Spring Mechanics

Presenter(s) Viviana Risca, Frank Cleary, Lara Collazo, Jean-Michel Mongeau (made materials)

Grade Level 7 **Standards Connection(s)** Physics, Biology, Applying concepts of math functions to real problems, The Scientific Method.

Abstract:
Our presentation group includes students from the Fletcher and Full labs at UC Berkeley. Because our research deals with how objects and materials in nature respond to forces, the concept of a spring is at the heart of what we do. In the classroom, we will explore how springs work starting with a simple question: how does the length of a spring change when we push or pull on it with weights? We will then do simple experiments to understand how combinations of springs work together and talk about how our observations apply to springs found in the natural world and in engineered systems (yes, that includes robots!). In the last third of the class, we will watch videos of spring-based engineering in action.

Vocabulary/Definitions:
force *– a push or pull;*
weight *– a force toward the center of the Earth that is felt by all objects on or near Earth;*
mass *– something that feels weight;*
spring *– an object that changes length in response to a force (and regains its original shape when the force is removed). Springs have a simple relationship between length and force.*
spring constant *– the amount of force needed to stretch a spring a certain distance, in Newtons/meter.*
uw *– unit of weight, a made-up unit we will use to measure weight in our experiment to make the math easier.*

Materials:
We will bring 9 compression spring setups and weights for each.
We ask the school to copy the enclosed handout.
Students should have metric rulers marked down to the millimeter level, calculators, and pens or pencils

Classroom Set-up:
Tables in 7 grouped areas, each area with 3 experiment stations and one station where students will discuss/write results. There is enough activity to easily keep 4 students busy at each area.

We need a projector set up to show PowerPoint (we will have video embedded). We would prefer to hook up our own laptop to the projector to ensure that the videos work.

Classroom Visit

1. Personal Introduction: _____5___ Minutes
We will introduce ourselves and briefly describe what we do in lab and how it connects to springs.

Topic Introduction: ______8_____ Minutes
Show movies of spring-like motion and how it relates to animal movement. Ask students to give examples of springs in real life. Give out "mystery objects" and tell the students to think about what they might be throughout the lesson.

Define force, spring, spring constant.

2. Learning Experience(s): ______20____ Minutes

Session A: 10 minutes

With volunteers at the board, calculate spring constant for two stretch bands using dummbell weights. Using this demo, show (a) Hooke's law formula, and (b) that different springs can have different spring constants. Demonstrate compression spring setup at the board. Define parallel and series setups.

Session B: 5 minutes

Students measure spring constant for one spring at their stations.

Session C: 5 minutes

What happens when you combine springs in parallel and series? Students come up with experiments and do them to figure out what happens to effective spring constant when springs are combined in the two ways. They write their initial guesses, methods and findings on the worksheet.

3. Wrap-up: Sharing Experiences and Building Connections ______10____ Minutes

(1) *Discuss (a) the students' hypotheses, (b) how they tested them – survey of methods used by the different groups, (c) what they found as a result of their experiment.*
(2) *Discuss thought questions in the worksheets and connect to college physics problems (what we did was quite advanced!).*
(3) Show movie of springy-leg robot (mystery objects revealed!) and of springy prosthetics for athletes (~ 1.5 minutes long each).

4. Close: ______7_____ Minutes.

Q&A about research and grad student life with the students. Make sure stations are re-set. Say goodbye to the students and tell them how to contact us if they have more science questions. Teacher should have this lesson plan with our lab websites.

TOTAL __50_ Minutes

Follow-up – After Presentation

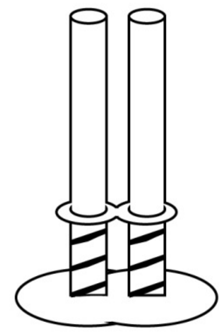
Feel free to email me with any further questions. Viviana, vrisca@berkeley.edu

(Viviana) Fletcher Lab; ***http://fletchlab.berkeley.edu***
(Jean-Michel) Full Lab: ***http://polypedal.berkeley.edu/twiki/bin/view/PolyPEDAL/WebHome***
(Frank) Yildiz Lab: ***http://physics.berkeley.edu/research/yildiz/***
(Lara) Klinman Lab: ***http://www.cchem.berkeley.edu/jukgrp/index.html***

Name: ________________________ Date:_______________________

Part 3:

a. Do you think putting 2 springs **in parallel** (shown below) will increase, decrease or not change the spring constant (k)? Circle your prediction.



INCREASE **NO CHANGE** **DECREASE**

b. Test your prediction and explain how you did it. Show your work below.

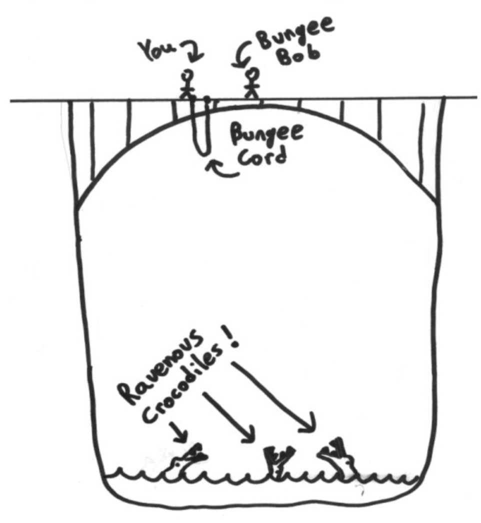
c. Was your hypothesis from part (a) correct?

Bonus questions:

3) What do you think would happen if you put 5 springs in series all on top of each other? Would the spring constant be larger or smaller than with just one spring? How many times bigger or smaller is K?

2) Bungee jumping is an activity where people are strapped to bungee cords, which behave similarly to the springs you used today. Participants jump off tall structures, like cranes or bridges, and fall to the ground until the bungee cord pulls them back up.

Imagine you are going bungee jumping off a very tall bridge. Bungee Bob from Bungee Bob's Bungee Adventures says you have to use 2 bungee cords. You can either tie both cords to the bridge, or connect the two cords end to end and only tie one end to the bridge. Which choice would put you closer to the ground? Which one would you choose?



Name: ___________________________ Date:_________________________

Key Equation: Spring constant = Weight / Distance moved

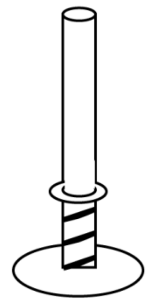
Practice on the board:

Spring	Weight	Original Length	Final Length	Distance Moved	Spring Constant
Spring A	uw	cm	cm	cm	uw/cm
Spring B	uw	cm	cm	cm	uw/cm

Your experiment:

Part 1:
Determine the spring constant of your spring. Try this 3 times and average your values to get a single number.

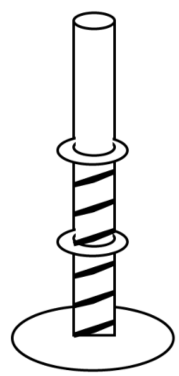
Weight	Original Length	Final Length	Distance Moved	Spring Constant
uw	cm	cm	cm	uw/cm
uw	cm	cm	cm	uw/cm
uw	cm	cm	cm	uw/cm



k_{avge} = _______________ uw/cm

Part 2:
a. Do you think putting 2 springs **in series** (shown below) will increase, decrease or not change the spring constant (k)? Circle your prediction.

INCREASE **NO CHANGE** **DECREASE**



b. Test your prediction and explain how you did it. Show your work below.

c. Was your hypothesis from part (a) correct?

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