

# INTERNATIONAL AS MATHEMATICS

## MA02

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

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Mark scheme

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**Key to mark scheme abbreviations**

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

Q	Answer	Marks	Comments
1(a)		<p><b>B1</b></p> <p><b>B1</b></p> <p><b>B1</b></p>	<p>Positive exponential curve of the correct form passing through the third, fourth and first quadrants</p> <p>Correct value of <math>x</math>-intercept provided a graph is drawn. Condone given as coordinates</p> <p><b>oe</b> Correct value of <math>y</math>-intercept provided a graph is drawn. Condone given as coordinates</p>
		<b>3</b>	

Q	Answer	Marks	Comments
1(b)	$[10 = 2^{k-3} - 4 \Rightarrow 2^{k-3} = 14 \Rightarrow]$ $k - 3 = \log_2 14 \text{ or } (k - 3)\log_a 2 = \log_a 14$ <p>or</p> $2^k \times \frac{1}{8} = 14$ $[k = 3 + \log_2 14 \Rightarrow]$ $[k = ] \log_2 8 + \log_2 14 \text{ or } k - \log_2 8 = \log_2 14$ <p>or</p> $2^k = 112$ $[k = ] \log_2 112$	<p><b>M1</b></p> <p><b>M1</b></p> <p><b>A1</b></p>	<p><b>oe PI</b>  <math>x = k</math> and <math>y = 10</math> substituted and logarithms used to form a linear equation in <math>k</math> with at least one side correct.                      or  <math>x = k</math> and <math>y = 10</math> substituted with use of index rule to write as an equation in <math>2^k</math>                      Condone <math>x</math> used for <math>k</math> throughout</p> <p><b>oe PI</b>                      Substitutes <math>\log_2 8</math> for 3 to obtain a correct equation.                      or                      Correct value of <math>2^k</math></p> <p><b>CAO</b>                      Must be in the correct form</p>
		<b>3</b>	

	<b>Question 1 Total</b>	<b>6</b>	
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Q	Answer	Marks	Comments
2(a)	$\frac{1}{2} \times 6^2 \times \theta = 16.2$	M1	oe Forms correct equation using $\frac{1}{2}r^2\theta$
	$\theta = \frac{16.2}{18}$ and $\theta = 0.9$	A1	oe Correct calculation with $\theta$ as subject leading to <b>AG</b>
		2	

Q	Answer	Marks	Comments
2(b)(i)	[Area of Triangle $ACD =$ $\frac{1}{2} \times 6 \times 14 \times \sin 0.9$	M1	oe Correct method for calculating the area with values substituted. PI by correct area of the triangle or correct final answer.
	[Area of Triangle $ACD =$ $32.89973... \text{ [cm}^2\text{]}$	A1	CAO AWRT 32.9 PI by correct final answer.
	[Shaded Area = $32.89973... - 16.2 =$ $16.7 \text{ [cm}^2\text{]}$	A1ft	CAO AWRT 16.7 ft their area of the triangle provided M1 scored.
		3	

Q	Answer	Marks	Comments
2(b)(ii)	$[r\theta = 6 \times 0.9 =] 5.4 \text{ [cm]}$  $[ CD ^2] = 6^2 + 14^2 - 2 \times 6 \times 14 \times \cos 0.9$ or $[ CD ^2] = 36 + 196 - 168 \cos 0.9$  $[ CD  = \sqrt{127.56952...}] = 11.29466... \text{ [cm]}$  $[\text{Perimeter} = 11.29466... + 5.4 + (14 - 6) =]$ $24.7 \text{ [cm]}$	<p><b>B1</b></p> <p><b>M1</b></p> <p><b>A1</b></p> <p><b>A1</b></p>	<p>Correct length of arc <math>BD</math> <b>PI</b> by correct final answer.</p> <p><b>oe</b> Correct application of the Cosine Rule with values substituted. <b>PI</b> by correct length of <math>CD</math> or 127.56... or correct final answer.</p> <p>Correct length of <math>CD</math> <b>AWRT</b> 11.3 <b>PI</b> by correct final answer.</p> <p>Correct perimeter <b>AWRT</b> 24.7</p>
		<b>4</b>	
	<b>Question 2 Total</b>	<b>9</b>	

Q	Answer	Marks	Comments
3(a)	$\left[ \left( \frac{9+12}{2}, \frac{5+2}{2} \right) = \right] \left( \frac{21}{2}, \frac{7}{2} \right)$ $\left[ \left( \frac{5-2}{9-12} \right) = \right] -1$ $y - \frac{7}{2} = x - \frac{21}{2} \text{ or } y = x - 7$ or $\frac{7}{2}$ $\frac{21}{2} - x$ $[y=0 \Rightarrow] -\frac{7}{2} = x - \frac{21}{2} \text{ and } x = 7$ or $[y=0 \Rightarrow] 0 = x - 7 \text{ and } x = 7$ or $\frac{7}{\frac{21}{2} - x} = 1 \Rightarrow x = 7$	<p><b>B1</b></p> <p><b>B1</b></p> <p><b>M1</b></p> <p><b>A1</b></p>	<p><b>oe</b> Correct mid-point of <math>QR</math></p> <p>Correct gradient of <math>QR</math> <b>PI</b> in later working</p> <p><b>oe</b> Correct equation of the perpendicular bisector of <math>QR</math> <b>ACF</b> or Correct expression for the gradient of the line from the mid-point of <math>QR</math> to <math>P</math></p> <p><b>oe</b> Indicates <math>y = 0</math> implies <math>x = 7</math> Could see <math>y = 0</math> substituted into the equation of the perpendicular bisector of <math>QR</math> or Sets the expression for the gradient of the line from the mid-point of <math>QR</math> to <math>P</math> equal to 1 and states <math>x = 7</math></p> <p>Must be convincingly shown</p>
		<b>4</b>	

Q	Answer	Marks	Comments
3(b)(i)	$(17, 4)$ $[r^2 =] (9-7)^2 + 5^2 \text{ or } [r =] \sqrt{(9-7)^2 + 5^2}$ or $[r^2 =] (12-7)^2 + 2^2 \text{ or } [r =] \sqrt{(12-7)^2 + 2^2}$ $(x-17)^2 + (y-4)^2 = 29$	<p><b>B1</b></p> <p><b>M1</b></p> <p><b>A2,1</b></p>	<p>Correct centre of <math>C_2</math></p> <p>Correct method for finding the radius or the square of the radius of <math>C_1</math> <b>PI</b> by <math>[r^2 =] 29</math> or <math>[r =] \sqrt{29}</math></p> <p><b>A1:</b> Correct LHS of equation in the correct form <b>A2:</b> Correct equation in the correct form</p>
		<b>4</b>	

Q	Answer	Marks	Comments
3(b)(ii)	Translation  $\begin{bmatrix} 10 \\ 4 \end{bmatrix}$	E1  E1ft	Transformation named  Correct vector. ft Their equation of $C_2$ from part (b)(i)
		2	
	<b>Question 3 total</b>	<b>10</b>	







Q	Answer	Marks	Comments
5(b)	$\left[ \log_7 \frac{216}{5} = \right] \log_7 216 - \log_7 5$ $[\log_7 216 - \log_7 5 =]$ $\log_7 6^3 - \log_7 625^{\frac{1}{4}}$ $3\log_7 6 - \frac{1}{4}\log_7 625$ $\left[ \log_7 \frac{216}{5} = \right] 3q - \frac{1}{4}p$	<p><b>M1</b></p> <p><b>M1</b></p> <p><b>M1</b></p> <p><b>A1</b></p>	<p><b>oe</b> Correctly expressing <math>\log_7 \frac{216}{5}</math> as the difference between two logarithms</p> <p><b>oe PI</b></p> <p>Correct expression for <math>\log_7 \frac{216}{5}</math> with powers of 6 and 625 substituted</p> <p><b>oe PI</b></p> <p>Correct expression using the multiple property of logarithms with both terms</p> <p><b>CAO</b></p>
5(b) Alt	$\left[ \log_7 \frac{216}{5} = \right] \log_7 216 - \log_7 5$ $[\log_7 216 =] \log_7 6^3$ and $[\log_7 625 =] \log_7 5^4$ or $[\log_7 5 =] \log_7 625^{\frac{1}{4}}$ $[\log_7 216 =] 3\log_7 6$ and $[\log_7 625 =] 4\log_7 5$ or $[\log_7 5 =] \frac{1}{4}\log_7 625$ $\left[ \log_7 \frac{216}{5} = \right] 3q - \frac{1}{4}p$	<p><b>M1</b></p> <p><b>M1</b></p> <p><b>M1</b></p> <p><b>A1</b></p>	<p><b>oe</b> Correctly expressing <math>\log_7 \frac{216}{5}</math> as the difference between two logarithms</p> <p><b>oe PI</b></p> <p>Correct expression for <math>\log_7 216</math> with power substituted.</p> <p>And</p> <p>Correct expression for <math>\log_7 625</math> or <math>\log_7 5</math> with power substituted.</p> <p><b>oe PI</b></p> <p>Correct expressions using the multiple property of logarithms.</p> <p><b>CAO</b></p>
		<b>4</b>	
	<b>Question 5 Total</b>	<b>7</b>	

Q	Answer	Marks	Comments
6(a)	$\left[ \binom{40}{6} \times 0.09^6 \times (1-0.09)^{40-6} = \right]$ 0.0826	B1	AWRT 0.0826
		1	

Q	Answer	Marks	Comments
6(b)	[P(Number of customers > 4) = 1 – P(Number of customers ≤ 4)]  1 – 0.7103  0.2897	M1   A1	PI By correct answer.   AWRT 0.2897
		2	

Q	Answer	Marks	Comments
6(c)(i)	[Var(Monday) = $40 \times 0.09 \times (1 - 0.09) =$ ] 3.276 [Var(total) = $3.276 + 2.3751 + 2.1294 =$ ] 7.7805	M1   A1	PI Finds variance for first day AWRT 3.28  oe AWRT 7.78
		2	

Q	Answer	Marks	Comments
6(c)(ii)	$\frac{7.7805}{0.09(1-0.09)}$ or $\frac{7.7805}{0.0819}$  95	M1   A1	oe Divides their 7.7805 by $0.09(1 - 0.09)$  CAO
		2	

	<b>Question 6 Total</b>	<b>7</b>	
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Q	Answer	Marks	Comments
7(a)	$\frac{P(R \cap C')}{P(C')} = \frac{23}{36}$	<b>M1</b>	Forms a correct equation with $P(R \cap C')$
	$P(R \cap C') = \frac{23}{36} \left(1 - \frac{17}{23}\right) = \frac{1}{6}$	<b>A1</b>	Finds correct value of $P(R \cap C')$
	$P(R \cap C) = P(R) - P(R \cap C') = \frac{1}{6} - \frac{1}{6}$ or $\frac{1}{6} = \frac{1}{6}$ or $P(R) = P(R \cap C')$ or $P(R \cap C) = 0$	<b>m1</b>	States and uses correct identity <b>oe PI</b>
	So they are mutually exclusive	<b>A1</b>	Gives correct conclusion.
		<b>4</b>	

Q	Answer	Marks	Comments
7(b)	$\frac{1}{6} + \frac{5}{7} - \frac{9}{50}$	<b>M1</b>	Correct calculation <b>PI</b>
	$\frac{368}{525}$	<b>A1</b>	<b>oe</b> <b>AWRT 0.701</b>
		<b>2</b>	

	<b>Question 7 Total</b>	<b>6</b>	
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Q	Answer	Marks	Comments
8(a)	$k + 5k + 9k + 14k = 1$	M1	Forms correct equation PI
	$k = \frac{1}{29}$	A1	Sight of $\frac{1}{29}$ oe
	$1 \times \frac{1}{29} + 5 \times \frac{5}{29} + 9 \times \frac{9}{29} + 14 \times \frac{14}{29}$	M1	Correct calculation for the mean for their $k$ or correct expression in terms of $k$
	Mean = $\frac{303}{29}$	A1	AG Correct calculation must be seen before final answer
		4	

Q	Answer	Marks	Comments
8(b)	$E(B) = 1 - \frac{11}{16} = \frac{5}{16}$	B1	oe
	$\frac{303}{29} + \frac{5}{16} + E(C) = 11$	M1	Correct equation to find $E(C)$ or correct expression for $E(C)$ using their $E(B)$
	$E(C) = \frac{111}{464}$	A1	AWRT 0.239
		3	

	<b>Question 8 Total</b>	<b>7</b>	
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Q	Answer	Marks	Comments
9	$0.7g - T = 0.7a$ $T - 0.4g = 0.4a$  $0.7g - 0.4g = 1.1a$  $a = 2.7 \text{ [m s}^{-2}\text{]}$	<b>M1</b>   <b>M1</b>   <b>A1</b>	<b>PI oe</b> Condone LHS of both multiplied by $-1$ or award for one correct equation.  <b>oe</b> Correct equation with $T$ eliminated <b>PI</b> by correct final answer.  <b>AWRT</b> 2.7, accept $\frac{147}{55}$
	<b>Question 9 Total</b>	<b>3</b>	



Q	Answer	Marks	Comments
<b>10(b)</b>	$\left[ \int v dt = \right] -\frac{1}{6}t^3 + \frac{19}{20}t^2$	<b>M1</b>	Allow one error in a coefficient <b>PI</b>
	$\left[ \int_0^2 v dt = \right] \left( -\frac{1}{6}(2)^3 + \frac{19}{20}(2)^2 \right) [- (0)]$	<b>M1</b>	Use of $t = 2$ with their integrated expression <b>PI</b>
	$\left[ \int_0^2 v dt = \right] \frac{37}{15}$	<b>A1</b>	<b>PI</b> by correct final answer. <b>AWRT 2.47</b>
	$[\text{Average speed} =] \frac{37}{30} \text{ [m s}^{-1}\text{]}$	<b>A1</b>	<b>AWRT 1.2</b>
		<b>4</b>	



Q	Answer	Marks	Comments
11(a)	$[I = ] 2 \times 12 - 2v$	<b>M1</b>	Condone $2v - 2 \times 12$ <b>PI</b> By correct lower or upper bound in the final answer.
	$[0 < v \leq 4]$ $16 \leq I < 24$	<b>A1</b>	Condone $16 < I < 24$
		<b>2</b>	

Q	Answer	Marks	Comments
11(b)	$2 \times 12 - 2mq = 2v + 4m$	<b>M1</b>	Correct equation.
	$v = 12 - 2m - mq$ or $v = 12 - m(2 + q)$	<b>m1</b>	Correctly rearranges to make $v$ the subject of the equation. Could be seen in an inequality but if so must be unsimplified.
	or $0 < 12 - 2m - mq \leq 4$ $0 < 12 - m(2 + q) \leq 4$	<b>A1</b>	<b>AG</b> Must be convincingly shown
		<b>3</b>	

