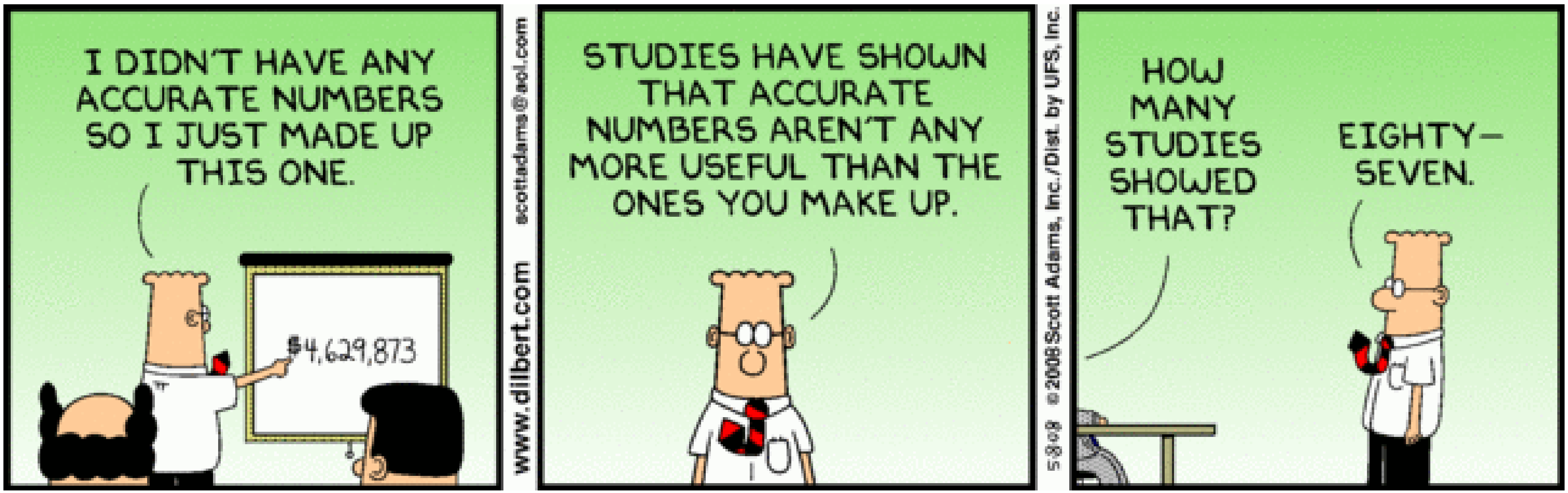
PHYS 121 – SPRING 2014



http://www.cs.vu.nl/~frankh/dilbert/accurate_numbers.gif

Don't tell our Lab Director, Dr. Driscoll, that I showed you this comic!

Chapter 1: Space, Time & Mass + Miscellaneous

version 01/14/2015, 19 slides

ANNOUNCEMENTS

- **Make sure your clicker or app is properly registered.**
  - 205 students used their clickers on Monday, of ~ 250 students ~80%.
  - As of Monday, ~ 72% of the class had properly registered their device(s).
  - We'll post list of registered devices in a few days.
  - We'll start using response data for ***BONUS POINTS*** after the DROP/ADD period ends.
  - The session ID "PHYS121" is only activated during class.
- **Refer to Blackboard for reading & homework assignments.**
  - The 'final' homework' assignment for next week will be posted after lecture on Friday.
  - Check Blackboard after 5 PM Friday to make certain nothing has changed.

ASSIGNMENTS FOR WEEK #1

- READINGS in Ohanian & Markert for this week
  - Skim through the Preface, Owner's Manual & Prelude
  - Read Chapter 1

    We will not review all of this material in class.

    If there's anything in Chapter 1 that confuses you, get HELP!

    HELP includes coming to see me during or outside office hours.
  - Read Chapter 2 + 3.1
- HOMEWORK #1 due WEDNESDAY, Jan. 21

    Note unusual due date due to MLK holiday on Monday
  - This assignment might be modified (*shortened*) after class on Friday.

LABORATORY

Lab#1: Uncertainty

in measuring the acceleration of gravity, *g*,

with a pendulum.

How to evaluate the reliability of numbers you measure & calculate.

≡ ERROR ANALYSIS

ERROR ANALYSIS

Error analysis can be difficult but is

VERY IMPORTANT!

Error analysis will be covered in lab

ad nauseum

Lab Manual Appendix V, Section D

http://physicslabs.phys.cwru.edu/files/pdf/mech/Appendix_V_Error%20Prop.pdf

In lecture, we'll only worry about

significant figures.

Error analysis will tell you the # of significant figures.

The reverse is not *quite* true.

SIGNIFICANT FIGURES

SIGNIFICANT FIGURES = # of meaningful digits in a value.

$3.254683722 \pm 0.02\ m$

$\Rightarrow$ 3.25 is significant, ± 0.02

0.004683722 is meaningless

If you don't know a length to better than 2 *cm*,

you have no business describing it to the nearest nanometer.

There are **3** significant figures in 3.25.

SIGNIFICANT FIGURES

- The # of significant figures should be established by proper error analysis.
- The number of significant figures in a final answer is limited by the input quantity with the lowest number of significant figures.
- For homework & exams, you'll normally be given information to 2 or 3 significant figures.
- Detailed rules for identifying significant figures and handling them in mathematical calculations are given in the text.
- HOWEVER, the best way to identify the number of significant figures you should use is with proper error analysis, as taught in lab.

Significant figures is a simplistic form of error analysis.

Professionals (*in training*), like you,

do REAL error analysis,

like you'll learn in lab

(*but this is impractical for homework & exam purposes*).

PROPER SOLUTIONS for HOMEWORK & EXAMS

In PHYS 121, the work you do towards obtaining an answer is more important (*for our purposes*) than the answer itself.

- Some PHYS 121 instructors assign ~ 10% of a problem's grade to the actual answer.
- The other 90% is associated with setting the problem up correctly.

- Homework and exam grades will be based in large part on the work you show,

  which means you **MUST SHOW YOUR WORK**.

- Depending on the nature of the problem, you might be expected to include the steps shown on the following slides.

PROPER SOLUTIONS

1. **Draw a figure & define the variables and coordinate systems you use.**

   Most people think visually rather than in text. The first step in working most problems is to draw a figure that represents the situation and defines various quantities you will use, such as the directions of your axes, initial velocities, angles, forces, etc.

2. **Provide the fundamental concept(s) you plan to use.**

   This will often be an equation, such as F = ma, but it could be a statement

   ~'Conservation of momentum will be used;

   it applies because there are no external forces.'

3. **Set up the equations for your specific situation using the constants and variables you've defined.**

   Getting to this point and doing it properly indicates that you understand 90% of the physics involved in the problem and will often result in your earning 90% of the possible credit.

PROPER SOLUTIONS

4. **Do the math.**

   This might only entail manipulation of symbols using geometry, trig, algebra and calculus, although you'll sometimes be asked for numerical answers.

   Work with symbols as far as possible,

   substituting in numbers only when necessary.

5. **Circle or underline your final answer** to make it easier to identify.

You're not done yet!

PROPER SOLUTIONS

6. CHECK YOUR ANSWER!

- **Units & dimensions**

  If you find that an object has moved a distance d = 10 seconds, you've made a mistake somewhere.

- **Significant figures:** 2 or 3 significant digits is *normally* appropriate for our homework and exam problems.

  If you provide far too many significant digits, as you might if you simply copy a calculator display, you will lose credit.

- **Magnitude** – problems you encounter in a physics class are usually designed to represent the real world.

  If you calculate that you are walking at twice the speed of light, you might have made a mistake.

PROPER SOLUTIONS

Giving unreasonable answers

(*in terms of dimensions/units or magnitude*)

will cost you extra points beyond those allocated directly to the mistake you made.

You might also see a comment on your work:

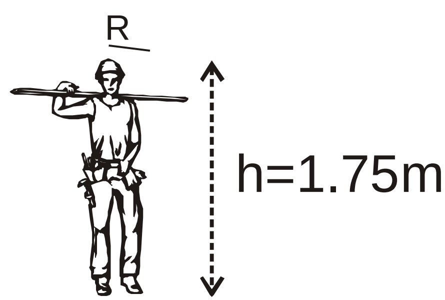
THINK!

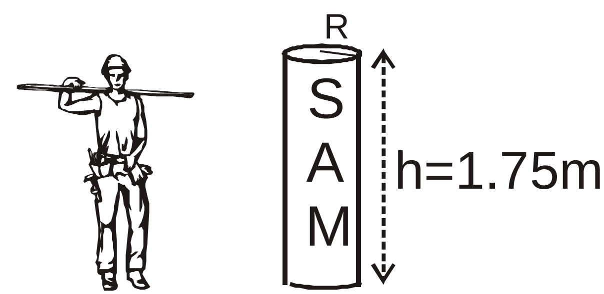
However, you can recover points you lost if you point out that you realize something is wrong, even if you can't find your mistake.

EXAMPLE OF HOW TO DO A HOMEWORK PROBLEM

Sam is 1.75 *m* tall (5'9"), wears an 80.0 *cm* belt (*31.5"*) and weighs 70.0 *kg* (*154 lbs*).
What is Sam's density (*mass per volume*) ρ? (ρ = Greek letter *rho*)

1. **Draw a figure, including the variables and coordinate systems you use.**





2. **Provide the fundamental concept(s)/equations you plan to use**.

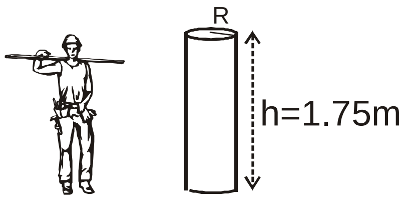
   Density ≡ mass per volume; $\rho = M/V$

   Sam ~ cylinder of same height and radius (*a cylindrical cow approximation.*)

3. **Set up the equations for your specific situation using the constants and variables you've defined.**

   $h = 1.75\ m$; radius R = circumference/(2π) = $0.80\ m/(2\pi) = 0.127\ m$

EXAMPLE OF HOW TO DO A HOMEWORK PROBLEM



4. **Do the math.**

$$\rho = M/V = M/(\pi R^2 h) = 70.0\ kg/\ /[\pi(0.127\ m)^2(1.75\ m)]$$
$$= 789\ kg/m^3$$

5. **Circle/underline your final answer** $\underline{\rho = 789\ kg/m^3}$

6. CHECK YOUR ANSWER!

- **Units & dimensions**
  √ My answer has dimensions & units of density; mass per volume, kg/m^3
- **Significant digits**
  √ My answer has 3 significant figures, as does the input data.
- **Magnitude**
  √ For comparison, water has a density 1 g/cm^3 = 1000 kg/m^3

  Sam's density is of the same order of magnitude as a cylinder of water; this seems about right given that we're made mostly of water.

DIMENSIONAL ANALYSIS

Learn to use *dimensional analysis*, defined in Ohanian section 1.6.

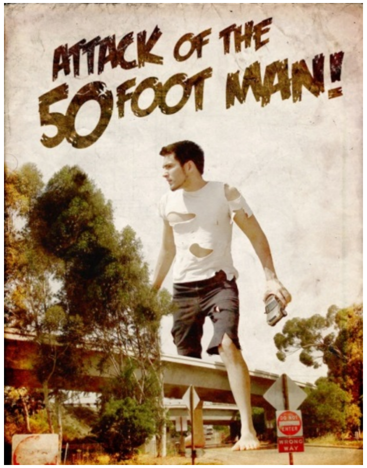
- You can sometimes determine or check the equation that describes some phenomenon simply by considering the dimensions of the terms involved.
- For example, how must velocity (m/s), displacement (m) and time (s) be related?

$$v = d/t$$

- Any argument of sine, cosine, tangent, exponential or log/ln ***MUST BE DIMENSIONLESS***, as in a distance divided by a distance.

$sin(distance) \sim sin(1\ m) \neq sin(100\ cm)$ & NEITHER MAKES SENSE!

$\Rightarrow$ *unforgivable error*



EXTREME CASES

Consider how your solution behaves as various parameters get very large or very small, when the answer might be obvious.

$v = d/t$ As d decreases $v \rightarrow 0$

If your answer doesn't behave this way, you made a mistake! FIND IT!

PS: Why shouldn't you worry about being attacked by a 50 foot man or a giant ant?

- The mass of an object is proportional to its volume while the strength of its skeleton is proportional to the cross-sectional area of the bones or exoskeleton.

So if you make an ant or a person larger without changing their structure dramatically, they will collapse under their own weight.

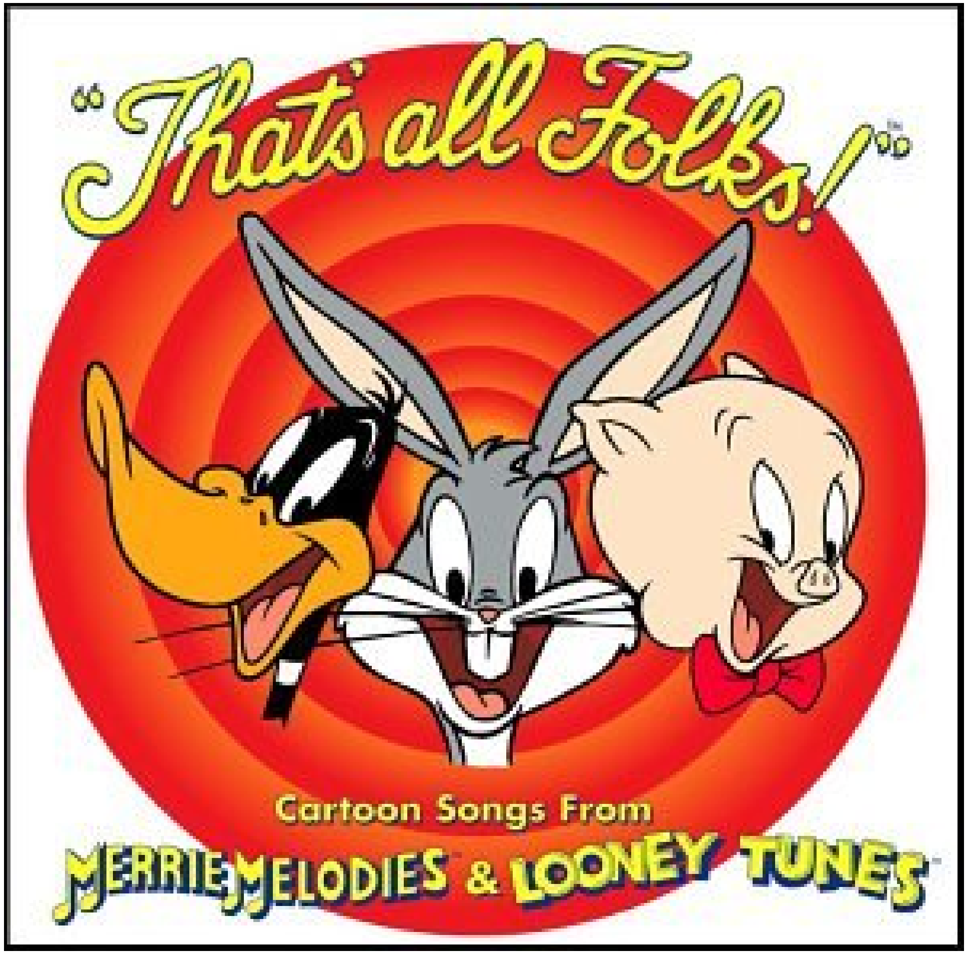
Smaller people are stronger, per pound (kg).

Take that Lebron James!

http://maddartist83.deviantart.com/art/Attack-of-the-50-Foot-Man-60361147

http://thebigblogtheory.wordpress.com/2010/04/12/s03e19-the-wheaton-recurrence/

THE END!



http://ecx.images-amazon.com/images/I/51K0DCKQ4FL.jpg