STUDENT'S GUIDE TO THE SAN FRANCISCO SCIENCE FAIR

INTRODUCTION

The Randall Museum invites your participation in the Annual San Francisco Science Fair. This event encourages students in grades 6 to 8 to conduct an original scientific investigation, make a best guess about the outcome and verify accuracy using good scientific procedures. The goal of the Science Fair is to encourage *participation*, not competition. The four subject categories are:

1. **BIOLOGICAL SCIENCES**: e.g., plant growth, cell structure, molds, preservatives, growth and development, animal behavior, ecology;
2. **PHYSICAL SCIENCES**: e.g., airplanes, probability, crystals, evaporation, solar power, electricity, computers, photography;
3. **BEHAVIORAL, SOCIAL AND HEALTH SCIENCES**: e.g., product tests, diseases, exercise, perception, aptitude tests, human behavior, medicine;
4. **ENVIRONMENTAL SCIENCE**: e.g., pollution, alternative energy.

Students must follow the procedures presented in this booklet in order to have their project accepted into the San Francisco Science Fair. Please pay particular attention to project format and display, safety rules, and humane practices.

Winning projects from grades 7 and 8 will pass on to the regional Golden Gate STEM Fair (GGSF) held at the U.S. Army Corps of Engineers Bay Model in Sausalito the week of March 9 - 14. **IF YOUR SCHOOL IS IN SAN FRANCISCO, YOU MUST ENTER OUR FAIR BEFORE GOING ON TO THE GGSF.** Our rules are designed so that projects qualifying for the S.F. Science Fair can generally go on to the GGSF without revision. **Note: Students whose projects involve live animals, human subjects (including surveys!), controlled substances, or pathogens MUST submit proposal forms BEFORE BEGINNING THEIR EXPERIMENTS,** absolutely no later than February 1st (this is for the GGSF not the Randall museum). Please see the GGSF website, **https://wp.ggstemfair.org**, for complete guidelines, forms, and addresses. This guide is intended to augment the accompanying STUDENT'S GUIDE TO THE SAN FRANCISCO SCIENCE FAIR. These guides should answer your questions regarding scientific methods and display format. If you have further questions, please email at sciencefaircoordinator@randallmuseum.org.

WHAT IS A SCIENCE FAIR PROJECT?

A science fair project is a logical and careful investigation of a scientific problem.

Students will begin with an idea or question of interest to them, research, experiment, conduct test to get their best guess (hypothesis) at the answer to the problem, and conclude by writing up their methods and results and displaying them.

HOW TO DO A SCIENCE FAIR PROJECT

MAKE SURE THE PROJECT IS A DISCOVERY, NOT A DEMONSTRATION.

A project that shows how rubbing a plastic comb through cat fur creates static electricity, causing things to cling to the comb, is a *demonstration* of an established scientific fact. An investigation of which materials best conduct static electricity, on the other hand, is a *discovery*. The difference is that in a discovery, the student did not know the answer, and could not have found it easily by looking in a textbook. **The following guidelines will clarify the differences for you.**

1. FINDING A PROBLEM TO SOLVE

A. **WHAT INTERESTS THE STUDENT?** All scientists (students included!) work on things that they find interesting. As you know, if students are disinterested, their work will show it. Have them choose topics that they enjoy and could investigate.

EXAMPLE: *A student may be interested in human behavior patterns. This is too large and unspecific to handle, so the student must:*

B. **NARROW IT DOWN.** The students need to limit their projects to single problems they can solve with the time and resources that they have. Students need to do RESEARCH using libraries, teachers, the Internet, and professionals in the sciences (e.g., a doctor) to find out what has been done (so they don't investigate something too obvious or trivial).

EXAMPLE: Most students have probably been told that listening to rock music makes studying more difficult. That may be, but the topic is still too general to do experiments on. Studying involves reading comprehension, memorization, problem-solving, etc. Thus, the student should select one factor, such as short- term memorization. Now the project is narrowed down to one manageable problem.

2. WRITING A HYPOTHESIS. The student must state the problem precisely and make a best guess at the answer, or HYPOTHESIS. It should be phrased so that it can be answered either "yes" or "no." Reassure them that a hypothesis is simply a statement to prove true or false by scientific research; it is not important that they guess “right.” They will be judged on the basis of originality, thoroughness, and clarity of their work. Stress to the students that they will not be graded down if their hypothesis proves to be incorrect or inconclusive.

EXAMPLE: One hypothesis could be: "People can perform a simple task of memory more accurately in silence than they can while listening to loud rock music." The hypothesis could also be that there is no effect, some effect, or the opposite effect. The student must select ONE possible outcome to test.

3. EXPERIMENTING

A. **DESIGNING A TEST FOR THE HYPOTHESIS.** The student must examine his/her best guess, WRITE IT DOWN, and design experiments to test it. All factors that could affect the results must be kept the same, or CONTROLLED, in all experimental trials, except for the factor being tested in the project. This can be difficult, because many factors that aren't obvious at first can skew results. Students must try to think of everything that could go wrong and figure out ways to avoid problems.

EXAMPLE: In the experiment testing the effect of loud rock music on memory, everyone has to hear the same music at the same volume; look at the same objects from the same distance, over the same amount of time, under the same lighting, and at about the same time of day; and so on. Everything should be identical, except that half of the test subjects will hear music (the EXPERIMENTAL GROUP) and half will hear no music (the CONTROL GROUP). Subjects should all have the same amount of time to think, and they should not be able to talk to each other during the experiment (that would probably change the results and ruin the experiment). In this example, the student will need forms for the subjects to fill out, a stopwatch, music, and a box of objects to memorize. All materials necessary to do the experiment correctly should be ready before beginning.

B. **MULTIPLE TRIALS** Students should do their experiments as many times as they can. Good science means examining a lot of information. If they do too few trials, unusual circumstances will have a greater effect on their results and thus decrease the value of their findings.

EXAMPLE: Maybe some kids are more used to rock music and can concentrate better with it playing, so the student should test a lot of kids to make sure that a few who can memorize better than most don't change the overall results too much. Remember: the more trials, the better, to ensure a more universal and useful conclusion.

C. **QUANTIFYING OBSERVATIONS.** Students must design a way to put their information into unambiguous numerical or quantitative form. They must be precise in order for their work to be repeatable, so a judge can tell exactly what they did and what they observed.

EXAMPLE: The student should record exactly how many objects were recalled accurately by each subject. These numbers should be separated into music vs. no music groups and tabulated.

D. ***KEEPING A PROJECT NOTEBOOK FOR THE HARD DATA.*** *Have your students record ALL DATA and everything that happens during their work in a PROJECT NOTEBOOK, even if the data seem to contradict their hypotheses. Record-keeping is crucial because science is the attempt to understand what happens.*

E. **EXAMINING RESULTS AND COMING TO A CONCLUSION.** When they have finished their experimental work, students must ORGANIZE the information. Charts, graphs, tables, and diagrams are useful in organizing data clearly. Now that they have interpreted their experimental information, **do their results support their hypotheses? If not, reassure them that they should not feel bad. DON'T let anyone change a hypothesis to fit the data**. A negative outcome to a hypothesis (the guess was incorrect) is just as important and illuminating as a positive one. If they have the time, they can make new hypotheses, experiment, and see what happens. This is the way science often works: with trial and error leading to further discovery.

EXAMPLE: Tabulate how many objects each person was able to recall and calculate averages for the two groups: music and no music. If the people who heard music remembered more objects on average, what are some possible reasons for this? These reasons should go into the report. Were the controls not good enough, or is something else happening? Maybe there were more girls in the music group, and girls might be *better at memorizing (this is unlikely but should not be ruled out). Such thinking will lead to new questions.*

4. COMMUNICATING THE RESULTS

A. **WRITING A FINAL REPORT** Many students doing science projects have good ideas and do accurate scientific work, but fail to explain their projects carefully. The students should communicate everything necessary for another person to do the same experiment again. They should not assume that anything is too obvious to write down. Good science means good communication! Everything must be clearly explained in a FINAL REPORT, which should be attached or connected to the finished display with a string or placed in a closable pouch along with data. (Do not glue the report directly to the display.) The report should include:

- Title page.
- Abstract, an abbreviated version of your final report.
- Table of contents.
- Question, variables, and hypothesis.
- Background research, The research paper you wrote before you started your experiment.
- Materials list.
- Experimental procedure.
- Data analysis and discussion, a summary of what you found out in your experiment, focusing on your observations, data table, and graph(s), which should be included at this location in the report.
- Conclusions.
- Ideas for future research. Some science fairs want you to discuss what additional research you might want to do based on what you learned.
- Acknowledgments. This is your opportunity to thank anyone who helped you with your science fair project, from a single individual to a company or government agency.
- Bibliography.

MAKE SURE THAT YOU ARE THOROUGH. A thorough scientist always points out weaknesses or alternative interpretations of the data and suggests research strategies for further study.

EXAMPLE: There could be many uncontrolled factors that affected the results (age, sex, musical preference, etc.). Other interpretations may occur to the student: perhaps classical music at the same volume would not have the observed effect; or perhaps the *lyrics in the sample, rather than the music itself, were distracting. New experiments can be done to test these new hypotheses. In this example, please note that the student did not PROVE that music makes it harder (or easier) to study. Rather, he or she obtained inferential evidence indicating that music probably makes it harder (or easier) to study.*

MAKING A DISPLAY

Each project must:

1. Be on a three-sided, self-supporting poster structure. The measurements of the board **MAY NOT EXCEED: 30" front to back, 48" wide, and 36" tall**.
2. Your exhibit should **tell all about your project**. **Include an Introduction or Statement of Purpose, Background research, Question and Hypothesis or Engineering goal, Materials, Method, Results - Tables, Graphs, Pictures, and Conclusions** using simple statements and attractive visuals.
3. Summarize the report with the headings listed.
4. Every paper should be checked for any type of grammatical errors before attaching to the board.
5. Your project will be surrounded by many others, so it should be attractive and easy to view.
6. Be able to stand on its own for at least one week. Our staff will not repair flimsy displays.
7. Extra items may not rest in front of boards. *(museum is open to the public, we are not responsible for lost or stolen items)* Foam core is the most durable display panel material. If mat board or thin cardboard are used, they should be reinforced on the back and sides.
8. Your display may have pictures **(not of student faces)** or sketches and properly labeled graphs of data. Student's name and other identifying information **must only be in one corner of the back of the display** and small enough to be covered with a 3"X 5" card during judging.

In keeping with GGSF guidelines, electricity will no longer be provided. Any working electrical apparatus may be powered only by batteries.

Unacceptable items for display:

● Live animals should NEVER be a part of your display, but may be shown by using a picture or sketch.

● Living organisms (including plants, fungi, and bacteria) as to not encourage mice or pests

● Any biological materials

● Chemicals

● Electrical items that need to be plugged in

SOME HELPFUL HINTS FOR YOUR LOCAL SCHOOL SCIENCE FAIR

1. Steer **away** from routine projects such as effects of fertilizers on plants or which paper towel brand is the most absorbent. Also, judges get tired of too many similar projects and may not give an unadventurous project the attention it deserves.
2. If working with working with humans or animals, submit proposals to the Scientific Review Committee by the GGSF deadline, Feb 1st, and comply with all humane regulations. To avoid this headache altogether, steer away from live animal projects.
3. Use parents, educators, and community contacts to full advantage to provide support and publicity for your local fair.
4. At the San Francisco Science Fair, we sometimes will re-categorize a project if we feel it belongs in a different place. This will not affect the outcome of judging.
5. **Please try to make sure your students, especially those who win awards, do attend our Awards Ceremony on Saturday, February 29 from 9:30 a.m. to 11:30 a.m.** We will contact your school on Friday, February 28 to let you know who your school's winners are.

JUDGING CRITERIA

All of our judges are a people in the local science community, varying from different ages and backgrounds. In order to keep from any bias people ensure your display board follows the rules above and to make all information is clear, and easy to read. Your board will be judged on:

1. **SCIENTIFIC METHODOLOGY** -- Does the experimental procedure test the hypothesis? Does the data support the conclusions? Was the work well controlled; were an adequate number of trials done; is the work repeatable; were good records kept? Does the student recognize the limitations of the project and suggest further ideas for research?
2. **CREATIVITY** -- Are there signs of insight and originality of approach? Is the project a discovery and not a demonstration? Do clarity of thought and imagination play a role in its development?

3. **COMMUNICATION** -- Is the problem easily understood and concisely stated? Is it logically presented? Is the display attractive, dramatic? Is the exhibit neatly constructed, with legible lettering? Are grammar and spelling correct? Do the title and report convey information that helps to develop the project idea?

SCIENCE FAIR RULES AND GUIDELINES

NOTE: These rules and guidelines have been designed such that any entrant into the San Francisco Science Fair at the Randall Museum will be eligible to go from there into the Golden Gate STEM Fair.

1. All work should be done by the entrant. Outside advising in the early stages from parents, teachers, or professionals is fine, but the student must do his or her own work.
2. Projects done by teams of more than one student will be accepted into the San Francisco Science Fair at the Randall Museum, but the Golden Gate STEM Fair accepts projects done alone. No groups allowed.
3. The student's name and any identifying information (school, teacher's name, etc.) may appear **only** on the back of the project and/or in a corner of the display small enough to be covered by a 3" by 5" card. Names will not be visible during judging. Awards or ribbons from your school science fair must be removed before setting up a display.
4. When set up for display, the project must be no larger than 44 inches wide by 30 inches deep and must be able to stand on a table by itself for at least a week. It should be labeled similarly to the diagram on page 6 in this booklet. Museum staff will not repair a poorly constructed display or in any other way attend to the equipment. Oversize projects may be disqualified.
5. All electrical apparatus must be built according to standard electrical safety laws. Projects that use 110 or more volts may not use push-button switches (doorbell type) or open- knife switches. All projects using 110 or more volts must have a main disconnect switch of a type approved by the National Board of Underwriters. All wires must be of the size and insulation appropriate for the current and voltage used. All electrical apparatus of 110 or more volts must be enclosed by barriers that positively prevent observers from receiving an electrical shock.
6. In keeping with GGSF guidelines, electricity will no longer be provided by the San Francisco Science Fair. Working electrical apparatus placed on display can be powered only by batteries.
7. Dangerous chemicals or drugs, open flames, and explosives must not be exhibited.

8. No hypodermic needles or syringes or other sharp objects are allowed with projects.
9. No live or dead animals, plants, or cultures (bacteria, fungi, molds, etc.), food, or liquids may be exhibited; use photographs or drawings instead.
10. **Projects that involve animals, humans, pathogens, or controlled substances must meet the requirements of the Golden Gate STEMFair**. For more information, see the GGSF website, https://wp.ggstemfair.org.
11. ALL entrants are responsible for the installation, maintenance, and removal of their projects. **All projects must be removed from the Randall Museum by the Saturday following the Science Fair Ceremony.** Any remaining or unclaimed projects will be discarded after this date. Museum staff will not be responsible for the security of items exhibited.