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. Equation of motion for the system in this experiment is

$\frac{d^2x}{dt^2} + \omega^2 x = \frac{m_0}{m_{tot}} g$ where $\omega^2 = \frac{k}{m_{tot}}$. Show that $x(t) = \frac{m_0 g}{k} - A\cos(\omega t + \delta)$ satisfies this equation. Derive the velocity v(t) and acceleration a(t) from x(t). **Show your calculations below explicitly or no credits!**

(2nd Question is on the next page!)

Q2. What would be the amplitude of the simple harmonic motion be if the mass on the hanger were doubled? **Justify your answers, show calculations if needed or no credits!**

Q3. Calculate the acceleration of the car at time t=T/4 where T is the period of the motion. **Show your calculations, if any necessary, <u>explicitly and justify your answer, or no credits</u>!**

1

Lab Report

Lab section:

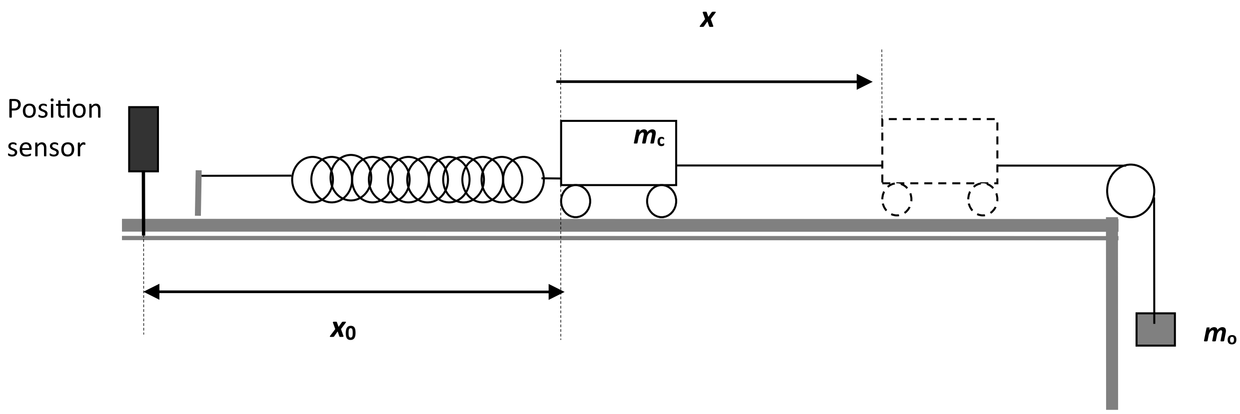
Name & Surname:

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 investigate the resultant of two forces, one constant, the other depending on displacement from equilibrium (restoring force).

THEORY :



The system shown in the figure will be exhibiting a periodic motion due to the variable restoring force in the spring. If we write the equation of motion:

$$\frac{d^2x}{dt^2} + \omega^2 x = \frac{m_o}{m_{total}} g$$

$$m_{total} = m_c + m_o$$

then, the solution of this equation will be:

$$x(t) = \frac{m_o g}{k} - ACos(\omega t + \delta)$$

whose period of oscillation is given by

$$\omega^2 = \frac{k}{m_{total}}.$$

Derivative of the position with respect to time will yield the velocity as a function of time and the second derivative will give us the acceleration:

$$v(t) = A\omega Sin(\omega t + \delta)$$

$$a(t) = A\omega^2 Cos(\omega t + \delta)$$

Notice that when the magnitude of the velocity reaches its maximum the acceleration becomes zero and vice versa.

APPARATUS: Car and track system, position sensor, data logger, spring, hanger and mass set.

3

PROCEDURE :

1. Disconnect car from the spring and compensate for friction.
2. Fix the spring to the car; locate the point where no force is acting on the car, keeping the car stationary, and place mass ***m*** on the holder.
3. Place the position sensor at least 30 cm away from the car. Start the data logger at the desired rate (suggested value is 10 per second) and let the car go. The car first accelerates ($mg > kx$), attains its maximum velocity where $mg = kx$, then decelerates ($mg < kx$) and finally stops to come back.
4. Using the data in the data logger's memory, calculate the average velocity for each interval.
5. **Plot** the **average velocity versus time** and **the total displacement versus time** curves.
6. From the velocity versus time graph, determine the maximum velocity which corresponds to zero acceleration and the corresponding time *t* and the period.
7. From the displacement versus time graph, determine the maximum displacement x_{eq}
8. Calculate other system parameters.

DATA

Description / Symbol **Value & Unit**

Mass on the holder m= . . . .

Initial distance

of the Car x_0 = ...

Number of the

Cylinders in the Car = ...

Data Taking

Rate = ...

4

DATA

Number of Intervals	t ( )	x ( )	Δx ( )	$v_{ave} = \Delta x / \Delta t$ ( )

5

6

READ FROM THE GRAPHS:

Description	Symbol	Value & Unit
Maximum velocity	v_{max} =	. . . .
Time Corresponding to to the max. Velocity	t =	. . . .
Equilibrium Displacement	$x_{eq.}$ =	. . . .

CALCULATIONS and RESULT:

Description / Symbol	Calculations (show each step)	Result	Dimension
Spring Constant k =	. . . .	. . . .	. . . .
	. . . .		
Period of Oscillation T =	. . . .	. . . .	. . . .
	. . . .		
Frequency of Oscillation ω =	. . . .	. . . .	. . . .
	. . . .		

7

Description / Symbol		Calculations (Show each step)	Result	Dimension
System Parameter	A =	....	....	....
		....		
Maximum Displacement	x_{max} =	....	....	....
		....		
Maximum Acceleration	a_{max} =	....	....	....
		....		
Total Mass	m_{total} =	....	....	....
		....		
Mass of the Car	m_{car} =	....	....	....
		....		

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

PHYL102 Intro **Presentation #4** **PHYL102 Lab Book**