

Pure Mathematics - Sample Paper - Mark Scheme

M = method mark, A = accuracy mark, B = independent mark. AO1 = procedural fluency, AO2 = mathematical reasoning/proof, AO3 = problem solving in context.

Question 1

Part	Scheme	Marks	AO
	$f(1) = 1 - 2 - 5 + 6 = 0 \rightarrow (x-1)$ is a factor	M1 A1	AO1
	Divide (or compare coefficients) to find $f(x) = (x-1)(x^2 - x - 6)$	M1	AO1
	$= (x-1)(x-3)(x+2)$	A1	AO1
	$x = 1, 3, -2$	A1	AO1

Total for Question 1: 6 marks

Question 2

Part	Scheme	Marks	AO
	$n^3 - n = n(n-1)(n+1)$ - the product of 3 consecutive integers	M1	AO2
	Among any 3 consecutive integers, at least one is divisible by 3	A1	AO2
	Among any 3 consecutive integers, at least one is divisible by 2 (in fact at least one of $n-1$, $n+1$ is even, or n itself)	A1	AO2
	Since the product contains a factor of 2 and a factor of 3, it is divisible by $2 \times 3 = 6$	A1	AO2
	Hence $n^3 - n$ is divisible by 6 for every positive integer n	A1	AO2

Total for Question 2: 5 marks

Question 3

Part	Scheme	Marks	AO
(a)	$(x-3)^2 + (y+1)^2 = 25$ by completing the square	M1	AO1
	Centre $(3, -1)$, radius 5	A1 A1	AO1
(b)	Substitute $y = x+k$ into the circle equation to get a quadratic in x	M1	AO1
	$2x^2 + (2k-4)x + (k^2+2k-15) = 0$	A1	AO1
	Set discriminant = 0: $(2k-4)^2 - 8(k^2+2k-15) = 0$	M1	AO1
	$-4k^2 - 32k + 136 = 0 \rightarrow k^2 + 8k - 34 = 0$	A1	AO1
	$k = -4 \pm 5\sqrt{2}$	A1	AO1

Total for Question 3: 9 marks

Question 4

Part	Scheme	Marks	AO
(a)	$R = \sqrt{5^2 + 12^2} = 13$	M1 A1	AO1
	$\tan \alpha = 12/5 \rightarrow \alpha = 67.38^\circ$	M1 A1	AO1
(b)	$13 \sin(x + 67.38^\circ) = 6 \rightarrow \sin(x + 67.38^\circ) = 6/13$	M1	AO1
	$x + 67.38^\circ = 27.50^\circ$ or 152.50° (principal + second solution)	M1	AO1
	$x = 320.1^\circ$	A1	AO1
	$x = 85.1^\circ$	A1	AO1
	Reject any solutions outside $0 \leq x < 360^\circ$	A1	AO1

Total for Question 4: 9 marks

Question 5

Part	Scheme	Marks	AO
(a)	Correct binomial coefficients ($\frac{1}{2}$ choose k) used with $(2x)^k$	M1	AO1
	$1 + (2/3)x - (4/9)x^2 + (40/81)x^3$	A1 A1 A1	AO1
	Valid for $ x < 1/2$	B1 B1	AO1
(b)	Substitute $x = 0.01$ (since $1 + 2(0.01) = 1.02$)	M1	AO1
	1.006622 (6 d.p.)	A1	AO1

Total for Question 5: 8 marks

Question 6

Part	Scheme	Marks	AO
(a)	$dx/dt = 6t, dy/dt = 12t^2$	M1	AO1
	$dy/dx = 12t^2/6t = 2t$	A1	AO1
(b)	At $t=1$: point (3,4), gradient = 2	M1 A1	AO1
	$y - 4 = 2(x - 3)$	M1	AO1
	$y = 2x - 2$	A1	AO1
(c)	Area = $\int_0^2 y(dx/dt) dt = \int_0^2 (4t^3)(6t) dt$	M1	AO3
	$= \int_0^2 24t^4 dt$	A1	AO3
	$= [24t^5/5]_0^2$	M1	AO3
	$= 768/5$ (exact)	A1	AO3

Total for Question 6: 13 marks

Question 7

Part	Scheme	Marks	AO
(a)	$\ln 50 = \ln A + 2 \ln b; \ln 400 = \ln A + 5 \ln b$	M1	AO3
	Subtract to eliminate $\ln A$: $3 \ln b = \ln 400 - \ln 50 = \ln 8$	M1	AO3
	$b = 8^{1/3} = 2$	A1	AO3
	$\ln A = \ln 50 - 2 \ln 2 \rightarrow A = 12.5$	A1	AO3

(b)	Any valid limitation, e.g. two points cannot confirm the model is a good fit / no way to assess how well the exponential form matches data between or beyond the given points	B1 B1	AO3
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Total for Question 7: 7 marks

Question 8

Part	Scheme	Marks	AO
(a)	Differentiate term by term: $2x + 3y + 3x(dy/dx) - 2y(dy/dx) = 0$	M1 A1	AO1
	Collect dy/dx terms: $dy/dx (3x-2y) = -(2x+3y)$	M1	AO1
	$dy/dx = -(2x+3y)/(3x-2y)$	A1 A1	AO1
(b)	Substitute (3,0): $9+0-0-9 = 0 \checkmark$	B1	AO1
	Gradient = $-(6+0)/(9-0) = -2/3$	M1 A1	AO1

Total for Question 8: 9 marks

Question 9

Part	Scheme	Marks	AO
(a)	$AB \rightarrow = b-a = 3i+j+2k$; for a parallelogram ABCD, $DC \rightarrow = AB \rightarrow$, so $d = c - (b-a)$	M1	AO1
	$d = 3i+6j+0k$	A1	AO1
(b)	$DC \rightarrow = c - d = 3i+j+2k = AB \rightarrow$	M1	AO2
	Since $AB \rightarrow = DC \rightarrow$, AB is parallel to and equal in length to DC, so ABCD is a parallelogram	A1 A1	AO2
(c)	$AC \rightarrow = c-a = 5i+5j+3k \rightarrow AC \rightarrow = \sqrt{59}$	M1 A1	AO1

Total for Question 9: 9 marks

Question 10

Part	Scheme	Marks	AO
(a)	$f(2) = -9, f(3) = 6$	M1	AO1
	Sign change $\rightarrow$ root lies between $x=2$ and $x=3$	A1	AO1
(b)	$f'(x) = 3x^2 - 4$	B1	AO1
	$x_1 = 2.72881$	M1 A1	AO1
	$x_2 = 2.70675$	A1	AO1
	$x_3 = 2.70653$	A1	AO1
	Correct Newton-Raphson formula applied consistently	B1	AO1

Total for Question 10: 9 marks

Question 11

Part	Scheme	Marks	AO
(a)	Case 1: $2x-5 = x+4 \rightarrow x = 9$	M1 A1	AO1
	Case 2: $-(2x-5) = x+4 \rightarrow x = 1/3$	M1 A1	AO1
	Both checked as valid ($x+4 \geq 0$ in both cases)	A1	AO1

(b)	V-shaped graph of $y = 2x - 5 $ with vertex at (2.5, 0), correctly positioned relative to the line $y = x + 4$	M1 A1	AO1
	Intersection points marked at $x = 1/3$ and $x = 9$	A1	AO1

Total for Question 11: 8 marks

Question 12

Part	Scheme	Marks	AO
(a)	Separate variables: $\int V^{-1/2} dV = \int -0.5 dt$	M1	AO3
	$2\sqrt{V} = -0.5t + c$	A1	AO3
	At $t=0$, $V=100$: $c = 2\sqrt{100} = 20$	M1	AO3
	$2\sqrt{V} = 20 - 0.5t$ (shown)	A1	AO3
(b)	Tank empty when $V=0$: $0 = 20 - 0.5t$	M1	AO3
	$t = 40$ minutes	A1 A1	AO3

Total for Question 12: 8 marks

Indicative grade boundaries

Indicative guide only, based on recent Pearson Edexcel Pure Mathematics boundary trends (out of 100).

Grade	A*	A	B	C	D	E
Mark $\geq$	78	67	58	49	41	33