Atoms, molecules and chemical formulae for Class 9

Visual learning guide - Science · Grade 9

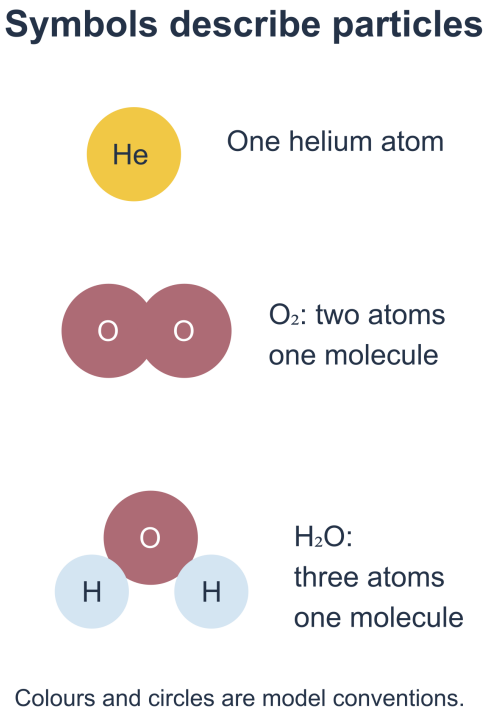
Distinguish atoms, molecules and ions, read formulae, count atoms and calculate simple relative masses with original worked examples.

Start with the key idea

An atom is the smallest unit of an element retaining its chemical identity. A molecule is a discrete group of bonded atoms. Formulae show composition, but ionic substances such as sodium chloride are described using formula units rather than individual molecules.

1. Separate atom, element and molecule

An element contains atoms with the same atomic number, meaning the same number of protons. At this stage, the key idea is identity: oxygen atoms remain oxygen atoms when they take part in ordinary chemical reactions, even when their partners change. Atoms are not absolutely indivisible; the historical atomic model was refined as smaller particles were discovered.



One helium atom, one oxygen molecule containing two atoms and one water molecule containing three atoms.

A molecule is a discrete bonded group. Oxygen gas contains O_2 molecules made of two oxygen atoms. Water contains H_2O molecules with atoms of two different elements. A molecule can therefore represent an element or a compound. Helium commonly exists as individual atoms, so do not force every element into a two-atom picture.

A particle drawing must include a key. Different colours are convenient symbols, not literal atom colours. Count circles and groups separately.

2. Read symbols and subscripts carefully

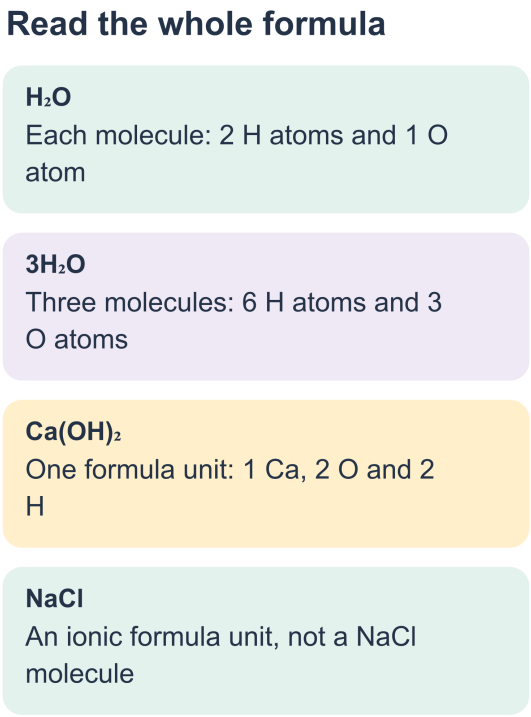
Chemical symbols use a capital first letter and, when present, a lowercase second letter. Co represents cobalt; CO represents carbon monoxide with carbon and oxygen. Letter case therefore changes meaning. A missing subscript means one atom of that element in the formula, not zero.

In H_2O, the 2 applies only to hydrogen. The oxygen count is one. In CO_2, there is one carbon atom and two oxygen atoms per molecule. A formula describes composition and should not be changed merely to make arithmetic easier.

A coefficient in front multiplies the whole formula. In $3H_2O$, multiply both the hydrogen count and oxygen count by three. Brackets also matter: $Ca(OH)_2$ contains two copies of the OH group, so it has two oxygen and two hydrogen atoms for each calcium.

3. Distinguish ions and formula units

An ion has a net electrical charge because its electron count differs from its proton count. A positive ion has fewer electrons than protons; a negative ion has more. Ordinary ion formation changes electron number, not the element-defining proton number. A polyatomic ion contains several bonded atoms carrying a net charge, such as the sulfate ion.



Formula reading examples show subscripts, coefficients, bracket multiplication and ionic formula-unit language.

Ionic solids consist of extended arrangements of oppositely charged ions. Sodium chloride is not usefully pictured as a collection of separate NaCl molecules. Its formula gives the simplest whole-number ratio of sodium ions to chloride ions: one to one. We call this a formula unit.

This distinction also affects mass language. Relative molecular mass applies to a molecular substance; relative formula mass is appropriate when using a formula unit. The arithmetic can look similar while the particle model differs.

4. Build simple formulae by balancing charge

For an ionic compound, the total positive and negative charges must balance. Magnesium ions have charge 2+ and chloride ions charge 1−. One magnesium ion therefore combines with two chloride ions in the simplest neutral ratio, giving $MgCl_2$. Do not write Mg_2Cl because the larger charge does not become a count of the same ion.

Calcium ions have charge 2+ and oxide ions charge 2−, so a one-to-one ratio already balances: CaO. Simplify a proposed ratio such as 2:2 when writing this kind of ionic formula. For calcium hydroxide, two OH groups are required, giving $Ca(OH)_2$; brackets preserve the group.

Use the charges or valencies supplied by the question, and learn common ions with their names. A cross-over shortcut is safe only when followed by a check of charge, grouping and simplest ratio.

5. Add relative masses with the correct counts

Relative atomic mass compares an element's average atomic mass with one twelfth of the mass of a carbon-12 atom. Relative masses are ratios and have no unit. For school calculations, use the values supplied, often rounded numbers such as H = 1, C = 12 and O = 16.

Relative molecular mass of water is 2 × 1 + 16 = 18. For carbon dioxide it is 12 + 2 × 16 = 44. A common error is to add the subscript itself instead of multiplying the element's mass. Write a small count table before adding.

If a question asks for the mass of one molecule in atomic mass units, the corresponding value may be expressed in u. Do not confuse that with the dimensionless relative molecular mass or the mass of an arbitrary sample in grams.

6. Connect particle counts with conservation

In an ordinary chemical reaction, atoms rearrange into new combinations. A balanced equation preserves the number of atoms of each element. This particle picture explains conservation of mass when the complete reacting system is considered. Gas leaving an open container can make the measured container mass fall without breaking the conservation principle.

A pure compound has elements in a fixed composition. Water has a hydrogen-to-oxygen atom ratio of 2:1, but its mass ratio using H = 1 and O = 16 is 2:16, or 1:8. Atom ratio and mass ratio answer different questions.

Use these ideas together: identify the particles, count each element, then apply the appropriate mass values. Do not conduct chemical mixing experiments at home to test a formula; drawings and teacher-provided data are enough for this practice.

5 worked examples with reasoning

1. Count atoms in $3H_2O$.

1. One molecule contains 2 H and 1 O.

2. Multiply each by 3: 6 H and 3 O.

3. There are 9 atoms altogether across 3 molecules.

2. Count atoms in $Ca(OH)_2$.

1. There is 1 calcium outside the brackets.

2. The bracket multiplier gives 2 oxygen and 2 hydrogen.

3. Total: 5 atoms per formula unit.

3. Write the formula for Mg^{2+} and Cl^{-}.

1. One Mg ion contributes +2.

2. Two chloride ions contribute −2.

3. The neutral simplest ratio is 1:2, giving $MgCl_2$.

4. Find relative molecular mass of CO_2 using C = 12, O = 16.

1. One carbon contributes 12.

2. Two oxygens contribute 32.

3. Total relative molecular mass = 44, without a unit.

5. Explain why water has atom ratio 2:1 but mass ratio 1:8.

1. Two H atoms contribute relative mass 2.

2. One O atom contributes 16.

3. The mass ratio 2:16 simplifies to 1:8; masses per atom differ.

Use the ideas without looking at the notes

Make count tables for $2H_2O$, $3CO_2$ and $Ca(OH)_2$. Separate particle count, element counts and total atoms. Then calculate relative masses using explicitly stated atomic-mass values.

Common questions

Are atoms indivisible?

No. Atoms contain smaller particles; ordinary chemical reactions rearrange atoms rather than changing their nuclei.

Can a molecule contain one element only?

Yes. O_2 is a molecule of an element.

Why use brackets in $Ca(OH)_2$?

The 2 applies to the whole OH group.

Is relative molecular mass measured in grams?

No. It is a dimensionless ratio; sample mass is a different quantity.

Can formula subscripts be changed while balancing an equation?

No. That changes the substances. Change coefficients instead.

Connect your learning

- Use atom counts to balance reactions
- Compare compounds with physical mixtures

Ask about guided Science learning if your child needs help explaining these ideas.

About this guide

Original explanations, examples, diagrams and practice by BananaLearn. The grade label indicates the intended learning level; this is not an official textbook extract or exam paper.

Atoms, molecules and chemical formulae for Class 9

Practice worksheet - Science · Grade 9

Name: _____ Date: _____

Show your working. Answers and explanations follow on a separate page.

Try each task before opening its answer. Give an example or reason, not only a label.

Write an answer and your reason before opening the explanation. Check the reasoning as well as the final answer.

1. How many atoms are in one O_2 molecule?

2. Is O_2 a compound?

3. How many oxygen atoms are in $4H_2O$?

4. How many total atoms are represented by $2CO_2$?

5. Count oxygen atoms in $Al_2(SO_4)_3$.

6. Are Co and CO the same?

7. Should solid NaCl be described as separate NaCl molecules here?

8. Does a positive ion have excess electrons?

Practice continued

9. Balance Ca^{2+} and O^{2-} into a simplest formula.

10. Balance Na^{+} and O^{2-}.

11. Find relative molecular mass of H_2 using H = 1.

12. Find relative molecular mass of CH_4 using C = 12 and H = 1.

13. Why may an open reaction container lose measured mass?

14. Does a coefficient change a substance's formula?

Answers and explanations

Answer key - Science · Grade 9

Atoms, molecules and chemical formulae for Class 9

1. 2.

The subscript counts oxygen atoms.

2. No.

It contains only one element.

3. 4.

Each of four molecules contains one O.

4. 6.

Two groups of three atoms.

5. 12.

There are three sulfate groups, each with four O.

6. No.

Co is cobalt; CO represents carbon monoxide.

7. No.

Use formula units for its ionic structure.

8. No.

It has fewer electrons than protons.

9. CaO.

One of each balances charge.

10. Na_2O.

Two positive charges balance one oxide ion.

11. 2.

Two hydrogen atoms contribute 2 × 1.

12. 16.

12 + 4 × 1 = 16.

13. Gas can leave the measured system.

The complete system still conserves mass.

14. No.

It changes the amount represented, not the composition of each particle.