GRADE LEVEL:
6-8

DURATION:
40 minutes

NGSS STANDARDS:
Understanding the Nature of Science

Science Practices: Carrying out an investigation

NE STANDARDS:
SC8.1.1
Formulate testable questions that lead to predictions and scientific investigations

MATERIALS:
- Cockroaches
- Washers
- String
- Paper sleds (4"x 5")
- Masking tape
- Data sheets
- Digital scale

VOCABULARY:
- Investigation or experiment
- Hypothesis
- Data
- Variable

COCKROACH TRACTOR PULL

ENTOMOLOGY
University of Nebraska

BACKGROUND:

Many insects are capable of lifting and moving many times their body weight. Observe, for example, ants carrying a large piece of bread at your next picnic.

At the 2012 Olympics in London, a gold medalist in men's weightlifting (Ilya Ilyin) managed to lift 513 pounds. Elephants can lift 600 pounds with their trunk. But for their size, ants are the real champion weightlifters. They can lift up to 50 times their body weight and carry it around over their heads. And they do this with their mouth! How can they do this? Why can't humans carry things much heavier than themselves?

OBJECTIVES:

- Students will explore the strength of Madagascar Hissing Cockroaches
- Students will determine how many pounds a human could pull if we had strength equivalent to a cockroach

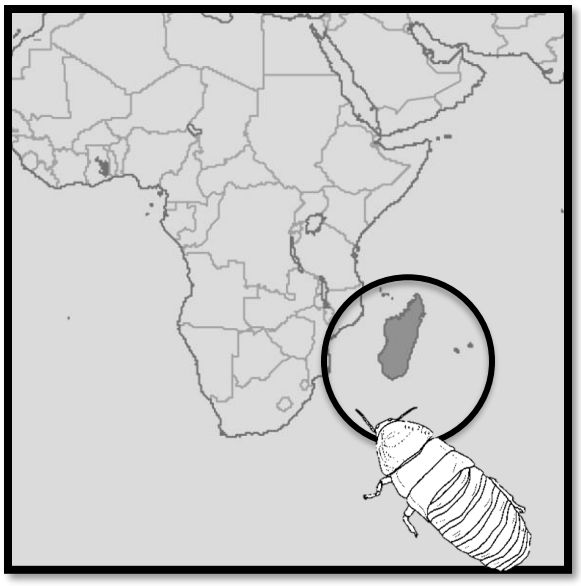
METHODS:

Before handing out data sheets, discuss with students the importance of having a systematic approach to science.

- **Identify a problem or question:**
  - What is the pulling power of a cockroach compared to a human?
- **Develop a hypothesis:**
  - Predict how many washers the cockroach will be able to pull on the paper sled.
  - Predict how much weight a human would have to pull to show similar strength?
- **Gather data:**
  - Each student selects a cockroach and weighs it on the digital scale.
  - Attach a paper sled to the cockroach by cutting a 4" piece of string and taping it to the cockroach with masking tape, tape the other end of the string to a paper sled.
  - Mark a starting line with masking tape and place your cockroach behind this line.
  - When the roach begins walking, add washers one at a time to the paper sled until you find the maximum number of washer the roach is able to pull.
  - Ask students to think about variables that might influence their cockroach's performance?
    - Cockroach health, size, age, sex, position at the starting line
    - Texture of the walking surface (carpet vs. table top)
    - Amount of tape and its placement on the cockroach, size of sled, small differences in weight of the washers

	• **Analyze data**:
	  ○ Compute the total weight pulled by the cockroach by weighing the washers on the digital scale.
	  ○ Determine how many pounds a 150 lb human could pull if he/she had the strength equivalent to a roach.
	• **Report results:**
	  ○ Have students record their calculations on their worksheet.
	  ○ Compare predictions vs. findings
	  ▪ Did cockroaches pull more or less than you predicted?
	  ▪ Do your calculations make sense?
	  ▪ Do cockroaches and humans possess similar strength?
	• **Draw conclusions and discuss implications:**
	  ○ "Why are insects so strong?"
	  ○ Discuss size and how it relates to surface to volume ratio
	  ○ As we get larger, our strength does not increase as quickly as our weight

COCKROACH TRACTOR PULL



Many insects are capable of lifting and moving many times their body weight.

Today, we are going see how strong Madagascar hissing cockroaches are. There are about 3,500 know species of cockroaches in the world. Cockroaches belong to the order Blattaria and most live in the tropics and subtropics. The Madagascar hissing cockroach is native to the island of Madagascar.

Questions:

1. How strong is a cockroach?
2. How many pounds could a 150 lb human pull if they had the strength equivalent to a cockroach?

Set-up:

1. Select a cockroach and record the weight of the roach
2. Predict how many washers the cockroach will be able to pull (be sure to state your prediction as a hypothesis)
3. Cut a piece of string and attach the string to the cockroach with tape. Tape the other end to the piece of paper (sled)
4. When the roach begins walking add washers to the sled, one at a time, until you find the maximum number the roach can pull
5. To answer question #1: Compute the total weight pulled by the roach (roach weights + total weight of washers).
6. To answer question #2: Determine how many pounds an individual weighing 150 lbs could pull if they had the strength equivalent to a cockroach.

DATA SHEET

Names:

_____

_____

_____

_____

Hypothesis Tested:

_____

_____

_____

_____

Calculations:

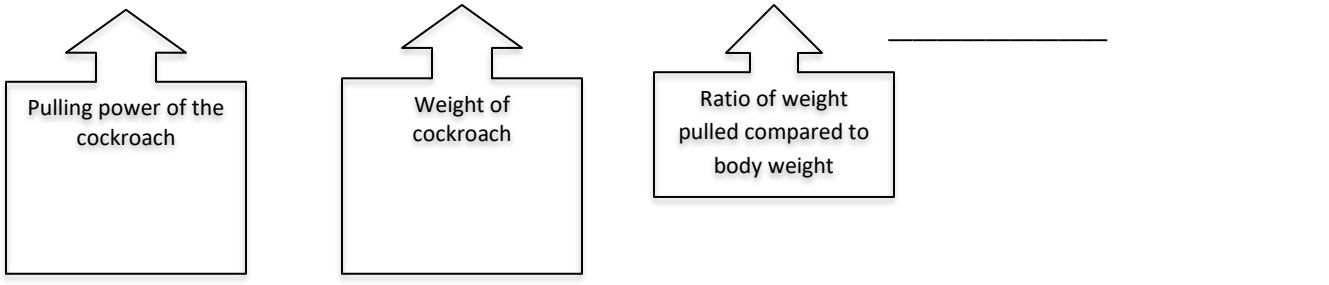
1. Weight of cockroach = _____

2. Number of washers × Weight of a washer = Pulling power of the roach

_____ × _____ = _____

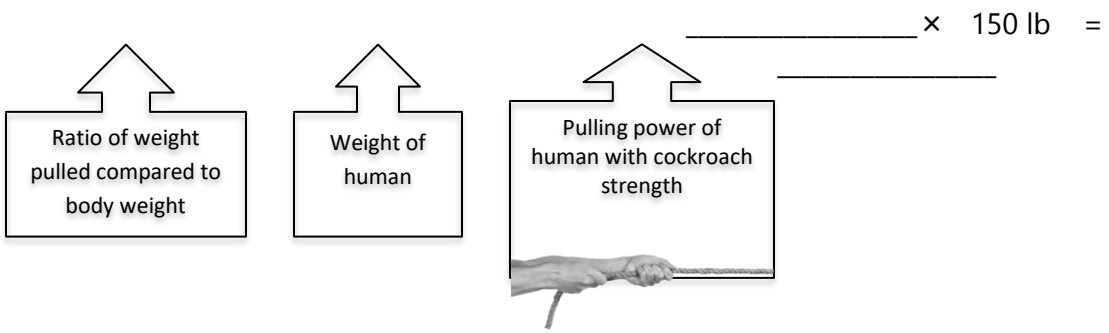
3. Determine how many pounds an individual weighing 150 lbs could pull if they had the strength equivalent to a cockroach

Step A: Calculate ratio of weight pulled compared to body weight



_____ ÷ _____ = _____

Step B: Calculate the pulling power of a 150 lb human with the strength of a cockroach



Questions:

1. What was the pulling power of your hissing cockroach?

2. Is the pulling power that your group calculated what you expected?

3. Are you results/solutions reasonable? Explain.

4. Why can hissing roaches pull so much (list at least 3 reasons)? Think about our discussion on advantages of small size and the exoskeleton.

5. Discuss the variables that could have influenced the results.

6. What did you learn from this experiment?