EXPERT TUITION

Maths Questions By Topic:

Data Presentation & Interpretation

Mark Scheme

A-Level Edexcel

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Qu	Scheme	Marks	AO
1. (a)	Negative (since gradient of regression line is negative)	B1 **(1)**	1.2
(b)	cm/day (o.e. e.g. cm day^{-1})	B1 **(1)**	2.2a
(c)	$3\times[\pm]1.1$ = decrease of 3.3 [cm]	M1 A1 **(2)**	3.4 1.1b
(d)	19 is (well) outside the range [1, 10] or involves extrapolation (o.e.) so (possibly) unreliable/ inaccurate (o.e.)	B1 **(1)**	2.4
		(5 marks)	

	Notes
	Answers may be written within the question.
(a)	B1 for stating "negative". Allow a correct interpretation e.g. as t increases then p decreases (o.e.) [ignore any values] B0 for contradictory statements e.g. "negative correlation since as t increases p increases"
(b)	B1 for a correct description of the units (allow fraction, /, or "per" and allow "d" for "day")
(c)	M1 for attempt at a calculation (allow use of $t = x$ and $t = x + 3$ followed by subtraction that should lead to 3.3) A1 for correct description must include word "decrease" (o.e.) and value "3.3" Just seeing: $22-1.1\times3=18.7$ is M0A0 BUT going on to subtract 18.7 from 22 scores M1 Reaching 3.3 and stating "decrease" or "reduced" (o.e.) will score the A1 too An answer of – 3.3 without a word describing decrease (o.e.) will just score M1A0
(d)	B1 for stating "unreliable" (o.e.) **and** giving a suitable reason based on idea of extrapolation Must have **both** statement about reliability **and** suitable reason e.g. t = 19 is too big or (Model is based on) t between 1 and 10 (only) [since this implies t = 19 is too big] Allow e.g. (model) "may not work" because of "extrapolation" Just saying "no" since "extrapolation" is B0 but "unreliable"(o.e.) since "extrapolation" is B1

Qu	Scheme	Mark	AO
2. (a)	<table><tr><th>Class</th><th>Frequency</th><th>Cum. Frequency</th></tr><tr><td>0 – 1</td><td>15</td><td>15</td></tr><tr><td>1 – 2</td><td>35</td><td>50</td></tr><tr><td>2 – 3.5</td><td>75</td><td>125</td></tr><tr><td>3.5 – 4.5</td><td>55</td><td>180</td></tr></table>	M1 A1	2.1 1.1b
	$\left[Q_2 =\right](3.5)+\frac{\frac{256}{2}-"125"}{"55"}\times(4.5-3.5)$ <u>or</u> $(4.5)-\frac{"180"-\frac{256}{2}}{"55"}\times 1$	M1	2.1
	$= 3.5545\ldots\ldots$ awrt **<u>3.55</u>**	A1 **(4)**	1.1b
(b)	Need area under curve to be 256 so $\int_{(0)}^{(8)} kx(8-x)\,\mathrm{d}x = 256$	M1	3.1a
	$k\left[4x^2-\frac{x^3}{3}\right]_{(0)}^{(8)} = 256$	M1	1.1b
	$\left\{k\left[4\times 8^2-\frac{8}{3}\times 8^2\right]=256\Rightarrow\right\}$ **<u>*k* = 3</u>**	A1 **(3)**	1.1b
(c)	[By symmetry median =] **<u>4</u>**	B1 **(1)**	2.2a
		(8 marks)	

	Notes
(a)	1st M1 for an attempt to form frequency table (at least 1st 4 rows and freq <u>or</u> cum freq seen must have the frequency of 75 correct and can condone one error/omission in 15, 35, 55) Frequencies or cum freq may be seen on bars of the histogram 1st A1 for identifying class, freq and cum freq (i.e. highlighted values from the table) <u>or</u> sight of 3.5-4.5, freq of 55 and "128" – 125 or 180 – "128" <u>or</u> diagram with 125, "128", 180, 3.5 & 4.5 May be implied by values in 2nd M1expression 2nd M1 for a correct calculation for Q_2 (condone error in end point e.g. 3.45 or 3.49 etc) Can ft their "125" (provided > 100) and their "55" Allow use of $(n + 1)$, usually see 128.5 – … leading to 3.5636… or awrt 3.56 2nd A1 awrt 3.55 but 3.555 is fine (allow 3.56 if $(n + 1)$ being used …need sight of $\frac{257}{2}$ etc) Correct answer with no incorrect working scores 4/4
(b)	1st M1 for identifying the need to find the area under the curve by integrating 2nd M1 for correct integration and = 256 (condone missing limits) A1 for $k = 3$ [May see use of calculator for the integration so score 2nd M1A1 together]
(c)	**NB The answer to part (c) may be written within the question.** B1 for 4 (Independent of their value of k but must be their "x" value) NB when $k = 0.25$ and $x = 4$ gives $y = 4$ so must be clear they intend median = 4 The statement in part (c) "$k = 4$" is B0

	Scheme	Marks	AO
3. (a)	Accept 990 to 1030 inclusive	B1 **(1)**	1.1b
(b)	Any range between 10 and 50 inclusive	B1 **(1)**	1.1b
		(2 marks)	

	Notes
(a)	B1 (Median pressures usually around 1000~1020) [LDS mark]
(b)	B1 Any answer in this range [LDS mark] Allow answers in the form $a \sim b$ where $\lvert b-a \rvert$ is between 10 and 50 Also allow the case where <u>both</u> a and b are in [10, 50]

Qu	Scheme	Marks	AO
4. (a)	From [5,20) fd = 3 or 1 large square = 2.5 passengers o.e.	M1	2.2a
	Correct bar above [0, 5)	A1	1.1b
	Correct bar above [20, 40)	A1	1.1b
		(3)	
(b)	For [40, 65) **130** passengers or for [65, 80) **60** passengers	M1	2.1
	For attempt to find total number of passengers = **331**	A1ft	1.1b
	[Median =] $40+\frac{\frac{1}{2}("331")-140}{"130"}\times 25$ or $65-\frac{270-\frac{1}{2}("331")}{"130"}\times 25$ (o.e.)	M1	1.1b
	$= 44.9038\ldots$ = awrt **44.9**	A1	1.1b
		(4)	
(c)	Upper outlier limit = $58.9 + 1.5\times(58.9 - 27.3) = 106\ (.3) > 90$	M1	2.4
	So oldest passenger is not an outlier	A1	2.2a
		(2)	
		(9 marks)	

	Notes
(a)	M1 for attempt at fd or a suitable method to deduce the scale for the histogram May be implied by one correct bar. 1st A1 for first bar [0, 5) with fd = 1 or 2 large squares high 2nd A1 for third bar with fd = 4.5 or 9 large squares high
(b)	1st M1 for an attempt using their fd to find the missing frequencies. May be in table 1st A1ft for a clear attempt to find the total number of passengers (ft their 130 and 60) 2nd M1 for any expression/equation leading to correct Q_2 Must be using 40-65 class 2nd A1 for awrt 44.9 (allow $(n + 1)$ leading to 45)
(c)	M1 for finding the upper outlier limit (expression or awrt 106) and stating or implying > 90 A1 dep on M1 seen for deducing NOT an outlier

Question	Scheme	Marks	AOs
5	1 square is $\frac{78}{12\times3+3\times4+2\times2}=\left[\frac{78}{52}=1.5\right]$ **and** $(8\times1+1\times8)\times"1.5"$	M1	3.1a
	24 students took less than 11 minutes	A1	1.1b
	Percentage of students = $\frac{"24"}{78+"24"+1\times8\times"1.5"+3\times4\times"1.5"}\times100$	M1	3.1b
	= 18.18… awrt 18%	A1	1.1b
		(4)	
			Total 4

Notes		
5	**M1:**	For clear use of frequency density to establish the fd scale and then use the area to find frequency of <11 minutes. Allow maximum of 3 errors in either the heights or widths in total if working shown. They may calculate the area using other size squares. Allow for realising they need to find the total number of squares (88) maximum of 4 errors in either the heights or widths and number < 11 minutes(16) - must have a maximum of 1 error in either the heights or widths (and not use the 78 as part of calulation)
	A1:	For correct values seen. Allow for 88 and 16
	M1:	For realising the need to find the total and calculating a percentage. (with "their 24" as the numerator). Allow $(8\times1+2\times8)\times"1.5"$ instead of $"24"+1\times8\times"1.5"$ If working shown can allow maximum of 2 errors in either the heights or widths in the calculation of the total. Allow "their 24" / 132 oe
	A1:	awrt 18

Question	Scheme	Marks	AOs
6(a)	0 to 500 m	B1	1.2
		(1)	
(b)	$1100+1600+1.5\times1600$ [= 5100]	M1	2.1
	5300 > 5100 therefore outlier	A1	1.1b
		(2)	
(c)	As the humidity increases the mean visibility decreases	B1	2.4
		(1)	
(d)	(Hours of) sunshine	B1	2.2b
		(1)	
			(5 marks)

Notes		
(a)	**B1:**	For realising it is the maximum distance and distance given with correct units. Allow 0 to 50dm or < 500m or < 50dm
(b)	**M1:**	Attempt to find Q_3 and the upper limit
	A1:	5100, if a value for the point is stated it must be above 5100 otherwise it is A0. For a statement comparing and conclusion it is an outlier or it is above Q_3 +1.5IQR. Allow accept the point circled is greater than 5100 oe
(c)	**B1:**	For a suitable interpretation of a negative correlation mentioning humidity and visibility
(d)	**B1:**	A correct deduction that the unlabelled variable is the hours of sunshine. Condone missing hours. Do not allow if more than one variable given. Must be quantative variable Not cloud cover since values bigger than 8 Not wind speed since values not integers Not daily mean temperature since mean temperature near to zero are unlikely in June

Question	Scheme	Marks	AOs
7(a)	$\sigma = \sqrt{\frac{3053}{160} - \left(\frac{692}{160}\right)^2}$	M1	1.1b
	$= 0.6129\ldots$ awrt 0.613	A1	1.1b
		(2)	
(b)(i)	This would have no effect as the piece of data would remain in the same class	B1	2.2a
(ii)	This would increase the standard deviation as change in mean is small and $6.4 - 4.6 \approx 3\sigma$ therefore estimate of standard deviation will increase	B1	2.2a
		(2)	
			(4 marks)

Notes		
(a)	**M1:**	A correct expression for σ
	A1:	Awrt 0.613 allow s = awrt 0.615
(b)	**B1:**	Correct deduction with suitable explanation Allow range for class. Do not allow there is no differences
	B1:	Correct deduction with suitable explanation. so would increase the standard deviation and a suitable reason. Allow the value is bigger than any others in the table **oe**

Question	Scheme	Marks	AOs
8(a)	Increase by 2.8 marks	B1	3.4
		(1)	
(b)	e.g. 'the best performance is predicted for the students who never wake up'	B1	3.5b
		(1)	
			(2 marks)

Notes

(a)	**B1:** Using the gradient of the regression equation must include increase(o.e.) and 2.8 'Increase by approximately 3 marks' is B0 but isw if 2.8 is seen $5.6 \div 2$ is not sufficient
(b)	**B1:** for any suitable limitation of the model e.g. the idea that the longer you sleep the better performance in the test or only valid between 0 and 24 hours (within range of the data) or only applicable to the amount of sleep the night before the test or only takes sleep into consideration/does not include other variables (factors) or cannot score below 26.1 marks on the test or the model might not be linear over the entire range or the model might predict more than the maximum mark B0: e.g. might not be correlation between *s* and *p* or individual student performance may vary

Question	Scheme	Marks	AOs
9 (a)	Tr(ace) (data needs to be converted to numbers before the calculation can be carried out)	B1	2.4
		(1)	
(b)	$[1+]\frac{138-131}{24}\times 4$	M1	2.1
	$= 2.1666\ldots$ awrt **2.17**	A1	1.1b
		(2)	
(c)	$\sigma = \sqrt{\frac{7704.1875}{184} - \left(\frac{539.75}{184}\right)^2} = 5.7676...$ $\sigma =$ awrt **5.77**	M1 A1	1.1b 1.1b
		(2)	
(d)(i)	Using class midpoints to estimate the mean assumes that the values are uniformly distributed **within the class(es)**.	B1	2.4
(ii)& (iii)	This is not the case here as the majority of the data (in the first class) are 0.	B1	2.3
	The actual mean is likely to be smaller than the estimate (since the first group has more values at 0 and close to 0)	dB1	2.2b
		(3)	
			(8 marks)

Notes	
(a)	**B1:** Identifying tr(ace) data Ignore comments about n/a, missing data, anomalies, etc.
(b)	**M1:** Correct fraction $\frac{7}{24}\times 4$ allow working down $[5]-\frac{155-138}{24}\times 4$ allow a correct equation leading to a correct fraction e.g. $\frac{x-1}{5-1}=\frac{138-131}{155-131}$ for M1 Use of $(n + 1)$ with 138.75 allow $\frac{7.75}{24}\times 4$ **A1:** awrt 2.17 (condone $\frac{13}{6}$) awrt 2.29 from $(n + 1)$ (condone $\frac{55}{24}$)
(c)	**M1:** Correct expression for standard deviation (allow mean = awrt 2.93) **A1:** awrt 5.77 correct answer only scores M1A1 (allow $s = 5.78$) **SC:** 5.76 with no working scores M1A0
(d)(i)	**B1:** Explaining that data assumed to be spread evenly across each class (o.e.) e.g. The midpoint of each class is the mean of each class or all the values in the class are located at the midpoint condone normally distributed within each class
Mark together (ii)&(iii)	**B1:** Demonstrating an understanding of the LDS that the majority of data values (in the first class) are at 0 or close to 0 (trace). **dB1:** (dependent upon 2nd B1) Correct inference based on knowledge of the LDS **SC:** If B1 is scored in (i) for 'The data are spread evenly across each class,' then in (ii) 'The data are not evenly distributed in the classes' scores B1 but in (iii) 'the actual mean is smaller' with no further justification scores B0

Qu	Scheme	Marks	AO
10(a)	Positive (correlation)	B1 (1)	1.2
(b)	Every extra point gives £4.5(0) more on pay (o.e.)	B1 (1)	3.4
(c)	e.g. For points < 11 it would give pay < 0 which is ridiculous	B1 (1)	2.4
		(3 marks)	

	Notes
(a)	B1 for "positive". Allow an interpretation e.g. "as points increase pay increases" is B1 Read whole answer: contradictory comments such as "positive correlation, as points increase pay decreases" scores B0
(b)	B1 for any correct comment conveying idea of <u>£s per point</u> and including a correct value; must have idea of <u>rate</u>. Can condone missing £ sign. Accept 4.5 e.g. "every 10 points earns an <u>extra</u> (or increase) of £45" is B1 BUT "every point earns £4.5(0)" is B0 *doesn't have idea of rate*
(c)	B1 for a suitable comment mentioning "points" or "pay" (o.e. e.g. "amount") <u>or</u> commenting on "small sample" or "range of points" used to find line <u>The following examples would score B1</u> Can say that *n* <u>points</u> (for $n < 10.\dot{4}$) would give <u>negative pay</u> so not suitable Any comment suggesting that some jobs would end up with <u>negative pay</u> Don't know the <u>range of points</u> used to find the <u>regression line</u> A <u>small sample</u> of <u>size</u> 8 may not be <u>representative</u> to cover all jobs B0 for a focus on "qualifications" or "hours" worked only <u>The following examples would score B0</u> Some jobs require no (or low) skills or qualifications (*need negative pay*)

Qu	Scheme	Marks	AO
11 (a)	$\bar{x} = 10.2\,(2222\ldots)$ awrt **10.2**	B1 (1)	1.1b
(b)	$\sigma_x = 3.17\,(20227\ldots)$ awrt **3.17**	B1ft	1.1b
	Sight of "knots" or "kn" (condone knots/s etc)	B1 (2)	1.2
(c)	October ….. since	B1	2.2b
	it is windier in the autumn or month of the hurricane or latest month in the year	B1 (2)	2.4
(d)(i)	They represent outliers	B1	1.2
(ii)	*Y* has low median so expect lowish mean (but outlier so > 7) and *Y* has big range/IQR or spread so expect larger st.dev	M1	2.4
	Suggests *B*	A1 (3)	2.2b
		(8 marks)	

Notes

NB $\bar{x} = \frac{184}{18}$ and $\sigma_x = \sqrt{\frac{2062}{18} - \bar{x}^2}$

(a) B1 for $\bar{x} = 10.2$ (allow exact fraction)

(b) 1st B1ft allow 3.2 from a correct expr' accept $s = 3.26(3984\ldots)$ [ft use of n/a]
Treating n/a as 0 May see $n = 31$ or $\bar{x} = 5.9354...$ which is B0 in (a) but here in (b) it gives $\sigma_x = 5.59(34\ldots)$ or $s = 5.6858\ldots$(awrt 5.69) and scores 1st B1
2nd B1 accept kn accept in (a) or (b) (allow nautical miles/hour)

(c) 1st B1 choosing October but accept September.
2nd B1 for stating that (Camborne) is windier in autumn/winter months "because it is winter/autumn/windier/colder in "month" " Sep $\leqslant$ "month" $\leqslant$ Mar
scores B1B1 for "month" = Sep or Oct and B0B1 for other months in range

(d)(i) B1 for outlier or the idea of an extreme value allow "anomaly"

(ii) M1 for a comment relating to location that mentions both median and mean and a comment relating to spread that mentions both range/IQR and standard deviation and leads to choosing *B*, *C* or *D*

ALT	**Choosing *A* or *E* is M0** Incorrect/false statements score M0 e.g. Q_3 = (mean + σ) or identify Q_2 = mean or *Y* has small spread **Use of outliers:** outlier is **(**mean + 3σ) (B = 19.9), (C = 18.95), (D = 20.2) Must <u>see</u> at least one of these values and compare to *Y*'s outlier[leads to *D* or *B*] A1 for suitable inference i.e. *B* (accept *D* <u>or</u> *B* or *D*) M1 **must** be scored

Question	Scheme	Marks	AOs
12(a)	$[Q_2 =]\ (5+)\ \frac{12}{15}\times 5$ **or** (use of $(n+1)$) $(5+)\frac{12.5}{15}\times 5$	M1	1.1a
	$= 9$ **or** 9.166… awrt 9.17	A1	1.1b
		(2)	
(b)	$[\sigma_x =]\ \sqrt{\frac{5675}{30}-\left(\frac{355}{30}\right)^2}\ = \sqrt{49.14...}$	M1	1.1a
	$=$ **awrt 7.01**	A1	1.1b
	Accept $\left(s_x = \sqrt{\frac{5675-30\left(\frac{355}{30}\right)^2}{29}} = 7.1294... \right)$	**(2)**	
(c)	$x = \frac{t-15}{2}$ or $t = 2x+15$	M1	3.1b
	Median $= 2' "9" + 15 = 33$ (allow awrt 33.3 from "9.17" in (a))	A1ft	1.1b
	Sd $= 2' "7.01" =$ 14.02... (awrt 14.0) [allow awrt 14.3 if s used]	A1ft	1.1b
		(3)	
(d)	The median time is "33" and "33" < 35 so 50% (30) should finish in 35 minutes. ALT Probability of being < 35 mins is $\frac{18}{30}$ \ $\frac{18}{30}' 60 = 36$ applicants to choose from.	M1	2.4
	It is likely that they will fill all 25 positions [providing those offered accept]	A1	2.2b
		(2)	

Notes: **(9 marks)**

(a) **M1:** For a suitable fraction $\times 5$ (ignore end points)
A1: For 9 or awrt 9.17 if using $n + 1$

(b) **M1:** For a correct expression for $\bar{x}$ and s_x or s_x
A1: For awrt $s_x = 7.01$ or $s_x =$ awrt 7.13

(c) **M1:** For realising $x = \frac{t-15}{2}$ and then rearranging to get a correct equation with t as the subject
May be implied by a correct answer for the median of t.
A1ft: ft their median
A1ft: ft their s_x or s_x. NB using s gives awrt14.3

(d) **M1:** For a suitable comparison following through their value for the median of t.
A1: A correct conclusion in context following through their value for the median of t.

Question	Scheme	Marks	AOs
13	$\left[\overline{t} = \frac{374}{20} = 18.7\right]$ $\sigma_t = \sqrt{\frac{7600}{20} - \overline{t}^2}$ $[= \sqrt{30.31}]$	M1	1.1a
	$= 5.5054\ldots$ awrt **5.51** (Accept use of $s_t = \sqrt{\frac{7600 - 20\overline{t}^2}{19}} = 5.6484\ldots$)	A1	1.1b
			(2 marks)
Notes:			
M1: For a correct expression for $\overline{t}$ and σ_t or s_t ft an incorrect evaluation of $\overline{t}$ **A1**: For σ_t = awrt 5.51 or s_t = awrt 5.65			

Question	Scheme	Marks	AOs
14	$17 + 45 + \frac{1}{3} \times 9$ $[= 65]$	M1	2.2a
	$(7 - 8)$ **14** or $(16 - 20)$ **5** [Values may be seen in the table]	M1 A1	3.1a 1.1b
	Percentage of motorists is $\frac{"65"}{6 + "14" + 17 + 45 + 9 + "5"} \times 100$	M1	3.1b
	= **67.7%**	A1	1.1b
			(5 marks)
Notes:			
M1: For a fully correct expression for the number of motorists in the interval **M1**: For clear use of frequency density in (4- 6) or (13- 15) cases to establish the fd scale. Then use of area to find frequency in one of the missing cases **A1:** For both correct values seen **M1**: For realising that total is required and attempting a correct expression for % **A1:** For awrt 67.7%			

Question	Scheme	Marks	AOs
15(a)	IQR = 2.3 and $20.6 \gg 2.4 + 1.5 \times 2.3$ (= 5.85) (Compare correct values)	B1	1.1b
		(1)	
(b)(i)	e.g. It is a piece of data and we should consider all the data o.e.	B1	2.4
(ii)	e.g. It is an extreme value and could unduly influence the analysis **or** It could be a mistake	B1	2.4
		(2)	
(c)	e.g. "as humidity increases rainfall increases"	B1	2.2b
		(1)	
(d)	e.g. a 10% increase in humidity gives rise to a 1.5 mm increase in rainfall **or** represents 0.15mm of rainfall per percentage of humidity	B1	3.4
		(1)	
			(5 marks)

Question	Scheme	Marks	AOs
16(a)	tr	B1	1.2
		(1)	
(b)(i)	$\mu = \frac{174.9}{31} = 5.6419\ldots$ awrt 5.64	B1	1.1b
(ii)	$\sigma_r = \sqrt{\frac{3523.283}{31} - \mu^2}$	M1	1.1b
	$= 9.04559\ldots$ awrt 9.05	A1	1.1b
		(3)	
(c)	Leuchars is in the North and Camborne is in the South	M1	2.4
	The mean is smaller for Leuchars than Camborne therefore there is no evidence that Dian's belief is true	A1ft	2.2b
		(2)	**(6 marks)**

Notes:

(a)	**B1**	Allow Tr or trace or Trace
(b)(i)	**B1**	For a correct mean awrt 5.64
(ii)	**M1**	For a correct expression for sd including the $\sqrt{}$ Ft their mean
	A1	awrt 9.05 (Allow s = 9.1932… awrt 9.19) NB awrt to 9.05 or 9.19 with no working is M1 A1
(c)	**M1**	For stating Leuchars is North of Camborne oe eg Camborne is further south
	A1ft	M1 must be awarded. A correct conclusion **and** correct comment about the means ft their mean in (b) Allow No
	SC	for No **and** there are only 2 places used so there is insufficient data. Mark as M0A1 on epen

Question	Scheme		Marks	AOs
17(a)	eg As the number of minutes <u>exercise</u> (m) increases the resting <u>heart rate</u> (h) decreases **or** the gradient of the curve is becoming flatter with increasing m: diminishing effect of each <u>additional minute</u> of <u>exercise</u>		B1	2.4
			(1)	
(b)	$\log_{10} h = -0.05\log_{10} m + 1.92$	$h = am^k \rightarrow \log_{10} h = \log_{10} am^k$	M1	1.1b
	$\log_{10} h = -\log_{10} m^{0.05} + 1.92$ or $\log_{10} h = \log_{10} m^{-0.05} + 1.92$ or $h = 10^{1.92-0.05\log_{10} m}$ oe	$\log_{10} h = \log_{10} a + \log_{10} m^k$ or $\log_{10} a = 1.92$	M1	2.1
	$\log_{10} hm^{0.05} = 1.92$ or $\log_{10}\left(\frac{h}{m^{-0.05}}\right) = 1.92$ or $h = 10^{1.92} \times 10^{-0.05\log_{10} m}$ oe	$\log_{10} h = \log_{10} a + k\log_{10} m$	M1	1.1b
	$hm^{0.05} = 10^{1.92}$ or $\frac{h}{m^{-0.05}} = 10^{1.92}$ or $h = 10^{1.92} \times 10^{\log_{10} m^{-0.05}}$	$\log_{10} a = 1.92$ and $k = -0.05$	M1	1.1b
	$h = 10^{1.92} m^{-0.05}$ or $h = 83.17...m^{-0.05}$ or a = awrt 83.17 **and** $k = -0.05$		A1	1.1b
			(5)	

Notes: **(6 marks)**

(a)	**B1**	eg Idea as one increases the other decreases (in context). Allow use of m and h eg As m increases h decreases. Do not allow negative correlation with no context or $\rho < 0$ Allow there is a negative correlation/association/relationship/exponential between minutes <u>exercise</u>(m) and resting <u>heart rate</u> (h) oe
(b)		**In this part once M0 is scored no more marks can be scored. Condone no base**
	M1	**May be implied by 2nd M1 mark** Method 1: Correct substitution for both x and y Method 2 : Taking the log of both sides
	M1	**May be implied by 3rd M1 mark** Method 1: Correct use of the power log rule **or** making h the subject Method 2 : Correct use of the addition/subtraction log rule
	M1	**This line implies M1M1M1** Method 1: Correct use of the addition/subtraction log rule or eq^n in the form $h = 10^{1.92} \times 10^{-0.05\log m}$ Method 2: A second correct step for correct use of the power log rule
	M1	**This line implies M1M1M1M1** Method 1: Correct removal of logs or $h = 10^{1.92} \times 10^{\log m^{-0.05}}$ Method 2: Log a (or a) and k correct
	A1	Allow h = awrt $83.2m^{-0.05}$ NB award 5/5 for a = awrt 83.2 and $k = -0.05$ or h = awrt $83.2...m^{-0.05}$ or $h = 10^{1.92} m^{-0.05}$

Qu 18	Scheme	Marks	AO
(a)	Negative	B1 **(1)**	1.2
(b)	Marc's suggestion <u>is compatible</u> because it's <u>negative correlation</u>	B1 **(1)**	2.4
		(2 marks)	
	Notes		
(a)	B1 for "negative" Allow "slight" or "weak" etc Allow a description e.g. "as x increases y decreases" or in context e.g. "people with longer last names tend to have shorter first names" A comment of "negative skew" is B0 **Need to see distinct or separate responses for (a) and (b)**		
(b)	B1 for a comment that suggests data is compatible with the suggestion **and** a suitable reason such as "there is negative correlation" <u>or</u> a description in x and y or in context <u>or</u> the points lie close to a line with <u>negative gradient</u> <u>or</u> draw line $y = x$ and state that <u>more points below the line</u> so <u>supports (or is compatible with)</u> his suggestion A reason based on just a **single point** is B0 e.g. " 11 letters in last name has only 5 in first name"		

Qu 19	Scheme	Marks	AO
(a)	Hectopascal <u>or</u> hPa	B1 **(1)**	1.2
(b)	$\overline{x} = \overline{y} + 1010$ <u>or</u> $\frac{214}{30} + 1010$	M1	1.1b
	= 1017.1333… awrt **<u>1017</u>**	A1 **(2)**	1.1b
(c)	$\sigma_x = \sigma_y$ (or statement that standard deviation is not affected by this type of coding)	M1	3.1b
	$\left[\sigma_y =\right] \sqrt{\frac{5912}{30} - ("7.13[33...]")^2}$ <u>or</u> $\sqrt{146.1822...}$	M1	1.1b
	= 12.0905… awrt **<u>12.1</u>**	A1 **(3)**	1.1b
(d)	High pressure (since approx. mean + sd) so clockwise Locations are (from North to South): Leuchars, Heathrow, Hurn	B1	2.4
	Wind direction is direction wind blows <u>from</u> So: Heathrow (**NE**) Hurn (**E**) Leuchars (**W**)	B1 **(2)**	2.2a
		(8 marks)	

	Notes
FYI	1 hPa = 100 Pa; 10hPa = 1 kPa; 1Pa = 1 Nm^{-2}
(a)	B1 for "hectopascal" <u>or</u> hPa (condone pascals, allow millibars <u>or</u> mb) o.e. Do NOT allow kPa <u>or</u> kilopascals <u>or</u> Pa on its own
(b)	M1 for a strategy to find $\overline{x}$ Allow an attempt to find $\sum x$ that gets as far as $\sum x = \sum y - 30 \times 1010$ [= 30 514] A1 for awrt 1017 (accept 1020) [Ignore incorrect units]
(c)	1st M1 for an overall strategy using the fact $\sigma_x = \sigma_y$ (can be implied by correct <u>final</u> ans) <u>or</u> for $\sum x = 30\,514$ and $\sum x^2 = 31\,041\,192$ (both seen and correct) 2nd M1 for a correct expression (with $\sqrt{}$)(ft their $\overline{y}$ to 3sf) allow awrt 146 for 146.1822.. <u>or</u> for correct expression in x can ft their $\sum x > 30\,000$ or their answer to (b) A1 (dep on 2nd M1) for awrt 12.1 [Ignore incorrect units]
Final answer	Final ans of awrt 12.1 scores 3/3 **but** if they then adjust for x e.g. add 1010 (M0M1A1)
(d)	1st B1 for at least one of these reasons (these 2 lines) clearly stated (may see diagram) Need "high pressure" **and** "clockwise" to score on 1st line Contradictory statements B0 e.g. correct N~S list but say "anticlockwise" 2nd B1 (indep of 1st B1) for deducing the 3 correct directions either in the table or stated as above If the answers in table and text are different we take the table (as question says)

Qu 20	Scheme	Marks	AO
(a)	Negative	B1 **(1)**	1.2
(b)(i) **(ii)**	Rainfall mm or Pressure hPa or Pascals or hectopascals or mb or millibars	B1 B1ft **(2)**	2.2b 1.1b
(c)	Humidity is high and there is evidence of correlation and $r < 0$ So expect amount of sunshine to be lower than the average for Heathrow(oe)	B1 **(1)**	2.2b
		(4 marks)	

	Notes
(a)	B1 for stating negative. "Negative skew" is B0 though
(b)(i)	B1 for mentioning "rainfall" (allow "rain" or "precipitation") or "pressure" (if more than 1 answer both must be correct) NB the other quantitative variable for Perth is: Daily Mean Wind Speed and scores B0 [Not allowed "wind speed" since $r = +0.15$ and in winter might expect wind to raise temp]
(ii)	B1ft for giving the correct units. If Daily Mean Wind Speed (kn) or knots "Wind speed" and "knots" would score B0B1 but any other variable scores B0B0
(c)	B1 for stating low amount of sunshine (o. e.) **and** some reference to $r < 0$ or fog Check for the following 2 features: (i) **low** sunshine: allow $\leqslant$ 5 hrs (LDS mean for 2015 is 5.3, humidity 97% is 4.1, $\geqslant$ 97% is 3.1) (ii) **negative** correlation may be described in words e.g. "high humidity gives low sunshine" or **fog** (LDS says >95% humidity is foggy) so less sunshine

Qu 21	Scheme	Marks	AO
(a)	[68 – 7 =] **61** (only)	B1 **(1)**	1.1b
(b)	[25 – 14] = **11**	B1 **(1)**	1.1b
(c)	$\left[\mu \text{ or } \bar{x} = \frac{607.5}{27} = \right]$ = **22.5**	B1 **(1)**	1.1b
(d)	$\sigma = \sqrt{\frac{17\,623.25}{27} - "22.5"^2}$ or $\sqrt{146.4629...}$	M1	1.1b
	= 12.10218… awrt **12.1**	A1 **(2)**	1.1b
(e)	$\mu + 3\sigma = "22.5" + 3 \times "12.1..."$ = awrt 59 so only **one** outlier	B1ft **(1)**	1.1b
(f)	Median increases implies that both values must be > 20	M1	3.1b
	Mean is the same means that $a + b = 45$	M1	1.1b
	So possible values are: e.g. $b = 21$ and $a = 24$ (o.e.)	A1 **(3)**	2.2b
(g)	Both values will be less than 1 standard deviation from the mean and so the standard deviation of all 29 values will be smaller	B1 **(1)**	2.4
		(10 marks)	

	Notes
(a)	B1 for correctly interpreting the box plot to find the range (more than 1 answer is B0)
(b)	B1 for correct understanding of IQR and answer of 11
(c)	B1 for 22.5 only (or exact equivalent such as $\frac{45}{2}$). Allow 22 mins and 30 secs.
(d)	M1 for a correct expression including square root. Allow $\sqrt{146}$ or better. Ft their mean A1 for awrt 12.1 NB Allow use of s = 12.3327… or awrt 12.3
(e)	B1ft for a correct calculation or value based on their μ and σ and compatible conclusion
(f)	1st M1 Correct start to the problem and a correct statement about the values based on median Allow if their final two values are both >20 2nd M1 for a correct explanation leading to equation $a + b = 45$ (o.e. e.g. equidistant from mean) Allow if their final two values sum to 45 A1 for a correct pair of values (both > 20 with a sum of 45) **and** at least some attempt to explain how their values satisfy at least one of the conditions (both > 20 or $a + b = 45$). Ignore $a =$ or $b =$ labels **NB** The values for a and b do not need to be integers.
(g)	B1 for a correct explanation. Must mention that both values are less than 1 sd (ft their answer to (d)) from the mean

Question	Scheme	Marks	AOs
22(a)	IQR = 26.6 – 19.4 [= 7.2]	B1	2.1
	19.4 – 1.5 × '7.2' [= 8.6] or 26.6 + 1.5 × '7.2' [= 37.4]	M1	1.1b
	Plotting one upper whisker to 32.5 **and** one lower whisker to 8.6 or 9.1	A1	1.1b
	Plotting 7.6 and 8.1 as the only two outliers	A1	1.1b
		(4)	
(b)	October (since it is the month with the coldest temperatures between May and October in Beijing)	B1	2.4
		(1)	
(c)	$[\sigma =]\sqrt{\frac{4952.906}{184}}$ or e.g. $[\sigma =]\sqrt{\frac{S_{xx}}{n}} = 5.188...$ [=5.19*]	B1cso*	1.1b
		(1)	
			(6 marks)

Notes

(a)	**B1:** for a correct calculation for the IQR (implied by 10.8 **or** 8.6 **or** 37.4 seen) **M1:** for a complete method for either lower outlier limit or upper outlier limit (allow ft on their IQR) (may be implied by the 1st A1 or a lower whisker at 8.6) **A1:** both whiskers plotted correctly (allow ½ square tolerance) **A1:** only two outliers plotted, 7.6 and 8.1 (must be disconnected from whisker) **NOTE:** A fully correct box plot with no incorrect working scores 4/4
(c)	**B1cso*:** Correct expression with square root **or** correct formula and 5.188 or better Allow a complete correct method finding $\sum x^2 = $ awrt 98720 and $\sigma = \sqrt{\frac{98715.9...}{184} - \left(\frac{4153.6}{184}\right)^2}$

Qu 23	Scheme	Marks	AO
(a)	[58 – 26 =] **<u>32</u>** (min)	B1 (1)	1.1b
(b)	$\mu = \frac{4133}{95} = 43.505263\ldots$ **awrt <u>43.5</u> (min)**	B1	1.1b
	$\sigma_x = \sqrt{\frac{202\,294}{95} - \mu^2} = \sqrt{236.7026...}$	M1	1.1b
	= 15.385… **awrt <u>15.4</u> (min)**	A1 (3)	1.1b
(c)	There are outliers in the data (or data is skew) which will affect mean and sd	B1	2.4
	Therefore use median and IQR	dB1 (2)	2.4
(d)	Value of 20, LQ at 26 and outliers will not change <u>or</u> state that median and upper quartile are the values that <u>do</u> change	B1	1.1b
	<u>More values now below 40 than above</u> so Q_2 <u>or</u> Q_3 will change and be lower	M1	2.1
	Both Q_2 <u>and</u> Q_3 will be lower	A1 (3)	2.4
		(9 marks)	

Notes

(b)
B1 for a correct mean (awrt 43.5)
M1 for a correct expression for the sd (including $\sqrt{\ }$)ft their mean
A1 for awrt 15.4 (Allow s = 15.4667… awrt 15.5)

(c)
1st B1 for acknowledging <u>outliers</u> or <u>skewness</u> are a problem for <u>mean and sd</u>
"extreme values"/"anomalies" OK May be implied by saying median and IQR not affected by..
We need to see mention of "outliers", "skewness" and the problem so "data is skewed so use median and IQR" is B0 unless mention that they are not affected by extreme values <u>or</u> mean and standard deviation can be "inflated" by the positive skew etc
2nd dB1 dep on 1st B1 for therefore choosing <u>median and IQR</u>

(d)
B1 for identifying 2 of these 3 groups of unchanged values or stating only Q_2 and Q_3 change
M1 for <u>explaining</u> that median or UQ should be lower.
E.g. the 2 values have moved to below 40 (or 58) and therefore more than 50% below 40 or (more than 75% below 58) <u>or</u> an argument to show that the other 3 values are the same. (o.e.)
Allow arrows on box plot provided statement in words about increased % below 40 or 58 etc
A1 for stating median <u>and</u> UQ are both lower with clear evidence of M1 scored

[If lots of values on 40 then median might not change but, since two values <u>do</u> change then UQ would change. If this meant that 92 became an outlier then we would have a new value for upper whisker and an extra outlier so effectively 3 values are altered. So median changes]

Question	Scheme	Marks	AOs
24(a)	Width = $0.4\times\ 5 =$ **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)**	
			(8 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)

Question	Scheme	Marks	AOs
25(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)**	1.2
(b)	Beijing and Jacksonville	B1	2.2a
		(1)	
(c)	Beijing and Jacksonville are the closest to the equator	B1	2.4
		(1)	
(d)	Use data from one place.	B1	2.4
		(1)	
			(4 marks)
Notes:			
(a) B1: for a correct statement using the data in the table			
(b) B1: both Beijing and Jacksonville – they do not need to be attached to G and H correctly.			
(c) B1: for the idea they are near the equator dependent only Beijing or Jacksonville being given in part(c)			

Question	Scheme	Marks	AOs
26(a)	**Area** = $8\times1.5=12$ cm^2 **Frequency** = 8 so 1 cm^2 = $\frac{2}{3}$ **hour (o.e.)**	M1	3.1a
	Frequency of 12 corresponds to area of 18 so height = $18\div2.5$ = **7.2 (cm)**	A1	1.1b
	Width = 5×0.5 = **2.5 (cm)**	B1cao	1.1b
		(3)	
(b)	$[\bar{y}=]\ \frac{205.5}{31}=$ awrt 6.63	B1cao	1.1b
	$\left[\sigma_y=\right]\ \sqrt{\frac{1785.25}{31}-\bar{y}^2}\ =\sqrt{13.644641}$ = **awrt 3.69** allow $[s=]\ \sqrt{\frac{1785.25-31\bar{y}^2}{30}}$ = **awrt 3.75**	M1 A1	1.1a 1.1b
		(3)	
(c)	Mean of Heathrow is higher than Hurn and standard deviation smaller suggesting Heathrow is more reliable	M1	2.4
	Hurn is South of Heathrow so does <u>not</u> support his belief	A1	2.2b
		(2)	
(d)	$\bar{x}+\sigma\approx10.3$ so number of days is e.g. $\frac{(11-"10.3")}{3}\times8\ (+5)$	M1	1.1b
	= 6.86 so **7 days**	A1	1.1b
		(2)	
			(10 marks)

Notes:

(a)

M1: for clear attempt to relate the area to frequency. Can also award if their height $\times$ their width = 18

A1: for height = 7.2 (cm)

(b)

M1: for a correct expression for σ or s, can ft their value for mean

A1: awrt 3.69 (allow s = 3.75)

(c)

M1: for a suitable comparison of standard deviations to comment on reliability.

A1: for stating Hurn is south of Heathrow and a correct conclusion

(d)

M1: for a correct expression – ft their $\bar{x}+\sigma\approx10.3$

A1: for 7 days but accept 6 (rounding down) following a correct expression

Question Number	Scheme	Marks
27. (a)	(3 – 6) mins has width 4 and is 2cm, (11 – 15) mins has width 5 so is **2.5**(cm) (3 – 6) mins has frequency of 38 and area of 19 cm^2 so 2 people(per cm^2)(o.e.) or frequency density $= \frac{38}{4} = 9.5 =$ height (11 – 15) mins has area of $2.5 \times h$ cm^2 so $h = \frac{12}{2 \times 2.5} =$ **2.4** (cm) allow $\frac{12}{5}$	B1 M1 A1 (3)
(b)	$Q_2 = (6.5) + \frac{12}{25} \times 2$ or $(8.5) - \frac{13}{25} \times 2$ = awrt **7.46**	M1 A1 (2)
(c)	$\sum fx = 38 \times 4.5 + ... + 7 \times 18 = 811.5$ and $\overline{x} = \frac{811.5}{100}$, = awrt **8.12**	M1, A1 (2)
(d)	$\sigma = \sqrt{\frac{8096.25}{100} - \overline{x}^2} = \sqrt{80.9625 - "65.85..."} = \sqrt{15.1(0)...}$, = awrt **3.89**	M1, A1 (2) **[Tot 9]**

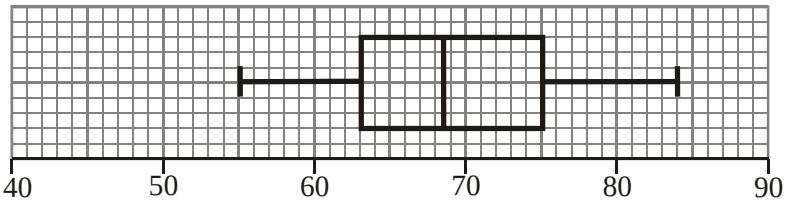
	Notes
(a)	B1 for width of 2.5 (cm) allow $\frac{5}{2}$ M1 for 2 people per cm^2 or a correct numerical equ'n for h or their width $\times$ height = 6 A1 for height of 2.4 (cm) [If just see 2.4 and 2.5 it must be clear which is h and which w]
(b)	M1 for a correct expr'n with sign (ignoring end point). Condone 12.5 for use of $(n + 1)$ A1 for awrt 7.46 (or 7.5 if using $(n + 1)$ but must see evidence of $(n + 1)$ approach)
(c)	M1 for an attempt at Σfx (i.e. full expression or $650 < \Sigma fx < 950$) and division by 100 Σfx may be in the table. A1 for 8.115 or awrt 8.12 (allow 8.11) [May be in (d) but must be labelled e.g. $\overline{x} = ...$]
(d)	M1 for a correct expression (ft their mean) including $\sqrt{}$. Allow s leading to $\sqrt{15.26...}$ A1 for awrt 3.89 Allow use of s = awrt 3.91 [Correct ans. only to (c) or (d) full marks]

Question Number	Scheme	Marks
28. (a)	Width (w) = **4** cm	B1
	Areas: 16 cm^2 represents 32 offices (o.e.) or their $h = \frac{6}{\text{their } w}$ (3sf) or $\frac{8}{3.2} \times 0.6$	M1
	So height (h) = **1.5** cm	A1
		(3)
(b)	e.g. $(45) + \frac{20}{25} \times 5$ or $(50) - \frac{5}{25} \times 5$ (o.e.) ; = (£) **49**	M1; A1
		(2)
(c)	$\frac{\sum fy}{90} = \frac{4420}{90}$, = (£) **49.11** (or better) (Allow $\frac{442}{9}$ or $49\frac{1}{9}$)	M1, A1
		(2)
(d)	$\sqrt{\frac{226687.5}{90} - \bar{x}^2} = \sqrt{106.8487...}$, = 10.3367 = awrt (£) **10.3**	M1, A1
		(2)
		[9]

	Notes
(a)	M1 for a correct calculation of areas 1 cm^2 = 2 offices (o.e.) A1 for h = 1.5 cm (Correct answer only 2/2)
(b)	M1 for a correct expression without end point. Allow "n + 1" so e.g. $(45) + \frac{20.5}{25} \times 5$ A1 for 49 or, if (n + 1) used, allow 49.1 (Correct answer of 49 only 2/2)
(c)	M1 for an attempt at $\frac{\sum fy}{90}$ with at least 3 correct products of $\sum fy$ or $4000 \leq \sum fy \leq 5000$ A1 for 49.11 (Allow 49.1 from correct working) (Correct answer only 2/2, 49.1 only M1A0)
(d)	M1 for a correct expression including $\sqrt{\ }$, ft their mean. Allow use of s A1 for awrt 10.3 Allow s = awrt 10.4 if clearly used. [NB use of 49.1 gives 10.389 $\Rightarrow$ A0 (Correct answer of 10.3 with no working is 2/2)

Question Number	Scheme	Marks
29.(a)	Width = **0.5** (cm) e.g 4 [cm^2] represents 8 babies or frequency densities are 8 and 34 Height = **17** (cm)	B1 M1 A1 (3)
(b)	$[Q_2 =]\ \{3\} + \frac{(25-9)}{(26-9)} \times 0.5$, or $\{3.5\} - \frac{(25-24)}{(41-24)} \times 0.5$ = awrt **3.47** (allow)	M1, A1 (2)
(c)(i)	$\sum fx = 1\times1 + 2.5\times8 + 3.25\times17 + 3.75\times17 + 4.5\times7 = 171.5$, $\bar{x} = \frac{171.5}{50} = (3.43)$ **(*)**	B1cso
(ii)	$\sqrt{\frac{611.375}{50} - 3.43^2}$,= 0.680147… = awrt **0.680** (Accept 0.68)	M1, A1 (3)
		[8 marks]

	Notes
(a)	M1 for clear representation of area with frequency or height × width = 8.5 A1 for 17 (cm) [Must be clear it is height not frequency] (Ans only must satisfy $h \times w = 8.5$)
(b)	M1 for $\frac{16}{17} \times 0.5$ or if using $n + 1$ for $\frac{16.5}{17} \times 0.5$ May see $-\frac{1}{17} \times 0.5$ if working down A1 for awrt 3.47 (or $\frac{59}{17}$) [check from correct working] or (if using $(n + 1)$ for 3.485 or awrt 3.49)
(c)(i)	B1cso for Σfx (at least 3 correct & no incorrect products seen) and correct $\frac{\sum fx}{50}$ or $\frac{171.5}{50}$
(ii)	M1 for a correct expression including square root. Must use 3.43 no ft A1 for awrt 0.680 (accept 0.68). Allow use of s = awrt 0.687 (Ans only 2/2)

Question	Scheme	Marks
30.	[Range = 48 – 9] = **39**	
(a)		B1
		(1)
(b)	[IQR = 25 – 12]= **13**	B1
		(1)
(c)	Median = $65+\frac{[9]}{13}\times 5 = \frac{890}{13}$ = awrt **68.5**° $\left[\text{Condone: } 65+\frac{[9.5]}{13}\times 5 = 68.7\right]$	M1 A1
		(2)
(d)	Lower Quartile = $60+\frac{9}{15}\times 5 =$ **63** **(*)**	M1 A1cso
		(2)
(e)(i)	$63-1.5\times(75-63)=45$	M1A1
	$75+1.5\times(75-63)=93$	
	No data above 93 and no data below 45 or 55>45 etc or there are no outliers.	A1
(ii)		M1 A1ft
		(5)
(f)	Median for the 70°angle is closer (to 70°)[than the 20° median is to 20°]	B1
	The range/IQR for the 70° angle box plot is smaller/shorter	B1
	Therefore, students were more accurate at drawing the 70° angle.	dB1
		(3)
		(14 marks)

	Notes
(c)	M1 for an attempt (should have 65 or 70, 13 and 5)NB working down: $70-\frac{[4]}{13}\times 5$
	Allow any correct method leading to $\frac{890}{13}$, the "5" may be implied by 65 and 70 seen
	A1 awrt 68.5 (condone 68.7 if (n+1) is used). Ans only of 68.5 is 2/2 but 68.7 needs M1
(d)	M1 for correct expression for the lower quartile (condone 9.25 if (n+1) used)
	Watch out for working down e.g. $65-\frac{6}{15}\times 5$ (M1) but e.g. $\frac{60+65}{2}=62.5=63$ is M0
	A1 for correct solution with no incorrect working seen (condone (n+1) giving 63.08..)
(e)(i)	M1 for either correct calculation (may be implied by one correct limit)
	A1 for either 45 or 93
	A1 for 45 and 93 and conclusion
(ii)	M1 for a box with 1 whisker drawn on each side (must see the line drawn)
	A1ft their median $63 < Q_2 < 75$ but quartiles (63 and 75), 55 and 84 must be correct.
Accuracy	Use 0.5 sq. accuracy so condone median on 68 or 69 if 68.5 seen
(f)	1st B1 for correct comparison of their **medians** (63 < (c) < 75) to true value
	2nd B1 for correct comparison of their **range** or **IQR** ("spread" is B0)
	Allow saying IQRs of 12 and 13 are similar. Ignore mention of "skewness" or "outliers"
	3rd dB1 dependent upon at least one previous B1 being scored for choosing 70°

Question Number	Scheme	Marks
31	mean $= \frac{60.8+20}{1.4}$ or $60.8 = 1.4x - 20$ (o.e.)	M1
	$= 57.7142\ldots$ awrt **57.7**	A1
	standard deviation $= \frac{6.60}{1.4}$ or $6.60 = 1.4x$	M1
	$= 4.7142\ldots$ awrt **4.71**	A1
		(4)
		Total 4
	Notes	
	1st M1 sub. 60.8 for *y* into a correct equation. Allow use of *x* or any other letter or expression for mean 1st A1 for awrt 57.7 or $\frac{404}{7}$ (o.e.). Correct answer only is 2/2 2nd M1 sub. 6.60 or 6.6 for *y* and ignoring the 20 Allow use of *x* or any other letter or expression for st. dev. $6.60^2 = 1.4^2 x^2$ is M0 until we see them take a square root. 2nd A1 for awrt 4.71 or $\frac{33}{7}$ (o.e.). Correct answer only is 2/2	

Question Number	Scheme	Marks
32 (a)	70 – 80 group - width **0.5 (**cm)	B1
	1.5 cm^2 is 10 customers <u>or</u> 3.75cm^2 is 25 customers <u>or</u> $0.5c = 3.75$ <u>or</u> $\frac{2.5}{\frac{1}{3}}$	M1
	70 – 80 group - height **7.5 (**cm)	A1
		(3)
(b)	Median = $(70) + \frac{13.5}{25} \times 10$ allow $(n + 1) = (70) + \frac{14}{25} \times 10$	M1
	= **75.4** (or if using $(n + 1)$ allow 75.6)	A1
		(2)
(c)	$\left[\text{Mean} = \frac{6460}{85}\right] =$ **76**	B1
	$\sigma = \sqrt{\frac{529400}{85} - 76^2}$	M1
	= 21.2658……. (s = 21.3920) **awrt 21.3**	A1
		(3)
		Total 8

	Notes
(a)	B1 for 0.5
	M1 for one of the given statements <u>or</u> any method where "their width" × "their height" = 3.75 Correct height scores M1A1 independent of width so B0M1A1 is possible.
(b)	M1 for a correct fraction: $+\frac{k}{25} \times 10$ where k = 13.5 or 14 for $(n + 1)$ case.
	NB may work down so look out for $(80) - \frac{11.5}{25} \times 10$ etc **Beware:** $69.5 + \frac{13.5}{25} \times 11 = 75.44$ (but M0)
(c)	M1 for a correct expression with square root, ft their mean A1 for awrt 21.3 or, if clearly using s allow awrt 21.4. Must be evaluated...no surds.

Question Number		Scheme	Marks
33.	(a)	4.5	B1 **(1)**
	(b)	<table><tr><th>Time</th><th>Frequency density</th></tr><tr><td>2-4</td><td>5</td></tr><tr><td>5-6</td><td>4.5</td></tr><tr><td>7</td><td>6</td></tr><tr><td>8</td><td>24</td></tr><tr><td>9-10</td><td>7</td></tr><tr><td>11-15</td><td>2.4</td></tr></table> f.d = 24 is represented as 6cm, so f.d. = 7 is represented as **1.75(cm)**	M1 A1 A1 **(3)**
	(c)	$\frac{1}{3}\times 15+9+\frac{1}{2}\times 6,=17$	M1, A1 **(2)**
	(d)	$\text{Median} = 7.5+\frac{40-30}{24}\times 1 = 7.91666.....$ **awrt** 7.92 or 7.93(75)	M1 A1
		$Q_1 = 4.5+\frac{20-15}{9}\times 2 = 5.6111111...$ **awrt** 5.61 or 5.66(666…)	A1
		$Q_3 = 8.5+\frac{60-54}{14}\times 2 = 9.357142.....$ **awrt** 9.36 or 9.46(4285….)	A1 **(4)** **[Total 10]**

Notes

(a) B1 for 4.5 (o.e.) only. NB 1.5~4.5 is B0

(b) M1 for evidence of f/w (at least 3 f.d. found). May be implied by a correct answer.
A1 for identifying 9-10 as 2nd highest bar from correct working e.g. $24x = 6\times 7$
A1 for 1.75(cm). Correct answer only 3/3

(c) M1 for a correct expression. May interpolate e.g. $\left[24+\frac{1}{2}\times 6-\frac{2}{3}\times 15\right]$ or (27 – 10)
A1 for 17

(d) M1 for one correct fraction in an expression for Q_1, Q_2 or Q_3
1st A1 for Q_2 **awrt** 7.92 (or 7.94 if (n +1) used – look for 40.5 instead of 40)
2nd A1 for Q_1 **awrt** 5.61 (or 5.67 if (n +1) used – look for 20.25 instead of 20)
3rd A1 for Q_3 **awrt** 9.36 (or 9.46 if (n +1) used – look for 60.75 instead of 60)
NB watch out for working down e.g. $8.5-\frac{14}{24}\times 1$ for Q_2

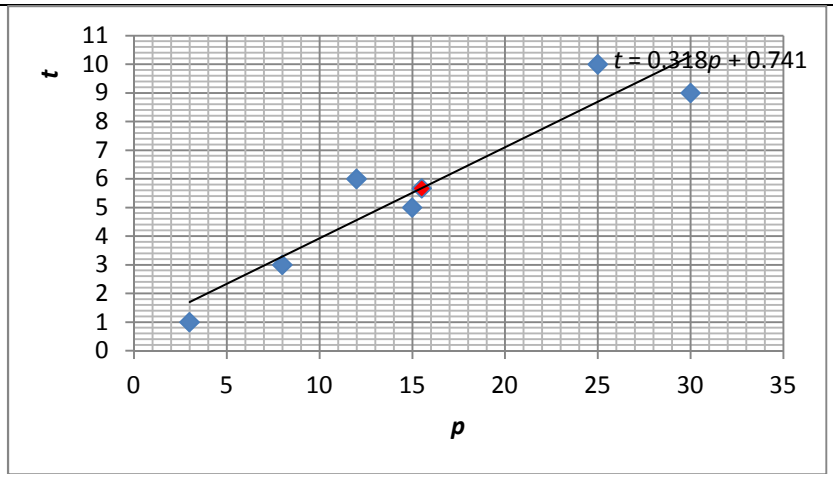
Question	Scheme	Marks
34. (a)	$\sum ft = 4837.5$ (allow 4838 or 4840)	B1
	Mean = $\frac{"4837.5"}{200} = 24.1875$ awrt **24.2** or $\frac{387}{16}$	M1 A1
	$\sigma = \sqrt{\frac{134281.25}{200} - \left(\frac{4837.5}{200}\right)^2}$	M1
	= 9.293 …..... (accept s =9.32) awrt **9.29**	A1 **(5)**
(b)	$Q_2 = [20.5] + \frac{(100/100.5 - 62)}{88} \times 5 = 22.659...$ awrt **22.7**	M1 A1 **(2)**
(c)	$Q_1 = 10.5 + \frac{(50/50.25)}{62} \times 10 [= 18.56]$ **(*)** (n + 1 gives 18.604…)	B1 cso **(1)**
(d)	Q_3= 25.5 (Use of n + 1 gives 25.734…)	B1
	IQR = 6.9 (Use of n + 1 gives 7.1)	B1 ft **(2)**
(e)	The data is skewed (condone "negative skew")	B1 **(1)**
(f)	Mean decreases and st. dev. remains the same. [Must mention mean and st. dev.] (from(a))	B1
	The median and quartiles would decrease. [Must refer to median and at least Q_1.] ((b)(c))	B1
	The IQR would remain unchanged (from (d))	B1 **(3)** **(14 marks)**

	Notes
	Correct answers only score full marks in each part except (c)
(a)	B1 for 4837.5 or 4838 or 4840 seen.
	If no $\sum ft$ seen (or attempt at $\sum ft$ seen), B1 can be implied by a correct mean of awrt 24.2
	1st M1 for attempt at their $\frac{\sum ft}{\sum f}$ allow 1sf so $\sum f$ = awrt 200 and $\sum ft$ = awrt 5000.
	Or award M1 for a clear attempt at mean where at least 4 correct products of $\sum ft$ are seen
	2nd M1 for correct expression including square root seen. Follow through their mean. Allow a transcription error in 134281.25 but not an incorrect re-calculation.
(b)	M1 for a correct fraction ×5 . Ignore end point but must be +. Allow use of (n + 1) giving 100.5…
(c)	B1cso for a fully correct expression including end point. NB Answer is given. Allow use of (n + 1) giving 50.25…but use of 50.5 scores B0
(d)	1st B1 for 25.5 (or awrt 25.7 using n + 1)
	2nd B1ft for their Q_3 – their Q_1 (or 18.6) (provided > 0) Accept awrt 2sf . Correct ans. only scores 2/2
(e)	B1 Must mention that the data is skewed or not symmetrical. Do not award for "outliers"
(f)	1st B1 for one correct comment from the above. May refer to parts (a), (b), (c) or (d)
	2nd B1 for two correct comments from the above
	3rd B1 for all 3 correct comments from the above

Question	Scheme	Marks
35. (a)	Width = 2×1.5 = **3 (cm)**	B1
	Area = $8\times1.5=12$ cm^2 Frequency = 24 so 1 cm^2 = 2 plants (o.e.)	M1
	Frequency of 12 corresponds to area of 6 so height = **2 (cm)**	A1 (3)
(b)	$[Q_2 =]\ (5+)\ \frac{19}{24}\times5$ **or** (use of $(n+1)$) $(5+)\frac{19.5}{24}\times5$	M1
	= 8.9583… **awrt 8.96** **or** 9.0625… awrt 9.06	A1 (2)
(c)	$[\bar{x} =]\ \frac{755}{70}$ or **awrt 10.8**	B1
	$[\sigma_x =]\ \sqrt{\frac{12037.5}{70}-\bar{x}^2}$ = $\sqrt{55.6326...}$	M1A1ft
	= **awrt 7.46** (Accept s = awrt 7.51)	A1 (4)
		[9]

	Notes
(a)	M1 for forming a relationship between area and no. of plants or their width × their height = 6 A1 for height of 2 (cm). Make sure the 2 refers to height and not plants!
(b)	M1 for a suitable fraction ×5 (ignore end points) A1 for awrt 8.96 (or $\frac{215}{24}$ or $8\frac{23}{24}$) or 9.06 (or $\frac{145}{16}$ or $9\frac{1}{16}$) if using $(n + 1)$
(c)	B1 for a correct mean. Accept exact fraction or awrt 10.8 M1 for a correct expression for σ or σ^2. Condone mixed up labelling- ft their mean A1ft for a correct expression – ft their mean but must have square root A1 for awrt 7.46 (use of s = awrt 7.51). Condone correct working and answer called variance.

Question Number	Scheme	Marks
36. (a)	Width = 4 (cm)	B1
	Area of 14 cm^2 represents frequency 28 and area of 4*h* represents 18	M1
	Or $\frac{4h}{18}=\frac{14}{28}$ (o.e.) **h = <u>2.25</u>** (cm)	A1
		(3)
(b)	$m=(240)+\frac{10}{22}\times 80$ (o.e.)	M1
	= 276.36... ($\frac{3040}{11}$) ((£)**<u>276</u>** $\leq m <$ (£)276.5)	A1
		(2)
(c)	$\sum fy = 31600$ leading to $\underline{\bar{y}=316}$	M1A1
	$\sigma_y=\sqrt{\frac{12452800}{100}-\left(\bar{y}\right)^2}$ = 157 .07... (awrt **<u>157</u>**) Allow *s* = 157.86...	M1A1
		(4)
	Notes	**9**
(a)	B1 for width (ignore units)	
	M1 for clear method using area and frequency <u>or</u> their width × their height = 9 e.g. seeing both fd of 0.7 and 0.225 (may see fd in the table) [Must use correct interval]	
(b)	M1 for $\frac{10}{22}\times 80$ or $\frac{10.5}{22}\times 80$ (o.e.). Allow use of (*n* + 1) leading to £278 .18... or [278, 278.5)	
	A1 Do not award if incorrect end-point seen but answer only is 2/2	
(c)	1st M1 attempt at $\sum fy$ with at least 3 correct products or ans. that rounds to 30 000 (to 1 sf) &/100	
	2nd M1 for correct expression including $\sqrt{\ }$. Follow through $\bar{y}$. Need $\sum fy^2$ correct but condone a minor transcription error e.g. 12458200.	

Question	Scheme	Marks
37. **(a)**		Use overlay B1 B1 (2)
(b)	Points (appear to) lie close to a (straight) line <u>or</u> "strong /high correlation"	B1 (1)
(c)	$\sum p = 93$ and $\sum t = 34$ (may be seen in table)	M1
	$S_{pt} = 694 - \frac{"93" \times "34"}{6} = [167]$ <u>or</u> $S_{pp} = 1967 - \frac{"93"^2}{6} = [525.5]$	M1
	$S_{pt} = 167$; S_{pp} = awrt 526	A1; A1 (4)
		[15]

	Notes
(a)	B2 for all 6 data points plotted correctly. B1 for any 5 correct. Points not wholly outside the circles.
(c)	1st M1 for attempting $\sum p$ and $\sum t$. Allow $80 < \sum p < 100$ and $30 < \sum t < 40$ 2nd M1 for one correct expression for S_{pt} or S_{pp}, f.t. their $\sum p$ and $\sum t$. 1st A1 for S_{pt} 2nd for S_{pp}

Question		Scheme	Marks
38.	(a)	One large square = $\frac{450}{"22.5"}$ or one small square = $\frac{450}{"562.5"}$ (o.e. e.g. $\frac{"562.5"}{450}$)	M1
		One large square = 20 cars or one small square = 0.8 cars or 1 car = 1.25 squares	A1
		No. > 35 mph is: $4.5\times"20"$ or $112.5\times"0.8"$ (or equivalent e.g. using fd)	dM1
		= **90** (cars)	A1 (4)
	(b)	$[\bar{x}] = \frac{30\times12.5+240\times25+90\times32.5+30\times37.5+60\times42.5}{450}$ $\left[=\frac{12975}{450}\right]$	M1 M1
		= 28.83... or $\frac{173}{6}$ **awrt 28.8**	A1 (3)
	(c)	$[Q_2 =]$ $20+\frac{195}{240}\times10$ (o.e.) [Allow use of (n + 1) giving 195.5 instead of 195]	M1
		= 28.125 [Use of (n + 1) gives 28.145…] **awrt 28.1**	A1 (2)
	(d)	$Q_2 < \bar{x}$ So positive skew | [Condone $Q_2 \approx \bar{x}$] [so (almost) symmetric]	B1ft dB1ft (2)
	(e)	[If chose skew in (d)] **median (Q_2)** Since the data is skewed or median not affected by extreme values | [If chose symmetric in (d)] **mean ($\bar{x}$)** Since it uses all the data	B1 dB1 (2)
			[13]

	Notes
(a)	1st M1 for attempt to count squares (accept "22.5" in [22, 23] and "562.5" in [550, 575]) **and** use 450 to obtain a measure of scale. [If using fd must use 450 to obtain scale factor] 1st A1 for a correct calc. for 20 or 0.8 or 1.25 etc [May be fd = 4 to 1 large sq. or 0.8 to 1 small sq. May be on the diagram.] 2nd dM1 dep on 1st M1 for correctly counting squares for > 35 mph and forming suitable expr' 2nd A1 for 90 with no incorrect working seen. e.g. $\frac{4.5}{22.5}\times450$ scores M1A1M1 and A1 when = 90 is seen. Answer only is 4/4
(b)	1st M1 for clear, sensible use of mid-points at least 3 of (12.5, 25, 32.5, 37.5, 42.5) seen 2nd M1 for an expression for $\bar{x}$ (at least 3 correct terms on num' and a compatible denominator) Follow through their frequencies. You may see these fractions: $\frac{16218.75}{562.5}$ (small squares), $\frac{12975}{450}$ (frequencies), $\frac{648.75}{22.5}$ (large squares) A1 for awrt 28.8 (answer only is 3/3)
(c)	M1 for a full expression for median (using their frequencies). May see e.g. $25+\frac{75}{120}\times5$ etc Do nor accept boundaries of 19.5 or 20.5, these are M0A0 A1 for awrt 28.1 (answer only is 2/2) [For use of (n + 1) accept 28.15 but not 28.2]
(d)	1st B1ft for a correct statement about their Q_2 and $\bar{x}$ [Condone $Q_2 \approx \bar{x}$ only if $\lvert Q_2 - \bar{x}\rvert < 1$] Do not accept an argument based on the shape of the graph alone. 2nd dB1ft dependent on 1st B1 for a compatible description of skewness. F.t. their values
Quartiles	If $Q_1 = 23.4$ and $Q_3 = 33.7 \sim 33.8$ are seen allow comparison of quartiles for 1st B1 in (d)
(e)	1st B1 for a correct choice based on their skewness comment in (d). If no choice made in (d) only Q_2 2nd dB1 for a suitable compatible comment

Question Number	Scheme	Marks
39 (a)	14, 5	M1 A1 **(2)**
(b)	21 + 45 + 3 = 69	M1 A1 **(2)** **Total 4**
NOTES		
(a)	M1 for 2x7 or 14 or 5x1 or 5 A1 for both 14 and 5	
(b)	M1 for 21+45+(0<frequency <9) A1 for 69 only. 69 no working, award M1A1 Incorrect answer with no working M0A0	

Question Number	Scheme	Marks
40. **(a)**	$\underline{10.5}$	B1 (1)
(b)	$(Q_2 =)\ (15.5+)\ \frac{\frac{1}{2}\times 30-14}{8}\times 3$ or $\frac{\frac{1}{2}\times 31-14}{8}\times 3$	M1
	$= \underline{15.875 \text{ or } 16.0625}$	A1 (2)
(c)	$\bar{x} = \frac{477.5}{30} = \underline{15.9}$ (15.916) [Accept $\frac{191}{12}$ or $15\frac{11}{12}$]	M1, A1
	$\sigma = \sqrt{\frac{8603.75}{30} - \bar{x}^2}$,= $\underline{5.78}$ (accept s = 5.88)	M1A1ft, A1 (5)
		(8 marks)

	Notes
	In parts (a) to (c) a correct answer with no working scores full marks for that value.
(a)	B1 for 10.5 which may be in the table
(b)	M1 for a correct ratio and times 3, ignore the lower boundary for this mark A1 for awrt 15.9 (if n =30 used) or awrt 16.1 (if n+1 = 31 is used)
(c)	1st M1 for attempt at $\sum fx$ (this may be seen in the table as fx: 10, 73.5, 70, 136, 82, 106 [condone 1 slip] or awrt 500) and use of $\frac{\sum fx}{\sum f}$ or a correct expression for mean. 1st A1 for awrt 15.9 2nd M1 for an attempt at σ or σ^2, can ft their mean, condone mis-labelling $\sigma^2 = \sqrt{...}$ etc Allow use of their $\sum fx^2$ (awrt 9000) 2nd A1ft for a correct expression including square root, ft their mean but not their $\sum fx^2$. No label or correct label is OK but wrong label (e.g. $\sigma^2 = \sqrt{...}$) is A0 3rd A1 for awrt 5.78, allow s = awrt 5.88. **SC** Allow M1A1A0 for awrt 5.79 if $\bar{x}$ correct

Question Number		Scheme	Marks
41	(a)	23, 35.5 (may be in the table)	B1 B1 (2)
	(b)	Width of 10 units is 4 cm so width of 5 units is **2 cm**	B1
		Height = 2.6×4 =**10.4 cm**	M1 A1 (3)
	(c)	$\sum fx = 1316.5 \Rightarrow \bar{x} = \frac{1316.5}{56} =$ awrt **23.5**	M1 A1
		$\sum fx^2 = 37378.25$ can be implied	B1
		So $\sigma = \sqrt{\frac{37378.25}{56} - \bar{x}^2}$ = awrt**10.7** allow s = 10.8	M1 A1 (5)
	(d)	$Q_2 = (20.5) + \frac{(28-21)}{11}\times 5$ = 23.68… **awrt 23.7 or 23.9**	M1 A1 (2)
			Total 12
	(b)	M1 for their width x their height=20.8. Without labels assume width first, height second and award marks accordingly.	
	(c)	1st M1 for reasonable attempt at $\sum x$ and /56 2nd M1 for a method for σ or s, $\sqrt{}$ is required Typical errors $\sum (fx)^2 = 354806.3$ M0, $\sum f^2 x = 13922.5$ M0 and $(\sum fx)^2 = 1733172$ M0 Correct answers only, award full marks.	
	(d)	Use of $\sum f(x-\bar{x})^2 =$ awrt 6428.75 for B1 lcb can be 20, 20.5 or 21, width can be 4 or 5 and the fraction part of the formula correct for M1 - Allow 28.5 in fraction that gives awrt 23.9 for M1A1	

Question Number		Scheme	Marks
42	(a)	2.75 or $2\frac{3}{4}$, 5.5 or 5.50 or $5\frac{1}{2}$	B1 B1 (2)
	(b)	Mean birth weight = $\frac{4841}{1500} = 3.227\dot{3}$ **awrt 3.23**	M1 A1 (2)
	(c)	Standard deviation = $\sqrt{\frac{15889.5}{1500} - \left(\frac{4841}{1500}\right)^2} = 0.421093...$ or $s = 0.4212337...$	M1 A1ft A1 (3)
	(d)	$Q_2 = 3.00 + \frac{403}{820} \times 0.5 = 3.2457...$ (allow 403.5….. $\rightarrow$ 3.25)	M1 A1 (2)
			Total [9]

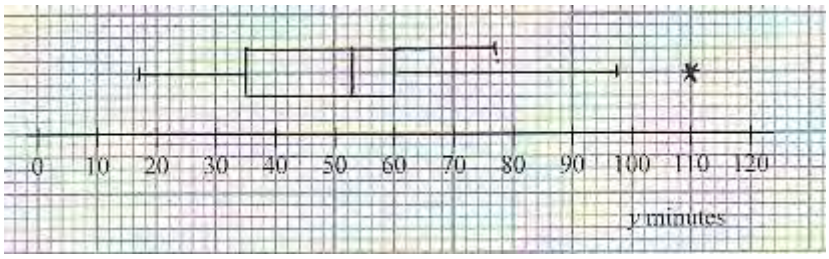
(b) M1 for a correct expression for mean. Answer only scores both.

(c) M1 for a correct expression (ft their mean) for sd or variance. Condone mis-labelling eg sd=… with no square root or no labelling
1st A1ft for a correct expression (ft their mean) including square root and no mis-labelling
Allow 1st A1 for $\sigma^2 = 0.177... \rightarrow \sigma = 0.42...$
2nd A1 for awrt 0.421. Answer only scores 3/3

(d) M1 for a correct expression (allow 403.5 i.e. use of $n + 1$) but must have 3.00, 820 and 0.5
A1 for awrt 3.25 provided M1 is scored.
NB 3.25 with no working scores 0/2 as some candidates think mode is 3.25.

Question Number	Scheme	Marks
43 (a)	1(cm) cao	B1
(b)	10 cm^2 represents 15 10/15 cm^2 represents 1 or $1cm^2$ represents 1.5 Therefore frequency of 9 is $\frac{10}{15}\times 9$ or $\frac{9}{1.5}$ Require $x\frac{2}{3}$ or $\div 1.5$ height = 6(cm)	M1 A1 **[3]**
Notes	If 3(a) and 3(b) incorrect, but their (a) x their (b)=6 then award B0M1A0 3(b) Alternative method: f/cw=15/6=2.5 represented by 5 so factor x2 award M1 So f/cw=9/3=3 represented by 3x2=6. Award A1.	

Question Number	Scheme	Marks
44 (a)	$Q_2 = 17 + \left(\frac{60-58}{29}\right) \times 2$	M1
	= 17.1 (17.2 if use 60.5) awrt 17.1 (or17.2)	A1 (2)
(b)	$\sum fx = 2055.5$ $\sum fx^2 = 36500.25$ Exact answers can be seen below or implied by correct answers.	B1 B1
	Evidence of attempt to use midpoints with at least one correct	M1
	Mean = 17.129… awrt 17.1	B1
	$\sigma = \sqrt{\frac{36500.25}{120} - \left(\frac{2055.5}{120}\right)^2}$	M1
	= 3.28 (s= 3.294) awrt 3.3	A1 (6)
		[8]
Notes	4(a) Statement of $17 + \frac{\text{freq into class}}{\text{class freq}} \times \text{cw}$ and attempt to sub or $\frac{m-17}{19-17} = \frac{60(.5)-58}{87-58}$ or equivalent award M1 cw=2 or 3 required for M1. 17.2 from cw=3 award A0. 4(b) Correct $\sum fx$ and $\sum fx^2$ can be seen in working for both B1s Midpoints seen in table and used in calculation award M1 Require complete correct formula including use of square root and attempt to sub for M1. No formula stated then numbers as above or follow from (b) for M1 $(\sum fx)^2, \sum (fx)^2 or \sum f^2 x$ used instead of $\sum fx^2$ in sd award M0 Correct answers only with no working award 2/2 and 6/6	

Question Number		Scheme	Marks
45	(a)	$Q_2 = 53, \quad Q_1 = 35, \quad Q_3 = 60$	B1, B1,B1 (3)
	(b)	$Q_3 - Q_1 = 25 \Rightarrow Q_1 - 1.5\times 25 = -2.5$ (no outlier) $Q_3 + 1.5\times 25 = 97.5$ (so 110 is an outlier)	M1 A1 (2)
	(c)		M1 A1ft A1ft (3)
	(d)	$\sum y = 461, \sum y^2 = 24\ 219 \therefore\ S_{yy} = 24219 - \frac{461^2}{10}$, = 2966.9 (*)	B1, B1, B1cso (3)
			[11]
	(a)	1st B1 for median 2nd B1 for lower quartile 3rd B1 for upper quartile	
	(b)	M1 for attempt to find one limit A1 for both limits found and correct. No explicit comment about outliers needed.	
	(c)	M1 for a box and two whiskers 1st A1ft for correct position of box, median and quartiles. Follow through their values. 2nd A1ft for 17 and 77 or "their" 97.5 and *. If 110 is not an outlier then score A0 here. Penalise no gap between end of whisker and outlier. Must label outlier, needn't be with *. **Accuracy** should be within the correct square so 97 or 98 will do for 97.5	
	(d)	1st B1 for $\sum y$ N.B. $\left(\sum y\right)^2 = 212521$ and can imply this mark 2nd B1 for $\sum y^2$ or at least three correct terms of $\sum\left(y-\bar{y}\right)^2$ seen. 3rd B1 for complete correct expression seen leading to 2966.9. So all 10 terms of $\sum\left(y-\bar{y}\right)^2$	

Question Number		Scheme	Marks
46	(a)	8-10 hours: width = 10.5 - 7.5 = 3 represented by 1.5cm 16-25 hours: width = 25.5 - 15.5 = 10 so represented by 5 cm 8- 10 hours: height = fd = 18/3 = 6 represented by 3 cm 16-25 hours: height = fd = 15/10 = 1.5 represented by 0.75 cm	B1 M1 A1 (3)
	(b)	$Q_2 = 7.5 + \frac{(52-36)}{18} \times 3 = 10.2$	M1 A1
		$Q_1 = 5.5 + \frac{(26-20)}{16} \times 2 [= 6.25 \text{ or } 6.3]$ or $5.5 + \frac{(26.25-20)}{16} \times 2$ [=6.3]	A1
		$Q_3 = 10.5 + \frac{(78-54)}{25} \times 5 [= 15.3]$ or $10.5 + \frac{(78.75-54)}{25} \times 5$ [=15.45 \15.5]	A1 A1ft (5)
		IQR = (15.3 - 6.3) = 9	
	(c)	$\sum fx = 1333.5 \Rightarrow \bar{x} = \frac{1333.5}{104} =$ AWRT 12.8	M1 A1
		$\sum fx^2 = 27254 \Rightarrow \sigma_x = \sqrt{\frac{27254}{104} - \bar{x}^2} = \sqrt{262.05 - \bar{x}^2}$ AWRT 9.88	M1 A1 (4)
			[12]

(a) M1 For attempting both frequency densities $\frac{18}{3}(=6)$ and $\frac{15}{10}$, and $\frac{15}{10} \times \text{SF}$, where $\text{SF} \neq 1$

(b) NB Wrong class widths(2 and 9) gives $\frac{h}{1.66...} = \frac{3}{9} \rightarrow h = \frac{5}{9}$ or 0.55… and scores M1A0

M1 for identifying correct interval and a correct fraction e.g. $\frac{\frac{1}{2}(104)-36}{18}$. Condone 52.5 or 53

1st A1 for 10.2 for median. Using $(n + 1)$ allow awrt 10.3

NB:

2nd A1 for a correct expression for either Q_1 or Q_3 (allow 26.25 and 78.75) Must see

3rd A1 for correct expressions for both Q_1 and Q_3 some

(c) 4th A1ft for IQR, ft their quartiles. Using $(n + 1)$ gives 6.28 and 15.45 method

1st M1 for attempting $\sum fx$ and $\bar{x}$

2nd M1 for attempting $\sum fx^2$ and $\sigma_x, \sqrt{}$ is needed for M1. Allow s = awrt 9.93

Question Number	Scheme	Marks
47.		
(a)	mean is $\frac{2757}{12}, = 229.75$ AWRT 230	**M1, A1**
	sd is $\sqrt{\frac{724961}{12} - (229.75)^2}, = 87.34045$ AWRT 87.3	**M1, A1**
	[Accept s = AWRT 91.2]	**(4)**
(b)	Ordered list is: 125, 160, 169, 171, 175, 186, 210, 243, 250, 258, 390, 420	
	$Q_2 = \frac{1}{2}(186 + 210) = 198$	**B1**
	$Q_1 = \frac{1}{2}(169 + 171) = 170$	**B1**
	$Q_3 = \frac{1}{2}(250 + 258) = 254$	**B1**
		(3)
(c)	$Q_3 + 1.5(Q_3 - Q_1) = 254 + 1.5(254 - 170), = 380$ Accept AWRT (370-392)	**M1, A1**
	Patients F (420) and B (390) are outliers.	**B1ft B1ft**
		(4)
		Total 11 marks

(a)	1st M1	for using $\frac{\sum x}{n}$ with a credible numerator and n = 12.
	2nd M1	for using a correct formula, root required but can ft their mean
NB		Use of $s = \sqrt{8321.84...} = 91.22...$ is OK for M1A1 here.
		Answers only from a calculator in (a) can score full marks
(b)		1st B1 for median= 198 only, 2nd B1 for lower quartile 3rd B1 for upper quartile
S.C.		If all Q_1 and Q_3 are incorrect but an ordered list (with $\geq$ 6 correctly placed) is seen and used then award B0B1 as a special case for these last two marks.
(c)	M1	for a clear attempt using their quartiles in given formula,
	A1	for any value in the range 370 - 392
	1st B1ft	for any one correct decision about B or F - ft their limit in range (258, 420)
	2nd B1ft	for correct decision about both F and B - ft their limit in range (258, 420)
		If more points are given score B0 here for the second B mark.
		(Can score M0A0B1B1 here)

48.

Width	1	1	4	2	3	5	3	12
Freq. Density	6	7	2	6	5.5	2	1.5	0.5

M1

0.5×12 or 6 **A1**

Total area is $(1\times 6)+(1\times 7)+(4\times 2)+....,=70$

$(90.5-78.5)\times\frac{1}{2}\times\frac{140}{\text{their } 70}$ **M1**

"70 seen anywhere" **B1**

Number of runners is 12 **A1**

(5)

Total 5 marks

1^{st} M1 for attempt at width of the correct bar (90.5 - 78.5)
[Maybe on histogram or in table]

1^{st} A1 for 0.5×12 or 6 (may be seen on the histogram. Must be related to the area of the bar above 78.5 - 90.5.

2^{nd} M1 for attempting area of correct bar $\times\frac{140}{\text{their } 70}$

B1 for 70 seen anywhere in their working

2^{nd} A1 for correct answer of 12.

Minimum working required is $2\times 0.5\times 12$ where the 2 should come from $\frac{140}{70}$

Beware 90.5 - 78.5 = 12 (this scores M1A0M0B0A0)

Common answer is $0.5\times 12 = 6$ (this scores M1A1M0B0A0)

If unsure send to review e.g. $2\times 0.5\times 12=12$ without 70 being seen