# Significant Figures in Chemistry

**Grade 11 – 12 chemistry · calculations**

Name: Date: Score: / 26

### Where the rules actually bite

In a chemistry calculation the significant figure rules stop being an exercise and start deciding marks. Three things come up constantly and each one trips students for a different reason.

The first is knowing what is **exact**. Mole ratios from a balanced equation, the 1000 mL in a litre, the 100 in a percentage and the 273.15 for kelvin are all definitions, not measurements, so they never limit an answer. Molar masses are quoted to enough figures that they will not limit it either, provided you use enough of them.

The second is **percent error**, which almost always ends up with fewer figures than the measurements it came from, because it starts with a subtraction of two close numbers.

The third is **logarithms**. In a pH only the digits after the decimal point are significant: the part before the point carries the power of ten. A concentration with two significant figures gives a pH quoted to two decimal places, and a pH of 4.35 gives a concentration with two significant figures and no more.

### The rules

- **Molar masses** from the periodic table are given to enough figures not to limit the answer; use at least as many as your data.
- A **balanced equation** gives exact mole ratios, so they never limit an answer.
- A **defined conversion** — 1000 mL in 1 L, 273.15 for kelvin — is exact.
- In a **logarithm**, only the digits after the decimal point are significant.
- Going **back** from a logarithm, the decimal places become significant figures.
- **Percent error** keeps the figures of the difference, which is usually fewer than you expect.

## Part A — Chemistry calculations show your working (12 marks)

1. A 2.50 g sample of NaCl (molar mass 58.44 g/mol). How many moles?

2. 25.0 mL of 0.100 mol/L HCl. How many moles?

3. Dilute 10.0 mL of 1.50 mol/L stock to 250.0 mL. New concentration?

4. A reaction yields 4.82 g where theory predicts 5.10 g. Percent yield?

5. A measured density is 1.28 g/mL; the accepted value is 1.36 g/mL. Percent error?

6. 2.00 mol of gas at 298 K and 1.00 atm. Volume, using R = 0.08206 L·atm/(mol·K)?

## Part B — pH and logarithms (8 marks)

1. $[H^+] = 2.50 \times 10^{-4}$ M. Find the pH.

2. $[H^+] = 1.0 \times 10^{-7}$ M. Find the pH.

3. pH = 4.35. Find $[H^+]$.

4. pH = 11.200. Find $[H^+]$.

## Part C — Find the error (6 marks)

1. A student reports a pH of 7 for a solution measured as $1.0 \times 10^{-7}$ M. Explain what is wrong and write the pH correctly.

2. A student divides 36.0 g by the 4 flasks it was shared between and writes 9 g, saying the 4 has one significant figure. Explain the mistake.

3. A student reports a percent error of 5.88% from a measured 1.28 g/mL against an accepted 1.36 g/mL. Explain why that is too many figures.

# Significant Figures in Chemistry — Answer Key

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## Part A — Chemistry calculations

1. **0.0428 mol**
   2.50 ÷ 58.44 = 0.042779… The mass has 3 s.f., so the answer keeps 3.

2. **$2.50 \times 10^{-3}$ mol**
   0.0250 L × 0.100 = 0.00250. Both have 3 s.f.; the 1000 mL per litre is a definition and exact.

3. **0.0600 mol/L**
   $c_1V_1 = c_2V_2$, so 1.50 × 10.0 ÷ 250.0 = 0.0600. The 10.0 has 3 s.f., so keep 3 and the trailing zero.

4. **94.5%**
   4.82 ÷ 5.10 × 100 = 94.509… Both masses have 3 s.f., and the 100 is exact.

5. **6%**
   |1.28 − 1.36| = 0.08, which has only 1 s.f. because subtracting close numbers destroyed the others. 0.08 ÷ 1.36 × 100 = 5.88…, so the answer is 6%.

6. **48.9 L**
   V = nRT/P = 2.00 × 0.08206 × 298 = 48.907… The data has 3 s.f., so the answer keeps 3.

## Part B — pH and logarithms

1. **pH = 3.602**
   The concentration has 3 s.f., so the pH gets 3 decimal places. The 3 before the point is the power of ten, not a measured digit.

2. **pH = 7.00**
   2 s.f. in, so 2 decimal places out. Writing "pH = 7" claims less than the data supports.

3. **$4.5 \times 10^{-5}$ M**
   2 decimal places in, so 2 s.f. out. Not $4.47 \times 10^{-5}$.

4. **$6.31 \times 10^{-12}$ M**
   3 decimal places in, so 3 s.f. out.

## Part C — Find the error

1. **It should be pH = 7.00.**
   The concentration has two significant figures, so the pH is quoted to two decimal places. "pH = 7" claims only that the concentration is somewhere near $10^{-7}$, which is far less than the measurement supports.

2. **The 4 flasks were counted, so the 4 is exact.**
   Exact values never limit an answer. 36.0 g has three significant figures, so the answer is 9.00 g. Reporting 9 g throws away two figures that were measured.

3. **The subtraction leaves only one significant figure.**
   1.36 − 1.28 = 0.08. The two densities agree in their leading digits and those digits cancel, leaving one figure. The percent error can carry no more than that, so it is 6%, not 5.88%.