

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)	$[P](0^\circ, -2)$	B1	Condone omission of units.
	$[Q](30^\circ, 0)$	B1	Condone omission of units. Allow $\left(\frac{\pi}{6}, 0\right)$
	$[R](300^\circ, -4)$	B1	If first two B1 marks not awarded, then allow SC1 for -2 for P and 30° for Q Condone omission of units. Allow $\left(\frac{5\pi}{3}, -4\right)$
		3	

Q	Answer	Marks	Comments
1(b)	Translation	E1	Correct single transformation named and no others
	$\begin{bmatrix} -105^\circ \\ 0 \end{bmatrix}$ or $\begin{bmatrix} 255^\circ \\ 0 \end{bmatrix}$	E1	oe Condone omission of units. Allow $\begin{bmatrix} -\frac{7\pi}{12} \\ 0 \end{bmatrix}$ or $\begin{bmatrix} \frac{17\pi}{12} \\ 0 \end{bmatrix}$ If more than one transformation described, then award E0 E0
		2	

	Question 1 Total	5	
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Q	Answer	Marks	Comments
2(a)	$\frac{22-7}{3-(-2)} [= 3]$ $3 \times -\frac{1}{2} \neq -1$ or $-\frac{3}{2} \neq -1$ or $-\frac{1}{3} \neq -\frac{1}{2}$ and AD is not a diameter [of C_1]	B1 E1ft	oe Correct unsimplified expression for the gradient of AB PI by correct gradient Shows or explains that the gradients are not perpendicular followed by a correct deduction ft their gradient of AB provided it is not equal to 2
		2	

Q	Answer	Marks	Comments
2(b)(i)	$\left(\frac{(-2)+18}{2}, \frac{7+17}{2} \right) = (8, 12)$	B1	oe Correct unsimplified coordinates of the midpoint of AE and AG
		1	

Q	Answer	Marks	Comments
2(b)(ii)	$[r^2 =] (18-8)^2 + (17-12)^2$ or $[r^2 =] (3-8)^2 + (22-12)^2$ or $[r^2 =] ((-2)-8)^2 + (7-12)^2$ $[r^2 =] 125$ or $[r =] 5\sqrt{5}$ or $\sqrt{125}$ $(x-8)^2 + (y-12)^2 = 125$	M1 A1 A1ft	oe Correct use of Pythagoras' Theorem PI by $r = 5\sqrt{5}$ or $r^2 = 125$ Correct value for r^2 or r ft their r^2
		3	

Q	Answer	Marks	Comments
2(c)	$[m =] \frac{22-12}{3-8} [= -2]$ $y - 22 = -2(x - 3)$ <p>or</p> $y - 12 = -2(x - 8)$ <p>or</p> $y = -2x + 28$ $[y = 0 \Rightarrow x = 14]$ $(14, 0)$	<p>M1</p> <p>A1</p> <p>A1</p>	<p>Correct method for finding the gradient of the normal PI in later working</p> <p>Correct equation of normal in any form, simplified or unsimplified May use $y = 0$ PI by correct final coordinates</p> <p>CAO Condone x-coordinate given only</p>
		3	

Q	Answer	Marks	Comments
2(d)	$(x-11)^2 + (y-7)^2 = 125$	B2ft	B2ft: Answer in the correct form, ft their k from part(b)(ii) Award B1ft for one correct bracketed term in an equation of the correct form set equal to their k from part(b)(ii)
		2	

	Question 2 Total	11	
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Q	Answer	Marks	Comments
3(a)	$(x-12)^2 \dots$ or $(y-10)^2 \dots$ $(x-12)^2 - 12^2 + (y-10)^2 - 10^2 + 163 [=0]$ or $(x-12)^2 - 144 + (y-10)^2 - 100 + 163 [=0]$ or $(x-12)^2 + (y-10)^2 = 81$ $[PQ = \sqrt{81} =] \quad 9$ $\frac{1}{2} \times 9 \times 9 \times \sin\theta = 20.25$ $\theta = \sin^{-1}\left(\frac{1}{2}\right)$ or $\sin\theta = \frac{1}{2}$ and $\theta = \frac{5\pi}{6}$	M1 M1 A1 M1 A1	 oe Correctly completes both squares simplified or unsimplified CAO PI in later working. oe Forms correct equation using formula for the area of a triangle ft their $ PQ $ Finds value for $\sin\theta$ and AG For $\frac{1}{2}$ accept 0.5
		5	

Q	Answer	Marks	Comments
3(b)	$\left[9 \times \frac{5\pi}{6} = \right] \frac{15\pi}{2} \text{ or } 23.5[6194\dots]$	B1ft	oe Correct arc length of QR ft their $ PQ $ from part (a) AWRT 23.6 PI by correct final answer.
	$\left[QR ^2 = \right]$ $9^2 + 9^2 - 2 \times 9 \times 9 \times \cos\left(\frac{5\pi}{6}\right)$ $\left[= 302.2[9611\dots]\right]$	M1	oe ft their $ PQ $ from part (a) Correct use of the Cosine Rule or Sine Rule Condone use of $\frac{\pi}{6}$ or 30°
	or $162 - 162 \cos\left(\frac{5\pi}{6}\right)$		
	or $\left[QR = \right] \frac{9 \sin\left(\frac{5\pi}{6}\right)}{\sin\left(\frac{\pi}{12}\right)}$		
	$\left[QR = \right] 17.3[8666\dots]$	A1	Correct value AWRT 17.4 PI by correct final answer.
	40.9	A1	AWRT 40.9 Condone 41.0 as final answer
		4	
	Question 3 total	9	

Q	Answer	Marks	Comments
4(a)	$\left[6^{3t-1} = \frac{27}{8} \Rightarrow \right]$ $3t - 1 = \log_6 \left(\frac{27}{8} \right)$ $\left[\frac{1}{3} \log_6 \left(\frac{27}{8} \right) = \right] \log_6 \left(\frac{27}{8} \right)^{\frac{1}{3}}$ $[t =] \frac{1}{3} + \log_6 \left(\frac{3}{2} \right)$	<p>M1</p> <p>M1</p> <p>A1</p>	<p>oe Correct equation with use of $\log_6 6^k = k$</p> <p>Use of a logarithm property PI, oe</p> <p>CAO</p>
		3	

Q	Answer	Marks	Comments
4(b)(i)	$[y =] \log_{10} x^2 \quad [+ \log_{10} (x + 5)]$ $[y =] \log_{10} (x^2 (x + 5))$ <p>and</p> $y = \log_{10} (x^3 + 5x^2)$	<p>M1</p> <p>A1</p>	<p>Use of log property for powers PI</p> <p>Use of log property for addition AG Must be convincingly shown</p>
		2	

Q	Answer	Marks	Comments
4(b)(ii)	$[m =] \frac{\log_{10} (396) - \log_{10} (144)}{6 - 4}$ $[m =] \frac{\log_{10} \left(\frac{11}{4} \right)}{2}$ $[m =] \log_{10} \left(\frac{1}{2} \sqrt{11} \right)$	<p>M1</p> <p>M1</p> <p>A1</p>	<p>oe Expression for the gradient with values substituted PI</p> <p>oe Use of logarithm property Accept fractions equivalent to $\frac{11}{4}$</p> <p>Correct answer in correct form A1 dependent upon both method marks scored</p>
		3	

	Question 4 Total	8	
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Q	Answer	Marks	Comments
5(a)	$7\tan^2x - \tan x = \frac{6}{\cos^2x}$ $\sin^2x - \sin x \cos x - 6\cos^2x = 0$ or $7\tan^2x - \tan x = \frac{6(\sin^2x + \cos^2x)}{\cos^2x}$ or $7\tan^2x - \tan x = 6(\tan^2x + 1)$ or $7\sin^2x - \sin x \cos x = 6(\sin^2x + \cos^2x)$ $\tan^2x - \tan x - 6 = 0$ and $(\tan x - 3)(\tan x + 2) = 0$	<p>M1</p> <p>M1</p> <p>A1</p>	<p>oe Use of $\tan x = \frac{\sin x}{\cos x}$ to obtain terms in $\tan x$ and \tan^2x</p> <p>oe Use of $\sin^2x + \cos^2x = 1$</p> <p>Simplified quadratic equation set equal to zero</p> <p>AG Must be convincingly shown</p>
		3	

[illegible]

Q	Answer	Marks	Comments
6(a)	8	B1	CAO
		1	

Q	Answer	Marks	Comments
6(b)	30	B1	CAO
		1	

Q	Answer	Marks	Comments
6(c)	9	B1	CAO
		1	

Q	Answer	Marks	Comments
6(d)	$1+6+4+3+\text{Var}(X_5)=39$ or $[\text{Var}(X_5)=] \ 25$ $[\text{SD}(X_5)=] \ 5$	M1 A1	PI by correct final answer CAO Accept $\sqrt{25}$
		2	

	Question 6 Total	5	
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Q	Answer	Marks	Comments
7(a)(i)	Bernoulli	B1	Accept binomial
		1	

Q	Answer	Marks	Comments
7(a)(ii)	$E(X) = 0.286$	B1	
		1	

Q	Answer	Marks	Comments
7(b)(i)	$\text{Var}(Y) = 5 \times \frac{1}{6} \left(1 - \frac{1}{6} \right)$ $\text{Var}(Y) = \frac{25}{36}$	M1 A1	oe $np(1-p)$ with correct values substituted PI by correct final answer AWRT 0.694
		2	

Q	Answer	Marks	Comments
7(b)(ii)	$P(Y=2) = \binom{5}{2} \left(\frac{1}{6} \right)^2 \left(\frac{5}{6} \right)^3$ $P(Y=2) = \frac{625}{3888}$	M1 A1	oe Correct calculation PI by correct answer AWRT 0.161
		2	

Q	Answer	Marks	Comments
7(c)	$0.286 \times \frac{625}{3888}$ $= \frac{715}{15552}$	M1 A1ft	$0.286 \times$ their answer to part (b)(ii) PI by correct final answer. AWRT 0.046 ft their answer to part (b)(ii) but answer must be at least 3 dp
		2	

	Question 7 Total	8	
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Q	Answer	Marks	Comments
8(a)	$\frac{44}{101}$	M1 A1	M1: Correct numerator or denominator, with fraction in interval (0, 1) A1: CAO, 0.435[64...]
		2	

Q	Answer	Marks	Comments
8(b)	$P(A) = \frac{78}{200} \text{ and } P(B) = \frac{91}{200}$ $P(A \cup B) = 1 - \left(\frac{101 - 26 - 44}{200} \right)$ $P(A \cap B) = \frac{78}{200} + \frac{91}{200} - \frac{169}{200}$ $P(A \cap B) = 0$ Hence mutually exclusive	<p>B1</p> <p>M1</p> <p>M1</p> <p>B1</p> <p>A1</p>	<p>oe PI by sight of 78 and 91 within a correct calculation, or 270 seen</p> <p>Correct calculation of $P(A \cup B)$ or finds corresponding frequency 169 or correct calculation of $P(A \cup B)'$</p> <p>PI, for example by sight of $101 - 26 - 44$ in a calculation</p> <p>Uses addition law or sets up a correct equation with their probabilities to find $P(A \cap B)$ or finds corresponding frequency.</p> <p>PI by $78 + 101 + 91 - 26 - 44 [= 200]$ or $78 + 101 + 91 - 26 - 44 - 200 [= 0]$</p> <p>Must be expressed as a probability, e.g. $A \cap B = \emptyset$ is B0</p> <p>Dependent on both previous M1 marks and all working correct</p>
		5	

	Question 8 Total	7	
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Q	Answer	Marks	Comments
9	$3 = 0.6(u - (-3u))$ $[3 = 2.4u]$ $u = 1.25$	M1 A1	Allow sign errors oe

	Question 9 Total	2	
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Q	Answer	Marks	Comments
10(a)	$1800 - 170 \times 9.8 = 170a$ $[a =] \frac{67}{85} \text{ ms}^{-2}$	M1 A1	A three-term equation with at least two fully correct Condone 9.81 m s^{-2} for g , but not 10 m s^{-2} AWRT 0.79 If 9.81 m s^{-2} used then final answer is $\frac{1323}{1700} = 0.778... \text{ m s}^{-2}$, AWRT 0.78 Condone omission of units
		2	

Q	Answer	Marks	Comments
10(b)	The resultant force is downwards [, so the acceleration is downwards.] The velocity of the box may be upwards	B1 E1	Calculation or explanation implying resultant force is downwards PI by statement that box could be accelerating downwards Allow 'moving upwards' B0 E1 not possible
		2	

	Question 10 Total	4	
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Q	Answer	Marks	Comments
11(a)(i)	$3t - 0.1t^2 = 0$ or $3 - 0.2t = 0$ $0.1t(30 - t) [= 0]$ or $t = 0$ and $t = 30$ or $[3 - 0.2t = 0 \Rightarrow] \quad t = 15$ [Therefore] $k = 30$	M1 A1	Uses $v = 0$ to form a quadratic equation in t or differentiates expression for v and sets equal to zero. At least one further intermediate line of working and AG Must be convincingly shown.
		2	

Q	Answer	Marks	Comments
11(a)(ii)	$[v = 3 \times 15 - 0.1 \times 15^2 =] \quad 22.5 \text{ ms}^{-1}$ $[t =] \quad 15 \text{ s}$	B1 B1	oe , condone omission of units Condone omission of units
		2	
Q	Answer	Marks	Comments
11(b)	$\left[\int (3t - 0.1t^2) dt = \right] \frac{3}{2}t^2 - \frac{0.1}{3}t^3$ $\left[\left[\frac{3}{2}t^2 - \frac{0.1}{3}t^3 \right]_0^{30} = \right]$ $\frac{3}{2}(30)^2 - \frac{0.1}{3}(30)^3 \left[- \left(\frac{3}{2}(0)^2 - \frac{0.1}{3}(0)^3 \right) \right]$ $= 450 \text{ [m]}$ $\left[\text{Average speed} = \frac{450}{30} = \right] 15 \text{ m s}^{-1}$	B1 M1 A1 B1ft	Correctly integrates expression for v PI Substitutes correct limits into their integration PI Correct change in displacement ft their 450 divided by 30, provided their 450 comes from integration Condone omission of units
		4	

Q	Answer	Marks	Comments
11(c)	$a = \frac{dv}{dt} = 3 - 0.2t$	M1	Differentiates v with respect to t PI by correct final answer
	[When $t = 0$, $a = 3 - 0.2 \times 0$]		
	[$a =$] 3 m s^{-2}	A1	Condone omission of units
		2	

	Question 11 Total	10	
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Q	Answer	Marks	Comments
12	[Friction =] $5\mu g$	B1	Correct expression for friction, such as 49μ PI by $a = -\mu g$ or $a = \mu g$
	$[-\mu \times 5g = 5a \Rightarrow] \quad a = -\mu g$	B1	Correct expression for acceleration Condone $a = \mu g$
	$v^2 = u^2 + 2as$		
	$0 = 36 + 2 \times -\mu g \times x$	M1	Uses a valid constant acceleration formula to find an expression for displacement Must be working with $a = -\mu g$
	$x = \frac{18}{\mu g}$	A1	

	Question 12 Total	4	
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