

# ***The Educational Pitfalls of 'Plug-In' Physics***

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The University of Southern Mississippi

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# Why do colleges make science students learn physics? (Ideal objectives)

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- To learn the importance of accuracy
- To learn how to formulate or quantify
- To learn logical or critical thinking
- To verify the theory with experiment

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Wait! How about the actuality?

# Students in Algebra-based Introductory Physics at the University of Southern Mississippi

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- ❑ High school education for STEM is very low. (Mississippi is the **worst** according to AIP data.)
  - ❑ About more than 60 % of them did not take physics in high school.
  - ❑ Most teachers in high school are not responsible for teaching...
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# How do they struggle?

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- Focusing on only grades and teacher's expectation
  - Minimizing the work
  - Copying someone's work
  - Using trifling skills to maximize the scores
    - Plug-in physics (legal cheating?)
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# What is “Plug-in Physics”?

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- ❑ Find the values in the problem.
  - ❑ Find the related variables.
  - ❑ Find the most probable formula.
  - ❑ Plug everything in the formula, and solve for the unknown “**without thinking.**”
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# Typical Mistake by “Plug-in” Physics (Part 1)

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- **Question:** The period of a pendulum and spring motion is equal. Both hanging masses are 2.0 kg. The length of pendulum is 1.0 m. Find the spring constant, knowing  $g$  is  $9.8 \text{ m/s}^2$ .

- Normal way

$$T = 2\pi\sqrt{\frac{\ell}{g}}$$

$$T = 2\pi\sqrt{\frac{m}{k}}$$

- Plug-in physics

$$F = kx \quad \Rightarrow \quad mg = kx \quad \text{Hooke's Law???$$

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# Typical Mistake by “Plug-in” Physics (Part 2)

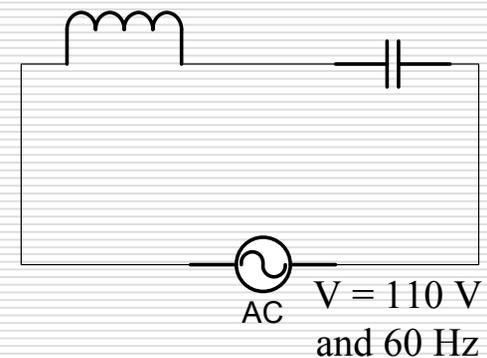
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□ **Question:** The following circuit is connected to an AC power. The inductor is 200 mH and the capacitor is 10  $\mu$ F. Find the impedance of the circuit.

■ Students are able to come up with

$$Z = \sqrt{R^2 + (X_L - X_C)^2}$$

■ But because of Plug-in physics...



**Where is the resistance (R)? I cannot find it to plug in the equation!**

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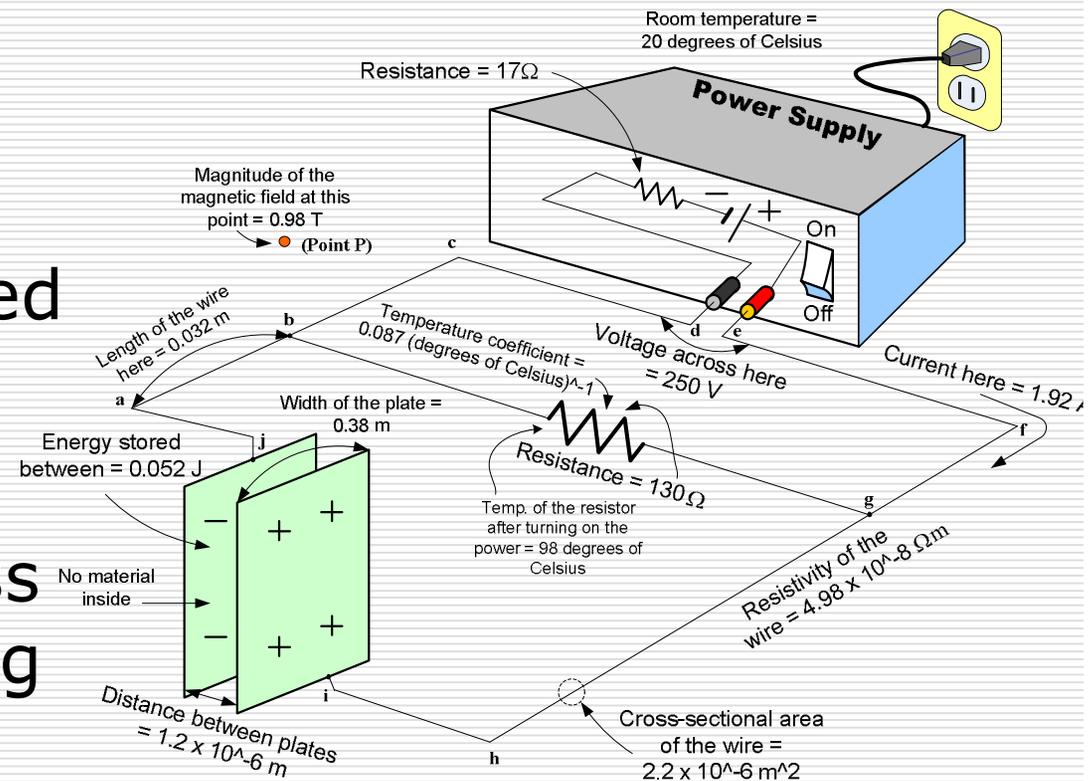
# Why does it happen?

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- Nobody cares about tutoring ⇒  
Acquiring a bad habit
  
  - Nobody cares about students' background ⇒ The problems and curriculum are too easy or too hard.
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# Strategies used at the University of Southern Mississippi

- More conceptual tricks
- Visually stimulated problems
- More arbitrariness in problem setting



It was successful, but...

# Pitfall I (Why people do this)

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- Students' point of view
    - We are not taught, but we have to survive! (Pressure from the school)
  - Professors' point of view
    - It's easy to do it! (Students will be happy and I won't be blamed.)
  - TAs' point of view
    - I don't want to get troubled! (Need to graduate as soon as possible.)
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## Pitfall II (Real reasons behind it)

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- Why do people give up?
    - If there is no incentive, people tend to go to an easier way. (Sociological fact)
  
    - Unfortunately, most of the school administrators do not have criteria for effective education. (Only negative evaluations)
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Thank you