Teacher, Parent, and Student's Guide to

SCIENCE FAIR BASICS

Introducing the process behind the competition.

This booklet contains a set of lesson plans and student activities intended to facilitate the process of Science & Engineering Fair competition. It has been prepared to offer help to those just beginning the experience of Science Fairs, primarily elementary or middle school teachers and students, but may prove helpful to students in high school who have never before participated.

The current official Georgia Science & Engineering Rule book should be used alongside these lessons. If the Rule Book is unavailable, a complete set of rules, forms, and ideas, as well as, an interactive version of these lessons is on the web site at www.uga.edu/oasp .

If these lessons will be used for classroom instruction, it is recommended that each student maintain a tabbed folder to receive each exercise as it is presented. Each page is intended as a single lesson. The facing page includes helpful teacher/sponsor instruction information, hints, and practices. Individuals can follow the lessons at home with some help from parents or sponsor.

Science & Engineering Fair rules

All rules and regulations used by the Georgia Science & Engineering Fair are the same as those used by the International Fair. Any local or regional fairs that are affiliated with the State Fair must also follow the same rules.

The complete set of rules, forms, ideas, and methods is available on the web site at no cost: **www.uga.edu/oasp**

Lesson 1

WONDER

Your first step for the Science & Engineering Fair is to pick your topic. Ideas can come from hobbies, interests, problems needing solutions. Many ideas are available through books and web sites, but the BEST ideas come from your own head.

A. Brainstorm all of your interests here. Think of activities or things that interest you or maybe something you've always wondered about. Use simple one-word ideas like plants, worms, cars, sports, fishing.....

B. Circle 3 of the ideas above that you like BEST.

C. Now look very carefully at your 3 choices. Which ONE do you already know something about AND really CARE about?
Underline that word.
Can't decide? Keep brainstorming. It will come to you.

D. Your underlined word is the start to your project. From now on we'll call it your TOPIC. Now we can begin.

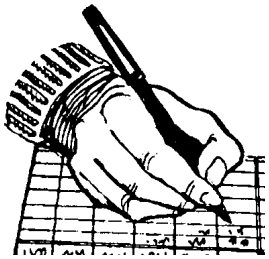
The Wheel of Science
Make a copy Wheel of Science found in the back of this booklet. Paste it onto cardboard and cut it out. Use a brad to attach the pointer. This is your guide to a great project. Use it at home or school to keep track of your progress.

Your Log Book

Your log book should contain accurate and detailed notes of everything you do for your research project. Good notes will show you are consistent and thorough. It will also help you when you write your ABSTRACT, RESEARCH PAPER, and DISPLAY.

1. A log book is a notebook that must be bound with stitching or glue so that the pages are not removable.

2. Your log book should be written in ink only. Do not use pencil or printouts from a computer (except graphs and charts).



3. Put your name and school on the front of your log book.

4. Include notes on readings and bibliographic information.

5. Include your thoughts, ideas, and trials.

6. Include your raw data (all of the measurements you collect during your experimental trials).

7. Staple in copies of graphs or charts.

8. Attach photos and label them.

9. Date every entry and enter each science activity you do.

10. Do not try to make your log book neat. It should be readable, but you may cross out information you don't want as you work. Never remove pages from your log.

Write about your topic in your log book. Write all of your thoughts, ideas, what you know already about your topic.
Remember to date the page.

You can start looking up information about your topic. Web sites and reference books are a good start. If you can, contact someone who works with anything to do with your topic. This is a great source of information and a possible way to work with an expert.

Add any information you gather into your log book.

Lesson 2
RESEARCH

Study everything known about your topic

1. Go to the library, record the topic information gathered and bibliographic information into your log book.

2. Talk to professionals in the field, take notes and record phone numbers, etc. into your log book.

3. Write to companies for information or visit their web sites. Web sites are especially good places to find building specs and equipment information.

4. Be on the lookout for areas of the topic that are not well understood. This may lead to NEW information with your research.

Organizing your Information:

5. Organize everything you have learned about your topic with an outline. Put your notes, papers, and information into a notebook with section labels.

6. Narrow down your information by focusing on a particular idea. This can help you define your question and help identify the procedure for testing.

Next Steps:

7. Think about where you will work. Science & Engineering Fair Rules limit what work can be done at home. (See the Rule Book for details)

8. Arrange for your work place and the person who will supervise you. Some projects require a Qualified Scientist. Others need a Designated Supervisor. Some projects are OK to do at home with a parent as supervisor. As you plan, keep this in mind.
(See the Rule Book or www.uga.edu/oasp for details)

These research areas have specific rules and forms, and require approval from a school science safety committee called the SRC/IRB.

- 3 human subjects
- 3 non-human vertebrates
- 3 pathogenic agents
- 3 controlled substances
- 3 recombinant DNA
- 3 human or animal tissue
- 3 hazardous materials or devises

If you think your project will deal with one or more of these, do not begin with your experiment. You should continue to define, question, plan, and prepare then get approved.

Lesson 3

DEFINE

Science or Engineering?

For the Science & Engineering Fair you can conduct a *Science* investigation or an *Engineering* investigation. The process is slightly different for each:

Science Process:

- Define the Problem
- Find a Purpose
- Write a Hypothesis
- Develop a Procedure
- Analyze Results
- Draw a Conclusion

Engineering Process:

- Define the Problem
- Find a Goal
- Develop design criteria
- Build and test prototype
- Analyze Results
- Draw a Conclusion

You may already know if you have a Science Investigation or an Engineering Investigation. Science Investigations create new knowledge about how things live, operate, or exist. Engineering projects generally involve construction or design of an idea or new product.

A. Do I have a Science Investigation Topic?

Answer these questions if you think you have a Science topic

- What MATERIALS are readily available for conducting experiments on _____ ? (Your topic)
- How does _____ ACT?
- How can you CHANGE the set of materials to affect the action?
- How can you MEASURE or describe the response of _____ to the change?

B. Do I have an Engineering Investigation Topic?

Answer each of these if you think you have an Engineering topic:

- What is the need you are meeting or the problem you want to solve using _____? (Your topic)
- What MATERIALS / EQUIPMENT are readily available for the design and testing of _____ ?
- What construction or testing standards will you set?
- How can you MEASURE the success of the design of _____?

Add this information to your log book.

Lesson 4

QUESTION

Coming up with a question to ask

Science & Engineering Projects usually start with a question. There are two types of questions that work well to help design your project:

1. Comparison/Choice Questions use a set of similar items and compare the action between them. Use a topic, a variable that is changed, and a measurable observation. Remember to change only one variable at a time.

Example: WHICH PAPER TOWEL SOAKS UP WATER THE FASTEST?
What is the topic?
What variable changes?
What can be measured?

2. Yes or No Questions get yes or no answers but still have variables and measurement. Use the topic, a variable that is changed, and a measurable observation.

Example: CAN A PERSON TELL SOUND DIRECTION WHEN BLINDFOLDED?
What is the topic?
What variable changes?
What can be measured?

Here are some other questions to try. Find the topic, the variable that is changed, and a measurable observation.

Which brand of soap makes the most suds?

In which type of liquid do plants grow best?

Which model car design will be the fastest?

B. Below or on scratch paper try to form your own question. Remember you need your TOPIC, CHANGEABLE VARIABLE, and MEASURABLE OBSERVATION.

C. Do I have a good question?

After you write your question, ask yourself:

1. Can it be answered through experimentation or investigation?

Example:

Question 1 - What is the temperature on Venus?

Question 2 - Which color gets warmest in sunlight?

Which question can be answered through experimenting? Which question can be answered by looking up the information in a resource book?

2. Is my question suitable for a Science or Engineering project?

a. Does it interest me?

b. Do I know a little about it?

c. Would it involve measuring?

d. Are equipment/supplies readily available to me?

e. Is it useful to find out about?

3. Are the materials workable and obtainable?

4. If I am doing a Science project, are there variables I can change?

Are there conditions that should stay the same? Can I think of a control?

5. If I am doing an Engineering project, can I design and build a prototype to test?

Will it be too expensive to redesign and test again?

Let's Recap:

1. What is your question?

2. Why is this important to find out?

3. What materials will you need to answer your question?

4. Will you follow the Science process or the Engineering process for your investigation?

Lesson 5

PREDICT

Part 1 Hypothesis Writing for Science Projects

For a science project you will use all of your knowledge and study information about the topic to predict the answer to the question you are asking. This is called an **hypothesis**.

Developing your Hypothesis.

1. Make your hypothesis an IF/THEN statement to show exactly what you are testing and what you expect to find.
2. Make your hypothesis a TESTABLE statement. At the end of your experiments you want to be able to say, "My hypothesis was supported."
3. NEVER change your hypothesis after experimenting. Remember, it is just an educated guess. The reason for an hypothesis is to remind you of the goal of your investigation. It forces you to think and plan before you begin.
4. You hypothesis should include the reasoning behind your prediction. Support your point of view with expert information.

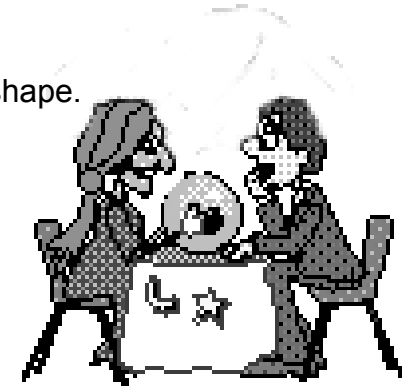
Let's try this:

Here is June Bug's hypothesis:

If I place lettuce seedlings under various colored lights, then I believe the seedlings under the RED light will grow the tallest. I believe this is true because I read that the wavelength of red light is better absorbed by the green chlorophyll in the plant leaf.

Does this hypothesis meet the standards above?
What was June Bug's question?
What materials and conditions does she need to test her hypothesis?
What steps should she take to test her hypothesis?
What could June use as a control?
How did June support her prediction?

Now you can see June's experimental plan is taking shape.



Your turn to write an hypothesis.

1. Look back at your question.
2. Get out your list of materials and conditions.
3. Think carefully about how you will proceed.
4. What do you expect to happen?
5. Why do you think that will happen?

Practice several hypotheses on scratch paper. Check with your sponsor, then write your hypothesis into your log book and date it.

Lesson 5

Set A Goal

Part 2 Design Criteria and Goal Setting for Engineering Projects

Engineering projects do not usually need an hypothesis. Engineers try to create new things and test out new ideas. They start with a goal and come up with the design and testing criteria to meet the goal.

Goals are what you want to accomplish with your project. A goal is the end product and the answer to your question.

Criteria are the guidelines, standards, and requirements you decide upon to control the design and testing in a fair and equal way.

Here is an example:

Billy Bass wants to test paper airplanes for distance flying.

1) What problem is Billy trying to solve?

2) What do you think his engineering **goal** should be?

3) What **criteria** should Billy Bass set up for building his planes?

4) What **criteria** should Billy Bass set up for testing his planes?

5) How will Billy Bass **test** his paper airplanes to see if they meet the goal?

Try setting your goal and developing your criteria here:

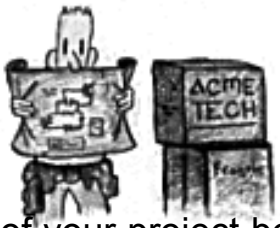
- What is the **problem or need** or your **question**?
- What engineering **goal** do you have in mind? What is it you want to accomplish?
- What **criteria** will you use for the materials and conditions of your idea?
- What **criteria** will you use for the testing of your idea?
- Using your criteria, what **steps** will you use to meet your goal?

Now your next steps should be much clearer. Write your answers to these questions into your log book.

Lesson 6

PLAN

Writing out the Project Plan



The Project Plan is the complete written organization of your project before you do it. You will give this plan to your sponsor. Your plan will go to the SRC/IRB committee if your project has anything to do with these subjects:

- human subjects
- animals
- pathogens
- controlled substances
- recombinant DNA
- human or animal tissue
- hazardous materials or devices

Here's what your plan should contain:

PROBLEM Tell the reader the question you are asking or the problem you will try to solve.

PURPOSE The purpose states the usefulness of the study. It tells why the project will be done.

HYPOTHESIS (for Science Projects) The hypothesis is your educated guess about the outcome of your investigation.

GOAL (for Engineering Projects) Tell exactly what you want to accomplish with your project.

DESIGN AND TESTING CRITERIA (For Engineering Projects)
Write the specific standards you will set to meet your goal.

PROCEDURES Describe in detail the method you will use to get your data and observations. Use photographs or drawings of equipment to describe your experiment further. Include a precise description of the testing and control groups and apparatus to be constructed or modified.

BIBLIOGRAPHY Include at least 3 books, articles, web sites, telephone conversations, etc.

When you have this all written out, enter it into your log book. Then type it on a computer, save it and print it out.

Your sponsor should give you **Research Plan Form (1A)**. Attach your plan to this and complete the information on the form. Do not complete the date for the beginning of experimentation yet.

You should also have the form called **Approval Form (1B)**. This must be signed by you, a parent, and your sponsor and dated at the top before you begin to experiment. Each individual and team member must complete their own copy of this form.

Please check with your sponsor for other required forms.

(All forms are available on the web site at www.uga.edu/oasp)

Lesson 7

EXPERIMENT

Finally!

You are now ready to begin your plan:

- Follow your project plan carefully**.** Do not change it unless you get permission to do so. Remember it has been approved**.**

- Keep detailed log book notes in ink of every experiment, measurement, and observation you do. Be sure to include things that don't work as well as the ones that do. You will use all of this information later, so take good notes.

- Keep your procedure controlled and exact. Think about what you are doing and how you might explain to someone else how to do it exactly the same to get the same results.

- Remember to include the following in your experiment:

  Control Group This is the set of test items that are treated as in a parallel experiment except for omission of the procedure or agent under test and which is used as a standard of comparison in judging effects. (Usually only for Science Projects)

  Experimental Groups The is the set of test items that undergo the various manipulation of variables.

  Large Sample Size Use at least 5 test items per experimental group. The greater the number used, the better.

  Repetition Repeat your trials many times to collect enough data to average and to demonstrate the validity of your method.

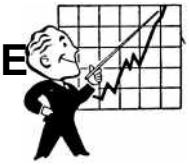
  Test, Redesign, and Test Again (for Engineering Projects)
  You want your prototype to be successful and to meet your goal.

Add your Experimental Start and Finish dates to
Research Plan Form (1A) or for teams (1A) Team Projects.

Lesson 8

ORGANIZE, ANALYZE, AND SYNTHESIZE

What does it all mean?



Do you remember June Bug's experiment under colored lights? Here is the raw data she wrote into her log book.

Colored Lights	WHITE					RED					BLUE					GREEN				
seedling height (cm) DAY 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DAY 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DAY 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DAY 6	.5	.5	.5	0	.5	0	.5	.5	0	.5	.5	.5	0	0	.5	.5	.5	.5	.5	.5
DAY 9	1	1	1	0	1	.5	1	1	0	1	1	1	0	0	1	1	1	0	1	1
DAY 12	2	2	2	.5	2	1	2	2	0	2	1	1	0	0	1	1	1	0	1	1
DAY 15	3	3	3	1	3	1	2	2	0	2	1	1	0	0	1	1	1	0	1	1
DAY 18	4	4	4	2	4	2	3	2	0	3	2	2	0	0	2	0	0	0	1	1
DAY 21	6	6	6	4	5	2	3	2	0	3	0	0	0	0	2	0	0	0	0	0

From the information on this chart, what did June Bug do?

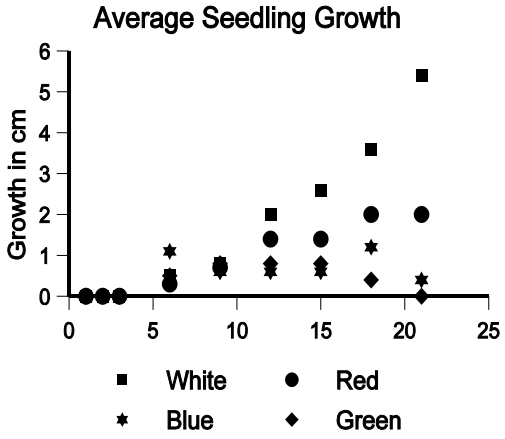
Can you find a pattern of growth from this data?

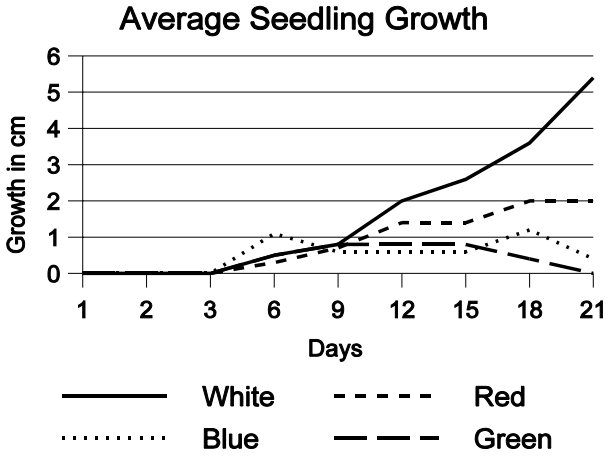
Find the average grow for each color of light. Find the average growth per seedling.

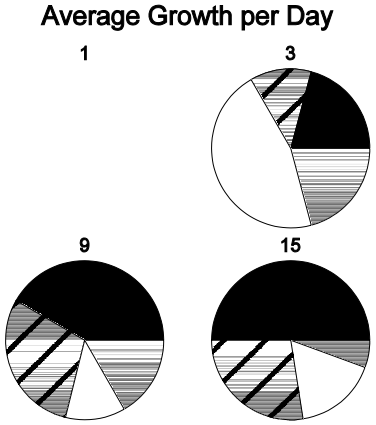
You do not want to display all of this raw data on your display board. It is too confusing and unorganized. You want to use averages and make graphs and charts to tell big picture of the information you collected and to show trends with the data.

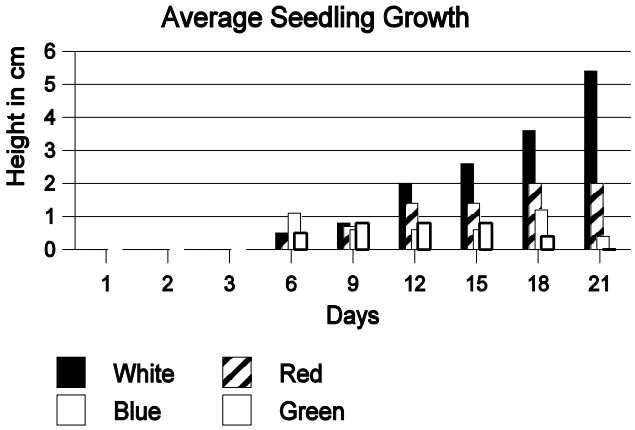
Engineers will use the averages of the raw data to show the success of their design.

A chart like this belongs in your notebook along with other supporting information. A copy of it can also be taped into your log book.









June Bug's hypothesis stated:

"If I place lettuce seedlings under various colored lights, then I believe the seedlings under the red light will grow the tallest."

1. Which chart helps us to see if the hypothesis was supported?

2. Find the averages of your data and make graphs and charts.

3. Remember to label carefully and completely so that your graphs can be understood without explanation from you.

4. Do your graphs or charts show the results the way you stated in your hypothesis or goal statement? Try different types of graphs to show the data in different ways.

5. Print a copy of the graphs and tape into your logbook. You can make larger print outs for your report and display board.

6. Did your experiment support your hypothesis or meet your goal? Should you go back and do more trials?

7. In your log book, talk about your data and how it related to your question, purpose, hypothesis, and goal. Include any problems and what you might do next.

Lesson 9

SUMMARIZE

Writing an Abstract

For your Science & Engineering Project you must write an abstract on the official Abstract Form. An abstract is a short summary of your complete project. It is limited to **250 words** or less.

Writing your abstract.

Most of the information has already been written into your log book and project plan. Your job will be to make it much shorter and write it in narrative form, like telling a science story.

You should include:

TITLE Keep the title brief and descriptive. Think of someone reading just the title and having a very good idea of what your project is all about.

PROBLEM Look at the copy of the Research Plan. Can you make a short sentence or 2 saying the same thing?

PURPOSE Again, look at the copy of the Research Plan. Can you make a short sentence or 2 saying the same thing?

HYPOTHESIS OR GOAL Do not re-word hypotheses or goal. You should use it just the way you wrote it in Research Plan.

DESIGN AND TESTING CRITERIA For Engineering projects, include a brief description of your criteria.

PROCEDURES You do not need to list the materials in an abstract. Keep procedures less specific than in the Research Plan. Some details may be necessary in order to explain the process best.

RESULTS Make this a short summary of results, using medians, means, and modes

CONCLUSIONS Tell what the results mean and whether or not the hypothesis was supported or the goal met.

Rules for Abstracts

• Abstracts must be typed or printed from a computer

• Use the Official Abstract Form only

• Limited to 250 words or less

• The abstract must be present on or in front of your display. It can not be in any other form than on the **Official Abstract Form**. Do not cut it out or label it in any other way.

• The abstract is limited to the square on the form. Do not include cover sheets, graphics, or pictures.

Lesson 10

REPORT

A full and complete explanation of your science story

For your Science & Engineering Project you will write a report about your total experience. Most of this is already written!
Just add a few more explanations to your abstract and include graphs, charts, and photos. Check your sentence structure and spelling and you are practically done.

Contents of the Report:

Title Page - include project title, name, address, school and grade.

Table of Contents - number each section and list here

Introduction - use background information, purpose of study, problem, question, design and testing criteria, and goal or hypothesis.

Materials & Procedures - write detailed lists and step-by-step process of research and testing, include design and testing criteria.

Photographs, drawings, plans -include equipment, procedures, apparatus, location, results.

Results - present in tables and graphs and explain in words, do not use raw data, discuss problems or errors that may have happened

Conclusions - summarize results, tell whether or not data supported hypothesis or met goal

Acknowledgments/Credits - thank those that helped: mentors, parents, teachers, etc.

Bibliography - list the reference material used in alphabetical order: books, web sites, papers, journal articles, and communication with experts

Type your report on the computer and print out a nice copy.
Put the copy in a notebook along with completed necessary forms and any other written material you want the judges to see.

Lesson 11

DOUBLE CHECK

Don't forget a thing!

Check below to make sure you have everything you will need before you make your display.

You should have:

- **Log Book** everything up-to-date, graphs, charts, dates
- **Notebook** with
  - T Scientific Research Paper
  - T Graphs and charts
  - T Photographs

  And Forms:
  - T Abstract on Official Form
  - T Sponsor Checklist Form (1)
  - T Research Plan (1A) or Team (1A)
  - T Approval Form (1B)

Other Forms you may need:

A. If you worked in a research lab (other than school)
Form (1C) and Form (2)

B. If you worked with human subjects
Form (4A) and possibly Form (4B)

C. If you worked with pathogenic agents or controlled substances
Form (2) or Form (3)

D. If you worked with vertebrate animals
Form (5) and
Form (2) or Form (3)

E. If you worked with animal or human tissue
Form (6)

F. If you worked with hazardous substances or devices
Form (3)

Put everything in order in your notebook. Use tabs to organize. Make a nice cover for the outside.

Lesson 12

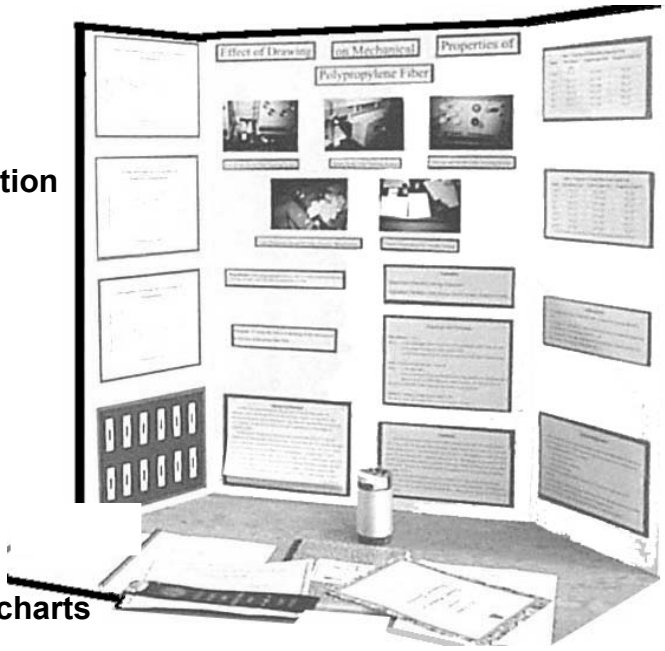
SHARE

Putting together your display board

CONGRATULATIONS! You are almost done!

One of the most important acts of doing a Science & Engineering Projects is sharing the information you have discovered with others.

At the Fair we share using a display board. The board can be made from cardboard, wood, or foam core. It should be folded or hinged to make 3 parts so that it can sit on a table.



Your display should include:

Title

Background Information and question

Purpose of project

Hypothesis or Goal

Materials and Methods

Design and Testing Criteria (for engineering projects)

Results

Conclusions

Photos, illustrations, graphs, and charts

Your display should **SHOW and TELL**. Make it visual, colorful, easy to follow, and informative.

- **Keep it simple.** Use a large colorful title and subtitles. Use bullets instead of paragraphs to discuss your project under each subtitle.
- **Use photos.** You must have written permission from any individuals other than yourself in photos used on the display. Have someone take photos of you during experimentation. Take pictures of your results, too.
- **Be organized.** Your display should be logically presented and easy to read. Follow the path of Scientific Method or Engineering Method from left to right, top to bottom.
- **Have a Good Title.** Simply and accurately represent your research. Use the same title on all your forms.
- **Easy to Read.** Your font size should be readable from at least 3 feet away. Your title should be in large letters, but not overwhelm the board. Your subtitles should stand out and be easy to find.
- **Follow the Rules.** Your display is restricted by certain size, safety rules and what can be displayed. Please read the Rule Book for details. Display all required and completed forms in your project notebook on the table in front of your display.

Practice for the Judging

The Judging at a Science & Engineering Fair is usually done by professionals in the field, teachers, and professors. The style of questioning is informal and personal.

Usually 1 or 2 judges will come to you after they have read your display board. They want to talk to you about your project. They want to find out how important this project is to you. They also want to know if you learned anything new and if you did it yourself.

Some of the questions judges might ask:

- Where did you get your idea?
- What will you do next?
- Why did you do _____?
- Why did you choose this project?
- Who helped you?
- What was the hardest thing to do?
- What did you learn?
- Were you surprised by anything?

Practice in front of your class, with your sponsor, or at home. Have them ask difficult questions about your research so that you will be prepared for the judges.

Find out about your first fair from your sponsor. Be on time and well dressed.

Bring the following to the Fair:

- Finished Display Board
- Notebook with completed forms and Project Report
- Log Book

Good Luck!

My Science & Engineering Fair Evaluation

Name _____ Date _____

My project taught me

_____
_____
_____
_____

The hardest thing to do on my project was

_____
_____
_____
_____

I enjoyed most

_____
_____
_____
_____
_____

I could have improved on

_____
_____
_____
_____
_____

Next year I think I will

_____
_____
_____
_____
_____
_____

Student Name _____ Date _____

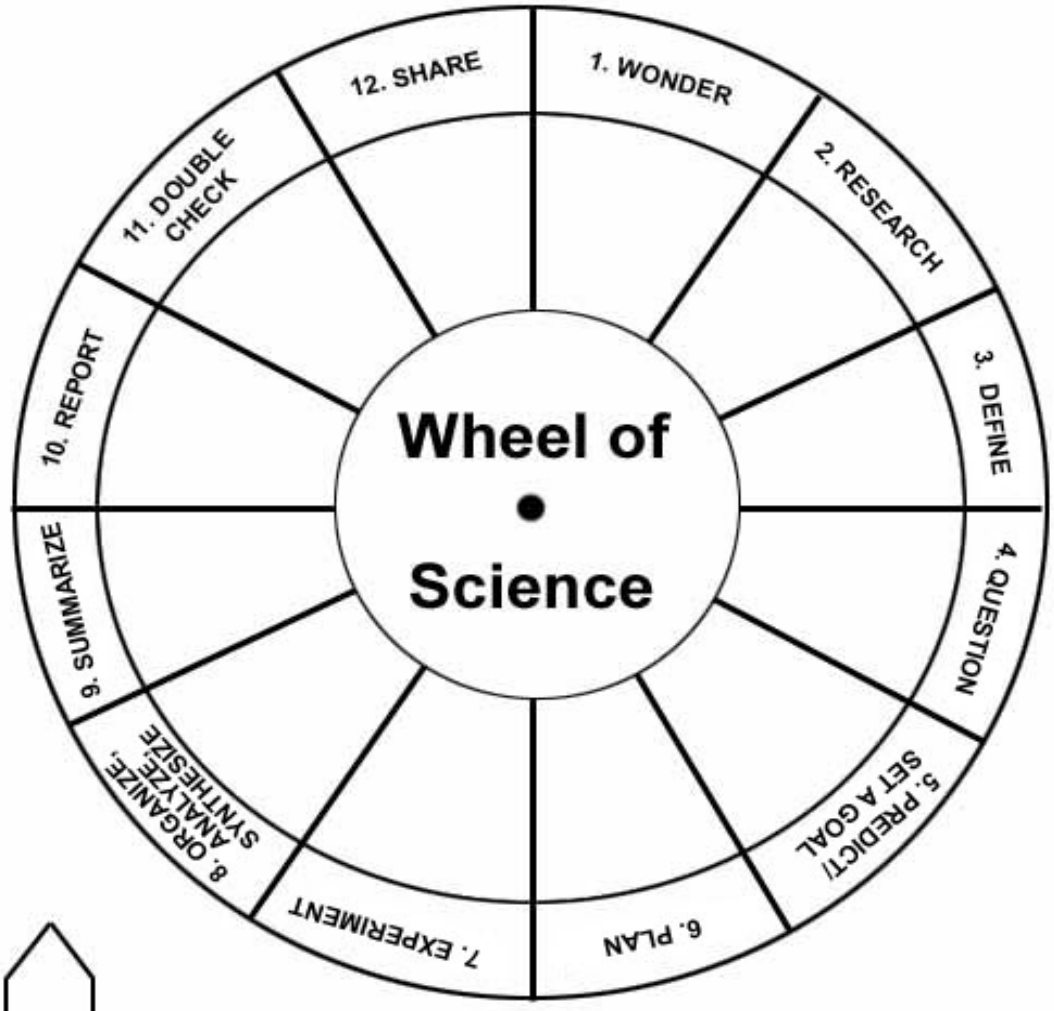
Project Title _____

Teacher Evaluation of Project

- ☐ Log book _____
- ☐ Notebook _____
- ☐ Abstract on Official Abstract Form_____
- ☐ Sponsor Checklist Form (1), signed and complete_____
- ☐ Research Plan (1A), signed and complete _____
    - ☐ Approval Form (1B), signed and complete
    - ☐ Any additional forms the project may require
    - ☐ Research Report with graphs and charts
- ☐ Visual Display _____
    - ☐ Attractive
    - ☐ Informative
- ☐ Communication about project_____

Comments overall

Use this Wheel of Science to help you follow each step along the way to a Science Fair project.



Paste this wheel and pointer onto a piece of poster board. Cut them out and attach the pointer to the middle of the wheel with a brad.