2022 - 2023

Regional Science and Engineering Fair

STUDENT HANDBOOK

Brevard Public Schools

Dr. Mark Mullins - Superintendent

NON-DISCRIMINATION NOTICE

SCHOOL BOARD OF BREVARD COUNTY

Educational Services Facility
2700 Judge Fran Jamieson Way
Melbourne, FL 32940-6601

SUPERINTENDENT

Dr. Mark Mullins, Ed.D.

SCHOOL BOARD MEMBERS

Misty Belford, Chairman
Cheryl McDougall, Vice Chairman
Matt Susin
Jennifer Jenkins
Katye Campbell

The School Board of Brevard County, Florida does not discriminate on the basis of race, color, national origin, sex (including sexual orientation, transgender status, or gender identity), disability (including HIV, AIDS, or sickle cell trait), pregnancy, marital status, age (except as authorized by law), religion, military status, ancestry, or genetic information or any other factor protected under applicable federal, state, or local law. The district also provides equal access to its facilities to the Boy Scouts and other patriotic youth groups, as required by the Boys Scout of America Equal Access Act. The School Board of Brevard County is in compliance with the Americans with Disabilities Act of 1990 (ADA) and the Amendment Act of 2008 (ADAA), the Florida Education Equity Act of 1984, Age Discrimination Act of 1967 and Section 504 of the Rehabilitation Act of 1973, Civil Rights Act of 1964 including: Title II, Title VI, and Title VII, United Stated Education Amendments of 1972 - Title IX, Age Discrimination in Employment Act (ADEA), and Individuals with Disabilities Act (IDEA). If you have questions, concerns, or wish to report possible violations involving any of the above or below items, please contact either individual below for assistance:

For concerns involving the public or students, including IDEA and 504 matters contact:

District Title IX Coordinator
District Compliance Officer - Students
2700 Judge Fran Jamieson Way
Melbourne, FL 32940
(321) 631-1911, Ext. 11438
titleix@brevardschools.org

For concerns involving employees or job applicants contact:

Director of Professional Standards and Labor Relations
Karyle Green
2700 Judge Fran Jamieson Way
Melbourne, FL 32940
(321) 631-1911 Ext. 11265
Green.karyle@brevardschools.org

Reasonable accommodations are available for persons with disabilities to complete the application and/or interview process. Applicants/Individuals with disabilities requesting accommodations under the Americans with Disabilities Act (ADA) may contact the Director of Professional Standards and Labor Relations for assistance. In the event that the district is not able to resolve your concerns, consider contacting the Office of Civil Rights for assistance. This Publication or portions of this publication can be made available to persons with disabilities in a variety of formats, including large print or audiotape. Student requests for this information should be made to the Office of Exceptional Student Education Program Support, (321) 633-1000, ext. 11520, at least two (2) weeks prior to the time you need the publication.

MISSION STATEMENT

Our Mission is to serve every student with excellence as the standard

Table of Contents

Understanding Your Regional Science and Engineering Fair

What is the Regional Science and Engineering Fair?

The Regional Science and Engineering Fair is a showcase of student projects in three divisions:

- Science
- Engineering
- Mathematics and Computer Science

You can choose the category in which you will compete, but you can only submit one project to the fair. For example, you cannot enter a coding project and also be a team member on an engineering project.

You will compete in a category with all other projects in that category, regardless of grade. For instance, a fourth grade student with a coding project will compete against fourth, fifth, and sixth grade students in the coding category.

Team projects consist of two students. Team projects will compete in the category against individual projects. Team members do not have to be in the same grade level, but both must be in grades 4-6. ***Both members of the team will need to complete separate logs and most of the required forms for the project***.

Categories for the Regional Science and Engineering Fair

There are 12 categories for the Regional Science and Engineering Fair: seven in Science, two in Engineering, and three in Mathematics and Computer Science.

Science Division

- Animal Sciences
- Chemistry
- Earth and Environmental Sciences
- Human Behavioral Sciences
- Microbiology
- Physics and Astronomy
- Plant Sciences

Engineering Division

- Engineering Mechanics
- Environmental Engineering

Mathematics and Computer Science Division

- Coding
- Mathematics
- Robotics and Intelligent Machines

Project Requirements

These are the project requirements for all divisions. Please see the BPS Elementary Science website for additional resources.

Use the SEF Student Checklists (1 for each division, at the end of each How-To section) to ensure your project meets the requirements for the Brevard Science and Engineering Fair.

1. Student projects, research plans, and testing procedures MUST be reviewed and approved by your teacher **before any testing begins.** Students and parents should work together to complete and review these forms.

2. Entered projects **MUST** be completed during the current school year (August through March).

3. Exhibits should be constructed and developed by the student(s) entering them. Help must be limited to supervision and guidance.

4. Students **MUST BE PRESENT** on Judging Day for the face-to-face project interview - no exceptions (tapes, videos, Facetime, Skype, etc.). If a student is not present, the project will still be judged on the quality of the project, display, and log book, but will not receive the interview points.

Projects that are NEVER Allowed in BPS Elementary Science and Engineering Fairs

Students are ***never*** allowed to do projects that are clearly dangerous.

- Testing involving firearms, knives or other items that could be considered weapons in a school setting (e.g. a paintball gun, BB gun, bow and arrow, etc.) is **not allowed**.
- Testing involving fireworks or other explosives is **not allowed**.
- Testing involving controlled substances, prescription drugs, alcohol, and tobacco is **not allowed**.
- Microbial experimentation (involving microscopic organisms such as bacteria, fungi, etc.) using samples/organisms collected from the environment for the purpose of isolating, using for growing, and/or culturing is **not allowed**.
- **NO projects involving mold or that produced mold,** even if it was unintentional or inadvertent, is **allowed**.
- Any project that could cause pain, distress, or death to the vertebrate is **not allowed**.

Display Requirements

1. Displays ***must*** meet all size requirements. Exhibits will be confined to table space which must not exceed **3 feet (91 cm) high, 4 feet (122 cm) from side to side, and 24 inches (61 cm) front to back**. Headers may be used, as long as the complete display fits within these size requirements. Projects larger than size limitations will be disqualified until changes are completed.

2. Backboards ***must*** be able to fold and lay flat. Two-dimensional paper, photos, pictures, lettering, designs, and borders should be used on the backboard. Three-dimensional items are acceptable ***as long as the board folds and lays flat***.

3. Students MAY use photographs that include their faces. Photo credit must be provided. One statement, such as, “All photographs taken by parents of Jeffrey.” or “All photographs taken by Johanna.” will suffice for documentation. ***Last name must not be included.***

4. Items used from the Internet must be credited (articles, graphs, charts, pictures, etc.).

5. Student’s last name or school name ***must*** **not** be visible on either side of the display or log book. Project numbers will identify participants.

6. Students’ last names or school names ***must*** **not** be visible on clothing during judging.

7. Research involving live specimens should be displayed through the use of drawings, charts, photographs, graphs, or original models.

8. Items prohibited on the display include, but are not limited to, the following:
   - Live animals, preserved animal bones, feathers, blood, or other animal parts
   - Live or dead plants (flowers, fruits/vegetables)
   - Soil, sand, rocks, seashells, chemicals, liquids
   - Sharp objects (metal cans, nails, screws, pins, glass, etc.)
   - Battery-operated lights
   - Any food or drink item
   - Any other potentially dangerous substance or item that may be hazardous in a public display
   - Any items that stop the board from folding and laying flat.

9. Only log books may be displayed in front of the exhibit/backboard prior to and after judging.

10. If the student wishes to display a 3-dimensional student-created model, engineering design prototype, laptop, tablet, robot, etc., ***it should only be brought on the day of judging and is the sole responsibility of the student.***
    - Display items must fit in the space allowed on the table top and within the height requirements of the display area. Items may not be demonstrated on the floor or in the air.

    Entrants should make every effort to secure his/her/their exhibit. The Fair Committee will safeguard all boards and log books, but the responsibility for the security of any additional components (laptop, drone, robot, prototype, etc.) rests on the participants.

11. Access to electrical outlets will not be provided or allowed.

How to Complete a Science Project

What is a Science project?
A science project is an independent study of a particular topic that uses the scientific method in order to answer a specific question about how or why something is being impacted in our world.

A science project is a science experiment. An experiment is a very specific type of science investigation. In an experiment, the researcher tests just one condition and sees what effect it will have on a test subject. The researcher can only make changes to that one, specific condition. Everything else in the experiment has to stay exactly the same for every trial, or else the experiment is not valid (fair).

1. Get an Idea for Your Science Project
Science is all around you. You use force and motion concepts when you ride your bike to school. You are impacted by the weather. Eating is a part of life processes. A science project is hiding inside everything that you do in your life. Start by asking “What if?” questions. For example, as you are riding your bike, think about what would happen if you had a bike with larger wheels, or smaller wheels. How would that change the speed you could go? That’s the start of a science project. Look around your world. Think about the things that you enjoy. Then start researching your favorite science topics to help you find a question that interests you. Talk over the list with your family, teacher or friends.

There are seven categories in the science division of the Science and Engineering Fair:

- ***<u>Animal Sciences</u>*** - This category addresses the study of all aspects of animals and animal life, animal life cycles, and animal interactions with one another or with their environment. This includes all aspects of human physiology, but excludes all human behavioral projects. It also includes the study of the behavior of animals. Many scientists work in the field of animal sciences. Some of them include:
    - physiology
    - mammalogy (mammals)
    - entomology (insects)
    - ichthyology (fish)
    - ornithology (birds)
    - herpetology (reptiles and amphibians)
- ***<u>Chemistry</u>*** - Studies exploring the science of the composition, structure, properties, and reactions of matter not involving biochemical systems are included in the Chemistry category. Chemistry careers include:
    - environmental chemistry
    - inorganic chemistry
    - organic chemistry
    - physical chemistry

- ***Earth and Environmental Sciences*** - This category focuses on Earth and the environment. It also includes meteorology and climate sciences. Possible fields in this category are:
    - atmospheric science and meteorology (weather)
    - climate science
    - environmental effects on ecosystem
    - geosciences
    - water science
- ***Human Behavioral Sciences*** - This category addresses studies of human thought processes, emotions, learning, decision-making, and behavior. Possible fields in this category are:
    - anthropology
    - psychology
    - neuroscience
- ***Microbiology*** - The microbiology category covers the study of microorganisms, including bacteria, fungi, prokaryotes, and simple eukaryotes, as well as antimicrobial substances. Microbiologists might study some of the following fields:
    - antimicrobial
    - bacteriology
    - environmental microbiology
    - microbial genetics
- ***Physics and Astronomy*** - Physics is the science of matter and ***energy*** and of the interactions between the two. Astronomy is the study of anything in the universe beyond the Earth. This category would also include studies of renewable energy structures (wind or hydroelectric turbine, photovoltaic cell, etc.) and/or processes, including energy production and efficiency. In this category, some possible career fields are:
    - electrician
    - astronomy, cosmology, and astrophysics
    - biological physics
    - magnetics and electromagnetics
    - mechanics
    - optics, lasers
- ***Plant Sciences*** - This category includes any project dealing with plants and how they live. If plants interest you, these are some of the careers you might choose:
    - agriculture/aquaculture
    - ecology
    - genetics/breeding
    - physiology

2. Start a Scientist's Log Book

A detailed scientist's log book with accurate records allows scientists to describe their investigations so others can repeat it and try to replicate the results. A bound notebook (such as a "composition notebook") is the best for a log book because it is a "legal document". A scientist's log book can be used to show timelines and dates. This could help the scientist prove that the results are not copies from someone else. For this reason, the book should be written in ink and mistakes should not be erased. Don’t worry about mistakes. Just put one line through it so they can still be read. This information could possibly be used at another time.

Setting Up Your Scientist’s Log Book: Divide the log book into two sections:

- In the **Daily Work** section, write down all the things you do or think about concerning your project each day. ***Make sure you date every entry.*** Think of it as a daily blog post:
    - What did you do today for your project?
    - Did you discuss the project with anyone?
    - Did you consider how to gather materials?
    - What issues did you run into today?
    - What did you research? Make sure to add the bibliography information for each source as you come to it.
    - Give details! Each day’s entry should show the progress on your project.

- In the **Data** section, make charts **before** you start testing. The data section of your log book should have all the data and observations from your testing. If you make a mistake, draw a line through it and rewrite it. Do not erase or white out a mistake.
    - Record all **measurements** in ink as you measure them during your testing.
    - Make **observations** during your testing. Observations help the scientist explain the data. For example, in one trial there may be a significant difference in the measurement from another trial. Through close observation, a scientist may notice something, such as wind changing direction, during a trial. These careful observations can help in explaining differences in trials.

3. Complete the Project Approval Form - 2 pages
This form lets your teacher know what you’ve chosen for your project. It gives an overview of your project with enough detail that anyone who reads it can get a pretty good idea of what you will be doing. Once your teacher approves the project, he/she will give this form back to you. It will have a list of other forms you will need to complete before you begin your project. ***Make sure you keep this signed form and all forms you complete--they are required to be turned in with your project.***

4. Become an Expert on Your Problem
The research phase of your project is very important. This is where you learn everything you can about the topic of your project. Spend some time getting background information. Good research will help you become an expert on your topic. Remember to write down the bibliographic information about each source you read, consult, or try to contact. Some ideas for places to go for research are:

- library
- internet--Make sure it is a ***reliable*** source of information (talk to your school media specialist about this).
- experts in the field
- Write to companies involved in your field.

5. Complete <u>Ethics Agreement</u> and <u>Risk Analysis and Designated Supervisor Form</u>

By signing the *Ethics Agreement*, you are saying that you won't copy someone else's work. You can refer to someone else's work, but you have to cite it in your log book and on the bibliography. Copy-and-pasting images, words, etc., from the Internet is considered plagiarism. If you identify *where* you got each part of what you copied (cite the source), you have done your job.

The *Risk Analysis and Designated Supervisor Form* is used to state all the risks in your project. Risks might include:

- the tools and materials you are using. How can you stay safe when you use them?
- the location you are testing in. Is it close to a road or body of water?
- the science safety tools you will be using.

In this handbook, the <u>Risk Assessment and Safety Considerations</u> section will help you complete this form.

6. Identify Your Variables

In an experiment, scientists call the conditions in their experiment "variables." It is very important to identify and control variables.

There are 3 types of variables:

- **independent variable** - This is the one thing you are changing in your experiment.
- **dependent variable** - This is what changes as a result of changing the independent variable. This is what you will measure to collect data.
- **controlled variables** - This is ***everything*** else in the experiment. These must be kept exactly the same in all your trials, or else it's not fair.

In your experiment, what are you changing? For example, if you are doing an experiment about whether adults or students are better at shooting basketballs, the thing that you are changing is the age of the test subjects (adults or students). That's your ***independent variable***.

How are you going to measure your experiment? In the example above, you'd measure it by counting how many shots each person made successfully. That's your ***dependent variable.*** The dependent variable is the data you will record for your experiment.

The final variable is the ***controlled variables.*** This is everything else in your project. Go back to the basketball example. Would it be fair to let the adults shoot from right under the basket, but the students have to shoot from the half-court line? NO! The controlled variables keep the experiment fair.

7. State the Problem in a Question Form

The Question asks what you are trying to find out or solve by testing. Make sure your question is a testable question. It should not be a demonstration, survey, or collection. Two common formats used for writing a question are:

<u>How will </u>salt <u>affect</u> the boiling temperature of liquids?
<u>What are the effects of</u> salt <u>on</u> the boiling temperature of liquids?

Be careful when using the words "<u>a</u>ffect" and "<u>e</u>ffect" because they are often confused and misused.

- "<u>A</u>ffect" is a verb that means "to influence". In the example above, the student is asking if salt will "influence" or affect the boiling of water.
- "<u>E</u>ffect" is usually used as a noun that means "a result, or something brought about by a cause." In the second example above, the student is asking what the "results" or "effects" will be when they add salt to boiling liquids.
- "Effective" is an adjective meaning "producing an expected result." It is also sometimes misused. A correct example would be, "Which of the tested air filtering systems is most effective?"

Some other formats that can be used are:

- "<u>What happens to</u> the stability of a boat <u>when</u> the pontoon design is changed?"
- "<u>Is there a relationship between</u> light color <u>and</u> the growth of bean plants?"
- "<u>Which of the tested</u> materials provides the best insulation?"

Your variables can help you write your Question. In the examples above, see if you can identify the independent variable (what the researcher is changing) and the dependent variable (what the researcher is measuring). Here are a few:

- How will <u>salt</u> ***(independent variable)*** affect the boiling <u>temperature</u> ***(dependent variable)*** of liquids?
- Is there a relationship between <u>light color</u> ***(independent variable)*** and the <u>growth</u> ***(dependent variable)*** of bean plants?

8. Identify Your Control Group and Experimental Group

It is very important to have a ***Control Group***. This is the group that is treated in the "normal" way so you can compare them to the ***Experimental Group***. The Experimental Group is the one that gets the ***independent variable***. Let's look at an example:

> How will salt affect the boiling temperature of liquids?

Salt is the independent variable, so the ***Experimental Group*** is the group that gets the salt added to the liquid. The group without the salt is the "normal" group--the ***Control Group.***

If your Question is based on a “What if…” question, you <u>do</u> have a Control Group--the situation that made you start wondering. If you were pitching a softball and started wondering, “What if it was raining and the softball was wet?” Your Control Group would be testing with dry softballs and your Experimental Group would be testing with wet softballs.

9. Research

Scientists need to get a full picture of the problem they are addressing before they start testing. That is where research comes in. You may want to start by researching to find out what other scientists have found about your topic in the past. Research will help you to fully understand your topic and help you to come up with a way to design your experiment.

For the Science and Engineering Fair, at least ***3 sources*** are required for the research phase. These sources must be documented in both the log book and on a bibliography. Interviewing an expert in the field of your project is an acceptable source. ***If your project uses a non-human vertebrate, one of your research sources must be about how to care for the animal.***

10. State Your Hypothesis

The hypothesis is a prediction of what you think will happen during your experimentation. Use background information to help you prepare the prediction. Be sure to write your hypothesis before you start your experiment. Write it as an “If…, then…” statement.

> In the example about the basketball experiment, a hypothesis might be, “**<u>If</u>** adults and students shoot 50 free-throws each, **<u>then</u>** the students will shoot an average of 5 baskets more than the adults.

A note about the Hypothesis: The results of the tests you will do later do not have to support the hypothesis in order for the experiment to be a success. It is important to note that your hypothesis will NOT be “proved” or “disproved.” Hypotheses are either “supported by the data” or “not supported by the data.” They aren’t proved; they aren’t right; they aren’t wrong.

11. Design the Experiment and Write a Procedure

The Procedure is the method you will use to test your hypothesis. The Procedure should explain the steps to be followed in order to find the answer to your question or problem. This is where you write how you will control all the variables. It is also where you write how you are going to control the risks you identified in your *Risk Assessment*.

It is very important that your Procedure is very specific and detailed, like a recipe in a cookbook. Other scientists should be able to pick up your Procedure, conduct your experiment and get very similar results. This is called a “replicable experiment.” Replicable means repeatable. All scientists work very hard to have a replicable experiment--if it’s not replicable, it’s not considered valid. One way to check if you’ve added enough detail is to have someone else take your Procedure and try to walk through the experiment (without actually using the materials). As that person tries to follow your Procedure, watch for steps you forgot to write.

Repeated trials should be part of your Procedure. Be sure to follow this very important part of the scientific method. In order for results to be considered valid, the experiment must be conducted multiple times and yield consistent results. There **must be** at least 3 trials, but 5-10 trials are preferred. The results will be more valid if you repeat the experiment as many times as possible.

After you've written your Procedure, go step by step and pull out the materials you will need to gather for your project. Be very specific about the amount of each material you will need.

Make sure that both the Procedure and Materials are written in your log book.

12. Conduct the Experiment

Follow your Procedure carefully to ensure valid scientific testing. While testing, record all data, in ink, directly into your log book. Be accurate and exact as you observe, measure, describe, count, and/or photograph. If necessary, make changes in your Procedure and document them in your log book. However, if you do make changes, you have to start your testing again. It wouldn't be valid to do half of the tests with one Procedure and the rest of the test with a different Procedure.

It's important to also write your observations during your testing. Your observations can help you make sense out of your data. Did you have one trial that had a different result from the others? What did you observe during that trial?

3. Analyze the Data (Results)

Look closely at the measurements you recorded in your log book. Think about the data and decide what the results mean. Try to find explanations for your observations. If possible, examine your results mathematically using percentages, mean, median, range, and mode. Be sure to know the meanings of these words if you use them. Also, in your results, identify data that is unusual or unexpected and try to explain it in your conclusion.

Graphs are used to make the data, trends, and patterns easy to understand, but you have to select the correct kind of graph. If you use a computer program to make your graph, you have lots of options. However, not every graph is appropriate for every project. The graph you choose should be easy to understand--just because it looks really interesting doesn't mean it's the best graph. The charts or graph will also go in your log book and on your display board. Make sure you include a key to help others read your graph.

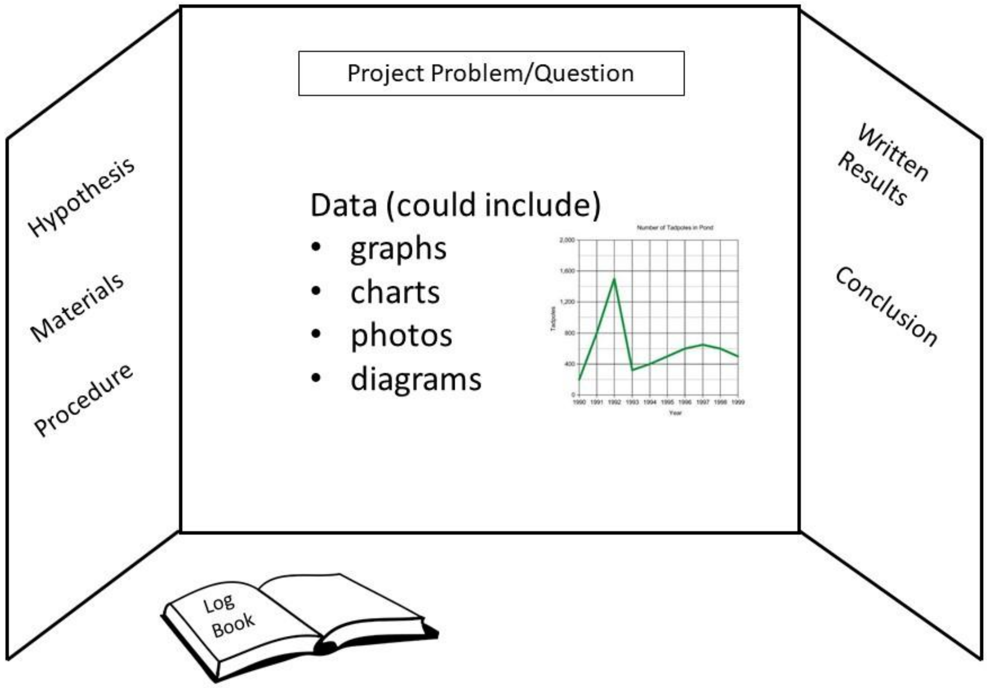
14. Make Conclusions

Conclusions are statements telling what you found out or learned during your investigation. This is a very important part of your project since you have likely learned a great deal. The conclusion is based on the results of your experiment. You will explain how the data you collected either does or does not support your hypothesis. Explain what further testing might be done to further answer your original question. Tell how people might apply your findings to everyday life. If you were to repeat this project, what changes would you make?

15. Communicate Your Results/Construct a Display

An important part of the scientific process is to share results with others. It is good to let others know what you have learned. You should be able to fully explain all parts of your project. The Sample Interview Questions section of this handbook can help you prepare to share your project with others.

This is a sample of a science project display board. Your board does not have to match this exactly, but it MUST have your problem and tell the story of your project.



SEF Student Checklist

Science Division

Student Name____

check each box	Congratulations on completing your project! Use your SEF Student Handbook and this checklist to be sure you have completed all of the required parts and that you stayed within the rules for your project. ***In order to be safe and fair, if you don't follow the rules, your project will not be permitted in the Regional Science and Engineering Fair.***
☐	Check the box if you have completed and signed all of the ***necessary forms*** for your project. Look on page 2 of your Project Approval Form for what you need.
☐	Check the box if your ***testable Question*** is on the board or in your log.
☐	Check the box if your ***Hypothesis*** is on the board or in your log.
☐	Check the box if your ***Materials*** list is on the board or in your log.
☐	Check the box if your ***Procedure*** is on the board or in your log.
☐	Check the box if your ***Results/Data*** are on the board ***and*** in your log.
☐	Check the box if your ***Bibliography*** is complete, with at least ***three sources,*** and with your project. ● If your project uses a non-human vertebrate, one of the sources ***must*** be about how to care for the animal.
☐	Repeated trials are important for a valid experiment. Check the box if you did ***at least*** 3 trials. ***Any project with less than 3 trials will not be entered in the Regional Science and Engineering Fair.*** The more trials you do, the more valid your results.
☐	A ***log book*** is required for each student scientist (team projects require a log book for each student). Check the box if ***your log book is complete and with your project***.
☐	You can use ***photographs,*** (even ones that show your face), but you have to tell who took the photos. If the same person took them all, just put one label that says, "All photos taken by _______." But only use first names. You can also say, "Scientist's mom took this photo," or "Photo taken by scientist." Check the box if you have labeled your photographs.
☐	Items used from the ***Internet*** (articles, graphs, charts, pictures, etc.) need to have labels to cite the source. For example, "This chart was from (URL of website)." Check the box if you've labeled your Internet sources (if this applies to you).
☐	Check the box if your display board is able to ***fold and lay flat*** and does not contain prohibited objects (such as lighting, soil, rocks, liquids, living or dead organisms, blood, sharp objects, plastic bottles, etc.).
☐	Check the box if your project ***meets all of the rules and requirements*** outlined in the *SEF Student Handbook*.

Judging Criteria: *Science Division*

_________________________/____

Project Number *Category*

Project Problem ____

	Superior	Very Good	Good	Poor	Notes
Research Question ● clear and focused ● testable using scientific methods ● real-world application	10	8	4	2	
Design and Methodology ● well-designed plan (easily replicated) ● variables identified and controlled	15	10	5	2	
Data Collection/Analysis ● systematic data collection ● sufficient repeated trials to ensure data validity ● conclusion supported by data	15	10	5	2	
Representation of Data ● accurate application of mathematics for analysis ● clarity of graphs/charts ● appropriate representation of graphs/charts	10	8	4	2	
Log Book ● detailed observations/entries ● sketches/diagrams ● dated entries ● evidence of research ● bibliography (at least 3 sources)	15	10	5	2	
Interview ● clear, concise, thoughtful response to questions ● understanding of science concepts ● degree of independence ● lessons learned ● ideas for future research ● If team, both members demonstrated significant contribution to project	15	10	5	2	
Display ● logical organization of project content ● tells story of project ● shows student learning	10	8	4	2	
Creativity ● project demonstrates imagination and inventiveness ● project opens up new possibilities or new alternatives	10	8	4	2	

**Form to be printed in green for the Regional Science and Engineering Fair.

Total _____________

How to Complete an Engineering Project

What is an engineering project?
An engineering project uses design and engineering processes to find a practical solution to a problem that addresses a need that exists.

Engineering Graphic: If you are doing an engineering project, make sure you use the Engineering Design Process diagram to guide your work through completing an engineering project. It is located on page 23.

1. Get an Idea for Your Engineering Project
Like a science project, an engineering project starts with a problem, but the problem is a bit different. In science, you might be asking a "What if?" question, such as "What will happen if I add food coloring to saltwater before I evaporate the water?" Engineering, on the other hand, looks at the real world, sees a problem or a condition that may not be working the best, and tries to solve the problem. In other words, what do you see in the real world that you think you can fix, change, or improve?

There are two categories in the Engineering division of the Science and Engineering Fair.

- ***Engineering Mechanics*** focus on the science and engineering involved in movement or structures. Some engineering fields connected to this category include:
    - aerospace and aeronautical engineering
    - circuit engineering
    - civil engineering
    - ground vehicle system engineering
    - industrial engineering/processing
    - mechanical engineering
    - naval systems engineering
- ***Environmental Engineering*** includes developing a prototype or process that solves an environmental problem. Environmental Engineering covers many careers in the real world, including:
    - bioremediation
    - land reclamation
    - pollution control
    - recycling and waste management
    - water resources management
    - invasive species management

2. Start an Engineer's Log Book
A detailed engineer's log book with accurate records allows engineers to describe their design process so others can follow the process. Your log should be a bound notebook (such as a composition book). It should be done fully in ink. That's because it can be used as a "legal document" to prove your invention is your creation. In the real world, the engineer's log book is used as proof for

patents and copyright. It can even be used as evidence in lawsuits over who was the first person to come up with a new idea. That's a pretty powerful book!

Don't worry about making mistakes or making a messy drawing. Mistakes are part of the process of learning and discovering. If you make a mistake, just draw one line through the mistake and keep going. Don't tear out pages or scribble out anything. It's possible that a design you thought wouldn't work early in the process turns out to be the solution to your problem.

Setting Up Your Engineer's Log Book: Divide your log book into two sections.

- In the **Daily Work** section, write down all the things you do or think about concerning your project each day. ***Make sure you date every entry.*** Think of it as a blog post each day:
    - What did you do today for your project?
    - Did you write your testing procedure?
    - Did you build your prototype?
    - Did you change your prototype today?
    - What issues did you run into today?
    - Who did you talk to about your project?
    - What did you research? Make sure to add the bibliography information for each source as you come to it.
    - Give details! Each day's entry should show the progress on your project.

- In the **Data** section, make charts **before** you start testing. The Data section of your log book should have all the data and observations from your testing. If you make a mistake, draw a line through it and rewrite it. Do not erase or white out a mistake.
    - Record all **measurements** in ink as you measure them during your testing.
    - Make **observations** during your testing. Observations help the engineer explain the data. For example, on one test cycle, a trial ends up much lower than all the other trials. The engineer observes that the prototype wheel was wobbling on that trial. So, the observation explains the data and both parts are very important. Sometimes, it's the unexpected observation that leads to a new idea for improving the prototype.

3. Complete the Project Approval Form - 2 pages

This form lets your teacher know what you've chosen for your project. It gives an overview of your project with enough detail that anyone who reads it can get a pretty good idea of what you will be doing. Once your teacher approves the project, he/she will give this form back to you. It will have a list of other forms you will need to complete before you begin your project. ***Make sure you keep this signed form and all forms you complete--they are required to be turned in with your project.***

4. Become an Expert in Your Problem

The research phase of your project is very important. This is where you learn everything you can about the topic of your project. If you are trying to solve a problem, you need to understand the problem. Spend some time getting background information. Good research will help you become an expert on your topic. Remember to write down the bibliographic information about each source you read, consulted, or tried to contact. Some ideas of places to go for research are:

- library
- internet--Make sure it is a ***reliable*** source of information (talk to your school media specialist about this).
- experts in the field
- Write to companies involved in your field.

5. Complete Ethics Agreement and Risk Analysis and Designated Supervisor Form

By signing the *Ethics Agreement*, you are saying that you won't copy someone else's work. You can refer to someone else's work, but you have to cite it in your log book and on the bibliography. Copy-and-pasting images, words, etc., from the internet is considered plagiarism. If you identify *where* you got each part of what you copied (cite the source), you have done your job.

The *Risk Analysis and Designated Supervisor Form* is used to state all the risks in your project. Risks might include:

- the tools and materials you are using. How can you stay safe when you use them?
- the location you are testing in. Is it close to a road or body of water?
- the science safety tools you will be using.

In this handbook, the Risk Assessment and Safety Considerations section will help you complete this form.

6. State the Problem in a Question Form

Your problem is what you are trying to fix with your prototype. The problem should be a practical need. Are you building a completely new item or are you modifying (changing) an existing item to make it work better in certain conditions? Whatever it is you are trying to do, your final prototype should be a solution to the problem you identified. Your problem should also be very specific. For instance, if you want to design a tool that can collect litter, be very specific about where the tool would be used (on the beach, in the water, on grass?). Also ask yourself, "What is the real-world application for my prototype?"

7. Research

Engineers need to get a full picture of the problem they are addressing before they start building their prototypes. That's where research comes in. If you are building a bridge, find out about different bridge designs and the uses, strengths, and weaknesses of each design. If you are designing a tool to solve an environmental issue, become an expert on the issue and on what other people have done to try to solve the problem. You don't want to duplicate something that has already been done; you want to come up with an original design. Research helps you to fully understand the problem and possible solutions before you start your design.

For the Science and Engineering Fair, at least ***3 sources*** are required for the research phase. These sources must be documented in both the engineer's log and on a bibliography. Interviewing an engineer or other expert in the field of your project is an acceptable source.

8. Brainstorm Ideas

Your initial design should start as a brainstorm of several designs. Don't stop at just one. Brainstorm alternative designs that might solve the problem. All of your designs should be in your log book, with detailed labels, materials needed, and measurements. Another engineer should be able to take your diagram and make an exact replica of your prototype, based only on your diagrams.

9. Choose Your Engineering Goal

Once you have multiple designs to choose from, select the one that you think best fits the specifics of your project. In science, we call this part the "hypothesis." In engineering, it is called the engineering goal. The engineering goal is a written description of the design you choose to build, test, and modify. Make sure you document in your log your rationale for choosing that design. At judging time, you might be asked about different ideas you brainstormed and why you thought your design was the best design.

10. Design the Testing Procedure

Your testing Procedure should mirror the real-world conditions, as much as possible, that the prototype will face. If you aren't able to test your prototype in the real world (due to safety considerations), come up with an "analogous" or simulated situation. For example, if your prototype is meant to be used in the Indian River Lagoon, but Science and Engineering Fair rules don't allow you to test in the actual Indian River Lagoon, where else could you set up a safe testing environment? Perhap a bathtub, child's pool, or other area would provide a suitable place. If your project is addressing the collection of invasive species, could you test it on toys instead? These not-quite-real-world conditions are used to simulate the real world and can be used for data collection.

Your testing Procedure should be very specific, as it describes the steps to be followed every time you test your prototype. It should include how you will measure the effectiveness of the prototype. Think about all necessary safety precautions and include them in the Procedure.

Testing your prototype should also include repeated trials. If you only test your prototype once in each cycle, your results may not be reliable.

11. Build a Prototype of Your Initial Design

As you build a prototype of your initial design, make sure you are following the design plan in your log. If you find you have to change the design as you build it, make sure to show that in your log.

Changing a prototype is called "modifying," and it is extremely important to document all modifications in engineering. ***Any project with no evidence of modifications will not be entered in the Regional Science and Engineering Fair.*** As you finish your prototype, it might be helpful to take a photo of it for documentation. However, photos are NOT a substitute for detailed diagrams in the log. Remember, another engineer should be able to build the same prototype out of just your diagram.

12. Testing, Analysis, and Modification

The Engineering Process is a loop of repeated testing (according to your Procedure), analysis of the results of the testing, then modification of the prototype, based on the analysis. The analysis should include the following questions:

- What on the prototype worked well?
- What parts of the prototype didn't work as well as expected?
- What parts of the prototype failed? It's okay if a part failed--that shows a part that definitely needs modification.

During testing, it's critical to record not just the measurement data, but also observations made as the prototype was performing. You might observe something that is causing the prototype to underperform. An example:

- You are testing your prototype for distance, but your prototype doesn't go as far as you expected (measurement). You observe that one gear is not spinning as well as the others (observation). That one gear could be a starting point for modifications.

Once you've analyzed your test results, it's time to modify your prototype to address the issues identified in testing. Document your changes with a new detailed and labeled sketch for each testing, analysis, modification cycle. Also, give a rationale for each change to your design, basing it on your testing and analysis. **You should be modifying your Initial Design, not starting over with a new design each time.**

The ***Testing - Analysis - Modification*** cycle of the Engineering Process should continue until you have a prototype that completely solves the problem you identified for your project.

A note about "perfect prototypes": If your prototype works perfectly the first time, consider if you have made the test requirement too lenient. In other words, did you account for ***all*** the different factors in the process? Engineers test their products and processes "to failure." How can you tell how much stress your device can take if you don't keep going until it fails? Once you know where it fails, you know the limits of your device. Then you can also engineer ways to increase what your device can do.

13. Final Prototype

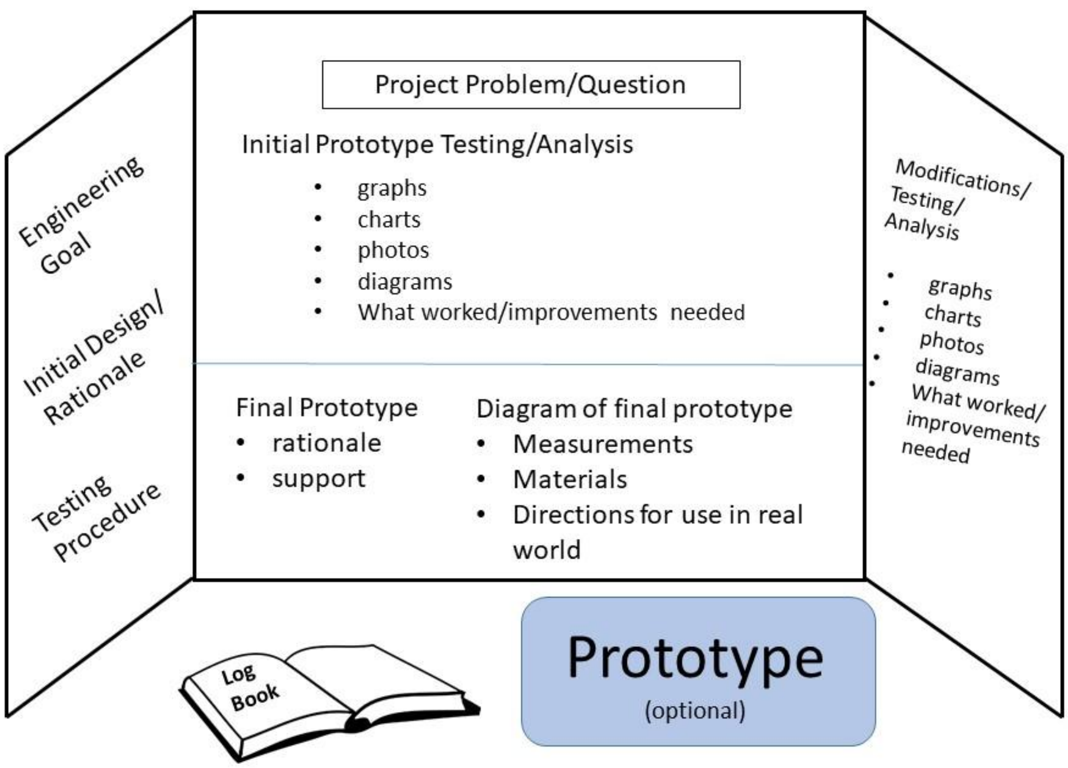
Once you have a prototype that solves the problem, you are ready for your final prototype. Your rationale (conclusion) for this being your final prototype should be supported by your data and analysis. You should also have a detailed diagram of your final prototype. Remember to include:

- measurements
- specific materials used
- specific directions for the use of your prototype in the real world

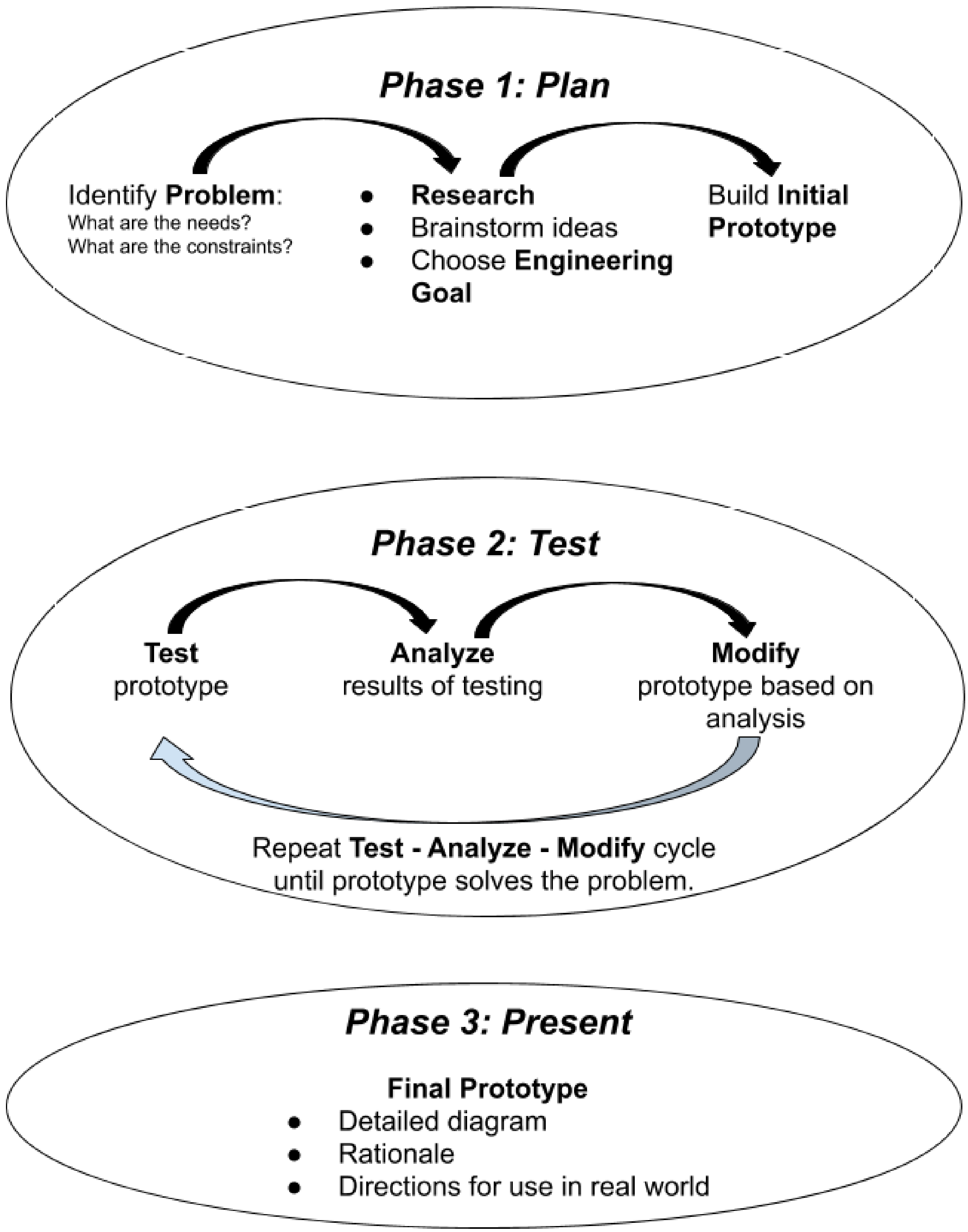
14. Communicate Your Results/Construct a Display

Engineers share their findings with others. If your prototype solves a problem, it is good to let others know about it! You should be able to fully explain all parts of your project:
- engineering goal
- initial design ideas
- testing procedure
- modifications made
- final reflection

On the next page is a sample of an Engineering Project Display Board. Your board does not have to match this exactly, but it MUST have your problem and tell the story of your project.



Engineering Design Process



SEF Student Checklist

Engineering Division

Student Name_______________________________________

check each box	Congratulations on completing your project! Use your SEF Student Handbook and this checklist to be sure you have completed all of the required parts and that you stayed within the rules for your project. ***In order to be safe and fair, if you don't follow the rules, your project will not be permitted in the Regional Science and Engineering Fair.***
☐	Check the box if you have completed and signed all of the ***necessary forms*** for your project. Look on page 2 of your Project Approval Form for what you need.
☐	Check the box if your ***problem/question*** is on the board or in your log.
☐	Check the box if your ***engineering goal*** is on the board or in your log.
☐	Check the box if your ***initial prototype design/rationale*** is on the board or in your log.
☐	Check the box if your ***testing procedure*** is on the board or in your log.
☐	Check the box if you have evidence of testing, analysis and modification to your initial prototype on the board. ***Any project with no evidence of modifications will not be entered in the Regional Science and Engineering Fair.***
☐	Check the box if your ***bibliography*** is complete, with at least ***three sources,*** and with your project.
☐	Check the box if you have a detailed diagram of your ***final prototype*** with directions for how to build it and how to use it in the real world.
☐	A ***log book*** is required for each student engineer (team projects require a log book for each student). Check the box if ***your log book is complete and with your project***.
☐	You can use ***photographs,*** (even ones that show your face), but you have to tell who took the photos. If the same person took them all, just put one label that says, "All photos taken by _______." But only use first names. You can also say, "Scientist's mom took this photo," or "Photo taken by scientist." Check the box if you have labeled your photographs.
☐	Items used from the ***Internet*** (articles, graphs, charts, pictures, etc.) need to have labels to cite the source. For example, "This chart was from (URL of website)" Check the box if you've labeled your Internet sources (if this applies to you).
☐	Check the box if your display board is able to ***fold and lay flat*** and does not contain prohibited objects (such as lighting, soil, rocks, liquids, living or dead organisms, blood, sharp objects, plastic bottles, etc.).
☐	Check the box if your project ***meets all of the rules and requirements*** outlined in the *SEF Student Handbook*.

Judging Criteria: *Engineering Division*

_________________________/____

Project Number *Category*

Project Problem____

	Superior	Very Good	Good	Poor	Notes
Research Problem • clear and focused • description of practical need or problem to be solved • real-world application	10	8	4	2	
Design and Methodology • well-designed plan for prototype and testing • explanation of limitations • explanation of alternatives	15	10	5	2	
Testing/Modifications • systematic data collection • evidence of testing, analysis, and modification of prototype • rationale for modifications • final design is supported by data	15	10	5	2	
Representation of Data/Design • accurate application of mathematics for analysis • clarity of graphs/charts/diagrams • appropriate representation of graphs/charts	10	8	4	2	
Log Book • detailed observations/entries • sketches/diagrams • dated entries • evidence of research • bibliography (at least 3 sources)	15	10	5	2	
Interview • clear, concise response to questions • understanding of science concepts • understanding of design process • degree of independence • lessons learned • ideas for future research • If team, both members demonstrate significant contribution to project	15	10	5	2	
Display • logical organization of project content • tells story of project • displays student learning	10	8	4	2	
Creativity • project demonstrates imagination and inventiveness • project opens up new possibilities or new alternatives	10	8	4	2	

**Form to be printed in blue for the Regional Science and Engineering Fair.

Total _____________

How to Complete a Mathematics or Computer Science Project

What is a computer science project?
A computer science project uses coding language to develop information processes or programs to demonstrate, analyze, or control a process/solution. Sometimes robots or intelligent machines are used to use the coding language and perform tasks.

What is a mathematics project?
A mathematics project involves using math to describe relationships between things. It could describe the relationship between the amount of force applied and the distance a ball travels, or it could be the probability of a specific event happening. The relationship is described as an equation, formula, or algorithm.

1. Get an Idea for Your Mathematics or Computer Science Project
Like a science fair project, a mathematics or computer science project starts with a problem, but the problem is a bit different. In science, you might be asking a “What if?” question, such as “What will happen if I add food coloring to saltwater before I evaporate the water?” Computer science and mathematics, on the other hand, look at the real world, see a problem, and use a coding language or equation to try to solve the problem. Examples in coding could include developing an application, designing a game, writing a program for a robot, or programming a microcontroller (Raspberry Pi, Arduino, AdaFruit Circuit). Examples in mathematics could include analyzing probability, calculating angles, devising an algorithm to solve a problem, or game theory.

There are three categories in the Mathematics and Computer Science division of the Science and Engineering Fair.

- ***Coding*** focuses on the study or development of software, information processes or methodologies to demonstrate, analyze, or control a process or solution. Learning to code could lead to a career in many fields, including:
    - video game developer
    - cybersecurity
    - programming languages
    - operating systems
    - application development
- ***Mathematics*** addresses studies of the measurement, properties, and relationships of quantities and sets using numbers and symbols. This includes the study of numbers, geometry, probability, and statistics. Career fields that use mathematics include:
    - financial analyst
    - computer systems analyst
    - statistician
    - game theory specialist
    - geometry and topography
    - mathematician

- ***Robotics and Intelligent Machines*** projects use machine intelligence to complete a task or reduce the reliance on human intervention. If you have an interest in computer science, you might look at a career in:
    - biomechanics
    - cognitive systems (artificial intelligence)
    - robot kinematics (how robots move)

2. Start Mathematician's or Programmer's Log Book

A detailed log book with accurate records allows programmers and mathematicians to describe their coding or mathematical processes and reflections on algorithm development and debugging so others can follow the process. Your log should be a bound notebook (such as a composition book). It should be done fully in ink. That's because it can be used as a "legal document" to prove your code/equation is your creation. In the real world, the log book is used as proof for patents and copyright. It can even be used as evidence in lawsuits over who was the first person to come up with a new idea. That's a pretty powerful book!

Don't worry about making mistakes or making a messy drawing. Mistakes are part of the process of learning and discovering. If you make a mistake, just draw one line through the mistake and keep going. Don't tear out pages or scribble out anything. It's possible that a string of code or equation you thought wouldn't work early in the process turns out to be the solution to your problem.

Setting Up Your Mathematician's or Programmer's Log Book

- Your log book is slightly different from one used by a scientist or engineer. For this division, your log book is a daily record of your progress as you work toward meeting your goal. It is very important that you record detailed notes about the work you complete on your project each day. Each day's entry will include **Daily Work** and **Daily Reflection**. Be sure to label each part for every entry that you make.
- If you make a mistake, draw a line through it and rewrite it. Do not erase or white out a mistake.
- In the **Daily Work** part of each entry, write down all the things you do or plan concerning your project each day. ***Make sure you date every entry.*** Think of it as a blog post each day:
    - What did you do today for your project?
    - Did you record any ideas for your program or equation (sketches of characters, tasks for your robot, story ideas for your game, input/output for your microcontroller, calculations for your problem)?
    - Did you change any of your code or equation today? Did you take screenshots before and after you made changes to your code? Did you rework your calculations to check for mistakes?
    - Who did you talk to about your project?
    - What did you research? Make sure to add the bibliography information for each source.
    - Give details! Each day's entry should show the progress on your project.

- In the **Daily Reflection** part of each entry, think about what you learned today:
    - What roadblocks or obstacles did you run into today? What new ideas or questions have come about as a result of working through the roadblock or obstacle?
    - What resources did you use to solve your problem (tutorials, asking a teacher for help, looking up code)?
    - If you made changes to your code or equation, what did you learn from it? How will your new learning help you be successful next time?
    - What successes did you have today? Did your successes spark new ideas for your code/program/equation?
    - Do you notice any patterns, repeated structures, or trends?

3. Complete the <u>Project Approval Form</u> - 2 pages

This form lets your teacher know what you've chosen for your project. It gives an overview of your project with enough detail that anyone who reads it can get a pretty good idea of what you will be doing. Once your teacher approves the project, he/she will give this form back to you. It will have a list of other forms you will need to complete before you begin your project. ***Make sure you keep this signed form and all forms you complete--they are required to be turned in with your project.***

4. Become an Expert in Your Problem

The research phase of your project is very important. This is where you learn everything you can about the topic of your project. If you are trying to solve a problem, you need to understand the problem. Spend some time getting background information. Good research will help you become an expert on your topic. Remember to write down the bibliographic information about each source you read, consulted, or tried to contact. Some ideas of places to go for research are:

- library
- internet--Make sure it is a ***reliable*** source of information (talk to your school media specialist about this).
- experts in the field
- Write to companies involved in your field.

5. Complete <u>Ethics Agreement</u> and <u>Risk Analysis and Designated Supervisor Form</u>

By signing the *Ethics Agreement*, you are saying that you won't copy someone else's work. You can refer to someone else's work, but you have to cite it in your log book and on the bibliography. Copy-and-pasting images, words, etc., from the internet is considered plagiarism. If you identify *where* you got each part of what you copied (cite the source), you have done your job.

The *Risk Analysis and Designated Supervisor Form* is used to state all the risks in your project. Risks might include:

- the materials and programs you are using. How can you stay safe when you use them?
- the location you are testing in. Is it close to a road or body of water?
- the tools you may use if building a robot or other intelligent machine.

In this handbook, the <u>Risk Assessment and Safety Considerations</u> section will help you complete this form.

6. State the Problem in a Question Form

Your project problem is how you will develop a program using a coding language/equation/formula to solve a problem. The problem should be a practical need. For coding or robotics problems, are you coding a completely new program or are you modifying (changing) existing code to make it work better in certain conditions? For mathematics problems, are you trying to find the probability of a specific outcome? Are you trying to find an equation that will describe a relationship between two outcomes? Whatever it is you are trying to do, your final program should be a process/solution to the problem you identified. Your problem should also be very specific. For instance, if you want to design a game, be very specific about which coding language and tasks your program will perform. For example, you might ask, “How can I use Scratch to design a chase style game?” For mathematics, you might ask, “What is the probability of winning a Rock, Paper, Scissors game?”

7. Research

Mathematicians and computer scientists need to get a full picture of the problem they are addressing before they start developing their programs/equations.That's where research comes in. For example, if you are programming a robot, find out the coding languages that are compatible with that robot. If you are using a microcontroller to program circuits, research what you will need to build the circuits, how the parts of the microcontroller operate, and the most efficient coding language for the microcontroller. If you are devising an algorithm for solving a Rubik’s Cube, research three-dimensional puzzles, how a Rubik’s Cube moves, and solutions for solving Rubik’s Cubes. Research helps you to fully understand the problem and possible solutions before you start your design.

For the Science and Engineering Fair, at least ***3 sources*** are required for the research phase. These sources must be documented in both the log book and on a bibliography. Interviewing a computer programmer, statistician or other expert in the field of your project is an acceptable source.

8. Develop a Project Goal

Your project goal should start as a brainstorm of several solutions/processes to your problem. Don’t stop at just one. Brainstorm alternative solutions/processes that might solve the problem, then choose the one that you think best fits the specifics of your project goal. At judging time, you will be asked about different ideas you brainstormed and why you thought your solution/process was the best. All of your solutions/processes should be in your log book, with detailed labels and components of your program. Programmers might include designs of a maze a robot navigates through, sketches of a character they are developing for Scratch, illustrations of circuits, or a display menu for an application. Mathematicians might include sketches of two-dimensional or three-dimensional objects, possible formulas, or diagrams of angles.

9. List Materials and Programs

Include any materials you plan to use, including specific robots, devices, and materials you need to complete tasks when appropriate (tape, construction paper, batteries, sensors, wire, LED lights, tape measure, protractor, compass, etc.). Also include a list of the programs and coding language (Scratch, Arduino IDE, MakeCode, Tynker, JavaScript, HTML5, C++, etc.), or formulas you will need.

10. Write an Algorithm or Testing Procedure

An **algorithm** is a to-do list for a computer or mathematics problem. A recipe is a good example of an **algorithm** because it tells you what you need to do step-by-step. It takes inputs (ingredients) and produces an output (the completed dish). The algorithm is your procedure for developing your code. Using statements, write the steps you will need to code to perform the tasks for your solution/processes. Your algorithm could be written as an outline, a list of steps, in a flow map, or in a storyboard.

A **testing procedure** is where you design a way to gather data about your mathematical problem. If you are devising a new way to solve a Rubik's cube, how would you test your formula?

11. Develop - Test - Modify

Mathematics: First, develop a formula, ratio, or solution for your problem. Test it according to your Procedure. The next step is analyzing your results and creating a graph. Was there a particular problem with one part of your formula/solution? Did you have any outliers in your data that need to be considered? After you test it several times, do you see any trends in your data tables/graphs? Adjust your formula, ratio, or solution and test it again. Keep repeating this cycle until you have a solution that best meets your needs.

On your Mathematics board, you will be required to display your process for developing your formula, ratio, or solution. Projects should include your testing procedure, graphs of data, trends and outliers, and your reflection. **If you used a mathematical application on your computer, you may choose to bring a computer to judging. *No computers will be supplied at the regional fair.***

Coding/Robotics and Intelligent Machines: Using your algorithm (step-by-step procedure), write your code to perform the tasks of your project goal. Good programmers run their programs after they write each line of code. They are testing that the code runs correctly. If an error in the code is discovered, it is easier to find the error in the string of code when you test your program frequently. Finding and correcting errors in your program is called **debugging**.

On your Coding or Robotics and Intelligent Machines board, you will be required to display changes you have made as you develop your program. Screenshots will help you document these changes. Projects should include screenshots of your initial program, several changes as you debug and modify your code, and your final program. You also might want to take screenshots of strings of code that you feel are significant to your project goal, a complicated design, or were challenging to develop. **Judges have to be able to inspect your final code. A printed copy of your entire final code is recommended. Student programmers may also choose to bring a computer to judging for this purpose. *No computers will be supplied at the regional fair.***

12. Final Reflection

Your final reflection should demonstrate your thinking about what you have learned. You could create a timeline with descriptions or steps in the process that show the creation of your project from start to finish. Discuss lessons learned from your project, including ideas you have for future research, steps or processes you would do differently, and other lessons you have learned that will help you with your program next time.

- Tell the story of your project. Why did you choose to solve this problem?
- Describe the design process you used in your project. Imagine you are telling a classmate about it who is interested in working on a similar project.
- Tell the story of how you solved roadblocks or obstacles that came up in the development of your program/equation. Give examples of a few challenges you encountered and how they created problems in your code.
- What resources did you use to problem solve?
- How did the ideas for parts of your program/equation change after you started?
- What new ideas, questions or goals have come about as a result of your work on this project?

13. Communicate Your Results/Construct a Display

Mathematicians and computer scientists share their findings with others. If your program/equation solves a problem, it is good to let others know about it! You should be able to fully explain all parts of your project: How did you come up with the problem?

Mathematics

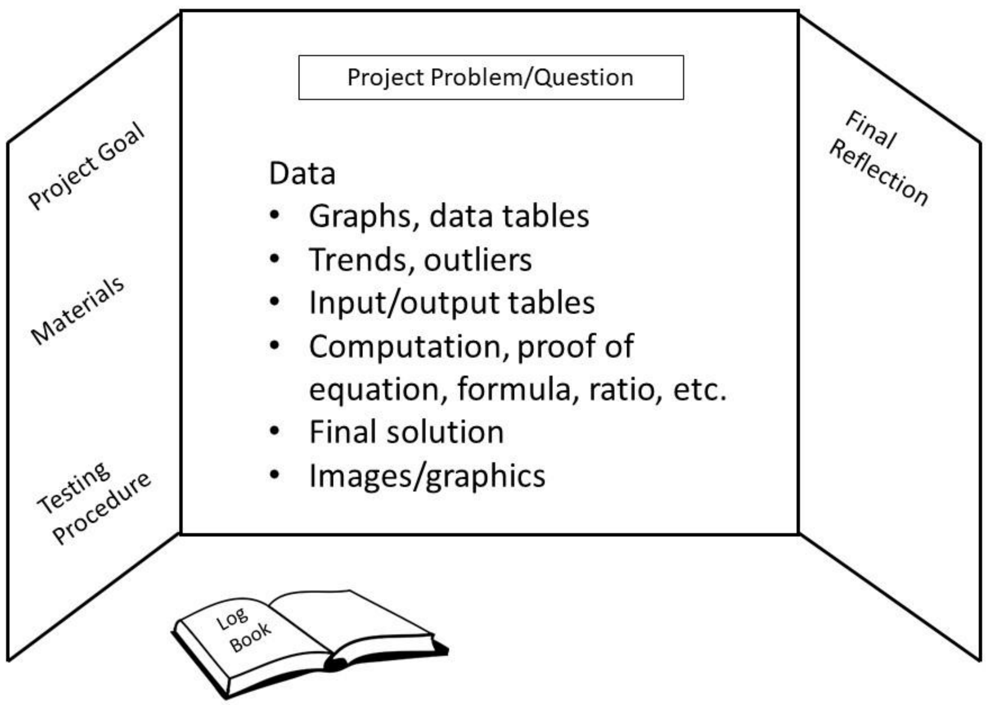
- process for developing formula, ratio, or solution
- testing procedure
- graphs of data
- trends
- explanation of outliers in your data
- final reflection

Coding/Robotics and Intelligent Machines

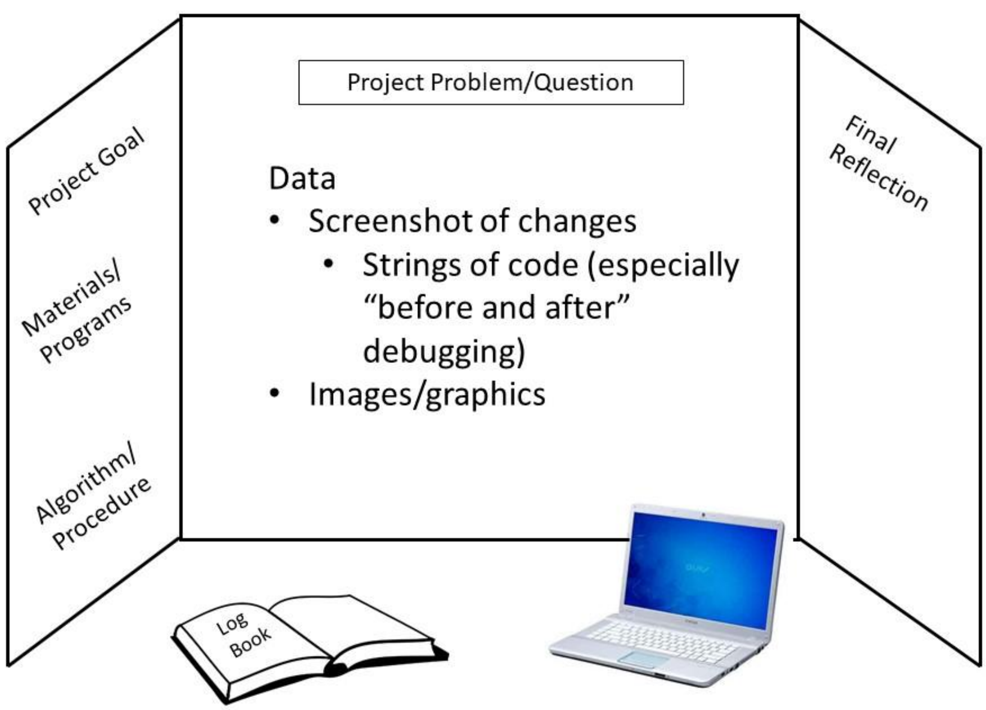
- coding language choice (Scratch, Arduino IDE, MakeCode, Tynker, JavaScript, HTML5, Xcode, C++, etc.)
- debugging process
- screenshots of code
- choice of specific important string of code
- modifications made
- final reflection
- **A printed copy of your entire final code or a computer that can access the code must be available during judging.**
- **You must bring your device to your interview to demonstrate how your program works. If you constructed or used a robot/intelligent machine, you must also bring that to your interview.**

Below are samples of a Mathematics and a Coding/Robotics and Intelligent Machines Project Display Board. Your board does not have to match this exactly, but it MUST have your problem and tell the story of your project.

Mathematics Suggested Layout



Coding/Robotics and Intelligent Machines Suggested Layout



SEF Student Checklist

Mathematics and Computer Science Division

Student Name____

check each box	Congratulations on completing your project! Use your SEF Student Handbook and this checklist to be sure you have completed all of the required parts and that you stayed within the rules for your project. ***In order to be safe and fair, if you don't follow the rules, your project will not be permitted in the Regional Science and Engineering Fair.***
☐	Check the box if you have completed and signed all of the ***necessary forms*** for your project. Look on page 2 of your Project Approval Form for what you need.
☐	Check the box if your ***project problem/question*** is on the board or in your log.
☐	Check the box if your ***project goal*** is on the board or in your log.
☐	Check the box if your ***materials and/or programs list*** is on the board or in your log.
☐	Check the box if your ***algorithm/procedure*** is on the board or in your log.
☐	Your board shows changes you made as you developed your program/equation. You can use screenshots as you ***debug and modify*** your program. You can add graphs and tables to show trends in data. Check the box if you have ***strings of code/graphs*** displayed on your board that show changes.
☐	Check the box if your ***final reflections*** are on the board.
☐	Check the box if your ***bibliography*** is complete, with at least ***three sources,*** and with your project.
☐	A ***log book*** is required for each student programmer (team projects require a log book for each student). Check the box if ***your log book is complete and with your project***.
☐	You can use ***photographs,*** (even ones that show your face), but you have to tell who took the photos. If the same person took them all, just put one label that says, "All photos taken by _______." But only use first names. You can also say, "Scientist's mom took this photo," or "Photo taken by scientist." Check the box if you have labeled your photographs.
☐	Items used from the ***Internet*** (articles, graphs, charts, pictures, etc.) need to have labels to cite the source. For example, "This chart was from (URL of website)." Check the box if you've labeled your Internet sources (if this applies to you.)
☐	Check the box if your display board is able to ***fold and lay flat*** and does not contain prohibited objects (such as lighting, soil, rocks, liquids, living or dead organisms, blood, sharp objects, plastic bottles, etc.).
☐	***Computer Science only:*** Check the box if you are prepared to bring a robot and/or computer to show the judges your code **OR** you have printed out your entire final code.
☐	Check the box if your project ***meets all of the rules and requirements*** outlined in the *SEF Student Handbook*.

Judging Criteria: *Mathematics and Computer Science Division*

________________________/____

Project Number *Category*

Project Problem____

	Superior	Very Good	Good	Poor	Notes
Research ● clear and focused ● description of practical need, problem to be solved, or purpose	10	8	4	2	
Design and Methodology ● well-designed plan for creating and testing program/equation ● explanation of choice of coding language/equation	15	10	5	2	
Testing and Modifying ● reflection throughout process *For Mathematics* ● the formula solves the problem ● trends are identified *For Computer Science* ● explanation of method of debugging program ● efficiency of code ● robot/device functions properly, if applicable	15	10	5	2	
Representation of Data/Design *For Mathematics* ● graphs identify trends ● clear graph of formula *For Computer Science* ● clarity of screenshots/graphics ● significance of coding strings represented	10	8	4	2	
Log Book ● dated entries/daily reflections ● sketches/diagrams/flow maps/world design ● access to entire code/formula/algorithm ● evidence of research ● bibliography (at least 3 sources)	15	10	5	2	
Interview ● clear, concise response to questions ● reflection on process/mathematical reasoning ● ideas for future research ● lessons learned ● If team, both members demonstrate significant contribution to project *For Computer Science* ● ability to connect specific code to task	15	10	5	2	
Display ● logical organization of project content ● tells story of project ● displays student learning ● device to demonstrate robot and/or program, if applicable	10	8	4	2	
Creativity ● project demonstrates imagination and inventiveness ● project opens up new possibilities or new alternatives	10	8	4	2	

**Form to be printed in yellow for the Regional Science and Engineering Fair.

Total _____________

Risk Assessment, Safety Considerations, Proper Disposal

For your project, you must complete a *Risk Assessment and Designated Supervisor Form.* Before any testing can take place, scientists and engineers must evaluate their projects for possible risks. A risk is any condition that could cause harm to the researcher, test subjects, or the environment. For every risk, the scientist and engineer needs to design a step of the Procedure to address ways to lessen the risk.

One very important part of controlling the risks is the disposal of non-native, genetically-altered, and/or invasive species (e.g. insects, plants, invertebrates, vertebrates), pathogens (disease-causing organisms), toxic chemicals, or foreign substances. Returning these items to the environment is prohibited, so you have to make plans for how to dispose of them safely. It is recommended that students reference their local, state, or national regulations and quarantine lists.

Risk	Safety Precautions and Disposal Procedures
Animal (living)	**Safety Precautions:** When handling animals, students should wear gloves and/or thoroughly wash after handling animals to prevent the spread of bacteria and diseases. Students should take precautions to guard against injuries, including bites and scratches, from the animals. The *Qualified Scientist* and the *Vertebrate Animal Care Forms* are **required** for all projects involving non-human vertebrate animals (mammals, birds, reptiles, amphibians, and fish). Adult supervision is required. Any project that could cause pain or distress to a vertebrate, or result in a vertebrate's death is **not allowed**.
Animal (tissue)	**Safety Precautions:** Animal tissue is a potentially hazardous biological agent. Students must wash hands before and after working with the animal tissue and wear gloves while working. Raw meat and poultry can carry harmful bacteria that can be transferred to utensils, surfaces, your hands, and other foods when you're cooking. Bacteria from raw meat, especially poultry, can cause salmonella (food poisoning). The workspace must be sterilized after working with the animal tissue, and any instruments used must be thoroughly cleaned with hot soapy water. Adult supervision is required. **Disposal Procedures:** Drip dry the animal tissue specimens prior to placing the items into a disposal container. The waste should be placed in a sealed, double-bagged garbage bag.
Batteries	**Safety Precautions:** Precautions should be taken when working with batteries. Batteries can become extremely hot when using wires to build circuits. Battery acid is corrosive and can burn skin and eyes and eat holes in clothing. Some batteries are also flammable. Lithium batteries can explode. Students should wear safety glasses when testing with batteries. **Disposal Procedures:** Single use batteries can be placed in the trash. Rechargeable and coin batteries should be recycled through mail in, take back, or drop off programs. For example, Lowes has a recycling program for rechargeable batteries.
Chemicals: This includes, but is not limited to, Lysol,	**Safety Precautions:** For every chemical you use, check the Safety Data Sheet (SDS) for precautions. You can find them at this website: https://chemicalsafety.com/sds-search/. It would be a good idea to print the SDS and include it in your log book.

hydrogen peroxide, rubbing alcohol, detergents, common household cleaners, bleach, baking soda, ammonia.	A wide variety of chemicals react dangerously when mixed with other chemicals and substances. Never mix bleach with other household chemicals, as a deadly toxic gas could be produced. Safety glasses and gloves should always be worn when working with chemicals. **Disposal Procedures:** Chemicals can be diluted with water and poured down the drain.
Composting	**Safety Precautions:** Composting is not allowed. Composting produces potentially pathogenic (disease-causing) microorganisms.
Culturing Microorganisms	**All testing must be done in a BSL-1 certified lab.** **Safety Precautions:** All microbial samples/organisms MUST be obtained from a science supplier/company and are limited to **Biosafety Level 1 (BSL-1)** organisms. Mold can NEVER be grown because it is extremely hazardous to health. **Using Blood Agar for culturing is not allowed.** Samples/organisms **MUST NOT** be collected from the environment, as they are potentially pathogenic (disease-causing). **Disposal Procedures:** The organism must be cultured in a sealed plastic petri dish. The petri dish must remain sealed throughout the experiment. The sealed petri dish is disposed of via autoclaving or disinfection under the supervision of the Qualified Scientist/Designated Supervisor.
Drones	**Safety Precautions:** A *Student Use of Drones* form must be completed. Students and their adult supervisor should conduct a safety inspection of the drone before flight. Never fly your drone over people or private property. Students should ask permission before flying over county parks. Be aware of power lines, trees, or other potentially hazardous structures when you are flying your drone. Larger drones can be extremely dangerous and cause serious bodily injury.
Electricity	**Safety Precautions:** Electricity is a potential hazard because of the possibility of shock or fire. Extreme care should be used around any electrical outlet. Students must have dry hands and skin, as well as a dry area on which to stand/work. Common sense in using any electrical equipment is essential. Inspect electrical equipment before plugging in to ensure that there are no breaks in the insulation.
Eye strain	**Safety Precautions:** Looking at a computer screen for a long period of time can cause eye strain and discomfort. Use the 20-20-20 rule when working on looking at a computer or tablet screen. Look away from the screen about every 20 minutes and look at an object about 20 feet away for 20 seconds to give eyes a break.
Fire	**Safety Precautions:** Testing involving fireworks or other explosives is **not allowed**. Adult supervision is required for any project where a flame is produced. A fire extinguisher must be on hand to extinguish accidental fires. Fires started by different agents must be extinguished differently (grease fires, chemical fires, electrical fires, etc.) Your

	bibliography should include fire safety research. If any fire is used or produced, it should be recorded in the researcher's log book. Fires can spread quickly. The location should be carefully considered before using fire for testing. It should be well-ventilated. Make sure smoke detectors are operational. Safety glasses should be worn during the experiment.
Gears/moving parts	**Safety Precautions:** Moving parts and gears can cause injuries to fingers and other body parts. Safety glasses should be worn when working with moving machinery. Long hair or loose clothing should be secured before testing to prevent them from getting caught in the moving parts.
Human Subjects: This includes, but is not limited to, taste tests, exercise, genetics.	**Safety Precautions:** Experiments on humans can be dangerous. You can never be too cautious when planning activities that directly affect the health of the students. Students may choose to use human subjects for their experiments but should be aware of risks, including but not limited to: ● **Allergic reactions** (to food, lotions, makeup, shampoo, or other beauty products, etc.) - To prevent allergic reactions from occuring, question participants about allergies and sensitivities prior to testing. ● **Muscle strain or injury** - To prevent strain or injury to muscles during physical activities (such as running, soccer, cheerleading), use mats, proper shoes, or other necessary equipment to ensure the safety of participants. ● **Dehydration and overexertion** - To prevent dehydration and overexertion, provide participants with plenty of water and breaks during testing. ● **Prolonged increased heart rate** - To prevent risks associated with prolonged increased heart rate, provide frequent rests and monitor heart rate during strenuous physical activity. ● **Heat exhaustion, heat stroke, sunburn** - To prevent heat exhaustion, heat stroke, and/or sunburn to participants, avoid performing strenuous activities in the heat of the day and/or for long periods of time in the sunlight. Also, provide frequent rests and water. ● **Dizziness, photosensitivity, dehydration, and/or seizures from flickering/strobing lights** - To prevent negative effects from flickering or strobing lights (such as effects used in video games, videos, lasers), question participants about photosensitivity prior to testing. Stop testing immediately if participants have any symptoms of dizziness, dehydration, sensitivity in their sight, or increased heart rate. When using human test subjects, the *Qualified Scientist Form*, *Informed Consent for Testing of Human Subjects Form*, and *Teacher Verification of Informed Consent Form*s are **required** to ensure the safety of the human subjects.
Internet safety	**Safety Precautions:** The Internet can be a great tool for students when working on projects. However, students should use caution when putting information on websites. Students should **NEVER** provide personal information such as names, addresses, emails, passwords, etc. and should always protect their passwords. Visit Common Sense Media for more information about Internet safety.
Lasers	**Safety Precautions:** Lasers used in the classroom must be of low power. Prolonged exposure to reflections from door knobs, glass plates, diamonds or other polished surfaces can cause retinal damage. To prevent damage to the eye, safety glasses should be worn during the experiment.

	Lasers should NEVER be pointed at eyes.
Location/ environmental conditions	**Safety Precautions:** Adult supervision is required if students are testing at the beach or near rivers or other bodies of water. Precautions should be used if testing is occurring near areas of high traffic or moving vehicles (parking lots). Weather conditions should be checked before experiments are conducted outside. Be aware of power lines or other structures that may be hazardous.
Plants	**Safety Precautions: Plants CANNOT be grown in water, sand or soil that was collected from the environment. *Safety glasses and gloves are required*** for working with plants. Students should wash hands thoroughly after handling. Never eat unknown berries, seeds, fruits, or any other plant part. Do not rub sap or plant juice into the skin, eyes, or open wound. There are many toxic plants that grow naturally in Florida. Students should take precautions to prevent poisoning. **Disposal Procedures:** Plants can be disposed of with yard waste.
Projectiles	**Safety Precautions:** Testing with projectiles could result in injury and requires adult supervision. Students should wear safety glasses during testing.The adult supervisor should make sure no one is in the target area before projectiles are launched.
Saliva/cheek cells	Extracting DNA from living organisms is **NOT permitted** at the elementary level.
Sand/soil	**Safety Precautions: *Safety glasses and gloves are required*** for working with sand or soil. Adult supervision is needed. Sand and soil samples may be collected from the environment ***only*** if sand/soil quality is the purpose of testing. **Plants or organisms CANNOT be grown in sand or soil that was collected from the environment.** **Disposal Procedures:** Sand and soil can be returned to the environment unless testing involves motor oil or chemicals. If motor oil was added to sand or soil, the waste must be taken to the landfill. If other chemicals were used, the sand or soil should be disposed of with yard waste.
Tools/ implements: This includes, but is not limited to, hammers, nails, glue guns, soldering pens, drills, screwdrivers, cutting tools, etc.	**Safety Precautions:** Testing involving firearms, knives, or other items that could be considered weapons in a school setting (e.g. a paintball gun, BB gun, bow and arrow, etc.) are NEVER allowed. Adult supervision is required if students are going to use tools. Injury can easily occur if students do not have proper guidance or training in using equipment (such as power tools, glue guns, soldering pens, etc.). Safety glasses must be worn to prevent injury.
Water collection	**Safety Precautions: *Safety glasses and gloves are required*** for working with water collected from the environment. Adult supervision is needed. Water samples may be collected from the environment ***only*** if water quality is the purpose of testing (dissolved oxygen, nitrates, phosphates, pH, salinity, turbidity, etc.). **Plants or organisms CANNOT**

	be grown in water that was collected from the environment. **Disposal Procedures:** Within 24 hours of collection, water must be disposed of appropriately. If nothing was added, it can be returned to the environment. If motor oil was added to the water, the water must be taken to the landfill. If other chemicals were used, the water should be diluted with additional water and poured down the drain.
Website rules	**Safety Precautions:** The Children's Online Privacy and Protection Act ("COPPA") requires that online service providers obtain parental consent before they knowingly collect personally identifiable information online from children who are under 13. Parents should review the terms of service before a student creates an account for use.

Sample Interview Questions

General Questions for All Projects

- Where did you get the idea for your project?
- Can you explain or describe your project?
- Describe your research process. What was the most interesting fact you learned during your research?
- How does your approach to the question differ from other scientists' previous approaches?
- How did you collect your data?
- What type of measurement tools did you use?
- What are the most important things you learned from your project?
- How can you apply what you have learned to “real life” situations?
- What kind of help did you receive while working on your project?
- How much time did you spend working on your project?
- What were some challenges or obstacles you encountered while doing your project?
- What ideas do you have for future research
- What would you do differently next time?
- What lessons have you learned that will help you next time?

Science Division

- Can you identify your independent and dependent variables?
- Did you have a control group? Explain your control group.
- What did you do to make sure your test was fair?
- Can you walk me through how and why you decided on this Procedure/experimental design?
- Describe your data collection process. What did you measure?
- Tell me about how you analyzed your data. Why did you choose this type of graph?
- How many trials did you conduct? Why did you choose that number of trials?
- How many times did you test? Why did you test this many times?
- How did you analyze your data?
- Why did you choose this graph to organize your data?

Specific questions for Engineering and for Mathematics and Computer Science divisions are continued on the next page.

Engineering Division

- How did you construct your prototype?
- Can you explain how you tested your prototype?
- Explain how your prototype changed from the initial design to your final design.
- Can you walk me through how and why you decided on this engineering design?
- What modifications did you make? Why did you make them?
- If you had more time, what modifications would you make?
- Explain your charts/graphs/diagrams.
- How did you analyze your results?

Mathematics and Computer Science Division

Mathematics

- What trends did you notice?
- Identify any outliers in your project.
- Describe the process you used for developing your mathematical representation.
- Explain your mathematical reasoning in solving your problem.
- Which part of your equation/formula are you most proud of, and why?
- Where might you see errors in your data?

Coding/Robotics and Intelligent Machines (Judges should actually use app, play game, or run robot.)

- Judge chooses a specific task in the program.
    - Where is this task in the code?
    - How did you decide how to code this section?
- What process did you use for debugging your program?
- Out of all possibilities, why did you choose to create ***this*** digital product?
- Why did you choose this coding language? (for example block coding versus JavaScript)
- Which string of code are you most proud of? Why?
- What modifications did you make to your robot or output device? Why?