

## 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.

**Mechanics. Ch<sub>1</sub>** 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<sub>2</sub>** Essays are typed, double-spaced, so that my prof. can write easily between the lines.

**Ch<sub>3</sub>** My hand-in is assembled as: PROBLEM SHEET, TYPOGRAPHY SHEET (if needed), 1<sup>st</sup> essay, 2<sup>nd</sup> essay, ... [Please do not put a cover on your exam; just securely staple it together, with the Problem Sheet **first!**.]

When possible, pages—including diagram pages—should be numbered consecutively. However, this may not be possible if you are assembling different PDFs into a single PDF; do the best you can. [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<sub>4</sub>** 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<sub>5</sub>** 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,  $\nabla g$ , we type '&g;'."

**Ch<sub>6</sub>** 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:  $\sin(x)$ ,  $\arctan(y)$ ,  $\log(z)$ ,  $\log_7(x)$ ,  $\exp(x)$ ,  $\text{Dom}(f)$ ,  $\text{CoDom}(f)$ ,  $\text{Range}(f)$ ,  $\text{Area}(E)$ . 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  $[x + y]$ .

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To avoid ambiguity, I, Student, write the evaluation symbol *with* the name of the variable. I do *not* write  $\left. x \cdot \cos(z) \right|_5^7$ , 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<sub>7</sub>** 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 " $\alpha$ " (alpha).

**Ch<sub>8</sub>** 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.*]

**Ch<sub>9</sub>** 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.

**Ch<sub>10</sub>** 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.

**Ch<sub>11</sub>** 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  $b < 5$ .”

**Ch<sub>12</sub>** 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  $\theta$  would exceed  $\pi/4$  and so  $x$  would be 3. But  $x$  is negative. Thus the cannonball did indeed hit the wall.”

**Ch<sub>13</sub>** 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.”

**Ch<sub>14</sub>** 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...”

**Ch<sub>15</sub>** 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 teammates! (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<sub>10</sub>** or **Ch<sub>11</sub>** is violated, or when “it” or “the function” is written several times, sometimes meaning  $g$ , sometimes  $f$ , sometimes  $f^{-1}$ , sometimes  $f'$ , sometimes  $f'' \dots$  —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<sup>5</sup>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⊗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  $\otimes$  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*