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A Simple LED Light Source for Multiple Online Experiments

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Online Physics Courses

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- In 2011 a survey showed that 31% of all students in higher education have enrolled in at least one online class.

"Going the Distance: Online Education in the United States, 2011," I. Elaine Allen and Jeff Seaman, Babson Survey Research Group, ISBN 978-0-9840288-1-8, November 2011

- In 2010 a poll of 398 two and four year degree granting institutions offering introductory physics courses.
  - 9.5% offer at least one introductory physics course online.
  - 3.8% offer lab in an online format.

- In 2012 a poll of 311 accredited degree-granting two-year colleges
  - 11% offer at least one section of introductory physics online
  - 6.8% offer at least one section of an introductory physics laboratory.

Anne M. Reagan, "Online Introductory Physics Labs: Status and Methods", Spring 2012 Proceedings of the Washington Academy of Sciences, pp 31-46

Why offer an online intro physics course?

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- Advantages to non-traditional students:
  - No commute.
  - Course is asynchronous It can fit into their schedule.

Online Physics Courses

- An online physics courses should have a physical laboratory component.
  - Accreditation
  - Transfer credit
  - “Hands On” learners
  - Simply isn’t science without experiments or observations

Online Physics Courses

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- Some Issues with online labs should be no surprise.
  - Online physics students will work on the labs at the last minute.
    - May not be just procrastination.
  - Online students will misread the laboratory instructions.
    - No matter how simple you think the instructions are
  - Help is asynchronous.

Off Site (online) Laboratory Equipment

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- Supplies and equipment for off-site labs should be:
  - Complete
  - Inexpensive
  - Easy to use
- In addition
  - Off-site lab experiments should be similar to on-site labs.
  - For technical students labs should be computer-based.

Off Site (online) Laboratory Equipment

- Controlling cost to the students should be a major effort.
- One method to control cost is to use the same equipment for multiple experiments.

LED Experiment Board

- The LED Experiment Board is an adaptation of the standard experiment for measuring Planck's Constant using LEDs
  - Feng Zhou, Todd Cloninger "Computer-Based Experiment for Determining Planck's Constant Using LEDs" *Phys. Teach*. **46**, 413-415 (Oct. 2008)
- Easy to use
- Compact PC board
- Uses 9 volt battery
- LEDs mounted asymmetrically
- Capacitor switched in or out of circuit
- Multiple LEDs can be lit at a time.

LED Experiment Board

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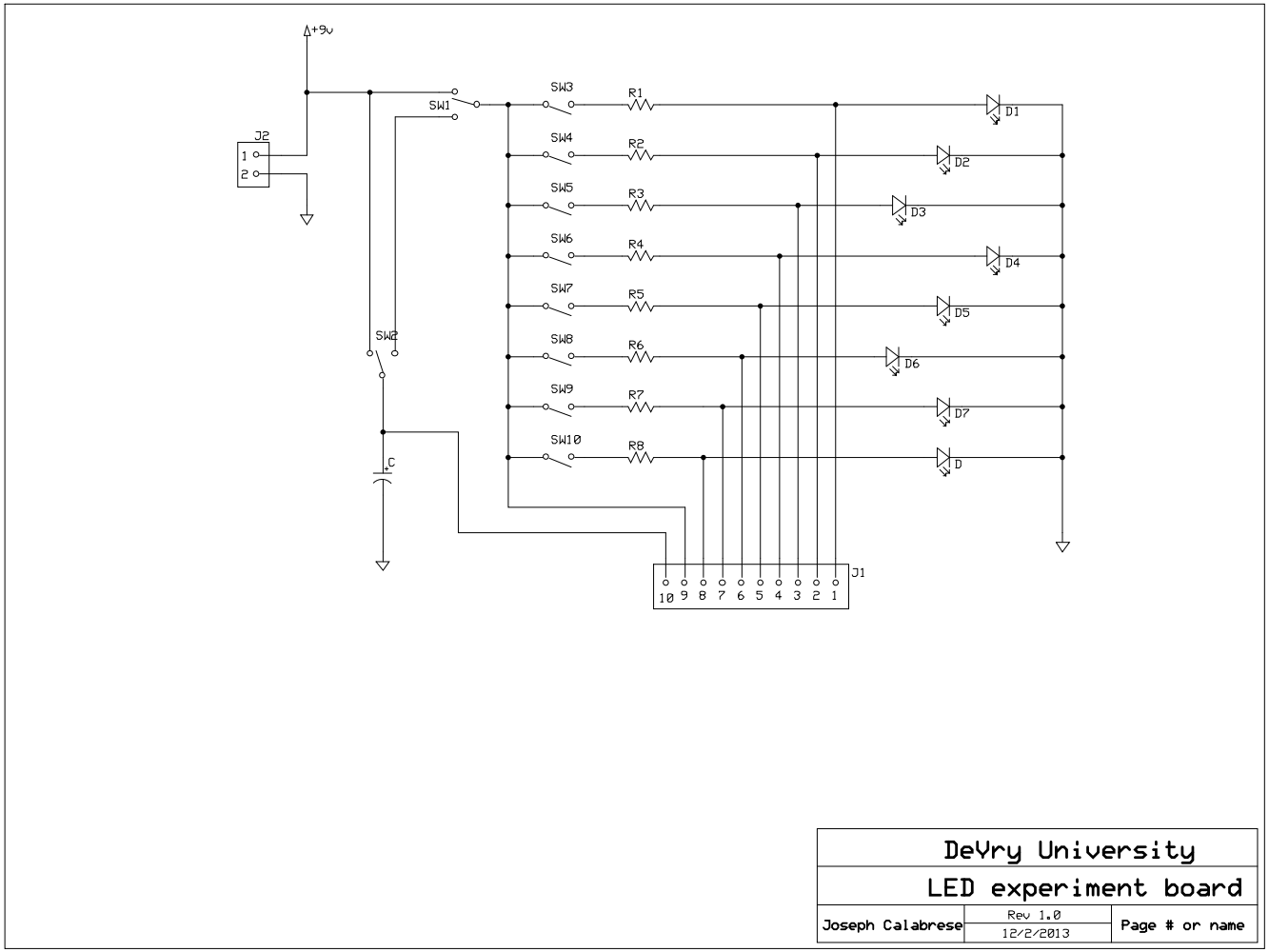
- Board can be used for:
  - Planck's Constant experiment
  - Physical Optics experiments
  - Geometric Optics experiments
  - Others

Circuit


+9v
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D7
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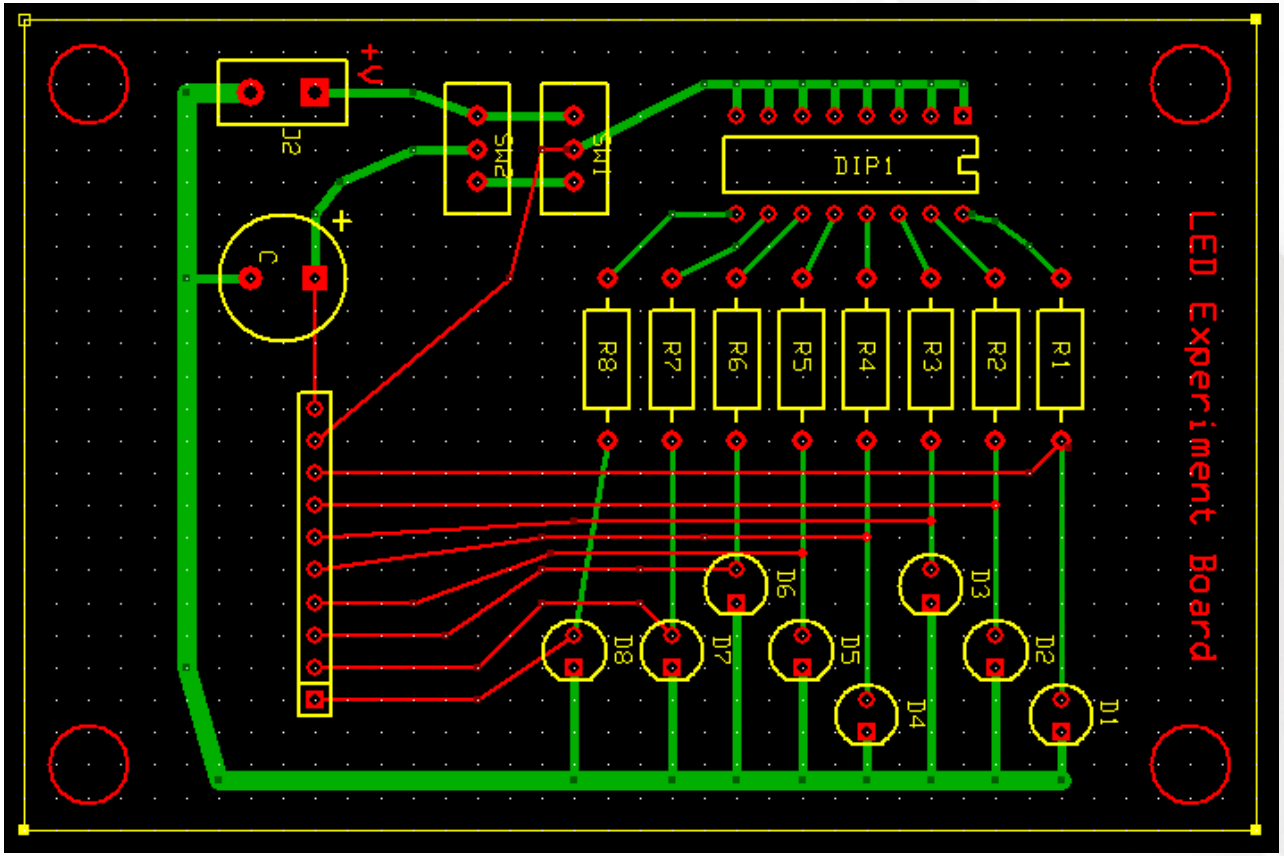
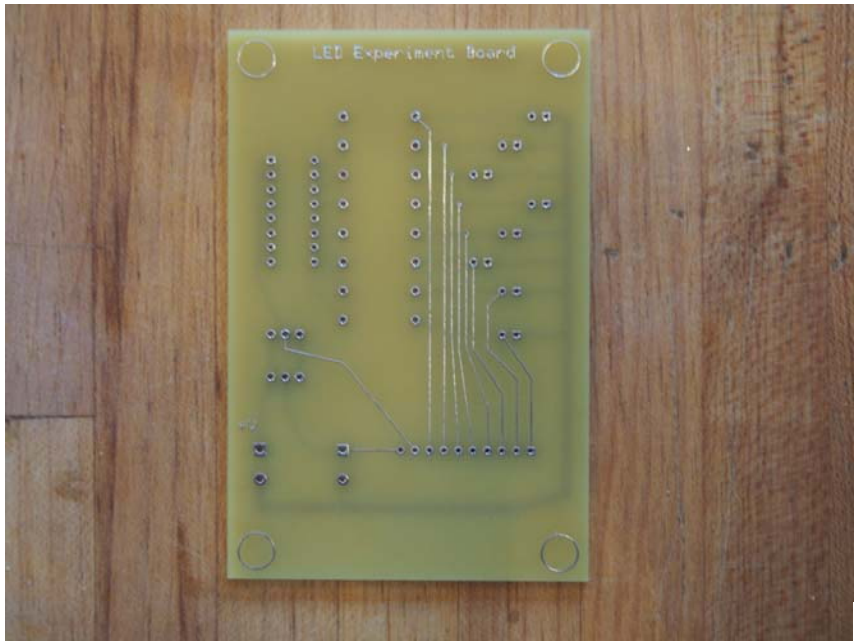
LED experiment board
Joseph Calabrese
Rev 1.0
12/2/2013
Page # or name

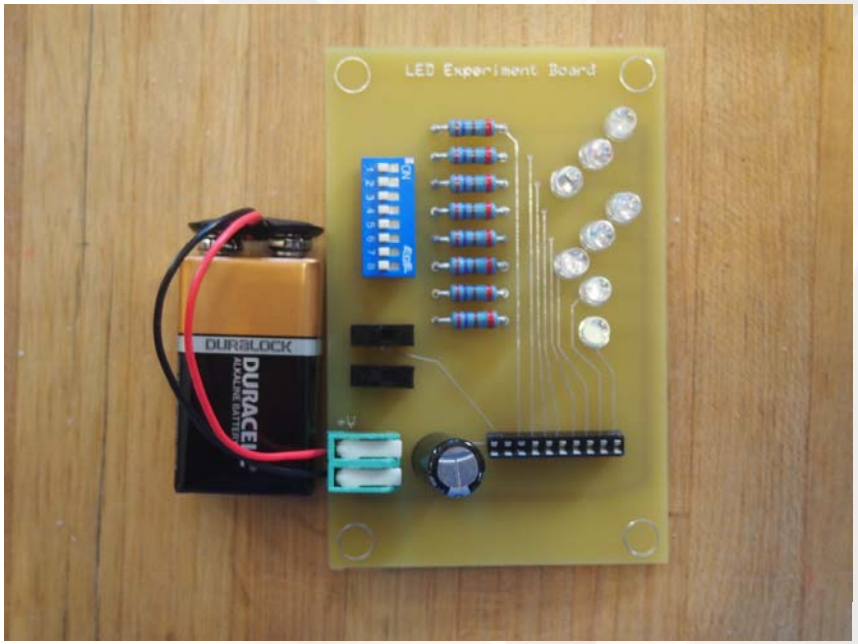
PC board

- expresspcb.com



PC board


LED Experiment Board


LED Experiment Board
DURALOCK
DURACELL

Costs

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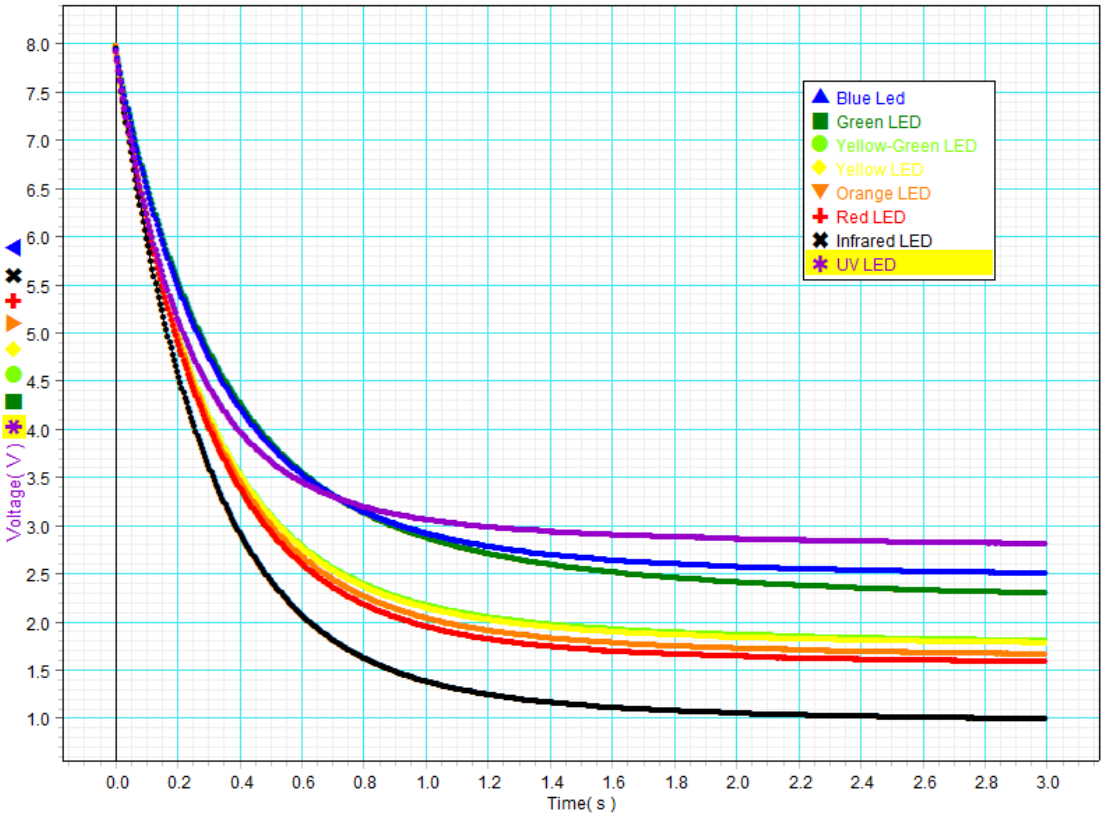
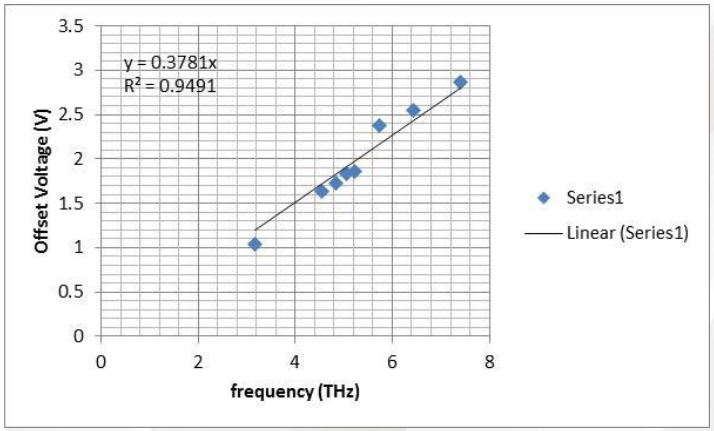
Item		unit cost	units		
PC board		$20.90	1		$20.90
SPDT slide switch		$0.56	2		$1.12
10 pos socket		$1.40	1		$1.40
Terminal block		$0.41	1		$0.41
1000 uF Capacitor		$0.74	1		$0.74
resistor 280 ohm		$0.09	8		$0.72
8 pos DIP switch		$1.14	1		$1.14
LED infrared		$0.52	1		$0.52
LED red		$0.64	1		$0.64
LED orange		$0.38	1		$0.38
LED yellow		$0.95	1		$0.95
LED yellow-green		$0.38	1		$0.38
LED green		$1.69	1		$1.69
LED blue		$1.50	1		$1.50
LED white		$2.43	1		$2.43
Total					$34.92

Planck's Constant Experiment

- Equipment
  - LED experiment board
  - PASCO Current Voltage Sensor
  - PASCO USB Link
  - Datastudio
  - DMM (optional)

Planck's Constant Experiment

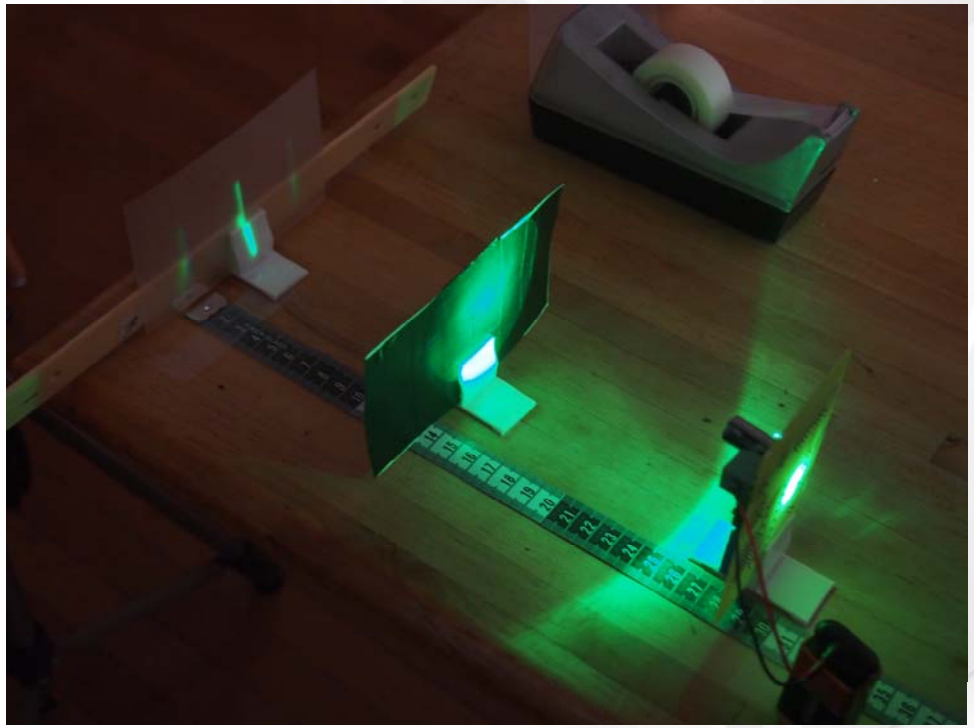




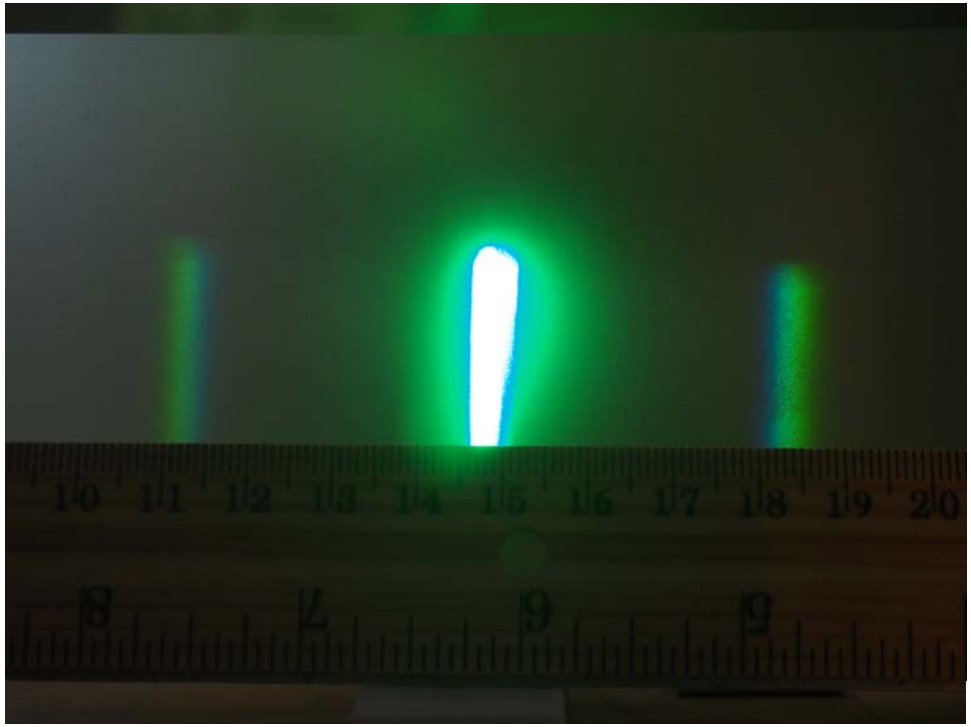
$$h(\text{exp}) = 6.08 \times 10^{-34}\ \text{J} \cdot \text{s}$$

Diffraction Grating Experiment

- Equipment
  - LED experiment board
  - Diffraction grating
  - Lens holders
  - Tape measure
  - Index card



Diffraction Grating Experiment



$$L = 13.4 \text{ cm}$$
$$y_1 = 3.65 \text{ cm}$$
$$y_2 = 3.60 \text{ cm}$$
$$\theta = \tan^{-1}\left(\frac{y}{L}\right)$$
$$\lambda = \left(\frac{1}{500}\right)\sin\theta$$
$$\lambda_{exp} = 522 \text{ nm}$$
$$\lambda_{nom} = 523 \text{ nm}$$

Geometric Optics Experiment

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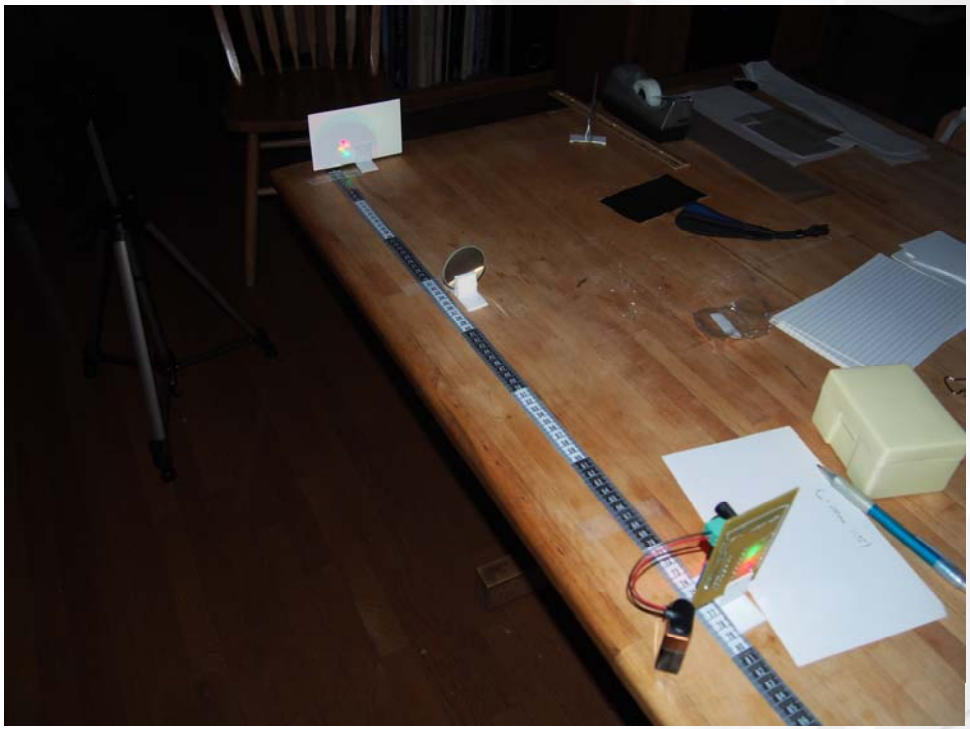
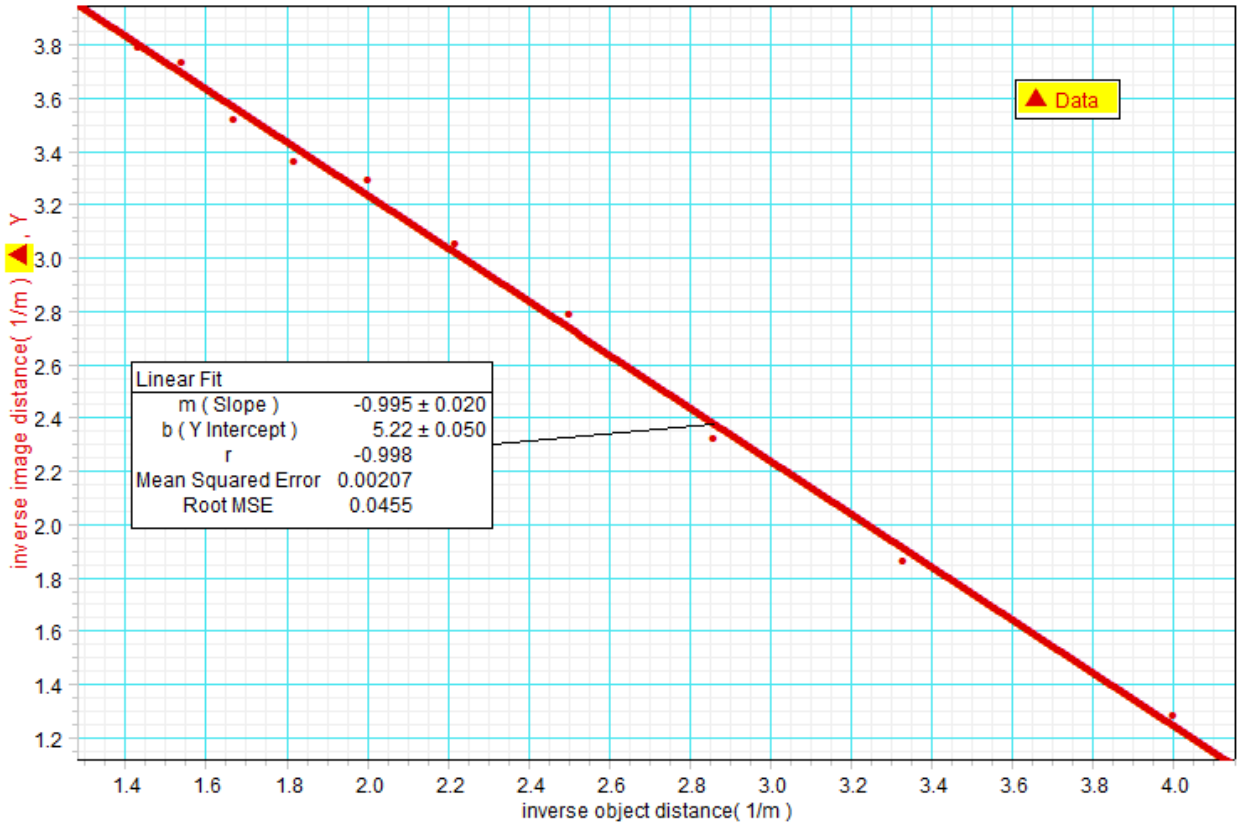
- Equipment
  - LED experiment board
  - Concave mirror
  - Convex lens
  - Lens holders
  - Tape measure
  - Index card



Geometric Optics Experiment



$f_{\text{exp}} = 197 \text{ mm}$

$f_{\text{nom}} = 200 \text{ mm}$

Conclusion

- The LED Experiment board is a low cost way to provide online students with equipment to complete several at-home experiments that are of the same type and quality as experiments done in an on-site physics lab.

- Questions?