

Nuggets: *Terms and Matter; Sig Figs, Density; Temperature Conversion; SI Units; Unit Conversions*

TERMS

Matter: has mass and volume; States of matter: solid, liquid, and gas;

Classification of Matter

Pure Substance: containing only 1 chemical substance (e.g., H₂O, Na(s), or NaCl), a substance with a constant composition (H₂O)

Mixtures: containing 2 or more Pure Substances in variable proportions

Homogeneous Mixture: 2 or more chemical substances uniformly mixed that cannot be separated by physical means (e.g., NaCl dissolved in H₂O)

Heterogeneous Mixture: 2 or more chemical substances, non-uniformly mixed that can be separated by physical means (e.g., black and white marbles)

Pure Substances

Element: a pure substance that contains a single type of atom and can not be decomposed into two or more substances; one of about 106 unique atoms on the periodic table (e.g., Ag, Fe, or Br₂)

Compound: 2 or more elements bonded together in fixed proportions (e.g., CO₂, KAl(SO₄)₂, or NO); a pure substance that contains two or more elements

Atom: the smallest chemical substance that has the properties of that element

Molecule: smallest discrete element or compound (e.g., O₂(g) or H₂O(g)) that maintains the chemical characteristics of that species; individual pieces

Ions: charged atoms or compounds

Chemical Property: how a substance reacts chemically (e.g., C(s) can react with O₂(g) to form CO₂(g))

Chemical Change: a chemical reaction has occurred and the atoms are rearranged or new ones added (going from C(s) to CO₂(g))

Chemical reactions: an equation that shows the starting material (*reactants*) and the finished material (*products*)

Physical Property: characteristics of chemicals (e.g., solubility, its phase, boiling and melting point, D, etc.)

Physical Change: a change in the state of matter (e.g., H₂O(s) to H₂O(l))

Extensive Property – property that depends on the quantity of material (mass)

Intensive Property – property that is independent on the quantity of material (density)

SIGNIFICANT FIGURES – *for exams, a problem with 3 numbers, 2 with three sig figs and 1 with four sig figs, the answer should contain 3 sig figs (though 4 sig figs will also probably be accepted on exams); note that your TA may expect the rules to be followed more exactly on quizzes*

- “Regular” number: All numbers are significant (5.447 = 4 sig figs; 1015 = 4 sig figs)
- Number is < 1: Numbers to the right of decimal are significant (0.2560 = 4 sig figs); leading zeros don't count as significant (0.0025 = 2 sig figs)
- Number is > 1: All zeros right of the decimal are significant (547.00 = 5 sig figs; 240.0 = 4 sig figs)
- Number is > 1 without decimal: all trailing zeros are not significant (547 = 3 sig figs; 240 = 2 sig figs)
- Defined quantity: Infinite sig figs (12 is 1 dozen = infinite sig figs)
- Scientific notation: All numbers of the argument are significant (2.304 x 10⁻² = 4 sig figs; 1.0400 x 10⁻⁴ = 5 sig figs)

Manipulating Sig Figs

- When A and B are multiplied/divided: answer has the same number of sig figs as the smaller number of sig figs in A or B ($1.20 \times (6 \times 10^{-2}) = 0.072$; with correct sig figs: 0.07)
- When A and B are added/subtracted: answer has the same number of decimal values as the smaller number of decimal values of A or B ($2.34 + 4.9 = 7.24$; with sig figs: 7.2)
- When A and B and C are added/subtracted and multiplied/divided: First parentheses (adjust to correct sig figs), second multiply/divide (adjust to correct sig figs); add/subtract (adjust to correct sig figs)

TEMPERATURE CONVERSIONS

$$K = 273 + ^\circ C \quad (\text{or } ^\circ C = K - 273)$$

$$^\circ F = \frac{9}{5} ^\circ C + 32 \quad [\text{or } ^\circ C = \frac{5}{9} \{^\circ F - 32\}]$$

$$\text{Density} = \frac{\text{mass}}{\text{volume}} \quad \text{units: g/ml (liquids), g/cm}^3 \text{ (solids), or g/L (gases)}$$

SI UNIT CONVERSIONS

$$G = \text{giga} = 1 \times 10^9$$

$$M = \text{mega} = 1 \times 10^6$$

$$k = \text{kilo} = 1 \times 10^3$$

$$d = \text{deci} = 1 \times 10^{-1}$$

$$c = \text{centi} = 1 \times 10^{-2}$$

$$m = \text{milli} = 1 \times 10^{-3}$$

$$\mu = \text{micro} = 1 \times 10^{-6}$$

$$n = \text{nano} = 1 \times 10^{-9}$$

$$p = \text{pico} = 1 \times 10^{-12}$$

$$f = \text{femto} = 1 \times 10^{-15}$$

$$\text{\AA} = \text{\AA}ngstrom = 1 \times 10^{-10}$$

$$1\text{ml} = 1\text{cm}^3$$

$$1000\text{L} = 1\text{m}^3$$

Another way to use conversion factors is (examples are for meters):

$$1\text{Gm} = 1 \times 10^9 \text{ m}$$

$$1\text{Mm} = 1 \times 10^6 \text{ m}$$

$$1\text{km} = 1 \times 10^3 \text{ m}$$

larger than the unit (e.g., meter) ↑

smaller than the unit ↓

$$1\text{m} = 1 \times 10^1 \text{ dm}$$

$$1\text{m} = 1 \times 10^2 \text{ cm}$$

$$1\text{m} = 1 \times 10^3 \text{ mm}$$

$$1\text{m} = 1 \times 10^6 \text{ }\mu\text{m}$$

$$1\text{m} = 1 \times 10^9 \text{ nm}$$

$$1\text{m} = 1 \times 10^{12} \text{ pm}$$

$$1\text{m} = 1 \times 10^{15} \text{ fm}$$

DIMENSIONAL ANALYSIS (UNIT CONVERSIONS)

Precision – measure of how close several measurements are to one another

Accuracy – how close a measured value is to the accepted value

Kinetic-Molecular Theory: All matter consists of tiny particles in constant motion. In solids, the particles are packed in close array. The particles vibrate but do not move past one another. In liquids and gases, particles are arranged randomly and can move past one another. In liquids the particles are close to one another so liquids can not be compressed, while in gases, the particles are large distances apart so gases are easily compressible. Because of the motion of gases, they always fill the container they are placed in.

- Classify each of the following as a physical property or a chemical property.
 - Density
 - Melting temperature
 - Substance that decomposes into two elements upon heating
 - A substance that does not react with sulfur
- Classify each of the following as a *heterogeneous mixture*, *homogeneous mixture*, or a *pure substance*.
 - water
 - water and white sand
 - water and oil
 - water and dissolved sugar
- Do the following unit conversions.
 - How many kg are there in 53g?
 - How many μL are there in 1.25kL?
 - What is the speed of light ($3.00 \times 10^8\text{m/s}$) in km/hr?
 - The amount of fresh water on earth is estimated to be $3.37 \times 10^8 \text{ km}^3$. What is this volume in L? ($1\text{cm}^3 = 1\text{ml}$)
- What does an intensive property mean and give an example.
 - What is a homogeneous solution and give an example.
 - What is a compound mean and given an example.
- The density of aluminum is 2.70 g/ml. How much volume is occupied by 0.055 kg of aluminum? Express the answer in units of ounces (oz). (1 liter = 1.057 quarts; 32 oz = 1 quart)
- A cube of metal has a side length of 2.0 cm and a mass of 40.0 grams. What is its density in g/cm^3 ?
- State the kinetic-molecular theory of matter.
 - Using the KMT, why does a solid have a fixed shape?
- The density of homogenized milk is 1.03 g/ml. How much does 1 cup (236 ml) of homogenized milk weigh, in pounds? (1 kg = 2.2 lbs)
- How many sig figs are in the following numbers? a. 124.02 b. 0.00045 c. 120,000,000 d. 10 e. 1.00045
- Tungsten metal, which is used in light bulb filaments, has the highest melting point of any metal, 3410 °C. What is this melting point in °F?
 - Helium has the lowest boiling point of any liquid. It boils at 4 K. What is its boiling point in °C and °F?

ANSWERS

- physical property
 - physical property
 - chemical property
 - chemical property
- pure substance
 - heterogeneous mixture
 - heterogeneous mixture
 - homogeneous mixture
- 0.053kg
 - $1.25 \times 10^9 \mu\text{L}$
 - $1.08 \times 10^9 \text{km/hr}$
 - $3.37 \times 10^{20} \text{ L}$
- A property that is independent of the quantity of material present. Density, boiling point, etc.
 - A solution (solvent + solute) that is uniform macroscopically. NaCl dissolved into water.
 - A compound is a substance that contains at least 2 elements. NaCl, H₂O, etc.
- 0.689 oz 6. 5.0 g/cm^3
- All matter consists of tiny particles in constant motion. In solids, the particles are packed in close array. The particles vibrate but do not move past one another. In liquids and gases, particles are arranged randomly and can move past one another. In liquids the particles are close to one another so liquids can not be compressed, while in gases, the particles are large distances apart so gases are easily compressible. Because of the motion of gases, they always fill the container they are placed in.
 - Since the particles in a solid do not move but rather only vibrate, the solid retains
- 0.535 lb 9. a. 5 b. 2 c. 2 d. 1 e. 6 10. a. 6170 °F b. -269 °C, -452 °F