CHEM 1211 Promo Workshop
Chapter 1:
Chemical Foundations

Looking for Study Help? Register for our *Semester Plan*, which includes **Workshops** for each chapter covered in your course, **Exam Review Sessions** for all your exams, including a handy **Mock Exam** with solutions, and **Office Hours**!

Prefer buying products individually? Use our Workshops, Exam Reviews, and Mock Exams individually to achieve your goals!

Current Course Offerings at Science Guyz:

- General Chemistry 1 - CHEM 1211
- General Chemistry 2 - CHEM 1212
- Physics 1 – PHYS 1111
- Physics 2 – PHYS 1112
- Organic Chemistry 1 - CHEM 2211
- Organic Chemistry 2 - CHEM 2212
- Biology 1 – BIOL 1107

Fall 2021

For hours of operation, important dates and other info, check our regularly updated website:

www.scienceguyz.com

Science Guyz, LLC | 250 W Broad St STE 102 Athens, GA 30601 | Phone: 706-723-8436
Email: tutor@scienceguyz.com | Website: www.scienceguyz.com |

The semester plan is only $230 (through August 18th, $250 after) and includes Workshops covering *all* chapters in your course, Office Hours online and in person at our store multiple times a week, Exam Reviews for each one of your major exams, and Mock Exams that are the length and style of your lecture exams. All materials have been redesigned for the Fall 2021 semester and reflect the most current version of the textbook (Zumdahl book).

We have detailed videos explaining all the concepts and problems in the workshops available to stream at https://scienceguyz1.vhx.tv. The videos can be watched at any time, but packets besides this promo must be picked up at our downtown store (250 W Broad Street STE 102 Athens, GA 30601)

Video Solution to the Promo can be found here:
https://youtu.be/jF4YaiJke5s

Don't miss out on the **most complete and experienced** academic support around for UGA STEM classes! With 10+ years of tutoring UGA students in Chemistry, Science Guyz has your back! See what student have to say about us on our Student Testimonial page.
https://www.scienceguyz.com/student-testimonials

<u>Learning Objectives:</u> By the end of this workshop, you should be able to:

- Understand the scientific method and what is included in it.
- Compare a hypothesis, theory, and law and know the differences between them.
- Recognize both quantitative and qualitative information and know the differences between them.
- Describe macroscopic versus microscopic properties and know the differences between them.
- Describe the difference between precision and accuracy and provide examples of each.
- Convert numbers into and out of scientific notation.
- Describe what significant figures are and why they are important to consider.
- Determine how many significant figures are present in a number and the rules behind how to determine this.
- Perform operations such as addition, subtraction, division, and multiplication with significant figures in mind.
- Perform multiple operations while considering significant figures.
- Perform temperature conversions between Celsius, Kelvin, and Fahrenheit.
- Describe conceptually the difference between the three different temperature scales.
- Describe the SI units used for common properties.
- Understand the metric system, including the prefixes and abbreviations and be able to convert to various units within the system.
- Understand why we use dimensional analysis and the applications of it in various situations.
- Recognize common conversions from various units.
- Be comfortable with multi-step unit conversions.
- Describe density and how we can apply this physical quantity to various situations.
- Describe the different classifications of pure substances and provide relevant examples of each.
- Describe the different classifications of mixtures and provide relevant examples of each.
- Recognize model interpretations of concepts from this chapter (pure substances, mixtures, etc.)
- Describe the difference between physical properties/changes and chemical properties/changes and provide examples of each.
- Describe the three states of matter, as well as the Kinetic-Molecular Theory of Matter.
- Define the Law of Conservation of Matter and recognize its applications.
- Define extensive and intensive properties and provide relevant examples of each.
- Describe the difference between mass and weight.

<u>Chemistry and its Methods</u>:

I. **The Scientific Method**: The path that leads from experiments, hypotheses and observations into theories or laws. The pathway of the scientific method is **questions → hypothesis → predictions → experimental tests → repeatable results that either support or refute the hypothesis.**

Figure 1: Work by "Thebiologyprimer " From Wikimedia Commons https://creativecommons.org/publicdomain/zero/1.0/deed.en

a. **Observation:** Something that you notice in nature or in an experiment. Observations are also referred to as data.

b. **Hypothesis**: A tentative explanation or prediction based on experimental observations. It is important to note that a hypothesis *MUST* be falsifiable to be considered scientific. We only accept a hypothesis when it has withstood *MULTIPLE* experimental tests and it has good explanatory power.

c. **Theory**: A unifying principle that explains a group of facts and the laws based on them. If a hypothesis can explain a large amount of experimental data, it can move from a hypothesis to a theory. Essentially, a theory amplifies a hypothesis and gives predictions.

d. **Law**: A concise statement of a relation that is always the same under the same conditions. Laws describe or predict some facet of the natural world. Some hypotheses attempt to explain a behavior that is summarized in a law.

> You may now be asking yourself "wow, a theory and a law pretty much sound like the same thing, how am a supposed to tell the difference?!" **Laws** will describe **what** will occur in a particular situation. Many laws (but not all) will be supported by a mathematical expression. **Theories** describe **why/how** that situation occurs.

e. **Qualitative Information**: Consists of <u>non-numerical</u> data such as the color of a substance or its physical appearance.

f. **Quantitative Information**: Consists of <u>numerical</u> data such as the mass of a substance or the temperature at which a substance melts or boils.

g. **Macroscopic**: Refers to properties of matter which is large enough to be seen with the naked eye (phase of matter, and expanding/contracting, for example).

h. **Microscopic**: Refers to properties of matter which is exceedingly small and requires the aid of a machine such as a microscope to view it (arrangement of electrons, for example).

<u>Example</u>: A __________________ is a mathematical expression that summarizes a pattern found in observations and a __________________ is the explanation of the expression based on experiments.

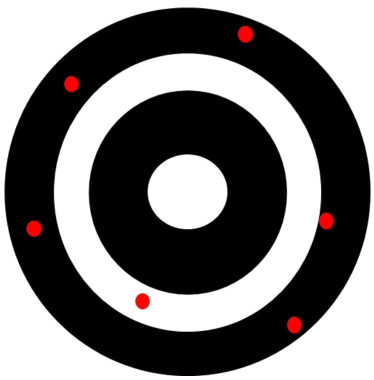
Science Guyz, LLC | 250 W Broad St STE 102 Athens, GA 30601 | Phone: 706-723-8436
Email: tutor@scienceguyz.com | Website: www.scienceguyz.com |

<u>Example</u>: In lab, you mix two chemicals and notice that the reaction between the two chemicals produces light. This is an example of a ______________ and a tentative explanation of this phenomenon that could be further tested would be your ________________.

<u>Accuracy vs Precision</u>:

I. **Accuracy:** Accuracy is a measure of how close a value obtained is to the true value.

II. **Precision:** A precise measurement is a measurement that yields similar results when repeated in the same manner. <u>Precision values do not have to correspond with the true value</u>.



Low precision, low accuracy

High precision, low accuracy

High precision, high accuracy

<u>Example</u>: Employees of the manufacturing plant are asked to make measurements regarding the amount of liquid present in a container. The amount of liquid present is known by the company to be 31.5 mL. Their collected measurement data is shown in the table.

Banks	**Ansley**	**Megan**	**Austin**	**Kailee**
31.0 mL	30.7 mL	29.7 mL	29.1 mL	31.1 mL
31.5 mL	30.5 mL	31.1 mL	30.1 mL	30.7 mL
30.8 mL	30.6 mL	27.6 mL	31.0 mL	29.9 mL

1. Which of the employee's measurements is the most *accurate*? ____________________

2. Which of the employee's measurements is the most *precise*? ____________________

Scientific Notation:

I. A number is written in **scientific notation** when in the form $a \times 10^n$ where $1 \leq |a| < 10$ and n is an integer. Scientific notation is used to make a large or small number with lots of zeros (like 18,300,000,000) more compact by writing them as a product of a power of 10.

Practice: Write 2,000.0 in scientific notation form.

1. Move the decimal so that the number has a value (absolute) between 1 and 10.
   In this example, we must move the decimal three places to the **left**.

$$2000.0 \Rightarrow 2.0000$$

2. Multiply the value you are left with by 10^n where n is the number of places the decimal was moved. If the decimal had to be moved to the left, make n positive, and if the decimal was moved to the right, make n negative. In this example, we moved the decimal 3 space to the left, so n is positive 3. Thus, in scientific notation, the value is.

$$\Longrightarrow 2.0000 \times 10^3$$

Practice: Write 0.000807 in scientific notation form.

1. We must move the decimal 4 places to the right to get a number between 1 and 10.

$$0.000807 \Rightarrow 8.07$$

2. Multiply by 10^{-4} (where the 4 is negative since we moved the decimal to the **right**) to get the value in scientific notation:

$$\Longrightarrow 8.07 \times 10^{-4}$$

Example: Convert the following numbers into or out of scientific notation.

0.0000783 ____________________

9.3×10^6 ____________________

<u>Significant Figures</u>:

Figure 2 Work by "Horia Varlan"/Flickr https://creativecommons.org/licenses/by/2.0/legalcode

I. **Significant figures** involve the numbers in a measured quantity or value that are known to be correct and one digit that is not known for sure. A common application of significant figures happens nearly every day in your General Chemistry lab with reading glassware.

- **a.** To the right a graduated cylinder. Each mark on the graduated cylinder represents a 0.1 mL increase in volume.
- **b.** With the graduated cylinder to the right, it is known for sure that the true liquid measurement lies between 15.0 mL and 15.1 mL. We are confident in the value of the ones and tenths place, but the digit in the hundredths place is an approximation.
- **c.** An appropriate guess for the amount of liquid in this graduated cylinder would be 15.<u>02</u> mL OR 15.<u>03</u> mL. Either answer would be fine since the digit in the hundredths place is an approximation.

II. **Rules for Significant Figures**:

- **a.** All non-zero numbers are significant.
- **b.** Zeroes between two other significant digits are significant, including numbers that include a decimal place (e.g. 2.<u>**0**</u>34, 1<u>**0**</u>14<u>**0**</u>3).
- **c.** Zeroes following a non-zero number that are also to the left of a decimal are significant (83<u>**000**</u>.)
- **d.** In numbers containing a decimal, all zeros at the end of the number are significant (0.023<u>**0**</u>)
  - Combining rules 2 and 4 shows us that the 3 zeros at the end of 0.071<u>**000**</u> are significant.
- **e.** Zeroes that do not have either a decimal point or non-zero digit to the right of them are "trailing" zeros and are ***not*** significant. (e.g. 32<u>**0**</u>)
- **f.** Zeroes that occur before any non-zero number are ***not*** significant (<u>**0**</u>.<u>**00**</u>147)

III. **Exceptions to traditional rules:**

- **a.** Counting numbers have an unlimited number of significant figures, meaning that there is no way to make them more precise than they already are. Examples of this would be counting 12 pencils or saying that a molecule is made of three atoms.
- **b.** Known conversions also fall in this category. For example, 1 foot = 12 inches is an example of an errorless conversion.

Example: Determine the number of Significant figures contained within each of the following numbers:

1. 0.0400 ____________________
2. 9.430 ____________________
3. 0.0067 ____________________
4. 2.00011 ____________________
5. 4.335 x10^{-22} ____________________
6. 9600 ____________________
7. 9 pencils ____________________

IV. Rounding following Mathematical Operations:

a. Following any mathematical operation, you must determine how many sig figs will be in your answer using sig fig rules.

b. Once you have deteremined the correct number of sig figs, you must round your answer to the correct number of significant figures by looking to the first non-significant digit in your answer.

c. If this number is 5 or greater, you will round your last significant digit up, otherwise you will round you answer down to the first significant digit to the left of the non significant digit.

V. Sig Figs in Multiplication and Division Problems:

a. When multiplying/dividing two or more numbers, to express your answer in the correct number of sig figs, your answer must contain the same number of sig figs as the value in your equation with the fewest number of sig figs.

(3.2005470) x (30.9) = ____________

VI. Sig Figs in Addition and Subtraction Problems:

a. When adding or subtracting two or more numbers, to express your answer in the correct number of sig figs, your answer must contain the same number of decimal places as the value in the equation with the fewest decimal places.

(321.1896) + (1.98665) + (0.1) = ____________

VII. Sig Figs with Multiple Operations:

a. You will often find yourself performing operations that involve both addition/subtraction rules and multiplication/division rules. Perform operations in order as dictated by PEMDAS and carry the exact numbers that you obtain throughout the operation. We will only consider significant figures at the end. Consider the examples below:

(2.9 x 4.719) + 12.710 = ____________

(30.0031 + 0.3) (6.211 – 6.185)/ 5.233 x 10^{-2} = ____________

Common SI Base Units Used in Chemistry:

I. **The International System of Units, or SI**, is the scientific system for measurements. Most measurements in Chemistry are made in SI units and it is important to know the SI unit used for each property provided below:

Property	**Unit Used**
Mass	Kilogram (kg)
Length	Meter (m)
Time	Second (s)
Temperature	Kelvin (K)
Amount of Substance	Mole (mol)

II. **The Metric System (Commit to Memory!):**

Prefix	**Abbreviation**	**Meaning**	**Example**
Giga-	G	10^9 (billion)	1 gigahertz = 1 x 10^9 Hz
Mega-	M	10^6 (million)	1 megaton = 1 x 10^6 tons
Kilo-	k	10^3 (thousand)	1 kilogram (kg) = 1 x 10^3 g
Dec-	d	10^{-1} (tenth)	1 decimeter = (dm) 1 x 10^{-1} m
Centi-	c	10^{-2} (hundredth)	1 centimeter = (cm) 1 x 10^{-2} m
Milli-	m	10^{-3} (thousandth)	1 millimeter = (mm) 1 x 10^{-3} m
Micro	µ	10^{-6} (millionth)	1 micrometer = (µm) 1 x 10^{-6} m
Pico-	p	10^{-12}	1 picometer = (pm) 1 x 10^{-12} m
Femto-	f	10^{-15}	1 femtometer = (fm) 1 x 10^{-15} m

III. **Other Useful Conversions:**

a. Several useful conversions are provided below. Depending on when you are taking this class you may be expected to memorize all conversions, or your instructor may give you certain ones. Ask your instructor for their expectations on the conversions!

1 kilometer = 0.62137 mile	1 mile = 5,280 feet
1 meter = 3.281 feet	1 inch = 2.54 cm
1 cm^3 = 1 mL	1 Angstrom (Å) = 1 x 10^{-10} m
1 pound = 453.59 g = 16 ounces	1 mile = 1760 yards

Science Guyz, LLC | 250 W Broad St STE 102 Athens, GA 30601 | Phone: 706-723-8436
Email: tutor@scienceguyz.com | Website: www.scienceguyz.com

<u>Dimensional Analysis Introduction</u>:

I. In chemistry studies, you will often have to convert from one unit to another. This can be a multistep process that can become tedious. Dimensional analysis provides a strategy to organize these conversions.

1. When unit conversions are needed, first establish what your final units must be.
2. Consider the numerator/denominator relationship of the final unit.
    a. For example, miles per hour requires miles in the numerator and hours in the denominator (miles / hour). So, the result of your dimensional analysis conversions must reflect this.
3. Choose a value as a starting point for your conversion. This is the first blank in "I am converting ____ to ___." It is usually helpful to start with a given value that only has one unit associated with it if possible.
4. Set up a series of conversion steps that allow you to cancel all unwanted units and leave you only with the final units.
    a. Each conversion step is a fraction. They may things like conversion factors (1 hour / 60 seconds) or properties like density (grams / liter) or molar mass (grams / mole)
    b. Units can be canceled when they are found in the numerator and denominator of a dimensional analysis calculation, *regardless of if they are in consecutive steps.*
5. Once your units have canceled to your final units, multiply across the numerators and denominators, divide the products, and you are finished.

<u>Example</u>: How many picograms are in a milligram?

<u>Example</u>: How many millimeters are in 4.20 centimeters?

<u>Example</u>: Convert 5.1 meters per second to micrometers per hour.

<u>Example</u>: Banks is travelling to Atlanta. One gallon of gas will allow him to travel for 8.5 miles. If it takes him 95 minutes to get to Atlanta and he travels at a speed of 65 miles/hour, how many gallons of gas does he use?

<u>Example</u>: You are a medical assistant and need to administer a medication to help a patient with hip pain. The recommended dosage of this medication is 6.71 mg/kg of body mass. What would be the dosage in milligrams for a 225-lb individual? <u>Note</u>: 1 lb = 453.59 g.

<u>Example</u>: Megan is moving up in the world and has decided it is time to install a pool. Megan wants the pool to have the following dimensions: 58.7 ft long and 27.0 ft wide and 9.50 ft deep.

1. Once the pool has been completed, how much water will Megan need to fill the pool (in cubic inches)?

2. Convert the cubic inches obtained in the previous example into cubic centimeters.

Temperature Conversions:

I. **Temperature** is a physical quantity representing the manifestation of thermal energy. It is how we associate something as being hot or cold. There are three different temperature scales that you need to become familiar with and how to convert between these different scales.

a. **The Celsius (°C) scale** is defined by assigning 0 °C to the freezing point of pure water and 100 °C to the boiling point of pure water.

b. **The Fahrenheit (°F) scale** is defined by assigning 32 °F to the freezing point of pure water and 212 °F to the boiling point of pure water.

c. **The Kelvin (K) scale** uses the same size unit as the Celsius scale but assigns 0 to the lowest possible temperature (absolute zero). There are no negative values associated with this scale and the ° symbol is not used in the scale.

d. The three formulas you need to commit to memory are provided below. On your exam, be ready to convert between the three scales and/or be asked a conceptual question about the scales.

K = °C + 273.15	**°C =** $\frac{5}{9}(°F - 32)$	**°F =** $\frac{9}{5}°C + 32$

Example: Convert each of the following temperatures into the desired units:

Pay special attention to the parenthesis placement is the Celsius versus Fahrenheit formulas!

1. 607 $°C$ to Kelvin: __________

2. 48.3 K to Celsius: __________

3. 340 $°F$ to Kelvin: __________

4. -39.1 $°C$ to Fahrenheit: ___________

States of Matter:

I. Whether a substance is a solid, liquid or gas refers to the **state** of the substance. The state of a substance depends on how the individual particles which make up a substance interact with one another. Remember that state changes are physical changes.

II. **The Kinetic-Molecular Theory of Matter:** states that as matter gains energy, its temperature increases. Increased temperature reflects an increase in the average kinetic energy of the particles. As this kinetic energy increases, matter eventually transforms from the solid phase to liquid, and eventually gas. Therefore, the gas phase contains the most kinetic energy, and solid the least.

a. **Solids:** In a solid, the attractive forces between the particles that compose the solid are stronger than the kinetic energy of the individual particles. As a result, particles within a solid are packed closely together and are arranged in a regular pattern. The particles within a solid do have some kinetic energy which causes the particles to vibrate back and forth about their average positions. However, particles within a solid seldom move past neighboring particles. Solids retain fixed volume and shape. Solids are *not* compressible.

b. **Liquids:** The kinetic energy of the particles in a liquid are such that they have begun to overcome their attractive forces. In a liquid, particles are arranged randomly rather than in a regular pattern. Liquids are fluid because the particles of liquids are not confined to specific areas and they can move past each other. Liquids have no definite shape. Instead, they assume the shape of the container in which they occupy. Liquids are *not* compressible.

c. **Gases:** In a gas, the kinetic energy of the particles that compose the gas is such that the individual particles of the gas have completely overcome their attractive forces of the individual particles. In a gas, under ideal conditions, the particles composing the gas are far apart. Gas particles fly about colliding with one another and the walls of the container in which they occupy. The random motion of gas particles allows a gas to fill the volume of the container in which they reside. Essentially, the volume of any container containing a gas equals the volume of the gas within the container. Gases ARE compressible.

Example:

1. What state is A in?

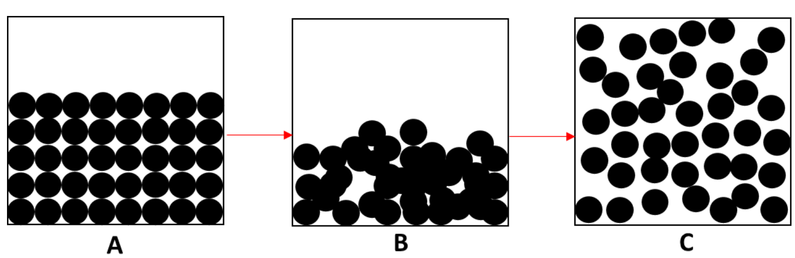
   ____

2. What state is B in?

   ____

3. What state is C in?

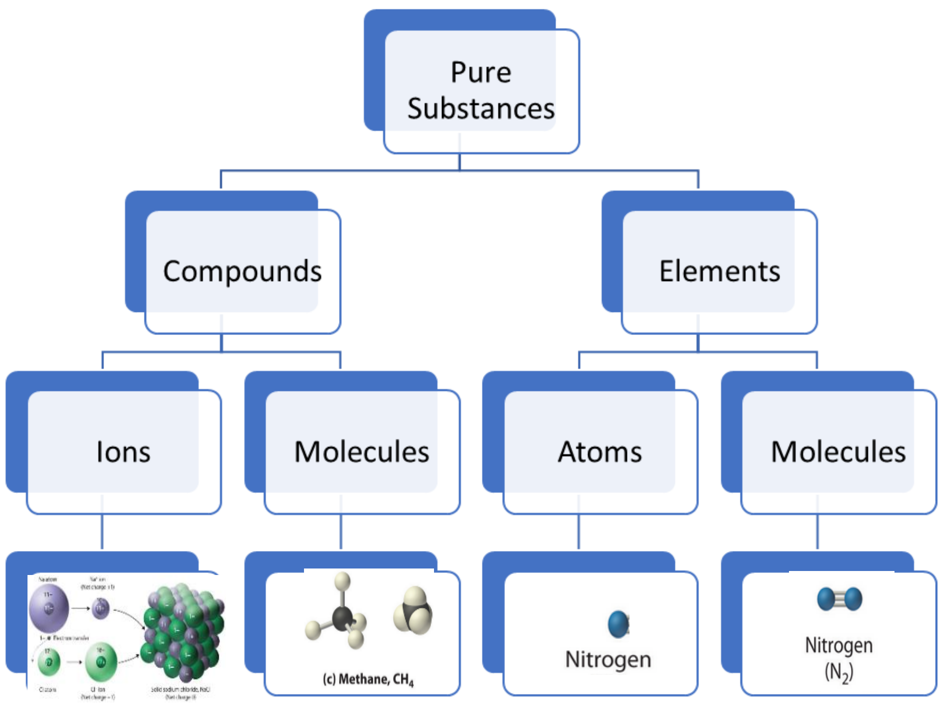
   ____



<u>Pure Substances and Mixtures:</u>

I. **Pure Substances**: Have a unique set of physical properties by which they can be recognized (ex: melting point, boiling point, and density). Additionally, pure substances <u>*cannot*</u> be separated into two or more different species by any physical technique at ordinary temperatures.

- **a. Elements**: Substances which *cannot* be subdivided by a chemical or physical process.
- **b. Molecules**: Formed when two or more atoms (the atoms can be the same or different) join to form chemical bonds in fixed ratios.
- **c. Compounds**: Groups of two or more *different* atoms joined by chemical bonds in fixed ratios. When atoms bind together to form compounds, the original properties of the elements (color, hardness, melting point, and boiling point) are replaced by the properties of the compound.
- **d. Ions**: Electrically charged atoms or groups of atoms (Na^+ or Cl^-).



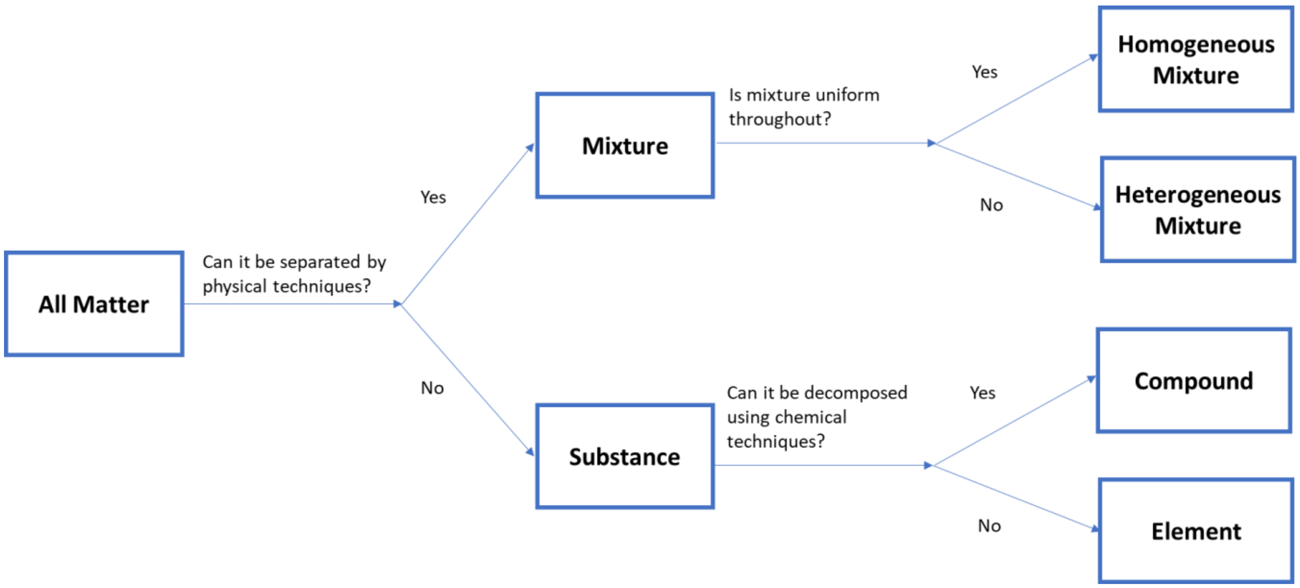
II. **Mixtures**: Consist of two or more pure substances that can be separated by physical techniques. Mixtures can be categorized as homogenous or heterogeneous. When a mixture is separated into its individual components (typically through a lab technique known as **filtration**), the components are considered purified.

- **a. Heterogeneous Mixture**: A mixture in which the components of the mixture are *unevenly distributed.* Examples include a bowl of cereal, milk, a salad, sand, and mud.
- **b. Homogeneous Mixture**: A mixture of two or more substances, in the same phase, which the substances are evenly distributed. Homogenous mixtures are often called **solutions**. Examples include wine, black coffee, and common sports drinks.

Example: You begin to boil some water for pasta! You are not paying attention and accidently evaporate all the water, leaving behind only salt crystals that were not previously visible in the water. This serves as an example of a ______________________________.

Example: The breakdown of liquid X produces two different liquids that are known to be pure substances. Using this information, answer each of the following statements as true or false.

1. True/False: Liquid X cannot be an element.
2. True/False: The products from the breakdown are for sure both elements.

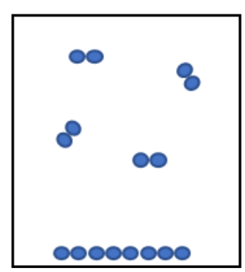


Pure substances and Mixtures and Model Interpretations:

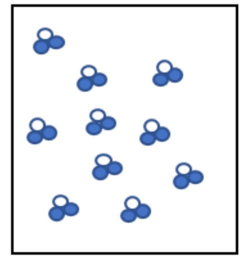
I. The definitions of types of pure substances and mixtures are straight forward at a glance; however, your exam is not going to be simple recall of definitions, but rather application of the different definitions.

II. Interpreting models and figures is an important skill you will develop throughout your time in CHEM 1211. An instructor will give you a figure or a model and ask you what it is an example of. We will walk through a few examples of this below.

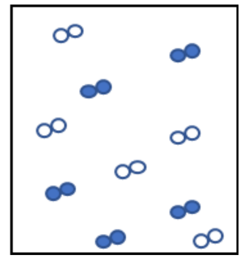
a. The model to the right has two spheres linked together that are the same color. Since all the spheres are the same color and nothing else is present, this is an example of a **pure substance**, more specifically a **molecule** made from the same elements. We know this since the spheres linked together are the same color. Another interpretation of this model could be a **phase change** since the molecules are close together with a defined shape at the bottom (solid) and closer to the top they are more spread out with not specific shape or volume (gas).



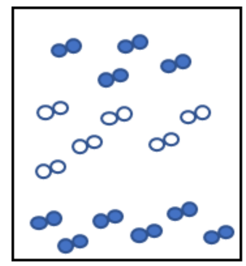
b. The model to the right has three spheres linked together with two of them being the same color and one being a different color. Since the spheres are not all the same color, this is an example of a **compound**. Understand that this it is still an example of a **pure substance** since there is nothing else present besides that one compound.



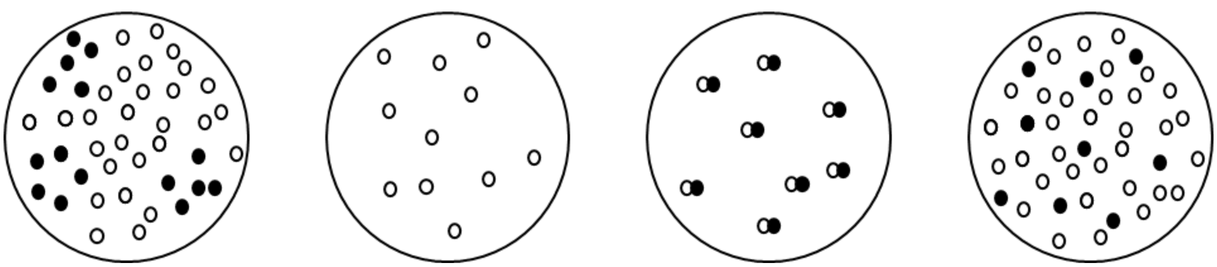
c. The model to the right has two different sets of spheres linked together that are different colors. Since we have these two separate sets of spheres that are different colors, we know that we are looking at a **mixture**. Defining this mixture further, we can see that there is an even distribution of the different colored spheres, meaning that we are looking at a **homogeneous mixture**.



d. The model to the right has two different sets of spheres linked together that are different colors. Since we have these two separate sets of spheres that are different colors, we know that we are looking at a **mixture**. Defining this mixture further, we can see that there is not an even distribution of the different colored spheres (they are layered), meaning that we are looking at a **heterogeneous mixture**.



Example: Four diagrams are provided below. Use these diagrams to answer the following questions.



I. **II.** **III.** **IV.**

1. Which diagram(s) represent(s) an element? __________
2. Which diagram(s) represent(s) a compound? __________
3. Which diagram(s) represent(s) a pure substance? __________
4. Which diagram(s) represent(s) a mixture? ___________

Physical Changes and Chemical Changes:

I. **Physical Properties**: Properties that can be observed and measured *without changing the composition of the substance.*
   a. Examples of physical properties include color, state of matter, melting point, boiling point, density, solubility, conductivity, malleability, ductility, and viscosity.

II. **Physical Changes**: Changes in the physical state (solid, liquid or gas) or size/shape of a substance.

III. **Chemical Changes**: Changes which convert one or more substance into one or more different substances.
   a. A chemical change will **always** result in a change in composition.
   b. There are other things that occur that indicate a chemical change has occurred, including odor production, color change, light production, new product formation, sound production, change in energy, and fizzing or foaming (gas).

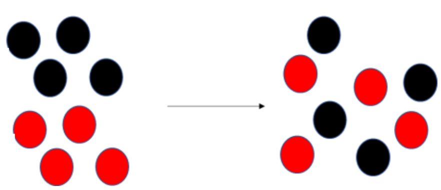
IV. **Chemical Properties**: Properties which determine whether and how readily a substance **reacts** (changes into a different substance).

Example: Describe the following changes as physical or chemical.

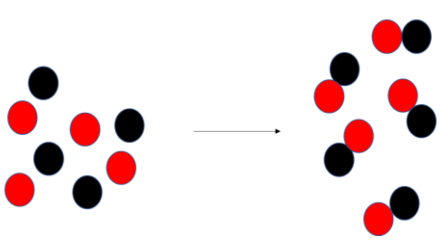
2. A piece of paper is burned ____________________________
3. Paper is balled up ____________________________
4. Removing salt from sea water ____________________________
5. Removing carbon from carbon dioxide ____________________________

Example: Several models are provided below. Identify whether the model is depicting a chemical change or a physical change.

1. Physical or chemical?

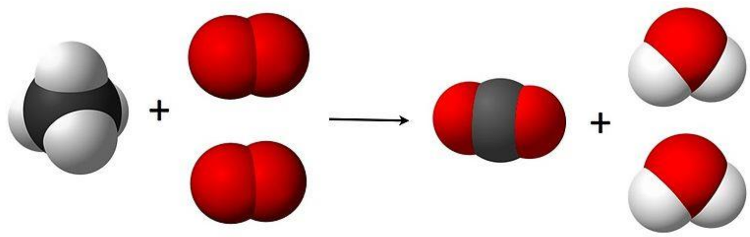


2. Physical or chemical?



<u>More on Physical Properties of Substances</u>:

I. **Law of Conservation of Matter:** For any system closed to all transfers of matter, the mass of the system must remain constant over time; the mass of a system cannot change if mass is not added or removed from the system.



$$CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O$$

<u>Example</u>: Element A is known to react with element B to form compound AB. Under ideal conditions, how much of element A is required to form 30.5 g of compound AB if we have 20 g of element B present?

II. **Intensive Properties**: An intensive property is a bulk property, meaning that it is a physical property of a system that does not depend on the size or the amount of sample in the system. Examples include density, odor, color, luster, malleability, ductility, conductivity, hardness, melting point, and boiling point.

III. **Extensive Properties**: An extensive property is a physical property of a system that changes with the size of the sample measured (it is additive). Examples include mass, volume, length, or total charge.

<u>The Difference Between "Mass" and "Weight":</u>

I. **Mass** describes the quantity of matter contained within a thing/object. The standard unit for mass is the kilogram, however we will often discuss mass in terms of grams. **Weight** on the other hand has to do with the force of gravity on an object and is proportional to the mass of an object.

a. If you were to take your weight on a scale on the Earth versus the moon, you weight would be significantly less on the moon since the gravitational force is less. Your mass however would be identical on the Earth as on the moon.

<u>Example</u>: For each of the following, determine if the statement provided is True or False:

1. True/False: An intensive property can be determined by dividing two extensive properties.
2. True/False: The value of an intensive property can change.
3. True/False: Density, boiling point, and melting point are all considered intensive properties.

<u>More on Density</u>:

I. **Density** is a common physical property that a pure substance or a homogenous mixture can demonstrate. Density is represented, mathematically, by dividing the mass of the pure substance by its volume. Density was used, before modern analytical methods, to determine the identity of an unknown substance. *In liquid and gas mixtures, substances that are less dense in the mixture will "float" on top of substances that are denser.*

$$\boxed{\boldsymbol{Density} = \frac{\boldsymbol{mass\ (g)}}{\boldsymbol{volume\ (mL\ or\ cm^3)}}}$$

a. A common application of density problems involves fluid displacement. The displacement of a fluid before an object is added to it and after can be used to determine volume of the object used in the displacement. A walk through of a practice problem involving fluid displacement and density can be seen in the following practice problem:

<u>Practice</u>: There is a small pellet of some metal that has a mass of 3.45 g. The pellet is placed into a beaker that contains 20.00 mL of water. The metal pellet is then submerged into the water, which causes the water level in the beaker to rise to 21.28 mL. What is the density of the metal pellet?

1. First subtract the change in water level to determine the volume of the metal pellet:

$$21.28\ \text{mL} - 20.00\ \text{mL} = 1.28\ \text{mL}$$

2. We are given the mass of the metal pellet, which is 3.45 g. We also know that the formula for density is mass/volume. We can now determine the density of the metal pellet:

$$3.45\text{g} \ / \ 1.28\ \text{mL} = \underline{2.70\ \text{g/mL}}$$

<u>Example</u>: A commonly used metal in a manufacturing plant is known to have a density of 11.25 g/mL. If a 0.400 kg cube sample of the metal were taken, what would the volume of the metal be (in cm^3)?

<u>Example</u>: There are three globes on display at your favorite local tutoring company, Science Guyz. These globes have the same mass but have increasing density with globe 1 having the smallest density and globe 3 having the largest. Rank the three globes in terms of increasing volume:

Figure 3 PickPik royalty free images.

Practice Set: Chapter 1

True/False Concept Practice:

Make sure you have your concepts down with these True/False Questions!

1. Scientific theories are derived from hypotheses. ____________
2. A theory can describe what nature does whereas a law explains why it behaves that way. ____________
3. Scientific law can make predictions based on past observations. ____________
4. A good hypothesis must be falsifiable. ____________
5. Theories can conclusively be proven. ____________
6. It is possible for data to be precise, but not accurate. ____________
7. The conversion of a gas to a liquid is an example of a chemical change. ____________
8. Solids, liquids, and gases are all compressible. ____________
9. Hydrogen taken from water is an example of a chemical change. ____________
10. A homogeneous mixture can also be called a solution. ____________
11. Wine, sports drinks, and black coffee are all examples of homogeneous mixtures. ____________
12. Mud, ice water, and a salad are all examples of heterogeneous mixtures. ____________
13. Water is an example of an element. ____________
14. Neon and helium are both examples of elements. ____________
15. Mass and volume are both examples of intensive properties. ____________
16. We can determine an intensive property by dividing two extensive properties. ____________
17. A molecule is composed of 12 atoms. This is equivalent to two significant figures. ____________
18. I measure 1.5600 m. This is equivalent to five significant figures. ____________
19. I combine water (density – 1.00 g/mL) and benzene (density – 0.880 g/mL) into a beaker. I would expect the benzene to be at the top. ____________
20. A color change is indicative of a physical change. ____________
21. A chemical change always results in a change in composition. ____________
22. 1 meter is equivalent to 1 x 10^9 gigameters. ____________
23. Salt is soluble in water. This is an example of a physical change. ____________
24. Molecules are a type of mixture. ____________
25. You predict that your testing average for CHEM 1211 will be an 85%. On your five exams you score an 85%, 85%, 86%. 84%, and 84%. This observation is both accurate and precise. ____________
26. You increase the mass of an object while keeping the volume the same. With this change, you would expect the density to also increase. ____________
27. You increase the volume of an object while keeping the mass the same. With this change, you would expect the density to also increase. ____________
28. Your mass is the same on Earth as it is on the moon. ____________
29. The SI unit for mass is the gram (g). ____________
30. 1 m^3 is equal to 100 cm^3. ____________

Free Response Practice:
Test your knowledge of the material in a free response fashion!

31. For each of the following numbers, indicate the number of significant figures and rewrite the number in scientific notation:

    a) 858.009 seconds
    Number of significant figures: ____________
    Scientific notation: ____________

    b) 0.000034383830 ft
    Number of significant figures: ____________
    Scientific notation: ____________

    c) 3809.08 kg
    Number of significant figures: ____________
    Scientific notation: ____________

32. A series of numbers are provided below. In each, determine if the zeros present are significant or not.
    a) 2.001 kg
    Zeros significant? ____________

    b) 350.00 kg
    Zeros significant? ____________

    c) 150 kg
    Zeros significant? ____________

    d) 0.006 kg
    Zeros significant? ____________

33. Determine whether each of the following is a heterogeneous or homogenous mixture:
    a) Vinegar: ____________

    b) Concrete: ____________

    c) A dilute solution of vinegar in H2O: ____________

    d) Sugar in your morning coffee: ____________

    e) Lemonade with ice: ____________

f) Mud and water: ____________

g) Salsa: ____________

h) A nice red wine: ____________

34. Define each of the following as either an extensive or intensive property:

a) Boiling point: ____________

b) Temperature: ____________

c) Volume: ____________

d) Length: ____________

e) Melting point: ____________

35. A building in Texas is 992 feet tall. How tall is this building in kilometers? Note: Please report your answer to the correct number of significant figures.

36. Some rectangle has side lengths of 5.2 cm and 14.76 cm. What are the perimeter and area of this rectangle? Note: Please report your answers to the correct number of significant figures.

37. Perform each of the following conversions.

a) 0.135 L → ??? mL

b) 435 cm^3 → ??? L

c) 3.55 m^3 → ??? cm^3

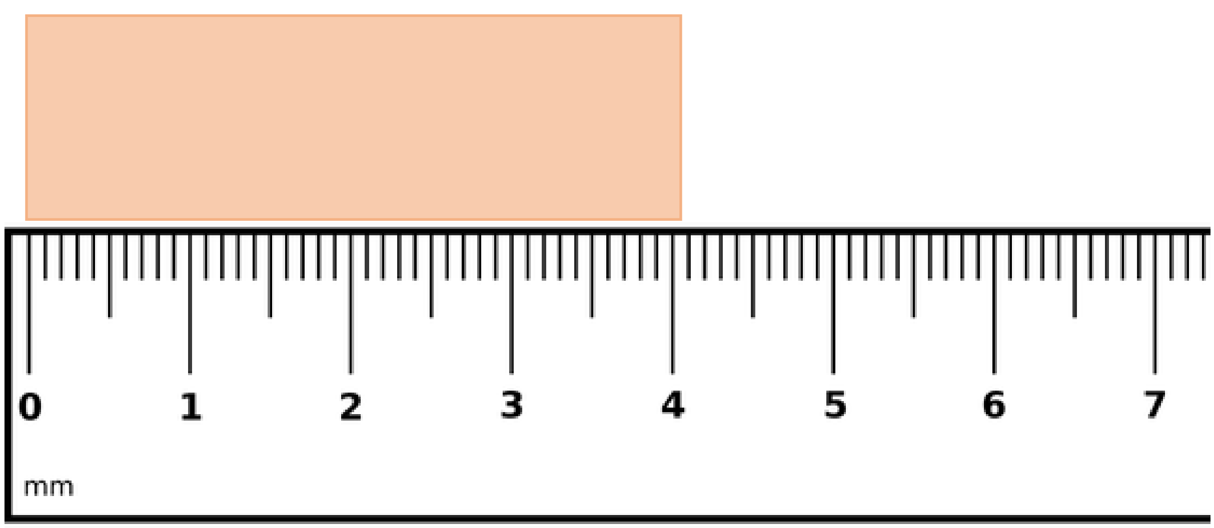
d) 55.5 in → ??? cm

e) 85 ft → ??? m

38. You are traveling at 75.5 miles per hour. How fast are your traveling in meters per second?
    Note: Please report your answer to the correct number of significant figures.

39. You work at a manufacturing plant and are producing a cylinder for a car that has a diameter of 3.54 centimeters and is 5.95 centimeters long. If the cylinder is made up of a metal alloy that is known to have a density of 12.1 g/cm^3, what is the mass (in kilograms) of the cylinder produced?
    Note: The volume of a cylinder can be determined from $V = \pi r^2 h$.

40. Considering significant figures, use the ruler to provide a measurement for the brick.



41. A marksman has arranged bullets of equal mass in order from left to right in increasing density: Bullet A, Bullet B, Bullet C, and Bullet D. You are asked by the marksman to re-order the bullets in order of decreasing volume. What order should the bullets be placed in?

Multiple-Choice Practice:
Test your knowledge of the material in a multiple-choice fashion!

42. You mix together a sample of sand, sugar and water. This serves as an example of ___________.
    a) A compound.
    b) A solid.
    c) A homogeneous mixture.
    d) A heterogenous mixture.
    e) A pure substance.

43. In your chemistry lab, you are exploring several properties of some unknown substance. These properties include:
    I. Density
    II. Boiling point
    III. Temperature
    IV. Mass
    V. Melting Point

    In the properties you investigated, which are considered intensive properties?

    a) I, II, and V.
    b) I, II, III, IV, and V.
    c) I, II, III, and V.
    d) III and IV.
    e) II and V.

44. A separatory funnel is a common instrument used in an organic chemistry lab. It is often used to separate layers of liquids, with the liquids separating in the funnel based on different densities.

    You have a separatory funnel with two liquids present. You know that the top liquid is water (0.998 g/mL), but you do not know what the bottom liquid is. Given the list of liquids below, which one could be the bottom layer?
    a) Heptane (0.790 g/mL).
    b) Triethylamine (0.876 g/mL).
    c) Benzene (0.901 g/mL).
    d) Any of the above liquids could be the top layer.
    e) None of the above could represent the top layer.

45. If you have a funnel that contains water (density: 1.00 g/mL), common cooking oil (density: 0.93 g/mL), and rubbing alcohol (density 0.786 g/mL) and you open the funnel and let the liquid run into a beaker, which liquid will reach the beaker first?
    a) Oil
    b) Alcohol
    c) Water
    d) They will all reach the beaker at the same time.
    e) Cannot determine from the information given.

46. A sample of matter is determined to be uniform throughout. In addition, it cannot be separated into other substances by physical means. The sample of matter could be considered _____________.

    I. A compound

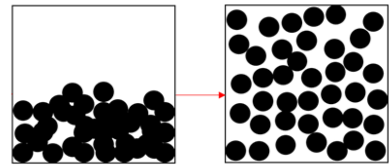
    II. An element

    III. A homogeneous mixture
    a) I only.
    b) II only.
    c) III only.
    d) I and II.
    e) I, II and III.

47. Quality control is an essential procedure to make sure that released products, such as medicine, make up, or food, are up to standard. Failing to have adequate quality control can be dangerous for the consumer and/or can ruin the name behind a product. A drug company is performing quality control on a common pain reliever. They randomly select five pills for analysis. In mg, the pills had masses 74, 73.86, 75.1, 75.5, and 73.62. What is the total mass of the five pain reliever pills?
    a) 372.08
    b) 372.1
    c) 372
    d) 370
    e) 400

48. A research scientist is performing a chemical reaction at 350 K. Based on your conversion knowledge, you know that this reaction was performed at _______ °F.
    a) 170.33.
    b) -23.15.
    c) 662.
    d) 318.
    e) 138.33.

49. A phase change describes the transition between the three states of matter: solid, liquid, and gas. An example of a phase change is provided to the right. What phase transition is depicted in the diagram?



   a) Liquid → Gas.
   b) Gas → Liquid.
   c) Solid → Gas.
   d) Solid → Liquid.
   e) Liquid → Solid.

50. Which of the following are considered chemical changes? *Select all that apply*.
   a) Ice melting in the summer heat.
   b) Light emission from fireworks.
   c) Burning a piece of paper.
   d) Iron rusting on an old car.
   e) Mixing hydrochloric acid and sodium hydroxide (a salt is produced).

51. Which of the following statement(s) is/are true regarding the temperature scales? *Select all that apply.*
   a) Negative values are not possible in all three temperature scales.
   b) The Kelvin scale uses the same size unit as the Celsius scale.
   c) 5 °C is equal to 66.6 °F.
   d) 0 K is the lowest possible temperature on the Kelvin scale.
   e) Water will boil at 212 °F or 100 °C.

52. Choose any statement that is incorrect. *Select all that apply*.
   a) Oxygen gas in the air is an element.
   b) Sugar and coffee together are an example of a homogeneous mixture.
   c) Molecules are two or more atoms chemically joined together.
   d) Tap water is a compound.
   e) A scientific law cannot be modified.

hydrogen 1 **H** 1.0079																		helium 2 **He** 4.0026
lithium 3 **Li** 6.941	beryllium 4 **Be** 9.0122												boron 5 **B** 10.811	carbon 6 **C** 12.011	nitrogen 7 **N** 14.007	oxygen 8 **O** 15.999	fluorine 9 **F** 18.998	neon 10 **Ne** 20.180
sodium 11 **Na** 22.990	magnesium 12 **Mg** 24.305												aluminium 13 **Al** 26.982	silicon 14 **Si** 28.086	phosphorus 15 **P** 30.974	sulfur 16 **S** 32.065	chlorine 17 **Cl** 35.453	argon 18 **Ar** 39.948
potassium 19 **K** 39.098	calcium 20 **Ca** 40.078		scandium 21 **Sc** 44.956	titanium 22 **Ti** 47.867	vanadium 23 **V** 50.942	chromium 24 **Cr** 51.996	manganese 25 **Mn** 54.938	iron 26 **Fe** 55.845	cobalt 27 **Co** 58.933	nickel 28 **Ni** 58.693	copper 29 **Cu** 63.546	zinc 30 **Zn** 65.39	gallium 31 **Ga** 69.723	germanium 32 **Ge** 72.61	arsenic 33 **As** 74.922	selenium 34 **Se** 78.96	bromine 35 **Br** 79.904	krypton 36 **Kr** 83.80
rubidium 37 **Rb** 85.468	strontium 38 **Sr** 87.62		yttrium 39 **Y** 88.906	zirconium 40 **Zr** 91.224	niobium 41 **Nb** 92.906	molybdenum 42 **Mo** 95.94	technetium 43 **Tc** [98]	ruthenium 44 **Ru** 101.07	rhodium 45 **Rh** 102.91	palladium 46 **Pd** 106.42	silver 47 **Ag** 107.87	cadmium 48 **Cd** 112.41	indium 49 **In** 114.82	tin 50 **Sn** 118.71	antimony 51 **Sb** 121.76	tellurium 52 **Te** 127.60	iodine 53 **I** 126.90	xenon 54 **Xe** 131.29
caesium 55 **Cs** 132.91	barium 56 **Ba** 137.33	57-70 *	lutetium 71 **Lu** 174.97	hafnium 72 **Hf** 178.49	tantalum 73 **Ta** 180.95	tungsten 74 **W** 183.84	rhenium 75 **Re** 186.21	osmium 76 **Os** 190.23	iridium 77 **Ir** 192.22	platinum 78 **Pt** 195.08	gold 79 **Au** 196.97	mercury 80 **Hg** 200.59	thallium 81 **Tl** 204.38	lead 82 **Pb** 207.2	bismuth 83 **Bi** 208.98	polonium 84 **Po** [209]	astatine 85 **At** [210]	radon 86 **Rn** [222]
francium 87 **Fr** [223]	radium 88 **Ra** [226]	89-102 **	lawrencium 103 **Lr** [262]	rutherfordium 104 **Rf** [261]	dubnium 105 **Db** [262]	seaborgium 106 **Sg** [266]	bohrium 107 **Bh** [264]	hassium 108 **Hs** [269]	meitnerium 109 **Mt** [268]	ununnilium 110 **Uun** [271]	unununium 111 **Uuu** [272]	ununbium 112 **Uub** [277]		ununquadium 114 **Uuq** [289]				

*Lanthanide series	lanthanum 57 **La** 138.91	cerium 58 **Ce** 140.12	praseodymium 59 **Pr** 140.91	neodymium 60 **Nd** 144.24	promethium 61 **Pm** [145]	samarium 62 **Sm** 150.36	europium 63 **Eu** 151.96	gadolinium 64 **Gd** 157.25	terbium 65 **Tb** 158.93	dysprosium 66 **Dy** 162.50	holmium 67 **Ho** 164.93	erbium 68 **Er** 167.26	thulium 69 **Tm** 168.93	ytterbium 70 **Yb** 173.04
**Actinide series	actinium 89 **Ac** [227]	thorium 90 **Th** 232.04	protactinium 91 **Pa** 231.04	uranium 92 **U** 238.03	neptunium 93 **Np** [237]	plutonium 94 **Pu** [244]	americium 95 **Am** [243]	curium 96 **Cm** [247]	berkelium 97 **Bk** [247]	californium 98 **Cf** [251]	einsteinium 99 **Es** [252]	fermium 100 **Fm** [257]	mendelevium 101 **Md** [258]	nobelium 102 **No** [259]