Writing Good Reports (and Papers)

(Lecture Notes; Shaul Hanany Spring 2008)

Writing well is important because
- With writing you convey your thoughts and results
- You are being judged by your teachers and peers

What is ‘Writing Well’?
- Informative
  - Quantitative
  - Substantive
- Clear, easy to follow
  - Organization
  - Proper English (grammar and punctuations)
  - Conciseness
  - Relevance
  - THINK ABOUT YOUR READER
    - Can s/he follow your line of reasoning
    - Is s/he familiar with the jargon language your are using

Is it necessary for a science paper to be entertaining, or appealing, or having suspense?

A poorly written paper indicates poorly thought idea or poorly executed experiment

Opening Remarks

- Not showing the reports in order to highlight their badness.
- Some may have good elements, some may not
- Our primary goal is to learn, not to criticize.
Discussion of “Measuring the Gravitational Constant Using an Electronic Torsion Balance” (Geppert and Zisla, 2003).

(Students: Read report, concentrate on Sections 1-4. Level of depth: understand overall goal and experiment technique. Less important: details of results. Answer questions before lecture.)

Class Work: go over report and discuss questions and answers.

Basics of Technique (my own reference)

The force of gravity applied by the large masses will apply a torque on the bar with the small masses. The torsion of the wire applies an opposing torque. When the two torques balance, the net torque is zero. The torque due to gravity is the fundamental unknown. If we could measure the torsional torque of the wire, we could derive $G$. How do we measure the torque of the wire? Find the angular displacement and use the known torsional spring constant of the wire.

But can improve by applying a magnetic field to null the torsional torque of the wire? If you knew exactly how to ‘null’ and you knew the torque due to the magnetic field, you would be done. But since nulling to zero is difficult, can null around any angular position and move the large masses and measure change in torque through change in magnetic field.

Class Discussion

(Goals of Scientific Writing)
Someone reading the report should be able to understand the fundamentals of the technique relatively quickly, perhaps in the first or second reading.

(Q1) Do you understand how the authors are attempting to measure $G$? If yes, how many times did you need to read the report to understand the basic technique?
(A1) Needed to read many times and to flip back and forth between many different sections. Even after I read the report several times I needed to consult with Kurt about key elements. Good papers may require several reads, but that is because they contain deep, thoughtful material. Not because it is hard to follow the intent of the author.

(Overall Organization)

(Q2) What comments do you have on the overall structure of the report?

(A2) (a) Apparatus before Theory: this makes for bad organization. It doesn’t make sense in terms of reading. (b) ‘Theory’ goes into details of experiment: separate Theory from Experiment.

Proper organization:
- **Introduction**
  - Should be brief giving the broadest perspective on the topic
  - State succinctly how your work matches with the broadest perspective of the topic
- **Theory (fundamental physics)**
  - Give the theoretical background.
  - Start broad and concentrate on your particular application
- **Experimental Setup**
  - Describe experimental setup
  - Discuss experimental issues that relate to proper execution of the experiment
  - Can include ‘theoretical’ considerations that do not belong to fundamental physics
- **Results**
- **Discussion**

(Organization within a section)

(Q3) Concentrate on the first two paragraphs of the Introduction. What comments do you have about the material presented?

(A3) First paragraph talks about a particular implementation of measurement of G - “Torque is compensated by magnetic forces, which are controlled by
negative feedback….”. It assumes prior knowledge by the reader “… the current required to maintain the rod at equilibrium” (which rod?).

- Start broad.
- The introduction should introduce the general topic and should state how the current work fits inside the broader perspective.
- The introduction is not a summary of the paper

(Q4) Concentrate on the ‘Theory’ and ‘Calibration Data’. Are the sections partitioned properly?

(A4) No. Problem relates to fundamental partition of paper. Need to discuss ‘Theory’ ‘Experimental Setup’ then ‘Calibration’, all in different sections.

(Fat, Information content, and Being quantitative)

(Q5) Concentrate on the third and fourth paragraphs in the Introduction. Identify the solid nuggets of science that you have learned from these paragraphs.

(A5) None. The phrases ‘not very well known’, ‘experiments have varied wildly’, ‘some postulated that G is not a “constant”, … do not mean anything in the exact sciences. Author should give range of uncertainty or give references to where quantitative information is provided.

(Q6) What have you learned from the first sentence of ‘Theory’?

(A6) Nothing. If a sentence relays no information, delete it.

(Style; Proper scientific writing)

(Q7) Identify 5 cases of improper scientific writing

(A7)
- Theory, first sentence: “The theory behind this experiment is rather simple”
• Theory, first paragraph: “In practice, this magnitude of this correction was well below the final uncertainty” (English, and BE QUANTITATIVE)
• Theory, end of second paragraph: “the trick of this experiment”
• Apparatus, bottom of page 3: “Besides the usual array of multimeters and oscilloscopes, …”
• Calibration Data, 6th paragraph: “This type support allowed fine control ...”
  o ‘allowed’, ‘must be done’ – not interesting. What you have done is more interesting.

(Good)

(Q8) What do you find good in this report

(A8) Sketches. Thoroughness. Error analysis. Obvious that a lot of good experimental work has been done.

Measurement of G: New structure of report

Introduction: History of Cavendish’s experiment. We are repeating his experiment, albeit using modern instrumentation. If using a slightly different or improved technique may, then may wish to highlight, but point to ‘discussion’ where differences are highlighted.

Theory: Law of Gravity. We want to determine G. Particular technique. Give balance of torques (see description above). Highlight what are the measureables and which ones are the derived quantities. Give sketch showing fundamental physics

Experimental Setup: describe experimental set up. Give drawing showing hardware and dimensions of relevant hardware.

Calibration:

Data:

Discussion:
Report #2: “Influence of Diffraction and Mesoscopic Disorder on Vortex Dynamics”.

(Q1) Scientific paper should be written in a ‘results’ style, concentrating on the important experiments and key results, but ignoring the history of the experimentation. There is a style of reporting that follows the history of the experimentation. In which style is this report written?

(A1) This is clearly a historical narrative of what has been tried and either failed and succeeded. The common thread to the report is history, rather than a particular physical phenomenon or insight.

It is quite common and perhaps natural that people describe what they have gone through. But this is NOT the proper structure of a scientific report. Your readers are not interested in what happened to you. They are interested in the science about which you are reporting. Therefore, focus on the results you are reporting, not about all the trials and errors you have gone through.

Specifically, look at the ‘Theory’ – why is it important what you ‘thought about’ in terms of the different ways to do the experiment? What IS important is what you have done and what the results were.

(Q2) What quantitative information have you learned from this report?

Essentially none. If the goal of the experiment was to quantify a phenomenon, or to analyze a phenomenon quantitatively, the authors have failed.

(Q3) Count the number of sentences in the Introduction that are absolutely necessary for the report, those that are ‘may be’, and those that are ‘not necessary’.
(A3) Review the structure of the introduction and analyze which paragraphs are relevant and which are not.

(Q4) The experimenters mention hypotheses that they plan to test experimentally. Do you find the way the hypotheses are presented compelling (explain your answer)?

(A4) Second paragraph of ‘theory’: “We hypothesized that we would observe a figure-8 flow pattern initially with the two blenders … We predicted that the 5.5 cm width was ideal”

There is no justification given for any of the hypotheses. A prediction is presented with absolutely no justification.

Report #3: “Resistance of Indium Nano-wires”.

Here I want to discuss some sub-parts in more detail.

(Q1) Does the introduction fulfill its role?
(A1) The role of the introduction is to give the reader a broad overview of the topic to be discussed, and to put the specific experiment in context. This introduction does not do that.

How about (SHOW SLIDE): “For example, the critical temperatures of lead and indium, which are materials that we are using in this experiment, are 7.2 and 3.4 K, respectively.

Nano-wires are wires with typical diameters of 10-9 meters. Their properties are interesting because …

Chan et al. (give reference) have recently reported that a nano-wire of indium does not superconduct at any temperature. The purpose of this study were to reproduce the phenomenon reported by Chan et al. and to study the effects of magnetic fields on the system”

(Q2) Which parts of the introduction are relevant for an ‘introduction’, which ones are not?
(A2) The first and second paragraphs are discussed above. The third paragraph should not be part of the introduction.

(Q3) Review the 3rd paragraph of the ‘introduction’. Does it belong in the introduction? If not, in which part does it belong?
(A4) Answered above.

(Q4) Concentrate on the section discussing ‘apparatus and experimental techniques’. Do you understand exactly how the samples were prepared? Did you need to read this section more than once to understand how they were prepared?

(A4) In the first line the authors describe PCTE filters. The mechanical construction of these filters is critical for the fabrication of their samples. A detailed drawing would have been appropriate (SHOW DRAWING ON BOARD).

Report #4: “Shklovskii Effect”.

(Q1) Purely in terms of “ease of reading”, how do you rate your experience reading these pages? On a scale of 1 – 5 with 5=’easy and flowing reading’ and 1=’very difficult to follow’, rate these two pages.

(A1) I would give it a rating of 1 or 1.5.

(Q2) Enumerate two primary factors that contribute to your rating.

(A2) (i) Dense line spacing, (ii) handwritten equations.

Need to point out that the quality of the material is quite high. It is unfortunate that the reader must overcome the difficulties of the presentation in order to appreciate the material.