

Question Number	Scheme	Marks
1.		
(a)	$\begin{aligned}(1+6x)^4 &= 1 + 4(6x) + 6(6x)^2 + 4(6x)^3 + (6x)^4 \\ &= 1 + 24x + 216x^2 + 864x^3 + 1296x^4\end{aligned}$	M1 A1 A1 (3)
(b)	substitute $x=100$ to obtain $\begin{aligned}601^4 &= 1 + 2400 + 2160000 + 864000000 + 129600000000 \\ &= 130,466,162,401\end{aligned}$	M1o.e. A1 (2)
2. (a)	<p>A graph showing a curve on a Cartesian coordinate system. The curve has a local minimum at approximately (-1, 1), crosses the x-axis at (0, 0) and (1, 0), and reaches a local maximum at the point (2, 7).</p>	B1 Shape B1 Point (2)
(b)	<p>A graph showing a curve on a Cartesian coordinate system. The curve has a local minimum at approximately (-1, 1), crosses the x-axis at (0, 0) and (1, 0), and reaches a local maximum at the point (2, 4).</p>	B1 Shape B1 Point (2)
(c)	<p>A graph showing a curve on a Cartesian coordinate system. The curve has a local maximum at the point (-2, 4), a local minimum at approximately (-1, 1), and a second local maximum at the point (2, 4).</p>	B1 Shape $>0$ B1 Shape $x<0$ B1 Point (-2, 4) (3)

3.	$\frac{x(2x+3)}{(2x+3)(x-2)} - \frac{6}{(x-2)(x+1)}$ $= \frac{x(x+1)-6}{(x-2)(x+1)}$ $= \frac{(x+3)(x-2)}{(x-2)(x+1)}$ $= \frac{x+3}{x+1}$	B1, B1 M1 A1ft M1 A1 A1 (7)
	<b>Alternative 1</b>	
	$\frac{2x^2 + 3x}{(2x+3)(x-2)} - \frac{6}{(x-2)(x+1)}$ $= \frac{(2x^2 + 3x)(x+1) - 6(2x+3)}{(2x+3)(x-2)(x+1)}$ $= \frac{(2x^3 + 5x^2 - 9x - 18)}{(2x+3)(x-2)(x+1)}$ $= \frac{(x-2)(2x^2 + 9x + 9)}{(2x+3)(x-2)(x+1)}$ $= \frac{(x-2)(2x+3)(x+3)}{(2x+3)(x-2)(x+1)}, = \frac{x+3}{x+1}$	B1 M1 A1ft A1 M1 A1, A1
	<b>Alternative 2:</b>	
	$\frac{2x^2 + 3x}{(2x+3)(x-2)} - \frac{6}{x^2 - x - 2}$ $= \frac{x(2x+3)}{(2x+3)(x-2)} - \frac{6}{x^2 - x - 2}$ $= \frac{x(x^2 - x - 2) - 6(x-2)}{(x-2)(x^2 - x - 2)}, = \frac{x^3 - x^2 - 2x - 6x + 12}{(x-2)(x^2 - x - 2)}$ $= \frac{x^3 - x^2 - 8x + 12}{(x-2)(x^2 - x - 2)}$ $= \frac{(x-2)(x^2 + x - 6)}{(x-2)(x^2 - x - 2)}$ $= \frac{(x+3)(x-2)}{(x-2)(x+1)}, = \frac{x+3}{x+1}$	B1 M1A1ft A1 M1 A1,A1

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4.	$\frac{dy}{dx} = \frac{1}{x}$ At $x=3$ , gradient of normal $= \frac{-1}{\frac{1}{3}} = -3$ $y - \ln 1 = -3(x - 3)$ $y = -3x + 9$	M1 A1 M1 M1 A1 (5)
5. (a)	$x(2x^2 - 1) = 4$ $2x^2 - 1 = \frac{4}{x}$ $2x^2 = \frac{4+x}{x}$ $x^2 = \frac{4+x}{2x}$ $x = \sqrt{\frac{2}{x} + \frac{1}{2}}$ <b>AG</b>  Alternative 1: $2x^2 - 1 - \frac{4}{x} = 0$ $2x^2 = 1 + \frac{4}{x}$ $x^2 = \frac{1}{2} + \frac{4}{2x}$ $x = \sqrt{\frac{1}{2} + \frac{2}{x}}$ <b>AG</b>  Alternative 2: $x^2 = \frac{2}{x} + \frac{1}{2}$ $2x^3 = 4 + x$ $2x^2 - x - 4 = 0$	M1 M1 A1 (3)  M1 M1 A1  M1 M1 A1  M1 M1 A1

	(b) $1.41, 1.39, 1.39$ $(1.40765, 1.38593, 1.393941)$	B1,B1,B1 (3)
	(c) $f(1.3915) = -3 \times 10^{-3}$ $f(1.3925) = 7 \times 10^{-3}$  change in sign means root between 1.3915 & 1.3925 $\therefore 1.392$ to 3 dp	M1 A1  B1 (3)
6.	(a) $-2x + 4 = \frac{3}{2x}$ $4x^2 - 8x + 3 = 0$ $(2x-3)(2x-1) = 0$ $x = 0.5, 1.5$	M1 A1 M1 A1 (4)
	(b) $\int_{0.5}^{1.5} -2x + 4 dx = \left[ -x^2 + 4x \right]_{0.5}^{1.5}$ or $\frac{1}{2} \times (3+1) \times 1$ $= 2$ $\int_{0.5}^{1.5} \frac{3}{2x} dx = \left[ \frac{3}{2} \ln x \right]_{0.5}^{1.5}$ $= \frac{3}{2} \ln 3$ $\therefore \text{Area} = 2 - \frac{3}{2} \ln 3$	M1 A1 M1 A1 A1ft A1 (6)
	Alternative solution: $\text{Area} = \int_{0.5}^{1.5} -2x + 4 - \frac{3}{2x} dx$ $= \left[ -x^2 + 4x - \frac{3}{2} \ln x \right]_{0.5}^{1.5}$ $= \frac{-9}{4} + \frac{1}{4} + 6 - 2 - \frac{3}{2} \ln 3$ o.e. $= 2 - \frac{3}{2} \ln 3$	M1 M1A1A1 A1ft A1

7. (a)	<table border="1" style="margin-left: auto; margin-right: auto;"> <tr><td>0</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td></tr> <tr><td>0</td><td>0.062</td><td>0.271</td><td>0.716</td><td>1.612</td><td>3.482</td></tr> </table>	0	1	2	3	4	5	0	0.062	0.271	0.716	1.612	3.482	B1, B1, B1 (3)
0	1	2	3	4	5									
0	0.062	0.271	0.716	1.612	3.482									
(b)	$1 \times \frac{1}{2} (0 + 3.482 + 2) \times (0.062 + 0.271 + 0.716 + 1.612)$ $= 4.402 \text{ m}^2$	B1,M1,A1ft A1 (4)												
(c)	$6 \times 4.402 = 26.4 \text{ m}^3$	B1 ft (1)												
(d)	trapezium rule overestimates $\therefore$ will be enough	B1B1 (2)												
8. (a)	$gf(x) = e^{2(2x+\ln 2)}$ $= e^{4x} e^{2\ln 2}$ $= e^{4x} e^{\ln 4}$ $= 4e^{4x}$ <span style="float: right;">AG</span>	M1 M1 M1 A1 (4)												
(b)	<p>A Cartesian coordinate system showing a curve starting from the left, crossing the x-axis at a negative value, and then increasing monotonically as x increases. The curve is above the x-axis for all x &gt; 0, indicating the function is positive in that region.</p>	B1 shape & (0,4) (1)												
(c)	$gf(x) > 0$	B1 (1)												
(d)	$\frac{d}{dx} gf(x) = 16e^{4x}$ $e^{4x} = \frac{3}{16}$ $4x = \ln \frac{3}{16}$ $x = -0.418$	M1 M1 attempt to solve A1 A1 (4)												

9. (a) (i)	$\frac{\cos 2x}{\cos x + \sin x} = \frac{\cos^2 x - \sin^2 x}{\cos x + \sin x}$ $= \frac{(\cos x + \sin x)(\cos x - \sin x)}{\cos x + \sin x}$ $= \cos x - \sin x \quad \mathbf{AG}$	M1 A1 (2)
(ii)	$\frac{1}{2}(\cos 2x - \sin 2x) = \frac{1}{2}(2\cos^2 x - 1 - 2\sin x \cos x)$ $= \cos^2 x - \frac{1}{2} - \sin x \cos x \quad \mathbf{AG}$	M1, M1 A1 (3)
(b)	$\cos \theta \left( \frac{\cos 2\theta}{\cos \theta + \sin \theta} \right) = \frac{1}{2}$ $\cos \theta (\cos \theta - \sin \theta) = \frac{1}{2}$ $\cos^2 \theta - \cos \theta \sin \theta = \frac{1}{2}$ $\frac{1}{2}(\cos 2\theta + 1) - \frac{1}{2}\sin 2\theta = \frac{1}{2}$ $\frac{1}{2}(\cos 2\theta - \sin 2\theta) = 0$ $\sin 2\theta = \cos 2\theta \quad \mathbf{AG}$	M1 M1 M1 M1 A1 (3)
(c)	$\sin 2\theta = \cos 2\theta$ $\tan 2\theta = 1$ $2\theta = \frac{\pi}{4}, \frac{5\pi}{4}, \frac{9\pi}{4}, \frac{13\pi}{4}$ $\theta = \frac{\pi}{8}, \frac{5\pi}{8}, \frac{9\pi}{8}, \frac{13\pi}{8}$	M1 A1 for 1 M1 (4 solns) A1 (4)