Physics 2BL: Experiments in Mechanics and Electricity
Spring Quarter, 2012

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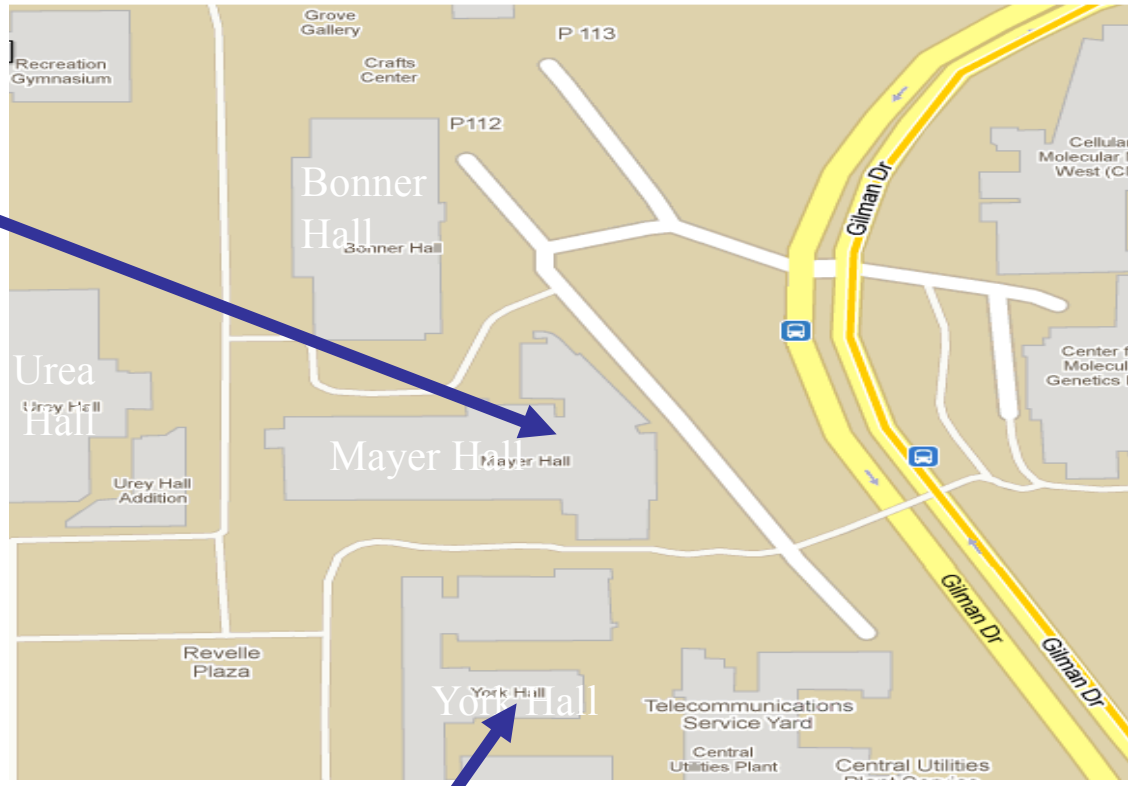
Introduction

My office is located in the 1623 Mayer Hall Annex mpaddock@ucsd, edu



Lab is located on second floor – MHA 2722

We are here

Expectations?

What do you think of physics?

Is this your first lab?

What do you hope to learn?

The Point of the Class

- Learn how scientists form models of nature -the process of doing science
- Learn to assess the accuracy of measurements
- Extend understanding of mechanics/electricity through hands-on exposure
- Learn how to report scientific results

Class components

- Labs – MHA 2722
- Lectures – York 2722
- Homework/Reading
- Website: http://physics.ucsd.edu/students/courses/spring2012/physics2bl
- Facebook page: http://www.facebook.com/UcsdPhys2bl

Introduction to labs and lectures

- Basics of mechanics and measurements
- Perform 4 labs
  - Two sessions to complete each
  - Design and improve techniques
- Emphasize uncertainties
  - Estimate errors
  - Propagate errors

Labs

- ~ 3 hours per meeting
- Organized around different aspects of scientific methods (observation, forming and testing models, measuring relationships)
- Read lab description and do pre-lab homework **BEFORE** lab session
- Short quizzes at the start of the lab
- Record contact information for your TA

Lab Write-ups

- Begin with lab number & title, date and you and your partners name
- Start with Taylor homework and prelab questions
- State briefly the objective
- Record all data with units and uncertainties
- Brief description of procedure
- Make clear labeled diagrams of setups
- Use graphs to present data, label axes, plot error bars – Origin or Excel

Lab Write-up continued

- Include and justify functional fit of data
- Show calculations of final derived quantities, include uncertainty analysis
- State results and comment on the agreement with expectations (or not)
  - Be quantitative (within uncertainty, t-value)

Grading

- Three components
  - 60 % for the labs and writeups
  - 20 % prelab quizzes/Homework
  - 20% final
  - 5% clicker questions, starting next week

Lectures

"The lecture method is the process whereby the lecture notes of the instructor get transferred to the notebooks of the students without passing through the brains of either!"
--Darrell Huff

That quote pretty much sums up my feelings about modern lectures

That is why I strongly encourage your participation in the lecture process

This is why we will be using clickers (http://www.iclicker.com)

Lectures

- Provide context for labs
- Error analysis
- Homework

Schedule

Meeting	Experiment
1 (Apr 2-6)	None (start Taylor)
2 (Apr 9-13)	1
3 (Apr 16-20)	1
4 (Apr 23-27)	2
5 (Apr 30-May4)	2
6 (May 7-11)	3
7 (May 14-18)	3
8 (May 21-25)	4
9 (May 28-June 1)	4
10 (June 4-8)	FINAL

Laboratory Sections

	Monday	Tuesday	Wednesday	Thursday	Friday
8:00 AM					
9:30 AM		A03		A07	
10:00 AM		**Boucheron**	A04	**Lin**	A10
11:00 AM		**Lin**	**Boucheron**	**Green**	**Murphy**
		744463	**Conger**	744467	**Cabrera**
12:30 PM		A01	744464		744470
1:00PM		**Conger**	A05		
2:00 PM		**Green**	**Green**		
		744461	**Wu**		
3:30 PM		A02	744465	A08	
		Stergiou	A06	**Green**	
5:00 PM		**Ye**	**Stergiou**	**Ye**	
		744462	**Ye**	744468	
6:30 PM			744466	A09	
				Murphy	
				Cabrera	
				744469	

Laboratory TAs

Leandra	Boucheron	lsbouche@ucsd.edu
Alvin	Cabrera	amcabrer@ucsd.edu
Casey	Conger	cconger@ucsd.edu
L. Stevie	Green	lsgreen@ucsd.edu
Han	Lin	hwl005@ucsd.edu
Devon	Murphy	dwmurphy@ucsd.edu
Andreas	Stergiou	anstergi@ucsd.edu
Po-Chun	Wu	pow004@ucsd.edu
Jingxin	Ye	j9ye@ucsd.edu

	A03 **Boucheron** **Lin** 744463	A04 **Boucheron** **Conger** 744464	A07 **Lin** **Green** 744467	A10 **Murphy** **Cabrera** 744470
	A01 **Conger** **Green** 744461	A05 **Green** **Wu** 744465		
	A02 **Stergiou** **Ye** 744462	A06 **Stergiou** **Ye** 744466	A08 **Green** **Ye** 744468	
			A09 **Murphy**	

Laboratory LTAC

Tera Austrum tbell@physics.ucsd.edu

	A03		A07	
	Boucheron	A04	**Lin**	A10
	Lin	**Boucheron**	**Green**	**Murphy**
	744463	**Conger**	744467	**Cabrera**
	A01	744464		744470
	Conger	A05		
	Green	**Green**		
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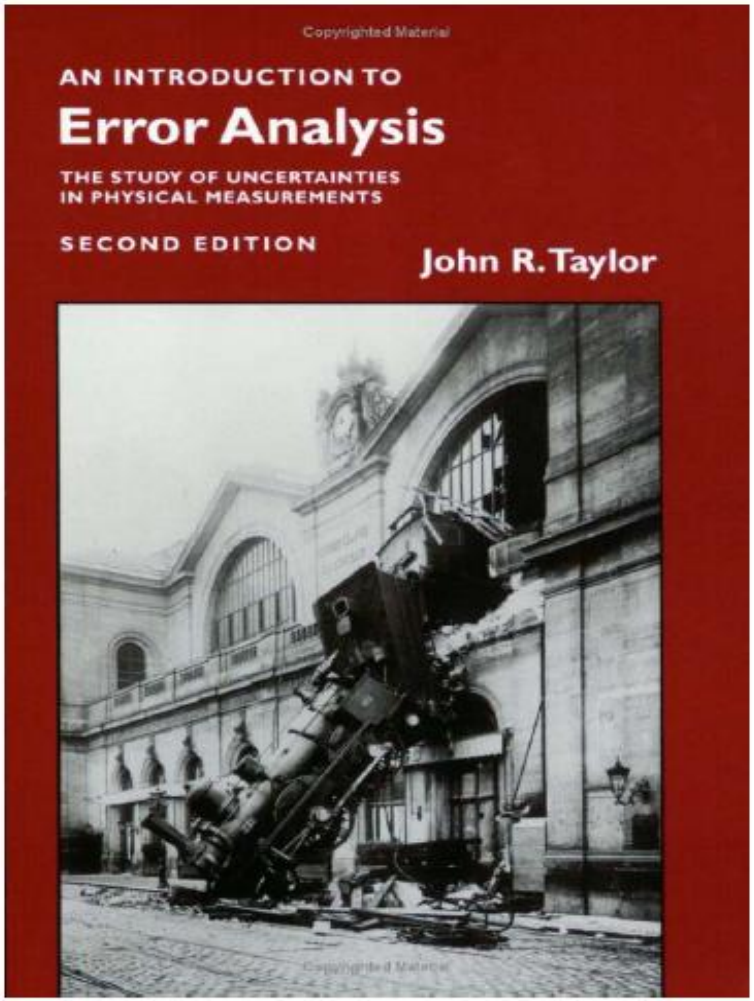
	Stergiou	A06	**Green**	
	Ye	**Stergiou**	**Ye**	
	744462	**Ye**	744468	
		744466	A09	
			Murphy	

Readings - Text - Homework

- Yes
- Taylor, *An Introduction to Error Analysis,* 2nd ed.
- Weekly homework on website



How to do Well!

- Show up to all lectures and labs
- Read **before** the lectures the recommended reading
- Before each lab:
  - Review lecture slides
  - Read experiment guidelines
  - Answer all pre-lab questions within.
- Do the homework/practice problems
- Ask questions!

The Four Experiments

- **Determine the average density of the earth**

Weigh the Earth, Measure its volume

– Measure simple things like lengths and times

– Learn to estimate and propagate errors

- **Non-Destructive measurements of densities, inner structure of objects**

– Absolute measurements *vs.* Measurements of variability

– Measure moments of inertia

– Use repeated measurements to reduce random errors

- **Construct and tune a shock absorber**

– Adjust performance of a mechanical system

– Demonstrate critical damping of your shock absorber

- **Measure coulomb force and calibrate a voltmeter.**

– Reduce systematic errors in a precise measurement.

Uncertainties/Errors

Errors

Mistakes – systematic

Uncertainties - not mistakes!

inevitable and intrinsic part of any experiment

Doing Science: Tools for Building Knowledge

- Science is a process that studies the world by:
  - Focussing - specific topic (***making a choice***)
  - Observing (***making a measurement***)
  - Refining Intuitions (***making sense***)
  - Extending (***seeking implications***)
  - Demanding consistency (***making it fit***)
  - Community evaluation and critique

Making a choice

- Choosing a channel on cat television
- Relates to the questions we are asking

choice - measure - make sense - seek implications - make it fit

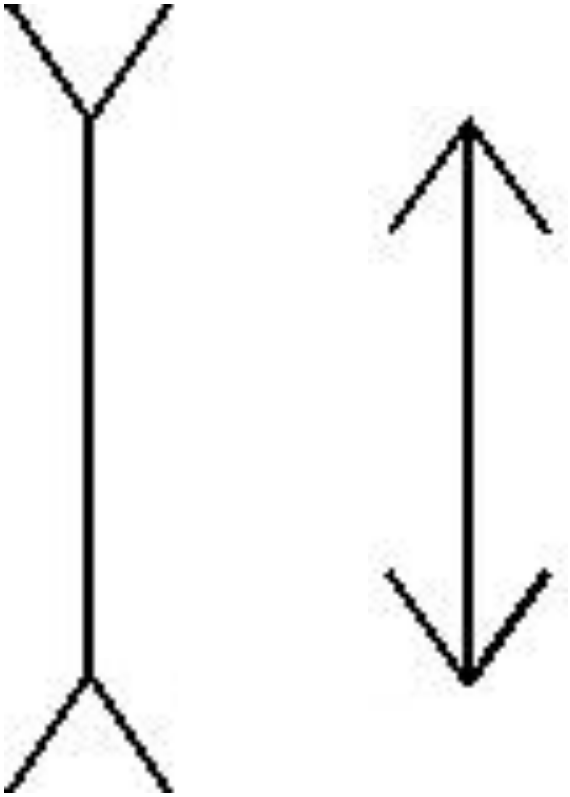
Making a Measurement (and sense)

- How do we see the world around us?
- How do we know we see things the same? (reliable)
- How do we know that we see things correctly? (valid)
- Our own VR:
  - We gather info through our senses
  - Our brains interpret these stimula
  - But don't necessarily get them right

choose - measure - make sense - seek implications - make it fit

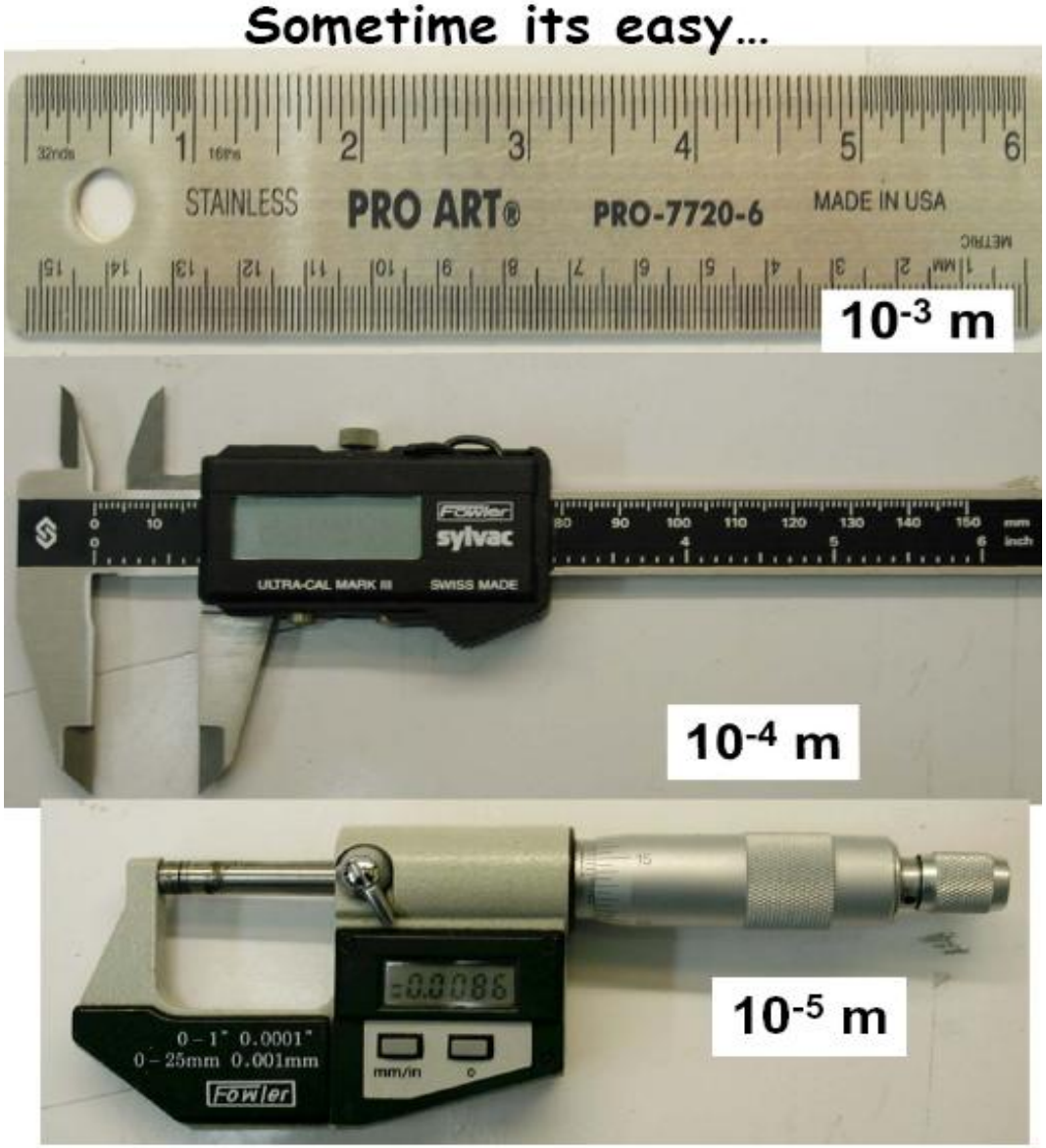
Making a Measurement

- Do these line segments look the same?
- Are they?



choose - measure - make sense - seek implications - make it fit

Uncertainties in devices

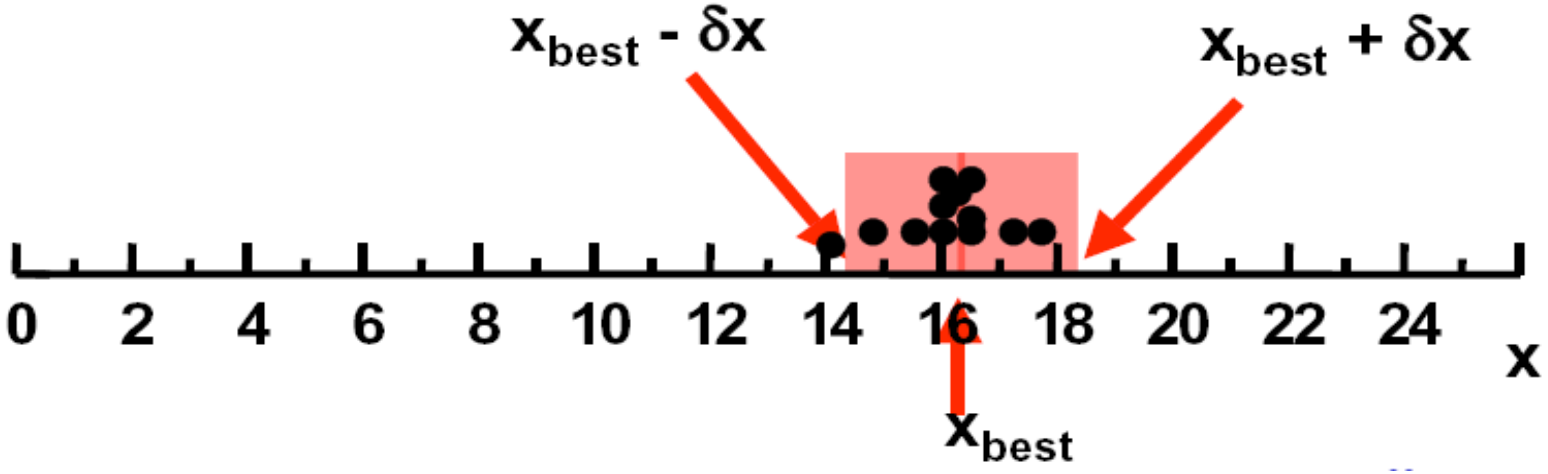


Determine range of values from multiple measurements

Statistically - Take a few measurements of some variable x

1. Find the most likely value - "best"
2. Estimate the spread - uncertainty

$$x = x_{best} \pm \delta x$$



Making Sense

- What is this?
- Hint: it's an animal
- Hint: it's not oriented correctly

choose - measure - make sense - seek implications - make it fit

Hmmmm….

- Does this help?

choose - measure - make sense - seek implications - make it fit

How about this?

- First this…

choose - measure - make sense - seek implications - make it fit

Now this

- Context matters…
- Here we are REFINING INTUITION and making sense, which depends upon context

choose - measure - make sense - seek implications - make it fit

Making sense of physics

- Does this look like dots
- Or deep relations of electric forces

$$\vec{F}_0 = \frac{1}{4\pi\varepsilon_0}\sum_{i=1}^{N}\frac{q_0 q_i}{\left|\vec{r}_i - \vec{r}_0\right|^3}(\vec{r}_i - \vec{r}_0)$$

choose - measure - make sense - seek implications - make it fit

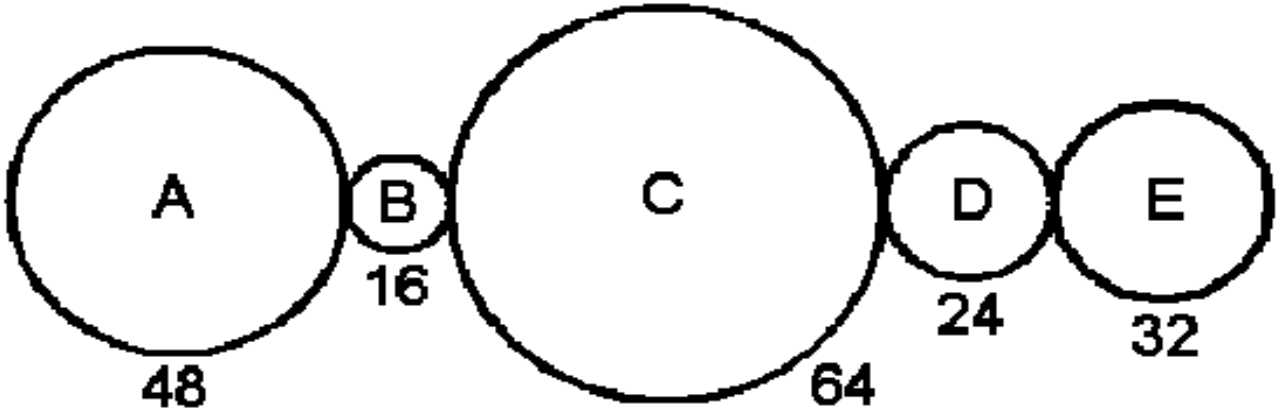
Seeking Implications

- Elaboration -- when we assume one thing it is bound to have implications beyond the exact case we are considering.
- Figuring out what something implies is a good way to examine the thing itself
- And develop MODELS which are applicable beyond our immediate case

choose - measure - make sense - seek implications - make it fit

Elaboration

- The drawing shows a chain of five gear-wheels, identified as **A** to **E**, each one meshing properly with its immediate neighbour(s). The number under each one show how many teeth that particular gear-wheel has.



- When **A** is turned clockwise ten full turns, **in which direction does E turn, and how many times?**

Birthday Problem

choose - measure - make sense - seek implications - make it fit

Seeking consistency / Making it Fit

- Science seeks consistency in patterns
- Want our principles to be as broad as possible
- Breadth depends upon the state of what we know
- Physics has been around for quite some time and hence, developed a high degree of consistency.

choose - measure - make sense - seek implications - make it fit

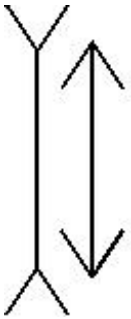
The puzzle analogy

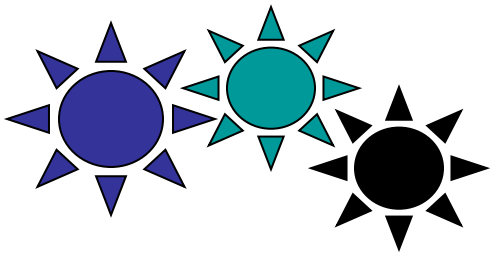
- Seek consistency
- Patterns fit
- Lack of consistency leads to frustration
- The same is true in physics

choose - measure - make sense - seek implications - make it fit

Next steps… summary cues

- Making a choice
- Making a measurement
- Making sense
- Elaboration
- Consistency





Homework

No lab this week

For next week: read Taylor chapters 1 - 3

Prelab problems

Taylor problems 2.1, 3.10, 3.28, 3.36