A-LEVEL MATHS (EDEXCEL 9MA0) · STATISTICS YEAR 1 · CHAPTER 2: MEASURES OF LOCATION AND SPREAD · A* EXAM PRACTICE

Hints online, answers free with an account:
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Measures of location and spread: A* questions

77 marks

Date

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X A* exam questions

A to A*

Extended Edexcel-style questions. Show every step. The hints are at the end of the sheet. Use one at a time.

X1 A data set of n values has mean μ and variance σ^2. Show that if k further values, each equal to μ, are added, the variance of the $n+k$ values is $\dfrac{n\sigma^2}{n+k}$. A data set of n values has variance 26. When one value equal to its mean is added, the variance becomes 24. Find n, and find the least number of values equal to the mean that must be added to the original n values so that the variance is less than half of 26. [9 marks]

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X2 Machine A fills 40 bags with mean mass 502 g and standard deviation 4 g. Machine B fills 60 bags with mean mass 497 g and standard deviation 3 g.

(a) Find the mean and the standard deviation of the masses of all 100 bags. [6 marks]

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(b) It is found that 5 of the bags from machine B were faulty. These 5 bags had mean mass 489 g and standard deviation 2 g. They are removed. Find the mean and the standard deviation of the masses of the remaining 95 bags. [5 marks]

(c) Explain, without further calculation, why removing the faulty bags reduced the standard deviation. [2 marks]

Total for X2: 13 marks

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X3 The table shows the values of x for some observations. The number of observations is not given. Using midpoints, the estimated mean is 22.75. Using linear interpolation, the median is 23, and it lies in the class $20 \leqslant x < 30$. Find p and q. [9 marks]

Value, x	Frequency
$0 \leq x < 10$	4
$10 \leq x < 20$	p
$20 \leq x < 30$	q
$30 \leq x < 50$	6

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X4 The masses, x grams, of 40 bags of flour are coded using $y = \dfrac{x - 1000}{5}$, giving $\sum y = 52$ and $\sum y^2 = 300$.

(a) Find the mean and the standard deviation of x. [4 marks]

(b) A second analyst codes the same masses using $z = \dfrac{x - 1010}{2}$. Show that $z = 2.5y - 5$. [2 marks]

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(c) Hence find $\sum z$ and $\sum z^2$ without finding $\sum x$ or $\sum x^2$. [4 marks]

(d) A bag of mass 1040 g is added. Show that this mass is more than 2 standard deviations above the mean, and state the effect on the standard deviation. [3 marks]

Total for X4: 13 marks

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X5 A group of n students has mean test mark 60 and standard deviation 10. Eight more students, each with a mark of 75, join the group. The mean mark of the whole group is now 63. Find n and the standard deviation of the marks of the whole group. [8 marks]

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X6 Six observations are $3, 7, 8, 12, 15$ and x.

(a) Show that the variance of the six observations is $\dfrac{5x^2 - 90x + 921}{36}$. [4 marks]

(b) Find the value of x that makes the standard deviation as small as possible, and find this least standard deviation. [3 marks]

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(c) Find the set of values of x for which the standard deviation is less than 4.5. [4 marks]

(d) Explain why the value of x in (b) equals the mean of the other five observations. [2 marks]

Total for X6: 13 marks

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X7 The daily rainfall, r mm, at a weather station on 120 days on which rain fell is shown in the table. (These values are for this question only; they are not taken from the large data set.) The first class counts the days recorded as "tr" (trace, less than 0.05 mm).

Rainfall, r (mm)	Frequency
tr	30
$0.05 \leq r < 2$	34
$2 \leq r < 5$	28
$5 \leq r < 10$	18
$10 \leq r < 20$	10

(a) Estimate the median and the interquartile range of the daily rainfall. [5 marks]

(b) Using 0.025 for each tr day and the midpoint of each other class, estimate the mean daily rainfall. [3 marks]

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(c) Kim leaves out the tr days. Estimate the median and the mean of the remaining 90 days, and explain what her averages describe. [4 marks]

Total for X7: 12 marks

F How did it go?

Colour one circle on each line.

	Not yet	Nearly	Yes
I can prove and use general results about the mean and variance when values are added.	○	○	○
I can find unknown frequencies, values or group sizes from given averages and measures of spread.	○	○	○
I can combine and separate groups using sums and sums of squares, and move between codings.	○	○	○
I can interpret averages and spread for data from the large data set, including trace values.	○	○	○

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Hints

Use one hint at a time. Cover the ones below it with a sheet of paper.

X1

Hint 1 Show first that adding values equal to μ does not change the mean.

Hint 2 Work with $\sum(x-\mu)^2$ rather than $\sum x^2$: what does each new value add to it?

Hint 3 For the last part, half of 26 is 13; solve the inequality and remember k is a whole number.

X2

Hint 1 Turn each mean and standard deviation into $\sum x$ and $\sum x^2$: $\sum x^2 = n(\sigma^2 + \bar{x}^2)$.

Hint 2 Removing bags means subtracting their totals from the combined totals, then dividing by 95.

Hint 3 For (c), compare 489 with the mean and the standard deviation from (a).

X3

Hint 1 Write n in terms of p and q; it is not given.

Hint 2 The mean gives one equation in p and q. Multiply out and collect terms.

Hint 3 The median is the $\frac{n}{2}$th value. Interpolate in $20 \leqslant x < 30$ with $4 + p$ values below it, and simplify before substituting.

X4

Hint 1 Decode with $x = 5y + 1000$: the mean shifts and scales, the standard deviation only scales.

Hint 2 Substitute $x = 5y + 1000$ into the formula for z.

Hint 3 Square $z = 2.5y - 5$ and sum each term; a constant summed 40 times gives 40 times the constant.

X5

Hint 1 Turn each mean into a total: the first group has total $60n$.

Hint 2 Use $\sum x^2 = n(\sigma^2 + \bar{x}^2)$ for the first group.

Hint 3 The variance of the whole group is $\dfrac{\sum x^2}{n+8} - 63^2$; do not average the two standard deviations.

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X6

Hint 1 Write $\sum x$ and $\sum x^2$ in terms of x and use the mean of the squares minus the square of the mean.

Hint 2 Complete the square on $5x^2 - 90x + 921$ to find the least value.

Hint 3 For (c), standard deviation less than 4.5 means variance less than 20.25; solve the quadratic inequality.

X7

Hint 1 Use the positions $\frac{n}{4}$, $\frac{n}{2}$, $\frac{3n}{4}$ with cumulative frequencies; a quartile can fall on a class boundary.

Hint 2 For the mean, multiply each midpoint by its frequency and add.

Hint 3 Without the tr days $n = 90$; subtract the tr days' contribution, 30×0.025, from $\sum fx$.

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