# Unbalanced forces

## Grade 3: Force Probe

**Aligned with National Standards**

ward's science
Single Probes

# overview

Students will simulate a tug-of-war using two WARD'S Single Force Probes to illustrate balanced and unbalanced forces. Unbalanced forces always result in motion of an object whether due to a pushing or pulling force.

This activity using one of WARD'S Single Probes to collect data, allowing students to focus on the scientific discovery and allowing more time to be spent on learning and developing higher levels of thinking in your students.

## time requirement:

This activity can be completed in one session of 30 minutes.

## materials required for the activity:

2 WARD'S Single Force Probes
String
Colored Tape
wooden box or block

Instructions (this booklet): Teacher's Guide and Student worksheet if needed.

# safety precautions

## general safety:

- Remind students to read all instructions before starting the lab activities, and to ask questions about safety and safe laboratory procedures. For the early grades that may not be proficient in reading yet, review the safety and lab procedures together with your students.
- Consider establishing a safety contract that students and their parents must read and sign. This is a good way to identify students with allergies (e.x. latex) so that you (and they) will be reminded of specific lab materials that may pose risks to individuals.
- Discuss safety concerns and appropriate behavior expectations with students prior to each science activity
- Make any necessary individual student modifications.
- Limit size of student working groups to a number that can safety perform the activity without causing confusion and accidents.

# framework for K-12 science education © 2012

**DIMENSION 1** Science and Engineering Practices

| | | | |
|---|---|---|---|
| | Asking questions (for science) and defining problems (for engineering) | | Use mathematics and computational thinking |
| | Developing and using models | | Constructing explanations (for science) and designing solutions (for engineering) |
| × | Planning and carrying out investigations | | Engaging in argument from evidence |
| × | Analyzing and interpreting data | × | Obtaining, evaluating, and communicating information |

**DIMENSION 2** Cross Cutting Concepts

| | | | |
|---|---|---|---|
| × | Patterns | | Energy and matter: Flows, cycles, and conservation |
| × | Cause and effect: Mechanism and explanation | × | Structure and function |
| × | Scale, proportion, and quantity | | Stability and change |
| | Systems and system models | | |

**DIMENSION 3** Core Concepts

| Discipline | Core Idea Focus |
|---|---|
| Physical Sciences | PS2: Motion and Stability: Forces and Interactions |

# next generation science standards © 2013

**NGSS STANDARDS**

| Elementary School Standards Covered |
|---|
| 3-PS2-1 Plan and conduct an investigation to provide evidence of the effects of balanced and unbalanced forces on the motion of an object. |

# national science education standards © 1996

| Content Standards (K-12) | | | |
|---|---|---|---|
| | Systems, order, and organization | | Evolution and equilibrium |
| × | Evidence, models, and explanation | × | Form and Function |
| × | Constancy, change, and measurement | | |

| Life Science Standards Elementary School | |
|---|---|
| × | Position and motion of Objects |

× Indicates standards covered in activity

# prior to class

- Go over the general use of the force probe.
- Make copies of worksheets/pictures if desired.
- Set up the materials needed for each group
- There are two separate set ups you can choose from, please read both an pick the best one for your class.

# objective

Students will help design an experiment that illustrates how balanced and unbalanced forces effect the motion of an object.

# background

Newton's First Law of Motion assumes that the forces acting on the object are balanced. When a book is at rest on a table, the force of gravity pushing down on the book is equal to the force of the desk pushing up. The forces acting on the book are balanced, so the book stays put. The same is true of objects in motion. If the forces acting on a moving object are balanced, and no other outside forces interfere, the object would keep on moving forever.

Unbalanced forces cause a change in position or motion. If two people are arm wrestling and both exert the same exact amount of force, their arms will be deadlocked in the same spot. The balanced forces cancel each other out, causing a state of equilibrium where there is no motion or change. As soon as one person exerts more force, the forces become unbalanced. Unbalanced forces always result in motion. In the case of the arm wrestling, the stronger arm will overtake the weaker arm and push it down.

## build upon prior knowledge:

- Ask students to sit in their chairs and ask them if the force of their weight down is equal to the force of the chair pushing up. *(Student responses may vary, but the forces should be equal.)*

- Ask the students to look at the picture below and decide if the person's weight is balanced with the force of the object they are laying or sitting on. *(Student responses should be: boy in hammock is balanced; mon on cushion is not balanced.)*

*(continued on next page)*

## guiding questions

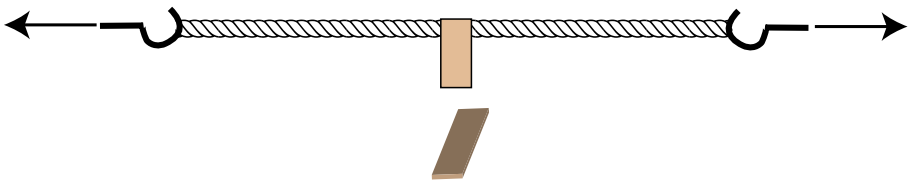
- What do you think will happen? (Hypothesis)
- What do you expect to learn?
- What tools are needed?
- How can we record our findings?

## procedure

**Set up 1:**

1. Connect one end of the string to the end of each WARD'S Single Force Probe. In the center of the string place a piece of colored tape. See the figure below.

2. Place another piece of colored tape on the table. This will signify the middle or starting position.



3. Have two students stand on either sides of the table and hold the WARD'S Single Force probes.

4. Explain that the goal of the first part of this experiment is to keep the colored tape in the middle of the line on the table. Each student will try to match the pulling force of their partner and read the force on the force probe. (For example, both students can try to pull the string with a force of 10N)

5. Ask students whether this demonstrates a balanced or unbalanced force and why.

6. Now have one student pull with only 5 N (or a smaller amount of force) and explain what happens to the colored tape. It should be seen that the colored tape on the string moves over the line towards the student who is pulling with a great force. Explain that the forces are now unbalanced and therefore movement occurred. Eventually the student who is pulling with the greater force will pull the other student across the room.

*(continued on next page)*

# lesson

**Set up 2:**

1. Set up a box between to students.

2. Have the students predict what would happen to the box if it were pushed in opposite directions by the same force. See the Figure below.

3. Have the students push on the box with equal force to see if their prediction is correct.

4. Now ask them what would happen of one person were to stop pushing.

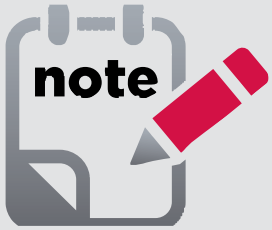
5. Have the students repeat the experiment above but have one person stop pushing.

## summarize

Students should understand that balanced forces do not produce movement on an object, while unbalanced forces cause the object to move in the direction of either the greater push or pull.

## extension

Students pick up their backpack every day and put it on their back. They know that it takes muscles to lift it up. Have they ever tried to figure out an easier way to lift it up? How about using a ramp? Show students that if they lift the backpack straight off of the floor, it requires a certain amount of force, BUT if they pull their backpack up a ramp in order to reach the same height, it will take less force. This can be done using the car once again and incorporating a ramp.




## teacher notes

- Review basic information about how to use the Single Force probe. Make sure the probes are calibrated to "zero" by pressing the balance icon on the unit icon (N or g) on the face of the screen and then press the balance icon.

- If you wish to change the value in which the force probe registers a positive or negative, press the same unit icon as above, then choose:


pulling is negative


pulling is positive

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