TECHNICAL COMMUNICATION

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Why do engineers need to know how to write good technical memos/reports?

- Need to communicate with peers
  - Multi-disciplinary projects
- Lives can depend on clearly communicating technical information
  - See case studies from *Technical Writing Style* [1] on course website
  - Expert witness in court cases
- **TO GET A GOOD GRADE IN THIS CLASS!**

[1] D. Jones. 1998. *Technical Writing Style.* Boston: Allyn and Bacon.

AME20213 – Technical Memo/Report Grading Sheet

Specific Technical Writing Considerations:

1. All Variables/Symbols Identified in Text:		0	2
2. All Variable's Units Presented (in correct format):		0	2
3. Proper Number of Significant Figures:		0	2
4. Uncertainties for Every Measured and Predicted Value:		0	2
5. All Figures/Tables Explained in Text:		0	2
6. Numerical Results Presented in Proper Format:		0	2
7. Correct Format for Figure/Table Labels:		0	2
8. All Figure Axes Properly Labeled:		0	2
9. References in Proper Format:		0	2
10. Correct Grammar:		0	2
11. Correct Spelling:		0	2

Overall Considerations:

12. Proper Format and Content (see text for details):	0	2	4
13. Professional Appearance:	0	2	4

Technical Deliverables:

14. Background/Methodology Explained:	0	2	4
15. Appropriate Plots (presence and quality):	0	2	4
16. Uncertainty Calculations:	0	2	4
17. Comparison of Measured and Theoretical Values:	0	2	4
18. Scientifically Viable Conclusions/Discussion:	0	2	4

TOTAL POINTS: _____ /50

Comments:

Technical Writing

Memo

- 2 to 3 pages plus appendices
- Not comprehensive explanation of theoretical or experimental methods
- Includes Summary, Findings, References, and Appendices

Report

- Long enough to thoroughly explain topic
- Comprehensive presentation of a topic including background and methodology
- Includes Title Sheet, Abstract, Table of Contents, Introduction, Approach, Results, Discussion, Conclusions, References, and Appendices

Overall Considerations

Technical Writing in General

- Write technical documents in third person
- Use past tense throughout document
- Limit the length of sentences. Break long sentences into shorter ones.
- Segment ideas into paragraphs such that the reader is lead through the presentation in a smooth and effortless fashion.
- All pages numbered consecutively except cover sheet
- Use correct English. Be careful not to confuse things like “its” and “it’s” or “effect” and “affect”
- Punctuate equations like they were part of the sentence

Overall Considerations

Proper Format and Content

- All necessary sections included
- How well the information is organized
  - Where the plots are placed in the text
  - Transitions from one subject to another
- Appropriate material covered in each section
  - Includes Appendices
  - When in doubt, refer to text!

Sections of a Memo

- Summary
  - One paragraph long
  - Significant results and conclusions
  - **SELF CONTAINED!**
- Findings
  - Material necessary to support conclusions
  - Include most important plots/tables
  - Quality not quantity
- References (more details to come)
- Appendix
  - Supporting information not in body
  - For this class, appendices may be hand-written **IF they are neat and legible**

Overall Considerations

Proper Format and Content

Common Mistakes

- Not putting results in Summary/Abstract
- Putting overly detailed instructions when discussing methodology (no step-by-step instructions)
- Not presenting ranges of parameters or other important information about experiment
- Putting new or unsupported claims in Conclusion
- Putting raw data in Appendices without explanations
- Not including technical background for equations

Overall Considerations

Professional Appearance

- All technical documents should be typed
  - Pick a word processing software and **learn to use it effectively**
  - Need to know how to handle text, tables, figures, and equations
- Any sketches are neatly drawn
- Equations should not use “*” for multiplication and, in general, fractions should be oriented vertically
- Tables and Figures are well organized within text
- Could your tables/figures/equations appear in a textbook or journal article?

Specific Technical Writing Considerations

All Variables/Symbols Identified in Text

In the Bernoulli equation (Equation 1), *P* is pressure, *V* is velocity, and ρ is density.

Common Mistakes

- Using "y = mx+b" for a calibration equation but not saying what any of these variables mean
- Not defining common variables (e.g. *V*, for velocity)
- Using the same variable for two different things
- Not defining variables in appendices
- Not italicizing quantity symbols

Specific Technical Writing Considerations

All Variable's Units Presented (in correct format)

Proper Number of Significant Figures

Systems of Units

Table 2.1 Five systems of units (adapted from [2] and [3])

Quantity	International System (SI)	Absolute Metric System (CGS)	English Engineering System (EE)	Absolute English System (AE)	Technical English System (TE)
Length	meter (m)	centimeter (cm)	foot (ft)	foot (ft)	foot (ft)
Time	second (s)	second (s)	second (s)	second (s)	second (s)
Mass	kilogram (kg)	gram (g)	pound-mass (lbm)	pound-mass (lbm)	*slug*
Force	*newton* (N)	*dyne*	pound-force (lbf)	*poundal*	pound-force (lbf)
g_c	$1\ \frac{\text{kg} \cdot \text{m}}{\text{N} \cdot \text{s}^2}$	$1\ \frac{\text{g} \cdot \text{cm}}{\text{dyne} \cdot \text{s}^2}$	$32.174\ \frac{\text{lbm} \cdot \text{ft}}{\text{lbf} \cdot \text{s}^2}$	$1\ \frac{\text{lbm} \cdot \text{ft}}{\text{poundal} \cdot \text{s}^2}$	$1\ \frac{\text{slug} \cdot \text{ft}}{\text{lbf} \cdot \text{s}^2}$

Preferred

Inconsistent !

Still Used in US

Common Unit Mistakes

Use decimal prefixes with a number's units, keeping its numerical value between 0.1 and 1000, such as 1.05 MJ instead of either 1.05 x 10^6 J or 1.05E6 J

Avoid using unacceptable abbreviations such as sec for second, cc for cubic centimeter, l for liter or ppm for parts per million. For example, express 7 ppm as 7 μL/L.

Factor	Prefix	Symbol
10^{24}	yotta	Y
10^{21}	zeta	Z
10^{18}	exa	E
10^{15}	peta	P
10^{12}	tera	T
10^{9}	giga	G
10^{6}	mega	M
10^{3}	kilo	k
10^{2}	hecto	h
10^{1}	deka	da
10^{-1}	deci	d
10^{-2}	centi	c
10^{-3}	milli	m
10^{-6}	micro	μ
10^{-9}	nano	n
10^{-12}	pico	p
10^{-15}	femto	f
10^{-18}	atto	a
10^{-21}	zepto	z
10^{-24}	yocto	y

Table 2.3: Prefixes for Units

Rules of Significant Figures

- The **most-significant digit** (msd) is the leftmost, nonzero digit.

- The **least-significant digit** (lsd) is the rightmost, nonzero* digit.
  *IF there is a decimal point, then the lsd also includes zero.

- The **number of significant figures** equals the number of figures between and including the least-significant digit and the most-significant digit
- Do not use more significant figures than you are certain about!
  - Just because a computer program can produce 13 significant figures, that does not mean you should use all of them

How many significant figures are there in each of the following ?

10.5800 105800 10.58 010580.

Specific Technical Writing Considerations

Uncertainties for Every Measured and Predicted Value

All Figures and Tables Explained in Text

- Statements like “the calibration plot can be seen as Figure 1,” by themselves are **NOT** enough.
- Plots and tables in appendices should referenced in body

Specific Technical Writing Considerations

Numerical Results Presented in Proper Format

- Need to include value, uncertainty, and confidence
  - Confidence can be omitted if stated earlier in text
- For more than three digits on either side of the decimal point put a space (not comma)
- Make sure to put a space between the number and its units (this includes %)
- When expressing ranges of values, use “to” rather than “-”
- When quoting composite expressions (like volume) include units for each number (for example, 3 m x 4 m x 5 m)

Specific Technical Writing Considerations

Correct Format for Figure/Table Labels

- Labeled with a number in sequential order based on the order in which they appear in the text
- Different numbering for figures and tables
- Labels go **below** figures and **above** tables!
- Title should be a stand-alone description of the content of the table/figure
  - Informative
  - Concise

Specific Technical Writing Considerations

All Figure Axes Properly Labeled

- Quantity/Symbol
  - Do not spell out Greek letters (for example ρ not rho)
- Units in brackets or parentheses
- Include tick marks
- Labels big enough to be easily read

Specific Technical Writing Considerations

References in Proper Format

- Numbered in consecutive order
- Do **NOT** include any references that are not cited in the body of the memo/report
- Use format from *The Chicago Manual of Style* [1]

References

[1] 2003. *The Chicago Manual of Style,* 15th ed. Chicago: The University of Chicago Press.

Specific Technical Writing Considerations

Correct Grammar

Correct Spelling

Technical Deliverables

Background/Methodology Explained

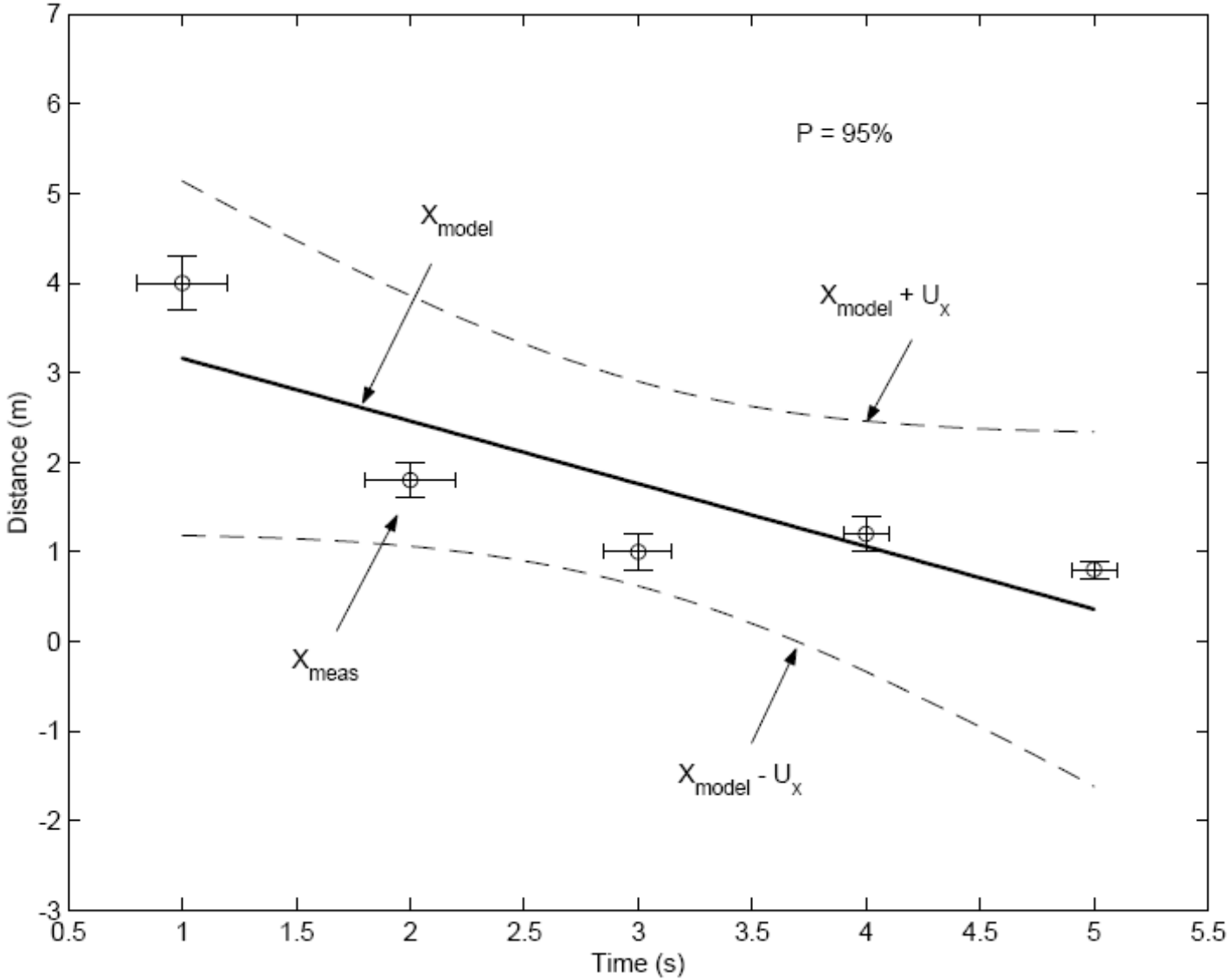
- Explained in enough detail so that an engineer at your level can critique your methodology
- State goals of the experiment
- Explain any important physics or governing equations
  - Do **NOT** copy and paste from handout

Technical Deliverables

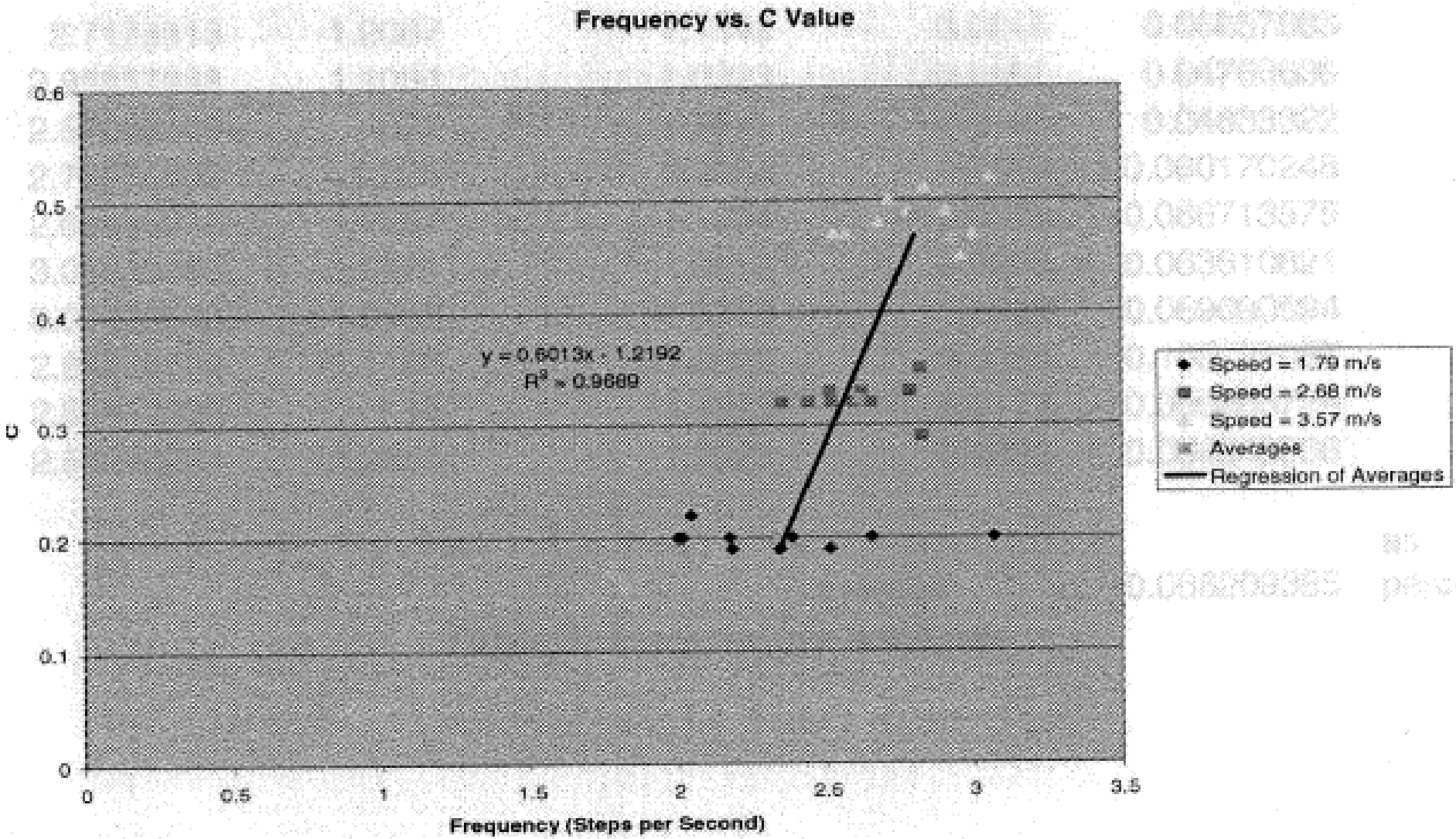
Appropriate Plots (presence and quality)

- Each lab will have different required plots (make sure to have them in your memo/report)
- **If all plots are present, but the formatting is extremely bad a score of zero will be given!**

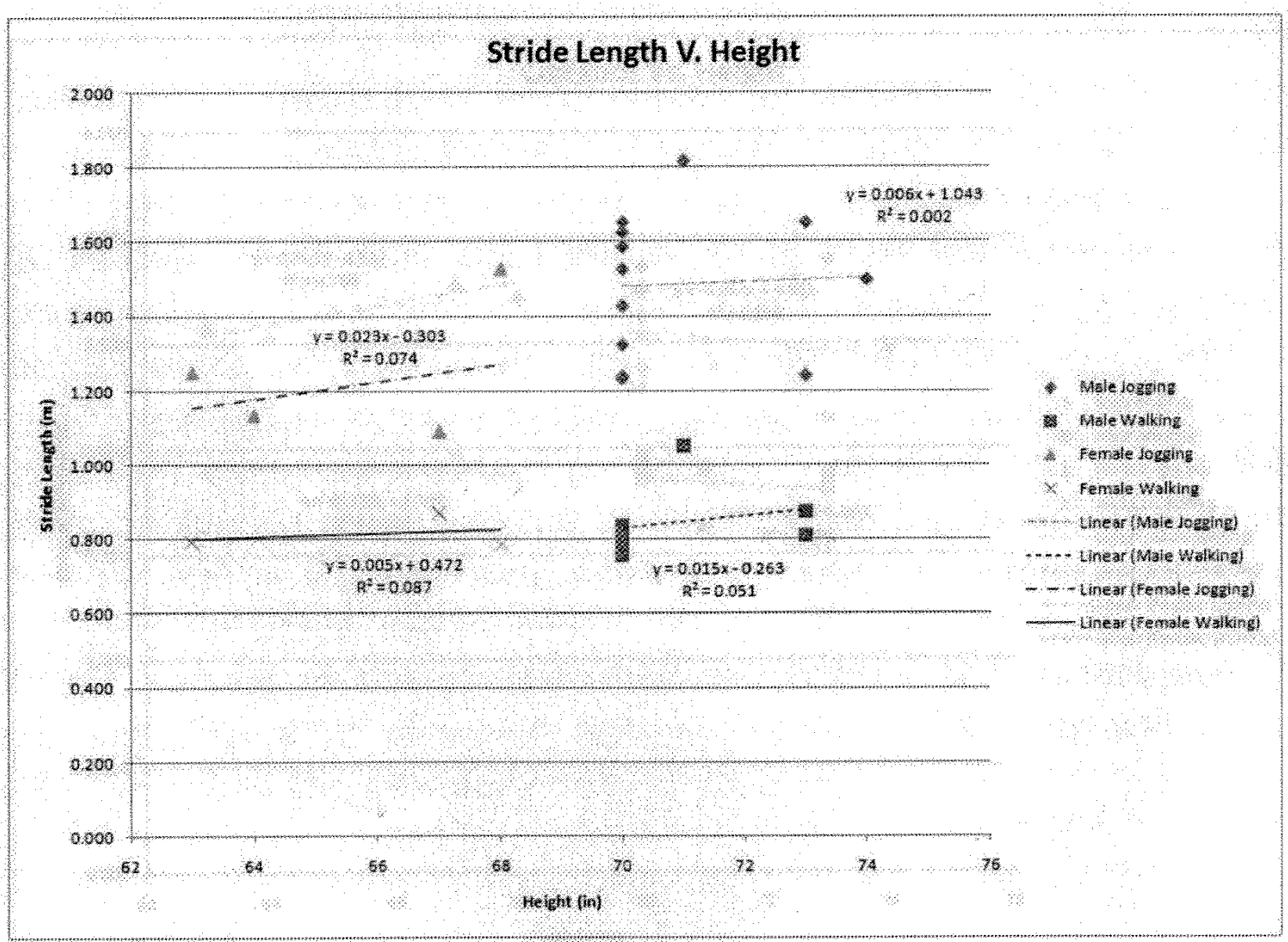
Good Plot


P = 95%
X_{model}
$X_{model} + U_x$
X_{meas}
$X_{model} - U_x$
Distance (m)
Time (s)
7
6
5
4
3
2
1
0
-1
-2
-3
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
5.5

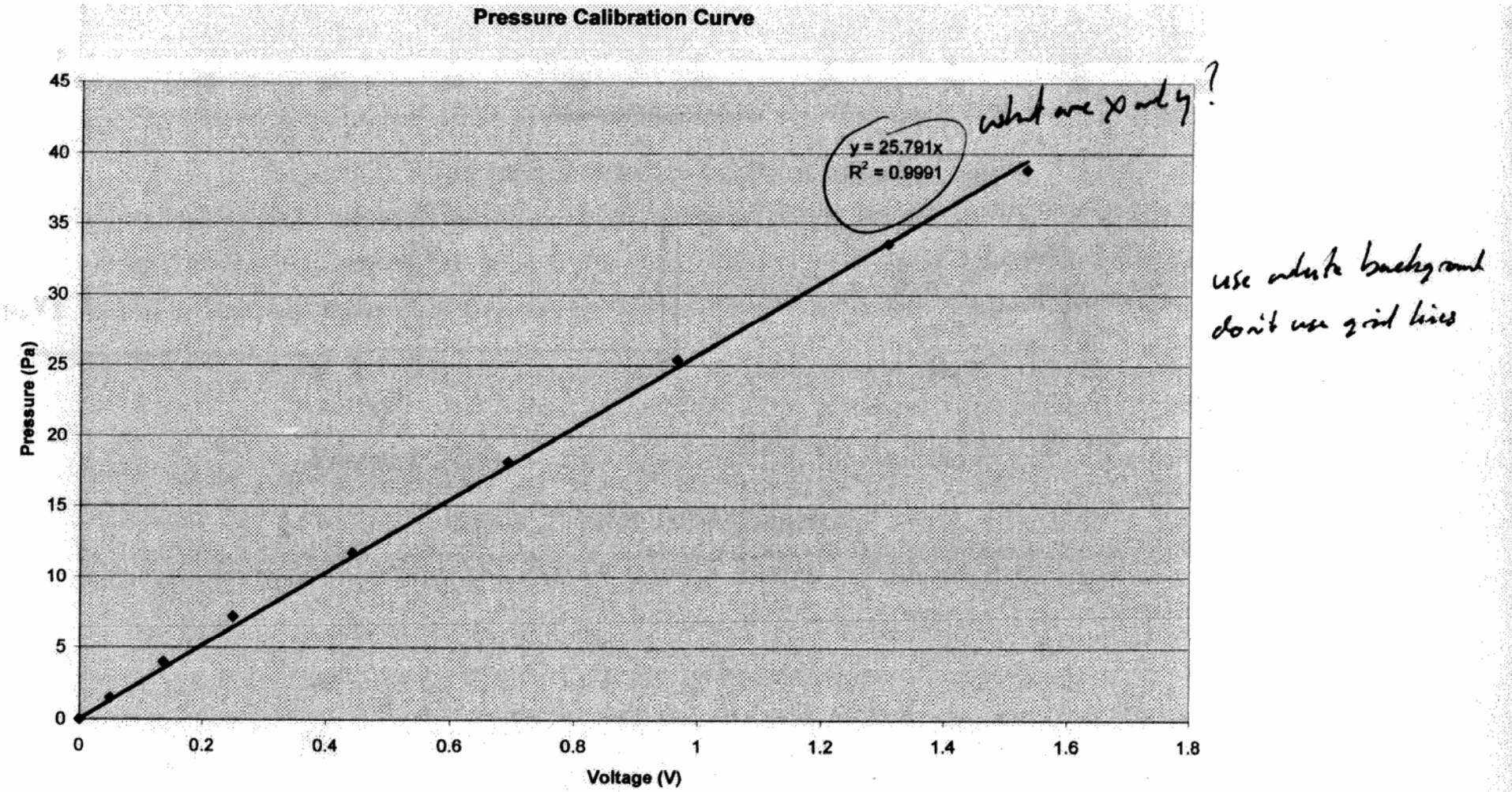
Incorrect Plot



Incorrect Plot



Incorrect Plot



Technical Deliverables

Uncertainty Calculations

- You will need to do uncertainty calculations for all of the labs
- Calculations should be placed in Appendix
- Should be easy to follow logic
- All rules about units and variable description used for body of memo/report apply to Appendix!
- Include how uncertainties were found (for example, resolution of certain equipment display)
- Useful to see how each source of uncertainty affect overall uncertainty

Technical Deliverables

Comparison of Measured and Theoretical Values

- You will be asked to compare measured and theoretical values frequently
- Use quantitative comparisons
  - X and Y differed by Z %
- **Do NOT use words such as “good”, “reasonable”, “acceptable”, or “significant”!**
- You can talk about values being within measurement uncertainties
- No **quantitative** comparison will receive a score of zero for this section

Technical Deliverables

Scientifically Viable Conclusions/Discussion

- Did measurements and theoretical results agree?
- If results did not agree give an explanation why
  - **“Human error” or “uncertainty in the measurements” are *NOT* acceptable explanations**
  - Back up with simple sample calculations
- Must have scientific merit!
  - No conspiracy theories
  - Viscous effects of air will not significantly affect the natural frequency of a vibrating beam

Technical Deliverables

Scientifically Viable Conclusions/Discussion

- Summary of what was accomplished in the lab
  - Include major findings
  - Do not discus anything new or make any new assertions
- If uncertainty is high, suggest ways to reduce it
  - Concentrate on greatest sources of uncertainty
- What did you learn during this lab?

Closing Comments

- Technical writing is a learned skill that takes practice
- Good technical writing is difficult
- Chapter 3 in textbook is an excellent resource (check it often when writing)
- The grading sheet should help in writing a good memo/report

Appendix

Format Mistakes “Quiz”

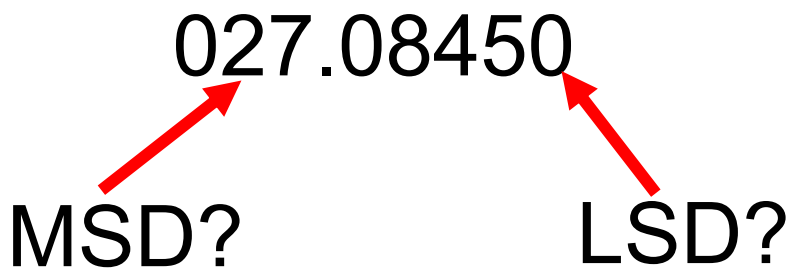
- Identify any format errors in the following.
- 2 – 3 m/sec 2 m/s to 3 m/s
- 42% 42 %
- Body temperature, T, equals 98.6*ºF*. *T* 98.6 ºF
- 1 x 10^{-4} J 0.1 mJ
- One ft. equals 12 in. exactly. ft
- 25,233º 25 233º
- 4000 ppm 4 mL/L or 4 mg/g …

Rules for Number Round Off

- To round off a number, truncate the number to its desired length and make the remainder a decimal fraction

- If the fraction > ½, round up the number's lsd
- If the fraction < ½. leave the number's lsd as is
- If the fraction = ½, round up the lsd IF it is odd

How Many Significant Figures ?



Number of significant figures = 7

Rounded off to 5 significant figures = 27.084

Some Interesting Units

- Guess the common units for the following

Amount of seed to sow an acre of ground bushel

Distance from head to wrist ell

Distance an arrow would fly bowshot

Distance walked on foot in 1 hour foot-hour

Distance a shout would carry houpée (French)

Distance seen when squatting beneath a horse 2 miles

Distance you can see to the horizon in miles $1.23\sqrt{\Delta h(ft)}$