

# Chemistry

## Chapter 14

# Central Science

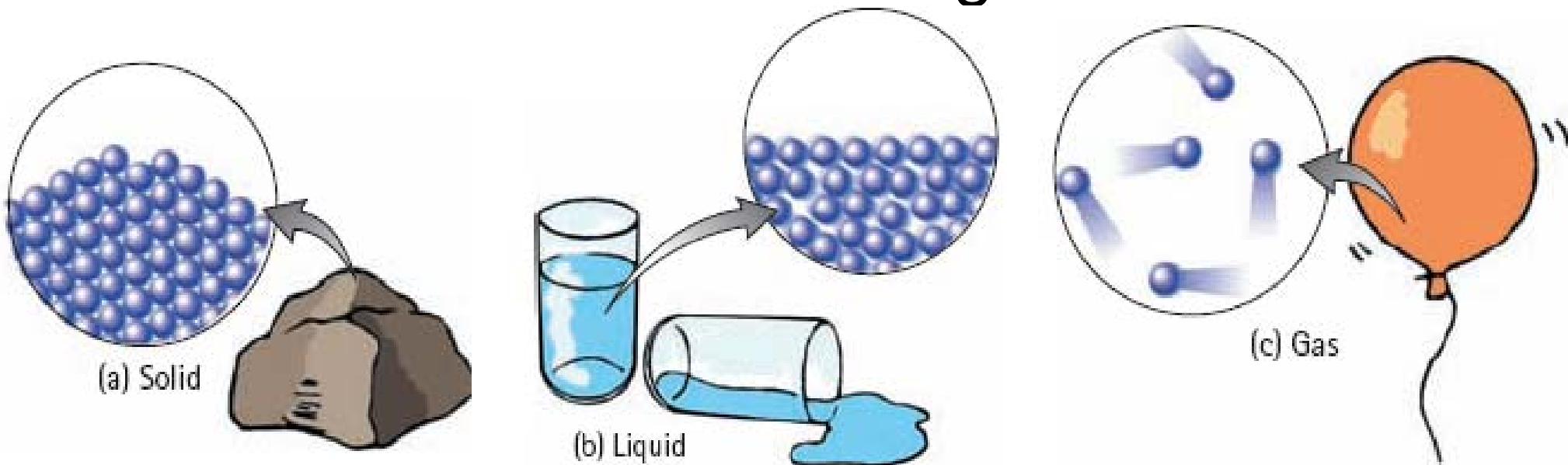
- Study of matter
- Transformations it can make
- Basic research—how things work
- Applied research—making useful things

# 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



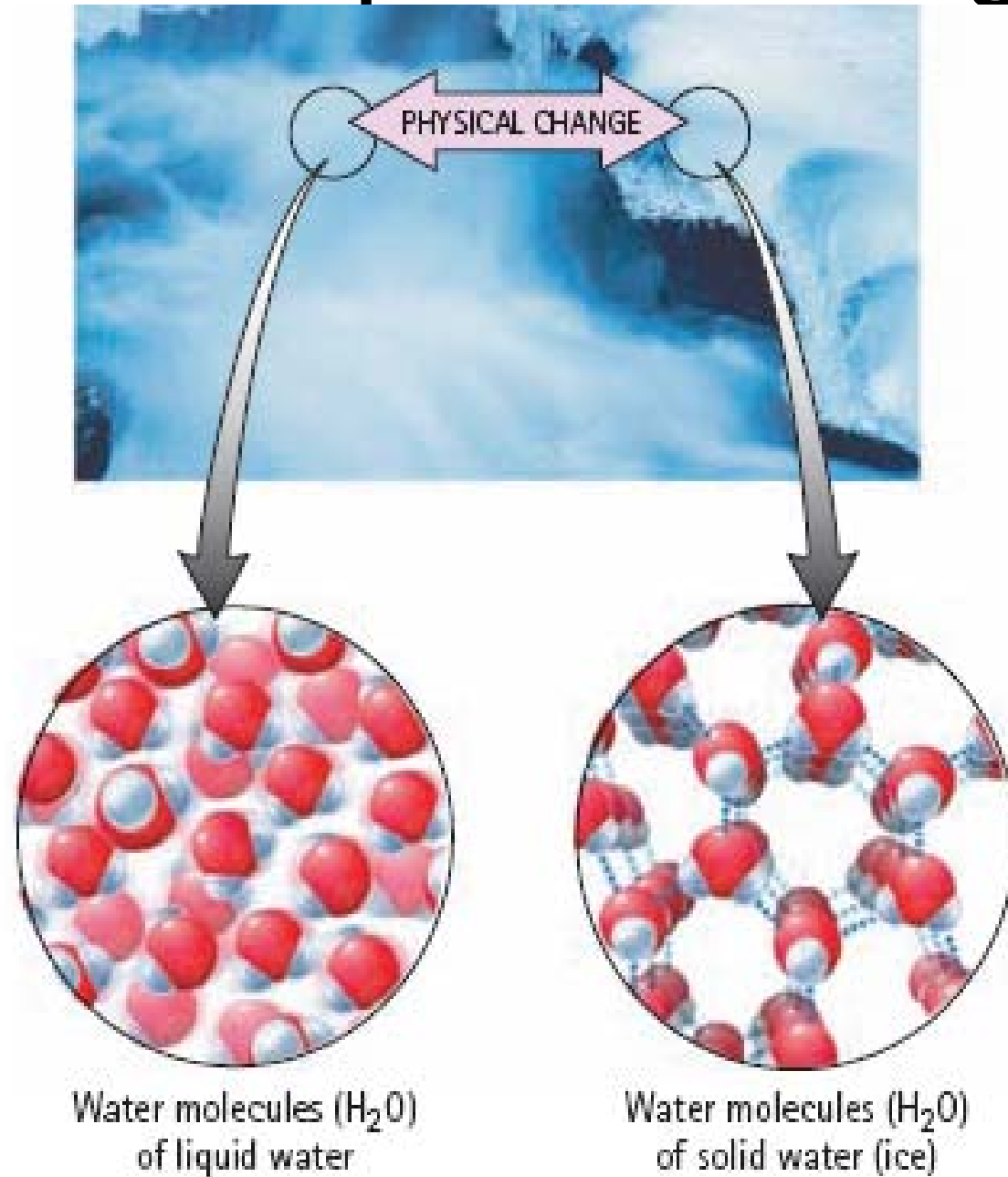
# Properties

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

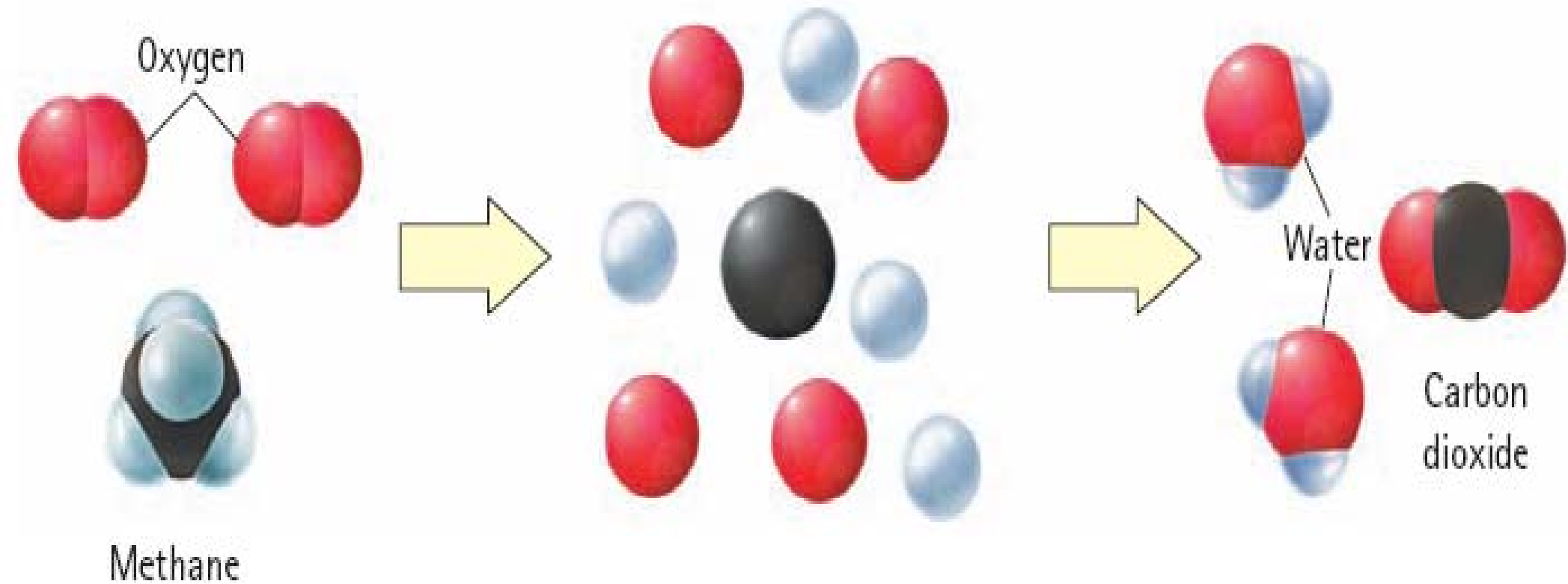
# Properties

- 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





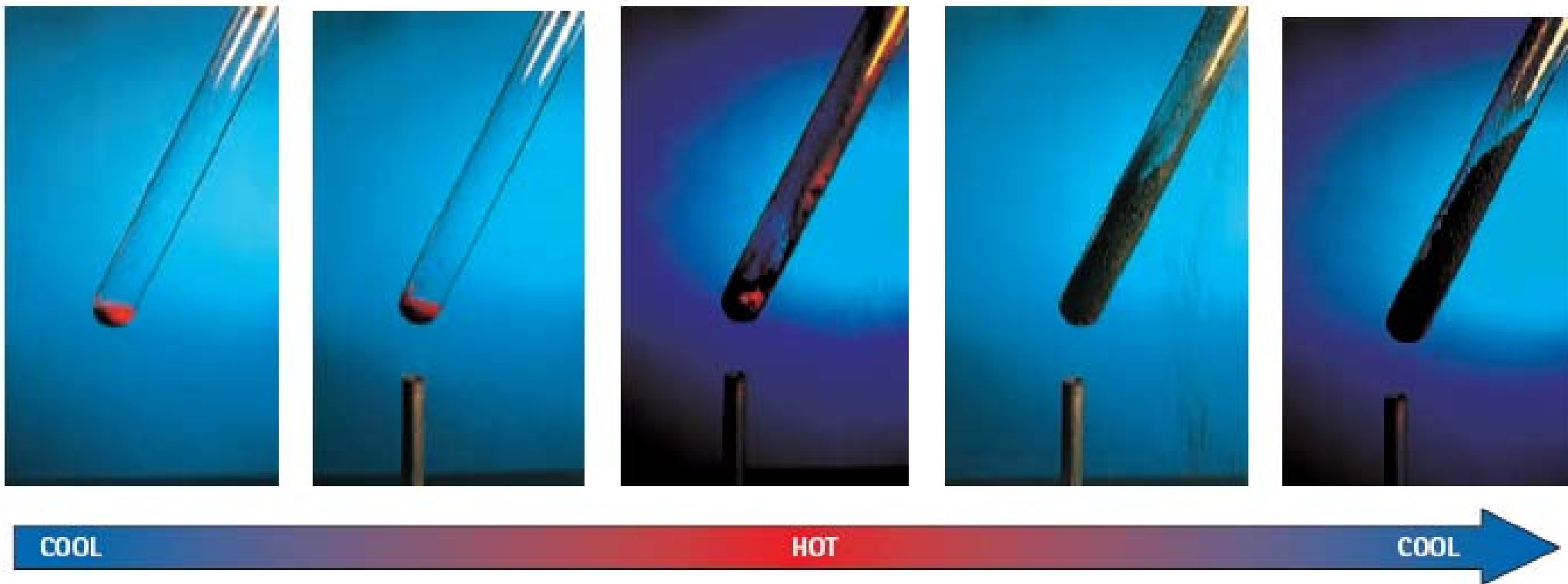
# Guidelines to determine which has occurred

- 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



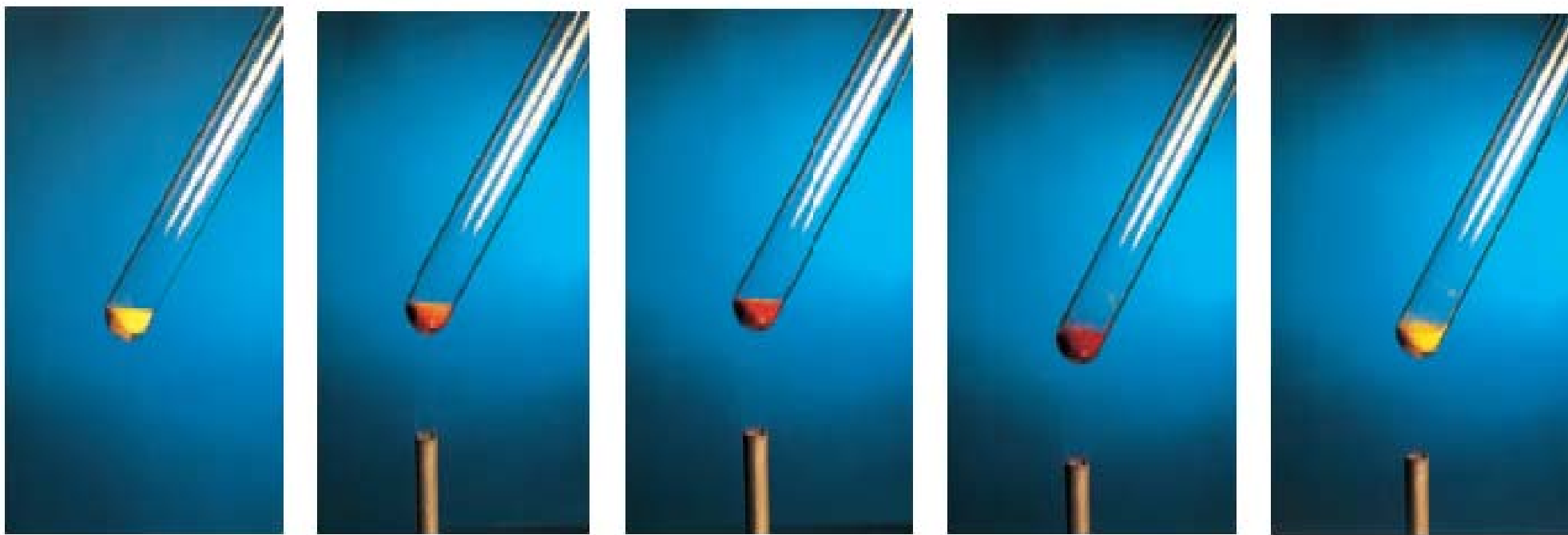
# Guidelines to determine which

- 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



COOL

HOT

COOL

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
  - O<sub>2</sub> oxygen
  - N<sub>2</sub> nitrogen
- Or be macromolecules: diamond crystals of C

# Compounds

- More than one type of atom in the molecule
- Has a **Chemical Formula**
- Sodium Chloride     $\text{NaCl}$
- Ammonia                 $\text{NH}_3$
- Subscript tells how many of each
- (Subscript 1 is omitted)

# MATTER

Pure

Element

Gold, Au

Sulfur, S<sub>8</sub>

Nitrogen, N<sub>2</sub>

Compound

Salt, NaCl

Carbon dioxide, CO<sub>2</sub>

Ammonia, NH<sub>3</sub>

Impure  
(mixture)

Homogeneous  
mixture

Solution

Air (N<sub>2</sub>, O<sub>2</sub>)

Salt water (NaCl, H<sub>2</sub>O)

White gold (Au, Pd)

Heterogeneous  
mixture

Sand in water

Oil and water

Sand and salt

Suspension

Milk (water, solid proteins)

Blood (water, solid proteins)

Fog (air, tiny water droplets)

- “Substances”

## MIXTURES

# Properties of Compounds

- Very different from elements of their composition
- Sodium
  - Shiny soft metal,
  - melts at  $97^{\circ}\text{C}$
  - Reacts violently with water
- Chlorine
  - Boils at  $-34^{\circ}\text{C}$
  - Toxic gas



# Properties of Sodium

- Opaque, soft shiny metal
- Very malleable: can be cut with knife
- Tarnishes rapidly in air
- Melts at about  $100^{\circ}\text{C}$
- Reacts violently with water, producing lye and hydrogen



# Properties of Chlorine

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



# Properties of Sodium Chloride

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



# Naming compounds first word

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

Legend:

- Metals
- Transition metals
- Nonmetals
- Noble gases
- Lanthanide series
- Actinide series

Callouts for Helium (He):

- Atomic number: 2
- Symbol of element: He
- Atomic weight: 4.003
- Name of element: Helium

1	1 <b>H</b> 1.0080 Hydrogen																	VIII A	2 <b>He</b> 4.003 Helium												
2	IA	3 <b>Li</b> 6.939 Lithium	II A	4 <b>Be</b> 9.012 Beryllium																	III A	5 <b>B</b> 10.81 Boron	IV A	6 <b>C</b> 12.011 Carbon	V A	7 <b>N</b> 14.007 Nitrogen	VIA	8 <b>O</b> 15.9994 Oxygen	VII A	9 <b>F</b> 18.998 Fluorine	10 <b>Ne</b> 20.183 Neon
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# Naming compounds second word

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

Legend:

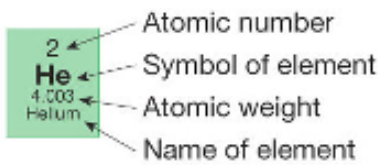
- Metals (Red)
- Transition metals (Orange)
- Nonmetals (Yellow)
- Noble gases (Green)
- Lanthanide series (Light Blue)
- Actinide series (Purple)

1	IA																IIA										III A										IVA										VA										VIA										VIIA										VIII A																																																																																																																																																																																																																			
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# Naming compounds NaCl

- Sodium Chloride

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- Metals
- Transition metals
- Nonmetals
- Noble gases
- Lanthanide series
- Actinide series

# Naming compounds $\text{Li}_2\text{O}$

- Lithium Oxide

1	<div style="display: flex; align-items: center;"> <div style="border: 1px solid black; padding: 5px; margin-right: 10px;"> <p>2 <b>He</b> 4.003 Helium</p> </div> <div> <p>Atomic number</p> <p>Symbol of element</p> <p>Atomic weight</p> <p>Name of element</p> </div> </div>																VIII A		
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6	55 <b>Cs</b> 132.91 Cesium	56 <b>Ba</b> 137.34 Barium	57 <b>TO</b> 71	72 <b>Hf</b> 178.49 Hafnium	73 <b>Ta</b> 180.95 Tantalum	74 <b>W</b> 183.85 Tungsten	75 <b>Re</b> 186.2 Rhenium	76 <b>Os</b> 190.2 Osmium	77 <b>Ir</b> 192.2 Iridium	78 <b>Pt</b> 195.09 Platinum	79 <b>Au</b> 197.0 Gold	80 <b>Hg</b> 200.59 Mercury	81 <b>Tl</b> 204.37 Thallium	82 <b>Pb</b> 207.19 Lead	83 <b>Bi</b> 208.98 Bismuth	84 <b>Po</b> (210) Polonium	85 <b>At</b> (210) Astatine	86 <b>Rn</b> (222) Radon	
7	87 <b>Fr</b> (223) Francium	88 <b>Ra</b> 226.05 Radium	89 <b>TO</b> 103	57 <b>La</b> 138.91 Lanthanum	58 <b>Ce</b> 140.12 Cerium	59 <b>Pr</b> 140.91 Praseodymium	60 <b>Nd</b> 144.24 Neodymium	61 <b>Pm</b> (147) Promethium	62 <b>Sm</b> 150.35 Samarium	63 <b>Eu</b> 151.96 Europium	64 <b>Gd</b> 157.25 Gadolinium	65 <b>Tb</b> 158.92 Terbium	66 <b>Dy</b> 162.50 Dysprosium	67 <b>Ho</b> 164.93 Holmium	68 <b>Er</b> 167.26 Erbium	69 <b>Tm</b> 168.93 Thulium	70 <b>Yb</b> 173.04 Ytterbium	71 <b>Lu</b> 174.97 Lutetium	
				89 <b>Ac</b> (227) Actinium	90 <b>Th</b> 232.04 Thorium	91 <b>Pa</b> (231) Protactinium	92 <b>U</b> 238.03 Uranium	93 <b>Np</b> (237) Neptunium	94 <b>Pu</b> (242) Plutonium	95 <b>Am</b> (243) Americium	96 <b>Cm</b> (247) Curium	97 <b>Bk</b> (248) Berkelium	98 <b>Cf</b> (251) Californium	99 <b>Es</b> (254) Einsteinium	100 <b>Fm</b> (253) Fermium	101 <b>Md</b> (258) Mendelevium	102 <b>No</b> (254) Nobelium	103 <b>Lw</b> (257) Lawrencium	

# Naming compounds $\text{CaF}_2$

- Calcium Fluoride

Legend:

- Metals
- Transition metals
- Nonmetals
- Noble gases
- Lanthanide series
- Actinide series

Callout for Helium (He):

- Atomic number: 2
- Symbol of element: He
- Atomic weight: 4.003
- Name of element: Helium

1																	VIII A	
1	1 H 1.0080 Hydrogen																	2 He 4.003 Helium
	IA	II A											III A	IV A	V A	VIA	VII A	VIII A
2	3 Li 6.939 Lithium	4 Be 9.012 Beryllium											5 B 10.81 Boron	6 C 12.011 Carbon	7 N 14.007 Nitrogen	8 O 15.9994 Oxygen	9 F 18.998 Fluorine	10 Ne 20.183 Neon
3	11 Na 22.990 Sodium	12 Mg 24.31 Magnesium	III B	IV B	V B	VI B	VI B	VIII B			B	II B	13 Al 26.98 Aluminum	14 Si 28.09 Silicon	15 P 30.974 Phosphorus	16 S 32.064 Sulfur	17 Cl 35.453 Chlorine	18 Ar 39.948 Argon
4	19 K 39.102 Potassium	20 Ca 40.08 Calcium	21 Sc 44.96 Scandium	22 Ti 47.88 Titanium	23 V 50.94 Vanadium	24 Cr 52.00 Chromium	25 Mn 54.94 Manganese	26 Fe 55.85 Iron	27 Co 58.93 Cobalt	28 Ni 58.71 Nickel	29 Cu 63.54 Copper	30 Zn 65.37 Zinc	31 Ga 69.72 Gallium	32 Ge 72.59 Germanium	33 As 74.92 Arsenic	34 Se 78.96 Selenium	35 Br 79.909 Bromine	36 Kr 83.80 Krypton
5	37 Rb 85.47 Rubidium	38 Sr 87.62 Strontium	39 Y 88.91 Yttrium	40 Zr 91.22 Zirconium	41 Nb 92.91 Niobium	42 Mo 95.94 Molybdenum	43 Tc (98) Technetium	44 Ru 101.1 Ruthenium	45 Rh 102.90 Rhodium	46 Pd 106.4 Palladium	47 Ag 107.87 Silver	48 Cd 112.40 Cadmium	49 In 114.82 Indium	50 Sn 118.69 Tin	51 Sb 121.75 Antimony	52 Te 127.60 Tellurium	53 I 126.90 Iodine	54 Xe 131.30 Xenon
6	55 Cs 132.91 Cesium	56 Ba 137.34 Barium	57 TO 71	72 Hf 178.49 Hafnium	73 Ta 180.95 Tantalum	74 W 183.85 Tungsten	75 Re 186.2 Rhenium	76 Os 190.2 Osmium	77 Ir 192.2 Iridium	78 Pt 195.09 Platinum	79 Au 197.0 Gold	80 Hg 200.59 Mercury	81 Tl 204.37 Thallium	82 Pb 207.19 Lead	83 Bi 208.98 Bismuth	84 Po (210) Polonium	85 At (210) Astatine	86 Rn (222) Radon
7	87 Fr (223) Francium	88 Ra 226.05 Radium	89 TO 103	57 La 138.91 Lanthanum	58 Ce 140.12 Cerium	59 Pr 140.91 Praseodymium	60 Nd 144.24 Neodymium	61 Pm (147) Promethium	62 Sm 150.35 Samarium	63 Eu 151.96 Europium	64 Gd 157.25 Gadolinium	65 Tb 158.92 Terbium	66 Dy 162.50 Dysprosium	67 Ho 164.93 Holmium	68 Er 167.26 Erbium	69 Tm 168.93 Thulium	70 Yb 173.04 Ytterbium	71 Lu 174.97 Lutetium
				89 Ac (227) Actinium	90 Th 232.04 Thorium	91 Pa (231) Protactinium	92 U 238.03 Uranium	93 Np (237) Neptunium	94 Pu (242) Plutonium	95 Am (243) Americium	96 Cm (247) Curium	97 Bk (248) Berkelium	98 Cf (251) Californium	99 Es (254) Einsteinium	100 Fm (253) Fermium	101 Md (258) Mendelevium	102 No (254) Nobelium	103 Lw (257) Lawrencium



# 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.

