

1. (a) 23, 35.5 (may be in the table) B1 B1 2

- (b) Width of 10 units is 4 cm so width of 5 units is 2 cm B1  
 Height =  $2.6 \times 4 = \underline{10.4 \text{ cm}}$  M1 A1 3

**Note**

M1 for their width  $\times$  their height = 20.8.

Without labels assume width first, height second and award marks accordingly.

- (c)  $\sum fx = 1316.5 \Rightarrow \bar{x} = \frac{1316.5}{56} =$  awrt 23.5 M1 A1

$$\sum fx^2 = 37378.25 \text{ can be implied} \quad \text{B1}$$

$$\text{So } \sigma = \sqrt{\frac{37378.25}{56} - \bar{x}^2} = \text{awrt } \underline{10.7} \quad \text{allow } s = 10.8 \quad \text{M1 A1} \quad 5$$

**Note**

1<sup>st</sup> M1 for reasonable attempt at  $\sum x$  and /56

2<sup>nd</sup> M1 for a method for  $\sigma$  or  $s$ ,  $\sqrt{\quad}$  is required

Typical errors  $\sum (fx)^2 = 354806.3$  M0,  $\sum f^2 x = 13922.5$  M0

and  $(\sum fx)^2 = 1733172$  M0

Correct answers only, award full marks.

- (d)  $Q_2 = (20.5) + \frac{(28-21)}{11} \times 5 = 23.68\dots$  awrt 23.7 or 23.9 M1 A1 2

**Note**

Use of  $\sum f(x - \bar{x})^2 =$  awrt 6428.75 for B1

lcb can be 20, 20.5 or 21, width can be 4 or 5 and the fraction part of the formula correct for M1 – Allow 28.5 in fraction that gives awrt 23.9 for M1A1

- (e)  $Q_3 - Q_2 = 5.6$ ,  $Q_2 - Q_1 = 7.9$  (or  $\bar{x} < Q_2$ ) M1  
 $[7.9 > 5.6 \text{ so } ]$  negative skew A1 2

**Note**

M1 for attempting a test for skewness using quartiles or mean and median.

Provided median greater than 22.55 and less than 29.3 award for M1 for

$Q_3 - Q_2 < Q_2 - Q_1$  without values as a valid reason.

SC Accept mean close to median and no skew oe for M1A1

[14]

2. (a) Median is 33 B1 1

(b)  $Q_1 = 24, Q_3 = 40, \text{IQR} = 16$  B1 B1 B1ft 3

**Note**

1<sup>st</sup> B1 for  $Q_1 = 24$  and 2nd B1 for  $Q_3 = 40$

3<sup>rd</sup> B1ft for their IQR based on their lower and upper quartile.

Calculation of range ( $40 - 7 = 33$ ) is B0B0B0

Answer only of IQR = 16 scores 3/3. For any other answer we must see working in (b) or on stem and leaf diagram

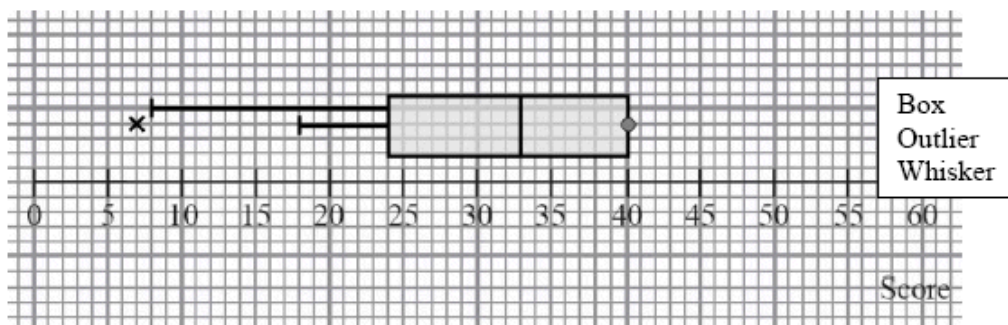
(c)  $Q_1 - \text{IQR} = 24 - 16 = 8$  M1  
So 7 is only outlier A1ft 2

**Note**

M1 for evidence that  $Q_1 - \text{IQR}$  has been attempted, their “8” ( $>7$ ) seen or clearly attempted is sufficient

A1 ft must have seen their “8” and a suitable comment that only one person scored below this.

(d)



B1ftB1B1ft 3

**Note**

1<sup>st</sup> B1ft for a clear box shape and ft their  $Q_1, Q_2$  and  $Q_3$  readable off the scale.

Allow this mark for a box shape even if  $Q_3 = 40$ ,  $Q_1 = 7$  and  $Q_2 = 33$  are used

2<sup>nd</sup> B1 for only one outlier appropriately marked at 7

3<sup>rd</sup> B1ft for either lower whisker. If they choose the whisker to their lower limit for outliers then follow through their “8”.

(There should be no upper whisker unless their  $Q_3 < 40$ , in which case there should be a whisker to 40)

A typical error in (d) is to draw the lower whisker to 7,  
this can only score B1B0B0

[9]

3. (a)  $2.75$  or  $2\frac{3}{4}$ ,  $5.5$  or  $5.50$  or  $5\frac{1}{2}$  B1 B1 2

(b) Mean birth weight =  $\frac{4841}{1500} = 3.227\bar{3}$  awrt 3.23 M1 A1 2

**Note**

M1 for a correct expression for mean. Answer only scores both.

(c) Standard deviation =  $\sqrt{\frac{15889.5}{1500} - \left(\frac{4841}{1500}\right)^2} =$   
0.421093... or  $s = 0.4212337...$  M1 A1ft A1 3

**Note**

M1 for a correct expression (ft their mean) for sd or variance. Condone mis-labelling eg sd=...

with no square root or no labelling

1<sup>st</sup> A1ft for a correct expression (ft their mean) including square root and no mis-labelling

Allow 1<sup>st</sup> A1 for  $\sigma^2 = 0.177... \rightarrow \sigma = 0.42...$

2<sup>nd</sup> A1 for awrt 0.421. Answer only scores 3/3

(d)  $Q_2 = 3.00 + \frac{400}{820} \times 0.5 = 3.2457....$  (allow 403.5.....  
 $\rightarrow 3.25$ ) M1 A1 2

**Note**

M1 for a correct expression (allow 403.5 i.e. use of  $n + 1$ ) but must have 3.00, 820 and 0.5

A1 for awrt 3.25 provided M1 is scored.

NB 3.25 with no working scores 0/2 as some candidates think mode is 3.25.

(e) Mean(3.23) < Median(3.25) (or very close) B1ft  
Negative Skew (or symmetrical) dB1ft 2

**Note**

1<sup>st</sup> B1ft for a comparison of their mean and median (may be in a formula but if  $\pm$  (mean – median) is calculated that's OK. We are not checking

the value but the sign must be consistent.)

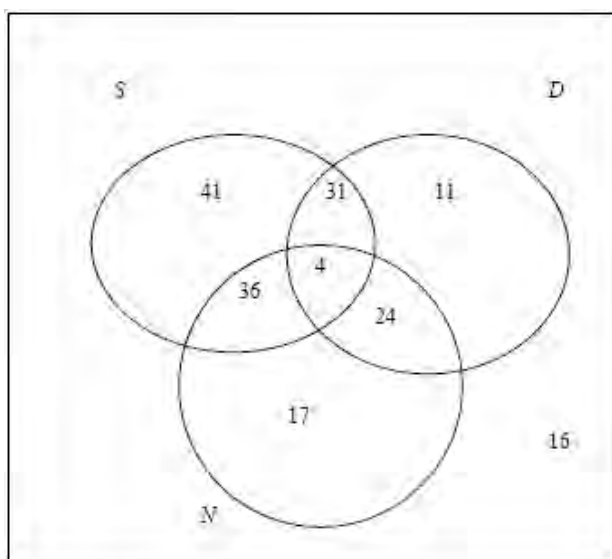
Also allow for use of quartiles provided correct values seen:  $Q_1 = 3.02, Q_3 = 3.47$

[They should get  $(0.22 \Rightarrow) Q_3 - Q_2 < Q_2 - Q_1 (= 0.23)$  and say (slight) negative skew or symmetric]

2<sup>nd</sup> dB1ft for a compatible comment based on their comparison.  
Dependent upon a suitable, correct comparison.  
Mention of “correlation” rather than “skewness” loses this mark.

[11]

4. (a)



3 closed curves and 4 in centre

M1

Evidence of subtraction

M1

31,36,24

A1

41,17,11

A1

Labels on loops, 16 and box

B1 5

### Note

2<sup>nd</sup> M1 There may be evidence of subtraction in “outer” portions, so with 4 in the centre then 35, 40 28 (instead of 31,36,24) along with 33, 9, 3 can score this mark but A0A0

N.B. This is a common error and their “16” becomes 28 but still scores B0 in part (a)

(b)  $P(\text{None of the 3 options}) = \frac{16}{180} = \frac{4}{45}$

B1ft 1

**Note**

B1ft for  $\frac{16}{180}$  or any exact equivalent. Can ft their “16” from their box. If there is no value for their “16” in the box only allow this mark if they have shown some working.

(c)  $P(\text{Networking only}) = \frac{17}{180}$  B1ft 1

**Note**

B1ft ft their “17”. Accept any exact equivalent

(d)  $P(\text{All 3 options/technician}) = \frac{4}{40} = \frac{1}{10}$  M1 A1 2

**Note**

If a probability greater than 1 is found in part (d) score M0A0

M1 for clear sight of  $\frac{P(S \cap D \cap N)}{P(S \cap N)}$  and an attempt at one of the probabilities, ft their values.

Allow  $P(\text{all 3} | S \cap N) = \frac{4}{36}$  or  $\frac{1}{9}$  to score M1 A0.

Allow a correct ft from their diagram to score M1A0 e.g. in 33,3,9 case in (a):  $\frac{4}{44}$  or  $\frac{1}{11}$  is M1A0 A ratio of probabilities with a product of probabilities on top is M0, even with a correct formula.

A1 for  $\frac{4}{40}$  or  $\frac{1}{10}$  or an exact equivalent

Allow  $\frac{4}{40}$  or  $\frac{1}{10}$  to score both marks if this follows from their diagram, otherwise some explanation (method) is required.

**[9]**

5. (a) 1(cm) B1  
cao

(b)  $10 \text{ cm}^2$  represents 15

$10/15 \text{ cm}^2$  represents 1

or  $1 \text{ cm}^2$  represents 1.5

Therefore frequency of 9 is

$$\frac{10}{15} \times 9 \text{ or } \frac{9}{1.5}$$

Require  $\times \frac{2}{3}$  or  $\div 1.5$

M1

height = 6(cm)

A1

**Note**

If 3(a) and 3(b) incorrect, but their

(a)  $\times$  their (b)=6 then award B0M1A0

Alternative method:

$f/cw = 15/6 = 2.5$  represented by 5 so factor  $\times 2$  award M1

So  $f/cw = 9/3 = 3$  represented by  $3 \times 2 = 6$ . Award A1.

[3]

6. (a)  $Q_2 = 17 + \left( \frac{60 - 58}{29} \right) \times 2$

M1

= 17.1 (17.2 if use 60.5)

awrt 17.1 (or 17.2)

A1

2

**Note**

Statement of  $17 + \frac{\text{freq into class}}{\text{class freq}} \times cw$

and attempt to sub or  $\frac{m - 17}{19 - 17} = \frac{60(.5) - 58}{87 - 58}$

or equivalent award M1

$cw = 2$  or  $3$  required for M1.

17.2 from  $cw = 3$  award A0.

(b)  $\sum fx = 2055.5$      $\sum fx^2 = 36500.25$

Exact answers can be seen below or implied by correct answers.

B1 B1

Evidence of attempt to use midpoints with at least one correct

M1

Mean = 17.129...

awrt 17.1

B1

$$\sigma = \sqrt{\frac{36500.25}{120} - \left( \frac{2055.5}{120} \right)^2}$$

M1

= 3.28 ( $s = 3.294$ )

awrt 3.3

A1

6

**Note**

Correct  $\sum fx$  and  $\sum fx^2$  can be seen in working

for both B1s

Midpoints seen in table and used in calculation award M1

Require complete correct formula including use of square root and attempt to sub for M1. No formula stated then numbers as above or follow from (b) for M1

$(\sum fx)^2, \sum (fx)^2$  or  $\sum f^2x$  used instead of  $\sum fx^2$  in sd award M0

Correct answers only with no working award 2/2 and 6/6

- (c)  $\frac{3(17.129 - 17.1379...)}{3.28} = -0.00802$  Accept 0 or  
awrt 0.0 M1 A1  
No skew/ slight skew B1 3

**Note**

Sub in their values into given formula for M1

- (d) The skewness is very small. Possible. B1 B1dep 2

**Note**

No skew / slight skew / 'Distribution is almost symmetrical' / 'Mean approximately equal to median' or equivalent award first B1. Don't award second B1 if this is not the case. Second statement should imply 'Greg's suggestion that a normal distribution is suitable is possible' for second B1 dep.

If B0 awarded for comment in (c).and (d) incorrect, allow follow through from the **comment** in (c).

**[13]**

7. (a)  $Q_2 = 53, Q_1 = 35, Q_3 = 60$  B1, B1, B1 3

**Note**

1<sup>st</sup> B1 for median

2<sup>nd</sup> B1 for lower quartile

3<sup>rd</sup> B1 for upper quartile

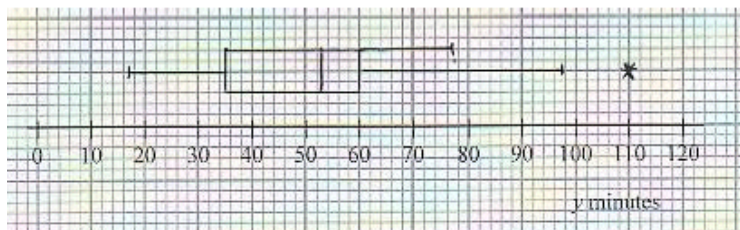
- (b)  $Q_3 - Q_1 = 25 \Rightarrow Q_1 - 1.5 \times 25 = -2.5$  (no outlier) M1  
 $Q_3 + 1.5 \times 25 = 97.5$  (so 110 is an outlier) A1 2

**Note**

M1 for attempt to find one limit

A1 for both limits found and correct. No explicit comment about outliers needed.

(c)



M1  
A1ft  
A1ft 3

**Note**

M1 for a box and two whiskers

1<sup>st</sup> A1ft for correct position of box, median and quartiles. Follow through their values.

2<sup>nd</sup> A1ft for 17 and 77 or “their” 97.5 and \*. If 110 is not an outlier then score A0 here. Penalise no gap between end of whisker and outlier. Must label outlier, needn’t be with \*.

**Accuracy** should be within the correct square so 97 or 98 will do for 97.5

(d)  $\sum y = 461, \sum y^2 = 24219 \therefore S_{yy} = 24219 - \frac{461^2}{10} = 2966.9(*)$  B1, B1,  
B1cso 3

**Note**

1<sup>st</sup> B1 for  $\sum y$  N.B.  $(\sum y)^2 = 212521$  and can imply this mark

2<sup>nd</sup> B1 for  $\sum y^2$  or at least three correct terms of  $\sum (y - \bar{y})^2$  seen.

3<sup>rd</sup> B1 for complete correct expression seen leading to 2966.9. So all 10 terms of  $\sum (y - \bar{y})^2$

(e)  $r = \frac{-18.3}{\sqrt{3463.6 \times 2966.9}}$  or  $\frac{-18.3}{3205.64...} = -0.0057$   
AWRT  $-0.006$  or  $-6 \times 10^{-3}$  M1 A1 2

**Note**

M1 for attempt at correct expression for  $r$ . Can ft their  $S_{yy}$  for M1.



- (f)  $r$  suggests correlation is close to zero so parent's claim is not justified B1 1

**Note**

B1 for comment rejecting parent's claim on basis of weak or zero correlation  
 Typical error is "negative correlation so comment is true" which scores B0  
 Weak negative or weak positive correlation is OK as the basis for their rejection.

**[14]**

8. (a) 8 – 10 hours: width =  $10.5 - 7.5 = 3$  represented by 1.5cm  
 16 – 25 hours: width =  $25.5 - 15.5 = 10$  so represented by 5 cm B1  
 8 – 10 hours: height =  $fd = 18/3 = 6$  represented by 3 cm M1  
 16 – 25 hours: height =  $fd = 15/10 = 1.5$  represented by 0.75 cm A1 3

**Note**

M1 For attempting both frequency densities  
 $\frac{18}{3} (=6)$  and  $\frac{15}{10}$ , and  $\frac{15}{10} \times SF$ , where  $SF \neq 1$  NB Wrong class  
 widths (2 and 9) gives  $\frac{h}{1.66...} = \frac{3}{9} \rightarrow h = \frac{5}{9}$  or 0.55...  
 and scores M1A0

- (b)  $Q_2 = 7.5 + \frac{(52 - 36)}{18} \times 3 = 10.2$   
 $Q_1 = 5.5 + \frac{(26 - 20)}{16} \times 2 [=6.25 \text{ or } 6.3]$  or  $5.5 + \frac{(26.25 - 20)}{16} \times 2 [=6.3]$  A1  
 $Q_3 = 10.5 + \frac{(78 - 54)}{25} \times 5 [=15.3]$  or  $10.5 + \frac{(78.75 - 54)}{25} \times 5 [=15.45 \text{ \textbackslash } 15.5]$  A1  
 $IQR = (15.3 - 6.3) = 9$  A1ft 5

**Note**

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

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

NB:

2<sup>nd</sup> A1 for a correct expression for either  $Q_1$  or  $Q_3$   
 (allow 26.25 and 78.75)

Must see

3<sup>rd</sup> A1 for correct expressions for both  $Q_1$  and  $Q_3$  some

4<sup>th</sup> A1ft for IQR, ft their quartiles. Using  $(n + 1)$  gives 6.28 and 15.45

method

(c)  $\sum fx = 1333.5 \Rightarrow \bar{x} = \frac{1333.5}{104} =$  AWRT 12.8 M1 A1

$\sum fx^2 = 27254 \Rightarrow \sigma_x = \sqrt{\frac{27254}{104} - \bar{x}^2} = \sqrt{262.05 - \bar{x}^2}$  AWRT 9.88 M1 A1 4

**Note**

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

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

(d)  $Q_3 - Q_2 [=5.1] > Q_2 - Q_1 [=3.9]$  or  $Q_2 < \bar{x}$  B1ft dB1 2

**Note**

1<sup>st</sup> B1ft for suitable test, values need not be seen but statement must be compatible with values used. Follow through their values

2<sup>nd</sup> dB1 Dependent upon their test showing positive and for stating positive skew If their test shows negative skew they can score 1<sup>st</sup> B1 but lose the second

(e) So data is positively skew

Use median and IQR, B1  
since data is skewed or not affected by extreme values or outliers B1 2

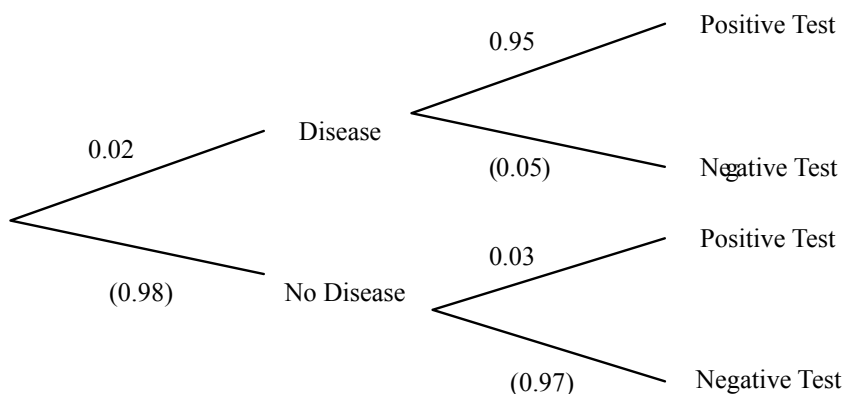
**Note**

1<sup>st</sup> B1 for choosing median and IQR. Must mention both. } Award independently

2<sup>nd</sup> B1 for suitable reason }  
e.g. "use median because data is skewed" scores B0B1 since IQR is not mentioned

**[16]**

9. (a)



Tree without probabilities or labels

0.02 (Disease), 0.95 (Positive) on correct branche

0.03 (Positive) on correct branch

M1: All 6 branches.

Bracketed probabilities not required.

M1

A1

A1

3

(b)  $P(\text{Positive Test}) = 0.02 \times 0.95 + 0.98 \times 0.03$   
 $= 0.0484$

M1A1ft

A1

3

M1 for sum of two products, at least one correct from their diagram

A1ft follows from the probabilities on their tree

A1 for correct answer only or  $\frac{121}{2500}$ 

(c)  $P(\text{Do not have disease} \mid \text{Positive test}) = \frac{0.98 \times 0.03}{0.0484}$   
 $= 0.607438... \quad \text{awrt } 0.607$

M1

A1

2

M1 for conditional probability with numerator following from their tree and denominator their answer to part (b).

A1 also for  $\frac{147}{242}$ .

- (d) Test not very useful OR  
 High probability of not having the disease for a person with a positive test

B1

1

**[9]**

10. (a) 50

B1

1

- (b)  $Q_1 = 45$   
 $Q_2 = 50.5$   
 $Q_3 = 63$
- ONLY      B1  
 B1  
 B1      3

- (c) Mean =  $\frac{1469}{28} = 52.464286..$       awrt 52.5      M1A1
- $Sd = \sqrt{\frac{81213}{28} - \left(\frac{1469}{28}\right)^2}$       M1
- = 12.164.... or 12.387216... for divisor  $n - 1$       awrt 12.2 or 12.4      A1      4

M1 for their 1469 between 1300 and 1600, divided by 28,

A1 for awrt 52.5 ..

Please note this is B1B1 on Epen

M1 use of correct formula including sq root

A1 awrt 12.2 or 12.4

Correct answers with no working award full marks.

- (d)  $\frac{52.46.. - 50}{sd} = \text{awrt } 0.20 \text{ or } 0.21$       M1A1      2

M1 for their values correctly substituted

A1 Accept 0.2 as a special case of awrt 0.20 with 0 missing

- (e) 1. mode/median/mean Balmoral > mode/median/mean Abbey
2. Balmoral sd < Abbey sd or similar sd or correct comment from their values,  
 Balmoral range < Abbey range,  
 Balmoral IQR > Abbey IQR or similar IQR
3. Balmoral positive skew or almost symmetrical AND  
 Abbey negative skew, Balmoral is less skew than Abbey  
 or correct comment from their value in (d)
4. Balmoral residents generally older than Abbey residents  
 or equivalent.
- Only one comment of each type max 3 marks      B1B1B1      3

Technical terms required in correct context in lines 1 to 3

e.g. 'average' and 'spread' B0

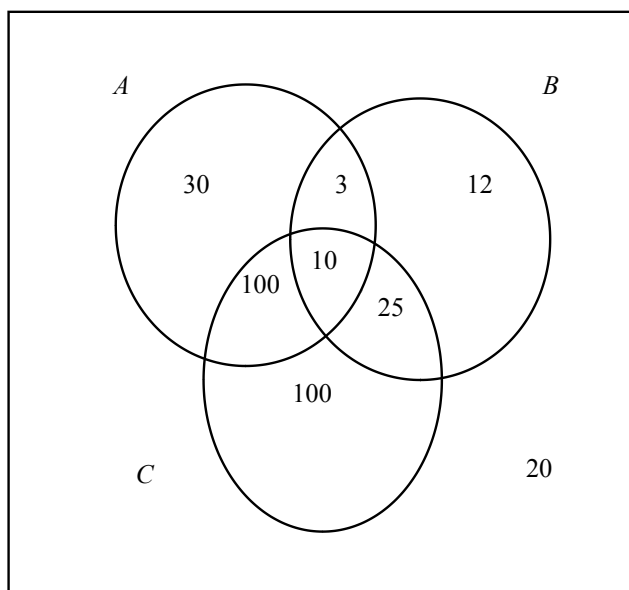
1 correct comment B1B0B0

2 correct comments B1B1B0

3 correct comments B1B1B1

[13]

11. (a)



3 closed intersecting curves with labels

100 100, 30

12, 10, 3, 25

Box

M1

A1

A1

B1 4

20 not required.

Fractions and exact equivalent decimals or percentages.

(b)  $P(\text{Substance } C) = \frac{100+100+10+25}{300} = \frac{235}{300} = \frac{47}{60}$  or exact equivalent M1A1ft 2

M1 For adding their positive values in C and finding a probability

A1ft for correct answer or answer from their working

(c)  $P(\text{All 3} | A) = \frac{10}{30+3+10+100} = \frac{10}{143}$  or exact equivalent M1A1ft 2

M1 their 10 divided by their sum of values in A

A1ft for correct answer or answer from their working

(d)  $P(\text{Universal donor}) = \frac{20}{300} = \frac{1}{15}$  or exact equivalent M1A1cao 2

M1 for 'their 20' divided by 300  
A1 correct answer only

[10]

12. (a) mean is  $\frac{2757}{12}, = 229.75$  AWRT 230 M1, A1  
sd is  $\sqrt{\frac{724961}{12} - (229.75)^2}, = 87.34045$  AWRT 87.3 M1, A1 4  
[Accept  $s = \text{AWRT } 91.2$ ]

1<sup>st</sup> M1 for using  $\frac{\sum x}{n}$  with a credible numerator and  $n = 12$ .

2<sup>nd</sup> M1 for using a correct formula, root required but can fit their mean

Use of  $s = \sqrt{8321.84...} = 91.22...$  is OK for M1 A1 here.

**Answers only from a calculator in (a) can score full marks**

(b) Ordered list is:  
125, 160, 169, 171, 175, 186, 210, 243, 250, 258, 390, 420  
 $Q_2 = \frac{1}{2}(186 + 210) = 198$  B1  
 $Q_1 = \frac{1}{2}(169 + 171) = 170$  B1  
 $Q_3 = \frac{1}{2}(250 + 258) = 254$  B1 3

1<sup>st</sup> B1 for median = 198 only, 2<sup>nd</sup> B1 for lower quartile 3<sup>rd</sup> B1 for upper quartile

**S.C.** If all  $Q_1$  and  $Q_3$  are incorrect but an ordered list (with  $\geq 6$  correctly placed) is seen and used then award B0B1 as a special case for these last two marks.

- (c)  $Q_3 + 1.5(Q_3 - Q_1) = 254 + 1.5(254 - 170) = 380$   
 Accept AWRT (370-392) M1, A1  
 Patients  $F$  (420) and  $B$  (390) are outliers. B1ftB1ft 4
- M1 for a clear attempt using their quartiles in given formula,  
 A1 for any value in the range 370 – 392  
 1<sup>st</sup> B1ft for any one correct decision about  $B$  or  $F$  – ft their  
 limit in range (258, 420)  
 2<sup>nd</sup> B1ft for correct decision about both  $F$  and  $B$  – ft their  
 limit in range (258, 420)  
 If more points are given score B0 here for the second B mark.  
 (Can score M0A0B1B1 here)
- (d)  $\frac{Q_1 - 2Q_2 + Q_3}{Q_3 - Q_1} = \frac{170 - 2 \times 198 + 254}{254 - 170} = 0.3$  AWRT 0.33 M1, A1  
 Positive skew. A1ft 3
- M1 for an attempt to use their figures in the correct formula  
 – must be seen  
 ( $\geq 2$  correct substitutions)  
 1<sup>st</sup> A1 for AWRT 0.33  
 2<sup>nd</sup> A1ft for positive skew. Follow through their value/sign of skewness.  
 Ignore any further calculations.  
 “positive correlation” scores A0

**[14]****13.**

M1

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

$0.5 \times 12$  or 6 A1

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

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

“70 seen anywhere” B1

Number of runners is 12 A1 5

- 1<sup>st</sup> M1 for attempt at width of the correct bar ( $90.5 - 78.5$ )  
[Maybe on histogram or in table]
- 1<sup>st</sup> A1 for  $0.5 \times 12$  or 6 (may be seen on the histogram).  
Must be related to the area of the bar above  $78.5 - 90.5$ .
- 2<sup>nd</sup> M1 for attempting area of correct bar  $\times \frac{140}{\text{their } 70}$
- B1 for 70 seen anywhere in their working
- 2<sup>nd</sup> A1 for correct answer of 12.

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

Beware  $90.5 - 78.5 = 12$  (this scores M1A0M0B0A0)

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

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

[5]

14. (a)  $\frac{1}{2}$  B1 1  
Accept 50% or half or 0.5  
Units not required.
- (b) 54 B1 1  
Correct answers only.  
Units not required.
- (c) + is an 'outlier' or 'extreme value' B1  
Any heavy musical instrument or a statement that the instrument is heavy B1 2  
'Anomaly' only award B0  
Accept '85 kg was heaviest instrument on the trip' or equivalent for second B1.  
Examples of common acceptable instruments; double bass, cello, harp, piano, drums, tuba  
Examples of common unacceptable instruments: violin, viola, trombone, trumpet, French horn, guitar



- (d)  $Q_3 - Q_2 = Q_2 - Q_1$  B1  
 so symmetrical or no skew Dependent – only award if B1 above B1 2  
 ‘Quartiles equidistant from median’ or equivalent award B1 then  
 symmetrical or no skew for B1  
 Alternative:  
 ‘Positive tail is longer than negative tail’ or ‘median closer to  
 lowest value’ or equivalent so slight positive skew.  
 B0 for ‘evenly’ etc. instead of ‘symmetrical’  
 B0 for ‘normal’ only

- (e)  $P(W < 54) = 0.75$  (or  $p(W > 54) = 0.25$ ) or correctly labelled and M1  
 shaded diagram  
 $\frac{54 - 45}{\sigma} = 0.67$  M1B1  
 $\sigma = 13.43 \dots$  A1 4

**Please note that B mark appears first on ePEN**

First line might be missing so first M1 can be implied by second.

Second M1 for standardising with sigma and equating to z value

NB Using 0.7734 should not be awarded second M1

Anything which rounds to 0.67 for B1.

Accept 0.675 if to 3sf obtained by interpolation

Anything that rounds to 13.3. – 13.4 for A1.

[10]

15. (a) Use overlay B2 2  
 Points B2, within 1 small square of correct point, subtract 1 mark  
 each error minimum 0.

- (b)  $S_{xy} = 28750 - \frac{315 \times 620}{8} = 4337.5$  \*\*answer given\*\* so award  
 for method M1  
 $S_{xx} = 15225 - \frac{315^2}{8} = 2821.875$  M1A1 3  
 Anything that rounds to 2820 for A1

- (c)  $b = \frac{4377.5}{S_{xx}} = 1.537 \dots = 1.5$  M1, A1  
 $a = \bar{y} - b\bar{x} = \frac{620}{8} - b \frac{315}{8} = 16.97 \dots = 17.0$  M1, A1 4  
 Anything that rounds to 1.5 and 17.0 (accept 17)

- (d) Use overlay B1ft  
B1ft 2

Follow through for the intercept for first B1.  
Correct slope of straight line for second B1.

- (e) Brand D. B1  
since a long way above / from the line (dependent upon 'Brand D' above) B1  
Using line:  $y = 17 + 35 \times 1.5 = 69.5$  M1A1 4

Anything that rounds to 69p – 71p for final A1.  
Reading from graph is acceptable for M1A1.  
If value read from graph at  $x = 35$  is answer given but out of range,  
then award M1A0.

**[15]**

16. (a) 18-25 group, area =  $7 \times 5 = 35$  B1  
25-40 group, area =  $15 \times 1 = 15$  B1 2

- (b)  $(25 - 20) \times 5 + (40 - 25) \times 1 = 40$  M1A1 2  
 $5 \times 5$  is enough evidence of method for M1.  
Condone 19.5, 20.5 instead of 20 etc.  
Award 2 if 40 seen.

- (c) Mid points are 7.5, 12, 16, 21.5, 32.5 M1  
 $\Sigma f = 100$  B1  
 $\frac{\sum fr}{\sum f} = \frac{1891}{100} = 18.91$  M1A1 4

Look for working for this question in part (d) too.  
Use of some mid-points, at least 3 correct for M1. These may be  
tabulated in (d).

Their  $\frac{\sum fr}{\sum f}$  for M1 and anything that rounds to 18.9 for A1.

(d)  $\sigma_t = \sqrt{\frac{41033}{100} - \bar{t}^2}$   $\sqrt{\frac{n}{n-1} \left( \frac{41033}{100} - \bar{t}^2 \right)}$  alternative OK M1  
 $\sigma_t = \sqrt{52.74...} = 7.26$  M1  
A1 3

Clear attempt at  $\frac{41033}{100} - \bar{t}^2$  or  $\frac{n}{n-1} \left( \frac{41033}{100} - \bar{t}^2 \right)$  alternative

for first M1.

They may use their  $\bar{t}$  and gain the method mark.

Square root of above for second M1

Anything that rounds to 7.3 for A1.

(e)  $Q_2 = 18$  or 18.1 if  $(n + 1)$  used B1  
 $Q_1 = 10 + \frac{15}{16} \times 4 = 13.75$  or 15.25 numerator gives 13.8125 M1A1  
 $Q_3 = 18 + \frac{25}{35} \times 7 = 23$  or 25.75 numerator gives 23.15 A1 4

Clear attempt at either quartile for M1

These will take the form 'their lower limit' + correct fraction  
 $\times$  'their class width'.

Anything that rounds to 13.8 for lower quartile.

23 or anything that rounds to 23.2 dependent upon method used.

(f) 0.376... B1  
Positive skew B1ft 2  
Anything that rounds to 0.38 for B1 or 0.33 for B1 if  $(n + 1)$  used.  
Correct answer or correct statement that follows from their  
value for B1.

[17]

17. (a) Positive skew (both bits) B1 1

(b)  $19.5 + \frac{(60-29)}{43} \times 10 = 26.7093...$  awrt 26.7 M1, A1 2  
(N.B. Use of 60.5 gives 26.825... so allow awrt 26.8)  
M1 for  $(19.5 \text{ or } 20) + \frac{(60-29)}{43} \times 10$  or better.  
Allow 60.5 giving awrt 26.8 for M1A1  
Allow their  $0.5n$  [or  $0.5(n + 1)$ ] instead of 60 [or 60.5] for M1.

(c)  $\mu = \frac{3550}{120} = 29.5833... \text{ or } 29\frac{7}{12}$  awrt **29.6** B1

$\sigma^2 = \frac{138020}{120} - \mu^2$  or  $\sigma = \sqrt{\frac{138020}{120} - \mu^2}$  M1

$\sigma = 16.5829... \text{ or } (s = 16.652...)$  awrt **16.6** (or  $s = 16.7$ ) A1 3

M1 for a correct expression for  $\sigma$ ,  $\sigma^2$ ,  $s$  or  $s^2$ .  
 NB  $\sigma^2 = 274.99$  and  $s^2 = 277.30$   
 Condone poor notation if answer is awrt 16.6 (or 16.7 for  $s$ )

(d)  $\frac{3(29.6 - 26.7)}{16.6}$  M1A1ft

$= 0.52...$  awrt **0.520** (or with  $s$  awrt 0.518) A1 3  
 (N.B. 60.5 in (b) ...awrt 0.499 [or with  $s$  awrt 0.497])

M1 for attempt to use this formula using their values to any accuracy. Condone missing 3.

1<sup>st</sup> A1ft for using their values to at least 3sf Must have the 3.

2<sup>nd</sup> A1 for using accurate enough values to get awrt 0.520  
 (or 0.518 if using  $s$ )  
 NB Using only 3 sf gives 0.524 and scores M1A1A0

(e)  $0.520 > 0$  correct statement about their (d) being  $> 0$  or  $< 0$  B1ft  
 So it is consistent with (a) ft their (d) dB1ft 2

1<sup>st</sup> B1 for saying or implying correct sign for their (d).  
 B1g and B1ft. Ignore "correlation" if seen.

2<sup>nd</sup> B1 for a comment about consistency with their (d) and (a)  
 being positive skew, ft their (d) only  
 This is dependent on 1<sup>st</sup> B1: so if (d)  $> 0$ , they say yes,  
 if (d)  $< 0$  they say no.

(f) Use Median B1  
 Since the data is skewed or less affected by outliers/extreme values dB1ft 2  
 2<sup>nd</sup> B1 is dependent upon choosing median.

(g) If the data are symmetrical or skewness is zero or  
normal/uniform distribution B1 1  
 ("mean = median" or "no outliers" or "evenly distributed" all score B0)

**[14]**

18. (a) Time is a continuous variable or data is in a grouped frequency table B1 1

- (b) Area is proportional to frequency or  $A \propto f$  or  $A = kf$  B1 1  
 1<sup>st</sup> B1 for one of these correct statements.  
 “Area proportional to frequency density” or  
 “Area = frequency” is B0
- (c)  $3.6 \times 2 = 0.8 \times 9$  M1  
 dM1  
 A1cso 3  
 1 child represented by 0.8  
 1<sup>st</sup> M1 for a correct combination of any 2 of the 4 numbers:  
 3.6, 2, 0.8 and 9  
 e.g.  $3.6 \times 2$  or  $\frac{3.6}{0.8}$  or  $\frac{0.8}{2}$  etc BUT e.g.  $\frac{3.6}{2}$  is M0  
 2<sup>nd</sup> M1 dependent on 1<sup>st</sup> M1 and for a correct combination of  
 3 numbers leading to 4<sup>th</sup>.  
 May be in separate stages but must see all 4 numbers  
 A1cso for fully correct solution.  
 Both Ms scored, no false working seen and comment required.
- (d) (Total) =  $\frac{24}{0.8}$ , = **30** M1, A1 2  
 M1 for  $\frac{24}{0.8}$  seen or implied.

[7]

19. (a) Indicates max / median / min / upper quartile / lower quartile (2 or more) B1  
 Indicates outliers (or equivalent description) B1  
 Illustrates skewness (or equivalent description e.g. shape) B1 3  
 Allows comparisons  
 Indicates range / IQR / spread  
*Any 3 rows*
- (b) (i) 37 (minutes) B1  
 (ii) Upper quartile or  $Q_3$  or third quartile or 75<sup>th</sup> percentage or  $P_{75}$  B1 2

(c) outliers

How to calculate correctly

‘Observation that are very different from the other observations  
and need to be treated with caution’

B1

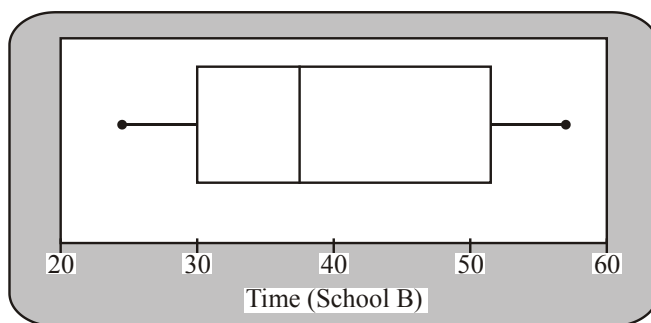
These two children probably walked / took a lot longer

B1

2

Any 2

(d)



Box &amp; median &amp; whiskers

M1

Sensible scale

B1

30, 37, 50

B1

25, 55

B1

4

(e) Children from school A generally took less time

B1

50% of B  $\leq$  37 mins, 75% of A  $<$  37 mins (similarly for 30)

B1

Median / Q1 / Q3 / of A  $<$  median / Q1 / Q3 / of (1 or more)

B1

A has outliers, (B does not)

B1

4

Both positive skew

IQR of A  $<$  IQR of B, range of A  $>$  range of BAny **correct 4 lines****[15]**

20. (a)  $P(\text{both longer than } 24.5) = \frac{11}{55} \times \frac{10}{54} = \frac{1}{27}$  or  $0.\dot{0}3\dot{7}$  or 0.037

2 fracs  $\times$  w / o rep

M1 A1

2

awrt 0.037

- (b) Estimate of mean time spent on their conversation is

$$\bar{x} = \frac{1060}{55} = 19\frac{3}{11} \text{ or } 19.\dot{2}\dot{7} \text{ or } 19.3$$

M1 A1 2

*1060 / total, awrt 19.3 or 19 mins 16s*

(c)  $\frac{1060 + \sum fy}{80} = 21$  B1

$21 \times 80 = 1680$

$$\sum fy = 620$$

M1

*Subtracting 'their 1060'*

$$\therefore \bar{y} = \frac{620}{25} = 24.8$$

M1 A1 4

*Dividing their 620 by 25*

- (d) Increase in mean value
- B1

Length of conversation increased considerably

During 25 weeks relative to 55 weeks B1ft 2

*Context- ft only from **comment** above*

**[10]**

21. (a) Mode is 56 B1 1

(b)  $Q_1 = 35, Q_2 = 52, Q_3 = 60$  B1, B1, B1 3

(c)  $\bar{x} = \frac{1335}{27} = 49.4 \text{ or } 49\frac{4}{9}$  exact or awrt 49.4 B1

$$\sigma^2 = \frac{71801}{27} - \left(\frac{1335}{27}\right)^2 = 214.5432\dots$$

M1 A1ft

$$\sigma = 14.6 \text{ or } 14.9$$

awrt 14.6(5) or 14.9 A1 4

(d)  $\frac{49.4 - 56}{14.6} = -0.448$  awrt range -0.44 to -0.46 M1A1 2

- (e) For negative skew; M1  
 Mean < median < mode A1  
 (49.4 < 52 < 56 not required) 2 compared correctly A1  
 3 compared correctly M1  
 $Q_3 - Q_2 < Q_2 - Q_1$  A1 ft 4  
 8 and 17  
 Accept other valid reason eg.  $3(\text{mean} - \text{median})/\text{sd}$  as alt for M1 A1

**[14]**

22. (a) Distance is a continuous. B1 1  
*continuous*
- (b) F.D = freq/class width  $\Rightarrow$  0.8, 3.8, 5.3, 3.7, 0.75, 0.1  
*or the same multiple of* M1 A1 2
- (c)  $Q_2 = 50.5 + \frac{(67 - 23)}{53} \times 10 = 58.8$  M1 A1  
*awrt 58.8/58.9*  
 $Q_1 = 52.48; Q_3 = 67.12$  A1 A1 4  
*Special case: no working B1 B1 B1 ( $\equiv$  A's on the open)*
- (d)  $\bar{x} = \frac{8379.5}{134} = 62.5335\dots$  B1  
*awrt 62.5*  
 $s = \sqrt{\frac{557489.75}{134} - \left(\frac{8379.5}{134}\right)^2}$  M1 A1 ft  
 $s = 15.8089\dots (S_{n-1} = 15.86825\dots)$  A1 4  
*awrt 15.8 (15.9)*  
*Special case: answer only B1 B1 ( $\equiv$  A's on the open)*

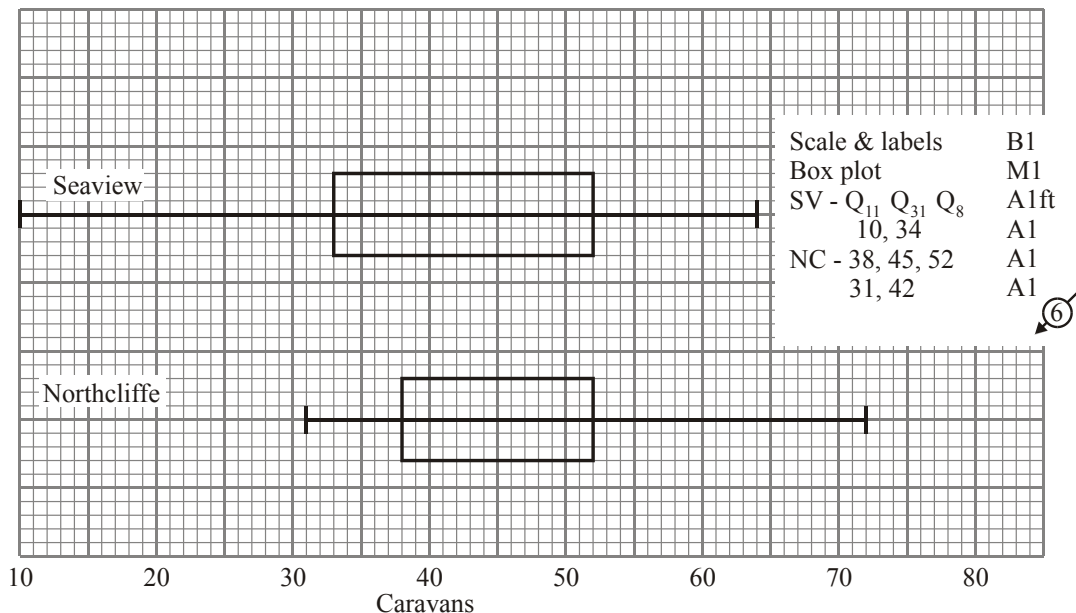


- (e)  $\frac{Q_3 - 2Q_2 + Q_1}{Q_3 - Q_1} = \frac{67.12 - 2 \times 58.8 + 52.48}{67.12 - 52.48}$  M1 A1ft  
*subst their  $Q_1$ ,  $Q_2$  &  $Q_3$  need to show working for A1ft and have reasonable values for quartiles*  
 $= 0.1366 \Rightarrow$  ; +ve skew A1; B1 4  
*awrt 0.14*
- (f) For +ve skew Mean > Median &  $62.53 > 58.80$   
or  $Q_3 - Q_2 (8.32) > Q_2 - Q_1 (6.32)$   
 Therefore +ve skew B1 1
- [16]**
23. (a)  $1.5 (Q_3 - Q_1) = 1.5(28 - 12) = 24$  B1  
*may be implied*  
 $Q_3 + 24 = 52 \Rightarrow 63$  is outlier  
*Att  $Q_3 + \dots$  or  $Q_1 - \dots$ ,  
 52 and -12 or 0 or evidence of no lower outliers* M1  
 A1  
 $Q_1 - 24 < 0 \Rightarrow$  no outliers A1  
*63 is an outlier*  
 M1  
 A1  
 A1 7
- (b) Distribution is +ve skew;  $Q_2 - Q_1 (5) < Q_3 - Q_2 (11)$  B1; B1 2
- (c) Many delays are small so passengers should find these acceptable or sensible comment in the context of the question. B1 1
- [10]**

24. (a)  $Q_1 = 33$ ,  $Q_2 = 41$ ,  $Q_3 = 52$

B1B1B1 3

(b)



- (c) Median of Northcliffe is greater than median of Seaview.  
Upper quartiles are the same  
IQR of Northcliffe is less than IQR of Seaview  
Northcliffe positive skew, Seaview negative skew  
Northcliffe symmetrical, Seaview positive skew (quartiles)  
Range of Seaview greater than range of Northcliffe

B1B1B1 3

*any 3 acceptable comments*

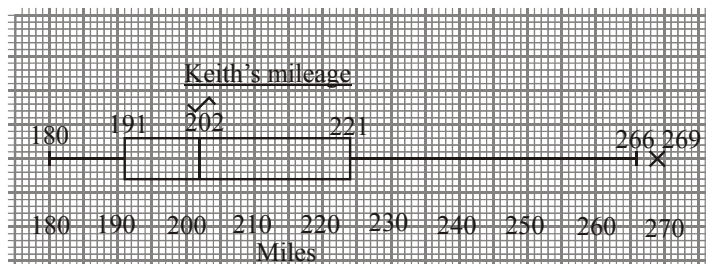
- (d) On 75% of the nights that month  
both had no more than 52 caravans on site.

B1  
B1 2

[14]

25. (a)  $a = 202, b = 202, c = 233$  B1,B1,B1 3

(b)  $Q_1 - 1.5(Q_3 - Q_1) = 191 - 1.5(221 - 191) = 146,$   
 $Q_3 + 1.5(Q_3 - Q_1) = 221 + 1.5(221 - 191) = 266$   
 attempt at one calculation, 146, 266 M1A1A1  
 $\Rightarrow 269$  is an outlier 269 A1dep



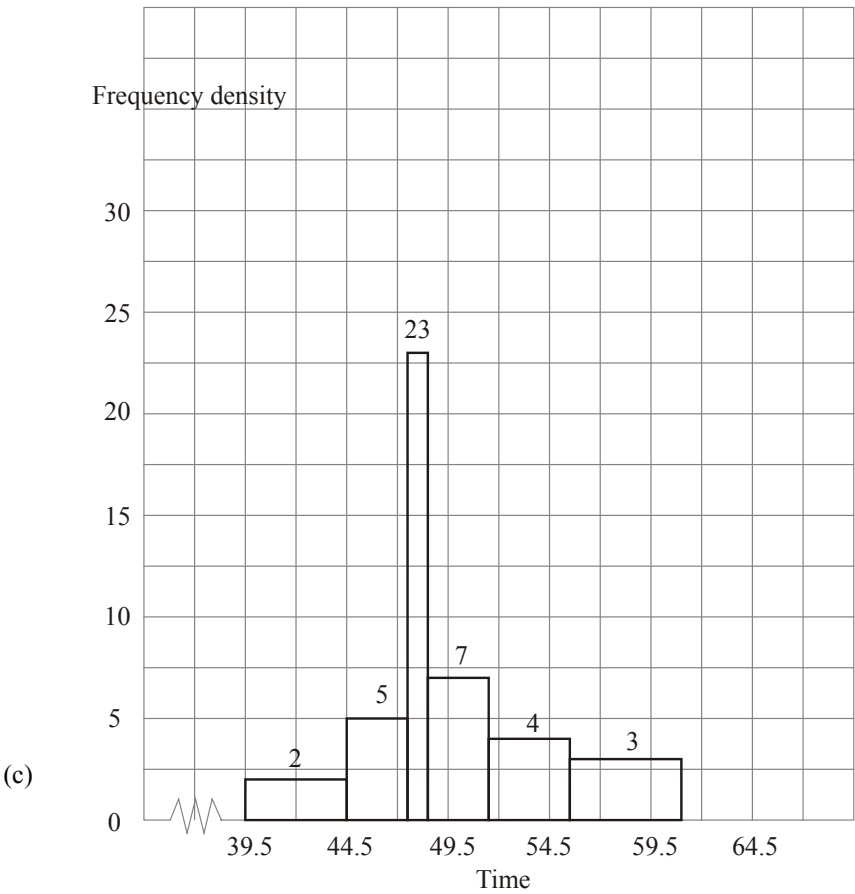
Scale and 'miles' B1  
 Box with two whiskers M1  
 191, their median, 221 A1ft  
 180, 266 or 263, 269 A1 8

(c) Keith:  $Q_2 - Q_1 = 11, Q_3 - Q_2 = 19 \Rightarrow$  positive skew one calc, +ve skew M1,A1  
 Asif:  $Q_2 - Q_1 = 16, Q_3 - Q_2 = 15 \Rightarrow$  almost symm or slight -ve skew A1 3

[14]

26. (a) Time data is a continuous variable B1 1

(b) 39.5, 44.5 both B1 1



Freq / class width (implied)  
Scales and labels  
Histogram, no gaps & their fd  
All correct

M1  
B1  
M1  
A1 4

[6]

27. (a) (i)  $\bar{x} = \frac{270}{16} = \underline{16.875}$  B1

*16.875, 16  $\frac{7}{8}$ ; 16.9; 16.88*

$$\text{s.d.} = \sqrt{\frac{4578}{16} - 16.875^2}$$

$$\frac{\sum x^2}{16} - \bar{x}^2 \text{ \& \text{v}} \quad \text{M1}$$

*All correct* A1 ft

$$= \underline{1.16592\dots}$$

*AWRT 1.17* A1

*SR: No working B1 only*

(ii) Mean % attendance =  $\frac{16.875}{18} \times 100 (= 93.75)$  B1 ft 5

*cao*

(b)

	First 4 1 means 14		Second 1 8 means 18	
(1)	4	1	4 4 4	(3)
(1)	5	1	5 5 5 5	(4)
(3)	6 6 6	1	6 6 6	(3)
(5)	7 7 7 7 7	1	7	(1)
(6)	8 8 8 8 8 8 8	1	8 8 8	(3)
(0)		1	9	(1)
(0)		2	0	(1)

*Both Labels and 1 key* B1

*Back-to-back S and L (ignore totals)* M1

*Sensible splits of 1* dep. M1

*First-correct* A1

*Second - correct* A1 5

(c)	Mode	Median	IQR	
First (F)	18	17	2	B1 B1 B1
Second (S)	15	16	3	B1 B1 B1 6

- (d) Median<sub>S</sub> < Median<sub>F</sub>; Mode<sub>F</sub> > Mode<sub>S</sub>;  
IQR<sub>S</sub> > IQR<sub>F</sub>; Only 1 student attends all  
classes in second; Mean%<sub>F</sub> > Mean%<sub>S</sub>

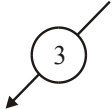
B1 B1 B1 3

Any *THREE* sensible comments

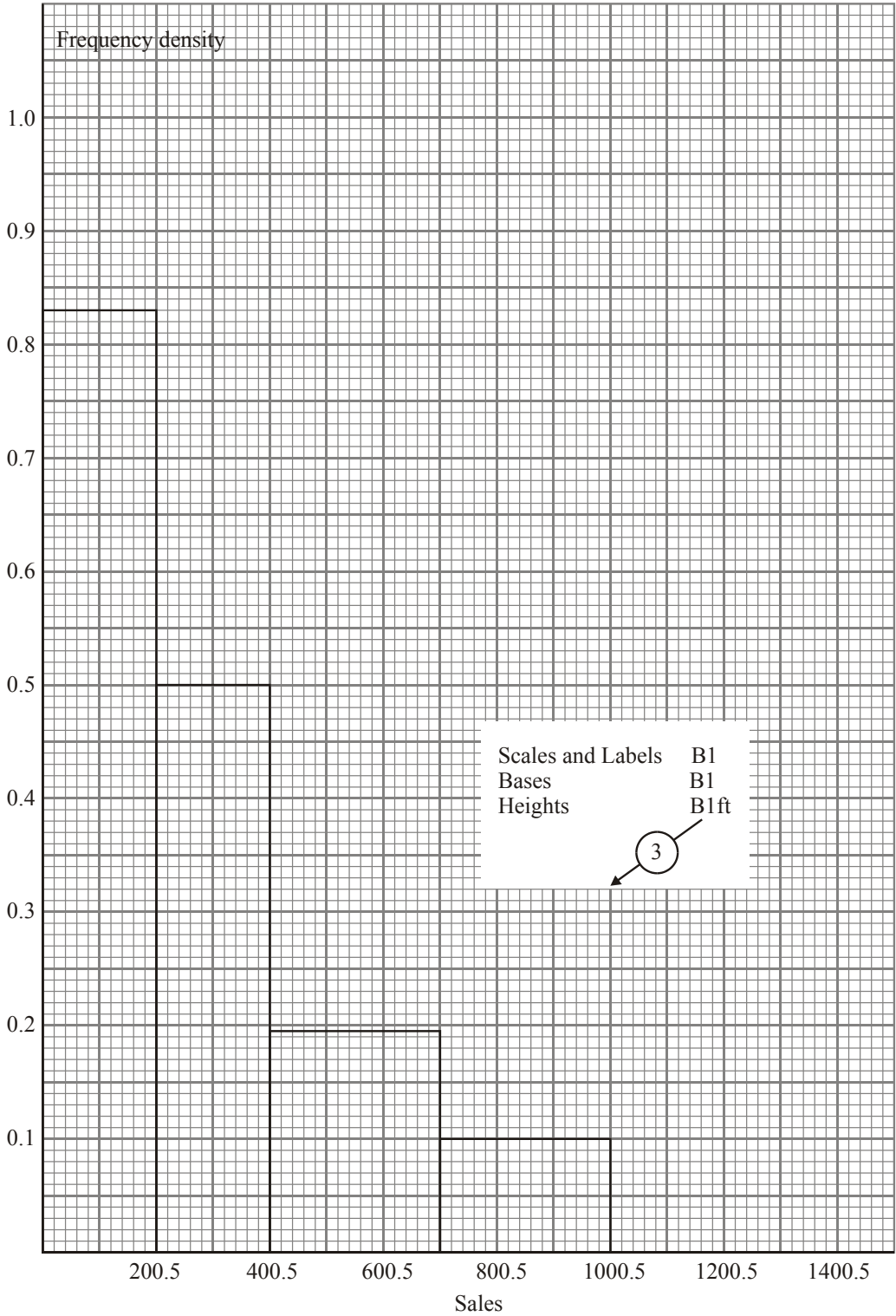
[19]

28. (a)

Sales	No. of days	Class width	Frequency density
1-200	166	200	0.830
201-400	100	200	0.500
401-700	59	300	0.197
701-1000	30	300	0.100
1001-1500	5	500	0.010

Frequency densities M1  
A1 5  
Graph 

NB Frequency densities can be scored on graph



(b)	$Q_2 = 200.5 + \frac{(180 - 166)}{100} \times 200 = \underline{228.5}$	228/229/230	M1 A1	
	$Q_1 = 0.5 + \frac{90}{166} \times 200 = \underline{108.933...}$	109 AWRT	A1	
	$Q_3 = 400.5 + \frac{(270 - 266)}{59} \times 300 = \underline{420.838}$	AWRT 421/425	A1	
	$(n = 270.75 \Rightarrow Q_3 = 424.6525)$			
	$IQR = 420.830... - 108.933... = \underline{311.905}$		B1ft	5
(c)	$\Sigma fx = 110980$ ; $\Sigma fx^2 = 58105890$		M1	
	<i>Attempt at <math>\Sigma fx</math> or <math>\Sigma fy</math></i>			
	$\Sigma fy = 748$ ; $\Sigma fy^2 = 3943.5$ where $y = \frac{x - 100.5}{100}$		M1	
	<i>Attempt at <math>\Sigma fx^2</math> or <math>\Sigma fy^2</math></i>			
	$\mu = 308.277\dot{7}$		M1 A1	6
	<i>308 AWRT</i>			
	$\sigma = 257.6238$			
	<i>258 AWRT</i>			
	No working shown: SR B1 B1 only for $\mu$ , $\sigma$ .			
(d)	Median & IQR		B1	
	Sensible reason e.g. Assuming other years are skewed.		B1 dep	2
				[18]
29.	(a) $\Sigma x = 12075$ ; $\Sigma x^2 = 15\,499\,685$			
	$\therefore \bar{x} = \frac{12075}{15} = \underline{805}$		B1	
	<i>cao</i>			
	$sd = \sqrt{\frac{15499685}{15} - 805^2} = 620.71491$		M1	
	$\sqrt{\quad}$ & correct method			
	3 s.f. 621		A1	3
	(NB Using $n - 1$ gives 642.50125...) (643)			



- (b) 99, 169, 299, 350, 475, 485, 550, 650, 689, 830,  
999, 1015, 1050, 2100, 2315

M1

*Attempt to order*

$$\therefore Q_2 = \underline{650}$$

A1

*cao 650*

$$\therefore IQR = Q_3 - Q_1 = 1015 - 350 = \underline{665}$$

*Attempt at  $Q_3 - Q_1$* 

M1

*cao 665*

A1

4

- (c)  $Q_3 + 1.5(Q_3 - Q_1) = 1015 + 1.5 \times 665 = 2012.5$

M1

*Use of given outlier formula*

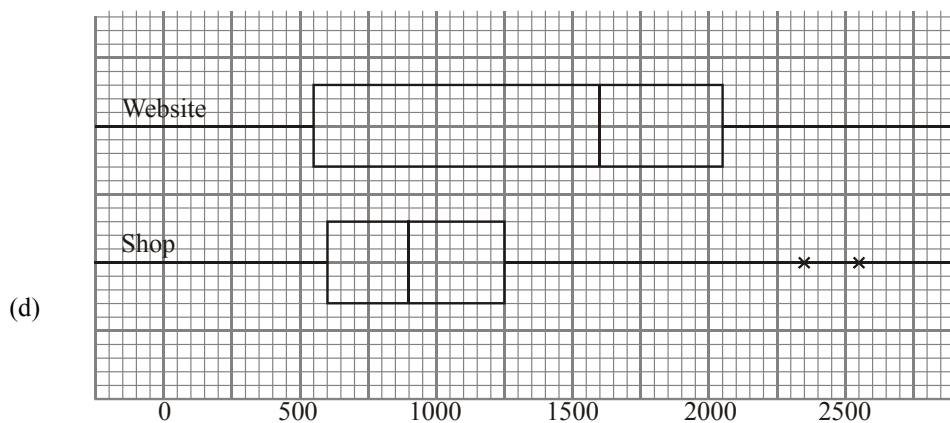
$$Q_1 - 1.5(Q_3 - Q_1) = 350 - 1.5 \times 665 < 0$$

M1

*Evidence both ends considered* $\therefore$  2100 and 2315 are outliers

A1

3



Two boxplots  
same scale  
both labelled

B1

Website

B1

Shop Box-plot

B1

Both outliers

B1

4

NB: For shop, right hand whisker drawn to 2012.5 is acceptable.

- (e) Median website > median shop  
 Website negative skew; shop approx symmetrical  
 Ignoring outliers  
 Ranges approximately equal  
 Shop  $Q_3 < \text{Website } Q_3 \Rightarrow$  shop sales low value  
 Website sales more variable in value  
 $IQR_W \geq IQR_S$

*Any two sensible comments*

B1 B1

2

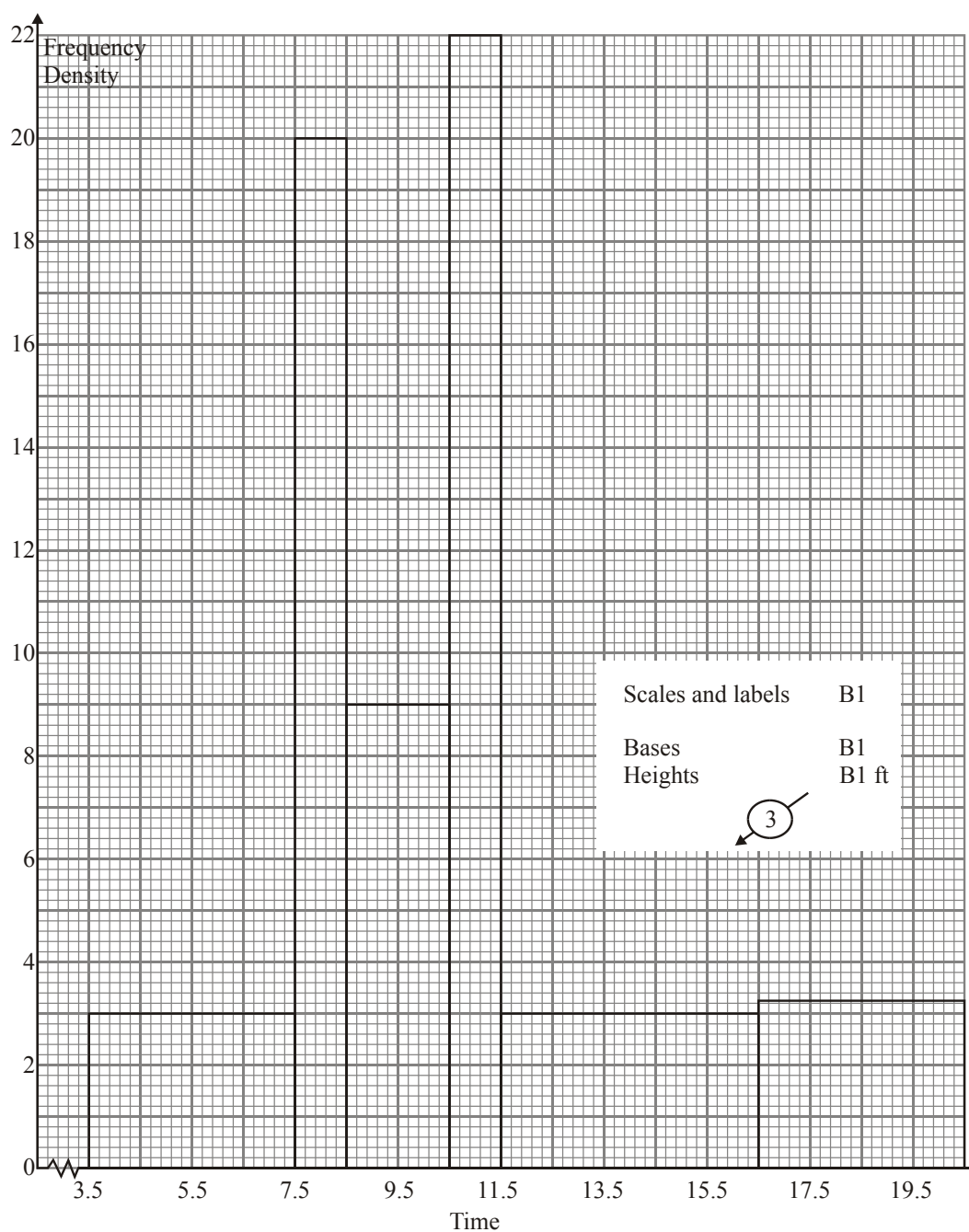
**[16]**

30. Frequency densities: 3.0, 20.0, 9.0, 22.0, 3.0, 3.25

*Can be implied  
from graph*

M1

A1



[5]

31. (a)  $\bar{x} = \frac{20+15+\dots+17}{14} = \frac{312}{14} = 22.2857\dots$  (awrt 22.3)

M1 A1 2

(b)

Bags of crisps	1/0 means 10	Total
0	5	(1)
1	0 1 3 5 7	(5)
2	0 0 5	(3)
3	0 1 3	(3)
4	0 2	(2)

Label & key  
2 correct rows  
All correct

B1  
B1  
B1 3

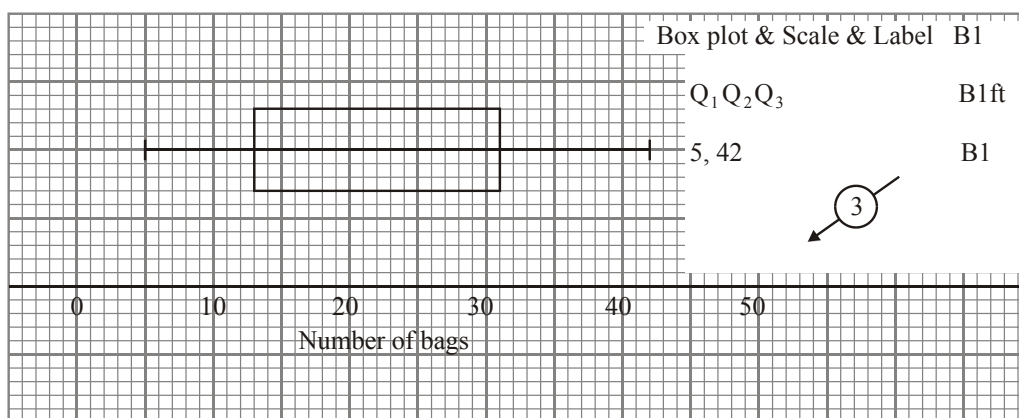
(c)  $Q_2 = 20$ ;  $Q_1 = 13$ ;  $Q_3 = 31$

B1; B1; B1 3

(d)  $1.5 \times \text{IQR} = 1.5 \times (31 - 13) = 27$  (can be implied)  
 $31 + 27 = 58$ ;  $13 - 27 = -14$  (both)  
 No outliers

B1  
M1  
A1 3

(e)



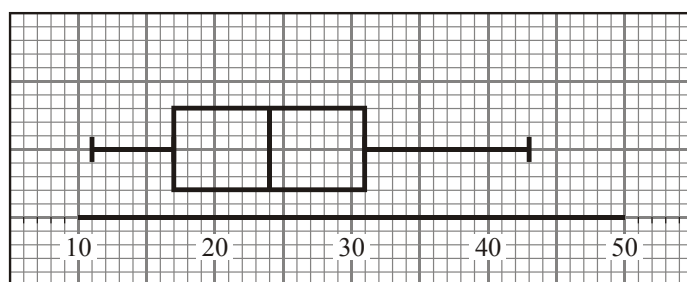
(f)  $Q_2 - Q_1 = 7$ ;  $Q_3 - Q_2 = 11$ ;  $Q_3 - Q_2 > Q_2 - Q_1$   
 Positive skew

M1  
A1 2

**[13]**

32. Frequency densities: 0.16, 1.0, 1.0, 0.4, 0.4, 0.08 M1, A1  
 Histogram: Scale and labels B1  
 Correct histogram B1 [4]
33. (a)  $Q_2 = \frac{16+16}{2} = 16$ ;  $Q_1 = 15$ ;  $Q_3 = 16.5$ ; IQR = 1.5 M1 A1; B1; B1; B1 5
- (b)  $1.5 \times \text{IQR} = 1.5 \times 1.5 = 2.25$  M1 A1  
 $Q_1 - 1.5 \times \text{IQR} = 12.75 \Rightarrow$  no outliers below  $Q_1$  A1  
 $Q_3 + 1.5 \times \text{IQR} = 18.75 \Rightarrow 25$  is an outlier A1  
 Boxplot, label scale M1  
 14, 15, 16, 16.5, 18.75 (18) A1  
 Outlier A1 7
- (c)  $\bar{x} = \frac{322}{20} = 16.1$  M1 A1 2
- (d) Almost symmetrical/slight negative skew B1  
 Mean (16.1)  $\approx$  Median (16) and  $Q_3 - Q_2$  (0.5)  $\approx$   $Q_2 - Q_1$  (1.0) B1 2 [16]
34. (a) Mode = 23 B1 1
- For  $Q_1$ :  $\frac{n}{4} = 10.5 \Rightarrow$  11th observation  $\therefore Q_1 = 17$  B1
- For  $Q_2$ :  $\frac{n}{2} = 21 \Rightarrow = \frac{1}{2}$  (21st & 22nd) observations
- $\therefore Q_2 = \frac{23+24}{2} = 23.5$  M1 A1
- For  $Q_3$ :  $\frac{3n}{4} = 31.5 \Rightarrow$  32nd observation  $\therefore Q_3 = 31$  B1 4

(c)



Box plot

M1

Scale &amp; label

M1

 $Q_1, Q_2, Q_3$ 

A1

11, 43

A1 4

(d) From box plot or

M1

$$Q_2 - Q_1 = 23.5 - 17 = 6.5$$

$$Q_3 - Q_2 = 31 - 23.5 = 7.5 \text{ (slight) positive skew}$$

B1 1

(e) Back-to-back stem and leaf diagram

B1 1

**[11]**

35. (a)  $\bar{y} = \frac{-467}{200}$  (can be implied)

B1

$$\therefore \bar{x} = 2.5\bar{y} + 755.0$$

M1

$$= 2.5 \left( \frac{-467}{200} \right) + 755.0$$

A1

$$= 749.1625$$

(accept awrt 749)

A1

$$S_y = \sqrt{\frac{9179}{200} - \left( \frac{-467}{200} \right)^2}$$

M1 A1

$$= 6.35946$$

A1

$$\therefore S_x = 2.5 \times 6.35946$$

M1

$$= 15.89865 \text{ (accept awrt 15.9)}$$

A1 9

(b) Standard deviation  $< \frac{2}{3}$  (interquartile range)

B1

Suggest using standard deviation since it shows less variation  
in the lifetimes

B1 2

**[11]**