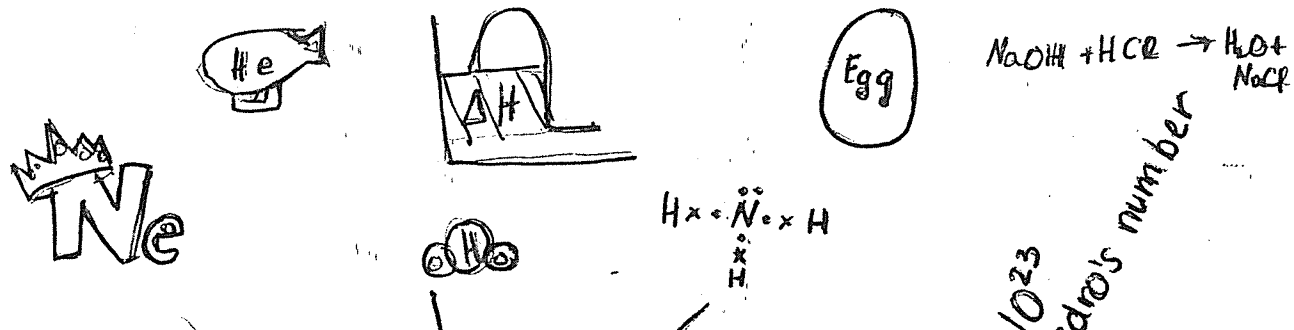
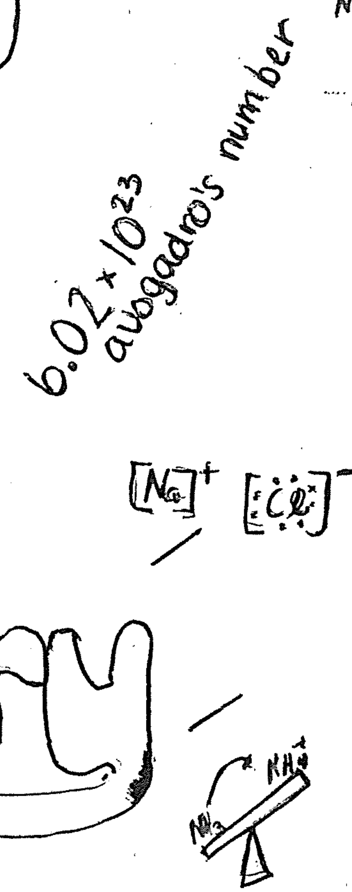
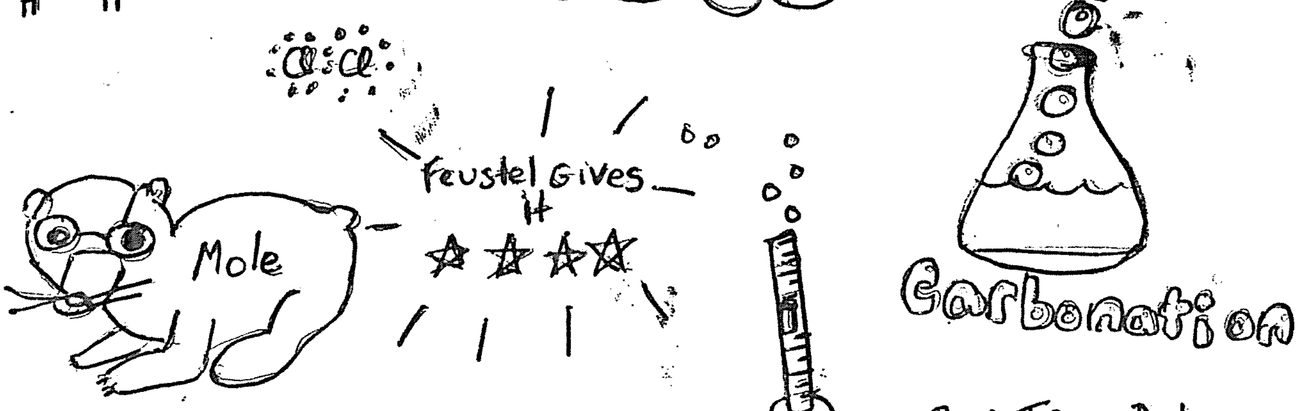




Accel Chemistry Review

2003

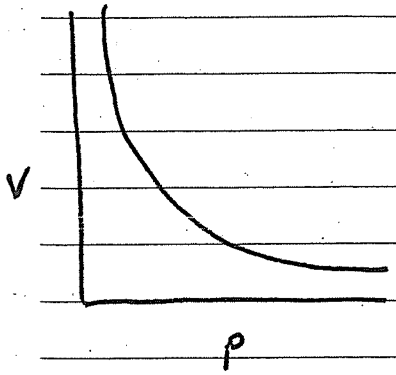


Aluminium

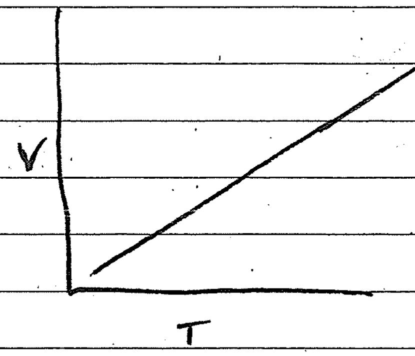
(with help from Mrs. Feustel)
And additions from Dr. Colascione

By: Tara Dolan & Alyssa Lang

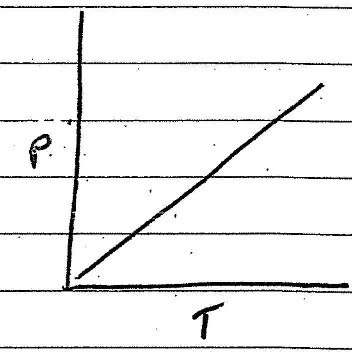
Got Curves!



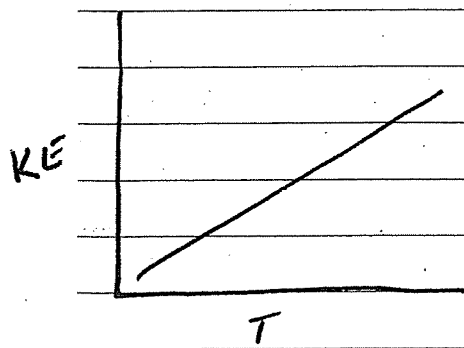
Boyles Law

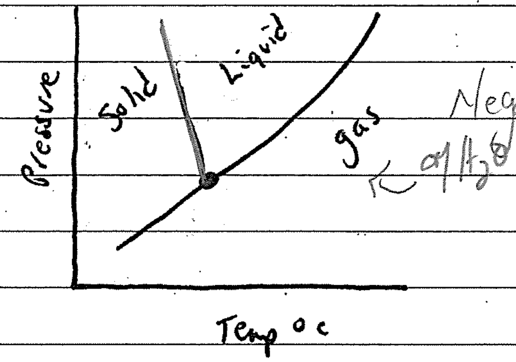


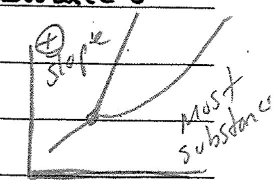
Charles Law



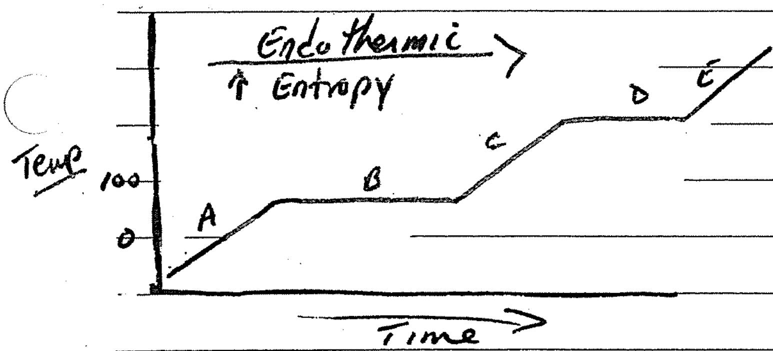
Gay-Lussac's





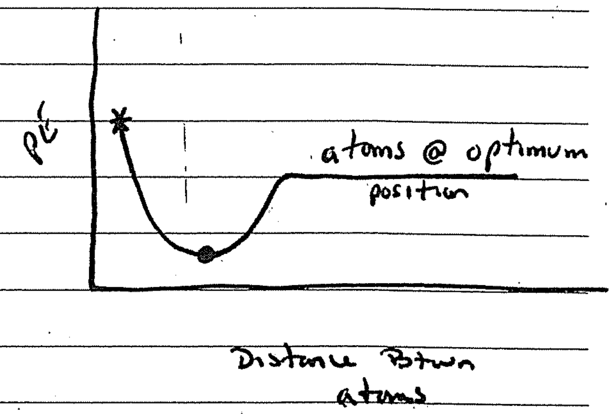


● Triple point (the specific temp & pressure when all 3 phases of a substance are present simultaneously)



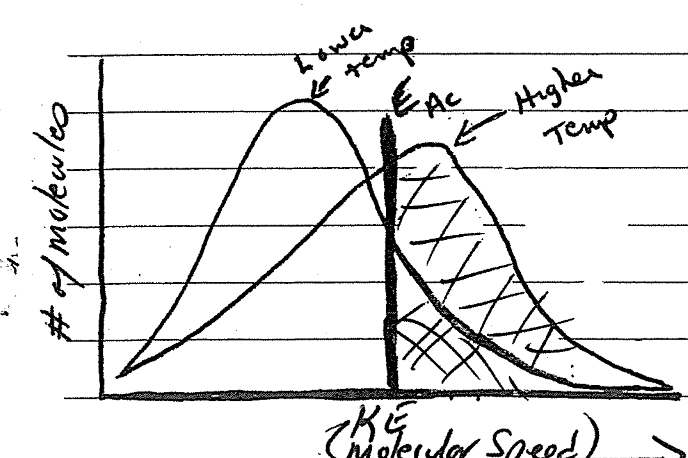
A, C, E (Change in state)
(increase in KE)

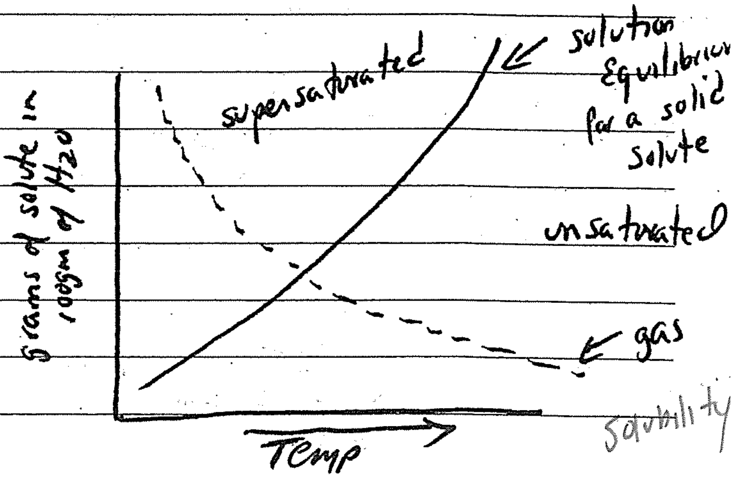
B, D (phase Equilibrium)
(increase PE →)

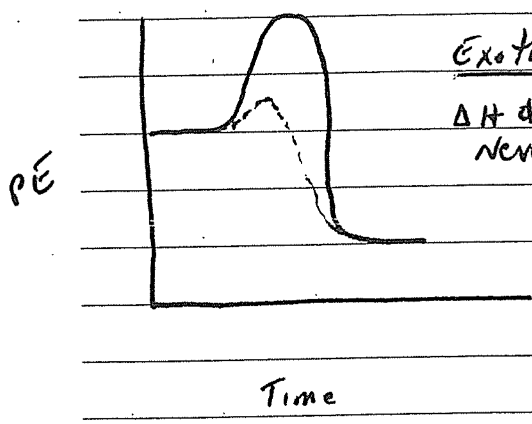


● PE will be lowest when molecule fo

* PE Peaks as atoms get too close & nuclear repulsion occurs.

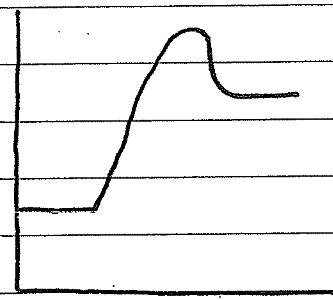




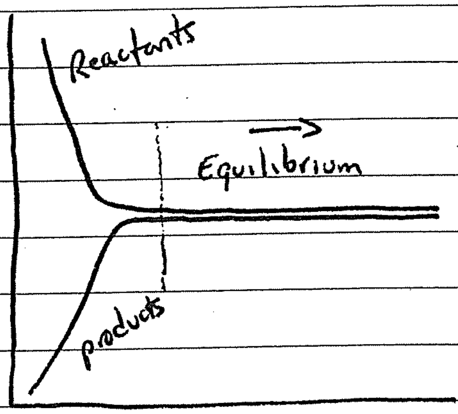


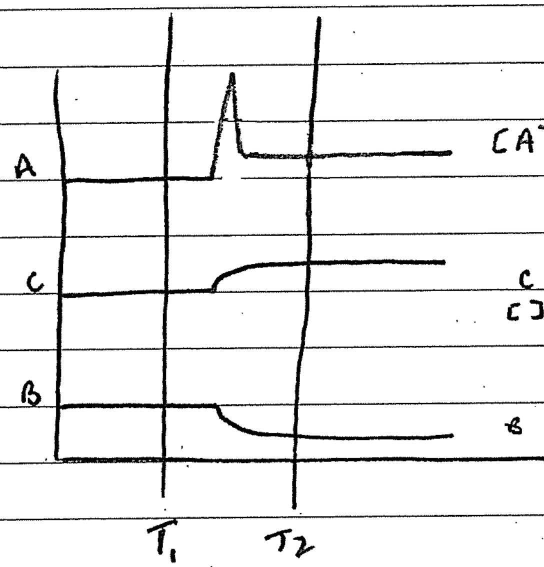
Exothermic

ΔH & PE's Never change



Endothermic

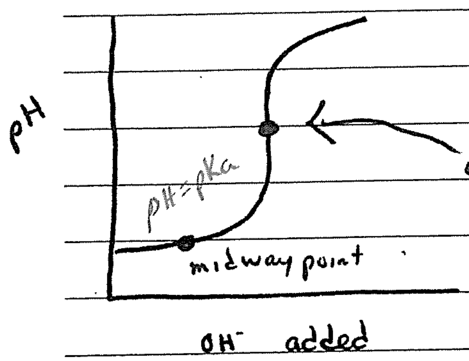




[A] was increased & at T_2 is a new equilibrium [ ]

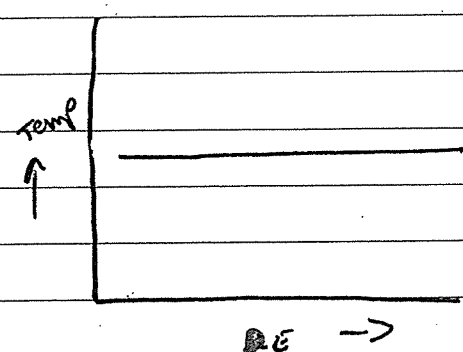
C is the product & its [ ] increases

B is one of the reactants & is used up

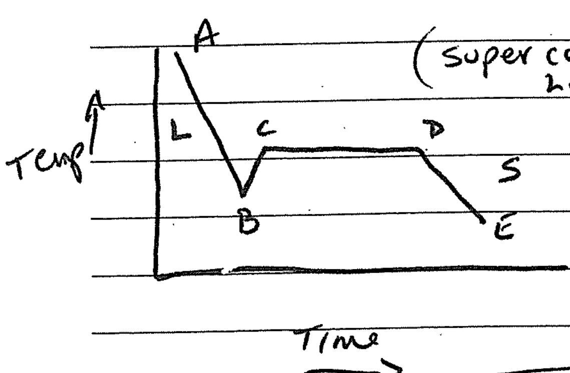


H^+ & OH^- neutralized

• the equivalence point in a titration



(Example of what this could represent)



(super cooled Liquid)

(phase Δ from B -> D)

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Revised August 2007

Qualitative Testing Factoid Sheet

Flame Test Colors

Ion	Flame color
Li^{+}, Sr^{2+}, Ca^{2+}	Red (various shades)
Na^{+}	Yellow/Orange
K^{+}	Lilac
Ba^{2+}	Green
Cu^{2+}	Blue-green

Transition metal ion colors

	+1	+2	+3	+4	+5	+6	+7
Sc			Colorless				
Ti			Violet	Colorless			
V		Violet	Green	Blue	yellow		
Cr		Blue	Green			Yellow (CrO_4^{2-}) / Orange ($Cr_2O_7^{2-}$)	
Mn		Pale pink		Brown		Drk Green	purple
Fe		Pale green	Yellow/Brown				
Co		Pink	Orange/Yellow				
Ni		Green					
Cu	Colorless	Blue					
Zn		Colorless					

Common Precipitate colors

WHITE	Blue	YELLOW	BLACK	Green	RED/BROWN
AgCl	Many Copper (II) ppt's.	AgI	Many Sulfides	Many Fe(II) ppt's.	Many Fe(III) ppt's.
$BaSO_4$		PbI_2			
$PbCl_2$					
Many non-transition metal hydroxides					
Many non-transition metal carbonates					
Many non-transition metal sulfates					

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Common Tests for gases

Gas	Test
Hydrogen	Squeaky pop with lighted splint
Oxygen	Re-lights glowing splint
Carbon Dioxide	Turns limewater milky
Ammonia	Pungent odor, turns red litmus paper blue, gives dense white fumes in contact with conc. HCl fumes

Common tests for cations and anions

Ion	Test
Carbonate and Hydrogen carbonate	Release CO_2 gas with acids
Sulfate	White ppt. of $BaSO_4$ with barium ions
Chloride	White ppt of AgCl with silver ions
Bromide	Cream ppt. of AgBr with silver ions
Iodide	Yellow ppt. of AgI with silver ions
Ammonium	NH_3 released with hydroxide ions

Color Changes in REDOX reactions

MnO_4^-(aq) → Mn^{2+}(aq) (Dark Purple) → (Pale Pink)
$Cr_2O_7^{2-}$(aq) → Cr^{3+}(aq) (Orange) → (Green)

Acid/Base Indicator Color changes

	ACID	BASE
Methyl orange	Red	Yellow
Methyl red	Red	Yellow
Litmus	Red	**Blue**
Universal	Red	**Blue/Purple**
Phenolphthalein	**Colorless**	Pink

Miscellaneous other "color data"

HALOGENS: Fluorine gas – pale yellow/green, Chlorine gas – green, Bromine liquid – orange/brown, Iodine solid – dark purple

NO_2 gas – orange/brown

Transmutation

How to determine the mode of decay:

- β^- decay — mass # greater than mass on Periodic table
- β^+ decay — mass # less than mass on " "
- He^{4+}_2 decay — mass # greater than 200 on " "

Electron Configuration Exceptions

Cr [Ar] $4s^1 3d^5$

Cu [Ar] $4s^1 3d^{10}$

Estimating pH

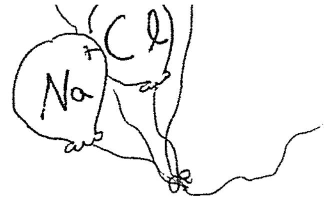
$[H^+] = 0.4 \times 10^{-4}$ pH = 4.5
(decimals round up)

$[H^+] = 4 \times 10^{-4}$ pH = 3.5
(whole #'s round down)

$[H^+] = 4.5 \times 10^{-4}$ pH = 3.3

(whole # takes precident)
& rounds down

Topic 1



Formula writing:

Ionic:

inary: Magnesium Chloride

Mg^{2+} Cl^{-}

$MgCl_2$

* Group 1A, 2A, Ag^+, Zn^{2+}, Al^{3+}; all ha only one oxidation #
* binary ionic compounds end in "ide" except hydroxide (which is a polyatomic ion, not a binary ionic compound)

Transition metals: can have more than one oxidation state. They can loose different numbers of electrons. They form colore compounds.

Stock System: is used for elements with more than one oxidation state. Always use the stock system for transitic elements.
* the # inside the bracket indicates the # of electrons lost by the metal

ex: copper (II) chloride: $Cu^{2+} + Cl^{-} \rightarrow CuCl_2$

Ternary ionic compounds: metal + a polyatomic ion
treat the polyatomic ion as a unit.

ex: $Mg^{2+} + SO_4^{2-} \rightarrow MgSO_4$

indicates a chemical reaction has occured:

1) a gas was produced (fizzing, bubbling, etc.)
2) a temperature change occured without you deliberately adding or subtracting heat
3) the presence of a precipitate.

* CO_2 extinguishes flame
* H_2O & CO_2 are products of complete combustion. Use limewater to test for their presence. If the lime water turns cloudy CO_2 & H_2O are

Conservation of Mass law: matter can neither be created nor destroyed.

Molecular Formula writing:

★ ions are NOT formed ★ electrons are shared ★ charge is apparen

Compound	Prefix	Stock System
N_2O	**di** nitrogen **mono**xide	nitrogen (I) oxide
NO	nitrogen **mono**xide	nitrogen (II) oxide
N_2O_3	**di** nitrogen **tri** oxide	nitrogen (III) oxide
N_2O_5	**di** nitrogen **pent** oxide	nitrogen (V) oxide
CCl_4	carbon **tetra** chloride	carbon (IV) chloride

* the prefix represents the number of atoms of each element presc in the compound. 1 = mono, 2 = di, 3 = tri, 4 = tetra, 5 = pent
* we only use the prefix "mono" on the second element in the compound.

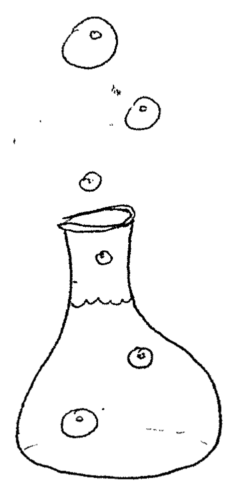
Types of reactions:

Synthesis = A + B → AB

decomposition = AB → A + B

Single replacement = A + BC → AB + C

Double replacement = AB + CD → AD + CB



Some descriptive Chem:

(which you really don't n[e]... to memorize

Families of elements:

The Alkali Metals: Group 1A

Na^+ Li^+

1) one valence electron
2) malleable, ductile good conductors of electricity
3) low density and low melting point
4) react with water and air
5) not found uncombined in nature

Alkaline Earth Metals: Group 2A

Mg^{2+}

1) 2 valence electrons
2) malleable, ductile
3) higher density and melting point than Alkali metals
4) the heavier ones react with water
5) not found uncombined in nature
6) used extensively in alloys
7) Magnesium forms a protective oxide coating around itself preventing it from reacting with other elements.
8) Berylium has a high melting point and is very strong.

Transition Metals: the d block

Cu^{2+}

1) more than one oxidation state
2) strong structually usefull metals, play an important role in living organisms
3) form colored compounds, solutions
4) used extensively in alloys

Au^+

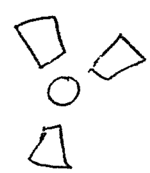
The Lanthanides

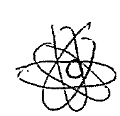
1) loose 3 electrons ○ form 3+ ions
2) soft, silvery
3) tarnish readily in
4) react slowly with water

The Actinides

1) all isotopes are radioactive
2) besides thorium and Uranium, all of the actinides are not found in nature, they are produced artificially.

U





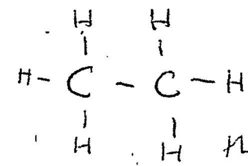
The Boron Group: Group 3A

1) Boron is a semi-metal, the other elements are metal.
2) lose 3 valence electrons to form 3+ ions

B^{3+}

The Carbon Group: Group 4A

1) the elements in this group are very different from each other
2) carbon is a non metal, silicon is a semi metal, the other elements are metals



carbon forms networks w itself. It has the most structure out of any element.

The Nitrogen Group: Group 5A

1) Nitrogen is a diatomic element
2) Nitrogen & phospherus are nonmetal,
3) arsenic and antimony are semi metals,
4) bismuth is a metal
5) Nitrogen and phosphorus are essential to the life cycle of many organisms.

N_2

$N \equiv N$

The Oxygen Group: Group 6A

1) 6 valence electrons
2) Oxygen, sulfur and selenium are nonmetals
tellurium is a semi metal
polonium is a metal.
3) Oxygen is the most abundant element on Earth

O_2

O_3

The Halogens: Group 7A

1) have an oxidation state of -1 if they are the most electronegative element in the compound.
2) All of the Halogens are diatomic
3) They react with most metals and many nonmetals
4) Fluorine is the most electronegative element

F_2 Br_2 Cl_2 I_2 At_2

The Noble Gases: Group 8A

1) the least reactive elements
2) Krypton & Xenon react with fluorine

Ne

Hydrogen: one of a kind

Bonding

Forces of attraction:

That hold atoms together:

① Ionic Bonds: AKA electro static bonds, electrovalent, egg

anion + cation = compound

(−) + (+) = (0)

Metal / non metal

ion = charged Particle

★ a way to see if ions are free is to see if they conduct electricity. ie: substances with mobile ions are good conductors

experimental evidence:

Ionic compounds are:

1) good conductors in the (aq) and (l) phase
2) solids are brittle
3) most ionic compounds are water soluable
4) Ionic compounds have high melting and boiling points.

② Metallic Bonds

★ a sea of electrons in positive ions

★ Mobile electrons

experimental evidence:

① metallic bonds are good conductors of heat and electricity

② Metallic substances have high boiling and Melting points

③ malleable, ductile, lusterous.

That hold atoms together

Bonds Between Atoms

3 types of Covalent Bonds

① non polar:

a) the atoms share electrons equally ex: diatomics

they have the same electronegativity.

② Polar:

a) the atoms have different electronegativities ex: H-Cl

b) they do not share equally

③ Parasite: AKA: Coordinate Covalent

a) one atom does not share any electrons, it steals from the other atom

ex: H × N × H (with H below N) ← coordinate covalent Bond — H^+ ← Parasite

Network Solids:

① macro molecules with non-polar covalent bonds.

★ hard, high melting point, boiling point

not good conductors of electricity

ex: sand, diamond, Graphite, silicon carbide,

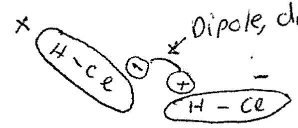
Graphite: is an exeption to the trend of traits that most network solids have.

1) good conductors of electricity
2) not hard
3) special "pi" bonds cause these traits

Bonds Between Molecules

Polar Molecule: the ends have different electronegativities

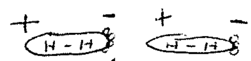
dipole-dipole force of attraction:



Medium strong.

Non polar Molecule: the ends have the same electronegativity

- ★ Van der Waal attractive forces: momentary attraction that keeps shifting.
- ★ the bigger the electron cloud of the atoms the stronger the van der waal forces



weak. (Think: "hula hoops") — more electrons on this side, causing it to be momentarily negative

Hydrogen Bond: a stronger form of dipole dipole for FON (Fluorine, Oxygen, Nitrogen) Why: FON are small but strong, they have exceptionally high electronegativity.

very strong ex: H_2O

Molecule-ion: when a polar molecule is attracted to an ion. type of dipole-dipole. ex: NaCl (aq), hydrolysis

★ Bonds between atoms are stronger than bonds between Molecules

---

VSEPR: electron pairs will arrange themselves to get out of each other's way. Influences Molecular shape.

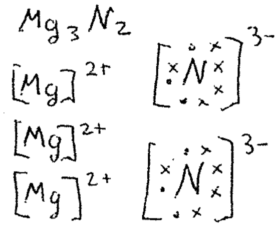
Molecule shapes:

220, 523	linear non-polar
532	t-shaped polar
330	trigonal planer Non polar
321, 422	bent polar
440	tetrahedral
431	pyramidal Polar
550	bi-pyramidal non-polar
541	Polar seesaw

Electron Dot-Diagrams

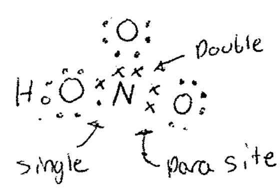
Ionic

Mg_3N_2



Covalent

HNO_3



Chemical & Physical Changes

substances have constant composition:

- <u>Element</u>: simplest form of matter, retains chemical characteristics cannot be separated into different ingredients.
- <u>Compound</u>: 2 or more different chemically bonded elements

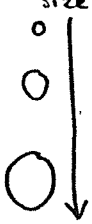
<u>constant composition</u>: atomic # / formula is the same throughout

<u>Mixtures</u>: 2 or more physically combined substances

<u>Solution</u>: homogeneous mixture, not a substance

<u>Heterogeneous</u>: visible differences in composition

particle size

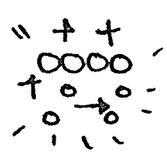


<u>Solution</u>: solid in a solid: mettallic alloy | solid in a liquid: NaCl (aq)
gas in a liquid: soda | liquid in a liquid: food coloring (aq)
molecules of solute & solvent distributed uniformly

<u>Colloid</u>: particles too small to be removed by filtration
tydall effect: light is refracted, ex: milk in water

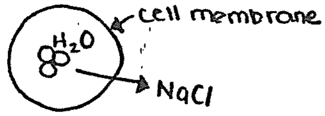
<u>Suspension</u>: relatively large particles will settle to the bottom if not continually stirred, can be separated w/ filtration or centrifuge

	Solid	Liquid	Gas
position:	structured	looser than solid	least structured
motion:	vibrational	vibrational, rotational, mixing, mingling	translational, vibrational, rotational
attraction:	strong	medium	least time for attractive forces to take hold



takes shape of container

<u>Osmosis</u>: movement of H_2O molecules from a high [ ] to a low [ ].



<u>reverse</u>: pressure forces H_2O through a membrane separating the H_2O from the ions

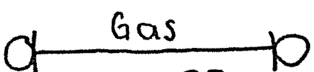
<u>Allotrope</u>: same phase, same element, same atom, different chem & physical properties, different structure

ex: carbon: diamond & graphite

physical & chemical properties

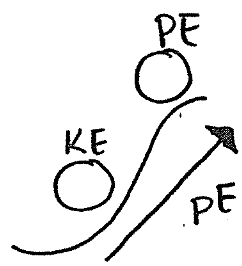
<u>physical</u>	<u>chemical</u>
color, smell BP/MP, hardness structure, texture bond strength	reactivity, products inactivity, how it burns, what it reacts with

PE = the position of one atom in relation to another

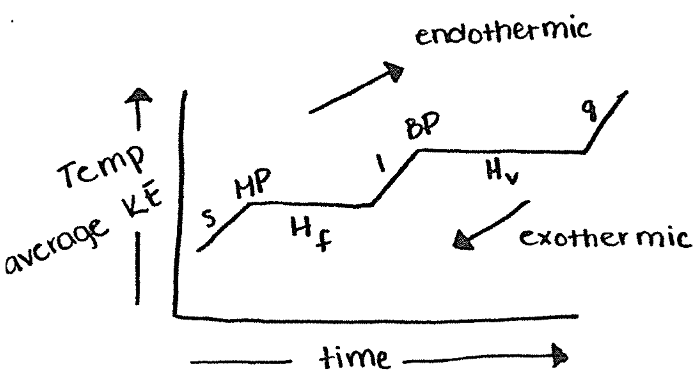


Solid @ low E state

solid P → gas K



Gas @ high ene state



physical equilibrium during phase change

☆ weak bonds ⇒ sublimation & deposition

Endo: heating curve
Exo: cooli

<u>endo</u>: the surroundings cool off, the thing heats up

<u>exo</u>: the surroundings heat up the thing cools off

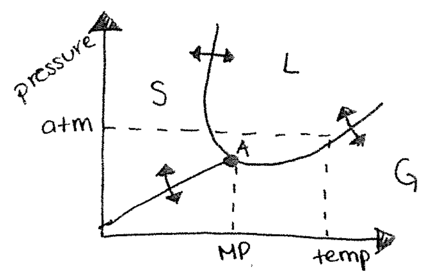
Phase change: PE↑ KE ⟼
heating: KE↑ PE ⟼

Chemical & Physical Changes

<u>crystalline solids</u>: highly ordered repeating pattern
unit cell, a piece taken from anywhere in the structure will be identical

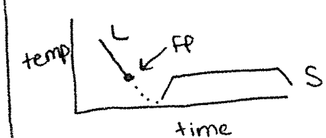
<u>Amorphous solids</u>: appear solid, unorderly structure
AKA: supercooled liquids

Triple pt.



- A all 3 phases in physical equilibrium
- A = the triple point

Supercooling



substance stays liquid under FP

the liquid molecules have to arrange themselves into solid order in order to freeze, stir to prevent

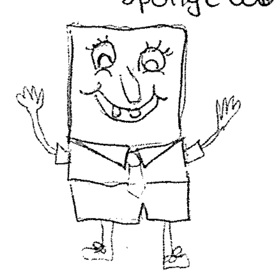
Endo & Exo rxn revisited

Activation Energy = the min. amt of E needed to start the rxn

the net ΔH = − (exo) more E is needed to form bonds / is released during bond formation

the net ΔH = + (endo) more E is needed to break bonds

Spongebob



Gas laws

STP = 101.3 Kpa, 1 atm, 760 mmHg, 760 torrs, 273 K, 0°C

Variables that affect gas behavior: temperature, pressure, volume, amount

★ as temperature decreases collisions with the sides of the container decrease, pressure decreases, direct relationship.

effusion: gas molecules randomly passing through pourous surfaces

★ as particle size decreases, particle speed increases, effusion rate increases

Vapor pressure: the pressure at which a becomes a
depends on speed and frequency of evaporating molecules.

★ as vapor pressure increases, evaporation rate increases, bond strength decreases

boiling point: when atmospheric pressure = vapor pressure of the liquid

★ as altitude increases, pressure decreases, boiling point decreases

Charles law: Temperature $\propto$ (is proportional to) Volume, $V = kT$, as temperature increases, V increases

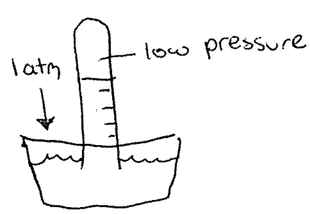
★ as temperature increases, molecule speed increases, the piston in the container moves up, volume increases, if there is no adjustable piston: pressure increases

Boyles law: Volume $\propto \frac{1}{\text{pressure}}$, $V = k\frac{1}{P}$, as volume decreases, pressure increases, and vice versa (indirect relationship)

Combined gas law: $\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$ use for changes in pressure, volume or temperature,

(T in Kelvin)

Torracelli's experiment:



Avagadro's law: all gases show the same physical behavior, regardless of their particle size

* gases with the same temperature, pressure and volume have the same # of molecules, amount = # of molecules

Dalton's law: each gas in a mixture acts independantly in exerting pressure on the walls of the container

* there is so much space between molecules that they don't bump into each other
* sum of individual pressures = total pressure $P_T = P_1 + P_2 + P_3$

Kinetic Molecular theory of gases Ideal gases

1) gases have mass
2) gases have tiny particles
3) particles move in straight line motion
4) collisions between particles are elastic, (they bounce back), Energy isn't lost.
5) gases have no attractive forces at high temperature and low pressure
   * during Freeze & Squeeze, gases have attractive forces.
6) gases have no volume in comparison to the container they occupy. (at high temp. and low pressure)
   * during Freeze & Squeeze gases gain volume as they phasechange

Gas Laws & Moles

Diffusion: the movement of one substance through another

The mole concept:

1.) 1 mole = 6.02×10^{23} particles
2.) establishes relationship between amu's & grams
3.) scale for expressing mass based on mass of carbon 12
4.) Avogadro's # = 1 mol
5.) 22.4 L @ STP (273K & 760 torr)

Molar mass: depends upon the mass of each element in a compound

Ideal Gas law: $PV = nRT$ (P = pressure, V = volume, n = # moles, R = given constant, T = temp)

* can be used at conditions other than STP

* the gas w/ the least # of e^- is the most ideal

Non-ideal conditions: freeze and squeeze

Things to Know:

1.) prefixes: mono, di, tri, tetra, penta ⇒ non ionic compounds
no direct transfer of e^-
suffix "ide" means binary except OH^-

2.) isotopes ⇒ different # neutrons
3.) cation = +, anion = −

Math Chapter

limiting reactant:
1) pick a product
2) calculate the yield using both products
3) the smaller one is the limiting reactant
4) use the limiting reactant to find all product amounts

sig figs: precision: how close individual measurements agree w/ eachother
accuracy: how close measurements are to the true value

* when you ×/÷ your final answer can only be as good as your least significant figure.

with decimals

→ 55.5

stop at first non-zero #

without decimals

202 ←

stop at first non-zero #

* when +/− look at the decimal. use the least amt. of sig. figs. after the decimal

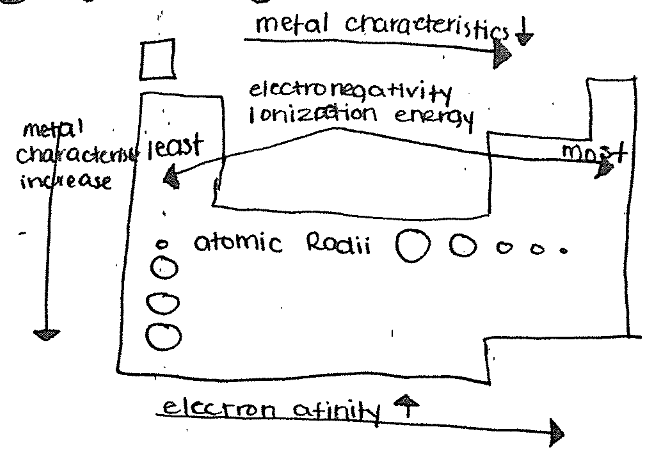
Tasks:
1) use factor conversions for problems at STP
2) use $PV = nRT$ for problems at less than ideal conditions
3) be able to find the yield & identify the limiting reactant
4) balance all equations
5) sig fig all answers

Periodic Trends

1) atomic radii:

a.) decreases across a period b/c atomic # and nuclear charge ↑ and electrons are pulled closer 2 the nucleus

b.) increases down a group because of a greater # of PEL's



2) Ionization energy: the amount of Energy needed to remove the most loosely bound electron in the gaseous phase

a) increases across a period; small but strong, proximity to the nucleus

b) decreas down a ~~period~~; far from the nucleus

3) Electronegativity: tendency/ability to gain electrons 0 = lowest, 4 = highest

a) increas across a period, metallic characteristic decreases

b) decreases down a group, metallic characteristics increase

4) Electron affinity: the energy change when an atom gains an electron

a) the more electrons you take the harder it is to take another, there is less negative power

b) when an atom gains an e^- energy is lost

c) the energy of reduction

d) across a period; EA increases, small but strong, EXCEPT Noble gasses, which have no electron afinity

e) down a group; EA decreases; the smaller the atom the more energy it releases, down a group energy is released.

5) Ionic Radius: when a neutral atom loses an electron, it's size decreases b/c there is now more positive nuclear force per e^- (nuclear charge remains the same)

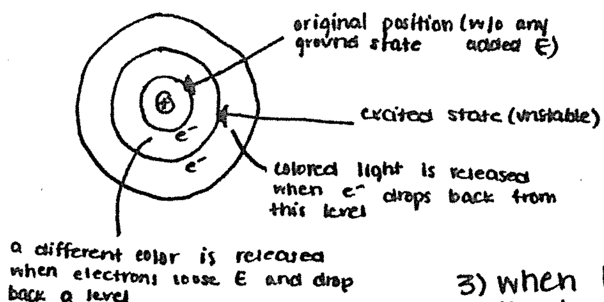
Atomic structure & Electron configurations

Dalton: atoms are single indivisible particles, different elements / atoms have elements made up of atoms, identical in their masses (overlooked isotopes). atoms of different elements have different masses, atoms combine in small whole # ratios

Thompson: plum pudding. positive with embedded negative charges. neutral, charge cannot be changed

Radioactivity: 1) so many particles crammed into a nucleus, it spits out particles until it is stable : when a substance spontaneously releases energy

2) Gamma ray - high frequency, short wavelength
   - a) alpha particle: takes e^- from compounds/atoms w/o combining
   - b) beta particle: e^-
   - c) positron: antimatter of e^-, when they meet they annihalate each other and form gamma radiation



Bohr Model

1) e^- will first occupy the energy level closest to the ⊕

2) e^- cannot exist between PEL's

3) when E is added the e^- jumps from the level it is on to a higher level

4) e^- absorb and releas energy in quantisized amounts
   Quantum: not continuous, specified
   visible light: e^- going from lower to higher state, when they jump back E(light) is released

Brightline spectra: each spectra line represents a different jump between PEL's
- only visible jumps are represented → more bright lines does not mean more e^- or PEL s

* it takes less E to fill an s orbital than a p orbital

Quantisization: energy is restricted to certain levels, it can only jump in incraments

Continuous energy: not restricted to incraments or levels, irrational #'s

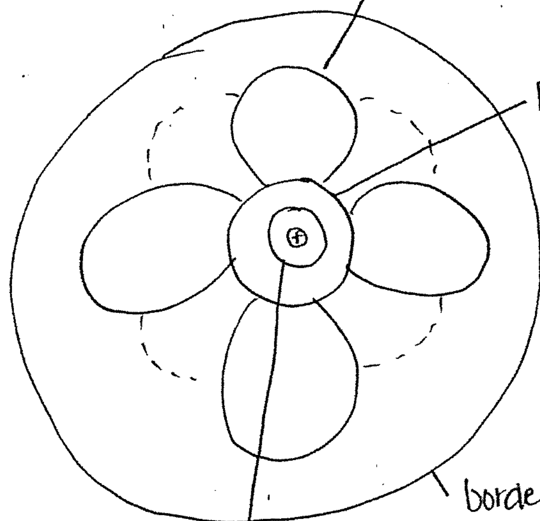
Electron dot diagram: $1s^2 2s^2 2p^3$ 5 valence e^-

Orbital notation: → [↑↓] [↑↓] [↑] [↑] [↑]

xx
x N x
x

Bus rule: e^- will be alone b4 they double up

PEL	Sublevel	Max # e^-
1	s	2
2	s p	8
3	s p d	18
4	s p d f	32



light is energy and particles: photoelectric cells = when light source is cut off, current is broken

photo electric effect - high frequency light ejects e^- from metals

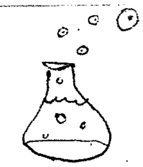
Bohr: PEL's groundstate, excited state

Hiesenburg: electron cloud
Shroadinger: e^- configuration
Pauli: ↑↓ opposite spin

nucleon → anything in nucleus
nuclid → nucleus
nuclear charge = protons

Rutherford's Model: (gold foil experiment) atoms are mostly empty space with a dense positively charged nucleus. Electrons exist only outside of the nucleus

Solutions chem review



Solute: the substance that gets dissolved

Solvent: the substance that does the dissolving or is in greater amount.

Salt: any anion except OH^- ionically bonded with any cation other than H^+

Molarity: $M = \frac{\text{mols of solute}}{\text{L of solution}}$
↑ Is affected by Temp Δ

Molality: $\frac{\text{mols of solute}}{\text{Kg Solvent}}$
↑ is NOT affected by temperature

[ ] = concentration

★ non polar substances will not dissolve in polar ones.

★ as saturation increases Molarity increases

$Keq = \frac{[\text{Products}]}{[\text{reactants}]}$

★ when solute settles to the bottom, the solution is saturated

write only products and reactants that are gases or solutions into the Keq

at a given temperature:

- **Unsaturated**: the solvent can hold more solute
- **Saturated**: the solvent is holding the maximum amount of solid it can hold
- **Supersaturated**: there is too much solute for the solvent to hold yet none of the solute precipitates out of solution. (a complex heating process is needed to reach this point)

Soluability Rules:

form **Soluable** compounds

1) Group 1A ions
2) Ammonium NH_4^+
3) Nitrate NO_3^-
4) acetate $C_2H_3O_2^-$ or CH_3COO^-
5) Hydrogen Carbonate HCO_3^-
6) Chlorate ClO_3^-
(7) perchlorate ClO_4^-
8) halogen ions (except when combined with Pb^{2+}, Ag^+, Hg^{2+}) Pretty Agrivated Hedgehogs.
9) Sulfates SO_4^{2-} (except when combined with Ag^+, Sr^+, Ba^{2+}, Pb^{2+}, Ca^{2+}) aggrivated Seniors Bake Peanut Butter Cakes

form **INSoluable** compounds

1) Carbonate CO_3^{2-}
2) Chromate CrO_4^{2-}
3) Phosphate PO_4^{3-}
4) Sulfide S^{2-}

except when combined with Group 1A ions or ammonium NH_4

5) Hydroxide (OH^-) (except when combined with: Ca^{2+}, Sr^{2+}, Ba^{2+} Common Strong Bases

★ the greater the amount of particles a substance breaks up into in solution, the greater the boiling point and the lower the freezing point.

ex: $C_6H_{12}O_{6(s)} + H_2O_{(l)} \rightarrow C_6H_{12}O_{6\,(aq)}$
1 mol → 1 mol

ex: $NaCl_{(s)} + H_2O_{(l)} \rightarrow Na^+_{(aq)} + Cl^-_{(aq)}$
1 mol → 1 mol + 1 mol = 2 mols

the NaCl raises boiling point and lowers freezing point more than the $C_6H_{12}O_6$ does

★ ionic solutes affect the melting and boiling points more than molecular solutes

<u>Colligative properties</u>: the more particles in the solution, the greater the changes to boiling and melting point.

$(M_1)(V_1) = (M_2)(V_2)$

(Molarity)(volume) of the first substance = (molarity)(volume) of the 2nd substance

used for dilutions and titrations

$\Delta T = (m)(i)(K)$

- ΔT: change in temperature
- m: molarity
- i: mols or parts
- K: constant of boiling point / freezing point

★ you only use molality when the mass is constant

★ ionic substances: are <u>volatile</u>, they break down easily and have greater colligative properties.

★ the weaker the bonds, the easier it is for a substance to dissolve

★ a solution can be saturated and dilute at the same time

<u>Phantoms</u>:
$NH_4OH \rightarrow NH_3 + H_2O$
$H_2SO_3 \rightarrow SO_2 + H_2O$
$H_2CO_3 \rightarrow CO_2 + H_2O$

<u>Keq</u>: more about this in the equilibreum topic
write only species that are gaseous or in solution into the Keq

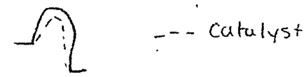
Kinetics and Equilibreum

Reaction rate: sufficient energy and proper orientation is needed for a reaction to occur

Factors that affect rxn rate:

1) as concentration increases, rxn rate increases
2) as surface area " " increases
3) as temperature " " increases
4) as bond strength " " **de**creases
5) Catalysts increase rxn rates
6) ionic substances react faster than covalent ones

5) Catalysts lower the Ea (activation energy) which increases rxn rate



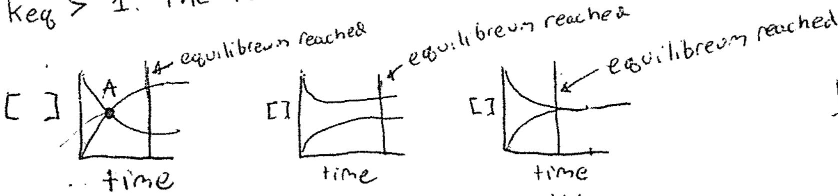
Reversible rxns:

dynamic equilibreum: rate of forward rxn = rate of reverse rxn
concentrations of products and reactants are constant but not equal
Occurs in a closed system

$$Keq = \frac{[Products]}{[reactants]}$$

is used to find the relative concentrations
Only write the concentration of a solution or gas (For everything else just write 1)

Keq ≈ 1: the rxn is at equilibreum
Keq < 1: the reverse rxn is favored, there are more reactants
Keq > 1: the forward rxn is favored, there are more products



Products Favored | Reactants Favored | neither Favored

at • A the concentrations of products and reactants are equal

Equilibreum

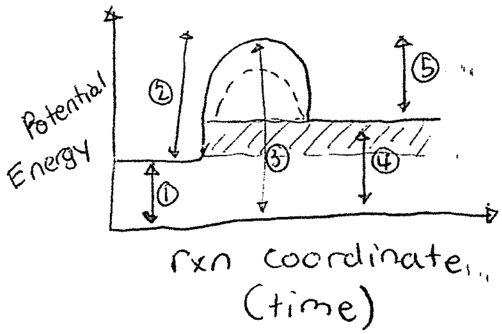
- **Physical**: ex: phase change
- **Solution**: ex: Saturation
- **Chemical**: ex: dynamic

Keq in those graphs is constant unless the temperature is changed.

Le chatlier's principal: A+B = C+D ↑ = increases, ↓ = decreases

increase [A]: A + B↓ ⇌ ↑C +↑D
increase [B]: ↓A + B ⇌ ↑C +↑D
increase [A & B]: A + B ⇌ ↑↑C + ↑↑D
increase [C]: ↑A + ↑B ⇌ C + D↓
increase [D]: ↑A + ↑B ⇌ ↓C + D
increase [C & D]: ↑↑A + ↑↑B ⇌ C + D

- ☆ heat has the same effect as concentration
- ☆ increase in pressure will shift the rxn in favor of the direction that produces fewer mols
- ☆ pressure will not effect a system with equal mols of products & reactants
- ☆ catalysts do not affect equilibreum



① Potential Energy of the reactants
② Activation energy of the forward rxn
③ Potential Energy of the activated complex
④ Potential Energy of the products.
⑤ Activation Energy of the reverse rxn

▨ = ΔH rxn

(dashed curve) = how the catalyst affects the rxn

ΔH_f := the energy change when one mole of products is formed from its elemental substances

Enthalpy: heat gained/lost in a chemical reaction. We want a spontaneous rxn, we want to minimize enthalpy. $\Delta H = -$

Entropy: the randomness of a chemical situation. we want a spontaneous rxn, we want to maximize entropy so particles will be more likely to collide $\Delta S = +$

Spontaneos: once it starts, it will continue

$\Delta H = +$, $\Delta S = -$ > no spontaneous rxn

$\Delta H = -$, $\Delta S = +$ > a spontaneous rxn will always occur.

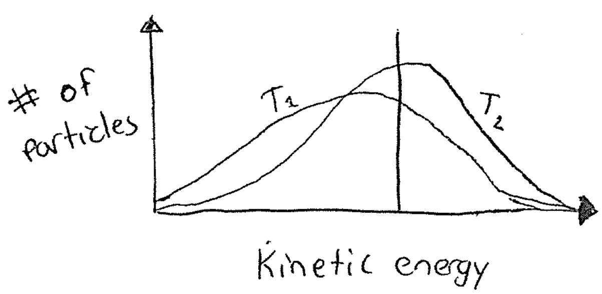
if $\Delta S = -$, $\Delta H = -$ or $\Delta S = +$, $\Delta H = +$ use Gibbs Equation $\boxed{\Delta G = \Delta H - T\Delta S}$

Temperature is always kelvin

$\Delta G = -$ Spontaneous	$\Delta H = -$ exothermic rxn	$\Delta S = -$ less random
$\Delta G = +$ non spontaneous	$\Delta H = +$ endo thermic rxn	$\Delta S = +$ more random

if energy is on the products side the rxn is exothermic

- if energy is on the reactants side the rxn is endo thermic



temperature was increased, rxn rate was increased

Acids & Bases

Acids: sour taste, molecular substances that conduct electricity, react with metals to produce gasses.
Acids are the only molecular substances that conduct electricity.

Bases: taste bitter, conduct electricity, feel slippery

Arrhenus definitions

Acids: a substance that donates/loses an H^+ in water

Bases: a substance that loses an OH^- in water

Bronsted Lowry definitions

Acids: a substance that donates/loses an H^+

Bases: a substance that accepts an H^+

Conjugate pair: two substances related by the exchange of 1 H^+

$$NH_3 + H_2O \rightleftharpoons NH_4 + OH$$

base acid acid base

acid anhydride: any non-metallic oxide that reacts with water to form an acid

$$NO_2 + H_2O \rightarrow HNO_2$$

basic anhydride: any metallic oxide added to water creates a base

$$CaO + H_2O \rightarrow Ca(OH)_2$$

Strong Acids

- HCl
- HBr
- HI
- H_2SO_4
- HNO_3
- $HClO_3$
- $HClO_4$

Strong Bases

- All group 1A metal ions + OH^-
- $Ca(OH)_2$
- $Sr(OH)_2$
- $Ba(OH)_2$

Strong Acid / base = weak bond

Neutralization

strong acid and strong base = neutral
weak acid and strong base = basic
strong acid and weak base = acidic
weak acid and weak base = K_a, stronger is bigger

Hydrolysis: when a salt chemically reacts with water. Reverse neutralization

$$NaF + HOH \rightarrow Na^+_{(aq)} + OH^-_{(aq)} + HF$$

HF ← not soluble, weak acid, strong base

stronger more OH floating around base > PH

Acids & Bases

The stronger the acid, the weaker it conjugate base

<u>Salts</u>: any compound containing a positive ion (except H^+) combined with a negative ion (except OH^-)

<u>Naming inorganic Acids:</u>

Binary: Hydro + element name + ic + acid
ex: Hydrochloric acid HCl
except H_2S = hydro sulfuric acid

Ternary: H_2SO_4 - ends in "ate" → element / polyatomic ion prefix name + "ic"
sulfuric acid, HNO_3 nitric acid
H_2SO_3 - ends in "ite" → element / polyatomic ion prefix name + "ous"
sulfurous, HNO_2 nitrous acid

Titration: used to determine the [ ] of an acid / base
$(Ma)(Va) = (Mb)(Vb)$

$PH = -\log [H_3O^+]$ describes concentration not strength
ex: .10 M HCl $-\log [1 \cdot 10^{-1}]$
$-1 (0 + -1) = 1$

12 M HCl = PH $-\log [1.2 \times 10^{-1}]$

<u>Auto ionization of water:</u>

$H_2O + H_2O \rightleftharpoons OH^- + H_3O^+$

<u>Amphiprotic</u> : can be on an acid or a base

<u>Indicators:</u>

$HI \rightleftharpoons H^+ + I^-$ (OH combine — base is added) # of free H^+ ↓
clear — pink

concentration changes color changes.

Oxidation Reduction

Leo Says Ger: Loss of electrons is oxidation
Gain of electrons is reduction

How to assign oxidation states:-

	Oxidation#
1) neutral, uncombined and diatomic elements:	0
2) monatomic ions	= ionic charge
3) Group 1A metals	1+
4) Group 2A metals	2+
5) Fluorine	−1
6) Halogens (if they are the most electronegative element in the compound)	−1
7) Hydrogen	+1
8) Hydrogen combined with a metal	−1
9) Oxygen	−2
10) Oxygen combined with fluorine ← more electronegative	+2
11) the sum of the oxidation # of all elements in a compound	0

a sample redox reaction with half reactions

$Zn_{(s)} + Cu\,SO_4{}_{(aq)} \rightarrow Cu_{(s)} + Zn\,SO_4{}_{(aq)}$ 1) Cross out spectators

$Zn^{0}_{(s)} + Cu^{2+}_{(aq)} \rightarrow Cu^{0}_{(s)} + Zn^{2+}_{(aq)}$ 2) assign oxidation #'s

$Zn^{0}_{(s)}$: Reduction agent; $Cu^{2+}_{(aq)}$: Oxidation agent

3) identify oxidation agent and reduction agent

4) write half reactions:

oxidation: $Zn^{0}_{(s)} \rightarrow Zn^{2+}_{(aq)} + 2e^-$

reduction: $Cu^{2+}_{(aq)} + 2e^- \rightarrow Cu^{0}_{(s)}$

5) (balance charges if necessary)

oxidation # increases during oxidation, (e−'s are lost)

oxidation # decreases during reduction, (e−'s are gained)

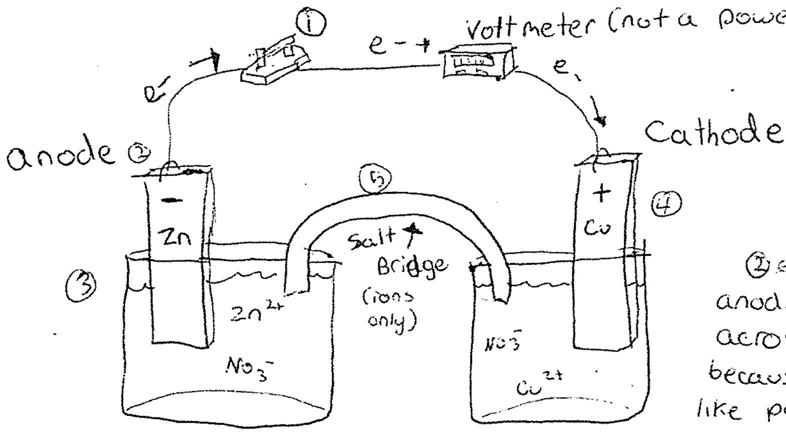
Reduction agent: gets oxidized

Oxidation agent: gets reduced.

anode: a piece of metal that loses electrons, gets oxidised.
* in a voltaic and electrolytic cell, the anode decreases in mass.

cathode: a piece of metal that gains electrons, gets reduced.
* in a voltaic and electrolytic cell, the cathode increases in mass

Voltaic cell: aka: Danielle cell & chemical cell,
* the voltaic cell contains a spontaneous reaction
it does not require a powersource



whats going on?

① the switch is flipped on

② electrons spontaneously leave the anode and travel towards the cathode across the wire. They want to go there because the cathode is positive, electrons like positive.

③ as electrons leave the anode, the anode decreases in mass. it becomes mostly positive Zn^{2+} ions which leave and become (aq).

④ meanwhile, back at the cathode, the electrons from the zinc cause Cu^{2+} ions from the solution to add to the cathode and increase its mass. when this happens the solution gets kinda negative because all the positive ions are leaving.

⑤ Thats where the salt bridge comes in! Ions (not electrons) move freely across the salt bridge balancing the net charges of each solution.

in a Voltaic cell

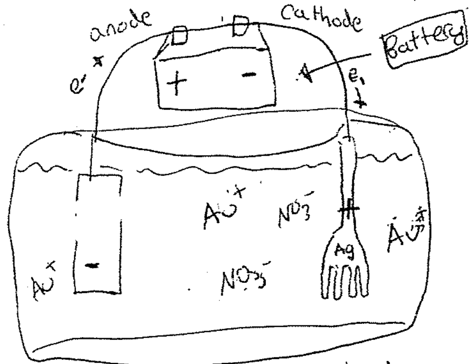
1) the anode is negative
2) the cathode is positive
3) the saltbridge carrys ions
4) the wire carries electrons
5) a battery/powersource isn't needed
6) the reaction is spontaneous

an ox: oxidation always occurs at the anode.
The metal with higher reactivity is always oxidized.

red cat: reduction always occurs at the cathode

Oxidation Reduction (Continued)....

The electrolytic cell: contains a non-spontaneous reaction, a battery is needed. AKA electroplating.



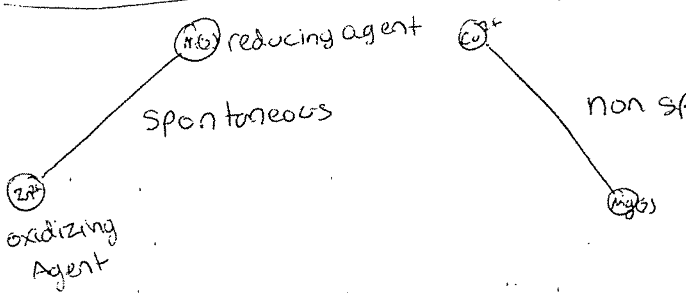
anode
"an ox"

Cathode
"red cat"

whats going on? we are trying to gold plate a fork

Normally because silver is more reactive than gold the silver fork would get oxidized. But we want the opposite to happen, so we use the battery as a pump to pump the electrons out of the gold, through the wire to the silver fork where gold ions from the solution will attach to the electrons and cause gold atoms to build a layer of gold on the silver fork.

How to use the table of standard Reduction potentials:



to figure out the E°:

1) Switch the sign of the voltage of the half-reaction for oxidation
2) add the voltages of the half reactions

- = non spontaneous
0 = at equilibreum
+ = Spontaneous

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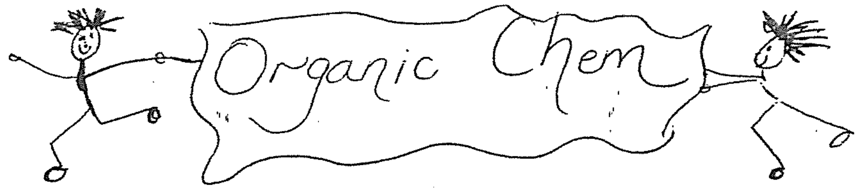


The Chemistry of carbon compounds!

THE HYDROCARBONS

Not very polar because C & H are very similar in EN.
Mostly insoluble in H_2O

- Open & branched HCs = Alkane, Alkenes, Alkynes
- Cyclic OR Aromatic = Benzene 

Nomenclature is based on the longest-continuous carbon chain present.

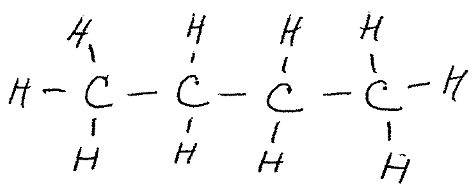
Prefixes – used to denote the number of carbon atoms

1 meth	4 but	7 hept	10 dec! ← (that's for Joe!)
2 eth	5 pent	8 oct	
3 prop	6 hex	9 non	

- Alkane = single = saturated bonds C_nH_{2n+2}
- Alkenes = 1 double bond between C atoms C_nH_{2n}
- Alkynes = 1 triple bond between C atoms C_nH_{2n-2}

ISOMER – compds with the same molecular formula BUT different structural formulas.

Try these for FUN :)



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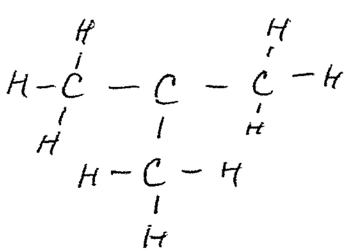
Name please!



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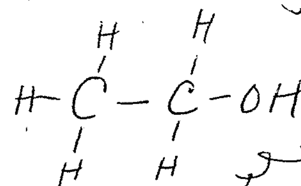
Name please!

Enough of those hydrocarbons –
lets move on to those FUN FUNCTIONAL GROUPS!

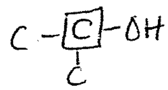
TRY to visualize the groups & where they attach to the carbon chain

① Alcohols R – OH

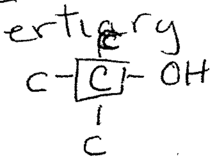


ethanol

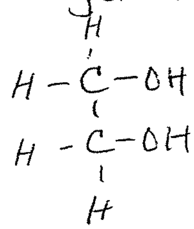
1 OH — Monohydroxy
- Primary C–[C]–OH
- Secondary



- Tertiary

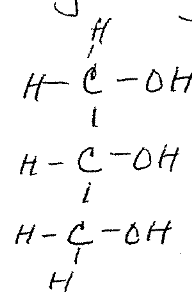


2 OHs — Dihydroxy



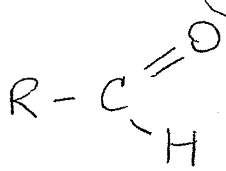
1,2 ethandiol

3 OHs — Trihydroxy



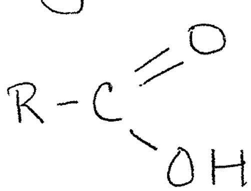
1,2,3 propantriol

② Aldehydes

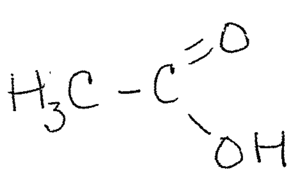


methanal

③ Organic Acids



"COOH"



ethanoic acid

MORE FUNCTIONAL GROUPS – BUT NOT – NOT AT THE END OF THE CARBON CHAIN

④ Ether  they will put you to zzzz

R – O – R   "ether or"

⑤ KETONE (LIKE ACETONE)

```
     O
     ||
R – C – R
```

methan<u>one</u>
ethan<u>one</u>

⑥ Ester  she's cookkie & smells good!

R – C – O – O – C – R

OR it can be drawn as

```
     O
     ||
R – C – O – R
```

⑦ Amine (the opposite of anice)

$R-NH_2$ = amino

GUESS what 2 functional groups an amino acid would have?

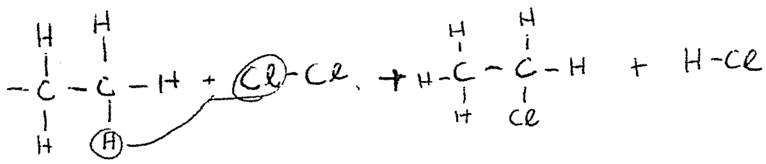
Organic reactions

Combustion: any organic substance + $O_2 \rightarrow CO_2 + H_2O$

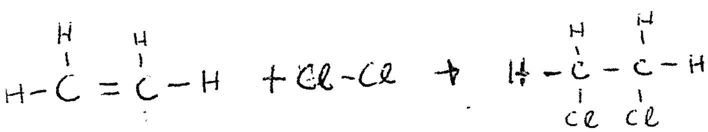
ex: $C_2H_4 + O_2 \rightarrow CO_2 + H_2O$

Substitution: any alkane + anion

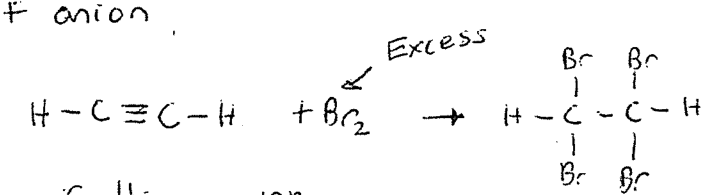
$C_2H_6 + Cl_2 \rightarrow C_2H_5Cl + HCl$



Addition: any alkene or alkyne + anion

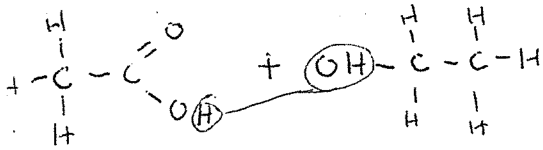


$C_2H_4 + Cl_2 \rightarrow C_2H_4Cl_2$



$C_2H_2 \quad +2Br_2 \rightarrow C_6H_2Br_4$

Esterification: organic acid + alcohol → water + Ester



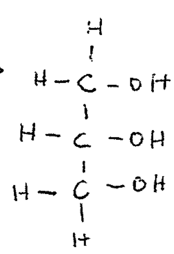
→ H_2O + ester

(Kinda like neutralyzation)

ethanoic acid + ethanol

Saponification Fat + Strong base → glycerol + soap

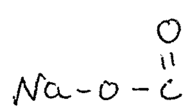
FAT + NaOH →



$C_3H_5(OH)_3$

glycerol

\+

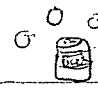


(soap)

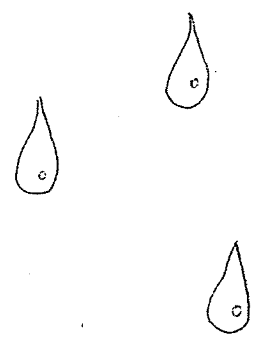
~~See back~~

Fermentation: Sugar + Enzymes → alcohol + CO_2

$C_6H_{12}O_6$ + Enzymes →  + $2CO_2$ (bubbles)

R-OH



Polymerization: monomers bonded to themselves to form a network or macro-molecule

monomer: a small unit of an organic compound

Addition polymerization: n(organic compound) → (organic compound)$_n$

$100C_2H_2 \rightarrow (C_2H_2)_{100}$

Condensation Polymerization:

(monomer containing OH) + (monomer containing H) → H_2O + n(Polymer)

[R]-[OH] + [H]-[R] → [H_2O] + [R]$_n$ (polymer)

The End