

Chemistry

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Periodic table

PERIODIC TABLE OF ELEMENTS																	
Chemical Group Block																	
1	2															17	18
1 1.0080 H Hydrogen Nonmetal																5 10.81 B Boron Metalloid	6 12.011 C Carbon Nonmetal
3 7.0 Li Lithium Alkali Metal	4 9.012183 Be Beryllium Alkaline Earth Me...															7 14.007 N Nitrogen Nonmetal	8 15.999 O Oxygen Nonmetal
11 22.989... Na Sodium Alkali Metal	12 24.305 Mg Magnesium Alkaline Earth Me...															13 26.981... Al Aluminum Post-Transition M...	14 28.085 Si Silicon Metalloid
19 39.0983 K Potassium Alkali Metal	20 40.08 Ca Calcium Alkaline Earth Me...	21 44.95591 Sc Scandium Transition Metal	22 47.867 Ti Titanium Transition Metal	23 50.9415 V Vanadium Transition Metal	24 51.996 Cr Chromium Transition Metal	25 54.93804 Mn Manganese Transition Metal	26 55.84 Fe Iron Transition Metal	27 58.93319 Co Cobalt Transition Metal	28 58.693 Ni Nickel Transition Metal	29 63.55 Cu Copper Transition Metal	30 65.4 Zn Zinc Transition Metal	31 69.723 Ga Gallium Post-Transition M...	32 72.63 Ge Germanium Metalloid	33 74.92159 As Arsenic Metalloid	34 78.97 Se Selenium Nonmetal	35 79.90 Br Bromine Halogen	36 83.80 Kr Krypton Noble Gas
37 85.468 Rb Rubidium Alkali Metal	38 87.62 Sr Strontium Alkaline Earth Me...	39 88.90584 Y Yttrium Transition Metal	40 91.22 Zr Zirconium Transition Metal	41 92.90637 Nb Niobium Transition Metal	42 95.95 Mo Molybdenum Transition Metal	43 96.90636 Tc Technetium Transition Metal	44 101.1 Ru Ruthenium Transition Metal	45 102.9055 Rh Rhodium Transition Metal	46 106.42 Pd Palladium Transition Metal	47 107.868 Ag Silver Transition Metal	48 112.41 Cd Cadmium Transition Metal	49 114.818 In Indium Post-Transition M...	50 118.71 Sn Tin Post-Transition M...	51 121.760 Sb Antimony Metalloid	52 127.6 Te Tellurium Metalloid	53 126.9045 I Iodine Halogen	54 131.29 Xe Xenon Noble Gas
55 132.90... Cs Cesium Alkali Metal	56 137.33 Ba Barium Alkaline Earth Me...		72 178.49 Hf Hafnium Transition Metal	73 180.9479 Ta Tantalum Transition Metal	74 183.84 W Tungsten Transition Metal	75 186.207 Re Rhenium Transition Metal	76 190.2 Os Osmium Transition Metal	77 192.22 Ir Iridium Transition Metal	78 195.08 Pt Platinum Transition Metal	79 196.96... Au Gold Transition Metal	80 200.59 Hg Mercury Transition Metal	81 204.383 Tl Thallium Post-Transition M...	82 207 Pb Lead Post-Transition M...	83 208.98... Bi Bismuth Post-Transition M...	84 208.98... Po Polonium Metalloid	85 209.98... At Astatine Halogen	86 222.01... Rn Radon Noble Gas
87 223.01... Fr Francium Alkali Metal	88 226.02... Ra Radium Alkaline Earth Me...		104 267.1... Rf Rutherfordium Transition Metal	105 268.1... Db Dubnium Transition Metal	106 269.1... Sg Seaborgium Transition Metal	107 270.1... Bh Bohrium Transition Metal	108 269.1... Hs Hassium Transition Metal	109 277.1... Mt Meitnerium Transition Metal	110 282.1... Ds Darmstadtium Transition Metal	111 282.1... Rg Roentgenium Transition Metal	112 286.1... Cn Copernicium Transition Metal	113 286.1... Nh Nihonium Post-Transition M...	114 290.1... Fl Flerovium Post-Transition M...	115 290.1... Mc Moscovium Post-Transition M...	116 293.2... Lv Livermorium Post-Transition M...	117 294.2... Ts Tennessine Halogen	118 295.2... Og Oganesson Noble Gas
			57 138.9055 La Lanthanum Lanthanide	58 140.116 Ce Cerium Lanthanide	59 140.90... Pr Praseodymium Lanthanide	60 144.24 Nd Neodymium Lanthanide	61 144.91... Pm Promethium Lanthanide	62 150.4 Sm Samarium Lanthanide	63 151.964 Eu Europium Lanthanide	64 157.2 Gd Gadolinium Lanthanide	65 158.92... Tb Terbium Lanthanide	66 162.500 Dy Dysprosium Lanthanide	67 164.93... Ho Holmium Lanthanide	68 167.26 Er Erbium Lanthanide	69 168.93... Tm Thulium Lanthanide	70 173.05 Yb Ytterbium Lanthanide	71 174.9668 Lu Lutetium Lanthanide
			89 227.02... Ac Actinium Actinide	90 232.038 Th Thorium Actinide	91 231.03... Pa Protactinium Actinide	92 238.0289 U Uranium Actinide	93 237.04... Np Neptunium Actinide	94 244.06... Pu Plutonium Actinide	95 243.06... Am Americium Actinide	96 247.07... Cm Curium Actinide	97 247.07... Bk Berkelium Actinide	98 251.07... Cf Californium Actinide	99 252.0830 Es Einsteinium Actinide	100 257.0... Fm Fermium Actinide	101 258.0... Md Mendelevium Actinide	102 259.1... No Nobelium Actinide	103 266.1... Lr Lawrencium Actinide

How to read a periodic table

1. Periods - elements in the same row with the same amount of electron shells
2. Group - elements in the same column sharing similar chemical properties and have the same amount of electrons in outer shell

3. Blocks - (s,p,d,f) based on electron configuration. Also explain chemical reactivity and bonding
4. Metals, non metals, metalloids - Metals on the left, metalloids in between and non metals on right

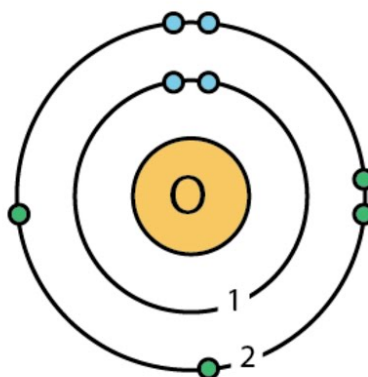
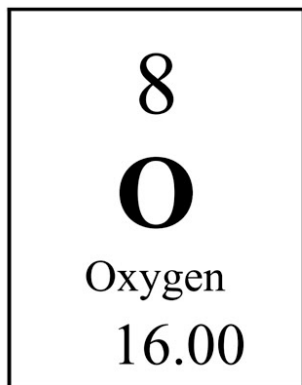
Molecule of elements

When atoms of the same element join together we get a **molecule** of that element

Oxygen is like this. Two oxygen atoms join together to make an oxygen molecule. Most of the oxygen in the air is in this form. Hydrogen and chlorine also have molecules with two atoms.

Bohr Diagram

Atomic Structure



Atomic number

- Number of protons in the nucleus of an atom

Atomic mass

- The average mass of protons, neutrons and electrons in an atom.

Valency

- Refers to how elements bond with each other
- Determined by the number of electrons in its **outermost** shell
- To have a stable configuration, it sometimes loses them to achieve a positive valency or gain them giving them a negative valency
- Electrons are **negative**
- Protons are **positive**
- Neutrons are **neutral**

Compounds and mixtures

A **compound** is made when atoms of **different elements** join together by **chemical bonding**.

- Properties are often very different from the elements they contain. E.g
 - Hydrogen and oxygen are both gases at room temp, but water is a liquid

A **mixture** is an impure substance created when 2 chemicals aren't chemically bonded but rather **mixed** together.

Naming Metal - nonmetal compounds

- Name metal first
- Name the non-metal component second and remove the last part of the word and add the suffix of "-ide"
 - Oxygen becomes oxide
 - Chlorine becomes chloride
- List of some anions
 - Ammonium NH_4
 - Bromide Br
 - Chloride Cl
 - Hydroxide OH^-
 - Iodide I
 - Nitrate NO_3^-
 - Carbonate CO_3^{2-}
 - Oxide O
 - Sulphate SO_4^{2-}
 - Sulphide S

- Phosphate PO_4^{3-}

Chemical formula - How to represent compounds

Compounds have constant composition with respect to mass because they are composed of atoms in fixed ratios

Ions

An ion is an atom that has gained or lost one or more electrons

Cations

Positive ions are ions that have lost electrons. They have more protons than electrons, so they carry a positive electrical charge.

Anions

Negative ions are atoms that have gained electrons. They have more electrons than protons so they carry a negative electrical charge.

Valencies

The valency of an ion is the charge that is formed when an atom changes into being an ion

E.g. Magnesium atom (Mg) turns into magnesium ion (Mg^{2+}). The valency of magnesium ion is 2+

OR

Oxygen atom (O) turns into the oxide ion (O^{2-}) The valency of the oxygen ion is 2-

Atom	Atom symbol	Electrons exchange	Ion symbol
Lithium	Li	1 lost	Li^+
Magnesium	Mg	2 lost	Mg^{2+}

Aluminium	Al	3 lost	Al ³⁺
Nitrogen	N	3 gained	N ³⁻
Oxygen	O	2 gained	O ²⁻
Chlorine	Cl	1 gained	Cl ⁻

Sulphate, phosphate, nitrate and hydroxide will be the main 4 you will need to know and use.

The process is similar, however we need to use brackets when there are 2 or more of sulphate, phosphate nitrate and hydroxide.

- Group 1 has +1 charge
 - Group 2 has +2 charge
 - Group 13 has 3+ charge
 - Group 14 has ± 4 charge
 - Group 15 has -3 charge
 - Group 16 has -2 charge
 - Group 17 has -1 charge
 - Group 18 is neutral (noble gases)
-

Chemical reactions

- **Physical** change, matter changes its **appearance** but not its composition
- **Chemical** change matter does change its **composition**

Signs of chemical reaction

- Change in colour

- Bubbles of fizzing which means a gas is being made
- A change in temperature
 - chemicals become hotter or colder
- A precipitate which is an insoluble solid substance being made
- The reacting chemicals slowly disappear, or new chemicals appear

Reactants and products

The reacting chemicals are called reactants or reagents. They are consumed and used in the chemical reaction.

Law of conversion

- The mass of reactants will always equal to the mass of products.
-

How atoms join to form compounds

Ionic bonding

- Attraction between 2 atoms that have **gained** or **lost** electrons to become charged ions.
- Only between negatively charged and positively charged ion
 - The negative ion **gives** electrons to the positive to form a **neutral** compound
- They have the following in common
 - Made up of positive and negative ions
 - Usually solids are room temperature

- Very high melting points because of electrostatic force of attraction between ions is very strong
- Usually dissolve in water to form aqueous solution

Covalent bonding

- Attraction between 2 atoms that secured by sharing electron/s from each of the atoms
- Bond over non metal atoms
- Properties include
 - Exist as gases, liquids or solids with low melting points because the forces of attraction between the molecules are weak
 - Generally don't conduct electricity because they aren't made up of ions
 - Usually insoluble in water

Metallic bonding

- Metallic bonds only exist in a group of metal atoms. They are responsible for maintaining the metal atoms in a solid form.
- They are described as the nuclei of metal atoms in a sea of electrons. This "sea of electrons" is the reason that metals are such good conductors of electricity and heat.

Comparing and contrasting ionic, covalent and metallic bonds

	Ionic	Covalent	Metallic
Electrons	Transferred	Shared, evenly or unevenly	Electron sea
Bond	Metal to nonmetal	Nonmetal to metal	Metal to metal

Electronegativity differences	Differences greater than 2	Differences between 0 and 2	NA
Make compounds	Yes by attraction of opposite charged ions	Molecules or molecular elements	No
State (STP)	Crystalline solid	Liquid, gas or solid	Malleable and ductile solid
Melting point	high	low	low
Conductivity	Liquid and aqueous state, yes	no	yes
Water solubility	high	low	no

Chemical equations

- Substances on the left side are **reactants** and the right are **products**
- State the state of each reactant next to the formula
- Abbreviations
 - Gas (g)
 - Liquid (l)
 - Solid (s)
 - Aqueous (aq)

Chemical reactions

- The total amount of energy stored in a substance is called **enthalpy** which is made up of:
 - Kinetic energy
 - Relates to the motion of the electrons and the atom.

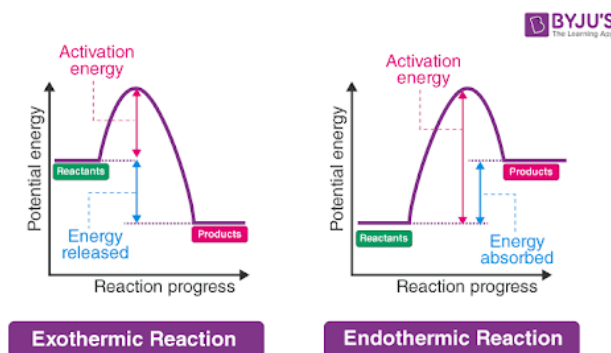
- Temperature is a measure of the average kinetic energy in atoms
- When a substance **rises** in temperature, its atoms move faster and therefore **higher** kinetic energy
- Potential energy
 - Attractions and repulsions present in the atom as well as the attractions present between different atoms
 - The extent of the bonds it forms with other atoms

Exothermic reactions

- Chemical reaction that releases energy
- Often causes an **increase** in temperature
 - Energy is released as heat

Endothermic

- A reaction in which energy is absorbed
- Energy must be **added** to the reaction
 - Causes a **drop** in temperature so they can take up energy
- **Absorb** energy
- E.g Photosynthesis is the most important endothermic reaction



Combustion

- Fast reaction of chemical with oxygen
 - Releases the **stored chemical energy** in form of heat, therefore **exothermic** reaction.
- If the reactant is a **metal**, the product will **always** be a **metal oxide**
- If the product that is being combusted is an **organic** material (eg. glucose), the products will **always** be **carbon dioxide** and **water**

Complete combustion

- When hydrocarbons or alcohols burn in lots of oxygen, carbon dioxide and water are produced
 - this is called **complete combustion**
- Produce heat energy which is able to be harnessed

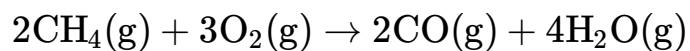
Incomplete combustion

- If supply of oxygen is **limited**, then **incomplete combustion** may occur

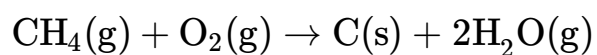
- Characterised by black smoky flames.

- Two reactions occur simultaneously:

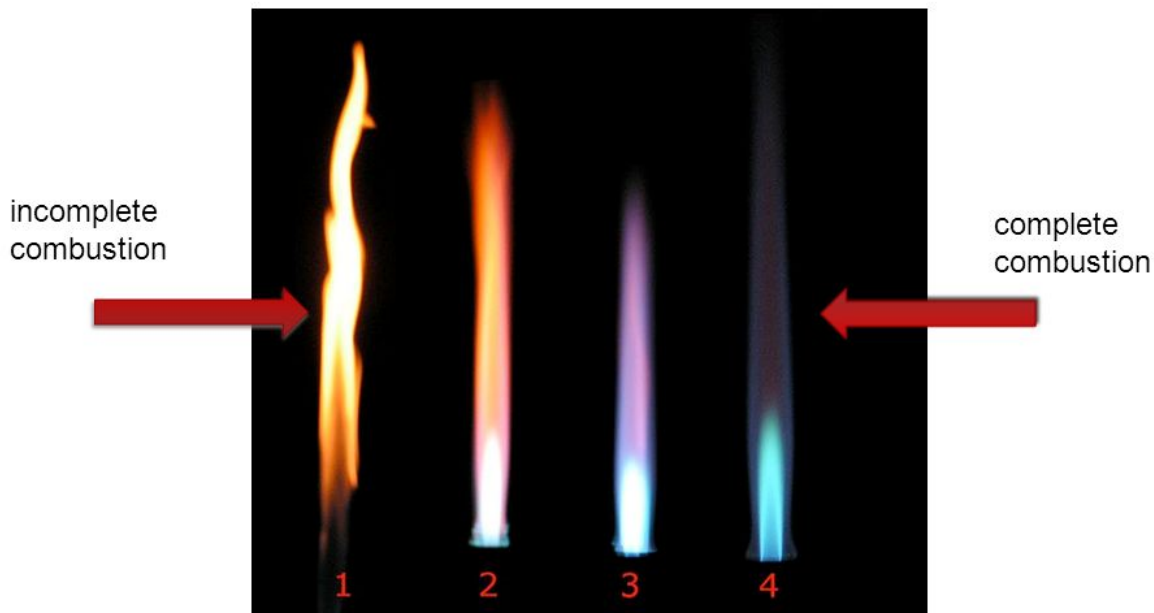
- Methane + oxygen → carbon monoxide + water



- Methane + oxygen → carbon + water



Example



How do living organisms get the energy to live?

- The body needs a constant supply of energy which comes from **digestion**
- **Glucose** from digested carbohydrates is an important substance that contains stored **chemical** energy

Respiration

- Living cells use a process called **respiration** to release energy from digested food (glucose), as it occurs in cells we call it **cellular respiration**

Glucose + oxygen → carbon dioxide + water + energy

- Reactants
 - Glucose from digestive system
 - Oxygen from respiratory system
- Waste products
 - Carbon dioxide exhaled
 - Water exhaled

Comparison of combustion and respiration

Similarities

- Release energy
- Require oxygen and a fuel source
- Product the same products
 - Carbon dioxide and water

Differences

Combustion	Respiration
takes place in open	Takes place in cells

Occurs in single step	Many steps
No enzymes	Controlled by enzymes
Energy release is vigorous and not under control	Energy release is more gradual and under control
Energy is released in form of heat and light (flame can result)	Energy is released in form of heat and energy rich compound

Acids, bases and neutralisation

Acids

- Contain hydrogen
- React with metals to create **salt** and **hydrogen gas**
- React with **carbonates** to create **salt**, **carbon dioxide** and **water**
- Examples
 - Hydrochloric acid HCl found in the stomach
 - Sulfuric acid H_2SO_4 found in car batteries
 - Nitric acid HNO_3
 - Acetic acid CH_3COOH found in vinegar
 - Carbonic acid H_2CO_3 found in soft drinks

Bases and alkalis

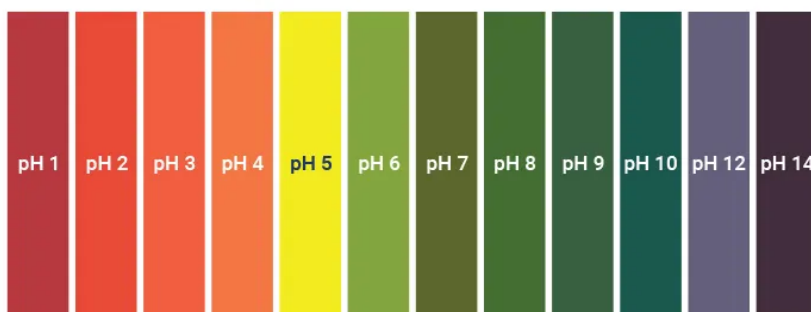
- Group of substances that neutralise acids, reacting with acids to form **salts** and **water**.
- Common bases used in classrooms
 - Sodium hydroxide NaOH
 - Potassium hydroxide KOH
- Sodium chloride is found in oven cleaners and drain unclogging agents

- Ammonium hydroxide floor cleaners
- Sodium bi-carbonate in bi-carbonate soda
- Sodium hydroxide is found in household soap
- Magnesium hydroxide found in antacid tablets

Indicators

- Chemicals that turn different colours in acid and base solutions
 - Red and blue litmus paper
 - Universal indicator
 - Phenolphthalein
 - Red cabbage

Universal Indicator Colour Chart (pH 1-14)



The tints of buffer contain 2% indicator (0.2ml per 10ml)
For use with Westlab Universal Indicator only.

Re-order code: 702-CHART
westlab.com.au

pH

- Measures how acidic or basic a substance is
- Scale of 1-14
- Acid < 7 pH
- Base > 7 pH
- Neutral = 7 pH
- Relates to how many H ions in the solution

pH 0	Battery Acid
pH 1	Stomach Acid
pH 2	Lemon Juice, Vinegar
pH 3	Orange Juice, Soda, Some Dental Rinses
pH 4	Tomato Juice, Beer
pH 5	Black Coffee
pH 6	Saliva, Cow's Milk
pH 7	Pure Water
pH 8	Sea Water, Ph-Neutralizing Dental Rinses
pH 9	Baking Soda
pH 10	Antacids
pH 11	Antacids, Dental Treatment Rinses
pH 12	Soapy water

Neutralisation

- When an acid reacts with a base. Water is always a product in a neutralisation reaction as is salt
 - Acid + Base → Salt + Water
 - Applications
 - Ant and bee stings are **acidic** so need to be neutralised with a **basic** solution
 - Tooth paste is slightly basic which neutralises acids made by tooth decay
-

Acids and metals

- Always react with a metal to produce salt and hydrogen gas H₂
- Represented by general word equation
 - ACID + METAL → SALT + HYDROGEN GAS
- Different acids produce different salts. E.g
 - Hydrochloric acid produces chloride salts

- Sulfuric acid produces sulfate salts
 - Nitric acid produces nitrate salts
-

Acids and Carbonates

- Carbonate is a substance containing CO_3
 - Acids always react with carbonates to produce a salt, water (H_2O) and carbon dioxide gas (CO_2)
-

Precipitation reactions

- When **sodium chloride** is dissolved in water to form an **aqueous** solution, it seems to 'disappear'.
 - The sodium ions and the chloride ions **separate** when they **dissolve** in water. Ions in aqueous solutions are therefore separate entities and are able to react independently.
 - When two solutions containing dissolved ions are mixed together, these ions are able to come into contact with each other.
 - **Oppositely** charged ions **attract**. In some cases, the attraction is strong enough to form ionic bonds and hence a **new ionic compound**.
 - Some of these compounds are **insoluble** (unable to dissolve in water) and so a **solid forms**. This solid is called a **precipitate**.
 - Chemical reactions in which precipitates form are called precipitation reactions.
-

Decomposition

- Reaction where **one** substance is broken into **2 or more** new substances
 - E.g Hydrogen peroxide is decomposed into water and oxygen
-

Rate of chemical reactions

- 3 main factors that affect the rate
 - Concentration
 - Surface area
 - Temperature
 - Chemical factors that affect reaction rate are called **catalysts** in non-organic and **enzyme** in organic
-