Standard deviation and variance worksheet with worked answers

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This worksheet contains ten exercises, from finding a mean to interpreting a standard deviation. The first few take a couple of minutes by hand; later ones bring in the shortcut formula, the difference between a population and a sample, frequency tables and grouped classes. Every exercise has a full worked answer.

It is written for high-school students revising statistics and for teachers who want a sheet they can print or adapt.

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Online version: https://macalculatriceenligne.com/ressources/en/standard-deviation-worksheet/

Key formulas

- Mean of N values: $\bar{x} = (x_1 + x_2 + \dots + x_N) \div N$.
- Variance (population): $V = [(x_1 - \bar{x})^2 + \dots + (x_N - \bar{x})^2] \div N$.
- Standard deviation: $\sigma = \sqrt{V}$, in the same unit as the data.
- Shortcut form: $V = (x_1^2 + \dots + x_N^2) \div N - \bar{x}^2$.
- Sample: to estimate the spread of a population from a sample, divide by N − 1 instead of N: $s^2 = [(x_1 - \bar{x})^2 + \dots + (x_N - \bar{x})^2] \div (N - 1)$.
- Data with frequencies n_i: $\bar{x} = \Sigma\, n_i x_i \div N$ and $V = \Sigma\, n_i x_i^2 \div N - \bar{x}^2$, where $N = \Sigma\, n_i$.

Rounding: a result written with “=” is exact; a result written with “≈” is rounded to 2 decimal places (a 5 in the third decimal place rounds up). Intermediate steps use exact values.

Questions

Exercise 1. Finding a mean

Eight students sat a test marked out of 20. Their marks were: 14, 7, 8, 13, 18, 9, 11, 16.

Find the mean mark $\bar{x}$.

Exercise 2. Variance of a small data set

Over one term, five students borrowed this many books from the school library: 12, 14, 6, 8, 15.

Only these five students are studied (they are the whole population). Find the mean, then the variance V.

Exercise 3. Standard deviation and units

Daily maximum temperatures recorded in a town over six days (°C): 8, 17, 9, 13, 11, 14.

a) Find the variance V and the standard deviation σ (treat the six days as the population).

b) What unit is V measured in? What about σ?

Exercise 4. The shortcut formula (mean of squares)

Daily step counts (in thousands) for one person over five days: 6, 10, 3, 12, 10.

Find the variance using V = (mean of the squares) − $\overline{x}^2$, then the standard deviation.

Exercise 5. Population or sample: divide by N or by N − 1

A basketball club has several hundred members. Six players are picked at random and their heights are measured (cm): 172, 195, 184, 171, 190, 180.

a) Find the standard deviation σ of these six heights, dividing by N.

b) Find the standard deviation s, dividing by N − 1.

c) Which of the two should be used to estimate the spread of heights across the whole club?

Exercise 6. Grouped data: frequency table

Students in one class were asked how many books they read last month:

Books read	**0**	**1**	**2**	**3**	**4**	**5**
Number of students	8	1	4	1	7	4

Find the total number of students N, then the mean, variance and standard deviation of the number of books read.

Exercise 7. Data grouped into classes

Travel time from home to school for 40 students, grouped into classes:

Time (min)	**Students**
[0, 10)	12
[10, 20)	7
[20, 30)	5
[30, 40)	8
[40, 60)	8

a) Why is it impossible to find the exact mean?

b) Using the midpoint of each class, estimate the mean and the standard deviation.

Exercise 8. Interpreting: same mean, different spread

Marks out of 20 for eight students in each of two groups:

Group A: 10, 11, 12, 12, 12, 12, 13, 14.
Group B: 7, 7, 9, 10, 14, 15, 17, 17.

a) Show that both groups have the same mean.

b) Find the standard deviation of each group.

c) Which group is more consistent? Write a one-sentence conclusion.

Exercise 9. What happens when every value changes

Price of the same notebook in five shops (€): 14, 13, 6, 10, 12.

a) Find the mean and the standard deviation of these prices.

b) Every shop raises its price by €2. Give the new mean and the new standard deviation without redoing the whole calculation.

c) Starting again from the original prices, every shop raises its price by 10%. Same question.

Exercise 10. The "mean ± 2 standard deviations" rule

Mass (g) of the 20 apples in one crate: 171, 150, 172, 215, 162, 140, 168, 157, 160, 145, 154, 171, 156, 169, 167, 162, 167, 145, 152, 150.

You are given $\Sigma x_i = 3233$ and $\Sigma x_i^2 = 527397$.

a) Find the mean and the standard deviation (the whole crate is the population).

b) Work out the bounds of the interval $[\overline{x} - 2\sigma, \overline{x} + 2\sigma]$.

c) How many apples have a mass inside this interval? What percentage is that? What can you say about the remaining apple?

Worked answers

Exercise 1. Finding a mean

1. Add the marks: 14 + 7 + 8 + 13 + 18 + 9 + 11 + 16 = 96.

2. Count the values: N = 8.

3. $\overline{x}$ = 96 ÷ 8 = 12.

Answer: the mean mark is 12 out of 20.

Exercise 2. Variance of a small data set

1. Mean: $\overline{x}$ = (12 + 14 + 6 + 8 + 15) ÷ 5 = 55 ÷ 5 = 11.

2. Work out how far each value is from the mean, then square it:

x_i	$x_i - \overline{x}$	$(x_i - \overline{x})^2$
12	1	1
14	3	9
6	−5	25
8	−3	9
15	4	16
Total	**0**	**60**

Check: the deviations always add up to 0, here 0.

3. V = sum of squares ÷ N = 60 ÷ 5 = 12.

Answer: $\overline{x}$ = 11 books and V = 12.

Exercise 3. Standard deviation and units

1. $\overline{x}$ = 72 ÷ 6 = 12 °C.

x_i	$x_i - \overline{x}$	$(x_i - \overline{x})^2$
8	−4	16
17	5	25
9	−3	9
13	1	1
11	−1	1
14	2	4
Total	**0**	**56**

2. V = 56 ÷ 6 ≈ 9.33.

3. σ = √V ≈ 3.06 °C (rounded to 2 decimal places).

b) V averages squared deviations, so its unit is °C². Taking the square root brings σ back to the unit of the data, °C, which is why σ is the figure we interpret.

Answer: V ≈ 9.33 °C² and σ ≈ 3.06 °C.

Exercise 4. The shortcut formula (mean of squares)

1. $\overline{x} = 41 \div 5 = 8.2$.

2. Squares of the values: 36, 100, 9, 144, 100. They add up to 389, so the mean of the squares is $389 \div 5 = 77.8$.

3. $\overline{x^2} = 8.2^2 = 67.24$.

4. $V = 77.8 - 67.24 = 10.56$.

5. $\sigma = \sqrt{V} \approx 3.25$ thousand steps.

This route skips the deviation column and gives exactly the same variance as the table method. Keep $\overline{x}$ exact (8.2 here): rounding the mean before squaring it throws the answer off.

Answer: V = 10.56 and σ ≈ 3.25.

Exercise 5. Population or sample: divide by N or by N − 1

1. $\overline{x} = 1092 \div 6 = 182$ cm.

x_i	$x_i - \overline{x}$	$(x_i - \overline{x})^2$
172	−10	100
195	13	169
184	2	4
171	−11	121
190	8	64
180	−2	4
Total	**0**	**462**

2. The squared deviations add up to 462.

a) $\sigma^2 = 462 \div 6 = 77$, so $\sigma \approx 8.77$ cm.

b) $s^2 = 462 \div 5 = 92.4$, so $s \approx 9.61$ cm.

c) The six players are only part of the club: they form a sample. To estimate the spread for the whole club, use s (divide by N − 1). The deviations are measured from the sample mean, which sits closer to the six values than the club's unknown mean does; dividing by N − 1 makes up for that. As a result, s is always slightly larger than σ.

Most school calculators show both values next to each other: the one that divides by N is often labelled σx, the one that divides by N − 1 is often labelled sx or Sx.

Answer: σ ≈ 8.77 cm; s ≈ 9.61 cm; use s for the club.

Exercise 6. Grouped data: frequency table

Each value x_i occurs n_i times, so every value is weighted by its frequency.

x_i	n_i	$n_i \times x_i$	$n_i \times x_i^2$
0	8	0	0
1	1	1	1
2	4	8	16
3	1	3	9
4	7	28	112
5	4	20	100
Total	**25**	**60**	**238**

1. $N = 8 + 1 + 4 + 1 + 7 + 4 = 25$.

2. $\bar{x} = \Sigma n_i x_i \div N = 60 \div 25 = 2.4$ books per student.

3. $V = \Sigma n_i x_i^2 \div N - \bar{x}^2 = 238 \div 25 - 2.4^2 = 9.52 - 5.76 = 3.76$.

4. $\sigma = \sqrt{V} \approx 1.94$ books.

Answer: $N = 25$; $\bar{x} = 2.4$; $V = 3.76$; $\sigma \approx 1.94$.

Exercise 7. Data grouped into classes

a) We do not know each student's exact time, only the class it falls in. We assume the students in a class are spread around its midpoint c_i = (lower bound + upper bound) ÷ 2. Watch the last class, which is wider: its midpoint is 50.

Class	c_i	n_i	$n_i \times c_i$	$n_i \times c_i^2$
[0, 10)	5	12	60	300
[10, 20)	15	7	105	1575
[20, 30)	25	5	125	3125
[30, 40)	35	8	280	9800
[40, 60)	50	8	400	20000
Total		**40**	**970**	**34800**

b) $\bar{x} \approx 970 \div 40 = 24.25$ min.

$V \approx 34800 \div 40 - 24.25^2 = 870 - 588.0625 = 281.9375$.

$\sigma \approx \sqrt{281.9375} \approx 16.79$ min.

These are estimates: they depend on the midpoint assumption, even though the arithmetic is exact.

Answer: $\bar{x} \approx 24.25$ min and $\sigma \approx 16.79$ min.

Exercise 8. Interpreting: same mean, different spread

a) Group A: 96 ÷ 8 = 12. Group B: 96 ÷ 8 = 12. The means are equal.

b) Group A: squared deviations add up to 10, $V_A = 10 \div 8 = 1.25$, $\sigma_A \approx 1.12$.

Group B: squared deviations add up to 126, $V_B = 126 \div 8 = 15.75$, $\sigma_B \approx 3.97$.

c) $\sigma_A < \sigma_B$: group A's marks stay close to 12, while group B's are further away (range 4 points for A, 10 points for B). The mean alone cannot tell the two groups apart; the standard deviation can.

Answer: $\sigma_A \approx 1.12$ and $\sigma_B \approx 3.97$; group A is more consistent.

Exercise 9. What happens when every value changes

a) $\bar{x} = 55 \div 5 = 11$ €.

x_i	$x_i - \bar{x}$	$(x_i - \bar{x})^2$
14	3	9
13	2	4
6	−5	25
10	−1	1
12	1	1
Total	**0**	**40**

$V = 40 \div 5 = 8$ and $\sigma \approx 2.83$ €.

b) New prices: 16, 15, 8, 12, 14. Every price, and so the mean, goes up by €2: the mean becomes 13 €. The deviations $x_i - \bar{x}$ are unchanged, so the standard deviation stays at $\sigma \approx 2.83$ €.

c) A 10% rise means multiplying by 1.1. New prices: 15.4, 14.3, 6.6, 11, 13.2. The mean is multiplied by 1.1: 11 × 1.1 = 12.1 €. Each deviation is multiplied by 1.1 too, the variance by $1.1^2 = 1.21$ and the standard deviation by 1.1: $\sigma' = 1.1 \times \sigma \approx 3.11$ €.

Direct check on the new prices: $V' = 9.68$ and $\sqrt{V'} \approx 3.11$, the same result.

Answer: a) $\bar{x} = 11$ €, $\sigma \approx 2.83$ €; b) 13 € and σ unchanged; c) 12.1 € and $\sigma' \approx 3.11$ €.

Exercise 10. The "mean ± 2 standard deviations" rule

a) $\bar{x} = 3233 \div 20 = 161.65$ g. $V = 527397 \div 20 - 161.65^2 = 26369.85 - 26130.7225 = 239.1275$, so $\sigma \approx 15.46$ g.

b) Use the unrounded σ for the bounds: $\bar{x} - 2\sigma \approx 130.72$ g and $\bar{x} + 2\sigma \approx 192.58$ g.

c) 19 apples out of 20 are inside the interval, which is 19 ÷ 20 × 100 = 95%. The only apple outside weighs 215 g: it is much heavier than the rest. A value this far from the mean is called an outlier; on its own it pushes up the standard deviation of the crate.

Answer: $\bar{x} = 161.65$ g; $\sigma \approx 15.46$ g; interval [130.72, 192.58]; 19 apples, i.e. 95%.

Answers at a glance

Exercise	Results
1. Finding a mean	$\bar{x} = 12$
2. Variance of a small data set	$\bar{x} = 11$; $V = 12$
3. Standard deviation and units	$V \approx 9.33$; $\sigma \approx 3.06$ °C
4. The shortcut formula (mean of squares)	$V = 10.56$; $\sigma \approx 3.25$
5. Population or sample: divide by N or by N − 1	$\sigma \approx 8.77$; $s \approx 9.61$
6. Grouped data: frequency table	$\bar{x} = 2.4$; $V = 3.76$; $\sigma \approx 1.94$
7. Data grouped into classes	$\bar{x} \approx 24.25$; $\sigma \approx 16.79$
8. Interpreting: same mean, different spread	$\sigma_A \approx 1.12$; $\sigma_B \approx 3.97$
9. What happens when every value changes	$\sigma \approx 2.83$; +€2: σ unchanged; +10%: $\sigma' \approx 3.11$
10. The “mean ± 2 standard deviations” rule	$\bar{x} = 161.65$; $\sigma \approx 15.46$; 19/20 = 95%

To check a result on your own data, use the site’s standard deviation calculator (in French): it gives the mean, the variance and the population standard deviation (÷N). See also the variance calculator and the mean calculator (in French).

How this worksheet is made: the data sets are drawn by a program from a fixed seed, and every mean, variance, standard deviation and worked step is recomputed by that program with exact fractions. No value is typed in by hand.