Teacher Guide and Student Journal

Sample Planning and Activity Pages

3rd grade

Forces and Interactions

Teacher Guide

Sample

Planning Sections & Activity #2

3rd grade

Forces and Interactions

CEREAL CITY SCIENCE
by BCAMSC

Forces and Interactions
3PNG

A Third Grade Unit
supporting
Next Generation Science Standards and
the Michigan Science Standards

developed and written by
Battle Creek Area Mathematics and Science Center
for

CEREAL CITY SCIENCE
by BCAMSC

Forces and Interactions

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Forces and Interactions

UNIT INTRODUCTION

GRADE LEVEL:

- Third Grade

THIS UNIT BUILDS KNOWLEDGE FROM KINDERGARTEN AND IS A PREREQUISITE FOR:

- Middle School: *Forces and Interactions*

ABOUT THIS UNIT:

This unit is intended to build on the experiences and understandings of forces and interactions from the Kindergarten Unit, *Motion: Pushes and Pulls*. Students made observations, internalized questions about those observations, and investigated through trial and error, allowing them to anticipate, interpret, and make sense of the motion of objects. This unit builds and refines those ideas into forms that enable more subtle inferences about objects and their behaviors over intervals of time and space. They form a better sense of causation and recognition of patterns in the motion of objects.

In this unit the activities are geared to build on the inherent knowledge and experience that third-grade students have already acquired and use their knowledge in a wider range of tasks. Students will be given the opportunity to examine, measure, reflect upon, describe, and discuss how forces of various origins are used to produce and control motion. They may be asked to analyze what they are already taking for granted. Students will look at things from a different perspective and consider what they may have previously overlooked. *Forces and Interactions* is designed for third-grade students, and as a result of these lessons, students will be able to:

1. Observe and measure the motion of objects to discover patterns in motion.
2. Recognize patterns in data to use to make predictions of future motion.
3. Manipulate materials to change the motion of an object with contact forces based on patterns of motion.
4. Collect and communicate evidence that multiple forces have strength and direction and act on objects (balanced and unbalanced forces).
5. Manipulate materials to change the motion of objects not in contact with one another using electric or magnetic interactions.
6. Demonstrate, through solving an engineering problem, how magnetism can be used to change the motion of an object.

NEXT GENERATION SCIENCE STANDARDS

Disciplinary Core Ideas	Activity
PS2.A: Forces and Motion • Each force acts on one particular object and has both strength and a direction. An object at rest typically has multiple forces acting on it, but they add to give zero net force on the object. Forces that do not sum to zero can cause changes in the object's speed or direction of motion. PS2.B: Types of Interactions • Objects in contact exert forces on each other.	1,2,3,4,6
3-PS2-1. Plan and conduct an investigation to provide evidence of the effects of balanced and unbalanced forces on the motion of an object.	1,2,3,4,5
PS2.A: Forces and Motion • The patterns of an object's motion in various situations can be observed and measured; when the past motion exhibits a regular pattern, future motion can be predicted from it.	1,2,3,4,5,6,
3-PS2-2. Make observations and/or measurements of an object's motion to provide evidence that a pattern can be used to predict future motion.	1,2,3,4,5,6
PS2.B: Types of Interactions • Electric and magnetic forces between a pair of objects do not require that the objects be in contact. The sizes of the forces in each situation depend on the properties of the objects and their distances apart and, for forces between two magnets, on their orientation relative to each other.	7,8
3-PS2-3. Ask questions to determine cause-and-effect relationships of electric or magnetic interactions between two objects not in contact with each other.	7,8
3-PS2-4. Define a simple design problem that can be solved by applying scientific ideas about magnets.	7,8
Science and Engineering Practices	
Asking Questions and Defining Problems	
• Ask questions that can be investigated based on patterns such as cause-and-effect relationships.	2,3,4,7,8
3-PS2-3. Ask questions to determine cause-and-effect relationships of electric or magnetic interactions between two objects not in contact with each other.	7,8
• Define a simple problem that can be solved through the development of a new or improved object or tool.	2,7,8
3-PS2-4. Define a simple design problem that can be solved by applying scientific ideas about magnets.	7,8

NEXT GENERATION SCIENCE STANDARDS

Planning and Carrying Out Investigations	
• Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence, using fair tests in which variables are controlled and the number of trials considered.	1,2,3,4,7,8
3-PS2-1. Plan and conduct an investigation to provide evidence of the effects of balanced and unbalanced forces on the motion of an object.	1,2,3,4,5
• Make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution.	1,2,3,4,7,8
3-PS2-2. Make observations and/or measurements of an object's motion to provide evidence that a pattern can be used to predict future motion.	1,2,3,4,5,6
Crosscutting Concepts	
Patterns	
• Patterns of change can be used to make predictions.	1,4,5,6,7
3-PS2-2. Make observations and/or measurements of an object's motion to provide evidence that a pattern can be used to predict future motion.	1,2,3,4,5,6
Cause and Effect	
• Cause-and-effect relationships are routinely identified.	1,2,3,4,5,6,7,8
3-PS2-1. Plan and conduct an investigation to provide evidence of the effects of balanced and unbalanced forces on the motion of an object.	1,2,3,4,5
• Cause-and-effect relationships are routinely identified, tested, and used to explain change.	1,2,3,4,5,6,7,8
3-PS2-3. Ask questions to determine cause-and-effect relationships of electric or magnetic interactions between two objects not in contact with each other.	7,8
Interdependence of Science, Engineering, and Technology	
• Scientific discoveries about the natural world can often lead to new and improved technologies, which are developed through the Engineering Design Process.	1,2, 7,9
3-PS2-4. Define a simple design problem that can be solved by applying scientific ideas about magnets.	7,8

PLANNING

UNIT AT A GLANCE

Activity	Time to Complete	Question	Phenomena	Summary: Students Will…
1	Preparation: 20 minutes Activity: 2 classes Lesson 2A: 45–50 min. Lesson 2B: 45–50 min.	How can we describe motion? How can we determine if there are patterns in observed motion?	A toy car strikes a barrier and it changes the direction of the car.	• Predict the motion of a toy vehicle. • Make and record observations of the car. • Record and analyze data for patterns. • Design an investigation to answer questions about motion of the car.
2	Preparation: 10 minutes Activity: 3 classes Lesson 2A: 45–50 min. Lesson 2B: 45–50 min. Lesson 2C: 45–50 min.	How do we measure motion? How can we change motion?	Design challenge: Design and carry out a plan to change the motion of a car to reach a determined destination and carry a load back to the starting point.	• Use prior data and observations about the motion of a toy vehicle. • Design and carry out an engineering plan to solve a problem. • Revise the engineering plan based on results.
3	Preparation: 10 minutes Activity: 2 classes Lesson 3A: 45–50 min. Lesson 3B: 45–50 min.	How can we find out if patterns in motion can be applied to different objects?	Different forces move objects in different directions at different speeds. The jumping frog requires a push that will make it move up and out in different directions. Different strengths of force change the motion of the cotton ball.	• Raise questions for investigation. • Design and carry out their investigation. • Determine the forces that affect the motion of the toys. • Recognize patterns that can be used to predict future motion of the toys.
4	Preparation: 15 minutes Activity : 5 classes Lesson 4A: 50–55 min. Lesson 4B: 50–55 min. Lesson 4C: 50–55 min. Lesson 4D: 50–55 min. Lesson 4E: 50–55 min.	How can we find out the effect of friction on motion? How is friction related to balanced and unbalanced forces?	The snail moves faster or slower depending on the surface it is moving on.	• Read a story about a problem of motion. • Make observations of friction using a variety of materials. • Conduct an investigation to determine the force of friction in a variety of materials.
5	Preparation: 15 minutes Activity 5: 2 classes Lesson 5A: 45–50 min. Lesson 5B: 45–50 min.	How can we find out the effect of gravity on motion?	The snail on rollers requires a push to start its motion. The snail stops and needs another push. The snail moves faster down the hill and needs a push up the hill.	• Continue to read about the problem of motion in the story. • Design an investigation to explore the effect of gravity on a variety of objects. • Recognize patterns associated with the force of gravity.

Students Figure Out How To:	Practices	PE at Lesson Level and Assessment
• Make observations and measurements to collect data about the motion of a toy vehicle. • Raise questions about the direction, distance traveled, and speed of the car. • Design an investigation to answer questions about the motion of the car.	Asking Questions and Defining Problems Planning and Carrying Out Investigations Analyzing and Interpreting Data Cause and Effect Patterns	PE at Lesson Level: Develop an initial understanding of how to describe motion. Review understanding of forces and how forces can change motion. Begin to raise questions and design an investigation. Formative Assessment: Class discussion/Science Talk Data chart Activity Pages
• Use data and observations to solve problems. • Use patterns in motion to determine future motion. • Determine when forces are balanced and unbalanced.	Asking Questions and Defining Problems Planning and Carrying Out Investigations Constructing Explanations and Defining Solutions Developing and Using Models Cause and Effect	PE at Lesson Level: Develop an understanding of how to use observations, patterns, and data to change motion. Formative Assessment: Activity pages Class discussion/Science Talk Summative Assessment: Journal Entry Product Descriptor and Presentations
• Collect and organize data. • Use data to recognize patterns. • Use patterns to predict future motion. • Compare and contrast forces used to move a variety of objects. • Measure distance traveled using metric system.	Asking Questions and Defining Problems Planning and Carrying Out Investigations Analyzing and Interpreting Data Constructing Explanations Cause and Effect	PE at Lesson Level: Use data to predict future motion of a variety of objects. Formative Assessment: Activity Pages Class discussion/Science Talk Summative Assessment: Investigation reports Journal Entry
• Relate friction to real-world applications. • Design an investigation to measure the force it takes to move an object over different surfaces. • Design an investigation to determine if adding weight will affect the force needed to move an object.	Asking Questions and Defining Problems Planning and Carrying Out Investigations Analyzing and Interpreting Data Patterns Cause and Effect	PE at Lesson Level: Recognize friction as a force that affects motion and use data to predict future motion. Formative Assessment: Activity Pages Class discussion/Science Talk Summative Assessment: Journal Entries Investigation reports (Conclusions)
• Relate gravity to their everyday activities. • Design an investigation to determine how gravity affects a variety of objects in motion. • Use patterns in data to predict future motion.	Asking Questions and Defining Problems Planning and Carrying Out Investigations Analyzing and Interpreting Data Constructing Explanations Cause and Effect Patterns	PE at Lesson Level: Recognize gravity as a force that affects motion and use data to predict future motion. Formative Assessment: Respond to Text Activity Page Summative Assessment: Journal Entries

UNIT AT A GLANCE

Activity	Time to Complete	Question	Phenomena	Students Will…
6	Preparation: 20 minutes Activity 6: 2 classes Lesson 6A: 45–50 min. Lesson 6B: 55–60 min.	How can we determine if objects at rest have forces acting on them?	Place an index card on a cup and a washer on top of the card, flick the side of the card with a sharp force, and observe the motion of the card and washer. Toys in Space	• Demonstrate through a simple device (cup, index card, and washer) how a force is necessary for motion. • Determine if there are examples on Earth that demonstrate Newton's first law.
7	Preparation: 5 minutes Activity 7: 3-4 classes Lesson 7A: 45–50 min. Lesson 7B: 20–30 min. Lesson 7C: 60-65 min.	How can we determine if electricity and magnetism are forces that affect motion?	Paper clips can move without touching the magnet to the paper clip. Two hanging magnets will attract and repel each other. Rub a balloon on hair or silk and the hair is attracted to the balloon. The properties of magnets and static electricity can provide a force to move objects without making contact.	• Demonstrate how magnets can attract and repel some objects depending on their properties. • Design an investigation to determine the strength and distance necessary to move small objects with a magnet. • Explore how objects charged due to static electricity attract and repel.
8	Preparation: 15 minutes Activity 8: 2–3 classes Lesson 8A: 50–55 min. Lesson 8B: 50–55 min.	How can electricity be used to make a magnet?	Paper clips are attracted to an electromagnet made from a battery, wire, and nail. Observe an electromagnet in a junkyard. Design challenge: Identify and solve a problem using the properties of magnets.	• Build an electromagnet to move objects. • Solve a problem using magnets as a noncontact force.

Students Figure Out How To:	Practices	PE at Lesson Level and Assessment
• Use evidence and patterns in evidence to determine the forces that affect motion.	Constructing Explanations Analyzing and Interpreting Data Developing and Using Models Cause and Effect Patterns	PE at Lesson Level: Relate information about motion to determine if there are patterns or "rules" that can apply to all motion on Earth. Summative Assessment: Class discussions/Science Talk Journal Entries
• Use data and observations to determine the force of a magnet needed to move an object over a distance. • Construct explanations regarding the ability of magnets to attract and repel one another. • Make connections between the charged balloon that attracts hair and the plastic comb that attracts paper dots.	Developing and Using Models Constructing Explanations and Designing Solutions Obtaining, Evaluating, and Communicating Information Developing and Using Models Cause and Effect	PE at Lesson Level: Solve a problem using magnets as a noncontact force. Formative Assessment: Class discussion/Science Talk Summative Assessment: Activity Pages Journal Entries
• Build a model of an electromagnet and analyze the construction to make improvements. • Apply their information about magnets as a noncontact force to design a device to solve a simple problem.	Developing and Using Models Constructing Explanations and Designing Solutions Cause and Effect Interdependence of Science, Engineering, and Technology	PE at Lesson Level: Evaluate an electromagnet and determine how to increase the strength of the magnet. Summative Assessment: Journal Entry Engineering Presentations

Activity 1: Observations of Motion: Toy Vehicle

Teacher Background Information

Motion is the changing of position of an object. The motion of an object can be described by its position, direction of motion, and speed. In this activity, students make observations of a car as it moves across the floor. The beginning activity is intended to lay the foundation by making observations to describe motion in terms of position, direction, and speed.

Young learners are familiar with the observable effects of motion but may not have considered the variety of motion that they observe every day. The various types of motion are visible all around us; a bicycle, a yo-yo, a Slinky, and an amusement park ride are all fun examples of motion. Students may not have considerable experience observing and measuring motion, looking for patterns in data, and predicting the future motion based on data. The high interest in motion of toys provides an opportunity for student-led investigations into motion. Students make observations, ask questions, and design and conduct an investigation to answer their questions. It is intentional that there is very little instruction on how the data should be collected, recorded, or presented. In this activity, students will show what they know and understand about motion and recording data.

Following activities focus on the necessity of gathering and presenting data in an organized fashion. Groups will have the opportunity to revisit this activity and use new skills in describing motion and calculating speed.

Engage the Learner

This phase of the learning introduces and activates prior knowledge regarding forces and motion. Students observe the motion of a toy vehicle and make connections between what they have observed and the learning task. They will make predictions, record their observations, and enter data in the Student Journals. Students' initial ideas are recorded on the *Thinking About Motion* chart. The chart is referred to and updated throughout the lessons, providing students with a venue in which to make conceptual change regarding motion.

Lesson 1A: Observations of Motion: Toy Vehicle

Advance Preparation

Duplicate copies of the Pre- and Post-Assessment for your class. (See Assessment section for assessment and rubric.)

Duplicate copies of the unit *Parent Letter* and *Activities To Do At Home* to be sent home.

ESTIMATED TIME

Lesson 1A: 60–65 minutes
Lesson 1B: 60–65 minutes

OBJECTIVE

Observe and measure the motion of objects to describe motion and discover patterns in motion.

KEY QUESTIONS

What patterns in motion can be observed through observation and measurement?

How do we describe motion?

PRE-ASSESSMENT

- Give the Pre-Assessment to assess the students' prior knowledge of the topics included in this unit.
- Additional time may be necessary beyond the estimated lesson time.
- This same assessment will be given at the end of the unit so the students' Pre- and Post- Assessment responses can be compared.
- Be consistent in administering the Pre- and Post-Assessments.
- The assessment and rubric are located in the Assessment section of the unit.

LESSON 1A

MATERIALS NEEDED
For each student:
- 2 student pages

For each group of 4:
- 1 measuring tape
- 1 toy vehicle (2 batteries)

Teacher provides:
- masking tape
- chart paper
- markers
- timing devices

TEACHING TIP

Throughout the activities in the Teacher Guide you will notice that specific student instructions from the Student Journal pages are given first and italicized. Additional information for the teacher follows the italicized instructions in plain print.

Specific student questions from the Student Journal are also italicized in the Teacher Guide. Answers to the questions are surrounded by parentheses.

READING

Key Ideas and Details

RI.3.1: Ask and answer questions to demonstrate understanding of a text, referring explicitly to the text as the basis for answers.

Integration of Knowledge and Ideas

RI.3.7: Use information gained from illustrations (e.g., maps, photographs) and the words in a text to demonstrate understanding of the text (e.g., where, when, why, and how key events occur).

Make a *Toy Vehicle Data Table* on the board or chart paper to record distance and time for the motion of the car. Place two C batteries in each toy vehicle.

Toy Vehicle Data Table

	Prediction What you think will happen?	Trial #1	Trial #2	Trial #3
Distance (cm)				
Time (sec.)				

Locate a flat surface and mark a starting line and ending line on a table or floor for the car demonstration.

Procedure

Engage the learner.

Read the *Fire Truck Express* text in the Student Journal as a class. Discuss the children's observations and the challenge in the story. Ask students to cite the children's observation that helped them to think about changing the direction of the fire truck. Ask students to share similar experiences with objects colliding. Ask students to describe observations of what happens when balls collide with the wall or other balls. Relate the students' experiences to observations of the children in the story.

Place the car on the starting line. Ask the students if the car is in motion. Ask, "Is the car moving? How can you tell?" Listen for responses that may include that it has not moved because it is in the same location or it has not traveled a distance. Ask, "What does the car need to start it in motion?" Listen for responses that may include that it needs a force, or a push or pull, to start the car in motion. Ask students if they think any forces are acting on the car when it is at rest. Note: Do not influence their responses at this time.

Ask students to predict what will happen when the car is set in motion. Have them write their predictions in the Student Journal.

Divide the class into groups of four students and distribute one car to each group. Provide sufficient time for students to make observations of how the car moves and what happens when it strikes a wall or barrier. Ask the students to write down their own descriptions of the motion of the car on the Activity Page in their Student Journals.

Draw your observations of the moving toy car. Write a list of what you observed as the toy car moved.

To facilitate the students' exploration of the motion of the car and recording of observations, circulate among the students and check their progress in recording their observations. To help students begin to construct explanations and make observations to produce data, ask:

- What was the first thing you noticed when the car started to move?
- What caused the car to move? Did you observe a push or a pull? What was the effect?
- What did you see, hear, or feel?
- How do you know that the car was moving?
- What path/direction did the car travel? How do you know?
- Did the speed of the car change or remain the same for the entire trip? How do you know?
- How might you use the measuring tape? Would measuring distance be helpful in learning more about the motion of the car?
- What about the classroom timer? What might you use a timer for?

After groups have had the opportunity to complete their observations,have them share their entries in the Student Journal with another group. Ask students to talk to one another about their entries and make adjustments based on the exchange. Look for observations that include:

- the direction the car was moving.
- that it traveled in a straight line or a curved path.
- a reference to its speed (slow, fast).
- sounds that the car made.
- that the car traveled on a flat surface.
- the distance it traveled using a reference point.
- the distance traveled in a given amount of time.

Ask one or two groups to share their observations and discuss the observation of motion as a class.

Summary Discussion: Science Talk

Conduct a whole-class sharing of observations collected from the investigation. Ask students if they have further questions or ideas that they would like to learn about motion. Did the motion of the toy vehicle generate any new questions? Record their questions and ideas of how they can investigate motion.

TEACHING TIP

The recording of observations and then sharing with others will help students to recognize that observations may differ based on the observer's point of view and the details that were recalled.

PS2.A: FORCES AND MOTION

- The patterns of an object's motion in various situations can be observed and measured; when the past motion exhibits a regular pattern, future motion can be predicted from it.

ASKING QUESTIONS AND DEFINING PROBLEMS

- Define a simple problem that can be solved through the development of a new or improved tool.

PLANNING AND CARRYING OUT INVESTIGATIONS

- Make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon or to test a design solution.

CROSSCUTTING CONCEPT

PATTERNS

- Patterns of change can be used to make predictions.

CROSSCUTTING CONCEPT

CAUSE AND EFFECT

- Cause-and-effect relationships are routinely identified, tested, and used to explain change.

TEACHING TIP

Science Talk is a conversation among the students that allows them to have the opportunity to orally express their ideas and listen to the ideas of others. Allow sufficient time for each student to express ideas and opinions. Encourage student-led conversation in the classroom.

Discuss if anyone measured the distance traveled and the amount of time it took to travel that distance. Relate the student-collected data to the speed the car was moving. Ask which trial showed the fastest speed and the slowest speed. Ask: How do you know that? What could we do to cause a difference in speed? What effect does force have on the speed of the car?

Ask the class to look for patterns in the data collected. Discuss the students' initial thinking regarding the term patterns in data. Explain that patterns are repeated or regular occurrences of data. Have the class compare the data collected over the three trials. What data has a regular pattern? As a class, predict what might happen if they conducted a fourth trial. Ask: Can we use the data to predict what might happen if we changed a variable such as the surface the car travels over? What might happen if the vehicle traveled up an incline? What might happen if the vehicle ran into a wall or obstacle?

Ask how the patterns observed in the motion of the car can help to solve the *Fire Truck Express* challenge. Accept all reasonable responses at this time.

Assessment: Formative
Use the class discussion, data chart, and Activity Pages to assess the students' initial thinking about observations of motion and how things move.

Use the class discussion to assess the students' understanding of how patterns can be used to make predictions of future motion.

Lesson 1B: Observations of Motion: Toy Vehicle

Advance Preparation

Make a *Thinking About Motion* chart to keep a record of students' initial understanding about motion and the progression of their thinking.

Procedure

Explore the concept.

Review the students' responses and data from the previous lesson. Check for student understanding regarding changes in motion and what causes change in motion to occur.

Review the challenge in the *Fire Truck Express* story. Check for understanding that the children in the story will need to plan how to cause the fire truck to change direction to travel to the kitchen for cookies. Divide the class into groups of four and have them brainstorm ideas that will help solve the challenge in the story.

Facilitate the team brainstorming by circulating among the students and listening to their ideas. To help students solve problems and design a solution, ask:

- Can someone explain what you have discussed so far?
- How would you describe Sam and Toni's problem in your own words?
- What do you already know about motion that might help solve the problem?
- Would using and writing on the diagram help?

Ask groups to share their ideas and justify their thinking using what they have observed about motion. Tell the class that in the following lessons, they are going to gather new information about motion that will help Sam and Toni receive cookies via the *Fire Truck Express.*

Display the *Thinking About Motion* chart. As a class, record students' initial ideas regarding motion. Facilitate the whole-class discussion and, to encourage all students to contribute to the session, ask:

- What are some of the objects that you have observed in motion today?
- How did the object begin to move? What kept it moving? What made it stop?
- How do you know?
- What do you think about what ________said?
- Does anyone have a similar answer but a different way to explain it?
- Do you understand what _____is saying?
- How might we find out or confirm if our ideas are correct?

MATERIALS NEEDED

For each student:
- 1 student page

For each group of 4:
- 1 measuring tape
- 1 toy vehicles (2 batteries)

Teacher provides:
- masking tape
- chart paper
- markers
- timing devices

PS2.A: FORCES AND MOTION

- **The patterns of an object's motion in various situations can be observed and measured; when the past motion exhibits a regular pattern, future motion can be predicted from it.**

Thinking About Motion

What We Think About Motion	How Can We Find Out?	What Do We Conclude?

TEACHING TIP

Take this opportunity to generate a word wall or board with vocabulary related to motion as students share their observations. Be sure that the word wall is generated and developed by the students and new words are added as needed to describe the motion of different objects.

PS2.A: Forces and Motion

- Each force acts on one particular object and has both strength and a direction. An object at rest typically has multiple forces acting on it, but they add to give zero net force on the object. Forces that do not sum to zero can cause changes in the object's speed or direction of motion.

TEACHING TIP

The Summary Discussion serves as the lesson "wrap-up" and is an essential part of student learning and understanding. If time does not permit the Summary Discussion at the end of the lesson, be sure to revisit the summary at the beginning of the next science lesson.

WRITING

Text Types and Purposes

W.3.1: Write opinion pieces on topics or texts, supporting a point of view with reasons.

Production and Distribution of Writing

W.3.4: With guidance and support from adults, produce writing in which the development and organization are appropriate to task and purpose.

Summary Discussion

Review the *Fire Truck Express* reading in the Student Journal. Ask students what information the children will need to help them solve the challenge. What observations do they already have that will help them to solve the challenge?

Listen for ideas of information regarding collisions and how when objects collide they exert a force on one another. Make a class list of student ideas of information regarding motion that will help solve the challenge. Have the students write their initial opinions in their Student Journals.

Look at the diagram of the position of the fire truck in Sam's play room and draw the path the truck must travel to get to the kitchen and back with a load of cookies. Brainstorm in your group some ideas that may help Sam and Toni get cookies delivered by the Fire Truck Express. Make a list of what Sam and Toni need to make their plan work.

Use this space to draw and plan your route for the toy car to travel from the playroom to the kitchen.

Use this space to draw and write what happened during your trials to get the car to change direction and travel to the kitchen and back to the playroom.

Assessment: Formative

Use the class discussion and Activity Pages to evaluate the students' initial ideas about motion.

Activity 2: Observations of Motion

Teacher Background Information

This activity is geared toward building new knowledge about motion and reviewing the concepts of forces first introduced at the kindergarten level. Students raise questions and design and conduct an investigation into the forces needed to make changes in direction of a moving object. In Lesson 2C they use their collective information to design a plan for the *Fire Truck Express* and make a model to solve the challenge.

Explore the Concept

The following lessons and activities continue student exploration into the motion of the toy vehicle. Students design an investigation to find out different ways they can change the motion of objects. They begin to apply the concept that a force is needed to change the motion and that forces act on objects with different strength and directions. Forces can cause change in motion or stop motion. This phase provides the opportunity for students to explore motion in a variety of settings and with a variety of materials.

Lesson 2A: Observations of Motion

Advance Preparation

Mark a starting line on a table or floor for the car demonstration.

Prepare a materials table for the students to choose materials to help them investigate their ideas. Your unit is packed with eight battery-operated vehicles. Set up a testing area for students to test their designs and take turns using the vehicles to complete their investigations.

Display the *Thinking About Motion* chart to keep a record of students' continued understanding about motion and the progression of their thinking.

Procedure

Explore the concept.

Review the list of observations and student ideas from the data of the moving car in the previous lesson. Discuss what information they can use to solve the *Fire Truck Express* challenge. Choose one of the common student observations, such as the direction (path) the car traveled. As a class, identify variables that could be tested in an experiment designed to change the direction. Ask:

- What are some things that we could do to change the *direction* of the car?
- What could we do to change the *distance* the car traveled?
- What could we do to change the *speed* at which the car was traveling?

ESTIMATED TIME

Lesson 2A: 55–60 minutes
Lesson 2B: 60–65 minutes
Lesson 2C: 60–65 minutes

OBJECTIVE

Observe and measure the motion of objects to describe motion and discover patterns in motion.

KEY QUESTIONS

How can we change motion based on observed patterns?

How do we describe motion?

MATERIALS NEEDED

For each student:
- 3 student pages

For each group of 4:
- 1 measuring tape
- 1 toy vehicles (2 batteries)

For the class:
- ramps
- barriers
- washers

Teacher provides:
- items to use as barriers (blocks, books, erasers, other small classroom supplies)
- masking tape
- chart paper
- markers
- timing devices

TEACHING TIP

Collisions are a review from their kindergarten experiences. It may be necessary to review the concept that when objects touch or collide, they push on one another and can change motion.

PS2.A: Forces and Motion

- Each force acts on one particular object and has both strength and a direction. An object at rest typically has multiple forces acting on it, but they add to give zero net force on the object. Forces that do not sum to zero can cause changes in the object's speed or direction of motion.

ASKING QUESTIONS AND DEFINING PROBLEMS

- Ask questions that can be investigated based on patterns such as cause-and-effect relationships.

PLANNING AND CARRYING OUT INVESTIGATIONS

- Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence, using fair tests in which variables are controlled and the number of trials considered.
- Make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution.

Ask students what they could change from the previous lesson that might affect the distance the car traveled, the speed the car traveled, or the direction the car traveled, or that might stop the car (i.e., add weight to the car, change the surface the car travels over, change the surface to an incline or decline, change direction with an applied force, etc.). Discuss the importance of changing only one variable for their investigation.

Explain that after the students conclude their investigations, the class will compile their observations and data to help solve the challenge in *Fire Truck Express*.

Divide the class into groups of four students. Display the materials table and explain that students can use any of the materials on the table or items at their tables or desks to design an investigation to explore change in the motion of the car.

Review the investigation format in the Student Journal.

1. *Write the question you are investigating.*
2. *Write what you already know about motion.*
3. *Write what you think you will find out.*
4. *List the materials you will use.*
5. *Draw and write how you will set up your investigation.*
6. *Make a chart to record your data.*
7. *Write what you found out.*

Give the groups sufficient time to form a question they would like to investigate and make a plan. Facilitate the activity by circulating among the teams and listening to their observations and thinking. To check student progress, ask:

- What possible questions have you discussed so far?
- What variable are you exploring with your question? What will you change from our class investigation? What do you think you will find out? Why do you think that?
- Why did you decide to use this procedure? Does that make sense? Does anyone have a different way to approach your question?
- How will you organize your results? What will you measure?
- What will you need to carry out your investigation?

If groups struggle to form a question, conduct a whole-class brainstorming session of possible questions to investigate. Make a list of different ways the motion of the car can be changed from the previous investigation (path the car traveled, change in direction, change in speed).

After the groups have decided on a question to investigate and completed a plan for their investigation, have them retrieve materials from the materials table and complete their investigations.

As the students carry out their investigations, circulate among the groups and check on their ability to complete the data collection and recording of data and observations. Ask:

- Can you explain what you have done so far?
- What do you want to find out?
- What do you already know about forces that will help you with your investigation?
- What do you notice when…?
- Can you identify the forces that make the car move, change direction, speed up?
- Do your results make sense?

Allow sufficient time for students to carry out their investigations and run at least three trials to collect data. Inform the groups that they will be allowed to share that data in the following lesson.

Assessment: Formative
Use the entries in the Student Journal Activity Pages to assess their ability to ask questions, design an investigation, and make observations and/or measurements to produce data.

TEACHING TIP

As you facilitate the group activity, carry a clipboard with paper and pencil to record student comments to refer to as the students present their findings. Listen for student use of terms related to motion (force, direction, speed, etc.) and incorporate their vocabulary into the Summary Discussion.

MATH INTEGRATION

Solve problems involving measurement and estimation of intervals of time.

3.MD.1 Tell and write time to the nearest minute and measure time intervals in minutes;, solve word problems involving addition and subtraction of time intervals in minutes.

Represent and interpret data.

3.MD.4. Generate measurement data by measuring lengths using rulers marked with halves and fourths of an inch. Show the data by making a line plot, where the horizontal scale is marked off in appropriate units: whole numbers, halves, or quarters.

TEACHING TIP

If you choose to combine Lesson 2A and 2B, students will be able to complete their investigations and share findings in one setting. Combining 2A and 2B may save time in setup and discussion.

Lesson 2B: Observations of Motion

Advance Preparation

Have available the material the students used to carry out their investigations from the previous lesson.

Display the *Thinking About Motion* chart to keep a record of students' continued understanding about motion and the progression of their thinking.

Cut one piece of string, 30 cm long.

Put masking tape on the floor to mark the center line for tug-of-war. Tie the piece of string on the rope halfway between the ends.

Preview the following videos that explain balanced and unbalanced forces.

https://www.youtube.com/watch?v=YyJSlcIbd-s

https://www.youtube.com/watch?v=aJc4DEkSq4I

Procedure

Explain the concept and define the terms.
Allow sufficient time for the teams to complete their investigations and share their results with the class. Make a class chart of their findings based on the questions each group was investigating.

Discuss the different results in investigations that changed the speed at which the car traveled. Have a student explain the forces necessary to slow or increase the speed of the car. Discuss any investigations that made the car change direction or stop and the forces necessary to change the direction and stop the car.

Have each group share their findings with the class. Ask students to look for patterns in their findings. The concept that it takes a force to change an object's speed or direction should be consistent throughout the student data and observations. Ask students who used barriers to change the direction of their car to explain the forces that occurred during the collision between the car and the barrier. Ask what forces were applied to the barrier by the moving car and to the car by the barrier. Look for an understanding that when objects touch or collide, they push on one another and motion can change. Collisions between any two objects can cause changes in the motion of one or both objects.

Write the term *force* on the board. Have the students discuss where they have heard the term and how it was used. Encourage students to use their findings from their investigations to explain the term force. Force is used in science to mean a push or a pull on an object. After the students are satisfied with the class definition

MATERIALS NEEDED

For each student:
- 1 student page

For each group of 4:
- 1 measuring tape

For the class:
- ramps
- barriers
- washers
- rope
- string

Teacher provides:
- items to use as barriers (blocks, books, erasers, other small classroom supplies)
- masking tape
- chart paper
- markers
- timing devices

TEACHING TIP

Encourage students to stay in the same team as the previous lesson for consistency in data collection.

PS2.A: FORCES AND MOTION

- Each force acts on one particular object and has both strength and a direction. An object at rest typically has multiple forces acting on it, but they add to give zero net force on the object. Forces that do not sum to zero can cause changes in the object's speed or direction of motion.

PS2.B: TYPES OF INTERACTIONS

- Objects in contact exert forces on each other.

TEACHING TIP

Students may need multiple examples of balanced and unbalanced forces to make the necessary connections between their observations and data and the class discussion.

CONSTRUCTING EXPLANATIONS AND DESIGNING SOLUTIONS

- Use evidence (e.g., measurements, observations, patterns) to construct or support an explanation or design a solution to a problem.
- Identify the evidence that supports particular points in an explanation
- Apply scientific ideas to solve design problems.

TEACHING TIP

Key terms to explain scientific phenomena are essential in student success in standardized assessments. To help students develop their scientific vocabulary, establish a class definition of key terms and then have the students write their definitions in the Key Terms of the Student Journal. Construct a class-generated word wall and encourage students to refer to it as they explain phenomena and results from investigations.

of the term force, have them write their definitions in the Student Journal. Inform the students that they will be able to revisit their definitions and make adjustments as they continue through the unit.

Ask the students what type of force (push or pull) is used in the game of tug-of-war, and what type of force is used to throw, kick or hit a ball.

Tell the students that they are going to do an activity that will help explain how things start moving. Ask the students if they have ever heard of the game called tug-of-war. If some students have not heard of this game, ask another student to describe what it is. Ask them what changes the motion of the rope from one side to the other.

Ask two volunteers to help demonstrate how things start to move. Have one student stand at each end of the rope and pull on it until it is taut. Position the string tied to the middle of the rope over the masking tape on the floor.

Instruct each student to pull equally on his/her end of the rope so that the string remains positioned over the masking tape. Have all the students notice that the string is not moving away from the mark on the floor. Ask a student to explain why the string is not moving. Look for responses that include an equal pull from each student on each end of the rope. Ask students to describe the force that occurs when the string is not moving and each student is pulling with the same amount of force. Write the term balanced force on the board and ask students to explain the term in their own words.

Ask another volunteer to join one of the other students pulling on the rope. Now there will be two students at one end and only one student at the other end of the rope. Ask students to predict which direction the string will move and why. Two students at one end of the rope create an unbalanced force, and the rope and string will move in the direction of the two students. Have all the students observe and discuss what is happening.

Give the class sufficient time to explore different combinations of students on each end of the rope. Encourage all students to participate in the tug-of-war to get the feeling of the pull or force that makes the string and rope move or change position.

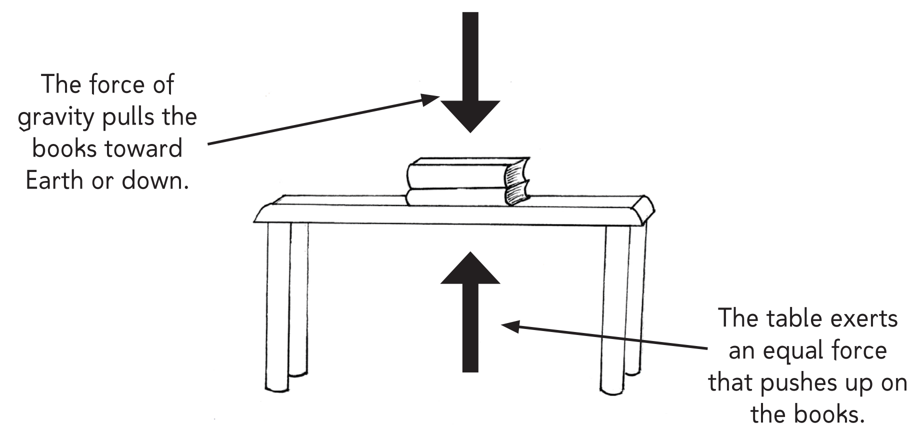
Ask students how the term balanced forces helps to explain the game of tug-of-war when two people are pulling with an equal force on the rope. Explain that in motion, when forces acting on

an object in opposite directions are equal or balanced, the object is not moving or is moving at a constant speed.
Place a book on the table in front of the room for all the students to view. Ask the students if the forces acting on the book are balanced. Discuss the following statement as it relates to the book:

Balanced forces are two forces acting on an object in opposite directions of equal force.

Balanced forces result in objects remaining at rest or moving at a constant speed.

Students may recognize the force of gravity that acts on all objects on Earth, but the force of the table (the reaction force) may be more difficult for students to understand. Draw a diagram on the board that shows the book on the table. Use equal-sized arrows to demonstrate the equal forces in opposite directions of the force of gravity and the reaction force of the table.



Ask students what would happen if the table did not apply an equal force. Ask the students to describe what would happen if an elephant sat on the table.

Have the students relate the term balanced forces to their observations of their investigations. When were the forces balanced?

Introduce the term *unbalanced forces*. Ask the class if they can use what they have learned about balanced forces to explain unbalanced forces. Relate the term unbalanced forces to an explanation of the game of tug-of-war when two people are pulling at one end and three people are pulling at the other end. Explain that in motion, when the forces acting on an object are not even or one force is stronger than another, the object is in motion. Push the book across the table. Ask the students to explain the motion of the book in terms of balanced and unbalanced forces.

Discuss the following statement as it relates to the book moving across the desk:

PS2.A: Forces and Motion

- Each force acts on one particular object and has both strength and a direction. An object at rest typically has multiple forces acting on it, but they add to give zero net force on the object. Forces that do not sum to zero can cause changes in the object's speed or direction of motion.

CAUSE AND EFFECT

- **Cause-and-effect relationships are routinely identified.**
- **Cause-and-effect relationships are routinely identified, tested, and used to explain change.**

TEACHING TIP

To find additional web addresses for videos that explain balanced and unbalanced forces, do a Google search with the subject "balanced and unbalanced forces for kids."

CAUSE AND EFFECT

- **Cause-and-effect relationships are routinely identified.**
- **Cause-and-effect relationships are routinely identified, tested, and used to explain change.**

PS2.A: FORCES AND MOTION

- Each force acts on one particular object and has both strength and a direction. An object at rest typically has multiple forces acting on it, but they add to give zero net force on the object. Forces that do not sum to zero can cause changes in the object's speed or direction of motion.

PS2.B: TYPES OF INTERACTIONS

- Objects in contact exert forces on each other.

WRITING

Research to Build and Present Knowledge

W.3.8: Recall information from experiences or gather information from print and digital sources; take brief notes on sources and sort evidence to provide categories.

Unbalanced forces that are pushing or pulling on an object result in a start in motion or a change in motion.

Ask students for their ideas of what motion looks like when the forces are unbalanced and what examples might be. Objects with unbalanced forces are objects in motion, and the forces make the object move in a certain direction at a certain speed.

Take this opportunity to discuss the cause-and-effect relationship between balanced forces and unbalanced forces. Discuss the cause that affects the motion of the cars in the student-led investigations. Look for ideas that relate to the forces that resulted in a change in motion in terms of speed and direction.

As a class, define the terms *balanced* and *unbalanced forces*. Only after the students are satisfied with their explanation of the terms, have them write the definitions in the Key Terms in their Student Journals.

Summary Discussion

As a class, view one of the websites that explains balanced and unbalanced forces. Discuss how the terms are explained in the video and compare to the explanations the students used in the classroom. Allow time for discussion regarding the class definition and the explanations in the videos. Have students make adjustments to their writing if necessary.

Revisit the *Thinking About Motion* chart. Make additions and revisions to the chart based on the findings from their investigations and their understanding of balanced and unbalanced forces and their cause-and-effect relationship. Discuss any observations or patterns in data that may be useful in helping to solve the challenge of the *Fire Truck Express*.

Read the Journal Entry prompt with the class. Encourage the groups to work together to answer the prompts.

Draw and label a model of your car when the forces were balanced. Write how you know when forces are balanced.

Draw and label a model of your car when the forces were unbalanced. Write how you know when forces are unbalanced.

Assessment

Use the class discussion and Journal Entry to assess the students' understanding of balanced and unbalanced forces.

Lesson 2C: Using What We Know About Motion

Teacher Background Information

The following lesson serves as an introduction to engineering and what scientists and engineers need to know about motion to solve problems and develop solutions to objects in motion. Students understand that engineers often take the research done by scientists and use it to solve real-world problems. Two problems to consider are how objects in motion change directions and what is the effect of adding mass to the motion of a vehicle (Newton's second law). In order to solve the *Fire Truck Express* challenge, students will need to apply what they have learned and recognize what more they need to learn about forces, direction change, and changes in weight.

Advance Preparation

Set up a materials table for the student-led engineering design activity.

Prepare an area in which the students can test their designs. Make copies of the handouts *Fire Truck Route* and *Fire Truck Route Product Descriptor* for each student.

Procedure

Elaborate on the concept.

Reread *Fire Truck Express* in the Student Journal as a class. Discuss what the children will need in order to solve the challenge.

- Change the direction of the car to travel from one room to another.
- Determine the effect of carrying a load (cookies) on the speed and distance the car will travel.

Ask students what information they can use from their investigations in the previous lessons. Record the student ideas on the board or chart paper.

After the class has completed their brainstorming, introduce the *Engineering Design Plan* (see pp. 130–31) in the Appendix). Explain that the class will work in teams and develop a model to solve the problem of how to get the car to the destination and back carrying a load.

Divide the class into their engineering teams. Distribute the *Fire Truck Route* and *Fire Truck Express Product Descriptor* handouts. Review the product descriptor and discuss items that students may not understand or points where they may have some confusion. Explain that the washers represent the cookies or extra weight the fire truck will carry back to the playroom.

MATERIALS NEEDED

For each student:
- 4 student pages
- handout: *Fire Truck Route*
- handout: *Fire Truck Express Product Descriptor*

For each group of 4:
- 1 measuring tape
- 1 toy vehicle (2 batteries)

For the class:
- washers
- ramps
- barriers
- timing devices
- masking tape

Teacher provides:
- timing device
- chart paper
- markers
- barriers (blocks, books, small boxes, cardboard)
- masking tape

INQUIRY TIP:

Refrain from negating any of the students' ideas, yet direct them to begin to think about materials that can be used in the classroom. For example, if a student asks to bring in a motorized car from home, respond by redirecting the student's attention with a question like, "What can you do to solve the challenge using the car provided in the classroom?"

ASKING QUESTIONS AND DEFINING PROBLEMS

- Use prior knowledge to describe problems that can be solved.
- Define a simple design problem that can be solved through the development of an object, tool, process, or system and includes several criteria for success and constraints on materials, time, or cost.

ANALYZING AND INTERPRETING DATA

- Represent data in tables and/or various graphical displays to reveal patterns that indicate relationships.

CONSTRUCTING EXPLANATIONS AND DESIGNING SOLUTIONS

- Apply scientific ideas to solve design problems.
- Generate and compare multiple solutions to a problem based on how well they meet the criteria and constraints of the design solutions.

MATH INTEGRATION

- 3.MD.4. Generate measurement data by measuring lengths using rulers marked with halves and fourths of an inch. Show the data by making a line plot, where the horizontal scale is marked off in appropriate units: whole numbers, halves, or quarters.

WRITING INTEGRATION

- W.3.2: Write informative/explanatory texts to examine a topic and convey ideas and information clearly.

Show the class the materials available for their projects. In their groups, have students prepare a design plan that they think will help them develop and build a model to solve the challenge of the *Fire Truck Express*. Explain that the cars will be used to model the toy fire truck in the story. Have the teams record their brainstorming ideas in the Student Journal.

1. Draw and write your plan to solve the challenge of the Fire Truck Express.

To facilitate the groups' planning, circulate among the groups and listen to their ideas. Ask:

- Can someone explain what you have discussed so far? What information do you need to help you solve the problem?
- How do you think your idea will help to solve the problem of the motion of the fire truck?
- How might the data collected from previous investigations help to design a plan to solve the challenge? What makes you think that?
- What materials will you need?
- What do you think will happen? What information do you base your predictions on?
- What observations will you record? How will you organize your data? Will a chart or graph be useful? (Assist groups in the data organization when necessary.)

Once the teams have decided on a reasonable plan, have them retrieve the materials they will be using from the materials table.

Give the groups sufficient time to set up their design plan, run two or three trials, and make adjustments in their design based on observations, data, and results. Students may need examples and guidance in setting up a data table. Encourage teams to use the data table from the previous lessons to help them organize their data and observations for their trial runs.

2. Make a data table to record your findings for each trial.

3. Draw and write how your plan solved the challenge of the Fire Truck Express.

4. Draw and write how you made changes to improve your model.

5. Explain your improvements. Use data to show the improvement in solving the challenge.

6. Write about the most difficult challenges in solving the problem of the Fire Truck Express. Tell why you think it was the most difficult.

Summary Discussion
After students have completed their engineering designs and recorded their solutions in their Student Journals, have the groups share their findings, challenges, and solutions with other groups. They should compare what they discovered with similar and different designs. Give sufficient time for them to add new information to their own findings. Ask the groups if their results supported their original thinking. Have students describe what they would change if they could do the design one more time.

Ask students to share any new discoveries they have about motion. Record student ideas on the *Thinking About Motion* chart. Discuss new ideas and changes in thinking that have occurred as a result of their investigations and engineering challenge.

Take this opportunity to review *balanced* and *unbalanced forces* within their design plans. Review the concept that forces are pushes and pulls that can start an object moving, change the speed and direction of an object, or stop an object. Ask the teams to identify the forces in their engineering design for the Fire Truck Express and tell if they were balanced or unbalanced. Ask students how they know when forces are balanced or unbalanced. Listen for ideas of balanced forces when the object is at rest or moving at a constant speed. Refer to the student definitions of the terms balanced and unbalanced forces from the previous lessons.

Assessment
Use the product descriptor, engineering solution, and Journal Entry to assess the students' understanding that objects in contact exert forces on each other, and that forces that do not sum to zero can cause changes in the object's speed and direction of motion.

Use the final presentations of the solution to the *Fire Truck Express* challenge to assess the students' ability to define a simple design problem and solve the problem through the development of a process.

PS2.A: FORCES AND MOTION

- Each force acts on one particular object and has both strength and a direction. An object at rest typically has multiple forces acting on it, but they add to give zero net force on the object. Forces that do not sum to zero can cause changes in the object's speed or direction of motion.

PS2.B: TYPES OF INTERACTIONS

- Objects in contact exert forces on each other.

CROSSCUTTING CONCEPT
Interdependence of Science, Engineering, and Technology

- **Scientific discoveries about the natural world can often lead to new and improved technologies, which are developed through the Engineering Design Process.**

Name ______________________________

Date ______________________________

Fire Truck Express: Product Descriptor

All engineering designs must include:	Yes	No
1. a written plan of how your car will move from the playroom to the kitchen .		
2. a written description of how your car will change direction and stop.		
3. a written explanation or diagram of the forces that moved the car, changed its direction, and made it stop. (balanced and unbalanced forces)		
4. a presentation to demonstrate how your car will change direction and travel from the play room to the kitchen.		
5. a presentation to demonstrate how your car will change direction and travel from the kitchen back to the play room.		
6. an oral explanation of how you completed the engineering task that includes:		
a. the most challenging part of completing the task.		
b. the easiest part of completing the task.		
c. changes you made after your initial trials.		
d. how your changes improved your engineering design.		
e. what you would change if your team had more time to complete the task.		
6. an oral presentation that include questions from the audience.		

Student Journal

Sample

Activity #2

3rd grade

Forces and Interactions

CEREAL CITY SCIENCE by BCAMSC

Student Journal
3.PS.NGSS

Forces and Interactions

A 3rd Grade Unit
supporting the
Next Generation Science Standards
and the Michigan Science Standards

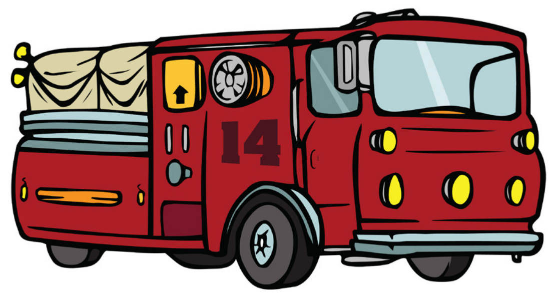
Name: ______________________

Name: ______________________________

Date: ______________________________

THE FIRE TRUCK EXPRESS!

Sam received a new fire truck from his friend Toni for his birthday. The truck ran on batteries and would travel a long distance. While Sam and Toni were playing with the fire truck they observed that each time the truck collided with an object it would change direction and keep on going in a different direction. Their observation gave them an idea.



"Hey!" said Toni. "What if we carefully place the chairs and other furniture in the path of the truck and make it go where we want it to go?"

"Good idea," replied Sam. "Let's make it go into the kitchen. I smell cookies baking, maybe we can send a message to my mom that there are two hungry cookie monster fire fighters in the living room."

"We can attach a note and ask for your mom to send us cookies on the fire truck express!" exclaimed Toni.

"Hmmm," thought Sam. "This will take some planning."

1A ACTIVITY
Observations of Motion

Name: ______________________________

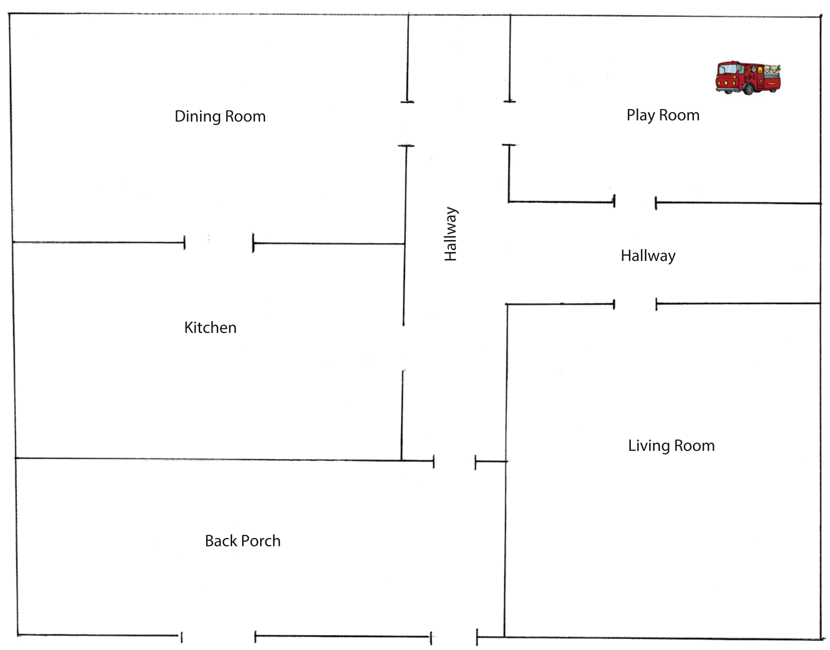
Date: ______________________________

Draw your observations of the moving toy car. Write a list of what you observed as the toy car moved.

Name: ______________________________

Date: ______________________________

Look at the diagram of the position of the fire truck in Sam's play room and draw the path the truck must travel to get to the kitchen and back with a load of cookies. Brainstorm in your group some ideas that may help Sam and Toni get cookies delivered by the "fire truck express." Make a list of what Sam and Toni need to make their plan work.



1B ACTIVITY
Observations of Motion

Name: ______________________

Date: ______________________

Use this space to draw and plan your route for the toy car to travel from the playroom to the kitchen.

Name: ____________________

Date: ____________________

Use this space to draw and write what happened during your trials to get the car to change direction and travel to the kitchen and back to the playroom.

ACTIVITY

2A Observations of Motion

Name: ______________________

Date: ______________________

1. Write the question you are investigating.

2. Write what you already know about motion.

3. Write what you think you will find.

Name: ______________________________

Date: ______________________________

4. List the materials you will use.

5. Draw and write how you will set up your investigation.

2A ACTIVITY
Observations of Motion

Name: ____________________

Date: ____________________

6. Make a chart to record your data.

7. Write what you found.

Name: ______________________________

Date: ______________________________

Draw and label a model of your car when the forces were balanced. Write how you know when forces are balanced.

____

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____

____

Draw and label a model of your car when the forces were unbalanced. Write how you know when forces are unbalanced.

____

____

____

____

2C ACTIVITY Fire Truck Express - Engineering

Name: ____________________

Date: ____________________

1. Draw and write your plan to solve the challenge of the *Fire Truck Express*.

Name: ____________________

Date: ____________________

2. Make a data table to record your findings for each trial.

3. Draw and write how your plan solved the challenge of the “Fire Truck Express.”

2C ACTIVITY
Fire Truck Express - Engineering

Name: ______________________

Date: ______________________

4. Draw and write how you made changes to improve your model.

5. Explain your improvements. Use data to show the improvement in solving the challenge.

Name: ______________________________

Date: ______________________________

6. Write about the most difficult challenges in solving the problem of the "Fire Truck Express." Tell why you think it was the most difficult.