

# Chemistry Vocabulary

## Introduction

## 1 Elements and elementary substances

### 1.1 Alkali metals

#### 1.1.1 Elements

| Atomic No. | Symbol | English Name | Latin Name | Rel. Atomic Mass |
|------------|--------|--------------|------------|------------------|
| 3          | Li     | Lithium      | Lithium    | 6.94             |
| 11         | Na     | Sodium       | Natrium    | 22.99            |
| 19         | K      | Potassium    | Kalium     | 39.10            |
| 37         | Rb     | Rubidium     | Rubidium   | 85.47            |
| 55         | Cs     | Cesium       | Caesium    | 132.91           |
| 87         | Fr     | Francium     | Francium   | (223)            |

#### 1.1.2 Elementary Substances

| Element | M.P. (°C) | B.P. (°C) | Crystal Structure | Application/Source      |
|---------|-----------|-----------|-------------------|-------------------------|
| Li      | 180.5     | 1342      | BCC               | Batteries, alloys       |
| Na      | 97.7      | 883       | BCC               | Reducing agent, coolant |
| K       | 63.5      | 759       | BCC               | Fertilizer, gun powder  |
| Rb      | 39.3      | 688       | BCC               | Photoelectric cells     |
| Cs      | 28.4      | 671       | BCC               | Atomic clocks           |
| Fr      | 27        | 677       | —                 | Radioactive, no use     |

#### 1.1.3 Preparation Methods

**Sodium (Na):** Electrolysis of molten NaCl:  $2\text{NaCl} \xrightarrow{\text{electrolysis}} 2\text{Na} + \text{Cl}_2 \uparrow$

**Potassium (K):** Reduction of KCl with Na at high temperature:  $\text{KCl} + \text{Na} \xrightarrow{\text{high T}} \text{K} \uparrow + \text{NaCl}$

## 1.2 Alkaline earth metals

#### 1.2.1 Elements

| Atomic No. | Symbol | English Name | Latin Name | Rel. Atomic Mass |
|------------|--------|--------------|------------|------------------|
| 4          | Be     | Beryllium    | Beryllium  | 9.01             |
| 12         | Mg     | Magnesium    | Magnesium  | 24.31            |
| 20         | Ca     | Calcium      | Calcium    | 40.08            |
| 38         | Sr     | Strontium    | Strontium  | 87.62            |
| 56         | Ba     | Barium       | Barium     | 137.33           |
| 88         | Ra     | Radium       | Radium     | (226)            |

### 1.2.2 Elementary Substances

| Element | M.P. (°C) | B.P. (°C) | Crystal Structure | Application/Source     |
|---------|-----------|-----------|-------------------|------------------------|
| Be      | 1287      | 2470      | HCP               | Alloys, X-ray windows  |
| Mg      | 650       | 1090      | HCP               | Alloys, fireworks      |
| Ca      | 842       | 1484      | FCC               | Reducing agent, cement |
| Sr      | 777       | 1382      | FCC               | Fireworks (red)        |
| Ba      | 727       | 1897      | BCC               | Drilling fluids        |
| Ra      | 700       | 1737      | BCC               | Radioactive, obsolete  |

### 1.2.3 Preparation Methods

**Magnesium (Mg):** Electrolysis of molten  $\text{MgCl}_2$ :  $\text{MgCl}_2 \xrightarrow{\text{electrolysis}} \text{Mg} + \text{Cl}_2 \uparrow$

Alternatively, reduction of  $\text{MgO}$  with coke:  $\text{MgO} + \text{C} \xrightarrow{\text{high T}} \text{Mg} \uparrow + \text{CO} \uparrow$

**Calcium (Ca):** Electrolysis of molten  $\text{CaCl}_2$  or reduction of  $\text{CaO}$  with  $\text{Al}$

## 1.3 Transition metals

### 1.3.1 Elements (First Row)

| Atomic No. | Symbol | English Name | Latin Name | Rel. Atomic Mass |
|------------|--------|--------------|------------|------------------|
| 21         | Sc     | Scandium     | Scandium   | 44.96            |
| 22         | Ti     | Titanium     | Titanium   | 47.87            |
| 23         | V      | Vanadium     | Vanadium   | 50.94            |
| 24         | Cr     | Chromium     | Chromium   | 52.00            |
| 25         | Mn     | Manganese    | Manganese  | 54.94            |
| 26         | Fe     | Iron         | Ferrum     | 55.85            |
| 27         | Co     | Cobalt       | Cobaltum   | 58.93            |
| 28         | Ni     | Nickel       | Niccolum   | 58.69            |
| 29         | Cu     | Copper       | Cuprum     | 63.55            |
| 30         | Zn     | Zinc         | Zincum     | 65.38            |

### 1.3.2 Important Elements (Other Rows)

| Atomic No. | Symbol | English Name | Latin Name  | Rel. Atomic Mass |
|------------|--------|--------------|-------------|------------------|
| 47         | Ag     | Silver       | Argentum    | 107.87           |
| 48         | Cd     | Cadmium      | Cadmium     | 112.41           |
| 74         | W      | Tungsten     | Wolframium  | 183.84           |
| 78         | Pt     | Platinum     | Platinum    | 195.08           |
| 79         | Au     | Gold         | Aurum       | 196.97           |
| 80         | Hg     | Mercury      | Hydrargyrum | 200.59           |

### 1.3.3 Elementary Substances

| Element | M.P. (°C) | B.P. (°C) | Crystal Structure | Application/Source         |
|---------|-----------|-----------|-------------------|----------------------------|
| Ti      | 1668      | 3287      | HCP               | Aerospace alloys, pigments |
| V       | 1910      | 3407      | BCC               | Steel alloys, catalysts    |
| Cr      | 1907      | 2671      | BCC               | Stainless steel, plating   |
| Mn      | 1246      | 2061      | Cubic             | Steel production           |
| Fe      | 1538      | 2862      | BCC               | Construction, machinery    |
| Co      | 1495      | 2927      | HCP               | Alloys, magnets            |
| Ni      | 1455      | 2913      | FCC               | Alloys, catalysts, coins   |

| Element | M.P. (°C) | B.P. (°C) | Crystal Structure | Application/Source        |
|---------|-----------|-----------|-------------------|---------------------------|
| Cu      | 1085      | 2562      | FCC               | Electrical wire, plumbing |
| Zn      | 419.5     | 907       | HCP               | Galvanization, batteries  |
| Ag      | 961.8     | 2162      | FCC               | Jewelry, conductors       |
| Cd      | 321.1     | 767       | HCP               | Batteries, pigments       |
| W       | 3422      | 5555      | BCC               | Light bulb filaments      |
| Pt      | 1768      | 3825      | FCC               | Catalysts, jewelry        |
| Au      | 1064      | 2856      | FCC               | Jewelry, electronics      |
| Hg      | -38.8     | 356.7     | Rhombohedral      | Thermometers, lamps       |

### 1.3.4 Preparation Methods

**Iron (Fe):** Reduction in blast furnace:  $\text{Fe}_2\text{O}_3 + 3\text{CO} \xrightarrow{\text{high T}} 2\text{Fe} + 3\text{CO}_2$

**Copper (Cu):** Roasting sulfide ore then reduction:  $2\text{Cu}_2\text{S} + 3\text{O}_2 \longrightarrow 2\text{Cu}_2\text{O} + 2\text{SO}_2$ , then  $\text{Cu}_2\text{S} + 2\text{Cu}_2\text{O} \longrightarrow 6\text{Cu} + \text{SO}_2 \uparrow$

Alternatively, leaching and electrowinning from oxide ores.

**Zinc (Zn):** Roasting then reduction with carbon:  $2\text{ZnS} + 3\text{O}_2 \longrightarrow 2\text{ZnO} + 2\text{SO}_2$ , then  $\text{ZnO} + \text{C} \longrightarrow \text{Zn} + \text{CO}$

**Chromium (Cr):** Reduction of  $\text{Cr}_2\text{O}_3$  with aluminum (thermite process):  $\text{Cr}_2\text{O}_3 + 2\text{Al} \longrightarrow 2\text{Cr} + \text{Al}_2\text{O}_3$

## 1.4 Post-transition metals

### 1.4.1 Elements

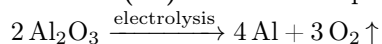
| Atomic No. | Symbol | English Name | Latin Name | Rel. Atomic Mass |
|------------|--------|--------------|------------|------------------|
| 13         | Al     | Aluminum     | Aluminium  | 26.98            |
| 31         | Ga     | Gallium      | Gallium    | 69.72            |
| 49         | In     | Indium       | Indium     | 114.82           |
| 50         | Sn     | Tin          | Stannum    | 118.71           |
| 81         | Tl     | Thallium     | Thallium   | 204.38           |
| 82         | Pb     | Lead         | Plumbum    | 207.2            |
| 83         | Bi     | Bismuth      | Bismuthum  | 208.98           |

### 1.4.2 Elementary Substances

| Element | M.P. (°C) | B.P. (°C) | Crystal Structure | Application/Source          |
|---------|-----------|-----------|-------------------|-----------------------------|
| Al      | 660.3     | 2519      | FCC               | Packaging, construction     |
| Ga      | 29.8      | 2204      | Orthorhombic      | Semiconductors, LEDs        |
| In      | 156.6     | 2072      | Tetragonal        | LCD screens, solders        |
| Sn      | 231.9     | 2602      | Tetragonal        | Solder, coatings            |
| Tl      | 304       | 1473      | HCP               | Rat poison (obsolete)       |
| Pb      | 327.5     | 1749      | FCC               | Batteries, radiation shield |
| Bi      | 271.4     | 1564      | Rhombohedral      | Alloys, cosmetics           |

### 1.4.3 Preparation Methods

**Aluminum (Al):** Hall-Héroult process (electrolysis of  $\text{Al}_2\text{O}_3$  dissolved in molten cryolite):



**Lead (Pb):** Roasting galena ( $\text{PbS}$ ) then reduction:  $2\text{PbS} + 3\text{O}_2 \longrightarrow 2\text{PbO} + 2\text{SO}_2$ , then  $\text{PbO} + \text{C} \longrightarrow \text{Pb} + \text{CO}$

**Tin (Sn):** Reduction of cassiterite ( $\text{SnO}_2$ ) with carbon:  $\text{SnO}_2 + 2\text{C} \longrightarrow \text{Sn} + 2\text{CO} \uparrow$

## 1.5 Metalloids

### 1.5.1 Elements

| Atomic No. | Symbol | English Name | Latin Name | Rel. Atomic Mass |
|------------|--------|--------------|------------|------------------|
| 5          | B      | Boron        | Borium     | 10.81            |
| 14         | Si     | Silicon      | Silicium   | 28.09            |
| 32         | Ge     | Germanium    | Germanium  | 72.64            |
| 33         | As     | Arsenic      | Arsenicum  | 74.92            |
| 51         | Sb     | Antimony     | Stibium    | 121.76           |
| 52         | Te     | Tellurium    | Tellurium  | 127.60           |
| 84         | Po     | Polonium     | Polonium   | (209)            |

### 1.5.2 Elementary Substances

| Element | M.P. (°C) | B.P. (°C)   | Crystal Structure | Application/Source          |
|---------|-----------|-------------|-------------------|-----------------------------|
| B       | 2075      | 4000        | Rhombohedral      | Glass, detergents           |
| Si      | 1414      | 3265        | Diamond cubic     | Semiconductors, solar cells |
| Ge      | 938.3     | 2833        | Diamond cubic     | Semiconductors, optics      |
| As      | 817       | 614 (subl.) | Rhombohedral      | Alloys, pesticides          |
| Sb      | 630.6     | 1587        | Rhombohedral      | Flame retardants, alloys    |
| Te      | 449.5     | 988         | Hexagonal         | Alloys, solar cells         |
| Po      | 254       | 962         | Cubic             | Radioactive, no common use  |

### 1.5.3 Preparation Methods

**Silicon (Si):** Reduction of silica ( $\text{SiO}_2$ ) with carbon in electric furnace:  $\text{SiO}_2 + 2\text{C} \xrightarrow{\text{high T}} \text{Si} + 2\text{CO} \uparrow$   
For ultrapure silicon (semiconductors): Trichlorosilane reduction:  $\text{SiHCl}_3 + \text{H}_2 \xrightarrow{\text{high T}} \text{Si} + 3\text{HCl}$

## 1.6 Halogen

### 1.6.1 Elements

| Atomic No. | Symbol | English Name | Latin Name | Rel. Atomic Mass |
|------------|--------|--------------|------------|------------------|
| 9          | F      | Fluorine     | Fluorum    | 19.00            |
| 17         | Cl     | Chlorine     | Chlorum    | 35.45            |
| 35         | Br     | Bromine      | Bromum     | 79.90            |
| 53         | I      | Iodine       | Iodum      | 126.90           |
| 85         | At     | Astatine     | Astatium   | (210)            |

### 1.6.2 Elementary Substances

| Element       | M.P. (°C) | B.P. (°C) | Physical State      | Application/Source        |
|---------------|-----------|-----------|---------------------|---------------------------|
| $\text{F}_2$  | -219.6    | -188.1    | Pale yellow gas     | Toothpaste, Teflon        |
| $\text{Cl}_2$ | -101.5    | -34.0     | Yellow-green gas    | Disinfectant, PVC         |
| $\text{Br}_2$ | -7.2      | 58.8      | Red-brown liquid    | Flame retardants, dyes    |
| $\text{I}_2$  | 113.7     | 184.3     | Purple-black solid  | Disinfectant, photography |
| $\text{At}_2$ | 302       | 337       | Solid (radioactive) | No practical use          |

### 1.6.3 Preparation Methods

**Chlorine (Cl<sub>2</sub>):** Electrolysis of brine (chlor-alkali process):  $2\text{NaCl} + 2\text{H}_2\text{O} \xrightarrow{\text{electrolysis}} \text{Cl}_2 \uparrow + \text{H}_2 \uparrow + 2\text{NaOH}$

Laboratory: Oxidation of HCl:  $\text{MnO}_2 + 4\text{HCl} \xrightarrow{\text{heat}} \text{MnCl}_2 + \text{Cl}_2 \uparrow + 2\text{H}_2\text{O}$

**Bromine (Br<sub>2</sub>):** Oxidation of bromide in seawater:  $2\text{Br}^- + \text{Cl}_2 \longrightarrow \text{Br}_2 + 2\text{Cl}^-$

**Iodine (I<sub>2</sub>):** Oxidation of iodide from brine or seaweed:  $2\text{I}^- + \text{Cl}_2 \longrightarrow \text{I}_2 + 2\text{Cl}^-$

Or from Chile saltpeter:  $2\text{NaIO}_3 + 5\text{NaHSO}_3 \longrightarrow \text{I}_2 + 3\text{NaHSO}_4 + 2\text{Na}_2\text{SO}_4 + \text{H}_2\text{O}$

**Fluorine (F<sub>2</sub>):** Electrolysis of KF in anhydrous HF:  $2\text{HF} \xrightarrow{\text{electrolysis}} \text{H}_2 + \text{F}_2 \uparrow$

## 1.7 Noble gases

### 1.7.1 Elements

| Atomic No. | Symbol | English Name | Latin Name | Rel. Atomic Mass |
|------------|--------|--------------|------------|------------------|
| 2          | He     | Helium       | Helium     | 4.00             |
| 10         | Ne     | Neon         | Neon       | 20.18            |
| 18         | Ar     | Argon        | Argon      | 39.95            |
| 36         | Kr     | Krypton      | Krypton    | 83.80            |
| 54         | Xe     | Xenon        | Xenon      | 131.29           |
| 86         | Rn     | Radon        | Radon      | (222)            |

### 1.7.2 Elementary Substances

| Element | M.P. (°C) | B.P. (°C) | Physical State | Application/Source     |
|---------|-----------|-----------|----------------|------------------------|
| He      | -272.2    | -268.9    | Colorless gas  | Balloons, cryogenics   |
| Ne      | -248.6    | -246.0    | Colorless gas  | Neon signs, lasers     |
| Ar      | -189.3    | -185.8    | Colorless gas  | Welding, light bulbs   |
| Kr      | -157.4    | -153.2    | Colorless gas  | Flash lamps, lasers    |
| Xe      | -111.8    | -108.1    | Colorless gas  | Anesthesia, ion drives |
| Rn      | -71       | -61.7     | Colorless gas  | Radioactive tracer     |

### 1.7.3 Preparation

Noble gases are obtained by fractional distillation of liquid air (except He and Rn).

**Helium (He):** Extracted from natural gas wells.

**Radon (Rn):** Decay product of radium, collected from uranium/thorium ores.

## 1.8 Other Nonmetals

### 1.8.1 Elements

| Atomic No. | Symbol | English Name | Latin Name  | Rel. Atomic Mass |
|------------|--------|--------------|-------------|------------------|
| 1          | H      | Hydrogen     | Hydrogenium | 1.008            |
| 6          | C      | Carbon       | Carboneum   | 12.01            |
| 7          | N      | Nitrogen     | Nitrogenium | 14.01            |
| 8          | O      | Oxygen       | Oxygenium   | 16.00            |
| 15         | P      | Phosphorus   | Phosphorus  | 30.97            |
| 16         | S      | Sulfur       | Sulfur      | 32.07            |
| 34         | Se     | Selenium     | Selenium    | 78.96            |

### 1.8.2 Elementary Substances

| Element                   | M.P. (°C) | B.P. (°C)       | Form/Structure   | Application/Source       |
|---------------------------|-----------|-----------------|------------------|--------------------------|
| H <sub>2</sub>            | -259.2    | -252.9          | Colorless gas    | Fuel, ammonia synthesis  |
| C<br>(graphite)           | 3825      | 4827<br>(subl.) | Hexagonal layers | Pencils, electrodes      |
| C (diamond)               | 3550      | —               | Cubic crystal    | Jewelry, cutting tools   |
| C<br>(fullerene)          | —         | —               | Molecular cage   | Research, electronics    |
| N <sub>2</sub>            | -210.0    | -195.8          | Colorless gas    | Fertilizers, inert atm.  |
| O <sub>2</sub>            | -218.8    | -183.0          | Colorless gas    | Respiration, combustion  |
| O <sub>3</sub><br>(ozone) | -192.5    | -112.0          | Blue gas         | Sterilization, UV shield |
| P<br>(white)              | 44.2      | 280             | Molecular solid  | Incendiaries, match      |
| P (red)                   | 590       | 431<br>(subl.)  | Amorphous        | Safety matches           |
| P<br>(black)              | —         | —               | Layered          | Research                 |
| S<br>(rhombic)            | 115.2     | 444.6           | Orthorhombic     | Sulfuric acid, vulcanize |
| S (monoclinic)            | 119       | 444.6           | Monoclinic       | Allotrope of sulfur      |
| Se<br>(gray)              | 221       | 685             | Hexagonal        | Photocells, glass        |

### 1.8.3 Preparation Methods

#### Hydrogen (H<sub>2</sub>):

- Steam reforming of methane:  $\text{CH}_4 + \text{H}_2\text{O} \xrightleftharpoons[\text{high T}]{\text{catalyst}} \text{CO} + 3 \text{H}_2$
- Electrolysis of water:  $2 \text{H}_2\text{O} \xrightarrow{\text{electrolysis}} 2 \text{H}_2 \uparrow + \text{O}_2 \uparrow$
- Laboratory: Reaction of metals with acids:  $\text{Zn} + 2 \text{HCl} \longrightarrow \text{ZnCl}_2 + \text{H}_2 \uparrow$

#### Oxygen (O<sub>2</sub>):

- Fractional distillation of liquid air
- Electrolysis of water:  $2 \text{H}_2\text{O} \xrightarrow{\text{electrolysis}} 2 \text{H}_2 \uparrow + \text{O}_2 \uparrow$
- Laboratory: Decomposition of KMnO<sub>4</sub>:  $2 \text{KMnO}_4 \xrightarrow{\text{heat}} \text{K}_2\text{MnO}_4 + \text{MnO}_2 + \text{O}_2 \uparrow$
- Or:  $2 \text{KClO}_3 \xrightarrow{\text{MnO}_2, \text{heat}} 2 \text{KCl} + 3 \text{O}_2 \uparrow$

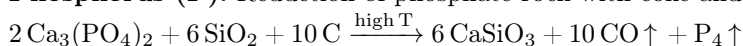
**Nitrogen (N<sub>2</sub>):** Fractional distillation of liquid air

**Chlorine (Cl<sub>2</sub>):** See Halogen section

#### Sulfur (S):

- Frasch process: Melting underground sulfur with superheated water
- Recovered from petroleum refining and natural gas processing

**Phosphorus (P):** Reduction of phosphate rock with coke and silica:



- 2 Acids and bases
- 3 Ions
- 4 Ores and alloys
- 5 Reactions
- 6 Hydrocarbons and their Halogen derivatives
- 7 Alicyclic compounds and aromatic compounds
- 8 Alcohol, phenols, ketones and aldehyde
- 9 Carboxylic acids and esters
- 10 Amines, amides and nitriles
- 11 Thiols and thioethers
- 12 Macromolecule
- 13 Plastics
- 14 Organic compounds in everyday life