

Inside the atom: particles and isotopes

Chemistry grades 9-10 (GCSE · IGCSE · O Level · Class 9-10) · Worksheet

Name: _____ Date: _____ Class: _____

These problems train you to count protons, neutrons and electrons, to write atoms and ions in standard notation, and to work out relative atomic mass from isotope data. They start with recall and finish with multi-step reasoning about abundances and evidence.

Use them for GCSE, IGCSE, O Level, CBSE Class 9-10 and NGSS high school chemistry. A periodic table helps with atomic numbers.

Level: Chemistry grades 9-10 (GCSE · IGCSE · O Level · Class 9-10) · **Curriculum:** HS-PS1-1, GCSE C1

Problem 1 Particles in the atom (easy)

State the relative charge and the relative mass of a proton, a neutron and an electron. Then say where in the atom each one is found.

Problem 2 Kitchen foil in Lagos (easy)

Chiamaka wraps suya in aluminium foil. An aluminium atom has atomic number 13 and mass number 27.

1. Calculate the number of protons.
2. Calculate the number of neutrons.
3. State the number of electrons in a neutral atom.

Problem 3 Which element? (easy)

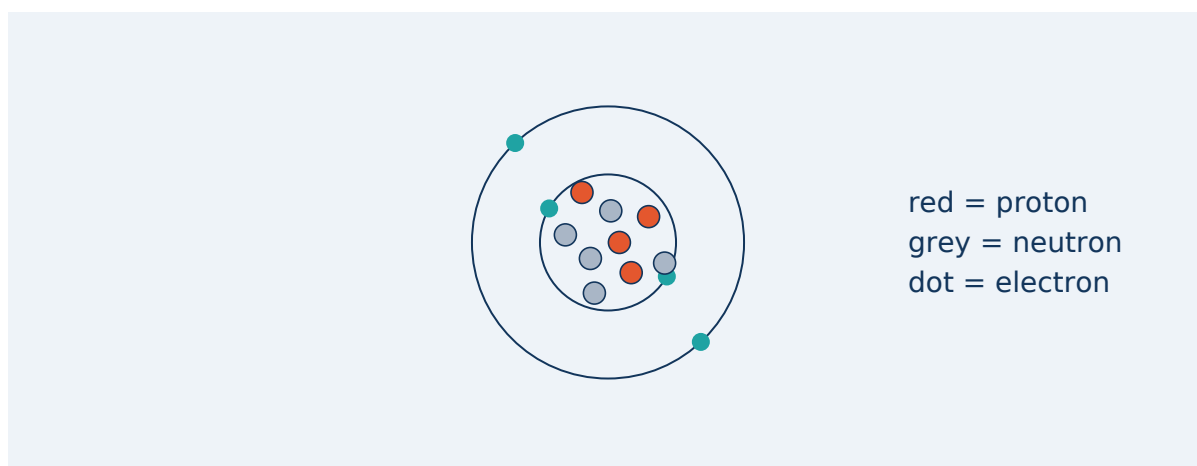
Identify the element for each atom, using the atomic number to decide: oxygen 8, chlorine 17, calcium 20, iron 26.

1. An atom with 17 protons.
2. An atom with 26 protons.
3. An atom with 8 protons.
4. An atom with 20 protons.

Problem 4 Reading an atom diagram (easy)

Atom X is drawn below. Count the particles in the diagram.

1. State the number of protons, neutrons and electrons.
2. Give the atomic number and the mass number.
3. Identify the element, given that it is the fourth element in the periodic table.



Atom X.

Problem 5 Why atoms are neutral (easy)

A copper atom has 29 protons.

1. State how many electrons it has.
2. Explain why the atom has no overall charge.

Problem 6 Complete the table (easy)

Copy and complete the table for four neutral atoms.

Atom	Atomic number	Mass number	Protons	Neutrons	Electrons
Potassium	19	39	?	?	?
Sulfur	16	32	?	?	?
Calcium	?	?	20	20	?
Silver	?	?	47	60	?

Problem 7 Neon isotopes (medium)

Neon-20 and neon-22 are both found in the air. Neon has atomic number 10.

1. Calculate the number of neutrons in each isotope.
2. State what is the same and what is different about the two atoms.
3. Explain why these are called isotopes.

Problem 8 Counting in ions (medium)

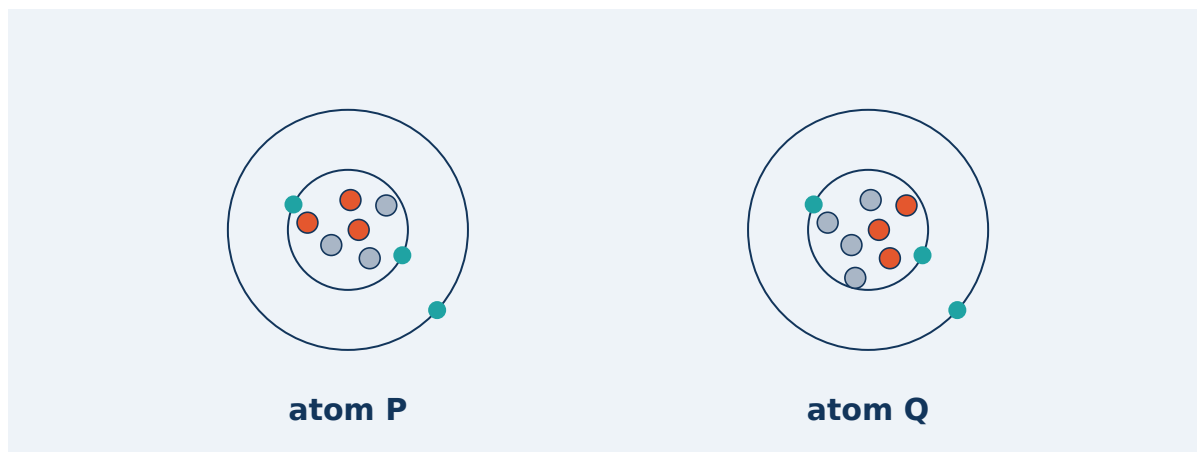
Calculate the number of protons, neutrons and electrons in each ion.

1. Magnesium-24 as Mg^{2+} (atomic number 12).
2. Oxygen-16 as O^{2-} (atomic number 8).
3. Fluorine-19 as F^- (atomic number 9).

Problem 9 Two lithium atoms (medium)

Atoms P and Q are shown below.

1. State the number of protons in each atom.
2. Write the mass number of each atom.
3. Explain whether P and Q are isotopes.
4. State whether they react in the same way, and why.



Atoms P and Q.

Problem 10 Boron mixture (medium)

Boron is 20 % boron-10 and 80 % boron-11.

Calculate the relative atomic mass of boron.

Problem 11 Copper from wiring (medium)

Copper wire carries current in a house in Leeds. Natural copper is 69 % copper-63 and 31 % copper-65.

1. Calculate its relative atomic mass to 3 significant figures.
2. Explain why the answer is not a whole number.

Problem 12 Build the symbol (medium)

Calculate what is missing for each atom.

1. An iron atom with 26 protons and 30 neutrons: give its mass number.
2. A gold atom with atomic number 79 and mass number 197: how many neutrons?
3. An atom with 15 protons and 16 neutrons: name it using atomic number 15 = phosphorus, and give its mass number.

Problem 13 Spot the errors (medium)

Wanjiru in Nairobi wrote three statements. Find the mistake in each and correct it.

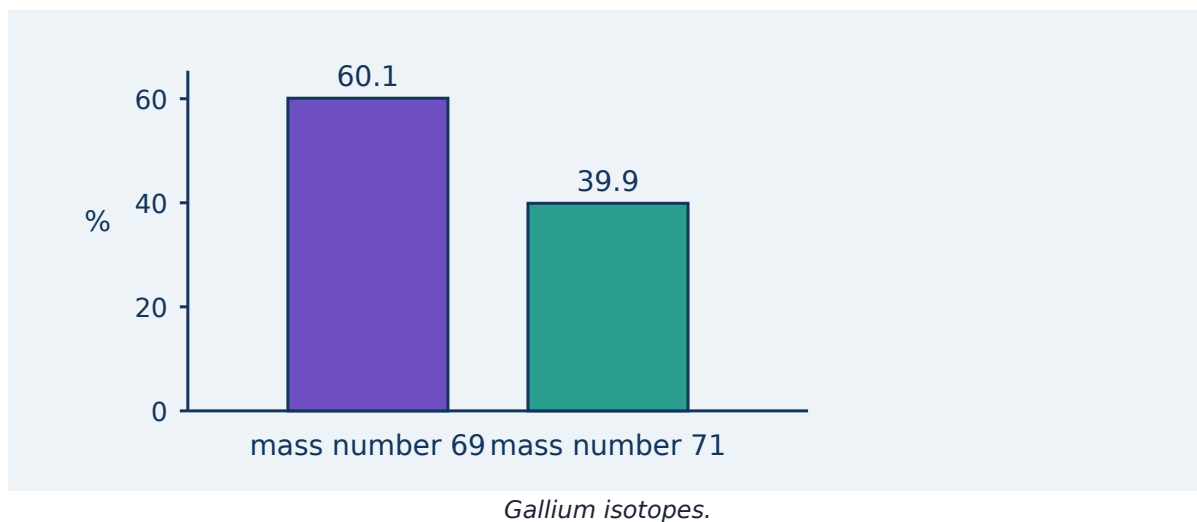
1. "Chlorine-37 has 37 protons."
2. "Isotopes of an element have different numbers of electrons."

3. "Relative atomic mass is the number of protons plus neutrons."

Problem 14 Gallium abundances (medium)

The chart shows the isotopes of gallium.

1. Read the percentage abundance of each isotope.
2. Calculate the relative atomic mass of gallium to 3 significant figures.



Problem 15 Unknown abundance (hard)

Bromine has two isotopes, bromine-79 and bromine-81. Its relative atomic mass is 79.9.

1. Let the abundance of bromine-79 be x %. Write an equation for A_r .
2. Solve it to find both abundances.
3. State the number of neutrons in each isotope (atomic number 35).

Problem 16 Neon from three isotopes (hard)

Neon in air is 90.5 % neon-20, 0.3 % neon-21 and 9.2 % neon-22.

1. Calculate the relative atomic mass of neon to 3 significant figures.
2. Explain why a rare isotope barely changes the answer.

Problem 17 Heavy water (hard)

Hydrogen-2 (deuterium) can replace hydrogen-1 in water. Ordinary water is made of hydrogen-1 and oxygen-16. Heavy water, D_2O , contains two hydrogen-2 atoms.

1. Calculate the relative formula mass of each, using masses 1, 2 and 16.
2. Calculate the percentage increase in mass for heavy water.
3. Explain why the two waters have similar chemistry.

Problem 18 Carbon-14 and nitrogen-14 (hard)

Both carbon-14 (atomic number 6) and nitrogen-14 (atomic number 7) have mass number

14.

1. Calculate protons, neutrons and electrons in each neutral atom.
2. Explain why they are not isotopes of each other.
3. Suggest why archaeologists in Cairo can still use carbon-14 to date wooden objects.

Problem 19 Identify the species (hard)

Name each species and give its symbol with charge, using the periodic table.

1. 17 protons, 18 neutrons, 18 electrons.
2. 20 protons, 20 neutrons, 18 electrons.
3. 13 protons, 14 neutrons, 10 electrons.

Problem 20 Gold foil evidence (hard)

In a gold foil experiment, 40 000 positive alpha particles were fired at a thin gold sheet. 39 996 passed through with almost no change of direction, and 4 were turned back sharply.

1. Calculate the percentage that passed through.
2. Explain what this suggests about the space inside an atom.
3. Explain what the 4 turned-back particles suggest about the nucleus.