# Investigating Forces
# Teacher Facilitation Notes

## In General . . .

- Project the slide deck in edit mode–do not show it as a slideshow.
- Hide the speaker notes before projecting. (View/Show Speaker Notes)
- Hide the toolbar. (Click on the up arrow at the right end of the tool bar.)
- Call on students to read the various content shown on slides.
- For each investigation, assemble the needed materials for each group and place in a central location for ease of distribution.
- Duplicate copies of the data sheets for each student.

## Materials Needed Per Group:

<u>Engage–The Great Ping Pong Ball Blow Out!</u>

| | | |
|---|---|---|
| Ping pong ball | Masking tape | Meter stick |

<u>Explore–The Effects of Forces</u>

| | | |
|---|---|---|
| Paper or foam bowl | Dried beans | Spring Scale |
| Baggie | Piece of felt | Legal-size clipboard |
| Piece of foil | Piece of sandpaper | Meter stick |
| Toy car | Pencil | Tape |
| Dictionary or large book | Large paper clips | Bar or wand magnet, 2 |
| Ring magnets, 3 | Unsharpened pencil | |

<u>Elaborate</u>

| | | |
|---|---|---|
| Small toy car | Paper clips, 2 | Tape |
| Magnet | Piece of paper | Cardboard |
| Marker | | |

## Other Materials

| | |
|---|---|
| Student Recording Sheets | Pencils |
| Straws, 1 per student | Science notebooks, 1 per student |
| Hole punch | |

# Investigating Forces
# Teacher Facilitation Notes, p. 2

## Engage: The Great Ping Pong Ball Blowout!

- Watch the video. Discuss pushes and pulls as desired.
- Read through the introductory portion of the investigation. Make sure students understand the question and what they are investigating.
- Read through the steps as the students investigate. Circulate among the groups asking questions, and redirecting thinking, as necessary.
- Once all students have had a chance to blow and record their results, ask the following questions:
    - Who blew the ball the farthest in your group? How far did it go?
    - Was the ball that went the farthest blown with a puff or a long breath?
    - What is the relationship between the puffs and the distance that the ball traveled?
    - What is the relationship between the long breaths and the distance that the ball traveled?
    - Was the force of your breath a push or a pull?
    - Was your breath a force that was in contact with the ball? Explain.

## Explore

- Before beginning this lesson, use a hole punch to make a hole near the top of each foam bowl. The hole should allow room for a spring scale to be hooked to the bowl. Fill a snack baggie with beans for each group.
- Read through the introductory slides with the students. Briefly discuss the types of forces. (Students will not be held accountable for naming forces as applied, tension, or noncontact–these are just scientific ways to name pushes and pulls. They do need to know that contact forces must be touching the object to affect its motion.)
- Throughout this lesson, reinforce the following ideas:
    - A force is a push or a pull.
    - Forces act on objects in certain directions.
    - Forces can cause objects to change motion, direction, or speed.
- As students begin the investigation, discuss how pushes and pulls are different. (A push moves the object away. A pull is toward you.) Remind the students that we say the ball is in *motion* when it is moving.
- What evidence can be used to know that a force was applied to the bowl? (It moved.)

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**Explore, continued**

- Be sure students understand that the stronger a push or a pull, the more movement it causes.
- Ask students if using their hands to push a pull the bowl is an example of a force in contact with the object or a force acting at a distance.
- If necessary, demonstrate how to use a spring scale to measure a force.
- Have groups work through the first part of the investigation. Ask questions, as desired.
- For the friction investigation, you might need to help students answer the question about the cause/effect relationship. They should understand that on smoother surfaces, less friction is produced. Conversely, on rougher surfaces, more friction is produced. (Asking this question gives this investigation a touch of correlational study.)
- As students investigate magnetism, point out that magnetism can cause motion when it is in contact with a magnetic object AND when it is not in contact with a magnetic object.
- During the magnetism investigation, point out that the magnet has two poles: a North pole and a South pole. When the North pole of one magnet is close to the South pole of another magnet, the first magnet can *pull* the second magnet. When the North pole of one magnet is close to the North pole of another magnet, the first magnet can *push* the second magnet away.
- Once they investigations are complete, discuss as desired.

**Explain**

- Call on volunteers to read each paragraph of the explanation slides.
- Emphasize the vocabulary terms as students read the passage.
- Discuss as desired, or use the following questions to guide the discussion.
  - What is a force?
  - Why does a ball sitting on the ground not move on its own?
  - What force slows or stops the movement of objects?
  - Which forces work by touching the object (contact force)?
  - Which forces do not have to touch the object to change their motion (noncontact force)?
  - What evidence shows that gravity is a force acting on objects found on or near Earth's surface?

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**Elaborate**

- Read through the design brief and criteria/constraints with students.
- Let groups work independently to design, construct, and present their magnetic race track.
- Allow time for a “Design Showcase” where groups present their final products. Ask questions as desired.

**Evaluate**

- Let students complete the quiz independently.
- Discuss evaluation as desired.

# Investigating Forces

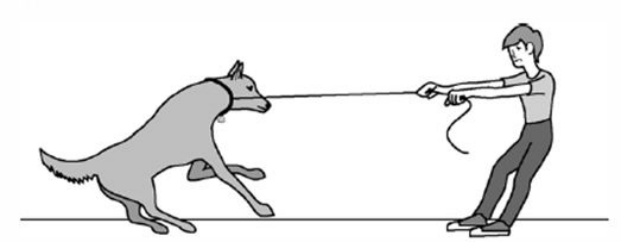
Name: KEY

## Evaluation

1. Which of the following are characteristics of friction? Mark all that apply.

   **A** Friction is a force.
   **B** Objects do not need to touch in order to have friction.
   **C** Friction does not act on moving objects.
   **D** Friction is a rubbing force between objects.
   **E** Friction is a force that slows or stops motion.

2. Which Of the following best describes the forces being used by the dog in this picture?



   **F** The dog is pulling on the ground and pulling on the rope.
   **G** The dog is pulling on the ground and pushing on the rope.
   **H** The dog is pushing off the ground and pulling on the rope.
   **J** The dog is pushing off the ground and pushing on the rope.

3. Which of these is caused by the same force that causes objects to fall toward the Earth's surface?

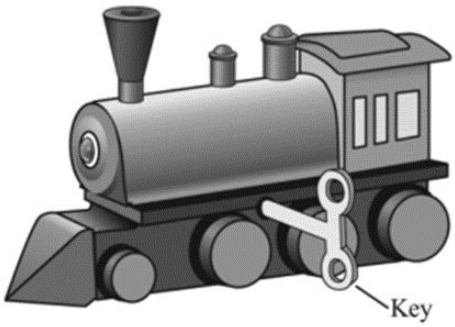
   **A** An apple falls from the tree when it is ripe.
   **B** A magnet pushes another magnet away.
   **C** A rolling ball slows down and stops.
   **D** A helicopter takes off straight up into the air.

# Investigating Forces

Name: KEY

## Evaluation

4. The picture shows a wind-up toy train. The key on the side of the train is turned to wind up the toy. A student turned the key 3 times and the train moved 15 cm. What would most likely happen in the student turned the key 6 times?




F The train would not move.

G The train would move more than 15 cm.

H The train would move less that 15 cm.

J The train would move backwards.

5. Throwing a paper airplane and kicking a soccer ball are both examples of–

A pulls

B pushes

C friction

D gravity

6. When a pushing force is used to move an object, the object moves–

F toward the force very quickly

G down towards the Earth's surface

H in the same direction as the force

J in the opposite direction of the force

7. Which of the following forces must be in contact with an object to change its motion?

A friction

B speed

C electricity

D gravity

# Investigating Forces

Name: KEY

## Evaluation

8. Which of the following forces can described as contact forces?

   F Friction
   G Gravity
   H Magnetism
   J Pushes
   K Pulls

9. The boy is about to kick the soccer ball. Which of the following best describes the motion of the soccer ball after the boy kicks it? The soccer ball will–

   A move with friction and then against friction
   B move toward the boy and then away from him
   C go straight down to the ground and roll to a stop
   D go higher in the air and then move away from the boy

10. Pretend you are outside on the playground. You and your friend are playing catch with a baseball. You wind up and throw the ball up in the air toward your friend. Draw an example of what would happen to the ball. Label all the forces that cause the ball to change motion.

**Students' drawings should show the ball going up in the air from a PUSH. Then GRAVITY will pull the ball down. If the ball hits the ground and rolls, FRICTION will stop its motion. Accept all reasonable answers that students can justify.**

# Investigating Forces

Name: _____

**Engage: The Great Ping Pong Ball Blowout!**

**Question**

How does the force of air affect the motion of a ping pong ball?

**My Hypothesis**

| The Great Ping Pong Ball Blowout! | | |
|---|---|---|
| | **Short Puff (in cm)** | **Long Breath (in cm)** |
| **Person #1** | | |
| **Person #2** | | |
| **Person #3** | | |
| **Person #4** | | |
| **Person #5** | | |
| **Person #6** | | |

**My Conclusions:**

# Investigating Forces

Name: _____

**Explore: The Effects of Forces, Part 1**

**Question**

How does mass affect the amount of force it takes to push or pull an object?

**My Hypothesis**

1. How did pushing the bowl harder affect its movement?

2. How is a push different from a pull?

3. Empty bowl _____

4. Bowl with beans _____

5. How does pushing and pulling the bowl with beans in it differ from pushing and pulling the empty bowl?

**My Conclusions:**

# Investigating Forces

Name: _____

**Explore: The Effects of Forces: Part 2 (Friction)**

1. Record the distance the car traveled in each trial.

| Surface | Distance Traveled (cm) |
|---|---|
| Plain ramp | |
| Felt-covered ramp | |
| Foil-covered ramp | |
| Sand-paper covered ramp | |

2. What force caused the car to stop rolling? _____

3. Which surface had the least friction? How do you know?

4. What is the cause/effect relationship between different types of surfaces and the amount of friction that occurs?

**My Conclusions:**

# Investigating Forces

Name: _____

**Explore: The Effects of Forces, Part 3 (Gravity and Magnetism)**

1. What happened when you let go of the paper clip?

2. You did not push or pull the paper clip, so what made the paper clip fall down to the top of your desk or table?

3. What happened when you touched the magnet to the paper clip?

4. What happened when you held the magnet close to the paper clip?

5. What did your group do to see if the magnet could move more than one paper clip at a time?

6. How did you make a magnet push the other magnet away?

**My Conclusions: Why do the ring magnets stay separated on the pencil?**

# Investigating Forces

Name: _____

**Elaboration: Race to the Finish!**

## Magnetic Race Track

Design and construct a magnetic race track for a toy car.

## Criteria/Constraints

- A toy car must go around the track using magnetic force.
- There must be at least 1 curved section of track, 1 straight section of track, and 1 zigzag section of track along which the car travels.
- The car must move along the track in 45 seconds or less.
- The magnet cannot touch the car directly.
- You may only use the materials listed in the Materials list.

## Materials

Small toy car
2 Paper clips
Tape
Magnet
Paper
Cardboard
Marker


## Design/Build/Test

- Plan how you will draw out your race track and make it curved, straight, and zigzag.
- Draw out your race track on the piece of cardboard.
- Decide how to make the car magnetic.
- Test the race track at least three times. Make any changes you need as you test it.
- Present your race track to the rest of the class.

# Investigating Forces

Name: _____

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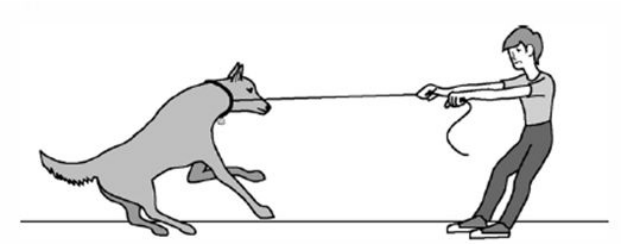

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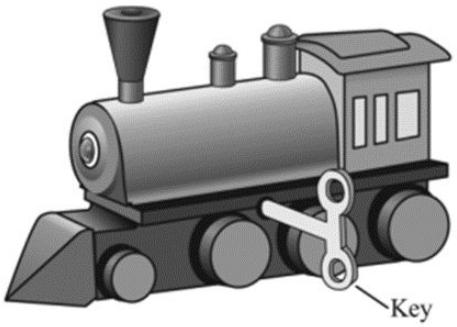


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7. Which of the following forces must be in contact with an object to change its motion?

A friction

B speed

C electricity

D gravity

# Investigating Forces

Name: _____

## Evaluation

8. Which of the following forces can change the motion of an object without touching the object? Mark all that apply.

   **F** Friction

   **G** Gravity

   **H** Magnetism

   **J** Pushes

   **K** Pulls

9. The boy is about to kick the soccer ball. Which of the following best describes the motion of the soccer ball after the boy kicks it? The soccer ball will–

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