PJAS GUIDE

Part I (Prior to Experimentation)

This guide is a tool for you to use to successfully complete your PJAS project. Your project will be carried out individually. You will find all the necessary forms and information needed to compete in the Pennsylvania Junior Academy of Science also if you choose to do so. Please share this with your parents so they are aware of your responsibilities and available resources. Please sign, have your parents sign and return the PJAS Forms.

What is PJAS?

The Pennsylvania Junior Academy of Science (PJAS) is a statewide organization of junior and senior high school students designed to stimulate and promote interest in science among its members through the development of research projects and investigations.

The project is should be designed to follow the steps of the scientific method which you will follow to answer a question or solve a problem through experimentation. This project is then shared with other students at the Regional Meeting usually held at the end of February.

Can I work with someone else on my project?

No, your science fair project will be conducted individually.

How will I be graded?

All students in Notre Dame's junior high will receive the same evaluation rubrics. This project will count for several grades throughout the school year: Idea and Variables – Quiz grade, Research Proposal – Test grade and Final Project – Test grade.

What are my choices?

As a student of Notre Dame of Bethlehem School you will be creating a proposal for PJAS and performing a scientific experiment according to the guidelines for the Pennsylvania Junior Academy of Science. The project must be in the following PJAS categories: Physiscs, Astronomy, Biology, Biochemistry, Botony, Computer, Ecology, Math, Microbiology, Chemistry, Engineering, Behavioral Science and Zoology.

What about area competitions?

All students are strongly encouraged to present their Research at the PJAS Regional Meeting. Any student receiving a first place award qualifies to attend the State Meeting at Penn State University in May. PJAS requires a ten-minute (maximum) oral presentation with a PowerPoint program. If you reach the state level competition at Penn State in the spring. There is a fee involved for participation.

"Whether you think you can or that you can't, you are usually right."
-Henry Ford

PJAS Parent Form

Dear Parent(s) /Guardian(s),

The PJAS Student Guide is now available online on Mrs. Iobst's website:
http://www.ndbethlehemschool.org/Mrs--Iobst-s-Page

Please review this guide with your child and discuss the responsibilities of PJAS. Please sign and return this form to acknowledge your review of this resource. If you do not have access to the Internet and will need to have a hard copy of the Guide provided for your child, please indicate that below by checking the box. Thank you.

Sincerely,

Karen Iobst

Student's Name (printed)

Parent Signature Date

Student Signature Date

☐ I do not have access to the Internet resources and will need a hard copy of the PJAS Student guide.

The Logbook

Whether you are a research scientist, a science fair student, or a first time PJAS student, a logbook is a crucial part of any research project. It is a detailed account of every phase of your project, from the initial brainstorming to the final research report. The logbook is proof that certain activities occurred at specific times. A logbook is a daily diary of your experiment. You may be asked to produce this for your teacher at various parts of the process.

Things you should know:

- **Entries in the logbook should be brief and concise. Full sentences are not required.**
- **Use a notebook that is sturdy and the pages won't easily fall out.**
- **Label the logbook with your name and number the pages.**
- **Date every entry.**
- **Include receipts, brainstorming ideas, tape things inside if needed.**
- **Don't worry about neatness.**
- **Use it during all phases of your project and include: all research (notes) and your Bibliography, copies of all PJAS forms, all your raw data, and rough drafts of all parts of your project.**
- **Glue, staple or tape loose papers.**
- **Keep it organized.**
- **Include any changes to the experiment you make along the way. [Don't make any major changes without consulting your science teacher!]**

Topic Selection

The process of choosing a topic is the first step to the success of your PJAS project. Some may even say that this is the MOST IMPORTANT step! There are some key factors to keep in mind when choosing your topic(s).

- **You should choose a topic that interests you! This is extremely important!**
- **Your topic must be TESTABLE.**
  - **Some topics, like Stars and Planets, are good to research but it would be hard to set up an experiment to test these "unreachable" objects.**
  - **Remember, you will be researching your topic in order to set up a testable experiment.**
  - **Your topic must be one that is able to show a cause and effect relationship among testing factors.**
- **You must be able to obtain research about your topic. The scientific process cannot be successful without proper research.**
- **If your topic does not meet the general criteria listed above, then you may not pursue this topic for your project.**

TOPICS TO AVOID

The following topics are not recommended without additional supervision or consultation.

Any topic that boils down to a simple preference or taste comparison. For example, "Which tastes better: Coke or Pepsi?"	**Such experiments don't involve the kinds of numerical measurements we want in a PJAS project. They are more of a survey than an experiment.**
Most consumer product testing of the "Which is best?" type. This includes comparisons of popcorn, bubblegum, make-up, detergents, cleaning products, and paper towels.	**These projects only have scientific validity if the Investigator fully understands the science behind why the product works and applies that understanding to the experiment. While many consumer products are easy to use, the science behind them is often at the level of a graduate student in college.**
Any topic that requires people to recall things they did in the past.	**The data tends to be unreliable.**
Effect of colored light on plants	**Several people do this project at almost every science fair. You can be more creative!**
Effect of music or talking on plants	**Difficult to measure.**
Effect of running, music, video games, or almost anything on blood pressure	**The result is either obvious (the heart beats faster when you run) or difficult to measure with proper controls (the effect of music).**
Effect of color on memory, emotion, mood, taste, strength, etc.	**Highly subjective and difficult to measure.**
Any topic that requires measurements that will be extremely difficult to make or repeat, given your equipment.	**Without measurement, you can't do science.**
Graphology or handwriting analysis	**Questionable scientific validity.**
Astrology or ESP	**No scientific validity.**

Any topic that requires dangerous, hard to find, expensive, or illegal materials.	**Violates the rules of virtually any science fair.**
Any topic that requires drugging, pain, or injury to a live vertebrate animal.	**Violates the rules of virtually any science fair.**
Any topic that creates unacceptable risk (physical or psychological) to a human subject.	**Violates the rules of virtually any science fair.**
Any topic that involves collection of tissue samples from living humans or vertebrate animals.	**Violates the rules of virtually any science fair.**

Research Topic

Name _____

Title:
(30 Characters max)

Category:
(Must be designated PJAS category)

Materials Needed:

Parent signature: **Date:**

EXAMPLE:

Research Question

Topic	Research Question	Independent Variable	Dependent Variable
Battery Brands	**What is the effect of using different battery brands (Duracell, Energizer, & Generic), on how long a CD player will run?**	**Battery Brands:** **Duracell** **Energizer** **Generic**	**Time:** **How long the CD player runs (in hours)**

- **Remember, your questions MUST show a cause and effect relationship!**
    - **The cause is something that can be changed or manipulated by the researcher (you). This is also known as the INDEPENDENT VARIABLE.**
    - **The effect is the RESULT of changing the independent variable. This is also known as the DEPENDENT VARIABLE.**

Research Question: Examples

Below are some research questions that some students have used in the past:

- **What is the effect of egg washing techniques on yolk color?**
- **What is the effect of pH of water on the heartbeat of daphnia?**
- **What is the effect of electromagnetic fields on algae cells?**
- **What is the effect of nitrate levels on bush beans?**
- **What is the effect of scent of paper on math test scores of middle school students?**
- **What is the effect of pain reliever on daphnia?**
- **What is the effect of centrifugal force on plant growth?**
- **What is the effect of temperature on the bounce height of a golf ball?**
- **What is the effect of different bridge designs on bridge strength?**
- **What is the effect of water on the tensile strength of fishing line?**
- **What is the effect of different kinds of paintballs on the accuracy?**
- **What is the effect of different types of wax on the speed of a snowboard?**
- **What is the effect of temperature on magnet strength?**

Name: _____

Research Question Table

Topic	Research Question	Independent Variable	Dependent Variable

PARENT SIGNATURE: **DATE:**

Name **Date** **Period**

SCIENCE FAIR TOPIC PROPOSAL

Research Question:

BRIEF DESCRIPTION OF THE EXPERIMENT YOU HAVE IN MIND:

I wish to

SUBMITTED FOR PARTICIPATION IN:

- ☐ **Notre Dame School class requirement ONLY**
- ☐ **Pennsylvania Junior Academy of Science**

Check-mark appropriate choice(s)

Research

It is time to gain more knowledge about your topic. This is done by researching. Quality, reliable research is necessary when conducting an experiment. It is a significant piece of your project; if you do not research well and gather good information, then all of your work is based solely on what you think. This is unacceptable in the world of science. Many students do not gather enough QUALITY information and this ends up hurting them in the end.

When conducting your research, the following guidelines should be followed:

- **You should have a MINIMUM of FIVE (5) GOOD sources.**
- **These must be sources that will help you to understand the science behind your topic, formulate your hypothesis and design your experiment.**
- **You may search books and website for possible topic ideas, but these are <u>not</u> included in the 5 sources research requirement.**
- **Search for RELIABLE sources, that are free from bias.**
  - **For example, most commercial companies will claim on their web site that their product is the best. The site may be useful to your project in other ways, but remember the company will be biased toward their product's performance.**
    - **Many reliable sites end in: ".edu,"".org," or ".gov." This is not *always* true, but is true more times than not.**

You will be required to keep a record of your research in your log book and document this research using the form on the next page.

Name Date

RESEARCH SUMMARY FORM

Use this form to document your research from your 5 required sources.

Source #1 (Identify your source by title, author, date, URL, etc.)

What information does this source provide that you find valuable to your science fair project?

Source #2 (Identify your source by title, author, date, URL, etc.)

What information does this source provide that you find valuable to your science fair project?

Source #3 (Identify your source by title, author, date, URL, etc.)

What information does this source provide that you find valuable to your science fair project?

Source #4 (Identify your source by title, author, date, URL, etc.)

What information does this source provide that you find valuable to your science fair project?

Source #5 (Identify your source by title, author, date, URL, etc.)

What information does this source provide that you find valuable to your science fair project?

Parent Signature: Date:

Background Information

- **<u>Variables</u> - Identify your independent and dependent variables.**
- **<u>Terms-</u> List and define any scientific terms that are relevant to your topic. Choose only terms that are unfamiliar to you or would be unfamiliar to most people. Choose only terms that are necessary to understand your topic or that may be needed during the experimental process.**
- **<u>Processes-</u> Summarize the important scientific concepts behind your research question/topic.**
- **Explain why you chose your topic.**
- **Explain how your project will benefit society.**

Use the example on the next page to help you complete this form

Your background information section is a "work in progress". It should be updated throughout the science fair process. You will find that you have information to add to this section as you continue through the process.

EXAMPLE:
BACKGROUND INFORMATION
"A WORK IN PROGRESS"

A. VARIABLES: Identify your independent and dependent variables.
The independent variable is the battery brands (Duracell, Energizer, and Generic) and the dependent variable is time (how long the CD player runs)

B. TERMS (list and define any scientific terms that are relevant to your topic)

electricity — the flow of electrons through a path

circuit — the path the electrons take

anode — the negative end of the battery

cathode — the positive end of the battery

electrolyte — the liquid which supplies the electrons through a chemical reaction

C. PROCESSES (Summarize (in paragraph form) the important scientific concepts behind your research question/topic)

HOW BATTERIES WORK: There are three parts to a battery — the anode, the cathode, and the electrolyte. A chemical reaction in the battery causes electrons to build up on the anode, giving it a net negative charge. This creates a potential difference between the anode and the cathode. Because like charges repel each other, the electrons want to move away from each other. Because opposite charges attract each other, the electrons want to move toward the positive cathode. The only way they can get there is through the wire/circuit. This is what creates an electric current. These electrochemical processes change the chemicals in the battery and eventually there are no more electrons available. Thus, the battery has no more power.

D. WHY **I** CHOSE MY TOPIC:
I chose this topic because my family uses a lot of batteries. I wanted to know which ones really work the longest so I can save money and time (going to the store to buy more batteries). E

HOW WILL MY PROJECT BE BENEFICIAL TO SOCIETY?
The results of my experiment will help other people save time and money by knowing which batteries really do work the longest.

Name:

BACKGROUND INFORMATION
"A WORK IN PROGRESS"

A. VARIABLES: Identify your independent and dependent variables.

B. TERMS (list and define any scientific terms that are relevant to your topic)

C. PROCESSES (Summarize (in paragraph form) the important scientific concepts behind your research question/topic)

D. WHY I CHOSE MY TOPIC:

E HOW WILL MY PROJECT BE BENEFICIAL TO SOCIETY?

Parent Signature Date

HYPOTHESIS

Congratulations! You are finished with the hardest part of your project: Deciding on a topic, narrowing it down, and researching it. Now it's time to formulate your hypothesis. A hypothesis is an educated, well thought-out prediction. A hypothesis is an attempt to give an explanation of the problem which is consistent with your research. Your research will be the foundation for the answer to your question. In order to write your hypothesis properly, you will need to change your question into an "if.. . then" statement. This statement will be your prediction. Your hypothesis MUST include the following:

- **Answer the question and state <u>WHAT</u> you think will happen and <u>WHY.</u>**
- **An "if. . .then" statement of your hypothesis (prediction)**
- **Your hypothesis may NOT use first person.**

Example:

- **If testing three different brands of alkaline batteries: Duracell, Energizer and generic, then the Duracell batteries will run a CD player for the longest period of time. According to research, Duracell contains a compound which has been found to extend battery life.**

Use the form on the next page to help you formulate your hypothesis.

Name:

PJAS: Hypothesis and Procedure

What is your research question?

Hypothesis: What is your If Then statement? (no 1st person pronouns and give a reason for your prediction)

What is your independent variable?

What is your dependent variable?

Think about all the other possible factors that may affect your experiment's outcome. These will be your controlled variables, so explain how you will keep them the same:

Does your experiment have a control group? If so, what is it? If not, why not?

Attach a copy of your **MATERIALS LIST & PROCEDURE** to this paper. Make sure it is in proper, step-by-step format and not a narrative/paragraph. See guide for examples.

Parent signature Date

EXAMPLE:

Materials

Your materials list is a vital way to keep a detailed record of the total amount of materials needed for the entire experiment. This list should be a bulleted or numbered list that is detailed, with specific brands, quantities and/or weights of items needed. All measurements should be in METRIC. Your list may change throughout your experiment and should be updated so that amounts and materials reflect the final experimental methods. A great site to help make these conversions if needed is:

http://www.metric-conversions.org/

For example:

Materials
CD player and CD
5 Duracell batteries
5 Energizer batteries
5 generic batteries
stopwatch

- **If you are building something, you may include a separate sheet with the directions on how you built your device. Keep the directions step by step and list all materials used as well. This will be labeled "Attachment A"**

PROCEDURE

The procedure of your PJAS project provides step by step directions to conduct an experiment. If the procedure is written correctly, it can be followed by anyone to repeat your experiment. The steps of the procedure are numbered and act as a "recipe" for your experiment. A procedure for our battery experiment might be:

1. Replace the batteries in a CD player with new Duracell batteries.
2. Turn on the CD player and record the time started.
3. Observe the CD player until the batteries are dead and the player stops. Record the time it stopped.
4. Calculate the total time, in hours, the CD player ran.
5. Repeat steps 1-4 four more times for Duracell batteries.
6. Repeat steps 1-5 for Energizer and generic batteries.

A science experiment should be a controlled experiment. The scientist may contrast an "experimental group" with a "control group". The two groups are treated EXACTLY alike except for the ONE independent variable being tested. Sometimes several experimental groups may be used. For example, in an experiment to test the effects of light on plant flowering, one could compare normal or natural day light (the control group) to several other types of light such as ultraviolet light, incandescent light, and fluorescent light. (The experimental groups)

Things you should know:

. Variables: The experiment will contain an element or elements that do not change and elements that will change. The independent variable is the variable you purposely manipulate (change). The dependent variable is the variable that is being observed and which changes in response to the independent variable. The variables that are not changed are called controlled variables. You need these controlled variables in order for your experiment to be valid.

. Control: The control is a particular sample that is treated the same as all the rest of the samples except that it is not exposed to manipulated variables.

. Collect Data: As you observe your experiment, you will need to record the progress of your experiment. Data can be whatever you observe about your experiment that may or may not change during the time of the experimentation. Examples of data are values in pH, temperature, a measurement of growth, color, distance, etc. Record all information in your science logbook.

. Photographs: Take pictures of your set-up and experiment as it progresses. You will be required to include this in your final oral presentation or on your display board.

. A typical experiment should have a minimum of 3 total trials or repeated experimentation for nonhuman subject experiments. The more trials, the more reliable your results will be.

. Your population size is very important in your experiment. You want to use a good representative sample when testing. If you are using plants, use at least five plants for each variable being tested. If you are testing humans, you need not repeat the experiment if you have enough of a population. It is suggested that at least 30 people are used in human testing. (A signed form must be given to each subject with a parental signature for subjects under the age of 18.) When testing invertebrates populations size should be 10 or more; for vertebrates, 5 or more. See your teacher for advice on sample size.

. When testing humans, do not use names. Call them "subjects and refer to them as "Subject A, Subject B", etc.

. Always include any changes made to procedures, mishaps, failures or mistakes in your log book and/or final project.

. Record everything in your science log book throughout the entire duration of the science fair project.

Variables where you control the change —
"independent variable"
Variables where you measure the change —
"dependent variable"
Variables you work to keep the same —
"controlled variables"

Notre Dame School

Research Plan Guidelines

A complete research plan is required and must accompany the PJAS Approval Form.

Provide a typed research plan and attach to Science Fair Approval Form. Please include your name on each page.

The research plan for ALL projects is to include the following:

1. Question or Problem being addressed
2. Hypothesis
3. Materials List
4. Numbered List of Procedures:
   Detail all procedures and experimental design to be used for data collection.
5. Data Analysis:
   Describe the procedures you will use to analyze the results.
6. Bibliography:
   List at least five (5) major references (e.g. science journal articles, books, internet sites) from your literature review. If you plan to use vertebrate animals, one of these references must be an animal care reference.

Items 1-4 below are subject-specific guidelines for additional items to be included in your research plan as applicable:

1. Human participants research:
   - **Participants:** Describe who will participate in your study (age range, gender, racial/ethnic composition). Identify any vulnerable populations (minors, pregnant women, prisoners, mentally disabled or economically disadvantaged).
   - **Recruitment:** Where will you find your participants? How will they be invited to participate?
   - **Methods:** What will participants be asked to do? Will you use any surveys, questionnaires or tests? What is the frequency and length of time involved for each subject?
   - **Risk Assessment**
     - **Risks:** What are the risks or potential discomforts (physical, psychological, time involved, social, legal etc) to participants? How will you minimize the risks?
     - **Benefits:** List any benefits to society or each participant.
   - **Protection of Privacy:** Will any identifiable information (e.g., names, telephone numbers, birthdates, email addresses) be collected? Will data be confidential or anonymous? If anonymous, describe how the data will be collected anonymously. If not anonymous, what procedures are in place for safeguarding confidentiality? Where will the data be stored? Who will have access to the data? What will you do with the data at the end of the study?
   - **Informed Consent Process:** Describe how you will inform participants about the purpose of the study, what they will be asked to do, that their participation is voluntary, and that they have the right to stop at any time.
2. Vertebrate animal research:
   - Briefly discuss potential **ALTERNATIVES** to vertebrate animal use and present a detailed justification for use of vertebrate animals.
   - Explain potential impact or contribution this research may have.
   - Detail all procedures to be used.
     - Include methods used to minimize potential discomfort, distress, pain, and injury to the animals during the course of experimentation.
     - Include detailed chemical concentrations and drug dosages.
   - Detail animal numbers, species, strain, sex, age, source, etc.
     - Include justification of the numbers planned for the research.
   - Describe housing and oversight of daily care.
   - Discuss disposition of the animals at the termination of the study.
3. Potentially Hazardous Biological Agents:
   - Describe Biosafety Level Assessment process and resultant BSL determination.
   - Give source of agent, source of specific cell line, etc.
   - List safety precautions.
   - Discuss methods of disposal.
4. Hazardous Chemicals, Activities, & Devices:
   - Describe Risk Assessment process and results.
   - List chemical concentrations and drug dosages.
   - Describe safety precautions and procedures to minimize risk.
   - Discuss methods of disposal.