DOCUMENT RESUME

ED 317 373 SE 050 855

AUTHOR Fredericks, Anthony D.; Asimov, Isaac
TITLE The Complete Science Fair Handbook. For Teachers and Parents of Students in Grades 4-8.
REPORT NO ISBN-0-673-38800-X
PUB DATE 90
NOTE 98p.; Drawings and small print may not reproduce well.
AVAILABLE FROM Good Year Books, Inc., 1900 East Lake Ave., Glenview, IL 60025 ($8.95).
PUB TYPE Guides - Classroom Use - Materials (For Learner) (051) -- Guides - Classroom Use - Guides (For Teachers) (052)

EDRS PRICE MF01/PC04 Plus Postage.
DESCRIPTORS *Elementary School Science; Exhibits; Extracurricular Activities; *Instructional Materials; Intermediate Grades; Junior High Schools; *Middle Schools; Science Activities; Science Education; *Science Fairs; *Science Instruction; Science Projects; *Secondary School Science; Student Research

ABSTRACT

Interest in a science fair is low when students feel undirected and lack the information they need to produce a successful project. For many students, parents, and teachers, planning and carrying out a science fair project may be very frustrating. This book is designed to be a reference that helps teachers guide students through this process. The emphasis is on the processes of science and the development of successful thinkers, not necessarily award winners. Strategies, ideas, and techniques to help students appreciate the world of science are provided. The handbook includes planning guides for teachers and students, timetables, suggestions for conducting research, ideas regarding the judging of projects, and a list of 68 resources. (CW)

Grades 4-8

A GOOD YEAR BOOK

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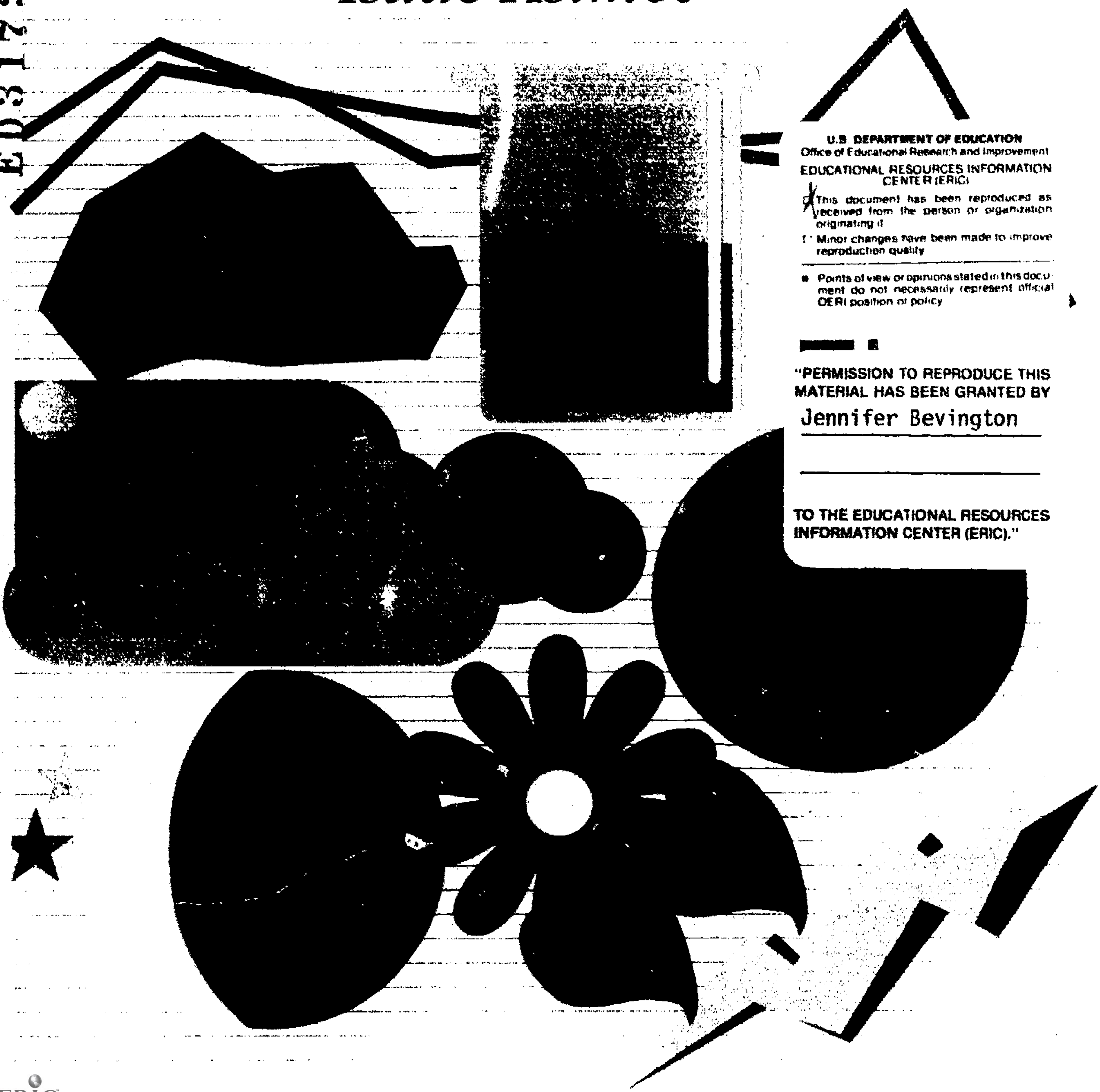
Anthony D. Fredericks

Isaac Asimov



FOR TEACHERS AND PARENTS
OF STUDENTS IN GRADES 4–8

THE COMPLETE SCIENCE FAIR HANDBOOK

by Anthony D. Fredericks
& Isaac Asimov

Illustrations by
Phyllis Disher Fredericks

This one's for Chris Jennison and Jenny Bevington—the two best friends a writer could ever have!

— A.D.F.

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Printed in the United States of America.

ISBN 0-673-38800-X

1 2 3 4 5 6 MCG 94 93 92 91 90 89

Photo of Isaac Asimov taken at the American Museum/Hayden Planetarium.

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Acknowledgments

Just as scientists depend on the work of others to guide them in their investigations, so do writers. The authors wish to extend their appreciation to the many people whose creativity and contributions made this work possible.

To those educators who unselfishly shared their ideas and materials, we offer special thanks: Mike Misko of the Catasauqua Area School District, Jim McKinney of the Southern York County School District, and Nat Harmon of the Dallastown Area School District.

Special thanks to Peggy Perdue and Bill Fleischman for their expertise in designing dynamic science fairs and their willingness to share the fruits of their labor.

We are grateful, too, to our intrepid researcher, Doris Flury, whose investigative skills and love of science contributed much to this project.

We especially thank Alan Ticotsky, Robert MacMillan, Jr., and Anita Meinbach, whose insightful critiques and thoughtful reviews throughout the several stages of the manuscript added immeasurably to the strength and vitality of the book.

And to Susan Ingerham and her daughter Leah, who provided the initial and continuing inspiration for the creation of this book, we are forever indebted.

But most important, we hope that a new generation of young scientists will be the ultimate benefactors of the contributions of our friends and colleagues—that will truly be the finest acknowledgment of all!

THE POINT OF SCIENCE FAIRS

"THE UNITED STATES IS, of all nations on Earth, the most technologically advanced."

But what do we mean when we say that? The phrase "the United States" is in many ways an abstraction. The United States is a region on the map, and it is also a region on the Earth's surface. It is a stretch of land with mountains and plains, rivers and deserts. It is a body of history and tradition, of laws and social custom. Yet all these things are empty of meaning if that is all that exists. So far, I have described only the background, the scenery of the play, the binding of the book. What we need, in addition, is the foreground, the actors of the play, the words in the book.

What the United States really is, more than anything else, is its population, the people that make it up, the people whose muscle and mind have formed, developed, and improved the nation over the generations and made out of what was once a wilderness, a mighty land that is the most technologically advanced on Earth.

But this means that it is the *American people* who are the most technologically advanced on Earth. Without our scientists, our engineers, our technologists, our construction workers, our skilled handlers of machinery, we could not maintain the technological superiority we possess. And that would mean we could not maintain our prosperity, our high standard of living, nor the strength we require to preserve our liberties and free way of life in a world that, for the most part, lacks all these things.

What must we do to preserve this successful technological advancement of our people? It would be foolish to concentrate on adult Americans, since they, for better or worse, have found their niches. They have received their education, chosen their work and social functions, and we must accept them as they are.

It is, rather, the children, who have not yet been educated, who have not yet chosen their work and social functions, on whom we must concentrate, for it is on them that we must rely to continue the technological advancement we need so much.

This is all the more so because the adult population is with us only temporarily. The decades pass, and our adults move into retirement. They are succeeded by the children, now grown up. Even before retirement, adults gradually find themselves out of touch with a technology that is rapidly improving and changing, while the children, growing up in that changed world, are at home in it.

It comes to this, then. If we are to keep the United States what it has been, and what it is now, we must concentrate on our children, for they are our greatest resource—our *only* resource in a way, for they will make all other resources possible.

And since it is our great technological expertise that keeps us comfortable and powerful, that means that our children must be well educated, well directed, well trained, in the direction that counts most—in the understanding of science and technology.

Of course, not everyone has the talent or the inclination to become a scientist or engineer, but those who do should surely receive the best education in that direction that is possible.

Again, we need to have millions of people who are skilled in other directions—farmers, entertainers, artists, writers, service workers—and yet even they should have some basic understanding of science and technology. After all, the important life-and-death decisions we as a nation must make concerning the ozone layer, acid rain, nuclear wastes, the greenhouse effect, pollution, all involve an understanding of science. Since the United States is a democracy, we must choose our own leaders and produce an enlightened public opinion that drives the leaders in appropriate directions. To know the proper leaders to choose and the proper directions in which to encourage them to move, requires, these days, an understanding of science and technology, or democracy will prove a failure.

So if our technological advancement is to remain best, the technological training of our youngsters must be the best, too. Unfortunately, there is general agreement that it isn't. We don't have enough teachers, especially teachers who understand science; and we don't have properly equipped schools. We must therefore strive to improve our educational procedures.

This can be done in many ways. Schools and teachers can use more money, more training, more equipment. In addition, however, there must be improvements in the very philosophy of teaching science.

It is insufficient merely to teach science as a block of facts, or as a set of rules. That can be unbearably dull for those who possess talent but lack a devouring fascination; for those who could do well if properly inspired, but *only* if properly inspired. We need something more than the words of a teacher presented to the student and then reproduced by the student on the test-paper. That is so easily resented at the start and forgotten at the last.

It would be useful to involve as many students as possible in the actual *practice* of science. The important thing about science is not the advanced conclusions that can only be reached and understood by virtuosos. It is not the endless bodies of facts already observed and established. It is a *process*, a way of thinking and acting. What counts is the *scientific method* that makes all else possible.

This is what youngsters should learn—how to think scientifically, how to reason logically, how to make observations, how to gather and organize them, how to perform experiments and draw conclusions, how to make an intelligent guess in advance as to what those conclusions might be, and see them supported or rejected or left undetermined. And they must learn the joy and pleasure of doing all this for the sake of learning and not for awards; just as a game of football can be exciting even if you don't win.

This is the point of science fairs—to engage the interest of youngsters—to introduce them to the scientific method—to encourage them to understand science and possibly to become a scientist or an engineer—to help maintain the scientific lead and the prosperity of our nation—and, perhaps, to transfer that prosperity to the whole world.

And for this reason, Anthony Fredericks and I have prepared this guide to science fairs.

Isaac Asimov

A NOTE TO TEACHERS

EVER SINCE THE LATE 1920S, science fairs have been an annual event at many schools around the country. A science fair offers students a showcase for their scientific investigations and discoveries. It has the potential for being a major, exciting school event.

Science fairs allow students to see how science works outside the classroom—how scientists investigate and learn about the world in which we live. Today more than ever, students need to understand and appreciate science: Scientific discoveries that affect their life and their future are taking place every day.

Yet science fairs vary enormously in design, purpose, and effectiveness. Some schools provide substantial guidance and support for their students. Others simply suggest that students participate. Often there is no pertinent information to help students plan and carry out their projects. If information is available, it is often superficial or incomplete.

Despite its potential for being one of the most exciting parts of your science curriculum, a science fair can be a source of frustration, too. Faced with the prospect of guiding students through the dynamics of a science fair, you may find few resources to share with your pupils. Often, resource material is limited to two or three mimeographed sheets provided by the director of the science fair. No wonder many teachers find science fair time a frustrating time.

If you tour a typical science fair you are likely to find.

- Too many volcanoes and solar system models; too little originality and planning
- A multitude of projects hastily constructed one or two nights before the science fair opened
- Projects that bear the unmistakable signature of Mom or Dad
- Projects that totally lack substantial research or background investigation
- Poorly constructed projects that fall apart or collapse after a few days
- Projects that appeared last year, and the year before, and the year before that
- Frustrated parents and uninterested students
- A low level of participation by a single class or an entire school

When interest in a science fair is low, a lack of direction and information may be suspected. Many students may feel that they are cast adrift in a sea of bewildering information with no rudder to steer them nor star to guide them. For most students, planning and carrying out a science project may be a lesson in frustration—to say nothing of the effects on their parents or teachers.

This book is designed to be a convenient ready reference that helps teachers guide their students through the exciting and dynamic world of science. Its concept of effectiveness in a science fair is not based on the number of ribbons awarded and won. Rather, it places a premium on the *processes* of science—on helping to develop successful thinkers, not on trophies and awards. This book provides the ideas, strategies, and techniques you need to help students appreciate the world of science and their place in it—including a host of explorations and discoveries that will endure long after the last display has been taken down.

This book is a systematic guide to the design and development of a successful science fair. It is intended to stimulate higher levels of participation, well-designed and functional projects, an abundance of originality, and your students' deeper appreciation of how they can actively participate in the scientific world. In short, these ideas will stimulate:

- Greater student participation
- Greater creativity, originality, and overall quality
- Greater use of investigative skills and problem solving activities
- A more positive attitude toward science

Everything you need to develop and promote a successful science fair is included. We suggest that you take time to read the different sections and to discuss them with your students. Let students know that taking part in the science fair is not only exciting in itself but will bring them a deeper appreciation of scientific processes and procedures.

As you discuss the different sections of this book with your students, invite their comments. Give them a chance to contribute their ideas to the science fair, and you'll be guaranteeing their motivation throughout the entire event. Above all, make it clear to them that participation and involvement—not ribbons and trophies—are the crucial elements of the fair.

The ideas and strategies in this book are offered as suggestions, not as absolutes. We encourage you to make additions, subtractions, and changes according to the needs of *your* science fair. You may find it useful to duplicate these pages so that students and parents can use them as your science fair progresses from plan to reality. You, your students, and your students' parents will find valuable ideas garnered from science fairs throughout the count y—procedures to ensure the success of any science fair.

The projects, strategies, and formats presented here are designed to give your students a fresh, exciting perspective on the scientific world. Their participation in a carefully crafted science fair can be their starting point for self-initiated investigations into the world around them. More important, this book and your science fair offer your students an enjoyable and worthwhile look at the wonders of science—a look that can last well beyond their projects and their school days.

A NOTE TO PARENTS

IS YOUR CHILD ABOUT TO PARTICIPATE in a science fair? Are you or your child wondering what to do or how to do it? Are you feeling nervous, anxious, or confused? Then this book is for you!

Science fairs can be one of the most exciting parts of the entire school curriculum. They provide children with an opportunity to explore the mysteries and marvels of the world in which we live and to develop an appreciation for the work of scientists. Yet for many families the announcement of an upcoming science fair can be an upsetting experience. Parents and children ask: How do we get started? Where do we get information? What should the final project look like? How much time do we need? Parents sometimes feel that schools do not provide them with enough information on how to plan and carry out a project. Without guidelines, families may be forced to improvise, hastily carting a last-minute project into the school gymnasium moments before the start of the science fair.

This book provides you and your child with a thorough, systematic approach to developing a successful science fair project—but it will not guarantee that your child will win a first-place ribbon or the grand prize trophy. The intent of this book is to help your child enjoy the *processes* of science discovery instead of focusing on winning a prize. Success is not defined in terms of how many awards your child's science fair project earns but by how well your child uses creative and investigative skills to discover more about his or her world.

The ideas, activities, and procedures outlined in this book will guide you and your child through an enjoyable and fascinating experience. Included are:

- How to plan and develop a project
- Sources of information and guidance
- Success factors that contribute to a display
- A host of potential projects and ideas
- How to assemble a project and write a report

- Standards used by science fair judges to evaluate projects
- A plan of action to ensure that the project will not have to be completed the night before the fair

Participating in a science fair can be a source of enormous satisfaction for your child, but it also means lots of planning and work. It is important that you offer encouragement and support whenever and wherever possible—not constructing the actual project but rather helping your child discover his or her own solutions. The value of a project lies in the amount of effort your child puts into it, not on how much work you contribute. Learning to solve problems is something scientists do every day. That experience will be an important part of the work your child does in developing his or her project. Instead of building the entire project, we encourage you to build ideas in your child's mind. As your child works on a selected project, ask:

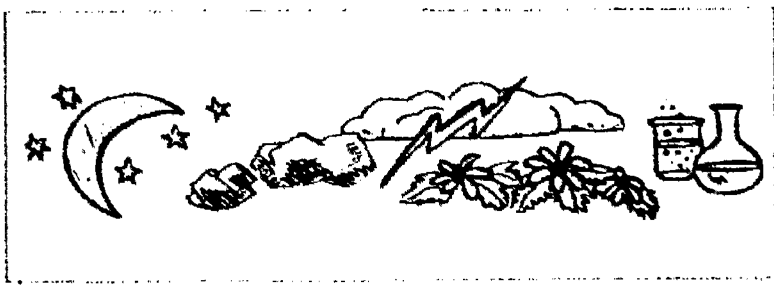
- What else could you contribute here?
- How would a scientist solve this?
- What other solutions can you think of?
- Is there another possibility?
- Can we look at this in another way?
- What else could we add?
- How do you feel about this project?
- Are you pleased with your effort? Why?
- Do we need anything additional?

We have designed this book to provide you and your child with many enjoyable experiences as you participate together in the selection, investigation, and construction of a science fair project. We encourage you to support your child's efforts at every step—guiding and encouraging whenever necessary. Your child's project can provide your entire family with many enjoyable hours together—time that will have a significant impact on your child's scholastic and personal growth.

TEACHERS: You may want to reproduce this and send it home with your students.

TO PARENTS: INTRODUCING OUR SCIENCE FAIR

Dear Parents:
Soon your child will be taking part in an exciting school event—a science fair. Science fairs offer children experiences in exploring beyond the classroom to understand more about their world. Investigating a selected science topic in detail can open up new vistas and a new appreciation for not only this planet but the worlds beyond.



I would like to invite you to work along with your child as he or she selects, investigates, and reports on an appropriate area of science. With your interest and your encouragement, your child can develop the skills and attitudes he or she needs to make this project a valuable experience. But do encourage your child to do most, if not all, of the work. Parents sometimes want to build an entire project, to make it "perfect." It is more important that your child wrestle with problems and try to solve them, because learning is in the doing. Guide your child whenever and wherever you can, but let the final project reflect your child's individual effort and design.

To help you in helping your child as we prepare for the science fair, I will be sending home instructions and suggestions throughout the coming weeks. These guidelines will give you and your child some ideas on how to create an effective project. Each sheet will show methods and processes that families can share throughout the science fair experience. Plan to take some time every now and then to talk these suggestions over with your child.

Remember that your child's success in our science fair will not be measured by ribbons, trophies, or certificates. Your child will succeed by learning and understanding more about science and how scientists work. Awards are secondary. The real goal of the science fair is stimulating your child's curiosity about the world.

I look forward to your participation in our upcoming science fair. Please call any time during the preparations and during the fair with your questions and suggestions. Let's work together so that our science fair will be a memorable and pleasant experience for your child.

Sincerely,

You can reach me at: (Phone) ________

between the hours of ________ and ________ (days) or ________ and ________ (evenings)

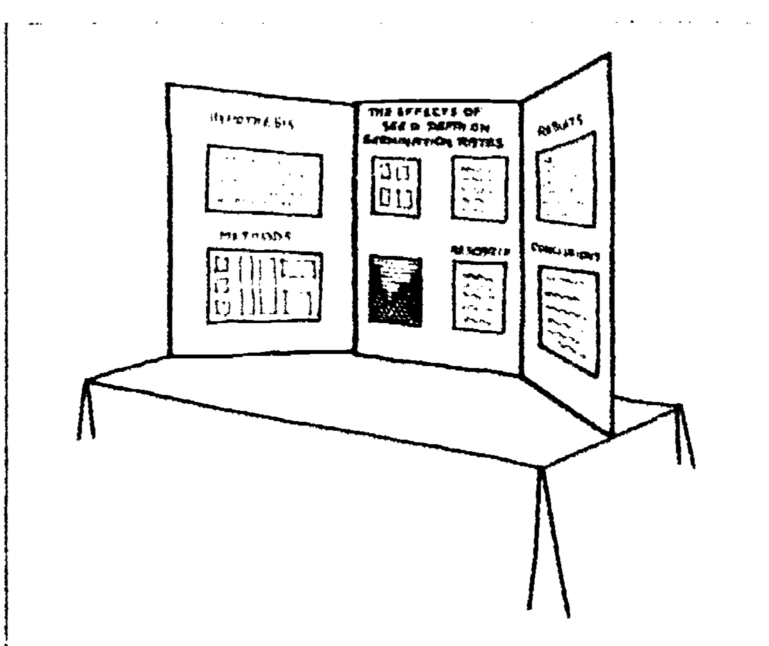
1 ■ WHAT IS A SCIENCE FAIR PROJECT?

A SCIENCE FAIR PROJECT IS A PRESENTATION of an experiment, a demonstration, a research effort, a collection of scientific items, or a display of scientific apparatus. It represents the efforts of a student's investigation into some area of interest and provides a way for the student to demonstrate the results of those investigations. A science fair project is a unique way for students to satisfy their own curiosity about the world around them and to pose questions for which they must seek out answers. It is a venture (and an adventure) into the world of scientific research that goes beyond lessons in the classroom or chapters in a book. Through the development of a science fair project, students gain a first-hand appreciation of the work of scientists and the value of their discoveries. Projects allow students to experiment, make decisions, form and re-form hypotheses, test and examine ideas, seek solutions, and most important, learn more about themselves and their world.

Science fair projects consist of three essential components. Each is discussed in more detail later.

■ Display Unit

The display unit forms the background for the project. It should be built of sturdy materials to provide a structure for a vertical display of graphs, charts, photographs, and other printed information. Usually three-sided, it includes the name of the project as well as other information that is vital to observers.

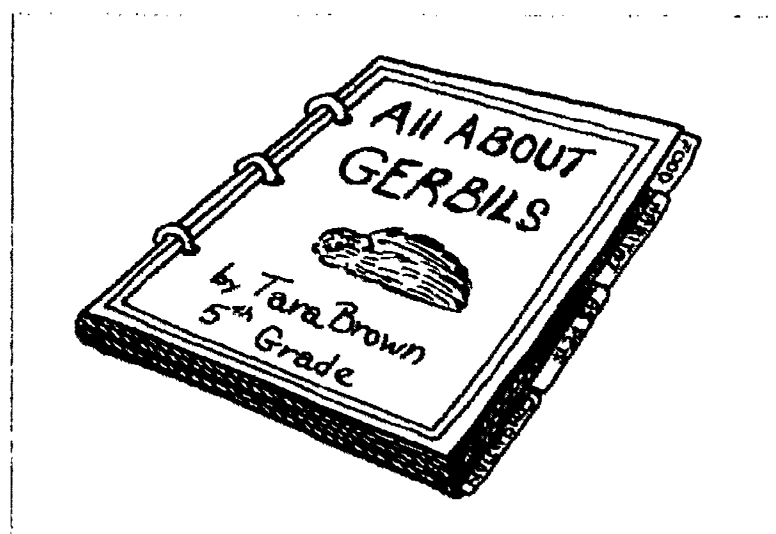


■ Exhibit Materials

The exhibit materials consist of items collected or demonstrated by the student, a set of apparatus, or the experiment the student carried out during his or her investigation. Display materials give the science project a three-dimensional effect and allow others to observe the actual materials involved in the student's investigation.

Written Report

It is important for students to keep a written record of their investigations. This record outlines the original problem the student chose and the means and methods used to investigate it. The written report should be accurate and easy to read, and it should give a clear summary of the entire project.



The final project a student sets up for a science fair is limited only by his or her imagination and curiosity. Projects have taken many forms and designs over the years—each the end product of a question a student had about the world of science. Helping students develop and expand a deeper appreciation for scientific investigations may be the most important by-product of a science fair project.

2 ■ KEYS TO A SUCCESSFUL PROJECT

SUCCESS IN A SCIENCE FAIR can be judged by a number of standards, but it should *not* be measured by ribbons, trophies, or other awards. If you, the student, have selected a topic, investigated it according to your own design, and reported the results of that investigation in the form of a display and a written report, you have succeeded. Winning "first place" or being "grand champion" is certainly praiseworthy, but your goal in taking part in the fair should be to investigate an area of interest and to discover new things about the area you choose. The satisfaction of making these discoveries will last far longer than blue ribbons or gold medals.

Here is a list of factors that you can use to evaluate your project and that your parents and teachers can use in judging it. Use the list throughout your investigations and also upon completion of the project to gauge the appropriateness of project features. Put a checkmark beside each factor to assess the completed project.

■ Does the project represent the student's own work?
Although students may receive help in investigating their topic and designing their respective projects, the final effort must be the student's—not that of a scientist, teacher, parent, or other adult.

■ Is the project the result of careful planning?
Successful projects cannot be accomplished overnight. They are the outcome of a systematic plan of action carried out over a period of time. A hastily constructed project undermines the value of the science fair.

■ Does the project demonstrate the student's creativity and resourcefulness?
Students should be permitted and encouraged to contribute their own ideas and ingenuity to the design and development of a particular project.

■ Does the project indicate a thorough understanding of the chosen topic?
Students need to investigate their chosen area as completely as possible. Doing so will take time. The project must reflect the results of those investigations done over an extended period.

■ Does the project include a notebook, written record, or final report?
The display should include a written summary of the investigation. Such a record provides observers with additional information on the subject and documents the student's work.

■ Does the project include a number of visual aids?
Photographs, charts, diagrams, graphs, tables, drawings, or even paintings liven up any display and make it more interesting.

■ Is the project sturdy and well constructed?
Using the proper materials and being careful in assembling a project are important, particularly if the display will be standing for several days. It must be within the required size limitations and should reflect a degree of permanence.

■ Are all signs and lettering neat and accurate?
The quality of a display is often judged by the attractiveness of signs, titles, and written descriptions.

■ Does the project meet all safety requirements?
When electrical items, specimens, or chemicals are used in a display, care must be taken to ensure the safety of any observers. The display of any live organisms is discouraged.

■ Is the display three-dimensional?
In addition to the background and accompanying written report, the inclusion of samples, apparatuses, collections, or other items is vital to the project. These should be attractively arranged in front of the background display.

■ Is all information accurate?
Any data gathered from outside resources, such as printed materials or interviews with experts, and data obtained from experiments must be presented accurately. All questions about data must be resolved before including them in a report or on a display.

■ Does the display present a complete story?
The student should illustrate the topic chosen for investigation, what was done during the investigation, the results, and a conclusion. In other words, the project should have a beginning, a middle, and end.

3 ■ FOR TEACHERS: HOW TO MAKE YOUR SCIENCE FAIR SUCCESSFUL

PUTTING ON A SCIENCE FAIR can intimidate even the most well-intentioned educator. The amount of time and work that precedes a successful fair often seems enormous. Nevertheless, the payoffs can be tremendous: students who gain an increased awareness of the importance of science in their lives and are able to investigate areas of interest that add to that knowledge base.

Here are some suggestions you may wish to consider as you prepare students for an upcoming fair. Use these ideas throughout the weeks preceding and during the fair to create a memorable event that students will look forward to in succeeding years.

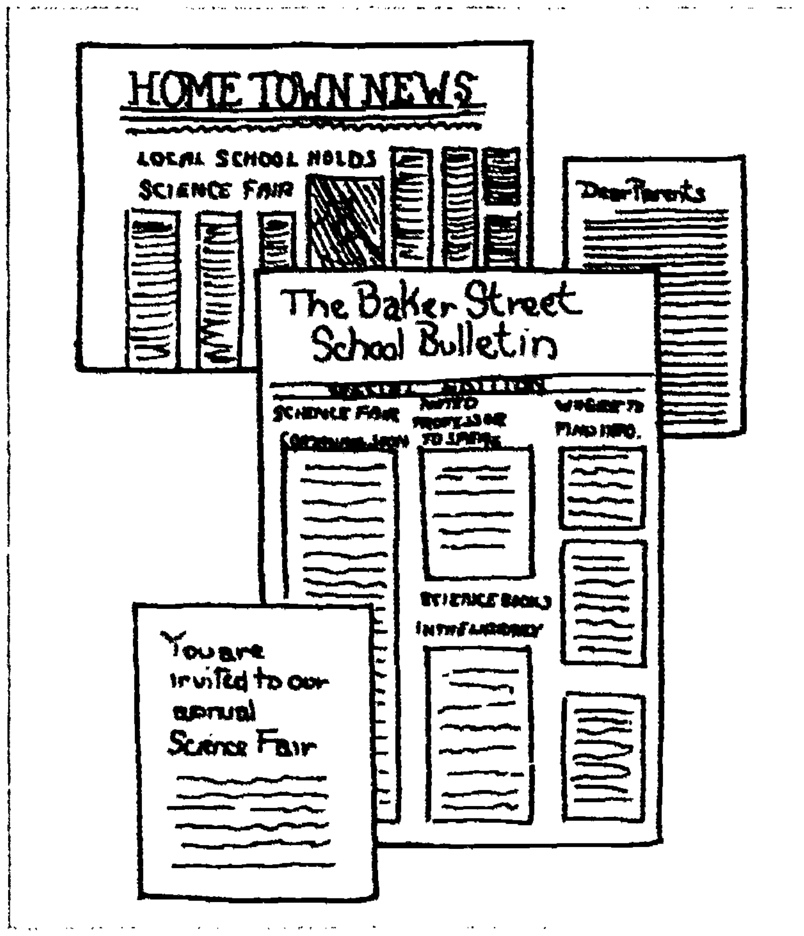
The reward is in the doing.
Emphasize to students that the object of the science fair is not to win first place or a blue ribbon but rather to participate. Some students may suspect that you don't mean it. You can ignite their interest by announcing that everyone who enters will receive some sort of recognition—whether it be in the form of a letter of appreciation or an announcement in the school newspaper. In short, everyone who enters wins.

Tie the fair in to other subjects.
Often science fairs are done in isolation from other areas of learning. Try to incorporate some of the strategies in this book throughout the school day. For example, writing the project report can be part of English lessons. Research for the project can be a part of reading lessons. Math skills can be reinforced through the measurement or estimation of project amounts and quantities. Social studies lessons can include an examination of famous scientists and their contributions. In short, a "whole curriculum" approach to science fairs can maximize interest and participation.

Involve the whole school in the team.
Work along with other individuals in your school to provide a team approach to the science fair. For example, ask the librarian to prepare a special display of books about science experiments or famous scientists. Have the principal visit class to talk about other science fairs. Encourage the reading specialist to present a story or lesson with a science theme. Ask a colleague to visit your room to share a science-related hobby or area of interest.

Involve the community.
Get students involved in promoting the science fair. Have them: Create a classroom or school newsletter. Distribute letters and notes to parents. Send invitations to the principal or other school officials. Write news releases about the fair and send them to the local newspaper. Students may wish to extend an invitation to a local scientist or college professor to visit your class and explain a concept or demonstrate a scientific principle. Invite parents and other community people to bring in rock collections, telescopes, or vacation slides to share with your students.

Students may wish to promote the science fair throughout the school by setting up a panel discussion in different classrooms (selected students can be designated experts in a particular field). In addition, pupils may want to prepare a demonstration for an all-school assembly, conduct a question-and-answer quiz show via the intercom system, or produce a special videotape for younger students to view.



Finally, special displays or projects set up around the school, especially if they are constructed by your students, can go a long way toward stimulating interest and high levels of participation.

Keep parents informed.
This book provides you with a number of forms, letters, and notices you can send to parents throughout the weeks prior to the science fair. Let parents know that you are eager to provide any additional information they need. You may wish to set up a special newsletter for parents, call parents periodically to offer assistance or guidance in project preparation, or meet with them after school or in a special evening meeting. Above all, try to alleviate their fears and uncertainties about the upcoming fair. In addition, impress upon them the necessity of supporting their child's efforts, not constructing their child's project.

Establish a long-range timetable and stick to it.
A major factor in unsuccessful science fair projects is lack of proper planning. Use the timetables in this book to ensure that students are allotting enough time for sufficient investigation of their areas of interest. Make sure your students—and their parents, too—understand that science projects must be investigated and constructed over a period of time and cannot be done in the one or two evenings preceding the fair.

Don't let "fear of science" stop you.
Not being scientifically oriented shouldn't discourage you from conducting a science fair. Join forces with another teacher: Establish a partnership and plan the event jointly. Locate parents and community members with science backgrounds. Invite them to visit the classroom regularly to assist you and the students in designing individual projects as well as the entire science fair. There is no need to work in isolation—a joint effort may be just the ticket for a productive and successful event.

Keep your principal or supervisor informed.
Good communication is essential to a successful science fair. Get your administrators involved in the dynamics of the fair and frequently solicit their advice on how to promote your students' efforts.

Keep it exciting; make it fun!
Above all, demonstrate by your own attitude that science fair projects are fun. Your attitude toward the fair goes a long way toward ensuring its success. Let students know how enthusiastic you are about the event and they will match your enthusiasm.

TWO SCIENCE FAIR TIMETABLES ■ 4

SUCCESSFUL SCIENCE FAIR PROJECTS take planning. Trying to put a project and report together a few nights before the scheduled opening can lead to disaster. Besides submitting a hastily constructed project, the student fails to develop an appreciation for the time and effort scientists need to conduct their investigations. Planning a project well in advance allows sufficient time for the necessary research, the construction of the display, the writing of the report, and the assembling of the final project. It also provides some leeway should difficulties arise in research or in obtaining vital materials.

The timetables that follow can be used by science fair coordinators, teachers, parents, or students. A 12-week and a 6-week timetable are provided, but students should use the 12-week if at all possible. Twelve weeks provide sufficient time to design a project, gather necessary data, develop a written report, and follow through on all components of a successful science fair project. Of course, circumstances may be such that the 6-week schedule must be followed.

As soon as you know the date(s) of the science fair, use a calendar to count back for 6 or 12 weeks from the opening date to find when preparations should begin. For example, if a science fair is scheduled for April 1, a 12-week preparation should begin on January 1.

■ 12-Week Timetable

Scheduled Completion Date | Actual Completion Date

Date of the science fair

Date to begin working on the project (count back 12 weeks from science fair opening date)

Week 1

- Choose a topic or problem to investigate
- Make a list of resources (school library, community library, places to write, people to interview)

Week 2

- Select your reading material
- Begin preliminary investigations
- Write for additional information from business firms, government agencies, and so on (see Resources)
- Start a notebook for keeping records
- Write down or sketch preliminary designs for your display

Week 3

- Complete initial research
- Interview experts for more information
- Decide how to set up your investigation or experiment
- Decide what materials you will use in the display. Make a list.
- Set up experimental design

Week 4

- Begin organizing and reading the materials sent in response to your letters
- Decide whether you need additional material from outside sources
- Begin collecting or buying materials for your display
- Begin setting up your experiment or demonstration
- Add information to project notebook as you get it
- Start your collection or experiment

Week 5

- Learn how to use any apparatus you need
- Continue recording notes and observations in your notebook
- Set up outline for written report

Scheduled Completion Date | Actual Completion Date

Week 6

- Gather preliminary information in notebook
- Work on first draft of written report

Week 7

- Start assembling display unit
- Continue recording notes
- Check books, pamphlets, magazines for additional ideas
- Verify information with experts: teachers, professors, scientists, parents

Week 8

- Begin designing charts, graphs, or other visual aids for display
- Take any photographs you need
- Record any observations on experiment
- Begin preparing signs, titles, and labels for display unit

Week 9

- Have photographs developed and enlarged
- Talk with experts again to make sure your work is accurate and on schedule
- Begin writing second draft of your report
- Continue recording observations in notebook

Week 10

- Write text for background of display and plan its layout
- Complete graphs, charts, and visual aids
- Finish constructing your display
- Work on final draft of written report

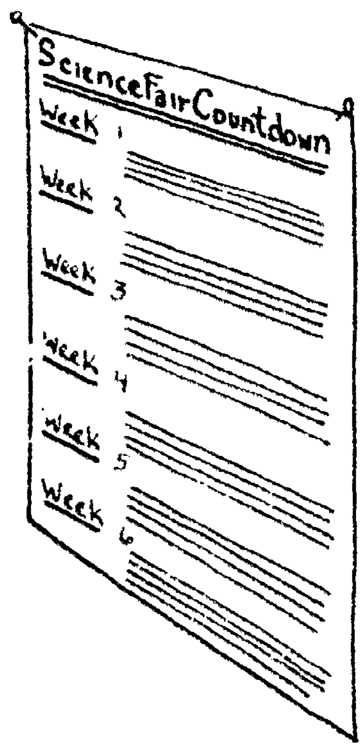
Week 11

- Complete your experiment or collection
- Write and type final copy of written report
- Do lettering of explanations and mount them on your display
- Mount graphs, charts, drawings, photographs
- Assemble apparatus or collection items; check against your list

Scheduled Completion Date | Actual Completion Date

Week 12

- Proofread your written report
- Set up display at home and check for any flaws (leave standing for 2 days)
- Carefully take display apart and transport it to science fair site
- Set up display
- Check and double-check everything
- Congratulate yourself!



■ 6-Week Timetable

Scheduled Completion Date | Actual Completion Date

Date of the science fair ______________________

Date to begin working on the project (count back 6 weeks from science fair opening date) ______________________

Week 1

- Choose a topic or problem to investigate
- Check resources in school or community library
- Contact experts in the field
- Gather all the written material you can find on the topic

Scheduled Completion Date | Actual Completion Date

Week 2

- Begin putting your project notebook together
- Start collections or experiment
- Begin designing display unit

Week 3

- Begin building display unit
- Design all visual aids
- Take the photographs you need
- Complete your research
- Consult with experts (scientists, college professors, teachers, parents) to check your progress
- Write first draft of report

Week 4

- Continue collecting items for display
- Continue your experiments
- Set up your apparatus and test it

Week 5

- Write second draft of report
- Construct background for display
- Design and assemble graphs or charts
- Complete lettering for display unit and mount it
- Double check your written data
- Complete experiment and record data

Week 6

- Write and type final report
- Set up display unit at home and test
- Transport display to science fair site, set it up, and test it

5 HELPING STUDENTS SELECT A TOPIC

CHOOSING AN APPROPRIATE TOPIC for a science fair project is often the most difficult part of the entire process: So many topics to choose among, a wealth of information available. No wonder students are bewildered. Teachers and parents can help provide direction and narrow down choices, but the final choice of topic should be the student's. His or her motivation will be a critical factor in the successful completion of the project. Parents and teachers may pose these questions to help students refine their choices and decide on the most suitable area to explore.

Interests

- What kinds of things do you enjoy doing?
- What area of science interests you the most?
- If you could be a scientist, what would you like to do?
- What are your hobbies or free time activities?
- What do you like to do on rainy days?
- What kinds of books do you like to read?
- Which movies or TV shows might give you ideas or information?
- What are your special skills or talents?

Difficulty Level

- How hard will this topic be for you to understand?
- What problems have you had with this subject before?
- Are you familiar with this topic or is it brand new?
- Do you think you will need to gather a lot of outside information?
- Will you be able to work in this area for 12 (or 6) weeks and still be interested?
- What special tools or apparatus do you think you'll need?

Time

- Will you be able to spend some time on this project every week for 12 (or 6) weeks?
- How long do you think you will need to gather information about this topic?

- Are you interested enough in this subject to spend a great deal of time on it?
- Will you need to set up a special schedule to complete all the things you need to do?
- Do you have enough free time at home to work on the project?

Materials

- What special materials do you think you'll need for this project?
- Do you have those materials at home or will you need to buy them?
- Will you need to construct anything complicated?
- Will you need help in putting the display together?
- Will you need to order any materials through the mail?
- Will you be able to buy materials in local stores?
- Will your materials be inexpensive or costly?

Guidance

- How much help will you need with your project?
- Will you be able to do most or all of the work yourself?
- Will you need to consult any experts in your chosen field?
- How much involvement will your parents have?
- Will you be able to build the display unit on your own?

Safety

- Will you be able to follow all safety rules in putting your project together?
- Are there any dangers from equipment or materials associated with your project?
- Will there be any dangers to observers of your project?
- Will there be any danger to you at any time during the investigation of this project?

Oftentimes students select a topic simply because everyone else has selected it (that's why there are so many volcanoes and solar system displays at most science fairs). Students need to understand that the choice of an appropriate topic depends on several factors that must be discussed and agreed on before the project is begun. Of course, the primary criterion will be: Is it something the student is truly interested in pursuing? Allowing students to explore self-chosen areas of interest will be a major factor in making the science fair a positive learning experience.

6 ■ SUGGESTIONS FOR PROJECTS

AS MENTIONED ALREADY, many students find that selecting a topic is one of the most difficult parts of the entire science fair experience. With so much to choose from, students are often overwhelmed by the enormous variety of potential subjects they can explore or examine. Making a decision on the most appropriate topic can be a time-consuming and mind-boggling experience, not just for students, but for teachers and parents, too.

The lists that follow are intended to provide a selection of potential topics for students to investigate. These lists are not intended to include all possible topics but rather to offer a diversity of subjects from which students can choose. It is important to note that the topics have been arranged by grade levels to make selection easier. To do this, we consulted leading science texts at each grade level to identify topics included in the science curriculum for that grade. That is, each of the topics on a particular list is normally taught at the grade for which it is listed. In addition, several experts in different fields were consulted for their ideas on potential topics for each grade level. Thus, students have the opportunity to select a topic commensurate with their interest as well as their specific grade level.

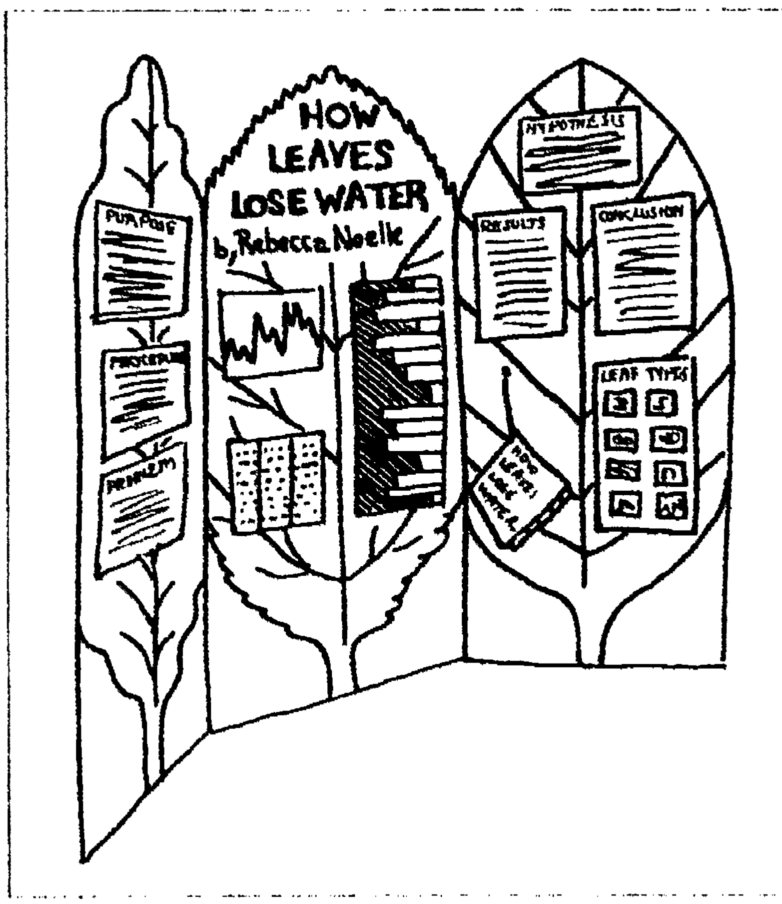
This does not mean that students should be restricted to any single list. Encourage students to select a topic in keeping with their desires and interests; not necessarily because it appears on a list headed by their particular grade. As teachers and parents guide students in the selection process, encouraging the exploration of a topic *not* commonly taught at the student's grade is certainly appropriate. These lists represent many grade levels and many ability levels, within grades. We've provided something for everyone across the grades as well as within a specific grade so that gifted, on-level, and remedial students will find a host of scientific possibilities to investigate.

These lists also provide a diversity of possibilities in each of the three major areas of science: life science, earth and space science, and physical science. Thus, students have an enormous range of topics in any discipline. Teachers and parents should assist students in examining the widest possible range of topics before making their final choice. Just by exploring possible topics, students discover the magnificence and diversity of the world of science and the enormity of its possibilities.

The potential topics listed within each grade level are organized into five categories: experiments, demonstrations, research, collections, and apparatus. These categories are not absolute, they overlap; but focusing on the types of projects possible helps students narrow down their selections.

Experiments

The type of project most often presented at science fairs is the experiment. These presentations allow students to pose a problem, design an experiment to investigate that problem, record and report their results, and make conclusions based upon those results (see the section on the scientific method). The final project is a display of the steps the student took, any successes or failures, and the implications of the data.

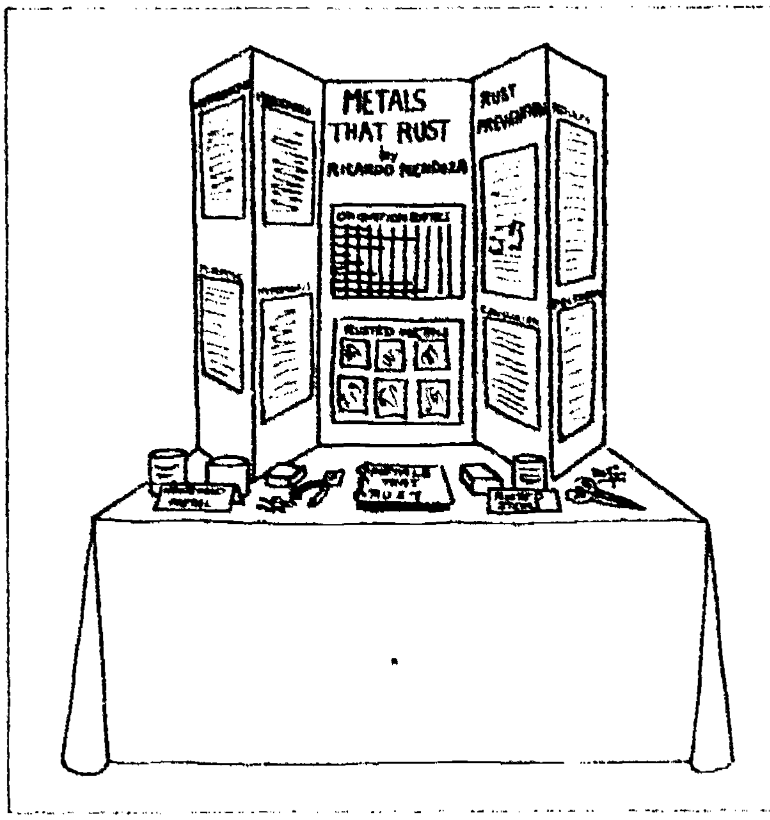


Demonstrations

In this type of project students demonstrate a particular science principle or fact. The demonstration should be self-contained; that is, observers can operate or manipulate any controls, switches, or devices needed for the demonstration. Students may wish to demonstrate how something works, a science phenomenon, or how something is created naturally or in the lab.

Research

In a research project, the student investigates a chosen area of science by consulting *primary* sources. That is, students will need to consult reading materials from libraries, museums, government agencies, and the like. In addition, they should interview



experts: scientists, health care workers, county agents, shop forepersons, and so on. Encourage on-site investigations at labs, factories, a printing plant, a farm, or fish hatchery. The intent is for the student to explore a scientific area in depth and detail and to report the findings in a vivid, interesting way through the project.

Collections

Collections are an assembly of items such as seashells, birds' nests, or telephone parts that show variety and diversity within a chosen area of science. Usually, collection projects will result from a hobby or other free-time activity. Collections need to include as many samples as possible to represent the magnitude of the topic.

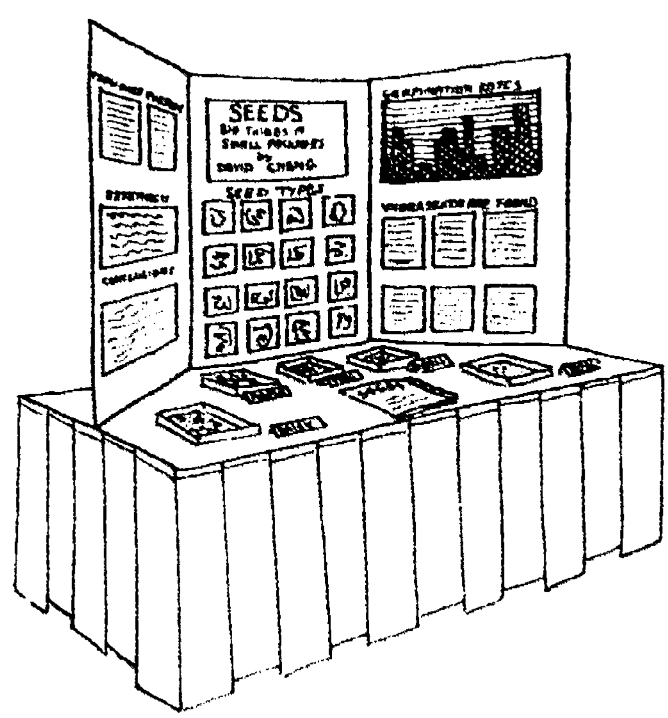
Apparatus

In this type of project students display some kind of scientific apparatus or instruments and describe their use or function in detail. The project should enumerate the importance of the apparatus for both scientists and the general public. Descriptions of how each apparatus is used within or outside the scientific community would also be appropriate.

Grades 4 to 5

Experiments

- Test any responses to real and artificial sweeteners.
- How do temperature changes affect a fish?
- Do preservatives stop bread mold from growing?
- How leaves lose water.
- The effect of sunlight on plants.
- The effect of crowding on plants.
- How changing the fulcrum affects a level.
- What fabrics make good insulators?
- How do charged objects act toward each other?
- Materials that are the best conductors of electricity.
- The effect of the height of a swinging mass on its energy.
- How are crystals formed?
- Removing salt from water.
- Which foods contain starch?
- Which sense organ can detect the greatest variety of sensory information?



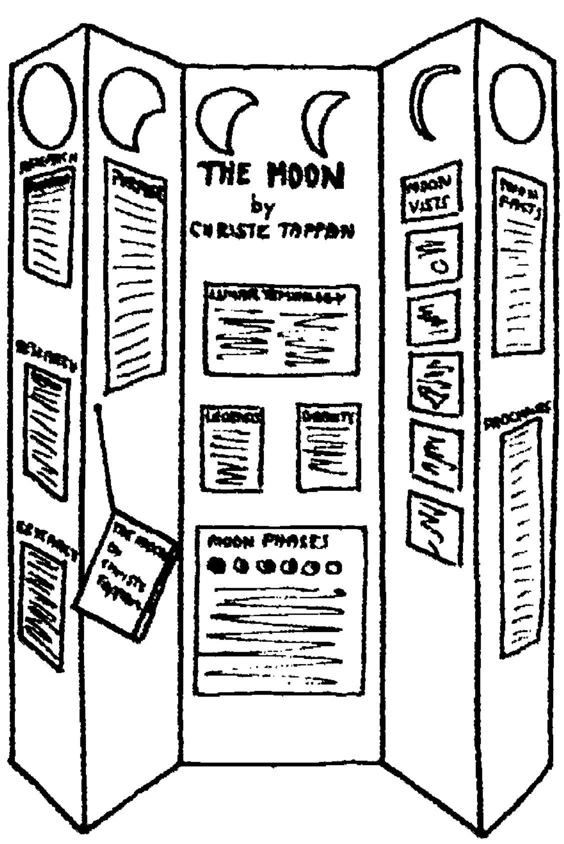
Demonstrations

- Construct a clay model (with cutaway sections) showing the three layers of the earth.
- Create your own fossils, using plaster casts.
- Make a model of the ocean's floor, labeling each part.
- Construct a model of the eye showing its different parts.
- Where different flavors are tested on the tongue.
- Using modeling clay, make a cross section of the skin.
- What does a magnetic field look like?
- Using a graduate, measure the volume of several objects.

- Set up a box with two holes in it (for hands to reach in) containing unknown objects. Participants reach inside and try to guess what the objects are by feeling them and describing their characteristics.
- Testing minerals for their various properties.

Research

- Show how living things depend on one another through food chains.
- Use food webs to show how members in a community get their energy.
- Illustrate how animals live underground.
- What are the types of jobs bees have in a honeybee colony?
- How are bees helpful to humans?
- Ants and their jobs.
- Show examples of parasite and host relationships.
- Diagram the parts of trees or flowers.
- The life cycle of nonseed plants.
- Prepare a nature guide to plants and trees on the school grounds or in your neighborhood.
- How plants make food.
- How animals and plants adapt in order to survive.
- Types of bird beaks and their function.
- Why animals hibernate.
- Pick a career in science and tell about it.



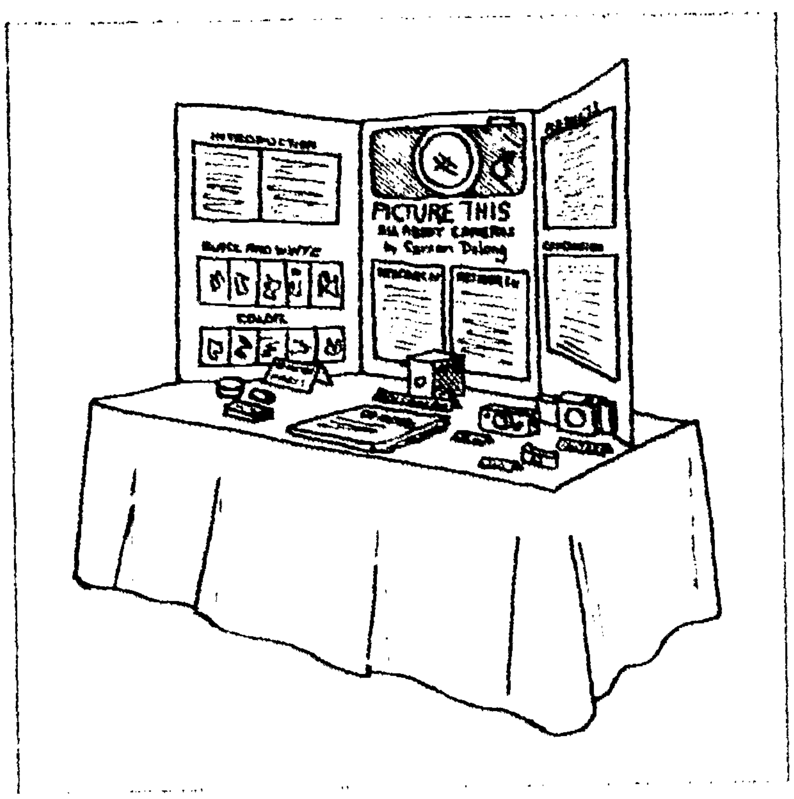
- Examples of potential and kinetic energy.
- Learn about insulators and conductors.
- How rocks are formed.
- Uses of rocks and minerals in everyday life.
- The formation of coal.
- Chart the Gulf Stream or any other major warm- or cold-water current.
- Using resources from the sea: advantages and disadvantages.
- All about the wind chill factor.
- How air temperature changes.
- The Beaufort wind scale.
- Chart similarities and differences between the planets

(temperature, distance from sun, moons, length of day, and so on).

- Everything you wanted to know about Saturn (or Mars, or Neptune, or Uranus . . .).
- Record local temperatures (at regular intervals) throughout the day for several weeks.
- Compare predicted weather with actual weather.
- The digestive system and how it works.
- From cells to systems.
- The human ear and how it works.
- What is colorblindness?
- The history of measurement.

Collections

- Clay models of animals that live in groups.
- Start your own ant colony.
- Collections of any of the following: leaves (fall foliage or green), pine cones and/or needles, weed seeds, plants that reproduce without seeds.
- Make casts of animal tracks.
- Birds' nests; collect the materials used in building nests.
- Monocot and dicot seeds and/or flowers.
- Simple machines used in everyday life.
- Start a collection of rocks found in the area.
- Collect some common minerals.
- Use pictures to show examples of animal populations: herds, colonies, schools, and so on.



- Display pictures of herbivores, carnivores, and omnivores. Label them and list the foods they eat.
- Collect items that show different forms of energy (chemical, light, sound, heat, electrical, mechanical).
- Demonstrate different types of animal teeth.

Apparatus

- Construct a homemade thermometer.
- Series and parallel circuits.
- How to make electromagnets.

- Make each of the following and describe how it works: barometer, anemometer, wind vane, rain gauge.
- Construct a balance and invent your own measuring system to measure matter.
- Make an electric question board.

Grades 5 to 6

Experiments

- How water rises in different kinds of plant stems.
- Does a temperature change in water affect a fish's rate of breathing?
- What are some behaviors of earthworms?
- What kinds of foods do certain types of birds prefer?
- Is air matter?
- Forming compounds.
- How heating water affects the rate at which materials dissolve.
- Factors affecting how fast liquids will mix.
- Boiling points of liquid substances.
- In which liquids will an ice cube float?
- Freezing points of different liquid substances.
- What effect does size of particles have on how fast a solute dissolves?
- How to make water wetter.
- What metals and/or materials will rust?
- Good and poor conductors.
- The effect of type of circuit used on the brightness of light bulbs.
- How does the color of an object affect how warm it gets?
- Where is the best place to position solar heating units?
- Can the wind be used to make electricity in the area where we live?
- Is a solar collector a feasible way to heat water?
- Are there solid particles in the air we breathe?
- The effect of dilution on reducing water pollution.

- What materials are biodegradable?
- What effect does the color of an item have on the amount of solar energy it absorbs?
- Observe cloud patterns for several weeks and try to predict the weather. How accurate are your predictions?
- Controlling eye blinking.
- The effect of removing minerals from bones.
- The effect of different kinds of physical activity on pulse rates.
- Factors affecting condensation.

Demonstrations

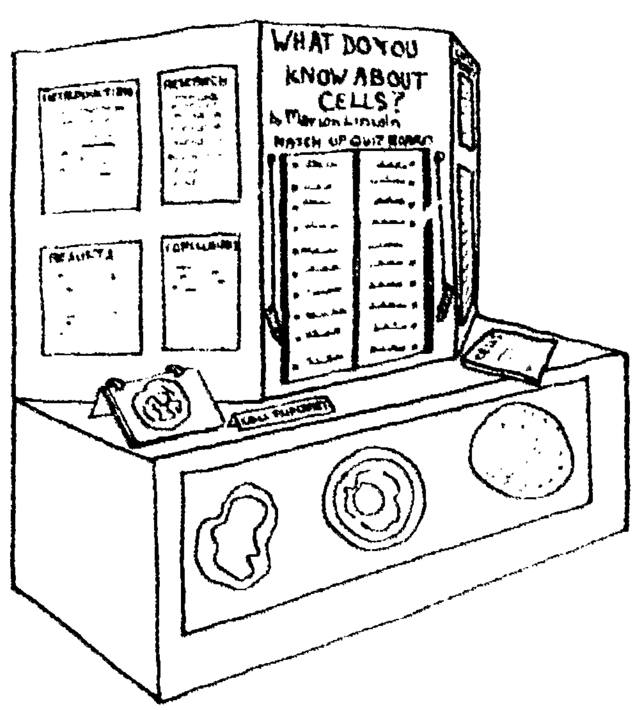
- Plant a dozen bean seeds. After they have sprouted, describe the changes that have occurred at intervals of 5 days.
- Make a model of a cross section of a leaf.
- Using real flowers, observe with a magnifying glass and locate their parts. Make a flower and its parts from modeling clay.
- Sprout seeds without using soil.
- Build an earthworm farm.
- Create and label the parts of an imaginary insect. Include all the body parts needed by a real insect.
- Where does water come from?
- Illustrate and name the birds that use discarded birds' nests.
- Collect materials that birds use and construct your own set of birds' nests.
- Pick an animal community and display it in a diorama.
- Create a terrarium.
- Make a model of an atom.
- Create models of a variety of common molecules.
- Have participants guess the contents of a wrapped box by using indirect evidence.
- Construct the two types of circuits.
- Compare and contrast the different types of batteries.
- How glaciers change the land.
- Construct a spider web (using twine or rope). Attach models of different spiders or important facts about arachnids.
- Make papier-mâché globes and sun. Use them to demonstrate the changing seasons.

- Construct a relief map of North America. Name and label the major air masses.
- Use cotton balls to make cloud formations.
- Cover boxes with black paper and punch holes through the back in patterns that represent constellations. Put a light source behind the boxes.
- Construct models of constellations using modeling clay, papier-mâché, or other appropriate materials.
- Make a working model of muscles and bones in the arm or leg.
- Prepare cutout drawings of the different major parts of the skeletal system. Challenge participants to assemble them.
- Using a life-sized paper model of a body and two different colors of yarn, show the circulatory system.
- Set up a display to test the lung capacity of different individuals.
- Use an art medium of your choice to make a model of the human heart.
- Demonstrate eclipses of the sun and moon.
- Using models, show the causes and effects of tides.

Research

- Study a local bird population, recording the number and types of birds that visit a feeder. Graph your findings.
- How plants get materials for food making.
- What is photosynthesis?
- What is respiration?
- Compare photosynthesis and respiration.
- How flowers produce seeds.
- Who are the invertebrates?
- The worm family.
- All about echinoderms.
- The structure of a fish.
- Chart the similarities and differences between reptiles and amphibians.
- The life cycle of a frog.
- The snakes of our area.
- Interesting facts about birds.
- The structure of bird bones and feathers.
- How milk is pasteurized.
- What are mammals?
- Everything you wanted to know about the platypus.

- Gestation periods of different mammals.
- All about koalas (or other Australian animals).
- Characteristics of the five groups of vertebrates.
- A whale of an assignment or all about whales.
- Endangered and threatened species of animals and/or plants.
- Environmental effects on the size of animal populations.
- Succession in an ecosystem.
- Research a science career that interests you.
- Make a time line of a famous scientist's life.
- So you want to be a zoologist (or botanist, microbiologist, chemist . . .)?
- Graph the numbers of kinds of animals in the major animal groups.
- Launch helium-filled balloons (including your name and address on a return postcard). Record and chart information received from respondents on distance traveled, wind direction, and elapsed time.
- Common uses for elements.
- How the symbols for the elements evolved.
- Solutions and suspensions found around me.
- Products that result from chemical changes.
- Electricity—the energy around us.
- Uses of parallel and series circuits.
- The impact of Michael Faraday's work.
- Rules for electrical safety.
- Sources of energy.
- Major locations of coal, oil, and natural gas.
- How are the major sources of energy used to produce electricity?
- The greenhouse effect: How will it affect the earth?
- Nuclear energy: benefits and problems.



- Ways to conserve energy.
- Physical and chemical weathering.
- How to prevent soil erosion.
- Water treatment plants.
- Effects of acid rain.
- Major sources of air, water, and land pollution.
- Preventing pollution: different ways, different methods.

- All about air masses.
- The global wind belts.
- Severe weather phenomena.
- Cold and warm fronts: What are they?
- Weather records and extremes.
- What is astronomy?
- The life cycle of a star.
- The skeletal system.
- Joints of our bodies.
- Activities of voluntary and involuntary muscles.
- The artificial heart.
- The function of the respiratory system.

Collections

- Observe earthworms by starting your own farm.
- Different types of invertebrates.
- The arthropods.
- Types of fish scales.
- Turtle shells.
- Collect different types of bird feathers and identify the birds they came from.
- Form bird beaks from clay. Show how beak shape is adapted to the food each bird eats.
- Collect discarded birds' nests.
- Using plaster of paris, make and paint several different life-size birds' eggs.
- Assemble pictures showing different ecosystems. List plant and animal populations in each.
- Common compounds in our environment (including chemical formulas).
- Collect pictures of fossil fuels and by-products of fossil fuels.
- Display household appliances and their wattage (can also include cost of operation per hour).
- Biodegradable and nonbiodegradable materials.
- Collect and label pictures of clouds.
- Display weather maps from newspapers, showing air masses.
- Make replicas of the three types of galaxies.
- Draw and label the parts of the heart from several animals.
- Assemble a collection of mollusks.

Apparatus

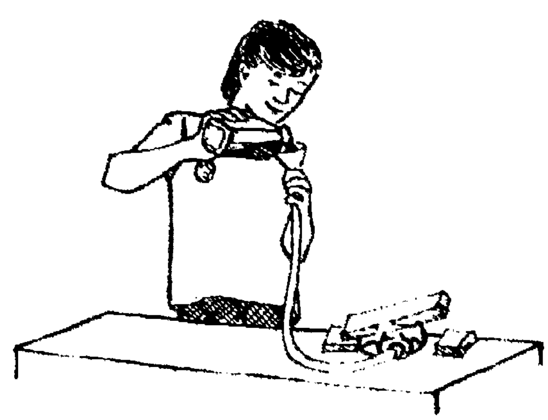
- Microscopes: a magnificent invention.
- Telescopes: pathways to the stars.
- How a generator produces energy.
- How to construct a wet cell.

- Build your own solar heater or cooker.
- Types of solar heaters.
- Turbines and their use in producing energy.
- Galileo and the telescope.
- What is a radio telescope?
- Using a weather map of the United States, choose major cities and chart the weather for each city, using appropriate weather symbols.

Grades 6 to 7

Experiments

- Can nonliving things grow?
- The effect of light on plants.
- How does root position affect plant growth?
- Factors affecting germination.
- Will bean stems grow downward if the only light source comes from below?
- Testing acids and bases to determine their pH.
- Use red-cabbage juice to determine whether materials are acids or bases.
- Factors that affect leaf decay.
- The effect of colored light bulbs on the growth of plants.
- Factors affecting wave frequency.
- The composition of soils in your area.
- Ways to desalinate salt water.
- At what temperature does condensation start?



- The relationship of relative humidity and barometric readings to changes in the weather.
- The effect of repetition on reaction times of different animals.
- Factors affecting the ability to memorize.
- How does heat affect sugar?
- The effect of light sources in producing shadows.
- How colored filters affect fading.
- The effects of different types of fertilizer (artificial and natural) on plant growth.
- What effect does the depth of a planted seed have on the plant's growth?

- The effect of salt water and other liquids on plant growth.
- The behavior of mealworms.
- Preferred materials for nest building.
- The effects of different types of practice on learning rates.

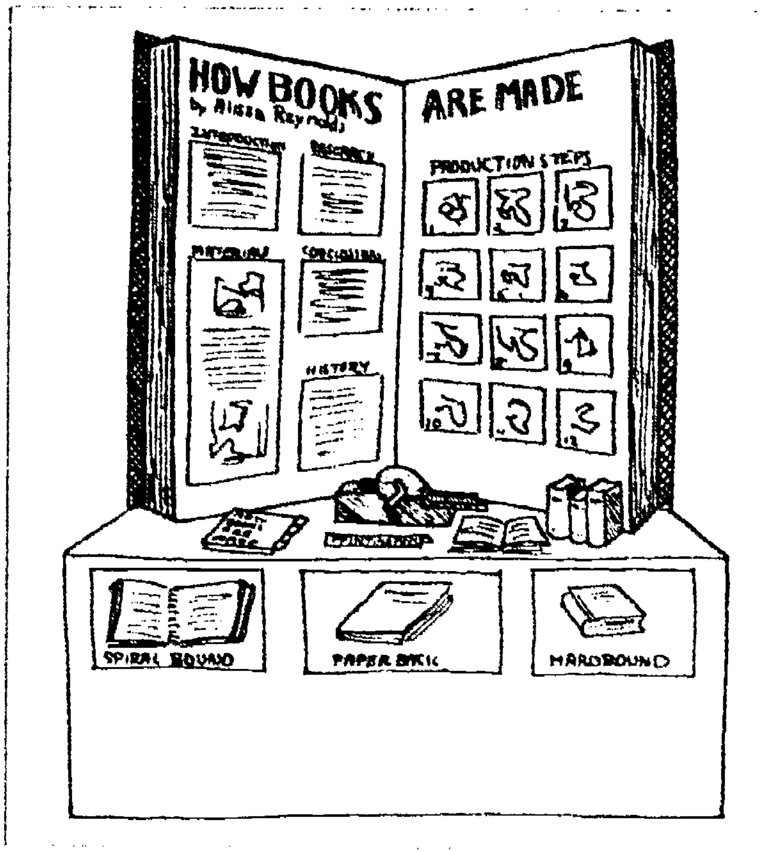
Demonstrations

- Use an art medium to show the main parts of an animal cell and a plant cell.
- Cell reproduction: a model of mitosis.
- Create replicas of one-celled animals.
- Prepare models of the different types of body tissues.
- Make models of birds' feet. Explain how they help each type of bird.
- Make plaster casts of horse and dog skulls, demonstrating the similarities and differences.
- Depict a major biome using a diorama or mural.
- Prepare a model of a world map and show the major biomes.
- The freshwater food chain.
- Use a prism and slide projector to produce a spectrum.
- How our eyes distinguish color.
- The effect of concave and convex lenses on light waves.
- Construct a working dimmer switch.
- Make an electric question board.
- Make your own telephone receiver.
- Demonstrate how a television screen produces moving images.
- North American mineral resources.
- Fossil fuel deposits in North America.
- Demonstrate how the continents could have been joined together in a single land mass many years ago.
- Make models of the different types of mountains.
- Construct models of different types of satellites.
- Make a model of a rocket.
- How a rocket moves.
- Prepare a time line illustrating the U.S. space program.
- Construct a model of the brain showing the areas that control specific body functions.
- Using an outline of the human body, construct a replica of the human nervous system.
- Create the world's most successfully adapted imaginary animal. Explain how each adaptation would help it survive and prosper.
- Major nerve pathways in the body.
- How is paper made? How can it be recycled?
- Set up a proje... 'n which participants determine whether they are right-brain dominant or left-brain dominant.

- What colors make up sunlight?
- Assemble the bones of a chicken (make sure they are boiled and cleaned before starting).
- Raise your own brine shrimp and report on their growth.

Research

- The use of plants in the world around us.
- The parts of a cell.
- What are single-celled organisms?
- Tissues, organs, and systems in the human body.
- Types of cells
- The giant sequoias.
- The field of dendrochronology.
- Tropism and phototropism.
- Adaptations of seeds.
- Biological clocks and how they function.
- The migration patterns of selected birds.
- Structural adaptations of animals.
- Beavers: all you ever wanted to know.
- The primates: How they evolved.
- Evolution of reptiles.
- What happens in the body of a hibernating animal (temperature, digestion, brain activity)?
- Learned versus instinctive behaviors.



- Imprinting.
- How the human body reacts to exercise and inactivity.
- What is a biome?
- Exotic animals and plants.
- What are epiphytes?
- Plants and animals of the desert.
- Inhabitants of the ocean depths.
- The effect of human activities on animal biomes.
- A career in botany (or zoology or physics).
- The development of the atomic theory.
- The use of isotopes in medicine and industry.
- Elements and compounds used in industry.
- Physical and chemical changes in our environment.

- Nuclear medicine.
- How different kinds of light bulbs work.
- Effects of a damaged ozone layer.
- How lasers are used in medicine and industry.
- How a telephone works.
- How can sound waves be recorded?
- The sending and receiving of radio/television signals.
- Is a career in chemistry for you?
- Role of forest fires in forest ecology.
- Renewable and nonrenewable resources.
- Benefits of recycling.
- Gasoline: from the ground to the station.
- Resources from the ocean.
- Sea floor nodules: What are they?
- Mariculture: Is it feasible?
- Resources found in your own state.
- Changes in the Earth's crust.
- All about plate tectonics and continental drift.
- Drilling for oil: How and where?
- Earthquakes: earthshattering events.
- What causes volcanoes?
- How mountains are formed.
- The meteorologist's job.
- What is relative humidity?
- The gathering of weather data.
- The National Weather Service.
- Hurricanes: just a lot of wind?
- The Space Shuttle program.
- The positive and negative uses of satellites.
- Weather patterns on other planets.
- How microchips are designed and made.
- The function of space probes.
- Could you be an astronaut?
- The future of the moon.
- Effects of space exploration on our lives on Earth.
- How industrial robots work.
- Functions of parts of the brain.
- The endocrine system: What does it do?
- All about biofeedback.
- How different organisms reproduce.
- Hereditary diseases.
- Location of volcanoes around the world.
- The origin of the moon.
- Chart the number of chromosomes in the body and sex cells of different plants and animals.
- Computer control in pattern weaving.

Collections

- Seeds and leaves from trees.
- Gather different sizes of firewood (before it is split). Count the annual rings to determine tree ages.
- Fruits and their seeds. Have participants match fruits with their respective seeds.
- Collect examples of animals that use protective coloration, protective resemblance, and mimicry.
- Different types of grains and their uses.
- Aquatic living things: marine and fresh water, plant and animal.
- Acids and bases used in everyday life.
- The inventions of Thomas Edison.
- Transparent, translucent, and opaque objects.
- Devices that have become smaller because of circuit technology.
- Recyclable materials.
- Items that use minerals.
- Display of nonorganic litter or trash found around the school, the home, or in the neighborhood.
- Products made from fossil fuel feedstocks.
- Edible seaweeds.
- Pictures of objects in space.
- Make illustrations of the brains of different mammals.
- Objects that act like mirrors: plane, convex, or concave.
- Types of plant propagation (seeds, layering, sexual and asexual)
- Collect leaves and chart, compare, and contrast all their properties. Note similarities and differences.
- The phases of the moon (use photographs and diagrams).

Apparatus

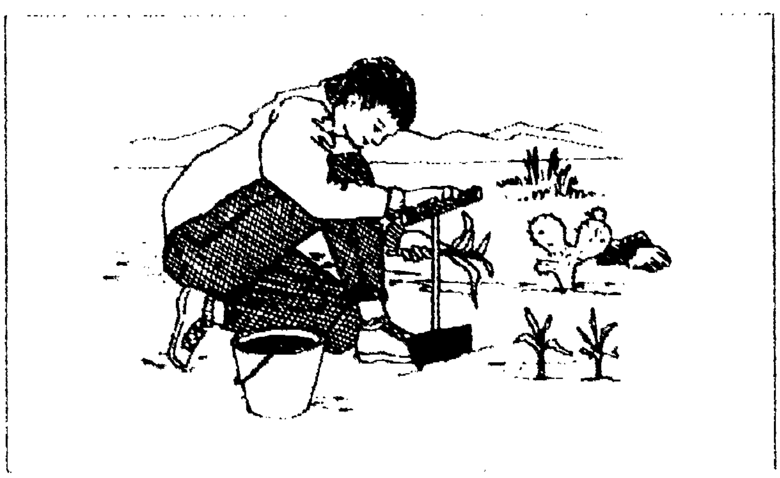
- Use a microscope to view cells from different objects. Include slides. Diagram each cell.
- Perpetual motion machines.
- The spectroscope.
- Computers in the field of science.
- How to make a solar still.
- Seismographs: What are they?
- Weather instruments and the information they give us.
- Using a wet/dry bulb thermometer to determine relative humidity.
- Telescopes: the different kinds and their uses.
- How to build your own radio telescope.
- Make a working hygrometer.
- Microscope parts and their function.

- Make a pinhole camera.
- You can make your own compass.
- The making of a turbine.
- A wind erosion recorder.

Grades 7 to 8

Experiments

- How water can be purified at home.
- Expansion rates of different metals.
- How sound is transmitted.
- Growth of rats in a vitamin-deficient environment.



- How copper plating takes place.
- Reaction of protozoa to different chemicals.
- Developing photographic film.
- Photosynthesis in lower species of plants.
- How gerbils learn their way through a maze.
- The growth of bacteria in different commercial disinfectants.
- How to measure the Earth.
- Chick hatching rates at different levels of humidity.
- Mold growth on different types of bread (wheat, white, rye).
- Growth patterns of yeast.
- The growth of grasses in different soils.
- How does acid rain affect seed germination?
- How we see colors.
- How the human digestive system works.
- An examination of plant cells.
- Reactions of seeds to different chemicals.
- The effects of salt versus sugar on plant or animal growth.
- How much water do different soils hold?
- Which type of insulation holds in heat the best?
- The effects of junk food on gerbils.
- Does affection influence the growth rate of hamsters?
- Effects on germination rates of seeds exposed to ultraviolet light.
- Phototropism and its effect in different plants.
- The effects of light direction on plant growth.
- How does electricity affect the growth of plants?

- Effects of cigarette smoke on selected insects.
- Effects of aspirin on the growth of selected plants.
- Do different types of music affect individuals' learning power?
- Effects of car exhaust on different plants.
- Ways to slow down plant growth.
- Effects of different colors on the eating habits of chicks.
- Effects of toothpaste on bacteria growth.
- Effects of noise on the growth of plants.

Demonstrations

- Wavelengths of sound produced by different musical instruments.
- Effects of light on the activities of rats.
- Growth and development of a chicken.
- A study of hydroponics.
- A panorama of optical illusions.
- Osmosis in plants: How does it work?
- What causes skin to darken in the sun?
- How pianos work.
- The effects of smoking on human health.
- How birds fly.
- How hair grows. Why hair falls out.
- Different types and degrees of noise pollution.
- How books or magazines are made.
- How candles are made: then and now.
- Things people write on.
- The effects of alcoholism.
- The birth of an island.
- The water cycle and how it operates.
- Mummies through the ages.
- Fluorescent light and seed growth.
- All about fingerprints.
- How does a rocket function?
- Pulleys and how they work.
- Different examples of water pollution.
- Contamination in our drinking water.
- Rocks: the ancient time machines.
- Plants in cooler environments.
- Biorhythms: Do they affect our lives?
- Effect of colored light on goldfish.

Research

- How matches work.
- How glass is made and used.
- Where is oxygen found?

- Dinosaur extinction: how and why?
- How is fingerprinting done?
- Teeth: How to use them, how to take care of them.
- Famous caves.
- Erosion: its principles, causes, and cures.
- The many uses of transistors.
- Cancer through the ages.
- The aerodynamics of different flying objects.
- The future of solar energy.
- Nuclear power: friend or foe?
- How hormones work in the human body.
- Different ways of putting out fires.
- Aviation past and present.
- Theories about life on other planets.
- Different ways to dispose of garbage and litter.
- A history of photography.
- Different types of cave dwellers.
- How plants and animals depend on each other.
- How chewing gum is made.
- The Ice Age and its aftermath.
- Tidal waves.
- The beginnings of agriculture.
- How to turn a desert into a farmland and vice versa.
- Pyramids past and present.
- Laser beam technology.
- Archeology as a profession.
- The development of telephones.
- How electricity is made.
- Radioactivity: problem or potential?
- How babies develop: stages of gestation.
- Different types of explosives.
- The human brain: form and function.
- The causes and effects of acid rain.
- How streams and rivers get polluted.
- The effects of drinking and driving.
- How age affects memory.
- Is eye color related to vision?
- Nerve centers in plants.

Collections

- Samples of local soils.
- Homemade crystals in different solutions.
- Seashells from near and far.
- Preserved snowflakes: No two alike?
- Samples of different spider webs.

- Food types showing sources of different vitamins and minerals.
- Different types of electromagnets and their uses.
- A study of eyeglasses.
- Computers: past, present, and future.
- Stringed instruments and their sounds.
- Precious gems and where they're found.
- Sailboats and how they work.
- Local fossils.
- Unidentified flying objects (UFOs).
- Engines, big and small.
- Parachutes through the years.
- Sources of drugs.
- Drugs used in medicine.
- Plant foods versus animal foods.
- Pollutants in our everyday environment.
- Wild berries and nuts.

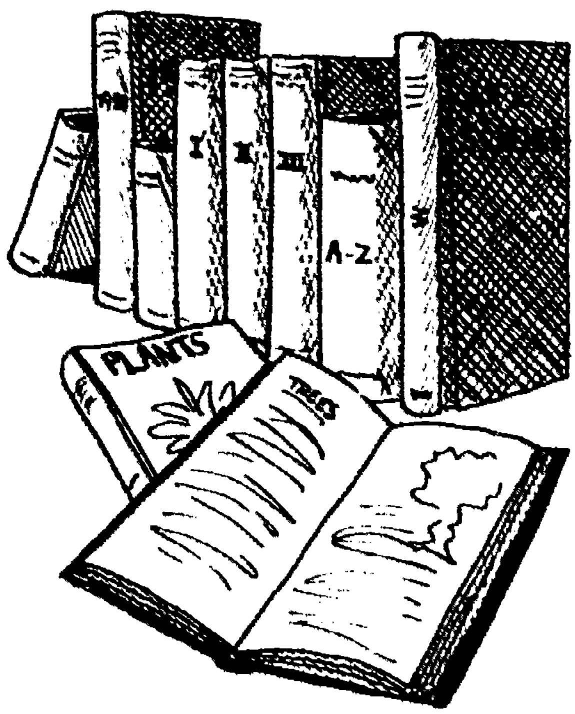
Apparatus

- Different types of pendulums.
- Thermometers, big and small.
- Uses of strobe lights.
- Telegraphs and their development.
- Robots.
- Crystal radios from yesteryear.
- Steam engines that made a difference.
- What a seismograph does.
- How a camera works inside and out.
- Different kinds of motors.
- Rockets into space.
- Simple machines used every day in the home.
- The most significant human inventions.
- Instruments used to study diseases.
- A study of windmills.

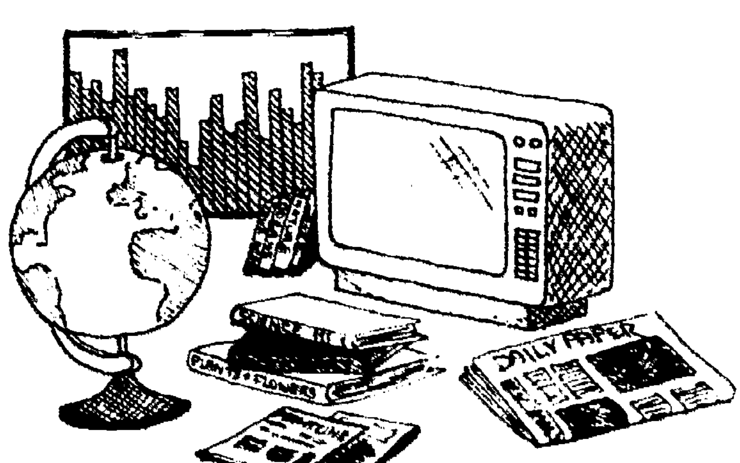
In all, students have a wide range of possibilities from which to choose. Students should not feel restricted to these lists but can be encouraged to seek potential topics beyond the limits of these pages. The science world has unlimited areas to investigate: students should feel free to explore in each and every corner, guided by their interest.

7 ■ CONDUCTING RESEARCH

BEFORE THEY BEGIN ANY SCIENCE PROJECT, students will find a wide variety of print and nonprint materials that can provide background information and offer additional ideas for exploration or development. Students should be encouraged to investigate as many different sources as possible to ensure a thorough understanding of their chosen topic.



The school library is a natural place to begin, but students should also explore the local public library, a nearby college or university library (many of which are open to the public), government agencies (which can provide needed materials free of charge or for a nominal fee), a local scientific laboratory (check in the phone book), newspaper or magazine offices, city or county agencies, or mail order businesses that distribute science materials (see the Resources list).



■ Materials to Investigate

Here are some materials students may wish to use.

encyclopedias
dictionaries
biographical dictionaries
atlases
pamphlets
records
newspaper files

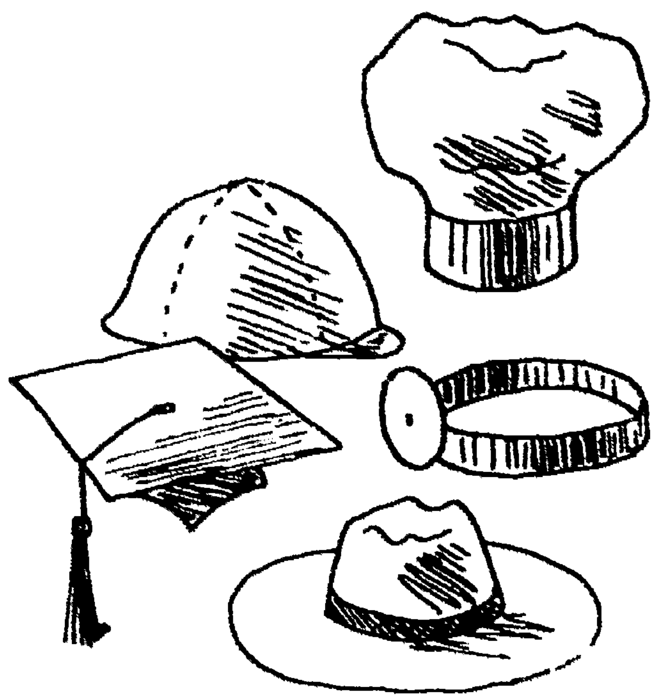
- maps
- bibliographies
- library card catalogs
- professional indexes
- audio and video recordings
- almanacs
- textbooks
- graphs
- brochures
- magazines and professional journals
- historical stories
- photographs and art
- charts
- magazine indexes
- public documents

Places to Go

Students often confine their research to the school library. It is certainly a good place to start—but only as a start. It should not be the sole source of information. Students should be encouraged to check out, not only other libraries, but businesses, government agencies, and the like. These investigations provide students with a well-rounded approach to their project: a vital concern of scientists everywhere. Here is a selection of places beyond the school library to explore.

- college library
- museums
- scientific societies
- local laboratory
- historical society
- recreation area
- pumping station
- state agencies
- city/county offices
- ranger station
- park
- Chamber of Commerce
- waste treatment plant
- TV/radio station
- planetarium
- manufacturing plants
- hardware store
- refuse collection firm
- medical laboratory
- zoo
- botanical garden
- gardening center
- farm
- state gamelands
- state seashore areas
- newspaper office
- college science department
- supermarkets
- restaurants
- glaziers
- pet store
- arboretum
- florist or plant nursery
- food processing plant
- university laboratory
- wildlife preserves
- travel agency brochures
- science periodicals (check Resources list)

TV specials
government publications (check Resources list)
publications of professional unions
computer databases



■ People to See

Students need to be aware that a successful science fair project may require consultations with individuals other than their teachers or parents. By interviewing experts in the chosen subject area or talking over the project with them, students may obtain new data or additional insights to incorporate into the project plan. Such discussions offer students an opportunity to share ideas and discuss diverse aspects of a chosen topic. People are often eager and honored to talk with students about their projects and can be a most valuable resource during the investigative process. Here are some individuals who might be interviewed (an interview form appears at the end of this section).

science teachers
professors
electricians
friends and neighbors
park rangers
college students
plumbers
librarians
veterinarians
city or county government officials
astronomers
high school students
computer operators
musicians
zoologists
gardeners
zoo personnel
meteorologists
environmentalists
ecologists
people encountered during field trips
scientists
corporate and research librarians
science writers
factory workers
doctors, nurses
farmers
medical laboratory workers
construction workers
travelers
sanitation workers
biologists
cartographers
conservationists
cooks

Interview Sheet

Name of person being consulted: Position:

Phone number for later questions:

Date of interview: Time of interview:

Location of interview:

Questions and Answers:

1.

2.

General Comments/Reactions/Ideas to Pursue:

8 ■ THE SCIENTIFIC METHOD

MANY STUDENTS ELECT TO CONDUCT AN EXPERIMENT for their science fair project. An experiment allows a student to investigate an area of science by means of principles and methods scientists use every day. An experiment should be effectively designed so that the student can discover the answer to a precisely defined problem. Students often make the mistake of selecting a problem that is too general or too broad in scope—one they do not have the resources, materials, or time to investigate properly. Most students need guidance so that the problem they choose to investigate is well within their capabilities and for which appropriate resources are available.

The **scientific method** consists of a series of steps that must be followed to ensure an effectively designed experiment. Note that the steps allow some leeway, offering students many ways to examine and explore an area of interest. Nevertheless, if the project is to yield scientific data that will expand the student's understanding, each of the following steps is essential.

STEPS OF THE SCIENTIFIC METHOD

1. Identify the problem.
2. Refer to authoritative sources.
3. Ask an appropriate question.
4. Develop a hypothesis.
5. Conduct experiments.
6. K[illegible]d records of methods and results.
[illegible]port the experiments.
8. Analyze the results.
9. Develop a conclusion.

■ Identifying the Problem

With so many potential topics from which to choose, students must narrow their choices to a specific one. Here is where guidance from teachers and parents becomes so important. It is not unusual for students to decide to do an experimental project on a broad topic like "grass" or "white mice," for example. Here is where students should be asked some questions that will assist them in defining a more specific problem. For example: "What feature about grass interests you the most?" "What question would you like to ask a gardener about the growth rate of different grasses?" "How do you think mice eat their food?" "How do mice survive cold temperatures?" Assist your students in carefully defining the scope of a problem for investigation and narrowing it to a level they can explore. This is a process scientists go through regularly and one that is essential to a well-designed, successful experiment.

■ Referring to Authority

Long before scientists begin to set up their experiments, they conduct some research in their chosen area. This means reading books, magazine articles, pamphlets, brochures, or any other printed information concerning their topic. It also means talking with or obtaining information from experts in the field. This is done through telephone conversations, personal visits, or attendance at special meetings or conferences. Like scientists, students should be prepared to conduct some investigative research before initiating an experiment. These discoveries can yield a significant amount of valuable data that sharpens a student's understanding of a selected field.

■ Asking an Appropriate Question

To develop an effective science experiment, students need to formulate a very specific question about the chosen area of interest. Parents and teachers can help. For example, a student who has an interest in learning about how plants grow in different colored lights might ask: What is the difference in the rate of growth of four different plants each grown in a different-colored light? Or a student who is interested in the nutritional needs of mice might ask: What is the difference in the weight of mice raised on a diet of junk food in comparison to mice raised on a nutritious diet? Notice how each question is very specific; it indicates the subjects to be studied, and the variables that will be observed. Being specific and identifying variables is important in helping the student sharpen his or her focus and carefully define the area to be investigated.

Developing a Hypothesis

After students have designed an appropriate question, they must turn that question into a hypothesis. A **hypothesis** is an educated guess, a statement of how the scientist thinks the experiment will turn out. It is a prediction, based on the best available information, of what the scientist believes will happen at the conclusion of the experiment. Although the hypothesis is founded on factual data the student has collected during the research stage, it is the student's *opinion* deduced from those facts. A well-constructed hypothesis identifies the subjects of the experiment (plants, mice) and states what is being measured (rate of growth, weight), the conditions of the experiment (different-colored light sources, junk food versus regular food), and the results expected (light colors produce faster growth rates than dark colors; a nutritious diet produces higher weights than a junk food diet). Thus a student's question about a specific area of interest can be developed into a hypothesis that forms the foundation of the student's investigation. For example:

- Bean plants grown under dark-colored light will grow more slowly than bean plants grown under light-colored light because of a lack of sufficient ultraviolet light waves.
- Mice raised on a diet of junk food will show lower body weights after 6 weeks than mice raised on a regular diet because of a deficiency of necessary nutrients in the junk food.

Conducting the Experiment

Testing one's hypothesis is at the heart of the scientific method. It is here that the student will organize and conduct an investigation examining the effects of changes in certain experimental conditions or experimental factors. In short, the student will learn what happens when a condition is created or altered. In addition, the implications of that change are also explored.

It is important that the student test or examine *one idea at a time*. It is easy for students to expand their experiments far beyond the limits established with the original hypothesis; however, for any results to be valid students must adhere to the original design. Often, this means a process of trial and error in which a problem is approached from many angles before a hypothesis can be confirmed.

It is also at this stage that students must decide how many times they will conduct their experiment, the number of subjects or items being subjected to the test, how long it will last, and what special materials they will need. Students also must decide how they will be measuring the effects of the experiment. Will it be done over a period of time, include a variety of sample types, or measure height, weight, growth rate, heartbeat, or other variables? For example, will the experiment take place over a few hours, days, or weeks? Will it include different varieties of animals or plants? What measuring instruments (scales, balances, stopwatches, clocks, thermometers, anemometers, wind gauges, yardsticks) will be used? Will the experiment be conducted in daylight or darkness, at high elevations or low elevations, in a lab or the family basement? The conditions under which the experiment will be carried out must be clarified prior to as well as during the entire experiment.

■ Keeping Records

Scientists always maintain records of everything they do during the course of an experiment. Students, too, should be encouraged to keep a log or record book of what they do and observe during the course of the investigation. Such record keeping permits the student to keep track of the individual events of the experiment and it provides a reference for identifying any errors that may creep into the experiment.

Not only does the log or record book provide an accurate summary of the "events" of an experiment; it is also important in showing others how the experiment was carried out. Others should be able to duplicate the experiment simply by following the student's record. Indeed, the well-maintained notebook is an invaluable part of any science fair experiment because it details the steps and procedures the student went through to arrive at new information.

■ Repeating the Experiment

Conducting an experiment once usually does not provide the scientist with sufficient data upon which to base a decision or conclusion. Thus it is important that the student plan adequate time to conduct the experiment more than once. Such a practice ensures that the results obtained the first time are accurate and precise. It also guarantees that any conclusions drawn from the results of the experiment are based on a wealth of information and not just a few isolated details.

■ Analyzing the Results

After the experiment has been conducted and all the necessary data collected it is time to analyze that information. What facts, numbers, or statistics were produced as a result of the experiment? Did three of the plants show slower rates of growth than a fourth? Was there a difference between all individual plants? How many mice had lower body weights on the junk food diet? Did the growth patterns differ significantly between the two groups of animals? The collection of this information and its analysis are vitally important parts of the entire project. It is here that the student assembles and looks over the available results in order to begin formulating a conclusion.

It is important to point out to the student that the data gathered may *not* confirm the original hypothesis. That is, as a result of this experiment the student may discover, for example, that there is no difference in the growth rate of bean plants grown under different colors of light. That's OK. Students need to understand that their original hypothesis was simply an educated guess based upon information at their disposal at the start of the experiment. It is possible that the results will not confirm that hypothesis but rather refute it. This happens to scientists all the time and is a natural and normal part of the scientific method: Science is advanced just as much by the knowledge that light color is *not* a factor in growth as by a finding that it *is* a factor. In an experiment, success is neither a positive or a negative finding but *any* clearly substantiated, repeatable result.

■ Developing a Conclusion

Now that the student has conducted the experiment, collected the necessary data, and analyzed the results it is time to formulate a conclusion. The conclusion should provide some answer to the original question (see above), although it is entirely possible that the experiment was unsuccessful in proving the hypothesis. There is certainly nothing wrong with a conclusion indicating that the question still remains unanswered. The importance of the experience lies in the student's having an opportunity to investigate and learn about an area of interest by means of the scientific method. Arriving at an ideal conclusion is not the goal—wrestling with a problem is.

In a sense, the conclusion represents what the student actually learned by conducting the experiment. It is also an opportunity for the student to suggest needed improvements in the experimental design or changes that could be made in attempting the experiment in the future. Most important, the conclusion should contain a statement or series of statements by the student on the importance of the experiment. For example, a student who discovered that a diet of junk food was associated with lower body weights for mice might discuss the importance of a well-rounded and nutritious diet in the maintenance of proper body weights for animals or humans. The conclusion, then, is an opportunity for the student to draw relationships between the experiment and the world in which he or she lives.

9 ■ Presenting the Project

AFTER STUDENTS HAVE SELECTED A TOPIC, investigated or experimented with that topic, and come to some conclusions about that area of science they will want to display their efforts for the science fair. Presenting the project can be one of the most satisfying parts of the entire experience. The science fair project display is the culmination of weeks of study and preparation: It's here that students can demonstrate their ingenuity and creativity in sharing what they have learned.

Each project entered in a science fair must consist of three elements: the display unit, the exhibit materials, and the written report. Together, these elements present a complete and thorough examination of an area of interest, a collection of new knowledge, or the results of a self-initiated experiment. In most science fairs, the displays are evaluated and thus must present a complete picture of the student's efforts for judges and observers alike.

Most science fairs provide students with display tables on which the project can be set up. *Before* designing the display, find out the length, width, and height of the tables to make sure there is enough room to arrange the display and that any written information can be read easily by observers. Keep in mind, however, that not all projects will need a display table (see the illustrations throughout this book).

■ Display Backdrop

The display unit (also known as the backboard) is crucial to presentation: It is what people see first; it establishes the "professionalism" of the student's efforts. As a kind of advertisement for the project, it must be well constructed and designed for maximum visual effect.

Materials

A good display unit must be constructed of sturdy and durable materials. It must stand for several days, so strong, rigid materials are preferred.

Pegboard
Pegboard has the advantage of providing predrilled holes from which displayed items can be hung. Easily available at most lumber yards or hardware stores, it can be cut to any size or shape. Its only disadvantage is its thinness and its tendency to buckle when heavy weights are hung from it. This can be corrected by nailing strips of wood around the perimeter of the back of the pegboard to provide the necessary support.

Plywood
Plywood comes in many thicknesses (1/4", 1/2", and 3/4" are commonly available). It provides a more than adequate backboard for any display unit. It can be cut into sections and hinged together for an effective display. If the plywood is to be painted, you'll need to buy "A" or "B" grade wood. If, however, the plywood will be covered with other materials such as felt, construction paper, or foil, "C" or "D" grade plywood will be adequate.

Corkboard
Corkboard is a lightweight material available in variety stores and lumber yards. It is not as rigid as other materials but has the distinct advantage of being easily portable from home to school.

Particle Board
The best-known brand of particle board is Masonite. This extremely sturdy material is obtainable at any lumber yard or building supply store. It provides a very solid backdrop for a display unit, particularly for backboards displaying heavy objects. Its disadvantages are its weight and difficulty in cutting.

Foam Board
This is an ideal material for display units and can be found in art supply or graphics supply stores. It is extremely lightweight, comes in thicknesses up to 8", and can be very easily cut with a utility or razor-blade knife. It consists of plastic foam covered on both sides with paper. Another advantage, aside from its light weight and sturdiness, is that when scored on the back with a knife it can be shaped into a curved display unit. Additionally, its surface can be easily painted and materials can be fastened to it with cellophane tape, pins, or glue.

Undesirable Materials
Materials that should not be used for a display unit include cardboard and posterboard. These materials are too light to stand on their own or hold display items for long periods.

Construction

The display unit must be freestanding; that is, it must stand on its own for several days. Thus most display units will consist of three equal-sized panels hinged together. Display units consisting of two or four panels are less frequently used. If foam board is chosen, it is possible to construct a curved display unit—a technique that adds a distinctive touch to the project. Display units come in many sizes, but here are some suggested dimensions based on standard measurements (in inches) of materials commonly used in science fair displays:

Height		Width		Depth
60	*	48	*	30
48	*	48	*	36
60	*	48	*	36
48	*	36	*	30

Setup

To provide for an attractive display unit, consider painting the backboard or covering it with construction paper, adhesive-backed paper, wallpaper, burlap, or some other appropriate material. It is best to keep the colors neutral so as not to detract from the display itself. The completed backdrop will include information about the project as a whole as well as other data summarizing important parts of the investigation.

The setup of a display unit is vitally important. Students should be prepared to make their backdrops attractive without including so much material that the display becomes visually crowded. By experimenting with different designs and formats, students should be able to come up with a mix that will enhance and illustrate the information.

The following information should be included on the display unit (see illustrations throughout this book for examples of different arrangements).

Purpose

This statement lists the student's reasons for pursuing the project. What did the student hope to learn by investigating this area?

Procedure

What did the student do to carry out his or her plan of action? What methods or materials were used to discover new information about a topic?

Problem
A problem statement outlines a condition or fact the student is uncomfortable with or seeks to investigate. *Note:* A problem statement is most commonly included in experiment-type projects.

Hypothesis
A hypothesis is an educated guess or prediction about what the student thinks will happen. *Note:* Hypotheses are used mainly in experimental projects.

Title of the Project
The title must describe, very succinctly, the focus of the project. It should be short (10 words or less), neatly lettered, and easy to read.

Results
What did the student learn during or after his or her investigation? In other words, what facts were discovered that were not known before?

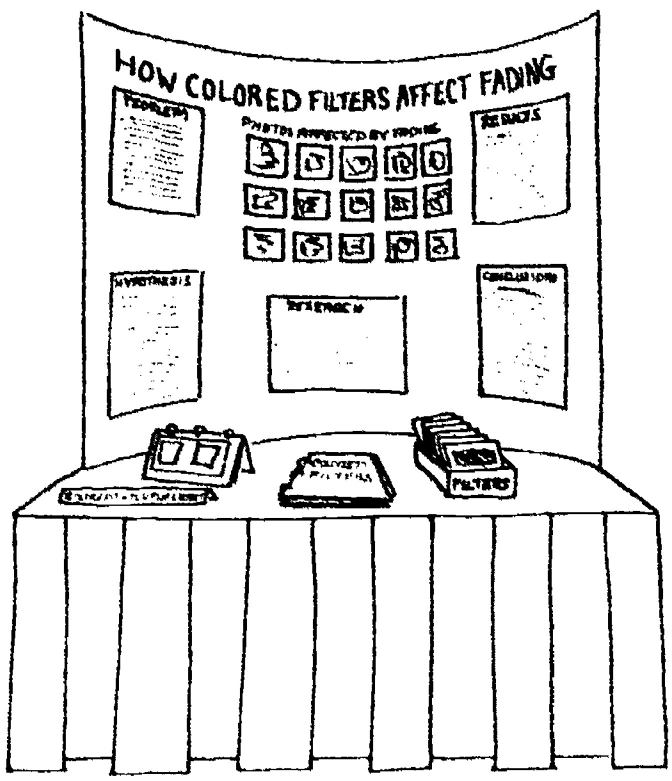
Conclusion
This statement summarizes the student's investigation. It should offer an answer to the student's original questions. Students may discover something not originally planned—that too should be included.

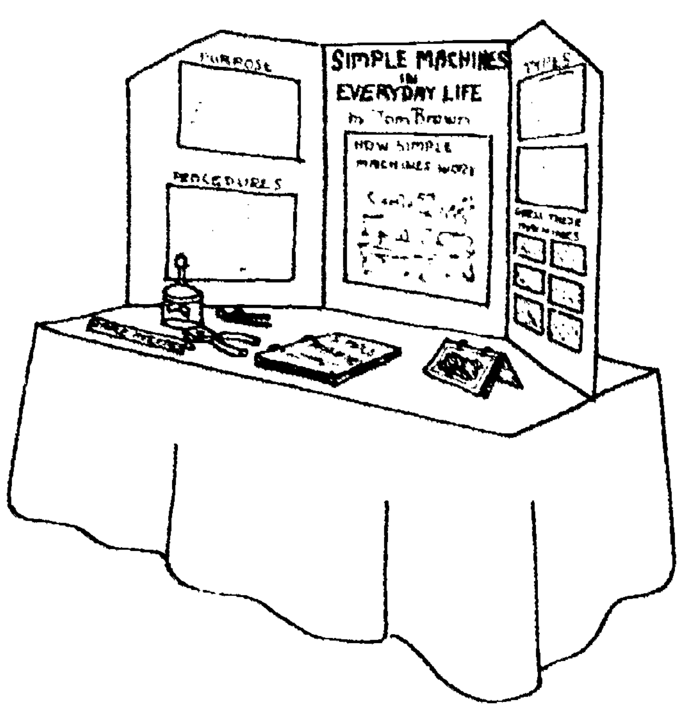
Visual Aids
These include photographs, charts, surveys, graphs, data, drawings or paintings, diagrams, or other illustrative materials that enumerate vital information gathered during the project.

Lettering
An important part of any display unit is the lettering. Good lettering can add much to a display by conveying an important message to all who look at it. It is important, therefore, that the lettering and signs used on the display unit be neat and of proper size. The title should have the largest letters, while signs posted over each supplemental section are smaller. Good hand-lettering is sometimes sufficient, but stencils or press-on letters (available at any art supply or large variety store) add a true professional appearance to the entire display. If available, computer graphics programs can be used to create labels, titles, and signs. The student should check and double-check all spelling and punctuation.

Exhibit Materials

The materials, items, devices, and samples shown in front of the backdrop unit can be an exciting part of any science project. These materials should reflect the items used throughout the student's investigation; they should provide a firsthand look at the scope of the project. In projects displaying collections, a good cross section of different types or groups of the selected items would be displayed. In a project illustrating an apparatus or a group of related apparatuses, examples of those items would be put on display for the viewer. If the student chooses to do an experiment, then the materials used throughout the experiment are set up for viewing. As a rule of thumb, the display items should tell a story or illustrate a concept sufficiently so that the student scientist need not be present to explain the entire project to an observer. Here are some procedures to keep in mind in setting up this part of the project.





- **Safety first!** Exhibit items should present no hazards to observers who may view the display. Thus no breakable or dangerous items should be included. If electricity is used, safeguards must be observed to prevent electrical shocks or hazards (battery-powered equipment is preferable).

A SAFETY CHECKLIST

[ ] Are electrical items like lamps safe: UL listed, no frayed cords or loose bulbs?

[ ] Could any item get hot enough to burn someone? Is it shielded from exploring hands?

[ ] Are liquids—chemicals, fertilizers, paints—in sealed or shatterproof containers?

[ ] Could electrical cords trip someone? Are they anchored?

[ ] Could a tug on the table cover bring down the whole display?

[ ] Could marbles or other round objects go astray and trip someone? Could a child swallow one?

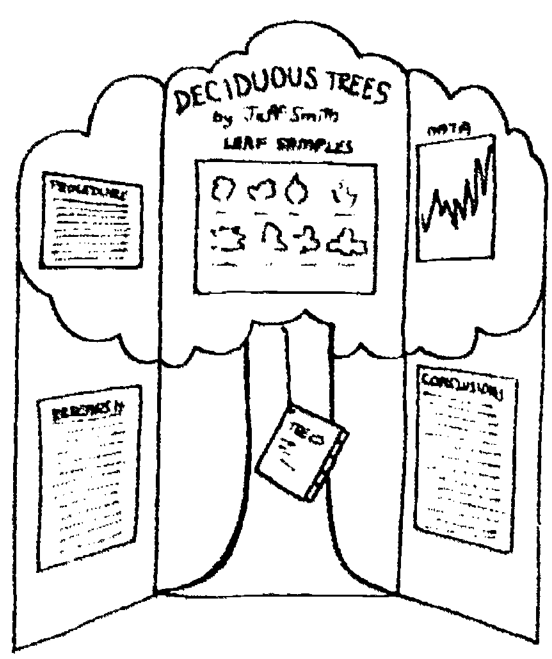
[ ] Are sharp objects firmly anchored or out of reach?

[ ] Will the display be safe if briefly left unattended?

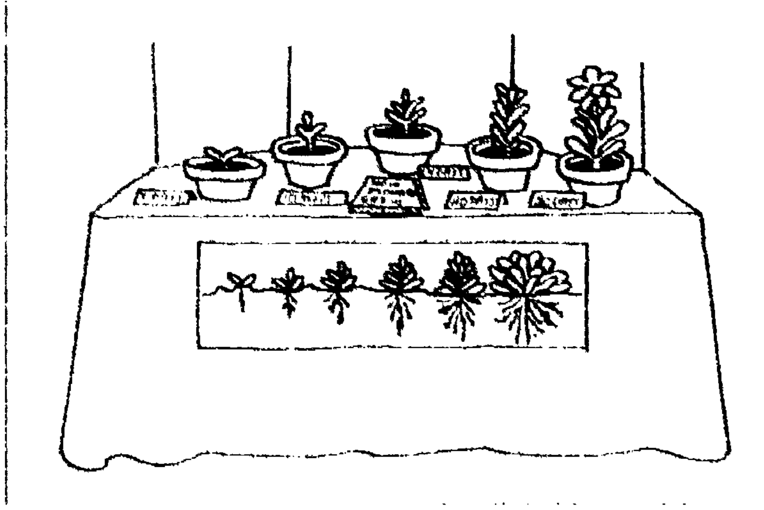
• **Set up items in an attractive format.** Have the students experiment with a variety of designs and formats to arrive at the most visually appealing one.

• **Avoid clutter.** It is important to include enough items to illustrate important concepts of the project, but it is equally important to avoid crowding the display table. Too many items detract from the display just as much as too few.

• **Avoid using liquids or chemicals.** The use of water, chemicals, or other liquids is discouraged, particularly for displays that will be standing for several days. Any spillage could be a hazard to the display or a neighboring display. It would be



preferable to take photographs of selected vessels or liquids at home and then post the photos on the display unit. (Allow time for doing this.)



- **Seal in smelly items.** If molds or decaying items are to be exhibited, they must be sealed tightly inside glass or plastic jars. All cautions must be observed to prevent these materials from being released into the surrounding area.
- **No animals of any kind** should be included in a display, especially displays left overnight. The care and maintainance of the animals cannot be guaranteed by the science fair director(s). The strain of having countless observers peek, point, and poke at animals can place an unnecessary strain on household pets. Thus, it is important that students carefully consider any projects which involve the use of animals. The animals should be left at home and photographs of them included as part of the display.

■ Written Report

The written report is a capsule summary of everything the student did to investigate the selected topic. It contains all the information the student collected or learned during the weeks leading up to the actual science fair. Whether the student decides to do an experiment, assemble a collection of objects, demonstrate a scientific principle, conduct some research into an interesting area of science, or show a particularly interesting piece of scientific apparatus, it will be necessary to record observations and information in written form. This written report provides observers with vital data on the scope of a project as well as its effect on a student's understanding of the topic.

Usually 5 to 30 pages in length, the report provides observers with a blow-by-blow account of everything the student did throughout the length and breadth of the project. It is meant to provide readers with a succinct, detailed accounting of the chosen project—including its impact on the student. Above all, it provides students with an opportunity to think about all the dimensions of their projects and to share their ideas with others.

Reports should be neatly bound in an attractive folder or binder (available at any variety, department, or stationery store). It is preferable for the report to be typewritten or done on a computer, but a neat handwritten copy may also be acceptable. Any written report for a science fair project should include:

Title Page

The first page in the report should include the title of the project as well as the name and grade of the student.

THE GROWTH OF CARNATIONS UNDER FOUR DIFFERENT COLORED LIGHTS

Jenny Bevington
Grade 5
Room 205

Table of Contents

1. Problem	2
2. Research	4
3. Question	6
4. Hypothesis	7
5. Experiment	8
6. Records	10
7. Results	14
8. Conclusion	17
9. Bibliography	18
10. Acknowledgments	20

Table of Contents

This page provides the reader with a list of the different parts of the project and the page number on which each section can be found.

THE EFFECTS OF TOOTHPASTE ON BACTERIA GROWTH

by
Jonathan Disher

CONTENTS

Statement of Purpose	2
Hypothesis	3
Research	4
Written Sources	5
Experts and Authorities	6
Other	8
Materials	10
Procedure	15
Observations and Results	18
Conclusion	21
Bibliography	23
Acknowledgments	26

Statement of Purpose

This two- or three-sentence statement explained what the student expected to discover by investigating the chosen topic. It also gives the reason why the student chose to learn more about that subject.

Hypothesis

Students who select an experiment to perform should include a hypothesis in the written report. A hypothesis is an educated guess about what the student thinks will occur as a result from conducting the selected experiment. It is not necessary to include a hypothesis for other types of projects.

Research

This is the part of the report that contains all the background information the student collected about the chosen topic. Any books or articles read, authorities consulted, or outside materials collected should be summarized and presented in this section. It should be written in the student's own words and not copied from an encyclopedia or other reference.

Materials

This is a list of all the materials and supplies used in the project. Quantities and amounts of each should also be indicated, especially if the student conducted an experiment.

Procedure

Here the student lists and describes steps he or she undertook to complete the project. Usually presented in a numbered format, this part of the report shows the stages of the project in such a way that others can reproduce the procedure.

Observations and Results

Here the student tells what he or she learned from the project. What new information was provided as a result of pursuing this topic? What does the student know now that wasn't known before? It is important to include any graphs, charts, or other visual data that summarizes the results of a study.

Conclusion

This is a brief statement explaining why a project turned out the way it did. Students should explain why the events they observed occurred. Using the word "because" is a good way to turn an observation into a conclusion. If an experiment was chosen, the conclusion should tell whether the hypothesis was proven or not proven.

Bibliography

The bibliography should list all the printed materials the student consulted in carrying out the project. Items should be listed in alphabetical order in a standard format. The Resources are one example of a format.

Acknowledgments

Here the student thanks all the individuals who assisted in the research or development of the project (including Mom and Dad). Everyone the student interviewed, including teachers, scientists, and other experts in the field, should be mentioned here.

JUDGING PROJECTS ■ 10

EVALUATING SCIENCE FAIR PROJECTS can be a difficult task for students as well as judges. Students who plan to enter projects deserve guidelines for their efforts—not to compete with other entrants but to make the current entry as good as possible and to prepare for future entries.

The judging criteria listed below have been garnered from science fairs held around the country. They provide teachers, parents, and most important, students with significant criteria against which to gauge projects. They are appropriate to evaluate all kinds of entries submitted to a science fair, but they are also designed to serve as a self-evaluative tool prior to entering one's project in the fair. These guidelines ensure that all students are evaluated according to an established set of criteria and that teachers and parents are aware of the elements that constitute a well-planned display.

How to Use This Checklist

The major parts of any science fair project are the *display*, *display materials*, and the *written report*. Each has been assigned a possible 100 points. In addition, projects involving experiments need to be evaluated for use of the scientific method.

To help your evaluation, points have been assigned to the major components of each category, and some criteria are listed below each. *Not every item in each list will apply to every project*. Check off the applicable ones that you believe have been fulfilled successfully, then assign a value between zero and the total potential points and fill it into the blank beside the component. Add the points, and you'll have a standard for comparing your project, or a project you are judging, with the best possible results.

These are suggestions—you may think of some additional criteria. Good judging!

■ Display

Score

Creativity (30 points)

- [ ] Are the materials presented imaginatively?
- [ ] Is there a distinctive approach to problem solving?
- [ ] Is the project or display original?
- [ ] Is the display designed in an unusual way?
- [ ] Is there a variety of equipment or items?
- [ ] Is the project out of the ordinary?
- [ ] Is new and interesting information included in the display?
- [ ] Are the data or results interpreted appropriately?
- [ ] Has the student shown inventiveness?

Scientific Thought (30 points)

- [ ] Is the experiment designed to answer a question?
- [ ] Are the procedures appropriate to the area of investigation?
- [ ] Is the topic or problem stated clearly and completely?
- [ ] Has scientific literature been cited?
- [ ] Have scientists or other experts been consulted?
- [ ] Has a systematic plan of action been stated?
- [ ] Is there a need for further research or investigation?
- [ ] Is there an adequate conclusion?
- [ ] Is a project notebook provided with the display?
- [ ] Is the project notebook sufficiently detailed in relation to the scope of the project?
- [ ] Have any problems or limitations that occurred been noted?
- [ ] Is the amount of data commensurate with the scope of the project?
- [ ] Does the student understand all the facts and/or theories?

Thoroughness (15 points)

- [ ] Is the project complete?
- [ ] Does the project represent a sufficient amount of time?
- [ ] Is a problem adequately answered or pursued?
- [ ] Are the notes complete?
- [ ] Are other potential solutions or approaches indicated?
- [ ] Does the project include a display unit, three-dimensional items, and a written report?
- [ ] Does the project tell a complete story?
- [ ] Is the information complete?
- [ ] Were all potential sources of information consulted?
- [ ] Is the display lightweight and portable?
- [ ] Is a sufficient number of items included in the display?
- [ ] Is the conclusion supported by results from an experiment?

Score

Skill (15 points)

- [ ] Does the project represent the student's own work?
- [ ] Does the project represent quality workmanship?
- [ ] How much outside assistance did the student need?
- [ ] Is the project artistically pleasing?
- [ ] Does the student know the subject well?
- [ ] Is there anything dangerous about the display?
- [ ] Did the display take a lot of time to set up?
- [ ] Was assistance necessary in setting up or preparing the display?
- [ ] Does the project indicate extensive planning?
- [ ] Is all equipment used within the student's level of understanding or expertise?
- [ ] How much supervision did the student require?

Clarity (10 points)

- [ ] Are titles and written descriptions neat, legible, and large enough to be read?
- [ ] Are the data clearly presented?
- [ ] Can the average person understand the project?
- [ ] Is the written material well prepared?
- [ ] Is the project self-explanatory?
- [ ] Are drawings and diagrams neat and attractive?
- [ ] Is the presentation logical and sequential?
- [ ] Is every piece of material important to the display?
- [ ] Is the display colorful and attractive?
- [ ] Are any supplemental guides provided?
- [ ] Are discussions clear and straightforward?

Total for Display

(100 possible points)

■ Written Report

Score

Title Page (2 points)

- [ ] Is it present?
- [ ] Are the title of the project and the student's name included?

Table of Contents (5 points)

- [ ] Are all parts listed?
- [ ] Are all sections listed in order?
- [ ] Are page numbers listed and correct?

Score

Statement of Purpose (15 points)

- [ ] Does it pose a question that can be investigated or measured?
- [ ] Does it pertain to the experiment or project conducted?
- [ ] Is it logical and defendable?
- [ ] Is it clear and understandable?
- [ ] Is it within the student's ability level?

Hypothesis (Included for experiments only.)

No points

- [ ] Does it answer the purpose?
- [ ] Does it tell what the student is trying to prove with the project?
- [ ] Is it clear?
- [ ] Is it scientifically sound?

Research (15 points)

- [ ] Does the research pertain to the topic?
- [ ] Is it complete and thorough?
- [ ] Does it represent a diversity of sources?
- [ ] Is it representative of the student's ability?
- [ ] Have both print and nonprint sources been consulted?

Materials (10 points)

- [ ] Are all materials listed?
- [ ] Are specific amounts given?
- [ ] Are there sufficient materials?

Procedures (10 points)

- [ ] Are procedures listed in chronological order?
- [ ] Could the project/experiment be replicated?
- [ ] Are the procedures easy to follow?
- [ ] Are they in a logical order?

Observations (15 points)

- [ ] Do observations indicate what was done in the project?
- [ ] Did the student choose the best form for recording the observations?
- [ ] Are observations clearly labeled?
- [ ] Are they sequential?

Score

Conclusion (15 points) ______

- [ ] Does it answer the purpose?
- [ ] If an experiment, does it adequately explain any results?
- [ ] Does it tie the entire paper together?
- [ ] Is it sufficient in form and length?

Bibliography (8 points) ______

- [ ] Is it in alphabetical order?
- [ ] Does it follow the required form?
- [ ] Is it sufficient in terms of the scope of the project?
- [ ] Have primary, scientific sources been consulted?
- [ ] Is range and scope of the bibliography reflected in the report itself?

Total for Written Report ______

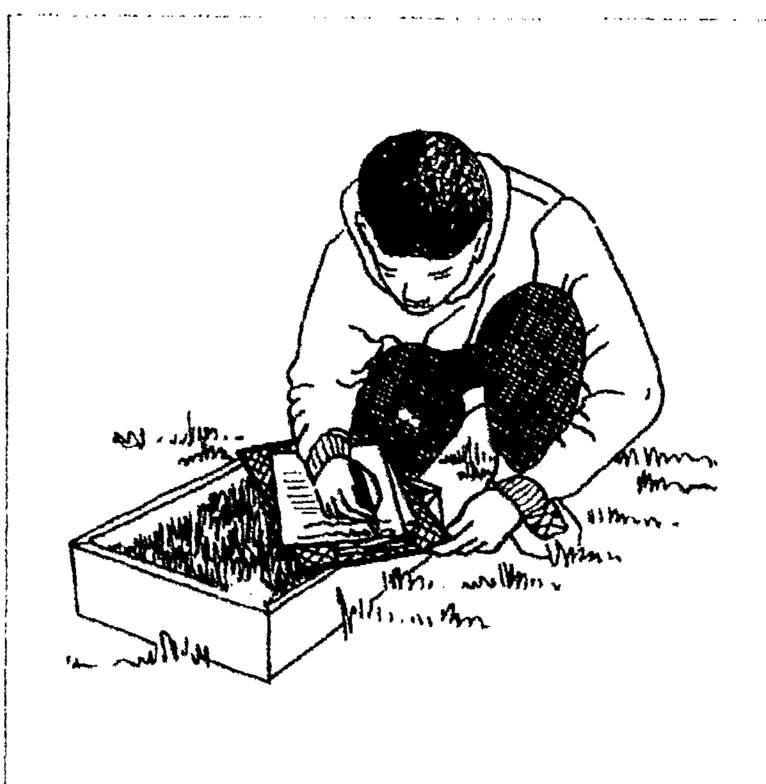
(100 possible points)

Total for Project ______

(200 possible points)

11 ■ STUDENT'S PLANNING GUIDE

TO THE STUDENT: A science fair project can be one of the most exciting projects you will ever do in school. But it takes time, planning, research, preparation, and lots of hard work. You will discover much about your chosen topic and much about yourself, too. You will examine, probe, and experiment with many ideas, techniques, and scientific principles, learning more about the world in which we live and more about the important work scientists do to help us understand our world. In short, you are about to begin one of the most thrilling journeys of your life—a journey into new discoveries and new adventures in science.



The Planning Guide below is designed to help you plan your journey both before and during your science fair project. Use it to select a topic for investigation, to decide what procedure to follow in exploring that topic, and to plan your steps for putting your completed project together for display at the science fair. Read this guide carefully and fill in or check off the necessary steps: It will make your work much easier. Remember that the success of your project will depend on the amount of work you wish to put into it *before* it is displayed at the science fair. Keep in mind that you can always ask other people (for example, your parents or teacher) for help or guidance in carrying out your project: Scientists help one another all the time! Now get ready—and **good luck!**

Science Fair Planning Guide

Things That Interest Me:

1. ______

2. ______

3. ______

4. ______

5. ______

How much time can I spend on my project each week:
______ hours

What area of science interests me the most:
- [ ] Life science
- [ ] Earth and space science
- [ ] Physical science

What type of project would interest me the most:
- [ ] Experiment (using the scientific method)
- [ ] Demonstration
- [ ] Research
- [ ] Collection
- [ ] Apparatus

What kinds of science materials or equipment do I enjoy or am I familiar with?

______

______

______

______

______

______

Possible Topics:

1.

Materials I already have:

Materials I would have to buy:

Help I will need with this topic: None Some A lot
How difficult will this be for me?
Very difficult Somewhat difficult Easy

2.

Materials I already have:

Materials I would have to buy:

Help I will need with this topic: None Some A lot
How difficult will this be for me?
Very difficult Somewhat difficult Easy

3.

Materials I already have:

Materials I would have to buy:

Help I will need with this topic: None Some A lot
How difficult will this be for me?
Very difficult Somewhat difficult Easy

Final Topic Choice:

Questions/Problems to Explore

Some questions about my topic I want to find answers to:

1.

2.

3.

4.

Conducting Research

Printed and audiovisual materials I should find and read:

1.

2.

3.

4.

5.

Places I could visit:

1.

2.

3.

4.

5.

People I could talk to:

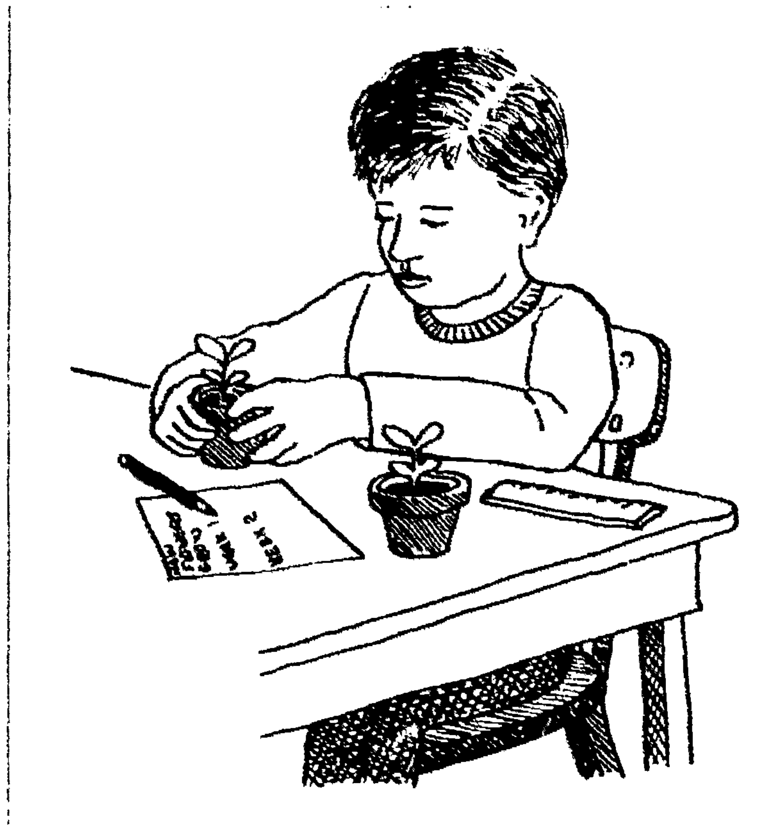
1.

2.

3.

4.

5.



Preliminary Timetable

Here is what I plan to do each week (subject to change). *Students:* Fill in 12 or 6 weeks according to your scheduled opening date.

Week 1 (to)
a.
b.
c.
d.

Week 2 (to)
a.
b.
c.
d.

Week 3 (to)
a.
b.
c.
d.

Week 4 (to)
a.
b.
c.
d.

Week 5 (to)
a.
b.
c.
d.
Week 6 (to)
a.
b.
c.
d.
Week 7 (to)
a.
b.
c.
d.
Week 8 (to)
a.
b.
c.
d.
Week 9 (to)
a.
b.
c.
d.
Week 10 (to)
a.
b.
c.
d.
Week 11 (to)
a.
b.
c.
d.
Week 12 (to)
a.
b.
c.
d.

For Experiments Only

Here are the steps for the scientific method. Fill in each one as a guide for your experiment.

- Problem I want to explore:

- References I will consult:
  Printed and audiovisual

  Places

  People

- Specific question I will examine:

- My hypothesis is:

- The experiment will consist of
  Subjects:

  Conditions:

  Tests:

  Time:

  Special materials:

Planned steps:

1.

2.

3.

4.

5.

6.

7.

8.

Record keeping

- What I did during the experiment:

- Results I got when I repeated the experiment:

- Final results of my experiment:

1.

2.

3.

4.

5.

- Conclusions I can base on those results:

- Did I prove my hypothesis? [ ] Yes [ ] No

Why or why not?

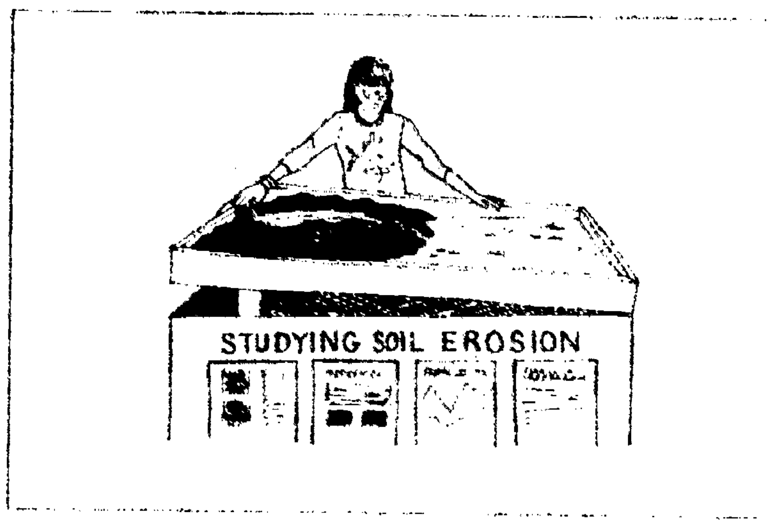
- What further or different research can I suggest?

Presenting the Project

Display Table

- Dimensions:

Height: ______ Width: ______ Depth: ______



- Table cover materials needed:

1. ______
2. ______
3. ______

Display Unit

- Materials needed:

______

______

______

- Dimensions of panels:

Height: ______ Width: ______ Depth: ______

- Written data to be included on display (check each one):

☐ Purpose
☐ Procedure
☐ Problem
☐ Hypothesis (for experiments)
☐ Title
☐ Results
☐ Conclusion

• Written data to be included on display:

- Visual aids (check each one)

☐ Photos
☐ Charts
☐ Graphs
☐ Artwork
☐ Diagrams
☐ Cartoons
☐ Pamphlets
☐ Brochures
☐ Mural
☐ Magazine clipping(s)
☐ Newspaper clipping(s)
☐ Poster(s)
☐ Drawing(s)

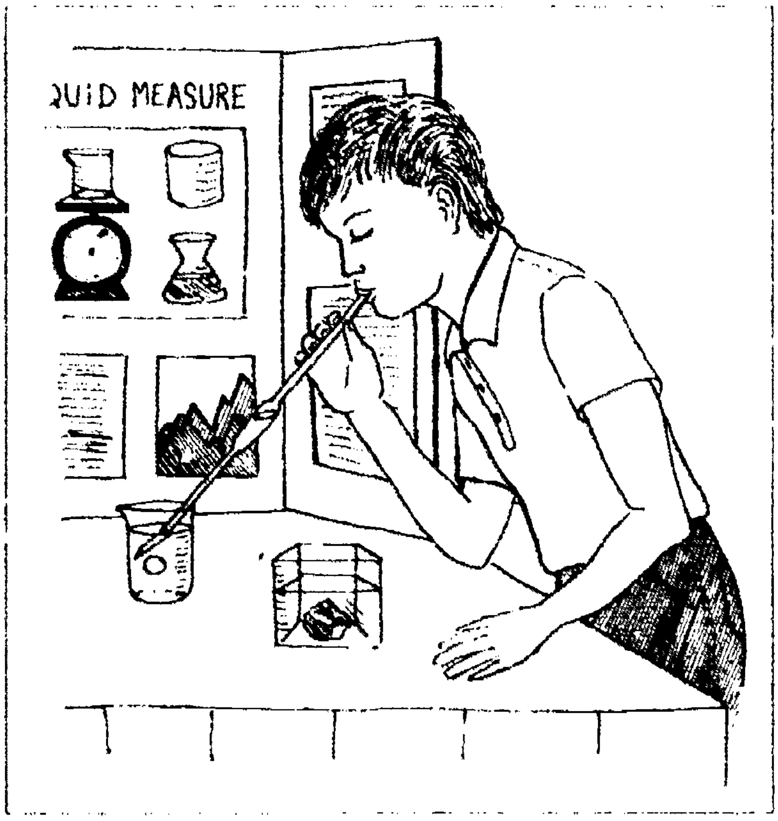


Exhibit Materials

• Which of the following do I want to include:

[ ] Apparatus

What types:

[ ] Specimens

What kinds:

[ ] Demonstration items

What types:

[ ] Special materials

What kinds:

• Are the items safe?

[ ] Yes [ ] No

• If "no," what do I need to make them safe?

• Will observers be able to handle them?

[ ] Yes [ ] No

Written Report

- Do I have an attractive folder?

[ ] Yes [ ] No

- Have I included the following:

[ ] Title page
[ ] Table of contents
[ ] Purpose
What is it:

[ ] Hypothesis (for experiments):
What it is:

[ ] Research
[ ] Materials
Types:

[ ] Procedures
[ ] Observations and results
[ ] Conclusion
[ ] Bibliography
What sources:

[ ] Acknowledgments
Who:

SCIENCE FAIR STUDENT ENTRY FORM

To be returned before: ______________________

Student Exhibitor Information
(please print or type)

Name: ______________________ ______________________
Last First

Age: ________ Grade: ________ Homeroom: ________

School: ______________________

Home Address:

____

____

Telephone: ______________________

Classification of Project (Check one category)

- [ ] Biochemistry
- [ ] Botany
- [ ] Chemistry
- [ ] Computer Science
- [ ] Earth and Space Science
- [ ] Engineering
- [ ] Environmental Sciences
- [ ] Mathematics
- [ ] Medicine and Health
- [ ] Microbiology
- [ ] Physics
- [ ] Zoology
- [ ] Other:

Type of Project (check one category)

- [ ] Experiment
- [ ] Research
- [ ] Collection
- [ ] Apparatus
- [ ] Demonstration

Student Project Information

Title of project: ____________________

Brief description of project:

____

____

____

____

____

____

____

Electrical outlet required: [ ] Yes [ ] No

Display table required: [ ] Yes [ ] No

Special setup or arrangements required: [ ] Yes [ ] No
(If yes, please describe):

____

____

____

____

____

____

____

PARENTS' AGREEMENT FORM

TO HAVE YOUR ENTRY ACCEPTED FOR EXHIBITION IN THE ______________________ SCIENCE FAIR THE FOLLOWING STATEMENTS MUST BE SIGNED.

A. The project described above, which I plan to enter in the ______________________ Science Fair, is my own work and has been completed by me according to the rules of the science fair.

B. I understand that the project is entered at my own risk and that ______________________ is/are not responsible for loss or damage to my project or any of its parts.

C. I agree to leave my project in place until ____________ (date) and to remove it by no later than ____________ (time) on ____________ (date). If it is not removed by the designated time, I authorize that it be disposed of properly.

____

Signature of Student

My son, daughter, or ward whose name appears at the top of this form and who has signed the statement above has my permission to participate in the ______________________ Science Fair in accordance with its rules and regulations.

____

(date)

____

Signature of Parent or Guardian

12 ■ RESOURCES

THESE RESOURCES PROVIDE teachers, parents, and students with additional information on the preparation of projects as well as sources that can provide invaluable data for a selected topic or area of investigation.

■ Books for Students

Gutnik, Martin J. (1980). *How to Do a Science Project and Report.* New York: Franklin Watts.

Sawyer, Roger W., and Farmer, Robert A. (1967). *New Ideas for Science Fair Projects.* New York: Arco.

Stoltzfus, John C., and Young, Morris N. (1972). *The Complete Guide to Science Fair Competition.* New York: Hawthorn Books.

VanDeman, Barry A., and McDonald, Ed C. (1984). *A Matter of Fact Guide to Science Fair Projects.* Harwood Heights: The Science Man Press.

■ Books for Teachers and Parents

Abruscato, Joe, and Hassard, Jack. (1977). *The Whole Cosmos Catalog of Science Activities.* Glenview, Il: Scott, Foresman and Co.

Fredericks, Anthony. (1988). *Think About It! Science Problems of the Day.* Sunnyvale, CA: Creative Publications.

Fredericks, Anthony, Cressman, Brad, and Hassler, Robert. (1987). *The Science Discovery Book.* Glenview, Il: Scott, Foresman and Co.

Iritz, Maxine, and Iritz, Frank. (1987). *Science Fair: Developing a Successful and Fun Project.* Blue Ridge Summit, PA: Tab Books.

Munson, Howard. (1962). *Science Activities with Simple Things.* Belmont, CA: David S. Lake Publishers.

Reid, Robert. (1962). *Science Experiments for the Primary Grades.* Belmont, CA: Fearon Teacher Aids.

Ticotsky, Alan. (1987). *Who Says You Can't Teach Science?* Glenview, Il: Scott, Foresman and Co.

■ Periodicals for Students

Cricket
Open Court Publshing Co.
315 5th St.
Peru, IL 61354

Current Health
General Learning Corporation
60 Revere Dr.
Northbrook, IL 60062

The Dolphin Log
The Cousteau Society
8440 Santa Monica Blvd.
Los Angeles, CA 90069

Faces: The Magazine About People
Cobblestone Publishing, Inc.
20 Grove St.
Peterborough, NH 03458

Highlights for Children
803 Church St.
Honesdale, PA 18431

National Geographic World
National Geographic Society
17th and M St. NW
Washington, DC 20036

Odyssey
Kalmbach Publishing Co.
1027 N. 7th St.
Milwaukee, WI 53233

Owl Magazine
The Young Naturalist Foundation
56 The Esplanade, Suite 306
Toronto, Ontario, Canada M5E 1A7

Ranger Rick
National Wildlife Federation
1412 16th St. NW
Washington, DC 20036

3-2-1 Contact
Children's Television Workshop
One Lincoln Plaza
New York, NY 10023

■ Periodicals for Teachers and Parents

Audubon
National Audubon Society
P.O. Box 51000
Boulder, CO 80321

Bird Watcher's Digest
Pardson Corp.
Box 110
Marietta, OH 45750

Discover
P.O. Box 359087
Palm Beach, FL 32035

Earth Science
4220 King St.
Alexandria, VA 22302

Environment
4000 Albemarle St. NW
Washington, DC 20016

Environmental Action
1525 New Hampshire Ave. NW
Washington, DC 20036

Geology
Geological Society of America
P.O. Box 9140
Boulder, CO 80301

International Wildlife
National Wildlife Federation
1412 16th St. NW
Washington, DC 20036

National Wildlife
National Wildlife Federation
8925 Leesburg Pike
Vienna, VA 22184

Natural History
Natural History Magazine
79th and Central Park W.
New York, NY 10024

Oceans
Ocean Magazine Associates, Inc.
2001 W. Main St.
Stamford, CT 06902

Outdoor America
Suite 1100, 1701 N. Ft. Myer Dr.
Arlington, VA 22209

School Science and Mathematics
School Science and Mathematics Association
126 Life Science Bldg.
Bowling Green State University
Bowling Green, OH 43403

Science
American Association for the Advancement of Science
1333 H St. NW
Washington, DC 20005

Science and Children
National Science Teachers Association
1742 Connecticut Ave. NW
Washington, DC 20009

Science Books and Films
American Association for the Advancement of Science
1333 H St. NW
Washington, DC 20005

Science Digest
P.O. Box 359107
Palm Beach, FL 32035

Science News
231 W. Center St.
Marion, OH 43305

The Science Teacher
National Science Teachers Association
1742 Connecticut Ave. NW
Washington, DC 20009

Sierra
730 Polk St.
San Francisco, CA 94109

Sky and Telescope
49 Bay State Rd.
Cambridge, MA 02238

Government Agencies

Bureau of Mines
U.S. Department of the Interior
2401 E St. NW
Washington, DC 20241

Department of Agriculture
14th St. SW
Washington, DC 20250

Department of Commerce
14th St. SW
Washington, DC 20230

Department of Defense
The Pentagon
Washington, DC 20301

Department of Education
400 Maryland Ave. SW
Washington, DC 20202

Department of Energy
1000 Independence Ave. SW
Washington, DC 20585

Department of Health and Human Services
200 Independence Ave. SW
Washington, DC 20201

Department of the Interior
2401 E St. NW
Washington, DC 20241

Department of State
2201 C St. NW
Washington, DC 20520

Department of the Treasury
1500 Pennsylvania Ave. NW
Washington, DC 20220

Fish and Wildlife Service
U.S. Department of the Interior
2401 E St. NW
Washington, DC 20241

National Aeronautic and Space Administration
600 Independence Ave. SW
Washington, DC 20546

National Oceanographic and Atmospheric Administration
U.S. Department of Commerce
14th St. NW
Washington, DC 20230

Public Health Service
U.S. Department of Health and Human Services
200 Independence Ave. SW
Washington, DC 20201

An organization that specializes in providing schools and teachers with classroom kits, activity books, and other materials useful in helping students develop effective science fair projects is "The Science Eye." Write or call them to obtain a catalog and a list of some of their services.

The Science Eye
P.O. Box 16418
Plantation, FL 33318
(305) 587-7977

The Science Eye
P.O. Box 11440
Pittsburgh, PA 15238
(412) 781-0970

Showboard, Inc., is a company that manufactures a standardized project display board ideal for use in science fairs. It is lightweight, easily portable, and available in two sizes: 3' x 4' and 4' x 4'. Showboard is sold at many office and school supply stores or can be ordered directly from the company.

Showboard, Inc.
3725 West Grace St., Suite 305
Tampa, FL 33607
(800) 323-9189 (outside Florida)
(800) 331-1252 (Florida, except Tampa)
874-1828 (Tampa)

Science Service conducts the annual editions of the International Science and Engineering Fair (ISEF) held throughout the country at various school, district, regional, and national levels. Students, parents, and teachers interested in obtaining a listing of ISEF rules for high-level science fair competition can do so by sending 50 cents to:

Science Service
1718 N Street NW
Washington, DC 20036

Individuals interested in obtaining up-to-date information on materials and supplies appropriate for science fairs may wish to write to science supply companies and request a catalog. Here is a list of some companies.

Fisher Scientific Company
4901 West Lemoyne
Chicago, IL 60651

Sargent-Welch Scientific Co.
7300 N. Linder Ave.
Skokie, IL 60076

Edmund Scientific Co.
Edscorp Building
Barrington, NJ 08007

Carolina Biological Supply Co.
2700 York Road
Burlington, NC 27215

Science Kit, Inc.
777 E. Park Dr.
Tonawanda, NY 14150

Delta Education, Inc.
P.O. Box M
Nashua, NH 03061

Denoyer-Geppert Co.
5235 Ravenwood Ave.
Chicago, IL 60640

NASCO Company
901 Janesville Ave.
Fort Atkinson, WI 53538

"I read the book from the perspective of a teacher *and* a parent. With each page I wished it had been available years ago! I have sought many sources for help with science fair projects and none, in any way, covered the subject from beginning to end in such a detailed, comprehensive, and 'workable' fashion. It's outstanding!"
—Anita Meinbach, Ed.D., Educational Specialist, Dade County Schools, Miami, Florida

"Parents should find this book very useful. The organization, timetables, and topic lists are all especially strong points and all address issues that parents and students struggle with on at-home projects. As a parent and a teacher, I'd buy the book."
—Alan Ticotsky, Elementary Teacher and Science Curriculum Committee Member, Carlisle, Massachusetts

Anthony Fredericks, Assistant Professor of Education at York College in Pennsylvania, is a recipient of the Innovative Teaching Award from the Pennsylvania State Education Association and is the "Parent Talk" columnist for *Teaching K-8* magazine. This is Dr. Fredericks' eighth Good Year Book. *The Science Discovery Book*, which Fredericks coauthored, was listed in *Science Books and Films* (a publication of the American Association for the Advancement of Science) as one of the best children's science books of 1987.

Isaac Asimov, prolific writer of science fact, fiction, and fantasy, is one of the most renowned authors in the world. Winner of five Hugo Awards from the World Science Fiction Society, he has published 412 books and thousands of shorter pieces. His best known works include *I, Robot* and the *Foundation* series. Asimov's first Good Year Book was *Fantastic Reading*, published in 1984.

ISBN 0-673-38800-X
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