STADIRA
TRAINING INSTITUTE

Mathematics – Analysis and Approaches
Standard Level
Paper 1 – Marking Key

Marks: 80
1 hour 30 minutes

DP MOCK EXAMINATION – SET 1

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Instructions to candidates

- This marking key uses IB-style notation: M = method mark, A = accuracy mark, R = reasoning mark, AG = answer given, FT = follow through from previous part.
- Award FT marks where a candidate uses an incorrect earlier answer correctly in later working.
- Accept answers correct to three significant figures, or the accuracy specified in the question.
- GDC boxes show one efficient TI-Nspire CX II method; any valid method receives full credit.
- Screens shown are drawn recreations of the TI-Nspire CX II display.

Information

- This marking key has 6 pages.
- The number of marks for each question or part question is shown in brackets [ ].

Question 1

Question	Solution / Working	Marks	Notes
1(a)	$(3x^2y^3)^3 = 27x^6y^9$ $\frac{27x^6y^9}{9x^4y^2} = 3x^2y^7$	M1 A1 A1	M1 for cubing every factor; A1 numerator; A1 final answer
1(b)	let the three consecutive integers be n − 1, n and n + 1, where $n \in \mathbb{Z}$ (n − 1) + n + (n + 1) = 3n 3n is a multiple of 3 for every integer n, so the sum is always divisible by 3 AG	M1 A1 AG1	Accept n, n+1, n+2 giving 3n + 3 = 3(n + 1). A proof by example scores M0

Total: [6 marks]

Question 2

Question	Solution / Working	Marks	Notes
2(a)	$(2+3x)^5 = 2^5 + C(5,1)\,2^4(3x) + C(5,2)\,2^3(3x)^2 + \ldots$ = 32 + 5(16)(3x) + 10(8)(9x²) + … = 32 + 240x + 720x²	M1 A1 A1	M1 for binomial coefficients used correctly
2(b)	term in x³ is $C(5,3)\,2^2(3x)^3$ = 10 × 4 × 27x³ coefficient = 1080	M1 A1 A1	

Total: [6 marks]

Question 3

Question	Solution / Working	Marks	Notes
3(a)	equal roots require Δ = b² − 4ac = 0, with a = k, b = k + 2, c = 3 $\Delta = (k+2)^2 - 4(k)(3) = k^2 + 4k + 4 - 12k$ $= k^2 - 8k + 4$ AG	M1 A1 AG1	
3(b)	k² − 8k + 4 = 0 $k = \frac{8 \pm \sqrt{64 - 16}}{2} = \frac{8 \pm \sqrt{48}}{2}$ $k = 4 \pm 2\sqrt{3}$	M1 A1 A1	Exact surd form required; 7.46 and 0.536 score A0 A0

Total: [6 marks]

Question 4

Question	Solution / Working	Marks	Notes
4(a)	using $\cos^2\theta + \sin^2\theta = 1$: $\cos^2\theta = 1 - \frac{9}{25} = \frac{16}{25}$ $\cos\theta = \frac{4}{5}$ (positive, since θ is acute) $\sin 2\theta = 2\sin\theta\cos\theta = 2 \times \frac{3}{5} \times \frac{4}{5}$ $= \frac{24}{25}$	M1 A1 M1 A1	
4(b)	$\cos 2\theta = 1 - 2\sin^2\theta = 1 - 2\left(\frac{9}{25}\right)$ $= \frac{7}{25}$	M1 A1	Accept $\cos^2\theta - \sin^2\theta = \frac{16}{25} -$

Total: [6 marks]

Question 5

Question	Solution / Working	Marks	Notes
5(a)	$\frac{dy}{dx} = 3x^2 - 4$	A1 A1	
5(b)	at x = 2: y = 8 − 8 = 0, so the point is (2, 0) gradient = 3(4) − 4 = 8 y − 0 = 8(x − 2) y = 8x − 16	A1 A1 M1 A1	

Total: [6 marks]

Question 6

Question	Solution / Working	Marks	Notes
6(a)	$x^2 - 6x + 11 = (x - 3)^2 - 9 + 11$ $= (x-3)^2 + 2$	**M1** **A1 A1**	M1 completing the square; A1 h = 3; A1 k = 2
6(b)	vertex (3, 2) axis of symmetry x = 3	**A1** **A1**	
6(c)	$f(x) \geq 2$	**A1**	FT from (a)
6(d)	f is not one-to-one on $\mathbb{R}$ — for example f(2) = f(4) = 3, so a horizontal line can meet the graph twice an inverse requires each output to come from exactly one input the largest such domain starts at the vertex, so a = 3	**R1** **R1** **A1**	
6(e)	let $y = (x - 3)^2 + 2$, so $(x - 3)^2 = y - 2$ $x - 3 = \pm\sqrt{y-2}$ since $x \geq 3$ the positive root is taken $f^{-1}(x) = 3 + \sqrt{x-2}$	**M1** **A1** **R1** **A1**	The R1 for justifying the positive square root is essential
6(f)	$x \geq 2$	**A1**	The domain of f^{-1} is the range of f
6(g)	translation 2 right and 5 down gives $g(x) = f(x - 2) - 5 = (x - 5)^2 + 2 - 5$ $g(x) = x^2 - 10x + 22$	**M1** **A1**	

Total: [16 marks]

Question 7

Question	Solution / Working	Marks	Notes
7(a)	$f'(x) = 3x^2 - 6x$ 3x(x − 2) = 0, so x = 0 or x = 2 f(0) = 0 and f(2) = 8 − 12 = −4 stationary points (0, 0) and (2, −4)	A1 M1 A1 A1 A1	A1 derivative; M1 set to zero; A1 x-values; A1 A1 the two points
7(b)	$f''(x) = 6x - 6$ f″(0) = −6 < 0, so (0, 0) is a local maximum f″(2) = 6 > 0, so (2, −4) is a local minimum	A1 A1 A1	
7(c)	$x^3 - 3x^2 = x^2(x - 3) = 0$ (0, 0) and (3, 0)	M1 A1	
7(d)	correct cubic shape, negative for 0 < x < 3 maximum at (0, 0) and minimum at (2, −4) shown x-intercepts at x = 0 (a turning point on the axis) and x = 3	A1 A1 A1	
7(e)	the curve lies below the x-axis for 0 < x < 3, so the integral is negative and the area is its modulus $\int_0^3 (x^3 - 3x^2)\,dx = \left[\frac{x^4}{4} - x^3\right]_0^3$ $= \left(\frac{81}{4} - 27\right) - 0 = -\frac{27}{4}$ $\text{area} = \frac{27}{4}$	R1 M1 A1 A1	A candidate who gives $-\frac{27}{4}$ as the area loses the final A1. Exact fraction required

Total: [17 marks]

Question 8

Question	Solution / Working	Marks	Notes
8(a)	amplitude = 3 $\textbf{period} = \frac{2\pi}{2} = \pi$ range $-2 \le f(x) \le 4$	**A1** **A1** **A1**	
8(b)	$3\sin(2x) + 1 = \frac{5}{2} \implies \sin(2x) = \frac{1}{2}$ for $0 \le x \le 2\pi$ the argument satisfies $0 \le 2x \le 4\pi$ $2x = \frac{\pi}{6}, \frac{5\pi}{6}, \frac{13\pi}{6}, \frac{17\pi}{6}$ $x = \frac{\pi}{12}, \frac{5\pi}{12}, \frac{13\pi}{12}, \frac{17\pi}{12}$	**M1** **R1** **M1 A1** **A1 A1**	R1 for doubling the interval — candidates who give only two solutions lose two A marks
8(c)	sine shape with two complete cycles over $0 \le x \le 2\pi$ principal axis $y = 1$ indicated maxima $\left(\frac{\pi}{4}, 4\right)$ and $\left(\frac{5\pi}{4}, 4\right)$ minima $\left(\frac{3\pi}{4}, -2\right)$ and $\left(\frac{7\pi}{4}, -2\right)$	**A1** **A1** **A1** **A1**	
8(d)	$f(x) = 4$ requires $\sin(2x) = 1$, which is the maximum value of the sine function over $0 \le 2x \le 4\pi$ this happens when $2x = \frac{\pi}{2}$ and $2x = \frac{5\pi}{2}$ so there are 2 solutions they are the two maximum points of the graph, where the line $y = 4$ is a tangent to the curve rather than a crossing	**R1** **M1** **A1** **R1**	

Total: [17 marks]