

How atoms join to make molecules

Grade 8 science (Year 9 · Class 8) · Worksheet

Name: _____ Date: _____ Class: _____

These problems train you to read chemical formulas, count atoms with subscripts and coefficients, and interpret ball-and-stick models. They start with simple recall and finish with multi-step calculations on scale and composition.

They match the middle-school science standard MS-PS1-1 and suit Year 9 and Class 8 students in schools around the world.

Level: Grade 8 science (Year 9 · Class 8) · **Curriculum:** MS-PS1-1

Problem 1 Water formula (easy)

Kofi in Accra reads: "A molecule of water contains two hydrogen atoms and one oxygen atom."

1. Write the formula of water.
2. State how many atoms are in one water molecule.
3. State how many different elements are in water.

Problem 2 Reading subscripts (easy)

Emma in Leeds finds the formulas O_2 , N_2 and CO_2 in her revision notes.

1. State the number of atoms in one molecule of each.
2. Identify which formulas show a molecule made of only one kind of atom.

Problem 3 Coefficient and subscript (easy)

Look at 3 H_2O .

1. State what the large 3 tells you.
2. State what the small 2 tells you.
3. Calculate the total number of atoms.

Problem 4 Atom or molecule (easy)

Diego in Texas sorts these into "single atoms" or "molecules": Cl_2 , He, CH_4 , NH_3 .

1. Identify which one is a single atom (a gas whose particles are not bonded together).
2. Identify which are molecules.
3. State how many atoms are in a CH_4 molecule.

Problem 5 True or false (easy)

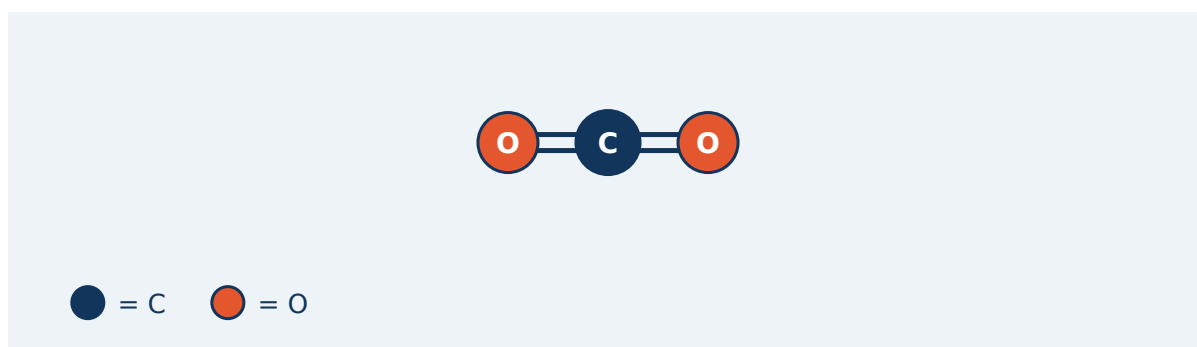
Decide whether each statement is true or false and correct any false one.

1. An atom is larger than a molecule made from it.
2. In CO_2 there are two oxygen atoms.
3. A molecule can contain different elements.
4. The formula O has the same meaning as O_2 .

Problem 6 Model X (easy)

Aisha in Kano builds Model X (see the figure) with navy balls for carbon and red balls for oxygen.

1. Count the atoms of each element.
2. Write the formula of the molecule.
3. State the total number of atoms.



Model X for Problem 6.

Problem 7 Counting in acid (easy)

The technician at a school in Nairobi labels three bottles: HCl , H_2SO_4 and NH_3 .

1. Calculate the number of atoms in one molecule of each.
2. State which has the most atoms.

Problem 8 Glucose in a drink (medium)

Wanjiru in Nairobi checks glucose, $\text{C}_6\text{H}_{12}\text{O}_6$, in an energy drink.

1. State the number of atoms of carbon, hydrogen and oxygen in one molecule.
2. Calculate the total number of atoms.
3. Calculate the fraction of the atoms that are hydrogen, as a percentage.

Problem 9 Several molecules (medium)

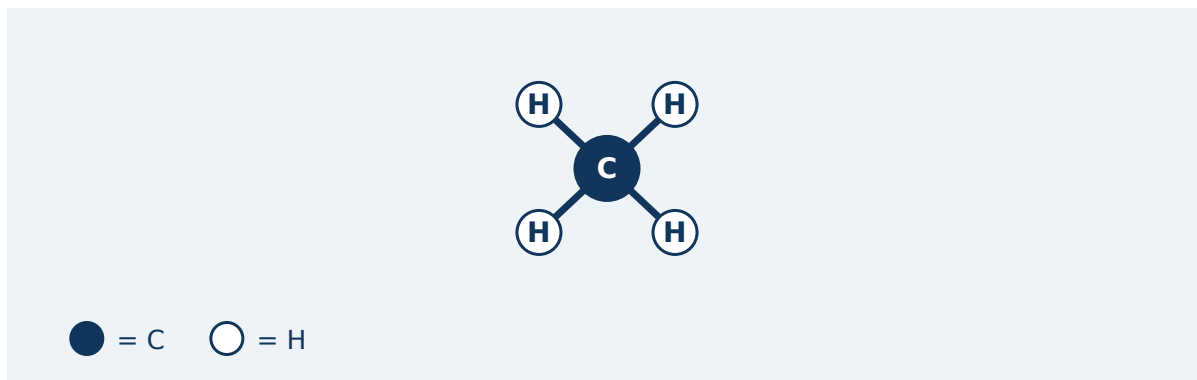
A teacher draws 4 CH_4 on the board.

1. State how many molecules there are.
2. Calculate the number of carbon atoms and of hydrogen atoms.
3. Calculate the total number of atoms.

Problem 10 Methane model (medium)

Look at the model of methane.

1. Write its formula.
2. Count the sticks (bonds) in the model.
3. Explain why the real molecule is not coloured and not made of balls and sticks.

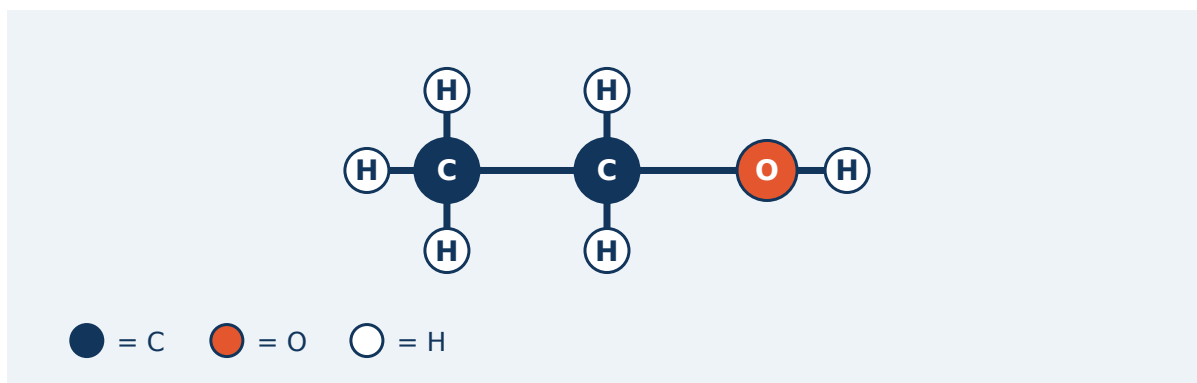


The model for Problem 10.

Problem 11 Ethanol model (medium)

Priya in Chennai studies a model of ethanol, the alcohol in hand sanitiser.

1. Count the atoms of each element.
2. Write the formula, listing carbon first, then hydrogen, then oxygen.
3. Count the bonds.



The model for Problem 11.

Problem 12 Size of a molecule (medium)

A water molecule is about 0.28 nm across, and $1 \text{ nm} = 1 \times 10^{-9} \text{ m}$.

1. Convert 0.28 nm to metres.
2. Calculate how many water molecules would fit side by side along a line 1.0 mm ($1.0 \times 10^{-3} \text{ m}$) long.

Problem 13 Spot the errors (medium)

Bilal in Lahore writes two statements in his notebook.

- (i) "Water has the formula HO_2 ."
- (ii) "3 CO_2 contains 6 atoms."

1. Identify the mistake in each.
2. Give the correct statement for each.

Problem 14 Oxygen and ozone (medium)

The air contains oxygen, O_2 . Ozone, O_3 , forms high above the ground.

1. State the number of atoms in a molecule of each.
2. Explain why O_2 and O_3 are different substances although both contain only oxygen atoms.
3. Calculate the number of atoms in 5 molecules of O_3 .

Problem 15 Formula from a description (medium)

Write the formula for each molecule.

1. One nitrogen atom bonded to three hydrogen atoms.
2. Two carbon atoms and four hydrogen atoms.
3. One carbon atom and four chlorine atoms (symbol Cl).
4. Calculate the number of atoms in each.

Problem 16 Model kit puzzle (hard)

Mei in Singapore has a kit with 18 carbon balls, 30 hydrogen balls and 24 oxygen balls. She wants to build as many complete glucose models ($\text{C}_6\text{H}_{12}\text{O}_6$) as possible.

1. Calculate how many models each type of ball could supply.
2. State the largest number of complete models she can build.
3. Calculate how many balls of each colour are left over.

Problem 17 Atom percentages in propane (hard)

Propane gas in a camping stove has the formula C_3H_8 .

1. Calculate the total number of atoms in one molecule.
2. Calculate the percentage of atoms that are carbon.
3. Calculate the percentage of atoms that are hydrogen.
4. Check that the two percentages add to 100 %.

Problem 18 Same atoms, different molecules (hard)

Ethanol and dimethyl ether both have the formula $\text{C}_2\text{H}_6\text{O}$. Ethanol is a liquid that boils at 78°C , while dimethyl ether is a gas that boils at -25°C .

1. State the number of atoms of each element in both molecules.
2. Explain how two different substances can have the same formula.

3. Suggest what a model builder would do differently for the two.

Problem 19 Comparing five substances (hard)

Hamza in Lahore compiles a data table.

1. Identify which substances are made of only one element.
2. Calculate the atoms in one molecule of each substance.
3. Calculate how many atoms are in 10 molecules of the substance with the most atoms per molecule.
4. Compare H_2O and H_2O_2 in one sentence.

Substance	Formula	State at 25 °C
Hydrogen	H_2	gas
Water	H_2O	liquid
Nitrogen	N_2	gas
Ammonia	NH_3	gas
Hydrogen peroxide	H_2O_2	liquid

Problem 20 Scaling up an atom (hard)

Imagine an atom (diameter 1×10^{-10} m) enlarged until it is the size of a cricket ball (diameter 0.070 m).

1. Calculate the magnification.
2. A human hair is 1.0×10^{-4} m thick. Calculate its thickness at the same magnification.
3. Convert your answer to kilometres.