SBA Conference

Worksheet, Detailed Report and Investigation Study

Nov 2013

Teachers' PDP

Understanding and Interpreting the Physics and Combined Science (Physics Part) Curricula (S4-S6) (Re-freshed)

Date: 2013/11/14

Venue: Lecture Theatre, EDB Kowloon Tong Centre

Time: 2:00 – 5:00 pm

HKDSE SBA Report 2013

- Experiments selected were appropriate, majority used 3 experiments each year.
- Most reports satisfactory marked.
- Assessment criteria and written feedback are advised.
- Diverse range of experiments are found.
- Simple and trivial experiments are not recommended for assessment.

Detailed / Full Report Writing

Lab. Manual

Title	Detailed	Full
1. Problem statement	✓	✓
2. Experimental hypothesis / objectives	✓	✓
3. Experimental design		
(i) Apparatus	✓	✓
(ii) Description of design	✓	✓
• Theory	(optional)	✓
• Procedure	✓	✓
(iii) Measurement	✓	✓
4. Data evaluation	✓	✓
5. Error analysis	(optional)	✓
6. Summary, conclusions and possible improvements	✓	✓

Assessment Rubric

Title	Rubric
Measurement	• Variables identified • Consistent data • Appropriate range of data • Accurate measurements/observations • Organized sequentially/logically • Labeled fully (units included) • Completed data table • Correct units • Correct tools/instruments

Assessment Rubric

Title	Rubric
Data evaluation	• Interpret and present data appropriately • Curve is appropriate to data trend • Points plotted accurately • Appropriate scale • Axes labeled with variables and units • Variables placed on correct axes • Calculated accurately • Substituted correctly into relationship • Relationship stated or implied • Units used correctly • Used all data available

Assessment Rubric

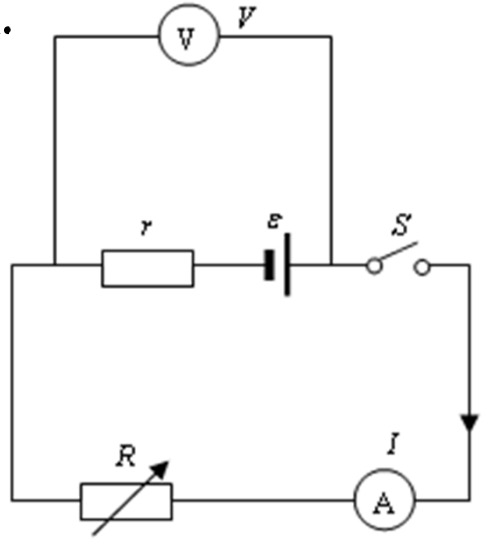
Title	Rubric
Error analysis	• Analysis accuracy of data • Estimate uncertainty in data/results • Units used correctly
Summary, conclusions and possible improvements	• Relate conclusions with scientific principle • Support by results of measurement • Consistent with data • Relationship among variables stated • Show qualitative/quantitative relationships • Sources of error • Suggest possible improvements

Sample Detailed Report

Title: To determine the internal resistance of a cell

Aim: Students are asked to make use of a voltmeter and an ammeter to determine the internal resistance of a cell from a V - I graph.

Apparatus: dry cell, ammeter, multi-meter, voltmeter, rheostat, resistance box.



Procedures

Less Structured	Structured
1. The experiment was set up as shown in the Figure 3. 2. The circuit was connected in series with a rheostat and an ammeter. 3. The external voltage across terminals of the cell was measured by a voltmeter. 4. The resistance R of the rheostat was adjusted to obtain 8 pairs of ammeter reading *I* and voltmeter reading *V* over the widest possible range of R.	1. Connect the circuit as shown in the Figure 3. 2. Keep the switch turned off. Take the reading of the voltmeter. This is the initial electromotive force (e.m.f.) of the cell. 3. Set the rheostat to zero. Turn on the switch and take the ammeter and voltmeter readings. Turn off the switch once the readings are taken. 4. Increase the resistance of the rheostat. Turn on the switch and adjust the rheostat until the current is roughly 0.1 A below the value in (3). Take the ammeter and voltmeter readings. Remember to turn off the switch once the readings are taken. 5. Repeat step 4 by decreasing the current in steps of 0.1 A. Plot a graph of the voltage *V* against the current *I*.

Measurement & Data Evaluation

1.	Voltage V/V	2	2.1	2.3	2.4	2.5	2.6	2.7	2.8
	Current I/A	0.083	0.060	0.050	0.040	0.030	0.023	0.015	0.005

2. Based on the circuit shown in Figure 3, the terminal voltage *V* across the cell was related to e.m.f. *E* of the cell, the internal resistance r of the cell and the current *I* by the following equation:

   $V = E - Ir$

   Or $V = -rI + E$ (This is a straight line equation of the form: y = mx + c)

3. The terminal voltage V against current *I* was plotted on a graph paper (Graph 1).

4. The slope of the graph was measured to give the internal resistance *r* and the Y-intercept to give the e.m.f. *E* of the cell.

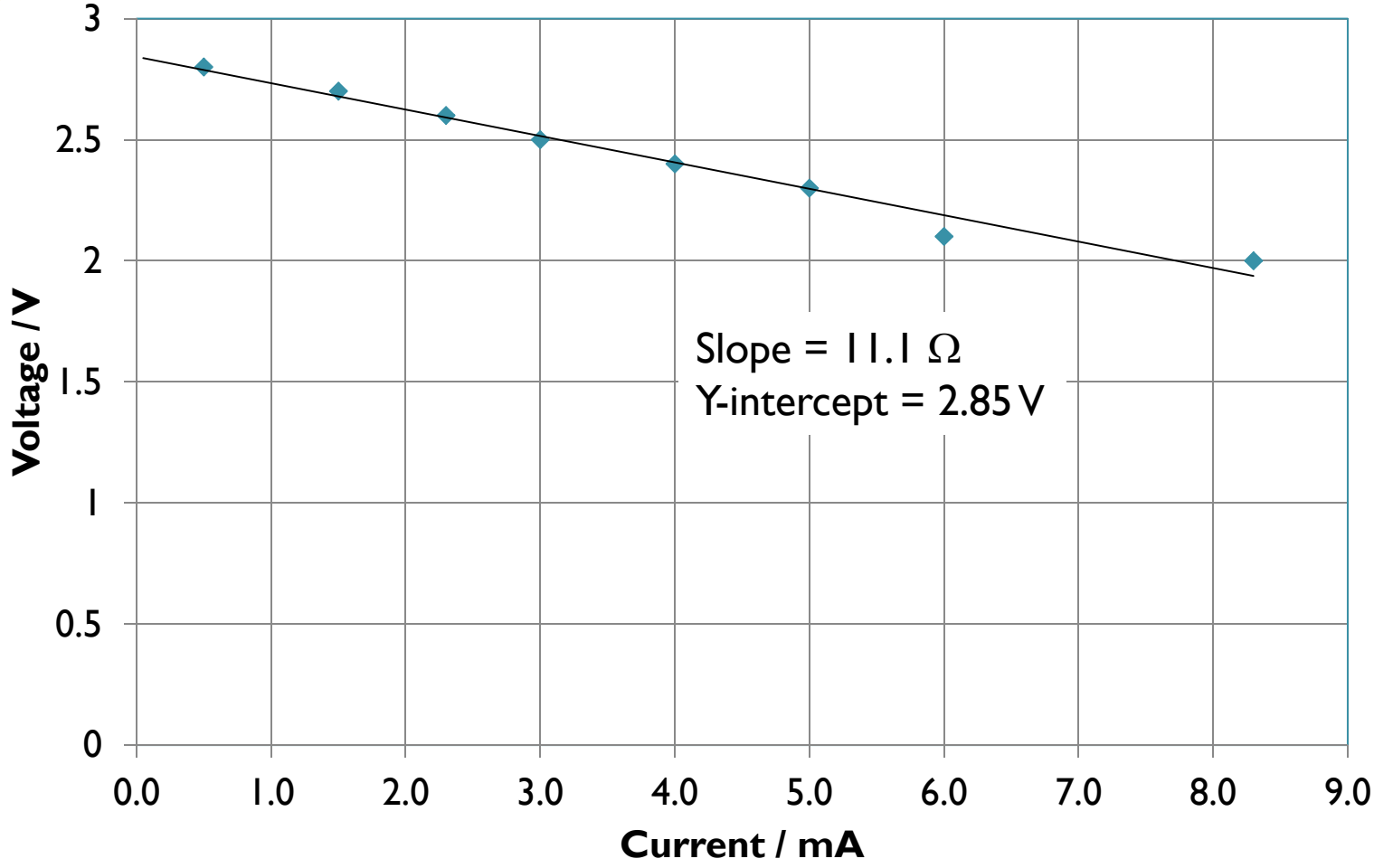
5. Slope of the graph = $-11.1\ V\ A^{-1}$

   Y-intercept = 2.85 V

6. The internal resistance of the cell = 11.1 Ω

   The e.m.f. *E* of the cell = 2.85 V

Terminal Voltage Vs Current

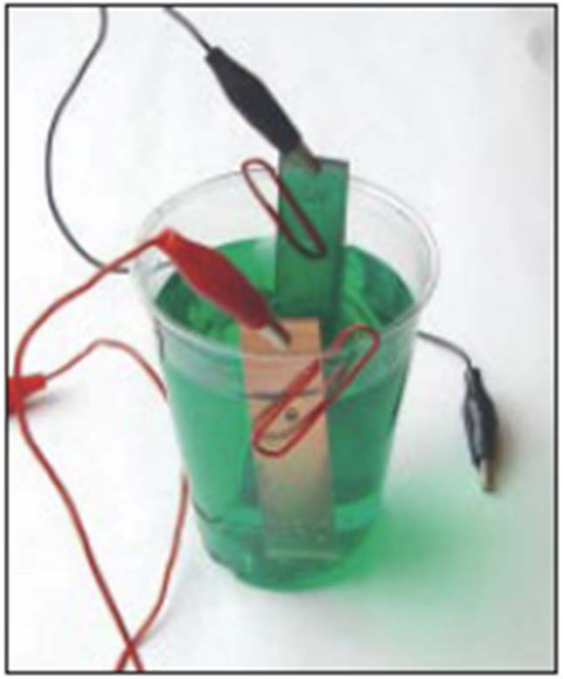


Discussion and Conclusion

- Source of error
  - The wire used to connect the circuit contains resistance, so thicker wire should be used to reduce the resistance, so a more accurate result will be obtained.
- Precautions
  - The multimeter should be set-zero before it is used as an ohmmeter. Set-zero is also necessary when the scale in the ohmmeter is changed.
  - The resistance box may have poor resistance because of rusting at the contact surfaces. Use sand-paper to polish all the contacting points before use.
  - Never close the switch while the connection is being made.
- Conclusion
  - Based on the result of experiment, the internal resistance of the cell was 11.1 Ω and the e.m.f. *E* of the cell was 2.85 V

(1) Making and Evaluating an Electrical Battery

- plastic cups (2)
- copper electrodes (2)
- zinc electrodes (2)
- (coated) paper clips (4)
- red light emitting diode (LED) (low current and high light output) (1)
- alligator clip leads (3)
- 1000-Ω resistor (1)
- 500-Ω resistor (1)
- container for preparation of the solution
- table salt (not ionized)
- stopwatch
- sandpaper (to clean the electrodes)
- multimeters (2)



Power and Energy

Table I. Voltage and current measured at 1-min intervals.

Reading #	Current (mA)	Voltage (V)
0	0.71	0.72
1	0.66	0.67
2	0.61	0.61
3	0.56	0.56
4	0.50	0.50
5	0.43	0.44
6	0.40	0.40
7	0.37	0.37
8	0.35	0.35
9	0.35	0.34
10	0.33	0.33
The open-circuit voltage: 0.78 V 1 mA = 1/1000 A		

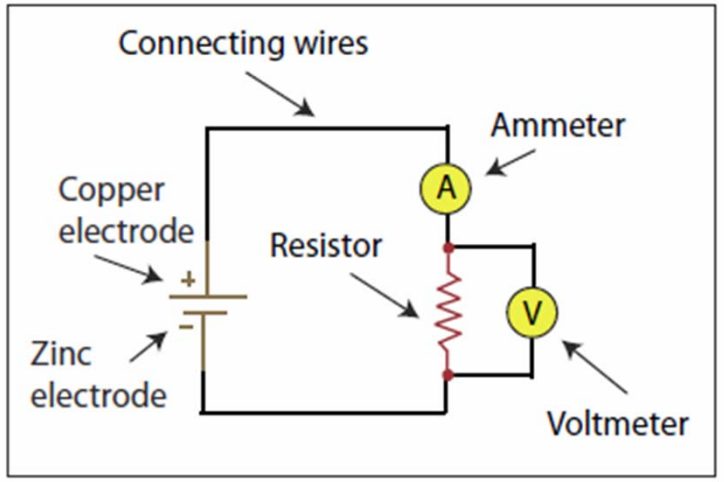
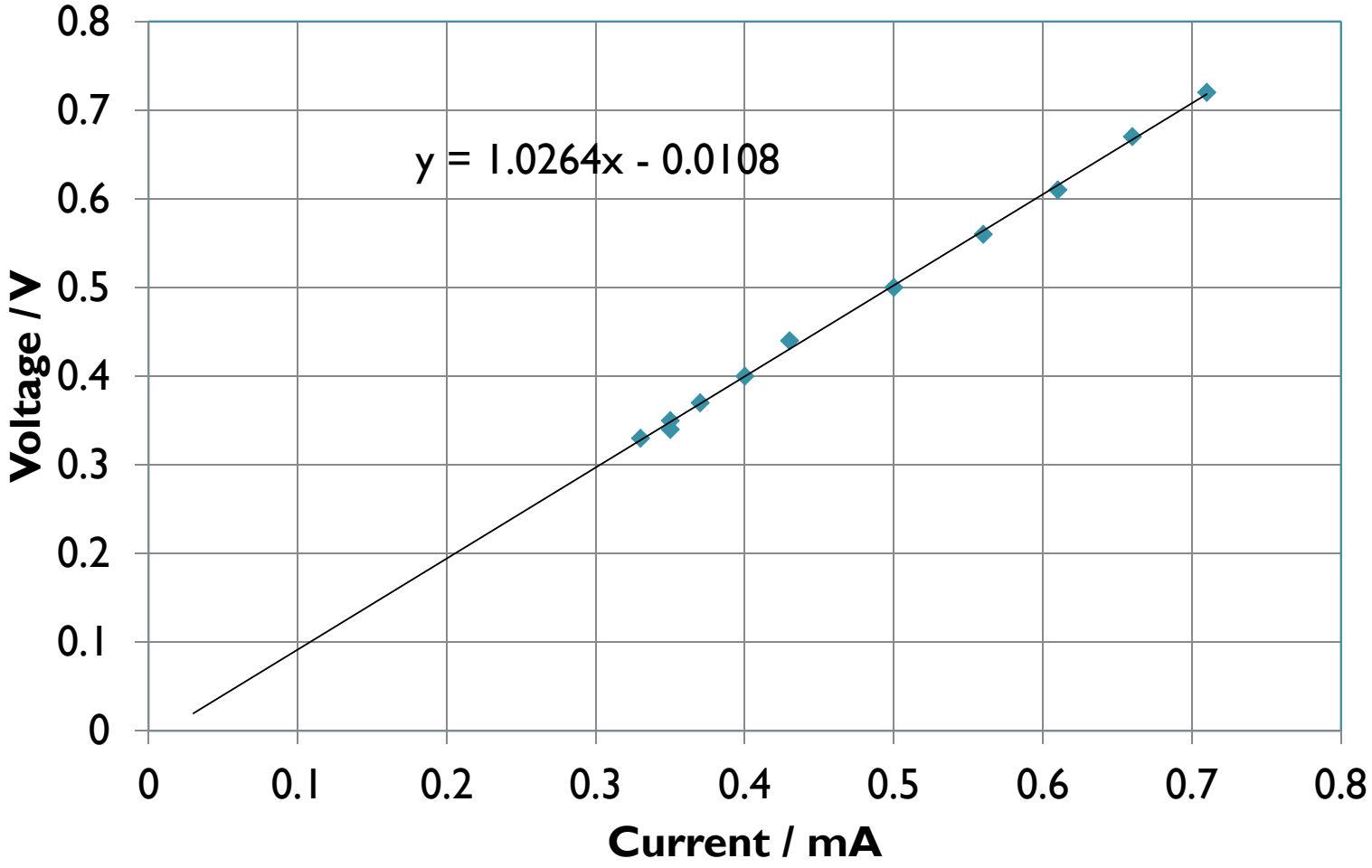
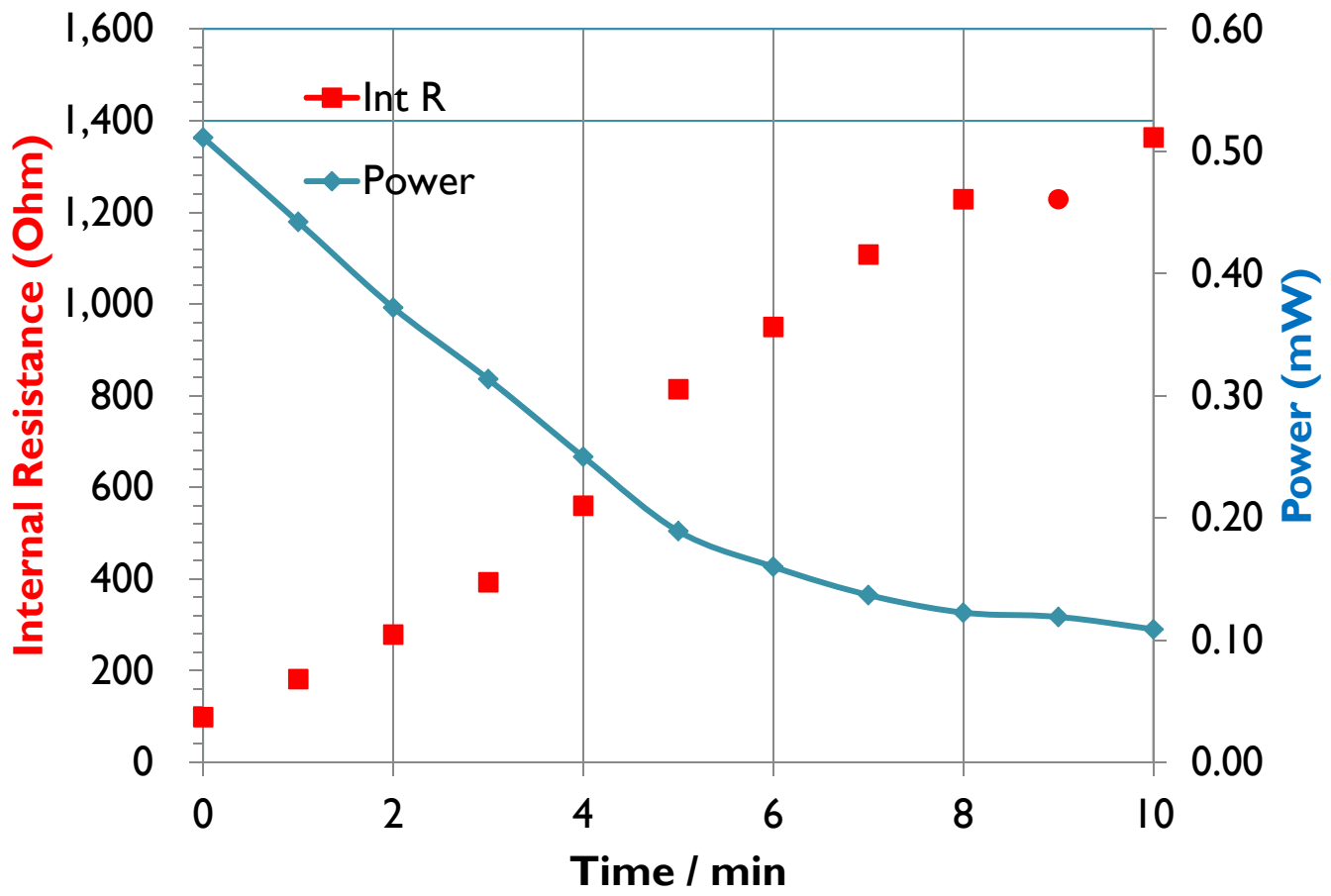


Fig. 3. Circuit for measuring the voltage across—and current through—the resistor.

Voltage Vs Current in 1 KΩ Resistor



1 KΩ Power dissipation Vs Time



Energy Dissipation = Power x Time

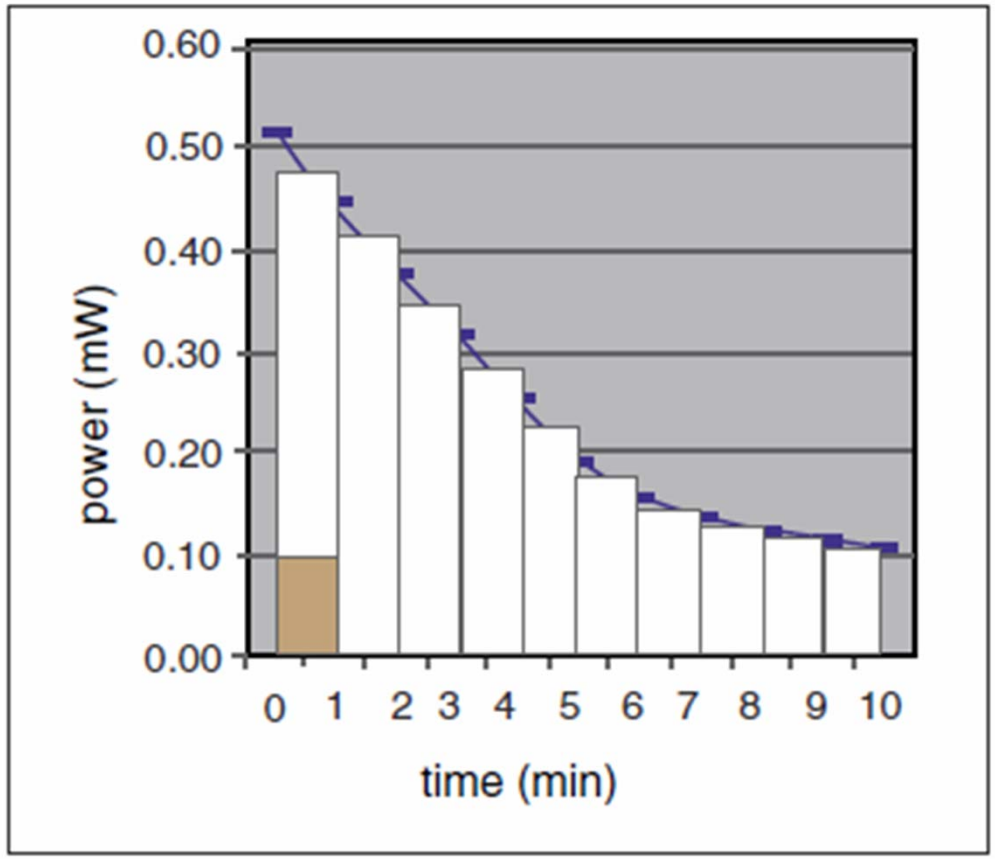


Fig. 5. Computing the energy dissipated in the 1000-Ω resistor for the 10-min interval.

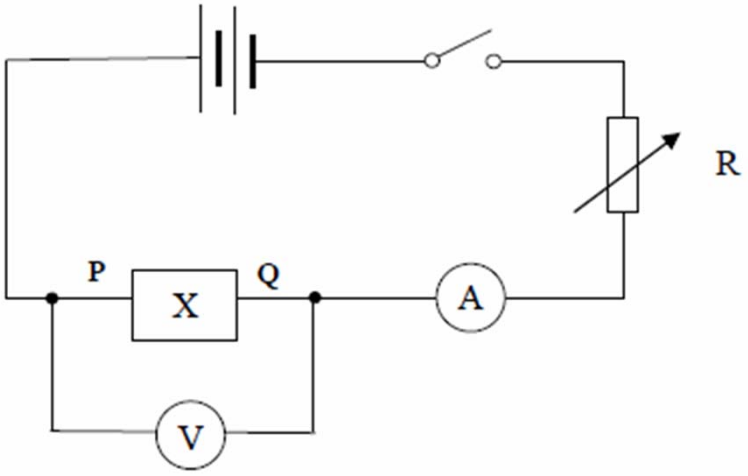
New Exemplars for SBA

- To estimate the amount of energy output by the battery during the measurement period.
- To estimate the internal resistance of the battery.
- To study effect of the electrode surface area.
- To study influence of the magnitude of external resistance.

(2) Determining the characteristic of a non-ohmic device

Ammeter reading I/A	0.10	0.14	0.18	0.22	0.26	0.30
Voltmeter reading V/V						

0.34	0.40	0.50	0.60	0.70	0.80

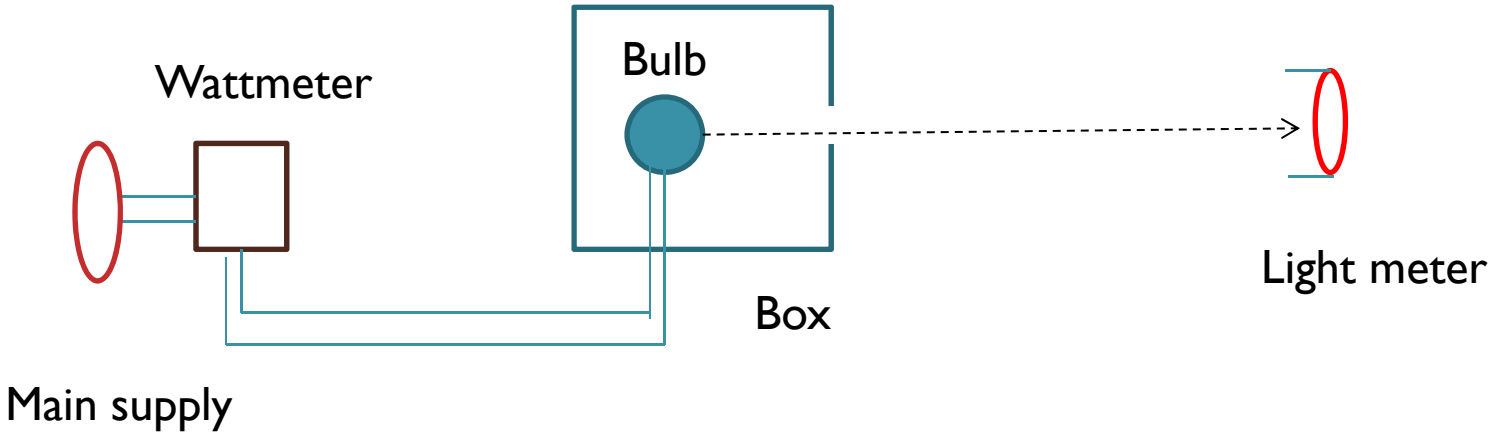


(3) Measuring the luminous flux and the energy efficiency of the Source

- Apparatus:

  lampstand (1), light source (1), wattmeter, (1)
  light meter (1), half-metre rule (1), box (1)

- Setup:



Measurement

Data	Measured by
Light Source	Filament Light bulb, CFL, LED
Electrical Power Input (W)	Wattmeter
Illuminance (lux)	Light meter (lux meter)
Distance (m)	Metre rule

Calculation:

E Illuminance (lux, lx) = Φ Luminous flux (lumen, lm) / Area (m^2)

Φ Luminous flux (lumen, lm) = E Illuminance (lux, lx) $\times 4\pi d^2$

$$\text{Efficacy} = \frac{Luminous\ Flux\ (lumen)}{Electrical_{Power\ Input}} = \frac{\emptyset}{P}$$

* Convert lumens (photometric unit) to Watts (radiometric unit)
* 683 lumens = 1 Watt

Inverse Square Law

(Luminous Flux, lm) ABSOLUTE or INTRINSIC brightness or Power or Luminosity

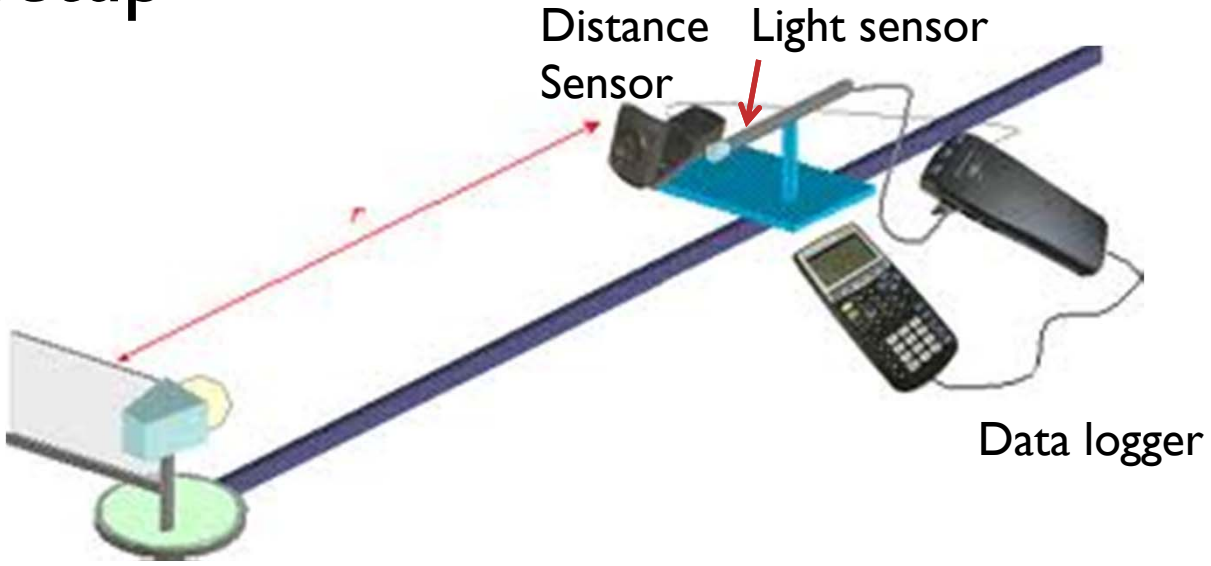
$$B \propto \frac{1}{d^2} \quad \text{or} \quad B = \frac{L}{4\pi d^2}$$

(Illuminance, lx) APPARENT brightness

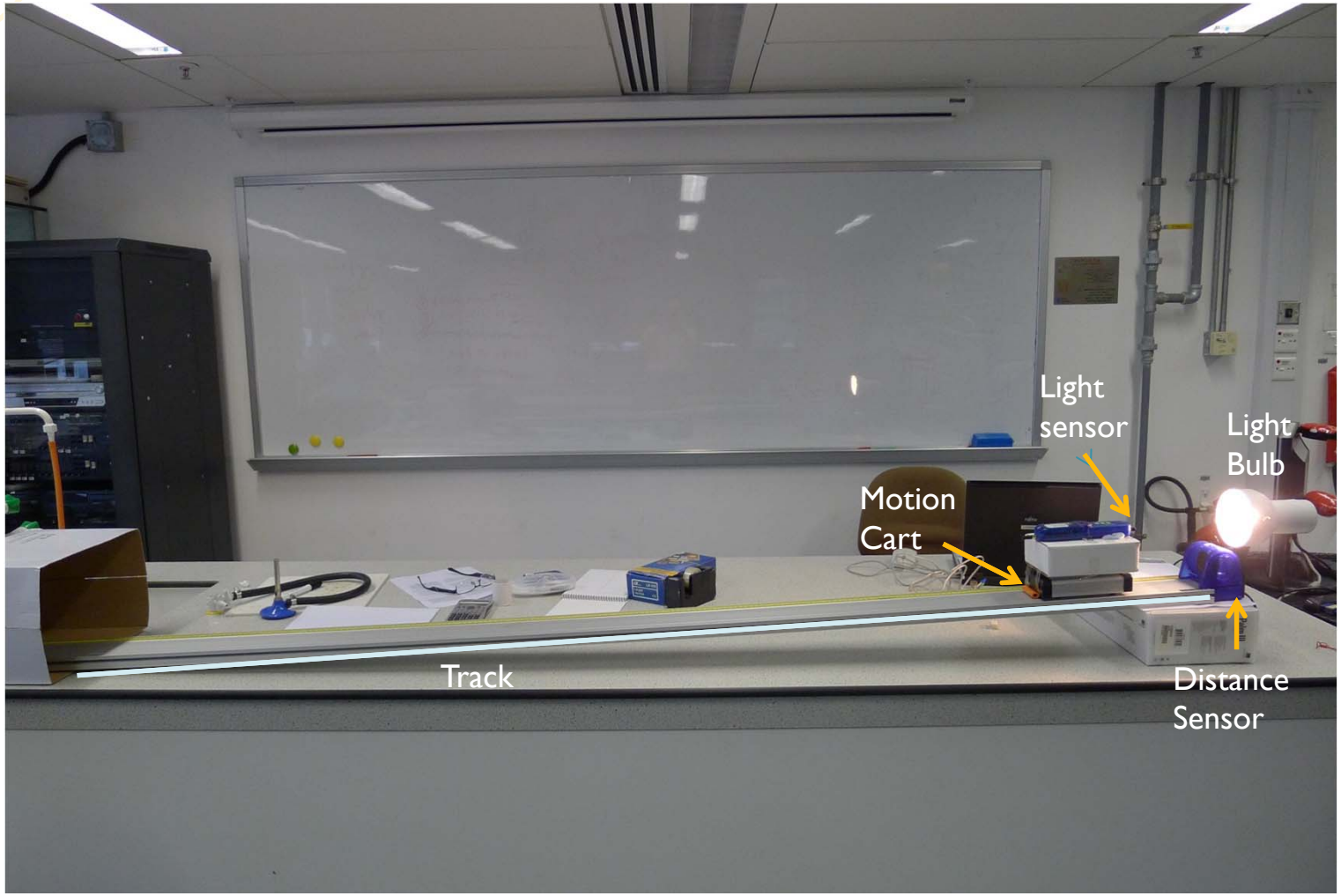
distance

$\pi = 3.14$

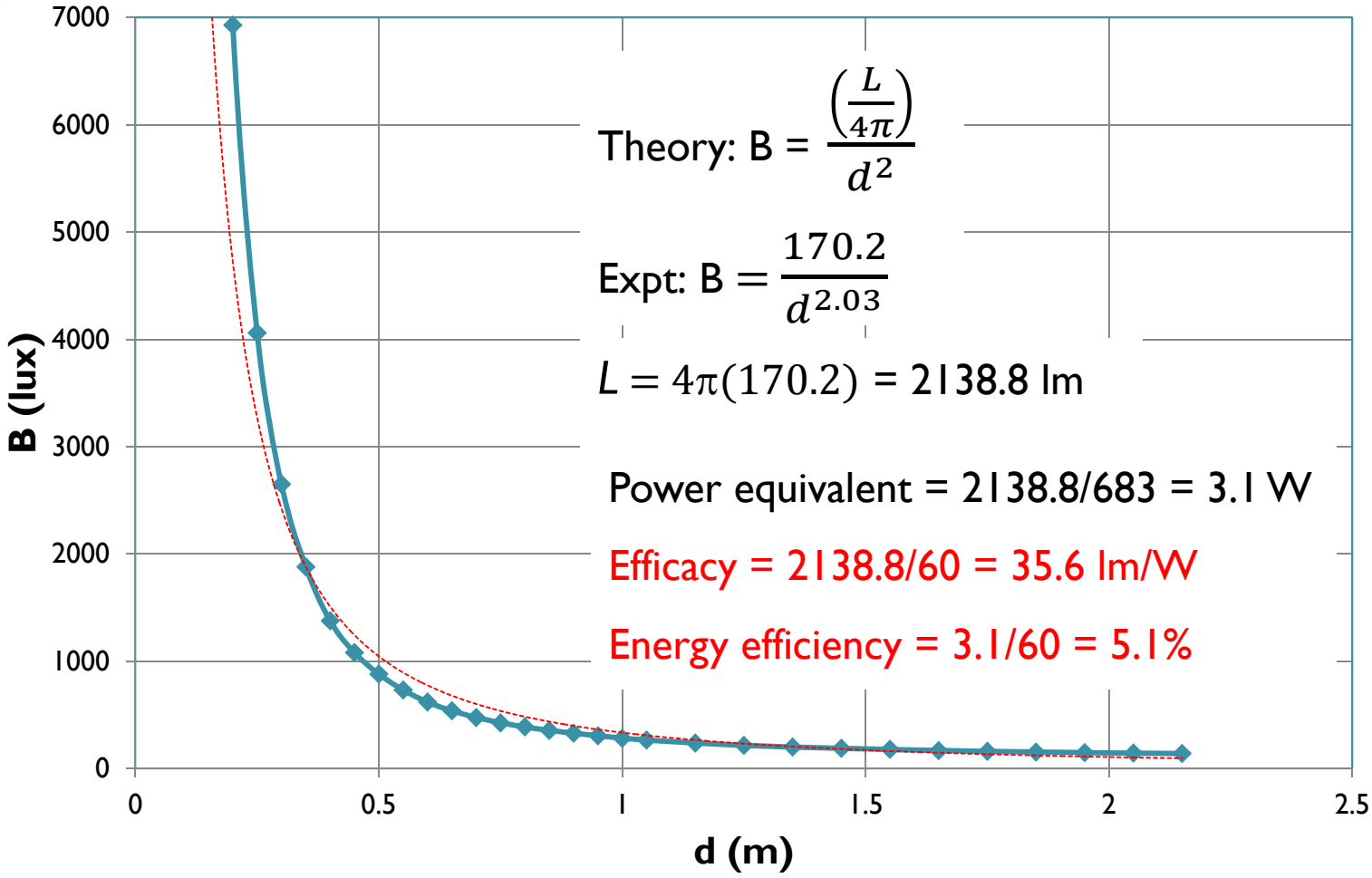
- Setup



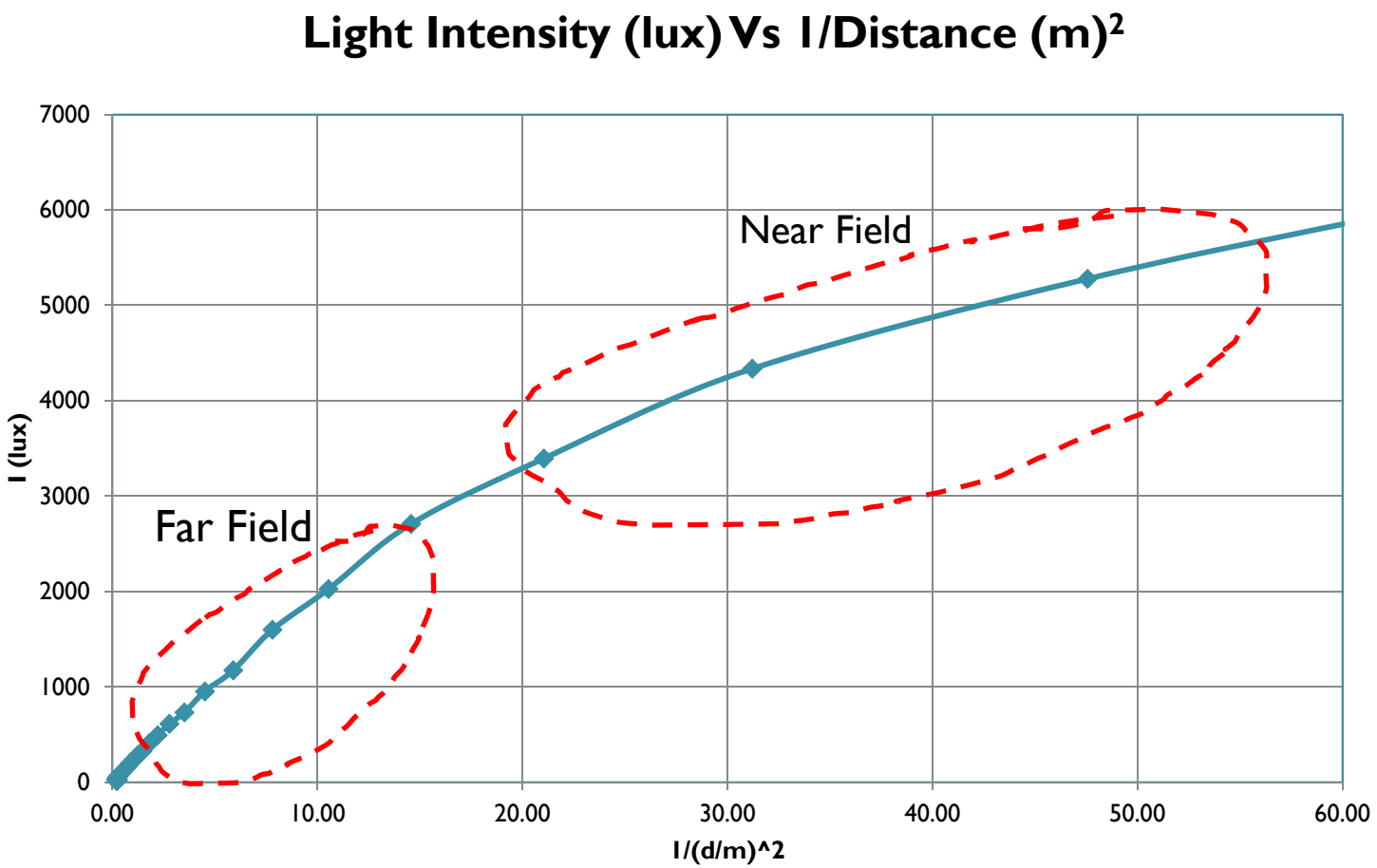
Data Logger Setup



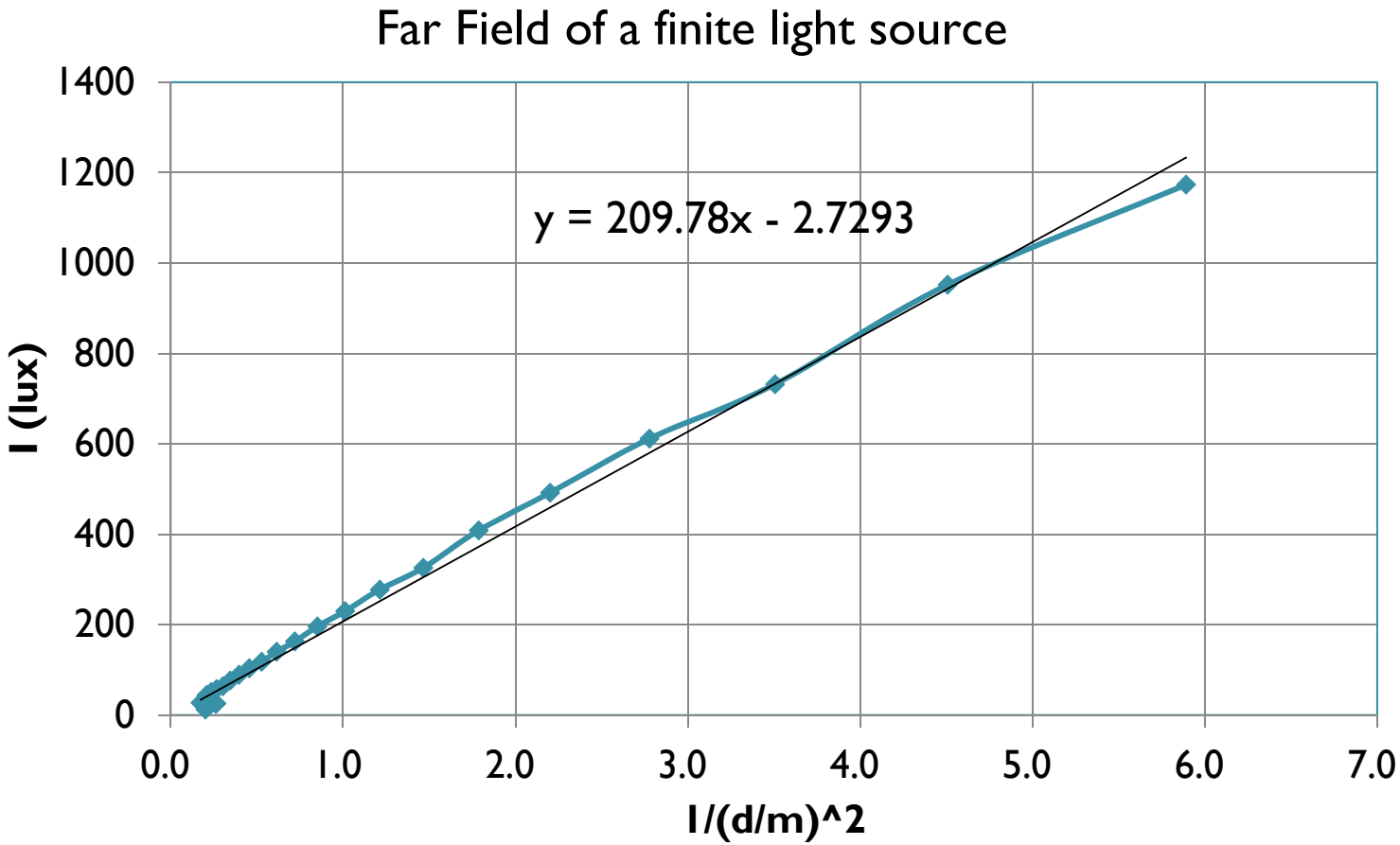
Filament light bulb (60 W)
Light Intensity (lux) Vs Distance (m)



Light Intensity (lux) Vs 1/ Distance $(m)^2$

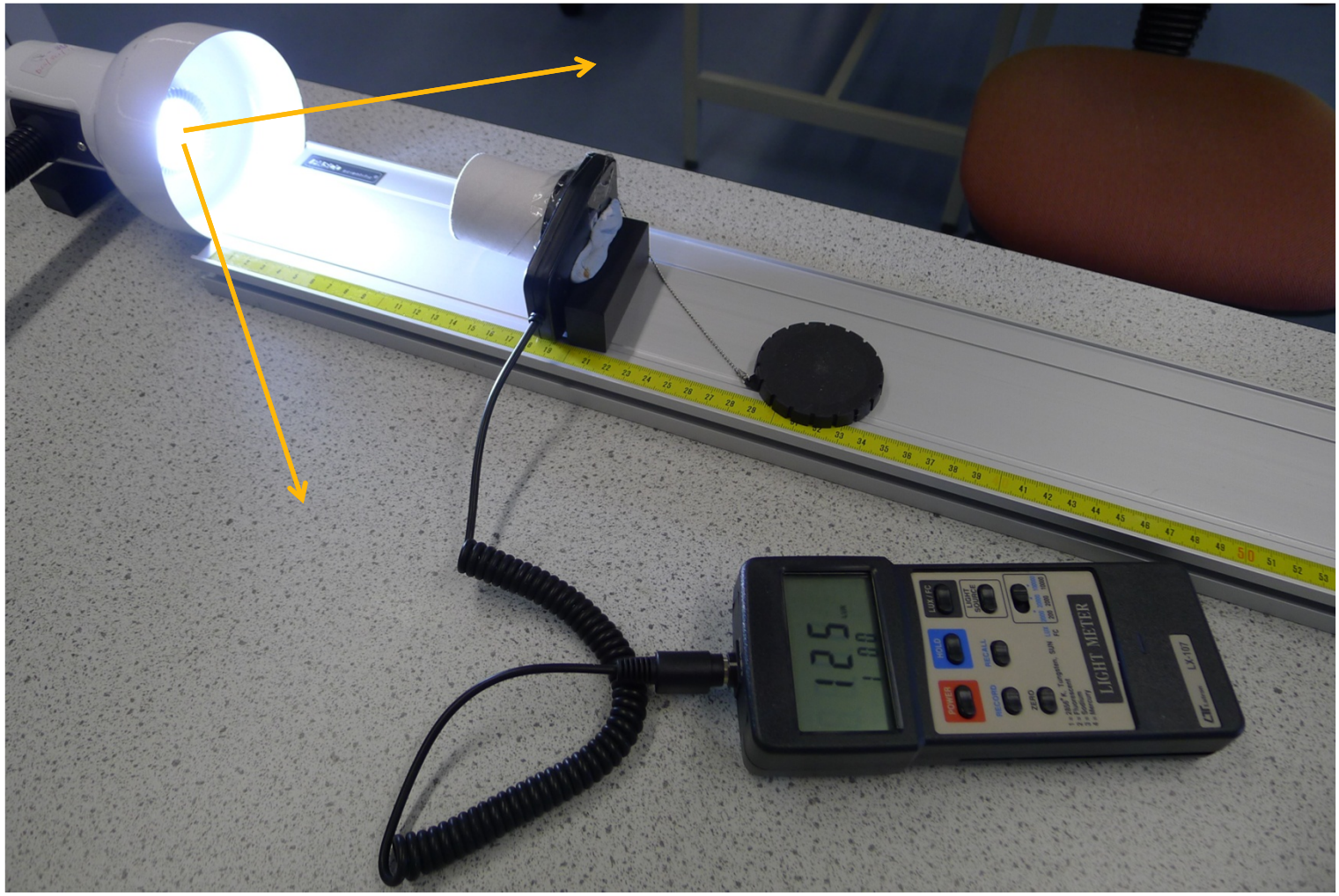


Light Intensity (lux) Vs 1/Distance $(m)^2$



Light Senors

Lux meter

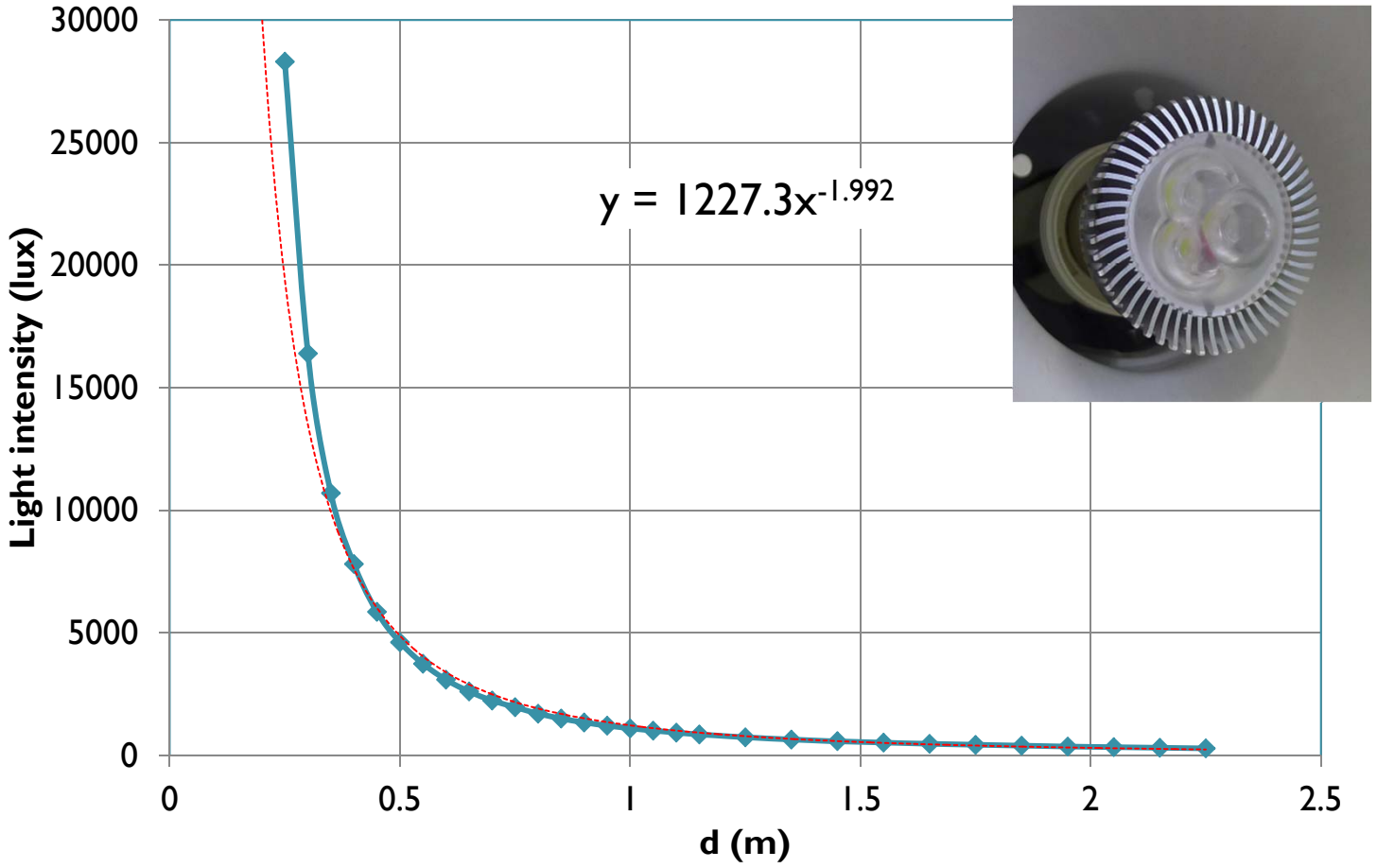


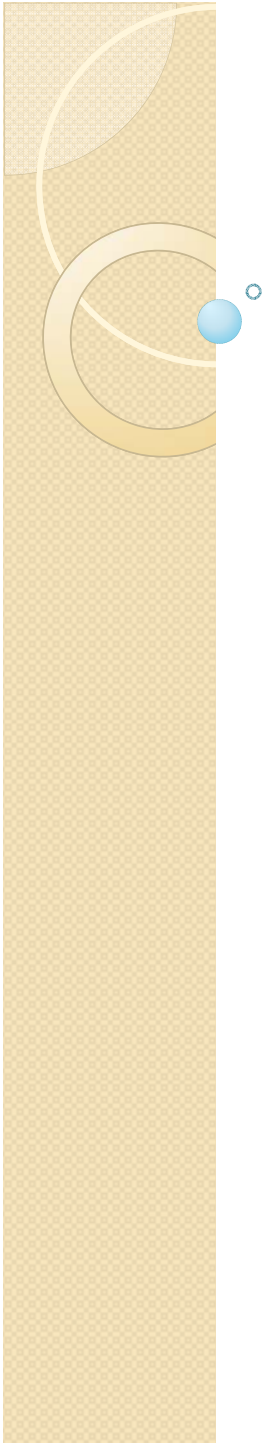
Efficacy of CFL

Title	Unit	Lux Meter	Smart phone
Input power	Watt (W)	12	12
Apparent brightness (Illuminance) $B = \frac{\left(\frac{L}{4\pi}\right)}{d^2}$	lm m^{-2} lux (lx)	$B = \frac{327.4}{d^{1.62}}$	$B = \frac{439.5}{d^{1.51}}$
Luminosity (Luminous Flux) $L = 4\pi B$	lumen (lm)	4114*	5523*
Efficacy (photometric unit)	lm/W	342	460
Efficiency (radiometric unit) *683 lumens = 1 Watt		50%	67%

* Angular correct factor should apply

LED (6 W)
Light Intensity (lux) Vs Distance (m)





Thanks