Pre-Lab Report

Lab section:

Name & Surname:

Table #:

<u>Before the Lab</u> complete this page YOURSELF! Hand it in <u>in the first 5 min</u>. of the session PERSONALLY!

You MUST justify your answers and show all steps. NO COPYCAT answers, or NO credits!

Please read <u>the relevant presentation</u> on PHYS LAB Website.

Q1. Draw the circuit for measurement of Ohm's law in this experiment. Do not forget to add rheostat! What is the function of it in the experiment?

Q2. Show dimensional analysis of resistance R explicitly! **Show your formulae / derivation below <u>explicitly or no credits</u>!**

(3^{rd} Question is on the next page!)

Q3. Below you are given a set of 4 data obtained in the Ohm's Law experiment. Calculate $\mathbf{R_i}$, $\mathbf{R_{average}}$ and $\boldsymbol{\sigma_R}$ and find **R** (Pay attention to significant figures and units!)

V(V)	I (A)	R_i ( )	$R_i - R_{average}$ ( )	$(R_i - R_{average})^2$ ( )
1.00	0.050			
1.25	0.055			
1.35	0.060			
1.50	0.085			
$R_{average}$=			σ_R=	
$R = R_{average} \pm \sigma_R$ =				

Comment on the result for $\mathbf{R_4}$, regarding $\mathbf{R_{average}}$ and $\boldsymbol{\sigma_R}$! **Show your formulae / derivation / calculations explicitly or no credits!**

1

Lab Report

Lab section:

Name & Surname:

Table #:

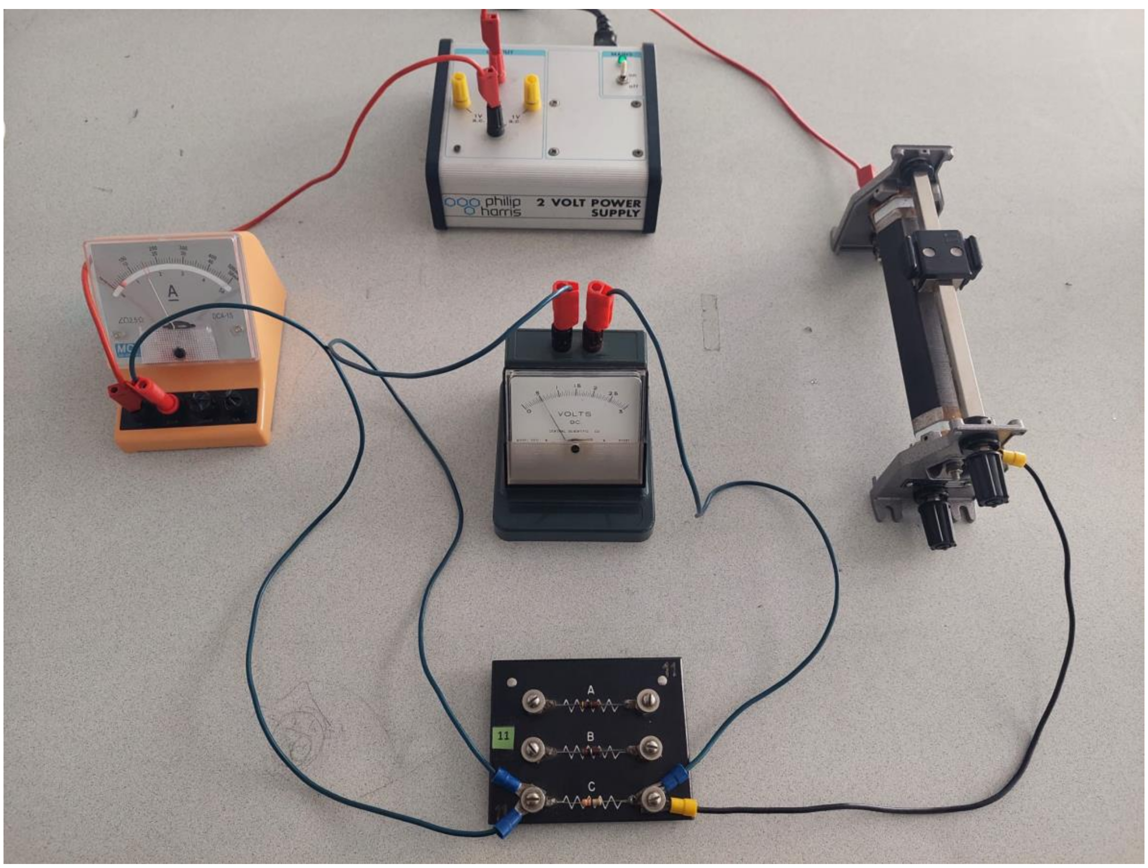
***Complete this report YOURSELF except DATA taking parts! Use a pencil for plots only and a pen for the rest!* Show your work clearly, NO COPYCAT analysis allowed, or NO credits!**

OBJECTIVE : To determine the resistance of a conductor making use of Ohm's Law.

THEORY : Most conductors show ohmic character when current passes through them. There is a linear relationship between the potential difference across such a conductor and the current passing through it, where the proportionality constant R is the resistance. This is Ohm's Law.

APPARATUS : Ammeter (0.5 A), voltmeter (3 V), rheostat, 2-V power supply, resistance board, knife switch.

PROCEDURE : Construct the circuit with the 2-V DC-power supply. Vary the applied voltage with the help of the rheostat and record ten readings for the current and the corresponding voltage across the conductor. Calculate the corresponding resistance for each voltage-current pair and compute the average and the standard deviation of the resistance.



2

DATA-TAKING

Unknown Resistance Number*	

# of measurements, N	*Voltage across the Resistance V ( )*	*# of Significant Figures :*	*Current in the Circuit I ( )*	*# of Significant Figures :*
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				

*** Write the unknown resistance number on resistance plate and the letter corresponding the resistance you measure. Example: 4C**

3

CALCULATIONS

# of measurements, *N*	R_i ( )	$R_{average} - R_i$ ( )	$(R_{average} - R_i)^2$ ( )
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
$\sum_{i=1}^{N}(R_i) =$		$\sum_{i=1}^{N}(R_{average} - R_i)^2 =$	
Average of R =		**Standard Deviation of R =**	

4

RESULTS

Description	Symbol	Calculation (show each step)	Result
Mean Resistance	$R_{average}$ =	. . . .	
		. . . .	
Standard Deviation of the Resistance Value	σ_R =	. . . .	
		. . . .	

RESULT:

$\boldsymbol{R = R_{average} \pm \sigma_R}$ = ...

Consult to the resources for this experiment from PHYS LAB Website:

PHYL201 Intro

Presentation #1

PHYL201 Lab Book

Pre-Lab Report

Lab section:

Name & Surname:

Table #:

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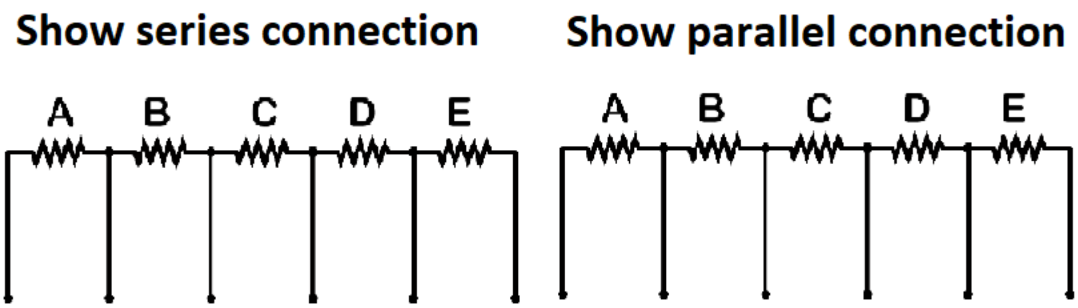
Please read the relevant presentation on PHYS LAB Website.

Q1. Connect three resistors B, C and D all together **a-** in series **b-** in parallel below. Show the direction of current flow using arrows:



Q2. Explain what happens when the galvanometer and the power supply are exchanged in a balanced Wheatstone bridge. What happens to balance then? Give a mathematical proof of it. (*Hint: Ignore the switch and rheostat on the bridge in the experiment. Draw the circuits before and after the exchange*)

(3rd Question is on the next page!)

Q3. Determine the uncertainty ΔR in the value of the unknown resistance if the uncertainty in determining the balance point on the slide-wire is ΔL. Consult to the introduction part of your Lab Book or you may search for "Error propagation". **Show your calculations below explicitly or no credits!**

1

Lab Report

Lab section:

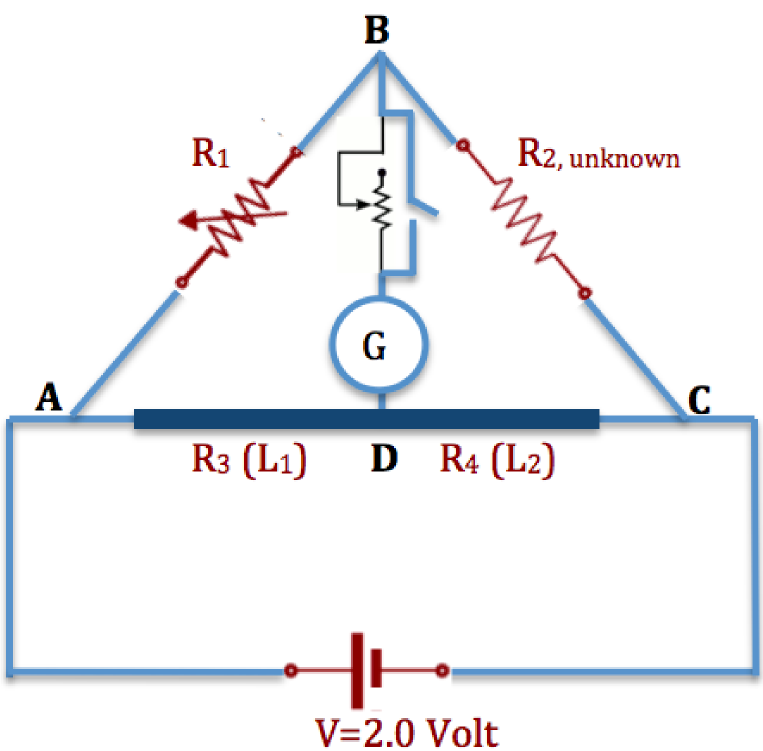
Name & Surname:

Table #:

Complete this report YOURSELF except DATA taking parts! Use a pencil for plots only and a pen for the rest! **Show your work clearly, NO COPYCAT analysis allowed, or NO credits!**

OBJECTIVE : To determine the resistance of various conductors and their series and parallel combinations using a slide-wire Wheatstone Bridge.

THEORY : In Wheatstone bridge there are two pairs of resistors connected in parallel. A galvanometer is connected between the points where individual resistors are connected together in each pair. To protect the galvanometer against excessive currents, a large resistance is connected in series with the galvanometer with the option to short it out using a switch. A low voltage power supply is connected across the points where each pair is connected in parallel to each other. In slide-wire Wheatstone Bridge case one pair of resistors is simply a wire and the galvanometer is connected to a point on the wire with the help of a sliding connection. The resistance ratio on this part of the circuit is simply the ratio of the lengths of the wire sections on each side of the sliding connection.



Assuming that the resistances in the wire part of the circuit are R1 and R2 and the other part are R3 and R4, let us further assume that the current passing through the wire part is I1 and the other part is I2. Then, adjusting the position of the sliding contact on the wire, the current through the galvanometer is brought to zero. This means that the potential differences across the resistances opposing each other in each pair will be equal:

$$I_1 R_1 = I_2 R_3$$

$$I_1 R_2 = I_2 R_4$$

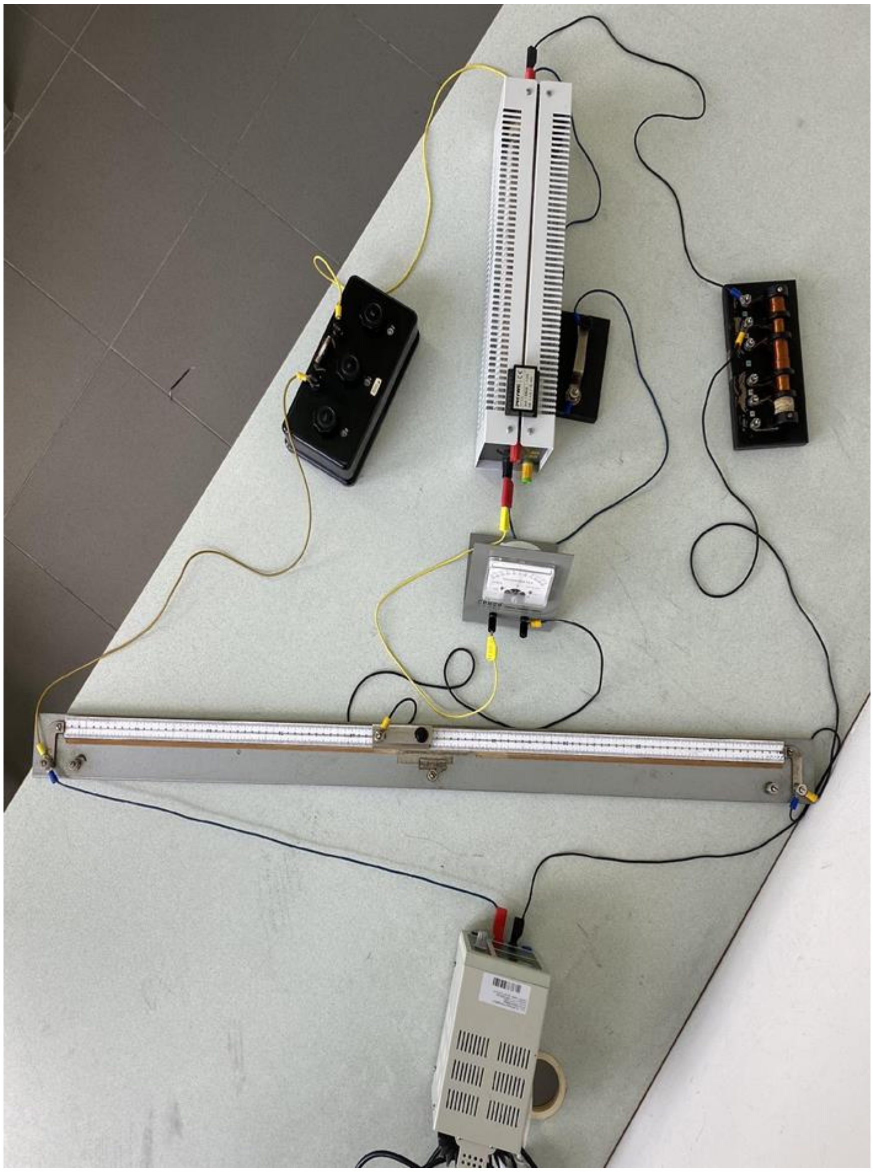
Dividing the first expression by the second one, we get

$$\frac{R_1}{R_2} = \frac{R_3}{R_4} = \frac{L_1}{L_2}$$

since the resistance of a wire is proportional to its length, cross section and its material. Both parts being part of the same wire, the ratio of the resistances is equal to the ratio of their lengths. Using such a bridge and a known resistance, for a 100.0 cm wire in the bridge, we can determine the value of an unknown resistance as:

$$R_x = \frac{(100.0 - L_1)}{L_1} R_1$$

APPARATUS : Slide-wire Wheatstone Bridge, galvanometer, resistance box, large resistance (rheostat), unknown resistance set, switch, a variable DC power supply.



PROCEDURE :

1. Set the power supply around 2.0 V.
2. Connect the circuit. Start with unknown resistance A. Set the resistance box to an appropriate value (generally 1 or 2 ohms) and move the contact key on the slide wire until bridge is balanced.
3. For the final precise adjustments close the switch and observe zero deflection on the galvanometer.
4. Note the point where the slide wire touches the contact key.
5. Repeat steps 2-3 & 4 for unknown resistances B and C.
6. Combine resistors A and C **in series** and place them into the bridge. Repeat steps 2-4.
7. Combine A and C **in parallel** and place them into the bridge. Determine the value of the combined resistance. Repeat steps 2-4 .
8. Calculate the value of the unknown resistances and their combinations in Table below.

3

DATA-TAKING

Name of the Resistance*	R_1 ( ) (Resistance Box)	L_1** ( ) # of Significant Figures =	L_2 ( ) # of Significant Figures =
R_A			
R_B			
R_C			
R_{Series} (A and C)			
$R_{Parallel}$ (A and C)			

*** Ignore unknown resistances D and E! R_1 can be different for different unknown resistances.**
**** L_1 should be in the interval 10.0 cm < L_1 < 90.0 cm. Otherwise, change R_1 and retry!**

CALCULATIONS

Symbol	Calculations (show each step)	Result
R_A =	. . . .	
R_B =	. . . .	
R_C =	. . . .	
R_{Series} =	. . . .	
$R_{Parallel}$ =	. . . .	

4

9. Calculate the expected values of R_{Series} and $R_{Parallel}$. You should use the formulae for equivalent resistance and the values calculated for R_A, R_B and R_C.
10. Compare R_{Series} and $R_{Parallel}$ with their expected values and calculate the percentage error. Take expected values as True Value.

CALCULATIONS

Symbol	Calculations (show each step)	Result
R_{Series} = *(expected)*	. . . .	. . . .
$R_{Parallel}$= *(expected)*	. . . .	. . . .

RESULTS

% Error for R_s : . . . .

% Error for $R_{//}$: . . . .

Consult to the resources for this experiment from PHYS LAB Website:

PHYL201 Intro

Presentation #2

PHYL201 Lab Book

Pre-Lab Report

Lab section:

Name & Surname:

Table #:

***Before the Lab* complete this page YOURSELF! Hand it in *in the first 5 min*. of the session PERSONALLY!**

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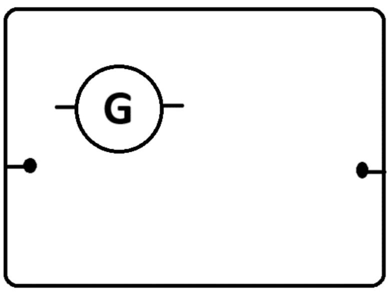
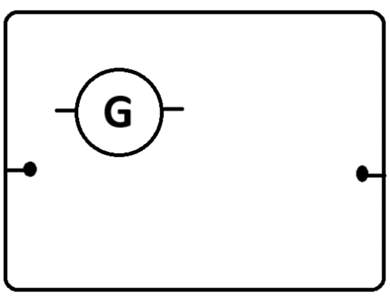
Please read the relevant presentation on PHYS LAB Website.

Q1. You are given 3 circuit elements: A galvanometer (G) whose internal resistance is R_G, and two resistors R_L and R_S. Their resistance values are related by the following inequality: $\mathbf{R_L >> R_G >> R_S}$. Using all or some of these circuit elements draw the internal structure of a Voltmeter and an Ammeter respectively.



Inside of a Voltmeter



Inside of an Ammeter

(2^{nd} Question is on the next page!)

Q2. A certain DC voltmeter has an internal resistance of 1000 Ohms per volt. What current in milliamperes is required for full scale deflection? . **Justify your answers, show calculations if needed or no credits!**

Q3. An ammeter and a voltmeter will be used to measure the current and the voltage across an electric lamp, respectively. If the voltmeter is connected as an ammeter and the ammeter as a voltmeter, what will happen? **Justify your answers, no credits!**

1

Lab Report

Lab section:

Name & Surname:

Table #:

Complete this report YOURSELF except DATA taking parts! Use a pencil for plots only and a pen for the rest! **Show your work clearly, NO COPYCAT analysis allowed, or NO credits!**

OBJECTIVE : To convert a galvanometer into an ammeter and a voltmeter of a given range.

THEORY : Ammeters are instruments for measuring the current passing through them. Ideally they should have zero internal resistance so that the voltage across them will be zero without changing the circuit characteristics that they are connected. However, the real ammeters have some resistance even though it is very small.

Voltmeters are instruments to measure the potential difference between the two points they are connected in a specific circuit. Ideal voltmeters should have infinite internal resistance so that they do not draw current from the circuit that they are connected. But the real voltmeters have some finite internal resistance.

To build a voltmeter we could use a sensitive galvanometer with a very high internal resistance to start with. Since we will be connecting the voltmeter in parallel to any circuit section with a voltage difference up to a maximum value, we should connect a series resistance to the galvanometer. If the full scale deflection is desired to be V, then equating the voltage across the voltmeter to V would give us:

$$I_G R_G + I_G R_{series} = V$$

where IG and RG are the galvanometer current and internal resistance, respectively. We can determine the series resistance from this expression.

We can also use the same galvanometer to construct an ammeter. This time we should connect a parallel resistance to the galvanometer to shunt the excess current from the galvanometer. In this case the voltage difference across the galvanometer and the shunt resistance will be the same:

$$I_G R_G = (I - I_G) R_{paralel}$$

where I is the current at which the galvanometer shows full scale deflection. We can determine the parallel resistance from this expression for our ammeter.

APPARATUS : Galvanometer, various wires and resistance boxes, switch, voltmeter, ammeter, and a 2-V power supply.

2

PART – 1: DETERMINATION OF THE CONSTANTS OF A GALVANOMETER

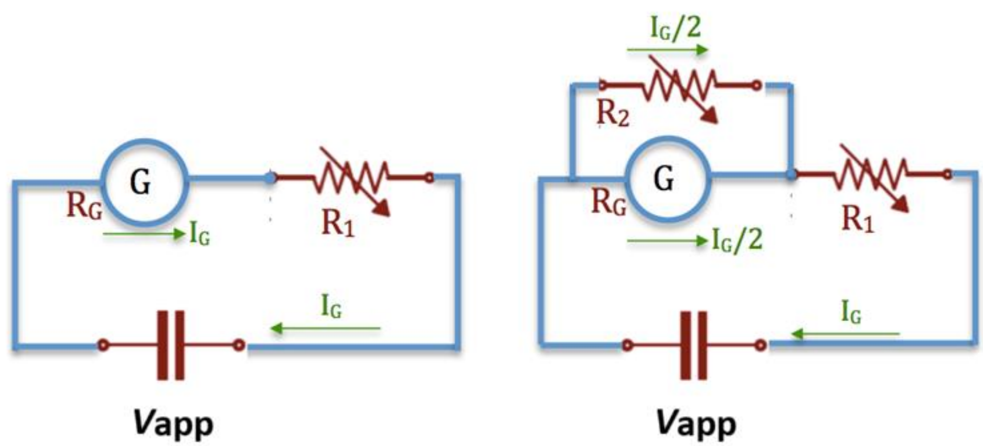
The values below will be given by your Lab Instructor during DEMO

Resistance to set for **FSD** R_1 = ...

Applied Potential V_{app}=. ....

Resistance to set for **HSD** R_2 = ...

CONSTANTS OF THE GALVANOMETER:



Description / Symbol	Formula-Calculation /	Value & Unit

Calculate Internal resistance of the Galvanometer R_G = ...

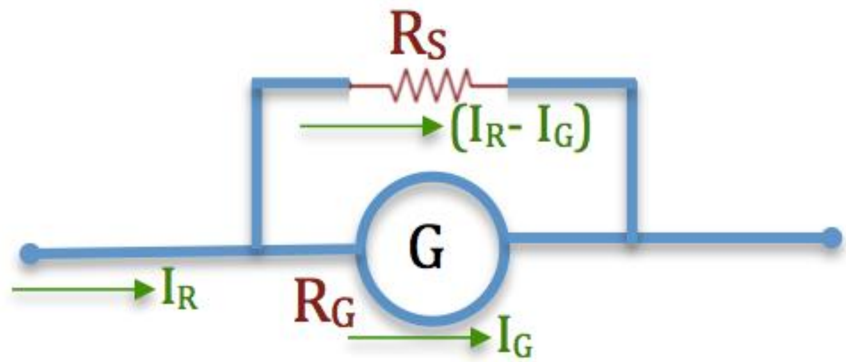
Calculate Max. Galvanometer Current I_G = ...

....

3

PART – 2: CONSTRUCTION OF AN AMMETER

Circuit for ammeter (theoretical):



Range for the Constructed Ammeter *(given)* I_R = . **1.0 A**

Given Resistance per unit length of the Copper Wire ρ_{cw} = **1.34 x 10^{-3} Ω/cm**

Description / Symbol	Formlula / Calculation	Value & Unit
Shunt Resistance R_S =	. . . .	
	. . . .	. . . .
Length of the Copper Wire L =	. . . .	. . . .
	. . . .	

4

Draw the circuit in which the constructed ammeter is used:

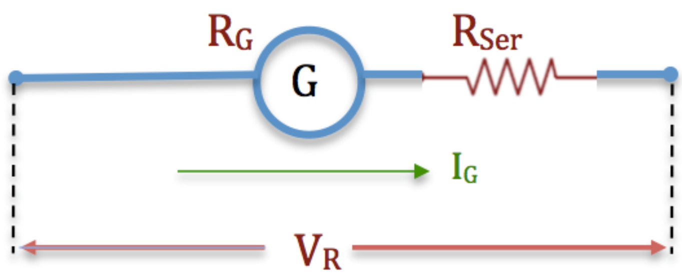
Description / Symbol	Value / Calculation	Result
Value read from the Galvanometer G_x =	. . . .	
Value read from the Constructed Ammeter I_{EV} =	. . . .	
	. . . .	
Value read from a Real Ammeter I_{TV} =	. . . .	
	. . . .	

% Error for *I*:

5

PART – 3: CONSTRUCTION OF A VOLTMETER

Circuit of voltmeter (theoretical):



Description / Symbol	Fomula / Calculation	Value / Result
Range for the Constructed Voltmeter V_R =	2.3 V + Table # / 10	
Series Resistance R_{Ser} =	. . . .	. . . .
.		
	. . . .	

Draw the circuit in which the constructed voltmeter is used:

6

Description/Symbol	Value / Calculation	Result

Value read from the Galvanometer G_Y = ...

Value read from the Constructed Voltmeter V_{EV} = ...

Value read from a Real Voltmeter V_{TV} = ...

% Error for *V*:

Consult to the resources for this experiment from PHYS LAB Website:

PHYL201 Intro

Presentation #3

PHYL201 Lab Book

Pre-Lab Report

Lab section:

Name & Surname:

Table #:

<u>Before the Lab</u> complete this page YOURSELF! Hand it in <u>in the first 5 min</u>. of the session PERSONALLY!

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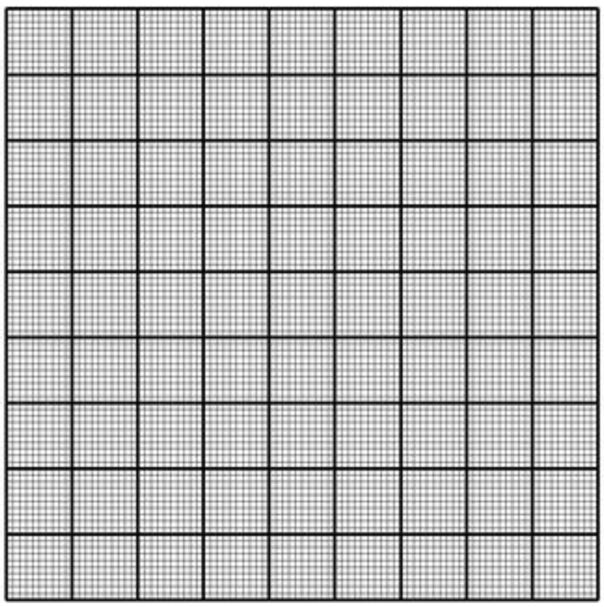
Please read <u>the relevant presentation</u> on PHYS LAB Website.

Q1. Plot a sine wave with 3 upper peaks on an oscilloscope screen given below. The length between the leftmost and the rightmost peak of a sinusoidal wave is measured to be L. Height between the maximum and minimum values of the same wave on vertical axis is measured to be 2A**.**



Show the formulation for the following:

a) Length of one wave (l) =

b) Period (T) =

c) Frequency (f) =

d) $V_{p\text{-}p}$ (Volt) =

e) V_{max} =

f) V_{rms} =

(Hint: You should express the result in terms of n: # of waves, [Time/div], [Volt/div], L and A)

(2nd Question is on the next page!)

Q2. Explain in your OWN WORDS and in ONE SENTENCE, the meanings of the following. **Do not write copycat answers or no credits!**

a) [Time/div]

b) [Volt/div]

Q3. Suppose that [Time/div] = 1.00 μs and [Volt/div] = 5.00 mV is given for the sine wave you have plotted in Question 1. Calculate the following. **Show your formulae / derivation below explicitly or no credits!**

a) Frequency of the sine wave.

b) V_{rms} of the sine wave.

1

Lab Report

Lab section:

Name & Surname:

Table #:

***Complete this report YOURSELF except DATA taking parts! Use a pencil for plots only and a pen for the rest!* Show your work clearly, NO COPYCAT analysis allowed, or NO credits!**

OBJECTIVE : To learn how to operate a cathode ray oscilloscope and how to use it in studying alternating current (AC) circuits.

THEORY : Cathode Ray Tube Oscilloscope displays all types of waveforms with an electron beam hitting the fluorescent screen. Electron beam is deflected according to the voltage applied to its vertical and horizontal inputs through amplifying circuits. Usually the voltage applied to its horizontal input is a periodic signal generated internally so that the screen displays a dynamic picture of the waveform applied to the vertical input. The rate of this internal sweeping frequency is set by the time-base dial or the horizontal sweep rate. Usually the horizontal sweep is calibrated to set specific time interval per centimeter on the screen. Similarly the vertical scale is set by the voltage knobs as specific voltage values per centimeter.

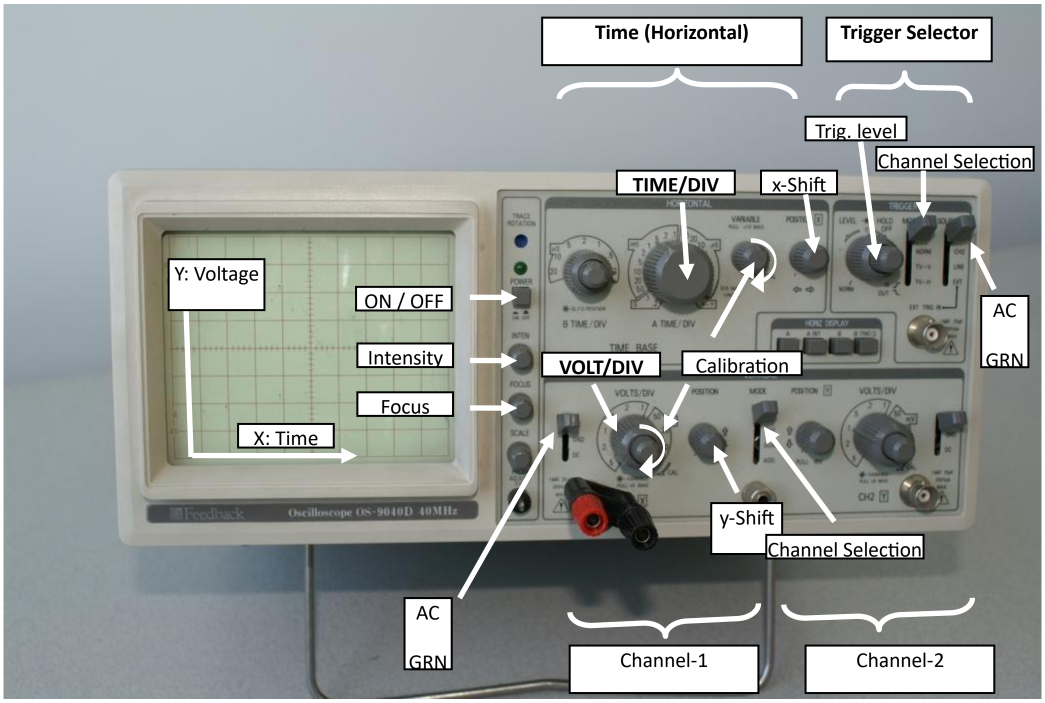
$$V_{rms} = \frac{V_{pp}/2}{\sqrt{2}} = \frac{V_{\max}}{\sqrt{2}}$$

Period or time intervals are also determined by measuring the horizontal length and multiplying this length by the horizontal sweep rate. Frequency of a periodic signal is also determined by inverting the period. Make sure that the calibration dials are turned all the way to the right (or in the direction of the arrow next to the dial) to ensure that the V/DIV and TIME/DIV settings are correct.

Displayed image on the screen can be moved up and down and left to right with corresponding dials. Starting position of the waveform display can be chosen by the adjustment of the trigger knob either automatically (auto) or manually (normal). There are also dials to adjust the intensity, focus, astigmatism, and panel lighting. Input type of the signal is selected through the three-position switch next to the vertical gain dial. AC means that the AC component of the signal is displayed. DC means the signal is displayed with its DC offset. GND means the input is grounded. This is selected if you want to make adjustments to the oscilloscope without the interference of the input signal. There are two identical sets of most of these dials in a two-channel oscilloscope that you will be using. You should refer to the oscilloscope manual for more specific dials.

2

APPARATUS : Two-channel oscilloscope and an oscillator i.e. Signal Wave Generator (SWG).



Cathode Ray Oscilloscope: In the experiment, we will use a digital version of it!

PROCEDURE :

1. Examine the front panel of the oscilloscope to become familiar with the various dials and controls.
2. Set the oscillator i.e. Signal Wave Generator (SWG) to produce a sine wave. To measure the frequency of the oscillator, set the TIME/DIV sweep dial to a number of values.
3. For each sweep dial value, measure the length of the wave on the screen and calculate the period. Then, determine the corresponding frequency.
4. Compare the calculated frequency with the oscillator frequency.

3

DATA-TAKING: PART-1

***Set SWG to* 500 Hz.**	f_{TV}*=

*Read the applied frequency fTV from oscilloscope screen.

** Do not change the amplitude of the applied wave and the Volt/Div dial setting for both readings

	TIME MESAUREMENTS**	
1st Reading	[TIME / DIV]$_1$	
	L_1	
	# of waves$_1$ in L_1	
	Length of the wave, λ_1	
	Period, T_1	
	Frequency, $f_{EV\text{-}1}$	

2nd Reading	[TIME / DIV]$_2$	
	L_2	
	# of waves$_2$ in L_2	
	Length of the wave, λ_2	
	Period, T_2	
	Frequency, $f_{EV\text{-}2}$	
	$f_{EV} = (f_{EV\text{-}1} + f_{EV\text{-}2})/2$	

Error for *f*:

4

SWG set to 500 Hz	
VOLTAGE MEASUREMENT	
[VOLT / DIV]	
V_{pp} (div)	
V_{pp} (Volt)	
$V_{max} = V_{pp} / 2$	
$V_{rms} = V_{max} / \sqrt{2}$	

DATA-TAKING: PART-2

***Set SWG to* 20 kHz.**	f_{TV}* =

*Read the applied frequency fTV from oscilloscope screen.

TIME MESAUREMENTS	
[TIME / DIV]	
L	
# of waves in *L*	
Length of the wave, λ	
Period, *T*	
Frequency, f_{EV}	

% Error for *f*:

5

DATA-TAKING: UNKNOWN FREQUENCY

$V_{measured}$*= V_{TV}	

*Measure V_{rms} using a multimeter

TIME MESAUREMENTS	
[TIME / DIV]	
L	
# of waves in L	
Length of the wave, λ	
Period, T	
Frequency, f_{EV}	

VOLTAGE MEASUREMENT	
[VOLT / DIV]	
V_{pp} (div)	
V_{pp} (Volt)	
$V_{max} = V_{pp} / 2$	
$V_{rms} = V_{max} / \sqrt{2}$	

% Error for V_{rms} :

Consult to the resources for this experiment from PHYS LAB Website:

PHYL201 Intro

Presentation #4

PHYL201 Lab Book

Pre-Lab Report

Lab section:

Name & Surname:

Table #:

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Please read the relevant presentation on PHYS LAB Website.

Q1. Starting from Kirchoff's law, derive $t_{1/2} = (\ln 2)RC$ expression. **Show your derivation / formulae explicitly or NO CREDITS!** (Hint: Solve the differential equation for charge and apply boundary conditions. Do not write the solution of the differential equation directly **or no credits!)**

(2nd Question is on the next page!)

Q2. What is the meaning of half-life for an RC circuit? To measure $t_{1/2}$, which condition needs to be satisfied? **Explain in YOUR OWN WORDS and <u>justify your answer,</u> or no credits!**

Q3. What is an integrating circuit? Which condition needs to be satisfied to observe it? **Explain in YOUR OWN WORDS and <u>justify your answer</u>, or no credits!**

1

Lab Report

Lab section:

Name & Surname:

Table #:

***Complete this report YOURSELF except DATA taking parts! Use a pencil for plots only and a pen for the rest!* Show your work clearly, NO COPYCAT analysis allowed, or NO credits!**

OBJECTIVE : To observe and measure the effects caused by the growth and decay of currents in a capacitor.

THEORY : When you connect a capacitor and a resistor in series and apply a specific waveform, the behavior of the circuit can be understood by applying the Kirchoff's laws:

$$R\frac{dq}{dt}+\frac{q}{C}=V_{app}\,.$$

Solution of this first order differential equation depends on the applied waveform. If the applied voltage is constant, then the solution for the charge or the voltage on the capacitor is a function that increases exponentially until it reaches the maximum value. On the other hand if we apply a square wave signal, choosing a period much longer than the half-life of the RC circuit or the RC time constant,

$$t_{1/2}=(\ln 2)RC\,,$$

provides us with a waveform repeatedly displaying the discharge of the capacitor when the square wave goes to the low level or "turns off."

On the other hand, if we go to the other extreme and choose a square wave signal with a period much shorter than the RC time constant, then the voltage across the capacitor is basically the integral of the applied potential. The circuit equation above can be approximated as:

$$R\frac{dq}{dt}\approx V_{app}\;\Rightarrow\;\frac{dq}{dt}=\frac{V_{app}}{R}$$

since the voltage on the capacitor is negligible compared to the voltage across the resistance. Even though we neglect the voltage across the capacitor when determining the current passing through the RC circuit, we can still get a nonzero voltage across it.

$$V_c=\frac{q}{C}=\frac{1}{RC}\int V_{app}\,dt$$

with the approximation that $V_c << V_{app}$.

APPARATUS : Oscilloscope, oscillator, resistance and capacitor boxes.

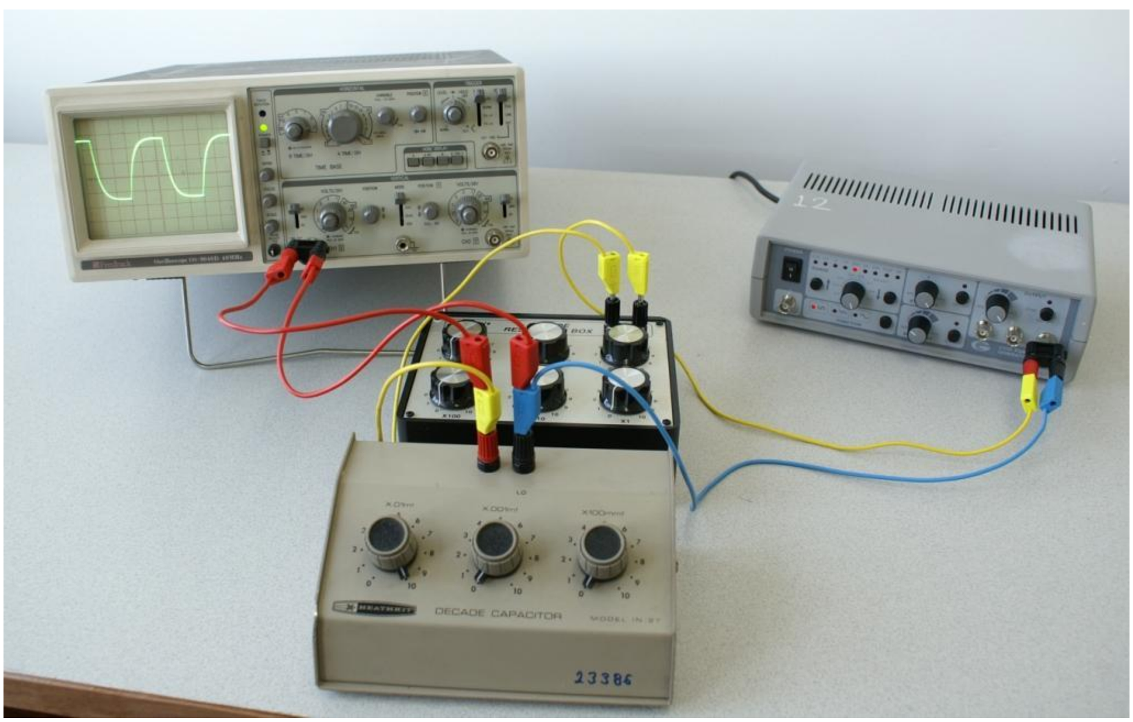
PROCEDURE :

Part 1:

1. Use 3000 Ω for *R* and 0.1 μF for *C*.
2. Calculate the true value of half-life of the RC circuit and determine the square wave frequency to set.
3. Construct your circuit and turn on your oscilloscope.
4. Adjust the controls for optimum focus, stability and trigger action.
5. From observed pattern on the oscilloscope screen, measure $t_{1/2}$.

Part 2:

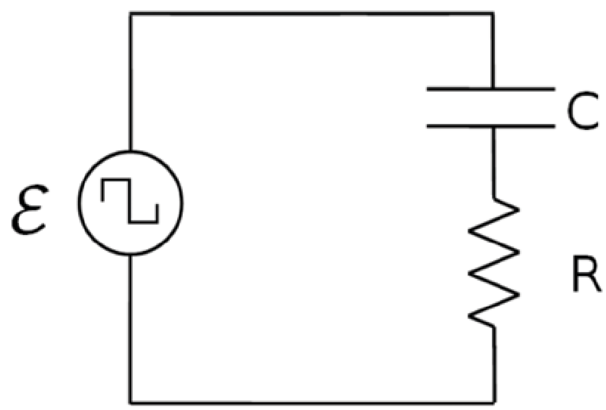
1. Use the same circuit but set much higher frequency on the Square Wave Generator.
2. Draw one period of the applied square wave voltage and using the same scale draw the corresponding pattern for the voltage across the capacitor below that.
3. Show that the capacitor voltage is proportional to the integral of the applied square wave voltage.



3

PART-1 DISCHARGING CHARACTERISTICS

Connect the circuit. Show where you should connect the oscilloscope on the circuit:



DATA GIVEN

Description	Symbol		Value	
Resistance set on the Resistance Box	R	=	3000 Ω	Given
Internal Resistance of the SWG	R_{SWG}	=	600 Ω	Given
Capacitance	C	=	0.1 μF	Given

Set *R* on resistance box and construct the circuit!

4

CALCULATIONS

Description	Symbol	Calculation (show each step)	Result
Total Resistance	R_T	=.	. . . .
True Value of the Half-Life	$t_{1/2TV}$	=	. . . .
Period	T	= 20 $t_{1/2}$=.	. . . .
Frequency of the SWG	f_{SWG}	=	. . . .

Set f_{SWG} on signal wave generator and connect the circuit!

DATA to be taken on Oscilloscope

Description	Symbol	Result
[VOLT/DIV]		= . . . .
[TIME/DIV]		= . . . .
Half-Life in cm	$t_{1/2EV}$ (cm)	= . . . .

RESULT

Description	Symbol	Calculation (show each step)	Result
Half-Life in sec	$t_{1/2EV}$	=	. . . .

% Error for $t_{1/2}$:

5

PART-2: AN INTEGRATING CIRCUIT

Set the frequency of the SWG to f_{SWG}= **20 kHz**. R_T and C values should be the same as Part-1.

Draw the Capacitor Voltage Waveform:

[VOLT/DIV]= . . . .   [TIME/DIV]= . . . .

Draw the applied Square Waveform: (Conenct the Oscilloscope directly on SWG)

[VOLT/DIV]= . . . .   [TIME/DIV]= . . . .

6

From the Graphs for the chosen t_1 and t_2, read the following data:

Symbol & Formula		Calculation (show each step)	Result
$V_c = V_{c2} - V_{c1}$	=	. . . .	. . . .
$\int_{t_1}^{t_2} V_{app}\,dt$	=	. . . .	. . . .
		. . . .	
$(\frac{1}{R_T C})_{TV}$	=	. . . .	. . . .
		. . . .	
$(\frac{1}{R_T C})_{EV} = \frac{V_{c2} - V_{c1}}{\int_{t_1}^{t_2} V_{app}\,dt}$	=	. . . .	. . . .
		. . . .	
% Error for (1/*RC*)	=	. . . .	. . . .

Consult to the resources for this experiment from PHYS LAB Website:

PHYL201 Intro

Presentation #5

PHYL201 Lab Book

Pre-Lab Report

Lab section:

Name & Surname:

Table #:

***Before the Lab* complete this page YOURSELF! Hand it in *in the first 5 min*. of the session PERSONALLY!**

You MUST justify your answers and show all steps. NO COPYCAT answers, or NO credits!

Please read the relevant presentation on PHYS LAB Website.

Q1. In your OWN WORDS, give a definition of μ_o in ONE SENTENCE!

Q2. Explain its meaning **in your OWN WORDS**! Why do we need μ_o?

(3rd Question is on the next page!)

Q3. Show the dimensional Analysis for μ_o. **Show your formulae / derivation below <u>explicitly or no credits</u>!**

Q4. What are the **relative** current directions in the wires in this experiment and how can you conclude this? How would you change the procedure or modify the setup if the relative directions were **otherway around**? *(Hint: Have a look at the paralel plate experiment! Do not offer to revert the current directions!)*

1

Lab Report

Lab section:

Name & Surname:

Table #:

***Complete this report YOURSELF except DATA taking parts! Use a pencil for plots only and a pen for the rest!* Show your work clearly, NO COPYCAT analysis allowed, or NO credits!**

OBJECTIVE : To measure the force between parallel, current carrying conductors and to analyze the dependence of this force on the constants of the system.

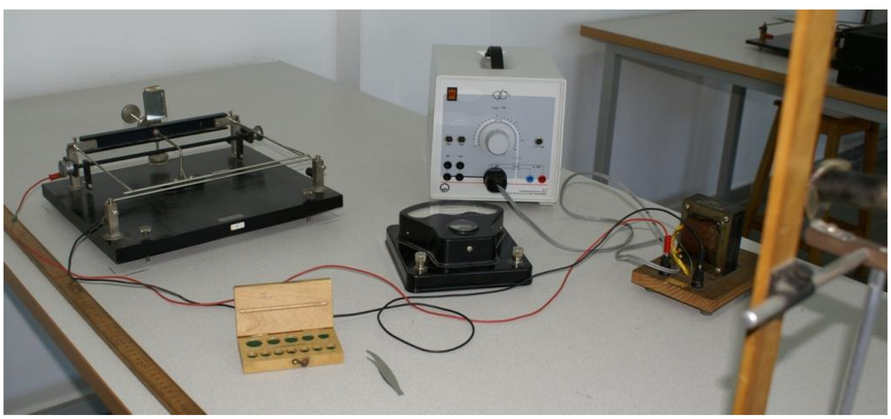
THEORY : Force between the current carrying wires is given as:

$$F = \frac{\mu_o}{2\pi}\frac{L}{d}I_1 I_2$$

and if the same current is passing through the wires as:

$$F = \frac{\mu_o}{2\pi}\frac{L}{d}I^2$$

where *L* is the length of the wires and *d* is the separation between the parallel wires. By measuring the force between current carrying parallel wires as a function of the current passing through them, we can determine the permeability of air. When the force values are plotted as a function of the squares of the corresponding current values, the straight line that fits the data best will have a slope that includes the permeability constant. From the slope of the straight line we can calculate the permeability constant as:



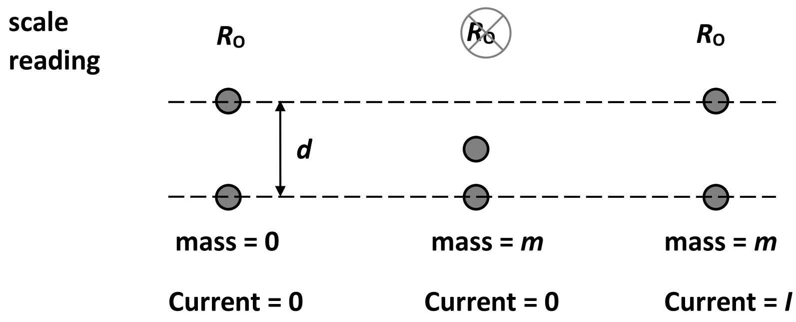
$$\mu_o = \frac{2\pi(slope)d}{L}$$

APPARATUS : Parallel-wires apparatus, laser pointer with a ruler, meter stick, 9-A AC-ammeter, AC power supply with a transformer.

PROCEDURE :

1. Adjust the counterpoise so that the separation between bars, d_o, is about 3 mm. Record the scale reading at equilibrium (R_o).
2. Then the upper bar is depressed until it is in contact with the lower bar, and a new scale reading is noted (R_c). The separation d_o is calculated.
3. To make measurements, add a certain mass to the weight pan, increase the current until the scale reading indicates the initial reading, R_o.
4. Read the ammeter. Plot F_m versus I^2 and determine μ_o.

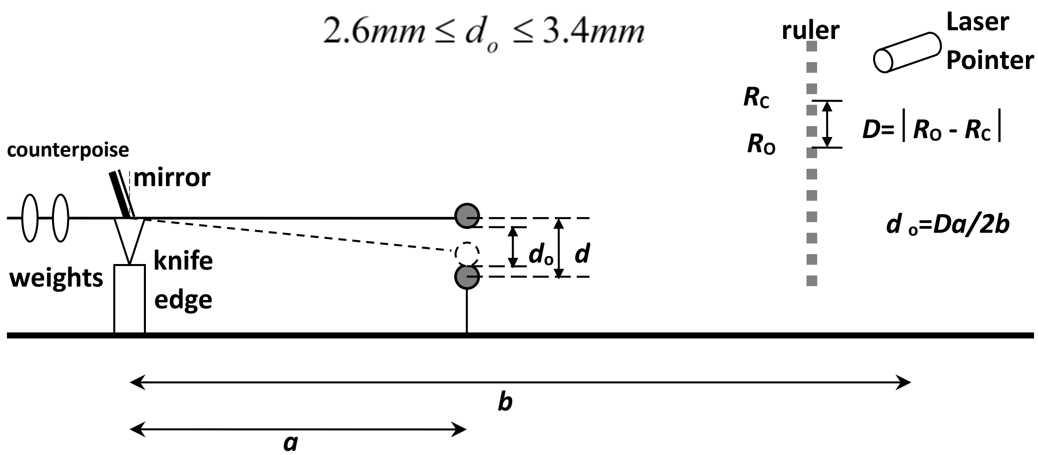
2



$$F_m = kI^2$$

$$k = \frac{\mu_o}{2\pi}\frac{L}{d}$$

$$2.6mm \le d_o \le 3.4mm$$



Theoretical Value of permeability of air:

μ_{oTV}= $4\pi \times 10^{-7}$ N /A^2 All figures significant!

DATA:

Description	Symbol		Value & Unit
Length of the lever arm	*a*	=	....
Distance from the scale with the mirror to the ruler	*b*	=	....

Spring 2024

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Physics Department

Force Between Current Carrying Wires

3

Description	Symbol		Value & Unit
Diameter of the wire	$2r$	=	. . . .
Length of the wire	L	=	. . . .
Reading when the wires are open	R_O	=	. . . .
Reading when the wires are closed	R_C	=	. . . .
Difference in readings	D	=	. . . .
Separation between the wires	d_o	=	. . . .
Separation between the wire centers	d	=	. . . .

Mass ***m* ( )**	**Current** ***I* ( )**	$F_m = m.g = k\,I^2$ **( )**	**Square of the Current** I^2 **( )**

4

Plot F_m versus I^2:

5

A) From the graph, choose two SLOPE POINTS other than data points,

SP_1 : (;)

SP_2 : (;)

RESULTS:

Description		Calculation (show each step)	Result
SLOPE	=	. . . .	. . . .
		. . . .	
$(\mu_o)_{EV}$	=	. . . .	. . . .
		. . . .	
% Error for μ_o	=	. . . .	. . . .
		. . . .	

Consult to the resources for this experiment from PHYS LAB Website:

PHYL201 Intro

Presentation #6

PHYL201 Lab Book

Pre-Lab Report

Lab section:

Name & Surname:

Table #:

***Before the Lab* complete this page YOURSELF! Hand it in *in the first 5 min*. of the session PERSONALLY!**

You MUST justify your answers and show all steps. NO COPYCAT answers, or NO credits!

Please read the relevant presentation on PHYS LAB Website.

Q1. Instead of directly measuring the distance between two parallel plates, explain why we use R open: Ro and R closed: R_C values in the experiment. Should they stay the same while taking data? Why? **Explain in your OWN WORDS!**

Q2. What are the dimensions and unit of the slope when you plot F versus V^2? **Show** dimensional **analysis explicitly**. What is the difference between its dimensions and its unit? **Show your formulae / derivation below explicitly or no credits!**

(3rd Question is on the next page!)

Q3. What are Using the setups of this and the previous experiment (Force Between Current Carrying Wires), can you determine the speed of light? **Justify your answer and give the formulation if it is possible, or no credits!**

1

Lab Report

Lab section:

Name & Surname:

Table #:

***Complete this report YOURSELF except DATA taking parts! Use a pencil for plots only and a pen for the rest!* Show your work clearly, NO COPYCAT analysis allowed, or NO credits!**

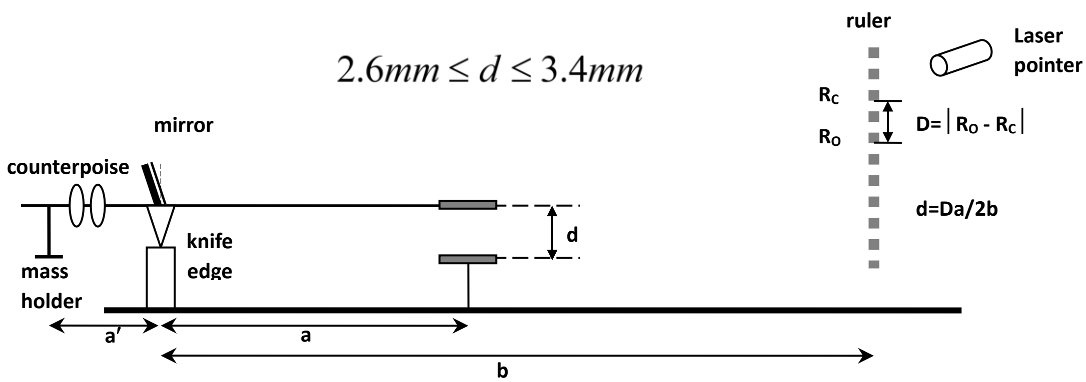
OBJECTIVE : To measure the force between two parallel plates as the voltage across them is varied, and to analyze the dependence of this force on the constants of the system, and to determine the permittivity constant.

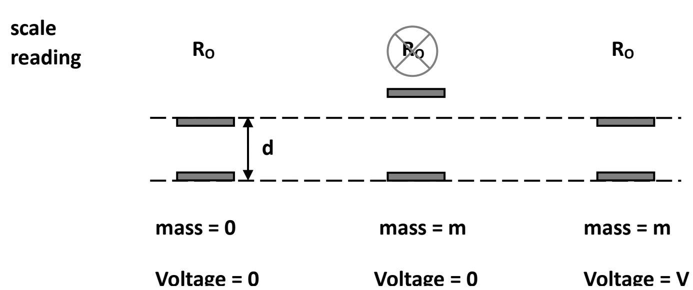
THEORY : The force between two charged plates can be shown as:

$$F = \frac{\varepsilon_o A}{2d^2} V^2$$

where ***A*** is the area of the plates, ***d*** is the separation between the plates and ***V*** is the voltage across them.

APPARATUS : Parallel-wires apparatus, laser pointer with a ruler, meter stick, high voltage power supply.





$$F_e = kV^2$$

$$k = \frac{\varepsilon_o A}{2d^2}$$

2

PROCEDURE :

1. Adjust the counterpoise so that the separation between the plates is about 3 mm.
2. Record the scale reading at equilibrium.
3. Then the upper plate is depressed until it is in contact with the lower plate, and a new scale reading is recorded.
4. The separation *d* is calculated using the expression $d = Da/2b$ where *D* is the difference in the readings on the ruler attached to the laser, *b* is the distance between the knife edge and the laser, and *a* is the distance between the knife edge and the plate center.
5. Add weights to the mass holder and increase the voltage until the original value of the plate separation *d* is recovered.
6. Record the corresponding values of *V* and *m*.
7. Compute the value of F_e for each value of *m*.
8. Plot F_e versus V^2 and find ε_0 from the slope.

Theoretical Value of permitivity of air:

$(\varepsilon_0)_{TV}$ = 8.85×10^{-12} N/V^2 All figures significant!

DATA:

Description	Symbol		Value & Unit
Length of the lever arm	*a*	=	. . . .
Lever arm for the weight	*a′*	=	. . . .
Distance from the mirror scale to the ruler	*b*	=	. . . .

3

Description	Symbol		Value & Unit
Length of the plate	L	=	....
Area of the plate	A	=	....
Reading when the plates are open	R_O	=	....
Reading when the plates are closed	R_C	=	....
Difference in readings	D	=	....
Separation between the plates	d	=	....
			....

Limits for d: 2.6 mm. $\leq d \leq$ 3.4 mm.

Mass m ( )	$F_e = mga'/a = kV^2$ ( )	Potential V ( )	Square of Potential V^2 ( )

4

Plot F_e versus V^2:

5

From the graph, choose two SLOPE POINTS other than data points,

SP_1 : (;)

SP_2 : (;)

RESULTS:

Description	Calculation (show each step)	Result
SLOPE =	. . . .	
	. . . .	
$(\mathcal{E}_o)_{EV}$ =	. . . .	
	. . . .	

% Error for $\mathcal{E}_o$:

Consult to the resources for this experiment from PHYS LAB Website:

PHYL201 Intro **Presentation #7** **PHYL201 Lab Book**