Resources to Prepare for University Physics

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University of Toronto Physics
Ontario Association of Physics Teachers 48th Annual Conference
Queen's University, Kingston ON, May 22, Session C2b, 2:45pm, Room 401

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Talk Outline

1. College Physics: **Free** Online Course to prepare students for First-Year University Physics
2. Physics of Music: **Not Free** Online course / textbook I have developed – great for first-year students
3. Active teaching techniques and **Assessing Students** in the age of AI

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A free teaching resource page I've developed

- https://harlow.physics.utoronto.ca/teaching/college-physics-open-course/

- Complete materials from a first-year university physics course, algebra-based.
- Based on PHY131H1F, University of Toronto, Fall of 2024 (with some additional test questions from previous years).
- The material has been organized by chapter for easy review and self-study.

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Topics – So far..

- Chapter 1: The Nature of Science and Physics
- Chapter 2: Kinematics in 1D
- Chapter 3: Kinematics in 2D
- Chapter 4: Force and Newton's Laws
- Chapter 5: Friction, Drag and Elasticity
- Chapter 6: Circular Motion and Gravity
- Chapter 7: Work and Energy
- Chapter 8: Momentum and Collisions
- Chapter 9: Torque and Static Equilibrium
- Chapter 10: Rotational Motion and Angular Momentum
- Chapter 16: Oscillations and Waves
- Chapter 17: Sound

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Example: Chapter 9: Torque and Static Equilibrium

- Pre-Class Reading (21 minutes):
  - Link to Book
  - Reading Intro Video: YouTube - Vimeo
- In-Class Content (1 hour and 16 minutes):
  - Lecture Video with Questions Removed: YouTube - Vimeo
  - Content Slides: Google Slides with Blanks - PDF with handwritten notes
- Review Material (20 questions, 54 minutes):
  - In-Class Questions: Google Slides Questions Only - PDF with Solutions
  - In-Class Solutions Video: YouTube - Vimeo
  - Test Questions: Google Slides Questions Only [for solutions and/or video of solutions please email jason.harlow@utoronto.ca]

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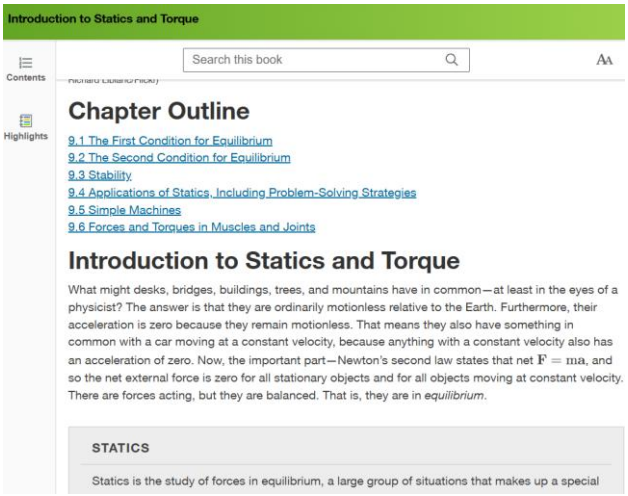
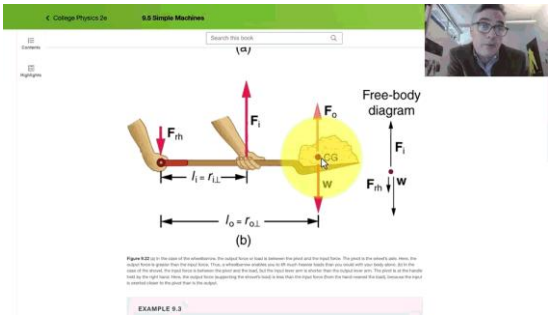
Example: Chapter 9: Preclass Reading + Video



- The reading is all of Chapter 9 from Openstax: pages 375 to 383
- The "Preclass Reading Video" walks students through the reading in 21 minutes.



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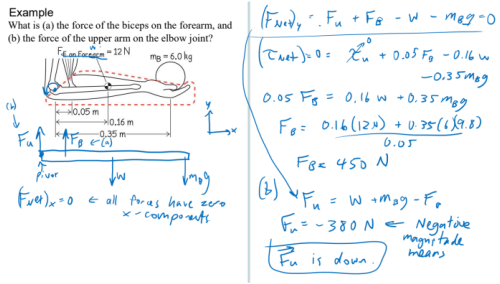
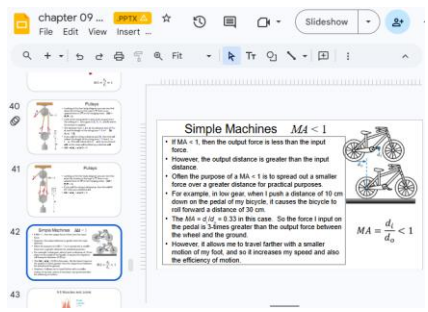
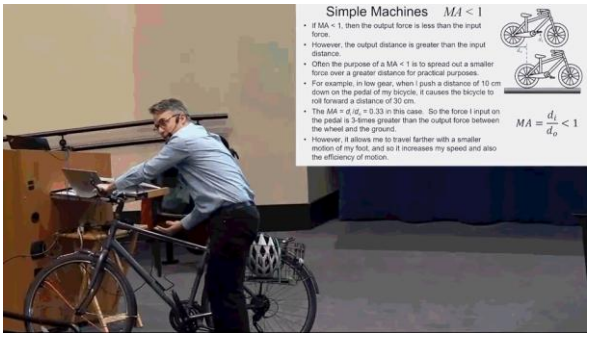
Example: Chapter 9: Classroom Video

- In-Class Content (1 hour and 16 minutes)
- Class announcements, unscripted discussions, blank pauses, etc have been removed.
- Demonstrations, Explanations, Examples included.







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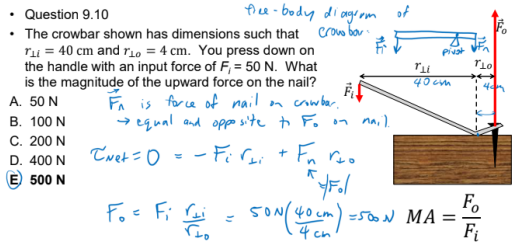
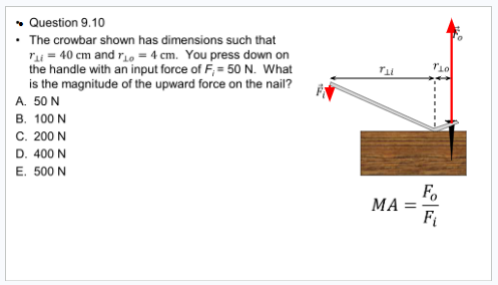
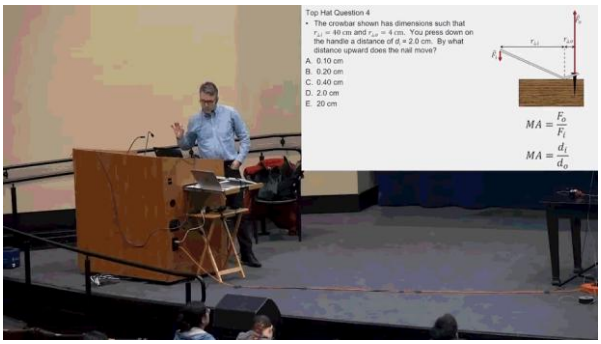
Example: Chapter 9: Practice Questions + Solutions

- 20 In-Class Questions (19 multiple-choice, one numerical)
- Class vote, explanation included in video
- Questions and fully explained solutions provided.







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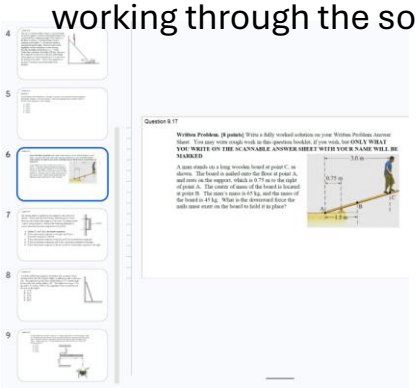
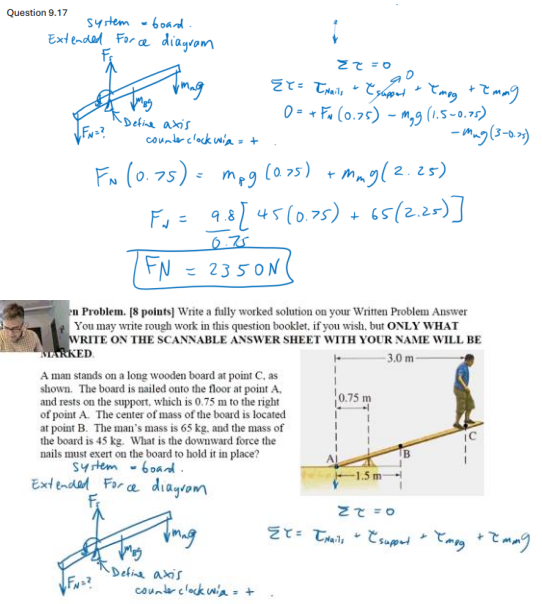
Example: Chapter 9: Practice Questions + Solutions

- 9 Test and Exam Questions on this material – Questions **only** are posted publicly.
- If you email me I can provide you with the full solutions and videos of me working through the solutions.





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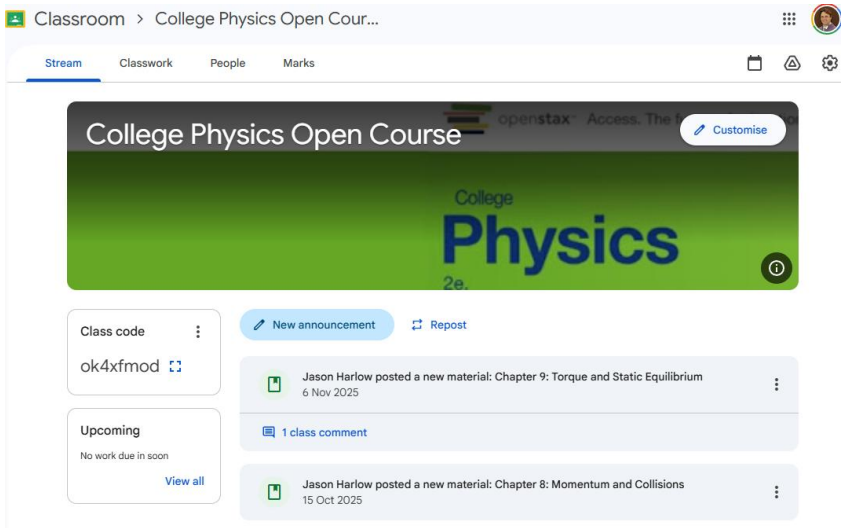
Google Classroom



- This is a space where anyone from the internet can ask questions, start discussions.

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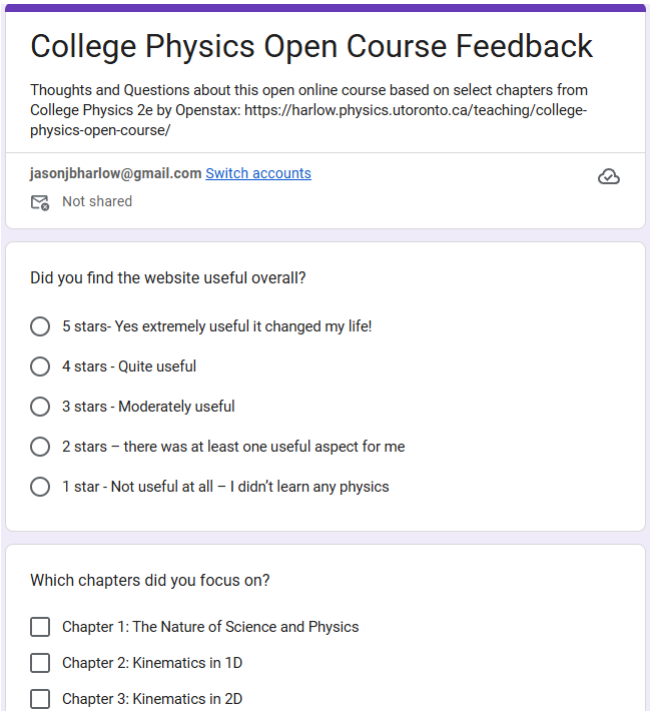
Feedback Form

- I'm seeking input from users about whether this is useful and what they might like to see improved or augmented.



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The Physics of Music

- This was the first online course taught in physics at U of T. I started developing it in 2016 and first taught it in 2018.
- I couldn't find a good textbook that used some math, and had opportunities for practice activities, while not going too deep.
- So I wrote a textbook; it has been recently published by TeachTiles, a company started by my coauthor (also a musician and former student) Mark Kazakevich.
- There are 12 "TileSets", each with full colour figures and animations, interactive examples, end-of-chapter questions with complete solutions and problems with no solutions provided (Instructors Guides available).
- There are over 70 "lecture videos" also available by request.

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Physics of Music – Digital Interactive Textbook

- https://www.teachtiles.com/preview/physics-of-music
- Published on “TeachTiles”, a new platform in which courses unfold in sets of Tiles - compact learning blocks that mix text, visuals, videos, simulations, and lots of opportunities to practice.
- Tiles guide students through each course concept, show how their understanding grows over time, and give them the freedom to jump back and revisit ideas whenever they need.
- Cost to students is about $25.

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In-Class Discussion Questions

- Device-based apps or browser-based quiz systems:
  - Google Forms
  - Top Hat
  - Poll Everywhere

School is boring – there is no other way to say it. Absorbing complex mathematical functions while staring at a powerpoint presentation is the least exciting way to spend 7 hours of your day. This may explain why 16% of US students are chronically absent from class.

- The problem I have with all of these systems is that I am sending my students to their phone or device in the middle of class.
- This creates a big **distraction** (as they check their notifications etc), and also creates a **less social atmosphere** – you are less likely to speak to your neighbour if your neighbour is looking at their phone – it's rude.

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In-Class Discussion Questions: Paper Version

- Blank paper works for small classes, if you have lots of students you can use a blank form and scan into gradescope.
- I provide a big box of pencils, blank forms, and foldable voting cards, all of which I distribute at the start of each class.
- During class I present the questions via Powerpoint, and try to get discussion going. Students can fill out their "first guess" and "consensus view".
- At the end of each class I collect the filled-out forms, scan them into a system called https://www.gradescope.ca/ and award participation + accuracy points.

- See an 14-minute YouTube Video explaining the details of exactly how I do this in a class of 100 students here: https://youtu.be/Yh-J9OdSnxc

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Writing Assignments and Problem Sets

- Many of the old assessment styles: essays and homework, can now be done in seconds by AI.
- Students submit original-looking work that is "original" (no way to prove copying), and the easiest thing for teachers is to just mark it and reward AI use.
- AI users justify their actions with "everyone does it", or "everyone who succeeds does it."
- Learning involves hard work, including some struggles and overcoming difficulties. Students can bypass all of this with AI, replacing a their educational development with an exercise in prompting, cutting and pasting.
- Honest students become bitter and disengaged from the academic process, sometimes focus on trying to police their friends.

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Writing Assignments: Suggestions

- Have them build something real, make a video showing it – I have each student create their own musical instrument using things around the house. Then they write about that video.
- Have them write about a hands-on activity or experiment, as opposed to web-based research.
- Some instructors interview each student about their paper – 15 minute "oral exams" to discuss their paper.

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In-person testing

- Old-fashioned in-person testing is vital for individual accountability – no devices except for a calculator, perhaps.
- It's good if the midterms and final exam total to 75% of the course mark.
- The other 25% is "unsupervised" in the sense that they have access to their devices.

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Shouldn't we try to <u>teach</u> AI?

- University of Calgary has a course called "Maximizing Learning with Effective GenAI Prompt Writing".
- Job ads might seek applicants with "Experience using generative AI tools for research" or "Familiarity with large language model tools and AI productivity software". (or so says AI…)
- I believe AI tools like ChatGPT are **too new** to be incorporated into education at this point.
- I suggest that we find ways to reward students who **fully avoid** AI use.

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My Opinion: **AI is bad for progress**

- The AI tools that are popular for research and writing (ChatGPT, Copilot, Claude) are mimicry engines.
- They are pretrained based on whatever came **before** the training. This introduces social and scientific biases.
- They seem sophisticated in their explanations, but are sycophantic and tend to agree with the questioner, in order to be more pleasing.
- Learners who use AI as part of their training are being "locked in" to old ideas, instead of receiving mentorship from a human professional who would naturally be thinking for the future.
- AI is **unprogressive** and promotes stagnation and apathy.

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Thank you!

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Let's talk more!
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These slides are available at Jason Harlow's webpage Google "Jason Harlow Teaching" click on **Teaching Resources for Instructors**

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