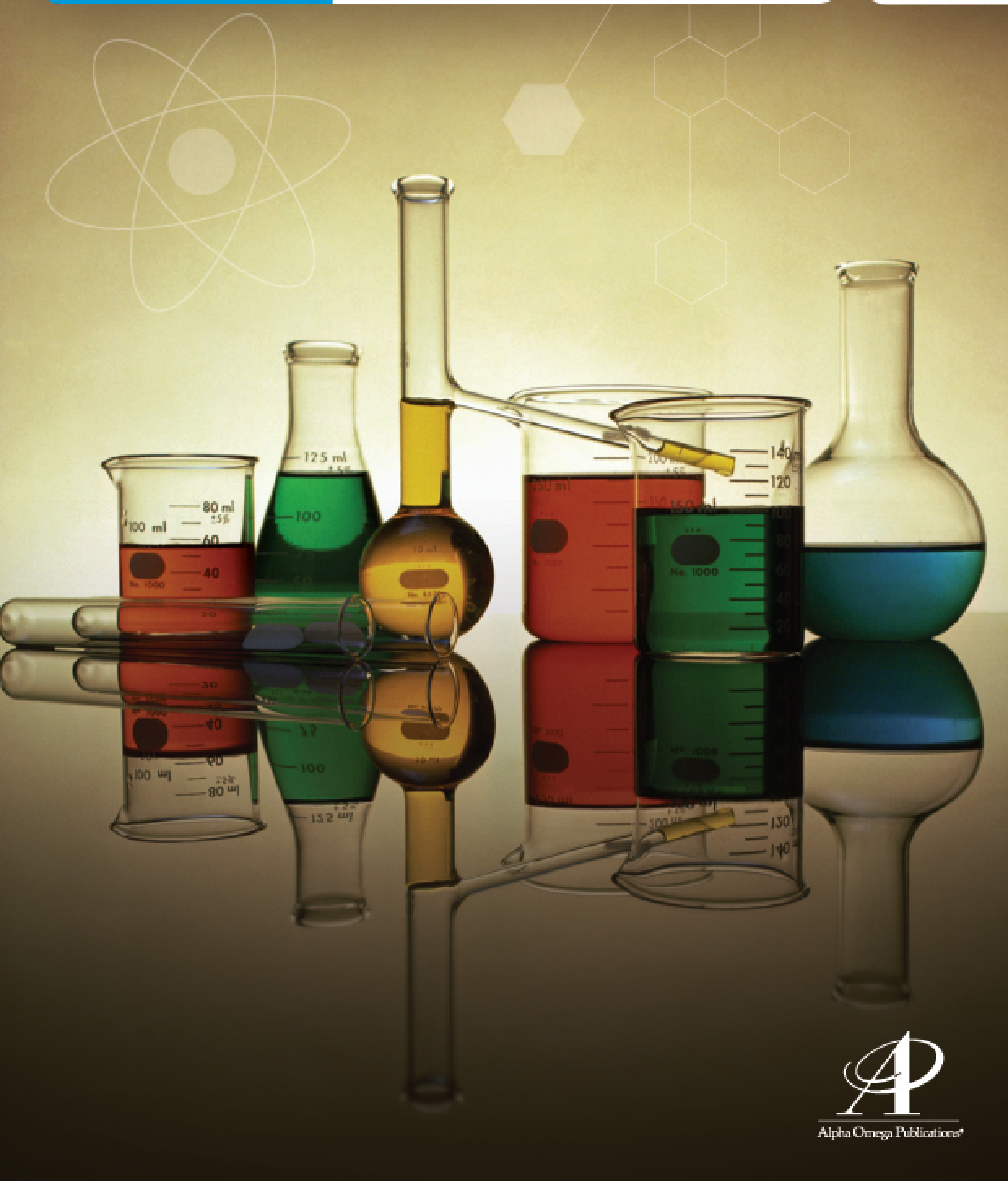
LIFEPAC® Science



Alpha Omega Publications®

SCIENCE 1106
CHEMICAL REACTIONS, RATES AND EQUILIBRIUM

CONTENTS

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SCIENCE 1106:
CHEMICAL REACTIONS, RATES AND EQUILIBRIUMS

Have you ever wondered why a fire is hot, or why the food you eat produces energy? In both examples, a reorganization of molecules occurs. In the fire, fuel reacts with oxygen to produce heat plus different chemicals. In the case of food eaten, digestion breaks up the molecules so that they can react with oxygen to produce heat (energy) and waste products. The reorganization of molecules involves energy and energy changes.

You will explore how molecular reorganization produces energy, how and why reactions occur, and what controls the rate of a reaction. You may need to review previous LIFEPACs. Also, be sure to have the Periodic Table from SCIENCE 1101 handy.

OBJECTIVES

Read these objectives. The objectives tell you what you will be able to do when you have successfully completed this LIFEPAC®.

When you have finished this LIFEPAC, you should be able to:

1. Describe how a reaction can be detected.
2. Interpret energy (enthalpy) diagrams.
3. Explain what factors affect the rates of reactions.
4. Explain Le Chatelier's Principle.
5. Describe an equilibrium condition in a reaction.
6. Apply the Law of Chemical Equilibrium.
7. Explain how condition variables affect an equilibrium reaction.

Survey the LIFEPAC. Ask yourself some questions about this study. Write your questions here.

I. CHEMICAL REACTIONS

With the models of atoms, molecules, and ions developed in previous LIFEPACs, we are now ready to investigate in depth the systems of chemical reactions. What is a chemical reaction? From our investigations so far, we may generalize that in a chemical reaction the atoms are rearranged to form new substances with new formulas. In other words, *the products (substances produced) are different in molecular makeup from the reactants (substances started with)*.

SECTION OBJECTIVES

Review these objectives. When you have completed this section, you should be able to:

1. Describe how a reaction can be detected.
2. Interpret energy (enthalpy) diagrams.

VOCABULARY

Study these words to enhance your learning success in this section.

endothermic	exothermic	precipitate
enthalpy	heat of reaction	

Note: All vocabulary words in this LIFEPAC appear in **boldface** print the first time they are used. If you are unsure of the meaning when you are reading, study the definitions given.

DETECTION

We see many examples of chemical reactions around us daily. The changing colors of the leaves, the growing of new body cells, the tarnishing of silverware, the fading of the color in paints, and the burning of gasoline in a car are all examples of chemical reactions. Some reactions are easy to detect and others go on too slowly to be noticed. How can chemical reactions be detected?

Solid formation. You studied in Science LIFEPAC 1102 about distinguishing between chemical, physical, and phase changes. Any reaction that caused the starting materials to completely lose their properties to form new and distinct substances was a chemical change. The next set of activities will help you to discover one way a chemical reaction can be detected.

Do this experiment. WEAR GOGGLES

These supplies are needed:

0.01 M NaCl solution, table salt – 0.58 g/L of solution

0.01 M K_2CrO_4 solution, dilute solution – 1.94 g/L of solution; solid can be purchased at drug, hobby or photo supply store

0.01 M $AgNO_3$ solution, about 1.7 g/L of solution or a diluted solution; solution can be purchased at a local drug or photo supply store

several small test tubes

several medicine (eye) droppers

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

❑ 1. Place ten drops of 0.01 M NaCl in a test tube and ten drops of 0.01 M potassium chromate, K_2CrO_4, in another test tube.

1.1 What do the three solutions look like? ______________________________

____

❑ 2. Put ten drops of silver nitrate, $AgNO_3$, in each of the other two solutions.

1.2 What happened in Step 2? ______________________________

____

1.3 Why do you believe a reaction did or did not occur? ______________________________

____

❑ 3. In a clean test tube put ten drops each of K_2CrO_4 and $AgNO_3$.

❑ 4. Slowly, a drop at a time, add NaCl until a significant change occurs.

1.4 What happened in Step 4? ______________________________

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1.5 What is your hypothesis for the observations and changes? ______________________________

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Color change. Another way to detect a chemical change is by comparing colors. When the leaves turn colors in the fall, a chemical change has occurred. The next experiment will show how color is used in reaction detection.

Do this experiment. **WEAR GOGGLES**

These supplies are needed:

0.01 M acidified iron (II) sulfate, $FeSO_4$ - 1.52 g/liter of solution and 1 ml concentrated HCl; solid $FeSO_4$ can be purchased at drug or hobby store

0.01 M potassium permanganate, $KMnO_4$ - 1.58 g/liter of solution; solid $KMnO_4$ can be purchased at drug, hobby, or chemical supply store 0.01 M NaCl solution

0.01 M ammonium nitrate, NH_4NO_3 - 0.80 g/liter of solution; solid ammonium nitrate can be purchased at drug or fertilizer store

several test tubes or baby-food jars

several medicine (eye) droppers

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

- ❑ 1. Place about 3 ml of 0.01 M acidified iron (II) sulfate, $FeSO_4$, in a test tube.
- ❑ 2. Add 6 drops of 0.01 M potassium permanganate, $KMnO_4$, 1 drop at a time, shaking the test tube after each additional drop.

1.6 What do the reactants look like? ________________________________

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1.7 What happens when the reactants are combined? ________________________________

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____

1.8 Why do you think a reaction has, or has not, occurred? ________________________________

____

____

- ❑ 3. Add 10 drops of 0.01 M sodium chloride, NaCl, to 10 drops of 0.01 M ammonium nitrate, NH_4NO_3.

1.9 What do the reactants look like? ________________________________

____

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1.10 What happens when the reactants are combined? ________________________________

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1.11 Why do you think a reaction has, or has not, occurred? ________________________________

____

____

Gas formation. We have now seen that chemical reactions can be detected by the change in color and by the formation of a **precipitate**. A third way is found to occur very frequently in nature. The production of methane gas, CH_4, when living material decays in the absence of oxygen, is a very important example of gas formation in a chemical reaction. This example is the source of natural gas, the gas used in kitchen stoves, home furnaces, and factories. When the living materials were covered during the time of Deluge (Genesis, Chapters 6-8), the decaying organic materials produced the methane gas. This gas is found both in oil wells and in coal mines.

Our study will investigate this third way to detect chemical reactions.