

INTERNATIONAL AS MATHEMATICS MA02

(9660/MA02) Unit PSM1 Pure Mathematics, Statistics and Mechanics

Mark scheme

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Key to mark scheme abbreviations

M	Mark is for method
m	Mark is dependent on one or more M marks and is for method
A	Mark is dependent on M or m marks and is for accuracy
B	Mark is independent of M or m marks and is for method and accuracy
E	Mark is for explanation
✓ or ft	Follow through from previous incorrect result
CAO	Correct answer only
CSO	Correct solution only
AWFW	Anything which falls within
AWRT	Anything which rounds to
ACF	Any correct form
AG	Answer given
SC	Special case
oe	Or equivalent
A2, 1	2 or 1 (or 0) accuracy marks
–x EE	Deduct x marks for each error
NMS	No method shown
PI	Possibly implied
SCA	Substantially correct approach
sf	Significant figure(s)
dp	Decimal place(s)
ISW	Ignore subsequent working

Q	Answer	Marks	Comments
1(a)	$[A =] \ 5$	B1	
	$[b =] \ 2$	B1	
		2	

Q	Answer	Marks	Comments
1(b)	$[\text{Period} =] \ 180^\circ$	B1ft	Condone missing units ft 360° divided by their b
		1	

Q	Answer	Marks	Comments
1(c)	$[Q] \ (315^\circ, -5)$	B1ft	Correct x -coordinate. Condone missing units ft 630° divided by their b
		B1	Correct y -coordinate
		2	

	Question 1 Total	5	
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Q	Answer	Marks	Comments
2(a)	$(17 - 3)^2 + ((-1) - (-5))^2$ or $\sqrt{(17 - 3)^2 + ((-1) - (-5))^2}$ $[PQ ^2 =] \ 212 \text{ or } [PQ =] \ 2\sqrt{53}$ $(\sqrt{106})^2 + (\sqrt{106})^2 = (2\sqrt{53})^2$ or $106 + 106 = 212$ and Since Pythagoras' Theorem is satisfied then angle $PRQ = 90^\circ$ and Therefore, PQ is a diameter of D	M1 A1 E1	oe Correct calculation for $PQ ^2$ or PQ unsimplified Correct value for $PQ ^2$ or PQ Accept $PQ = \sqrt{212}$ oe Shows lengths PR, QR and PQ satisfy Pythagoras' Theorem, states that Pythagoras' Theorem is satisfied, concludes angle $PRQ = 90^\circ$ and gives final conclusion
		3	

Q	Answer	Marks	Comments
2(b)	$\left(\frac{3+17}{2}, \frac{(-5)+(-1)}{2} \right) [= (10, -3)]$ $(x-10)^2 + (y+3)^2 = \frac{53}{4}$	M1 A2, 1	Oe Correct method for finding the centre of D PI A1: Correct LHS or RHS of equation in the correct form A2: Correct equation in the correct form
		3	

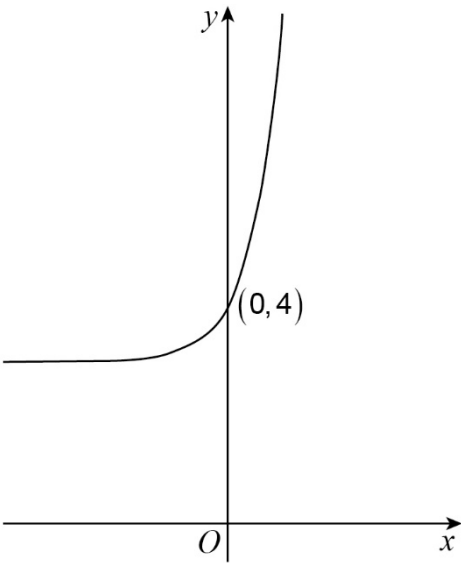
Q	Answer	Marks	Comments
2(c)	$y = -\frac{2}{7}x + \frac{51}{14}$ $[m' =] \frac{7}{2}$ $\left[y - (-3) = \frac{7}{2}(x - 10) \Rightarrow \right]$ $y = \frac{7}{2}x - 38$	M1 A1 A1	Correct rearrangement of equation of tangent at S PI Condone error in constant term oe Correct gradient of normal at S PI By correct final answer oe CAO
		3	
	Question 2 Total	9	

Q	Answer	Marks	Comments
3(a)	$\frac{ AD }{\sin \frac{\pi}{4}} = \frac{8\sqrt{6}}{\sin \frac{\pi}{3}}$ and $ AD = 16 \text{ cm}$	B1	oe Correct use of the Sine Rule and AG
		1	

Q	Answer	Marks	Comments
3(b)	$\left[\text{Arc Length} = r\theta \Rightarrow \theta = \frac{12}{16} = \right] \frac{3}{4} \text{ [radians]}$ $\left[\text{Area} = \right] \frac{1}{2} \times 7 \times 16 \times \sin \frac{3}{4}$ $\left[\text{Area} = \right] 38.2 \text{ [cm}^2\text{]}$	B1 M1 A1	oe Correct value for angle BAD Correct method for finding the area ft Their angle BAD CAO AWRT 38.2 Area = 38.17177...
		3	

Q	Answer	Marks	Comments
3(c)	$\left[BD ^2 = \right] 7^2 + 16^2 - 2 \times 7 \times 16 \times \cos \frac{3}{4}$ $\left[= 141.10169... \right]$ $\left[BD = \right] 11.9 \text{ [cm]}$	M1 A1	oe Correct use of the Cosine Rule. ft Their angle BAD CAO AWRT 11.9 $ BD = 11.87862...$
		2	

	Question 3 total	6	
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Q	Answer	Marks	Comments
4(a)		B1 B1	Exponential curve of the correct form in the first and second quadrants Correct coordinates or value of y-intercept
		2	

Q	Answer	Marks	Comments
4(b)(i)	$2 \times 6^{2x} - 10 \times 6^x - 27 = 6^x + 3$ or $2X^2 - 10X - 27 = X + 3$ $2X^2 - 11X - 30 = 0$ $[X =] \frac{15}{2}$ and $[X =] -2$ $6^x = -2$ or $x = \log_6[-2]$ not possible and So P and Q intersect at exactly one point	M1 A1 B1 E1	oe Starts to solve simultaneously and eliminates y to form a correct equation PI By correct simplified quadratic equation in X Correct quadratic equation in X in the correct form oe Gives both possible values of X oe Rejects -2 as a possible value and makes concluding statement Must have scored B1
		4	

Q	Answer	Marks	Comments
4(b)(ii)	$\left(\log_6 \frac{15}{2}, \frac{21}{2}\right)$	B2, 1	oe B1: One correct coordinate in exact form B2: Correct coordinates in exact form Condone not given as coordinates but must be clearly identified
		2	
	Question 4 Total	8	

Q	Answer	Marks	Comments
6	$[24 =] \log_n n^{24}$ $\log_n k^3 + \log_n (nx)^6 = \log_n (3x^2)^2 - 24$ $[\log_n k^3 (nx)^6 = \log_n (3x^2)^2 - 24 \Rightarrow]$ $24 = \log_n \left[\frac{(3x^2)^2}{k^3 (nx)^6} \right]$ or $30 = \log_n \left[\frac{(3x^2)^2}{k^3 x^6} \right]$ $[n^{24} k^3 (nx)^6 = (3x^2)^2]$ $\Rightarrow k^3 n^{30} x^6 = 9x^4 \Rightarrow$ $x^2 = \frac{9}{k^3 n^{30}}$ $x = \frac{3}{k^{\frac{3}{2}} n^{15}}$	B1 M1 M1 M1 A1	PI Writing 24 as its equivalent in $\log_n$ oe Correct use of a logarithm rule oe Correct use of logarithm rules to form an equation with a single logarithm term Condone $\log_n n^{24}$ for 24 oe $\log_n$ eliminated and term in x isolated CAO Any correct simplified form
		5	
	Question 6 Total	5	

Q	Answer	Marks	Comments
7(a)	$\frac{31}{269}$	B1	AWRT 0.115
		1	

Q	Answer	Marks	Comments
7(b)	$\frac{21+12+16+13+9+8+13}{269}$	M1	PI By correct calculation or correct answer Condone one omitted value or an error in one of the values in the numerator
	$\frac{92}{269}$	A1	AWRT 0.342
		2	

Q	Answer	Marks	Comments
7(c)	$\frac{9}{14+8+19+9}$	M1	PI By correct calculation or correct answer Condone one omitted value or an error in one of the values in the denominator
	$\frac{9}{50}$	A1	oe
		2	

	Question 7 Total	5	
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Q	Answer	Marks	Comments
8(a)	$\binom{12}{5} \times 0.4^5 \times (1-0.4)^{12-5}$ $= 0.227$	M1 A1	Correct calculation of probability PI By correct value oe Eg 0.6652 – 0.4382 AWRT 0.227
		2	

Q	Answer	Marks	Comments
8(b)(i)	[Mean = $12 \times 0.4 =$] 4.8	B1	
		1	

Q	Answer	Marks	Comments
8(b)(ii)	Standard deviation = $\sqrt{12 \times 0.4 \times (1-0.4)}$ $= 1.7$	B1	AG Must be convincingly shown
		1	

Q	Answer	Marks	Comments
8(b)(iii)	$P(X < 4.8 - 1.7) + P(X > 4.8 + 1.7)$ $= P(X \leq 3) + P(X \geq 7)$ $P(X \leq 3) + 1 - P(X \leq 6)$ $[= 0.2253 + 1 - 0.8418]$ 0.3835	M1 M1 A1	Identifies at least one correct probability for their mean and standard deviation Applies $P(X \geq x) = 1 - P(X \leq x - 1)$ oe
		3	

	Question 8 Total	7	
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Q	Answer	Marks	Comments
9(a)	$0.68 \times (1 - 0.68) = 0.2176$	B1	oe
		1	

Q	Answer	Marks	Comments
9(b)(i)	0.68×0.3	M1	Multiplies two probabilities together with at least one correct probability
	0.204	A1	oe
		2	

Q	Answer	Marks	Comments
9(b)(ii)	$22.0576 = 0.2176 + \text{Var}(Y)$	M1	Finds the correct value of $\text{Var}(Y)$ for their $\text{Var}(X)$ oe
	$\text{Var}(Y) = 21.84$		
	$\text{Var}(Y)$ $= 6^2 \times 0.1 + 11^2 \times 0.6 + 0.1c^2$ $- (6 \times 0.1 + 11 \times 0.6 + 0.1c)^2$	M1	Finds a correct unsimplified expression in terms of c for $\text{Var}(Y)$
	$\text{Var}(Y) = 0.09c^2 - 1.44c + 24.36$	A1	Correct expression for $\text{Var}(Y)$ in terms of c
	$0.09c^2 - 1.44c + 24.36 = 21.84$ $0.09c^2 - 1.44c + 2.52 = 0$	M1	Sets their $\text{Var}(Y)$ in terms of c equal to their $\text{Var}(Y)$ and rearranges to form a three term quadratic equation equal to zero
	$c = 14$	A1	If $c = 2$ is seen, it must be rejected
		5	

	Question 9 Total	8	
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Q	Answer	Marks	Comments
10(a)	$\mu R = 4g\mu = 39.2\mu$	M1	Friction found, may be embedded
	$F - \mu R = 4 \times 0.1$	A1	Allow $F = 0.4 + 4g\mu$
	$F = 0.4 + 39.2\mu$		
		2	

Q	Answer	Marks	Comments
10(b)	$4v = 40 \Rightarrow v = 10$	B1	or $v = -10$
	$a = \frac{0 - 10}{2} = -5$	M1	Ignore signs
	$-39.2\mu = 4 \times (-5)$	M1	
	$\mu = 0.51$	A1	AWRT 0.51
		4	

	Question 10 Total	6	
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Q	Answer	Marks	Comments
11	$[s_Q =] 35 - \frac{1}{2} \times 9.8 \times t^2$	M1	PI By $14t = 35$ Ignore signs
	$[s_P =] 14t - \frac{1}{2} \times 9.8 \times t^2$	M1	PI By $14t = 35$ Ignore signs
	$t = 2.5$	A1	Correct value of t
	$[y =] 14 \times 2.5 - \frac{1}{2} \times 9.8 \times 2.5^2$	M1	Uses their value of t in a correction formula for the height above ground of either particle
	or		
	$[y =] 35 - \frac{1}{2} \times 9.8 \times 2.5^2$		
	4.38 [m]	A1	AWRT 4.4
Question 11 Total		5	

Q	Answer	Marks	Comments
12(a)		B1 B1	Curved, continuous shape must extend below t axis and have a positive intercept with the vertical axis Clearly listed or labelled on diagram $(0, 3k)$ $(3, 0)$
		2	

Q	Answer	Marks	Comments
12(b)	$\left[\int a dt = \right] \int k(3 + 2t - t^2) dt$ $[v = k] \left(3T + T^2 - \frac{T^3}{3} \right)$ $\left(3T + T^2 - \frac{T^3}{3} \right) \left[- \left(3 \times 0 + 0^2 - \frac{0^3}{3} \right) \right] = 0$ $T^2 - 3T - 9 = 0$ $[T =] \frac{3 + 3\sqrt{5}}{2} \text{ [seconds]}$	M1 A1 M1 M1 A1	Clear intent to integrate with at least 2 terms correct (with or without k) PI Fully correct integration Their definite integral set equal to 0 Allow for $\int_0^T k(3 + 2t - t^2) dt = 0$ PI Reaches a quadratic factor leading to a value for T eg allow for $kt(t^2 - 3t - 9) = 0$ or similar PI Must be exact
		5	

Q	Answer	Marks	Comments
12(c)	$[v_{\max} =] k \left(3(3) + (3)^2 - \frac{(3)^3}{3} \right)$	M1	Uses $t = 3$ and their $\int a dt$ (possibly seen only in (b) to find v
	$[v_{\max} =] 9k \text{ [m s}^{-1}\text{]}$	A1	CAO
		2	
	Question 12 Total	9	