Forces and Patterns of Motion
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 filmstrip to the left. (View/Hide Filmstrip.)
- 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.

Materials Needed:

Explore: Balanced and Unbalanced Forces

Table tennis ball, 1 per pair of students
Plastic food container, 1 per group
Pennies, 30 per group
Straws, ½ per student
String, about 40 cm per group
Spring scale, 1 per group

Explain: Forces in Motion

Large sheets of construction paper of chart paper
Markers
Pencils
Rulers

Elaborate: Energy Transfer in Colliding Objects

Dominoes, 20 per group
Grooved rulers*, 2 per group
Masking tape
Golf balls, 5 per group
Textbooks, 2-3 per group

Evaluate:

Card stock
Tape or ticky-tack

Other Materials

Student Recording Sheets
Student Summative Evaluation
Pencils
Basketball or tennis ball
Science notebooks

*Use plastic rulers with a wide groove.

Advanced Preparations

Explore

- Cut straws in half so that each student can have ½ straw.
- Use a nail or a hole punch to poke a hole in the end of a disposable food container for each group. Tie one end of the string to the container. (See the drawing to the right.) Make a loop in the other end of the string.

Elaborate: Duplicate the Round-up Posters on cardstock.

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Engage: Forces and Their Properties

- Gently roll a ball along the floor or a table top. Roll it slowly so that it stops on its own.
- On a surface visible to all students, brainstorm words and terms that describe what the ball did. If necessary, carefully elicit words and terms such as *motion, force, start, stop*, etc.
- Introduce the topic with Engage Slide #1. Read and discuss the remainder of the Engage slides, calling on students to verbalize previous knowledge that they might have of forces and motion.

Explore: Balanced and Forces

- **NOTE**: In this lesson, the terms *equal forces* and *unequal forces* are used interchangeably with *balanced force* and *unbalanced forces.* The more accepted term for forces that are equal in size and opposite in direction is *balanced forces*. The term *unbalanced forces* is most often used to describe forces where the force applied in one direction is greater than the force applied in the opposite direction. It might be a good idea for students to be able to use both sets of terms when describing the motion of objects in this activity.
- Divide class into pairs. Give each student ½ straw and each pair of students 1 table tennis ball.
- Tell students to place the ball down on a flat surface (desk, table, floor, etc.). Ask students to describe the motion of the ball as it rests on the flat surface. They should understand that the ball is not in motion, it is *at rest*.
- Ask the following questions:
    - You know that forces such as a push or a pull make an object move. You also know that forces such as friction stop the movement of objects. Are there any forces acting on an object that is at rest, or still? Why or why not?
    - What forces are working on the ball to keep it at rest? (The pull of gravity and the pushing up of the surface)*

*The force that surfaces exert to prevent solid objects from passing through them is known as the *normal force*. Normal force is a contact force. If two surfaces are not in contact, they cannot exert a normal force on each other. Explain this to students as desired, but do not hold them responsible for defining normal force.

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Explore: Balanced and Forces, continued

- When the ball is at rest, are the forces acting on it equal or unequal? How do you know?
- What other objects can you see in the classroom that have equal forces working on them?

- Make sure each student has a recording sheet and a pencil. Have them complete part 1 of the recording sheet.
- Have each student use their half straw to blow a gentle puff of air at the ball and observe what happens.
- Ask the following questions:
  - What happens to the ball when the air comes in contact with it?
  - Why does the ball move?
  - What is motion?
  - When the ball moves, are the forces acting on it equal or unequal? How do you know?
  - Does the ball keep moving forever? What force causes the ball to stop moving?
  - In what direction does the push from the air move the ball? In what direction does friction work to stop the motion of the ball?
  - Are the force of gravity the pushing up of the surface still affecting the ball? How do you know?
- Explain that force is a *cause* and motion (or inertia) is the *effect*.
- Introduce Explore Lab #1. (The table tennis ball activity was an introduction to the exploration labs.) Read and discuss the Key Concept and the Key Question for this activity. Make sure groups have the necessary materials.
- Remind students that forces are measured in Newtons using a spring scale. If necessary review how to use and read a spring scale.
- Depending on student ability levels, complete this exploration as a class with each group finding and recording their own data OR with each group working independently to complete the investigation.
- Direct them to record their measurements on their data table.
- Ask the following questions:
  - How much force did it take to lift the empty container? The container with 30 pennies? Why is there a difference in the force needed?
  - How does mass affect the force it takes to lift or move the container?
  - When were the forces acting on the container balanced? Unbalanced?
  - Which object would take more force to start or stop its motion: a compact car or an eighteen-wheeler truck? Why?

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Explore: Balanced and Forces, continued

- Introduce Explore Lab #2. Read and discuss the Key Concept and the Key Question for this activity. Make sure groups have the necessary materials.
- Depending on student ability levels, complete this exploration as a class with each group finding and recording their own data OR with each group working independently to complete the investigation.
- Direct them to record their measurements on their data table and answer the questions on their recording sheet.
- Ask the following questions:
  - How did changing the force that hit the golf ball change the motion of the ball?
  - When were the forces acting on the golf ball balanced? How do you know?
  - When were the forces acting on the golf ball unbalanced? How do you know?
  - What force caused the ball to slow down and eventually stop?
  - How does increasing or decreasing the strength of a force affect the motion of an object?
- Discuss these activities as desired. Be sure that students can identify forces that act on an object when it is balanced and unbalanced.

Explain

- Read and discuss the explain slides. Review parts of the explore activities where appropriate to the reading.
- Divide the class into 6 groups. Each group will be responsible for creating an anchor chart for one aspect of this lesson:
  - Forces (Push and Pull)
  - Unbalanced forces vs. Balanced forces
  - Patterns of Motion
  - Friction
  - Magnetism
  - Gravity
- Go over the slides showing the directions and tips for making these anchor charts. Give students time to create and present their charts.
- Have students present and explain their charts.
- Display the charts around the classroom or in nearby hallway.

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Elaborate: Energy Transfer in Colliding Objects

- Read and discuss the introductory elaborate slide.
- Have groups complete Activity 1: The Domino Effect independently. Circulate among the groups asking questions and redirecting thinking as needed.
- Once all of the groups have completed the activity, facilitate a class discussion of their observations and conclusions. Make sure students verbalize how energy transfers from one domino to another causing motion.
- Continue in the same manner for Activity 2: Energy and Collisions.
- Discuss as desired.

Evaluate

- Force and Motion Round-up:
  - Randomly place the posters around the room. Mix them up so that they are not in the order in which they print. Tape them to walls or set them on counters, desks, tables, etc.
  - Students begin at any location. (To avoid confusion, you might assign each pair of students a starting poster so that there are only two people at the first poster.) They read the question at the bottom of the poster and then find the answer at the top of another poster somewhere in the classroom.
  - Students record their answers next to the correct question.
  - The process continues until all of the students have completed the circuit.
  - If completed correctly, the students should begin and end at the same poster!
- Have students complete the quiz independently.

Forces and Patterns of Motion

Name: KEY

Evaluation

1. A boy slides down a slide at a playground. Which **TWO** forces most affect the motion of the boy as he moves down the slide?

A Friction
B Speed
C Magnetism
D Gravity
E Inertia

2. When a moving object collides with an object at rest and makes it move, energy is–

F reflected back to the moving object from the still object
G canceled by the object that is not moving
H slowed down by friction from the moving object
J transferred from the moving object to the still object

3. A child put her soccer ball on the ground on the side of a hill. Which force acted on the soccer ball to make it roll down the hill?

A Gravity
B Friction
C Magnetism
D Normal

4. What causes objects to move or change their motion?

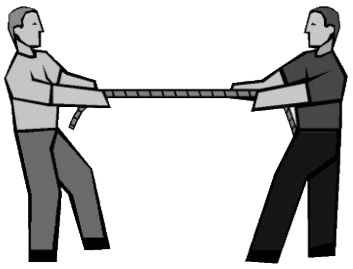
F Position and direction
G Balanced forces
H Unbalanced forces
J Speed and acceleration

Forces and Patterns of Motion

Name: KEY

Evaluation

5. Two men are each pulling on the opposite ends of a rope. If the men are pulling with balanced forces, what will happen to the rope? The rope will–



A stay in place between the two men

B move quickly to the right

C move slowly to the left

D fall to the ground

The illustration shows a girl pulling an empty wagon. Use the picture to answer questions 6 and 7.

6. How would the motion of the wagon be affected if she pulled with more force? **Sample Answers: The wagon would move faster, more easily, etc.**

7. How would the motion of the wagon be affected if she loaded the wagon with books and pulled it with the same force as she pulled the empty wagon?

Sample Answers: The wagon would move more slowly, be more difficult to pull, etc.

8. An object moving along a surface suddenly increases speed. What might cause this to happen?

F Balanced forces act on the object to keep it moving at the same speed.

G Unbalanced forces act on the object to change its speed.

H Opposite and equal forces act on the object to speed it up.

J Unequal forces cause the object to move in different directions.

Forces and Patterns of Motion

Name: KEY

Evaluation

9. A boy on a skateboard is rolling along a smooth sidewalk. His skateboard hits a rough spot and slows down. Which of the following best explains what caused the skateboard to slow down?

A The mass of the boy on the skateboard

B The size of the wheels on the skateboard

C Friction from the rough spot on the sidewalk

D Gravity on the skateboard and the boy

10. When a small, moving object collides with an unmovable object like a wall–

F the wall will move in the same direction and speed as the moving object

G the moving object will keep moving in the same direction and speed

H energy will be transferred from the object to the wall and back to the moving object

J both the wall and the moving object will be still because the forces acting on them are balanced

11. The illustration shows what happens when a magician pulls a tablecloth out from under some dishes on a table. Which of the following best explains why the dishes remain on the table after he pulls off the tablecloth?

A The inertia of the dishes

B The mass of the tablecloth

C The type of dishes he used

D The rough surface of the tablecloth

Unbalanced forces

#1

What is the term used to describe a push or a pull?

Force

#18

What term describes the amount of matter in an object or substance?

Mass

#6

What term means that something, such as energy, passes from one object to another?

Transfer

#4

What force causes a moving object to slow down as it rubs against another object or surface?

Friction

#17

What force pulls magnetic materials across a distance?

Magnetism

#3

What is the force that pulls all objects toward one another?

Gravity

#5

What term is used to describe two opposite and equal forces acting on an object?

Balanced forces

#11

What term describes the movement of an object in any direction?

Motion

#2

What property describes the tendency of an object to resist a change in motion?

Inertia

#12

What is the term for the ability to do work or cause changes in matter?

Energy

#16

What scientific tool is used to measure force (in Newtons)?

Spring Scale

#13

What is the term that describes a force that is applied to an object by another object or an organism?

Applied force

#9

The amount of force that is applied to an object is called its _____.

Strength

#7

What is the scientific term for something that keeps repeating in the same way?

Pattern

#15

What is the line or path along which something moves?

Direction

#14

What is a synonym for balanced forces?

Equal forces

#8

What are 2 forces that make it possible for a person to walk on a sidewalk?

Gravity and friction?

#10

What is it called when the forces acting on an object are unequal?

Forces and Patterns of Motion

Name: _____

Explore: Balanced and Unbalanced Forces, Introduction

1. In the box below, draw a sketch of the ball resting on the flat surface. Add labels to show the forces acting on the resting ball. Draw arrows to show the directions that the forces are acting.

2. What happened when the force of the air contacted the ball? Draw a sketch of the ball in motion in the box below. Label the forces acting on the ball as it moves and finally comes to a stop. Draw arrows to show the directions the forces are acting.

3. When are the forces acting on the ball equal (balanced)? How do you know? _____

   _____

   _____

4. When are the forces acting on the ball equal (balanced)? How do you know? _____

   _____

   _____

Forces and Patterns of Motion

Name: _____

Explore: Balanced and Unbalanced Forces, Explore Lab #1

1. Record the data from your exploration in the table below.

	Force Required to Lift Container Up				Force Required to Pull Container			
	Trial 1	**Trial 2**	**Trial 3**	**Average**	**Trial 1**	**Trial 2**	**Trial 3**	**Average**
Empty Container								
Container 10 pennies								
Container 20 pennies								
Container 30 pennies								

2. How did the strength of the force required to lift the empty container 30 cm compare to the strength of the force required to pull the container 30 cm?

_____

_____

3. Did it take more force to pull the empty container 30 cm or to pull the container with 30 pennies a distance of 30 cm? Give evidence from the data table to explain your answer.

_____

_____

4. How does mass affect the strength of the force needed to move an object? Use evidence from the data table to support your conclusion.

_____

_____

_____

_____

Forces and Patterns of Motion

Name: _____

Explore: Balanced and Unbalanced Forces, Explore Lab #2

1. Record the data from your exploration in the table below.

	Distance Golf Ball Traveled (in cm)			
	Trial 1	**Trial 2**	**Trial 3**	**Average**
Pulled back to 2 cm				
Pulled back to 4 cm				
Pulled back to 6 cm				

2. Compare the distances the golf ball traveled when you changed how far you pulled back on the ruler. What can you conclude?

_____

_____

_____

3. When were the forces acting on the golf ball balanced? What forces were acting on the ball when it was balanced?

_____

_____

4. When were the forces acting on the golf ball unbalanced? What forces were acting on the ball when it was unbalanced?

_____

_____

5. How does increasing or decreasing the strength of a force affect the motion of an object? _____

_____

_____

Forces and Patterns of Motion

Name: _____

Explain: Forces in Motion

Study each phrase or situation. Decide if it describes BALANCED FORCES or UNBALANCED FORCES. Write the correct term in each box.

Equal forces acting in opposite directions

A rolling ball comes to a slow stop

A book lying on a table

Two forces that are not equal in strength

A car keeps moving in the same direction at the same speed

An apple falls from a tree

1. How do forces affect the motion of objects? _____

_____

_____

2. What is the difference between balanced and unbalanced forces? _____

_____

_____

Forces and Patterns of Motion

Name: _____

Elaborate: Energy Transfer in Colliding Objects

1. What force was applied to make the domino at rest move? _____

   _____

2. How was energy transferred from one domino to another when you placed them in a straight line or any other pattern? _____

   _____

   _____

3. What did you observe when you released one golf ball into the line of 4 golf balls? _____

   _____

4. What did you observe when you released 2 golf balls into the line of 3 golf balls? Why do you think this happened? _____

   _____

   _____

5. What is happening to the energy in the moving golf ball when it collides with the other golf balls? How do you know? _____

   _____

   _____

6. When the golf ball hit the wall, how did the motion of the golf ball change? How did the motion of the wall change? _____

   _____

7. Based on your investigations, what can you conclude about the transfer of energy when objects collide? _____

   _____

   _____

Forces and Patterns of Motion

Name: _____

Evaluate: Force and Motion Roundup

Directions: Locate and write the correct answer to each question in the spaces provided.

1	What is the term used to describe a push or a pull?	
2	What property describes the tendency of an object to resist a change in motion?	
3	What is the force that pulls all objects toward one another?	
4	What force causes a moving object to slow down as it rubs against another object or surface?	
5	What term is used to describe two opposite and equal forces acting on an object?	
6	What term means that something, such as energy, passes from one object to another?	
7	What is the scientific term for something that keeps repeating in the same way?	
8	What are 2 forces that make it possible for a person to walk on a sidewalk?	
9	The amount of force that is applied to an object is called its _____.	

Forces and Patterns of Motion

Name: _____

Evaluate: Force and Motion Roundup, page 2

10	What is it called when the forces acting on an object are unequal?	
11	What term describes the movement of an object in any direction?	
12	What is the term for the ability to do work or cause changes in matter?	
13	What is the term that describes a force that is applied to an object by another object or an organism?	
14	What is a synonym for balanced forces?	
15	What is the line or path along which something moves?	
16	What scientific tools is used to measure force (in Newtons)?	
17	What force pulls magnetic materials across a distance?	
18	What term describes the amount of matter in an object or substance?	

Forces and Patterns of Motion

Name: _____

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1. A boy slides down a slide at a playground. Which **TWO** forces most affect the motion of the boy as he moves down the slide?

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Forces and Patterns of Motion

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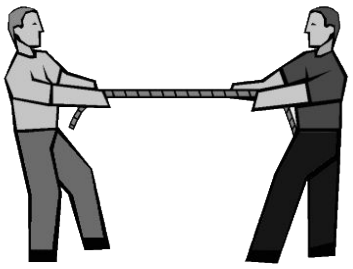

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Forces and Patterns of Motion

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