The Checklist (Secrets of a Job Well Done)

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ABSTRACT: This is written from the POV of someone taking a team take-home exam. Most points are valid for in-class math essays, as well.

A pilot goes through a detailed checklist (*Fuel? Ailerons work?*) before taking off —this helps to prevent crashes. Here is a checklist that you should use for each of the Take-home exams.

You, speaking to me

I've carefully thought about what each of the following paragraphs mean. I, and each of my team-mates, have checked that the exam we are about to hand-in jibes with the paragraphs below.

I understand that if I disagree with a team-mate's solution, then I can write my own "dissenting opinion", which will be graded separately. (jk: I've never had a student do this, but the opportunity is there.)

Mechanics. **Ch$_1$** I've signed the honor code. (Each team member signs.) *Each member* of my team has a *complete copy* (paper) of the hand-in, including diagrams, computer data,...

Ch$_2$ Essays are typed, triple-spaced, so that my prof. can write easily between the lines.

Ch$_3$ My hand-in is assembled as: PROBLEM SHEET, TYPOGRAPHY SHEET (if needed), 1st essay, 2nd essay,.... [Please do not put a cover on your exam; just securely staple it together, with the Problem Sheet **first**!.]

My writeup for each essay problem starts on a new sheet of paper. (I may use both sides of each sheet, or only the front side.) All pages –including diagram pages– are numbered consecutively [probably by hand] as *Page 3 of 23* or *P.3/23*. [The problem sheet is page 1.]

Figures are interspersed with the text pages that refer to them, i.e, if Figure A is first referred to on page 3, then the figure should *be* page 2 or page 4 or should appear on page 3.

Ch$_4$ My hand-in is solidly *stapled* in such a way that my aging prof. with poor eyesight can easily read everything without taking the writeup apart. (Please put the staples vertically, in the upper lefthand corner.) Where I have written symbols by hand, they are large and clear.

Notation and Mathematics. **Ch$_5$** If I use notation which is *different* from that used in class, then I have included a TYPOGRAPHY SHEET explaining it. (However, notation which is specific to an essay, should be at the beginning of that essay.) For example, I might write:

"We use underbar to indicate subscripts e.g, 'x_2' and 'x_{n+1}' for x_2 and x_{n+1}. Similarly, we use caret to indicate superscripts e.g, 'x^2' and 'x^{n+1}' for x^2 and x^{n+1}. Analogously, we use 'int_{a+1}^{2b} f(x) dx' to indicate $\int_{a+1}^{2b} f(x)\,dx$. For the gradient, ∇g, we type '&g'."

Ch$_6$ I have written expressions **unambiguously**, e.g, for the expression "$1/a+b$" I bracket it either $[1/a]+b$ or $1/[a+b]$, depending on my meaning. Similarly, I write function application *using parentheses*, e.g: $\sin(x)$, $\arctan(y)$, $\log(z)$, $\log_7(x)$, $\exp(x)$, $\mathrm{Dom}(f)$, $\mathrm{CoDom}(f)$, $\mathrm{Range}(f)$, $\mathrm{Area}(E)$. But I use *brackets, for grouping*. E.g

$$z[x+y]$$

means that I, Student, am *multiplying* z by $[x+y]$; which might be better written as $z\cdot[x+y]$. But

$$z(x+y)$$

means that z is a function and I am *evaluating* this fnc at $[x+y]$.

To avoid ambiguity, I, Student, write the evaluation symbol *with* the name of the variable. I do *not* write $\boxed{x\cdot\cos(z)\big|_5^7}$, asking my poor prof. to guess whether I mean $x\cdot\cos(\beta)\big|_{\beta=5}^{\beta=7}$ **or** $x\cdot\cos(\beta)\big|_{x=5}^{x=7}$. Similarly, I have not forgotten to write the *infinitesimal* in integrals e.g, I write "$\int x\cdot\cos(\beta)\,d\beta$" or "$\int x\cdot\cos(\beta)\,dx$", depending on what I mean, but I do **not** write "$\int x\cdot\cos(\beta)$".

Ch$_7$ I, Student, do not confound uppercase and lowercase letters; if I mean "n", then I have not written "N". When I use Greek letters, I write/type them so they are not confounded with Roman letters, e.g, "a" is not the Greek letter "α" (alpha).

Ch8 Trigonometric functions are written using radian measure. Also, I have not written the oxymoron "$\sin^{-1}$" when I mean "arcsin". (sin is not 1-to-1 and so **does not have** an inverse function. The arcsin fnc is the inverse of a *restriction* of sin.)

Exposition. [*Prof K.: Although much of what is said next seems obvious, please reflect upon it.*]

Ch9 Whenever *I, Student*, use a new symbol [a symbol already appearing in the problem statement is not *new*] in my essay, then I have defined it explicitly, e.g, "Let v denote the volume of the parallelepiped P" or "Let $v(t)$ be the velocity of the spaceship at time t."

Moreover, my sentence is specific: The sentence "Let d denote the distance from the centroid to the line." is good, but I write the better sentence

> *"Let d denote the* ***perpendicular*** *distance from the centroid of the region R_6 to the line L_2."*

In order to define quantities, when it is helpful (and it usually is...) I have used a *carefully drawn and labeled picture*, in addition to a clear sentence. The picture is LARGE (typically, a full page), as is all the writing on it. I include a detailed caption so that the reader knows *what this is a picture of* and what all of the labeled quantities *mean*. I realize that a careful and consistent use of colors may make my image more easily comprehended.

Ch10 I have used the right word for each concept. An example:

> *France's greatest lexicographer, Emile Littré, was once found by his wife in flagrante delicto –and in the conjugal bedroom no less– with their housemaid.*
> *"Emile", cried Mrs. Littré, "I am surprised!"*
> *"No, my dear," replied the erring lexicographer calmly.*
> *"You are astonished. It is we who are surprised."*

I do not confound these words: function, equation, graph, formula, coefficient, inequality —I realize that these mean different things and I take the time to choose the correct word.

Ch11 I have not used a comma to mean "then"! Instead of writing "If $x = 0$, $y = 5$, $z = 2$" I make the correct choice between "If $x = 0$ and $y = 5$, then $z = 2$" and "If $x = 0$ then $y = 5$ and $z = 2$". Similarly, instead of "When $a > 0$, $b < 5$." I write (something like) "Whenever $a > 0$, then $b < 5$."

Ch12 I have not written "Thus x would be 3" when I mean "Thus x is 3" or (probably better) "Thus x equals 3". I have used the conditional mode only when I am doing an *argument by contradiction*, e.g, "Suppose, for the sake of contradiction, that the cannonball doesn't have sufficient energy to hit the wall. Then θ would exceed $\pi/4$ and so x would be 3. But x is negative. Thus the cannonball did indeed hit the wall."

Ch13 Each of my essays starts with an announcement of my results, stated specifically, and with units. For example, suppose the problem-sheet describes the flight of a baseball and then asks "How high did the baseball go and does it clear a 14 foot fence which is 300 feet from home plate?" Then I will start my writeup by: "I will show that the baseball reaches a maximum height of 74 feet, and fails to clear the fence by 2 feet. Thus Joe does NOT make a home run."

Ch14 I have *announced my methods*, before applying them. Theorems are cited *by name* (preferred), or by theorem-number and page number. Rather than just blunder into a computation, I say "By L'Hôpital's Rule applied to the ratio f'/h''..." or, "By theorem 12, on page 786..."

Ch15 Most importantly, I have done a quality job. I have done *much more* than what was asked of me. And –by the way– *I worked even harder than my team-mates!* (But don't tell them please –I don't want to hurt their feelings...)

Phrases used in grading

Below, the professor is speaking to the team. I may number long comments that I write on your exam as "∗1:", "∗2:", etc. In contrast, I use "(∗1)" to *refer* to comment "∗1:".

TSNV *"This sentence no verb."* For example, suppose you write "$\int_2^5 x^2\,dx$" on one line and you write "$\int_2^5 x\,dx$" on the next. What you *probably* mean is that the first number [the definite integral] is bigger than the second, because $x^2 > x$ for all $x \in [2, 5]$. However, you failed to write "'>" between the integrals and so I have no idea what relation you intended to assert

between the two numbers.

Remember that relations such as "$=$", "$\neq$", "$>$", "$\in$", "$\ni$", "$\supset$", "*is prettier than*", are verbs [or rather, are phrases which play the role of a verb].

CR *"Can't read"* —I can't make out what you've written here. Also: SP, *"SPelling error"*. Also: TINE, *"This Is Not English"* —your paragraph is seriously ungrammatical and/or is incoherent. This often happens when **Ch$_{10}$** or **Ch$_{11}$** is violated, or when "it" or "the function" is written several times, sometimes meaning g, sometimes f, sometimes f^{-1}, sometimes f', sometimes f''... —you get the idea.

DYMean *"Do you mean..."* Also: MW?, *"Means what?"* —I can't figure out the meaning of something that you have written.

MI^{5}WGA The famous *"Maybe If I Ignore It, It Will Go Away"* error. The student ignores unpleasant cases, e.g, he divides both sides of an equation by $[y-3]$, conveniently forgetting to analyze the case when $y=3$. Or he has proven that $\sqrt{x^2}=5$ and then blithely concludes that $x=5$ –cheerfully overlooking that x might have been negative.

Y$\not\gg$Y Also written YCY: "You contradict yourself" —usually written with arrows pointing at two assertions you've written that contradict each other. I use a tilted $\not\gg$ for "contradiction".

Magic? Where is the justification for the step you just did? A related error is HDYTKYC? –*"How do you know that you can?"* The student has used the conclusion of a theorem, but has not verified the hypotheses.

OYAWYOWTOP! *"Oops, You've Assumed What YOu Wanted TO Prove!"* [I may just abbreviate this as *Oy!*] If you are trying to show that "A implies B" then you may assume A. However, you must not assume B —*that* is what you are trying to prove.

WFFW? *"What Follows From What?"* The students lists a sequence of assertions, but without employing useful connective phrases such as: But, ... which implies ..., In contrast to the preceding inequality, Nonetheless, Consequently from eqn. 6, ... which, together with the Chain Rule applied to $\sin(\cos(x))$, shows ...

One particular way a student might commit a WFFW? is the dreaded SS, the *"Semicolon Soup"*. Here, the student *could* have carefully structured a paragraph clearly showing his reasoning. Instead he chose to toss together a bunch of fragments, placing a semicolon between each pair, thinking that this will fool his benighted professor into believing that what he has written is English. He is wrong; it won't, and it isn't.

Cheers, Prof. K