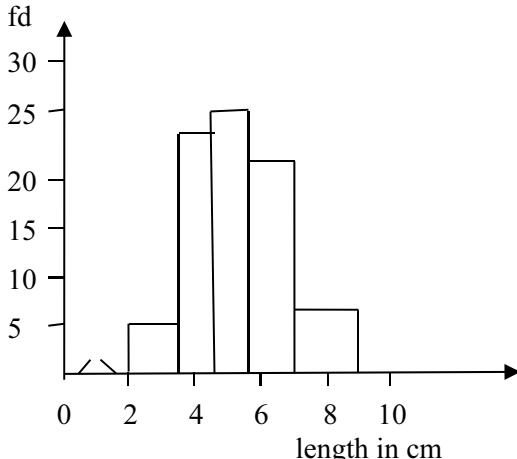


A LEVELS STATISTICS (P6)(S1)

SHEET 1: BASICS MARK SCHEME

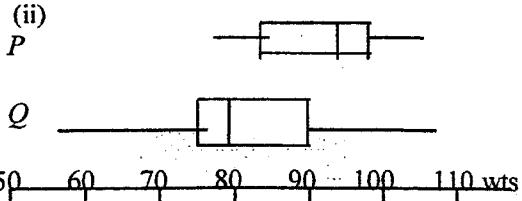
1 (i)	UQ 5.5 – 7.0 cm	B1 [1]
(ii)	fd 5.33, 25, 28, 20.7, 6, fd	M1 Attempt at fd or scaled freq [fr/cw]
	 <p>A frequency distribution graph with the y-axis labeled 'fd' ranging from 0 to 30 and the x-axis labeled 'length in cm' ranging from 0 to 10. There are four bars. The first bar has a height of approximately 5. The second bar has a height of approximately 23. The third bar has a height of approximately 25. The fourth bar has a height of approximately 7. The bar widths are 1, 2, 2, and 2 respectively.</p>	A1 Correct heights seen on graph
		B1 Correct bar widths no gaps
		B1 [4] Labels (fd and length/cm) and correct bar ends
2 (i)	$\text{new mean} = \frac{9 \times 7.1 + 18 \times 5.2}{27}$ $= 5.83$	M1 Mult by 9 and 18 and dividing by 27 A1 [2] correct answer

(ii)	$1.45^2 = \text{so } \frac{\sum x_t^2}{9} = 472.6125 \text{ mm}$ $0.96^2 = \frac{\sum x_g^2}{18} - 5.2^2 \text{ so}$ $\sum x_g^2 = 503.3088$ $\text{New sd}^2 = \frac{472.6...^2 + 503.3...^2}{27} - 5.83...^2 = 2.117$ $\text{New sd} = 1.46$	M1	subst in a correct variance formula sq rt or not correct $\sum x_t^2$ (rounding to 470)
		A1	correct $\sum x_g^2$ (rounding to 500)
		M1	using $\sum x_t^2 + \sum x_g^2$, dividing by 27 and subt comb mean ²
		A1 [5]	correct answer

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

4 (i)	<p>time in sec</p>	B1	LQ = 2.6 med = 3.8–3.85, UQ = 6.4–6.6
		B1	Correct quartiles and median on graph ft linear from 2–10
		B1	End whiskers correct not through box
		B1 4	Label need seconds and linear 2–10 axis or can have 5 values on boxplot no line provided correct

(ii)	$1.5 \times \text{IQR} = 1.5 \times 3.8 = 5.7$ $\text{LQ} - 5.7 = -\text{ve}, \text{UQ} + 5.7 = 12.1 \text{ i.e. } > 10$ So no outliers AG	M1	Attempt to find $1.5 \times \text{IQR}$ and add to UQ or subt from LQ OR compare $1.5 \times \text{IQR}$ with gap 3.6 between UQ and max 10
		A1 2	Correct conclusion from correct working need both

MARKING	SCEHMES = 0.829	M1 ₃	For use of tables based on their z value either end NB can't get if z is too large or too small
		A1 5	For correct answer
5 (i)	LQ = 72, or 73 or 71.5 only median = 78, UQ = 88 or 87.75 only	B1 B1 B1 3	Accept Q ₁ , Q ₂ , Q ₃ LQ UQ muddle scores B1 B0 and possibly B1 for median
(ii)		B1 B1 B1ft B1 4	For only one numbered linear scale For country P all correct on linear scale For Q all correct on linear scale For P and Q labelled, weights or kg shown SR non linear scale max B0 B0 B0 B1 Or max B0 B1 B0 B1 if one error in an otherwise linear scale NB No outliers
(iii)	people heavier in P than in Q weights more spread out in Q	B1 B1 2	Or equivalent statement Or equivalent statement Cannot have two statements saying the equivalent of the same category (wts, spread, skewness). Must have the same statement relating to P and to Q.

- 6 The first part of this question was the worst attempted on the Paper, with many imaginative and varied (but incorrect) reasons for why the graph was misleading. The stem-and-leaf diagram was very well attempted by almost everybody. Most candidates remembered to give a key. The median was poorly attempted however, with many candidates thinking it was the $\frac{n}{2}$ th term, even from 21 people, and of those who obtained the correct number (the 11th), some quoted it as 9 rather than 79. Many wrote the numbers out in order to find the median, rather negating the purpose of a stem-and-leaf diagram.

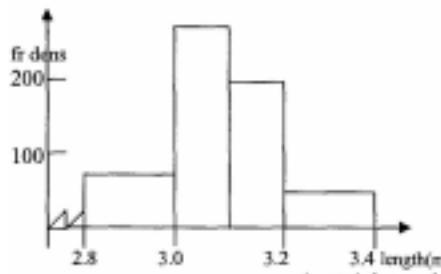
Answers: (i) false zero; (ii)(b) 79.

- 7 This question was very well done with many candidates achieving full marks. There was some confusion about what constituted the mid-point of the intervals, but credit was given for trying almost anything apart from an end point or class width. In working out the standard deviation credit was given for using their (albeit wrong) mid-point. Thus many method marks were gained by candidates who did not quite produce the final correct mean and standard deviation. A few candidates used 0.5, 10.5, etc as end points thus losing a mark, but nearly everyone knew how to calculate frequency density for the histogram. The graphs were very pleasingly drawn, with straight ruled lines, and scales and axes labelled.

Answers: (i) 18.4, 13.3;
(ii) frequency densities 2.2, 4.0, 3.2, 1.8, 1.0, 0.2 or scaled frequencies usually of 11, 20, 16, 9, 5, 1.

- 8 Approximately half the candidates appreciated the need to find a scaled frequency, or frequency density. It was pleasing to see most candidates had touching bars on the histogram, with the vertical axis labelled as frequency density, but only a small number labelled the horizontal axis as being area or m^2 and thus many candidates lost a mark.
- 9 This question was well done by nearly everyone. There are still some Centres who do not teach candidates to use SD mode on their calculators, and so there were pages of working for the standard deviation when all that was required was a single number from their calculator. It is to be hoped that candidates realise that when only one mark is given, they are not expected to do pages of working. The second part was well answered, with many candidates having a good knowledge of the relationship between consistency and standard deviation.

Answers: (i) 139, 83.1; (ii) team B, smaller standard deviation.

10 (i) $a = 8/0.2 (= 40)$	B1	
(ii) 	M1 B1 B1 ft 3	Uniform linear scales from at least 2.8 to 3.4 on the x-axis and 0 to 240 on the y-axis, both axes labelled, accept m or length, on x-axis Correct widths, no 0.05s, no gaps Four bars correct, ft on their (i) consistent with their vertical labelling, heights within $\frac{1}{2}$ small square
(iii) $\frac{17+24+19}{17+24+19+8}$ $= 60/68 \text{ or } 0.882$	M1 A1	For three terms in num and 4 terms in denom (can be implied) NB fd.s ie $85 + 240 + 190/555$ get M1 A0 For correct answer, a.e.f

11 (i) Mean $= 745/18 = 41.4$	B1	For correct answer, a.e.f.
sd $= \sqrt{\frac{33951}{18} - \left(\frac{745}{18}\right)^2}$	M1	For $\sqrt{[33951/18 - (\text{their } 41.4)^2]}$ or $\div 17$
$= 13.2$	A1	For correct answer 13.1 gets A0 with PA # 1

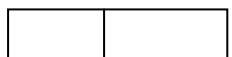
12 (i) $5 \times 2 + 15f + 30 \times 11 + 60 \times 4 = 27.5(17 + f)$	M1	For attempt at LHS, accept end points or cl width
$f = 9$	M1	For attempt at RHS, must have $17 + f$
total = 26 AG	A1 [4]	For correct f For correct answer given, ft if previous answer rounds to 9
(ii) $\sigma = 16.1$	M1	For method including sq rt and mean squared (can be implied if using calculator, must be x^2f on mid-points) or $\sum \frac{f(x - \bar{x})^2}{26}$
	A1 [2]	For correct answer

13 (i) shows all the data

B1 [Or other suitable advantage e.g. can see the shape, mode etc.(ii) Not exercise LQ = 5.4
Median = 6.5
UQ = 8.3**B1****B1ft****B1ft** [3] ft on first answer missing the decimal point

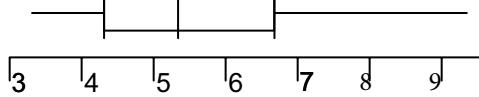
(iii)

not ex

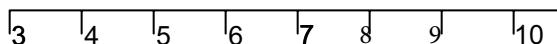
**B1**

For one linear numbered scale from 3 to 9.5, or two identically positioned scales

ex

**B1ft**

For not exercise all correct on linear scale

**B1**

For exercise correct on linear scale

B1**[4]** For two labels and cholesterol and scale labelled

SR non linear scale max B0 B0 B0 B1

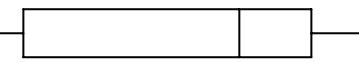
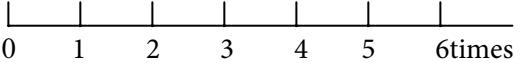
SR no graph paper lose one mark

<p>14 (i) $(41.2 \times 10 + 46.3 \times 13) / 23$ $= 44.1$</p>	M1 A1	For multiplying by 10 and 13 respectively and dividing by 23 For correct answer
<p>(ii) $15.1^2 = \frac{\sum x_w^2}{10} - 41.2^2$ $\sum x_w^2 = 19254.5$</p> <p>$12.7^2 = \frac{\sum x_m^2}{13} - 46.3^2$</p> <p>$\sum x_m^2 = 29964.74$ Total $\Sigma = 49219.24$</p> <p>$sd = \sqrt{\left(\frac{49219.24}{23} - 44.1^2 \right)} = 14.0$</p>	M1 A1 A1 A1 A1	For correct substitution from recognisable formula with or without sq rt For correct $\sum x_w^2$ (can be rounded) For correct $\sum x_m^2$ (can be rounded) For using 23 and their answer to (i) in correct formula For correct answer

<p>15 median \$47000 data have an outlier, are skew etc</p>	B1 B1 B1	3 Must have 47000 Accept any equivalent reason
---	------------------------	---

16 (i) 30.35 years	B1	1	
(ii) 4.8×5 = 24	M1 A1	2	Multiplying by 5 Correct answer
(iii) $4 + 18 + 24 + 28 + 26 + 10$ = 110	M1 A1	2	Summing their 6 attempts at frequencies Correct answer
(iv) $24 / 88$ = 0.273	M1 A1ft	2	Dividing their (ii) by their attempt at > 25 group Correct answer, ft on above

17	<table border="1"> <thead> <tr> <th>Weight</th><th></th></tr> </thead> <tbody> <tr> <td>41.5-45.5</td><td></td></tr> <tr> <td>45.5-49.5</td><td></td></tr> <tr> <td>49.5-53.5</td><td></td></tr> <tr> <td>53.5-57.5</td><td></td></tr> <tr> <td>57.5-61.5</td><td></td></tr> </tbody> </table>	Weight		41.5-45.5		45.5-49.5		49.5-53.5		53.5-57.5		57.5-61.5		M1 A1 M1 A1	4	<p>Five groups</p> <p>Correct boundaries, accept 42-45, 46-49 etc</p> <p>Attempt to calculate frequencies Σ 29, 30 or 31.</p> <p>5 frequencies correct</p>
Weight																
41.5-45.5																
45.5-49.5																
49.5-53.5																
53.5-57.5																
57.5-61.5																

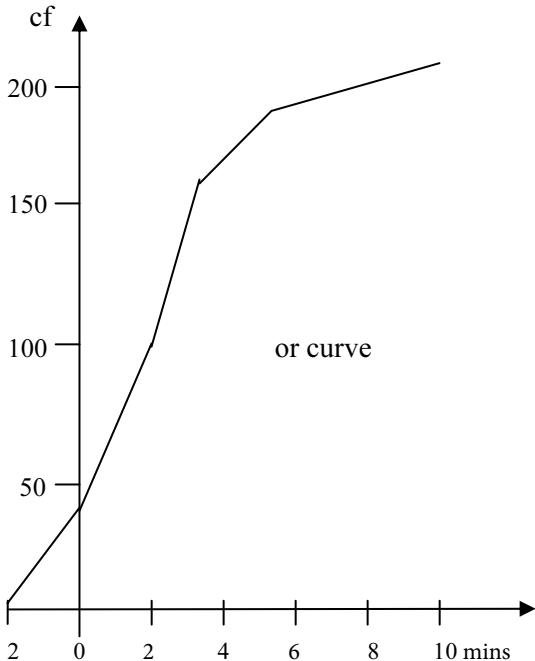
18 (i) $LQ = 4 \text{ hr } 42 \text{ min} - 3 \text{ hr } 48 \text{ min}$ = 54 min (0.9 hours)	M1 A1	2	Subtracting IQR from UQ Correct answer
(ii)	B1		Correct whiskers(accept hour decimals or minutes)
	B1		Correct median line, can be broken or extended
	B1ft		Correct UQ and LQ ft on their (i), box ends
	B1	4	correct uniform scale label hours or minutes, could be heading or key

19	mean = $35 - 15/12$ = 33.75 (33.8) minutes $sd = \sqrt{82.23/12 - (-15/12)^2}$ = 2.3 minutes	M1 A1 M1 A1 4	For -15/12 seen Correc answer $82.23/12 - (\pm \text{their coded mean})^2$ Correct answer
----	---	------------------------------------	--

20 (i)	<table border="1"> <thead> <tr> <th colspan="2">16 yr olds</th><th>9 year olds</th></tr> </thead> <tbody> <tr><td>7, 4</td><td>11</td><td></td></tr> <tr><td>9, 8,</td><td>12</td><td></td></tr> <tr><td>7, 0</td><td>13</td><td>0, 2, 7,</td></tr> <tr><td>8</td><td>14</td><td>2, 4,</td></tr> <tr><td></td><td>15</td><td>0, 1, 9,</td></tr> <tr><td>5</td><td>16</td><td>0, 1, 4, 7,</td></tr> </tbody> </table> <p>Key 7 13 2 means 13.7 minutes and 13.2 minutes</p>	16 yr olds		9 year olds	7, 4	11		9, 8,	12		7, 0	13	0, 2, 7,	8	14	2, 4,		15	0, 1, 9,	5	16	0, 1, 4, 7,	B1	3 columns including an integer stem in the middle, single digits in leaves. Can go downwards
16 yr olds		9 year olds																						
7, 4	11																							
9, 8,	12																							
7, 0	13	0, 2, 7,																						
8	14	2, 4,																						
	15	0, 1, 9,																						
5	16	0, 1, 4, 7,																						
B1	One leaf column correct, ordering not necessary																							
B1	Other leaf column correct (ordering not nec) and both leaves labelled correctly (could be in key)																							
B1 4	Key correct both ways or two keys one each way, must have minutes																							
(ii)	\sum (8 pupils) = 106.8 \sum (9 pupils) = $13.6 \times 9 (= 122.4)$	B1	106.8 seen or implied																					
		B1	for 13.6×9																					
	New pupil's time = 15.6 min	B1ft 3	Ft on 122.4 – their \sum																					
			8																					

21 (i) $-73.2/24 (= -3.05)$ $a = 8.95 + 3.05 = 12$	M1 A1	Accept $(-72.4 + \text{anything})/24$ Correct answer
OR $8.95 \times 24 (= 214.8)$ $\Sigma x - \Sigma a = -73.2$ $\Sigma a = 288 \quad a = 12$	M1 A1	For 8.95×24 seen Correct answer obtained using Σx and Σa

22 (i) some trains were up to 2 minutes early	B1	1	Or sensible equivalent, must use the idea 'early' 2 not needed												
<hr/>															
(ii) cf table			NB All M marks are independent.												
<table border="1"> <tr><td>Min late, less than</td><td>0</td><td>2</td><td>4</td><td>6</td><td>10</td></tr> <tr><td>C freq</td><td>43</td><td>9</td><td>163</td><td>185</td><td>204</td></tr> </table>	Min late, less than	0	2	4	6	10	C freq	43	9	163	185	204	M1		Attempt at C F table with upper limits no halves
Min late, less than	0	2	4	6	10										
C freq	43	9	163	185	204										



- | | |
|----|--|
| M1 | Uniform linear scales from at least 0 to 10 and 0 to 204 and at least one axis labelled, CF or mins or t |
| M1 | Attempt at graph their 5 points. (-2, 0) not nec (could be midpoints or lower bounds not f d) |
| M1 | Attempt at median along 102 or 102.5 line |
| M1 | Attempt at LQ along 51/52 line and UQ along 153/154 line from graph |

Median = rounding to 2.1 to 2.4 min
 IQ range = rounding to 3.2 to 3.6 min

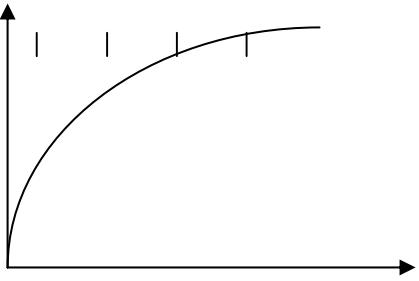
- | | |
|----|--|
| B1 | Correct median |
| A1 | 7 Correct IQ range allow from midpoints etc |
-

23	(i)	median = 16 th along = 24 LQ = 16 not 15.5	B1 B1	
	(ii)	UQ = LQ + 19 = 35 $x = 5$	M1 A1	For adding 19 to their LQ in whatever form Must be 5 not 35. c.w.o.

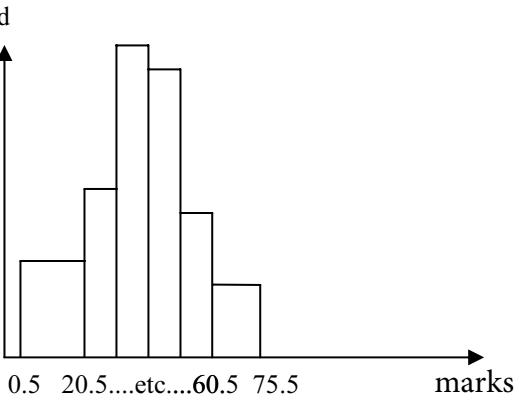
24	(i)	fd: 22, 30, 18, 30, 14	M1	Attempt at freq density or scaling
			A1 B1 B1 B1	correct heights seen on graph Bar lines correctly located at 0.55, 1.05, 2.05, 3.05, no gaps correct widths of bars both axes uniform from at least 0 to 15 or 30, and 0.05 to 4.5 and labelled, (fd, or freq per half hour , time, hours, t)
	(ii)	mid-points 0.3, 0.8, 1.55, 2.55, 3.8 $= 199.5 / 95$ mean = 2.1 hours	M1 M1 A1	an attempt at mid-points (not class widths) using $(\Sigma \text{their } fx) / \text{their } 95$ correct answer from 199.5 in num

25 mean = 38.4 mm sd = 4.57 mm c.a.o	B1 M1 A1 [3]	Correct answer Correct method if shown (can be implied) must see a $\sqrt{}$ sign Correct answer
---	------------------------	---

26 (i)	10 4 4 9 11 5 7 12 0 4 5 13 2 4 14 2 5 15 16 0 8	B1	Correct stem
	key 10 4 represents 104	B1 [3]	Correct leaves, must be sorted and in columns and give correct overall shape
		B1 [3]	Key, must have vertical line in both

27 (i)	$a = 494$ $b = 46$	B1 B1 [2]	
(ii)		B1 B1 M1 A1 [4]	Correct linear scale minimum 0 to 540 and 0 to 60 Labels (cf or people or number of people) and (time, or minutes) and attempt at cf or cf step polygon Attempt to plot points at (10, 210), (20, 344), (30, 422), (40, 494) Correct graph through (0, 0) and (60, 540)
(iii)	median is 13.5 to 14.6 min	M1 A1 [2]	Attempt to read from graph at line $y = 270$ or 270.5 Correct answer
(iv)	$(5 \times 210 + 15 \times 134 + 25 \times 78 + 35 \times 72 + 50 \times 46) / 540$ $= 9830 / 540$ $= 18.2 \text{ min}$ $(5^2 \times 210 + 15^2 \times 134 + \dots) - 18.2^2$ $\text{sd} = 14.2 \text{ min}$	M1 A1 M1 A1 [4]	Using mid points and frequencies Correct mean Attempt at $\Sigma x^2 f / \Sigma f - \text{their mean}^2$ numerically, could use cfs, ucb, but not class widths Correct answer
(v)	$18.2 \pm 7.1 = 11.1, 25.3$ $390 - 225$ $= 155 \text{ to } 170 \text{ people}$	M1 A1 [2]	Attempt to read their mean $\pm \frac{1}{2} \text{ sd}$ from cf graph Correct answer

28 (i) 67	B1 [1]	
(ii) LQ = 64 Med = 73 UQ = 90	M1	Attempt to find all 3 quartiles can be implied
	B1	Correct end whiskers (not dots or boxes), not through box, must look accurate
	B1	Correct median line in box must look accurate
	B1	Correct box ends must look accurate
	B1 [5]	Correct uniform scale from at least 33 to 99, and label 'books' oe can be seen in title or scale
(iii) books are fatter/ wider, or standard deviation /IQ range of the number of books per shelf is less	B1 [1]	Any sensible comment about width of books or s.d / IQ range not mean/media

29 (i) class widths 20, 10, 10, 10, 10, 15 freq density: 2.0, 3.4, 5.6, 5.4, 2.9, 1.4	M1	Attempt at fd or scaled frequency
	A1	Correct heights seen on graph
	B1	Bar lines correctly located at 20.5, 30.5, 40.5, 50.5 and 60.5, no gaps
	B1	Correct widths of bars
	B1 [5]	Both axes uniform from at least 0 to 5.6 and 0.5 to 75.5 and labelled (fd or fr per mark, marks)
(ii) mid-points 10.5, 25.5, 35.5, 45.5, 55.5, 68 mean = $\Sigma xf / 234 = 8769.5/234$ = 37.5 var = $\Sigma x^2 f / 234 - \text{mean}^2$ sd = 16.9	M1 A1 M1 A1 [4]	Attempt at $\Sigma xf / 234$ using mid-points, NOT class widths, NOT upper class bounds Correct answer Numerical attempt at correct variance formula, NOT class widths Correct answer

30 (i)	Key 1 2 represents 12 people	B1	Correct stem
0 2 5 6 8 8 1 2 4 6 7 7 9 2 1 2 3 3 5 6 7 3 1 5		B1	Correct leaves must be sorted and accurate
		B1 [3]	Key; must have people o.e

(ii) median = 19 people LQ = 10, UQ = 24 IQ range = $24 - 10 = 14$ people	B1 B1 B1ft [3]	Correct median Correct quartiles Ft their quartiles
(iii) median because mode could be any number which is duplicated more than twice	B1 [1]	Correct answer must say something about the mode being not much use or another sensible reason

31 (i) $\bar{x} = 18.9$ ($132/7$) sd = 12.3	B1 B1 [2]	
(ii) median	B1 [1]	
(iii) mode inappropriate because it is 10 and this is the lowest value. mean inappropriate because it is affected by the outlier (of 48).	B1 B1 [2]	Sensible reason allow if seen in (ii) Sensible reason allow if seen in (ii) not 'outliers' in plural

32 median $A = 2.0 - 2.1$ or $\bar{x}_A = 2.0 - 2.1$ median $B = 3.8 - 3.9$ or $\bar{x}_B = 3.4 - 3.5$ Country B has heavier babies on average IQ range $A = 2.4 - 1.5 = 0.9$ or sd = $0.5 - 0.7$ IQ range $B = 4.5 - 2.2 = 2.3$ or sd = $1.2 - 1.4$ Country B has greater spread of weights	M1 A1 B1 M1 A1 A1 [6]	For finding medians or using mid-pts and freqs to find means, or seen on 2 box-plots Correct medians or means for A and B Correct statement allow '...higher median...' etc. Finding spreads by IQ range or range or sd or 2 box-plots Correct IQ range or sd for A and B (± 0.1 kg) or correct IQR on box-plots Correct statement
---	--	--

33 mean = 18.2 $sd = \sqrt{876/50}$ $= 4.19$	B1 M1 A1 [3]	Correct unsimplified expression seen Correct answer
--	-------------------------------	--

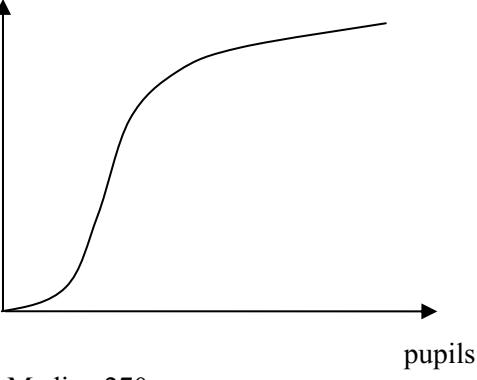
34 (i) $3 = 2x / 10$ $x = 15$ height = freq / class width $= x / 20 = 0.75$ cm	M1 A1 M1 A1 [4]	Attempt at using freq density = freq / cw Correct answer Attempt at using fd = freq / cw with different cw from above Correct answer
(ii) mean wt = $(5.5 \times 30 + 15.5 \times 60 + 23 \times 45 + 28 \times 75 + 40.5 \times 60 + 60.5 \times 15) / 285$ $= 26.6$ grams	M1 M1 A1 [3]	Using freqs or frequency ratios and mid-points, attempt not ucb, not cw (can do it without x) Correct unsimplified answer can have fr ratios Correct answer

35 (i) $\Sigma(x - 50) = 824 - 16 \times 50 = 24$ $\frac{\Sigma(x - 50)^2}{16} - \left(\frac{\Sigma(x - 50)}{16} \right)^2 = 6.5^2$ $\Sigma(x - 50)^2 = 712$	B1 M1 A1 [3]	Correct answer Consistent substituting in the correct coded variance formula OR valid method for Σx^2 then expanding $\Sigma(x - 50)^2$, 3 terms at least 2 correct Correct answer
(ii) new mean = $896/17 (= 52.7)$ $\text{new var} = \frac{712 + 22^2}{17} - \left(\frac{24 + (72 - 50)}{17} \right)^2$ new sd = 7.94	B1 M1 A1 [3]	Correct answer Using the correct coded variance formula with $n = 17$ and new coded mean ² OR their $(\Sigma x^2 + 72^2)/17 - \text{their new mean}^2$ Rounding to correct answer, accept 7.95 or 7.98 or 7.91

36 (i) sugar <hr/> 194 1 5 9 195 8 1 196 2 4 7 9 4 3 198 4 199 8 7 4 1 201	B1 B1 B1	Correct stem must be integers. (stem and leaves can be in reverse order) Correct leaves flour must be single and ordered Correct leaves sugar must be single and ordered
key 1 196 2 means 1.961 kg for sugar and 1.962 kg for flour	B1ft [4]	Correct key needs all this, ft if single leaves and 1.96 etc in stem
(ii) med = 1.989 kg $\text{IQ range} = 2.011 - 1.977$ $= 0.034 \text{ kg}$	B1 M1 A1 [3]	correct median sub their LQ from their UQ, UQ > med, LQ < med Correct answer

37 (i) $\bar{x} = 60 + 245/70$ $= 63.5$	M1 A1 [2]	245/70 seen Correct answer
(ii) $\Sigma(x - 50) = \Sigma x - \Sigma 50$ $= 245 + 70 \times 60 - 70 \times 50$ $= 945$	M1 A1 [2]	Any valid method, involving 70 Correct answer

<p>38 (i)</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <tr><td>2 to 4</td><td>4 to 6</td><td>6 to 7</td><td>7 to 8</td><td>8 to 10</td><td>10 to 16</td></tr> <tr><td>20</td><td>4</td><td>34</td><td>3</td><td>30</td><td>36</td></tr> </table>	2 to 4	4 to 6	6 to 7	7 to 8	8 to 10	10 to 16	20	4	34	3	30	36	M1 A1 A1 [3]	Using fd to evaluate freqs Any four correct All correct
2 to 4	4 to 6	6 to 7	7 to 8	8 to 10	10 to 16									
20	4	34	3	30	36									
<p>(ii) mid-points 3, 5, 6.5, 7.5, 9, 13 $E(X) = (3 \times 20 + 5 \times 44 + 6.5 \times 34 + 7.5 \times 30 + 9 \times 30 + 13 \times 36) / 194 = 1464/194$ $= 7.55$</p>	M1 A1ft [2]	5 or 6 correct mid-points Correct answer, ft on 6 correct mid-points and the frequencies in their table												
<p>(iii) $p = 60/194 (0.309)$ $P(1) = 2 \times (60/194)(134/193)$ $= 8040/18721 (0.429)$</p>	B1ft M1 A1 [3]	60/194 seen, ft on (their 30 + their 30) / their total multiplying a probability by 2 Correct answer												

<p>39 (i)</p> 	M1 M1 (Indpt) A1 [3]	Sensible attempt at graph using u.c.b. 2500 seen in median attempt on a CF graph Can be implied
<p>(ii) 20% less than 160</p>	M1 A1 [2]	Using 20% Correct answer + or - 5
<p>(iii) $2100 - 1600 = 500$</p>	B1 [1]	
<p>(iv) $(50.5 \times 200 + 125.5 \times 600 + 175.5 \times 800 + 225.5 \times 500 + 300.5 \times 2000 + 400.5 \times 600 + 525.5 \times 300) / 5000$ $= 268$</p>	M1 M1 A1 A1 [4]	Using an attempt at mid-points Using an attempt at frequencies Correct mid-points or frequencies Correct answer only

<p>40 (i) Mean = $45 - 148/36 = 40.9$ or $1472/36$ <i>EITHER</i> $\text{Var} = 3089/36 - (-148/36)^2 = 68.9$ $\text{sd} = 8.30$</p> <p><i>OR</i> $\Sigma x^2 = 3089 - 36 \times 45^2 + 90 \times 1472 = 62669$ $\text{Var} = \left(\frac{62669}{36} - \left(\frac{1472}{36} \right)^2 \right)$</p> <p>$\text{sd} = 8.30$</p>	B1 M1 A1 [3]	Correct answer $3089/36 - (\pm \text{their coded mean})^2$ Correct answer
	M1 A1	Expanding $\Sigma(x - 45)^2$ with at least 2 terms correct and solving, then substituting their Σx^2 in correct variance formula with their mean ² subt numerically Correct answer

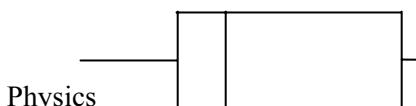
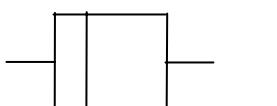
(ii) New $\Sigma(x - 45) = -148 - 16 = -164$ New $\Sigma(x - 45)^2 = 3089 + 16^2 = 3345$ New sd = $\sqrt{3345/37 - (-164/37)^2}$ = 8.41 OR $\Sigma x = 36 \times 45 - 148 = 1472$ New $\Sigma x = 1472 + 29 = 1501$ $\Sigma x^2 = 3089 - 36 \times 45^2 + 90 \times 1472 = 62669$ New $\Sigma x^2 = 62669 + 29^2 (= 63510)$ New sd = $\sqrt{63510/37 - (1501/37)^2}$ = 8.41	M1 M1 M1 A1 [4]	Adding their coded new value to -148 Adding their (coded value) ² to 3089 Subst in coded var formula, can have one of 29 and one of -16 here Correct answer
	M1	Finding Σx and adding 29
	M1	Finding Σx^2 and adding 29^2 , at least 2 terms of 3089, 36×45^2 , 90×1472

41 (i)	M1 M1 M1 A1 [4]	Attempt at cf table (up to 200) Linear scale minimum 0 to 200 and 20 to 80, and labels Attempt to plot points at (20.5, 10), (40.5, 42), (50.5, 104), (60.5, 154), (70.5, 182), (90.5, 200), accept (20, 10), (40, 42) or (21, 10), (41, 42) etc All points correct and joined up, allow (0, 0) or (0.5, 0)
(ii) Line on graph up from 30 $200 - 20 = 180$ <i>OR</i> using lin int $10 + \frac{(30 - 20.5)}{20} \times 32 = 25.2$ = 174.8	M1 A1 [2] M1 A1	Line or mark seen, can be implied if matches graph and in range Accept 174 – 180 if reading from graph Can have 20 or 20.5 Accept decimals, 174 – 175 if using lin int
(iii) Line on graph across from 150 59 rooms <i>OR</i> lin int $50.5 + 46/50 \times 10$ = 59 or 60	M1 A1 [2] M1 A1	Line or mark seen, can be implied if matches graph and in range. 150 seen and line between 140 and 160 Accept 58 – 60 Can have 50 or 50.5 Must be integer

42 (i) $(3.6 \times 9 + 64) / 24$ = 4.02 years	M1 A1 [2]	Mult by 9, adding 64 then dividing by 24 Correct answer
(ii) $\frac{\Sigma x_A^2}{9} - 3.6^2 = 1.925^2$ $\Sigma x_A^2 = 150$ $\frac{150.0 + 352}{24} - 4.017^2 = 4.780$	M1 A1 M1	Attempt to find Σx_A^2 using correct variance formula Correct Σx_A^2 Using 352 + their 150 in correct variance formula
sd = 2.19	A1 [4]	Correct answer

43 (i) median _A < 35 or 20 ≤ median _A < 35 or median _A = 33.0/33.1/33.5/33.6 or median _B ≥ 50 or 50 ≤ median _B < 70 or median _B = 51.7/51.9/52.2/52.4 median _B > median _A	B1	Correct numerical statement re median _A or median _B
	B1	Correct numerical statement re other median and a conclusion
OR A has 66 cand 50 < mark < 100, so med _A < 50 or B has 156 cand 50 < mark < 100, so med _B > 50 median _B > median _A	B1	As before
	B1	As before
(ii) 159 - 68 = 91	B1 [1]	Correct final answer
(iii) mean = $\left(\frac{4.5 \times 25 + 14.5 \times 43 + 27 \times 91}{+ \dots + 84.5 \times 40} \right) / 300$ = 11270 / 300 = 37.6	M1 M1 M1 A1 [4]	Using an attempt at mid-points, not end points or class widths Using an attempt at frequencies, not cum freqs Sum of 6 prods, correct freqs, divided by 300 Correct answer

44 (i) $133/n + 25 = 28.325$ $n = 40$ $3762/40 - 3.325^2 = 82.99$ standard deviation = 9.11	M1 A1 M1 A1 [4]	Equation involving 133, 25 and 28.325 Correct answer for n Using coded mean in variance formula Correct answer
(ii) $82.99 = \sum x^2 / 40 - 28.325^2$ $\sum x^2 = (82.99 + 28.325^2) \times 40$ = 35412 (35400) OR $\sum (x - 25)^2 = \sum x^2 - 50 \sum x + 40 \times 25^2$ $\sum x^2 = 3762 + 50 \times 1133 + 25000$ = 35412	M1 A1 M1 A1 []	Using uncoded material in variance formula Correct answer Expanding and substituting for $\sum x$ Correct answer

45 (i) History: lowest 27, highest 57, LQ = 33 med = 39 UQ = 50 Physics  History  10 20	M1 [1]	Attempt to find history quartiles and median by putting in order or stem and leaf (can be implied if the answer is reasonable) Correct history median and quartiles Uniform scale and labels Correct history graph ft their quartiles line not through box Correct physics graph
(ii) Physics marks are more spread out than History marks	B1 [1]	Any sensible comment

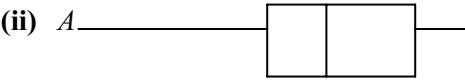
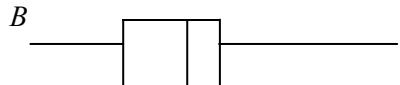
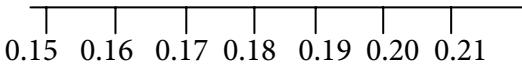
46 $\bar{x} = 59.4$ $\sigma = 7.68$	B1 M1 A1	[3]	Correct method (can be implied by correct answer) Correct answer
--	----------------	-----	---

47 (i) 45 – 50 g (ii) LQ in 40 – 45 UQ in 50 – 60 Smallest IQ range could be 5 Largest IQ range could be 20 (iii) 50 (iv) freqs 0, 20, 30, 50, 60, 50, 10 fd 0, 2, 3, 10, 12, 5, 1	B1 M1 A1 B1 M1 B1 A1 A1	[1] [2] [1] Attempt at frequencies and fd Correct labels and scales with a histogram-type shape Correct bar widths starting at 20 Correct heights of bars	Considering groups containing LQ and UQ (can be implied) Correct answer

48 (i) LQ = 15, Median = 18, UQ = 26 	B1 B1 B1✓ B1✓	[4]	LQ = 15, Median = 18, and UQ = 26 Linear scale and labels Quartiles and median box, ft on their values, but M – LQ < UQ – M Whiskers from 5 to LQ and UQ to 80, ft on their values
(ii) most (3/4) are earning less than 26K, not many earning high salaries, etc	B1	[1]	Any sensible answer
(iii) (a) IQ range = 11 high outlier is above $26 + 1.5 \times 11$ $= 42500$ euros	B1 M1 A1	[3]	IQR = 11 Their UQ + 1.5 × their IQ range Correct answer
(b) Low outlier is below $15 - 1.5 \times 11 = -1.5$	B1✓	[1]	Correct reason, must involve subtraction, ft on their LQ and 1.5 × their IQR

49 (i) Flat screen	<table border="1"> <tr><td></td><td>conventional</td></tr> <tr><td>6</td><td>5 7 9</td></tr> <tr><td>6</td><td>7 1 4 5 7</td></tr> <tr><td>9 5</td><td>8 5 6</td></tr> <tr><td>6 4 2 1</td><td>9</td></tr> <tr><td>7 4</td><td>10</td></tr> </table>		conventional	6	5 7 9	6	7 1 4 5 7	9 5	8 5 6	6 4 2 1	9	7 4	10	B1	Correct stem must be integers
	conventional														
6	5 7 9														
6	7 1 4 5 7														
9 5	8 5 6														
6 4 2 1	9														
7 4	10														
	key 5 8 4 means 0.85 m for flat screen	B1	Correct flat screen leaves												
	and 0.84 m for conventional	B1 [4]	Key must have units and TV type												
(ii)	Conventional median = 0.74 conv IQ range = $0.81 - 0.68 = 0.13$	B1 M1 A1 [3]	Correct median Their UQ – their LQ Correct answer												
(iii)	mean = 0.927 sd = 0.0882	B1 B1 [2]	Need 3 s.f. (Accept 0.0878 to 0.0889)												

50	$\bar{x} = 4.3$ $sd = \sqrt{\left(\frac{8287.5}{150} - 4.3^2 \right)} = \sqrt{36.76} = 6.063$ $\Sigma(x - \bar{x})^2 = 150 \times 6.063^2$ $= 5514 (5510)$	B1 M1 M1 A1 [4]	4.3 or 645/150 or 18.49 seen Subst in correct formula to find sd or var or expand $\Sigma(x - \bar{x})^2$ correctly and substitute Mult by 150 Answer rounding to 5510
----	--	--------------------------	---

51 (i)	A: median = 0.186, IQ range = $0.198 - 0.179$ $= 0.019$	B1 M1 A1ft [3]	Subt LQ from their UQ Correct IQ range ft dp in wrong place
(ii)	 	B1ft	2 correct boxes ft (i) OK if superimposed
		B1	2 pairs correct whiskers lines up to box not inside
		B1 [3]	Correct uniform scale from at least 0.15 to 0.21 seen. No scale no marks (ii) unless perfect A and B with all 10 values shown

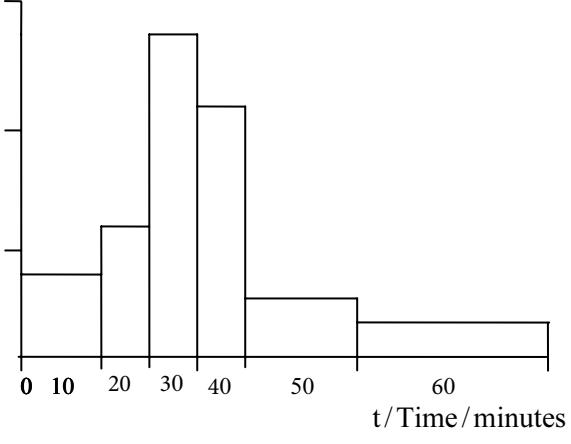
52 (i)	$72/n + 100 = 104.8$ or $72 + 100n = 104.8n$ $n = 15$	M1 A1 [2]	$72/n$ or $100n$ and $104.8n$ seen or implied correct answer
--------	---	--------------	---

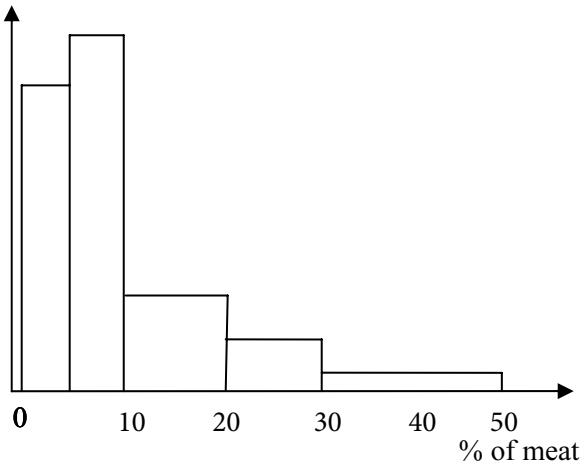
(ii) $sd^2 = 499.2/15 - (72/15)^2 (= 10.24)$	M1	numerical use of a correct sd/variance formula, their n
$sd^2 = \sum(x-104.8)^2/15 -$		numerical use of different correct sd/var formula, their n
$(\sum(x-104.8)/15)^2$	M1	correct final answer
$\sum(x-104.8)^2 = 153.6 (154)$	A1 [3]	

53 $\Sigma x - \Sigma 36 = -60$	M1	Expanding brackets ie mult by 24 and subt 60
$\Sigma x = 24 \times 36 - 60 = 804$	A1 [2]	Correct answer
OR $\bar{x} = 36 - 60/24 = 33.5$	M1	Dividing by 24 and subt from 36
$\Sigma x = 33.5 \times 24 = 804$	A1	Correct answer
$\Sigma x^2 - 2.36\Sigma x + \Sigma 36^2 = 227.6$	M1	Expanding brackets with $36\Sigma x$ and $\Sigma 36^2$ min
$\Sigma x^2 = 27011.$	M1 [3]	$\Sigma x^2 - 2 \times 36\Sigma x + \Sigma 36^2 = 227.6$ seen Correct answer
OR $227.76/24 - (-2.5)^2 = sd^2 = 3.24$	M1	$227.76/24 - (\text{their coded mean})^2$ seen
$\Sigma x^2/24 - (-2.5)^2 = 3.2$	M1	$\Sigma x^2/24 - (\bar{x})^2 = \text{their var if +ve seen o.e.}$
$\Sigma x^2 = 27011.$	A1	Correct answer

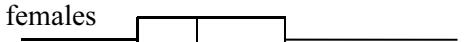
54 (i)			
	14 3	B1	Correct stem
	15 3 4 5	B1	Correct leaves
	16 1 4 8 8		
	17 3 7		
	18 5		
Key: 14 3 represents 14300 dollars	B1 [3]	Key need dollars	
(ii) LQ = 15400	B1 [1]	Correct answer	
(iii) $5/11 \times 4/10 \times 2/9 \times 3C2 = 4/33 (0.121)$	B1	Mult 3 diff fractions or (5C2 or 2C1)	
OR $\frac{5C2 \times 2C1}{11C3}$	B1	seen in num	
	B1 [3]	Mult by 3C2 o.e. or correct denom	
		Correct answer	

55 (i) median in 15–20 mins, UQ in 25–40 mins	B1		
	B1 [2]		

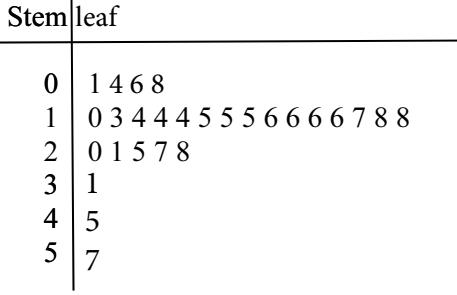
<p>(ii) fd 1.9, 2.4, 5.6, 4.4, 1.2, 0.65 or Scaled freq 9.5, 12, 28, 22, 6, 3.25</p> 	M1 A1 B1 B1		Attempt at fd or scaled freq [f/(attempt at cw)] Correct heights seen on diagram Correct bar widths visually no gaps Labels (time / mins and fd or freq per 5 min) and correct bar ends [4]
<p>(iii) $(5 \times 19 + 12.5 \times 12 + 17.5 \times 28 + 22.5 \times 22 + 32.5 \times 18 + 50 \times 13)/112 = 2465/112 = 22.0$ minutes</p>	M1 A1 		Attempt at $\Sigma xf / 112$ using mid-points, NOT classwidths, NOT upper class bounds Correct answer accept 22 [2]

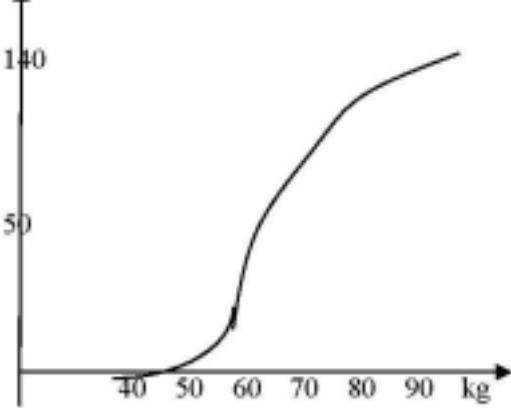
<p>56 (i) $(3 \times 59 + 8 \times 67 + 15.5 \times 38 + 25.5 \times 18 + 40.5 \times 11)/193 = 11.4$</p> $\sigma^2 = (3^2 \times 59 + 8^2 \times 67 + \dots)/193 - (11.43..)^2$ $\sigma = 9.78 \text{ or } 9.79$	M1 A1 M1 A1		Attempt to calculate the mean using midpoints not ends, with frequencies, can be implied Correct mean Using $\Sigma x^2 f$ with mean ² subtracted numerically, can be implied Correct answer, method marks can be implied 4
<p>(ii) fd = 11.8, 13.4, 3.8, 1.8, 0.55</p> 	M1 A1 B1 B1 B1		Attempt at frequency density or scaling Correct heights seen on graph Bar lines correctly located at 5.5, 10.5, 20.5 and 30.5, no gaps, their scale which may be non-linear correct widths of bars, independent of bar lines Both axes uniform, from at least 0 to 14 if fd and 0.5 to 50.5, and labelled (fd or freq per 5% and % meat or % or meat) 5

<p>57 (i) $sd^2 = 1957.5/30 - (234/30)^2$ $sd = 2.1$</p> <p>(ii) $86 = 234/30 + c$ $c = 78.2$</p>	M1 A1 M1 A1		Subst in formula or expand Accept 2.10 234/30 seen [2] 234/30 seen [2]
---	--	--	---

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

59	$\bar{x} = 50 + 81.4/22 = 53.7$ $\text{var} = 671/22 - 3.7^2 = 16.81(16.8)$ $16.81 = \Sigma x^2/22 - 53.7^2$ $= 63811(63800)$ OR $\Sigma x - 22 \times 50 = 81.4 (\Sigma x = 1181.4)$ $\Sigma x^2 - 100\Sigma x + 22 \times 50^2 = 671$ $\Sigma x^2 = 671 +$ $\text{Var} = \Sigma x^2/22 - (\Sigma x/22)^2 = 16.81$	M1 A1 M1 A1 M1 M1 A1 A1	[4]	Attempt to find variance using coding in both, correct formula Correct answer using their var and their mean with uncoded formula for both correct answer expanded eqn with 22×50 seen expanded eqn with 2 or 3 terms correct correct answer correct answer
----	---	--	-----	--

60 (i)	Stem leaf 	B1 B1		Correct stem condone a space under the 1 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	[3]	Correct key must have \$, ft 2 special cases
(ii)	Median = 160 LQ = 140 UQ = 210 IQ range = UQ - LQ = 70	B1 M1 A1	[3]	Subt their LQ from their UQ Correct answer cwo
(iii)	1.5 × IQ range = 105 Lower outlier is below 35 Upper outlier is above 315 Outliers 10, 450, 570	M1 A1ft A1	[3]	Mult their IQ range by 1.5 can be implied Correct limits ft their IQ range and quartiles Correct outliers

<p>61 (i) (40, 0), (50, 12) etc. up to (90, 144) cf points</p>  <p>(ii) 80 weigh less than 67.2 kg $c = 67.2$</p>	<p>B1</p> <p>B1 [2]</p> <p>M1 A1 ft [2]</p>	<p>Axes, (cf) and labels (kg), uniform scales from at least 0–140 and 40.5–69.5 either way round</p> <p>All points correct, sensible scale (not 12), polygon or smooth curve</p> <p>Subt 64 from 144 Accept anything between 67 and 68 ft from incorrect graph</p>
---	---	--

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

M1
A1frequencies attempt not cf
Correct freqs

$$\begin{aligned} \text{mean wt} &= (45 \times 12 + 55 \times 22 + 62.5 \\ &\quad \times 30 + 67.5 \times 28 + 80 \times 52) \\ &\quad / 144 \\ &= 9675 / 144 \\ &= 67.2 \text{ kg} \\ \text{Var } &(45^2 \times 12 + 55^2 \times 22 + \\ &62.5^2 \times 30 + 67.5^2 \times 28 + 80^2 \times \\ &52) / 144 \\ &- (9675/144)^2 = 127.59 \end{aligned}$$

M1

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

A1

Correct mean

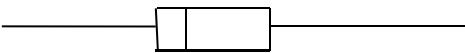
$$\text{sd} = 11.3, \text{ allow } 11.2$$

A1

[6] Correct answer

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

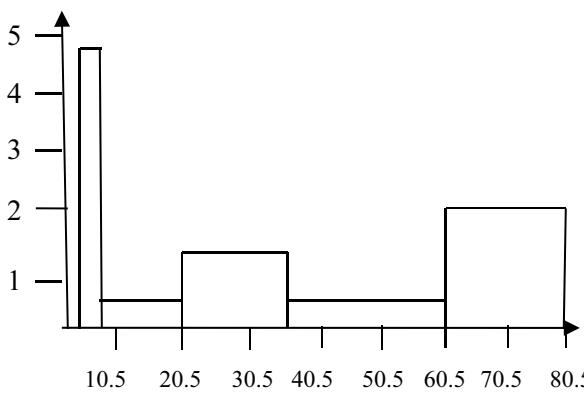
<p>62 $\Sigma(x - 5) = 116 - 18 \times 5$ $= 26$</p> $\frac{\Sigma(x-5)^2}{18} - \left(\frac{26}{18}\right)^2 = \frac{967}{18} - \left(\frac{58}{9}\right)^2$ $\Sigma(x - 5)^2 = 257$ <p>OR coded mean = $58/9 - 5 = 1.444$ $\Sigma(x - 5) = 1.444 \times 18 = 26$</p> $\Sigma(x - 5)^2 = \Sigma x^2 - 10\Sigma x + 25 \times 18$ $= 967 - 1160 + 450 = 257$	<p>M1 A1</p> <p>M1 M1</p> <p>A1</p> <p>M1 A1</p> <p>M1 A1 A1</p>	<p>Obtaining Σx and subtracting 18×5 Correct answer</p> <p>Subst in correct var formula all coded vals Subst in correct var formula all uncoded</p> <p>Correct answer</p> <p>Subtracting 5 from true mean and mult by 18 Correct answer</p> <p>Expanding $\Sigma(x-5)^2$ 3 terms needed Any 2 terms correct Correct answer</p>
--	--	--

<p>63 (i)</p>  <p>200 300 400 500 600 700 800 900 1000 House price, 000's dollars</p>	<p>B1 B1 B1 B1</p>	<p>Linear scale or 5 values shown and labels or in heading, need thousands of dollars, Correct median Correct quartiles</p>
<p>(ii) $1.5 \times 170 = 255$ Expensive houses above $690 + 170 \times 1.5 = 945$ i.e. 957 and 986 thousands of dollars</p>	<p>M1</p>	<p>Mult their IQ range by 1.5</p>
<p>(iii) doesn't show all the data items</p>	<p>A1</p>	<p>Correct answers from correct wkg need thousands of dollars</p>
	<p>B1</p>	<p>Need to see 'individual items' oe</p>

<p>64 (i) number = $1.5 \times 50 = 75$ (AG)</p> <p>(ii) freqs are 10, 25, 50, 75, 30 (15, 15) Mean = $(10 \times 125 + 25 \times 162.5 + 50 \times 187.5 + 75 \times 225 + 30 \times 300)/190 = 40562.5/190 = 213$ (213.48 ...)</p> <p>$sd^2 = 10 \times 125^2 + 25 \times 162.5^2 + 50 \times 187.5^2 + 75 \times 225^2 + 30 \times 300^2)/190 - (213.48 ...)^2$</p> <p>$sd = 46.5$ or 46.6</p> <p>(iii) have used the raw data</p>	<p>B1 M1 A1 M1 A1 M1 A1 B1</p>	<p>[1] [1] [1] [1]</p>	<p>Must see 1.5×50 Attempt at freqs not fd Correct freqs attempt at mid points not cw or ucb or lcb correct mean subst their $\Sigma f x^2$ in correct variance formula [6] [1]</p>
---	--	------------------------------------	--

<p>65 bars are not touching oe Area not rep by frequency, not used fd, not labelled fd</p>	<p>B1 B1</p>	<p>Sensible reason involving not touching, no gaps, class boundaries, group data not continuous (may be the negative) Must be frequency density oe. Wrong height not sufficient. (Best 2 reasons awarded)</p>
---	------------------	--

<p>66 (i) class widths 5, 15, 15, 25, 20</p> $fd = \frac{24}{5}, \frac{9}{15}, \frac{21}{15}, \frac{15}{25}, \frac{42}{20}$ $= 4.8, 0.6, 1.4, 0.6, 2.1$	<p>M1</p>	<p>Attempt at class widths</p>
	<p>B1</p>	<p>Correct widths of bars, with or without halves, seen on diagram</p>



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

M1

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

A1

3

correct answer

(iii) LQ in 6 – 20

UQ in 61 – 80

Least value of IQ range is $61 - 20 = 41$

B1

B1

B1

3

ft any or both wrong quartile ranges if
sensible

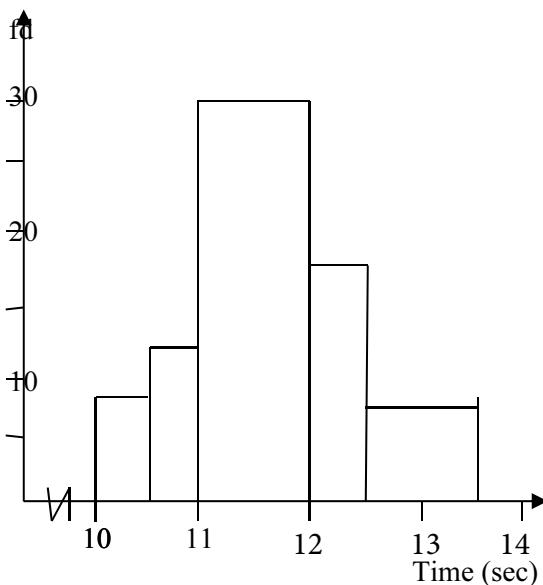
67 (i) 6

B1

1

Must see in (i)

(ii) freqs 4 6 30 9 8
 fd 8



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

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

$$\begin{aligned} \text{(iii)} \quad E(X) &= (10.25 \times 4 + 10.75 \times 6 + 11.5 \times \\ &\quad 30 + 12.25 \times 9 + 13 \times 8) / 57 \\ &= 11.7(11.662) \end{aligned}$$

M1

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

$$\begin{aligned} \text{Var}(X) &= (10.25^2 \times 4 + 10.75^2 \times 6 + \\ &\quad 11.5^2 \times 30 + 12.25^2 \times 9 \\ &\quad + 13^2 \times 8) / 57 - (11.662...)^2 \\ &= 0.547 \end{aligned}$$

M1

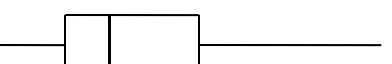
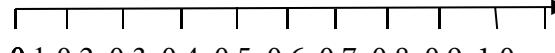
numerical attempt at correct variance formula
with mean² subt ft their "midpoints" i.e. ucb,
cw, etc.

A1

4

accept answers between 0.547 and 0.610
condone 0.6, 0.60

68 (i)	<table border="1"> <thead> <tr> <th>Adults</th><th></th><th>Children</th></tr> </thead> <tbody> <tr><td>8 6 5 4 3</td><td>4</td><td>3</td></tr> <tr><td>7 4 3 3 2 1</td><td>5</td><td>4</td></tr> <tr><td>8 4 3 1</td><td>6</td><td>1 2 7 8</td></tr> <tr><td></td><td>7</td><td>2 7</td></tr> <tr><td></td><td>8</td><td>1 3 4 6 9</td></tr> <tr><td></td><td>9</td><td>2 5</td></tr> </tbody> </table> <p>key $3 5 4$ represents 53 seconds for adults and 54 seconds for children</p>	Adults		Children	8 6 5 4 3	4	3	7 4 3 3 2 1	5	4	8 4 3 1	6	1 2 7 8		7	2 7		8	1 3 4 6 9		9	2 5	B1	Single stem and key correct – including adults, children and seconds
Adults		Children																						
8 6 5 4 3	4	3																						
7 4 3 3 2 1	5	4																						
8 4 3 1	6	1 2 7 8																						
	7	2 7																						
	8	1 3 4 6 9																						
	9	2 5																						
		B1	Right hand leaves correct shape																					
		B1	Left hand leaves correct shape																					
(ii)	<p>Two from: Children's estimates more spread out Adults estimates lower Adults are symmetrical whereas children are skewed</p>	B1	oe																					
		B1	oe																					
		2	oe																					
69 (i)	$\text{new mean } \frac{172.6 \times 28 - 161.8}{27} = 173$	M1 A1	Mult by 28, subt 161.8 and dividing by 27 or 28 Correct ans																					
(ii)	$\text{original } \Sigma x^2 = (4.58^2 + 172.6^2) \times 28$ $= 834728.6$ (835000) $\text{Remaining } \Sigma x^2 = 834728.6 - 161.8^2$ $= 808549.36$ $\text{sd of remaining} = \sqrt{\frac{808549.36}{27} - 173^2}$ $= 4.16$	M1 A1 M1 A1	Subst in formula to find Σx^2 and attempt to make Σx^2 subject, with 2 terms both squared Correct answer Subtract 161.8^2 from their original Σx^2 Correct ans, accept 4.15 or 3.93																					

70	$\text{mean} = (5 + (-2) + 12 + 7 + (-3) + 2 + (-6) + 4 + 0 + 8) / 10$ $= 2.7$ $\text{var} = (5^2 + (-2)^2 + \dots + 8^2) / 10 - 2.7^2 = 35.1 - 2.7^2$ $= 27.8$	B1 M1 A1	Subst in correct var formula must have $- \text{mea}^2$ Correct answer
71 (i)	$\text{median A} = 0.52$ $\text{LQ} = 0.41$ $\text{UQ} = 0.79$	B1 B1 B1ft	ft wrong units
(ii)	 	B1 B1 B1	2 correct boxes ft (i) OK if superimposed 2 pairs correct whiskers lines up to box not inside
0		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

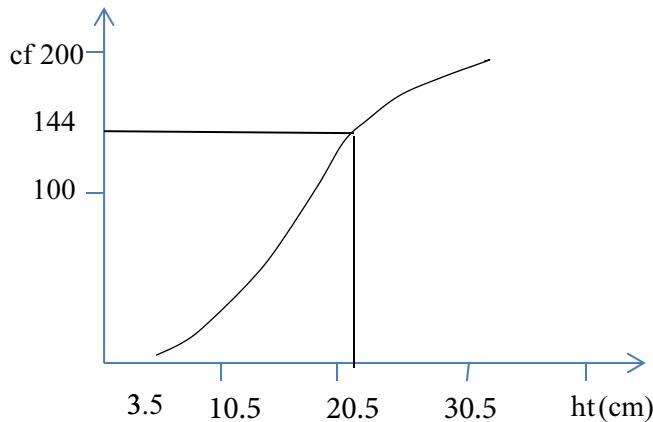
- (iii) Smartphone B is quicker, slightly less variable, etc.

B1

1 oe sensible answer

72 (i)

ht	<10.5	<15.5	<20.5	<25.5	<30.5
CF	2	54	132	172	200



- (ii) 72% less, i.e. 144 less than ht h .
 $h = 22.5 \text{ cm}$

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

$$\text{sd} = 6.01$$

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 single value in range 21 to 23 inclusive

A1 2

Using mid points attempt 7 ± 0.5 in correct var formula incl – mean²

B1

At least 4 correct midpoints

A1 3

Correct ans

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

B1 1

$$\begin{aligned} \text{(ii)} \quad (0.7^2 + 2.4^2 + 2.2^2 + 0.5^2 + 6.3^2 + 4.9^2 + 0.3^2) \\ = 75.13 \quad (75.1) \end{aligned}$$

B1 1

$$\begin{aligned} \text{(iii)} \quad \text{mean} &= 63.4375 \\ \text{Variance} &= 75.13/8 - (11.5/8)^2 \\ &= 7.32 \end{aligned}$$

B1¹

M1

A1 3

ft 62 + their (i)/8
their(ii)/8 – ((i)/8)²
correct answer

$$\begin{aligned} \text{OR mean} &= 507.5/8 = 63.4375 \\ \text{Var} &= 32253/8 - 63.4375^2 = 7.32 \end{aligned}$$

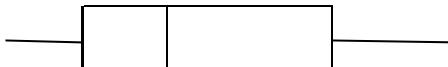
B1

M1

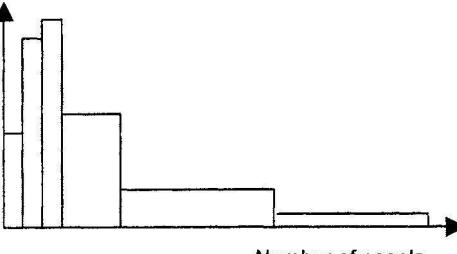
A1

subst in correct variance or standard deviation formula
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

MARKING SCHEMES		TOPIC 1: BASICS QUESTIONS		
74	(i) Stem	26	B1	Correct stem (or reversed order)
	1 4 5 7 8 9 9	B1		Correct leaves, ordered in numerical sequence, with $\frac{1}{2}$ 'column' tolerance
	2 1 2 2 3 4 5 6 6 8 8	B1		
	3 0 2 6 8	B1		
	4 1 2 5 6 7	B1		
	Key 1 4 represents 14 glasses (of water)	3		Key must include 'glasses' or similar drinking item
	(ii) LQ = 20 Med = 26 UQ = 37	B1		Correct median
		B1		Correct quartiles
		B1		Correct on diagram if any wrong med or quartiles.
		B1		Linear scale based upon 3 quartiles plotted
		B1		Correct end points of attached whiskers not through box
		5		Linear axis, label, both must be seen
	SC No values stated	B2		
	3 quartiles on diagram in correct relative positions	B1		
	End points of attached whiskers not through box			
	correct relative to quartiles	B1		

75	$\sum x = 105$ $\sum x^2 = 1439$ mean = 13.1 sd = 2.76	B1	For $\sum x^2 = 1439$
		B1	For answer
		3	For answer

76	(i) Class width 20, 20, 20, 40, 100, 100 Frequency density: 2.3, 5.5, 6.1, 2.5, 0.86, 0.36 	B1	For class widths
		M1	Attempt at frequency density or scaled frequency
		M1	Graph with 6 bars of appropriate relative widths (any height)
		A1	For x-axis going from 0 – 300 properly
		5	All correct including axes labelled
	(ii) $\left(\frac{122 + 110 + 46}{500}\right)^3 = 0.172$	M1	For cubing their probability
		A1	For correct answer

77	both axes correct points median IQ range	B1 M1 A1 B1 ft M1 A1 ft	For correct scales and labels on at least one axis For points at upper bounds or 15.5 or 14.5 All correct and smooth curve or straight lines On mid-points or upper bounds For evaluating their UQ – their LQ For correct answer, ft on correct upper bounds only
----	---	--	--

78(i) $-47.2/30 = -1.573$

OR $\Sigma x - \Sigma 110 = -47.2$ and $\Sigma 110 = 3300$

$$\bar{x} = 110 - 1.573 = 108 (108.4)$$

$$\text{standard deviation} = \sqrt{\frac{5460}{30} - (-1.573)^2}$$

$$= 13.4$$

B1

B1

M1

A1

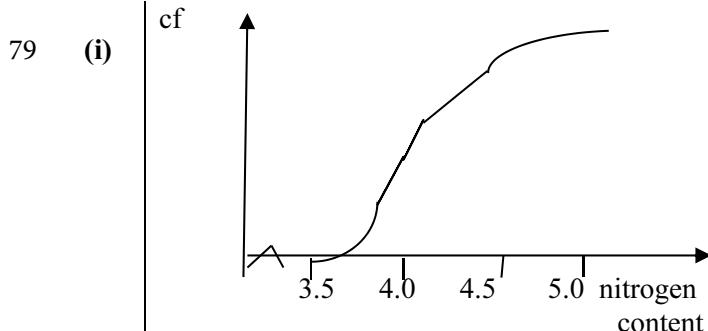
4

For correct answer

$$\text{For } \sqrt{\frac{5460}{30} - (\text{their coded mean})^2}$$

For correct answer

79



B1

M1

A1 [3]

Uniform axes cf and nitrogen content labelled, at least 0 to 70 and 3.5 to 4.8 seen

5 points plotted correctly on graph paper

3.5	3.8	4.0	4.2	4.5	4.8
0	6	18	41	62	70

All points correct and a reasonable curve (condone 1 missed point) or line segments.

(ii)

$$70 - \text{their } 55 = 15 \\ = 21.4\%$$

M1
A1 [2]

Subt a value > 41 from 70 (or $n/70$, $n < 29$)

Correct ans, accept 18.5 – 22

(iii) median = 4.15

B1 [1]

Accept $4.1 < \text{median} < 4.2$, nfww

80

$$\Sigma x - 100n = 216$$

$$2416 - 100n = 216$$

$$n = 22$$

OR

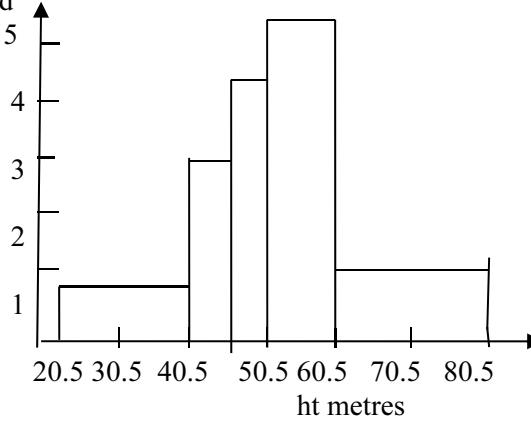
$$\frac{2416}{n} = \frac{216}{n} + 100$$

$$n = 22$$

B1

(ii)	LQ = 91 UQ = 109 IQ range = 18	B1 B1 ^b 2	Both quartiles correct Correct IQR if wrong quartiles, LQ < UQ, not 12 – 4 etc
(iii)	$\Sigma x_{15} = 1399$ $\Sigma x_{16} = 16 \times 93.9 = 1502.4$ New wt = $1502.4 - 1399 = 103$ (103.4)	M1 M1 A1 3	Attempt at Σx_{15} for either team Mult 93.9 by 16 attempt Correct answer

82	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	B1 M1 A1 3 Or B1 M1 A1 3	$\Sigma(t-2.5) = 75$ B0 until $\div 250$ Subst in variance formula both terms coded Correct answer Substituting their Σt^2 from expanded 3-term expression, 250 and 2.8 in variance formula
----	---	--	--

83 (i)	fd 0.9, 3, 4.2, 5.2, 1.4  ht metres	M1 A1 B1 B1 4	Attempt at scaled freq [f/(attempt at cw)] Correct heights seen on diagram Scale no less than 1cm to 1 unit Correct bar widths visually no gaps 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)	$(30.5 \times 18 + 43 \times 15 + 48 \times 21 + 55.5 \times 52 + 70.5 \times 28)/134$ $= \frac{7062}{134} = 52.701$ $Var = (30.5^2 \times 18 + 43^2 \times 15 + 48^2 \times 21 + 55.5^2 \times 52 + 70.5^2 \times 28)/134 - 52.701^2$ $= 392203.5/134 - 52.701^2 = 149.496$ $sd = 12.2$	M1 M1 A1 M1 A1 5	Attempt at unsimplified, mid points (at least 4 within 0.5) Attempt at Σfx their mid points $\div 134$ Correct mean rounding to 53 Attempts at Σfx^2 their mid points \div their $\Sigma f - \text{mean}^2$ Correct answer, nfw