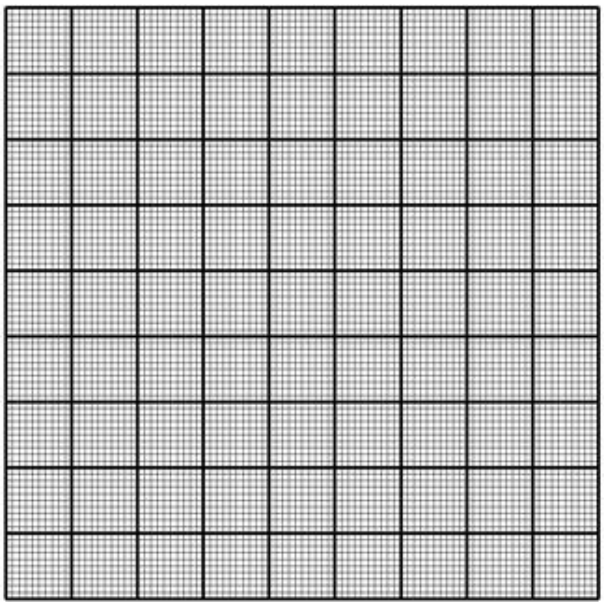
Lab Report

Complete this report YOURSELF except DATA taking parts! This report will not be submitted (except the very last page), but you should carefully complete it as preparation for the applied exam.

Suggested Pre-Lab Questions

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**.**

1



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)

Q2. Explain in your OWN WORDS and in ONE SENTENCE, the meanings of the following.

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.**

a) Frequency of the sine wave.

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b) V_{rms} of the sine wave.

Q4. Starting from Kirchoff's law, derive $t_{1/2} = (\ln 2)RC$ expression. **Show your derivation / formulae explicitly!** (Hint: Solve the differential equation for charge and apply boundary conditions. Do not write the solution of the differential equation directly**)**

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EXPERIMENT :

OBJECTIVE : To learn how to operate a cathode ray oscilloscope and how to use it in studying alternating current (AC) circuits. To observe and measure the effects caused by the growth and decay of currents in a capacitor.

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 manual (normal). There are also dials to adjust the intensity, focus, astigmatism, and panel lighting. The 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 adjust 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. One should refer to the oscilloscope manual for more specific dials.

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:

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

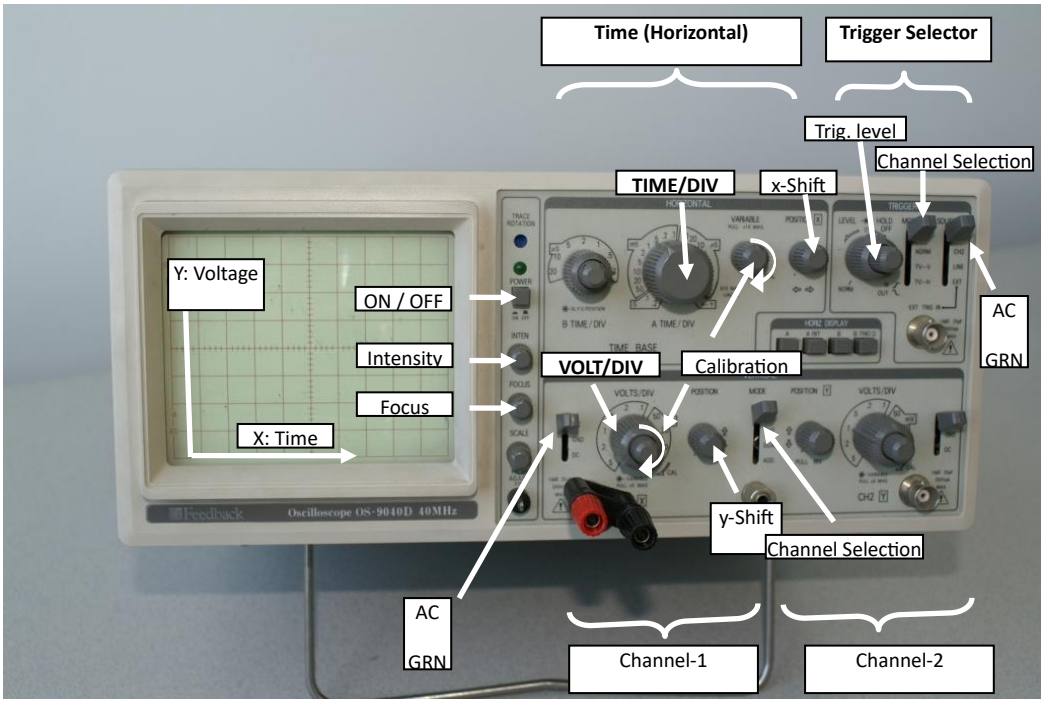
Solution of this first order differential equation depends on the applied waveform. If the applied voltage is constant, then the solution for the charge or the voltage on the capacitor is a function that increases exponentially until it reaches the maximum value. On the other hand if we apply a

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."

APPARATUS : Two-channel oscilloscope and an oscillator i.e. Signal Wave Generator (SWG), resistance and capacitor boxes, cables.



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

PROCEDURE :

PROCEDURE – Part 1

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 given value in order to produce a sine wave. To measure the frequency of the oscillator, set the TIME/DIV sweep dial to a number of values. You may also need to play with VOLT/DIV sweep.
3. You should observe at least 3, at most 8 full waves on the screen. Measure the distance between leftmost and rightmost upper peaks.
4. Count the number of waves between the leftmost and rightmost upper peaks, then calculate the length of one wave.
5. Calculate period and the corresponding frequency.
6. Compare the calculated frequency with the frequency given on oscilloscope.
7. Fill in the tables for two different frequency values. .

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PROCEDURE – Part 2

1. Use 3000 Ω for R and 0.1 μF for C. Connect the circuit.
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, set the frequency calculated in the previous step on oscillator (SWG).
4. Adjust the controls for optimum focus, stability and trigger action.
5. From the observed pattern on the oscilloscope screen, measure $t_{1/2}$.
6. Convert $t_{1/2}$ (cm) to $t_{1/2}$ (sec). Compare the true value of half-life and the experimental result.

PART-1a

***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*:

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

PART-1b

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***Set SWG to* 20 kHz.**	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-1}	

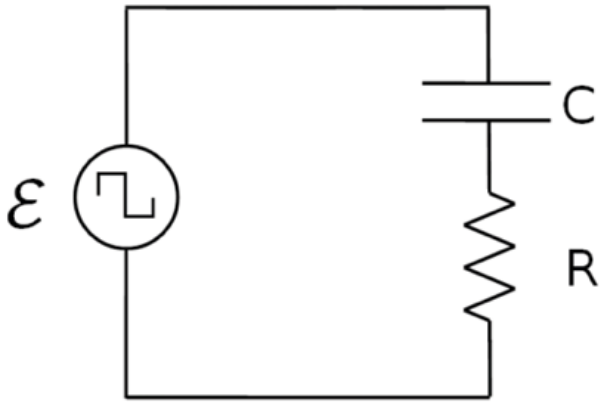
2nd Reading	[TIME / DIV]$_2$	
	L_2	
	# of waves$_2$ in L_2	
	Length of the wave, λ_2	
	Period, T_2	
	Frequency, $f_{EV\text{-}2}$	
	$f_{EV} = (f_{EV\text{-}1} + f_{EV\text{-}2})/2$	

Error for f:

***SWG* set to 20 kHz Hz**	
VOLTAGE MEASUREMENT	
[VOLT / DIV]	
V_{pp} (div)	
V_{pp} (Volt)	
$V_{max} = V_{pp} / 2$	
$V_{rms} = V_{max} / \sqrt{2}$	

PART-2: DISCHARGING CHARACTERISTICS of a CAPACITOR

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!

CALCULATIONS

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

RESULT

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

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

Suggested Post-Lab Question

Q1. 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 justify your answer!**

Post-Lab Report

Aim of the experiment:

Suggestions for possible solutions to the problems experienced during the experiment:

Conclusion:

13 I have completed this experiment myself as specified in the lab sheet and as explained by the lab instructor.

Name & Surname:

Student ID:

Lab Section:

Table #:

Date:

Signature of the student

As the instructor of this Lab Section I confirm that the student has participated in and completed this experiment on time.

Stamp of the PHYS Labs and signature of the instructor

This page serves as proof of the fact that the student participated in and completed the experiment, only if it is submitted in time and accepted by the Lab instructor. The student and the instructor shall sign it along with the stamp of the Physics Laboratories.