TIPS FOR CHOOSING A RESEARCH TOPIC

1) Choose a topic that answers a question.

- Does the width of bird's wing make them faster? *(good)*
- Why do birds suddenly appear? (*It's a start, but needs work)*
- I like birds, let's do something with birds. *(bad)*
- I want to break glass. *(very bad)*
- Let's do a four factor DOE with birds. (*also very bad*)

2) Determine a TOPIC. NOT an experiment.
Let your background research help you design an experiment.
Do not design an experiment, and then think of a problem.

- I am going to throw rocks at glass then count the pieces. (*very bad*)
- Let's do a four factor DOE with birds. (*still very bad*)
- What makes one racing pigeon faster than another racing pigeon? Let's find two different sized Pigeon and determine their average speed over a given distance. (decent)

3) Think of a way to solve a problem, then design the experiment.

- When removing blight from a neighborhood, disposing of material can be very costly and time consuming, is there and easier or cheaper method of disposing of materials? Reducing the volume of disposed material makes it easier and cheaper, breaking glass into very small pieces reduces the volume of garbage, what methods are available to break glass into small pieces? *(decent)*

4) The experiment determines the statistical test, not you.

- We are comparing # of pieces produced by three different methods of breaking glass
  (A-Nova maybe?)
- We are racing two sets of birds with different feather lengths against each other
  (T-test comparing velocities ?)
- Let's do a four factor DOE with birds.
  (Enough with the birds! Where are you going to get 17 of the same but different birds?)

NOTE: Breaking glass and racing birds are not to be considered for research projects.

Possible Physics Topics to apply to your Research:

Forces and Laws of Motion
- Friction
- Drag Forces
- Force and Acceleration
- Projectile Motion

Conservation of Energy
- Simple Machines
  - Work
  - Power
  - Efficiency
- Coefficient of Restitution
  - Elastic, Gravitational PE

Momentum and Collisions
- Impulse/Change in Momentum
- Elastic Collisions
- Inelastic Collisions
- Conservation of Momentum

Rotational Motion
- Rotational Inertia
- Torque
- Rotational Equilibrium
- Laws of Gravity
- Conservation of Momentum
- Conservation of Energy

Fluid Mechanics
- Buoyant Forces
- Bernoulli's Principle
- Pressure

Heat and Thermodynamics
- Heat vs. Work
- Solar energy
- Gas laws
- Conservation of Energy
- Specific Heats
- Heat of Vaporization
- Heat of Fusion

Waves

Simple Harmonic Motion
- Hooks Law
- Period, Amp etc

Sound
- Speed of Sound
- Intensity
- Decibel Level
- Frequency

Light
- Lenses
- Mirrors
- Interference of Light
- Reflection
- Refraction
- Diffraction
- Color / Pigments

Electrical Energy
- Current, Voltage, Resistance
- Ohms Law
- Parallel Circuits
- Series Circuits
- Magnetic fields
- Generators

Nuclear Decay

OTHERS

THE RESEARCH PAPER

INTRODUCTION

The Introduction portion of the final paper should be written so it supports your Problem Statement. The introduction should answer the following questions.

- What you are doing?
- *Describe Problem or explain Question.*
- Why you are doing it?
- *Why is it important? Who does it effect? Possible Applications?*
- What scientific concepts will you apply to help solve your problem?
- How are you going to do it?
- *(describe experiment)*

REVIEW OF LIT

The Review of Literature is written to <u>*support your hypothesis*</u>.
It should include scientific and experimental back ground that supports your ***hypothesis!***

What scientific concepts apply to your problem?
How do they apply to your hypothesis?
What other research and/or experiments have you read about that apply to your problem?
How does this research support your hypothesis?

- It is not a list of random definitions
- It is not a description of labs that are similar to yours.
- It is not a book report on your topic.
- Do not write about the African Swallow vs. Eagles in a fight when you are determining the effect of surface area on drag force on the wings of birds.
- If your hypothesis says *Nike* brand racing birds are faster than *Addidas* brand racing birds, you should explain what is different about *Nike* and *Addidas* birds that would make one faster than another.

EXPERIMENAL DESIGN

Your procedure should reflect exactly what you did when collecting data.

- List exact dimensions
- Do not assume everyone knows what the "proper height" should be.
- "Record data" is too vague
- Diagrams should not be a set of random pictures of the materials.
- The LABELED diagram should demonstrate how the equipment was used in the data collection process.
- The LABELED diagram(s) should be a visual reference someone can use to set up your experiment.

DATA AND OBSERVATIONS

Also include appropriate computer screens, equipment readouts, and sequenced photo shots of activity.

- If you had to read graph from the Lab Quest to get data, show an example of the graph.
- If the before and after were drastically different, show the difference.
- If different results appear different, show an example.
- If you measured the diameter of an impact crater, show a large and a small impact crater, not just one impact crater. LABEL the Measurements.

DATA ANALYSIS

Include a brief final paragraph that summarizes the results of the data analysis.
Do not make the reader go back a read all the footings under the graphs to determine overall results.

CONCLUSION

- Accept or Reject Hypothesis based on DATA.
- Explain How the ***Data*** Collected determined if you would accept or reject your hypothesis.
- Support that decision with the stats.

Example:
Hypothesis: *If a birds wing has a larger surface area, then it will be faster than a bird with a smaller surface area.*
Data: *Avg speed of large surface area = 12 m/s*
Avg speed of small surface area = 7 m/s

Conclusion: We accept hypothesis because the bird with the large surface area had faster average speed of 12 m/s compared to the small surface area that had an avg. speed of only 7 m/s.
The T-test had a p-value of 0.00000000000000000000000005 when supports this conclusion because blah blah blah.

- Use only final conclusion of stats. Do not just repeat the data analysis.
- Explain, in detail, Scientific Reasons for your results.
- Use Science, not just Data.
  If you reject your hypothesis, what scientific reason explained why your results were different than expected.

- NEVER SAY HUMAN ERROR!!
- NEVER SAY YOU DID NOT HAVE ENOUGH TIME!!
- How would you apply what you have learned?

If you were betting on a racing pigeon, would you want bet on the bird with large or small wings?

Further Research does NOT mean the same experiment with slightly different values.
Example: We tested birds with surface areas of 15 cm2 and 20 cm2. For Further Research we could test birds with 25 and 30 cm2 area wings. (Lame)

THE PRESENTATION

Your Presentation should summarize the research process. It should answer 4 basic questions:

- What are we doing?
- Why are we doing it?
- How did we do it?
- What did we learn?

You should be able to put your Research Paper into Presentation Form by emphasizing 4 parts of the paper:

1. INTRODUCTION
    a. What are we doing?
    b. Why are doing it? (why is it important?)

2. REVIEW OF LIT
    a. Why are doing it? (why do I think it will work?)
    b. Justify your Hypothesis with scientific reasoning.
    c. Use diagrams, pictures, animations etc. to make the audience understand the concepts and reasoning behind your project.
    d. This may be the most important part the presentation.

3. EXPERIMENAL DESIGN + DATA &OBSERVATIONS
    a. How did you do it?
    b. Show more than one trial
    c. Show major differences in data. *Example:(High Trials vs. Low Trial)*

4. CONCLUSION
    a. What did you learn?
    b. Did you accept or reject your hypothesis? Why or Why not?
    c. Explain with ***DATA*** and ***scientific reasoning***
    d. Use the stats to support the data, NOT to replace the data?
    e. How would you apply what you have learned?
    f. This is the 2nd most important part of the presentation.

Notice, the statistical analysis is not one the four sections. That is because this is a scientific presentation, NOT an AP Stats presentation. The majority of your presentation should be scientific background and reasoning.