# Changing data: effect on the mean and standard deviation

Grade 9 | Worked solutions

**GCSE Statistics topic practice**

**1** The midday temperature in a town was recorded on each day in June. The temperatures had a mean of 15 °C and a standard deviation of 4 °C.

A temperature of $C$ degrees Celsius is changed to $F$ degrees Fahrenheit using the formula $F = 1.8C + 32$

a. Work out the mean of the temperatures in degrees Fahrenheit. (1)

b. Work out the standard deviation of the temperatures in degrees Fahrenheit. (1)

c. Explain why adding 32 to every temperature does not change the standard deviation. (1)

(3 marks)

a) Every temperature is multiplied by 1.8, then 32 is added

mean = 1.8 x 15 + 32

mean = 27 + 32

mean = 59°F

b) Multiplying by 1.8 multiplies the spread by 1.8

sd = 1.8 x 4

sd = 7.2°F

c)

Adding 32 moves every temperature up by the same amount

The gaps between the temperatures stay the same,

so the spread does not change

a) 59°F b) 7.2°F c) same shift, same spread

**2** The 20 workers at a factory have a mean weekly wage of £480 with a standard deviation of £36.

a. Every worker is given a 5% pay rise and then a further £10 a week. Work out the new mean and the new standard deviation of the weekly wages. (2)

b. Instead of the pay rise, a new worker joins the original 20 workers on a weekly wage of exactly £480. Calculate the standard deviation of the weekly wages of the 21 workers. Give your answer correct to the nearest penny. (2)

(4 marks)

a) A 5% rise multiplies every wage by 1.05

480 x 1.05 = 504

36 x 1.05 = 37.8


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Adding £10 moves every wage up by the same amount

The mean goes up by 10, the spread does not change

new mean = 504 + 10

new mean = £514

new sd = £37.80

b) The new wage is equal to the mean

so the mean stays at £480

$sd^2 = \frac{\text{sum of } (x - \text{mean})^2}{n}$

sum of $(x - \text{mean})^2 = 20 \times 36^2$

sum of $(x - \text{mean})^2 = 25920$

The new worker adds $(480 - 480)^2 = 0$ to this sum

new sd $= \sqrt{\frac{25920}{21}}$

new sd $= \sqrt{1234.28...}$

new sd = £35.13

**a) mean £514, sd £37.80 b) £35.13**

**3** Kwame records the mass, $x$ kg, of each of 10 parcels. For his recorded masses

$\Sigma x = 150$ and $\Sigma x^2 = 2410$

a. Work out the mean and the standard deviation of the recorded masses. (2)

b. Kwame then finds that he recorded one parcel as 23 kg when its mass was really 13 kg. Work out the correct mean and the correct standard deviation of the 10 masses. (3)

(5 marks)

a) $\text{mean} = \frac{\text{sum of } x}{n}$

$\text{mean} = \frac{150}{10}$

mean = 15 kg

$sd^2 = \frac{\text{sum of } x^2}{n} - \text{mean}^2$

$sd^2 = \frac{2410}{10} - 15^2$

$sd^2 = 241 - 225$

$sd^2 = 16$

sd = 4 kg


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b) Take out the wrong value, put in the correct one

$$\text{sum of } x = 150 - 23 + 13$$

$$\text{sum of } x = 140$$

$$\text{mean} = \frac{140}{10}$$

$$\text{mean} = 14 \text{ kg}$$

Do the same with the squares

$$\text{sum of } x^2 = 2410 - 23^2 + 13^2$$

$$\text{sum of } x^2 = 2410 - 529 + 169$$

$$\text{sum of } x^2 = 2050$$

$$sd^2 = \frac{2050}{10} - 14^2$$

$$sd^2 = 205 - 196$$

$$sd^2 = 9$$

$$sd = 3 \text{ kg}$$

**a) mean 15 kg, sd 4 kg b) mean 14 kg, sd 3 kg**

**4** The marks, $x$, in a Statistics test had a mean of 52 and a standard deviation of 12. The highest mark was 96.

The teacher scales every mark using $y = ax + b$ where $a$ and $b$ are positive numbers. The scaled marks, $y$, have a mean of 60 and a standard deviation of 9.

a. Work out the value of $a$ and the value of $b$. (3)

b. Ravi says, "Every student's scaled mark is higher than their original mark." Show that Ravi is not right. (2)

(5 marks)

a) Only the multiplier a changes the sd

$$12a = 9$$

$$a = \frac{9}{12}$$

$$a = 0.75$$

The mean is multiplied by a, then b is added

$$0.75 \times 52 + b = 60$$

$$39 + b = 60$$

$$b = 21$$


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b) Scale the highest mark, 96

$y = 0.75 \times 96 + 21$

$y = 72 + 21$

$y = 93$

93 is less than 96, so this mark went down

Ravi is not right

a) a = 0.75, b = 21 b) 96 becomes 93, so not right

**5** A class is split into two groups for a French speaking test. The table shows information about the marks.

| | Number of students | Mean mark | Standard deviation |
|---|---|---|---|
| Group A | 12 | 60 | 5 |
| Group B | 8 | 70 | 10 |

a. Work out the mean mark for all 20 students. (2)

b. Calculate the standard deviation of the marks of all 20 students. Give your answer correct to 3 significant figures. (3)

(5 marks)

a) Find the total of all the marks

$\text{total} = 12 \times 60 + 8 \times 70$

$\text{total} = 720 + 560$

$\text{total} = 1280$

$\text{mean} = \frac{1280}{20}$

$\text{mean} = 64$

b) $sd^2 = \frac{\text{sum of } x^2}{n} - \text{mean}^2$

so $\text{sum of } x^2 = n \times (sd^2 + \text{mean}^2)$

Group A

$\text{sum of } x^2 = 12 \times (5^2 + 60^2)$

$\text{sum of } x^2 = 12 \times 3625$

$\text{sum of } x^2 = 43500$

Group B

$\text{sum of } x^2 = 8 \times (10^2 + 70^2)$

$\text{sum of } x^2 = 8 \times 5000$

$\text{sum of } x^2 = 40000$


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All 20 students

$$\text{sum of } x^2 = 43500 + 40000$$

$$\text{sum of } x^2 = 83500$$

$$sd^2 = \frac{83500}{20} - 64^2$$

$$sd^2 = 4175 - 4096$$

$$sd^2 = 79$$

$$sd = \sqrt{79}$$

$$sd = 8.89$$

a) 64 b) 8.89


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