

**Specimen Paper 9MA0/03 - Statistics & Mechanics mark scheme**

Question	Scheme	Marks	AOs
<b>1(a)</b>	Width = $0.4 \times 5 = 2$ (cm)	B1	3.1a
	Area = $12 \text{ cm}^2$ Frequency = 15 so $1 \text{ cm}^2 = \frac{5}{4}$ packet o.e	M1	1.1b
	Frequency of 9 corresponds to area of 7.2 Height = $7.2 \div 2 = 3.6$ (cm)	A1	1.1b
		<b>(3)</b>	
<b>(b)</b>	$[Q_2 =] (248 +) \frac{22}{35} \times 4$ or (use of $(n+1)$ ) $(248 +) \frac{22.5}{35} \times 4$	M1	1.1a
	= awrt 250.5 (g) or 250.6	A1	1.1b
		<b>(2)</b>	
<b>(c)</b>	Mean = awrt 250.4 (g)	B1	1.1b
	$[\sigma_x =] \sqrt{\frac{5644171.75}{90} - \left(\frac{22535.5}{90}\right)^2} = \sqrt{15.64...}$	M1	1.1b
	= awrt 4.0 (g)	A1	1.1b
	Accept $\left( s_x = \sqrt{\frac{5644171.75 - 90\left(\frac{22535.5}{90}\right)^2}{89}} = 3.977... \right)$	<b>(3)</b>	
<b>(d)</b>	$H_0 : \mu = 250 \quad H_1 : \mu > 250$	B1	2.5
	$\bar{X} \sim N\left(250, \frac{4^2}{90}\right)$ and $\bar{X} > 250.4$	M1	3.3
	$P(\bar{X} > 250.4) = 0.171...$	A1	3.4
	$0.171 > 0.05$ or $z = 0.9486... < 1.6449$	A1	1.1b
	There is insufficient evidence that the mean weight of coffee is greater than 250 g, or there is no evidence to support the sellers claim.	A1	2.2b
		<b>(5)</b>	
<b>(e)</b>	It is consistent as (the estimate of) the mean is close to (the estimate of) the median which is true for the normal distribution.	B1ft	3.5b
		<b>(1)</b>	
<b>(14 marks)</b>			

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### Notes:

(a) **B1:** for correct width

**M1:** for clear attempt to relate the area to frequency.

May be implied by their height  $\times$  their width = 7.2

**A1:** for height = 3.6 cm

(b) **M1:** for  $\frac{22}{35} \times 4$  or  $\frac{22.5}{35} \times 4$

**A1:** awrt 250.5 or 250.6

(c) **B1:** awrt 250.4

**M1:** for a correct expression for  $\sigma$  or **S**, can ft their mean

**A1:** awrt 4.0 (allow  $s$  = awrt 4.0)

(d) **B1:** hypotheses stated correctly

**M1:** for selecting a correct model, (stated or implied)

**A1:** for use of the correct model to find  $p$  = awrt 0.171 (allow  $z$  = awrt 0.948)

**A1:** for a correct calculation, comparison and correct statement

**A1:** for a correct conclusion in context mentioning mean weight and 250

(e) **B1:** evaluating the validity of the model used in (d)

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Question	Scheme	Marks	AOs
<b>2(a)</b>	Not suitable with a correct reason eg the points do not lie close to a straight line. there appear to be two populations if $G$ and $H$ were removed it appears to be a negative correlation	B1	1.2
		<b>(1)</b>	
<b>(b)</b>	$H_0 : \rho = 0$ $H_1 : \rho > 0$	B1	2.5
	Critical value 0.5509	M1	1.1a
	Reject $H_0$		
	There is evidence that pmcc is greater than zero	A1	2.2b
		<b>(3)</b>	
<b>(c)</b>	Beijing and Jacksonville	B1	2.2a
		<b>(1)</b>	
<b>(d)</b>	Beijing and Jacksonville are the closest to the equator	B1	2.4
		<b>(1)</b>	
<b>(e)</b>	Use data from one place.	B1	2.4
		<b>(1)</b>	
<b>(7 marks)</b>			
<b>Notes:</b>			
<b>(a) B1:</b> for a correct statement using the data in the table			
<b>(b) B1:</b> for both hypotheses in terms of $\rho$ <b>M1:</b> for selecting a suitable critical value compatible with their $H_1$ <b>A1:</b> for a correct conclusion stated			
<b>(c) B1:</b> both Beijing and Jacksonville – they do not need to be attached to G and H correctly.			
<b>(d) B1:</b> for the idea they are near the equator dependent only Beijing or Jacksonville being given in part(c)			

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Question	Scheme	Marks	AOs
<b>3(a)</b>	[ $A$ = no. of bulbs that grow into plants with blue flowers,] $A \sim B(40, 0.36)$	M1	3.3
	$p = P(A \geq 21) = 0.0240$	A1	1.1b
	$C$ = no. of bags with more than 20 bulbs that grow into blue flowers, $C \sim B(5, p)$	M1	3.3
	So $P(C \leq 1) = 0.9945\dots$ awrt 0.995	A1	1.1b
		<b>(4)</b>	
<b>(b)</b>	[ $T \sim$ number of bulbs that grow into blue flowers] $T \sim B(n, 0.36)$		
	$T$ can be approximated by $N(0.36n, 0.2304n)$	B1	3.4
	$P\left(Z < \frac{244.5 - 0.36n}{\sqrt{0.2304n}}\right) = 0.9479$	M1	1.1b
	$\frac{244.5 - 0.36n}{\sqrt{0.2304n}} = 1.625$ or $\frac{244.5 - 0.36x^2}{0.48x} = 1.625$	M1 A1	3.4 1.1b
	$0.36n + 0.78\sqrt{n} - 244.5 = 0$	M1	1.1b
	$n = 625$	A1cso	1.1b
		<b>(6)</b>	
<b>(10 marks)</b>			
<b>Notes:</b>			
<b>(a) M1:</b> for selecting an appropriate model for $A$ <b>A1:</b> for a correct value of the parameter $p$ for $C$ <b>M1:</b> for selecting an appropriate model for $C$ <b>A1:</b> for awrt 0.995			
<b>(b) B1:</b> for correct normal distribution <b>M1:</b> for correct use of continuity correction equal to a $z$ value where $ z  > 1$ <b>M1:</b> for standardisation with their $\mu$ and $\sigma$ <b>A1:</b> for a correct equation <b>M1:</b> using a correct method to solve their 3-term quadratic <b>A1:</b> 625 on its own cso			

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Question	Scheme	Marks	AOs
<b>4(a)</b>	$P(S \cap D') = 0$	B1	1.1b
		(1)	
<b>(b)</b>	$P(C   S \cap D) = \frac{0.27}{0.6} = \frac{9}{20} = 0.45$	M1	3.1b
	$\therefore 80 \times "0.45"$	M1	1.1b
	$= 36$	A1	1.1b
		(3)	
<b>(c)</b>	$[P(C) \times P(S) = P(C \cap S)]$		
	$P(S) = 0.6, P(C) = 0.27 + v + u, P(S \cap C) = 0.27$	M1	3.1a
	$0.6 \times (0.27 + u + v) = 0.27 \quad \text{or} \quad u + v = 0.18 \quad \text{o.e}$	A1	1.1b
	$\left[ P(D   C) = \frac{P(D \cap C)}{P(C)} \right] \quad P(D \cap C) = 0.27 + v$	M1	3.1a
	$\frac{14}{15} = \frac{0.27 + v}{0.27 + v + u} \quad \text{or} \quad 14u - v = 0.27 \quad \text{o.e}$	A1	1.1b
	$15u = 0.45$	M1dd	1.1b
	$u = 0.03 \quad v = 0.15$	A1	1.1b
	$w = 0.22$	A1ft	1.1b
		(7)	
<b>(11 marks)</b>			
<b>Notes:</b>			
<b>(a) B1:</b> correct answer only			
<b>(b) M1:</b> for a correct ratio of probabilities formula with at least one correct value and multiplying by 80 <b>A1:</b> a correct answer			
<b>(c) M1:</b> for translating the problem and realising the equation $P(C) \times P(S) = P(C \cap S)$ needs to be used with at least 2 parts correct. <b>A1:</b> a correct equation <b>M1:</b> for a correct probability formula with $P(D \cap C) = 0.27 + v$ <b>A1:</b> a second correct equation <b>M1dd:</b> dependent on the previous 2 method marks being awarded. Solving the two simultaneous equations by eliminating one variable. May be implied by either $u$ or $v$ correct <b>A1:</b> $u$ correct <b>A1:</b> $v$ correct <b>A1ft:</b> $w = 0.22$ , ft <i>their</i> $u, v$ provided that $u + v + w < 0.4$			

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Question	Scheme	Marks	AOs
<b>5(a)</b>	$P(L_x > 160) = P\left(Z > \frac{160-150}{25}\right)$		
	$= P(Z > 0.4)$		
	$= 1 - 0.6554$		
	$= \text{awrt } 0.345 \quad 0.34457.....$	B1	1.1b
	Expected number $= 12 \times "0.345"$	M1	1.1b
	$= 4.13$ (allow 4.14)	A1	1.1b
		<b>(3)</b>	
<b>(b)</b>	$P(L_y < 180) = 0.841621.....$	B1	3.4
	$\frac{180-160}{\sigma} = 0.8416$	M1	1.1b
	$\sigma = \text{awrt } 23.8$	A1	1.1b
		<b>(3)</b>	
<b>(c)</b>	The standard deviations for two companies are close but the mean for company Y is higher	M1	2.4
	therefore choose company Y	A1	2.2b
		<b>(2)</b>	
<b>(8 marks)</b>			
<b>Notes:</b>			
<b>(a) B1:</b> awrt 0.345 <b>M1:</b> for multiplying their probability by 12 <b>A1:</b> 4.13 (allow 4.14)			
<b>(b) B1:</b> for use of the correct model to find the correct value of $z$ awrt 0.842 <b>M1:</b> for standardising = to a $Z$ value $0.5 < Z < 1$ <b>A1:</b> awrt 23.8			
<b>(c) M1:</b> for a correct reason following their part(b) <b>A1:</b> for making an inference that follows their part(b)			

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Question	Scheme	Marks	AOs
1	$\mathbf{r} = (-4.5\mathbf{i} + 3\mathbf{j})$	B1	1.1b
	Use of $\mathbf{r} = \mathbf{u}t + \frac{1}{2}\mathbf{a}t^2$	M1	3.1b
	$(-4.5\mathbf{i} + 3\mathbf{j}) = 3\mathbf{u} + 0.5(\mathbf{i} - 2\mathbf{j}) 3^2$	A1ft	1.1b
	$\mathbf{u} = (-3\mathbf{i} + 4\mathbf{j})$	A1	1.1b
		(4)	
(4 marks)			
<b>Notes:</b>			
<b>B1:</b> Correct displacement vector <b>M1:</b> Use of correct strategy and/or formula to give equation in $\mathbf{u}$ only (could be obtained by two integrations) <b>A1ft:</b> Correct equation in $\mathbf{u}$ only, following their displacement vector <b>A1:</b> Correct answer			

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Question	Scheme	Marks	AOs
2	Differentiate wrt $t$	M1	1.1a
	$\mathbf{a} = (2t - 3) \mathbf{i} - 12 \mathbf{j}$	A1	1.1b
	$(2t - 3)^2 + (-12)^2$	M1	1.1b
	$(2t - 3)^2 + (-12)^2 = (6.5 / 0.5)^2$ oe	M1	2.1
	$4t^2 - 12t - 16 = 0$	A1	1.1b
	$(t - 4)(t + 1) = 0$	M1	1.1b
	$t = 4$	A1	1.1b
		(7)	
(7 marks)			
<b>Notes:</b>			
<p><b>M1:</b> At least one power going down  <b>A1:</b> A correct expression  <b>M1:</b> Sum of squares of components (with or without square root) of <math>\mathbf{a}</math> or <math>\mathbf{F}</math>  <b>M1:</b> Equating magnitude to 6.5/0.5 or 6.5 as appropriate and squaring both sides  <b>A1:</b> Correct quadratic = 0 in any form  <b>M1:</b> Attempt to solve a 3 term quadratic  <b>A1:</b> 4</p>			



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Question	Scheme	Marks	AOs
<b>3(a)</b>	Resolve perp to the plane	M1	3.1b
	$R + 25 \sin 30^\circ = 3g \cos 20^\circ$	A1	1.1b
	Equation of motion up the plane	M1	3.1b
	$25 \cos 30^\circ - 3g \sin 20^\circ - F = 3a$	A1	1.1b
	$F = 0.3R$	B1	1.2
	Correct strategy: sub for $F$ and solve for $a$	M1	3.1b
	$a = 2.4$ or $2.35 \text{ (m s}^{-2}\text{)}$	A1	2.2a
		(7)	
<b>(b)</b>	e.g. Include air resistance	B1	3.5c
		(1)	
<b>(c)</b>	$R = 3g \cos 20^\circ$ so $F_{\max} = 0.9 g \cos 20^\circ$	B1	3.1b
	Consider $3g \sin 20^\circ - 0.9g \cos 20^\circ$	M1	2.1
	Since $> 0$ , box moves down plane. *	A1*	2.2a
		(3)	
<b>(11 marks)</b>			
<b>Notes:</b>			
<p><b>(a)</b>  <b>M1:</b> Using an appropriate strategy to set up first of two equations, with usual rules applying  <b>A1:</b> <math>g</math> does not need to be substituted  <b>M1:</b> Using an appropriate strategy to set up second of two equations, with usual rules applying  <b>A1:</b> Neither <math>g</math> nor <math>F</math> need to be substituted (-1 each error)  <b>B1:</b> <math>F = 0.3R</math> seen  <b>M1:</b> Correct overall strategy to solve problem by substituting for <math>F</math> and solving for <math>a</math>  <b>A1:</b> Only possible answers, since <math>g = 9.8</math> used.</p>			
<p><b>(b)</b>  <b>B1:</b> e.g. include air resistance, allow for the weight of the rope</p>			
<p><b>(c)</b>  <b>B1:</b> Correct overall strategy (First equation could be implied)  <b>M1:</b> Must be difference or a comparison of the two values  <b>A1*:</b> Given answer</p>			

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Question	Scheme	Marks	AOs
<b>4(a)</b>	Moments about $A$ (or any other complete method)	M1	3.3
	$T \cos 30^\circ \times (1 \sin 30^\circ) = 20g \times 1.5$	A1	1.1.b
	$T \cos 30^\circ \times (1 \sin 30^\circ) = 20g \times 1.5$	A1	1.1.b
	$T = 679 \text{ or } 680 \text{ (N)}$	A1	1.1.b
		<b>(4)</b>	
<b>(b)</b>	Resolve horizontally	M1	3.1b
	$X = T \cos 60^\circ$	A1	1.1b
	Resolve vertically	M1	3.1b
	$Y = T \cos 30^\circ - 20g$	A1	1.1b
	Use of $\tan \theta = \frac{Y}{X}$ and sub for $T$	M1	3.4
	$49^\circ$ (or better), below horizontal, away from wall	A1	2.2a
		<b>(6)</b>	
<b>(c)</b>	Tension would increase as you move from $D$ to $C$	B1	3.5a
	Since each point of the rope has to support the length of rope below it	B1	2.4
		<b>(2)</b>	
<b>(d)</b>	Take moments about $G$ , $1.5Y = 0$	M1	3.3
	$Y = 0$ hence force acts horizontally.*	A1*	2.2a
		<b>(2)</b>	

**(14 marks)**

**Notes:**

**(a)**

**M1:** Correct overall strategy e.g.  $M(A)$ , with usual rules, to give equation in  $T$  only

**A1:** (A1A0 one error) Condone 1 error

**A1:** (A0A0 two or more errors)

**A1:** Either 679 or 680 (since  $g = 9.8$  used)

**(b)**

**M1:** Using an appropriate strategy to set up first of two equations, with usual rules applying e.g. Resolve horiz. or  $M(C)$

**A1:** Correct equation in  $X$  only

**M1:** Using an appropriate strategy to set up second of two equations, with usual rules applying e.g. Resolve vert. or  $M(D)$

**A1:** Correct equation in  $Y$  only

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**M1:** Using the model and their  $X$  and  $Y$

**A1:** 49 or better (since  $g$  cancels) Need all three bits of answer to score this mark  
or any other appropriate angle e.g  $41^\circ$  to wall, downwards and away from wall

**(c)**

**B1:** Appropriate equivalent comment

**B1:** Appropriate equivalent reason

**(d)**

**M1:** Using the model and any other complete method e.g. the three force condition for equilibrium

**A1\*:** Correct conclusion GIVEN ANSWER

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Question	Scheme	Marks	AOs
<b>5(a)</b>	Using the model and horizontal motion: $s = ut$	M1	3.3
	$12 = T \times 45 \cos 10^\circ$	A1	1.1b
	$T = 0.2707..$	A1	1.1b
	Using the model and vertical motion: $s = ut + \frac{1}{2}at^2$	M1	3.4
	$s = 45T \sin 10^\circ + 4.9T^2$	A1	1.1b
	Correct strategy: sub for $T$ and find $s$	M1	3.1b
	$d = 3.5 - 2.4752 - 1$	M1	3.1b
	$= 2.5 \text{ (cm)} \quad (2 \text{ SF})$	A1	2.2a
		<b>(8)</b>	
<b>(b)</b>	Using the model and vertical motion: $v = u + at$	M1	3.3
	$v = 45 \sin 10^\circ + 9.8T$	A1	1.1b
	Speed $= ((45 \cos 10^\circ)^2 + v^2)^{0.5}$	M1	3.1b
	$46 \text{ (m s}^{-1}\text{)} \quad (2 \text{ SF})$	A1	1.1b
		<b>(4)</b>	
<b>(c)</b>	Model does not take account of air resistance.	B1	3.5b
	Model does not take account of the size of the tennis ball	B1	3.5b
		<b>(2)</b>	
<b>(14 marks)</b>			
<b>Notes:</b>			
<b>(a)</b> <b>M1:</b> Using the model and correct strategy <b>A1:</b> Correct equation in $T$ only <b>A1:</b> 0.271 or better <b>M1:</b> Using the model and correct strategy <b>A1:</b> Correct equation <b>M1:</b> Sub for $T$ and solve for $s$ <b>M1:</b> Correct method to find $d$ using their $s$ <b>A1:</b> 2.5 is the only correct answer			
<b>(b)</b> <b>M1:</b> Using the model and correct strategy <b>A1:</b> Correct equation <b>M1:</b> Must have found a $v$ and usual rules apply. Square root is needed.			

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**A1:** 46 (2 SF) is only correct answer

**(c)**

**B1:** Other appropriate answer e.g. spin of the ball, wind effect

**B1:** Other appropriate answer e.g. spin of the ball, wind effect