

Elements and Compounds

Chapter 14

Central Science

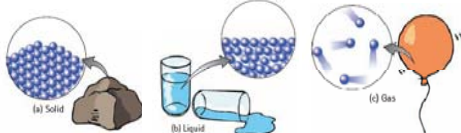
- Study of matter
- Transformations it can make
- Basic research—how things work
- Applied research—making useful things

Submicroscopic world

- Made of atoms
- Link to make molecules

Phases of Matter

- Three normal states at Earth's surface
 - Solid
 - Liquid
 - Gas
- How the molecules hold together



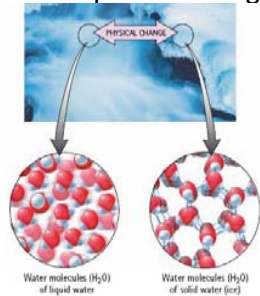
Properties

- What is it like?
- What phase?
- Color
- Reflectance
- Odor
- Density
- Texture ...

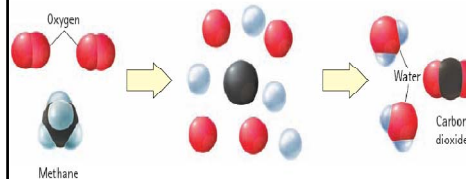
Properties

- Physical changes
 - Usually dependent on conditions
 - New substance NOT created
- Chemical changes
 - A reaction occurs
 - Transforms in to something different that has new properties

Water—phase change



Methane—chemical change



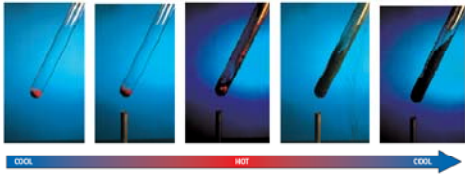
Guidelines to determine which has occurred

- Return to original conditions
 - Do you get the original substance back?
 - Warm it up
 - Cool it down
 - Goes from ice to water
 - Goes from water to ice
- Physical change



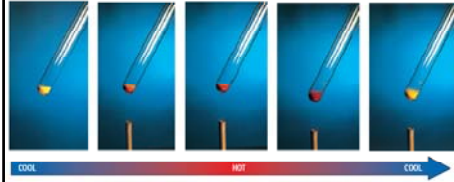
Guidelines to determine which

- Return to original conditions
 - Do you get the original substance back?
 - Warm it up
 - Cool it down
- Ammonium dichromate becomes ammonia, water vapor and chromium oxide



Guidelines to determine which

- Return to original conditions
 - Do you get the original substance back?
 - Warm it up
 - Cool it down
- Potassium Chromate returns to yellow powder



Imagine that you can watch a small collection of molecules that are moving around slowly while vibrating and bumping against each other.

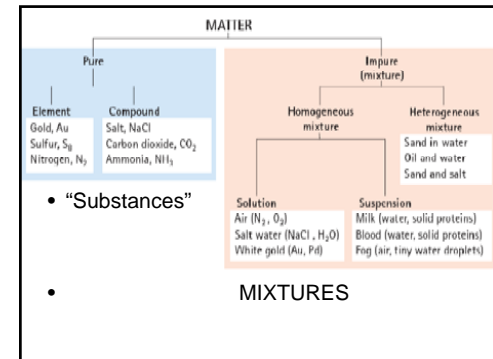
The slower moving molecules then start to line up, but as they do so, their vibrations increase. Soon all the molecules are aligned and vibrating about fixed positions. What is happening?

Elements

- Substances not bonded to other types of atoms
- May be single atoms in elemental formula
 - Au Gold
 - Li Lithium
- May have more than one atom to make molecules of that substance
 - O₂ oxygen
 - N₂ nitrogen
- Or be macromolecules: diamond crystals of C

Compounds

- More than one type of atom in the molecule
- Has a **Chemical Formula**
- Sodium Chloride NaCl
- Ammonia NH₃
- Subscript tells how many of each (Subscript 1 is omitted)



Properties of Compounds

- Very different from elements of their composition
- Sodium
 - Shiny soft metal,
 - melts at 97° C
 - Reacts violently with water
- Chlorine
 - Boils at -34° C
 - Toxic gas

Properties of Sodium

- Opaque, soft shiny metal
- Very malleable: can be cut with knife
- Tarnishes rapidly in air
- Melts at about 100°C
- Reacts violently with water, producing lye and hydrogen



<http://en.wikipedia.org/wiki/Sodium>

Properties of Chlorine

- Yellowish gas at room temperature
- Toxic to organisms at low concentrations
- Reacts readily with most other elements
- Characteristic odor



http://www.amazingrust.com/Experiments/show_tuCl2.html

Properties of Sodium Chloride

- Clear, brittle solid at room temperature
- Melts at 800° C
- Not toxic—table salt
- Not reactive with water



http://dharaniam.in.tradeindia.com/Exporters_Suppliers/Exporter19695_325973/Sodium-Chloride.html

Bonding of atoms makes molecules

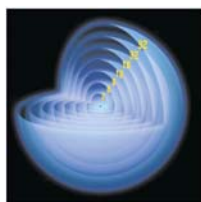
- The Formation of Ions and Ionic Bonds
- Types of bonds
 - Metallic Bonds
 - Covalent Bonds
 - Polar Covalent Bonds
- Molecular Polarity and Molecular Attractions

Causes of bonding

- Atoms bond together through their electrons
- Electrons behave as though they are contained within a series of seven concentric shells
- Outer shell electrons interact with electrons of other atoms
- These are the VALENCE electrons

Electron Shells

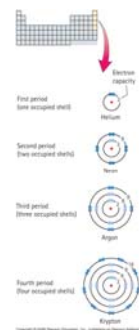
- Maximum number of electrons in each shell is shown
- Inner shell fills up before next shell begins to get electrons
- Full shells are most stable



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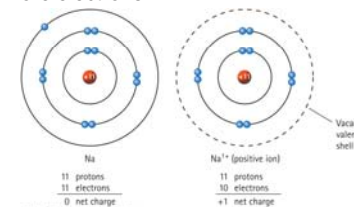
Full electron shells

- Outer electron shells of noble gases are full



Sodium Ion Formation

- Ion: An atom that has lost or gained one or more electrons

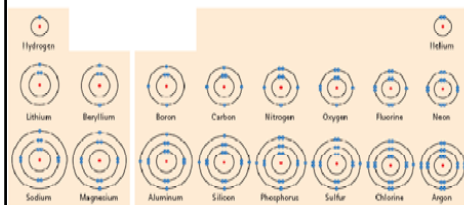


GROUPS

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
1	H													B	C	N	O	F	Ne
2	Li	Be												Al	Si	P	S	Cl	Ar
3	Na	Mg												Ga	Ge	As	Se	Br	Kr
4	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn		In	Sn	Pb	Bi	Po	At
5	Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd		Sb	Te	I	Xe		
6	Cs	Ba	La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg		Tl	Pb	Bi	Po	At	Rn
7	Fr	Ra	Ac	Rf	Db	Sg	Bh	Hs	Mt	Jun	Uun	Uub							
6th-period subset	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu					
7th-period subset	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr					

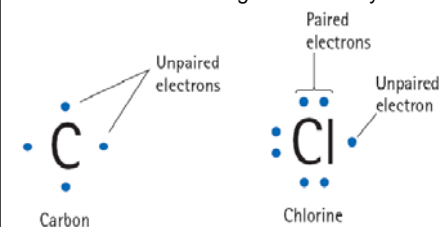
Electrons shells in periodic table

- First three periods



Electron Dot Structure

- A notation showing only the valence electrons surrounding the atomic symbol



Valence Electron dot structure for elements not in transition metal groups

1	2	13	14	15	16	17	18
H ·							He:
Li ·	·Be·	·B·	·C·	·N·	·O·	·F·	·Ne:
Na ·	·Mg·	·Al·	·Si·	·P·	·S·	·Cl·	·Ar:
K ·	·Ca·	·Ga·	·Ge·	·As·	·Se·	·Br·	·Kr:
Rb ·	·Sr·	·In·	·Sn·	·Sb·	·Te·	·I·	·Xe:
Cs ·	·Ba·	·Tl·	·Pb·	·Bi·	·Po·	·At·	·Rn:

Ion

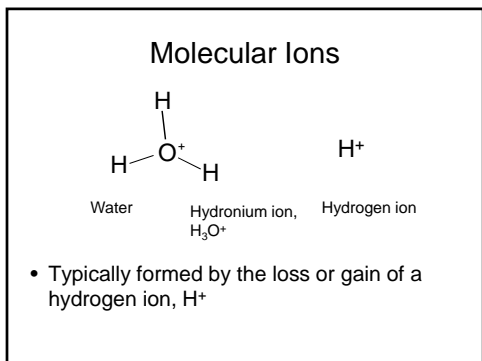
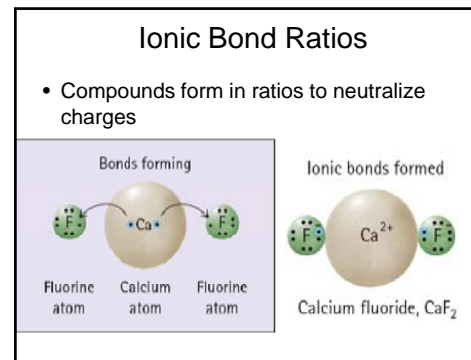
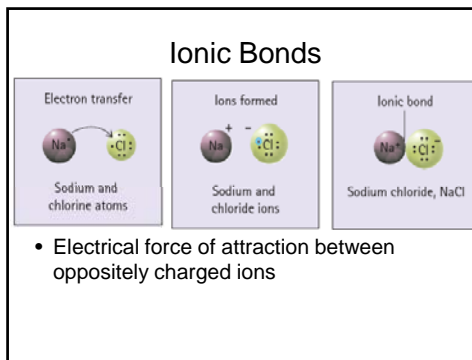
- An atom, molecule, or compound with a different number of protons and electrons
- More protons: positive CAT ION
– THE t looks like a plus sign...
- More electrons: negative AN ION
– Negative has an N in the prefix
- Both are all one word: anion, cation

Ion formation

- Lose electrons
– more protons than electrons
– positive charge
- Gain electrons
– More electrons than protons
– Negative charge
- More than one can be lost or gained
- Determine by position in periodic table

Electron dot structure pattern

1	2	13	14	15	16	17	18
H ·							He:
Li ·	·Be·	·B·	·C·	·N·	·O·	·F·	·Ne:
Na ·	·Mg·	·Al·	·Si·	·P·	·S·	·Cl·	·Ar:
K ·	·Ca·	·Ga·	·Ge·	·As·	·Se·	·Br·	·Kr:
Rb ·	·Sr·	·In·	·Sn·	·Sb·	·Te·	·I·	·Xe:
Cs ·	·Ba·	·Tl·	·Pb·	·Bi·	·Po·	·At·	·Rn:



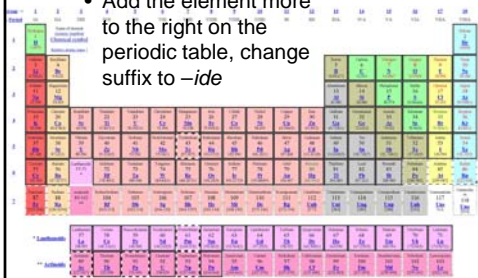
- ### Groups of atoms forming ions
- Molecular ions
 - Bonds within group are covalent
- | | |
|-----------------|-------------------------------|
| Hydronium ion | H ₃ O ⁺ |
| Ammonium ion | NH ₄ ⁺ |
| Bicarbonate ion | HCO ₃ ⁻ |
| Nitrate ion | NO ₃ ⁻ |
| Hydroxide ion | OH ⁻ |
| Carbonate ion | CO ₃ ²⁻ |
| Sulfate ion | SO ₄ ²⁻ |
| Phosphate ion | PO ₄ ³⁻ |

Naming compounds first word

- Start with element more to the left side of periodic table

Naming compounds second word

- Add the element more to the right on the periodic table, change suffix to *-ide*

A periodic table with element Chlorine (Cl) highlighted in green. The table is color-coded by groups: alkali metals (red), alkaline earth metals (orange), transition metals (purple), metalloids (yellow), nonmetals (green), and noble gases (blue). Lanthanides and actinides are shown at the bottom.

Naming compounds NaCl

- Sodium Chloride

A periodic table with elements Sodium (Na) and Chlorine (Cl) highlighted in green. The table is color-coded by groups: alkali metals (red), alkaline earth metals (orange), transition metals (purple), metalloids (yellow), nonmetals (green), and noble gases (blue). Lanthanides and actinides are shown at the bottom.

Naming compounds Li₂O

- Lithium Oxide

A periodic table with elements Lithium (Li) and Oxygen (O) highlighted in green. The table is color-coded by groups: alkali metals (red), alkaline earth metals (orange), transition metals (purple), metalloids (yellow), nonmetals (green), and noble gases (blue). Lanthanides and actinides are shown at the bottom.

Naming compounds CaF₂

- Calcium Fluoride

A periodic table with elements Calcium (Ca) and Fluorine (F) highlighted in green. The table is color-coded by groups: alkali metals (red), alkaline earth metals (orange), transition metals (purple), metalloids (yellow), nonmetals (green), and noble gases (blue). Lanthanides and actinides are shown at the bottom.

Naming different compounds of same elements

- When more than one compound is formed from differing ratios of the same atoms, a prefix is added to distinguish them
 - Carbon Dioxide
 - Carbon Monoxide

Naming Common Compounds

Some have traditional names

- Water
- Ammonia
- Methane
- Propane
- etc.