Name:_____

INTRODUCTION TO PCS C-STEM Program

What is C-STEM? In the past we have called this project a Science Fair project. We have decided to rename this program to represent what we do as a school more accurately. Science Fair is one day. C-STEM is a process and a whole mind set.

C: Communication. Scientists must be able to communicate their findings. Whether it be writing or presenting; the best communicators go far.

S: Science. Scientists are critical thinkers. They ask questions. They try to find answers. We were created to think and ask questions.

T: Technology. Technology is the application of science. We think of high tech devices like our phones and computers. Students must be technologically literate. We live in a society that relies on technology advancement.

E: Engineering. Science with design. Engineers solve the world's problems. There is always a high demand for engineers even in fields that aren't necessarily traditional engineering jobs. Engineers figure it out and then improve design to make things work better than the original design.

M: Mathematics. The foundation for everything. Math is in art, music, science, technology, engineering, athletics and life. Scientists use math daily and need it to be successful. When students see Math integrated into their world, it no longer becomes acceptable to "be bad at Math." A society that is ok to not to be their best at math is a society that will fail. At Park Christian School, we strive to be excellent in Academics. C-STEM helps us be who we strive to be.

Each year Park Christian School students compete against schools across the state and win awards for outstanding projects. Our students have an opportunity that no other Fargo-Moorhead students do – that is to do independent scientific research and present locally, regionally, at the state and international level.

So why do C-STEM projects? **The growth in students is more than just science knowledge.** Students learn to persevere. They learn to solve problems. They learn to break a large project into small pieces. They learn how to speak to adults and persuade judges that their project is the best. They choose the science that they learn. The experience is also something that can be put on college applications. Students have created very interesting projects that impact their lives. Students find out what they want to do or in some cases find that they do not like that specific subject, all discovered before they begin college. Students from the C-STEM programs are now doctors, engineers, professors, attorneys, dentists, researchers, and teachers sharing their knowledge of science and problem solving with others. Our students score higher on average in the science section of the ACT because they have collected data and analyzed it independently. The ACT science section is almost all interpreting graphs and data tables.

The trend in science education, through the adoption of state and national standards, is to incorporate more inquiry learning in the classroom (Llewellyn, 2002). PCS Science Department utilizes these ideas to allow the students to explore and design a project in a way that will optimize inquiry learning. This class will meet or exceed all state science standards at the grade levels taught.

So what is inquiry? Many educators think that inquiry is simply hands-on activities. Although most inquiry involves hands-on work, there are many hands-on activities that educators use that do not involve inquiry (Llewellyn, 2002). Inquiry can be defined in many different ways. The Exploratorium in San Francisco identified several statements regarding the definition of inquiry. According to the Exploratorium,

> *Inquiry is an approach to teaching that involves a process of exploring the natural or material world, which leads to asking questions and making discoveries in the search of new*

understandings. Inquiry, as it relates to science education, should mirror as closely as possible the enterprise of doing real science.

The inquiry process is driven by one's own curiosity, wonder, interest or passion to understand an observation or solve a problem. The process begins by the learner noticing something that intrigues, surprises, or stimulates a question. What is observed often does not make sense in relationship to the learner's previous experience or current understanding. Action is then taken through continued observing, raising questions, making predictions, testing hypotheses and creating theories and conceptual models. The learner must find [his or her] own idiosyncratic pathway through this process: it is hardly ever a linear progression, but rather more of a back and forth or cyclical series of events. As the process unfolds more observations and questions emerge, giving occasion for deeper interaction and relationship with the phenomena-and greater potential for further development of understanding. Along the way, the inquirer is collecting and recording data, making representations of results and explanations, drawing upon other resources such as books, videos, and colleagues. Making meaning from the experience requires intermittent reflection, conversations and comparison of findings with others, interpretation of data and observations, and applying new conceptions to other contexts as one attempt to construct new mental frameworks of the world. Teaching science using the inquiry process requires a fundamental Reexamination of the relationship between the teacher and the learner whereby the teacher becomes a facilitator or guide for the learner's own Process of discovery and creating understanding of the world. (Llewellyn, 2002)

The normal course curriculum will be covered in an eighteen week period. Each student should focus his/ her research in one of the twenty-two Intel ISEF Categories. This fast paced approach will keep the student moving quickly through the curriculum. Each student must closely monitor the stresses in his/ her life and be sure to communicate with parents and teacher when he/ she feels stressed out.

There are twenty-one assignments broken into 5 steps that the student will complete throughout the process of this project. The teachers will give feedback and suggestions for improvement. The student will have time to make revisions on all assignments. This will be a huge change for the student. Students typically hand in work once and forget about it. It is expected that the student will rework assignments until they are excellent. Students who rework assignments will most likely have a higher grade and a higher quality project. **The choice is up to each student.** Small assignment will be given a 10 point grade in the C-STEM section of the grade book. It is very important that the student keep up with assignments and students will find that revised work will benefit their grade tremendously. Students will find a list of criteria at the end of each task. The individual assignments will address all of these criteria. The student will be able to rework all steps for two weeks after the step due date. Each student will have flexibility to meet all grades. Each project will be independent; however, key parts need to be completed on a timely basis to make a high quality project. **Procrastination is not an acceptable excuse and causes unnecessary stress for all involved**. There is no substitute for hard work. It is better to make your best attempt at an assignment and allow the teacher or mentor to give you feedback. Revisions will expand the student's knowledge base and allow for a more professional product. When confused, ask for help!

At the completion of this process, the student will have written a scientific paper, completed a project display board, and have a well-documented journal. The journal will show the progress of your project from beginning to end. **The journal is essential for documenting your progress on your project.**

A sample journal sheet may look like the following:
Your Science Journal may be electronic, handwritten in a notebook, or you may photocopy this page
The only requirement is that **each time** you work on your project you document it.

PROJECT SCIENCE JOURNAL

Name: _____Date:_____

Please check the type(s) of journal activity (ies) covered in this entry:

_____Proposal/Forms	_____Literature Search
_____Hypothesis	_____Experimental Plan
_____Data Collection	_____Data Analysis
_____Writing Paper	_____Display Board
_____Presentation Preparation	_____Other,_____

Please journal below the key things that you accomplished on your project today. Attach all pertinent papers, such as plan sheet, to this entry.

Researcher Signature:_____

You are about to embark on one of the biggest challenges, your science fair project. **Be inquisitive, be flexible, work hard to learn as much about your project, and most of all have fun!**

STEP 1: RESEARCH QUESTION PROPOSAL

The first step that you will be faced with is the project proposal. A well-designed project must follow all International Science and Engineering Fair (ISEF) rules. These rules may be found at https://student.societyforscience.org/intel-isef-forms The C-STEM program is guided by rules to protect the rights and welfare of the student researcher, protect the rights and welfare of the human participant, ensure adherence to federal regulations, ensure use of safe laboratory practices, and protect the environment We may think that any project is acceptable however we must follow guidelines set out by the Society for Science. Be very careful to follow all rules, especially if you are completing a project with human subjects, microorganisms, or vertebrate animals. **Before you *begin* your project, you must complete all forms and signatures.** A well-planned project will work smoother in the long run. Take the time to evaluate each step. Enjoy, have fun, and impress yourself with the best project that you have ever completed.

For many projects, the most difficult task is getting started. As you prepare yourself for this amazing journey, there are a few things that must take place before we begin. To begin, you must have a topic for your project. The research project plan, as described by ISEF, is the development of a scientific research project involving several sets of data and experiments. A good project should contain a controlled experiment with as many trials as can be accomplished. A good statistical test usually requires 30 replicates for best results. A MINIMUM OF 4 REPLICATES IS MANDATORY FOR ALL VARIABLES. You will find a variety of sources in most libraries that will get you started on possible topics. Remember these are projects that have already been accomplished and you may need to take the idea or procedure and modify it into a new and unique project. The PCS library has resources for online research.

Here are a few suggestions for selecting a research question:

a. Talk with your parents, friends, teachers, or those in the scientific community about your ideas. Discuss time limits (all data should be completed by before you go on Christmas break), budget limits, and possible outcomes of the project.
b. Choose a research question that interests you. Look for something you are curious about. You will be spending months on this project; it should be something you consider fun and challenging.
c. Choose a research question which is feasible. Be sure it is at your level. Don't choose a college level project, you will be overwhelmed. Don't choose a very basic project because you think it will be easy to do. These projects end up requiring a lot more time and energy trying to create more things to do to get it up to your level. Work with materials that you have access to utilize. Projects with humans and vertebrate animals will take a considerable amount of time and energy to get everything approved and all forms completed. Choose wisely!
d. Try to narrow your research question without making it too difficult to find sources. You will want to find 10-15 sources to have an effective project. For example, cancer is a very broad topic that could be narrowed down to treatment of bone cancer.
e. Do not try to design your experiment. You do not need to know WHAT you are doing yet. That will come with time. Allow your experimental ideas to develop as you conduct your literature search on your research question. Your sources will help you develop a well-designed controlled experiment as you collect notes on your research question. Don't limit yourself at this time.
f. Incorporate your topic ideas into operational science: (Ask these three questions) 1) Is this observable?, 2) Is this testable? 3) Is this repeatable?
g. Does your research question fit into the scientific process? 1) scientific question 2) researchable 3) form a hypothesis or goals, 4) experiment, 5) gather and record results/data, and 6) conclusion. Will your research question fit into this framework?
If you are doing an Engineering, mathematical, or computer science project your process will include GOALS instead of a hypothesis.

h. The following categories represent areas from which you may develop topic ideas:

*Animal Sciences (ANIM)
*Behavioral and Social Sciences (BEHA)
Biochemistry (BCHM)
*Biomedical and Health Sciences (BMED)
Biomedical Engineering (ENBM)
Cellular and Molecular Biology (CELL)
Chemistry (CHEM)
Computational Biology and Bioinformatics (CBIO)
Earth and Environmental Sciences (EAEV)
Embedded Systems (EBED)
Energy: Chemical (EGCH)
Energy: Physical (EGPH)
Engineering Mechanics (ENMC)
Environmental Engineering (ENEV)
Materials Science (MATS)
Mathematics (MATH)
*Microbiology (MCRO)
Physics and Astronomy (PHYS)
Plant Sciences (PLNT)
Robotics and Intelligent Machines (ROBO)
Systems Software (SOFT)
Translational Medical Science (TMED)

***These categories often require preapproval and extra paperwork.**

Once you have settled in on a category, you need to bring your focus to a specific problem to solve. A well-defined problem will help you to focus your project, define the data to be collected, and speed up the process of implementing your experimental plan.

Scientific research will deepen your understanding of a subject through problem solving. By applying the processes and procedures of scientific research to your project, not only are you immersed in an interesting project, but the results may also yield benefits to all humans.

PLEASE TYPE and SAVE ALL DOCUMENTS

Assignment 1: CHOOSE A CATEGORY and SET UP JOURNAL

In order to select a research question, you first need to decide what *kind* of science you are interested in. Go to the following link to read about the categories and sub-categories. After you know what kind of science you are interested in, you are able to proceed to define the research question assignment.
https://student.societyforscience.org/intel-isef-categories-and-subcategories

Once you have selected a category make an entry into your Journal. Every time you work on your project you will add another entry.

Assignment 2: DEFINE RESEARCH QUESTION

The most frequent question asked by a judge at a science fair is, “Why did you choose this project?” Before you begin a project, you will want to address this question. Why are you doing a project? Why is it important to you, your school, the scientific community, or society? We will often use the word problem when speaking of a research question because this is something we are looking to solve.

To define the research question, you begin by asking to whom is this idea an issue. Who owns the problem? Who are the stakeholders that are directly involved with the problem? Who or what is being acted upon? Who or what would benefit from improvement in the problem? How you define the problem will affect what you decide to research. For example, let's say you wanted to test the effects of seed type on growth in your garden. The following is one example for defining this problem:

WHO? The producers (farmer or home gardener)

STAKEHOLDERS? Farmers, gardeners, chemical company that produced the seed, seed company, salespeople, state or federal regulatory agencies, advisors (county extension agent, consultants)
ACTED UPON? Seed Types, Soil Conditions, and Growth Conditions
BENEFITS? Farmer or home gardener, consumers of the products, profits for company, environment

Knowledge of who is involved and why your project is important will help you understand more about why this project is important to society. A judge needs to know that you understand why you did this project and why it is important to you. A project that shows an important application in your life will be more successful than a project assigned as a classroom project. **Seek out a project that will hold your interest throughout the multiple months that you will work with this topic.** Don't hesitate to ask your teacher or parents for help if you can't seem to get started.

The following worksheet will help you to define your problem as you begin to explore the importance of this project. Remember to write in your journal EVERYTIME you work on your project.

DEFINE THE Research Question
The following is another example:

Your Name
ISEF Category (and sub category if you know it) *Physics: Biological Physics*
Research Question: *How could I improve my jump shot in basketball?*

Be sure your answers are in complete sentences and thorough answers.

1. Explain your research question that you would like the answer to, wouldn't mind spending time learning about, and cannot be googled for the answer.

I love basketball. I need to make better jump shots and want to know how to do that using physics.

2. Who or what are the stakeholders that are involved with this project.

The stakeholders would be any person who plays basketball and wants to improve their shot.

3. Why is this project important for you, and why do you want to do this specific one? the community? mankind?

If there is a novel way to become better I want to know and how to implement it into my training. I could publish my results and help other coaches and players.

4. List all practical applications of real life for this project.

I think practical applications include building stronger muscles, creating muscle memory, having a higher shooting percentage, being a better player. This will help me and anyone else who plays basketball.

Assignment 3: FORMS

Forms are probably the most frustrating part of the science fair project. They can be a lot of work; however, if they are completed before the project begins, most problems can be avoided. The best place to begin the forms is to use the Rules Wizard at: https://student.societyforscience.org/intel-isef-forms This will identify which forms are necessary for your project. These forms help to document your project, which will ensure safety for you and the subjects along the way. Although these seem very tedious to complete, it is essential that they all are on file with proper signatures BEFORE you begin experimentation.

Every student must complete **Checklist for Adult Sponsor (1), Student Checklist (1A),** and **Approval Form (1B)**. These are approval forms and all required signatures before starting the experimental potion of your project. Other projects may require additional forms, such as working in another lab or dealing with humans, microorganisms, or vertebrate animals. Go online! These forms can be completed on-line and printed for your teacher. You must print these, have them signed by your parents, and then turn them into your teacher then stored in a folder.

Although your teacher does not want to limit your topic choice, previous experience has shown that human projects, microbiology projects, and vertebrate animal projects require a lot of extra effort on your part to get all forms completed. These usually involve prior approval before beginning your experimentation. Although this should not keep you from a project, you must address all other possible projects that could be completed without the use of humans or vertebrate animals. Seriously consider using an invertebrate animal for test subjects.

You probably are already overwhelmed with requirements. The process is very time consuming. You should plan on spending 2-5 hours a week if you plan on completing an excellent project. It will take a lot of hard work and perseverance to complete the project. Stick with it. Stay disciplined and get your work in on time. Your teacher can be an excellent help for you. **Procrastination causes unnecessary stress for all.**

ASSIGNMENT 3
Complete Checklist 1, Form 1A, 1B, and other forms as needed. Print forms and turn them in. They have to be approved before you can begin experimenting. You may continue to research without the approval signatures (but not your parent signature). **Record your work in your journal EVERYTIME you work on your project.**

STEP 2: Research and Hypothesis (LITERATURE SEARCH)

One of the most important aspects of the C-STEM project is for you to become the expert about your topic. The only way that you will be able to make informed decisions about your project is for you to do as much research as possible relating to your topic. I realize that this is not a popular step, but it is crucial to the success of the project. This background information will be the basis for the introduction to your paper. It will also help you to answer the questions that the judges will ask you at the science fairs. Remember, you must be the expert in your field of study to be able to successfully discuss your project with others.

This is where your English class will help (at least in 7th and 8th grade). We will discuss what will happen in Science and what will happen in English. Science class will focus on Research and Design. This will involve setting up and keeping your journal/ log book, searching for sources, getting your preliminary bibliography done (5 key sources), and your experimental plan. Your English class will focus on writing your Review of Research. This is also known as your research paper. You will use the research you find in

science and then take notes on your research, formulate an outline, type your paper, have it peer edited, and submit your final paper complete with a bibliography.

A literature search should cover all varieties of sources available to you. Sources may include, but are not limited to, books, newspapers, magazines, scientific journals, brochures, reports, tapes, videos, lectures, interviews, or the internet. The key is to find as much information as possible. Don't set your goals low. It is better to set a goal to find 15 sources and only find 10, rather than having a goal of 3 and finding 3. In the end, you must have a minimum of 5 cited sources in your bibliography. Search the media center, the Internet, a university library, or at home. Ask your parents or teacher for ideas. Don't waste time searching by asking google your research question. If you are able to find the "answer" your idea is not deep enough. Materials don't magically appear. It takes a lot of hard work and MANY hours of dedicated research to develop an adequate file of information.

You will want to search for primary authoritative sources. These are sources that have original research results with the original author(s). Journals, magazines, books, and newspapers are your best choices to find original research. Secondary sources are not as good; however; they may provide some good general background information about your topic. Realize that these sources are written about the topic, but are not authoritative regarding factual results or conclusions. A good file will have a good assortment of both of these types of sources.

It is recommended that you explore beyond the Internet. Although the Internet has a vast array of information, it may be difficult to determine the validity of the site. If there is not an author or date published, it is probably not a very good source. It is recommended that for every Internet site found, you should find a non-internet site (online journals are NOT considered internet sources). This will help to balance your sources so you have a variety of viewpoints. There are some excellent search engines that directly connect you to a journal. InfoTrac is an excellent tool to find primary authoritative sources on-line. Proquest is a good search engine for newspaper sources. MINITEX Library Information Network will provide many possible sources. Electronic Library for Minnesota (ELM) is a new resource available to all citizens of Minnesota. You can access this through your local library or from home by visiting www.elm4you.org . Internet sources can be fabricated very easily. Some may even look like research, but they are fake. Check out the sample in the classroom showing data on the California Velcro Crop. Reputable cites usually end in .edu or .gov. **Be careful with Internet sources!!!!** For North Dakota residents I recommend you go to the Fargo Public Library and find out what is available free to you. PCS has a subscription for many online Journals. It is on PCS's website.

Some areas that you should be trying to locate include similar scientific studies, current and historical studies, alternative viewpoints about the problem, information about sub problems, or interviews with informed people in the field. Learn about the science behind your problem. Remember your goal is to develop a question to be solved. You need a strong background of information to help you accomplish this goal. The library can help you a lot when searching for scientific information. Don't hesitate to ask for help as you are searching. We will spend a couple of class periods using the laptops for research.

As you search for sources, don't eliminate or try to evaluate the source for your project. You might use it after four weeks of testing. You want to keep a research file with copies of as many sources as possible. This research file will be used extensively throughout your project. A box or file system is recommended.

Once you have obtained your sources, you need to document them for future use. It is recommended that you create a bibliography source card (in Microsoft Word or on a notecard) for every source that you have found. Be sure to use the proper format for bibliography cards. See the following pages for examples.

Keep your bibliography cards alphabetized. This will help you when you need to type your cited sources. It is *suggested* that you begin with a minimum of ten sources. You may add more as your project progresses. If you are using vertebrate animals in your research, YOU MUST HAVE ONE SOURCE DESCRIBING THE CARE OF THE ANIMAL. This is an ISEF regulation. It does make sense that you should know how to care for an animal BEFORE you begin working with them. Your teacher has a variety of sources that will help you here. You will need to record everything in APA format. Use your writing packet for help and samples of recording sources.

When you find a source, automatically record the source in the bibliography format on your notecard. It seems time consuming now, but later it will save you a huge amount of time! The note cards can be electronic. (That is what I would do).

When you have a bibliography card for each source, you will begin taking notes on each source. A note card is a record of one piece of information that you may use in writing your paper. This note card should include the source and a keyword reference. These keyword references will be used as key ideas when writing the introduction to your paper. Be sure to use a keyword on each note card and cross-reference the source so you can use this in documentation later in writing your paper. Use of direct and indirect quotations will provide documentation needed in your written paper. Direct quotations are taken word-for-word from the source. You should include the page number with the quote as this will be needed later when writing your paper. Indirect quotes involve taking a passage and stating it in your own words without changing the meaning of the original passage. A suggestion is that you do not use more than two consecutive words from the original passage. Be sure to use quotes on all materials that you copy from the source. **YOU MUST DOCUMENT ALL REFERENCED NEW INFORMATION.** You will have approximately 4 weeks to get notes on all of your sources. It is recommended that you begin by taking notes on books or borrowed items that need to be returned. If you need to photocopy a source and highlight it, put it in your file for later. Copied materials will always be in your file for later reference. Remember: Copying information at PCS requires you pay for the copies.

Some key ideas that the note cards should include are definitions, facts, previous data or studies conducted on your topic, procedural information, safety guidelines, etc. If you think you may use the information as background information in your paper, it must be recorded on the note cards. These will save you a lot of time when writing your paper.
A sample note card is shown below.

Your "note cards" may be kept on your computer and typed

Author, Date	Keyword
"Direct Quotation" (page number)	
An indirect quote allows you to include information Which is not taken word for word from the text.	

Don't underestimate the importance of this step. You must be the expert if you are going to convince a judge that you are responsible for this work. Good luck in your search.

This step involves the preliminary stages of taking notes. Remember you will continue this process for many weeks. It is important that your notes are complete and organized by keywords. This will help you as you begin to write the introduction of your paper. You will save yourself A LOT of time if you take good notes.

Remember that each note card should focus only on one key idea. It is better to separate all ideas on many different cards. Be sure to include the keyword on each card. Some students have found that highlighting the keywords with a color code is very helpful in putting the same ideas together. Each card should reference the source, either by number or code (if you don't use the complete entry).

The note cards need to reflect adequate knowledge base for the complexity of your project. A general project will have many more note cards than a specific topic, which is narrowed down. It is expected that numerous hours will be needed to prepare you for understanding your project. This is not a step to take lightly. You will save many hours later if you do a good job here. As the saying goes, "you can pay me now, or you can pay me later!" Put in the time NOW!!

An alternative to notecards is to collect sources and keep a copy of each journal. Using a highlighter you can highlight the key ideas in that source. This approach saves you time initially, but it will take you longer when you are assembling your paper.

The research file is a compilation of all information that you have collected through your searches. This file will probably have a number of copied sources, note card files, interview responses, notes from experts in the field, and copies of journal articles. It is important that you know everything that is available so you can relate to your topic. This file will continue to grow as you find even more information through future searches. This file will document all of the hours of searching that you have completed on your project. Once again, don't eliminate potential sources. Keep them in your file until you are 100% sure that you won't need them later in the project. The more you search, read, and understand the project, the easier it will be to explain your project to the judges.

Assignment 4: Key Sources

The final step in the project proposal is to locate at least five key sources that you will use to find background information about your project. These should be primary authoritative sources. This means the source should contain original data or information that is verifiable in a scientific way. These could include books, magazines, scientific journals, interviews, or abstracts. You should avoid internet websites, unless you can verify the credibility of the source. Beware of fake internet sources that look like scientific research. Usually, most internet sources from educational sources (www.???.edu) or government sources (www.???.gov) are credible. A good scientific search engine or database may be a good starting place. **When you find a source, be sure to copy all necessary information for an APA citation.** We will discuss proper format for sources at a later time.

This will be your project proposal. Be sure to type this work so that it may be reviewed by other scientists. Their input may save you many hours of frustration at a later time.

Be sure to keep yourself organized. Save all work in your cloud storage as well as a storage device. Keep a backup in case something happens. As you continue to put your project together, you will need every step from the process. DO NOT waste your time retyping earlier work. When we get

down to "Crunch Time," your organization will be very helpful. Hang in there, put together a great project, and most of all HAVE FUN!

ASSIGNMENT 4

1. Develop a list of **five key sources** to be used in your project. You should have 10 to 15 sources but you only need to include 5 of them. Include one source for care of animals if completing a project with vertebrates.
2. Type and save in your cloud storage upload to Teams.

Assignment 5: OUTLINE FOR PAPER

Now that you have a good foundation for your project, we need to turn our attention to the early stages of writing a scientific paper. The first section of the paper is the introduction, which summarizes the key background ideas that you have been collecting in your literature search (in the past it was called Review of Research). It is very helpful to establish an outline for writing your paper. You have been accumulating note cards using different keywords. You should be able to take these keywords and organize your paper in the order that you wish to write your introduction. You will want to look at each keyword to identify how you may subdivide the keyword into smaller groups. A sample outline is shown below. Note that you always find two subdivisions below each heading. If you only have one subdivision, then it should be included in the heading. It is recommended that the introduction include a purpose statement and the last paragraph of the introduction focus on the hypothesis of your study.

As you plan your outline, plan so that the ideas flow from one into another. Avoid jumping from topic to topic and then back to the original topic. Keep your ideas together by subject or keywords and you should have no problem. Remember that you will end with the hypothesis for your project. Build up to this with the most important aspect of your background being discussed before the purpose statement and hypothesis.

SAMPLE OUTLINE

I. Hook Paragraph
   A. Attention getter
   B. What you are looking to solve
II. Body
   A. Main Idea
      1. Supporting fact from research (citation)
      2. Supporting fact from research (citation)
      3. Supporting fact from research (citation)
   B. Main Idea
      1. Supporting fact from research (citation)
      2. Supporting fact from research (citation)
      3. Supporting fact from research (citation)
   C. Main Idea
      1. Supporting fact from research (citation)
      2. Supporting fact from research (citation)

3. Supporting fact from research (citation)

III. Statement of Hypothesis or Goal(s)
   A. Summary of what you learned from research (Research shows)
   B. Goal(s) or Hypothesis (If…then…may)

Assignment 6: Review of Research (INTRODUCTION)

The introduction is a very important part of your final paper. It provides an adequate review of the research, and it defines key facts and ideas that are central to solving your problem. **The Review of Research is typically 8 to 16 paragraphs in length depending on the complexity of your project.** Remember that you will add to this paper to formulate the final product. A historical review and any previous studies relating to your problem should be documented in the introduction.

The introduction tells your readers about the topic by briefly describing what you intend to do and what others have already done. Describe any facts that helped you formulate your hypothesis. You must give a clear picture of the work already done in the area you are studying. Be sure to read about the work of other scientists. Avoid the temptation to include all facts that you read about during your note taking experience. You may have discovered many interesting facts during your literature search, but **only include material that is important to your project.**

It is recommended that you *end* the Review of Research with your hypothesis or goals. Some suggestions for your introduction include:

1) Begin with an opening sentence that gets the reader's attention. Avoid starting your introduction with "My project is about . . ."
2) Define key background terms used in your study. These are probably your keywords from your note cards.
3) Organize your paragraphs by keywords from your research.
4) Include related studies.
5) DOCUMENT all borrowed information by quoting, by giving reference to the source, or by citing the source.
6) End your introduction with the purpose of your study.
7) Avoid using First Person writing style. Don't use personal pronouns such as I, we, and they unless absolutely necessary.
8) Write the introduction as if it could be published and written by anyone.

When referring to examples, remember each one has good and bad parts. These are not necessarily perfect examples to follow word for word. You may also find the guidelines from the Minnesota Academy of Science to be very useful.

Remember, you should be trying to impress yourself with solving a problem. Don't try to impress your teacher or the judge with your brilliant intelligence. Show a genuine look at a unique problem that you are attempting to solve.

Why is this research important to the world? Why is it important to you? How does this problem fit into everyday living? These are some of the questions that your purpose statement should address. Your purpose should address an ethical project showing a reason that this work is important. It is important to show how this project applies to your life. Refer back to assignment 1 which addresses these ideas.

The purpose statement should be clear and concise. Get to the point. Don't put a lot of fluff in the purpose statement. A good purpose statement should be three to six sentences in length. Give some explanation but keep it brief. Keep all explanations in the body of the introduction section.

ASSIGNMENT 6

1. To develop a sound theoretical/methodological framework for your project.
2. To adequately review the literature available to you regarding your project.
3. To develop a clear purpose statement and hypothesis for use in the paper and on the display board.
4. Type your research part of your paper called the introduction.

Assignment 7: HYPOTHESIS OR GOALS

Information Regarding a HYPOTHESIS (most projects)

BEFORE you begin experimenting, you must create at least one hypothesis. You may find that your project does involve three or more alternative hypotheses. You will need to prioritize these hypotheses to determine your plan of attack for addressing these hypotheses. Scientific knowledge is obtained through the process of developing an idea, hypothesis, experimental plan, and then developing conclusions based on these results. Scientists use deductive reasoning to process an idea. This is based on previous knowledge that the learner has already acquired. As you read this, think about how your hypothesis fits with your previous knowledge base and your experimental plan.

The hypothesis is more than simply an educated guess as most books like to address it. The hypothesis is an idea or prediction which you see as the best possible solution to your problem. Keep in mind that the hypothesis must be capable of being tested. A clear and concisely written hypothesis will tell the reader what it is you think will be the solution to the problem being tested.

Example Hypothesis:

> If low temperatures suppress muscle contractions, and I break toothpicks for one minute with warm hand and then for one minute with the same hand after soaking it in ice water for five minutes, then I may break more toothpicks with the warm hand.
>
> Explanation of how this is a good hypothesis: This begins with the hypothesis that low temperatures suppress muscle contractions, and beginning with the word 'if' makes the hypothesis tentative. This form also includes how this hypothesis will be tested, and ends with a specific, measurable, predicted outcome of the experiment.

A hypothesis is If my research, then this should or may because of… (If, then, because statement)

Information Regarding GOALS

If you have chosen an Engineering, Mathematics, or a Computer Science project you will be creating goals rather than hypotheses. BEFORE you begin experimenting, you must create at least one goal. You may find that your project does involve more than one and that is fine. You will need to prioritize these goals to determine your plan of attack for addressing all of them. Scientific knowledge is obtained through the process of developing an idea, making goals, designing your experimental plan, and then developing conclusions based on these results. Scientists use deductive reasoning to process an idea. This is based on previous knowledge that the learner has already acquired. As you read this, think about how your goals fit with your previous knowledge base and your experimental plan.

Goals are outcomes of what you want to accomplish during this time we call experimentation. Are you building a prototype? Are you modifying a current object? Are you writing new code or developing an app? Are you trying to come up with a new mathematical equation or applying statistics to an existing data set? All of these examples need goals. You will list your goals in the last paragraph of your review of research.

Assignment 8: BIBLIOGRAPHY

The bibliography is a record of ALL sources that were cited somewhere in the paper. Most of these will be from the literature search; however, some may be procedural or from the discussion section. The bibliography of cited sources will change throughout the process of writing your paper. If you have kept accurate bibliography cards, you should be able to copy the entry from the cards.

This is one section that you definitely want to save on your website and a storage device. It is very important to have a backup. It is tedious to get everything formatted so you don't want to type this part more than one time. If you need to add a source, it will be easy to insert as necessary.

You will want to follow the format from the beginning of this step. Remember to alphabetize your sources. Typically the author's last name is usually first. **Use APA style.** Mrs. Issak and Miss Faul will be able to help you with this part. Please use the writing packet you have been given to complete this assignment.

STEP 3: Data Collection

Data collection is, for most students, the most enjoyable part of the project. Most scientists agree that work in the lab is fun. Here you will develop procedures, revise ideas, and collect data. You will have fun in experimentation; however, you must document all work by recording everything that was done. Data is anything that we can measure or observe. Data can be placed into two different categories: quantitative and qualitative.

Quantitative data is any observation that is numerical in nature (think quantity). This data is easily replicable as it is a number measurement. This type of data can be analyzed using a variety of statistical tests. Good quantitative data is something that can be replicated by other research scientists. It is critical that accurate data be recorded for future use and reference. Because quantitative data has a specific measurement, it must have a specific unit of measurement that was used. Be sure to label all quantitative data with the proper unit. **Remember that <u>metric units</u> are the language of science.**

Qualitative data is any written observations that you notice during experimentation (think quality). These may include possible problems that you encountered. They may be outside forces that you feel may help explain the quantitative results that are being recorded. Qualitative data are your interpretations of what you are observing. Due to this fact, qualitative data may not be replicable by other research scientists. Most judges will focus their attention on the quantitative data, however good qualitative notes can help you explain this data more clearly. **All researchers should keep a good journal documenting BOTH quantitative AND qualitative data.**

It is imperative that all data is taken and recorded as accurately as possible. A good journal/log book will help you verify your work and adds validity to your study. **REMEMBER, you keep a journal entry each**

time you work on any aspect of your project. Now we will add the Data Collection sheet. The data collection sheet is one way to record your data. You may keep this information in a bound journal or on separate sheets compiled together. A well-prepared data collection sheet will help you to identify exactly what you plan to collect. It also forces you to predict other possible data or problems that you may encounter. A well-designed data collection sheet will replace the journal entry during data collection. ISEF strongly suggests a well-documented journal as part of the final display. Record keeping can be tedious, but it is critical for developing conclusions about the data collected.

Assignment 9: EXPERIMENTAL DESIGN

Now that you have a preliminary hypothesis, you are ready to begin the process of designing your experiment. The main focus of this chapter will be exploring the basic procedures that you want to accomplish. **Remember this is only a plan. It may change as you continue to progress through the project.** This plan will be used by the scientific review committee to approve your work before you begin if you need preapproval and will be part of your post-project summary if you didn't need preapproval. Be sure to give enough detail so that someone else could repeat your work. Realize that if your plan changes, you will need to have it reevaluated by the review committee. This may lead to a three to four week delay. It is very important to do the planning work up front to avoid changes.

You may find it helpful to look in various books to help you understand the experimental design process. You may reference the Science Buddies website here: http://www.sciencebuddies.org/science-fair-projects/top_research-project_experimental-design.shtml Another great source is Students and Research by Julia H. Cothron (Cothron, et al., 1989). Ms. Holter has the book Success with Science: The Winner's Guide to High School Research by Shiv Gaglani (Gaglani, et al, 2011) as well.

You should include the following ideas in your plan: variables, treatments, controls, experimental procedures and replications, plans for data collection, methods of data analysis, and necessary materials and equipment needed to complete this project. You should also include a brief timeline, which outlines the timeframe for experimentation. Adequate time must be saved for data analysis and presentation preparation. Begin experimentation as soon as you have approval. **DO NOT WAIT TO SET UP YOUR EXPERIMENT BECAUSE YOU THINK IT CAN BE DONE IN TWO DAYS! Remember this is DUE BEFORE Christmas break.** You may encounter many challenges that could delay your project.

You should continue to write in your journal for each day that you work on your project. Judges want to know that this is your work, and the journal verifies each day that you work on your project.

The experimental design plan sheet will ask that you complete the following parts:

1) **Title:** The title should concisely describe your project. It should catch the reader's attention and show what the project is about. The best project titles are between 8-10 words in length. (At the end you can modify your title as needed)
2) **Independent Variable (manipulated variable):** This variable is the one which you are using to test your hypothesis. This is what you, as the scientist, are manipulating in the experiment.
3) **Dependent Variable (responding variable):** This is the variable that you are measuring as data in your experiment. This variable is dependent upon what the independent variable is causing in the experiment. This is the information that you are going to use to try to analyze the effect that your independent variable had on the experiment.
4) **Control or Baseline:** The control is a group of identical constants set up to compare to the independent variable(s). (Control example: If you are testing the growth rate of rats when given Sucralose, you would need a group of rats that were not given Sucralose.) A baseline is the conditions of what you have before

you start your experiment (Baseline: If you were working on improving the efficiency of a machine, you would need to test the initial machine before improvements.)

5) **Constants:** These are the variables that are kept the same in both the experimental and control group settings. The more constants that you control in your experiment the easier it will be to analyze your data and come up with valid conclusions. A common error in C-STEM projects is when these are not identified.
6) **Repeated Trials:** Every experimental design requires more than one trial for reducing possible errors in your experimental design. The number of trials will depend upon the availability of subjects, cost of materials, and ease of collecting data. A MINIMUM OF FIVE TRIALS MUST BE COMPLETED FOR ALL PROJECTS. Statisticians recommend 30 trials for good statistical evidence when using analysis such as the T-Test. If you are testing multiple variables, each variable must be tested five times each. For example, if you are testing the damage beverages do to teeth, you must have a minimum of five teeth in each beverage.
7) **Procedure:** The procedure describes what you plan to do with the project. Remember this is only a plan, and things may change. Theoretically, another scientist should be able to duplicate your work by following this procedure.
8) **Materials Needed:** A detailed list of materials needed will help you to get organized before you begin your research project. It will also allow your teacher to see what equipment the school may have to help you with your project. Be as specific as possible here, as this will save you a lot of time later in the project. **If you need to borrow anything from the school, be sure you check it out and return it promptly.**

Assignment 10: DATA COLLECTION SHEET

The data collection sheet is one way that you can keep track of all quantitative and qualitative data. Most students find it will save them time in the long run. The data collection sheet is one piece of paper that will include all of the major experimental information needed for a good journal. If you prepare a place to record your data, then when you are collecting the data it will be much faster. You will eliminate a lot of repetitive record keeping if you use the data collection sheet. It is very important that you record the data as you collect it. Don't rely on your memory to recall critical data.

The data collection sheet should include, but is not limited to, the following information:
Design your own Data collection sheet. Save in cloud storage and print a copy.

1. Date of data collection
2. Trial number (both control and experimental)
3. Brief procedure with independent variable(s) identified
4. Quantitative data (dependent variable)
5. Qualitative data (observations and notes – these may be very helpful later during conclusion writing and/or data analysis)
6. Constants (include items such as environmental conditions, location, set up, etc. that will stay the same in all testing)
7. Title
8. Your name and/or signature
9. **Everything must be in metric units.**

Assignment 11: EXPERIMENT

It's finally time to do your experiment. This is what you have been waiting for**! Be sure you have left yourself enough time to complete this section and still have time to adequately analyze your data.** Use your previous assignment (Data collection sheet) to record the data you are collecting. Be sure you are recording data in metric units. Your measurements should have numbers. It's impossible to do statistics when you only have qualitative data.

Assignment 12:

Do your experiment and record Data in data collection sheets. Make as many copies of your sheet for each trial. Be sure to fill out completely.

Take pictures of your experiment. You will need them later. Take more than you think you will need or use.

STEP 4: DATA AND CONCLUSIONS

As soon as the data is completed, it is time to do some type of statistical analysis. **Have you been journaling**? If the average data for group A is 12 and the average data for group B is 8, does this mean that the two sets of data are different? Yes, 12 is bigger than 8 – but is it statistically significant? There must be a way that shows that your original hypothesis was supported by the data. Numbers don't mean anything without their units, and in Science we use the *metric system*.

In order to reach a valid scientific conclusion about your hypothesis you must run some type of statistical analysis. There are many different types of statistics to use. In the following pages you will find information about a variety of different ways to analyze data. You may find it necessary to contact a local statistician at a college or university to help you with your specific project.

It is critical that you use the right type of analysis and that you understand what it is that you are doing. Without statistics, you cannot say that your data supported or did not support your original hypothesis. The evidence that you obtain about your data will be necessary to adequately form a conclusion about your project. Don't hesitate to ask for help on this step!

You may find from your statistical analysis that more trials are necessary. In all my years of working with C-STEM projects, I have never had a student collect too much data. A common problem, however, is too little data. Most statisticians agree that thirty replicates are necessary for adequate use of many statistical tests. Depending on the complexity of your project, your number of replicates changes. For example, seventh grade projects will be fine with the minimum number of 5. Eighth and tenth grade projects *may* need more depending on the experiment.

Assignment 12: STATISTICAL ANALYSIS

Statistical Analysis is not something that you will master in high school. It will be a continual learning experience as you learn more about how statistics can help you as the scientist to show your point. Basically, statistics can be broken down into three categories: descriptive, correlation, and inferential. ***All projects must use descriptive statistics*.** These include making pictures of your data in the form of graphs and looking at trends of the data. Correlation statistics attempts to look for relationships between data sets to try to make a stronger explanation of what is happening. Inferential statistics uses mathematical principles to show proof that there is a causal relationship between the variables being tested (Blaisdell, 1993). Beginning projects (seventh grade and some eighth grade) will focus on the descriptive aspects. Intermediate projects (most eighth grade and some tenth grade) should advance to the correlation level, while advanced projects (some tenth grade) will deal with inferential statistics. It is not recommended that a beginner project use

inferential statistics unless they can explain everything that was done. Parents and mentors should avoid doing the statistics for students as most judges will be able to identify who completed and understands their own project.

ASSIGNMENT 12

a) To use statistical analysis to determine significance in your data.
b) To write a plan for what type of data you have collected, the type of statistical analysis you will attempt, the type of test to be used, and the level of significance that will be used to draw conclusions on your project. Remember this is a plan for what you hope to accomplish.

Assignment 13: MATERIALS AND METHODS

The materials and methods section is the next part of the paper to be completed. Basically, this section puts your procedures into paragraph form for your paper. This section describes how you conducted your study. It will include materials and equipment used and all procedures completed. This is not a list of steps; everything should be written in sentences placed in paragraph format. NO RESULTS should be included in the methods section.

Note that pictures can be very helpful in describing your procedures. The pictures can be placed in an appendix at the conclusion of the paper. If pictures are included in the paper, you must refer to them at some point in the written form. It is important that you include how data was collected and the number of trials performed. If you are using a published procedure, you simply need to document the source used for the procedure. If a large amount of time was needed to engineer or build your apparatus, you may include this here. In some cases a good labeled sketch is as good as or better than pictures. You may also use a combination of pictures and diagrams.

You may include pilot studies or failed attempts if your paper is not too lengthy. This shows your ability to work through the entire problem. It is not recommended for the advanced project; however, beginners may use this to show how they solved their problem from beginning to end.

Avoid first person writing style. Do not use "I" when writing this section. Instead of saying, "I then performed three tests." Say – "Three tests were then performed." You may need some help from a parent or teacher to help proofread this section. This is not an easy section to complete. Avoid the long and drawn out version which includes every minor detail. However, be sure you include enough detail for the reader so that he/she could replicate your work.

ASSIGNMENT 13

1. To write your procedures in paragraph form to be used in the body of the paper.

Assignment 14: GRAPHS/TABLES

As you analyze your data, you need to find a way to display your data in a way that judges will understand. A clear table and graph is the easiest way to show a lot of data in a small space. A well-organized result section will make it easier to write your final conclusions.

All data should be displayed in chart or graph form. A data table can show a lot of numbers in a small area. You will want to be selective in the types of graphs and tables chosen and what data to include. For example, if you have 60 individual trials, you will want to include the mean results only. All of the

original data will be in your data journal, which will be available at your display for judges to review. **Do not graph raw data.** Avoid duplicating data in table and graph format unless it is extremely important to your study. In these cases you may want to put the table and graph in the same chart. When you make your board, you will have graphs that explain your data tables.

The type of graph is very important. For example, a line graph is only used when you have continuous data. Independent data points, which are not found on a continuum, should use a bar or column graph. If you were showing percents or parts of a whole, a pie chart would be best. You can include qualitative observations in a survey format if you used a survey to collect information. **Be sure to check with your parent or teacher to be sure you are using the best graphs or charts for the type of data you are displaying.** A good source for graphing is Students and Research (Cothron, et al., 1989). When graphing, remember "y depends on x" that means the independent variable (manipulated variable) is graphed on the x axis and the dependent variable (responding variable) is graphed on the y axis. When you name your graph, it should be named: y axis title versus x axis title.

ASSIGNMENT 14

1. To construct appropriate tables and graphs to analyze data.
   Type and Save in cloud storage then upload to Teams.

STEP 5: PUTTING IT ALL TOGETHER

Now that you are almost completed with your project, you need to think about how you will communicate your project to the judges. You will need to finish the last parts of the written paper, complete your journal, place all materials on a display board, and prepare to speak with judges about your project. The key to these final aspects of your project will be practice, practice, and MORE PRACTICE!!! If you are the expert on your topic, which you should be by now, it should be relatively easy to talk about what you did, why you did it, how you designed it, and what you plan to do in the future. Good luck, all of the hours of work are going to shine through at this time. This is why you have worked so hard!

Assignment 15: RESULTS and CONCLUSION/DISCUSSION (PAPER)

Now that you have completed all graphs and tables, you need to write about your results. This section of the paper should be written in paragraph form. You should present your results of your research findings in a logical order. You must refer to tables, charts, or graphs as you discuss the data. Tables and graphs should be numbered separately and include captions and should be placed in an appendix. Numbering will enable you to refer to each graph or table in the text easily. Be sure to give a reference back to the appendix that has the graph or table.

Even though you may present your results in a graphic form, you must explain in text the important features of each table, graph, etc. This is also the appropriate place to report the results of statistical analysis of your data. Remember to report the type of statistical test used and the p value used to determine significance (usually $p<0.05$).

Once again, avoid the use of first person writing style. Rather than "My data indicates…" you should write, "The data from this study indicates…"

The next section of the paper will be the conclusion section. You need to interpret your results in this section. Begin by restating your hypothesis or goals and explain how your data either supported or rejected your initial research questions. Discuss your research findings in relationship to what is already known about the research problem (this is found reported in your introduction section). You may want to document previous research findings to help strengthen your conclusions. Your conclusions can include relevant, subjective observations or comments however you must state that these are speculation only.

Acknowledge any limitations that affect the research results. Include major problems encountered. Be careful that these are problems that are out of your control, such as "the plants in the control seemed to die more than group 1". Don't imply that the problems were because you didn't work or try hard enough such as "I didn't read the thermometer correctly all the time."

Include future experimentation plans, which are directly a result of your study. Statistical techniques used to manipulate data may have limitations. Some of the treatment effect might have been caused by a random, uncontrolled intervening variable. Again, acknowledge these limitations and other factors over which you had no control. State how these might have influenced the outcomes of the study. Possibilities for further research suggested by your study might also be presented.

Some excellent strategies for writing conclusions can be found in Students and Research (Cothron et al., 1989), Scientific Writing in Biology (Brooks and Wallace, 1995), and A Short Guide to Writing About Biology (Pechenik, 1997). You may find a variety of sources in your local library which will help you with your writing. Read samples and get an idea of what needs to be addressed in these two sections. Don't hesitate to ask for help from your teacher. This step may involve a number of revisions to get it in its best form.

ASSIGNMENT 15

1. To put your results of your study into paragraph form, which will be used in the final paper.
2. To write a conclusion based on the relationship between the data collected and the original hypothesis.
   Type and save in cloud storage then upload to Teams

Assignment 16: ABSTRACT

It is now time to begin the final piece of the puzzle, the abstract. This is a one-page summary of the entire project. An abstract gives the reader a quick overview of the entire project. The abstract should include parts of the introduction, purpose, hypothesis, procedure, results and conclusions. It should be single-spaced and no more than 200 words. You should use a readable font of 12 so the reader can see the words. Do not try to squeeze extra words by using a small font. When you have finished typing your abstract save the file. Then copy and paste the text into the ISEF Abstract form. Your abstract must fit into this form. It will be the only one we use for competitions. Furthermore, this abstract must be vertically placed in your display during judging.

Sample Abstract

Effects of Marine Engine Exhaust Water on Algae
Jones, Mary E.

123 Main St., Hometown, PA 30920
Hometown High School, Hometown, PA

Purpose of the Experiment (paragraph 1)

An introductory explanation of the reason for carrying out the project. (Your hook)

A statement of the problem and the hypothesis created to answer the problem. Explain what you based your hypothesis on. (Use your research shows sentence from your Review of Research)

Procedures Used (paragraph 2)

A *summary* of the way you carried out the project. What you tested and how you tested it. What you measured and how you measured it. You do not need to include all the materials you used.

An abstract should only include procedures done by the student.

Observation/Data/Results (paragraph 3)

This section should provide the results that lead directly to the conclusions you have drawn. You don't have to give too many details about the results, but your averages or your most significant results can be referred to.

Any significant observations you made about the experiment while you were carrying it out. How outside factors may have affected your project.

Conclusions (paragraph 4)

Conclusions from the investigation should be described briefly.

The summary paragraph should reflect on the process and possibly state some applications for the investigation to the real world.

An abstract does not include a bibliography.

According to Martin and Brenstein (1998) the abstract should be the summary of principal findings of the paper. It should be a stand-alone document that gives all essential information about your project. They suggest that the abstract should not include headings or include information that is not in the paper. You should not use first person style or include references, figures or tables. Avoid abbreviations and do not emphasize minor details. "While it is difficult to be both concise and descriptive at the same time, that is exactly what you should strive for when writing an abstract. Say only what is essential, using no more words than necessary to convey the meaning. Examine every word carefully." (Martin and Brenstein, 1998, pg. 4)

Ask your teacher to show you examples from previous ISEF and state fairs to see samples relating to your topic.

ASSIGNMENT 16

c) To prepare an abstract for your project.

Assignment 17: FINAL PAPER

Things will wrap up very quickly in the next few days. The final paper is a compilation of all the steps that you have completed so far in your project. Your science project must be presented in written form so that it can be reviewed and studied by others. **Scientists need to share their knowledge so others can learn as well.**

As you arrange your paper, you need to update any changes that have been made since that step was last evaluated. You want to be sure to write in a past tense mode. Most scientific papers will include the following parts: abstract, title page, table of contents, introduction (we called it your Review of Research), procedure, results, conclusions, acknowledgements, sources cited, and appendixes.

Remember that the competition rules limit the paper to a total of 20 pages. The computer content should not exceed 1.6 megabytes of space as these will be emailed to judges. Work to say the most that you can in a manageable space.

Three small parts of the paper that still need to be completed are the title page, the acknowledgement section, and the table of contents.

The title page is obviously the cover to your paper. The title page states the title of the research, the category of the research, the student's name and grade in school. The first thing that a judge observes on your project is the title. The title should be well thought out and carefully constructed. The title should catch the eye of the observer without being excessively detailed or over the head of the observer. The title should define your project, giving as much detail as possible. The title should be clear and concise. Don't use a lot of connecting words. The best titles are usually ten words or less. Keep it simple, yet intriguing.

The paper competition suggests that the following rules be followed:

1. do not write the title as a question
2. do not use abbreviations
3. avoid excess words such as a, an, or the
4. avoid phrases such as a study of or investigations of
5. length of title should be more than 2-3 words but less than 14-15 words
   (Martin and Brenstein, 1998)

Sample titles are included below. You can also find sample titles in the media center or any science fair project book. (Carnahan and Hartmann, 1988; Hulse and Mc Mullin, 1991; Press, 1998) Abstracts from previous ISEF and State Competitions are online.

Title Examples:

1) Comparing Buffalo Fish Mucus and Synthetic Slime on Racing Swimwear

2) Concrete Reinforcement Phase III: Strengthening Concrete Beams Using Fiberglass Reinforced Plastic Rods and Carbon Laminates

3) The Impact of Electronic Tapes on Lesser Snow Goose Harvest Rates

4) Phase 3: The Effect of Radiation (X-Rays) on Sweet Corn Seeds

5) The Effects of Metal Hydroxide Sludge on Plant Growth

6) Automatic Packet Reporting System: Building a Large Scale Geospatial Database

The acknowledgement section allows you to thank and recognize those individuals or groups that significantly helped you with your research. You may want to check with organizations or individuals to be sure that they will allow you to put their name in your paper. Some companies and individuals are not

allowed to put their name on your work. This is a nice thank you section for individuals that guided you through the process. Acknowledgements may be included in the paper but are not allowed to be displayed on the display board.

The table of contents will help to organize your paper. It will direct the reader to all of the major sections in your paper. Although this may seem like a trivial thing to do, it may mean the difference to advancing to the next level or staying at home. A well-organized paper will be easier to follow for the judges who are reading them.

The research paper that is submitted for competition must be stapled with one staple. No other binding is allowed for competition. NO PLASTIC COVERS, FOLDER, OR THREE-RING BINDER IS ALLOWED FOR JUDGING if you compete in the Paper Competition at Regionals. You may bind your final paper for display purposes at your project display.

The paper is key to advancing in the paper competition. A strong effort here will be rewarded later in the science fair. You have put so much effort into your project that you don't want this part to be sloppy. An excellent paper should be able to be submitted for publication if everything works out.

ASSIGNMENT 17

Compile the entire project into a final paper. **Papers should be a minimum of 5-6 pages and a maximum of 20 pages, including appendices**. Length assumes a 12-point, Times New Roman font. There is no set outline for papers, but National JSHS recommends using the following outline:

1. A title page or cover page stating the student's name, school address, and title of the research
2. Acknowledgement of major assistance received
3. Table of contents
4. Any applicable disclaimers and statements (e.g. "research involving non-human vertebrates or human subjects was conducted under the supervision of an experience teacher or researcher and followed all state and federal regulatory guidance applicable to the human and ethical conduct of such research").
5. Introduction
6. Materials and methods
7. Results
8. Discussion and conclusions
9. References
10. Appendices (if needed)

Assignment 18: BOARD DISPLAY

It is now time to begin the visual display for others to admire your work. Each display must be arranged so that it clearly identifies all aspects of the project. It should tell a story about how you solved your original problem. It should be neat, attractive, and be the focal point for the judges' attention. Your display needs to show the title, purpose or problem, hypothesis, procedure, results, conclusions and abstract. If room permits you may include pictures, display materials, video, etc. Most judges will read from left to right, so it is wise to begin the story on the top left side and end with the conclusion on the bottom right side.

The display size is limited to 76cm (30 inches) deep from front to back, 122cm (48 inches) wide from side to side, and 274cm (108 inches) tall from floor to top. Most tables are 76cm high (30 inches). **Refer to the latest copy of the ISEF display rules for the latest rules on what can be displayed.**

Normally, power of 110 volt AC, single-phase service with 500 watts per exhibit will be available. Requests for other power needs must be made prior to the fair. Additional power costs will be the responsibility of the participant. The student should provide an adequate extension cord for the project. Power should be used only if necessary to power equipment that is absolutely essential to show the judges. Special effects, such as lights or a laptop, are not recommended unless critical for the judges to see. Remember that judges will cut through the fluff of the display to focus on the project content. If the power is not essential to the project content, avoid using it.

Each student is expected to assemble his or her own exhibit. Help will be limited to packing and unpacking or to situations where the physical size or weight is such that assistance is required. Be sure that you understand how everything fits together. You will need to bring the tools necessary to assemble your project. Check with your school or fair director to see if they provide basic tools.

Perhaps the most important part of the display is lettering, so it should be done with great care. Stencils, pre-made letters, or computer signs may all be used. Focus on color combinations which will enhance your project. Be sure they are easy to read and bring focus to the key parts of your project. Size of the lettering is important. Titles should be at least 2 inches tall, while subtitles should be at least 1 inch letters. Paragraph writing should not be smaller than font size 20. Judges should be able to be read the display from a distance of four to five feet away. The display should be a summary of key ideas. It does not have to be in paragraph form. Bullets and short phrases are acceptable, and some judges prefer to not have to read lengthy paragraphs on the display. During competition, the judges read through the displays without the presenter present, prior to judging. Be sure the display is easy to follow without the presenter explaining everything. The author has found that most judges do not like the display if it is a copy of the written paper put on display. The paper should be available at the display for the judges to read if they want. Most display judging will only be 10 – 15 minutes in length. Be sure the judge is able to see all of the key ideas of your display and also have adequate questions answered.

Several types of arrangements can be used for your display. Avoid copycat displays. Make your display unique to your project. It should be neat and well organized. AVOID CLUTTER! You will find that good pictures of your equipment may be more effective than a clutter of equipment. You will find several examples of display arrangements and pictures of displays in the Science room. Your teacher has several pictures on a CD from previous ISEF fairs. Ask your teacher or parents if you need supplies to put your display together. Be creative and put together a fun display. Judges will remember unique displays; however the key always comes back to your knowledge and project content.

Please make sure your project display meets all ISEF rules. Please do everything you can to abide by these rules. I will show you in class where the list is of what can and cannot be brought in. Remember pictures say a thousand words! Instead of bringing in items, **TAKE PICTURES! Be sure to journal!**

ASSIGNMENT 18 To prepare a display board which meet the needs of your project.

Assignment 19: ORAL PRESENTATION TOCLASS

This is a nerve racking experience. First and foremost remember to breathe!! You will do fine. Your job is to show the class and teacher how much are you learning from your project. We are there to listen to you and ask questions. They are very interested to learn what you did in your project and how you did it. Therefore, show excitement in your presentation. Speak up and be confident!

First begin by introducing yourself and shake your judge's hands.

Then begin with…the title of my project is _____. Do not read the abstract because you will go over all of that in your presentation.

Given them a little background information about your subject (approximately 3-5 sentences). After setting the stage to what you researched, begin by telling them:

The purpose of my project was to _____

I hypothesized that _____ would happen because _____.

I went about performing the experiment by _____

_____

If you look at the data you will see _____

I put them into a graph so that I could compare the results and come to a conclusion (Explain the graphs)

Finally, I concluded that _____

Think about what you would do again if you redid the experiment- this may be a question that the judge will ask you.

It is ok to use note cards, but do not read from them. They are there to help you if you get stuck- do not rely on them to give you all the information. Also you do not want to sound as if you memorized your presentation. Just practice and be prepared

PRACTICE, PRACTICE, PRACTICE. Do you get the feeling that there is a key theme to presenting?

Be enthusiastic, friendly, calm and in control. Always thank the audience for their attention and ask if they have any more questions. Remember that practice will be extremely important in how well you do on your oral presentation.

ASSIGNMENT 19
Present Your Project to the class

Assignment 20: SCIENCE FAIR COMPETITIONS

You are now ready for competition. The science fair begins with the local science fair (usually held the last Thursday in January). This is required. It is good practice working with judges, especially if this is your first science fair.

The next level of competition is the regional science fair. This fair is usually the third or fourth Friday in February. It is at U of M Crookston. This fair is the springboard for all future competitions. You must be selected to advance to a higher level competition. Winners can advance to the State Science Fair or the International Science and Engineering Fair. The State Fair is a three day event in the Cities in March or April. The International Science Fair is held in various cities, usually the second week in May. 2019 will be in Phoenix, AZ. There are many special awards at all levels of competition.

Although winning awards should not be your only motivation, it is a great reward for the hours of hard work that you have put into your project. Scientists enjoy talking to young scientists. Have fun and share what you have discovered.

A checklist to make sure your project is ready for the Science Fair…

RESEARCH AND REPORT

- ❑ I have stated my purpose simply and clearly
- ❑ I have given enough background information.
- ❑ I have identified all my sources of information.
- ❑ I have listed all the materials I used, and I have described them clearly.
- ❑ I have outlined all the details of my procedure so that another person could repeat my project with the same results
- ❑ I have used various ways of displaying my results: neat log, charts, tables, graphs, pictures, diagrams.
- ❑ I checked the accuracy of any calculations in my results.
- ❑ My conclusion answers the question in my purpose.
- ❑ My conclusion is supported by my results.
- ❑ I have given possible applications of my results to everyday situations.
- ❑ I have identified possible experiments or projects that arise from my results
- ❑ I have acknowledged all the people who helped me with my project.
- ❑ I have chosen a good title for my project.

BOARD

- ❑ Items are laid out in an orderly fashion.
- ❑ The size of the board suits the amount of material.
- ❑ Written material is typed.
- ❑ I have used no more than 3 colors.
- ❑ Everything can be read while standing 1 or 2m away.
- ❑ The titles are large and legible.

ORAL PRESENTATION

- ❑ I am completely familiar with the research work.
- ❑ I am familiar with my results
- ❑ I am familiar with ways that the information I've gathered can be put
- ❑ to practical use.
- ❑ I know what specific information is found in every part of my project.
- ❑ I have practiced my presentation.
- ❑ I have practiced my smiling power lately