IN PERFECT HARMONY

STUDENT WORKBOOK

LAUNCH

ACTIVITY 1

SLOW-MO STRETCH

Have you ever been mesmerized by a metal spring toy or watched one "walk" down the stairs? Let's analyze the motion of a spring in slow motion to see what is really happening.

I SPRING DROP

WHAT YOU NEED:

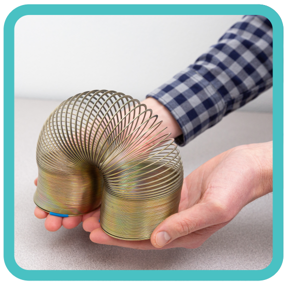
FROM THE KIT:

- Metal spring toy

OTHER ITEMS:

- Smartphone or tablet with video camera

WHAT TO DO:



1. Hold the metal spring toy from both ends, and bounce the coils back and forth to observe the motion. Think about how these coils would move if you dropped the spring from an extended position.

PREDICT:

In this experiment, you will drop the spring from an extended position, as pictured. Do you think the bottom of the spring will fall first, the top of the spring will fall first, or the entire spring will fall at once? Explain your prediction using what you know about forces.

2. Find a place to record the falling spring using your smartphone or tablet. You might want to use a chair or step ladder to extend the spring farther. Make sure the spring falls safely on a protected surface, as the toy is quite heavy.

***Note:** If you do not have a smartphone or tablet with slow-motion video capabilities, visit homesciencetools.com for a link to our slow-motion video. On our website, search for "In Perfect Harmony". Under the "More Information" section, there is a link to the video.*

ACTIVITY 2

THE FORCE RETURNS

In the last activity, you may have expected the spring toy to fall freely to the ground. So, why did the bottom of the spring appear to stay in place until the rest of the spring above it fell? The reason has to do with the forces on the spring.

LEARNING GOALS:

- I can do an investigation to determine the relationships between the amount of extension, spring constant, and force for a spring.

2 NEWTON REVIEW

Forces in Your World

The falling of the metal spring toy demonstrated a change between balanced and unbalanced forces. **Balanced forces** means that an object does not change speed or direction. The coils of the spring may have been moving slightly at the start of the experiment, but as you held the spring in your hand you were applying a balanced force. When you released the spring, there were **unbalanced forces** meaning the object changed speed or direction.

After your observations, you listed some of the forces you thought were balanced or unbalanced in this experiment. When you released the spring, the force of gravity pulled the spring toward Earth's center. Your hand holding the spring toy was applying tension so that the spring did not fall to the ground. **Tension** is a force applied through a string or cable, pulled tight through forces acting from opposite ends.

You may have identified many of the forces from Activity 1, but let's review some common forces:

TYPE	SYMBOL	DEFINITION
gravitational force	F_g	the force of attraction between two objects based on their masses and the distance between them
normal force	F_N	the force exerted on an object that is in contact with another stable object or surface; acts in the direction perpendicular to the surface
friction force	F_f	the resistance to the motion of two objects sliding over each other
applied force	F_A	a push or pull by a person or another object
tension force	F_T	the force through a string, rope, cable, or wire when it is pulled tight by forces acting from opposite ends

THINK ABOUT IT!

1. What do you notice about the increasing mass for each additional steel ball?

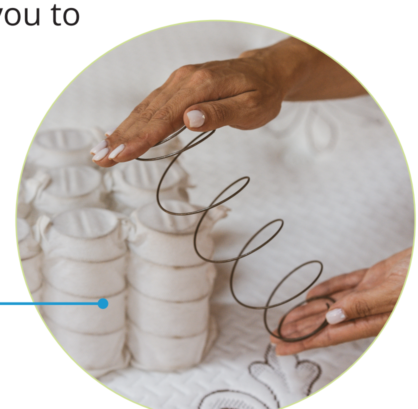
2. How does the increase of the mass relate to the length of the spring in the spring scale and the measurements in Newtons on the opposite side of the spring scale?

3. How would the length of the spring – and measurement reading on the spring scale – change if you added additional steel balls that were exactly the same size?

7

Snap to It

In this experiment, you saw that the spring scale held the weight of the steel balls in tension with the pull of gravity. These balanced forces allowed you to read the measurements on the spring scale and observe the spring force in action. **Spring force** is the force from a stretched or compressed spring that is acting on any object attached to the spring. In addition to what you observed in this experiment, a compression spring pushes back with force when compressed. These are often found in seat cushions and mattresses.



Using a spring in the scale allows the measurement to snap back to zero after the mass is removed. The scale also directly measures the pull of gravity. As you read in the previous lesson, the mass of an object is directly proportional to its weight due to gravity. The pull of the weights is related to the length of the spring and the measurement lines on the side of the device.

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Kit	SU-PERHAR
Instructions	IN-PERHARS
Revision Date	7/2022