \ \overrightarrow{OQ} = \begin{pmatrix} 5 \\ 3 \\ 2 \end{pmatrix}$	
$(\overrightarrow{PQ})\begin{pmatrix}5\\2\end{pmatrix}\begin{pmatrix}1\\2\end{pmatrix}\begin{pmatrix}4\\2\end{pmatrix}\begin{pmatrix}-4\\c\end{pmatrix}m(\overrightarrow{QP})\begin{pmatrix}-4\\c\end{pmatrix}\end{pmatrix} = 0 \text{ in } l_1 \text{ and } \mu = -1 \text{ in } l_2$	M1
$ \begin{pmatrix} PQ = \\ 2 \end{pmatrix} \begin{bmatrix} 3 \\ 2 \end{pmatrix} \begin{bmatrix} -5 \\ 2 \end{bmatrix} \begin{bmatrix} 6 \\ 0 \end{bmatrix} \text{ of } \begin{pmatrix} QP = \\ 0 \end{bmatrix} \begin{bmatrix} -6 \\ 0 \end{bmatrix} $ Correct \overline{PQ} or \overline{QP} . Also allow for direction, $ \mathbf{d}_{PQ} = 2\mathbf{i} + 3\mathbf{j} + 0\mathbf{k} \text{ and allow}$ coordinates e.g. (4, 6, 0)	A1
$\mathbf{d}_{1} = \begin{pmatrix} 1 \\ 2 \\ 3 \end{pmatrix}, \ \mathbf{d}_{PQ} = \begin{pmatrix} 4 \\ 6 \\ 0 \end{pmatrix} \Rightarrow \begin{pmatrix} 1 \\ 2 \\ 3 \end{pmatrix} \bullet \begin{pmatrix} 4 \\ 6 \\ 0 \end{pmatrix} \qquad \qquad$	M1
$\cos q = \pm \left(\frac{(1)(4) + (2)(6) + (3)(0)}{\sqrt{(1)^2 + (2)^2 + (3)^2} \cdot \sqrt{(4)^2 + (6)^2 + (0)^2}} \right)$ $Dependent on the previous Mmark. An attempt to apply the dotproduct formula between\pm A \begin{pmatrix} 1\\ 2\\ 3 \end{pmatrix} \text{ and their } \overline{PQ} \text{ or } \overline{QP} d$	dM1
$\cos \theta = \frac{16}{\sqrt{14} \cdot \sqrt{52}} \Rightarrow \theta = 53.62985132 = 53.63 \ (2 \text{ dp})$ Anything that rounds to 53.63	A1
	[5]

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(c)	$\frac{d}{\sqrt{52}} = \sin q \qquad \qquad$	Writes down a correc he shortest distance,	t trigonometric equation in d. e.g. $\frac{d}{\text{their } PQ} = \sin q$, e	volving p.e. M1
	$\left\{d = \sqrt{52}\sin 53.63 \Longrightarrow\right\} d = 5.8064$. = 5.81 (3sf)	Anything that rounds to 5	.81 A1
				[2]
	Alternative for part	(c): (Let <i>M</i> be the po	bint on l_1 closest to Q)	
	$\overrightarrow{OM} = \begin{pmatrix} 1\\ -3\\ 2 \end{pmatrix} + \lambda \begin{pmatrix} 1\\ 2\\ 3 \end{pmatrix} \Rightarrow \overrightarrow{QM} = \begin{pmatrix} 1\\ -3\\ 2\\ 2 \end{pmatrix}$ $\begin{pmatrix} \lambda - 4\\ 2\lambda - 6\\ 3\lambda \end{pmatrix} \bullet \begin{pmatrix} 1\\ 2\\ 3 \end{pmatrix} = 0 \Rightarrow \lambda - 4 + 4\lambda$ $\begin{pmatrix} \lambda - 4\\ 2\lambda - 6\\ 3\lambda \end{pmatrix} \bullet \begin{pmatrix} 1\\ 2\\ 3 \end{pmatrix} = \lambda - 4 + 4\lambda - 12 + 4\lambda$ $\lambda = \frac{8}{7} \Rightarrow \overrightarrow{QM} = \frac{1}{7} \begin{pmatrix} -20\\ -26\\ 24 \end{pmatrix} \Rightarrow \overrightarrow{QM} = \frac{1}{49}$	$ \frac{1}{2} + \lambda \begin{pmatrix} 1\\ 2\\ 3 \end{pmatrix} - \begin{pmatrix} 5\\ 3\\ 2 \end{pmatrix} $ $\frac{1}{2} + 2 \lambda = 0 $ $9\lambda = 0 \Longrightarrow \lambda = \frac{8}{7} $ $\frac{1}{2} \sqrt{20^2 + 26^2 + 24^2} $	Applies a complete and co method that leads to an ex for the shortest distance	prrect pression M1
	$=\sqrt{\frac{236}{7}}=5.81$		Anything that rounds to 5	.81 A1
				[2]
				11

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 $\int \frac{1}{\left(2x-1\right)^2} \mathrm{d}x$

(2)

Figure 2 shows a sketch of the curve with equation y = f(x) where

$$f(x) = \frac{12}{(2x-1)} \qquad 1 \le x \le 5$$

The finite region *R*, shown shaded in Figure 2, is bounded by the line with equation x = 1,

the curve with equation y = f(x) and the line with equation $y = \frac{4}{3}$.

The region R is rotated through 2π radians about the x-axis to form a solid of revolution.

(b) Find the exact value of the volume of the solid generated, giving your answer in its simplest form.

(6)



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Question Number		Scheme	Notes	Marks
9.		$f(x) = \frac{12}{(2x - x)^2}$	$\frac{1}{1}, 1 \le x \le 5; \ y = \frac{4}{3}$	
	$(1) (2r-1)^{-1} (2r-1)^{-1}$		$(2x-1)^{-2} \to \pm / (2x-1)^{-1} \text{ or } \pm / u^{-1}$ where $u = 2x \pm 1; \lambda \neq 0$	M1
(a)	$\int \frac{1}{(2x)}$	$\left\{ \frac{1}{(-1)^2} dx \right\} = \frac{1}{(-1)(2)} \left\{ +c \right\}$	$\left(\frac{(2x-1)^{-1}}{(-1)(2)}\right) \text{ or } -\frac{1}{2(2x-1)} \text{ oe with or without } +c.$	A1
			Can be simplified or un-simplified.	[2]
(b)		$\rho \int \left(\frac{12}{2x-1}\right)^2 dx$ For $\pi \int \left(\frac{12}{2x-1}\right)^2 dx$ or $\pi \int \frac{144}{(2x-1)^2} dx$ Ignore limits and dx . Can be implied and the π may be recovered later.		B1
		$V_{1} = 1$	$44\rho \left[\frac{-1}{2(2x-1)}\right]_{1}^{5}$	
			Applies <i>x</i> -limits of 5 and 1 to an expression of the form $\pm \beta (2x-1)^{-1}$; $\beta \neq 0$ and subtracts the correct way round.	M1
	$= 144(\pi) \left(\left(\frac{1}{2(2(5)-1)} \right) - \left(\frac{1}{2(2(1)-1)} \right) \right)$		$\overline{2(2(1)-1)}) $ Correct expression for the integrated volume with or without the π . Can be simplified or un-simplified. Can be implied by 64 or 64 ρ	
		$\left\{ = -72(\pi$	$\left(\frac{1}{9} - 1\right) = 64(\pi)$	
	Note: $\pi \int_{1}^{5} \left(\frac{12}{2x-1}\right)^2 dx$ or $\int_{1}^{5} \left(\frac{12}{2x-1}\right)^2 dx$ evaluated directly as 64π or 64 with no incorrect			
	<u>working seen</u> scores M1A1 (presumably on a calculator) Attempts to use the formula p_{1}^{2} , with numerical r			
			and <i>h</i> with at least one of $r = \frac{4}{3}$ or $h = 4$ correct	M1
	$\left\{V_{\text{cylin}} ight.$	hat $\left\{ = \rho\left(\frac{4}{3}\right)^2 (4) \left\{ = \frac{64}{9}\rho \right\} \right\}$	or attempts $\pi \int_{1}^{5} \left(\frac{4}{3}\right)^{2} dx$ or $\pi \int_{0}^{5} \left(\frac{4}{3}\right)^{2} dx$	
			Correct expression for V_{cylinder}	
			$p\left(\frac{4}{3}\right)^2$ (4) or $\frac{64}{9}p$ implies this mark	Al
	$\begin{cases} Vol(R) \end{cases}$	$= 64\rho - \frac{64\rho}{9} $ \Rightarrow Vol(R) $= \frac{5}{2}$	$\frac{512}{9}p$ $\frac{512}{9}p$ or $56\frac{8}{9}p$	A1
				[6] 8
			Question 9 Notes	
9. (b)	Note	See extra notes below for how t	o mark attempts at $\pi \int_{1}^{2} \left(\left(\frac{12}{2x-1} \right) - \left(\frac{4}{3} \right) \right)^2 dx$	
	Note	An acceptable approach is $\pi \int_{1}^{1}$	$\int \left(\left(\frac{12}{2x-1}\right)^2 - \left(\frac{4}{3}\right)^2\right) dx$	

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Attempts at
$$\pi \int_{1}^{5} \left(\left(\frac{12}{2x-1} \right) - \left(\frac{4}{3} \right) \right)^{2} dx$$
:

$$V = \pi \int_{1}^{5} \left(\frac{12}{2x-1} - \frac{4}{3} \right)^{2} dx = \pi \int_{1}^{5} \left(\frac{144}{(2x-1)^{2}} - \frac{32}{2x-1} + \frac{16}{9} \right) dx$$
B1 for the embedded $\rho \int \left(\frac{12}{2x-1} \right)^{2} dx$ (π may be recovered later)

$$= \pi \left[-\frac{72}{2x-1} - 16\ln(2x-1) + \frac{16}{9}x \right]_{1}^{5}$$

$$= \pi \left[\left(-\frac{72}{9} - 16\ln 9 + \frac{80}{9} \right) - \left(-72 + \frac{16}{9} \right) \right]$$
M1A1 for the embedded $-\frac{72}{9} - (-72)$ or $\left(-\frac{72}{9} - (-72) \right) \pi$
 $\left(= \frac{640}{9}\pi - 48\ln 9 \right)$

$$V = \pi \int_{1}^{5} \left(\frac{12}{2x-1} - \frac{4}{3}\right)^{2} dx = \pi \int_{1}^{5} \left(\frac{144}{(2x-1)^{2}} + \frac{16}{9}\right) dx$$

B1 for the embedded $\rho \int \left(\frac{12}{2x-1}\right)^{2} dx$ (π may be recovered later)
 $= \pi \left[-\frac{72}{2x-1} + \frac{16}{9}x\right]_{1}^{5}$
 $= \pi \left[\left(-\frac{72}{9} + \frac{80}{9}\right) - \left(-72 + \frac{16}{9}\right)\right]$
M1A1 for the embedded $-\frac{72}{9} - (-72)$ or $\left(-\frac{72}{9} - (-72)\right)\pi$
 $\left(=\frac{640}{9}\pi\right)$

$$V = \pi \int_{1}^{5} \left(\frac{12}{2x-1} - \frac{4}{3}\right)^{2} dx = \pi \int_{1}^{5} \left(\frac{144}{(2x-1)^{2}} - \frac{16}{9}\right) dx$$

B1 for the embedded $\rho \int \left(\frac{12}{2x-1}\right)^{2} dx$ (π may be recovered later)
 $= \pi \left[-\frac{72}{2x-1} - \frac{16}{9} x \right]_{1}^{5}$
 $= \pi \left[\left(-\frac{72}{9} - \frac{80}{9} \right) - \left(-72 - \frac{16}{9} \right) \right]$
M1A1 for the embedded $-\frac{72}{9} - (-72)$ or $\left(-\frac{72}{9} - (-72) \right) \pi$
 $\left(= \frac{512}{9} \pi \right)$

WMA02

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10. The curve *C* satisfies the equation

 $x e^{5-2y} - y = 0$ x > 0, y > 0

The point *P* with coordinates $(2e^{-1}, 2)$ lies on *C*.

The tangent to C at P cuts the x-axis at the point A and cuts the y-axis at the point B.

Given that O is the origin, find the exact area of triangle OAB, giving your answer in its simplest form.

(7)

Past Paper (Mark Scheme)

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Question		·			
Number		Scheme		Marks	
10.		$C: xe^{5-2y} - y = 0$ or $\ln x + 5 - \frac{1}{2}$	$2y - \ln y =$	= 0; $P(2e^{-1}, 2)$ lies on C.	
	Either • e^5 • e^5 • $\frac{1}{x}$ • $\frac{d}{d}$		$\pm Ae^{5-2y} \pm Bxe^{5-2y} \frac{dy}{dx} \pm \frac{dy}{dx} (= 0)$ or $\pm Ae^{5-2y} \pm By \frac{dy}{dx} \pm \frac{dy}{dx} (= 0)$ or $\pm \frac{A}{x} \pm K \frac{dy}{dx} \pm \frac{B}{y} \frac{dy}{dx} (= 0)$ or $\pm \frac{dx}{dy} = \pm Ae^{\pm \alpha \pm 2y} \pm Bye^{\pm \alpha \pm 2y}$ or $\pm Ae^{\pm 5} = \pm Be^{\pm 2y} \frac{dy}{dx} \pm Kye^{\pm 2y} \frac{dy}{dx}$		
	• e ⁵	$= e^{2y} \frac{dy}{dx} + 2y e^{2y} \frac{dy}{dx}$	Correct di implied b	ifferentiation. The " $= 0$ " may be y later work.	A1
		Ignore any " $\frac{dy}{dx}$ =" in fr	ont of their	differentiation	
	At P , e^5 $\Rightarrow e^{-5}$	$e^{x^{-2}(2)} - 2(2e^{-1})e^{5-2(2)}\frac{dy}{dx} - \frac{dy}{dx} = 0$ $e^{x^{-1}} - 4\frac{dy}{dx} - \frac{dy}{dx} = 0 \implies \frac{dy}{dx} = \frac{e}{5}$	Uses <i>P</i> (2 find a nur have extra rearrange- substitutin evidence.	e^{-1} , 2) and their gradient equation to merical value for $\frac{dy}{dx}$ or $\frac{dx}{dy}$. Could a or fewer $\frac{dy}{dx}$ terms and may have d their expression wrongly before mg. Accept $\frac{dy}{dx}$ = awrt 0.54 as	M1
	•	$\left\{ m_T = \frac{e}{5} \Rightarrow \right\}$ $y - 2 = \frac{e}{5} \left(x - \frac{2}{e} \right) \text{ or } x - \frac{2}{e} = 5e^{-1}$ $2 = \frac{e}{5} (2e^{-1}) + c \Rightarrow c = \frac{8}{5} \Rightarrow y = 1$	$\frac{e}{5}x + \frac{8}{5}$	Dependent on the previous M mark. A correct attempt at an equation of the tangent at the point $P(2e^{-1}, 2)$ using their numerical $\frac{dy}{dx}$. If using $y = mx + c$ must reach as far as $c =$	d M1
	$y = 0 \Longrightarrow x = 0 \Longrightarrow$	$-2 = \frac{e}{5}\left(x - \frac{2}{e}\right) \Rightarrow x = -\frac{8}{e} \left\{\Rightarrow A \\ \Rightarrow y - 2 = \frac{e}{5}\left(-\frac{2}{e}\right) \Rightarrow y = \frac{8}{5} \left\{\Rightarrow B \\ \Rightarrow B \\$	$\left(-\frac{8}{e},0\right)$ $\left(0,\frac{8}{5}\right)$	Finds at least one correct intercept. For $-\frac{8}{e}$, allow awrt -2.94.	A1
		Area $OAB = \frac{1}{2} \left(\frac{8}{e}\right) \left(\frac{8}{5}\right)$	Depender Applies $\frac{1}{2}$ and y_B are negative a	nt on both previous M marks. $\frac{1}{2}$ (their x_A)(their y_B) where their x_A e exact . Condone a method that gives a area.	dd M1
		$=\frac{32}{5e} \text{ or } \frac{32}{5}e^{-1}$	$\frac{32}{5e}$ or $\frac{32}{5}$	e^{-1} . Allow 6.4 e^{-1} but not e.g. $\frac{64}{10e}$	A1
					[7] 7
		Qu	estion 10 N	Notes	
	Note	Accept the alternative notation for	the differen	tiation e.g. $e^{5-2y}dx - 2xe^{5-2y}dy - dy = 0$	C

Mathematics C34

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Figure 3 shows a sketch of part of the curve C with equation

$$y = \frac{\sqrt{x^2 - 9}}{x} \qquad x \ge 3$$

The finite region R, shown shaded in Figure 3, is bounded by the curve C, the x-axis and the line with equation x = 6

(b) Use the substitution $x = 3 \sec \theta$ to find the exact value of the area of R. [Solutions based entirely on graphical or numerical methods are not acceptable.]

(7)

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Summer	2018	The 2nd and 2rd method WWW, MVStUGVDIO.COM, in desirable but the EVIAthematics C3	4
	. Note	The 2 and 5 method marks are available for work in decimals but the final method mark	
Past Paper	Matreenem	elaguiroal his resource was created and owned by Pearson Edexcel WMA)2
•	,	requires exact work.	
	Note	Accept y' for $\frac{dy}{dx}$	

Question Number	Scheme	Notes	Marks
11. (a)	$x = 3\sec q = \frac{3}{\cos q} = 3$	$3(\cos q)^{-1}$	
	$\frac{\mathrm{d}x}{\mathrm{d}q} = -3(\cos q)^{-2}(-\sin q)$	$\frac{\mathrm{d}x}{\mathrm{d}q} = \pm k \Big((\cos q)^{-2} (\sin q) \Big)$	M1
	$\frac{\mathrm{d}x}{\mathrm{d}q} = \left\{\frac{3\sin q}{\cos^2 q}\right\} = \left(\frac{3}{\cos q}\right)\left(\frac{\sin q}{\cos q}\right) = \underline{3\sec q \tan q} *$ $\frac{\mathrm{d}x}{\mathrm{d}\theta} = \left\{\frac{3\sin \theta}{\cos^2 \theta}\right\} = \left(\frac{3}{\cos \theta}\right)(\tan \theta) = \underline{3\sec \theta \tan \theta} *$ $\frac{\mathrm{d}x}{\mathrm{d}\theta} = \left\{\frac{3\sin \theta}{\cos^2 \theta}\right\} = \left(\frac{3\tan \theta}{\cos \theta}\right) = \underline{3\sec \theta \tan \theta}$	Convincing proof with no notational or other errors such as missing θ 's or missing signs or inconsistent variables. But use of $\cos^{-1}\theta$ as $\frac{1}{\cos\theta}$ is OK. Must see both <u>underlined steps</u> . Allow $3\tan\theta \sec\theta$	A1 *
	If the $\frac{dx}{d\theta}$ is included on the lhs it must be correct buppossible if it appears correctly at some	t condone its omission and apply isw if	
			[2]
(a) Alt 1	$x = 3\sec q = \frac{3}{\cos q}$		
	$\begin{cases} u = 3 \qquad v = \cos q \\ \frac{\mathrm{d}u}{\mathrm{d}q} = 0 \qquad \frac{\mathrm{d}v}{\mathrm{d}q} = -\sin q \end{cases}$		
	$\frac{dx}{dq} = \frac{0(\cos q) - (3)(-\sin q)}{(\cos q)^2}$	Accept $\frac{0 \times (\cos \theta) \pm (3)(\sin \theta)}{(\cos \theta)^2}$ as evidence but if the quotient rule is quoted, it must be correct.	M1
	$\frac{\mathrm{d}x}{\mathrm{d}q} = \left\{\frac{3\sin q}{\cos^2 q}\right\} = \left(\frac{3}{\cos q}\right)\left(\frac{\sin q}{\cos q}\right) = \underline{3\sec q \tan q} *$ $\frac{\mathrm{d}x}{\mathrm{d}\theta} = \left\{\frac{3\sin \theta}{\cos^2 \theta}\right\} = \left(\underline{\frac{3}{\cos \theta}}\right)(\tan \theta) = \underline{3\sec \theta \tan \theta} *$	Convincing proof with no notational or other errors such as missing θ 's. Must see both <u>underlined steps</u> . Allow $3\tan\theta\sec\theta$	A1 *
	If the $\frac{dx}{d\theta}$ is included on the lhs it must be correct but possible if it appears correctly at some	t condone its omission and apply isw if	
		* 0	1

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(b)	$y = \frac{\sqrt{x^2 - 9}}{10}, x \ge 3; x = 3 \sec \theta \Rightarrow \frac{dx}{10} = 3 \sec \theta \tan \theta$			
	$\int \frac{\sqrt{x^2 - x}}{x}$	$\frac{x}{1-9} dx = \int \frac{\sqrt{((3\sec\theta)^2 - 9)}}{3\sec\theta} 3\sec\theta \tan\theta d\theta$	Full substitution of $\frac{\sqrt{x^2 - 9}}{x}$ in terms of <i>q</i> and "dx" as their "± <i>k</i> sec <i>q</i> tan <i>q</i> ". This may be implied if they reach ± $\lambda \int \tan^2\theta \{d\theta\}$ with no incorrect working seen.	M1
	Note:	: If $\sqrt{x^2 - 9}$ is simplified incorrectly to $x - 3$ the substitution (Any subsequent p	ne first mark is still available for a full	
		$= 2\int tor^2 \theta d\theta$	$\frac{\pm \lambda \int \tan^2 \theta \{ d\theta \}}{(\text{Allow } \pm \lambda \int \tan \theta \tan \theta \{ d\theta \})}$	M1
		$= 5 \int tan \theta d\theta$	$3\int \tan^2\theta \{d\theta\}$ (Allow 3 $\int \tan\theta \tan\theta \{d\theta\}$)	A1
		$= (3) \int (\sec^2 \theta - 1) \mathrm{d}\theta$	Dependent on the previous M mark applies $\tan^2 q = \sec^2 q - 1$	dM1
		$=(3)(\tan\theta-\theta)$	$k\tan^2\theta \to k\bigl(\tan\theta - \theta\bigr)$	A1
		$\begin{cases} \operatorname{Area}(R) = \int_{3}^{6} \frac{\sqrt{(x^2 - 9)}}{x} \mathrm{d}x = \end{cases}$	$= \left[3\tan q - 3q\right]_{0}^{\frac{\rho}{3}}$	
		$= \left(3\tan\left(\frac{p}{3}\right) - 3\left(\frac{p}{3}\right)\right) - (0)$	Substitutes limits of $\frac{p}{3}$ and 0 into an expression that contains a trigonometric and an algebraic function and subtracts the correct way round. [Note: Limit of 0 can be implied.] If they return to <i>x</i> , they must substitute the limits 6 and 3 and subtract the correct way round having previously obtained a trigonometric and an algebraic function.	M1
		$=3\sqrt{3}-p$	3√3 - <i>p</i>	A1
	$[3\tan\theta-3]$	$3\theta]_0^{\frac{\pi}{3}} = 3\sqrt{3} - \pi$ can score the final M1A1 but	if no substitution is shown and the answer	
				[7]
		Augstion 1	1 Notos	9
11. (a)	Note	$x = \frac{3}{\cos\theta} \Rightarrow x\cos\theta = 3 \Rightarrow \frac{dx}{d\theta}\cos\theta - x\sin\theta$	$\theta = 0 \Rightarrow \frac{dx}{d\theta} = \frac{x \sin \theta}{\cos \theta} = 3 \sec \theta \tan \theta \text{ is M1}.$	A1.
	NI. 4	$\frac{1}{dt}$	$\frac{-\cos \psi \pm b}{9} = 0$	
(b)	Note	A decimal answer of 2.054559769 (witho	ut a correct exact answer) is A0.	

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12. (a) Show that	at		
	$\cot x - \tan x \equiv 2 \cot 2x, \qquad x \neq 90n^\circ, \ n \in \mathbb{Z}$	(4)	
(b) Hence, o	or otherwise, solve, for $0 \leqslant \theta < 180^{\circ}$		
	$5 + \cot(\theta - 15^\circ) - \tan(\theta - 15^\circ) = 0$		
giving yo [<i>Solution</i>	our answers to one decimal place. It is based entirely on graphical or numerical methods are not acce	ptable.] (5)	
40			

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Question Number	Scheme	Notes	Marks		
12.	$\cot x - \tan x \equiv 2\cot 2x$				
(a)	$\cot x - \tan x = \frac{\cos x}{\sin x} - \frac{\sin x}{\cos x}$	Attempts to write both $\cot x$ and $\tan x$ in terms of $\sin x$ and $\cos x$ only	M1		
	$= \frac{\cos^2 x}{\sin x \cos x} - \frac{\sin^2 x}{\cos x \sin x} \left(= \frac{\cos^2 x - \sin^2 x}{\sin x \cos x} \right)$	Dependent on the previous M mark Attempts to find the same denominator for both fractions	dM1		
	$= \frac{\cos 2x}{\frac{1}{2}\sin 2x} \left(=\frac{2\cos 2x}{\sin 2x}\right)$	Dependent on both the previous M marks. Evidence of correctly applying either $\cos 2x = \cos^2 x - \sin^2 x$ or $\sin 2x = 2\sin x \cos x$	ddM1		
	$= 2\cot 2x$ (*)	Correct proof with no notational or other errors such as missing <i>x</i> 's or inconsistent variables.	A1 *		
			[4]		
(a) Alt 1	$\cot x - \tan x = \frac{1}{\tan x} - \tan x$	Writes $\cot x$ in terms of $\tan x$	M1		
	$\frac{1}{\tan x} - \frac{\tan^2 x}{\tan x} \left(= \frac{1 - \tan^2 x}{\tan x} \right)$	Dependent on the previous M mark Attempts to find the same denominator for both fractions	dM1		
	$\frac{2}{\tan 2x}$	Dependent on both the previous M marks. Evidence of correctly applying $\tan 2x = \frac{2 \tan x}{1 - \tan^2 x}$	ddM1		
	$= 2 \cot 2x$ (*)	Correct proof with no notational or other errors such as missing <i>x</i> 's or inconsistent variables.	A1*		
			[4]		
(a) Alt 2	$2\cot 2x = \frac{2}{\tan 2x}$	Applies $\cot 2x = \frac{1}{\tan 2x}$	M1		
	$= \frac{2}{\frac{2\tan x}{1-\tan^2 x}}$	Dependent on the previous M mark Attempts to apply the double angle formula for $\tan 2x$	dM1		
	$=\frac{1-\tan^2 x}{\tan x} = \frac{1}{\tan x} - \tan x$	Dependent on both the previous M marks. Obtains a rational fraction with a single denominator and attempts to split this up into 2 terms	ddM1		
	$= \cot x - \tan x (*)$	Correct proof with no notational or other errors such as missing <i>x</i> 's or inconsistent variables.	A1 *		
			[4]		

(b)	$5 + \cot(\theta - 15^\circ) - \tan(\theta - 15^\circ) = 0$				
		$\Rightarrow 5 + 2\cot() = 0$	Obtains an equation of this form.	M1	
		$\cot(\dots) = -\frac{5}{2} \implies \tan(\dots) = -\frac{2}{5}$	Obtains an equation of the form $tan() = \pm \frac{2}{5}$	M1	
	$2\theta - 30 = \tan^{-1}\left(-\frac{2}{5}\right)$		Can be implied by e.g. $2\theta - 30 = awrt - 21.8$ or $2\theta - 30 = awrt - 21.8$	A1	
	θ	$=$ awrt 4.1° or $\theta =$ awrt 94.1°	One correct answer e.g. anything that rounds to 4.1 or anything that rounds to 94.1	A1	
	θ =	= awrt 4.1° and θ = awrt 94.1°	Both answers correct. Ignore any extra answers out of range but withhold this mark if there are any extra values in range.		
		Altomativa ta	nort (b):		[5]
		$5 + \cot() - \tan() = 0 \Rightarrow$ $\tan^{2}() - 5\tan() = 0$	$5\tan()+1-\tan^2()$ ()-1=0	M1	
	Multiples through by tan() to obtain a 3TQ in tan()				
		$\tan() = \frac{5 \pm \sqrt{25 + 4}}{2}$	Solves their 3TQ and proceeds to $tan() =$		
	Can be implied by e.g.				
		$(\theta - 15^\circ) = \tan^{-1}\left(\frac{5 \pm \sqrt{25 + 4}}{2}\right)$	$\theta - 15 = 79.099$ or $\theta - 15 = -10.900$	A1	
	$\theta = awrt 4.1^{\circ}$ or $\theta = awrt 94.1^{\circ}$		One correct answer e.g. anything that rounds to 4.1 or anything that rounds to 94.1	A1	
	θ=	= awrt 4.1° and θ = awrt 94.1°	Both answers correct. Ignore any extra answers out of range but withhold this mark if there are any extra values in range.	A1	
					[5]
		Questi	ion 12 Notes	I	,
		Allow candida	ates to "meet in the middle" e.g.		
		$lhs = \frac{1}{\tan x} - \tan x$	$hx = \frac{1 - \tan^2 x}{\tan x}$: M1dM1 as in Alt1		
(a)	Note	rhs = $2\cot 2x = \frac{2}{\tan 2x} = \frac{2}{\frac{2\tan 2x}{1-\tan 2x}}$	$\frac{2}{\frac{n_x}{n^2 x}}$: ddM1 uses double angle for tan2x on rhs		
	$=\frac{1-\tan^2 x}{\tan x}$ so lhs = rhs				
L	I	111 COII	T T T T T T T T T T T T T T T T T T T		

(2)

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1 13. (a) Express $\frac{1}{(4-x)(2-x)}$ in partial fractions.

The mass, x grams, of a substance at time t seconds after a chemical reaction starts is modelled by the differential equation

$$\frac{\mathrm{d}x}{\mathrm{d}t} = k(4-x)(2-x), \quad t \ge 0, \ 0 \le x < 2$$

where k is a constant.

Given that when t = 0, x = 0

(b) solve the differential equation and show that the solution can be written as

$$x = \frac{4 - 4e^{2kt}}{1 - 2e^{2kt}}$$
(7)

Given that k = 0.1

(c) find the value of t when x = 1, giving your answer, in seconds, to 3 significant figures.

(2)

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Question Number	Scheme	Notes	Marks
13. (a)	$\frac{1}{(4-x)(2-x)} = \frac{A}{(4-x)} + \frac{B}{(2-x)}$ $\Rightarrow 1 \equiv A(2-x) + B(4-x) \Rightarrow A = \dots \text{ or } B = \dots$	Forming a correct identity. For example, $1^{\circ} A(2-x) + B(4-x)$ from $\frac{1}{(4-x)(2-x)} = \frac{A}{(4-x)} + \frac{B}{(2-x)}$	M1
	$A = -\frac{1}{2}, B = \frac{1}{2}$ giving $\frac{-\frac{1}{2}}{(4-x)} + \frac{\frac{1}{2}}{(2-x)}$	and finds at least one of $A =$ or $B =$ $\frac{-\frac{1}{2}}{(4-x)} + \frac{\frac{1}{2}}{(2-x)}$ or any equivalent form. <u>Cannot be recovered from part (b) and</u> <u>must be stated as partial fractions in (a)</u> <u>and not just the values of the constants.</u>	A1
	Correct answer in (a)	scores both marks	
			[2]
(b)	$\frac{\mathrm{d}x}{\mathrm{d}t} = k\left(4-x\right)\left(2\right)$	$-x), t \ge 0$	
	$\int \frac{1}{(4-x)(2-x)} \mathrm{d}x = \int k \mathrm{d}t$	Separates variables correctly. dx and dt should be in the correct positions, though this mark can be implied by later working. Ignore the integral signs.	B1 oe
	$\frac{1}{2}\ln(4-x) - \frac{1}{2}\ln(2-x) = kt(+c)$	$\pm \lambda \ln \alpha (4-x) \pm \mu \ln \beta (2-x),$ $\lambda \neq 0, \ \mu \neq 0, \ \alpha \neq 0, \ \beta \neq 0$	M1
	$\frac{1}{2}\ln(1-x) = \frac{1}{2}\ln(1-x) = kt (+c)$ Or e.g. $\frac{1}{2}\ln(8-2x) - \frac{1}{2}\ln(4-2x) = kt (+c)$	$\frac{1}{2}\ln(4-x) - \frac{1}{2}\ln(2-x) = kt$ oe Do not condone missing brackets around the 4 - x and/or the 2 - x unless they are implied by subsequent work.	A1
	$\{t = 0, x = 0 \Longrightarrow\} \frac{1}{2}\ln 4 - \frac{1}{2}\ln 2 = 0 + c \ \left\{\Longrightarrow\right\}$	$c = \frac{1}{2} \ln 2$ Using both $t = 0$ and $x = 0$ in an integrated equation containing a constant of integration.	M1
	$\frac{1}{2}\ln(4-x) - \frac{1}{2}\ln(2-x) = kt + \frac{1}{2}$	$\ln 2 \Rightarrow \ln \left(\frac{(4-x)}{2(2-x)}\right) = 2kt$	
	Starting from an equat	ion of the form	
	$\frac{4-x}{4-2x} = e^{2kt}$ $\frac{\pm / \ln(\partial - x) \pm m \ln(b)}{a \text{ fully correct method}}$ a fully correct method only). Must have a co evaluated.	$-x$) = ± kt + c , λ , μ , α , $\beta \neq 0$, and applies to eliminate their logarithms. (Sign errors nstant of integration that need not be	M1
	$4 - x = 4e^{2kt} - 2xe^{2kt} \Longrightarrow 4 - 4e^{2kt} = x - 2xe^{2kt}$ $\implies 4 - 4e^{2kt} = x(1 - 2e^{2kt}) \Longrightarrow x = \frac{4 - 4e^{2kt}}{1 - 2e^{2kt}} $ (*)	Dependent on the previous M mark A complete correct method of rearranging to make <i>x</i> the subject allowing sign errors only. Must have a constant of integration that need not be evaluated.	dM1
	1 - 2C	Achieves the given answer with no errors.	A1 *
			[7]

(c)	$\left\{ \frac{1}{2} \right\}$	$\frac{4-x}{4-2x} = e^{2kt} $ $\Rightarrow e^{2kt} = \frac{4-1}{4-2} \left\{ = \frac{3}{2} \right\}$	Substitutes $x = 1$ leading to $e^{2kt} = $ value Note: $k = 0.1$	M1			
	$t=\frac{1}{2(0.1)}$	$\ln\left(\frac{3}{2}\right) = 2.027325541 \left\{= 2.03 \text{ (s)} (3 \text{ sf})\right\}$	Anything that rounds to 2.03 Do not apply isw here and do not accept the exact value.	A1			
					[2]		
					11		
		Question 13 I	Notes				
		May use an earlier form of thei	r equation to find t when $x = 1$ e.g.				
		$\frac{1}{2}\ln(3) - \frac{1}{2}\ln(1) = 0.$	$1t + \frac{1}{2}\ln 2 \Longrightarrow 0.2t = \ln \frac{3}{2}$				
		M1: For correct proces	M1: For correct processing leading to $kt = value$				
(0)	Note	$t = \frac{1}{2(0.1)} \ln\left(\frac{3}{2}\right) = 2.0273$	$325541 \ \left\{ = \ 2.03 (s) (3 \text{sf}) \right\}$				
		A1: Anything t	that rounds to 2.03				
		Do not ap	oply isw here				

14. Given that

(a) show that

y

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where A is a constant to be found.



Figure 4 shows a sketch of part of the curve with equation y = f(x) where

 $f(x) = \frac{24(x^2 - 4)^{\frac{1}{2}}}{r^3} \qquad x > 2$

(b) Use your answer to part (a) to find the range of f.

(c) State a reason why f^{-1} does not exist.

(5)

(1)



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Question Number	Mark Scheme) This resource was created and Scheme	owned by Pearson Edexcel Notes	WMA02 Marks
14.	(a) $y = \frac{(x^2 - 4)^{\frac{1}{2}}}{x^3}, x > 2;$ ((b) $f(x) = \frac{24(x^2 - 4)^{\frac{1}{2}}}{x^3}, x > 2$	
(a)	$u = (x^2 - 4)^{\frac{1}{2}}$ $v = x^3$	$(x^2 - 4)^{\frac{1}{2}} \rightarrow \pm / x(x^2 - 4)^{-\frac{1}{2}}, \ \lambda \neq 0.$ Can be implied.	M1
	$\frac{\mathrm{d}u}{\mathrm{d}x} = \frac{1}{2}(2x)(x^2 - 4)^{-\frac{1}{2}} \frac{\mathrm{d}v}{\mathrm{d}x} = 3x^2$	$(x^2 - 4)^{\frac{1}{2}} \rightarrow \frac{1}{2}(2x)(x^2 - 4)^{-\frac{1}{2}}$ un-simplified or simplified. Can be implied.	A1
	$\frac{\mathrm{d}y}{\mathrm{d}x} = \frac{\frac{1}{2}(2x)(x^2 - 4)^{-\frac{1}{2}}(x^3) - 3x^2(x^2 - 4)^{\frac{1}{2}}}{x^2}$	Applies $\frac{vu\ell - uv\ell}{v^2}$ with $u = (x^2 - 4)^{\frac{1}{2}}, v = x^3$, their $u\ell$ and their $v\ell$.	M1
	dx $(x^3)^2$	Correct $\frac{dy}{dx}$, un-simplified or simplified.	A1
	$= \frac{x^4(x^2-4)^{-\frac{1}{2}}-3x^2(x^2-4)^{\frac{1}{2}}}{x^6}$		
	• $\frac{dy}{dx} = \frac{(x^2 - 4)^{-\frac{1}{2}}(x^4 - 3x^2(x^2 - 4))}{x^6}$ • or	Simplifies $\frac{dy}{dx}$ by either correctly taking out a factor of $(x^2 - 4)^{-\frac{1}{2}}$ from their numerator or by multiplying numerator and denominator	M1
	• $\frac{dy}{dx} = \frac{x^2(x^2 - 4)^2 - 3(x^2 - 4)^2}{x^4}$	by $(x^2 - 4)^{\frac{1}{2}}$	
	$\frac{\mathrm{d}y}{\mathrm{d}x} = \frac{x^2 - 3(x^2 - 4)}{x^4 (x^2 - 4)^{\frac{1}{2}}} \implies \frac{\mathrm{d}y}{\mathrm{d}x} = \frac{-2x^2 + 12}{x^4 (x^2 - 4)^{\frac{1}{2}}}$	Correct algebra leading to $\frac{dy}{dx} = \frac{-2x^2 + 12}{x^4(x^2 - 4)^{\frac{1}{2}}}$ $\left\{A = -2\right\}$	A1
			[6]
	Alternative by	product rule:	
	$u = (x^2 - 4)^{\frac{1}{2}}$ $v = x^{-3}$	$(x^{2} - 4)^{\overline{2}} \rightarrow \pm / x(x^{2} - 4)^{\overline{2}}, \lambda \neq 0.$ Can be implied.	M1
	$\frac{\mathrm{d}u}{\mathrm{d}x} = \frac{1}{2}(2x)(x^2 - 4)^{-\frac{1}{2}} \frac{\mathrm{d}v}{\mathrm{d}x} = -3x^{-4}$	$(x^2 - 4)^{\frac{1}{2}} \rightarrow \frac{1}{2}(2x)(x^2 - 4)^{-\frac{1}{2}}$ un-simplified or simplified. Can be implied.	A1
	$\frac{\mathrm{d}y}{\mathrm{d}x} = \frac{1}{2}(2x)(x^2 - 4)^{-\frac{1}{2}}(x^{-3}) + (-3x^{-4})(x^2 - 4)^{\frac{1}{2}}$	Applies $vu' + uv'$ with $u = (x^2 - 4)^{\frac{1}{2}}$, $v = x^{-3}$, their $u\ell$ and their $v\ell$.	M1
	dx = 2	Correct $\frac{dy}{dx}$, un-simplified or simplified.	A1
	$\frac{\mathrm{d}y}{\mathrm{d}x} = \frac{1}{x^2(x^2-4)^{\frac{1}{2}}} - \frac{3(x^2-4)^{\frac{1}{2}}}{x^4} = \dots$	Simplifies $\frac{dy}{dx}$ by correctly writing as two fractions and attempts a common denominator	M1
	$\frac{dy}{dx} = \frac{x^2 - 3(x^2 - 4)}{x^4(x^2 - 4)^{\frac{1}{2}}} \implies \frac{dy}{dx} = \frac{-2x^2 + 12}{x^4(x^2 - 4)^{\frac{1}{2}}}$	Correct algebra leading to $\frac{dy}{dx} = \frac{-2x^2 + 12}{x^4(x^2 - 4)^{\frac{1}{2}}}$ $\left\{A = -2\right\}$	A1
			[6]

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Past Paper (Mark Scheme) This resource was created and owned by Pearson Edexcel			WMA02
(b)	$\begin{cases} f'(x) = \frac{24(-2x^2 + 12)}{x^4(x^2 - 4)^{\frac{1}{2}}} = 0 \Rightarrow \\ 24(-2x^2 + 12) = 0 \Rightarrow x^2 = 6 \end{cases}$	Sets the numerator of their $\frac{dy}{dx} = 0$ or the numerator of their $fl(x) = 0$ and solves to give $x^2 = K$, where $K > 0$	M1
	$\Rightarrow x = \sqrt{6} \text{ or awrt } 2.45$	$x = \sqrt{6}$ or awrt 2.45 (Allow $x = \pm \sqrt{6}$ or awrt ± 2.45) (may be implied by their working)	A1
	$f(\sqrt{6}) = \frac{24(6-4)^{\frac{1}{2}}}{(\sqrt{6})^{\frac{1}{2}}} = \frac{24\sqrt{2}}{\sqrt{2}} = \frac{4}{\sqrt{2}} \text{ or } \frac{4}{\sqrt{2}}$	Dependent on the previous M mark.Substitutes their found x into $f(x)$ or the givenexpression from part (a). May be implied byawrt 2.3 or may need to check their value.	dM1
	$\left(\sqrt{6}\right)^3$ $6\sqrt{6}$ $\sqrt{3}$ 3	cso leading to $f_{max} = \frac{24\sqrt{2}}{6\sqrt{6}}$ or $\frac{4}{\sqrt{3}}$ or $\frac{4}{3}\sqrt{3}$ (Must be exact here)	A1
	Range: $0 < f(x) \leq \frac{4}{3}\sqrt{3}$ or $0 < y \leq \frac{4}{\sqrt{3}}$ Or e.g. $\left(0, \frac{4}{3}\sqrt{3}\right]$	Correct range of y or $f(x)$. Also allow ft on their maximum exact value if both of the M's have been scored. Allow f or "range" for $f(x)$.	Alft
			[5]
(c)	The function f is many-one	 Also accept "the function f is not one-one" or "the inverse is one-many". This mark should be withheld if there are contradictory statements. 	B1
			[1]
			12
14 (a)	Question 14 Notes		
14 (C)	 f is many to one (or 2 values in domain of f map to one in the range) f is not one to one f⁻¹ would be one to many the inverse would be one to many it would be one to many it is not one to one the graph illustrates a many to one function Do NOT allow it is many to one You can't reflect in y = x Any reference to "it" we must assume refers to the inverse because of the wording in the question		