

# **Memorization or Understanding: are we teaching the right thing?**

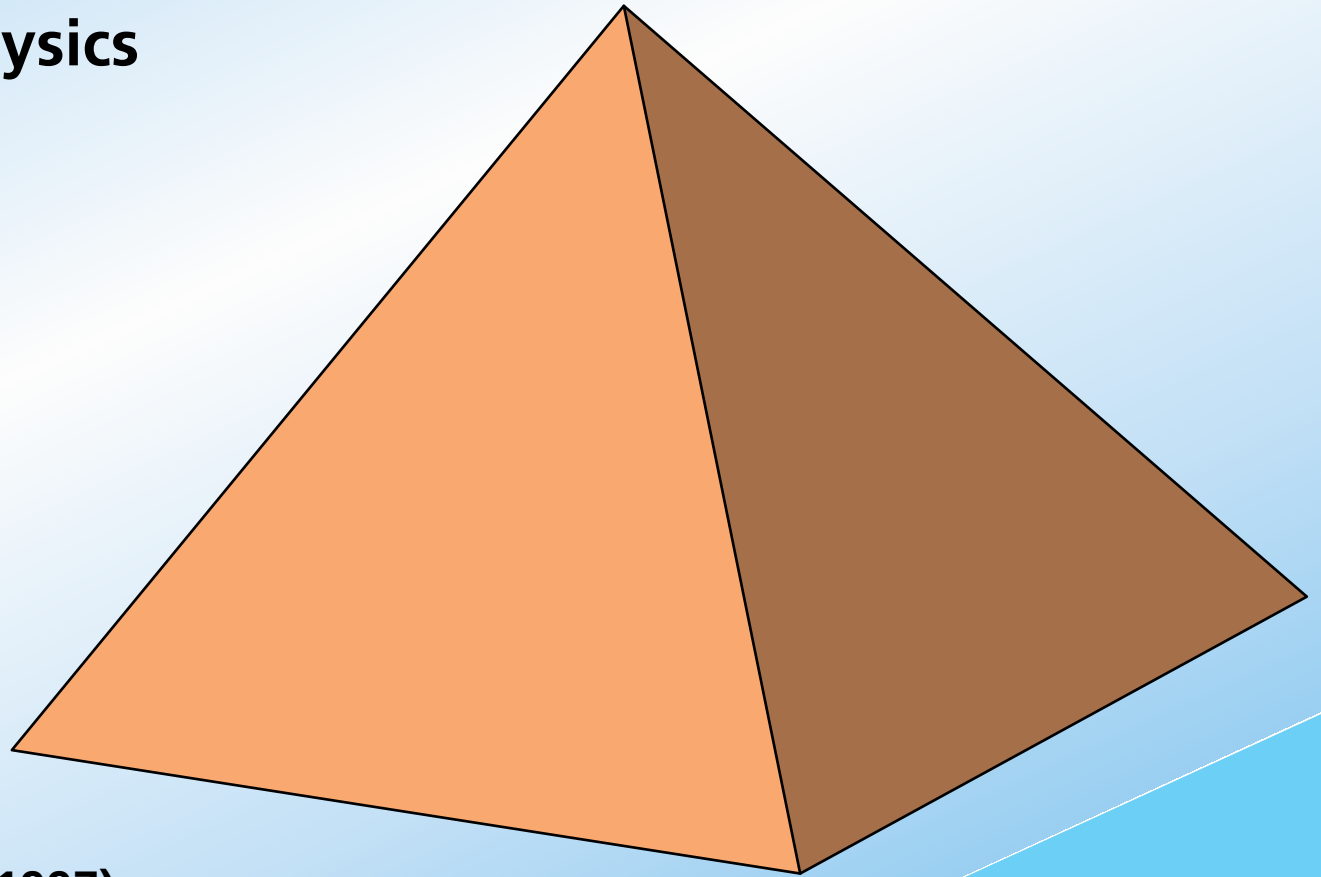
**Eric Mazur  
Harvard University**



2003 ETOP Meeting  
Tucson, AZ, 8 October 2003

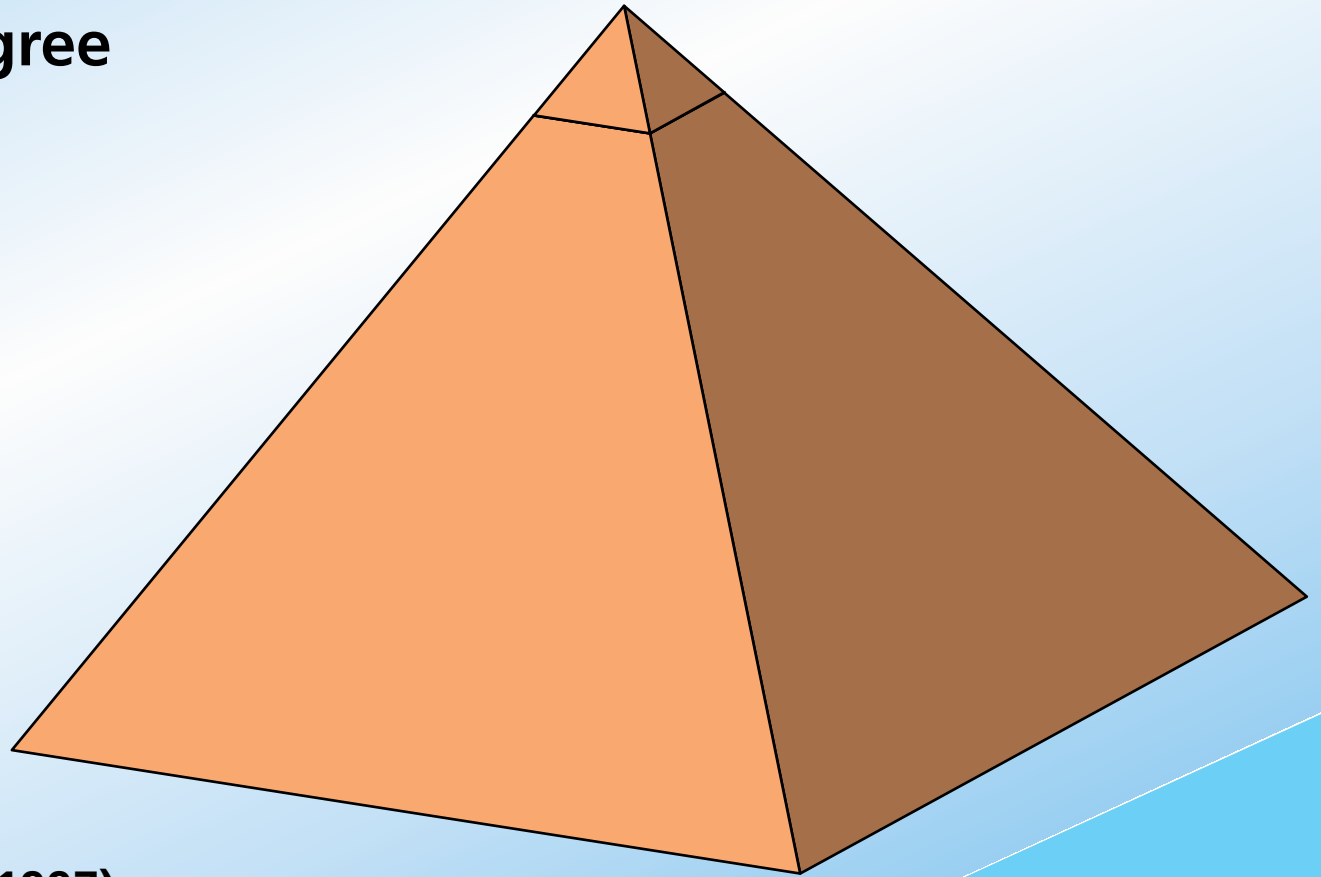
# *We have a problem*

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



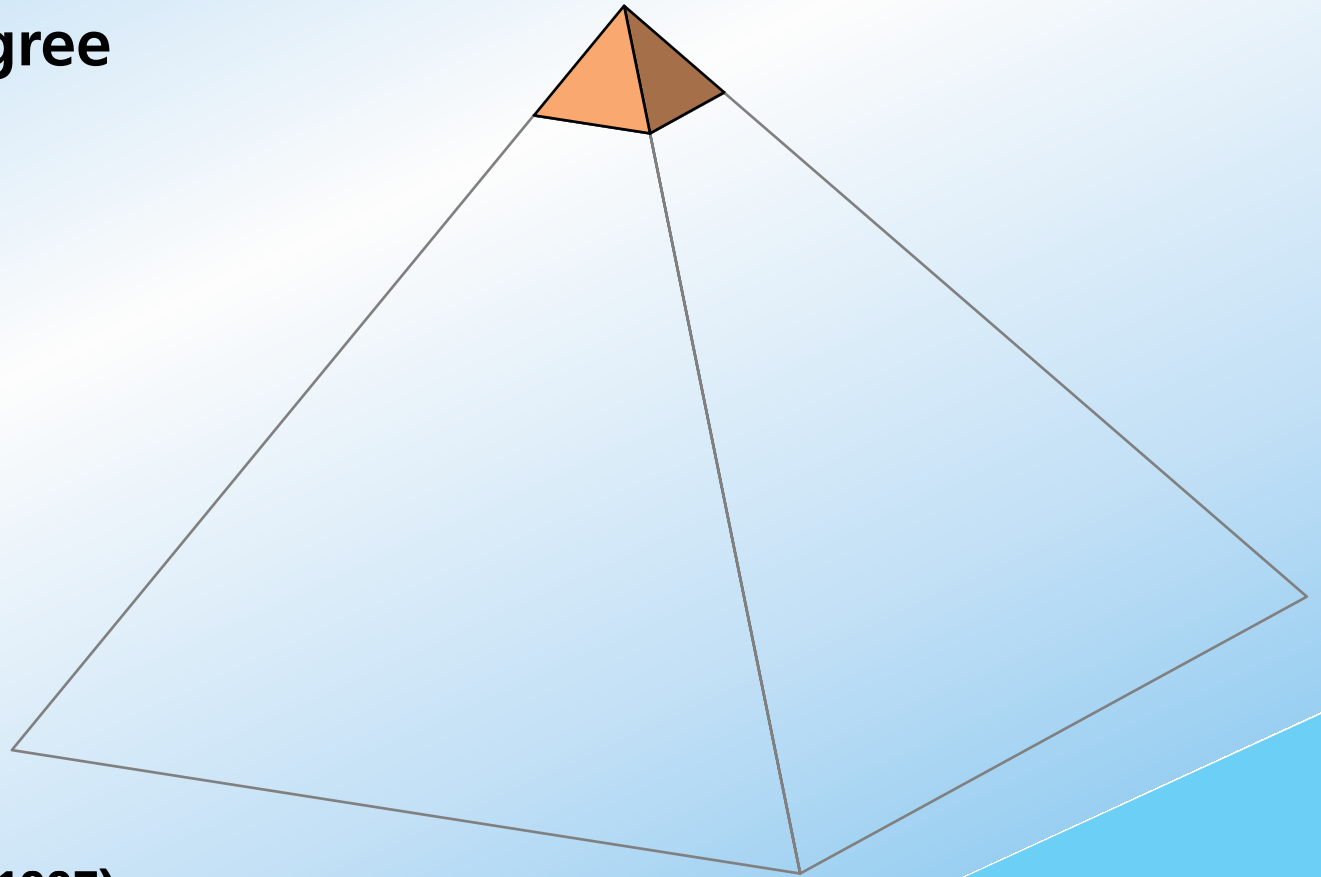
# *We have a problem*

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



# *We have a problem*

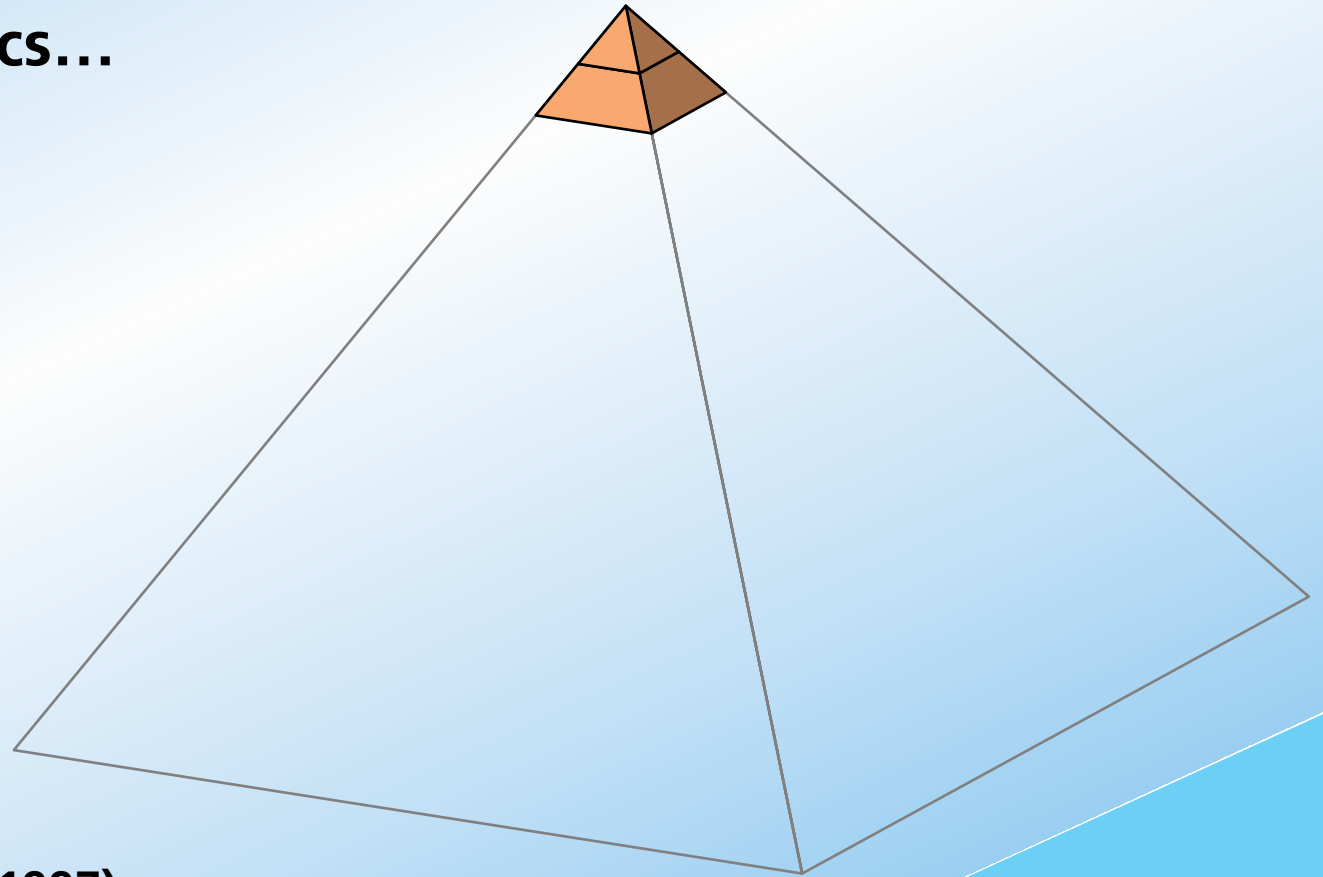
**Of the 4,300 students with  
a bachelor's degree  
in physics...**



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

# *We have a problem*

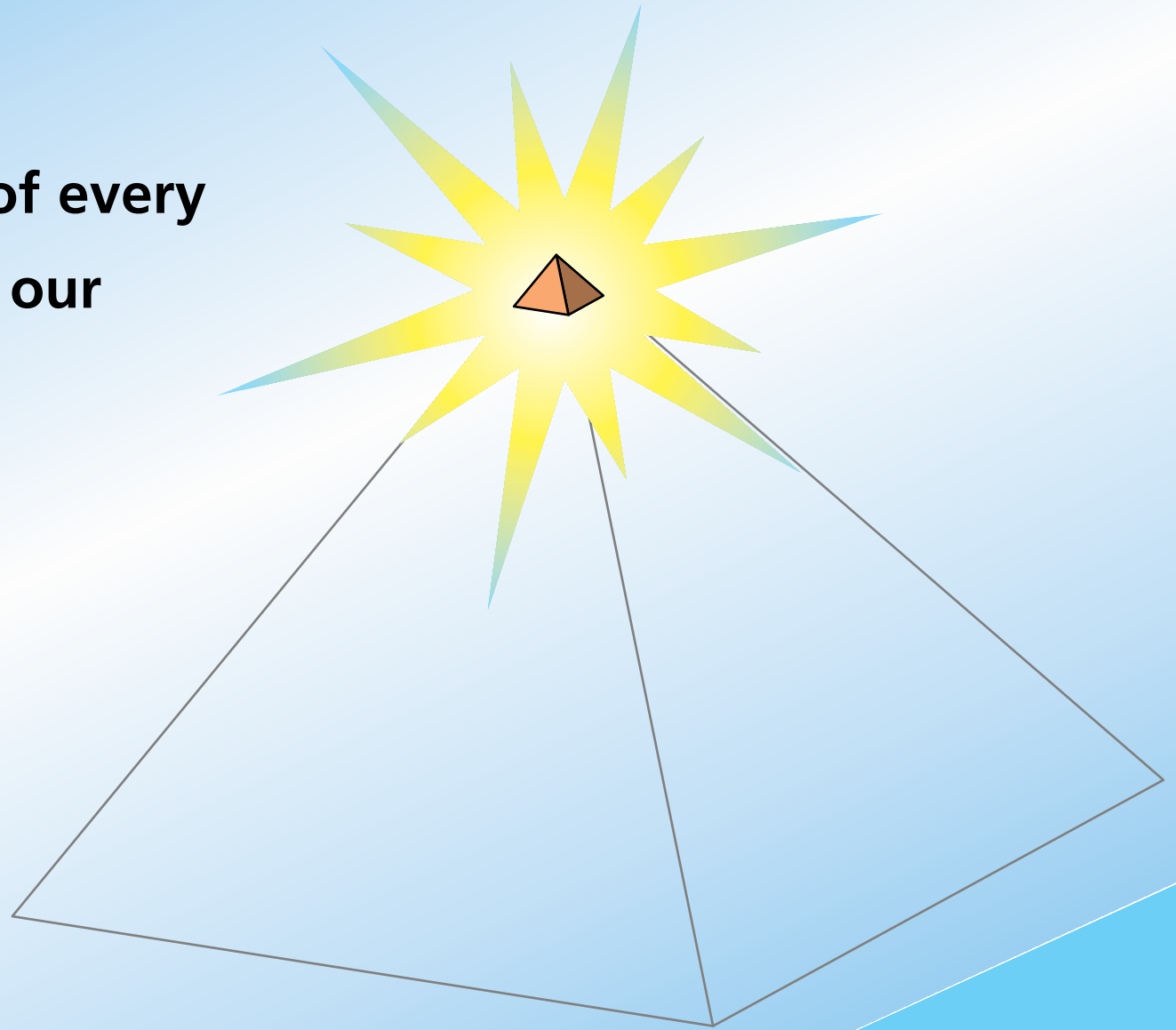
**about 35% go on to get a graduate  
degree in physics...**



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

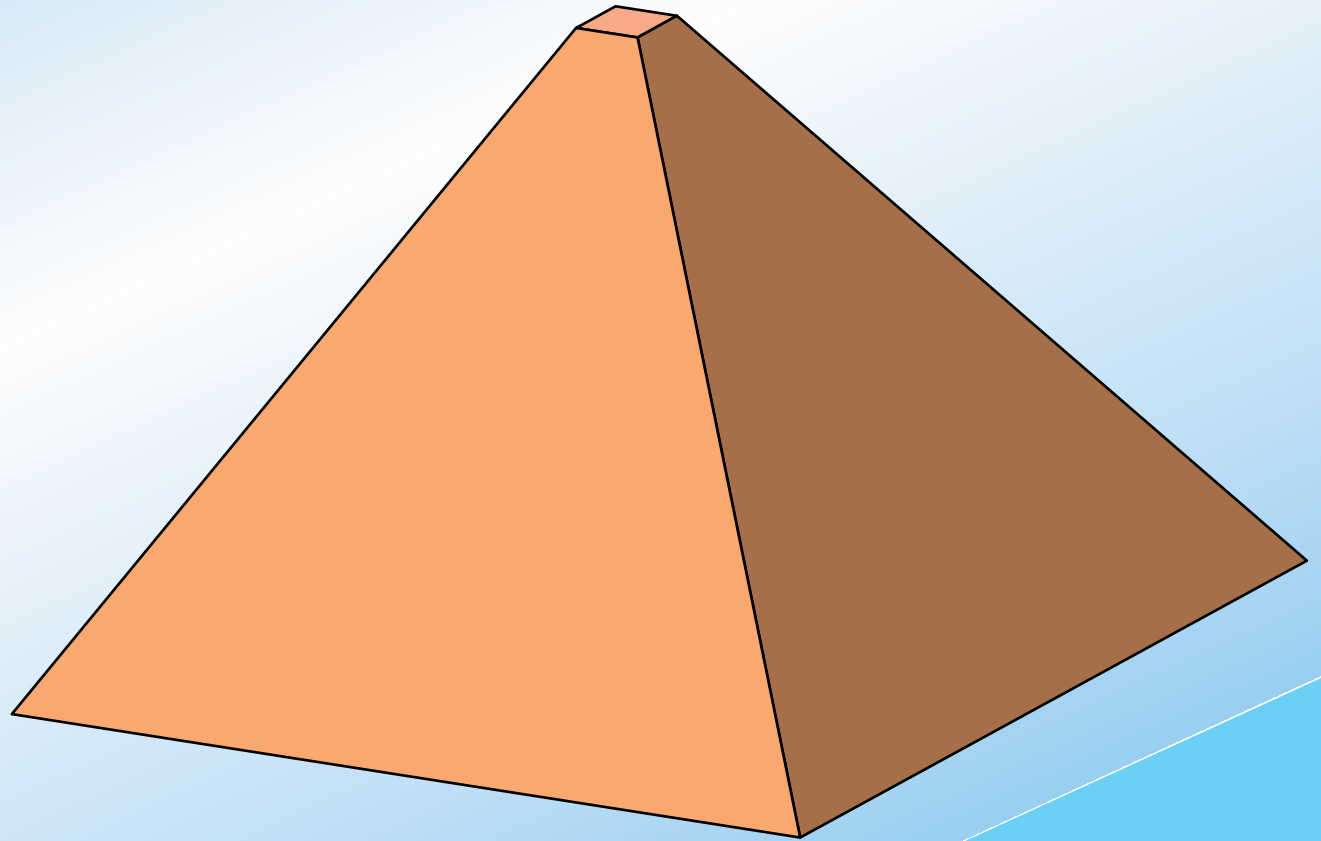
# *We have a problem*

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



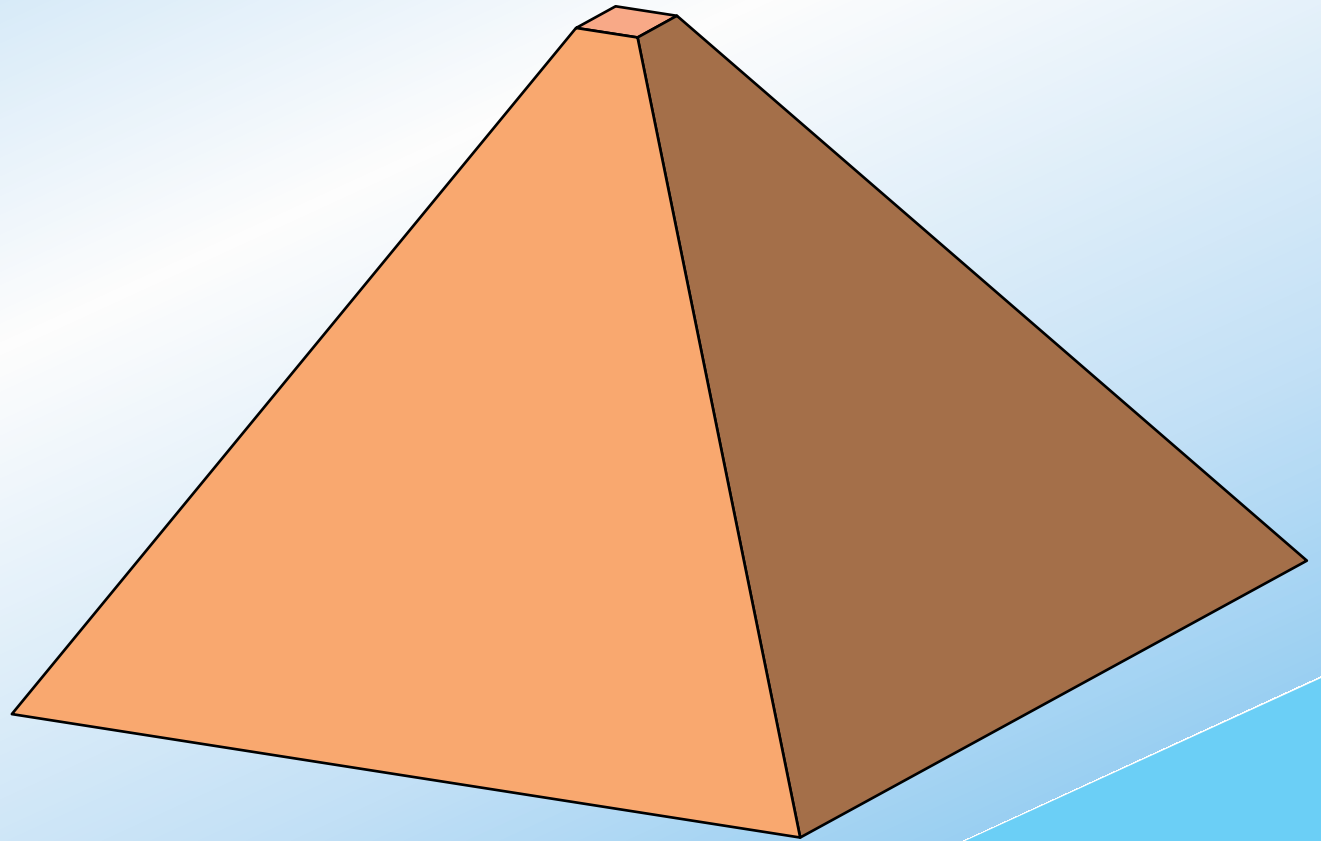
# *We have a problem*

**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*

**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?*"**



A close-up photograph of a diverse group of young people, likely students, smiling and looking towards the left. The image has a slightly desaturated, warm tone. The text "Why do we have this problem?" is overlaid in the lower center of the image.

**Why do we have this problem?**

## *Why do we have this problem?*

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

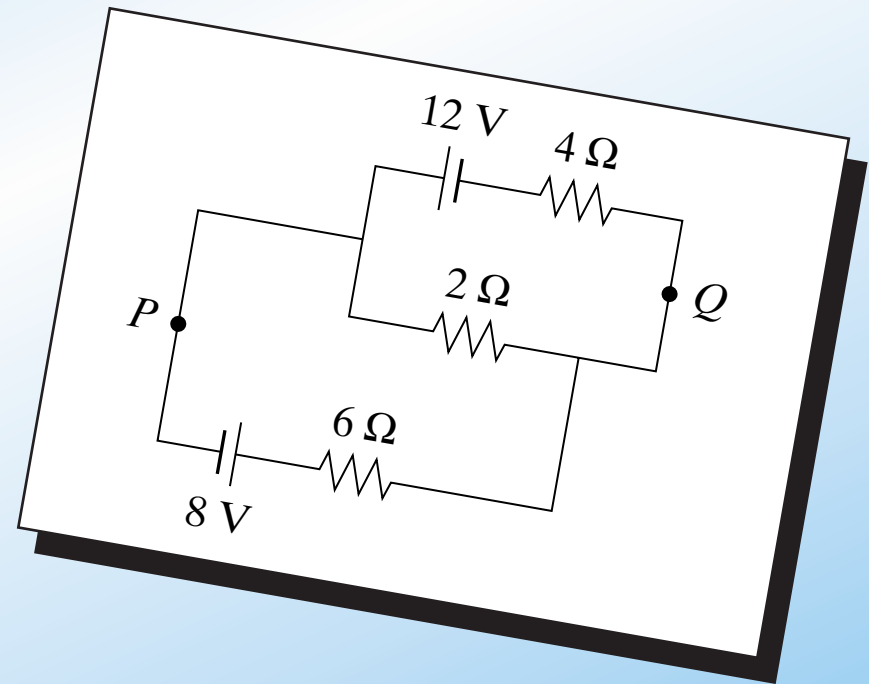
## *Why do we have this problem?*

**Conventional problems reinforce bad study habits**



## *Why do we have this problem?*

**Conventional problems reinforce bad study habits**

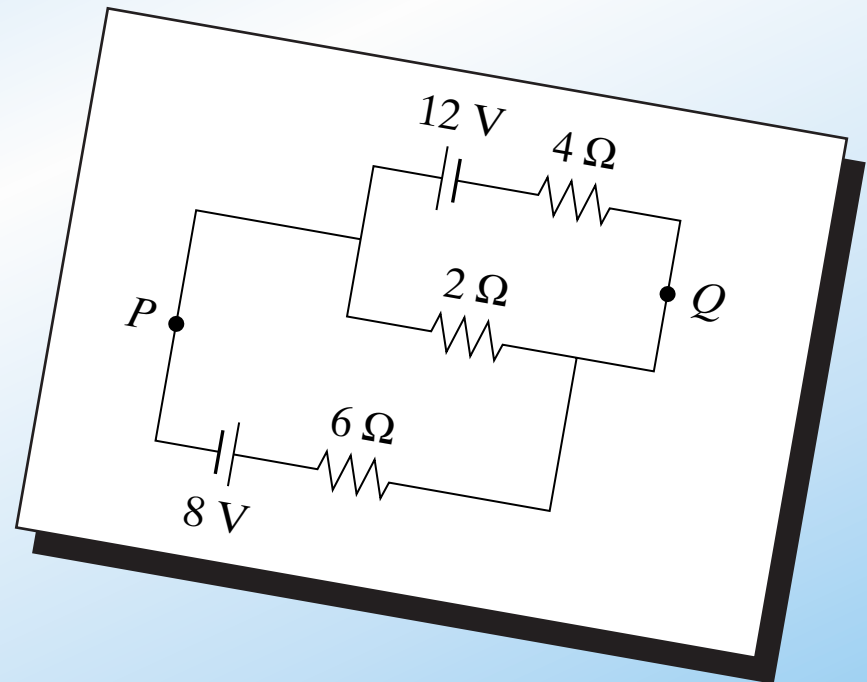


# Why do we have this problem?

## Conventional problems reinforce bad study habits

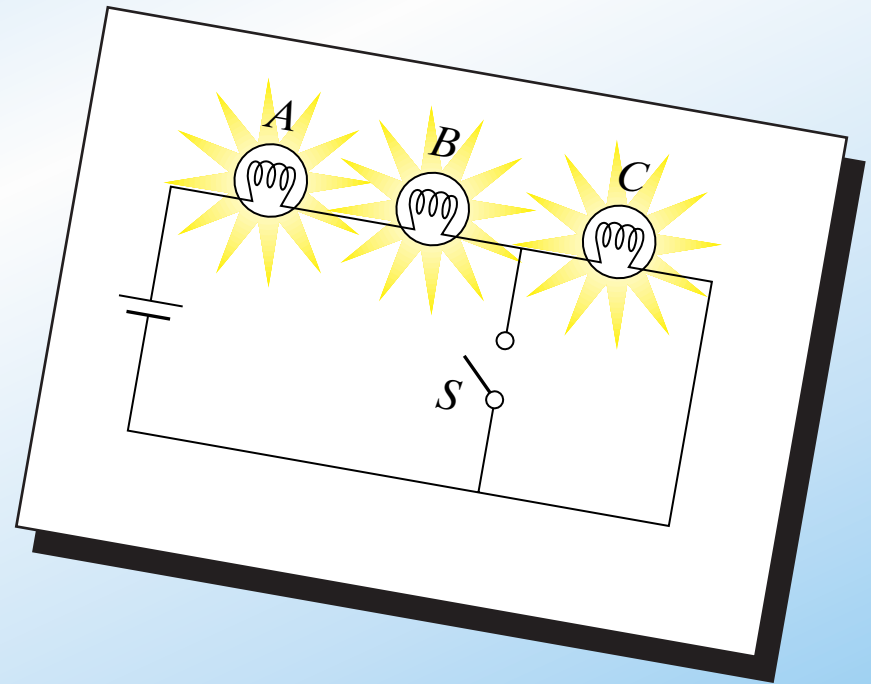
Calculate:

- (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?**

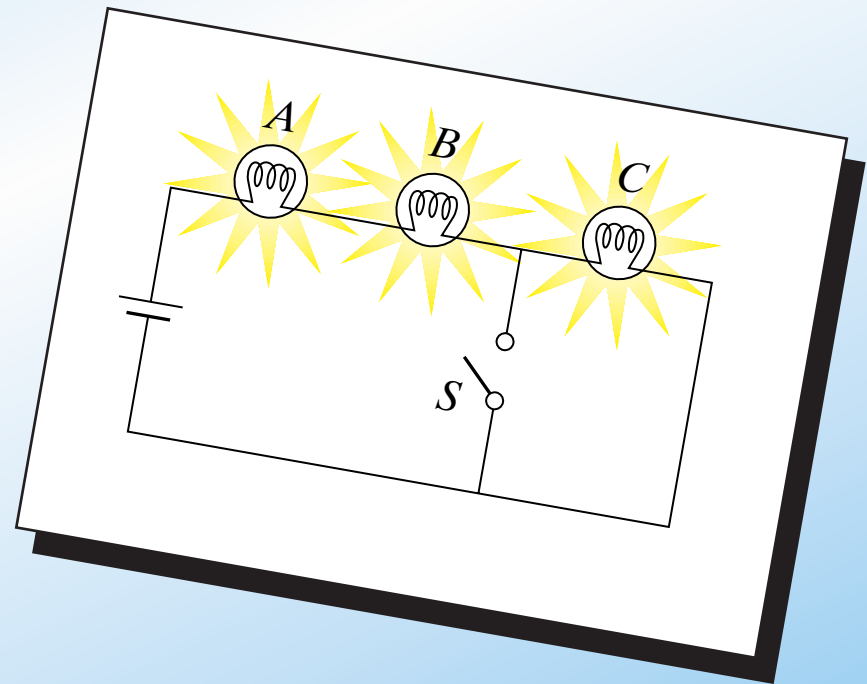


# *Why do we have this problem?*

## Are basic principles understood?

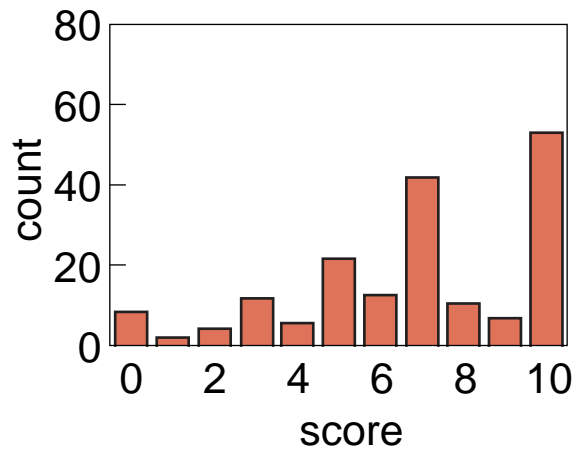
When  $S$  is closed, what happens to the:

- (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?

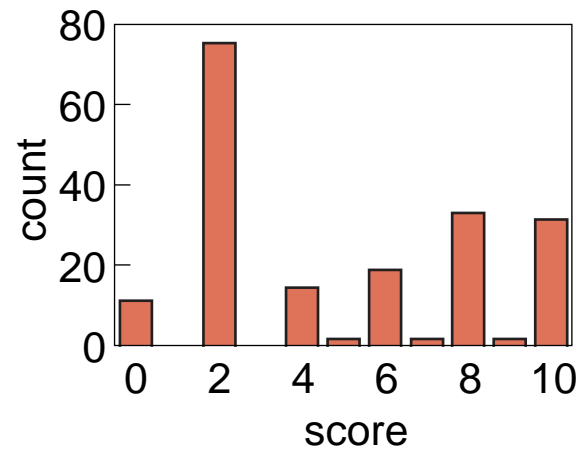


# Why do we have this problem?

conventional

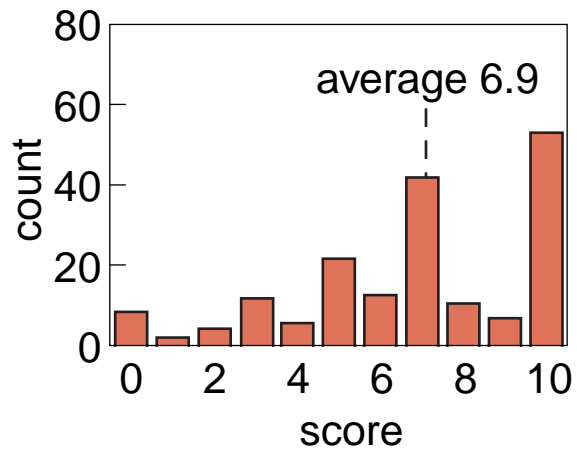


conceptual

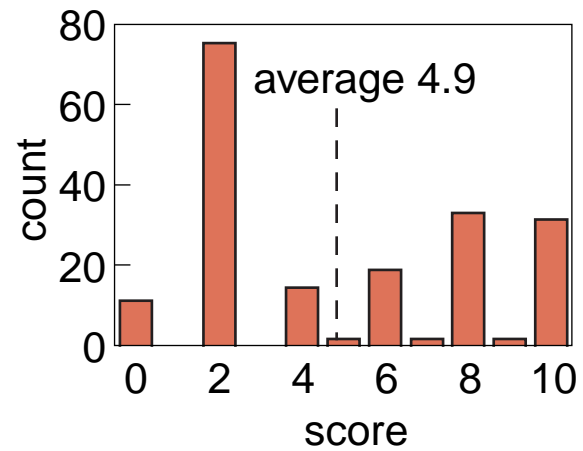


# Why do we have this problem?

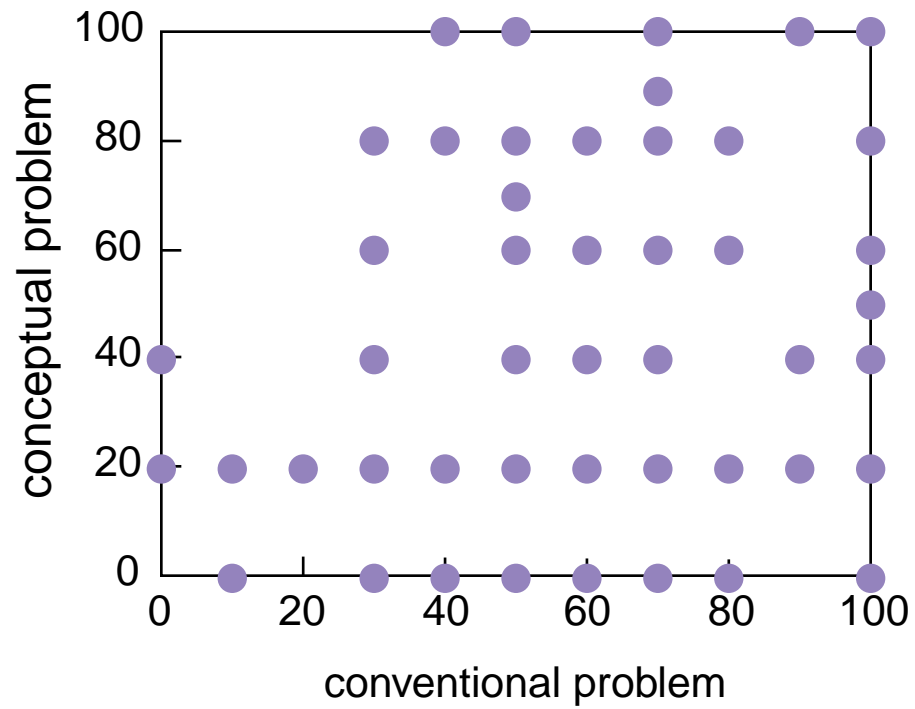
## conventional



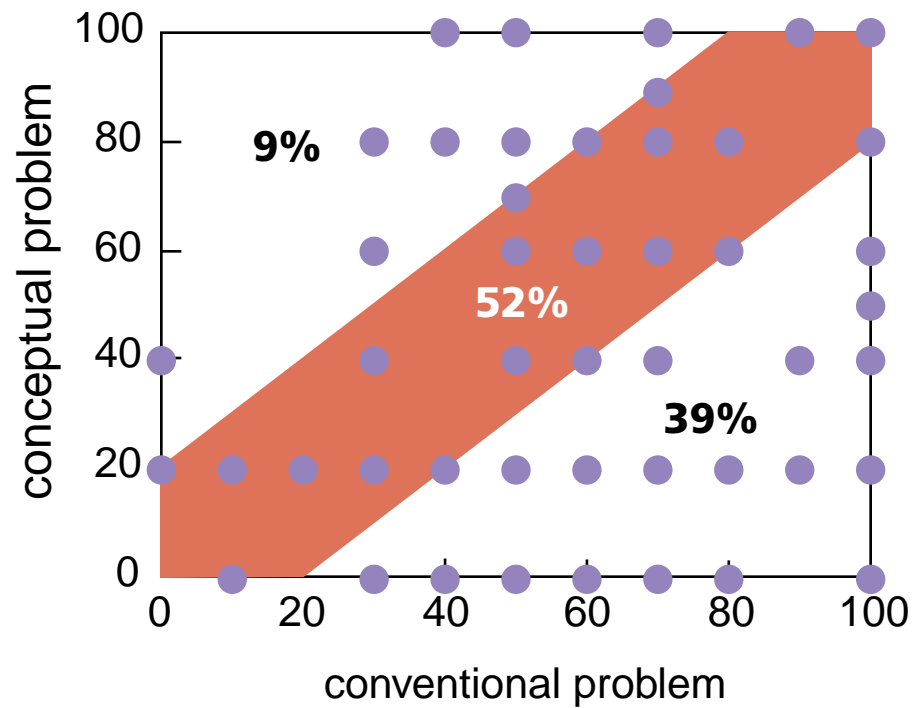
## conceptual



# *Why do we have this problem?*



# Why do we have this problem?







So what should we do?

# *Peer Instruction*

**Help students take more responsibility for learning!**

# *Peer Instruction*

## **Main features:**

- ▶ **Pre-class reading**
- ▶ **In class: depth, not coverage**
- ▶ **ConcepTests**

# *Results*

**Better understanding leads to better  
problem solving!**

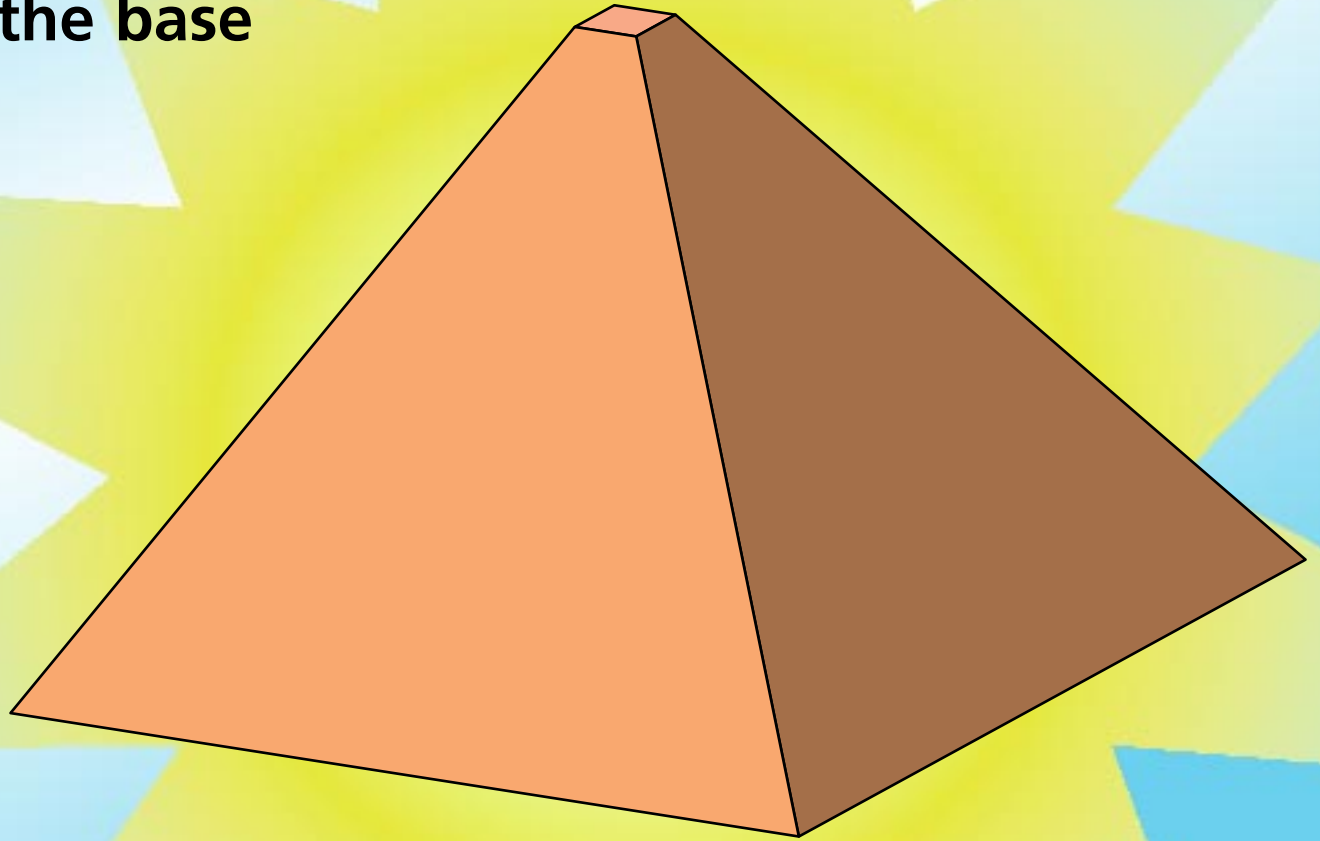
# *Results*

**Better understanding leads to better  
problem solving!**

**(but “good” problem solving doesn’t always  
indicate understanding!)**

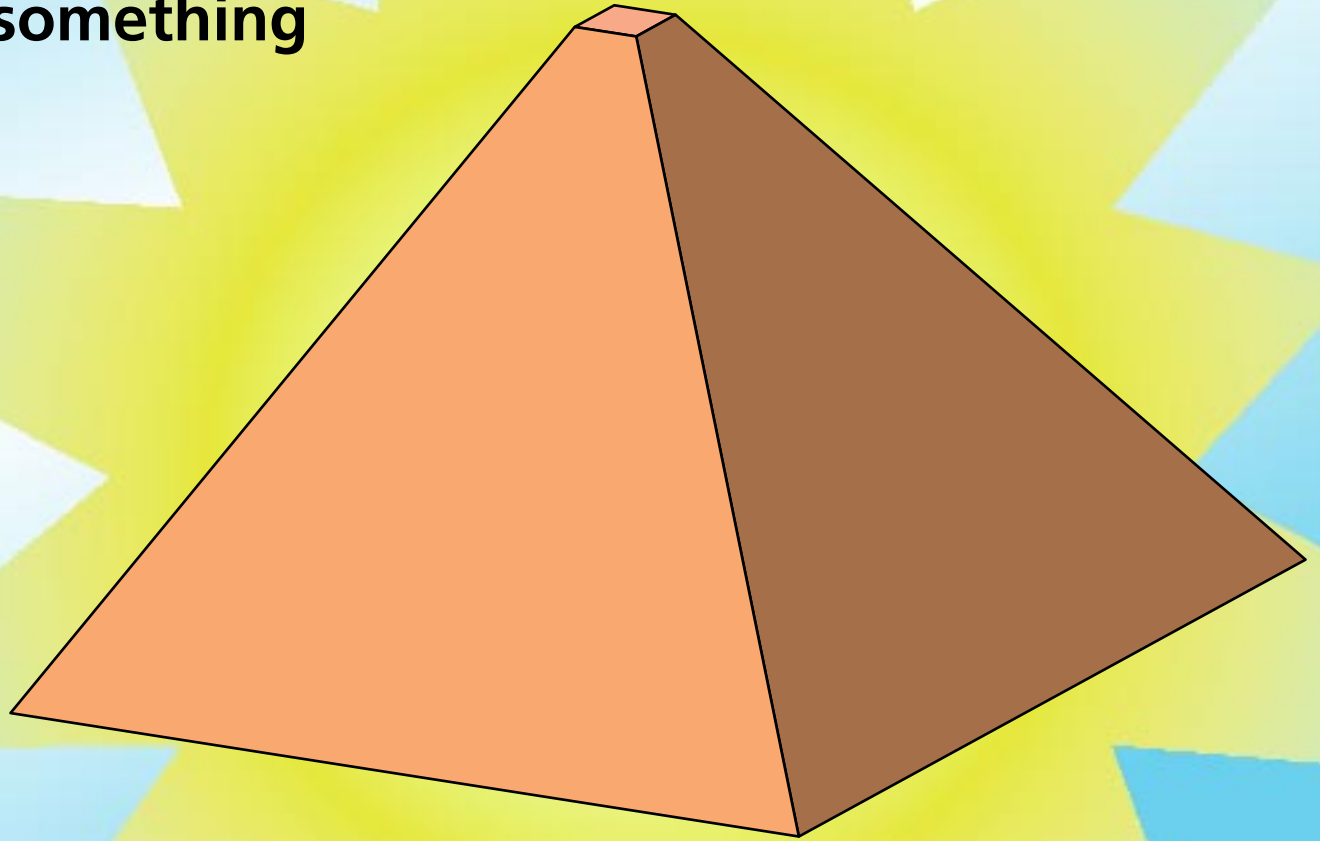
# *Conclusion*

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



# *Conclusion*

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



## **Funding**

**National Science Foundation**

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

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