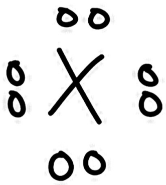
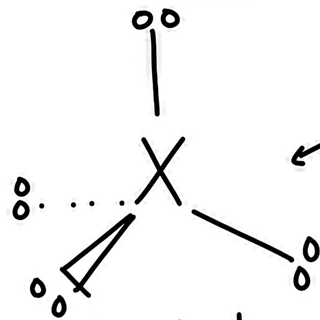
Valence Shell e^- pair repulsion (VSEPR)





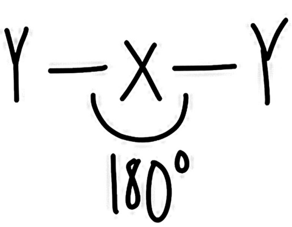
e⁻ spread out as far as possible from each other

Dot Structure　　3D Structure

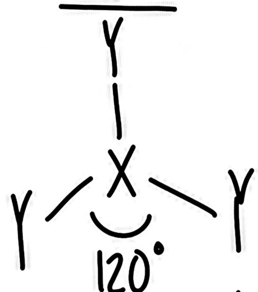
Valence Shell e^- pair repulsion (VSEPR)

The number of groups (1-4) around central atom determine shape

1 - 2

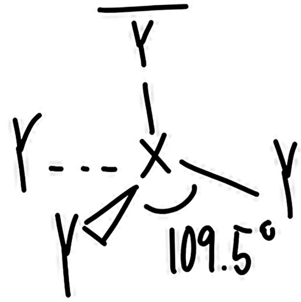


3



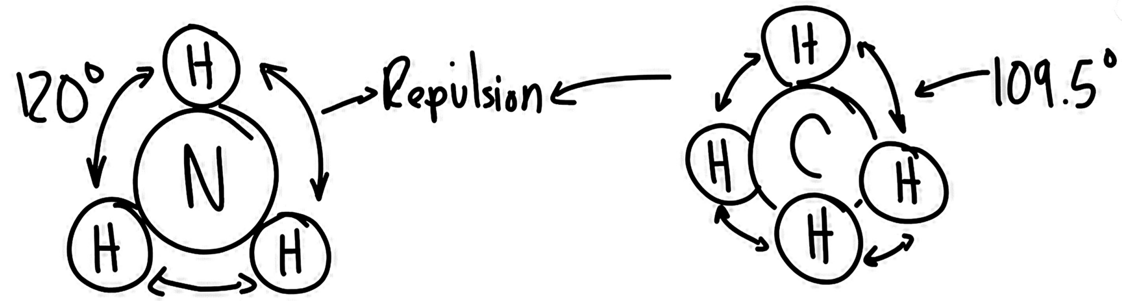
X = Central Atom

4



Valence Shell e^- pair repulsion (VSEPR)

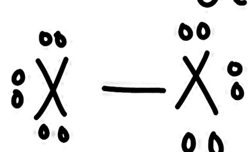
$\underline{NH_3}$ (N = central) $\underline{CH_4}$ (C = central)



Valence Shell e^- pair repulsion (VSEPR)

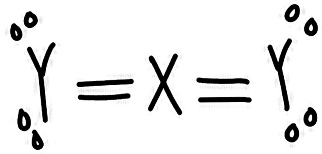
The number of atoms and e^- pairs determine shape

<u>1</u> 1 bond, 0 e^- pairs



linear
(diatomic)

<u>2</u>



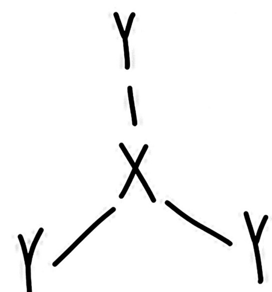
← 1 and 2 are both linear

linear
2 bonds 0 e^- pairs

Valence Shell e^- pair repulsion (VSEPR)

The number of atoms and e^- pairs determine shape

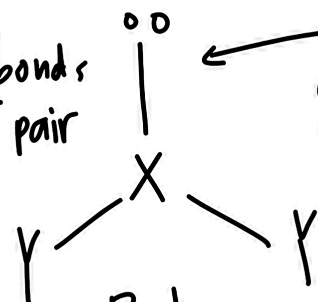
3



Triginal Planar

3 bonds
0 e^- pairs

2 bonds
1 e^- pair



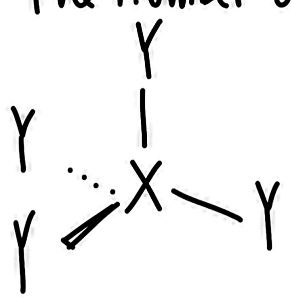
e^- pairs are invisable (can't see)

Bent

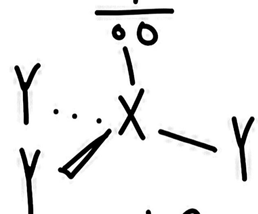
Valence Shell e^- pair repulsion (VSEPR)

The number of atoms and e^- pairs determine shape

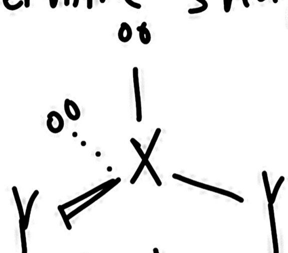
4



Tetrahedral
4 bonds 0 e^- pair



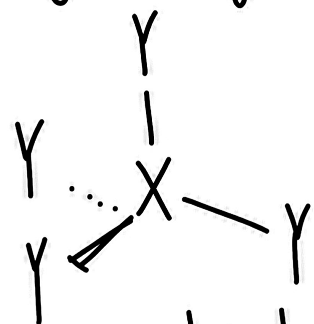
Triginal Pyramid
3 bonds 1 e^- pair



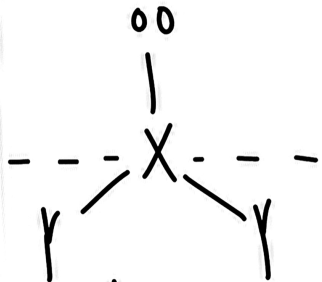
Bent
2 bonds 2 e^- pair

Valence Shell e^- pair repulsion (VSEPR)

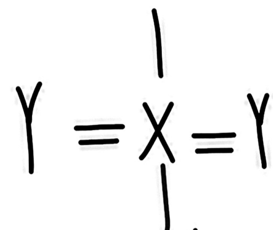
Symmetry - Same atoms/e^- pairs on both sides



symmetrical



Not-symmetrical



symmetrical

Valence Shell e^- pair repulsion (VSEPR)

Examples SiO_2

Dot Structure

O = Si = O

VSEPR

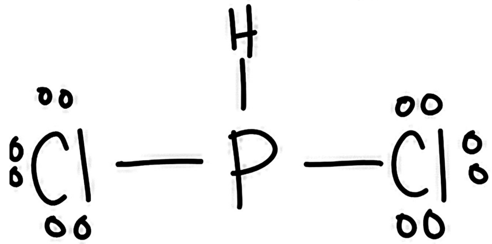
O = Si = O

bonds 2 e^- pairs 0

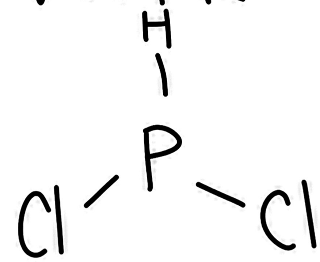
Valence Shell e^- pair repulsion (VSEPR)

Examples $HPCl_2$

Dot Structure



VSEPR

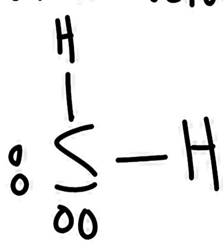


bonds 3 e^- pairs 0

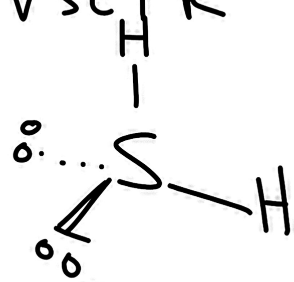
Valence Shell e^- pair repulsion (VSEPR)

Examples H_2S

Dot Structure



VSEPR



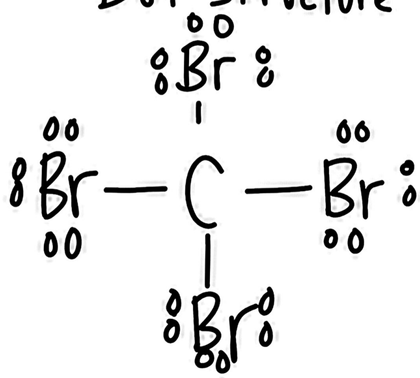
bonds 2 e^- pairs 2

Valence Shell e^- pair repulsion (VSEPR)

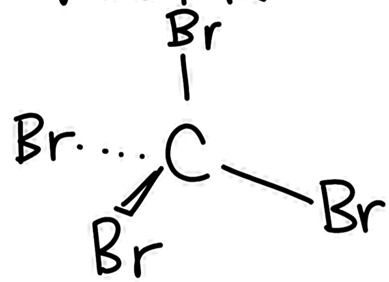
Examples

CBr_4

Dot Structure



VSEPR



bonds 4 e^- pairs 0

Electronegativity and atomic bonding

Electroneg. - An atoms ability to attract e^- to itself

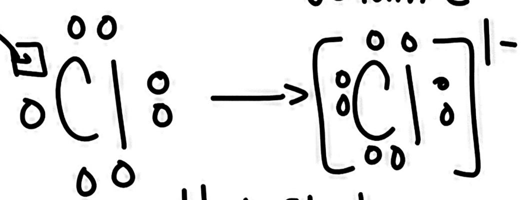
Metals + Metalloids	Non-Metals
Want to lose e^- / low desire to obtain e^-	Want to gain e^- / high desire to obtain e^-

lose e^-

$\dot{Na} \longrightarrow Na^+$

Low Electroneg.

gain e^-



High Electroneg.

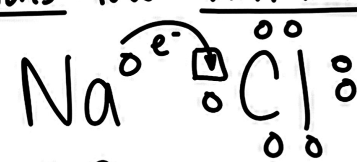
Electronegativity and atomic bonding

Atomic Interaction

Ionic Bonding

A low electroneg. atom gives an e^- to a high electroneg. atom

metals : low   non-metals : high



0.9   3.0

Electroneg. Diff. (ED) $= 3.0 - 0.9 = 2.1$

Ionic : ED > 1.9 (metal + non. metal)

Electronegativity and atomic bonding

Atomic Interaction

Non-Polar Bonding

Two atoms with simular electroneg. share e^-'s equally w/ each other.

Two non-metals

H_2 (H — H)

H ⟷ H (shared)

2.1 2.1

ED = 2.1 − 2.1 = 0

Non-Polar: ED < 0.5 (equal sharing)

Electronegativity and atomic bonding

Atomic Interaction

Polar Bonding

Two atoms share e^- unequally due to large Electroneg. Difference (ED)

Two non-metals

HCl (H — Cl)

e^- less often H $\xleftrightarrow{e^-}$ Cl e^- more often

2.1 3.0

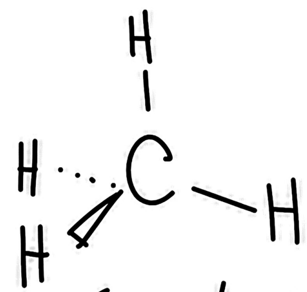
ED between 0.5 − 1.9 (Polar)

ED = 3.0 − 2.1 = 0.9

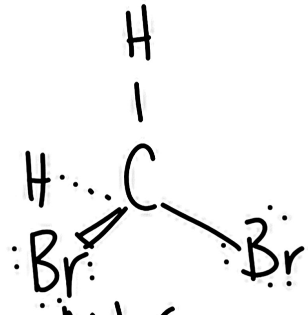
Molecular Symmetry

Symmetrical : Non-Polar

Not Symm. : Polar or Non-Polar (Depends on Bonds)



Symm./NonPolar



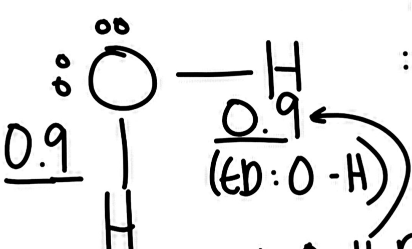
Not Symm.

Polar or Non-Polar?

Not Symmetrical : Polar or Non-Polar?

Polar Bonds : Likely Polar

Non-Polar Only : Non-Polar

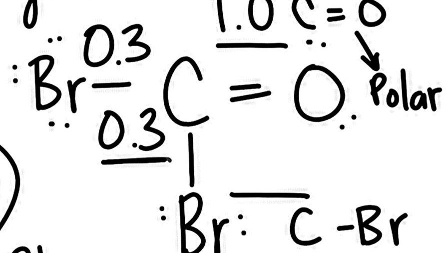


O-H: Polar

not symm. ✓

molecule is polar!

1.0 C=O



C-Br

not symm ✓

molecule is polar

Non-Polar

symmetrical OR only non-polar bonds

Polar

Not Symm + Polar Bonds

Dipoles and molecular interactions

Polar Molecules have dipoles

+ end — H — O — end

H (2.1) less electro. (more +)

O (3.0) more electro. (more −)

Polar and Polar

H — O   H — O

$\underbrace{\cdots}$ bond between + and − dipole ends

Dipole is a representation of + and − ends of a polar molecule

Molecular Interactions

Intramolecular attractions:

Connections between atoms in a compound or molecule

Ionic: Transfer of e^-

metal $\xrightarrow{e^-}$ non-metal

strong + to − attraction | $A^+ — B^-$ + to −

Polar: Unequal sharing of e^-

Low Electro $\xleftrightarrow{e^-}$ High Electro.
(less ofter) (more often)

Dipole: (+ end) [High ED] (− end)

Non-Polar: Equal or nearly equal sharing of e^-

Diatomic [ED<0.5]

$A \xleftrightarrow{e^-} A$ equal

$A \xleftrightarrow{e^-} B$ nearly equal

Molecular Interactions

Intermolecular Attractions

Connections between two or more molecules or ions (+ or -) from ionic compounds.

Re: Dipole

(+) Polar (−)

Re: Ionic

$A^+ — B^-$ (Ionic)

Ionic Interaction

+ and − Crystal structure

VIBRATION

$Na^+ — Cl^- \cdots Na^+ — Cl^-$

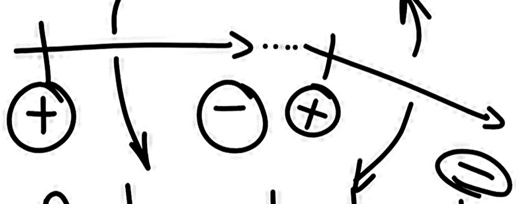
$Cl^- — Na^+ \cdots Cl^- — Na^+$

State	Intermolecular
Solid	Strong

Molecular Interactions

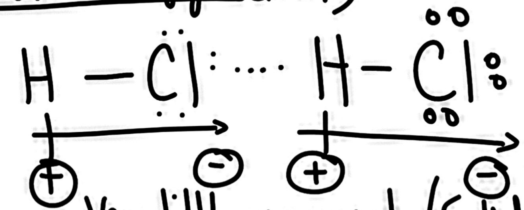
Polar - Polar Bond

Dipole - Dipole Interaction



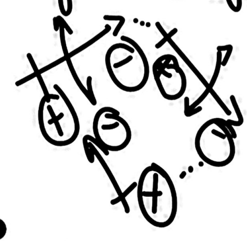
Dipole can break and reform.

Low Energy (Heat)



Very little movement / Solid

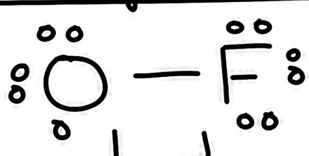
Higher Energy (Heat)



Flow: Break and Reform bonds

Liquid

Electroneg. and Bond Type (Review) [Intramolecular]



Bond Type?

3.5 4.0

ED

$4.0 - 3.5 = 0.5$

Bond: Polar (slightly)

Ionic: $ED > 1.9$
Metal = Ionic

Polar $ED > 0.4$
No Metals

Non-Polar $ED < 0.4$
No Metal

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Molecular Interactions

Non-Polar - Non-Polar Bond

No Direct Interaction

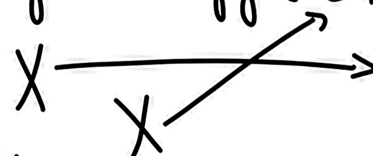
nonpolar nonpolar
no charges no charges

Molecules can collide but don't bond

Low Energy (Heat)

Lower speed, gas

Higher Energy (Heat)



Higher Speed, gas

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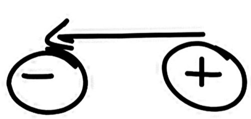
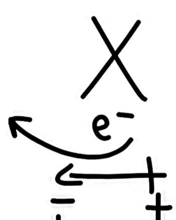
Molecular Interactions

Polar - Non-Polar Bond

Dipole - Induced Dipole



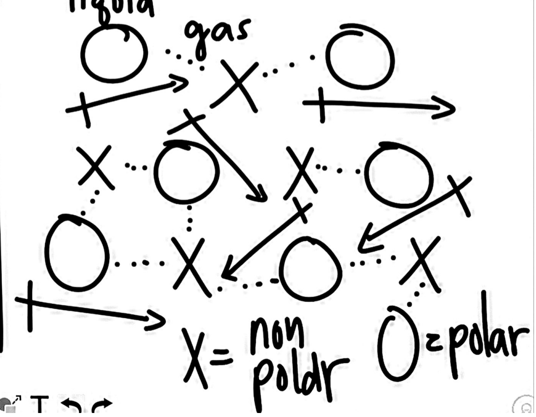
Permanent Dipole



e^- in X attracted to + dipole

temporary dipole (Induced)

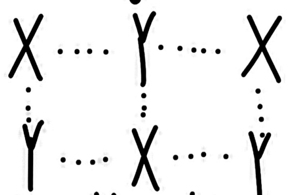
Induced dipoles occur when non-polar gases mix in polar liquids



X = non polar O = polar

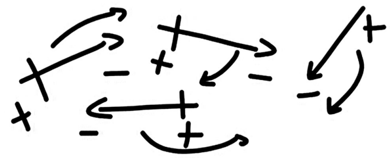
Bond Strength and States of Matter

Solid : Ionic
Strong Inter.



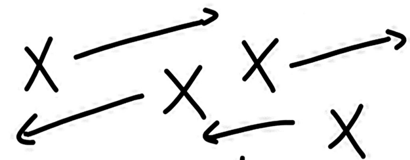
Low Heat / Energy
Vibration Only

Liquid : Polar
Medium Interact.



Medium Heat / Energy
Particles Flow over each other
Form/Break Bonds

Gas : Non-Polar
Weak Interact



High Heat / Energy
Particles Flow / No Bonds

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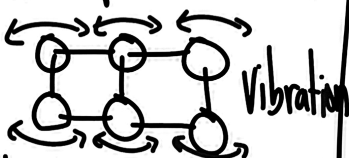
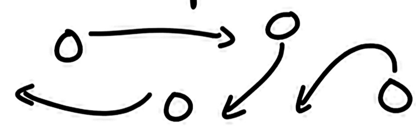
Energy and Change of State

State: The position and connections for part. in matter
atom, ion, compound, molecule

Solid	Liquid	Gas
Fixed Shape and Size	Var. Shape Fixed Size	Var. Shape and Size
Vibrate along the bonds	Flow but are still bonded to other part.	Flows w/ no bonds to other particles





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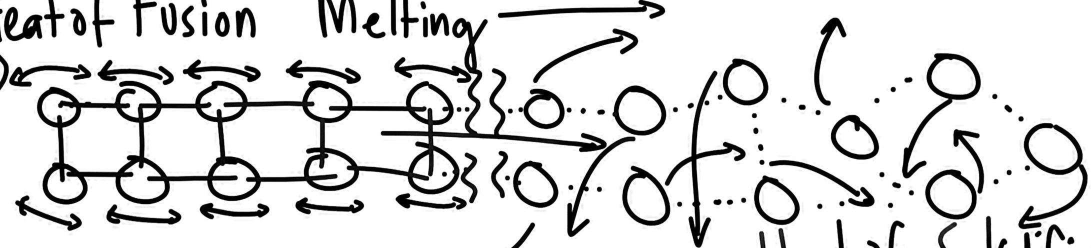
Energy and Change of State

Solid — State Change → Liquid

Heat of Fusion (add) — Melting →



Solid ← Freezing — Liquid

Heat of Solidification (lost)

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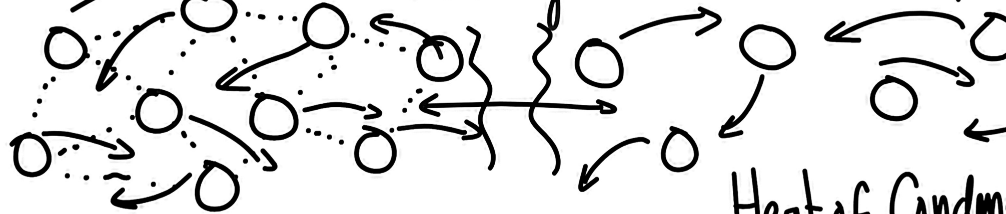
Energy and Change of State

Liquid	State Change	Gas
	Boiling →	Heat of Vaporization (add)
Liquid	← Condensing	Heat of Condensation (lose) Gas



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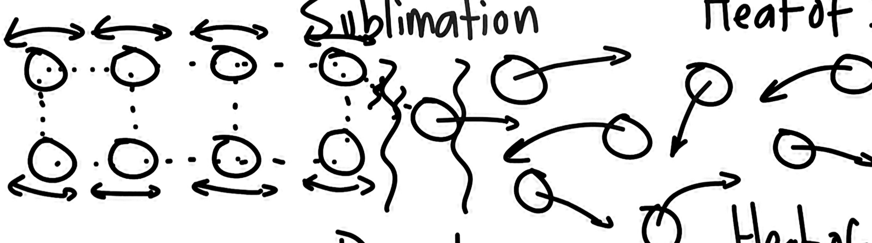
Energy and Change of State

Solid	State Change	Gas
	Sublimation →	Heat of Sublimation
Solid	← Deposition	Heat of Deposition Gas



Energy and Change of State

Na – Cl
strong Ionic Bond
(Hard to break)

H – Cl
weaker polar Bond
(easier to seperate)

Stronger Bonds need more E to break

H – Cl ED = 0.9
stronger polar — stronger

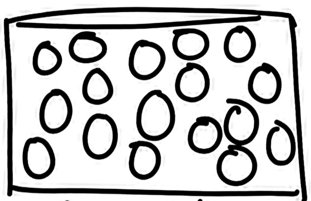
H – C
weaker nonpolar — weaker

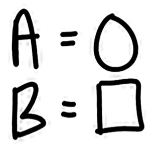
Larger ED, stronger bond / Harder to Break

Molecular Interactions - Mixtures and Solutions

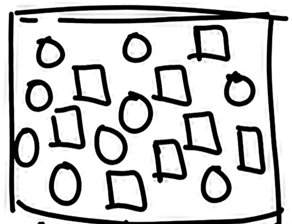
Atoms/Compounds/Molecules Can be **pure** (single type) or **combined** (multiple types)
(Phase = Part)

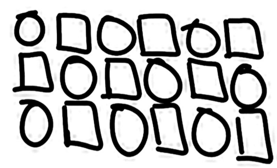
Pure Substance 1phase	Combined Substance 2+phase





One substance



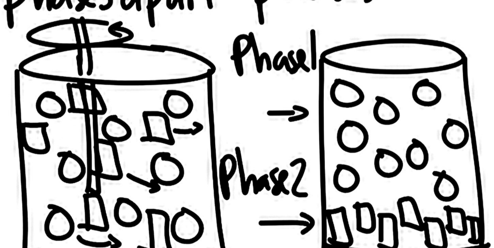


Liquid Two Substances Solid

Analyzing Pure and Combined Substances

Mixture : Mult. substances combined in 2+ phases

you can tell phases apart



Agitating (stir/shake) Stop Agitating

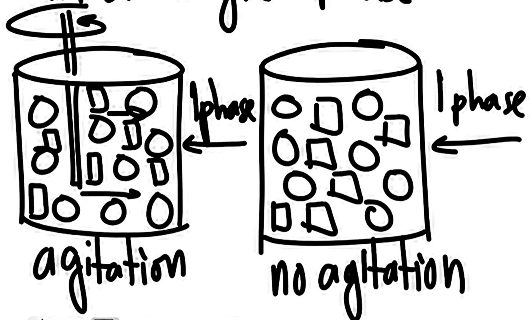
Hetero genous Mixture

Multiple phases where agitation combines, no agitation seperates

Insoluble : Does not stay combined w/o agitation (seperate)

Analyzing Pure and Combined Substances

Solution : Two or more substances "mix" together in a single "phase"



Homogenous Solution

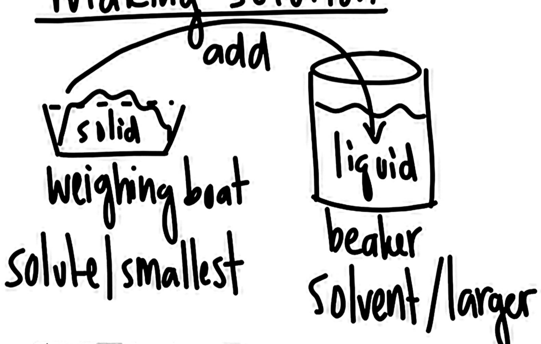
Single phase mixture where one particles dissolves with another.

Soluble : Two things mix together in a single phase

Forming Mixtures and solutions

Mixing Process

Making Solution



Solution

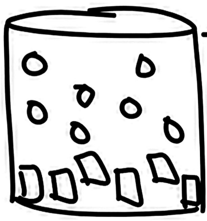
Solute : smaller part and add it to

Solvent : larger part

Solution : Solute dissolved in a solvent

Mixture and Solutions Compared

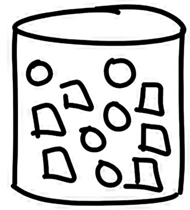
Heterogenous Mixtures



no direct interaction (no mixing)

Non-Polar molecules

Homogenous Solutions



strong or weak Molecule interaction (mix together)

polar molecules w/ polar or ionic

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Formation of a Hydrate

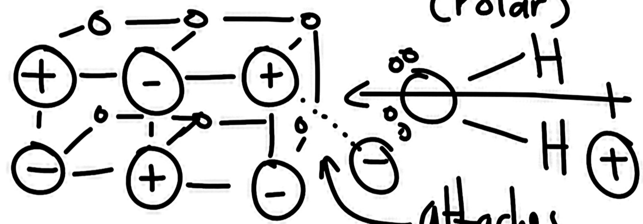
Hydrate

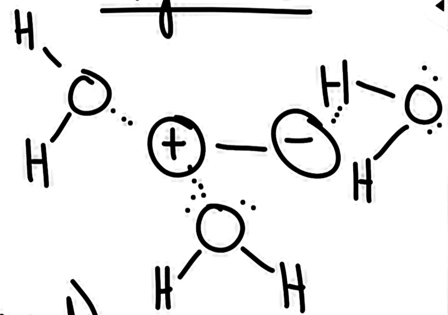
"Hydro" → Water

Ionic Compound

Water (Polar)

Hydrate





attaches water to the "salt" (ionic compound)

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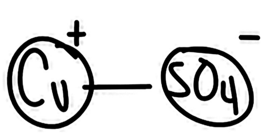
Anhydrous and Hydrated compounds

without water water

Anhydrous

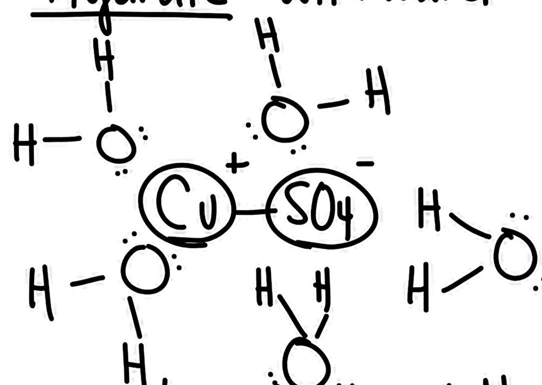
without water



Fine light green/white solid

Hydrate

with water



course/crystal bright blue

Anhydrous and Hydrated compounds

Molar/Atomic Ratio | Salt : Water (Ratio)

Anhydros Ratio

Salt : Water 1 : 0

No (0) Water

Hydrated Ratio

1 : 1	monohydrate (1)	1 : 4	tetra (4)
1 : 2	dihydrate (2)	1 : 5	penta (5)
1 : 3	trihydrate (3)	1 : 6	hexa (6)

Hydrate Examples

$CuSO_4 \cdot \underline{5}H_2O$

Ratio : 1 | 5

$CuSO_4$: Copper(II) Sulfate

$\underline{5}H_2O$: Penta hydrate

Copper(II) Sulfate Pentahydrate

Fe_2O_3 Iron(III) Oxide

$MnCl_2$ Manganese(II) Chloride

Na_2SO_4 Sodium Sulfate

$Zn_2S_2O_3$ Zinc(I) Thiosulfate

$Bi(NO_2)_3$ Bismuth(III) Nitrite

$Al_2(SO_3)_3$ Aluminum Sulfite