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

Mark scheme

June 2025

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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)	$[\text{Period} =]$ $180°$	**B1ft**	Condone missing units **ft** $360°$ divided by their b
		1	

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

	Question 1 Total	**5**	

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

Q	Answer	Marks	Comments
2(b)	$\left(\dfrac{3+17}{2}, \dfrac{(-5)+(-1)}{2}\right)$ $\left[=(10,-3)\right]$	M1	**Oe** Correct method for finding the centre of D **PI**
	$(x-10)^2 + (y+3)^2 = \dfrac{53}{4}$	A2, 1	**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)	$y = -\dfrac{2}{7}x + \dfrac{51}{14}$	M1	Correct rearrangement of equation of tangent at *S* **PI** Condone error in constant term
	$[m' =]\ \dfrac{7}{2}$	A1	**oe** Correct gradient of normal at *S* **PI** By correct final answer
	$\left[y - (-3) = \dfrac{7}{2}(x - 10) \Rightarrow\right]$ $y = \dfrac{7}{2}x - 38$	A1	**oe CAO**
		3	

| | Question 2 Total | 9 | |

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

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

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

		Marks	
	Question 3 total	**6**	

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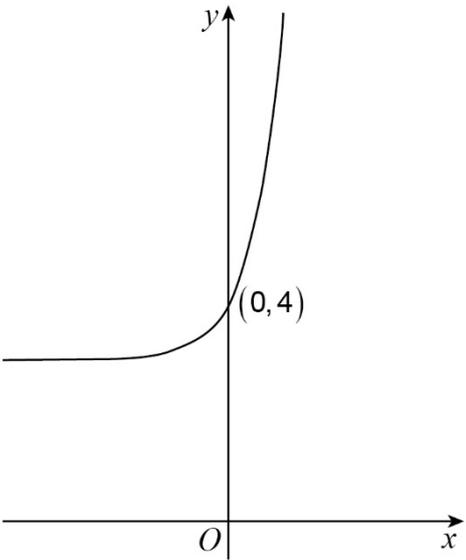
Q	Answer	Marks	Comments
4(b)(i)	$2 \times 6^{2x} - 10 \times 6^x - 27 = 6^x + 3$ or $2X^2 - 10X - 27 = X + 3$	**M1**	**oe** Starts to solve simultaneously and eliminates y to form a correct equation **PI** By correct simplified quadratic equation in X
	$2X^2 - 11X - 30 = 0$	**A1**	Correct quadratic equation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

Q	Answer	Marks	Comments
4(b)(ii)	$\left(\log_6 \dfrac{15}{2}, \dfrac{21}{2} \right)$	**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
5(a)	$\left[3\cos^2\theta + 5\sin\theta = 9\sin^2\theta \Rightarrow \right]$ $3\left(1 - \sin^2\theta\right) + 5\sin\theta = 9\sin^2\theta$	M1	**oe** Squaring both sides of the equation and use of $\sin^2\theta + \cos^2\theta = 1$
	$12\sin^2\theta - 5\sin\theta - 3 = 0$ and $\left(4\sin\theta - 3\right)\left(3\sin\theta + 1\right) = 0$	A1	Quadratic simplified and set equal to zero and **AG**
		2	

Q	Answer	Marks	Comments
5(b)	$4\sin\left(x - 25^\circ\right) - 3 = 0$ or $3\sin\left(x - 25^\circ\right) + 1 = 0$	M1	**oe** Condone θ used instead of $x - 25^\circ$
	$\left[\sin\left(x - 25^\circ\right) = \dfrac{3}{4} \Rightarrow\right]$ $\left[x - 25^\circ = \right]\ 48.5\left[9037...^\circ\right]$ and $\left[\sin\left(x - 25^\circ\right) = -\dfrac{1}{3} \Rightarrow\right]$ $\left[x - 25^\circ = \right]\ -19.4\left[7122...^\circ\right]$	A1	Both correct values rounded or truncated to 1 dp Condone omission of units
	$\left[x = \right]\ 73.6^\circ,\ 156.4^\circ,\ 5.5^\circ,\ 224.5^\circ$	B2, 1	**B2**: All four correct values given to 1 dp and no others **B1**: Two correct values given to 1 or more dp
		4	

Q	Answer	Marks	Comments
5(c)	$\left[x = \right]\ 73.6^\circ,\ 156.4^\circ$	B1	
		1	

	Question 5 Total	**7**	

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

	Question 6 Total	5	

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

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

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

	Question 7 Total	**5**	

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

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

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

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

	Question 8 Total	**7**	

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)	$22.0576 = 0.2176 + \mathrm{Var}(Y)$ $\mathrm{Var}(Y) = 21.84$	**M1**	Finds the correct value of $\mathrm{Var}(Y)$ for their $\mathrm{Var}(X)$ **oe**
	$\mathrm{Var}(Y)$ $= 6^2 \times 0.1 + 11^2 \times 0.6 + 0.1c^2$ $\quad -(6 \times 0.1 + 11 \times 0.6 + 0.1c)^2$	**M1**	Finds a correct unsimplified expression in terms of c for $\mathrm{Var}(Y)$
	$\mathrm{Var}(Y) = 0.09c^2 - 1.44c + 24.36$	**A1**	Correct expression for $\mathrm{Var}(Y)$ in terms of c
	$0.09c^2 - 1.44c + 24.36 = 21.84$ $0.09c^2 - 1.44c + 2.52 = 0$	**M1**	Sets their $\mathrm{Var}(Y)$ in terms of c equal to their $\mathrm{Var}(Y)$ 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**	

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

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

	Question 10 Total	**6**	

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

	Question 11 Total	**5**	

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

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

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

	Question 12 Total	9	