Element, Mixture, Compound Lab

Background: Material engineers and mechanical engineers are focused on understanding different materials so that they can create new materials with desired properties. For example, they take advantage of the varying strengths and abilities of different materials to make composite materials that are engineered materials made from two or more constituent materials with significantly different physical or chemical properties.

Learning Objectives:

After this activity, students should be able to:

- Distinguish and describe the three types of matter: elements, compounds, mixtures.
- Define pure and impure materials.
- Give some examples of elements, mixtures, and compounds.
- Explain the different properties of each group of materials.
- Explain how chemical engineers use these terms when solving problems related to water purification and distillation of crude oil.
- Explain how material and mechanical engineers use these terms regarding creating new composite materials.
- Explain what metal alloys are and explain the significance of metal alloys in material science and material engineering.
- Give some applications of non-metal alloys.

Introduction/Motivation

We are all completely surrounded by matter. To better understand this matter—how it affects you, how you affect it and how it can be manipulated to our benefit—we need get a basic understanding of the types and properties of matter. The diversity of the matter in the world and in the universe is astounding. If we are to understand this diversity, we must start with a way of organizing and describing matter.

All matter is made of elements that are fundamental substances that cannot be broken down by chemical means. An **element** is a substance that can not be further reduced as to simpler substances by ordinary processes.

A **compound** is a pure substance composed of two or more different atoms chemically bonded to one another. That means that it can not be separated into its constituents by mechanical or physical means and only can be destroyed by chemical means.

A **mixture** is a material containing two or more elements or compounds that are in close contact and are mixed in any proportion. For example, air, sea water, crude oil, etc. The constituents of a mixture can be separated by physical means like filtration, evaporation, sublimation and magnetic separation. The constituents of a mixture retain their original set of properties. Further, mixtures can be classified to homogeneous and heterogeneous mixtures. A homogeneous

mixture has the same uniform appearance and composition throughout its mass. For example, sugar or salt dissolved in water, alcohol in water, etc. A heterogeneous mixture consists of visibly different substances or phases. The three phases or states of matter are gas, liquid and solid. A heterogeneous mixture does not have a uniform composition throughout its mass.

New materials are among the greatest achievements of every age and they have been central to the growth, prosperity, security and quality of life of humans since the beginning of history. New materials open the door to new technologies, whether in civil, chemical, construction, nuclear, aeronautical, agricultural, mechanical, biomedical or electrical engineering.

The study of metal alloys, which are mixture of different metals, is a significant part of materials science and material engineering. Of all the metallic alloys in use today, the alloys of iron (steel, stainless steel, cast iron, tool steel, alloy steels) make up the largest proportion both by quantity and commercial value. Iron alloyed with various proportions of carbon gives low, mid and high carbon steels. For the steels, the hardness and tensile strength of the steel is directly related to the amount of carbon present, with increasing carbon levels also leading to lower ductility and toughness. The addition of silicon and graphitization produce cast iron. The addition of chromium, nickel and molybdenum to carbon steels (more than 10%) gives us stainless steels.

Other significant metallic alloys are those of aluminium, titanium, copper and magnesium. Copper alloys have been known for a long time (since the Bronze Age), while the alloys of the other three metals have been relatively recently developed. The alloys of aluminium, titanium and magnesium are also known and valued for their high strength-to-weight ratios and, in the case of magnesium, their ability to provide electromagnetic shielding. These materials are ideal for situations in which high strength-to-weight ratios are more important than bulk cost, such as in the aerospace industry and certain automotive engineering applications.

Other than metals, polymers and ceramics are also an important part of materials science. Polymers are the raw materials (the resins) used to make what we commonly call plastics. Plastics are really the final product, created after one or more polymers or additives have been added to a resin during processing, which is then shaped into a final form.

Another industry application is the making of composite materials. Composite materials are structured materials composed of two or more macroscopic phases. Applications range from structural elements such as steel-reinforced concrete, to the thermally insulative tiles that play a key and integral role in NASA's Space Shuttle thermal protection system, which protects the surface of the shuttle from the heat of re-entry into the Earth's atmosphere. One example is reinforced carbon-carbon (RCC), The light gray material withstands reentry temperatures up to 1510 °C (2750 °F) and protects the Space Shuttle's wing leading edges and nose cap. RCC is a laminated composite material made from graphite rayon cloth and impregnated with a phenolic resin.

Other examples can be seen in the "plastic" casings of television sets, cell phones and other modern devices. These plastic casings are usually a composite material.

Vocabulary/Definitions

compound: A pure chemical substance consisting of two or more different chemical elements.

element: A substance consisting one type of atom.

heterogeneous mixture: A mixture that consists of visibly different substances or phases.

homogeneous mixture: A mixture that has the same uniform appearance and composition throughout its mass.

mixture: A substance consisting mixing two or more material.

solution: A homogeneous mixture composed of two or more substances.

Procedure:

1. Walk around to stations 1-9. Categorize the materials in each dish as an element, homogenous mixture, heterogeneous mixture or compound.
2. Record this date in Table A
3. Discuss results with class.
4. Read through the review chart below and answer the pre-lab questions. Then, rotate through the stations, identifying each substance as an element, compound, or mixture. If it is a mixture, be sure to include whether it is Homogeneous or heterogeneous. Be sure to include 3 observations of the substance, and a meaningful REASON for your classification!

Investigating Questions

- Describe the three types of matter: elements, compounds and mixtures.
- Define pure and impure materials.
- Give some examples of elements, mixtures, and compounds.
- Explain the different properties of each group of materials.
- Explain how chemical engineers use these terms when solving problems related to water purification and distillation of crude oil.
- Explain how material and mechanical engineers use these terms regarding creating new composite materials.
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- Give some applications of nonmetal alloys.

Name: _____ Date: _____

Element, Compound , Mixture Lab: Data Sheet

Table A:

Dish #	Element	Compound	Heterogeneous Mixture	Homogeneous Mixture
1				
2				
3				
4				
5				
6				
7				
8				
9				

Element	Compound	Mixture

Part 2:

Directions- Rotate through the stations, identifying each substance as an element compound, or mixture. If it is a mixture, be sure to include whether it is **homogeneous** or **heterogeneous**. Be sure to include **3 observations** of the substance and meaningful **reason** for you classification.

Station #/Identify Substance	Description/Observations	Classification (Element, Compound, Mixture)	How do you know?
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			