ONE MASS MOVEMENT BETWEEN TWO SPRINGS

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QUESTION

WHEN MASS IS ATTACHED BETWEEN TWO SPRINGS AND DISPLACED AND ALLOWED TO OSCILLATE, IS THE ENERGY CONSERVED AND WHAT KIND OF MOTION DOES IT PRACTICE?

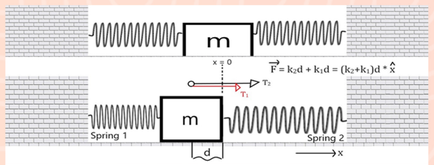
HYPOTHESIS

SINCE THE FRICTION IS CONSIDERED TO BE THEORETICALLY ZERO, THERE IS NO ENERGY LOST DURING THE MOVEMENT OF MASS.

HENCE, THE ENERGY IS CONSERVED BETWEEN THE OSCILLATIONS OF THE MASS AND IT OSCILLATES BY SIMPLE HARMONIC MOTION BETWEEN THE TWO SPRINGS.

ALSO, THE ANGULAR FREQUENCY OF THE MASS' OSCILLATION REMAINS CONSTANT THROUGHOUT ITS MOTION.

PROJECT OVERVIEW



- A CONSTANT MASS WILL BE DISPLACED A DISTANCE X AND ALLOWED TO OSCILLATE BETWEEN THE TWO SPRINGS
- THE TIME TAKEN FOR EACH OSCILLATION WILL BE RECORDED ALONG WITH THE X
- THE OBJECT'S ANGULAR FREQUENCY WILL BE CALCULATED FOR EACH ONE OF ITS OSCILLATIONS BY

$$X_t = d\cos(\omega t + a)$$
$$\omega = \cos^{-1}(x_t/d)/t$$

- THEN ANGULAR FREQUENCY WILL BE PLOTTED AGAINST TIME TO SEE IF ENERGY IS CONSERVED (SIMPLE HARMONIC MOTION PRACTICED)
- THE PROCESS WILL BE REPEATED FOR THREE DIFFERENT COMBINATIONS OF SPRINGS.

VARIABLES

CONTROLLED:
MASS OF THE OBJECT M, SPRINGS' CONSTANT

INDEPENDENT VARIABLES:
ARRANGEMENT OF SPRINGS

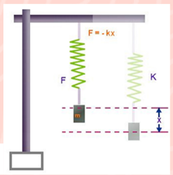
DEPENDENT VARIABLES:
ANGULAR FREQUENCY ω

MATERIALS

- A MASS M (0.420 KG)
- SPRING 1 WITH SPRING CONSTANT K_1
- SPRING 2 WITH SPRING CONSTANT K_2
- AIR TABLE
- VIDEO CAMERA, RULER

PROCEDURE

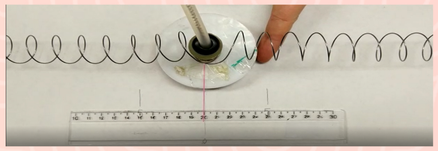
- FIRST THE SPRING CONSTANTS OF THE TWO SPRINGS WILL BE CALCULATED BY HANGING A MASS FROM THE SPRINGS AND RECORDING THE CHANGE OF SPRING LENGTH & $F = k\Delta x \Leftrightarrow k = mg/\Delta x$



-AFTER THAT, TWO SPRINGS WITH EQUAL SPRING CONSTANTS WILL BE BOUND TO TWO SIDES OF THE MASS M AND THE MASS WILL BE STRETCHED TO ONE SIDE AND SET IN MOTION.

-VIDEO WILL BE RECORDED AND THEN TIME PERIOD WILL BE CALCULATED FOR EACH OSCILLATION.

-THE PROCESS WILL BE REPEATED FOR TWO *SPRINGS 1*, TWO *SPRING 2* AND THEN *SPRING 1 WITH SPRING 2.*



-ANGULAR FREQUENCY VALUES WILL BE CALCULATED, PLOTTED AND COMPARED WITH THEORETICAL VALUES OF Ω

DATA/ OBSERVATIONS

Mass M = 0.426 kg
Spring constant k_1 = 0.11
Spring constant k_2 = 0.20

It was observed that the values of ω remained fairly constant but decreased overtime due to effects of friction

Table1: Spring 1 on both sides

x_t (m) x10^{-2}	t (s)	Δt (s)	ω (rads^{-1})
6.5	0	0	0
-6.3	0.51	0.51	0.48
6.0	0.92	0.41	0.43
-5.8	1.32	0.40	0.36
5.4	1.75	0.43	0.34
-4.9	2.29	0.54	0.32
4.5	2.80	0.51	0.29

Since the value varies, average values of ω are taken as obtained ω values.

Experiment 1: ω_1 = 0.37
Experiment 2: ω_2 = 0.71
Experiment 3: ω_3 = 1.13

Now, to compare these value with theoritical values, the formula:

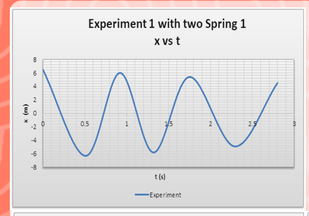
$$\omega = \sqrt{\frac{k_1 + k_2}{m}}$$

is used and theoritical value are:

Experiment 1: ω_1 = 0.51
Experiment 2: ω_2 = 0.92
Experiment 3: ω_3 = 0.85

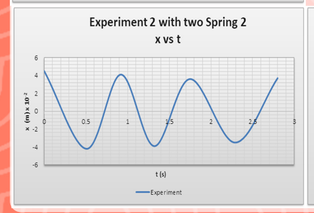
So, percentage errors are: 37.8%, 26.2% and 34.1% respectively.

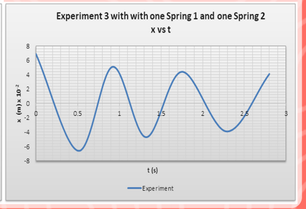
GRAPHS

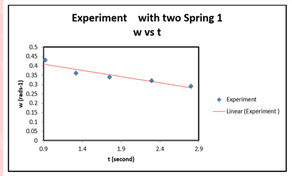


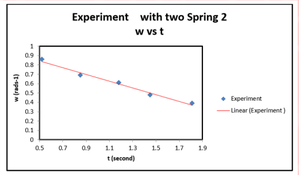
THESE GRAPHS PRESENT THE DISPLACEMENT OF MASS M FROM THE REFERENCE POSITION WITH RESPECT TO TIME.

ESSENTIAL GRAPHS TO IDENTIFY THE SIMPLE HARMONIC MOTION AND TO KNOW THE CONSISTENCY IN AMPLITUDE OF MASS' MOTION



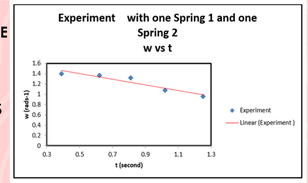






THESE GRAPHS DEMONSTRATE THE RELATIONSHIP OF ω WITH RESPECT TO THE TIME ELAPSED SINCE START OF EXPERIMENT.

IT SHOWS THAT THE VALUE OF ω DECREASES LINEARLY DUE TO THE EFFECTS OF RESISTANCE AND IMPLIES THAT THEORETICALLY, IT SHOULD REMAIN CONSTANT THROUGHOUT MOTION.



CONCLUSION

AS DEMONSTRATED BY THE DISPLACEMENT-TIME GRAPHS, THE OBJECT OBSERVES SIMPLE HARMONIC MOTION AND IF THE EFFECT OF FRICTION/ OTHER CAUSES OF ERROR ARE NEGLECTED, ENERGY IS CONSERVED DURING THE EXPERIMENT. ENERGY CONVERTS FROM ELASTIC POTENTIAL ENERGY IN ONE SPRING TO KINETIC ENERGY OF MASS AND BACK.

IT IS ALSO IMPLIED THAT THE SPRING CONSTANT OF THE SPRING HAS AN EFFECT ON THE ANGULAR FREQUENCY AS WELL AS IT IS INVERSELY PROPORTIONAL.

FINALLY, IF THE EFFECT OF EXTERNAL FACTORS LIKE FRICTION IS NEGLECTED, THE PLACEMENT OF SPRINGS/ TYPE OF SPRINGS HAS NO EFFECT ON THE TYPE OF MOTION OF OBJECT AS IT STILL OBSERVES SIMPLE HARMONIC MOTION.

HENCE, ENERGY IS CONSERVED AND SIMPLE HARMONIC MOTION IS OBSERVED (as expected)

REFERENCES

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