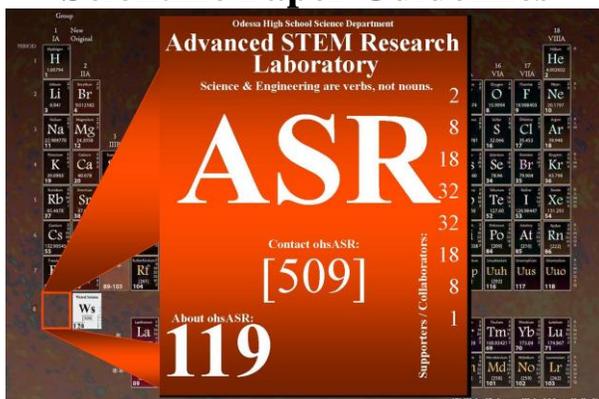


ADVANCED STEM RESEARCH

Advanced STEM Research Laboratory

Odessa High School Science Department

Scientific Paper Guidelines



All papers will be typed using Time New Roman font (12-point unless otherwise indicated), and standard margins. All sentences must be complete using proper usage of spelling and grammar. All spacing will be double space unless otherwise indicated. This report shall adhere to the style of writing indicative to scientific format: past tense and in 3rd person. The report will continue as one flowing source. Do not create new pages for each header, but rather place 1 single space between each header. Add a brief header (your title) with your name to every page of your research report EXCEPT the very first page. The entire paper CAN NOT exceed 20 pages. Individual requirements are as follows:

(1) TITLE

A. To Earn Full Credit:

Identify the important contents of the paper and orient the reader by specifying the major findings and perspective. It's important to give your paper a title that is descriptive of the nature of your research. This is the first element of your paper that your colleagues will see, and you want it to stimulate curiosity. Your title will appear in a crowded list containing dozens of other research titles, so choose the title carefully. By the way, a search through the titles of articles in the science journals shows that the typical length for titles is about 10-20 words. Just make certain the title is clear, and reflects the nature of your work and discovery. The beginning to each word is capitalized, with the exception of prepositions. There is no word indicating this is the title. A good idea is to revise or compose a new title when you are completely finished with your research paper.

B. Formatting Requirements:

16-point font; Bold; Left Justified; Single Spaced

C. Example:

Refer to accompanying research paper.

(2) AUTHOR / MENTOR / DATE / LOCATION / EMAIL / PHONE

A. To Earn Full Credit:

This tells the reader exactly who conducted the research, and wrote the paper. Your natural name found on your birth certificate is appropriate complete with your middle initial. Some research papers involve collaborations by 2 or more researchers; you need to work out with your collaborators the ordering of names in the paper. Under your name, place the word Mentor: Jeffery R. Wehr, and add other mentors if needed. The date should be updated every time you work on your paper until the final copy is ready for print. The final date will be the day you are 100% complete. The next element of the paper informs the reader where you were when you did the research. In your case, you were within the Advanced STEM Research Laboratory, Odessa High School, Odessa, WA. Next put your email, and on the next line the lab's telephone number.

B. Formatting Requirements:

All: 12-point font; Left Justified; Single Spaced

C. Example:

Refer to accompanying research paper.

(3) KEY WORDS

A. To Earn Full Credit:

Usually written after your paper is complete, your key words are just those: key words that summarize your paper used for searching methodology for others.

B. Formatting Requirements:

Key Words: Bold; Underlined; 12-point font; Left Justified; Single Spaced
Key Words themselves: 12-point font; Left Justified; Single Spaced

C. Example:

Refer to accompanying research paper.

(4) ABSTRACT

A. To Earn Full Credit:

Summarize in a short passage the major elements of your paper including objectives, methods, results, and conclusion/discussion. First, keep it simple and concise. No one will read an Abstract that is itself a mini-essay. The purpose of the abstract is to announce the bottom line of your work: What did you study, and what did you find? Your abstract must be 200-250 words or less to cover all of the bases in a lengthy piece of research. Try to remember that this may be the only thing that the majority of readers ever read about your research. They will skip your paper and read someone else's if the Title and the Abstract do not sound interesting. So, keep them short and flashy! No stats should be placed into this paragraph. It is written in a single paragraph. Usually this must be written last, as it includes all other portions of your research paper. Note the word Abstract above the passage. This must be 200-250 words MAXIMUM!

B. Formatting Requirements:

Word: 12-point; Bold; Left Justified; All Capitalized
Passage: 12-point font; Left Justified; Single Spaced

C. Example:

Refer to accompanying research paper.

(5) INTRODUCTION

A. To Earn Full Credit:

Set the stage for your scientific argument. This should interest or “hook” the reader creating an awareness of the potential significance of your research. This piece describes the particular issue or issues that your paper will address, why these issues are important, and provides the reader with a mini history lesson to the topic. No research is conducted in a vacuum. No matter what you elect to investigate, there is likely to be some paper out there, already published, that has some relevance to your topic. **IT IS YOUR RESPONSIBILITY TO FIND ALL OF THE RELEVANT ARTICLES AND CITE THOSE THAT IMPACT YOUR WORK.** You may have to do a bit of library research to uncover additional papers that have been published. Usually, all of this work is done **BEFORE** you start your investigation. You might, for instance, be reading someone's paper on infrared observations of the Orion Nebula, and decide to study the infrared emission from the Lagoon Nebula. Have these already been made? If not, you are free to do them yourself if you have the resources. But make sure that you tell the reader why such observations are needed by citing similar studies done by others. Introductions have to be kept simple, and should probably not constitute more than 15 percent of your paper. Again, I cannot stress enough that you make certain you include citations to all related work that has been published, but keep this list brief. No one wants to see 50 citations, but the top 8 or 15 may be a good number. The introduction must include relative background information, clearly defined uncommon names or terms used during the report, and citations to sources located in your references / literature cited.

B. Formatting Requirements:

Word: 12-point; Bold; Underlined; Left Margin; First Letter Capitalized
Passage: 12-point font; Standard margins; Double Spaced

C. Example:

Refer to accompanying research paper.

(6) MATERIALS / METHODS

A. To Earn Full Credit:

This section tells the reader all about how you conducted the research to get the new data you are presenting. For purely theoretical papers there is no 'Observation' section, but usually a section that presents the basic outline of the theoretical modeling and the basic equations that comprise such a research program. Mold the methodology that provides the context for evaluating your data. This includes measurements, controls, variables you considered and did not consider, and materials you think are necessary to include. Drawings, figures, or tables are a must for this section and

should be created with professional software such as Google SketchUp or similar. All types of units need to be addressed and possible explanations as to why your procedure was conducted in the manner you chose. This section should be so complete that a person with no scientific knowledge could completely reproduce your procedure.

B. Formatting Requirements:

Word: 12-point; Bold; Underlined; Left Margin; First Letter Capitalized

Passage: 12-point font; Standard margins; Double Spaced

C. Example:

Refer to accompanying research paper.

(7) RESULTS

A. To Earn Full Credit:

Summarize and illustrate your findings. This portion should emphasize important trends and patterns. **IT SHOULD NOT** include any conclusive ideas like, “The data prove that birds fly...” Prove should **NEVER** be used anywhere in your research paper. I cannot emphasize enough that you do not draw conclusions during this portion of your research paper. You need to compare your data statistically, but only to validate your experimental process! In other words, create a table showing the mean, standard deviation, variance, and population of each trial (minimum and maximum values from your data set are not uncommon, but not necessary). Since your experiment is trying to show the relationship of something against something else (or comparing one trial or set with another), then your results should include sentences that relate to this topic. Input which trial had the maximum values and which trial had the minimum values with numbers and units to support your discussion (which comes next)...**BUT NOT WHY THEY HAD THESE VALUES!!!** Save this for the discussion.

Any data supported by graphs or tables in your report should reveal a “trend” for that data. **THIS IS WHAT WE ARE AFTER!!!** Input these trends in your results... specifically if the trend is positive (slope rises) or inverse/negative (slope falls).

Discuss the standard deviation trend...why is trial 1 the highest for standard deviation (if it was)? Why are the standard deviations for the middle trials lower than either end? Of course, you would not explain **WHY** in your results, simply that they differ (and make sure you place the number and unit for all you mention.

Remember you **MUST** mention your tables or figures textually within the results **BEFORE** the actual table or figure is shown. Each table or figure must have a label with a complete sentence (usually) explaining the table or figure (see Figure 3) (note how I textually mentioned Figure 3 **BEFORE** you saw Figure 3, then, I may refer back to it at my leisure).

If you use numbers within the text of your results, make sure they have proper units along with them (if needed). We use this data so much, we assume everyone knows what we are talking about. An example:

The calibration of trial 2 (T2) was 0.39. (INCORRECT)

The calibration due to elasticity loss of the launching mechanism during trial 2 (T2) was 0.39 m. (CORRECT)

Stay consistent with your nouns...if you are calling your trials the control data, then call them the control data throughout your entire paper. I realize you are tremendously excited about your data, but do not capitalize words which need not be capitalized: Trial 1 should be trial 1, Standard Deviation should be standard deviation...**HOWEVER, DO** capitalize the “F” in “Figures” and “T” in “Tables.”

WRITE SUCCINCTLY!

* Use verbs instead of abstract nouns

Instead of: take into consideration
Write: consider

* Use strong verbs instead of "to be"

Instead of: The enzyme was found to be the active agent in catalyzing...
Write: The enzyme catalyzed...

B. Formatting Requirements:

Word: 12-point; Bold; Underlined; Left Margin; First Letter Capitalized
Passage: 12-point font; Standard margins; Double Spaced

C. Example:

Refer to accompanying research paper.

(8) DISCUSSION

A. To Earn Full Credit:

This is where you can hypothesize and tell the reader what the data you found means. **DO NOT USE**, “I think that...” but rather, “...the data supports...” Here is the place to discuss the works of other researchers too and tie in their findings with your own. This section is the heart of your paper. It describes in detail just what you are planning to do with the data and evidence you have now accumulated. The reader has been very patient going through all of the previous sections, so you had better make this section “sing.” The Discussion section describes how you have interpreted the direct observations, and the derived quantities you presented in the previous sections. This interpretation should lead the reader to some new insight to your particular research area, perhaps a re-determination of some critical idea used by other researchers, a new refinement to a theory, or evidence that some previously-held understanding is incomplete or incorrect in some fundamental way.

Choose and execute the proper statistical analysis for your research: t-test, z-test, chi square, ANOVA, Tukey’s HSD, or Pearson r to name a few. You may have to check online or what is common in the literature on which statistical analysis best fits your data. Being sure there is or is not a statistical difference between your data sets is crucial for proper data analysis! Then expand on what the differences or lack of differences means?

Often in the past, this portion is the most neglected because it is left until the end to

complete, however, this portion of your research paper is perhaps the most important! It should also include the “real world” relevance of why the topic that you chose to devote so much time toward may or may not impact the scientific or engineering world. Other good suggestions include offering what may have went wrong with your research or how you would improve your research when you continue it next year.

B. Formatting Requirements:

Word: 12-point; Bold; Underlined; Left Margin; First Letter Capitalized
Passage: 12-point font; Standard margins; Double Spaced

C. Example:

Refer to accompanying research paper.

(9) ACKNOWLEDGEMENTS

A. To Earn Full Credit:

Use complete sentences offering gratuity to person(s) you deem important toward the completion of your research or paper. Normally we do not thank persons such as our parents for “giving birth” to us, but if your mother or father helped you with a design or technique, you may offer words of thanks, making sure you note each person’s full name, **NOT** that she is **MOM**. Make sure you are specific with the reason you are thanking them; if you can not be specific, that is an indication you do not need to acknowledge that person.

B. Formatting Requirements:

Word: 12-point; Bold; Underlined; Centered; First Letter Capitalized
Passage: 12-point font; Standard margins; Single Spaced

C. Example:

Refer to accompanying research paper.

(10) APPENDICES

A. To Earn Full Credit:

Any larger informative document you either used or refer to continually that is too large for the main body of the paper, should be included in an appendix. Typical appendices include surveys used, extensive test reports from qualitative or quantitative analysis, or specification manuals for particular apparatus or methods.

B. Formatting Requirements:

Word: 12-point; Bold; Centered; First Letter Capitalized
Passage: A header explaining the document, followed by a picture or document imbedded in the paper. 12-point; Single Spaced

C. Example:

Refer to accompanying research paper.

(11) LITERATURE CITED

A. To Earn Full Credit:

Cite the sources you used inside of your research paper. Do not cite dictionaries, encyclopedias, or other reference materials. In this portion, your research should be supported by **JOURNAL** articles paralleling your research. There are many citation formats used in science: CBE, ACS, IEEE, CHICAGO, MLA to name a few. Place citation numbers for references and notes within brackets: [3]. Do not use superscript numbers or author last name anymore. Citations are numbered sequentially, first in the text, then through the references and notes, then through the figure and table captions, and finally through the supporting online material. List initials first for all authors: AB Opus, BC Hobbs. Do not use "and." Use *et al.* (italics) for more than five authors. Titles of cited articles can now be included, with words in lower case except for proper nouns, followed by a period (see samples). Journal titles are in italics and abbreviated (you may have to look up HOW to abbreviate each journal); volume numbers follow, in boldface. Do not place a comma before the volume number or before any parentheses. You may give the full inclusive pages of the article, but do NOT have to use p or pp for pages. Journal years are in parentheses: (1996). End each listing with a period.

B. Formatting Requirements:

Word: 12-point; Bold; Underlined; Centered; First Letter Capitalized
Passage: 12-point font; Standard margins; Single Spaced.

C. Example:

Journals

- One Author

1. N Tang, On the equilibrium partial pressures of nitric acid and ammonia in the atmosphere. *Atmos. Environ.***14**, pp. 819-834 (1980).

- Two or More Authors (note there is NO *and* or *&* sign)

2. WR Harvey, S Nedergaard, Sodium-Independent Active Transport of Potassium in the Isolated Midgut of the Cecropia Silkworm. *Proc. Natl. Acad. Sci. U.S.A.* **51**, pp. 731-735 (1964).

Books

3. D Curtis *et al.*, in *Clinical Neurology of Development*, B Walters, Ed. (Oxford Univ. Press, New York, 1983), pp. 60-73.

Technical Reports

4. GB Shaw, "Practical uses of litmus paper in Möbius strips" (Tech. Rep. CUCS-29-82, Columbia Univ., New York, 1982).

Published Online Only

5. NH Sleep, Stagnant lid convection and carbonate metasomatism of the deep continental lithosphere. *Geochem. Geophys. Geosyst.*, **10**, Q11010 (2009), doi:10.1029/2009GC002702.