



Technical Writing For Engineers

Larry Baxter
Brigham Young University



Outline



- **Why Write?**
- **Mechanics**
 - Outlines
 - Paragraphs
- **Punctuation, grammar**
 - Variety of common grammatical errors
 - Colons, dashes, etc.
- **Style**
 - Concise writing
 - Active vs. passive structures
 - Tense



Writing Is Essential



- **Utilitarian aspects**

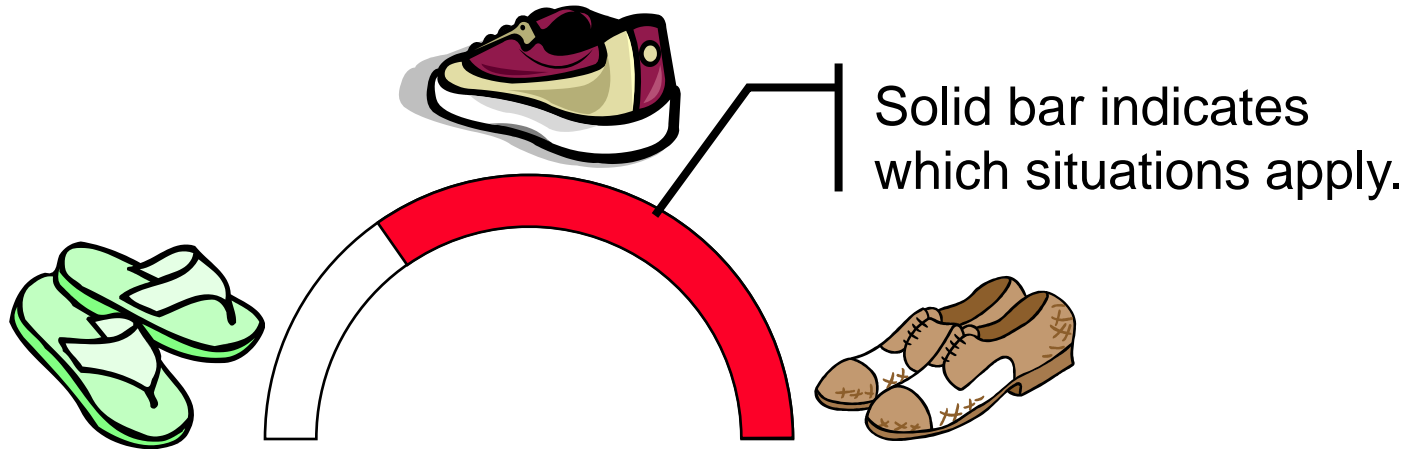
- May be the single most important skill you develop.
- Huge impact on your professional career.
- Engineers are (and must be) excellent writers.

- **Gratification aspects**

- Lifelong activity.
- Permeates all aspects of life.
- Enhances reading, speaking, and all aspects of communication.



Rules Depend on Your Shoes



- Casual (sandals): Even old friends cringe when you violate rules at this level. However, communicating as if wearing wingtips when actually wearing sandals may also represent poor form.
- Informal (tennis shoes): These rules are important for informal communication with clients or managers and first discussions with colleagues.
- Formal (wingtips): These rules are important for formal communication, official or archival documents, messages to the king, and similar situations. This category includes rules important in all other categories.



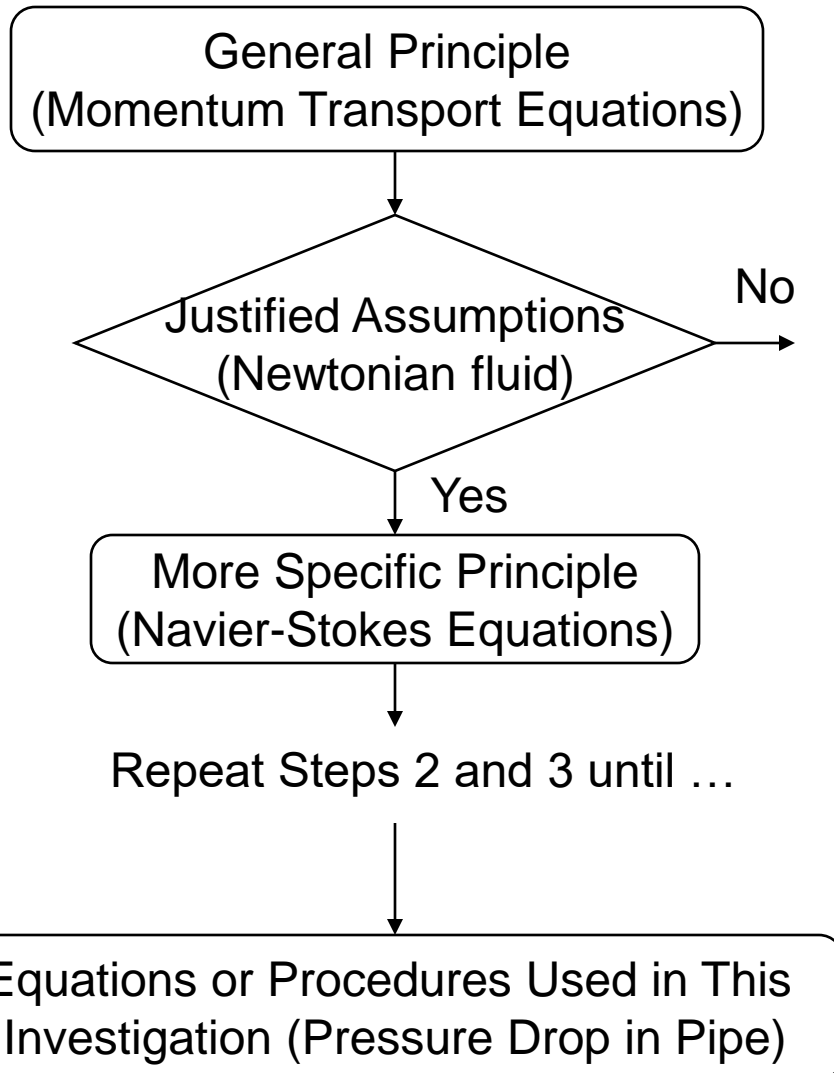
Poor and Better Writing



- ☺ The bullet symbol appearing on this line represents improved or good examples of usage. If you have Arial font installed, it should be a smiling face.
- ☹ The bullet symbol appearing on this line represents poor or worse examples of usage. If you have Arial font installed, it should be a frowning face.



Logic Flow: Deductive Reasoning

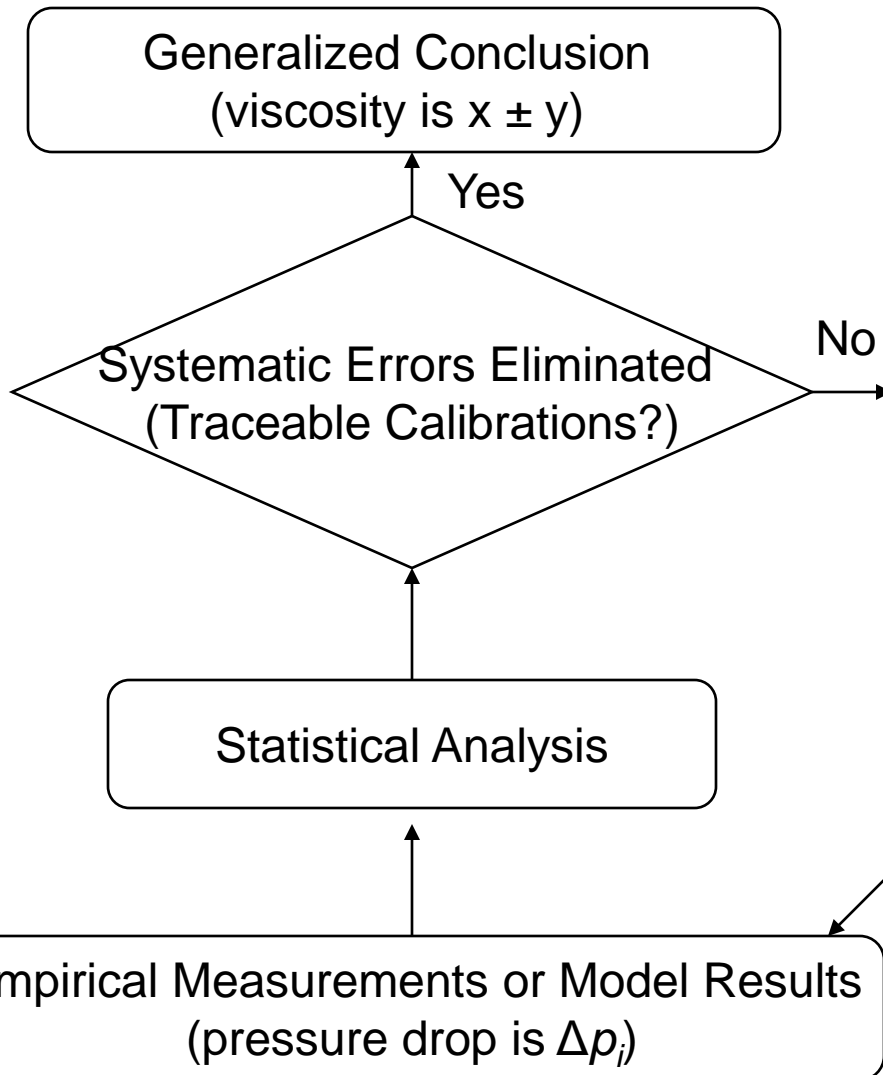


Deductive reasoning – all assumptions are clear and logically lead to equations or procedures used for analysis. Author should be aware of all of them. Critical or less obvious ones should be justified in text.

This section of the report can and should be written prior to doing experiments.



Logic Flow: Inductive Reasoning



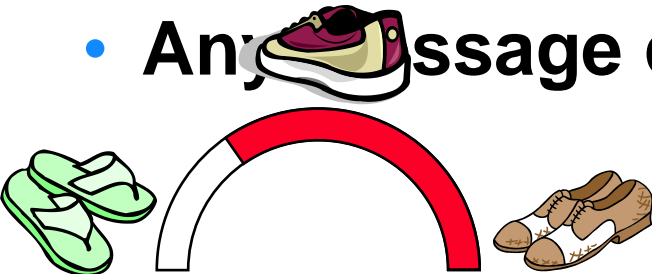
Inductive reasoning – statistically valid generalizations about your objective based on measurements.



Use Available Tools



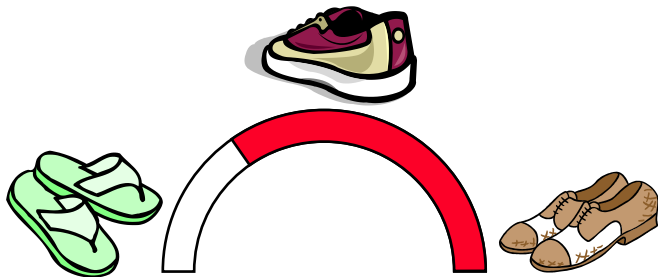
- Write and organize an outline first. (Use Outline feature of MS Word or other programs).
- Outline your paper to the paragraph level.
- Structure paragraphs (topic sentence, etc.).
- Pay attention to grammar, style, and mechanics. Red and green underlines in MS Word (or other programs) are useful and generally accurate.
- First drafts are rarely acceptable as final drafts.
- Any message can be presented in any length.



General Guidelines



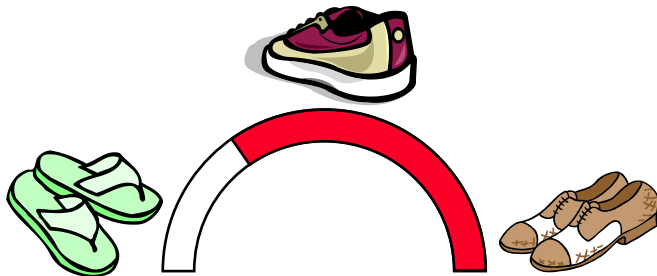
- **Be direct.**
- **Be specific.**
- **Be concise.**
- **Use active voice and present tense when appropriate.**



Structure of a Paragraph



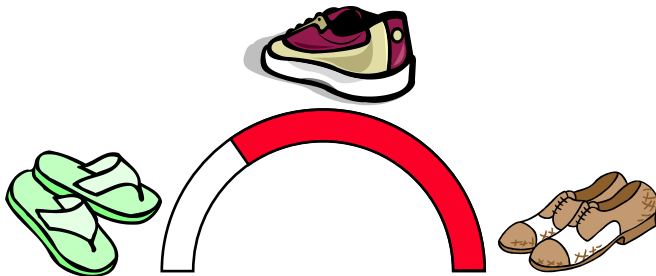
- Paragraphs should (generally) start with a topic sentence.
- Everything in the paragraph should support the topic sentence.
- Long paragraphs should end with a summary sentence.



Elements of Critical Thinking



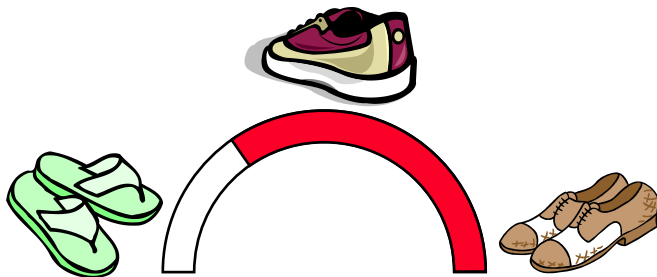
- **Start with and recognize premise and assumptions.**
- **Develop ideas consciously using both deductive and inductive reasoning.**
- **Don't advocate or advertise; Just report and comment.**
- **Self-critical analysis is essential.**



Problems with Verbs



- Subject-verb agreement
- Misuse of verb
- Tense, mood, voice



Grammar: Terminal Prepositions



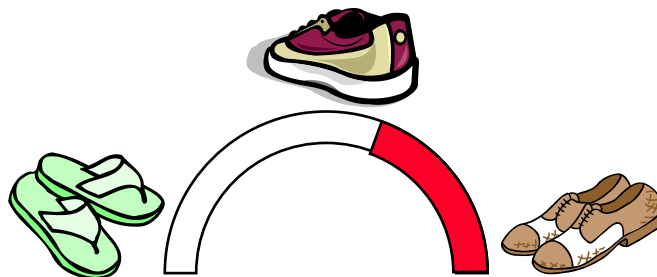
- **Ending with Prepositions**

☹️ The computer did not know where the signal was at.

😊 The computer did not know where the signal was. (The computer could not sense the signal.)

☹️ We did not know who to give the report to.

😊 We did not know to whom the report should be given.



Grammar: Agreement in Number



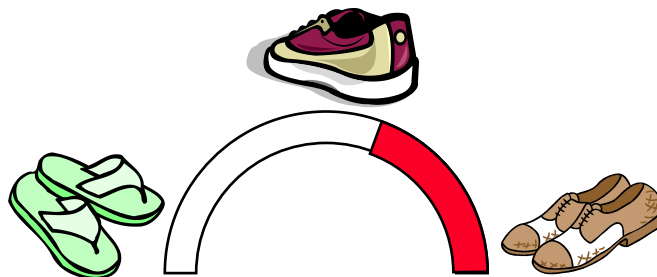
- Inconsistency in number is possibly the single most common error of capable writers.

☹️ Everyone please take their seat.

😊 Everyone please take his or her seat.

☹️ Each of the valves opened at their designated times.

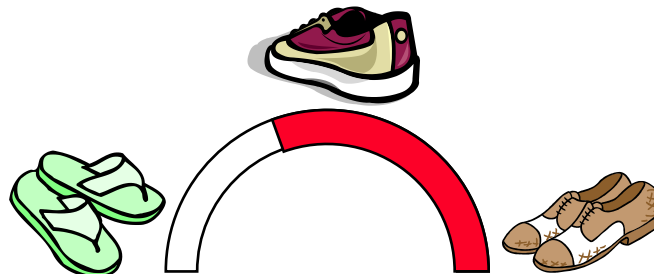
😊 Each of the valves opened at its designated time.



Grammar: Hyphens



- ☺ The high-temperature tank ruptured.
- ☺ The twenty-five-meter pipe.
- ☺ The blue-green fluid leaked. (compound adjective in this case)
OR
The leaking fluid was blue green. (predicate modifier in this case and is not hyphenated)
- ☺ The six- or eight-bit A/D converter.
- ☺ The *in situ* analysis indicates poor mixing. (no hyphen)



Grammar: Dashes



- Many dashes and one hyphen. We focus on three: em dash (2x hyphen) —; en dash (1.5x hyphen) –; hyphen (the one on the keyboard) -.
- MS Word provides these under Insert/Symbol/Special Characters
- Em dash is most common (other than hyphen) and can also be formed by two repeated hyphens surrounded by words or by Ctrl Alt Num- (Num- is the minus sign on keypad).
- Em dash replaces commas and sometimes colons
 - Steady state—if it exists at all—was not achieved during these experiments.
- En dash separates numbers (but words are generally preferred) and is formed from Ctrl Num-.
 - The 45–105 °C temperature range.



Grammar: Units



- The National Institute of Standards and Technology, NIST, is the US representative to the SI and similar committees and has an extensive list of rules for units. See file on website. A few common issues:
 - Abbreviated units that derive from people's names are capitalized (but spelled out units are not).
 - V, K, and kg; volt, kelvin, and kilogram but degrees Celcius
 - Celcius (not centigrade), Fahrenheit, and Rankine degrees have degree symbols as part of the letter (space between number and degree symbol, not between degree and letter). Kelvin does not use degree symbol, nor do you say degree (3 kelvins, not 3 degrees Kelvin).
 - 45 °C, not 45° C, 68 °F, 512 °R, 325 K
 - 45° is an angle, not a temperature.
 - Values and units are not hyphenated when used as adjectives unless they are spelled out.
 - 3 mm tube or three-millimeter tube, but not 3-mm tube.



SI Base Units



quantity	quantity symbol	dimension	SI unit	SI unit symbol
length	l	L	meter	m
mass	m	M	kilogram	kg
time	t	T	second	s
electric current	I	I	ampere	A
thermodynamic temperature	T	Θ	kelvin	K (not °K)
amount of substance	n	N	mole	mol (not mole)
luminous intensity	I_V	J	candela	cd



Relevant Special Derived Units



Derived Quantity	Special Name	Special Symbol	Expression in other SI units	Expression in SI base units
plane angle	radian	rad		$m m^{-1} = 1$
solid angle	steradian	sr		$m^2 m^{-2} = 1$
frequency	hertz	Hz		s^{-1}
force	newton	N		$kg m s^{-2}$
pressure	pascal	Pa	N/m^2	$kg m^{-1} s^{-2}$
energy	joule	J	$N m$	$kg m^2 s^{-2}$
power	watt	W	J/s	$kg m^2 s^{-3}$
Celcius temperature	degree Celcius	$^{\circ}C$		K



Units Accepted for Use With SI



	Name	Symbol	Value in SI units
time	minute	min	1 min = 60 s
	hour	h	1 h = 60 min = 3600 s
	day	d	1 d = 24 h = 86 400 s
plane angle	degree	°	1° = $(\pi/180)$ rad
	minute	'	1' = $(1/60)$ ° = $(\pi/10\,800)$ rad
	second	"	1" = $(1/60)'$ = $(\pi/648\,000)$ rad
	liter	l, L ^a	1 L = 1 dm ³ = 10 ⁻³ m ³
	metric ton ^b	t	1 t = 10 ³ kg

^aL is accepted to avoid confusion of lower-case l with the number 1. Script l, ℓ, is not accepted.

^bThis quantity is commonly designated tonne in other countries, but metric ton is the official US designation.



Units Not Accepted for SI



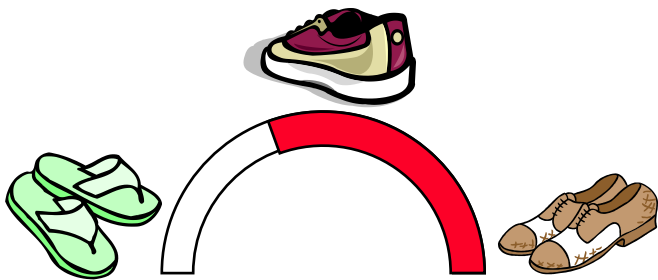
- **Outdated CGS units.**
 - **Viscosity:** SI units Pa s should be used in place of poise, P (1 P = 0.1 Pa s).
 - **Kinematic viscosity;** SI units m^2/s should be used in place of stokes, St (1 St = $10^{-4} \text{ m}^2/\text{s}$).
 - **Length:** SI unit meter or micrometer should be used in place of micron (μ). However, micrometer (μm) is fully accepted – and the ångstrom (1 Å = 0.1 nm), nautical mile (1 nautical mile = 1852 m) and the knot (1 knot = 1 nautical mile/s = 1852 m/3600 s) are temporarily accepted.
- **Outdated miscellaneous units.**
 - **Pressure:** SI unit Pa should be used rather than torr (1 torr = 101 325/760 Pa) or atmosphere (1 atm = 101 325 Pa). However, the bar (1 bar = 100 000 Pa) is temporarily accepted.



Grammar: Perform a Which Hunt



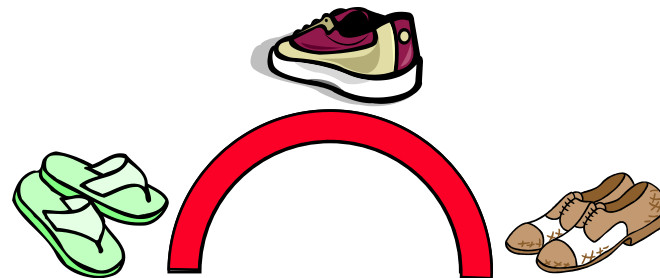
- ☹️ The pump which malfunctioned had a bad seal.
- 😊 The pump that malfunctioned had a bad seal.
- 😊 German, which language I speak, has many (six I believe) words for “you.”



Grammar: Case and Tense Matter



- ☺ The assignment came to me and my partner (not my partner and I).
- ☺ My instructor told me he was most impressed.
- ☺ The two major contributors were my partner and I (not me and my partner).
- ☺ The author of this report was I (not me).
- ☺ The data fit a straight line and are consistent with first-order kinetics.

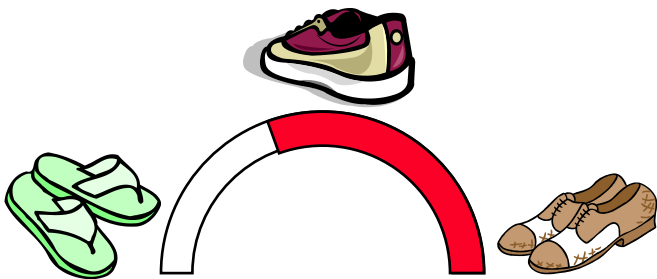


Grammar: Dangling Constructions



- **Ensure the subject of introductory sentences agrees with that of the remainder of the sentence.**
 - ☹️ **Having studied the costs, several questions arise.**
 - 😊 **Having studied the costs, we posed the following questions.**

 - ☹️ **To obtain more precise data, surrogate chemicals were used.**
 - 😊 **To obtain more precise data, investigators used surrogate chemicals.**



Grammar: Avoid Split Infinitives

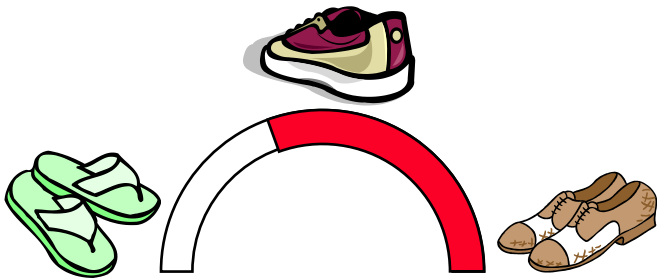


☹️ The coal was able to barely burn.

😊 The coal was barely able to burn.

☹️ The tank was too cold for the reaction to significantly proceed.

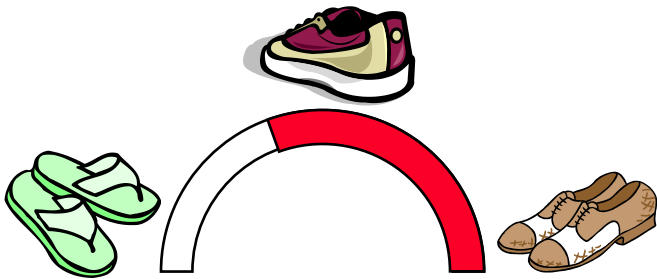
😊 The tank was too cold for the reaction to proceed significantly.



Less Is More



- **Wordiness represents a constant challenge.**
- **Concise sentences and terms have more impact and hold interest.**
- **Concise writing requires significant rewriting.**



Conciseness Tips



- Useless phrases.

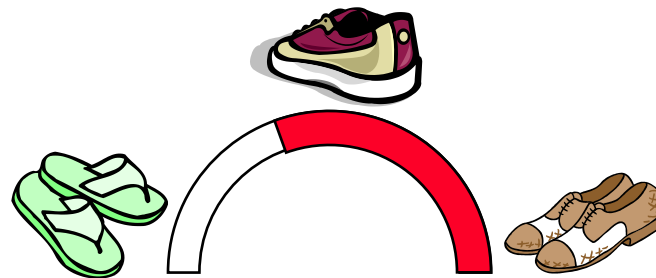
- ☹️ There was an increase in temperature.

- 😊 The temperature increased (changed from 75 °C to 100 °C).

- Redundant words.

- ☹️ The time-temperature history of the particle appears in the figure.

- 😊 The particle temperature history appears in the figure.



Conciseness Tips



- **Non-essential Relative Clauses**

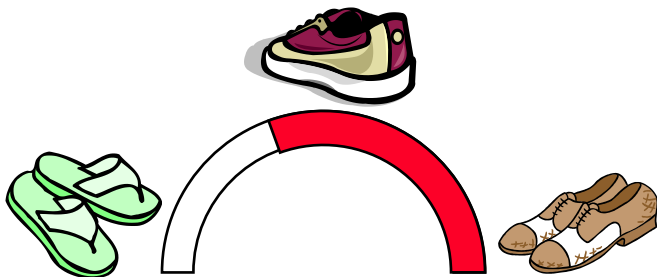
- ☹️ The wires that come from the thermocouple that is in the distillation column require rerouting.

- 😊 The distillation column thermocouple leads require rerouting.

- **Unnecessary Prepositions**

- ☹️ The reading of the temperature meter for the hot tank was 214 °C.

- 😊 The hot-tank temperature meter read 214 °C.



Conciseness Tips



- **Empty Prepositional Phrases**

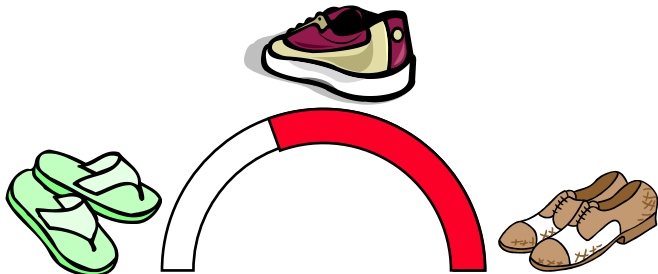
- ☹️ **Students are required by the university to make payments of their fees at the time of registration.**

- 😊 **The university requires students to pay registration fees.**

- **Vagueness**

- ☹️ **Many students feel anxiety stress when they find themselves in a testing situation.**

- 😊 **Exams make many students nervous (or anxious).**



Conciseness Tips



- **Unnecessary qualifiers**

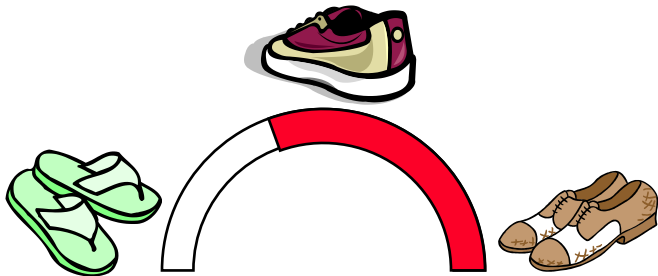
- ☹️ It should be noted that the reactor was hot.

- 😊 The reactor was hot.

- **Indirect references**

- ☹️ The professor in my section of the Unit Operations Laboratory class graded the report.

- 😊 Br. Baxter graded the report.



Conciseness Tips



- **Minimize prepositions**

- ☹️ The temperature of the fluid increased rapidly.

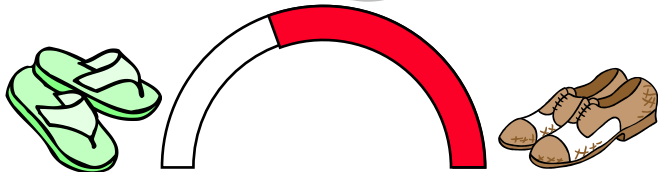
- 😊 The fluid temperature increased rapidly.

- **Especially avoid preposition strings**

- ☹️ The concentration of benzene in the fluid outside of the tank exceeded EPA limits.

- 😊 The benzene concentration in the external fluid exceeded EPA limits.

- 😊 The external-fluid benzene concentration exceeded EPA  limits.



International Issues



- **American and British (German & French) define billion and larger numbers differently**
 - **US: million = 10^6 ; billion = 10^9 ; trillion = 10^{12} ; ... centillion = 10^{303}**
 - **UK: million = 10^6 ; billion = 10^{12} ; trillion = 10^{18} ; ... centillion = 10^{600}**
 - **Conclusion: don't use words for numbers greater than a million (use SI-style designations).**
- **Commas commonly appear in numbers reported from overseas where US practice is to use decimal points**
 - **45,249.69895 in the US is 45 249,698 995 in many other places.**
 - **Resolution: use an en space to separate numbers into groups of three and use the decimal point as usual. The number above is best represented as, 45 249.698 995. However, 8,143.2347 is 8143.2347. If you see 45 249,698 995 recognize it as a (probably European) version of 45 249.698 995.**



Use Symbols Accurately



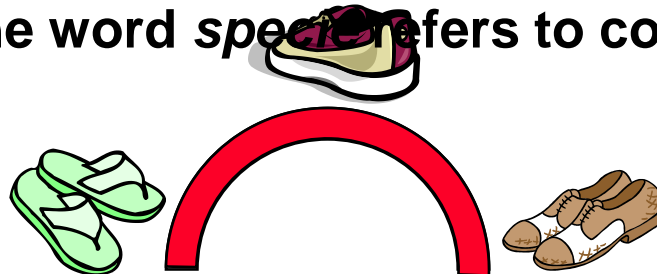
\approx	<i>proportional</i>
$\approx\approx$	<i>approximately equal</i>
\equiv	<i>equal by definition</i>
\ln	<i>natural logarithm</i>
\lg or \log	<i>base 10 logarithm</i>



Plurals and Other s Problems



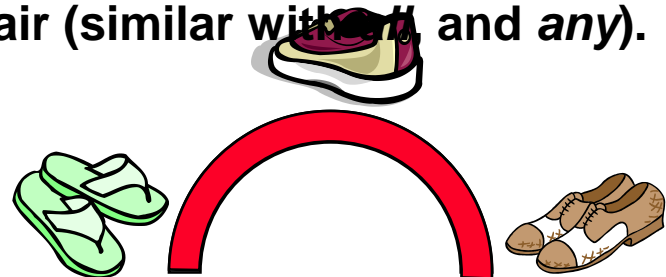
- ***It's* means it is. *Its* means belonging to it.**
 - ☺ It's rare that the level exceeds its upper control limit.
- **The primary noun in titles and similar compound words receives an s when plural.**
 - ☺ Heats of formation, not heat of formations.
 - ☺ Points of view, not point of views (but better is viewpoints)
- **Some plurals depend on meaning**
 - ☺ Books have indexes. Numbers and variables have indices
 - ☺ Some institutions (*Chicago Manual of Style*) prefer appendixes rather than appendices for material at the end of books – consistent with indexes.
 - ☺ A single chemical species. (The word *species* refers to coinage, not chemicals).



Subject Verb Agreement



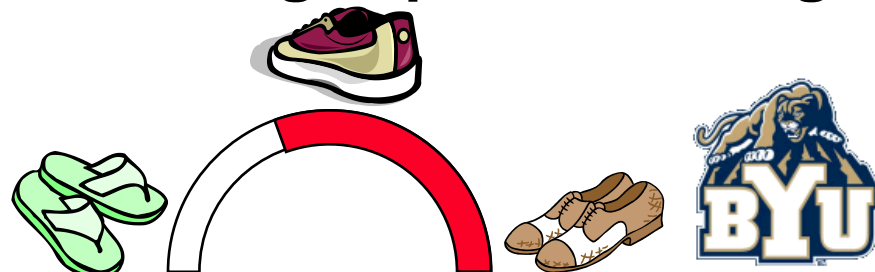
- Subject-verb agreement requires attention, particularly when the subject and verb are separated by other words.
 - ☺ The thermocouples wired to the A/D board indicate reactor status.
- Compound subjects linked by *and* generally require plural verbs.
 - ☺ Temperature and, for non-ideal gases, pressure influence gas enthalpy.
- Compound subjects linked by *or* generally require verbs matching the closest noun.
 - ☺ A higher reflux ratio or two additional stages produce column performance within specifications.
 - ☺ Two additional stages or a higher reflux ratio produces column performance within specifications.
- Indefinite pronouns generally require singular verbs.
 - ☺ Each of the experiments requires 10 kg of solvent.
 - ☺ But: Some of the experiments require hours to conduct.
 - ☺ Some of the reagent reacts with the air (similar with *all* and *any*).



Active Verbs



- Forms of the verb *to be* convey no action, often leading to weak sentences.
 - ☹️ A loose connection was responsible for voltage spikes that melted the power supply.
- Passive verbs focus on what is acted upon rather than the actor.
 - ☹️ The power supply was melted by voltage spikes that were caused by a loose connection.
- Active verbs concisely convey meaning directly.
 - 😊 A loose connection generated voltage spikes, melting the power supply.



Some Reference Books



- Grossman, John, 1993, *The Chicago Manual of Style : The Essential Guide for Writers, Editors, and Publishers (14th Edition)*, 921 pages
- Strunk, W. Jr., E. B. White, 2000, “*The Elements of Style*,” 4th Edition
- Turabian, K., 1996, “*A Manual for Writers of Term Papers, Theses, and Dissertations*,”



Verbs



- **Subject-verb agreement – intervening words – match verb to subject, not the closest noun**
 - ☺ High levels of air pollution damage the respiratory tract.
 - ☺ A full set of weights costs five-hundred dollars.
 - ☺ The reaction rate expression, together with its parameters, appears in Table 1. (similarly, phrases beginning with *as well as*, *in addition to*, *accompanied by*, and *along with* do not make a singular noun plural).



Verbs



- **Subject-verb agreement – compound subjects – *and* usually forms a plural subject where as *or, nor, either...or*, etc. form subjects consistent with the noun closest to the verb.**



Capitalization



- Names of specific items generally are capitalized.
 - ☹️ The Constitution (if US constitution is implied) describes three branches of government.
 - 😊 The constitution (if any generic constitution is implied) describes elections of officers campus organizations.
 - 😊 Figure 7 illustrates model predictions base on Equation 9.
 - 😊 The figure illustrates model predictions based on this equation.

