Hints online, answers free with an account: mathswariz.uk/worksheets/a-level-statistics-coding/

Coding

112 marks

Date

A Do Now

Quick questions to start. Some use earlier lessons; some set a slip that the examiner reports say costs marks.

A1 Needed today [2 marks]

The values $12, 15, 21$ have mean 16. Write down the mean of $22, 25, 31$ and the mean of $120, 150, 210$.

Answer .....

A2 Needed today [2 marks]

Make x the subject of $y = \dfrac{x - 40}{5}$.

Answer .....

A3 Common slip [2 marks]

A data set has standard deviation 3. Every value is increased by 10. Write down the new standard deviation.

A4 Needed today [2 marks]

For 4 values, $\sum x = 20$ and $\sum x^2 = 120$. Find the variance.

Answer .....

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B Example, then your turn

Your teacher works through each example with you. Then try the one beside it.

EXAMPLE 1

The masses, x grams, of five bags are $203, 207, 205, 209, 211$. Use the coding $y = x - 200$ to find the mean and standard deviation of x.

Hint Find $\bar{y}$ and σ_y from the small coded values. Then $\bar{x} = \bar{y} + 200$, and the standard deviation is not changed by subtracting 200.

B1 The heights, x m, of five hills are $1020, 1050, 1030, 1060, 1040$. Use the coding $y = \dfrac{x - 1000}{10}$ to find the mean and the standard deviation of x. [5 marks]

Answer .....

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EXAMPLE 2

Data are coded using $y = \dfrac{x - 50}{4}$. For 20 values, $\sum y = 36$ and $\sum y^2 = 150$. Find the mean and the standard deviation of x.

Hint Find $\bar{y}$ and σ_y first. Rearrange: $x = 4y + 50$, so $\bar{x} = 4\bar{y} + 50$ and $\sigma_x = 4\sigma_y$.

B2 The masses, x grams, of 25 cakes are coded using $y = \dfrac{x - 120}{5}$, giving $\sum y = -15$ and $\sum y^2 = 234$.

(a) Find the mean mass of the cakes. [3 marks]

Answer .....

(b) Find the standard deviation of the masses. [3 marks]

Answer .....

Total for B2: 6 marks

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EXAMPLE 3

The lengths of 40 planks are grouped in classes with midpoints $105, 115, 125, 135, 145$ cm and frequencies $4, 9, 14, 8, 5$. Using $y = \dfrac{x - 125}{10}$, estimate the mean and the standard deviation of the lengths.

Hint The coded midpoints are $-2, -1, 0, 1, 2$. Work out $\sum fy$ and $\sum fy^2$, then decode.

B3 [6 marks]

The times, x minutes, of 50 phone calls are grouped in classes with midpoints $2.5, 7.5, 12.5, 17.5, 22.5$ and frequencies $6, 10, 15, 12, 7$. Using $y = \dfrac{x - 12.5}{5}$, estimate the mean and the standard deviation of the times.

Answer .....

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EXAMPLE 4

Each of 12 values of x is reduced by 15 and then divided by 3 to give y. Then $\bar{y} = 4.2$ and $S_{yy} = 32.4$. Find the mean and the standard deviation of x.

Hint The coding is $y = \dfrac{x - 15}{3}$. Each deviation $x - \bar{x}$ is 3 times $y - \bar{y}$, so $S_{xx} = 3^2 S_{yy}$.

B4 [5 marks]

For 16 values of x, the coding $y = \dfrac{x - 200}{5}$ gives $\bar{y} = 1.25$ and $S_{yy} = 60$. Find the mean and the standard deviation of x.

Answer .....

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C1 Air pressures, x hPa, are coded using $y = x - 450$. The coded values have mean 2.4 and standard deviation 3.2. Jamal says the standard deviation of x is 453.2. Explain his mistake and find the mean and standard deviation of x. [4 marks]

C2 Data are coded using $y = \dfrac{x - 20}{4}$. The variance of y is 2.5. Ana says the variance of x is $4 \times 2.5 = 10$. Explain her mistake and find the standard deviation of x. [4 marks]

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C3 For 50 values, the coding $y = \dfrac{x - 20}{10}$ gives $\sum y = 104$. Kemi writes $\sum x = 10 \times 104 + 20 = 1060$. Explain her mistake and find $\sum x$ and the mean of x. [4 marks]

C4 Data are coded using $y = \dfrac{x - 30}{2}$. The coded data have $\bar{y} = 5$ and $\sigma_y = 1.5$. Rob writes $\bar{x} = (5 + 30) \times 2 = 70$. Explain his mistake and find $\bar{x}$ and σ_x. [4 marks]

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C5 The masses, x kg, of five parcels are $4.32, 4.35, 4.31, 4.36, 4.33$. Choose a suitable coding to make the arithmetic simple, and find the mean and standard deviation of x. [5 marks]

Answer .....

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D1 The daily maximum temperatures, $t\ ^\circ\mathrm{C}$, at a weather station on 30 days (values for this question only) are coded using $y = \dfrac{t - 20}{2}$. Then $\sum y = -9$ and $\sum y^2 = 132$.

(a) Find the mean of t. [3 marks]

Answer .....

(b) Find the standard deviation of t. [4 marks]

Answer .....

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(c) The temperature in degrees Fahrenheit is $F = 1.8t + 32$. Find the mean and the standard deviation of the temperatures in degrees Fahrenheit. [3 marks]

Answer .....

Total for D1: 10 marks

D2

The daily mean pressures, x hPa, at a weather station on the 31 days of one month (values for this question only, not from the large data set) are coded using $y = x - 1010$, giving $\sum y = 124$ and $\sum y^2 = 1260$. Sam says: "$\sum x = 124 + 1010 = 1134$, so the mean pressure is $\frac{1134}{31} = 36.6$ hPa."

Sam is wrong.

(a) Find $\sum x$ correctly. [2 marks]

Answer .....

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

Answer .....

(c) Explain why the standard deviation of x is the same as the standard deviation of y, and why Sam's mean cannot be right. [3 marks]

Total for D2: 9 marks

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D3 For 40 values of x, the coding $y = \dfrac{x - 25}{5}$ gives $\sum y = 18$ and $\sum y^2 = 116$. Find $\sum x$ and $\sum x^2$, and hence the standard deviation of x. [7 marks]

Answer .....

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D4 The heights, x cm, of some plants are grouped in classes with midpoints $145, 155, 165, 175, 185$ and frequencies $5, 12, k, 10, 5$. The coding $y = \dfrac{x - 165}{10}$ is used. The estimate of the mean height is 164.6 cm.

(a) Show that $\sum fy = -2$ for every value of k. [2 marks]

Answer .....

(b) Hence find k. [3 marks]

Answer .....

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(c) Estimate the standard deviation of the heights. [4 marks]

Answer .....

Total for D4: 9 marks

D5 Group A has 10 values, coded using $y = x - 50$, with $\sum y = 24$ and $\sum y^2 = 90$. Group B has 15 values, not coded, with $\sum x = 780$ and $\sum x^2 = 40695$.

(a) Find $\sum x$ and $\sum x^2$ for group A. [4 marks]

Answer .....

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(b) Find the mean and the standard deviation of all 25 values. [5 marks]

Answer .....

Total for D5: 9 marks

D6 The weekly pay of the workers at a firm has mean £400 and standard deviation £30. Next year each worker's pay x will become $1.05x + 20$.

(a) Find the mean of next year's pay. [3 marks]

Answer .....

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(b) Find the standard deviation of next year's pay. [3 marks]

Answer .....

(c) The manager says that the standard deviation will go up by more than £20 because everyone gets an extra £20. Explain why the manager is wrong. [2 marks]

Total for D6: 8 marks

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E Extension

Stretch

No route is given. The hints are at the end of the sheet. Use one at a time.

E1 For 20 values of x, $\sum x = 1260$ and $\sum x^2 = 80460$. The values are coded using $y = \dfrac{x - a}{b}$, where a and b are constants and $b > 0$. The coded values have $\sum y = 30$ and $\sum y^2 = 165$. Find a and b. [9 marks]

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Extension hints

Cover these with paper. Uncover one at a time.

E1

Hint 1 Find the mean and the variance of x, and the mean and the variance of y.

Hint 2 Coding by $y = \dfrac{x - a}{b}$ divides the variance by b^2, whatever a is. This gives b.

Hint 3 Then use $\bar{y} = \dfrac{\bar{x} - a}{b}$ to find a.

How did it go?

Colour one circle on each line: not yet, nearly, yes.

I can code data to simplify a calculation, and decode the mean and standard deviation.	○ ○ ○
I can find the mean and standard deviation of x from coded summary statistics.	○ ○ ○
I know that adding or subtracting a constant does not change the standard deviation, and that dividing by a constant divides the variance by its square.	○ ○ ○
I can decode totals, combine a coded group with another group, and find the coding constants.	○ ○ ○

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