



Chemistry N Review Guide

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Range: 1.0-2.0

Introduction to Chemistry

Chemistry is the study of:

1. **Composition**
2. **Changes**

of **Matter**

Alchemy is:

1. The study to turn other substances into **gold**
2. **Protoscience** that contributed to the development of chemistry

Matter is anything that has **mass** and occupies **space**

Branches of Chemistry

| Example | Branch | Definition |
|-------------------------------------|-----------------------------|---|
| Pharmaceuticals | Organic Chemistry | Study of all chemicals with carbon compounds formed with carbon chains that link |
| Minerals, Semiconductors | Inorganic Chemistry | Study of all chemicals without carbon |
| Metabolism, Fermentation | Biochemistry | Processes that happen in living organisms |
| Food nutrients, quality control | Analytical Chemistry | Study of matter composition Commonly with precise percentages |
| Reaction rates, reaction mechanisms | Physical Chemistry | Mechanism, rate and energy transfer during change, whether or not reactions can happen |

The Scientific Method is a logical and systematic approach to solve a problem.

The 4 steps are:

1. **Observation** – state problem
2. **Hypothesis and research** – propose explanation
3. **Design and experiment** – test hypothesis
4. **Provide conclusion** – judgement based on data obtained

Planning, operation and analysis will continue and repeat until the results are given and proven

Variables are quantities that are **not fixed and tested**:

- **Independent**: changed factors
- **Dependent**: response to the independent
- **Controlled**: constants, not changed

The **Control Group** is **not affected** by independent variable

Qualitative Data **does not rely on numbers** while **Quantitative Data** **relies on numbers and units**

Theories (why it happens) are **well tested explanations**, sets of conclusions and hypotheses that are **valid and proven**. They:

1. **Are imperfect** and open to revision
2. Can **predict results** of further experiments

Scientific Laws (what happens) are **concise statements** that **summarises the results** of the observations in experiments and are correct

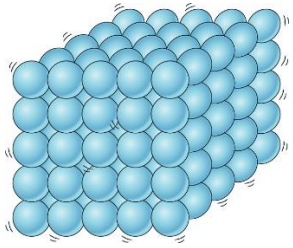
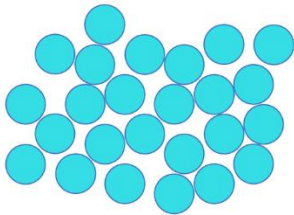
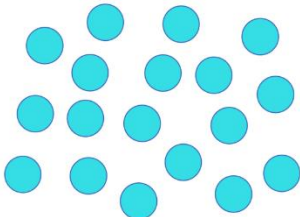
Models are **visual, verbal and or mathematical explanations** of experimental data

Matter and Change

Property is the recognizable characteristic of matter that enables us to figure its type:

- **Physical Properties** are **conditions or qualities** that can be **observed or measured without changing substance composition** (state, colour, conductivity)
- **Chemical Properties** are the **ability for a substance to undergo specific chemical change, only observable under chemical change** (tendency for rust, toxicity, stability)

States of Matter

| State | Characteristic | Attraction Force | Motion of Particle |
|--|--|------------------|---|
| Solid  | Incompressible, definite shape and volume, high density | Very strong | Vibration in fixed position |
| Liquid  | Slightly compressible, no definite shape but definite volume, high density | strong | Free movement but not far movement |
| Gas  | Highly compressible, no definite shape or volume, low density | Very weak | Free and far movement |

Vapor describes the **gaseous state** of a substance **generally in liquid or solid state at room temperature**

Physical changes do not change composition of material despite changes in properties

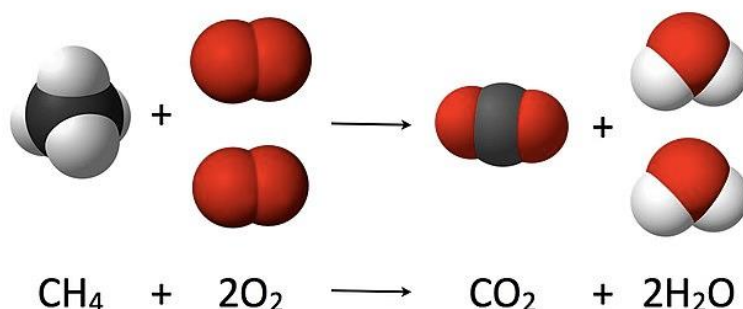
Chemical changes produce matter with different compositions compared to original matter:

- **Reactants** are substances **present at the start** of reaction
- **Products** are the substances **produced** in the reaction

Transfer of energy, change in colour or the formation of a **precipitate** (solid that forms and settles out of a liquid mixture) are all **cues to chemical change**

The Law of Conservation of Mass:

- **Matter can neither be created nor it can be destroyed** in a given chemical reaction
- **Total mass of reactants = total mass of products**



Mixtures are **physical blends** between 2 or more components

- **Proportions** can be **changed without changing mixture identity**
- **Heterogeneous mixtures** have **no uniform composition** throughout (2 or more phases)
- **Homogeneous mixtures** have **uniform composition** throughout – also called **solutions** (single phase)
- **Phase** describes **part of a sample with uniform composition** and properties

Separating Mixtures

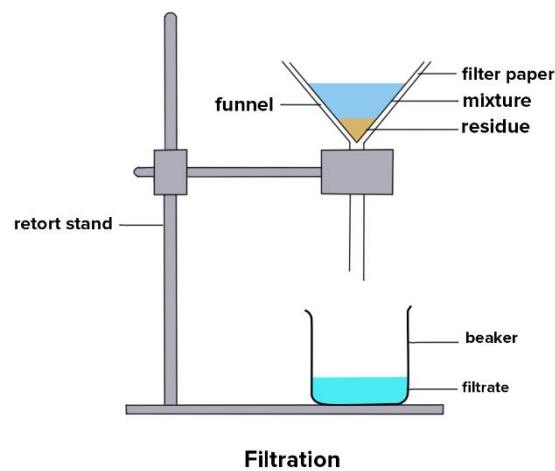
To Separate Heterogeneous Mixtures:

Separating by using differences in physical properties:

1. Decant or pour off the other layer
2. Cool mixture down until a specific substance in the mixture turns solid

Filtration:

- Process of **separating solid from liquid** in heterogeneous mixture
- Requires **filter funnel** and **filter paper**
- **Relies on size of particle, or molecule of substance**

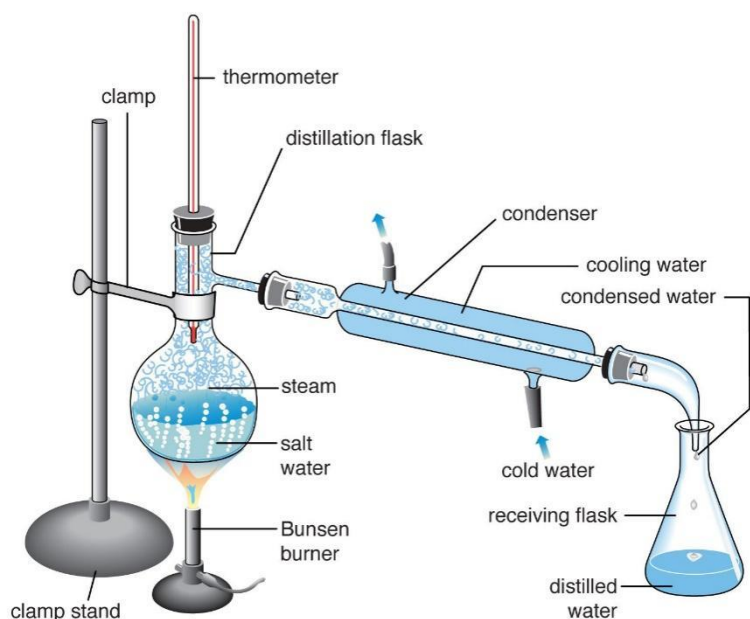


To Separate Homogeneous Mixtures:

Distillation:

- Technique based on different abilities of substances to **form gases**
- Use **distillation flask** to contain
- Use **condenser** to cool down gas into liquid

- Use **thermometer** to measure temperature



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- Use **burner** to burn
- **Relies on the boiling point of substance** – the higher the difference in the boiling point of the substances, the better distillation works out

To Separate Solid Mixtures of Different Solubilities:

Step 1: Dissolution

Dissolve one solid to make it a liquid mixture while the other solid stays solid

Step 2: Filtration

Filer the solid substance from the liquid mixture

Step 3: Crystallisation

Technique used to separate a solid dissolved in liquid

Using Magnetic Properties:

- Take advantage of **magnetic properties** of substances to separate a mixture
- Ex: separate iron nails from aluminium with a magnet

A **Substance** is matter that has uniform and definite composition. Within a

substance, there are:

- **Elements**: simplest form of matter with **unique set of properties** and is made of **atoms of one kind** – some have atoms as smallest particle (ex: Au), some have molecules as smallest particles (ex: Cl₂)

Magic 7! H₂, N₂, O₂, F₂, Cl₂, Br₂, I₂

Note that some molecules have **more than 2 atoms** (O₃, S₈, C₆₀)

- **Compounds**: substance with 2 or more elements **chemically combined** in **fixed proportion** (cannot be broken down with physical ways)

To distinguish Substances from Mixtures:

Consider if the material has more than one version: if the material has more than one version, it is a mixture. Substances have fixed compositions only.

Chemical Symbols are one or two letter symbols that **represent each element** (first letter capitalised)

Chemical Formulas represent compounds with symbols, but also:

- Tells **which elements** make up the compound
- Tells **how many atoms** of each element are present in the compound

Subscript number tells how many atoms of that element exist in one unit (no subscript = 1 atom present)

Periodic Table: arrangement of elements in which elements are separated into groups **based on a set of repeating properties**:

- Elements in order from left to right and top to bottom by **atomic number**
- **Period**: **horizontal row** (7 total), in which **element properties change gradually and predictably**
- **Group/Family**: **vertical column** (18 total) where **elements have similar properties**

Classifications of the elements include:

- **Metals**: **lustrous, malleable conductors** that are solid at room temperature (most elements)

- **Metalloids**: possess **physical and chemical properties of both metals and nonmetals**
- **Nonmetals**: **upper right side of periodic table**, generally **brittle, dull, poor conductors that are either solids or gases** (graphite is exception to being poor conductor, Br₂ is the only liquid nonmetal at room temperature)

The Periodic Table:

| | | | | | | | | | | | | | | | | | |
|---------------------------------|---------------------------------|--------------------------------|-------------------------------------|---------------------------------|----------------------------------|----------------------------------|---------------------------------|----------------------------------|------------------------------------|-----------------------------------|-----------------------------------|---------------------------------|---------------------------------|---------------------------------|-----------------------------------|----------------------------------|---------------------------------|
| 1 | | | | | | | | | | | | | | | | | 2 |
| 1 H Hydrogen 1.008 | | | | | | | | | | | | | | | | | 2 He Helium 4.003 |
| 3 Li Lithium 6.941 | 4 Be Beryllium 9.012 | | | | | | | | | | | | | | | 10 Ne Neon 20.180 | |
| 11 Na Sodium 22.990 | 12 Mg Magnesium 24.305 | | | | | | | | | | | | | | | 18 Ar Argon 39.948 | |
| 19 K Potassium 39.098 | 20 Ca Calcium 40.078 | 21 Sc Scandium 44.956 | 22 Ti Titanium 47.867 | 23 V Vanadium 50.942 | 24 Cr Chromium 51.996 | 25 Mn Manganese 54.938 | 26 Fe Iron 55.845 | 27 Co Cobalt 58.933 | 28 Ni Nickel 58.693 | 29 Cu Copper 63.546 | 30 Zn Zinc 65.38 | 31 Ga Gallium 69.723 | 32 Ge Germanium 72.631 | 33 As Arsenic 74.922 | 34 Se Selenium 78.971 | 35 Br Bromine 79.904 | 36 Kr Krypton 83.798 |
| 37 Rb Rubidium 85.468 | 38 Sr Strontium 87.62 | 39 Y Yttrium 88.906 | 40 Zr Zirconium 91.224 | 41 Nb Niobium 92.906 | 42 Mo Molybdenum 95.95 | 43 Tc Technetium 98.907 | 44 Ru Ruthenium 101.07 | 45 Rh Rhodium 102.906 | 46 Pd Palladium 106.42 | 47 Ag Silver 107.868 | 48 Cd Cadmium 112.414 | 49 In Indium 114.818 | 50 Sn Tin 118.711 | 51 Sb Antimony 121.760 | 52 Te Tellurium 127.6 | 53 I Iodine 126.904 | 54 Xe Xenon 131.293 |
| 55 Cs Cesium 132.905 | 56 Ba Barium 137.328 | 57-71 Lanthanoids | 72 Hf Hafnium 178.49 | 73 Ta Tantalum 180.948 | 74 W Tungsten 183.84 | 75 Re Rhenium 186.207 | 76 Os Osmium 190.23 | 77 Ir Iridium 192.217 | 78 Pt Platinum 195.085 | 79 Au Gold 196.967 | 80 Hg Mercury 200.592 | 81 Tl Thallium 204.383 | 82 Pb Lead 207.2 | 83 Bi Bismuth 208.980 | 84 Po Polonium [208.962] | 85 At Astatine 209.987 | 86 Rn Radon 222.018 |
| 87 Fr Francium 223.020 | 88 Ra Radium 226.025 | 89-103 Actinoids | 104 Rf Rutherfordium [261] | 105 Db Dubnium [262] | 106 Sg Seaborgium [266] | 107 Bh Bohrium [264] | 108 Hs Hassium [269] | 109 Mt Meitnerium [278] | 110 Ds Darmstadtium [281] | 111 Rg Roentgenium [280] | 112 Cn Copernicium [285] | 113 Nh Nihonium [286] | 114 Fl Flerovium [289] | 115 Mc Moscovium [289] | 116 Lv Livermorium [293] | 117 Ts Tennessine [294] | 118 Og Oganesson [294] |

Number

Symbol

Name

Atomic Mass

| | | | | | | | | | | | | | | |
|---|---------------------------------------|--|---|--|---|---|---|---|---|---|--|--|---|--|
| 57 La Lanthanum 138.905 | 58 Ce Cerium 140.116 | 59 Pr Praseodymium 140.908 | 60 Nd Neodymium 144.243 | 61 Pm Promethium 144.913 | 62 Sm Samarium 150.36 | 63 Eu Europium 151.964 | 64 Gd Gadolinium 157.25 | 65 Tb Terbium 158.925 | 66 Dy Dysprosium 162.500 | 67 Ho Holmium 164.930 | 68 Er Erbium 167.259 | 69 Tm Thulium 168.934 | 70 Yb Ytterbium 173.055 | 71 Lu Lutetium 174.967 |
| 89 Ac Actinium 227.028 | 90 Th Thorium 232.038 | 91 Pa Protactinium 231.036 | 92 U Uranium 238.029 | 93 Np Neptunium 237.048 | 94 Pu Plutonium 244.064 | 95 Am Americium 243.061 | 96 Cm Curium 247.070 | 97 Bk Berkelium 247.070 | 98 Cf Californium 251.080 | 99 Es Einsteinium [254] | 100 Fm Fermium 257.095 | 101 Md Mendelevium 258.1 | 102 No Nobelium 259.101 | 103 Lr Lawrencium |

| | | | | | | | | | |
|--------------|----------------|------------------|-------------|-----------|----------|---------|-----------|------------|----------|
| Alkali Metal | Alkaline Earth | Transition Metal | Basic Metal | Metalloid | Nonmetal | Halogen | Noble Gas | Lanthanoid | Actinoid |
|--------------|----------------|------------------|-------------|-----------|----------|---------|-----------|------------|----------|

Credits: Helmenstine, T. (2021, May 2). *Colored periodic table - printable periodic table*. Science Notes and Projects. <https://sciencenotes.org/colored-periodic-table/>

Information to Know:

- **First 20 elements** of the Periodic Table
- Chemical Formulas of **Baking Soda (NaHCO_3)**, **Sucrose ($\text{C}_{12}\text{H}_{22}\text{O}_{11}$)**, **Sulfuric Acid (H_2SO_4)**, **Hydrogen Peroxide (H_2O_2)** and **Sulphur Dioxide (SO_2)**