Teaching Assistant Handbook

Physics department, MIT

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Introduction

Welcome to the Physics Teaching Assistants (TAs) Handbook. The purpose of this document is to equip you, the graduate teaching assistants in MIT's Physics Department, with the essential resources to support your growth as educators and effectively communicate with students.

In these pages, you will discover practical tips and suggestions to assist you in your role within MIT's physics courses. It is important to note that this is not an exhaustive list, and the advice provided may not apply to every situation you encounter.

As a teaching assistant, you will be given specific responsibilities. To thrive in this role, you are encouraged to take time to self-reflect, actively listen to both the instructor(s) and students, and review end-of-term evaluations to improve your teaching! You will learn as you go. You can access the subject evaluation reports here (requires Kerberos).

Your TA duties may involve working in a laboratory or lecture class, and the time required can vary from week to week. In total, including preparation, you should spend up to 20 hours per week on the course you TA. Just like the instructors, you may find it necessary to invest time in preparing or refreshing your knowledge of the course you are assigned to.

Please be aware that maintaining friendships with students in your classroom can pose a conflict of interest. If you find yourself in such a situation, it is crucial to promptly inform the instructor so that mutually agreeable solutions can be explored.

The upcoming sections in this handbook are presented without any specific order. The initial segments offer essential information regarding contacts, resources, and class regulations at MIT. Following that, you'll find practical tips and best practices for the various responsibilities you may encounter as a TA.

Feel free to explore these sections as needed, based on your specific requirements and interests. We've organized this handbook to be a flexible resource that can adapt to your unique journey as a TA.

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Comprehensive contacts and resources guide

In your role as a Teaching Assistant (TA), you may have questions or need assistance. The first point of contact for many queries will be the course instructor(s). However, there are other resources available both within the department and at MIT that can prove helpful to you. In some cases, you can also ask a more experienced TA.

2.1 Contacts

- Shannon Larkin (`slarkin@mit.edu`): general questions about your academic path
- Christoph Paus (`paus@mit.edu`): questions regarding your current and future TA appointments
- Leah Kahn (`kahn712@mit.edu`): schedule office hours in a tutor room, borrow textbook(s) for the term, schedule review sessions in a classroom, get exams printed

2.2 Resources to improve your teaching

Here are a few resources and opportunities to improve your teaching and mentoring skills and get additional practice, all available at MIT.

Opportunities to learn about teaching and mentoring

- TA days workshops: last week of August and of January. Series of independent 2-hour workshops on various teaching topics.

- 8.998 Teaching and Mentoring MIT Students: course emphasizing teaching and mentoring skills in one-on-one and small group settings, covering topics like cognition, communication, motivation, and peer mentorship.

Opportunities to practice teaching

- Teaching Certificate Pathways: interactive workshops by the MIT Teaching+Learning Lab to develop teaching skills, leading to a teaching certificate. The content is the same but the format and intended audience are different.
  - Grad Teaching Development Tracks: four thematic tracks, each consisting of two to three 2-hour workshops. For early- and mi-program graduate students.
  - Kaufman Teaching Certificate Program: ten 2-hour workshops in a single semester. For late-program graduate students and postdocs.
- Teaching development fellow (TDF) for the Physics department. Organize activities to improve the TA experience and meet with TDFs from other department to share best practices.
- MIT ESP Splash: teach high school students about a topic of your choice over a weekend
- MITES Saturdays/Semester/Summer: teach middle and high school students
- Plan an activity over IAP: an activity is a lecture or a series of lectures which are not for credit, but advertised for the MIT community. If you are interested, members of the Physics Education Group would be happy to mentor you in designing a course.

Opportunities to practice mentoring

- Physics mentoring program: mentor first- and second-year students taking introductory classes
- Physics directed reading program: paired with an undergraduate student to study a topic over IAP

2.3 Resources for personal support and advice

Below you will find a list of resources available at MIT with information about the intended audience and the type of help they provide.

- Student Support Services (S3): advice and advocacy for undergraduate students facing personal or academic challenges. Students requesting extensions will often cc an associate dean from S3.
- Ombuds Office (confidential): independent, neutral, and informal resource where you can express concerns about any aspect of your experience at MIT.
- Violence Prevention & Response (confidential): advice and advocacy for the MIT community on sexual assault, intimate partner violence, stalking, and unhealthy relationships.
- GradSupport: advice and advocacy for graduate students facing personal or academic challenges.
- MIT Medical: support the health and well-being needs of the MIT community
- MIT Police: for complaints of harassment that are of potentially criminal nature, such as sexual assault.

Although as a TA you are a mandatory reporter, it is not your job to diagnose or treat students; rather, direct them to someone who can help – APO, S3, OGE, CARE Team, etc.

2.4 Academic calendar

Before the start of the term, you should familiarize yourself with the academic calendar. This step will ensure that you don't schedule tutorials, review sessions, or office hours on statutory holidays, student holidays, or the Spring break. The observed holidays usually are: Indigenous Peoples Day, Veterans Day, Thanksgiving Day, Martin Luther King, Jr. Day, Presidents Day, and Patriots Day.

Class sessions at MIT commence five minutes after the scheduled time and conclude five minutes before the scheduled hour or half-hour. You should follow the same schedule for tutorials, while office hours typically runs for the full scheduled time

According to MIT's policy, there can be no mandatory class-related events from Monday through Thursday between 5 pm and 7 pm, as well as from Friday at 5 pm to Monday at 8 am. However, you can still host office hours and review sessions during these times since these events are considered optional for the students.

Assignments cannot have due dates after the last day of class. Yet, you can grant individual extension for assignments that extend beyond the last day of class.

3

General best practices

3.1 Inclusive teaching

Inclusive teaching intends to support all students. In your recitations and office hours, make sure to

- Introduce technical language or equations before using them. Technical jargon and abbreviations used out of context can be intimidating for many learners.
- Monitor your interactions with different genders, ethnicities, etc. Take time to reflect.
- Allow time for pair or group discussions before sharing answers with the whole class.

3.2 Recognizing bias

Bias appears in many places, often without us noticing. Let's start by defining it, then present possible solutions to reduce it.

- *Implicit Bias:* Unconscious bias affecting grading decisions, often based on student's identity or personal characteristics.
- *Halo Effect:* One positive characteristic (such as a well-written first answer on an assessment) disproportionately affects the overall grading of a student's work.
- *Confirmation bias:* A student did well the previous term or is attentive in class, thus will do well.
- *Central (or "A") Tendency Bias:* Reluctance to assign very high or very low grades, causing grades to cluster around the middle range.

You can easily reduce most of this bias!

- Use detailed rubrics. They can have positive or negative scoring. If a student comes to complain about a grade, you can explain your rubric. Otherwise, it may be hard to remember your grading scale a few weeks after you graded a specific problem.
- Anonymize students' work. In Gradescope, you can enable anonymous grading when creating an assignment. In SpeedGrader (integrated in Canvas), this has to be manually done. However, if the student writes their name on their assignment, you will see it. Consider asking the students to avoid writing their name if they submit online. For tests and exams, consider flipping them and starting to grade from the end, such that you don't see the student name before you are done grading.
- Reflect and re-calibrate regularly. Keep track of the grades you gave on different problems and how they are distributed.
- Ask for peer-review of your grading scheme. This can be the professor, a TA, or another grader.

3.3 Using Socratic questioning

Socratic questioning is a powerful teaching technique that encourages students to find answers by engaging their critical thinking and drawing from their own knowledge. As a TA, mastering this skill can significantly enhance your effectiveness in guiding students' learning. Here, we will delve into the nuances of effective questioning and explore the different types of questions at your disposal.

Key Principles of Effective Socratic Questioning

- *Ask a single clear question:* Precision is key. A well-phrased, straightforward question paves the way for productive discussion and thought.
- *Embrace the silence:* After asking a question, resist the urge to immediately provide the answer. Give your students the space and time to formulate their responses. Wait silently for at least 5 to 10 seconds to allow them to think and respond.

- *Identify and reinforce correct thinking:* When a student offers a valid perspective or insight, acknowledge it and reinforce their correct thinking. This positive reinforcement encourages a deeper understanding and boosts their confidence. It is also good to periodically summarize key points that have been discussed.
- *Avoid yes/no questions:* Yes/no questions typically lead to one-word answers and do little to stimulate critical thinking or foster meaningful discussions. Instead, opt for questions that prompt elaboration and exploration.
- *Clarity is key:* Steer clear of vague, ambiguous, or overly complex questions. Tailor your questions to the students' current level of understanding. As a TA, you have the insight to gauge their knowledge and adjust your inquiries accordingly.

There are different types of questions you can ask:

- *Clarification questions:* elicit deeper explanations or clarify a point. They encourage students to articulate their ideas more clearly.
  - **e.g.** What do you mean by that?
- *Assumption questions:* challenge students to identify and scrutinize underlying assumptions in their reasoning. They encourage critical thinking and a deeper examination of their thought process.
  - **e.g.** What assumptions are you making in your argument? Is there an alternative assumption we should consider?
- *Probing questions:* delve into the details, encouraging students to explore a concept further. They often lead to deeper insights and a more comprehensive understanding of the topic.
  - **e.g.** Could you provide an example to illustrate your point? What might happen if we change the value of this variable?

Handling student frustration

It's important to acknowledge that not every student will have immediate answers to your questions. Some may become frustrated or seek quick solutions from you. In such situations, it's essential to strike a balance between encouraging independent thinking and providing guidance. You can:

- Offer hints or partial guidance without fully providing the answer.
- Encourage them to think step by step and guide them through the thought process.
- Use analogies or real-life examples to make the concept more accessible.
- Reassure them that it's okay to ask questions and seek help when needed.

4

Facilitating learning best practices

4.1 Office hours and Piazza

Office hours are generally held in one of the tutor room on the third floor of building 8, close to the Academic Programs Office (APO). To request a room for the term, email Anna Maria Convertino with the schedule of your office hours and the expected number of students who would attend.

In the case of Piazza or request for help via email or other electronic means, make sure to set boundaries. Announce your active hours in which you will answer students. If you don't open your work email on weekends, that's alright, but make sure the students are aware.

This is your chance to interact one on one with your students, and may help you to identify gaps in their knowledge that you may want to bring up for the whole class in your next recitation, or encourage the professor to address in class.

A few tips:

- *Do not* do the students' homework for them! It is often harder to give them tips than the full answer, but it is more rewarding to the student if they can arrive at the result with your guidance.
- Interact one-on-one with your students: you can identify the gaps in their knowledge that you can then cover in recitation or ask the instructor to address in class. If two students are having trouble with the same problem, get them to talk and see if they can help each other move forward.
- You can consider acknowledging the question before answering it, e.g. "I like your question".
- For in-person office hours, try to level your height with the student. You want to set a different dynamic from a classroom and be more approachable.

- If possible, try to learn the name of your students.
- Prioritize answering questions from students who are struggling.
- Encourage students to work together in your office hours, and to ask you questions only when the whole team gets stuck.
- When a student asks you to check if their answer is correct, encourage them to check if the order of magnitude of their answer is correct. Ask them to study limiting cases and make sure the units match the quantity they are looking for.
- Consider bringing the textbook(s) for students to consult. They can forget their own physical copy, it can too heavy to carry, or their laptop may be out of power.
- When there are a lot of students, help them in turns by answering one question or giving them one tip at a time, to ensure everyone gets a chance to get help.

Power dynamics: some students are very confident, some are struggling. You have to juggle both in your office hours. It takes practice!

4.2 Giving recitations and review sessions

Recitations and review sessions for an upcoming exam can consist of problem-solving sessions, reviewing the in-class material, and/or discussing topics that are interesting and go beyond the course. If you plan to review the in-class material, start by identifying the difficult and important concepts covered recently.

- As you prepare your recitation, determine *what* is the goal of your recitation. What should your students know by the time they come out of the room? Then determine what is the best way to achieve this. For example, you can prepare a review of the difficult and important concepts or design relevant conceptual questions and problems.
- If you make a mistake, it happens; react calmly and quickly to fix your mistake.

- If you don't know the answer to a question from the students, you can answer "I don't know, but I will find out and get back to you". You can answer by posting the answer on Piazza or send via email to the class, mention it in the following recitation, or through personal email to the student. And you *better* get back to them!
- Make your recitation interesting and dramatic. Start by pointing out a problem, ask students their opinion on how to resolve it, and show how to resolve it.

4.3 Help in labs

At MIT, there is a single laboratory class required for an undergraduate degree in physics: Junior lab. You should familiarize yourself with the list of experiment, Canvas, and the syllabus. There are many deadlines and the syllabus is instrumental in staying organized. You will help in assigning students to lab partnerships, and assigning these partnerships to experiments based on their preferences. There are many experiments and you are not expected – nor should you – to learn all of their conceptual designs and underlying physics. Your role as TA is to help the students with implementing statistics and error analysis, as well as provide support with coding.

- Help students with writing and debugging their code throughout their data analysis.
- Help students with the experiments (when the experiments are pre-designed for them): why they use this apparatus, how to take measurements, what their goals are, how to repair or configure, etc.
- Help students define their experiment (when they have freedom to design it): determine the underlying physics and goal of the measurement, and how to use their tools to achieve this
- Refer students to resources (textbooks, websites, user guides, etc.). This can be specific to the experiment, the concepts behind the experiment, and how to code in Python, for example.
- If you want to commit further, you can also learn all the experiments and related physics to be able to help them.

4.4 Online courses

TEACHING online has a different dynamic than teaching in person, and a major issue can be student motivation.

Online learning can appear to be a lonely experience for the student, which can have trouble keeping focused on classwork. You want to encourage group discussions so students get to interact with each other. For example, consider starting with a few minutes of social time, potentially centered around a question that prompts the students to share something about themselves. Separate the students in small breakout rooms on Zoom (3-4), and encourage them to annotate, or work on a Google doc that they can all access at the same time.

Encourage students to use the chat feature, and that they can message only the instructor if they want to. Make sure you keep an eye on the chat to answer promptly the students questions. Encourage them also to use the raise hand button to ask their questions. You can turn on anonymous annotations, such students can write a question directly on your slides or material without their name being displayed.

Use the built-in polls to assess if the students grasped what you taught them, and take control of their own learning rather than passively listening to you.

When you ask a question, do not be afraid of silence. It takes time to think and process, and time appears to run more slowly when you cannot see your students' face.

5

Exams, assignments and grading best practices

5.1 Grading

When assignments are a significant fraction of the course mark, students learn more than when course marks are based solely on exam scores. In order to learn from their assignments, students need feedback that is:

- frequent and timely, so it still matters to the students. Grading is vital feedback for our students and is most effective if it is given very soon after they have submitted their work. Try to return homework within *one week* of collecting it unless otherwise specified by the instructor.
- focused on their performance and learning.
- specific and detailed, providing guidance for future efforts.
- encouraging for the student to improve, and matches the purpose of the assignment. Consider giving feedback before the score.

It is also a good idea when posting the marks and feedback to encourage the students to review their assignment and the feedback you gave them, and ask them to make sure they understand why they lost marks. It is good practice to keep track of the common errors. You can write post in Piazza with points of confusions, have the instructor address them in lecture, or discuss them in recitation.

Specifically, to help you with grading homework problems, it is good practice to:

- Work out the problem yourself before you start grading it. Determine the concepts required to solve the problem. Assign points to each of the concepts.
- Initially, quickly read over many students' answers to get a feeling for the range of answers, and most common mistakes.

- Mark only one question at a time, rather than the entire problem set for each student.
- Ask yourself questions: How clearly does the solution communicates reasoning? Does the solution use correct concepts, such as major equations, vector analysis, diagrams, etc.?

Aim to grade anonymously. For exams with the student name on the cover sheet, you can flip the exams and start from the last page. In Canvas Speedgrader, make use of the function to hide students' name. In Gradescope, you can enable anonymous grading for the assignments.

Finally, if you have trouble reading the student's answer, remove a small number of points accordingly and mention it in your feedback.

5.2 Invigilating

As part of your TA position you may be required to invigilate a midterm and a final exam. Invigilation hours are counted in your TA hours for the semester. *Do not make plans for vacations or trips home until you have seen the final exam schedule.* Your duties will be to:

- Answer questions from students during exams. The types of questions that are appropriate for you to answer should be worked out with the professor in advance.
- Ensure that there is no cheating. If you suspect cheating is occurring, do not confront the student yourself. Let the supervising professor know, and give them any evidence that you can provide.

5.3 Writing solutions to problem sets and exams

As part of your TA position you may be required to write the solutions of the problem sets, midterm, and final exams. Here are a few things to keep in mind:

- Clearly identify the different subparts of a question ([a], [b], ...)
- Include intermediary steps and text to describe what you are doing.
- Proofread

5.4 Assisting students in their term paper

You are likely to be much more used to reading papers than your students. You will be helping them structure their term paper so the flow of ideas is easy to follow, point them to references, and help them understand calculations that they are trying to reproduce.

- Start by pointing students to textbooks. There are other textbooks than the one used in class that may have a chapter on the student's topic. Then, point them to review articles. It is unlikely a student will choose a topic that came out in the past year. You can refer the students to MIT library. The librarians can help search efficiently.
- Communicate clearly what are the expectations. Is a poor grammar and/or orthography going in the calculation of the points?
- In some cases, it can be useful to hold a short session on using LaTeX; how to include figures and tables, create a bibliography, etc.

5.5 Overseeing undergraduate graders

Undergraduate graders work by the hour and report those to the Academic Physics Office (APO).

- You can give them up to ~ 10 h per week.
- *Avoid bias:* If you have more than one grader, avoid implicit bias and halo effect by dividing the problem set questions among the graders.
- Plan not to give them work during the final exam period.
- *Timely feedback:* Strongly encourage them to do their grading within a week.

6

Technology in and out of the classroom

6.1 Generative artificial intelligence (AI)

Generative artificial intelligence (AI) is a new tool that is (or should be) changing how we teach and how we evaluate progress in learning. We should ask ourselves *How can we use these tools in a way that fosters thinking and learning for our students?*

It is also possible you do not want your students to make use it. One approach to mitigating the use of ChatGPT in assignment and assessment design is to incorporate more in-class or otherwise synchronous assignments, either written or oral, or change your current grade weighting to emphasize these. You can then ensure that students are developing their critical thinking and writing skills while promoting academic integrity.

In introductory courses, generative AI tools tend to consistently outperform average students in assignment and quiz questions. In advanced courses, generative AI tools usually require multiple iterations and significant effort (e.g. breaking up the problem into steps) to produce solutions for complex and advanced problems.

Using generative AI as a TA

1. Use generative AI to design grading rubrics.

   > Prompt: You are an expert teacher in physics, skilled in creating interesting questions for students and assessing student work. Create a [positive/negative]-marking only rubric suitable for [Canvas Speedgrader/Gradescope]. This rubric should be intended for [my third-year Physics undergraduate] students, and it should be tailored to assess both the given question and its corresponding solution key, assuming that the question is worth [2 points].
   >
   > Question: [...]

2. Use generative AI to write solutions to a problem set or exam. This can help you save time typing and you can focus on making sure there is no typo.

3. Use generative AI to develop exam questions. Make sure to give it a good prompt; the year of the course, the learning objectives of the course, the prerequisite knowledge, whether the students have access to a cheat sheet, etc.

Get your students to use generative AI

Generative AI can support students in their own learning to support parts of their ideation, research, and writing processes, while doing other parts themselves grounded in disciplinary and course-specific topics and methods. You could require students to submit screenshots of the AI outputs, and describe how they built their answer on that. It's important to remind students that AI can make mistakes and provide false information, and that they need to check the AI outputs and correct them as needed. Make sure the students treat generative AI as a fellow student who can make mistakes, not as the instructor who knows the answer.

Students could use AI platforms to do basic research to get an overview of a topic, and to help them focus later work based on concepts and keywords they have learned. They could be asked to solve an assignment, then run it through a generative AI tool, and test how using a different prompting can modify or improve the response.

In the context of a term paper, students can input parts of their writing into ChatGPT or other tools to receive feedback on common grammatical errors and tone. ChatGPT can not only edit writing, but explain what it changed and why, which could be a useful way for students to learn.