Lab Experiment #5:

The Slide Wire Potentiometer

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PHYS 200BL
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Data

The EMF listed on the standard cell $\epsilon_s = 1.01916\ \text{V}$
The voltage of the power supply $V_{AB} = 1.995\ \text{V}$

New Dry Cell

The balance position of the standard cell $s = 48.4\ \text{cm}$

	Iter 1	Iter 2	Iter 3	Iter 4	Iter 5	Avg Value	Std Dev
x of cell	$69.0\ \text{cm}$	$70.5\ \text{cm}$	$72.6\ \text{cm}$	$71.4\ \text{cm}$	$71.3\ \text{cm}$	$70.9\ \text{cm}$	$1.19\ \text{cm}$
x_L of loaded cell	$22.8\ \text{cm}$	$19.4\ \text{cm}$	$19.0\ \text{cm}$	$15.1\ \text{cm}$	$15.1\ \text{cm}$	$18.3\ \text{cm}$	$2.91\ \text{cm}$
ϵ_x from x	$1.45\ \text{V}$	$1.48\ \text{V}$	$1.53\ \text{V}$	$1.50\ \text{V}$	$1.50\ \text{V}$	$1.49\ \text{V}$	$0.0250\ \text{V}$
V_T from x_L	$0.480\ \text{V}$	$0.409\ \text{V}$	$0.400\ \text{V}$	$0.318\ \text{V}$	$0.318\ \text{V}$	$0.385\ \text{V}$	$0.0613\ \text{V}$

	Iter 1	Iter 2	Iter 3	Iter 4	Iter 5	Avg Value	Std Dev
r	40.5Ω	52.7Ω	56.4Ω	74.6Ω	74.4Ω	59.7Ω	13.1Ω

Old Dry Cell

The balance position of the standard cell $s = 48.0\ \text{cm}$

	Iter 1	Iter 2	Iter 3	Iter 4	Iter 5	Avg Value	Std Dev
x	$71.4\ \text{cm}$	$74.5\ \text{cm}$	$73.2\ \text{cm}$	$72.7\ \text{cm}$	$76.8\ \text{cm}$	$73.7\ \text{cm}$	$1.83\ \text{cm}$
x_L	$27.9\ \text{cm}$	$25.0\ \text{cm}$	$23.8\ \text{cm}$	$24.7\ \text{cm}$	$25.7\ \text{cm}$	$25.4\ \text{cm}$	$1.38\ \text{cm}$
ϵ_x	$1.52\ \text{V}$	$1.58\ \text{V}$	$1.55\ \text{V}$	$1.54\ \text{V}$	$1.63\ \text{V}$	$1.57\ \text{V}$	$0.0389\ \text{V}$
V_T	$0.592\ \text{V}$	$0.530\ \text{V}$	$0.505\ \text{V}$	$0.524\ \text{V}$	$0.545\ \text{V}$	$0.540\ \text{V}$	$0.0293\ \text{V}$
r	31.1Ω	39.6Ω	41.5Ω	38.9Ω	39.8Ω	38.2Ω	3.61Ω

Daniell Cell

The balance position of the standard cell $s = 50.0\ \text{cm}$

	Iter 1	Iter 2	Iter 3	Iter 4	Iter 5	Avg Value	Std Dev
x	$48.9\ \text{cm}$	$49.4\ \text{cm}$	$49.5\ \text{cm}$	$49.5\ \text{cm}$	$49.5\ \text{cm}$	$49.4\ \text{cm}$	$0.233\ \text{cm}$
x_L	$21.3\ \text{cm}$	$19.6\ \text{cm}$	$19.7\ \text{cm}$	$19.5\ \text{cm}$	$19.2\ \text{cm}$	$19.9\ \text{cm}$	$0.739\ \text{cm}$
ϵ_x	$0.997\ \text{V}$	$1.01\ \text{V}$	$1.01\ \text{V}$	$1.01\ \text{V}$	$1.01\ \text{V}$	$1.01\ \text{V}$	$0.00475\ \text{V}$
V_T	$0.434\ \text{V}$	$0.400\ \text{V}$	$0.402\ \text{V}$	$0.397\ \text{V}$	$0.391\ \text{V}$	$0.405\ \text{V}$	$0.0151\ \text{V}$
r	25.9Ω	30.4Ω	30.3Ω	30.8Ω	31.6Ω	29.8Ω	1.99Ω

Lab Questions

1. Using a voltmeter would only measure the *terminal voltage,* and we would not be computationally aware of the internal resistance of the battery.
2. Yes - environmental and equipment conditions can and do change over time.
3. By reasoning of the answer to question #2, the balance position of the standard cell can and does change over time; even if the standard cell is reliable to deliver consistent EMF, variable conditions such as temperature fluctuations and charge state of the wires can introduce discalibration.
4. Yes - longer wires tend to "artificially" inflate measured resistance values.
5. For $V_{AB} = 1.995\ \text{V}$:

New dry cell	Iter 1	Iter 2	Iter 3	Iter 4	Iter 5
x	$69.0\ \text{cm}$	$70.5\ \text{cm}$	$72.6\ \text{cm}$	$71.4\ \text{cm}$	$71.3\ \text{cm}$
ϵ_x	$1.38\ \text{V}$	$1.41\ \text{V}$	$1.45\ \text{V}$	$1.42\ \text{V}$	$1.42\ \text{V}$

Old dry cell	Iter 1	Iter 2	Iter 3	Iter 4	Iter 5
x	$74.1\ \text{cm}$	$74.5\ \text{cm}$	$73.2\ \text{cm}$	$72.7\ \text{cm}$	$76.8\ \text{cm}$
ϵ_x	$1.48\ \text{V}$	$1.49\ \text{V}$	$1.46\ \text{V}$	$1.45\ \text{V}$	$1.53\ \text{V}$

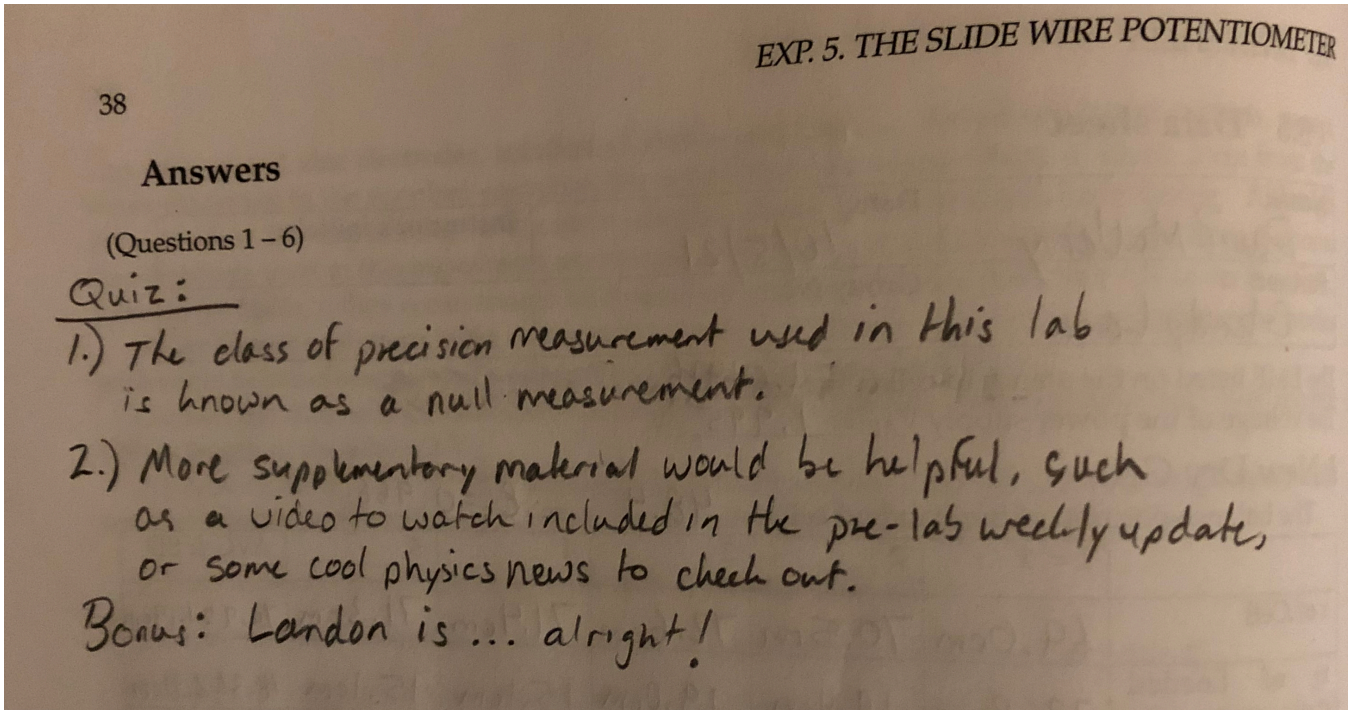
Daniell cell	Iter 1	Iter 2	Iter 3	Iter 4	Iter 5
x	$48.9\ \text{cm}$	$49.4\ \text{cm}$	$49.5\ \text{cm}$	$49.5\ \text{cm}$	$49.5\ \text{cm}$
ϵ_x	$0.976\ \text{V}$	$0.986\ \text{V}$	$0.988\ \text{V}$	$0.988\ \text{V}$	$0.988\ \text{V}$

These values are not the same as the values calculated using the experimental method. However, because the value of the EMF of the standard cell is known to be accurate, allegedly to 6 significant figures, this reduces the propagation of uncertainty and gives us a more accurate measurement than solely utilizing the meter stick.

6. For this lab, we were not using batteries which were clearly indicated as "old" or "new." Our data shows more variation in EMF and resistance for our "new" battery than for the "old" battery. Regardless of how worn they were assumed to be, as a

battery is used, its ability to deliver a consistent voltage is decreased. This is due to a number of reasons, including repeated chemical reactions occuring internally (which may deplete reagents over multiple reactions), stresses (both from environmental sources as well as from within) on the materials used to construct the battery, corrosion of terminals over time, or how the storage environment of the battery changes over the course of its use.

Data sheet + Quiz



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Answers

(Questions 1 – 6)

Quiz:

1.) The class of precision measurement used in this lab is known as a null measurement.

2.) More supplementary material would be helpful, such as a video to watch included in the pre-lab weekly update, or some cool physics news to check out.

Bonus: London is ... alright!

5.6 Data sheet

Name: David McVeay	Date: 10/5/21	Instructor's initials:
Partner: Glendy Lara	Group No:	

The EMF listed on the standard cell $\mathcal{E}_s$ = 1.01916 V
The voltage of the power supply V_{AB} = 1.995 V

I. New Dry Cell.

The balance position of the standard cell s = 48.4 cm

	i = 1	2	3	4	5	AVG & SD
x of Cell	69.0cm	70.5cm	72.6cm	71.4cm	71.3cm	70.9 ± 1.19cm
x_L of Loaded Cell	22.8cm	19.4cm	19.0cm	15.1cm	15.1cm	18.3 ± 2.91cm
$\mathcal{E}_x$ from x	1.45V	1.48V	1.53V	1.50V	1.50V	1.49 ± 0.0250V
V_T from x_L	0.480V	0.409V	0.400V	0.318V	0.318V	0.385 ± 0.0613V
r	40.5Ω	52.7Ω	56.4 Ω	74.6 Ω	74.4 Ω	59.7 ± 13.1 Ω

II. Old Dry Cell.

The balance position of the standard cell s = 48.0 cm

	1	2	3	4	5	AVG & SD
x of Cell	74.1cm	74.5cm	73.2cm	72.7cm	76.8cm	73.7 ± 1.83cm
x_L of Loaded Cell	27.9cm	25.0cm	23.8cm	24.7cm	25.7cm	25.4 ± 1.38cm
$\mathcal{E}_x$	1.52V	1.58V	1.55V	1.54V	1.63V	1.57 ± 0.0389V
V_T	0.592V	0.530V	0.505V	0.524V	0.545V	0.540 ± 0.0293V
r	31.1 Ω	39.6 Ω	41.5 Ω	38.9 Ω	39.8 Ω	38.2 ± 3.61 Ω

III. Daniell Cell.

The balance position of the standard cell s = 50.0 cm

	1	2	3	4	5	AVG & SD
x of Cell	48.9cm	49.4cm	49.5cm	49.5cm	49.5cm	49.4 ± 0.233 cm
x_L of Loaded Cell	21.3cm	19.6cm	19.7cm	19.5cm	19.2cm	19.9 ± 0.739cm
$\mathcal{E}_x$	0.997V	1.01V	1.01V	1.01V	1.01V	1.01V ± 0.00475V
V_T	0.434V	0.400V	0.402V	0.397V	0.391V	0.405 ± 0.0151V
r	25.9 Ω	30.4 Ω	30.3 Ω	30.8 Ω	31.6 Ω	29.8 ± 1.99 Ω