Question Number	Scheme	Marks
1 (a)	$2\times36=72 \quad 8\times4=32$	M1 A1
		(2)
(b)	$[13]+\frac{(204-184)}{120}\times2$ $\quad$ $[13]+\frac{(204.5-184)}{120}\times2$	M1
	$=\frac{40}{3}=$ awrt 13.3	A1
		(2)
(c)	Symmetrically distributed/No skew as the mean ≈ median	B1
		(1)
(d)	$\frac{32}{4}+152+\frac{120}{2}\left[=220\right]$	M1
	$\frac{'220'}{408}\times\frac{'219'}{407}$	M1
	$\frac{365}{1258}$ or 0.2901… awrt 0.29	A1
		(3)

		Notes	Total 8
(a)	**M1**	For any equivalent method to find either frequency Maybe implied by either correct frequency Also maybe implied by two frequencies which add to 104 Also maybe implied by a correct scale on the fd axis , at least 3 labels	
	A1	For 72 and 32	
(b)	**M1**	For any equivalent method to find the median e.g. $\frac{Q_2-13}{15-13}=\frac{204-184}{304-184}$ or $\frac{15-Q_2}{Q_2-13}=\frac{304-204}{204-184}$ allow working downwards $[15]-\frac{(304-204)}{120}\times2$	
	A1	awrt 13.3	
(c)	**B1**	For a correct identification of skew [which must either be symmetric/no skew or (slight) negative skew] with a correct supporting reason. Condone mean < median so negative skew Allow use of 'their median' in the comparison provided 'their median' … 13.2 Allow Q_1 = awrt 10.8 or awrt 10.9 **and** Q_3 = awrt 15.1 **and** $Q_2-Q_1>Q_3-Q_2$ so negative skew. Comments referring only to the diagram (being symmetrical therefore no skew) send to review	
(d)	**M1**	For a correct method to find the number of plants between 8cm and 14cm (may be implied by sight of 220)	
	M1	For $\frac{n}{408}\times\frac{n-1}{407}$ or $\left(\frac{n}{408}\right)^2$ with 210 ,, n ,, 230	
	A1	awrt 0.29 may see $\frac{3025}{10404}$ from $\left(\frac{220}{408}\right)^2$	

Question Number	Scheme	Marks
2 (a)(i)	Mean = 71.83… awrt 71.8	B1
(ii)	Standard deviation = $\sqrt{\frac{62802}{12}-\left(\frac{862}{12}\right)^2}$ or variance = $\frac{62802}{12}-\left(\frac{862}{12}\right)^2$	M1
	$\sqrt{73.47...}=8.571…$ 8.57 * (to 3s.f.)	A1*
		(3)
(b)	$S_{xx}=62802-\frac{862^2}{12}\left[=\frac{2645}{3}=881.66...\right]$	M1
	$r=\frac{512.67}{\sqrt{413.67\times'881.66...'}}$	M1
	= 0.8489… awrt 0.849	A1
		(3)
(c)	Mean = $\frac{5}{9}\times('71.8'-32)$	M1
	= 22.11… awrt 22.1	A1ft
	Standard deviation = $\frac{5}{9}\times 8.57...$	M1
	= 4.76… awrt 4.76	A1
		(4)
(d)	$r='0.8489...'$ / same (as for x and y)	M1
	r not affected by (linear) coding oe	A1
		(2)
	Notes	**Total 12**

(a)(i)	**B1**	awrt 71.8 Allow $\frac{431}{6}$ oe
(ii)	**M1**	A correct method to find the standard deviation or the variance ft their mean for M1 only Also allow s.d. $=\sqrt{\frac{S_{xx}}{n}}$
	A1*	Must see at least one simplification of working **and** the given answer 8.57. e.g. $\sqrt{73.47...}$ **or** 8.572 **or** 8.571… **or** $\frac{23\sqrt{5}}{6}$ **or** $\sqrt{\frac{2645}{36}}$ therefore s.d. = 8.57* (to 3s.f.) $\sqrt{\frac{62802}{12}-71.8^2}$ scores M1A0 (use of 71.8 or 71.83 always scores M1A0). To get required accuracy must see at least 71.833 used i.e. $\sqrt{\frac{62802}{12}-71.833^2}$
(b)	**M1**	A correct method to find S_{xx} (implied by awrt 882)
	M1	A correct method to find PMCC using their value of S_{xx}
	A1	awrt 0.849
(c)	**M1**	A correct method to find the mean ft their mean in part (a)
	A1ft	awrt 22.1 ft their mean in part (a)
	M1	A correct method to find the standard deviation (do not isw if any further calculation is done after multiplying by $\frac{5}{9}$)
	A1	awrt 4.76
(d)	**M1**	r = their part (b) provided –1 ,, their part (b) ,, 1 allow 2 s.f. on the ft
	A1	Any correct reasoning but M1 must be scored. Allow e.g. 'addition/subtraction **and** multiplication/division does not affect r' ,

Question Number	Scheme	Marks
3 (a)	$1-p$, $\frac{7}{8}$ and $\frac{9}{10}$ in the correct place on tree diagram	B1
		(1)
(b)	$\frac{1}{8}p+\frac{1}{10}(1-p)=0.11$	M1 A1ft
	$p=\frac{2}{5}$	A1
		(3)
(c)	$'\frac{2}{5}'\times\frac{1}{8}=\frac{1}{20}$	M1 A1ft
		(2)
(d)	$\mathrm{P}(\mathrm{Y12}\mid R)=\frac{'\frac{2}{5}'\times\frac{7}{8}}{1-0.11}$ or $\mathrm{P}(\mathrm{Y12}\mid R)=\frac{'\frac{2}{5}'\times\frac{7}{8}}{'\frac{2}{5}'\times\frac{7}{8}+'\frac{3}{5}'\times\frac{9}{10}}$	M1
	$=\frac{35}{89}$	A1
		(2)

	Notes	Total 8
(a)	**B1**	For a fully correct tree diagram with all 3 correct labels. Allow if $1-p$ is seen and crossed out/replaced with a numerical probability.
(b)	**M1**	For $\frac{1}{8}p$ or $\frac{1}{10}'(1-p)'$ seen in an equation for p
	A1ft	For a fully correct equation in p or correct ft equation based on their tree diagram
	A1	oe correct answer scores 3 out of 3
(c)	**M1**	For $p\times\frac{1}{8}$ ft their p, provided p is a probability
	A1ft	For a correct answer ft their p, provided p is a probability. Correct answer scores 2 out of 2
(d)	**M1**	For a correct ratio of probabilities. Can ft their p, provided p is a probability
	A1	For $\frac{35}{89}$ (Allow awrt 0.393)

Question Number	Scheme	Marks
4 (a)	$LQ = 28$ or $UQ = 48$	B1
	$'48'+1.5('48'-'28')[=78]$	M1
	$90 > 78$ so, 90 is an outlier*	A1*
		(3)
(b)	$b = \frac{1735.6}{1667.6}[=1.04...]$	M1
	$a = 38.2 - 'b'(42.2)[=-5.72....]$	M1
	$s = -5.72 + 1.04f$ *	A1*
		(3)
(c)	For every **extra mark** (oe) in **French/*f***, **Spanish/*s* goes up** (oe) by [on average] **1.04 marks**	B1
		(1)
(d) (i)	$s = -5.72 + 1.04 \times 55 = 51.48$ awrt 51.5	M1 A1
(ii)	$s = -5.72 + 1.04 \times 18 = 13$	A1
		(3)
(e)	• The first estimate is an interpolation/The second estimate is an extrapolation • 55 is within the range of data/18 is not within the range of data • 55 is closer to the mean/18 is further away from the mean …..so 51.5 is the more reliable estimate	M1 A1
		(2)

	Notes	Total 12
(a)	**B1**	For either LQ or UQ correct (may be seen in calculation for M1)
	M1	Correct use of $Q_3 + 1.5 \times (Q_3 - Q_1)$ ft their LQ and their UQ provided their UQ > their LQ
	A1*	For both LQ and UQ correct and identifying 90>78 or 90 is an outlier Answer is given so no incorrect working can be seen
(b)	**M1**	For a correct method to find the gradient
	M1	For a correct method to find the intercept (division by 11 is M0)
	A1*	Cao (dep on both M marks) must see printed answer $s = -5.72 + 1.04f$
(c)	**B1**	For a correct numerical interpretation of the gradient in context which must include marks at least once
(d) (i)	**M1**	For a correct substitution into the regression equation. May be seen in (i) or (ii) or implied by one correct answer
	A1	awrt 51.5 Allow 51 or 52
(ii)	**A1**	13 or awrt 13.0
(e)	**M1**	For any equivalent correct reason Ignore extraneous non-contradictory comments For the second bullet point **must** be clear that they are referring to French marks (24,, f ,, 68). Do **not** allow comments that refer to the range of Spanish marks e.g. ‘‘51.5’ is within the range of data/‘13’ is not within the range of data’ Do **not** allow ‘55 is closer to the median (than 18)’
	A1	For clearly identifying the estimate from part (d)(i): 51.5 or 55 or (i) or ‘the first estimate’ , etc.

Question Number	Scheme	Marks
5 (a)	$P(X < 38.8) = P\left(Z < \frac{38.8-40}{4}\right)\left[= P\left((Z < -0.3)\right)\right]$	M1
	$= 1 - 0.6179 = 0.3821*$	A1*
		(2)
(b)	$P(\text{Qualify}) = 1-(0.3821)^3$ or $1-0.3821+0.3821\times(1-0.3821)+0.3821^2\times(1-0.3821)$	M1
	$[= 0.9442]$	
	$P(X > 44) = P\left(Z > \frac{44-40}{4}\right)\left[= P\left((Z > 1)\right)\right]$	M1
	$[= 1-0.8413] = 0.1587$	A1
	$P(X > 44 \text{ on 2nd attempt} \mid \text{Qualify}) = \frac{0.3821\times'0.1587'}{'0.9442'}$	M1
	0.06422... awrt 0.0642	A1
		(5)

	Notes	Total 7
(a)	**M1**	For standardising using 38.8, 40 and 4 (allow ±)
	A1*	Must see 1 – 0.6179 or we must see 0.38209 or 0.38208… or better Answer is given so no incorrect working can be seen (but condone poor probability notation)
(b)	**M1**	For a correct method to find the probability of qualifying
	M1	For standardising using 44, 40 and 4 (implied by 1 – 0.8413 or awrt 0.1587)
	A1	awrt 0.16
	M1	For a correct ratio of probabilities ft their 0.1587 and their 0.9442. Use of 0.6179 in the denominator is M0
	A1	awrt 0.0642

Question Number	Scheme	Marks
6 (a)	$P(B\|A)=\dfrac{P(B\cap A)}{P(A)}$	
	$0.3=\dfrac{P(B\cap A)}{x}\Rightarrow P(B\cap A)=0.3x$	M1
	$P(A\cup B)=P(A)+P(B)-'P(A\cap B)'$	M1
	$0.65=x+y-0.3x\Rightarrow 0.65=0.7x+y$	
	$14x+20y=13$ *	A1*
		(3)
(b)(i)	$P(B\cup C)=P(B)+P(C)$ or $P(B\cap C)=0$	M1
	$0.85=\dfrac{1}{2}x+2y$	A1
(ii)	Attempt to solve the 2 equations simultaneously	M1
	$x=0.5$ $y=0.3$	A1
		(4)
(c)	$P(B\|A)=0.3$ **and** $P(B)='0.3'$	$P(A)\times P(B)='0.5'\times'0.3'$ **and** $P(A\cap B)=0.3\times'0.5'$ or $P(A\cap B)$ = '0.5' + '0.3' – 0.65 — M1
	So, A and B are statistically independent	A1ft
		(2)

	Notes	**Total 9**
(a)	**M1**	Use of $P(B\|A)=\dfrac{P(B\cap A)}{P(A)}$ assuming independence is M0 e.g. $P(B\cap A)=P(B)\times P(A)[=xy]$ May be implied by $P(B\cap A)=0.3x$ (may be seen on a Venn diagram)
	M1	Use of $P(A\cup B)=P(A)+P(B)-P(A\cap B)$ with substitution of $P(A\cup B)$, $P(A)$ and $P(B)$ (the equation may be seen in a Venn diagram) $0.65=x+y-0.3x$ implies M1M1
	A1*	Answer is given so no incorrect working can be seen
(b)(i)	**M1**	Use of $P(B\cup C)=P(B)+P(C)$ or sight of $P(B\cap C)=0$
	A1	Any correct second equation in x and y which need not be simplified.
(ii)	**M1**	Attempt to solve the 2 equations simultaneously. Either a correct substitution seen or a correct method to eliminate x or y
	A1	For $x=0.5$ and $y=0.3$
(c)	**M1**	For finding all of the probabilities needed for a test for independence (probabilities must be labelled) ft their values of x and y $P(B\|A)$ **and** $P(B)$ or $P(A), P(B)$ **and** $P(A\cap B)$ For $P(A\cap B)$ we **must** see working shown
	A1ft	For a correct ft conclusion for their values of x and y (must have scored M1)

Question Number	Scheme	Marks
7 (a)	$\frac{k+4}{8}=1 \quad [k=4^*]$	B1*
		(1)
(b)	x: 1 | 2 | 3 | 4 $P(X=x)$: $\frac{1}{13}$ | $\frac{7}{26}-\frac{1}{13}=\frac{5}{26}$ | $\frac{15}{26}-\frac{7}{26}=\frac{4}{13}$ | $1-\frac{15}{26}=\frac{11}{26}$	M1 M1 A1
		(3)
(c)	4	B1ft
		(1)
(d)	$E(X)=1\times\frac{1}{13}+2\times'\frac{5}{26}'+3\times'\frac{4}{13}'+4\times'\frac{11}{26}'\left[=\frac{40}{13}\right]$	M1
	$E(X^2)=1^2\times\frac{1}{13}+2^2\times'\frac{5}{26}'+3^2\times'\frac{4}{13}'+4^2\times'\frac{11}{26}'\left[=\frac{135}{13}\right]$	M1
	$\text{Var}(X)='\frac{135}{13}'-'\left(\frac{40}{13}\right)'^2\left[=\frac{155}{169}\right]$	M1
	$\text{Var}(13X-6)=13^2\times'\frac{155}{169}'$	M1
	$=155$	A1
		(5)

Y: 7 | 20 | 33 | 46

$P(Y=y)$: $\frac{1}{13}$ | $\frac{5}{26}$ | $\frac{4}{13}$ | $\frac{11}{26}$

$E(Y)=7\times'\frac{1}{13}'+20\times'\frac{5}{26}'+33\times'\frac{4}{13}'+46\times'\frac{11}{26}'[=34]$

$E(Y^2)=7^2\times'\frac{1}{13}'+20^2\times'\frac{5}{26}'+33^2\times'\frac{4}{13}'+46^2\times'\frac{11}{26}'$ $[=1311]$

$\text{Var}(13X-6)='1311'-'34'^2$

Notes — **Total 10**

(a)	**B1***	$\frac{k+4}{8}=1$ oe Allow verification method $\frac{4+4}{8}=1$ provided they conclude $k=4$
(b)	**M1**	For a correct method to find one probability from $x=2$, $x=3$ or $x=4$ (implied by any one correct probability from $x=2$, $x=3$ or $x=4$)
	M1	For a correct method to find a second probability from $x=2$, $x=3$ or $x=4$ (implied by any two correct probabilities from $x=2$, $x=3$ or $x=4$)
	A1	For a fully correct probability distribution. Need not be in a table, but 1, 2, 3 and 4 must be associated with correct probability
(c)	**B1ft**	Must be consistent with the highest probability in their distribution in part (b). If no distribution is found, then the answer must be 4
(d)	**M1**	For a correct method to find E(X) (implied by awrt 3.08) ft their table use of $\sum xF(x)$ is M0 or for a correct probability distribution for $13X-6$ ft their probabilities in (b)
	M1	For a correct method to find E(X^2) (implied by awrt 10.4) ft their table use of $\sum x^2F(x)$ is M0 or for a correct method to find E(Y) ft their table
	M1	Use of $E(X^2)-E(X)^2$ ft their E(X^2) and their E(X) or for a correct method to find E(Y^2) ft their table
	M1	Use of $13^2\,\text{Var}(X)$ ft their Var(X) or use of $E(Y^2)-E(Y)^2$ ft their E(Y^2) and their E(Y)
	A1	Cao

Question Number	Scheme	Marks
8 (a)	$P(X > \mu + 2k) = 0.2$ or $P(X < \mu - 2k) = 0.2$ or $P(X < \mu + 2k) = 0.8$ or $P(X > \mu - 2k) = 0.8$	M1
	$\frac{\mu + 2k - \mu}{6} = 0.8416$ or $\frac{\mu - 2k - \mu}{6} = -0.8416$	M1 A1
	$k = 2.5248...$ awrt 2.52	A1
		(4)
(b)	$P\left(Y > \frac{3}{2}\mu\right) \Rightarrow P\left(Z > \frac{\frac{3}{2}\mu - \mu}{\sigma}\right) \Rightarrow P\left(Z > \frac{\frac{1}{2}\mu}{\sigma}\right)$	M1
	$\mu = \frac{3}{2}\sigma^2 \Rightarrow P\left(Z > \frac{'\frac{1}{2}\left(\frac{3}{2}\sigma^2\right)'}{\sigma}\right)\left[= P\left(Z > \frac{3}{4}\sigma\right)\right]$ or $\sigma = \sqrt{\frac{2\mu}{3}} \Rightarrow P\left(Z > \frac{\frac{1}{2}\mu}{\sqrt{\frac{2\mu}{3}}}\right) = \left[P\left(Z > \frac{1}{2}\sqrt{\frac{3\mu}{2}}\right)\right]$ or $\frac{\frac{1}{2}\mu}{\sigma} = k$ and $2\mu = 3\sigma^2$	M1
	$'\frac{3}{4}\sigma' = 1.5$ or $\frac{1}{2}\sqrt{\frac{3\mu}{2}} = 1.5$ or $3\sigma^2 = 6\sigma$	M1
	$\mu = 6$ only, $\sigma = 2$ only	A1 A1
		(5)

	Notes		Total 9
(a)	**M1**	For any of the given tail probability statements which may be seen on a diagram Also may be implied by awrt ±0.84 seen	
	M1	For standardising using μ and 6 and setting = to z value, where $0.8 < \lvert z \rvert < 0.9$ Implied by $(\pm)\frac{k}{3} = (\pm)0.84$ or better	
	A1	For a fully correct standardisation with a compatible z value. $\lvert z \rvert$ must be 0.8416 or better	
	A1	awrt 2.52 (Allow 2.525) Answer only 2.52 is M1M1A0A1 Answer only 2.5248 is M1M1A1A1	
(b)	**M1**	For standardising using $\frac{3}{2}\mu$, μ and σ	
	M1	For substitution of $\mu = \frac{3}{2}\sigma^2$ into their standardisation **or** setting up two equations in μ and σ	
	M1	For their expression for σ only or μ only used with ±1.5	
	A1	$\mu = 6$ or $\sigma = 2$	
	A1	$\mu = 6$ and $\sigma = 2$ must reject any other values if found	