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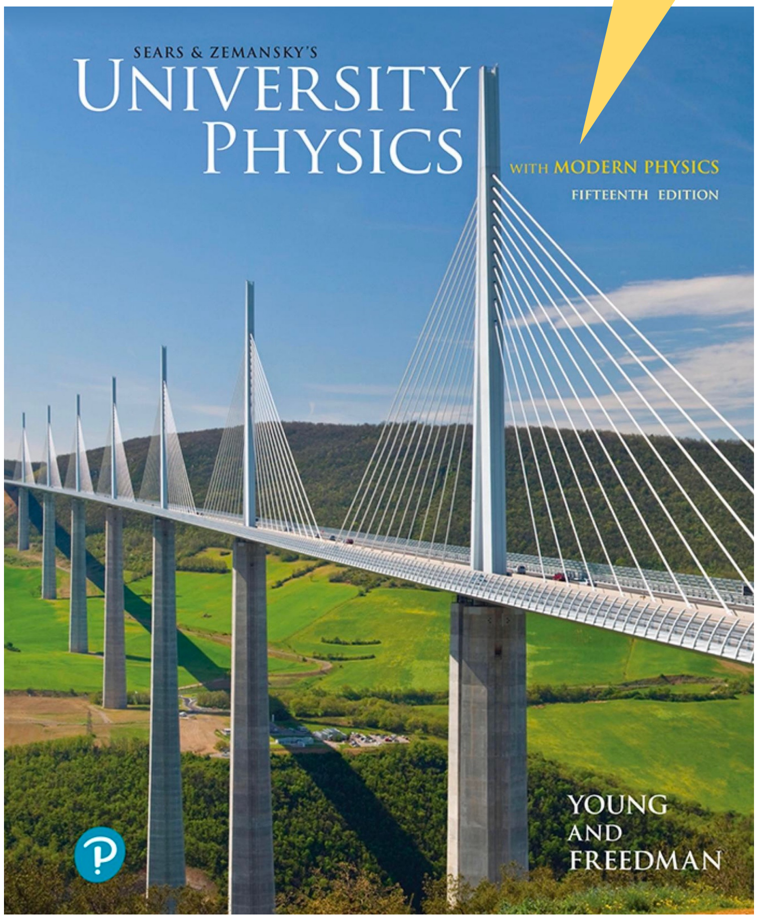
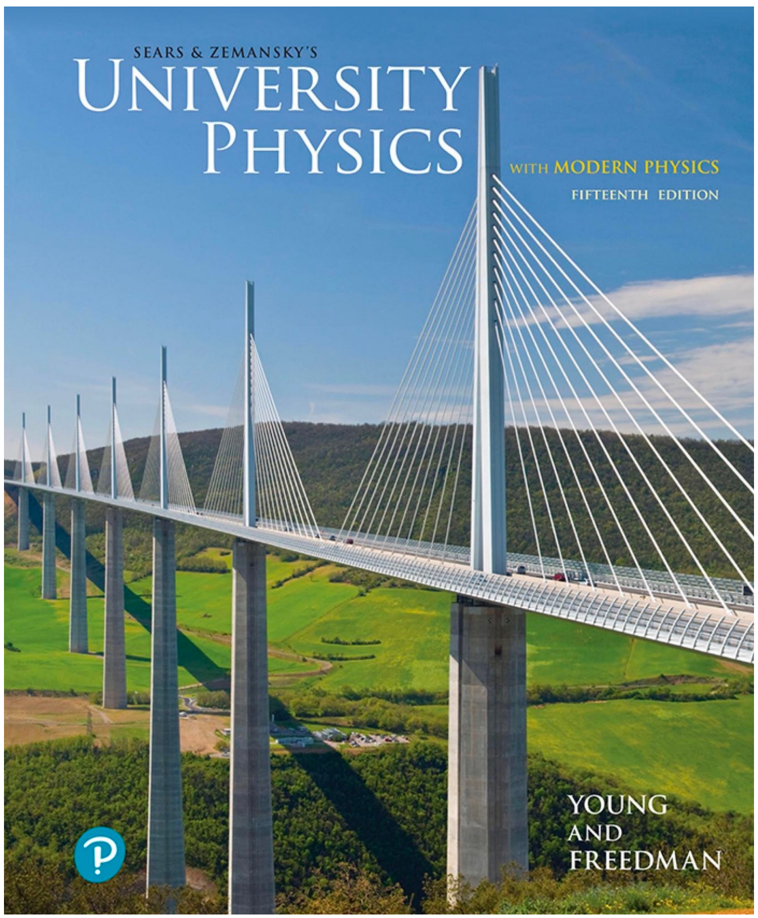
ACTIVATING UNIVERSITY PHYSICS: MAKING PHYSICS LECTURES COME ALIVE



ROGER FREEDMAN
AIRBOY@UCSB.EDU

10 MAY 2023

PLEASE FEEL FREE TO ASK QUESTIONS DURING THE WEBINAR!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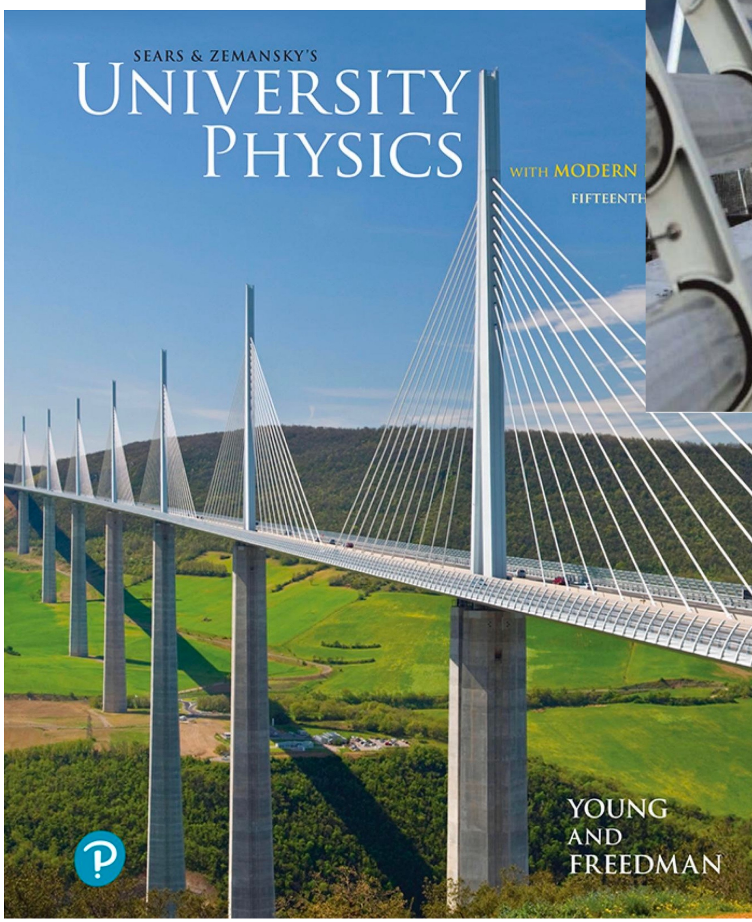
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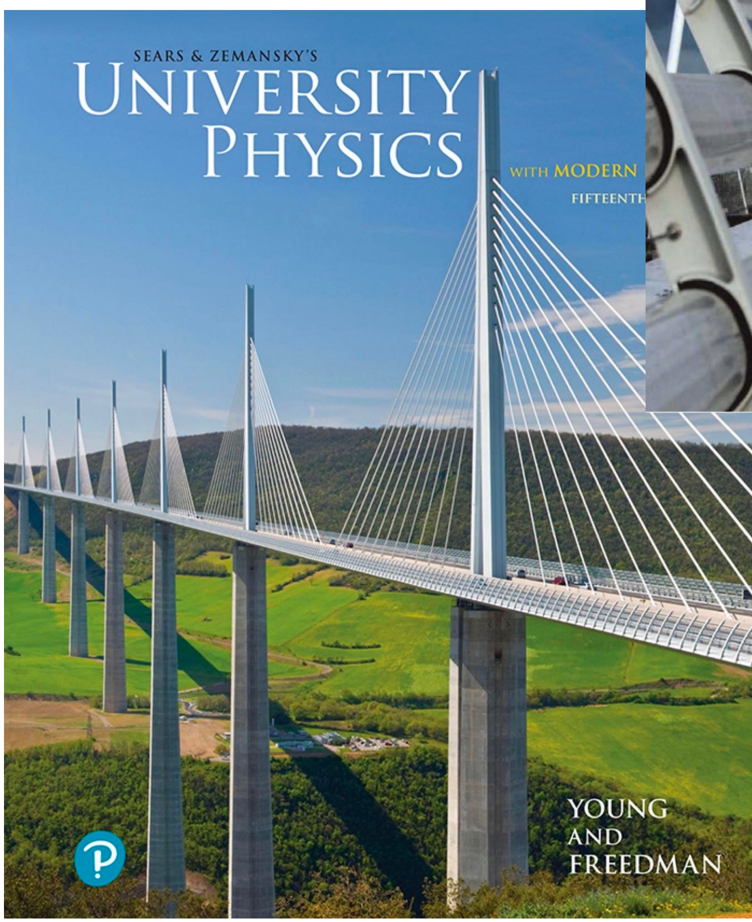
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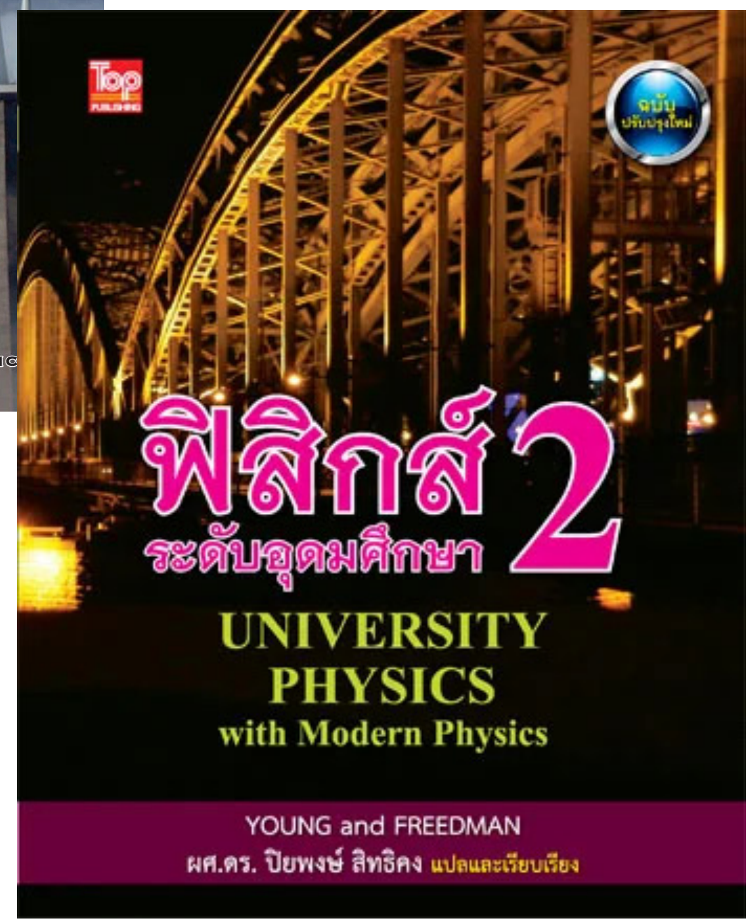
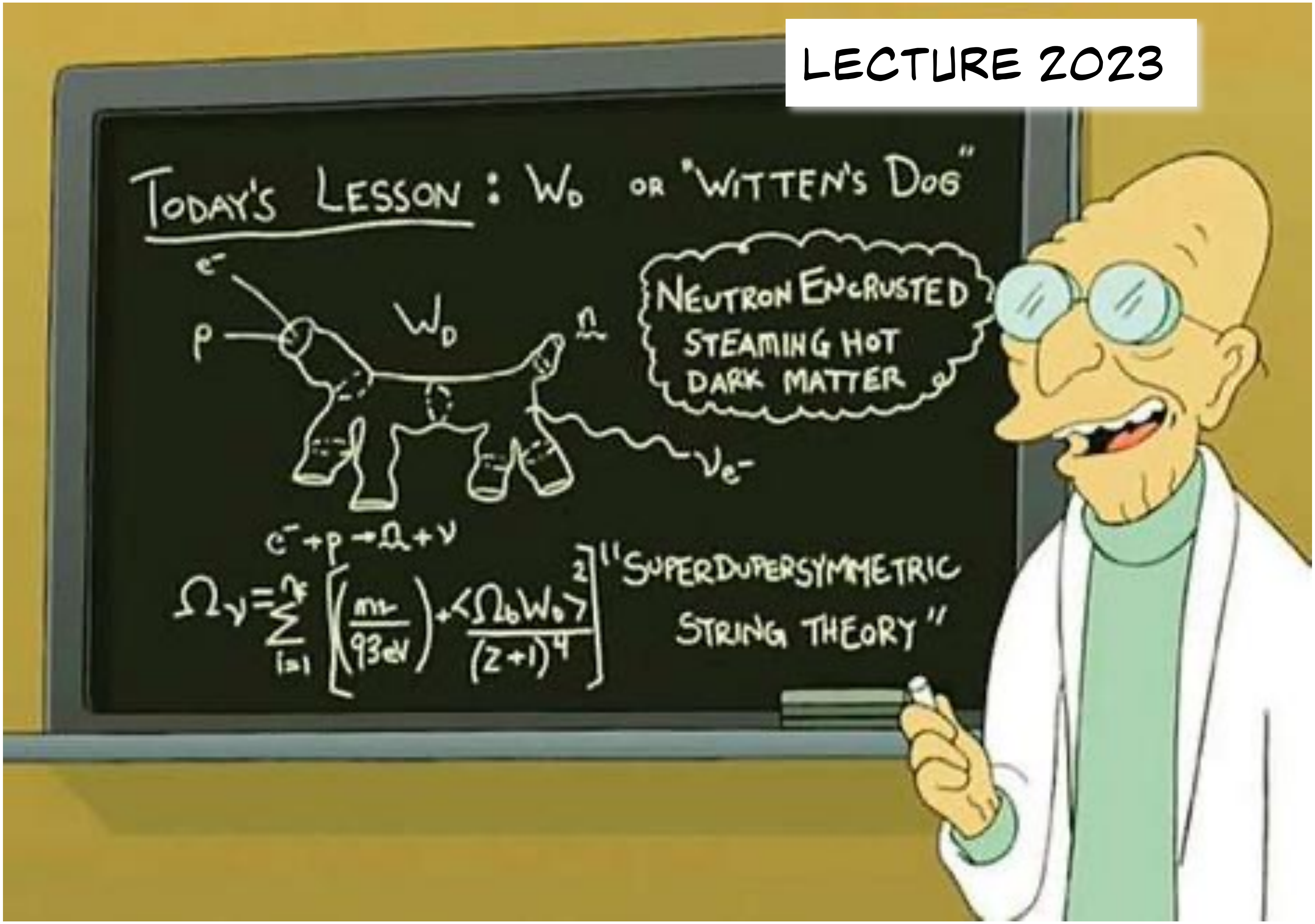

ฟิสิกส์ 2
ระดับอุดมศึกษา
UNIVERSITY PHYSICS
with Modern Physics
YOUNG and FREEDMAN
ผศ.ดร. ปิยพงษ์ สิทธิคง แปลและเรียบเรียง

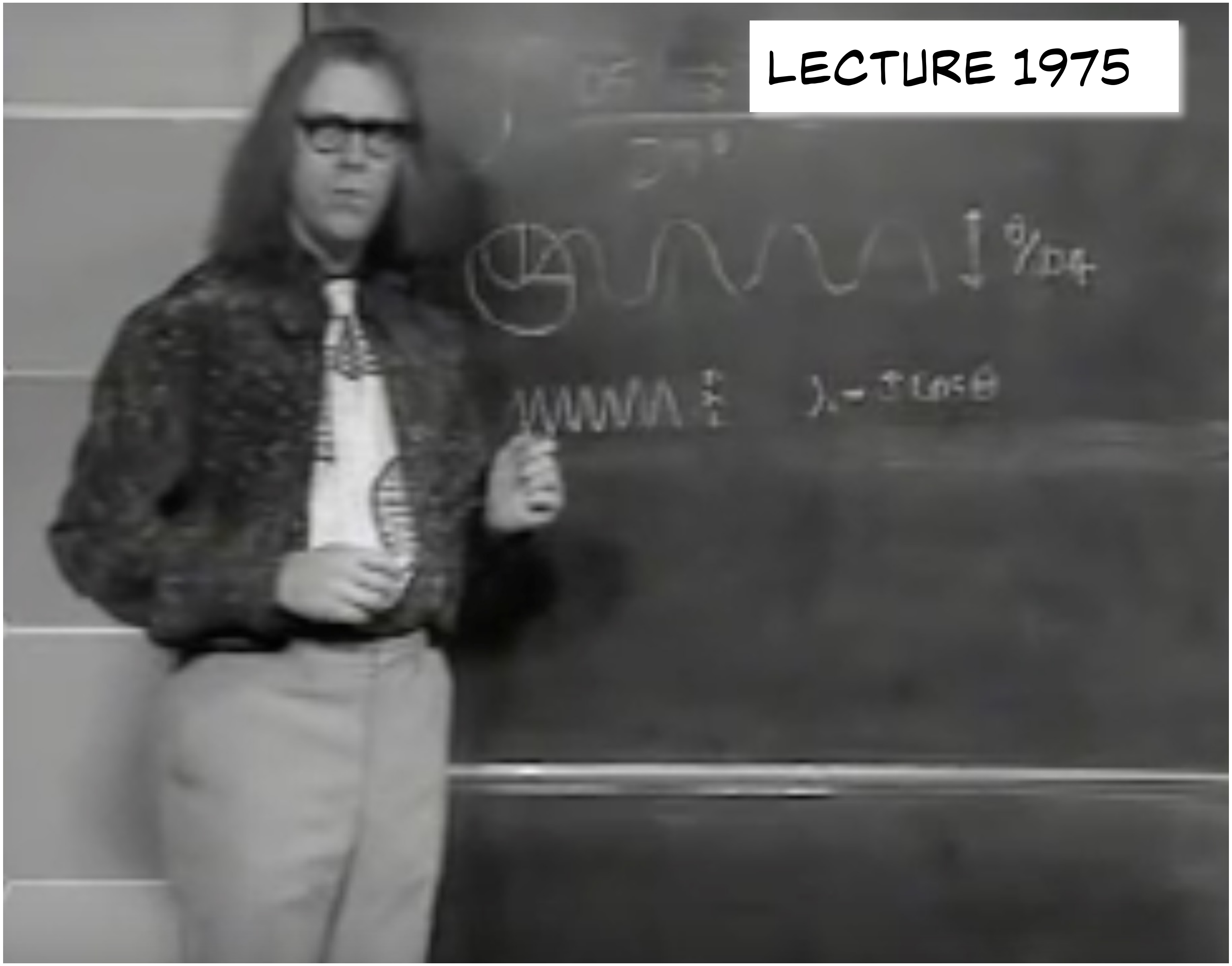
I UNDERSTAND
THE **CONCEPTS**...

I UNDERSTAND THE **CONCEPTS**...

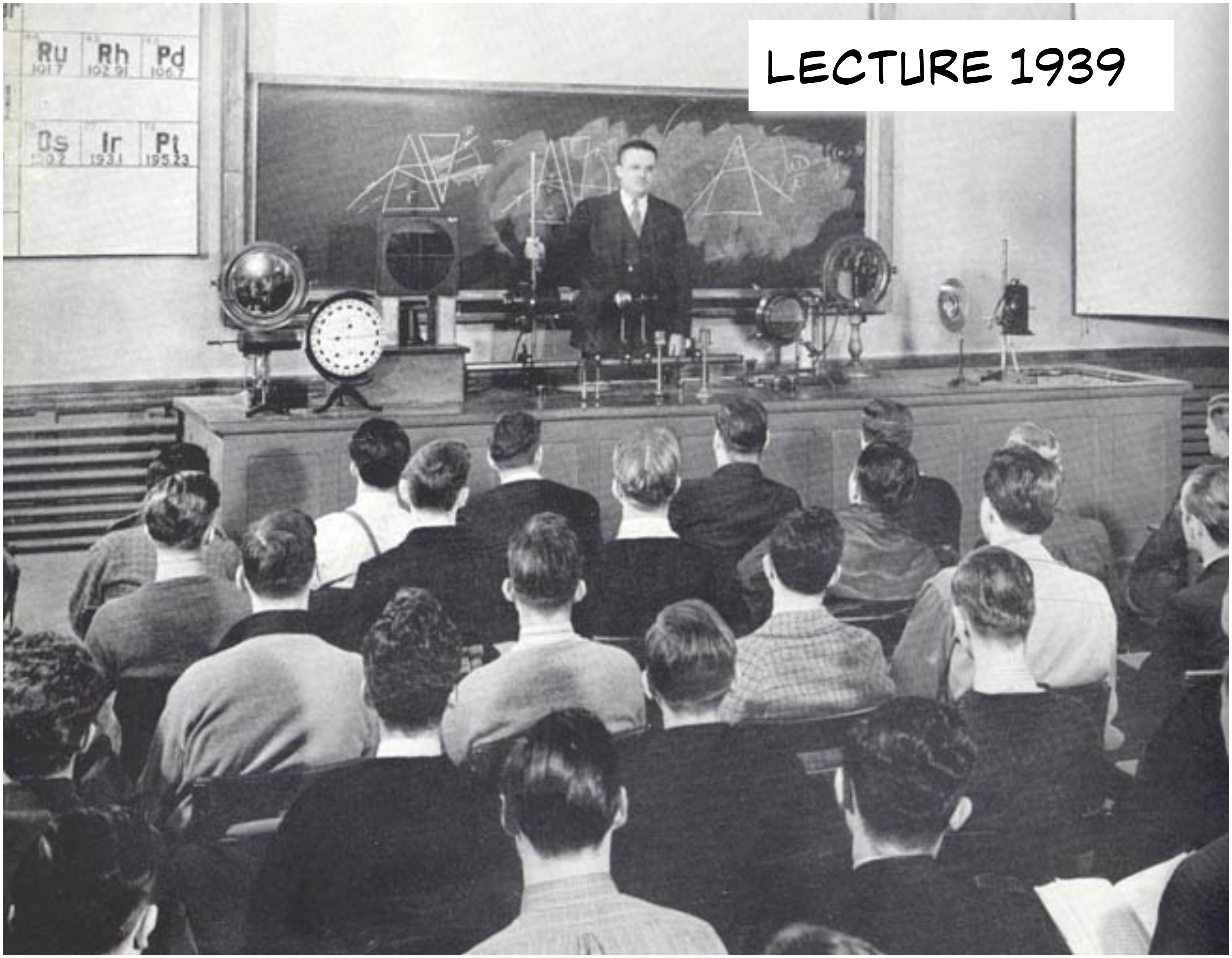
... I JUST CAN'T DO THE **PROBLEMS**!


LECTURE 2023
TODAY'S LESSON : W_D OR "WITTEN'S DOG"
NEUTRON ENCRUSTED STEAMING HOT DARK MATTER
"SUPERDUPERSYMMETRIC STRING THEORY"

(FUTURAMA)



(BBC)



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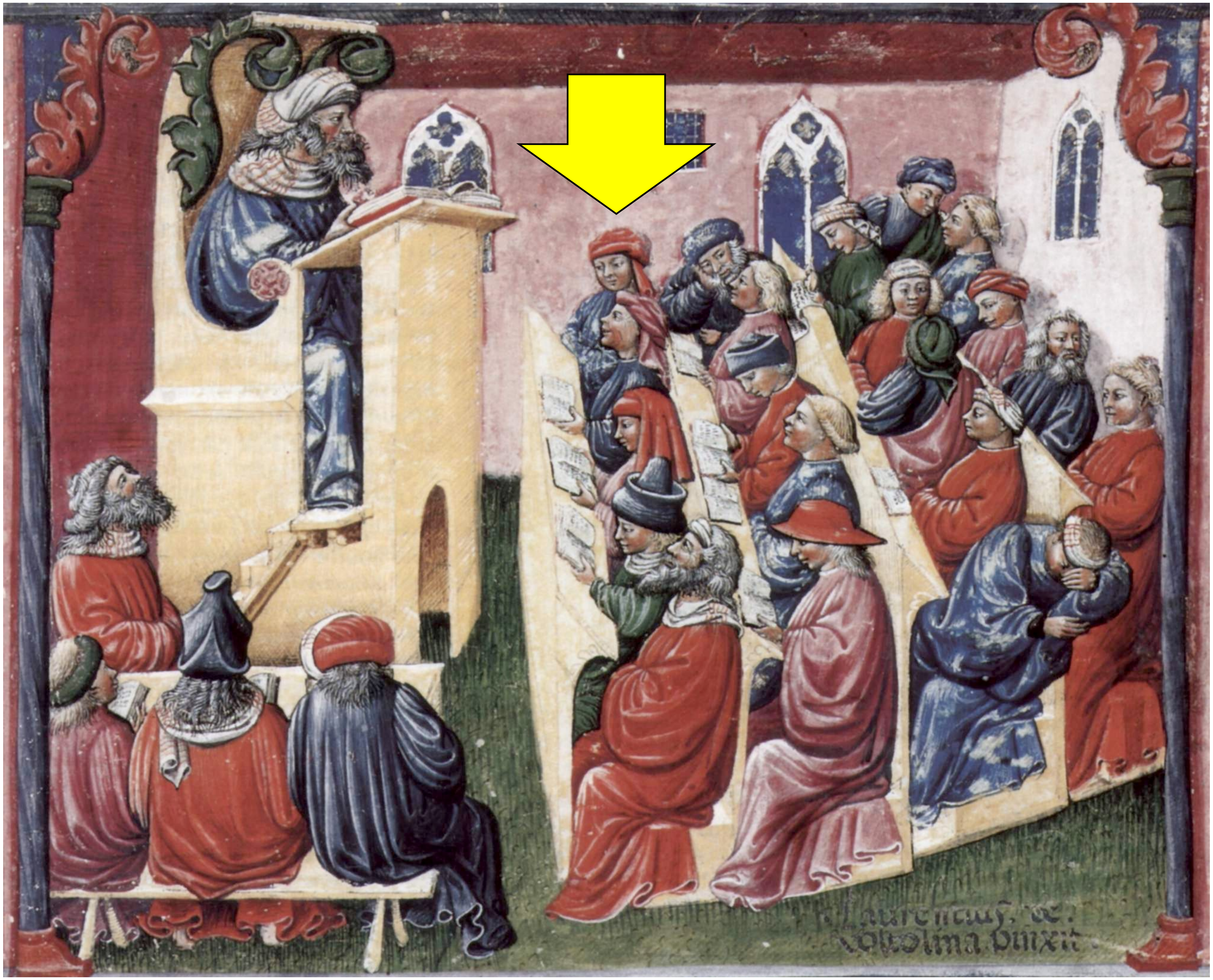

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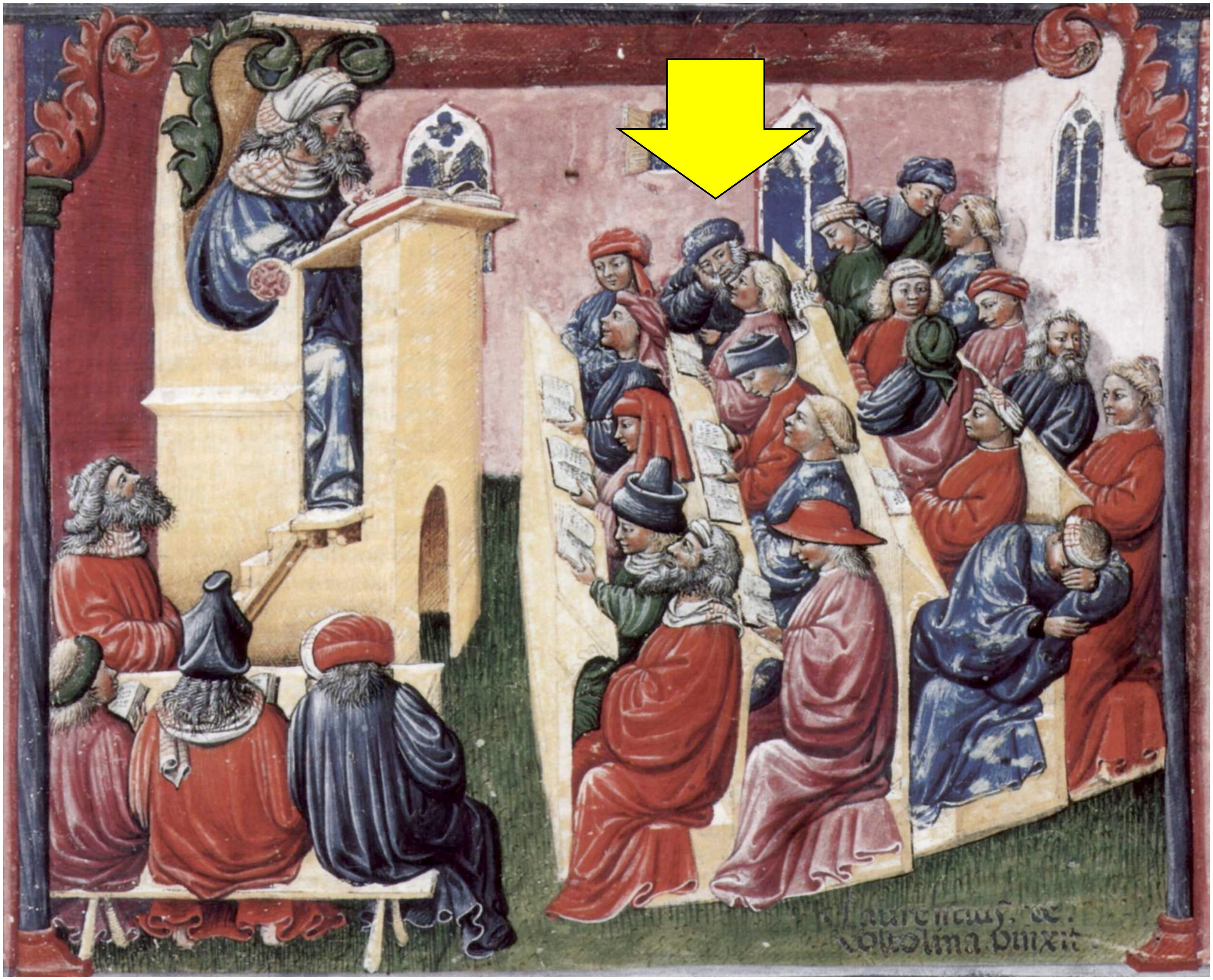

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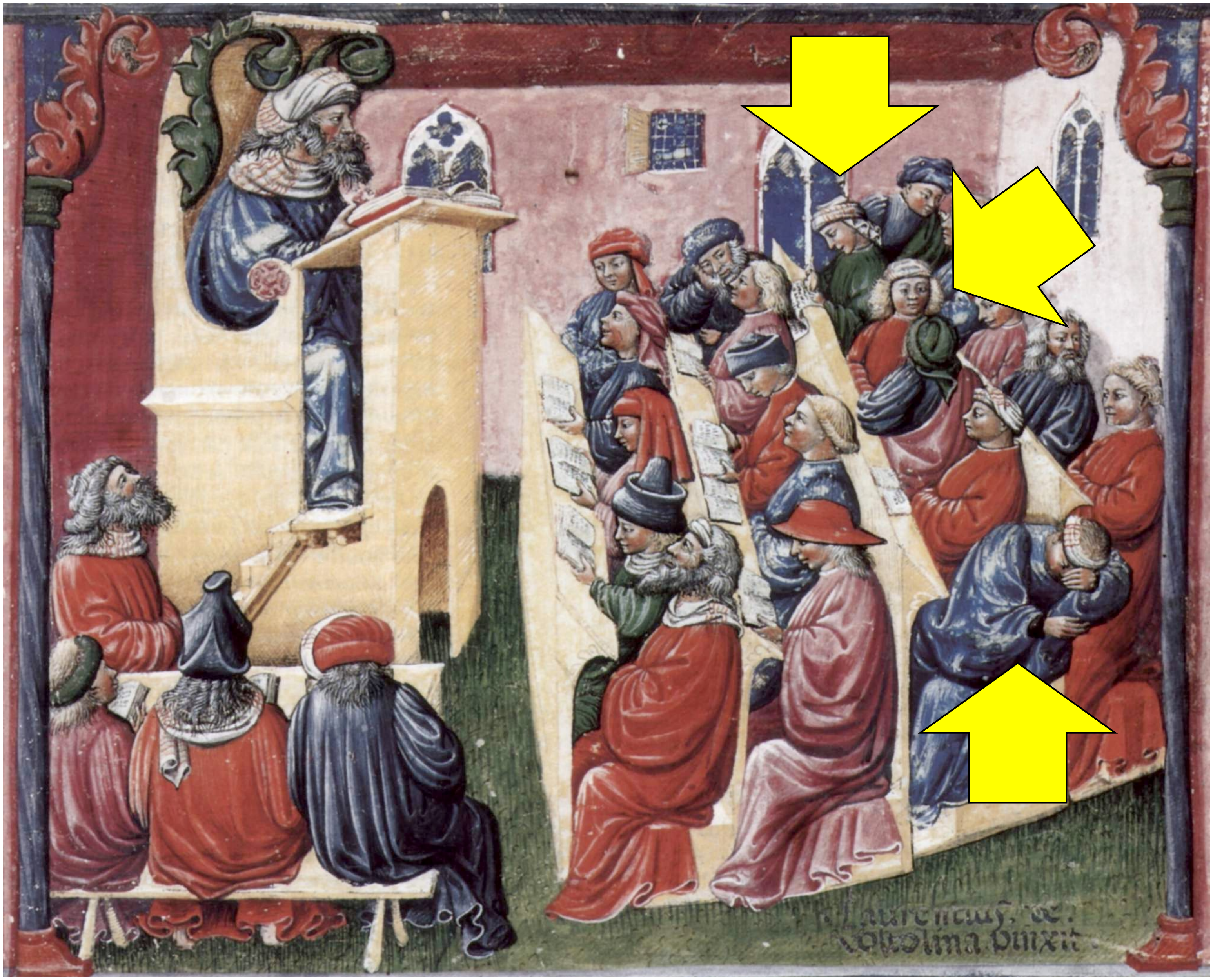

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Student Learning Gains in Physics

Class learning gain: $g = \dfrac{\langle \text{post-test\%} \rangle - \langle \text{pre-test\%} \rangle}{100 - \langle \text{pre-test\%} \rangle}$

STUDENT LEARNING GAINS IN PHYSICS

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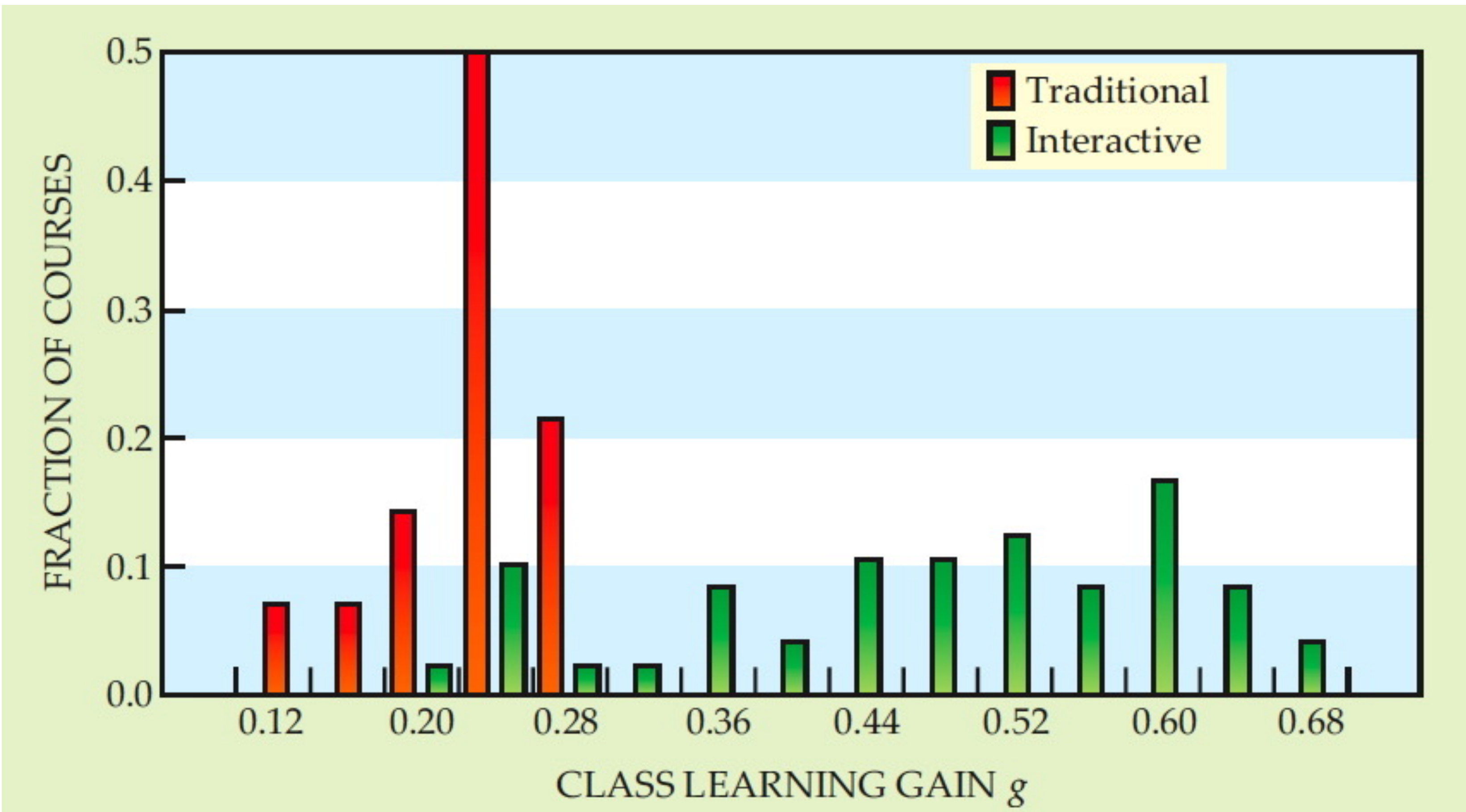

E. E. PRATHER, A. L. RUDOLPH, AND G. BRISSENDEN, PHYSICS TODAY 62(10):41-47 (2009)

STUDENT LEARNING GAINS IN PHYSICS

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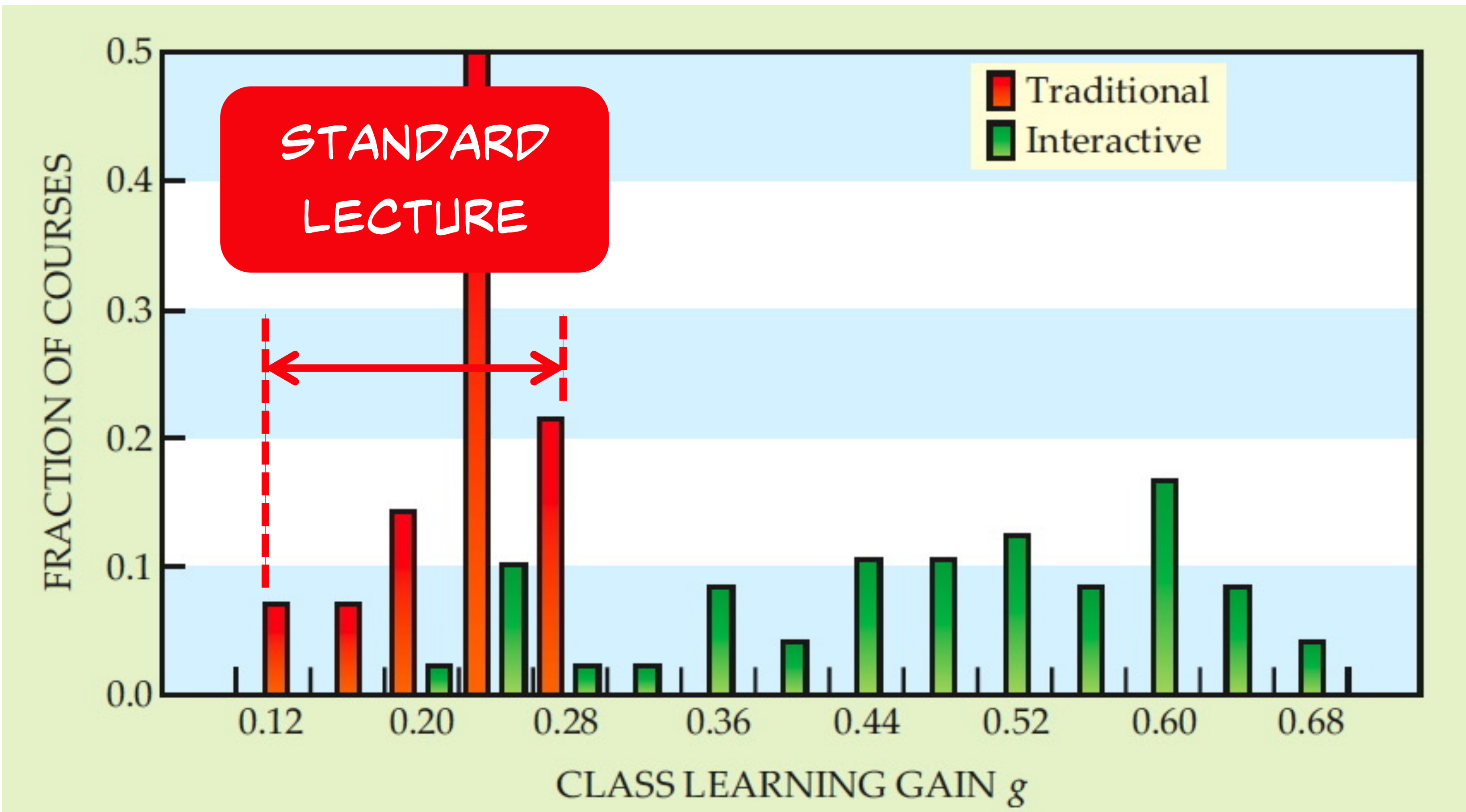

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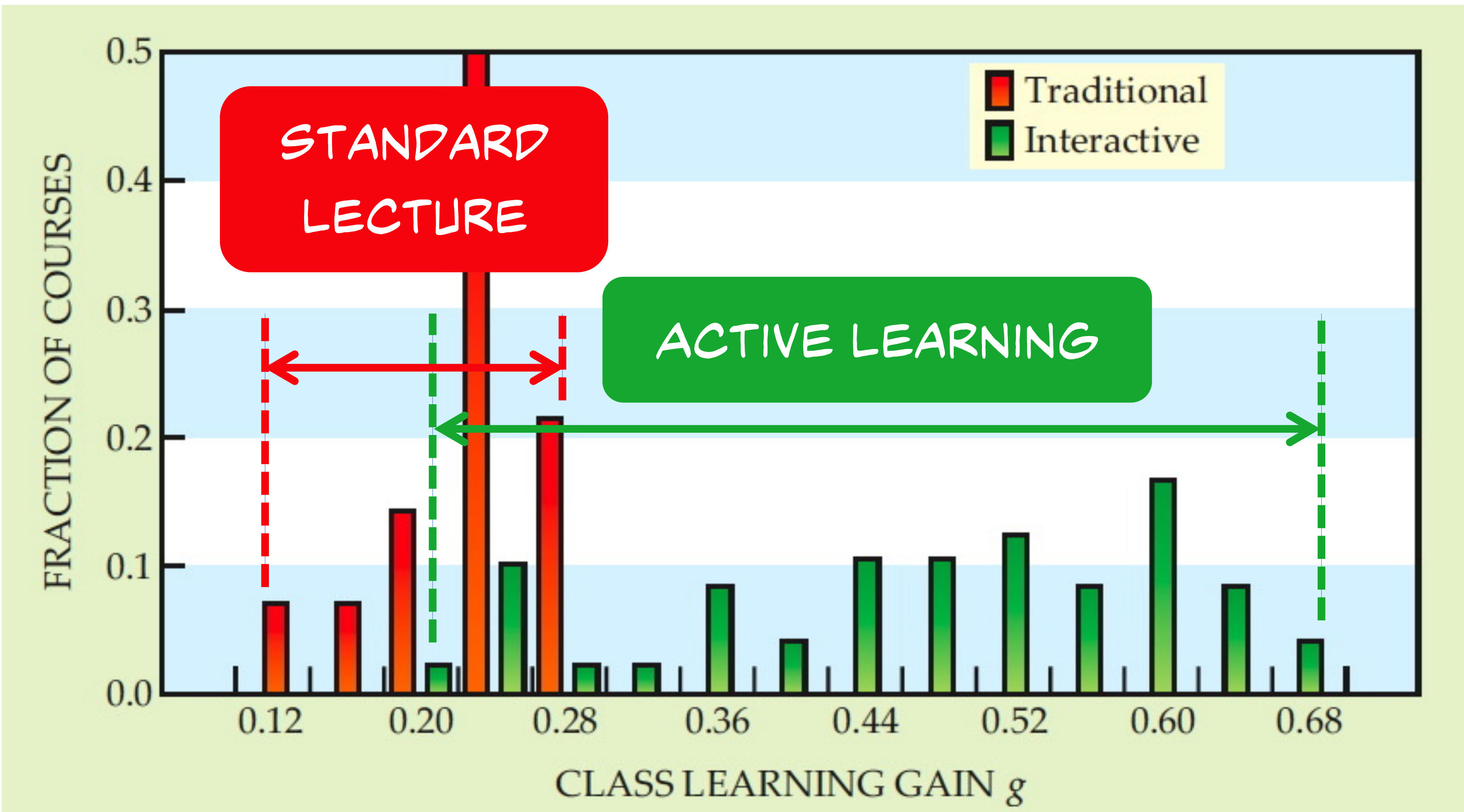

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WHAT IS ACTIVE LEARNING?

WHAT IS **ACTIVE LEARNING?**

STUDENTS ARE *ACTIVELY ENGAGED* DURING THE CLASS PERIOD

What is **Active Learning?**

Students are *actively engaged* during the class period

- Answering conceptual questions

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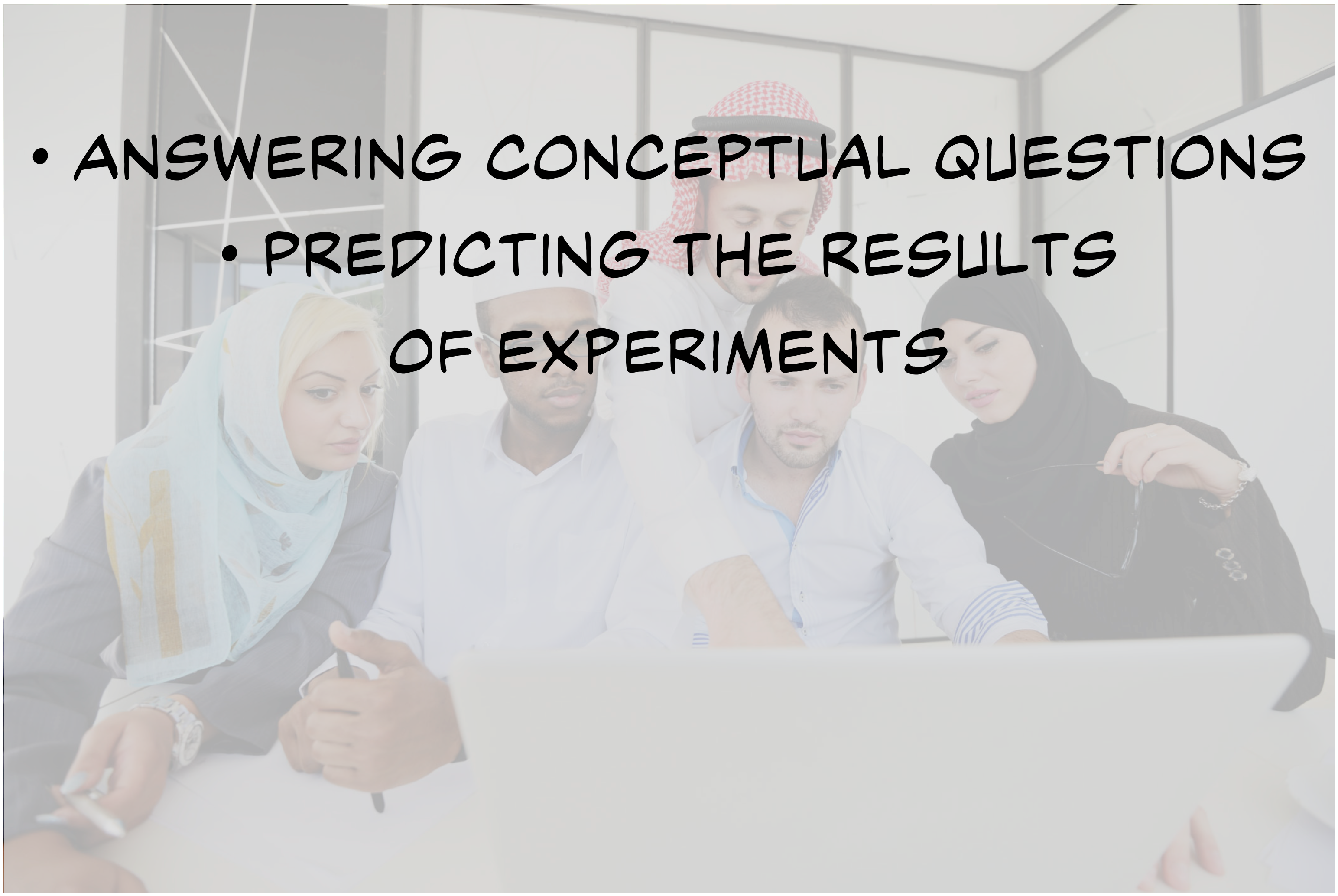

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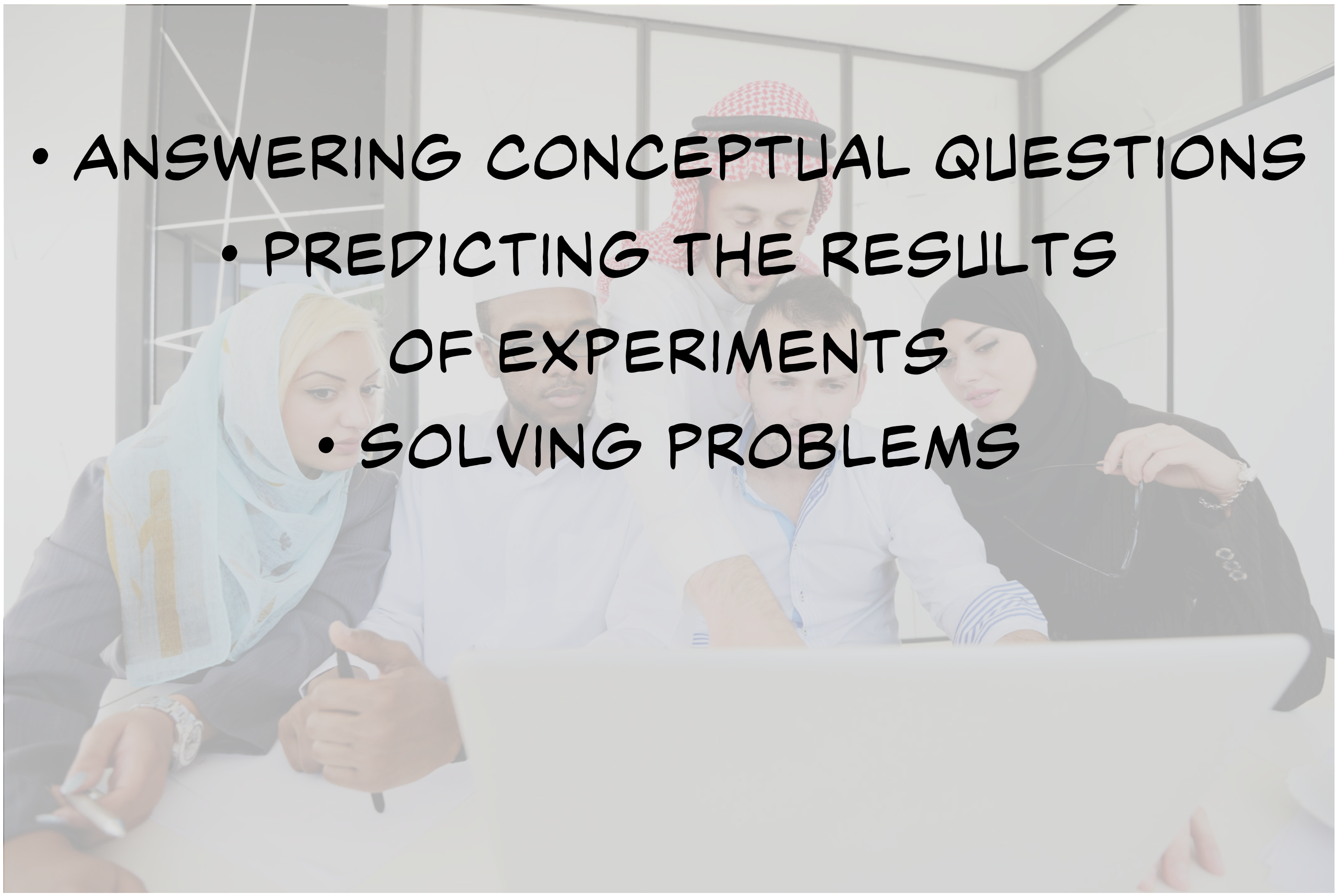

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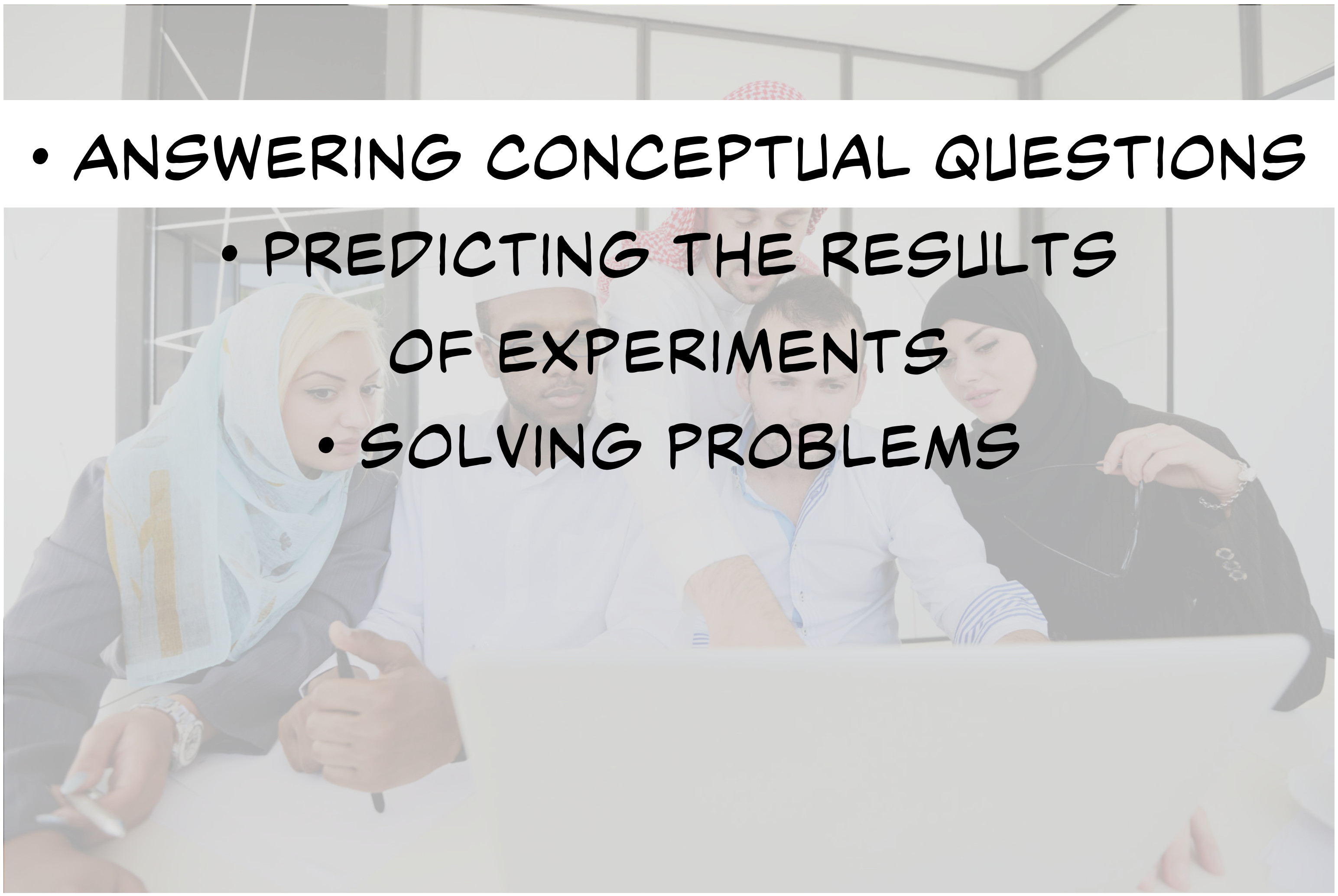
- PREDICTING THE RESULTS OF EXPERIMENTS
- SOLVING PROBLEMS



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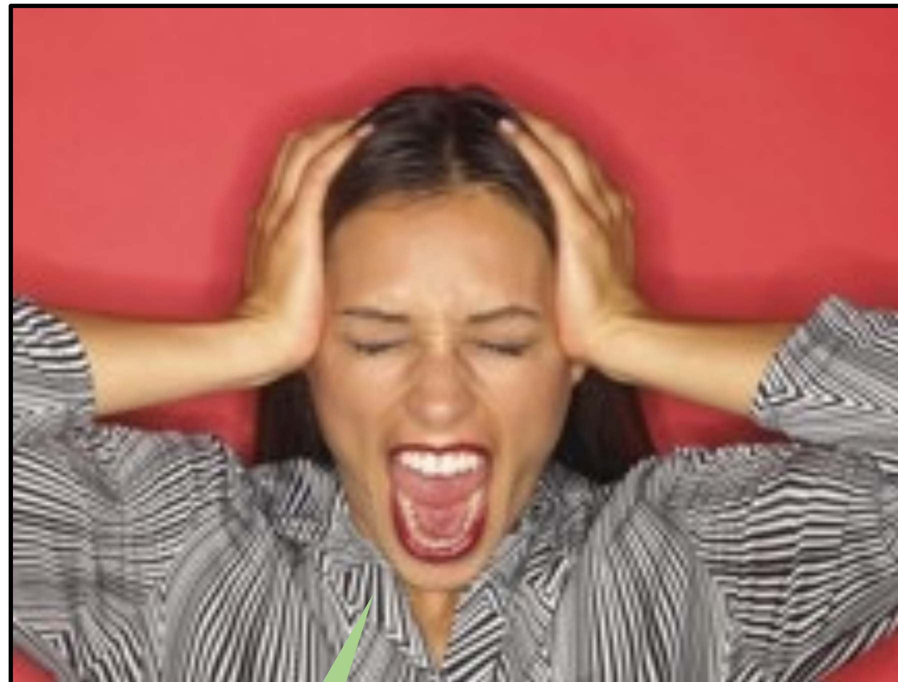
I CAN DO THE PROBLEMS THAT ARE JUST LIKE THOSE IN THE BOOK...



I CAN DO THE PROBLEMS THAT ARE JUST LIKE THOSE IN THE BOOK…

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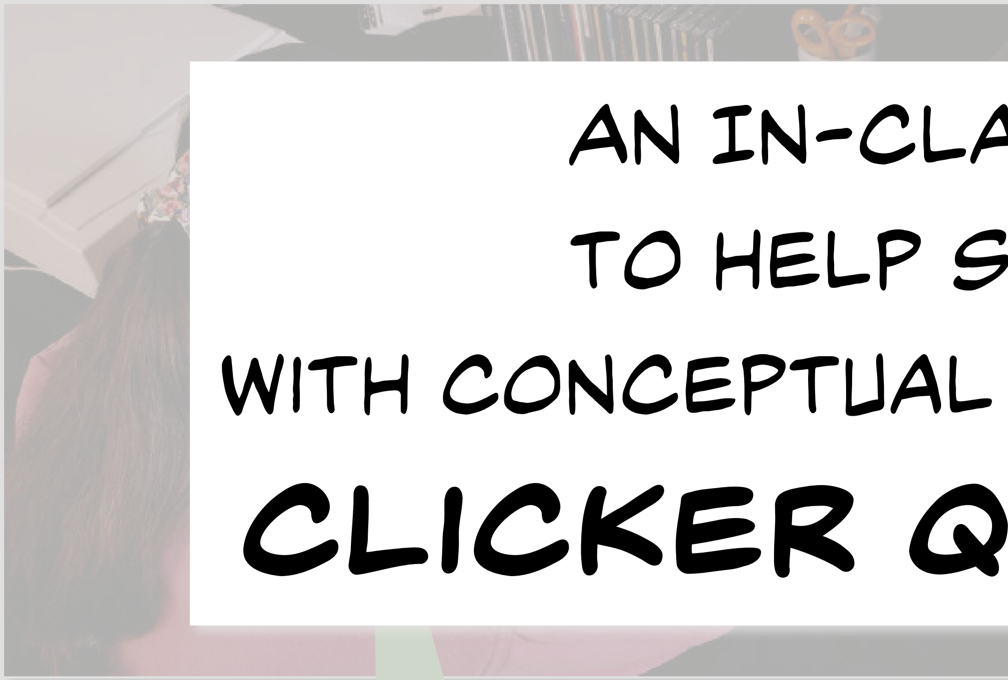

AN IN-CLASS TOOL TO HELP STUDENTS WITH CONCEPTUAL UNDERSTANDING:

CLICKER QUESTIONS

I CAN DO THE PROBLEMS THAT ARE JUST LIKE THOSE IN THE BOOK…

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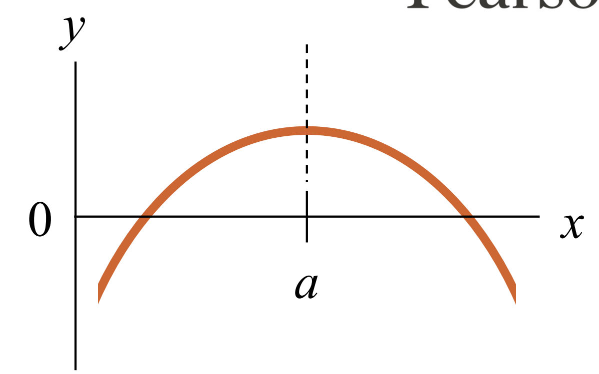
QUESTION



A wave on a string is moving to the right. This graph of $y(x, t)$ versus coordinate x for a specific time t shows the shape of part of the string at that time.

At this time, what is the *velocity* of a particle of the string at $x = a$?

A. The velocity is upward.

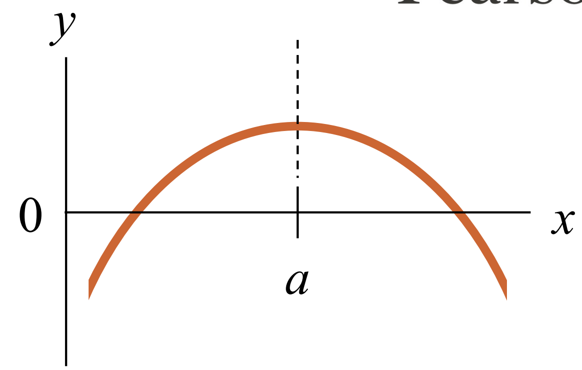
B. The velocity is downward.

C. The velocity is zero.

D. Either A. or B. is possible.

E. Any of A., B., or C. is possible.

ANSWER



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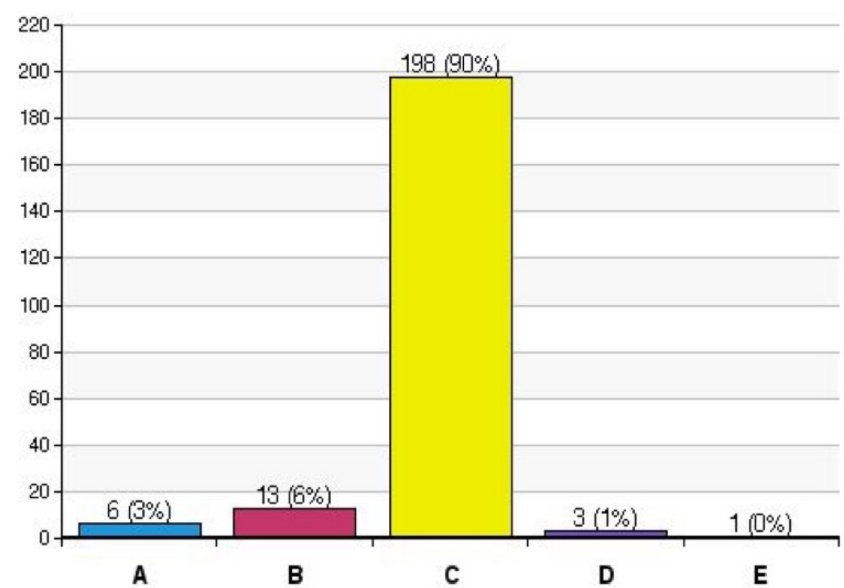

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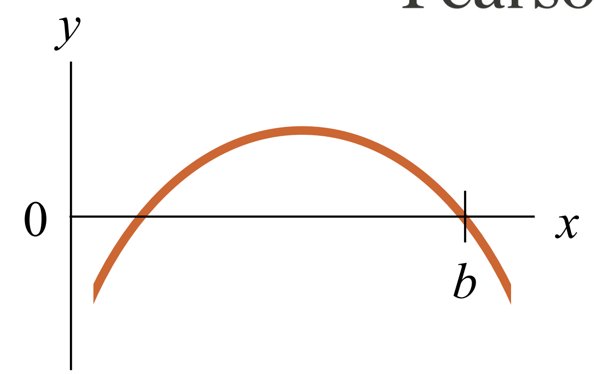

At this time, what is the *velocity* of a particle of the string at $x = b$?

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ANSWER

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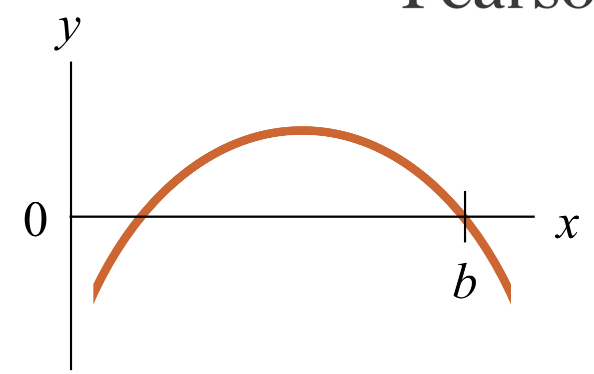

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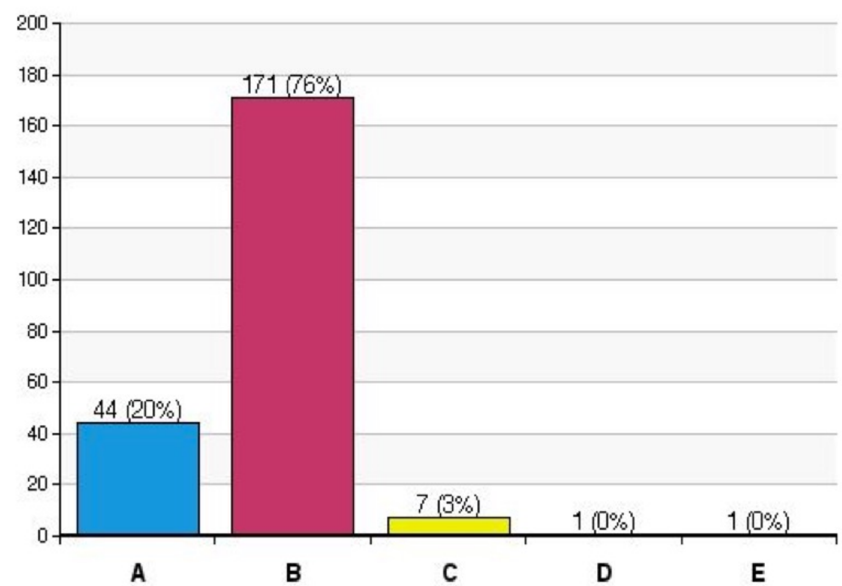


A RANKING TASK

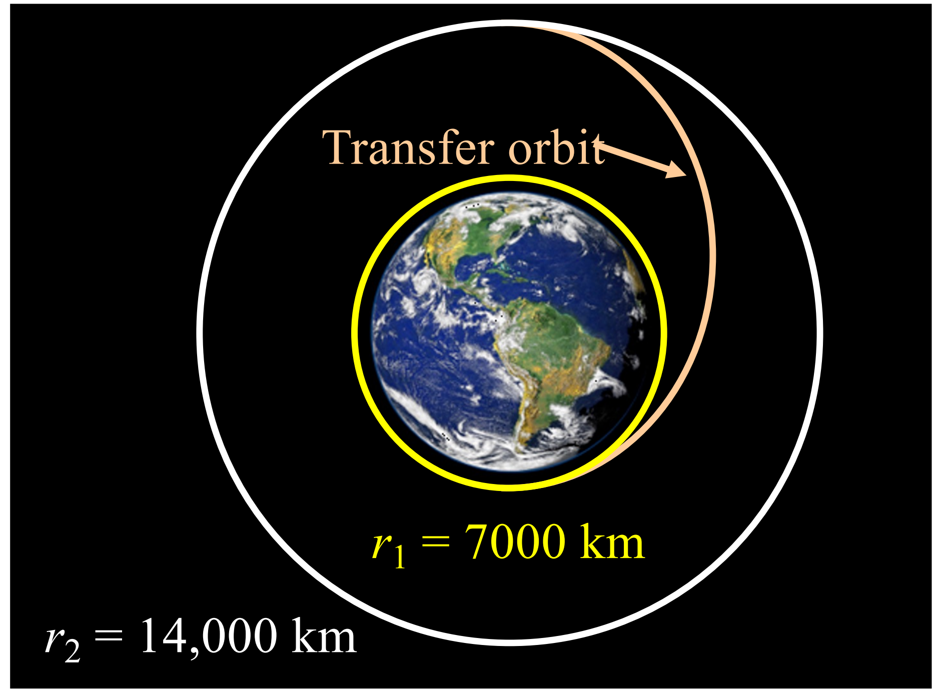
The figure shows three orbits of a spacecraft around the Earth:

A. circular orbit, radius $r_1 = 7000$ km

B. circular orbit, radius $r_2 = 14{,}000$ km

C. an elliptical transfer orbit between the orbits A and B

Rank these three orbits from *highest* to *lowest* angular momentum.



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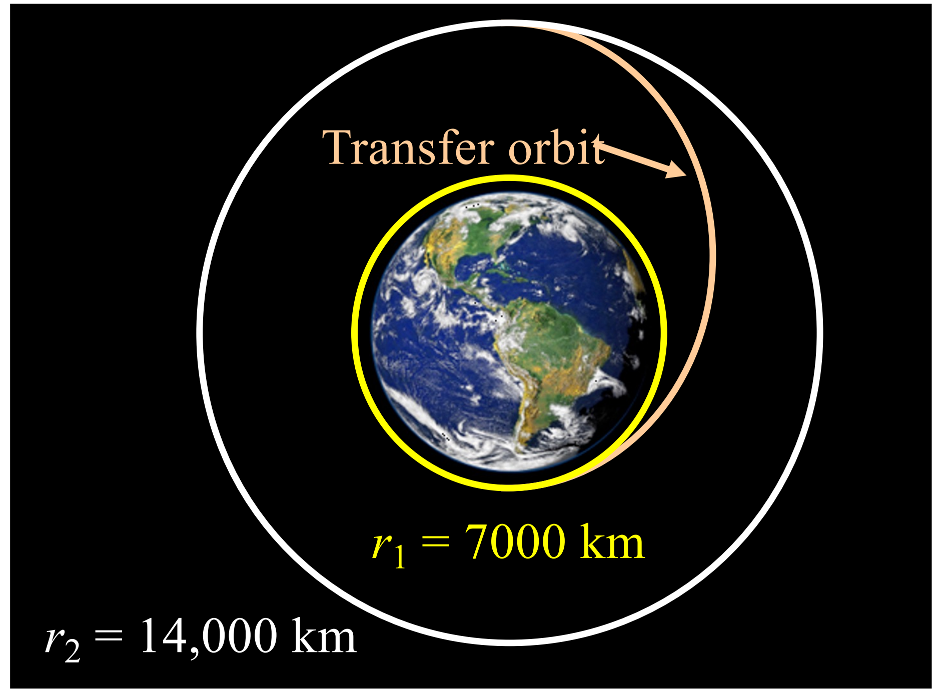

B, C, A

WHAT ACTIVE LEARNING PROVIDES

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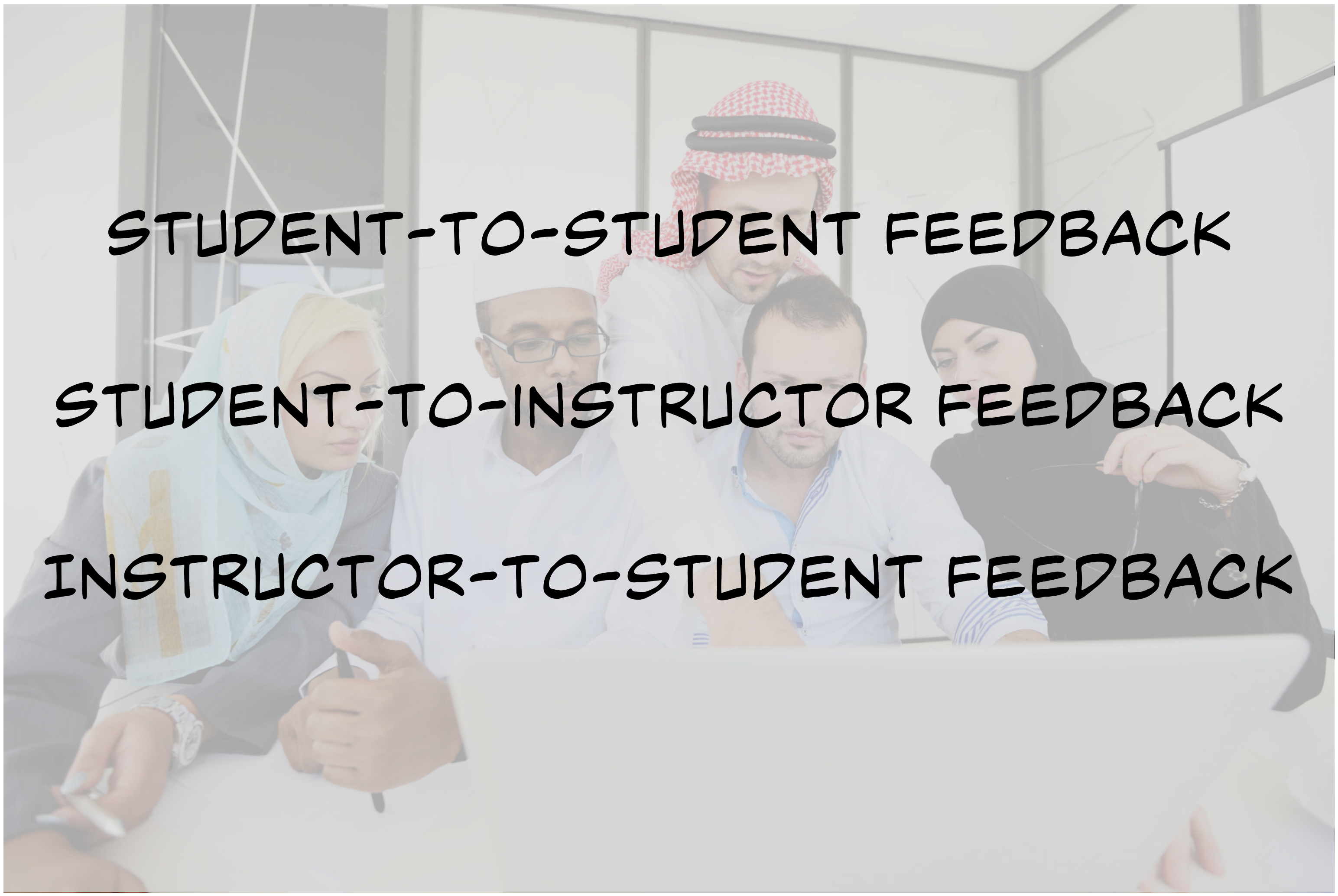
STUDENT-TO-STUDENT FEEDBACK

STUDENT-TO-INSTRUCTOR FEEDBACK

WHAT ACTIVE LEARNING PROVIDES



STUDENT-TO-STUDENT FEEDBACK

STUDENT-TO-INSTRUCTOR FEEDBACK

INSTRUCTOR-TO-STUDENT FEEDBACK

WHERE CAN CLICKER QUESTIONS (AND ANSWERS!) BE FOUND?

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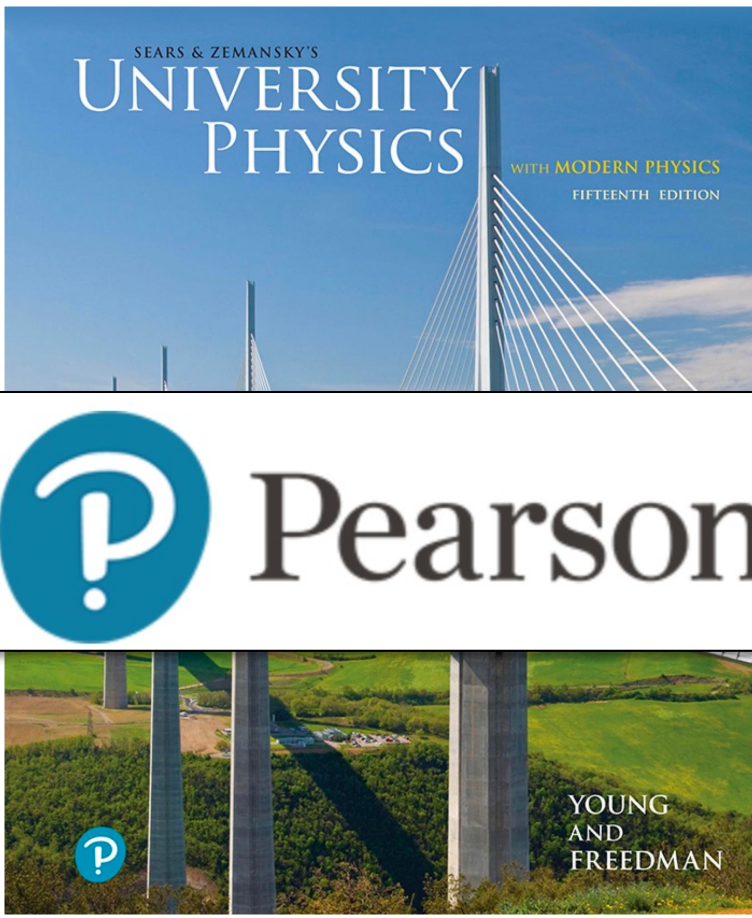

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Help

INSTRUCTOR RESOURCES

Home > Resources by Chapter > Chapter 2

Resources by Chapter

Chapter 2: Motion Along a Straight Line

Download instructor resources from the links below.

Lecture Outline and Text Elements

Chapter 2 Lecture and Text Elements zip, 43.3 MB

Download a .zip archive of chapter summary materials, end-of-chapter elements, figures and photos, key equations, problem-solving strategies, tables, chapter images in PowerPoint, and the accessible PowerPoint lecture outline for Chapter 2.

Chapter 2 Clicker Questions pptx, 945 KB

Clicker questions in PowerPoint with alt text for accessibility.

MasteringPhysics includes extensive

video content

MASTERINGPHYSICS INCLUDES EXTENSIVE **VIDEO CONTENT**

-- VIDEO *TUTOR SOLUTIONS*

-- VIDEO *TUTOR DEMONSTRATIONS*

-- *CONCEPTUAL* VIDEOS

-- VIDEO *LECTURES* BY PROF. MATT ANDERSON, SAN DIEGO STATE UNIVERSITY

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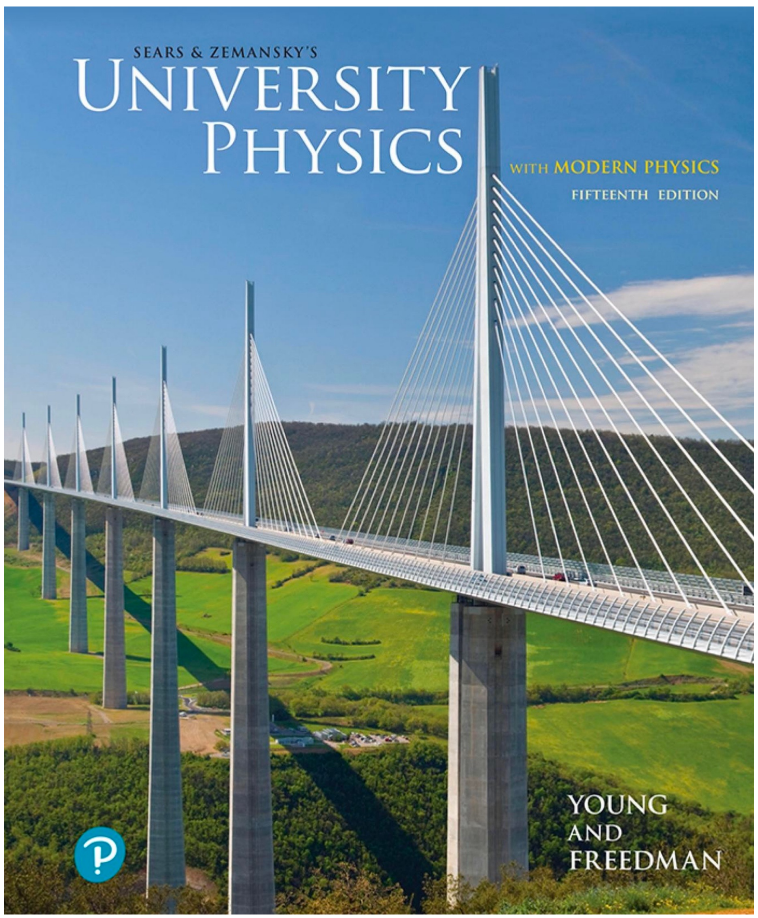
IDEA: USE THESE TO REPLACE PART OR ALL OF YOUR OWN LECTURES -- FREEING UP CLASS TIME FOR ACTIVE LEARNING!

-- VIDEO *LECTURES* BY PROF. MATT ANDERSON, SAN DIEGO STATE UNIVERSITY

TEXTBOOK FEATURES

DESIGNED TO HELP WITH STUDENT LEARNING

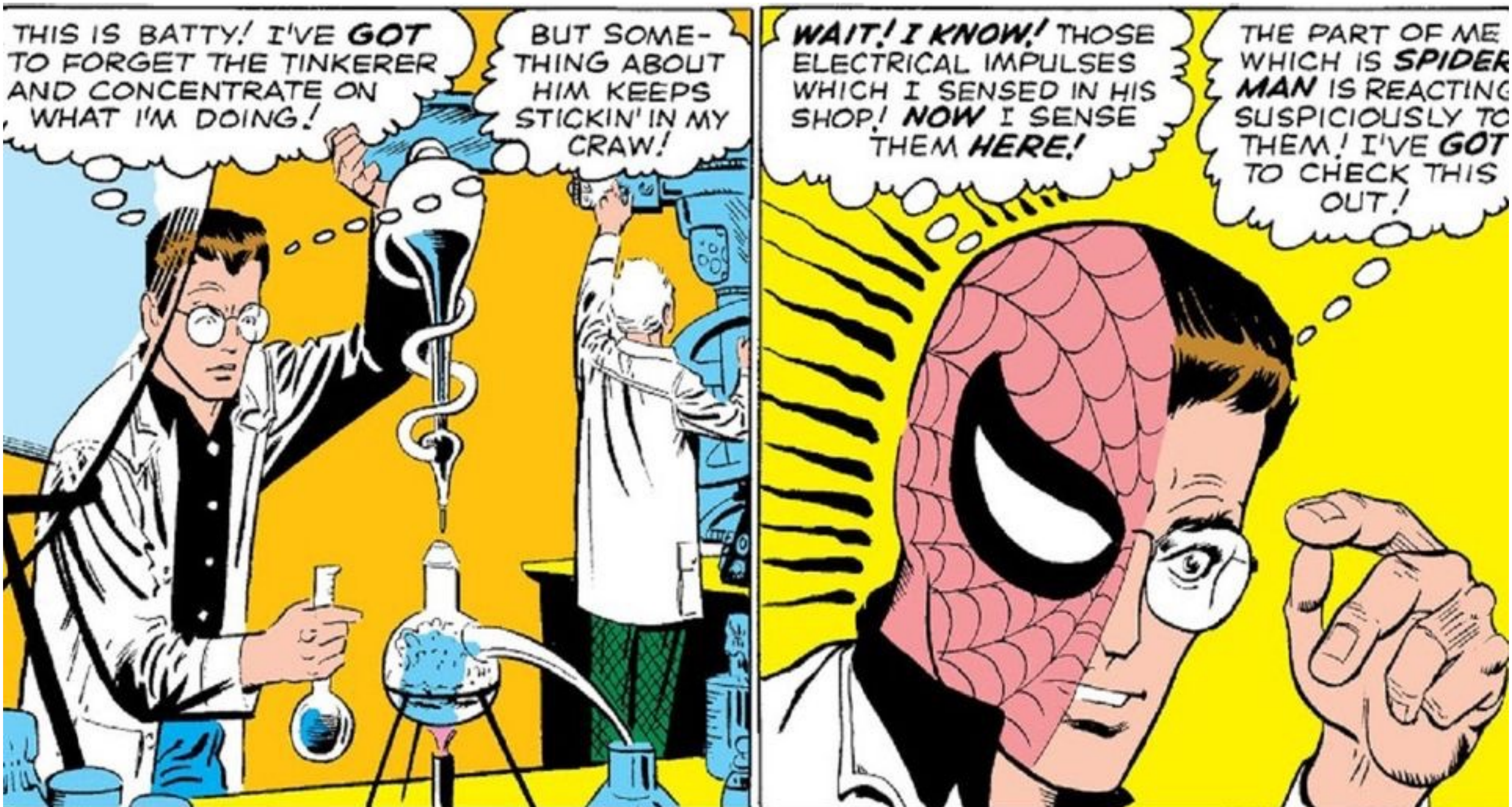


VISUAL AIDS TO LEARNING

VISUAL AIDS TO LEARNING

THE AMAZING SPIDER-MAN #2, APRIL 1963 ©MARVEL

VISUAL AIDS TO LEARNING



THE AMAZING SPIDER-MAN #2, APRIL 1963 ©MARVEL

Visual Aids to Learning

A key equation as presented in most textbooks

$$\vec{F}_{A\text{ on }B} = -\vec{F}_{B\text{ on }A} \qquad (4.10)$$

VISUAL AIDS TO LEARNING

A KEY EQUATION AS PRESENTED IN MOST TEXTBOOKS

$$\vec{F}_{A \text{ on } B} = -\vec{F}_{B \text{ on } A} \tag{4.10}$$

THE SAME EQUATION AS PRESENTED IN YOUNG & FREEDMAN

Newton's third law: When two objects *A* and *B* exert forces on each other ...

$$\vec{F}_{A \text{ on } B} = -\vec{F}_{B \text{ on } A} \tag{4.10}$$

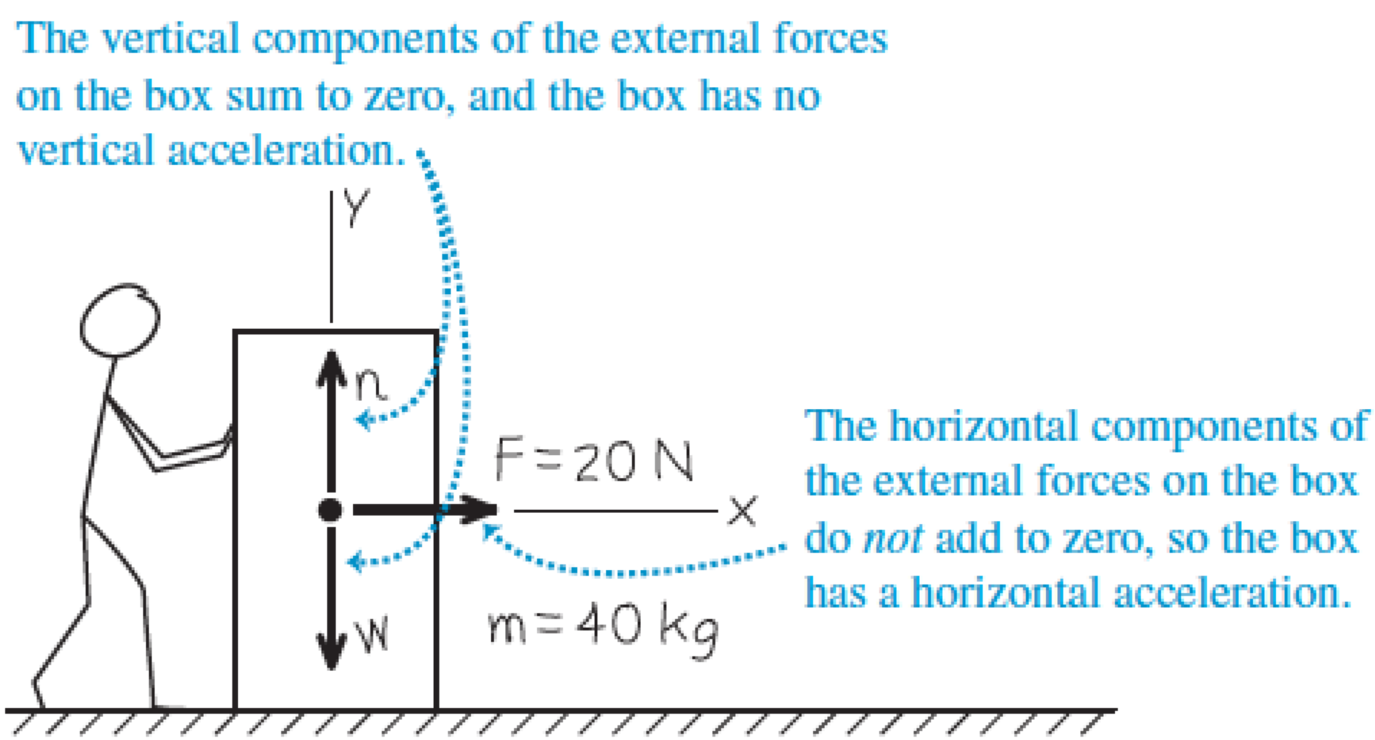
... the two forces have the same magnitude but opposite directions.

Note: The two forces act on *different* objects.

VISUAL AIDS TO LEARNING

MOST FIGURES ARE ALSO ANNOTATED

Figure 4.17 Our sketch for this problem.



PROBLEM-SOLVING GUIDANCE

PROBLEM-SOLVING GUIDANCE

ISEE: IDENTIFY, SET UP, EXECUTE, EVALUATE

PROBLEM-SOLVING GUIDANCE

ISEE: IDENTIFY, SET UP, EXECUTE, EVALUATE

-- USED IN PROBLEM-SOLVING STRATEGIES IN EVERY CHAPTER

PROBLEM-SOLVING STRATEGY 16.1 Sound Intensity

IDENTIFY *the relevant concepts:* The relationships between the intensity and amplitude of a sound wave are straightforward. Other quantities are involved in these relationships, however, so it's particularly important to decide which is your target variable.

SET UP *the problem* using the following steps:

1. Sort the physical quantities into categories. Wave properties include the displacement and pressure amplitudes A and p_{max}. The frequency f can be determined from the angular frequency ω, the wave number k, or the wavelength λ. These quantities are related through the wave speed v, which is determined by properties of the medium (B and ρ for a liquid, and γ, T, and M for a gas).
2. List the given quantities and identify the target variables. Find relationships that take you where you want to go.

EXECUTE *the solution:* Use your selected equations to solve for the target variables. Express the temperature in kelvins (Celsius temperature plus 273.15) to calculate the speed of sound in a gas.

EVALUATE *your answer:* If possible, use an alternative relationship to check your results.

PROBLEM-SOLVING GUIDANCE

ISEE: IDENTIFY, SET UP, EXECUTE, EVALUATE

-- USED IN PROBLEM-SOLVING STRATEGIES IN EVERY CHAPTER

-- USED IN ALL WORKED EXAMPLES

EXAMPLE 16.5 Intensity of a sound wave in air WITH VARIATION PROBLEMS

Find the intensity of the sound wave in Example 16.1, with $p_{max} = 3.0 \times 10^{-2}$ Pa. Assume the temperature is 20°C so that the density of air is $\rho = 1.20 \text{ kg/m}^3$ and the speed of sound is $v = 344$ m/s.

IDENTIFY and SET UP Our target variable is the intensity I of the sound wave. We are given the pressure amplitude p_{max} of the wave as well as the density ρ and wave speed v for the medium. We can determine I from p_{max}, ρ, and v from Eq. (16.14).

EXECUTE From Eq. (16.14),

$$I = \frac{p_{max}{}^2}{2\rho v} = \frac{(3.0 \times 10^{-2}\text{ Pa})^2}{2(1.20\text{ kg/m}^3)(344\text{ m/s})}$$

$$= 1.1 \times 10^{-6}\text{ J/(s}\cdot\text{m}^2) = 1.1 \times 10^{-6}\text{ W/m}^2$$

EVALUATE This seems like a very low intensity, but it is well within the range of sound intensities encountered on a daily basis. A very loud sound wave at the threshold of pain has a pressure amplitude of about 30 Pa and an intensity of about 1 W/m^2. The pressure amplitude of the faintest sound wave that can be heard is about 3×10^{-5} Pa, and the corresponding intensity is about 10^{-12} W/m^2. (Try these values of p_{max} in Eq. (16.14) to check that the corresponding intensities are as we have stated.)

KEYCONCEPT The intensity (power per unit area) of a sound wave is proportional to the square of the pressure amplitude of the wave. The proportionality constant depends on the density of the medium and the speed of sound in the medium.

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PROBLEM-SOLVING GUIDANCE

ISEE: IDENTIFY, SET UP, EXECUTE, EVALUATE

-- USED IN PROBLEM-SOLVING STRATEGIES IN EVERY CHAPTER

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$$I = \frac{p_{max}^2}{2\rho v} = \frac{(3.0 \times 10^{-2}\ \text{Pa})^2}{2(1.20\ \text{kg/m}^3)(344\ \text{m/s})}$$

$$= 1.1 \times 10^{-6}\ \text{J/(s} \cdot \text{m}^2) = 1.1 \times 10^{-6}\ \text{W/m}^2$$

EVALUATE This seems like a very low intensity, but it is well within the range of sound intensities encountered on a daily basis. A very loud sound wave at the threshold of pain has a pressure amplitude of about 30 Pa and an intensity of about 1 W/m^2. The pressure amplitude of the faintest sound wave that can be heard is about 3×10^{-5} Pa, and the corresponding intensity is about 10^{-12} W/m^2. (Try these values of p_{max} in Eq. (16.14) to check that the corresponding intensities are as we have stated.)

KEYCONCEPT The intensity (power per unit area) of a sound wave is proportional to the square of the pressure amplitude of the wave. The proportionality constant depends on the density of the medium and the speed of sound in the medium.

Problem-Solving Guidance

-- Key Concept called out explicitly in all examples

EXAMPLE 16.5 Intensity of a sound wave in air WITH VARIATION PROBLEMS

Find the intensity of the sound wave in Example 16.1, with $p_{max} = 3.0 \times 10^{-2}$ Pa. Assume the temperature is 20°C so that the density of air is $\rho = 1.20\ \text{kg/m}^3$ and the speed of sound is $v = 344$ m/s.

IDENTIFY and SET UP Our target variable is the intensity I of the sound wave. We are given the pressure amplitude p_{max} of the wave as well as the density ρ and wave speed v for the medium. We can determine I from p_{max}, ρ, and v from Eq. (16.14).

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KEYCONCEPT The intensity (power per unit area) of a sound wave is proportional to the square of the pressure amplitude of the wave. The proportionality constant depends on the density of the medium and the speed of sound in the medium.

PROBLEM-SOLVING GUIDANCE

-- KEY CONCEPT CALLED OUT EXPLICITLY IN ALL EXAMPLES

-- THREE EXAMPLES PER CHAPTER HAVE ASSOCIATED VARIATION PROBLEMS

EXAMPLE 16.5 Intensity of a sound wave in air WITH VARIATION PROBLEMS

Find the intensity of the sound wave in Example 16.1, with $p_{max} = 3.0 \times 10^{-2}$ Pa. Assume the temperature is 20°C so that the density of air is $\rho = 1.20\ \text{kg/m}^3$ and the speed of sound is $v = 344$ m/s.

IDENTIFY and SET UP Our target variable is the intensity I of the sound wave. We are given the pressure amplitude p_{max} of the wave as well as the density ρ and wave speed v for the medium. We can determine I from p_{max}, ρ, and v from Eq. (16.14).

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KEYCONCEPT The intensity (power per unit area) of a sound wave is proportional to the square of the pressure amplitude of the wave. The proportionality constant depends on the density of the medium and the speed of sound in the medium.

PROBLEM-SOLVING GUIDANCE

-- **KEY CONCEPT** CALLED OUT EXPLICITLY IN ALL EXAMPLES

-- THREE EXAMPLES PER CHAPTER HAVE ASSOCIATED **VARIATION PROBLEMS**

GUIDED PRACTICE

For assi

KEY EXAMPLE VARIATION PROBLEMS

Be sure to review EXAMPLES 16.5, 16.6, 16.7, 16.8, and 16.9 (Section 16.3) before attempting these problems.

VP16.9.1 A 256 Hz sound wave in air (density 1.20 kg/m^3, speed of sound 344 m/s) has intensity 5.50×10^{-8} W/m^2. (a) What is the wave's pressure amplitude? (b) If the intensity remains the same but the frequency is doubled to 512 Hz, how does this affect the pressure amplitude?

VP16.9.2 At a certain distance from a fire alarm, the sound intensity level is 85.0 dB. (a) What is the intensity of this sound? (b) How many times greater is the intensity of this sound than that of a 67.0 dB sound?

VP16.9.3 A lion can produce a roar with a sound intensity level of 114 dB at a distance of 1.00 m. What is the sound intensity level at a distance of (a) 4.00 m and (b) 16.0 m from the lion? Assume that intensity obeys the inverse-square law.

VP16.9.4 The sound intensity level inside a typical modern airliner in flight is 66.0 dB. The air in the cabin has density 0.920 kg/m^3 (less than in the atmosphere at sea level) and speed of sound 344 m/s. (a) What is the pressure amplitude of this sound? (b) If the pressure amplitude were increased by a factor of 10.0, what would the new sound intensity level be?

(ANSWERS TO THE VARIATION PROBLEMS ARE PROVIDED AT THE END OF THE CHAPTER)

PROBLEM-SOLVING GUIDANCE

-- BRIDGING PROBLEM IN EACH CHAPTER

HELPS TRANSITION TO END-OF-CHAPTER PROBLEMS

(ANSWER PROVIDED AT END OF CHAPTER)

BRIDGING PROBLEM Loudspeaker Interference

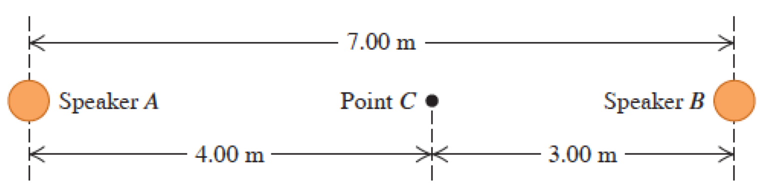
Loudspeakers *A* and *B* are 7.00 m apart and vibrate in phase at 172 Hz. They radiate sound uniformly in all directions. Their acoustic power outputs are 8.00×10^{-4} W and 6.00×10^{-5} W, respectively. The air temperature is 20°C. (a) Determine the difference in phase of the two signals at a point *C* along the line joining *A* and *B*, 3.00 m from *B* and 4.00 m from *A* (**Fig. 16.39**). (b) Determine the intensity and sound intensity level at *C* from speaker *A* alone (with *B* turned off) and from speaker *B* alone (with *A* turned off). (c) Determine the intensity and sound intensity level at *C* from both speakers together.

SOLUTION GUIDE

IDENTIFY and SET UP

1. Choose the equations that relate power, distance from the source, intensity, pressure amplitude, and sound intensity level.

Figure 16.39 The situation for this problem.



2. Decide how you'll determine the phase difference in part (a). Once you have found the phase difference, how can you use it to find the amplitude of the combined wave at *C* due to both sources?
3. List the unknown quantities for each part of the problem and identify your target variables.

EXECUTE

4. Determine the phase difference at point *C*.
5. Find the intensity, sound intensity level, and pressure amplitude at *C* due to each speaker alone.
6. Use your results from steps 4 and 5 to find the pressure amplitude at *C* due to both loudspeakers together.
7. Use your result from step 6 to find the intensity and sound intensity level at *C* due to both loudspeakers together.

EVALUATE

8. How do your results from part (c) for intensity and sound intensity level at *C* compare to those from part (b)? Does this make sense?
9. What result would you have gotten in part (c) if you had (incorrectly) combined the *intensities* from *A* and *B* directly, rather than (correctly) combining the *pressure amplitudes* as you did in step 6?

CONFRONTING MISCONCEPTIONS

CONFRONTING MISCONCEPTIONS

-- CAUTION PARAGRAPHS IN EVERY CHAPTER

CONFRONTING MISCONCEPTIONS

-- CAUTION PARAGRAPHS IN EVERY CHAPTER

-- POINT OUT COMMON POINTS OF CONFUSION

CAUTION **Wave velocity vs. particle velocity** Remember that the velocity of the wave as a whole is *not* the same as the particle velocity. While the wave continues to move in the direction of propagation, individual particles in the wave medium merely slosh back and forth, as shown in Fig. 16.1. Furthermore, the maximum speed of a particle of the medium can be very different from the wave speed.

CONFRONTING MISCONCEPTIONS

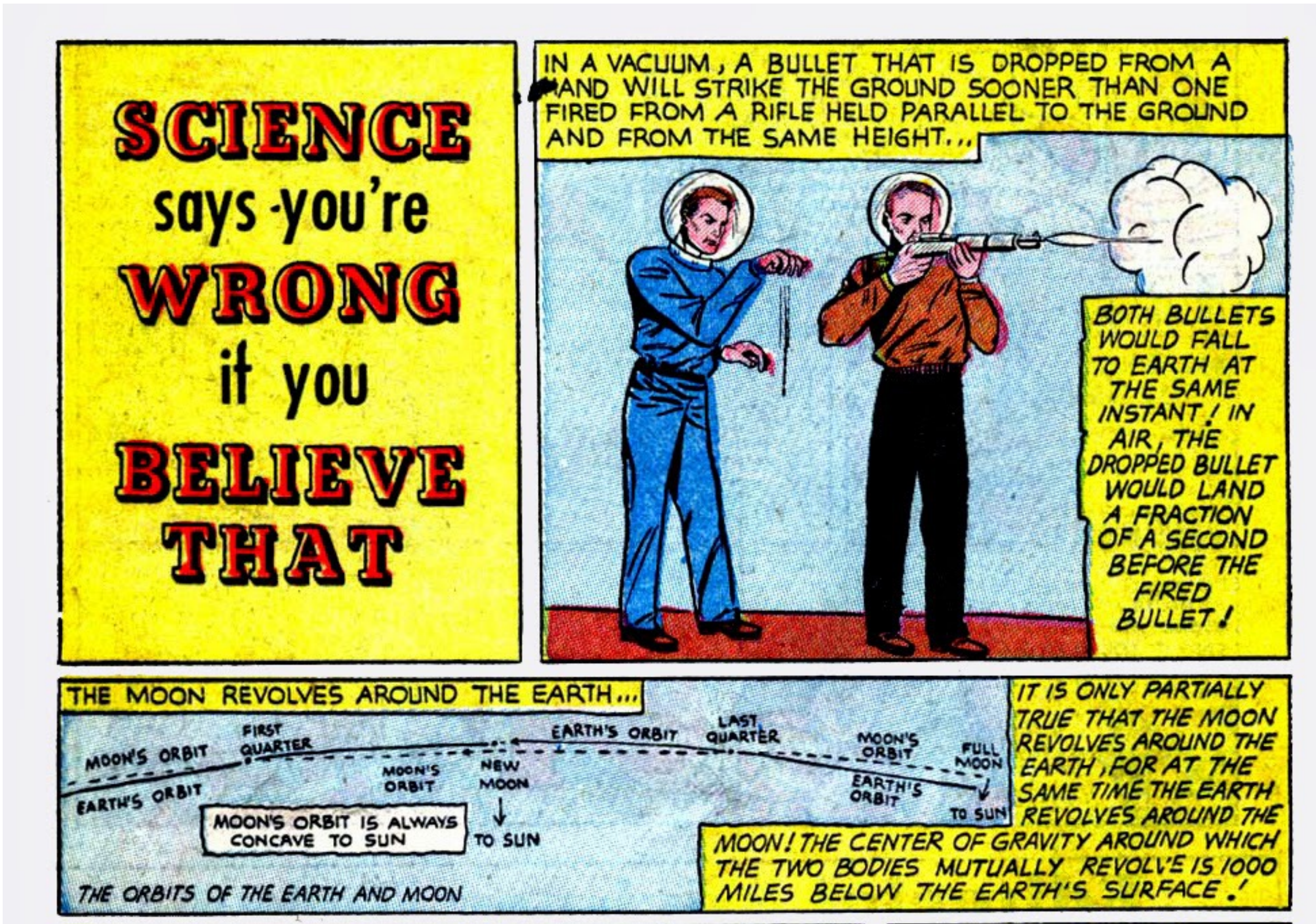
-- CAUTION PARAGRAPHS IN EVERY CHAPTER

-- POINT OUT COMMON POINTS OF CONFUSION

-- POINT OUT COMMON PRECONCEPTIONS ABOUT PHYSICS

CAUTION **Any particle following a curved path is accelerating** When a particle is moving in a curved path, it always has nonzero acceleration, even when it moves with constant speed. This conclusion is contrary to the everyday use of the word "acceleration" to mean that speed is increasing. The more precise definition given in Eq. (3.9) shows that there is a nonzero acceleration whenever the velocity vector changes in *any* way, whether there is a change of speed, direction, or both.

CONFRONTING MISCONCEPTIONS



CONFRONTING MISCONCEPTIONS

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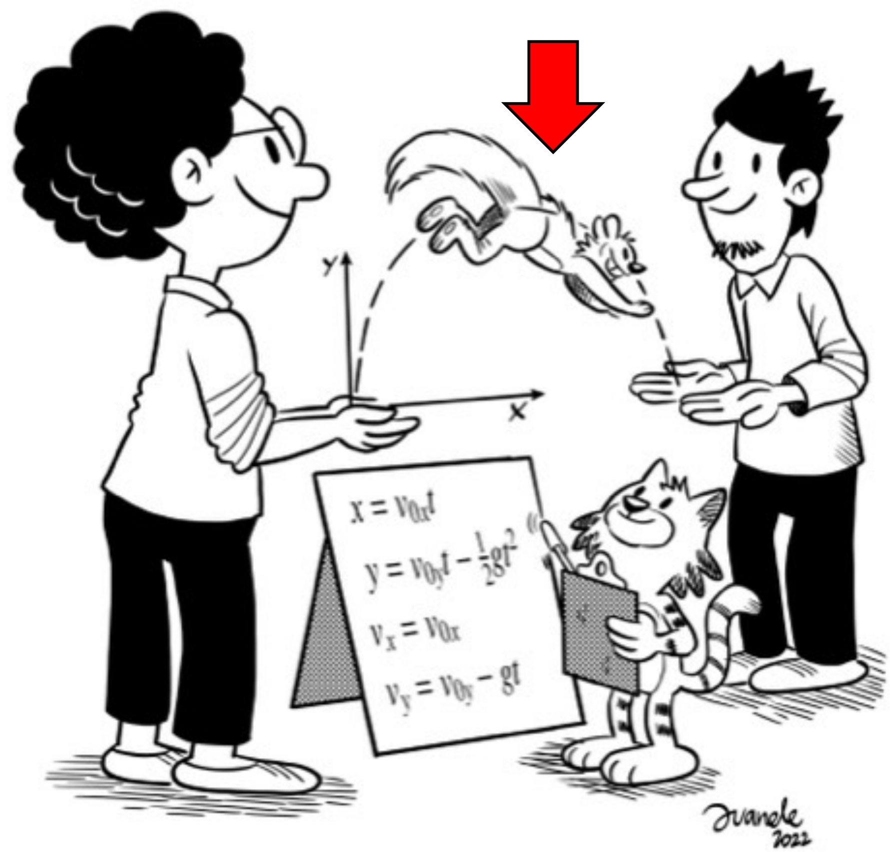
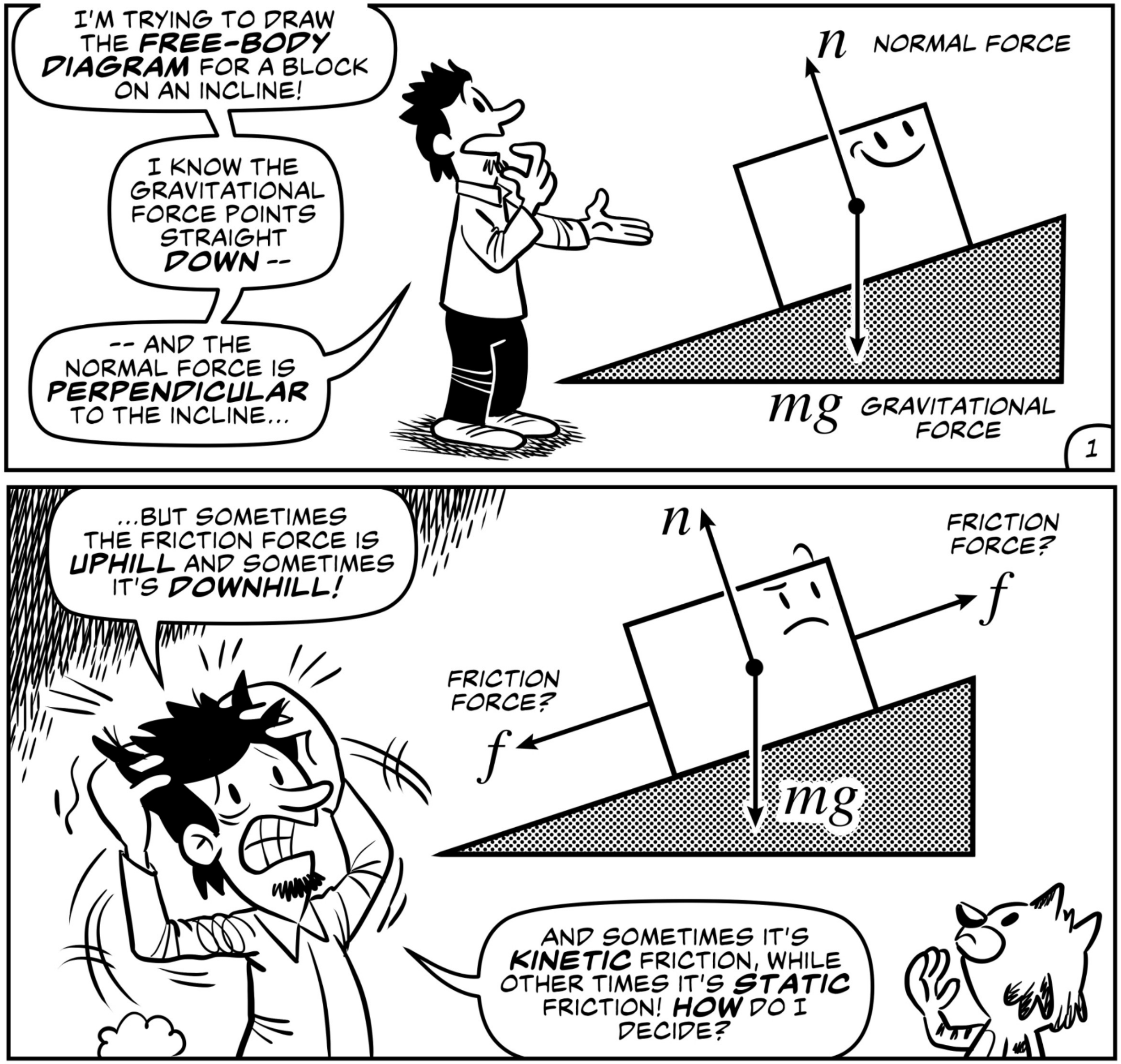
THE SQUIRREL



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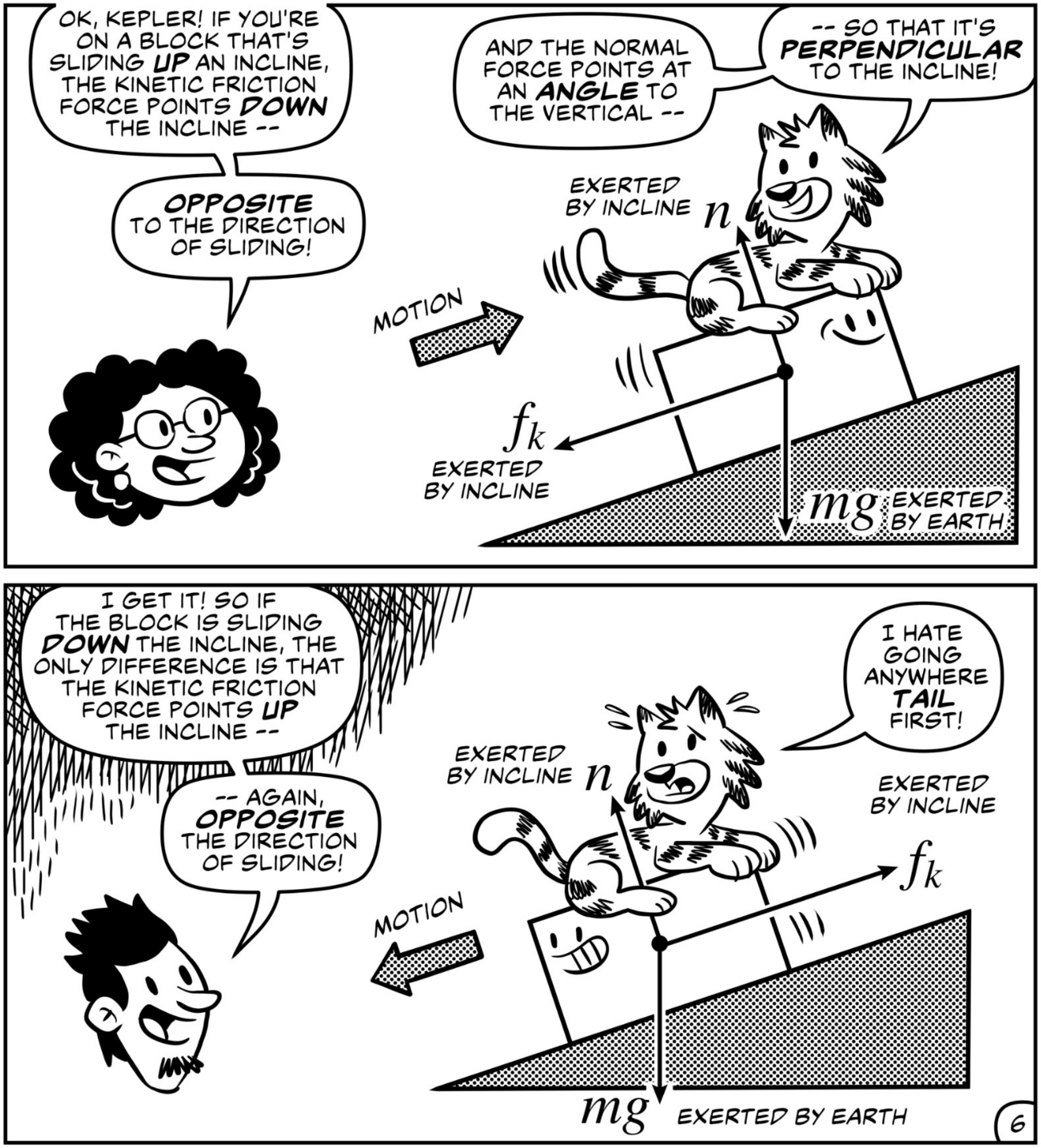
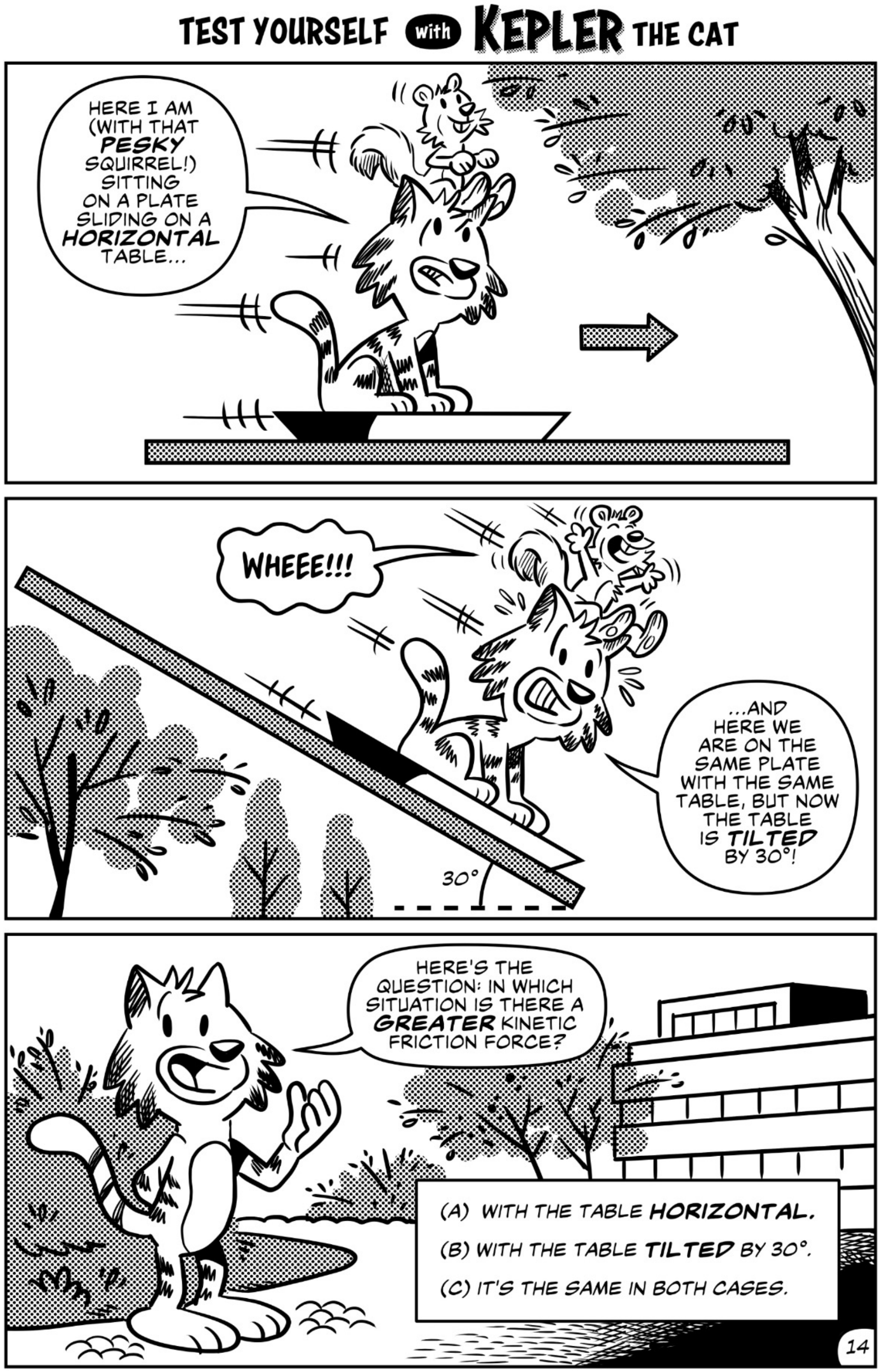
ALONZO HAS THE SAME DIFFICULTIES WITH PHYSICS AS MANY TYPICAL STUDENTS



ELENA PROVIDES ALONZO WITH STUDENT-TO-STUDENT GUIDANCE (WITH COMIC RELIEF FROM **KEPLER**)



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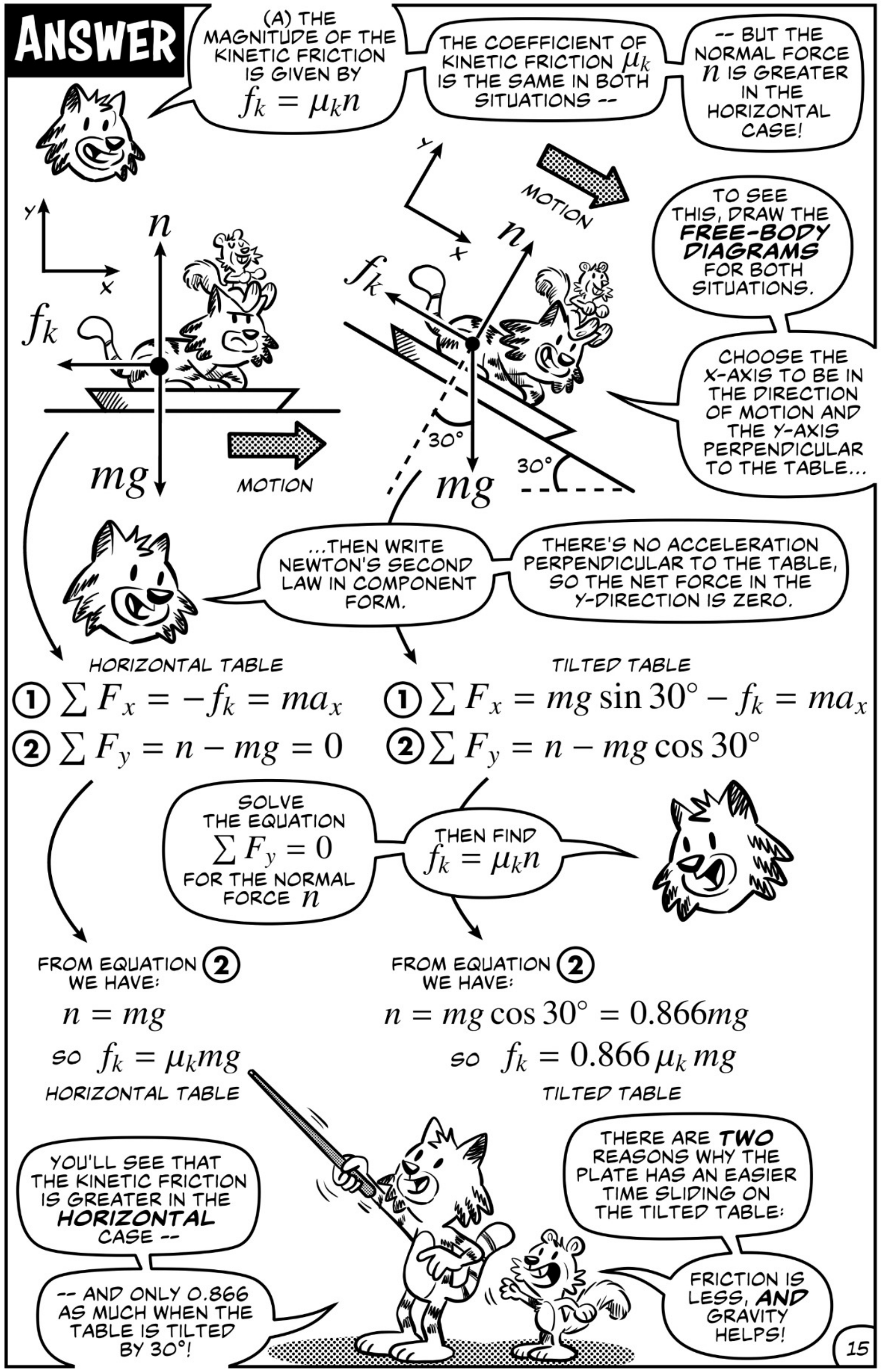
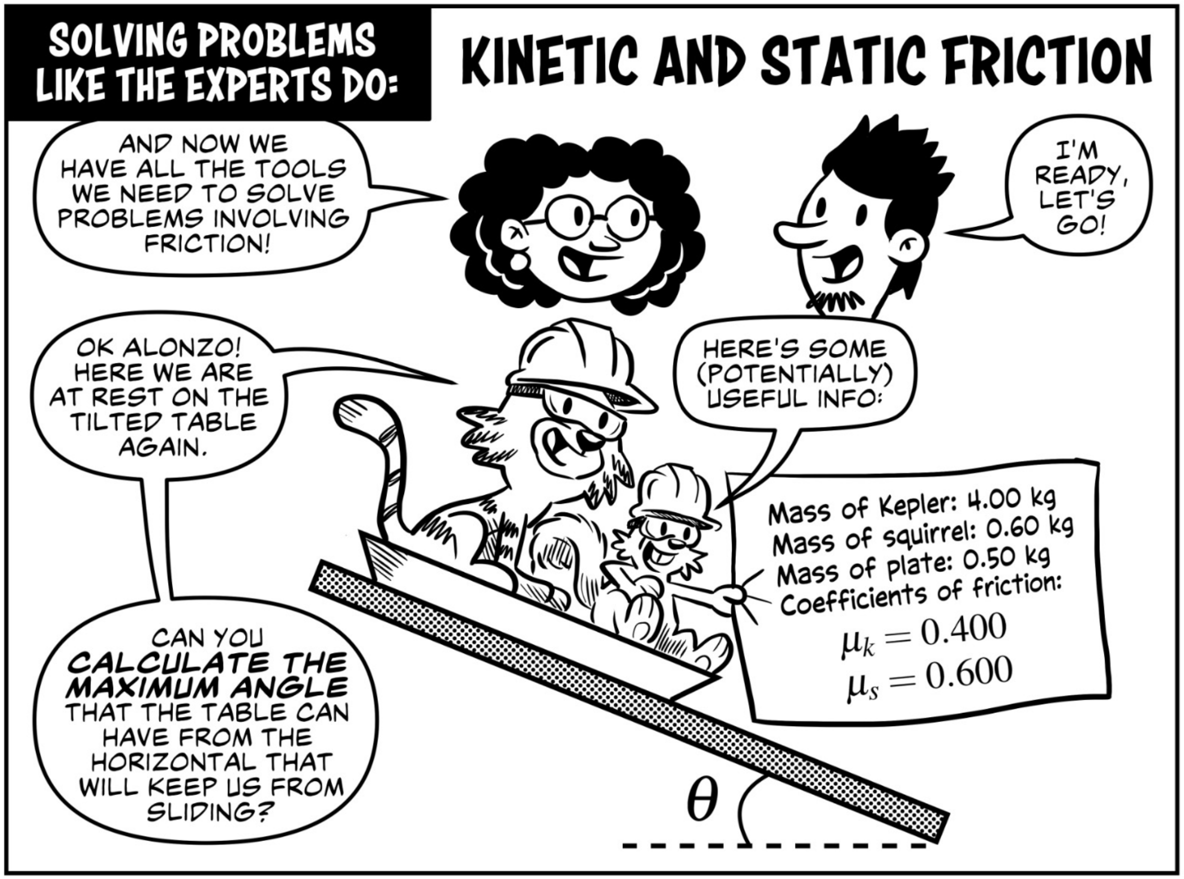
KEPLER CHECKS FOR CONCEPTUAL UNDERSTANDING



KEPLER CHECKS FOR CONCEPTUAL UNDERSTANDING … AND PROVIDES GUIDANCE WITH ASSISTANCE FROM **THE SQUIRREL**



THE ENTIRE CAST PROVIDES GUIDANCE WITH SOLVING PHYSICS PROBLEMS

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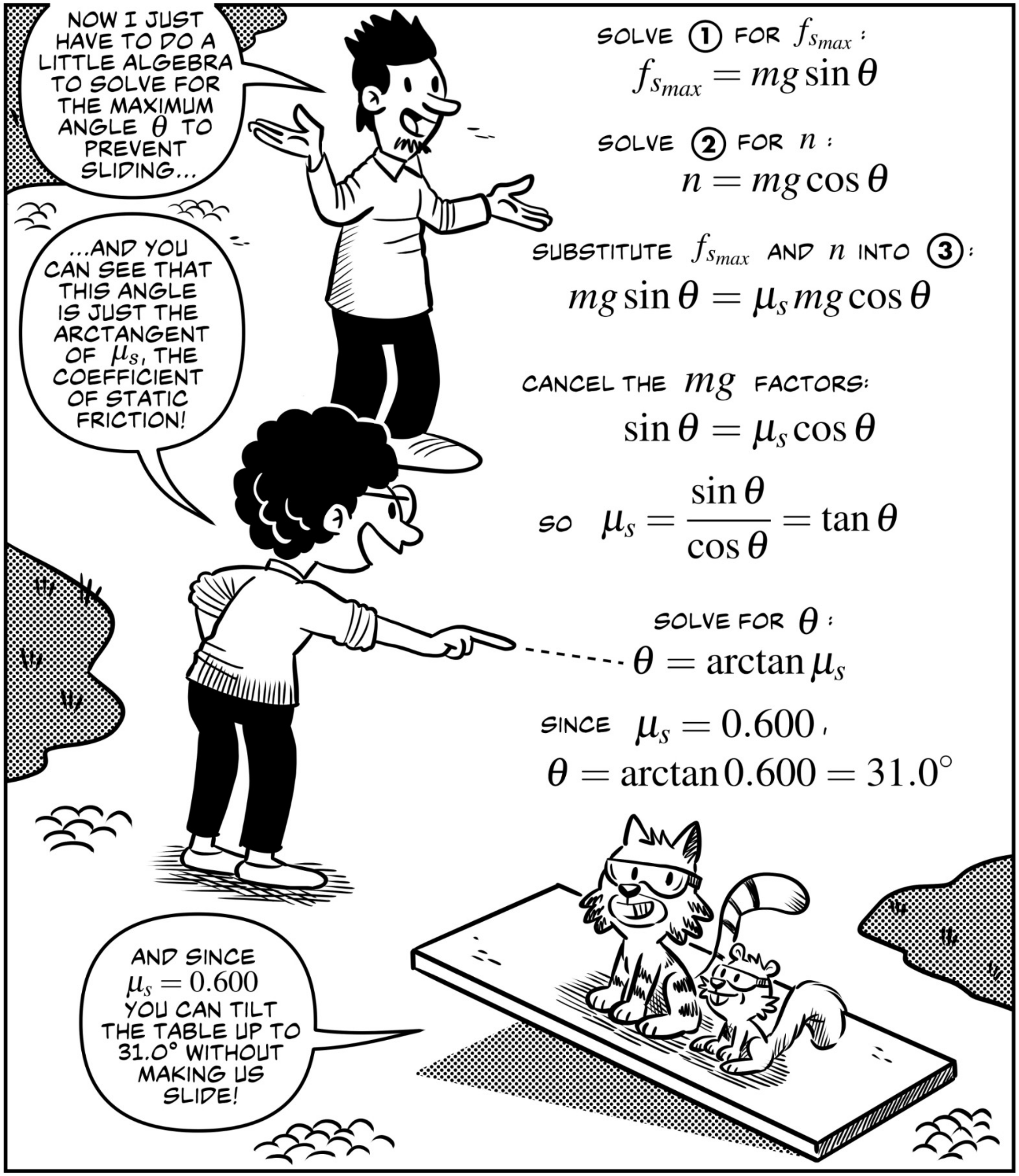
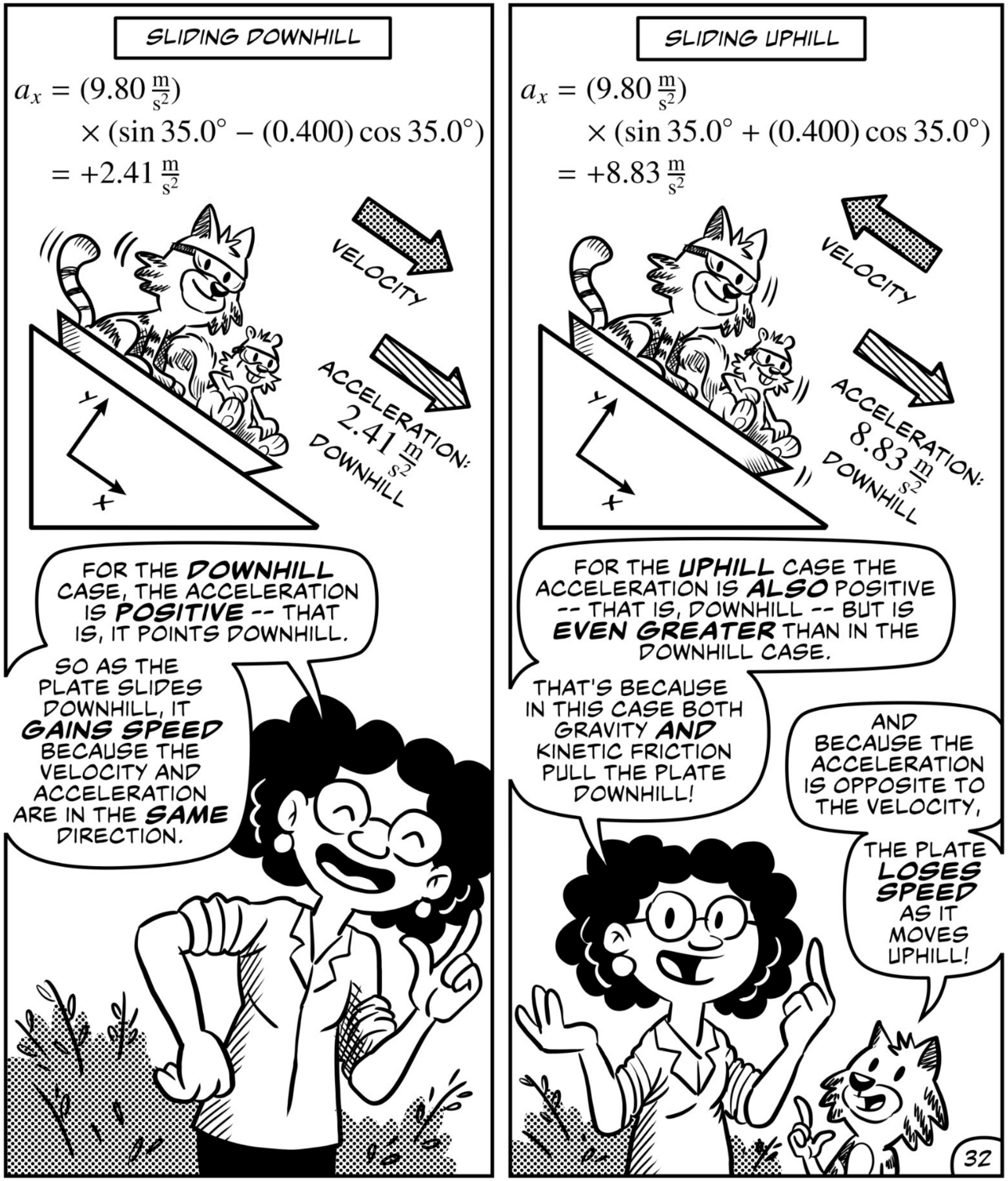


THE ENTIRE CAST PROVIDES GUIDANCE WITH SOLVING PHYSICS PROBLEMS ...INCLUDING STEP-BY-STEP HELP!



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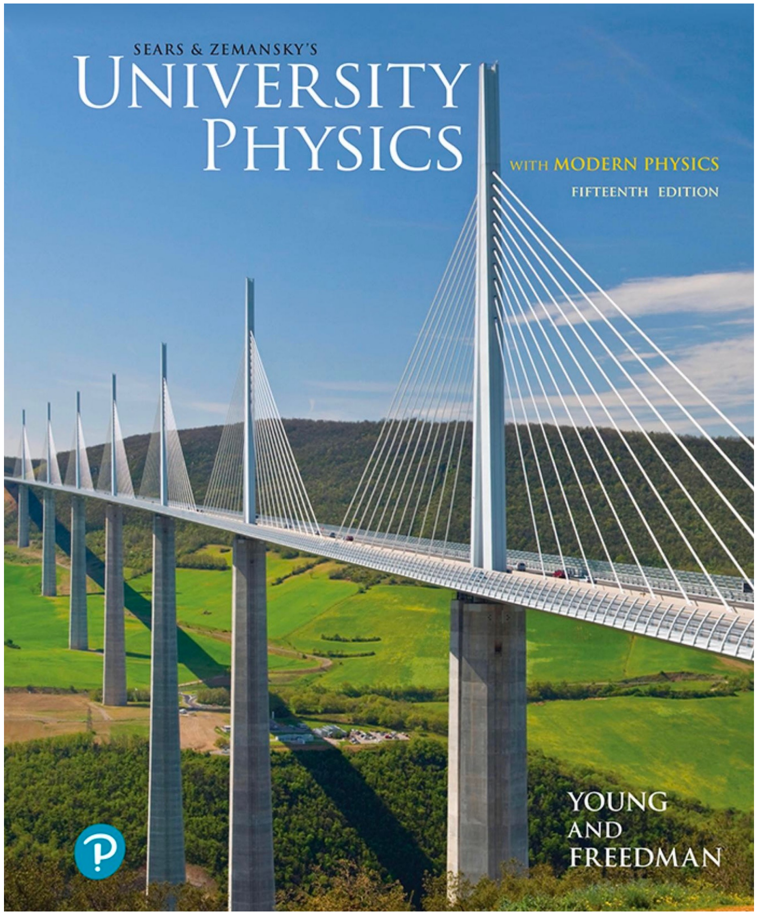
ELENA AND KEPLER DEMONSTRATE THAT PROBLEM-SOLVING DOESN'T END WITH FINDING A NUMBER OR FORMULA ... YOU MUST ALSO INTERPRET THE ANSWER!

EACH CHAPTER OF THE COMIC BOOK WILL ALSO BE AVAILABLE IN **SPANISH**



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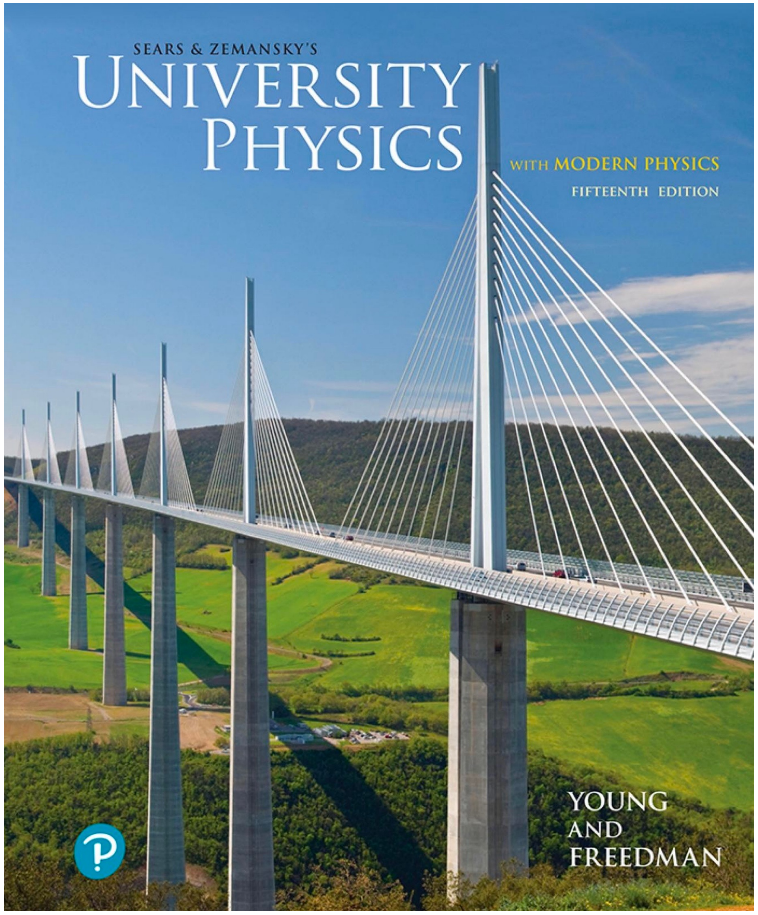

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LINKS TO INFO ABOUT ACTIVE LEARNING, A SAMPLE CHAPTER OF THE COMIC BOOK, CHATGPT, AND MUCH MORE!

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