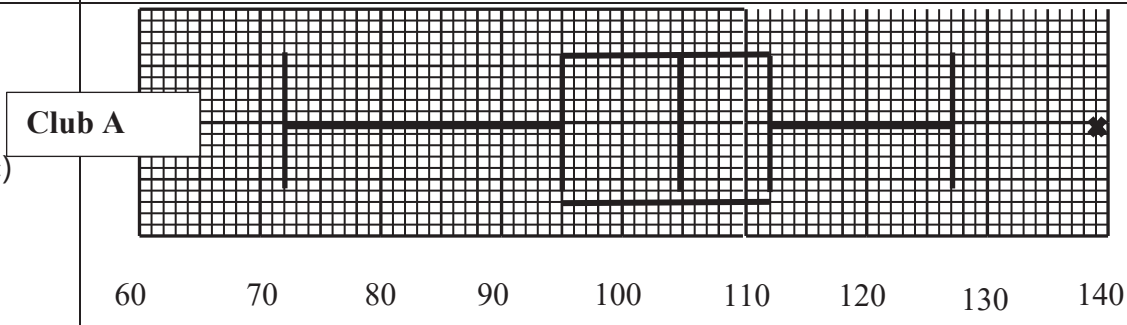
Question Number	Scheme	Marks
1(a)	$[S_{hw} =]604135 - \frac{1160 \times 4160}{8}$ or $[S_{ww} =]2166600 - \frac{4160^2}{8}$	M1
	$[S_{hw} =]935$	A1
	$[S_{ww} =]3400$	A1
		(3)
(b)	$r = \frac{"935"}{\sqrt{286 \times "3400"}} = 0.9481...$ awrt **0.948**	M1A1
		(2)
(c)	$b = \frac{"935"}{286}[= 3.269...]$	M1
	$a = \frac{4160}{8} - "3.269..." \times \frac{1160}{8}[= 45.96...]$	M1
	$w = 46.0 + 3.27h$ *	A1*
		(3)
(d)	[On average] for **each/1** [cm] increase in **height/*h*** the **weight/*w* increases** by "**3.27**"[kg]	B1
		(1)
(e)(i)	546.31 awrt **546**	B1
(ii)	601.9 awrt **602**	B1
		(2)
(f)	The 1st estimate is more reliable estimate since… • The 1st estimate is an **interpolation**/The 2nd is an **extrapolation** • 153(height) is within data range/170 is not within data range • 153 is closer to the mean(height)/170 is further from the mean	B1
		(1)

	Notes		Total 12
(a)	**M1**	for a correct expression for S_{hw} or S_{ww} implied by either correct answer	
	A1	935 cao	
	A1	3400 cao	
(b)	**M1**	for a valid attempt at *r* allow ft their values from (a)	
	A1	awrt 0.948 correct answer scores 2 out of 2	
(c)	**M1**	for a correct numerical expression to find the value of *b*	
	M1	for a correct method to find the value of *a* ft their *b* Allow $w - 520 = "3.269..."(h - 145)$ oe for this mark	
	A1*	correct solution with both method marks and correct given equation stated. do not award this mark if there is incorrect working **seen** e.g. *a* =	

		45.85 rounding to $a = 46.0$ do not allow $w = 46 + 3.27h$
(d)	**B1**	for a correct numerical interpretation which includes **height/*h*** and **weight/*w*** if units are stated then they must be correct
(e)(i)	**B1**	awrt 546
(ii)	**B1**	awrt 602
(f)	**B1**	for 1st estimate oe **and** a correct supporting reason. ignore extraneous non-contradictory comments. for 2nd/3rd reason, do not allow comments that refer to **weights**

Question Number	Scheme	Marks
2(a)	[LQ =] 95	B1
	[UQ =] 112	B1
		(2)
(b)	"95"−1.5×("112"−"95") or "112"+1.5×("112"−"95")	M1
	"95"−1.5×("112"−"95") **and** "112"+1.5×("112"−"95")	A1ft
	So only outlier is 139	A1
		(3)
(c)		M1M1 M1A1ft
		(4)
(d)	(Club B has) positive (skew)	M1
	So club B weights are more varied above the median (than below the median)	A1
		(2)

	Notes	Total 11
(a)	**B1**	correct lower quartile 95 cao
	B1	correct upper quartile 112 cao
(b)	**M1**	a correct method to find either the lower or upper outlier boundary ft their values from (a)
	A1ft	correct attempt to find both the lower and upper outlier boundary ft their values from (a) this mark is for both correct ft expressions which need not be evaluated but may be implied by both of 69.5 and 137.5
	A1	(dep on M1 only) for identifying 139 as an outlier
(c)	**M1**	for a box with 1 upper whisker and 1 lower whisker
	M1	for lower whisker plotted at 72 and upper whisker plotted at 127 or '137.5 (condone 137 to 138)'
	M1	for quartiles plotted at 'Q_1', 105 and 'Q_3'
	A1ft	for a fully correct boxplot with 1 outlier marked at 139 only ft 'Q_1', 'Q_3' and '137.5'
(d)	**M1**	for identifying positive (skew) ignore comments about the skewness of Club A positive correlation is M0
	A1	for a correct contextual interpretation of positive skew indicating that there is greater variation above the median

Question Number	Scheme		Marks
3(a)	$\left[\mathrm{P}(Y=y)=\right]\frac{1}{6}$ [y =] 1, 2, 3, 4, 5, 6		B1dB1
			(2)
(b)	[Discrete] **uniform** [distribution]		B1
			(1)
(c)	$\mathrm{E}(Y)=\frac{6+1}{2}[=3.5]$ or $\mathrm{E}(Y)=\frac{1+2+3+4+5+6}{6}[=3.5]$	$4Y+3$: 7, 11, 15, 19, 23, 27	M1
	$\mathrm{E}(4Y+3)=4\times"3.5"+3$	$\mathrm{E}(4Y+3)=\frac{"7"+"27"}{2}$ or $\frac{"7"+"11"+"15"+"19"+"23"+"27"}{6}$	M1
	17		A1
			(3)
			Total 6

(a)	**B1**	for identifying $\mathrm{P}(Y=y)=\frac{1}{6}$ as the only probability Ignore labels. (May be seen in a table). Must be seen in part (a). Stating or using Normal, Binomial (or other distribution) is B0
	dB1	Dep on previous B1 for y = 1, 2, 3, 4, 5, 6 Ignore labels. (May be seen in a table) Must be seen in part (a).
	SC	Use of inaccurate value for $\frac{1}{6}$ can score B0B1 if otherwise fully correct e.g.

1	2	3	4	5	6
0.167	0.167	0.167	0.167	0.167	0.167

(b)	**B1**	do not allow continuous uniform [distribution] do not allow Normal uniform
(c)	**M1**	a correct method to find E(Y) (implied by 3.5) **or** sight of 7, 11, 15, 19, 23, 27 (allow one slip) $1\times\frac{1}{6}+2\times\frac{2}{6}+3\times\frac{3}{6}+4\times\frac{4}{6}+5\times\frac{5}{6}+6\times\frac{6}{6}$ is M0
	M1	use of $4\mathrm{E}(Y)+3$ ft their $\mathrm{E}(Y)$ must be clear that they are using their E(Y) e.g. $4\left(\frac{1}{6}\right)+3$ is M0

		or a correct method to find E(4*Y* + 3) ft their 7, 11, 15, 19, 23, 27
	A1	cao 17 scores 3/3

Question Number	Scheme	Marks
4(a)	$0.05 + 0.1 + a + b + 0.35 = 1$ [$a + b = 0.5$]	M1
	$-0.05 + a + 2b + 1.05 = 1.8$ [$a + 2b = 0.8$]	M1
	$b = 0.3$ $a = 0.2$	A1
		(3)
(b)	<table><tr><td>[x]</td><td>−1</td><td>0</td><td>1</td><td>2</td><td>3</td></tr><tr><td>[F(x)]</td><td>0.05</td><td>0.15</td><td>0.35</td><td>0.65</td><td>1</td></tr></table>	B1B1ft
		(2)
(c)	0.15	B1
		(1)
(d)	$\mathrm{E}(X^2) = 1\times0.05 + 1\times"0.2" + 4\times"0.3" + 9\times0.35[= 4.6]$	$\mathrm{E}(5-3X) = 8\times0.05 + 5\times0.1 + 2\times"0.2" - 1\times"0.3" - 4\times0.35[= -0.4]$ or $\mathrm{E}(5-3X) = 5 - 3\times1.8[= -0.4]$ M1
	$\mathrm{Var}(X) = "4.6" - 1.8^2 = 1.36$	$\mathrm{E}(5-3X)^2 = 64\times0.05 + 25\times0.1 + 4\times"0.2" + 1\times"0.3" + 16\times0.35[= 12.4]$ M1
	Var(5 – 3X) = 9 × "1.36" = 12.24	Var(5 – 3X) = "12.4" – ("−0.4")^2 = 12.24 M1
	awrt **12.2**	A1
		(4)

	Notes	Total 10
(a)	**M1**	for either correct equation in a and b
	M1	for both correct equations in a and b
	A1	both $a = 0.2$ oe and $b = 0.3$ oe correct answers score 3 out of 3 unless from obvious incorrect working
In part (b) and (d) working labelled in script takes priority. Look out for working shown under the table which can be marked if it does not contradict the working in the script.		
(b)	**B1**	for 3 correct values of x and their associated cumulative probabilities
	B1ft	for a fully correct cdf ft their a and b provided both are probabilities and $a + b = 0.5$
(c)	**B1**	0.15 oe
(d)	**M1**	for method to find $\mathrm{E}(X^2)$ with at least 3 correct (ft) non-zero products (may be implied by 4.6) only allow ft products which use **probabilities** or a method to find E(5 – 3X) with at least 3 correct (ft) non-zero products (may be implied by −0.4) or use of E(5 – 3X) = 5 – 3E(X)
	M1	for a correct method to find Var(X) ft their $\mathrm{E}(X^2)$ (may be implied by 1.36) or a correct method to find E(5 – 3X)^2 (may be implied by 12.4)

	M1	for use of $3^2\text{Var}(X)$ ft their Var(X) or use of E(5 – 3X)^2 – (E(5 – 3X))^2
	A1	awrt 12.2 working must be shown Answer only send to review.

Question Number	Scheme	Marks
5(a)	Width = 7.2	B1
	Area of 21.6 for a frequency of 75 so $\frac{21.6}{75}\times 40 = 11.52$ for a frequency of 40 or $w \times h = 11.52$ or fd = 15	M1
	$\left[h = \frac{11.52}{7.2} \text{ or } \frac{2}{15}\times 12 =\right] 1.6$	A1
		(3)
(b)	$[Q_2 = 130+]\frac{5}{63}\times 10$ or $[Q_2 = 130+]\frac{5.5}{63}\times 10$ or $\frac{x-130}{140-130} = \frac{150-145}{208-145}$ or $\frac{140-x}{140-130} = \frac{208-150}{208-145}$	M1
	= awrt 130.8 or awrt 130.9	A1
		(2)
(c)(i)	$[\bar{y} =]\frac{6000}{300}[=20]$ and $[\bar{w} =] 2\times "20" + 200$	M1
	$= 240$	A1
		(2)
(c)(ii)	$[\text{Var}(y) =]\frac{150000}{300} - "20"^2 [= 100]$	M1
	$[\text{Var}(w) =] 4\times "100" = 400$	M1A1
		(3)

	Notes	Total 10
(a)	**B1**	7.2 or exact equivalent
	M1	for sight of 11.52 or $w \times h = 11.52$ or fd = 15 May be implied by $h = 1.6$
	A1	1.6 or exact equivalent
(b)	**M1**	for any valid method to find the median allow use of $n+1$ allow working backwards $[140 -]\frac{58}{63}\times 10$ or $[140 -]\frac{57.5}{63}\times 10$
	A1	awrt 130.8 allow awrt 130.9 if using $(n+1)$ No fractions
(c)(i)	**M1**	for a correct method to find the mean of w Alt: $\sum w = 6000\times 2 + 300\times 200 [= 72000]$ and $\bar{w} = \frac{"72000"}{300}$
	A1	cao correct answer is 2/2
(c)(ii)	**M1**	for a correct method to find Var(y) or for $\sum w^2 = 17\,400\,000$
	M1	for a correct method to find Var(w) ft their Var(y) $2\times "100" + 200 = 400$ is M0A0 or for $\text{Var}(w) = \frac{17\,400\,000}{300} - "240"^2$
	A1	cao answer only with no working shown scores M1M0A0
	SC	If no marks scored in (ii), allow M1(M0A0) for

		$\sqrt{\frac{150000}{300} - "20"^2}$

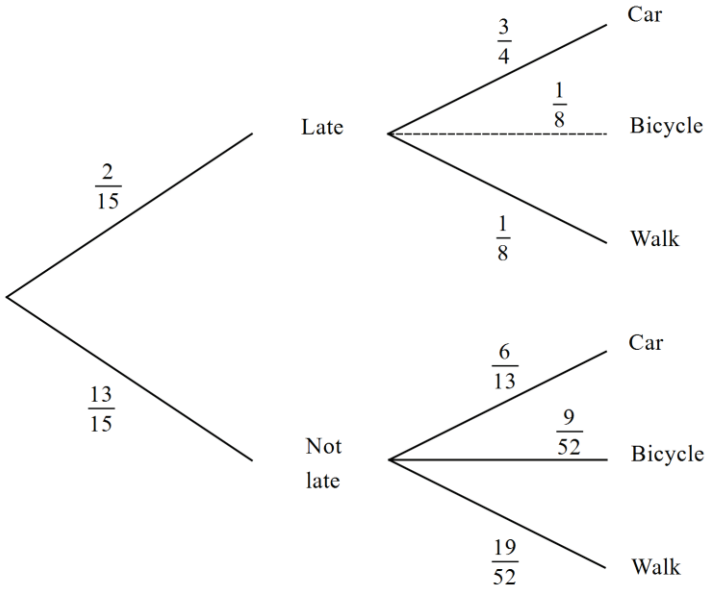
Question Number	Scheme	Marks
6(a)	$\mathrm{P}(A)=0.6$ $\mathrm{P}(B)=0.24+0.09+x$ $\mathrm{P}(A\cap B)=0.24$	M1
	$0.6(0.33+x)=0.24$	M1
	$x=0.07$	A1
		(3)
(b)	$\mathrm{P}(B\mid C')=\dfrac{0.24+"0.07"}{0.6+"0.07"+z}=\dfrac{31}{75}$	M1
	$z=0.08$	A1
		(2)
(c)	$y=1-0.36-0.24-$ "0.07" $-0.09-$ "0.08"	M1
	$y=0.16$	A1ft
		(2)
(d)(i)	0.36	B1
(ii)	0.67	B1ft
		(2)

	Notes	Total 9
(a)	**M1**	for at least 2 of the 3 correct probabilities/probability expressions seen or used (implied by 2nd M1) $0.24+0.09+x$ may be implied by embedded working e.g. x = "P(B)" – 0.24 – 0.09
	M1	for use of $\mathrm{P}(A\cap B)=\mathrm{P}(A)\times\mathrm{P}(B)$ oe to form a correct equation in x
	A1	oe correct answer scores 3/3
(b)	**M1**	for a correct conditional probability equation ft "their x" substituted or just x allow $\mathrm{P}(B\mid C')=\dfrac{0.24+"0.07"}{1-0.09-y}=\dfrac{31}{75}$
	A1	oe correct answer scores 2 out of 2
(c)	**M1**	for a correct expression to find y ft their x and their z values substituted where x and z are probabilities do not allow blank/no answers for x and/or z as zero may be implied by $x+y+z=0.31$ with x, y, and z as probabilities
	A1ft	ft their x and their z $x+y+z=0.31$ where x, y, and z are probabilities
(d)(i)	**B1**	oe
(ii)	**B1ft**	0.67 oe or 0.6 + "their x" ft "their x" where "their x" and 0.6 + "their x" are probabilities

Question Number	Scheme	Marks
7(a)	$[\mathrm{P}(48.45 < W < 54.4) =]\mathrm{P}\left(Z < \frac{54.4-51}{1.7}\right) - \mathrm{P}\left(Z < \frac{48.45-51}{1.7}\right)$	M1M1
	$[0.9772 - 0.0668] = 0.9104$ Cal: 0.91044... awrt 0.910	A1
		(3)
(b)	$[\mathrm{P}(53.55 < W < 54.4) =]"0.9772" - (1 - "0.0668")$ [= 0.044] Calc:0.044057....	M1
	$[\mathrm{P}(W > 53.55 \mid 48.45 < W < 54.4) =]\frac{"0.044"}{"0.9104"}$	M1
	= 0.04833 awrt 0.0483/0.0484	A1
		(3)
(c)	$\frac{64.58-\mu}{\sigma} = -0.5244$ (Calc: – 0.524400...)	M1
	$\frac{69.46-\mu}{\sigma} = 1.2816$ (Calc: 1.281551)	M1
	$4.88 = 1.806\sigma \Rightarrow \sigma = 2.702...$ awrt 2.7 $\mu = 65.996...$ awrt 66	dM1A1
		(4)
	Notes	**Total 10**

(a)	**M1**	Standardising with 54.4, 51 and 1.7 (implied by ±2) or standardising with 48.45, 51 and 1.7 (implied by ±1.5) using 1.7^2 is M0
	M1	Standardising with 54.4, 51 and 1.7 **and** 48.45, 51 and 1.7 **and** attempt to find correct probability using $p - q$ oe (where $0.5 < p < 1$ and $0 < q < 0.5$) or $p - (1 - r)$ oe (where $0.5 < p < 1$ and $0.5 < r < 1$) If 1st M1 scored, then may be implied by correct answer
	A1	awrt 0.910 condone 0.91 correct answer with no working scores 0
(b)	**M1**	for a valid attempt to find $\mathrm{P}(53.55 < W < 54.4)$ e.g. $"0.9772" - (1 - "0.0668")$ May be implied by awrt 0.044/0.0441
	M1	for a conditional probability in the form $\frac{p}{"0.9104"}$ where $0 < p <$ "0.9104" assuming independence is M0 e.g. $\frac{p \times "0.9104"}{"0.9104"}$
	A1	awrt 0.0483/0.0484 No fractions
(c)	**M1**	for standardising 64.58 and setting equal to z value where $0.5 < \lvert z \rvert < 0.6$ **or** for standardising 69.46 and setting equal to z value where $1 < \lvert z \rvert < 1.5$
	M1	for standardising 64.58 and setting equal to z value where $-0.6 < z < -0.5$ oe with compatible signs **and** for standardising 69.46

		and setting equal to z value where $1 < z < 1.5$ oe with compatible signs
	dM1	Dep on 1st M1 for attempting to solve their two linear equations (using substitution or elimination) leading to an equation in one variable Implied by either $\sigma = \text{awrt } 2.7$ or $\mu = \text{awrt } 66$
	A1	both $\sigma = \text{awrt } 2.7$ **and** $\mu = \text{awrt } 66$ **and** both 0.5244 (or better) **and** 1.2816 (or better) seen

Question Number	Scheme	Marks
8(a)	$\frac{1}{2}\times\frac{1}{5}+\frac{1}{6}\times\frac{1}{10}+\frac{1}{3}\times\frac{1}{20}=\frac{2}{15}*$	B1*
		(1)
(b)	$\frac{\frac{1}{2}\times\frac{1}{5}}{\frac{2}{15}}\left[=\frac{\frac{1}{10}}{\frac{2}{15}}\right]=\frac{3}{4}*$ or $1-\frac{\frac{1}{6}\times\frac{1}{10}+\frac{1}{3}\times\frac{1}{20}}{\frac{2}{15}}=\frac{3}{4}*$	M1A1*
		(2)
(c)		B1B1 M1A1
		(4)

	Notes	Total 7
(a)	**B1***	for a correct expression which is the sum of three products of probabilities leading to the given answer allow $\frac{1}{10}+\frac{1}{60}+\frac{1}{60}=\frac{2}{15}$
(b)	**M1**	for $\frac{1}{2}\times\frac{1}{5}\left[=\frac{1}{10}\right]$ (do not award if embedded in an incorrect calculation) or use of 1 – …. with $\frac{1}{6}\times\frac{1}{10}+\frac{1}{3}\times\frac{1}{20}$
	A1*	for a fully correct expression leading to the given answer
(c)	**B1**	for $\frac{13}{15}$ oe in the correct place on the tree diagram
	B1	for $\frac{1}{8}$ oe and $\frac{1}{8}$ oe in the correct place on the tree diagram

	M1	for $\frac{\frac{4}{5}\times\frac{1}{2}}{\frac{13}{15}}\left[=\frac{6}{13}\right]$ oe or $\frac{\frac{1}{6}\times\frac{9}{10}}{\frac{13}{15}}\left[=\frac{9}{52}\right]$ oe or $\frac{\frac{1}{3}\times\frac{19}{20}}{\frac{13}{15}}\left[=\frac{19}{52}\right]$ oe implied by 1 correct probability in the correct place on tree diagram
	A1	for $\frac{6}{13}$ oe and $\frac{9}{52}$ oe and $\frac{19}{52}$ oe in the correct place on tree diagram