Honors Chemistry

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Contents

Unit 1

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Lesson 1: The Science of Chemistry **Unit 1**

Definition 1 (Chemistry)**.** Chemistry is the study of composition and the structure of materials and the changes they undergo.

This includes studying materials found in our:

- Ocean
- Atmosphere
- Environment
- Underground
- Etc.…

Chemistry is one of many fields of science that investigate phenomena such as climate change to discover their causes.

Definition 2 (Science)**.** Science must be based on empirical observations, experimentation, explanations based on logical reasoning.

- OBSERVABLE: Science attempts to explain natural phenomena by analyzing and observing the world and testing ideas about it.
- TESTABLE: Science must be able to answer a testable question using observation and experimentation. Investigations must produce empirical evidence that can be observed or measured to be considered science.
- REPLICABLE: Empirical evidence can be replicated, or reproduced, and verified by other scientists if they conduct the same tests and under the same conditions.
- RELIABLE: The more an experiment is repeated, with the same outcomes, the more reliable the evidence becomes. Evidence with bias also increases its reliability.
- FLEXIBLE: Science is an ever-changing body of knowledge as new observations are made through experimentation. As new information is discovered, new evidence can add to current evidence, allowing scientists to improve their theories.

Many fields of knowledge, such as philosophy and art add to our view of the world. They help us appreciate the beauty of the world, interact with one another and decide what is wrong and right. But, since there aren't any observations and tests being applied in those fields and everything in them are just beliefs and opinions, then it cannot be called science.

These two questions will help you determine if the question can be answered with science:

- If the question is asking about an opinion or a moral value, it's not something that can be measured using scientific process. Therefor, it cannot be answered with science.
- If the answer to the question cannot be tested and observed, it is not considered science.

The Scientific Method

A scientific method is a series of steps for investigating questions and testing ideas. There are several versions of the **scientific method**, but all of the versions are based on rational thinking, inquiry, and experimentation. The **scientific method** includes five main steps:

- Question: A scientific method always starts with a question. As long as it's testable, you can use science to find the answer.
- Research: It's important that you always explore what other scientists before have observed and discovered because that information may be able to solve your current question.
- Hypothesis: Most hypotheses are made with the **"if/then"** statements. If "this" happens, then "that" will take place. This helps you know how one thing can affect another and gives you variables to test.
- Testing: An experiment allows you to test your hypothesis to determine if you're correct or incorrect.
- Independent Variable: This variable is the factor the scientist has chosen to change in the experiment. A good experiment should change only one independent variable because this allows the scientist to focus only on the outcome of that specific variable.
- Dependent Variable: This variable is the factor that changes in response to the independent variable in an experiment.
- Controlled Variables: These variables are the factors the scientist chooses to keep constant over the course of the experiment. By keeping all other factors constant, anything happens to the dependent variable is caused by the independent variable.

Sep 09 2021 Thu (08:20:00)

Lesson 2: Measuring Matter **Unit 1**

All measurements are made of **2** parts:

- A number.
- A unit.

Definition 3 (Matter)**.** Anything that takes up space, whether big or small, is **Matter**.

Definition 4 (Volume)**.** In science, the amount of space an object occupies is called **volume**

Definition 5 (Mass)**.** **Mass** is a measure of the amount of matter in an object. This means, the more **Matter** an object has, the object's **Mass** increases.
Scientists measure the **Mass** of an object using the base **Unit Gram**.

U.S. Customary System

The **U.S. Customary System (English System)** consists of measurements we use every day to describe:

- How much we have.
- What size we want.
- How far we want to go.
- Etc ...

The **United States** is the one of three countries in the **whole world** that use this system.

Type	U.S. Customary System	Metric System
Length	inch, foot, mile	meter
Mass/Weight	ounce, pound, ton	gram
Volume	pint, quart, gallon	liter
Temperature	degrees Fahrenheit	degrees Celsius

Table 1: The **U.S. Customary System (English System)**

Metric System

The **Metric System** is a system of measuring units based on the power of 10. It's the preferred system used in science measurement because so many countries already use metrics as their standard measurement system.

One reason for the widespread use of the **Metric System** is that it seems to simplify the number of measurements. Instead of multiple units for the same measurements, such as:

- Inches.
- Feet.
- Miles.

for length, the **Metric System** uses only one word for the length, the **Meter**.

For larger or smaller measurements, metric prefixes are used rather than changing the unit of measure or using fractions, like quarter of an inch. A prefix works with any unit of measure in the **Metric System**:

- Meter.
- Gram.
- Liter.

Prefix	Symbol	Multiplier	Example
Kilo-	k	1,000	Kilometer (km)
Hecto-	h	100	Hectometer (hm)
Deca-	da	10	Decameter (dam)
Unit		1	Meter (m)
Deci-	d	0.1	Decimeter (dm)
Centi-	c	0.01	Centimeter (cm)
Milli-	m	0.001	Millimeter (mm)

Table 2: The **Metric System Prefix References**

The International System of Measurement

The **International System of Measurement of Units** is the primary system used by scientists and engineers. It will also be used in **Chemistry**. In this system, scientists have specified what units should be used as the seven base units of measurement from which all other units are derived.

Converting Units

Quantity (Symbol)	Name of Unit (Symbol)
Length (l)	Meter (m)
Mass (m)	Kilogram (kg)
Time (t)	Second (s)
Electric Current (i)	Ampere (A)
Thermodynamic Temperature (T)	Kelvin (k)
Amount of Substance (n)	Mole (mol)
Luminous Intensity (l_v)	Candela (cd)

Table 3: The **Metric System Prefix References**

Definition 6 (Dimensional Analysis)**.** Analyzing the relationships between different quantities, identify their units of measurement, and convert their quantities for equal comparison.

Dimensional Analysis uses a ratio, or a conversion factor to change units of measurement while maintaining the value of measurement.

In a **Conversion Factor**, the **numerator** and **denominator** equal the same amount, just in different units.

For example, to convert 3 miles into feet, you would multiply 3 miles by a conversion factor created from the units of miles and feet. Because 1 mile equals 5,280 feet, two conversion factors can be created

$$1 = \frac{1 \text{ mile}}{5,280 \text{ feet}} \text{ or } 1 = \frac{5,280 \text{ feet}}{1 \text{ mile}}.$$

Multiplying any number, such as 3 miles, by either of these fractions does not change the number's overall value.

Derived Units

Definition 7 (Derived Units)**.** Some measurements you are familiar with, such as speed, contain more than one **Unit**.

A very common **Derived Unit** is **Volume**. For liquids and gasses, **Volume** tends to be measured in liters. But, for regular-shaped solids, measurements and calculations can determine their **Volume**. To calculate the **Volume** of the cube in Figure 1, just raise the side measurement to the third power.

$$V = (3cm)^3$$
$$V = (3 \times 3 \times 3)cm$$
$$V = 27cm^3$$

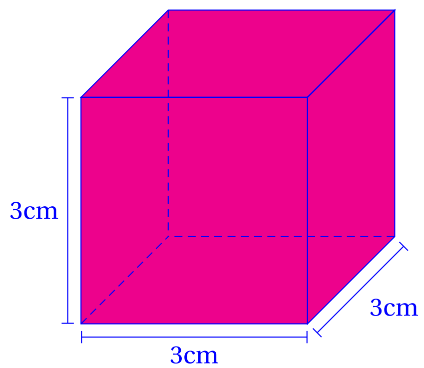

Figure 1: Cube that's $3 \times 3 \times 3$

Now, let's learn how to convert **Derived Units**:

Length	Weight	Liquid Capacity
1 foot = 12 inches	1 pound = 16 ounces	1 cup = 8 fluid ounces
1 yard = 3 feet	1 ton = 2,000 pounds	1 pint = 2 cups
1 mile = 5,280 feet		1 quart = 2 pints
1 mile = 1,760 yards		1 gallon = 4 quarts

Table 4: U.S. Customary Units of Measure

Length	Weight/Mass	Liquid Capacity
1 foot = 2.54 centimeters	1 pound = 0.454 kilograms	1 gallon = 3.785 li
1 meter = 39.37 inches	1 ton = 2.2 pounds	1 liter = 0.264 gall
1 mile = 1.609 kilometers	1 ounce = 28.35 grams	1 liter = 1,000 cub
1 kilometer = 0.6214 miles		1 milliliter = 1 cub

Table 5: Metric Units of Measure

Prefix	Symbol	Multiplier	Example
Kilo-	k	1,000	Kilometer (km)
Hecto-	h	100	Hectometer (hm)
Deca-	da	10	Decameter (dam)
Unit		1	Meter (m)
Deci-	d	0.1	Decimeter (dm)
Centi-	c	0.01	Centimeter (cm)
Milli-	m	0.001	Millimeter (mm)

Table 6: The **Metric System Prefix References**

Example 1 (Fractional Unit)**.** If you start with a number that has a factional unit, there may be more steps to the **Dimensional Analysis**. It doesn't have to be harder, you still want to make sure that you cancel out all the units except the units you want in your final answer. Look at the following problem to see how to change the numerator and/or denominator of a fractional unit.

In this problem, you've been asked to convert from the fractional unit kilometers per hour to the unit centimeters per second. This means that you'll need to convert the numerator and denominator to get the final answer.

When you have a given that has a fractional unit, it can be helpful to write the measurement as a fraction with an one in the denominator:

$$\frac{0.36km}{1h}.$$

This makes it more obvious that there are two numbers that need to convert: $0.36km$ and $1h$.

Once you know what needs to be converted, you can determine those relationships that will help you go from kilometers to centimeters and hours to seconds.

Since you need to change both the numerator and the denominator, you can start with the numerator first. The one hour is still in the denominator, but you can ignore it until you get kilometers converted to centimeters:

$$\frac{0.36\,\cancel{\mathrm{km}}}{1h} \times \frac{1{,}000\,\cancel{\mathrm{m}}}{1\,\cancel{\mathrm{km}}} \times \frac{100cm}{1\,\cancel{\mathrm{m}}}.$$

Notice that the units that need to be canceled (km and m) are all diagonal from each other. That leaves centimeters as the only unit that does not cancel. It is in the numerator, where it needs to be for the final answer.

Now that we've changed the numerator from the unit km to cm on top, you can continue the problem by changing the denominator from hr to sec:

$$\frac{36,000cm}{1\,\cancel{\mathrm{h}}} \times \frac{1\,\cancel{\mathrm{h}}}{60\,\cancel{\mathrm{min}}} \times \frac{1\,\cancel{\mathrm{min}}}{60sec}.$$

Notice that you need to put hours on the top of the next conversion in order to cancel out with ours in the denominator from hr to sec

Notice that you need to put hours on the top of the next conversion in order to cancel out with hours in the denominator of the given. In the next step, the minutes unit is canceld to leave seconds in the denominator – where it needs to be for the final answer:

$$\frac{36,000cm}{1\,\cancel{\mathrm{h}}} \times \frac{1\,\cancel{\mathrm{h}}}{60\,\cancel{\mathrm{min}}} \times \frac{1\,\cancel{\mathrm{min}}}{60sec} = 10\frac{cm}{s}$$
$$0.36\frac{km}{h} = 10\frac{cm}{s}$$

Example 2 (Powered Unit)**.** Some units are raised to a power. **Area** and **Volume** of solids are the common ones.

Area is measured in squared length, such as the square meter, m^2, while **Volume** is measured in cubic length, such as the cubic meter, m^3. Because one cubic centimeter equals 1 milliliter, that conversion is quite simple. However, there are times you must convert from one cubic meter to a cubic centimeter. Let's look at an example:

Convert the **Volume** $5.0m^3$ to the unit cm^3.

Just like any unit conversion, we look at the starting and ending units, then think about what we know that can help us convert the units. You haven't learned an equivalent relationship between cubic metres and cubic centimeters, but you know the relationship between the meters and centimeters:

$$1m = 100cm.$$

We simply use the relationship we already know and cube the entire thing. This makes the fraction a three dimensional **Volume** measurement instead of a one dimensional length measurement:

$$\left(\frac{100cm}{1m}\right)^3.$$

After we do that, we can setup the problem, by starting with the given measurement and adding the relationship we already know.

The units m^3 and m cannot cancel out because they are not exactly the same. The entire conversion factor must be cubed in order to make the units match:

$$5.0m^3 \times \frac{100cm}{1m}$$
$$5.0m^3 \times \left(\frac{100cm}{1m}\right)^3$$
$$5.0m^3 \times \left(\frac{1,000,000cm^3}{1m^3}\right)$$

Now that the cubic meter units are able to cancel, it's time to calculate the answer. Because the entire fraction is being cubed, the numbers and units must all be cubed:

$$5.0m^3 \times \frac{1,000,000cm^3}{1m^3} \times \frac{5.0 \times 1,000,000cm^3}{1}$$
$$= 5,000,000cm^3 \text{ or } 5 \times 10^6 cm^3$$

Therefore, $5.0m^3$ is equivalent to $5 \times 10^6 cm^3$.

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Lesson 3: Energy and Temperature **Unit 1**

Particles in motion can cause change due to their motion. For example:

Definition 8 (Energy)**. Energy** is the ability to cause change or the ability to do work. **Energy** is measured in the **SI Unit Joules**:

$$\text{Joule} = \frac{kg \times m^2}{sr}.$$

Definition 9 (Work)**. Work** is the process of causing matter to move against an opposing force. When matter moves, it's position is changing. For that to happen, it requires **Energy**.

All forms of energy can be broadly classified as either:

- **Potential Energy**.
- **Kinetic Energy**.

Different Kinds of Energy

Definition 10 (Potential Energy)**. Potential Energy** is the energy an object has because of it's current position or composition. For example, you have someone standing on a plane $25,000 ft$ above ground before he sky dives which gives in **Potential Energy**.

Potential Energy is also known as **Stored Energy** because it's energy that is there, but hasn't been used. You can think about it as, winding up a toy car, then once you let it go, all of the energy comes out as **Kinetic Energy**.

Definition 11 (Kinetic Energy)**. Kinetic Energy** is energy an object has due to its motion. Like I mentioned before, when you wind up a toy car and then let it go, that's an example of **Kinetic Energy**.

Definition 12 (Mechanical Energy)**. Mechanical Energy** is the movement of objects from one place to another

EXAMPLES:

- Turning wheels.
- Wind blowing.

Definition 13 (Stored Mechanical Energy). **Stored Mechanical Energy** is the energy stored in objects by application of force.

EXAMPLES:

- Compressed spring.
- Pulled back string of a bow before shooting the arrow.

Definition 14 (Electrical Energy). **Electrical Energy** is the movement of electrical charge.

EXAMPLES:

- Electricity running though wires.
- Lighting.

Definition 15 (Electrical Potential Energy). **Electrical Potential Energy** is the stored energy of electric charges due to their position and interaction around other charges.

EXAMPLES:

- Non-moving charges in circuits.

Definition 16 (Radiant Energy). **Radiant Energy** is electromagnetic energy that travels in waves.

EXAMPLES:

- X-Rays.
- Microwaves.
- Visible light.
- Radio waves.

Definition 17 (Chemical Energy). **Chemical Energy** is stored in the bonds of atoms and molecules.

EXAMPLES:

- Biomass.
- Natural gas.
- Propane.

Definition 18 (Sound Energy)**. Sound Energy** is the movement of energy through substances in longitudinal waves. Sound is produced when a force causes an object to move or vibrate, which is when energy is transferred through the object in a wave.

Definition 19 (Nuclear Energy)**. Nuclear Energy** is energy stored in the nucleus of an atom. This is the energy that holds atoms together and can be released in processes called fusion and fission.

Definition 20 (Thermal Energy)**. Thermal Energy** also known as **heat**, **Thermal Energy** is the internal energy in a substance caused by vibration of atoms and molecules. **Geothermal Energy** is an example of **Thermal Energy**. Heat is also a byproduct of a lot of energy conversions.

Definition 21 (Gravitational Energy)**. Gravitational Energy** is the **Potential Energy** of position. The rock resting at the top of a hill has **Gravitational Potential Energy**.

Although there are many forms of energy, the **Law of Conservation of Energy** states that ***"Energy can be converted from one form to another, but it's not created or destroyed in ordinary physical and chemical processes."***

Sep 13 2021 Mon (10:54:11)

Lesson 4: Properties of Matter **Unit 1**

There are four known states of matter:

- Solid
- Liquid
- Gas
- Plasma

Definition 22 (Phase)**.** Each one of these stages is known as a **Phase**. Each one has it's own properties, such as:

- Shape
- Particle Motion

Solid substances can be **hard**, or **soft**, but they have low **compressibility** and usually maintain their shape on their own.

On the other hand, a substance in a **liquid** will take the shape of the container it's poured into and fill the container from the **bottom up**.

A **gas substance** will fill up the entire container spreading out evenly because their particles can be forced closer together with pressure.

Like **gas**, **plasma** can spread evenly in a container and be compressed, but its composition differs. **Plasma Particles** are positively and negatively charged, which allows plasma to conduct electricity and create magnetic fields.

A **physical property** can be changed without altering the identity of a material. Each physical properties can be classified as either an **Extensive Property**, or an **Intensive Property**.

Extensive Property

- Shape
- Volume
- Length
- Mass

are classified as **Extensive Physical Properties**. An extensive property is a physical property that depends on the sample size.

Example 3 (Extensive Physical Properties)**.** For example, if you have a large amount of metal and a small amount of the same metal, these two samples will have different volumes.

Intensive Property

- Magnetism
- Density
- Melting
- Boiling
- Points
- Color

are all classified as **Intensive Physical Properties**. Intensive properties do not depend on the size of the samples. No matter how much or how little of the substance you have, an intensive physical property stays the same.

Example 4 (Intensive Property)**.** For example, if you have a large amount of metal and a small amount of the same metal, these two samples will have the same density.

Physical Properties of Matter

Definition 23 (Phase State)**.** The phase:

- Solid
- Liquid
- Gas
- Plasma

of a substance is a physical property.

Definition 24 (Density)**.** The ratio of mass per volume is a physical property that does not depend on the size of the sample.

Definition 25 (Ductility)**.** The ability to be pulled or stretched to make wire is a physical property of metals.

Definition 26 (Malleability)**.** Some substances have the ability to be:

- shaped
- Dented
- Extended

by beating with a:

- Hammer
- Rolling

Definition 27 (Melting Point)**.** The temperature at which a solid becomes a liquid is its **Melting Point**.

Definition 28 (Solubility)**.** A substance is **Soluble** if it's able to dissolve in another substance.

Definition 29 (Boiling Point)**.** The temperature at which a liquid becomes a gas is its **Boiling Point**.

Definition 30 (Compressibility)**. Compressibility** is a physical property. It describes how much the volume of matter decreases under pressure. Substances with high compressibility can be squeezed or flattened to fit into smaller spaces.

Definition 31 (Electrical and Thermal Conductivity)**.** The ability to transmit electricity or heat through the structure of a substance is a physical property shared by all metals.

Density

Because density is an intensive physical property, its value for a substance does not change based on the sample size of that substance. Because of this, density is often used to identify unknown materials. Density measures the degree to which something is compacted, or the quantity of mass per unit volume.

$$density = \frac{mass}{volume}.$$

Example 5 (Example One)**.** The sample of a cork has a mass of $2.88g$ and a volume of $12.0mL$. What's the density of the cork?

We have the following information:

$$mass = 2.88g$$
$$volume = 12.0mL.$$

We are asked to calculate density. So, use the formula:

$$density = \frac{mass}{volume}.$$

Substitute the numbers and divide:

$$d = \frac{2.88g}{12.0mL}$$
$$d = 0.25\frac{g}{mL}.$$

Example 6 (Example Two)**.** This sample of marble block is in the shape of a **cube**. It has a mass of $22.4kg$ and a side length of $2m$. What's the density of the block?

First, find the volume of the cube:

$$V = (2m)^3$$
$$v = 8m^3.$$

The given information:

$$mass = 22.4kg$$
$$volume = 8m^3.$$

So, use the formula:

$$density = mass/volume.$$

Substitute the numbers and divide:

$$d = \frac{22.4kg}{8m^3}$$
$$d = 2.8\frac{kg}{m^3}.$$

Chemical Properties of Matter

Definition 32 (Reactivity). **Reactivity** is a chemical property. It refers to the readiness of a substance to undergo a chemical change.

There are some substances, like gold or platinum, that do not react so easily with other substances. The low reactivity of these elements is perfect for jewelry making because they will not rust or tarnish when exposed to other substances.

An element with high reactivity, like fluorine - a poisonous gas - can spontaneously explode when exposed to other substances.

Definition 33 (Flammability). **Flammability** is a chemical property. It describes how easily a substance can be set on fire. This is very important when it comes to building safety.

For instance, some Styrofoam-based insulation products have higher flammability than other fire-resistant products. Builders avoid using flammable materials in homes.

Alcohol and gasoline are two liquids that are highly flammable.

Definition 34 (Toxicity). **Toxicity** is a chemical property. It describes the ability of a substance to damage or harm an organism.

Higher toxicity equals more harm. For example, exposure to a gram of mercury, an element that is liquid metal, can cause death to humans.

There are some creatures that are labeled venomous or poisonous because of their ability to harm other living creatures due to the toxic substances they naturally produce.

Definition 35 (Heat of Combustion). The **heat of combustion** is a chemical property. It measures how much heat is given off when a substance is burned.

Definition 36 (Corrosion). **Corrosion** is the irreversible damage or destruction of a material due to a chemical or electrochemical reaction.

Definition 37 (Decomposition). Some compounds decompose into more than one different element or compound as bonds are broken. Hydrogen peroxide (H_2O_2), a chemical you may have around your house, is stored in a dark container to slow down **decomposition**, which can be caused by heat and light.

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Lesson 5: Changes of Matter **Unit 1**

Definition 38 (Physical Change)**.** A **Physical Change** is a change in a substance from one form to another without changing its composition. A physical change can be a change to any physical property of an object, such as its size or shape.

Definition 39 (Chemical Change)**.** A **Chemical Change** is change in a chemical substance into one more different substance. This type of change occurs at the molecular level, where atoms are re-arranged to form new molecules during chemical reactions. Unlike **Physical Change**, **Chemical Change** is permanent.

All mater has physical and chemical properties. Understanding these how properties are affected when matter changes will allow you to know if a substance has undergone a physical or chemical change.

Here are some clues that will help you tell if something has undergone a chemical change:

1. production of flame
2. color change
3. bubbling or fizzing
4. temperature change
5. smoke
6. production of light
7. formation of a substance in a different state

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Lesson 6: Pure Substances and Mixtures **Unit 1**

All matter can be classified into two main categories

- Mixtures
- Pure Substances

Definition 40 (Matter)**.** **Matter** is anything that takes up **Mass** and **Space**.

Mixtures

A mixture is created when solids, liquids, or gases mix with one another. Mixtures can occur with substances that are in the same states of matter or of different states of matter. Each substance in a mixture maintains its individual composition and property.

Definition 41 (Homogeneous)**.** In this type of mixture, just one substance looks the same throughout. Dissolving sugar in a glass of water forms a **homogeneous** mixture, as the sugar seems to disappear. Even when examined under a microscope, the sugar water appears the same throughout.

Some examples of **Homogeneous Mixtures** are:

- Air
- Perfume
- Bleach
- Steel

Definition 42 (Heterogeneous)**.** Candies in a mixture will not be dispersed evenly. Heavier pieces may sink to the bottom of the pile, and smaller pieces may be at the edges. Vegetable soup is an example of a heterogeneous mixture because each spoonful will have a slightly different mixture of vegetable pieces and seasoning.

Some examples of **Heterogeneous Mixtures** are:

- Rocks
- Cereal
- Sand

Definition 43 (Physical Separation)**.** Mixtures contain compounds and elements that can be physically separated from one another. For example, you can pull out your favorite fruit from a fruit salad and leave the others in the bowl. Or you can boil a saltwater mixture to cause the water to evaporate and leave salt particles.

Pure Substances

A pure substance consists of a single element or type of compound. For example, gold is a **Pure Substance** because it's made from a single element: gold.

Definition 44 (Elements)**.** An **Element** is a substance that cannot be broken down into simpler substances. All elements on the periodic table of elements are examples of **Pure Substances**.

Definition 45 (Compounds)**.** A **Compound** is matter composed of two or more **Elements**. A molecule is the smallest unit of a **Compound**.

Some examples of **Compounds** are:

- Alcohol
- Water
- Baking Soda
- Glucose

Definition 46 (Chemical Separation)**.** Pure substances made from compounds can only be chemically separated into the elements that make them up. The compound table salt ($NaCl$) is made from the elements **Sodium** and **Chlorine**. A chemical reaction would be needed to separate these two elements from one another.

Sep 21 2021 Tue (10:37:32)

Lesson 7: Laboratory Techniques **Unit 1**

Different kinds of measurement tools

Definition 47 (Test tubes and test tube holder). Used to hold small amounts of a substance

Definition 48 (Dropper pipettes). Used to transport a measured volume of liquid

Definition 49 (Ring clamp and stand). A metal stand with a clamp used to support a container of material for testing

Definition 50 (Thermometer). An instrument used for measuring temperature

Definition 51 (Florence flask). A container used for uniform heating and boiling of liquids

Definition 52 (Beaker with glass stirring rod). A cylindrical glass container for holding substances and a glass rod for safe stirring of materials

Definition 53 (Erlenmeyer flask). A flat-bottomed flask for substances

Definition 54 (Balance scale). A device that compares the weight of an unknown object on one scale pan to the weight of a standard mass on the other scale pan

Definition 55 (Bunsen Burner). A heat source for heating substances in the laboratory

Definition 56 (Mortar and pestle). Used to crush ingredients or substances by grinding them into a powder

Definition 57 (Graduated cylinder). Equipment used to measure the volume of a liquid and some solids using water displacement

Definition 58 (Funnel). Used for guiding liquid or powder into a small opening

Definition 59 (Crucible). A ceramic or metal container used for melting or heating substances

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Lesson 8: Honors Scientific Knowledge **Unit 1**

Science is often considered the pursuit and acquisition of knowledge. Therefore, any actions that mimic this search for answers can look like science. However, the key difference between an explanation built with science and one built without it is the gaining of evidence through experimentation and the scientific method.

Sometimes a practice or belief claims to be science, but it does not follow the scientific method or is not proven reliable through experimentation. This is called pseudoscience. Let's learn why these examples of pseudoscience are not considered examples of science.

Scientists seek to understand the world around us and to learn how things work. To find answers, they investigate all sorts of natural phenomena and conduct experiments to collect data for analysis and interpretation. But to prove that their interpretations are valid, and in turn become scientific explanations of natural phenomena, their investigations must meet certain criteria.

- Following Logic
  Using logic to interpret experimental data is important to the validity of a scientific explanation. For example, if data show that water evaporates with the addition of heat, it would not be proper logic to assume the water spontaneously evaporated.

- Peer Review
  Frequent examinations by scientists result in some ideas being refuted and replaced with other ideas. This frequent examination and testing makes scientific explanations more valid and durable over time.

- Global Access
  Scientific knowledge is constantly changing and developing because new observations or predictions are made every day. All scientific knowledge should be examined and re-examined using the steps of the scientific method to collect new empirical evidence.

- Rules of Evidence
  It is important that scientists share their investigations and conclusions with others so they can be tested and used by scientists all over the world.

Hidden Phenomena

A scientific explanation should be observed, tested, or measured to be considered valid and reliable. Yet, there are some natural events that just can't be observed or tested using the technology available. For instance, in the 16th century Nicolaus Copernicus first proposed a mathematical heliocentric model. It theorized that the sun, not Earth, was the center of our solar system. The model was supported by empirical evidence collected from astronomers tracking objects in the night sky. But the model could not be completely confirmed until we sent probes and people into space centuries later.

Also, there are things in ancient history, before the written word, that scientists can only theorize about based on studies of items from that period. For example, the existence of dinosaurs is supported by numerous sources of their skeletal remains collected all around the world. Although no one has seen a living dinosaur, studies of these remains support that they once lived in vast numbers.

Theories and Hypothesis

Within the body of scientific knowledge are two very important components: hypotheses and theories. Both types of scientific knowledge are developed using background research and can change over time using the scientific method. The difference is that scientific theories are well-tested hypotheses. They describe why things happen using empirical evidence collected and tested by multiple scientists using multiple kinds of investigations over a significant period. Hypotheses, on the other hand, are predictions or tentative explanations of phenomena that have not yet been fully tested or have been dis-proven.