Workshop 6.
Force Against Force

Magnets stick to other magnets and to metal objects made of iron or steel. How much force is required to break the attraction between two magnets? In this workshop, fourth-grade students explore ways to balance the force of magnetism against the force of gravity. A magnet placed in a cup on one side of a pan-balance is stuck to a stationary magnet beneath the cup. When enough washers are placed on the opposite side of the balance, the magnets will separate. Graphical analysis shows some unexpected results.

On-Site Activities and Timeline

Getting Ready

30 minutes

Canary Physics Follow-Up

Your homework for Workshop 5 was to solve a canary physics problem. Now, discuss with your group some of your ideas about the truckload of canaries. Does the group believe that the bridge will break or hold together when the truck drives over?

A Penny for Your Thoughts on the 10-Cent Experiment

In the Workshop 5 video, you saw an experiment where two wooden blocks were first dropped, then slid down a ramp. One block had twice the mass of the other. Perhaps you tried the experiment to see how the sliding blocks behaved. What would happen if the ramp were much less steep? Share your ideas with the other participants.

Tug of War

Materials:

A non-carpeted floor

Two chairs, preferably with wheels

A rope or cord at least 4 to 6 meters long

Instructions:

1. From your group, select a person of very large mass and a person of very small mass. Have each sit in a chair facing the other, each holding one end of the rope. Move the chairs back so the two people are as far apart as possible, with the rope stretched tightly between them.
2. The two participants will now try each of the following challenges (move back to the original starting position before each trial):
    a. The high-mass person "reels in" the low-mass person by pulling the rope
    b. The low-mass person "reels in" the high-mass person
    c. Both "reel in" each other
3. After each activity, the people in the chairs should discuss what they felt during the activity, and those watching should describe the motion they observed.
4. Repeat the same experiment with two people of approximately equal mass and discuss your results.

Questions (discuss with a partner):

How does motion relate to mass?

How does motion relate to force?

On-Site Activities and Timeline, cont'd.

Watch the Workshop Video

60 minutes

As you watch the video, look for the "10-Cent Experiment." You may want to try it yourself at home. Instructions can be found on page 49.

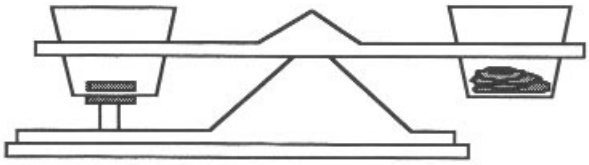
Going Further

30 minutes

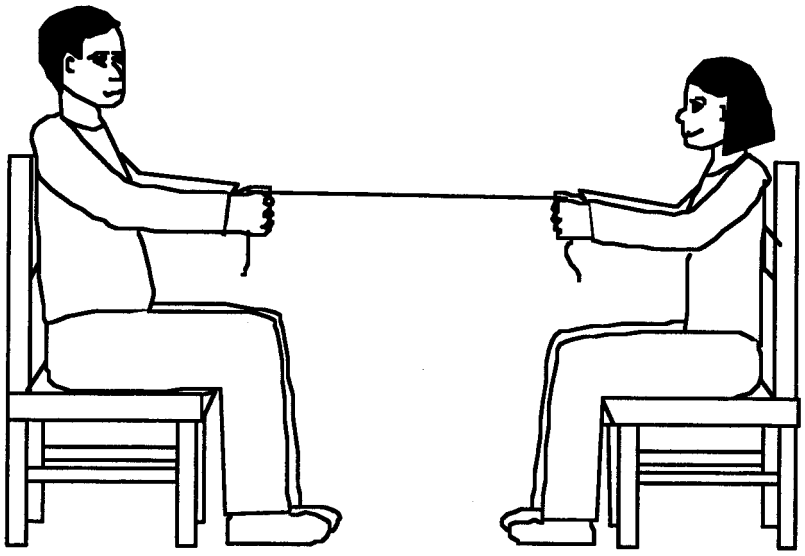
Can You Find All the Forces?

Work with a partner on the following activities and questions:

1. In the Workshop 6 video, students were separating magnets by using washers in a pan balance to provide a force. Below is a picture of a balance similar to the one in the video. Use arrows to represent all the places where force is being exerted.

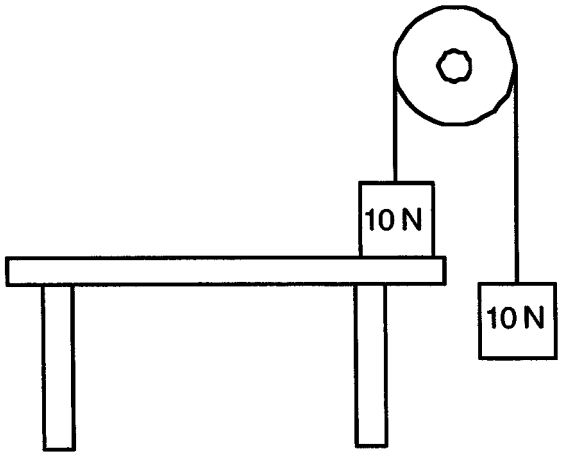


2. In the Workshop 6 Getting Ready, you participated in a makeshift tug-of-war while sitting in chairs, or watched some of your colleagues do so. Below is a picture of two people participating in this activity. Use arrows to represent each force being exerted.



On-Site Activities and Timeline, cont'd.

3. Below is a picture of two blocks attached to a string that passes over a pulley. The blocks have equal mass. One block is resting on the table and the other is hanging freely.

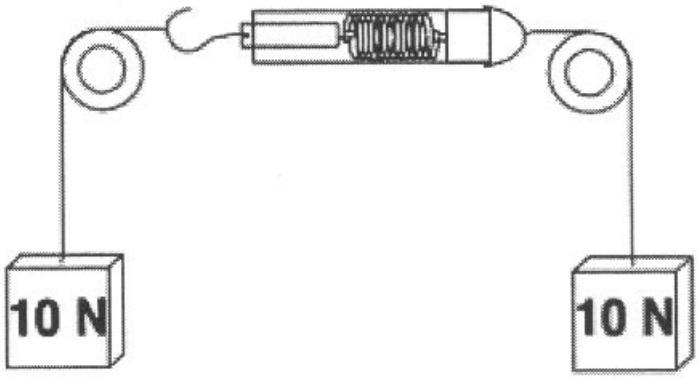


   a. Draw arrows to show each force being exerted.

   b. Explain what will happen if the table is removed.

   c. Be prepared to discuss your reasoning with the rest of the group.

4. Below is a picture of two blocks of equal mass attached by strings to a spring scale. The strings pass over two pulleys as shown. What do you expect the spring scale to read? Be prepared to discuss your reasoning with the rest of the group.



To check your answers, go to the *Science in Focus: Force and Motion* Web site at:

http://www.learner.org/channel/workshops/force

For Next Time

Homework Assignment

The Clipper Picker Upper

1. Find the strongest magnet you have in your house. Most likely you will find it on your refrigerator door! See how many paper clips the magnet can pick up end to end.
2. In your journal, write your thoughts about the following:
   a. Why does a paper clip behave like a magnet when it is attached to a real magnet?
   b. What do you think is happening to the paper clip to make it behave "magnetically"?

The 10-Cent Experiment

Materials:

Four small ring magnets

A pencil

Instructions:

1. Slide the pencil through the four ring magnets, then hold the pencil horizontally.
2. Now, tip the pencil and hold it vertically.
3. Note the behavior of the magnets.

Questions:

Did the magnets behave differently when the pencil was vertical?

Why?

Notes