Study Guide Answers

Standard S8P1. Students will examine the scientific view of the nature of matter.

S8P1a. Distinguish between atoms and molecules.

A. What is an atom? Be very specific…list everything you know about an atom.

All matter is made up of atoms. **Atoms** are the basic building block of matter. Atoms are made up of even smaller particles called subatomic particles. **Protons** are particles that carry a **positive charge**. **Neutrons** are particles that carry **no electric charge**. The **nucleus** is the **center** of the **atom** that is made up of **both protons and neutrons**. **Electrons** are particles that carry a **negative charge** and **surround** the **nucleus** in what is know as the **electron cloud on energy levels**. There is a limit to the number of electrons each energy level can hold. The first energy level holds 2 electrons, the second holds 8, the third holds 18, the fourth holds 32, and the fifth holds 50. The **number** of **electrons** in the **outermost energy level** of an **atom** is referred to as the atoms **valence electrons**. The **number** of **valence electrons** is **important** because it tells scientists **how likely** that **atom is** to **combine with other atoms** to **form compounds**. In a **neutral**, or uncharged, **atom**, the **number** of **electrons** is **equal** to the **number** of **protons**.

Elements and Atomic Number
Atoms of different elements have different numbers of protons. The number of protons found in the nucleus of an atom is called the **atomic number**. The atoms of each element are different because each element has a different atomic number.

Importance of Atomic Number
The atomic number of an element is very important, because it identifies that element. No two elements have the same atomic number. Hydrogen has an atomic number of 1. This means that a hydrogen atom has one proton in its nucleus. Oxygen has an atomic number of 8. Gold has much larger atoms than either hydrogen or oxygen. Gold has an atomic number of 79.

Atomic Number and Electrons
If you know the atomic number of an element, you can find the number of electrons in an atom of that element. An atom is neutral. It has neither a positive nor a negative charge. In order for an atom to be neutral, the number of electrons must equal the number of protons. The positive and negative charges cancel each other. So the number of electrons is always equal to the atomic number, or the number of protons.

Mass of an Atom
The mass of an atom is very small. Scientists cannot measure the mass of an atom in grams. In order to measure the mass of an atom, scientists have developed a special

unit. This unit is called the atomic mass unit, or amu. One amu is equal to the mass of one proton. Neutrons and protons have the same mass. Therefore, one amu is also equal to the mass of one neutron. The mass of an electron is equal to 1/1836 amu. Because electrons are so small, only the masses of protons and neutrons are used to find the mass of an atom.

Atomic Mass (AKA: Mass Number)
Because atoms of different elements have different numbers of protons and neutrons, they also have different masses. The total number of protons and neutrons in the nucleus of an atom is called the atomic mass. Each element has its own atomic mass (mass number).

You can find the number of neutrons in an atom by using this formula:

Neutrons = mass number (protons + neutrons) – atomic number (protons)

B. What is a molecule?

Molecules are formed by the combination of one or more types of atoms chemically joined together. Unlike atoms, molecules can be subdivided to individual atoms. The atoms are bonded together in a molecule. Molecules also are not visible to the naked eye, while can be seen through highly magnifying microscopes and other scientific devices. Water is comprised of numerous water molecules. Each water molecule is made up of one oxygen atom and two hydrogen atoms. So a water molecule can be further divided into oxygen and hydrogen atoms. But these atoms cannot be subdivided. What are some examples of molecules?

C. Distinguish between atoms and molecules. Can you tell if something is an atom or a molecule?

An atom is smallest particle in an element that has the properties of the element. It is **not** possible to breakdown the atom further and it still retain the properties of the element. For example the atoms of the element gold cannot be broken down further and still have the properties of gold. Molecules are formed by the combination of two or more atoms chemically joined together. Unlike atoms, molecules can be subdivided to individual atoms.
Examples of Atoms – H He Li O N Ne Mg (Notice that each one of these examples is just one atom, a single element.)

Examples of Molecules – O_2 $C_6H_{12}O_6$ H_20 KCL_3 Li_3 (Notice that in each one of these examples, each molecule is made up of at least two atoms bonded together.)

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S8P1b. Describe the difference between pure substances and mixtures.

A. What is a pure substance? Don't just define it, explain it!

A pure substance has a homogeneous composition (the same throughout) that cannot be broken down or separated using physical means. This means that if you can take something and separate it into simpler means through any physical process, it is NOT a pure substance.

B. What are some examples of pure substances?

All elements are pure substances because they cannot be broken down into simpler means by ordinary chemical means. So Hydrogen, Nitrogen, Silver, and all of the other elements are pure substances.
Other pure substances are water, carbon dioxide, sugar, and salt because none of these things can be broken down into simpler means through physical processes.

C. Would elements and compounds be characterized as pure substances? Why or why not? Defend your answer!
Yes, elements and compounds are both characterized as pure substances because neither can be broken down into simpler means by physical means.
Compounds are pure substances composed of two or more different atoms chemically bonded to one another. Properties of a compound:

- A compound cannot be separated into its constituents by mechanical or physical means.
- Properties of a compound differ entirely from those of its constituent elements
- A compound is a homogeneous substance. That is it is the same throughout in properties and composition.
- The constituent elements in a compound are in a fixed proportion by weight.
- Examples are Water (H_2O), Table Sugar ($C_{12}H_{22}O_{11}$), and Table Salt (NaCl)

D. What is a mixture?

Mixtures form when two or more substances combine without joining together chemically. There are **two basic types of mixtures; Heterogeneous and Homogeneous**.

Heterogeneous Mixtures are mixtures where the substances are not mixed evenly. Some examples of heterogeneous mixtures are cereal and milk, soil, and salad.

Homogeneous Mixtures are mixtures that contain two or more substances that are evenly mixed but are still NOT bonded together. Another name for a homogeneous mixture is a solution. Examples of homogeneous mixtures are frozen popsicle, ocean water, the atmosphere, and steel.

E. Describe the difference between pure substances and mixtures.

Pure substances cannot be broken down by physical means and mixtures can.

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Standard S8P1. Students will examine the scientific view of the nature of matter.

S8P1e. Distinguish between changes in matter as physical or chemical.

A. What are some characteristics of a physical change?

A physical change alters the physical properties of a substance without changing the identity of the substance. Physical changes cause a change in properties such as volume, mass, or phase. Many physical changes can be reversed to change the matter back to its former condition. For example, after an ice cube melts to form liquid water, the change can be reversed by cooling the water until it once again turns to ice. Some examples of physical changes are cutting wood, melting butter, ripping paper into pieces, and molding clay.

B. What are some characteristics of a chemical change?

Chemical Changes – A chemical change occurs when a substance is changed into a new substance with different properties.
During a chemical change, the identity of a substance is changed. For example, if you make a chocolate cake, you need to assemble the ingredients – sugar, eggs, flour, and chocolate – to make the batter. When you bake the batter, its identity changes; the batter becomes a cake in which the identities of the original substances have changed. Baking a cake involves chemical changes.

A **Chemical Reaction** is the process by which new substances are formed during a chemical change. Some signs that indicate a chemical reaction has occurred include the forming of gases, a change in color, the release of heat, or the emission of light. Another sign of a chemical reaction is the formation of a precipitate. A precipitate is a solid that forms from a chemical reaction that takes place in a solution.

C. How can you distinguish between a physical and a chemical change? What are some things you need to look for?

Unlike a physical change, it is very difficult or impossible to reverse the effects of a chemical change. During a chemical change, the identity of a substance is changed and in a physical change the identity is the same.

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S8P1f. Recognize that there are more than 100 elements and some have similar properties as shown on the Periodic Table of Elements.

A. How is the Periodic Table of Elements primarily arranged?

Today, elements are arranged primarily by their atomic number (number of protons).

B. What are some other ways that the Periodic Table is arranged? Make sure you list all of the ways that we have discussed in class.

Not only is the Periodic Table arranged by the atomic number, but it is also arranged by physical description as well such as metals, nonmetals, and metalloids. Some other ways that the Periodic Table is arranged is by Groups and Periods, number of valence electrons, and reactivity.

C. What are some physical properties of metals, nonmetals, and metalloids?

Metals are shiny (have luster), they are good conductors of thermal energy and electricity, they are malleable and ductile, and they tend to lose electrons in a chemical reaction. Nonmetals are the exact opposite. The are dull, they are poor conductors of thermal energy and electricity, they are brittle, and they tend to gain electrons in a chemical reaction. Metalloids have some properties of both metals and nonmetals.

D. Where are the metals, nonmetals, and metalloids located on the Periodic Table?

Metals take up the majority of the Periodic Table. They start at the left side of the Periodic Table and move over towards the right side. The metalloids are located between the metals and nonmetals in a staircase like shape towards the right side of the Periodic Table. The nonmetals are on the far right side of the Periodic Table.

E. What are groups?

A vertical column in the periodic table is a group, or chemical family. Groups are numbered from 1 to18. Elements in the same group have similar chemical properties (this is why they are sometimes referred to as chemical families). These similar properties occur because the elements in a group all have the same number of valence electrons (number of electrons in the outermost energy level of an atom). The number

and arrangement of valence electrons help scientists determine how atoms will combine with other atoms and form compounds.

Reactivity describes how likely an element is to from a bond with other elements. The most chemically active metals are in Group 1. The metals in Group 1 are called Alkali Metals. All of the alkali metals have one valence electron that allows them to easily combine with nonmetals. Although Hydrogen (H) is the first element in Group 1, it is not an alkali metal. Hydrogen is placed in this group because, like the alkali metals, it has one valence electron.

The metals in Group 2 are called Alkali Earth Metals. Group 2 metals are highly reactive but are slightly less reactive and harder than Group 1 metals. The reactivity of Group 1 and Group 2 metals increases with increasing atomic number.

Groups 3 through 12 include the transition metals. Transition metals are usually hard solids with high melting points.

Between the metals and nonmetals on the periodic table are elements called metalloids. Metalloids are elements that have some properties of both metals and nonmetals.

Group 13 is known as the Boron Group.
Group 14 is known as the Carbon Group.
Group 15 is known as the Nitrogen Group.
Group 16 is known as the Oxygen Group.

Halogens are nonmetals in Group 17. The halogens are the most reactive nonmetals. Reactivity in nonmetals increases as atomic number decreases, so Fluorine is the most reactive nonmetal. Halogens react with alkali metals to form salts. Elements in the halogen family exist in all three phases. Fluorine (F) and Chlorine (Cl) are gases, Bromine (Br) is a liquid, and Iodine (I) and Astatine (At) are solids at room temperature.

The last column of the periodic table is Group 18. The elements in Group 18 are known as the Noble Gases. Noble gases are the least reactive of all the elements.

F. Why are groups sometimes called chemical families?

Elements in the same group have similar chemical properties (this is why they are sometimes referred to as chemical families). These similar properties occur because the elements in a group all have the same number of valence electrons (number of electrons in the outermost energy level of an atom).

G. What are some different things that elements in a group share?

Number of valence electrons, similar chemical properties, and similar reactivity levels.

H. What are periods?

Each horizontal row in the Periodic Table is called a period. Periods are numbered from 1 to 7. In the Periodic Table, elements in periods are arranged in order of increasing atomic number. When you move from left to right across a period, the elements become more stable.

I. What happens to the stability of the elements as you move from left to right across a period?

When you move from left to right across a period, the elements become more stable.

J. What do valence electrons have to do with reactivity?

Reactivity describes how likely an element is to from a bond with other elements. The most chemically active metals are in Group 1. The metals in Group 1 are called Alkali Metals. All of the alkali metals have one valence electron that allows them to easily combine with nonmetals. Although Hydrogen (H) is the first element in Group 1, it is not an alkali metal. Hydrogen is placed in this group because, like the alkali metals, it has one valence electron.

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S8P1g. Identify and demonstrate the Law of Conservation of Matter.

A. What does the Law of Conservation of Matter state?

According to the Law of Conservation of Matter, atoms cannot be created nor destroyed as a result of a chemical reaction. Scientists know that there must be the same number of atoms on each side of the equation.

B. What are reactants and products?

Reactants are the substances there before the reaction occurs.
Products are the substances that remain after the reaction takes place.

C. See if you can not only answer the following questions relating to the Law of Conservation of Matter, but defend your answers as well.

$$Na_2O + H_2O \longrightarrow ?$$

a. The reactants involved in a chemical reaction are shown above. How many O atoms must be present in the product that forms from this reaction?

1 Oxygen atom has to be present because there is 1 oxygen atom in the reactants.

b. If the reactants contain 12 carbon atoms and 4 oxygen atoms, what must be true of the products?

They must contain 12 carbon atoms and 4 oxygen atoms because of the Law of Conservation of Matter.