Patterns of 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–Moving Along</u>

Toy car	Pencil	Meter stick
Moving Along Template		

<u>Explore–Just Hanging Around (Gravity)</u>

Identical Rubber bands, 5	Large paper clips, 5	Meter stick
Scissors, 1 pair	Highlighter, 1	Pennies, 40-50
Digital scale or balance	Baggie, 1	Wooden ruler, 1

<u>Explore–Is Friction Fiction</u>

Sneaker	Spring scale

Access to different surfaces: tabletop, tile, carpet, grass, sidewalk

<u>Elaborate</u>

Craft sticks, 15	Cardstock, 2 sheets	Felt square, 1
Masking tape, 30 cm	Wax paper, 30 cm sheet	Rubber bands, 3
Foil, 30 cm sheet	Chenille sticks, 4	Playdough
Legal-size clipboard	Several thick books	

<u>Evaluation</u>

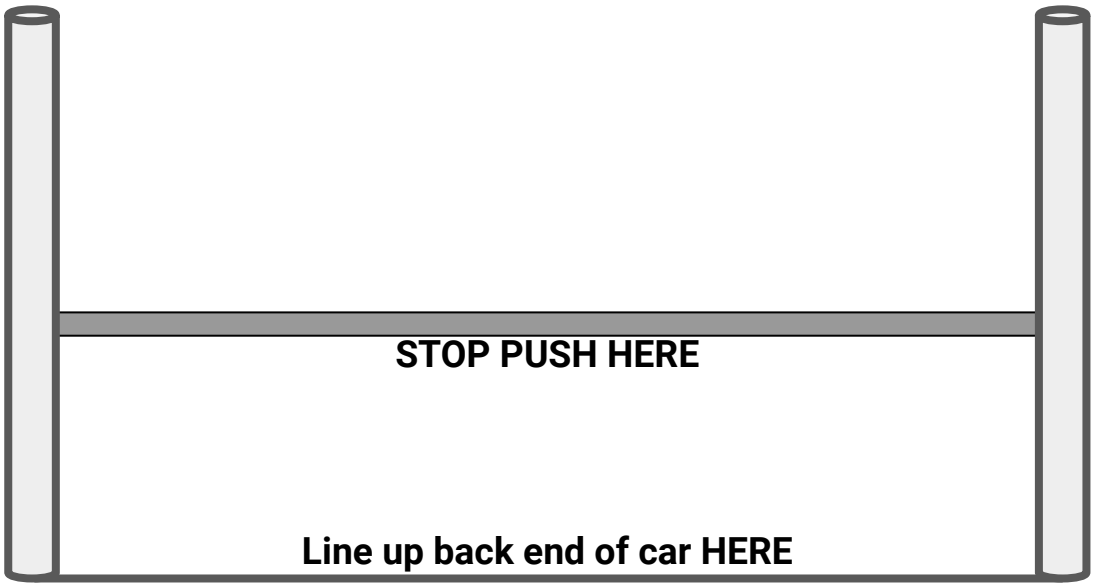
Markers

Large sheet of construction paper or chart paper

Other Materials

Student Recording Sheets	Pencils	Cardstock
Hole punch	Student evaluation documents	

Patterns of Forces
Moving Along Template



Trial 1

START PENCIL PUSH HERE

Trial 2

START PENCIL PUSH HERE

Trial 3

START PENCIL PUSH HERE

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Engage: Moving Along

- Duplicate a copy of the *Moving Along* template on cardstock for each group.
- Call on volunteers to read the introductory page. Discuss as desired.
- Have groups complete the investigation independently or working in tandem as you read each step.
- Once the students have completed the investigation, facilitate a classroom discussion. The following questions may be used:
    - What is a force?
    - When you moved the car with the pencil, in what direction did the car move, toward you or away from you?
    - Was this a push or a pull? How do you know? [A push moves the object away from the source of the force. A pull moves the object toward the source of the force.]
    - Was the force in contact with the car or did it work at a distance? Explain.
    - In which trial did the car move the longest distance? Why do you think this happened?
    - Give an example of something you have pushed today; something you have pulled.

Explore: Just Hanging Around (Gravity)

- Use the hole punch to punch holes in snack baggies. Put 40-50 pennies in a baggie for each group. Place all of the needed materials in a central location for ease of distribution.
- Read through the introductory paragraph with students. Discuss as desired.
- As students do the first part of the investigation, the observer should get down close to the floor or the top of the desk, so they can easily see that the two objects hit at the same time.
- Facilitate a discussion once the students have completed the entire investigation. The following questions might be used in prodding discussion:
    - What is gravity?
    - How do you know gravity works on objects near the Earth?
    - What happened when you dropped two objects with different masses? Does mass affect the pull of gravity? Explain.
    - Why did the rubber bands stretch when you put the objects on them?
    - Which rubber band stretched the most? Why? [Most likely the baggie of pennies stretched the rubber band the most. That is because the pennies have the greatest weight.]
- Discuss as desired.

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Explore: Is Friction Fiction?

- As they do this investigation, remind students that the spring scale is used to measure a pulling force as the shoe moves. The unit of measurement is known as Newtons (N). More Newtons means it takes more force to pull the shoe.
- Allow the groups to work independently on this investigation. Take them to the various locations where they can find a tiled floor, a carpeted floor, a sidewalk, and grass.
- Facilitate a class discussion concerning their results and conclusions. If desired, ask the following questions:
  - What tool did you use to measure force?
  - What unit is used to describe the force?
  - What force was produced between the shoe and the surface over which it moved?
  - Was this a force in contact or a force at a distance?
- If desired, discuss the negative and positive aspects of friction. For example, the lack of friction on a wet tile floor may cause someone to fall and injure themselves. However, friction in a car's brakes allow the car to stop.

Explore: What's the Attraction

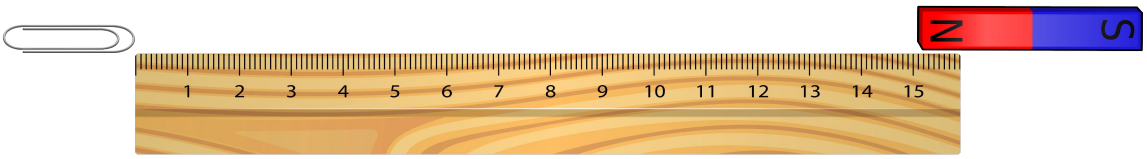
- Read through the introductory slide with the students. Discuss as desired.
- Read the question with the students and have them record their hypotheses on the data sheet.
- Work together as a class to design an investigation to find out the answers to the question. (See Sample in this document.) Write the procedures on the board or project using a document camera.
- Depending on ability level, allow the groups to work independently or in tandem as you read and discuss each procedure.
- Facilitate a class discussion about their results and conclusions. If desired, ask questions like the following:
  - When you pushed and pulled it around on the table, was the magnetic force in contact with the paper clip or working at a distance?
  - When you pushed the magnet toward the paperclip at the end of the ruler, what happened?
  - Did the magnet have to touch the paper clip to move it? Why not?
  - What happened when the North poles of each magnet were facing each other? The South poles?

Patterns of Forces
Sample Lesson: What's the Attraction

Procedures

Part 1: Magnets can pull objects.

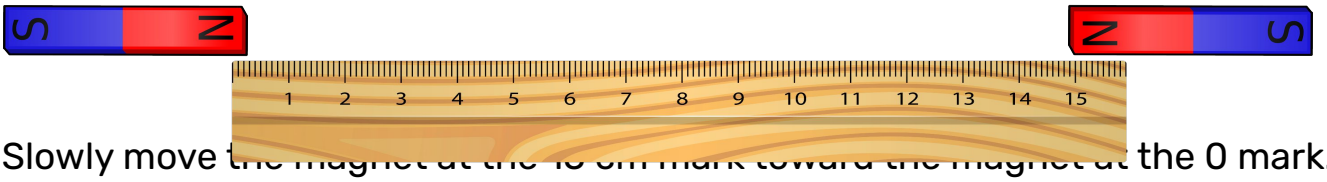
- Lay the ruler flat on the desk or table. Set the narrow end of a paperclip on the table close to the ruler so that it is at the 0 mark.
- Place a bar magnet on the table next to the ruler so that the front end of the magnet is at the 15 cm mark.



- Holding the ruler in place with one hand, SLOWLY slide the magnet toward the paperclip with your other hand. As soon as the paperclip moves toward the magnet, STOP moving the magnet.
- Record the location of where the magnet stopped along the ruler in your data table.
- Repeat this procedure two more times.

Part 2: Magnets can push objects.

- Lay the ruler flat on the table or desk. Place the North pole of one magnet (magnet A) at the end of the ruler at the 0 mark.
- Place the other magnet (magnet B) with the North pole end at the 15 cm mark.



- Slowly move the magnet at the 15 cm mark toward the magnet at the 0 mark. Take note of how many centimeters they are away from each other when magnet A begins to move.
- Repeat this procedure two more times and record all data on your data sheet.
- Now, flip the magnets. Have magnet A's south pole at the 0 mark and magnet B's south pole at the 15 cm mark. Repeat slowly moving magnet B towards magnet A until it moves three times. Record your data on the data sheet.
- Answer the questions and record your conclusions on the data sheet.

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Explain

- Read the introductory information with students.
- Watch the video. Stop the video to discuss or further explain key ideas as the students watch.
- Discuss the video as desired.
- Have students complete the graphic organizer to define and illustrate pushes/pulls, gravity, friction, and magnetism.
- Use the last two slides in this section to help students check their graphic organizers.

Elaborate

- Read through the directions with the students.
- Students will need to use the clipboards and books to make ramps for testing their sleds.
- Let them work in groups to complete the design challenge. Circulate among the groups as they work, asking questions and redirecting thinking as needed.
- Once all of the groups have completed their sleds, have a Design Showcase for students to display and explain their projects.
- Discuss as desired.

Evaluate

- Divide the class into 5 groups. Each group will be responsible for creating an anchor chart on one aspect of this lesson:
  - Forces (Push and Pull)
  - Contact forces vs. Non-contact forces
  - Gravity
  - Friction
  - Magnetism
- Go over the slides showing the directions and tips for making these anchor charts. Give students time to create and present their charts.
- Display the charts around the classroom or in nearby hallway.
- Let students complete the quiz independently.
- Discuss evaluation as desired.

Patterns of Forces

Name: KEY

Evaluation

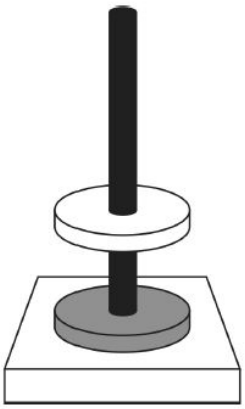
1. Which of the following forces do not need to be in contact with an object in order to change the object's motion? Mark 2 answer choices.

   A Friction
   B Magnetism
   C Gravity
   D Air resistance

2. A student tests the strength of several different magnets. Which observation could best help her compare the strength of the magnets?

   F The shape of the magnets
   G The size of the magnets
   H The type of objects attracted to the magnets
   J The distances objects are from the magnets when attracted

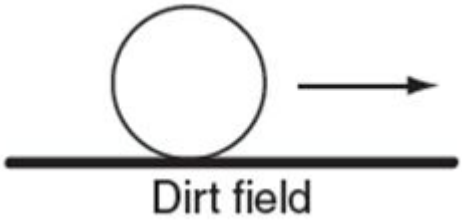
3. A student places one magnet on a wooden rod above another magnet as shown in the illustration. Why does the top magnet appear to float above the bottom magnet?



   A The magnets are made of different materials.
   B The like poles of the magnets push each other away.
   C The opposite poles of the magnets push each other away.
   D The like poles of the magnets are affected differently by gravity.

4. The picture shows a ball rolling along the dirt. What force(s) are acting on the ball? How do those forces affect the motion of the ball?

Gravity keeps the ball down on the ground.
Friction between the ball and the dirt cause the ball to slow down and stop.

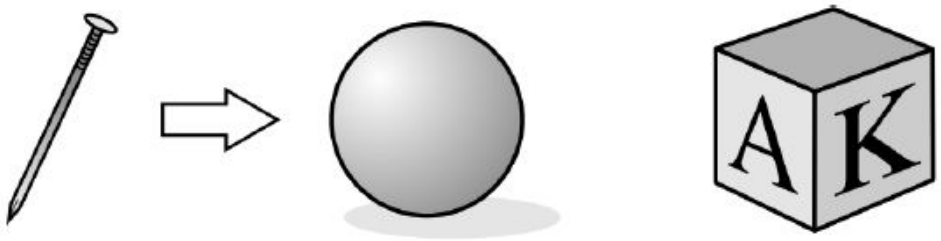


Patterns of Forces

Name: KEY

Evaluation

5. The picture shows a nail being attracted by Object X. The nail moves toward Object X, but the wood block does not. Which kind of force causes only the nail to move toward Object X?



Nail **Object X** **Wood block**

(F) Magnetism
G Gravity
H Friction
J Contact

6. Mark all answers that apply. More friction happens when an object rubs against–

F a smooth surface like tile
(G) a bumpy surface like a sidewalk
H an icy surface like a frozen pond
(J) a rough surface like asphalt
K a soft surface like thick carpet

7. A baseball player applies a pushing force on a ball thrown into the air. What applies a pulling force to the ball at the same time?

A The mass of the ball
(B) The force of gravity
C How hard the player squeezes the ball
D The force of friction

Patterns of Forces

Name: KEY

Evaluation

8. Which of the following events are caused by contact forces? Mark two answers.

F Falling back to Earth when you jump into the air

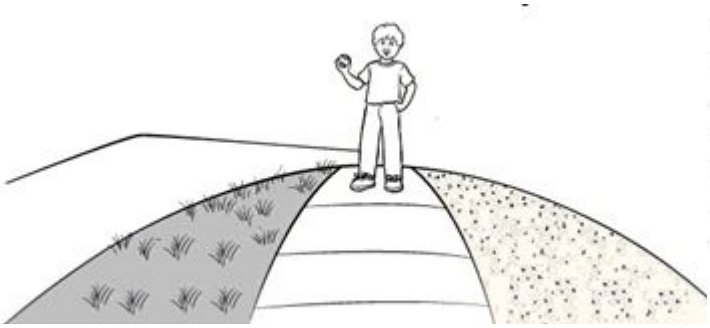
G Hitting a baseball with a bat

H Two magnets pushing each other away

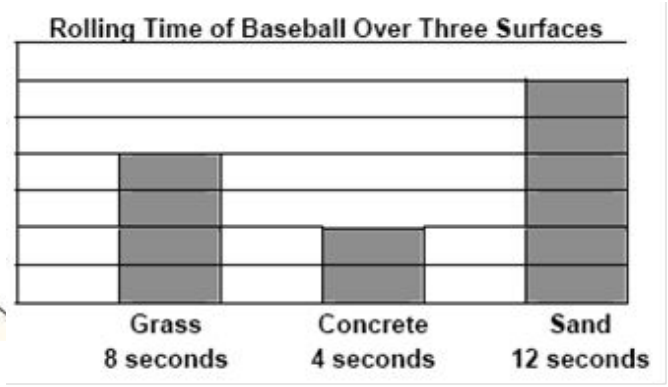
J Pulling a door open

K An apple falling from a tree when it is ripe

Use the illustration and the information in the graph to answer questions 9 and 10.



Grass Concrete Sand



9. Grass, concrete, and sand cover different parts of a hill. A student rolls a baseball down each part of the hill. He times how long it takes for the ball to reach the bottom. The results are shown in the graph. Which if the following is the student's best hypothesis for this investigation?

A Grass is softer than sand or concrete.

B Concrete is stronger than grass or sand.

C A ball rolls faster on concrete than on grass or sand.

D Gravity and friction work together to move a ball downhill.

10. Why does the ball roll at different speeds over the different surface?

F The force of gravity is different on each surface.

G Each surface has a different mass.

H Each surface covers part of the hill.

J The force of friction is different on each surface.

Patterns of Forces

Name: _____

Engage: Moving Along!

Moving Away	
Trial	**Distance Traveled (in cm)**
#1	
#2	
#3	

1. Which trial caused the car to move the greatest distance?

2. Why do you think the car moved different distances in each trial?

3. What is a force? Define this term in your own words!

My Conclusions: How does a force affect the movement of an object?

Patterns of Forces

Name: _____

Explore: Just Hanging Around (Gravity)

Question
What effect does gravity have on hanging objects?

My Hypothesis

Object	Mass (in grams)
Scissors	
Highlighter	
Baggie of pennies	
Wooden ruler	

1. What force caused the rubber bands to stretch? How do you know?

2. Which object has the greatest mass?

3. Which object stretched the rubber band the most? Why do you think this happened?

My Conclusions: What is the relationship between weight and the force of gravity?

Patterns of Forces

Name: _____

Explore: Is Friction Fiction?

Question
How does the texture of surface affect the friction between them?

My Hypothesis

Surface	Trial 1	Trial 2	Trial 3
Tabletop			
Tile floor			
Carpeted floor			
Sidewalk			
Grass			

1. On which surface did it take the most force to pull the shoe?

2. On which surface did it take the least force to pull the shoe?

3. What do you think caused the differences in the amount of force needed to pull the shoe on the various surfaces?

My Conclusions:

Patterns of Forces

Name: _____

Explore: What's the Attraction?

Question

At what distance will magnets begin to attract or repel objects?

My Hypothesis

Part 1: Pulling

	Distance between objects when paper clip moved (cm)
Trial 1	
Trial 2	
Trial 3	

Part 2: Pushing

	Distance between poles when magnet moved (cm)
Trial 1	
Trial 2	
Trial 3	

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

2. Why did the paperclip move when the magnet got close to it?

3. Why did one magnet move away when the other magnet got close to it?

My Conclusions: In what ways can magnets make objects move?

Patterns of Forces

Name: _____

Explain: Patterns of Forces

Directions: Define each vocabulary term. Then draw and label an illustration of each term.

Types of Forces

Push-and-Pull

Definition:

Illustration:

Gravity

Definition:

Illustration:

Friction

Definition:

Illustration:

Magnetism

Definition:

Illustration:

Patterns of Forces

Name: _____

Elaboration: Slip, Sliding Away

Sled Model

Design and construct a model of a sled that can safely carry a playdough person from the top to the bottom of a slope.

Criteria/Constraints

- The model sled must be constructed using only the given materials
- The model sled must slide freely down the slope without being pushed.
- The model sled must be able to carry a “person” as it slides.
- The slope must be a minimum of 30 cm in length.

Materials

(You may only use these materials, but you do not need to use them all.)

Craft sticks, 15
Cardstock, 2 sheets
Masking tape, 30 cm
Wax paper, 1 sheet (30 cm)
Foil, 1 sheet (30 cm)
Felt square, 1
Rubber bands, 3
Chenille sticks, 4
Playdough (to make person)

Design

Draw a sketch of what you think the sled should look like. Be sure to label the materials you will use in your construction.

Patterns of Forces

Name: _____

Elaboration: Slip, Sliding Away

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Construct

- Build the sled–it might not work the first time you test it.
- Test the final design at least three times.

1. Is the sled constructed using only the given materials?
2. Does the sled slide freely down the slope?
3. Does the “person” stay on the sled as it slides?

Improve

1. What is one way you could change your design to make it even better?
2. How could you make the sled go down the slope faster? Slower?
3. What could you do to make sure the “person” does not fall off the sled as it moves down the slope?

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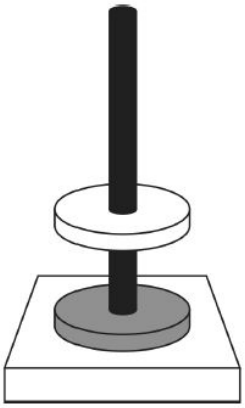

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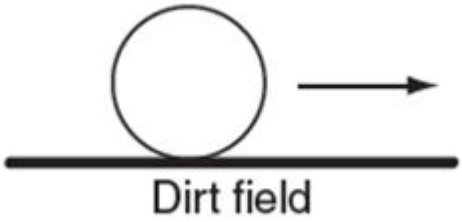

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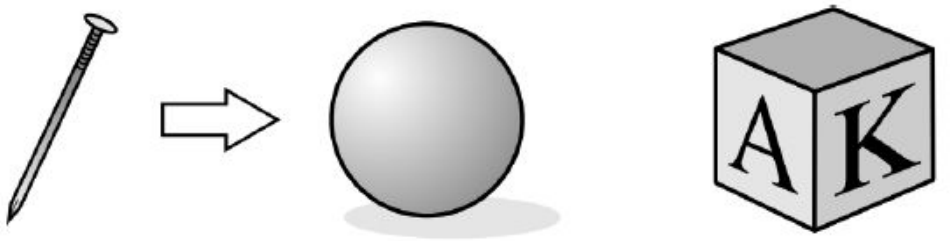

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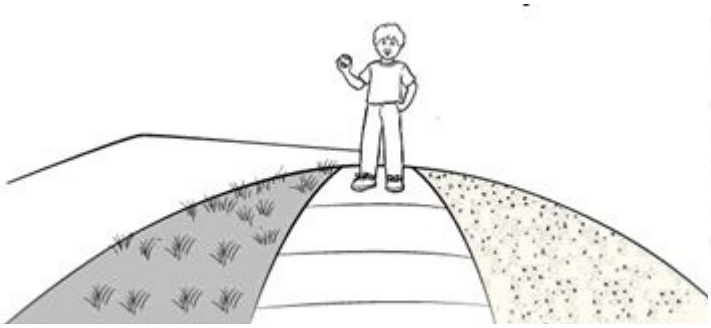

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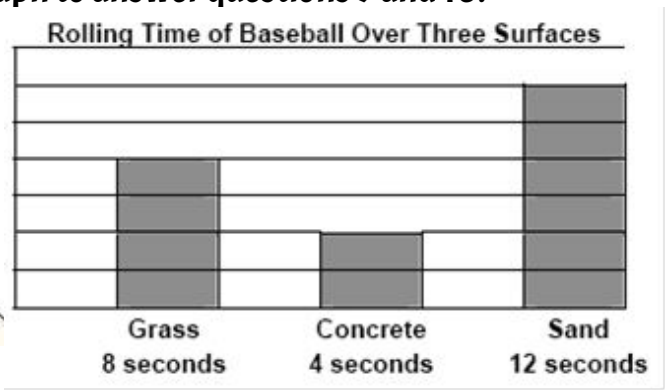

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