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An administrators guide for the implementation of kindergarten through twelfth grade science fairs

Sue Fithian

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California State University
San Bernardino

An Administrators Guide
for the Implementation of
Kindergarten through Twelfth Grade
Science Fairs

A Project Submitted to
The Faculty of the School of Education
In Partial Fulfillment of the Requirements of the Degree of
Master of Arts
in
Education: Administration Option

By
Sue Fithian
Moreno Valley, California
1989
Project Summary

An Administrators Guide for the Implementation of Kindergarten through Twelfth Grade Science Fairs

Sue Fithian
Masters Project
Spring 1989
Statement of the Problem

The purpose of this project was to provide a complete and comprehensive guide for implementing a Science Fair for grades Kindergarten through twelfth at the district level and at the school site level. This guide/manual includes, complete packets for district level and site level administrators and Science Fair Committee members, planning guide - flow charts, and evaluation forms for staff development-inservice and student projects. A student-parent packet for each level was also included to familiarize students and parents with procedures of the fair, as well as the processes for the development and construction of a Science Fair project.

The goal of this project was to assist administrators, teachers, students, and parents with the planning, organizing, and development of a Science Fair program and project. The materials and information that were developed and accumulated for this guide were designed so that all persons participating in a Science Fair could do so successfully.

The writer of this project felt that the development of Science Fairs at the district and site level would help offer a unique opportunity for all students to undertake scientific exploration. The goal of science education in California is to motivate students to investigate and explain scientific phenomena through the use of the scientific method. Science Fairs can help to meet this goal as students develop their projects for the school site or district level fair.
Procedure

The contents of this project are divided into eleven sections. A review of the relevant literature and research in the area of science instruction is in the first section. The current research indicated that a student's cognitive and affective development in science is affected by the method of instruction. The research also clearly demonstrated that an activity-based science program which included the use of Science Fairs, resulted in increased motivation and a higher retention of knowledge.

This Science Fair guide/manual was developed to facilitate the organization of a Science Fair for grades Kindergarten through twelve. This guide provides a comprehensive list of planning procedures, guidelines for students' projects, inservices for teachers, and an evaluation of the process.

A flow chart of activities to be considered by the administrator and the Science Fair Committee was intended to help the development and operations of a district and site level fair.

Conclusion

Development and implementation of a Science Fair enables students to find answers for themselves. Students become involved in learning how to learn. In developing a science project, a student is faced with a problem. In solving that problem the student actively participates in gaining information and knowledge. His retention is increased. The rewards are inherent in discovering something on one's own. Science Fair projects help students
develop skills and attitudes which are essential for individual thought and learning.

The Science Fair provides us with the tools that can be used to improve current methods of science instruction. By making Science Fairs more relevant and useful to our students, we may increase their motivation to involve themselves in it. As students seek answers to scientific phenomena, they seek answers to life. They come to realize their potential in overcoming problems which confront them in their everyday living.

Included are the components of the Quality Science Indicators and the goals of the Science Framework set forth by the California State Department of Education. The writer of this project also felt that through the use of Science Fairs many of the quality indicators and science goals could easily be met.

We are, as educators, shaping the future of our society. All students should be provided with as many opportunities to explore the scientific as possible. Science Fairs provide one such opportunity.

Acknowledgments

The guide is based on the writer's own experiences with Science Fairs and on a collaboration of packets from many sources. These sources are listed in the "Notes of Thanks" at the conclusion of the guide.
The K-12 Science Fair Guide for Administrators, Science Committees and Teachers
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I.

Science Fairs

A.

An Introduction for Administrators and Teachers

B.

Striving for the Best
A.

An Introduction for Administrators and Teachers
Science Fairs help to fulfill the need to implement a meaningful science curriculum that covers more than a large body of knowledge. An increase in the awareness of a science curriculum that teaches more than basic science data began during the late 1950's. This increased awareness in science was known as the Sputnik era.

There are many benefits from planning a science fair. These include increased interest in science, heightened community awareness, and an exchange of scientific thoughts and ideas. A science fair presents a unique opportunity to highlight student achievements in science.

As individuals we ask questions. When we find answers to those questions we gain knowledge. The science project stimulates inquiry, which is a process that leads us to discover knowledge independently. Inquiry leads us to evaluate and synthesize our thoughts in a cognitive and affective manner.

For the individual child, science fair projects provide additional motivation and an opportunity to apply acquired knowledge. Science fair projects encourage children to undertake scientific explorations, apply their own creativity, and helps to employ critical thinking skills. The science fair promotes individual research and furnishes an occasion to communicate ideas effectively. It provides for public recognition of student effort and quality work.

The science fair stimulates students to investigate and explain scientific concepts. Students apply many of the skills and techniques used by scientists to organize knowledge and generate scientific principles. Students learn how
to use the scientific method, which will lead them to question, speculate, explain, and predict scientific phenomena. Students learn to:

1. Put their questions into words
2. Formulate a clear-cut hypothesis
3. Put the hypothesis through various tests
4. Interpret the results

For the school and district, a science fair helps to strengthen the school's science program. As a culminating event, it furnishes an opportunity to reinforce and expand classroom science experiences and to focus student learning. It provides the potential for home and community involvement and establishes a means for exchanging scientific ideas between students, teachers, and parents. It also stimulates the cooperative effort of parents in recognizing, encouraging, and developing the scientific potential of students.

For the student, development of a science project should follow a process. There is a discipline which must be practiced by the students, and understood by the teachers. Students should question why certain events happen, while simultaneously acquiring and process of inquiry aims to make the student:

1. Independent in scientific thought
2. Systematic in the approach to a problem
3. Empirical in attitude toward natural phenomena
4. Inductive in the search for knowledge
Development and implementation of a science fair will enable students to find answers for themselves. Students become involved in learning how to learn. In developing a science project, the student is faced with a problem. In solving that problem the student actively participates in gaining information and knowledge. The student's retention is increased. The rewards are inherent in discovering something on his own. This provides the student with the intrinsic motivation to carry learning further. The student develops skills and attitudes which are essential for individual thought and learning.

The science fair provides educators with the tools that can be used to improve current methods of science instruction. By making science more relevant and useful to all students, we will increase their motivation to involve themselves in it. As students seek answers to scientific phenomena, they seek answers to life. They come to realize their potential in overcoming problems which confront them in their everyday living.

The district and school levels, implementation of a science fair should be an important base of the science curriculum. The science fair provides a unique opportunity to generate interest in science. The science fair has the ability to reform and to improve the science curriculum of a school. It can unify a staff's commitment to the teaching of science, and provide parents the opportunity to support and enrich the science instructional level for their own child.

Research conducted by Robert E. Yager and John E. Penick (1984), concluded that an elementary teacher's interest, attitude, and method of instruction plays a major role in motivating students to want to learn about science. The teacher who actively generate enthusiasm and employs an
activity-based science program, stimulated the students to want to learn about science. The science fair serves to pull all of the strings together as teacher, students and parents team up and get involved.

Teacher interest and enthusiasm play important roles in the development of a successful school science fair. Inservicing is a key element in involving a school's staff. Dorothy Gabel and Peter Rubba (1978), examined the correlation between an elementary teacher's attitude toward teaching science and inservicing. Teachers will display much more confidence and a willingness to teach a subject if their knowledge of that particular subject is enhanced.

Coordination of efforts between the science fair director and the staff is imperative. By inservicing the staff, and supplying resource and curriculum materials, the director/committee helps to insure success for all concerned. The long-term benefits are increased enthusiasm, and an enriched science program.

Often, when teachers present a lesson to children, there is a tendency to tell all, to flood their minds with all of the potential knowledge. Karran P. Raghbir (1979), states "teachers tell students too much; they deprive them of the opportunity to learn for themselves." Teachers have a reason for doing this: 1) to save time, and 2) it is easier. Raghbir argues that an activity-based science program will motivate and stimulate inquiry. He states that teachers should provide students with "the opportunity to develop the strategies and attitudes associated with those of the scientist." Raghbir demonstrated that an activity-based program will lead to greater student achievement. "Students have shown significantly higher gains for these cognitive factors: formulating hypotheses, making assumptions, designing and executing investigations,
understanding variables, observing carefully, recording data, analyzing and interpreting results, and synthesizing new knowledge; and for attitude development: curiosity, openness, responsibility, and satisfaction.  

Lloyd E. Story and Iva D. Brown (1979), studied the link between the elementary students attitude toward science and the method of instruction. The study showed a significant increase in attitude for students involved in an activity-based science program. The implications of the study are exciting when one considers the science fair. The projects that students select for a science fair will be activity based. The word "project" is synonymous with activity. Science fair projects require students to perform many activities as they develop their projects with the use of the scientific method.

Linda Hogh and Martha Piper (1982), studied the relationship of attitudes and the learning of scientific concepts of elementary students. Their study found that there is a correlation between student attitude, method of instruction, and learning. The study demonstrated that an activity-based science program results in students retaining more knowledge (as opposed to a lecture-based program). Inherent in the development of a science project is the motivation and interest generated by actively participating in the discovery of scientific principles. It also seems evident that students may potentially retain more knowledge as they develop and study about their science projects.

A search of the ERIC database DIALOG Information Retrieval Service resulted in the findings cited above. The historical development of Science Fairs over the past 30 years was inconclusive. Administrators and teachers who are interested and involved in Science Fairs have seen an increase in
student participation, but there isn't any actual documented research materials
to support this statement.

All of these studies align themselves with the general goal of the science
fair, students enjoy discovering things on their own. Students enjoy being able
to answer their own questions. Students who have a positive attitude toward
science are more likely to display higher achievement, view science as
relevant, and feel better about themselves. The teacher's job is crucial.
Teachers need to feel comfortable with their roles in the development of the
science fair. Clearly, success or failure of the science fair depends greatly on
the knowledge and attitudes of teachers. The best way to do that is provide
teacher inservice time and through an activity-based science program. It can
begin with a science fair. The training and knowledge that students, parents
and teachers receive about science processes will increase the motivation and
the interest in science and science fairs.

The science fair serves as the perfect vehicle to initiate and extend all of
these ideas. The approach to any science fair must be calculative and well
planned and must provide the necessary resources for all concerned, on
exactly why and how the fair will be organized. The guesswork is then
eliminated, which allows the organizers and participants to achieve their goal of
a successful science fair. This guide can assist the planners of a District
Science Fair or a site level science fair to achieve that goal.
B.

Striving for the Best

Meeting the State of California's Goals for Science Instruction through Science Fairs
The current California State Science Framework Addendum and the Quality Criteria for School Review expresses concern for the need of a model of expectation for learners' achievements in science. In 1978, the science framework set forth a coherent set of science education goals and objectives. The four major goals identified for science instruction were: 1) achieving scientific attitudes; 2) achieving rational and creative thinking processes; 3) achieving manipulative and communicative skills; and 4) achieving scientific knowledge. The current addendum expands these goals to add descriptions of the learning processes involved with science:

1. Observing - seeing, hearing, feeling, tasting and smelling
2. Communicating - silent, oral, written, and pictorial
3. Comparing - sensory comparisons, relative positive comparisons, linear comparisons, weight comparisons, capacity comparisons, answer quantity comparisons
4. Organizing - data gathering, sequencing, grouping, and classifying
5. Relating - using space-time relationships, formulating experimental hypotheses, controlling and manipulating variables, and experimenting
6. Inferring - synthesizing and analyzing, generalizing, recognizing and predicting patterns, starting laws
7. Applying - using knowledge to solve problems, and inventing

These goals and processes as outlined in the state framework are inherent in the efforts of a child to develop a science project. Depending on the developmental stages of the learners, students will use most, if not all of these processes as a result of their own investigations.

The science fair provides the opportunities for students to apply the skills of using these processes. The science fair provides the structure that can
enable the students to attain concepts of science in a manner fitting their individual needs.

The science fair also enables students to develop fundamental skills and to acquire the knowledge necessary to explore the world of science that surrounds them. Students are motivated to look for explanations of objects and events, and to test their explanations through a demonstration or experiment. In addition, the skills that students learn, such as identifying problems, analyzing information, and drawing conclusions, will assist them in problem solving and critical thinking skills for use in other areas of their lives.

It is widely accepted that a science fair builds the self-esteem of students. Students can take pride in their accomplishments. It is a stimulating and motivation experience.

It can be a learning experience for teachers as well. It creates the opportunity for teachers to get involved in science, and extend this enthusiasm into the development of their school's science program.

A well organized science fair and the project, produced for it can motivate and enhance a child's curiosity. It can organize the knowledge they already have, and it can provide them with a way to broaden their knowledge and understanding of concepts they have yet to discover.

The following pages are provided to assist the site administrator and committee members with an understanding to the goals, objectives and expectation of science curriculum and instruction in the State of California.
<table>
<thead>
<tr>
<th>Values, Aspirations, and Attitudes</th>
<th>Knowledge</th>
</tr>
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<tbody>
<tr>
<td>* Develop a positive attitude toward science and learning*</td>
<td>* Acquired organized scientific knowledge to interpret the natural environment*</td>
</tr>
<tr>
<td>* Express curiosity about objects and events and be aware of order and beauty in the natural environment*</td>
<td>* Understand basic generalizations, relationships, and principles applicable to all the disciplines of science*</td>
</tr>
<tr>
<td>* Appreciate and respect all living organisms (including self) and their place in the environment*</td>
<td>* Understand content in the major disciplines of science*</td>
</tr>
<tr>
<td>* Appreciate science as an endeavor of humans from all ethnic and cultural backgrounds*</td>
<td>* Understand the ways in which science and technology affect the environment, society, and human interaction*</td>
</tr>
<tr>
<td>* Value and be aware of the preparation that is necessary for careers in science*</td>
<td>* Apply scientific attitudes, thought processes, skills, and knowledge to personal decision making*</td>
</tr>
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</table>

<table>
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<tr>
<th>Rational and Creative Thinking Process</th>
<th>Skills Development</th>
</tr>
</thead>
<tbody>
<tr>
<td>* Develop and apply rational and creative thinking processes*</td>
<td>* Develop skills in the manipulation of materials and equipment; taking care of and handling living organisms; gathering, organizing, and communicating scientific information*</td>
</tr>
<tr>
<td>* Develop the ability to generate and organize data*</td>
<td>* Assemble and use laboratory apparatus, tools, materials, and technology for scientific purposes*</td>
</tr>
<tr>
<td>* Develop the ability to apply and evaluate data and generate theories*</td>
<td>* Handle and take care of living organisms*</td>
</tr>
<tr>
<td>* Use data-generating and theory-building processes in problem solving*</td>
<td>* Use a variety of methods for generating descriptive and quantitative data*</td>
</tr>
<tr>
<td>* Demonstrate scientific information through the use of models, diagrams, and displays*</td>
<td>* Organize and communicate scientific data, procedures, and conclusions*</td>
</tr>
<tr>
<td></td>
<td>* Use mathematical concepts in interpreting data and solving problems*</td>
</tr>
</tbody>
</table>
School Program Quality Criteria in Science

This criterion focuses on the effect of the science program on the students. It deals with the completeness of the science program, identification of the skills and concepts to be learned, the range and depth of the content, and the instructional methodologies that enable students to acquire the necessary skills and knowledge in science. When applying this criterion, consider all students participating in all programs offered by the school.

Students discover and learn about the natural world by using the methods of science as extensions of their own curiosity and wonder. Students acquire biological and physical science knowledge from a balanced science curriculum which offers the fundamental concepts, terms, processes, and skills. Building on their understanding of science concepts, student learn about the logic of the scientific method, the techniques of the science laboratory, and the applications of science to the world around us. Students also develop the science process skills which are the "critical thinking skill" of science: observing, comparing, organizing, inferring, relating, and applying.

Instructional methods and the sequential introduction of new experiences in the primary grades lay the foundation for more conceptual content in the intermediate grades. Instructional methods emphasize using scientific techniques as learning techniques; lessons regularly require students to observe and interpret phenomena in natural and laboratory settings. Concepts and theories from readings are applied to observed phenomena. Basic science texts are supplemented by materials which include laboratory specimens, scientific equipment, and an array of simulations that employ technology. Community resources such as local scientists and engineers, parks and nature trails, and science and natural museums expand the science program.

Basic skills are applied and extended throughout the science program. Student learn how to read scientific writing, how to create and develop graphs and charts, how to solve complex problem involving different kinds of data, how to apply mathematics skills in analyzing data, how to record observations in an organized fashion, how to write laboratory and research reports, and how to explain scientific material orally.

- Students experience science as a regular part of their curriculum.
  - Science instruction is provided on a regular basis. (Students devote at least one-half hour per day, on the average, to learning science.)
  - Science goals and curriculum standards are reinforced throughout the school program (both academic and extracurricular).
  - Students' progress in science is monitored and feedback is given to students and parents.
• Instructional content focuses on conceptual understanding of the facts, principles, and theories of science as the foundation upon which the processes, techniques, and applications of science are based. Teachers cultivate students' concept formation beyond rote facts and vocabulary.

• Students receive instruction in a comprehensive balanced science curriculum which includes:
  - The life, earth, and physical sciences
  - The interdependence of people and the natural environment
  - The historical development of science by persons and cultures of different backgrounds
  - The relationship between science, technology, and society
  - Participatory (hands-on) laboratory techniques
  - Facts about careers in science and technology

• Students observe and conduct experiments to learn scientific processes, including:
  - Observing - Inferring
  - Comparing - Relating
  - Organizing - Applying

• In addition to hands-on experiences, students learn science content from field observations, teacher demonstrations, group experiments, individual science fair projects, and a variety of print and electronic media as a part of their regular instruction.

• Assignments include such activities as:
  - Observing and recording natural phenomena inside and outside the school
  - Science projects involving teacher guidance and parent involvement
SCIENCE PROCESS CONTENT AND DEVELOPMENTAL STAGES

**CONTENT**
- OBSERVING
  - SEEING
  - HEARING
  - FEELING
  - TASTING
  - SMELLING
- COMMUNICATING
  - SILENT
  - VERBAL
  - WRITTEN
  - PICTORIAL
- COMPARING
  - SENSORY COMPARISONS
  - RELATIVE POSITION COMPARISONS
  - LINEAR COMPARISONS
  - WEIGHT COMPARISONS
  - CAPACITY COMPARISONS
  - QUANTITY COMPARISONS
- ORGANIZING
  - DATA GATHERING
  - SERIATING, SEQUENCING, ORDERING
  - GROUPING
  - CLASSIFYING
- RELATING
  - MEASURING SPACE-TIME RELATIONSHIPS
  - FORMULATING EXPERIMENTAL HYPOTHESES
  - CONTROLLING AND MANIPULATING VARIABLES
  - EXPERIMENTING
- INFERRING
  - SYNTHESIZING, ANALYZING
  - GENERALIZING
  - RECOGNIZING AND PREDICTING PATTERNS
  - STATING LAWS
  - FORMULATING EXPLANATORY MODELS AND THEORIZING
- APPLYING
  - USING KNOWLEDGE TO SOLVE PROBLEMS
  - INVENTING (TECHNOLOGY)

**PROCESS**
- OBSERVING
- COMMUNICATING
- COMPARING
- ORGANIZING
- RELATING
- INFERRING
- APPLYING

**STAGES**
- SENSORY MOTOR
- PRECONCEPTUAL
- INTUITIVE
- CONCRETE
- OPERATIONAL
- FORMAL
- OPERATIONAL
### Descriptions of Processes Shown on the Chart

**Observing**

The main route to knowledge is through observing, using all the senses. This process is a distinct one by which people come to know about the characteristics of objects and their interactions.

**Communicating**

Objects are named and events are described by people so that they can tell others about them. Communicating is a fundamental human process that enables one to learn more about a greater range of information than could be learned without this process.

**Comparing**

Comparing is a distinct process by which people systematically examine objects and events in terms of similarities and differences. By comparing the known to something unknown, one gains knowledge about the unknown. All measurements are forms of comparing.

**Organizing**

Knowledge of principles and laws is gained only through the systematic compiling, classifying, and ordering of observed and compared data. Bodies of knowledge grow from long-term organizing processes.

**Relating**

Relating is a process by which concrete and abstract ideas are woven together to test and explain phenomena. Hypothetical-deductive reasoning, coordinate graphing, the managing of variables, and the comparison of effects of one variable on another contribute to the attainment of the major concepts of science.

**Inferring**

The process of realizing ideas that are not directly observable is the process of inferring. The process leads to predictive explanations for simple and complex phenomena.

**Applying**

Use of knowledge is the applying of knowledge. Inventing, creating, problem-solving, and determining probabilities are ways of using information that lead to gaining further information.
II. Preparing for Staff Development

- Conveying that Science Fair Projects meet a wide range of goals.
- Self-Assessment Checklist for Teachers.
- Additional activities that will develop and/or improve a teacher's competencies in Science.
- Data Analysis sheet to help in budgeting for Staff Development.
- A Workshop Evaluation form.
Science Fair Projects help to meet the different needs and interests of individual students and cover many of the attitudes, values, process and content requirements set forth by the California State Department of Education.

Through the use of Science Fairs and the projects developed for the fair, teachers are helping each student to:

1. Develop and extend their personal interests and experiences through science.
2. Promote critical questioning of unsupported inferences, hypotheses, and theories. Promote an awareness of energy/ecological relationships in the environment and of their social and economic implications.
3. Engage in the major activities that are employed in scientific inquiry: observing, experimenting, verifying, predicting, organizing, inferring, analyzing, synthesizing, and generalizing.
4. Develop fundamental skills in manipulating materials and equipment; in caring for and handling living things; and in gathering, organizing, and communicating scientific information.
5. Develop concepts and ideas that are appropriate to their levels of development, their reading abilities, and their varying needs.
6. Integrate the knowledge and skills learned in other disciplines (e.g., mathematics, language arts, health, and social sciences) with those abilities that lead to the achievement of scientific goals.

Teachers who are made aware of the science goals and objectives that can be met through the use of Science Fair Projects are much more likely to buy into the development of a site level fair.

Teachers themselves must acquire particular competencies if they are to develop them in their students. Teachers first must acquire scientific attitudes, thinking processes, skills, and knowledge. These and others competencies can be achieved only if teachers are given opportunities for self-evaluation and self-improvement.
The use of the following Self-Assessment Checklist, developed by the National Science Teacher Association, will help your staff to become more in tune with their wants, needs, and feelings about science in general.

Additional activities that will help your staff develop and improve their competencies may include participating in the following activities:

- Special events scheduled for teachers to hear outstanding speakers, to observe demonstrations, to become acquainted with new materials and equipment, and to discuss special problems or needs. One should realize, however, that isolated events have little long-term effect without some follow-up.
- Inservice programs of specified duration with qualified leaders to accomplish certain specific objectives. Such programs are effective only if the activities require real involvement of the participants and if a close relationship exists among the activities undertaken to meet the stated objectives.
- On-the-job experience in the classroom where the teacher tests and evaluates the new materials and techniques. Many of the instructional materials and techniques have first been observed by the teacher at workshops and conferences.
- Formal courses conducted by colleges and universities for updating and enriching the competencies of science teachers. These courses can help prepare the teacher to lead the students into special areas.
- Advanced research at the college or university level; in industrial laboratories; or in public, private, and governmental agencies. This can involve field work in various scientific disciplines. It also can provide excellent opportunities for developing the skills, attitudes, and approaches needed in science instruction.
Self-Assessment Checklist
for Teacher of Science
at the K-12 level

Scientific Attitudes, Thinking Processes,
Skills, and Knowledge.

1. My students see in me an attitude of open-mindedness and suspended judgment.

2. I enjoy designing and conducting experimental studies to test hypotheses or account for discrepant events.

3. I willingly subject personally acquired data and ideas to peer criticism.

4. I am proficient in manipulating and utilizing the tools and equipment of science.

5. I am able to apply mathematics to gathering, processing, and communicating data in my teaching (measurement in metric units).

6. I can use oral and written communication skills effectively.

7. I am familiar with the basic recognition and recall content of my field an/or level of science.

8. I understand the factors affecting the physical, emotional, and intellectual growth and development of my students.

9. I can identify and construct conditions that motivate inquiry in the learner.

10. I use effective methods and materials to guide students in their consideration of science-related careers.

11. I seek to know, understand, and support the needs, aspirations, and positive attitudes of the community toward education.
12. I interact and cooperated with other teachers in providing a health, balanced total school atmosphere.

13. I am aware of community resources that will enhance my science instructional program.

14. I can describe the interrelationship among various fields of scientific endeavor.

15. I know of scientists in my community and can relate them to my instructional program.

16. I work with other teachers to interrelate the teaching of science with that of other subjects.

17. I can interpret the relationships between science and other aspects of human endeavor.

18. I have developed and follow a philosophy of education which deals with the place of science teaching in the school's total education effort.

19. I am aware of energy/ecological relationships in the environment and of their social and economic implications.

20. I have studied the social/economic/environmental impacts of science and the social and moral responsibilities of scientists.

Instructional Methods and Techniques

1. I use specific course and curriculum development techniques (construction of lesson plans, development of minicourses, modules of learning activity packages, writing performance objectives, and the like).
2. I know where to obtain and how to use data (about each learner's conceptual level, cognitive style, interests, and abilities) to provide unique individual experiences.

3. I can effectively utilize current technological devices and materials in my teaching (e.g., motion pictures, overhead projectors, audio and videotape recorders, and computer time-share).

4. I can select, construct, use, and interpret various kinds of evaluation instruments for determining student progress.

5. I use a variety of teaching styles (i.e., student inquiry, lecture, demonstration, individual project work, convergent and divergent questioning, seminars, and simulations).

6. I make provisions for the safety of students while they are participating in classroom/laboratory activities and can handle emergencies that arise.

7. I implement a variety of forms of classroom organization: individual, small and large group, open classroom, laboratory, and team teaching.

8. I can provide a rich environment (of data sources, materials for experimentation, phenomena to observe, and ideas) for use by my students in achieving class objectives.

9. I am familiar with the legal requirements relative to the care and use of animals in the classroom in my instructional program.

Professional Education and Development

1. My background equipped me with the understanding of the life, physical, and earth-space sciences needed for teaching in my current assignment.

2. I have a working knowledge of recent national curriculum projects: e.g., Science Curriculum Improvement Study (elementary) or
3. I participate in the activities of at least one (nation, state, or local) organization primarily related to science teaching; e.g., the National Science Teachers Association and the California Science Teachers Association.

4. I attend the conferences and conventions held by national, state, or local organizations related to my field of science interest (American Association of Physics Teachers, American Chemical Society, National Association of Biology Teachers, and National Science Teachers Association).

5. I have attended one or more special inservice programs for science teaching (e.g., summer institute, inservice institute, or inservice course) in the past two years.

6. I contribute to the development or evaluation of new programs and ideas in science teaching; e.g., I participate in or conduct a research study, develop innovative curriculum materials, or pilot-test newly developed materials.

7. I participate in the science teacher preparation programs of nearby colleges and universities by working with student teachers and/or teaching extension courses.

8. I use professional days or released time to visit other schools and observe innovative science programs and/or outstanding teachers in action.

9. I use my training and experience to identify students with special needs or problems and refer them to persons or agencies qualified to provide help.

10. I am familiar with the special science-related opportunities (clubs, competitions, fairs, symposia, or congresses) available to my students and encourage and advise them in their participation.
This form may be used to analyze the needs of your staff, and provide a base for funds needed to implement staff development.

## Data Analysis Sheet for Professional Inservice and Growth in Science

<table>
<thead>
<tr>
<th>Personnel</th>
<th>Professional growth resources</th>
<th>Available materials and services</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Through school-directed activities</td>
<td>Through other directed activities</td>
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<tr>
<td>Category</td>
<td>Science In-service</td>
<td>Science Content</td>
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<tr>
<td>Science specialist</td>
<td>Number</td>
<td></td>
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<tr>
<td>Multisubject teacher</td>
<td></td>
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<tr>
<td>Teacher aides</td>
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<tr>
<td>Other school personnel (e.g., lab assistants)</td>
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<tr>
<td>Nonschool personnel (e.g., volunteers)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
# Science Fair

*Workshop Evaluation Summary*

1. The objectives of the workshop were:  
   - stated & implemented: 5 4 3 2 1  
   - vague/not implemented: 2 1
   - logical/clever/creative:  
     - not my style: 2 1
     - right up my alley/useful:  
       - not useful now/maybe later: 2 1

2. The organization of the workshop was:  
   - right up my alley/useful: 5 4 3 2 1
   - not useful now/maybe later:  
     - too long: 2 1

3. The ideas and activities presented were:  
   - too short: 5 4 3 2 1
   - too long:  

4. The duration of the session was:  
   - 5 4 3 2 1

5. In what ways could the presenter have made the sessions more beneficial (if any):

6. This workshop was provided to assist in the improvement of science education. Please let us know how we may assist you to implement this workshop or otherwise provide assistance:

   Examples:  
   - _____ sample units  
   - _____ resource persons  
   - _____ staff inservice  
   - _____ more workshops  
   - _____ model programs  
   - _____ other:

Return this summary to ___________________________
III.

Getting Ready for and implementing a District Level Science Fair
District Level Science Fair

Success of the District Level Science Fair depends on careful planning and preparation. The following pages, developed in two forms, as a flow chart with check off sheets and in a numerical/paragraph style, will help the committee plan and initiate a successful district level science fair.

District Level Science Fair

- District Administrator
- Science Fair Committee
- Committee Tasks

- Calendar of Events
  - Page_____

- Budget Development
  - Page_____

- School Site Assistance
  - Page_____  

- Fair Day Before/After
  - Page_____
District Level Administrator
Duties and Responsibilities

Selection of Science Fair Committee Members that Represents K-12 teachers

To coordinate, oversee, and schedule all activities for Committee Members.

To provide support and release time and/or pay to Committee Members for services rendered.

To seek Board of Education approval and budget support

To delegate Committee Tasks
CALENDAR OF EVENTS

____ Select Committee members one from each grade level
____ Schedule committee meetings for the year.
____ Contact County for County/State/National Fair dates.
____ Select Science Fair location.
____ Select Dates for District Level Fair.
____ Determine number of entries per site.
____ Contact School Sites and schedule time to provide teacher inservice.
____ Prepare Fair Packets for teacher inservice.
____ Provide all school sites with Fair Dates, the number of entries that will be excepted, a school copy of the Science Fair Packets and a contact person at the district level.
____ Secure site level Fair dates from each school
____ Send monthly update/reminder flyers to school sites about the Fair.
____ Contact news media for coverage of District Fair and School Site Fairs.
____ Coordinate efforts of committee members for each task. Review at monthly meeting.

____ Budget
____ Site Assistance
____ Fair Days Preparation

____ Before
____ During
____ After

____ Additional Activities

____________________________________________________________________________________
____________________________________________________________________________________
____________________________________________________________________________________
____________________________________________________________________________________
____________________________________________________________________________________
BUDGET DEVELOPMENT

Estimate cost to support winners at a County, State, and National level
Include: teacher release time, number of possible entries, transportation, meals, lodging, and entry fee if necessary.

Calculated sub. teacher pay for committee members release time to conduct Fair business.

Provide extra duty pay if possible to all committee members

Calculate Award cost

____ trophies 1st - 2nd - 3rd place at each grade level

____ ribbons to 4th - 5th - 6th

____ Honorable Mention ribbons for the remainder of participants

Estimate xerox cost for Science Fair packets at each School site

Include an Administrative allowance to cover any small cost that may be included.

Estimate site fee if applicable, include set-up and clean up time.

Seek School Board approval for budgeted items.

Prepare necessary paper work for all purchase orders.

Additional Activities
### Awards/Judging

#### Sample Set-Up

**AWARDS**

- **Trophies** - will be awarded to 1st, 2nd, and 3rd place winners at each grade level, k-12

- **Ribbons** - will be given to 4th, 5th, and 6th places

  - all others will receive Honorable Mentions. (Rationale: all were winners at their school sites).

**JUDGING**

- **Certificates** - for all entries

<table>
<thead>
<tr>
<th>Grade</th>
<th>Entries Allowed</th>
<th>Number of School Sites</th>
<th>Judges</th>
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<tbody>
<tr>
<td>K</td>
<td>1st and 2nd place</td>
<td>x 13 schools</td>
<td>= 26</td>
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<tr>
<td>1</td>
<td>1st and 2nd place</td>
<td>x 13 schools</td>
<td>= 26</td>
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<td>2,3,4,5</td>
<td>1st and 2nd place</td>
<td>x 13 schools</td>
<td>=104</td>
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<td>6</td>
<td>1st through 6th place</td>
<td>x 7 schools</td>
<td>= 42</td>
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<td>7</td>
<td>1st through 6th place</td>
<td>x 3 schools</td>
<td>= 18</td>
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<td>8</td>
<td>1st through 6th place</td>
<td>x 3 schools</td>
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<td>9</td>
<td>1st through 5th place</td>
<td>x 2 schools</td>
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<td>10</td>
<td>1st through 5th place</td>
<td>x 2 schools</td>
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<tr>
<td>11</td>
<td>1st through 5th place</td>
<td>x 1 school</td>
<td>= 5</td>
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<tr>
<td>12</td>
<td>1st through 5th place</td>
<td>x 1 school</td>
<td>= 5</td>
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</tbody>
</table>

It is recommended that there be one judge from within the district and one from outside the district to judge each grade level.
# Awards Worksheet

<table>
<thead>
<tr>
<th>Place</th>
<th>Type of Award</th>
<th>Grade Level(s)</th>
<th>Estimated Cost per Award</th>
<th>Awards needed for each grade level</th>
<th>Total Cost</th>
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<tbody>
<tr>
<td>1st</td>
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<td>6th</td>
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<tr>
<td>Honorable Mention</td>
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</table>

**Total Awards Cost**

$__________

*See Awards/Judging Sample for more information.*
SITE LEVEL INSERVICE

Schedule inservice days at each school site or at a central location for teachers.

Send out an information flyer on the District Science Fair and the upcoming inservice.

Conduct inservice for teachers, include parents if possible, or schedule a separate day for them.

Evaluate the success of the inservice.

Supply each site with the teacher and home packet, suggest that they make copies to check out to students who are interested in completing a project.

Assist each site in developing a calendar. Share the District level check off sheet for things to be done.

Ask all committee members to assist the school sites with their Fairs.

Communicate to each site the number of entries that will be allowed at the District Fair.

Stay in contact with school sites.
FAIR DAYS

Judging

___ Have committee members suggest names of judges

___ Send letters to suggested list of judges that was developed by the committee members

___ Send letter of thank to persons who have committed to be judges, with fair dates and judging time and criteria included in the letter.

___ Inservice judges on judging criteria. The night of the judging.

___ Have refreshments for judges.

___ Judge entries, score and determine winners.

___ Develop list of winners for awards program insert.

___ Notify school sites of their winning entries and a reminder of the award ceremony. Ask schools to notify parents of the winning entries.

___ Send letter of thanks to judges

___ Send list of winning entries to county fair committee

___ * See Awards/Judging Sample for more information.

Project Set Up

___ Fill up place cards with entries number on each project by grade level.

___ Make signs for each grade level.

___ Prepare judging packets for each entry and a score sheet for each grade level.

___ Prepare program, with list of all projects for the Awards night, insert winners list after judging.

___ Place project cards on display tables - have persons setting up the display, go to where their place card is.
Sample Letter to Judges

Dear

[Name of School] School is conducting a Science Fair for its students. The purpose of this Science Fair is to encourage students to continue their studies in the areas of Math and Science; to reward student efforts; and to identify outstanding projects which will be submitted for competition on the District level.

The Science Fair is scheduled for [Date] at [Time]. Students will set up their projects on [Date] from 8:00 a.m. to 4:00 p.m. Judging will take place from 4:00 p.m. to 8:00 p.m. on [Date] with no one else present. Refreshments will be provided to Judges. Awards presentation will be held [Date].

Your name was suggested as a person who might be interested in assisting us by serving as one of our grade level Judges. There will be [Number] judges from outside the school and [Number] judges from the school who will determine 1st, 2nd, and 3rd place winners at each grade level. You would be joined by one of our experienced teachers in judging student projects at one grade level only. I'm enclosing a copy of the Selection Criteria which will be applied to each project in its judging.

I realize that you are very busy person but I hope you will find time in your busy schedule to help our student learn and grow. Please call use at [Phone Number] to confirm your participation. Thank you very much for your dedication and commitment to our youth.

Sincerely,
Project Number: _______________
Category: _______________

1. CREATIVENESS (25 points total)
   1. The problem is original or is a unique approach to an old problem (considering the student’s grade level) 1 2 3 4 5
   2. Equipment and materials are used ingeniously 1 2 3 4 5
   3. Interpretation of data is appropriate for student’s grade level 1 2 3 4 5
   4. Application of project information shows student’s creative involvement 1 2 3 4 5
   5. Student shows evidence of understanding that unanswered questions remain 1 2 3 4 5

   CREATIVENESS TOTAL ____________

Judges: Use 11a or 11b – not both

11a. SCIENTIFIC THOUGHT/ENGINEERING GOALS (30 points total)
   1. The hypothesis is clearly stated and the project is clearly designed 1 2 3 4 5
   2. The project shows depth of study and effort 1 2 3 4 5
   3. Project exhibits orderly recording and analysis of data 1 2 3 4 5
   4. Sampling techniques and data collection are appropriate for the problem 1 2 3 4 5
   5. Scientific procedures are appropriate and organized 1 2 3 4 5
   6. Conclusions formulated are logical, based on the data collected, and are relevant to the hypothesis 1 2 3 4 5

   SCIENTIFIC THOUGHT TOTAL ____________
11b. ENGINEERING AND INVENTION GOALS (30 points total)

1. Does the project reflect knowledge of existing solutions to the problem? 1 2 3 4 5
2. Does the project solve the problem better than existing solutions? 1 2 3 4 5
3. Does the solution meet an established need or create a new need? 1 2 3 4 5
4. Does the solution work? 1 2 3 4 5
5. Does the solution reflect an awareness of environmental safety? 1 2 3 4 5
6. Is the solution economical and appropriate to the problem? 1 2 3 4 5

ENGINEERING AND INVENTION GOALS TOTAL

111. THOROUGHNESS (15 points total)

1. The study is complete within the scope of the problem. 1 2 3 4 5
2. Scientific literature has been searched. 1 2 3 4 5
3. Experiments have been repeated and careful records have been kept. 1 2 3 4 5

THOROUGHNESS TOTAL

IV. SKILL (15 points total)

1. Special skills needed for construction or use of equipment is evident. 1 2 3 4 5
2. Special mathematical, computational or observational skills are evident. 1 2 3 4 5
3. Project is skillfully designed so that it yields valid, reliable, and accurate data. 1 2 3 4 5

SKILL TOTAL

V. CLARITY (10 points total)

1. The project notebook is well organized, neat and accurate. 1 2 3 4 5
2. The purpose, procedures and conclusions are clearly outlined and the title accurately reflects the problem. 1 2 3 4 5

CLARITY TOTAL

GRAND TOTAL

*ENTER ON FRONT OF FORM ALSO

SPECIAL COMMENTS OR CLARIFYING STATEMENTS:
Project Display Card

The project display cards are to be placed in front of each entry. The form is to be folded in half for judging. Judges are to see each project as a grade level entry. Student names should not be present. After the judging is completed the cards should be placed flat in front of the display or in a tri-folded manner.

Each entry should start with the grade level and be followed with the project number. For example, Kindergarten projects would be numbered K-1, K-2, K-3..., 1st grade would be 1-1, 1-2, 1-3..., 9th grade would be 9-1, 9-2, 9-3... etc. Be sure to double check project numbers with the information that is filled out on the scoring sheets.
TO: Principals
   Vice-Principals

FROM:

DATE:

SUBJECT: LIST OF SCHOOL SITE SCIENCE FAIR WINNERS

Please be advised that you are to submit to my office by [date] at 4:00 p.m., a list of your school site Science Fair winners who will be participating at the District Level.

If this list is not received by this time, your school site winners will not be included into the District's Science Fair Program.

School Site ____________________________

Names of winners by Grade Level:
<table>
<thead>
<tr>
<th>Project#</th>
<th>Score</th>
<th>Total Score</th>
<th>Award</th>
<th>Student's Name</th>
</tr>
</thead>
<tbody>
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**Awards night**

- Request help from Board Members to hand out awards.
- Send out invitations to community members.
- Notify press for coverage.
- Order awards for each grade level. Trophies for 1st - 2nd - 3rd; large ribbons for 4th - 5th - 6th; small ribbons for all other projects.
- Notify parents or the school site of the winners.
- Send a letter to all students who participated in the fair encouraging them to enter every year.

**Clean Up**

- Send as many projects home as possible after the awards night.
- Notify school site of any remaining projects that haven't been picked up.
- Leave the area the way you found it.
- Send a letter of thanks to all persons who helped to make the fair a success.
Develop the Program Guide as soon as all the names of the entries are available. The following page can be used as a cover sheet for student's name and grade level. Duplicating the cover and students' names on one sheet will save on paper and will provide a place to add the insert of the winner's name.

Sample

Outside

Half Sheet Insert

Inside

<table>
<thead>
<tr>
<th>Science Fair 19 - -</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade K Name</td>
</tr>
<tr>
<td>Grade 1</td>
</tr>
</tbody>
</table>

continue until all names are listed
1) Start early in the year. Coordinators of the fair should be assigned as soon as the new school year begins.

2) Use the resources included in the manual to inservice the staff. Staff commitment to the science fair is the key to success. Coordinators should provide teachers with necessary materials, and keep them updated on the progress of the fair.

3) Make a timeline. By specifically outlining your plan of attack, you will insure success. Be sure to include such things as printing, inservice dates, parent letters, lesson pacing, ordering of ribbons and awards, arranging for judges, and the place and time of the fair itself.

4) As staff inservicing, it is important to brainstorm suggestions that the teachers at your school may have. Some teachers may have had a lot of experience in organizing science fairs. They may provide excellent suggestions.

5) You may find it beneficial to have each class at your school make a class project. These projects could be set up in a convenient place to demonstrate to your students what a proper science fair project should look like. They would help to guide the students at your school in developing their own science projects.

6) From the start, keep parents informed on the progress of the fair. Parents usually play a key role in the development of their child's project. The student-parent packet encourages parental participation. Parents can supply special material, take students to the library, and serve as excellent resources. You may want to arrange for some parents to help on the day of the fair.

7) Choose your judges early. Inservice them by reviewing the judges evaluation form, and discussing the judging process you plan to use. Teachers, administrators, local business people, parents, etc., may all make excellent judges. The most important thing is their ability to interact with the students, and to get the most information out of the student concerning their science project. They should have some background in science.

8) Awards should be given to all students who participate in the fair. Participation ribbons and certificates will make all of those who entered feel successful. 1st, 2nd and 3rd place ribbons should be awarded according to the Danish system (that is, there are no ties. All participants who tie, receive the same place).
9) Arrange the publicity for your fair. Invite administrators, business persons, school board members, parents, the local paper, etc., to come to your school and witness this terrific event. It not only strengthens the relationship between the community and the school, but it will also strengthen the child's commitment to science.

10) Arrange to have your science fair at a site where all of the projects can be displayed together. Make a plan for setting up the projects. Don't underestimate the space you'll need. You never have enough! It is best to organize projects by grade level. You will need to consider accessibility, traffic, weather, availability of electrical outlets, refrigeration, and a water supply. Consider safety precautions such as loose cards, unstable panels, and fire extinguishers.

11) It is best to plan the fair in two stages. First, judge the projects. You may want to judge the projects in the classrooms. If that is not possible, judge them at the site the day before the fair. This gives you plenty of time to make your awards and display them on the projects. The second stage is the fair itself. Make a schedule for class visitation. Fifteen to twenty minutes is usually adequate time for a visitation. Allow two classes in at a time. Participants from the classrooms may wish to stand beside their projects and explain it to their classmates. It is best not to have the participants there all day.

12) The night of the science fair will be very exciting. Parents, grandparents, and friends will all be drawn to the event by the students. Plan at least two hours for viewing of the projects. Students should not remove their projects on the night of the fair. Arrange to have parents pick the projects up the following day. All of your hard work will pay off on the night of the fair.
IV.

Getting Ready for and implementing a School Level Science Fair
Site Level Science Fair

Success of the Site Level Science Fair depends on careful planning and preparation. The following pages, developed in two forms, as a flow chart with check off sheets and in a numerical/paragraph style, will help the committee plan and initiate a successful school site science fair.

School Site Science Fair

Principal

Science Fair Committee

Committee Tasks

Calendar

Budget

Teacher/Parent Assistance

Fair Day Before/After

Events

Development

Page

Page

Page

Page
TO: Staff
FROM: Science Fair Committee
ABOUT: Science Fair

Enclosed you will find suggestions and background materials for our Science Fair. Use any and all of it to suit your needs. If you need more help see

_______________________________________________. We will be giving you a letter to go home to parents.

This year we are stressing science projects. Collections are acceptable only if classification and analysis tasks are involved. No hobby exhibits will be accepted. Projects involving the presence of live animals will not be accepted. Either group or individual projects will be welcome.

Some preliminary days:

February 1 - student applications due to teacher
February 4 - teacher gives # of applicants to Science Fair Committee
March 21 - set up during day
March 21 - PTA - Science Fair
March 22 - School viewing
### SCIENCE FAIR - CALENDAR OF EVENTS

<table>
<thead>
<tr>
<th>Date</th>
<th>Event</th>
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<tbody>
<tr>
<td>Wednesday, February 10th</td>
<td>Teacher Inservice, at 2:50 in the library</td>
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<tr>
<td>Friday, March 18</td>
<td>Projects are due - submit list of students names to __________________. Set up project in __________. More information will be forthcoming.</td>
</tr>
<tr>
<td>Monday, March 21st</td>
<td>Judging of entries</td>
</tr>
<tr>
<td>Tuesday, March 22nd</td>
<td>Parent night time ____ to ____. ____________ and ____________ will stay to greet parents. Let us know if you want to help.</td>
</tr>
<tr>
<td>Wednesday, March 23rd</td>
<td>Classroom visitations</td>
</tr>
<tr>
<td>Thursday, March 24th</td>
<td>Schedule and sign-up forthcoming to all classrooms</td>
</tr>
<tr>
<td>Friday, March 25th</td>
<td>Winning projects, a total of 15, are to be taken to the district fair. Projects must be set up at the district fair by 3 p.m. Parents are to transport the projects if possible. All other projects are to be sent home.</td>
</tr>
<tr>
<td>Tuesday, March 29th</td>
<td>District Fair judging (5-8 p.m.)</td>
</tr>
<tr>
<td>Wednesday, March 30th</td>
<td>District Fair Days</td>
</tr>
<tr>
<td>Thursday, March 31st</td>
<td>District Awards Night</td>
</tr>
<tr>
<td>Friday, April 1st</td>
<td>All projects must be picked up from the District fair by 12 noon.</td>
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</tbody>
</table>

**Tips To Remember:**

* Students names are not to be on the front of their display. Use a 3 X 5 index card and include the following information.
  
  --student name and grade level
  --teacher and room number
  --project title

* Encourage parents to help set up their child's project, and to provide transportation necessary to the district fair.
* Encourage all of your students to do a project.
* Save entries for Open House.
* Students can do their whole project at home.

"Science Fair Packets for Home Use" should be checked out and returned by students. This will save on copying costs and packets can be saved and reissued the following year.
Science Fair Parent Workshop

Dear Parents,

The Science Fair is here! It's a great opportunity for your child to explore the world of science and have fun!

To help all those interested in entering the Science Fair, two Fair Workshops will be given on _______________. If you will be attending, please return the bottom portion to your child's teacher.

Due to limited supervision, STUDENT MAY ONLY ATTEND IF ACCOMPANIED BY A PARENT.

Yes, I'm interested. I will attend the workshop on ________________.

square 2:45 p.m. in room 12
square 6:30 p.m. in the library

Signature_________________________
Sample Letter to Judges

Dear [Name],

School is conducting a Science Fair for its students. The purpose of this Science Fair is to encourage students to continue their studies in the areas of Math and Science; to reward student efforts; and to identify outstanding projects which will be submitted for competition on the District level.

The Science Fair is scheduled for _________ at _____________. Students will set up their projects on _________ from 8:00 a.m. to 4:00 p.m. Judging will take place from 4:00 p.m. to 8:00 p.m. on _________ with no one else present. Refreshments will be provided to Judges. Awards presentation will be held _________.

Your name was suggested as a person who might be interested in assisting us by serving as one of our grade level Judges. There will be _____ judges from outside the school and _____ judges from the school who will determine 1st, 2nd, and 3rd place winners at each grade level. You would be joined by one of our experienced teachers in judging student projects at one grade level only. I'm enclosing a copy of the Selection Criteria which will be applied to each project in its judging.

I realize that you are very busy person but I hope you will find time in your busy schedule to help our student learn and grow. Please call use at __________ to confirm your participation. Thank you very much for your dedication and commitment to our youth.

Sincerely,
Total Score ______________

SCIENCE FAIR
JUDGE'S WORKSHEET

Project Number: ______________

Category: ______________

1. CREATIVENESS (25 points total)

1. The problem is original or is a unique approach to an old problem (considering the student's grade level) 1 2 3 4 5
2. Equipment and materials are used ingeniously 1 2 3 4 5
3. Interpretation of data is appropriate for student's grade level 1 2 3 4 5
4. Application of project information shows student's creative involvement 1 2 3 4 5
5. Student shows evidence of understanding that unanswered questions remain 1 2 3 4 5

CREATIVENESS TOTAL ______________

Judges: Use 11a or 11b – not both

11a. SCIENTIFIC THOUGHT/ENGINEERING GOALS (30 points total)

1. The hypothesis is clearly stated and the project is clearly designed 1 2 3 4 5
2. The project shows depth of study and effort 1 2 3 4 5
3. Project exhibits orderly recording and analysis of data 1 2 3 4 5
4. Sampling techniques and data collection are appropriate for the problem 1 2 3 4 5
5. Scientific procedures are appropriate and organized 1 2 3 4 5
6. Conclusions formulated are logical, based on the data collected, and are relevant to the hypothesis 1 2 3 4 5

SCIENTIFIC THOUGHT TOTAL ______________
ENGINEERING AND INVENTION GOALS (30 points total)

1. Does the project reflect knowledge of existing solutions to the problem? 1 2 3 4 5
2. Does the project solve the problem better than existing solutions? 1 2 3 4 5
3. Does the solution meet an established need or create a new need? 1 2 3 4 5
4. Does the solution work? 1 2 3 4 5
5. Does the solution reflect an awareness of environmental safety? 1 2 3 4 5
6. Is the solution economical and appropriate to the problem? 1 2 3 4 5

ENGINEERING AND INVENTION GOALS TOTAL

THOROUGHNESS (15 points total)

1. The study is complete within the scope of the problem. 1 2 3 4 5
2. Scientific literature has been searched. 1 2 3 4 5
3. Experiments have been repeated and careful records have been kept. 1 2 3 4 5

THOROUGHNESS TOTAL

SKILL (15 points total)

1. Special skills needed for construction or use of equipment is evident. 1 2 3 4 5
2. Special mathematical, computational or observational skills are evident. 1 2 3 4 5
3. Project is skillfully designed so that it yields valid, reliable, and accurate data. 1 2 3 4 5

SKILL TOTAL

CLARITY (10 points total)

1. The project notebook is well organized, neat and accurate. 1 2 3 4 5
2. The purpose, procedures and conclusions are clearly outlined and the title accurately reflects the problem. 1 2 3 4 5

CLARITY TOTAL

GRAND TOTAL

*ENTER ON FRONT OF FORM ALSO

SPECIAL COMMENTS OR CLARIFYING STATEMENTS:
TO: Staff
FROM: Science Fair Committee
DATE:
SUBJ: Names for Certificates/Ribbons/Program Guide

May we please have a list of names of the children and their projects? We wish to give each participant a certificate for his/her project efforts. In order for the secretaries to type their names, we need this list by ___________________________ before you leave school.

Thank you,

Science Fair Committee

_______________________________
TEACHER

_______________________________
GRADE LEVEL

_______________________________
STUDENT’S NAMES
Project Display Card

The project display cards are to be placed in front of each entry. The form is to be folded in half for judging. Judges are to see each project as a grade level entry. Student names should not be present. After the judging is completed the cards should be placed flat in front of the display or in a tri-folded manner.

Each entry should start with the grade level and be followed with the project number. For example, Kindergarten projects would be numbered K-1, K-2, K-3..., 1st grade would be 1-1, 1-2, 1-3..., 9th grade would be 9-1, 9-2, 9-3... etc. Be sure to double check project numbers with the information that is filled out on the scoring sheets.
Project No. _________
Grade Level _________
Project Title ______________

This project was completed by

______________________________

School Site ____________________

Teacher ________________________

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ATTENTION
SCIENCE FAIR WINNERS

Congratulations to all of the Science Fair winners!! The first and second place winners from Kindergarten through third grades and the first, second and third place winners from the fourth and fifth grades will be sent to our District Science Fair.

Projects need to stay at school through Tuesday, March 29th and may be picked up after 12:00 noon but before 3:00 p.m.

DISTRIBUT SCIENCE FAIR CALENDAR & INFORMATION

DATE:
March 30 - Setup from 8:00 a.m. to 4:00 p.m.
(Teachers/Parents/Principals from school sites)

Judging - 4:00 p.m. to 8:00 p.m.
(No one else present)

March 31 - Exhibition - 8:00 - 4:00 p.m.
Break - 4:00 - 5:00 p.m.
Exhibition - 5:00 - 7:00 p.m.
Awards - 6:00 - 7:00 p.m.

April 1 - Pickup of projects 8:00 a.m. - noon
(hall must be vacated by noon)

SITE:
District Office

Trophies - will be awarded to 1st, 2nd, and 3rd place winners at each grade level, K-12

AWARDS:
Ribbons - will be given to 4th, 5th, and 6th places
all others will receive Honorabel Mentions
(rationale: all were winners at their schools)
Program Guide

Develop the Program Guide as soon as all the names of the entries are available. The following page can be used as a cover sheet for student's name and grade level. Duplicating the cover and students' names on one sheet will save on paper and will provide a place to add the insert of the winner's name.

Sample
1) Start early in the year. Coordinators of the fair should be assigned as soon as the new school year begins.

2) Use the resources included in the manual to inservice the staff. Staff commitment to the science fair is the key to success. Coordinators should provide teachers with necessary materials, and keep them updated on the progress of the fair.

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9) Arrange the publicity for your fair. Invite administrators, business persons, school board members, parents, the local paper, etc., to come to your school and witness this terrific event. It not only strengthens the relationship between the community and the school, but it will also strengthen the child's commitment to science.

10) Arrange to have your science fair at a site where all of the projects can be displayed together. Make a plan for setting up the projects. Don't underestimate the space you'll need. You never have enough! It is best to organize projects by grade level. You will need to consider accessibility, traffic, weather, availability of electrical outlets, refrigeration, and a water supply. Consider safety precautions such as loose cards, unstable panels, and fire extinguishers.

11) It is best to plan the fair in two stages. First, judge the projects. You may want to judge the projects in the classrooms. If that is not possible, judge them at the site the day before the fair. This gives you plenty of time to make your awards and display them on the projects. The second stage is the fair itself. Make a schedule for class visitation. Fifteen to twenty minutes is usually adequate time for a visitation. Allow two classes in at a time. Participants from the classrooms may wish to stand beside their projects and explain it to their classmates. It is best not to have the participants there all day.

12) The night of the science fair will be very exciting. Parents, grandparents, and friends will all be drawn to the event by the students. Plan at least two hours for viewing of the projects. Students should not remove their projects on the night of the fair. Arrange to have parents pick the projects up the following day. All of your hard work will pay off on the night of the fair.
V.

Selected References

- For Teachers
- For Students
Teacher References

Information

Riverside County Schools
Norwood C. Hazard, Curriculum Specialist
Science and Environmental Education
3939 - Thirteenth Street
P.O. Box 868
Riverside, CA 92502

San Bernardino County Schools
(Inland Science Fair Regulation and Application Forms)
Forrest Miller, Curriculum Coordinator
Science and Mathematics, Computer Education
201 North "E" Street
San Bernardino, CA 92415

California State Science Fair
(CSSF Regulations and Application Form)
Charles Carr, Education Office
Museum of Science and Industry
Exposition Park
700 State Drive
Los Angeles, CA 90037

Student Exposition of Energy Resources
(SEER Fair)
SEER Fair Regulations and Application Form
The SEER Fair Film (16mm)
"I'm a SEER" - student booklet
Esther Wiley
National Energy Foundation
727 West 7th Street, #254
Los Angeles, CA 90017

Resources

Office of San Bernardino County Superintendent of Schools
Professional Library
201 North "E" Street
(Third Floor)
San Bernardino, CA 92415
The following materials may be borrowed by teachers in person or requested by phone and delivered via JET mail patrons in Riverside Co. only.

Filmstrips
Developing a Science Fair Project ERC Media #718, #719, #720, #721
sound - 1981

Organizing a Science Fair Project ERC Media #427
silent - 1968
Encyclopedia Britannica Films
7 sample topics; upper junior high school and senior high school

Books (Science is centered in the 500's, particularly 501 - 510 in the Dewey Decimal System.)

Elementary Science Activities for Every Month of the Year

Junior Science Sourcebook
Bainbridge, J.W., Stockdale, R.W., and Wastnedge, E.R.
London: Collins Publishing Col. 1970

Discovery Activities for Elementary Science
Carin, Arthur A., and Sund, Robert B.
Columbus, OH: Chas, E. Merrill Co., 1964

Science Experiments You Can Eat
Cobb, Vicki

Elementary Teacher's Classroom Science Demonstrations and Activities
Hennessy, David E.
The Everyday Science Sourcebook
Lowery, Lawrence F.
Boston, MA: Allyn and Bacon, Inc., 1978

Science Fair Handbook
San Diego County Department of Education 1982

The Complete Guide to Science Fair Competition
J. Stoltzfus, M. Young, Hawthorne Books, NY 1972

Setting Up a Science Project

101 Science Projects

Your Science Fair Project
W. Moore, Putnam 1964

Backyard Scientists
J. Hoffman, P. Yeg, 1983

Student References

The following books and magazines are very helpful in stimulating science interest and ideas.

BOOKS
Build-It-Yourself Science Laboratory, Raymond E. Barrett, Doubleday & Co., Inc., Garden City, N. Y. $4.50
Amateur Scientist, Scientific American, 415 Madison Ave. New York 17, N. Y.
The Living Laboratory, James D. & Rebecca H. Witherspoon, Doubleday & Co., Garden City, N.Y. $3.95
101 Simple Experiments with Insects, H. Kalmus, Doubleday & Co., Inc. Garden City, N. Y., $2.95
NSA Project Books, National Science Teachers Association, 1201 Sixteenth St., N.W., Washington 6, D.C.
Research Problems in Biology, Anchor Books, Doubleday & Co., Inc. Garden City, N.Y., Series 1, 95 cents
MAGAZINES
Scientific American, 415 Madison Ave., New York 17, N.Y.
Science Digest, 250 West 55th St., New York 19, N.Y.
Nature and Science, The Natural History Press, Garden City, N.Y.
Science World, 50 West 44th St., New York City 36

BOOKLETS
Science Projects for the Elementary School, OMSI, 4015 S.W. Canyon Rd.
Science Projects for the Junior & Senior High School, OMSI, see above, each 50 cents

PAMPHLETS, Etc.
General Science Projects and Investigation Center for Applied Research in Education 1976

Simple Biology Investigations
Center for Applied Research in Education 1976

Ideas for Science
NSTA 1962

Science Projects for the Intermediate Grades
Schneider, M. 1971

Inland Science Fair Manual

Conservation Science Fair Projects
Soil Conservation Society of America 1970

Your Science Fair
Welte, A. 1959
VI.

Teacher Packet Forms for Science Fairs

- Scientific Method
- Letters to Parents
- Timeline for Projects
- Worksheets for Students to turn in
The Scientific Method

The Scientific Method is a way of working an a problem using a series of related steps. In brief, these steps are as follows:

Sample 1

TOPIC, QUESTION, OR PROBLEM RESEARCH
Quotes from People and Literature - Books, Magazines, TV, Newspaper

HYPOTHESIS
An Educated Guess, stated as a question in which can be answered "yes" or "no", and the answer based on data which student can gather.

EXPERIMENTATION
Describe Procedure and Materials to be used.

DATA
Collected as Data Tables
Simplified to and displayed as Graphs, Histograms, etc.

CONCLUSION
A Statement of Data-based Results
A yes or no answer to Hypothesis
Defendable through Logic, Reasoning, Common Sense

NEXT QUESTION
Are new issues raised?
What remains of interest to students?
**DEFINE THE PROBLEM**

You can't solve a problem unless you see that one exists. Scientists must be able to see problems and ask questions. You must be able to state a problem in the form of a question. The question must be worded so as to identify the area of study and limit the area to a specific, narrow topic for investigation. For example: Will roots grow in light?, or What conditions favor the rusting of iron? How does a magnetic field effect the growth of crystals? What wavelength of light has the greatest effect on photosynthesis?

---

**HYPOTHESIS**

**FORM A HYPOTHESIS**

A hypothesis is a proposed answer to your problem. Before you begin an experiment you should make a hypothesis (answer) to your problem. Your experiment must test your hypothesis. The results of your experiment will prove (or disprove) your hypothesis. It isn't important that the hypothesis is correct (right); its purpose is to give you direction in setting up your experiment.
PROCEDURE

COLLECTING INFORMATION
Before scientists experiment, they spend a lot of time reading. A scientist wants to find out what work has been done on their problem. Reports of research from all over the world are published in many journals, books and magazines. You must go to the library or to people who have information that will help you understand your problem.

PLANNING THE EXPERIMENT
Before you begin to experiment or build equipment you should do some planning. Write down what you are going to do to solve your problem. Get some help from parents, teachers or professional with backgrounds in your problem area. Write your plan and have one (or more) of these people look it over: problems might be avoided by doing this.

Then.............write down the steps you took to begin and to complete your project. Your journal will help you, if your journal is completed in the right manner.
**MATERIALS**

Make a list that includes EVERYTHING that was used or needed to prove your hypothesis. Don't leave anything out, and if possible put the items in the order that they were used.

---

**DATA / OBSERVATIONS**

**KEEPING A JOURNAL**

You must keep a notebook (journal) of everything you do for the project. The journal (notebook) must include your experiment plan, materials use procedure, observations, mistakes, changes .... EVERYTHING! The journal is like a diary of the project, from start to finish.
SHOWING YOUR DATA

It is extremely important in any scientific investigation to keep very close records of what you're doing. You should try observe your experiment on daily basis if possible. You may write your observations in a spiral notebook. Each observation should have the date and time you observed your experiment. Try not to miss a thing!!! You never know what might be very important in the end.

Plan on using a chart or graph to show your data. Tell which type of graph you will use and what it's title will be.

Use charts and graphs in your daily log.

1. **Bar Graph** - A graph in which length of a bar represents a number.
   Sample:

2. **Pictograph** - A picture representing an idea.
   Sample: (fish caught on Monday)

3. **Line Graph** - All points are connected by straight or curved lines.
   Sample:

4. **Circle or Pie Graph** - A graph used to show parts of a whole
   Sample:
SHOWING YOUR DATA

Plan on using a chart or graph to show your data. Tell which type of graph you will use and what its title will be.

Use charts and graphs in your daily log.

1. **Bar Graph** - A graph in which length of a bar represents a number.
   Sample:
   
   ![Bar Graph Example](image)

2. **Pictograph** - A picture representing an idea.
   Sample: (apples picked in five days)
   
<table>
<thead>
<tr>
<th>Day</th>
<th>Apples Picked</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monday</td>
<td>????????????</td>
</tr>
<tr>
<td>Tuesday</td>
<td>????????</td>
</tr>
<tr>
<td>Wednesday</td>
<td>????????????</td>
</tr>
<tr>
<td>Thursday</td>
<td>????????????</td>
</tr>
<tr>
<td>Friday</td>
<td>????????????</td>
</tr>
</tbody>
</table>

   ![Pictograph Example](image)

3. **Line Graph** - All points are connected by straight or curved lines.
   Sample:
   
   ![Line Graph Example](image)

4. **Circle or Pie Graph** - A graph used to show parts of a whole.
   Sample:
   
   ![Pie Chart Example](image)
What happened when you finished your experiment? Results can be in either written form, paragraph style, or in the form of a graph.

When the experiment has been completed, you should be able to reach some conclusion. Can you prove or disprove your hypothesis? Conclusions should be written based on the data. Sometimes, you may obtain data which contradicts your expectations. You may tend to ignore this data and will write a conclusion based on your expectations instead. You must write a conclusion based on the data ALL THE DATA. Sometimes the data may be inconclusive, no clear cut indicators of a conclusion. Be aware SOME EXPERIMENTS WILL FAIL. Honesty and willingness to admit an experiment was unsuccessful is all a part of the scientific method.
You must set up an experiment that will either prove or disprove your hypothesis. The procedure, how much and what kind of materials used must be written in your journal so someone else could do it EXACTLY the same as you.

Experiments are usually designed with both a CONTROL group and an EXPERIMENTAL (or test) group. Having two groups allows comparisons to be made between what occurs under normal conditions and what occurs under test conditions. Suppose you wanted to find out if plants grow better with fertilizer: this is the experimental group. The other plants world not be given the fertilizer: this group is the control group.
Dear parents:

Your child is being encouraged to take part in the school science fair, an activity designed to encourage the natural curiosity of children and carefully scaled to their special interests and abilities. Although we will discuss methods and procedures in the classrooms, most of their work will be done at home. Your suggestions and encouragement will be of great value. Projects that require student involvement in "hands-on" experimentation, data collection, and problem solving are most desirable.

The following list of steps (which will be discussed in greater detail in the classroom) should be of help to both you and your youngster:

1. Start early. Read about an area you would enjoy investigating. The more you read the easier it is to develop a project.

2. Discuss your ideas with others. Try a variation on a known experiment.

3. Think through and decide on a problem to be studied. Help your student narrow the focus. Keep your problem simple. (When helping your child select a project, be sure to include safety as one consideration.)

4. State a hypothesis (a scientific guess about the probable results). For instance, "I think that aspirin in the water used for plants will help them grow taller", is a hypothesis. Test only one thing at a time (control other variables).

5. Plan the steps of the experiment you will use to test your hypothesis. List "Materials and Procedures" you will use. Help your student plan a calendar of events.

6. Begin the experiment(s) and observations. Plan a display to show your work. Be neat - very neat.

7. Keep accurate records of everything done. It is helpful to keep all notes in a journal.

8. Write a summary, drawing conclusions about your results. Ask someone to read your Display and Summary for understanding.

Lists of suggested projects will be made available to your child in the classroom. Many useful reference books may be found in the school library.

A proposal for entering the Science Fair is to be turned in to your child's teacher no later than

All projects are due by noon on projects will be displayed during the open house that evening.

Sincerely,
Science Fair Committee

..............................School
SAMPLE FORM: 2

Dear Parents:

Our school will be having a Science Fair on _______________________. Projects from our fair will be selected to enter the ______________________ Unified School District Science Fair on ______________________.

Your child is being asked to take part in the Science Fair because we believe it will provide a valuable opportunity for youngsters to be creative, to have pride in their work, and to experience the hands-on use of the scientific method.

Although we will discuss methods and other information related to the District Science Fair will be part of the classroom science curriculum during __________ and __________. In this packet you will find a science fair timeline, district rules, sample project titles, definitions of terms, information on how to set up a project notebook, and judging criteria. It is our hope that this will be a useful tool for you to use to help your child.

Should you have any questions regarding the school or district science fairs, please don't hesitate to call.

This is a very exciting science event for our school. We believe that parents will enjoy and take great pride in the creative and unique science projects developed by their children.

Sincerely,
<table>
<thead>
<tr>
<th>TASK</th>
<th>DUE DATE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Choose a problem to investigate.</td>
<td></td>
</tr>
<tr>
<td>2. Do some background research/get advice.</td>
<td></td>
</tr>
<tr>
<td>3. Develop a hypothesis.</td>
<td></td>
</tr>
<tr>
<td>4. Decide on the procedures you will use.</td>
<td></td>
</tr>
<tr>
<td>5. Make a list of materials you will need/gather materials.</td>
<td></td>
</tr>
<tr>
<td>6. Conduct your investigation/collect data.</td>
<td></td>
</tr>
<tr>
<td>7. Organize your data/research.</td>
<td></td>
</tr>
<tr>
<td>8. Draw your conclusions.</td>
<td></td>
</tr>
<tr>
<td>9. Write your research report.</td>
<td></td>
</tr>
<tr>
<td>10. Proofread you research report.</td>
<td></td>
</tr>
<tr>
<td>11. Design your exhibit.</td>
<td></td>
</tr>
<tr>
<td>12. Construct your visual aids and exhibit backdrops.</td>
<td></td>
</tr>
<tr>
<td>13. Turn in your project.</td>
<td></td>
</tr>
<tr>
<td>14. Present your project.</td>
<td></td>
</tr>
</tbody>
</table>
### STEPS IN DEVELOPING SCIENCE FAIR PROJECTS

<table>
<thead>
<tr>
<th>TASK</th>
<th>DATE DUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Choose a problem to investigate.</td>
<td></td>
</tr>
<tr>
<td>Problem:</td>
<td></td>
</tr>
<tr>
<td>Write the problem as a question.</td>
<td></td>
</tr>
<tr>
<td>2. Do some background research/get advice.</td>
<td></td>
</tr>
<tr>
<td>Where did you get your research?</td>
<td></td>
</tr>
<tr>
<td>List the people or books you used to get your information.</td>
<td></td>
</tr>
<tr>
<td>3. Develop a hypothesis.</td>
<td></td>
</tr>
<tr>
<td>Write your hypothesis:</td>
<td></td>
</tr>
<tr>
<td>4. Decide on the procedures you will use.</td>
<td></td>
</tr>
<tr>
<td>List your procedures:</td>
<td></td>
</tr>
<tr>
<td>5. Make a list of materials you will need to gather</td>
<td></td>
</tr>
<tr>
<td>List the materials that you will need to get and where to get them.</td>
<td></td>
</tr>
<tr>
<td>Materials</td>
<td>Where you will get them</td>
</tr>
<tr>
<td>Continue the list on the back. Make sure you include all the materials.</td>
<td></td>
</tr>
<tr>
<td>TASK</td>
<td>DATE DUE</td>
</tr>
<tr>
<td>------</td>
<td>---------</td>
</tr>
<tr>
<td>6.</td>
<td>Conduct your investigation/collect data.</td>
</tr>
</tbody>
</table>
| 7.   | Organize your data/results.  
     | Attach data/results. | |
| 8.   | Draw your conclusions.  
     | State conclusions: | |
| 9.   | Write your research report.  
     | Complete science notebook. | |
| 10.  | Proofread your report. | |
| 11.  | Design your exhibit.  
     | Make paper model of what your Science Fair Exhibit will look like. | |
| 12.  | Construct your visual aids and exhibit backdrop. | |
| 13.  | Turn your project in. | |
| 14.  | Present your project. | |
Do not worry about the exact title for your project for now. Your project may change somewhat as you read more about your chosen topic. Once you have started your library research, you will see how to narrow your topic to a specific question or problem.
WORKSHEET #2

Name __________________________________________

Grade __________________________________________

Teacher _________________________________________

The tentative title of my Science Project is:

_________________________________________________________________________

_________________________________________________________________________

The purpose of my Science Project is

_________________________________________________________________________

_________________________________________________________________________

My hypothesis is:

What do I expect to happen?

_________________________________________________________________________

_________________________________________________________________________

What do I think the end result will be?

_________________________________________________________________________

_________________________________________________________________________

Teacher's approval
WORKSHEET #3

SAMPLE BIBLIOGRAPHY FORM

The following are examples of the exact bibliography form required for all research papers. Please take careful notice of all punctuation, capitalization, and spacing.


Interview: Chapman, James Ph.D., Science Professor, Santa Ana College, (Santa Ana, Ca., January 29, 1973.)

Please list your resources for your Science Project below. Use the bibliography form.

Name ____________________________

Grade ____________________________

Date ____________________________

Project Title ________________________________________________________________

Bibliography Resources:

__________________________________________________________________________

__________________________________________________________________________

__________________________________________________________________________

__________________________________________________________________________

__________________________________________________________________________

__________________________________________________________________________

(Use another sheet if necessary)
A. PLANNING YOUR INVESTIGATION
You have already stated your purpose or problem which you hope to solve by scientific experimentation. Please give careful thought to your project and answer the following questions to be turned in carefully written on notebook paper.
1) What do you plan on doing to solve the problem?  
2) What equipment, apparatus, and materials will you need? How will you get these?  
3) What information will you need? How will you use this information?  
4) What preparations have you made?  
5) How long will the investigation take?  
6) Where do you propose to carry out the investigation?  
7) What value or importance does your proposed investigation have?  
8) What weakness (if any) does your investigation have? 
   Grades 7-8 required   Grades 5-6 optional

B. CARRYING OUT YOUR INVESTIGATION
1) What specific question or problem are you isolating to test?  
2) Are you testing with only one variable? What is that variable?  
3) What controls are you using?  
4) How will you evaluate your equipment? Grades 7-8 required Grades 5-6 optional  
5) Are you testing cause and effect relationships? If so, what are they? Grades 7-8 required Grades 5-6 optional  
6) What measurements will you make during your investigation? Are these measurements as accurate as possible?  
7) How will you organize records and interpret data?  
8) What computations will you need to make?
   Teacher Approval: __________________
WORKSHEET #5

Name ____________________________
Grade ____________________________
Teacher ____________________________

EVALUATION......Did I -

1) State the purpose of my project clearly? ____________________________
   YES   NO

2) Prove or disprove my hypothesis? ____________________________
   YES   NO

3) Explain the procedure I followed so someone else could duplicate it? ____________________________
   YES   NO

4) Show my results? ____________________________
   YES   NO

5) Make sure my conclusions were supported by the evidence in the form of data derived accurately? ____________________________
   YES   NO

6) Explain what I have proven in my conclusion ____________________________
   YES   NO

7) State all data accurately? ____________________________
   YES   NO

8) Number my pages correctly? Start numbering with the second page of the text. Place the number "2" in the upper right hand corner and number consecutively to the end. ____________________________
   YES   NO

9) Are my subheadings correct? Use a subheading (or side heading, as it is called) to introduce each new section. Triple space above and below the side heading. Underline the side heading. ____________________________
   YES   NO

10) Make my report so clear that I would understand it even if I knew only as much as the reader knows from reading it? ____________________________
     YES   NO

Evaluate your project using the criteria that Science Project Judges would use:

A. Display 10 points
B. Daily log 10 points
C. Notebook 30 points
D. Creative Ability 20 points
E. Scientific Thought 30 points

TOTAL 100 points
## SCIENCE FAIR EVALUATION

<table>
<thead>
<tr>
<th>Name</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Title of Project</td>
<td></td>
</tr>
<tr>
<td>Why did you choose this subject (explain fully)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>How much time do you feel you spent? (hours)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Researching material</td>
<td></td>
</tr>
<tr>
<td>2. Preparing reports</td>
<td></td>
</tr>
<tr>
<td>3. Conducting your experiments or surveys</td>
<td></td>
</tr>
<tr>
<td>4. Assembling your display</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Have you done anything like this before?</th>
<th>YES</th>
<th>NO</th>
<th>(circle one)</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Do you think this was a worth-while idea?</th>
<th>YES</th>
<th>NO</th>
<th>(circle one)</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>If no, why not?</th>
<th></th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Do you feel your research skills are better as a result of this activity?</th>
<th>YES</th>
<th>NO</th>
<th>(circle one)</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>What do you think was the most important thing(s) you learned?</th>
<th></th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Is this something you would like to do again?</th>
<th>YES</th>
<th>NO</th>
<th>(circle one)</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>If no, why not?</th>
<th></th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>If your friends from another room saw the displays, what did they say about them?</th>
<th></th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>If your parents saw them what did they say?</th>
<th></th>
</tr>
</thead>
</table>
# STUDENT EVALUATION FORM

RATE YOUR OWN PROJECT:
TITLE OF PROJECT __________________________ Name __________________________

A. CLASSIFICATION OF PROJECT (Classify as to type - score between suggested point values)

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>INVESTIGATION</td>
<td>Problem requires experimentation and/or collecting and analyzing data in order for student to arrive at some conclusion or theory</td>
<td>20-30 pts.</td>
</tr>
<tr>
<td>TECHNICAL OR SOME EXPERIMENTATION</td>
<td>Basically an applied science project. Student constructs something using principles of science and/or has done an experiment which is basically a demonstration.</td>
<td>15-25 pts.</td>
</tr>
<tr>
<td>ILLUSTRATION</td>
<td>The student is showing something about science through a collection, display, are, or craft medium. Very little scientific or technical</td>
<td>5-15 pts.</td>
</tr>
</tbody>
</table>

B. LOG OR NOTEBOOK (This is to be judged - choose most appropriate sentence)

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>PROBLEM OR IDEA</td>
<td>Problem or idea of project highly original</td>
<td>7</td>
</tr>
<tr>
<td>IDEA:</td>
<td>Problem or idea somewhat original and/or approach original</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Problem or idea not original - but quite difficult or unusual</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Problem or idea not original - Idea quite common</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Problem or idea not clear or lacking</td>
<td>0</td>
</tr>
<tr>
<td>BACKGROUND</td>
<td>Student possessed or secured adequate background information through reference books, interviews, and/or experimentation</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Fairly adequate background information - student makes sincere attempt to secure more information</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>No background information necessary or difficult to evaluate</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Limited information secured even though available and desirable</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>No attempt to secure any information even though necessary</td>
<td>0</td>
</tr>
<tr>
<td>OBSERVATIONS</td>
<td>Usually keen observations made during work</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Good observations were made during work</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Unable to determine because of type of project</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Some observations made - many overlooked</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>No observations made even though warranted</td>
<td>0</td>
</tr>
<tr>
<td>RECORDING DATA</td>
<td>Usually fine job of recording data: written records, graphs, pictures, and/or notes</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Data carefully and accurately recorded, mechanics good</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Project did not require recordings of data or item hard to evaluate</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Data recorded in a somewhat acceptable manner - some lacking</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Data poorly recorded</td>
<td>0</td>
</tr>
<tr>
<td>CONCLUSIONS OF STUDENT</td>
<td>Conclusions or results of work valid, based on experimentation, observations, or technical work. Shows insight</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Conclusions or results valid, based on work</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>No conclusions possible or difficult to evaluate</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Conclusions somewhat valid</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Conclusions lacking or largely invalid</td>
<td>0</td>
</tr>
<tr>
<td>COMMUNICATION SKILLS</td>
<td>Student shows excellent ability to communicate, mechanics excellent</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Student show good ability to communicate, mechanics good</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Log written or typed by other than student. Cannot be evaluated</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Log not clear. Spelling and mechanics may be poor</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Communication and mechanics poor. Log carelessly written</td>
<td>0</td>
</tr>
</tbody>
</table>

LOG TOTAL


<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>HYPOTHESIS:</strong></td>
<td>Student formed very logical hypothesis based on information, observations, experiences, and some experimentation</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Student formed fairly logical hypotheses</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>No hypotheses necessary and/or difficult to evaluate</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Poor hypotheses formed, based on information</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>No hypotheses formed, even though called for</td>
<td>0</td>
</tr>
<tr>
<td><strong>EXPERIMENTS:</strong></td>
<td>Experiments or activities pertinent to project. Equipment or experiment quite original</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Activities or experiment pertinent - somewhat original</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Activities and/or experiments difficult, but not original</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Activities and/or experiments not difficult or original</td>
<td>0</td>
</tr>
<tr>
<td><strong>VALIDITY OF RESULTS:</strong></td>
<td>Results valid: rechecked by running additional tests or experiments</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Results valid: based on adequate samplings but not rechecked</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Results somewhat valid: control, tests, or samplings not adequate</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Results mostly invalid: based on limited samplings or tests</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Unable to determine results from project or log</td>
<td>0</td>
</tr>
<tr>
<td><strong>SCIENTIFIC ACCURACY:</strong></td>
<td>Statements, terms, mathematics and/or instrumentation scientifically correct</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Project contains some minor inaccuracies</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Project is somewhat inaccurate</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Project is largely inaccurate</td>
<td>0</td>
</tr>
<tr>
<td><strong>EFFORT OR TECHNIQUES:</strong></td>
<td>Project took unusual amount of care and/or techniques</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Project took considerable time, care and/or techniques</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Project did not require more than average time, care, and/or techniques</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Project quite simple, requires little effort or techniques</td>
<td>0</td>
</tr>
<tr>
<td><strong>PHYSICAL HELP:</strong></td>
<td>Student did all physical work, required little advice</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Student required only a very limited amount of physical help</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Student received only necessary help</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Student required unnecessary physical help</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Student required excessive amount of help</td>
<td>0</td>
</tr>
<tr>
<td><strong>CURIOSITY:</strong></td>
<td>Student shows an usually high degree of curiosity</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Student shows a high degree of curiosity</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Unable to determine because of nature of project</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Student showed some curiosity</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Student shows little or no curiosity</td>
<td>0</td>
</tr>
<tr>
<td><strong>CREATIVITY IN USE OF MATERIAL:</strong></td>
<td>Student made excellent use of common materials, very creative</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Student made good use of common materials, somewhat creative</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Item not appropriate because of nature of project</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Student used mostly prepared material - and/or not creative</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Student used prepared kits or materials only</td>
<td>0</td>
</tr>
<tr>
<td><strong>NEW PROBLEMS OR FURTHER USE:</strong></td>
<td>Student shows deep insight in recognizing new problem or application</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Student recognized new problems and/or has future use of work</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Item not valid or difficult to determine</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Student shows limited ability to recognize new problem or use</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Student unable to recognize new problem k</td>
<td>0</td>
</tr>
</tbody>
</table>

C. PROJECT TOTAL

B. Log Total

A. Type Score

GRAND TOTAL
JUDGING CRITERIA

DISPLAY
- Neatly prepared and well organized
- Free of misspellings and corrections
- Visually attractive
- Equipment, charts, graphs, illustrations, etc. clearly labeled
- Use of tables, graphs to summarized data

REPORT / JOURNAL / RESEARCH
- Student has done sufficient research for the scope of the project
- Research is presented in a written report
- Journal is neat, organized, and reflects the entire process used in developing the project
- Student has consulted several sources in his/her research
- Bibliography is included in written report

SCIENTIFIC CONTENT
- Clear statement of the problem or aim of project
- Title of project reflects the problem
- Clearly stated hypothesis
- Materials and procedures are listed, accurate and detailed
- Approach to the problem is consistent with the scientific method
- Accurate collection and treatment of data
- Logical conclusion drawn from data
- Student aware of sources of error, and suggests further areas of study

THROUGHNESS
- The study is complete within the scope of the problem
- Experiment has been repeated or sufficient numbers have been tested
- Project skillfully designed to yield valid, reliable and accurate data

SKILL
- Special skill needed for construction or use of equipment is evident
- Special mathematical, computation or observational skills are evident
- Level of difficulty of the project appropriate form grade level

CREATIVITY
- The problem is original or is a unique approach to an old problem (considering the students grade level)
- Equipment and materials are used ingeniously:
  - In the manner of presentation
  - In recognizing practical possibilities and limitations
- Student has chosen a relevant problem for the project
Sample 1  SCIENCE FAIR GENERAL REGULATIONS

1. All entries to the District Science Fair must come from K-12 grade students currently attending a school in Unified School District. Entries must follow all Science Fair regulations.

2. Each entry must come from one individual student.

3. The work on the project should be done by the student. If any outside help or assistance is given, it must be described in the project notebook. (example: advice from a local scientist, parental help with the construction of display, etc.)

4. Only one space will be provided for each exhibit. Exhibits should not exceed the following dimensions.

5. Exhibits must be free standing and must be constructed of durable material. If electrical hook-ups are needed, arrangements must be made at least one week in advance.

6. No live vertebrate organisms may be displayed. Consider using photographs or drawings instead.

7. If live vertebrate animals or human subjects are used in experiments, the students must complete a "Certificate of Compliance" for humane treatment of vertebrate organisms. Forms will be available through the principal's office at each school.

8. Dangerous chemical, drugs, or open flames may not be displayed. All electrical equipment must conform to standard electrical safety laws.

9. No dangerous, viral, or bacteria materials may be in open containers on display.

10. Students and parents should be aware that, although care will be taken, damage could possibly occur to projects while on display. The district will not be responsible for lost, stolen or damaged items.

11. Projects will be removed by the specific date, or they will be disposed of.

The district reserves the right to reject projects which are unsuitable for display.
SCIENCE FAIR GENERAL REGULATIONS

1. Construction must be durable with all parts firmly attached. No attachment to walls will be allowed. Provision for the support for the back of the exhibit should be made.

   The physical dimensions of the display shall not exceed these standards:

   30 inches deep, 48 inches wide, and to stand not more that 96 inches from the floor

2. A copy of the Student Report, Student Entry Form, and, if applicable, Certification of Humane Treatment of Live Vertebrate Animals or Certification of Compliance of Research Involving Human Subjects should be attached to the Science Fair project display. Personal and school identification shall be concealed at the time of judging.

   • Human parts other than teeth, hair, nails, histological sections, and liquid tissue slides (properly acquired) may not be exhibited.

   • Photographs or other visual presentations of any surgical techniques, dissections, autopsies and/or laboratory techniques depicting vertebrate animals in other than normal conditions may not be displayed on student's exhibit but may be contained in the accompanying notebook.

3. No dangerous viral or bacterial materials may be on display. Non-dangerous bacterial material must be safely contained in unbreakable and sealed containers.

   • Controlled Substances (drugs, chemicals, anesthetics, etc., the use of which is regulated by the Comprehensive Drug Abuse Prevention and Control Act of 1970) must conform to existing local, state, and federal laws. Such substances may not be exhibited at the Fair.

   • All recombinant DNA research must be carried out in accordance with the revised (July 19, 1978 or subsequent) NIH Guidelines for Research Involving Recombinant DNA Molecules. Only research normally conducted without containment in a microbiological laboratory and performed under the supervision of an appropriately qualified scientist will be permitted. The facilities to be used must be described in the research plan. Research requiring containment is prohibited.

4. Live vertebrate animals may not be displayed during the Fair. Live vertebrate subjects in experiments must be protected from trauma.

   • Live or preserved vertebrate animals or parts including embryos may not be exhibited at the Fair.

   • Insect collections will be permitted on display.

5. Electrical materials must be in keeping with standard safety laws and practices. Displays will be inspected for compliance with such laws.

   • Wiring must be properly insulated and fastened.

   • Wiring switches and the metal parts of high voltage circuits must be located out of reach of observers and must include an adequate overload safety device.
• Approved connecting cords of the proper load-carrying capacity must be used for 110-volt operation of lights, motors, transformers, and other equipment.

• Standard switches must be used for 110-volt circuits. Open knife switches or bell-ringing push buttons are not acceptable for circuits exceeding 12 volts.

• Batteries with open top (wet cell batteries) are not permitted.

• Electrical connections in 110-volt AC must have an Underwriters Laboratories approved cord (of proper load carrying capacity) at least 2 meters long and equipped with a standard grounded plug.

• Devices (vacuum tubes, lasers, etc.) which generate dangerous rays must be properly shielded.

• Only Class I and Class II (not Class III or Class IV) lasers may be operated at the Fair. These lasers must:
  
  1) have a protective housing or barricade preventing human access to the beam during operation;
  2) be disconnected from the power source when not being operated;
  3) be operated only in the presence of the exhibitor; and
  4) when displayed, be accompanied by a sign reading: LASER RADIATION: DO NOT STARE INTO BEAM.

6. Open flame will not be permitted in the display. No has or water outlet will be provided.

• Research involving gasohol must conform to Department of Treasury, Bureau of Alcohol, Tobacco and Firearms (ATF) regulations. For specific information, call the Western Region office, (415) 974-9616.

• Fire regulations prohibit the use of highly flammable or combustible materials in project displays. Backboard panels must be of masonite, pegboard, hardboard, foamcore, or wood to which poster paper, cardboard, or fabric may be attached.

• No dangerous or combustible chemicals may be exhibited. (Tanks which have held such chemicals, unless first purged with carbon dioxide, are also prohibited.) Rockets MUST NOT contain fuel.

• Devices producing temperatures in excess of 100°C must be adequately insulated.

7. Only one exhibit will be allowed per student and only one student may work on each project. (Primary grades may provide group or class projects. The first name on the registration form will receive recognition.)

8. All work must be done by the student. Adults may supply materials, advice, and consultation.

9. The Science Fair Committee reserves the right of refusal of an exhibit which it deems unsafe or unsuitable for public exhibition.

The Science Fair Committee and all cooperating groups will assume no responsibility for loss or damage to any exhibit or part thereof. Students assume responsibility for all displayed equipment.
REGULATIONS FOR EXPERIMENTS WITH ANIMALS

Any student's research involving the use of animals must comply with the requirements of the California Education Code and the International Science and Engineering Fair Regulations for Experiments with Animals.

State of California Education Code Division 8, Chapter 5, Section 1, Article 2

In the public elementary and high schools or in public elementary and high school sponsored activities and classes held elsewhere than on school premises, live vertebrate animals shall not, as part of a scientific experiment or any purpose whatever:

a. Be experimentally medicated or drugged in a manner to cause painful reactions or induce painful or lethal pathological conditions.

b. Be injured through any other treatment, including, but not limited to, anesthetization or electric shock.

Live animals on the premises of a public elementary or high school shall be housed and cared for in a humane and safe manner.

The provisions of this section are not intended to prohibit or constrain vocational instruction in the normal practices of animal husbandry.

International Science and Engineering Fair Regulations for Experiments with Animals

1. The basic aims of experiments involving animals are to achieve an understanding of life processes and to further knowledge. They do not include the development of new or refinement of existing surgical techniques or experiments in toxicological studies. Experiments involving animals (excluding Homo sapiens), vertebrate embryos and fetuses and embryos of fowl within three days of hatching, must have clearly defined objectives requiring the use of animals to demonstrate a biological principle or answer scientific propositions. Such experiments must be conducted with a respect for life and an appreciation of humane considerations that must be afforded all animals.

2. The use of Protista and other invertebrates is to be encouraged for most experiments involving animals. Their wide variety and the feasibility of using larger numbers than is usually possible with vertebrates makes them especially suitable.

3. To provide for humane treatment of animals, an animal care supervisor knowledgeable in the proper care and handling of experimental animals must assume primary responsibility for the conditions under which the animals are maintained. If the school's faculty includes no one with training in this area, the services of a qualified consultant must be obtained.

4. All animals must be lawfully acquired and their care and use must be in compliance with local, state and federal laws.

5. The comfort of the animals used in any experiment using live vertebrate animals shall be a prime concern.

No experiment using live vertebrate animals shall be attempted unless the animals are obtained from a reliable source and the following conditions can be assured: appropriate, comfortable quarters; adequate food and water; human treatment and
gentle handling. Care must be provided at all times, including weekends and vacation periods. An experiment in nutrition deficiency or the ingestion of hazardous or reputedly toxic materials may proceed only to the point where symptoms of the deficiency or toxicity appear.

Appropriate measures shall be taken to correct the deficiency or toxicity, if such action is feasible, or the animal(s) shall be killed by a humane method. Experiments involving stress will be permitted only when such stress does not produce pathological lesions. The student shall not be allowed to provide euthanasia except under close supervision and in the presence of the animal care supervisor.

6. No experiment involving anesthetics, drugs, thermal procedures, physical stress, organisms pathogenic to humans or other vertebrates, ionizing radiation, carcinogens or surgical procedures may be undertaken except under the direct supervision of an experienced and qualified biomedical scientist or designated adult supervisor. (Experiments involving any procedures listed in this paragraph which are not in violation of the "painful reaction" or "injured" restrictions of the California Education Code are permitted if certified by a qualified biomedical scientist prior to the beginning of the investigation.)

It is permissible for the student and designated adult supervisor to consult with a biomedical scientist to obtain detailed instructions and guidance in the techniques to be used by the student under the direct continuous supervision of the designated adult supervisor. In this instance, the designated adult supervisor will be required to certify in writing jointly with the biomedical scientist. Either the biomedical scientist or adult supervisor must provide continuing supervision to assure compliance with the protocol. Major deviations from the approved protocol may be implemented only with the written approval of the biomedical scientist.

The biomedical scientist or adult supervisor must be in the same locality as the student for the duration of the experimental work except for short trips. This means that a project started in one city may not be continued in another unless an alternate designated adult supervisor, approved by the biomedical scientist, agrees to supervise the project prior to the continuation of the experimental work.

A biomedical scientist is defined as one who possesses an earned doctorate degree in science or medicine who has current working knowledge of the techniques to be used in the research under consideration. A designated adult supervisor is defined as an individual who has been properly trained in the techniques and procedures to be used in the investigation. The biomedical scientist must certify that the designated adult supervisor has been so trained.

Students planning research involving the use of live vertebrate animals must, before acquiring them for experimentation (or, in the case of pets or livestock, before starting the experiment):

a. become familiar with the regulations above
b. obtain form, "Certification of Humane Treatment of Live Vertebrate Animals," from the school project advisor, complete the "Protocol" section and return it to the advisor for review and signature.

If the experiment involves procedures described in paragraph 5 on the previous pages, which do not cause "painful reactions" or "injury" to the animal as prohibited by the California Education Code, take the form "Certification of Humane Treatment of Live Vertebrate Animals" to the biomedical scientist who will supervise the research. The biomedical scientist must become familiar with the restrictions as stated on the form as well as with the Protocol before completing the CERTIFICATION BY BIOMEDICAL SCIENTIST.
CERTIFICATION OF HUMANE TREATMENT OF LIVE VERTEBRATE ANIMALS

(page 1)

INSTRUCTIONS: This form, properly completed, must be part of the carefully planned procedures for experimentation with live vertebrate animals. It must accompany any such project exhibited at, or when presented for any public display associated with the ____________Science Fair. All sections must be completed except the "Certification By Biomedical Scientist: and the "Certification by Designated Adult Supervisor" which need be completed only by those students carrying on experiments involving anesthetics, drugs, thermal procedures, physical stress, organisms pathogenic to humans or other vertebrates, ionizing radiation, carcinogens, nutritional deficiencies, toxicity, or surgical procedures as specified on page 2 of this form, please see).

STUDENT DESCRIPTION OF PROTOCOL FOR EXPERIMENT

Purpose of the Project:

Starting Date:

Name and address of site at which investigation will take place:

Number of species of animals to be used:

List objectives of the experiment and describe fully the methods and techniques involved (including planned use of anesthetics, drugs, thermal procedures, physical stress, organisms pathogenic to humans or other vertebrates, radiation, carcinogens or surgical procedures). When the use of electric current, laser beams, sound stimuli or other artificial stimuli are an integral part of the Protocol, they must not exceed the normal tissue tolerances for the species concerned (as indicated in the Biology Data Handbook, 2nd Edition; editors, P.O. Altman and D.S. Dittmer; publisher, Federation of American Societies for Experimental Biology).

Describe proposed methods of animal care (i.e. cage dimensions, type of bedding used, temperature range of cage room, and frequency of feeding, watering and cage cleaning).

Describe planned disposition of all animals used in experiments. (Note: Euthanasia, if conducted, should be performed by the biomedical scientist, the designated adult supervisor or the animal care supervisor. The following methods are acceptable: administration of barbituric acid derivatives in conformance with the provisions of applicable laws*, inhalation of ether or chloroform, induction of hypoxia with carbon dioxide or nitrogen, and cervical dislocation. The following methods are unacceptable: injection of air into the brain and injection of any product containing strychnine, curare, succinylocholine or other neuromuscular blocking agents.)

NAME/ADDRESS OF PERSON WHO WILL PERFORM EUTHANASIA, IF NEEDED:

Name of Entrant ___________________________ School ___________________________

Project title ___________________________

I hereby offer the following as evidence of the compliance of this project with existing law. I and my Project Advisor have studied the quotations of State Law/Education Code and the Regulation of the International Science and Engineering Fair, as found in the ____________Science Fair "Regulation for Experiments with Animals", and declare that this project has been conducted within the letter and the spirit of applicable law.

Student Signature ___________________________

CERTIFICATION OF HUMANE TREATMENT OF LIVE VERTEBRATE
(page 2)

CERTIFICATIONS
THE FIRST TWO CERTIFICATIONS MUST BE COMPLETED FOR ALL PROJECTS
INVAOLING LIVE VERTEBRATE ANIMALS
(see INSTRUCTIONS, page 1)

**CERTIFICATION BY TEACHER/ADVISOR**
I agree to sponsor the student named above and assume responsibility for compliance with the existing rules and regulations pertaining to experiments with animals.

<table>
<thead>
<tr>
<th>Signature</th>
<th>Name (type or print)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date</td>
<td>Institution</td>
</tr>
<tr>
<td></td>
<td>Title</td>
</tr>
<tr>
<td>Institution Address</td>
<td>Phone</td>
</tr>
<tr>
<td>Home Address</td>
<td>Phone</td>
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</table>

**CERTIFICATION BY ANIMAL CARE SUPERVISOR** of compliance with California Education Code and Paragraph 3 of the ISEF Regulation for Experiments with Animals. (Must be completed prior to receipt of animals by the student.)

I certify that I have reviewed and approved the protocol and will supervise and accept primary responsibility for the quality of care and handling of the live vertebrate animals used by the designated student. I further certify that I am knowledgeable in the proper care and handling of experimental animals, meet prevailing animal care supervisory requirements and that, if an animal must be euthanized, I will be present and will perform or direct the procedure using such agents as are recommended.

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<td>Title</td>
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<td>Institution Address</td>
<td>Phone</td>
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<tr>
<td>Home Address</td>
<td>Phone</td>
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</table>

**CERTIFICATION BY DESIGNATED ADULT SUPERVISOR** (if required)
I certify that I have been trained in the techniques to be used by this student and will provide direct supervision for the research.

<table>
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<tr>
<th>Signature</th>
<th>Name (type or print)</th>
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<tbody>
<tr>
<td>Date</td>
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<td>Title</td>
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<td>Institution Address</td>
<td>Phone</td>
</tr>
<tr>
<td>Home Address</td>
<td>Phone</td>
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</table>

**CERTIFICATION BY BIOMEDICAL SCIENTIST** (if required) of compliance with the California Educational Code and paragraph 6 of the ISEF Regulations for Experiments with Animals. (Must be completed prior to the start of the project).

I certify that I have reviewed and approved the protocol; that if the student or designated adult supervisor is not trained in the necessary procedures I will ensure his/her training; that I will assure that the requirements of the California Education Code and the ISEF Regulations for Experiments with Animals are fully met; that I will provide advice and supervision during the project; and that I am a qualified biomedical scientist with a working knowledge of the techniques to be used by the student in this research.

<table>
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<th>Signature</th>
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<td>Date</td>
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<td>Institution Address</td>
<td>Phone</td>
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<tr>
<td>Home Address</td>
<td>Phone</td>
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</tbody>
</table>

**Brief Summary of Experience in the Field Covered by the Protocol:**

This form, properly completed, must accompany all projects covered by the provisions of paragraph 6, ISEF Regulations for Experiments with Animals.
 Students: Complete this page

Name of Entrant: ___________________________ Grade: ________
School: ___________________________ District: ________
Project Title: ___________________________

INSTRUCTIONS AND EXPLANATION OF NEED FOR CERTIFICATION

Because federal regulations have become more rigid, students must plan carefully before undertaking research which involves the use of human subjects in either behavioral or biomedical studies. This will protect subjects from unnecessary exposure to physical or psychological risks and experimenters and schools from legal to complications.

A human subject is legally defined as:

A person about whom an investigator (professional or student) conducting scientific research obtains (1) data through intervention or interaction with the person or (2) identifiable private information.

A subject at risk is legally defined as:

Any individual who may be exposed to the possibility of injury, including physical, psychological or social injury, as a consequence of participation as a subject in any research . . .

Students using human subjects must comply with all regulations that reflect the will of society and plan proper methodology for the protection of those subjects. It is essential that they be alert to humane concerns at all times.

The following steps must be taken before any student begins research involving human subjects:

(1) The student completes the "Protocol" section of this form and submits it to the sponsoring teacher.

(2) The sponsoring teacher reviews the "Protocol" and determines if any potential physical, psychological or social risk is involved.

(a) if none is apparent, the teacher signs the certification. (No additional certification is necessary.)

(b) if any question exists, the student must redesign the experimental study or plan a different study.

NOTE: Any project involving human subjects that is developed with the advice and assistance of personnel at a medical/scientific organization must comply with any regulations of that organization requiring approval of its Institutional Review Board and Informed Consent Certification.
Students: Complete this page

Name of Entrant: ___________________________ Grade: ___________________________

School: ___________________________ District: ___________________________

Project Title: ___________________________

PROTOCOL

Describe proposed experimental procedures:

Explain why human subjects are proposed for this experimentation:

Describe and assess any potential risk (physical, psychological, social, legal, etc.):

Describe the potential benefits to the individual or society:

Signature of Student: ___________________________

Date: ___________________________

CERTIFICATION BY TEACHER/ADVISOR

(Must be completed before the start of experimentation.)

"I certify that, upon reviewing this protocol, I found that the experimental procedures constitute no physical, social or psychological risk to either experimenter or subjects."

"I agree to supervise this experimentation and will insure that it is conducted in a humane, risk-free manner."

Signature ___________________________ Typed Name ___________________________

Institution ___________________________ Title ___________________________

Institution Address ___________________________ Phone ___________________________

Home Address ___________________________ Home Phone ___________________________

Federal Regulations are intended to assure the protection of human subjects in behavior and biomedical research.

"This form, properly completed, must be part of the carefully planned procedures for any experiment involving human subjects. It must accompany any such project exhibited at or presented for any public display associated with the ___________________________ Science Fair."
How Does My Garden Grow?

PROCEDURE

STEP 1
PLANTING

STEP 2
MEASURING

STEP 3
WATERING

STEP 4
KEEPING RECORDS

RESULTS

EXPERIMENTAL MATERIALS

A B C DE

MY RADISHES

CONCLUSION

In my test the plants watered with vitamin C grew best, and A grew next best.
Additional Display Options

*Note: Size limit 2\(\frac{1}{2}\) x 4 feet
First Place

Science Fair

Principal:

Teacher:
Third Place

Science Fair

3rd

Principal

Teacher
Honorable Mention
Science Fair

Principal

Teacher
VII.

The K-5 Science Fair Packet for Home Use
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PARENT INTRODUCTION

Developing a science fair project can be a valuable and rewarding experience for both the student and parent. It allows the student an opportunity to explore areas of science they find interesting, to be creative, and to develop problem solving skills. Science fair projects can also be frustrating and confusing if the process is not fully understood.

The following guide was designed to assist parents in helping their children develop a successful science fair project. I hope that you will take time to read through this entire guide and become informed about the rules, regulations and process involved before embarking on a project idea.

Included in this guide you will find helpful hints on constructing displays and a description of the types of projects which are acceptable. Additionally, I have included a list of judging criteria used to evaluate projects and a list of project ideas from which to choose.
STUDENT INTRODUCTION

The best kind of project is a research project. Research is what science is all about. The title of a research project is usually in the form of a question. But, you don't know the answer to the question before you begin the project.

Research projects involve conducting an experiment and making observations. The experiment and observations help you to answer the question yourself. In some projects you still may not know the answer when the project is completed. Rather, you discover what is not the answer instead!

You are not expected to do original research, something that has never been done before. The answer to almost any question you might develop is probably known by some scientists. It is NOT so much the question that is important but the PROCESS you use in solving the problem.

Questions do not have to be difficult ones; usually a simple question makes the best project. It would be foolish for you to try to solve questions such as "What are the causes of cancer?" or "What chemicals are found in the cell?" or even "How do people learn to speak?". It is better that you do a good job on a little question than a poor job on a big question!

All research projects involve a problem solving method know as the Scientific Method. The scientific method is used by scientists to find the answer to their question. The scientific method is simply a procedure for testing ideas and conducting experiments. What follows is a brief review of the scientific method and the rules (criteria) for creating a science project.
HELPFUL HINTS TO DEVELOPING A SUCCESSFUL SCIENCE FAIR PROJECT

1. START EARLY ---
A TYPICAL PROJECT, from start to finish, will take from two to four months. Starting early will allow time for mistakes (you will make some), gathering data and making good displays.

2. KEEP GOOD RECORDS ---
Most of the judges will look at the student log book; so, it is very important to maintain good, accurate records of your work. Try to keep your log book neatly written so you and the judges can easily see and read the work you've done.

3. USE ILLUSTRATIONS AND PHOTOGRAPHS ---
Pictures (photos and illustrations) should be used to describe the procedures used, recording of data and to how the experiment set-up and design. A good picture is worth a thousand words of explanation.

4. MAKE A STURDY DISPLAY ---
The project display should be neatly organized and built of strong, sturdy materials. If you make the frame of wood, you may be able to use the same frame for future projects.

5. SPEND TIME MAKING THE DISPLAY ---
Again, the time you take to make your project as neat and strong as possible will pay off. Your project should be clearly labeled, attractive and neatly organized (see our suggestions on page 20). A good project on a poor display will not be rated highly and may be overlooked. All reports and labels should be typed.

6. GET HELP WHEN YOU NEED IT ---
Have your parents assist you with (NOT DO) the project. Your teacher will also assist you. When you are finished, have your parents act as judges. Use the judging criteria (page 19 in this book), go through a test by your parents or teachers. Make sure you don't wait too long to start, so you will have time to get help, if you need it.
DEFINITE THE PROBLEM

You can't solve a problem unless you see that one exists. Scientists must be able to see problems and ask questions. You must be able to state a problem in the form of a question. The question must be worded so as to identify the area of study and limit the area to a specific, narrow topic for investigation. For example: Will roots grow in light?, or What conditions favor the rusting of Iron? How does a magnetic field effect the growth of crystals? What wavelength of light has the greatest effect on photosynthesis?

HYPOTHESIS

FORM A HYPOTHESIS

A hypothesis is a proposed answer to your problem. Before you begin an experiment you should make a hypothesis (answer) to your problem. Your experiment must test your hypothesis. The results of your experiment will prove (or disprove) your hypothesis. It isn't important that the hypothesis is correct (right); its purpose is to give you direction in setting up your experiment.
COLLECTING INFORMATION
Before scientists experiment, they spend a lot of time reading. A scientist wants to find out what work has been done on their problem. Reports of research from all over the world are published in many journals, books, and magazines. You must go to the library or to people who have information that will help you understand your problem.

PLANNING THE EXPERIMENT
Before you begin to experiment or build equipment, you should do some planning. Write down what you are going to do to solve your problem. Get some help from parents, teachers, or professionals with backgrounds in your problem area. Write your plan and have one (or more) of these people look it over: problems might be avoided by doing this.

Then.............write down the steps you took to begin and to complete your project. Your journal will help you, if your journal is completed in the right manner.
Make a list that includes EVERYTHING that was used or needed to prove your hypothesis. Don’t leave anything out, and if possible put the items in the order that they were used.

KEEPING A JOURNAL
You must keep a notebook (journal) of everything you do for the project. The journal (notebook) must include your experiment plan, materials use procedure, observations, mistakes, changes .... EVERYTHING! The journal is like a diary of the project, from start to finish.
1. **Title Page**
   Including the title or the question.
   In the bottom right hand corner, include: name, date, period and school.

2. **Introduction**
   Include a statement about your project.
   Also include all of your research about your project.

3. **Hypothesis**
   State your hypothesis.

4. **Materials**
   List your materials.

5. **Method, Procedure**
   List the procedure so you could hand your notebook to someone and they could reproduce the same experiment exactly. This must be a step-by-step description of your project.

6. **Results, Data** (graphs, tables, drawings)
   List in an orderly fashion all of the information that you gathered. This should be done in a neat manner. Also, you must include all of your daily notes and observation sheets at the end of this section.

7. **Conclusion**
   Write your conclusion to your experiment. List any problems, or possible explanations for any unexpected results or findings.

8. **Bibliography**
   List the bibliography.

9. **Acknowledgments**
   This area is for you to give credit to anyone who gave you any special advice or help. Examples: companies that gave you information, people who helped you find information in a library, a store, people who helped you to design or build special parts of your project.
SHOWING YOUR DATA

Plan on using a chart or graph to show your data. Tell which type of graph you will use and what it's title will be.

Use charts and graphs in your daily log.

1. **Bar Graph** -
   A graph in which length of a bar represents a number.
   
   Sample:
   
   ![Bar Graph Example](image)

2. **Pictograph** -
   A picture representing an idea.
   
   Sample:
   
<table>
<thead>
<tr>
<th>Monday</th>
<th>Tuesday</th>
<th>Wednesday</th>
<th>Thursday</th>
<th>Friday</th>
</tr>
</thead>
</table>
   | 🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎🍎애플

3. **Line Graph** -
   All points are connected by straight or curved lines.
   
   Sample:
   
   ![Line Graph Example](image)

4. **Circle or Pie Graph** -
   A graph used to show parts of a whole.
   
   Sample:
RESULTS

What happened when you finished your experiment? Results can be in either written form, paragraph style, or in the form of a graph.

CONCLUSION

When the experiment has been completed, you should be able to reach some conclusion. Can you prove or disprove you hypothesis? Conclusions should be written based on the data. Sometimes, you may obtain data which contradicts your expectations. You may tend to ignore this data and will write a conclusion based on your expectations instead. You must write a conclusion based on the data ALL THE DATA. Sometimes the data may be inconclusive, no clear cut indicators of a conclusion. Be aware SOME EXPERIMENTS WILL FAIL. Honesty and willingness to admit an experiment was unsuccessful is all a part of the scientific method.
You must set up an experiment that will either prove or disprove your hypothesis. The procedure, how much and what kind of materials used must be written in your journal so someone else could do it EXACTLY the same as you.

Experiments are usually designed with both a CONTROL group and an EXPERIMENTAL (or test) group. Having two groups allows comparisons to be made between what occurs under normal conditions and what occurs under test conditions. Suppose you wanted to find out if plants grow better with fertilizer: this is the experimental group. The other plants world not be given the fertilizer: this group is the control group.
PICKING YOUR PROJECT

This booklet contains ideas for science projects. There may be one or more suggestions that you will want to explore. Use these ideas as a springboard to start you thinking. Perhaps you will come up with your own original problem which may bear only a slight resemblance to our suggestion.

In any event, consider the following points in selecting and carrying out your project:

1. Is it possible to complete the project that you are considering in the time you have available? If not, change your project. Develop a time schedule and stick to it.

2. Is the project somewhat original? Does it give you the opportunity to find out through observation or experimentation something you do not already know?

3. Do you have enough experience and knowledge of the techniques that will be necessary to complete the project? Consider whether you have the time and ability it takes to gain the required background knowledge and skills.

4. Can you really define what you want to do? Select a small part of a large idea and really explore this in depth. It is much better to explore a small idea thoroughly than a large idea lightly.

5. What equipment will be necessary for your project? Do you have the finances to secure such equipment? Are you able to borrow certain necessary equipment?

6. Can you do most of the project yourself? If you will require too much outside help, it would be better to select an easier project.

7. What do you already know about your problem? Make a preliminary search for published material related to your project. This will help you "get the picture" more clearly, save you from duplication previous work, suggest additional avenues to explore, and furnish the beginnings of your bibliography.

8. If your experiment involves the use of plants or objects, do you have enough specimens so that your results are reliable? An experiment with just one or two plants proves nothing.

9. If your project requires the use of controls, is your control plant or animal reliable? Since you must compare your experimental plant or animal with your control to determine the changes, your control should NOT be influenced in any way by your experimental plant or animal.
10. Have you started your project log at the very beginning of your investigations? Record your progress, your thoughts, your failures as well as successes. Make careful notes, accurate notes. Put down all the data, even though it doesn't seem to fit. Let the facts speak for themselves.

11. Do you accurately measure and record on charts what you find out? Remember, measurement is the heart of any science project.

12. What are the assumptions upon which you base your experiment? What things do you assume to be true in order to perform your experiment? What would be the effect if your assumptions are not all true?

13. What are the limitations of your findings? Is the weighing instrument satisfactory? Are the samples you are using of the quality you need?

14. Have you talked your project over with others? Wise counsel at the start will often save much wasted time and effort. The questions and comments of others can greatly help your thinking on a problem.

15. What are the possible hazards to your safety, the safety of others, and to any animals or materials used in the project? Can you eliminate such hazards?

16. What conclusions can you draw from the data you collect? Be careful not to draw conclusion unless you have definite evidence to support those conclusions.

17. The preparation of your finished log is important. Science is an orderly study. A sloppy log, poorly written, with misspelled words, conveys but one impression--not very scientific.

18. Have you given credit to those who have helped you? It's honest, it's expected, and you may want help again sometime.

After you have completed your project, use the self-judging score sheet score yourself. Then let your parents and teacher judge you with the same score sheet. Find out where you are weak and improve your project.

* A score of 80 to 100 means you are bound to be a winner.
* If you score 70 to 80, you are close. A little improvement will do it.
* A 60 to 70 score indicates you probably have overlooked something in your work.
* A score under 60 indicates you should talk with your science teacher or someone who understands science and the methods scientists use in their work.
STUDENT CHECK LIST

1. Is my project free of written mistakes and corrections?  
2. Is my spelling, punctuation and grammar correct?  
3. Does my project look neat, and well organized?  
4. Have I included a written report and bibliography to go with my topic?  
5. Do I understand my project well enough to be able to explain and discuss it with judges?  
6. Have I given credit to teachers, parents or other individuals who have assisted me?  
7. Do I understand my data and realize the possible sources of errors in my findings.  
8. Have I completed the necessary forms if my project includes the use of human or vertebrate subjects.  
9. Have I used graphs, tables and charts to summarize the data? Have they been checked for accuracy?  
10. Does my display meet all the regulations for size and safety?  
11. Does my conclusion address the problem and hypothesis?  
12. Is the conclusion based solely on my data, and not my opinion of what I think should have happened.  
13. Does my procedure give a detailed account of what I did? Could someone else read my procedure and conduct my experiment EXACTLY as I did?  
14. Do I have a journal reflecting the entire process of developing my projects, with dates and descriptions from start to finish?
YOUR WRITTEN REPORT CHECKLIST

_____ #1 Title: Clearly state the question of your project.

_____ #2 Abstract: Often a scientific paper begins with a brief abstract or summary of the highlights which are described in the full report. It is usually no more than 3 to 5 sentences. Its purpose is to give the reader an idea of what is contained in a report. The abstract is a great time-saver for the busy scientist who is browsing through many reports and articles. Although the abstract appears on the same page as the title, it is written after the written report is completed.

_____ #3 Introduction and Background Information: You should begin with some word or introductory statement in which you deal with such questions as how you came to select this particular project and why you think it is worth spending time on. The student will give a background in which he describes previous work in the field and basic information about his topic to give proper credit to others for providing previous work, for assistance, and for ideas. Taking credit for yourself for ideas or work done by others is not part of scientific attitude.

_____ #4 The Question and Purpose: The introduction leads to a clear statement of the specific problem which you have attacked.

_____ #5 The Hypothesis: State what you thought was going to happen before you began this project.

_____ #6 The Materials and Method: The statement of the problem and the hypothesis are followed by a detailed description of the materials used and the methods employed. This description must be so exact and so complete that anyone who wants to do so can replicate your experiment. Often a photograph or a diagram of your setup can save a great many words of description.

_____ #7 The Observation: Naturally, you must report what happened. How you summarize your results will depend on the type of investigation you have carried out, but pictures and tables are always appropriate.

_____ #8 Analysis and Results: After you have summarized your observations, you are to analyze and interpret them. Graphs are helpful to make clear the direction in which your results point.

_____ #9 In Conclusion: The analysis of the results lead to a statement of conclusion. You should give the line of reasoning, the logic which leads you to reach the conclusion. Please refer back to the section on "Keeping Your Daily Log."
#10 Limitations: The logic by which you reached your conclusion may have some flaws, or you may realize that your experiment had certain weaknesses. This is the time to state the limitations for your conclusion and the source of error which weaken your results. It is better to state these limitations yourself than to have them pointed out to you later.

#11 Implications and Applications: In light of the weaknesses and limitations of your experiment, which are the limitations? Can you suggest any further research along these lines? Are there any practical applications which may grow out of this work? Do not hesitate to state them here!

#12 Bibliography: It is necessary to list all reference which you used in your work. These references are to be listed in alphabetical order by author’s name at the end of the report.
STUDENT EVALUATION FORM

RATE YOUR OWN PROJECT:
TITLE OF PROJECT ____________________________ Name _______________

A. CLASSIFICATION OF PROJECT  (Classify as to type - score between suggested point values)

<table>
<thead>
<tr>
<th>INVESTIGATION:</th>
<th>Problem requires experimentation and/or collecting and analyzing data in order for student to arrive at some conclusion or theory</th>
<th>20-30 pts.</th>
</tr>
</thead>
<tbody>
<tr>
<td>TECHNICAL OR SOME EXPERIMENTATION:</td>
<td>Basically an applied science project. Student constructs something using principles of science and/or has done an experiment which is basically a demonstration.</td>
<td>15-25 pts.</td>
</tr>
<tr>
<td>ILLUSTRATION:</td>
<td>The student is showing something about science through a collection, display, art, or craft medium. Very little scientific or technical</td>
<td>5-15 pts.</td>
</tr>
</tbody>
</table>

B. LOG OR NOTEBOOK  (This is to be judged - choose most appropriate sentence)

<table>
<thead>
<tr>
<th>PROBLEM OR IDEA:</th>
<th>Problem or idea of project highly original</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Problem or idea somewhat original and/or approach original</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Problem or idea not original - but quite difficult or unusual</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Problem or idea not original - idea quite common</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Problem or idea not clear or lacking</td>
<td>0</td>
</tr>
<tr>
<td>BACKGROUND</td>
<td>Student possessed or secured adequate background information through reference books, interviews, and/or experimentation</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Fairly adequate background information - student make sincere attempt to secure more information</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>No background information necessary or difficult to evaluate</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Limited information secured even though available and desirable</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>No attempt to secure any information even though necessary</td>
<td>0</td>
</tr>
<tr>
<td>OBSERVATIONS:</td>
<td>Usually keen observations made during work</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Good observations were made during work</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Unable to determine because of type of project</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Some observations made - many overlooked</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>No observations made even though warranted</td>
<td>0</td>
</tr>
<tr>
<td>RECORDING DATA:</td>
<td>Usually fine job of recording data: written records, graphs, pictures, and/or notes</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Data carefully and accurately recorded, mechanics good</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Project did not require recordings of data or item hard to evaluate</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Data recorded in a somewhat acceptable manner - some lacking</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Data poorly recorded</td>
<td>0</td>
</tr>
<tr>
<td>CONCLUSIONS OF STUDENT:</td>
<td>Conclusions or results of work valid, based on experimentation, observations, or technical work. Shows insight</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Conclusions or results valid, based on work</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>No conclusions possible or difficult to evaluate</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Conclusions somewhat valid</td>
<td>2</td>
</tr>
<tr>
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SCIENCE FAIR EVALUATION

Name ____________________________________________
Title of Project ______________________________________
Why did you choose this subject (explain fully) ________________________________

How much time do you feel you spent? (hours)
1. Researching material __________________________
2. Preparing reports ____________________________
3. Conducting your experiments or surveys _________
4. Assembling your display __________________________

Have you done anything like this before? YES NO (circle one)

Do you think this was a worth-while idea? 4YES NO (circle one)
If no, why not? ______________________________________

Do you feel your research skills are better as a result of this activity? YES NO (circle one)

What do you think was the most important thing(s) you learned? ________________

Is this something you would like to do again? YES NO (circle one)
If no, why not? ______________________________________

If your friends from another room saw the displays, what did they say about them?
________________________________________________________________________

If your parents saw them what did they say? ________________________________
JUDGING CRITERIA

DISPLAY
- Neatly prepared and well organized
- Free of misspellings and corrections
- Visually attractive
- Equipment, charts, graphs, illustrations, etc. clearly labeled
- Use of tales, graphs to summarized data

REPORT/JOURNAL/RESEARCH
- Student has done sufficient research for the scope of the project
- Research is presented in a written report
- Journal is neat, organized, and reflects the entire process used in developing the project
- Student has consulted several sources in his/her research
- Bibliography is included in written report

SCIENTIFIC CONTENT
- Clear statement of the problem or aim of project
- Title of project reflects the problem
- Clearly stated hypothesis
- Materials and procedures are listed, accurate and detailed
- Approach to the problem is consistent with the scientific method
- Accurate collection and treatment of data
- Logical conclusion drawn from data
- Student aware of sources of error, and suggests further areas of study

THROUGHNESS
- The study is complete within the scope of the problem
- Experiment has been repeated or sufficient numbers have been tested
- Project skillfully designed to yield valid, reliable and accurate data

SKILL
- Special skill needed for construction or use of equipment is evident
- Special mathematical, computation or observational skills are evident
- Level of difficulty of the project appropriate form grade level

CREATIVITY
- The problem is original or is a unique approach to an old problem (considering the students grade level)
- Equipment and materials are used ingeniously:
  - In the manner of presentation
  - In recognizing practical possibilities and limitations
- Student has chosen a relevant problem for the project
**Problem:** Will vitamins help plants grow?

**Research:**
- Survey
- Plant
- Watering
- Dad/Gardener

**Hypothesis:** I think Vitamin C will help because it comes from the sun.

**Procedure:**
1. Planting
2. Measuring
3. Watering
4. Keeping records

**Results:**

**Conclusion:** In my test the plants watered with Vitamin C grew best, and A grew next best.
Additional Display Options

*Note: Size limit 2 $\frac{1}{2}$ x 4 feet
PROJECTS RELATED TO ASTRONOMY

1. HOW MUCH OF THE SUN'S LIGHT REACHES THE EARTH?
   Light goes out from the sun in all directions. Considering the distance that the earth is away from the sun, what part of the sun's total light eventually reaches the earth?

2. IS THERE A FORM OF LIFE ON OTHER PLANETS?
   Find out the conditions for life on the various planets. Reproduce these conditions as best you can and expose culture mediums to these conditions. Attempt to grow some form of bacteria in each of these conditions.

3. CAN YOU DESIGN A ROCKET FOR TRAVEL TO ANOTHER GALAXY?
   What are the problems involved in such a long distance journey?

4. DOES THE EARTH TURN?
   Try to collect as much evidence as possible to prove that the earth does spin on its axis.

5. CAN YOU CHART THE MOON?
   With a telescope or binoculars study the moon and draw a map of it. Locate on your drawing as many geographical features as you can observe. What is the best time of month for observing the moon?

6. HOW WOULD THE EARTH APPEAR TO AN OBSERVER ON THE MOON?
   Would the earth go through phases? Would you see the earth at some times and not at others? Would there be an earth-rise and an earth-set?

7. DOES THE MOON RISE AT THE SAME TIME EVERY NIGHT?
   If not, why not?

8. HOW BRIGHT IS THE MOON?
   Can you use a photography light meter or some other instrument to determine the brightness of the moon? Compare it with the brightness of the sun. Can you use photographic paper to measure the light?

9. DOES THE MOON CHANGE IN SIZE?
   The moon appears very large when it first rises. It seems to get smaller as it moves overhead and then seems to grow in size again as it moves downward toward the west. Can you develop a method for proving either that the moon does or does not change size?
10. HOW FAST DOES THE MOON TRAVEL AROUND THE EARTH?
Does the moon always move at constant speeds? How many degrees
does the moon seem to move across the sky every hour? Compare this
with the number of degrees that the stars seem to move.

11. HOW FAST DO STARS MOVE?
Develop a method for determining the apparent distance that a star
moves in a period of time. See if all stars are moving across the sky at
the same rate. Attempt to explain what causes the movement of the stars.

12. HOW LONG DOES IT TAKE THE MOON TO MAKE ONE COMPLETE TRIP
AROUND THE EARTH?
Determine this figure through observation rather than through reading.
What would happen to the orbit of the moon if the moon should speed up
in its path around the earth? Whirl a ball on a rubber string and see what
happens.

13. WHAT CAUSES THE PHASES OF DIFFERENT SHAPES OF THE MOON?
Darken a room and use a slide projector and a large rubber ball or
basketball.

14. DOES THE MOON REVOLVE?
Note the position of various features on the moon over a period of time.

15. WHAT ANIMALS ARE MORE ACTIVE AT NIGHT?
Does this activity depend on moonlight?
What effect does the shape of the moon
have upon success in fishing?

16. HOW DOES THE SURFACE OF THE MOON
COMPARE WITH THAT OF THE EARTH?
What causes the seas on the moon?
Can you measure some of these seas?

17. ARE ALL THE CRATERS ON THE MOON ALIKE?
Why do the craters on the moon seem to run in a straight line?
What is your theory?

18. WHY ARE THE MOUNTAINS ON THE MOON TALLER AND MORE
JAGGED THAN THOSE ON THE EARTH?
Try some experiments with erosion and weathering.
19. COULD PLANTS GROW IN SOIL FOUND ON THE MOON?
What plants and animals might live in the temperature extremes of the moon? How long would various insects, plants, and animals continue to live if exposed to an atmosphere similar to that of the moon?

20. HOW COULD YOU TALK ON THE MOON?
Can you experiment with talking through solids, radio in a vacuum, etc.?

21. IS THERE ONLY ONE MOON IN OUR SOLAR SYSTEM?

22. IS THE MOON LARGER THAN THE SUN?
Why does it appear larger?

23. CAN WEATHER PREDICTIONS BE MADE ACCURATELY FROM THE MOON'S APPEARANCE?

PROJECTS RELATED TO METEOROLOGY

1. CAN YOU KEEP A DAILY WEATHER CHART?
Record the temperature, barometric pressure, and type of weather you have each day at a certain definite time. Note any relationship between temperature, pressure and the type of weather that follows. Then see if you can predict weather from the data you have gathered.

2. CAN YOU PREDICT THE WEATHER BY OBSERVING CLOUD FORMATIONS?
Through library research study the types of clouds. Then keep a cloud diary. In this diary list the type of cloud, its height, and the amount of cloud cover in the sky. Record the weather conditions that follow. After you have studied the comparison, see if you can predict the weather from cloud formations.

3. CAN A HOME-MADE WEATHER STATION MAKE AN ACCURATE WEATHER REPORT?
Develop a home-made weather station by making various weather instruments, including a barometer, humidity gauge, wind vane, rain trap, and rain gauge. Use this equipment to make and record weather data. See how accurately you can forecast with this data.
4. SUNRISES AND SUNSETS: DO THEY VARY AND WHY?
Record sunrise and sunset time for a number of months. Determine how much difference there is between sunrise on day and sunrise on the following day. Is the rate of change consistent from day to day? Record your data on a graph and then explain the result.

5. COLOR: DOES IT AFFECT EVAPORATION?
Cover containers with various colored materials. Fill them with water. Determine out of which container the water evaporates first. Is there a relationship between the rate of evaporation and the color of the container?

6. WHAT FACTORS AFFECT THE EVAPORATION OF WATER?
Place containers in different locations which vary the temperature, light, and other factors. See which container evaporates first. Repeat the experiment, using different-shaped containers.

7. DOES HEIGHT AFFECT TEMPERATURE?
Measure the temperature at different heights for a certain location. Conduct this experiment both inside and outside your home at various hours of the day. Determine when and if an increase in height does affect the temperature.

8. HOW ACCURATE IS THE TV WEATHER MAN?
Compare your predictions with the TV weatherman. Then record the actual weather that occurs. Figure your percentage of error as compared with the TV forecaster.

9. HOW DOES THE TEMPERATURE OF THE AIR AFFECT THE GROUND TEMPERATURE?
Record the air temperature and the ground temperature over a period of time. Record them at various hours of the day. What theory can you develop to explain the results?

10. HOW DOES THE TEMPERATURE OF THE AIR AFFECT THE TEMPERATURE UNDER THE GROUND?
Dig holes of varying depth and insert small thermometers. Fill the holes back in with dirt. Record the air temperature and these various underground temperatures over a period of time. Does the ground get colder or warmer the farther down you go? How does the temperature in a cave compare with the temperature above the ground?

11. WHICH WAY DOES THE WIND BLOW MOST FREQUENTLY?
Measure the wind direction each morning and each night for a period of time. What is the percentage of time that the wind is blowing? Determine the percentage of time that the wind blows from various directions. Is wind direction related to the weather that follows?
12. **HOW DOES THE HEIGHT OF AIR ABOVE THE FLOOR AFFECT ITS TEMPERATURE?**
   Record the temperature at different heights up to the ceiling. Compare your results after you have done several rooms. Check outside temperatures in the same way.

13. **WHAT OBJECTS AROUND YOU INDICATE THE SEASON OF THE YEAR?**
   If you woke up after a long Rip van Winkle sleep; how would you decide what season of the year it was? What causes the seasonal changes that you would find in plants, animals, temperature, etc.?

**PROJECTS RELATED TO GEOLOGY**

1. **WHAT CAUSES A DESERT?**
   Investigate the conditions which produce the various deserts found in your state. How do these conditions vary from one geographical location to another? Can you re-create, on a small scale, conditions which might temporarily support desert vegetation and wildlife? Can this exist permanently?

2. **CAN YOU MINE GOLD?**
   Find out the various methods of mining for gold. Investigate the streams and land areas around you and in other areas of the state you have an opportunity to check. Are you able to locate sources of gold?

3. **WHY DO SOME ROCKS FLOAT?**
   Why do some rocks float while other rocks sink? Pumice sometimes floats and at other times sinks. See if you can investigate the factors affecting the buoyancy of pumice and other floating rocks.

4. **DOES BEACH SAND CONTAIN IRON?**
   Sand often contains small particles of iron which you can detect with a magnet. Are such iron deposits part of the sand on every beach? Is there more iron in the sand near the mouth of a river? What causes such deposits?

5. **HOW ARE VOLCANOES FORMED?**
   Do some library research on the different types of volcanoes. Visit any that are in your area. Construct a model for each type.

6. **HOW DO ROCKS CHANGE?**
   Examine rock in many locations. Attempt to explain what changes that rocks have undergone since their formation. Try to analyze which natural forces have been working on these rock. Examples of such natural forces would be wind and water erosion.
7. IS ROCK EVER "SOFT"?
One of the methods of rock identification is by degree of hardness. How can you tell how hard or "soft" a rock is?

8. HOW DO THE VARIOUS TYPES OF ROCKS BECOME SOIL?
Learn the difference between metamorphic, sedimentary, and igneous rocks. Then try to produce soil from examples of each. Which type erodes the easiest? Which type produces the richest soil? Can you make a seed grow in the soil you have produced?

9. HOW ACTIVE HAVE VOLCANOES BEEN IN YOUR STATE?
With the aid of library research trace the story of volcanic activity in your state. Collect examples of the lavas in as many locations as you can. See if you can actually chart some of these flows and eruptions on a map of your own.

10. HOW IS SOIL FORMED?
From library research, determine the composition of various types of soil. Examine soils around your area and compare with your findings. See if you can produce some of the soils mechanically from raw materials.

11. HOW ARE FOSSILS FORMED?
Through library research discover the different types of fossils: imprints, casts, etc. Try to reproduce these different fossil types artificially through the use of plaster of paris, clay, or other material. In what type of soil are fossils usually found? Examine the ground around the area where you live. What is the most likely fossil type in your area?

PROJECTS RELATED TO CHEMISTRY

1. WHY DOES INK CHANGE COLOR WHEN YOU WIPE OFF YOUR PEN?
What causes the change in color: something in the air, dyes in ink, type or temperature of the water in the ink, or the various kinds of paper? Vary some of these conditions as well as the type and color of the ink.

2. WHAT IS THE EFFECT OF FREEZING UPON VARIOUS HOUSEHOLD ITEMS?
Are clocks affected by freezing temperatures? Motors? Fruits and vegetables? Ink? A flashlight? A bar or soap? Try freezing almost anything found around the house and then try to explain the results.

3. HOW FAST DOES WATER "CLIMB"?
Fill cups with water colored with bluing or vegetable dyes. Place different types of materials hanging with one end in the water. Time them to see
which material water can climb the fastest. Suggested materials are: wool, outing flannel, cotton, taffeta, nylon, paper toweling, notebook paper, wax paper, blotting paper, string.

4. CAN YOU MAKE COLORED SALT CRYSTALS?
Find out how to "grow" salt crystals. See if you can grow colored salt crystals by using food coloring, dyes, etc. in the liquid. Can you grow bigger crystals by using other forms of salt instead of table salt? Do you alter crystal growth by adding other liquids to the salt solution?

5. WHAT EFFECTS DO DIFFERENT LIQUIDS HAVE ON EGGS?
Submerge the eggs in such liquids as vinegar, bleach, alcohol, gasoline, milk, water, etc. Leave the eggs in the liquid for varying lengths of time. Examine the outer shell of the the egg. Break open the egg and examine the inside. Do all liquids affect eggs in the same way?

6. ARE DETERGENTS HARMFUL TO PLANT AND ANIMAL LIFE?
Test the effect of detergents in the water used to water plants. Place guppies of goldfish in water polluted with detergent. Use the detergent water for drinking water for rats or white mice. Be sure to have a control for each experiment.

7. WHAT MATERIAL WILL DISSOLVE IN WATER?
Try dissolving some solids (salt, sugar, butter, flour, egg, etc.) in cold water. Does stirring help? What effect does heat have on the ability of water to dissolve materials? Try dissolving different materials in water of varying temperatures. What effect does the amount of surface area have on the rate at which a substance dissolves in a liquid? Try dissolving a large piece of material. Then try breaking the material into small pieces.

8. WHAT IS THE WATER CYCLE?
Can you make an artificial water cycle?

9. CAN YOU LIST AND IDENTIFY THE MATERIALS AROUND YOU?
Which are solids? Liquids? Gases? Can you change materials (matter) from one state to another (solid to liquid, etc.)?

PROJECTS RELATED TO BIOLOGY

1. WHAT ARE THE TEMPERATURE LIMITS FOR LIFE OF DIFFERENT PLANTS?
What is the coldest and warmest temperature at which they will live and flourish? Is temperature the only condition that varies, or is moisture involved too?

2. WHAT IS THE MINIMUM WATER REQUIREMENT FOR VARIOUS PLANTS?
Plant a number of seeds in small containers. Give each seed a different amount of water, keeping a careful chart on the amount and frequency of watering. Does a plant prefer a small amount of water often or a larger amount less frequently? What is the maximum amount of water a plant can receive and still flourish? Try bean seeds, corn kernels, grass seeds, wheat grains.

3. DOES WATER CONTAIN AIR?
   Do fish need air in water in order to live? How does pollution in the water affect the plant and animal life?

4. WHAT PLANTS NEED LIGHT IN ORDER TO GROW?
   How much light a day must different forms of plant life have? How much light is necessary for mushrooms to grow?

5. WILL SOME PLANTS GROW IN DIFFERENT FORMS OF ARTIFICIAL LIGHT?
   What effect does colored light have on the growth of various plants?

6. WHAT ARE THE LIGHT REQUIREMENTS OF ANIMALS?
   What animals seek light? What animals avoid light? How are the eyes of various living things alike and unalike?

7. WHAT PLANTS AND ANIMALS CAN ADJUST TO CHANGING ENVIRONMENTS?
   What plants and animals are unable to adjust?

8. HOW DOES COLORATION AFFECT AN ANIMAL'S ABILITY TO SURVIVE?
   How are some animals able to change their coloration in order to blend in with their environment? Why are some animals colored with "warning" colors? What effect does the changing of the coloration of an animal have on its ability to live in its environment?

9. HOW DO VARIOUS ANIMALS AVOID BEING EATEN?
   What insects do not seem to appeal to insect-eating animals and birds?

10. WHAT ANIMALS ARE PROTECTED BECAUSE OF THEIR GENERAL APPEARANCE?
   What animals (particularly insects) depend on being mistaken for other animals?

11. DO ALL SPIDERS SPIN WEBS?
   How do different spiders spin their webs? How strong are the webs of different spiders? Will one spider get caught in the web of another? How does a spider avoid being caught in her own web?
12. CAN SPIDERS SEE?
   How well can they see? Can spiders detect odors? What do spiders eat? Do all spiders bite? How? What environmental changes can the spider withstand?

13. WHAT DO CENTIPEDES EAT?
   How many legs do centipedes have? Do they exhibit a positive or negative tropism toward light?

14. WHAT KIND OF INSECTS LIVE IN YOUR AREA?
   Pick out one small section and keep record throughout the year. Which of the insects are helpful to man? Which of them are harmful to man?

15. WHAT ARE THE CHARACTERISTICS OF AN INSECT?
   Examine a grasshopper. How do insects smell and feel? Can you investigate the vision of various insects? Can you measure the number of vibrations per second that various insects move their wings? How do insects hear? Can you compare the hearing ability in various insects?

16. HOW DOES A BIRD TAKE A BATH?
   Make a shallow birdbath and put it in a well-protected place. The discarded top of a garbage can makes a fine birdbath. The depth should vary from one to two or three inches. Use sand or gravel to regulate the depth. Do all the birds which frequent your area take baths? Do some birds bathe more often than others? Which birds use shallow water and which use the deeper spots? Do they all bathe in the same way? What time of day is the most popular? How long does the average bird stay in the water? Do the temperature and the weather affect bird bathing?

17. ARE ALL BIRDS ABLE TO FLY?
   Why have some birds apparently lost the power of flight? Do all birds fly in the same way? Make careful observations and draw the various flight patterns on a chart. Does the flight pattern have any connection with the king of food the birds eat?

18. WHAT IS THE DIFFERENCE BETWEEN A BUTTERFLY AND A MoTH?
   Can you observe them both through a life cycle.

19. WHAT INSECTS ARE BUGS?
   What is the difference between bugs and other insects? How do the wings of various insects differ?

20. WHAT FOOD WILL THE GRASSHOPPER EAT?
   How does the grasshopper chew its food? How often must grasshoppers eat? Can they do without water or food for a longer period of time?
VIII.

The 6-12 Science Fair Packet for Home Use
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<td>Sample Fair Display Styles</td>
<td>18-19</td>
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</tbody>
</table>

Projects Related to:
- Astronomy .................................. 20-22
- Biology .................................... 23-34
- Chemistry .................................. 35-47
- Geology .................................... 48-49
- Meteorology ................................ 50-51
PARENT INTRODUCTION

Developing a science fair project can be a valuable and rewarding experience for both the student and parent. It allows the student an opportunity to explore areas of science they find interesting, to be creative, and to develop problem solving skills. Science fair projects can also be frustrating and confusing if the process is not fully understood.

The following guide was designed to assist parents in helping their children develop a successful science fair project. I hope that you will take time to read through this entire guide and become informed about the rules, regulations and process involved before embarking on a project idea.

Included in this guide you will find helpful hints on constructing displays and a description of the types of projects which are acceptable. Additionally, I have included a list of judging criteria used to evaluate projects and a list of project ideas from which to choose.
The best kind of project is a research project. Research is what science is all about. The title of a research project is usually in the form of a question. But, you don't know the answer to the question before you begin the project.

Research projects involve conducting an experiment and making observations. The experiment and observations help you to answer the question yourself. In some projects you still may not know the answer when the project is completed. Rather, you discover what is not the answer instead!

You are not expected to do original research, something that has never been done before. The answer to almost any question you might develop is probably known by some scientists. It is NOT so much the question that is important but the PROCESS you use in solving the problem.

Questions do not have to be difficult ones; usually a simple question makes the best project. It would be foolish for you to try to solve questions such as "What are the causes of cancer?" or "What chemicals are found in the cell?" or even "How do people learn to speak?". It is better that you do a good job on a little question than a poor job on a big question!

All research projects involve a problem solving method know as the Scientific Method. The scientific method is used by scientists to find the answer to their question. The scientific method is simply a procedure for testing ideas and conducting experiments. What follows is a brief review of the scientific method and the rules (criteria) for creating a science project.
HELPFUL HINTS TO DEVELOPING A SUCCESSFUL SCIENCE FAIR PROJECT

1. START EARLY ---
A TYPICAL PROJECT, from start to finish, will take from two to four months. Starting early will allow time for mistakes (you will make some), gathering data and making good displays.

2. KEEP GOOD RECORDS ---
Most of the judges will look at the student log book; so, it is very important to maintain good, accurate records of your work. Try to keep you log book neatly written so you and the judges can easily see and read the work you've done.

3. USE ILLUSTRATIONS AND PHOTOGRAPHS ---
Pictures (photos and illustrations) should be used to describe the procedures used, recording of data and to how the experiment set-up and design. A good picture is worth a thousand words of explanation.

4. MAKE A STURDY DISPLAY ---
The project display should be neatly organized and built of strong, sturdy materials. If you make the frame of wood, you may be able to use the same frame for future projects.

5. SPEND TIME MAKING THE DISPLAY ---
Again, the time you take to make your project as neat and strong as possible will pay off. Your project should be clearly labeled, attractive and neatly organized (see our suggestions on page 18). A good project on a poor display will not be rated highly and may be overlooked. All reports and labels should be typed.

6. GET HELP WHEN YOU NEED IT ---
Have your parents assist you with (NOT DO) the project. Your teacher will also assist you. When you are finished, have your parents act as judges. Use the judging criteria (page 17 in this book), go through a test by your parents or teachers. Make sure you don't wait to long to start, so you will have time to get help, if you need it.
**PROBLEM**

**DEFINE THE PROBLEM**
You can't solve a problem unless you see that one exists. Scientists must be able to see problems and ask questions. You must be able to state a problem in the form of a question. The question must be worded so as to identify the area of study and limit the area to a specific, narrow topic for investigation. For example: Will roots grow in light?, or What conditions favor the rusting of iron? How does a magnetic field effect the growth of crystals? What wavelength of light has the greatest effect on photosynthesis?

---

**HYPOTHESIS**

**FORM A HYPOTHESIS**
A hypothesis is a proposed answer to your problem. Before you begin an experiment you should make a hypothesis (answer) to your problem. Your experiment must test your hypothesis. The results of your experiment will prove (or disprove) your hypothesis. It isn't important that the hypothesis is correct (right); its purpose is to give you direction in setting up your experiment.
COLLECTING INFORMATION
Before scientists experiment, they spend a lot of time reading. A scientist wants to find out what work has been done on their problem. Reports of research from all over the world are published in many journals, books, and magazines. You must go to the library or to people who have information that will help you understand your problem.

PLANNING THE EXPERIMENT
Before you begin to experiment or build equipment, you should do some planning. Write down what you are going to do to solve your problem. Get some help from parents, teachers, or professionals with backgrounds in your problem area. Write your plan and have one (or more) of these people look it over: problems might be avoided by doing this.

Then.............write down the steps you took to begin and to complete your project. Your journal will help you, if your journal is completed in the right manner.
A

leave anything out, and if possible put the items in
the order that they were used.

MATERIALS

Make a list that includes EVERYTHING that was
used or needed to prove your hypothesis. Don’t
leave anything out, and if possible put the items in
the order that they were used.

DATA / OBSERVATIONS

KEEPING A JOURNAL
You must keep a notebook (journal) of everything you do for the project.
The journal (notebook) must include your experiment plan, materials use
procedure, observations, mistakes, changes .... EVERYTHING! The
journal is like a diary of the project, from start to finish.

I saw yellow spots.
SCIENCE FAIR NOTEBOOK

1. Title Page
   Including the title or the question.
   In the bottom right hand corner, include: name, date, period and school.

2. Introduction
   Include a statement about your project.
   Also include all of your research about your project.

3. Hypothesis
   State your hypothesis.

4. Materials
   List your materials.

5. Method, Procedure
   List the procedure so you could hand your notebook to someone and
   they could reproduce the same experiment exactly. This must be a
   step-by-step description of your project.

6. Results, Data (graphs, tables, drawings)
   List in an orderly fashion all of the information that you gathered. This
   should be done in a neat manner. Also, you must include all of your
   daily notes and observation sheets at the end of this section.

7. Conclusion
   Write your conclusion to your experiment. List any problems, or
   possible explanations for any unexpected results or findings.

8. Bibliography
   List the bibliography.

9. Acknowledgments
   This area is for you to give credit to anyone who gave you any special
   advice or help. Examples: companies that gave you information,
   people who helped you find information in a library, a store, people
   who helped you to design or build special parts of your project.
SHOWING YOUR DATA

Plan on using a chart or graph to show your data. Tell which type of graph you will use and what it’s title will be.

Use charts and graphs in your daily log.

1. **Bar Graph**
A graph in which length of a bar represents a number.

Sample:

![Bar Graph Example]

2. **Pictograph**
A picture representing an idea.

Sample:

Apples picked in five days

![Pictograph Example]

one 🍎 = 100 apples

3. **Line Graph**
All points are connected by straight or curved lines.

Sample:

![Line Graph Example]

4. **Circle or Pie Graph**
A graph used to show parts of a whole.

Sample:

![Pie Graph Example]
What happened when you finished your experiment? Results can be in either written form, paragraph style, or in the form of a graph.

When the experiment has been completed, you should be able to reach some conclusion. Can you prove or disprove you hypothesis? Conclusions should be written based on the data. Sometimes, you may obtain data which contradicts your expectations. You may tend to ignore this data and will write a conclusion based on your expectations instead. You must write a conclusion based on the data ALL THE DATA. Sometimes the data may be inconclusive, no clear cut indicators of a conclusion. Be aware SOME EXPERIMENTS WILL FAIL. Honesty and willingness to admit an experiment was unsuccessful is all a part of the scientific method.
You must set up an experiment that will either prove or disprove your hypothesis. The procedure, how much and what kind of materials used must be written in your journal so someone else could do it EXACTLY the same as you.

Experiments are usually designed with both a CONTROL group and an EXPERIMENTAL (or test) group. Having two groups allows comparisons to be made between what occurs under normal conditions and what occurs under test conditions. Suppose you wanted to find out if plants grow better with fertilizer: this is the experimental group. The other plants would not be given the fertilizer: this group is the control group.
PICKING YOUR PROJECT

This booklet contains ideas for science projects. There may be one or more suggestions that you will want to explore. Use these ideas as a springboard to start you thinking. Perhaps you will come up with your own original problem which may bear only a slight resemblance to our suggestion.

In any event, consider the following points in selecting and carrying out your project:

1. Is it possible to complete the project that you are considering in the time you are considering in the time you have available? If not, change your project. Develop a time schedule and stick to it.

2. Is the project somewhat original? Does it give you the opportunity to find out through observation or experimentation something you do not already know?

3. Do you have enough experience and knowledge of the techniques that will be necessary to complete the project? Consider whether you have the time and ability it takes to gain the required background knowledge and skills.

4. Can you really define what you want to do? Select a small part of a large idea and really explore this in depth. It is much better to explore a small idea thoroughly than a large idea lightly.

5. What equipment will be necessary for your project? Do you have the finances to secure such equipment? Are you able to borrow certain necessary equipment?

6. Can you do most of the project yourself? If you will require too much outside help, it would be better to select an easier project.

7. What do you already know about your problem? Make a preliminary search for published material related to your project. This will help you "get the picture" more clearly, save you from duplication previous work, suggest additional avenues to explore, and furnish the beginnings of your bibliography.

8. If your experiment involves the use of plants or objects, do you have enough specimens so that your results are reliable? An experiment with just one or two plants proves nothing.

9. If your project requires the use of controls, is your control plant or animal reliable? Since you must compare your experimental plant or animal with your control to determine the changes, your control should NOT be influenced in any way by your experimental plant or animal.
10. Have you started your project log at the very beginning of your investigations? Record your progress, your thoughts, your failures as well as successes. Make careful notes, accurate notes. Put down all the data, even though it doesn't seem to fit. Let the facts speak for themselves.

11. Do you accurately measure and record on charts what you find out? Remember, measurement is the heart of any science project.

12. What are the assumptions upon which you base your experiment? What things do you assume to be true in order to perform your experiment? What would be the effect if your assumptions are not all true?

13. What are the limitations of your findings? Is the weighing instrument satisfactory? Are the samples you are using of the quality you need?

14. Have you talked your project over with others? Wise counsel at the start will often save much wasted time and effort. The questions and comments of others can greatly help your thinking on a problem.

15. What are the possible hazards to your safety, the safety of others, and to any animals or materials used in the project? Can you eliminate such hazards?

16. What conclusions can you draw from the data you collect? Be careful not to draw conclusion unless you have definite evidence to support those conclusions.

17. The preparation of your finished log is important. Science is an orderly study. A sloppy log, poorly written, with misspelled works, conveys but one impression—not very scientific.

18. Have you given credit to those who have helped you? It's honest, it's expected, and you may want help again sometime.

After you have completed your project, use the self-judging score sheet to score yourself. Then let your parents and teacher judge you with the same score sheet. Find out where you are weak and improve your project.

* A score of 80 to 100 means you are bound to be a winner.
* If you score 70 to 80, you are close. A little improvement will do it.
* A 60 to 70 score indicates you probably have overlooked something in your work.
* A score under 60 indicates you should talk with your science teacher or someone who understands science and the methods scientists use in their work.
STUDENT CHECK LIST

1. Is my project free of written mistakes and corrections? ___

2. Is my spelling, punctuation and grammar correct? ___

3. Does my project look neat, and well organized? ___

4. Have I included a written report and bibliography to go with my topic? ___

5. Do I understand my project well enough to be able to explain and discuss it with judges? ___

6. Have I given credit to teachers, parents or other individuals who have assisted me? ___

7. Do I understand my data and realize the possible sources of errors in my findings. ___

8. Have I completed the necessary forms if my project includes the use of human or vertebrate subjects. ___

9. Have I used graphs, tables and charts to summarize the data? Have they been checked for accuracy? ___

10. Does my display meet all the regulations for size and safety? ___

11. Does my conclusion address the problem and hypothesis? ___

12. Is the conclusion based solely on my data, and not my opinion of what I think should have happened. ___

13. Does my procedure give a detailed account of what I did? Could someone else read my procedure and conduct my experiment EXACTLY as I did? ___

14. Do I have a journal reflecting the entire process of developing my projects, with dates and descriptions from start to finish? ___
YOUR WRITTEN REPORT CHECKLIST

#1 Title: Clearly state the question of your project.

#2 Abstract: Often a scientific paper begins with a brief abstract or summary of the highlights which are described in the full report. It is usually no more than 3 to 5 sentences. Its purpose is to give the reader an idea of what is contained in a report. The abstract is a great time-saver for the busy scientist who is browsing through many reports and articles. Although the abstract appears on the same page as the title, it is written after the written report is completed.

#3 Introduction and Background Information: You should begin with some word or introductory statement in which you deal with such questions as how you came to select this particular project and why you think it is worth spending time on. The student will give a background in which he describes previous work in the field and basic information about his topic to give proper credit to others for providing previous work, for assistance, and for ideas. Taking credit for yourself for ideas or work done by others is not part of scientific attitude.

#4 The Question and Purpose: The introduction leads to a clear statement of the specific problem which you have attacked.

#5 The Hypothesis: State what you thought was going to happen before you began this project.

#6 The Materials and Method: The statement of the problem and the hypothesis are followed by a detailed description of the materials used and the methods employed. This description must be so exact and so complete that anyone who wants to do so can replicate your experiment. Often a photograph or a diagram of your setup can save a great many words of description.

#7 The Observation: Naturally, you must report what happened. How you summarize your results will depend on the type of investigation you have carried out, but pictures and tables are always appropriate.

#8 Analysis and Results: After you have summarized your observations, you are to analyze and interpret them. Graphs are helpful to make clear the direction in which your results point.

#9 In Conclusion: The analysis of the results lead to a statement of conclusion. You should give the line of reasoning, the logic which leads you to reach the conclusion. Please refer back to the section on "Keeping Your Daily Log."

#10 Limitations: The logic by which you reached your conclusion may have some flaws, or you may realize that your experiment had certain weaknesses. This is the time to state the limitations for your conclusion and the source of error which weaken your results. It is better to state these limitations yourself than to have them pointed out to you later.

#11 Implications and Applications: In light of the weaknesses and limitations of your experiment, which are the limitations? Can you suggest any further research along these lines? Are there any practical applications which may grow out of this work? Do not hesitate to state them here!

#12 Bibliography: It is necessary to list all reference which you used in your work. These references are to be listed in alphabetical order by author's name at the end of the report.
STUDENT EVALUATION FORM

RATE YOUR OWN PROJECT:
TITLE OF PROJECT ___________________________ Name ________________

A. CLASSIFICATION OF PROJECT (Classify as to type - score between suggested point values)

INVESTIGATION: Problem requires experimentation and/or collecting and analyzing
data in order for student to arrive at some conclusion or theory ......................... 20-30 pts.

TECHNICAL OR SOME EXPERIMENTATION: Basically an applied science project.
Student constructs something using principles of science and/or has done an
experiment which is basically a demonstration. .................................................. 15-25 pts.

ILLUSTRATION: The student is showing something about science through a collection,
display, are, or craft medium. Very little scientific or technical ............................... 5-15 pts.

B. LOG OR NOTEBOOK (This is to be judged - choose most appropriate sentence)

PROBLEM OR IDEA: Problem or idea of project highly original ........................................ 7
Problem or idea somewhat original and/or approach original ................................. 5
Problem or idea not original - but quite difficult or unusual .................................. 3
Problem or idea not original - idea quite common .................................................... 1
Problem or idea not clear or lacking ........................................................................... 0

BACKGROUND Student possessed or secured adequate background information through
reference books, interviews, and/or experimentation ................................................. 4
Fairly adequate background information - student make sincere
attempt to secure more information ........................................................................... 3
No background information necessary or difficult to evaluate ............................... 2
Limited information secured even though available and desirable ......................... 1
No attempt to secure any information even though necessary .................................. 0

OBSERVATIONS: Usually keen observations made during work .................................. 5
Good observations were made during work ............................................................... 4
Unable to determine because of type of project ....................................................... 3
Some observations made - many overlooked ......................................................... 2
No observations made even though warranted ....................................................... 0

RECORDING DATA: Usually fine job of recording data: written records, graphs, pictures,
and/or notes .............................................................................................................. 5
Data carefully and accurately recorded, mechanics good ......................................... 4
Project did not require recordings of data or item hard to evaluate ...................... 3
Data recorded in a somewhat acceptable manner - some lacking ......................... 2
Data poorly recorded .............................................................................................. 0

CONCLUSIONS OF STUDENT: Conclusions or results of work valid, based on experimentation,
observations, or technical work. Shows insight ....................................................... 5
Conclusions or results valid, based on work ............................................................ 4
No conclusions possible or difficult to evaluate ....................................................... 3
Conclusions somewhat valid .................................................................................... 2
Conclusions lacking or largely invalid ....................................................................... 0

COMMUNICATION SKILLS: Student shows excellent ability to communicate, mechanics
excellent ..................................................................................................................... 4
Student show good ability to communicate, mechanics good ................................ 3
Log written or typed by other than student. Cannot be evaluated ......................... 2
Log not clear. Spelling and mechanics may be poor ................................................. 1
Communication and mechanics poor. Log carelessly written .................................. 0

LOG TOTAL 15
### PROJECT

**HYPOTHESIS:**
- Student formed very logical hypothesis based on information, observations, experiences, and some experimentation ........................................... 4
- Student formed fairly logical hypotheses ........................................... 3
- No hypotheses necessary and/or difficult to evaluate ............................ 2
- Poor hypotheses formed, based on information ...................................... 1
- No hypotheses formed, even though called for ....................................... 0

**EXPERIMENTS:**
- Experiments or activities pertinent to project. Equipment or experiment quite original ................................................................. 5
- Activities or experiment pertinent - somewhat original .......................... 3
- Activities and/or experiments difficult, but not original ....................... 1
- Activities and/or experiments not difficult or original .......................... 0

**VALIDITY OF RESULTS:**
- Results valid: rechecked by running additional tests or experiments ........... 5
- Results valid: based on adequate samplings but not rechecked ............... 4
- Results somewhat valid: control, tests, or samplings not adequate .......... 3
- Results mostly invalid: based on limited samplings or tests .................. 1
- Unable to determine results from project or log .................................. 0

**SCIENTIFIC ACCURACY:**
- Statements, terms, mathematics and/or instrumentation scientifically correct ................................................................................................. 4
- Project contains some minor inaccuracies ............................................. 3
- Project is somewhat inaccurate ............................................................. 1
- Project is largely inaccurate .................................................................... 0

**EFFORT OR TECHNIQUES:**
- Project took unusual amount of care and/or techniques .......................... 4
- Project took considerable time, care and/or techniques .......................... 3
- Project did not require more than average time, care, and/or techniques .......... 2
- Project quite simple, requires little effort or techniques .......................... 0

**PHYSICAL HELP:**
- Student did all physical work, required little advice ............................... 4
- Student required only a very limited amount of physical help ................ 3
- Student received only necessary help .................................................... 2
- Student required unnecessary physical help ......................................... 1
- Student required excessive amount of help ............................................ 0

**CURIOSITY:**
- Student shows an usually high degree of curiosity .................................. 4
- Student shows a high degree of curiosity ............................................... 3
- Unable to determine because of nature of project ................................... 2
- Student showed some curiosity ................................................................ 1
- Student shows little or no curiosity ...................................................... 0

**CREATIVITY IN USE OF MATERIAL:**
- Student made excellent use of common materials, very creative ............... 4
- Student made good use of common materials, somewhat creative .......... 3
- Item not appropriate because of nature of project .................................. 2
- Student used mostly prepared material - and/or not creative ................... 1
- Student used prepared kits or materials only ........................................ 0

**NEW PROBLEMS OR FURTHER USE:**
- Student shows deep insight in recognizing new problem or application .... 5
- Student recognized new problems and/or has future use of work ............. 4
- Item not valid or difficult to determine .................................................. 3
- Student shows limited ability to recognize new problem or use ............... 1
- Student unable to recognize new problem k ......................................... 0

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<tr>
<th>A. Type Score</th>
<th>B. Log Total</th>
<th>C. PROJECT TOTAL</th>
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JUDGING CRITERIA

DISPLAY
- Neatly prepared and well organized
- Free of misspellings and corrections
- Visually attractive
- Equipment, charts, graphs, illustrations, etc. clearly labeled
- Use of tales, graphs to summarized data

REPORT / JOURNAL / RESEARCH
- Student has done sufficient research for the scope of the project
- Research is presented in a written report
- Journal is neat, organized, and reflects the entire process used in developing the project
- Student has consulted several sources in his/her research
- Bibliography is included in written report

SCIENTIFIC CONTENT
- Clear statement of the problem or aim of project
- Title of project reflects the problem
- Clearly stated hypothesis
- Materials and procedures are listed, accurate and detailed
- Approach to the problem is consistent with the scientific method
- Accurate collection and treatment of data
- Logical conclusion drawn from data
- Student aware of sources of error, and suggests further areas of study

THROUGHNESS
- The study is complete within the scope of the problem
- Experiment has been repeated or sufficient numbers have been tested
- Project skillfully designed to yield valid, reliable and accurate data

SKILL
- Special skill needed for construction or use of equipment is evident
- Special mathematical, computation or observational skills are evident
- Level of difficulty of the project appropriate form grade level

CREATIVITY
- The problem is original or is a unique approach to an old problem (considering the students grade level)
- Equipment and materials are used ingeniously:
  - In the manner of presentation
  - In recognizing practical possibilities and limitations
- Student has chosen a relevant problem for the project
How Does My Garden Grow?

**PROBLEM**
Will vitamins help plants grow?

**RESEARCH**
Survey mom and dad gardener.

**HYPOTHESIS**
I think vitamin C will help because it comes from the sun.

**PROCEDURE**

**STEP 1**
Planting

**STEP 2**
Measuring

**STEP 3**
Watering

**STEP 4**
Keeping records

**RESULTS**

**CONCLUSION**
In my test the plants watered with vitamin C grew best, and a crew next best.

**EXPERIMENTAL MATERIALS**

**MY RADISHES**

**PROJECT DISPLAY**
Size limit 2 1/2 x 4 feet
Additional Display Options

*Note: Size limit 2 1/2 x 4 feet
PROJECTS RELATED TO ASTRONOMY

1. WHAT IS THE DIFFERENCE BETWEEN A REFLECTOR AND A REFRACTOR TELESCOPE? Develop a working model of each type of telescope. What are the strengths and limitations of these two types of telescope?

2. HOW FAST DO STARS MOVE? Develop a method for determining the apparent distance that a star moves in a period of time. See if all stars are moving across the sky at the same rate. Attempt to explain what causes the movement of the stars.

3. CAN YOU EXPERIMENT WITH ECLIPSES? Develop your own theory to explain an eclipse. What causes an eclipse of the moon and of the sun? If you were on the moon, would there ever be an eclipse of the earth?

4. CAN MAN LIVE ON OTHER PLANETS IN OUR SOLAR SYSTEM? Through library research find out the condition on the various planets. Then list the limitations of man. Try to determine whether man could adjust to the conditions found on the various planets in the solar system.

5. HOW CAN YOU TAKE PICTURES OF THE STARS? What are the problems in taking pictures of the stars? What are you able to learn from observing star photographs? What would be the best location on earth to take pictures of the stars?

6. WHAT CAN YOU LEARN FROM THE SUN'S SHADOW? Does the length of the sun's shadow vary with the time of day? Does the length and direction of the sun's shadow change at different times in the year?

7. HOW MUCH OF THE SUN'S LIGHT REACHES THE EARTH? Light goes out from the sun in all directions. Considering the distance that the earth is away from the sun, what part of the sun's total light eventually reaches the earth?

8. IS THERE A FORM OF LIFE ON OTHER PLANETS? Find out the conditions for life on the various planets. Reproduce these conditions as best you can and expose culture mediums to these conditions. Attempt to grow some form of bacteria in each of these conditions.

9. CAN YOU DESIGN A ROCKET FOR TRAVEL TO ANOTHER GALAXY? What are the problems involved in such a long distance journey?

10. DOES THE EARTH TURN? Try to collect as much evidence as possible to prove that the earth does spin on its axis.

11. WHAT CAN YOU LEARN FROM A TIME EXPOSURE PHOTOGRAPH OF THE NORTH STAR? Set up your camera so that you can take a time exposure of the North Star. What is the angle at which your camera should be pointing toward the North Star? How does this angle compare with the latitude of your location on earth?

12. HOW CAN YOU PROVE THE EARTH DOES REVOLVE ABOUT THE SUN? What evidence can you find that will help to prove that the earth does travel around the sun rather than the sun travel around the earth.

13. ARE TIDES AND THE POSITION OF THE MOON IN SOME WAY RELATED? Use a star chart or actually record the highs and lows of tides over a period of time (see a tide table). Compare the high tides with the position of the sun and moon. Can you tell the position and height of the tides from the location of the moon?
14. CAN YOU CHART THE MOON?
With a telescope or binoculars study the moon and draw a map of it. Locate on your drawing as
many geographical features as you can observe. What is the best time of month for observing
the moon?

15. HOW WOULD THE EARTH APPEAR TO AN OBSERVER ON THE MOON?
Would the earth go through phases?
Would you see the earth at some times and not at others?
Would there be an earth-rise and an earth-set?

16. DOES THE MOON RISE AT THE SAME TIME EVERY NIGHT?
If not, why not?

17. HOW BRIGHT IS THE MOON?
Can you use a photography light meter or some other instrument to determine the brightness
of the moon? Compare it with the brightness of the sun. Can you use photographic paper to
measure the light?

18. DOES THE MOON CHANGE IN SIZE?
The moon appears very large when it first rises. It seems to get smaller as it moves overhead
and then seems to grow in size again as it moves downward toward the west. Can you develop
a method for proving either that the moon does or does not change size?

19. HOW FAST DOES THE MOON TRAVEL AROUND THE EARTH?
Does the moon always move at constant speeds? How many degrees does the moon seem to
move across the sky every hour? Compare this with the number of degrees that the stars seem
to move.

20. DOES THE MOON ALWAYS TRAVEL THE SAME PATH THROUGH THE SKY?
Use an astrolabe to take readings as to elevation (how high up in the sky) and declination (how
many degrees from true north). What is the actual shape of the moon's orbit? What affects the
orbit of the moon?

21. HOW LONG DOES IT TAKE THE MOON TO MAKE ONE COMPLETE TRIP AROUND THE
 EARTH?
Determine this figure through observation rather than through reading. What would happen to
the orbit of the moon if the moon should speed up in its path around the earth? Whirl a ball on a
rubber string and see what happens.

22. WHAT CAUSES THE PHASES OR DIFFERENT SHAPES OF THE MOON?
Darken a room and use a slide projector and a large rubber ball or basketball.

23. DOES THE MOON REVOLVE?
Note the position of various features on the moon over a period of time.

24. WHAT ANIMALS ARE MORE ACTIVE AT NIGHT?
Does this activity depend on moonlight? What effect does the shape of the moon have upon
success in fishing?

25. HOW DOES THE SURFACE OF THE MOON COMPARE WITH THAT OF THE EARTH?
What causes the seas on the moon? Can you measure some of these seas?

26. ARE ALL THE CRATERS ON THE MOON ALIKE?
Why do the craters on the moon seem to run in a straight line? What is your theory?

27. WHY ARE THE MOUNTAINS ON THE MOON TALLER AND MORE JAGGED THAN THOSE
 ON THE EARTH?
Try some experiments with erosion and weathering.
28. COULD PLANTS GROW IN SOIL FOUND ON THE MOON? 
What plants and animals might live in the temperature extremes of the moon? How long would various insects, plants, and animals continue to live if exposed to an atmosphere similar to that of the moon?

29. HOW COULD YOU TALK ON THE MOON? 
Can you experiment with talking through solids, radio in a vacuum, etc.?

30. IS THERE ONLY ONE MOON IN OUR SOLAR SYSTEM?

31. IS THE MOON LARGER THAN THE SUN? 
Why does it appear larger?

32. CAN WEATHER PREDICTION BE MADE ACCURATELY FROM THE MOON’S APPEARANCE?
PROJECTS RELATED TO BIOLOGY

1. WHAT ARE THE TEMPERATURE LIMITS FOR LIFE OF DIFFERENT PLANTS?
   What is the coldest and warmest temperatures at which they will live and flourish? Is temperature the only condition that varies, or is moisture involved too?

2. WHAT IS THE MINIMUM WATER REQUIREMENT FOR VARIOUS PLANTS?
   Plant a number of seeds in small containers. Give each seed a different amount of water, keeping a careful chart on the amount and frequency of watering. Does a plant prefer a small amount of water often or a larger amount less frequently? What is the maximum amount of water a plant can receive and still flourish? Try bean seeds, corn kernels, grass seeds, wheat grains.

3. DOES WATER CONTAIN AIR?
   Do fish need air in water in order to live? How does pollution in the water affect the plant and animal life?

4. HOW DO PLANTS GET NITROGEN?
   Can plants live without nitrogen?

5. WHAT PLANTS NEED LIGHT IN ORDER TO GROW?
   How much light a day must different forms of plant life have? How much light is necessary for mushrooms to grow?

6. WILL SOME PLANTS GROW IN DIFFERENT FORMS OF ARTIFICIAL LIGHT?
   What effect does colored light have on the growth of various plants?

7. WHAT ARE THE LIGHT REQUIREMENTS OF ANIMALS?
   What animals seek light? What animals avoid light? How are the eyes of various living things alike and unalike?

8. WHAT PLANTS AND ANIMALS CAN ADJUST TO CHANGING ENVIRONMENTS?
   What plants and animals are unable to adjust?

9. HOW DOES COLORATION AFFECT AN ANIMAL'S ABILITY TO SURVIVE?
   How are some animals able to change their coloration in order to blend in with their environment? Why are some animals colored with "warning" colors? What effect does the changing of the coloration of an animal have on its ability to live in its environment?

10. HOW DO VARIOUS ANIMALS AVOID BEING EATEN?
    What insects do not seem to appeal to insect-eating animals and birds?

11. WHAT ANIMALS ARE PROTECTED BECAUSE OF THEIR GENERAL APPEARANCE?
    What animals (particularly insects) depend on being mistaken for other animals?

12. HOW ARE VARIOUS ANIMALS EQUIPPED TO GET AIR?

13. HOW MANY DIFFERENT KINDS OF MOVEMENT CAN YOU OBSERVE AMONG ANIMALS?
    Do all animals move? How far do various animals move in a day? Can you calculate the speed?

14. HOW INTELLIGENT ARE VARIOUS ANIMALS?
    Can you set up intelligence test for small animals? A maze works very well for mice and rats. Remember there must be a reward at the end -- food, or the animal's cage.

15. DOES AN ANIMAL LEARN FROM EXPERIENCE?
    Introduce a single rat to a maze. Note the length of time it takes him to solve it and count the number of false turns he makes. Keep a graph and record each trial. Does the performance
improve at a regular rate? This experiment can also be done with guinea pigs, hamsters, rabbits or chickens.

16. **HOW LONG DOES AN ANIMAL REMEMBER WHAT IT HAS LEARNED?**
   After the rat has learned the route, don't put it in the maze for awhile. Test it again after a few days, a week, a few weeks, or a month. Compare the second graph with the original one.

17. **DOES A MOTHER ANIMAL TEACH HER YOUNG?**
   If the mother rat has solved the maze, does she help her babies along? Is there any cooperation among the babies?

18. **DOES AGE AFFECT THE LEARNING ABILITIES?**
   Try a group of old rats and a group of young rats on a maze, one at a time. Which age learns the maze the quicker? Wait for a week or so and try again. Which age has the better memory?

19. **HOW STRONG IS AN ANIMAL’S SENSE OF SMELL?**
   Take your dog for a walk. Watch him use his sense of smell to follow various trails. Test his sensory abilities by hiding some food. Drag it along the floor or ground first. Can he find it as quickly if you do not drag it? Do some breeds have a better sense of smell than others? Remember, you cannot draw a general conclusion from just one animal.

20. **HOW STRONG IS AN ANIMAL’S SENSE OF HEARING?**
   Use a high frequency dog whistle for testing. How far away can a dog hear it? Can a dog hear a human whistle at a greater distance than a person can?

21. **CAN ANIMALS DISTINGUISH COLOR?**
   Devise a test to see whether your dog can distinguish color. Try testing a bird for that ability. Can insects distinguish color? Does color-distinguishing ability have anything to do with the food which the animal, bird, or insect eats?

22. **CAN YOU TIME THE RATE OF RESPONSE TO VARIOUS STIMULI?**
   Some common stimuli are heat, pain, electrical current, odor, fear, hunger, light, darkness, noise, moisture, and gravity.

23. **DO THE ROOTS OF ALL PLANTS GROW TOWARD MOISTURE?**
   Do the leaves of all plants grow toward light? Are plants intelligent?

24. **HOW DO VARIOUS PLANTS AND ANIMALS REPRODUCE?**
   How closely do the young plants and animals resemble their parents?

25. **WHAT DO VARIOUS OBJECTS LOOK LIKE UNDER THE MICROSCOPE?**
   How do the cells of various plants and animals compare? Do all living things have cells? Are all the cells of a living thing alike?

26. **WHAT DO THE CELLS OF AN ONION MEMBRANE LOOK LIKE?**
   Place in a drop of water and cover with a cover glass. How does staining a material help in locating the parts of a cell? Use iodine, methylene blue, or ink as a stain on the onion membrane. What is the cell structure of a geranium or a rhubarb leaf?

27. **DO ALL PLANTS HAVE CELL WALLS?**
   Do all cells have a nucleus? Is the nucleus of all cells alike?

28. **WHAT DOES THE PROTOPLASM INSIDE YOU CHEEK LOOK LIKE?**
   Scrape your cheek with a toothpick and place the material in a drop of water on a glass slide. Does dandruff contain cells?

29. **HOW DO THE SIZE OF CELLS VARY IN VARIOUS PLANTS AND ANIMALS?**
   How big are the largest cells? Try the yolks of various eggs. How big are the smallest cells?
30. **HOW ARE LIVING THINGS CLASSIFIED?**
Collect various plants. Can you divide the plants up into their correct phylum? Remember the four basic parts: roots, stems, leaves, and flowers.

31. **HOW ARE ANIMALS CLASSIFIED?**
Can you classify various animals brought to class?

32. **IS ALGAE FOUND IN BOTH FRESH AND SALT WATER?**
How many different kinds of algae can you locate? What is the difference in the cells of these algae? What is the appearance of algae? Scrape some algae off a tree (pleurococcus) and compare under the microscope with pond scum algae spirogyra. Can you divide various algae into their color classes: green, blue-green, brown, and red?

33. **IS ALGAE EDIBLE?**
Is algae nourishing? Will fish eat algae? Can humans use algae as a food material? Will animals eat food made of algae?

34. **UNDER WHAT CONDITIONS WILL ALGAE GROW THE BEST?**
Does algae seek light (phototropism)? Will algae grow without sunlight? What is the rate of growth of various algae? In some salt water algae adaptable to fresh water?

35. **HOW SMALL ARE VARIOUS FORMS OF BACTERIA?**
Can you measure bacteria? Can you find bacteria in the air? Can you find bacteria in the water? in soil?

36. **WHAT CONDITIONS PRODUCE THE MOST BACTERIA?**
How fast do bacteria grow under certain conditions? Will bacteria grow in darkness? Will bacteria grow in freezing temperatures? What effect does humidity have on the growth of different kinds of bacteria?

37. **WHERE DO BACTERIA GROW?**
What kinds of bacteria do you find around your home? What kinds of bacteria do you find in your school? What kinds of bacteria do you find on your body?

38. **ARE ALL YEAST CELLS ALIKE?**
What does yeast look like under the microscope? How large are yeast cells?

39. **UNDER WHAT CONDITIONS DOES YEAST GROW THE BEST?**
Vary the temperature, solution, light, etc. What effect do yeast plants have on sugar?

40. **ARE ALL MOLDS ALIKE?**
How do molds reproduce? What conditions are favorable for mold reproduction? How large do molds grow? Is light necessary for the growth of molds? Are the tubes of mold plants attracted by the pull of gravity?

41. **UNDER WHAT CONDITIONS DO MUSHROOMS GROW BEST?**
Will mushrooms grow in the dark? in the light? What temperature extremes can mushrooms stand? how do mushrooms reproduce? Which mushrooms are edible? Which are poisonous?

42. **UNDER WHAT CONDITIONS WILL LICHENS EXIST?**
Will lichens grow without moisture? Without sunlight? On what material will lichens grow? Will lichens continue to grow under freezing conditions?

43. **WHAT ENVIRONMENTS ARE FAVORABLE FOR THE GROWTH OF MOSSES?**
Why do mosses grow so low to the ground?

44. **WHERE ARE LIVERWORTS FOUND?**
What conditions are favorable for their growth? Will liverworts live in water? What are the beneficial uses of liverworts?

45. WHAT CONDITIONS ARE FAVORABLE FOR THE GROWTH OF FERNS?
Why do ferns grow higher than mosses? Can ferns adapt to a salt water environment? Under what conditions will the horsetail fern continue to survive?

46. HOW ARE THE SEEDS OF VARIOUS PLANTS TRANSFERRED FOR REPRODUCTION?
How much water is really needed by the various seed-growing plants?

47. WHAT KIND OF CONIFERS ARE IN THE REGION AROUND YOU?
What percentage of each do you find? How do the seeds of various conifers compare? What is their weight and area? Under what conditions will the seeds start growing?

48. UNDER WHAT CONDITIONS WILL SEEDS START GROWING?
Can you experiment with different kinds of seeds and then test whether they will grow?

49. HOW FAR WILL SEEDS TRAVEL?
Tree seeds have various kinds of “wings” which enable them to travel for long distances on the wind. Try flying various tree seeds from the top of a windy hill. Try releasing them from an upstairs window. Which seeds fly the farthest? Do they come from the trees which have the widest distribution in your area? What other factors are involved in their growth?

50. ARE BIRDS AND RODENTS THE CHIEF ENEMIES OF SEEDS?
A single mouse may eat hundreds of seeds a day. In an area which has much wildlife, reforestation may run into difficulties. Color a number of seeds with bright harmless vegetable dyes and put them out for the birds. Put out a “control group” of uncolored seeds for comparison. Try different colors and different types of seeds. put the seeds in an area where there are many squirrels. Are they more partial to the natural than the colored seeds?

51. WHERE ARE VARIOUS FORMS OF PROTOZOA FOUND NATURALLY?
What are the problems of culturing various forms of protozoa? What is their weight and area? Under what conditions will the seeds start growing?

52. WHERE CAN HYDRA BE FOUND AROUND YOUR AREA?
What will hydra eat? How does the hydra feed? How does hydra reproduce? How do jellyfish compare with hydra?

53. ARE JELLYFISH ADAPTABLE TO CHANGING ENVIRONMENT?
How long does it take the nerve cells of a jellyfish to react? What will jellyfish eat? How do jellyfish locate their food? What is the power of the stinging cells of the jellyfish? Will jellyfish regenerate parts?

54. CAN PLANARIA REGENERATE PARTS?
Try different experiments with the planaria. Under what hostile conditions can planaria survive?

55. WHAT EFFECT DO EARTHWORMS HAVE ON THE SOIL?
Do earthworms prefer an acid or alkaline soil?

56. UNDER WHAT CONDITIONS DO EARTHWORM THRIVE?

57. ARE EARTHWORMS ATTRACTED BY ELECTRICITY?
Can earthworms learn? What kind of diet is best for earthworms? How far under the surface of the ground can they live? Are fish attracted to the color or the odor of the earthworm?
58. HOW STRONG IS THE GRIP OF A STARFISH?
Will all starfish atomize (throw off an arm)? Will one arm of a starfish regenerate a whole body?
Experiment with various forms and conditions of regeneration among starfish.

59. HOW FAR WILL A STARFISH MOVE IN A DAY?
Can starfish tolerate some fresh water? Can starfish stand great temperature variations? Do
starfish exhibit a positive or negative tropism toward light? Is this true for all wave lengths of
light? Try colored light. What will starfish eat?

60. HOW FAST CAN A MOLLUSK MOVE?
Try various members of the phylum, such as marine snails, slugs, clams, mussels. How strong
is the resistance of the bivalve mollusk against having its shell opened?

61. HOW FAST CAN DIFFERENT MEMBERS OF THE LAND SNAIL FAMILY MOVE?
Compare a land slug with a sea slug.

62. WHAT IS AN OPERCULUM?
How does a sea snail keep water in his shell and air out of his shell when he is exposed to the
air between tides? How watertight is the operculum of different members of the ocean snail
family?

63. CAN LOBSTERS AND CRAYFISH SEE?
Can a lobster or crayfish swim? How do they move?

64. DO ALL SPIDERS SPIN WEBS?
How do different spiders spin their webs? How strong are the webs of different spiders? Will
one spider get caught in the web of another? How does a spider avoid being caught in her
own web?

65. CAN SPIDERS SEE?
How well can they see? Can spiders detect odors? What do spiders eat? Do all spiders bite?
How? What environmental changes can the spider withstand?

66. WHAT DO CENTIPEDES EAT?
How many legs do centipedes have? Do they exhibit a positive or negative tropism toward
light?

67. WHAT KINDS OF INSECTS LIVE IN YOUR AREA?
Pick out one small section and keep a record throughout the year. Which of the insects are
helpful to man? Which of them are harmful to man?

68. WHAT ARE THE CHARACTERISTICS OF AN INSECT?
Examine a grasshopper. How do insects smell and feel? Can you investigate the vision of
various insects? Can you measure the number of vibrations per second that various insects
move their wings? How do insects hear? Can you compare the hearing ability in various
insects?

69. CAN YOU EXPERIMENT WITH SOME OF THE BODY PROCESSES OF INSECTS?
How do various insects reproduce? How do you tell the males from the females? Can you
determine the amount of plant material a caterpillar or other insect will eat in the larval stage?

70. CAN YOU COLLECT VARIOUS INSECTS AND DIVIDE THEM INTO THEIR CORRECT ORDER
ACCORDING TO THEIR WINGS OR OTHER DETERMINING FACTORS?
Can you collect and study several types of moths and butterflies in order to determine the
difference between the two?

71. HOW DOES MAN CONTROL THE MOSQUITO?
Can you experiment with different types of odors and the effect on mosquitoes? Try a variety of the commercial repellants and determine which one is most successful.

72. CAN YOU MEASURE THE STRENGTH OF VARIOUS INSECTS?
What insect will destroy others? Can you experiment to determine this? Can you experiment with the diet of various insects? Can you compare the wings of various insects as to construction, size, etc.?

73. WHAT INSECTS ARE ATTRACTIONED TO LIGHT?
What insects have a negative tropism? What insects do damage in your locality?

74. WHY ARE INSECTS SO "SUCCESSFUL"?
Can insects think? How intelligent are the various forms?

75. HOW DO VARIOUS INSECTS SPEND THE WINTER?
Where can you find them during the winter? What insects must be exposed to a constant source of moisture in order to avoid drying up? Can you test various insects, including some found in the soil?

76. HOW DO DIFFERENT INSECTS REACT TO THE STIMULI OF LOUD SOUNDS?
When you try to catch a fly, is it the shadows, sounds, or air current which gives the fly a warning? Can flies learn or become conditioned? Try conditioning them to escape from some trap.

77. WHAT IS THE EFFECT OF HIGH AND LOW TEMPERATURES ON THE HOUSEFLY?

78. WILL THE HUMAN BREATH ACTIVATE INSECTS?
Try ants, stick insects, or butterflies on cold mornings or in cool temperatures. Which insects exert a positive tropism or attraction toward a breeze or small wind? Which insects will face into the wind? What is the effect of nicotine on various insects? Can certain insects stand cigarette smoke?

79. HOW LONG CAN CERTAIN INSECTS LIVE ON THE FOLLOWING DIETS: SUGAR WATER VERSUS RAW MEAT?
Be sure to try blowflies as well are other insects.

80. WHAT IS THE EFFECT OF VISION ON AN INSECT'S MOVEMENT?
Can you hypnotize stick insects? Try rolling them between your fingers gently.

81. HOW DOES THE LENGTH OF THE TRACHEA AFFECT THE SIZE OF AN INSECT?
What effect does temperature have in the frequency and amplitude of the respiratory movement of insects? Use stick insects, bees, moths, and beetles. The insect can be magnified by being placed in the beam of a projector. Watch the shadow. What is the effect of added carbon dioxide in the air on the respiratory rate of insects.

82. WHAT EFFECT DOES TEMPERATURE HAVE ON THE RESPIRATORY MOVEMENT OF INSECTS?
Use stick insects, bees, moths, or beetles. The insects can be magnified by being placed in the beam of a projector. Watch the shadow and observe the frequency and amplitude of respiration.

83. WHAT IS THE EFFECT OF ADDED CARBON DIOXIDE IN THE AIR ON THE RESPIRATORY RATE OF INSECTS?

84. WHAT CONDITIONS ARE NECESSARY FOR A RICH OXYGEN SUPPLY IN WATER?
What is the effect of stagnant or warm water on the amount of oxygen dissolved in the water? What affect does water with little dissolved oxygen have on the respiration of such water insects as water beetles and water insect larvae?
85. WHAT PERIODS OF THE DAY ARE CERTAIN INSECTS THE MOST ACTIVE?
Will the pattern of activity set by insects be upset by periods of continuous darkness and periods of continuous illumination?

86. WHAT IS THE WALKING ORDER OF THE LEGS OF VARIOUS TYPES OF INSECTS?
How does the insect modify his walking pattern with the removal of one or more legs? What insects will atomize their legs easily (shed one or more legs)?

87. WHAT IS THE EFFECT OF TEMPERATURE ON THE TIME IT TAKES A MOTION TO FLUTTER BEFORE IT CAN FLY?
Keep one hot and one cold.

88. HOW LONG CAN A FLY STAY SUBMERGED IN WATER OR ALCOHOL AND STILL LIVE?
Submerge an insect in a mixture of alcohol and paraffin and then observe under a lens.

89. WHAT INSECTS MAY BE CHARGED BY STATIC ELECTRICITY?

90. HOW DO CATERPILLARS REACT TO A PHYSICAL STIMULUS?
Touch the caterpillar lightly on various parts of the body. Are all reactions alike? What are the reaction of the caterpillar to stimuli such as heat and cold? How does it react to vibrations? How do other insects react to vibration? Do water beetles react to red light?

91. DO STICK INSECT EXHIBIT A FALLING REFLEX?
How does this compare with a cat?

92. HOW DOES THE SMELLING ABILITY OF VARIOUS INSECTS DIFFER?
Have a test tube containing food and another with no food. Make an insect maze.

93. CAN BEES LEARN?
Use dishes of different concentrations of sugar. At varying lengths of time test the memory of the bee.

94. HOW DO ANTS FOLLOW THE TRAIL OF OTHER ANTS?
Try making an artificial trail with a weak solution of formic acid.

95. WHICH INSECTS HAVE A NEGATIVE TROPISMS TOWARD THE PULL OF GRAVITY?
Try water bugs and other insects. Use a seesaw that tilts under the weight of the insect. Why does an insect crawl up to the end of a branch or leaf and then reverse directions and go downward? Try flies, ants, etc. in a closed bottle. Can you change the direction the insect wants to go by turning the bottle end for end?

96. CAN YOU EXPERIMENT WITH THE EFFECTS OF LIGHT AND THE ABSENCE OF LIGHT UPON THE MOVEMENTS OF INSECTS?
What is the reaction of the moth to light? When you chase flies, why do they head for the window? Is the reaction due to the light? Will certain insects, such as beetles, caterpillars, and stick insects change their direction of movement when the direction of light is changed? (Use a flashlight.) Then try using two different sources of light that can be turned on and off. What larvae, pupae, and marine life react to the stimuli of a moving shadow? Is the reaction due to the movement or to the change in light intensity?

97. CAN BEES TELL TIME?
Feed bees a sugar solution at a certain time each day. Will bees appear at this time after a few days of conditioning?

98. WHAT INSECTS HAVE THE POWER OF BREAKING OFF THEIR BODY PARTS?
Which ones can regenerate these parts? Try stick insects and grasshoppers. Does regeneration of legs occur just in the young insects, or can adults do it too?
99. WHAT IS THE DIFFERENCE BETWEEN A BUTTERFLY AND A MOTH?
Can you observe them both through a life cycle?

100. WHAT INSECTS ARE BUGS?
What is the difference between bugs and other insects? How do the wings of various insects differ?

101. WHAT FOOD WILL THE GRASSHOPPER EAT?
How does the grasshopper chew its food? How often must grasshoppers eat? Can they do without water or food for a longer period of time?

102. WHAT FOODS DO EARTHWORMS EAT?
Observations are necessary. How often and how much do earthworms eat? How do earthworms digest their food? Dissect earthworms to determine how they compare with humans.

103. HOW DO VARIOUS INSECTIVOROUS PLANTS ATTRACT INSECTS?
"Insectivorous" means insect-eating. This group includes the pitcher plant, Venus flytrap, and sundew. How do insectivorous plants digest and use their food? Do insectivorous plants need sunlight? What effect does temperature have on the sensitivity of the Venus flytrap? What kind of insects will various insectivorous plants eat?

104. ARE FISH COLD OR WARM-BLOODED?
Can you measure the temperature of a fish?

105. HOW DO SCALES HELP FISH?
How do the scales of various fish compare?

106. HOW DO THE GILLS OF A FISH REMOVE OXYGEN FROM THE WATER?

107. WHAT IS THE DIFFERENCE BETWEEN TOADS AND FROGS?
Can you discover this by observation? Can you keep a record of the changes in the life cycle of a frog from the egg to the adult stage? What effect does temperature have on the hatching of frog eggs? How far can frogs jump? Do people get warts from touching toads?

108. WHAT IS THE DIFFERENCE BETWEEN SALAMANDERS, NEWTS, AND LIZARDS?
Can you discover this by observation? What effect does temperature have on the rate of motion of various lizards? Try snakes, turtles, horned toads, etc.

109. WHAT CHANGES IN ENVIRONMENT CAN TURTLES WITHSTAND?
Can turtles be frozen in a block of ice and still live? Will turtles eat frogs? How strong are turtles? What is one turtle power? How strong is the turtle's jaw? What effect has the direction of light on a turtle's motion? What happens to reptiles and amphibians in the winter? Can you use a refrigerator to duplicate these conditions?

110. WHAT OBSERVATIONS CAN YOU MAKE ABOUT SNAKES?
What kind of snakes are found in your locality? Are snakes intelligent? Can snakes remember? What percentage of the population is afraid of snakes? How does this change with age? Why do many people dislike snakes? Is this based on a personal experience? What are the food habits of various snakes?

111. HOW DO SNAKES REACT TO DIFFERENT STIMULI, SUCH AS SOUND, DIFFERENT COLORED LIGHTS, ETC.?
What snakes are nocturnal? Can some snakes see in the dark? How does a snake smell? Can snakes see? Do they depend on vision or smell in searching for food? How do snakes get moisture? Can they live without water? How does a snake move? Do all snakes move the same way?
112. WHAT BIRDS DO YOU OBSERVE AROUND YOUR LOCALITY?
Do you see different types of birds at different times of the year? Do birds live in one particular area or do they travel quite a distance in a day?

113. HOW IS A BIRD'S BODY SUITED FOR SPECIAL PURPOSES?
Do birds have backbones? How do bones of a bird compare with those of a mammal? Are birds cold-blooded? What is the temperature of the body of different kinds of birds? Does this temperature vary? What can you tell about a bird from its feet? What can you tell about a bird from its beak?

114. WHAT DO THE DIFFERENT VARIETIES OF BIRDS EAT?
How much will they eat? How do hawks and owls locate their food? Can hawks and owls see in the dark? What birds eat seeds of weed plants? Are scavenger birds helpful? How do they locate their food?

115. HOW DO NEST OF VARIOUS BIRDS COMPARE?
Which is the strongest? Which is the largest? Which is the smallest? What is the safety factor of bird nests? How much weight can various nests hold as compared with the number and weight of the eggs of different birds?

116. WHAT IS THE SOCIAL BEHAVIOR OF A FLOCK OF BIRDS?
Does the flock stay together and feed together for the greater part of the day and roost together at night? Does the whole flock fly away from an area at once, on a given signal? Or is a flock formed only for certain purposes: for roosting together, at nesting time, when feeding, or as a colony. Does it exist during the winter only? For purposes of migration only? Does the flock roost in the same place each night, or does it move from place to place to roost?

117. HOW DOES A BIRD TAKE A BATH?
Make a shallow birdbath and put it in a well-protected place. The discarded top of a garbage can makes a fine birdbath. The depth should vary from one to two or three inches. Use sand or gravel to regulate the depth. Do all the birds which frequent your area take baths? Do some birds bathe more often than others? Which birds use shallow water and which use the deeper spots? Do they all bathe in the same way? What time of day is the most popular? How long does the average bird stay in the water? Do the temperature and the weather affect bird bathing?

118. ARE ALL BIRDS ABLE TO FLY?
Why have some birds apparently lost the power of flight? Do all birds fly in the same way? Make careful observations and draw the various flight patterns on a chart. Does the flight pattern have any connection with the kind of food the birds eat?

119. DO BIRDS PRACTICE EQUALITY OF THE SEXES?
Chose four or five species of birds in your area and study the differences between males and females. Are they clothed differently? Do both sexes sing? Do both sexes share the nest-building? Do they both sit on the nest? Do they both feed the babies?

120. HOW DO LEAVES VARY IN SIZE, SHAPE, AND STRUCTURE?
Which seeds are monocots (single seed leaf), and which seeds are dicots (seeds with two halves)? Try corn, beans, peas, rice, and oats. How do the leaves of monocots and dicots differ? Examine corn and beans as two examples.

121. WHAT PLANTS SECRETE A WAXY SUBSTANCE (CUTICLE) THAT COVERS THE OUTSIDE OF THE LEAVES?
What is the purpose of this waxy covering? What purpose is served by the veins in leaves? Is the epidermis or outside covering of a leaf transparent? If so, why?

122. WILL A PLANT LIVE IN PURE OXYGEN?
Will a plant live and grow in pure carbon dioxide? Make some carbon dioxide and find out. What percentage of carbon dioxide can plants tolerate?

123. **WHAT PRODUCT OR GAS IS GIVEN OFF AS A RESULT OF PHOTOSYNTHESIS?**
Can you collect the gas by covering a water plant with a funnel and collecting the gas with a test tube? Be sure the water contains carbon dioxide.

124. **WHAT EFFECT DOES LIGHT HAVE ON THE RATE OF PHOTOSYNTHESIS?**
Will a plant live and grow in pure carbon dioxide? Make some carbon dioxide and find out. What percentage of carbon dioxide can plants tolerate?

125. **WHAT KIND OF GAS IS GIVEN OFF BY ANIMALS AS A WASTE PRODUCT OF BREATHING?**
Can plants use the carbon dioxide given off by animals? Place plants and animals in a box. Note how long the plant remains healthy. Try the experiment again, but this time without the animal. Can animals use the gas given off by plants? Try the experiments given before, but this time remove the plant.

126. **WHAT INFLUENCES THE RATE OF PHOTOSYNTHESIS?**
Is the rate of photosynthesis influenced by the temperature? Is it influenced by the intensity of the sunlight? Is it influenced by the amount of carbon dioxide in the air? By the amount of water present?

127. **WHAT ARE THE LIGHT REQUIREMENTS OF VARIOUS PLANTS?**
How do plants adapt themselves in order to receive the exact amount of light necessary for growing? What color rays in sunlight are used in the process of photosynthesis? Experiment on plants by using colored lights or a colored filter with sunlight. What color of ray from sunlight is not absorbed at all by the leaf? Remember the color of the leaf.

128. **HOW DO THE ROOTS OF VARIOUS PLANTS COMPARE?**
How strongly do the root systems of various plants anchor the plants to the soil? Can you measure the pull required to remove the plant. What effect do different kinds of soil have on the ability of roots to anchor plants in the ground?

129. **WHAT IS THE STRUCTURE OF MAKE-UP OF ROOTS AND ROOT HAIRS?**
Examine the roots of young bean or wheat plants. You may start the plants by placing the seeds on damp blotting paper in a dish and then covering the dish.

130. **HOW DOES SOIL WATER ENTER A ROOT?**
What is osmosis? Use a carrot for your root. Make a carrot osmometer and experiment with sugar solutions.

131. **HOW ARE SOILS KEPT FERTILE?**
Can you experiment with the fertility of different soils? Can you experiment by making your own fertilizer and using it on plants? Will fish serve as good fertilizer? Plant some beans or corn over a buried fish. What foods, animals, or plants make good fertilizer? Can you experiment with crop rotation?

132. **CAN YOU GROW PLANTS IN WATER (HYDROPONICS)?**
Can you experiment with different kinds of chemicals in the growing of plants in water? What effect has temperature on the growth rate of plants grown in water? What is the effect of different amounts of sunlight on plants grown by the hydroponic method?

133. **HOW DO STEMS SERVE PLANTS?**
Can you compare the stems of different plants? How does temperature affect the rate the water rises through the capillary tubes of a plant? Use a stalk of celery and colored water. Will plants lift up liquids other than water? How does the rate compare with that of water?
134. **HOW MUCH WATER IS GIVEN OFF BY LEAVES OF VARIOUS PLANTS AND TREES (TRANSPIRATION)?**

How does the rate of transpiration vary with the season? With the temperature?

135. **HOW DOES A TREE GROW?**

Can you determine the year in which various trees started to grow by comparing growth rings on stumps? Can you determine what years the tree grew the most and what years it grew the least? How does this compare with the weather cycle? Can you determine the year in which various trees started to grow by comparing growth rings on stumps with the growth rings of a tree whose age is known?

136. **WHAT USE IS BARK TO A TREE?**

How much bark is necessary for the tree to stay alive? Will a tree die if the bark is removed in a ring all around the tree? Try this experiment on branches. What effect has the removal of some bark of a tree on the growth rate? Can you find examples in nature of bark removed from a tree.

137. **HOW DO TWIGS OF DIFFERENT KINDS OF TREES DIFFER?**

Buds are important to the future of a tree, but they also serve as clues to its past. Botanists can identify many trees just by looking at their twigs. Cut twigs from various trees and study their similarities and differences.

138. **HOW MANY KINDS OF SCARS DOES A TWIG HAVE?**

A corky layer called a leaf scar is left when a leaf falls off. How many leaf scars can you find on your twigs? A bud scar is formed where the terminal bud begins growing into a new section of twig. The distance between bud scars is the length a twig grows in a year. How many of these scars are on your twigs? Does this distance differ for twigs from various trees? For various twigs on the same tree? Does the growth for one year measure the same length as the growth in another year?

139. **CAN YOU "FORCE" TWIGS TO LEAF OUT OF TO FLOWER?**

Cut twigs from several trees or shrubs in late winter or early spring. Put them in water and observe them daily. Which buds open first. Do all the buds open? If you take off the terminal (end) bud, does this affect the rest of the buds?

140. **WHAT EFFECT DOES MOISTURE HAVE ON SEED GERMINATION?**

What factor are necessary before a seed will start growing? Put some bean seeds in a glass with a damp paper towel. Put a third group in the bottom of a glass with an inch of water. What happens to the three groups?

141. **WHAT EFFECT DOES LIGHT HAVE ON SEED GERMINATION?**

Develop an experiment in which all seeds have the same amount of moisture but varying amounts of light. Try another experiment in which the variable factor is temperature.

142. **HOW DO SEEDS TRAVEL?**

List the number of different ways seeds get from one place to another: parachuting, hitchhiking, exploding, etc. Make a seed collection and classify it according to the method of travel. Why do seeds need to get away from their "parents"? Which way of travelling seems to be the most efficient?

143. **HOW MUCH WATER DO VARIOUS ANIMALS DRINK IN A DAY?**

How does this amount compare with their body weight? What factors affect the amount of water an animal drinks in a day? Why must the body have water?

144. **WHAT EFFECT DOES A LACK OF SODIUM HAVE ON THE BODY?**

Can you experiment using a salt-free diet? Is salt given off by the body when we perspire?
145. WHY IS IRON NEEDED IN THE BODY?
What is the effect of a lack of iron in the body? Can you carry on this experiment on a white rat? What foods are good sources of iron? Can you test this food for the presence of iron?

146. WHAT OTHER MINERALS ARE NEEDED IN THE BODY?
How can you detect minerals in foods? Burn bread or sugar by heating in a jar lid. The ashes left are minerals. Can you determine the proportion of minerals to the total weight of various kinds of foods?

147. WHAT VITAMINS DOES THE BODY NEED?
What is the effect of a lack of vitamin C in our diet? Can you carry on a controlled experiment with a white rat? What is the effect of a lack of vitamin A in our diet? What effect has vitamin E on the ability of rats to reproduce? Is this true of other animals? What effect has temperature on vitamin loss? What vitamins are destroyed by water?

148. WHAT IS A BALANCED DIET?
Is milk a perfect food? Is fish really "brain food"? Can you get smarter by eating lots of fish? Are tea and coffee harmful to children? How true are advertisements about certain foods on the market? What foods lose their vitamins by canning? Is soda pop harmful to the human body? Is fluorine in drinking water harmful to white rats?

149. WHAT EFFECT DOES GOOD POSTURE HAVE ON HEALTH?
Are you taller in the morning or at night? Can you keep track of your growth rate during the year? Do you grow more in the winter or in the summer? Does the season of the year affect your intelligence? Are you smarter in the winter when you are going to school?

150. WHAT IS DIGESTION?
What happens to food during digestion? What effect does saliva have on starchy foods? Make a starch solution test for sugar. Add equal amounts of saliva to starch solution. Wait for ten minutes and then test again for sugar. What effect does temperature have on the rate of digestion of starch to sugar by saliva? Carry on the experiment as above, but this time hold one test tube in your hand while leaving a control in a stand.
PROJECTS RELATED TO CHEMISTRY

1. WHY DOES INK CHANGE COLOR WHEN YOU WIPE OFF YOUR PEN?
   What causes the change in color: something in the air, dyes in the ink, type or temperature of the water in the ink, or the various kinds of paper? Vary some of these conditions as well as the type and color of the ink.

2. WHAT IS THE EFFECT OF FREEZING UPON VARIOUS HOUSEHOLD ITEMS?
   Are clocks affected by freezing temperatures? Motors? Fruits and vegetables? Ink? A flashlight? A bar of soap? Try freezing almost anything found around the house and then try to explain results.

3. HOW FAST DOES WATER “CLIMB”?
   Fill cups with water colored with bluing or vegetable dyes. Place different types of materials hanging with one end in the water. Time them to see which material water can climb the fastest. Suggested materials are: wool, outing flannel, cotton, taffeta, nylon, paper towelling, notebook paper, wax paper, blotting paper, string.

4. WHY DOES IRON CORRODE?
   Try placing iron nails in different solutions. Expose some nails to air while others remain submerged in the solution. Try protecting some of the nails with different materials or covering.

5. WHAT ACIDS ARE FOUND IN FRUITS?
   Investigate and identify the acids found in fruits. Compare the strengths of the acids in various fruits. You might compare varieties of the same fruit to see if there is a difference in the acid content.

6. CAN YOU DESIGN A METHOD TO TAKE THE SALT FROM SALT WATER?
   Collect the pure water and the salt residue and compare to see if any material was lost in the reaction. Use your device with a sample of water containing the percentage of salt as found in the Great Salt Lake in Utah. Would your device separate the salt and purify the water from such a lake?

7. CAN YOU MAKE COLORED SALT CRYSTALS?
   Find out how to “grow” salt crystals. See if you can grow colored salt crystals by using food coloring, dyes, etc. in the liquid. Can you grow bigger crystals by using other forms of salt instead of table salt? Do you alter crystal growth by adding other liquids to the salt solution?

8. WHAT FACTORS AFFECT THE BOILING POINT OF WATER?
   How can you get water to boil more rapidly? Does the shape and material from which the pan is made affect the boiling time? Are there materials which hasten the boiling when added to water?

9. CAN YOU DEVELOP A HOME-MADE CHEMISTRY SET?
   What materials can you find around the house and neighborhood that can be used to improvise your own chemistry apparatus and chemicals.

10. CAN YOU FIND A GOOD PLASTER MIX?
    Test the properties of various plaster mixes to determine the best plaster mix for patching cracks in basements, walls, etc. in your town. Strength, shrinkage, and the finished surface are some of the qualities to be considered.

11. DOES HOT WATER FREEZE FASTER THAN COLD WATER?
    This is a common saying. Investigate this statement scientifically.

12. WHAT EFFECTS DO HOUSEHOLD STAINS HAVE ON MODERN FLOOR COVERINGS?
    Many modern floor coverings are supposed to be resistant to stain. Test this idea by collecting examples of modern floor coverings (vinyl, linoleum, plastic, rubber, asphalt, and wood) and
subjecting them to different kinds of stains. The materials used should be common household items, such as ink, perfume, ammonia, fruit juice, iodine, paint, glue, alcohol, machine oil, burning cigarette. Let all set for the same length of time, them rinse under water and wipe with wet, then a dry, cloth.

13. WHAT EFFECTS DO DIFFERENT LIQUIDS HAVE ON EGGS?
Submerge the eggs in such liquids as vinegar, bleach, alcohol, gasoline, mild, water, etc. Leave the eggs in the liquid for varying lengths of time. Examine the outer shell of the egg. Break open the egg and examine the inside. Do all liquids affect eggs in the same way?

14. HOW DID THE PIONEERS DYE THEIR CLOTHES? HOW DO NATURAL DYES COMPARE WITH MODERN DYES?
Read about early pioneers. Try dyeing different fabrics, using the same methods as those of the pioneers. Then try dyeing the materials with the modern commercial dyes of today. Compare your results.

15. WHAT MATERIALS HOLDS THE DYE BEST?
Dip-test a number of different materials (wool, cotton, rayon, nylon, linen, etc.) into a dye.

16. IN WHAT LIQUIDS DO PINS RUST THE FASTEST?
Collect as many different kinds of liquids as possible. Submerge the pins in the jars containing the liquids. Observe the reaction over a long period of time. Try to explain your results.

17. ARE DETERGENTS HARMFUL TO PLANT AND ANIMAL LIFE?
Test the effect of detergents in the water used to water plants. Place guppies or goldfish in water polluted with detergent. Use the detergent water for drinking water for rats or white mice. Be sure to have a control for each experiment.

18. HOW DO DIFFERENT LIQUIDS VARY IN THEIR ABILITY TO RETAIN HEAT?
Bring a number of different liquids to approximately 212°F. Remove the liquids from the heat. Every two minutes check their temperatures until it has reached 150°F. Record this information on a graph. Suggested liquids for experimentation are: salt water, tap water, honey, syrup, tomato juice, motor oil.

19. HOW HARD IS WATER?
What causes "hard water"? How can you determine the hardness of water? Collect samples of water from different locations in your state. Compare the hardness of water from these locations and explain your results. See if you can determine the effects of hard water on normal living.

20. WHAT IS THE CARBON DIOXIDE CYCLE?
Many books describe the carbon dioxide cycle. See if you can set up an experiment to prove that this cycle does actually exist.

21. CAN YOU MAKE A FIRE EXTINGUISHER?
Design a fire extinguisher. Experiment with various chemicals, both solid and liquid, to determine which combinations would be effective if used in a fire extinguisher.

22. WHAT RETARDS SPOILAGE IN BREAD?
Preserve slices of bread at different temperature and in different kinds of wrappers. Also experiment with various kinds of breads: home-made, rye, French, bread with preservative and bread without. Preserve for one week or ten days and check for dryness and/or mold.

23. WHAT STAIN REMOVERS WORK BEST FOR COMMON HOUSEHOLD STAINS?
Try a number of stains, such as tea, fruit, grass, ballpoint ink, oil, mustard, coffee, catsup, etc. on both white and colored cloth. Try the same stains on different materials: cotton, wool, rayon, dacron, silk, etc. As stain removers, use soap and water, cold water, salt water, alcohol, ammonia, hot water, chlorine bleach, and an instant spot remover.
24. **HOW DO DIFFERENT KINDS OF WATER AFFECT VARIOUS METALS?**

Fill bottles with sea (salt) water, tap water, and distilled water. Drop in various kinds of scrap metal and tabulate which water discolors first with which metals.

25. **WHAT ARE SOME CHEMICAL USES FOR LICHENS?**

Lichens are primitive plants found growing on many rocky surfaces. Chemists have said that lichen plants can be used in many ways in the preparation of food. You can make pudding, soup, biscuits, and other foods from lichen plants. Perhaps you could make litmus paper by dipping a strip of paper towel into lichen soup.

26. **WHAT EFFECTS DO SOFT DRINKS HAVE ON MEAT AND CLOTH?**

Some soft drinks are more powerful than others in reacting with other substances. Rate soft drinks on this basis from the results of your experiments. What components in soft drinks cause the reaction?

27. **HOW CAN YOU LEARN TO RECOGNIZE VARIOUS FABRICS?**

Test various textiles for their properties. You might try some of the following tests: tearing, creasing, burning, staining, and boiling. See if you can develop tests that will enable anyone to recognize the various fabrics. Try this test out on some of your friends and see if they can identify fabrics by using your method.

28. **HOW CAN YOU DETERMINE THE QUALITY OF GROUND MEAT?**

Hamburger is often made by grinding up scraps of meat. Sometimes the scraps contain little lean but a large amount of fatty material. When such fatty hamburger is heated, the fat turns into grease. Collect the grease given off during cooking by a measured amount of hamburger. Compare the fat content of the samples from many stores. Stores may add starch to their product. Determine the starch content of the meat samples by using a few drops of iodine. Starch turns iodine purple.

29. **WHAT GIVES THE BEST PROTECTION TO VINYLTILE?**

Many schools and homes use vinyl tile as a floor covering. Certain liquids spilled on such tile can cause bad staining. See what protective coating can be given this tile to protect it from alcohol, dyes, shoe polish, and the like.

30. **CAN YOU MAKE YOUR OWN TOOTHPASTE?**

Establish the standard of a model toothpaste. Then try to develop such a toothpaste through experimentation with ingredients. Develop some tests to determine the cleansing power, as well as other properties of your toothpaste.

31. **HOW IS CARBON DIOXIDE PRODUCED?**

Produce carbon dioxide gas in as many ways as you possibly can. Try to develop a way of doing this geologically, with plants and animals, by chemical means, and other methods. Test the amount of carbon dioxide found in soda pop, the air, crowded rooms, etc.

32. **HOW DO LIQUIDS AFFECT DIFFERENT MATERIALS?**

Collect as many different kinds of liquids as you can. Test the effect of each of these liquids on as many solids as you can. See which liquids cause the most change and which cause no harmful effects. Try to analyze the chemical or physical reaction in each test.

33. **HOW DO PLASTICS REACT?**

Devise various tests and experiments which will determine the properties of different kind of plastics. These tests could be designed to determine strength, effect of temperature, resistance to scratching, ability to bend, etc. Analyze the properties of different commercial plastic materials. Who makes the strongest toys, wash tubs, cobs, etc.

34. **HOW WET IS WOOD?**
What is the affect of damp or wet lumber upon its usability? What is the difference between "dry" and "wet" lumber? Use different temperatures and conditions to see the effect of the rate of evaporation and the total moisture lost as the result of drying wood. How fast can you dry wood without damaging the product?

35. WHY DOES POPCORN POP?
What affects the popping time of different varieties of popcorn? Does soaking the seed in various liquids affect the time of popping and the quality of the popcorn? Will a seed pop if you cut it in half before popping? Will the seeds pop if they have previously been frozen?

36. HOW CAN STAINS BE REMOVED FROM CLOTHING?
Stain different cloths with a variety of natural dyes and food material found in nature. These stains will vary from grass stains to beer attacks. Then try to remove them with a home-made stain remover. Determine the type of stain remover needed for each kind of stain. Which are the best commercial stain-removers on the market? Test these stain removers with your home-developed product.

37. WHAT FOOD CONTAIN STARCH?
Place small amounts of each food to be tested in a pan of water. After the water has boiled, add iodine. If the mixture of food and water does contain starch, the mixture should turn a bluish color. What native plants also contain starch? Which of these plants could be used as a food source?

38. WHAT IS THE FLAMMABILITY OF VARIOUS HOUSEHOLD MATERIALS?
What materials found in the home will burn? Can you develop a table of materials as you test them. The table should list degrees of flammability from materials that burn violently to those which resist burning. These experiments should be performed under adult supervision only.

39. WHAT ARE THE EFFECTS OF HOME CHEMICALS ON METALS?
What chemical found around the house will stain or otherwise affect different kinds of metals. Classify such household materials as a result of your experiments. Can you explain why some chemicals cause an effect while others do not?

40. WHAT CAN YOU LEARN ABOUT THE OXIDATION OF FABRICS?
See what you can discover about the burning of various kind of cloth. Note the color and height of the flame. Determine the speed at which each fabric burns as well as any characteristic odor given off. See if you can identify the type of fabric by its ashes.

41. CAN YOU DEVELOP A METHOD OF REMOVING DYES?
Dyes that color some materials often run and discolor the item of clothing. Develop methods of removing various dyes. Note any adverse effect on the material.

42. WHAT IS THE DIFFERENCE BETWEEN A PHYSICAL CHANGE AND A CHEMICAL CHANGE?
Discover as many examples of change as you can in one day. Then attempt to classify and explain the changes on the basis of physical or chemical properties. Perform some experiments involving chemical and physical change. See if your experiments support the general definition of physical and chemical change.

43. CAN YOU FIND THE SCIENCE IN CERAMICS?
Experiment with colors and types of glazes. See if you can develop your own glazes and colors by varying the ingredients. Develop your own formulas for color and glaze combinations.

44. WHAT ARE THE PROPERTIES OF ICE?
Measure the amount of expansion that occurs when water in a liquid form changes into a solid. Experiment with the freezing and melting of ice. Add other materials in the water and see if these affect the freezing and melting points.
45. WHAT LIQUIDS WILL FREEZE?
Determine the melting and freezing points of various liquids. See if you can form frozen cubes of these liquids. Compare the density of these frozen cubes with the density of water.

46. DOES SALT AFFECT THE FREEZING AND BOILING POINTS OF WATER?
Determine the freezing and boiling points of water. Then add small amounts of salt and determine the freezing and boiling for each solution. Graph the results from both a temperature change standpoint and a time standpoint.

47. CAN EVAPORATION OF DRY ICE BY CONTROLLED?
Dry ice is a problem in that it is difficult to store. See if temperature, wrapping materials, air currents, or shape affects the rate at which dry ice evaporates. Use CAUTION when working with dry ice.

48. CAN YOU INVESTIGATE THE EFFECTS OF ACID AND ALKALINE SOLUTION ON FLOWERS?
Observe and measure the effects of various acids and bases on the pH of solutions. Investigate the effects of acid and alkaline solutions on the coloring compounds present in flowers, using the petals as indicators.

49. WHAT IS THE FLAMMABILITY OF VARIOUS WOODS?
Develop a scale for rating the flammability of wood. Test and rate various kinds of woods and record. What factors affect the rate at which wood burns? These experiments should be performed under adult supervision.

50. WILL NAILS RUST IN SALT WATER?
Can you determine the reason for the reaction or non-reaction which takes place?

51. CAN YOU LIST AND IDENTIFY THE MATERIALS AROUND YOU?
Which are solids? Liquids? Gases? Can you change materials (matter) from one state to another (solid to liquid, etc.)?

52. WHAT DOES THE FLAME OF A CANDLE CONSIST OF?
Blow out a candle and then bring a lighted match into the gas given off. Can you collect the vapors from a candle and change them into a solid? Conduct the vapors into a cold bottle by using bent glass tubing. Is hydrogen gas given off during the burning of a candle? Hold a cold glass over a candle flame. Does a candle flame give off carbon dioxide? Collect gas from the flame. Pour lime water into the bottle containing the gas. Lime water turns cloudy if carbon dioxide is present.

53. WHAT PART OF A CANDLE FLAME IS THE HOTTEST?
Can you measure the amount of heat given off at various parts of a candle flame?

54. WHAT IS THE DIFFERENCE BETWEEN A MIXTURE AND A COMPOUND?
Mix iron filings and sulfur together. Is this a mixture or a compound? Can you separate the iron and sulfur? Mix two grams of sulfur and 3.5 grams of iron filings in a test tube. Heat with an alcohol burner. Can you separate the iron and sulfur? Is this a compound or a mixture?

55. WHAT MATERIALS WILL DISSOLVE IN WATER?
Try dissolving some solids (salt, sugar, butter, flour, egg, etc.) in cold water. Does stirring help? What effect does heat have on the ability of water to dissolve materials? Try dissolving different materials in water of varying temperatures. What effect does the amount of surface area have on the rate at which a substance dissolves in a liquid? Try dissolving a large piece of material. Then try breaking the material into small pieces.

56. WHAT IS THE WATER CYCLE?
Can you make an artificial water cycle?
57. CAN YOU DETERMINE THE AMOUNT OF MINERALS IN DIFFERENT WATER SAMPLES BY THE PROCESS OF DISTILLATION?
   Do you lose any of the water during the process? Be sure to measure and keep track of your finding.

58. HOW CAN YOU SEPARATE WATER ELECTRICALLY BY ELECTROLYSIS?
   If you use washing soda as an electrolyte (substance in water to help conduct electricity), what effect does the amount of electrolyte in solution have on the rate of gas production of hydrogen? Of oxygen? In breaking water apart by electrolysis, what effect does increasing the distance between the electrodes have on the production of hydrogen and oxygen?

59. WHAT IS THE RATIO OF HYDROGEN TO OXYGEN IN VARIOUS TYPES OF WATER?
   Is the ratio the same in sea water? What is the effect of increasing the amount of current on the rate at which water breaks up during electrolysis? Will electrolysis work with both A.C. and D.C. current? What pole gives off hydrogen? Oxygen? Is this always true?

60. WHAT NATURAL SUBSTANCES CONTAIN OXYGEN?

61. OXYGEN FORMS WHAT PART OF AIR?
   Pour water around a burning candle attached to the bottom of a bowl or pie plate. Place a baby bottle over the candle. How high did the water rise in the bottle? This distance indicates the amount of oxygen used up in the burning.

62. WHAT EFFECT DOES OXYGEN HAVE ON BURNING?
   Heat some steel wool in the flame of an alcohol burner. Place the red-hot steel wool into a bottle of oxygen. Light some sulfur with a match and lower it into a bottle of oxygen. What effect does oxygen have on burning wood? Get a small bottle of oxygen from a shop that has a cutting torch. Light a splinter of wood and blow out the flame. Quickly lower the wood into the bottle of oxygen.

63. WHAT MATERIALS WILL BURN?
   What materials will not burn? What temperature is necessary for different materials to start to burn? This temperature is called the kindling temperature. Will all wood start to burn at the same temperature?

64. IS OXYGEN HEAVIER OR LIGHTER THAN AIR?
   Can you determine this experimentally?

65. IS WATER GIVEN OFF WHEN HYDROGEN IS BURNED?
   Hold a cold glass over a hydrogen flame. What materials can be used to generate hydrogen?

66. IS HYDROGEN LIGHTER THAN AIR?
   To what altitude will a home-made hydrogen balloon rise? What is the effect of temperature and pressure on the rate at which a balloon filled with hydrogen will rise?

67. HOW DOES A CARBON DIOXIDE FIRE EXTINGUISHER WORK?
   Can you make a home-made extinguisher? If you use baking soda and vinegar, what effect does the temperature of the vinegar have on the thrust of the water out of the nozzle?

68. CAN YOU POUR INVISIBLE CARBON DIOXIDE?
   Is carbon dioxide heavier than air? What effect does carbon dioxide have on burning?

69. WHY DOES LIME WATER TURN MILKY WHEN EXPOSED TO CARBON DIOXIDE?
   Make lime water by mixing a teaspoon of hydrated lime with one pint of water. After the lime sinks to the bottom of the bottle, filter the liquid and screw the lid down tightly.
70. DOES YOUR BREATH CONTAIN CARBON DIOXIDE?
   Blow through a straw into a test tube containing lime water.

71. DOES THE AIR AROUND US CONTAIN CARBON DIOXIDE?
   Place a dish of lime water on a table. Observe later. If carbon dioxide is present, there should
   be a scum on the water.

72. WHAT EFFECT DOES EXERCISE HAVE ON THE PRODUCTION OF CARBON DIOXIDE?
   Run a distance and then test your breath by blowing into a test tube containing lime water.

73. WHAT ROCKS, WHEN COMBINED WITH ACIDS, WILL PRODUCE CARBON DIOXIDE?
   Try marble, limestone, granite, and other common rocks.

74. WHAT PART OF THE ATMOSPHERE IS NITROGEN?
   Burn a candle in a bowl of water. Cover the candle with a baby bottle. The gas remaining in the
   bottle after the water rises is almost all nitrogen.

75. IS AMMONIA GAS SOLUBLE IN WATER?
   Place a test tube of the gas upside down over a bowl of water. Remove your finger which is
   covering the opening. The solubility of the gas is shown by the amount of water that rushes up
   the test tube.

76. WHAT EFFECT DOES AMMONIA HAVE ON LITMUS PAPER?
   Check both the liquid and the gas forms.

77. HOW CAN YOU PRODUCE AMMONIA?
   Heat household ammonia gently and collect gas. What are the properties of ammonia gas? Is it
   heavier or lighter than air?

78. WHAT CAUSES THE WHITE SMOKE WHEN THE FUMES OF HYDROCHLORIC ACID COME IN
    CONTACT WITH THE FUMES OF AMMONIA?
   Dampen the inside of a jar with hydrochloric acid. Fill a second jar with ammonia gas. Place a
   piece of cardboard over the jar with hydrochloric acid. Turn the jar containing ammonia gas over
   and place it on the cardboard. Remove the cardboard.

79. WHAT LIQUIDS AND OTHER MATERIALS CONTAIN CHLORINE?
   Mix half an teaspoon of starch with about 60 ml. of water. Bring the water to a boil. Dissolve a
   very small amount of potassium iodide (about as much as 4 grains of rice) in the mixture. Dip
   strips of the filter paper or paper towels in the mixture and then dry them. A strip will turn blue in
   the presence of chlorine.

80. WHAT EFFECT DOES CHLORINE HAVE ON LIVING THINGS?
   Place a drop of clorox or other bleach in a drop of water containing protozoa and other
   microscopic plants and animals. Examine through a microscope.

81. CAN CHLORINE BE MADE FROM HYDROCHLORIC ACID?
   Put a gram of manganese dioxide into a test tube. Add 6 ml. (about 1/4 of the test tube) of
   hydrochloric acid and heat gently. Test with chlorine test paper. Be careful not to breathe into
   the gas directly. Move your hand back and forth over the test tube and sniff the air as the
   gas moves toward you.

82. IS CHLORINE WATER-SOLUBLE?
   Add some water to a bottle containing chlorine. Cover the mouth of the bottle with the bottom
   of your hand. What should happen if some of the chlorine dissolves in the water?

83. WILL CHLORINE REACT WITH HYDROGEN AND HYDROGEN COMPOUNDS?
   Lower a burning candle into a bottle of chlorine. The candle is made of hydrogen and carbon. If
   the chlorine combines with the hydrogen, what would be given off?
84. WILL CHLORINE COMBINE WITH DIFFERENT METALS?
Twist a piece of wire around some steel wool. Heat the steel wool with a match. Lower the steel wool into a bottle containing chlorine. If the chlorine mixes with the iron in the steel wool, iron chloride should be formed. Iron chloride is a brownish gas.

85. DOES CHLORINE BLEACH COTTON AND LINEN?
Hang a colored strip of cotton or linen cloth in a bottle of chlorine. Cover the bottle. Try a second bottle of gas, but this time moisten the cloth. If it is the chlorine that does the bleaching, the dry cloth should turn white.

86. IS CHLORINE HEAVIER THAN AIR?
Test to see if chlorine will rise out of a bottle. Be careful not to breathe the gas.

87. HOW CAN YOU RECOGNIZE AN ACID?
Dilute acid, such as hydrochloric, in a ratio of one part acid to three parts water. Dip the end of one finger in the acid water mixture. How does acid taste? How does an acid feel to the touch?

88. HOW CAN YOU DETECT AN ACID?
Place a drop of acid on a strip of blue litmus paper. Does the litmus change color? Try other acids. Are the results the same?

89. WHAT EFFECT DO ACIDS HAVE ON METALS?
Place small bits of a metal in a test tube. Add a strong acid, such as hydrochloric. What happens to the metal? Is a gas given off? Do acids have the same effect on all metals?

90. DO ALL ACIDS REACT THE SAME ON A CERTAIN KIND OF METAL?

91. HOW CAN YOU RECOGNIZE A BASE?
Dissolve a teaspoon of lye in a half glass of water. Place about ten drops of this solution into a glass of water. Dip your finger into this very diluted solution and then taste. Place a drop of lye on blue litmus paper. Try placing another drop on red litmus paper.

92. DO ALL BASES HAVE THE SAME CHARACTERISTIC TASTE?
Try other bases. Be sure to dilute the base with a large amount of water.

93. WHAT LIQUIDS IN YOUR HOUSEHOLD ARE BASES?

94. HOW CAN YOU MAKE LITMUS PAPER?
Slice leaves of red cabbage into strips. Boil these strips in hot water and let stand for about half an hour. The liquid can then be used as an indicator. You can soak paper towel strips in the colored water and let dry. Try making other indicators by using blueberries, cherries, different flowers, and other plants and vegetables.

95. WHAT EFFECT DO ACIDS HAVE ON BASES?
Make a lye solution. Place a drop of phenolphthalein solution into a small solution of lye in a test tube. The phenolphthalein should color the solution. Now add an acid such as hydrochloric. Is the solution of hydrochloric acid and lye base an acid or a base?

96. WHAT EFFECT DOES A BASE HAVE ON FAT MATERIAL?
Drop a lump of fat into a test tube containing a lye solution. Heat gently. What happens to the fat? What does the solution feel like?

97. WHAT EFFECT DO BASES HAVE ON ACIDS?
Put a drop of phenolphthalein solution into a small amount of diluted hydrochloric acid. Pour this solution into a lye solution. The ratio of hydrochloric acid to lye solution should be about two parts acid to five parts base. Try other acids and bases to see if all bases act on acids in the same manner.
98. **HOW IS PHENOLPHTHALEIN SOLUTION MADE?**
   Get some phenolphthalein powder from a drugstore. Mix a pinch of the powder in a one-ounce bottle of denatured alcohol. Try out your mixture on different bases.

99. **WHAT SOLUTIONS CONDUCT ELECTRICITY?**
   Wire up a flashlight bulb in series with a container for liquids. Attach carbon rods to the two ends of wires going into the liquid solution. When current passes through a liquid which conducts electricity, the bulb will light up. If the liquid will not conduct electricity, the bulb will not light.

100. **WHAT EFFECT DOES TEMPERATURE OF THE WATER HAVE ON THE AMOUNT OF MATERIAL THAT WILL DISSOLVE IN IT?**
   Try dissolving a measured amount of salt in cold water. Try dissolving the same amount in warm water. Can you keep a graph of the amount of salt that will dissolve at different temperatures?

101. **WHAT IS A SATURATED SOLUTION? A SUPERSATURATED SOLUTION?**
   Add a chemical to water. Stir until you find that some of the chemical won't dissolve with any amount of stirring. The solution is saturated. Heat and add more of the chemical. The solution is now supersaturated. It holds more of the chemical than it normally can at room temperature. Cool the liquid. What should happen?

102. **WILL ALL CHEMICALS DISSOLVE IN THE SAME AMOUNTS IN WATER AT GIVEN TEMPERATURES?**
   Can you keep a chart of the amount of different chemicals that will dissolve at given temperatures?

103. **WHAT EFFECT DOES TEMPERATURE HAVE ON THE FORMATION OF CRYSTALS?**
   Make a supersaturated solution of alum or epsom salt. Four some of the solution on a warm piece of glass or microscope slide. Pour another sample of the solution on a cold pane of glass.

104. **IF YOU ADD MATERIALS TO A LIQUID (SUCH AS SALT TO WATER) TO MAKE A SOLUTION, DOES THIS RAISE OR LOWER THE FREEZING AND BOILING POINT OF WHEN LIQUID?**
   Try various chemicals and liquids.

105. **WHAT EFFECT HAS THE RATE OF EVAPORATION ON THE FORMATION OF CRYSTALS?**
   Make a supersaturated solution of sugar. Pour some of this into several jars. Suspend a string into the center of the sugar solution in each jar. Control the rate of evaporation by using jars with different-sized openings.

106. **WHAT FOODS AND MATERIALS FOUND AROUND THE HOUSE CONTAIN ACID? WHICH CONTAIN BAGES?**
   Try ammonia, tea, soda pop, lye, aspirin, grapefruit, orange, milk of magnesia, lime water, cleanser, tomatoes, vinegar, milk, cream, and similar materials.

107. **CAN YOU DETERMINE THE NORMAL PH CONDITION IN THE MOUTHS OF VARIOUS ANIMALS AND HUMANS?**

108. **CAN YOU MAKE A SALT FROM A METAL AND AN ACID?**
   Try a few drops of hydrochloric acid on zinc or aluminum strips. Test with blue and red litmus paper. A salt should not be affected either color of litmus paper.

109. **HOW CAN IODINE STAINS BE REMOVED?**
   Stain a cloth with iodine. Mix a few hypo (sodium thiosulfate) crystals in water. Place drops of hypo on the stain. Try removing an iodine stain by other methods.
110. IS IODINE FREED WHEN CHLORINE IS ADDED TO A SOLUTION OF POTASSIUM IODIDE CRYSTALS?
Add a few drops of chlorox or other bleach to a solution of potassium iodide crystals.

111. IN WHAT FORM DOES SULFUR EXIST AS CRYSTALS?
Examine flowers of sulfur under the microscope. Heat sulfur in a test tube. Filter the sulfur through a paper towel or filter paper. Examine crystals formed on filter paper under the microscope. Examine under polarized lights.

112. WHAT EFFECT DO SULFUR FUMES HAVE ON THE COLOR IN DIFFERENT MATERIALS?
Heat a small amount of sulfur powder in a metal lid. Hold the lid by wrapping a stiff wire around the lid for a handle. When the sulfur in the lid starts to burn well, lower the burning sulfur into a Mason jar. Sulfur dioxide fumes will be given off in the jar. Place different colors of materials into the jar and cover it so that the fumes cannot escape.

113. HOW IS SULFURIC ACID MADE?
Lower burning sulfur into a jar. After the fumes fill the jar, remove the burning sulfur and add a few cc. of water. Shake the bottle and then test with litmus paper.

114. IS SULFUR DIOXIDE SOLUBLE IN WATER?
Fill a baby bottle with sulfur dioxide fumes. Insert a one-hole stopper containing a piece of glass tubing. Invert the gas-filled bottle over a container of water. If the gas is water-soluble, the water should run up the glass tubing and into the bottle containing the gas.

115. WILL SULFUR DIOXIDE SUPPORT BURNING?

116. HOW CAN YOU MAKE HYDROGEN SULFIDE IN YOUR HOME LABORATORY?
Fill a test tube one-eighth full of powdered sulfur. Add a small lump of candle wax. Heat the test tube. Hydrogen sulfide has the smell of rotten eggs and is quite unpleasant.

117. HOW DO YOU GROW A SILICON GARDEN?
Place a layer of sand on the bottom of a wide-mouth mason jar. Fill the jar with an equal mixture of water and water-glass (sodium silicate). Add crystals of different salts, such as copper sulfate, alum, epsom salts, zinc sulfate, and sodium sulfate. Let the jar stand undisturbed.

118. CAN YOU DETERMINE THE DENSITY OF DIFFERENT METALS?
Weigh the sample. Determine the volume by the amount of water displaced when you submerge the metal in water. Figure the weight per unit volume.

119. HOW IS BORAX USED IN CHEMICAL ANALYSIS?
Make a small loop by wrapping the end of a piece of nichrome wire around the end of a pencil. Insert the other end of the wire into a piece of heated glass tubing or a cork. Either the cork or the glass tubing will serve as a handle. Heat the wire loop and dip it into melted borax to form a bead. Touch the bead to the chemical to be tested. Then heat the bead again in a very hot flame. You may use a blowpipe with an alcohol lamp. The color of the bead when cold, compared to the color when the bead is hot is used to determine the metal.

120. HOW CAN YOU TEST FOR BORIC ACID?
Make and indicator paper by dipping strips of paper towelling in mustard. Wash the mustard off and allow the strips to dry. The strip turns brown when exposed to boric acid. This is because of the coloring matter (turmeric) in the mustard.

121. CAN YOU TEST THE HARDNESS OF WATER AROUND THE AREA IN WHICH YOU LIVE?
Make a test solution by dissolving about a gram of soap flakes in about 20 cc. of denatured alcohol or duplicator fluid. Filter the solution. Test the unknown sample by filling a baby bottle half full of the water. Add about 10 drops of your soapy test solution to the water. Cover and shake the baby bottle. The amount of foam indicates the degree of hardness, with very hard
water making little foam. Check the amount of foam formed by using rain water and distilled water.

122. CAN YOU DISTILL HARD WATER AND REMOVE IMPURITIES?
Test your distilled water with a hardness test.

123. CAN YOU DETERMINE THE DENSITY OF DIFFERENT METALS?
Weigh the sample. Determine the volume by the amount of water displaced when you submerge the metal in water. Figure the weight per unit volume.

124. DO METALS GIVE OFF A CHARACTERISTIC COLOR WHEN THEY BURN?
Sprinkle bits of different metals into the flame of an alcohol burner. Record the colors given off. Aluminum is easily available in the form of pie tins or foil.

125. WHAT IS THE REACTION OF ALUMINUM WITH A BASE?
With an acid? Drop strips of aluminum into HCl. What gas is formed? Make up a weak-base solution of sodium hydroxide (lye). Drop the aluminum strips into the lye. What gas is given off? What is left in the bottle?

126. HOW CAN ALUM BE USED TO CLEAR WATER?
Add a spoonful of dirt to two jars of water. Stir to mix the dirt throughout the water. In one of the jars add about half a teaspoon of alum and two teaspoons of ammonia. Why does the dirt seem to settle out? What effect does temperature have on this?

127. CAN CRYSTALS BE GROWN WITH DOUBLE SALTS?
Make a supersaturated solution of potassium aluminum sulfate or ammonium aluminum sulfate. These double salts are called alum. Heat your solution and add your salt until no more can be dissolved. Strain off the liquid and allow the undissolved alum to cool. Save the liquid. Pick out the largest of the crystals and discard the rest. Replace the discarded alum crystals with an unequal amount of fresh alum salt. Heat to dissolve the new crystals in the liquid you have saved. Allow this solution to cool and then pour the solution into a baby bottle. Tie a thread around the largest crystal you have saved. This crystal is then suspended in the solution in the baby bottle. The solution should be allowed to evaporate slowly and remain undisturbed.

128. HOW SMALL IS A MOLECULE?
Dissolve a gram of potassium permanganate in a 100 cc. of water. This gives a solution of 1/100 or 1 to 100. The color is due to the KMnO₄ molecules moving around in the water. Remove 10 cc. of this solution and add to 90 cc. of fresh water. You now have a solution of 1 to 1000. Can you still see a color? Repeat this with several additional bottles of water. Be sure always to take your colored solution from the bottle containing the weakest solution. Can you still see the molecules after you have diluted the solution to 1 to one million parts?

129. WILL ALL IRON RUST?
What effect does humidity have on the rusting of iron? Wedge a piece of steel wool into the bottom of a glass. Invert the glass over a pie tin containing water. For your control, repeat the experiment but don't use any water. Compare the results after several days. If water rises in the glass, something must have been used up out of the air in the glass.

130. HOW CAN RUST BE PREVENTED?
Rust is iron reacting with oxygen in a very slow combustion process. Can you coat iron nails with different materials to prevent the oxygen from reaching the iron? Will rust occur without moisture?

131. HOW IS COPPER SULFATE USED IN CHEMICAL ANALYSIS?
Crush some copper sulfate crystals and pour them into a test tube. Heat and stir these crystals until they have formed a white powder. You have removed all the water from the copper sulfate. If you add a drop of a liquid that does not contain water, the crystals will not change. If
you add a drop of water, blue crystals will form. You can test many liquids for the presence of water. Try rubbing alcohol, gasoline, vinegar, and others.

132. WHAT IS THE REPLACEMENT SERIES FOR METALS?
Metals vary in their amount of activity. The replacement series is a list starting with the most active metal, potassium, and going down to the least active metal, gold. You can discover the correct order of the metals in this series by simple experiments. If a metal such as iron (a nail) is placed in a solution of a salt of a less active metal such as copper sulfate, the more active iron will replace the less active copper. The copper then will form around the nail and plate it. Iron then is more active than copper. If we place a piece of copper in a solution of silver nitrate, we find the copper replaces the silver, and silver is plated on the copper metal. Therefore, copper is more active than silver. All of these activity experiments can be performed under the microscope or microprojector. Place a stand of wire of the metal being tested on a blank microscope slide. Add a drop of the metal salt solution to the wire.

133. HOW MANY DIFFERENT KINDS OF PLATING CAN YOU DO?
Remember to use one of the metals listed in the replacement series and a salt of another metal that is listed below the finest metal (one that is less active).

134. WHAT CAUSES SILVER TO TARNISH?

135. WHAT FORMS OF CARBON WILL CONDUCT ELECTRICITY?
Try different types of coal, graphite (lead in a pencil), diamonds, charcoal, and others.

136. WHAT CHEMICALS COMPOSE COAL?
Crush a lump of bituminous coal into a powder. Fill a test tube about one-quarter full of this powdered coal. Place a wad of cotton near the mouth of the test tube to act as a filter. Insert a rubber stopper containing a L-shaped piece of glass tubing. The opening to the tubing should be drawn to a jet point. Heat the coal in the test tube over an alcohol burner. Fumes will form and escape through the jet point. Will these fumes burn? Test the gas by inserting litmus paper into the test tube. Ammonia will turn red litmus paper blue. Acetic acid will turn blue litmus paper red.

137. WHAT CHEMICALS COMPOSE WOOD?
Try the same experiment as above?

138. WHAT FOODS CONTAIN CARBON?
Heat small bits of such foods as bread, sugar, potatoes, cheese. What is the final product formed after you have heated the food material until it "burns"?

139. WILL SUGAR BURN?
Can the vapors given off by heated sugar be ignited?

140. DOES METHANE GAS COME FROM COAL?
Break lumps of bituminous coal into a powder. Fill a funnel with the coal powder and place a bottle over the funnel. Turn the bottle over so that the funnel containing the coal powder is resting on the bottom of the bottle. Fill the bottle with water and place a test tube containing water over the opening to the funnel. If a gas is given off, the gas will rise in the test tube and slowly force the water out. You may have to wait several days.

141. WHAT ARE THE PROPERTIES OF METHANE?
First make sodium acetate by adding washing soda (sodium carbonate) to 1/2 cup of white vinegar until all the carbon dioxide possible is given off. Evaporate the liquid slowly at a low heat. The white powder that remains is sodium acetate. Now mix equal amounts of sodium acetate, calcium oxide, and sodium hydroxide in a test tube and heat slowly. Collect the methane gas given off by bubbling through water.

142. CAN A GAS BE TURNED DIRECTLY INTO A SOLID?
Crush mothballs and heat gently. The gas given off is naphthalene. Place a jar containing ice over the gas vapor being given off by the heated mothballs. If the gas can be turned directly into a solid (sublimation), crystals will form on the bottom of the jar.

143. IS TURPENTINE A HYDROCARBON?
Pour a little turpentine into a jar lid. Place a short piece of clothesline rope or heavy string in the lid to serve as a wick. Light the wick. Hold a jar over the flame. If the turpentine is a hydrocarbon, it should give off carbon when it burns, and a black soot should form inside the jar.

144. WHAT SWEET-TASTING FOODS CONTAIN GLUCOSE SUGAR?
Make your test solutions "A" and "B". Solution A is made by dissolving 5 grams of copper sulfate into 70 cc. of water. Solution B is made by dissolving 7 grams of lye (sodium hydroxide) into 70 grams of water. Then add 25 grams of rochelle salt (sodium potassium tartrate) to this solution. In order to use the test solutions, heat a mixture of 3 cc. of Solution A and 3 cc. of Solution B. Add a few drops of the material to be tested to the mixture. If glucose is present, a red precipitate (solid) of cuprous oxide will be formed. Test fruits, honey, molasses, corn syrup, cane sugar, maple syrup, and beet sugar.

145. CAN ONE TYPE OF SUGAR BE CHANGES INTO ANOTHER?
Dissolve 2 grams of cane sugar (sucrose) into 20 cc. of water. Add about 15 drops of hydrochloric acid. Heat gently and test with Solutions A and B. If the sucrose turns to glucose, a red precipitate should be formed.

146. HOW DO YOU MAKE A TEST SOLUTION FOR STARCH?
Dilute one part of tincture of iodine with nine parts water. Iodine gives a blue color to materials composed of starch.

147. DOES A POTATO CONTAIN STARCH?
Grate a potato and place the gratings in a cheesecloth. Dip the cheese cloth into a bowl of water and squeeze the gratings inside. Repeat many times until the juice is all in the bowl. Let the material in the bowl settle and then pour off excess water. Let the liquid in the bowl evaporate. Test the dried material left in the bowl with an iodine test solution.

148. WHAT KIND OF SOAP OR DETERGENT GIVES THE MOST SUDS?
Fill test tubes with different kinds of detergents and soaps. Add oil drops. Which detergents and soaps mix with the oil? Add one part lime water to two parts solution. Shake the test tube and note the amount of foam compared with other soap products.

149. WHAT IS THE COMPOSITION OF EGG WHITE?
Mix a half and half mixture of egg white and water. Add an equal amount of denatured alcohol. If albumin is present, it will coagulate into white flecks.

150. WHAT IS THE COMPOSITION OF ALBUMIN?
Heat coagulated egg white in a jar lid. Test for ammonia by smell and litmus paper. Continue to heat the albumin. If the albumin turns black, it also contains carbon.

151. CAN YOU COLOR ICE?
Try to develop a method so that the food coloring will spread out and color all of the ice rather than just collecting at the middle.

152. WHAT MAKES THE BEST BUBBLES?

153. IS IT CHEAPER TO MAKE OR TO BUY SOAP?
Make soap from a good standard recipe and then compare the cost with that of commercial products. Is the home-made or the commercial varieties more effective?

154. WHAT AFFECTS THE RATE AT WHICH COFFEE COOLS?
How does the size, shape, and material of which a cup is made affect the rate at which coffee cools? Does sugar and cream have an effect upon this cooling rate?
PROJECTS RELATED TO GEOLOGY

1. WHAT CAUSES A DESERT?
Investigate the conditions which produce the various deserts found in your state. How do these conditions vary from one geographical location to another? Can you re-create, on a small scale, conditions which might temporarily support desert vegetation and wildlife? Can this exist permanently?

2. HOW CAN YOU DETECT URANIUM ORE BY THE USE OF ACIDS?
Some ores give off little radioactivity. Can you develop a test to identify uranium ores? How reliable is this test?

3. HOW ARE ROCKS AND MINERALS IDENTIFIED?
Develop tests to help you classify various rocks and minerals. See if you can develop a potential use for each of these rocks and minerals, depending on the properties.

4. OF WHAT ARE ROCKS COMPOSED?
Analyze rocks found in your state. Use the anion and cation analysis method. The book, SEMIMICRO QUALITATIVE ANALYSIS, by Caldwell and King is a good reference book for this project.

5. WHAT AREAS AROUND YOU ARE SAFE FOR BUILDING?
What factors cause slides? Determine which areas are stable and which areas are not stable. Road cuts will give you a clue as to the type of soil in each area.

6. HOW IS TACONITE MINED AND PROCESSED?
See if you can do library research on the process of mining taconite. Experiment with some of the steps involved and see if you can reproduce any of the steps on a smaller scale.

7. CAN YOU MINE GOLD?
Find out the various methods of mining for gold. Investigate the streams and land areas around you and in other areas of the state you have an opportunity to check. Are you able to locate sources of gold?

8. WHY DO SOME ROCKS FLOAT?
Why do some rocks float while most rocks sink? Pumice sometimes floats and at other times sinks. See if you can investigate the factors affecting the buoyancy of pumice and other floating rocks.

9. WHAT CAUSES CRYSTALS TO BE FORMED IN NATURE?
What kinds of crystals are formed naturally? Investigate crystals which are found in the world of nature. Determine the properties of such crystals. Collect examples and examine the conditions under which the specimens were formed.

10. DOES OUR SOIL CONTAIN IRON?
Collect samples of soil from around your area. Collect both top soil and sub-soil from different depths. Extract any iron deposits from the soil samples and try to arrive at a theory to explain your results.

11. DOES BEACH SAND CONTAIN IRON?
Sand often contains small particles of iron which you can detect with a magnet. Are such iron deposits part of the sand of every beach? Is there more iron in the sand near the mouth of a river? What causes such deposits?

12. HOW ARE VOLCANOES FORMED?
Do some library research on the different types of volcanoes. Visit any that are in your area. Construct a model for each type.
13. HOW DO ROCKS CHANGE?
Examine rocks in many locations. Attempt to explain what changes the rocks have undergone since their formation. Try to analyze which natural forces have been working on these rocks. Examples of such natural forces would be wind and water erosion.

14. IS ROCK EVER "SOFT"?
One of the methods of rock identification is by degree of hardness. How can you tell how hard or "soft" a rock is?

15. HOW DO THE VARIOUS TYPES OF ROCKS BECOME SOIL?
Learn the difference between metamorphic, sedimentary, and igneous rocks. Then try to produce soil from examples of each. Which type erodes the easiest? Which type produces the richest soil? Can you make a seed grow in the soil you have produced?

16. WHAT FACTORS AFFECT SOIL EROSION?
Set up some sample plots of ground in a location near where you live. Experiment with different types of vegetation or other factors. Use one plot as an experimental plot and another as a control. Compare your results.

17. HOW ARE MINERAL DEPOSITS DISCOVERED?
What are the conditions or clues that lead prospectors to discover mineral deposits? Do these clues vary for different types of minerals? Is there any land around the area in which you live that may contain mineral deposits?

18. HOW ARE MINERAL DEPOSITS ANALYZED?
Ore is analyzed to determine its composition and pinpoint the richness of a mineral deposit. Can you find out how a sample of ore is analyzed?

19. HOW IS SOIL FORMED?
From library research, determine the composition of various types of soil. Examine soils in your area and compare with your findings. See if you can produce some of the soils mechanically from raw materials.

20. HOW ARE FOSSILS FORMED?
Through library research discover the difference types of fossils: imprints, casts, etc. Try to reproduce these different fossil types artificially through the use of plaster of paris, clay, or other materials. In what type of soil are fossils usually found? Examine the ground around the area where you live. What is the most likely fossil type in your area?

21. HOW ARE FOSSILS EXTRACTED?
Fossils, gems, and minerals are found imbedded or enclosed in rocks. This rock is called the matrix. What methods are used for extracting fossils from their surrounding matrix? Experiment with various methods of removal which you may devise. Try boiling, freezing, burning and chemical methods of separation.

22. HOW ACTIVE HAVE VOLCANOES BEEN IN YOUR STATE?
With the aid of library research trace the story of volcanic activity in your state. Collect examples of the lavas in as many locations as you can. See if you can actually chart some of these flows and eruptions on a map of your own.

23. WHAT CAUSES ICE CAVES TO FORM?
Are there any ice caves in the state in which you live? What causes these ice caves? Can you produce this effect experimentally?

24. WHAT CAUSES ROCKS TO FORM IN COLUMNS?
In quarries or along road cuts you sometimes see columns of rock which seem to form a geometric pattern. This rock is called columnar basalt. Why do such perfect structures form? Is the rock from which these columns are formed similar to rocks found in other formations?
PROJECTS RELATED TO METEOROLOGY

1. **CAN YOU KEEP A DAILY WEATHER CHART?**
   Record the temperature, barometric pressure, and type of weather you have each day at a certain definite time. Note any relationship between temperature, pressure, and the type of weather that follows. Then see if you can predict weather from the data you have gathered.

2. **CAN YOU MAKE A SIX-MONTH WEATHER ANALYSIS?**
   Clip the daily weather reports from the newspapers. Determine the average temperature for each month, as well as the average for a six-month period. Repeat this for air pressure, rainfall, and other conditions.

3. **HOW ACCURATE IS THE TV WEATHERMAN?**
   Compare your predictions with the TV weatherman. Then record the actual weather that occurs. Figure your percentage of error as compared with the TV forecaster.

4. **HOW ACCURATE IS A WEATHER GLASS?**
   Make a chemical weather glass as explained in many science books. Compare the predictions of the weather glass with those of the newspaper. Compare the predictions of both with the actual weather that occurs.

5. **DOES THE TYPE OF WEATHER HAVE ANY EFFECT ON HUMAN EMOTIONS?**
   Record relative humidity, barometric pressure, temperature and cloud formations for a period of time. Devise some type of chart for students to record generally how they feel, and have a number of them keep the chart for the same period of time. Compare the weather data with the state of mind of the students. Do their fluctuations seem to have any connection with your weather records?

6. **DOES HEIGHT AFFECT TEMPERATURE?**
   Measure the temperature at different heights for a certain location. Conduct this experiment both inside and outside your home at various hours of the day. Determine when and if an increase in height does affect the temperature.

7. **WHAT IS PRESSURE?**
   Perform a number of experiments on air pressure. Come to some conclusions as to the cause of pressure and the uses of air pressure.

8. **HOW DOES THE TEMPERATURE OF THE AIR AFFECT THE GROUND TEMPERATURE?**
   Record the air temperature and the ground temperature over a period of time. Record them at various hours of the day. What theory can you develop to explain the results?

   Dig holes of varying depths and insert small thermometers. Fill the holes back in with dirt. Record the air temperature and these various underground temperatures over a period of time. Does the ground get colder or warmer the farther down you go? How does the temperature in a cave compare with the temperature above the ground?

10. **DOES THE DIFFERENCE OF ONE MILE AFFECT WEATHER COMPUTATION?**
    Have a friend or several friends record temperatures and other weather conditions around your home. Compare the data over a period of time. Try to identify any land features or other factors that might influence the weather data.

11. **CAN YOU PREDICT THE WEATHER BY OBSERVING CLOUD FORMATIONS?**
    Through library research study the types of clouds. Then keep a cloud diary. In this diary list the type of cloud, its height, and the amount of cloud cover in the sky. Record the weather conditions that follow. After you have studied the comparison, see if you can predict the weather from cloud formations.
13. CAN A HOME-MADE WEATHER STATION MAKE AN ACCURATE WEATHER REPORT?
Develop a home-made weather station by making various weather instruments, including a barometer, humidity gauge, wind vane, rain trap, and rain gauge. Use this equipment to make and record weather data. See how accurately you can forecast with this data.

14. WHAT IS HUMIDITY AND HOW IS IT MEASURED?
Through library research find out just what humidity, dew point, and other terms related to humidity indicator actually are. Construct a hair hydrometer or other humidity indicator, such as a wet and dry bulb thermometer. Try to determine the humidity of the air.

15. WHICH WAY DOES THE WIND BLOW MOST FREQUENTLY?
Measure the wind direction each morning and each night for a period of time. What is the percentage of time that the wind is blowing? Determine the percentage of time that the wind blows from various directions. Is wind direction related to the weather that follows?

16. SUNRISES AND SUNSETS: DO THEY VARY AND WHY?
Record sunrise and sunset time for a number of months. Determine how much difference there is between sunrise one day and sunrise the following day. Is the rate of change consistent from day to day? Record your data on a graph and then explain the results.

17. COLOR: DOES IT AFFECT EVAPORATION?
Cover containers with various colored materials. Fill them with water. Determine out of which container the water evaporates first. Is there a relationship between the rate of evaporation and the color of the container?

18. WHAT FACTORS AFFECT THE EVAPORATION OF WATER?
Place containers in different locations which vary the temperature, light, and other factors. See which container evaporates first. Repeat the experiment, using different-shaped containers.

19. WHAT EFFECT DOES FREEZING HAVE ON VARIOUS TYPES OF WATER?
Use identical amounts of tap, spring, ocean, and lake water in the same size of containers. Which water freezes the fastest? Which one melts the most rapidly? Try to explain your data.

20. WHAT ARE THE NATURAL INDICATORS OF WIND SPEED AND DIRECTION?
Notice around your community the number of materials which can be used to detect air movement. See if you can rate these indicators as to their sensitivity to wind.

21. WHAT INSTRUMENTS ARE USED TO COLLECT WEATHER DATA?
What are the principles behind weather instruments? Can you "invent" a new weather instrument?

22. HOW DOES THE HEIGHT OF AIR ABOVE THE FLOOR AFFECT ITS TEMPERATURE?
Record the temperature at different heights up to the ceiling. Compare your results after you have done several rooms. Check outside temperatures in the same way.

23. WHAT OBJECTS AROUND YOU INDICATE THE SEASON OF THE YEAR?
If you woke up after a long Rip van Winkle sleep, how would you decide what season of the year it was? What causes the seasonal changes that you would find in plants, animals, temperature, etc.?
IX.

Definitions of Scientific Terms for use in the K-5 and 6-12 at home Science Fair Packets
DEFINITIONS OF TERMS

1. **Abstract** - A short, written summary of a scientific research paper which usually includes the purpose, procedures, results and conclusions of the project.

2. **Acknowledgements** - Giving credit to the people who helped you during your project.

3. **Affect** - A verb. To make something happen to. A poor diet can affect someone's health.

4. **Apparatus** - The instruments, materials, tools etc. needed for scientific use, experiments, etc.

5. **Background Information** - This is the preliminary research gathered from books, periodicals, interviews, etc.

6. **Background Information or Research** - Any necessary information, definitions, etc. that may be necessary to begin or continue your experiment, and to develop your hypothesis.

7. **Bar Graph** - A type of graph where comparisons are made through vertical lines of differing lengths.

8. **Bibliography** - A list of books, magazines, pamphlets, and the sources that you consulted during your project.

9. **Cause** - Anything that produces an effect or result.

10. **Celsius** - Scale used in the metric system of measurement of temperature.

11. **Classification** - Grouping or ordering of objects by similarities, differences, or interrelationships. The basic requirement is that the system be useful.

12. **Computation** - A way of determining results.

13. **Conclusions** - Your statement of what you found to be the answer to your problem (question) with support or data from your observations.

14. **Conclusions** - Interpretations made based on the outcome of your result and answering the question or comparison suggested by your purpose.

15. **Control** - Test group that has all the variables standardized; the basis for comparison.

16. **Controlled Experiment** - An experiment in which all conditions are the same (controlled) except for the variables you are testing (the manipulated variable).
17. **Data** - Materials, information, and measurement gathered from your observations; facts or figures from which conclusions can be inferred.

18. **Data/Observations** - A complete record of all measurements and observations you have made during the experiment. Keep all original notes, data sheets, ideas, charts, etc. Keep a day-to-day account of your project.

19. **Dependent Variable** - A change in events or results that is linked and controlled by another factor that has also been changed.

20. **Effect** - A noun. Something that happens as a result of something else. To make happen. Daily exercise will have a good effect on your health.

21. **Exhibit** - The visual presentation of your Science Project that includes your backboard and a safe sampling of some of the materials used.

22. **Experiment** - A planned investigation to determine the outcome that would arise from changing the variables or changing what might be the considered natural.

23. **Exposure** - The amount of time light is permitted to reach film in a camera.

24. **Factor** - Any of the circumstances or conditions that bring about a result.

25. **Frequency** - The number times any action or occurrence is reported in a given period.

26. **Further Research** - Does your work suggest ideas for future experiment? "What's next?"

27. **Gram** - The unit of measure for mass used in the metric system.

28. **Hypothesis** - A scientific guess about the relationship between the manipulated and responding variable. The hypothesis provides guidance for an investigator about what data to collect.

29. **Hypothesis** - A statement of an idea that can be tested experimentally. The hypothesis is based on research and states what investigator intends to prove or disprove. A proposed solution to a problem. (Plural, "hypotheses")

30. **Independent Variable** - Something that can be changed in an experiment without causing a change in the other variables.

31. **Infer** - Drawing meanings or conclusions from what has been read or observed.
32. **Inference** - Possible explanation or interpretation of an observation.

33. **Line Graph** - Type of graph where two coordinates representing different quantities are plotted on the graph with all points connected by straight or curved lines.

34. **Liter** - The unit of measure in the metric system that represents volume.

35. **Log** - The daily written observations of your experimentation, kept in a notebook or journal.

36. **Manipulated Variable** - A variable that is deliberately changed in a situation (e.g. different amounts of light).

37. **Mass** - The unit of measure in the metric system for the amount of matter present. It is not the same as weight. Mass is a measurement not influenced by gravitational forces.

38. **Materials** - A list of all the materials that you need.

39. **Mean** - The average of a group of values that is found by adding the values and dividing this sum by the total number of values present.

40. **Meter** - The unit of measure in the metric system used to represent linear (distances) measurements.

41. **Objective** - Relating to that which is external to the mind, unbiased.

42. **Observation** - Obtaining information through the five senses.

43. **Predict** - To determine the outcome of something before it actually happens.

44. **Prediction** - A forecast of what a future observation might be.

45. **Probability** - The chance of something likely to happen or not to happen.

46. **Procedure** - The structure followed to carry the project through from start to finish, written in outline form.

47. **Procedures** - A complete and detailed list of the steps followed during your experimentation.

48. **Qualitative Observation** - Making observations that record what types of items, specimens, chemicals, etc., that are present.

49. **Quantitative Observation** - Differ from the above in that exact measurements are made as numbers present, or changes in quantities.
50. **Record** - To set down, as in writing.

51. **Replicate** - One of several identical experiments, procedures, or samples.

52. **Responding Variable** - A variable that may change as a result of the manipulated variable (e.g. height of plant growth).

53. **Sphygmomanometer** - (sfig-mo-man-ometer) Device used to determine the amount of blood pressure being exerted on artery walls.

54. **Statement of the Problem (Question)** - A simple statement or question describing the problem you are investigating.

55. **Statistics** - The collecting of facts and information and putting them into different classifications.

56. **Subjective** - Relating to that which is existing in your mind; biased.

57. **Variable** - A condition that changes or varies in a situation.

58. **Variable** - Something within an experiment that can change. This change may or may not be able to be controlled. All of the following are variables in a study of the effect of light on plant growth: type of plant, type of soil, amount of water, room temperature, noise, health of plant, age of plant, and light (variable being tested).

59. **Vertebrate** - Classification of animals with backbones, which includes fish, snakes, and many others including man.

60. **Volume** - The amount of space an object occupies or displaces.
X.

References and Bibliography
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Sue D. Fithian

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