Key: Yellow highlight = required component

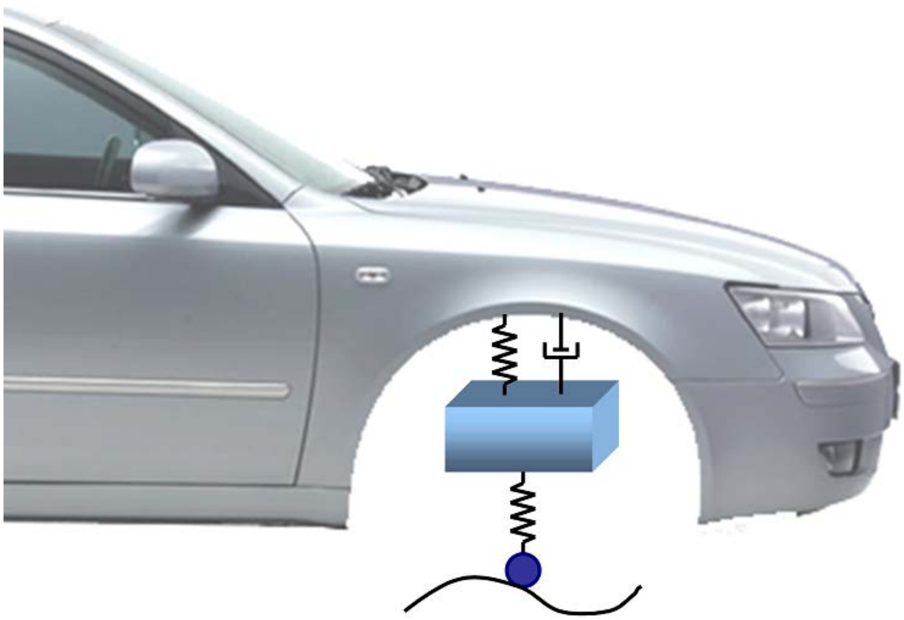
Blank Activity Template (←put your title here!)

Subject Area(s) Physics

Associated Unit **Mechanics**

Associated Lesson **Simple Harmonic Motion**

Activity Title **Understanding Simple Harmonic Motion in Oscillating Systems**



Header

Image 1 **Image file:** ___? **ADA Description:** Cartoon illustrating the car suspension system **Source/Rights:** Copyright © http://www.intechopen.com/source/html/17687/media/image47.png **Caption:** Relating the mass-spring system to the car suspension system

Grade Level 12 (11-12)

Activity Dependency

Time Required **40 minutes**

Group Size 2

Expendable Cost per Group US $ 0

Summary

In this activity, students are familiarized with the main concepts of simple harmonic motion. They will experiment with an oscillating system, namely, the mass-spring system and decide

whether it exhibits simple harmonic motion. Finally, they will learn to identify simple harmonic motion in other oscillating systems through simple observations.

Engineering Connection

Oscillating systems and simple harmonic motion play an important role in engineering systems. In mechanical engineering, cars can be viewed as mass-spring oscillating systems. In civil engineering, bridges and buildings can be considered as oscillating systems. In fact, proper engineering design requires a understanding of oscillating systems and harmonic motion.

Engineering Category =

Choose the category that best describes this activity's amount/depth of engineering content:

1. Engineering analysis or partial design

Keywords

Oscillating systems, mass-spring, pendulum, simple harmonic motion,

Educational Standards (List 2-4)

State STEM Standard (required)

Texas: Science [2010] Physics (Grades 9 - 12) Science concepts. The student knows and applies the laws governing motion in a variety of situations.

ITEEA Standard (required)

International Technology and Engineering Educators Association: Technology [2000]

The Nature of Technology (Grades K - 12) Standard 2. Students will develop an understanding of the core concepts of technology.

NGSS Standard (strongly recommended)

CCSS Standard (strongly recommended)

Pre-Requisite Knowledge

Learning Objectives

After this activity, students should be able to:

- Understand simple harmonic motion and Hooke's law
- Calculate an unknown spring constant
- Verify the correctness of the expression for the effective mass of the system

Materials List

Each group needs:

- Lab Stand
- Set of masses
- A timer or stop watch
- Two springs of differing stiffness
- Meter stick

Introduction / Motivation

Start by talking about oscillations. Define oscillatory motion as a type of motion that repeats itself. Give examples of oscillatory motion and systems in engineering. For instance, the car suspension is an oscillatory system. A boat floating in the water is an oscillatory phenomenon.

Show a video or a picture of the Tacoma Narrows Bridge disaster to illustrate the importance of understanding oscillatory and harmonic phenomena.

Vocabulary / Definitions

Word	Definition

Procedure

Background

In the associated lesson "Simple Harmonic Motion", students learned the concepts of simple harmonic motion and worked on problems related to mass-spring systems. Thus, students should have already completed their worksheets and should be familiar with Hooke's law and period/frequency equations.

Before the Activity

-

With the Students

- Attach the first spring to the lab stand.
- Measure the distance from the top of the lab stand top to the end of the spring, and record this position. This is called the rest position.
- Place a 10g mass at the end of the spring. Check if this mass moves the spring about 1 centimeter, and measure the distance from the top to the end of the spring again. Record this distance in second column of the data table. If the spring does not stretches less than 0.5 cm use more mass instead (20g masses for examples).
- Pull the spring down and let it oscillate.
- Measure the time for the mass to oscillate thirty cycles. Start the timer when the mass reaches the very bottom, and count cycles by the mass returning to that same position.
- Continue adding masses in 10g (20g) increments to the spring until you have a total of 100g (200g) on the spring. Measure the distance at each new amount of mass.
- Once finished, use the second spring and repeat the experiment. Now you should have two data tables each with 10 distances, periods and masses.

Attachments

shm_lab_sheet.doc

Safety Issues

-

Troubleshooting Tips

Investigating Questions

Assessment

Activity Embedded Assessment

Descriptive Title: Fill up the attached lab sheet

Activity Extensions

Activity Scaling

- For lower grades, ___?
- For higher grades, ___?

Additional Multimedia Support

References

Other

Redirect URL

Contributors

Amin Merouane, Roberto Dimaliwat

Supporting Program

University of Houston, National Science Foundation GK-12 program

Acknowledgements

Classroom Testing Information

This lesson was conducted in 11/19/2013 in with AP-Physics students Westfield high-school, Spring, TX

Understanding Simple Harmonic Motion in Oscillating Systems: Lab Sheet

Name:

Score:

Hooke's Law:

1. Determine the Weight of the mass using: $F = m\,g$, use $g = 10\ m/s^2$

2. Determine the elongation of the spring by subtracting the Distance from the table to the spring from the Rest Position of the spring.

3. Calculate the spring constant using: $k = F/x$

4. Calculate the spring constant using: $k = 4\,\pi^2\ m/T^2$

5. Calculate the potential energy stored in the spring using: $PE = 1/2\,k\,x^2$

6. Determine the average spring constant for each of the springs using previously calculated values from the displacement and the period, comment on the differences if any.

Spring 1:

Rest Position:

Trial	Mass	Displacement	Period	Weight	Elongation	Spring Constant (k) From Displacement	Spring Constant (k) From Period	Potential Energy
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								

Average spring constant from displacement:

Average spring constant from period:

Spring 2:

Rest Position:

Trial	Mass	Displacement	Period	Weight	Elongation	Spring Constant (k) From Displacement	Spring Constant (k) From Period	Potential Energy
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								

Average spring constant from displacement:

Average spring constant from period: