

The Educational Pitfalls of 'Plug-In' Physics

The University of Southern Mississippi

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

- 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

Wait! How about the actuality?

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

- ❑ 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?

- 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”?

- ❑ 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)

- **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 m/s^2 .

- Normal way

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

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

- Plug-in physics

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

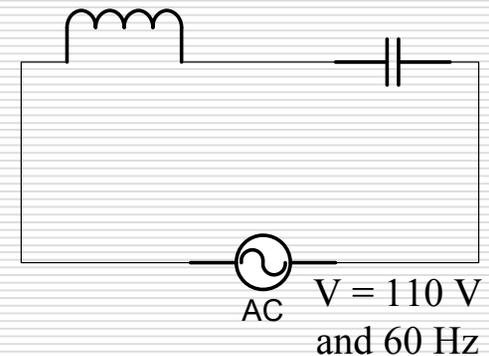
Typical Mistake by “Plug-in” Physics (Part 2)

□ **Question:** The following circuit is connected to an AC power. The inductor is 200 mH and the capacitor is 10 μ 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!

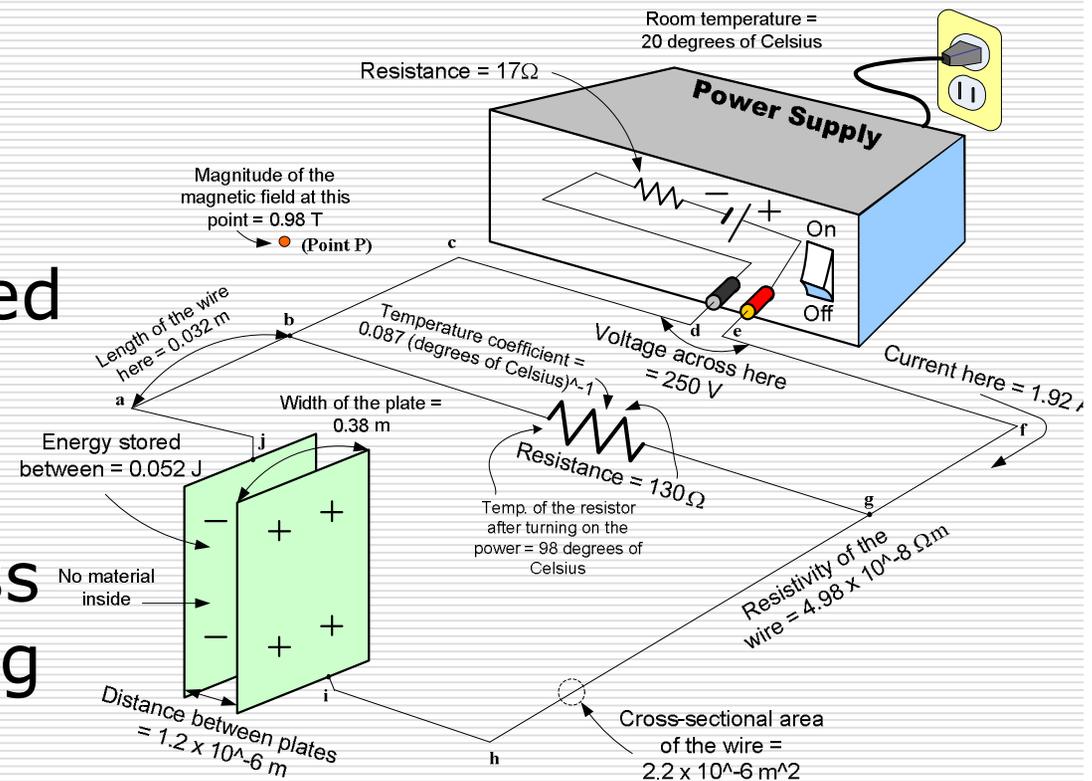
Why does it happen?

- 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)

- 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)

- 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