1 Advice for new students

Doing a PhD or an MSc can be tough - really tough. You will probably work harder than you ever have in your life before and will at times, feel more challenged than you ever have before. The good news though, is that a PhD or an MSc can also be incredibly rewarding and enriching. I hope this document ensures we get off to a good start!

To achieve something concrete, you should have a very good understanding of what it is that you are trying to achieve. If you are not aiming for something specific, you can't possibly expect to achieve a definite result. In this document I have spelled out what I think you should achieve - see if you agree or not. You might have a slightly different idea - and that is OK - its your degree.

In a nutshell, if you have been properly educated you should have the ability to inquire and create constructively and independently without external controls. This is not going to happen overnight so don't panic if it looks like a daunting task right now. Lets spell out the first sentence of this paragraph.

2 What should you be expecting to get out of your degree?

You should be in a position to inquire and create on the basis of the resources available to you - those facts that you appreciate and comprehend. You need to know where to look, to know how to formulate serious questions, how to sensibly question accepted results (if that is appropriate), to find your own way, to shape the questions that are worth pursuing and to develop the path to pursue them. That means knowing and understanding many things, but also much more important than what you have stored in your mind to know where to look, how to look, how to question, how to challenge, how to proceed when you have ground to a halt, and to be able to independently deal with the challenges that the your problem presents to you.

You should know when you are making progress and when you are wasting time and, when you are wasting time you should be able to find new directions and avenues of exploration that allow you to move forwards again. You should know when you have established a result, what the result is and what facts have been used or assumed to get your result. You should be able to

test your results and assign a confidence level to each result you have derived.

You should be able to discuss your results sensibly with other experts in the field. You should be able to get useful information from conversations with colleagues. You had to learn how to get the most out of a lecture and the most out of a textbook. Now you need to learn how to get the most out of discussions with colleagues - so practise as much as you can. You need to be able to give clear seminars that will communicate your work. You need to be able to think on your feet and answers questions coming from the audience. You need to have the confidence to say "I don't know" when you don't.

You should know how to get the most out of reading a paper. When starting a paper you should be able to decide in how much detail you need to read the paper. Do you need reproduce all of the details, or is a quick read enough? Which sections are important for your goals?

3 Why is research difficult?

There are lots of reason why. Here I will list some of them.

In your undergraduate career you had examinations. For each course and even for parts of a single course! This means that you recieved frequent and unambiguous feedback about what you had mastered and what you had to work harder on. By the time you passed every exam, you had mastered everything you needed to.

When you do research, there is no external feedback till the very end, when your idea has worked and your paper can be written. Your peers in the field will decide if the paper meets the standard that it can be published. In this environment, you need to monitor yourself. During your MSc and PhD your supervisor is a safety net - they know the ropes and can give you feedback. Try to gauge how you are doing and compare to the feedback you get from your supervisor. This is one way that you might learn to monitor yourself.

Another difficulty is that you are solving very difficult problems - so difficult in fact, that no one else has solved them! You will get stuck and you will spend a lot of time being stuck. Try not to get too stressed and try to find healthy habits to relieve the stress. Perhaps a long walk, or a good book or something like that. When doing your PhD/MSc, when you are stuck you should formulate questions for your supervisor, or even just meet them and explain exactly what the problem is. We are all on a tight timetable and you

don't have the luxury of wasting months in the dark on your own. If you don't meet with your advisor often enough, and you struggle on your own, expect to get frustrated and lose motivation.

Finally, what you are trying might be impossible. So you need to get good at knowing when a tough problem can be cracked with just a bit more effort and when you should cut your losses and move on. This is not easy even for very experienced researchers.

4 How do you get benefit from your supervisor?

Your supervisor is busy and even if your advisor genuinely cares[1] about your education and future career, there is a limit to how much time they will spend with you. You want to maximize the benefit from the time you spend with your supervisor. This section will describe how this might be accomplished.

You should be asking lots of questions. There is an art to asking really good questions - questions that get precisely to the heart of the matter you are discussing. Practise asking good questions and after you have an answer think about the kinds of questions you might have asked. Sometimes just thinking up a good question to ask will help you to overcome the difficulty you face because it will inject some clarity into your thinking.

You must ask your supervisor for guidance. You might start with asking until you have clarified things to the level of detail you might request from a tutorial problem - these are requests like "Tell me exactly what I should do next because I don't want to make a mistake." In this way you are forcing your supervisor to formulate a precise concrete question. But, you should graduate from this as quickly as possible. Ultimately you want to have the ability to turn some vague thinking into a precise question. Much better questions are things like: "What are you expecting to find and where is this intuition coming from?"

Think about the level on which you have a conversation with your advisor. Are you quizzing him on some small technical detail needed to move between two lines of notes he gave you or are you getting an insight into the logical structure and ideas motivating the work the two of you are pursuing?

[1]The reality is that not every advisor will care, so choose your advisor carefully!

Communicate clearly. Think about what you want to achieve in a conversation with your supervisor and how best to communicate this. When you send an email don't send something glib like "Hi, My notes are attached." That communicates nothing. Rather send a message explaining what you have done and where you need input. Do you want your supervisor to suggest a way forwards when you are stuck, confirm a result you have or resolve something that is puzzling you? Make that clear. If you send a note at 2a.m. what kind of feedback do you expect your supervisor can give you at 8a.m. the same morning? If you want thoughtful and considered input, send a file days before you are meant to meet.

A good student will contribute technical results and perhaps even creative ideas. A poor student will need everything they complete to be checked by their advisor. For any starting student, you will need your supervisor to check some of what you do, but the point is that you should grow past this stage, to the point where you know what is correct or not. If you are unsure of whether or not something is correct you should know why you are uncertain and you should be able to get advice on this point.

If your supervisor starts to work in earnest on the project the two of you are involved in, you should drop everything else and focus on the project. There are many things (projects, other graduate students, teaching, grant writing) all competing for your supervisor's time. If your supervisor finds themselves waiting for you to respond to requests or progress on the problem, don't expect to get a lot more of their time.

You should not be late for meetings and you should not miss a meeting without an apology and explanation of what happened. You should acknowledge any email that is sent to you. If you are asked to do something, you should do it. If you need something, speak up and ask for it. If you are concerned or have some issues with how your degree is progressing, discuss it with your supervisor. Don't wait until problems are being realized - talk to your supervisor well before their input is needed.

5 Good Habits

1. Check the arXiv everyday.
2. Keep a notebook for your project and try to write something in it everyday. You must generate your own momentum on your project.
3. When an idea does work, think it through. Understand what worked as

simply as possible and try to construct as many valid points of view as is possible. What have you learned from this success?
4. For every idea that does not work, develop a clear and precise understanding of exactly what went wrong and why. Before trying the idea, you thought it would work but it didn't. What was wrong with your initial thinking? Get into the habit of understanding everything properly.
5. Attend as many seminars as possible. Attend lecture series that are useful. Practice asking questions and honing your skills of learning in seminars and lectures. Try talking to the speaker after the seminar.
6. Read through this document regularly and see how you are progressing. Also keep your eyes open for situations in which you can further hone any of the skills you should be learning.
7. Find a good hobby to release stress. Have a life outside of physics.

6 Other resources

Look here for what other people think:

http://faculty.washington.edu/hueyrb/pdfs/advice.pdf

https://sites.google.com/site/adviceforgraduatestudents/

https://www.gsas.harvard.edu/prospective_students/what_i_wish_i_had_known.php

I'm sure there are many more! I got these by googling "advice for graduate students." I got 168 000 000 hits; these were the first three hits.

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