

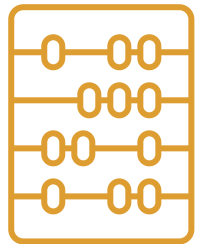


**General**

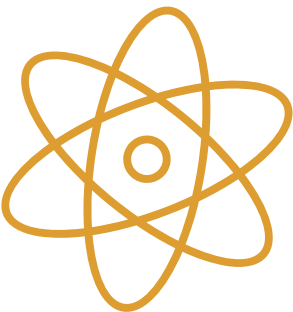


**Chemistry**

**Must**



**Knows!**



# Formula sheet

$$^{\circ}\text{F} = (1.8 \times ^{\circ}\text{C}) + 32$$

$$\lambda\nu = c \quad \text{where } c = 2.998 \times 10^8 \text{ m/s}$$

$$E = h\nu = \frac{hc}{\lambda} \quad \text{where } h = 6.626 \times 10^{-34} \text{ J} \cdot \text{s}$$

*Formal charge*

$$= [\# \text{ valence } e^{-} \text{ on neutral atom}] \\ - [(\# \text{ lone } e^{-} \text{ pairs}) + \left(\frac{1}{2} \# \text{ bonding } e^{-}\right)]$$

$$K_w = [\text{H}^+][\text{OH}^-]$$

$$q = mc\Delta T$$

$$M = \frac{n}{V}$$

$$PV = nRT \quad \text{where } R = 0.08206 \frac{\text{L} \cdot \text{atm}}{\text{mol} \cdot \text{K}}$$

$$N_A = 6.022 \times 10^{23} \text{ formula units/mol}$$

$$\text{Density } (d) = \frac{m}{V}$$

$$\text{Percent mass} = \frac{\text{mass analyte}}{\text{total mass}} \times 100$$

$$M_1V_1 = M_2V_2$$

$$\text{pH} = -\log [\text{H}^+]$$

$$[\text{H}^+] = 10^{-\text{pH}}$$

# Why do we need chemistry?

Chemistry is everywhere!

## Agriculture

- Improving soil fertility
- Developing pesticides

## Daily Life and Safety

- Cooking
- Cleaning
- Cosmetics

## Medicine

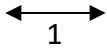
- Critical for developing drugs
- Understanding body processes
- Maintaining health

## Environment Solutions

- Reducing contaminants
- Recycle waste
- Combat climate change

# The Periodic Table

Period (# of energy levels)



	1																			
	IA																			
1	<b>H</b> Hydrogen 1 1.008																			
	2																			
2	<b>Li</b> Lithium 3 6.94 2-1	<b>Be</b> Beryllium 4 9.012 2-2																		
3	<b>Na</b> Sodium 11 22.98976928 2-1	<b>Mg</b> Magnesium 12 24.305 2-2																		
4	<b>K</b> Potassium 19 39.0983 2-1	<b>Ca</b> Calcium 20 40.078 2-2	<b>Sc</b> Scandium 21 44.955908 2-2	<b>Ti</b> Titanium 22 47.887 2-2	<b>V</b> Vanadium 23 50.9415 2-3	<b>Cr</b> Chromium 24 51.9961 2-3	<b>Mn</b> Manganese 25 54.938044 2-3	<b>Fe</b> Iron 26 55.845 2-3	<b>Co</b> Cobalt 27 58.933 2-3											
5	<b>Rb</b> Rubidium 37 85.4678 2-1	<b>Sr</b> Strontium 38 87.62 2-2	<b>Y</b> Yttrium 39 88.90584 2-2	<b>Zr</b> Zirconium 40 91.224 2-2	<b>Nb</b> Niobium 41 92.90637 2-3	<b>Mo</b> Molybdenum 42 95.95 2-3	<b>Tc</b> Technetium (43) 98.90625 2-3	<b>Ru</b> Ruthenium 44 101.07 2-3	<b>Rh</b> Rhodium 45 102.91 2-3											
6	<b>Cs</b> Cesium 55 132.90545196 2-1	<b>Ba</b> Barium 56 137.327 2-2	57-71 Lanthanides	<b>Hf</b> Hafnium 72 178.49 2-2	<b>Ta</b> Tantalum 73 180.94788 2-3	<b>W</b> Tungsten 74 183.84 2-3	<b>Re</b> Rhenium 75 186.21 2-3	<b>Os</b> Osmium 76 190.23 2-3	<b>Ir</b> Iridium 77 192.22 2-3											
7	<b>Fr</b> Francium 87 223 2-1	<b>Ra</b> Radium 88 226 2-2	89-103 Actinides	<b>Rf</b> Rutherfordium 104 261 2-2	<b>Db</b> Dubnium 105 262 2-3	<b>Sg</b> Seaborgium 106 263 2-3	<b>Bh</b> Bohrium 107 264 2-3	<b>Hs</b> Hassium 108 265 2-3	<b>Mt</b> Meitnerium 109 266 2-3											

- Alkali Metals
- Non-metals
- Alkaline Earth Metals
- Transition Metals
- Metalloids
- Noble Gases

Group/  
Family/  
Colum

	57	58	59	60	61	62	63
	<b>La</b> Lanthanum 138.91 2-3	<b>Ce</b> Cerium 140.12 2-3	<b>Pr</b> Praseodymium 140.91 2-3	<b>Nd</b> Neodymium 144.24 2-3	<b>Pm</b> Promethium (145) 144.91262 2-3	<b>Sm</b> Samarium 150.36 2-3	<b>Eu</b> Europium 151.96 2-3
	89	90	91	92	93	94	95
	<b>Ac</b> Actinium 227 2-3	<b>Th</b> Thorium 232.04 2-3	<b>Pa</b> Protactinium 231.04 2-3	<b>U</b> Uranium 238.03 2-3	<b>Np</b> Neptunium 237 2-3	<b>Pu</b> Plutonium 244 2-3	<b>Am</b> Americium 243 2-3

18

2  
**He**Helium  
4.0026  
210  
**Ne**Neon  
20.180  
2-818  
**Ar**Argon  
39.948  
2-8-836  
**Kr**Krypton  
83.798  
2-8-18-854  
**Xe**Xenon  
131.29  
2-8-18-3686  
**Rn**Radon  
(222)  
2-8-18-32-18-8118  
**Og**Oganesson  
(294)  
2-8-18-32-32-18-8

13

IIIA

14

IVA

15

VA

16

VIA

17

VIIA

5  
**B**  
Boron  
10.81  
2-36  
**C**  
Carbon  
12.011  
2-47  
**N**  
Nitrogen  
14.007  
2-58  
**O**  
Oxygen  
15.999  
2-69  
**F**  
Fluorine  
18.998  
2-710  
**Ne**  
Neon  
20.180  
2-813  
**Al**  
Aluminium  
26.982  
2-8-314  
**Si**  
Silicon  
28.085  
2-8-415  
**P**  
Phosphorus  
30.974  
2-8-516  
**S**  
Sulfur  
32.06  
2-8-617  
**Cl**  
Chlorine  
35.45  
2-8-718  
**Ar**  
Argon  
39.948  
2-8-810  
VIII B11  
IB12  
IIB28  
**Ni**  
Nickel  
58.693  
2-8-16-229  
**Cu**  
Copper  
63.546  
2-8-18-130  
**Zn**  
Zinc  
65.38  
2-8-18-231  
**Ga**  
Gallium  
69.723  
2-8-18-332  
**Ge**  
Germanium  
72.630  
2-8-18-433  
**As**  
Arsenic  
74.922  
2-8-18-534  
**Se**  
Selenium  
78.971  
2-8-18-635  
**Br**  
Bromine  
79.904  
2-8-18-736  
**Kr**  
Krypton  
83.798  
2-8-18-846  
**Pd**  
Palladium  
106.42  
2-8-18-847  
**Ag**  
Silver  
107.87  
2-8-18-18-148  
**Cd**  
Cadmium  
112.41  
2-8-18-18-249  
**In**  
Indium  
114.82  
2-8-18-18-350  
**Sn**  
Tin  
118.71  
2-8-18-18-451  
**Sb**  
Antimony  
121.76  
2-8-18-18-552  
**Te**  
Tellurium  
127.60  
2-8-18-18-653  
**I**  
Iodine  
126.90  
2-8-18-18-754  
**Xe**  
Xenon  
131.29  
2-8-18-18-878  
**Pt**  
Platinum  
195.08  
2-8-18-32-18-179  
**Au**  
Gold  
196.97  
2-8-18-32-18-180  
**Hg**  
Mercury  
200.59  
2-8-18-32-18-281  
**Tl**  
Thallium  
204.38  
2-8-18-32-18-382  
**Pb**  
Lead  
207.2  
2-8-18-32-18-483  
**Bi**  
Bismuth  
208.98  
2-8-18-32-18-584  
**Po**  
Polonium  
(209)  
2-8-18-32-18-685  
**At**  
Astatine  
(210)  
2-8-18-32-18-786  
**Rn**  
Radon  
(222)  
2-8-18-32-18-8110  
**Ds**  
Darmstadtium  
(285)  
2-8-18-32-32-18-1111  
**Rg**  
Roentgenium  
(282)  
2-8-18-32-32-18-2112  
**Cn**  
Copernicium  
(285)  
2-8-18-32-32-18-2113  
**Nh**  
Nihonium  
(284)  
2-8-18-32-32-18-3114  
**Fl**  
Flerovium  
(289)  
2-8-18-32-32-18-4115  
**Mc**  
Moscovium  
(290)  
2-8-18-32-32-18-5116  
**Lv**  
Livermorium  
(293)  
2-8-18-32-32-18-6117  
**Ts**  
Tennessine  
(294)  
2-8-18-32-32-18-7118  
**Og**  
Oganesson  
(294)  
2-8-18-32-32-18-864  
**Gd**  
Gadolinium  
157.25  
2-8-18-25-1-265  
**Tb**  
Terbium  
158.93  
2-8-18-27-1-266  
**Dy**  
Dysprosium  
162.50  
2-8-18-29-1-267  
**Ho**  
Holmium  
164.93  
2-8-18-29-1-268  
**Er**  
Erbium  
167.26  
2-8-18-30-1-269  
**Tm**  
Thulium  
168.93  
2-8-18-31-1-270  
**Yb**  
Ytterbium  
173.05  
2-8-18-32-1-271  
**Lu**  
Lutetium  
174.97  
2-8-18-32-1-2

8

96  
**Cm**  
Curium  
(247)  
2-8-18-32-15-1-297  
**Bk**  
Berkelium  
(247)  
2-8-18-32-17-1-298  
**Cf**  
Californium  
(251)  
2-8-18-32-19-1-299  
**Es**  
Einsteinium  
(252)  
2-8-18-32-19-1-2100  
**Fm**  
Fermium  
(257)  
2-8-18-32-20-1-2101  
**Md**  
Mendelevium  
(258)  
2-8-18-32-21-1-2102  
**No**  
Nobelium  
(259)  
2-8-18-32-21-1-2103  
**Lr**  
Lawrencium  
(260)  
2-8-18-32-22-1-2

9

# Significant Figures

Used to indicate the precision of a measured number

## RULES

- All non-zero digits are significant
  - Ex. 125  $\Rightarrow$  3 SF
- All zeros between non-zero digits are significant
  - Ex. 101  $\Rightarrow$  3 SF
- Zeros following a non-zero and a decimal are significant
  - Ex. 0.3500  $\Rightarrow$  4 SF
- Zeros to the left of non-zero digits are NOT significant
  - Ex. 0.001  $\Rightarrow$  1 SF
- Zeros following a non-zero digit only are NOT significant
  - Ex. 100  $\Rightarrow$  1 SF
- The last digit is always an estimate (Trailing zeroes only count if there is a decimal)
  - Ex. 100.0  $\Rightarrow$  4 SF

TRY THESE!

0.0053567

2.60

6

670

542000.

6271.91

### ADDITION & SUBTRACTION

Same # of decimal places as the # with the least # of decimal places

Ex.

$$11.\underline{31} + 33.\underline{264} + 4.\underline{1} = 48.674 \Rightarrow 48.7$$

### MULTIPLICATION & DIVISION

Same # of sig figs as the # with the least # of sig figs

Ex.

$$5.282 \times 3.42 = 18.06444 \Rightarrow 18.1$$

## Scientific Notation

$$\begin{array}{c} \underbrace{4500000} = 4.5 \times 10^6 \\ \begin{array}{ccc} | & | & | \\ \text{Coefficient} & \text{Base} & \text{Exponent} \end{array} \end{array}$$
$$\begin{array}{c} \underbrace{0.00453} = 4.53 \times 10^{-3} \\ \begin{array}{ccc} | & | & | \\ \text{Coefficient} & \text{Base} & \text{Exponent} \end{array} \end{array}$$

Try these:

0.0006

0.2

540,000,000

6.95

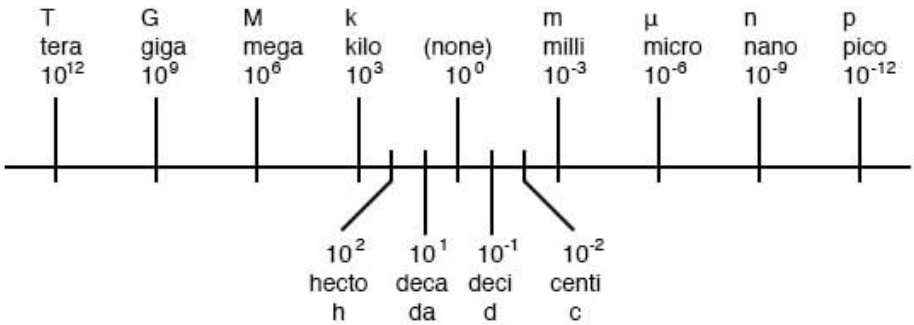
# SI units and measurements

Quantity	Symbol	SI unit
Length	l	Meter (m)
Mass	m	Gram (g)
Time	t	Second (s)
Temperature	T	Kelvin (K)
Amount	n	Moles (mol)
Electric current	I	Ampere (A)

## Derived Units (Combination of base units)

Area	A	Square meter ( $m^2$ )
Volume	V ( $l*w*h$ )	Cubic meter ( $m^3$ )
Molar mass	M	g/mol

# Unit conversions



The Great Man King Henry Died □ Drinking Chocolate Milk Many Nights

## SUBTRACT EXPONENTS!!!

Ex.

$$0.0075 \text{ Gm} = \text{_____} \text{ Km}$$

$$9 - (-3) = 6$$

$$0.\underline{007500} \text{ Gm} \Rightarrow 7500 \text{ Km}$$

TRY THESE!

$$244,475.3 \mu\text{s} = \text{_____} \text{ hs}$$

$$0.0002 \mu\text{g} = \text{_____} \text{ mg}$$

$$2,103.55 \text{ s} = \text{_____} \text{ ks}$$

$$0.00091 \text{ TL} = \text{_____} \text{ ML}$$

$$4,096 \text{ MB} = \text{_____} \text{ GB}$$

$$11,120.33 \text{ ng} = \text{_____} \text{ cg}$$

$$448.5 \text{ cg} = \text{_____} \text{ g}$$

$$104 \text{ km} = \text{_____} \text{ m}$$

$$0.00046 \text{ ks} = \text{_____} \text{ cs}$$

$$2500 \text{ m} = \text{_____} \text{ km}$$

$$210 \text{ hm} = \text{_____} \text{ cm}$$

$$198 \text{ g} = \text{_____} \text{ kg}$$

$$0.00034 \mu\text{L} = \text{_____} \text{ cL}$$

$$0.0000012 \text{ Gm} = \text{_____} \text{ mm}$$

# Dimensional Analysis

A conversion factor is the relationship between two units

$$\frac{1 L}{1000 ml}$$

$$\frac{1 ft}{12 inches}$$

$$\frac{1 hr}{60 min}$$

$$\frac{\text{Molar mass}}{1 mole}$$

$$\frac{1 mole}{6.022 \times 10^{23} atoms}$$

Ex. 30 ft = ? inches

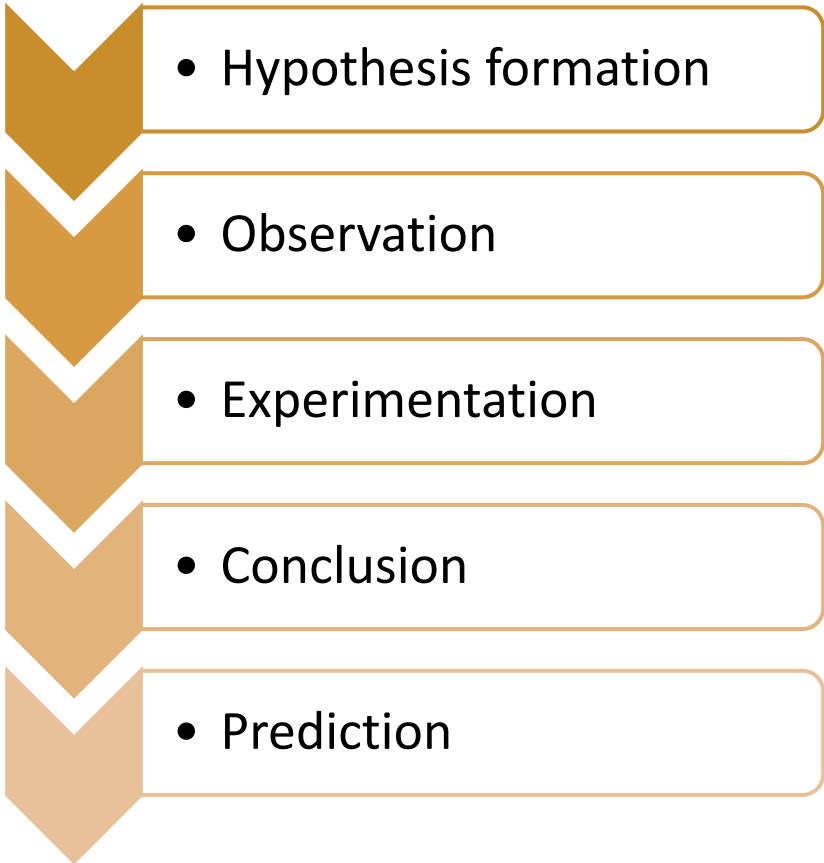
$$\frac{30 \cancel{ft} \quad | \quad 12 \text{ inches}}{1 \cancel{ft}} = 360 \text{ inches}$$

Try this:

How many atoms in 32.0 g of  $KNO_3$ ?

# The Scientific Method

Number the steps of the scientific method.

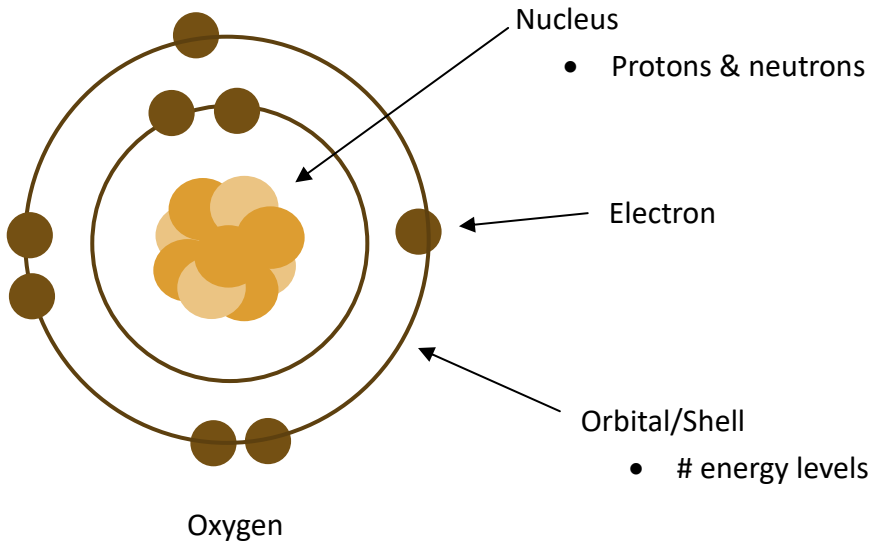


# Atoms

- The smallest piece of an element
- Invisible to the human eye
- Made up of subatomic particles:
  - Protons
    - Has a (+) charge
  - Neutrons
    - No charge
  - Electrons
    - Has a (-) charge

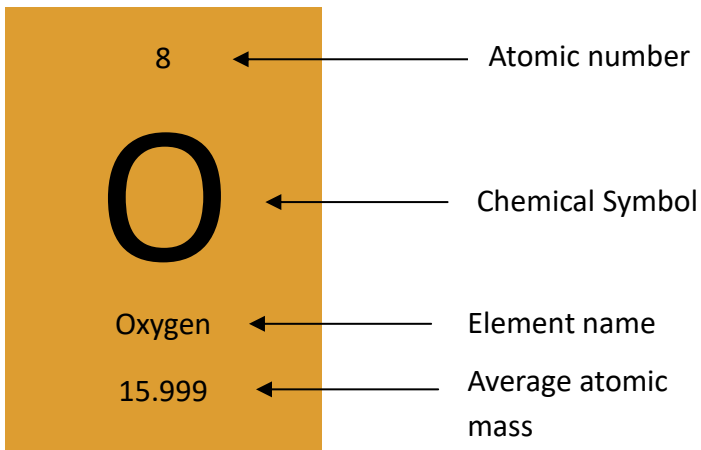
**MATTER**  
Anything that has mass and takes up space

**ATOM**  
Smallest unit of matter



# Atomic number defines elements

- Atomic number = # protons = # electrons
  - Chemical behavior  $\Rightarrow$  determined by # and arrangement of electrons ( $e^-$ )
  - Atoms are electrically neutral aka. the ones in the periodic table
- Protons + Neutrons = Mass #
- Period # = # of shells
- Valence electrons  $\Rightarrow$  # of electrons in their outer shell
  - Members of groups A
    - Group # = # valence electrons
- Element
  - Substance that cannot be broken down by ordinary chemical means



# Ions

- Charged particles
  - Cation  $\Rightarrow$  less electrons = net positive charge
  - Anion  $\Rightarrow$  more electrons = net negative charge

Using the periodic table, fill in the following table

# protons	# electrons	Overall charge	Element symbol & charge	Neutral (N) Cation (C) Anion (A)
+7	-10			
+12	-10			
+19		1+		
			$P^{-3}$	
+8		0		

# Isotopes

- Different # of neutrons, same # of protons
- Radioactive isotopes – unstable (break apart) and emit radiation

Using the periodic table, fill in the following table

	Carbon-12	Carbon-13	Carbon-14
# protons			
# neutrons			
# electrons			

# Chemical Bonds

## Intramolecular forces

### Covalent bonds

- Between 2 non-metals or/and metalloids
- Share 2 valence electrons per bond
- Strength  $\Rightarrow$  # of shared  $e^-$ 
  - Single bond ( $2e^-$ )
  - Double bond ( $4e^-$ )
  - Triple bond ( $6e^-$ )

### Ionic bonds

- Between a metal and a nonmetal
- Transfer of electrons
- Oppositely charged ions
  - Ex.  $Na^+ + Cl^- \Rightarrow NaCl$

## Intermolecular forces

### Hydrogen bonds

- Between polar molecules
- Strong and transitory; cumulative
- Electropositive hydrogen – electronegative nitrogen, oxygen, or fluorine (NOF)

### London Dispersion Forces

- Weak – not a chemical bond
- In all molecules but the only one in non-polar molecules

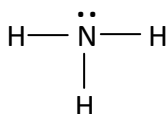
# Lewis Structures

How to Draw a Lewis Structure:

1. Find total valence electrons
2. Draw skeleton structure using single bonds
3. Assign remaining valence electrons
4. Make multiple bonds if all octets aren't filled

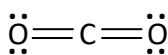
Ex.  $NH_3$

$$5 + 3(1) = 8 e^-$$



$CO_2$

$$4 + 2(6) = 16 e^-$$



A single  
bond



$2e^-$

Try these:

$BCl_3$

$H_3O^+$

$CCl_4$

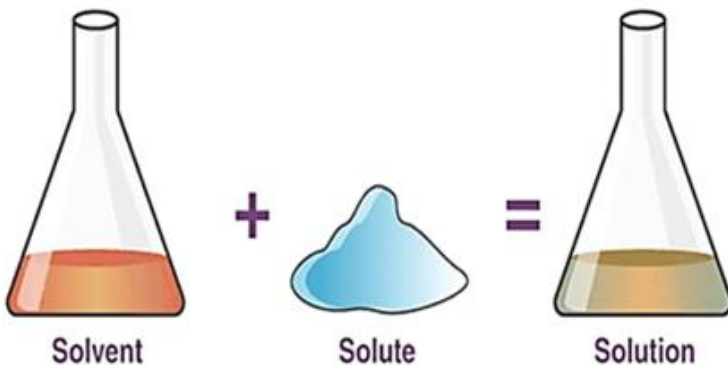
$H_2CO$

# Pure substances, mixtures & solutions

- Pure substances  $\Rightarrow$  Made of a single compound or element
  - Ex. water ( $H_2O$ )
- Mixture  $\Rightarrow$  Made of different substances
  - There are 2 kinds of mixtures:
    - Heterogeneous a.k.a. you can see the different components
      - Cereal in milk
      - Ice in soda
      - A salad
    - Homogeneous a.k.a. you can't see the different parts (it's uniform)
      - Steel
      - Air
      - Salt water

If solvent is  
water then  
it's an  
aqueous  
solution (aq)

Sometimes homogeneous mixtures are called solutions.



# Acids and Bases

## Acid

- Strong acids dissociate in water  $\Rightarrow$  increases  $[H^+]$ 
  - Lowers pH
  - Makes it more acidic
- Stronger acid – lower pH

## Base

- Strong bases dissociate in water  $\Rightarrow$  increases  $[OH^-]$ 
  - Lowers  $[H^+]$
  - Raises pH
  - Makes it more basic

## Buffers

- Weak Acid + Weak Base  $\rightarrow$  Conjugate Base + Conjugate Acid  
 $H_2O(l) + NH_3(aq) \rightarrow OH^-(aq) + NH_4^+(aq)$
- Resist changes in pH when an acid or base is added
- Keeps pH relatively constant

