

# **Illinois Junior Academy of Science**

## **Policy & Procedure Manual**



**September 2008 – August 2010**

*This Policy and Procedure Manual replaces and supersedes all previous publications.*

A copy of this manual should be given to all Science  
Project Sponsors and Student Participants

**This Manual May Be Downloaded From The IJAS  
Website and Duplicated As Needed**

Official Website

**[www.ijas.org](http://www.ijas.org)**

## AIMS AND OBJECTIVES OF THE POLICY AND PROCEDURE MANUAL

The primary aim of this manual is to communicate the information needed by the student and sponsor so that a safe and humane experimental project or paper is presented at the regional and state expositions. Please read this book carefully and resolve any questions before you enter a project or paper.

While the Illinois Junior Academy of Science would like for all schools and regions to follow all rules, regulations, and guidelines of the state organization, it does not have the power to enforce these policies at the school or regional level. However, the Illinois Junior Academy of Science will insist that all projects and papers entered into state competition meet ALL of the rules, regulations, and guidelines of the Illinois Junior Academy of Science.

Projects that are sent to the State Science Exposition that do not meet the rules, regulations, and guidelines of the Illinois Junior Academy of Science will be disqualified.

The Board of Directors of the Illinois Junior Academy of Science will allow no exceptions to the rules and guidelines as stated in this policy and procedure manual.

Safety rules are not meant to be barriers to progress that have been arbitrarily imposed to make it difficult for students to present a project. The objective of the *Policy and Procedure Manual* is to provide policies and procedures that are designed for the safety of the experimenter, as well as the safety of those that will judge and/or view the project.

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## Join IJAS!

**Membership in IJAS is open to all public and private schools in the state of Illinois.**

Find out how rewarding participation in IJAS activities can be. Visit us on the web at:

[www.ijas.org](http://www.ijas.org)

Join by **December 31** to take advantage of our regular annual membership fee.

**Note: All participants in IJAS activities, projects or sessions at the State Exposition must be enrolled in IJAS member schools.**

**The Illinois Junior Academy of Science**  
**Policy and Procedure Manual**  
**Effective September 2008 through August 2010**

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# ILLINOIS JUNIOR ACADEMY OF SCIENCE

## MISSION STATEMENT

The mission of the Illinois Junior Academy of Science is to present science as a rational observation and systematic investigation of natural phenomena; to stress the importance of critical thinking and logical reasoning; and to encourage students to view science as an interdisciplinary study applicable to society and its interactions with the environment.

## WHAT IS A SCIENCE EXPOSITION?

A Science Exposition is the occasion at which students present their science projects and papers to judging teams and to other participants and visitors. The exposition may be local, regional, or statewide; it may involve from fewer than ten to over a thousand projects. A science exposition is NOT a competition. Students do not compete against one another nor do schools compete against other schools. Each project is independently judged against a set of objective scientific criteria.

Science exposition means different things to different people:

- TO STUDENTS, it means an opportunity to pursue some aspect of science, which is interesting, and to learn first hand the basics of the scientific process.
- TO TEACHERS, it is an incentive that may be placed before the more capable, science-oriented student.
- TO ALL OF US, it provides encouragement and recognition for those students who may become the scientists of the future.

All Illinois schools, public and non-public, which enroll students in grades seven through twelve, are invited to join the Illinois Junior Academy of Science and participate in the Illinois Junior Academy of Science sponsored science exposition by contacting the Illinois Junior Academy of Science. You will find that there are many people willing to help you with student problems, with the local fair or exposition, and with the regional and the state exposition. For you as a sponsor or student participant, this *Policy and Procedure Manual* represents one source of help.

All participants at all local, regional, and state expositions, to assure safety and minimize confusion, should follow the rules and regulations listed in this policy manual.



## ILLINOIS STATE GOALS AND STANDARDS

As a result of participation in scientific investigation and the science exposition, students fulfill several of the *Illinois State Goals and Learning Standards*. These include:

- **State Goal 3 (English/Language Arts):** To write to communicate for a variety of purposes.
- **State Goal 4 (English/Language Arts):** To listen and speak effectively in a variety of situations
- **State Goal 5 (English/Language Arts):** To use the language arts to acquire, assess and communicate information.
- **State Goal 7 (Mathematics):** Estimate, make and use measurements of objects, quantities and relationships and determine acceptable levels of accuracy.
- **State Goal 8 (Mathematics):** To use algebraic and analytical methods to identify and describe patterns and relationships in data, solve problems and predict results.
- **State Goal 10 (Mathematics):** To collect, organize and analyze data using statistical methods; predict results; and interpret uncertainty using concepts of probability.
- **State Goal 11 (Science):** To understand the processes of scientific inquiry and technological design to investigate questions, conduct experiments and solve problems.
- **State Goal 12 (Science):** To understand the fundamental concepts, principles and interconnections of the life, physical and earth/space sciences.
- **State Goal 13 (Science):** To understand the relationships among science, technology and society in historical and contemporary contexts.



# THE SCIENCE PROJECT

## CATEGORIES

**Students must design an experiment to investigate a question or problem. A project based solely on library research is NOT an acceptable project. The following guidelines should give you an indication of what type of experimentation can be done within each category and help to place a given project in the proper category for judging. NOTE THAT A MODEL OR DEMONSTRATION IS NOT AN ACCEPTABLE PROJECT.**

**AEROSPACE SCIENCE...** is the science of the study and investigation of the earth's atmosphere and outer space. In the wide sense, it would include the design, manufacture, and operation of aircraft. Some topics that fall within this division are the operation of rockets, guided missiles, anything related to space travel, operation, and/or construction of satellites, observations of airflow patterns within tunnels, and the use of navigational equipment.

**ASTRONOMY...** is the science dealing with all of the celestial bodies in the universe, including the planets and their satellites, comets and meteors, the stars and interstellar matter, the star systems known as galaxies, and clusters of galaxies. Modern astronomy is divided into several branches: astrometry, the observational study of the position and motions of these bodies; celestial mechanics, the mathematical study of their chemical composition and physical condition from spectrum analysis and the laws of physics; and cosmology, the study of the universe as a whole.

**BEHAVIORAL SCIENCE\*...** is the science that studies the demeanor or deportment of humans and other animals by means of observable response and the interpretation of the same as offered by the social sciences, sociology, psychology, etc. Some topics that fall within this division are the effect of stimuli on organisms and their responses, learning, motivation, emotion, perception, thinking, individuality, personality, and adjustment.

**BIOCHEMISTRY\*...** is the branch of chemistry relating to the processes and physical properties of living organisms. Topics that fall within the biochemistry division are the properties and reaction of carbohydrates, lipids, proteins, enzymes, blood, urine, vitamins, hormones, poisons, and drugs. The chemistry of absorption, digestion, metabolism, respiration, and photosynthesis as organic processes also belong in this category.

**BOTANY...** is the division of biology that deals with plant structure, reproduction, physiology, growth, classification, and disease. Some topics included in this category are specialization in plants, functions of various plant structures, reproduction, and heredity.

**CELLULAR & MOLECULAR BIOLOGY\*...** is the study of the organization and functioning of the individual cell; molecular genetics focusing on the structure and function of genes at a molecular level. Other topics may include the structure and function of the immune system, innate and acquired immunity, and the interaction of antigens with antibodies. Molecular biology concerns itself with understanding the interactions between the various systems of a cell, including the interrelationships of DNA, RNA and protein synthesis and learning how these interactions are regulated.

**CHEMISTRY...** is the science that deals with the structure, composition, and properties of substances and of their transformations. Some topics included in this category are the composition of various compounds, the formulation of various compounds, the study of gas laws, atomic theory, ionization theory, and the analysis of organic and inorganic products.

**COMPUTER SCIENCE...** includes the study and development of computer hardware, software engineering, Internet networking and communications, graphics (including human interface), simulations/virtual reality or computational science (including data structures, encryption, coding, and information theory). Topics in this category may include writing an original program and comparing it to an existing one, developing a new language and comparing it to an existing one, etc.

**CONSUMER SCIENCE\*...** is the study of comparisons and evaluations of manufactured or commercial products. Topics included in this category are taste tests, color preferences, quality control, and product efficiency.

**EARTH SCIENCE...** is the science concerned with the origin, structure, composition and other physical features of the earth. Some topics that fall within this division are geology (earth composition, rock formation, fossils, minerals, and fossil fuel); geography (landforms, soils, classification of streams, erosion, and sedimentation); oceanography (ocean waves, ocean currents, composition of ocean water and coastal zone management); seismology; geophysics; and meteorology.

**ELECTRONICS...** is the branch of engineering and technology that deals with the manufacture of devices such as radios, television sets, and computers that contain electron tubes, transistors, chips, or related components. Topics in this category are circuits (electrical, electric digital and analog) for communication such as radio, radar, laser, transistor, television, and integrated circuits; electricity; electric motors; solar cells and amplifiers.

**ENGINEERING...** is concerned with the practical application of scientific knowledge in the design, construction, and operation of roads, bridges, harbors, buildings, and machinery, lighting, heating, and communication systems. Some topics in this category are stress testing of building materials, strength composition of building materials, collection of data from operating systems to compare and contrast their effectiveness.

**ENVIRONMENTAL SCIENCE...** is the study of the protection and care of natural resources. Topics included in this category are solar energy and its uses, water purification and usage, pollution control, soil chemistry, and insecticides. Within this area is ecology, which is the study of ecological systems, and ecological population studies.

**HEALTH SCIENCE\*...** is that science concerned with the study of the human body and good health practices. Topics to be found under this category are proper diet, care of the teeth, care of the eyes, and hygiene.

**MATERIALS SCIENCE...** is the study of materials, nonmetallic as well as metallic, and, how they can be adapted and fabricated to meet the needs of modern technology. Using the laboratory techniques and research tools of physics, chemistry, and metallurgy, science is finding new ways of using plastics, ceramics, and other nonmetals in applications formerly reserved for metals.

**MATHEMATICS...** is the science dealing with the measurement, properties, and relationships of quantities as expressed in numbers or symbols whether in the abstract or in their practical connections. Some topics included under mathematics are arithmetic (use of numbers, symbols, and numerical systems); algebra (probability, theory of equations, progressions, permutations and combinations); geometry (topology, study of geometric figures, similar figures, and scale drawings); calculus; trigonometry, statistics and graphing.

**MICROBIOLOGY\*...** is the branch of biology concerned with the study of microorganisms. Topics to be found in this category are the structure and physiology of bacteria, viruses, yeasts, fungi, and protozoa, and studies involving cells or tissues in cultures.

**PHYSICS...** is the science that deals with the laws governing motion, matter, and energy under conditions susceptible to precise observation as distinct from chemistry or sciences dealing with living matter. Topics found in the category of physics are hydrostatic force and pressure, gravity, Newton's Laws, relativity, kinetic theory, motion forces, work, energy, sound, light, and magnetism.

**ZOOLOGY\*...** is the science that deals with animals with reference to their structure, functions, development, evolution, and classification. Some topics that fall within this category are structural and functional studies of vertebrates and invertebrates, physiology, reproduction, heredity, and embryology.

**\* PROJECTS IN THESE CATEGORIES MAY NEED AN ENDORSEMENT(S)**

## CHOOSING A TOPIC

- **Be creative!** Plan a project that is original in plan or execution. The project should express scientific ideas in new or better ways.
- **Be scientific:** investigate and explore an interest - a fascination - something that gives you a question you would like to be able to answer. The library is an excellent place to start.
- The student should consider the research problem in relation to his or her scientific background, financial situation, desire to contribute to science, the time required for the study, and the availability of resources and materials.
- It is important that each project have a central theme or purpose, that is, to answer a definite scientific question or to solve a problem.
- The experimentation behind a science project is what is significant. It is not the choice of the topic that is most important, but the way the project is handled. Sometimes the simplest topic offers the greatest challenge to the imaginative and intelligent student.
- Start planning early in the year.
- Be realistic about the amount of time needed and available.

## USING THE SCIENTIFIC METHOD

### 1. FORMULATE YOUR RESEARCH OBJECTIVES

Decide what question you want to answer or what problem you want to solve. Be sure to have adequate technical and financial resources available to conduct your research. State your objective clearly in writing.

### 2. PERFORM BACKGROUND RESEARCH

Before you begin your project, you must become as knowledgeable as you can about your topic and about other research that has been done on that topic. You may use books, scientific literature, the Internet, or interviews with scientists or other knowledgeable people. This research not only helps you get ready to conduct your experiment, but will form the background for the Review of Literature (**see page 14**) required in your report.

### 3. FORMULATE A HYPOTHESIS

Based on the background research, write a statement that predicts the outcome of the experiment. Many hypotheses are stated in an “if . . . then” statement where the “if” statement pertains to the independent variable, and the “then” statement pertains to the dependent variable. For example, if plants are grown under various colors of light, then the plants grown under blue and red lights will show the greatest increase in biomass.

### 4. DESIGN THE EXPERIMENT

Decide what data you need to meet your research objective and how you will collect it. Be sure to consider possible hazards in your experimental approach and decide how you can conduct your research safely (**Consult the Safety section pages 8-12**). In addition, IJAS has special rules concerning the use of human and non-human vertebrates in your research. Be sure to consult these rules (**see page 9**) before finalizing your experimental design.

In order to obtain valid experimental results, consider the following items when designing the experiment:

- Make sure the quantity and quality of data you collect provides a reasonable assurance that your research objectives will be met.
- Identify all significant variables that could affect your results.
- Control any significant variables not manipulated in your experiment to the extent possible.
- Include a control or comparison group in your experimental design.

Be sure to establish deadlines for completing the different phases of your research. These phases might include building equipment, collecting data, analyzing the results, writing the report, constructing your display board. Also, remember to use metric measurements whenever possible.

## 5. CONDUCT THE EXPERIMENT

Follow your experimental design to collect data and make observations. Be sure to keep a log as you conduct the experiment to record your data, any problems you encounter, how you addressed them, and how these problems might have affected your data. This log will be used when you write your report.

Keep these points in mind when conducting your experiment:

- If you get results that seem wrong or inconsistent, do not just throw them out. Try to figure out what happened. Maybe the data is correct and your hypothesis is flawed. Try to explain these “outliers” in your report.
- Don’t get discouraged when you encounter problems. Scientists often have to repeat experiments to get good, reproducible results. Sometimes you can learn more from a failure than you can from a success.

## 6. REPORT THE RESULTS

Your report should provide all the information necessary for someone who is unfamiliar with your project to understand what you were trying to accomplish, how you did it, and whether you succeeded. It should be detailed enough to allow someone else to duplicate your experiment exactly. Be sure to include charts and graphs to summarize your data. The report should not only talk about your successful experimental attempts, but also the problems you encountered and how you solved them. For IJAS judging, you must also prepare an oral report (**see page 16**) and a display board (**see page 18**) to accompany the written report.

Be sure to consult this policy manual, section “Writing A Scientific Research Paper,” for IJAS report guidelines (**see page 13**). These guidelines must be followed exactly.

## RULES AND REGULATIONS

The student and the sponsor have ultimate responsibility for the safety of the student and test subjects while doing experiments or otherwise developing a project for a Science Exposition. Because many dangers may not be readily apparent, some guidelines are presented here to aid in developing a safer project.

All project development and experimentation must be conducted only with proper supervision. This is particularly true for chemicals, radiation sources, and biological cultures many of which are governed by rules and regulations, both State and Federal, that affect both handling and disposal.

All exhibits must conform to the following regulations for Region and State expositions. These same rules should be used, where applicable, at local as well as district expositions.

- Your school must currently be a member of the Illinois Junior Academy of Science, Inc.
- To participate at the State Exposition you must have participated in a Regional Fair and have been selected for the State Exposition.
- No projects presented in previous years will be allowed at the Region or State Exposition unless they have been improved and expanded and are the result of further research and experimentation.
- Grades 7 and 8 make up the Junior Division, while grades 9, 10, 11, 12 are in the Senior Division.
- A typed research paper plus a typed one-page Abstract of the paper must be displayed with your project. The Abstract is the first page of the research paper and serves as the cover sheet(see Appendix – page 44). At the State Exposition, you must have three (3) copies of your complete research paper. Copies of your research paper may be used for special judging and may NOT be returned. It is recommended that you retain the original copy of your research paper.
- A typed Safety Sheet signed by the student and his/her sponsor must be located behind the Abstract in the research paper. Lack of a signed Safety Sheet will result in the project being disqualified. This sheet must specify all hazards and potential hazards in addition to the precautions taken by the experimenter. If no safety hazards exist, a statement to that effect must be made(see Appendix – page 45).
- If your project involves human or non-human vertebrates, vertebrate tissues, microorganisms, the appropriate Endorsement must follow the Safety Sheet in your research paper. Lack of this Endorsement will result in disqualification. (see Appendix – pages 46-48)
- A copy of the Abstract, Safety Sheet, and Endorsement sheet(s) (if applicable) must be displayed on the front of the exhibitor's display board. They may be reduced to a minimum of a half sheet of standard paper.
- Students are to remain with their projects during the official period of judging.
- Projects may involve more than one student, but not to exceed four students.
- A student may enter only one project.
- Normal wear and tear on the exhibit is to be expected during the time that the exhibit is open to the public. If valuable equipment is on display, it is your responsibility for its supervision.
- All equipment, material, and research papers exhibited during the science exposition are entered at the risk of the exhibitor. Neither the Illinois Junior Academy of Science nor the sponsors assume any responsibility for loss or damage to such equipment, materials, or research papers.

# SAFETY GUIDELINES FOR EXPERIMENTATION

## CHEMICAL

- Students should always wear eye protection and appropriate protective clothing when working with any chemical.
- The student and the sponsor should seek data from a textbook, Merck Index, Material Safety Data Sheet (MSDS) or other responsible source regarding the health hazards, combustibility, and compatibility of the chemical with other chemicals. Before beginning a project review the recommended procedures for safe use and handling of the chemical.
- All chemicals must be disposed of in accordance with State and Federal Environmental Rules and Regulations.
- If possible, the student should work under the supervision of a responsible chemist.
- The Safety Sheet must include a statement as to the proper handling of any chemicals.
- Students who produce alcohol in connection with a science fair project must obtain permission from the Bureau of Alcohol, Tobacco, and Firearms. Refer to: [natirevctr@cinc.atf.treas.gov](mailto:natirevctr@cinc.atf.treas.gov) or phone 1-800-398-2282.

## ELECTRICAL AND MECHANICAL

- All electrical apparatus that operates with 115-volt current should be constructed in accordance with the National Electrical Code (NEC). If in doubt, contact a competent electrician.
- Many experiments can be done using a low amperage, 6 or 12-volt electrical source. As these are much safer electrical sources, their use should be considered when doing a project.
- The Safety Sheet must include a statement as to proper electrical construction.

## FIRE AND RADIATION

- Students should always wear eye protection when working with any open flame.
- Students using radiation sources (laser, U-V light, X-ray, microwaves, or high intensity radio waves [RF]) should be adequately shielded from such sources. Many experiments using these sources should not be undertaken unless under the direct supervision of an adult familiar with the equipment and hazards involved.
- No student may work with any radioactive materials unless the work is conducted in a licensed laboratory under the direct supervision of a licensed individual.
- The Safety Sheet **must include an explanation of protective measures.**

## BIOLOGICAL

### Use and Care of Humans as Test Subjects

Recognizing that human beings are vertebrate animals and yet need different criteria, the following policies will govern the use of human beings. No project will be allowed that is in violation of any of these rules.

No person may perform any experiment for the student that violates any of these rules. No person may give permission for a project that is in violation of these rules except in special cases as described in the section "**Exceptions**" (see page 12)

If using a human as a test subject is decided upon, **the following rules MUST BE FOLLOWED.**

- Students who have a project involving human test subjects, must complete, with their sponsor, the Humans As Test Subjects Endorsement (see Appendix- page 46) form that is included in this policy manual. Feel free to duplicate as needed.
- Humans must not be subjected to treatments that are considered hazardous and/or that could result in undue stress, injury, or death to the subject.
- No primary or secondary cultures (the growth of microorganisms, tissue cells, or other living matter in a specially prepared nutrient medium) taken directly (mouth, throat, skin, etc.) or indirectly (eating utensils, countertops, doorknobs, toilets, etc.) will be allowed. However, cultures obtained from reputable biological suppliers or research facilities are suitable for student use. (see Microorganisms section page 10).
- Quantities of food and non-alcoholic beverages are limited to normal serving amounts or less and must be consumed in a reasonable amount of time. Normal serving amounts must be substantiated with reliable documentation. This documentation must be attached to the Humans as Test Subjects Endorsement form. No project may use over-the-counter drugs, prescription drugs, illegal drugs, or alcohol in order to measure their effect on a person.
- The only human blood that may be used is that which is either purchased or obtained from a blood bank, hospital, or laboratory. No blood may be drawn by any person or from any person specifically for a science project. This rule does not preclude a student making use of data collected from blood tests not made exclusively for a science project.
- Projects that involve exercise and its effect on pulse, respiration rate, blood pressure, and so on are allowed provided the exercise is not carried to the extreme. Electrical stimulation is not permitted. A valid, normal physical examination must be on file for each test subject. Documentation of same must be attached to the Humans as Test Subjects Endorsement form.
- Projects that involve learning, ESP, motivation, hearing, vision, and surveys require the Humans as Test Subjects form. (see Appendix page 46)

### Use and Care of Non-Human Vertebrates

The basic aim of experiments involving animals is to achieve an understanding of life processes and to further society's knowledge. Experiments requiring the use of vertebrates must have a clearly defined objective, investigate a biological principle, and/or answer a scientific inquiry. Such experiments must be conducted with a respect for life and an appreciation of humane considerations.

To the degree possible, all students should be cautioned about doing projects that involve vertebrates. However, if the teacher and the student feel that vertebrates must be used, the following rules MUST and WILL apply. This policy will place the Illinois Junior Academy of Science in close accord with the "School Code of the State of Illinois."

It is strongly recommended that living organisms such as plants, bacteria, fungi, protists, worms, snails, insects or other invertebrates be used. Their wide availability, simplicity of care, and subsequent disposal make them very suitable for student work.

No non-human vertebrate projects will be allowed that are in violation of any of these rules. No person may perform any experiment for the student that violates any of these rules. No person may give permission for a project that will be in violation of these rules except in special cases as described in the section "**Exceptions**" (see page 12)

- Students who have projects that involve non-human vertebrates must complete, with their sponsor, the Non-Human Vertebrate Endorsement (see Appendix page 47) form that is included in this policy manual. Feel free to duplicate as needed.
- The student and the sponsor have the responsibility to see that all animals have proper care in well-ventilated, properly lighted locations with proper nutrition, proper temperature, adequate water, and sanitary surroundings. Care must be taken to see that the organisms are properly cared for during weekends and vacation periods.
- No primary or secondary cultures (the growth of microorganisms, tissue cells, or other living matter in a specially prepared nutrient medium) involving warm-blooded animals taken directly (mouth, throat, skin, etc.) or indirectly (cage debris, droppings, countertops, etc.) will be allowed. However, cultures purchased from reputable biological supply houses or research facilities are suitable for student use. (see Microorganisms section, page 10)
- No intrusive or pain-producing techniques may be used. Included in these techniques would be things such as surgery, injections, taking of blood, burning, electrical stimulation, or giving of over-the-counter drugs, prescription drugs, illegal drugs, or alcohol to measure their effect.
- No changes may be made in an organism's environment that could result in undue stress, an injury, or death to the animal.
- No vertebrates can be used as the independent or dependent variables in an experiment that could result in undue stress, an injury, or death to the animal.
- For maze running and other learning or conditioning activities, food or water cannot be withheld for more than 24 hours. If the animal has a high metabolic rate, then food or water cannot be withheld for a length of time that would produce undue stress on the animal.
- Chicken or other bird embryo projects are allowed, but the treatment must be discontinued at or before 72 hours before scheduled hatch day. At that time the egg must be destroyed.
- Projects that involve behavioral studies of newly hatched chickens or other birds will be allowed if no changes have been made in the normal incubation and hatching of the organism, and that all vertebrate rules are followed (only non-manipulated eggs may be hatched).

### **Use and Care of Microorganisms**

No microorganism projects will be allowed that are in violation of any of these rules. No person may perform any experiment for the student that violates any of these rules. No person may give permission for a project that will be in violation of these rules except in special cases as described in the section "**Exceptions**" (see page 12)

- Students who have a project involving microorganisms must complete, with their sponsor, the Microorganisms Endorsement (see Appendix- page 48) form that is included in this policy manual. Feel free to duplicate as needed.
- This area of science, may involve many dangers and hazards while experimenting. It is the sole responsibility of all teacher(s)/sponsor(s) to teach students proper safety methods and sterile techniques.

- The Illinois Junior Academy of Science prohibits the use of **primary** or **secondary** cultures taken from humans or other warm-blooded animals in any project because of the danger from unknown viruses or other disease-causing agents that may be present. Pure cultures of microorganisms known to inhabit warm-blooded animals may be obtained from reputable suppliers and used in proper settings.
  - **Culture:** the growth of microorganisms, tissue cells, or other living matter in a specially prepared nutrient medium.
  - A **primary culture** is one taken from a vertebrate animal, living or dead. For example, a culture may NOT be taken from a mouth, throat, skin, hamburger, meat, chicken, or fish.
  - A **secondary culture** is a culture taken from an object that has come in contact with a vertebrate animal. For example, a culture may NOT be taken from eating utensils, door knobs, toilets, countertops, milk, eggs, etc.
- All microorganism experimentation must be conducted in a laboratory setting such as a science classroom or professional research facility.
- Projects involving viruses and recombinant DNA projects should be done with the help of a professional and should comply with the National Institutes of Health (NIH) Guidelines unless the project is limited to a kit obtained from a legitimate supply house.
- All cultures should be destroyed by methods such as, autoclaving or with a suitable NaOCl (bleach) solution before disposal.
- For information on “Micro-Organisms for Education”, visit [www.science-projects.com/safemicrobes.htm](http://www.science-projects.com/safemicrobes.htm)

## EXCEPTIONS

Exceptions to the rules will NOT be granted except in two circumstances:

- The student performs the experiments and is supervised in a university lab, a research facility, or a professional facility. In these circumstances, the student must have a letter, on the organization/research facility's letterhead, from the supervisor stating that the student worked under constant supervision and that all rules and regulations were followed as to the ethical treatment of animals.

This original letter should:

- directly follow the required endorsement form in the student's original written paper
- a copy of this letter must be sent to the IJAS Safety Chair two weeks prior to the State Exposition

[krincker@goodshepherdcollinsville.org](mailto:krincker@goodshepherdcollinsville.org)

**Keith Rincker - IJAS Safety Chair  
Good Shepherd Lutheran School  
1300 Belt Line Rd.  
Collinsville, IL 62234**

- a **copy of this letter must be displayed on the front of the display board** with the other endorsement sheets.
- If the student will not be supervised in a professional research institute, approval for any exceptions to the rules will be granted only if the following conditions are met:
  - The student must seek approval for the project **before December 1** of the school year that the student wishes to enter the Regional or State Exposition. Requests for approval will not be accepted after that date.
  - The student must prepare a detailed proposal of the project that includes the hypothesis, the proposed methods of experimentation, and the safety measures to be taken to ensure the good health of the vertebrate being tested.

The proposal is submitted to the

**IJAS Scientific Review Committee Chair**  
[bethbrown3@gmail.com](mailto:bethbrown3@gmail.com)

- If the proposal receives approval, the project may be entered into the State Exposition. A written reply to the sponsor or student regarding the decision will be made no later than 2 weeks following receipt of the request.
- A copy of the **approval letter is displayed on the front of the display board** with the other endorsements.
- The **approval letter** is inserted into the student's written paper directly following the **appropriate Endorsement**.

## ~ THE EXPOSITION ~

### PROJECT SESSION

#### WRITING A SCIENTIFIC RESEARCH PAPER FOR A SCIENCE PROJECT

*NOTE: There are additional requirements for papers being submitted to the Paper Session. Refer to the appropriate section for these requirements.*

Scientists, regardless of their level of achievement, are only as effective as their ability to communicate to others, in spoken or written word, the results of their endeavors. A scientific paper is, very simply, a clearly written, concise report of an experimental research project. **THREE (3) COPIES OF THE PAPER ARE REQUIRED BECAUSE NOT ALL PAPERS COLLECTED CAN BE RETURNED.**

#### THE PHYSICAL ARRANGEMENT OF THE WRITTEN REPORT

The following section establishes the basic written report requirements. Familiarity with the basic techniques and requirements will help you to read and understand scientific publications, give you an inside view of how scientists think, and help you to write your own scientific paper describing the results of your research experimentation. The main point to keep in mind is to think before you write, then rethink, revise, rewrite, and reread again and again. Make it clear and concise.

**The paper must include (in this order):**

1. **ABSTRACT** - In preparing your abstract, you must keep in mind that:
  - The abstract is a concise summary of your work.
  - As the first sheet of your research paper, it will help the reader form an opinion of your work.
  - You will find writing and rewriting will help you produce a good short summary of your project in the required form.
  - The physical form of the abstract is as follows:
    - Typed single-spaced
    - Limit the abstract to about 200 words or less.
    - Limit the abstract to three (3) paragraphs:
      1. Purpose
      2. Procedure
      3. Conclusion
  - Use the Abstract Form in the **Appendix** (only the front side of the form should be used).
2. **SAFETY SHEET** - all safety hazards and precautions must be identified. If no safety hazards exist, a statement to that effect must be made. Use the form found in the **Appendix. (see page 45)**
3. **ENDORSEMENTS** - when human or non-human vertebrates or microorganisms are used, endorsement sheets are required. Forms are found in the **Appendix. Approval letters should follow endorsements, if required.**
4. **TITLE PAGE** - your title should be concise and clear.

5. **TABLE OF CONTENTS** - include page numbers.
6. **ACKNOWLEDGMENTS** - should give credit to those who have helped you in your investigations for guidance, materials, and/or use of facilities.
7. **PURPOSE AND HYPOTHESIS** - should state precisely the question you are attempting to investigate. Include your hypothesis or the expected outcome of your test.
8. **REVIEW OF LITERATURE** - is to report to the reader background information and/or work done in the past that pertains to your project. These references should be properly documented and listed in the section "Reference List". Traditional footnotes are not to be used for citing references. The correct citation style to use is discussed in detail in the *Publication Manual of the American Psychological Association, Fifth Edition, 2001*, or later.

**FOR FORMAT and EXAMPLES: (see page 41 - "Format for Parenthetical Citation Within the Text of the Review of Literature")**

9. **MATERIALS AND METHODS OF PROCEDURE** - should be a simple chronological account of what was done. The explanation of what was done must be clear and detailed enough so that the reader can duplicate the work. The apparatus and materials used should be listed - explain the workings of any apparatus you constructed or used. Drawings, diagrams that are clearly labeled, and photographs are appropriate if they enhance and clarify your explanation - do not use them as filler.
10. **RESULTS** - should be organized in tables and/or charts with graphic presentations, when applicable. Choosing the appropriate graph is important. The graphs should be presented so that they are easily read by someone not familiar with the work. If quantitative data are not involved, a day-by-day log may be used in place of the tables and charts. In either case, care should be taken to insure accuracy and clarity.
  - A discussion section should follow the data section to include your evaluation and interpretation of the data and/or results of your investigation.
11. **CONCLUSION** - should be a concise evaluation and interpretation of the data and/or results. The conclusion should be limited to the results of the investigation and should refer to the stated purpose and hypothesis. Experimental error should be estimated and considered when drawing the conclusion. **(see page 51 for an explanation of Estimating Experimental Error)**
12. **REFERENCE LIST** - is a list of published articles, books, and other communications actually cited in the paper. Sources should be current. The Reference List section is arranged alphabetically according to the author/editor's last name when it is known or the first significant word in the title if the author/editor is not known. The correct style to use for citing references in the Reference List section is discussed in detail in the *Publication Manual of the American Psychological Association, Fifth Edition 2001*, or later.

**FOR APA FORMAT AND EXAMPLES: (see page 35 "Format for Reference List")**

## TECHNICAL POINTS OF A SCIENTIFIC PAPER

In preparing the paper, the author should be concerned with the following mechanics:

- The paper must be **typed, doubled spaced** and have at least one-inch margins.
- Use only one side of the page.
- The font style and size (for example 10 or 12 pt Times New Roman) must be appropriate for a scientific paper.
- The paper must be neat and legible.
- There is no limit on the number of pages permitted in the project session portion of the exposition. **Note: Paper session does have a page limitation – (see page 20)**
- Type the last name of the student listed on the first line of the abstract at the top of each page.
- Tabular information should be kept to a minimum. Each table, chart, or drawing should not be more than one page in length and tabular data should not be duplicated in the text. Headings for tables and columns should be brief. Tables, charts, and drawings should be done on standard 8 1/2 x 11" paper.
- Graphs should be suitably titled and have both axes correctly labeled. Do not forget to include the correct units of measurement for any numbers.
- Photographs should be of good quality and contrast, and should have captions typed under them.

## DESIRED QUALITIES OF SCIENTIFIC WRITING

The following points should help you to write your paper in an acceptable scientific style:

- When writing the first draft, do not start until you have clearly thought out your paper; the desired final result should be a clear and understandable paper.
- The tone of the paper should be established as one of objectivity.
- Learn to use the technical words that save space or that convey meaning better than common words; by all means avoid the use of vague terms.
- Sentences should be short and simple.
- The use of the 1st person "I" or "We" should be avoided whenever possible. Terms such as "The research experiment" or "The exhibitor" are examples of 3rd person usage. Third person is the preferred method for scientific writing. While scientific writing demands detachment and impartiality, do not be afraid to use "I" if the clarity and simplicity of the sentence is improved.
- After you have written your first draft, reread, revise, and rewrite it. Put yourself in someone else's mental shoes and read it slowly and thoughtfully. Have you omitted any steps? Are the steps in the proper order? Do your sentences say what you want them to say? If possible, have someone else read it; if not, put it away for a few days, and then reread it yourself. Your paper must be an accurate report of what you have done - check and recheck your calculations, references, spelling, and grammar.

## **UNDESIRED QUALITIES OF SCIENTIFIC WRITING**

Many of the faults in scientific papers can be traced to editing failures - objective reading of the many drafts of your paper will reveal fallacies and other faults that can and should be eliminated from your final draft. Errors to avoid may include:

- An illogical or unrelated grouping of facts.
- An unjustified switch in point of view as indicated by a change of subject or voice.
- The omission of vital facts or steps in procedures, interpretations, or conclusions.
- The needless repetition of facts.
- The imprecise use of words, the use of words in a manner peculiar only to the author or a small group, or the use of words only for the sake of the use of words.
- The inclusion of inaccurate or improper use of paraphrases or references.
- The exclusion of valuable data that were unfavorable to the conclusion.
- The drawing of conclusions not supported by the facts and data presented in the paper.
- Inaccuracy in calculations, spelling, grammar, and quotations.
- The lack of objectivity.
- Omitting literature citations in the text of the Review of Literature.

## **ORAL PRESENTATION**

In presenting your project to the judges at a science exposition, the following approaches have proven successful for many students.

### **1. INTRODUCTION**

- State your name(s), age, school.

### **2. ACKNOWLEDGMENTS**

- Give credit to those whom you have contacted and to those who have helped you.
- Discuss any work done in the past pertaining to your project.

### **3. PURPOSE AND HYPOTHESIS**

- State exactly what the investigation is attempting to discover.
- Make a prediction about the outcome.
- How did you get interested in this project? Give the reason for choosing it.

### **4. BACKGROUND INFORMATION**

- Background explanation for your project (to familiarize the judges), scope of your study, etc. This should include a **summary** of the Review of Literature.

## 5. PROCEDURE

- Proceed in a logical manner, telling what you did step by step.
- Be complete. Do not leave out necessary details.
- Use visual aids: charts, pictures, graphs, etc. Point to your display, but stand aside when you do this.
- Explain how your apparatus was used. If you constructed it yourself, tell the judges you did, if not, give credit to those who helped you. Judges are more interested in your results and conclusions than in the apparatus.
- Discuss ways you avoided experimental error such as use of appropriate instrumentation and measurements, large enough sample size, and/or having controls when possible.
- Discuss statistical aspects of experimental errors such as averages, ranges, and/or other statistical analogies.

## 6. RESULTS (DATA AND DISCUSSION)

- Explain both your controls and your experimental variables.
- Remember to use proper units of measure with your data.
- Point to graphs, charts, etc., when you refer to them.

## 7. CONCLUSION

- State in a concise and logical order the conclusions you can validly draw from the experimentation you have done and the data and/or observation obtained.
- Discuss how you plan to continue your project, if applicable.

## 8. ANY QUESTIONS

- When you have finished, ask the judges if there are any questions they would like to ask.
- When they ask you questions, think before you answer them. Answer slowly! If you don't know the answer say, "I'm not sure but I think..."
- If they ask you a question that is not related to your project and you do not know the answer, then say, "I really haven't been concerned with this in my project, but it might be interesting to look into it."
- Thank the judges for any suggestions they may have for bettering your research.

## 9. OTHER SUGGESTIONS

- Speak slowly!
- Be forward but polite, dynamic, and above all interested in what you are doing.
- Remember that you are a salesperson and therefore your job is to sell your product to the judges. The judges are interested in your work - which is why they are judging you.
- **Your presentation should not exceed 10 minutes.**

## **DISPLAY RULES**

1. Before judging, all of the displays will be carefully inspected by the safety committee at the regional and state expositions. **A copy of the Abstract, Safety Sheet(s), Endorsement(s)/required document (if applicable), must be displayed on the front of the exhibitor's display board.**
2. **Your display must not exceed the dimensions of 76 cm front to back, 122 cm from side to side, and 152 cm from table to top.** This applies to ALL parts of your project. **No apparatus may exceed this space. No apparatus may be under, behind, in front of, alongside, or hanging off of the display table. No apparatus that poses a safety risk to viewers may be displayed and may be removed at the discretion of the Safety Chair.**
3. Your display must be designed to sit on a table and be self-supporting.
4. Material used for packing displays may not be kept within the display area, including under the table. It must be taken from the building.
5. Table drapes or covers are not allowed.
6. Spotlights, floodlights, or decorative lighting must not be used to illuminate your display.
7. Any violation of these safety regulations will result in a letter to the sponsor with the reason for disqualification or potential disqualification. No project will be disqualified if the safety violation can be corrected on the spot with a minimum of effort.

## **PLANNING AN ATTRACTIVE DISPLAY**

- The student should construct the display, with the parent, teacher, or sponsor providing guidance, encouragement, and constructive criticism.
- The title should be brief, captivating, and sufficiently descriptive to identify the project.
- Lettering should be neat, easily visible, and uncluttered. Check correctness of spelling.
- Displays should be neat and presentable.
- Do not display any previous awards on your project.
- Wall space for posters, tape, tacks, etc., is not available. Construct displays so that wall space is not required.
- Exhibitors should bring their own tape, thumbtacks, and other supplies.
- The Abstract, Safety Sheet, and any endorsements must be placed on the front of the display board. They may be reduced to a minimum of a half sheet of standard paper and stacked.

## **SAFETY RULES FOR DISPLAY**

Science Exposition is the time for communication. You are being judged on your ability to present your research to a scientist. This is neither the time nor place to demonstrate your experiment. **You should leave all lab equipment at home or at school. Pictures, drawings, and diagrams should replace equipment.**

### **BIOLOGICAL DISPLAY HAZARDS**

- **Animals.** No vertebrate or invertebrate animals or animal tissues may be displayed in any exhibit at the Regional or State Expositions.
- **Hypodermic Needles.** Hypodermic needles and syringes or other sharp objects may not be displayed.
- **Cultures.** No cultures of any kind may be displayed including those containing organisms with recombinant DNA. Students should rely upon color photos in their displays whenever possible.

### **CHEMICAL AND GLASSWARE DISPLAY HAZARDS**

- No glass object may be displayed unless it is a component of some unique apparatus. The apparatus must be secured, without sharp edges, and away from the table's edge.
- Chemicals may not be displayed. Substitute photographs or drawings.

### **ELECTRICAL AND MECHANICAL DISPLAY HAZARDS**

- In rare instances, electrical or mechanical apparatus may be displayed after the approval of an IJAS safety inspector.
- All projects involving electrical or mechanical apparatus are to be operated only upon judges' request.

### **FIRE AND RADIATION DISPLAY HAZARDS**

- **Hazardous Materials.** Materials that are explosive, highly flammable, corrosive, or highly poisonous are not to be brought to the exhibit. Displays or demonstrations using rocket fuels, armed rockets, and explosives of any kind are prohibited. Compressed gas cylinders of any type are not permitted. Aerosol cans may not be displayed.
- **Fire Hazards.** Open flames, torches, burners, electrical heating units or hot plates are not to be displayed or used for demonstration.
- **Radiation.** Lasers, UV light, X-rays, radioactive materials, or microwaves may not be displayed.

## **QUESTIONS AND/OR CLARIFICATIONS**

**All questions or clarifications regarding these safety regulations will be made to the IJAS Safety Chair, in writing a minimum of 4 weeks by regular mail or 1 week by e-mail, prior to the fair/exposition with a copy sent to the IJAS President.** There will be no deviation from those regulations designed for the safety of the fair participants, judges, and visitors. **The decision of the IJAS Safety Chair with the advisement of the IJAS President will be final on all requests.**

IJAS Safety Chair E-mail: [krincker@goodshepherdcollinsville.org](mailto:krincker@goodshepherdcollinsville.org)

**Address: Keith Rincker - IJAS Safety Chair  
Good Shepherd Lutheran School  
1300 Belt Line Rd.  
Collinsville, IL 62234**

## PAPER SESSION

### THE FOLLOWING SET OF RULES APPLIES EXCLUSIVELY TO ENTERING THE SCIENCE FAIR PAPER SESSION

If you decide to enter your project in the Paper Session, write your paper following the guidelines given in the section entitled “Writing a Scientific Research Paper for a Science Project”, but check the following additional regulations and procedures.

- Paper Session projects and presentations may involve more than one student. All awards will be presented to the student whose name is first on the Abstract.
- Students may have only one entry in the Paper Session either: a paper or essay, but not both.
- The paper should be an accurate presentation of a project done by the student(s) and should reveal the experimentation and/or observations that have been made. Experimentation is required as explained in the Category section. A paper based solely on library research is not acceptable.
- Previously presented papers will not be allowed unless they include a significant amount of additional research and experimentation. These previously presented papers must be made available to the state Paper Session Chair if requested.
- **The maximum length of the paper is 30 pages. The page total includes the Abstract, Safety Sheet, Title Page, Table of Contents, Body of the Paper, Reference List, and appendices of data, graphs, photos, etc. The endorsements will not be counted in the page total.**
- A total of **four (4) copies of the paper**, typed and readable, must be submitted to the Regional Paper Session Chair by the date established at the regional level.
- The author should be sure to **keep a fifth copy** because the four submitted copies will not be returned
- Type the last name of the student listed on the first line of the Abstract at the top of each page.
- When the papers are submitted to the Regional Paper Chair by the sponsor:
  - Each copy of the paper **MUST BE STAPLED** in the **upper left corner**. **NO FOLDERS, BINDERS, BINDINGS, OR CLIPS!!!**
- The presentation may be read, given from notes, or be a computer presentation. The complete presentation may take no longer than ten (10) minutes, with additional time allowed for questions and answers.
- Display boards are not permitted, however graphs, charts, tables, etc. may be presented manually, but may not exceed the dimensions of a standard 8.5” X 11” sheet of paper. Presentations may be given with the use of any type of LCD or overhead projector. Only overhead projectors are provided.
- Further research conducted after the regional fair can be indicated, from redrawn charts or graphs, and furnished to the judges at the time of presentation by means of an addendum presented by the student.
- State awards for Paper Session will be given at the Awards Assembly on the final day of the State Exposition.

# ESSAY CONTESTS

## STUDENT OFFICER ESSAY CONTEST

### PURPOSE

The Illinois Junior Academy of Science Student Officer Essay Contest is sponsored by the Illinois Junior Academy of Science for the purpose of providing students the experiences of researching, writing, and presenting an essay in an area of current interest.

### DEFINITION

The essay entered should be based on library research. However, this does not rule out the possibility of personal experimentation as a supplement to the library research.

### STRUCTURE

Write clearly and simply using correct spelling and grammar. The essay must include:

- An Essay Cover Page as the first page of the essay. (see **Appendix page 49**)
- A title that is indicative of the content of the essay.
- A table of contents.
- A text that includes an introduction, body, and summary. Introductory material may be set up in one or more paragraphs. The summary should also include your general conclusions.
- A Reference List showing references used.
- A Safety Sheet and Humans as Test Subject or Non-Human Vertebrate Endorsements only if supplemental experimentation is used.

### RULES

- The contest is open to students in Grades 7 through 12 enrolled in a school that is registered with the Illinois Junior Academy of Science.
- All essays entered must have a single author.
- The essay should be 1200 to 1500 words and must be typed, double-spaced on one side of the paper only.
- The essay must include a cover page as the first page of the essay. The Essay Cover Page form is found in the **Appendix. (see Page 49)**
- Ten minutes will be allowed for the presentation. It should be presented, not read to the judges. It may be given from notes. Presentation is a significant part of the paper rating.
- A total of **four (4)** typed and readable copies are submitted to the Regional Paper Chair. These copies will not be returned.
- The authors of papers selected for presentation in the Paper Session, at the IJAS State Exposition, will be notified at their regional fair.

- The current topic of the Student Officer Essay Contest will be announced at the State Exposition in May, again via the President's Fall and Winter Newsletters, and is posted on the IJAS website.

## **JUDGING CRITERIA**

Since the topics may change, some specific criteria will be noted in the State President's Fall and Winter Newsletters and on the IJAS website at [www.ijas.org](http://www.ijas.org).

## **SELECTION PROCESS**

- Essays are to be submitted to the Regional Paper Chair for presentation at the Regional Paper Session.
- Regional paper sessions will judge essay presentations to select one entry to the state level Student Officer Essay Contest.
- The Regional Paper Session Chair will notify each state qualifier at the Regional Paper Sessions.
- Students whose essay qualifies for presentation at the IJAS State Exposition in May will receive information from the Student Essay Officer Chairperson.

## **ADDITIONAL ESSAY CONTESTS**

Several other organizations also offer the opportunity for student research in particular fields. The presentation of awards takes place at the IJAS banquet on Friday evening of the essay presentation. These essays must also have an Essay Cover Page when submitted. (see **Appendix page 49**)

- Additional essays and requirements will be announced in the fall and/or winter mailing and on the IJAS website.
- The Illinois Junior Academy of Science Board of Directors and/or the contest corporate sponsors will annually determine financial awards for these contests.

# DESIGN CONTEST

## RULES OF PROCEDURE

- Any student in grades seven through twelve whose school is a member of the Illinois Junior Academy of Science is eligible to take part in the cover design contest.
- Students do **NOT** need to compete in local, regional, or state science expositions with a project, paper, or essay to be eligible.
- All entries must be postmarked no later than **January 15<sup>th</sup>** of the year of the science fair.
- Use an 8.5"x11" sheet of white paper for each entry. The design **MUST** be oriented **PORTRAIT**, **NOT LANDSCAPE**.
- Include the words "Illinois Junior Academy of Science" in your design. This should be large enough to be seen on your **original** design.
- The design must be original and **may not be computerized, but the words "Illinois Junior Academy of Science" may be computerized.**
- The theme of the design changes each year. Check the president's Fall mailing and the IJAS website for more information
- Keep the design simple.
- **All submissions must be BLACK INK ON WHITE PAPER. No color paper or pencil.**
- Please include the following on the **back of student's entry**:

### **Student's Information**

Student's Name  
Home mailing address  
Home telephone number  
E- mail

### **Sponsor's Information**

School name  
Name  
E-mail  
Phone number  
Region number (ask your sponsor)

- The design committee will judge all entries. The top entries will be presented to the IJAS Student Officers, and final voting will take place. The entries of the top ten finalists will be displayed at the State Science Exposition in May, and the designers of the winning entries (banquet brochure, T-shirt, and paper session brochure) will receive monetary awards.

# JUDGING CRITERIA FOR PROJECTS AND PAPERS – SCORING RUBRIC

The following are criteria for the Illinois Junior Academy of Science judging procedure. Judges who are not agents of the Illinois Junior Academy of Science may use other criteria for selection of their special awards. **THE DECISION OF THE JUDGES IS FINAL.**

- There are three levels of each factor being examined during the judging procedure.
- Student experimenters should strive to achieve the top line for each criterion.

## SCIENTIFIC METHOD: OVERALL IMPRESSION OF THE PROJECT

### KNOWLEDGE GAINED

- ❖ The student exhibits a thorough understanding of the topic as demonstrated through presentation and/or correct responses to questions. The student has acquired scientific skills.
- ❖ The student is somewhat familiar with topic area but cannot answer all questions effectively. Demonstrates minimal acquired scientific skills.
- ❖ The student demonstrates little to no knowledge gained nor scientific skills.

### SCIENTIFIC APPROACH

- ❖ The student has a well defined problem and uses a logical, orderly method for solving the problem. The problem was solved using scientific principles.
- ❖ The student has an adequately defined problem OR attempts to follow scientific method, but not both.
- ❖ The student has little to no evidence of scientific method used.

### EXPERIMENTAL APPROACH: INDEPENDENT VARIABLES

- ❖ The independent (experimental) variable(s) have been thoroughly defined
- ❖ The independent (experimental) variable(s) have not been thoroughly defined.
- ❖ The independent (experimental) variable(s) have not been defined.

### EXPERIMENTAL APPROACH: CONTROLLED VARIABLES

- ❖ Those significant variables not manipulated have been controlled.
- ❖ Not all significant variables have been controlled.
- ❖ Few or no significant variables have been controlled.

### EXPERIMENTAL APPROACH: CONTROL/COMPARISON GROUP

- ❖ The method was appropriate and effective. A control or comparison group was in evidence.
- ❖ Method was inappropriate, but an attempt for control or comparison was made.
- ❖ Experimentation was not performed, i.e. project was a demonstration or exhibit. No control group present.

### RELIABILITY OF DATA

- ❖ The data collected is numerical and metric, if applicable. **Repeated trials provide for adequate data.** The data is reliable.
- ❖ Data collected is not numerical and metric when applicable, AND/OR data collected is marginal.
- ❖ Little or no data collected.

## **ESTIMATING EXPERIMENTAL ERROR**

- ❖ Measurement error affecting the conclusion has been considered.
- ❖ Some measurement error affecting the conclusion has been considered.
- ❖ Experimental error has not been considered.

## **VALIDITY OF CONCLUSION**

- ❖ The conclusion is consistent with the data and/or observations. The conclusion is based on the data collected.
- ❖ Conclusion is present, but inconsistent with data.
- ❖ No conclusion or no valid conclusion present

## **ORIGINALITY**

- ❖ Demonstrates a novel approach and/or idea. It is highly creative.
- ❖ Some creativity and/or originality is demonstrated.
- ❖ No originality or creativity is demonstrated.

## **WRITTEN REPORT**

### **ABSTRACT**

- ❖ The abstract contains a concise summary of the purpose, procedure, and conclusion in 200 words or less.
- ❖ One or two parts of the abstract is/are missing or inadequate.
- ❖ Abstract is missing or is entirely inadequate.

### **SAFETY SHEET**

- ❖ The safety sheet identifies all of the major safety hazards, precautions taken, and any endorsement sheets (if necessary) describes the use of humans, non-human vertebrates or microorganisms and ensures the safe use of such organisms.
- ❖ Safety sheet is present, but not all major hazards have been identified, precautions taken are missing, and any endorsement sheets (if necessary) do not completely describe the use of humans, non-human vertebrates or microorganisms and ensures the safe use of such organisms.
- ❖ Safety sheet is not present and or any endorsement sheets (if necessary) are missing.

### **TITLE PAGE AND TABLE OF CONTENTS**

- ❖ The title page is clear and concise. The table of contents is complete and includes pagination.
- ❖ One or two elements is (are) missing.
- ❖ Title page and table of contents are missing.

### **ACKNOWLEDGEMENTS**

- ❖ Credit has been given to those who have helped with the project.
- ❖ Acknowledgements are missing.

### **PURPOSE AND HYPOTHESIS**

- ❖ The problem has been defined and a prediction has been made.
- ❖ The problem has been defined OR a prediction has been made, but not both.
- ❖ Neither the problem nor a prediction is present.

## **REVIEW OF LITERATURE**

- ❖ The Review of Literature is thorough, adequately cited within the review of literature, and pertinent to topic using APA format, fifth edition or later.
- ❖ The Review of Literature is inadequate OR citations are inadequate (not sufficient in number or did not follow APA format, fifth edition or later.)
- ❖ Little or no use of citations and/or review of literature is irrelevant to topic.

## **MATERIALS**

- ❖ All materials are listed and measurements are in metric, if applicable.
- ❖ Not all materials are listed or measurements are not in metric, when applicable.
- ❖ No materials are listed.

## **PROCEDURE**

- ❖ The procedure is complete and easy to follow; all steps have been included. Measurements are in metric, if applicable.
- ❖ Procedure is present, but not complete or confusing OR measurements were not in metric if applicable.
- ❖ Procedure is missing.

## **RESULTS**

- ❖ The results are organized in tables and/or graphs and can be easily read by someone not familiar with the work. Data is quantitative and explanations are given when needed.
- ❖ Results are less organized, not quantitative, and difficult to understand.
- ❖ Results are not present.

## **CONCLUSION**

- ❖ The conclusion reflects a concise evaluation and interpretation of the data and/or results. The conclusion referred to the purpose and hypothesis.
- ❖ The conclusion is present, but is inconsistent with data collected and/or does not refer to the purpose and hypothesis.
- ❖ No conclusion is present.

## **REFERENCE LIST**

- ❖ The quality and quantity of sources is adequate for the topic. The sources listed are cited within the Review of Literature using APA format, fifth edition or later. Sources are current.
- ❖ Quality and quantity of sources is less than adequate, or sources not all cited within Review of Literature, or APA format, fifth edition or later, was not followed.
- ❖ No reference list present.

## **ORAL PRESENTATION**

### **PRESENTATION QUALITY**

- ❖ Clear presentation; concisely summarizes the project. Information is relevant and pertinent.
- ❖ Information given is adequate, but presentation is difficult to follow.
- ❖ Information jumbles, irrelevant; presentation is unclear.

### **DYNAMICS**

- ❖ The student speaks fluently with good eye contact; is polite, dynamic, and interested in their project.
- ❖ The student was polite and interested in their project. Moderate eye contact. Relied heavily on note cards.
- ❖ No eye contact. Read from notes. Did not seem interested.

## DISPLAY

### **INFORMATION: EXPERIMENTAL**

- ❖ Gives complete explanation of the project. Display includes graphics, charts, or pictures.
- ❖ Adequate information is present, but not thorough.
- ❖ Missing pertinent information.

### **INFORMATION: TECHNICAL REQUIREMENTS**

- ❖ A copy of the Abstract and Safety Sheet are displayed. Endorsement Sheets are displayed, if applicable.
- ❖ One of the required forms is missing.
- ❖ The required forms have not been displayed.

### **ARTISTIC QUALITIES**

- ❖ Display board is neat, organized, and appealing. No spelling errors are present.
- ❖ Display board is neat, but not well organized. Spelling errors are present.
- ❖ Display board was carelessly prepared; sloppy.

## RATING CRITERIA

**When rating the project and paper, the judges should consider the following:**

### **GOLD AWARD**

The following criteria may identify an outstanding project.

- A scientific approach to a specific problem is supported with relevant experimentation.
  - ❖ Approach indicates creativity.
  - ❖ Conclusions logically deduced from experimental data.
  - ❖ Clear concise research paper containing Abstract in required form, Safety Sheet, and Endorsement Sheet, when appropriate.
- Students can speak knowledgeably on contents of paper and area of investigation.
- Good quality and quantity of background information is reflected in the Review of the Literature and Reference List.

### **SILVER or BRONZE AWARD**

A lesser degree of the above, e.g., insufficient Reference List, lack of thoroughness in experimental technique or observation, or lack of knowledge of subject area.

### **PARTICIPATION CERTIFICATE**

A serious omission or mistake is present - e.g., no proof of experimentation or no scientific approach is evident. Any model or demonstration will be issued a Participation Certificate. The Judging Chair will supply specific tips and pointers for a given category.

# JUDGING INFORMATION FOR THE PROJECT AND PAPER SESSIONS

## AN OVERVIEW

Judging is, without a doubt, one of the most important phases of any science exposition. Because of its extreme importance, all judges should carefully review the following:

- **Expositions are not intended to be contests between students or schools. Each exhibitor is to be judged based on the rating criteria and not in comparison to another exhibitor.**
- Even though many exhibits show a remarkable degree of scientific knowledge, all judges are asked to keep in mind that all of the exhibitors are junior or senior high school students, many of whom are experiencing their first taste of scientific evaluation by a distinguished critic.
- As a judge, use your own good judgment at all times. Be honest with yourself and the student. Keep in mind that only a small percentage of the students will ever actually go into scientific research; however, many of them will have a great deal to say about the future of science. Certainly, a valuable experience with science at this level might potentially reap valuable rewards later.
- The opportunity to discuss their project with interested adults acting as judges is a high point for most students. Be aware that most students have spent many months preparing for a judging period, which normally lasts fifteen minutes. Feel free to discuss any aspect of the student's work; they deeply appreciate all questions and comments.
- In order to participate as a judge, you must be beyond high school age.

## JUDGING MECHANICS

- Be sure to report for final instructions promptly on the day of the Exposition. Allow yourself enough time to park your car, and to allow for traffic interference so that you will report on time. The Category Judging Chair will inform you about when and where to report.
- At the judges meeting, you will be informed of any last minute changes and/or special requests concerning judging assignments.
- Each team is to be assigned about six projects or papers to judge. Again, **each exhibitor is to be judged based on the rating criteria and not in comparison to other exhibitors or based on your personal preferences.**
- The Regional and State Expositions are so planned that each judging team is allowed fifteen to thirty minutes for each project or paper. This does not mean that you must spend this much time on each project. Times may vary, more or less, depending upon the quality and interest of the project.
- You may be asked to judge projects in both divisions, Junior - grades 7 & 8, and Senior - grades 9, 10, 11, and 12. If so, remember to judge them based on individual merit, and please keep the maturity of the exhibitor in mind.
- It is imperative that each judging team finish its judging responsibilities and have its judging results turned into the Category Chair on time. Enough time must be available to prepare the awards by the Awards Chair. Please allot your time accordingly so that results are turned in when due.

- Students must be with their project or at their assigned paper session room at the time of judging. If the student cannot be located within a reasonable period of time, then the project or paper is considered a No Show, and no rating is to be given.
- Many intangible factors are involved in judging. These can be evaluated only by talking with the student and cannot be estimated merely by looking at the physical aspects of the exhibit. Judges should keep in mind that a spectacular exhibit or one composed of costly equipment is not necessarily the best science project.
- Be pleasant and interested.
- Please remember that you are working with tomorrow's scientists; their "decision for science" may rest on the impression you leave on them.
- **Fill out and return the judge's comment sheet to the student.** Please indicate comments that would help the student improve. Comments might be positive or negative, but should not be sarcastic. Please make sure that your comments are clear and to the point. **Do not indicate the award on this sheet.**
- Each project judged must have a final score so that the certificate of award can be made. **Be certain that you are using the correct rubric when scoring the project.** Do not show the student the score. Information on specific guidelines and procedures concerning ratings will be supplied and discussed by the judging chair.
- Be sure every project for which you are responsible has been judged. Return the scoring rubric immediately following the judging of each project. DO NOT hold all scoring rubrics until you are finished judging all projects.
- **Judges must return all materials (except for abstracts) to the student. You may not keep any other portion of the student's paper.**



## INFORMATION FOR PARENTS, SPONSORS AND TEACHERS

### PARENTS (Sponsors and Teachers)

We know that you are proud of the accomplishments of your son or daughter and that you are anxious to see them succeed in this introductory phase of a possible career or a lifelong interest in science. The parent's role is to support their son or daughter's independent efforts, not to take over the project. Your challenge is to provide just enough assistance to allow your son or daughter's own efforts to take center stage, while offering ideas and resources that might help your child raise their efforts to a higher level.

Keep in mind the following suggestions:

- Review this *Policy and Procedure Manual* in its entirety and any other materials your son or daughter's science teacher (sponsor) sends home about the requirements of the project. All regional and state information is sent to only one sponsor per school.
- Encourage your child as he or she brainstorms ideas for the project. Do not be too quick to shoot ideas down as impractical or expensive – let them explore ideas first. If you have concerns, form them into questions for your son or daughter to consider. If possible, allow him or her to rule out impractical ideas before you do.
- Make sure you understand what is required before approving a science project topic. Will it be able to be accomplished with all the other activities that your child is involved in, along with other academic requirements?
- Support your child in researching their topic and conducting the experiment; assist by supplying transportation (if needed), and access to information and materials. Often excellent learning opportunities will present themselves. You could teach your child to use a piece of equipment or machinery rather than doing it yourself just because it might be easier.
- Make sure you are familiar with the safety guidelines and see that they are followed.
- Assist your child in thinking through experimental procedures and how they plan to record and organize their data.
- Your child might need assistance in preparing their display board and presentation. Your role should be secondary to their efforts – things like reading through and suggesting editorial changes, helping with advanced computer applications, assisting with display board layout, and listening to their presentation.
- The Illinois Junior Academy of Science attempts to award and recognize as many students as possible. Proper handling of the successes and disappointments of a competition can lead to the continued efforts towards a higher goal.
- Celebrate the successes and spend a moment looking at what went wrong. Encourage a discussion as to how things might have been done differently. This process is an important part of both learning and science.
- A student may be denied participation at the next level of exhibition if the project or paper is found to violate the established rules and regulations published in the most recent copy of the *Policy and Procedure Manual* of the Illinois Junior Academy of Science.
- Special award judges, who are not agents of the Illinois Junior Academy of Science, may use other criteria for selecting their special awards.
- In general, show an interest in your son or daughter's progress, offer support and encouragement, help them overcome problems, and praise their good efforts.
- If in doubt, contact your son or daughter's science teacher or sponsor for assistance or encourage your child to do so.
- **IN ALL STAGES OF COMPETITION, THE JUDGE'S DECISION IS FINAL.**

## SPONSORS AND TEACHERS

Behind the student is the sponsor, often a teacher of a science subject, but occasionally a dedicated citizen. These volunteers are the unsung heroes of the local, regional, and state expositions. The ways in which they can assist the students are:

- Instill interest within the students.
- Register in the fall with the Illinois Junior Academy of Science (IJAS). Registration deadline is **December 31**.
- Provide materials that will help the student select the project: *The Illinois Junior Academy of Science Policy and Procedure Manual*, regional mailings, state mailings, and access to the IJAS website at [www.ijas.org](http://www.ijas.org).
- Discuss how to develop a project, and show results of past projects.
- Review the rules governing the use of humans and non-human vertebrate animals. If students intend to carry out human or other vertebrate animal experimentation make certain that they are aware of the procedures to follow and that they complete the proper endorsement forms. **(see Appendix page 46, 47)**
- Participate in a local Science Exposition. This local exposition will give the students experience in the displaying and explaining of their projects and may determine which projects are worthy of Regional competition.
- Establish a deadline calendar. For example, project selection to be by the first week in October, progress reports by December, final sketches by January, and projects completed and ready for presentation by early February. This will leave time for final adjustments before the Regional Fairs.
- Consult your Regional Chair for deadline dates pertinent to your Region. **Information can be found on the IJAS website at [www.ijas.org](http://www.ijas.org).**
- Arrange periodic small group discussions of progress on projects and provide an opportunity to analyze and solve problems related to individual projects.
- Offer encouragement and guidance.
- Solicit the cooperation of other adults for their facilities and services to be used in construction as well as guidance in the research paper writing.
- Help students with the technicalities involved in preparing the project and paper. **Make sure they are aware of the safety regulations and formats to be followed.**
- Check the project and paper carefully to be sure the student has complied with all safety regulations and with the regulations for writing the paper and abstract before signing your name to the safety and/or endorsement sheets. **AS A SPONSOR, YOU ARE RESPONSIBLE FOR ALL ASPECTS OF THE STUDENT'S PROJECT.**
- Request the necessary entry materials for both the project and paper sessions. Since regional procedures may vary, **consult with your Regional Chair for specific details.**
- **Furnish judges** for both the Regional and State Expositions. Failure to comply with this requirement may result in the return of your project and/or paper entries. Judges must be aware of their responsibilities. If they cannot attend, they must provide a suitable replacement in the same judging area.
- **Furnish safety inspectors, runners, awards room workers, and other volunteers** as required by the regional and/or state organizations.

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ILLINOIS JUNIOR ACADEMY OF SCIENCE REGIONS .....	Inside Back Cover

# STUDENT PROJECT AND SAFETY CHECKLIST

## The Illinois Junior Academy of Science

### Project Checklist

#### **Abstract**

- \_\_\_\_\_ First page of paper.
- \_\_\_\_\_ 3 paragraphs with proper headings: Purpose, Procedure, and Conclusion.
- \_\_\_\_\_ Typed single-spaced.
- \_\_\_\_\_ 200 words or less.

#### **Safety Sheet**

- \_\_\_\_\_ Second page of paper.
- \_\_\_\_\_ Hazards listed, precautions described.
- \_\_\_\_\_ Signed by sponsor.

#### **Endorsement(s)/required document, if applicable**

- \_\_\_\_\_ Third page of paper; subsequent pages, as needed.
- \_\_\_\_\_ Signed by student and sponsor; proper documentation is attached, if necessary.

#### **Title Page**

- \_\_\_\_\_ Clear and concise.

#### **Table of Contents**

- \_\_\_\_\_ Pagination is accurate.

#### **Acknowledgments**

- \_\_\_\_\_ Credit is given to those who have helped.

#### **Purpose and Hypothesis**

- \_\_\_\_\_ States precisely what the investigation was attempting to discover.
- \_\_\_\_\_ States a definite question or problem.
- \_\_\_\_\_ Hypothesis is present.

#### **Review of the Literature**

- \_\_\_\_\_ Use of 3rd person is evident.
- \_\_\_\_\_ Logical and/or related grouping of information.
- \_\_\_\_\_ Accuracy in calculations, spelling, grammar, and quotations.
- \_\_\_\_\_ Typed double-spaced, one inch margins, single-sided.
- \_\_\_\_\_ Parenthetically cited.

#### **Materials and Methods of Procedure**

- \_\_\_\_\_ Apparatus and materials are listed.
- \_\_\_\_\_ Drawings and photographs are present if they enhance and clarify the apparatus.
- \_\_\_\_\_ Step-by-step, chronological procedures are present.
- \_\_\_\_\_ Number of test groups is adequate and the number of trials within each test group is adequate.
- \_\_\_\_\_ The control of variables is evident.

**Results**

- \_\_\_\_\_ Data is organized into tables or charts with accompanying graphs, if appropriate.
- \_\_\_\_\_ Data is quantitative and correct units of measurement (metric) are used.
- \_\_\_\_\_ Data is clear and accurate.
- \_\_\_\_\_ The effect of experimental error was estimated and considered.

**Conclusions**

- \_\_\_\_\_ Evaluation and interpretation of data is present.
- \_\_\_\_\_ Refers back to purpose and hypothesis; answers the original question.
- \_\_\_\_\_ Is valid and limited to the results of the experiment.

**Reference List**

- \_\_\_\_\_ References come from a variety of sources.
- \_\_\_\_\_ References are current.
- \_\_\_\_\_ Reference list is alphabetical.
- \_\_\_\_\_ Proper format is used for all references.

**Experimental Safety**

The following procedures were followed:

- \_\_\_\_\_ No cultures were obtained from humans, except those from supply houses.
- \_\_\_\_\_ Quantities of food and non-alcoholic beverages were limited to normal serving sizes, and consumed in a reasonable amount of time.
- \_\_\_\_\_ Blood was not drawn exclusively for the science project.
- \_\_\_\_\_ Projects involving exercise have a valid normal physical examination on file and exercise was not carried to the extreme.
- \_\_\_\_\_ No cultures were obtained from warm-blooded animals.
- \_\_\_\_\_ No intrusive techniques were used.
- \_\_\_\_\_ No extreme changes were made in the organism's normal environment.
- \_\_\_\_\_ Food or water was not withheld for a period that would cause undue stress based on the animal's metabolic rate.
- \_\_\_\_\_ Animals were properly cared for with adequate ventilation, food, and water.
- \_\_\_\_\_ Chicken or other bird embryo treatment was discontinued at or before 72 hours before hatching.
- \_\_\_\_\_ All microorganisms were destroyed by autoclaving or with NaOCl (bleach) solution.

**Exhibition Safety**

- \_\_\_\_\_ Project fits on tabletop within 76 X 122 cm limitations allowed; is no taller than 152 cm (5 ft).
- \_\_\_\_\_ No glass object may be displayed unless it is a component of some unique apparatus. The apparatus must be secured, without sharp edges, and away from the table's edge.
- \_\_\_\_\_ Chemicals are not displayed. Photographs should be substituted.
- \_\_\_\_\_ Hazardous materials: explosive, flammable, corrosive, or poisonous materials, rockets, compressed or aerosol cans are not displayed.
- \_\_\_\_\_ Fire hazards: no open flames, torches, burners, or electric hotplates are displayed.
- \_\_\_\_\_ Radiation: no laser, UV-light, X-rays, or other radioactive materials are displayed.
- \_\_\_\_\_ Packing materials are not on or under the table.
- \_\_\_\_\_ No table drapes or other coverings are present.
- \_\_\_\_\_ No vertebrates, invertebrates, or animal tissues are displayed.
- \_\_\_\_\_ No hypodermic needles or syringes are displayed.
- \_\_\_\_\_ No cultures of any kind are displayed.
- \_\_\_\_\_ Electrical and/or mechanical equipment may not be displayed unless approved by IJAS Safety Inspector.

**Miscellaneous**

- \_\_\_\_\_ Three copies of the complete research paper for Project Session participants.
- \_\_\_\_\_ Display board - Reminder: no chairs or table covers are allowed.
- \_\_\_\_\_ Entry Tag Ribbon – worn by the presenter.
- \_\_\_\_\_ A copy of the Abstract, Safety Sheet, and Endorsements (if applicable) are displayed on the front of the display board.
- \_\_\_\_\_ Electrical extension cord, if needed for your project. The project has already been designated as needing electricity.
- \_\_\_\_\_ Friday night banquet tickets - see sponsor for information.

## **Format for Reference List**

The correct style to use for citing references in the Reference List section is discussed in detail in the *Publication Manual of the American Psychological Association, Fifth Edition, 2001, or later* (APA style). Be careful to follow the punctuation, indentation, and format shown below.

- The Reference List must be double-spaced. **Note:** If using the actual *APA Publication Manual*, all example references are single-spaced to save space in the *Publication Manual*.
- The Reference List should be alphabetized according to the first letter of each entry.
- Although the five-space indent style of citing is the suggested format, the hanging paragraph format is acceptable.
- Italics are preferred over the use of underlining.
- The abbreviation for Page(s), p. or pp., is not used except in references to newspapers.
- Electronic source references must provide the date the information was retrieved, and also the name and/or address of the source.

### **BOOKS**

#### **Typical Book - One author:**

The author's last name is listed first. It is followed by the date of publication, in parentheses, ending with a period. Next, include the book title, which is in italics. Capitalize only the first word of the title (and the first word of the subtitle, if any) and any proper names. Include any additional information necessary for retrieving the book (such as "3rd ed." or "Vol. 4") in parentheses, immediately after the title. Identify the city and the state where the publisher is located. Then, place a colon (:) and identify the name of the publisher, clearly and briefly. Spell out the names of associations and university presses, but omit superfluous terms such as "Publishers," "Co.," or "Inc." If two or more locations are given, give the location listed first or the publisher's home office. Close with a period.

#### **Example:**

- Arnheim, R. (2001). *Art and visual perception*. Berkeley, CA: University of California Press.

#### **Book - Multiple authors:**

When a work has between two and six authors, cite all authors. When a work has more than six authors cite the first six authors followed by "et al." to indicate the remaining authors. The entry should begin with the last name of the first author, followed by his or her initials. Authors appear in alphabetical order. Date of publication comes next, in parentheses. The title should be italicized, but only the first word should be capitalized. Place of publication comes next, then the publisher. Use a colon after the place of publication. Each portion of the entry should be separated by a period and two spaces.

#### **Examples:**

- Festinger, L., Riecken, H., & Schachter, S. (2003). *When prophecy fails*. Minneapolis: University of Minnesota Press.
- West, S., Sandler, I., Tein, J., Ivy, P., Patterson, H., Roeder, K., et al. (2001). *Nerve cells and insect behavior*. Cambridge, MA: Harvard University Press.

#### **Book - Corporate author:**

- Institute of Financial Education. (2001). *Managing personal funds*. Chicago: Midwestern Publishing.

### **Book - Edited volume:**

When an editor or editors is listed for a text, begin with the last name of the editor(s) followed by the initials. Then the abbreviation "Ed." or "Eds." appears in parentheses. Date of publication comes next, also in parentheses. The title should be italicized, but only the first word should be capitalized. Place of publication follows, then the publisher. Use a colon after the place of publication. Each portion of the entry should be separated by a period and two spaces.

### **Examples:**

- Maher, B. A. (Ed.). (2003). *Progress in experimental personality research*. New York: Academic Press.
- Letheridge, S., & Cannon, C.R. (Eds.). (2001). *Bilingual education: Teaching English as a second language*. New York: Praeger

### **Second Works by Same Author(s):**

When listing two or more works by the same author in your reference list, the work with the earlier publication date should come first:

- Brown, R. (1958). *Words and things*. New York: Free Press, Macmillan.
- Brown, R. (1965). *Social psychology*. New York: Free Press, Macmillan.

If the publication date is the same, then the entries should appear alphabetically by title (excluding "A" or "The"):

- Neisser, U. (1967). *Cognitive psychology*. New York: Wiley.
- Neisser, U. (1967). *Personality and assessment*. New York: Wiley.

### **Book - No author identified:**

If no author is identified, begin with the title, italicized. Only the first important word should be capitalized. Date of publication should follow, in parentheses. Place of publication and publisher come next. Use a colon after the place of publication. Each portion of the entry should be separated by a period and two spaces.

### **Example:**

- *Experimental psychology*. (2004). New York: Holt.

### **Book - Work in an anthology:**

- Rubenstein, J. P. (2003). *The effect of television violence on small children*. In B.F. Kane (Ed.), *Television and Juvenile Psychological Development* (pp. 112-134). New York: American Psychological Society.

## **PERIODICALS: JOURNALS-MAGAZINES-NEWSPAPERS**

Once you are familiar with the basic pattern to APA journal references, it is relatively easy to format a variety of journal references, no matter how strange the journal may seem.

- Page, E. (1968). The use of the computer in analyzing student essays. *International Review of Education*, 14, 253-263.

### **Points to note:**

**Authors** are listed with the last name first, followed by a comma and the initial of the first name. Include the last name and the first initial for all authors. For an article with multiple authors, separate the names with commas after the initials. Include an ampersand before the last author. For example: Parham, K., Fischer, C., & Austin, K. If there is no author given, treat the article title as the author, and move it into the author slot before the publication date. If the author is a corporate group, spell out the full name of the corporate author. Signal the end of the author element with a period.

Enclose in parentheses the **year** the text was copyrighted. Type a period outside the parentheses to finish the element. For non-journal periodicals, such as magazines or newspapers, give the year first then the month and day, if specified in the publication. (See examples under Article in a Monthly Periodical and Article in a Weekly Periodical.)

Do not underline the **title** or place quotations around it. Capitalize only the first word of the title. If there is a subtitle, capitalize it as well. Place a period at the end of the title. If there is important information about the form of the article, this should be enclosed in brackets and placed after the title. The terminal period is placed after the bracketed information. Example: The future of writing centers [President's address].

Include the full **journal title**, using upper and lowercase letters. Unlike the article title, the journal title is italicized. Follow the journal title with a comma.

### **Journals with Continuous Pagination**

In APA style, journals with continuous pagination are considered to be the norm, so no modification of the standard listing is needed.

- Passons, W. (1967). Predictive validities of the ACT, SAT, and high school grades for first semester GPA and freshman courses. *Educational and Psychological Measurement*, 27, 1143-1144.

### **Journals with Non-continuous Pagination**

Because pagination begins anew with each issue of this journal, it is necessary to include the issue number in parentheses after the volume number. Note that there is a comma between the issue number and the page numbers, but no comma between the italicized volume number and the issue number.

- Sawyer, J. (1966). Measurement and prediction, clinical and statistical. *Psychological Bulletin*, 66 (3), 178-200.

### **Newspaper Articles**

- Monson, M. (1993, September 16). Urbana firm obstacle to office project. *The Champaign-Urbana News-Gazette*, pp. 1,8.

### **No Author Identified**

Begin with the title, italicized. Only the first important word should be capitalized. Date of publication should follow, in parentheses. Place of publication and publisher come next. Use a colon after the place of publication. Each portion of the entry should be separated by a period and two spaces.

- *Experimental psychology*. (1938). New York: Holt.

## **OTHER SOURCES**

### **Computer Software**

The name(s) of the programmers are listed at the head of the entry, last names first, followed by a period. After listing the date in parentheses followed by a period, italicize the title, and specify in brackets that the source is a computer program. List the location and the organization's name that produced the program. Add any other necessary information for identifying the program (in this example).

- Arend, Dominic N. (1993). *Choices* [Computer program]. Champaign, IL: U.S. Army Corps of Engineers Research Laboratory. (CERL Report No. CH7-22510).

### **Film or Videotape**

The main people responsible for the videotape are given, with their roles identified in parentheses after their names. After the title, the medium is identified (here, a videotape). The distributor's name and location comprises the last part of the entry.

- Weir, P.B. (Producer), & Harrison, B.F. (Director). (1992). *Levels of consciousness* [Videotape]. Boston, MA:Filmways.

### **Interviews**

Interviews used as sources may be published or unpublished, and the format for listing an interview will differ according to the type.

A references entry for a published interview should use the following format:

- Archer, N. (1993). [Interview with Helen Burns, author of *Sense and Perception*]. *Journal of Sensory Studies*, 21, 211-216.

In this example, the interview lacks a title, so a description of the interview is given in brackets. If the interview has a title, include the title (without quotation marks) after the year, and then give a further description in brackets if necessary. The entry should follow the format of the original source of the interview (in this case, a journal article with one author).

Unpublished interviews do not need a reference page entry because they are what the Publication Manual of the APA calls "personal communications" and so "do not provide recoverable data." Include these references in the text of your document, according to the following format:

- (N. Archer, personal interview, October 11, 1993)

### **TV or Radio**

The name(s) of the producer, director, or other significant contributors are listed at the head of the entry, last names first. Each name is followed by a description in parentheses of that individual's function (in this example, Keillor and Lynn, respectively, are the producer and the director), and a period should appear after the final parentheses. After listing the date in parentheses followed by a period, italicize the program title, and specify in brackets whether it is a radio or television program. List the location and the local station where you saw or heard the program.

- Keillor, Garrison (Producer), & Smith, Lynn (Director). (2 Oct.1993). *A prairie home companion* [Radio Program]. St. Louis, MO: KMOX.

## ELECTRONIC SOURCES

Electronic formats can be found at: <http://www.apa.org/science/pubs.html>

### **World Wide Web, Home page/Secondary page:**

Author/editor (if known). (Revision or copyright date, if available). Title of page. Publication, Page number(s). Retrieved Date, from Protocol: Site/Path/File

- Manuka Honey USA Home Page. (2006). Retrieved July 25, 2007, from Manuka Honey USA Web site: <http://www.manukahoneyusa.com>
- Goizueta, R.C. (1996, February 26). Annual report to share owners. Retrieved July 24, 2007, from Coca-Cola Company Web site: <http://www.cocacola.com/co/chairman.html>
- Huang, G (2007, March 17). Tiny organisms remember the way to food. *NewScientist.com*, Retrieved July 25, 2007, from <http://www.newscientist.com/article/dn11394-tiny-organisms-remember-the-way-to-food.html>

### **Encyclopedia article, Online**

- Stock market crash of 1929. (1995). In *Britannica Online* [Web]. Retrieved July 12, 2007, from <http://www.eb.com>
- Schlessinger, D. (2007). Staphylococcus. In World Book Online Reference Center [Web]. Retrieved July 25, 2007, from <http://www.worldbookonline.com/wb/Article?id=ar529480&st+staphylococcus>

### **Encyclopedia article, CD-ROM:**

Author/editor (if given). (Date). Title of material accessed. In *Source*. Retrieved Publication medium, *edition or version (if relevant)*. Location: Name of Producer.

Example with author:

- Daniel, R. T. (2003). The history of Western music. In *Britannica Online: Macropaedia*. Retrieved CD-ROM. Carlsbad, CA: Compton's NewMedia, Inc.

Example without author:

- Genetic engineering. (2001). In *Compton's Interactive encyclopedia, Version 2.0*. Retrieved CD-ROM. Carlsbad, CA: Compton's NewMedia, Inc.

### Journal/Magazine Article, Online

Author. (Date). Title. *Journal or Magazine Title*, volume, paging. Retrieved Date, from URL

- Koehn, D (1995). The ethics of handwriting analysis in pre-employment screening. *The Online Journal of Ethics*, 1, Retrieved September 6, 2007, from [http:// condor.depaul.edu/ethics/hand.html](http://condor.depaul.edu/ethics/hand.html)
- Insecticide gets help from gut bacteria. (2006, September 6). *Science News*, Retrieved October 12, 2007, from [http://findarticles.com/p/articles/mi\\_m1200/is\\_14\\_170/ai\\_n16864779](http://findarticles.com/p/articles/mi_m1200/is_14_170/ai_n16864779)

### Newspaper Article, Online

Author. (Date). Title. *Newspaper Title*, Retrieved Date, from URL Protocol: Site/Path/File

- Markoff, J. (1996, June 5). Voluntary rules proposed to help insure privacy for Internet users. *The New York Times*, Retrieved September 21, 2007, from <http://www.nytimes.com/library/cyber/week/y05dat.html>

## APA RESOURCE WEBSITES

These materials will introduce you to APA documentation, step-by-step instructions, Format, Citations, and Reference Lists. However, it is suggested you reference the *Publication Manual of the American Psychological Association, Fifth Edition, 2001, or later*, whenever possible.

<http://www.easybib.com>

<http://www.rapidcite.com>

<http://www.stylewizard.com>

<http://www.noodletools.com>

<http://www.citationmachine.net>

<http://www.wisc.edu/writing/Handbook/DocAPA.html>

University of Illinois Writers' Workshop

([http://www.english.uiuc.edu/CWS/wWORKSHOP/writer\\_resources/citation\\_styles/apa/apa.htm#authors](http://www.english.uiuc.edu/CWS/wWORKSHOP/writer_resources/citation_styles/apa/apa.htm#authors))

# FORMAT FOR PARENTHETICAL CITATION WITHIN THE TEXT OF THE REVIEW OF LITERATURE

**NOTE: ALL REFERENCES CITED WITHIN THE TEXT MUST APPEAR IN THE REFERENCE LIST, AND ALL ENTRIES IN THE REFERENCE LIST MUST BE CITED IN THE TEXT.**

## Direct Quotations Of Sources

Quotations of less than 40 words should be incorporated in the text and enclosed within double quotation marks. Using the "author-date method" of citation, the quotation is followed with a reference to the publication year, and the page number. These elements must be enclosed in parentheses, together or separately. A complete reference must appear in the reference list at the end of your paper.

- He stated, "The 'placebo effect,'...disappeared when behaviors were studied in this manner" (Smith, 2001 , p.276), but he did not clarify which behaviors were studied.
- Smith (2001) found that "the 'placebo effect,' which had been verified in previous studies, disappeared when [his own and others'] behaviors were studied in this manner" (p. 276).

If quoting from an Internet source or CD-ROM, use the same format as for other quotations, but use [Online] or [CD-ROM] in place of a page number reference.

- He stated, "The 'placebo effect,'...disappeared when behaviors were studied in this manner" (Smith, 2001, [Online]), but he did not clarify which behaviors were studied.

When making a quotation of more than 40 words, use a free-standing "block quotation" on a new line; indent five to seven spaces and omit quotation marks.

- Smith (2001) found the following:

The "placebo effect," which had been verified in previous studies, disappeared when behaviors were studied in this manner. Furthermore, the behaviors *,were never exhibited*[italics added], even when real [sic] drugs were administered. Earlier studies were clearly premature in attributing the results to a placebo effect (p. 276).

## Reference Citations in the Text

Whenever **using your own words** to refer indirectly to another author's work (**paraphrasing**), you must identify the original source. The "author-date method" of citation is used for this purpose, but without quotations marks. A complete reference must appear in the reference list at the end of your paper.

- One recent study finds a genetic link to alcoholism (Jones, 1997).

If the author's last name appears in the citation, then only the year is required:

- Jones finds a genetic link to alcoholism (1997).

## **Multiple Authors**

When a work has only two authors, use both of their names each time their work is cited, joined by an ampersand (&) if in parentheses, or by the word "and" if in text:

- in parentheses--(Cortez & Jones, 1997)
- in text--Cortez and Jones (1997)

For three, four, or five authors, refer to all authors the in the first citation, then use the first author's last name followed by the abbreviation "et al." in all subsequent citations:

- first citation--(Cortez, Jones, Gold, & Hammond, 1998)
- subsequent citations--(Cortez et al., 1998)

For six or more authors, use the first author's last name followed by the abbreviation et al.:

- all mentions--(Cortez et al., 1999)

### **Different Authors with the Same Last Name**

When citing different authors with the same last name, include their first and middle initials, so that a reader can differentiate between them:

- (B.A. Jones, 1998); (R.F. Jones, 1998)

### **More Than One Work by the Same Author**

If you are citing more than one work by the same author, include enough information so that your reader can differentiate between them. For instance, if you have used two studies by the same authors (from different years), you simply need to include their dates of publication:

- (Jones, Crick, & Waxson, 1989); (Jones, Crick, & Waxson, 1998)

or, if you are citing both at once:

- (Jones, Crick, & Waxson, 1989, 1998)

If you are citing more than one work from the same year, use the suffixes "a," "b," "c" etc., so that your reader can differentiate between them (these suffixes will correspond to the order of entries in your references page):

- (Jones, Crick, & Waxson, 1999a); (Jones, Crick, & Waxson, 1999b)

### **Multiple Authors Cited Together**

The format for this type of citation is similar to that for citing more than one work by the same author (see above), except that semicolons are used to differentiate between authors:

- (Jones, 1998; Heckels, 1996; Stolotsky, 1992)

### **Group Authors**

When identifying group authors, use the same format as noted for single authors above, but substitute the company name.

If the name is easy to abbreviate, then write out the full name in the first citation, and abbreviate it in all subsequent citations. If it is difficult to abbreviate, write out the full name each time:

- first citation--(National Institute of Mental Health [NIMH], 1999)
- subsequent citation--(NIMH, 1999)

## **No Author Available**

If no author is available, use a short form of the title (the shortest form that will allow you to recognize the work properly). For instance, if you were working with a study called "The Effects of Aspirin on Heart Attack Victims" you might use the following:

- ("The Effects," 1995)

If you were working with an entire book with no author called Aspirin and Heart Attacks, you might use:

- (Aspirin, 1991)

If the text is attributed to "Anonymous," then use the following format:

- (Anonymous, 1999)

## **Specific Parts of a Source**

In general, direct quotes are used much less often in APA style than they are in MLA style. However, if the occasion warrants one, then the following format is used:

- (Asaki & Klotzky, 1987. p. 333)

## **Personal Communication**

Personal communications receive a slightly more elaborate in-text citation, since they are not cited in the references section of an APA-style document:

- (H.J. Simpson, personal communication, September 29, 1999)



# ABSTRACT

## The Illinois Junior Academy of Science

CATEGORY \_\_\_\_\_ STATE REGION # \_\_\_\_\_  
SCHOOL \_\_\_\_\_ IJAS SCHOOL # \_\_\_\_\_  
CITY/ZIP \_\_\_\_\_ SCHOOL PHONE \_\_\_\_\_  
SPONSOR \_\_\_\_\_

NAME OF EXHIBITOR\* \_\_\_\_\_ GRADE \_\_\_\_\_

NAME OF EXHIBITOR \_\_\_\_\_ GRADE \_\_\_\_\_

NAME OF EXHIBITOR \_\_\_\_\_ GRADE \_\_\_\_\_

NAME OF EXHIBITOR \_\_\_\_\_ GRADE \_\_\_\_\_

\* If this project is awarded a monetary prize, the check will be written in this exhibitor's name, and it will be his/her responsibility to distribute the prize money equally among all participating exhibitors.

PROJECT TITLE \_\_\_\_\_

1. Limit Abstract to 3 paragraphs (about 200 words or less). a) Purpose - what you set out to investigate; b) Procedure - how you did it; c) Conclusion - based on your results. LABEL EACH PARAGRAPH.
2. Must be typed, single-spaced on the front of this form. DO NOT write on the back of this form.
3. THREE (3) copies of your COMPLETE paper are required at the State Science Project Exposition. FOUR (4) copies of your COMPLETE paper are required for the State Paper Session Competition.

**The above form must be duplicated. Student generated forms must be in essentially the same format.**

This form MUST be displayed on the front of the exhibitor's display board. It may be reduced to half a sheet of paper.

# SAFETY SHEET

## The Illinois Junior Academy of Science

**DIRECTIONS:** The student is asked to read this introduction carefully, fill out the bottom of this sheet, and sign it. The science teacher and/or advisor must sign in the indicated space.

**SAFETY AND THE STUDENT:** Experimentation or research may involve an element of risk or injury to the student, test subjects and to others. Recognition of such hazards and provision for adequate control measures are joint responsibilities of the student and the sponsor. Some of the more common risks encountered in research are those of electrical shock, infection from pathogenic organisms, uncontrolled reactions of incompatible chemicals, eye injury from materials or procedures, and fire in apparatus or work area. Countering these hazards and others with suitable controls is an integral part of good scientific research.

In the **box** below, list the principal hazards associated with your project, if any, and what specific precautions you have used as safeguards. Be sure to read the entire section in the *Policy and Procedure Manual of the Illinois Junior Academy of Science* entitled "SAFETY GUIDELINES FOR EXPERIMENTATION" before completing this form.

SIGNED \_\_\_\_\_  
Student Exhibitor(s)

SIGNED \_\_\_\_\_  
Sponsor\*

\*As a sponsor, I assume all responsibilities related to this project.

**This Sheet Must Be Typed**

This form MUST be displayed on the front of the exhibitor's display board. It may be reduced to half a sheet of paper.

# HUMANS AS TEST SUBJECTS ENDORSEMENT

## The Illinois Junior Academy of Science

THESE RULES WILL BE STRICTLY ENFORCED FOR THE STATE SCIENCE EXPOSITION. NO REGION SHOULD SEND A PROJECT TO THE STATE EXPOSITION THAT DOES NOT MEET THESE REGULATIONS.

Students and sponsors doing a human vertebrate project must complete this form. The signature of the student or students and the sponsor indicates that the project was done within these rules and regulations. Failure to comply with these rules will mean the disqualification of the project at the state level. This form must follow the Safety Sheet in the project paper.

1. Humans must not be subjected to treatments that are considered hazardous and/or that could result in undue stress, injury, or death to the subject.
2. No primary or secondary cultures taken directly (mouth, throat, skin, etc.) or indirectly (eating utensils, countertops, doorknobs, toilets, etc.) will be allowed. However, cultures obtained from reputable biological suppliers or research facilities are suitable for student use.
3. Quantities of food and non-alcoholic beverages are limited to normal serving amounts or less and must be consumed in a reasonable amount of time. Normal serving amounts must be substantiated with reliable documentation. This documentation must be attached to the Humans as Test Subjects Endorsement form. No project may use over-the-counter, prescription, illegal drugs, or alcohol in order to measure their effect on a person.
4. The only human blood that may be used is that which is either purchased or obtained from a blood bank, hospital, or laboratory. No blood may be drawn by any person or from any person specifically for a science project. This rule does not preclude a student making use of data collected from blood tests not made exclusively for a science project.
5. Projects that involve exercise and its effect on pulse, respiration rate, blood pressure, and so on are allowed provided the exercise is not carried to the extreme. Electrical stimulation is not permitted. A valid, normal physical examination must be on file for each test subject. Documentation of same must be attached to the Humans as Test Subjects Endorsement form.
6. Projects that involve learning, ESP, motivation, hearing, vision, and surveys require the **Humans as Test Subjects** form.

In this space, briefly describe the use of humans and assess the risk(s) to them in your project. Use the back of this page if necessary.

The **signatures** of the student, or students, and sponsor below indicate that the project conforms to the above rules of the Illinois Junior Academy of Science.

\_\_\_\_\_  
(Sponsor)

\_\_\_\_\_  
(Student)

\_\_\_\_\_  
(Date)

\_\_\_\_\_  
(Student)

**This Sheet Must Be Typed**

This form MUST be displayed on the front of the exhibitor's display board. It may be reduced to half a sheet of paper.



Check box if exception/approval letter is required and attached (see page 12)

# NON-HUMAN VERTEBRATE ENDORSEMENT

## The Illinois Junior Academy of Science

THESE RULES WILL BE STRICTLY ENFORCED FOR THE STATE SCIENCE EXPOSITION. NO REGION SHOULD SEND A PROJECT TO THE STATE EXPOSITION THAT DOES NOT MEET THESE REGULATIONS.

Students and sponsors doing a non-human vertebrate project must complete this form. The signature of the student or students and the sponsor indicates that the project was done within these rules and regulations. Failure to comply with these rules will mean the disqualification of the project at the state level. This form must follow the Safety Sheet in the project paper.

1. The student and the sponsor have the responsibility to see that all animals have proper care in well-ventilated, properly lighted locations with proper nutrition, proper temperature, adequate water, and sanitary surroundings. Care must be taken to see that the organisms are properly cared for during weekends and vacation periods.
2. **No** primary or secondary cultures involving warm-blooded animals taken directly ( mouth, throat, skin, etc.) or indirectly (cage debris, droppings, etc.) will be allowed. However, cultures purchased from reputable biological supply houses or research facilities are suitable for student use.
3. No intrusive or pain- producing techniques may be used. Included in these techniques would be things such as surgery, injections, taking of blood, burning, electrical stimulation or giving of over-the-counter, prescription, illegal drugs, or alcohol to measure their effect.
4. No changes may be made in an organism's environment that could result in undue stress, an injury, or death to the animal.
5. No vertebrates can be used as the independent or dependent variables in an experiment that could result in undue stress, an injury, or death to the animal.
6. For maze running and other learning or conditioning activities, food or water cannot be withheld for more than 24 hours. If the animal has a high metabolic rate, then food or water cannot be withheld for a length of time that would produce undue stress on the animal.
7. Chicken or other bird embryo projects are allowed, but the treatment must be discontinued at or before ninety-six hours from fertilization.
8. Projects that involve behavioral studies of newly hatched chickens or other birds will be allowed if no changes have been made in the normal incubation and hatching of the organism, and that all vertebrate rules are followed.

In this space, briefly describe the use of non-human vertebrates and assess the risk(s) to them in your project. Use the back of this page if necessary.

The **signatures** of the student, or students, and sponsor below indicate that the project conforms to the above rules of the Illinois Junior Academy of Science.

\_\_\_\_\_

(Sponsor)

\_\_\_\_\_

(Student)

\_\_\_\_\_

(Date)

\_\_\_\_\_

(Student)

**This Sheet Must Be Typed**

This form MUST be displayed on the front of the exhibitor's display board. It may be reduced to half a sheet of paper.



Check box if exception/approval letter is required and attached (see page 12)

# MICROORGANISM ENDORSEMENT

## The Illinois Junior Academy of Science

THESE RULES WILL BE STRICTLY ENFORCED FOR THE STATE SCIENCE EXPOSITION. NO REGION SHOULD SEND A PROJECT TO THE STATE EXPOSITION THAT DOES NOT MEET THESE REGULATIONS.

Students and sponsors doing a microorganism project must complete this form. The signature of the student or students and the sponsor indicates that the project was done within these rules and regulations. Failure to comply with these rules will mean the disqualification of the project at the state level. This form must follow the Safety Sheet in the project paper.

1. This area of science may involve many dangers and hazards while experimenting. It is the sole responsibility of all teacher(s)/sponsor(s) to teach students proper safety methods and sterile techniques.
2. The Illinois Junior Academy of Science prohibits the use of primary or secondary cultures taken from humans or other vertebrate animals in any project because of the danger from unknown viruses or other disease-causing agents that may be present. Pure cultures of microorganisms known to inhabit vertebrate animals may be obtained from reputable suppliers and used in proper settings.
3. Microorganism experiments must be conducted in a laboratory such as science classroom or research facility.
4. Projects involving viruses and recombinant DNA should be done with the help of a professional and should comply with the National Institutes of Health (NIH) Guidelines unless the project is limited to a kit obtained from a legitimate supply house.
5. All cultures should be destroyed by methods such as autoclaving or with a suitable NaOCl (bleach) solution before disposal.

In this space, identify and briefly describe the use of microorganisms in your project. Use the back of this page if necessary.

The **signatures** of the student or students and sponsor below indicate that the project conforms to the above rules of the Illinois Junior Academy of Science.

\_\_\_\_\_  
(Sponsor)

\_\_\_\_\_  
(Student)

\_\_\_\_\_  
(Date)

\_\_\_\_\_  
(Student)

**This Sheet Must Be Typed**

This form MUST be displayed on the front of the exhibitor's display board. It may be reduced to half a sheet of paper.



Check box if exception/approval letter is required and attached (see page 12)

# ESSAY COVER PAGE

The Illinois Junior Academy of Science

**CATEGORY**  
(Circle One)

Student Officer Essay

**STATE REGION #** \_\_\_\_\_

Other \_\_\_\_\_

NAME \_\_\_\_\_

ADDRESS \_\_\_\_\_

CITY/ ZIP \_\_\_\_\_

PHONE (\_\_\_\_) \_\_\_\_\_

GRADE \_\_\_\_\_

AGE \_\_\_\_\_

SCHOOL \_\_\_\_\_

IJAS SCHOOL # \_\_\_\_\_

ADDRESS \_\_\_\_\_

CITY/ ZIP \_\_\_\_\_

PHONE (\_\_\_\_) \_\_\_\_\_

SPONSOR \_\_\_\_\_

**ESSAY TITLE** \_\_\_\_\_

STUDENT SIGNATURE \_\_\_\_\_

SPONSOR SIGNATURE \_\_\_\_\_

**This Sheet Must Be Typed**

## CORRECT SI METRIC SYSTEM USAGE

SI is the symbol for the Syst<sub>me</sub> International d'Unites, the modernized version of the metric system that the USA and other nations have agreed to use. (Do not abbreviate it as S.I.)

This list is provided to point out the correct way to use the metric system and to show many of the incorrect examples of its usage that may be given on package labels and in other printed matter. These correct ways to use SI are set by the international standards that define SI.

### General Guidelines:

1. The short forms for SI units (such as mm for millimeters) are called **symbols**, *not* abbreviations.
2. SI symbols *never end with a period* unless they are the last word in a sentence.
  - **RIGHT:** 20 mm, 10 kg
  - **WRONG:** 20 mm., 10kg.
3. SI symbols should be preceded by digits *and a space must separate the digits from the symbol*.
  - **RIGHT:** It was 300 mm wide. The millimeter width was given.
  - **WRONG:** It was 300mm wide. The mm width was given.
4. Symbols *always are written in the singular form* (even when more than one is meant).
  - **RIGHT:** 1 mm, 500 mm, 1 kg, 36 kg
  - **WRONG:** 500 mms, 36 kgs
  - **BUT:** It is correct to pluralize written-out metric unit names: 25 kilograms, 250 millimeters
5. The symbol for a compound unit that is *a quotient of two units is indicated by a solidus* or by a negative exponent.
  - **RIGHT:** km/hg\ or km·h<sup>-1</sup>
  - **WRONG:** kmph or kph (do not use p as a symbol for “per”)
  - **BUT:** It is correct to say or write “kilometers per hour.”
6. The meaning of an SI symbol can be changed when substituting a capital letter for a lower case letter.
  - **RIGHT:** mm (for millimeter, which means 1/1000 of a meter)
  - **WRONG:** MM or Mm (M is the prefix for mega, which means one million; a megameter is a million meters)

EXAMPLES OF CORRECT AND INCORRECT USAGE		
q For	q Correct Usage	q Incorrect Usage
kilometer	km	Km. km., KM, kms. K, k
meter	m	M, m.
millimeter	mm	Mm, mm., MM
liter	L or l	L., l.
milliliter	mL or ml	ML, MI, mL., ml., mls
kilogram	kg	KG, KG., Kg, Kg., kgr, kgs,
gram	g	G, G., g., gr, GR, GRM,
microgram	µg	mcg
hour	h	hr, hrs, HR, h., HR., HRS.
second	s	sec, S, SEC, sec., s., S.
cubic centimeter	cm <sup>3</sup>	cc
kilometer per hour	km/h	KPH, kph, kmph, km/hr
Kilohertz	kHz	KHZ, KHZ, Khz
Megahertz	MHz	MHZ, Mhz
Hectopascal	hPa	HPa, HPA, Hpa, mb
Kilopascal	kPa	KPa, KPA, Kpa
degree Celsius	°C	C, deg CS
Kelvin	K	°K, deg K

Note: A 5K race would be a five Kelvin race, while a 5k race would be a five kilo race, neither of which would be accurate. Kilometer should be pronounced KILL-oh-meet-ur, not kill-AHM-it-ur.

The information above was adapted from the U.S. Metric Association Website, <http://www.metric.org>  
Students are encouraged to visit the website for more information.

## ESTIMATING EXPERIMENTAL ERROR

Suggested but not required.

Science is all about measurement. Understanding data variability and potential error sources is essential to a full understanding of experimental science. It is a scientific truth that no measurement is ever 100 percent accurate. There is always some error.

Experimental error can occur in many ways, with random, systematic and measurement errors being most identifiable. The level of understanding experimental error is proportional to the student's grade and age level. Measurement error is usually easiest for them to understand.

Measurement errors most commonly come from the person(s) doing the measuring, the instrument used, and the environmental conditions at the time of measurement. Students should be aware of why experiments do not or might not have the same results when repeated. A scientist should also understand how measurement error affects conclusions drawn from the data.

One of the expectations researchers and judges have for science experiments is quantifiable results. There are two types of variable data that students may be working with: Quantitative and Qualitative data.

**Qualitative data** refers to data that is categorical as in surveys where we are asking questions that result in a yes or no answer or other questions that result in categorical responses, such as whether you are a girl or a boy, your grade in school, or your favorite color. When dealing with qualitative data we are looking for the incidence or likelihood of a particular response. We can still quantify the counts that were collected by turning them into sample proportions or percentages.

A **sample proportion** is the number of times a single response we are describing is obtained divided by the total number of trials.

For example, if we had surveyed 50 students and 20 of them were girls, the sample proportion of girls to the sample is 0.40 (20/50) and multiplying this value by 100, becomes 40 percent (40%).

Another example could occur in an experiment where we ask a subject if they preferred Coca Cola over other cola brands. We may give our subjects a taste test and ask them which they preferred, Coke or the other brand. If we observe 35 of 50 subjects who preferred Coke over the other Cola brands then the percentage in our sample who prefer Coke to other brands is 70%. (35/50 multiplied by 100).

It is very important that you realize however that the percent or proportion you calculate for your experiment is YOUR SAMPLE RESULT that holds true only for the survey YOU conducted and the subjects YOU interviewed. When others repeat your survey using a different set of subjects, they most probably will obtain different results. Experimental error tries to describe or predict the different percentages that could occur if your study was repeated again and again under the conditions laid out in your procedure. We will describe how experimental percentages could deviate shortly. For now, just remember that reporting the sample percent is not enough because it just reflects the results of your one experiment.

The other type of data many of you will be working with is quantitative data.

**Quantitative data** is data that you collect that is numeric in nature as how high a ball bounces in centimeters, the growth of your plants each week under varying conditions in centimeters, the distance a ball can be thrown under varying conditions in meters. REMEMBER THAT YOUR DATA MUST BE MEASURED IN METRIC UNITS. When the variable(s) involved in an experiment is numeric, the statistic most commonly reported by students to describe the results of repeated trials is the mean or median. However, when dealing with repeated measurements or trials there are three related statistical quantities that can help describe the variability and experimental error. These are the mean, standard deviation and standard error of the mean.

The *mean* is the sum of all the recorded measures of your experiment divided by the number of trials. Unfortunately many students only report the mean result for each variable in their experiment and ignore the amount of variability that

could exist between the various trials conducted on the same experiment.. That is why we also need to find the standard deviation and standard error of the mean.

**Standard deviation can be described as a measure of spread or variation in your sample trials.** Statistics tells us we can be about 70 percent (70%) certain that if we repeat the same measurement one more time, the numeric value of the next measurement will be less than one standard deviation away from the sample mean. Statistics also tells us that we can be around 95 percent (95%) certain that if we repeat the same measurement one more time, the value of the next measurement will be less than two standard deviations away from the mean.

We can think of standard deviation as a measure that is a partner to the mean value of your sample trials. It helps us to describe the error or variability attached to your trial mean. The standard deviation formula used by older students is:

**Formula for Standard Deviation:** 
$$s = \sqrt{\frac{\sum(X - \bar{X})^2}{(n - 1)}}$$
 Where n is the number of trials

The standard deviation is a statistical measure that can also be computed on any scientific calculator or statistical software package or Excel.

Students in the junior high may not have the expertise to calculate the standard deviation using this formula. Alternatively, a close approximation for the standard deviation can be calculated by finding the range of your trial measures and then dividing that range by 4. (Recall that the range is the difference between the high and low trial measures.) Your judges should accept this approximation to the standard deviation.

The more trials you perform with your experiment, the smaller the experimental error will be. Another statistical measure that takes the sample size into account when interpreting your experimental error is the standard error of the mean. This measure not only depends on the standard deviation but also on the number of trials run on the experiment as well.

The **standard error of the mean**, SEM, is an estimate used to describe the variation that can occur in the means of your trials when your experiment is repeated again with the same number of trials. It has a similar interpretation to the mean and standard deviation but the SEM relates to the variation we can expect in the experimental means when repeating the experiment with the same number of trials. We can be about 70 percent certain that if you or someone else repeats your entire experiment again with the same number of trials, the MEAN from the new experiment will be less than one standard error of the mean away from the mean value of your experiment. We are also about 95 percent certain the new mean will be less than two standard errors of the mean away from the mean value of your experiment. The standard error of the mean will decrease as the number of trials to your experiment increases.

**The formula for the standard error of the mean is: SEM =S divided by the square root of n where n is the number of trials used in the experiment.**

Suppose we are trying to determine whether two metal rods expand by different amounts when heated. We can design the experiment to measure the expansion of these rods. Suppose we take three measurements and calculate the average expansion for each rod. The data below is in millimeters. Here the sample size n equals 3 (referring to 3 trials).

<b>Rod Expansion in mm</b>			
	<b>Trial 1</b>	<b>Trial 2</b>	<b>Trial 3</b>
<b>Metal Rod #1</b>	<b>558</b>	<b>543</b>	<b>567</b>
<b>Metal Rod #2</b>	<b>549</b>	<b>542</b>	<b>550</b>

Computing the means you will find the mean expansion of Metal Rod #1 is 556 mm and that of Metal Rod #2 is 547 mm. Some of you may be apt to jump to the conclusion that Rod #1 has a higher expansion rate than Rod #2 since its mean is 9 mm higher, BUT this is not a valid conclusion because no measure of variability was attached to the trial measures and means.

Let us start by finding the range of the expansion measures for each rod. In the above example, the range of expansion measures for Rod #1 is 24 mm and for Rod #2, it is 8 mm. Taking the range of each rod's measures and dividing by 4, gives us an approximation for the standard deviation. We can now develop the following results:

**Metal Rod #1**

**Range = 567 – 543 = 24**  
**Approximate Standard Deviation = 24/4 = 6**

We can use these results to describe the variability that we can expect in the expansion measures from trial to trial. We are around 70 percent sure that the expansion measures for Rod #1 could deviate anywhere from the mean +/- 6 mm and we are around 95 percent sure that the expansion measures could deviate from the mean +/- 12 mm.

This means around 70 percent of the expansion measures for Rod #1 should fall between 550 and 562 millimeters, and with 95 percent certainty the expansion measures for Rod #1 should fall between 544 and 568 millimeters.

**Metal Rod #2**

**Range = 550 – 542 = 8**  
**Approximate Standard Deviation = 8/4 = 2**

Here we can expect 70 percent expansion measures for Rod #2 to deviate anywhere from the mean +/- 2 mm, and we are about 95 percent certain that the expansion rates could deviate from the mean +/- 4 mm.

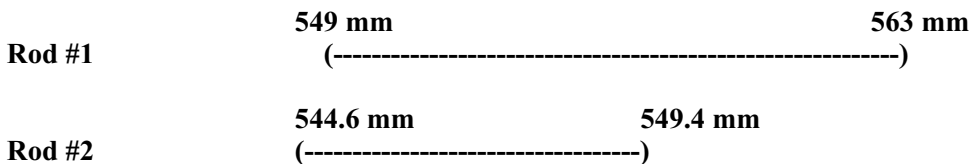
This means we have a 70 percent chance that the expansion measures of Rod #2 will fall between 545 and 549 mm and a 95 percent chance that the expansion measures of Rod #2 will fall between 543 to 551 millimeters.

We can then compare the means of the expansion measures between the two rods and be at least 95 percent certain that there is indeed a significant difference between the two mean measures using confidence intervals. We can compute the 95 percent confidence intervals describing the expected mean variability by adding and subtracting twice the approximate value of the standard error of the mean (SEM) from the mean of each rod type. If the intervals computed for the two rods overlap, there is no significant difference between the two mean measures. However, if the intervals do not overlap, there is a significant difference and in this example, we could then conclude that Rod #1 indeed has a greater expansion value than Rod #2.

The sample size used in this example consists of three trial measures. In order to compare the mean results from other experimenters who might be performing this same experiment also with three trials, we need to compute the standard error of the mean. The standard error of the mean takes the number of trials into account. For Rod #1 with a mean expansion of 556 mm, the SEM = 6 /  $\sqrt{3}$  or 3.5 mm. The 95 percent confidence interval is formed by multiplying the SEM value by 2 and adding or subtracting it from the mean expansion value. Hence with 95 percent certainty we expect the **mean** expansion values obtained for Rod #1 when performing the same experiment with three trials again and again to lie between 556 +/- 2 (3.5) mm, or between 549 and 563 mm.

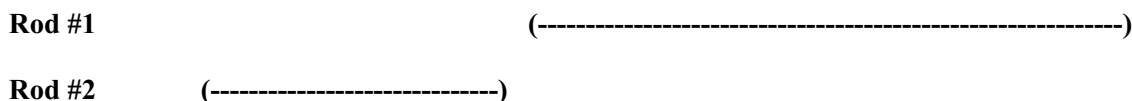
For Rod #2 with a mean of 547 mm, we calculate the SEM based on a sample of three trials to be 2 /  $\sqrt{3}$  or 1.2 and its 95 percent **mean** expansion zone to be 547 mm +/- 2(1.2) mm or between 544.6 and 549.9 mm.

The 95 percent confidence intervals for the **mean expansion values** expected from experiments of the same nature conducted with 3 trials produce the following results:



The above intervals show the mean expansion measures for Rod #1 could range from 549 to 563 mm with 95 percent certainty and Rod #2's mean expansion measures could range from 544.6 to 549.4 mm. Hence what looked to be a significant difference earlier in the mean expansion measures between the two Rods by just comparing the means turns out not to be true. Taking into account the variability we can expect in other experimental runs when repeating this experiment with three trials, shows that the difference in means between the two rods is not significant. Again the reason for no significant or reportable difference is that there is a slight overlap in the 95 percent mean interval estimates.

If the 95 percent confidence intervals for the means had no overlap as charted below, there would have been a significant difference. We could then have concluded that the mean expansion values of the two rods is significantly different with 95 percent certainty.



In the above experiment if we assume the standard deviations of the two rod types stay at 6 mm and 2 mm respectively, increasing the number of trials from 3 to 5 would reduce the SEM's for Rod #1 to  $6/\sqrt{5}$  or 2.7 mm (before it was 3.5 mm) and the new SEM for Rod #2 becomes  $2/\sqrt{5}$  or 0.9 mm (before it was 1.2 mm). Taking ten repeat trials would further yet reduce the SEM's still more (1.9 mm and 0.6 mm). By increasing the number of trials in an experiment we will also reduce the width of the 95 percent confidence interval. This also reduces the experimental error associated with your experiment. Hence, the more trials you conduct when performing your experiment, the better.

Of course, the number of trials conducted does depend on the amount of time and funds you have available. But instructors and judges usually realize that students between 7<sup>th</sup> and 12<sup>th</sup> grade do not have the resources of large laboratories and as a result, allow students to draw conclusions based on experiments with smaller numbers of trials. However, every student should try to conduct the most trials as they can within their own limitations.

**NOTE:** many junior high and senior high students are capable of computing the standard deviation from the statistical formula denoted earlier. The above procedure using the Range divided by 4 as an approximation to the standard deviation was just shown to simplify reading of this section for all science fair exhibitors especially those in junior high.

We can also compute a standard error measure to describe the variability among qualitative measures as the sample proportion. The standard error of proportion, commonly known as SEP, can be used to describe how someone else's reported experimental proportion could deviate from your experimental proportion when repeating your experiment under the same conditions with the same sample size. It is interpreted the same way as the standard error of the mean.

**The formula for the standard error of proportion, SEP, is:  $SEP = \text{Square root of the fraction } (p) (1 - P) / n$**

In the formula above, p refers to the sample proportion. Again, as the sample size n increases, the SEP decreases.

Describing experimental error using the above concepts is often difficult for many students. Students are advised to work within their own limitations. The important issue is that all experiments should have quantifiable results and be conducted with as many repeat trials as possible.

The **main purpose of experimental error in science fair projects** is that students are not just to draw conclusions on mean and median results. Variability measures should be considered in their conclusions.

Students are encouraged to ask their math or science teacher for the best way to calculate and deal with measurement error for your experiment.

When students discuss the results of their project, they should be able to think of reasons why experiments did not or might not have had the same results when repeated. They should be able to name at least one possible source of error, and be able to describe with some degree of confidence how certain they are about their results.

Students should begin to think of ways to improve the precision and accuracy of their data, identify reasons for too much variability in their data, and note how experimental error can be reduced by collecting more data, taking a better control of the measurement process and better control of the experimental variables.

For an informative article, go to <http://www.hcrc.ed.ac.uk/cogsci2001/pdf-files/0600.pdf>.

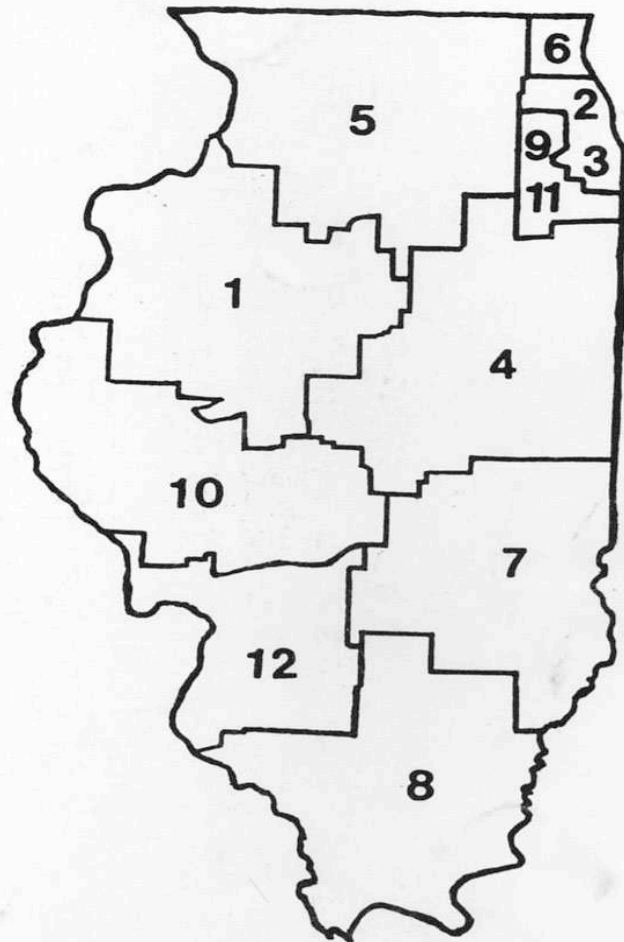
Here are some questions that you may wish to consider when designing your science fair experiment:

- Will my experimental design generate data that is accurate and precise enough to answer my research question?
- How can I improve the accuracy of my data?
- Is there too much variability in my data?
- Can I reduce my measurement error by:
  - a. collecting more data?
  - b. better control of the measurement process?
  - c. better control of the experimental variables?

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