IN PERFECT HARMONY

TEACHER GUIDE

LAUNCH

PLANNING

Here's a suggested schedule for this kit! The activities are designed to be completed in order, but you can decide when to do them over time. The time required for each lesson may vary.

ACTIVITY INFORMATION	SECTION(S)	TIME REQUIRED	DAY/ LESSON
ACTIVITY 1: SLOW-MO STRETCH Observe the unique motion of springs using slow-motion technology. **Time required: 45 min**	☐ Spring Drop	45 minutes	Day 1
ACTIVITY 2: THE FORCE RETURNS Learn about balanced and unbalanced forces to draw diagrams. **Time required: 3 h**	☐ Newton Review	90 minutes	Day 2
	☐ Drawing Within the Lines ☐ Show What You Know	90 minutes	Day 3
ACTIVITY 3: SPRING BACK Use math to understand the motion and forces of springs. **Time required: 3 h**	☐ Spring int…		

4 DRAWING WITHIN THE LINES

Down to a Dot

- In this section, the student will learn how forces on an object can be described in a free-body diagram.
  - They will start with examples and then draw their own free-body diagrams.
- The vocabulary terms center of mass and free-body diagram are defined.
- This section is meant to build on the student's understanding of forces, and give them the tools to correctly describe the motion of an object using a free-body diagram.
  - The student's prior drawings about forces should be used to reflect in the next subsection.

REFLECT

Question 1: Review your drawings of forces from the first two activities. Use what you have learned to create an accurate free-body diagram of the spring toy mid-fall. Use a dot to represent the center of mass, and show gravity and tension. Make sure the diagram shows these forces balanced or unbalanced as the spring falls.

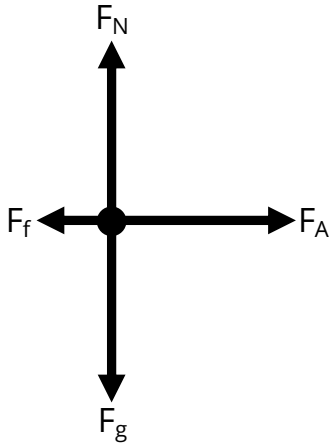
Answer:

- The diagram should show a dot with a short arrow representing the force of tension from the spring pointed up and a long arrow representing the force of gravity pointing down.
- They may also share that their drawings did not represent balanced and unbalanced forces with proportional arrow length.

How to Help: *Have the student review the symbols for forces listed and some example free-body diagrams in this activity.*

Question 2: Draw a free-body diagram of a shopping cart accelerating to the right, from a stationary position. Include the applied force, gravity, normal force, and friction in your diagram.

Answer:



How to Help: *Now that your student has an understanding of simplified free-body diagrams, this should be the standard for further diagrams and descriptions.*

activity 3

SPRING BACK

In Activity 1, your student observed how the force of tension on the metal spring toy could oppose the force of gravity. Even as it fell to the ground, you found that the spring had its own tension that pulled throughout the coils. Let's learn more about the tension and compression forces in a spring.

LEARNING GOALS:

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

SPRING INTO ACTION

WARNING! Sharp objects can cause injury. Don't cut or poke yourself.

PREPARATION AND SUPERVISION

- In this experiment, the student will observe the connection between the extended spring and the measurements of the spring scale.
- The vocabulary term compression is defined.
- If your student has difficulty holding the cup and paper clips to the spring scale, use a small amount of masking tape to hold the paper clips on the spring scale.
- The weight of the plastic cup and string to not have enough mass to pull the spring, so they are discounted from this set of observations. In the next section, the student will need to measure the starting weight of the cup with a more sensitive spring.

MULTIPLE AGES AND ABILITIES:

The experiments in this activity are a great opportunity to include multiple students of different ages and abilities. The experiments involve holding the spring, observing measurements, and recording data. Assign different student roles and they can switch or keep their roles for the experiment in the next section.

One student can focus on holding the spring scale steady, while another student can measure and record the data, or add additional balls in the experiment.

THINK ABOUT IT!

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

Answer: Each ball added the same amount of mass because the balls all weighed the same amount.

How to Help: *Have the student examine each of the steel balls to make sure that they are all the same size and weight.*

LAUNCH

SCIENCE UNLOCKED

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Kit	SU-PERHAR
Instructions	IN-PERHART
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