Science STUDY GUIDE #1

Written by Ivan HRB on 10/1/2018

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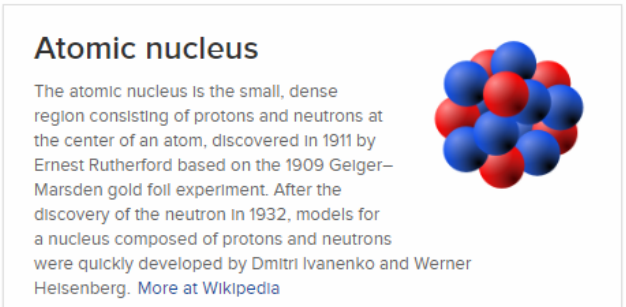
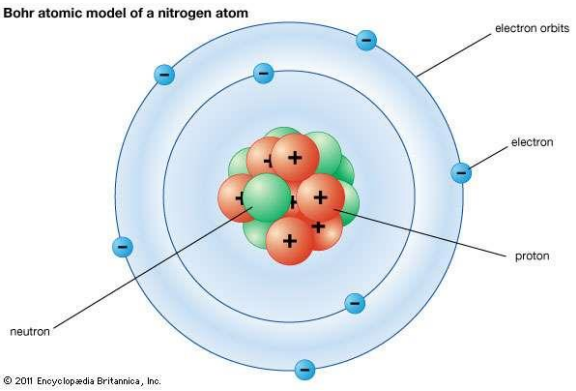
The Atomic Theory

- Everything is made of matter (any material that takes up space and has mass)
- Mass ≠ weight
  - Mass never changes
  - Weight may change based on gravitational pull
- 4 states of matter
  - Solid (symbol: s)
  - Liquid (symbol: l)
  - Gas (symbol: g)
  - Plasma
- Phase change (changing from one state of matter to another)
  - Solid to liquid – Melting (liquification)
  - Solid to gas – Sublimation
  - Liquid to solid – Freezing
  - Liquid to gas – Vaporization
  - Gas to liquid – Condensation
  - Gas to solid – Deposition

The Atom

- The basic unit of matter – Atoms
- How do we know that atoms still exist?
  - Still called the "Atomic **Theory**"
  - Theory – Explanation of a phenomenon, not 100% if correct, decent of evidence

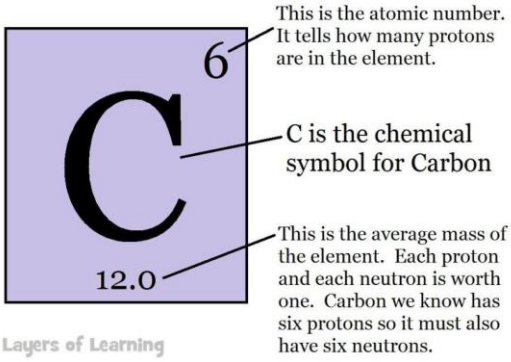




Subatomic Particle Name	Symbol	Charge	Location of Particle	Mass of Particle
Proton	(+)	Positive	Nucleus	1 atomic mass unit (amu)
Neutron	(n)	None	Nucleus	1 amu
Electron	(-)	Negative	Energy Field	Almost nothing

- Electron charge + Proton charge = 0
- Neils Bohr (Denmark)
  - First to design atomic model (Bohr Atom)
  - Couldn't explain anything other than hydrogen (no neutrons)
- Dimitri Mendeleev (1869 Russia)
  - Did not create periodic table, made it better
  - Put every element in its proper place; organized and simplified table

Elements



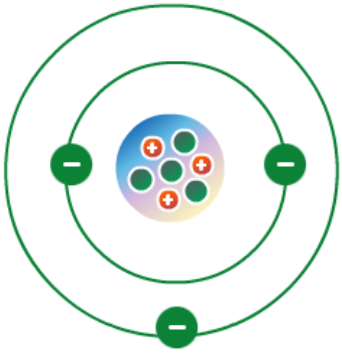
- The simplest form that matter can exist
- Atomic #: Number of protons & electrons
- Atomic Mass: Mass of protons, neutrons, electrons
- Element + Another Element = Compound
- **Compound Attributes for H_2O (water)**
  - Common Name
    - Water
  - Scientific Name
    - **Di**hydrogen **Mon**oxide (2 Hydrogen, 1 oxygen)
  - Molecular Formula
    - H_2O
  - Molecular Mass
    - 18 amu
  - Molecular structure

Ions

- When an atom gains/loses an electron, it becomes an ion
  - Loses/gains electrons to become more stable
  - Most stable when outer valence shell is full
    - Rule of 8 (All atoms want 8 outmost electrons
- (Hydrogen) H^+ lost an electron to become more stable

- (Chlorine) Cl^- gained an electron
- Ions like to get together
    - $Na^+ + Cl^- = NaCl$ ($Sodium^+$ - $Chlorine^-$ = Sodium Chloride)

Atomic Models



Lithium

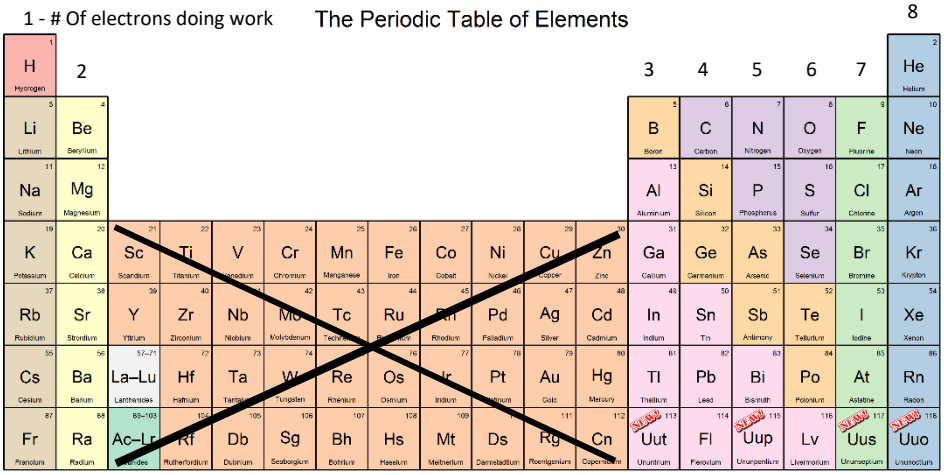
Atomic #: 3 (3 protons & 3 electrons)

Amu: 7 (3 protons + 4 neutrons)

# of neutrons = Amu - # of protons

The Octet Rule – "The Rule of 8"

- Every atom wants 8 electrons

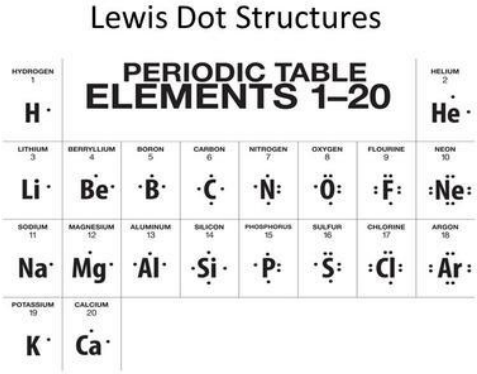


- Atoms want to bind with elements from numbered groups to total 8 electrons
- Can mix all from behaving groups
    - Example: 1 & 6

Lewis Dot Structure

- Dots represent outer electrons (up to 8)
- Keep dots spread out
- No dots on corners

$H^o\ {}_oH = H_2H$



Science STUDY GUIDE #2

Written by Ivan HRB on 10/31/2018

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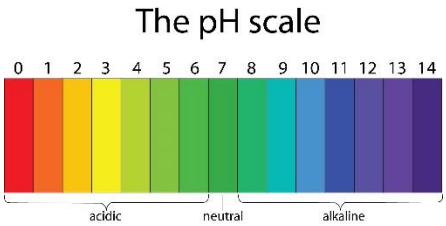


pH Scale

- The amount of hydrogen ions that something had
- Humans need pH balance to maintain **homeostasis**

Hydrocarbons

- Compounds made from **only** hydrogen and carbon are…
  - …combustible… (light on fire)
  - …Explosive…
  - … and Carcinogens (can cause cancer)

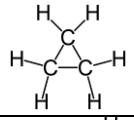
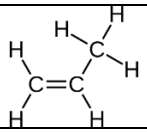
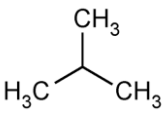
HONC Rule

Atom	Hydrogen	Oxygen	Nitrogen	Carbon
Symbol	*H*	*O*	*N*	*C*
"Friends"	1	2	3	4

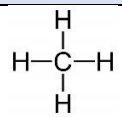
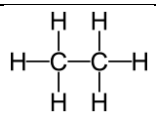
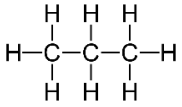
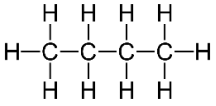
*Hint: When making a molecule, build the carbon **backbone** first! Then add all the other elements and finally add hydrogen at the end.*

Isomers of Molecules

- Isomer = 2 or more compounds with same formula but different atomic arrangements and properties

Name	Structure	Formula	Mass
[3] Cyclopropane		C_3H_6 (g)	42 amu
[3] Propene		C_3H_6 (g)	42 amu
[4] Isobutane		C_4H_{10} (g)	58 amu

List of Hydrocarbons

Name	Structure	Formula	Mass
[1] Methane		CH_4 (g)	16 amu
[2] Ethane		C_2H_6 (l)	30 amu
[3] Propane		C_3H_8 (g, l)	44 amu
[4] Butane		C_4H_{10} (g, l)	58 amu
[5] Pentane		C_5H_{12}	72 amu
[6] Hexane		C_6H_{14}	86 amu
[7] Heptane		C_7H_{16}	100 amu
[8] Octane		C_8H_{18}	114 amu
[9] Nonane		C_9H_{20}	128 amu
[10] Decane		$C_{10}H_{22}$	142 amu

Carbohydrates and Proteins

- Carbs are made of CHO
  - Starches are made and stored by plants
  - Used as **energy** in humans
- Proteins are CHON
  - Glycogen is made by animals
  - Used for **growth and repair** in humans

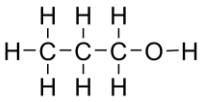
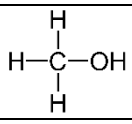
Alcohols

- Vodka → Potatoes
- Whiskey → Rye
- Cider → Apples
- Beer → Wheat
- Ethanol → Corn
- Sake → Rice

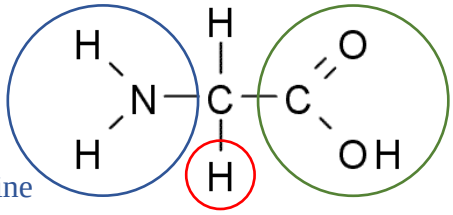
All alcohol comes from plants!

Alcohols Cont.

- Alcohols are made of CHO
  - That's why alcohol makes you fat
- Propanol
  - -ol indicates an alcohol

Name	Structure	Formula	Mass
Propan**ol**		$C_3H_7(OH)_{(g)}$	60 amu
Methan**ol**		$CH_3(OH)_{(g)}$	32 amu

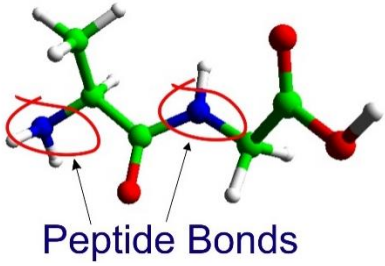
Proteins – Amino Acid



Organic = Contains carbon
Inorganic = Doesn't contain carbon

Protein Synthesis

- **Must** loose **one** molecule of water to create bond between amino acids
- A chemical reaction that has to **lose** waster to create (synthesize) a compound is called **dehydration** synthesis
  - Results in protein composed of two amino acids
  - Newly added amino acid is joined to other by peptide bond
- Monomer (Amino Acids)
- Polymer (All hooked together)



Four types of macromolecules

- Carbohydrates [CHO]
- Lipids [CHO]
- Proteins [CHON]
- Nucleic Acids [CHON]

Why do you eat?

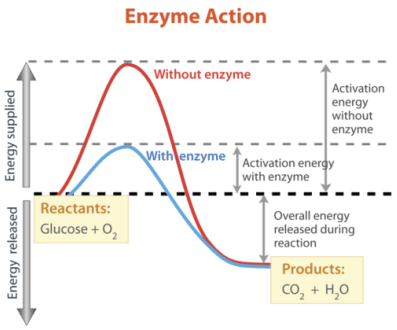
- To obtain energy
  - Breaking chemical bonds = **energy**
  - **Calories** = Unit of energy

Temperature

- **Fahrenheit** & **Celsius** (Centigrade)
- Human body temperature
  - **98.6**° F
  - **37**° C
- Water boils at…
  - **212**° F
  - **100**° C
- Water freezes at…
  - **32**° F
  - **0**° C

Enzymes – Activation Energy

- Activation energy = **E_A**
- The energy that must be invested for a **chemical** reaction to take place
- All or nothing – Give it all or **get nothing**
- Enzymes are protein
  - Are needed for life
  - Made to work on specific compound
- Enzymes lower the activation energy needed to start a reaction
- Enzymes can be reused 100 - 30,000,000 times
- Every sugar has its own **specific** enzyme
- What enzyme works with lactose?
  - Lactase
- Enzymes end with -ase
- Sugars end with -ose
- Enzymes are **catalysts** (Speed up reaction, not used up)



Enzymes in real "real" life

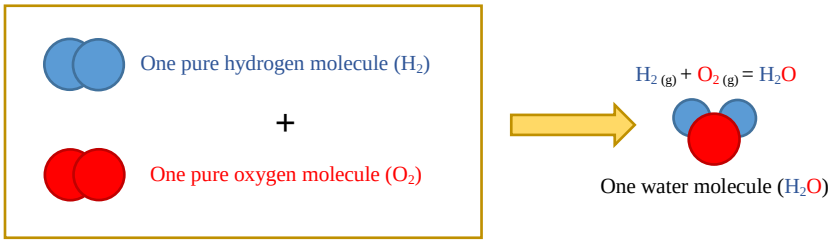
- Cows can eat grass but we can't because it contains cellulose, and we lack the enzyme cellulase
- Lactose intolerance = body's lack of the enzyme lactase
  - Trying to digest lactose makes you queasy
- People with contact lenses must clean protein deposits off with protease

Reactants versus Product(s)

$H_{2\,(g)} + O_{2\,(g)} = H_2O$

Reactants Products

Chemical Reactions



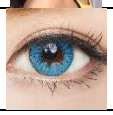
Endothermic vs Exothermic

- Exothermic reactions **release** energy
- Endothermic reactions **absorb** energy

Item	Reaction
	Exothermic
	Exothermic
	Exothermic
	Endothermic
	Endothermic
	Endothermic

Steel feels cold because it absorbs your hand's heat

Chemical vs Physical Change

Process	Image	Phys or Chem?
Haircut		Physical
Dying your hair		Chemical
Perm		Chemical
Hair Relaxer		Chemical
Colored contacts		Physical

Evidence of Chemical Reactions

- Evidence for chemical reactions include changes in…
  - Temperature
  - Color
  - State
  - Flavor
  - Odor

Metabolism

Synthesis + **Degradation** = **Metabolism**

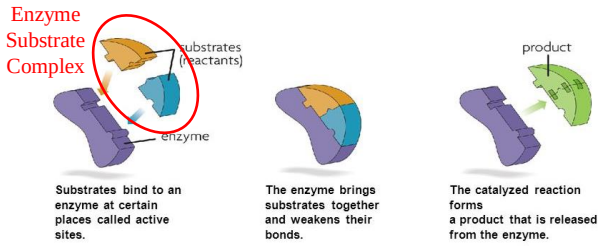
Anabolic + **Catabolic** = **Metabolism**

Making Bonds | Breaking Bonds | Homeostasis (Balance)

- Enzymes control chemical reactions in cells
  - Control cells' metabolic reactions

Lock and Key Model

- The **lock-and-key model** helps illustrate how enzymes function.
  - ***substrates** brought together & combined into **products***
  - ***Each enzyme only catalyzes one type of reaction***



Catalyst = Used, but not used up; speeds up a reaction

The Olestra Fiasco

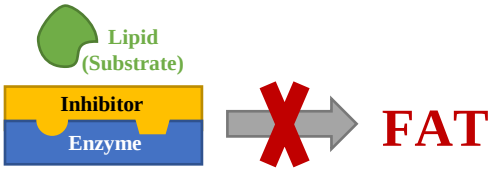
Olestra = Artificial fat = Diarrhea - "Anal Leakage"

Trans fats = Artificial fat

Body lacks enzymes to break down artificial fats. No fat is produced, but there is a risk of intestinal trouble

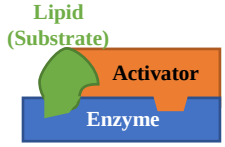
Pancreas = Organ that produces enzymes

Enzyme Inhibitors



Inhibitors temporarily attach to an enzyme, preventing the substrate from latching on and in turn, preventing a reaction

Enzymes – Activators



Activators work by activating an enzyme to accept a substrate

Enzymes – Environment

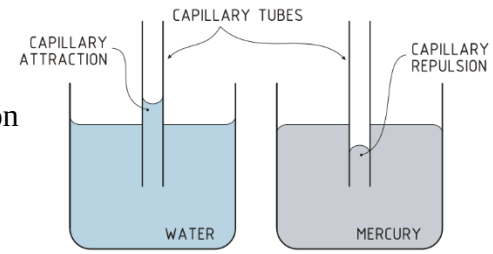
- Factors which influence reaction rates include
  - pH – **Different enzymes need a different pH**
  - Substrate – **More substrates = Enzyme works harder**
  - Temperature – **Testicles = 2° lower than body temp**
  - Inhibitors or activators = **Slow/Speed up reaction**
  - Enzyme – **What type is it?**
- When an enzyme no longer works and its shape is altered, it is considered **denatured**

Video – "Crash Course: Why Hydrogen is a Tramp"

- **Carbon** = small, 12 amu
- Due to small size, carbon can form itself into rings, spirals, etc.
- Carbon bonds with pretty much everything (needs four atoms)
  - Core atom of complicated structures
- Carbon is basis of life
- Carbon forms covalent bonds (atoms share electrons)
- **Gilbert Lewis** = Created **Lewis dot structure**
  - Nominated for Nobel prize 35 times; more nominations than anyone else ever
    - Won zero times
  - Coined term photon
  - Produced first molecule of heavy water
- Ionic bonds do not…
  - share electrons
  - Donate of accept electrons
  - Live as a charged atom or ion
- **Hydrogen bonds** = bonds between polar molecules
  - Water sticks together at top of glass = bonds sticking together = surface tension

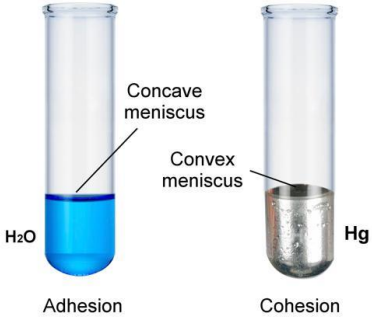
Video – "Crash Course: Water"

- Water is only substance that naturally occurs in all three forms (solid, liquid, gas)
- H_2O uses a covalent bond
- Water is a polar molecule – stick together
  - **Hydrogen bonds** = bonds between poles
- **Cohesion** = same substance sticks together
- **Adhesion** = one substance sticking to other substance
- **Capillary action** = water climbs up straw due to cohesion
- Water is amazing solvent
  - Most powerful solvent
- Substances that dissolve in water = **Hydrophilic**
- **Hydrophobic** = Materials that cannot dissolve into water



Video – "Crash Course: Water" – Continuation

- **Henry Cavendish**
  - First to recognize hydrogen gas as a distinct substance
  - Determined to composition of water
  - Established composition of atmosphere
  - Calculated density of the Earth
  - Only published 20 papers
  - Pre-discovered Richter's law, Ohm's law, Coulombs law, etc.
- Frozen water is less dense than liquid water, ice floats on water
- Water has high heat capacity
  - Really good at holding onto heat
  - Hard to heat up, cool down



Video – "Boseman: Enzymes"

- Catalase (very common enzyme)
  - Breaks down hydrogen peroxide (H_2O_2)
- $2H_2O_2$ breaks down into $2H_2O$ and O_2 (water, oxygen)
- 40 million hydrogen peroxide molecules are broken down each second
- Active site = hole in enzyme
  - Substrate fits into it
- Activator = Turns on enzyme
- Inhibitor = Turns off enzyme
  - Competitive
    - Chemical is blocking activation site
  - Allosteric
    - Changing the enzyme's shape
- Chemical tug lowers activation energy (pH, mechanical)
- Turning enzymes on or off
  - Simply stop producing enzyme
    - **Gene Regulation** = Doesn't code proteins until ready
  - Activation
    - Adding something to enzyme to make it work
- There are two types of activators
  - Cofactors
    - Small chemicals
    - inorganic
  - Coenzymes
    - Organic
    - Known as "Vitamins"

Video – "Boseman: Enzymes" Continuation

- Two hypes of inhibition
    - Competitive inhibition
        - Using other chemical (inhibitor)
        - Blocks activation site
        - Competing for space with substrate
    - Allosteric inhibition
        - Allosteric site is on enzyme
        - Inhibitor bonds to allosteric site
        - Covers up or changes shape of active site