Name: _____ Date: _____ Class Notes
Chemistry

Energy

Energy is the ability to move or change matter.

Everything in the universe consists of two things: energy and matter. Actually, energy and matter are different forms of the same thing and science in its simplest form is the study of matter and energy. So, it is important that you understand what matter and energy are and how both are organized. Let's start with energy.

Energy is the ability to move or change matter. The different forms of energy include kinetic, potential, thermal, gravitational, sound, elastic and electromagnetic energy. Usually a form of energy can be associated with a related force. For our purposes, we are interested in kinetic and potential energy. **Kinetic energy** is the energy an object has due to its motion. **Potential energy** is stored energy due to an object's position or chemical composition.

"Nothing changes unless something moves." –Albert Einstein

Think About It

- What is energy?
- What is kinetic energy?
- What is potential energy?

Matter

Matter is anything that has mass and volume. It's the stuff around you!

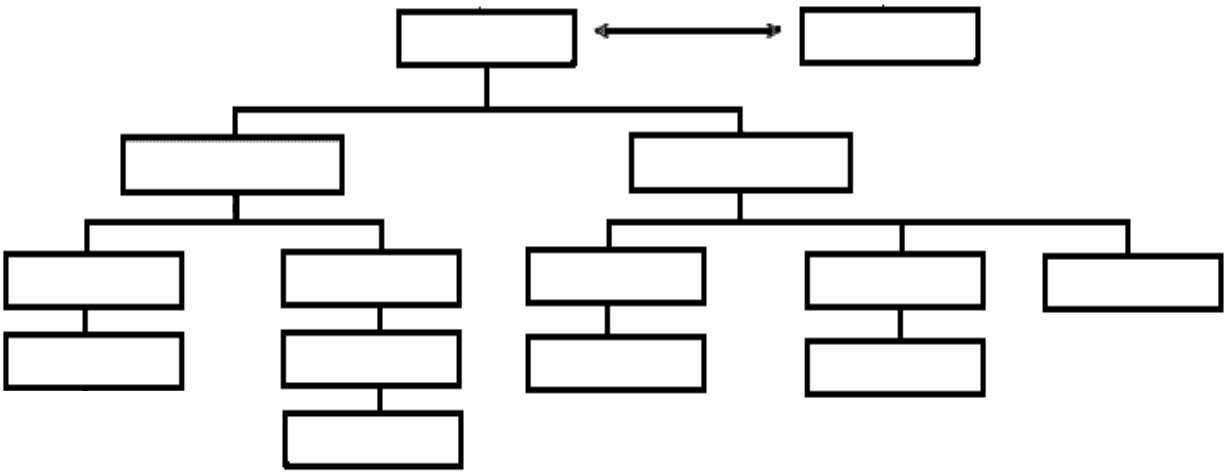
Matter is all the stuff around you. It is the food you eat, the air you breathe and the clothes you wear. Even you are made-up of matter. Therefore, you need to know the different types, forms and properties of matter.

Matter is anything that has mass and volume. **Mass** is the amount of inertia in matter and the **volume** is the amount of space occupied by matter. **Inertia** is the resistance to change and the greater the inertia the greater the mass.

Divisions of Matter

Many times matter is divided into two categories: pure substances and mixtures. It is important that you can distinguish one form of matter from another so that you can describe the changes you observe.

Fill in the chart.



Pure Substances

Pure substances consist of one material with a definite composition and definite properties. Pure substances are divided into two groups: elements and compounds.

Elements are the simplest forms of chemical substances and cannot be broken down by ordinary chemical means. Examples would be hydrogen (H), sulfur (S) or gold (Au). The simplest form of an element is an **atom**.

Compounds are chemical combinations of elements that can be described with a chemical formula and can only be separated by chemical means. Examples of compounds are water (H_2O), sugar ($C_{12}H_{22}O_{11}$) and salt (NaCl). The simplest forms of a compound are molecules or formula units.

Practice

Identify the following (**c**)ompound or (**e**)lements.

_____ the copper in a penny	_____ distilled water	_____ table sugar
_____ table salt	_____ oxygen	_____ silver in a bracelet

Mixtures

Mixtures are all around you. A salad is a mixture of vegetables, a glass of soda is a mixture of water, sugar and flavoring and air is a mixture of gases like nitrogen, oxygen and carbon dioxide.

Mixtures are physical combinations of two or more substances with varying compositions, varying properties and can be separated by ordinary physical processes. Usually, mixtures are divided into two main groups: those that are homogeneous and those that are heterogeneous.

Homogenous mixtures are the same throughout and do not separate into phases when left alone. Many homogeneous mixtures are **solutions** that consist of a solute and a solvent. The **solute** is the material that dissolves and the **solvent** is the material that causes the dissolving. Solutions are completely dissolved and see through.

An alloy is a solution of two or more elements, at least one of which is a metal, where the resulting material has metallic properties. Alloys are usually made to improve on the properties of the elements that make them up. Steel for example, is much stronger than iron, which is its main component.

Heterogeneous mixtures have no definite composition and separate into phases when left alone. Heterogeneous mixtures can be separated by ordinary physical means. Examples of heterogeneous mixtures are blood, Italian salad dressing and soda pop.

Another type of mixture is a colloid. A **colloid** is a suspension that doesn't separate because the particles aren't completely dissolved and remain suspended causing the mixture to appear cloudy. This cloudiness, called the **Tyndall effect**, is due to the scattering of light by the suspended particles.

A solution does not scatter light because the particles are at the molecular level and way too small to reflect light. However, the colloidal particles are large enough to reflect light and yet small enough not to settle. The scattering of light from automobile head-lights in fog and of a light beam by dust particles are examples of the Tyndall effect.

Colloids are formed from all combinations of solids, liquids or gases (except mixtures of non-reacting gases which are true solutions). Aerosols, foams, emulsions and sols are different types of colloids. Examples of colloids are shaving cream, whipped cream and gelatin.

"A man should look for what is, and not for what he thinks should be."
– Albert Einstein

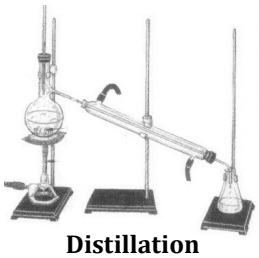
Types of Colloids

Name	Example
Fog (liquid in gas)	
Smoke (solid in gas)	
Foam (gas in liquid)	
Emulsion (liquid in liquid)	
Sol (solid in liquid)	
Gel (liquid in solid)	

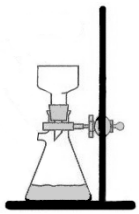
Separating Mixtures

Separating pure substances is very difficult and requires large amounts of energy, but mixtures can be separated by physical means. Some of the techniques used to separate mixtures are:

- filtration – the use of a mesh such as filter paper to separate a solid and a liquid
- distillation – the use of heating and evaporation to separate a solution
- chromatography – the use of solubility and colors to separate a solution
- centrifugation – the use of spinning to separate solids
- extraction – the use of chemical to separate suspensions
- dialysis – the use of diffusion or osmosis to separate suspensions



Distillation



Filtration

Practice

Identify the following **(col)**loid, **(hetero)**geneous or (**homo)**geneous.

_____ whole milk _____ hamburger _____ Kool-Aid™

_____ blood _____ whipped cream _____ salt water

The Changes of Matter

The changes that matter undergoes are classified as either chemical or physical. A **physical change** is a change in the form of a substance, but its chemical composition remains the same. Cutting a wooden plank in half is an example of a physical change. The plank is in two pieces but it is still wood.

Physical changes are described by using physical properties. **Physical properties** are characteristics of substance that don't result in a new substance. Examples are:

- mass and volume
- density
- weight
- color
- malleability
- ductile

A **chemical change** is a change in which a new substance or substances is created with new properties and a different composition. Burning a wooden plank would result in smoke, heat and ashes. It would no longer be wood. Chemical changes are the results from a chemical reaction.

Chemical changes are described using chemical properties. **Chemical properties** are characteristics of a substance that result in new substances. Examples are:

- flammability
- reactivity with water
- corrosiveness
- pH

Practice

Identify the following as a **(P)**hysical or **(C)**hemical properties.

_____ color	_____ flammable	_____ malleable
_____ corrosive	_____ soluble	_____ odor

The States of Matter (Phases)

The five states of matter are distinguished from one another by the differences in physical properties and these differences are due to the **kinetic energy** in the atoms or molecules of the substance. The more kinetic energy contained in a substance the

greater the ability of the particles to break loose from each other. Thus, the molecules of a liquid have more kinetic energy than those of a solid.

It is necessary that you know each state of matter and its physical properties to completely understand the chemical behavior of matter.

- Bose-Einstein Condensate (BEC)
- Solid
- Liquid
- Gas
- Plasma

Bose-Einstein Condensate (BEC)

In the 1920's Satyendra Nath Bose proposed that if a gas became cold enough all the atoms would drop to the lowest energy level creating a new state of matter. But, he was unable to reach temperatures low enough (absolute zero) to prove his hypothesis. So, Bose asked Einstein to review his findings and help him get his paper published. Einstein agreed with Bose's ideas and helped him get the paper published. However, it would be 70 years before anyone would prove that the Bose-Einstein Condensate existed.

Solids

Solids contain a very small amount of kinetic energy so the particles in a solid have a strong attraction to each other. Thus, solids have a definite volume and a definite shape.

There are two main types of solids: crystalline and amorphous. Crystalline solids are solid materials in which the particles are arranged in repeating geometric patterns. The particles of amorphous solids lack any particular order and do not form crystals.

Crystalline	Amorphous

Liquids

Liquids contain a little more kinetic energy than solids so the particles are able to pull away from each other. Thus, liquids can flow and take the shape of the container but still have a fixed volume.

Some liquids flow faster than others, this is referred to as viscosity. **Viscosity** is the resistance to flow. The slower something flows the greater the viscosity. Honey is more viscous than oil which is more viscous than water.

Gases

Gases contain a lot of kinetic energy and the particles are in constant, random motion. Thus, gases can flow; take the shape of the container and the volume of the container. Gases are described by the Kinetic-Molecular theory which states the particles of a gas are in constant, random motion; the motion of one particle is unaffected by the motion of others unless particles collide; the collision of a particle with the side of the container creates a "push" called pressure.

Plasma

Plasma was first identified by Sir William Crookes in 1879. Plasma is similar to gas in that it has no definite shape or definite volume. But, plasma is extremely high in energy due to the removing of electrons from atoms to create ions. Examples of plasma are neon lights and stars.

Phase Changes

Ice, water and water vapor are all the same substance; H_2O. The difference between each phase is the amount of kinetic energy present in the water molecules. The water vapor (gas) has more kinetic energy than the water (liquid) and the water has more kinetic energy than the ice (solid). So, the water vapor moves more freely than the water and the water moves more freely than the ice.

Kinetic energy is responsible for the different phases of matter. The more kinetic energy available to a substance the easier the atoms or molecules of that substance can pull free from the forces that hold the particles together. If you want to change ice to water you increase the kinetic energy and melt it. If you want to change water to ice you decrease the kinetic energy and freeze it. The key to a phase change is the removing or adding of kinetic energy.

Phase Changes	Name	Energy
Solid to Liquid		
Liquid to Solid		
Liquid to Gas		
Liquid to Gas		
Gas to Liquid		
Solid to Gas		
Gas to Solid		

Think About It

- What is energy? Kinetic energy? Potential energy?
- What is matter, mass, and volume?
- What is inertia?
- Do you know the divisions of matter?
- Do you know the different pure substances?
- Do you know the different mixtures?
- Can you recognize chemical and physical properties?
- Can you recognize chemical and physical changes?
- Do you know the phases of matter?
- Do you know the phase changes?

Practice

Determine whether the following are elements, compounds, heterogeneous, homogeneous mixture or colloid:

_____ peanut butter sandwich

_____ pudding

_____ table salt

_____ the silver in a bracelet

_____ a Dr Pepper ™

_____ wood

THINKING

Which is easier to separate, a homogeneous or heterogeneous mixture? Explain.

_____

_____

_____

"I learned very early the difference between knowing the name of something and knowing something." - Richard Feynman