EXPERIMENT 1

SIMPLE HARMONIC MOTION

John Q. Student

January 1, 2013

Lab Partners:

Galileo Galilei
Isaac Newton
Michael Faraday
Albert Einstein

DATA SHEET
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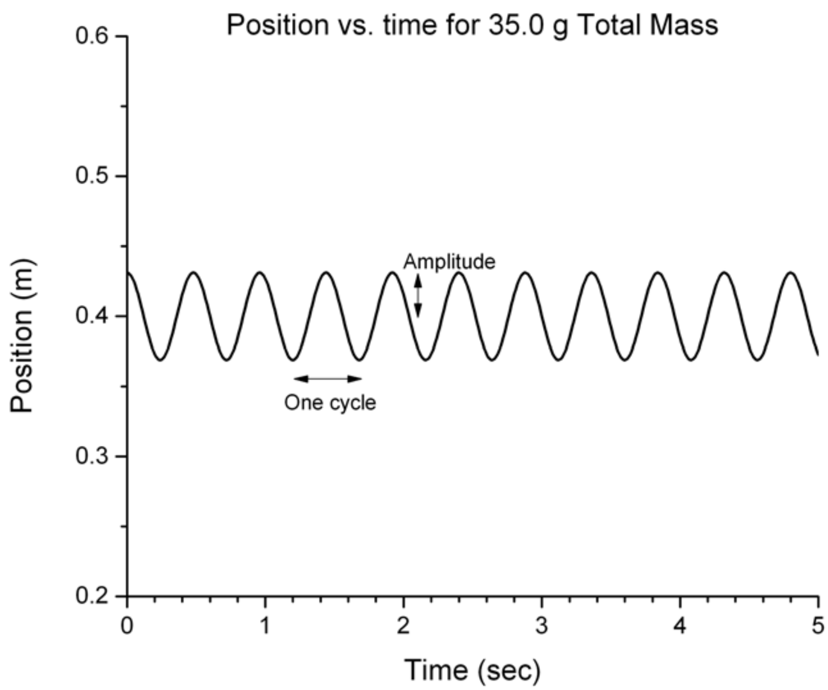
PROCEDURE 1.

3.



4. Peak positions were found to be at 6.1 cm and 2.0 cm. The amplitude of the motion is therefore 6.1 – 2.0 = 3.1 cm

Adjacent peaks were found to be at times 3.025 sec and 3.500 sec. The period of the motion is therefore 3.500 – 3.025 = 0.475 sec.

PROCEDURE 2.

1. Period and Amplitude.

Initial displacement (cm)	t_1 (sec)	t_2 (sec)	Period (sec)
2.0	2.025	2.504	0.479
4.0	3.124	3.619	0.495
8.0	1.248	1.726	0.478

c) There does not seem to be any relationship between period and amplitude. This indicates simple harmonic motion, since independence of the period from the amplitude is what distinguishes simple harmonic motion from other types of harmonic motion.

2. Period and Mass.

Mass (g)	t_1 (sec)	t_2 (sec)	Period (sec)
35.0	1.814	2.290	0.476
45.0	3.116	3.705	0.589
55.0	2.150	2.755	0.605
70.0	1.217	1.889	0.672

c) As the mass is increased, the period of the motion increases. When the mass was doubled (from 35.0 g to 70.0 g), the period did not double; rather it increased by a factor of $0.672/0.476 = 1.41 \approx \sqrt{2}$, which suggests that the period is proportional to $\sqrt{m}$.

PROCEDURE 3.

1. The original equilibrium position is x = 0.315 m

2.

Added mass Δm (g)	Weight Δmg (N)	New position. (m)	Displacement Δx (m)	Spring const. (N/m)
20.0	0.196	0.350	0.035	5.60
30.0	0.294	0.367	0.052	5.65
40.0	0.392	0.377	0.062	6.32

5. From the last column, the average value of the spring constant is found to be 5.86 N/m.

ANALYSIS

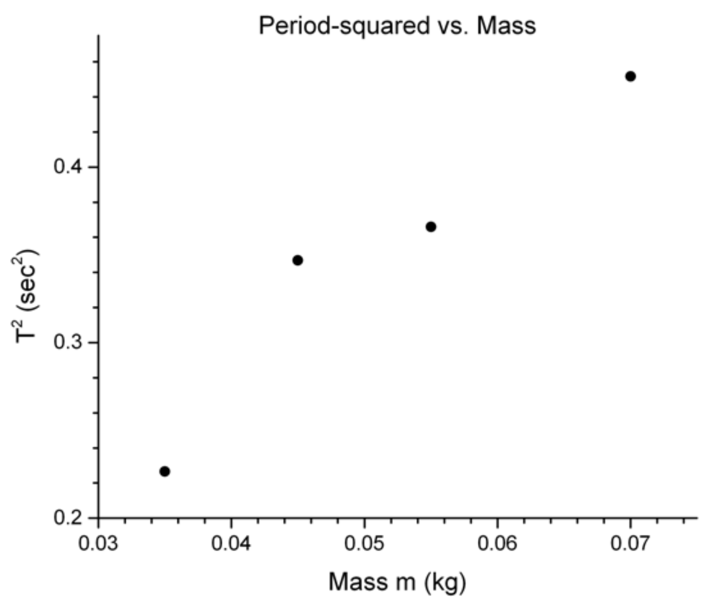
1. a) The period *T* squared as a function of mass *m* is

$$T^2 = 4\pi^2 \frac{m}{k}$$

which is the equation of a straight line with slope $4\pi^2/k$. Using the average measured spring constant k=5.86 N/m, we find a predicted slope of $4\pi^2/(5.86 \text{ N/m}) = 6.74 \text{ sec}^2/\text{kg}$.

b) No, I would *not* expect a plot of T vs. m to show a linear relationship, since the theoretical equation predicts T is proportional to $\sqrt{m}$.

c)



The transformed data *does* show a linear plot, as predicted from the equation in part (a) above: T^2 should be proportional to *m*.

d) A linear regression analysis of T^2 vs. m (with *T* in sec and *m* in kg) gives:

Slope:	5.97 sec^2/kg
y-intercept:	0.042 sec^2
r:	0.9605

An explicit function for T^2 as a function of *m* is then

$$T^2 = 5.97\ m + 0.042$$

where *m* is in kg and *T* is in seconds.

e) The experimental slope (part d) and predicted slope (part a) compare fairly well, with a percent difference of $(6.74-5.97)/(6.74)\times 100\% = 11\%$

2. To double the period of the oscillator, one would need to quadruple the mass, since the period is proportional to the square root of the mass.

3. To double the period of the oscillator, one would need to choose a spring whose spring constant is $\frac{1}{4}$ that of the original spring, since the period is inversely proportional to the square root of the spring constant.