Things that I should check before turning in my lab
PS315 Modern Physics
April 7, 2009

updated: Dec. 31, 2010

1. Use: data "were" … and … datum "was"
2. When describing how you went about taking the measurements, don't write it as a list. Don't write it in a recipe fashion. Do not use the imperative tense (like the sentences in this paragraph).
3. Reduce the number of references to www. You don't have to eliminate them; just reduce them. Many websites are transient and material you reference may get moved or deleted. Your professionally written lab report should stand the "test of time." Assume that people need to read your reference 10 - 20 years from now.
4. Describe the physics quantities when you present an equation, especially if it might be ambiguous:
   "where θ = the angular displacement (radians or degrees), U = the potential (volts)," etc.
5. Reality check on physical quantities:
   "where the gap size between the parallel plates d = 0.3μm." Are you sure the separation is that small? How does this size compare with something else of known dimensions? Does it make sense.
6. Consistency/Quality checks: Q = ____ ± δQ where δQ was as big as Q.
7. Citations: Don't give a list of references if you don't cite them in the text. References serve very little purpose if you don't context them with the item you are discussing in your text.
8. No Excel Histograms. These pictures stick out and don't present themselves well in a formal paper. The fonts are different and the graphs don't have a clean appearance. The Excel graphs serve a useful purpose in your lab book b giving you a quick look at your data; however, you should switch to Matlab or Mathematica to generate a clean plot or histogram.
9. Using Mathematica 7.0 is great! However, some students write about it as if it were doing the work for them. It gives the reader (me) the impression that you have relegated all your "smarts" to a computer program. At best, reference to Mathematica 7.0 should be assigned to a footnote and nothing more. Say it "once or twice" as appropriate and leave it alone. Mathematica and Matlab are tools and their importance does not need to be overstated. The focus of your formal report should be on the science (i.e., the physics) and not so much the mathematical tools. This may seem a bit unfair once you compare how much time you spend using the mathematical tools versus the time spent on the physics and taking the measurements. However, C'est la vie, and that's par for pursuing a career in science.
10. "My measurements were prone to error." That's a pretty vague statement. What kind of errors? Be specific. What did you do to improve the precision of your measurement? It takes great care to make a good measurement. ref: NIST
11. Use a spell checker in LED, or other LaTeX editors. Check your spelling
12. What is the significance of knowing *e*, the fundamental charge? Are you climbing a mountain just because it's there, or are there some other important ramifications to the field of physics once you identify that there is a fundamental charge?
13. In the Millikan Oil Drop experiment, plot $Q = ne$. You're measuring the charge, not the integer n. Ultimately, you are going to identify the progression of $n = 1, 2, 3, \ldots$; however, you should plot first what you measure, not necessarily the thing you're looking for. You should pretend that you're plotting this data (like Millikan did) without knowing *a priori* that $Q/e = 1, 2, 3, \ldots$

14. The Millikan Oil Drop is frequently repeated today. While it is becoming old technology (90+ years old), it is still very much in use today. Don't downplay that fact that this is old technology and that is why your measurements are not the quality they should be. If you think your measurement is limited by the fact that you are using "old technology," then describe a better way to improve the measurement. However, in this case, the equipment is plenty good to for making the observations you need to take. This is an experiment that requires a lot of patience, and also, collecting a lot of data can make the results more meaningful. Another example where we employ old technology for "cutting edge" physics experiments is interferometers (e.g., LIGO) even though the technology was developed a hundred years ago.
15. When measuring the terminal velocity (Millikan Oil Drop), did you determine the distance it should fall before reaching terminal velocity? To make a measurement of terminal velocity with $v_o=0$ at $t_o = 0$, doesn't make sense. STOP, and think about what you are doing!
16. Drop the same oil drop 10 times and measure $v \pm \delta v$. Plot the histogram of terminal velocities for one drop, and show how you calculated δv for one oil drop.
17. <u>Don't quote a measurement without an uncertainty</u>. Without the uncertainty, the reader has no idea whether or not your measurement is meaningful. The savvy reader will always calculate $\delta x/x$ in their mind in order to determine how significant your measurement is. If you do not quote the uncertainty, the reader has no choice but to conclude that the experimenter doesn't care about the quality of their measurements. At this point, the reader will left with the following question, "Why should I continue reading this paper if the experimenter does not care about the quality of their own measurements?" However, if the experimenter does a good job of describing their error analysis, the savvy reader can suggest ways to improve the measurements or the analysis. This kind of dialogue is a *rite of passage* to becoming part of the scientific community. Providing a clear error analysis also brings credibility to what you're doing.
18. No first-person plural or first person singular. No "I" or "we" or "my" or "our"
19. Labs are a great place to do a reality check of what you learn in class, or what you read in books. Do the sizes, speeds, and distances make sense?
    Radius = ($1.44 \times 10^{-11} \pm 5 \times 10^{-14}$) meters. Does that measurement make sense with the laboratory equipment you have on hand? A different question: "Is your measurement really that good?" $\delta r/r = 5 \times 10^{-14} / 1.44 \times 10^{-11} = 3.47 \times 10^{-3}$, or 0.347 %.
20. When you discuss errors, don't be vague. Be specific. If you think something of significance could have contributed to the error, estimate the magnitude. Determine whether or not the error is "systematic" or "random." Try to reduce the error in your measurement if you can.
21. Do some preliminary calculations during the two weeks that you're doing the experiment. This gives you enough time to repeat the measurements, and improve the quality of the measurements. Don't just take one set of measurements and think that you've finished the task. Think about how you can improve the measurements, and go back and take another set of measurements. Analyze all your measurements. Describe how your improved measurement method improved (hopefully) your results.
22. Don't start sentences with:
    Figure 1 shows . . . .
    Table 1 shows . . . .
    Equation 3 shows the relationship . . . . .
23. Helmholtz--Do you know the region over which the magnetic field is homogeneous? You should plot the magnetic field for a Helmholtz coil and show the region over which it is

uniform. Sounds like a job for Mathematica. Is it consistent with your measurement apparatus?
What about the light bending as it passes through the spherical bulb? Is that of any significance?

24. You should not cite a paper you haven't read (e.g., Millikan's paper from 1909). Did you really read it and understand what he did? Actually, you should be able to read Millikan's paper and understand it. Again, do not cite a paper you haven't taken the time to read.
25. Write your final results as (6.475 ± 0.154) $\times 10^{-7}$ m. Please use this form.
26. If you're quoting an accepted value from the NIST tables of physical constants, you can use the concise form → h = 6.626 070 040(81) $\times 10^{-34}$ J·s .
27. Avoid using equal signs in the text. For example, don't write "The voltage was set to $U_3 = 4.9$ volts."
28. Too much detail (e.g., tables of data) does not help to convey they thoughts you are trying to convey. For example, it would be more desirable (and more easily interpreted) if the data were <u>plotted in a figure</u> instead of <u>listed in a table</u>.
29. When you type physical quantities in the text, don't write it in text form:
    2.7637x10^9 C/Kg This is not very professional.
    Write it as an equation using $ . . . . $ in LaTeX 2.7637×10^9 C/kg .
30. Do not quote your measurements with more significant digits than you can justify. For example: h = (6.191 ± 0.01212) $\times 10^{-34}$ has some problems. Do you really know the first value to 4 significant digits? Do you really know the uncertainty to 4 significant digits. This should be written as: $h = (6.19 \pm 0.01) \times 10^{-34}$ J·s .
    Now, this raises another question. Do you believe the quality of your measurement is:

$$\frac{0.01}{6.19} = 0.16\% \quad ??$$

31. Using "double quotes" in LaTeX requires a minor modification. You must use two single left-side quotes (upper left-hand part of the keyboard, usually with the tilde ~ sign) in order to form the left side of the double-quote. Do something similar for the right-hand side: Use two single right-side quotes (usually the same key as the double quote on the right-side of the keyboard) to form the right side of the double-quote. Give it a try.
32. In most professional papers, the result(s) of your experiment should be quoted in (1) the abstract, in (2) the analysis, and finally (3) in the conclusions.
33. If you plot the error bars in your figures and they are truly too small to see, say this in the figure caption so the reader knows that you haven't ignore them.