Matter and Changes in Matter – *Read the attached information and answer the following questions.*

Matter

1. Why does the balloon filled with air have a greater mass than the empty balloon?

2. Shining a light on the balance has not effect on the balance (the balance arms do not move.) Why?

3. Why is energy not matter?

Changes in Matter

Physical Changes

4. When water freezes or melts, is it still water or is it a new chemical substance?

5. What do we call a change that does not result in the formation of any new substances?

6. When you dissolve sugar in water does it loose the property of tasting sweet?

7. When the sugar is dissolved in the water no new substance is formed so we call that a ____________ change.
8. List the three physical changes pictured in Fig 12-6.

Chemical Changes

9. What causes the sour taste of bad milk?

10. When a change produces one or more new substances what is that called?

11. How are chemical changes represented?

12. What do we call the starting materials of a chemical change?

13. What side of the chemical equation do we list the products?

14. Looking at Table 12-5, what are the products for the chemical change, Photosynthesis?

Properties and Chemical Changes

15. Are the properties of the new substances (products) produced in a chemical change the same as the properties of the starting materials (reactants?)

16. Is erosion a chemical or physical change?

17. Is corrosion a physical or chemical change?

Conservation of Matter

18. TRUE or FALSE In a chemical change atoms are created and/or destroyed.
19. The Conservation of Matter states:

Matter

Defining Matter

Look around you. The objects you see, such as this book, your desk and chair, and the walls and ceiling, are all composed of *matter*. The air that surrounds you, which is a mixture of gases, is also made of matter. In fact, every solid, liquid, and gas is a form of matter.

Matter is defined as anything that has *mass* and takes up space. ***Mass*** is the total amount of material in an object. We measure mass with an equal-arm balance, as shown in Figure 12-1. Notice that a balloon filled with air has a greater mass than an empty balloon, since air has mass. The amount of space an object occupies is called its ***volume***. The air in the filled balloon in Figure 12-1 takes up space, giving the balloon a greater volume than the empty balloon.

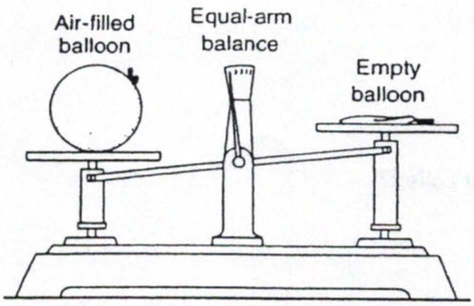

Figure 12-1. The air-filled balloon is heavier and takes up more space than the empty balloon because air is matter.

Is there anything that is not made of matter, that has no mass and takes up no space? Figure 12-2 shows that shining a light on a balance has no effect on the balance. This is because light is a form of energy. Energy is not matter, since it has no mass and no volume. Some other forms of energy are heat and sound.

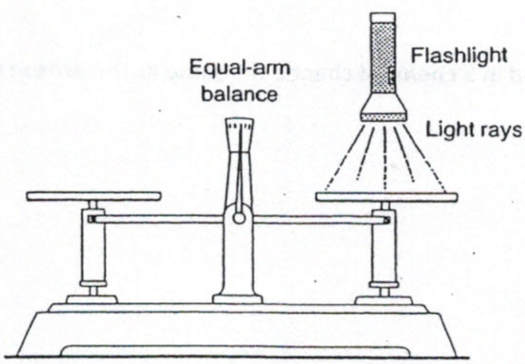

Figure 12-2. The balance is unaffected by the light shining on it, because light is not matter.

Changes in Matter

Physical Changes

As you know, the chemical formula for water is H_2O because each water molecule is made up of two atoms of hydrogen and one atom of oxygen. What is the formula for ice? When water freezes, the arrangement of its molecules changes, but the molecules themselves do not change. They are still H_2O. A change of phase, such as freezing or melting, does not produce any new substances. A change that does not result in the formation of any new substances is a ***physical change.*** All changes of phase are physical changes. Crushing ice cubes into small pieces is also a physical change, since both crushed ice and ice cubes are made of the same substance.

Similarly, when you dissolve sugar in water, the sugar still tastes sweet and the water is still wet. No new substances have been formed, so dissolving is a physical change. Figure 12-6 shows why boiling, melting, and dissolving are physical changes.

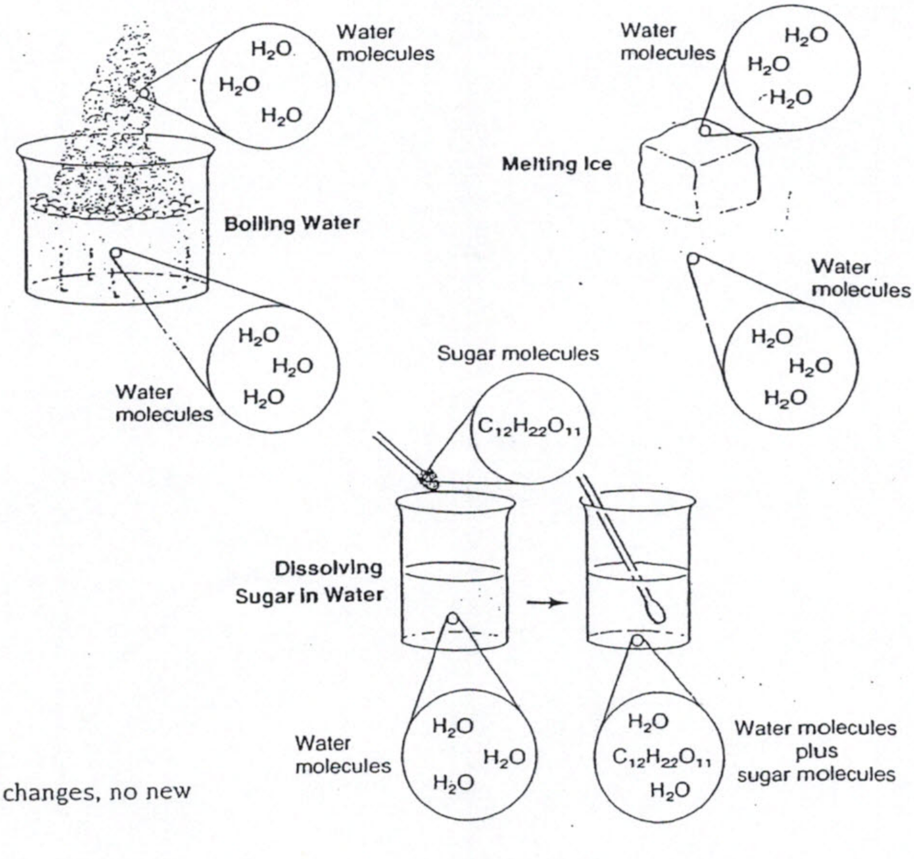

Figure 12-6. During physical changes, no new substances are formed.

Chemical Changes

What happens if you forget to put a carton of milk back into the refrigerator? First, the milk gets warm. This is a physical change. However, if you leave the milk out too long, it turns sour. The sour taste is caused by the production of a new substance called *lactic acid*. A change that produces one or more new substances is called a ***chemical change.*** When a chemical change occurs, we say there was a chemical reaction. Burning paper produces smoke and ash, both of which are new products. Burning is always a chemical change.

Forming a compound always involves a chemical change, whereas forming a mixture involves only physical changes. Similarly, it requires a chemical change to break apart a compound. Mixtures, however, can be separated through physical changes. For example, salt water can be boiled, thus leaving the salt behind; and blood can be spun in circles (centrifuged), thus separating it into its various components.

Chemical changes can be represented by chemical equations. A chemical equation uses formulas and numbers to keep track of a chemical change. The starting materials, called the *reactants*, are listed on the left side of the equation. The final materials, called the *products*, are listed on the right side. An arrow separates the two sides. The equation for the burning of coal would be written as:

$$C + O_2 \rightarrow CO_2$$

A chemist reads this equation as, "carbon plus oxygen yields carbon dioxide." In this reaction, carbon and oxygen are the reactants, and carbon dioxide is the product. Table 12-5 gives some examples of chemical changes.

Table 12-5. Examples of Chemical Changes

Chemical Change	*Reactants*	*Products*	*Equation*
Burning coal	Carbon (C) + oxygen gas (O_2)	Carbon dioxide gas (CO_2)	$C + O_2 \rightarrow CO_2$
Rusting of iron	Iron (Fe) + oxygen gas (O_2)	Rust (Fe_2O_3)	$4Fe + 3O_2 \rightarrow 2Fe_2O_3$
Tarnishing of silver	Silver (Ag) + sulfur (S)	Tarnish (Ag_3S)	$3Ag + S \rightarrow Ag_3S$
Photosynthesis	Carbon dioxide gas (CO_2) + water (H_2O)	Glucose ($C_6H_{12}O_6$); Oxygen gas (O_2)	$6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$

Properties and Chemical Changes

The new substances produced by a chemical change have their own properties. These properties differ from those of the original substances that reacted, since those substances are no longer present. For example, the element sodium is a metal that explodes on contact with water. The element chlorine is a poisonous green gas. When sodium and chlorine combine in a chemical reaction, they produce sodium chloride, commonly known as table salt. The new substance formed has completely different properties from those of the original materials, which no longer exist. During a chemical reaction, the atoms are rearranged to form new substances. This involves the breaking of existing chemical bonds and the formation of new bonds.

Both physical and chemical changes occur in nature. The wearing away of a mountain by streams is an example of a physical change called *erosion*.

Erosion is the physical wearing away of rock material at Earth's surface. The Grand Canyon in Arizona was formed by this physical change over millions of years.

The Statue of Liberty in New York City is made of copper but does not look copper colored. This is due to a chemical reaction between the copper and the air, which produces a new, green-colored substance. The chemical wearing away of a metal is called *corrosion*. Corrosion, which forms a new substance, is a chemical change. Erosion, which only moves substances around, is a physical change.

Conservation of Matter

In a chemical change, no atoms are created and no atoms are destroyed. Every atom that is present before a reaction takes place is still there after the reaction takes place. What has changed is the way the atoms are arranged. Chemical reactions change only the way atoms are bonded to one another.

Figure 12-7 shows what happens when hydrogen and oxygen combine to form water in a chemical reaction. How many atoms of hydrogen are there before the reaction takes place? How does this compare with the number of hydrogen atoms after the reaction takes place? There are four hydrogen atoms before and after the reaction. How are the starting substances (the reactants) different from the substances formed (the products)?

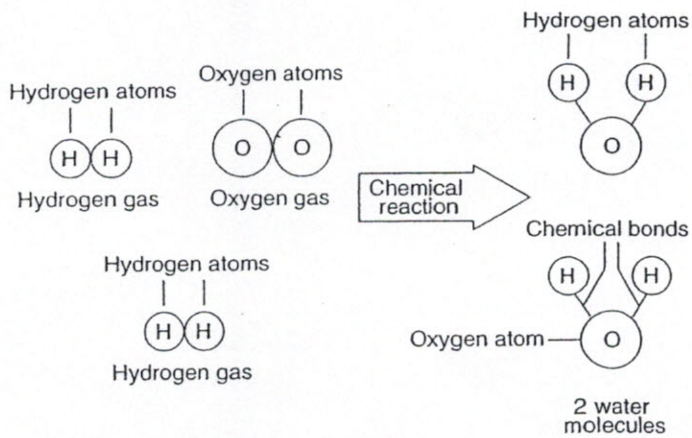

Figure 12-7. The Law of Conservation of Matter: In a chemical reaction, such as the formation of water, there are the same number of atoms before and after the reaction.

Before the reaction, each hydrogen atom was bonded to one other hydrogen atom; after the reaction, each hydrogen was bonded instead to an oxygen atom. How would the mass of the starting materials compare to the mass of the materials formed? The mass remains the same, since no atoms were created or destroyed. This is an example of the *Law of Conservation of Matter*, which states that matter can neither be created nor destroyed in a chemical reaction. It can, however, be changed from one form to another. It is important to remember to account for all the substances before and after a reaction. In particular, it may be easy to forget about gases in the air, since it is difficult to capture and weigh them.