# **Year 2003**

## VCE

# Mathematical Methods Trial Examination 1

# **Suggested Solutions**

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These solutions are suggested solutions only. Teachers and students should carefully read the answers and comments supplied by the Mathematics Examiners.

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Question 1 D	Question 2 C
Amplitude of $4\cos(3x - \frac{\pi}{2})$ is 4 This graph has a maximum of 4 and a minimum of - 4.	When $t = 2$ , $y = 2$ which is true for A,C and E Looking only at A,C and E, When $t = 6$ , $y = 1.5$ which is not true for A or E
When $y = 4\cos(3x - \frac{\pi}{2}) - 1$ the graph has a	
maximum of $4 - 1 = 3$ and a minimum of $-4 - 1 = -5$	
∴ Range is [-5,3]	
Question 3 E $\sqrt{2}\cos^2 x + \cos x - \sqrt{2} = 0$ $0 \le x \le 2\pi$ $(\sqrt{2}\cos x - 1)(\cos x + \sqrt{2}) = 0$ $\Rightarrow \sqrt{2}\cos x = 1$ or $\cos x = -\sqrt{2}$ $-1 \le \cos x \le 1$ $\therefore \cos x \ne -\sqrt{2}$ $\therefore \cos x = \frac{1}{\sqrt{2}}$ $0 \le x \le 2\pi$ $\therefore x = \frac{\pi}{4}, \frac{7\pi}{4}$ Sum of solutions $= \frac{\pi}{4} + \frac{7\pi}{4} = 2\pi$	Question 4 A This is a sin or cos graph. Maximum = 4 Minimum = -2 $\therefore$ Amplitude = 3 (midway between -2 and 4) Graph has been translated up 1 so +1 on end. Period = $\pi = \frac{2\pi}{n}$ $\therefore n = 2$ Phase shift is $\frac{\pi}{4}$ to the right, $\therefore (x - \frac{\pi}{4})$ The graph without the phase shift would have had a maximum when $x = 0, \therefore$ cos graph.
Question 5 E $(2x-3)^7 = (2x)^7 - {7 \choose 1}(2x)^6(3)^1 + {7 \choose 2}(2x)^5(3)^2$ $-{7 \choose 3}(2x)^4(3)^3 + {7 \choose 4}(2x)^3(3)^4$ $-{7 \choose 5}(2x)^2(3)^5 + \dots$	Question 6 B $\log_e(x^2) - \log_e(2x) = q$ $\log_e \frac{x^2}{2x} = q$ $\log_e \frac{x}{2} = q$ $e^q = \frac{x}{2}$
Coefficient of $x^2$ is $-\binom{7}{5}(2)^2(3)^5 = -20412$	$x = 2e^q$

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Question 7 E	Question 8 C
$h(x) = \frac{h(x)}{4}$ If $g(x)$ is $[-4,0)$ then $f(x)$ is $[-4,0)$ If $g(x)$ is $[-4,4]$ then $f(x)$ is $[-4,4]$ If $g(x)$ is $(0,4)$ then $f(x)$ is $(0,4)$ If $g(x)$ is $(-4,0]$ then $f(x)$ is $(-4,0]$ If $g(x)$ is $(0,6]$ then $f(x)$ is $(0,4]$	The graph of $y = \frac{1}{x}$ is reflected in the <i>x</i> axis to give $y = -\frac{1}{x}$ . It is translated 2 units to the right to give $y = -\frac{1}{x-2}$ . It is dilated by a factor <i>k</i> to give $y = -\frac{k}{x-2}$ . When $x = 0$ , $y = 1$ $y = -\frac{k}{-2} = 1$ $\therefore k = 2$ $y = -\frac{2}{x-2}$ which means the original graph has been reflected in the <i>x</i> axis, translated 2 units to the right parallel to the <i>x</i> axis and dilated by a factor of 2
Question 9 C	Question 10 C
For this many-one function to have an inverse that is also a function, it must have its domain restricted so that it is a one-one function. This can be done by restricting the domain from the axis of symmetry, which in this case is $x = 0$ . $\therefore$ [0,3] which means $a = 0$	Asymptote for $y = be^x$ is $y = 0$ $\therefore$ asymptote for $y = be^x + a$ is $y = a$ Asymptote on the given graph is $y = -6$ $\therefore a = -6$ When $x = 0$ , $y = a + b = 1$ from graph $\therefore b = 7$

Question 11 C	Question 12 E
Let $y = e^x$	Equation of graph is of the form
. 4	$y = k(x-a)(x-b)(x-c)^2$
$y = 1 + \frac{4}{y}$	When $x = 0$ , $y < 0$
$y^2 = y + 4$	$\therefore$ k is negative and could be -1
	$\therefore y = -(x-a)(x-b)(x-c)^2$
$y^2 - y - 4 = 0$	$\therefore y = -(x-b)(x-a)(x-c)^2$
$y = \frac{1 \pm \sqrt{1 + 16}}{2}$	$\therefore y = (b - x)(x - a)(x - c)^2$
2	$\therefore y = (x - a) (b - x)(x - c)^2$
$y = \frac{1 \pm \sqrt{17}}{2}$	
$\therefore e^x = \frac{1 + \sqrt{17}}{2} \text{ or } \frac{1 - \sqrt{17}}{2}$	
But $e^x > 0$	
$\therefore e^x = \frac{1 + \sqrt{17}}{2} = 2.56155$	
$\therefore x = \log_e 2.56155 = 0.9406$	
Question 13 D	Question 14 B
Let $u = 3x^2 + 5$	Gradient of curve at point of tangency = gradient
$du = \epsilon u$	of tangent line = $1$
$\frac{du}{dx} = 6x$	$\therefore \frac{dy}{dx} = 1$ at point of tangency
$y = \log_e u$	$\therefore 2x = 1$
$\frac{dy}{du} = \frac{1}{u}$	
du u	$\Rightarrow x = \frac{1}{2}$
$\frac{dy}{dx} = \frac{dy}{du} \frac{du}{dx}$	
	When $x = \frac{1}{2}$ , $y = \frac{1}{2} - 7$
$\frac{dy}{dx} = \frac{1}{u} \times 6x$	1
$\alpha x = \alpha$	$\Rightarrow y = -6\frac{1}{2}$
$\frac{dy}{dx} = \frac{6x}{u} = \frac{6x}{3x^2 + 5}$	$\therefore$ Point of tangency is $\left(\frac{1}{2}, -\frac{13}{2}\right)$
	On curve when $x = \frac{1}{2}$ , $y = -\frac{13}{2}$
	$\therefore -\frac{13}{2} = \frac{1}{4} + c$
	$\Rightarrow c = -\frac{26}{4} - \frac{1}{4} = -\frac{27}{4}$

$\frac{dy}{dx} = x^{2} \times \frac{d}{dx} \cos 2x + \cos 2x \times \frac{d}{dx}x^{2}$ $= x^{2} \times (-2\sin 2x) + \cos 2x \times 2x$ $= -2x^{2} \sin 2x + 2x \cos 2x$ When $x = \pi$ $\frac{dy}{dx} = -2x^{2} \sin 2\pi + 2\pi \cos 2\pi$ When $x = \pi$ $\frac{dy}{dx} = -2x^{2} \sin 2\pi + 2\pi \cos 2\pi$ $\frac{dy}{dx} = -2x^{2} \sin 2\pi + 2\pi \cos 2\pi$ $\frac{dy}{dx} = -0 + 2\pi = 2\pi$ Question 18 B $\frac{dy}{dx} = -3x^{2} + 4x + 7 = 0 \text{ for T.P.}$ $(3x-7)(-x-1) = 0$ $\therefore 3x = 7 \text{ or } x = -1$ $\therefore \text{ turning points exist at x = \frac{7}{3} \text{ or } x = -1 When x < -1 \frac{dy}{dx} < 0 When x > \frac{7}{3} \frac{dy}{dx} < 0 When x > \frac{7}{3} \frac{dy}{dx} < 0 Hence, local minimum when x = -1 and gradient is positive for -1 < x < \frac{7}{3} Question 21 D f(x) = \int (3e^{\pi} \sin \frac{x}{4})dx f(x) = 3e^{\pi} (-\cos \frac{x}{4}) + \frac{1}{4} + c f(x) = -12e^{\pi} \cos \frac{x}{4} + c f(x) = -12e^{\pi} \cos \frac{x}{4} + c f(x) = -12e^{\pi} \cos \frac{x}{4} + c \frac{dy}{dx} = 12e^{\pi} \cos \frac{x}{4} + c \frac{dy}{dx} = 12$	Question 15 B	Question 16 B
$\begin{aligned} x^{2} \times (-2\sin 2x) + \cos 2x \times 2x \\ x^{2} = -2x^{2} \sin 2x + 2x \cos 2x \end{aligned}$ $\begin{aligned} For 0 < x < 4 except when x = 2, y = f(x) is an increasing graph, hence the gradient, i.e. f'(x) is greater than 0 in this region. \end{aligned}$ $\begin{aligned} When x = \pi \\ \frac{dy}{dx} = -2\pi^{2} \sin 2\pi + 2\pi \cos 2\pi \end{aligned}$ $\begin{aligned} \frac{dy}{dx} = -2\pi^{2} \sin 2\pi + 2\pi \cos 2\pi \end{aligned}$ $\begin{aligned} \frac{dy}{dx} = -2\pi^{2} \sin 2\pi + 2\pi \cos 2\pi \end{aligned}$ $\begin{aligned} \frac{dy}{dx} = -2\pi^{2} \sin 2\pi + 2\pi \cos 2\pi \end{aligned}$ $\begin{aligned} \frac{dy}{dx} = -2\pi^{2} \sin 2\pi + 2\pi \cos 2\pi \end{aligned}$ $\begin{aligned} \frac{dy}{dx} = -2\pi^{2} \sin 2\pi + 2\pi \cos 2\pi \end{aligned}$ $\begin{aligned} \frac{dy}{dx} = -3x^{2} + 4x + 7 = 0 \text{ for T}.P. \\ (3x-7)(-x-1) = 0 \end{aligned}$ $\therefore 3x = 7 \text{ or } x = -1 \therefore x = \frac{7}{3} \text{ or } x = -1 \end{aligned}$ $\begin{aligned} \text{When } x < -1  \frac{dy}{dx} < 0 \end{aligned}$ $\begin{aligned} \text{When } x < -1  \frac{dy}{dx} < 0 \end{aligned}$ $\begin{aligned} \text{When } x < \frac{7}{3}  \frac{dy}{dx} < 0 \end{aligned}$ $\begin{aligned} \text{When } x > \frac{7}{3}  \frac{dy}{dx} < 0 \end{aligned}$ $\begin{aligned} \text{Hence, local minimum when } x = -1 \text{ and gradient is positive for } -1 < x < \frac{7}{3} \end{aligned}$ $\begin{aligned} \text{Question 20 D} \end{aligned}$ $\begin{aligned} \text{Question 21 D} \\ \text{Area of trapezium } = \frac{1}{2}(f(1) + f(1.5))0.5 + \frac{1}{2}(f(1.5) + f(2))0.5 \\ f(1) = 1 + 3 = 4 \\ f(1.5) = 2.25 + 3 = 5.25 \\ f(2) = 4 + 3 = 7 \end{aligned}$ $\therefore \text{ Area under graph } = \frac{1}{4}(f(1) + 2f(1.5) + f(2)) \\ \therefore \text{ Area under graph } = \frac{1}{4}(f(1) + 2f(1.5) + f(2)) \end{aligned}$		-
$\begin{aligned} -2x^{2} \sin 2x + 2x \cos 2x \\ \text{When } x = \pi \end{aligned}$ $\begin{aligned} \frac{dy}{dx} &= -2\pi^{2} \sin 2\pi + 2\pi \cos 2\pi \\ \frac{dy}{dx} &= -2\pi^{2} \sin 2\pi + 2\pi \cos 2\pi \\ \frac{dy}{dx} &= -2\pi^{2} \sin 2\pi + 2\pi \cos 2\pi \end{aligned}$ $\begin{aligned} \frac{dy}{dx} &= -2\pi^{2} \sin 2\pi + 2\pi \cos 2\pi \end{aligned}$ $\begin{aligned} \frac{dy}{dx} &= -2\pi^{2} \sin 2\pi + 2\pi \cos 2\pi \end{aligned}$ $\begin{aligned} \frac{dy}{dx} &= -2\pi^{2} \sin 2\pi + 2\pi \cos 2\pi \end{aligned}$ $\begin{aligned} \frac{dy}{dx} &= -2\pi^{2} \sin 2\pi + 2\pi \cos 2\pi \end{aligned}$ $\begin{aligned} \frac{dy}{dx} &= -2\pi^{2} \sin 2\pi + 2\pi \cos 2\pi \end{aligned}$ $\begin{aligned} \frac{dy}{dx} &= -2\pi^{2} \sin 2\pi + 2\pi \cos 2\pi \end{aligned}$ $\begin{aligned} \frac{dy}{dx} &= -2\pi^{2}^{2} \sin 2\pi + 2\pi \cos 2\pi \end{aligned}$ $\begin{aligned} \frac{dy}{dx} &= -2\pi^{2}^{2} \sin 2\pi + 2\pi \cos 2\pi \end{aligned}$ $\begin{aligned} \frac{dy}{dx} &= -2\pi^{2}^{2} \sin 2\pi + 2\pi \cos 2\pi \end{aligned}$ $\begin{aligned} \frac{dy}{dx} &= -2\pi^{2}^{2} \sin 2\pi + 2\pi \cos 2\pi \end{aligned}$ $\begin{aligned} \frac{dy}{dx} &= -2\pi^{2}^{2} \sin 2\pi + 2\pi \cos 2\pi \end{aligned}$ $\begin{aligned} \frac{dy}{dx} &= -2\pi^{2}^{2} \sin 2\pi + 2\pi \cos 2\pi \end{aligned}$ $\begin{aligned} \frac{dy}{dx} &= -2\pi^{2}^{2} \sin 2\pi + 2\pi \cos 2\pi \end{aligned}$ $\begin{aligned} \frac{dy}{dx} &= -2\pi^{2}^{2} \sin 2\pi + 2\pi \cos 2\pi \end{aligned}$ $\begin{aligned} \frac{dy}{dx} &= -2\pi^{2}^{2} \sin 2\pi + 2\pi \cos 2\pi \end{aligned}$ $\begin{aligned} \frac{dy}{dx} &= -2\pi^{2}^{2} \sin 2\pi + 2\pi \cos 2\pi \end{aligned}$ $\begin{aligned} \frac{dy}{dx} &= -2\pi^{2}^{2} \sin 2\pi + 2\pi \cos 2\pi \end{aligned}$ $\begin{aligned} \frac{dy}{dx} &= -2\pi^{2}^{2} \sin 2\pi + 2\pi \cos 2\pi \end{aligned}$ $\begin{aligned} \frac{dy}{dx} &= -2\pi^{2}^{2} \sin 2\pi + 2\pi \cos 2\pi \end{aligned}$ $\begin{aligned} \frac{dy}{dx} &= -2\pi^{2}^{2} \sin 2\pi + 2\pi \cos 2\pi \end{aligned}$ $\begin{aligned} \frac{dy}{dx} &= -2\pi^{2}^{2} \sin 2\pi + 2\pi \cos 2\pi \end{aligned}$ $\begin{aligned} \frac{dy}{dx} &= -2\pi^{2}^{2} \sin 2\pi + 2\pi \cos 2\pi \end{aligned}$ $\begin{aligned} \frac{dy}{dx} &= -2\pi^{2}^{2} \sin 2\pi + 2\pi \cos 2\pi \end{aligned}$ $\begin{aligned} \frac{dy}{dx} &= -2\pi^{2}^{2} \sin 2\pi + 2\pi \cos 2\pi \end{aligned}$ $\begin{aligned} \frac{dy}{dx} &= -2\pi^{2}^{2} \sin 2\pi + 2\pi \cos 2\pi \end{aligned}$ $\begin{aligned} \frac{dy}{dx} &= -2\pi^{2}^{2} \sin 2\pi + 2\pi \cos 2\pi \end{aligned}$ $\begin{aligned} \frac{dy}{dx} &= -2\pi^{2}^{2} \sin 2\pi + 2\pi \cos 2\pi \end{aligned}$ $\begin{aligned} \frac{dy}{dx} &= -2\pi^{2}^{2} \sin 2\pi + 2\pi \cos 2\pi \end{aligned}$ $\begin{aligned} \frac{dy}{dx} &= -2\pi^{2}^{2} \sin 2\pi + 2\pi \cos 2\pi \end{aligned}$ $\begin{aligned} \frac{dy}{dx} &= -2\pi^{2}^{2} \sin 2\pi + 2\pi \end{aligned}$ $\begin{aligned} \frac{dy}{dx} &= -2\pi^{2}^{2} \sin 2\pi + 2\pi \end{aligned}$ $\begin{aligned} \frac{dy}{dx} &= -2\pi^{2}^{2} \sin 2\pi + 2\pi \end{aligned}$ $\begin{aligned} \frac{dy}{dx} &= -2\pi^{2}^{2} \sin 2\pi + 2\pi \end{aligned}$ $\begin{aligned} \frac{dy}{dx} &= -2\pi^{2}^{2} \sin 2\pi + 2\pi \end{aligned}$ $\begin{aligned} \frac{dy}{dx} &= -2\pi^{2}^{2} \sin 2\pi + 2\pi \end{aligned}$ $\begin{aligned} \frac{dy}{dx} &= -2\pi^{2}^{2} \sin 2\pi + 2\pi \end{aligned}$ $\begin{aligned} \frac{dy}{dx} &= -2\pi^{2}^{2} \sin 2\pi + 2\pi \end{aligned}$ $\begin{aligned} \frac{dy}{dx} &= -2\pi^{2}^{2} \sin 2\pi + 2\pi \end{aligned}$ $\begin{aligned} \frac{dy}{dx} &= -2\pi^{2}^{2} \sin 2\pi + 2\pi \end{aligned}$ $\begin{aligned} \frac{dy}{dx} &= -2\pi^{2}^{2} \sin 2\pi + 2\pi \end{aligned}$ $\begin{aligned} \frac{dy}{dx} &= -2\pi^{2}^{2} \sin 2\pi + 2\pi \end{aligned}$ $\begin{aligned} \frac{dy}{dx} &= -2\pi^{2}^{2} \sin 2\pi + 2\pi \end{aligned}$ $\end{aligned}$ $\begin{aligned} \frac{dy}{dx} &= -2\pi^{2}^{2} \sin 2\pi +$	$\frac{dx}{dx} = x \times \frac{dx}{dx} \cos 2x + \cos 2x \times \frac{dx}{dx}$	
$= -2x^{2} \sin 2x + 2x \cos 2x$ When $x = \pi$ $\frac{dy}{dx} = -2\pi^{2} \sin 2\pi + 2\pi \cos 2\pi$ $\frac{dy}{dx} = -0 + 2\pi = 2\pi$ Cuestion 18 B $\frac{dy}{dx} = -0 + 2\pi = 2\pi$ The derivative does not exist at $x = 2$ or at $x = -1$ , or at $x = 4$ $\therefore$ domain of $f^{1}(x) = R \setminus \{-1, 2, 4\}$ Cuestion 18 B $\frac{dy}{dx} = -3x^{2} + 4x + 7 = 0 \text{ for T.P.}$ $(3x - 7)(-x - 1) = 0$ $\therefore 3x = 7 \text{ or } x = -1$ $\therefore x = \frac{7}{3} \text{ or } x = -1$ When $x < -1$ $\frac{dy}{dx} < 0$ When $-1 < x < \frac{7}{3}$ $\frac{dy}{dx} < 0$ When $x > \frac{7}{3}$ $\frac{dy}{dx} < 0$ Hence, local minimum when $x = -1$ and gradient is positive for $-1 < x < \frac{7}{3}$ Question 20 D $f(x) = \int (3e^{x} \sin \frac{x}{4})dx$ $f(x) = 3e^{x} \int (\sin \frac{1}{4}x)dx$ $f(x) = 3e^{x} (-\cos \frac{x}{4}) + \frac{1}{4} + c$ $f(x) = -12e^{x} \cos \frac{x}{4} + c$ $f(x) = -12e^{x} \cos \frac{x}{4} + c$ $\frac{1}{2}e^{x} + 2e^{x}$ $\frac{1}{2}e^{x} + 2e^{x} + 2e^{x}$ $\frac{1}{2}e^{x} + 2e^{x} + 2e^{x} + 2e^{x}$ $\frac{1}{2}e^{x} + 2e^{x} + 2e^{x} + 2e^{x}$ $\frac{1}{2}e^{x} + 2e^{x} + 2e^{x} + 2e^{x} + 2e^{x}$ $\frac{1}{2}e^{x} + 2e^{x} + 2e^{x} + 2e^{x} + 2e^{x}$ $\frac{1}{2}e^{x} + 2e^{x} $	$= x^2 \times (-2\sin 2x) + \cos 2x \times 2x$	
When $x = \pi$ Question 17 B $\frac{dy}{dx} = -2\pi^2 \sin 2\pi + 2\pi \cos 2\pi$ The derivative does not exist at $x = 2$ or at $\frac{dy}{dx} = -2\pi^2 \sin 2\pi + 2\pi \cos 2\pi$ The derivative does not exist at $x = 2$ or at $\frac{dy}{dx} = -0 + 2\pi = 2\pi$ Cuestion 18 B $\frac{dy}{dx} = -3x^2 + 4x + 7 = 0$ for T.P.Question 19 C $(3x-7)(-x-1) = 0$ $y = \int \frac{dx}{2x+1}$ $(3x-7)(-x-1) = 0$ $y = \int \frac{dx}{2x+1}$ $\therefore$ turning points exist at $x = \frac{7}{3}$ and $x = -1$ $y = \frac{1}{2}\int \frac{2dx}{2x+1}$ When $x < -1$ $\frac{dy}{dx} < 0$ When $x > \frac{7}{3}$ $\frac{dy}{dx} < 0$ F(x) = $\int (3e^x \sin \frac{x}{4})dx$ Area of trapezium $= \frac{1}{2}(a+b)h$ $f(x) = 3e^x \int (\sin \frac{1}{4}x)dx$ $x = 4$ $f(x) = -12e^x \cos \frac{x}{4} + c$ $f(1.5) = 2.25 + 3 = 5.25$ $f(2) = 4 + 3 = 7$ $x$ Area under graph $= \frac{1}{4}(f(1) + 2f(1.5) + f(2))$	$= -2x^2\sin 2x + 2x\cos 2x$	
$\begin{aligned} \frac{dy}{dx} &= -0 + 2\pi = 2\pi \\ x &= -1, \text{ or at } x = 4 \\ \therefore \text{ domain of } f^{1}(x) = R \setminus \{-1,2,4\} \end{aligned}$ $\begin{aligned} &\textbf{Question 18 B} \\ \frac{dy}{dx} &= -3x^{2} + 4x + 7 = 0 \text{ for T.P.} \\ (3x - 7)(-x - 1) = 0 \\ \therefore 3x = 7 \text{ or } x = -1 \\ \therefore \text{ turning points exist at } x = \frac{7}{3} \text{ or } x = -1 \\ \therefore \text{ turning points exist at } x = \frac{7}{3} \text{ on } x = -1 \end{aligned}$ $\begin{aligned} &\textbf{When } x < -1  \frac{dy}{dx} < 0 \\ \text{When } x < -1  \frac{dy}{dx} < 0 \\ \text{When } x > \frac{7}{3}  \frac{dy}{dx} < 0 \\ \text{Hence, local minimum when } x = -1 \text{ and} \\ \text{gradient is positive for } -1 < x < \frac{7}{3} \end{aligned}$ $\begin{aligned} &\textbf{Question 20 D} \\ f(x) = \int (3e^{\pi} \sin \frac{x}{4}) dx \\ f(x) = 3e^{\pi} \int (\sin \frac{1}{4}x) dx \\ f(x) = 3e^{\pi} (-\cos \frac{x}{4}) + \frac{1}{4} + c \\ f(x) = -12e^{\pi} \cos \frac{x}{4} + c \end{aligned}$ $\begin{aligned} &\textbf{Question 21 D} \\ \textbf{Area of trapezium} = \frac{1}{2}(f(1) + f(1.5))0.5 + \frac{1}{2}(f(1.5) + f(2))0.5 \\ f(1) = 1 + 3 = 4 \\ f(1.5) = 2.25 + 3 = 5.25 \\ f(2) = 4 + 3 = 7 \\ \therefore \text{ Area under graph} = \frac{1}{4}(f(1) + 2f(1.5) + f(2)) \\ \textbf{X} \end{aligned}$	When $x = \pi$	
$\frac{dy}{dx} = -0 + 2\pi = 2\pi$ $\therefore \text{ domain of } f^{1}(x) = R \setminus \{-1,2,4\}$ Question 18 B $\frac{dy}{dx} = -3x^{2} + 4x + 7 = 0 \text{ for T.P.}$ $(3x-7)(-x-1) = 0$ $\therefore 3x = 7 \text{ or } x = -1  \therefore x = \frac{7}{3} \text{ or } x = -1$ $\therefore \text{ turning points exist at } x = \frac{7}{3} \text{ and } x = -1$ When $x < -1$ $\frac{dy}{dx} < 0$ When $x < -1$ $\frac{dy}{dx} < 0$ When $x > \frac{7}{3}$ $\frac{dy}{dx} < 0$ Hence, local minimum when $x = -1$ and gradient is positive for $-1 < x < \frac{7}{3}$ Question 20 D $f(x) = \int (3e^{\pi} \sin \frac{x}{4}) dx$ $f(x) = 3e^{\pi} (-\cos \frac{x}{4}) + \frac{1}{4} + c$ $f(x) = -12e^{\pi} \cos \frac{x}{4} + c$ $f(x) = -12e^{\pi} \cos \frac{x}{4} + c$ $\int (15) = 2.25 + 3 = 5.25$ $f(2) = 4 + 3 = 7$ $\therefore \text{ Area under graph } = \frac{1}{4}(f(1) + 2f(1.5) + f(2))$	$\frac{dy}{dx} = -2\pi^2 \sin 2\pi + 2\pi \cos 2\pi$	
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$(3x-7)(-x-1) = 0$ $\therefore 3x = 7 \text{ or } x = -1  \therefore x = \frac{7}{3} \text{ or } x = -1$ $\therefore \text{ turning points exist at } x = \frac{7}{3} \text{ and } x = -1$ When $x < -1$ $\frac{dy}{dx} < 0$ When $-1 < x < \frac{7}{3}$ $\frac{dy}{dx} < 0$ When $x > \frac{7}{3}$ $\frac{dy}{dx} < 0$ Hence, local minimum when $x = -1$ and gradient is positive for $-1 < x < \frac{7}{3}$ Question 20 D $f(x) = \int (3e^{\pi} \sin \frac{x}{4})dx$ $f(x) = 3e^{\pi} \int (\sin \frac{1}{4}x)dx$ $f(x) = -12e^{\pi} \cos \frac{x}{4} + c$ $f(x) = -12e^{\pi} \cos \frac{x}{4} + c$ $f(x) = -12e^{\pi} \cos \frac{x}{4} + c$ $y = \frac{1}{2} \int \frac{2dx}{2x+1}$ $y = \frac{1}{2} \log_{e}(2x+1) + c$ $y = \frac{1}{2} (1 + 1) + c$	-	-
$\therefore 3x = 7 \text{ or } x = -1  \therefore x = \frac{1}{3} \text{ or } x = -1$ $\therefore \text{ turning points exist at } x = \frac{7}{3} \text{ and } x = -1$ When $x < -1$ $\frac{dy}{dx} < 0$ When $-1 < x < \frac{7}{3}$ $\frac{dy}{dx} > 0$ When $x > \frac{7}{3}$ $\frac{dy}{dx} < 0$ Hence, local minimum when $x = -1$ and gradient is positive for $-1 < x < \frac{7}{3}$ Question 20 D $f(x) = \int (3e^{\pi} \sin \frac{x}{4}) dx$ $f(x) = 3e^{\pi} \int (\sin \frac{1}{4}x) dx$ $f(x) = -12e^{\pi} \cos \frac{x}{4} + c$ $f(x) = -12e^{\pi} \cos \frac{x}{4}$		
$\therefore \text{ turning points exist at } x = \frac{1}{3} \text{ and } x = -1$ When $x < -1$ $\frac{dy}{dx} < 0$ When $-1 < x < \frac{7}{3}$ $\frac{dy}{dx} > 0$ When $x > \frac{7}{3}$ $\frac{dy}{dx} < 0$ Hence, local minimum when $x = -1$ and gradient is positive for $-1 < x < \frac{7}{3}$ Question 20 D $f(x) = \int (3e^{\pi} \sin \frac{x}{4}) dx$ $f(x) = 3e^{\pi} \int (\sin \frac{1}{4}x) dx$ $f(x) = 3e^{\pi} (-\cos \frac{x}{4}) + \frac{1}{4} + c$ $f(x) = -12e^{\pi} \cos \frac{x}{4} + c$ $f(x) = -12e^{\pi} \cos \frac{x}{4} + c$ $f(x) = x + c$ $f($	5	
$\begin{aligned} & \text{When } -1 < x < \frac{7}{3}  \frac{dy}{dx} > 0 \\ & \text{When } x > \frac{7}{3}  \frac{dy}{dx} < 0 \\ & \text{Hence, local minimum when } x = -1 \text{ and} \\ & \text{gradient is positive for } -1 < x < \frac{7}{3} \end{aligned}$ $\begin{aligned} & \textbf{Question 20 D} \\ & f(x) = \int (3e^{\pi} \sin \frac{x}{4}) dx \\ & f(x) = 3e^{\pi} \int (\sin \frac{1}{4}x) dx \\ & f(x) = 3e^{\pi} (-\cos \frac{x}{4}) + \frac{1}{4} + c \\ & f(x) = -12e^{\pi} \cos \frac{x}{4} + c \end{aligned}$ $\begin{aligned} & \textbf{Question 21 D} \\ & \text{Area of trapezium} = \frac{1}{2}(a+b)h \\ & \therefore \text{ Area under graph} = \frac{1}{2}(f(1) + f(1.5))0.5 + \\ & \frac{1}{2}(f(1.5) + f(2))0.5 \\ & f(1) = 1 + 3 = 4 \\ & f(1.5) = 2.25 + 3 = 5.25 \\ & f(2) = 4 + 3 = 7 \\ & \therefore \text{ Area under graph} = \frac{1}{4}(f(1) + 2f(1.5) + f(2)) \\ & \text{Area under graph} = \frac{1}{4}(f(1) + 2f(1.5) + f(2)) \\ & \text{Area under graph} = \frac{1}{4}(f(1) + 2f(1.5) + f(2)) \\ & \text{Area under graph} = \frac{1}{4}(f(1) + 2f(1.5) + f(2)) \\ & \text{Area under graph} = \frac{1}{4}(f(1) + 2f(1.5) + f(2)) \\ & \text{Area under graph} = \frac{1}{4}(f(1) + 2f(1.5) + f(2)) \\ & \text{Area under graph} = \frac{1}{4}(f(1) + 2f(1.5) + f(2)) \\ & \text{Area under graph} = \frac{1}{4}(f(1) + 2f(1.5) + f(2)) \\ & \text{Area under graph} = \frac{1}{4}(f(1) + 2f(1.5) + f(2)) \\ & \text{Area under graph} = \frac{1}{4}(f(1) + 2f(1.5) + f(2)) \\ & \text{Area under graph} = \frac{1}{4}(f(1) + 2f(1.5) + f(2)) \\ & \text{Area under graph} = \frac{1}{4}(f(1) + 2f(1.5) + f(2)) \\ & \text{Area under graph} = \frac{1}{4}(f(1) + 2f(1.5) + f(2)) \\ & \text{Area under graph} = \frac{1}{4}(f(1) + 2f(1.5) + f(2)) \\ & \text{Area under graph} = \frac{1}{4}(f(1) + 2f(1.5) + f(2)) \\ & \text{Area under graph} = \frac{1}{4}(f(1) + 2f(1.5) + f(2)) \\ & \text{Area under graph} = \frac{1}{4}(f(1) + 2f(1.5) + f(2)) \\ & \text{Area under graph} = \frac{1}{4}(f(1) + 2f(1.5) + f(2)) \\ & \text{Area under graph} = \frac{1}{4}(f(1) + 2f(1.5) + f(2)) \\ & \text{Area under graph} = \frac{1}{4}(f(1) + 2f(1.5) + f(2)) \\ & \text{Area under graph} = \frac{1}{4}(f(1) + 2f(1.5) + f(2)) \\ & \text{Area under graph} = \frac{1}{4}(f(1) + 2f(1.5) + f(2)) \\ & \text{Area under graph} = \frac{1}{4}(f(1) + 2f(1.5) + f(2)) \\ & \text{Area under graph} = \frac{1}{4}(f(1) + 2f(1.5) + f(2)) \\ & \text{Area under graph} = \frac{1}{4}(f(1) + 2f(1.5) + f(2)) \\ & \text{Area under graph} = \frac{1}{$	: turning points exist at $x = \frac{7}{3}$ and $x = -1$	2 2 2 2
$\begin{aligned} \text{When } x > \frac{7}{3} & \frac{dy}{dx} < 0 \\ \text{Hence, local minimum when } x = -1 \text{ and} \\ \text{gradient is positive for } -1 & < x < \frac{7}{3} \end{aligned}$ $\begin{aligned} \textbf{Question 20 D} \\ f(x) = \int (3e^{\pi} \sin \frac{x}{4}) dx \\ f(x) = 3e^{\pi} \int (\sin \frac{1}{4}x) dx \\ f(x) = 3e^{\pi} (-\cos \frac{x}{4}) \div \frac{1}{4} + c \\ f(x) = -12e^{\pi} \cos \frac{x}{4} + c \end{aligned}$ $\begin{aligned} \textbf{Question 21 D} \\ \text{Area of trapezium} = \frac{1}{2}(a+b)h \\ \therefore \text{ Area under graph} = \frac{1}{2}(f(1) + f(1.5))0.5 + \\ \frac{1}{2}(f(1.5) + f(2))0.5 \\ f(1) = 1 + 3 = 4 \\ f(1.5) = 2.25 + 3 = 5.25 \\ f(2) = 4 + 3 = 7 \\ \therefore \text{ Area under graph} = \frac{1}{4}(f(1) + 2f(1.5) + f(2)) \\ \text{Area under graph} = \frac{1}{4}(f(1) + 2f(1.5$	When $x < -1$ $\frac{dy}{dx} < 0$	
Hence, local minimum when $x = -1$ and gradient is positive for $-1 < x < \frac{7}{3}$ Question 20 D $f(x) = \int (3e^{\pi} \sin \frac{x}{4})dx$ $f(x) = 3e^{\pi} \int (\sin \frac{1}{4}x)dx$ $f(x) = 3e^{\pi} (-\cos \frac{x}{4}) \div \frac{1}{4} + c$ $f(x) = -12e^{\pi} \cos \frac{x}{4} + c$ Question 21 D Area of trapezium $= \frac{1}{2}(a+b)h$ $\therefore$ Area under graph $= \frac{1}{2}(f(1) + f(1.5))0.5 + \frac{1}{2}(f(1.5) + f(2))0.5$ f(1) = 1 + 3 = 4 f(1.5) = 2.25 + 3 = 5.25 f(2) = 4 + 3 = 7 $\therefore$ Area under graph $= \frac{1}{4}(f(1) + 2f(1.5) + f(2))$	When $-1 < x < \frac{7}{3}  \frac{dy}{dx} > 0$	
gradient is positive for $-1 < x < \frac{7}{3}$ Question 20 D       Question 21 D $f(x) = \int (3e^{\pi} \sin \frac{x}{4})dx$ Area of trapezium $= \frac{1}{2}(a+b)h$ $f(x) = 3e^{\pi} \int (\sin \frac{1}{4}x)dx$ $\therefore$ Area under graph $= \frac{1}{2}(f(1) + f(1.5))0.5 + \frac{1}{2}(f(1.5) + f(2))0.5$ $f(x) = -12e^{\pi} \cos \frac{x}{4} + c$ $f(1.5) = 2.25 + 3 = 5.25$ $f(2) = 4 + 3 = 7$ $\therefore$ Area under graph $= \frac{1}{4}(f(1) + 2f(1.5) + f(2))$	When $x > \frac{7}{3} = \frac{dy}{dx} < 0$	
Question 20 D       Question 21 D $f(x) = \int (3e^{\pi} \sin \frac{x}{4}) dx$ Area of trapezium $= \frac{1}{2}(a+b)h$ $f(x) = 3e^{\pi} \int (\sin \frac{1}{4}x) dx$ $\therefore$ Area under graph $= \frac{1}{2}(f(1) + f(1.5))0.5 + \frac{1}{2}(f(1.5) + f(2))0.5$ $f(x) = -12e^{\pi} \cos \frac{x}{4} + c$ $f(1.5) = 2.25 + 3 = 5.25$ $f(2) = 4 + 3 = 7$ $\therefore$ Area under graph $= \frac{1}{4}(f(1) + 2f(1.5) + f(2))$	Hence, local minimum when $x = -1$ and	
$f(x) = \int (3e^{\pi} \sin \frac{x}{4}) dx$ $f(x) = 3e^{\pi} \int (\sin \frac{1}{4}x) dx$ $f(x) = 3e^{\pi} (-\cos \frac{x}{4}) \div \frac{1}{4} + c$ $f(x) = -12e^{\pi} \cos \frac{x}{4} + c$ $f(x) = -12e^{\pi$	gradient is positive for $-1 < x < \frac{7}{3}$	
$f(x) = \int (3e^{x} \sin \frac{1}{4})dx$ $f(x) = 3e^{\pi} \int (\sin \frac{1}{4}x)dx$ $f(x) = 3e^{\pi} (-\cos \frac{x}{4}) \div \frac{1}{4} + c$ $f(x) = -12e^{\pi} \cos \frac{x}{4} + c$ $f(x) = -12e^{\pi} \cos \frac$	Question 20 D	-
$f(x) = 3e^{\pi} \int (\sin \frac{1}{4}x) dx$ $f(x) = 3e^{\pi} (-\cos \frac{x}{4}) \div \frac{1}{4} + c$ $f(x) = -12e^{\pi} \cos \frac{x}{4} + c$ $f(x) = -12e^{\pi} \cos $	$f(x) = \int (3e^{\pi} \sin \frac{x}{x}) dx$	Area of trapezium = $\frac{1}{2}(a+b)h$
$f(x) = 3e^{\pi}(-\cos\frac{x}{4}) \div \frac{1}{4} + c$ $f(x) = -12e^{\pi}\cos\frac{x}{4} + c$ $f(x) = -12e^{\pi}\cos\frac{x}{4} + c$ $f(x) = -12e^{\pi}\cos\frac{x}{4} + c$ $f(1.5) = 2.25 + 3 = 5.25$ $f(2) = 4 + 3 = 7$ $\therefore \text{ Area under graph} = \frac{1}{4}(f(1) + 2f(1.5) + f(2))$	1	: Area under graph = $\frac{1}{2}(f(1) + f(1.5))0.5 +$
$f(x) = -12e^{\pi} \cos \frac{x}{4} + c$ $f(1.5) = 2.25 + 3 = 5.25$ $f(2) = 4 + 3 = 7$ $\therefore \text{ Area under graph} = \frac{1}{4}(f(1) + 2f(1.5) + f(2))$	4	$\frac{1}{2}(f(1.5) + f(2))0.5$
f(2) = 4 + 3 = 7 $\therefore \text{ Area under graph} = \frac{1}{4}(f(1) + 2f(1.5) + f(2))$	$\int (x) - 3e^{-1} (-\cos \frac{1}{4}) + \frac{1}{4} + c$	f(1) = 1 + 3 = 4
f(2) = 4 + 3 = 7 ∴ Area under graph = $\frac{1}{4}(f(1) + 2f(1.5) + f(2))$	$f(x) = -12e^{\pi}\cos\frac{x}{2} + c$	f(1.5) = 2.25 + 3 = 5.25
	4	f(2) = 4 + 3 = 7
: Area under graph = $\frac{1}{4}(4+10.5+7) = 5.375$		: Area under graph = $\frac{1}{4}(f(1) + 2f(1.5) + f(2))$
		: Area under graph = $\frac{1}{4}(4+10.5+7) = 5.375$

Question 22 B	Question 23 D
$\int_{a}^{a} e^{2x} dx = 21623.037$	$\sum \Pr = 1$
$\frac{1}{3}$	$\therefore b = 1 - (0.2 + 0.3 + 0.1)$
$\frac{1}{2}e^{2x}]_3^a = 21623.037$	$\therefore b = 1 - 0.6$
	$\therefore b = 0.4$
$\frac{1}{2}[e^{2a} - e^6] = 21623.037$	$\mu = \sum x \Pr(X = x) = 1.2$
$e^{2a} - e^{6}$ ] = 43246.074	$\therefore -0.4 - 0.3 + 0.4a + 0.1a + 0.4 = 1.2$
$e^{2a} = 43246.074 + e^{6}$	$\therefore 0.5a = 1.5$
$e^{2a} = 43649.50279$	$\therefore a = 3$
$2a = \log_e 43649.50279$	
2a = 10.684	
<i>a</i> = 5.3	
Question 24 C $x - \mu$	Question 25 C Without replacement, hypergeometric
$Z = \frac{x - \mu}{\sigma}$	Pr at least one green $=$ Pr 1 is green
$1.5 = \frac{a - 10}{4}$	or Pr 2 are green
	$\Pr(x=1) + \Pr(x=2)$
6 = a - 10 $a = 16$	$=\frac{\binom{2}{1}\binom{4}{1}}{\binom{6}{2}} + \frac{\binom{2}{2}\binom{4}{0}}{\binom{6}{2}}$
Question 26 A	= 0.6 Question 27 D
	Binomial
$\sigma = \frac{1}{2}$	p = 0.4
	<i>q</i> = 0.6
3 4	<i>n</i> = 3
	<i>x</i> = 1
	$\Pr(X=1) = \binom{3}{1} (0.4)^1 (0.6)^2$
$\Pr(X > 4) = \Pr(Z > 2) \qquad \qquad Z = \frac{x - \mu}{\sigma}$	$\Pr(X=1) = 0.43$
$Pr(X > 4) = Pr(Z > 2) \qquad Z = \frac{x - \mu}{\sigma}$ $Pr(X > 4) = 1 - Pr(Z < 2) \qquad Z = \frac{4 - 3}{\frac{1}{2}} = 2$	
$\Pr(X > 4) = 1 - 0.9772$	
$\Pr(X > 4) = 0.0228$	
$\Pr(X > 4) = 2.28\%$	

### Page 6

Question 1	Question 2
$2x - 3 \ge 0$ $\therefore 2x \ge 3$ $\therefore x \ge \frac{3}{2}$ $\therefore \text{ Domain } [\frac{3}{2}, \infty) \qquad (1 \text{ mark})$ When $x = \frac{3}{2}$ $f(x) = -\frac{1}{2} \times 0 + 4 = 4$ When $x \to \infty$ $f(x) \to 4 - a$ very large number $\therefore f(x) \to -\infty$ Range(- $\infty$ , 4] (1 mark)	$\frac{\log_a \frac{16}{2}}{\log_a 2} = \frac{\log_a 8}{\log_a 2} \qquad (1 \text{ mark})$ $= \frac{\log_a 2^3}{\log_a 2}$ $= \frac{3\log_a 2}{\log_a 2}$ $= 3 \qquad (1 \text{ mark})$
Question 3 $x = \frac{25}{7}$	Question 4 a. $f(x) = 3\sin(\frac{1}{3}x)$ $f^{1}(x) = 3 \times \frac{1}{3}\cos(\frac{1}{3}x)$
Using Pythagorean triad 7:24:25 x = 24 $\theta$ is in the 4 <sup>th</sup> quadrant $\therefore$ tan $\theta$ is negative (1 mark) 24	$= \cos(\frac{x}{3})$ (1 mark) <b>b.</b> Minimum value of $3\sin(\frac{x}{3})$ , from the amplitude would be $-3$ (1 mark)
$\therefore \tan \theta = -\frac{24}{7} \qquad (1 \text{ mark})$ Question 4 b.(continued) $3\sin(\frac{x}{3}) = -3$ $\sin(\frac{x}{3}) = -1 \qquad 0 \le x \le 8\pi$ $0 \le \frac{x}{3} \le \frac{8\pi}{3}$	would be $-3$ (1 mark) Question 5 a. $\frac{dy}{dx} = -8(3-2x) \times (-2)$ $\frac{dy}{dx} = 16(3-2x) = 0$ for turning point $\Rightarrow (3-2x) = 0$ $\Rightarrow x = \frac{3}{2}$
$\frac{x}{3} = \frac{3\pi}{2}$ $x = \frac{9\pi}{2}$ (1 mark) Minimum is $-3$ when $x = \frac{9\pi}{2}$	When $x = \frac{3}{2}$ $y = 5 - 4(3 - 3)^2$ $\Rightarrow y = 5 - 0 = 5$ Turning point is $(\frac{3}{2}, 5)$ (1 mark)

Question 5	Question 6
b.	a.
$y = -4(3-2x)^2 + 5$	$E(x) = \sum x \Pr(X = x)$ = $\frac{1}{6} + \frac{2}{6} + \frac{3}{6} + \frac{4}{6} + \frac{5}{6} + \frac{6}{6}$
Graph of $y = x^2$ is translated $\frac{3}{2}$ units to the	
right parallel to the $x$ axis. (1 mark)	$=\frac{21}{6}$
It is translated 5 units up parallel to the y axis	= 3.5 (1 mark)
(1 mark)	
It is reflected in the <i>y</i> axis because of the	
minus sign in front of the equation (1 mark)	
It is dilated by a factor of 16 in the y	
direction(because of the $-4 \times (-2)^2$ which	
is the coefficient of $x^2$ in the expansion	
(1 mark)	
Question 6	Question 7
b.	Sampling without replacement is hypergeometric
95% confidence limits: $\mu \pm 2\sigma$	Pr(X < 2) = Pr(x = 0) + Pr(X = 1) (1 mark)
$\sigma = \sqrt{x^2 p(x) - \mu^2}$	(6)(24) $(6)(24)$
$x^{2}p(x) = \frac{1}{6} + \frac{4}{6} + \frac{9}{6} + \frac{16}{6} + \frac{25}{6} + \frac{36}{6}$	$\Pr(X < 2) = \frac{\begin{pmatrix} 0 & 24 \\ 0 & 10 \end{pmatrix}}{\begin{pmatrix} 30 \end{pmatrix}} + \frac{\begin{pmatrix} 0 & 24 \\ 1 & 9 \end{pmatrix}}{\begin{pmatrix} 30 \end{pmatrix}}  (1 \text{ mark})$
$x^2 p(x) = \frac{91}{6} = 15.1667$	(10) $(10)$
$\sigma = \sqrt{15.1667 - 12.25} = 1.708 \qquad (1 \text{ mark})$	Pr(X < 2) = 0.3264 to four decimal places
$2\sigma = 3.42$	(1 mark)
$\mu \pm 2\sigma = 3.5 \pm 3.42$	
$0.08 \le \mu \le 6.92$	
$0.1 \le \mu \le 7.0$ (1 mark)	

Question 8	Question 8	
a.	b.	
$y = e^{\cos x}$ Let $u = \cos x$ $\frac{du}{dx} = -\sin x$ $y = e^{u}$ $\frac{dy}{du} = e^{u}$ $\frac{dy}{dx} = \frac{dy}{du}  \frac{du}{dx}$ $\frac{dy}{dx} = e^{u}(-\sin x)$	<b>b.</b> $\int -\sin x e^{\cos x} dx = e^{\cos x} + c \text{ where } c \text{ is a constant}$ $\int \sin x e^{\cos x} dx = -e^{\cos x} - c  (1 \text{ mark})$ $\therefore \int_{0}^{\frac{\pi}{2}} \sin x e^{\cos x} dx = -e^{\cos x} ]_{0}^{\frac{\pi}{2}}$ $\therefore \int_{0}^{\frac{\pi}{2}} \sin x e^{\cos x} dx = (-e^{\cos \frac{\pi}{2}}) - (-e^{\cos 0})$ $\therefore \int_{0}^{\frac{\pi}{2}} \sin x e^{\cos x} dx = -e^{0} + e^{1} = e - 1  (1 \text{ mark})$	
$\frac{dy}{dx} = -\sin x e^{\cos x} \qquad (1 \text{ mark})$		

#### END OF SUGGESTED SOLUTIONS 2003 Mathematical Methods Trial Examination 1

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