

Resources to Prepare for University Physics

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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

Introduction to Statics and Torque

Search this book

Contents

Chapter Outline

- 9.1 The First Condition for Equilibrium
- 9.2 The Second Condition for Equilibrium
- 9.3 Stability
- 9.4 Applications of Statics, Including Problem-Solving Strategies
- 9.5 Simple Machines
- 9.6 Forces and Torques in Muscles and Joints

Introduction to Statics and Torque

What might desks, bridges, buildings, trees, and mountains have in common—at least in the eyes of a physicist? The answer is that they are ordinarily motionless relative to the Earth. Furthermore, their acceleration is zero because they remain motionless. That means they also have something in common with a car moving at a constant velocity, because anything with a constant velocity also has an acceleration of zero. Now, the important part—Newton's second law states that $\text{net } \mathbf{F} = m\mathbf{a}$, and so the net external force is zero for all stationary objects and for all objects moving at constant velocity. There are forces acting, but they are balanced. That is, they are in *equilibrium*.

STATICS

Statics is the study of forces in equilibrium, a large group of situations that makes up a special

- 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.

College Physics 2e 9.5 Simple Machines

Figure 9.20 (b) shows the forces on the forearm. The input force F_b is applied to the biceps muscle, which is attached to the forearm at a distance l_b from the pivot. The output force F_o is applied to the hand, which is at a distance l_o from the pivot. The weight W of the forearm acts at a distance l_o from the pivot. The free-body diagram shows the forces F_b , F_i , F_o , and W .

EXAMPLE 9.3

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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.

Example
What is (a) the force of the biceps on the forearm, and (b) the force of the upper arm on the elbow joint?

$(F_{net})_x = 0 = \sum F_x = 0.05 F_b - 0.16 W - 0.35 m g$
 $0.05 F_b = 0.16 W + 0.35 m g$
 $F_b = \frac{0.16(12N) + 0.35(1)(9.8)}{0.05}$
 $F_b = 450 \text{ N}$
 (b) $F_{net,y} = 0 = F_u + F_b - W - m g = 0$
 $F_u = W + m g - F_b$
 $F_u = -380 \text{ N}$ ← Negative magnitude means F_u is down

chapter 09 ...

Simple Machines $MA < 1$

- If $MA < 1$, then the output force is less than the input force.
- However, the output distance is greater than the input distance.
- Often the purpose of a $MA < 1$ is to spread out a smaller force over a greater distance for practical purposes.
- For example, in low gear, when I push a distance of 10 cm down on the pedal of my bicycle, it causes the bicycle to roll forward a distance of 30 cm.
- The $MA = d_i/d_o = 0.33$ in this case. So the force I input on the pedal is 3 times greater than the output force between the wheel and the ground.
- However, it allows me to travel farther with a smaller motion of my foot, and so it increases my speed and also the efficiency of motion.

$MA = \frac{d_i}{d_o} < 1$

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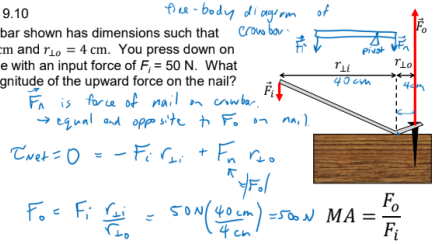
Example: Chapter 9: Practice Questions + Solutions

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

• Question 9.10

The crowbar shown has dimensions such that $r_{Li} = 40 \text{ cm}$ and $r_{Lo} = 4 \text{ cm}$. You press down on the handle with an input force of $F_i = 50 \text{ N}$. What is the magnitude of the upward force on the nail?

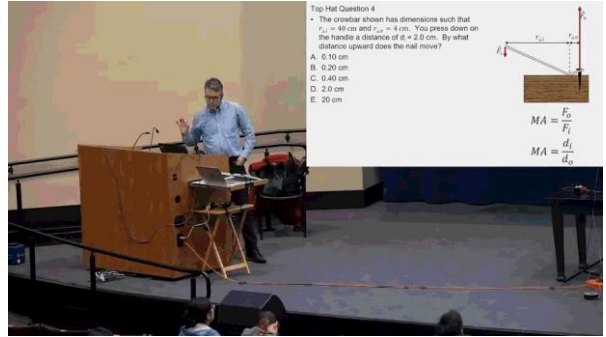
- A. 50 N
- B. 100 N
- C. 200 N
- D. 400 N
- E. 500 N



• Question 9.10

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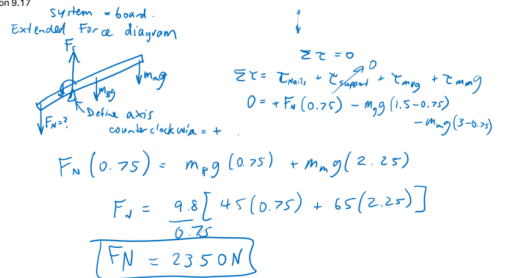
$$MA = \frac{F_o}{F_i}$$


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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.

Question 9.17

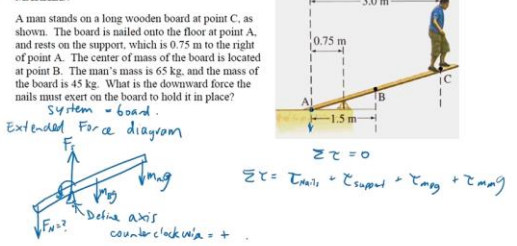


Question 9.17

Written Problem. [8 points] Write a fully worked solution on your Written Problem Answer Sheet. You may write rough work in this question booklet, if you wish, but **ONLY WHAT YOU WRITE ON THE SCANNABLE ANSWER SHEET WITH YOUR NAME WILL BE MARKED**.

A man stands on a long wooden board at point C, as shown. The board is nailed onto the floor at point A, and rests on the support, which is 0.75 m to the right of point A. The center of mass of the board is located at point B. The mass of the board is 45 kg, and the mass of the man is 65 kg. What is the downward force the nails must exert on the board to hold it in place?

Written Problem. [8 points] Write a fully worked solution on your Written Problem Answer Sheet. You may write rough work in this question booklet, if you wish, but **ONLY WHAT YOU WRITE ON THE SCANNABLE ANSWER SHEET WITH YOUR NAME WILL BE MARKED**.



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Google Classroom

The screenshot shows a Google Classroom interface for a course titled 'College Physics Open Course'. The page has a navigation bar with 'Stream', 'Classwork', 'People', and 'Marks'. Below the navigation bar is a header banner for the course with a 'Customise' button. On the left side, there is a sidebar with 'Class code' (ok4xfmod) and 'Upcoming' (No work due in soon). The main content area shows a 'New announcement' button and a list of materials posted by Jason Harlow, including 'Chapter 9: Torque and Static Equilibrium' (6 Nov 2025) and 'Chapter 8: Momentum and Collisions' (15 Oct 2025).

- 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.

College Physics Open Course Feedback

Thoughts and Questions about this open online course based on select chapters from College Physics 2e by Openstax: <https://harlow.physics.utoronto.ca/teaching/college-physics-open-course/>

jasonjbharlow@gmail.com [Switch accounts](#) 🔒

✉ Not shared

Did you find the website useful overall?

5 stars- Yes extremely useful it changed my life!

4 stars - Quite useful

3 stars - Moderately useful

2 stars - there was at least one useful aspect for me

1 star - Not useful at all - I didn't learn any physics

Which chapters did you focus on?

Chapter 1: The Nature of Science and Physics

Chapter 2: Kinematics in 1D

Chapter 3: Kinematics in 2D

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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 teach 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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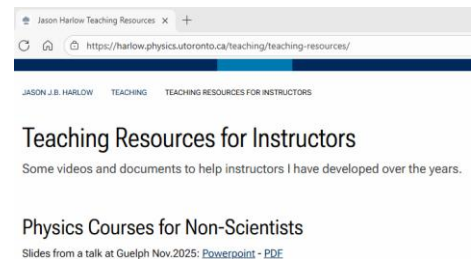
Thank you!



Jason Harlow
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TORONTO
Downtown Campus

Let's talk more!

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Jason.harlow@utoronto.ca



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

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