Zen and the art of doing physics problems

Zen Physics - a guide to problem solving

1. *Read* the question *carefully*, and then *reread it*. In physics problems there are usually **keywords** that hint at **physics principles** applicable to the problem. In addition, there are often **modifiers** that change what the question means. (It's ironic, but often physics students have more difficulty with the **English** of a question than with the **Physics**.)

2. *Draw* a **picture** of the situation described. It's surprising how often this simple step makes you realize you must *read* the question *again to clarify* an important detail of the situation. (Sometimes you'll need multiple diagrams!) Drawing a good picture is often the **key** to solving a problem. *Don't be afraid* of *draw*ing *a different picture* – if the first one isn't helping to provide insights into the problem.

3. *Label* the picture with *all* relevant information that you know. *Write* both **symbols** and **numbers** with **units** – if you know them. E.g. $m = 84.0$ kg for the mass (not weight) of a person. You'll often need a **coordinate system** an **origin** and for the problem – *add* them to the picture.

4. *Write down* what **variable** or **parameter** the question is asking for in the form of an "equation question" using the correct symbol, e.g., **Q.** $\vec{F} = ?$

5. *Write down* **relationships** between things you know and want. This means *writing* **equations** that include some or all of the variables you identified in steps **3.** and **4.** that go with the picture. This may sometimes introduce more **unknown variables** ☹, which means you'll need to *put* them in your picture and maybe *find more* equations. The total number of **independent** equations you need must equal the total number of **unknowns** in the problem. The things in those equations should all be *labeled* in your picture. If they are not, then you'll need to *add stuff* to (or *redo*) your picture. *Using* **pencil** for physics is **good**!

6. *Derive* a new equation (**algebraic** or **calculus**) for the answer in terms of things you know. This should be done with symbols – no **algebra with numbers** (**AWN**)!

7. *Plug* in the numbers for the things you know into your equation for the answer. You *must* include units!

8. *Chug* through your equation and calculate the **numerical answer** and the **units** of the answer (*figure out* the units <u>from your equation</u>).

9. **Sanity check**: **(i)** units; **(ii)** magnitude; **(iii)** sign and **(iv)** significant figures … of your answer to make sure that they <u>all</u> make sense. (i) If your answer has the <u>wrong</u> **units**, then you probably made a mistake with your algebra ☹. If that happens, go back and check your work. (ii) This is a ballpark check for your answer. If the **magnitude** (size) of the answer doesn't make sense, then you probably made a mistake. (iii) Check that the **sign** (**direction** for a **vector**). A vector *without* direction is just *pointless* 😊. (iv) If you got everything else right, you wouldn't want to lose points for **sig. figs.** – would you?

10. Indicate your **final answer** with a **box** or **<u>underlining</u>**. If you got the correct answer, wouldn't you want the grader to be able to *find it*? 😊

Zen Physics

Physics is NOT about **memorizing** a whole bunch of facts and formulas. It's about learning to **think** about the physical world in a quantitative way. During **Zen Physics** problem solving, you may even *forget* the original question – this is a sure sign of **enlightenment** in problem solving!

When we're working a problem in class, your task is NOT to memorize how to do the problem. Your goal is to *solve* the problem yourself as we work on it together. The idea is for you to *understand how* to solve the problem by yourself **from scratch**, *figuring out* (for yourself) what to do next, at each and every step. This means you need to *know why* we chose to do each step. If it's not clear to you why we did something – then *please ask* in class – *don't wait* till later! You won't be the only person with questions.

Homework grade for "attempts"

The purpose of the **homework** is to *help you do well* in the course. The only way to succeed is for you to work on the homework *by yourself*. The assigned problems are usually *very difficult*. The idea is for you to **think** about them yourself as you work through the **problem solving method** discussed above and in class. Therefore, when you are working on a homework problem, you should always read the question and then *work* through the problem as far as you can *by yourself*. When you get stuck, you should *write out* a short sentence explaining where you are in the problem solving process (i.e. which **step number** you got stuck at) and what you think you might need to keep going (e.g. a relationship between force and acceleration). If you do that for **homework**, you'll receive **full credit** for correctly **attempting** the problem – if you get to step **5.** or higher.

If you're still stuck, *consulting with others* on your homework is acceptable and *encouraged*. However, you must *write up and turn in* your own solution that must include your **individual attempt** following the procedure outlined above.

Midterm Tests and Final Exam graded for "correctness"

The Tests and Final Exam will be graded for **correctness** rather than attempt effort. **Partial credit** will be given for each **conceptual portion** of your problem solution that is correctly worked out **algebraically**. No partial credit will be given for doing "**algebra with numbers**" (**AWN**). Numerical errors (with the correct units) will only result in a moderate deduction. However, an important part of physics is to understand your answer, and to satisfy yourself that it's reasonable. No credit will be given for a skipped problem or for providing an answer to a numerical problem without showing the work required to obtain the answer (unless it's a multiple-choice question).