

# **PHYSICS EDUCATION: TRANSFERRING INFORMATION OR ENGAGING THE MIND?**

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Harvard University**

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San Diego, CA  
30 October 1999**



# *Executive Summary*

**Education must adapt to a changing world**

# *Executive Summary*

**The goals of education remain the same:**

# *Executive Summary*

**The goals of education remain the same:  
transfer knowledge and develop skills...**

## *Executive Summary*

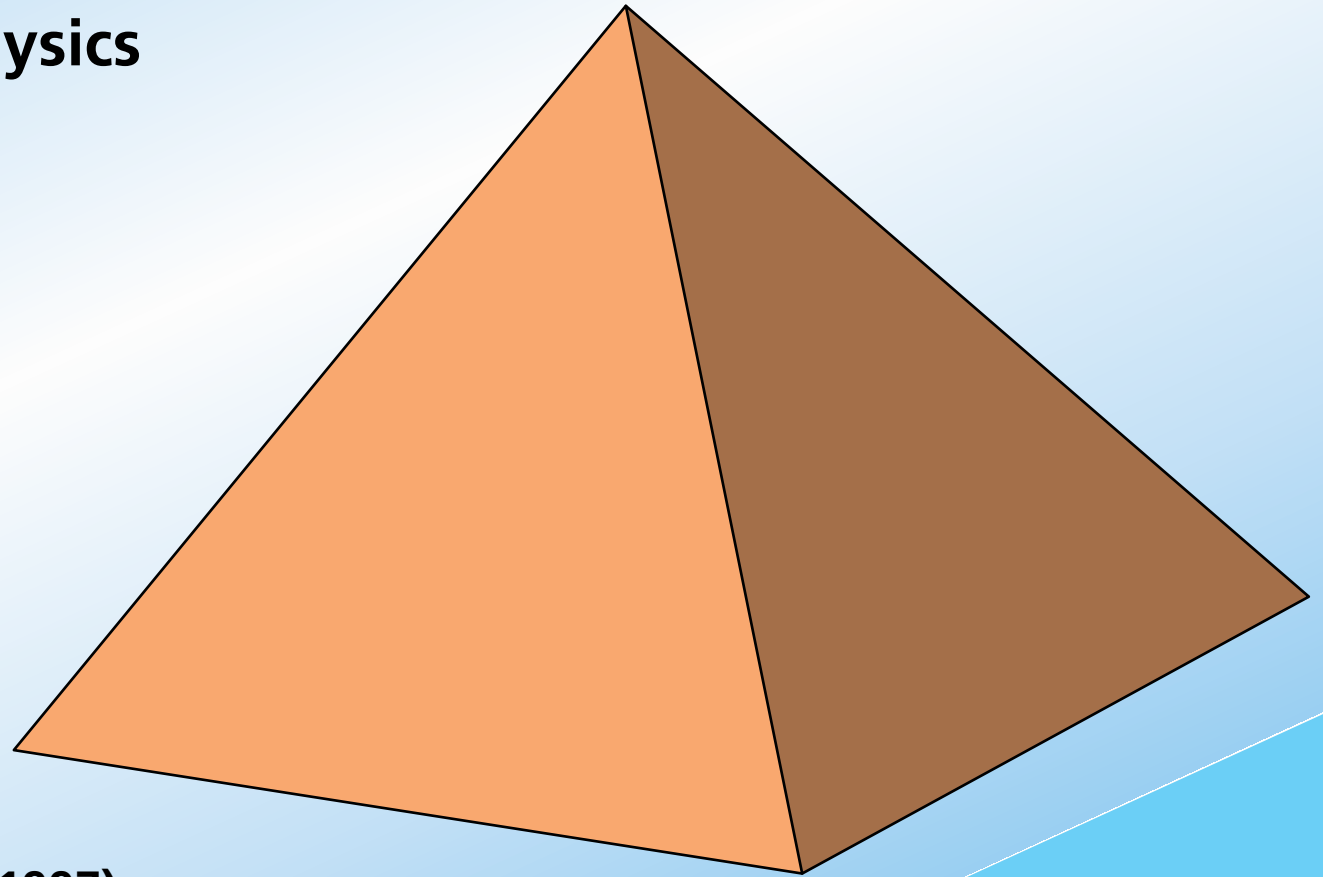
**...but the modern workplace requires new skills**

## *Executive Summary*

- ▶ **thinking skills**
- ▶ **complex problem solving skills**
- ▶ **lifelong learning skills**
- ▶ **interpersonal and teamwork skills**

# *We have a problem*

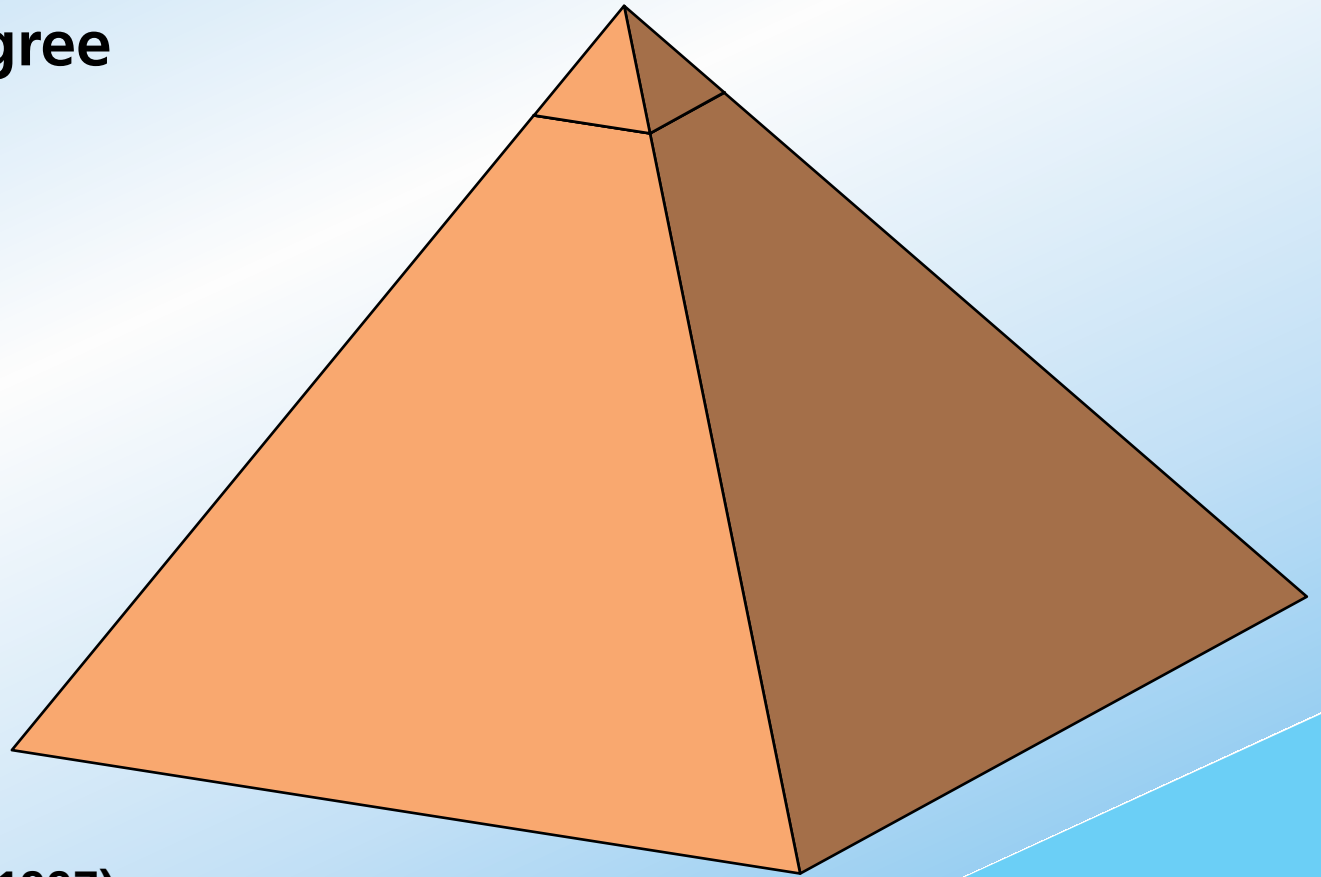
**380,000 students take  
introductory physics  
each year...**



***AIP Report R-151.33 (1997)***

# *We have a problem*

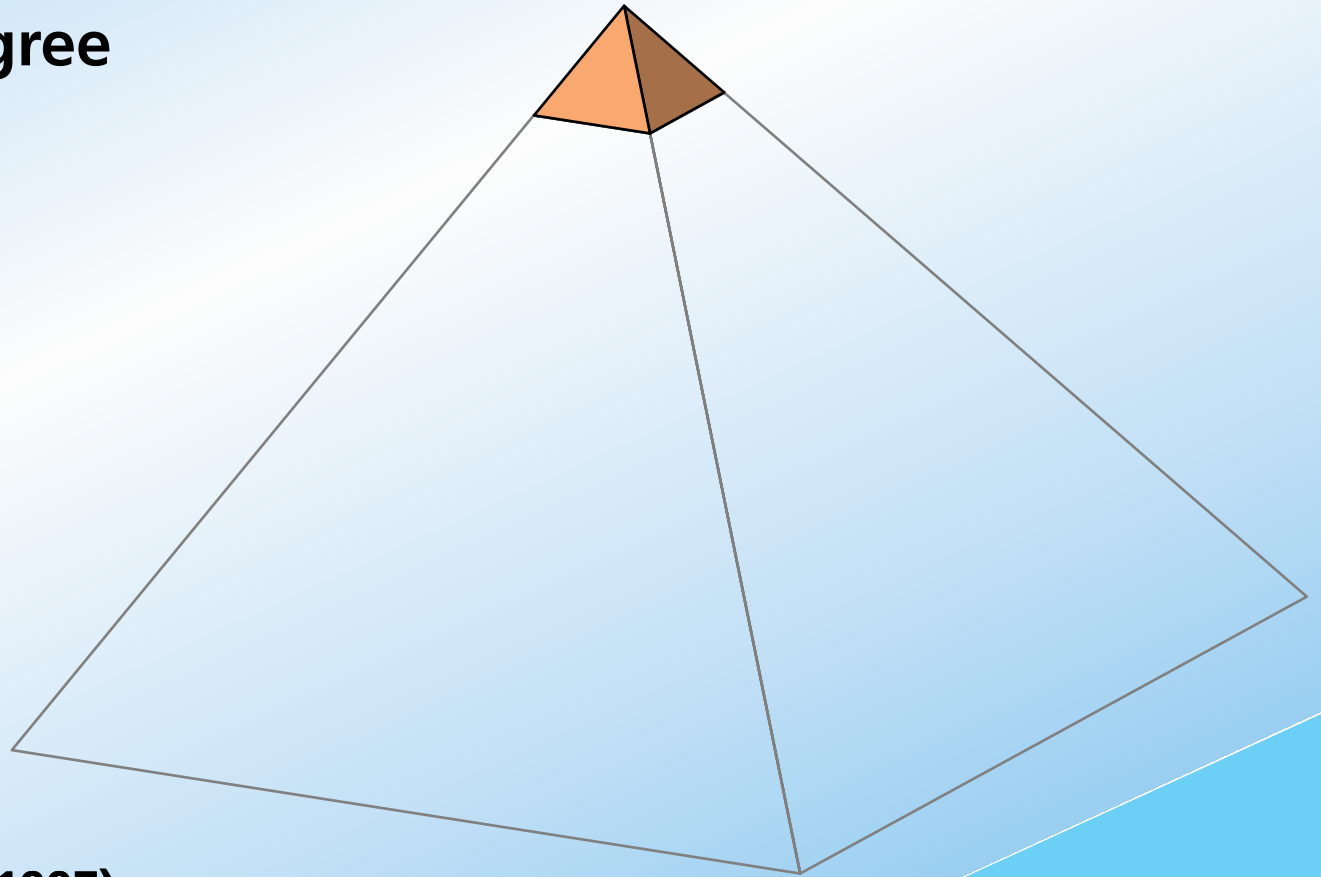
**about 1% of these get  
a bachelor's degree  
in physics**





# *We have a problem*

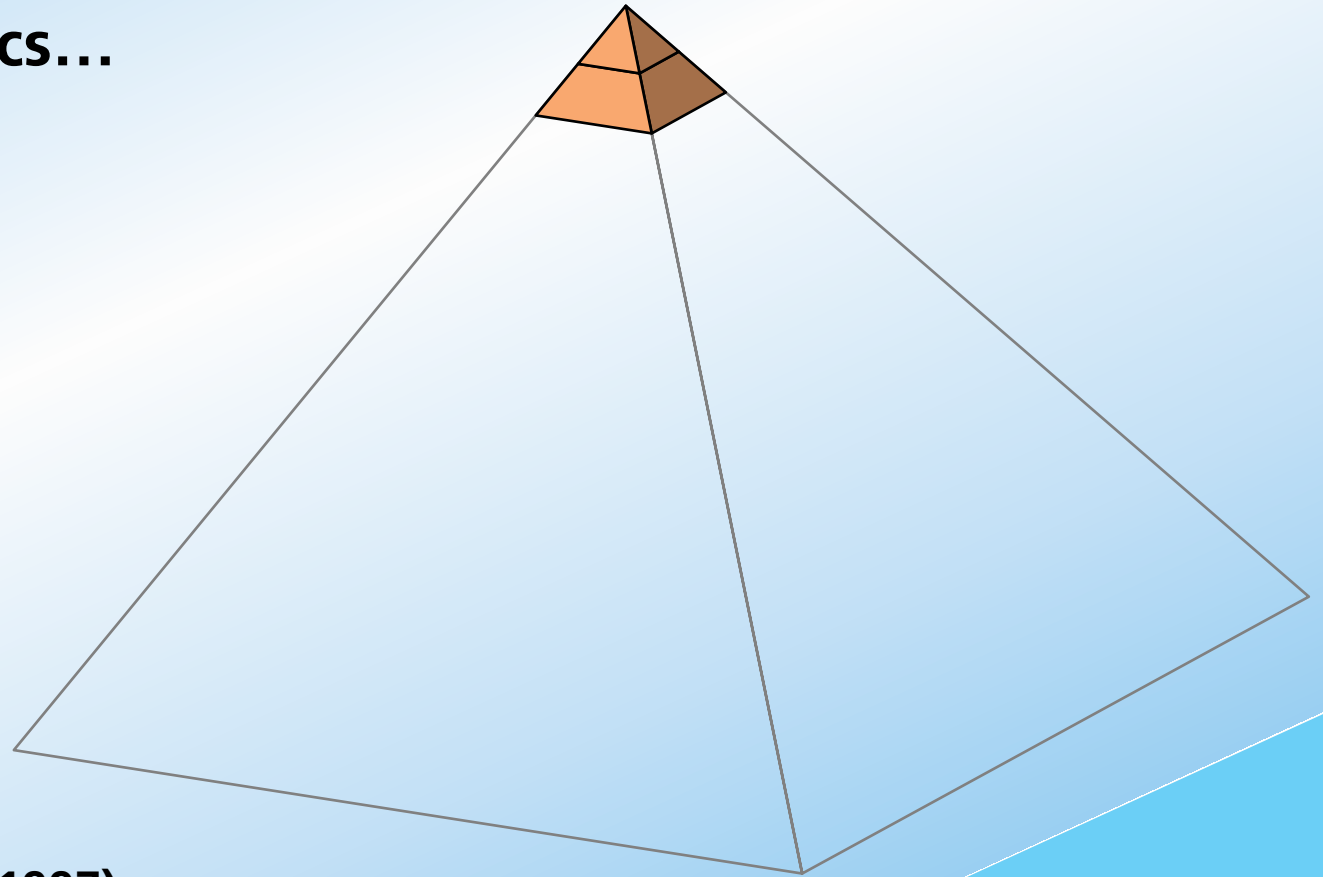
**Of the 4,300 students with  
a bachelor's degree  
in physics...**



***AIP Report R-151.33 (1997)***

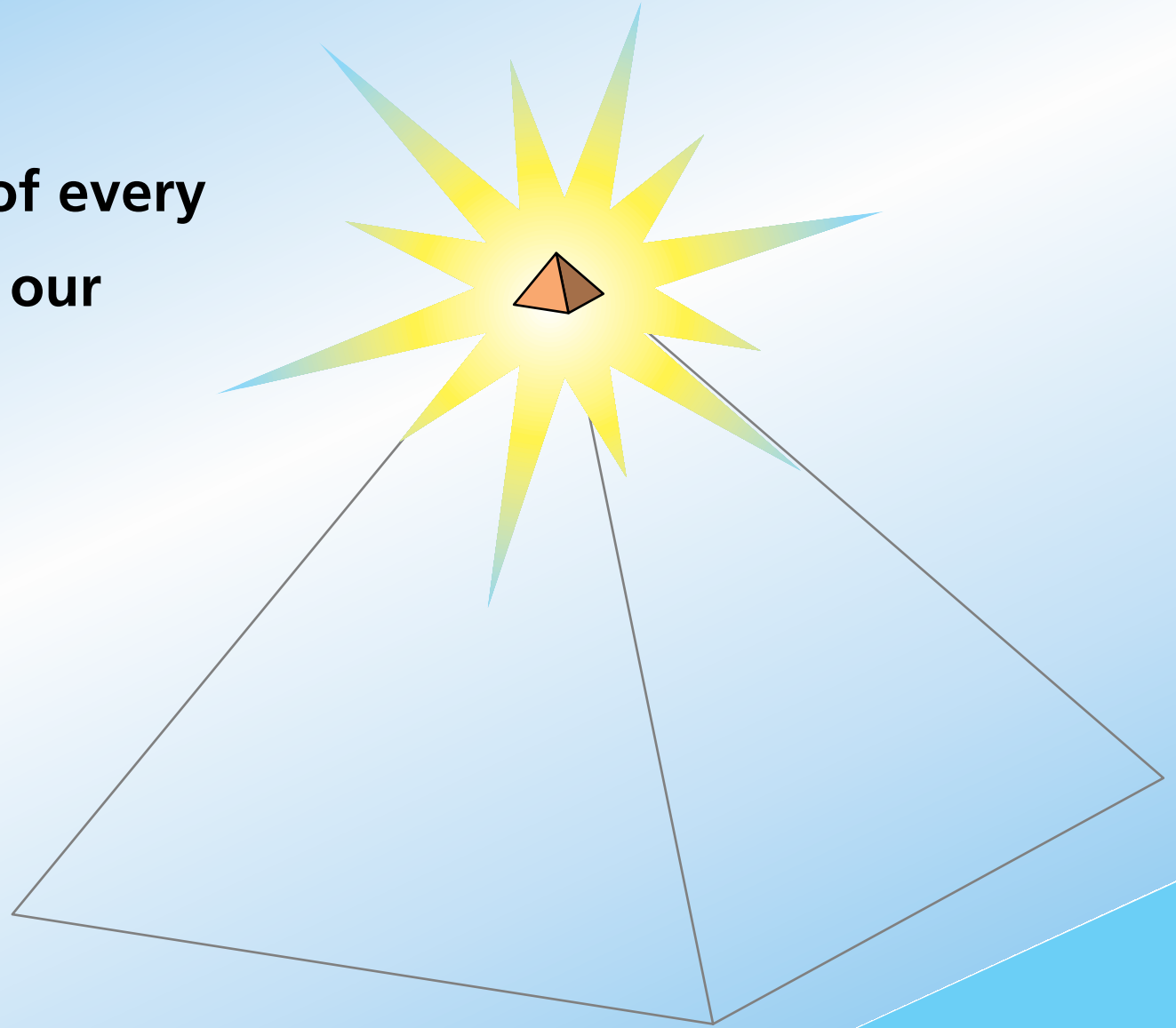
# *We have a problem*

**about 35% go on to get a graduate  
degree in physics...**



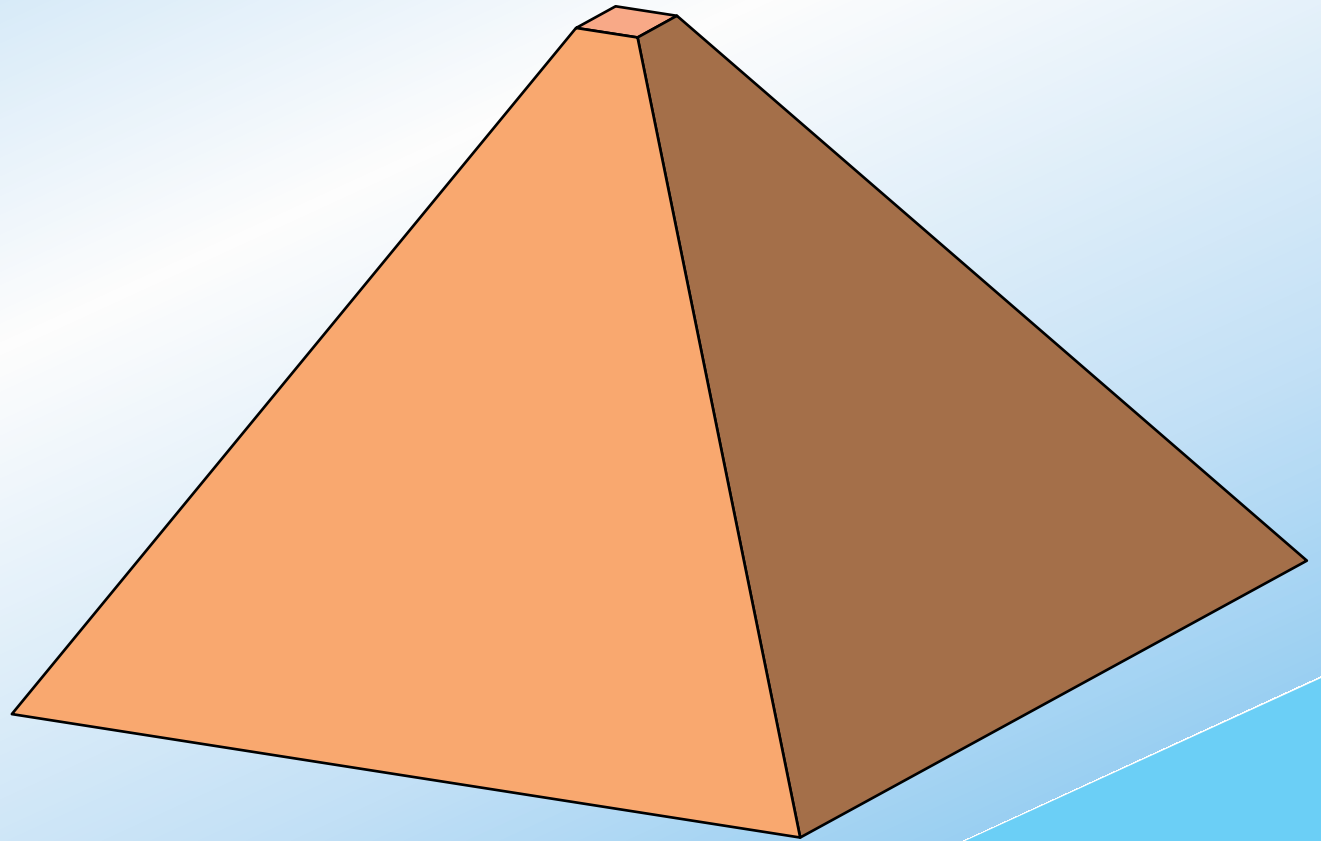
# *We have a problem*

**That's one out of every  
260 students in our  
introductory  
courses!**



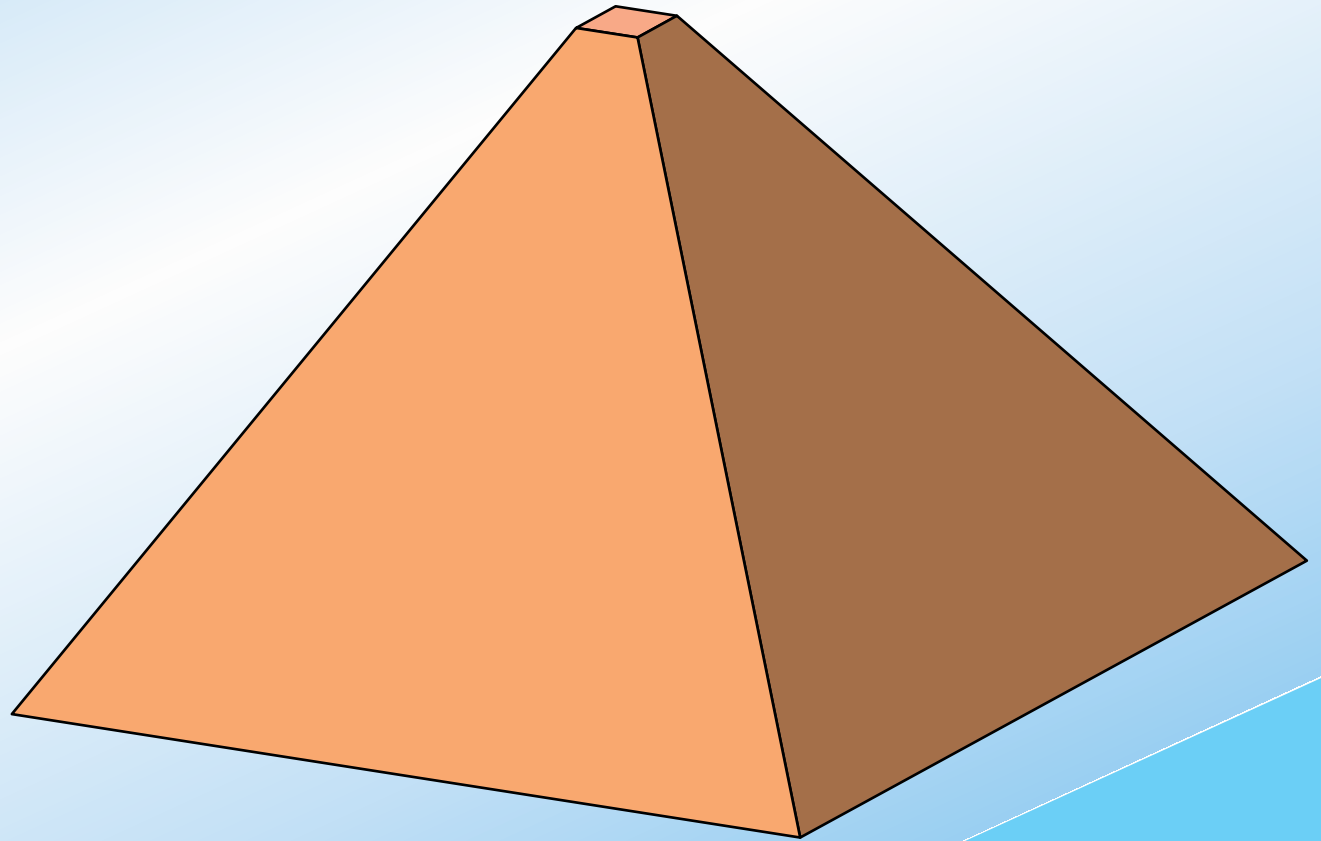
# *We have a problem*

**What about the  
other 259...?**



# *We have a problem*

**What do we know  
about these  
students?**



# *We have a problem*

## **Some disturbing symptoms:**

- ▶ **frustration**
- ▶ **lack of understanding**
- ▶ **lack of basic knowledge**



# *We have a problem*

**They know the jargon:**

- ▶ **circular motion**
- ▶ **barometric pressure**
- ▶ **light radius**
- ▶ **something to the power times ten to the something**



## *We have a problem*

**They are aware of their lack of knowledge**

- ▶ **I graduated from college but I didn't study *astronomy***
- ▶ **It's been a while since I've had physics**

## *We have a problem*

**They are aware of their lack of knowledge**

- ▶ **I graduated from college but I didn't study *astronomy***
- ▶ **It's been a while since I've had physics**

**...and they don't care!**

*We have a problem*

**Should we worry?**

*We have a problem*

**We'd better!**



## *We have a problem*

**"I took four years of science and four years of math...**

**A waste of my time,  
a waste of the teacher's time,  
and a waste of space...**

**You know,  
I took *physics*.**

**For *what?*"**





**Why do we have this problem?**

## *Why do we have this problem?*

**Lectures focus on transfer of information...**

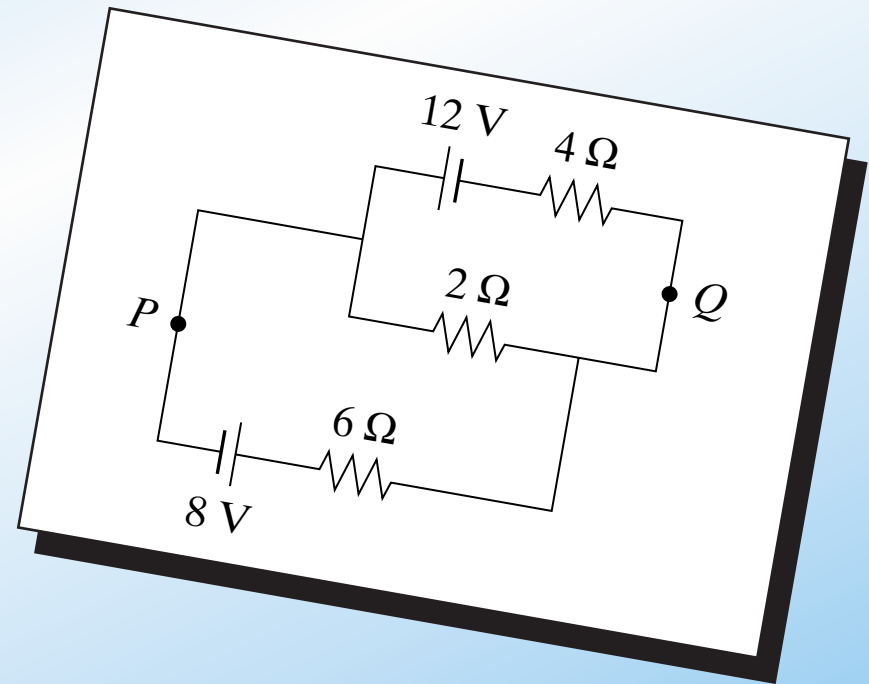


## *Why do we have this problem?*

**Conventional problems reinforce bad study habits**

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**Conventional problems reinforce bad study habits**

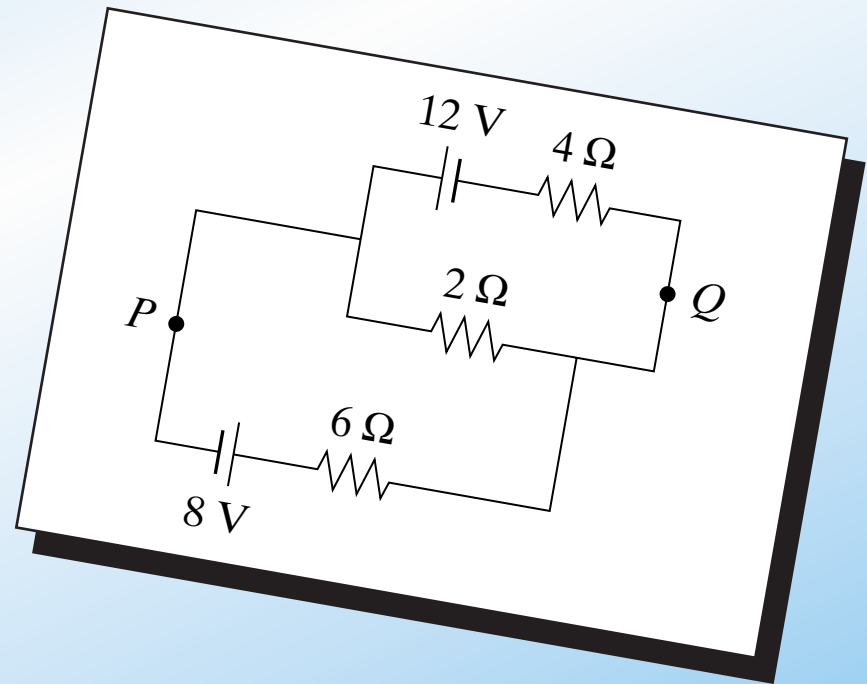


# Why do we have this problem?

## Conventional problems reinforce bad study habits

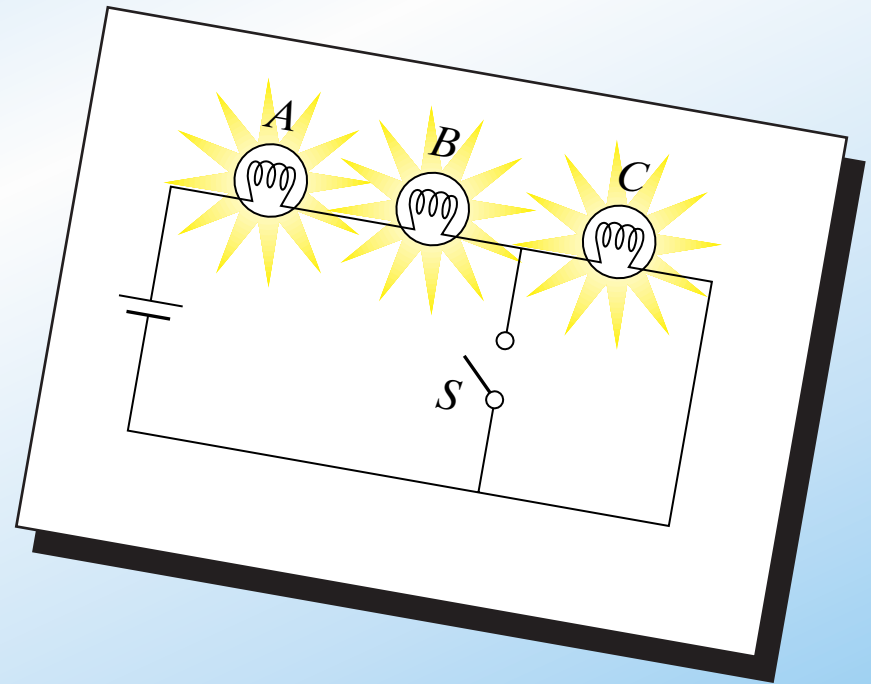
Calculate:

- (a) the current in the  $2\text{-}\Omega$  resistor, and
- (b) the potential difference between points  $P$  and  $Q$



*Why do we have this problem?*

**Are basic principles understood?**

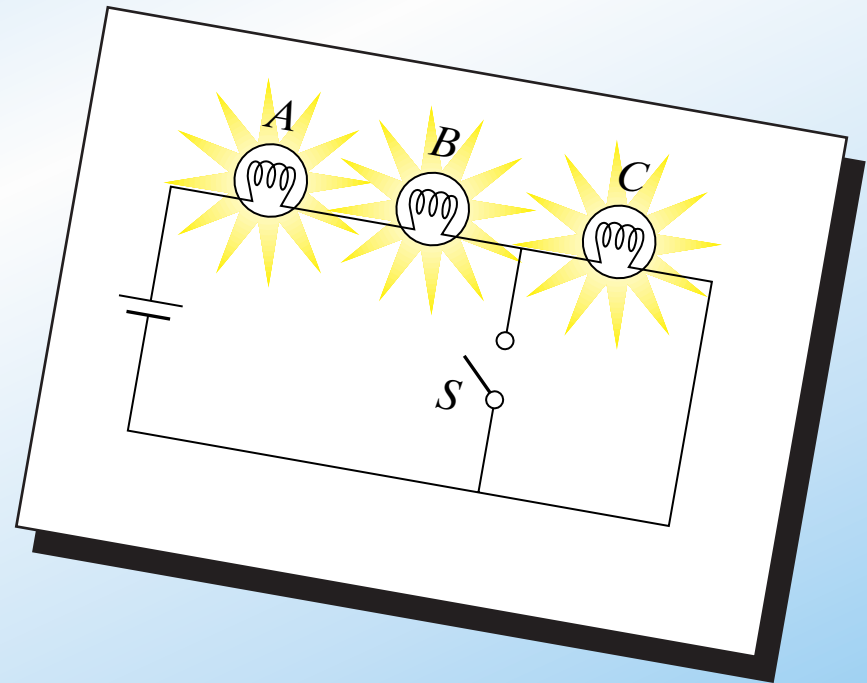


# Why do we have this problem?

## Are basic principles understood?

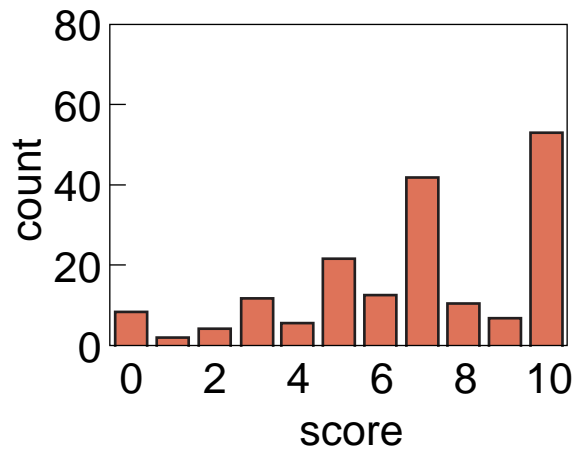
When  $S$  is closed, what happens to the:

- (a) intensities of  $A$  and  $B$ ?
- (b) intensity of  $C$ ?
- (c) current through battery?
- (d) voltage drop across  $A$ ,  $B$ , and  $C$ ?
- (e) total power dissipated?

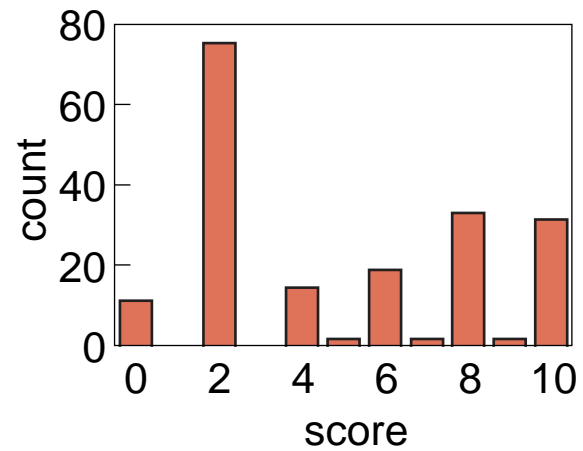


# Why do we have this problem?

conventional

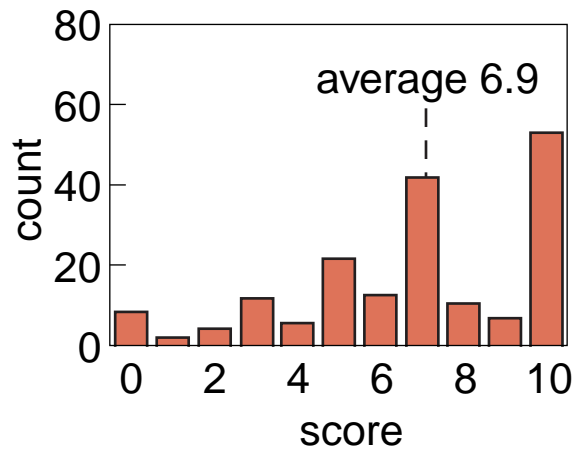


conceptual

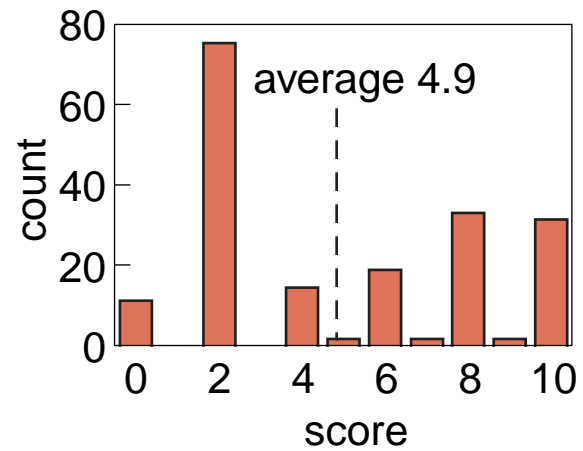


# Why do we have this problem?

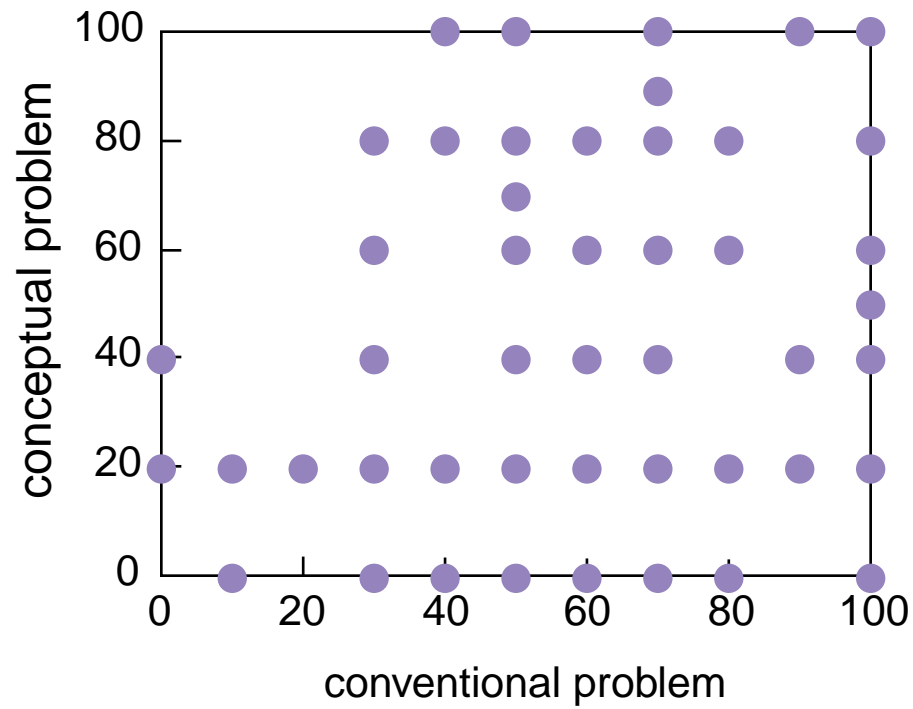
## conventional



## conceptual

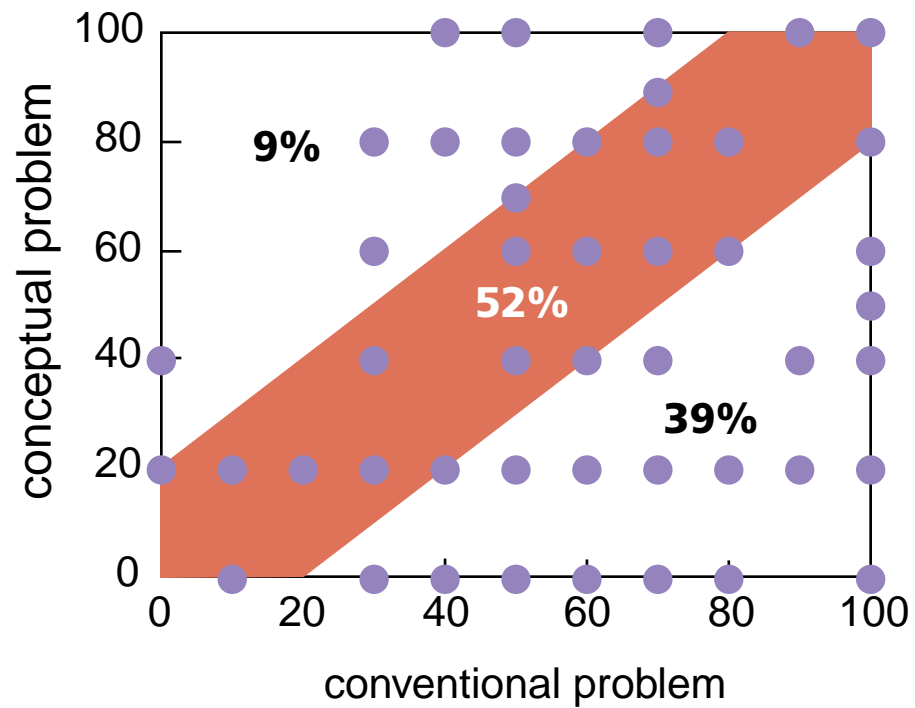


# Why do we have this problem?





# Why do we have this problem?

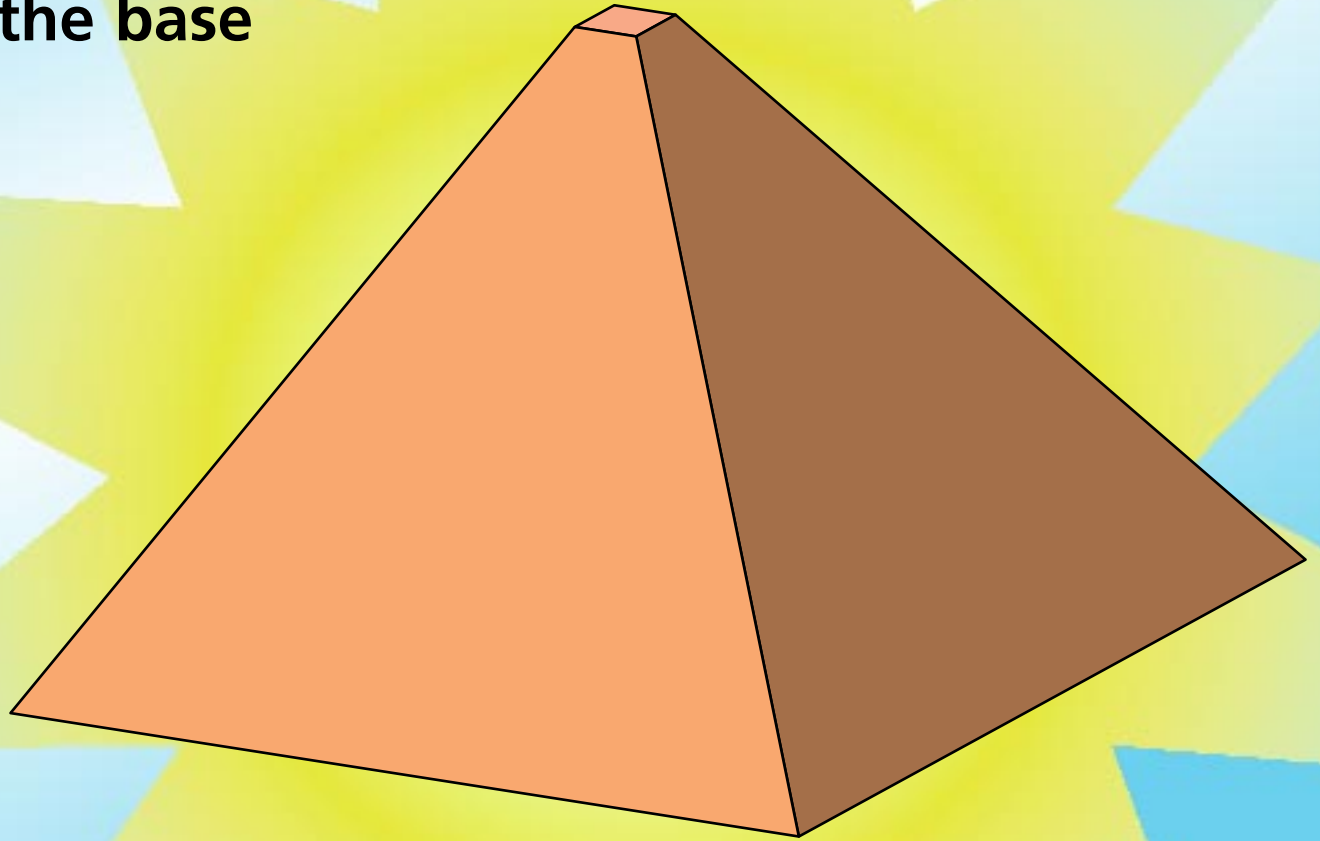


A large lecture hall filled with students seated at desks, facing a stage. A lecturer is standing at a podium on the stage, and a large projection screen displays text. The text on the screen is partially legible and appears to be a list of items or a document. The room is dimly lit, with the stage area being the primary light source. The students are mostly seen from behind, looking towards the front of the room. The overall atmosphere is that of a formal academic setting.

So what should we do?

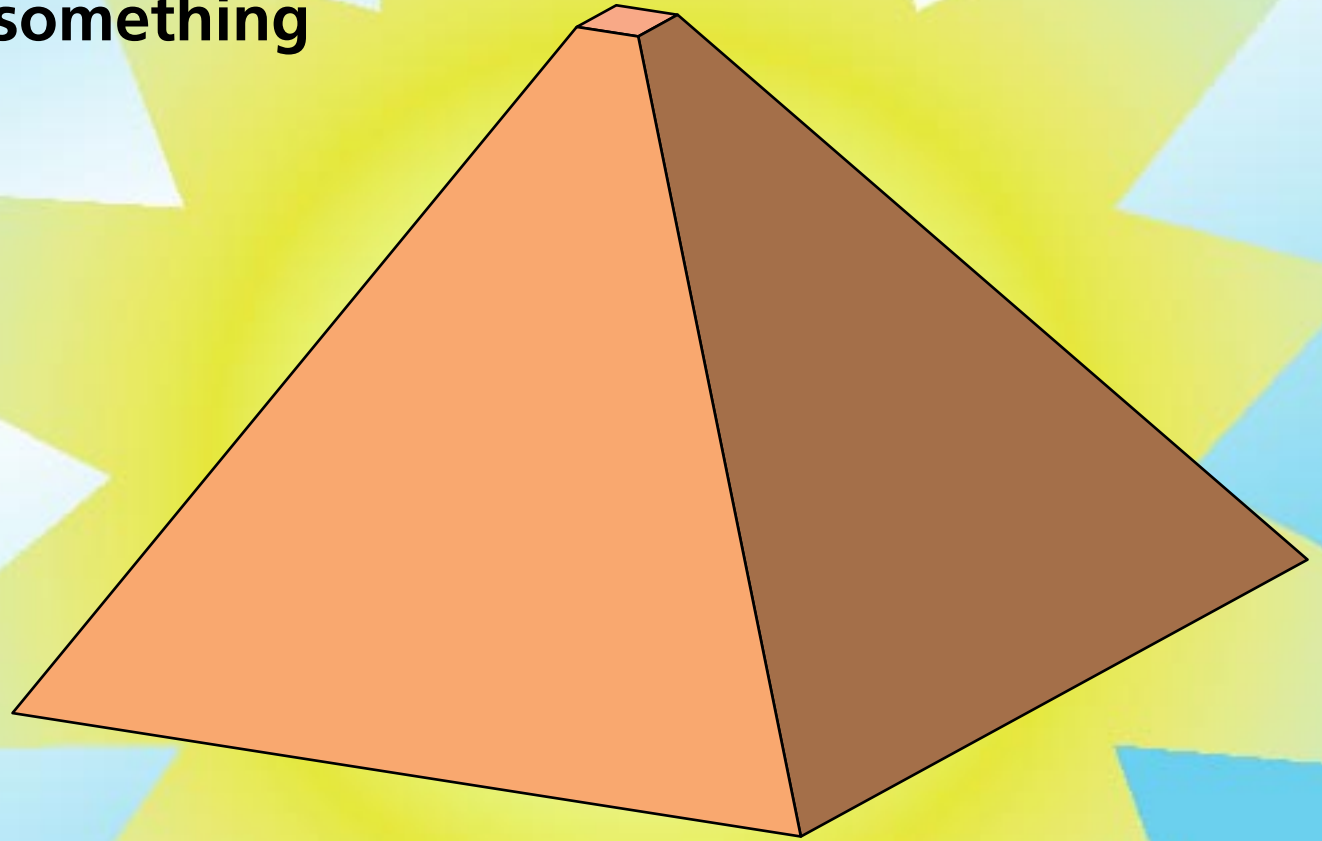
# *Conclusion*

**Let's not forget the base  
of the pyramid!**



# *Conclusion*

**Let's give them something  
of value!**





# *Conclusion*

## **Challenges:**

- ▶ **internal skepticism**
- ▶ **growing pains**
- ▶ **limited circle of influence**

# *Conclusion*

## **Rewards:**

- ▶ **engagement**
- ▶ **improved understanding**
- ▶ **class is fun!**

## **Funding**

**National Science Foundation**

**For a copy of this talk and  
additional information:**

**<http://mazur-www.harvard.edu>**