

The Tug of War

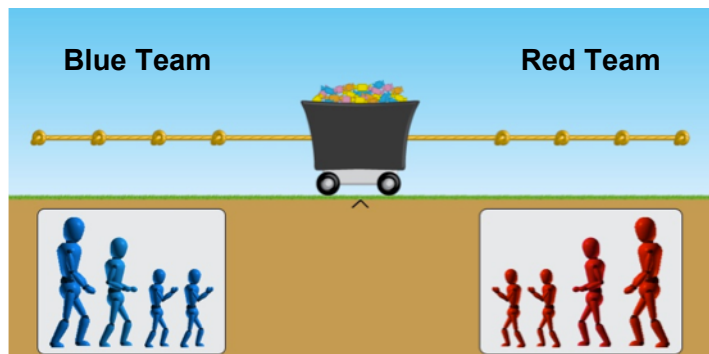
YWBAT observe how *unbalanced* force affects an object's motion.

YWBAT observe how *balanced* force affects an object's motion.

1. Go to bit.ly/phetforce in Chrome, and click on "**Net Force**".

There are other parts to the game, but we're going to focus on the **Tug of War** first. The program should look like the picture when you open it.

To choose members of each team to pull on the rope, drag them where you want them to pull.



2. Take a moment to play around a bit and see how the game works. As you play, make observations to help you answer to the following question:

How does the cart respond when one team pulls harder? (*circle all that apply*)

HINT: There's MORE THAN ONE correct answer here!

- constant speed increasing speed decreasing speed zero speed

3. a. Reset the game, then **READ THESE STEPS CAREFULLY:**

STEP 1: Add one small guy and press "Go!" to get the cart moving a tiny bit.

STEP 2: BEFORE he wins, take the guy off so no one's pulling and watch the cart respond.

b. **How does the cart respond after the guy stops pulling?**

- constant speed increasing speed decreasing speed zero speed

4. In this question, your goal is to connect this Tug-of-War game to situations we saw in Rulerball. **Write the letter of each Tug-of-War situation on the left next to the Rulerball situation on the right that matches it most closely.** "A" is done for you as an example.

- | | |
|--|---|
| A. No one pulls the cart, and it stays still. | A ruler makes the ball slow down. _____ |
| B. The cart keeps moving with no one pulling it. | A ball is at rest on the floor. <u>A</u> |
| C. The tug of war is tied, and the cart stays still. | A ruler makes the ball speed up. _____ |
| D. A guy pulls the cart, and it speeds up. | A ruler holds the ball against a wall. _____ |
| E. A guy pulls the cart, and it slows down. | A ball moves through the no touch zone. _____ |

5. Two scientists have two different ideas about how the cart behaves. **Circle the idea matches your observations so far.** (Not necessarily the idea you agree with.)



Do NOT go on until you discuss Q5 with your entire group.

Aristotle: The cart moves in the direction of a team that's pulling harder. The cart *can't* keep moving unless one team is pulling harder, so if there is no pull the cart slows down.

Galileo: The cart stays at a constant velocity unless one team is pulling harder. The cart *speeds up or slows down* only when one team is pulling harder than the other.

To do 6 & 7, you'll need to **PREDICT** BEFORE TESTING. **Read carefully.**

6a. **PREDICT:** In a moment, you'll add **one small red guy** to get the cart moving to the right, then quickly add **one small blue guy** to **balance the pull on both sides.**

USE THE IDEA YOU CIRCLED IN QUESTION 5 TO PREDICT, NOT YOUR OPINION.

When the pull on a moving cart is balanced by an equal pull on the other side, the cart:

stops immediately slows down and stops stays at a constant speed speeds up

6b. **TEST:** STEP 1 - Add a small red guy, then press "Go!" to get the cart moving a tiny bit.

STEP 2 - Add one small blue guy to balance the pull on the other side.

What does the cart do when a blue guy balances out the red guy's pull? (circle)

stops immediately slows down and stops stays at a constant speed speeds up

7a. **PREDICT:** In a moment you'll complete the two steps below. BEFORE carrying out these steps, read the steps carefully and predict the cart's motion:

STEP 1: Add a small red guy, then press "Go!" to get the cart moving.

STEP 2: Add a large BLUE guy, to make the pull *stronger* to the left.

ACCORDING TO THE IDEA YOU CIRCLED, when you add a large blue guy, the cart will:

stop immediately move left immediately slow down, then stop speed up to the left

7b. **TEST: How does the cart respond when you make the blue team stronger than the red team as the cart is already moving toward the right? (circle all that apply)**

stop immediately move left immediately slow down, then stop speed up to the left

8. **CHECK:** Which scientist's idea from above best matches your tests? Aristotle Galileo

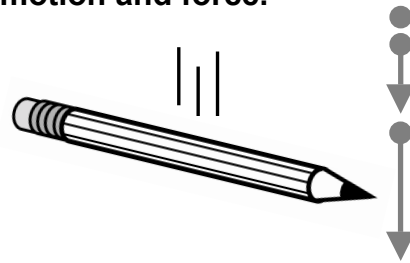
9. Explore other parts of the game by selecting them at the bottom. Look back at situations A through E in question 4, and create similar situations in OTHER parts of the game. Describe and/or draw diagrams for situations you create below.

YWBAT read a motion map to determine how an object is moving.

YWBAT describe the accurate connection between motion and force.

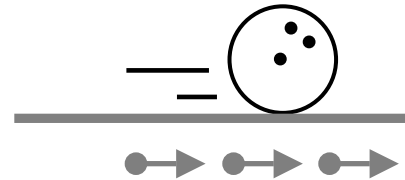
1. A **pencil** falls toward the ground:

- a. **motion:** constant motion
 increasing speed decreasing speed
- b. **force:** balanced force unbalanced force



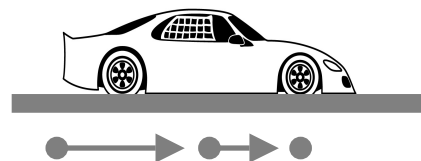
2. A **bowling ball** rolls through the no touch zone:

- a. **motion:** constant motion
 increasing speed decreasing speed
- b. **force:** balanced force unbalanced force



3. A **car** applies its brakes:

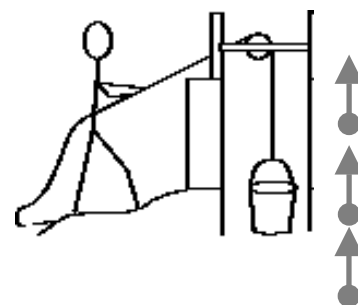
- a. **motion:** constant motion
 increasing speed decreasing speed
- b. **force:** balanced force unbalanced force



4. Write a sentence in your own words to describe the connection between motion and force **that we're using here:**

5. A person raises a **bucket** in a well:

- a. **motion:** constant motion
 increasing speed decreasing speed
- b. **force:** balanced force unbalanced force

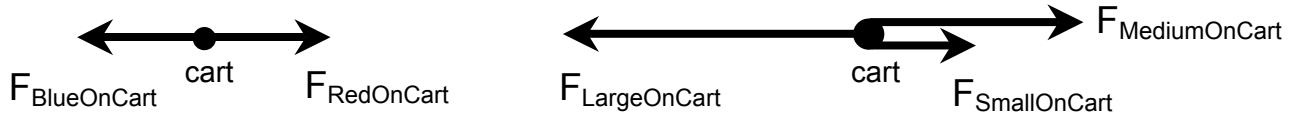


6. **True or False:**
- a. Force causes motion. T F
- b. Unbalanced force causes change in motion. T F
- c. The more force is exerted on an object, the faster the object moves. T F

CHALLENGE: You may either *watch BFM 5*, OR try to figure out how to use *congruency marks* in these situations.

CONNECT
BFM 5

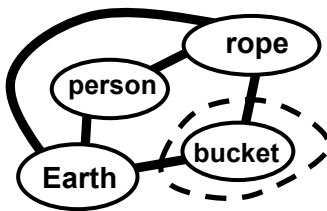
- In a force diagram, the length of an _____ should show the _____ of a _____.
- These diagrams show different tug-of-war situations, both balanced:
For each, add **CONGRUENCY MARKS** to show *balanced force*.



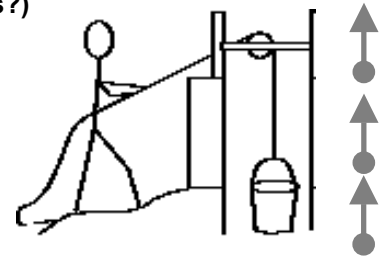
YWBAT use arrow length and congruency marks to show force strength and balance.

- A person raises a bucket in a well, straight up at a constant speed:

- Circle: *constant motion* or *changing motion* *balanced force* or *unbalanced force*
- system diagram
- force diagram (cong. marks?)

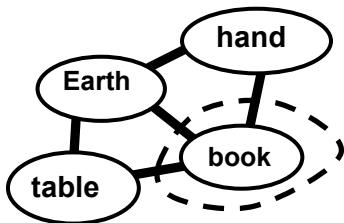


● bucket

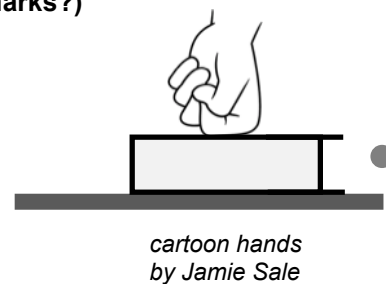


- A hand pushes down on a book that's sitting on a table. The book is *at rest*.

- Circle: *constant motion* or *changing motion* *balanced force* or *unbalanced force*
- system diagram
- force diagram (cong. marks?)



● book



- A man and a woman are holding a heavy box. The box is *at rest*.

- Circle: *constant motion* or *changing motion* *balanced force* or *unbalanced force*
- system diagram
- force diagram (cong. marks?)

● box

