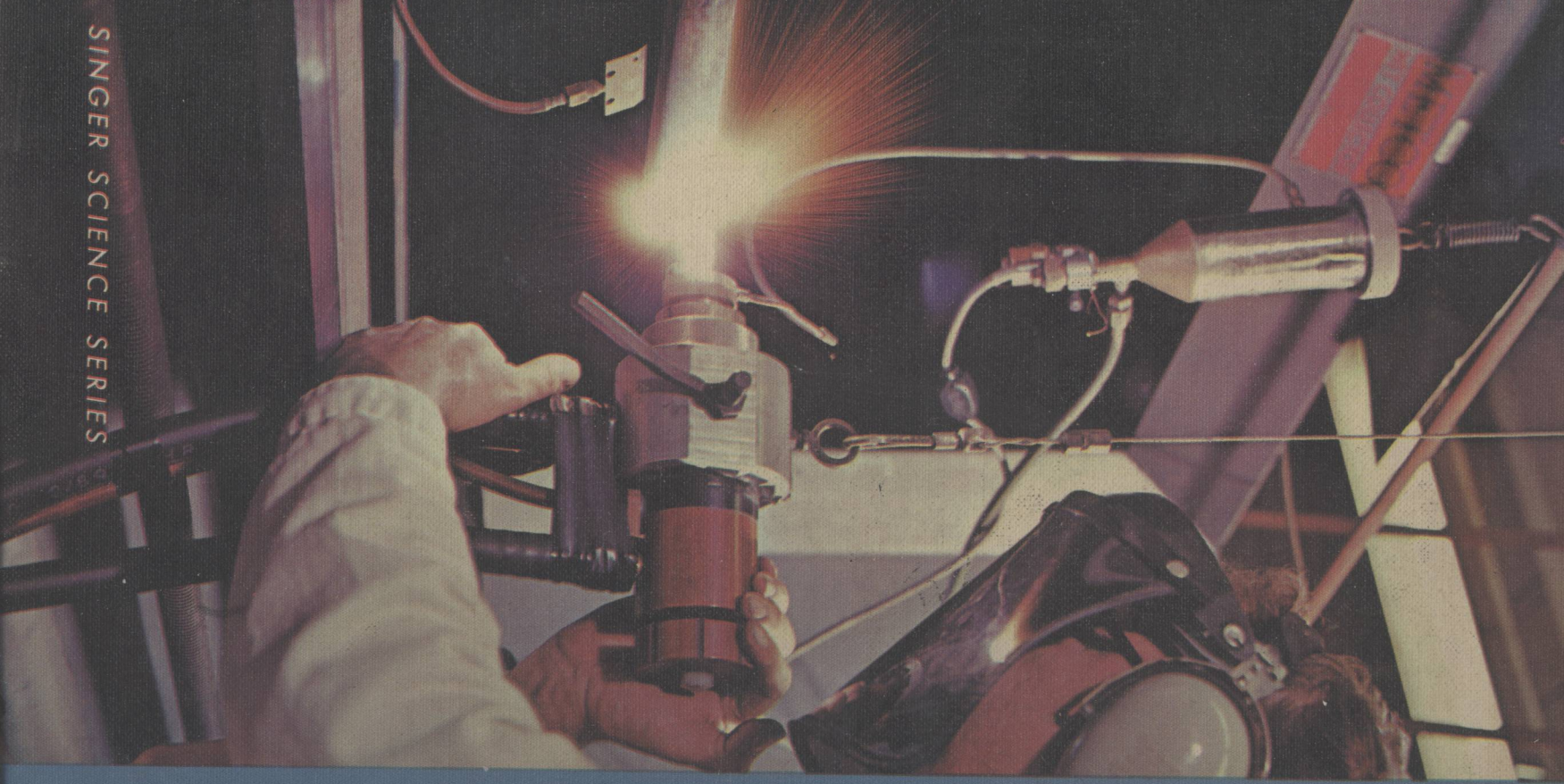
SINGER SCIENCE SERIES



scientists solve problems

scientists solve problems

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SINGER SCIENCE SERIES

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John Gammons Read
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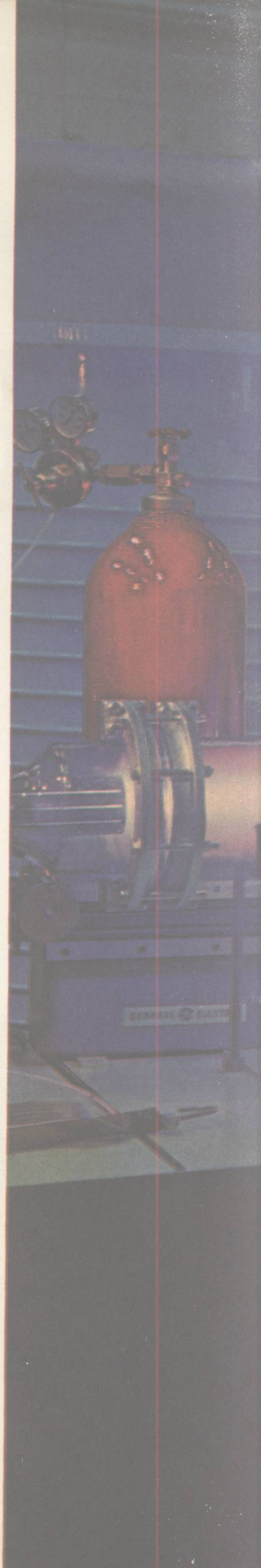

Space research scientists test the propulsive force of ionized gas for possible use as a stabilizer for space vehicles.

Photograph courtesy of General Electric Company.

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scientists solve problems

contents

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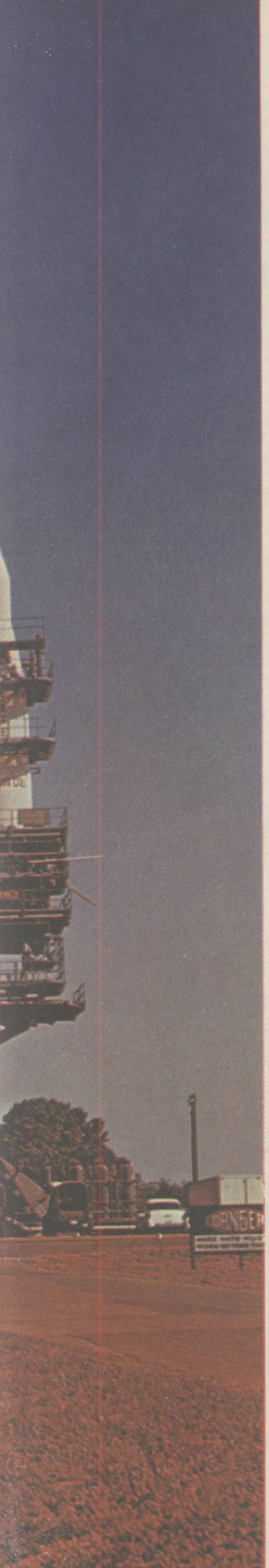
COVER PHOTOGRAPH

The plasmajet, whose scream requires earmuffs on the operator, produces arc-flame temperatures up to 30,000° F. and spray coats equipment with both metallic and nonmetallic materials.

Photograph courtesy of E. I. du Pont de Nemours & Co.

UNIT ONE



Scientists, science, and space

Man is an energy system that can be maintained in an artificial environment in space.

National Aeronautics and Space Administration

Chapter 1

New ideas for studying science

Because you are older, you are able to understand some ideas that you could not have understood a few years ago. For this reason the ideas in this book are about the work that scientists do and the work that technologists do. This work is properly called *research*, which is a method of getting information. This book will help you understand how some new ideas were discovered through research. It will help you understand some of the ideas that were discovered very recently. You will find an emphasis on new ideas in this book. Some of the ideas are those that scientists have discovered in the field of *basic science*. Some of them are ideas that technologists have discovered in the field of *applied science*.

Basic science and applied science are both useful. Research in basic science always comes before research in applied science. You have to know about something before you can do anything about it. If you are going to make a medicine to cure a disease, you have to know something about the human body and disease before you can make the medicine. If you are going to make a new electric motor, you have to know something about electricity and magnetism before you can apply this knowledge to construct your new motor. Basic scientists are interested in the search for knowledge. Applied scientists are interested in the use that may be made of this knowledge. If you are thinking of a career in science, you will want to decide which kind of science interests you more. You will want to decide whether to use your talents doing basic research or use them in applying new information to the development of new products.

Basic scientists are a very important group of people in the world today. Educated boys and girls should know what scientists are really like and what they do. Those people who are working in the fields of applied science are also an important group of people in the world today. You should know what they are really like and what they do. In addition, you should realize that these two kinds of work are only two among many important kinds in the world today. Many other kinds of work are equally important. As you become older, you should learn about all of the kinds of work that are being done. This will help you decide what you should be doing to help yourself and others by using your abilities and your talents in the best way possible.

Why study science?

One of the important ideas to remember about science is that it is a body of knowledge that may be improved at any time by better ideas. Scientists question some of the ideas that seem to be true at the present time. Some scientists doubt some of the theories of other scientists. Scientists are challenged by what they do not know. The privilege of doubting is a freedom that scientists must have to make their discoveries. Scientists must be free to experiment, to do research, to question facts, and to start on new roads of discovering truth.

Perhaps you have heard many reasons, while you have been in school, why you should study science. You may have heard many reasons why science is important to know. More likely you have heard how useful science can be to you and to other people. A very important idea about science and scientists was stated by Dr. Lee A. DuBridge. He made this important statement: "The true value of science is not in its byproducts, but in its goals. The true value of applied science is not the dollar value, but its human value."

Dr. DuBridge believes, as do many other scientists, that basic science is a useful area of human learning and that applied science is important because of its goals of human comfort, leisure, culture, and happiness that it can help people achieve.

use reference books and make charts

1. On a sheet of paper list the following areas of science. After each area write the definition of it.
   Example: Botany—a study of plants.
   Aeronautics, anatomy, anthropology, archeology, astronomy, bacteriology, ballistics, biochemistry, botany, chemistry, conchology, cybernetics, dermatology, entomology, ethnology, geography, geology, glaciology, hematology, horticulture, ichthyology, immunology, mammalogy, mathematics, metallurgy, meteorology, microscopy, mineralogy, oceanography, ornithology, paleontology, physics, physiology, roentgenology, toxicology, zoology.
2. Underline those areas that are basic sciences. Place an X in front of those that are applied sciences.
3. Make a chart and classify each area under one of these five headings: (1) plants and animals, (2) human body, (3) earth, (4) universe, and (5) matter-energy.
4. Make a chart showing four columns. Print at the top of the first column the word *comfort;* at the top of the second, *leisure;* at the top of the third, *culture;* and at the top of the fourth, *happiness.* In each column list a number of things that have been made as a result of applied science and that have contributed to these goals. Examples: *comfort*—furnaces; *leisure*—television; *culture*—books.

As you read and study this book, you will find that the goals of basic and applied science are described in the work of the basic scientist and the applied scientist. The goal of basic science—to discover truth—is shown in much of the research you will read about. The goal of applied science—to promote human comfort, leisure, culture, and happiness—is also described. "Science will be judged not by how fast it helps us to travel, but where it helps us to go." This statement of Dr. DuBridge is important for you as a student. Your study of science should be judged not by how fast it helps you travel through life, but where it helps you to go. It may help you to become a scientist. It may help you to become a better educated person.

Opportunities for you

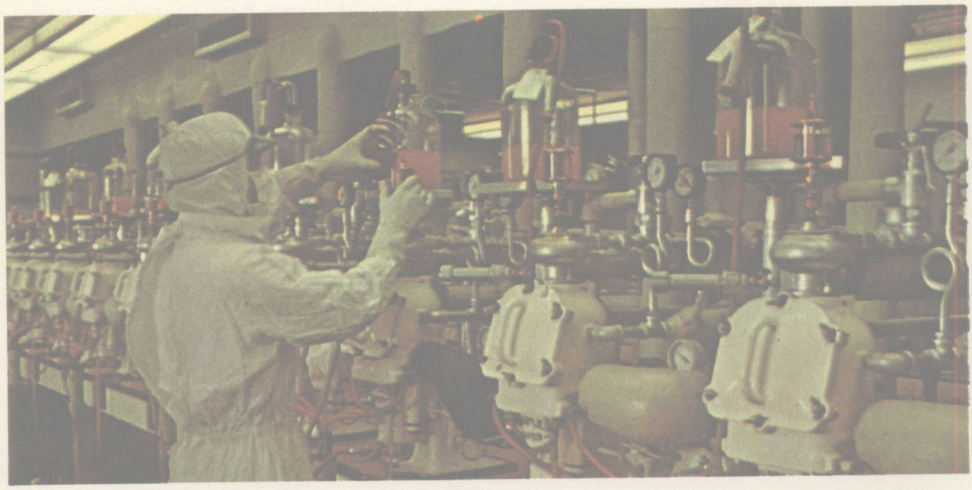
If you become a scientist, what will be your characteristics? Dr. DuBridge lists three characteristics of a person who chooses science for a lifework.

1. He has the urge to explore.
2. He has the urge to create.
3. He has the urge to compete.

You will have an opportunity this year to do these three things. You may enjoy them so much that you may decide this is what you would like to do for your lifework. In addition to these characteristics, Dr. R. P. Feynman, a well-known atomic physicist, adds another. He says that a scientist knows the importance of an idea. Throughout this book you will discover the importance of many ideas that scientists have had and how they have used them to devise experiments and to do research to discover new ideas or test old ones. You will also study the ideas of those who work in the field of applied science and understand much of the world as it is today. Perhaps like those who now work in the field of science, with more knowledge you will find more

Intricate and highly specialized equipment is the tool of some scientists.

Chas. Pfizer Co., Inc.



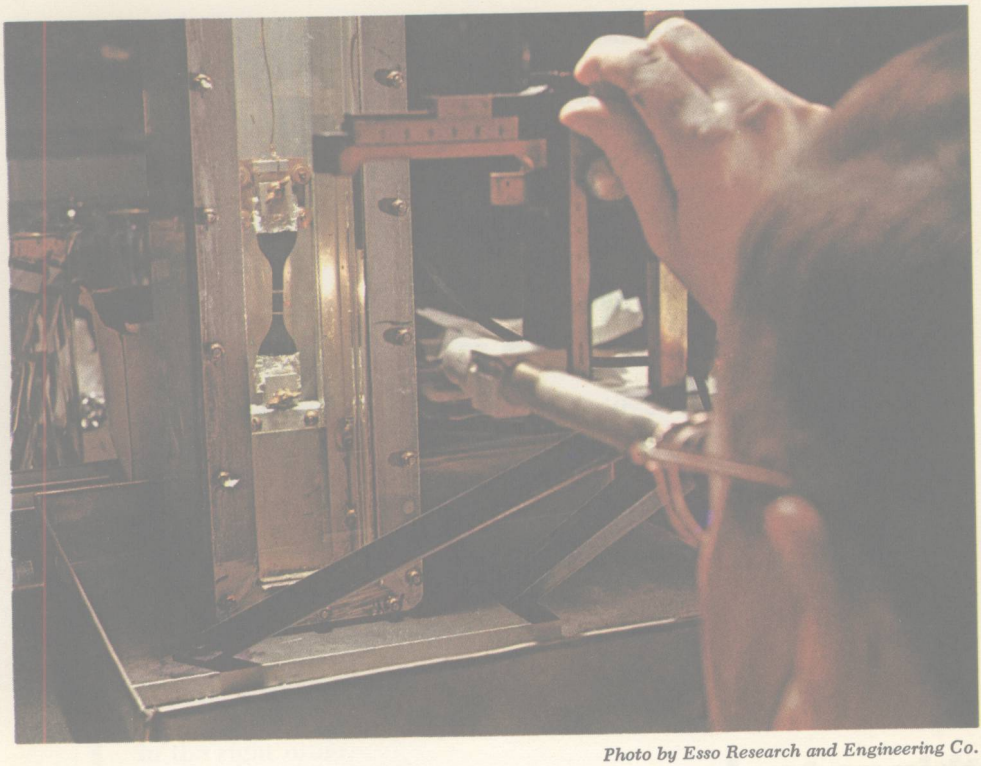


Photo by Esso Research and Engineering Co.

Precision is a requirement in scientific research.

of the mystery of the world to be explored, and you will be lured to continue that exploration for many years. You will discover as you study and read about the people who do research that basic and applied science do contribute to man's physical, intellectual, and spiritual well-being and that you will be a better person for having studied science.

write a paragraph

Explain what you think you would like to do for a lifework. Tell why you made your choice. Read your paragraph to the class.

Idea guides

Several idea guides are described in this book to help you in your study of science this year. The idea guides require your special attention. They are ideas that are very important in the world today. You cannot think about science correctly unless you understand them. You should use the idea guides to help you organize your information. You will use the idea guides to help you understand the new information presented in this book. Your first idea guide appears in Chapter 2. Study them and review them often.

important ideas to remember

Research is based on the ideas that scientists have discovered in the past, on new ideas that scientists are testing, and on recent information that has been proved to be true at the present time. If you are to understand what is happening in the world of science, you need to know about the recent ideas that scientists have discovered through research. The great nations of the world cannot progress unless their citizens know and understand what scientists are doing and why they are doing it.

words to know and use

1. Define or explain by writing sentences the following words and terms used in this chapter: *research, basic science, applied science.*
2. The word *culture* has many meanings. Use a dictionary and read the definitions of the word. Write sentences using different meanings.

questions to answer

1. What is the difference between basic and applied science?
2. What is scientific research?
3. What are idea guides?
4. What are four characteristics of a scientist?
5. What is one idea about science expressed by Dr. DuBridge?

things to do

1. With the assistance of your teacher, select one student to write letters of inquiry to the California Institute of Technology and the Massachusetts Institute of Technology. Ask for a catalog on the requirements for admission. Make a report on admission requirements. From an examination of the catalogs, make a report on the kinds of occupations for which you can be trained.
2. Examine your list of areas of science and their definitions. On a sheet of paper list the areas of science. Under each area write at least two questions that you may have had at one time or another and that pertain to the particular area. Search for answers to your questions as you study science this year. Compare your questions with those of some of your classmates. Combine your classmates' questions to make a notebook of science questions.

sustained science studies

A sustained science study is one that continues for some time. It is a problem that you want to solve. It is one that requires considerable work as well as time. The solution to the problem may be unknown to scientists.

Carry on sustained science studies this year. To get started with one sustained science study, select one of the areas of science and read about it this year. Use reference books. Select one project you would like to do in your area. Show it to the class at the end of the year.

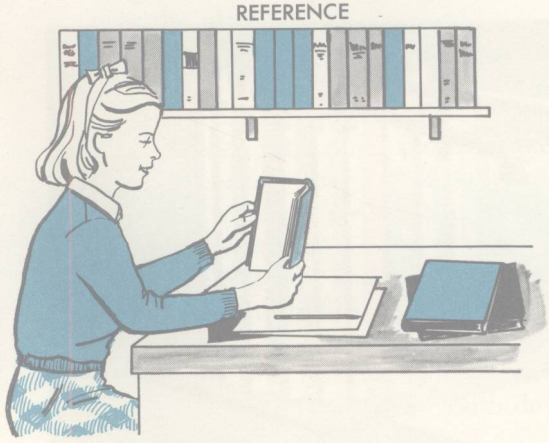
Chapter 2
New ideas about you in space

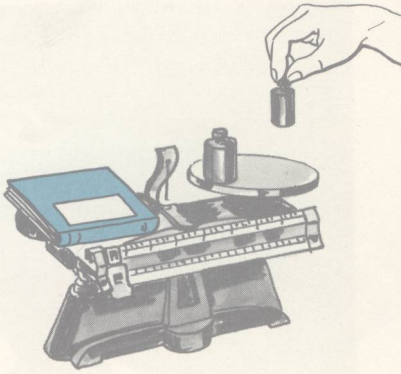
Why is it necessary for so much research to be done in the world today? The answer is quite simple. People have questions but lack the answers. People want to do things, but they don't know how to do them. Why is research the method to use to answer questions? Some questions can be answered by reading books. Some questions can be answered by asking an authority. Some questions can be answered by observation. Some questions can be answered by measuring. Some questions can be answered only by doing research.

finding answers

Read the questions. Read the ways of answering them. Tell which method would be best to answer each question. The answers are not in the right order.

Question	*Method of Finding Answer*
1. What time is it?	Measure
2. What is an atom?	Observe
3. What research has Dr. DuBridge done?	Do research
4. How much does my science book weigh?	Ask an authority
5. What is the best material for a nose cone?	Read





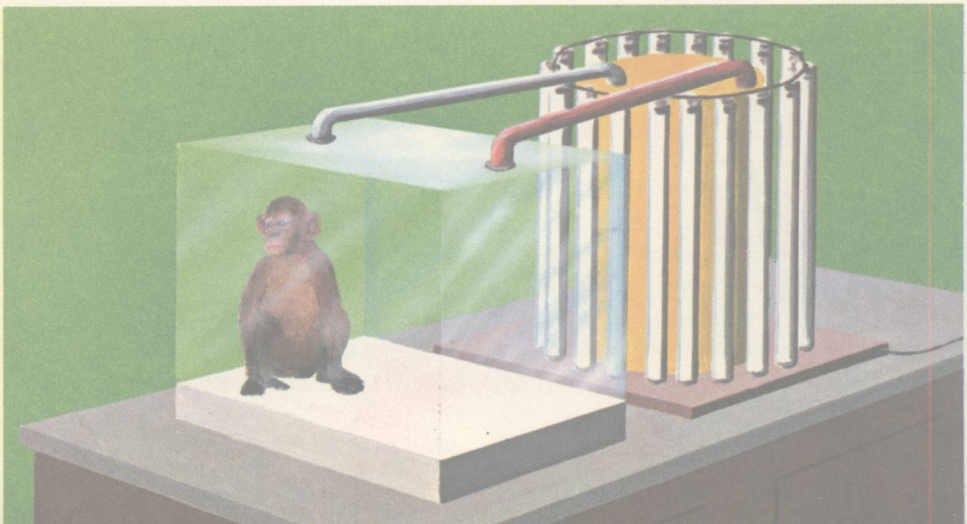
Two kinds of research must be done in the world today to find the answers to some questions and to find out how to do things. People want to go to the moon. Basic scientific research must be done to find the answers to questions about the human body and the effects of space travel on it. No one can read a book, observe, or ask an authority how to do it. Research is needed. The scientist must do the basic scientific research on the human body and space. The answers to his questions are used by the technologist to guide his research to make the machines and clothing. Without these two kinds of research—basic scientific research and applied scientific research—man will not get to the moon.

What is research? You remember that it is a method of getting information. No one has discovered a better way of answering some kinds of questions. The research method is used to get as truthful answers as possible to questions. The opinion of a person is unimportant. The facts are important. As you study the science in this chapter, you will learn about many kinds of research. You will learn about the contributions scientists and technologists have made and the questions that are not yet answered about you in space. Here is your first new idea guide.

idea guide **Man is an energy system that can be maintained in an artificial environment in space.**

How can you get oxygen?

The picture of the little monkey in the plastic box illustrates the kind of research that scientists are doing to learn how to provide oxygen for astronauts. An astronaut is one who flies through space. How can an experiment like this one help scientists answer the question regarding oxygen? The monkey is in a plastic box which is constructed so that air cannot get into



or out of it. Study the picture to help you understand the experiment. To the left of the box is a tank. Around the tank are fluorescent lamps. Inside the tank are water plants called algae. The tank is connected to the plastic box. The monkey cannot get air from the room because the box is sealed. Without air the monkey will die because it cannot get oxygen. The carbon dioxide that the animal exhales must be removed or the monkey will die. Without air from the outside, the monkey is living. Why?

Several facts that were discovered by research and have been known for many years are used in this experiment with the monkey. One of the facts is that plants give off oxygen during photosynthesis. You can do an experiment to help you understand this fact. Two other facts that scientists have discovered through research can be understood by doing two other experiments.

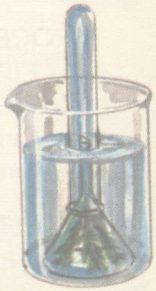
experiment

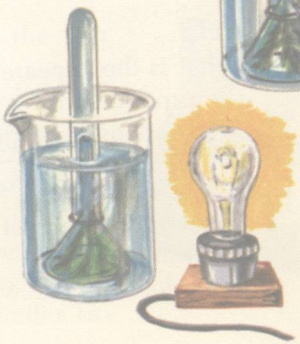
PROBLEM

How can you show that plants give off oxygen?

MATERIALS

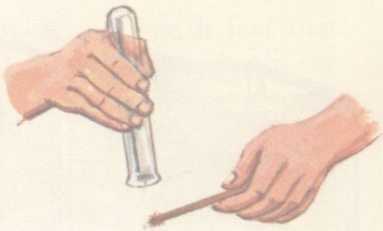
1. Growing water plant such as Elodea
2. One test tube
3. One glass funnel
4. One large beaker
5. Water
6. Wood splints and matches





PROCEDURE

1. Place the funnel upside down over the plant.
2. Fill the test tube with water.
3. Place the test tube over the end of the funnel. This step must be done under water to avoid losing the water that is in the tube.
4. Place the beaker near a light bulb or in sunlight and watch to see what happens to the water in the test tube.
5. When the test tube is partly empty, test the material in the tube with a glowing splint. Keep the test tube mouth under water until you are ready to test the material. Test the material with the test tube mouth down.



RESULTS

1. What happens to the water in the test tube?
2. What happens to the glowing splint?
3. Why is the test tube held upside down when testing the material in it?

CONCLUSIONS

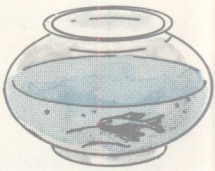
1. Why does the glowing splint burst into flame?
2. How can the release of oxygen by plants aid man in space?
3. In space what energy source is needed for plant growth?

experiment

PROBLEM

How can you show that animals give off carbon dioxide?

MATERIALS

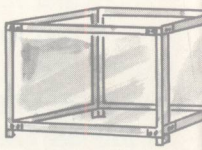


1. One small fish
2. One small aquarium without plants
3. Limewater

PROCEDURE

1. Fill the aquarium two thirds full of limewater.
2. Place the fish in the limewater. CAUTION! Wash your hands after using the limewater. Do not rub your eyes. Limewater can irritate your eyes.

RESULTS



1. What is the appearance of the limewater at the beginning of the experiment?
2. What changes occur in the limewater?

CONCLUSIONS

1. What is the name of the gas that changes the appearance of limewater?
2. Why does the limewater change?