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

Mark scheme

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Version: V1 Final Mark Scheme

Mark schemes are prepared by the Lead Assessment Writer and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation events which all associates participate in and is the scheme which was used by them in this examination. The standardisation process ensures that the mark scheme covers the students' responses to questions and that every associate understands and applies it in the same correct way. As preparation for standardisation each associate analyses a number of students' scripts. Alternative answers not already covered by the mark scheme are discussed and legislated for. If, after the standardisation process, associates encounter unusual answers which have not been raised they are required to refer these to the Lead Examiner.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of students' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

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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)

Q	Answer	Marks	Comments
1(a)	$p-q$	**B1**	
1(b)	$\log_3\left(5^2\times 2\right)$ or $\log_3\left(5\times 5\times 2\right)$ $2\log_3 5+\frac{1}{2}\log_3 4$ or $\log_3 5+\log_3 5+\frac{1}{2}\log_3 4$ $2p+\frac{1}{2}q$	**B1** **M1** **A1**	PI Complete, correct application of log rules.
	Total	**4**	

Q	Answer	Marks	Comments
2(a)	$\frac{\sin\beta}{4}=\frac{3/7}{6}$ oe and $\sin\beta=4\times\frac{3/7}{6}$ oe $\sin\beta=\frac{2}{7}$	**M1** **A1**	Use of sine rule with values substituted and correct unsimplified rearrangement. AG
2(b)	$\cos^2\beta+\sin^2\beta=1$ $\cos^2\beta=\frac{45}{49}$ $\cos\beta=\frac{3\sqrt{5}}{7}$	**M1** **m1** **A1**	Stated or used, PI Correct substitution and rearrangement CSO
	Total	**5**	

Q	Answer	Marks	Comments
3(a)	$\left(\sqrt{17}\right)^2+\left(\sqrt{17}\right)^2$	**M1**	oe
	$\left(\left(\sqrt{17}\right)^2+\left(\sqrt{17}\right)^2=\right)34$	**A1**	
		B1	For correct LHS
	$(x-4)^2+(y-1)^2=34$	**B1ft**	ft their 34 provided M1 scored. Equation must be in the correct form
3(b)	$(x-1)^2+(y-3)^2=34$	**B2ft**	B1 for each correct bracketed term in an equation of the correct form or $(x-7)^2+(y+1)^2$ ft their 34
3 (c)	$(x-6)^2-36+(y-2)^2-4+2=0$	**M1**	Completes the square twice
	$\left((x-6)^2+(y-2)^2=\right)38$	**A1**	Finding correct radius squared for the circle. PI by correct radius.
	The two circles have different radii	**E1**	E1 for comparing radii in the context of the question. E1 for statement on Jane's claim.
	(Hence) Jane is not correct	**E1**	Stating she is not correct and giving a correct reason. No working seen scores E0E0
	Total	**10**	

Q	Answer	Marks	Comments
4	$3.6=\frac{1}{2}\times r^2\times 0.8$	**M1**	oe. Use of $A=\frac{1}{2}r^2\theta$
	$r=3$	**A1**	
	$OD=12$	**B1**	PI
	$\left(CD^2=\right)6^2+12^2-2\times6\times12\times\cos0.8$	**M1**	Correct substitution into Cosine Rule
	$\left(CD^2=\right)79.674233...$	**M1**	Correct order of evaluation to find CD^2
	$(CD=)\,8.93$	**A1**	AWRT
	Total	**6**	

Q	Answer	Marks	Comments
5(a)	Exponential curve and increasing function in the first and second quadrants with the correct form, asymptotic to the negative x –axis from above.	**B1**	
	15 marked on y-intercept of curve on positive y –axis.	**B1**	Condone correct coordinates
5(b)	$\log_5\left(15\times 7^x\right)=\log_5 625^{2x}$	**M1**	Forms correct equation in x. Condone missing 5 in $\log_5$
	$\log_5 15+\log_5 7^x$	**M1**	Correct use of $\log(ab)=\log(a)+\log(b)$ Condone missing 5 in $\log_5$
	$x\log_5 7$ or $2x\log_5 625$ or $8x\log_5 5$ or $4x\log_5 25$ or $8x$	**M1**	Correct use of $\log\left(a^b\right)=b\log(a)$ for at least 1 term. Condone missing 5 in $\log_5$
	$1+\log_5 3+x\log_5 7=8x$	**A1**	Completely correct unsimplified linear equation in x with $\log_5 5$ replaced by 1 Condone missing 5 in $\log_5$
	$x\left(8-\log_5 7\right)=1+\log_5 3$	**M1**	Correct rearrangement of their equation with x factorised out. Must be seen as an equation. Condone missing 5 in $\log_5$
	$x=\dfrac{1+\log_5 3}{8-\log_5 7}$	**A1**	Must see all 5s in $\log_5$
	Total	**8**	

Q	Answer	Marks	Comments
6	$5\sin x(3\cos x-2)$ or $4(3\cos x-2)$ or $4(2-3\cos x)$	**M1**	Attempt at one factorisation.
	$5\sin x(3\cos x-2)=4(2-3\cos x)$ or $5\sin x(3\cos x-2)+4(3\cos x-2)=0$	**M1**	Both sides of equation factorised correctly. Maybe sum of two brackets set equal to zero
	$(5\sin x+4)(3\cos x-2)=0$	**A1**	Factorised form set equal to zero. PI by $5\sin x+4=0$ and $3\cos x=2$
	$\sin x=-\frac{4}{5}$ $\cos x=\frac{2}{3}$	**m1** **A1**	**m1** for one correct **A1** for both correct PI by $x=-0.927$ or -2.214 (or more accurate) PI by $x=0.841$ or -0.841 (or more accurate)
	$x=-0.927,\ -2.214,\ 0.841,\ -0.841$	**B2**	Condone more accurate answers. $(-0.927295...,\ -2.21429...,\ \pm 0.841068...)$ **B2** for exactly 4 answers to the correct accuracy **B1** for at least 2 answers to the correct accuracy Ignore answers outside of the interval. If more than two answers for each inside the interval, -1 for each extra from Bs to a min of 0.
	Total	**7**	

Q	Answer	Marks	Comments
7(a)	0.251	**B1**	AWRT
7(b)	P(W < 3) = P(W ≤ 2) = 0.167	**M1** **A1**	Attempts to find correct probability Allow for 0.833 AWRT
7(c)	Not a good model, … Probability of winning unlikely to be constant from game to game	**E1** **E1**	Concludes not a good model and any reason, even incorrect Comment about probability not being constant or winning in one match unlikely to be independent of winning in another match
	Total	**5**	

Q	Answer	Marks	Comments
8(a)	E(Y^2) = $(3 \times 1^2 + 1)^2 \times 0.4$ + $(3 \times 2^2 + 2)^2 \times 0.25$ + $(3 \times 3^2 + 3)^2 \times 0.35$ Var(Y) = E(Y^2) – (E(Y))^2 = $370.4 – 15.6^2$ = 127.04	**M1** **M1** **A1**	Applies formula for E(Y^2) Implied by sight of 370.4 or 1852/5 oe Applies formula for Var(Y) Condone applied to X instead Accept 3176/25 oe
8(b)	Var(0.5Y – 6) = 0.5^2 Var(Y) = 31.76	**M1** **A1ft**	Applies formula for Var (aY + b) Accept 794/25 oe Follow through their Var (Y)
8(c)	$E\left(\sum_{i=1}^{3} Y_i\right)$ = 3E(Y) = 46.8	**M1** **A1**	Applies formula for $E\left(\sum_{i=1}^{3} Y_i\right)$ PI
	Total	**7**	

Q	Answer	Marks	Comments
9(a)	$P(B \cup S) = 0.7$ $P(S) = 0.4$	B1	States $P(B \cup S)$ and $P(S)$ Accept $P(B \cup S) = 7/10$ oe and $P(S) = 4/10$ oe Also award for $P(S) = 0.4$ and number of customers going to the bank and supermarket is 35 (35 might be implied by Venn diagram)
	$P(B \cap S) = 0.04$	B1	$P(B \cap S) = 2/50$ oe
	$P(B \cup S) = P(B) + P(S) - P(B \cap S)$ $0.7 = P(B) + 0.4 - 0.04$	M1	Uses Addition formulae to find $P(B)$ Also award for number of customers going to the bank $= 35 - 20 + 2 = 17$
	$P(B) = 0.34$	A1	Accept 17/50 oe
	$P(B) \times P(S) = 0.34 \times 0.4 = 0.136$	A1ft	Multiplies $P(B)$ and $P(S)$ Follow through their $P(B)$ and $P(S)$
	$P(B \cap S) \neq P(B) \times P(S)$ Therefore events B and S are not independent	E1	Mathematically statement of dependence and conclusion
9(b)	$P(S \mid B') = \frac{20-2}{20-2+15}$ or $\frac{0.36}{0.66}$	M1	Applies conditional probability formula
	$= \frac{6}{11}$	A1	OE Do not accept rounded decimals
	Total	**8**	

Q	Answer	Marks	Comments
10	$10.4 = 0.4 \times v - 0.4 \times (-20)$ $v = 6$	**M1** **A1**	Allow for $10.4 = 0.4 \times v - 0.4 \times (20)$
	Total	**2**	

Q	Answer	Marks	Comments
11(a)	$2 + 36t - 6t^2$	B2	Three term expression with one error scores B1.
11(b)	$36 - 12t = 0$ $t = 3$ $7 + 2(3) + 18(3^2) - 2(3^3) \quad (= 121)$ $121 - 7$ 114	M1 A1ft M1 M1 A1	Differentiating their v and setting equal to zero or attempt to complete the square to obtain $a(t-3)^2 + b$. For value of t for which v is a maximum. ft their v from part (a) provided B1 scored. Substituting their $t = 3$ into the expression for the displacement Subtracting 7 from their displacement at $t = 3$ CAO
	Total	**7**	

Q	Answer	Marks	Comments
12(a)	$R - 2g = 10$	**M1**	Three term equation of motion ignoring signs with $20g$ or 196 and 20×0.5 or 10
	$R = 206$	**A1**	For correct R
12(b)	$11000 - (900 + 20x)g = 0.5(900 + 20x)$ or $11000 - (900 + 20x)g \geq 0.5(900 + 20x)$	**M1**	oe. Equation of motion, ignoring signs, including consideration of total mass of lift and x boxes. May be seen as an inequality, ignoring signs. Condone $>$
		A1	Correct equation or inequality. Condone $>$
	$10x + 20gx = 11000 - 900g - 450$ or $10x + 20gx \leq 10550 - 900g$	**M1**	oe. Simplification of their equation or inequality isolating terms in x on one side and constant terms on the other. Condone $<$
	$(x =)\ 8.39...$ or $x \leq 8.39...$	**A1**	AWRT 8.4 Condone truncated to 8.3 PI by 8 in correct concluding statement If working with inequalities correct inequality must be seen here. Condone $<$
	8 boxes	**E1**	Correct statement including whole number of boxes dependent upon correct working seen.
12(b) ALT	$11000 - \mathrm{M}g = 0.5M$ or $11000 - \mathrm{M}g \geq 0.5M$	**M1**	oe. Equation of motion, ignoring signs, including consideration of total mass of lift and boxes M. May be seen as an inequality, ignoring signs. Condone $>$
		A1	Correct equation or inequality. Condone $>$
	$(M =)\ 1067.96...$ or $(M \leq)\ 1067.96...$	**M1**	AWRT 1068 Solving equation or inequality for M
	$(x =)\ 8.39...$ or $x \leq 8.39...$	**A1**	AWRT 8.4 For number of boxes unrounded. Condone truncated to 8.3 PI by 8 in correct concluding statement If working with inequalities correct inequality must be seen here. Condone $<$
	8 boxes	**E1**	Correct statement including whole number of boxes dependent upon correct working seen.
	Total	**7**	

Q	Answer	Marks	Comments
13	(Displacement =) -75 or 75	**B1**	Both values. PI by later working. Recognises that displacement could be ± 75
	$3\times 10+\frac{1}{2}\times a\times 10^2=75$ or $3\times 10+\frac{1}{2}\times a\times 10^2=-75$	**M1**	Use of constant acceleration formula to gain at least one correct equation. Values substituted but need not be evaluated.
	$a=0.9$	**A1**	oe
	$a=-2.1$	**A1**	oe
	Total	**4**	