Science and Engineering

Project Manual

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Science Fair Introduction

Information and online handouts at http://scienceatfcs.brineyweb.com/science-project

Science Fair Fun!

- Share your videos and produce a science fair video of your class projects.
- Create skits and how to videos.
- Start a science club and create enthusiasm for science. (http://scienceatfcs.brineyweb.com/fcs-science-club)

International Science and Engineering Fair

- Five levels of Competition: 1) Class, 2) School, 3) Regional, 4) State, 5) International

Real Science Made Easy

- Easy step-by-step procedure written out for you in this manual and on the web at http://scienceatfcs.brineyweb.com/science-project.

Competitive Goals

- Representation in all fifteen categories.
- Oral competition with power point slides.
- Every project well-done is a winning project.
- The goal of science is to gain accurate knowledge and correct answers to questions.

Opportunities To Work Like A Scientist

- Choose a sophisticated subject and title.
- Work in a lab with a scientist.
- Extra effort in experimental **repetition** and **statistical analysis** gains more points.
- Use photographs to show work.
- Follow the schedule to reduce stress.
- Be familiar with the judging score card and process.

Benefits Of Doing A Science Project

- Science sharpens the mind to discern and discover truth.
- The scientific method is used every day: Observation -> Interpretation -> Experimentation
- Challenge: A test of character and discipline to follow instructions.
- Projects are for science lab credit and part of the science experience. It counts as a major part of your grade.

Resources For Your Science Project

Handouts

- Schedule Page with web addresses to websites with project ideas.
- Send an email request for Science fair ideas and for help to your teacher.
- Keep **all** papers in your science project notebook.

Information for paperwork

- School name: _____
- Address: _____
- Phone number: _____
- Teacher/Adult sponsor:
    - Physical Science, _____
    - Biology, _____
    - Chemistry, _____
    - Physics, _____
- Your social security number is required to collect prize money.
- SRC/IRB members
    - _____
    - _____
    - _____
    - _____

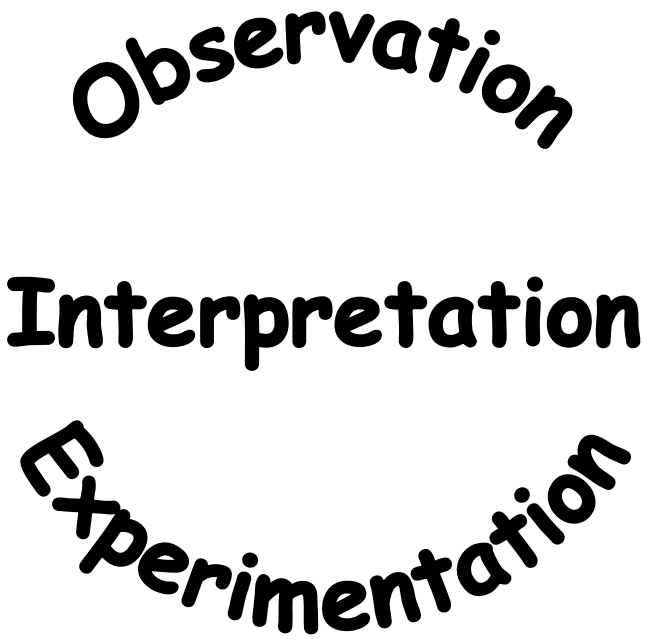
Dates To Remember

- Class paperwork due: _____
- Regional paperwork due: _____
- State paperwork due: _____
- International paperwork due: _____

Science Project Schedule

Week 1	Learn how to fill in Research Forms 1, 1A, 1B for IRB and SRC approval.
	Take quiz on Scientific Method.
Week 2	Review literature for a topic and create your formatted bibliography.
Week 3	Select a topic, read relevant references, and write down quotes and claims.
Week 4	Write and submit an introduction with references.
Week 5	Narrow topic/question and turn in forms **with** a research plan.
Week 7	Create your result table for collecting data with unit measurements, control, and variables.
Week 8	Write out your Materials and Methods page. Determine what forms must be filled out.
Week 9	Submit notebook with forms, Research Plan, Intro, M&M, result table, and bibliography.
Nov. 1	Begin experiment, record results, take pictures.
Jan. week 1	Turn in notebook with experimental data recorded in result tables.
Jan. week 2	Design graphs and charts. Write a result description.
Jan. week 3	Write your Conclusion.
Jan. week 4	Write your Abstract form.
Feb. week 1	Design and make your display board.
Feb. week 2	SCHOOL **Oral Presentation**s (< 5 minutes) and Peer judging
Feb. week 3	SCHOOL SCIENCE FAIR
	Submit paperwork (forms and research plan) for regional SRC review.
Feb. week 4	Edit science paper **and** display.
March	Compete at Regional Fair
	Write thank you letters with pictures to award donors and helpers
April	Compete at State Fair
May	Compete at ISEF, National Competition

Scientific Reporting



Observation: Information Skills

1. Choose topic: read and think about questions to answer.
2. Narrow your topic for study and research, record references.
3. Read, take notes about your topic, record references.
4. Ask a question or propose a problem to be solved.

Interpretation: Reasoning Skills

5. Propose an answer to your question or a solution to the problem.
6. Explain why you think your hypothesis and prediction is correct.

Experimentation: Process Skills

7. Design a result table: Identify what variables should be measured and controls you will use.
8. Design your experiment: materials and method with repetition and control.
9. Submit your Research plan.
10. Conduct your experiment.

Present Results And Conclusion

11. Record the results using observation skills.

12. Analyze the results with interpretation skills.

13. Write a Conclusion and a proposal for further experimentation.

Report Your Research

14. Introduction: State the problem or question and the hypothesis, explain your topic, what others already knew, and why this is important to know.

15. Materials and method: Describe the materials in your experiment and what you did in detail so that someone else can repeat the experiment.

16. Results: Report your results in an easy-to-understand chart or table. Use descriptive labels on charts and include a written explanation of each chart.

17. Conclusion: Explain why your results lead you to a conclusion and how it compares with other findings and conclusions. Propose further experiment to be done and the significance of your findings.

18. Bibliography: Cite five non-web sources in correct reference format.

19. Abstract: Write a concise, one paragraph explanation of what you discovered and how you discovered it.

Personal Checklist

Creativity (30 points)

1. Project idea: assigned, copied, helped, original
2. Project design: assigned, copied, helped, original
3. Project equipment: assigned, copied, helped, original
4. Project analysis: assigned, copied, helped, original
5. Display design: poor, fair, good

Scientific Thought/Engineering Goals (30 points)

1. Problem defined: none, fair, clear
2. Problem justified: none, unclear, unjustified, justified
3. Predictions made: none, unclear, unjustified, justified
4. Procedure to find solution: none, unclear, inappropriate, appropriate
5. Control and variables: none, unclear, inappropriate, appropriate
6. Application of findings suggested: none, unclear, unjustified, justified

Thoroughness (15 points)

1. Problem made relevant to other work: none, inadequate, fair, good
2. References cited: none, inadequate, good
3. Control: none, inappropriate, good
4. Repetition of tests: none, inadequate, good
5. Project notes: none, inadequate, good
6. Time spent on project: none, inadequate, good
7. Result tables: none, inadequate, good

Skill (15 points)

1. Observation and information gathering: simple, challenging, assisted, supervised, individual
2. Assistance required: simple, challenging, assisted, supervised, individual
3. Experimental design: simple, challenging, assisted, supervised, individual
4. Experimental equipment: simple, challenging, assisted, supervised, individual
5. Analysis: simple, challenging, assisted, supervised, individual

Clarity (10 points)

1. Display labels, pictures, and writing: unclear, readable, easily read
2. Display charts and tables: unclear, readable, relevant, labeled, meaningful
3. Display organization and flow:
4. Written science paper organization:
5. Written science paper writing style:
6. Oral presentation and interview:

Project Ideas

1. Most international project winners are originals.
2. Projects must use the scientific method, not a demonstration.
3. Show innovation and sophistication.
4. Lots of ideas can be found on the internet. Choose a project worthy of high school competition.

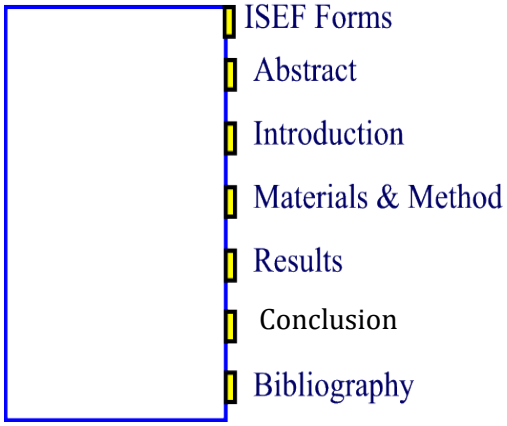
- (https://www.education.com/science-fair/high-schoolhttps://www.education.com/science-fair/high-school
- http://www.scifair.org

- Converting Sunlight Into Electricity
- Decomposing Sawdust
- Conditions Of Making Coal
- Formation Of Evaporite Rocks
- Hydraulic Pressure Of Roots
- Tensile Strength Of Exoskeletons
- Chemo Attractants For Roaches
- Surface Area Efficiency For Evaporators On Heat Pumps
- Net Energy After Compressing Vaporized Alcohol
- Mineral Content Of Water After Leeching Through Strata
- Bacterial Static/ Antibacterial Chemicals In Plants
- Preferred Wavelengths Of Light By Insects
- Hail Stone Formation
- High Protein Cookies Low In Fat
- Conditions For Accelerating Electrical Current
- What Chemicals Dissolve Dried Paint?
- Strata Formation Due To Water Sorting
- Why Are Some Spider Webs Stronger Than Others?
- Conditions For Fossilization
- What Is The Role Of Dust In Cloud Formation?
- Does CO2 Attract Mosquitoes?
- Rating Soil Conditions For Conductivity Of Shock Waves Released During Earthquakes
- Weed Control Techniques
- Sound Vibration Effect On Structural Materials
- Ingredients In Shampoos That Strengthen Hair
- Photo Conversion To Electricity
- Decomposition Of Sawdust
- Antimicrobial Agents On Microbes
- Gum Chewing And Memory/Learning
- Temperature And Pressure Relationships
- Combustion Comparisons
- Paint Thinner And Dissolution Of Paint
- Water Sealant And Water Absorption By Wood
- Water Separation Of Soil
- Comparing Tensile Strength Of Spider Silk And Steel
- Uniformity VS Catastrophism
- Conditions For Fossilization Of Plants
- Comparing Speed Of Electricity In Different Materials
- Nutritional Needs Of Molds
- Cholesterol Free Cookies
- Plant Chemical Inhibits Growth Of Bacteria
- Rate Of Leaching (Water) Through Different Types Of Soil
- Color Preference By Insects
- Counting Hair Bristles On Insects
- Comparing Public And Private Schools
- What Elements In Sand Give It Color?
- Robo Roach
- Lightening Bugs As Food For Glowing
- Insect Repellants

Your Written Science Report

1. Submit all your paperwork in a paper binders secured with metal tabs.
2. Your finished notebook will have the following:

Order Of Papers In Your Science Project Notebook



The ISEF Competition Forms

International Science and Engineering Forms

1. Click here to find and download forms.
2. Type and print for a professional look.
3. Fill out forms completely and correctly to successfully compete.
4. Keep originals and submit duplicates to regional and state SRC.
5. Organize your paperwork in the correct order.
    a. Entry Form
    b. Adult Sponsor/Safety Assessment form (1)
    c. Research Plan (See Research Plan below for details)
    d. Abstract (1A #10.)
    e. Approval form (1B)
    f. Others if appropriate in # order (2,3,4,5, etc.)
6. All experiments involving humans in any way must fill out **form 4**.
7. If you are still wondering if you need a form, remember: "When in doubt, fill it out."
8. If you are using Continuation Form 7 include the precious form 1A, Research plan, and abstract.

Correct Order Of Dates On Forms

1. Adult sponsor checklist (1). *First date.*
2. Student signature (1B) and (7). *The next date.*
    a. Student and Parent signature (1B)
    b. Qualified scientist/ Designated Supervisor (2) (3) (5) (5B) (6A) (6B)
    c. IRB (4)
    d. Veterinarian (5)
    e. FCS SRC chair (5) (6A)
3. Informed consent form of human participants, if any.
4. School SRC Chair (1B).
5. Experimental date (1A). Beginning and ending dates.
6. Supervising adult (1C). Signed after the experiment is done.

Research Plan

(one page in the following format)

Your Name

Title of project

A. PROBLEM/QUESTION: A brief synopsis of the background that supports your research problem and explain why this research is important and if applicable, explain any societal impact of your research.

B. HYPOTHESIS/ENGINEERING GOALS. (Include the reason you think your hypothesis is correct.)

C. PROCEDURE (materials & method)

D. RISK AND SAFETY: Identify any potential risks and safety precautions needed.

E. DATA ANALYSIS: Describe how you will use to analyze the data/results.

F. BIBLIOGRAPHY: (5 literature references cited and formatted correctly.

1.

2.

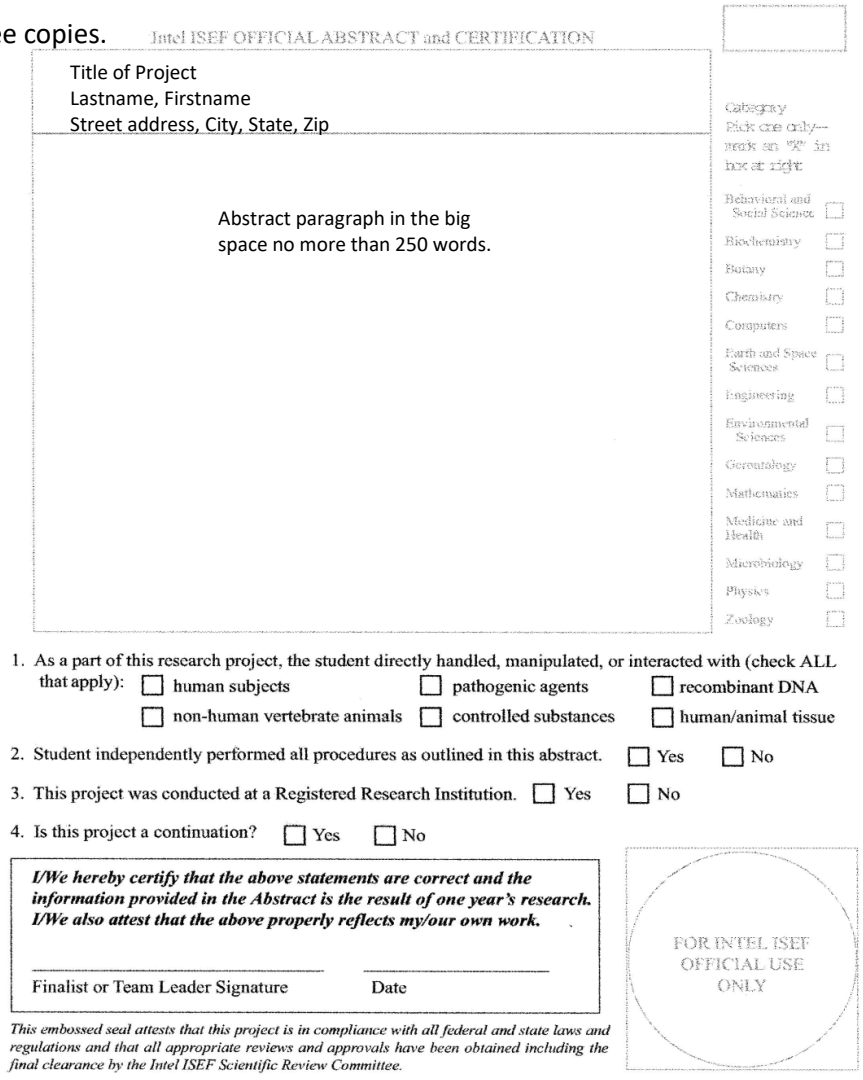
3.

4.

5.

Preparing Your Abstract

1. This is the <u>last</u> page you will write.
2. Write a summary paragraph describing what you discovered and how you discovered it. You should have a minimum of …
    a. At least one sentence summarizing your introduction.
    b. At least one sentence summarizing your method.
    c. At least one sentence summarizing your results.
    d. At least one sentence summarizing your conclusion.
3. 250 words or less, single spaced, 12-point type, in a space of 5.5” x 6”, **on the current official form** (https://www.societyforscience.org/isef/forms/).
4. Make Three copies.



Intel ISEF OFFICIAL ABSTRACT and CERTIFICATION

Title of Project
Lastname, Firstname
Street address, City, State, Zip

Abstract paragraph in the big space no more than 250 words.

Category
Pick one only—mark an "X" in box at right

Behavioral and Social Science
Biochemistry
Botany
Chemistry
Computers
Earth and Space Sciences
Engineering
Environmental Sciences
Gerontology
Mathematics
Medicine and Health
Microbiology
Physics
Zoology

1. As a part of this research project, the student directly handled, manipulated, or interacted with (check ALL that apply): ☐ human subjects ☐ pathogenic agents ☐ recombinant DNA ☐ non-human vertebrate animals ☐ controlled substances ☐ human/animal tissue
2. Student independently performed all procedures as outlined in this abstract. ☐ Yes ☐ No
3. This project was conducted at a Registered Research Institution. ☐ Yes ☐ No
4. Is this project a continuation? ☐ Yes ☐ No

I/We hereby certify that the above statements are correct and the information provided in the Abstract is the result of one year's research. I/We also attest that the above properly reflects my/our own work.

Finalist or Team Leader Signature _____ Date _____

This embossed seal attests that this project is in compliance with all federal and state laws and regulations and that all appropriate reviews and approvals have been obtained including the final clearance by the Intel ISEF Scientific Review Committee.

FOR INTEL ISEF OFFICIAL USE ONLY

Introduction

Write in objective, third person present tense style.

The first paragraph introduces your topic of interest and its interest to science. Begin with the question to answer or the problem to solve. Explain (1) why you chose this topic, and (2) emphasize the uniqueness, novelty, and innovation of the idea.

The second paragraph states your hypothesis and the reason why you think your experiment will support your hypothesis.

The third paragraph describes what is already known about the topic. Cite quotes and claims by other researchers.

Reference citation: (Last name, date of publication). Example, Soil pH of 6 has been shown to stunt the growth of corn plants **(Rayford, 2017).** The reader can then go to your bibliography page to find the full reference for Rayford's report.

Materials And Method

1. Write in objective, third person present tense style.
2. List and describe the materials used in your experiment. (Include brand names, quantities, model names of equipment, etc.)
3. Describe how to do the experiment as you would a cooking recipe.
4. Describe risk and safety assessment.
5. Include a drawing or picture of your experiment if appropriate.
6. If appropriate, emphasize creativity, your own design, self-construction, a new approach, innovation.
7. Identify the control and variables in the experiment.
8. Point out the repetition.
9. Describe statistical analysis method is appropriate.

Example

Materials And Method

Materials

- Gravy Train dog food by General Mills
- Puppy Chow in cans by Hunts
- Bosch pH meter
- Brawny Extra Strength paper towels
- Sun Maid Lemon juice
- Bernoulli Extra Virgin Olive Oil
- Four-week-old Beagles

Method

1. Place eight groups of four Beagles into six cages.
2. Feed two groups of Beagles 4 ounces of Gravy Train daily.
3. Feed one group of Beagles 4 ounces of Gravy Train daily with 1 ounce of lemon juice.
4. Feed two groups of Beagles 4 ounces of Puppy Chow daily.
5. Feed one group of Beagles 4 ounces of Puppy Chow daily with 1 ounce of lemon juice.
6. Place paper towels under the food dishes to collect food spillage.
7. After four days for feeding puppies these diets, collect and weigh the spilled food, and test the pH.
8. Immerse the spilled food in oil that is twice the weight of the food. Measure the buoyancy of the food.
9. Record results in prepared table.
10. There were no risks for Beagles or student researcher.
11. Daily results will be graphed to compare the pH and buoyancy of the Puppy Chow with that of the control group fed Gravy Train.

Results

There are four parts to your result section: 1) Result description, 2) Result tables, 3) Result graphs and charts, and 4) Result pictures.

Result description

Write in objective, third person present tense style.

The result description is a written description explaining your observations. Refer to your table, graphs, charts, and photos (cite the Label # of the table, chart, etc.) as you explain what happened during your experiment. You **do not** explain the conclusions from the results in this section. Just describe the facts and point out things the reader should notice, such as trends, changes, similarities, and differences.

Result Table(s)

Record your quantified observations in tables. The Tables, graphs, and charts should be clearly understood on their own. Write a meaningful title and label every table and chart.

Examples of a result table.

Table 1. Tensile Strength (Newtons) Of Three Different Spider Webs.

Spider species	Force (N) to stretch	Force to break (N)	Length (mm) of stretch	Force of elasticity (N)
Genus species 1				
Test 1				
Test 2				
Test 3				
Genus species 2				
Test 1				
Test 2				
Test 3				
Genus species 3				
Test 1				
Test 2				
Test 3				

Table 2. The Effect Of Temperature Change On Carbon Dioxide Concentration In Air.

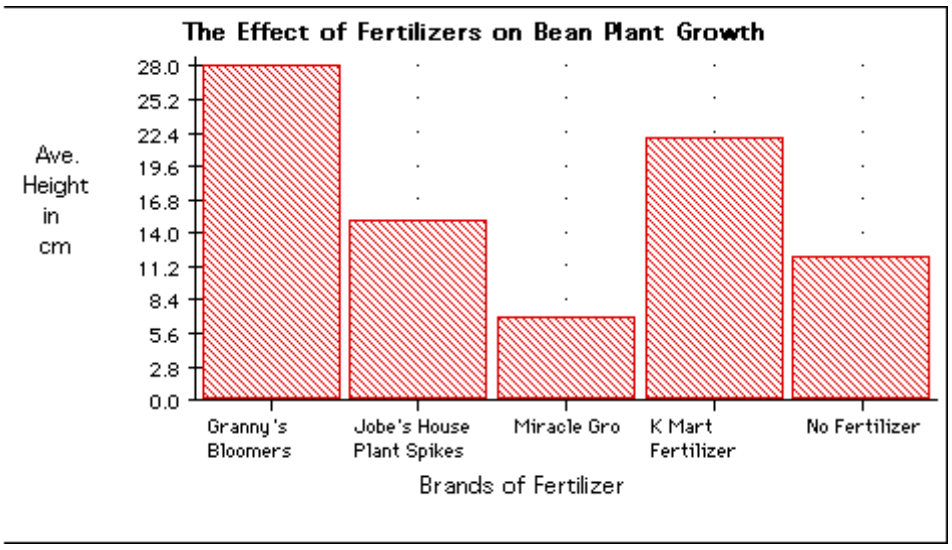
Temperature (C)	CO_2 (g/m^3)
20^0	10
15^0	15
8^0	20
0^0	30

Result Graphs

Organize and present the result information in graphs and charts to clearly show patterns. The Tables, graphs, and charts should be clearly understood on their own. Write a meaningful title and label for every table and chart. Include legends, and axes descriptions.

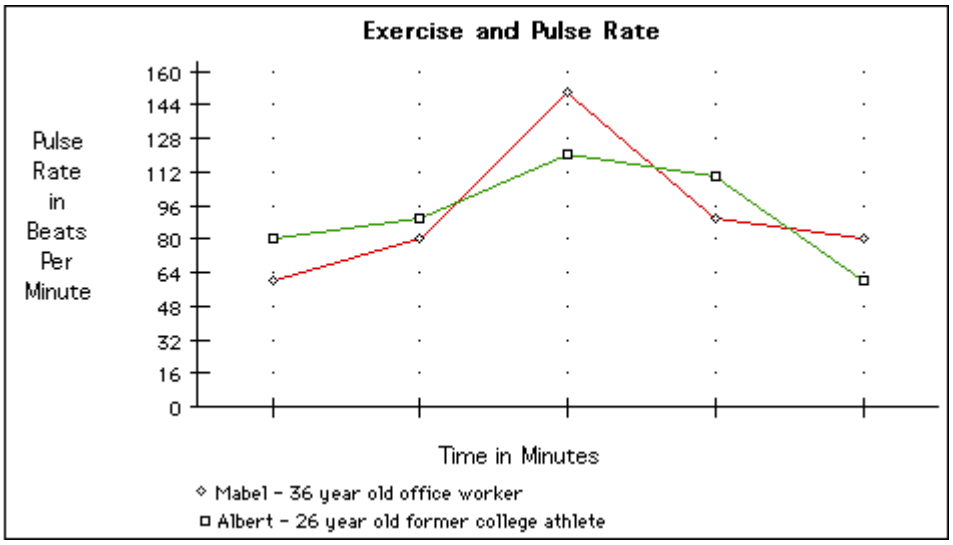
A bar graph example: A bar graph is used to compare results from different groups. Notice how easy it is to see what was done in the experiment below with bean plant growth and different brands of fertilizer. (adapted from http://www.twingroves.district96.k12.il.us/ScienceInternet/ChartsGraphs.html)

Graph 1. Bean Plants Growth Taller in "Granny's Bloomers" Fertilizer.



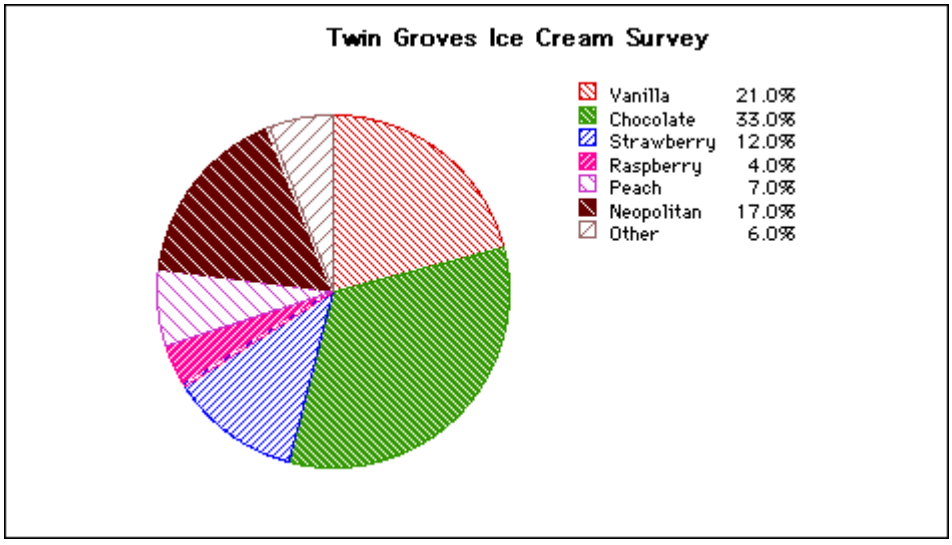
A line graph example: A line graph is used to show continuing data; how one thing is affected by another. It's clear to see how things are going by the rises and falls a line graph shows. This kind of graph is needed to show the effect of an independent variable on a dependent variable. In the sample below, the pulse rate of a person is shown to change over time. As time continues, the pulse rate changes. (adapted from http://www.twingroves.district96.k12.il.us/ScienceInternet/ChartsGraphs.html)

Graph 2. Little Difference In Pulse Rate Of Man Ten Years Older Than Woman.



A circle (pie) graph example: A circle graph is used to show how a part of something relates to the whole. This kind of graph is used to show percentages. (adapted from http://www.twingroves.district96.k12.il.us/ScienceInternet/ChartsGraphs.html)

Graph 3. Chocolate Is The Preferred Flavor In Pine Grove, AR.



Photographs

1. Photographs are useful to show the judges visual scales of colors and shades, lab technique, results, devices used in the experiment, and/or lab environment.
2. People shown in a picture need to **sign a release form** approving use of the picture in your results.
3. Make sure that pictures are appropriate and do not show violation of safety procedures.
4. Every photo must identify and credit the photographer.

Conclusion

State your conclusion in your first sentence. Then, explain how and why the results support your conclusion considering your control and repetition comparisons.

Include the following in your conclusion.

- Explain how the variables contributed to the results and the possible involvement of uncontrolled variables.
- Explain difficulties to avoid next time.
- Compare your findings with the findings of others.
- Discuss what else could be done or other questions to be answered.
- Propose future experiments to continue this project.

Bibliography

1. Cite a minimum of five non-web references. *
2. List your references in alphabetical order so that readers can easily find the reference.
3. Include a minimum of least five **literature** references.
4. If vertebrates are used, you must include an additional literature reference for animal care. Go to https://www.societyforscience.org/isef/international-rules/vertebrate-animals to learn more about animal care requirements.
5. For help, use Easy bibliography maker, http://www.easybib.com

Literature reference format example for periodicals

1. Last name is first for the first person mentioned. Then the date. Then the Title of the article. Then the publication name. Then the volume and pages numbers.

Alrich, J., F.M. Bush, and R. Fulton. 1982. Comparative Studies Of Pathogenic Mechanisms. Journal of Medicine **23**:43-56.

Literature reference format example for books

1. Last name is first for the first person mentioned. Then the Title. Then the editor, if there is one. Then the publisher's name and location. Then the copyright date. Then the page number from which the quote or information was taken.

Gehron, Paul. Studies of Disease, edited by Prather B. Guillen, published by Kirken Brothers & Comp., Chicago, IL. Copyright 1985. Page 14.

Web page reference

1. Last name is first for the first person mentioned. Then the Title. Then the date. Then the editor, if there is one. Then the online publisher's name. Then URL. Then the date you read the article enclosed in brackets.

Stoddard M. Teaching Students to Be Active learners. Feb 1995. AHSL Educational Services. http://amber.medlib.arizona.edu/homepage.html. [Accessed 16 Mar 1995].

*After the five literature citations, you can cite as many others as you want.

Grading Of Final Written Science Report

	Points
Notebook turned in on time	40
Notebook folder	10
Order	10
Forms	20
Entry	
Forms 1, 1A, 1B, research plan, abstract	
Others	
Introduction	20
Method and Materials	10
Results (written description, tables/charts, labels)	30
Conclusion	20
Bibliography (five correctly formatted)	20
Total	**180**

Points are also given for keeping up with assignments leading up to the final product.

Your Science Project Display

Information must include…

- Summary: State problem or question, hypothesis, and abstract information. “Abstract” label cannot be used on display board.
- A brief introduction.
- A brief description of your procedure. Materials may not be necessary.
- Present your results in graphs, fully labeled.
- A brief statement of your conclusion.
- All pictures of people must have consent forms and photographer credited.

Design of Display

- The goal is to communicate simply, quickly, and clearly.
- Use the standard science fair project display board. (30” deep, 48” width, 108” height: floor to top. Table is 36” high & standard board 62” high)
- Write name, school, and school phone number on the back.
- Fonts for the Title and Headings should be 36 point or larger sans serif.
- Fonts for Text should be minimally 18-point serif type.
- Organize the information to flow so that viewers read the summary first (make sure the problem and hypothesis are stated identified first), then the introduction, then the method, then the results, then conclusion. Result Graphs and photos look best in the middle section of the board. Photographs, charts, and graphs enhance appearance.
- Use an artistic and creative design to make the board attractive and interesting and relevant to your project title.

Grading of Display Board

	Points
1. Turned in on time	40
2. Display labels	
○ (title, introduction, procedure, results, conclusion)	25
○ Font size and clarity of labels	25
○ Fail to use “summary” instead of “abstract”	-15
1. Flow and organization	20
2. Text font clarity and size	15
3. Charts, tables, Pictures	15
4. Missing consent form for pictures with other people in it	-15
5. Visual presentation and clarity	20
6. Creativity	20
Total	**180**

Oral Competition

Prepare visual aids of:

1. Title page
2. Problem or Question
3. Hypothesis
4. Bullet list of why this project is significant.
5. Bullet list of what is known about this project.
6. State how you propose to answer your question.
7. Bullet list of your procedure
8. Result charts and graphs (one graph per slide)
9. Conclusion and proposal for future application and research on this topic
10. Use 18-point font or larger.
11. Color makes it nicer.
12. Keep it simple. One thought per slide.

Points for Oral Presentation

Presented on time (2 or 8 minutes)	20
Length (8 minutes)	10
Flow of thought	10
Clarity of thought:	20
Visual Aids: clear and appropriate	20
Presentation style: Eye contact, gestures, poise, appearance, voice	20
Total	***100***

Preparing For The Interview

1. Look the judges in the eye and answer questions with confidence.

2. State your purpose and problem.

3. Explain your project design and conclusions.

4. Where and how did you get the idea?

5. Why did you choose this project?

6. What was your control? How much repetition?

7. Explain how the equipment works.

8. Explain the implications of your conclusion.

9. Were other methods considered?

10. Emphasize and state plainly originality and innovation in your project.

11. Propose future direction, application, and plans for the project.

12. Prepare a single sided fact sheet with talking points.

Appendix And Notes

FCS Science Fair resources and information, http://scienceatfcs.brineyweb.com/science-project

ISEF forms online, https://student.societyforscience.org/international-rules-pre-college-science-research?pid=312

Regional fair info at Center for Mathematics and Science Education

State Fair preparation, Search internet for cmase NWASEF at the U of A, [https://arksfa.org/]