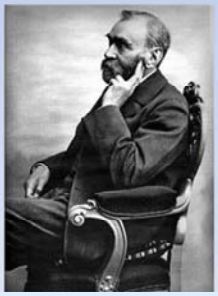
How can Non-Chemists Understand and Apply Chemistry?



Billy Puk

October 29, 2013

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Biography

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Recology
San Francisco
WASTE ZERO

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Acknowledgement

- Larry Sweetser
  Owner/Consultant
  Sweetser & Associates

Assisting you through the regulatory maze
SWEETSER & ASSOCIATES

- Ionie Wallace, REHS
  Interim Deputy Fire Marshal
  San Bernardino Fire Department

SAN BERNARDINO COUNTY FIRE DEPT

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Basic Terms

1) Chemistry – study of the properties of materials (matter) and the changes that materials undergo.

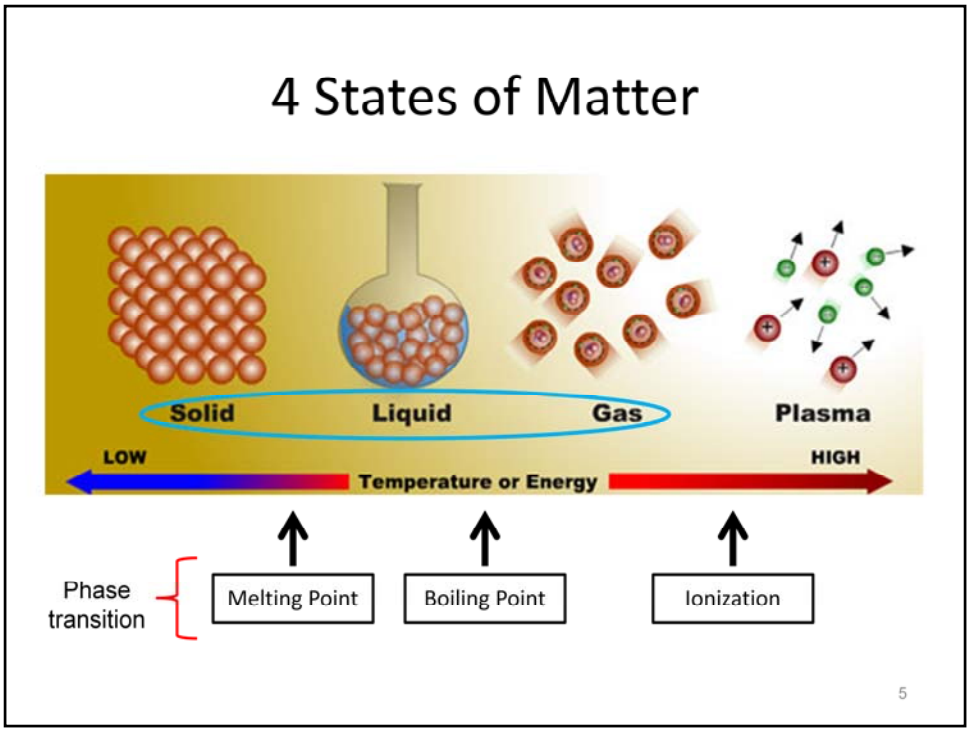
2) Matter – anything that occupies space and has mass.

3) Atom – the smallest representative particle of an element.

4) Element – substance that cannot be separated into simpler substances by chemical means.

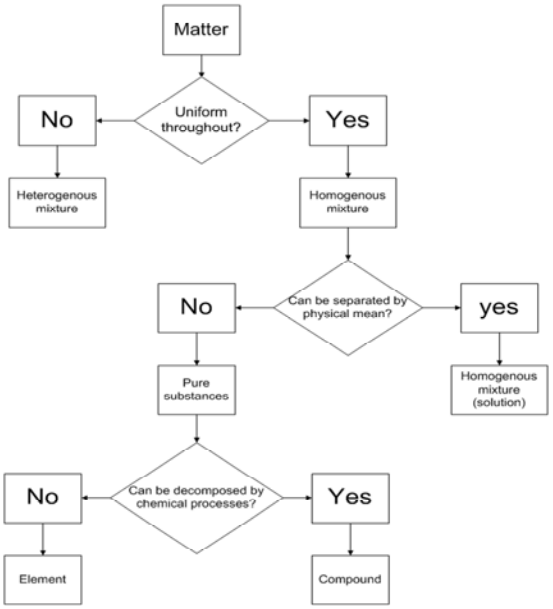
5) Compound – substance composed of 2 or more elements united chemically in definite proportions.

4



Images:
http://www.nasa.gov/mission_pages/themis/auroras/sun_earth_connect.html#.UmC5xKySx_c

Classification of Matter



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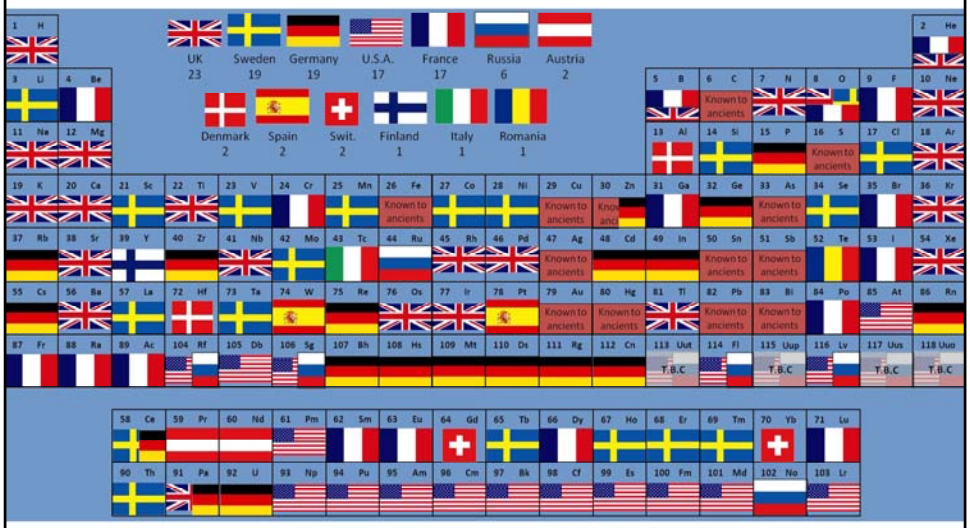
What is This?



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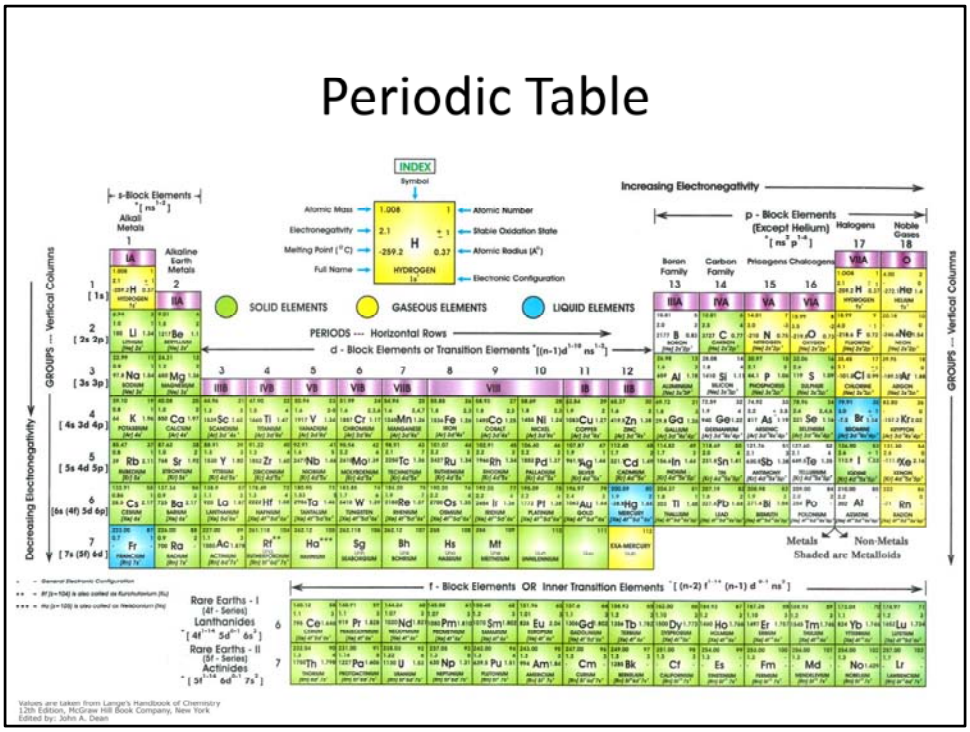
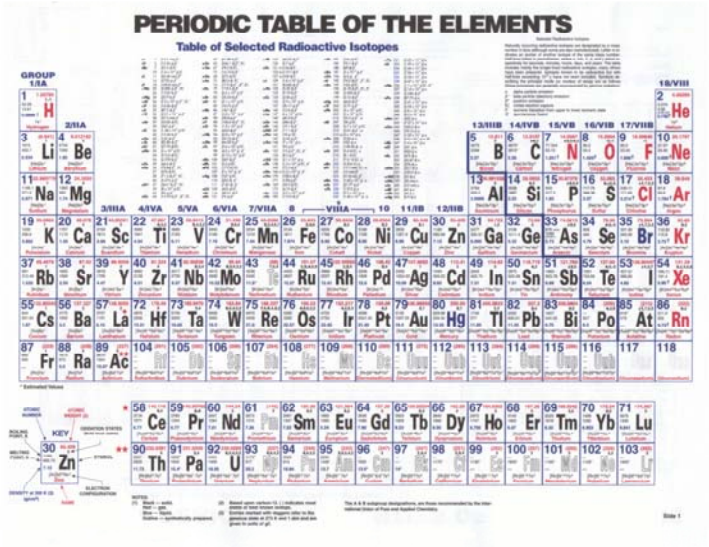
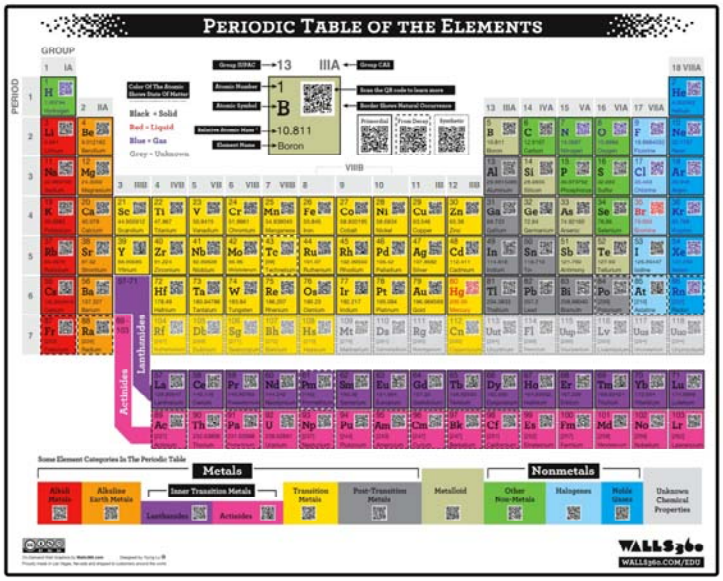
Periodic Table



Periodic Table



Periodic Table



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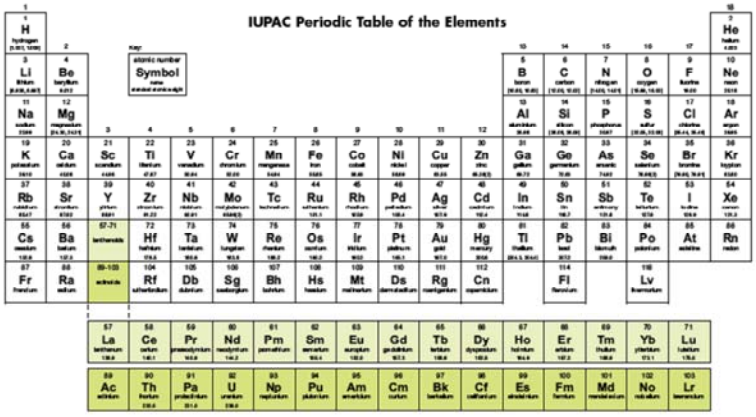
Periodic Table



Notes

- IUPAC 2011 Standard atomic weights abridged to four significant digits (Table 4 published in *Pure Appl. Chem.* 85, 1047-1078 (2013); http://dx.doi.org/10.1351/PAC-REP-13-03-02). The uncertainty in the last digit of the standard atomic weight value is listed in parentheses following the value. In the absence of parentheses, the uncertainty is one in that last digit. An interval in square brackets provides the lower and upper bounds of the standard atomic weight for that element. No values are listed for elements which lack isotopes with a characteristic isotopic abundance in natural terrestrial samples. See IAC for more details.
- "Aluminum" and "cesium" are commonly used alternative spellings for "aluminium" and "caesium."
- Claims for the discovery of all the remaining elements in the last row of the Table, namely elements with atomic numbers 113, 115, 117 and 118, and for which no assignments have yet been made, are being considered by a IUPAC/IUPAP Joint Working Party.

For updates to this table, see iupac.org/reports/periodic_table/. This version is dated 1 May 2013.

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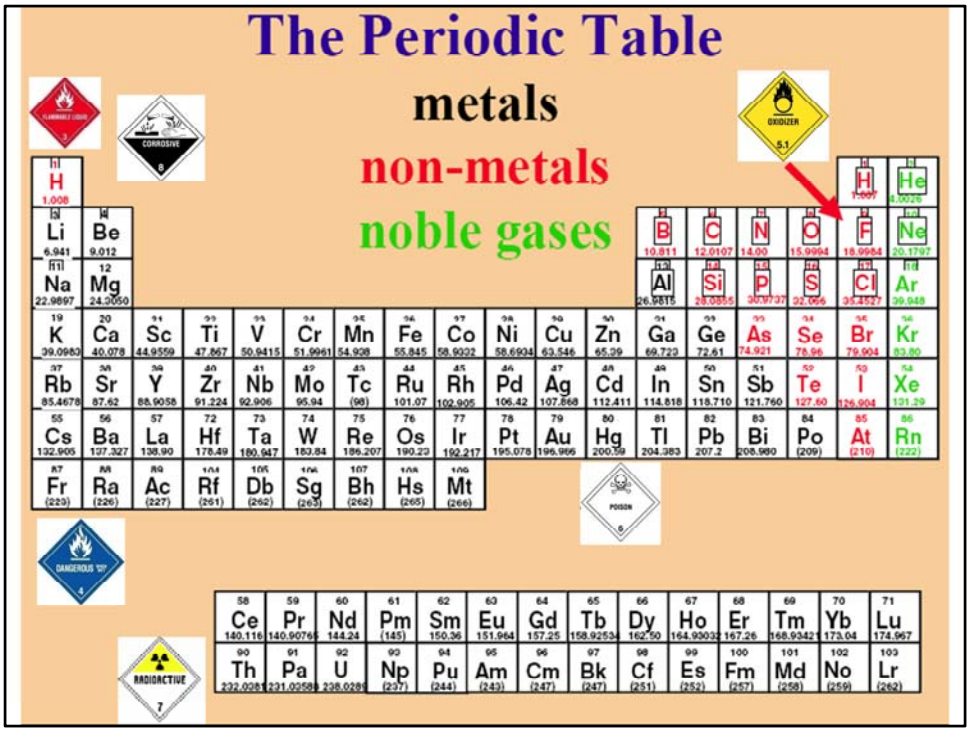
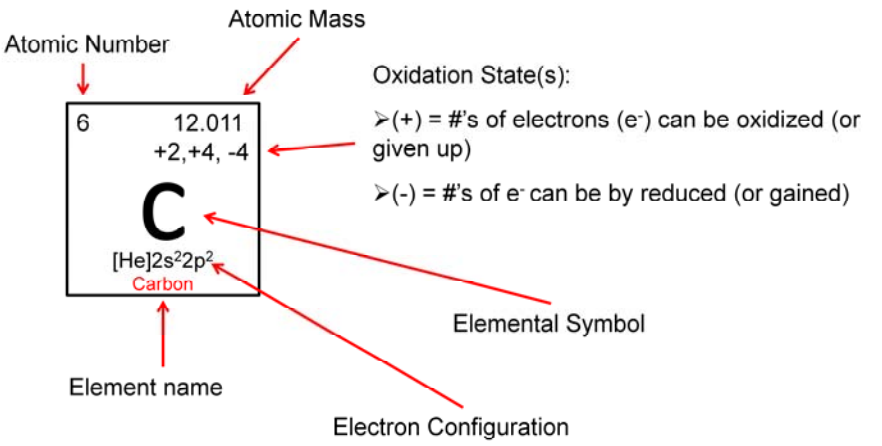

The Periodic Table
metals
non-metals
noble gases
CORROSIVE
OXIDIZER
5.1
POISON
DANGEROUS "DP"
RADIOACTIVE
7

Decoding the Element from Table



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Common Chemical Symbols

- Carbon = C
- Chlorine = Cl
- Hydrogen = H
- Lithium = Li
- Nitrogen = N
- Oxygen = O
- Potassium = K
- Sodium = Na

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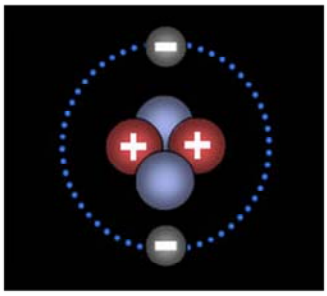
Atoms

- Electron
  - negatively charged (–) particle found outside of and surrounding the atomic nucleus to form a shell;
  - mass is 1,836x less than mass of proton.
- Proton
  - positively charged (+) particle found in the atomic nucleus
  - Atomic Number
- Neutron
  - neutral particle in atomic nucleus;
  - slightly more mass than protons.



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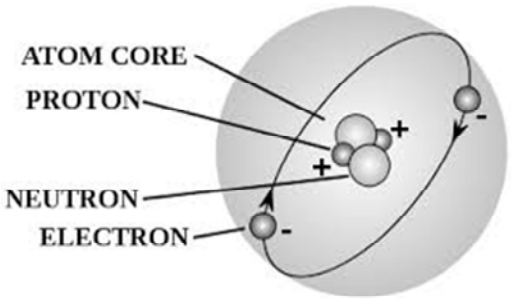
Simple Math



	relative mass	relative charge
proton	1	+1
neutron	1	0
electron	1/1836	-1

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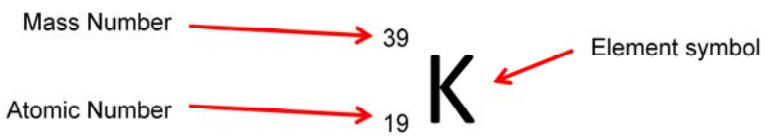
Atomic Mass/Number

- Atomic Mass = #'s of Protons + #'s of Neutrons
- Atomic Number = #'s of Protons



- Protons = 19
- Neutrons = 39 – 19 = 20

17

Isotopes

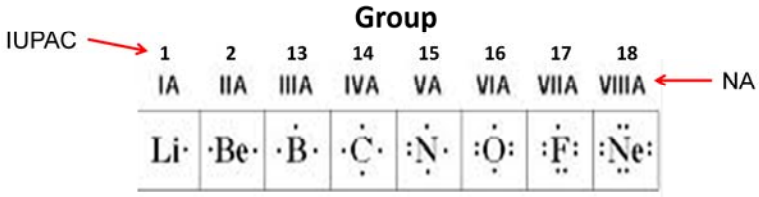
	Symbol	protons	neutrons	mass number
carbon-11	^{11}C	6	5	11
carbon-12	^{12}C	6	6	12
carbon-13	^{13}C	6	7	13
carbon-14	^{14}C	6	8	14

Almost 99% of the carbon found in nature consists of ^{12}C.

18

Valence Electrons

In general, the number of valence electrons of a representative element is equal to the group number



IUPAC = International Union of Pure and Applied Chemistry

NA = North America

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Alkali Metals – Group 1

- Very Reactive
- Do not occur freely in nature
- One e^- in outer shell
- Soft, malleable, ductile, good conductor
- Can explode in contact with water

- Lithium, Sodium, Potassium, Rubidium, Cesium & Francium

Click here for alkali metals reacts with water
Click here for Na in explosive action!

20

Alkaline Earth Metals – Group 2

- Very reactive
- Not freely found in nature
- Hard
- 2 e^- in outer shell

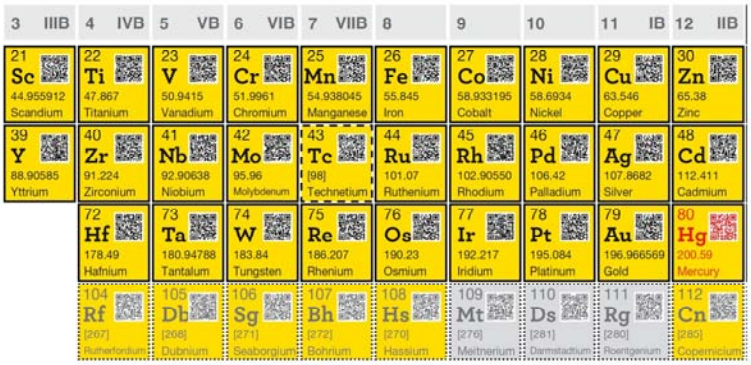
- Beryllium, Magnesium, Calcium, Strontium, Barium, Radium

Click here for group 2 metals reacts with water!

21

Transition Metals (Groups 3-12)

- Ductile & Malleable
- Conduct electricity and heat
- Metals commonly found in electronics

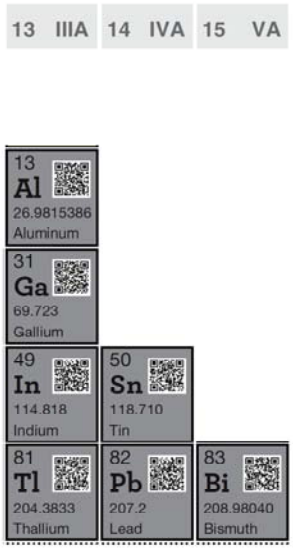


22

Other Metals (Groups 13-15)

- Solid
- High density
- Opaque
- Various e^- in outer shell

- Aluminum, Gallium, Indium, Tin, Thallium, Lead, Bismuth



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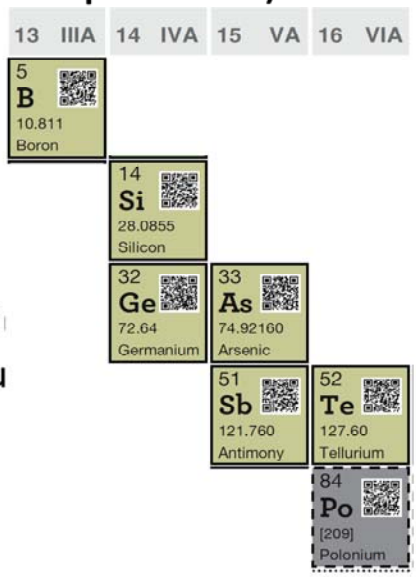
Metalloids (Group 13-16)

- Properties of both
  - metals and nonmetals
- Carry electrical charge
- Boron, Silicon, Germani
  Arsenic, Antimony, Tellu
  Polonium



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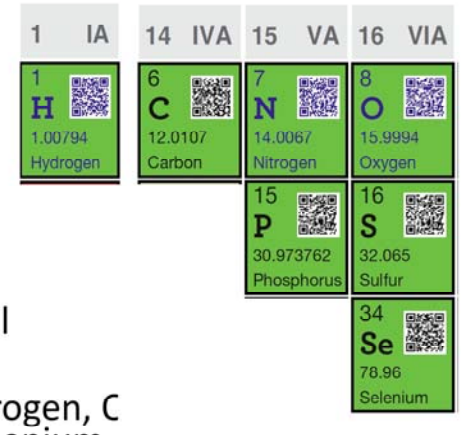
Non-metals – Groups 14-16

- Do not conduct
  - electricity or heat well
- Gas or solid form
- Very brittle if solid
- Cannot be
  - Rolled into wires
  - Pounded into sheets
- Various e^- in outer shell

- Hydrogen, Carbon, nitrogen, C
  Phosphorus, Sulfur, Selenium



25

Halogens – Group 17

- VERY REACTIVE
- "Salt-former"
- Form acid when reacts w/ H_2
- 7 e^- outer shell
  - Needs only 1 e^- to complete the shell
- Fluorine, Chlorine, Bromine, Iodine, Astatine

26

Noble Gases – Group 18

- Inert, stable elements except Kr, Xe & Rn
- Simple asphyxiants
- Maximum e^- in outer shell
  - All e^- has filled the outer shell
- Helium, Neon, Argon, Krypton, Xenon, Radon

27

Rare Earth – Group 3

- 6th and 7th period
- Lanthanide and Actinide Series
  - Lanthanide series – soft silvery metals

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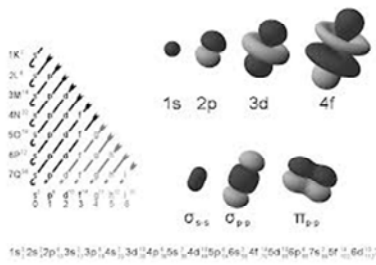
Chemical Bonding

- Atoms like to have a full outer shell and will gain/lose or share electrons to achieve a full outer shell.
- Electron configuration plays an important role
  - *s* orbital = 2 e^- max
  - *p* orbital = 6 e^- max
  - *d* orbital = 10 e^- max
  - *f* orbital = 14 e^- max



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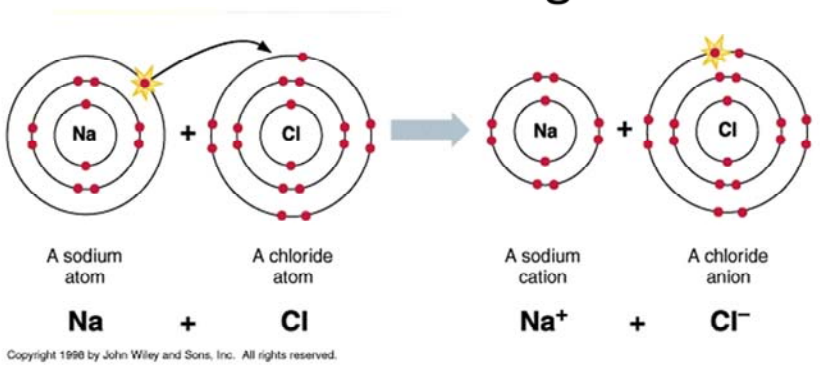
Ionic Bonding

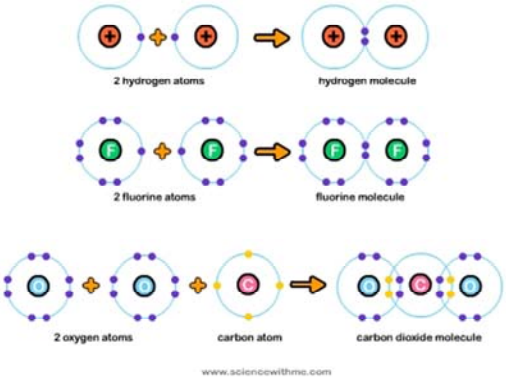


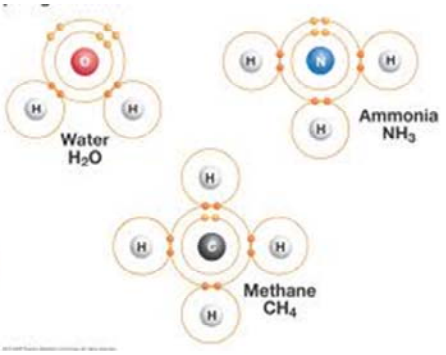
- The outer most valence e^- transfers from one atom to another.
- Bond forms mostly between elements in Group 1 (IA) or 2 (IIA) and elements Group 17 (VIIA).

30

NaCl = table salt

Covalent Bonding





Bonds are formed by sharing e^-

- Most elemental gases, e.g. F_2, H_2 & O_2
- Nonmetal only compound, e.g. CO_2, CH_4, H_2O

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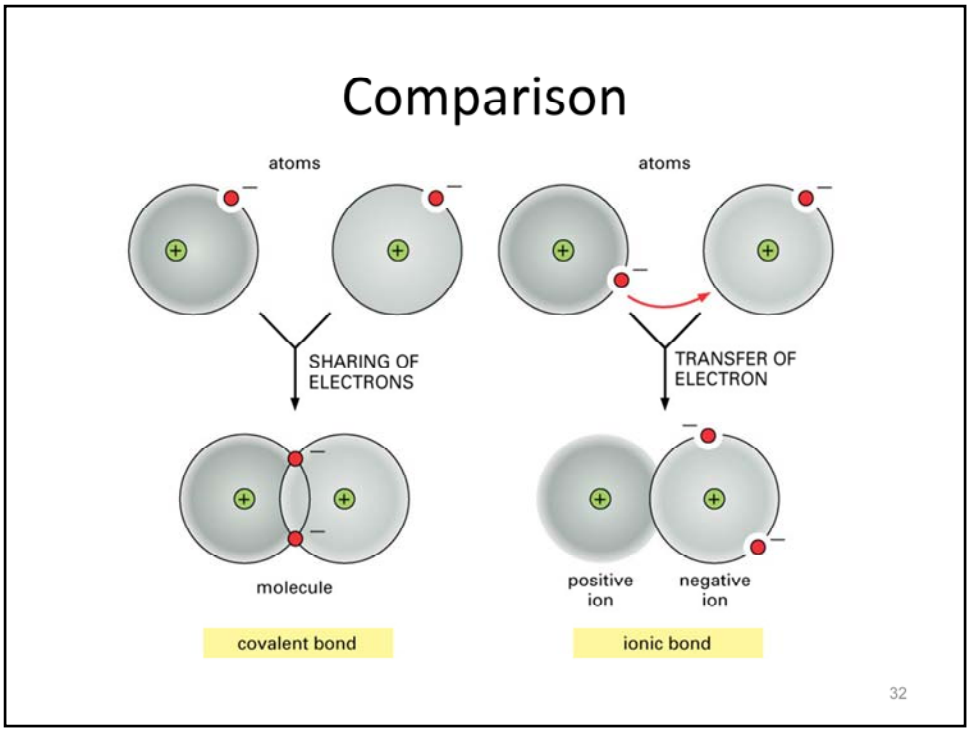
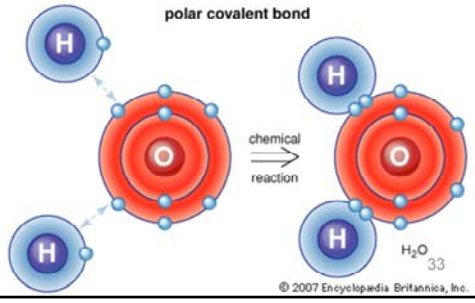


More on You Tube about bonding – covalent bond, ionic bond and hydrogen bond in biochemistry

http://www.youtube.com/watch?v=l580C493zYg

Compound

- 2 or more elements bonded together
- Metal-nonmetal naming, prefixes (cation) and suffixes (anion)
  - NaCl: Na = cation & Cl = anion
- Hydrogen (H_2) + oxygen (O_2) → water (H_2O)
- Some common groups
  - NO_2 = nitrite
  - NO_3 = nitrate
  - SO_4 = sulfate
  - PO_4 = phosphate



Have You Seen This Before?

Drum was bulged!

Chemical reaction persisted!

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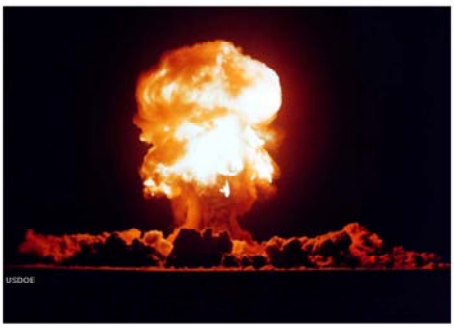
Vapor pressure?

Chemical Reactions



- Chemical changes are a result of chemical reactions
- All chemical reactions involve a change in substance and a change in energy

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Chemical Reactions

4 General Types:

- Synthesis/Combination (A+B → C)
  - e.g. $2H_2 + O_2 \rightarrow 2H_2O$
- Decomposition (C → A+B)
  - e.g. $CaCO_3 \rightarrow CaO + CO_2$
- Single Replacement (A+BC → B+AC)
  - e.g. $Zn + 2HCl \rightarrow H_2 + ZnCl_2$
- Double Replacement (AB+CD → AD+CB)
  - e.g. $HCl + NaOH \rightarrow NaCl + H_2O$

Reactant(s)

Product(s)

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Chemical Reactions

Chemical reactions always involve a change in energy

- Endothermic: energy is required for the reaction to occur
  - e.g. $H_2O(s)$ + heat → $H_2O(l)$
- Exothermic: energy is released in reaction (stored in chemical bonds)
  - e.g. NaOH(*aq*) + HCl(*aq*) → NaCl(*aq*) + $H_2O(l)$ + heat

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April 16, 1947 – Texas City

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For more information:

http://www.youtube.com/watch?v=TworcINhDhQ&list=PLwF3lvZzHzmTXO8rkWg7PLoGHKpt8lUyO

Major Chemical Groups

Salts and non-salts
Inorganic
Organic

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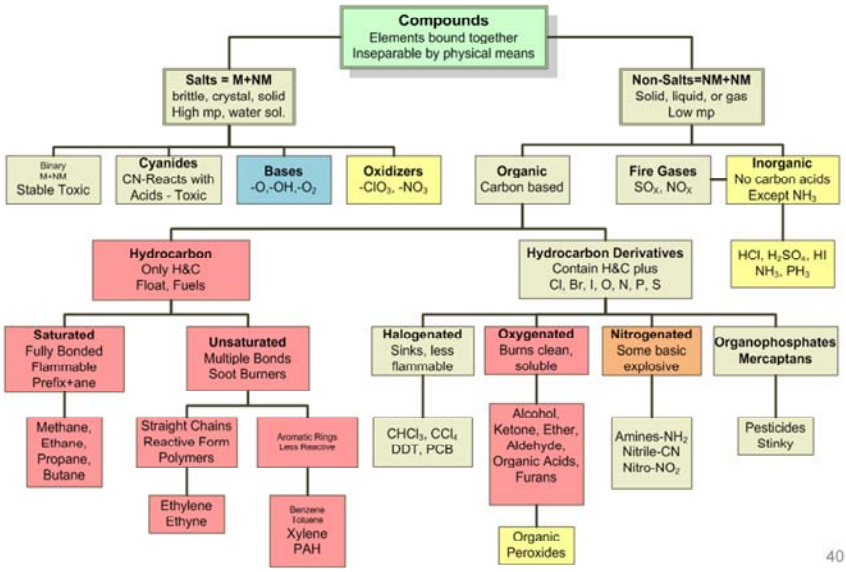
Major Chemical Families



Salts

- Formed when an acid and a base react with one another
- Salts may be toxic
- May contain heavy metals
- May have a heavy metal in the name, i.e. “copper” and “lead”

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Inorganic vs. Organic

USDA ORGANIC

Inorganic Organic

Old-fashioned type of association

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Difference

- Organic = compounds consists of carbon
  - Usually, in combination of hydrogen (hydrocarbon), oxygen, nitrogen, or sulfur
- Inorganic = all other compounds
  - Let's explore this type of compounds first

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Inorganic Chemicals

- Acids
  - Hydrochloric (muriatic), sulfuric, nitric acids
- Bases
  - Sodium hydroxide (lye), potassium hydroxide
- Salts
  - 6 types; binary salt, metal cyanide, metal oxide, metal hydroxide, metal peroxide, metal oxysalt (i.e. $BaSO_4$)

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Inorganic Pesticides

- Compounds containing heavy metals
  - lead, mercury, zinc, copper
- Compounds containing metalloids
  - arsenic, boron
- Compounds containing nonmetals
  - sulfur, fluoride

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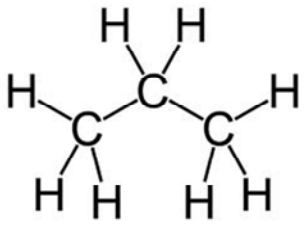
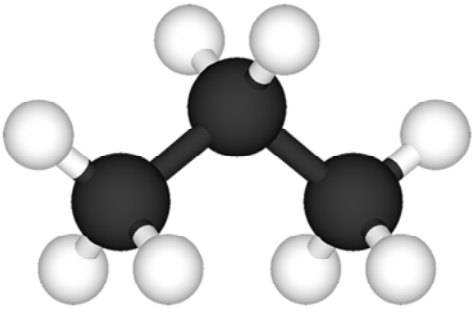
Organic Chemicals

- Based on the chemistry of carbon
- Hydrocarbons are the root of most organic chemicals





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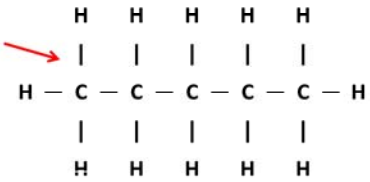
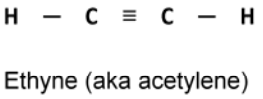
Naming Organic Chemicals

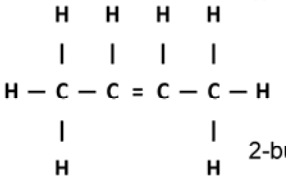
- Name tells you the structure
- Prefix
  - Meth-, eth-, prop-, but-, pent-, hex-, hep-, oct-
- Suffix
  - -ane, single bond, saturated
  - -ene, double bonds
  - -yne, triple bonds



pentane



Ethyne (aka acetylene)



2-butene

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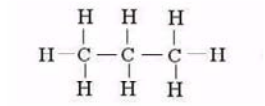
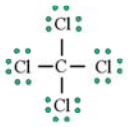
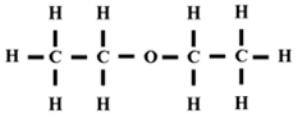
Hydrocarbons

- Aliphatics
  - methane, propane, hexane
- Aromatics
  - benzene, xylene, toluene
- Halogenated Hydrocarbons
  - CFC's, PCB's
- Oxygenated Hydrocarbons
  - alcohols, aldehydes, ketones. ethers

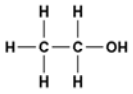
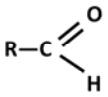
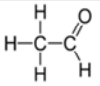
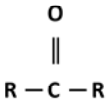
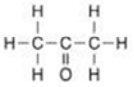






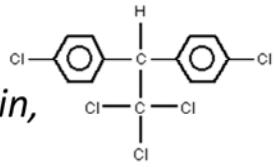
Ethyl Ether
$C_2H_5OC_2H_5$

Functional Groups

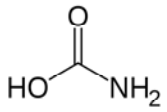
Functional Groups	Class of Molecules	Formula	Example
Hydroxyl OH	Alcohols	**R–OH**	 Ethanol
Carbonyl CHO	Aldehydes		 Acetaldehyde
CO	Ketones		 Acetone
ROR	Ether	**R-O-R**	$CH_3–O–CH_3$ Dimethyl ether

49

Organic Pesticides



- Organohalogenated - *DDT, Aldrin, Chlordane, Methyl Bromide*
- Organophosphates - *Parathion, Malathion Diazinon, Dichlorvos, Chlorpyrifos*
- Carbamates - *Baygon, Aldicarb, Carbaryl (Sevin)*
- Urea Derivatives - *Linuron*



50

DDT = dichloro-diphenl-trichloroethane (diagram top)

Carbamate derives from carbamic acid (diagram bottom)

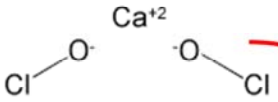
Hazards of Organic Chemicals

- Many are flammable
  - Flammability characteristics should be known
- Many are Anesthetic
  - They should always be used in well-ventilated spaces
- Some are Carcinogenic
  - Toxicity limits should be known and appropriate PPE worn

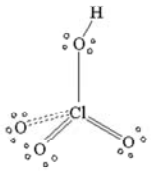
51

Dangerous Chemicals

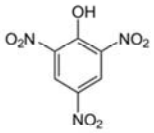
- Calcium hypochlorite



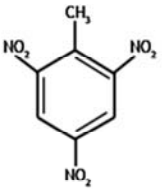
- Perchloric acid



- Picric acid



- Trinitrotoluene (TNT)



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Properties of Chemicals

Physical Properties

- Measurable
  - Density, melting pt, boiling pt, solubility

Chemical Properties

- How chemicals react
  - Flammability, oxidation states, toxicity

53

Physical States

- Solid

- Liquid

- Gas

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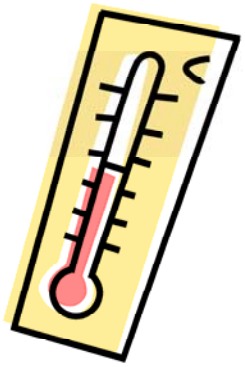
Melting and Freezing Point

- Temperature at which the chemical will change state
  - Solid to a liquid (melting) or
  - Liquid to a solid (freezing)



55

Boiling Point

- The temperature at which the vapor pressure is equal to atmospheric pressure
- Liquids boil at different temperatures

56

Specific Gravity

- Specific Gravity is the ratio of the density of a substance compared to water
  - Unitless
  - Water = 1
  - Less than 1 will float
  - More than 1 will sink

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Densities and Specific Gravity's of Some Common Liquids

Substance	Density (gm/cm3) @ 15°C	Specific Gravity
Gasoline*	0.7-0.8	0.7-0.8
Water	1.00	1.00
Chloroform*	1.498	1.498
Mercury	13.6	13.6

* Click here and here for gasoline information; click here for chloroform

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Vapor Pressure

- Is the pressure exerted by the vapor that evaporates from a liquid in a closed space
- A measure of the rate of evaporation
- As temperature increases, the vapor pressure increases
- Temp ↑ = Pressure ↑

59

Vapor Density

- Is the molecular weight of a gas or vapor divided by the molecular weight of air (28.9 atomic mass unit; amu)
- It tells us whether a gas is lighter or heavier than air
  - Unitless
  - Air =1
  - Greater than 1 will fall
  - Less than 1 will rise

60

Vapor Density of Some Common Gases

Gas	AMU	Vapor Density
Hydrogen (H_2)	2	0.07
Methane (CH_4)	16	0.55
Air	28.9	1.00
Carbon Dioxide (CO_2)	44	1.52
Chlorine (Cl_2)	35.45	2.45

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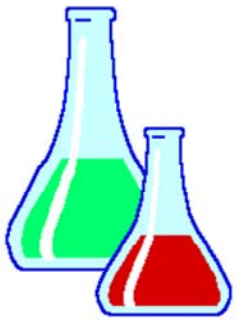
Solubility



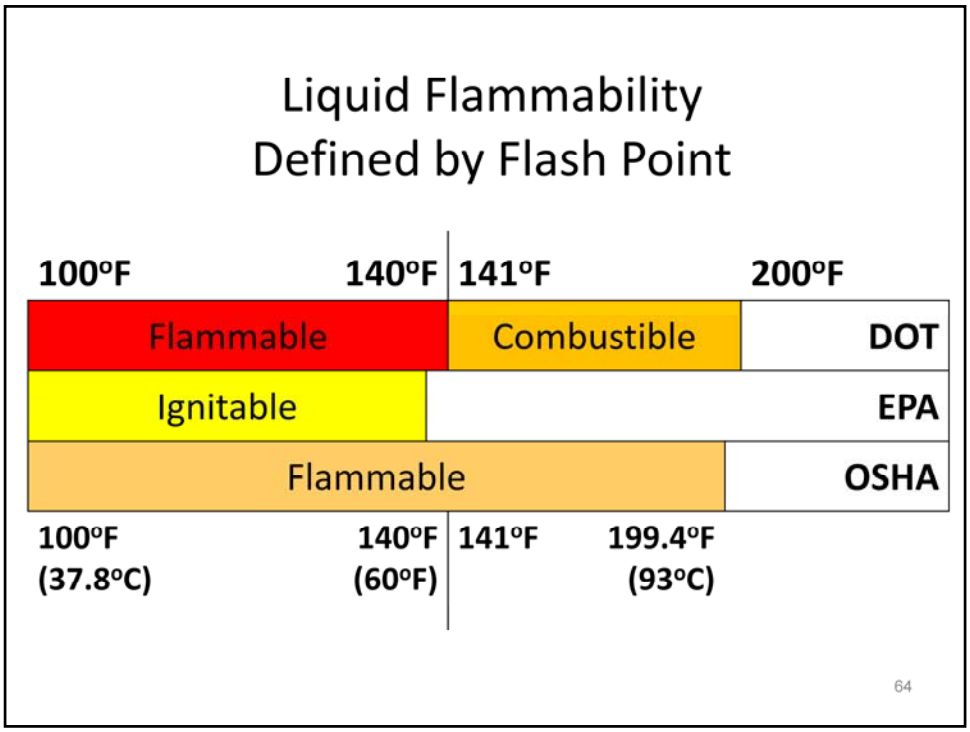
- The ability of a solid, liquid, or gas to dissolve in a solvent, usually a liquid
- The amount of a substance that dissolves in a given quantity of solvent at a given temperature to form a saturated solution.

62

Flash Point

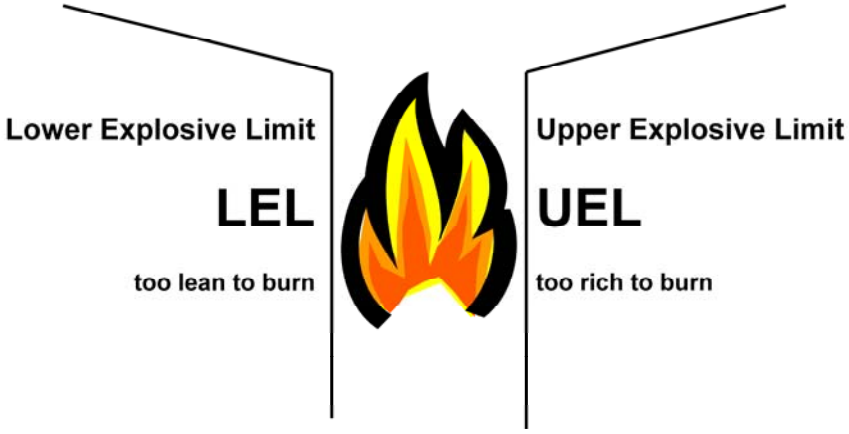
- Is the minimum temperature at which a substance gives off vapor sufficient to form an ignitable mixture with air
- Lower the flash point, higher the flammability

63


Liquid Flammability
Defined by Flash Point
100°F
140°F
141°F
200°F
Flammable
Combustible
DOT
Ignitable
EPA
Flammable
OSHA
100°F
(37.8°C)
140°F
(60°F)
141°F
199.4°F
(93°C)
64

Explosive/Flammable Range

Vapor to Air concentrations that ignite/burn



65

Physical Properties Related to Flammability*

Liquids	Boiling Point	Flash Point	LEL	UEL
Acetone	133	0	2.5	12.8
Ethanol	173	55	3.3	19
Gasoline	102	-45	1.4	7.6

* NIOSH Pocket Guide

66

Auto Ignition Temperature

- Is the minimum temperature at which a substance ignites without application of a flame or spark
- Is usually considerably higher than the flash point

67

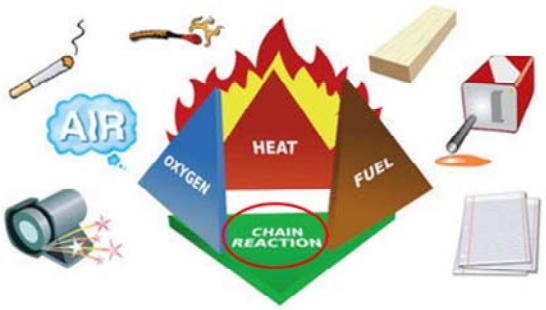
Auto Ignition Temperature*

Item	Flashpoint (°F)	Auto ignition (°F)
Acetone	0	869
Ethanol	55	689
Gasoline	-45	536
Phosphorus, transparent	NA	120
Wood	NA	572

* http://www.engineeringtoolbox.com/fuels-ignition-temperatures-d_171.html 68

Fire

Triangle



Tetrahedron

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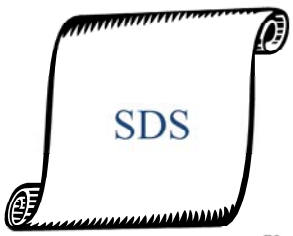
Safety Data Sheet (SDS)

- Required by OSHS
- Information was listed various from Uniformly standardized for easy access company to company.
- Describes physical & chemical properties
- Lists safety requirements
- Shows primary hazards



70

Sample SDS Layout: Benzene/HCl

1) Product/Company ID
2) Hazards ID
3) Composition
4) First Aid Measure
5) Firefighting Measure
6) Accidental Release Measure
7) Handling & Storage
8) Exposure Controls/PPE
9) Physical & Chemical Properties
10) Stability & Reactivity
11) Toxicological Info.
12) Ecological Info.
13) Disposal Consideration
14) Transport Info.
15) Regulatory Info.
16) Other Info.

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SDS Limitations

- Specific to product, not mixtures or contamination
- Not all ingredients always listed
  - if % is low, trade secrets or not part of activity (i.e. inert ingredients)
- Environmental & disposal information very general

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The Invisible Killer

Dihydrogen monoxide is colorless, odorless, tasteless, and kills uncounted thousands of people every year. Most of these deaths are caused by accidental inhalation of DHMO, but the dangers of dihydrogen monoxide do not end there. Prolonged exposure to its solid form causes severe tissue damage. Symptoms of DHMO ingestion can include excessive sweating and urination, and possibly a bloated feeling, nausea, vomiting and body electrolyte imbalance. For those who have become dependent, DHMO withdrawal means certain death.

Dihydrogen monoxide:

- is also known as hydroxl acid, and is the major component of acid rain.
- contributes to the "greenhouse effect."
- may cause severe burns.
- contributes to the erosion of our natural landscape.
- accelerates corrosion and rusting of many metals.
- may cause electrical failures and decreased effectiveness of automobile brakes.
- has been found in excised tumors of terminal cancer patients.

Quantities of dihydrogen monoxide have been found in almost every stream, lake, and reservoir in America today. But the pollution is global, and the contaminant has even been found in Antarctic ice. DHMO has caused millions of dollars of property damage in the midwest, and recently California.

Despite the danger, dihydrogen monoxide is often used:

- as an industrial solvent and coolant.
- in nuclear power plants.
- as a fire retardant.
- in the distribution of pesticides. Even after washing, produce remains contaminated by this chemical.
- as an additive in certain "junk-foods" and other food products.

Companies dump waste DHMO into rivers and the ocean, and nothing can be done to stop them because this practice is still legal. The impact on wildlife is extreme, and we cannot afford to ignore it any longer!

73

Chemical Classification

- Hazardous Substance/Materials/Wastes
- DOT, EPA, OSHA
- Hazardous Characteristics
  - Corrosive
  - Toxic
  - Flammable
  - Oxidizer
  - Reactives
  - Others

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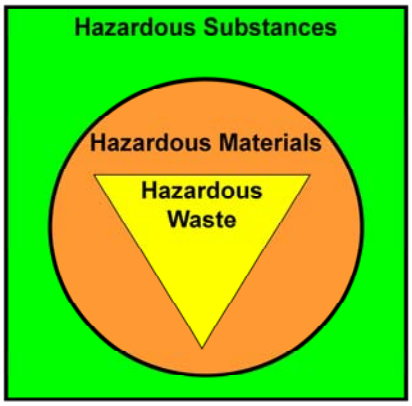
Hazardous

- Hazardous Substance
- Hazardous Materials
- Hazardous Wastes



75

DOT Hazard Classes

- Explosives Class 1
- Gases, Class 2
- Flammable, Class 3
- Flammable, Class 4
- Oxidizers, Class 5
- Poisonous, Class 6
- Radioactive, Class 7
- Corrosives, Class 8
- Other, Class 9

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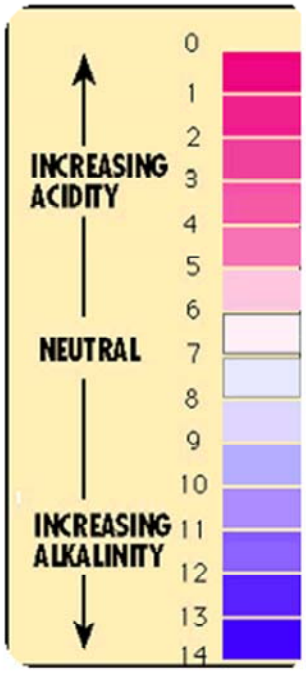
Hazardous Waste Classes

- Corrosive
- Toxic
- Flammable
- Oxidizers
- Reactives
- Other

77



pH Scale

Hydrogen Ion concentration

$0.0001 = 10^{-4}$ pH=4

$0.0000001 = 10^{-7}$ pH=7

$0.0000000001 = 10^{-10}$ pH=10

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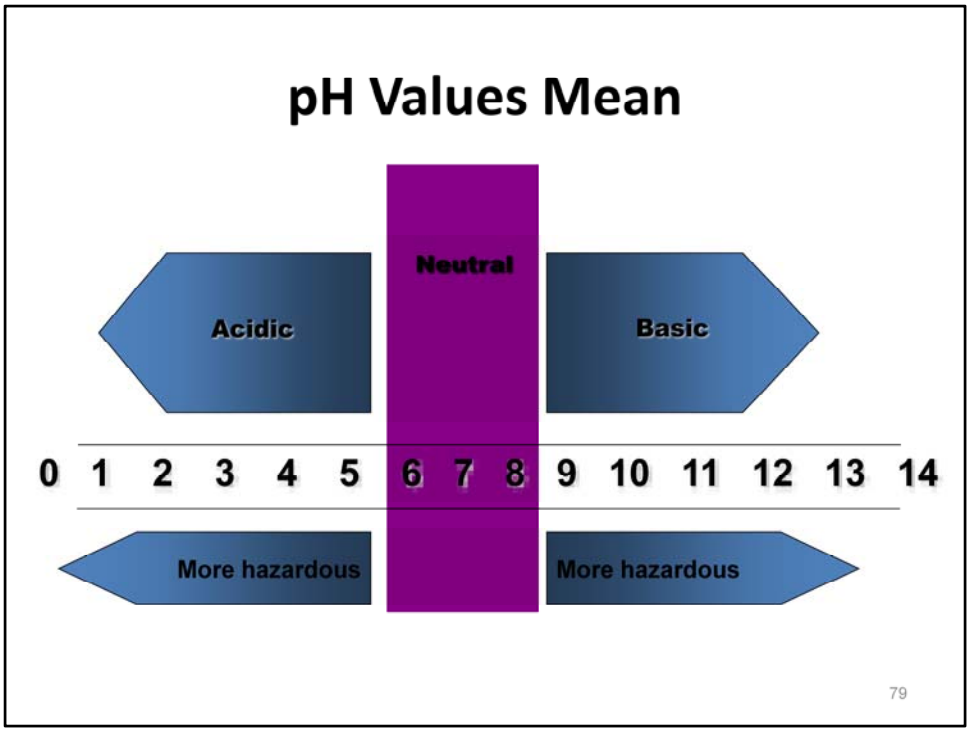
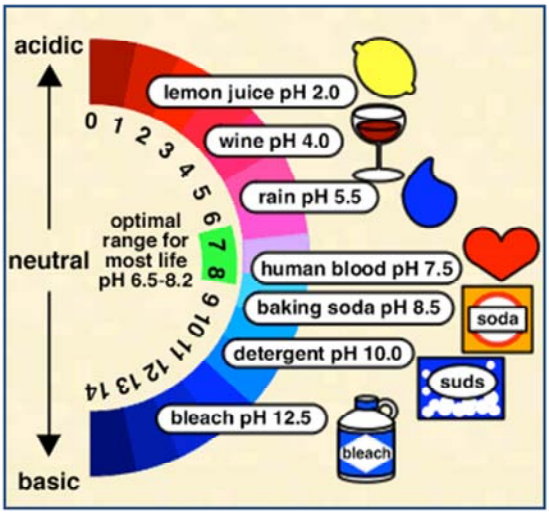

pH Values Mean
Neutral
Acidic
Basic
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14
More hazardous
More hazardous
79

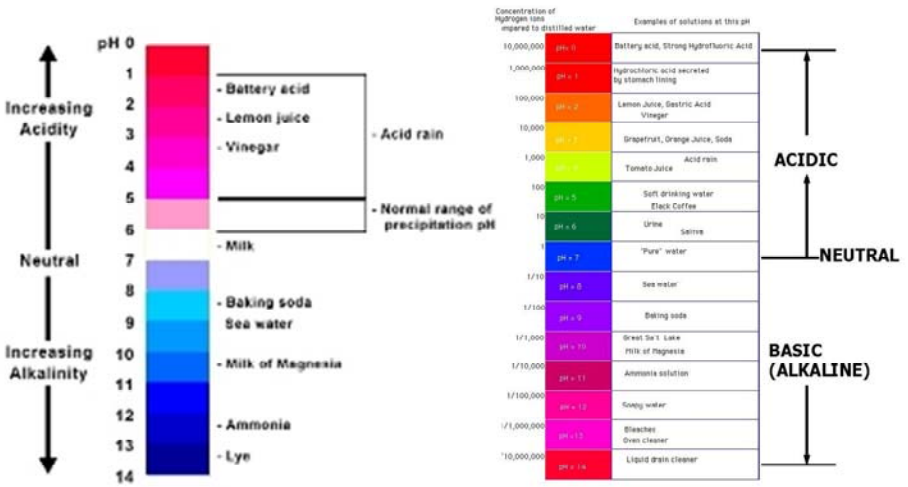
pH Scale



pH = 3

80

pH Scales


Increasing Acidity
Neutral
Increasing Alkalinity
pH 0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
- Battery acid
- Lemon juice
- Vinegar
- Acid rain
- Normal range of precipitation pH
- Milk
- Baking soda
Sea water
- Milk of Magnesia
- Ammonia
- Lye
Concentration of Hydrogen ions compared to distilled water
Examples of solutions at this pH
10,000,000
1,000,000
100,000
10,000
1,000
100
10
1
1/10
1/100
1/1,000
1/10,000
1/100,000
1/1,000,000
1/10,000,000
pH = 0
pH = 1
pH = 2
pH = 3
pH = 4
pH = 5
pH = 6
pH = 7
pH = 8
pH = 9
pH = 10
pH = 11
pH = 12
pH = 13
pH = 14
Battery acid, Strong Hydrofluoric Acid
Hydrochloric acid secreted by stomach lining
Lemon Juice, Gastric Acid
Vinegar
Grapefruit, Orange Juice, Soda
Acid rain
Tomato Juice
Soft drinking water
Black Coffee
Urine
Saliva
"Pure" water
Sea water
Baking soda
Great Salt Lake
Milk of Magnesia
Ammonia solution
Soapy water
Bleaches
Oven cleaner
Liquid drain cleaner
ACIDIC
NEUTRAL
BASIC (ALKALINE)

Corrosive

OSHA Definition:

"A chemical that causes visible, destruction of, or irreversible alterations in, living tissue by chemical action at the site of contact.

82

Identifying Acids

- Have pH less than 7
  - Hazardous waste is ≤ 2
  - Practical < 4

- Taste tart
- React with metal to form hydrogen gas

- Often have "acid" in the name
- Often have a chemical formula that begins with "H"

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Acids

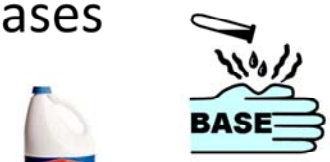
- Car batteries
- Muriatic acid
- Hydrochloric acid
- Flux
- Metal cleaner
- Rust removers
- Boric Acid
- Car Battery Acid
- Copper Cleaners
- Etching Solutions
- Ferric Chloride
- Drain cleaners can be either acid or base

- **Hydrochloric Acid**
- **Hydrofluoric Acid**
- **Metal Cleaners**
- **Muriatic Acid**
- **Navel Jelly**
- **Phosphoric Acid**
- **Pool Acid**
- **Sheep Dip**
- **Sodium Bisulfate**
- **Sulfuric Acid**
- **Toilet Bowl Cleaners ***

* Check Ingredients for proper classification

84

Identifying Bases



- Have a pH greater than 7
  - Hazardous waste is ≥12.5
  - Practical > 10

- Taste bitter
- Have a slippery, soapy feel
- May have “hydroxide”, or “alkali”, or “caustic” in the name
- Often has “OH” in the chemical formula

85

Base/Alkaline/Caustic

- **Alkaline batteries**
- **Bleach**
- **Sodium hydroxide (Lye)**
- **Drain cleaners can be either acid or base ***
- **Ammonia and Ammonia Based Cleaners**
- **Battery Terminal Cleaner**
- **Caustic Soda**
- **Cesspool Cleaners ***
- **Household cleaners ***
- **Lime**
- **Oven Cleaners ***
- **Window Cleaners**

* Check Ingredients for proper classification

86

Demo# 1
pH Paper Test

87

Example: Acetic Acid

Glacial: pH = 0

28%: pH = 3

88

pH Summary

- It is a scale 
- It applies only to aqueous systems

- Low numbers (acids)
- High numbers (bases)
- Both corrosive

89

DEMO #2

Mixing Acid and Base

90

Neutral

- Examples
  - Flammable
    - Gasoline
    - Solvents
    - Pesticides
  - Poison
    - Pesticides
    - Oil
  - Non flammable
    - Latex paint

91

Neutral/Flammable

- Acetone
- Adhesives *
- Aerosol
- Alcohols
- Artificial Snow
- Automotive Oils
- Automotive Waxes
- Bar-B-Que Lighter Fluid
- Benzene
- Brake Fluid
- Diesel Fuel
- Enamel/Oil Base Paint
- Ether
- Ethylene Glycol
- Fingernail Polish and Remover
- Floor/Furniture Polish
- Gasoline
- Glues *
- Grease
- Household Waxes
- Isopropyl Alcohol
- Kerosene
- Lacquer Thinner
- Lacquer Paint (unsolidified)
- Linseed Oil
- Liquid Waxes *
- Liquid Butane
- Methanol
- Paint Thinners
- Paint Strippers *
- Petroleum Distillates
- Plastic Cement
- Power Steering Fluid
- Roofing Cement
- Roofing tar
- Sealers
- Silicone Sprays
- Spot Remover/Dry Cleaning Fluids
- Thinner
- Tire Black
- Toluene
- Turpentine
- Windshield Wiper Fluid
- White Gas
- Wood Filler/Putty
- Wood Stain
- Xylene

* Check ingredients for proper classification

92

Neutral/Flammable - Poisons

- Ant and Roach Killer
- Anti-Freeze
- Arsenic Compounds
- Automotive Cleaners
- Bacterial Pipe Cleaners
- Bordeaux Mix
- Boric Acid
- Bug Remover
- Chlordane
- Chrome-Silver Polishes *
- Chromium
- Copper Sulfate
- DDT
- Diazinon
- Dimethylamine Salts
- Disinfectants *
- Dog Repellent
- Ethylene Glycol
- Fertilizers
- Flea Spray/Powder
- Fungicides *
- Gopher Killer
- Insect Sprays
- Lead Compounds
- Lice Powder
- Lindane
- Malathion
- Mercury
- Methylene Chloride
- Mole Killer
- Moth Crystals
- Pentachlorophenol
- Pesticides
- Pharmaceuticals
- Plant Food
- Pruning Paint
- Pyrethrins
- Rat Poison
- Rose Dust
- Sheep Dip
- Snail/Slug Killer
- Strychnine
- Tar Remover
- Weed and Grass Killer
- Windshield Wiper Fluid*

* Check Ingredients for proper classification

93

Oxidizers

- Compounds which are capable of reacting with and oxidizing (giving off oxygen) other materials
- Usually contain O_2
- May cause or enhance the combustion of other materials

94

Common Signal Words for Oxidizers

Oxidizer Identification Store away from other materials	
Oxidizer Key Word Prefix or Suffix	Examples
-ate -ite -peroxide Peroxy-	Ammonium nitrate Potassium permanganate Calcium hypochlorite Methyl ethyl ketone peroxide (MEKP) Peroxyacetic acid

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Demo# 3
Oxidizer/Peroxide Test

96

Other Chemical Characteristics

Pyrophoric

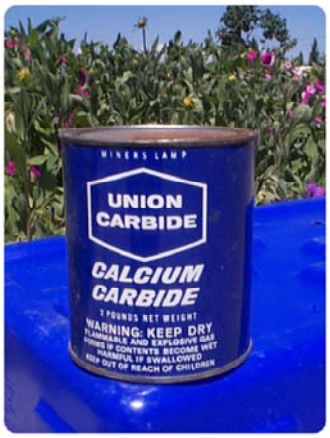
- Materials that ignite spontaneously in air

Water Reactive

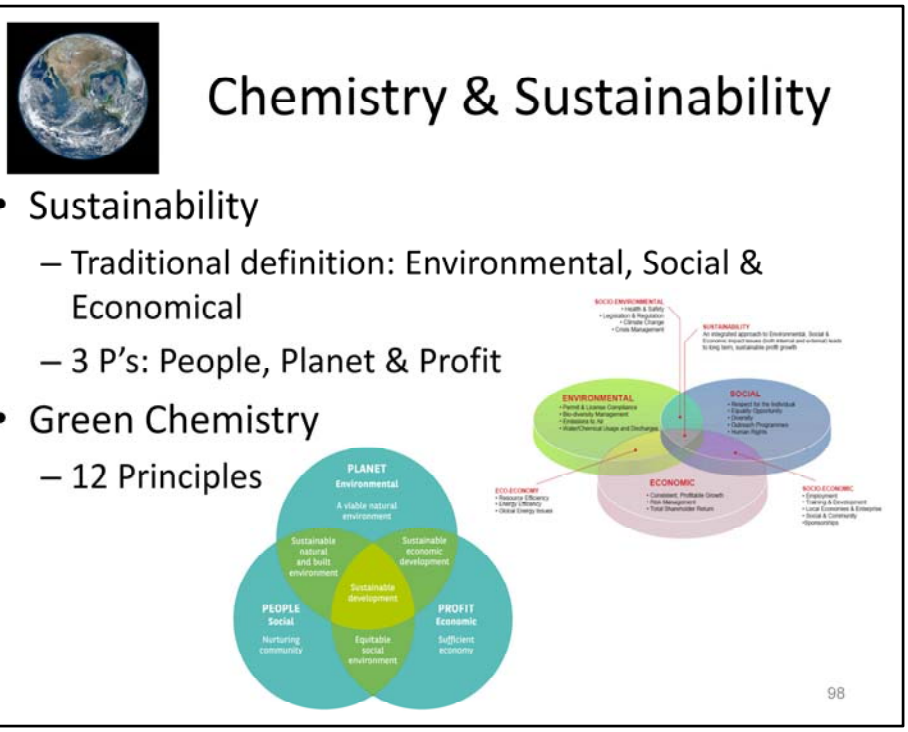
- Materials that react violently with water

Explosives

Radioactive



97



According to USEPA (http://www.epa.gov/sciencematters/june2011/principles.htm),

1) Prevention
It's better to prevent waste than to treat or clean up waste afterwards.

2) Atom Economy
Design synthetic methods to maximize the incorporation of all materials used in the process into the final product.

3) Less Hazardous Chemical Syntheses
Design synthetic methods to use and generate substances that minimize toxicity to human health and the environment.

4) Designing Safer Chemicals
Design chemical products to affect their desired function while minimizing their toxicity.

5) Safer Solvents and Auxiliaries
Minimize the use of auxiliary substances wherever possible make them innocuous when used.

6) Design for Energy Efficiency
Minimize the energy requirements of chemical processes and conduct synthetic methods at ambient temperature and pressure if possible.

7) Use of Renewable Feedstocks
Use renewable raw material or feedstock rather whenever practicable.

8) Reduce Derivatives
Minimize or avoid unnecessary derivatization if possible, which requires additional reagents and generate waste.

9) Catalysis
Catalytic reagents are superior to stoichiometric reagents.

10) Design for Degradation
Design chemical products so they break down into innocuous products that do not persist in the environment.

Iodine Clock Reaction

http://www.youtube.com/watch?v=C5tOEBmBAHg

99

Nothing can be created or destroyed in nature.

Chemistry helps us to understand
this natural phenomenon in life.

Recology
San Francisco
WASTE ZERO

100