2011 Rundle College Science Fair Handbook

Equipped with his five senses, man explores the universe around him and calls the adventure Science.
~Edwin Powell Hubble

Research is what I'm doing when I don't know what I'm doing.
~Wernher Von Braun

Sheets required with this package include:

- ✓ Time Line and Checklist, with dates for when steps are due.
- ✓ Introductory letter.

The direct link to Science Fair online is: www.quia.com/pages/rundlesf.html

Science Fair Handbook

Welcome to another Science Fair! This handbook is designed to give you guidance through all of the many steps within this project. It will give you information on how to complete each step within the project to keep you on track from the beginning to the end of the project. Refer to the separate schedule sheet for when all of the following steps are due and don't forget to get your sheet signed by your parents each time you complete a step before the due dates.

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Useful websites

http://www.sciencebuddies.org
http://school.discovery.com/sciencefaircentral/
http://www.all-science-fair-projects.com/
http://www.scifair.org/
http://scienceclub.org/scifair.html
http://www.tryscience.org/
http://mathforum.org/teachers/mathproject.html
http://www.ars.usda.gov/is/kids/fair/ideasframe.htm
Many more when you Google "science fair!"

Science Fair Steps

Step 1 – Log Books

Students need to have a separate binder for their Science Fair project. This binder must be hard covered and no larger than 1 ½ ". Cloth covered binders are not recommended as they are generally larger and difficult to move. This binder will be used to organize your science fair as well as used to present your project at the fair. The logbook must be brought to school for all check-up dates, and should contain all work completed up to that time. The binder can easily be divided up into the following sections using dividers, and you should have around 10 of these. Each section should be labeled with the following labels. Please keep the time-line and handbook at the back of the binder for reference.

Section 1 – Daily Journal	Section 6 – Experimental Materials and Procedure
Section 2 – Scientific Question	Section 7 – Data Management
Section 3 – Variables	Section 8 – Conclusions
Section 4 – Background Research	Section 9 – Applications, Further Questions, and Project Improvements
Section 5 - Hypothesis	Section 10 – Timeline and Guidebook

In addition to these sections you should have a title page either on the cover of your logbook or inside the front cover. Your title page should include:

- ✓ Title of Project (centered on page)
- ✓ "Logbook" (centered under title)
- ✓ your name, school, grade in lower right hand corner
- ✓ Illustrations are optional

Step 2 – Daily Journal

You need a small 3-holed notebook that can fit into your binder for this section. Daily journal entries should include hand-written entries for each day you work on the project. This section is written in the same way as a daily diary, and you should include feelings, frustrations, insights as well as a summary of what you are doing on your project. **All rough work, such as notes, tables, graphs, or your research report should be kept in this booklet.** Each entry **must** include a date.

Step 3 – Asking Your Scientific Question

Once you have decided what you want to investigate, you must put your question into terms that will allow you to investigate it using the scientific method.

Experimental Project Question:

This must be very specific and limited. It should describe where you came up with the idea or why you feel that your topic will be interesting to you. This portion should be in a paragraph format before your question is stated. (see below for an example) Remember advanced topics must be checked with your teacher first.

Example:

- What is the effect of temperature on the volume of air?
- How does the viscosity of a liquid affect its boiling point?
- Which paper towel is the most absorbent?

Each of these questions briefly describes the experiment, involve critical thinking and promote investigative skills. In other words they are good science questions!

Along with your scientific questions, this page in the logbook should contain a brief explanation of why you chose to do this project.

Example:

Scientific Question

I have noticed that some people are much more sensitive to light than others. I want to know why, and I thought that it might have something to do with eye colour. I also know that your pupil size changes in light and dark, and I wanted to do an experiment to see if different coloured eyes react differently to light.

My scientific question is:

What effect does eye colour have on pupil dilation?

By the way: pupil dilation means, how wide the iris of your eye (black part) opens in response to darkness to allow more light into the eye.

Step 4 – Identifying Your Variables

Identifying your variables is very important to produce a "Fair Test." If you have correctly identified your variables, your project will be a fair test. There can only be ***one*** manipulated variable and ***one*** responding variable. All other things that could change must be constant, or kept exactly the same.
There are three types of variables that you need to identify:

Manipulated Variable – is what you change in order to see what happens.

It is the "cause" part of your scientific question. For example, if you asked, "What effect does eye colour have on pupil dilation?" you would look at individuals with different eye colours. Your manipulated variable would then be eye colour!

Responding Variable – is the change you are observing for.

This is the effect part of your scientific question. In the eye colour experiment, you have asked if pupil dilation will change, and so that is the responding variable.

Controlled Variable - any other factors that could possibly affect your experiment.

These factors must be identified and kept exactly the same at all times throughout your experiment so that your results are valid. For the eye colour experiment, you would need to make sure that you did the test exactly the same on each individual – same light source, same distance away, same amount of time, same way of measuring response, subjects the same age etc.

Step 5 – Background Research Paper

Your background research should be presented in detail in the research section of your Log Book. This will be one of the most important steps in your science project. It is necessary to gather as much information as possible so that you fully understand your project. The information in your completed research paper will help you make a logical hypothesis, and help you explain your final conclusions.

Basic Requirement:

Your completed background research paper should have a title, be neatly organized and be a minimum of **four handwritten** pages (blue or black pen, double spaced, one side of the paper only). Illustrations are in addition to the four page requirement – they do not count as part of the minimum four pages. The bibliography should be on a separate page at the end of the background research paper.

What to Research:

The subjects you will be researching are those that you have already defined as your manipulated and responding variables! To understand and interpret your scientific investigation, you must find out all you can about these things.

For the sample eye colour experiment, the manipulated variable was defined as eye colour. You would then find out as much information as you could about what eye colour is, why different people have different eye colours, what causes eye colour, what part of the eye is coloured etc. Your responding variable was defined as pupil dilation. You would then need to find out what dilation is, how and why the eye dilates, and what outside factors might effect pupil dilation.

Adding Extras:

Your research paper can be enhanced by including interesting related facts, information about your experimental set-up, new discoveries being made in this field by other researchers, related pictures or labeled illustrations.

Where to Find Information:

Good sources of information include libraries (science encyclopedia, textbooks, magazines) Internet or specialists (science teacher, scientists, Science Hotline, or others with specialized knowledge).

Taking Notes:

In the research section of your Log Book, you should have three sections:

1. Information about the Manipulated Variable.
2. Information about the Responding Variable.
3. Other Interesting Information.

As you find information, take notes in your science journal, **including where the information came from**. Summarize key ideas only – **do not copy complete sentences. Plagiarism is illegal!** Each entry should also include the source from which you obtained the information, so it can properly be included in your bibliography later on.

Plagiarism = copying work from another source and claming it as your own thoughts and ideas. This includes changing only a few words in a sentence.

Making an Outline:

Once you have completed your research and have organized your notes, it is time to summarize your ideas into paragraph form for your Background Research Report. Your Background Research Report will have a **minimum of 5** well developed paragraphs. Remember that a paragraph has an introductory sentence (what the paragraph is about), several informative sentences and a concluding sentence that summarizes what has been said. Your Background Research Report should contain the following paragraphs:

Your report needs to include an outline in the following format, or following the Expository Pillar from your Language Arts classes.

1. Introductory Paragraph – reason for the report, general description of what the report will be about, how it relates to the experiment you are performing for Science Fair.
2. Information on Manipulated variable.
3. Information on Responding variable
4. Other Relevant Information – interesting info, historical info, new discoveries.
5. Concluding Paragraphs – review of what has been learned, statement about how what was learned will help with the Science Fair project.

This will need to be handed in with your research report.

Writing the Final Report:

Follow these tips to create your final report:

- Write a rough draft first. This (like the final report) should be written double spaced, but should be done in pencil to make editing easy.
- Re-phrase your notes into complete sentences, **using your own words.**
- Write information about your variables first since that is what you have research notes for, then go back and write the introductory and concluding paragraphs.
- Edit your report! Check for grammar, spelling, punctuation, labels for illustrations, neatness and ensure your writing makes sense.

Bibliography:

There must be a minimum of **5 references** in your bibliography. Your bibliography should be a separate page of paper located at the end of your Background Research Report. All the resources you have obtained information from for your report must be listed here in alphabetical order. This will include any books, magazines, newspapers, web sites or professionals you obtained information from.

The way information is presented in your bibliography depends on the type of resource:

Books:
Author's Last Name, Author's First Name (date of publication). Underlined Title of the Book, City: Name of Publisher.

Encyclopedias:
Underlined Name of Encyclopedia. (Year of Edition), Publisher, Topic Title. Page numbers.

Internet Websites:
Domain Address http:// … (date visited). Author's name (if given), Underlined Title of the Site (if given)

Magazines or Newspapers:
Author's Last Name, Author's First Name (date of publication) "Title of Article," Underlined Title of Magazine/Newspaper, page numbers.

Professional Contacts:
Last name, First name (date of conversation) Title, Organization, Address/Phone Number.

Step 6 – Stating Your Hypothesis

The hypothesis is your "best guess" answer to your scientific question. This is a statement that is **possibly** true and is based on the knowledge you gained through your research. A hypothesis needs to be tested to prove whether it is true or false. The hypothesis is usually written as an "**if/then**" statement.

In our example using eye colour, if the research done on the topic indicated that people with lighter coloured eyes are more sensitive to light because their pupils do not dilate as quickly, your hypothesis might be:

"***If*** **you have lighter eye colour (blue),** ***then*** **your pupils will not dilate in the presence of a light source as quickly as an individual with darker eye colour (brown)**"
Note that your hypothesis **does not** say anything about why you believe that a certain outcome will happen. The explanation as to why something does/does not happen belongs in your Conclusion section.

Step 7 – Experiment Design: *Materials*

You will need to design the experiment you will be doing for your Science Fair project. Designing the experiment and deciding what things you need for your experiment is like cooking using a recipe.
A recipe will tell you the food ingredients you need, their exact amounts and other information like the size/shape of pan needed, the temperature the oven needs to be set to or any other utensils you need. A recipe tells you completely what items you need and exactly what to do with them. You will be writing a 'recipe' for your experiment. All the things you need to conduct your experiment will be referred to as your 'Materials.' The more detailed you can make this list, the better. Please remember that all scientific measurements need to be specified in **metric units.**

Step 8 – Experiment Design: *Procedure/Experimental Set-Up*

The procedure is the detailed set of instructions, step by step, that you will follow in order to carry out your experiment or build your model. Just as a recipe tells you in what order to add your ingredients and details what to do with them, your procedure will in detail specify what to do with your materials. Even if you already know what to do without writing it down, you need to detail exactly how to do your experiment in your Procedure section. The Procedure must be written with enough detail that another person could come along and replicate your experiment exactly the same way you did it. Keep the following things in mind when you write your Procedure:

- Steps should be sequential, detailed and very specific.
- Each step should describe only one action.
- Ensure that you state which variables must be kept constant and what must be done to accomplish that.
- Clearly explain how your manipulated variable will be changed in your experiment or how your model will be put together.
- Clearly explain **what** to measure and observe for when describing the responding variable.
- Make sure that you include the number of times that the experiment needs to be repeated (number of trials). You should have at least three trials in your experiment in order to prove reproducibility of results.

Your Procedures section should also include a detailed, labeled drawing of your project, called your **Experimental Set-Up.** The experimental set-up will also be an

excellent way of allowing you to visualize what you will be doing before you actual begin the experiment. This may allow you to highlight any areas where your procedure may be inadequate and modify it before starting the experiment.

Step 9 – Observing Results and Collecting Data

The results (data collected) of a scientific investigation are usually expressed in two ways:

1. Written form – this reports the results with words and numbers (measurements).
2. Picture form – these record observations that may be difficult to describe. Photographs may be used or you may include drawings to illustrate your results.

While conducting your experiment or model test, it is absolutely essential that you make careful observations and record all information. You should **look for** and **record** both ***quantitative*** and ***qualitative*** changes. These notes should be included in your journal entry for the day of the experiment or test.

Quantitative changes are those which must be measured using a calibrated measuring device such as a thermometer, scale or ruler. Remember always to use metric units when recording qualitative changes.

Qualitative changes are those that you observe directly through use of your senses (sight, touch, smell, sound and taste). Make your observations as specific as possible.

All experiments and tests should be repeatable and by looking back at other trials on your data records, you will be able to see if your experimental or test procedure is working well. Remember that **no change** is an important observation, so do not hesitate to include that on your records.

When preparing to do your experiment:

1. Decide on what changes you are going to observe using your senses (qualitative) and what you are going to measure (quantitative).
2. Decide a recording system that will work for both of these types of observations. This must be decided on and be in place **before** your experiment or test begins. You can make a rough copy of it in your journal.

The best way to record data you collect is in table form. This allows you to be better organized and analyze your results. You may have a separate table for each experiment (trial), or you can combine trials in one table. You must include:

- The date and number of the trial.
- Your manipulated variable value.
- Space for quantitative measurements (include metric units of measure).
- Space for qualitative observations (written or picture descriptions).

Data may also be collected in frequency diagrams, stem and leaf plots or line plots. These may be used **in addition** to a data table, but not as the only method of data collections.

The last thing required in your Observations section is a **Short Summary Paragraph** which briefly summarizes your experimental findings. This is often forgotten, so make a note to yourself to include it!

Step 10 – Managed Data

The data collected from your experiment is called "raw data." You now need to modify your raw data into a form where it can be easily understood at a glance. Graphs can help communicate data in an organized way that clearly demonstrates the relationships between the types of information being presented. There are several different types of graphs – bar, double bar, histogram, line, circle, pictograph and scatter plots. (See your Math textbook Unit 6 for more info) Whatever type of graph you choose to use it should make it easy for anyone looking at it to understand the results of your project.

In each graph, two sets of data will be represented – the manipulated and responding variables which you have recorded on your observation charts. The manipulated variable is usually shown on the horizontal (X) axis and the responding variable is usually shown on the vertical (Y) axis.

It is important to be considerable thought into your graphs before actually making them. You may find that your data would adapt equally well to more than one type of graph. If that is the case, multiple graphs are an excellent idea!
Minimum 3 graphs No showing the same set of data of course!

Step 11 – Conclusions

The conclusion is the final outcome of your experiment as supported by the data and observations you collected. The conclusion must answer your initial scientific question and verify whether you hypothesis was correct or incorrect. In order to draw a conclusion, you must make a judgment based on your observations and the facts that you founds during you research. The conclusion is an **inference,** not a fact. The more evidence (facts and observations) you have the better your inference can be. Because your conclusion is a judgment, it means that you are willing to change your opinion if new evidence comes along which proves you are wrong. This is what the scientific process is all about! Your conclusion should roughly follow the guidelines given here:

- *I wanted to find out …* (re-state your original scientific question and reason for asking it)
- *Based on my research, I guessed …* (re-state your hypothesis). Summarize the evidence from your Background Research Report that made you think this.
- *My experiment showed that …* (summarize your observations from your data tables, and analyze trends or patterns that you may have noticed in your graphs).
- *My hypothesis was …* (correct or incorrect).
- *I believe this was because …* (state your inference based on the facts learned during your research and observations made during your experiment or tests).

Remember: If you find that your experiment **did not** verify your hypothesis, do not be discouraged. Your project will not be judged on your success or failure, but rather on your understanding of the scientific method and use of a sound procedure.

Step 12 – Applications

In this section, you should state why it is useful or goof to know these results? What practical problem can it help society solve? This should take the form on one well constructed paragraph.

Step 13 – Asking Further Questions

Based on what you have learned, what new questions do you have that you had not even thought of before? Is there another experiment or test that you could do? If your project was a good one, it will raise more questions that it answered and should list several of these (who knows, maybe you are well on your way to starting next years Science Fair Project already!)

Step 14 – Ways in Which Your Project Could be Improved

Once your project is complete, you should not stop thinking like a scientist. They are always asking further questions, thinking of new ideas, and realizing that they could have done something differently. In this section of your project, you should address the following things:

- **Experimental Error –** think about where some potential sources of error might have occurred in your experiment. Could the measurements have been made more accurately? Were some of the variables not as well-controlled as they should have been? Some of these will not come to light until after your experiment has been completed. Remember that there is always something that can be done to improve you work and you should list as many factors as possible that would improve your work.
- **What Could Have Been Done Differently –** Do you think you might have used different subjects or different variables? Would you have done things in a different order or made your measurements in another way? Could you have built your model in a different way or used a different scale? If you think about parts of your project that were more difficult to do or less clear, you can explain what you would do differently next time.

Step 15 – Finalizing Your Report

Once your Background Research Report has been completed, you need to prepare all your research for hand-in in your **Log Book.** Your Log Book should be divided into 10 sections (as outlined in Step 1). The title of each section should be clearly written on the tab. Use the following check list to ensure all your information is included properly in your Log Book before handing it in for evaluation:

1. Title Page – title of your experiment (as it will be presented on your display board), the words 'Log Book,' your name, grade and school.
2. Bibliography, including **all** references and outside sources of help.
3. Completed Daily Journal (written neatly and up-to-date).
4. Scientific Question, written out along with a brief explanation of why you chose it.
5. Variables (Manipulated, Responding, and Controlled) are written out.
6. Background Research Report is completed and included.
7. Hypothesis is clearly stated.
8. Listing of Materials used in your experiment.
9. Procedure used to conduct your experiment is included along with an illustration of your Experimental Set-Up.
10. Data Tables and a brief summary paragraph is included.
11. All graphs and charts are complete.
12. Conclusions are discussed in detail.
13. Applications are discussed.
14. Further Questions are suggested.
15. How the project could be improved are included.

Step 16 – Display Design

After completing your experiment and writing a Background Research Report, your next step is to share your project and the information you have learned with others. This will be done through the use of a display, consisting of a backboard and any materials that you feel are necessary to fully explain your experiment. Backboards should be bright, interesting and clear so that people will be drawn to them and spend some time looking at them. You will want to spend some time planning the best way to display your information. It is best to keep it simple! Your board should include the following:

- Title of your project – in bold letters. You might consider using a catchy phrase to get people's attention.
- Statement of your Scientific Question.

- Hypothesis Statement.
- Summary of Variables (Manipulated, Responding, Controlled).
- Materials List.
- Procedure.
- Labeled illustration of your Experimental Set-Up.
- Summary of Results (copy of all tables). You may also include photographs to illustrate visual changes that occurred during your experiment.
- Summary of Managed Data (copy of graphs and charts).
- Summary of Conclusions.
- Any interesting background information or illustrations.
- Your name, school and grade.

All written information on your board must be **typed.** Chose carefully what you want on your display board – your board should be well balanced – not too much information crammed on and not so little information that your display is sparse and uninteresting.
Your Science Fair Log Book will be placed in front of your display board, along with your actual experimental set-up (if possible).

Step 17 – Preparing for Your Oral Presentation.

The final step in your Science Fair Project is to create an oral presentation. People viewing your display board or looking through your research may have a lot of questions or be interested in learning more about your project from you.
Some tips to consider when preparing and oral presentation:

- Remember to politely introduce yourself at the start of your presentation.
- Tell your audience the title of your project and briefly explain why you chose to do it.
- Walk through your project, step by step.
- When you are sharing your project, feel free to refer to your display board at any time, but do not just read the display to your audience.
- Be sure to make eye contact, speak clearly and **know your project**.
- Remember that 'practice makes perfect.' If you are nervous about this presentation, consider writing yourself a short script and practicing presenting it to the mirror or family and friends to gain confidence.