Physics 2CL:
Electricity & Magnetism
Waves &Optics

Summer Session II, 2010

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The Point of the Class

- Learn how scientists form models of nature -the process of doing science
- Learn to assess the accuracy of measurements
- Learn to propagate uncertainties to calculated quantities
- Extend understanding of electricity/waves/optics through hands-on exposure
- Learn how to report scientific results

Class components

- Pre-Lab Questions
- Labs **MHA 2544**
- Lectures
- Homework/Reading
- Website: http://physics.ucsd.edu/students/courses/summer2010 click on physics2CL

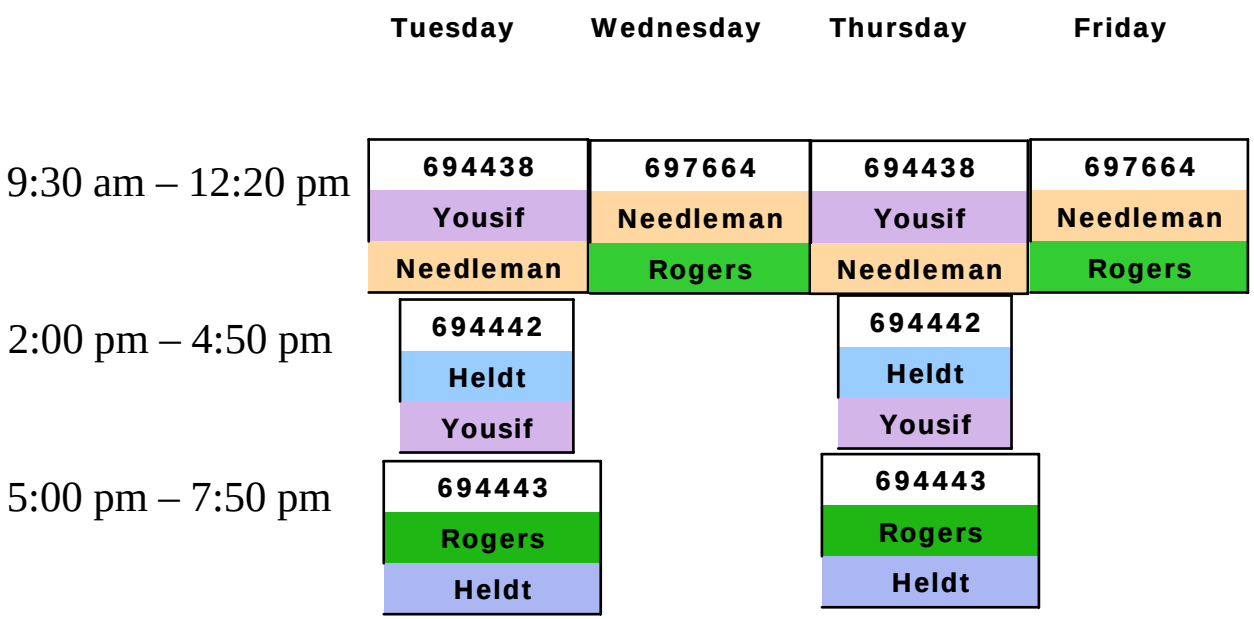
Introduction

- Basics of electricity and magnetism, waves and optics
- Perform 6 labs
  - One per meeting starting Thursday
- Formal report on one of last three labs

Labs

- 3 hours per meeting
- 2 meetings per week
- 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
- Need TWO quad ruled notebooks

Lab Sections



TAs:
- Ben Heldt
- Hosam Yousif
- Marcle Needleman
- Sean Rogers

TA Coordinator:
Andy Briggs

Schedule

Meeting	Experiment
1 (Aug. 3 or 4)	none
2 (Aug. 5 or 6)	0
3 (Aug. 10 or 11)	1
4 (Aug. 12 or 13)	1
5 (Aug. 17 or 18)	2
6 (Aug. 19 or 20)	3
7 (Aug. 24 or 25)	4
8 (Aug. 26 or 27)	5
9 (Aug. 31 or Sept. 1)	6

Lectures

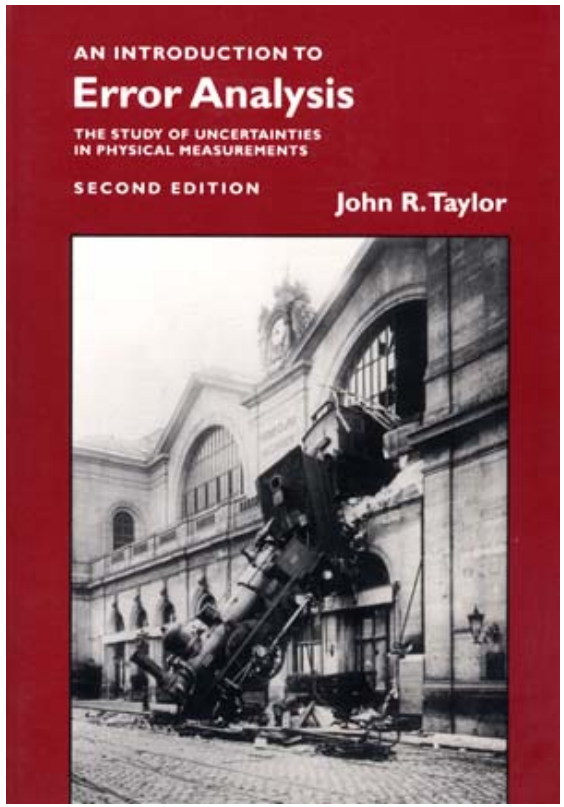
- Provide context for labs
- Error analysis
- Discuss broader applicability of issues
- Homework

Grading

- Two components
  - 55 pts lab
  - 25 pts for formal report
  - 20 pts for prelab quizes

Readings - Text - Homework

- Yes
- Taylor, *An Introduction to Error Analysis*, 2nd ed.
- Additional readings may appear on website
- Weekly homework (all given on syllabus, starting with meeting #2)



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

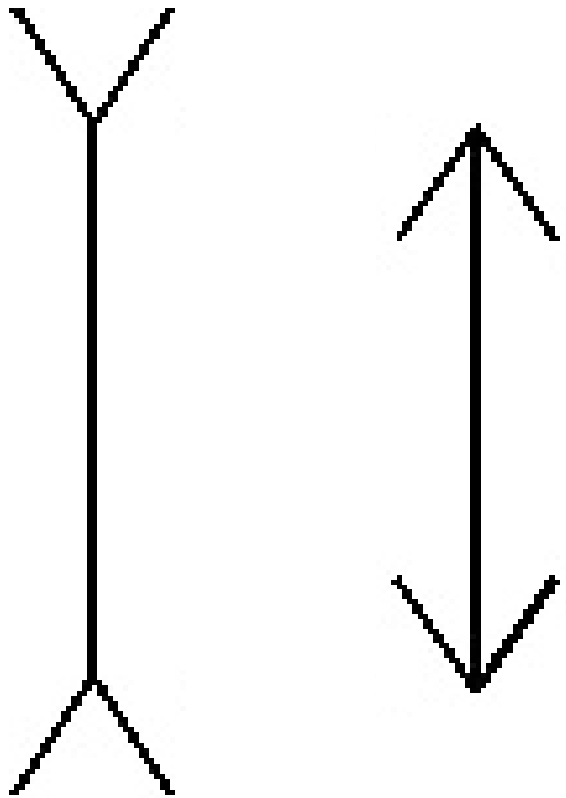
Making a Measurement (and sense)

- 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

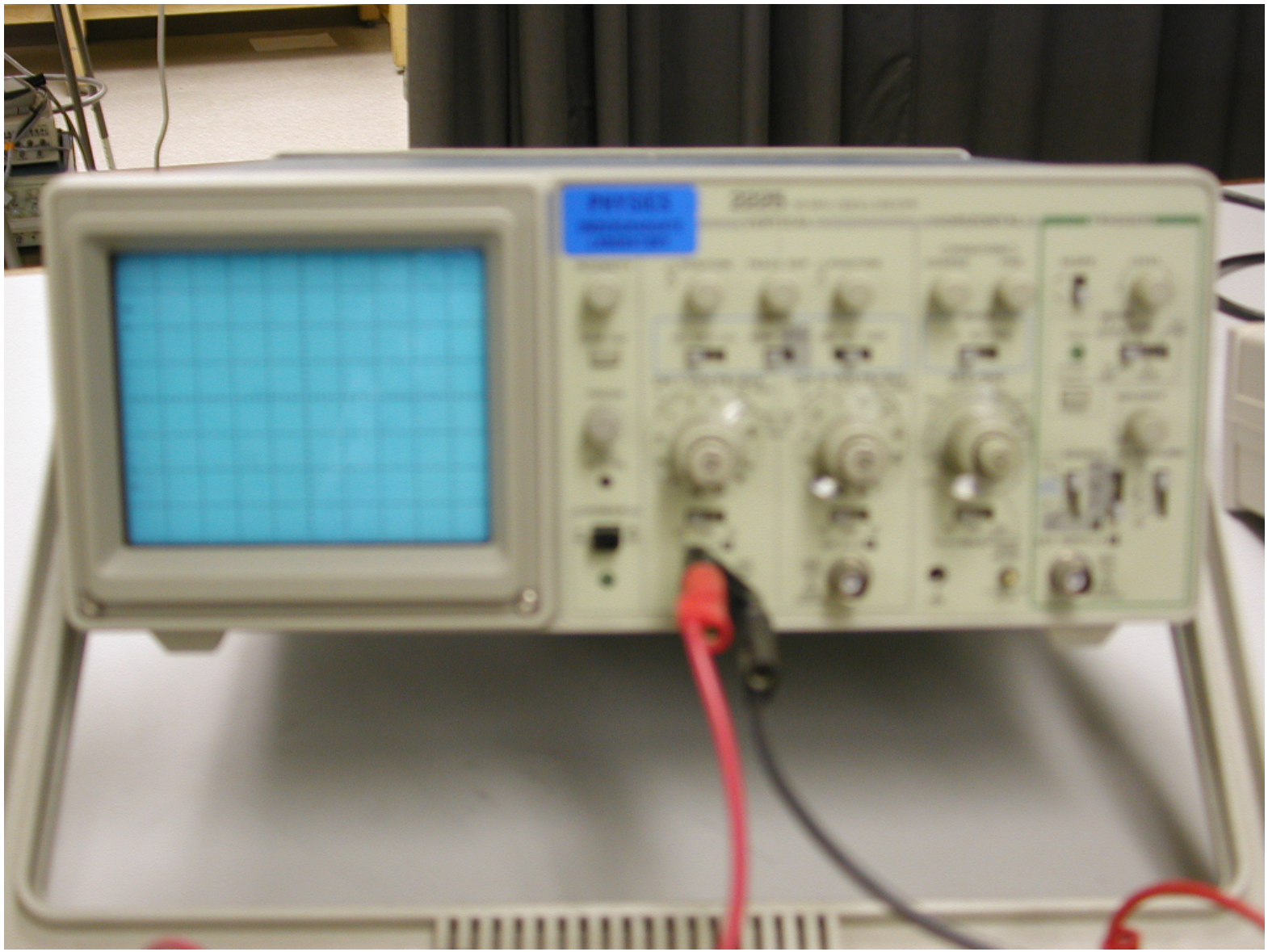
Making a Measurement

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

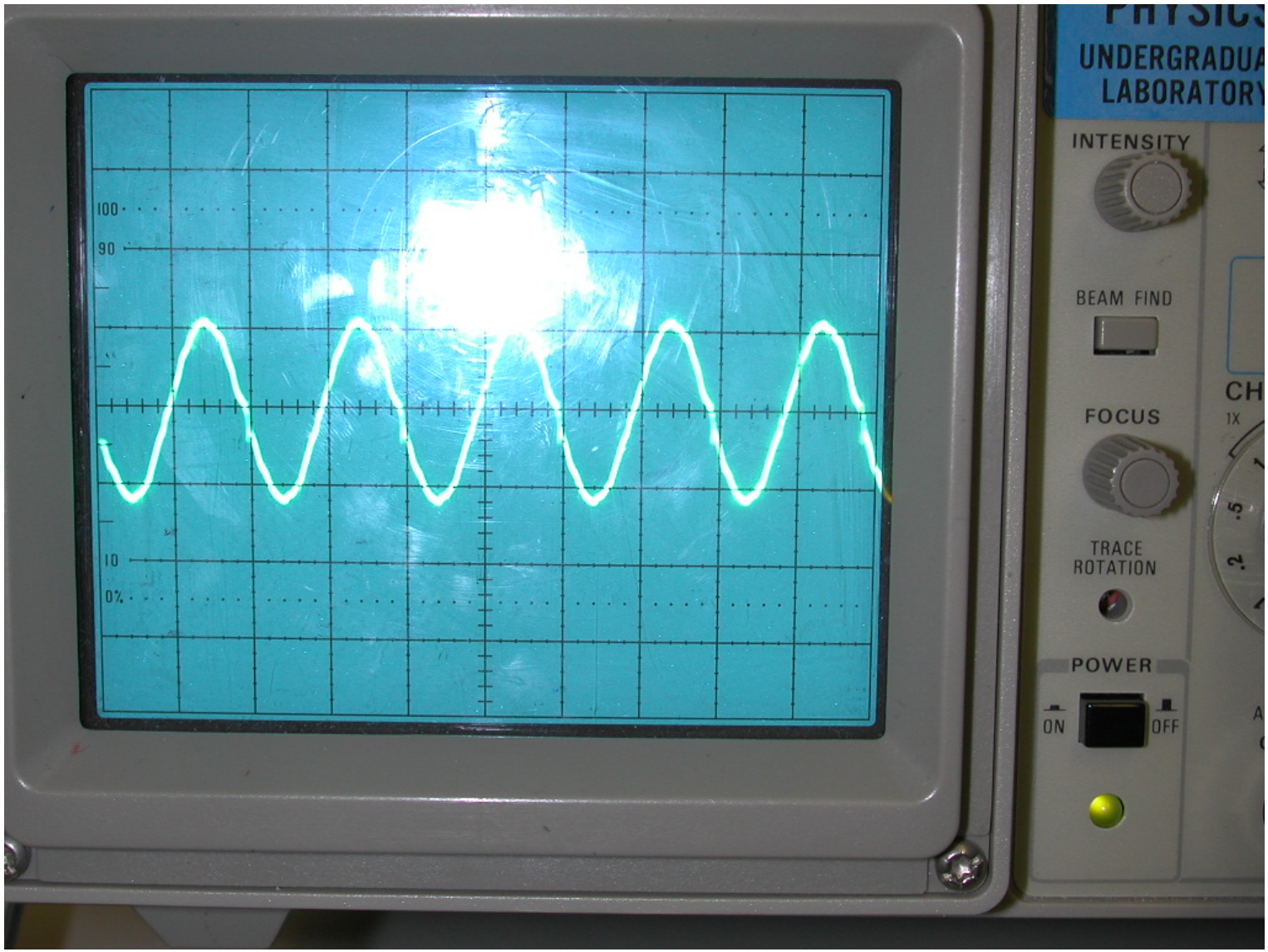


choose - measure - make sense - seek implications - make it fit

Oscilloscope



Oscilloscope Screen



Volt-Ohmmeter

Function Generator

Circuit Components

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

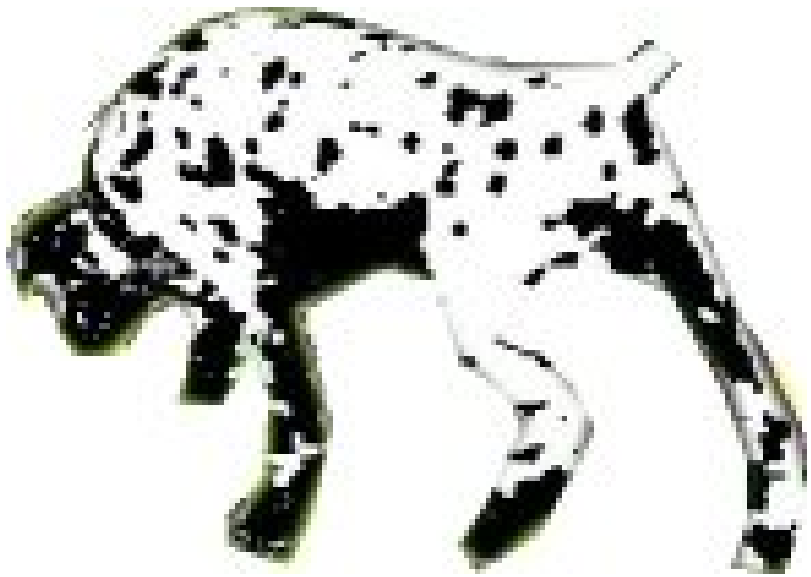
Hmmmm….

- 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

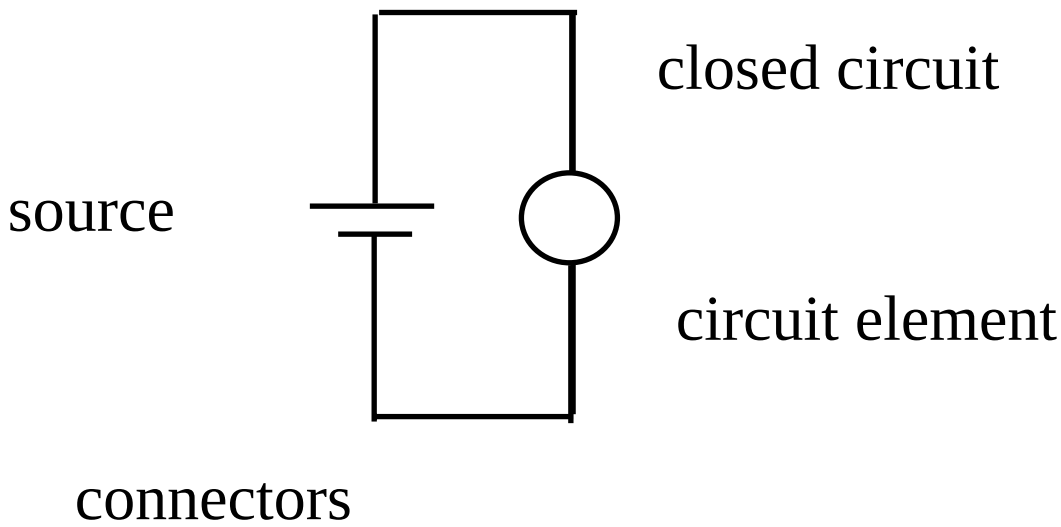
Making sense of physics

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

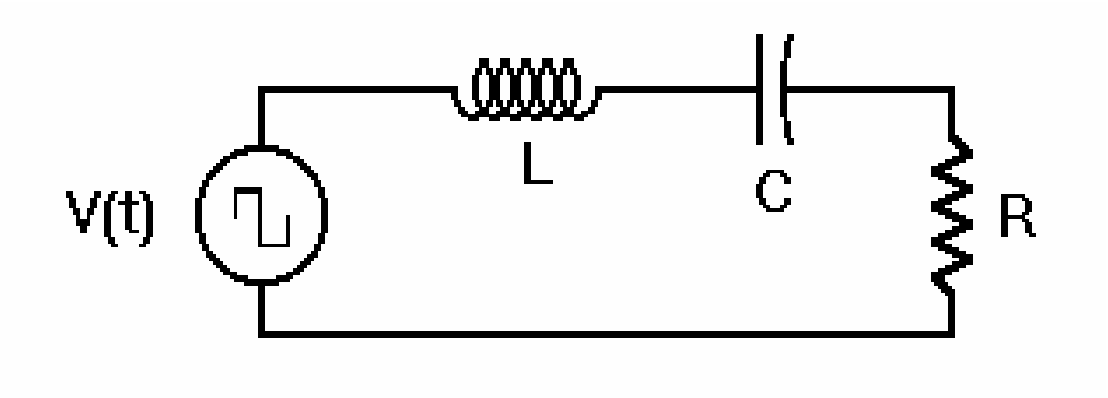
$$\vec{F}_0 = \frac{1}{4\pi\varepsilon_0}\sum_{i=1}^{N}\frac{q_0 q_i}{\left|\vec{r}_i - \vec{r}_0\right|^3}(\vec{r}_i - \vec{r}_0)$$

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

Electrical Circuits



Physics of first 4 labs



$$I(t) = I_0 e^{-t/2\tau} \sin \omega t$$

$$\omega = \sqrt{{\omega_0}^2 - \frac{1}{4\tau^2}} = \sqrt{\frac{1}{LC} - \frac{R^2}{4L^2}}$$

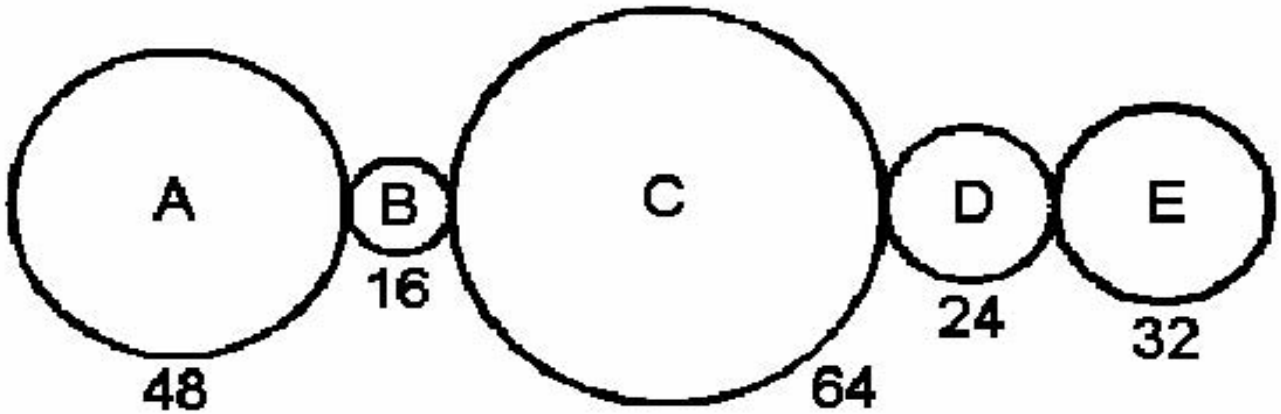
Seeking Implications

- 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?**

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

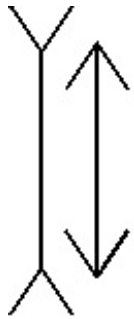
The puzzle analogy

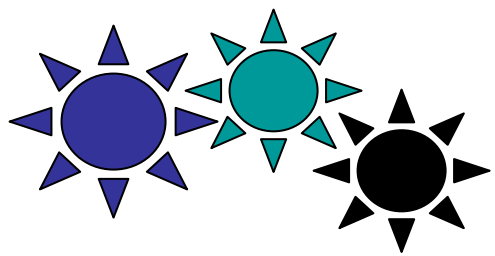
- Seek consistency
- Patterns fit
- Lack of consistency leads to frustration
- The same is true in physics

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

Next steps… summary cues

- Making a choice
- Making a measurement
- Making sense
- Elaboration
- Coherence





Lab Experiments

Mayer Hall Addition room # 2544

First lab starts Thursday Aug 5th

10 -15 minute quiz - Prelab problems/ Homework

Quad ruled notebook – recording lab work

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

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)

Reminder/Homework

- Prepare for Exp. 0
- Can obtain individual labs on Website under Handouts
- Read Taylor Chapters 1 & 2
- Problems 2.1, 2.5