ORLANDO SCIENCE CENTER

GUIDELINES FOR PAPERS

for

DR. NELSON YING SCIENCE COMPETITION
ORLANDO SCIENCE CENTER

General details

- The paper should not exceed 10 pages, not including references and appendices.
- References and appendices (e.g., for long tables of data) should not exceed 5 pages.
- Write the paper double spaced, in a standard font (e.g., Times) no smaller than 12 point.
- Use the format outlined below.

Title

- Write a short title (no more than two lines) that communicates the scientific content of the work.
  Example: "Seasonal Variation of Nitrate Concentration in the Indian River"
- Avoid using catchy titles that are fun but devoid of scientific content.
  Example: "Where Has All the Nitrate Gone?"

Your Full Name

Name of your school

Abstract

- Write one paragraph that summarizes your research.
- The abstract must communicate:
  1. The main questions and/or hypotheses;
  2. The key results and conclusions; and
  3. The significance of those findings.
- Recommended approach:
  1. Write the abstract last.
  2. Select key sentences from your paper.
  3. Edit those sentences so they give a coherent and connected summary of the key findings.

1. Introduction

- Introduce your general subject.
  Your audience is a set of scientists with varied backgrounds and specialties. Explain the importance of the subject to someone not already working in that discipline. Including citations to the literature.
- Focus the narrative down to your specific research questions or hypotheses.
  Explain why your research was worth doing, and more specifically, why you choose your particular system for study.
- If your project is driven by hypotheses, then state them clearly.
  A scientific hypothesis is an if-then statement, or a cause-effect statement (e.g., if *X* happens, then *Y* follows, or *X* causes *Y*). If your research cannot be simply stated that way,

phrase it as a question (i.e., do not force a hypothesis). For example, a research question may be phrased as “What happens if *X*?” or “When does *X* happen?” Include any null hypotheses you may have.

- If your research is "discovery-driven," then state the question(s) you tried to address.

  Many great discoveries in science are driven not necessarily by a narrowly defined hypothesis, but rather by an open-ended question − a "what would happen if..." type of question − the answer to which reveals something new about how nature works. If your research is discovery driven, then state the question(s) you tried to address.

  State the question(s) clearly. Indicate why these are important questions and how answering them generates knowledge or information that is not already available from the literature.

- Use third person throughout the paper.

  Third person voice is preferred in scientific writing. For example, "Samples were prepared following the method of Zabinsky et al." rather than: "I prepared the samples..." But use active voice whenever possible. For example, "Nitrate concentration in the Indian River varied seasonally..." is preferred to "Nitrate concentrations are shown by the data to have varied seasonally."

- Define key terms and concepts related to the problem.

  Remember your audience – they will be able to follow your narrative, but they should not have to look up many specialty terms and acronyms.

- Include diagrams as needed.

  Diagrams throughout your work can be extremely helpful for explaining concepts efficiently. Number the figures. Each figure should be directly referred to, or "called out," within the text. Provide a succinct caption that explains components of the figure.

2. Methods

- Describe your methods in sufficient detail that the reader could repeat the study.

  Specifically, explain:

1. Where and when was the investigation conducted?
2. Who helped conduct the study, including planning, hands-on work, and analyses and writing? List all who contributed and how they helped (e.g., mentor, parents, a peer, a graduate student in your mentor's lab, etc.).
3. What was the structure of the investigation? *This is important!* Your audience needs to understand how the investigation was conducted. For example, how many times were experiments repeated, or how many replicates were there per study group? How were the data collected? Were measurements recorded once per replicate, or multiple times? What were the experimental controls? Include photos and flow charts as appropriate to better show the study system and processes involved.
4. What equipment, software, and/or protocols were used?
5. What statistical analyses were used, and with which software? *Analyses must match the experimental design.*
6. Cite approvals obtained in advance (if needed) by an Institutional Review Board (if people were your subjects) or Institutional Animal Care and Use Committee (if vertebrate animals were your subjects).

3. Results

- Summarize the results of your study.
- Start with a summary statement (e.g., "*N* samples were collected for each of the *X* treatments during *T* weeks") and then get more specific.
- Give the experimental facts without interpretation.

  Present your data, measurements, and observations, without discussion. Save detailed discussion and interpretation of the data for the Discussion section. Your own measurements and observations can be presented without citation, because this is entirely your own work. Something that needs a citation should go in the Discussion, and not in the Results section.
- Use tables and graphs when possible.

  Tables and graphs are *essential* to clearly convey results. Make these as clear as possible.
- Report the methods used to analyze the data, in combination with tables and figures.
- Report the uncertainty in your measurements.

  Explain the major sources of uncertainty and how uncertainty was determined. Where measurements are given as averages (or other statistical quantity), give error bars (ideally as 95% confidence intervals (CIs). Keep in mind that two averages are only statistically significant if one average lies outside the other's CI. Use similarly rigorous criteria to analyze results and make conclusions. Do not show raw data and expect your audience to detect overall patterns.

4. Discussion

- Begin with a general paragraph that serves as a summary of details presented in subsequent paragraphs.
- Discuss specific results.

  Proceed with paragraphs that explain your interpretations of specific results. Provide answers to your hypotheses or questions. Answer the questions: "What do the results mean? Why are they important?" Cite literature throughout these paragraphs as needed.
- Now shift to the general again.

  Write one or more paragraphs that explain implications of your findings for the study system and beyond. How is the theory or practice of your broader subject affected by your research? What are the next steps to this line of inquiry? What questions remain for future research projects?

  Connect your results to cited literature and the hypotheses/questions posed in the Introduction. How do your results advance the subject beyond the cited knowledge base? Do your results support or negate previous findings?
- End with a summary paragraph.

  Finish this section with a summary statement of evidence related to your hypothesis/question (e.g., in summary, results supported the hypothesis that *X* causes *Y*, though results also depended on *Z*).

5. Conclusions

- Conclude with a final paragraph that makes clear to your audience what the main findings were and why those results are important.

6. Acknowledgements

- List all individuals who helped you complete the work. These include collaborators, mentors, teachers, parents, individuals who provided equipment or other resources, and proof readers. For each individual, give their affiliation and briefly state their contribution.
- Example:

  "The author thanks Mr. James C. Maxwell (Neighborhood High School) for helping develop the research questions, Dr. Gilbert Lewis (Local University) for providing access to instrumentation, Ms. Rosalind Franklin (Santa Fe Institute) for helping solve problems with data analysis, and Charles L. Dodgson for proof reading this report."

7. References

- List all references cited above, using a standard format (e.g., APA or MLA) appropriate to a representative journal for your discipline. Ensure that all references listed are cited and vice versa.
- Make sure the literature you use and cite is the most current. The older literature is no less valuable, but be sure your understanding of your field is current.

A note on plagiarism:

- The review committee will check submitted materials for plagiarism.
- Plagiarism is defined as taking someone else's words or ideas and passing them off as your own.
- The best way to avoid plagiarism is to give credit when using the ideas of others through citation. Citation is required for both direct quotes and rephrased ideas.

Example papers:

Provided below are some examples of peer-reviewed articles that illustrate most of the requirements outlined above. Please consult these and similar peer-reviewed articles.

1. C. D. Hatch, J. S. Wiese, C. C. Crane, K. J. Harris, H. G. Kloss, and J. Baltrusaitis. "Water adsorption on clay minerals as a function of relative humidity: Application of BET and Freundlich adsorption models." Langmuir, **28**, 1790−1803 (2012) (http://pubs.acs.org/doi/pdfplus/10.1021/la2042873).
2. G. J. Miller, A. M. G. Cunningham, Y. Iwase, N. L. Lautensack, W. M. Sattley. "A laboratory activity demonstrating the antibacterial effects of extracts from two plant species, *Moringa oleifera* and *Allium sativum* (Garlic)." *J. Microbiol. Biol. Educ.*, **18**, 1 - 6 (2017) (http://www.asmscience.org/content/journal/jmbe/10.1128/jmbe.v18i3.1306).
3. V. Oliveira. "Measuring *g* with a classroom pendulum using changes in the pendulum string length." *Phys. Educ.* **51**, 063007-1 - 063007-1 (2016) (http://iopscience.iop.org/article/10.1088/0031-9120/51/6/063007).

4. M. Á. González, M. Á. González, J. Vegas, and C. Llamas. "Measuring the coefficient of restitution and more: a simple experiment to promote students' critical thinking and autonomous work." *Phys. Educ.* **52**, 055002-1 - 055002-13 (2017) (http://iopscience.iop.org/article/10.1088/1361-6552/aa71ea).
5. C. Baldock and R. Johnson. "Investigation of kinetic friction using an iPhone." *Phys. Educ.* **51**, 065005-1 - 065005-6 (2016) (http://iopscience.iop.org/article/10.1088/0031-9120/51/6/065005).

Further Information:

If you have any questions, please feel free to contact us at **competitions@osc.org**.