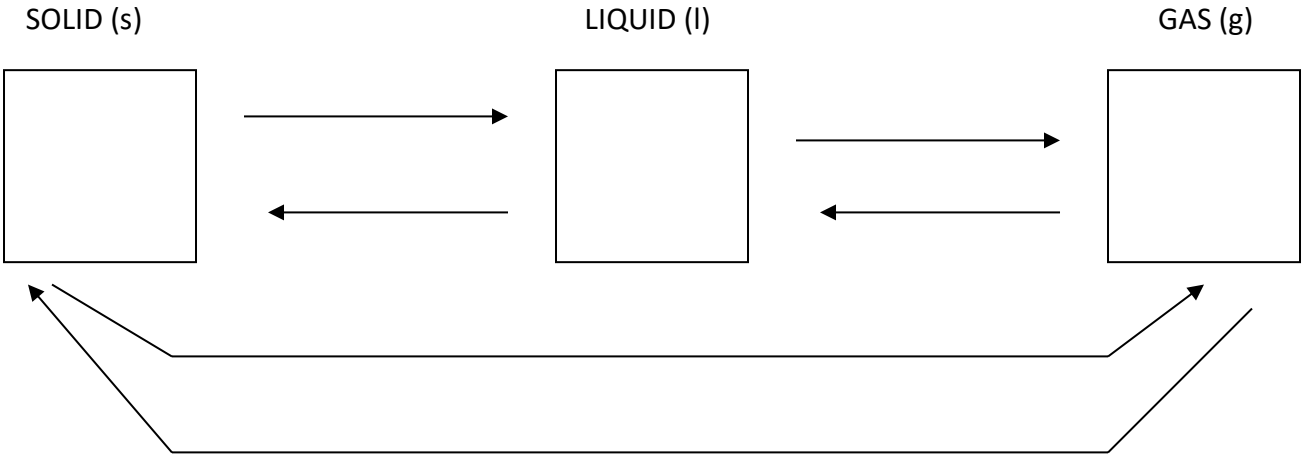
MATTER

OBJECTIVE #1: Identify and Describe Phases of Matter



	Solid	Liquid	Gas
Shape (Has a fixed shape or takes the shape of the container)			
Volume (Has a fixed volume or takes the volume of the container)			
Density (high or low)			
Particle arrangement (rigid or free)			
Attraction (particles are highly attracted and close or weakly attracted and spread out)			

a. Which of the following has a definite shape?

- $HCl_{(g)}$ - $H_2O_{(l)}$ - $Cu_{(s)}$

b. Which of the following has a definite volume?

- $LiF_{(g)}$ - $Br_{2(l)}$ - $Mg_{(s)}$

c. Which substance has neither a definite shape or a define volume?

- $Cl_{2\,(g)}$ - $CCl_{4\,(l)}$ - $NaCl_{(s)}$

OBJECTIVE #2: Solve for Density and Percent Error

A) **Density** is the measurement of mass divided by volume. For solids and liquids, the unit for density is g/mL or g/cm^3 (1 mL = 1 cm^3) For gases, which require a large amount to have a measurable density, the units for density are g/L. A substance's density can help identify it. For example, water has a density of 1.00 g/mL, and gold has a density of 19.3 g/mL.

The formula can be found on Reference Table T:

Table T
Important Formulas and Equations

Density	$d = \frac{m}{V}$	d = density m = mass V = volume

a. Calculate the density of 5.00 gram sample of an unknown substance, which has a volume of 5.15mL.

b. Using Reference Table S, identify the unknown substance in question (a) above.

c. Calculate the mass of a substance with a density of 2.50 g/mL and a volume of 23.0mL.

d. Calculate the volume of a metal rectangle with a height of 2.0cm, a length of 3.0cm, and a width of 1.0cm.

e. If the metal in question (d) above is iron, calculate the mass. (Hint: density is on table S)

B) **Percent Error:** The most common way to analyze experimental error is to compare your results with a known value (if available). The formula for percent error is also on Reference Table T.

- *The lower the percent error (0 – 10%), the better the results of an experiment.*

Percent Error	$\% \text{ error} = \frac{\text{measured value} - \text{accepted value}}{\text{accepted value}} \times 100$

* measured value is what YOU get during experiment
* accepted value is what you SHOULD have gotten

Use the following data as an example.

Density of Water (from experiment)	Density of water (actual or known value)
	1.00 g/mL

Given these two numerical values, percent error can be calculated as follows:

a. A student determines the density of an object to be 6.82 g/mL. The accepted value is 6.93 g/mL. Calculate the student's percent error.

b. A student determines the density of Zinc to be 7.56 g/mL. Using Reference Table S, determine the accepted value for the density of Zinc. Then determine the student's percent error.

OBJECTIVE #3: Unit and Prefix Conversions

Reference Table D contains the selected units of measurements, with symbols, names and the quantity it represents. This table is also commonly called selected **BASE** units.

Table D
Selected Units

Symbol	Name	Quantity
m	meter	length
g	gram	mass
Pa	pascal	pressure
K	kelvin	temperature
mol	mole	amount of substance
J	joule	energy, work, quantity of heat
s	second	time
min	minute	time
h	hour	time
d	day	time
y	year	time
L	liter	volume
ppm	parts per million	concentration
M	molarity	solution concentration
u	atomic mass unit	atomic mass

Reference Table C contains the selected prefixes that are available for converting base units into smaller or larger increments.

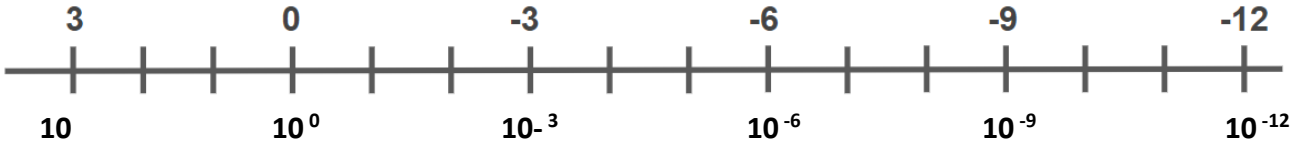
Table C
Selected Prefixes

Factor	Prefix	Symbol
10^{3}	kilo-	k
10^{-1}	deci-	d
10^{-2}	centi-	c
10^{-3}	milli-	m
10^{-6}	micro-	μ
10^{-9}	nano-	n
10^{-12}	pico-	p

The value of a base unit (staring measurement) is a "factor" of 1, or 10^{0}.

It would be located between the kilo- and deci- prefix.

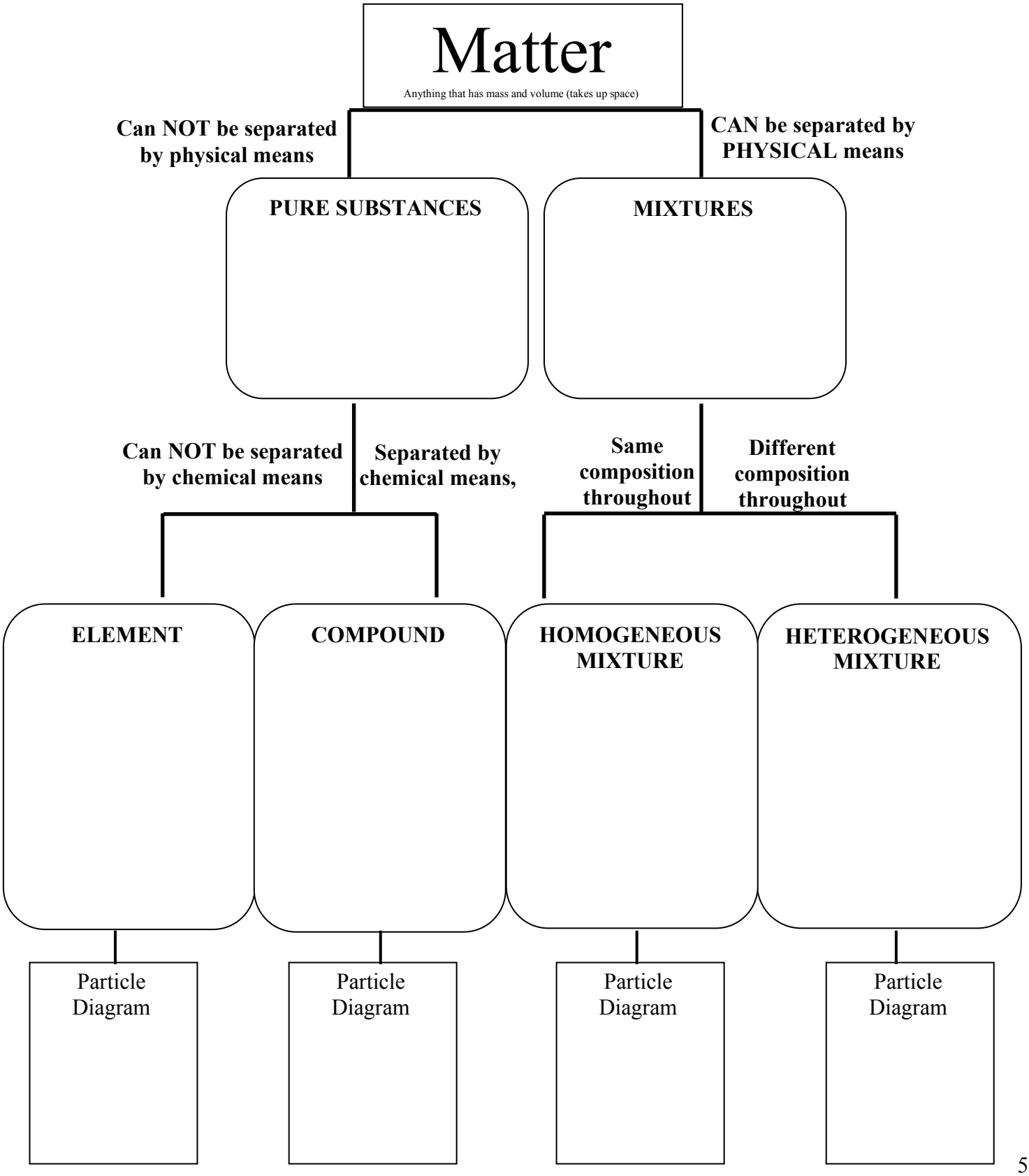
When converting between a base unit to prefix, or prefix to prefix, a number line like the one below can help indicate what direction (left or right) to move the decimal point, as well as how many placeholders to move it.



How many milliliters are equal to 9.62 L?	How many kilojoules are equal to 540.3 J?
How many kilograms are equal to 0.08051 g?	How many nanometers are equal to 2.05 m?
How many centimeters are equal to 2.2 km?	How many picograms are equal to 0.359 mg?

OBJECTIVE #4: Classify and Describe Types of Matter

Matter can be grouped or classified into two main categories: Pure Substances or Mixtures. From there, pure substances can be broken down into elements or compounds; mixtures can be broken down into homogeneous or heterogeneous.



Practice: Classification of Matter

Classify each of the following with the combination of terms listed below.

pure substance – element *mixture – homogeneous*
pure substance – compound *mixture – heterogeneous*

1. $HCl_{(aq)}$
2. sugar ($C_{11}H_{22}O_{11}$)
3. $KBr_{(s)}$
4. Soil
5. $Cl_{2\,(g)}$
6. water
7. $CH_2(OH)_{2\,(aq)}$
8. Sodium

9. Matter that is composed of two or more different elements chemically combined in a fixed proportion is classified as
(1) a compound (2) an element (3) a mixture (4) a solution

10. A compound differs from an element in that a compound
(1) is homogeneous
(2) has a definite composition
(3) has a definite melting point
(4) can be decomposed by a chemical reaction

11. A compound differs from a mixture in that a compound always has a
(1) homogeneous composition
(2) maximum of two elements
(3) minimum of three elements
(4) heterogeneous composition

12. A heterogeneous material may be
(1) an element (2) a compound (3) a pure substance (4) a mixture

13. Which statement is an identifying characteristic of a mixture?
(1) a mixture can consist of a single element
(2) a mixture can be separated by physical means
(3) a mixture must have a definite mass
(4) a mixture must be homogeneous

14. Which must be a mixture of substances?
(1) solid (2) liquid (3) gas (4) solution

15. Which substance can be decomposed by chemical means?
(1) aluminum (2) octane (3) silicon (4) xenon

16. Which substance cannot be broken down by a chemical reaction?
(1) ammonia (2) argon (3) methane (4) water

17. Two substances, A and Z, are to be identified. Substance A cannot be broken down by a chemical change. Substance Z can be broken down by a chemical change. What can be concluded about these substances?
(1) Both substances are elements.
(2) Both substances are compounds.
(3) Substance A is an element and substance Z is a compound.
(4) Substance A is a compound and substance Z is an element.

18. 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

19. Two different samples decompose when heated. Only one of the samples is soluble in water. Based on this information, these two samples are

(1) both the same element
(2) two different elements
(3) both the same compound
(4) two different compounds

20. Tetrachloromethane, CCl_4, is classified as a

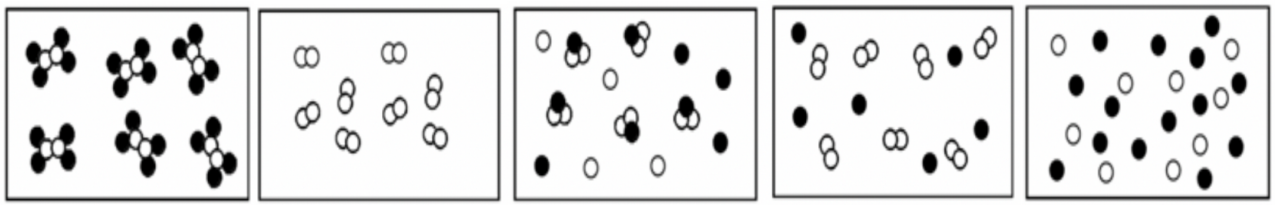
(1) compound because the atoms of the elements are combined in a fixed proportion
(2) compound because the atoms of the elements are combined in a proportion that varies
(3) mixture because the atoms of the elements are combined in a fixed proportion
(4) mixture because the atoms of the elements are combined in a proportion that varies

Practice: Particle Diagrams

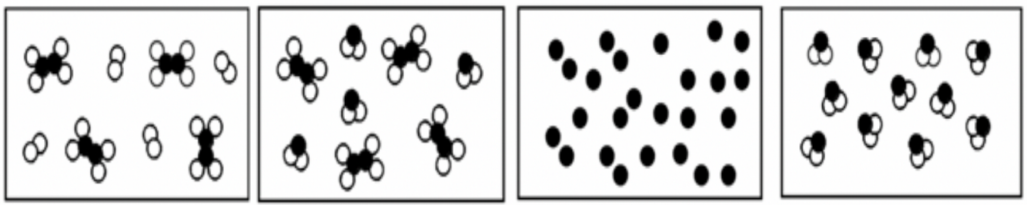
a) Classify each of the pictures below as:

A = Element
B = Compound
C = Mixture of elements
D = Mixture of Compounds
E = Mixture of Elements and Compounds

**Each circle represents an atom and each different color represents a different kind of atom. If two atoms are touching then they are bonded together.



_____ _____ _____ _____ _____



_____ _____ _____ _____

b) Draw a diagram of a:

pure element	pure compound	mixture of two elements	mixture of an element & a compound	mixture of two elements & a compound

c) In terms of composition/type of atoms, what is the difference between a monatomic element and a diatomic element?

d) Use the following key for the questions below: = element X = element Z

8 atoms of element X in *gaseous* form	4 molecules of compound. X_2Z in *liquid* form	Homogeneous mixture of element Z with element X (5 atoms of each element)

OBJECTIVE #5: Understand the Law of Conservation of Matter (Mass)

- Rule: Matter (mass) cannot be created nor destroyed during an ordinary chemical reaction

  Chemical Reaction: _____ → _____
  (beginning substances) (ending substances)

- During a chemical reaction, bonds break, atoms rearrange and new bonds reform.
  - However, the number & type of atoms cannot change during physical or chemical changes

Example:

$2\ NaCl$	→	$2\ Na$	+	Cl_2
15.5 g		12.2 g		? g

a. For the following reaction: $CH_4(g) + H_2O(g) \rightarrow 3\ H_2(g) + CO(g)$, 2.55 grams of CH_4 and 3.48 g of H_2O are combined in a sealed container. What will be the mass of the two products combined?

b. In the following reaction: $Mg(s) + 2\ HCl\ (l) \rightarrow MgCl_2(l) + H_2(g)$, 3.50 grams of Mg are added to 10.0 g of HCl. If 12.9 grams of $MgCl_2$ are produced, how much hydrogen is also produced?

OBJECTIVE #6: Identify and Describe Changes in Matter

There are two main types of changes matter can undergo: physical changes and chemical changes.

Physical Properties/Changes – change the features of a substance without changing the identity

- _____
- _____
- _____
- _____
- _____
- _____
- _____
- _____

Chemical Properties/Changes – changes in the chemical composition of the substance, and will make substances change into new substances and change properties.

- _____
- _____
- _____
- _____
- _____
- _____

Practice: Physical and Chemical Changes

1. Label the following as physical (P) or chemical (C) properties:

texture: ____ flammable: ____ boiling point: ____

odor: ____ color: ____ chemical composition: ____

2. Label the following as physical (P) or chemical (C) changes:

corrosion: ____ melting: ____ mixing: ____

freezing: ____ cutting: ____ decaying: ____

3. Chemical properties can be used to
   a) determine the temperature of a substance
   b) determine the density of a substance
   c) differentiate between two compounds
   d) differentiate between two mixtures

4. Which change is most likely to occur when a molecule of $H_2(g)$ and $O_2(g)$ collide properly?
   a) a chemical change, because a compound will be formed
   b) a chemical change, because a new element will be formed
   c) a physical change, because a compound will be formed
   d) a physical change, because a new element will be formed

5. Which of the following is not a physical property?
   a) magnetic b) crystalline c) oxidize d) powdered

6. Which of the following is a chemical property?
   a) boils b) dissolves c) sublimes d) reacts

OBJECTIVE #7: Identify and Describe How to Separate Mixtures

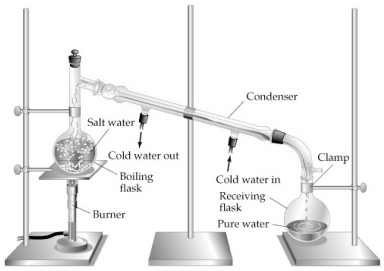
A) Homogeneous Mixtures

a. Distillation

A process that separates out a substance dissolved in water

by their _____

Examples: Carbon dioxide from Soda
Gasoline dissolved in Crude Oil
Salt dissolved in water



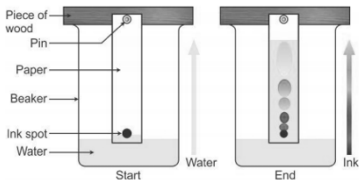
During distillation, the mixture is HEATED until the component (part) with the _____ boiling point has been reached. This part then begins to turn into a gas vapor, and leaves the main flask to be condensed into a liquid elsewhere in the setup.

b. Chromatography

A process that separates out the components (parts) of a homogeneous

mixture based on _____ and/or _____

to the chromatography filter paper



Paper Chromatography

Example: Black ink

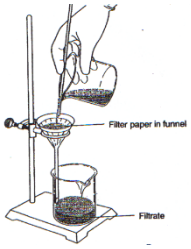
- If the molecule is large and/or strongly attracted to the paper, it will move slowly;
- If the molecule is small and/or not very attracted to the paper, it will move quickly up the paper

B) Heterogeneous Mixtures

a. Filtration

A process that separates a solid from a liquid it is contained in based on particle _____

- If the particle size is small enough, they will pass the filter paper
- If the particle size is too large, it will be retained in the filter paper



1. By using a paper filter, which of the following can be separated?
   a) two liquids mixed together
   b) two solids mixed together
   c) a solid mixed in a liquid
   d) a gas mixed in a liquid

2. Equal amounts of ethanol (rubbing alcohol) and water are mixed at room temperature. Which process is used to separate the ethanol from the water?
   a) reduction b) distillation c) filtration d) ionization

3. Crude oil is separated into its components by
   a) fractional distillation
   b) filtration
   c) column chromatography
   d) paper chromatography

4. The principle that allows paper chromatography to separate mixtures depends on the components of the mixtures having
   a) different boiling points
   b) different attractive forces
   c) different densities
   d) similar solubility in water