Lesson 4.2
Investigating Balanced Forces
Lesson Overview

Students continue to explore and collect evidence of multiple forces acting on a single object. They construct a device, the Floating Paper Clip Device, in which multiple forces act on a paper clip, causing the paper clip to float. Students gather more evidence about multiple forces on an object by reading, in *Handbook of Forces*, about balanced forces. This text provides more examples of balanced forces and helps students conceptualize evidence of this happening. The class concludes that the forces acting on the floating paper clip are in opposite directions and of equal strength. The Word Relationships routine helps students use unit vocabulary to reflect on their understanding of balanced forces. This lesson enables students to further investigate balanced forces through firsthand experience and text.

**Anchor phenomenon:** The floating train rises, floats above the track, then later falls back to the track.

**Investigative phenomenon:** A paper clip floating at the end of a string

**Students learn:**

- When gravity and another force on an object are balanced, the object won’t fall.
- An object that is not moving may have balanced forces acting on it.
- Subheadings describe the kinds of information found in a section of a reference book.
Students read about more examples of balanced forces. This helps them make sense of what they observed with the floating paper clip.

**Instructional Guide**

1. **Introduce the reading activity.** Let students know that reading part of the reference book *Handbook of Forces* can help them make sense of how the Floating Paper Clip Device works.

2. **Distribute copies of Handbook of Forces.** Distribute one copy of the book to each pair of students.

3. **Add to the Setting a Purpose for Investigating and Reading chart.** With student input, generate a purpose statement for the reading. Remind students that a purpose for reading should be based on what questions they are investigating and trying to answer. Write the purpose for reading in the “Reading” column of the chart. The purpose might be some variation of:

   - “Find out information that might explain why the paper clip floated” or
   - “Understand what can keep something from falling”

   Remind students that they will use sticky notes to mark information in the text related to their purpose.

4. **Have students use the table of contents.**

   Remember that we’ve used this reference book before to find information. The investigation we just finished has left me with some questions. I think this book might contain some information that would help us explain what we just observed. Where should we start if we want to try to find out more about how the paper clip could float? [Table of contents.]

   With student input, identify the section of the book most likely to have information related to the investigation of the Floating Paper Clip Device. [Multiple Forces.]
5. **Explain the purpose of subheadings.** Let students know that subheadings provide more information about what you’ll find within a section of a reference book. Point out the subheadings listed under the “Non-Touching Forces” section.

We know that gravity and magnetic force are kinds of non-touching forces. The table of contents lets us know where we can find information about them, since they each have their own section.

6. **Have students identify the subheading listed under the “Multiple Forces” section.** Explain that this subheading—“Balanced and Unbalanced Forces”—provides some information for students to keep in mind as they read.

7. **Distribute sticky notes. Partners read pages 18–23.** Distribute two sticky notes to each student. Have pairs read and mark evidence in the book that helps with the purpose the class has set. Circulate and provide support if needed.

8. **Introduce and discuss the term balanced forces.**

   - What did the book call forces that keep an object from moving? [Balanced forces.]

   - What does it mean for two forces on an object to be balanced? [They are equal in strength. They act on the object in opposite directions.]

   - Another way to say this, is that the balanced forces give zero net force on the object.

9. **Post the balanced forces vocabulary card.** Post the balanced forces vocabulary card to the Vocabulary section of the classroom wall.

   - The forces on the train must be balanced when the train is floating, because it is not moving up or down. The same must be true when the train is resting on the tracks.

10. **Discuss examples of balanced forces from the book.** Call on volunteers to share examples of balanced forces from the book. For each example, ask what the two forces are and what direction each force is acting on the object.

   - Objects that are touching always exert forces on each other, even if they are not moving. What are some examples from the book where forces are acting and objects aren’t moving? What forces are present?

11. **Introduce the word stable.**

    - Remember when we talked about how scientists focus on when things change and when they stay the same? When forces exerted on an object are balanced, the object does not change movement. When something is not changing, scientists say that it is stable.

    Write the words *changing* and *stable* on the board and point out that they are opposites.

    - Many different kinds of scientists think about when things are changing and when they are stable.
Teacher Support

Background

Science Note: About Balanced Forces
When forces on an object are balanced, the sum of the forces is zero. For example, when you hold a book in your hand, the downward force of gravity is equal in strength to the opposite upward touching force of your hand on the book, so the forces add up to zero. When the forces on an object are balanced, its motion does not change. This is easiest to observe when an object is not moving, and it remains motionless. Moving objects that have balanced forces acting on them continue to move in the same direction with the same speed. A dog pulling a sled across the snow exerts a force on the sled in one direction. Due to friction, the snow exerts a force on the runners of the sled in the opposite direction. When the force of the dog and the frictional force of the snow are balanced, the sled moves at a steady speed.

Rationale

Pedagogical Goals: Introducing the Term Balanced Forces After Reading
We suggest you wait to introduce the term balanced forces until after students read this section of the reference book. This allows students the opportunity to discover for themselves (by reading) the main idea that helps explain the floating paper clip: that the upward and downward forces exerted on the paper clip are balanced. Some students may find it challenging to make sense of the reading because this unfamiliar term is so central to the reading, even though the text is written to explain and introduce the term. The after-reading discussion is meant to clarify any confusion. You could also reread part or all of this section of the text as a class once the term balanced forces has been introduced.
Learning More from Handbook of Forces

Students read about more examples of balanced forces. This helps them make sense of what they observed with the floating paper clip.

Instructional Guide

1. **Introduce the reading activity.** Let students know that reading part of the reference book *Handbook of Forces* can help them make sense of how the Floating Paper Clip Device works.

2. **Distribute copies of Handbook of Forces.** Distribute one copy of the book to each pair of students.

3. **Add to the Setting a Purpose for Investigating and Reading chart.** With student input, generate a purpose statement for the reading. Remind students that a purpose for reading should be based on what questions they are investigating and trying to answer. Write the purpose for reading in the “Reading” column of the chart. The purpose might be some variation of:
   - “Find out information that might explain why the paper clip floated” or
   - “Understand what can keep something from falling”

Remind students that they will use sticky notes to mark information in the text related to their purpose.

4. **Have students use the table of contents.**

Recuerden que hemos usado este libro de referencia antes para encontrar información. La investigación que acabamos de terminar me dejó con algunas preguntas. Pienso que este libro podría contener información que nos ayudaría a explicar lo que acabamos de observar. ¿Dónde debemos comenzar si queremos averiguar más sobre cómo pudo flotar el clip? [Contenido].

With student input, identify the section of the book most likely to have information related to the investigation of the Floating Paper Clip Device. [Multiple Forces.]
5. **Explain the purpose of subheadings.** Let students know that subheadings provide more information about what you’ll find within a section of a reference book. Point out the subheadings listed under the “Non-Touching Forces” section.

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11. **Introduce the word stable.**

Write the words changing and stable on the board and point out that they are opposites.

Sabemos que la gravedad y la fuerza magnética son tipos de fuerzas a distancia. El contenido nos dice dónde podemos encontrar información sobre ellas, ya que cada una de ellas tiene su propia sección.

¿Cómo llamaba el libro las fuerzas que impiden que se mueva un objeto? [Fuerzas en balance].

¿Qué significa que dos fuerzas sobre un objeto estén en balance? [Son iguales en intensidad. Actúan sobre el objeto en direcciones opuestas].

Otra manera de decir esto es que las fuerzas en balance dan cero fuerza neta sobre el objeto.

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