Unit 3- Review

Chemistry 0

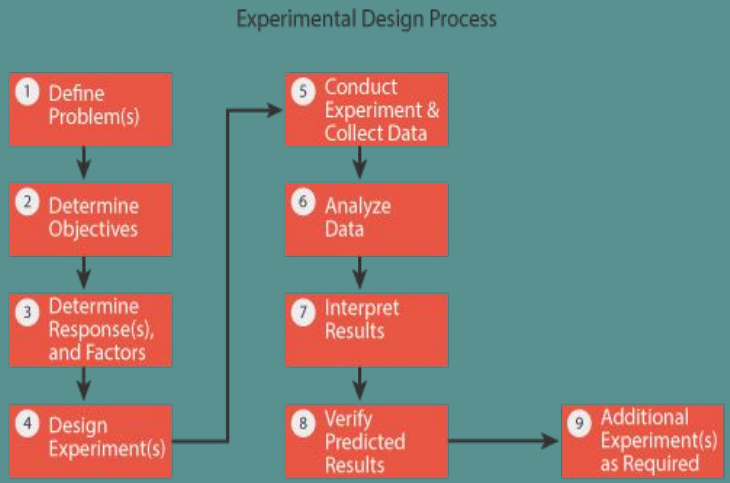
May 2021, L. Tracey Gao

Scientific Inquiry

- Observation
- Research
- Hypothesis
- Experiment
- Data collection and analysis
- Conclusion
- Communication of ideas and results

Designing an experiment

- Scientists need to figure out a plan for testing a hypothesis. To do this, they need to design an experiment.
- They need to vary only one factor of their experiment at a time so that they know that the results are related to the one factor that was altered.
- When designing an experiment, scientists must also identify the variables and controls.



https://www.moresteam.com/toolbox/design-of-experiments.cfm

Measurement

- Demonstrate the difference between accuracy and precision
- Identify common physical properties
- Explain the difference between mass and weight
- Work with metric prefixes
- Perform simple conversions between metric units
- Write large and small numbers in scientific notation

MEASUREMENT

Measure	What It Measures	Scientific Units	US Customary Units
Mass	The amount of matter in an object	Kilograms(kg), grams (g)	Pounds
Length	How long an object is	Meters (m)	Inches, feet, miles
Volume	The amount of space an object occupies	Liters (L), cubic meters (m^3), cubic centimeters (cm^3)	Pints, quarts, gallons
Temperature	The average kinetic energy of particles	^0C, K	^0F
Density	Ratio of mass to volume for an object	kg/m^3, g/mL	Pounds per cubic inch
Pressure	The amount of force per unit area	Pa, atm, mmHg	Pounds per square inch (psi)
Energy	The ability to do work or generate heat	J, cal, eV	BTU

Common Prefixes and the Quantities

Prefix	*Symbol*	*Numerical Value*
Tera-	T	10^{12}(1,000,000,000,000)
Giga-	G	10^{9}(1,000,000,000)
Mega-	M	10^{6}(1,000,000)
Kilo-	k	10^{3}(1,000)
Centi-	c	10^{-2}(0.01)
Milli-	m	10^{-3}(0.001)
Micro-	μ	10^{-6}(0.000001)
Nano-	n	10^{-9}(0.000000001)
Pico-	p	10^{-12}(0.000000000001)

Scientific Notation

- **Scientific notation** is the method scientists use to quickly write very large or very small number.

- It can be as easy as counting. First, move the decimal in the appropriate direction. Move the decimal to the right for small numbers and to the left for large numbers. THen count the number of places the decimal moved to figure out the correct exponent.

Laboratory Equipment- Basic Equipment

- **Beaker:** A wide, open container with a flat bottom made of glass or plastic. It is a simple container used to mix, heat, or hold substances.
- **Flask:** A glass container with a thin “neck” that widens to a rounded base. Flasks can be used to measure, heat, or store liquids.
- **Test tube:** A small cylindrical glass tube that has a rounded, u-shaped bottom. It is used to hold or heat small amounts of a substance during laboratory experiments.

Measuring Liquid Volumes

- **Buret:** A long glass cylinder used to accurately measure and dispense a specific volume of liquid. It is often used for titrations, where scientists place an Erlenmeyer flask directly below the tip of the buret and then control the amount of liquid released from the buret.
- **Graduated cylinder:** A tall, cylindrical container used to measure the volume of a liquid. They are made in many different sizes, ranging from 10 mL to 2,000 mL.

Measuring Mass

- Mass is measured using devices known as **balances**, which measure mass by comparing an object of unknown mass to an object of known mass.

Triple-beam balance

https://www.drinstruments.com/school-triple-beam-balance.html

Analytical balance

https://v-medtech.com/

Measuring Temperature

- **Thermometer**: A device used to measure temperature.

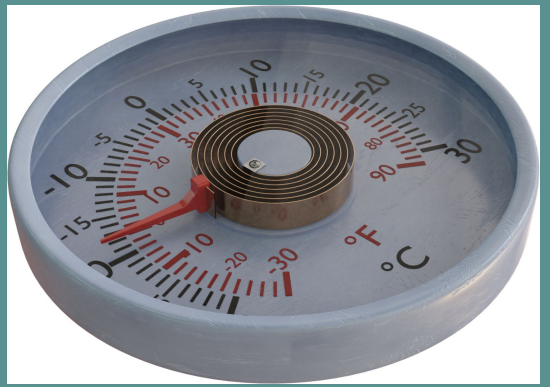
Traditional bulb thermometer

https://highschoolenergy.acs.org/

Digital thermometer

https://www.thomassci.com/

Bimetallic strip thermometer

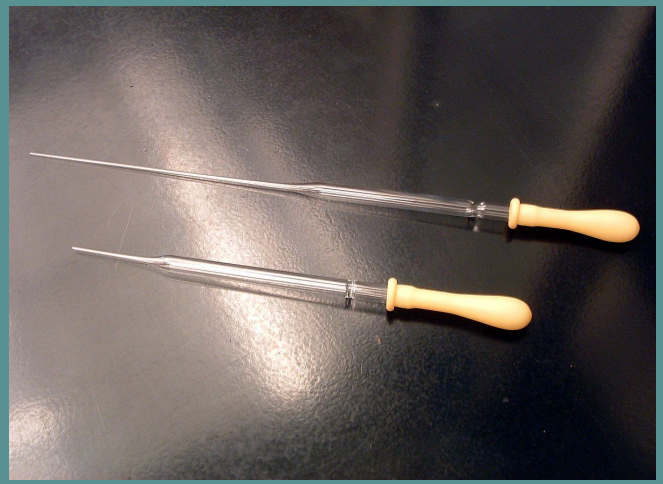


https://www.tec-science.com/

Transferring Liquids

- **Pipette:** A device used to measure and move a liquid from one container to another.

Pasteur pipette



https://en.wiktionary.org/wiki/Pasteur_pipette

Volumetric pipette

https://www.fishersci.com/

Heating Materials

- **Bunsen burner:** A gas burner that produces a single, steady flame for laboratory experiments.The flame burns at the top of a vertical metal tube connected to a natural gas source.

https://www.chemistryworld.com/

Laboratory and Chemical Safety

- **WHERE TO FIND CHEMICAL SAFETY INFORMATION:**
  - Product container labels include important information about storage and handling, as well as warnings, first aid information, and other emergency details.
  - Health Flammability Reactivity Symbol gives a very quick overview of things to consider when storing or handling the chemicals.
  - Hazard Communication Standard Labels provides information to the workers on the specific hazardous chemical.
  - Safety Data Sheet (SDS) gives information about the proper way to handle or work with a certain substance.

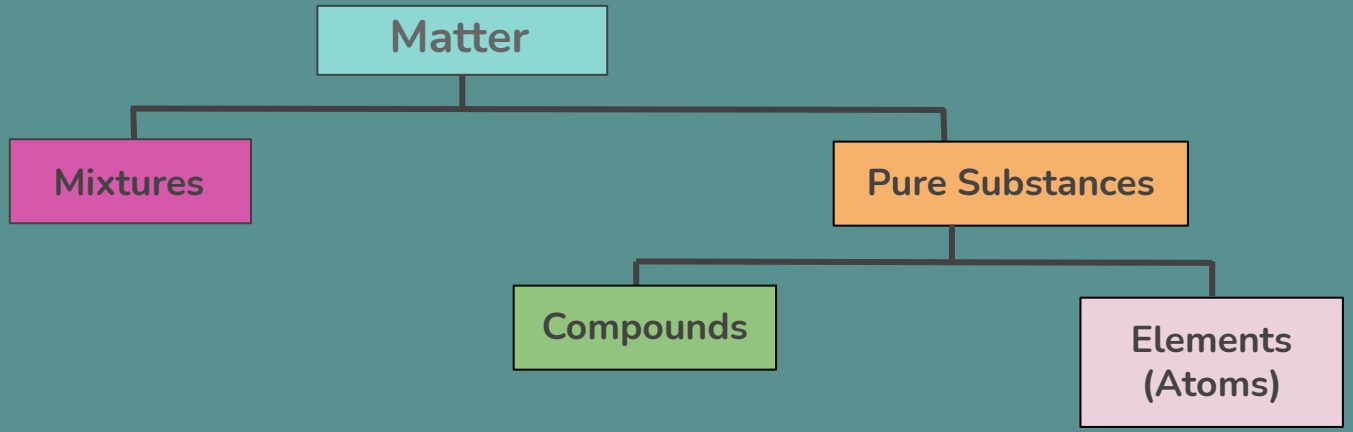
Laboratory and Chemical Safety

- **WARNING SYMBOLS:**
  - Anyone working with chemicals should become familiar with these common warning symbols. These symbols are often found on chemical containers and around laboratories.
  - Their job is to keep people informed of any potential hazards.
  - They are designed to be noticed and they ultimately help make sure that people use chemicals in a safe and responsible manner.

Laboratory and Chemical Safety

- **GENERAL SAFETY RULES:**
  - *When working in the laboratory*:
    - Always read through directions and SDSs completely before beginning an experiment.
    - Avoid touching your eyes, nose or mouth when working in the laboratory.
    - Keep your face away from the opening of a container that holds chemicals.
    - Wear the proper protective gear and clothing.
    - When mixing chemicals, follow the instructions carefully.
    - Work with other people, never work alone.
    - Wear safety goggles to protect your eyes.
    - Know where safety equipment is located.
    - Do not eat or drink in the laboratory.
    - Be careful when working with sharp objects.

Pure Substances and Mixtures



What is a Mixture?

- A compound, such as oxygen gas, carbon dioxide, or nitrogen, is chemically bonded.

- Mixtures are not chemically bonded.

Types of Mixtures

- Homogeneous Mixtures: It is a mixture that is the same throughout. The molecules are mixed on a molecular level so they are essentially invisible. It appears uniform.
- Heterogeneous Mixtures: It is a mixture that is not the same throughout. It has particles that are small, but much larger than molecules. They are on a macromolecular scale and are often visible. It appears either milky or even lumpy.

Solutions, Suspensions and Colloids

- **Solution** is a type of homogeneous mixture. It may be colored, but it is transparent, the molecules or ions are invisible, and they do not settle out on standing. It is a mixture of a solute in a solvent. Example: *Salt and water*.
- **Suspension** is a type of heterogeneous mixture. It is a mixture of water and non-dissolved material. The particles in suspensions are larger than those found in solutions. Example: *Oil and water*.
- **Colloids** are a type of **heterogeneous mixtures**. It has particles that are quite difficult to see individually, but are intermediate in size between those found in solutions and suspensions. It remains dispersed and doesn't settle at the bottom. Example: *Milk*.

Solubility of Solutions

- Solubility is the relative ability of a solute to dissolve into a solvent.
- It is a physical property and not a chemical property because no chemical reaction takes place.
- When a molecule or compound dissolves in something, we say it is *soluble*.
- Soluble compounds form homogeneous mixtures, while insoluble compounds form heterogeneous mixtures.

Separation of Mixtures

- The most appropriate technique for separating a mixture depends on the type of mixture and the chemical and physical properties of the components.

- Physical properties include color, size, melting point, boiling point, volatility, and solubility.

Techniques of Separation

- Separation techniques depend on the differences in physical properties for each component in a mixture, including color, size, melting point, boiling point, volatility and solubility.
  - Filtration
  - Evaporation
  - Distillation
  - Chromatography

Intro to Organic Chemistry

- Organic chemistry is a special branch of chemistry that singles out just one element for special consideration- Carbon.

Class of Organic Molecules

- Hydrocarbons: contain only hydrogen and carbon. They are all very nonpolar, flammable, and similar in both appearance and touch.
    - Alkanes
    - Alkenes
    - Alkynes
    - Aromatics

Alcohols and Amines

- An alcohol is any molecule with a -OH group attached to a carbon atom.
- An amine is any molecule with a $-NH_2$ group attached to a carbon atom.
- Both the -OH group and $-NH_2$ group are very polar, so alcohols and amines are usually polar. They tend to dissolve well in water, and the liquid alcohol, especially, can at as solvents for other polar molecules.

Aldehydes, Acids, and Ketones

- An aldehyde is any molecule that: has only an H atom on one side of the carbonyl.
- An acid is any molecule that: has an -OH group next to the carbonyl.
- A ketone is a molecule that: has carbon atoms on both sides next to the carbonyl.

Carbohydrates

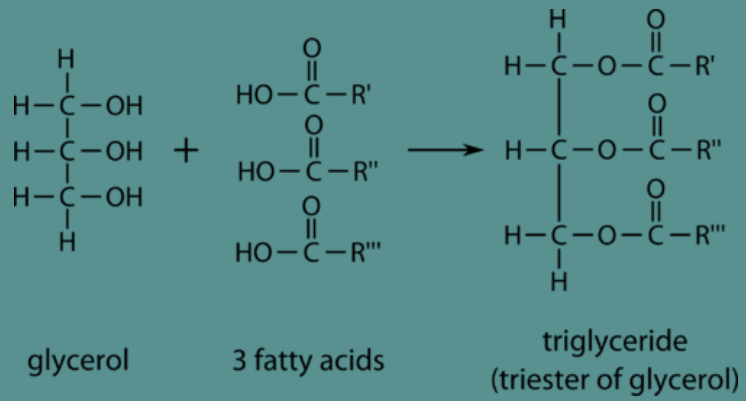
- Carbohydrates are molecules that are essential for living things. Carbohydrates are found in small simple sugars and large complex polymers. Small simple sugars are called monosaccharides.
- The smallest monosaccharides have three carbon atoms. These are called trioses. Large simple sugars with four, five, six, and seven carbons are called tetroses, pentoses, hexoses, and heptoses, respectively.

Lipids: Fats and Steroids

- Another important group of nutrients required for the healthy maintenance and function of our bodies are the lipids.
- Lipids include fats, steroids, waxes, fat-soluble vitamins, and other molecules.
- Fats allow the body to absorb fat-soluble vitamins, provide energy, and are an essential component of cellular membranes.
- Steroids are found in both plants and animals and are among the most important natural products.

Fats

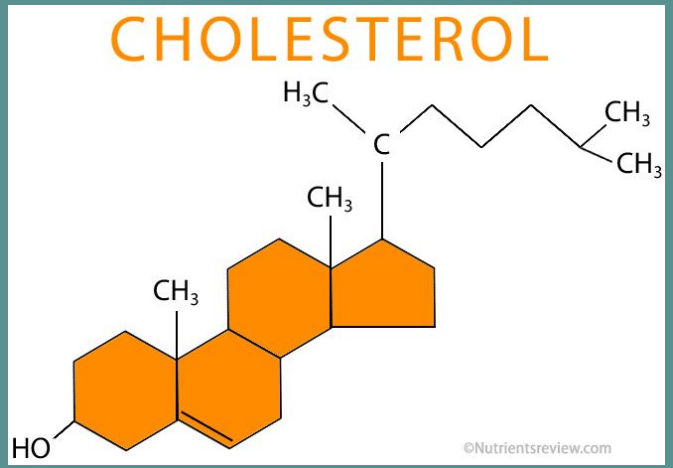
- The most common fats in living things are made from glycerol.
- Glycerol is a small three-carbon carbohydrate. Fats are made of a derivative of glycerol, called a triglyceride.



https://chem.libretexts.org/

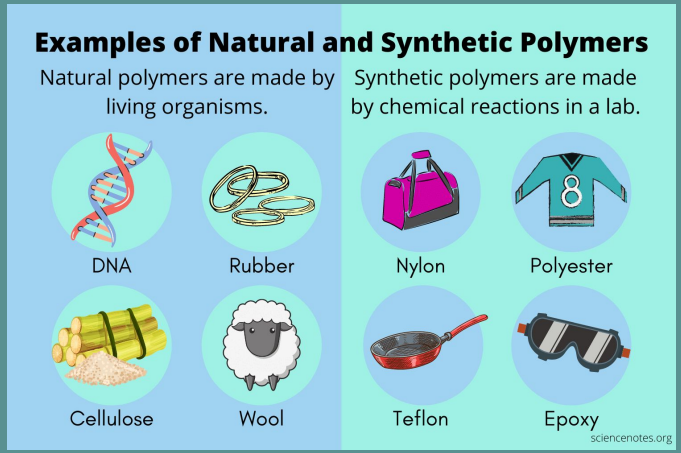
Steroids

- Cholesterol is the most common steroid found in animals. Cholesterol is a type of lipid found in the brain and spinal column tissues of humans and is the major component in the plasma membranes of animal cells.



Polymers

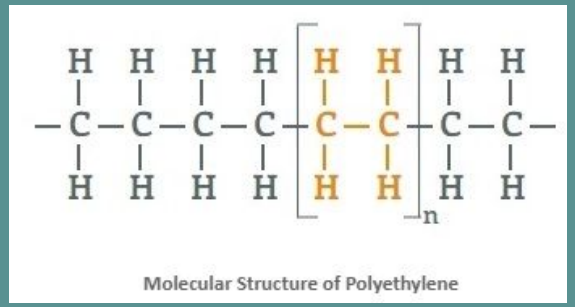
- Molecules with repeating units are called polymers.
- Polymers are found everywhere. Both naturally occurring polymers and man-made polymers are found in our everyday life.



Polymer Structure

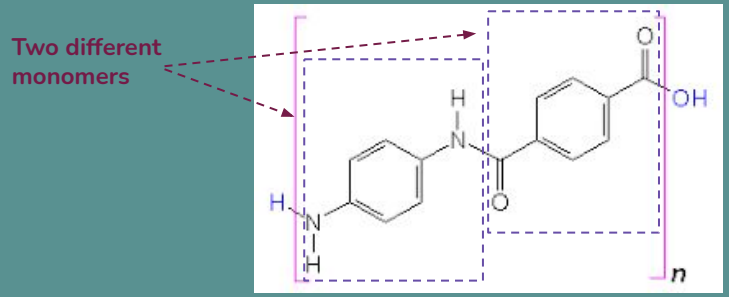
- Monomers
  - The individual units of a polymer are called monomers.
  - When the repeating monomer units are all identical, the polymer is called a homopolymer. If more than one type of monomer is used, the polymer is called a copolymer.

Polyethylene is a homopolymer made of ethylene monomers



https://omnexus.specialchem.com/selection-guide/polyethylene-plastic

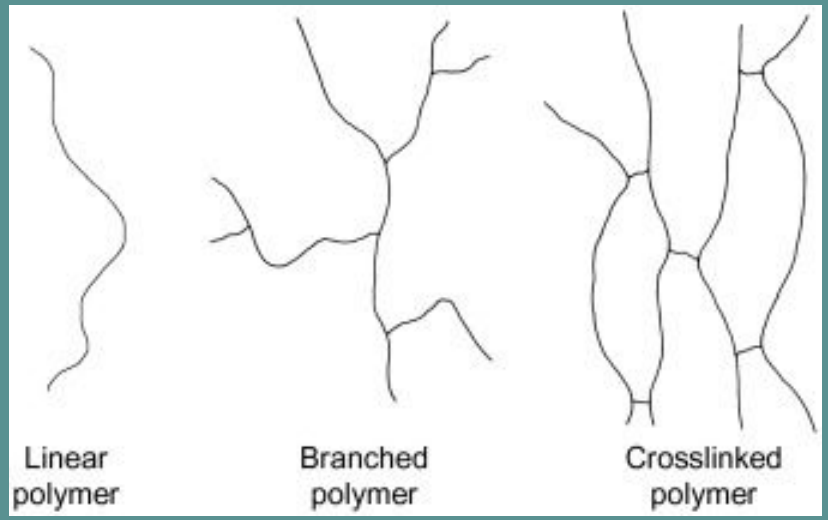
KEVLAR® is a copolymer composed of two different monomers.



http://www.chm.bris.ac.uk/motm/kevlar/kevlarh.htm

Polymer Structure

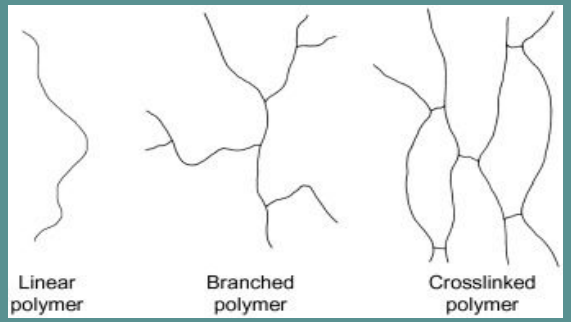
- Linear Polymer
- Branched Polymer
- Crosslinked Polymer



https://www.sciencedirect.com/topics/materials-science/branched-polymer#:~:text=Branched%20polymers%20are%20defined%20as,%2C%20and%20comb%2Dshaped%20polymers.

Polymer Properties

- The **physical properties** of a polymer (its hardness, stretchiness, melting temperature, etc.) are largely determined by the **structure** of the polymer and the way in which the polymer chains pack with each other in a solid.



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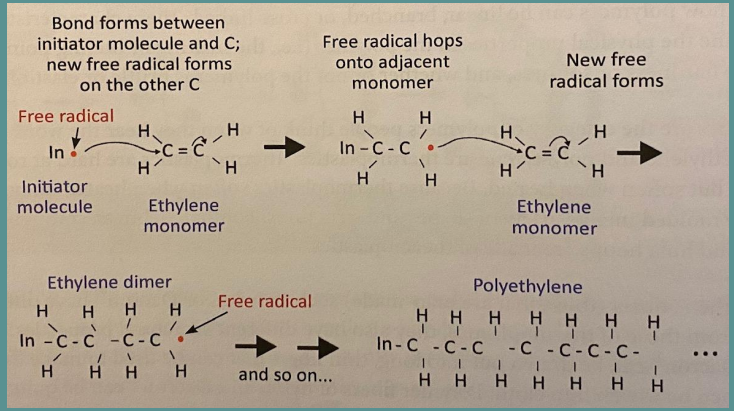
Polymer Properties

- **Thermoplastics** soften when heated, they can be easily molded into a variety of shapes and structures.
  Examples: polyethylene and polystyrene
- **Synthetic fibers** can be drawn out into long, thin fibers that can be used to make thread which can then be woven into cloth.
  Examples: nylon
- **Elastomers** are polymers that have the ability stretch and spring back to their original shape.
  Examples: natural rubber

Polymer Addition Reactions

- Addition reactions link together molecules using double bonds as the functional group.
- It starts with the formation of a free radical. A free radical is just a “dangling bond”- an unbonded electron that is very reactive.



ISBN 10: 1936114593 Publisher: Gravitas Publications, Incorporated, 2012

Polymer Condensation Reactions

- A condensation reaction is a chemical reaction in which two monomers combine to form a new molecule, giving off a by-product water.
- This type of reaction is very useful for chaining monomer units together into long-chain polymers called condensation polymers.