Question	Scheme	Marks	AOs
1(a)	Width = $0.4\times\ 5 = \mathbf{2}$ (cm)	B1	3.1a
	Area = 12 cm^2 Frequency = 15 so 1 $cm^2 = \frac{5}{4}$ 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
		(3)	
(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
		(2)	
(c)	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 $\left(s_x = \sqrt{\frac{5644171.75 - 90\left(\frac{22535.5}{90}\right)^2}{89}} = 3.977... \right)$	**(3)**	
(d)	$H_0 : \mu = 250 \quad H_1 : \mu > 250$	B1	2.5
	$\bar{X} \sim N\left(250, \frac{4^2}{90}\right)$ and $\bar{X} > 250.4$	M1	3.3
	$P\left(\bar{X} > 250.4\right) = 0.171\ldots$	A1	3.4
	$0.171 > 0.05$ or $z = 0.9486\ldots < 1.6449$	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
		(5)	
(e)	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
		(1)	
			(14 marks)

Notes:
(a) B1: for correct width **M1:** for clear attempt to relate the area to frequency. May be implied by their height × 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 σ 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)

Question	Scheme	Marks	AOs
2(a)	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
		(1)	
(b)	$H_0 : \rho = 0 \quad H_1 : \rho > 0$	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
		(3)	
(c)	Beijing and Jacksonville	B1	2.2a
		(1)	
(d)	Beijing and Jacksonville are the closest to the equator	B1	2.4
		(1)	
(e)	Use data from one place.	B1	2.4
		(1)	
			(7 marks)

Notes:

(a) B1: for a correct statement using the data in the table

(b) B1: for both hypotheses in terms of ρ

M1: for selecting a suitable critical value compatible with their H_1

A1: for a correct conclusion stated

(c) B1: both Beijing and Jacksonville – they do not need to be attached to G and H correctly.

(d) B1: for the idea they are near the equator dependent only Beijing or Jacksonville being given in part(c)

Question	Scheme	Marks	AOs
3(a)	[A = no. of bulbs that grow into plants with blue flowers,] A~B(40, 0.36)	M1	3.3
	$p = \mathrm{P}(A \geq 21) = 0.0240$	A1	1.1b
	C = no. of bags with more than 20 bulbs that grow into blue flowers, C~B(5, p)	M1	3.3
	So $\mathrm{P}(C \leq 1) = 0.9945\ldots$ awrt 0.995	A1	1.1b
		(4)	
(b)	[T ~ number of bulbs that grow into blue flowers] T~ B(n, 0.36)		
	T can be approximated by N(0.36n, 0.2304n)	B1	3.4
	$\mathrm{P}\left(Z < \dfrac{244.5 - 0.36n}{\sqrt{0.2304n}}\right) = 0.9479$	M1	1.1b
	$\dfrac{244.5 - 0.36n}{\sqrt{0.2304n}} = 1.625$ or $\dfrac{244.5 - 0.36x^2}{0.48x} = 1.625$	M1 A1	3.4 1.1b
	$0.36n + 0.78\sqrt{n} - 244.5 = 0$	M1	1.1b
	$n = 625$	A1cso	1.1b
		(6)	
			(10 marks)

Notes:

(a) **M1:** for selecting an appropriate model for A

A1: for a correct value of the parameter p for C

M1: for selecting an appropriate model for C

A1: for awrt 0.995

(b) **B1:** for correct normal distribution

M1: for correct use of continuity correction equal to a z value where $|z| > 1$

M1: for standardisation with their μ and σ

A1: for a correct equation

M1: using a correct method to solve their 3-term quadratic

A1: 625 on its own cso

Question	Scheme	Marks	AOs
4(a)	$P(S \cap D') = 0$	B1	1.1b
		(1)	
(b)	$P(C \mid S \cap D) = \frac{0.27}{0.6} = \frac{9}{20} = 0.45$	M1	3.1b
	$\therefore 80 \times "0.45"$	M1	1.1b
	$=36$	A1	1.1b
		(3)	
(c)	$[P(C) \times P(S) = P(C \cap S)]$		
	$P(S) = 0.6$, $P(C) = 0.27 + v + u$, $P(S \cap C) = 0.27$	M1	3.1a
	$0.6 \times (0.27 + u + v) = 0.27$ or $u + v = 0.18$ o.e	A1	1.1b
	$\left[P(D \mid C) = \frac{P(D \cap C)}{P(C)} \right]$ $P(D \cap C) = 0.27 + v$	M1	3.1a
	$\frac{14}{15} = \frac{0.27 + v}{0.27 + v + u}$ or $14u - v = 0.27$ o.e	A1	1.1b
	$15u = 0.45$	M1dd	1.1b
	$u = 0.03$ $v = 0.15$	A1	1.1b
	$w = 0.22$	A1ft	1.1b
		(7)	
			(11 marks)

Notes:

(a) B1: correct answer only

(b) M1: for a correct ratio of probabilities formula with at least one correct value and multiplying by 80

A1: a correct answer

(c) M1: 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.

A1: a correct equation

M1: for a correct probability formula with $P(D \cap C) = 0.27 + v$

A1: a second correct equation

M1dd: 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

A1: *u* correct

A1: *v* correct

A1ft: w = 0.22, ft *their* u, v provided that $u + v + w < 0.4$

Question	Scheme	Marks	AOs
5(a)	$P(L_X > 160) = P\left(Z > \frac{160-150}{25}\right)$		
	$= P(Z > 0.4)$		
	$= 1 - 0.6554$		
	= awrt 0.345 0.34457…..	B1	1.1b
	Expected number = $12 \times$"0.345"	M1	1.1b
	= 4.13 (allow 4.14)	A1	1.1b
		(3)	
(b)	$P(L_Y < 180) = 0.8416\,21…..$	B1	3.4
	$\frac{180-160}{\sigma} = 0.8416$	M1	1.1b
	$\sigma =$ awrt 23.8	A1	1.1b
		(3)	
(c)	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
		(2)	
			(8 marks)

Notes:

(a) B1: awrt 0.345
M1: for multiplying their probability by 12
A1: 4.13 (allow 4.14)

(b) B1: for use of the correct model to find the correct value of *z* awrt 0.842
M1: for standardising = to a *Z* value $0.5 < Z < 1$
A1: awrt 23.8

(c) M1: for a correct reason following their part(b)
A1: for making an inference that follows their part(b)

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
	$(-4.5\mathbf{i} + 3\mathbf{j}) = 3\mathbf{u} + 0.5(\mathbf{i} - 2\mathbf{j})\ 3^2$	A1**ft**	1.1b
	$\mathbf{u} = (-3\mathbf{i} + 4\mathbf{j})$	A1	1.1b
		(4)	
			(4 marks)

Notes:

B1: Correct displacement vector

M1: Use of correct strategy and/or formula to give equation in **u** only (could be obtained by two integrations)

A1ft: Correct equation in **u** only, following their displacement vector

A1: Correct answer

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)

Notes:

M1: At least one power going down
A1: A correct expression
M1: Sum of squares of components (with or without square root) of **a** or **F**
M1: Equating magnitude to 6.5/0.5 or 6.5 as appropriate and squaring both sides
A1: Correct quadratic = 0 in any form
M1: Attempt to solve a 3 term quadratic
A1: 4

Question	Scheme	Marks	AOs
3(a)	Resolve perp to the plane	M1	3.1b
	$R + 25\sin30^o = 3g\cos20^o$	A1	1.1b
	Equation of motion up the plane	M1	3.1b
	$25\cos30^o - 3g\sin20^o - F = 3a$	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 (m s^{-2})	A1	2.2a
		(7)	
(b)	e.g. Include air resistance	B1	3.5c
		(1)	
(c)	$R = 3g\cos20^o$ so $F\max = 0.9\ g\cos20^o$	B1	3.1b
	Consider $3g\sin20^o - 0.9g\cos20^o$	M1	2.1
	Since > 0 , box moves down plane. *	A1*	2.2a
		(3)	
			(11 marks)

Notes:

(a)
M1: Using an appropriate strategy to set up first of two equations, with usual rules applying
A1: g does not need to be substituted
M1: Using an appropriate strategy to set up second of two equations, with usual rules applying
A1: Neither g nor F need to be substituted (-1 each error)
B1: $F = 0.3R$ seen
M1: Correct overall strategy to solve problem by substituting for F and solving for a
A1: Only possible answers, since g = 9.8 used.

(b)
B1: e.g. include air resistance, allow for the weight of the rope

(c)
B1: Correct overall strategy (First equation could be implied)
M1: Must be difference or a comparison of the two values
A1*: Given answer

Question	Scheme	Marks	AOs
4(a)	Moments about A (or any other complete method)	M1	3.3
	$T\cos30^o$ x $(1\sin30^o) = 20g$ x 1.5	A1	1.1.b
	$T\cos30^o$ x $(1\sin30^o) = 20g$ x 1.5	A1	1.1.b
	$T =$ 679 or 680 (N)	A1	1.1.b
		(4)	
(b)	Resolve horizontally	M1	3.1b
	$X = T\cos60^o$	A1	1.1b
	Resolve vertically	M1	3.1b
	$Y = T\cos30^o - 20g$	A1	1.1b
	Use of $\tan\theta = \frac{Y}{X}$ and sub for T	M1	3.4
	49^o (or better), below horizontal, away from wall	A1	2.2a
		(6)	
(c)	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
		(2)	
(d)	Take moments about G, $1.5Y = 0$	M1	3.3
	$Y = 0$ hence force acts horizontally.*	A1*	2.2a
		(2)	
			(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

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° 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

Question	Scheme	Marks	AOs
5(a)	Using the model and horizontal motion: $s = ut$	M1	3.3
	$12 = T \times 45\cos 10^o$	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
	$s = 45T\sin 10^o + 4.9T^2$	A1	1.1b
	Correct strategy: sub for T and find s	M1	3.1b
	$d = 3.5 - 2.4752 - 1$	M1	3.1b
	$= 2.5$ (cm) (2 SF)	A1	2.2a
		(8)	
(b)	Using the model and vertical motion: $v = u + at$	M1	3.3
	$v = 45\sin 10^o + 9.8T$	A1	1.1b
	Speed $= ((45\cos 10^o)^2 + v^2)^{0.5}$	M1	3.1b
	46 (m s^{-1}) (2 SF)	A1	1.1b
		(4)	
(c)	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
		(2)	
			(14 marks)

Notes:

(a)
M1: Using the model and correct strategy
A1: Correct equation in T only
A1: 0.271 or better
M1: Using the model and correct strategy
A1: Correct equation
M1: Sub for T and solve for s
M1: Correct method to find d using their s
A1: 2.5 is the only correct answer

(b)
M1: Using the model and correct strategy
A1: Correct equation
M1: Must have found a v and usual rules apply. Square root is needed.

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