POTIONS - 2026
Grades 4,5
Study Guide/Outline

This study guide is intended to help coaches understand the topics the event will cover and the level of comprehension expected for those topics. It is recommended and expected that additional materials, websites and activities be used to help prepare the teams for this event.

Topics for Grades 4,5

- States of Matter (or phases): solid, liquid, gas
- Properties of solids, liquids, gases
- Transitions between phases
- Law of Conservation of matter/mass
- Structure of matter: atoms, elements, molecules, compounds
- Mixtures
- Periodic table of elements
- Atomic numbers, mass numbers, Bohr models
- Basic elements: H, O, N, C, Al, Na, Cu, Cl, P, S, He, Ar
- Physical and chemical properties, physical vs. chemical changes
- Acids and bases, pH scale
- Environmental Science
- Ink Chromatography

Additional Topics for Grade-5 only:

- Chemical reactions - activation energy, reaction rates, equilibrium, reactants and products, equations and stoichiometry
- Ions and Isotopes (what they are and how they are represented)
- Chemical bonding - ionic vs. covalent
- Periodic Trends:
    - Atomic Radius Trends
    - Metallic Character Trends
- Iodine Test

Study Guide/Outline: *Grade-specific concepts are marked accordingly.*

I. What is Chemistry?

The science that studies substances that make up matter and the changes that take place when substances interact. In other words, everything you hear, see, smell, taste, and touch involves chemistry and chemicals (matter). For example, chemistry is involved in cooking and making ice as well as in fireworks, paint, medicine, digestion of food, shape of a snowflake, etc.

People who study chemistry are called chemists. By studying what matter is made of, chemists create new substances. They have made plastics, building materials, new medicines, insecticides, and many other substances that are useful in everyday life.

II. What is Matter?

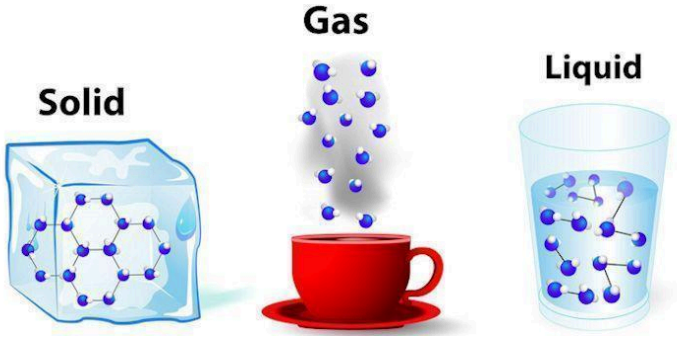
Everything around us is made up of matter. You are matter, the bed you sleep on is matter and the air you breathe are all types of matter.

- **Matter** is anything that has **mass** and takes up space (and so, it has **volume**).
- **Mass** is the amount of matter in an object. The mass of something is determined by the number of atoms (see below), the type of atoms and the **density** of those atoms. Mass is measured in grams.
- **Volume** is the amount of space something occupies.
- **Density** is the amount of matter in a certain volume.

III. States of matter

Matter can be primarily found in three physical states (also called phases): solid, liquid and gas

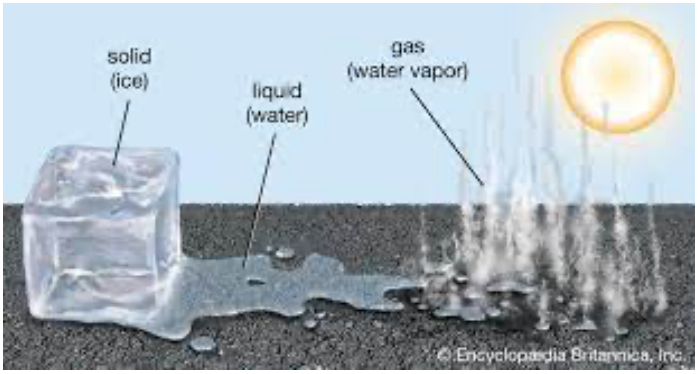
- **Solid** - A solid has a definite shape (rigid) and a definite volume.
- **Liquid** - A liquid has a definite volume but no defined shape.
- **Gas** - A gas has no definite shape (takes the shape of its container) or volume.



(Note: Students do not need to know about plasmas and Bose-Einstein condensates. Students need to understand the basic concepts of volume and density.)

IV. Transitions Between States/Phases

- Matter is found in one of those physical states but can change from one state to another. Matter can change from one state to another when a physical force is applied to it. This physical force is often a change in temperature (heat energy). Example: Heat can be applied to change ice to water to steam/vapor



- When matter moves from one state to another, its density changes. **Density** is the amount of matter in a given volume (in other words, how compact a substance is).
- When a material changes state, its smallest units, called molecules, behave differently. However, the material's molecules do not break apart and form into a different material. They remain the same.
- A change in the state of matter is a reversible change. You can turn water into ice and then back into water.
- Terms for the transitions between phases of matter
    - **Freezing** - a process where a liquid changes to a solid by cooling. The temperature at which this occurs is called the freezing point of the substance.
    - **Melting** - a process where a solid changes to a liquid by adding heat. The temperature at which a solid becomes a liquid is called its melting point.
    - **Evaporation/Boiling** - a process where a liquid changes to a gas by adding heat. The temperature at which this occurs is called the boiling point of the liquid..
    - **Condensation** - a process where a gas changes to a liquid by cooling. The temperature at which this occurs is called the condensation point of the substance. Example: rain, fog, mist, etc.
    - **Sublimation** - a process where solid transforms into a gas without ever becoming a liquid. Example: dry ice - when dry ice gets exposed to air, dry ice directly changes its phase from solid to gas.

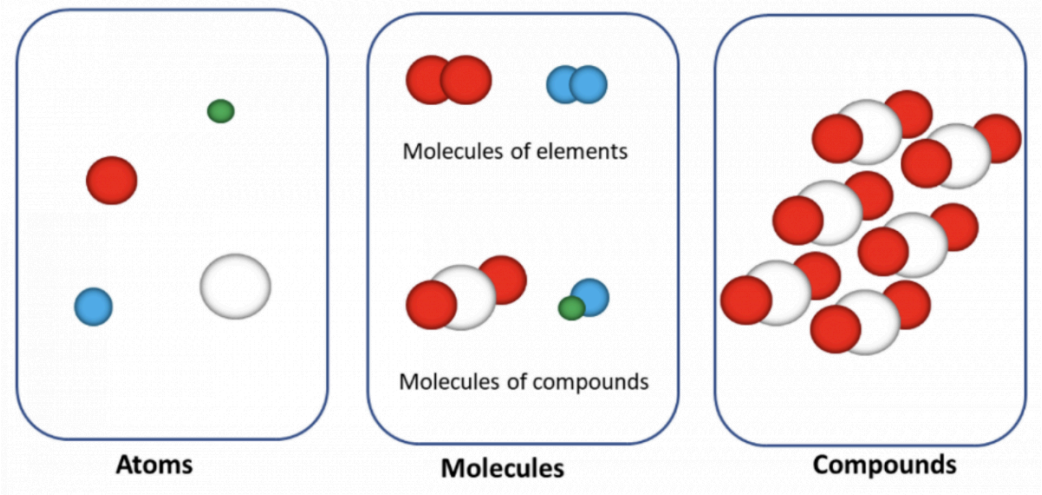
V. Law of Conservation of Matter/Mass

- Simple version - Matter can neither be created nor destroyed.
- Students should understand that this applies to both physical and chemical changes. When you have a certain amount (mass) of water and you boil it, you still have the same mass of water. It has just transferred from liquid water to water vapor. See more under physical and chemical reactions.

VI. Structure of Matter

All matter is composed of atoms. Therefore, the atom is the basic building block of matter.

- **Atom** - The smallest particle of any element that still retains the characteristics of that element.
- **Elements** - An element is a pure substance made from a single type of atom. Each element has specific properties. For example, gold is a shiny metal but oxygen is an invisible gas.
- **Molecule** - A molecule is formed when two or more atoms bond together. These atoms can either be of the same element (Oxygen, O_2) or of different elements (water, Hydrogen and Oxygen, H_2O).
- **Compound** - When the molecule is made of different elements, it can also be called a compound. When different elements are combined, they form a new substance with its own properties. Example: Water (H_2O) consists of molecules made up of 2 hydrogen atoms and 1 oxygen atom.



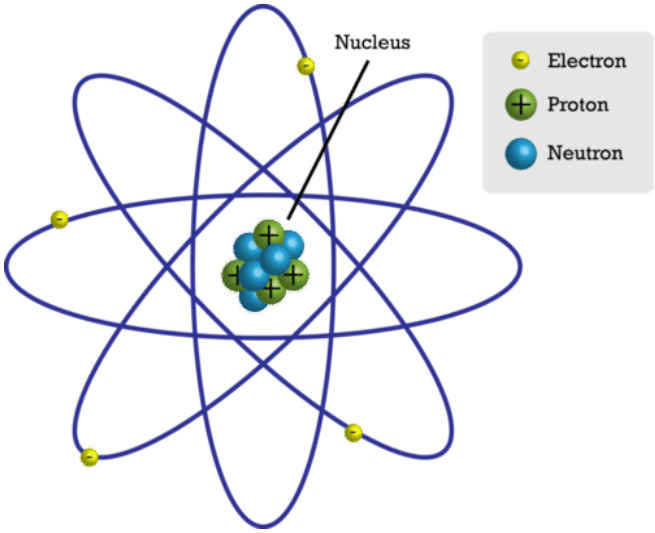
A. Basic Atomic Structure

Atoms are the fundamental building block or the smallest unit of matter. Particles that are smaller than an atom are called subatomic particles. There are three main subatomic particles. These subatomic particles are found in the center of the atom (nucleus) or moving around the nucleus.

- **Protons** - found in the nucleus, have a positive charge
- **Neutrons** - found in the nucleus, have no charge (neutral)
- **Electrons** - negatively charged particles that spin around the outside of the nucleus in what are referred to as an electron cloud. Electrons are much smaller than protons and neutrons.

- There are different kinds of atoms based on the number of electrons, protons, and neutrons each atom contains.
- In the periodic table, atomic number is found to the upper left of the element abbreviation. It indicates the number of protons in the element.
- Mass number is found below the element abbreviation, and approximately gives the total number of protons + neutrons in the atom.

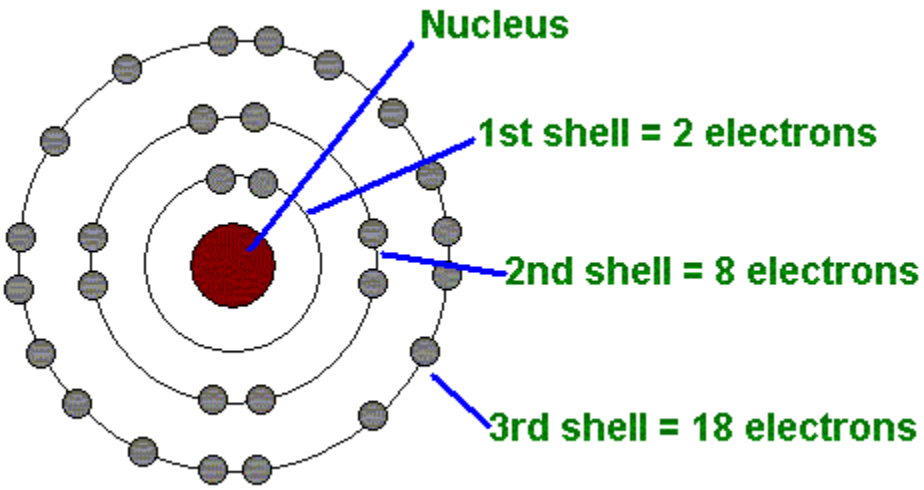
- Any atom of a specific element will always have the same number of protons.
- In the atom of a specific element, the number of protons and electrons are the same (except for ions) but the number of neutrons can differ (isotopes).



B. Bohr model

The electrons of atoms do not just float around wherever they want in the electron cloud. They circle the nucleus in specific electron shells or orbitals.

- Electron orbital rule - The electrons of an atom will be located in specific orbitals starting with the one closest to the nucleus:
  - ➢ K = First orbital/shell holds 2 electrons
  - ➢ L = Second orbital/shell holds 8 electrons
  - ➢ M = Third orbital/shell holds 18 electrons



5th grade only: Students must be able to identify elements based on a provided basic Bohr model for an element.

C. Ions (5th grade only)

An atom itself can have a positive or negative charge. Since the number of protons in an atom does not change, it is the gain or loss of electrons that will give an atom a charge. An atom with a charge is called an **ion**.

- Ions - atoms with extra electrons or missing electrons
- Cation – missing an electron, positively charged: H+
- Anion – gained an electron, negatively charged: Cl-
- Ions of opposite charge like to interact and form bonds

D. Isotopes (5th grade only)

An atom of a specific type of element can have different numbers of neutrons. Atoms with different numbers of neutrons are called **isotopes.**

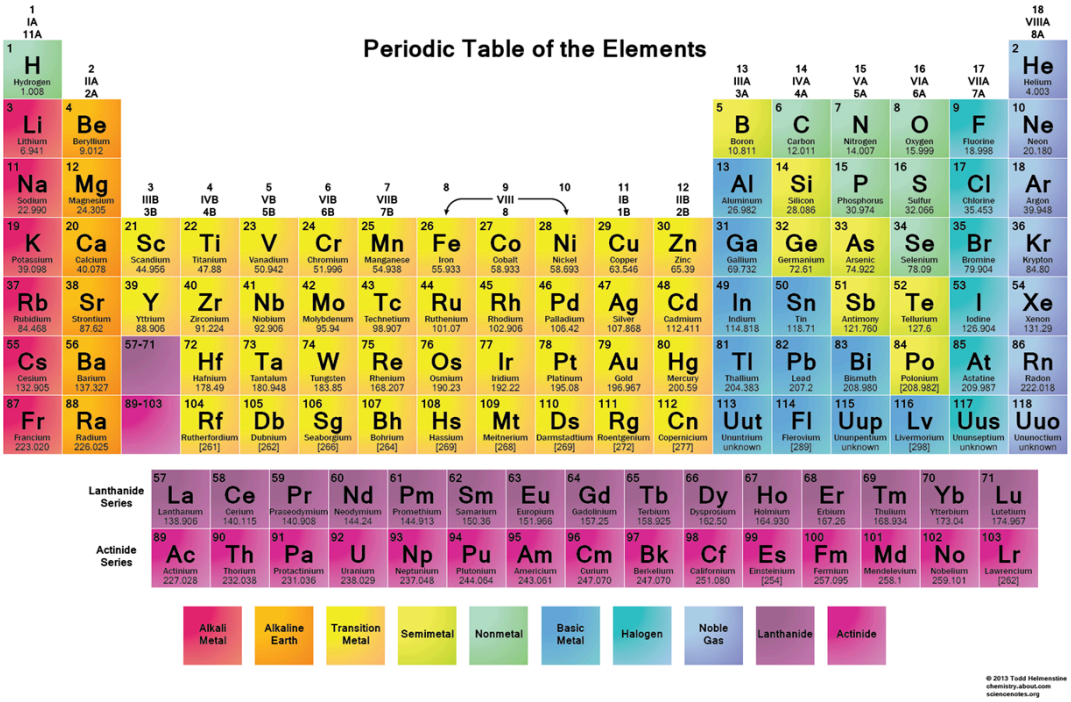
- Since neutrons are neutral the charge of that atom is not changed.
- Neutrons do contribute to the mass of an atom so if it has an extra neutron or it loses a neutron, that isotope will have a different mass than the most common form of that element.
- Isotopes of a type of element act the same way chemically.
- Example – Carbon:
  - ➢ most common form has 6 neutrons & 6 protons ^{12}C or just C
  - ➢ an isotope with an additional neutron ^{13}C

VII. Periodic Table of Elements

The periodic table contains all the elements organized based on their atomic structure. That means that each element is made of atoms that are slightly different and therefore, behave in a different way. Gold is an element and its atoms are arranged in a way that makes gold a shiny metal. Oxygen is another element but its atoms are arranged so that oxygen is a colorless gas.

A. Basic organization of periodic table:
   - ○ Each square represents one element. In the square is the name of the element (or its abbreviation), the atomic number of the element, and often its atomic mass.
   - ○ The elements are organized in the table from left to right in order of increasing atomic number.
   - ○ Groups - The vertical columns. Same # of electrons in their outermost shell.
   - ○ Periods – The horizontal rows. Same # of shells.

B. Additional information in the Periodic Table:
   - ○ Atomic number – how many protons/electrons an element has
   - ○ Atomic weight – sum of the atoms' protons, neutrons and electrons (but electrons are so small that they add very little weight).
   - ○ Symbol – abbreviation for the name of the element.
   - ○ Atomic mass – Atomic number = # of neutrons



Note: A separate pdf file of the above Periodic table is available on the WESO website. A similar version will be provided to grades 4 and 5 at the event. They do not need to memorize the full names of the elements. That information would be provided if needed.)

C. Element Families
Elements are grouped into families based on the way they behave chemically.
- Metals
  - Good conductors of heat and electricity
  - High melting point
  - Malleable
  - Chemically reactive
  - Easily combine with other metals to make mixtures called alloys.
  - Broken down into Alkali Metals, Alkaline Earth Metals and Transition Metals
- Nonmetals: There are 17 elements that are loosely grouped as nonmetals and have properties usually opposite that of metals. They are poor conductors of electricity and heat and in the solid state are non lustrous and brittle.
  - Halogens - Group 17, very chemically reactive
  - Noble gases - Group 18, Non reactive because they have full outer electron shells

D. Basic Elements:
Hydrogen, Oxygen, Nitrogen, Carbon, Aluminum, Sodium, Copper, Chlorine, Phosphorus, Sulfur, Helium, Argon

Students need to know:

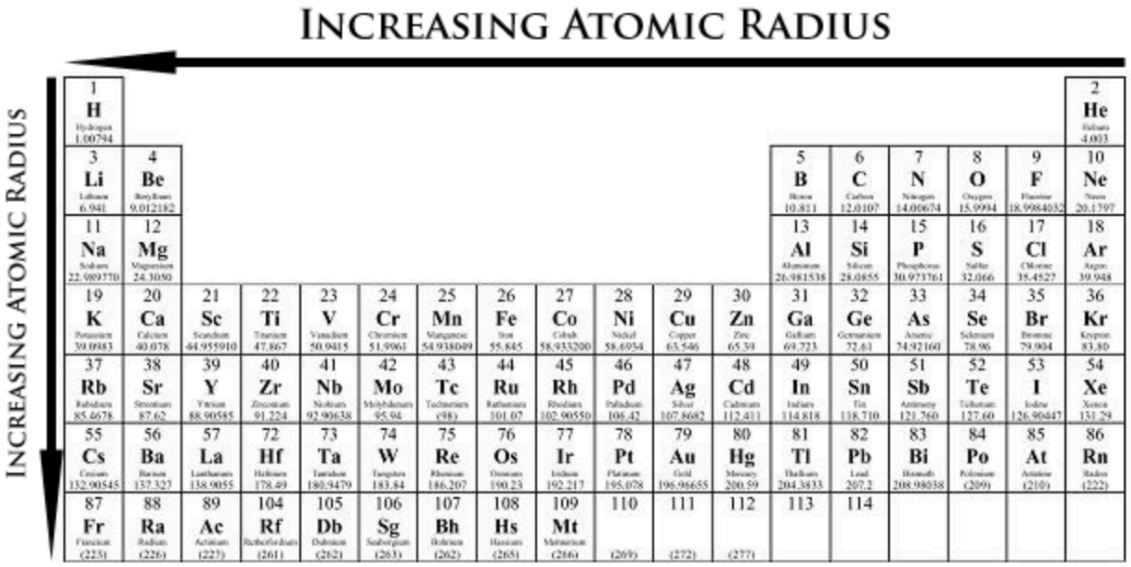
- general characteristics of these elements and their uses
- group classification – (Metal, Nonmetal, Halogen, Noble Gas).
- where you would commonly find this element
- physical state at room temp. and pure form – solid, liquid, gas

The following sites are useful:
http://www.ducksters.com/science/elements.php
http://www.chem4kids.com/files/elements/

E. Periodic Trends **(5th Grade Only)**:

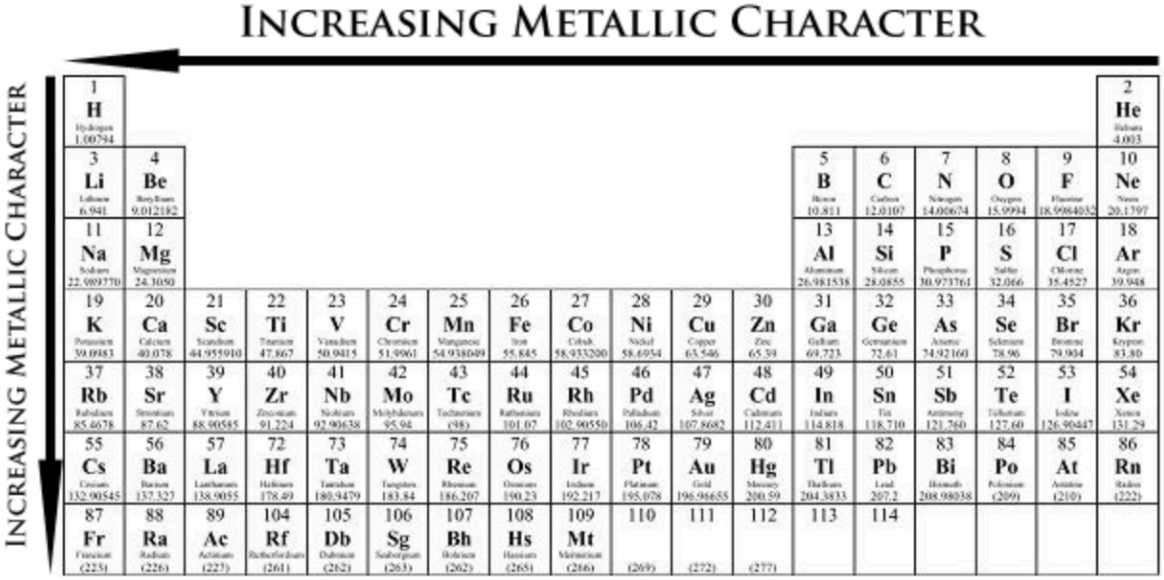
Periodic trends are specific patterns that are present in the periodic table that illustrate different aspects of a certain element, including its size and its electronic properties. Periodic trends provide a tool to quickly predict an element's properties.

- Atomic Radius Trend - Atomic size gradually decreases from left to right across a period of elements and increases from top to bottom within a group.
    - Atomic radius decreases from left to right within a period. This is caused by the increase in the number of protons and electrons across a period. One proton has a greater effect than one electron; thus, electrons are pulled towards the nucleus, resulting in a smaller radius.
    - Atomic radius increases from top to bottom within a group. This is caused by electron shielding.



- Metallic Character Trends - Metallic character gradually decreases from left to right across a period of elements and increases from top to bottom within a group.

- The metallic character of an element can be defined as how readily an atom can lose an electron.
- From right to left across a period, metallic character increases because the attraction between valence electrons (the electrons in the outermost shell of an atom) and the nucleus is weaker, enabling an easier loss of electrons.
- Metallic character increases as you move down a group because the atomic size is increasing.



VIII. Physical vs. Chemical Properties

All matter has both physical and chemical properties.

- Physical properties
  - A physical property can be measured or observed without changing the identity of the substance.
  - Examples: mass, volume, length, size, shape, color, odor/smell, state, texture, hardness, density, solubility, boiling point, melting point
- Chemical properties
  - A chemical property is determined by a substance's ability to interact chemically with another substance. Matter has chemical properties that will describe its ability to undergo chemical change or reaction to form new substances.
  - Examples: flammability, acidity, reactivity, combustible.

IX. Physical vs Chemical Changes

- Physical change - When a substance undergoes a physical change the substance itself does not change even though it may look different.
  - Examples: When water freezes it is now a hard solid but it is still water.

- Chemical change - When a substance undergoes a chemical change, there is a chemical reaction and a new substance is formed. During a chemical change, energy is either given off or absorbed (used).
    - Example: When you mix baking soda and vinegar you will produce a new substance one of which is carbon dioxide which is released as a gas producing bubbles.

Indicators of Physical Change	**Indicators of Chemical Change**
change of state/phase: melting, freezing, vaporization, et.	production of light (flames, fire)
	change in temperature
change in shape or form	unexpected color change*
dissolving	odor/smell
absorption	bubbles (gas production)
color change*	precipitate (solid formed when 2 liquids are mixed)
	production of sound

* Color change is tricky. If you mix dark blue paint with white, you get light blue paint. This is a physical change. Color change by itself is not a good indicator of either form of change.

X. Chemical Reactions (5th grade only)

When you observe a chemical change you are observing a chemical reaction. A chemical reaction is the formation or breaking of a bond between atoms to make a new substance. If you mix sodium with chlorine, a chemical reaction will take place producing sodium chloride which is table salt.


sodium

+


chlorine

—>


sodium chloride

(table salt)

XI. Chemical Bonding (5th grade only)

- Not all atoms will bond with every other atom.
- Atoms want a full outermost electron shell so they will share, take or give up electrons and in the process, a chemical bond is formed.
- Types of Bonds:
  - **Ionic bonds:**
    - An Ionic bond is formed when one atom gives up or takes an electron from another atom to complete its outer electron orbital
    - Always form between a metal and a nonmetal
    - Ion – When an atom takes an electron from another atom, it has gained a negative charge and is called an ion (anion). The atom that gave up its electron is now missing one and so it has a positive charge and is also called cation.
  - **Covalent bonds:**
    - A Covalent bond is formed when electrons are shared between two atoms
    - Form between nonmetals
- The number of chemical bonds any atom can make is equal to the number of electrons it needs to fill its outer orbital. Example: Carbon has 4 electrons in its second or outermost orbital. It wants 4 more electrons and can have 4 chemical bonds.

XII. Chemical Equations (5th grade only):

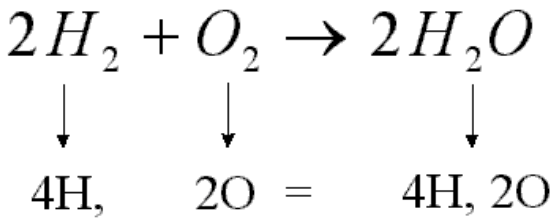
- Chemical reactions are represented by a chemical equation like below.

$$\underbrace{2H_2 + O_2}_{\text{reactants}} \rightarrow \underbrace{2H_2O}_{\text{product}}$$

- The molecules you start with are the **reactants** and the molecules you end up with are the **products**.
- These reactions can be reversed.

XIII. Stoichiometry (5th grade only):

- Chemists need to know the amounts of substances that are involved in reactions.
- Stoichiometry is the term used to describe the measurement of the number of atoms involved in a chemical reaction.
- The law of conservation of mass/matter dictates that every atom in the reactants needs to be accounted for in the products.



Reactants	Products
2 molecules of hydrogen = 4 atoms of hydrogen	2 molecules of H_2O (water) = 4 atoms of hydrogen and 2 atoms of oxygen
1 molecule of oxygen = 2 atoms of oxygen	

XIV. Chemical Reactions - Additional concepts they should know in brief (5th grade only):

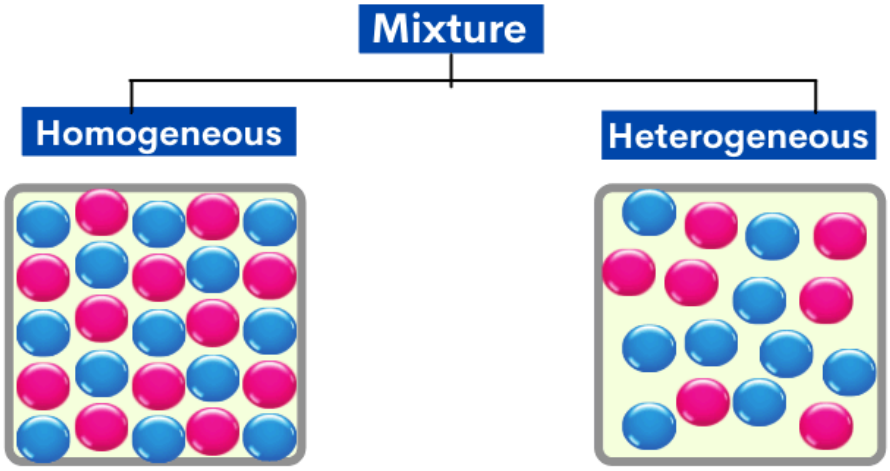
- **Reaction Rate -** is the speed at which a reaction happens (or how quickly products are formed). Some things that can affect the rate of a chemical reaction are: concentration of the reactants, temperature, pressure
- **Activation energy -** The energy needed to get a reaction started.
- **Equilibrium** - Chemical reactions are reversible and often the products want to go back to being reactants. Equilibrium is the point where the rates of the forward and reverse reactions are occurring at an equal rate. It does not mean that the amount of reactants is equal to the amount of products.

XV. Classifying Matter

- **Pure substances** - Any type of matter that is made up of only one type of element or one type of molecule or compound (chemically bonded). Pure substances can not be broken up by their physical properties alone.

- **Mixtures**
  A combination of substances whose characteristic properties don't change even though they are mixed together. The substances in a mixture are combined physically not chemically. Because they are not combined chemically, mixtures

can be separated based on their physical properties. There are two types of mixtures, homogeneous and heterogeneous.



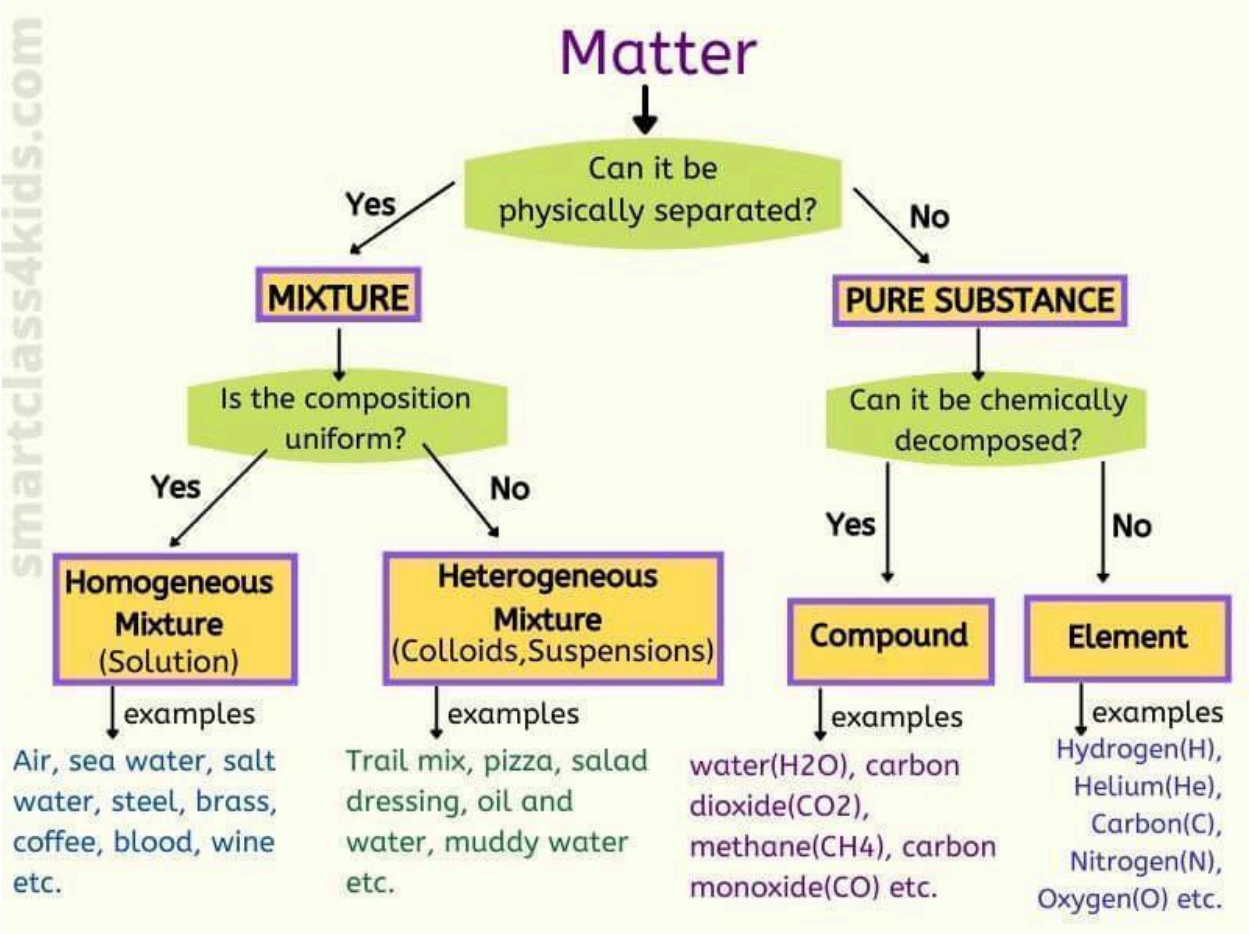
A. **Homogeneous mixtures** – the molecules are evenly distributed throughout the mixture (salt water, kool aid, mineral ores, air, etc.)
   - **Solution** - A homogeneous mixture where a substance is dissolved in a liquid (usually).
     - **Solvent** – the substance that something is dissolved into (usually a liquid)
     - **Solute** – the substance that is dissolved (solid, gas or liquid)
     - Example: When you make a saltwater solution, the water is the solvent and the salt is the solute.

   - **Alloys**: An alloy is made up of at least two different chemical elements, one of which is a metal (example: cast iron, brass, steel, etc.).

B. **Heterogeneous mixtures** - the molecules are not evenly distributed throughout the mixture (milk, wood, peanut butter, sandy water, etc.)

   - **Suspensions** - A suspension is a mixture between a liquid and particles of a solid. The particles suspended in the liquid, meaning they do not dissolve and are dispersed throughout the liquid. But the solid particles will settle and separate over time if left alone.
     - Example – sandy water, etc.
   - **Colloid** - A mixture where microscopic particles of one substance are evenly distributed throughout another substance. The particles in a colloid can be solid, liquid or gas.
     - Example - milk, smoke, whipped cream, etc.
   - **Emulsion** - A colloid composed of two liquids (oil and water) that usually do not mix together. You can shake them and mix them up but they will separate back out to oil and water when left standing.

- Example - salad dressing



XVI. Acid, Base and pH scale

Acids and bases are two groups of chemical compounds with opposite properties that we come across often in the laboratory and in everyday life.

- **Acids** - generally taste sour or tart and turn litmus paper red. A solution of an acid is called acidic. Examples: vinegar, orange juice, stomach acid, etc.
- **Bases** - generally taste bitter and may feel slippery to the touch and turn litmus paper blue. A solution of a base is called basic or alkaline. Examples: baking soda, bleach, detergent, etc.

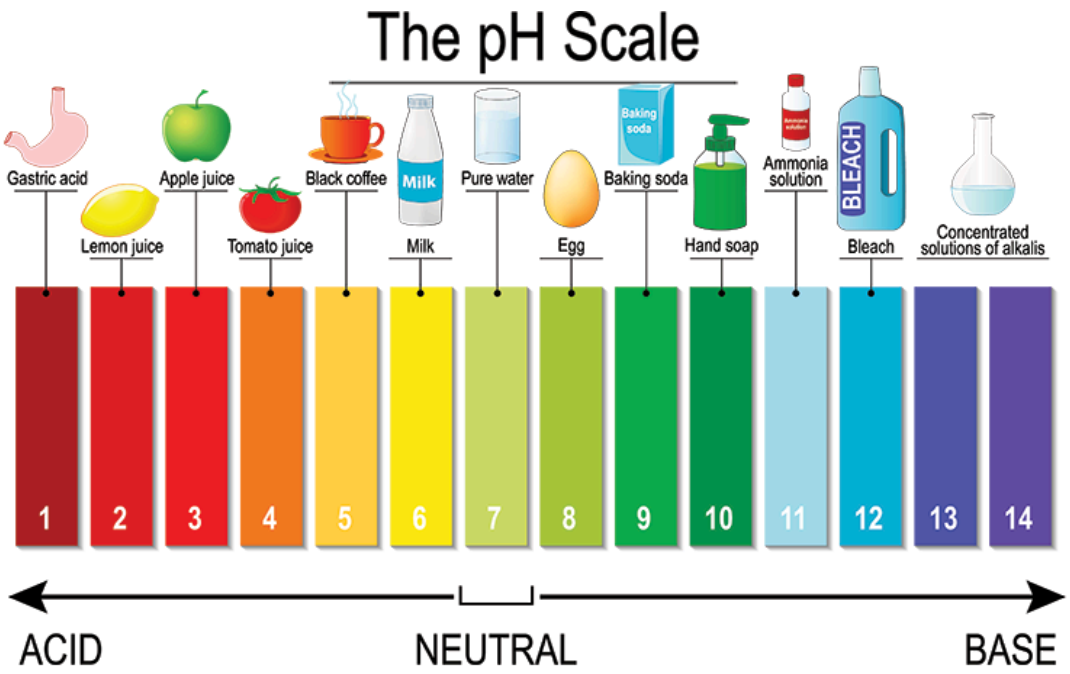
Strong acids and strong bases are dangerous chemicals. So, they should never be tasted or touched.

pH Scale

We measure the strength of acids and bases on a pH scale which goes from 0 to 14. pH stands for **p**otential of **h**ydrogen and tells you how many hydrogen ions a solution has.

- Acids - Solutions on the pH scale less than 7. The lower the pH, the stronger the acid or more “acidic”.

- Bases - Solutions on the pH scale greater than 7. The higher the pH, the stronger the base or more “basic”.
- Neutral - Solutions with a pH = 7.



pH Indicators

- Acids and bases can cause many organic substances to change color. Example: what happens when lemon juice is added to tea? And then add baking soda to tea?
- A substance that changes color when an acid or base is added to it is called an indicator.
- Litmus paper is a common indicator used in the laboratory. It turns red in an acid solution and blue in a basic solution. A neutral solution turns litmus paper a color midway between red and blue.

<u>How do acids and bases differ chemically?</u> (5th grade only)

- The Bronsted-Lowry definition of acids and bases is as follows:A **Brønsted-Lowry acid** is any species that can donate a proton (H+) to another molecule. A **Brønsted-Lowry base** is any species that can accept a proton from another molecule. In short, **a Brønsted-Lowry acid** is a **proton donor (PD)**, while **a Brønsted-Lowry base** is a **proton acceptor (PA)**.
- Remember ions? When hydrogen loses its electron, the only thing left to it is a proton. Therefore, a hydrogen ion (H^+) is referred to as a proton.
- The following video is helpful with the basic explanation of acids and bases: https://youtu.be/DupXDD87oHc

XVII. Metric System (all grades)

Teams should understand the correct use of the metric system for the lab skills portion of the event. If asked to record the weight of something, it should be given in grams (g) not lbs or ozs. They must make sure the balance is set accordingly. If asked for the volume of a liquid, it should be given in liters (l) or milliliters (ml). An answer is not correct without the units. No conversions will be asked.

XVIII. Environmental Science

A. Renewable and non-renewable energy:

Renewable energy refers to energy sources that replenish naturally over a short period of time, like sunlight, wind, and water power, while non-renewable energy comes from finite sources that cannot be replaced quickly once used up, such as coal, oil, and natural gas (fossil fuels) which take millions of years to form

Key points about renewable energy:

- Naturally replenished: Sources like solar, wind, and hydropower are constantly available due to natural processes.
- Environmentally friendly: Generally produce lower greenhouse gas emissions compared to non-renewable sources.
- Examples: Solar panels, wind turbines, hydroelectric dams, geothermal energy.

Key points about non-renewable energy:

- Limited supply: Once used up, these resources cannot be readily replaced within a human timeframe.
- Potential environmental concerns: Burning fossil fuels releases significant amounts of greenhouse gases contributing to climate change. Nuclear accidents using uranium, while not a fossil fuel, have potential environmental concerns.
- Examples: Petroleum, coal, oil, natural gas, nuclear.

B. Clean Water Act:

The Clean Water Act (CWA), 1972, establishes the rules to regulate discharges of pollutants into the waters of the United States. The primary purpose of the CWA is to maintain and restore the integrity of the nation's bodies of water. Under the CWA, the EPA has implemented pollution control programs such as setting wastewater standards for industry. The EPA has also developed national water quality criteria guidelines.

The CWA made it unlawful, without permit, to discharge any pollutant from a ***point source*** into navigable waters.

- ***Point source*** pollution refers to pollutants discharged from a single, identifiable source like a pipe or factory, while ***non-point source*** pollution is diffuse contamination from a wide area, like runoff from agricultural land, where the exact source is difficult to pinpoint. Essentially, point source pollution comes from a specific location, whereas non-point source pollution is dispersed across a larger area.

Examples of pollutants are;

1. dangerous pathogens,
2. water so hot it could kill plants/animals/bacteria,
3. nutrients such as nitrogen that can cause overgrowth of algae and
4. industrial chemicals.

One specific class of industrial chemicals problematic in the Huron river are PerFluoroAlkyl Substances (PFAS). These are a group of man-made chemicals widely used in various consumer products due to their water-, oil-, and stain-resistant properties. However, these compounds are concerning due to their frequent release as a source of pollution, ability to accumulate in the environment and human body, potentially causing adverse health effects. These "forever chemicals" stay in the environment for a long time and are considered by the EPA to be an urgent public health and environmental issue.

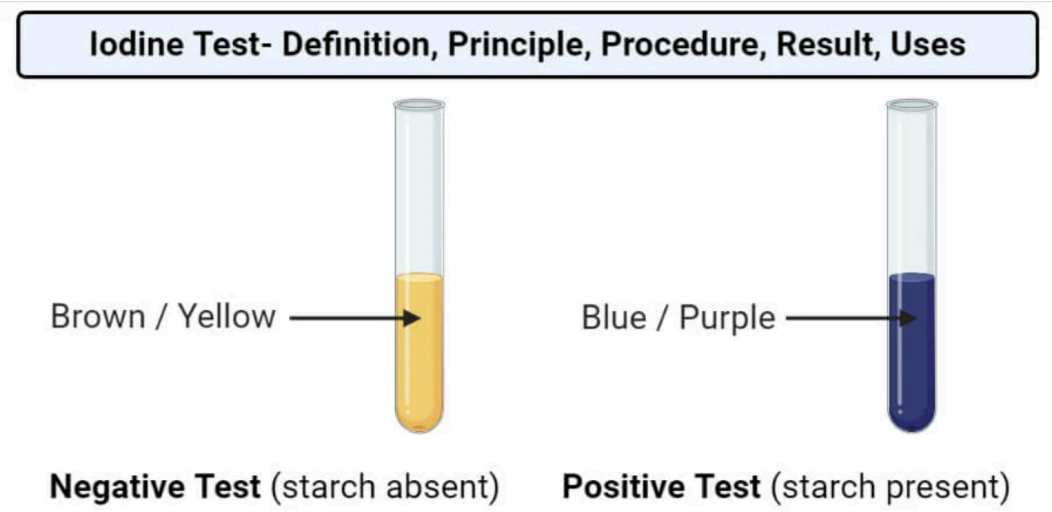
I. Ink Chromatography:

- Chromatography is a method for analyzing mixtures by separating them into the chemicals from which they are made. In ink chromatography, you are separating the colored pigments that make up the color of the pen.
- To perform **ink chromatography**, you put a small dot of ink to be separated at one end of a strip of filter paper. This end of the paper strip is placed in a **solvent**. The solvent moves up the paper strip and, as it travels upward, it dissolves the mixture of chemicals and pulls them up the paper. The chemicals that dissolve best in the solvent will move up the paper strip further than chemicals that do not dissolve as well. What is produced from this method is a **chromatogram**.
- Example Experiments - Do NOT need to calculate Rf values
  - https://www.msichicago.org/fileadmin/assets/educators/learning_labs/documents/ink_chromatography.pdf
  - https://www.wellappointeddesk.com/2020/07/ink-chromatography/

Iodine Test (**5th Grade Only**):

- The iodine test is a chemical reaction-based identification test for starch.
  - Starch is a carbohydrate found in plants.

- Add Iodine-KI solution or directly on a potato or other materials such as bread, crackers, or flour. A blue-black color results if starch is present. If starch amylose is not present, then the color will stay orange or yellow. Starch amylopectin does not give the color, nor does cellulose, nor do disaccharides such as sucrose in sugar.



SOME REFERENCE SITES:

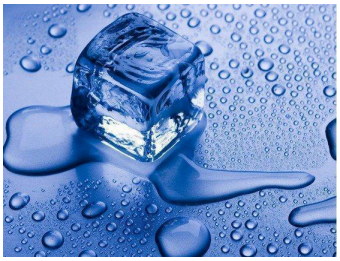
https://smartclass4kids.com/chemistry/
http://www.ducksters.com/science/
http://www.chem4kids.com

SAMPLE QUESTIONS:

Which state of matter has no defined shape or volume? Choose the correct answer.

A. solid
B. liquid
C. gas
D. ice

What type of phase change is occurring in the picture below (picture of ice melting):



Answer: Melting

Match the following to the proper description:

O_2 H_2O H

Represents a compound H_2O
Represents an atom H
Represents a molecule O_2 and H_2O

Choose the correct answer:
Water boils at 100° C.

A. this is a physical property
B. this is a chemical property

Choose correct answer:
Iron rusts in a damp environment.

A. this is a physical change
B. this is a chemical change

Identify the solution, solvent and solute in the pictures below:

solute solvent solution

State True or False:

1. Acids and bases have a variety of strengths. True
2. Every liquid is either an acid or a base. False

If you have 10 grams of frozen water, what will be the mass of the water when it melts?

1. it will be more than 10 grams
2. it will be less than 10 grams
3. it will be 10 grams

The atomic number of an element refers to the:

A. number of protons in an atom of that element
B. number of neutrons in an atom of that element
C. the sum of the number of protons, neutrons and electrons
D. the order that the element was discovered

Answer the following questions (short answers):
You have two different elements both with a total of 3 electron orbits/shells.

A. Would these elements be found in the same period or group? Period
B. Which period or group would you find them in? Period 3

Match the correct symbol to the statement:
H, O, N, C, Al, Na, Cu, Cl, P, S, He, Ar

A. This soft metal will react violently when it comes in contact with water but when bonded with chlorine forms table salt. Na
B. This gas is the most common element in the universe. H

What of the following is not a renewable source of energy?

A. Solar panels
B. Geothermal heated floors
C. Nuclear power plants
D. Wind turbines

A point source of waste water discharge is from a large farm, true or false?

TRUE FALSE

A company discharges perfluorooctanoic acid (PFOA) and perfluorooctanoic sulfonic acid (PFOS) into the Huron river. What will happen to the pH of the river near the discharge?

A. The river water will drop in pH.
B. The river water will increase in pH.
C. River species of fish and plants will die.
D. Nothing

Grade-5 only:

Choose the correct answer:
The sodium ion shown here (Na+) has how many electrons?

A. 20
B. 11
C. 12
D. 10

Fill in the blank:
^{18}O and ^{16}O are _____ of oxygen.

isotopes

Choose the correct answer:
In respect to chemical bonding, would you expect helium to:

A. form ionic bonds with other atoms
B. form covalent bonds with other atoms
C. not bond with other atoms

State true or false:
Acids are electron acceptors. True

Balance the following equations:

____ P_4 + ____ O_2 —> ____ P_4O_{10}

_____ Fe + _____ Cl_2 —-> _____ $FeCl_3$

Image Citations:

Solid, Gas, Liquid. Digital Image. http://clipart-library.com/clipart/1568938.htm

States of Matter. Digital Image.
https://cdn.britannica.com/05/92905-050-C1D29DD9/states-matter-liquid-gas.jpg

Atoms, Molecules, Compounds. *RMIT University, Learning Lab.* (2021)
https://emedia.rmit.edu.au/learninglab/content/atoms

Bohr's Model . Digital Image. *Comer's Chemistry Classroom.*
https://sites.google.com/site/comerschemistryclassroom/useful-links/bohr-s-model-2

Physical Change vs Chemical Change. Digital Image. *Smart Class 4 Kids*. (2022)
https://smartclass4kids.com/chemical-change-and-physical-change/

Homogeneous and Heterogeneous Mixtures. Digital Image. *Smart Class 4 Kids*. (2022)
https://smartclass4kids.com/homogeneous-mixture/

Matter Flowchart. *Smart Class 4 Kids*. (2022)
https://smartclass4kids.com/homogeneous-mixture/

Brookshire, Bethany. The pH Scale. *Science News for Students.* (2019)
https://www.sciencenewsforstudents.org/article/scientists-say-ph

Physical vs Chemical change. Digital Image
https://smartclass4kids.com/chemical-change-and-physical-change/