| 1 | (i) | | 0 \| 6
1 \| 5　8
2 \| 1　5　8
3 \| 1　1　3　5　8　9
Key　1 \| 8　represents 18 people | G1

G1

G1

[3] | Stem (in either order) and leaves
Sorted and aligned

Key | Do not allow leaves 21 ,25, 28 etc
Ignore commas between leaves
Allow stem 0, 10, 20, 30
Allow errors in leaves if sorted and aligned**.** Use paper test if unsure about alignment – hold a piece of paper vertically and the columns of leaves should all be separate. Alternatively place a pencil vertically over each column. If any figures protrude then deem this as non-alignment.
Highlight this error |
| | (ii) | | Negative | B1

[1] | | Allow -ve but NOT skewed to the left
Do not allow 'negative correlation' |

1	(iii)		Median = 29.5	B1	CAO	
			Mean = 26.7 (26.6666) or $26^2/_3$ or $^{80}/_3$ or $26.\dot{6}$	B1	CAO	Do not allow 27 but condone 26.6 www
			Mode = 31	B1	CAO	
			The mode is not at all useful as it is just by chance that it is 31.	E1	Allow any reasonable	

			Mark awarded for stating not useful and
			   -not representative of data
			   -does not represent Central Tendency
			   -happened by chance (or similar)
			   -comment about not appearing significantly more (only one repetition/only twice/ etc)
			
			 No mark for stating it would be useful
			 OR NOT USEFUL because of
			   -spread/range
			   -sample size
			   -negatively skewed
			   -unaffected by outliers
			   -isn't close to mean and median
					comment	

			[4]			

2	(i)		Inter-quartile range $= 18.1 - 17.8 = 0.3$	B1		
			Lower limit $17.8 - (1.5 \times 0.3)$ $(= 17.35)$	M1		FT their IQR for M marks only
			No outliers at lower end.	A1	dep on 17.35	Allow 'No values below 17.35 for first A1
						Allow 'Lower limit = 17.35 so no outliers (at lower end)'
						Watch for use of median giving 17.45 which gets M0A0
						You must be convinced that comments about no outliers refer to lower tail only.
			Upper limit $18.1 + (1.5 \times 0.3)$ $(= 18.55)$	M1		
			(Max is 18.6) so at least one outlier at upper end.	A1	dep on 18.55	Allow 'At least one value above 18.55' for second A1
						Allow 'any value above 18.55 is an outlier' so at least one outlier.

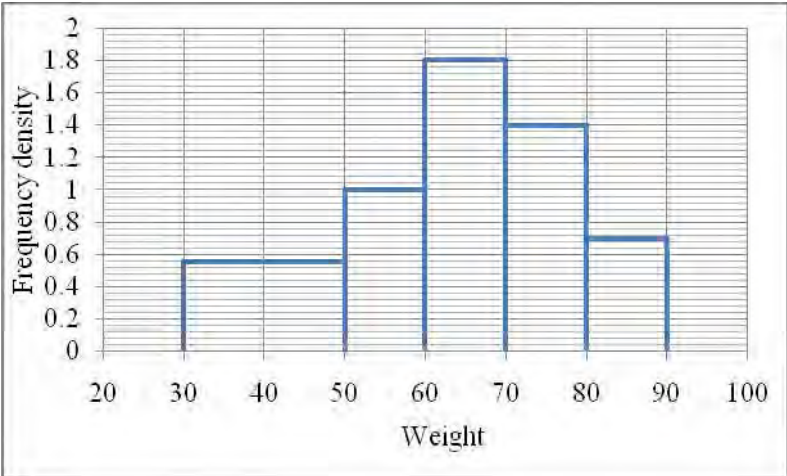| Question	Answer	Marks		Guidance
				Do not allow 'There MAY be one outlier' oe Condone 'one outlier' Condone 'there are outliers' Watch for use of median giving 18.35 which gets M0A0 You must be convinced that comments about some outliers refer to upper tail only.
		[5]		
2 (ii)	$P(A) = P(\text{All 3 have orange centres}) = \dfrac{7}{20} \times \dfrac{6}{19} \times \dfrac{5}{18} = \dfrac{7}{228}$	M1	For 7/20×	Allow final answer of 0.031 with working ALTERNATIVE SCHEME $^7C_3/^{20}C_3$ $= 35/1140 = 7/228 = 0.0307$ M1 for either term in correct position in a fraction M1 for correct fraction A1 CAO
		M1	For product of correct three fractions Without extra terms	
	$= 0.0307 \ (0.030702)$	A1	CAO Allow full marks for fully simplified fractional answers	
	$P(B) = P(\text{All 3 have same centres}) =$ $\left(\dfrac{7}{20} \times \dfrac{6}{19} \times \dfrac{5}{18} \right) + \left(\dfrac{6}{20} \times \dfrac{5}{19} \times \dfrac{4}{18} \right) + \left(\dfrac{4}{20} \times \dfrac{3}{19} \times \dfrac{2}{18} \right) + \left(\dfrac{3}{20} \times \dfrac{2}{19} \times \dfrac{1}{18} \right) =$	M1	For at least two correct triple products or fractions or decimals	ALTERNATIVE SCHEME $^7C_3/^{20}C_3$ $+ \ ^6C_3/^{20}C_3 + ^4C_3/^{20}C_3 + ^3C_3/^{20}C_3$ M1 for at least two correct terms
	$= 0.0307 + 0.0175 + 0.0035 + 0.0009$	M1	For sum of all four correct	M1 for sum of all four (all correct) either as combinations or decimals
	$= 0.0526 \quad = \dfrac{1}{19} \ (0.052632)$	A1	CAO	A1 CAO
	$\left(= \dfrac{7}{228} + \dfrac{1}{57} + \dfrac{1}{285} + \dfrac{1}{1140} \right)$	**[6]**	Allow 0.053 or anything which rounds up to 0.053 with working	**Please check all of the answer space for this part**

2	(iii)	$P(A\mid B) = \dfrac{0.0307..}{0.0526..}$	M1	For their 'A' divided by their 'B'	Allow 0.584 from $\dfrac{0.0307}{0.0526}$
		$= 0.583 \ (= 0.58333)$	A1	FT their answers to (ii) provided answer < 1	Allow $\dfrac{7}{12}$
		$P(B\mid A) = 1$	B1 **[3]**	CAO	
	(iv)	$P(\text{All have orange centres}) = 0.0307^2 = 0.00094 \ \text{or} = \dfrac{49}{51984}$ $= (0.00094260)$	M1 A1 **[2]**	For their 0.0307^2 FT	Allow 9.4×10^{-4} condone 0.0009 or 9×10^{-4}
	(v)	$P(\text{Has to select} > 2) = 1 - P(\text{Has to select} \leq 2)$ $= 1 - \left(\dfrac{14}{20} + \left(\dfrac{6}{20} \times \dfrac{14}{19}\right)\right) = 1 - (0.7 + 0.221) = 1 - 0.921$ $= 0.079 \quad (=0.078947)$	M1 M1 A1 **[3]**	For $\left(\dfrac{6}{20} \times \dfrac{14}{19}\right)$ For $1 -$ sum of both CAO	For any of the methods below allow SC2 for $1 - 0.079 = 0.921$ or $1 - 3/38 = 35/38$ o.e. as final answer This is $1 - P(C' + CC')$
		OR $P(\text{Has to select} > 2) = P(\text{First 2 both cherry}) = \left(\dfrac{6}{20} \times \dfrac{5}{19}\right)$ $= 0.079 \quad = \dfrac{3}{38}$	M2 A1	For whole product CAO	Without extra terms added M1 if multiplied by k/18 only where 0<k<18 (seen as a triple product only) This is $P(CC)$.

			OR $1 - (P(0 \text{ cherries}) + P(1 \text{ cherry}))=$ $1-\left(\dfrac{14}{20}\times\dfrac{13}{19}+\left(\dfrac{6}{20}\times\dfrac{14}{19}\right)+\left(\dfrac{14}{20}\times\dfrac{6}{19}\right)\right)$ $=1-(0.4789+0.2211+0.2211)=1-0.9209$ $=0.079$ **OR** $\left(\frac{6}{20}\times\frac{5}{19}\times\frac{14}{18}\right)+\left(\frac{6}{20}\times\frac{5}{19}\times\frac{4}{18}\times\frac{14}{17}\right)+\left(\frac{6}{20}\times\frac{5}{19}\times\frac{4}{18}\times\frac{3}{17}\times\frac{14}{16}\right)+\left(\frac{6}{20}\times\frac{5}{19}\times\frac{4}{18}\times\frac{3}{17}\times\frac{2}{16}\times\frac{14}{15}\right)+\left(\frac{6}{20}\times\frac{5}{19}\times\frac{4}{18}\times\frac{3}{17}\times\frac{2}{16}\times\frac{1}{15}\times\frac{14}{14}\right)$	M1 M1 A1 M1	For any term For 1 – sum of all three CAO For any term	This is $1 - P(\text{C'C' + CC' + C'C})$ This is $P(\text{CCC' + CCCC' + CCCCC'}$ $+ \text{CCCCCC' + CCCCCCC'})$
			$=\dfrac{7}{114}+\dfrac{14}{969}+\dfrac{7}{2584}+\dfrac{7}{19380}+\dfrac{1}{38760}$ $=0.079$	M1 A1	For sum of all five terms (all correct) CAO	

Question			Answer	Marks	Guidance
3	(i)		<table><tr><td>Upper Bound</td><td>20</td><td>30</td><td>40</td><td>50</td><td>60</td><td>70</td><td>80</td><td>90</td></tr><tr><td>Cumulative Freq</td><td>0</td><td>10</td><td>40</td><td>82</td><td>105</td><td>114</td><td>119</td><td>120</td></tr></table> 	B1 G1 G1 G1 G1 [5]	Cumulative frequencies All correct For plotted points (Provided plotted at correct UCB positions) For joining points (within ½ a square) For scales For labels All marks dep on good attempt at cumulative frequency, but not cumulative fx's or other spurious values.	Plotted within ½ small square If cf not given then allow G1 for good attempt at cf. e.g. if they have 0,10,40,72,95,104,109,110

Question			Answer	Marks		Guidance
3	(ii)					Based on 60th value ft their curve (not LCB's) Allow 40 for m.p. plot without checking graph B0 for interpolation If max value wrong (eg 110) FT their max value for all 3 marks
			Median = 45	B1	Allow answers between 44 and 46 without checking curve. Otherwise check curve. No marks if not using diagram.	
			Q1 = 37 Q3 = 53	B1	For Q3 or Q1 Allow Q1 between 37 and 38 without checking Allow Q3 between 52 and 54 without checking	Based on 30th and 90th values ft their curve (not LCB's) Allow Q1 = 32; Q3 = 48 without checking graph
			Inter-quartile range = 53 – 37 = 16	B1	For IQR providing both Q1 and Q3 are correct	B0 for interpolation B2 for correct IQR from graph if quartiles not stated but indicated on graph Allow from mid-point plot Must be good attempt at cumulative frequency in part (i) to score any marks here Lines of best fit: B0 B0 B0 here. Also cumulative frequency bars: B0 B0 B0 here
				[3]		

Question		Answer	Marks	Guidance

4 (i)

Weight	Frequency	Group Width	Frequency density
$30 \leq w < 50$	11	20	0.55
$50 \leq w < 60$	10	10	1
$60 \leq w < 70$	18	10	1.8
$70 \leq w < 80$	14	10	1.4
$80 \leq w < 90$	7	10	0.7

M1

For fd's - at least 3 correct
Accept any suitable unit for fd such as eg freq per 10g.

A1

G1

linear scales on both axes and labels

Vertical scale starting from zero (not broken - but can get final mark for heights if broken)

G1 width of bars

Guidance:

M1 can be also be gained from freq per 10 – 5.5, 10, 18, 14, 7 (at least 3 correct) or similar. If fd not explicitly given, M1 A1 can be gained from all heights correct (within half a square) on histogram (and M1A0 if at least 3 correct)

Linear scale and label on vertical axis IN RELATION to first M1 mark ie fd or frequency density or if relevant freq/10, etc (NOT eg fd/10).

However allow scale given as fd×10, or similar.
Accept f/w or f/cw (freq/width or freq/class width)

Ignore horizontal label

Can also be gained from an accurate key

G0 if correct label but not fd's.
Must be drawn at 30, 50 etc NOT 29.5 or 30.5 etc NO GAPS ALLOWED
Must have linear scale.
No inequality labels on their own such as 30 ≤W<50, 50 ≤W<60 etc but allow if 30, 50, 60 etc occur at the correct boundary position. See additional notes. Allow this mark even if not using fd's

Question			Answer	Marks		Guidance
				G1	height of bars	Height of bars – must be linear vertical scale. FT of heights dep on at least 3 heights correct and all must agree with their fds
						If fds not given and at least 3 heights correct then max M1A0G1G1G0
						Allow restart with correct heights if given fd wrong (for last three marks only)
				[5]		

Question	Answer	Marks	Guidance
4 (ii)	Mean = $$\frac{(40\times11)+(55\times10)+(65\times18)+(75\times14)+(85\times7)}{60} = \frac{3805}{60}$$	M1	For midpoints Products are 440, 550, 1170, 1050, 595	For midpoints (at least 3 correct) No marks for mean or sd unless using midpoints
	$= 63.4$ (or 63.42)	A1	CAO (exact answer 63.41666…)	Answer must NOT be left as improper fraction as this is an estimate Accept correct answers for mean and sd from calculator even if eg wrong Sxx given
	$\Sigma x^2 f = (40^2\times11)+(55^2\times10)+(65^2\times18)+(75^2\times14)+(85^2\times7)$ $= 253225$			
	$S_{xx} = 253225 - \dfrac{3805^2}{60} = 11924.6$	M1	For attempt at S_{xx} Should include sum of at least 3 correct multiples fx^2 $- \Sigma x^2/n$ At least 1dp required Use of mean 63.4 leading to answer of 14.29199.. with $S_{xx} = 12051.4$ gets full credit.	Allow M1 for anything which rounds to 11900 Allow SC1 for RMSD 14.1 (14.0976…) from calculator. Only penalise once in part (ii) for over specification, even if mean and standard deviation both over specified.
	$s = \sqrt{\dfrac{11924.6}{59}} = \sqrt{202.11} = 14.2$	A1	63.42 leads to 14.2014… Do not FT their incorrect mean (exact answer 14.2166…)	If using $(x-\bar{x})^2$ method, B2 if 14.2 or better (14.3 if use of 63.4), otherwise B0
		[4]		

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Question		Answer	Marks	Guidance	
4	**(iii)**	$\bar{x} - 2s = 63.4 - (2 \times 14.2) = 35$	M1	For either No marks in (iii) unless using $\bar{x} + 2s$ or $x - 2s$	Only follow through numerical values, not variables such as *s*, so if a candidate does not find *s* but then writes here 'limit is 63.4 + 2 × standard deviation', do NOT award M1
		$\bar{x} + 2s = 63.4 + (2 \times 14.2) = 91.8$	A1	For both (FT)	Do not penalise for over-specification
		So there are probably some outliers at the lower end, but none at the upper end	E1	Must include an element of doubt and must mention both ends	Must have correct limits to get this mark
			[3]		
	(iv)	Mean $= \dfrac{3624.5}{50} = 72.5\text{g}$ (or exact answer 72.49g)	B1	CAO Ignore units	
		$S_{xx} = 265416 - \dfrac{3624.5^2}{50} = 2676$	M1	For S_{xx}	M1 for 265416 - 50 × their mean^2 BUT NOTE M0 if their $S_{xx} < 0$ For s^2 of 54.6 (or better) allow M1A0 with or without working.
		$s = \sqrt{\dfrac{2676}{49}} = \sqrt{54.61} = 7.39\text{g}$	A1	CAO ignore units Allow 7.4 but NOT 7.3 (unless RMSD with working)	For RMSD of 7.3 (or better) allow M1A0 provided working seen For RMSD^2 of 53.5 (or better) allow M1A0 provided working seen
			[3]		

	Question		Answer	Marks	Guidance	
4	**(v)**		Variety A have lower average than Variety B oe	E1	FT their means Do not condone lower central tendency or lower mean	Allow 'on the whole' or similar in place of 'average'.
			Variety A have higher variation than Variety B oe	E1	FT their sd	Allow 'more spread' or similar but not 'higher range' or 'higher variance' Condone less consistent.
				[2]		