

*Spark!*

**STUDENT RESEARCH  
FROM IDEA TO COMPETITION**



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AP Biology & AP Capstone Research  
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## Recognitions:

- Truman T. Bell Excellence in Service Award
- CCISD- District Secondary Teacher of the Year
- Sigma Xi-Rice UTM Outstanding Science Teacher
- Terri Berry SEFH Teacher of the Year-Sr. Div.
- Claude L Wilson Award for Teaching Excellence
- Coca-Cola Scholars- Educator of Distinction
- Regeneron STS Teacher of Merit
- U.S. Presidential Scholar's Most Influential Teacher



Science Fair Website

**Keep yourself  
organized**

# PROJECT CHECKLIST

**STUDENT NAME**

The diagram illustrates a sequence of 10 frames, each containing 10 small squares. The frames are arranged in a grid with alternating colors (blue, purple, red, yellow, green) and are connected by diagonal lines, suggesting a sequence or flow.

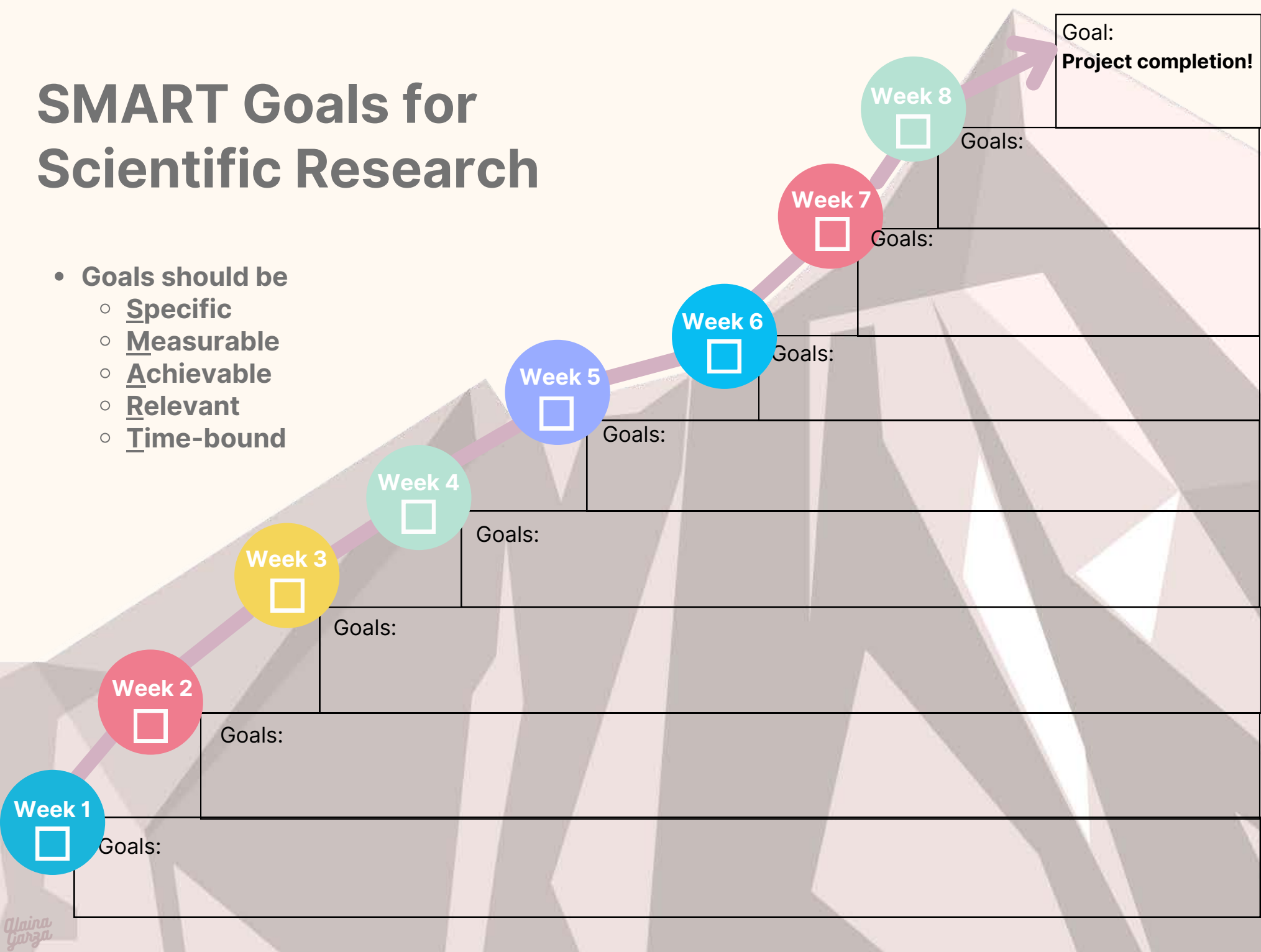
**Keep your students  
organized**

## Research Due Dates

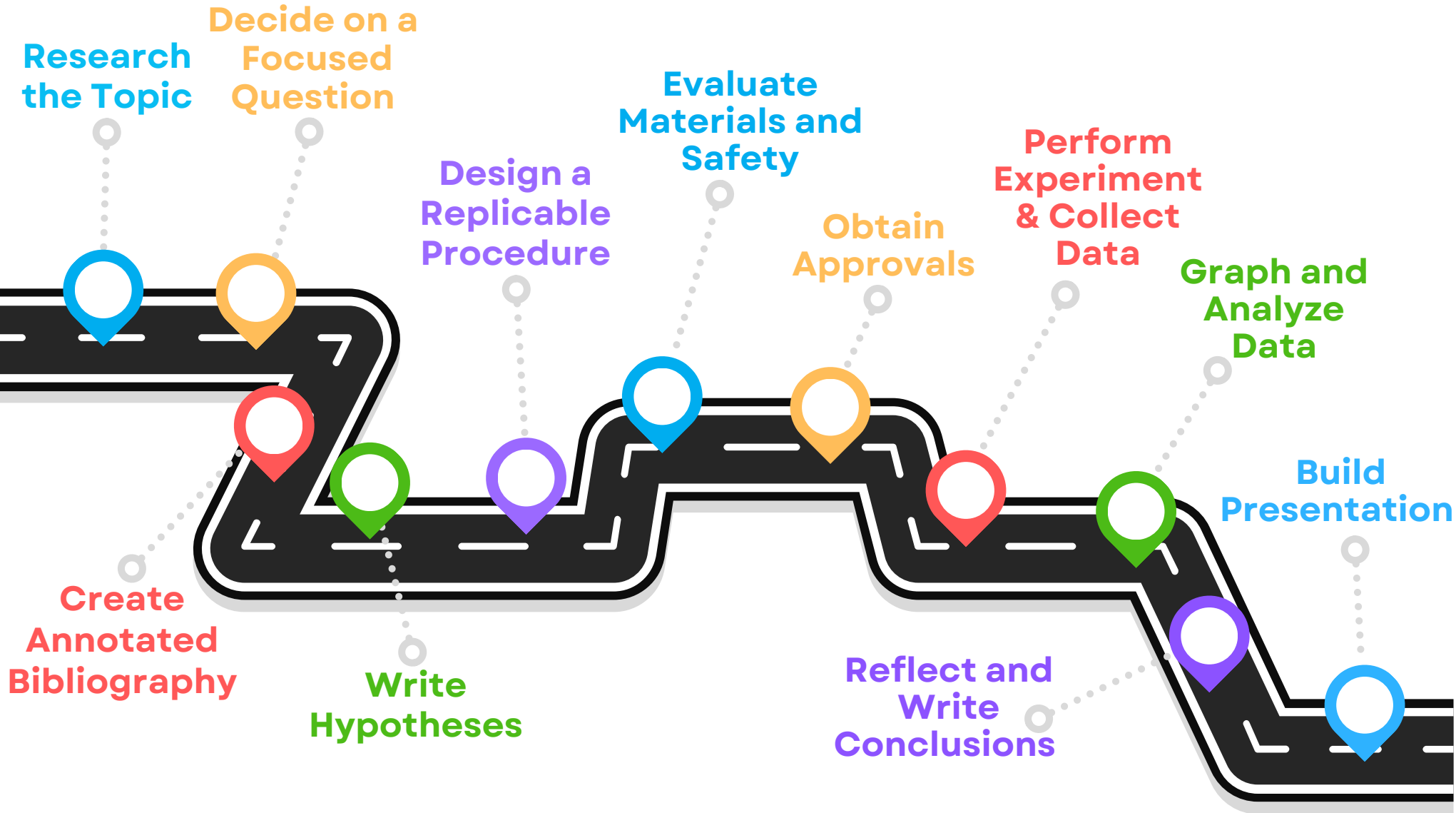
ITEM	DUE DATE	CHECK
Project Idea Form		<input type="checkbox"/>
5 Annotated Sources with Background Form		<input type="checkbox"/>
Hypothesis Form		<input type="checkbox"/>
Alignment Form		<input type="checkbox"/>
Method Design Form with 5 more Annotated Sources		<input type="checkbox"/>
Materials Form		<input type="checkbox"/>
Data Check		<input type="checkbox"/>
Data Analysis Check		<input type="checkbox"/>
Conclusions Form		<input type="checkbox"/>
Notebook and Board Completed		<input type="checkbox"/>

# SMART Goals for Scientific Research

- Goals should be
  - Specific
  - Measurable
  - Achievable
  - Relevant
  - Time-bound



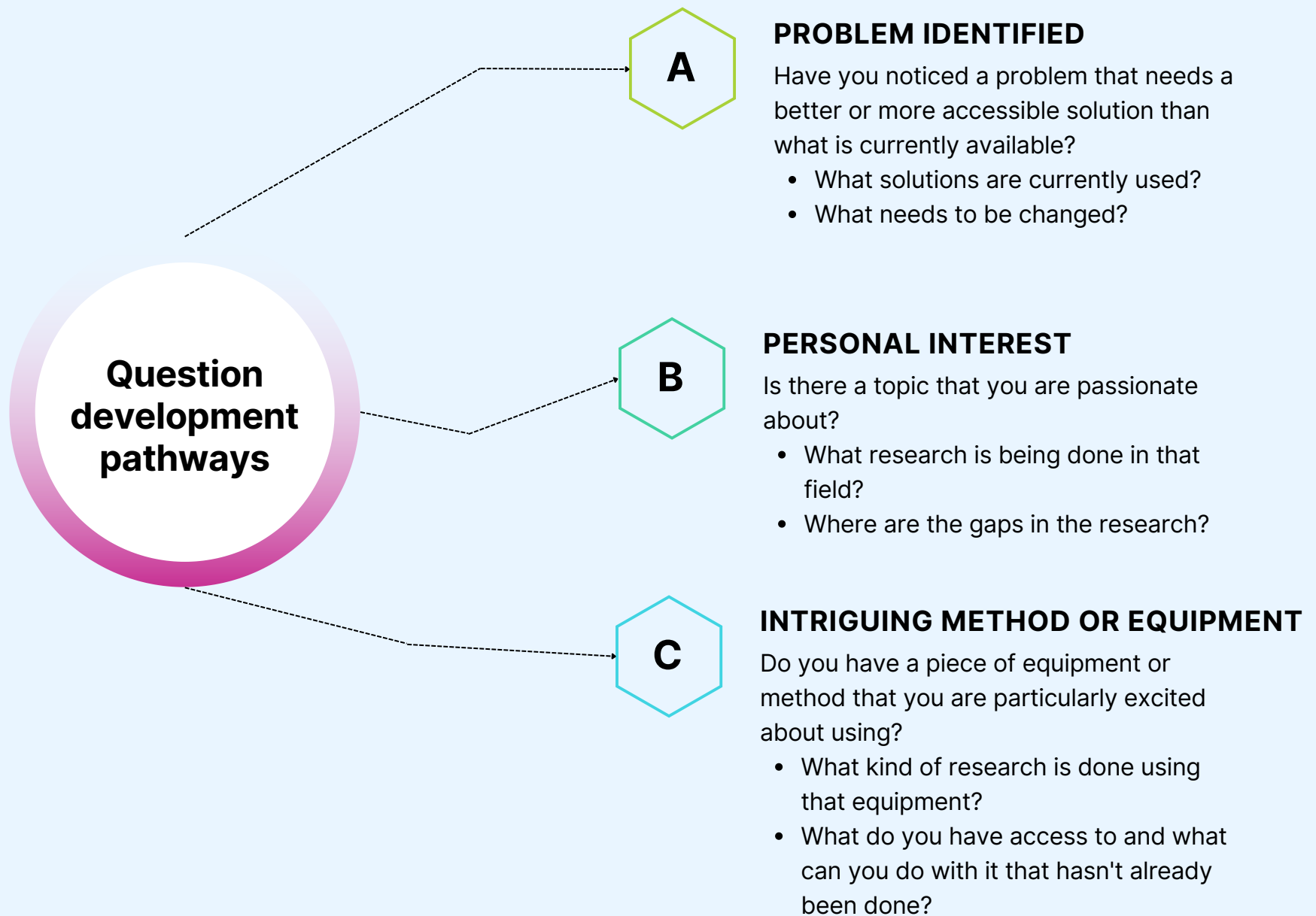
# Project Roadmap



# FINDING AN IDEA

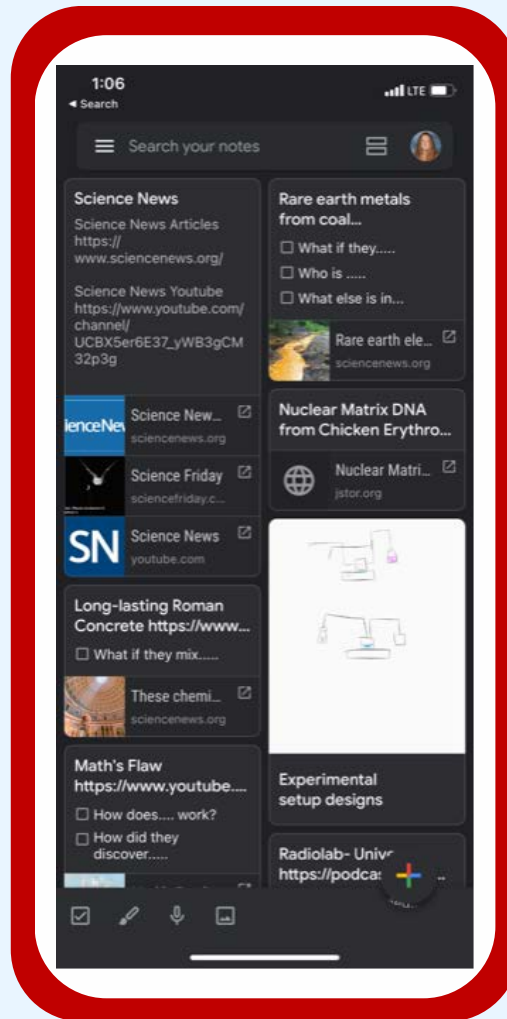








**They may not always have our  
computers or lab journals with them,  
but they do have.....**



# Organize Thoughts and Ideas



Use something like Google Keep to make it easy to store your ideas and questions all year!

Google Keep interface showing a collection of notes and reminders.

**Notes:**

- Science News**
  - Science News Articles <https://www.sciencenews.org/>
  - Science News Youtube [https://www.youtube.com/channel/UCBX5er6E37\\_yWB3gCM32p3g](https://www.youtube.com/channel/UCBX5er6E37_yWB3gCM32p3g)
  - Science Friday <https://www.sciencefriday.com/>
- Rare earth metals from coal ...**
  - ☐ What if they.....
  - ☐ Who is .....
  - ☐ What else is in...
- Nuclear Matrix DNA from Chicken Erythrocytes Contains  $\beta$ ...**
  - [https://www.jstor.org/stable/22670?searchText=chicken%20dna&searchUri=%2Faction%2FdoBasicSearch%3FQuery%3Dchicken%2Bdna&ab\\_segments=0%2Fbasic\\_search\\_gsv2%2Fcontrol&refreqid=fastly-default%3A4532cfb38cc99311eb9f7b0b50b2705c](https://www.jstor.org/stable/22670?searchText=chicken%20dna&searchUri=%2Faction%2FdoBasicSearch%3FQuery%3Dchicken%2Bdna&ab_segments=0%2Fbasic_search_gsv2%2Fcontrol&refreqid=fastly-default%3A4532cfb38cc99311eb9f7b0b50b2705c)
- Experimental setup designs**
- Long-lasting Roman Concrete...**
  - ☐ What if they mix.....
- Math's Flaw**
  - <https://www.youtube.com/watch?v=HeQX2HjkcNo>
  - ☐ How does.... work?
  - ☐ How did they discover.....
- Radiolab - Universe...**
  - ☐ What if they tried.....
  - ☐ What if they changed.....
- Math's Fundament...**
  - [www.youtube.com](https://www.youtube.com/watch?v=HeQX2HjkcNo)

Open-source licenses



## LOOKING FORWARD

Name something that you are excited about for this year.

Name something that you are nervous about for this year.



## A CHALLENGE

What is one challenge that you have faced during your time at this school?

How has it shaped who you are now?



## AN OPPORTUNITY

What is one opportunity that you have been given while at this school?

How has it shaped who you are now?



## UPSETTING FINDINGS

Name two research findings that you trust, but wish were not true.



## AN INTEREST

What is an interest that you have that defines you in an essential way?

How does it define you?



## A TICKET

You've been given a ticket to go anywhere, anytime...

Where will you go?

What will you do?

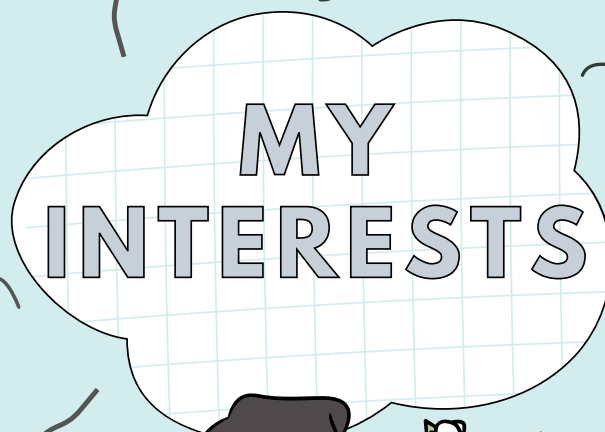
What will happen when you get there?



## A TALENT

What is a talent that you have that defines you in an essential way?

How does it define you?



# More Prompts



Write about an item you have that isn't expensive but means a lot to you.



Recall an important memory from your childhood and tell it from the perspective of someone else who was present.



What is the most adventurous thing you've eaten?



If you could live inside one of your favorite stories, what would you change about it?



What was the last piece of media you read, heard, or saw that inspired you?



Write about what you think the world will look like in 10 years.



Recall an object you found on the sidewalk/side of the road. Why did someone give it away? Why did they have it to begin with?

# I Wonder.....

5 QUESTIONS A DAY

Day 1

Day 2

Day 3

Day 4

Day 5

Day 6

Day 7

# Podcasts or Science News

SCIENCE FRIDAY, THE HIDDEN BRAIN, TED RADIO HOUR,  
RADIOLAB, BBC DISCOVERY, AND JOE'S BIG IDEA.  
SCIENCE FRIDAY EDUCATE PODCASTS

<p><b>Details</b></p> <p>What was this show generally about? If there were multiple stories, what was each of them about?</p> <p> </p>	<p><b>Perspectives</b></p> <p>What were the view or ideas from each stakeholder, lens, guest?</p>
<p><b>Data</b></p> <p>What data was presented and what were the conclusions?</p>	<p><b>Questions</b></p> <p>What questions do you have as they are talking and what did this leave you wondering? List your questions as you listen to the podcast</p>

Student Name and Class Period: \_\_\_\_\_

**Instructions:** Go to <https://www.npr.org/search> and type in one of the topics that we are studying. (you may need to search for synonyms to find more podcasts)

- Read through the podcasts that come up and choose one that sounds really interesting (needs to be about 20-30 minutes long).

Podcast Show: \_\_\_\_\_

Episode Title: \_\_\_\_\_

Episode Date: \_\_\_\_\_

# FINDING YOUR PROJECT

## WHAT IS YOUR INTEREST?

HAVE YOU NOTICED A PROBLEM OR A TOPIC THAT YOU WANT TO EXPLORE MORE?

## DISCOVER WHAT IS KNOWN

LISTEN TO PODCASTS, WATCH SCIENCE VIDEOS, READ ONLINE POSTS ABOUT YOUR TOPIC.

## DEVELOP YOUR QUESTION

USING THE ARTICLES, JUSTIFY THAT THERE IS A PROBLEM AND YOUR REASONING BEHIND THE GOAL/HYPOTHESIS.

## GO TO THE SOURCE

READ PEER-REVIEWED JOURNAL ARTICLES. WHAT HAVE OTHERS FOUND IN THIS TOPIC?  
Science builds upon other scientist's work.

## IDENTIFY SOLUTIONS

WHAT METHODS COULD YOU USE FOR EXPERIMENTATION? JUSTIFY WHICH WOULD BE BEST, AGAIN USE THE ARTICLES. KEEP IN MIND WHAT IS FEASIBLE FOR YOU.





# GOING TO THE SOURCE

## GENERAL TOPIC

## POSSIBLE NARROW TOPICS TO STUDY

IDEAS

## CURRENT RESEARCH & THE SOURCES

# PROJECT NOTEBOOK TITLE

Your project title should be informative, it does not need to be cute.

- No spiral notebooks.
- Dates are important!
- Use PEN! Science should be messy, there should be things that are crossed out. No white out!
- Never tear out pages! Just fold a page over if you don't want it.



# PROJECT NOTEBOOK SECTIONS

01

## Table of Contents

---

Add page numbers to the table of contents

02

## Problem or Engineering Goal

---

What are you attempting to accomplish with this project?

03

## Introduction/Rationale

---

Why did you choose this project?  
Who will this project help?  
Elaborate and "hook" your reader!

04

## Research Notes

---

Annotated Bibliography.  
You need at least 10 sources.

05

## Hypotheses

---

Why do you think this? You need supporting paragraphs with in-text citations from your research articles.

06

## Experimental Design

---

What are your variables?  
What are your experimental groups and control groups? Why?  
What are the limitations of the procedure?

07

## Materials List

---

Make a bulleted list.  
Make sure you list amounts, concentrations, etc.

08

## Procedure with Safety

---

Be very detailed! It should be replicable.  
Include all safety precautions that will be taken.

09

## Daily Log

---

Handwritten with dates. Include pictures and activities.

\*Photos cannot include other people's faces or any brand names.

10

## Raw Data

---

Data charts go here, handwritten or printed from the computer. Include all samples.

11

## Data Analysis

---

Place graphs here and describe any trends that you see.  
Add your statistical analyses and explain what they mean.

12

## Conclusions

---

What parts of your data supported or did not support the hypothesis?  
Why did the data show what it did? What is the science behind it?  
What are the implications of your results?  
What would you have done differently?  
How can this study be furthered in the future?



# Scholarly Research Resources

Check with the school library!

1

[Science Direct](#)

2

[Research Gate](#)

3

[National Library of Medicine](#)

4

[National Academies](#)

5

[PubMed](#)  
[PubMed Central](#)

6

[DOAJ- Directory of Open Access Journals](#)

7

Scopus, Jstor, IEEE Xplore or  
Ebsco if your school has access.



# Establishing the Need

## Background Research

**QUESTION/GOAL:**

**Rationale:** Why is this problem important to you and the community/society/research world?  
*-Justify the significance of your project using published articles.*

**Context:** Establish a setting of who, what, where and possibly when for this research.  
*-Justify the using published articles.*

Reason 1

Reason 2

Sources

Who is affected by this problem?

Where is this issue occurring?

How often and for how long has it been happening?

Sources

APA Citation

Summary of its conclusions

*Annotated  
Bibliography*

Quotations

How is it relevant to your project?

# Method Research

## ARTICLE 1

Scientific question:

Method description:

How I might use this:

## ARTICLE 2

Scientific question:

Method description:

How I might use this:

## ARTICLE 3

Scientific question:

Method description:

How I might use this:

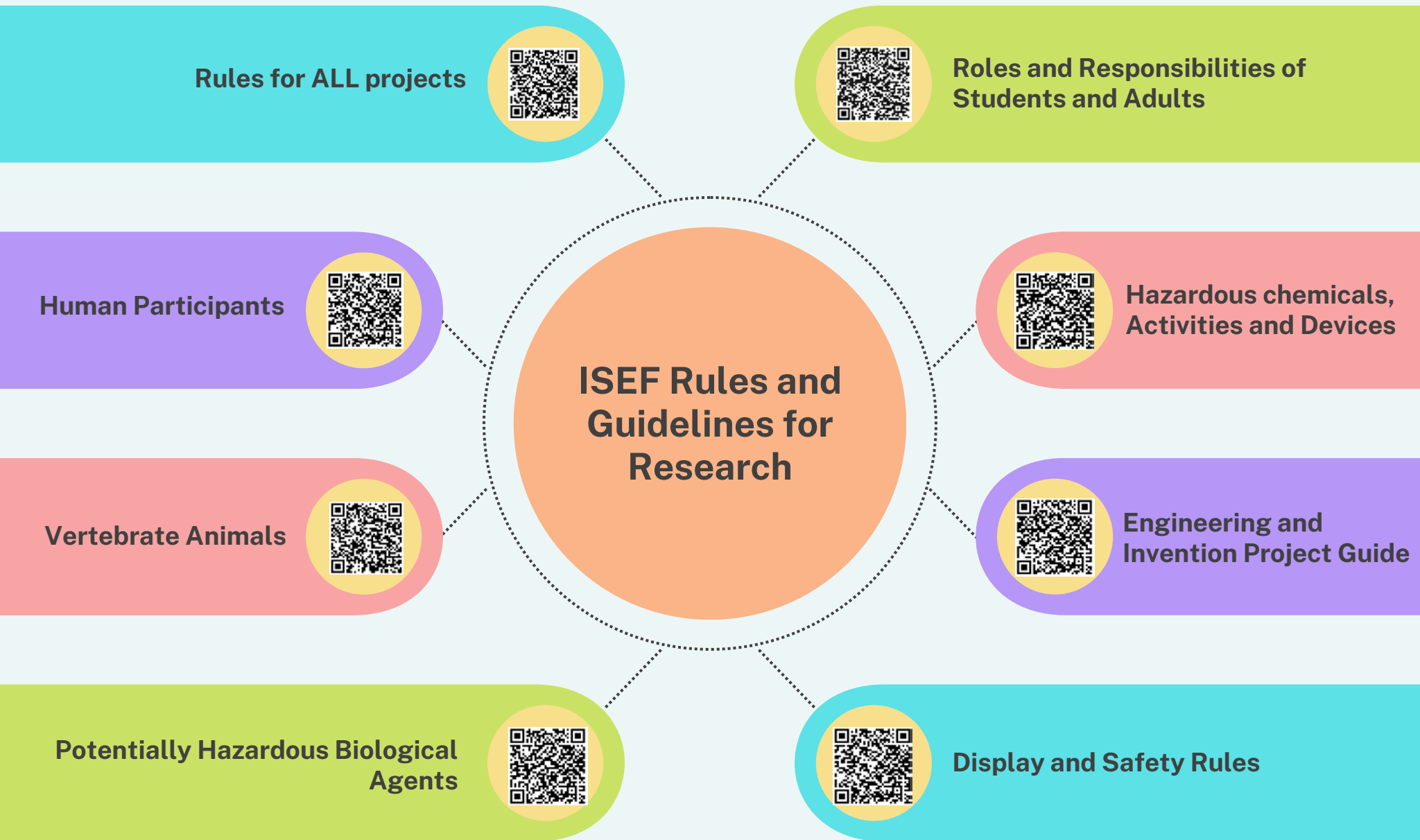
## ARTICLE 4

Scientific question:

Method description:

How I might use this:





# Rules Tour

## Microsoft Form

For the teacher to have the students fill out.

***SRC Forms Flowchart***

# Project Support

## Finding supplies and mentors



### SEND LOTS OF E-MAILS!

Many people are interested in helping the next generation scientists but don't have a way to do so. Your emails will give them that chance! Even if you get a series of Nos, all you need is one Yes! Send as many as you can, just be clear in what you are asking of them and why you have chosen to email them specifically.



1

### LAB KITS

Many science and CTE teachers have lab kits that can be modified to test different variables. For example: Aquatic science: water quality test kits, AP Biology: DNA Analysis and PCR kits, Physics: PASCO or Vernier test probes, etc.



2

### FAMILY FRIENDS AND CONTACTS

Your family may know someone that works at a hospital, pharmacy, university, environmental organization, engineering firm, etc. They would be great resources to mentor or brainstorm with. They may even have access to supplies to use!



3

### PREVIOUS PROJECTS FROM OTHERS

Students can expand on projects that other students have done in previous years.

- Hold a meeting at the end of competition season for students to talk about future studies that may spark ideas for others.



4

### LOCAL COMMUNITY GROUPS

Find mentors or assistance for data collection by contacting educational outreach programs from local organizations. Parks, zoos,

### APPLY FOR GRANTS

Check with district Education Foundation, [STEMgrants.com](http://STEMgrants.com), Society for Science Research Grants

# METHOD DESIGN

<b>INDEPENDENT VARIABLE</b>	<i>What will you be changing for each group?</i>	
<b>DEPENDENT VARIABLE</b>	<i>What will you be measuring or collecting data on?</i>	
<b>CONTROL GROUP</b>	<i>How will you set up a group that does not have the variable applied to it? This will be what you compare your experimental group(s) to. Can you include both positive and negative control groups?</i>	
<b>SAMPLE SIZE</b>	<i>How many groups will you be testing and how many times will you collect data on them?</i>	
<b>CONSTANTS</b>	<i>What are things that you need to make sure stay the same for all groups? -things that could have an effect on the results if they were changed.</i>	
<b>ALTERNATIVE HYPOTHESIS/ PROJECT GOAL</b>	<i>Based on your research, what are your predicted results for the experimental group when compared to the control group?</i>  <i>If your project is an engineering one, what is your goal and how will you know if it has been met?</i>	
<b>NULL HYPOTHESIS</b>	If hypothesis testing is involved: <i>What results would you see if the independent variable does not end up having an effect on the experimental group? *This can be rejected with statistical analysis.</i>	

# SUPPORTING YOUR HYPOTHESIS

## HYPOTHESIS

This is a proposed answer to your research question.

Now, using your background research articles, explain how you came up with that answer.

REASONING  
SUPPORT FROM  
ARTICLE 1

REASONING  
SUPPORT FROM  
ARTICLE 2

REASONING  
SUPPORT FROM  
ARTICLE 3

# PROJECT ALIGNMENT

## Problem or Question



## Hypothesis or Engineering Goal



## Procedure Overview and Data Collection



Does your hypothesis or engineering goal propose an answer to your problem or question?

Will the procedure that you have designed lead to an answer to the the problem or question?

Will the procedure that you have designed provide data to support or refute your hypothesis or engineering goal?

# Materials List

## MATERIAL

(INCLUDE CONCENTRATIONS OF CHEMICALS IF APPLICABLE)

## QUANTITY

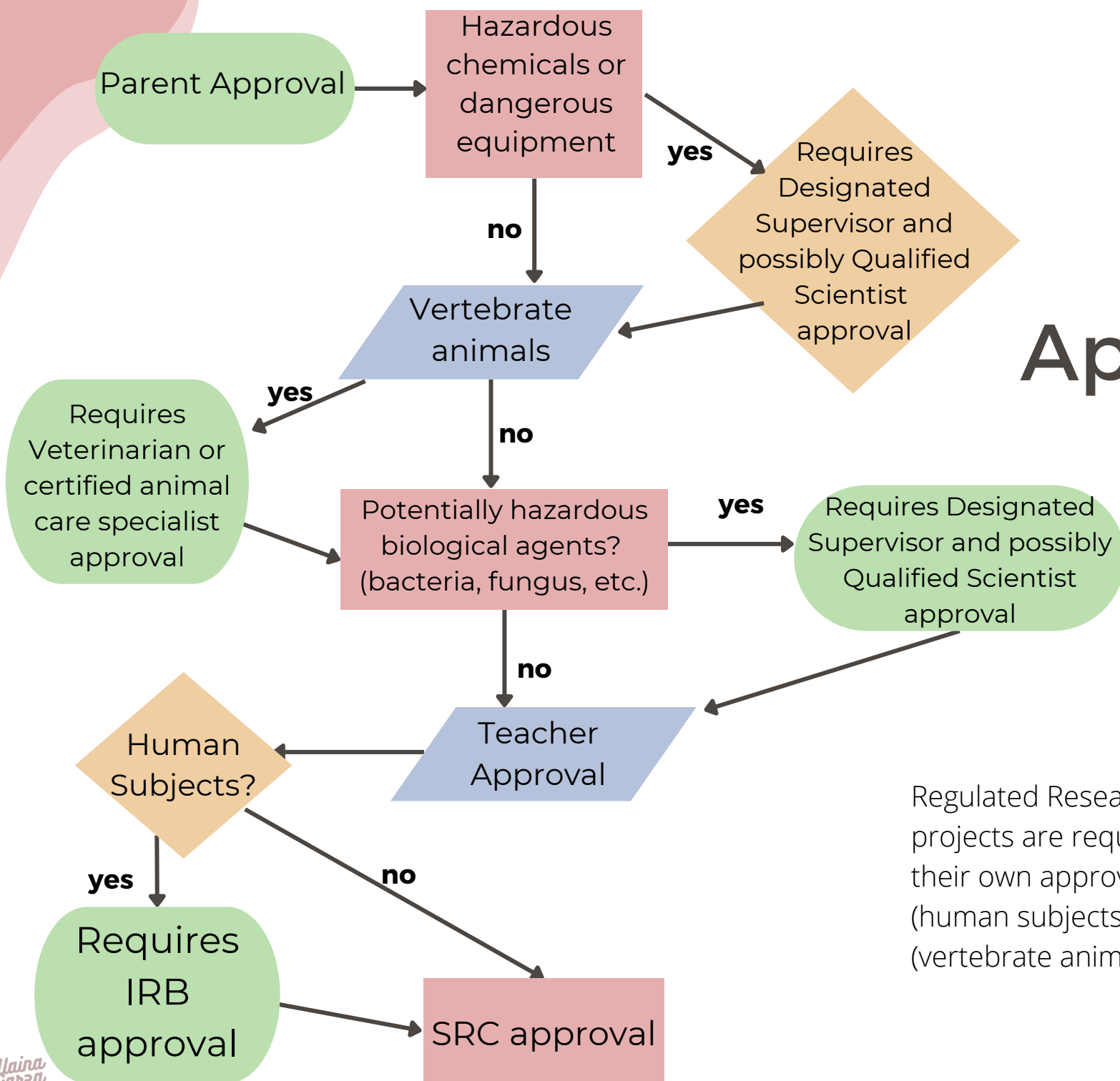
WHERE IT WILL BE  
OBTAINED FROM

HAZARDOUS OR  
DANGEROUS?

PURCHASE  
COST  
IF APPLICABLE




# Approvals



Regulated Research Institution projects are required to have their own approvals for IRB (human subjects) or IACUC (vertebrate animals).

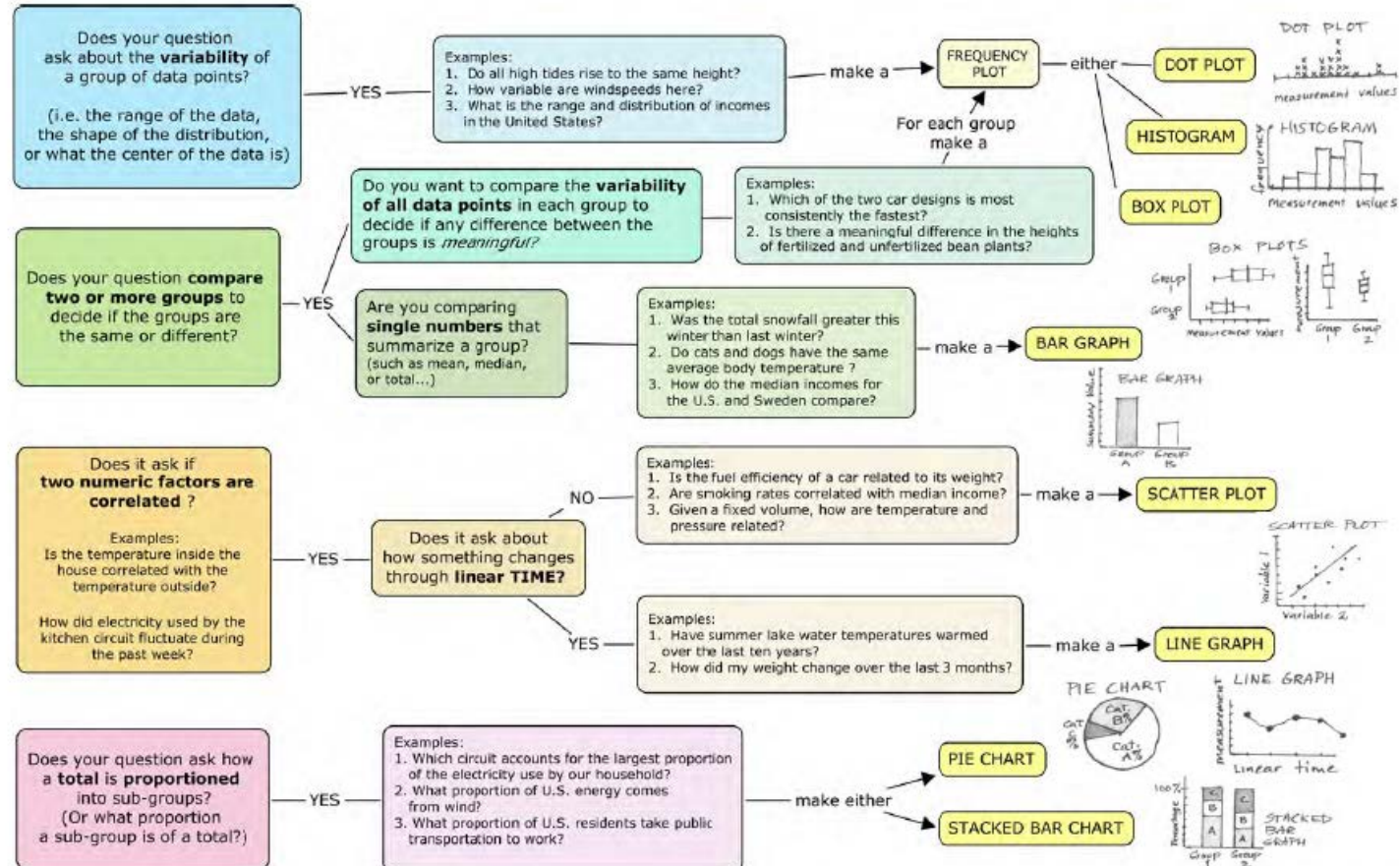
# Daily Log- Handwritten

[illegible]

## Graph Choice Chart

What question would you like to explore?

Write your question as a complete sentence.



## Graphing tips

Variability questions: Frequency plot (3 kinds)		Dot plot	Box & whisker plot	Histogram
Kind of data: <b>One categorical group and One numeric variable (one axis)</b>  <i>Frequency plots show how variable the group is. Describe variability by range, measure of center (mean, median, or mode), and the shape of the distribution.</i>				
Comparing groups questions:		Frequency plots	OR	Bar graph
Kind of data: <b>Two or more categorical groups &amp; One numeric variable</b>  <i>Frequency plots allow you to compare how variable the groups are. Bar graphs only show a single number (ie. sum, average, percent or count) for each group.</i>			OR	
		(To compare two groups of values)		(To compare two summary values)
Correlation questions:		Scatter plot	OR	Line graph (for time series)
Kind of data: <b>Two numeric variables</b>  <i>Both variables must be continuously numeric. Connect dots only if one variable is linear time (i.e. days, years...) Put time on the X-axis. Show correlation with a 'line of best fit'.</i>			OR	
Proportion (percentage) questions:		Pie chart	OR	Stacked bar graph
Kind of data: <b>Size of a subgroup as a percentage of the whole group (Total of sub-groups must = 100%)</b>  <i>In pie charts and stacked bar graphs, all sub-group percentages must total 100%.</i>			OR	

### Criteria for an informative graph:

- \_\_\_ Graph type fits the question
- \_\_\_ Axes are drawn & scaled correctly
- \_\_\_ Axes are labeled clearly, correctly
- \_\_\_ Units are given
- \_\_\_ Data are plotted accurately
- \_\_\_ Legend is present, if needed
- \_\_\_ Graph is overall neat & legible
- \_\_\_ Title and/or caption present
- \_\_\_ Trend line shown (scatter plot or line graph only)
- \_\_\_ Graph helps answer the question

*(There are other kinds of questions and other kinds of graphs, and often more than one graph type is useful for a given question. Learn to graph data for these basic kinds of questions first.)*



# STATISTICAL TESTS

Is my data categorical, discrete

or continuous?

[Click Here](#)



Is my data normally distributed?

[Click Here](#)



## Statistical Tests

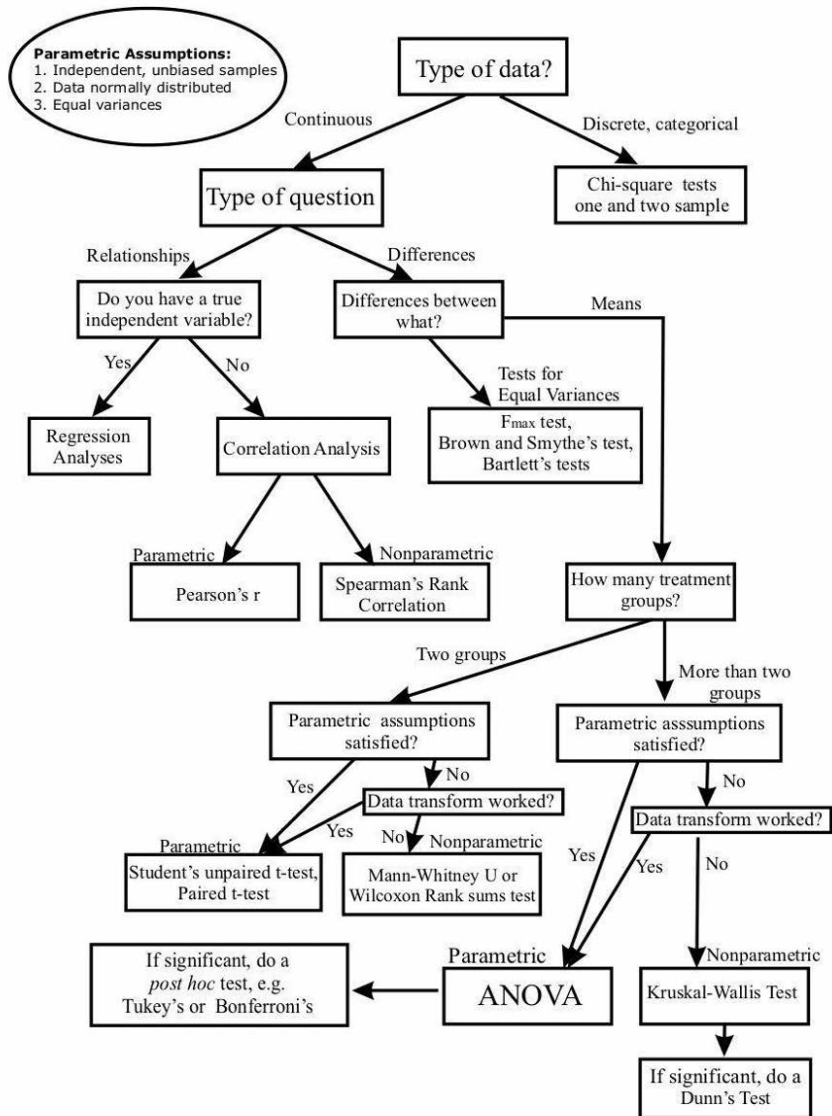
The following statistical tests are used to determine whether observed differences are statistically significant.

1. Parametric tests are used when data follow a particular distribution (e.g., a normal distribution—a bell-shaped distribution where the median, mean, and mode are all equal). These tests are generally more powerful.
2. Nonparametric tests are used when a particular distribution cannot be assumed; they rank data rather than taking absolute differences into account.
3. Unpaired tests compare values from independent samples.
4. Paired tests are performed on paired data. For example, where the same parameter is measured on each patient before and after an intervention.
5. Two-tailed tests should be used when an intervention could potentially lead to either an increase or decrease of the outcome.
6. One-tailed tests should be used when an intervention can have only one plausible effect on the outcome.

[Science Direct Article link with more information](#)



## Flow Chart for Selecting Commonly Used Statistical Tests



# Writing the Conclusions

## STEP 1

### Hypotheses/Goal Reflections

- How does your data support or refute your hypotheses or engineering goals?
- Did you reject or fail to reject your null hypotheses if you had them? What was your p-value?
- Why does your data show what it does? Connect it to your background research. What is the science?

## STEP 2

### Limitations & Error Analysis

- What struggles did you encounter with your experiment?
- How could these limitations and errors have affected your results?
- How did you attempt to minimize the effects of the limitations and errors?
- What would you do differently next time to improve your experiment?

## STEP 3

### Implications of findings

- How do your results impact the research that has already been done by others?
- Could your results have an impact on any other group or environment? How?

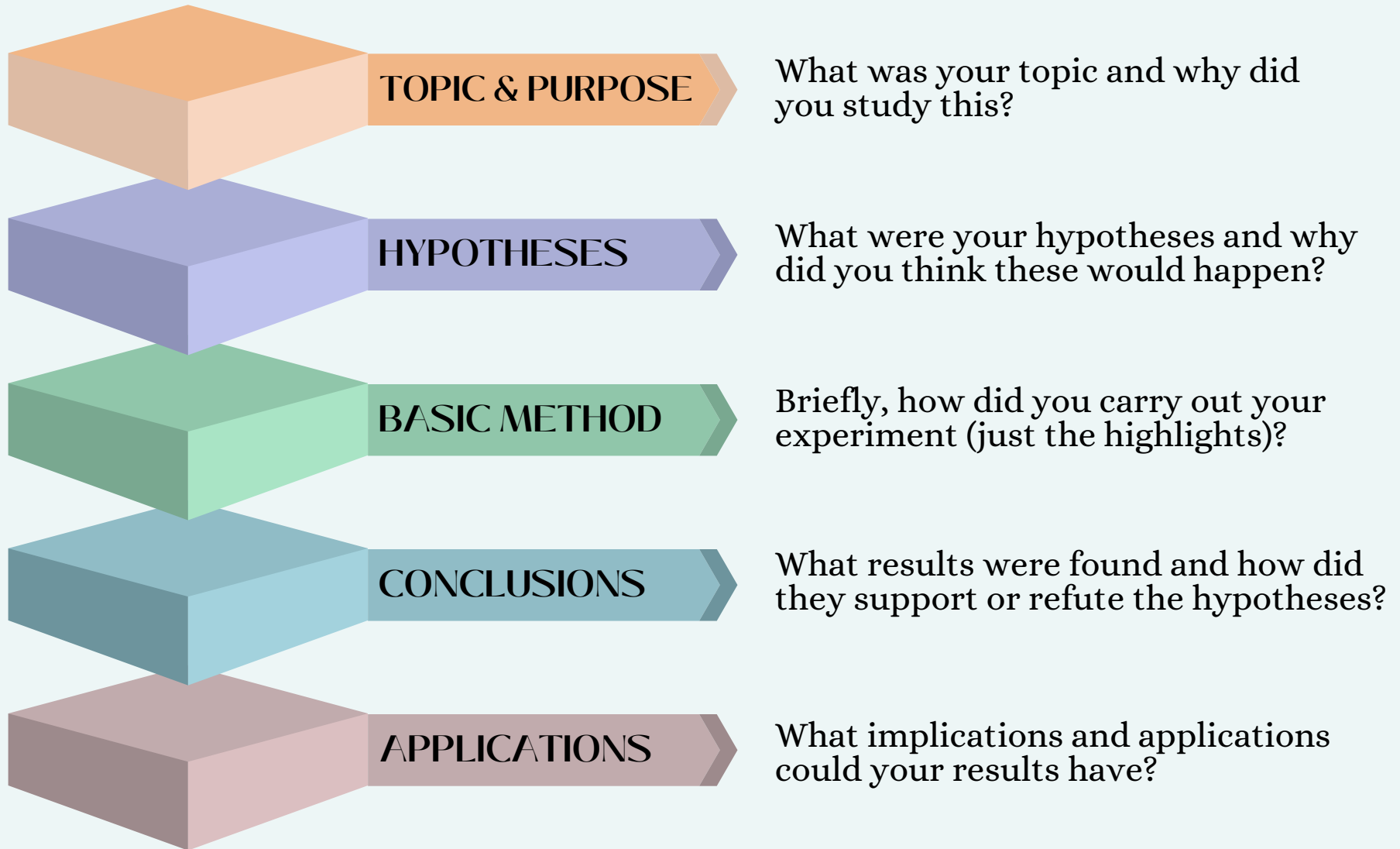
## STEP 4

### Future studies

- How can your research be furthered?
- What questions has this research made you wonder about?

# Writing the Abstract

## Under 250 Words





# Google Drive- Research Process Forms



drive.google.com/drive/u/0/folders/1eg8c885RngCWgNOKIBeDpKRbBsgdnJ3W

Drive Search in Drive

My Drive > AP Research- Garza > Research Process Forms

Files

Name ↑

1 Project Student Checklist

2 Project Teacher Checklist

3 SMART Goals in Research

4 Annotated Bibliography

5 Establishing the Need

6 Hypothesis

7 Method Design

8 Materials List

9 Conclusion Outline

office Scienteer Gmail HEB Hotmail Overdrive OneDrive

Error

Info

Calendar

Google Assistant

Google Assistant

Google Assistant

Google Assistant

Google Assistant

Google Assistant

Google Assistant

Google Assistant

Google Assistant

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Google Assistant

Google Assistant

Google Assistant

Google Assistant

Google Assistant

# HOW TO BE A GREAT PRESENTER

Create a 2-3 minute elevator speech that walks your audience through your board.



\*When answering questions, don't be afraid to say that you don't know.

# A Possible Board Layout

## TITLE

### Introduction

Include your purpose and rationale.  
May include problem statement.

### Review of Literature

Background research should include  
in-text citations.

### Hypotheses or Solutions and Reasoning

Include in-text cited background  
research on why/how you came to  
these hypotheses.

### Works Cited

APA format is preferred. MLA is fine too.

### Materials

### Procedure

### Data Analysis

Describe what the data are  
showing and which statistical  
tests you ran. Explain why your  
ran those tests.

### Conclusions

### Future Studies

Ideas for furthering this research

### Results

Data tables, graphs and pictures

\*all graphs, charts and images need to have a citation or "made by student researcher"

\*no faces or brand names in images

Display & Safety Rules



## ***Suggested Questions***

- What was your favorite part of your project?
- Was there anything that was surprising to you?
- If you were going to do this project again, what might you do differently?
- Where did you get this idea?
- How did you come up with your hypotheses?
- What was your control?
- How did you choose your independent and dependent values?
- Will you explain this graph?
- Who might want to know about your results?
- How did you calculate that result?
- How many times did you repeat your experiment?
- Who helped you with your experiment?
- How are your findings important?
- What questions are you left wondering?
- Did you have fun doing your project?
- What did you learn from your project?
- How does your project relate to other research?
- Why did you chose to do a science fair project?
- Did you run into any problems?
- Walk me through your lab notebook.
- Does your project have practical applications?
- Could you have come up with another conclusion?
- How much time did you spend on your experiments?
- How did you come to your conclusions?
- What was the most challenging part of your project?
- How did you address the limitations of your method?

# Judging Form & Comment Card

Project Title:

<p><b>I. Research Question (10 pts)</b></p> <p><b>Science</b></p> <ul style="list-style-type: none"> <li>• clear and focused purpose</li> <li>• identifies contribution to field of study</li> <li>• testable using scientific methods</li> </ul> <p><b>Engineering</b></p> <ul style="list-style-type: none"> <li>• description of a practical need or problem to be solved</li> <li>• definition of criteria for proposed solution</li> <li>• explanation of constraints</li> </ul>	<p>low &lt; 1 2 3 4 5 6 7 8 9 10 &gt; high</p> <p>Comments:</p>
<p><b>II. Design and Methodology (15 pts)</b></p> <p><b>All projects</b></p> <ul style="list-style-type: none"> <li>• well designed plan and data collection methods</li> <li>• variables and controls defined, appropriate and complete</li> </ul> <p><b>Engineering</b></p> <ul style="list-style-type: none"> <li>• exploration of alternatives to answer need or problem</li> <li>• identification of a solution</li> <li>• development of a prototype/model</li> </ul>	<p>low &lt; 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 &gt; high</p> <p>Comments:</p>
<p><b>III. Execution: Construction and Testing (20 pts)</b></p> <p><b>All projects</b></p> <ul style="list-style-type: none"> <li>• systematic data collection and analysis</li> <li>• reproducibility of results</li> <li>• appropriate application of mathematical and statistical methods</li> <li>• sufficient data collected to support interpretation and conclusions</li> </ul> <p><b>Engineering</b></p> <ul style="list-style-type: none"> <li>• prototype demonstrates intended design</li> <li>• prototype has been tested in multiple conditions/trials</li> <li>• prototype demonstrates engineering skill and completeness</li> </ul>	<p>low &lt; 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 &gt; high</p> <p>Comments:</p>
<p><b>IV. Creativity (20 pts)</b></p> <ul style="list-style-type: none"> <li>• project demonstrates significant creativity in one or more of the above criteria</li> </ul>	<p>low &lt; 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 &gt; high</p> <p>Comments:</p>
<p><b>V. Presentation (35 pts)</b></p> <p>a) Poster/Powerpoint (10 pts)</p> <ul style="list-style-type: none"> <li>• logical organization of material</li> <li>• clarity of graphics and legends</li> <li>• supporting documentation displayed</li> </ul> <p>b) Interview/Video (25 pts)</p> <ul style="list-style-type: none"> <li>• clear, concise, thoughtful responses to questions</li> <li>• understanding of basic science relevant to project</li> <li>• understanding of interpretation and limitations of results and conclusions</li> <li>• degree of independence in conduction project</li> <li>• recognition of potential impact in science, society and/or economics</li> <li>• quality of ideas for further research</li> <li>• for <u>team</u> projects: contributions to and understanding of project by all members</li> </ul>	<p>low &lt; 1 2 3 4 5 6 7 8 9 10 &gt; high Comments:</p> <p>low &lt; 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 &gt; high Comments:</p>



# QUESTIONS

## IDEAS