Research Proposal

A written research proposal is a 3 – 5-page document that outlines your project. It demonstrates your understanding of the topic, states a viable Research Question (or Engineering Goal) and outlines an appropriate process for answering that question (or reaching the goal). If you are working in a lab with a university mentor, the project may be determined already. It will be your job to fully understand and be able to explain the procedure. That means you need to spend a lot of time acquainting yourself with the area of research, the equipment being used and the background knowledge that was required to design the project.

Note: writing a proposal is NOT a one-time effort. Use feedback provided by your classmates, your mentor and your teacher to help you clarify what you intend to do. Try to keep your writing concise and accurate, using as few words as possible. Explain terminology the first time it appears in your writing.

A proposal is written as a narrative, where each section starts with a heading that is bold-faced. For example:

Title: Literally write the word Title (in **bold face:**) followed by the title of your project. The title needs to be concise, descriptive and informative. Try to limit the title to 120 characters or less.

Problem & Rationale: Write these words (in **bold face:**) followed by a short paragraph stating the problem, summarizing the background that supports your research problem, why you are studying it, and how you plan to find a solution. You can enhance this paragraph by explaining why this research is important and by identifying any societal impacts of your research. Try to limit this section to 200 words or less.

Research Question or Engineering Goal: Write these words (in **bold face**:) followed by a clear statement of your Research Question or your Engineering Goal.

Research Design Table: Write these words (in **bold face**:) and include the latest draft of your Research Design Table. The table you insert should be updated from the original version.

Addendum to the Research Design Table:

1. For expected outcome(s) identified in the Research Design Table, provide brief justification(s) for anticipated results based on information from credible sources provided at the end of the proposal.
2. For an Engineering Goal, identify conditions of success. This would be in the form of a numerical value for distance, speed, rate, time *etc*.
3. For any extraneous variables noted, speculate about any effects these might have on the results and if there are ways to limit the influence of these confounding variables.

4. For any challenges identified, describe way(s) to address and overcome these, for example, changes to the experimental design, alternative methods to answer the same question or experts to ask for advice.

Research Plan: Write these words (in **bold face:**). This section makes up the bulk of your proposal. You need to tell the reader what <u>you</u> are going to do, what data or information you will need to collect to answer the Research Question or address the Engineering Goal. Scientific research must include a **Materials Section** with all materials explicitly identified, and a **Methods Section** describing how the project will be set up and how data will be collected. *Note: describe only your project. Do not include work done by your mentor or others.*

Materials Section of the Research Plan can often contain a list:

- All supplies, consumables, tools, instruments
- Use exact technical specifications (*e.g*. purity of chemicals, concentrations, suppliers …)
- State model of each apparatus used
- State genus, species & characteristics of each organism
- Include amounts of each item

Methods Section of the Research Plan often describes (as a Narrative):

- How will data be collected?
- How will measurements be taken?
- How will the data be measured?
- What tools & techniques will be used?
- How will qualitative observations be recorded?
- How often will data be collected & recorded?
- How long will the experiment last?
- How does your design address potential extraneous variables?

Data Analysis: Write these words (in **bold face:**). You need one paragraph identifying how you will examine and analyze data/information that you are collecting.

Risks & Safety: Write these words (in **bold face:**). You need to discuss any risks and how safety will be maintained. List any expected approvals you will need such as IRB's.

Bibliography: Write this word (in **bold face:**) you need FIVE references, and they must be cited properly in MLA or APA format. Here we are looking for a brief list of sources of information for this project. List major references (*e.g.* science journal articles, books, internet sites). If you plan to use vertebrate animals, one of these references must be an animal care reference.

Appendices: Write this word (in **bold face:**) include any items that are too big to fit into the context of the written proposal, such as large tables, figures or safety documentation.

Everyone loves a checklist

Written Proposal Checklist

	Missing	Needs Work	Acceptable
Mechanics			
Each section heading is in **Bold Face**			
Used 12 pt. Font			
Used double spacing			
Used 1" margins			
Title			
Concise			
Descriptive			
Informative			
Variables Evident			
Problem & Rationale			
States the problem or topic			
Background research is summarized			
Claims are supported by evidence from literature			
States why you are studying it			
Explains how you are addressing the problem or how you plan to find a solution			
Research Question or Engineering Goal			
Focus of research evident			
The question or goal conveys a clear purpose			
Variables to be counted/observed are identified or strongly implied			
Research Design Table			
Complete			
Addendum to Research Design Table			
Justification(s) provided for anticipated result(s)			
Conditions of success given (only for Engineering Goal)			
Influence of extraneous variables is discussed			
Possible ways to overcome challenges are described			
Research Plan			
2 – 5 paragraphs in length			
Materials			
All materials used are listed			
Used Technical Specifications (e.g. purity of			

chemicals, brand, apparatus model..)			
Included amounts of materials used			
Methods			
First paragraph describes how the project will be organized			
Included any preparation needed before research can begin			
Described in detail what will be done			
Described how data will be collected			
Described what tools and techniques will be used			
Described how observations and measurements will be recorded			
Described how often data will be collected and recorded			
Described how long the experiment will last			
Discussed how the research design addresses potential extraneous variables – address each variable individually			
Data Analysis			
Brief description of method that will be used to analyze the data/information collected			
Risk & Safety			
Identified any risks or hazards			
Described safety precautions that will be followed			
Listed approvals needed before the work can begin (including an IRB)			
Bibliography			
Five sources of information listed			
Citation follows APA or MLA format			
Internet sites include date of access			

Teacher Notes:

Point values are avoided in the checklist (above) for a few reasons:

1. Most students, at this point, assume full ownership of their projects and adding point values only serves to raise their anxiety. For me, it seemed better to keep them focused on doing a good job.
2. This format sets students up for success by helping them to identify the sections that need improvement.

Here are some suggestions for things to look out for when reviewing a student's proposal:

Does the Rationale • hold your interest • explain the problem • identify a gap in knowledge	**Is the Research Question/Goal** • clear • feasible • significant • focused	**Are Challenges** • identified • and possible solutions considered thoughtfully
Does the Research Plan • explain the procedure adequately • align with the question/goal • include a method for data analysis	**Is the Data** • appropriate for the Question/Goal • something a student can collect	**Are Ethics and Safety** • measures identified • approvals identified • considerations described with care
At least five References • are listed • are cited appropriately		

Example of Research Proposal

This example reflects research done by Ariel Firebaugh & Kyle Haynes, Department of Environmental Studies, University of Virginia. To see the original work go to: https://news.virginia.edu/content/galaxy-fireflies-or-not-researchers-study-lightings-effects-insects, or visit: https://uva.theopenscholar.com/haynes-lab/.

Title: The Influence of LED Flood Lights on Firefly Behavior at Night

Problem & Rationale: There is an interest in how artificial light present at night influences wildlife. According to Haynes *et al*, this may be the most threatening form of rapid anthropogenic change for insects. Fireflies are an integral part of ecosystems (Faust). They also communicate via bioluminescence, providing warning signals as well as courtship signals (Owens). It is possible that they may be decreasing in number because of light added to their environment. If light pollution from humans interferes with the firefly's ability to communicate with others, this could result in fewer fireflies finding a mate and thus lowering the overall population of fireflies. If such an interference is measured, guidelines could be suggested for using lighting (spectrum, intensity or timing) which minimizes the impact on insect populations.

Research Question: Does light pollution change the courtship displays of fireflies?

Research Design Table:

Research Question or Goal: *Does light pollution change the courtship displays of fireflies?*	
Expected Outcome(s): *The number of light flashes will depend on the amount of artificial light present.*	**Reason for Choosing this Question/Goal:** *There is an interest in how artificial light at night influences wildlife.*
Constants: *Window of time* *Location of experiment* *Amount of artificial light*	**Background Questions:** *At what time do fireflies light up?* *Do males and/or females display lights?* *What is the habitat & region of fireflies?* *What is the life cycle of a firefly?* *What do fireflies eat?* *What are major predators of fireflies?* *What is the usual ratio of males to females?* *Is artificial light known to influence the behavior of other insects?*
Variables (observed or counted): *Number of fireflies* *Number of firefly light flashes* *Intensity of light (lumens)* *Spectra of light*	**Extraneous Variables (potential):** *Weather* *Potential Predators (frogs, birds, bats …)* *Noise* *Additional light from nearby homes or cars*

	Light from the moon *Insecticides* *Other species of insects*	
Resources needed		
Time: *10 consecutive nights plus time needed to set up equipment*	**Equipment:** *Flood lights/source of electricity* *Extension cords* *Light gauge to quantify # lumens* *Clock*	**Materials:** *Several isolated areas* *Mesh cannisters to hold females* *Poles on which to mount cannisters*
Expected Approvals Needed: *Permission to use area of land*	**Risks to Consider:** *Electric lines could be hazardous if there is a heavy dew or precipitation* *Other insects may be affected by light as well*	
Sources of Information for Project: *Carnegie Library of Pittsburgh* *Kyle Haynes (Assoc. Director of Blandy Experimental Farm)* *Fireflies, Glow-worms, and Lightning Bugs (Lynn Frierson Faust)*	**Anticipated Challenges:** *It could be a challenge to set up & monitor several plots each evening.* *It might be hard to count accurately the number of fireflies present.*	

Addendum to the Research Design Table:

The rate of light flashes, emitted by a female firefly or male firefly, is expected to change depending on the amount of artificial light present.

It might be hard to count accurately the number of fireflies present in each area, so the number of fireflies will be counted three times, and an average will be taken.

Research Plan:

Materials Section:

- Flood lights
- Electricity source
- Extension Cords
- Light Gauge
- Eight large, isolated areas of field
- Mesh Cannisters to hold females
- Poles on which to mount cannisters

Methods Section:

Prior to data collection, each field area will be measured and set up with a pole and a place on the pole to attach a mesh cannister that houses a female firefly. Half (*i.e.* four) of the research areas will also be set up with a flood light that can illuminate the field.

Between the hours of 9 pm – 11 pm, each area will be monitored for 15-minute intervals. During this time, the number of fireflies present will be counted three times and the number of light flashes by the housed female and the number of responding light flashes of flying males will be recorded. This procedure will be repeated for 10 consecutive evenings, rotating when each area is first monitored.

Data Analysis:

Data will be analyzed using ANOVA (Analysis of Variance). This will allow one to compare the means (population counts and number of flashes) in the different groups and assess the statistical significance of group differences. Using ANOVA, one will be able to determine if the variation found within groups is greater than the variation between groups.

Risks & Safety:

Electrical lines could be hazardous if there is heavy dew or precipitation. Care will be taken to set up the lines only when conditions are dry and to keep the lines and electrical outlets covered. Data will not be collected in the event of rain.

Approval will be needed to use the area of land for this project.

Bibliography:

Faust, Lynn Frierson, Fireflies, Glow-worms, and Lightning Bugs: Identification and Natural History of the Fireflies of the Eastern and Central United States and Canada, University of Georgia Press (2017).

Gaston, Kevin J. et al, Impacts of Artificial Light at Night on Biological Timings, Annual Review of Ecology, Evolution and Systematics, Vol 48:49-68 (November 2017).

Haynes K, Robertson B. A transdisciplinary research agenda for understanding insect responses to ecological light pollution informed by evolutionary trap theory. Current Opinion in Insect Science, Vol 45:91–96 (2021).

Miller, Kenneth R and Levine, Joseph S., Biology, Prentice Hall (2010).

Owens, Avalon C.S. and Lewis, Sara M., Narrow-spectrum artificial light silences female fireflies (Coleoptera: Lampyridae), Insect Conservation & Diversity, Vol 14(2):199 (2021).