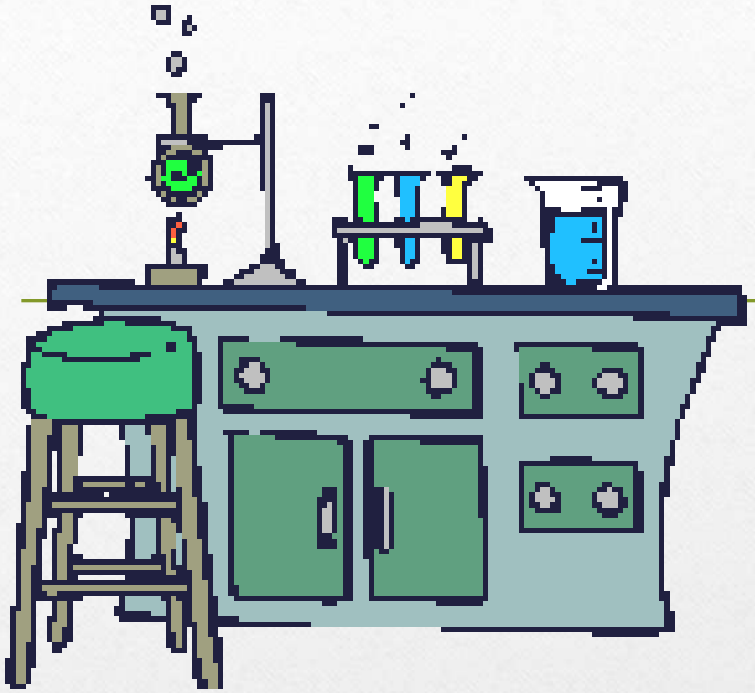

# Chapter 2

# *"Matter and Change"*

# Section 2.1
# Properties of Matter

- OBJECTIVES:
  - Identify properties of matter as extensive or intensive.

# Section 2.1
# Properties of Matter

- OBJECTIVES:
  - Define physical property, and list several common physical properties of substances.

# Section 2.1
# Properties of Matter

- OBJECTIVES:
  - Differentiate among three states of matter.

# Section 2.1
# Properties of Matter

- OBJECTIVES:
  - Describe a physical change.

# Describing Matter

- Properties used to describe matter can be classified as:

1) Extensive – depends on the *amount* of matter in the sample

   - Mass, volume, calories are examples

2) Intensive – depends on the *type* of matter, not the amount present

   - Hardness, Density, Boiling Point

# Matter

- Matter is anything that has mass, and takes up space
- Mass = a measure of the amount of "stuff" (or material) the object contains (don't confuse this with weight, a measure of gravity)
- Volume = a measure of the space occupied by the object

- Matter that has a uniform and definite composition is called a PURE SUBSTANCE

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- True or False? Every sample of a given substance has identical intensive properties because every sample has the same composition.
- Hardness, color, conductivity, and malleability are examples of physical properties.

# Properties are…

- Words that describe matter (adjectives)
- Physical Properties- a property that can be observed and measured without changing the material's composition.
- Examples- color, hardness, m.p., b.p.
- Chemical Properties- a property that can only be observed by changing the composition of the material.
- Examples- ability to burn, decompose, ferment, react with, etc.

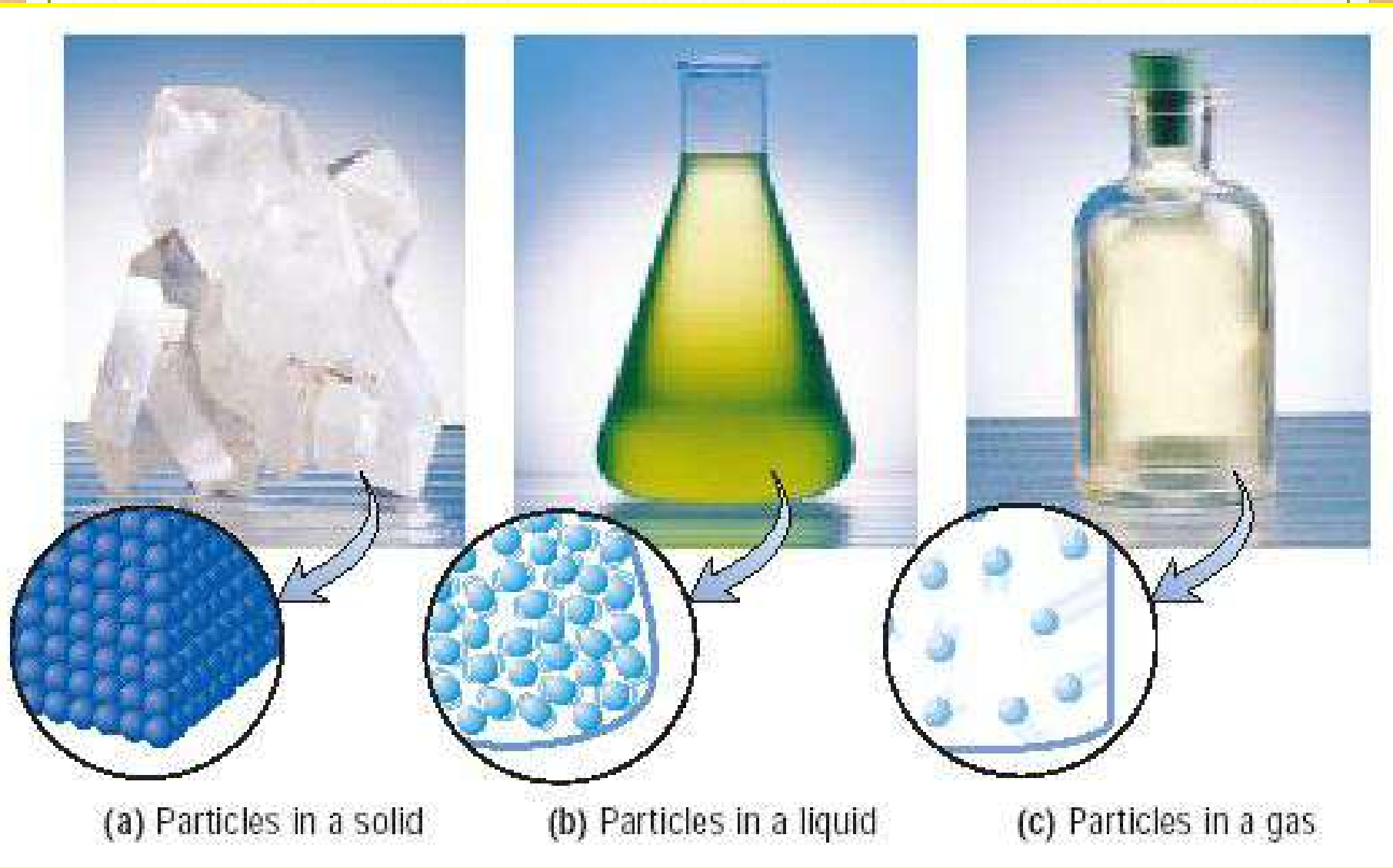
# Which has the lowest melting point?
# Which has the highest?

| Property | Helium | Neon | Argon | Krypton | Xenon | Radon |
|---|---|---|---|---|---|---|
| Density (g/dm$^3$) | 0.1786 | 0.9002 | 1.7818 | 3.708 | 5.851 | 9.97 |
| Boiling point (K) | 4.4 | 27.3 | 87.4 | 121.5 | 166.6 | 211.5 |
| Melting point (K) | 0.95 | 24.7 | 83.6 | 115.8 | 161.7 | 202.2 |
| Enthalpy of vaporization (kJ/mol) | 0.08 | 1.74 | 6.52 | 9.05 | 12.65 | 18.1 |
| Solubility in water at 20 °C (cm$^3$/kg) | 8.61 | 10.5 | 33.6 | 59.4 | 108.1 | 230 |
| Atomic number | 2 | 10 | 18 | 36 | 54 | 86 |
| Atomic radius (calculated) (pm) | 31 | 38 | 71 | 88 | 108 | 120 |
| Ionization energy (kJ/mol) | 2372 | 2080 | 1520 | 1351 | 1170 | 1037 |
| Allen electronegativity | 4.16 | 4.79 | 3.24 | 2.97 | 2.58 | 2.60 |

# States of matter

1) Solid- matter that can not flow (definite shape) and has definite volume.
2) Liquid- definite volume but takes the shape of its container (flows).
3) Gas- a substance without definite volume or shape and can flow.
   - Vapor- a substance that is currently a gas, but normally is a liquid or solid at room temperature. (Which is correct: "water gas", or "water vapor"?)

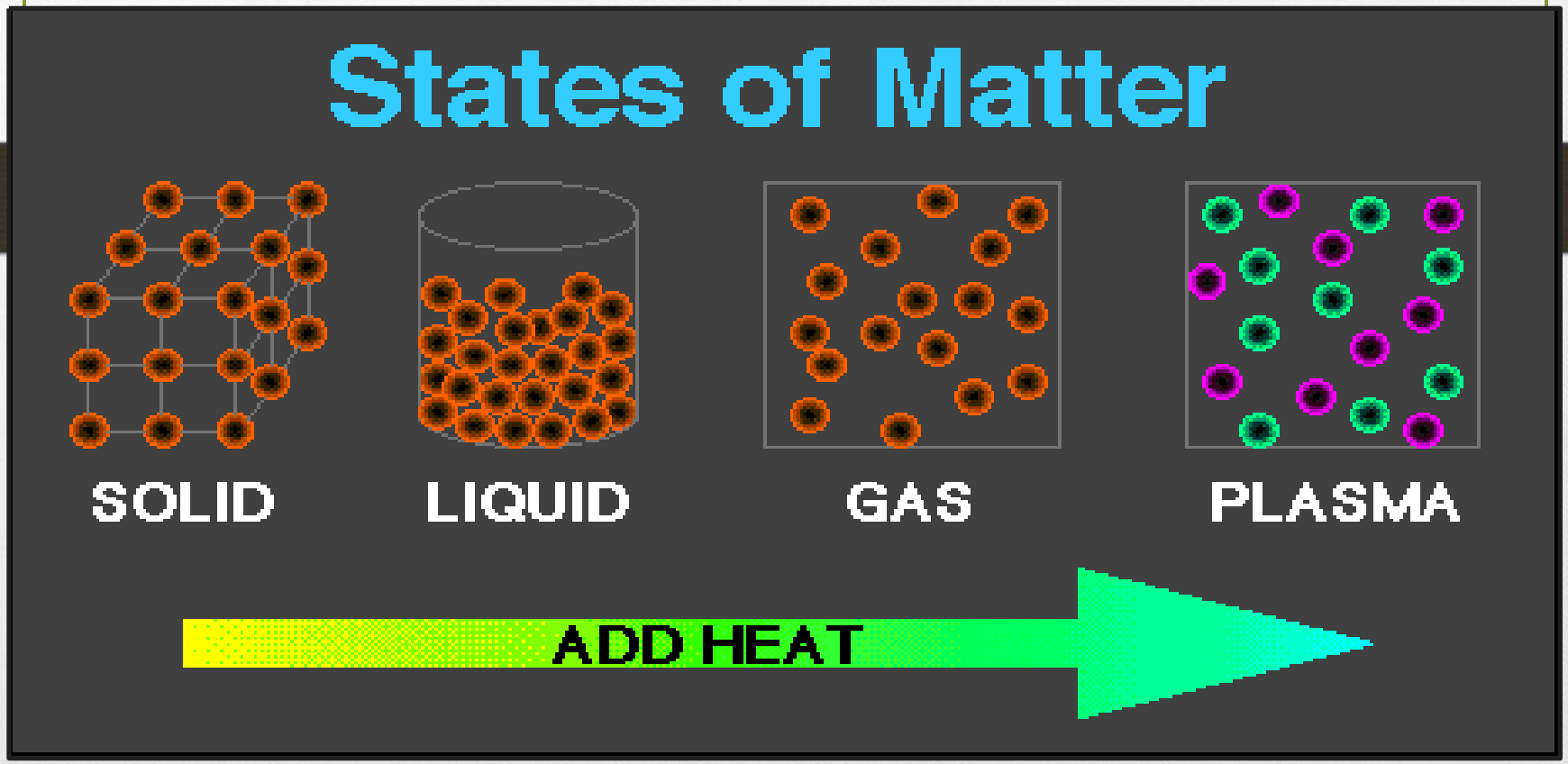
# Three Main Phases – page 41

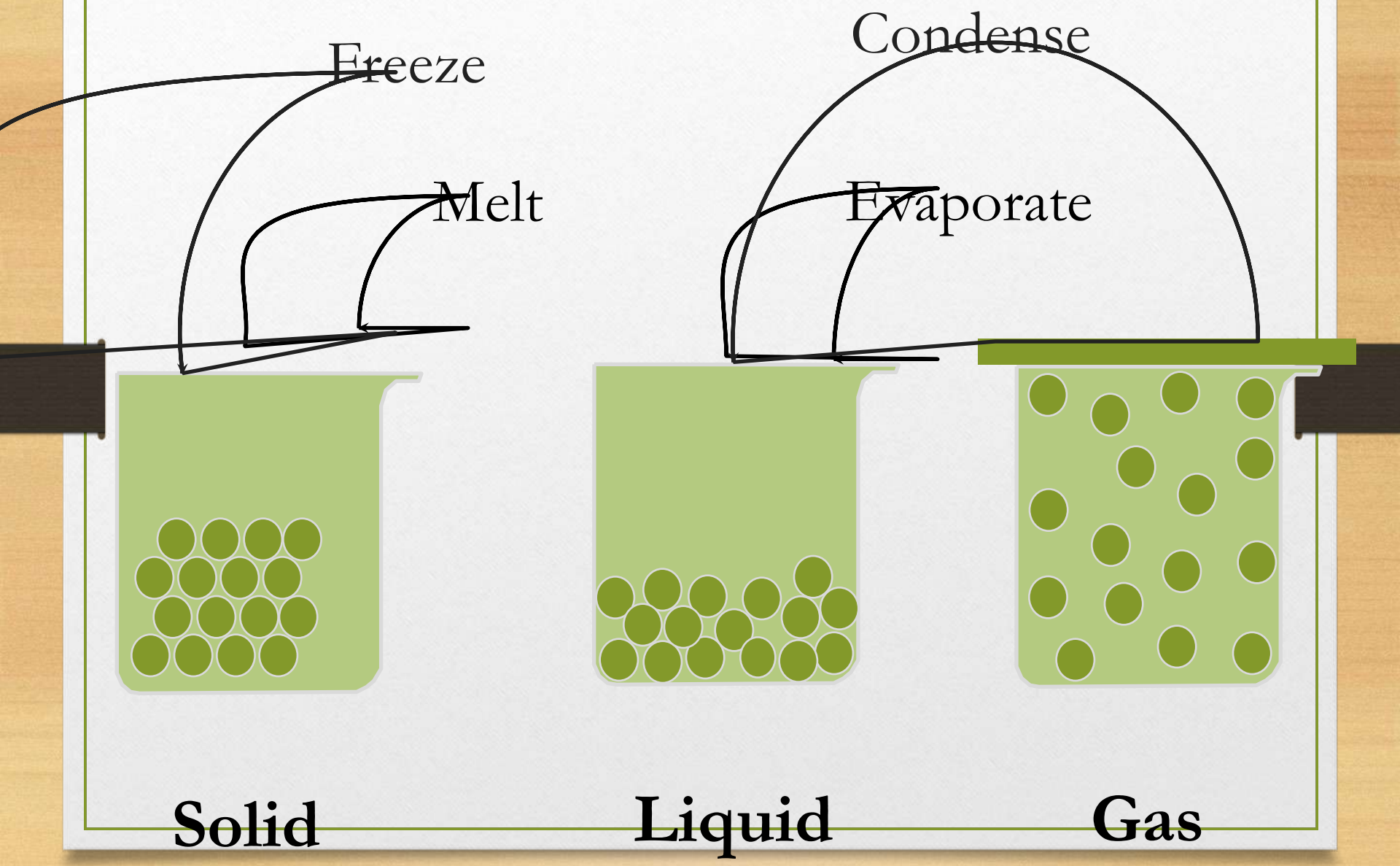


# States of Matter

| | Definite Volume? | Definite Shape? | Result of a TemperatureIncrease? | Will it Compress? |
|---|---|---|---|---|
| Solid | YES | YES | Small Expans. | NO |
| Liquid | YES | NO | Small Expans. | NO |
| Gas | NO | NO | Large Expans. | YES |

# 4th state: Plasma - formed at high temperatures; ionized phase of matter as found in the sun




Freeze
Melt
Condense
Evaporate
Solid
Liquid
Gas

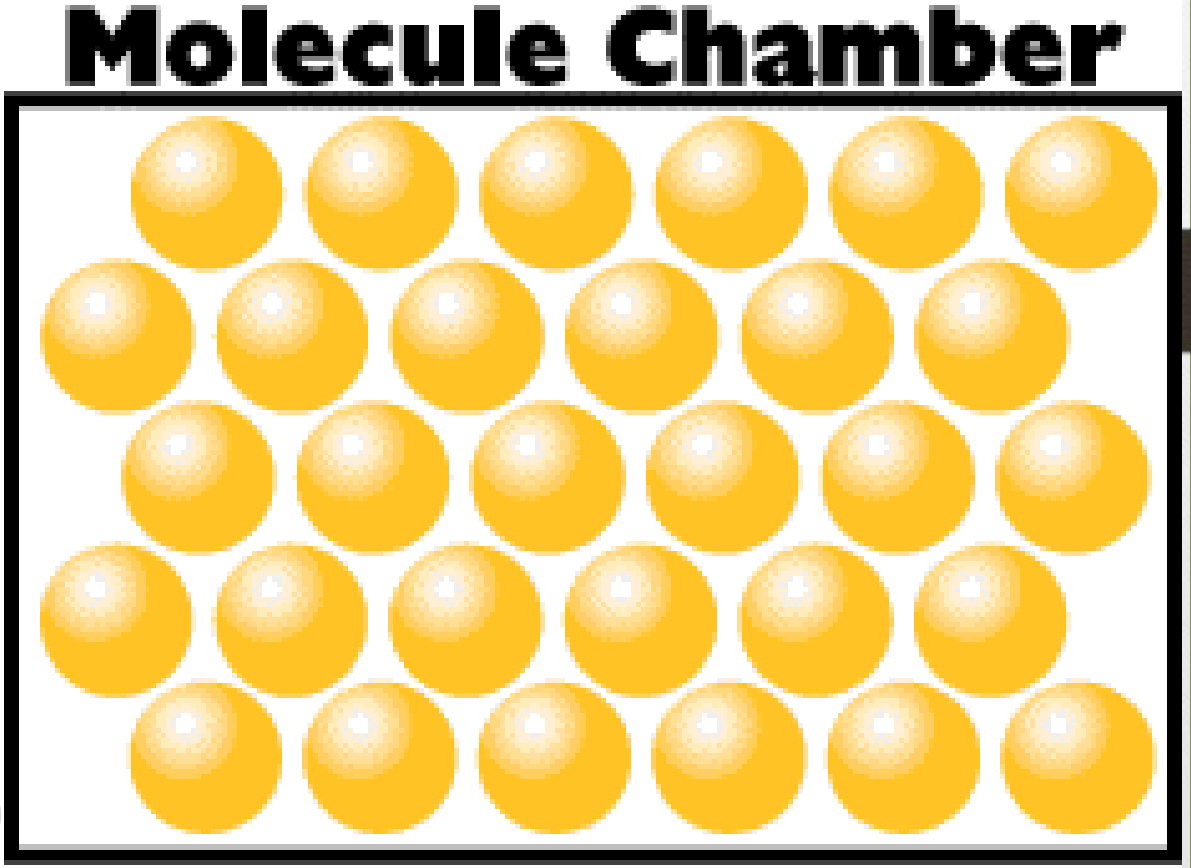
# Copper Phases - Solid

≤ 1083°C

GAS

LIQUID

SOLID



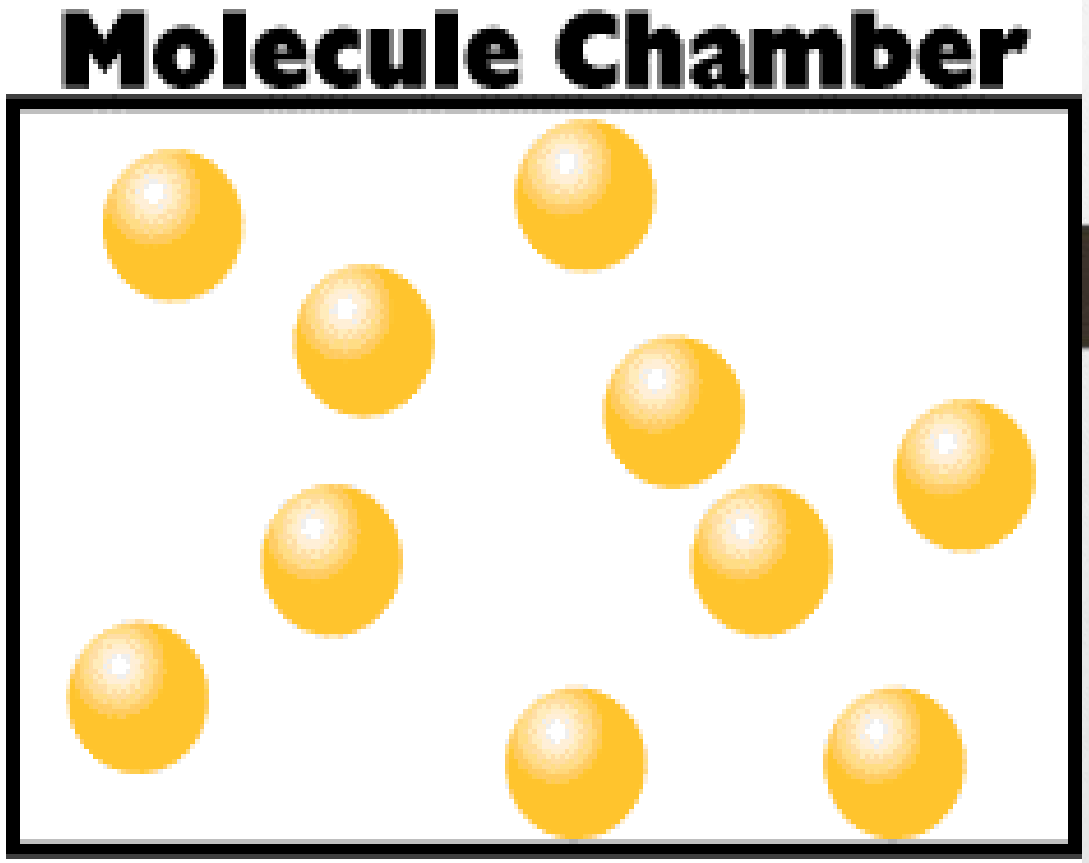
# Copper Phases - Liquid

1083-2594°C

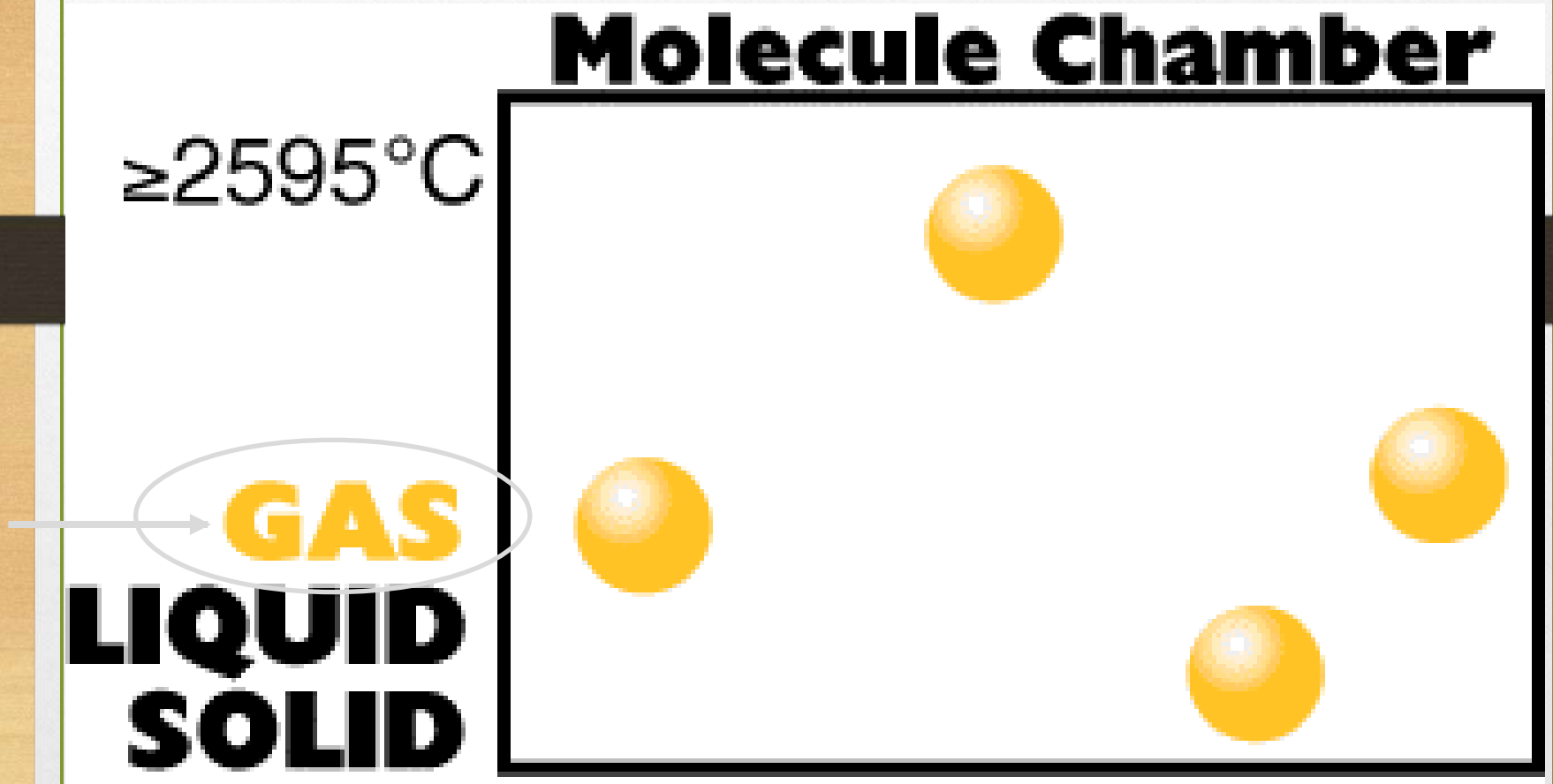
GAS

LIQUID

SOLID



# Copper Phases – Vapor (gas)



# Physical vs. Chemical Change

- During a physical change, some properties of the material change, but the composition of the material does not.
  - Boil, melt, cut, bend, split, crack
  - Is boiled water still water?
- Can be **reversible**, or **irreversible**
- Chemical change - a change where a new form of matter is formed.
  - Rust, burn, decompose, ferment

# True or False?

- Physical changes can be reversible or irreversible?

# Section 2.2
# Mixtures

- OBJECTIVES:
  - Categorize a sample of matter as a substance or a mixture.

# Section 2.2
# Mixtures

- OBJECTIVES:
  - Distinguish between homogeneous and heterogeneous samples of matter.

# Section 2.2
# Mixtures

- OBJECTIVES:
  - Describe two ways that components of mixtures can be separated.

- Mixtures are a physical blend of at least two substances; have variable composition. Most samples of matter are mixtures. They can be either:

1) Heterogeneous – the mixture is not uniform in composition
   - Chocolate chip cookie, gravel, soil.
2) Homogeneous - same composition throughout; called "solutions"
   - Kool-aid, air, salt water
- Every part keeps it's own properties.

# Solutions are homogeneous mixtures

- Mixed molecule by molecule, thus too small to see the different parts
- Can occur between any state of matter: gas in gas; liquid in gas; gas in liquid; solid in liquid; solid in solid (alloys), etc.
- Thus, based on the distribution of their components, mixtures are called homogeneous or heterogeneous.

# Phase?

- The term "phase" is used to describe any part of a sample with uniform composition of properties.
- A homogeneous mixture consists of a single phase
- A heterogeneous mixture consists of two or more phases.
- Note Figure 2.6, page 45

# True or False?

- A phase is used to describe any part of a sample with uniform composition and properties.

# Practice Problem 9 & 10

Properties of Iron: metal, gray, doesn't dissolve in water, magnetic

Properties of Table Salt: solid, white, dissolves in water, not magnetic

9. Give one physical property that could be used to separate iron from table salt. Explain your reason.

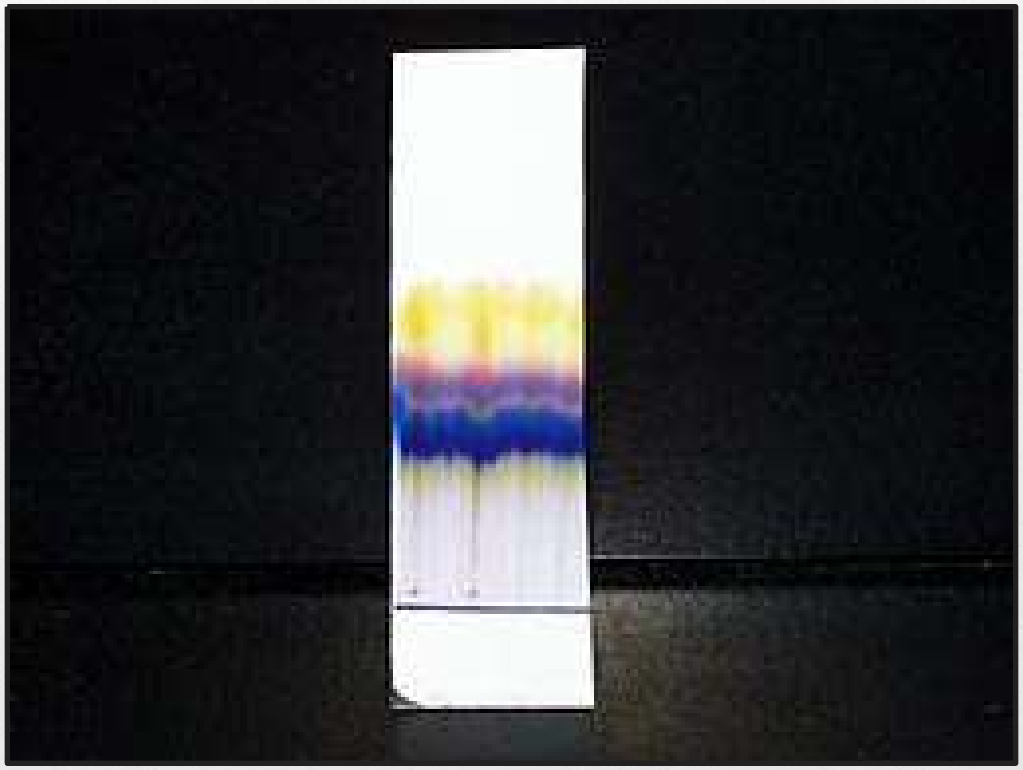
10. Give a second physical property that could be used to separate iron from table salt. Explain your reason.

# Separating Mixtures

- Some can be separated easily by physical means: rocks and marbles, iron filings and sulfur (use magnet)
- Differences in physical properties can be used to separate mixtures.
- Filtration - separates a solid from the liquid in a heterogeneous mixture (by size) (Think of a coffee filter)

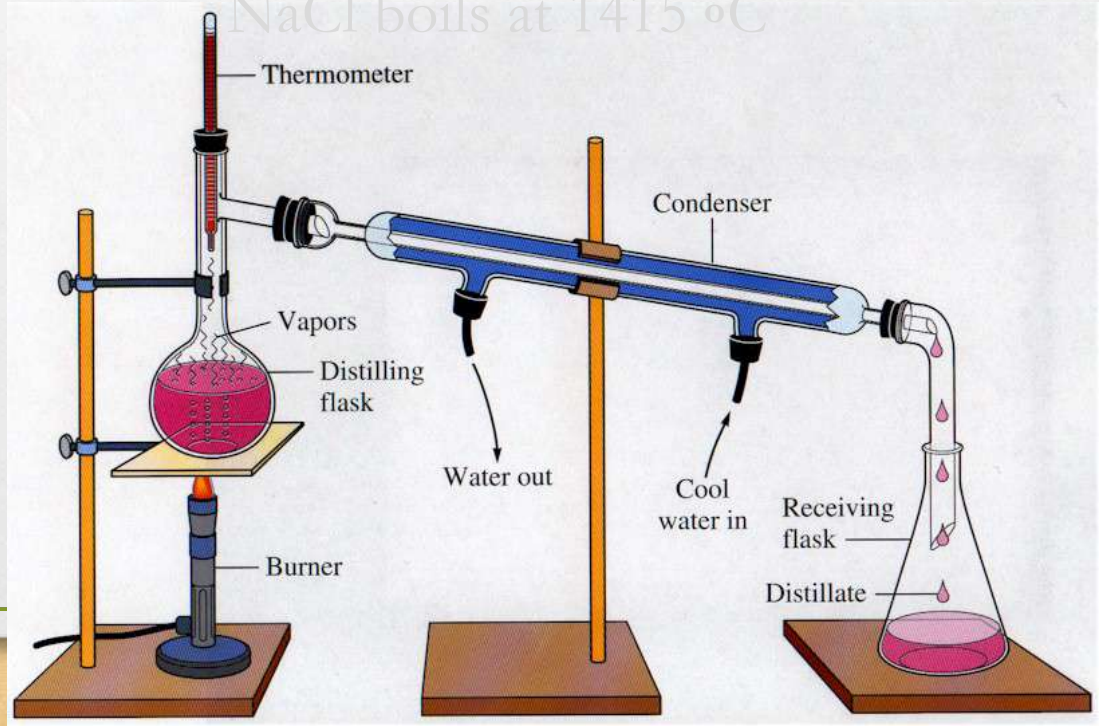
# Separation of a Mixture

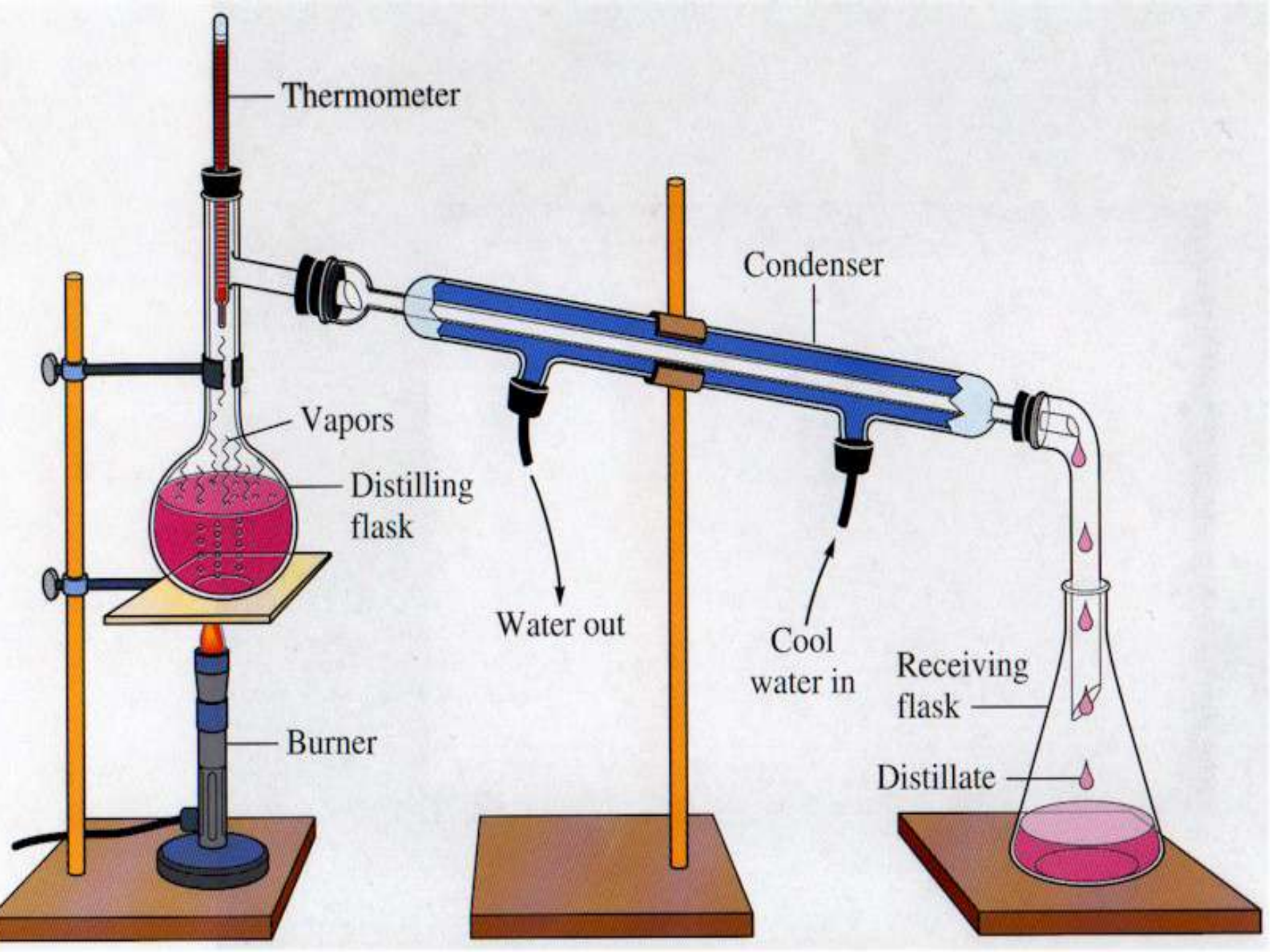
Components of dyes such as ink may be separated by <u>paper chromatography</u>.



# Separation of a Mixture

**Distillation:** takes advantage of different boiling points. The liquid with the lowest boiling point will be vaporized and separated first.




Thermometer
Condenser
Vapors
Distilling flask
Water out
Cool water in
Receiving flask
Burner
Distillate

# Crystallization

- If you wanted to remove salt from water, you could boil off the water or let it evaporate. This separates the salt from the water in crystals.

# Section 2.3
# Elements and Compounds

- OBJECTIVES:
  - Explain the differences between an element and a compound.

# Section 2.3
# Elements and Compounds

- OBJECTIVES:
  - Distinguish between a substance and a mixture.

# Section 2.3
# Elements and Compounds

- OBJECTIVES:
  - Identify the chemical symbols of elements, and name elements given their symbols.

**Substances** are either:

a) elements, or

b) compounds

# Substances: element or compound

- Elements- simplest kind of matter
  - cannot be broken down any simpler and still have properties of that element!
  - all one kind of atom.
- Compounds are substances that can be broken down only by chemical methods
  - when broken down, the pieces have completely different properties than the original compound.
  - made of two or more atoms, chemically combined (not just a physical blend!)

# Compound vs. Mixture

| Compound | Mixture |
| --- | --- |
| Made of one kind of material | Made of more than one kind of material |
| Made by a chemical change | Made by a physical change |
| Definite composition | Variable composition |

# Which is it?

Element Compound Mixture

# Where are elements found?

**In the periodic table!!!**

**Examples: Ne, S, W, Na**

**Compounds are combinations of elements.**

**Examples: NaCl, MgI**

# Elements vs. Compounds

- Compounds **can** be broken down into simpler substances by chemical means, but elements **cannot**.
- A "*chemical change*" is a change that produces matter with a **different composition** than the original matter.

# Chemical Change

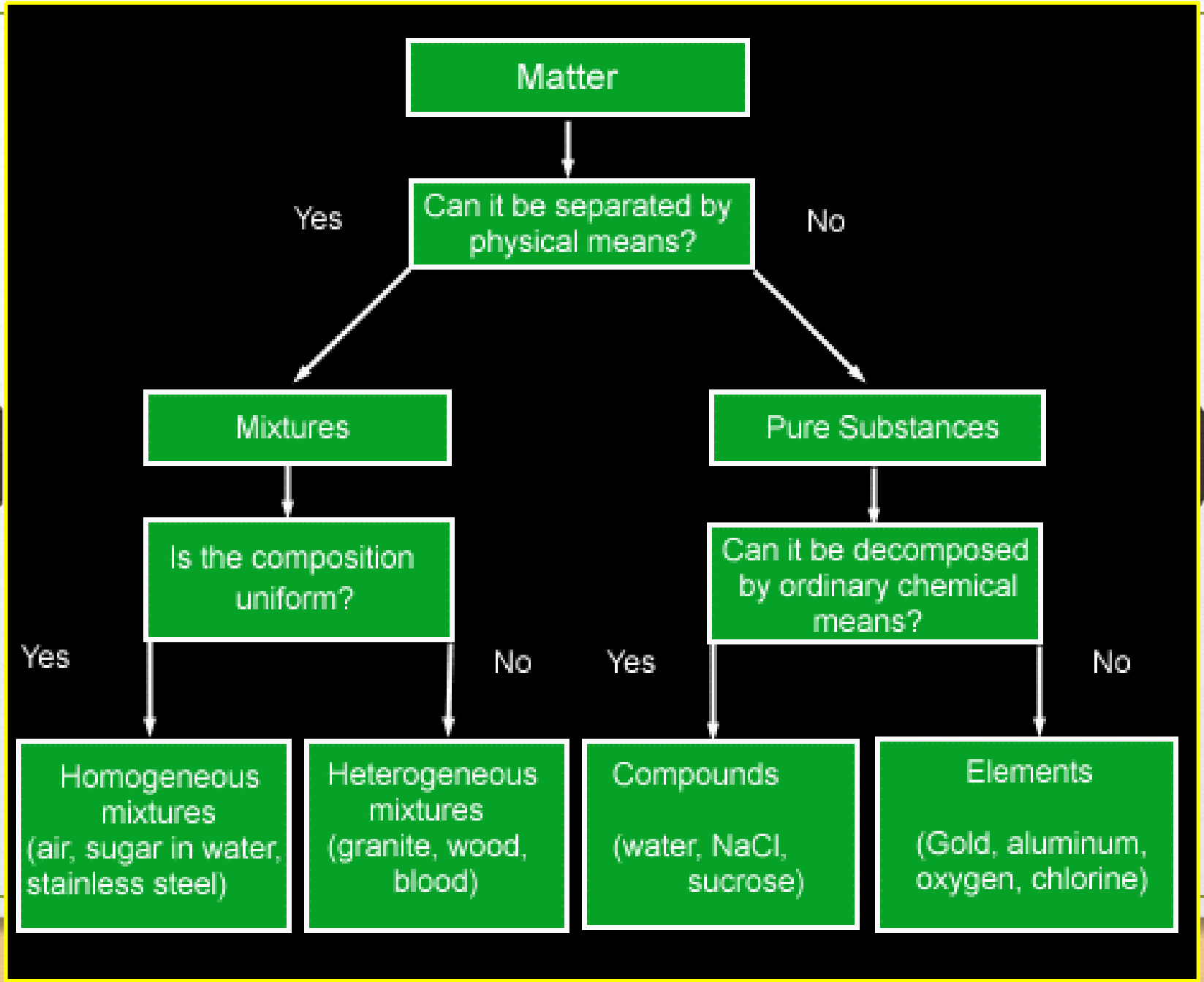
**A change in which one or more substances are converted into different substances.**


***Heat*** **and** ***light*** **are often evidence of a chemical change.**

# Properties of Compounds

- Quite different properties than their component elements.
- Due to a CHEMICAL CHANGE, the resulting compound has new and different properties:
  - Table sugar – carbon, hydrogen, oxygen
  - Sodium chloride – sodium, chlorine
  - Water – hydrogen, oxygen

# Classification of Matter



# Symbols & Formulas

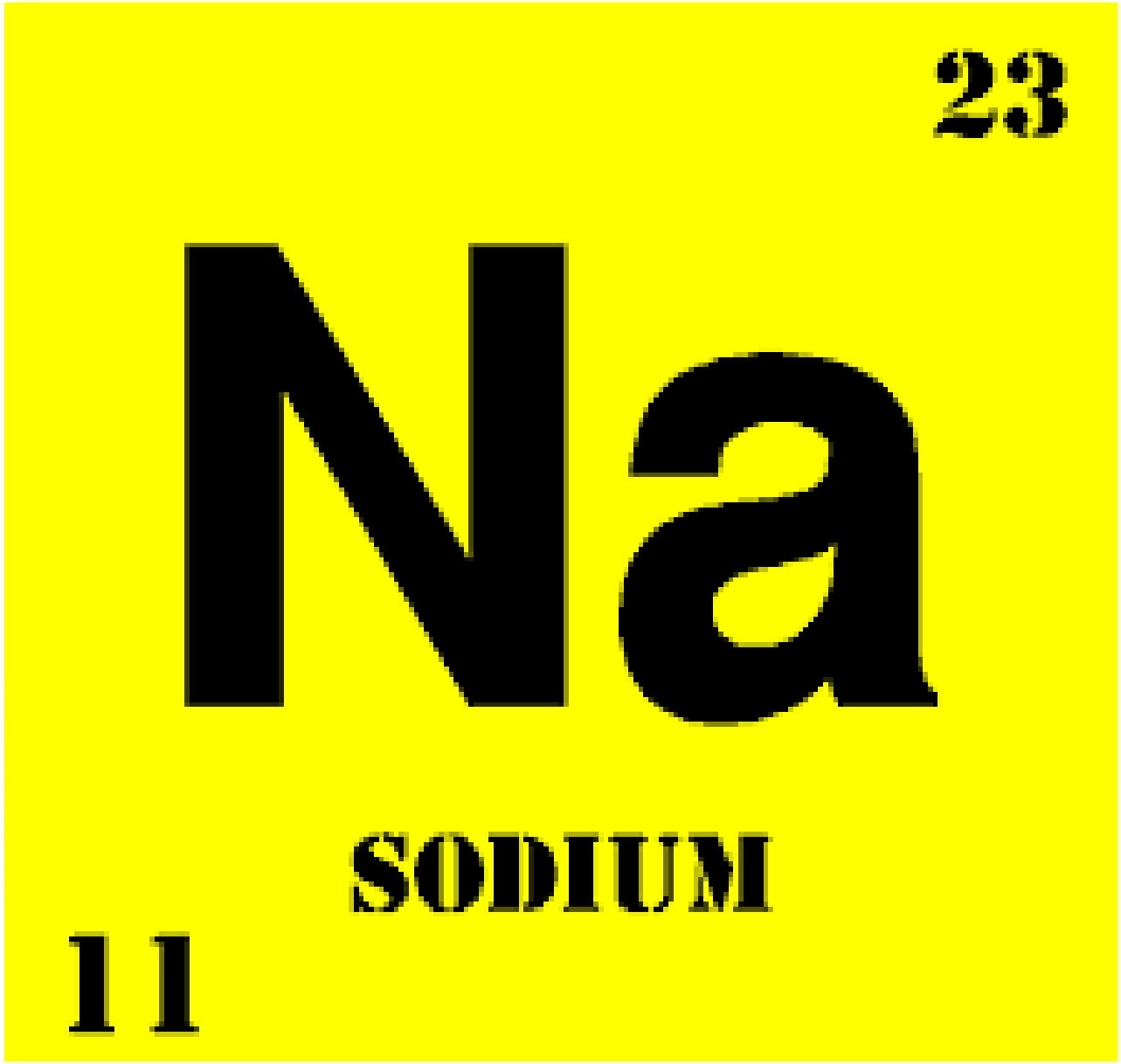
- Currently, there are ***117*** elements
- Elements have a 1 or two letter symbol, and compounds have a formula.
- An element's first letter always capitalized; if there is a second letter, it is written lowercase: B, Ba, C, Ca, H, He
- ***Start learning*** the elements names and symbols listed in Table B.7 on page R53
- Some names come from Latin or other languages; note Table 2.2, page 52

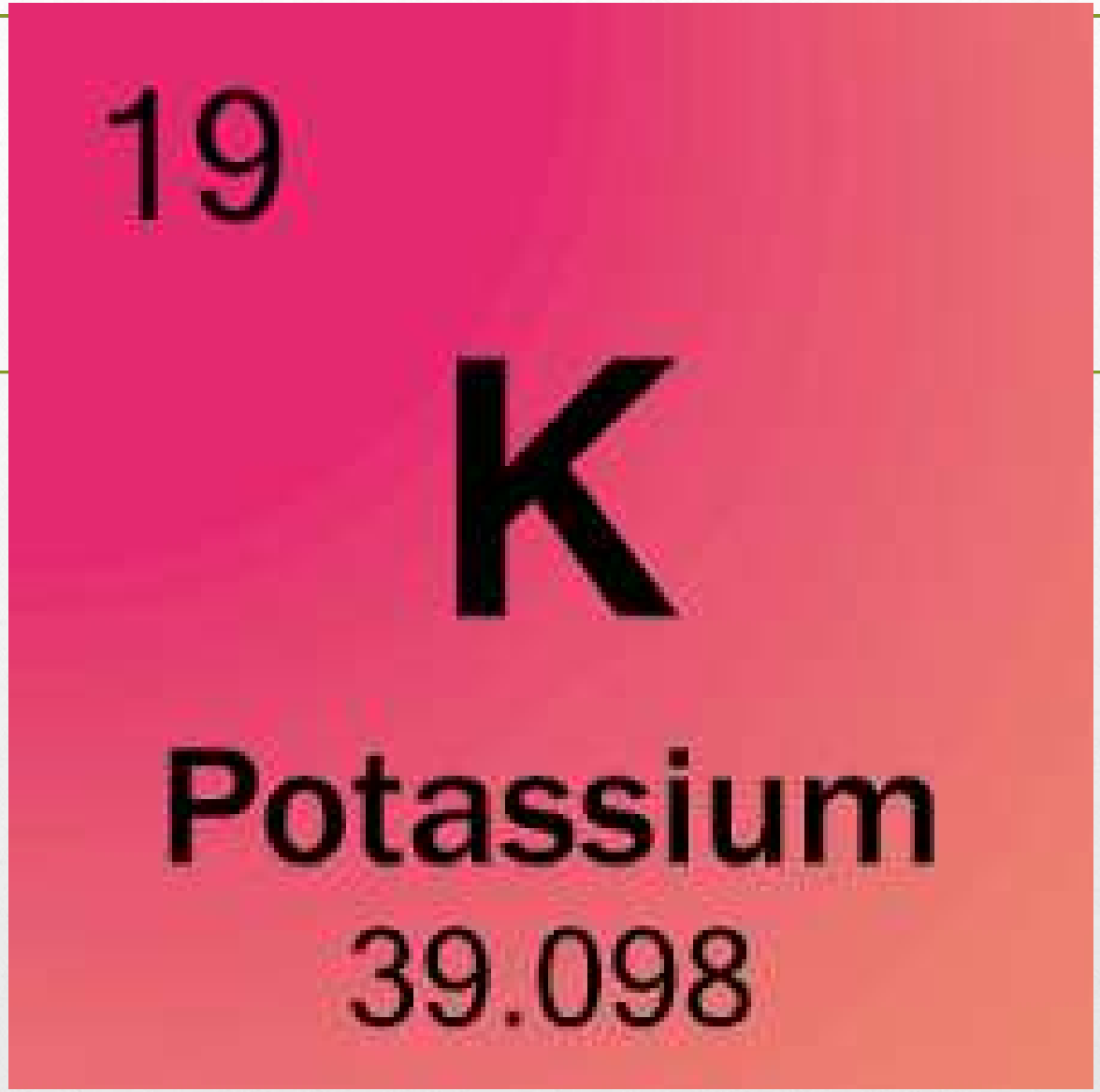
# Problem 18

- Liquid A and Liquid B are clear liquids. They are placed in open containers and allowed to evaporate. When evaporation is complete, there is a white solid in container B, but no solid in container A. From these results, what can you infer about the two liquids?

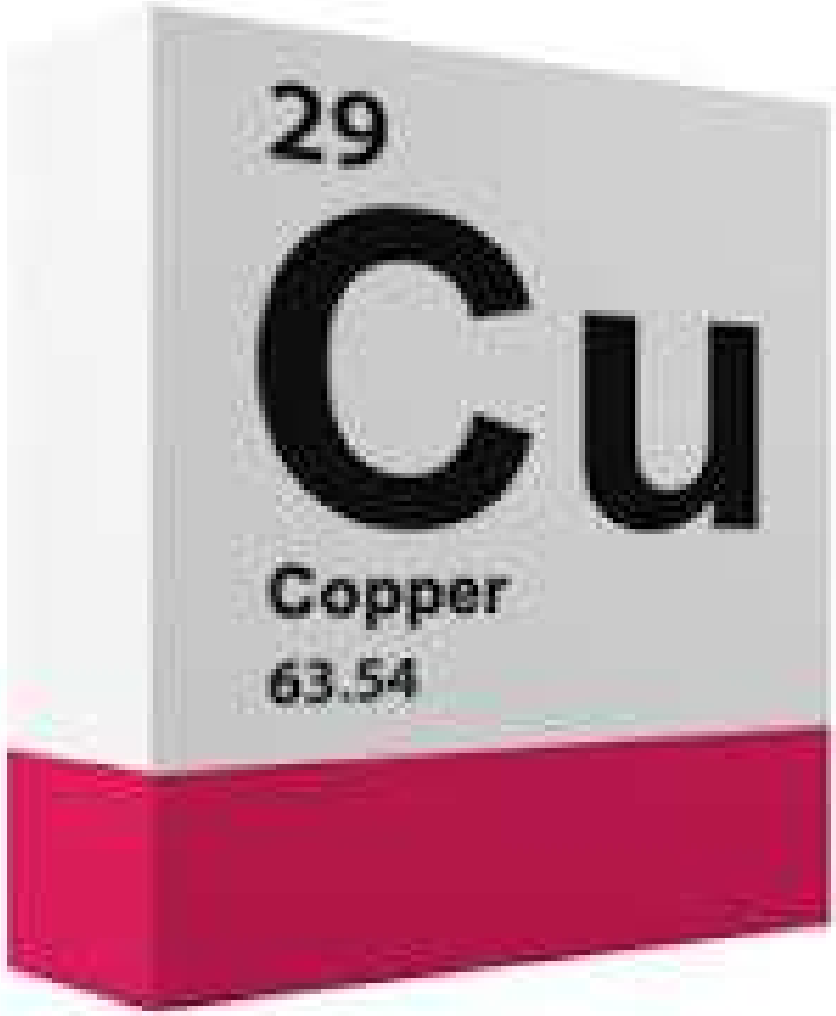
# Problem 19

- A clear liquid in an open container is allowed to evaporate. After three days, a solid is left in the container. Was the clear liquid an element, a compound, or a mixture? How do you know?


23
Na
SODIUM
11


19
K
Potassium
39.098


26
Fe
Iron
55.847


29
Cu
Copper
63.54

# $K_2S$

- This formula tells us there are 2 potassiums for every 1 sulfur
- The subscript “2” belongs to the element in front of it (K)

# Section 2.4
# Chemical Reactions

- OBJECTIVES:
  - Describe what happens during a chemical change.

# Section 2.4
# Chemical Reactions

- OBJECTIVES:
  - Identify four possible clues that a chemical change has taken place.

# Section 2.4
# Chemical Reactions

- OBJECTIVES:
  - Apply the law of conservation of mass to chemical reactions.

# Chemical Changes

- The ability of a substance to undergo a specific chemical change is called a chemical property.
  - iron plus oxygen forms rust, so the ability to rust is a chemical property of iron
- During a chemical change (also called chemical reaction), the composition of matter always changes.

# Chemical Reactions are…

- When one or more substances are changed into new substances.
- Reactants- the stuff you start with
- Products- what you make
- The products will have NEW PROPERTIES different from the reactants you started with
- Arrow points from the reactants **to** the new products

# Recognizing Chemical Changes

1) **Energy** is absorbed or released (temperature changes hotter or colder)
2) **Color** changes
3) **Gas** production (bubbling, fizzing, or odor change; smoke)
4) formation of a **precipitate** - a solid that separates from solution (won't dissolve)
5) **Irreversibility** - not easily reversed

But, there are examples of these that are not chemical – boiling water bubbles, etc.

# Conservation of Mass

- During any chemical reaction, the mass of the products is always equal to the mass of the reactants.
- All the mass can be accounted for:
  - Burning of wood results in products that appear to have less mass as ashes; where is the rest?
- **Law of conservation of mass**

# 19 Figure 2.15 Conservation of Mass

- Page 55

43.43 g Original mass = 43.43 g Final mass

reactants = product

# End of Chapter 2

# Matter and Change