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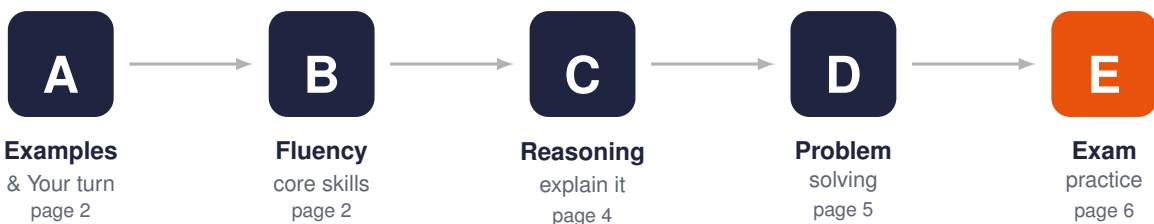
A-LEVEL MATHEMATICS • STATISTICS 1

Location and Spread

Worked Solutions

Pearson Edexcel International A Level (WST01) & A Level (9MA0) • Calculator and statistical tables allowed: show every step

Full worked solutions for the free Measures of Spread and Location worksheet, A-Level and International A-Level Maths



Tap a section to jump straight to it

Full worked solutions for every question on the Statistics 1 Measures of Spread and Location worksheet, in the same order and with the same question numbers.

How to mark your work. Tick each step you got right, not just the final answer. At A-level most marks are for method, so a wrong final answer can still earn most of the marks. If you lost marks, find the *first* line where your working is different from ours. That is the thing to fix.

In Section E: **M** = method mark, **dM** = method mark that depends on the previous M mark, **A** = accuracy mark (needs the M mark before it), **B** = independent mark.

Question sheet

Exam questions by topic

Statistics 1 exam questions

More worksheets



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A**Your turn answers**

Compare each line of your working with the solution.

CORE

A1 $n = 25$, $\sum fx = 68$; the median is the 13th value (cumulative 4, 10, 19): **mean 2.72, median 3, mode 3**

A2 20th value, in 25–30 (17 below): $25 + \frac{20 - 17}{15} \times 5$: **26.0 g**

A3 $\bar{x} = 12.5$; $\sigma^2 = \frac{1983}{12} - 12.5^2 = 165.25 - 156.25 = 9$: **mean 12.5, sd 3**

STRETCH

A4 $\sum fx = 59$, $\sum fx^2 = 187$: $\sigma^2 = 9.35 - 2.95^2 = 0.6475$: **mean 2.95, sd 0.805**

A5 $x = 10y + 200$: $\bar{x} = 10(-1.5) + 200$, $\sigma_x = 10(0.7)$: **$\bar{x} = 185$, $\sigma_x = 7$**

A6 $\sum x = 160 + 300 = 460$; $\sum x^2 = 8(16 + 400) + 12(9 + 625) = 3328 + 7608 = 10936$
 $\sigma^2 = \frac{10936}{20} - 23^2 = 17.8$: **mean 23, sd 4.22**

A7 P_{10} (4th): $10 + \frac{4}{5} \times 10 = 18$; P_{90} (36th): $30 + \frac{4}{8} \times 10 = 35$: **17 g**

B**Fluency solutions**

One mark for each correct part. The notes in italics explain why each sequence was chosen.

CORE

B1 (a) $\frac{63}{7}$: **9** (b) **9** (c) **7** (d) $\frac{63+21}{8}$: **10.5**

One large value moves the mean but would not move the median far.

B2 (a) $\frac{15}{4} = 3.75$, so the 4th value: **6** (b) 8th value: **8** (c) 11.25, so the 12th: **12** (d) **6**

Discrete rule: if $\frac{n}{4}$ is not whole, round up.

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B3 (a) 20th: $160 + \frac{5}{15} \times 5$: **161.7 cm** (b) 10th: $155 + \frac{6}{11} \times 5$: **157.7 cm**
 (c) 30th: $165 + 0$: **165 cm** (d) **7.27 cm**

Lower class boundary + (values needed $\div$ class frequency) $\times$ class width.

B4 (a) $\sqrt{152.5 - 144}$: **2.92** (b) $\sqrt{160.25 - 156.25}$: **2** (c) $\sqrt{\frac{90}{10}}$: **3** (d) $\sqrt{44 - 36}$: **2.83**

Every route gives the variance first; the sd is its square root.

B5 (a) $\frac{21}{20}$: **1.05** (b) $\sum fx^2 = 39$: $\sqrt{1.95 - 1.05^2}$: **0.921** (c) **1**

Use $\sum fx$ and $\sum fx^2$, both divided by $\sum f = 20$

B6 (a) **mean 103.2, sd 1.5** (b) **mean 45, sd 8**
 (c) $\bar{y} = 2$, $\sigma_y^2 = 18 - 4 = 14$: **mean 34, sd $2\sqrt{14} \approx 7.48$** (d) **mean 25, sd 6**

Adding or subtracting moves the mean only; multiplying or dividing scales both.

STRETCH

B7 (a) $\frac{830}{40}$: **20.75** (b) $\sqrt{\frac{20800}{40} - 20.75^2}$: **9.46** (c) 20th value, top of 10–20: **20.0**
 (d) mean $>$ median: **slight positive skew**

Grouped estimates use the class midpoints 5, 15, 25, 35

B8 (a) $\frac{480 + 360}{20}$: **42** (b) $\frac{250 - 30}{9}$: **24.4** (c) $\frac{800 - 25 + 52}{20}$: **41.35**

(d) $\sum x^2 = 33\,000 - 625 + 2704 = 35\,079$: $\sqrt{\frac{35\,079}{20} - 41.35^2}$: **6.64**

Change the totals $\sum x$ and $\sum x^2$, then recalculate.

B9 (a) 4th: $0 + \frac{4}{5} \times 10$: **8** (b) 36th: $30 + \frac{4}{8} \times 10$: **35** (c) **27**

(d) $Q_1 = 10 + \frac{5}{15} \times 10 \approx 13.3$, $Q_3 = 20 + \frac{10}{12} \times 10 \approx 28.3$: **15**

The 10th percentile is the $\frac{10}{100} \times 40 = 4$ th value.



B10 (a) $\bar{y} = 1.2$, $\sigma_y^2 = \frac{136}{25} - 1.44 = 4$; $\bar{x} = 4(1.2) + 60$, $\sigma_x = 4(2)$: **mean 64.8, sd 8**

(b) 25×64.8 : **1620** (c) $25(64 + 64.8^2)$: **106576** (d) $\sqrt{\frac{25 \times 64}{26}}$: **7.84**

A value equal to the mean adds nothing to $\sum(x - \bar{x})^2$ but increases n

C

Reasoning solutions

Your wording can be different. Check that your reason makes the same point.

CORE

C1 4 is the variance: $\frac{400}{10} - 6^2 = 4$. The sd is its square root: **2**

C2 15 is just the class midpoint and ignores where the 20th value lies in the class. Use interpolation: $10 + \frac{12}{14} \times 10 =$ **18.6 minutes**

C3 Subtracting 4 moves every value but not the spread: the sd is unchanged. **mean 14, sd 5**

C4 She subtracted the mean, not the mean squared: $\sigma^2 = \frac{8180}{20} - 20^2 = 409 - 400 = 9$: **sd 3**

STRETCH

C5 The mean stays 30, but n grows while $\sum(x - \bar{x})^2 = 360$ does not: the sd decreases.

$\sqrt{\frac{360}{11}}$: **5.72**; Eli is wrong about the sd.

C6 The 20 is added to each of the 50 values: $\sum w = 10\sum y + 20n$

$10(104) + 20(50)$: **$\sum w = 2040$, mean 40.8**

C7 "More accurate" is not a valid reason; the mean is affected by the extreme value.

Use the median with the IQR: they are not affected by the extreme value.



C8 (a) $\sum(x - \bar{x})^2 = \sum x^2 - 2\bar{x}\sum x + n\bar{x}^2 = \sum x^2 - 2n\bar{x}^2 + n\bar{x}^2 = \boxed{\sum x^2 - n\bar{x}^2}$

(b) Adding k : each $x - \bar{x}$ is unchanged, so **the variance is unchanged**.

Multiplying by k : each $x - \bar{x}$ becomes $k(x - \bar{x})$, so **the variance is multiplied by k^2**

D**Problem solving solutions**

There is often more than one correct method. Any complete, correct method scores full marks.

CORE

D1 (a) $\frac{18(24.5) + 12b}{30} = 26$, so $441 + 12b = 780$, $b = \frac{339}{12}$: **$b = 28.25$**

(b) The total increases by 12 minutes: **the mean increases by 0.4 minutes**

D2 (a) 40th value, in 5–10 (38 below): $5 + \frac{2}{24} \times 5$: **5.42 minutes**

(b) Q_1 (20th): $2 + \frac{8}{26} \times 3 \approx 2.923$; Q_3 (60th): $5 + \frac{22}{24} \times 5 \approx 9.583$: **6.66 minutes**

D3 (a) The total without the leaf a is 895, so $30 + a = 37$: **$a = 7$**

(b) Median: 11th value: **42**; Q_1 6th = 33, Q_3 16th = 50: **IQR 17**

D4 (a) **mode 44**; $\bar{x} = \frac{1150}{25} = \mathbf{46}$; $\sigma = \sqrt{\frac{54200}{25} - 46^2} = \sqrt{52} = \mathbf{7.21}$

(b) $\frac{46 - 44}{7.21} \approx 0.277$: **positive skew**

STRETCH

D5 (a) $n = 23$: 6th, 12th and 18th values: **$Q_1 = 24, Q_2 = 30, Q_3 = 36$**

(b) $36 + 1.5(12) = 54$ and $24 - 18 = 6$: only 68 is above 54, nothing is below 6: **68 is the only outlier**

D6 (a) The total rises by 2×18.2 and n by 2: **the mean is unchanged**

(b) $\sum(x - \bar{x})^2 = 30 \times 4.1^2 = 504.3$ is unchanged and n increases: **it decreases**; $\sqrt{\frac{504.3}{32}} = \mathbf{3.97}$



D7 (a) $\sum y = 50(15.2) - 20(14) = 760 - 280$: **480**

(b) $\sum x^2 = 20(9 + 196) = 4100$; all 50: $50(3.5^2 + 15.2^2) = 12\,164.5$: **$\sum y^2 = 8064.5$**

$\bar{y} = 16$: $\sqrt{\frac{8064.5}{30} - 16^2} =$ **3.58**

D8 (a) $y = -2, -1, 0, 1, 2$: $\sum fy = -18$, $\sum fy^2 = 78$; $\bar{y} = -0.3$, $\sigma_y = \sqrt{1.3 - 0.09} = 1.1$

$\bar{x} = 10\bar{y} + 25$, $\sigma_x = 10\sigma_y$: **mean 22 g, sd 11 g**

(b) 30th, in 20–30 (28 below): $20 + \frac{2}{18} \times 10$: **21.1 g** (c) mean > median: **positive skew**

E**Exam practice solutions**

Mark-scheme notes are shown on the right of each line.

CORE

Exam questions for everyone

E1 (a) 12 in a bar 10 wide: 1.2 people per minute; heights give 24, 18, 14 in 20–30, 30–40, 40–60

$\frac{5}{10}(24) + 18 + \frac{10}{20}(14) = 12 + 18 + 7$: **37 employees**

(b) 40th value, in 20–30 (18 below): $20 + \frac{22}{24} \times 10$

29.2 minutes

(c) Q_1 (20th): $20 + \frac{2}{24} \times 10 \approx 20.8$; Q_3 (60th): $30 + \frac{18}{18} \times 10 = 40$

IQR 19.2 minutes

(d) mean 32 > median 29.2: **positive skew**

(e) $\sigma = \sqrt{\frac{104\,300}{80} - 32^2} = \sqrt{279.75}$

16.7 minutes

M1

A1

M1

A1

M1 A1

A1

B1

M1

A1



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- E2** (a) $n = 25$: 13th value **35**; 7th = 26 and 19th = 46: **IQR 20** B1 B1
- (b) $\bar{x} = 36.6$; $\sigma = \sqrt{\frac{37993}{25} - 36.6^2} = \sqrt{180.16}$ M1
- 13.4 seconds (3 s.f.)** A1*
- (c) $46 + 1.5(20) = 76$ and $26 - 30 = -4$ M1
- the smallest value 14 and the largest 63 lie between them: **no outliers** A1
- (d) $\frac{915 + 15 \times 40.2}{40} = \frac{1518}{40}$ M1
- 37.95 seconds** A1
- (e) second group: $\sum x^2 = 15(9.5^2 + 40.2^2) = 25594.35$; all 40: $37993 + 25594.35 = 63587.35$ M1 M1
- $\sqrt{\frac{63587.35}{40} - 37.95^2}$: **12.2 seconds** A1

STRETCH

- E3** (a) $n = 15$: 4th, 8th and 12th values: **$Q_1 = 27, Q_2 = 31, Q_3 = 41$** B1 B1
- (b) $41 + 1.5(14) = 62$ and $27 - 21 = 6$ M1
- only 71 is above 62, nothing below 6: **71 is the only outlier** A1
- (c) $\frac{41 - 62 + 27}{14} = \frac{6}{14} \approx 0.429$ M1
- positive skew** A1
- (d) Median: $B\ 33 > A\ 31$, so B took longer on average; IQR: $A\ 14 > B\ 8$, so A 's times were more varied B1
- A has an outlier and is skewed: **the median and IQR are not affected by the extreme value** B1
- (e) $\bar{x} = \frac{523}{15}$: **34.9 minutes** B1
- $\sigma = \sqrt{\frac{20541}{15} - \left(\frac{523}{15}\right)^2}$ M1
- 12.4 minutes** A1
- (f) $\frac{523 - 71 + 17}{15} = \frac{469}{15}$: **31.3 minutes** B1
- 17 is still below the median and the 8th value is still 31: **the median is unchanged** B1

