EXP.1: Emprical Equations – Part 1

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.

Experiment

OBJECTIVE : To study a nonlinear phenomenon and determine the parameters related to the motion through a linear representation.

THEORY : Physics laws are based on experiments. We may obtain some relationships starting from the first principles or established physics laws through physical and mathematical reasoning. These relationships are accepted as valid laws if they are shown to be valid by all sorts of experiments. However, in some cases we may not know the underlying physical principle. We may have only our observation of the phenomenon. From the observation we may try to develop a relationship between the quantities that are being measured. Of course, if there are more than two quantities involved, we should set all the quantities to a constant value except two of them and then measure one of these two by varying the value of the other quantity.

For example, in the periodic motion of metal rings placed on a knife edge fixed on the wall, there are several quantities; the radius, thickness of the rings, and the period of the oscillations are some of the quantities that we can think of. If we want to determine the relationship between the radius and the period of the oscillations, we should have rings made of the same material and thickness. Then we should let the rings oscillate and measure the period as a function of the radius, making sure that the initial amplitudes are the same. Once we obtain the data, we can try different relationships between the period and the radius; linear, quadratic, cubic, etc. However, this would be a time-consuming process. Instead we assume that the relationship is in the form of $T = ar^n$, which is not linear. By taking the logarithm (base-10) of both sides, we get $\log T = \log a + n \log r$. This is a linear expression whose slope and y-intercept can be easily obtained through graphical analysis. We can either plot the data on a log-log graph paper or the logarithm of the values on a regular graph paper. Then we can determine the exponent n from the slope of the straight line.

Establishing physics laws in this way produces expressions that are already validated by the experiment. Of course, we should still try to derive the same expression through logical reasoning and starting from the known and well-established physics laws.

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APPARATUS: A set of five metal rings, vernier calipers, stop watch, meter stick

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PROCEDURE : Each one of the five metal rings is suspended successively from a knife edge. The rings are made to oscillate from side to side. The period of oscillations is determined by taking average over at least 10 oscillations. The diameter of each ring is also determined. After obtaining the data, you should plot them on a log-log graph paper. Determine the slope and intercept from the plot.

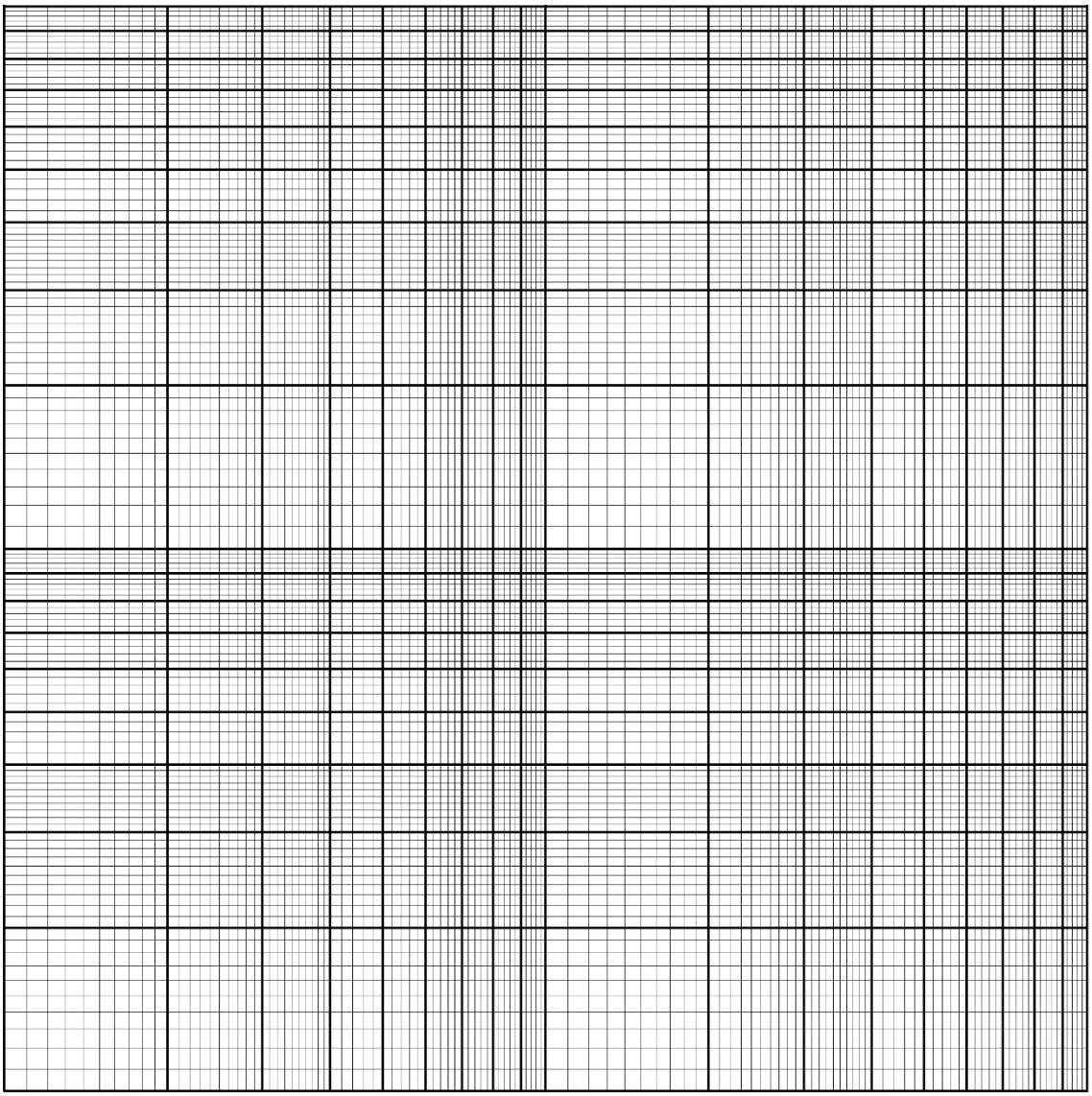
DATA-TAKING

Description	**Symbol (unit)**	**RING NUMBER**				
		- 1 -	**- 2 -**	**- 3 -**	**- 4 -**	**- 5 -**
Inner Diameter	D_i ( )					
Outer Diameter	D_o ( )					
10 Periods	t ( )					

CALCULATIONS

Description	**Symbol (unit)**	**RING NUMBER**				
		- 1 -	**- 2 -**	**- 3 -**	**- 4 -**	**- 5 -**
Diameter	D ( )					
One Period	T ( )					

Use **D** & **T** data set:



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

SP_1 : (;)

SP_2 : (;)

B) **Calculate "*n*" using SP_1 and SP_2** (*Show your calculations clearly)*

n = ...

. . . . . .

C) **By reading the *y*-intercept of the line from the graph, determine *A*,**

(*Show your calculations clearly)*

Intercept **=** . . . . . .

. . . . . .

A **=** . . . . . .

. . . . . .

D **(for T=1 sec)** **=** . . . . . .

. . . . . .

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RESULTS

Express the results and their dimensions below:

Symbol		Result	Dimension
n	**=**	. . . . .	. . . . .
A	**=**	. . . . .	. . . . .

Suggested Post-Lab Questions

Q1. Linearize the equation $T = A R^n$. When you plot the linearized form, what does n correspond to? What is the y-intercept? Explain!

Q2. Can we use this set of rings in the experiment to determine gravitational acceleration? If yes, explain how! (Do not suggest free fall, use the procedure in the experiment.)

In the next experiment, which is an applied exam, you will have the same setup and the same experiment, however you will plot on a linear paper, instead of the logarithmic one.

Post-Lab Report

Aim of the experiment:

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

Conclusion:

7 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.