

## 4.5: Chemical Symbols and the Atomic Number

### Learning Objectives

- Define atomic number.
- Determine the number of protons and electrons in an atom.

It is important to be able to distinguish atoms of one element from atoms of another element. Elements are pure substances that make up matter, so each one is given a unique name. The names of elements are also represented by unique one- or two-letter symbols, such as H for hydrogen, C for carbon, or He for helium. However, it would be more powerful if these names could be used to identify the numbers of protons and neutrons in the atoms. That's where atomic number and mass number are useful.



Figure 4.5.1: Each element has a unique number of protons. Sulfur has 16 protons, silicon has 14 protons, and gold has 79 protons. Images used with permission (public domain for sulfur and silicon, gold is licensed by CC-BY-SA-NC-ND; [Alchemist-hp](#)).

### Chemical Symbol

A **chemical symbol** is a one- or two-letter designation of an element. Some examples of chemical symbols are O for oxygen, Zn for zinc, and Fe for iron. The first letter of a symbol is always capitalized. If the symbol contains two letters, the second letter is lower case. The majority of elements have symbols that are based on their English names. However, some of the elements that have been known since ancient times have maintained symbols that are based on their Latin names, as shown in [Table 4.5.1](#).

Table 4.5.1: Symbols and Latin Names for Elements

Chemical Symbol	Name	Latin Name
Na	Sodium	Natrium
K	Potassium	Kalium
Fe	Iron	Ferrum
Cu	Copper	Cuprum
Ag	Silver	Argentum
Sn	Tin	Stannum
Sb	Antimony	Stibium
Au	Gold	Aurum
Pb	Lead	Plumbum

### Atomic Number

Scientists distinguish between different elements by the **atomic number** ( $Z$ ), which represents the number of protons in the nucleus of one atom of that element. All atoms of an element have the same number of protons, and every element has a different number of protons in its atoms. If an atom has 26 protons ([Figure 4.5.2](#)), we know it is an iron atom. An atom with two protons is

always a helium atom, since its atomic number is 2. No other element will have two protons in a single atom.

Period	1																	2	
	H																	He	
	1.008																	4.003	
	3	4																	
	Li	Be																	
	6.939	9.012																	
	11	12																	
Na	Mg																		
22.99	24.31																		
19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36		
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr		
39.10	40.08	44.96	47.90	50.94	52.00	54.94	55.85	58.93	58.69	63.55	65.38	69.72	72.61	74.92	78.96	79.90	83.80		
37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54		
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe		
85.47	87.62	88.91	91.22	92.91	95.96	(99)	101.07	102.91	106.4	107.87	112.41	114.82	118.71	121.75	127.60	126.90	131.29		
55	56	57-70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	
Cs	Ba	*	Lu	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn	
132.91	137.33		174.97	178.49	180.95	183.84	186.21	190.23	192.22	195.08	196.97	200.59	204.38	207.2	208.98	(209)	(210)	(222)	
87	88	89-102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	
Fr	Ra	**	Lr	Rf	Db	Sg	Bh	Hs	Mt	Ds	Rg	Cn	Nh	Fl	Mc	Lv	Ts	Og	
(223)	(226)		(262)	(265)	(268)	(271)	(270)	(277)	(276)	(281)	(280)	(285)	(284)	(289)	(288)	(293)	(294)	(294)	
			*	57	58	59	60	61	62	63	64	65	66	67	68	69	70		
				La	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb		
				138.91	140.12	140.91	144.24	(147)	150.36	151.96	157.25	158.93	162.50	164.93	167.26	168.93	173.04		
			**	89	90	91	92	93	94	95	96	97	98	99	100	101	102		
				Ac	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No		
				(227)	232.04	231.04	238.03	(237)	(244)	(243)	(247)	(247)	(251)	(252)	(257)	(258)	(259)		

atomic number (Z)

chemical symbol

atomic mass, amu

26

Fe

55.85

Figure 4.5.2: Periodic Table showing the atomic numbers and atomic masses.

Of course, since neutral atoms require one electron for every proton, an element's atomic number also indicates the number of electrons in a neutral atom of that element. For example, hydrogen has an atomic number of 1. This means that an atom of hydrogen has one proton, and, if it's neutral, one electron as well. Gold, on the other hand, has an atomic number of 79, which means that an atom of gold has 79 protons, and, assuming it's neutral, 79 electrons.

### ⚗ Neutral Atoms

Atoms are neutral in electrical charge because they have the same number of negatively charged electrons as they have positively charged protons. Therefore, the atomic number of an atom also tells you how many electrons the atom has. This, in turn, determines many of the atom's chemical properties.

### ✏ Exercise 4.5.1

How many protons and electrons in one atom of each element, assuming the atom is electrically neutral?

- A. Co
- B. Na
- C. Ca
- D. Sr

#### Answer A

27 protons, 27 electrons

#### Answer B

11 protons, 11 electrons

**Answer C**

20 protons, 20 electrons

**Answer D**

38 protons, 38 electrons

### Summary

- Elements are pure substances that make up all matter, so each one is given a unique name.
- The names of elements are also represented by unique one- or two-letter symbols.
- Each element has a unique number of protons. An element's atomic number is equal to the number of protons in the nuclei of any of its atoms.

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