Owen J. Roberts School District

Independent Science Research Plan and Experiment



Student Scientist: _____

HR Teacher: _____ **Grade:** _____

Released with permission from the Owen J. Roberts School District (October 2017)

INTRODUCTION

A science experiment that is well done is a source of great pride and satisfaction. Like many school assignments, a science experiment is not an easy job. It will require plenty of time, thought, and hard work. However, by doing a science experiment you will have an opportunity to understand what real science is all about. By doing a science experiment, you will learn how scientists solve problems.

Science and experimenting go hand in hand. Scientists use the scientific method to solve problems by making observations, by writing down what they see, and by conducting experiments. Such activities are known as scientific research.

When doing a science experiment, you must first decide on a suitable topic for investigation. Then you develop a plan which you write down. It should tell step by step how you expect to proceed. As you carry out your plan, you too will use the scientific method to experiment, observe, and draw conclusions. The final step will be to prepare a display. In this way, you will be prepared to share your work at the Science Research Competition.

IMPORTANT!

Before doing the experiment it is important to have:

□ **A science research notebook or logbook** - In a notebook or binder, keep a complete account of what you do each day during your experiments. Accurate and detailed notes help to organize your research. Be sure to include both qualitative and quantitative observations. Sometimes what seems unimportant when you do it may be very important later. The information from the notebook is used when your final display is prepared.

□ **A calendar to help with time management** – Use a calendar to help you plan when you will be able to complete this experiment. Write all of your activities on the calendar, including sports practices/games, tournaments, field trips, music lessons, etc. *Be sure to highlight important due dates and checkpoints from the EC Checklist and Timeline*. This will help you see when you will have time to work on your experiment.

□ **A definite work area** - It should be a safe place for you to work and store your materials. Remember, this experiment may take several days or weeks and you do not want to keep moving it from place to place.

PLANNING YOUR RESEARCH EXPERIMENT

Do you wonder why certain things happen? Is there something that you would like to learn more about? Brainstorm some possible topics that are interesting to you. You can find ideas in library books and on the Internet, but remember that you want to do something that is UNIQUE and interesting to you. You will be working on this for several days or weeks. The more you like the topic, the more you will enjoy your science research and experiment**.**



This list of ideas should be your first entry in your logbook. Don't forget to include the date and time! When you see this logbook image, remember to take out your science research notebook and record your work.

The scientific method is to be used for all science experiments. It is a logical step-by-step framework that guides researchers when performing an experiment so that the process may be repeated to generate similar results.



SELECT A TOPIC

Look through the possible categories in Appendix A to find a topic that is interesting to you. The library and the Internet are some sources to help you find an interesting and UNIQUE idea for your experiment. Please remember that some topics will require additional paperwork to make sure that you and your subjects are safe. Do preliminary research on some of your ideas. As you collect information, you may find that some of these topics will not be a good choice for a science experiment. A model, diagram, or research simply explains, but does not test, a scientific concept. (A model of a volcano or a diagram of the solar system are valuable sources of information but are not experiments that test something.) You will be doing a science *experiment* which uses the scientific method to *test* a hypothesis. *(Students taking a quiz after studying in the morning or at night tests which time of day would be most effective for learning.)*

Example: *I like sports, video games, candy, and school. If I choose sports or video games, it might be hard to design a project that accurately measures something. If I choose candy, it won't be unique. I like to do well in school. I can try to find out when it is the best time to study for tests so I get good grades.*



STEP 1: DEFINE YOUR PROBLEM/QUESTION AND PURPOSE

There are two parts to a problem/question, the cause and the effect. The **cause** is the action that makes an object's property change. The **effect** is the property of an object that changes and can be measured. **Be sure you are choosing something that can be measured so you can collect data, analyze it and look for patterns, and then draw conclusions from your results.**

Example: *Does studying at a certain time of day (cause) affect short term memory recall? (effect)*

The purpose of your experiment should be a sentence or two. It should tell what you expect to find out about your question. It should also tell why you want to answer your question.

Example: *The purpose of my experiment is to determine the best time of day for me to study for a test. I want to see if I should study in the morning or in the evening to make sure I get good grades on my test.*



STEP 2: RESEARCH THE TOPIC

Once you find an interesting topic that can be tested, find out as much about it as you can. Be sure to include what you already know about the topic in addition to the new information you research. Sources of information may include books, magazines, encyclopedias, teachers, scientists, professionals, libraries, businesses, school, family friends, the Internet, and newspapers. Your research will help you develop your hypothesis, so the more time you spend researching, the stronger your experiment will be.

This research should be included in your logbook every time you gather information. Don't forget to include the date and time! You must also record your sources so you can list them in your bibliography. See Appendix C to find the information required for each type of source.
Use http://www.easybib.com/ to format the information using APA format, just like you learned in your Library special.

Example: *For this experiment, I would gather information about short term memory recall, energy levels and how they are influenced by time of day, possible test items for my experiment, "night owl" vs. "early bird" types of people, common daily schedules of teenagers, etc. It might look like this:*

October 19, 2:30 PM: teens experience a "low tide" in the morning and a "high tide" in the afternoon (Book resource: Christopher Gabrieli and Warren Goldstein, Time to Learn: How a New School Schedule is Making Smarter Kids, Happier Parents, and Safer Neighborhoods, John Wiley and Sons Inc., 2008)

STEP 3: WRITE A HYPOTHESIS

A **hypothesis** is a statement, based upon your research that predicts the outcome of your experiment. Your hypothesis should answer your problem/question.

Write your hypothesis as an "If…then…because" statement. It should not be a question or an open-ended sentence. The "because' part of your hypothesis comes from the things you learned while doing research.

Correct Example: ***IF*** *I study in the evening,* ***THEN*** *my test scores will be higher* ***BECAUSE*** *natural rhythms in teenagers reach peak efficiency later in the day.*

Incorrect Example: *What is the best time of day for me to study for a test?*

Incorrect Example: *I am going to find the best time of day to study for tests so I get good grades.*

DESIGNING YOUR RESEARCH EXPERIMENT

STEP 4: WRITE A MATERIALS LIST

Make a list of all materials you will need to conduct the experiment. Be specific with how many you will need of each item, the size, brand, etc. Gather all of your materials early so that you can keep working once you begin.

Example:
6 copies of PSSA released specific vocabulary lists and reading passages
24 copies of written quizzes with recall questions
6 pencils
6 highlighters
1 stopwatch
Cinderella Story DVD
Monopoly board game

STEP 5: WRITE THE PROCEDURE

Write down the step-by-step instructions to perform the experiment. They should be detailed enough that someone else could repeat your experiment exactly. The steps should be numbered and in complete sentences. Be specific! Include how you will measure the changes and how many times your procedure will be repeated. Remember to always use **metric** measurements! You may need to revise your materials list as you develop the experimental procedure.

Example:

1. *Invite girls aged 12 – 14 years old for a sleepover*
2. *Feed them the same dinner and snacks during the evening*
3. *Study the first vocabulary list and reading passage at 7:30 PM and study for 15 minutes*
4. *Watch a movie for one hour*
5. *Complete the first written quiz within a 15 minute testing session*
6. *Finish the movie and play the same board game until midnight*
7. *Lights out and quiet time at midnight*
8. *Wake up at 8:15 AM and eat the same breakfast*
9. *Study the second vocabulary list and reading passage at 9:00 AM and study for 15 minutes*
10. *Play the same board game for one hour*
11. *Complete the second written quiz within a 15 minute testing session*
12. *Repeat steps #1 – 11 for four trials (sleepovers)*
13. *Grade the vocabulary and reading passage parts of the written quiz to find the number correct in each section and the percentage score for the reading passage*



STEP 6: IDENTIFY THE VARIABLES AND CONSTANTS

The **independent variable** is what will change during your experiment. There is only ONE. The independent variable is the "IF" part of the hypothesis.

The **dependent variable** is what will be measured and observed during your experiment. The dependent variable is the "THEN" part of the hypothesis. There may be several, but choose only ONE.

The **constants/controls** are the other parts of the experiment that must be kept the same to make sure it is a fair test.

Example*:*

VARIABLES		**CONSTANTS/CONTROLS**
INDEPENDENT	**DEPENDENT**	
*** Time of day	*** Score on each portion of written quiz	ALL subjects were female between ages of 12 – 14 years
	Overall score on written quiz	ALL subjects studied and tested for the same amount of time
	Amount of time it takes to finish the written quiz	ALL subjects participated in the same activities throughout the testing session (movie, game, sleep environment, etc.)
		ALL subjects ate the same dinner, snacks, and breakfast at the same time

***** If you have more than one independent and dependent variable, go back to revise your procedure. Having more than one may interfere with your results *****

STEP 7: DEFINE METHODS OF OBSERVATION AND MEASUREMENT

There are two types of observation that should be used as you conduct the experiment. Qualitative observations use the five different senses to describe the changes. Quantitative observations include numbers, measurements, and time. Decide how you will **RECORD** and **DISPLAY** observations. Will you use a chart, table, graphs, drawings, photographs? Find a way to objectively measure the results: time elapsed, distance traveled, height grown, etc. You may find it helpful to set up your observation recording sheet before you start the experiment.

Example*: How many girls are there? What are the ages in years? What are they doing while they are studying? What are they doing when they are taking the test? List what they eat and drink. Tell how much they sleep. When grading the quizzes, calculate the number correct and also the percent score for the reading passages. Take pictures to document your observations but be sure to avoid any faces.*

STEP 8: WRITE YOUR BIBLIOGRAPHY

The reference materials used to gather information about your experiment should be included in the bibliography. This information should include author, title, publisher, date of publication, place of publication and page numbers. See Appendix C for guidance in formatting your sources. You can also use http://www.easybib.com to help you.

Example:

Gabrieli, Christopher, and Goldstein, Warren. Time to Learn: How a new school schedule is making smarter kids, happier parents, and safer neighborhoods. John Wiley & Sons, Inc., San Francisco, CA, 2008.

McPherson, F. 2001. Time of day effects in immediate and delayed memory. http://memory-key.com/ResearchReports/folkard88.htm 10/28/2009

THIS FULFILLS THE DISTRICT REQUIREMENT FOR THE INDEPENDENT SCIENCE RESEARCH PLAN.

Please consider completing the scientific method and conducting the experiment. See detailed information about these options on the EC Checklist and Timeline or the school's website.

CONDUCT THE EXPERIMENT



STEP 9: CONDUCT EXPERIMENT FOLLOWING THE PROCEDURE

Test your hypothesis by **following the Independent Science Research Plan** completed using the steps above. **Record all data and observations** in your logbook. The logbook is like a diary of your experiment. Each time you work on your experiment, include the date and time. Be sure to include both quantitative and qualitative observations. You should also include your thoughts and ideas about how your experiment is progressing. If the outcomes are not what you expect, discuss reasons why and provide an explanation. Sometimes the experiments that do not work out as planned provide you the most information about your topic. It requires you to figure out why you did not get the results you expected. If you would like to make revisions to your procedures to try and test your hypothesis again, check with your science fair coordinator first.

Keep your **ORIGINAL** journal. An original, handwritten journal allows others to see that you took notes as you performed the experiment instead of trying to remember what happened when it was finished. **You should conduct at least three trials for your experiment.** Repeat the experiment enough times so that you are confident in your results. A limited number of trials can impact the reliability of your work and affect how your experiment is judged during the competition. This also helps make your results and conclusions more credible.

Example:

Date	Time	Observation – Trial #1
Oct. 31	6:00 PM	6 female friends arrive for the sleepover study
Oct. 31	6:30 PM	We eat dinner. All have two slices of pizza, 1 cup of chips, 1 cup of pretzels, 4 cookies, and a bottle of water
Oct. 31	7:30 PM	All 6 girls are sitting at the dining room table in their pajamas. They each have a highlighter to use when reading the passages. They are given the first vocab list and reading passage. They also have access to a highlighter to use when reading, but no one chooses to use it. All of the girls read the short essay first but only read it once. Then they begin the vocab list. Subject SMC reads each word from the list quietly and then closes her eyes and repeats it several times before moving on to the next word. The other 5 girls read the entire list and then repeat it until 15 minutes has passed. Subject MRG "jumps" when I say STOP.
Oct. 31	7:45 PM	Girls give me their vocab lists and passages. Subject EGD begins to discuss the reading passage but I quickly tell her she is not allowed to talk about it until after they take the written quiz. We go down to our family room and begin to watch "Cinderella Story."
Oct. 31	8:40 PM	I pause the movie and pass out a clipboard to each girl. On the clipboard there is a written quiz to assess their short term memory recall of the vocab words and basic reading comprehension. The clipboards are facing down so that when I say BEGIN, the girls can turn them over and immediately start the quiz.

Oct. 31	8:45 PM	The girls begin the quiz. Subject KMM taps the point of her pencil on the paper before she circles each answer. At the 3-minute mark, Subject MEF tells KMM to stop tapping and the rest of the girls giggle.
Oct. 31	9:00 PM	I say STOP and the girls put their pencils down. Subject EGD asks if she can talk about the passage now and then says it was very short and surprised that it was nonfiction. Subject RNB suggested that was because it would be easier to ask questions about nonfiction than fiction.
Oct. 31	9:10 PM	Each girl has two cups of ice cream and we watch the rest of the movie.
Oct. 31	9:55 PM	The movie ends and we begin to play Monopoly.
Oct. 31	10:45 PM	Each girl has one more cup of pretzels and another bottle of water.
Nov. 1	12:00 AM	Girls are settled in their sleeping bags in the family room and lights are turned off. A few girls talk and giggle quietly. All are asleep by 12:30 AM.



STEP 10: ANALYZE DATA COLLECTED

Look at the data and measurements you have collected. What does it tell you? Graphing the results is a great way to see relationships which aren't obvious otherwise. Read your notes and observations. Find the patterns, trends, and relationships.

Example: *Record all data in a table. List the subjects' codes to help identify them. Include their ages, and their reading and vocabulary scores for each testing session. Calculate the average vocabulary results for the entire group and then each age group. Do the same for the reading results. Create a graph that compares each of these results. (See photo example of display in Appendix D.)*



STEP 11: CONCLUSIONS AND REAL WORLD APPLICATIONS

What conclusions can you make about the experiment that you did? How does your conclusion compare to the hypothesis made? Explain how they were alike and different. Tell if your hypothesis was proved or disproved. What else did you learn by conducting this experiment? If the experiment was inconclusive, what could you do differently next time? Reflect on your results to see what changes could be made. **Don't retell your procedure and results. Discuss the patterns you see and explain why they occurred.** Connect your conclusions to your problem and question. How are they related? Who might be interested in your results? How can your results be applied to our everyday lives?

Example:

Twenty-four girls participated in this experiment. They ranged in age from 12 – 14 years old. The overall average scores of the vocabulary test were slightly higher in the evening than in the morning. The overall average reading scores were also slightly higher in the evening than in the morning. The data was then broken down by age. Those averages showed some interesting differences. The 12 year old girls had better vocabulary scores in the morning than in the evening. The 13- and 14- year olds had better vocabulary scores in the evening than the morning and the difference was especially significant for the 14 year olds.

For the reading tests, the 12- and 14- year old girls had better scores in the evening than the morning. The 13 year olds had slightly higher reading scores in the morning.

This data agrees with some of the research that says older teens naturally perform better later in the day because of their natural body rhythms. Overall, my hypothesis was correct in stating that studying in the evening would be better. This was especially true for my older 14 year old group. If this experiment would be done again, a larger sample size with a bigger range group could be used. It would also be helpful to have the same number of girls in each age group to make the data even more accurate.

The results from this experiment could help teachers and principals plan efficient school days for the younger teenaged students. It can help students adjust their daily activities to make sure they have time in the evening to study. Then we can all improve our grades.



STEP 12: WRITE YOUR ABSTRACT

An abstract summarizes your science research experiment. It is limited to 250 words or less and should fit on one page. It can be written in three paragraphs. The first should tell the purpose of the experiment (why you did it). The second paragraph should be a summary, not a list, of your procedures (how you did it). The final paragraph should be a narrative of the data and conclusions (what you discovered). It may also include any possible research applications. Do not include graphs or tables here. Think of the abstract as the introduction of your project to the reader, just like the back of a good book. It BRIEFLY tells what the experiment is about to invite the person to take a closer look at your science research experiment.

Example (232 words):

The purpose of this experiment is to determine the effect of time of day on short term memory recall in girls 12 – 14 years old. This information would help teenaged girls choose the best time in their daily schedules for studying so they do well on tests. The hypothesis is that studying in the evening will lead to better memory recall results than studying in the morning.

Twenty-four girls were tested for short term memory recall in the evening and morning. These tests consisted of a list of eight vocabulary words and a short nonfiction text from appropriate grade level sources. The girls were given fifteen minutes each session to study the two parts. Then they spent an hour watching a movie or playing a game. After that hour, they took a written quiz to see what they could recall.

The overall vocabulary and reading average scores were just slightly higher in the evening than in the morning. The age group results showed that the 12 year olds did better in the morning, but the older 13- and 14- year old girls did better in the evening. My hypothesis was correct in stating that the teenaged girls that study at night will do better on their tests than those that study in the morning. These results can help students plan to study in the evening so they get the best grades possible. (232 words)

APPENDIX A – Experiment Categories

Behavioral and Social Sciences
Human and animal behavior, social and community relationships, psychology, sociology, anthropology, archaeology, ethology, linguistics, learning, perception, urban problems, reading problems, public opinion surveys, educational testing, etc***. (NOTE: There are many safety regulations and restrictions on experiments involving human subjects. ALL experiments involving human subjects require consent forms by participants and parents, even if you are just conducting a survey. They will also need to be approved by your school's IRB before the experiment can begin. Please keep this in mind as you plan the timelines for conducting your experiment.)***

Biochemistry
Chemistry of life processes - molecular biology, molecular genetics, enzymes, photosynthesis, blood chemistry, protein chemistry, food chemistry, hormones, etc.

Botany
Study of plant life – agriculture, agronomy, horticulture, forestry, plant taxonomy, plant physiology, plant pathology, plant genetics, hydroponics, algae, etc.

Chemistry
Study of nature and composition of matter and laws governing it - physical chemistry, organic chemistry (other than biochemistry), inorganic chemistry, materials, plastics, fuels, pesticides, metallurgy, soil chemistry, etc.

Computer Science
Study and development of computer software and hardware and associated logical devices

Consumer Science (Grades 4 – 8 only)
Science of the normal use of consumer products including product testing and comparison

Earth and Space Sciences
Geology, mineralogy, physiography, oceanography, meteorology, climatology, astronomy, speleology, seismology, geography, etc.

Engineering
Technology experiments that directly apply scientific principles to manufacturing and practical uses - civil, mechanical, aeronautical, chemical, electrical, photographic, sound, automotive, marine, heating and refrigerating, transportation, environmental engineering, etc.

Environmental Science
Study of pollution (air, water, and land) sources and their control, ecology

Mathematics
Development of formal logical systems or various numerical and algebraic computations, and the application of these principles - calculus, geometry, abstract algebra, number theory, statistics, complex analysis, probability

Medicine and Health Sciences
Study of diseases and health of humans and animals - dentistry, pharmacology, pathology, ophthalmology, nutrition, sanitation, pediatrics, dermatology, allergies, speech and hearing, etc. ***(NOTE: There are many safety regulations and restrictions on experiments involving human subjects. ALL experiments involving human subjects require consent forms by participants and parents, even if you are just conducting a survey. They will also need to be approved by your school's IRB before the experiment can begin. Please keep this in mind as you plan the timelines for conducting your experiment.)***

Microbiology
Biology of microorganisms - bacteriology, virology, protozoology, fungi, bacterial genetics, yeast, etc. **This includes allowing foods to rot to see which develops mold first, comparing products to see which keeps food fresh for the longest period of time, or testing different antibacterial products*. (NOTE: This area is off-limits to anyone without access to at least a BSL-1 lab! Please check with your school's science fair coordinator before selecting this category.)***

Physics
Theories, principles, and laws governing energy and the effect of energy on matter - solid state, optics, acoustics, particle, nuclear, atomic, plasma, superconductivity, fluid and gas dynamics, thermodynamics, semiconductors, magnetism, quantum mechanics, biophysics, etc.

Zoology
Study of animals - animal genetics, ornithology, ichthyology, herpetology, entomology, animal ecology, paleontology, cellular physiology, circadian rhythms, animal husbandry, cytology, histology, animal physiology, invertebrate neurophysiology, **(NOTE: There are many safety regulations and restrictions on experiments involving vertebrate animals. These experiments require SRC approval and must be submitted to a committee in Philadelphia for approval. You may not get this approval back until the beginning of December or even later. Please keep this in mind as you plan the timelines for conducting your experiment.)**

APPENDIX B - Online Resources

CAUTION: The following web sites are provided as additional resources. With the exception of the first address, these sites may or may not be compatible with the rules and regulations of the Owen J. Roberts and Chester County Science Fairs.

http://www.societyforscience.org/isef/document

The Owen J. Roberts science fair finalists may be eligible to compete in the Chester County, Delaware Valley, and Intel ISEF research competitions. Therefore, the guidelines of this organization are used at all levels of competition.

http://www.sciencebuddies.org/

This website was used as a source of information to complete this resource packet. Several ideas and LOTS of valuable information to guide you through your planning and design can be found here.

http://school.discoveryeducation.com/sciencefaircentral/

A comprehensive guide to creating your science research experiment

Here are some additional websites for ideas. Be careful to choose an experiment that can be ***tested*** and not just a science project or model.

http://www.ipl.org/div/projectguide/

http://education.com/science-fair/

http://earthquake.usgs.gov/learn/kids/

These sites were accessible when last checked in October 2017.

APPENDIX C - Bibliography

As you are doing your research, be sure to document the resources that you use. Here are the requirements for each type of resource. List all of the information in your original logbook as you do your research. When you are ready to create your bibliography for the display board, use the Easy Bib website to help format the information for each of your sources.

http://www.easybib.com/

Information needed for each source. Punctuation and underlining are included to guide students with the proper formatting.

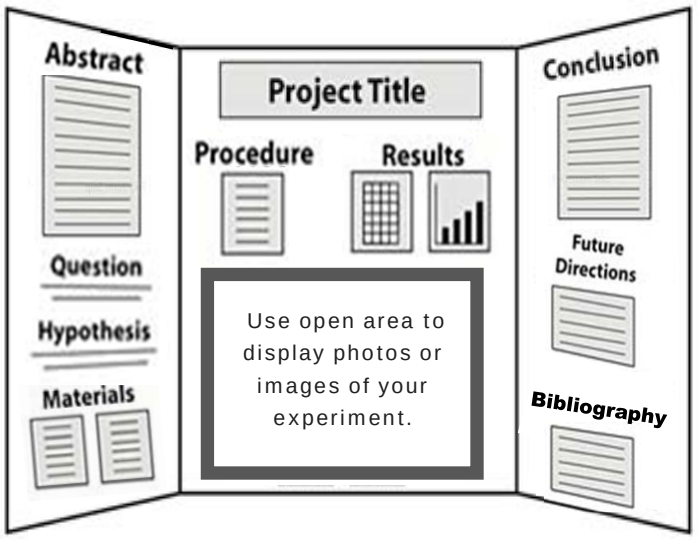
- **Book:** author name(s), title, city of publication, publisher, year
- **Website:** author name(s), "website title," date created, <web address>, (date used/accessed)
- **Magazine/Journal:** author name(s), "article title," magazine title, date, pages used
- **Article in a Reference Book:** author name(s), "article title," series title, city of publication, publisher, date, pages used
- **Encyclopedia article:** author name(s), " title of article", title of encyclopedia, year
- **Expert Interview:** "name of interview or person being interviewed", method of interview, date
- **Newspaper:** author name(s), "article title," newspaper, date, pages used

APPENDIX D – Display Tips

<u>YOUR NAME SHOULD NOT BE DISPLAYED ON THE FRONT OF YOUR BOARD OR ANY PLACE IN YOUR LOGBOOK!</u> Your school science fair coordinator will give you specific information as to how to identify your display board and materials.

Your display should contain the following sections:

1. Title
2. Abstract
3. Question/Problem and Purpose
4. Hypothesis
5. Materials
6. Procedure
7. Results and Data Analysis
8. Conclusion and Real World Applications
9. Bibliography
10. Logbook



upper left-hand corner of the board!!

<u>Science Research Experiment Display Board Notes</u>

<u>Remember:</u>

- A 250 word (or less) abstract **<u>must</u>** appear on your display board. An abstract should include the purpose of the experiment (why), summary of procedures (how), and data and conclusions (what). It also may include any possible research applications. **<u>The abstract should be placed on the upper left hand panel.</u>**

- Display the components in order, starting on the left side panel, moving to the middle, and concluding on the right panel. The middle panel should have your title at the top in easy-to-read lettering that stands out.

- Your titles should attract people to your display. They should be short enough so as to not look cluttered and they should be legible from 10 feet away. The text (style and font size) appearing on your display should be able to be easily read from 3 feet away.

- Your name must not appear anywhere on the front of the display board or logbook.

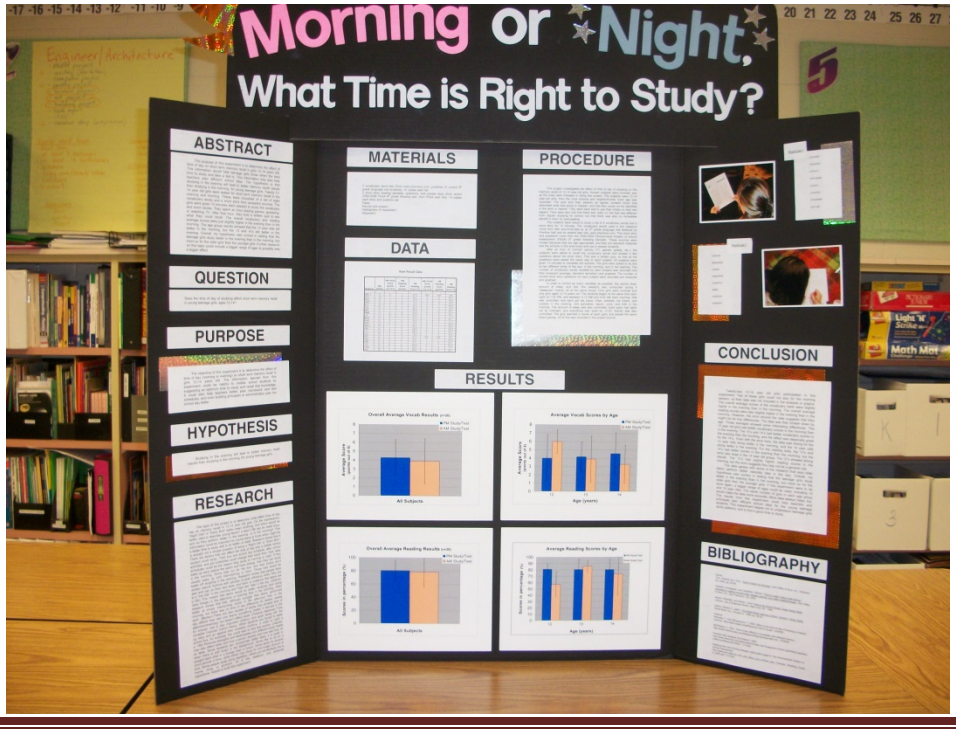
Do:

- Do make your board SCIENTIFIC, not artistic!!!
- Do spread out and balance the way text, pictures, graphs, etc. appear on your board. The most important information should be at eye level on your display. Avoid having it look cluttered or leaving large empty spaces.
- Do use graphs, charts and tables to present data and add color and variety to your display.
- Do use photographs of your apparatus/plants/products to clarify what you did. Focus on the process rather than the person. DO NOT INCLUDE FACES IN YOUR PICTURES! Be sure to cite where you found the image, clip art, or photograph. If you took the picture, it is appropriate to label it "Photograph taken by student researcher."
- Do practice answering questions about your experiment. Part of the judging process will involve a short interview about what you did and what you learned.

Do Not:

- Do not use photographs in which face of people appear. These would have to be covered up before the board could be displayed. Del Val is beginning to accept photos of the student researcher on the board as long as the focus is on the experiment, not the student.
- Do not plan to have anything on the table in front of your display besides your logbook. There are many restrictions and limitations to what can be displayed. **Everything else should be attached to the display board or shown in photographs.**
- Do not display any plants/plant materials, soil, food or food wrappers, chemicals (including water), glass, sharp objects, etc. (Ask your school coordinator if you have any questions.)

Sample Science Research Experiment Display



APPENDIX E

Scoring Rubric for Independent Research Plan ONLY

Independent Science Research Plan – Curriculum Requirement

Name:_____ **Date:**_____

Criteria	Points Earned	Points Possible	Comments
1. Rationale • Why is your research important? (If applicable, explain any societal impact on your research)		**5**	
2. Problem/Question and Purpose • Is it a testable question referencing a cause and effect relationship or a measurable change? • Does it include the purpose? Is it relevant?		**5**	
3. Hypothesis • Does the hypothesis include the cause and effect of the expected outcome? • Is the hypothesis testable? • Is the hypothesis based on research?		**5**	
4. Materials • Are the materials **listed and appropriate** for the experiment? • Are the quantities for each item listed and use metric units?		**5**	
5. Procedure • Are the steps sequentially numbered? • Are the steps involved in the experiment **detailed**? • Are the **procedures appropriat**e for the experiment?		**10**	
6. Variables and Constants • **Does the experiment have a single independent variable?** • **Does the experiment have a defined dependent variable?** • Are the **constants** listed?		**10**	
7. Identify and explain how data collection will occur • Are there both qualitative and quantitative observation records? • Are data charts and tables included? • Are measurements in metric units? • Is the data measurable and related to the problem statement?		**5**	
8. Bibliography • Are the sources cited correctly? • Are the sources relevant, current, and appropriate? • Is more than one type of resource used?		**5**	
Total Points		**50**	

NOTES:

APPENDIX F – OJR Science Research Competition Rubric

Scoring Legend

4 or 8 – exemplary evidence demonstrating advanced knowledge and comprehension
3 or 6 – sufficient evidence demonstrating proficient knowledge and comprehension
2 or 4 – basic evidence demonstrating preliminary knowledge and comprehension
1 or 2 – minimal evidence demonstrating limited knowledge and comprehension
0 – no evidence or item is missing

Preliminary Judging Criteria (done without students present)

DISPLAY PRESENTATION	**4**	**3**	**2**	**1**	**0**

- Is the display logically organized with the abstract in the upper left corner and the focus of the experiment at the center of the board?
- Is the display neat and legible with appropriate text size and style? Does the display focus on the ***science***?
- Are spelling, punctuation, and grammar correct?
- Does the display include key components to provide a thorough picture of the project? (abstract, question/problem, hypothesis, materials, procedure, results/data analysis, conclusion, bibliography, log book)

ABSTRACT	**4**	**3**	**2**	**1**	**0**

- Does the abstract concisely sum up the project in 250 words or less?
- Does it describe the purpose (why), the procedure (how), and the conclusions (what was learned and what can you do with the results)?

PROBLEM QUESTION AND PURPOSE	**4**	**3**	**2**	**1**	**0**

- Is the problem/question relevant to the student's life?
- Does the student investigate an original question or use an original approach or technique?
- What is s/he expecting to learn as a result of this experiment?
- Does the purpose of this project contribute to a group beyond the student researcher? (FLL core values)

RESEARCH AND BIBLIOGRAPHY	**4**	**3**	**2**	**1**	**0**

- Did the student use more than one *type* of resource? (internet, books, interview, scientific journal, etc.)
- Did the student utilize age-appropriate, credible sources for the background research?
- Does the research relate to the problem/question?
- Did the student include a bibliography? Are the sources cited correctly?

HYPOTHESIS	**4**	**3**	**2**	**1**	**0**

- Is the hypothesis based on the student's research? Does it tell WHY this is the expected outcome?
- Is it a statement that includes the cause and effect of the expected outcome? (Ex. If/then statements)
- Is the hypothesis presented so that it could be answered through experimentation using the scientific method?

EXPERIMENTATION: DESIGN AND VARIABLES	**8**	**6**	**4**	**2**	**0**

- Is there a complete and accurate list of materials?
- Is the experiment designed so that it is a fair test that produces unbiased results?
- Are the procedures written in a numbered, sequential, detailed manner so that the experiment is repeatable?
- Does the experiment identify only one independent variable (thing want to change)?
- Does the experiment identify a specific dependent variable (change that will be measured)?
- Are all other components identified and controlled or kept constant throughout the entire experiment?
- Are there multiple trials and sufficient sample size so that individual errors are averaged out?

EXPERIMENTATION: DATA COLLECTION	**8**	**6**	**4**	**2**	**0**

- Is there a journal/log present? Is it an original journal used throughout the entire experimentation process?
- Does the journal include all steps of the scientific method, including the research?
- Does it include dates, times, and both quantitative data (relevant measurements and numbers) and qualitative data (observations and descriptions of changes) in each entry?
- Is there a systematic data collection process to ensure the experimental technique is accurate?
- Is appropriate data collected to support interpretation and conclusions?
- Did the student include photographs or approved materials to help document or describe the experiment?

DATA ANALYSIS AND RESULTS	**8**	**6**	**4**	**2**	**0**

- Is the data presented in an organized way so it is easy to understand?
- Was any analysis performed to discover relationships/trends/patterns in the data?
- Does the analysis include comments or reasons for the relationships/trends/patterns?
- Were appropriate applications of mathematical methods used to analyze the data?
- Was student able to account for any errors or outliers?

CONCLUSIONS/RESULTS	**8**	**6**	**4**	**2**	**0**

- Are the conclusions supported by the data collected during the experiment?
- Does the conclusion address the hypothesis, even if the hypothesis was incorrect? If appropriate, does the student provide possible reasons for why hypothesis was incorrect?
- Is there a discussion of the scientific concepts or principles and how they relate to the experimental results?
- Does the student have any ideas for further research or improving this experiment?
- Did the student share how this information could be used in the real world?

Oral Interview Judging Criteria (when students return after dinner)

• Does the *student* explain why s/he chose the topic?	4	3	2	1	0
• What research did the *student* do to develop the hypothesis? Can the *student* explain the relationship between the research and the hypothesis?	4	3	2	1	0
• Can the *student* explain how and why s/he designed the experiment this way? How did you decide the number of trials to run for this experiment?	4	3	2	1	0
• Can the *student* explain what the variables are in this experiment?	4	3	2	1	0
• Can the *student* explain the results? Does the *student* have any ideas for further research?	4	3	2	1	0
• Can the *student(s)* answer with clear, concise, thoughtful responses? If this is a team project, are ALL members of the team able to explain all components of the project? When answering questions, is the *student* using proper vocabulary to explain the basic science concepts relevant to the project?	4	3	2	1	0

TOTAL STUDENT SCORE: _____/__76__

APPENDIX G – Directions for Completing ISEF Forms

DO NOT BEGIN YOUR EXPERIMENT UNTIL YOU RECEIVE APPROVAL FROM THE SCIENCE FAIR COMMITTEE.
We are looking forward to a safe and successful Science season!

Please check your school's website for scanned copies of these forms. Each one has yellow highlighters to indicate what needs to be completed. If you would prefer to type the information directly on the documents, without the support of the yellow highlights, you can use the fillable PDF versions. They are also available on the school website, but can also be accessed from the ISEF site at https://student.societyforscience.org/forms. BE SURE TO PRINT OUT EACH PAGE AND GET SIGNATURES WHERE NEEDED BEFORE YOU SUBMIT THESE COMPLETED FORMS AND YOUR RESEARCH PLAN.

All projects must complete forms 1, 1A, part of 1B, and include a detailed procedure of your experiment. Certain projects also require additional forms, like Zoology or when Human Subjects are part of your data collection. Use the tips below to help you complete these forms.

Form 1: ALL must complete part 1 – 3, 5, and the bottom of this form. If you are working with animals or humans, you will also need to fill out the appropriate boxes in parts 4 and 6. The ISEF rules and guidelines can be found at the link above. The Adult Sponsor is the person that will be supervising you as you conduct the experiment (usually a parent or guardian).
Form 1A: ALL must complete parts 1a – 6 and 8 – 10 before you submit these forms. Include a copy of the Independent Science Research Plan that you completed for science class. AFTER you complete your experiment, you will enter the exact start and end dates in part 7 and write the abstract for part 11.
Form 1B: Complete part 1 of this form. Science Fair committee members or the ISEF SRC will review and complete parts 2 or 3 as necessary AFTER we review your plan.

Form 4 and Sample Informed Consent Form: If you are using humans in your experiment, you will need to complete these forms in addition to forms 1, 1A, and 1B. This includes surveys, observing people, or asking them to perform a physical task. Complete sections 1 – 3 of form 4. If you are working with a physician or nurse, check "yes" in section 4. All others should check "no" for the qualified scientist. Science Fair committee members will complete the rest of that form AFTER we review your plan. You will also need to complete the Sample Informed Consent Form (or a similar consent form) and attach any surveys you may use. We suggest completing the top part (up until the Voluntary Participation section) and then making copies of that to give to your volunteers to sign as you perform the experiment. You will need to get the student's signature and the parent's signature for EVERY participant. For example, if you are asking classmates about their favorite candy bar, you will need each student to sign a consent form and then bring it home for the parent to sign too. Please see your teacher if you have any questions about this part.

Form 5A : If you are working with animals, you need to complete form 5A ONLY in addition to forms 1, 1A, and 1B. (You do not need form 5B unless you are working with an animal in a research lab. See your teacher if you have any questions.) Tell what type of animal you are observing (dog, cat, bird, etc.). Describe what you will be doing with the animal. Tell about the environment where you are observing the animal. Is it the natural habitat or in your kitchen as it eats? If you are studying eating habits, how often will you feed the animal and what food sources will you provide? How often will you be watching the animals? How many animals are you expecting to see? After the experiment, will the animals continue to exist in their natural habitat or live in your home as the family pet? Contact the Science Fair Coordinator if you need help completing this form.

This may seem like a lot of paperwork, but the purpose is to make sure that you and your subjects are SAFE during this experiment. If you have any questions *about the forms*, you can contact your Science Fair Coordinator. Once we review your research plans, there *may* be another form to be completed. This would depend on materials or your procedure. Remember, DO NOT START YOUR EXPERIMENT UNTIL THESE FORMS HAVE BEEN APPROVED.

APPENDIX H – EC Checklist and Timeline

Steps of Scientific Method (Science Rocks Pages)	Expectations	DUE DATE (May be given to teacher prior to Due Date but NO LATER THAN this due date)
Problem/Question/Purpose (Pages 2 – 3) Appendix A – Categories Appendix B – Online Resources	• Select a topic that interests you • Clearly define a problem or question about that topic that can be answered through experimentation • Explain the purpose of doing an experiment for your problem/question. WHY is it important and HOW will it help us?	Wednesday, October 11
Research (Page 3) Bibliography (Page 6) Appendix C - Bibliography Hypothesis (Page 4)	• Take notes as you research your topic to learn more about your problem/question • Document the reference in a bibliography • Use the information from your research to formulate your hypothesis using the "IF…THEN . . .BECAUSE" format	Monday, October 16
Variables and Constants Methods of Observation and Measurement (Pages 5 – 6)	• Define the *Independent Variable* • Define the *Dependent Variable* and how it will be measured • List the things you need to keep *Constant*	Monday, October 23
Materials Procedure (Pages 4 – 5)	• List the materials and quantities needed • Use a numbered list for the steps of your procedure	Monday, October 30

Complete
Independent Research Plan
 	
Select experimentation OPTIONS if desired
	• Combine all of the steps listed above into ONE NEAT, ORGANIZED, STAPLED packet
	• Complete and attach the EC Independent Research Plan Cover Sheet
	• CHOOSE FROM THE FOLLOWING OPTIONS
	  • Curriculum requirements only
	  • Conduct experiment for DISPLAY ONLY and opportunity to score Advanced on district rubrics
	  • Conduct experiment for COMPETITION and opportunity to score Advanced on district rubrics. (REQUIRES ADDITIONAL ISEF COMPETITION FORMS AND PRE-APPROVAL BEFORE BEGIN EXPERIMENT)
		Monday, November 13

THE PREVIOUS STEPS FULFILL THE DISTRICT REQUIREMENT FOR THE INDEPENDENT RESEARCH PLAN THAT MUST BE COMPLETED BY EVERY STUDENT.

Parents and students have the option to continue with the scientific method and conduct an actual experiment. If you choose to move forward, there are two options available.

1. DISPLAY ONLY with Potential for "Advanced" on the District Report Card in the Nature of Science Category
    - Students that CHOOSE to continue with the scientific method and complete the scientific method with experimentation are exceeding the district grade level expectations for the Independent Research Plan. This offers the student the opportunity to earn "Advanced" on the report card if all parts of the experiment and display are completed properly and to a level that is consistent with advanced learning. Simply completing the necessary steps without quality data collection, analysis, conclusions and presentation does not guarantee an "advanced" grade for the student.
    - These experiments are considered "Display Only" and will NOT be eligible to compete in the school/county competition.
2. COMPETE in the School Research Competition (requires additional forms and APPROVAL OF PROJECT PRIOR TO BEGINNING EXPERIMENT)
    - Students that CHOOSE to compete in the school competition also have the potential for "Advanced" on the report card
    - Students that CHOOSE to compete in the school competition are required to complete the ISEF forms found on the school website. This includes at least an Adult Sponsor Form, Student Checklist, and Parent Approval Form. Other forms may be required, depending on your experiment category. Please see Appendix G in the District Science Rocks packet for more information about these forms.

Students that CHOOSE to compete in the school competition MUST submit the proper forms and Independent Research Plan to the school's science fair coordinator BEFORE beginning their experiment and data collection. Competition rules prohibit any student from collecting data before a science fair coordinator can review the research plan to check for safety and experiment design. DO NOT START YOUR EXPERIMENT UNTIL YOU RECEIVE THIS APPROVAL!

The Independent Science Research Plan will include a cover sheet where students, parents, and teachers will be able to document their level of interest. Parents will be asked to choose one of the options below to indicate whether or not they will be conducting the experiment. Parents and students will sign the form so it can be handed to the science teacher and be a part of the student's Independent Science Research Plan.

- ☐ My child has completed the necessary requirements for the science research plan and <u>they will NOT be conducting the optional experiment portion of the project</u>. They will not have the option to earn an advanced grade on the report card.
- ☐ My child chooses to complete the scientific method with experimentation, allowing them the option to earn an advanced grade on the report card. They <u>choose NOT to enter the formal Science Research Competition</u> and their project will be considered "Display Only".
- ☐ My child **<u>chooses to compete in the Science Research Competition</u>**, allowing them the option to earn an advanced grade on the report card. We have completed the necessary competition forms and given them to the science fair coordinator with a copy of the Independent Research Plan. My child will participate in the event on Wednesday, January 10th, 2018.

IF YOU CHOOSE TO CONDUCT AN EXPERIMENT, PLEASE CONTINUE TO FOLLOW THESE STEPS OF THE SCIENTIFIC METHOD		
Steps of Scientific Method (Science Rocks Pages)	**Expectations**	**DUE DATE (May be given to teacher prior to Due Date but NO LATER THAN this due date)**
Conduct the APPROVED experiment (Pages 7 – 8)	• Be sure to follow the procedure that has been approved so you are safe • Record all quantitative and qualitative data entries in a logbook AS YOU PERFORM THE EXPERIMENT • Remember to include date and time with each entry • Perform enough trials to validate your results (at least 3) • Take pictures OF THE EXPERIMENT AND RESULTS to use later. NO FACES!	Monday, December 4
Analyze data (Page 8)	• Create tables, charts, graphs, etc. to help you organize your data • Look for any patterns, trends, and relationships • Are there any outliers or things you didn't expect? Try to find out why	Monday, December 11
Conclusion (Pages 8 - 9)	• Compare results to the hypothesis • How are they the same? How are they different? • Were you able to prove your hypothesis or was it incorrect? Is it possible that you did not get enough data to prove or disprove it? • DO NOT RETELL YOUR PROCEDURE. Share the patterns you found in your data and explain why they occurred. • Explain how your results can be applied to the real world or any ideas for future research experiments.	Friday, December 15

Abstract (Page 9)	• 3 paragraphs, no more than 250 words total
	  • WHY chose this experiment
	  • HOW the experiment was performed
	  • WHAT was learned and may be relevant to the real world
		Monday, December 18

Assemble Display Board Appendix D – Display Guides	• Boards can be purchased in a variety of colors from the school office for $6 • Includes display board, title header, and scientific method sticker sheet	Monday, January 8, 2018
Compete in EC SRC Appendix F – Competition Rubric	Detailed schedule will be shared with students at a later date	EC Scheduled Fair Date Wednesday, January 10, 2018