

AS-Level

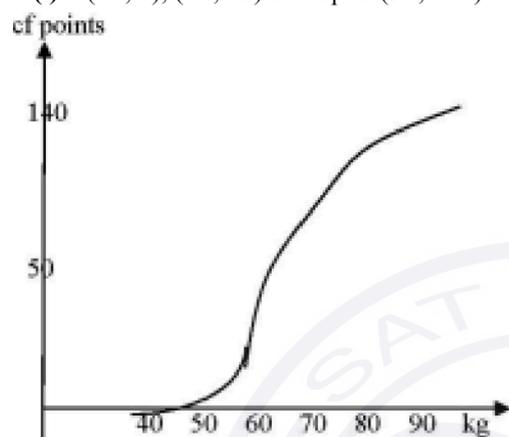
Topic : Data Representation

May : 2013-May :2025

Answer

Question 1

(i) (40, 0), (50, 12) etc. up to (90, 144)



B1

Axes, (cf) and labels (kg), uniform scales from at least 0–140 and 40.5–69.5 either way round

B1

[2]

All points correct, sensible scale (not 12), polygon or smooth curve

(ii) 80 weigh less than 67.2 kg

$$c = 67.2$$

M1

A1 ft

[2]

Subt 64 from 144
Accept anything between 67 and 68 ft from incorrect graph

(iii) freqs 12, 22, 30, 28, 52

M1

A1

frequencies attempt not of
Correct freqs

$$\begin{aligned} \text{mean wt} &= (45 \times 12 + 55 \times 22 + 62.5 \\ &\quad \times 30 + 67.5 \times 28 + 80 \times 52) \\ &\quad / 144 \end{aligned}$$

M1

Using mid points attempt, i.e. 44.5, 45, 45.5, in correct mean formula, unsimplified, no cfs, condone 1 error.

$$= 9675 / 144$$

A1

Correct mean

$$= 67.2 \text{ kg}$$

$$\begin{aligned} \text{Var} &= (45^2 \times 12 + 55^2 \times 22 + \\ &\quad 62.5^2 \times 30 + 67.5^2 \times 28 + 80^2 \times \\ &\quad 52) / 144 \end{aligned}$$

M1

Substituting their mid-pts squared (may be class widths, lower or upper bound) in correct var formula even with cfs with their mean²

$$- (9675/144)^2 = 127.59$$

$$\text{sd} = 11.3, \text{ allow } 11.2$$

A1

[6]

Correct answer

Question 2

(i)	<table border="1"> <thead> <tr> <th>Stem</th> <th>leaf</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>1 4 6 8</td> </tr> <tr> <td>1</td> <td>0 3 4 4 4 5 5 5 6 6 6 6 7 8 8</td> </tr> <tr> <td>2</td> <td>0 1 5 7 8</td> </tr> <tr> <td>3</td> <td>1</td> </tr> <tr> <td>4</td> <td>5</td> </tr> <tr> <td>5</td> <td>7</td> </tr> </tbody> </table>	Stem	leaf	0	1 4 6 8	1	0 3 4 4 4 5 5 5 6 6 6 6 7 8 8	2	0 1 5 7 8	3	1	4	5	5	7	B1	Correct stem condone a space under the 1
Stem	leaf																
0	1 4 6 8																
1	0 3 4 4 4 5 5 5 6 6 6 6 7 8 8																
2	0 1 5 7 8																
3	1																
4	5																
5	7																
		B1	Correct leaves must be single digits and one line for each stem value or 2 lines each stem value														
	Key 1 4 represents \$140	B1ft	Correct key must have \$, ft 2 special cases														
(ii)	Median = 160 LQ = 140 UQ = 210 IQ range = UQ - LQ = 70	B1 M1	Subt their LQ from their UQ														
		A1	Correct answer cwo														
(iii)	$1.5 \times \text{IQ range} = 105$ Lower outlier is below 35 Upper outlier is above 315 Outliers 10, 450, 570	M1 A1ft A1	Mult their IQ range by 1.5 can be implied Correct limits fit their IQ range and quartiles Correct outliers														

Question 3

$\bar{x} = 50 + 81.4/22 = 53.7$	M1	Attempt to find variance using coding in both, correct formula
$\text{var} = 671/22 - 3.7^2 = 16.81(16.8)$	A1	Correct answer
$16.81 = \Sigma x^2/22 - 53.7^2$	M1	using their var and their mean with uncoded formula for both
$= 63811(63800)$	A1	correct answer
OR		
$\Sigma x - 22 \times 50 = 81.4$ ($\Sigma x = 1181.4$)	M1	expanded eqn with 22×50 seen
$\Sigma x^2 - 100 \Sigma x + 22 \times 50^2 = 671$	M1	expanded eqn with 2 or 3 terms correct
$\Sigma x^2 = 671 + 118140 - 55000 = 63811$	A1	correct answer
$\text{Var} = \Sigma x^2/22 - (\Sigma x/22)^2 = 16.81$	A1	correct answer

Question 4

(i)	females: med \$22 700 LQ \$21700 UQ \$24 000	B1	[2]	Any 2 correct
(ii)	males	B1		Uniform scale and labels must see Salary, \$000
	females	B1		Correct graph for females ft their quartiles. Line not through box
		B1	[3]	Correct graph for males

Question 5

(i)	$sd^2 = 1957.5/30 - (234/30)^2$ $sd = 2.1$	M1	[2]	Subst in formula or expand
		A1		Accept 2.10
(ii)	$86 = 234/30 + c$ $c = 78.2$	M1	[2]	234/30 seen
		A1		

Question 6

bars are not touching oe	B1		Sensible reason involving not touching, no gaps, class boundaries, group data not continuous (may be the negative)
Area not rep by frequency, not used fd, not labelled fd	B1	2	Must be frequency density oe. Wrong height not sufficient. (Best 2 reasons awarded)

Question 7

4 (i)		B1	[4]	Linear scale or 5 values shown and labels or in heading, need thousands of dollars,
		B1		Correct median
		B1		Correct quartiles
		B1		Correct end points of whiskers not through box
(ii)	$1.5 \times 170 = 255$ Expensive houses above $690 + 170 \times 1.5 = 945$ i.e. 957 and 986 thousands of dollars	M1		Mult their IQ range by 1.5
		A1	2	Correct answers from correct wkg need thousands of dollars
(iii)	doesn't show all the data items	B1	1	Need to see 'individual items' oe

Question 8

$$\Sigma(x - 5) = 116 - 18 \times 5 = 26$$

$$\frac{\Sigma(x - 5)^2}{18} - \left(\frac{26}{18}\right)^2 = \frac{967}{18} - \left(\frac{58}{9}\right)^2$$

$$\Sigma(x - 5)^2 = 257$$

OR coded mean = $58/9 - 5 = 1.444$

$$\Sigma(x - 5) = 1.444 \times 18 = 26$$

$$\Sigma(x - 5)^2 = \Sigma x^2 - 10\Sigma x + 25 \times 18 = 967 - 1160 + 450 = 257$$

M1		Obtaining Σx and subtracting 18×5
A1		Correct answer
M1		Subst in correct var formula all coded vals
M1		Subst in correct var formula all uncoded
A1	5	Correct answer
M1		Subtracting 5 from true mean and mult by 18
A1		Correct answer
M1		Expanding $\Sigma(x-5)^2$ 3 terms needed
A1		Any 2 terms correct
A1		Correct answer

Question 9

(i)

Adults		Children
	4	3
8 6 5 4 3	5	4
7 4 3 3 2 1	6	1 2 7 8
8 4 3 1	7	2 7
	8	1 3 4 6 9
	9	2 5

key 3 | 5 | 4 represents 53 seconds for adults and 54 seconds for children

B1		Single stem and key correct – including adults, children and seconds
B1		Right hand leaves correct shape
B1	3	Left hand leaves correct shape

(ii)

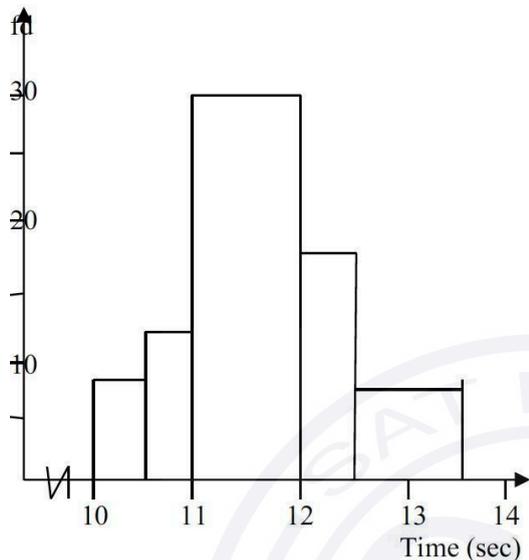
Two from:
 Children's estimates more spread out
 Adults estimates lower
 Adults are symmetrical whereas children are skewed

B1		oe
B1		oe
B1		oe
2		

Question 10

6 (i) 6

(ii) freqs 4 6 30 9 8
fd 8 12 30 18 8



B1 1 Must see in (i)

M1 Attempt at scaled freq or fd (must be f/cw) at least three f/cw

A1 Correct heights seen on graph

B1 Correct-looking widths from 10, 10.5 etc. no gaps no extra lines

B1 4 Labels and linear axes or squiggle need time or secs, fd,

(iii) $E(X) = (10.25 \times 4 + 10.75 \times 6 + 11.5 \times 30 + 12.25 \times 9 + 13 \times 8) / 57$

$= 11.7(11.662)$

$Var(X) = (10.25^2 \times 4 + 10.75^2 \times 6 + 11.5^2 \times 30 + 12.25^2 \times 9 + 13^2 \times 8) / 57 - (11.662...)^2$

$= 0.547$

M1 Using mid-point attempt (not end points) with their freq or cf at least 2 sensible ones

A1 Correct mean

M1 numerical attempt at correct variance formula with mean² subst ft their "midpoints" i.e. ucb, cw, etc.

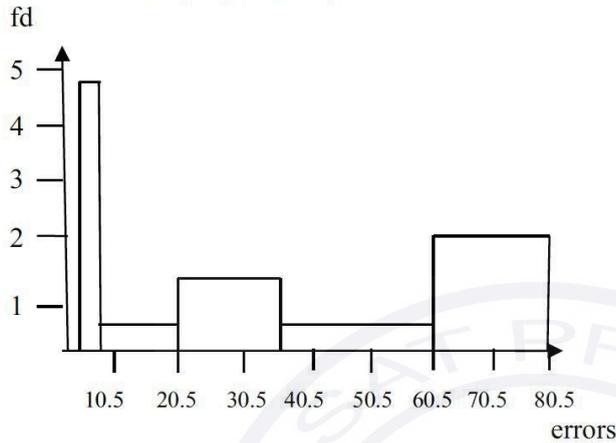
A1 4 accept answers between 0.547 and 0.610 condone 0.6, 0.60

Question 11

7 (i) class widths 5, 15, 15, 25, 20

$$fd = \frac{24}{5}, \frac{9}{15}, \frac{21}{15}, \frac{15}{25}, \frac{42}{20}$$

$$= 4.8, 0.6, 1.4, 0.6, 2.1$$



M1

Attempt at class widths

B1

Correct widths of bars, with or without halves, seen on diagram

M1

Attempt at fd or scaled freq

A1

Correct heights seen on graph ft their fd

B1

5

Correct labels, scales and halves

(ii) mean =

$$\frac{(3 \times 24 + 13 \times 9 + 28 \times 21 + 48 \times 15 + 70.5 \times 42)}{111}$$

$$= 40.2 \text{ errors}$$

M1

Using mid points

M1

using $(\Sigma \text{ their } fx) / \text{their } 111$

A1

3

correct answer

(iii) LQ in 6 - 20

UQ in 61 - 80

$$\text{Least value of IQ range is } 61 - 20 = 41$$

B1

B1

B1[✓]

3

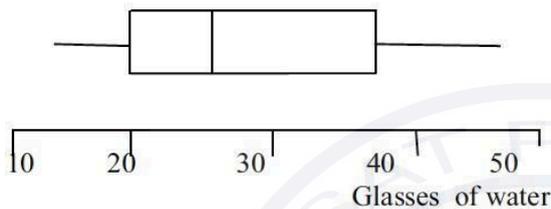
ft any or both wrong quartile ranges if sensible

Question 12

4 (i)	Stem	leaf
	1	4 5 7 8 9 9
	2	1 2 2 3 4 5 6 6 8 8
	3	0 2 6 8
	4	1 2 5 6 7

Key 1|4 represents 14 glasses (of water)

(ii) LQ = 20 Med = 26 UQ = 37



SC No values stated

3 quartiles on diagram in correct relative positions

End points of attached whiskers not through box

correct relative to quartiles

B1	Correct stem (or reversed order)
B1	Correct leaves, ordered in numerical sequence, with ½ 'column' tolerance
B1 3	Key must include 'glasses' or similar drinking item
B1	Correct median
B1	Correct quartiles
B1√	Correct on diagram fit any wrong med or quartiles.
B1	Linear scale based upon 3 quartiles plotted
B1	Correct end points of attached whiskers not through box
B1 5	Linear axis, label, both must be seen
B2	
B1	

Question 13

(i) $0.7 - 2.4 + 2.2 - 0.5 + 6.3 + 4.9 + 0 + 0.3$
 $= 11.5$

(ii) $(0.7^2 + 2.4^2 + 2.2^2 + 0.5^2 + 6.3^2 + 4.9^2 + 0.3^2)$
 $= 75.13$ (75.1)

(iii) mean = 63.4375
 Variance = $75.13/8 - (11.5/8)^2$
 $= 7.32$

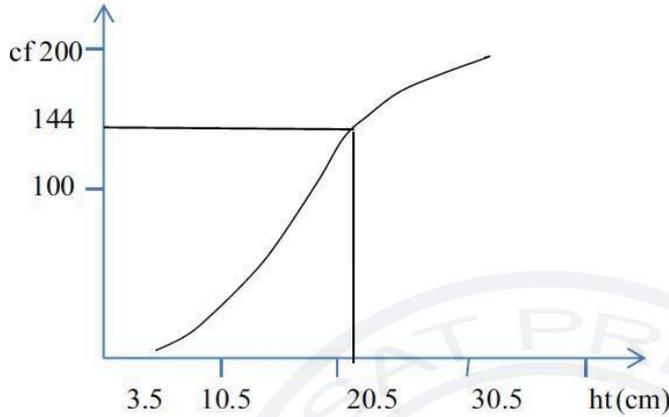
OR mean = $507.5/8 = 63.4375$
 Var = $32253/8 - 63.4375^2 = 7.32$

B1 1	
B1 1	
B1√	ft 62 + their (i)/8
M1	their(ii)/8 - ((i)/8) ²
A1 3	correct answer
B1	
M1	subst in correct variance or standard deviation formula
A1	correct answer – allow 6.62, 6.93–7.04, 7.260–7.325
	Marks can be awarded in (i) or (ii) if not 'contradicted' by further working

Question 14

6 (i)

ht	<10.5	<15.5	<20.5	<25.5	<30.5
CF	22	54	132	172	200



(ii) 72% less, i.e. 144 less than ht h .
 $h = 22.5$ cm

(iii) $\text{var} = (7^2 \times 22 + 13^2 \times 32 + 18^2 \times 78 + 23^2 \times 40 + 28^2 \times 28) / 200 - 18.39^2$
 $= 74870 / 200 - 18.39^2$
 $= 374.35 - 18.39^2$
 $= 36.1579$

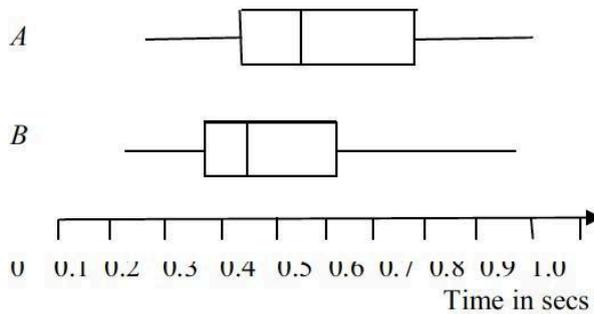
sd = 6.01

- B1 At least 4 CFs correct seen on graph
- B1 Labels correct, i.e. all of ht, cm, cf
- M1 Attempt at upper end points either 10 or 10.5 or 11 at least 4 upper end points
- A1 4 All correct, i.e. points joined up from (3.5, 0) to (10.5, 22)....to (30.5, 200) Straight lines or curve
- M1 144 used can be implied
- A1 2 single value in range 21 to 23 inclusive
- M1 Using mid points attempt 7 ± 0.5 in correct var formula incl - mean²
- B1 At least 4 correct midpoints
- A1 3 Correct ans

Question 15

4 (i) median A = 0.52
LQ = 0.41
UQ = 0.79

(ii)



- B1
- B1
- B1ft 3 ft wrong units
- B1 2 correct boxes ft (i) OK if superimposed
- B1 2 pairs correct whiskers lines up to box not inside
- B1 3 Correct uniform scale need at least 4 values on it. No scale no marks unless perfect A and B with all 10 values shown, in which case score B1B1B0

Question 16

$$\begin{aligned} \text{mean} &= (5 + (-2) + 12 + 7 + (-3) + 2 + (-6) \\ &\quad + 4 + 0 + 8) / 10 \\ &= 2.7 \\ \text{var} &= (5^2 + (-2)^2 + \dots + 8^2) / 10 - 2.7^2 = \\ &= 27.8 \end{aligned}$$

B1

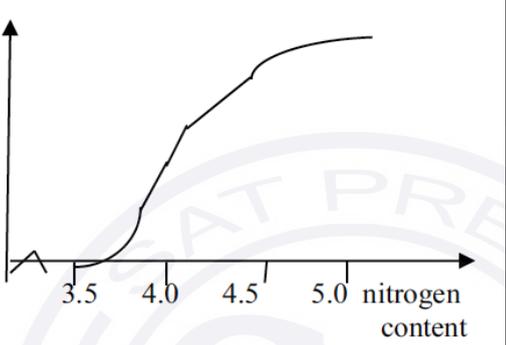
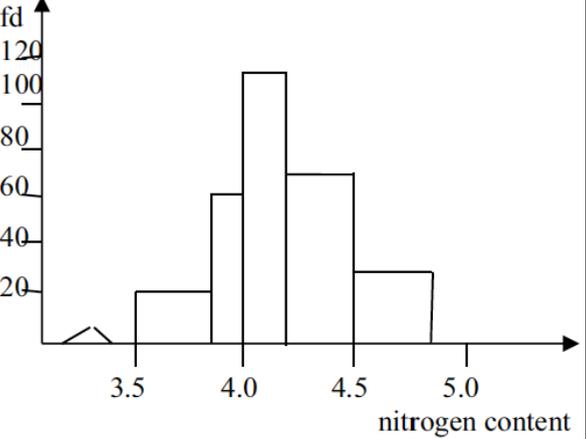
M1

A1

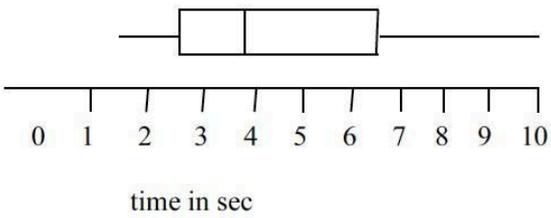
3

Subst in correct var formula must have $-\text{mean}^2$
Correct answer

Question 17

<p>(i)</p>		<p>B1</p> <p>M1</p> <p>A1 [3]</p>	<p>Uniform axes cf and nitrogen content labelled, at least 0 to 70 and 3.5 to 4.8 seen</p> <p>5 points plotted correctly on graph paper</p> <table border="1" data-bbox="1102 869 1544 943"> <tr> <td>3.5</td> <td>3.8</td> <td>4.0</td> <td>4.2</td> <td>4.5</td> <td>4.8</td> </tr> <tr> <td>0</td> <td>6</td> <td>18</td> <td>41</td> <td>62</td> <td>70</td> </tr> </table> <p>All points correct and a reasonable curve (condone 1 missed point) or line segments.</p>	3.5	3.8	4.0	4.2	4.5	4.8	0	6	18	41	62	70						
3.5	3.8	4.0	4.2	4.5	4.8																
0	6	18	41	62	70																
<p>(ii)</p>	<p>$70 - \text{their } 55 = 15$ $= 21.4\%$</p>	<p>M1</p> <p>A1 [2]</p>	<p>Subt a value > 41 from 70 (or $n/70$, $n < 29$) Correct ans, accept 18.5 – 22</p>																		
<p>(iii)</p>	<p>median = 4.15</p>	<p>B1 [1]</p>	<p>Accept $4.1 < \text{median} < 4.2$, nfw</p>																		
<p>(iv)</p>	<table border="1" data-bbox="352 1317 922 1462"> <tr> <td>nit cont</td> <td>3.5–3.8</td> <td>3.8–4.0</td> <td>4.0–4.2</td> <td>4.2–4.5</td> <td>4.5–4.8</td> </tr> <tr> <td>fr</td> <td>6</td> <td>12</td> <td>23</td> <td>21</td> <td>8</td> </tr> <tr> <td>fd</td> <td>20</td> <td>60</td> <td>115</td> <td>70</td> <td>26.7</td> </tr> </table>	nit cont	3.5–3.8	3.8–4.0	4.0–4.2	4.2–4.5	4.5–4.8	fr	6	12	23	21	8	fd	20	60	115	70	26.7	<p>M1</p> <p>M1</p>	<p>Attempt at freqs, at least 3 correct, ignore labelling</p> <p>Attempt at fd as f/cw only at least 3 correct FT (Accept $f/cw \times k$)</p>
nit cont	3.5–3.8	3.8–4.0	4.0–4.2	4.2–4.5	4.5–4.8																
fr	6	12	23	21	8																
fd	20	60	115	70	26.7																
		<p>A1</p> <p>B1</p> <p>B1 [5]</p>	<p>Correct heights seen on graph (plot at 4.8, 27 A0) Graph paper must be used (3 correct relative heights implies M1M1)</p> <p>Correct bar ends seen on graph – graph paper used</p> <p>Correct linear scale and labels.</p>																		

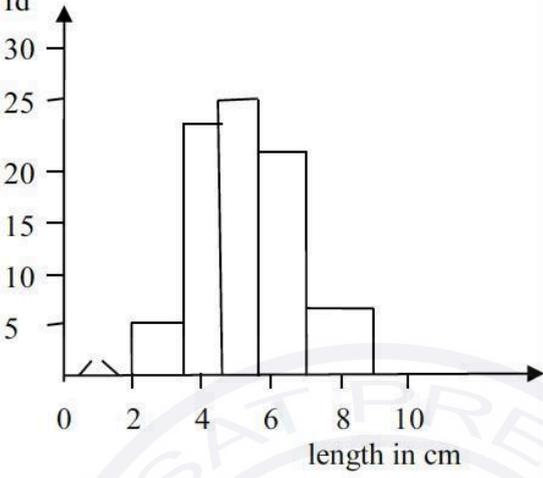
Question 18

<p>(i)</p>		<p>B1 B1 ✓ B1 B1</p>	<p>LQ = 2.6 med = 3.8– 3.85, UQ = 6.4– 6.6 Correct quartiles and median on graph ft linear from 2–10 End whiskers correct not through box 4 Label need seconds and linear 2–10 axis or can have 5 values on boxplot no line provided correct</p>
<p>(ii)</p>	<p>$1.5 \times \text{IQR} = 1.5 \times 3.8 = 5.7$ $\text{LQ} - 5.7 = -\text{ve}, \text{UQ} + 5.7 = 12.1 \text{ i.e. } > 10$ So no outliers AG</p>	<p>M1 A1</p>	<p>Attempt to find $1.5 \times \text{IQR}$ and add to UQ or sub from LQ OR compare $1.5 \times \text{IQR}$ with gap 3.6 between UQ and max 10 2 Correct conclusion from correct working need both</p>

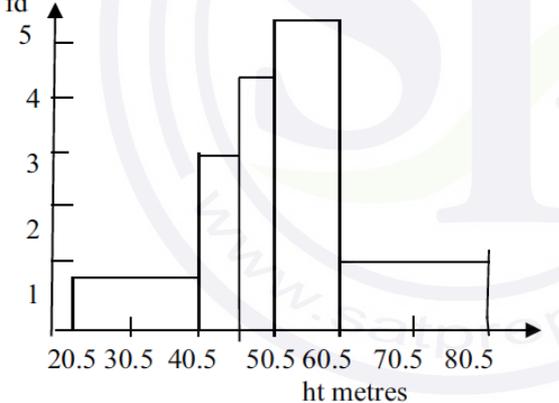
Question 19

<p>mid points 13, 30.5, 40.5, 50.5, 73</p>	<p>M1</p>	<p>Attempt at midpoints at least 3 correct</p>
<p>Mean = $\frac{4 \times 13 + 24 \times 30.5 + 38 \times 40.5 + 34 \times 50.5 + 20 \times 73}{120}$ $= \frac{5500}{120} = 45.8$</p>	<p>M1 A1</p>	<p>Using their midpoints i.e. cw, ucb, 1/2 cw and freqs into correct formula must be divided by 120 Correct answer from correct working Evaluating</p>
<p>var = $\frac{4 \times 13^2 + 24 \times 30.5^2 + 38 \times 40.5^2 + 34 \times 50.5^2 + 20 \times 73^2}{120}$ $- (45.8\dots)^2$ $= \frac{278620}{120} - 45.8\dots^2$ $= 2321.8333 - 45.8\dots^2$ sd = 14.9</p>	<p>M1 A1</p>	<p>$\frac{\sum fx^2}{120}$ – their \bar{x}^2 must see their 45.8^2 subtracted allow cw etc 5 Correct answer</p>

Question 20

(i)	UQ 5.5 – 7.0cm	B1	[1]
(ii)	<p>fd 5.33, 25, 28, 20.7, 6,</p> 	M1	Attempt at fd or scaled freq [fr/cw]
		A1	Correct heights seen on graph
		B1	Correct bar widths no gaps
		B1	[4] Labels (fd and length/cm) and correct bar ends

Question 21

(i)	<p>fd 0.9, 3, 4.2, 5.2, 1.4</p> 	M1	Attempt at scaled freq [f/(attempt at cw)]
		A1	Correct heights seen on diagram Scale no less than 1cm to 1 unit
		B1	Correct bar widths visually no gaps
		B1	4 Labels (ht/metres and fd or freq per 20m etc.) and end points at 20.5 etc. condone 2 end point errors, scale no less than 1cm to 5m for 20,30... unless clearly accurate, linear scale between 20.5 and 80
(ii)	$(30.5 \times 18 + 43 \times 15 + 48 \times 21 + 55.5 \times 52 + 70.5 \times 28) / 134$ $= \frac{7062}{134} = 52.701$ $\text{Var} = (30.5^2 \times 18 + 43^2 \times 15 + 48^2 \times 21 + 55.5^2 \times 52 + 70.5^2 \times 28) / 134 - 52.701^2$ $= 392203.5 / 134 - 52.701^2 = 149.496$ $\text{sd} = 12.2$	M1	Attempt at unsimplified, mid points (at least 4 within 0.5)
		M1	Attempt at Σfx their mid points $\div 134$
		A1	Correct mean rounding to 53
		M1	Attempts at Σfx^2 their mid points \div their $\Sigma f - \text{mean}^2$
		A1	5 Correct answer, nfw

Question 22

coded mean = 0.3 oe $sd = \sqrt{\frac{96.1}{250} - (0.3)^2}$ $= 0.543$ Alt: $\Sigma(t-2.5)^2$ expanded $\Sigma t^2 = 2033.6$ $sd = \sqrt{\frac{2033.6}{250} - 2.8^2}$ $= 0.543$	<table border="0"> <tr> <td style="width: 10%;">B1</td> <td style="width: 10%;"></td> <td>$\Sigma(t - 2.5) = 75$ B0 until $\div 250$</td> </tr> <tr> <td>M1</td> <td></td> <td>Subst in variance formula both terms coded</td> </tr> <tr> <td>A1</td> <td style="text-align: center;">3</td> <td>Correct answer</td> </tr> <tr> <td>Or</td> <td></td> <td></td> </tr> <tr> <td>B1</td> <td></td> <td></td> </tr> <tr> <td>M1</td> <td></td> <td>Substituting their Σt^2 from expanded 3-term expression, 250 and 2.8 in variance formula</td> </tr> <tr> <td>A1</td> <td style="text-align: center;">3</td> <td></td> </tr> </table>	B1		$\Sigma(t - 2.5) = 75$ B0 until $\div 250$	M1		Subst in variance formula both terms coded	A1	3	Correct answer	Or			B1			M1		Substituting their Σt^2 from expanded 3-term expression, 250 and 2.8 in variance formula	A1	3	
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Or																						
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A1	3																					

Question 23

(i)	<table border="1" style="width: 100%; border-collapse: collapse; text-align: center;"> <thead> <tr> <th style="width: 30%;">team A</th> <th style="width: 5%;"></th> <th style="width: 5%;">team B</th> </tr> </thead> <tbody> <tr> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>7 5 7 9</td> </tr> <tr> <td></td> <td>4</td> <td>4</td> <td>2</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>8 2 3 4 6</td> </tr> <tr> <td></td> <td>9</td> <td>8</td> <td>7</td> <td>6</td> <td>1</td> <td></td> <td></td> <td></td> <td>9 4 5 6</td> </tr> <tr> <td></td> <td></td> <td>9</td> <td>7</td> <td>4</td> <td>0</td> <td></td> <td></td> <td></td> <td>10 1 8</td> </tr> <tr> <td></td> <td></td> <td></td> <td>6</td> <td>5</td> <td></td> <td></td> <td></td> <td></td> <td>11 1 3 5</td> </tr> <tr> <td></td> <td></td> <td></td> <td></td> <td>2</td> <td></td> <td></td> <td></td> <td></td> <td>12</td> </tr> </tbody> </table> <p>key 1 9 4 means 91 kg for team A and 94 kg for B</p>	team A									team B										7 5 7 9		4	4	2						8 2 3 4 6		9	8	7	6	1				9 4 5 6			9	7	4	0				10 1 8				6	5					11 1 3 5					2					12			<table border="0"> <tr> <td>B1</td> <td></td> <td>Correct stem can be upside down, ignore extra values, allow 70, 80 etc with suitable numerical key</td> </tr> <tr> <td>B1</td> <td></td> <td>Correct team A must be on LHS, alignment \pm half a space, no late entries squeezed in, no crossing out if shape is changed</td> </tr> <tr> <td>B1</td> <td></td> <td>Correct team B in single diagram can be either LHS or RHS</td> </tr> <tr> <td>B1</td> <td style="text-align: center;">4</td> <td>Correct key or keys for their diagram/s, need both teams, at least one kg.</td> </tr> </table>	B1		Correct stem can be upside down, ignore extra values, allow 70, 80 etc with suitable numerical key	B1		Correct team A must be on LHS, alignment \pm half a space, no late entries squeezed in, no crossing out if shape is changed	B1		Correct team B in single diagram can be either LHS or RHS	B1	4	Correct key or keys for their diagram/s, need both teams, at least one kg.
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(ii)	LQ = 91 UQ = 109 IQ range = 18	<table border="0"> <tr> <td>B1</td> <td></td> <td>Both quartiles correct</td> </tr> <tr> <td>B1</td> <td style="text-align: center;">2</td> <td>Correct IQR ft wrong quartiles, LQ < UQ, not 12 - 4 etc</td> </tr> </table>	B1		Both quartiles correct	B1	2	Correct IQR ft wrong quartiles, LQ < UQ, not 12 - 4 etc																																																																														
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(iii)	$\Sigma x_{15} = 1399$ $\Sigma x_{16} = 16 \times 93.9 = 1502.4$ New wt = $1502.4 - 1399 = 103$ (103.4)	<table border="0"> <tr> <td>M1</td> <td></td> <td>Attempt at Σx_{15} for either team</td> </tr> <tr> <td>M1</td> <td></td> <td>Mult 93.9 by 16 attempt</td> </tr> <tr> <td>A1</td> <td style="text-align: center;">3</td> <td>Correct answer</td> </tr> </table>	M1		Attempt at Σx_{15} for either team	M1		Mult 93.9 by 16 attempt	A1	3	Correct answer																																																																											
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A1	3	Correct answer																																																																																				

Question 24

$\Sigma x - 100n = 216$ $2416 - 100n = 216$ $n = 22$ OR $\frac{2416}{n} = \frac{216}{n} + 100$ $n = 22$	<table border="0"> <tr> <td>B1</td> <td></td> <td>$\Sigma x - 100n$ seen</td> </tr> <tr> <td>B1</td> <td></td> <td>Subst 2416 for their Σx</td> </tr> <tr> <td>B1</td> <td style="text-align: center;">3</td> <td>Correct answer</td> </tr> <tr> <td>B1</td> <td></td> <td>2416/n seen or 216/n + 100 oe eg $\Sigma x/n - 100 = 216/n$</td> </tr> <tr> <td>B1</td> <td></td> <td>correct equation</td> </tr> <tr> <td>B1</td> <td></td> <td>Correct answer</td> </tr> </table>	B1		$\Sigma x - 100n$ seen	B1		Subst 2416 for their Σx	B1	3	Correct answer	B1		2416/n seen or 216/n + 100 oe eg $\Sigma x/n - 100 = 216/n$	B1		correct equation	B1		Correct answer
B1		$\Sigma x - 100n$ seen																	
B1		Subst 2416 for their Σx																	
B1	3	Correct answer																	
B1		2416/n seen or 216/n + 100 oe eg $\Sigma x/n - 100 = 216/n$																	
B1		correct equation																	
B1		Correct answer																	

Question 29

(i)	$\Sigma x = 862$	B1	1	Must be stated or replaced in (ii) Can see (i) and (ii) in any order
(ii)	$362/10 + a = 86.2$ $a = 50$	M1 A1	2	86.2 ± 36.2 seen oe Correct answer, nfw

Question 28

(i)	$1845/9 (= 205)$ $c = 2205 - 205 = 2000$ OR $\Sigma x = 2205 \times 9 (= 19845)$ $\Sigma x - \Sigma c = 1845$ $\Sigma c = 19845 - 1845 = 18000$ $c = 2000$	M1 A1		Accept $(1845 \pm \text{anything})/9$
(ii)	$\text{var} = \frac{477450}{9} - 205^2$ $= 11025$ OR $\text{var} = \frac{43857450}{9} - 2205^2$ $= 11025$	M1 A1		For $\frac{477450}{9} - (\text{their coded mean})^2$
(iii)	new total = $2120.5 \times 10 = 21205$ new price = $21205 - 19845$ $= 1360$	M1 A1	[2]	For their $\Sigma x^2/9 - 2205^2$ where Σx^2 is obtained from expanding $\Sigma(x-c)^2$ with $2c\Sigma x$ seen
		M1 A1	[2]	Attempt at new total

Question 29

(i)		B1		Labels 'time' and 'seconds', 'boys' and 'girls' on correct plots and scaled line
		B1		One box and whisker all correct on graph paper – ignore boy or girl label
		B1	[3]	Second box and whisker all correct (on graph paper and ignore boy/girl label) on SAME scaled line.
(ii)	girls smaller range or IQ range than boys /girls less spread out oe girls generally quicker than boys or girls median < boys median (not mean) oe boys almost symmetrical, girls +vely skewed oe	B1 B1	[2]	Any 2 comments – MUST be a comparison

Question 30

(i)	<table border="0" style="margin-left: auto; margin-right: auto;"> <tr> <td style="padding-right: 20px;">Bronlea</td> <td></td> <td>Rogate</td> </tr> <tr> <td style="padding-right: 20px;">6 3 0</td> <td style="padding-right: 20px;">4 5 7 7</td> <td></td> </tr> <tr> <td style="padding-right: 20px;">7 4 3 1</td> <td style="padding-right: 20px;">0 1 3 5 6 8</td> <td></td> </tr> <tr> <td style="padding-right: 20px;">8 7 5 4 2 1 2</td> <td style="padding-right: 20px;">3 3 6</td> <td></td> </tr> <tr> <td style="padding-right: 20px;">3 2 3 4</td> <td></td> <td></td> </tr> <tr> <td style="padding-right: 20px;">5 4</td> <td></td> <td></td> </tr> </table>	Bronlea		Rogate	6 3 0	4 5 7 7		7 4 3 1	0 1 3 5 6 8		8 7 5 4 2 1 2	3 3 6		3 2 3 4			5 4			<p>B1 Correct single stem</p> <p>B1 Correct ordered leaves Bronlea</p> <p>B1 Correct ordered leaves Rogate</p> <p>B1 Correct overall shape</p>
	Bronlea		Rogate																	
6 3 0	4 5 7 7																			
7 4 3 1	0 1 3 5 6 8																			
8 7 5 4 2 1 2	3 3 6																			
3 2 3 4																				
5 4																				
	<p>Key 3 1 5 represents 13 kph for Bronlea and 15 kph for Rogate</p>	<p>B1 [5] Single key must have both towns and units consistent with their values</p>																		
(ii)	<p>median Bronlea = 23 km per hour</p> <p>IQ range Rogate = 23 – 7</p> <p>= 16</p>	<p>B1 Units not necessary</p> <p>M1 Subt their LQ <14 from their UQ>14 from Rogate leaf</p> <p>A1 [3]</p>																		
(iii)	<p>Rogate is less windy than Bronlea</p>	<p>B1 [1] Not a comparison of a statistic but interpretation of information</p>																		

Question 31

(i)	<p>cf 16, 56, 104, 130, 160</p>	<p>M1 Attempt at cf table (up to 160) no graph needed accept %cf but give final</p>
		<p>B1 linear scale minimum 0 to 160 and 0 to 120</p> <p>M1 Attempt to plot points at (30, 16), (50, 56), (70, 104), (90, 130), (140, 160) up to 2 errors can have a polygon</p> <p>A1 [4] All points correct from their scale and joined up, with (0,0) as well</p>
(ii)	<p>median \$59</p> <p>IQR = 82 – 43</p> <p>= \$39</p>	<p>B1 accept 57–60 or ft their graph if used lb, midpts instead of ub or assume linear interpolation.</p> <p>M1 Subt a (sensible) LQ from a sensible UQ (generous)</p> <p>A1 [3] Ans ft need a cf graph and UQ 80–84, LQ</p>
(iii)	<p>160 – 149</p> <p>= 11</p> <p>OR 115 is mid pt of last interval so # of shoppers is 30/2 = 15 (can be implied)</p>	<p>M1 41–46</p> <p>A1 [2] Subtracting from 160 can be implied</p> <p>Correct answer accept 9–16</p>
(iv)	<p>mean = (15×16+ 40×40 +60×48+ 80×26 + 115×30)/160</p> <p>= 10250/160 = \$64.1= \$64.1</p>	<p>M1 Using $\Sigma xf/160$ with mid-points</p> <p>A1 [2]</p>

Question 32

<p>(i)</p>	<p>B1 B1 B1 B1</p>	<p>Horizontal axis from min of 140 to 190 and vertical axis from 0 to minimum of 60 and two CF graphs on the same set of axes.</p> <p>Labels: CF; height (ht) in cm; girls; boys in correct places</p> <p>CF graph going through (150, 0), (160, 20), (170, 43), (180, 55) and (190, 60)</p> <p>CF graph going through (140, 0), (150, 12), (160,33), (170,50), (180, 60) [and (190, 60)]</p>
<p>(ii) 42 (± 1) shorter than 165. $(18(\pm 1))/60 \times 100 = 30\% (\pm 1.7\%)$</p>	<p>M1 M1 A1</p>	<p>Line or reading from 165 on their cf graph or subtracting from 60</p>
<p>(iii) can see which is taller; see which of boys or girls is more spread out</p>	<p>B1</p>	<p>any sensible comment in context</p>

Question 33

<p>(i)</p> <p>cw 5, 5, 10, 20, 40 fd 8, 6, 1.8, 1.7, 0.2</p>	<p>M1 M1 A1 B1 B1</p>	<p>cw either 4 or 5 etc fd or scaled freq [f/their cw attempt] fd may be $\div 1000$</p> <p>Correct heights seen accurately on diagram</p> <p>Correct bar ends, accurately plotted on axis</p> <p>Labels fd and capacity (thousands) Correct horizontal scale required. Vertical scale linear from 0</p>
<p>(ii) $(5 \times 40 + 10 \times 30 + 17.5 \times 18 + 32.5 \times 34 + 62.5 \times 8) / 130$ $= 2420 / 130 = 18.6$ thousand</p>	<p>M1 A1</p>	<p>$\Sigma fx / 130$ where x is mid point attempt (value within class, not end pt or cw)</p>
<p>(iii) median group = 8 – 12 thousand LQ group = 3 – 7 thousand</p>	<p>B1 B1</p>	<p>Thousands not needed</p>

Question 34

(i)	<table style="border-collapse: collapse; margin-left: 20px;"> <tr> <td style="border-right: 1px solid black; padding: 5px;">Factory <i>A</i></td> <td style="padding: 5px;"></td> <td style="border-right: 1px solid black; padding: 5px;">Factory <i>B</i></td> <td style="padding: 5px;"></td> </tr> <tr> <td style="border-right: 1px solid black; padding: 5px;"></td> <td style="text-align: right; padding: 5px;">9</td> <td style="border-right: 1px solid black; padding: 5px;">3</td> <td style="padding: 5px;">1 5 8</td> </tr> <tr> <td style="border-right: 1px solid black; padding: 5px;">9 8 8 7 4 3 0</td> <td style="text-align: right; padding: 5px;">5</td> <td style="border-right: 1px solid black; padding: 5px;">4</td> <td style="padding: 5px;">2 4 7 8 9</td> </tr> <tr> <td style="border-right: 1px solid black; padding: 5px;">5 3 1 1 1</td> <td style="text-align: right; padding: 5px;">6</td> <td style="border-right: 1px solid black; padding: 5px;">5</td> <td style="padding: 5px;">1 4 6 8</td> </tr> <tr> <td style="border-right: 1px solid black; padding: 5px;"></td> <td style="text-align: right; padding: 5px;"></td> <td style="border-right: 1px solid black; padding: 5px;">6</td> <td style="padding: 5px;">4</td> </tr> </table>	Factory <i>A</i>		Factory <i>B</i>			9	3	1 5 8	9 8 8 7 4 3 0	5	4	2 4 7 8 9	5 3 1 1 1	6	5	1 4 6 8			6	4		M1	Attempt at ordering factory <i>B</i>
	Factory <i>A</i>		Factory <i>B</i>																					
	9	3	1 5 8																					
9 8 8 7 4 3 0	5	4	2 4 7 8 9																					
5 3 1 1 1	6	5	1 4 6 8																					
		6	4																					
				B1	Correct stem																			
				B1	Correct leaves factory <i>A</i>																			
				B1	Correct leaves factory <i>B</i>																			
				B1	Correct key need factory <i>A</i> and factory <i>B</i> and units																			
[5]																								
(ii)	median factory <i>B</i> = 0.048 g			B1	using their key i.e. 48, 0.48 etc or correct																			
	IQR = UQ – LQ = 0.055 – 0.04			M1	Subt their LQ from their UQ for factory <i>B</i>																			
	= 0.015			A1	[3]																			
(iii)	generally heavier in factory <i>A</i>			B1	oe																			
	Masses more spread out in factory <i>B</i>			B1	[2] must refer to context, e.g. mass																			

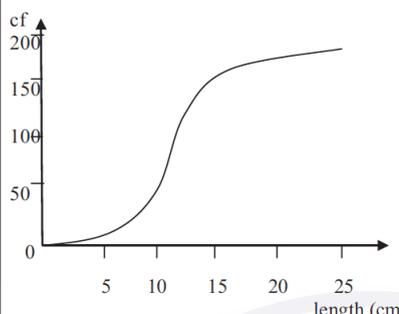
Question 35

(i)	LQ = 0.7495 Med = 0.7507 UQ = 0.7517	M1	Attempt to find all 3 quartiles can be implied, Condone LQ=0.7496, Med=0.7506, UQ=0.7515
		B1	Correct median line in box using their scale
		A1	Correct quartiles in box
		B1	Correct end whiskers(not dots or boxes), lines not through box,
		B1	Correct uniform scale from at least 0.7473 to 0.7532, and label (wt) kg oe can be seen in title or scale
Total:		5	
(ii)	Normal	B1	
	Symmetrical/peaks in middle or tails off quickly	B1	Need symm + another reason
	Total:	2	

Question 36

1.6 -1.5 2.3 1.4 -0.6 -0.9 2.5 1.9 2.4 1.9 2.8 1.0	M1	Subtracting 1760, allow max 2 slips
Mean = 1.23	A1	
sd = 1.39	A1	
Mean of $x = 1761.23$, sd of $x = 1.39$	A1	ft their coded mean and sd.
		<i>SR B1 correct mean and sd without use of coded process</i>
Total:	4	

Question 37

7(i)	freq = fd × cw 10, 40, 120, 30	M1 A1	Attempt to multiply at least 3 fds by their 'class widths'										
	Totals:	2											
7(ii)	<table border="1" style="margin-bottom: 10px;"> <tr> <td>length</td> <td>< 5</td> <td>< 10</td> <td>< 20</td> <td>< 25</td> </tr> <tr> <td>cf</td> <td>10</td> <td>50</td> <td>170</td> <td>200</td> </tr> </table> 	length	< 5	< 10	< 20	< 25	cf	10	50	170	200	B1 B1 M1 A1	3 or more correct cfs heights on graph 10, 50, 170, 200 Labels correct cf and length(cm), linear scales from zero (allow 0.5 on horizontal axis) Attempt (at least three) at plotting at upper end points (either 5 or 5.5, 10 or 10.5 etc.) Starting at (0, 0) polygon or smooth curve increasing with plotted points at lengths 5, 10, 20 and 25
length	< 5	< 10	< 20	< 25									
cf	10	50	170	200									
	Totals:	4											
(iii)	median = 14.2	B1	Median (accept 13.2 – 15.2)										
	'18.5' – '10'	M1	Subt their LQ from their UQ if reasonable from their graph										
	IQR range = 8.5	A1FT	Correct FT using LQ = 10 and UQ between 17.5 and 19.5										
	Totals:	3											
7(iv)	mean = $(2.5 \times 10 + 7.5 \times 40 + 15 \times 120 + 22.5 \times 30) / 200$	M1	Using mid points (± 0.5) and their frequencies from 7(i) in correct formula										
	= 14	A1											
	Totals:	2											

Question 38

(i)	med = 3.2	B1	Accept 3.2 ± 0.05
	UQ = $3.65 \leq uq \leq 3.7$ LQ = $2.55 \leq lq \leq 2.6$	M1	UQ – LQ, UQ greater than <i>their</i> 'median', LQ less than <i>their</i> 'median'
	IQR = $1.05 \leq iqr \leq 1.15$	A1	Correct answer from both LQ and UQ in given ranges
	Total:	3	
(ii)	$134 - 24 = 110$	B1	Accept $108 \leq n \leq 112$, n an integer
	Total:	1	
2(iii)	$200 - 12 = 188$ less than length l	M1	188 seen, can be implied by answer in range, mark on graph.
	$l = 4.5$ cm	A1	Correct answer accept $4.4 \leq l \leq 4.5$
	Total:	2	

Question 39

1(i)	fd 16, 14, 11, 505, 2.5	M1	Attempt at fd (must be at least 3 freq/cw) – may be implied by graph
		A1	Correct heights seen on graph i.e. must see a gap for fd = 2.5 etc.
		B1	Correct end points of bars and correct widths
		B1	labels fd, sec. Time can be optional. Linear axes, condone $0 \leq t < 20$ etc.
	Total:	4	
1(ii)	$(10 \times 320 + 30 \times 280 + 50 \times 220 + 80 \times 220 + 120 \times 100) / 1140$	M1	using $\Sigma fx / n$ with mid-point attempt ± 0.5 , not ends not class widths
	= 45.8	A1	
	Total:	2	

Question 40

1(i)	<i>EITHER:</i> $\frac{\sum x}{30} - k = \frac{315}{30} = 10.5$	(M1)	Dividing 315 by ± 30 and + or – from 50.5 need both and no more
	$k = 5.5 - 10.5 = 40$	(A1)	Correct answer from correct working
	<i>OR:</i> $\sum x = 50.5 \times 30 = 1515, 1515 - 30k = 315$	(M1)	Mult by 50.5 by 30 and + or – 315 and dividing by ± 30 need all these
	$k = 40$	(A1)	Correct answer from correct working. 1200 gets M0
	Total:	2	
1(ii)	<i>EITHER:</i> $\text{var} = 4022/30 - 10.5^2 (=23.817)$	(M1)	Subst in correct coded variance formula
	sd = 4.88	(A1)	
	<i>OR:</i> $\sum x^2 - 2(40)\sum x + 30(40)^2 = 4022, \sum x^2 = 77222$ $\text{Var} = 77222/30 - 50.5^2 (= 23.817)$	(M1)	Expanding with $\pm 40\Sigma x$ and $\pm 30(40)^2$ seen
	sd = 4.88	(A1)	
	Total:	2	

Question 41

(i)		<p>B1 Stem, digits 5, 7, 9 can be missing here, can be upside down</p> <p>B1 All leaves in correct order increasing from stem, (5, 7 and 9 can be missing), condone commas</p> <p>B1 Reasonable shape, requires all values of the stem, only one line for each stem and leaves must be lined up. Can be upside down or sideways. No commas. Condone one 'leaf' error.</p> <p>B1 Correct key must state 'medals' or have 'medals' in leaf heading or title</p>
(ii)	<p>Med = 17 LQ = 10 UQ = 35</p> <p>Number of medals</p>	<p>4</p> <p>B1 Median correct</p> <p>B1 LQ and UQ correct</p> <p>B1 Uniform scale from 2 to 104 (need 3 identified points min) and label including medals (can be in title)</p> <p>B1 FT Correct box med and quartiles on diagram, FT their values</p> <p>B1 Correct end-whiskers from ends of box but not through box</p>
		5

Question 42

$\Sigma(x - 45) = 1218 - 20 \times 45 = 318$	B1	
$\frac{\Sigma(x - 45)^2}{20} - \left(\frac{\Sigma(x - 45)}{20}\right)^2 = 4.2^2$	<p>M1 Fully correct substitution in the correct coded variance formula with their $\Sigma(x - 45)$</p> <p>OR valid method for $\Sigma x^2 = 74\,529$ ($4.2^2 = \frac{\Sigma x^2}{20} - \left(\frac{1218}{20}\right)^2$) and expanding $\Sigma(x - 45)^2$ correctly</p> <p>$= \Sigma x^2 - 90\Sigma x + 20 \times 45^2 = '74\,529' - 90 \times 1218 + 40\,500 = 5409$</p>	
$\Sigma(x - 45)^2 = 5409$	A1	
		3

Question 43

(i)	points (50, 14), (80, 62), (100, 132), (120, 140)	B1 Correct cfs values seen listed, in or by table or on graph, 0 not required
		<p>B1 Axes labelled 'cumulative frequency' (or cf) and 'circumference [or cir or c etc.] (in) cm'. Linear scales – c.f. 0–140 circumference 40–120 (ignore <40 on circ.) At least 3 values stated on each axis, but (0,0) can be implied without stating.</p> <p>B1 All points plotted accurately</p>
		3
(ii)	140 – 54 = 86	M1 Finding correct value from graph (checked ±1 mm) or linear interpolation. Subtraction from 140 can be implied
	Percentage = 61.4%	A1 60.5% ≤ Ans ≤ 64.5%
		2

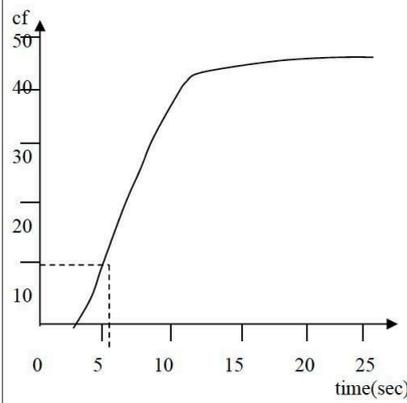
Question 44

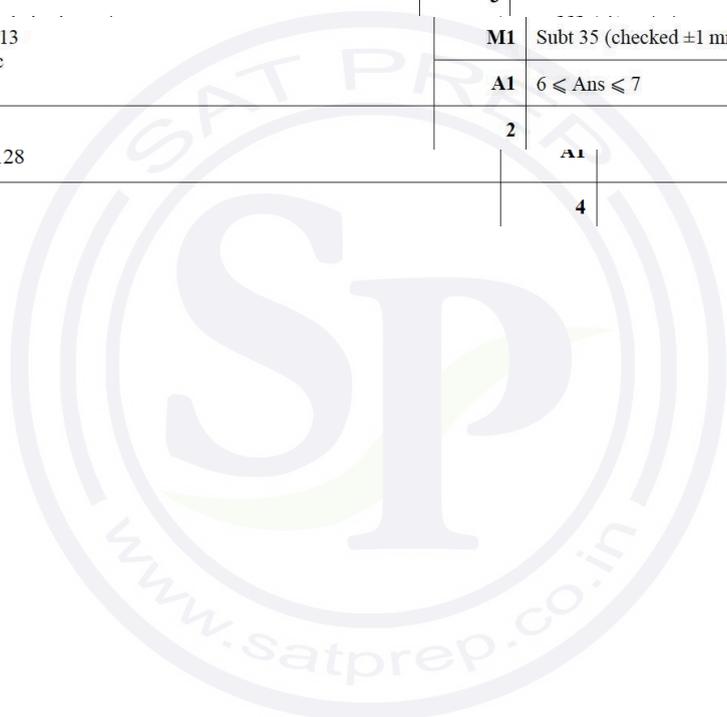
<i>EITHER:</i> $(\Sigma x =) 11.5n = 27 + 10n$	(M1) Expanding brackets and forming a three term equation involving 27 and at least one term in n , without x
	M1 $10n$ or $11.5n$ seen in expression without x ($1.5n = 27$ implies M2)
$n = 18$	A1)
<i>OR:</i> $11.5 = \frac{27}{n} + 10$	(M1) Dividing coded sum by n and forming a three term equation involving 11.5 and at least one term in n , without x
	M1 $27/n$ seen in expression without x ($1.5 = \frac{27}{n}$ implies M2)
$n = 18$	A1)
	3

Question 45

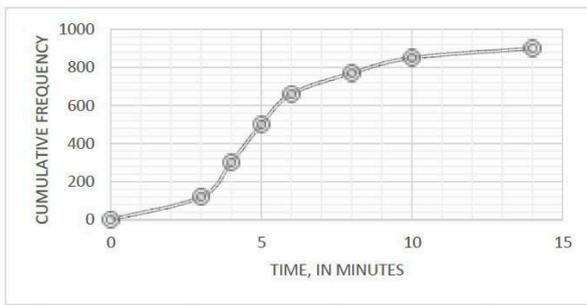
(i)	$\frac{(48.7 \times 12 + 38.1 \times 7)}{19}$	M1 Accept unsimplified (may be separate calculations)
	$= 44.8$	A1
		2
(ii)	$7.65^2 = \frac{\Sigma x^2}{12} - 48.7^2 \quad \Sigma x^2 = 29162.55$	M1 Substitution in one correct variance formula
	$4.2^2 = \frac{\Sigma y^2}{7} - 38.1^2 \quad \Sigma y^2 = 10284.75$	A1 One Σx^2 or Σy^2 correct (can be rounded to 4sf)
	Combined var = $\frac{(29162.55 + 10284.75)}{19} - 44.79^2$	M1 Using their Σx^2 and Σy^2 and their 4(i) in the variance formula
	$= \frac{39447.3}{19} - 44.79^2$	
	Combined $\sigma = 8.37$ or 8.36	A1
		4

Question 46

(i)	<p>Points (5.5,10), (8.5,25), (11.5,42), (16.5,46), (25.5,48)</p> 	<p>B1 Correct cfs values seen listed, in or by table or on graph, 0 not required</p> <p>B1 Axes labelled “cumulative frequency” (or cf) and “time [or t etc.] (in) seconds (or sec etc.)”. Linear scales – cf 0–48, time 2.5 – 25.5 (ignore <2.5 on time.) At least 3 values stated on each axis, but (0,0) can be implied without stating.</p> <p>B1 All points plotted accurately, (5, 10) etc. scores B0. Curve or line segments drawn starting at (5.5,10) and passing within ‘1 scale unit’ vertically and horizontally of plotted points</p>
		3
(ii)	<p>$48 - 35 = 13$ $t = 6.5 \text{ sec}$</p>	<p>M1 Subt 35 (checked ± 1 mm on graph) from 48 or 50,</p> <p>A1 $6 \leq \text{Ans} \leq 7$</p>
	<p>$\sum x^c = 21128$</p>	2
		<p>A1</p> <p>4</p>



Question 48



t	0	3	4	5	6	8	10	14
cf	0	120	300	500	660	770	850	900

Median value: 4.8 (minutes)

M1 A1 Attempt to plot cumulative frequencies at ucb and all points joined between $(3, y_1)$ and $(14, y_2)$. Cf table not required.

Linear scales starting at $(0,0)$ and axes labelled cf and time in mins, all points correct; (allow straight lines or curves)

M1 450 seen in median attempt on increasing CF graph (independent);

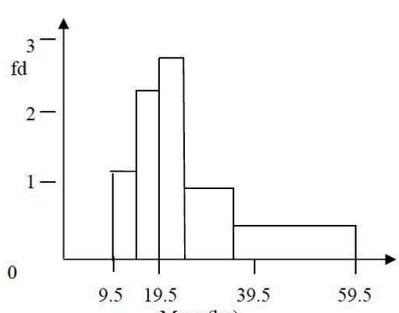
A1 FT Correct $(4.7 \leq m < 4.9)$ or FT from reading their increasing graph at cf = 450

4

Question 49

4(i)	Mean = $(30 \times 1500 + 21 \times 2400)/51$	M1 Multiply by 30 and 21, summing and dividing total by 51 $\left(\frac{45000 + 50400}{51} \right)$
	= 1870 (1870.59)	A1 correct answer (to 3sf)
	Total:	2
4(ii)	$230^2 = \frac{\sum x_F^2}{30} - 1500^2$ so $\sum x_F^2 = 69\,087\,000$	M1 One correct substitution into a correct variance formula
	$160^2 = \frac{\sum x_L^2}{21} - 2400^2$ so $\sum x_L^2 = 121\,497\,600$	A1 Correct $\sum x_F^2$ (rounding to 69 000 000 2sf)
	New var = $\frac{69\,087\,000 + 121\,497\,600}{51} - 1870.588^2 = 237\,853$	A1 Correct $\sum x_L^2$ (rounding to 121 000 000 3sf)
	New sd = 488	M1 using ' $\sum x_F^2$ ' + ' $\sum x_L^2$ ' dividing by 51 and subtracting 'i' squared. (Correct ' $\sum x_F^2$ ' + ' $\sum x_L^2$ ' = 190 584 600)
	Total:	A1 Correct answer accept anything between 486 and 490
		5

Question 50

1(i)	15–19 (kg) cao	B1 kg not necessary; condone 14.5 – 19.5
	Total:	1
1(ii)	fd = 1.2, 2.4, 2.8, 1, 0.32	M1 Attempt at fd [$f/(attempt\ at\ cw)$] or scaled freq (may be implied by 4 correct)
		A1 Correct heights seen on diagram with linear vertical scale from $(x, 0)$
		B1 Correct bar widths (1:1:1:2:5) visually no gaps with linear horizontal scale from $(9.5, y)$ and first bar starting at $(9.5, y)$
		B1 Histogram, using attempted fds, with labels (mass, kg and fd seen) and at least 3 linearly spaced values on each axis. Horizontal axis must range from at least 9.5 to 59.5 If horizontal axis clearly starts from zero, either a break in the scale must be indicated or the scale must be linear from zero.

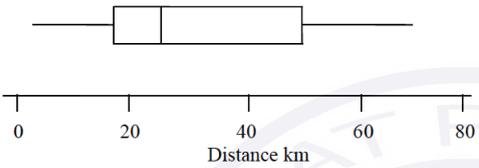
Question 51

5(i)	$a = 40$	B1	
		1	
i(ii)	$\text{Mean} = \frac{0.5 \times 14 + 1.5 \times 46 + 3.5 \times 102 + 7.5 \times \text{their } 40 + 20 \times 40}{242}$ $= \frac{1533}{242}$	M1	Numerator: 5 products with at least 3 acceptable mid-points \times appropriate frequency FT (i) . Denominator: 242 CAO
	$= 6 \frac{81}{242}$ or 6.33	A1	CAO (6.3347... rounded to 3 or more SF)
		2	
iii)	fd = 14, 46, 34, ($\frac{\text{their } (i)}{5} =$) 8, 2	M1	Attempt at fd [f/(attempt at cw)] or scaled freq
		A1FT	Correct heights seen on diagram with linear vertical scale from (x, 0) FT their $\frac{a}{5}$ only
		B1	Correct bar widths (1:1:3:5:20) at axis, visually no gaps, with linear horizontal scale from (0, y), first bar starting at (0,0)
		B1	Labels (time, mins, and fd(OE) seen, some may be as a title) and a linear scale with at least 3 values marked on each axis. (Interval notation not acceptable)
		4	

Question 52

(i)	38	B1	
		1	
ii)	Median = 38.5	B1	CAO
	IQR = 40 - 38	M1	$39 < \text{UQ} < 45 - 36 < \text{LQ} \leq 38$
	= 2	A1	If M0 awarded SCB1 for both UQ = 40 or 40.5 and LQ = 38 or 37.75 seen
		3	

Question 53

(ii)	$1.5 \times \text{IQR} = 48$ Method 1 $\text{LQ} - 48 = -ve, (\text{i.e.} < 0)$ $\text{UQ} + 48 = 98 (\text{i.e.} > 70)$	M1	Attempt to find $1.5 \times$ their IQR and add to UQ or sub from LQ
	hence no outliers	A1	Correct conclusion from correct working, need both ends. No need to state comparisons.
	Method 2 $\text{LQ} - 5 = 13 (< 48)$ $70 - \text{UQ} = 20 (< 48)$	M1	Compare their $1.5 \times \text{IQR} (= 48) >$ gap (20) between UQ and max 70 or LQ and min 5
	Hence no outliers	A1	Correct conclusion from correct working, need both ends. No need to state comparisons
(i)	LQ = 18, Median = 25, UQ = 50	2	
	 <p style="text-align: center;">Distance km</p>	B1	median correct
		B1	LQ and UQ correct
		B1	Quartiles and median plotted as box graph with linear scale min 3 values
		B1ft	Whiskers drawn to correct end points with linear scale, not thr' box, not joining at top or bottom of box. Ft their UQ and LQ. Whiskers must be with ruler If scale non-linear or non-existent SCB1 if all 5 data values (quartiles and end points) have values shown and all are correct numerically and fulfil the 'box' and 'whiskers ruled line' requirements
	B1	Label to include 'distance or travelled' and 'km,' allow 'total km', linear scale, numbered at least 5 – 70.	
		5	

Question 54

$\Sigma(x - 10) = 186 - 12 \times 10 = 66$	B1	Correct answer
$\frac{\Sigma(x - 10)^2}{12} - \left(\frac{\Sigma(x - 10)}{12}\right)^2 = 4.5^2$	M1	Consistent substituting in the correct coded variance formula OR Valid method for Σx^2 then expanding $\Sigma(x - 10)^2$, 3 terms with at least 2 correct
$\Sigma(x - 10)^2 = 606$	B1	Correct answer
	3	

Question 55

(i)	<table border="1" style="width: 100%; text-align: center;"> <thead> <tr> <th style="width: 30%;">Anvils</th> <th style="width: 10%;"></th> <th style="width: 10%;"></th> <th style="width: 30%;">Brecons</th> </tr> </thead> <tbody> <tr> <td></td> <td>8</td> <td>15</td> <td></td> </tr> <tr> <td></td> <td>9 5</td> <td>16</td> <td>6</td> </tr> <tr> <td></td> <td>5 3 2 0</td> <td>17</td> <td>0 1 2 2 8</td> </tr> <tr> <td></td> <td>4 1 0</td> <td>18</td> <td>1 2 3 3</td> </tr> <tr> <td></td> <td>6</td> <td>19</td> <td>2</td> </tr> <tr> <td></td> <td></td> <td></td> <td>Key: 5 16 6 means 165 cm for Anvils and 166 cm for Brecons</td> </tr> </tbody> </table>	Anvils			Brecons		8	15			9 5	16	6		5 3 2 0	17	0 1 2 2 8		4 1 0	18	1 2 3 3		6	19	2				Key: 5 16 6 means 165 cm for Anvils and 166 cm for Brecons	B1	Correct stem, up or down
Anvils			Brecons																												
	8	15																													
	9 5	16	6																												
	5 3 2 0	17	0 1 2 2 8																												
	4 1 0	18	1 2 3 3																												
	6	19	2																												
			Key: 5 16 6 means 165 cm for Anvils and 166 cm for Brecons																												
				B1	Correct Anvils labelled on left, leaves in order from right to left and lined up vertically, no commas																										
				B1	Correct Brecons labelled on same diagram on right hand side in order from left to right and lined up vertically, no commas																										
				B1	Correct key, not split, both teams, at least one with cm																										
				4																											
(ii)	Median = 173			B1	Correct median (or Q2)																										
	LQ = 169; UQ = 181 IQR = 181 - 169			M1	Either UQ = 181 ± 4, or LQ = 169 ± 4 and evaluating UQ - LQ																										
	= 12			A1	Correct answer from 181 and 169 only																										
				3																											
(iii)	$\Sigma x = 1923 + 166 + 172 + 182 (= 2443)$ $\Sigma x^2 = 337221 + 166^2 + 172^2 + 182^2 (= 427485)$			M1	Correct unsimplified expression for Σx and Σx^2 , may be implied																										
	Mean = $\frac{\Sigma x}{14} = \frac{2443}{14} = 174.5$			M1	Correct unsimplified mean																										
	Variance = $\frac{\Sigma x^2}{14} - \left(\frac{\Sigma x}{14}\right)^2 = \frac{427485}{14} - \left(\frac{2443}{14}\right)^2$			M1	Correct unsimplified variance using 14, their Σx and their Σx^2 , not using 1923 and/or 337221																										
	S d = 9.19			A1	Correct answer																										
				4																											

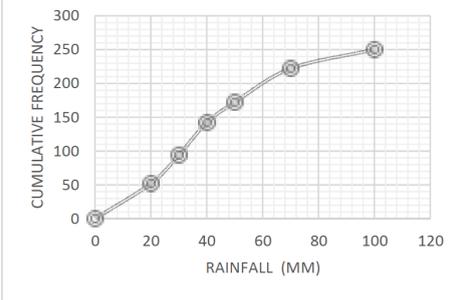
Question 56

(i)	median = 0.225; LQ = 0.215: UQ = 0.236	B1	Correct median (Q_2)												
	IQR = 0.236 – 0.215	M1	$0.232 < \text{UQ } (Q_3) < 0.238 - 0.204 < \text{LQ } (Q_1) < 0.219$												
	= 0.021	A1	www Omission of all decimal points MR-1 If M0 awarded SCB1 for both LQ = 0.215: UQ = 0.236 seen												
		3													
(ii)		B1	Linear scale between 0.20 to 0.26 (condone omission of 0.26) axis labelled (time and seconds), at least one box plot attempted, no lines through boxes, whiskers not at corner of boxes												
		B1 ft	Labelled correct graph for A, (ft their median/quartiles), condone lines through boxes, whiskers at corner of boxes												
	<table border="1"> <tr> <td>A</td> <td>0.200</td> <td>0.215</td> <td>0.225</td> <td>0.236</td> <td>0.250</td> </tr> <tr> <td>B</td> <td>0.205</td> <td>0.217</td> <td>0.235</td> <td>0.245</td> <td>0.258</td> </tr> </table>	A	0.200	0.215	0.225	0.236	0.250	B	0.205	0.217	0.235	0.245	0.258	B1	Labelled correct graph for B, condone lines through boxes, whiskers at corner of boxes SC If B0B0 scored because graphs not labelled/labels reversed SCB1 if both 'correct' Penalty MR-1 if graphs plotted on separate axes unless both scales align exactly.
	A	0.200	0.215	0.225	0.236	0.250									
B	0.205	0.217	0.235	0.245	0.258										
	3														

Question 57

(i)	$\frac{15.5 \times 12 + 910}{12 + 20}$	M1	Unsimplified total age divided by <i>their</i> total members (not 12, 20 or 2)
	= 34.25 or 34¼ (years)	A1	Correct exact answer (isw rounding), oe (34 years 3 months)
		2	
(ii)	Considering Juniors: variance = $\frac{\sum x^2}{12} - 15.5^2 = 1.2^2$	M1	$\frac{\sum x^2}{k} - 15.5^2 = 1.2^2, k = 12 \text{ or } 20$
	$\sum x^2 = 2900.28$	A1	Answer wrt 2900
	Considering whole group: $\sum z^2 = \sum x^2 + \sum y^2 = 2900.28 + 42850 = 45750$ Variance = $\frac{\sum z^2}{32} - \mu^2 = \frac{\text{their } 45750}{12 + 20} - (\text{their } 34.25)^2$ (= 256.63)	M1	<i>Their</i> 45750 > 42850 (not 85700 or rounding to 1.8×10^9) in correct variance or std deviation formula ($\sum x^2$ and addition may not be seen)
	s d = 16.0(2)	A1	Correct final answer, condone 16.03
	4		

Question 58

(i)		B1	Appropriate linear scales starting at (0,0), axes labelled cf and Rainfall, mm
		B1	Correct graph, points plotted at ucb, allow straight lines or curve
		2	
(ii)		M1	Read off from increasing graph at cf = 150
	42	A1	Correct answer ($41 \leq r \leq 43$)
		2	
(iii)	Frequencies 52, 42, 48, 30, 50, 28	B1	Correct frequencies
	Mean age = $(10 \times 52 + 25 \times 42 + 35 \times 48 + 45 \times 30 + 60 \times 50 + 85 \times 28) / 250$	B1	Correct midpoints (allow one error)
	= 9980/250	M1	Using $\Sigma fx/250$ with mid-points attempt, not cf, cw, lb, ub
	= 39.9(2) oe	A1	Correct answer
	Variance = $10^2 \times 52 + 25^2 \times 42 + 35^2 \times 48 + 45^2 \times 30 + 60^2 \times 50 + 85^2 \times 28) / 250 -$ mean ² = 539.59	M1	Attempt at variance using their midpoints and their mean
	$\sigma = 23.2$	A1	Correct answer for sd
		6	

Question 59

(i)	$\sigma^2 = \frac{\Sigma(x-c)^2}{n} - \left(\frac{\Sigma(x-c)}{n} \right)^2$ $3.2^2 = \frac{3099.2}{40} - \left(\frac{\Sigma(x-c)}{40} \right)^2$	M1	Use correct formula with values substituted
	$\left(\frac{\Sigma(x-c)}{40} \right)^2 = 67.24 :$ $\Sigma(x-c) = 40 \times \sqrt{67.24}$	M1	Rearrange to make <i>their</i> $\left(\frac{\Sigma(x-c)}{40} \right)^2$ the subject, unsimplified.
	= 328	A1	Exact value, cao
		3	
(ii)	$\Sigma x - 40c = \textit{their (i)}$ $\text{Mean} = \frac{\textit{their (i)}}{40} + 50$ $= 58.2$	B1FT	FT <i>their (i)</i>
		1	

Question 60

(i)	Dolphins	Sharks	B1	Correct stem can be upside down, ignore extra values,
		5 9	B1	Correct Dolphin must be on LHS,
	9 5 5 3 2	6 4 6 8	B1	Correct Sharks on either LHS or RHS of back-to-back. Alignment \pm half a space, no late entries squeezed in, no crossing out if shape is changed. Condone a separate RHS stem-and-leaf diagram
	5 3 2	7 0 1 2 4 7	B1FT	Correct single key for <i>their</i> single diagram, need both teams identified and 'kg' stated at least once here or in leaf headings or title.
2 2 0	8 0 4			
			4	
(ii)	Median = 72 LQ = 65, UQ = 80,		B1	$72 < UQ < 82 - 62 < LQ < 72$
	IQR = 80 - 65		M1	nfww
	= 15		A1	SCB1 if M0 scored for LQ = 65 and UQ = 80
			3	

Question 61

(i)	Thaters School	Whitefay Park School	B1	Correct stem can be upside down, ignore extra values,
		8 3	B1	Correct Thaters School labelled on left, leaves in order from right to left and lined up vertically, no commas
	8 8 7 6 4 2	4 5 7 5 3 6 6 6 1 4 6 9 7 3 5 8 8 3	B1	Correct Whitefay Park School labelled on same diagram on right hand side in order from left to right and lined up vertically, no commas
	Key 8 4 5 represents 48 minutes for Thaters School and 45 minutes for Whitefay Park School.		B1	FT Correct key for <i>their</i> diagram, need both teams identified and 'minutes' stated at least once here or in leaf headings or title. SC If 2 separate diagrams drawn, SCB1 if both keys meet these criteria
			4	
(ii)	LQ = 50 UQ = 61.5		B1	Both quartiles correct
	IQ range = 61.5 - 50 = 11.5		B1	FT $61 \leq UQ \leq 62 - 48 \leq LQ \leq 52$
			2	
(iii)	$\Sigma(x - 60)^2 = (-15)^2 + (-13)^2 + (-7)^2 + (-4)^2 + (-4)^2 + 1^2 + 4^2 + 6^2 + 9^2 + 13^2 + 23^2 + 15^2 + 18^2$		M1	Summing squares with at least 5 correct unsimplified terms
	= 1856		A1	Exact value
			2	
(iv)	Var = mean of coded squares - (coded mean) ² $= \frac{\Sigma(x - 60)^2}{13} - \left(\frac{\Sigma(x - 60)}{13} \right)^2$		M1	Using two coded values in correct formula (variance or sd)
	Var = $\frac{\text{their } 1856}{13} - \left(\frac{46}{13} \right)^2$ = 130		A1	Correct answer SC if correct variance obtained by another method give SCB1
			2	

Question 62

(i)	Advantage: comment referring to spread or range or shape	B1	Comments referring to quartiles, IQR, Range, median, shape, skewness, data distribution, spread score B1 Any comments with reference to mean or standard deviation or any other 'disadvantage' will score B0 Comments referring to '5-value plot', comparison with another data set, overview or ease of drawing/plotting/reading require an appropriate advantage statement.
	Disadvantage: comment referring to limited data information provided	B1	Comments referring to no individual data, no information about the number of values, unable to calculate mean, standard deviation, variance and mode score B1 Any comments with reference to median, shape or any other 'advantage' will score B0 Comments referring to 'size of data set' or 'average' require an appropriate disadvantage statement. Comments referring to outliers are ignored in all cases (as outliers are not in the syllabus content) unless supported by an appropriate advantage / disadvantage statement. If comments not clearly identified, assume first comment is the advantage.
		2	
5(ii)	Not mean as data skewed by one large value	B1	Comment which identifies 768 (or 'a very large number') as the problem. Condone the use of 'outlier'
	Not mode as frequencies all the same	B1	Comment which indicates that no mode exists (e.g. all the data is different, there is no repeated number, all the values are different)
	Median	B1	Median identified as choice, dependent upon statements for mean and mode being given, even if incorrect or very general.
	SC: Mean is identified as most suitable		
	Not mode as frequencies all the same	SCB1	Comment which indicates that no mode exists
Not median as not all values used	SCB1	Comment which indicates limitation of median e.g. median is not in middle of range.	
		3	
iii(a)	<p>LQ = 256 or 256.5 Med = 280 UQ = 329 Min 190 max 375</p>	B1	Median, UQ and LQ values seen, may not be identified or identified correctly. (Not read from box plot unless value stated)
		B1	FT Median and quartiles plotted in box on graph, linear scale
		B1	Correct end points, whiskers from ends of box but not through box, not at top or bottom of box
		B1	Uniform scale from 190 to 375 (need at least 3 linear identified points min) and labelled 'time' and 'minutes' (can be in title) No time axis or time axis with no scale attempt, Max B1B0B0B0
		4	
iii(b)	IQR = <i>their</i> 329 – <i>their</i> 256 = 73 or 72.5	B1	FT Must follow through only from <i>their</i> stated values (condone if correct quartiles stated here), not reading from graph.
		1	

Question 63

(i)	$\Sigma(t - 120) = -25 + 6 - 3 + 15 + 0 + 5 - 6 - 1 + 16 = 7$	M1	Attempt to sum both $(t - 120)$ and $(t - 120)^2$ Correct ans using $\Sigma t - 9 \times 120$ and $\Sigma (t - 120)^2$ M1A1
	$\Sigma(t - 120)^2 = 25^2 + 6^2 + 3^2 + 15^2 + 0^2 + 5^2 + 6^2 + 1^2 + 16^2 = 1213$	A1	Both correct, www, SC correct ans no working B1B1
		2	
(ii)	$\text{Var} = \frac{\Sigma(t - 120)^2}{9} - \left(\frac{\Sigma(t - 120)}{9}\right)^2 = \frac{\text{their } 1213}{9} - \left(\frac{\text{their } 7}{9}\right)^2$	M1	Using two coded values in correct formula including finding Σt from 7 etc
	$= 134.(2)$	A1	Correct answer SC if correct variance obtained by another method from raw data give SCB1
		2	
	Median Maths = 40	M1	Indication of finding medians, such as mark on graph or reference marks to 700 pupils, condone poor terminology such as 'mean'
	Median English = 55	A1	Both values correct, condone $54 < \text{English} < 56$ but 54, 56 get A0
	Median of English is larger than median of Maths	B1	Correct statement, median must be referenced within answer. No credit if statement references 'means'
	Range Maths is 100 or IQ range Maths = $80 - 12 = 68$	M1	Evidence of finding either both ranges or both IQ ranges i.e. see a minus
	Range English is 60 or IQ range English = $62 - 42 = 20$	A1	Both ranges or IQR correct
	Maths marks have more spread than English marks	B1	Correct conclusion. Accept standard deviation but must see some figures
		6	

Question 64

(i)	Correct labels and scales	B1	Axes labelled 'cumulative frequency' (or cf) and 'time (or t) [in] min(utes)', linear scales from 0 to 90 and 0 to 200 with at least 3 values marked on each axis.
	7 correctly plotted points above upper boundaries joined in a curve or line segments	B1	(0, 0); (10, 16); (20, 50); (30, 106); (50, 146); (70, 176); (90, 200)
		2	
(ii)	29	B1	$28 \leq \text{median} \leq 30$
		1	
(iii)	120 seen	M1	For seeing 120 in a calculation or marked on the graph
	37	A1FT	$36 \leq \text{Ans} \leq 39$ or FT from <i>their</i> graph SC1 unsupported answer in range
		2	
(iv)	Frequencies 16 34 56 40 30 24	B1	Seen. Allow unsimplified
	$\text{Est. Mean} = \frac{5 \times 16 + 15 \times 34 + 25 \times 56 + 40 \times 40 + 60 \times 30 + 80 \times 24}{200}$	M1	At least 4 correct midpoints (5, 15, 25, 40, 60, 80) used in a calculation
	$\frac{7310}{200}$	M1	Summing products of <i>their</i> 6 mid-points (not lower or upper bound or class width) \times <i>their</i> frequencies / 200 (or <i>their</i> Σf), unsimplified
	36.55	A1	Accept 36.6
		4	

Question 65

(i)	Median = 51 UQ = 57.5, LQ = 40	B1	
	IQR = UQ – LQ	M1	$55 \leq \text{UQ} \leq 62 - 38 \leq \text{LQ} \leq 45$
	17.5	A1	NFWW
		3	
(ii)	Result will be disproportionately affected by 110	B1	Affected by an extreme/large value There is a large outlier ...contains outliers such as 110... Not 'mean affected by extreme values'
		1	

Question 66

(i)	0.5 2.4 3 1.4 0.4	M1	At least 3 frequency densities calculated (frequency \div class width) e.g. $\left(\frac{10}{20}, \frac{10}{19} \text{ or } \frac{10}{19.5}\right)$ may be read from graph using <i>their</i> scale, 3SF or exact
	All heights correct on graph.	A1	
	Bar ends of 9.5, 29.5, 39.5, 59.5, 89.5	B1	
	Axes labelled: Frequency density (fd) and speed/km h ⁻¹ (or appropriate title). Linear scales $9.5 \leq$ horizontal axis ≤ 89.5 , $0 \leq$ vertical axis ≤ 3 , 5 bars with no gaps	B1	
		4	
(ii)	$\frac{19.5 \times 10 + 34.5 \times 24 + 44.5 \times 30 + 54.5 \times 14 + 74.5 \times 12}{\text{their } 90}$ $= \frac{195 + 828 + 1335 + 763 + 894}{90}$ $= \frac{4015}{90} \text{ or } \frac{803}{18}$	M1	Uses at least 4 midpoint attempts (e.g. 19.5 ± 0.5). Allow unsimplified expression.
	$44 \frac{11}{18}$ or 44.6 (km h ⁻¹)	A1	Final answer not an improper fraction NFWW
		2	

Question 67

(i)	$\Sigma x = 60 \times 20 = 1200$	B1	
	$\frac{\Sigma x^2}{20} - 60^2 = 4^2$	M1	Correct variance formula used, condone = 4
	$\Sigma x^2 = 3616 \times 20 = 72320$	A1	Exact value
		3	
(ii)	$\Sigma x = 1200 + 550 = 1750$ $\Sigma x^2 = 72320 + 40500 = 112800$	M1	Summing both values of Σx and Σx^2
	Mean = $\frac{\text{their } 1750}{30} = 58.3$	B1FT	FT <i>their</i> 1750 (not 550 or 1200)/ <i>their</i> (20+10), accept unsimplified
	Variance = $\frac{\text{their } 112800}{30} - \left(\frac{\text{their } 1750}{30}\right)^2 (= 357.89)$	M1	substitute <i>their</i> Σx and Σx^2 into correct variance formula
	s.d. = 18.9	A1	
		4	

Question 68

(i)	$156 - 55 = 99$	B1	$98 \leq \text{answer} < 100$
		1	
(ii)	$90\% \text{ of } 160 = 144$	M1	144 seen, may be marked on graph
	$(L =) 22$	A1	
		2	
(iii)	Median = 15.6 UQ = 18.8, LQ = 12.7	B1	$15.5 < \text{median} < 15.8$
	IQR = 18.8 - 12.7	M1	$18.5 < \text{UQ} < 19 - 12.5 < \text{LQ} < 13$
	6.1	A1	$6.0 \leq \text{IQR} \leq 6.2$
		3	
(iv)	The Median higher for Ransha (1st set of data)	B1	Any correct comparison of central tendency, must mention median
	IQR lower for Ransha (1st set of data)	B1	Any correct comparison of spread, must refer to IQR
		2	

Question 69

(i)	$\sigma^2 = \frac{\sum(x-c)^2}{n} - \left(\frac{\sum(x-c)}{n}\right)^2$ $3.2^2 = \frac{3099.2}{40} - \left(\frac{\sum(x-c)}{40}\right)^2$	M1	Use correct formula with values substituted
	$\left(\frac{\sum(x-c)}{40}\right)^2 = 67.24 :$ $\sum(x-c) = 40 \times \sqrt{67.24}$	M1	Rearrange to make <i>their</i> $\left(\frac{\sum(x-c)}{40}\right)^2$ the subject, unsimplified.
	= 328	A1	Exact value, cao
		3	
(ii)	$\sum x - 40c = \text{their (i)}$ Mean = $\frac{\text{their (i)}}{40} + 50$ = 58.2	B1FT	FT <i>their (i)</i>
		1	

Question 70

(i)	Dolphins	Sharks	B1	Correct stem can be upside down, ignore extra values,
		5 9	B1	Correct Dolphin must be on LHS,
	9 5 5 3 2	6 4 6 8	B1	Correct Sharks on either LHS or RHS of back-to-back. Alignment \pm half a space, no late entries squeezed in, no crossing out if shape is changed. Condone a separate RHS stem-and-leaf diagram
	5 3 2	7 0 1 2 4 7	B1FT	Correct single key for <i>their</i> single diagram, need both teams identified and 'kg' stated at least once here or in leaf headings or title.
	2 2 0	8 0 4		
		Key: 3 6 4 means 63 kg for Dolphins and 64 kg for Sharks		
			4	
(ii)	Median = 72 LQ = 65, UQ = 80,		B1	$72 < UQ < 82 - 62 < LQ < 72$
	IQR = 80 - 65		M1	nfw
	= 15		A1	SCB1 if M0 scored for LQ = 65 and UQ = 80
			3	

Question 71

(a)	15, 63, 129, 150	B1	Correct cumulative frequencies seen (may be on graph)
		B1	$0 \leq \text{Horizontal axis} \leq 30, 0 \leq \text{vertical axis} \leq 150$ Labels correct: length cm, cf
		M1	At least 3 points plotted at upper end points (e.g. allow 9, 9.5, 10) with a linear horizontal scale.
		A1	Linear vertical scale, all points at correct upper end points (9.5 etc.), curve drawn accurately, joined to (0,0) (condone (-0.5, 0))
		4	
(b)	60% of 150 = 90	M1	90 seen or implied by use on graph
	Approx. 16.5 [cm]	A1FT	FT <i>their</i> increasing cumulative frequency graph, Use of graph must be seen. If no clear evidence of use of graph SCB1FT correct value from <i>their</i> graph
		2	

(c)	Midpoints: 4.75, 12, 17, 25	M1	At least 3 correct midpoints used (39449.4375 implies M1)
	$\text{Var} = \frac{4.75^2 \times 15 + 12^2 \times 48 + 17^2 \times 66 + 25^2 \times 21}{150} - 15.295^2$	M1	Using midpoints ± 0.5 in correct var formula, including subtraction of <i>their</i> μ^2 .
	= 29.1	A1	
		3	

Question 72

(a)	<table style="margin-left: auto; margin-right: auto;"> <tr> <td style="border-right: 1px solid black; padding: 5px;">A</td> <td style="border-right: 1px solid black; padding: 5px;"></td> <td style="padding: 5px;">B</td> </tr> <tr> <td style="border-right: 1px solid black; padding: 5px;"></td> <td style="border-right: 1px solid black; padding: 5px;">2</td> <td style="padding: 5px;">6</td> </tr> <tr> <td style="border-right: 1px solid black; padding: 5px; text-align: center;">5 2 0</td> <td style="border-right: 1px solid black; padding: 5px;">3</td> <td style="padding: 5px; text-align: center;">0 1 5 8</td> </tr> <tr> <td style="border-right: 1px solid black; padding: 5px; text-align: center;">9 7 2 1 1</td> <td style="border-right: 1px solid black; padding: 5px;">4</td> <td style="padding: 5px; text-align: center;">1 2 2 7 9</td> </tr> <tr> <td style="border-right: 1px solid black; padding: 5px; text-align: center;">3 2</td> <td style="border-right: 1px solid black; padding: 5px;">5</td> <td style="padding: 5px; text-align: center;">2</td> </tr> <tr> <td style="border-right: 1px solid black; padding: 5px; text-align: center;">4</td> <td style="border-right: 1px solid black; padding: 5px;">6</td> <td style="padding: 5px;"></td> </tr> </table>	A		B		2	6	5 2 0	3	0 1 5 8	9 7 2 1 1	4	1 2 2 7 9	3 2	5	2	4	6			
A		B																			
	2	6																			
5 2 0	3	0 1 5 8																			
9 7 2 1 1	4	1 2 2 7 9																			
3 2	5	2																			
4	6																				
	KEY 1 4 2 means \$41 000 for A and \$42 000 for B																				
	Correct stem		B1																		
	Correct A on LHS		B1																		
	Correct B on same diagram		B1																		
	Correct key for <i>their</i> diagram, both companies identified and correct units		B1																		
			4																		
(b)	Median = [S]42 000		B1																		
	LQ = [S]35 000 UQ = [S]52 000		B1																		
	IQR = [S]17 000 (FT if $49000 \leq UQ \leq 53000 - 32000 \leq LQ \leq 41000$)		B1 FT																		
			3																		
i(c)	Sum of given 11 numbers is 433 000		M1																		
	Sum of 12 numbers, including new = $38\,500 \times 12 = 462\,000$		M1																		
	Difference = new salary = [S]29 000		A1																		
			3																		

Question 73

b)	$\sum x - 50n = 144$	B1
	$50n + 144 = 944$	M1
	$n = 16$	A1
		3

Question 74

(a)	Median = 0.238	B1																		
	UQ = 0.245, LQ = 0.231, So IQR = 0.245 – 0.231	M1																		
	0.014	A1																		
		3																		
(b)	<table border="1"> <thead> <tr> <th></th> <th></th> <th>LQ</th> <th>M</th> <th>UQ</th> <th></th> </tr> </thead> <tbody> <tr> <td>A</td> <td>0.220</td> <td>0.231 FT</td> <td>0.238 FT</td> <td>0.245 FT</td> <td>0.254</td> </tr> <tr> <td>B</td> <td>0.211</td> <td>0.224</td> <td>0.232</td> <td>0.243</td> <td>0.256</td> </tr> </tbody> </table>			LQ	M	UQ		A	0.220	0.231 FT	0.238 FT	0.245 FT	0.254	B	0.211	0.224	0.232	0.243	0.256	
		LQ	M	UQ																
A	0.220	0.231 FT	0.238 FT	0.245 FT	0.254															
B	0.211	0.224	0.232	0.243	0.256															
	Medians and quartiles correctly plotted for <i>A</i> or <i>B</i>	B1																		
	End points correct for <i>A</i> or <i>B</i>	B1																		
	Completely correct, including scale	B1																		
		3																		
(c)	Lengths of rods produced by machine <i>A</i> are longer. (B1 for comparison of central tendency)	B1																		
	Lengths of rods produced by machine <i>A</i> are less spread out (B1 for comparison of spread)	B1																		
		2																		

Question 75

(a)	Class widths: 10, 5, 15, 20, 10	M1
	Frequency density = frequency/ <i>their</i> class width: 1.8, 4.8, 2, 1, 0.8	M1
	All heights correct on diagram (using a linear scale)	A1
	Correct bar ends	B1
	Bar ends: 10.5, 15.5, 30.5, 50.5, 60.5	B1
		5
(b)	11 – 15 and 31 – 50	B1
	Greatest IQR = 50 – 11 = 39	B1
		2
(c)	Mean = $\frac{18 \times 5.5 + 24 \times 13 + 30 \times 23 + 20 \times 40.5 + 8 \times 55.5}{100} = \frac{2355}{100} = 23.6$	B1
	Var = $\frac{18 \times 5.5^2 + 24 \times 13^2 + 30 \times 23^2 + 20 \times 40.5^2 + 8 \times 55.5^2}{100} - \text{mean}^2$	M1
	$\frac{77917.5}{100} - \text{mean}^2 = 224.57$	A1
	Standard deviation = 15.0 (FT <i>their</i> variance)	A1 FT
		4

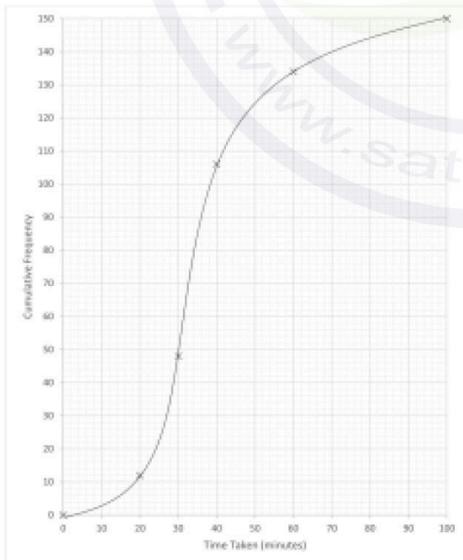
Question 76

(a)	Class widths: 5, 5, 10, 20, 30 Frequency density: 2, 1, 2.6, 1.6, 0.6	M1	At least 3 class widths correct and used in a calculation
		M1	At least 3 correct frequency densities unsimplified – FT <i>their</i> class widths
		A1	All correct heights on a histogram using a linear vertical scale from zero – no FT
		B1	Correct upper bar ends (5.5, 10.5, 20.5, 40.5, 70.5) and 4 correct lower bar ends of 5.5, 10.5, 20.5, 40.5. Condone 0 or 1.
	B1	Linear scales with at least 3 values indicated on each axis, vertical scale from 0, axes labelled 'fd' and 'no. of (incorrect) notes', or better.	
		5	
(b)	LQ: 11 – 20 UQ: 21 – 40	B1	Both UQ and LQ correct
	Greatest IQR = 40 – 11 = 29	B1 FT	Subtract lower end of <i>their</i> LQ interval from upper end of <i>their</i> UQ interval
		2	
(c)	Midpoints: 3 8 15.5 30.5 55.5	M1	At least 4 midpoints correct and used
	$\text{Mean} = \frac{3 \times 10 + 8 \times 5 + 15.5 \times 26 + 30.5 \times 32 + 55.5 \times 18}{91}$ $= \frac{30 + 40 + 403 + 976 + 999}{91}$ $= \frac{2448}{91}$	M1	Correct formula with <i>their</i> midpoints (not upper boundary, lower boundary, class width, frequency density, frequency or cumulative frequency)
	26.9, $26\frac{82}{91}$	A1	Accept 26 or 27
		3	

Question 77

(a)	<table border="1" style="margin: auto;"> <thead> <tr> <th style="text-align: left;">Dados</th> <th style="text-align: left;">Linva</th> </tr> </thead> <tbody> <tr> <td style="text-align: right;">8 6 0</td> <td style="text-align: right;">0 2 9</td> </tr> <tr> <td style="text-align: right;">6 5 2 0 0</td> <td style="text-align: right;">1 0 1 2 5 6</td> </tr> <tr> <td style="text-align: right;">8 2 2</td> <td></td> </tr> <tr> <td style="text-align: right;">6 3 2 6</td> <td></td> </tr> <tr> <td style="text-align: right;">2 4 0</td> <td></td> </tr> </tbody> </table>	Dados	Linva	8 6 0	0 2 9	6 5 2 0 0	1 0 1 2 5 6	8 2 2		6 3 2 6		2 4 0		B1	Correct stem can be upside down, ignore extra values
	Dados	Linva													
	8 6 0	0 2 9													
	6 5 2 0 0	1 0 1 2 5 6													
8 2 2															
6 3 2 6															
2 4 0															
		B1	Correct Dados labelled, leaves in order and lined up vertically (less than midway to next column), no commas etc, no extra terms												
		B1	Correct Linva on opposite side of stem labelled, leaves in order and lined up vertically (less than midway to next column), no commas etc, no extra terms												
	KEY 6 3 2 means 36 cm (snow) in Dados and 32 cm (snow) in Linva	B1	Correct single key for their diagram, need both resorts identified and 'cm' stated at least once here or in leaf headings or title. SC If 2 separate diagrams drawn, SCB1 if both keys meet these criteria B0B1B0SCB1 max.												
		4													
(b)	Median or Q2 = 15 (cm)	B1	Correct												
	UQ or Q3 = 28 cm, LQ or Q1 = 10 cm IQR = 28 – 10	M1	$22 \leq UQ \leq 36 - 8 \leq LQ \leq 10$												
	18 (cm)	A1	WWW												
		3													
(c)	On average the snowfall in Davos is higher	B1 FT	FT from <i>their</i> 5(b) values for Dados. Statement comparing central tendency in context												
	The amount of snowfall in Linva varies more than in Davos	B1 FT	Statement comparing spread in context Note: simply stating and comparing the values is not sufficient.												
		2													

Question 78

(a)		M1	At least 4 points plotted at upper end points, with both scales linear with at least 3 values indicated
	Correct cumulative frequency curve	A1	All plotted correctly with curve drawn joined to (0, 0), axes labelled cumulative frequency, time, minutes
		2	
(b)	$150 \times 0.76 = 114$	M1	114 SOI, may be on graph
	$k = 45$ (mins)	A1 FT	Clear indication that <i>their</i> graph has been used, tolerance ± 1 mm
		2	

(c)	Frequencies: 12 36 58 28 16	B1	Correct frequencies seen
	$\text{Mean} = \frac{10 \times 12 + 25 \times 36 + 35 \times 58 + 50 \times 28 + 80 \times 16}{150}$	B1	At least 4 correct midpoints seen and used
	$\frac{120 + 900 + 2030 + 1400 + 1280}{150}$	M1	Correct formula with <i>their</i> midpoints (not upper boundary, lower boundary, class width or frequency density).
	38.2, $38\frac{1}{5}$	A1	
	$\text{Variance} = \frac{12 \times 10^2 + 36 \times 25^2 + 58 \times 35^2 + 28 \times 50^2 + 16 \times 80^2}{150} - \text{mean}^2$ $= \frac{1200 + 22500 + 71050 + 70000 + 102400}{150} - \text{mean}^2$	M1	Substitute <i>their</i> midpoints and frequencies (condone use of cumulative frequency) in correct variance formula, must have '- <i>their</i> mean ² '
	(Standard deviation = $\sqrt{321.76}$) = 17.9	A1	
		6	

Question 79

(a)	<table border="1"> <tr> <td>Distance</td> <td>0-4</td> <td>5-10</td> <td>11-20</td> <td>21-30</td> <td>31-40</td> <td>41-60</td> </tr> <tr> <td>Upper boundary</td> <td>4.5</td> <td>10.5</td> <td>20.5</td> <td>30.5</td> <td>40.5</td> <td>60.5</td> </tr> <tr> <td>Cumulative frequency</td> <td>12</td> <td>28</td> <td>60</td> <td>126</td> <td>146</td> <td>150</td> </tr> </table>	Distance	0-4	5-10	11-20	21-30	31-40	41-60	Upper boundary	4.5	10.5	20.5	30.5	40.5	60.5	Cumulative frequency	12	28	60	126	146	150	B1	Correct cumulative frequencies seen (may be by table or plotted accurately on graph), condone 12 not stated.
Distance	0-4	5-10	11-20	21-30	31-40	41-60																		
Upper boundary	4.5	10.5	20.5	30.5	40.5	60.5																		
Cumulative frequency	12	28	60	126	146	150																		
		B1	Axes labelled 'distance (or d) [in] km' from 0 to 60 and 'cumulative frequency' (or cf) from 0 to 150.																					
		M1	At least 5 points plotted at upper end points for <i>d</i> (allow upper boundary ± 0.5) with a linear scale for distance, condone 0 – 4 interval inaccurate, no scale break on axis. Not bar graph/histogram unless clear indication of upper end point only of each bar.																					
		A1	All plotted correctly at correct upper end points (4.5 etc.) with both scales linear ($0 \leq d \leq 60$, $0 \leq cf \leq 150$), curve drawn accurately joined to (0,0), cf line > 150 , no daylight if > 150 .																					
		4																						
(b)	70% of 150 = 105	M1	105 seen or implied by indication on grid.																					
	Approx. 27	A1 FT	Strict FT <i>their</i> increasing cumulative frequency graph, use of graph must be seen. If no clear evidence of use of graph: SC B1 FT correct value from <i>their</i> increasing cumulative frequency graph.																					
		2																						
(c)	Midpoints: 2.25, 7.5, 15.5, 25.5, 35.5, 50.5	B1	At least 5 correct midpoints seen.																					
	$\text{Mean} = \frac{2.25 \times 12 + 7.5 \times 16 + 15.5 \times 32 + 25.5 \times 66 + 35.5 \times 20 + 50.5 \times 4}{150}$ $= \frac{27 + 120 + 496 + 1683 + 710 + 202}{150}$	M1	Using 6 midpoint attempts (e.g. 2.25 ± 0.5), condone one error not omission, multiplied by frequency, accept unevaluated, denominator either correct or <i>their</i> Σ frequencies.																					
	$\left[= \frac{3238}{150} \right] = 21.6, 21\frac{44}{75}$	A1	Evaluated, WWW, accept $21.5[866\dots]$.																					
		3																						

Question 80

(a)	Mean height = $\frac{\Sigma x + \Sigma y}{6+11} = \frac{1050+1991}{6+11} = \frac{3041}{17}$	M1	Use of appropriate formula with values substituted, accept unsimplified.
	178.9	A1	Allow 178.88, $178\frac{15}{17}$, 179
		2	
(b)	$\frac{\Sigma x^2 + \Sigma y^2}{6+11} = \frac{193700+366400}{6+11}$	M1	Use of appropriate formula with values substituted, accept unsimplified.
	$Sd^2 = \frac{560100}{17} - \text{their } 178.88^2 [= 948.289]$	M1	Appropriate variance formula using <i>their</i> mean ² , accept unsimplified expression.
	Standard deviation = 30.8	A1	Accept 30.7
		3	

Question 81

(a)	60	B1	Accept 60 or 61. No decimals
		1	
(b)	65% of 160 = 104	M1	$0.65 \times 160 (=104)$ seen unsimplified or implied by use on graph
	136 (cm)	A1	Use of graph must be seen. SCB1 correct value (136 only) if neither 104 nor use of graph are evident
		2	
(c)	UQ: 150 LQ: 76 IQR = 150 - 76 = 74 [cm]	M1	$UQ - LQ$; $148 \leq UQ \leq 152$; $74 \leq LQ \leq 78$.
		A1	Must be from 150 - 76
		2	

Question 82

(a)	Includes all data	B1	Reference to <i>either</i> including all/raw data or further statistical processes are possible that cannot be found using data from box-and-whisker, eg frequency, mean, mode or standard deviation not only median, IQR, range or spread which can be found from both.																																																
		1																																																	
(b)	<table border="1" style="margin-left: 20px;"> <thead> <tr> <th colspan="3">Amazons</th> <th colspan="5">Giants</th> </tr> </thead> <tbody> <tr> <td></td> <td>8</td> <td>17</td> <td>5</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>4</td> <td>2</td> <td>1</td> <td>18</td> <td>2</td> <td>4</td> <td>7</td> <td>9</td> </tr> <tr> <td>8</td> <td>6</td> <td>0</td> <td>19</td> <td>2</td> <td>3</td> <td>5</td> <td>5</td> </tr> <tr> <td>5</td> <td>2</td> <td>1</td> <td>20</td> <td>4</td> <td></td> <td></td> <td></td> </tr> <tr> <td></td> <td>5</td> <td>21</td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> </tbody> </table> <p>Key: 1 18 2 means 181 cm for Amazons and 182 cm for Giants</p>	Amazons			Giants						8	17	5					4	2	1	18	2	4	7	9	8	6	0	19	2	3	5	5	5	2	1	20	4					5	21						B1	Correct stem can be upside down, ignore extra values
Amazons			Giants																																																
	8	17	5																																																
4	2	1	18	2	4	7	9																																												
8	6	0	19	2	3	5	5																																												
5	2	1	20	4																																															
	5	21																																																	
		B1	Correct Amazons labelled on left, leaves in order from right to left and lined up vertically (less than halfway to next column), no commas or other punctuation.																																																
		B1	Correct Giants labelled on same diagram, leaves in order and lined up vertically (less than halfway to next column), no commas or other punctuation.																																																
		B1	Correct single key for their diagram, need both teams identified and 'cm' stated at least once here or in leaf headings or title. SC for if 2 separate diagrams drawn, award SCB1 if both keys meet these criteria (Max B1, B0, B0, B1)																																																
		4																																																	
(c)	[UQ = 202 (cm), LQ = 182 (cm)] [IQR =] 202 - 182 = 20 (cm)	M1	$201 \leq UQ \leq 205 - 181 \leq LQ \leq 184$																																																
		A1	WWW																																																
		2																																																	

(d)	$[\Sigma_{11} = 2132$ $\Sigma_{15} = 191.2 \times 15 = 2868]$	B1	Both Σ_{11} and Σ_{15} found. Accept unevaluated.
	<i>their</i> $2868 = \text{their } 2132 + (180 + 185 + 190) + h$	M1	Forming an equation for the height using <i>their</i> Σ_{11} and Σ_{15} .
	181 (cm)	A1	
Alternative method for Question 7(d)			
	$[\Sigma_{15} = 191.2 \times 15 = 2868$ $\Sigma_{15} = 2687 + h]$	B1	Σ_{15} found using the mean and raw data methods. Accept unevaluated.
	<i>their</i> $2868 = \text{their } 2687 + h$	M1	Forming an equation for the height using <i>their</i> Σ_{15} expressions.
	181 (cm)	A1	
Alternative method for Question 7(d)			
	$[\Sigma_{15} = 2687 + h$ $\frac{\Sigma_{15}}{15} = 191.2]$	B1	Σ_{15} found using raw data method and statement on calculating new mean. Accept unevaluated.
	<i>their</i> $\frac{2687 + h}{15} = 191.2$	M1	Forming an equation for the height using <i>their</i> Σ_{15} expressions
	181 (cm)	A1	
		3	N.B. All methods can be presented as a logical numerical argument which can be condoned if clear.

Question 83

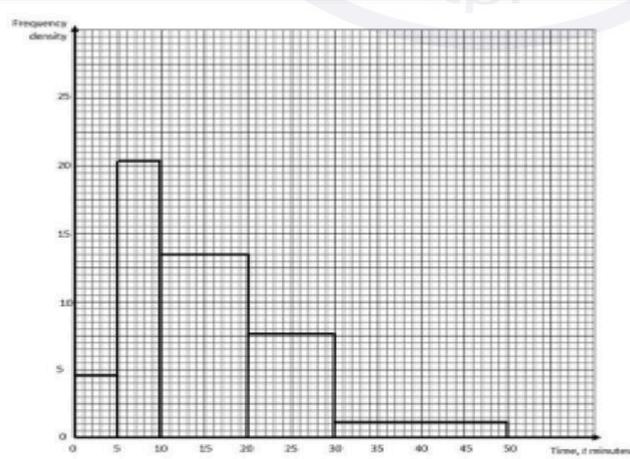
(a)	<table border="1"> <tr> <td>Class width</td> <td>10</td> <td>10</td> <td>20</td> <td>20</td> <td>40</td> </tr> <tr> <td>Frequency Density</td> <td>1.6</td> <td>5.4</td> <td>3.9</td> <td>1.6</td> <td>0.5</td> </tr> </table>	Class width	10	10	20	20	40	Frequency Density	1.6	5.4	3.9	1.6	0.5	M1	At least 4 frequency densities calculated, accept unsimplified. May be read from graph using <i>their</i> scale, 3SF or correct
Class width	10	10	20	20	40										
Frequency Density	1.6	5.4	3.9	1.6	0.5										
		A1	All heights correct on graph												
		B1	Bar ends at 0, 10, 20 ..., etc. with a horizontal linear scale with at least 3 values indicated, $0 \leq \text{horizontal axis} < 100$												
		B1	Axes labelled: Frequency density (fd), time (t) and seconds. Linear vertical scale, with at least 3 values indicated $0 \leq \text{vertical axis} < 5.4$												
		4													

(b)	$\text{Mean} = \left[\frac{16 \times 5 + 54 \times 15 + 78 \times 30 + 32 \times 50 + 20 \times 80}{200} \right]$ $= \frac{80 + 810 + 2340 + 1600 + 1600}{200}$	M1	Uses at least 4 midpoint attempts (e.g. 5 ± 0.5). Accept unsimplified expression, denominator either correct or <i>their</i> Σ frequencies
	$\left[\frac{6430}{200} = \right] 32 \frac{3}{20} \text{ or } 32.15$	A1	Accept 32.2
		2	
(c)	A value in correct UQ (40–60) – a value in correct LQ (10–20)	M1	
	Greatest possible value is $60 - 10 = 50$	A1	Condone 49.9
		2	

Question 84

(a)	<table border="1" style="display: inline-table; margin-right: 20px;"> <thead> <tr> <th colspan="4">Lakeview</th> <th colspan="4">Riverside</th> </tr> </thead> <tbody> <tr> <td>9</td><td>4</td><td>0</td><td>1</td> <td>8</td><td>8</td><td></td><td></td> </tr> <tr> <td>8</td><td>7</td><td>6</td><td>2</td> <td>0</td><td>1</td><td>3</td><td>4</td> </tr> <tr> <td></td><td>3</td><td>2</td><td>0</td> <td>0</td><td>6</td><td>7</td><td></td> </tr> <tr> <td></td><td></td><td>1</td><td>4</td> <td></td><td></td><td></td><td></td> </tr> </tbody> </table> <p>Key: 6 2 3 means 26m for Lakeview and 23m for Riverside</p>	Lakeview				Riverside				9	4	0	1	8	8			8	7	6	2	0	1	3	4		3	2	0	0	6	7				1	4					B1	Correct stem, ignore extra values.
Lakeview				Riverside																																							
9	4	0	1	8	8																																						
8	7	6	2	0	1	3	4																																				
	3	2	0	0	6	7																																					
		1	4																																								
		B1	Correct Lakeview labelled on left, leaves in order from right to left and lined up vertically, no commas.																																								
		B1	Correct Riverside labelled on same diagram, leaves in order and lined up vertically, no commas.																																								
		B1	Correct key for their diagram, need both teams identified and 'm' stated at least once here or in leaf headings or title. SC If 2 separate diagrams drawn: SC B1 if both keys meet these criteria.																																								
		4																																									
(b)	UQ = 32, LQ = 19	M1	$(30 \leq \text{UQ} \leq 33) - (14 \leq \text{LQ} \leq 22)$																																								
	IQR = $32 - 19 = 13$	A1	WWW																																								
		2																																									

Question 85

(a)	Cw: 5 5 10 10 20	M1	At least 4 frequency densities calculated (f/cw), accept unsimplified and class widths ± 1 of true values. May be implied by graph.
	Fd: 4.6 20.4 13.5 7.6 1.2	A1	All heights correct on graph NOT FT
		B1	Bar ends at 0, 5, 10, 20, 30, 50 clear intention not to draw at 4.5 or 5.5 etc.
		B1	Axes labelled: Frequency density (fd), time (t) and mins (or appropriate title). Linear scales between 0 and 20.4 or above on vertical axis, and 0 and 50 or above on the horizontal axis. (Axes may be reversed.)
		4	
(b)	$\frac{2.5 \times 23 + 7.5 \times 102 + 15 \times 135 + 25 \times 76 + 40 \times 24}{360}$	M1	Uses at least 4 midpoint attempts (e.g. 2.5 ± 0.5) in correct formula, accept unsimplified expression, denominator either correct or <i>their</i> Σ frequencies .
	$\left[\frac{5707.5}{360} = \right] 15.9, 15 \frac{41}{48}$	A1	Evaluated.
		2	

Question 86

(a)	Cumulative frequency graph drawn	B1	Axes labelled 'cumulative frequency' (or cf) from 0 to at least 140 and 'distance (or d) [in] m' from 0 to at least 1600, linear scales with at least 3 values stated.														
		B1	All plotted correctly at correct upper end points (200 etc.) curve drawn accurately joined to (0, 0) (straight line segments B0) but no daylight above 140. Cf scale no less than 2 cm = 20 children .														
		2															
(b)	[UQ at 75% of 140 = 105, LQ at 25% of 140 = 35] [IQR:] 700 – 260	M1	Accept $660 \leq UQ \leq 720 - 240 \leq LQ \leq 290$. If values are outside our range, FT providing scales linear and increasing cf drawn.														
	440	A1	Accept correct evaluation of $660 \leq \text{their } UQ \leq 720 - 240 \leq \text{their } LQ \leq 290$ with clear indication that graph has been used for at least one of 105 or 35.														
		2															
(c)	[Mean =] $\frac{16 \times 100 + 30 \times 250 + 42 \times 400 + 34 \times 700 + 12 \times 1050 + 6 \times 1400}{140}$	B1	<table border="1"> <tbody> <tr> <td>Frequencies</td> <td>16</td> <td>30</td> <td>42</td> <td>34</td> <td>12</td> <td>6</td> </tr> <tr> <td>Mid-points</td> <td>100</td> <td>250</td> <td>400</td> <td>700</td> <td>1050</td> <td>1400</td> </tr> </tbody> </table> <p>5 or 6 correct frequency values seen.</p>	Frequencies	16	30	42	34	12	6	Mid-points	100	250	400	700	1050	1400
		Frequencies	16	30	42	34	12	6									
		Mid-points	100	250	400	700	1050	1400									
		B1	5 or 6 correct midpoint values seen.														
M1	Values substituted into mean formula using <i>their</i> midpoints which must be in the class – condone 1 data error. Accept $\frac{1600 + 7500 + 16\,800 + 23\,800 + 12\,600 + 8400}{140}$ or $\frac{70\,700}{140}$. Condone $\frac{70\,770}{140}$ for M1 .																
505	A1	WWW															
Variance = $\frac{16 \times 100^2 + 30 \times 250^2 + 42 \times 400^2 + 34 \times 700^2 + 12 \times 1050^2 + 6 \times 1400^2}{140} - 505^2$	M1	Values substituted into variance formula using (<i>their</i> mean) ² and <i>their</i> midpoints and <i>their</i> frequencies (including for denominator). Accept unsimplified. Condone 1 data error. Accept: $\frac{160\,000 + 1\,875\,000 + 6\,720\,000 + 16\,660\,000 + 13\,230\,000 + 11\,760\,000}{140}$ or $\frac{50\,405\,000}{140}$ or 360 035.7143] – [505 ² or 255 025] If formula stated accept 105 010 or 105 011 WWW.															
	S.d. = $\left[\sqrt{105\,010.7} \right] = 324$	A1	WWW														
		6															

Question 87

(a)	<table border="1" style="display: inline-table; margin-right: 20px;"> <thead> <tr> <th style="text-align: center;">Rebels</th> <th style="text-align: center;">Sharks</th> </tr> </thead> <tbody> <tr> <td style="text-align: right;">9 8 5</td> <td style="text-align: right;">6 8</td> </tr> <tr> <td style="text-align: right;">6 5 4 3</td> <td style="text-align: right;">1 2 4 5 5 6 8</td> </tr> <tr> <td style="text-align: right;">2 2 0</td> <td style="text-align: right;">3 3 4 5 6</td> </tr> <tr> <td style="text-align: right;">9 5 3</td> <td style="text-align: right;">9 2</td> </tr> <tr> <td style="text-align: right;">2 10</td> <td></td> </tr> </tbody> </table> <p>Key: 8 7 2 means 78 kg for Rebels and 72 kg for Sharks</p>	Rebels	Sharks	9 8 5	6 8	6 5 4 3	1 2 4 5 5 6 8	2 2 0	3 3 4 5 6	9 5 3	9 2	2 10		<p>B1 Correct stem, ignore extra values (not in reverse).</p> <p>B1 Correct Rebels labelled on left, leaves in order from right to left and lined up vertically, no commas.</p> <p>B1 Correct Sharks labelled on same diagram, leaves in order and lined up vertically, no commas.</p> <p>B1 Correct key for their diagram, need both teams identified and 'kg' stated at least once here or in leaf headings or title.</p> <p>SC If 2 separate diagrams drawn, SC B1 if both keys meet these criteria.</p>
Rebels	Sharks													
9 8 5	6 8													
6 5 4 3	1 2 4 5 5 6 8													
2 2 0	3 3 4 5 6													
9 5 3	9 2													
2 10														
		4												
(b)	<p>Median = 84 (kg)</p> <p>[UQ = 93, LQ = 80] 93 – 80</p> <p>[IQR =] 13 (kg)</p>	<p>B1</p> <p>M1 $95 \leq UQ \leq 89 - 79 \leq LQ \leq 82$</p> <p>A1 WWW</p>												
		3												
(c)	<p>Box and whisker with end points 75 and 102</p> <p>Median and quartiles plotted as found in (b)</p>	<p>B1 Whiskers drawn to correct end points not through box, not joining at top or bottom of box.</p> <p>B1 FT Quartiles and median plotted as box graph.</p>												
		2												
(d)	e.g. Average weight of Rebels is higher than average weight of Sharks	<p>B1 Acceptable answers refer to: Range, skew, central tendency within context. E.g. range of Rebels is greater B0. Range of weights of the rebels is greater B1. Simple value comparison insufficient.</p>												
		1												

Question 88

(a)	$\left[\frac{\sum x}{40} - k = \frac{\sum(x-k)}{40} \right]$ $\frac{40 \times 34}{40} - k = \frac{520}{40}$ $k [= 34 - 13] = 21$	<p>M1 Forms an equation involving $\sum x$, $\sum(x-k)$ and k. Accept at a numeric stage with k.</p> <p>A1 Evaluated.</p>
		2
(b)	$\text{Var} = \left[\frac{\sum(x-k)^2}{40} - \left(\frac{\sum(x-k)}{40} \right)^2 \right] = \frac{9640}{40} - \left(\frac{520}{40} \right)^2 = [241 - 13^2 =]$	<p>M1 Values substituted into an appropriate variance formula, accept unsimplified.</p>
	72	A1
		2

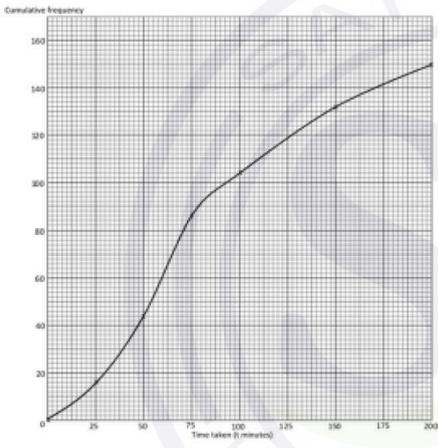
Question 89

(a)	<table border="1" style="display: inline-table; margin-right: 20px;"> <tbody> <tr> <td>Class Width</td> <td>30</td> <td>15</td> <td>20</td> <td>10</td> <td>25</td> </tr> <tr> <td>Frequency Density</td> <td>0.7</td> <td>2</td> <td>3.4</td> <td>8.6</td> <td>1.8</td> </tr> </tbody> </table>	Class Width	30	15	20	10	25	Frequency Density	0.7	2	3.4	8.6	1.8	<p>M1 At least 4 frequency densities calculated</p> <p>A1 All heights correct on graph</p> <p>B1 Bar ends at 0.5, 30.5, 45.5, 65.5, 75.5, 100.5 (at axis), 5 bars drawn, condone 0 in first bar 0.5 ≤ time axis ≤ 100.5, linear scale with at least 3 values indicated.</p> <p>B1 Axes labelled: Frequency density (fd), time (t) and mins (or appropriate title). Linear fd scale, with at least 3 values indicated 0 ≤ fd axis ≤ 8.6</p>
Class Width	30	15	20	10	25									
Frequency Density	0.7	2	3.4	8.6	1.8									
		4												
(b)	66 – 75	<p>B1 Condone 65.5 – 75.5</p>												
		1												
(c)	Distribution is not symmetrical	<p>B1 Or skewed, ignore nature of skew</p>												
		1												

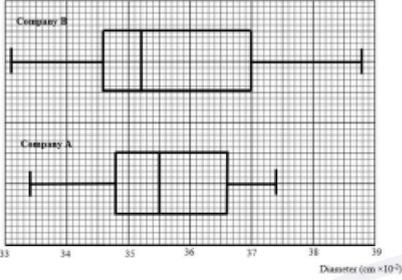
Question 90

(a)	$\left[\frac{123.4}{20} = \right] 6.17$	B1	Accept 6 m 17 cm, $\frac{1234}{200}$.
		1	
(b)	$\frac{10\text{th} + 11\text{th}}{2} = \frac{5.4 + 5.5}{2} = 5.45$ (m)	B1	Accept 5 m 45 cm.
		1	
(c)	The mean is unduly influenced by an extreme value, 19.4.	B1	Comment must be within context.
		1	

Question 91

(a)	Cumulative frequency (cf) graph	M1	At least 3 points plotted accurately at class upper end points (25,16) (50,44) (75,86) (100,104) (150, 132) (200, 150). Linear cf scale $0 \leq cf \leq 150$ and linear time scale $0 \leq \text{time}(\text{mins}) \leq 200$ with at least 3 values identified on each axis.
		A1	All points plotted correctly, curve drawn (within tolerance) and joined to (0,0). Axes labelled cumulative frequency (cf), time (t) and minutes (min), or a suitable title.
		2	
(b)	Line from cumulative frequency = 30 to meet graph at t is between 37.5 and 42	B1 FT	Not from wrong working. Must be an increasing cumulative frequency graph.
		1	

Question 92

(a)	Median = 0.355 [IQR =] 0.366 – 0.348 0.018	B1 Identified condone Q2. M1 $0.365 \leq UQ \leq 0.369 - 0.343 \leq LQ \leq 0.349$. Subtraction may be implied by answer. A1 If 0/3 scored SC B1 for figs Median = 355 IQR = 18.
		3
(b)	Box-and-whisker plot on provided grid 	B1 All 5 key values for <i>B</i> plotted accurately in standard format using <i>their</i> scale. Labelled <i>B</i> . Check accuracy in the middle of vertical line. B1 FT All 5 key values for <i>A</i> , FT from part 3(a), plotted in standard format accurately using <i>their</i> scale. Labelled <i>A</i> . Check accuracy in the middle of vertical line. B1 Whiskers not through box for both, not drawn at corners of boxes, single linear scale with at least 3 values stated, covering at least 0.34 to 0.38 and labelled diameter (<i>d</i> etc) and cm. Accept as a title.
		3 If both plots attempted and plot(s) not labelled, SC B1 for at least 1 fully correct set of values plotted.
(c)	A comparison in context	B1 Single comment comparing spread or central tendency in context. Must reference either diameter or pipes. Not a simple numerical comparison of statistical values such as median, range, IQR or min/max.
		1

Question 93

$\Sigma x - \Sigma 200 = \Sigma(x - 200)$	B1 Forming a correct 3-term (linear) equation from Σx , $\Sigma 200$ and $\Sigma(x - 200)$. Accept $6846 - 200n = 446$ OE. Condone 1 sign error.
$\Sigma 200 = 200n$	B1 SOI
$[200n = 6846 - 446 = 6400] \quad n = 32$	B1 WWW
	3

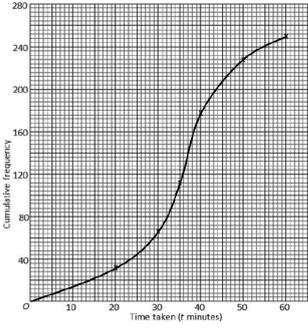
Question 94

(a)	<table border="1"> <tr> <td>Class width</td> <td>20</td> <td>10</td> <td>10</td> <td>20</td> <td>30</td> </tr> <tr> <td>Frequency density</td> <td>22</td> <td>72</td> <td>92</td> <td>15</td> <td>4</td> </tr> </table> 	Class width	20	10	10	20	30	Frequency density	22	72	92	15	4	<p>M1 At least 4 frequency densities calculated (Frequency \div class width, e.g. $\frac{440}{20}$ (condone $\frac{440}{19.5}$, $\frac{440}{20.5}$) Accept unsimplified, may be read from graph using <i>their</i> scale</p> <p>A1 All heights correct on graph NOT FT</p> <p>B1 Bar ends at [0,] 20, 30, 40, 60, 90 at axis with a horizontal linear scale with at least 3 values indicated. $0 \leq$ horizontal scale \leq 90</p> <p>B1 Axes labelled frequency density (fd), time (<i>t</i>) and minutes (mins) or in a title. Linear vertical scale, with at least 3 values indicated $0 \leq$ vertical axes \leq 92 (condone 90 used).</p>
Class width	20	10	10	20	30									
Frequency density	22	72	92	15	4									
		4												
(b)	<table border="1"> <tr> <td>Midpoints</td> <td>10</td> <td>25</td> <td>35</td> <td>50</td> <td>75</td> </tr> </table> <p>[Mean = 31.44 given] [Variance = $\frac{440 \times 10^2 + 720 \times 25^2 + 920 \times 35^2 + 300 \times 50^2 + 120 \times 75^2}{2500} - 31.44^2$] = $\frac{44000 + 450000 + 1127000 + 750000 + 675000}{2500} - 31.44^2$ [= $\frac{3046000}{2500} - 31.44^2 = 229.9264$] Or Variance = $\frac{440(10 - 31.44)^2 + 720(25 - 31.44)^2 + 920(35 - 31.44)^2 + 300(50 - 31.44)^2 + 120(75 - 31.44)^2}{2500}$ = $\frac{202256 + 29860 + 11659 + 103342 + 227697}{2500} = \frac{574814}{2500} = 229.9264$</p> <p>Standard deviation = 15.2</p>	Midpoints	10	25	35	50	75	<p>B1 At least 4 correct midpoints seen</p> <p>M1 Correct formula for variance or standard deviation ($-$ mean² included with <i>their</i> midpoints (not upper bound, lower bound, class width, frequency density, frequency or cumulative frequency) and <i>their</i> $\sum f$ if calculated. Condone 1 data error.</p> <p>A1 WWW, allow 15.16[3...]</p>						
Midpoints	10	25	35	50	75									
		3												
(c)	30–40	B1												
		1												
(d)	Stays the same, data still in same intervals	B1 Frequencies unchanged												
		1												

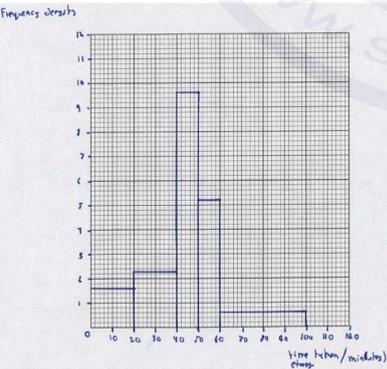
Question 95

$\sum x - 50 \times 20 = 35$; $\sum x = 1035$ or $\bar{x} = \frac{35}{50} + 20 = \frac{1035}{50}$ [= 20.7]	B1 Correct value for $\sum x$ or \bar{x} .
$\frac{25036}{50} - \left(\frac{\sum x}{50}\right)^2 = \frac{25036}{50} - \left(\frac{1035}{50}\right)^2$	M1 $\frac{25036}{50} - \left(\text{their} \left(\frac{\sum x}{50}\right)^2\right)$
72.23	A1 Exact answer only SC B1 for 72.23 with no substitution in formula.
	3

Question 96

(a)	Cumulative frequency graph		M1 At least 3 points plotted accurately at class upper end points: (20,32), (30, 66), (35, 112), (40, 178), (50, 228), (60, 250). Linear cf scale $0 \leq cf \leq 250$ and linear time scale $0 \leq \text{time} \leq 60$ with at least 3 values identified on each.
			A1 All points plotted correct, curve drawn (within tolerance) and joined to (0,0). Axes labelled cumulative frequency (cf), time (t) and minutes (min or m) – or a suitable title. Axes can be the other way round.
			2
(b)	Line drawn from 150 on cf axis to meet graph at about $t=38$ minutes		B1 FT Must be an increasing cf graph with correct upper bounds. Use of graph must be seen. Expect an answer in range $37 \leq t \leq 39$ for a correct graph
			1
(c)	[Frequencies] [32] 34 46 66 50 22		B1 May be unsimplified and/or in variance calculation.
	[Midpoints] 10 25 32.5 37.5 45 55		M1 At least 5 correct midpoints seen , may be unsimplified.
	[Variance] = $\frac{32 \times 10^2 + 34 \times 25^2 + 46 \times 32.5^2 + 66 \times 37.5^2 + 50 \times 45^2 + 22 \times 55^2}{250} - 34.4^2$ $[= \frac{333650}{250} - 34.4^2 = 151.24]$		M1 Correct unsimplified Variance formula with <i>their</i> midpoints and <i>their</i> frequencies for var or sd. (– mean ² included)
	[Sd =] 12.3		A1 Awrt WWW SC B1 for 12.3 if second M1 not awarded.
			4

Question 97

(a)	Cw 20 20 10 10 40 Fd 1.6 2.3 9.6 5.2 0.6		M1 At least 4 frequency densities calculated $\frac{f}{cw}$ eg $\frac{32}{20}$ (condone $\frac{f}{cw \pm 0.5}$ if unsimplified), accept unsimplified, may be read from graph using <i>their</i> scale no lower than 1 cm = fd 1
			A1 All bar heights correct on graph, using <i>their</i> suitable linear scale with at least 3 values indicated, no lower than 1 cm = fd 2.
			B1 Bar ends at [0,] 20, 40, 50, 60, 100 (at axis), 5 bars drawn $0 \leq \text{time axis} \leq 100$, linear scale with at least 3 values indicated.
			B1 Axes labelled frequency density (fd), time (t) and minutes (mins, m) or appropriate title. (Axes may be reversed).
			4

(b)	Midpoints 10 30 45 55 80	B1	At least 4 correct midpoints seen (check data table).
	<p>[Mean = 43.2 given]</p> <p>[Var =] $\frac{32 \times 10^2 + 46 \times 30^2 + 96 \times 45^2 + 52 \times 55^2 + 24 \times 80^2}{250} - 43.2^2$</p> <p>Or</p> $\frac{32(10 - 43.2)^2 + 46(30 - 43.2)^2 + 96(45 - 43.2)^2 + 52(55 - 43.2)^2 + 24(80 - 43.2)^2}{250}$	M1	<p>Appropriate variance formula with <i>their</i> 5 midpoints (not upper bound, lower bound, class width, frequency density, frequency or cumulative frequency).</p> <p>Condone 1 frequency error.</p> <p>If correct midpoints seen accept</p> $\left\{ \frac{3200 + 41400 + 194400 + 157300 + 153600}{250} \text{ or } \frac{549900}{250} \right\}$ <p>$- \{43.2^2 \text{ or } 1866.24\}$.</p>
	$= \left[\frac{549900}{250} - 43.2^2 = 333.36 \right]$ <p>Sd = 18.3</p>	A1	<p>www, final answer 18.25814887 to at least 3SF.</p> <p>If M0 earned SC B1 for final answer 18.25814887 to at least 3SF.</p>
		3	

Question 98

(a)	<table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th style="text-align: center;">Lions</th> <th style="text-align: center;">Tigers</th> </tr> </thead> <tbody> <tr> <td style="text-align: center;">9</td> <td style="text-align: center;">16</td> </tr> <tr> <td style="text-align: center;">9 8</td> <td style="text-align: center;">17 9</td> </tr> <tr> <td style="text-align: center;">9 7 6 1 0</td> <td style="text-align: center;">18 0 3 4 7</td> </tr> <tr> <td style="text-align: center;">6 0 0</td> <td style="text-align: center;">19 0 1 4 5 7</td> </tr> <tr> <td></td> <td style="text-align: center;">20 1</td> </tr> </tbody> </table>	Lions	Tigers	9	16	9 8	17 9	9 7 6 1 0	18 0 3 4 7	6 0 0	19 0 1 4 5 7		20 1	B1	Correct stem can be upside down, ignore extra values (not in reverse).
Lions	Tigers														
9	16														
9 8	17 9														
9 7 6 1 0	18 0 3 4 7														
6 0 0	19 0 1 4 5 7														
	20 1														
		B1	Correct Lions labelled on left, leaves in order from right to left and lined up vertically, no commas or other punctuation.												
		B1	<p>Correct Tigers labelled on same diagram, leaves in order and lined up vertically, no commas or other punctuation.</p> <p>If the correct data for Lions and Tigers is transposed, treat as a single error in Lions and condone in Tigers.</p>												
	Key 1 18 3 means 181 cm for Lions and 183 cm for Tigers	B1	<p>Correct single key for their diagram, need both teams identified and 'cm' stated at least once here or in leaf headings or title.</p> <p>SC If 2 separate diagrams drawn, SC B1 if both keys meet these criteria (Max B1, B0, B0, B1).</p>												
		4													
(b)	Median = 186 cm	B1													
	[UQ = 190 cm, LQ = 179 cm] IQR = 190 - 179	M1	$189 \leq UQ \leq 190 - 178 \leq LQ \leq 180$												
	11[cm]	A1	WWW												
		3													
(c)	Tigers are (generally) taller	B1	Comparison about central tendency in context.												
	Heights of Tigers are slightly less consistent than heights of Lions	B1	Comparison about spread in context. (Condone 'similar spread' in context.)												
		2													

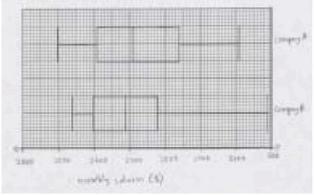
Question 99

(a)	<table border="1"> <tr> <td>Upper value</td> <td>60</td> <td>90</td> <td>110</td> <td>140</td> <td>180</td> <td>240</td> </tr> <tr> <td>cf</td> <td>4</td> <td>12</td> <td>26</td> <td>51</td> <td>58</td> <td>60</td> </tr> </table>	Upper value	60	90	110	140	180	240	cf	4	12	26	51	58	60	B1	All cumulative frequencies stated. May be under data table, condone omission of 4. May be read accurately from graph, must include 4.
Upper value	60	90	110	140	180	240											
cf	4	12	26	51	58	60											
		M1	At least 5 points plotted at class upper end points, daylight rule tolerance. Linear cf scale $0 \leq cf \leq 60$, linear time scale $30 \leq \text{time} \leq 240$ with at least 3 values identified on each axis.														
		A1	All points plotted correctly. Curve drawn (within tolerance), no ruled segments, and joined to (30, 0). Axes labelled 'cumulative frequency' and 'hours [of sunshine]' (OE including appropriate title).														
		3															
(b)	$[60 \times 0.7 =] 42$	M1	42 may be implied by clear use on graph.														
	126	A1 FT	Must be clear evidence on graph of use of 42, e.g. an appropriate mark on either axis, appropriate mark on curve. FT from increasing cf graph only read at 42 only.														
		2															
(c)	Midpoints: 45, 75, 100, 125, 160, 210	B1	At least 5 correct mid-points seen, check by data table or used in formula.														
	$[\text{Mean} =] \frac{4 \times 45 + 8 \times 75 + 14 \times 100 + 25 \times 125 + 7 \times 160 + 2 \times 210}{60}$ $[= \frac{6845}{60}]$	M1	Correct mean formula using their 6 midpoints (must be within class, not upper bound, lower bound), condone 1 data error If correct midpoints seen accept $\frac{180 + 600 + 1400 + 3125 + 1120 + 420}{60}$														
	$= 114, 114 \frac{1}{12}$	A1	Accept $114.1, 114.08[3\dots]$ If A1 not awarded, SC B1 for $114, 114 \frac{1}{12}, 114.1$ or $114.08[3\dots]$.														
		3															

Question 100

(a)	Median = 99 [minutes]	B1	
	[IQR =] 106 – 83	M1	$105 \leq UQ \leq 112 - 82 \leq LQ \leq 87$.
	23 [minutes]	A1	www. If M0 scored SC B1 for 23 www.
		3	
(b)	The times for the Cheetahs are faster than the times for the Panthers	B1	Correct statement comparing central tendency in context.
	The times for the Cheetahs are more spread than the times for the Panthers	B1	Correct statement comparing range/IQR in context.
		2	
(c)	[Total time including Kenny = $99 \times 20 =] 1980$	B1	Accept unsimplified.
	[Kenny's time =] $1980 - 1862$	M1	For <i>their</i> $1980 - \text{their } 1862$.
	$= 118$ [minutes]	A1	Accept 1 hour 58 mins.
	Alternative Method for Question 4(c)		
	$\frac{1862 + \text{their Kenny's time}}{20} = 99$	B1	$\frac{1862 + \text{their Kenny's time}}{20} = 99$ seen.
	[Kenny's time = $99 \times 20 - 1862$]	M1	For <i>their</i> $99 \times 20 - \text{their } 1862$.
	$= 118$ [minutes]	A1	Accept 1 hour 58 mins.
		3	

Question 101

(a)	Median = 2710	B1	Must be identified, condone Q2. Ignore units throughout.												
	2840 – 2610	M1	$2820 \leq UQ \leq 2850 - 2600 \leq LQ \leq 2620$.												
	230	A1	www If M0 scored SC B1 for 230 www. If key ignored consistently: B0 Median = 271 SC M1 $282 \leq UQ \leq 285 - 260 \leq LQ \leq 262$ SC A1 23.												
		3													
(b)	Box-and-whisker plot on provided grid. 	B1	All 5 key values for <i>B</i> plotted accurately in standard format using a linear scale with 3 identified values. Labelled <i>B</i> . Scale at least 1 cm = \$100.												
	<table border="1"> <tbody> <tr> <td>B:</td> <td>2540</td> <td>2600</td> <td>2690</td> <td>2780</td> <td>3090</td> </tr> <tr> <td>A:</td> <td>2500</td> <td>2610</td> <td>2710</td> <td>2840</td> <td>3010</td> </tr> </tbody> </table>	B:	2540	2600	2690	2780	3090	A:	2500	2610	2710	2840	3010	B1FT	All 5 key values for <i>A</i> , FT from (a), plotted accurately in standard format using a linear scale with 3 identified values. Labelled <i>A</i> . Scale at least 1cm = \$100
B:	2540	2600	2690	2780	3090										
A:	2500	2610	2710	2840	3010										
		B1	Whiskers not through box for both, not drawn at corners of boxes, single linear scale for the diagram and labelled 'salaries' (oe) and \$.												
		3													
(c)	Examples: Mean less appropriate than median because of extreme value for company <i>B</i> [at \$3090]. No, extreme value in company <i>B</i> . No, \$3090 is an anomaly.	B1	Must refer to company <i>B</i> , may be implied by appropriate use of \$3090. Must include an indication that the mean is not appropriate. No contradictory statements can be present, e.g. acceptable comment with 'but mean could be used for company <i>A</i> '. Condone reference to \$309.												
		1													

Question 102

(a)	$\text{Var} = \left[\frac{\Sigma(x-q)^2}{50} - \left(\frac{\Sigma(x-q)}{50} \right)^2 \right] = \frac{14235}{50} - \left(\frac{700}{50} \right)^2$ $[= 284.7 - 196 = 88.7]$	M1	$\frac{14235}{a} - \left(\frac{700}{a} \right)^2$; where $a = 49, 50, 51$.
	[sd = $\sqrt{88.7}$ =] 9.42	A1	9.4180677 rounded to at least 3SF.
		2	
(b)	$\Sigma x - 50q = 700$ $[2865 - 50q = 700]$	M1	Forming equation with Σx , $50q$ and 700.
	$q = 43.3, 43\frac{3}{10}$	A1	If M0 scored, SC B1 for 43.3 WWW.
		2	

Question 103

(a)	<table border="1"> <tr> <td>cw</td> <td>800</td> <td>400</td> <td>800</td> <td>1200</td> <td>1600</td> </tr> <tr> <td>fd</td> <td>0.01</td> <td>0.03</td> <td>0.0625</td> <td>0.04</td> <td>0.02</td> </tr> </table>	cw	800	400	800	1200	1600	fd	0.01	0.03	0.0625	0.04	0.02	<p>M1 At least 4 frequency densities calculated (F/cw, e.g. $\frac{8}{800}$ (condone $\frac{8}{n}$, $799 < n < 801$)). Accept unsimplified, may be read from graph using <i>their</i> scale.</p>
	cw	800	400	800	1200	1600								
fd	0.01	0.03	0.0625	0.04	0.02									
	<p>A1 All heights correct on graph.</p> <p>B1 Bar ends at 50, 850, 1250, 2050, 3250, 4850 read at the axis with a horizontal linear scale with at least 3 values indicated. $50 \leq \text{horizontal scale} \leq 4850$.</p> <p>B1 Axes labelled frequency density (fd) and population (pop) OE, or in a title. Linear vertical scale, with at least 3 values indicated. Vertical axis must cover at least the range $0 \leq \text{vertical axis} \leq 0.0625$. Axes may be reversed.</p>													
		4												
(b)	2100 – 3200	<p>B1 Accept 2050 – 3250 OE. Condone '4th interval'.</p>												
		1												
(c)	3249 – 1250	<p>M1 $2050 \leq UQ < 3250 - 1250 \leq LQ < 2050$.</p>												
	1999	<p>A1 Condone $3250 - 1250 = 2000$.</p>												
		2												

Question 104

(a)		<p>M1 At least 3 points plotted accurately at class upper end points (40,0) (60,14) (65,38) (70,60) (85,106) (100,120). Linear cumulative frequency scale $0 \leq cf \leq 120$ and linear weight scale $40 \leq \text{weight(kg)} \leq 100$ with at least 3 values identified on each axis. Condone scale reversed.</p>
		<p>A1 All points plotted correctly, curve drawn (within tolerance) and joined to (40,0). Axes labelled cumulative frequency (cf), weight (w) and kg (kilograms) – or a suitable title.</p>
		2
(b)	$[120 \times 0.65 =] 78$ seen	<p>M1 May be implied by use on graph.</p>
	76 [kg]	<p>A1 $75 < \text{hours} < 79$. Indication of use of graph required.</p>
		2

(c)	Frequencies: [0] 14 24 22 46 14	B1	At least 5 correct frequencies seen (condone omission of 0).
	Midpoints: 20 50 62.5 67.5 77.5 92.5	B1	At least 5 correct midpoints seen (condone omission of 20).
	Mean = $\frac{0 \times 20 + 14 \times 50 + 24 \times 62.5 + 22 \times 67.5 + 46 \times 77.5 + 14 \times 92.5}{120}$ $= \frac{[0] + 700 + 1500 + 1485 + 3565 + 12950}{120} \left[= \frac{8545}{120} \right]$	M1	Correct formula for mean using <i>their</i> midpoints and <i>their</i> frequencies, implied by $\frac{8545}{120}$ if correct midpoints & frequencies seen. May be gained in variance calculation. If midpoints not clearly identified, condone midpoints ± 0.5 .
	= 71.2	A1	Accept $\frac{1709}{24}$, $71\frac{5}{24}$ or 71.208333 to at least 3SF. If M0 scored, SC B1 for $\frac{1709}{24}$, $71\frac{5}{24}$ or 71.208333 to at least 3SF www.
	Variance = $\frac{0 \times 20^2 + 14 \times 50^2 + 24 \times 62.5^2 + 22 \times 67.5^2 + 46 \times 77.5^2 + 14 \times 92.5^2}{120} - 71.2^2$ $\frac{[0] + 35000 + 93750 + 100237.5 + 276287.5 + 119787.5}{120} - \left(\frac{8545}{120}\right)^2$ [= 138.23]	M1	Correct formula for variance using <i>their</i> midpoints, <i>their</i> frequencies and <i>their</i> mean. Implied by $\frac{625062.5}{120} - \left(\frac{8545}{120}\right)^2$ if correct midpoints & frequencies seen.
	Standard deviation = 11.8	A1	11.757016 to at least 3SF.
		6	

Question 105

(a)	<table border="1"> <tr> <td>Class width</td> <td>20</td> <td>10</td> <td>5</td> <td>10</td> <td>15</td> </tr> <tr> <td>Frequency density</td> <td>0.9</td> <td>4.8</td> <td>6.8</td> <td>3.2</td> <td>1.2</td> </tr> </table>	Class width	20	10	5	10	15	Frequency density	0.9	4.8	6.8	3.2	1.2	M1	At least 4 frequency densities calculated by $\frac{f}{cw}$ e.g. $\frac{18}{20}$ (condone $\frac{f}{cw}$ if unsimplified). Accept unsimplified, may be read from graph using <i>their</i> scale, no lower than 1cm = 1 fd.
Class width	20	10	5	10	15										
Frequency density	0.9	4.8	6.8	3.2	1.2										
		A1	All bar heights correct on graph (no FT), using their suitable linear scale with at least 3 values indicated, no lower than 1cm = 1 fd.												
		B1	Bar ends at 120.5, 130.5, 135.5, 145.5, 160.5. 5 bars drawn with a horizontal linear scale, no lower than 1cm = 10min, with at least 3 values indicated. $100 \leq \text{horizontal scale} \leq 160$.												
		B1	Axes labelled frequency density (fd), time (t) and minutes (min, m) or, or an appropriate title. (Axes may be reversed).												
		4													
(b)	[Midpoints] 110.5 125.5 133 140.5 153	B1	At least 4 correct mid-points seen, may be by data table or used in formula.												
	Mean = $\frac{18 \times 110.5 + 48 \times 125.5 + 34 \times 133 + 32 \times 140.5 + 18 \times 153}{150}$ $= \frac{1989 + 6024 + 4522 + 4496 + 2754}{150}$	M1	Correct formula for mean using midpoints ± 0.5 , condone 1 midpoint error within class.												
	= 131.9	A1	Accept 132, $131\frac{9}{10}$, or $\frac{1319}{10}$. Must be identified.												
	Variance = $\frac{18 \times 110.5^2 + 48 \times 125.5^2 + 34 \times 133^2 + 32 \times 140.5^2 + 18 \times 153^2}{150} - (their\ 131.9)^2$	M1	Appropriate variance formula with <i>their</i> 5 midpoints within class (not upper bound, lower bound, class width, frequency density, frequency or cumulative frequency). Condone 1 error. If correct midpoints seen, accept $\left\{ \frac{3200 + 41400 + 194400 + 157300 + 153600}{150} \text{ or } \frac{2630272.5}{150} \right\}$ $- \{131.9^2 \text{ or } 17397.61\}$.												
	[= 137.54] [Standard deviation =] 11.7	A1	11.7277448... to at least 3SF. Accept $11.6 \leq \sigma < 11.95$ www. If M0 awarded, SC B1 $11.6 \leq \sigma < 11.95$ www.												
		5													

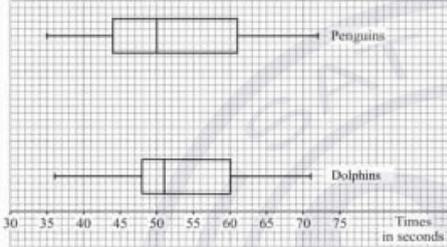
Question 106

(a)	[IQR =] 31 – 23.7	M1	$30.5 < UQ < 31.25 - 23.25 < LQ \leq 24$ Evidence of graph use must be seen at least once.
	7.3	A1	$7.0 \leq IQR \leq 7.5$ If M0 scored, SC B1 for $7.0 \leq IQR \leq 7.5$ wwww.
		2	
(b)	[65% of 120 =]78	B1	Seen or implied by use on graph.
	28.5	B1	$28 < \text{ans} < 29$
		2	

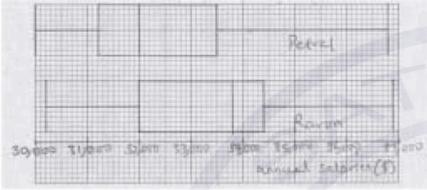
Question 107

(a)	<table border="1"> <tr> <td>Class width</td> <td>20</td> <td>10</td> <td>5</td> <td>5</td> <td>10</td> <td>20</td> </tr> <tr> <td>Frequency density</td> <td>0.4</td> <td>2.3</td> <td>7.0</td> <td>10.4</td> <td>2.0</td> <td>0.6</td> </tr> </table>	Class width	20	10	5	5	10	20	Frequency density	0.4	2.3	7.0	10.4	2.0	0.6	M1	At least five frequency densities (f/cw), e.g. $\frac{8}{20}, \frac{23}{10}, \dots$ Accept unsimplified.
Class width	20	10	5	5	10	20											
Frequency density	0.4	2.3	7.0	10.4	2.0	0.6											
		A1	All heights correct on graph (no FT).														
		B1	Bar ends at [0,] 20, 30, 35, 40, 50, 70 with a linear scale and at least three values indicated 'linearly'.														
		B1	Axes labelled frequency density (fd) and time (mins). Frequency density scale vertical starts at 0 with a linear scale and at least three values indicated 'linearly'. Axes can be reversed.														
		4															
(b)	Midpoints 10, 25, 32.5, 37.5, 45, 60	B1	At least five correct mid-points seen or used in formula.														
	$\text{Mean} = \frac{10 \times 8 + 25 \times 23 + 32.5 \times 35 + 37.5 \times 52 + 45 \times 20 + 60 \times 12}{150}$ $\left[= \frac{5362.5}{150} \right]$	M1	Correct mean formula using their 6 midpoints (must be within class, not upper bound, lower bound). Condone one error. If correct midpoints seen, accept $\frac{5362.5}{150}$ or $\frac{80 + 575 + 1137.5 + 1950 + 900 + 720}{150}$.														
	$= 35.75, 35\frac{3}{4}$	A1	Accept 35.8, not $\frac{143}{4}$. If A0 scored, SC B1 for $35.75, 35\frac{3}{4}$ only.														
		3															
(c)	$30 \leq t < 35$	B1	Condone '3rd' interval, 30 – 35.														
		1															

Question 108

(a)	<table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th style="text-align: center;">Penguins</th> <th style="text-align: center;">Dolphins</th> </tr> </thead> <tbody> <tr> <td style="text-align: center;">9 5</td> <td style="text-align: center;">3 6</td> </tr> <tr> <td style="text-align: center;">8 5 5 4 2</td> <td style="text-align: center;">4 1 3 8 9 9</td> </tr> <tr> <td style="text-align: center;">9 8 6 0</td> <td style="text-align: center;">5 0 1 4 6 6</td> </tr> <tr> <td style="text-align: center;">8 6 1</td> <td style="text-align: center;">6 0 1 4</td> </tr> <tr> <td style="text-align: center;">2</td> <td style="text-align: center;">7 1</td> </tr> </tbody> </table> <p>Key: 2 4 1 means 42 seconds for Penguins and 41 seconds for Dolphins</p>	Penguins	Dolphins	9 5	3 6	8 5 5 4 2	4 1 3 8 9 9	9 8 6 0	5 0 1 4 6 6	8 6 1	6 0 1 4	2	7 1	<p>B1 Correct stem, ignore extra values (not in reverse, not split). If a split stem-and-leaf plot is used (i.e. stem values are repeated), the remaining B marks are available.</p> <hr/> <p>B1 Correct Penguins labelled on left, leaves in order from right to left and lined up vertically (less than halfway to next column), no commas or other punctuation.</p> <hr/> <p>B1 Correct Dolphins labelled on same diagram, leaves in order and lined up vertically (less than halfway to next column), no commas or other punctuation.</p> <p>If the correct data for Penguins & Dolphins is transposed, treat as a single error in Penguins and condone in Dolphins.</p> <hr/> <p>B1 Correct key for their diagram, need both clubs labelled and 'sec' or 's' stated at least once here, or in leaf headings or title.</p> <p>If two separate diagrams drawn: SC B1 if both keys meet these criteria.</p>
Penguins	Dolphins													
9 5	3 6													
8 5 5 4 2	4 1 3 8 9 9													
9 8 6 0	5 0 1 4 6 6													
8 6 1	6 0 1 4													
2	7 1													
		4												
(b)														
	For Dolphins, median is 51	B1 Plotted on box.												
	LQ = 48, UQ = 60	B1 Plotted on box.												
	Correct end points for whiskers and diagram labelled Dolphins	B1 Correct end points of whiskers (36 and 71). Whiskers not through box, not drawn at corners of boxes, diagram labelled.												
		3												
(c)	Dolphins have more consistent times than Penguins or Penguins are faster (have faster times) than Dolphins	B1 Reason given in context. Can be reference to either the central tendency or spread.												
		1												

Question 109

(a)	Median = 32000	B1	Clearly identified, e.g. Q2, med. Accept 32k.												
	[UQ = 33500, LQ = 31200] [IQR =] 33500 – 31200	M1	$33300 \leq UQ \leq 33700 - 31100 \leq LQ \leq 31200$ Implied if both quartile values are stated and an appropriate IQR is calculated accurately.												
	= 2300	A1	WWW Ignore \$ signs. If M0 scored, SC B1 for 2300 WWW. If key ignored consistently: B0 Median = 320 SC M1 $325 \leq UQ \leq 335 - 311 \leq LQ \leq 312$ SC A1 23.												
		3													
(b)	Box-and-whisker plot on provided grid	B1	All five key values for <i>R</i> plotted accurately in standard format using a linear scale with at least three linear values. Labelled <i>R</i> . Condone whiskers through box or at corners of boxes or extending $\frac{1}{2}$ square beyond limit. Scale no less than 1 cm = \$1000. Daylight rule applied to vertical lines of box.												
	 <table border="1" data-bbox="288 952 678 1032"> <tbody> <tr> <td>R</td> <td>30 200</td> <td>32 000</td> <td>33 800</td> <td>34 400</td> <td>36 900</td> </tr> <tr> <td>P</td> <td>30 000</td> <td>31 200</td> <td>32 000</td> <td>33 500</td> <td>36 800</td> </tr> </tbody> </table>	R	30 200	32 000	33 800	34 400	36 900	P	30 000	31 200	32 000	33 500	36 800	B1FT	All five key values for <i>P</i> , FT from (a), plotted accurately in standard format using a linear scale with at least three linear values. Labelled <i>P</i> . Condone whiskers through box or at corners of boxes or extending $\frac{1}{2}$ square beyond limit. Scale no less than 1 cm = \$1000. Daylight rule applied to vertical lines of box.
	R	30 200	32 000	33 800	34 400	36 900									
P	30 000	31 200	32 000	33 500	36 800										
		B1	Whiskers not through box (condone $\frac{1}{2}$ square in box) for either, not drawn at corners of boxes. single linear scale for the diagram and labelled 'salaries' (OE) and \$. If only one plot attempted, SC B1 for meeting all the requirements above.												
		3													
(c)	Median because there is an extreme value (\$36800)	B1	Do not accept 'values'. Must identify median and reference either the extreme value (anomaly, outlier, 36 800) or the skew in context (e.g. concentrated in lower values, positive skew).												
		1													

Question 110

(a)	<table border="1"> <tr> <td>cw</td> <td>20</td> <td>10</td> <td>10</td> <td>5</td> <td>20</td> </tr> <tr> <td>fd</td> <td>0.8</td> <td>3.2</td> <td>7.6</td> <td>12.8</td> <td>0.6</td> </tr> </table>	cw	20	10	10	5	20	fd	0.8	3.2	7.6	12.8	0.6	<p>M1 At least four frequency densities calculated $\frac{f}{cw}$ (e.g. $\frac{16}{20}$).</p> <p>Condone $\frac{f}{cw \pm 0.5}$ if unsimplified.</p> <p>Accept unsimplified, may be read from graph using <i>their</i> scale no lower than 1 cm = fd 2.</p>
cw	20	10	10	5	20									
fd	0.8	3.2	7.6	12.8	0.6									
		<p>A1 All bar heights correct on graph, not FT.</p> <p>Using their suitable linear scale with at least three values indicated, no lower than 1 cm = fd 2.</p> <p>B1 Bar ends at 150, 160, 170, 175, 195. Five bars drawn with a horizontal linear scale no lower than 1 cm = 10 cm, with at least three values indicated, $130 \leq \text{horizontal scale} \leq 195$.</p> <p>B1 Axes labelled frequency density (fd) height (h) and cm, OE, or an appropriate title. (Axes may be reversed)</p>												
		4												
(b)	<p>[LQ:] $160 \leq h < 170$ [UQ:] $170 \leq h < 175$</p> <p>$175 - 160 = 15$</p>	<p>M1 $170 \leq h < 175 - 160 \leq h < 170$</p> <p>UQ and LQ classes seen.</p> <p>A1 $175 - 160 = 15$</p> <p>If M0 scored, SC B1 for $175 - 160 = 15$.</p>												
		2												

Question 111

(a)	<p>[For all 45 values Mean =] $\frac{439 + 470}{45} + 30$</p> <p>= 50.2</p>	<p>M1 $\frac{439 + 470}{45}$ or $\frac{909}{45}$ seen.</p> <p>A1 If M0 awarded, SC B1 50.2 WWW.</p>
	<p>Alternative Method for Question 1(a)</p> <p>[For all 45 values Mean =] $\frac{25 \times 30 + 470 + 20 \times 30 + 439}{45}$</p> <p>= 50.2</p>	<p>(M1) $\frac{1220 + 1039}{45}$ or $\frac{2259}{45}$ seen.</p> <p>(A1) If M0 awarded, SC B1 50.2 WWW.</p>
		2
(b)	<p>For all 45 values $Sd^2 = \frac{12405 + 11346}{45} - \left(\frac{909}{45}\right)^2$</p> <p>sd [= $\sqrt{119.76}$] = 10.9</p>	<p>M1 <i>their</i> $\frac{(12405 + 11346)}{45}$ or 23751 - $\left(\frac{909}{45}\right)^2$</p> <p>A1 If M0 awarded, SC B1 10.9 WWW.</p>
		2

Question 112

(a)	<table border="1"> <tr> <td>H(cm)</td> <td>10–19</td> <td>20–29</td> <td>30–39</td> <td>40–44</td> <td>45–49</td> <td>50–54</td> <td>55–59</td> </tr> <tr> <td>UB</td> <td>19.5</td> <td>29.5</td> <td>39.5</td> <td>44.5</td> <td>49.5</td> <td>54.5</td> <td>59.5</td> </tr> <tr> <td>cf</td> <td>[10]</td> <td>28</td> <td>60</td> <td>102</td> <td>130</td> <td>144</td> <td>150</td> </tr> </table>	H(cm)	10–19	20–29	30–39	40–44	45–49	50–54	55–59	UB	19.5	29.5	39.5	44.5	49.5	54.5	59.5	cf	[10]	28	60	102	130	144	150	<p>B1 Cf values 28, 60, 102, 130, 144, 150 seen, Condone omission of 10. May be implied by accurate plotting (scale no less than 1cm = 10). May be by data table.</p>
H(cm)	10–19	20–29	30–39	40–44	45–49	50–54	55–59																			
UB	19.5	29.5	39.5	44.5	49.5	54.5	59.5																			
cf	[10]	28	60	102	130	144	150																			
		<p>B1 Linearly scaled axes correctly labelled cumulative frequency (cf) (from 0 to 150) and height (h) and centimetres (cm) (from 9.5 to 59.5) with at least 3 values identified on each. Axes can be the other way round.</p> <p>M1 At least 4 points plotted at upper boundary ± 0.5, (e.g. allow (19, 19.5 or 20, 10) etc.) on correctly scaled axes. (9.5,0), (19.5,10), (29.5, 28), (39.5, 60), (44.5,102), (49.5, 130), (54.5, 144), (59.5,150).</p> <p>A1 All points plotted correctly, curve drawn (within tolerance), joined to (9.5, 0) and not going beyond above 150 vertically. A0 if straight line segments used.</p>																								
		4																								
(b)	[150 \times 0.3 = 45]	M1 Use of graph must be seen.																								
	Line drawn from 45 on cf axis to meet graph at $h = 36$	A1 FT Must be an increasing cf graph. Expect an answer in range $35 \leq h \leq 37$ for a correct graph.																								
		2																								
(c)	Midpoints 14.5, 24.5, 34.5, 42, 47, 52, 57	B1 At least 6 correct midpoints seen, may be unsimplified, may be in calculation, may be by data table.																								
	$\text{Mean} = \frac{10 \times 14.5 + 18 \times 24.5 + 32 \times 34.5 + 42 \times 42 + 28 \times 47 + 14 \times 52 + 6 \times 57}{150}$ $\left[= \frac{145 + 441 + 1104 + 1764 + 1316 + 728 + 342}{150} \right]$	M1 Correct unsimplified mean formula with <i>their</i> midpoints (not ub, lb, upper limits, lower limits, cw, fd, f or cf and must be within class). If midpoints correct, accept partially evaluated.																								
	$= \frac{5840}{150}, \frac{584}{15}, 38\frac{14}{15}, 38.9$	A1 Accept answers wrt 38.9 WWW If M1 withheld, SC B1 for $\frac{5840}{150}, \frac{584}{15}, 38\frac{14}{15}, 38.9$.																								
	$\text{sd}^2 = \frac{10 \times 14.5^2 + 18 \times 24.5^2 + 32 \times 34.5^2 + 42 \times 42^2 + 28 \times 47^2 + 14 \times 52^2 + 6 \times 57^2}{150} - \left(\text{their} \frac{5840}{150} \right)^2$ $\left[= \frac{244285}{150} - \left(\text{their} \frac{5840}{150} \right)^2 \right]$	M1 Correct unsimplified variance formula with <i>their</i> midpoint (not ub, lb, upper limits, lower limits, cw, fd, f or cf and must be within class). If midpoints correct, accept partially evaluated																								
	[= 112.76] standard deviation $\left[\sqrt{112.76} \right] = 10.6$	A1 AWRT 10.6 WWW. If second M1 withheld, SC B1 for 10.6 WWW.																								
		5																								

Question 113

(a)	<table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th style="text-align: center;">Falcons</th> <th style="text-align: center;">Kites</th> </tr> </thead> <tbody> <tr> <td style="text-align: center;">9 8 3</td> <td style="text-align: center;">2</td> </tr> <tr> <td style="text-align: center;">8 6 4 2</td> <td style="text-align: center;">4 0 0 5 7 8</td> </tr> <tr> <td style="text-align: center;">9 8 6 2 1 0</td> <td style="text-align: center;">5 2 4 8 9 9</td> </tr> <tr> <td style="text-align: center;">9 4 6</td> <td style="text-align: center;">0 1 3 5</td> </tr> <tr> <td style="text-align: center;">6 7</td> <td></td> </tr> </tbody> </table> <p>Key: 1 5 4 means 51 minutes for Falcons and 54 minutes for Kites</p>	Falcons	Kites	9 8 3	2	8 6 4 2	4 0 0 5 7 8	9 8 6 2 1 0	5 2 4 8 9 9	9 4 6	0 1 3 5	6 7		<p>B1 Correct stem, ignore extra values (not in reverse, not split). If a split stem-and-leaf plot is used (i.e. stem values are repeated) the remaining B marks are available.</p> <p>B1 Correct Falcons labelled on left, leaves in order from right to left and lined up vertically, no commas or other punctuation.</p> <p>B1 Correct Kites labelled on same diagram, leaves in order and lined up vertically, no commas or other punctuation.</p> <p>Penalise each error only once in question. E.g. commas in both sets of data.</p> <p>B1 Correct key, for their diagram, need both teams names and 'mins' at least once here, or in leaf headings or title.</p> <p>If 2 separate diagrams drawn max marks B1 if both stems correct. B1 if Falcons correct to the left of the stem. B1 if both keys correct including 'mins' and team name.</p>
Falcons	Kites													
9 8 3	2													
8 6 4 2	4 0 0 5 7 8													
9 8 6 2 1 0	5 2 4 8 9 9													
9 4 6	0 1 3 5													
6 7														
	4													
(b)	<p>Median = 51 [minutes]</p> <p>[IQR =] 59 – 44</p> <p>= 15 [minutes]</p>	<p>B1 Accept Q2, must be identified.</p> <p>M1 $58 \leq UQ \leq 64 - 42 \leq LQ \leq 46$. Implied if both quartile values are stated and an appropriate IQR calculated accurately.</p> <p>A1 WWW</p>												
	3													
(c)	<p>$\left[\text{mean} = \frac{792 + 783}{30} = \frac{1575}{30} = 52.5, 52\frac{1}{2}, \frac{105}{2} \right]$</p> <p>$\sum x^2 = 85727$</p> <p>$\text{sd}^2 = [\text{Variance} = \left[\frac{(43504 + 42223)}{30} - \left(\frac{792 + 783}{30} \right)^2 \right]$</p> <p>$\frac{85727}{30} - \left(\frac{1575}{30} \right)^2 [= 101.3167]$</p> <p>$\sigma = (\sqrt{101.3167}) = 10.1$</p>	<p>B1 $\frac{1575}{30}$ is not acceptable for this mark.</p> <p>M1 Accept unsimplified variance formula. FT <i>their</i> mean. Ignore any square root leading to sd for this mark.</p> <p>A1 AWRT. Must be identified, e.g. sd, s, std d, σ. Condone 'short' square root signs. If M1 not awarded, SC B1 for, $\sigma = \sqrt{101.3167}$ or $\sqrt{\frac{6079}{60}}$ oe = 10.1.</p>												
	3													

Question 114

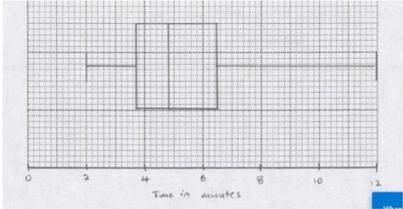
(a)		<p>M1 At least 4 points plotted within tolerance at upper bounds. Linear cf scale $0 \leq cf \leq 200$ and linear time scale $0 \leq t \leq 70$, with at least 3 values identified on each. Minimum scale uses at least $\frac{1}{2}$ the grid.</p> <p>A1 All points plotted correctly. Curve drawn and joined to (0, 0). Axes labelled cumulative frequency (cf), time (t) and minutes (min) – or a suitable title.</p>
	2	
(b)	<p>Median = 33</p> <p>[IQR =] 42 – 26</p> <p>16</p>	<p>B1 FT Must be identified. Evidence of use of graph must be seen. Strict FT $\pm \frac{1}{2}$ square on time axis.</p> <p>M1 $41 \leq UQ \leq 43 - 25 < LQ \leq 27$. If outside of range FT $\pm \frac{1}{2}$ square on time axis.</p> <p>A1 FT</p>
	3	

(b)	Median = 33	B1 FT	Must be identified. Evidence of use of graph must be seen. Strict FT $\pm \frac{1}{2}$ square on time axis.														
	[IQR =] 42 – 26	M1	$41 \leq UQ \leq 43 - 25 < LQ \leq 27$. If outside of range FT $\pm \frac{1}{2}$ square on time axis.														
	16	A1 FT															
		3															
(c)	<table border="1"> <tr> <td>Midpoint</td> <td>7.5</td> <td>20</td> <td>27.5</td> <td>35</td> <td>45</td> <td>60</td> </tr> <tr> <td>Frequency</td> <td>18</td> <td>28</td> <td>42</td> <td>52</td> <td>36</td> <td>24</td> </tr> </table>	Midpoint	7.5	20	27.5	35	45	60	Frequency	18	28	42	52	36	24	B1	At least 5 correct midpoints or 5 correct frequencies seen.
Midpoint	7.5	20	27.5	35	45	60											
Frequency	18	28	42	52	36	24											
	$\text{Mean} = \frac{18 \times 7.5 + 28 \times 20 + 42 \times 27.5 + 52 \times 35 + 36 \times 45 + 24 \times 60}{200}$	M1	Correct mean formula using <i>their</i> 6 midpoints (must be within class, not upper bound, not lower bound) condone 1 error and <i>their</i> 6 frequencies (not cumulative frequencies).														
	$= 33.65, 33 \frac{13}{20}$	A1	Accept 33.7, not $\frac{673}{20}$.														
		3															

Question 115

(a)	<table border="1"> <tr> <td></td> <td>< 9.5</td> <td>< 14.5</td> <td>< 19.5</td> <td>< 24.5</td> <td>< 29.5</td> <td>< 39.5</td> </tr> <tr> <td>CF</td> <td>18</td> <td>46</td> <td>106</td> <td>178</td> <td>226</td> <td>250</td> </tr> </table> 		< 9.5	< 14.5	< 19.5	< 24.5	< 29.5	< 39.5	CF	18	46	106	178	226	250	B1	At least 4 of 46, 106, 178, 226, 250 cumulative frequencies correct. May be implied by accurate plotting if scale suitable. May be by data table.
	< 9.5	< 14.5	< 19.5	< 24.5	< 29.5	< 39.5											
CF	18	46	106	178	226	250											
		B1	Linearly scaled axes correctly labelled cumulative frequency (cf) (from 0 to 250), length (oe) and cm (from 5 to 39.5) – or a suitable title, with at least 3 values identified on each. Axes can be the other way round. Axes must be more than 50% of grid.														
		M1	At least 4 points correctly plotted at class upper end points (9.5, 14.5, 19.5, 24.5, 29.5, 39.5) on scaled axes.														
		A1	All points plotted correct, curve drawn (within tolerance) and joined to (4.5,0) and not going above 250 vertically within range. A0 if straight line segments used.														
		4															
(b)	[250 \times 0.62 = 155]	M1	Clear indication of use of graph at cf 155 is required.														
	Line drawn from 155 on cf axis to meet graph at $l = 23$	A1 FT	Must be an increasing cf graph. Expect an answer in the range $22.5 \leq l \leq 23.5$ from correct graph.														
		2															
(c)	Midpoints 7, 12, 17, 22, 27, 34.5	B1	At least 5 correct midpoints seen, may be unsimplified, may be in calculation, may be by data table.														
	$\text{Mean} = \frac{7 \times 18 + 12 \times 28 + 17 \times 60 + 22 \times 72 + 27 \times 48 + 34.5 \times 24}{250}$	M1	Correct unsimplified mean formula using <i>their</i> 6 midpoints (not upper bound, lower bound, upper limits, lower limits, cw, fd, f or cf and must be within class) condone 1 error. If midpoints correct accept $\frac{5190}{250}$ or $\frac{126 + 336 + 1020 + 1584 + 1296 + 828}{250}$.														
	= 20.76	A1	Accept $20 \frac{19}{25}$, $20 \frac{38}{50}$ or $20 \frac{76}{100}$, not improper fraction If M1 withheld, SC1 for 20.76 oe WWW.														
		3															

Question 116

(a)	Accept 43 or 44	B1	
		1	
(b)	 <p>Median = 4.8</p>	B1	Plotted on box.
	LQ = 3.7 or 3.8, UQ = 6.5 or 6.6	B1	Plotted on box.
	Correct end points for whiskers and whiskers drawn	B1	Correct end points of whiskers (2 and 12). Whiskers not through box, not drawn at corners of box. Accept end points of whiskers as dots or without vertical line.
	Linear scale and labelled Time in minutes	B1	OE. Linear scale from 2 to 12, at least 3 equally spaced values marked using at least half of the grid. Label to include time and minutes.
		4	

Question 117

(a)	$4960 - 40k = 836$ or $\frac{4960}{40} - k = \frac{836}{40}$	B1	Also accept $124 - k = 20.9$ or $40k = 4124$ OE.
	$k = 103.1$	B1	
		2	
(b)	Method 1		
	$[sd^2 =] \frac{25410.8}{40} - \left(\frac{836}{40}\right)^2$	M1	
	$[sd^2 = 198.46,]$ sd = 14.1	A1	14.08758... to at least 3SF. If M not awarded SCB1 for correct answer WWW.
	Method 2		
	$[sd^2 =] \frac{622978.4}{40} - 124^2$	M1	622978.4 comes from expansion of $\sum(x - k)^2 = 25410.8$ substituting in relevant values.
	$[sd^2 = 198.46,]$ sd = 14.1	A1	14.08758... to at least 3SF. If M not awarded SCB1 for correct answer WWW.
		2	

Question 118

(a)	Cumulative frequency graph drawn	<p>B1 At least 5 points plotted accurately at class upper end points: (10, 34), (20, 86), (30, 142), (40, 208), (60, 265), (90, 300). Linear cf scale $0 \leq cf \leq 300$ and linear time scale $0 \leq t \leq 90$ with at least 3 values identified on each. Bar/histograms score B0.</p> <p>Required axes must be over 50% of grid size. Axes can be the other way round.</p> <p>B1 All points plotted correct, curve drawn, no line segments and joined to (0,0) passing within $\frac{1}{2}$ square of points. Axes labelled cumulative frequency (cf), time (t) and minutes (min or m) – or a suitable title. Curve must be <300 for $0 \leq t < 90$.</p>
		2
(b)	Line drawn from 180 on cf axis to meet graph	<p>M1 Use of graph must be seen. Must be an increasing graph. Annotate this mark on 5(a) grid.</p>
	[k =] 35 minutes	<p>A1 FT Strict FT, reading at their curve condone use of <i>t</i>.</p>
		2
(c)	Frequencies: [34,] 52, 56, 66, 57, 35	<p>B1 May be un-simplified and/or in variance calculation.</p>
	Midpoints: 5, 15, 25, 35, 50, 75	<p>B1 At least 5 correct midpoints seen, may be un-simplified, may be in calculation, may be by data table.</p>
	$\text{Mean} = \frac{34 \times 5 + 52 \times 15 + 56 \times 25 + 66 \times 35 + 57 \times 50 + 35 \times 75}{300}$ $\left[\frac{170 + 780 + 1400 + 2310 + 2850 + 2625}{300} \right]$ $\left[= \frac{10135}{300} \right]$	<p>M1 Correct un-simplified mean formula with <i>their</i> 6 midpoints (not upper bound, lower bound, upper limits, lower limits, class width, frequency density, frequency or cumulative frequency and must be within class) and <i>their</i> frequencies (not cw, cf, or fd), accept un-simplified.</p> <p>Condone 1 value error on numerator. The 'table' approach may be used with multiplications and additions implied by appropriate values.</p>
	= 33.8	<p>A1 WWW. $33.78 \leq \text{mean} \leq 33.8, \frac{2027}{60}, 33\frac{47}{60}$.</p> <p>If M not scored, SCB1 for $\frac{2027}{60}, 33\frac{47}{60}, 33.78$.</p> <p>(Note: $\frac{10135}{300}$ scores A0).</p>

Question 119

(a)	<table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th style="text-align: center;">Gulls</th> <th style="text-align: center;">Hérons</th> </tr> </thead> <tbody> <tr> <td style="text-align: center;">9 7</td> <td></td> </tr> <tr> <td style="text-align: center;">8 6 6 3 2 8</td> <td style="text-align: center;">1 3 5 7</td> </tr> <tr> <td style="text-align: center;">8 7 2 9</td> <td style="text-align: center;">2 3 5 7 9 9</td> </tr> <tr> <td style="text-align: center;">4 0 10</td> <td style="text-align: center;">8</td> </tr> </tbody> </table> <p>Key: 7 9 5 means 9.7 seconds for Gulls and 9.5 seconds for Herons</p>	Gulls	Hérons	9 7		8 6 6 3 2 8	1 3 5 7	8 7 2 9	2 3 5 7 9 9	4 0 10	8	<p>B1 Correct stem, ignore extra values (not in reverse, not split). If a split stem-and-leaf plot is used (i.e. stem values are repeated), the remaining B marks are available.</p> <p>B1 Correct Gulls labelled on left, leaves in order from right to left and lined up vertically (less than halfway to next column), no commas or other punctuation.</p> <p>B1 Correct Herons labelled on same diagram, leaves in order and lined up vertically (less than halfway to next column), no commas or other punctuation.</p> <p>Penalise each error only once in question. E.g. commas in both sets of data</p> <p>If the correct data for Gulls & Herons is transposed, treat as a single error in Gulls and condone in Herons.</p> <p>B1 Correct key for their diagram, need both clubs labelled and 'sec' or 's' stated at least once here, or in leaf headings or title.</p> <p>SC: If 2 separate diagrams drawn, max marks: B1 if both stems correct, B1 if Gulls is correct to the left of the stem B0 B1 if both keys correct including 'sec' or 's'</p>
Gulls	Hérons											
9 7												
8 6 6 3 2 8	1 3 5 7											
8 7 2 9	2 3 5 7 9 9											
4 0 10	8											
		4										
(b)	Median = 8.8 (seconds)	B1 Clearly identified, e.g. Q2, med, m..										
	[LQ 8.3, UQ 9.8] 9.8 – 8.3	M1 $9.7 \leq UQ \leq 10.0 - 8.2 \leq LQ \leq 8.6$. Implied if both quartile values are stated and the appropriate IQR is calculated accurately.										
	1.5	A1 WWW If M0 scored SCB1 for 1.5 WWW.										
		3										
(c)	Mean = $\frac{175.0 + 30 \times 8.4}{50}$ or $\frac{175.0 + 252.0}{50}$	M1										
	= 8.54	A1 If M0 scored, SCB1 for 8.54 WWW.										
		2										
(d)	$1.38^2 = \frac{(1823.0 + \sum y^2)}{50} - \text{their} \left(\frac{427.0}{50} \right)^2$	M1 Substitute values into correct variance formula, any form.										
	Solve to find $\sum y^2$	DM1 Rearrange equation to obtain $\sum y^2$. $\frac{\sum y^2}{50} = 1.38^2 + \text{their} \left(\frac{427.0}{50} \right)^2 - \frac{1823.0}{50}$.										
	$\sum y^2 = 1918.8$	A1 Mark final answer. If one or both M marks not awarded, SCB1 for 1918.8 seen as final answer WWW mark final answer.										
		3										