



# Preparing for Engineering Physics - A Studio Approach

## Gateway Science and Math Course Reform

Mark Morgan-Tracy

Jeff Saul

Jim Thomas

Mary Odom

Jacob Miller, graduate assistant



# Physics $\neq$ Math

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Our premises:

- It is not possible to succeed in engineering physics without a solid foundation in algebra, geometry, and trigonometry.
  
- It is possible to NOT succeed in engineering physics even with a solid foundation in algebra, geometry, and trigonometry.

From extensive discussions among the instructors of the Physics 160 series, we perceive that the high DFW rate is due to a large fraction of students who attempt the series but lack the mathematical sophistication to succeed. Although all students have been exposed to the necessary mathematical skills, for many of them their knowledge is not solid, and they do not understand how to apply math to physical situations.

# “Physics” Problems vs. Math Problems

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Hard Question:

Jeff has quarters and dimes that add up to \$1.60

Jim has twice as many quarters and half as many dimes that add up to \$2.30

How many does each have?

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Easy Question:

$$25x + 10y = 160$$

$$50x + 5y = 230$$

# “Physics” Problems vs. Math Problems

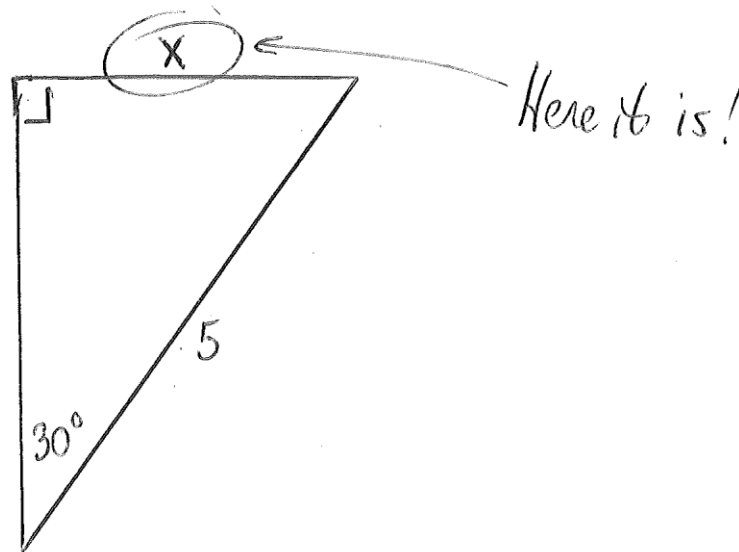
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Hard Question:

A sailor steers his boat on a direct course  $30^\circ$  east of due north. After traveling 5 miles, how far east has he gone?

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Easy Question: Find  $x$ .



# Physics 140

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- Completely new course (MMT is teaching it now for the first time.)
  - Emphasis on describing physical situations using mathematics and then solving
  - Studio approach - essentially NO lectures
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Text: “Preparing for General Physics”, by Arnold Pickar, Portland State University

This is a “self study” book with 21 “review” units and “skill drills.” Students will be required to do the skill drill *before* coming to class. They are to be collected and “checked off”, but not graded. (Solutions are in text anyway!)

In class, students will work together on worksheets that our team has designed. These worksheets are sometimes much more challenging (and, we hope, **more interesting!**) than the Pickar drills.

# Class Wiki

•All credit to Jacob Miller, graduate assistant on the project. (Jacob also contributed a number of worksheets!)

The screenshot shows a web browser window with the URL [http://phys140.shoutwiki.com/wiki/Main\\_Page](http://phys140.shoutwiki.com/wiki/Main_Page). The page title is "Physics 140". The main content area features a large blue "ShoutWiki" logo on the left and a "Main Page" heading. Below the heading, there is a welcome message: "Hey Everyone! Welcome to the Physics 140 Wiki!". This is followed by a paragraph stating that the pages are dedicated to activity sheets and should be up-to-date. A numbered list of 17 activities follows, including "Roadmap", "Activity 1 - Scientific notation", "Activity 2 - Units and Unit Conversions", "Activity 3 - Writing equations from sentences", "Activity 4 - Proportions and ratios", "Activity 5 - Linear equations", "Activity 6 - Linear motion", "Activity 7 - Basic algebra", "Activity 9 - Simultaneous linear equations", "Activity 10/11 - Distance to the moon and sun", "Activity 12/13 - Geometry of circles", "Activity 14/15 - Vectors", "Activity 16 - Quadratic equations", "Activity 17 - Other powers", "Activity 19a - Exponential growth and decay", "Activity 19b - Logarithms", and "Activity 20/21 - Atomic activity (two parts)".

At the bottom of the page, there are several utility links: "Improve Physics 140 by editing this page", "View random page", "History", "Permanent link", "Report a problem", "Send to a friend", and "Share this article" with social media icons. A recent edit by "Jmilla" on 13 January 2014 is also noted.

On the left sidebar, there is a search bar for "Physics 140", a "MORE WIKIS" dropdown, and a list of navigation links: "Upload file", "Special pages", "Help", "Recent changes", "Random page", and "What links here". Below this is a "Community" section with "One article on this wiki", a "Create account" button, and a "Log in" link for existing members. At the very bottom of the sidebar is a "Latest Activity" section.

# Example Worksheets



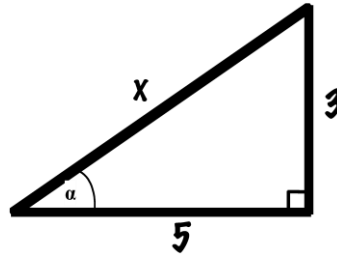
# Example Worksheets





# Student weakness is not *just* in translating into math...

$$\frac{1}{R} + \frac{1}{4R} = ?$$

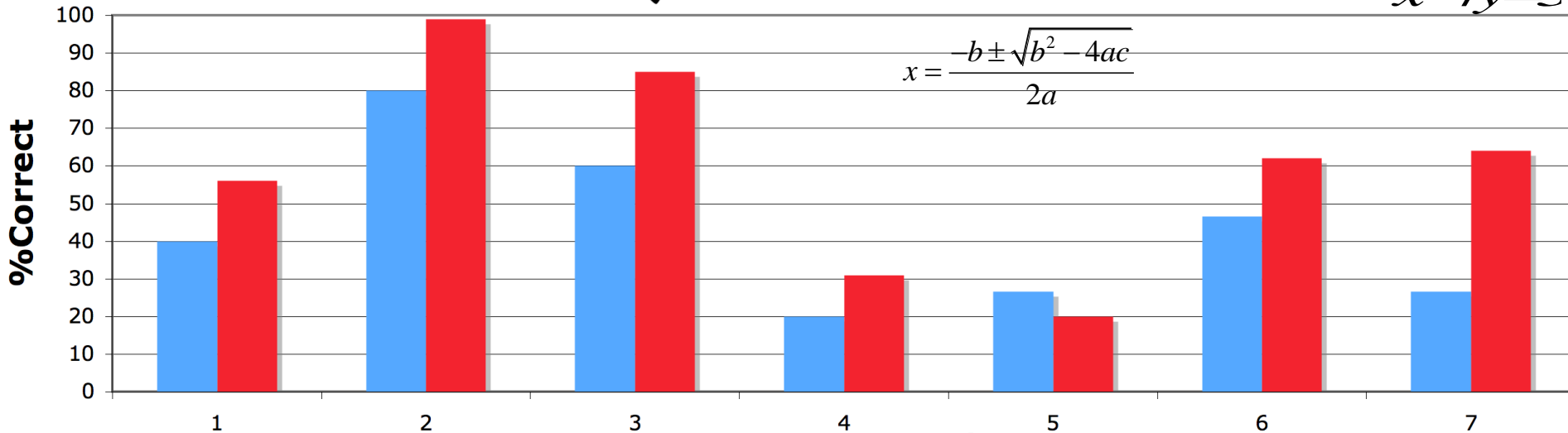


Given  $x^2 + x + k = 0$   
for what value(s) of  $k$   
will there be only one  
solution for  $x$ ?

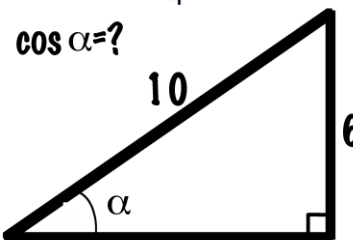
$$4x + 3y = 6$$

$$-x - 7y = 3$$

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$



Solve for  $t$ :  
 $v = u + at$



Given that  $K = \frac{1}{2}mv^2$ ,  
if  $v$  is doubled and  $m$   
held constant, then  $K$   
will:

Red 161  
Blue 140

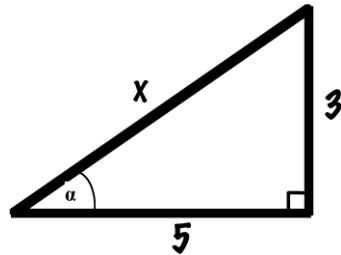
Same questions are “difficult” for both groups.

**Q4: Jumping to conclusions**

**Q5: Thinking about what equations mean**

(Mediocre results on Q1 and Q7 simply reflect poor math competency - students have not properly memorized the symbol manipulation rules we call math.)

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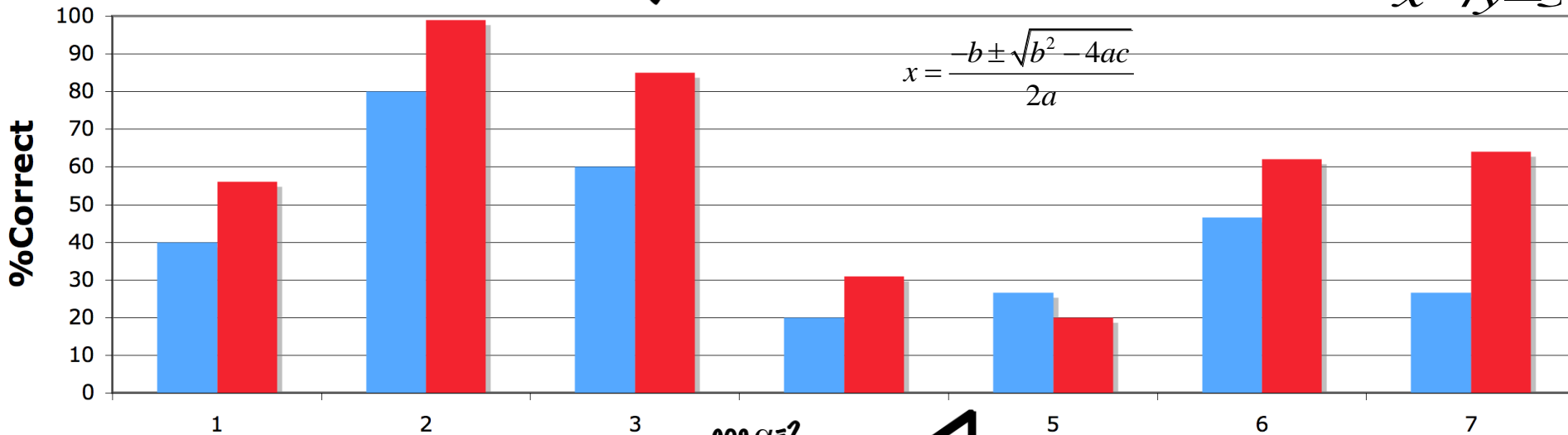


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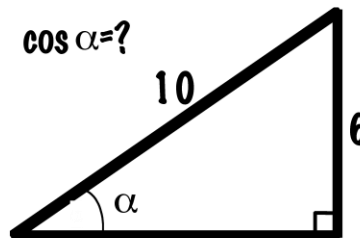
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$\cos \alpha = ?$



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Red 161  
Blue 140

# Saul Pre-test

Questions I thought would be difficult (and were):

6' tall man casts 8' shadow. How tall is a tree that casts a 28' shadow?

(38%)



*Estimate*  $\log_{10} 500$ .  
(No calculator allowed!)  
(19%)

Questions that disappointed me:

Simplify  $3(2^n) + 2(2^n)$   
(25%)

Solve for x:  $0.2x + 1 = 0.02x$   
(25%)