

SCIENCE 810

SCIENCE AND TECHNOLOGY

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MATTER IN CHANGE

Natural factors and man cause changes. Your body is growing and changing constantly. Sometimes you like what is happening and sometimes you do not. Weather conditions change from sunshine to rain and may bring floods that cause misery for many people. Man can do very little about weather conditions, but he may be able either to prevent or to relieve some of the results. A dam built in the right place may prevent disaster.

The physical, chemical, and nuclear changes of matter are frequently not controllable by human beings. God rules the world and He manages all change. The wonder of all creation is that God created men to be the caretakers of the energy and power found in nature. The responsibility is great, and we are all accountable to God for what we do with it. Our bodies and our lives are part of our responsibility. What we do with our lives is most important. Careful thought regarding a vocation should begin with asking God for guidance that we may become good caretakers of our lives and use God's wonders for His glory.

Physical change. The changes most easily recognized are physical changes. A change in size, shape, color, or form does not change the chemical composition of matter, only the physical properties which are often obvious. Physical change is also more easily accomplished than chemical change. Heat applied to matter usually causes it to expand (except water, which expands as it freezes). When matter expands, it takes up more space. As heat is applied the molecules move faster, and bounce against each other harder, and the space between the molecules increases. Cooling will slow this process and will return the matter to its original form. No

chemical change has taken place. The matter has not changed composition, just form.

Matter has many physical characteristics. *Soluble* substances can dissolve in liquids. The molecules separate from each other and scatter among the liquid molecules. If a substance cannot dissolve, it is said to be *insoluble*.

Matter changes from one form to another. Solid, liquid, and gas are the possible forms of matter. More heat changes a liquid to a gas. Changing from one form to another is called a *phase* change. The change is made by the addition or removal of heat. For every substance the amount of heat added or removed to make the change happen is different. Heat capacity is the amount needed for change by each substance and is also called *specific heat*. Specific heats are recorded in tables for easy referral so that the scientist can conduct his experiments with accuracy.

The pressure cooker is a good example of matter in change. Water boils at 100° Celsius at sea level in an open container. Under such conditions, however fast it boils, the temperature stays the same. Water can be made hotter than 100°C or boiling. A pressure cooker works on this principle. In the closed container the water boils and changes to steam. This builds up pressure which cannot escape. As heat continues to be supplied, the temperature goes up to approximately 107°C. The food cooks more quickly. If the steam builds up too much pressure, the safety valve will blow out preventing damage.

Many people think the moisture they see above boiling water is steam. Actually steam is heated water vapor and forms an invisible gas. As the steam rises above the boiling liquid, it cools and forms tiny droplets of water that you can see.



Do this investigation at home.



These supplies are needed:

pressure cooker

directions from a cake mix box



Follow these directions and answer the questions. Put a check in the box when each step is completed.

- ☐ 1. Examine a pressure cooker at home or in a store.
- ☐ 2. Ask your mother to explain the principles of operation or refer to the book that came with it from the manufacturer.

1.55 Why does the cooker have a valve with a gauge on it? _____

1.56 What is the purpose of the rubber gasket on the lid? _____

1.57 What kind of changes occur in a pressure cooker? _____

1.58 Read the high altitude directions for baking a cake mix. Why are they different from regular directions? _____

Chemical change. Chemical changes take place when the *appearance* and *composition* of matter change. New substances are formed but atoms are neither made nor lost. Some form of energy is released to bring about a chemical change. Electrolysis of water is a good example. The chemical equation for this process is $\text{H}_2\text{O} \rightarrow 2\text{H} + \text{O}$. Read it this way: water (H_2O) splits into ($\rightarrow$) two atoms of hydrogen (2H) and

one atom of oxygen (O). The short form is called a *chemical equation*.

Mother accidentally leaves a silver spoon in a dish of custard. Custard contains eggs and eggs contain sulfur. The spoon turns black (tarnishes). Read this equation of what happened: $2\text{Ag} + \text{S} \rightarrow \text{Ag}_2\text{S}$. If you said two atoms of silver plus one atom of sulfur forms ($\rightarrow$) silver sulfide, you were correct.



Do this investigation.



These supplies are needed:

jar or beaker

iron filings

water



Follow the directions and do the activity. Put a check in the box when each step is completed.

- ☐ 1. Prepare your Science Record form so you can record your entries.
- ☐ 2. Rinse the jar or glass with water and shake out as much moisture as you can without drying it entirely. Caution: Do not hit the sink or any hard surface that could cause the jar to break in your hand.

- ☐ 3. Sprinkle some iron filings into the jar carefully so that they will stick to the side of the jar in the moisture. Set aside and observe daily until you see the iron filings turn reddish brown.
- O1.59 Write your result and conclusion on the SR form. Then give your SR form to your teacher.
- 1.60 Two iron atoms joined three oxygen atoms from the air to form one molecule of iron oxide (Fe_2O_3) or rust. Write this change in a chemical equation.
-

Chemical equations represent the chemical changes that take place constantly. Rusting and tarnishing are two examples. Fermentation (which aids in making yeast breads), souring of milk, spoiling of food, digestion, photosynthesis, and the manufacture of many items, such as glass and plastics are additional examples.

Water can be changed physically from solid to liquid to gas but the molecule is not changed. The water molecule is split by electrolysis into its atoms, hydrogen and oxygen, in a chemical change.

Recently the nucleus of an atom was split into two fragments of approximately equal mass. The splitting of the atom produced energy. Although this feat was accomplished in the 1940s, we refer to it as *recent* compared to the more than two thousand years since Aristotle made important contributions to the entire scheme of science study. *Nuclear fission*, the name of this process, is considered part of the third way matter changes. This principle is the basis for nuclear power plants.

Acids and bases. Acids are very important to the chemist. Acids are very common and very useful. Sometimes they seem destructive because strong acids are quite active. They taste sour. Vinegar is acetic acid (CH_3COOH). Vinegar is used for its tart (sour) flavor in many foods, especially

pickles. It also serves as a preservative. Hydrochloric acid made in your stomach aids digestion. Sulfuric acid is used as an electrolyte with water in storage batteries. Sulfuric acid can burn your clothes or your skin if splattered. All acids should be handled with care. Chemical formulas for acids, such as HCl (hydrochloric), H_2SO_4 (sulfuric), and CH_3COOH (acetic) all have one atom in common. What is it? If you said *hydrogen*, you are correct.

Tests are made to determine whether solutions are acidic by using litmus paper or a liquid called phenolphthalein. Acid tests are very common in the laboratory where either one may be used easily. Acid tests are also used in the home, in industry, and for medical diagnosis. Litmus is sold at the drugstore and even made up in kits so a person may make regular acid tests under the supervision of the doctor. Blue litmus turns red when the solution is acid. Blue litmus does not change color if the solution is a base. Red litmus paper turns blue for a base but does not change for an acid.

The pH scale shown in Science LIGHTUNIT 803, page 31, shows how acids and bases are evaluated for strength in terms of the hydronium (H_3O^+) concentration. Acids and bases are on opposite ends of the scale. A base is a substance that tastes bitter and feels slippery like oil. All bases contain at least one metal plus hydrogen and oxygen

combined as a hydroxide ion (OH^-). If we have two hydroxide ions, the OH is placed in parentheses (OH) and the 2 becomes a subscript of the OH ion (OH_2).

Acids usually have the positive ion of hydrogen, like HCL (hydrochloric acid), H_2SO_4 (sulfuric acid), HNO_3 (nitric acid), and H_3PO_4 (phosphoric acid). Bases usually have the negative ion of OH (hydroxide) like NaOH and $\text{Ca}(\text{OH})_2$. Salts like NaCl, NaSO_4 and KCl usually have neither of these ions. Usually the only exceptions to the above rules are the weak acids like vinegar (CH_3COOH) and the weak base aluminum hydroxide (NH_4OH), which have both ions.

Warning: The sour taste for acid and the bitter taste for the base have been given as

characteristics of the two substances. Although this fact is true, it is not presented to tell you to test unknown substances by tasting. Do *not* taste any *unknown* substance at any time.

The midpoint of the pH scale is neutral. When acids and bases are combined the properties of each are destroyed. The chemical compound formed is a salt, and the salt has its own characteristics. Sodium chloride (table salt) is the one known best, but it is only one of many. Salt is used to season food to improve its flavor; but if salt touches an open sore, it will hurt. Bushes and grass die if the salt used to melt snow and ice on sidewalks and streets gets on the plants. Acids and bases are helpful but must be handled with respect because they can be equally harmful.



Complete these statements.

- 1.61 Every acid has an atom of a. _____ ; every base has at least one b. _____ and c. _____ ion.
- 1.62 An acid combined with a base forms a _____.



Write the letter of the correct choice on the line.

- | | | |
|------|--------------------------------|---------|
| 1.63 | _____ NaOH | a. acid |
| 1.64 | _____ HCl | b. base |
| 1.65 | _____ $\text{Ca}(\text{OH})_2$ | c. salt |
| 1.66 | _____ H_2SO_4 | |
| 1.67 | _____ NaCl | |
| 1.68 | _____ CuSO_4 | |
| 1.69 | _____ CH_3COOH | |
| 1.70 | _____ $\text{Al}(\text{OH})_2$ | |



Review the material in this section in preparation for the Self Test. The Self Test will check your mastery of this particular section. The items missed on this Self Test will indicate specific areas where restudy is needed for mastery.