10 Good Habits for Solving Problems (in Physics 101/102 and beyond…)

1. **Write down everything (relevant) you know about the problem** (what the main parameters are of interest—mass, spring constant, g, velocity, times, etc.—and which values you know) This includes information like whether it's a statics problem or not. Sifting out irrelevant information is a good skill for life…
2. **Sketch the geometry**. If the problem involves more than one time, draw a few sample sketches at different times. If you know functional dependences, sketch those. (That is, this quantity varies sinusoidally with time, etc.)
3. **Write down all relationships**. This includes free-body diagrams, action-reaction pairs, relevant equations, etc. But, it might also involve statements: "these two masses move as a group, always having the same velocity and acceleration", for example.
4. **Remind yourself what the original question was.** At this point, if you reread the problem, the right approach often jumps out at you. If not, you know what you are trying to do. You will not solve for the wrong quantity or otherwise waste time!
5. **Don't use numerical values for physical quantities until the last step.** Substituting numerical values too early can build faulty reasoning into your calculation. (Remember from discussion section how you might have written down the wrong spring forces the first time through, because you ignored some forces?)
6. **Do all the math explicitly.** Skipping steps in your derivations often leads to faulty mathematical reasoning. Even if you are doing basic algebra, write it all out in almost all cases!
7. **Watch out for common math snafus.** You will become familiar with these, and I'll often mention them: reversing the direction of a vector, confusing degrees with radians when computing angles, doing trigonometry using the wrong angle, etc.
8. **Keep the units at every step in your calculation & convert all the units into standard SI units.** You can easily check your math by making sure the units work out correctly. That way, for example, you know that your forces are working out to be in units of Newtons, rather than m/s. If you don't need to do unit conversions, you may use a unit like cm or nN, or even a nonstandard unit (like light-years, a unit of length, or the chemist's kilocalorie/mol, a unit of energy), if it gives you answer with the correct scale for the problem at hand. (Reaction times are naturally measured in milliseconds, molecular scale forces are expressed naturally in nN or pN, for example, astronomers use special units for very large distances, etc.)
9. **Watch out for significant figures.** Report your results with the correct number of significant figures, although you are welcome to keep additional significant figures in the intervening steps. Often one or two additional significant figures is all that's needed to avoiding rounding errors.
10. **Check for reasonableness.** You can often look back at your answer and the original problem and see why a surprising answer makes sense. ("Oh! The top spring has to support not just the spring attached to it, but all the masses below that one.") You also should watch out for reasonableness of numerical answers: "That small child is exerting a pushing force of 1,000,000 N? I don't think so!" and guide you to where you might have gone wrong.

And a few more tips that come in handy on occasion…

Join a study group and work on the problem in a team. You may have successfully gone it alone in earlier courses, but most scientists (and other professionals) work in teams for a reason: you get the advantage of many different minds with different and complementary skill sets. Also, if you can explain the problem to your study group, you can explain it well on your answers. And, you won't suffer and despair in solitude. (You: "I can't do problem 3." The rest of your group: "AAAAAH! Problem 3!!!")

If you can't solve the problem assigned (by the instructor or Nature itself!), **try making up a simpler version and solving it first.** Example: if you can't solve a problem in 2 or 3 dimensions, try making up a one dimensional version and solving it first. Or, ignore a few forces and ask what would happen without them ("I'm not sure how to include friction, so let's do it without friction first.") And so on.

See if you can compare this problem to one you already solved. "OK, if we have a monkey hanging on a rope and another monkey is hanging on its tail…hey, that's a lot like those two masses on springs we worked on in discussion section! How did that one work again? Let's look at our notes…"

Consider limiting cases. For example, with a mass sliding down a plane, what happens when the angle goes to zero? To 90 degrees? To 180 degrees? When friction is zero? In another problem, you might consider what happens when the mass of one object is much greater than the mass of another. And so on. Do your calculated answers agree with the expected physics?

Don't stop once you've solved a problem; take your solution and handle it a bit. Do you see now any simple results that you couldn't see in advance? ("Oh, the spring on top has to support both masses, so it exerts a force equal to their total mass times g.") Can you talk through what's happening in words now that you have the equations that explain the physics?

Look for larger implications. You might at first be very focused on just getting a numerical value right. When you're done, reexamine why you were assigned this problem. There might be a larger lesson you ought to be getting—make sure you learned that too!

Use all of your intelligence. Some people work best using equations and reasoning algebraically. Others do better using visual aids, while others can talk through problem using words and raw logic. Still others are kinesthetic learners and reasoners—they will get a problem better if they act it out. Think about your problem-solving styles and use the full range. (You: "Let's act this out. Ahmed, you're the driver, Jennie, you're the car, and Gene's the airbag." Gene: "Why am I always the thing that gets hit?")

Stop thinking about it and go do something else. I'm not joking! Your mind often keeps working on a problem when you're not focused on it. You can have your best ideas about how to solve problems (in physics or elsewhere) while taking a run, practicing the piano, taking a shower, etc. This of course assumes you didn't leave the assignment until the last minute…and you've had enough sleep…