"Dans les champs de l'observation le hasard ne favorise que les esprits préparés."
"In the fields of observation, chance favors only the prepared mind."

— Louis Pasteur

1 Writing a Research Proposal

As a general rule, scientists must write research proposals in order to secure funding for their salaries, equipment, and other expenses. Scientists may also need to write a research proposal in order to secure authorization from their supervisors to carry out a project, even if no additional funding is required. A well-crafted research proposal explains **what** the project is about, **how** it will be carried out, and **why** it should be done. All three elements are necessary to convince the reader to support the project. The folks making these decisions often want to invest their resources (time and money) in "sure shots." Research proposals are often submitted competitively, meaning many scientists will submit proposals, but only the best proposals will receive funding or approval. Regardless of competition, a well-thought out research proposal provides you with a plan for your project, which helps avoid dead ends, wasted time, and other "surprises."

1.1 Example Research Proposals

Your research proposal will be about 1-2 pages in length. The example proposals listed below are a bit shorter so that we have time to read them and discuss in class. Read both proposals, and discuss the questions below as a group.

1. "Dancers and artists have long incorporated optical illusions into their performances by taking advantage of the basic laws of physics. Why do expert dancers appear to defy the laws of gravity? We learned in class that all objects near the surface of the Earth accelerate towards the ground at the same rate, $a = 9.8$ m/s/s and that all projectiles will have parabolic motion. For our project, we will analyze the motion of a ballerina. We will find videos of professional ballet performances from YouTube; we will only choose videos in which the camera is perpendicular to the stage. Using video analysis, Logger Pro, and kinematics, we will calculate the motion of the ballerina during *pirouettes* and *grand jetés*."

What did this proposal do well? What could it do better?

2. "We will use a cell phone camera to collect videos of two basketball scenarios. In the first video, one of our group members, a former high school varsity basketball player, will attempt a slam dunk. In the second video, one of our group members who is not very athletic will attempt the same slam dunk. Using Logger Pro video analysis, we will record the x and y position vs. time for the various parts of the athletes' bodies: arms, legs, torso, head. Using estimates of each parts' relative mass and the center of mass (COM) equation, we will also calculate the x and y position vs. time for their COM. Then we will analyze the plots of COM position vs. time and compare."

   What did this proposal do well? What could it do better?

1.2 Brainstorming Activity

1. Think about a general topic you'd like to investigate. Outside of class, you'd be expected to do some background research. For now, just use what you've learned so far in class in thermodynamics or electric fields.

2. Choose one of those topics, and write down some potential questions you could ask and investigate. You may take one of the activities we completed and think about how you could extend the experiment to ask new questions.

3. Choose one of your research questions. What steps will you need to take to answer your question?

4. Think about the data you will collect. What do you imagine presenting in your Results section? What tables and graphs will you make? You might not know *what* those graphs will look like, but what do you expect to plot on the x vs. y axes?

1.3 More Questions to Consider as you Write your Proposal

- Introduction/Background
  - What is the general topic area in which you will be working?
  - What is the problem or concept you are learning about?
  - Why is the topic interesting or worthwhile to you?
- Objectives
  - What do you aim to accomplish in your project?
  - What will you measure, and under what conditions?
  - What will you calculate, model, or simulate?
  - What are your starting assumptions or conditions?
  - How will you know you have accomplished what you set out to do (criteria for success)?
- Approach
  - How will you accomplish your objective? What will you do?
  - What are the principal steps during the project? How long will each take?
  - What steps will be the most difficult, and how will you overcome the difficulties?
  - What equipment or other resources will you need?
  - Which of these do you already have, and which will you have to make or acquire?
- References: List all pertinent books or papers that you have consulted to prepare your proposal.