

Simple Step-by-Step  
Guides to Solving  
Chemistry Problems

Counting Electrons,  
Protons & Neutrons

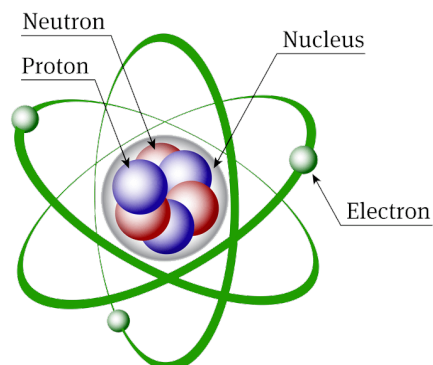


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## Counting Electrons, Protons & Neutrons

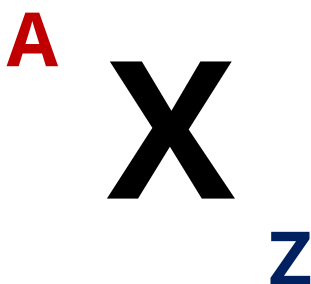
- Atoms have a nucleus containing protons and neutrons.
- Electrons orbit the nucleus within specific energy levels.
- Atoms are made mostly of empty space.
- Protons have a positive (+) charge.
- Electrons have a negative (-) charge.
- Neutrons have no charge, i.e. are neutral.
- All atoms of the same element have the same number of protons.
- The proton number (also known as the atomic number) defines an element.
- Isotopes are forms of an element that have the same number of protons but different numbers of neutrons.



Nuclear notation provides a convenient means of conveying the mass number and the atomic number of an element.

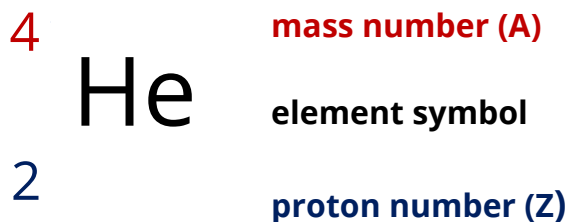
**Atomic Mass (A):**  $A = \text{Number of Protons} + \text{Number of Neutrons}$

**Proton Number (Z):** Sometimes called the atomic number. Equals the number of protons in the nucleus and the number of electrons in the electron cloud.



**Chemical Symbol (X):** One or two letter abbreviations derived from the element's English or Latin name

Shorthand nuclear notation: eg C-12, B-11, U-235 etc. It may also be written as  $^{12}\text{C}$  and  $^{12}\text{C}$ . Remember that the value of Z is derived from the chemical symbol.

**For Example:**

Number of protons (Z)	Number of electrons	Number of neutrons (N = A - Z)
2	2	4 - 2 = 2

**Other Examples**

Element Name	Isotopic Notation	No. of Protons	No. of Electrons	No. of neutrons
Name	${}^A_ZX$	Z	Z	A - Z
Boron	${}^{11}_5\text{B}$	5	5	11-5 = 6
Magnesium	${}^{24}_{11}\text{Mg}$	11	11	23-11 = 12
Copper	${}^{65}_{28}\text{Cu}$	28	28	65-28=37
Bromine	${}^{80}_{35}\text{Br}$	35	35	80-35=45
Uranium	${}^{238}_{92}\text{U}$	92	92	238-92=146

Atoms (and molecules) can gain or lose electrons to form ions. Cations (positive ions) are formed when atoms (molecules) lose one or more electrons, whilst the gain of one or more electrons creates anions (negative ions). Thus, for ions:

$$\text{number of electrons in an ion} = \text{proton number} - \text{ion charge}$$

**Examples**

Chloride ion,  $\text{Cl}^-$

$$\begin{aligned} \text{No. of electrons} &= \text{proton number} - \text{ion charge} \\ &= 17 - -1 \\ &= 18 \end{aligned}$$

Magnesium,  $\text{Mg}^{2+}$

$$\begin{aligned}\text{No. of electrons} &= \text{proton number} - \text{ion charge} \\ &= 12 - +2 \\ &= 10\end{aligned}$$

## ? Practice Problems

Answer each of the following using your knowledge of chemistry and the Periodic Table.

1. An atom contains 55 protons. What is the element symbol?
2. An atom contains 31 protons, 39 neutrons and 31 electrons. What is the mass number of this atom?
3. What is the number of total subatomic particles in an atom of B-11?
4. What is the atomic number of Zn-65?
5. How many neutrons are in an atom of 201-Hg?
6. What is the nuclear charge of an atom of nitrogen-14
7. Write the isotopic notation for the particles described below. Remember to include: symbol, proton number, relative atomic mass and charge (if there is one).
  - a) a particle with 4 protons, 3 electrons and 4 neutrons
  - b) a particle with 1 proton, 2 neutrons and no electrons
  - c) a particle with 29 protons, 29 electrons and 34 neutrons
  - d) a particle with 47 protons, 46 electrons and 59 neutrons
8. Fill in the gaps.

Chemical symbol	No. of Protons	No. of Neutrons	No. of Electrons	Relative Atomic Mass
B		6		
$\text{Na}^+$	11			24
$\text{O}^{2-}$				16
	31	37		

	43			100
Pb <sup>2+</sup>				207
		102	70	
Al <sup>3+</sup>				27
V		28		
	92	146		
	2	2		
Mo		53		

**Answers are given on the following page.**

**Practice Problem Answers:**

- An atom contains 55 protons. What is the element symbol? **Cs**
- An atom contains 31 protons, 39 neutrons and 31 electrons. What is the mass number of this atom?  **$A = 31 + 39 = 70$**
- What is the number of total subatomic particles in an atom of B-11?  **$5p + 5e + 6n = 16$**
- What is the atomic number of Zn-65?  **$Z = 30$**
- How many neutrons are in an atom of 201-Hg?  **$Z = 80, A = 201$ . Number of neutrons =  $201 - 80 = 121$**
- What is the nuclear charge of an atom of nitrogen-14?  **$Z = 7$ . Therefore nuclear charge = +7**
- Write the isotopic notation for the particles described below. Remember to include: symbol, proton number, relative atomic mass and charge (if there is one).
  - a particle with 4 protons, 3 electrons and 4 neutrons  **${}^7\text{Be}_4$**
  - a particle with 1 proton, 2 neutrons and no electrons  **${}^3\text{H}_1^+$**
  - a particle with 29 protons, 29 electrons and 34 neutrons  **${}^{63}\text{Cu}_{29}$**
  - a particle with 47 protons, 46 electrons and 59 neutrons  **${}^{108}\text{Ag}_{47}^+$**

8. Fill in the gaps.

Chemical symbol	No. of Protons	No. of Neutrons	No. of Electrons	Relative Atomic Mass
B	5	6	5	11
Na <sup>+</sup>	11	13	10	24
O <sup>2-</sup>	8	8	10	16
Ga	31	37	31	68
Tc	43	57	43	100
Pb <sup>2+</sup>	82	105	80	207
Yb	70	102	70	172
Al <sup>3+</sup>	13	14	10	27
V	39	28	39	67
U	92	146	92	238
He	2	2	2	4
Mo	42	53	42	96