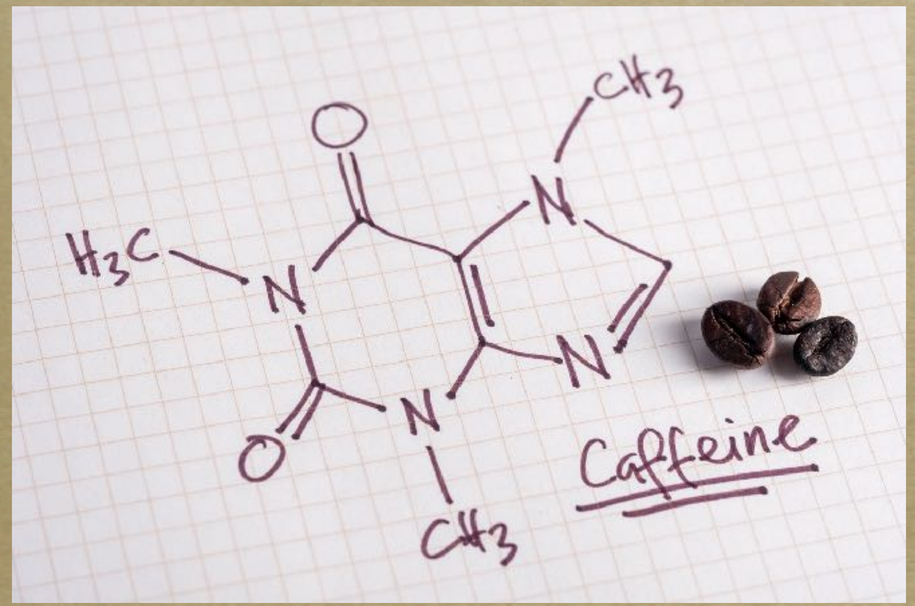
States & Properties of Matter

Unit 1 - Topics 4 & 5

Pure Substances

Topic 4 - Elements and Compounds

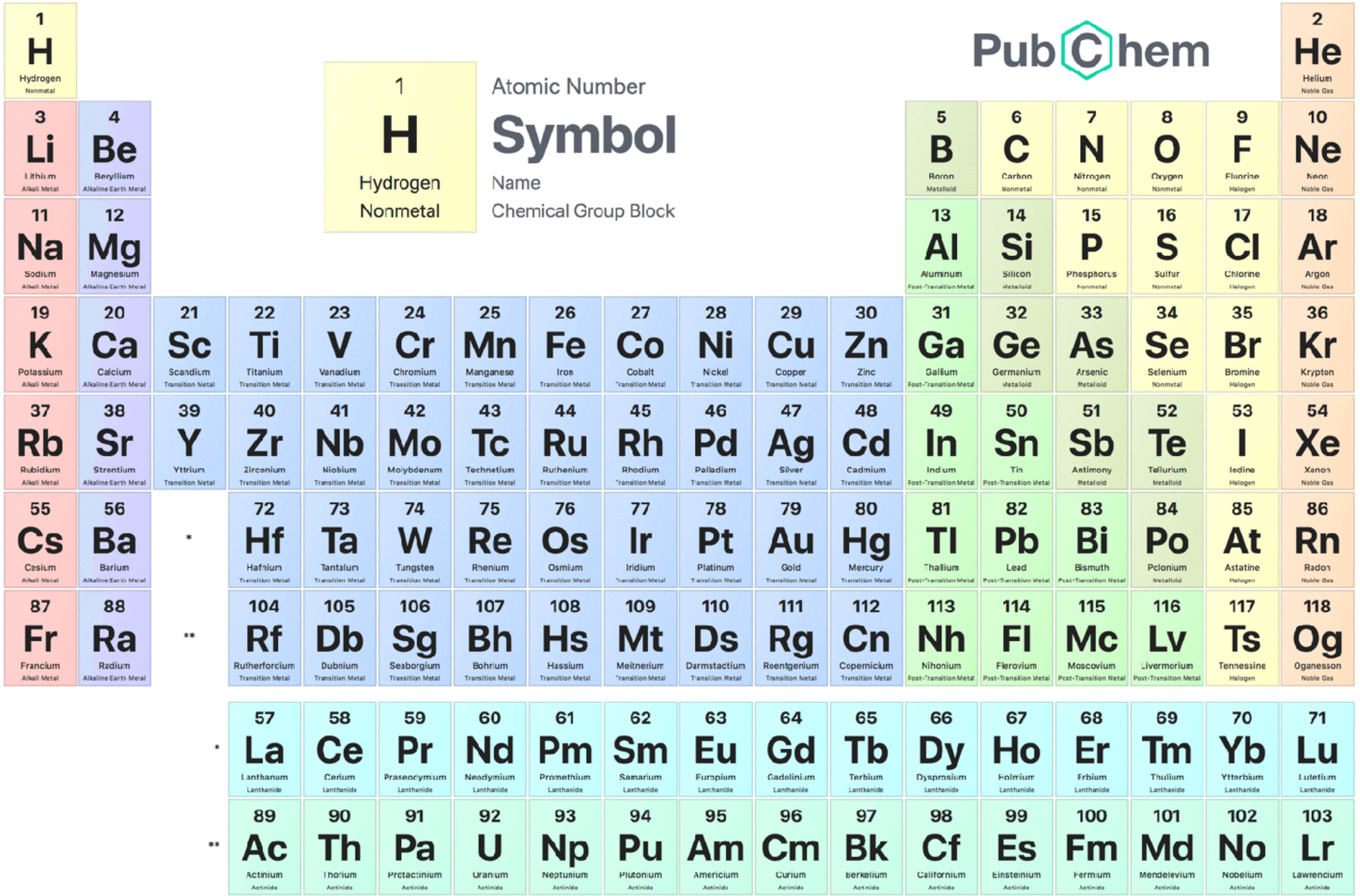


Elements

- Pure substances that only contain one kind of **atom** and cannot be separated into a simpler substance.
- *Examples*: Sodium (Na) and Copper (Cu)

- Have their own unique properties
- Represented by a distinct <u>symbol</u>
- *92 naturally occurring elements (rest are man made)*

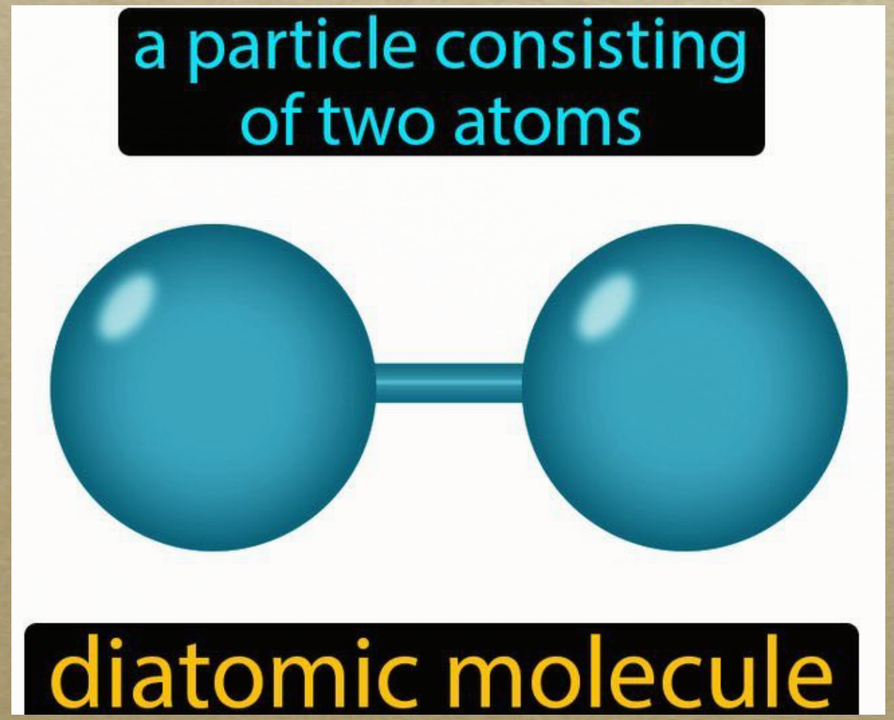
PERIODIC TABLE OF ELEMENTS

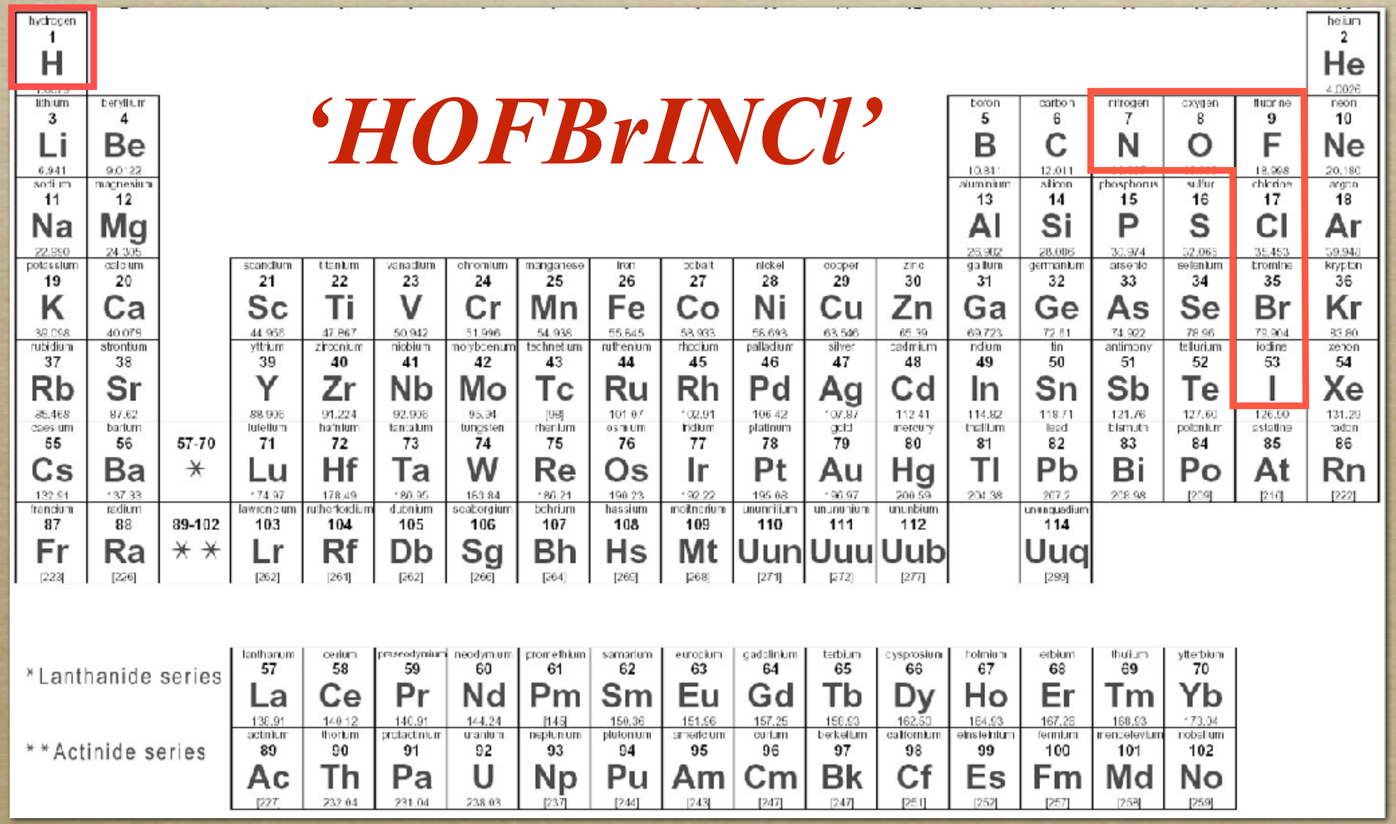


Diatomic Elements

'The Diatomic 7'

- There are seven elements that exist as chemically bonded **pairs** of two atoms.
- H_2, N_2, O_2, F_2, Cl_2, Br_2, I_2

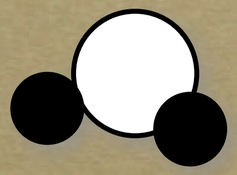




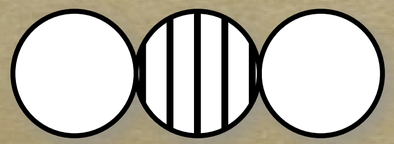
Compounds

- Pure substances that aren't elements are **compounds**.
  - composed of more than one kind of atom
- The elements in the compounds can only be separated by a <u>chemical change</u>!
- Fixed ratio (for example → 1:2, 1:1)

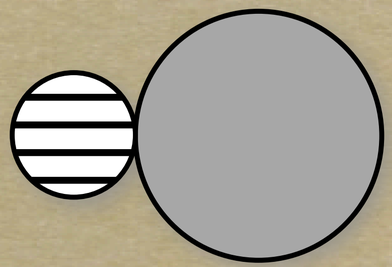
H_2O



CO_2



$NaCl$



Understanding Chemical Formulas

Subscripts

- little numbers following an element symbol
- how many atoms of that element are present

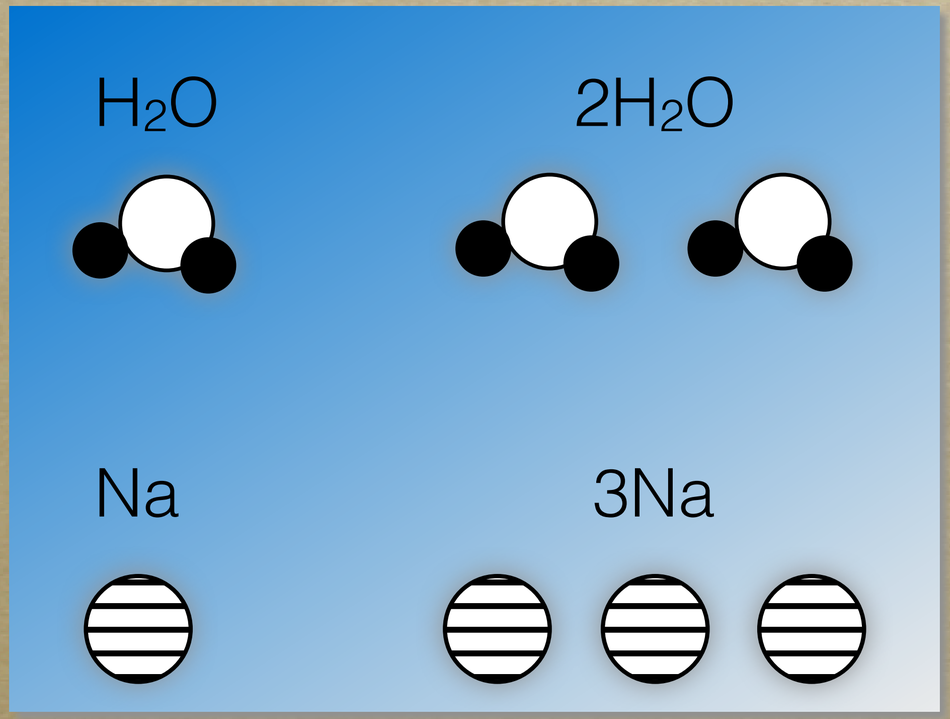
H_2O	2 Hydrogens, 1 Oxygen
CO_2	1 Carbon, 2 Oxygens
NaCl	1 Sodium, 1 Chlorine

No subscript = 1

Understanding Chemical Formulas

Coefficients

- number in front of a formula
- how many atoms or molecules you have



No coefficient = 1

Practice with Formulas

Na_2S: How many atoms of Na are there? 2

CO: C = 1 O = 1

CO_2: C = 1 O = 2

Br_2: Br = 2

H_2SO_4: H = 2 S = 1 O = 4

How many molecules of KCl in 4KCl? 4

How many molecules of Na_2S in $3Na_2S$? 3

Na + S is a mixture. Likewise, Na_2S ⊕ KCl is a mixture. WHY?

Regents Practice

Which of these contains only one substance?

(1) distilled water
(2) sugar water
(3) saltwater
(4) rainwater

Which terms are used to identify pure substances?

(1) an element and a mixture
(2) an element and a compound
(3) a solution and a mixture
(4) a solution and a compound

Regents Practice

Which substance represents a compound?

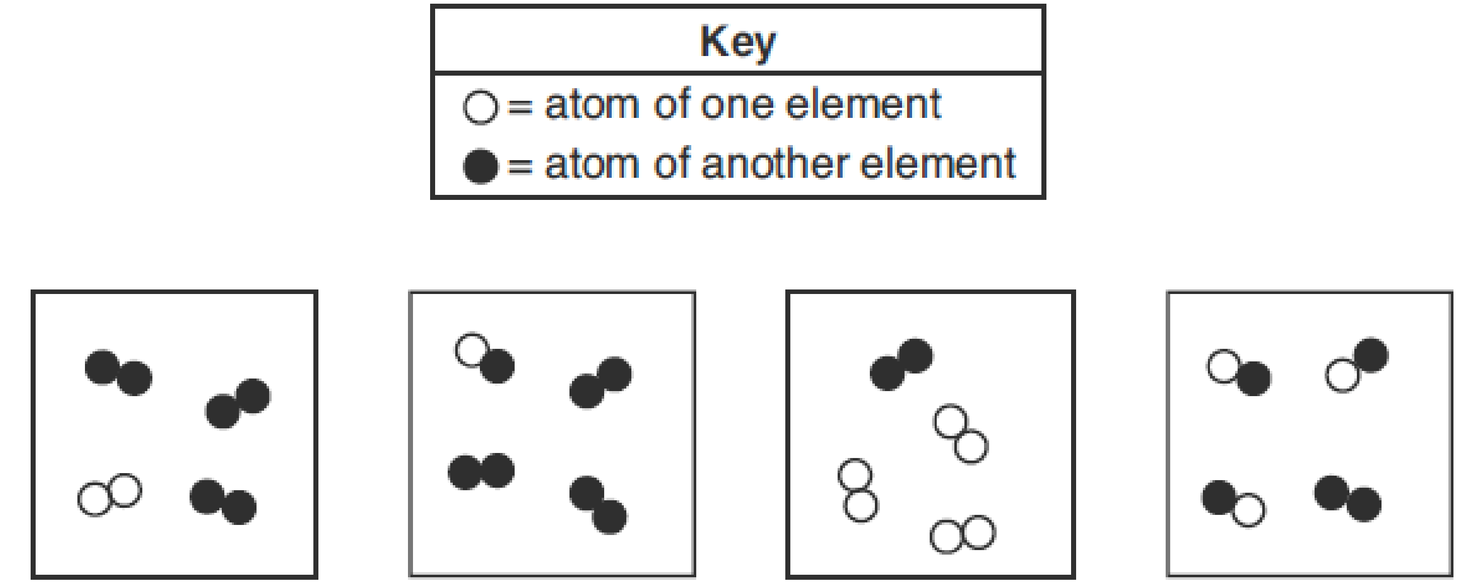
(1) C(s)
(2) Co(s)
(3) CO(g)
(4) $O_2(g)$

What is the total number of different elements present in NH_4NO_3?

(1) 7
(2) 9
(3) 3
(4) 4

Regents Practice

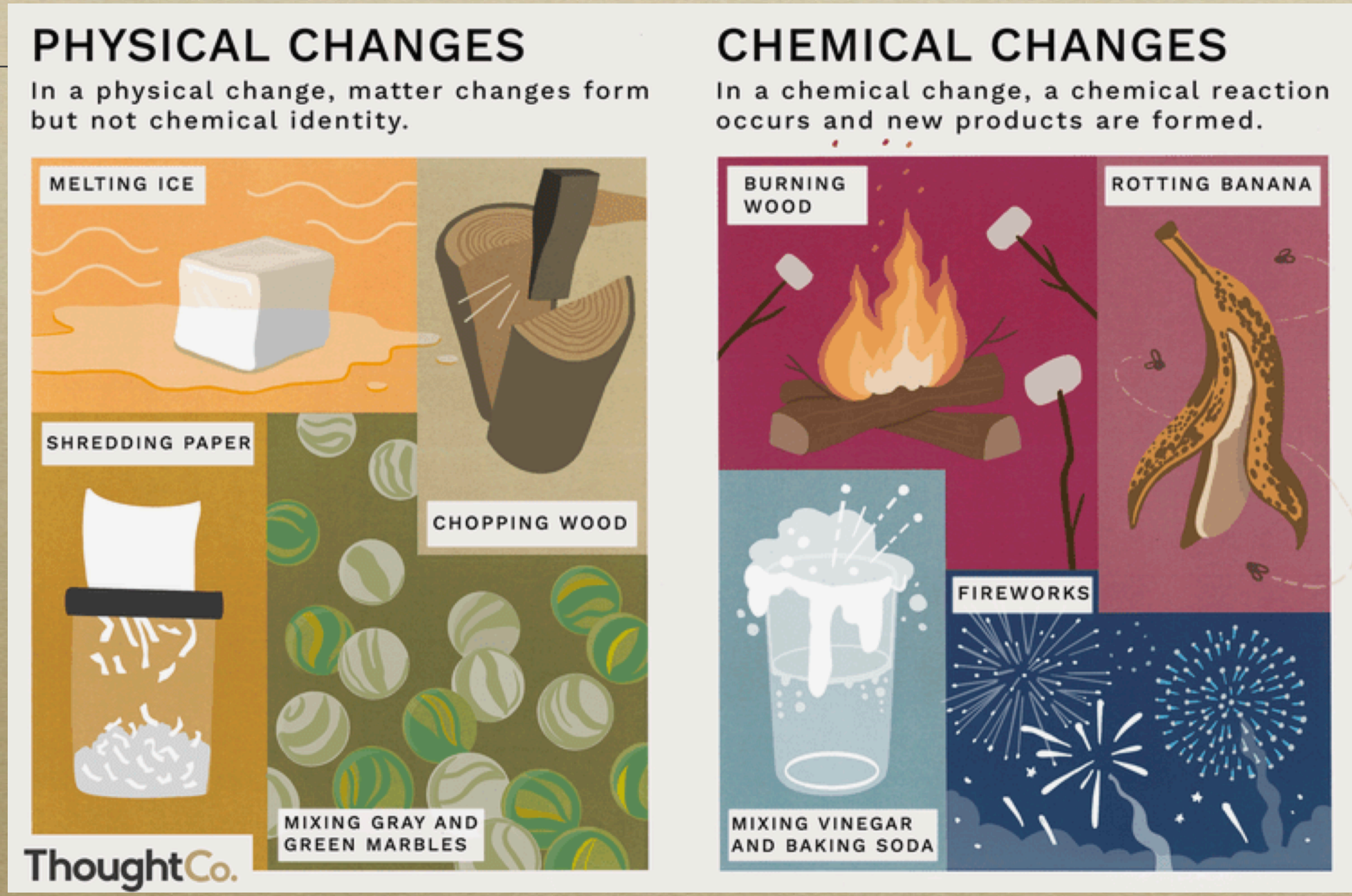
Which two particle diagrams represent mixtures of diatomic elements?



(1) *A* and *B*
(2) *A* and *C*
(3) *B* and *C*
(4) *B* and *D*

Changes

Topic 5

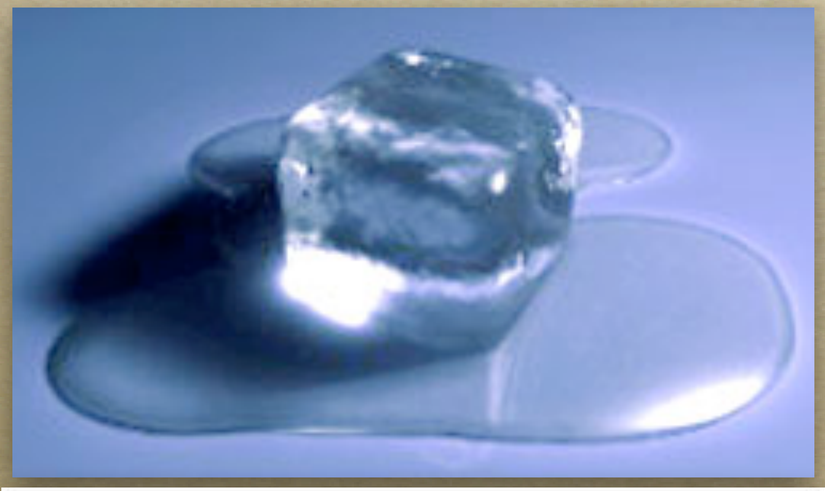


Changes in Matter

Physical	Chemical
- Change from one form to another **without** the **change in its chemical identity**. - Still the **same substance** - Effect on physical properties (i.e. density) - Generally easy to reverse.	- Change that is accompanied with the **change in its chemical identity** - Forms **new substance** - Effect on physical and chemical properties - **Not easy to reverse** without additional chemical reactions

Physical vs. Chemical Changes ***Practice***

- Explain whether the two pictures below are examples of chemical or physical changes.



Physical change - in this case, it's still water. You just changed from solid water (ice) to liquid water.

Physical change - in this case, the sugar is still there and we can recover it if we evaporated all of the water.

Energy & Change

Energy

- The ability to do work.

- Energy changes with BOTH chemical and physical changes.

Heat

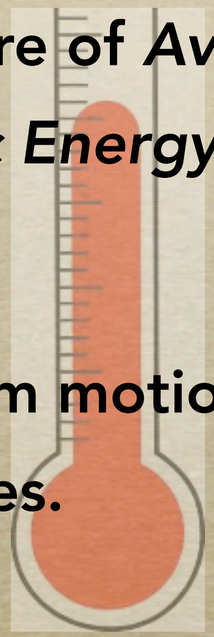
- Energy transferred between objects of different temperature.

- Heat flows from warm to cold.

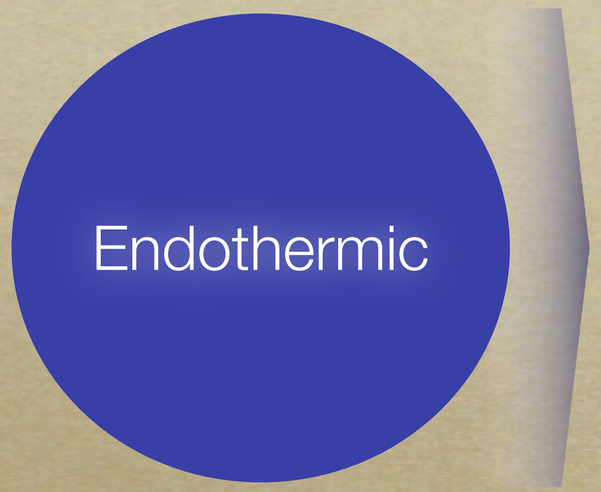
Temperature

- Measure of *Average Kinetic Energy*.

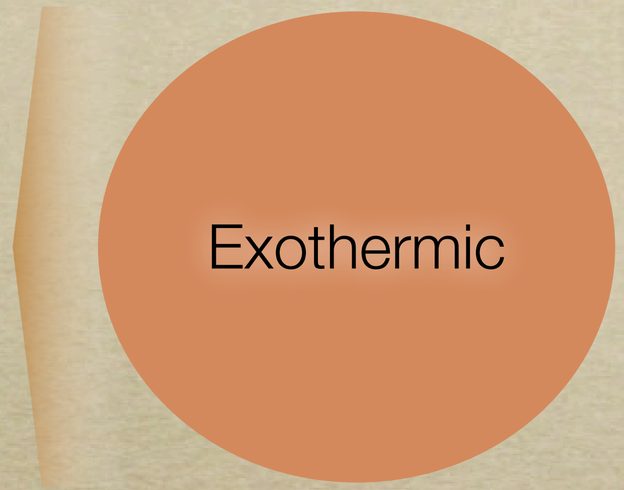
- Random motion of particles.



Energy Changes



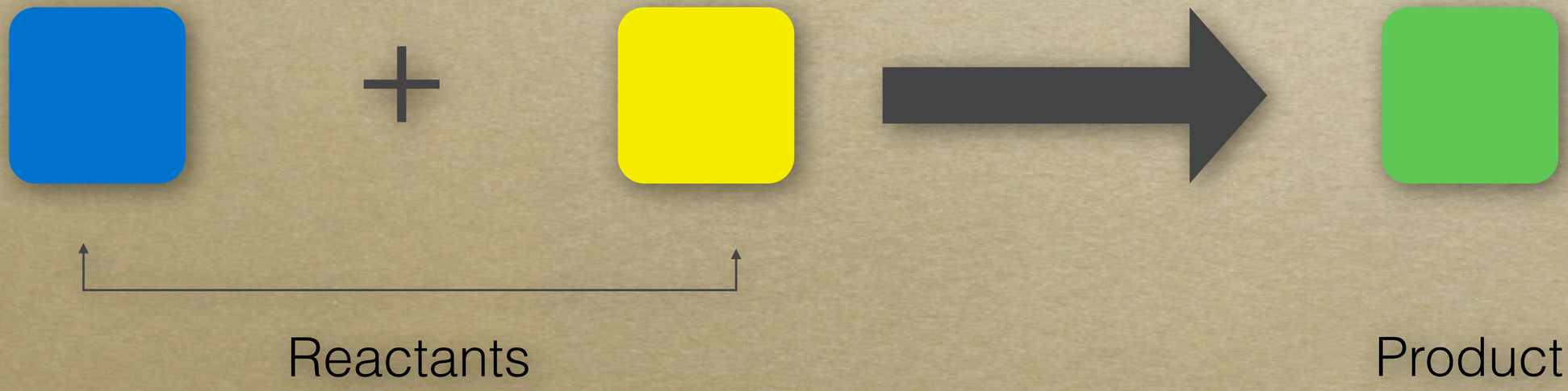
- Requires heat.
- Ex. Melting ice.



- Produces heat.
- Ex. Burning a log.

Chemical Equations

- In Math, you use an equal sign (=) in an equation.
- In Chemistry, we use an arrow (→) in an equation.
- An **equation** describes a chemical change.



Law of Conservation of Energy

- **Energy cannot be created or destroyed. *Total energy is constant!***
- **Input = output**

$2Na + Cl_2 \rightarrow 2NaCl + heat$

Physical or Chemical change? **Chemical**

Exothermic or Endothermic? **Exothermic**

Is the equation balanced (*shows conservation of mass*)? **Yes**

Another Example

$H_2O(s)$ + heat → $H_2O(g)$

Physical or Chemical change? **Physical**

Exothermic or Endothermic? **Endothermic**

Is the equation balanced (*shows conservation of mass*)? **Yes**

Regents Practice

Which substance can *not* be decomposed by a chemical change?

(1) Ne
(2) N_2O
(3) HF
(4) H_2O

Which process represents a chemical change?

(1) melting of ice
(2) corrosion of copper
(3) evaporation of water
(4) crystallization of sugar

Which process is a chemical change?

(1) melting of ice
(2) boiling of water
(3) subliming of ice
(4) decomposing of water

Regents Practice

Which set of procedures and observations indicates a chemical change?

(1) Ethanol is added to an empty beaker and the ethanol eventually disappears.
(2) A solid is gently heated in a crucible and the solid slowly turns to liquid.
(3) Large crystals are crushed with a mortar and pestle and become powder.
(4) A cool, shiny metal is added to water in a beaker and rapid bubbling occurs.

Which two substances can *not* be broken down by chemical change?

(1) C and CuO
(2) C and Cu
(3) CO_2 and CuO
(4) CO_2 and Cu

Regents Practice

Key
○ = an atom of an element
● = an atom of a different element

Which statement describes the type of change and the chemical properties of the product and reactants?

(1) The equation represents a physical change, with the product and reactants having different chemical properties.

(2) The equation represents a physical change, with the product and reactants having identical chemical properties.

(3) The equation represents a chemical change, with the product and reactants having different chemical properties.

(4) The equation represents a chemical change, with the product and reactants having identical chemical properties.

Regents Practice

Which substance can be broken down by chemical means?

(1) CO
(2) Ce
(3) Ca
(4) Cu

Which equation represents a physical change?

(1) $H_2O(s) + 6.01\ kJ \rightarrow H_2O(\ell)$
(2) $2H_2(g) + O_2(g) \rightarrow 2H_2O(g) + 483.6\ kJ$
(3) $H_2(g) + I_2(g) + 53.0\ kJ \rightarrow 2HI(g)$
(4) $N_2(g) + 2O_2(g) + 66.4\ kJ \rightarrow 2NO_2(g)$

Do or do not. There is no try.

- The Empire Strikes Back / Yoda

Unit Essentials

Topic 2: States & Properties of Matter

ESSENTIALS: Know, Understand, and Be Able To…

- ❑ Matter is classified as a substance or a mixture of substances.
- ❑ Substances can be differentiated by physical properties.
- ❑ Physical properties of substances, such as density, conductivity, malleability, solubility, and hardness, differ among substances.
- ❑ Describe the states of the elements at STP.
- ❑ Use a simple particle model to differentiate among properties of solids, liquids, and gases
- ❑ A physical change results in the rearrangement of existing particles in a substance. A chemical change results in the formation of different particles with changed properties.

TEXT REFERENCE: p. 39-42 and 44-47

Topic 3: Mixtures

ESSENTIALS: Know, Understand, and Be Able To…

- ❑ A pure substance has a constant composition throughout a sample
- ❑ Mixtures are composed of two or more substances that can be separated by physical means.
- ❑ When substances are mixed together, either a homogeneous or a heterogeneous mixture is formed
- ❑ A solution is a homogeneous mixture of solute dissolved in a solute
- ❑ The proportions of components in a mixture can be varied.
- ❑ Differences in properties such as density, particle size, boiling point, freezing point and solubility permit physical separation of components of a mixture.
- ❑ Describe the processes of filtration and distillation in the separation of a mixture.

TEXT REFERENCES: p. 44-47

Topic 4: Pure Substances

ESSENTIALS: Know, Understand, and Be Able To…

- ❑ Elements are substances that are composed of atoms that have the same atomic number.
- ❑ Elements cannot be broken down by chemical change.
- ❑ Elements can be differentiated by physical properties substances, such as density, conductivity, malleability, solubility, and hardness.
- ❑ Elements can also be differentiated by chemical properties.
  Chemical properties describe how an element behaves during a chemical reaction.
- ❑ A compound is a substance composed of two or more different elements that are chemically combined in a fixed proportion**.** A chemical compound can be broken down by chemical change.
- ❑ Use particle models/diagrams to differentiate among elements, compounds, and mixtures.

TEXT REFERENCES: p. 48-52

Topic 5: Changes

ESSENTIALS: Know, Understand, and Be Able To…

- ❑ During a physical change the chemical makeup of a substance ***does not*** change. Physical changes can be reversed. Dissolving and phase changes are examples.
- ❑ During a chemical change the chemical makeup of a substance ***does*** change. Chemical changes cannot be reversed. Burning, rusting, cooking, digesting, etc. are examples.
- ❑ Chemical changes can be described by equations which include reactants and products.
- ❑ Equations are written in balanced form. This illustrates the Conservation of Matter, which states that matter can neither be created or destroyed.
- ❑ Physical and chemical changes can be exothermic or endothermic. Be able to distinguish between exothermic and endothermic reactions using experimental data.
- ❑ The Law of Conservation of Energy states that energy can neither be created nor destroyed.

TEXT REFERENCES: p. 53-55