STEAM through Sports Program

A LEGO® Education Program

Introductory BricQ Motion Prime

STEAM through Sports Program

LEGO® Education BricQ Motion Prime Introductory Program

4 days
6 hours per day

Program Overview:

This 4-day camp outline will provide students with a STEAM-focused hands-on activities to promote 21st century skills, social and emotional learning, as well as review math, language arts and science. Each day, students will participate in team building activities and opportunities for physical activity as well as receive a daily team briefing for daily challenges aligned to standards. Daily challenges will help students develop skills and knowledge to complete the culminating project of creating a game that uses balls and force and motion.

	Essential Questions	Daily Activities
Day 1	**Welcome to Orientation** What are forces? What makes something move?	Types of forces Types of motion **Free Kick**
Day 2	What types of motion can be caused gears? How do different size gears affect motion?	**Pass the Ball**
Day 3	How do Newton's Laws of Motion apply to a propeller car?	**Propeller Car**
Day 4	How can one moving object cause an object at rest to move?	**Strike the Ball** Present your game to the class

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Prior to First Day of the Program:

1. Sort the BricQ Motion Prime sets.
2. Go through the Getting Started guide. https://education.lego.com/en-us/start/bricq-motion-prime#Introduction
3. Determine a naming convention for each set and label. Suggestion to include school initials and a number (Example: Millcreek Elementary BricQ Motion Prime kits names could be MEBQ1; MEBQ2; MEBQ3)and write name on the lid and inventory sheet.
4. Print one copy of the student worksheet for each team of 2 students. https://education.lego.com/v3/assets/blt293eea581807678a/blt39f06cbd7b2f1a3f/5eabfbf1b8a6356e4ddc0ce7/U3L4-worksheet.pdf
5. Gather a rulers, tape measure, and scissors for each group.
6. Gather any consumable materials needed for the week (chart paper, sticky notes markers, pens, pencils, tape).
7. Determine a procedure for when a LEGO® element is dropped (everyone freeze; say LEGO down/LEGO found) and where to place the LEGO element if found and does not belong to the finder.

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Learning through Sports Program Day 1

Welcome to Orientation

Big Question:

- What is force?
- What makes an object move?

Materials needed for the day:

- BricQ Motion Prime sets
- Chart paper
- Student journals or journals (could be paper stapled together with students creating the outside of the journal using construction paper and other consumable materials)
- Pens
- Pencils
- Markers
- Sticky notes
- Tape
- Scissors
- Rulers and tape measures

Day 1: Outline for the Day

Outline of Day	Tasks	Time	Materials
9:00 - 10:30	Introductions	30 min	• BricQ Motion Prime Set
	Establishing group rules and expectations	15 min	• Chart paper • Markers • Pens
	Team Building Activity	15 min	• BricQ Motion Prime Set
	Team Briefing 1	5 min	• None
	Partner selection, team name and team badge	25 min	• Varies, based on the activity selected • Team badge templates • Markers • Pencils • Scissors

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10:30 - 10:35	Break		
10:35 - 11:25	Workplace Wellness (physical activity)	10 min	Varies, based on the activity selected
	Design a journal for record keeping	20 min	Student journals (see note in materials section) Markers Scissors Construction Paper Other craft materials
	Reading and wondering about simple machines	20 min	Book about simple machines Student journals
11:25	Get ready for lunch		
11:30 - 12:00	Lunch		
12:00 - 2:10	Team Briefing 2	10 minutes	• None
	Challenge 1: Free Kick Red Shoe	40 min	• Student journals • BricQ Motion Prime sets • Student worksheets • Building Instruction Booklet
	Challenge 2: Free Kick Yellow Shoe	20 min	• Student journals • BricQ Motion Prime sets • Student worksheets • Building Instruction Booklet
	Break	5 min	• None
	Challenge 3: Free Kick Purple Shoe	20 min	• Student journals • BricQ Motion Prime sets • Student worksheets • Building Instruction Booklet
	Challenge 4: Free Kick Math	25 min	• Student journals • BricQ Motion Prime sets • Student worksheets • Building Instruction Booklet

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	Disassemble and inventory sets	10 min	• BricQ Motion Prime sets
2:10 - 2:30	Daily debrief and wrap up	20 min	• Student journals

Introductions
Time: 30 minutes
Materials:
- BricQ Motion Prime Set

Purpose: For students to get to know each other

Show a video of people kicking a ball, especially soccer. Ask students how many of them have played soccer. What was hard about getting the ball to go exactly where you want it? What forces were at work on the ball? Ignite a discussion about the forces. Then ask students to think about one thing they would like to learn about forces.

Using the LEGO® bricks, have students build a model that shows one way they have played a game that moves a ball. There are no wrong answers to the building of a model. When time to share, have students say their name and share their model.

Group Rules and Expectations
Time: 15 minutes
Materials:
- Chart paper
- Markers

Using a piece of chart paper, establish group rules and expectations for the week as a class. You can have campers sign the chart paper and then place the rules and expectations in a location that can be reviewed each day. Ask students to think about how they would like to be treated and the role of a partner. Consider the role of feedback and how it can help to improve ideas. Have two people work together when building with LEGO® elements so they each have the opportunity to find pieces and to put pieces together.

Team Building Activity
Time: 15 minutes
Materials:
- BricQ Motion Prime Set

Explain to students that each day will include a team building challenge. Working together is an important skill and just like other skills, we can practice it to get better and better.

Build the tallest tower
Have students work in pairs. Make sure each group has the same bricks or give a constraint of using a specific number of bricks. Challenge students to build the tallest tower they can within 5 minutes. At the end of the 5 minutes, encourage students to reflect on:

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- What was challenging?
- How did you overcome the challenge?
- What was successful?
- How did you work together?
- If you were to do this tower build again, what would you change?

Have a short discussion on how individuals work together as a team. Ask students what works well and what does not.

Team Briefing 1:
Time: 5 minutes
Materials: None

Say this:

Welcome to orientation! Your first tasks for today are as follows:
- *Determine a partner for training exercises*
- *Work with partner to determine a name for your design company and a logo*
- *Design a journal for keeping important records this week*
- *Explore different ways we use force and motion*

Partner Selection, Design Company Name and Logo
Time: 25 minutes
Materials:
- Student journals (see note in materials section)
- Markers
- Scissors
- Construction paper
- Other craft materials

You can use several different activities to help students find a partner to work with for the week.

Once partners have been established, student teams can determine a design company name (team name) for their team and design a logo.

While teams are working, assign each group a BricQ Motion Prime set to use for the week.

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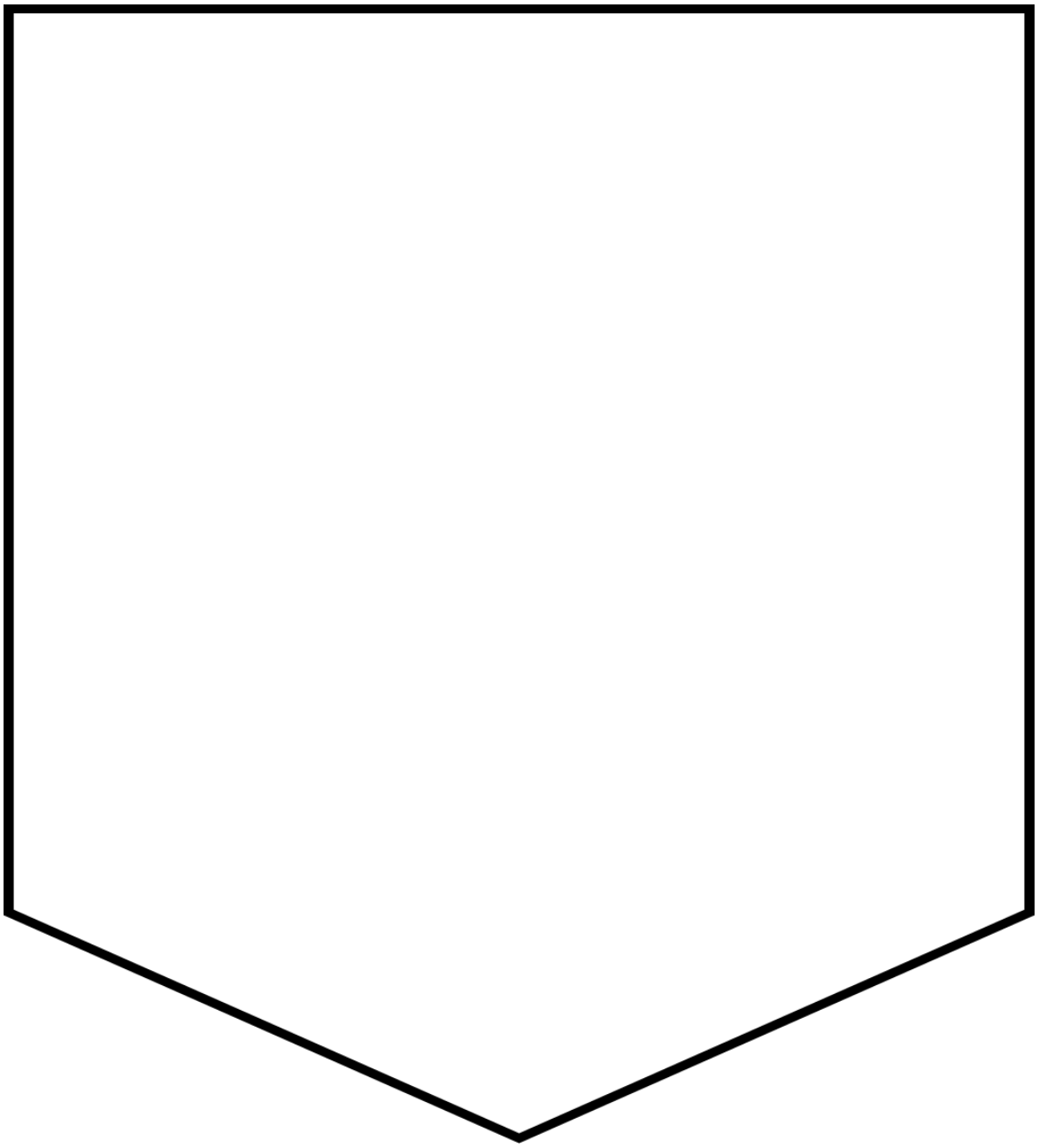
Logo Templates



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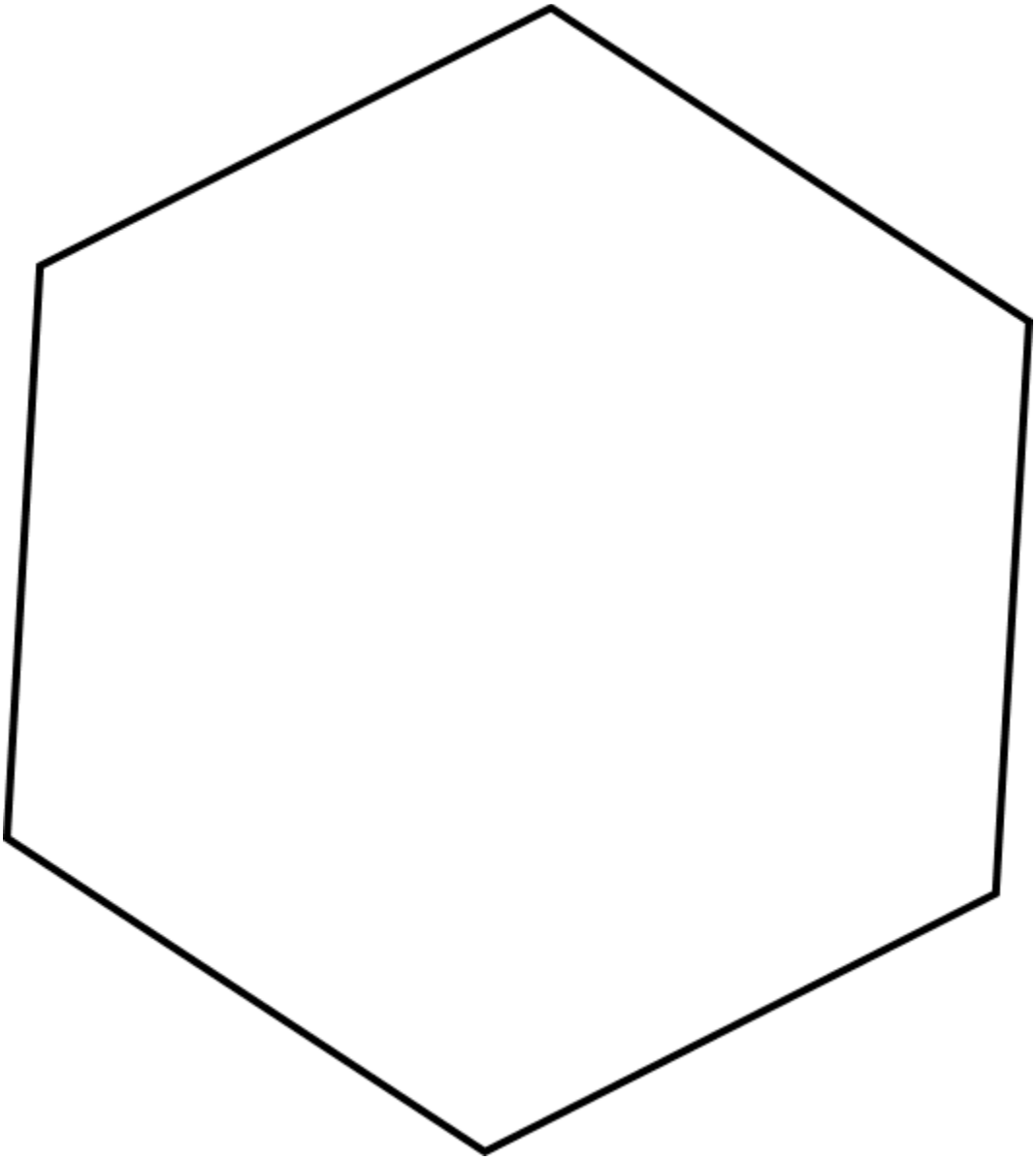
Logo Template



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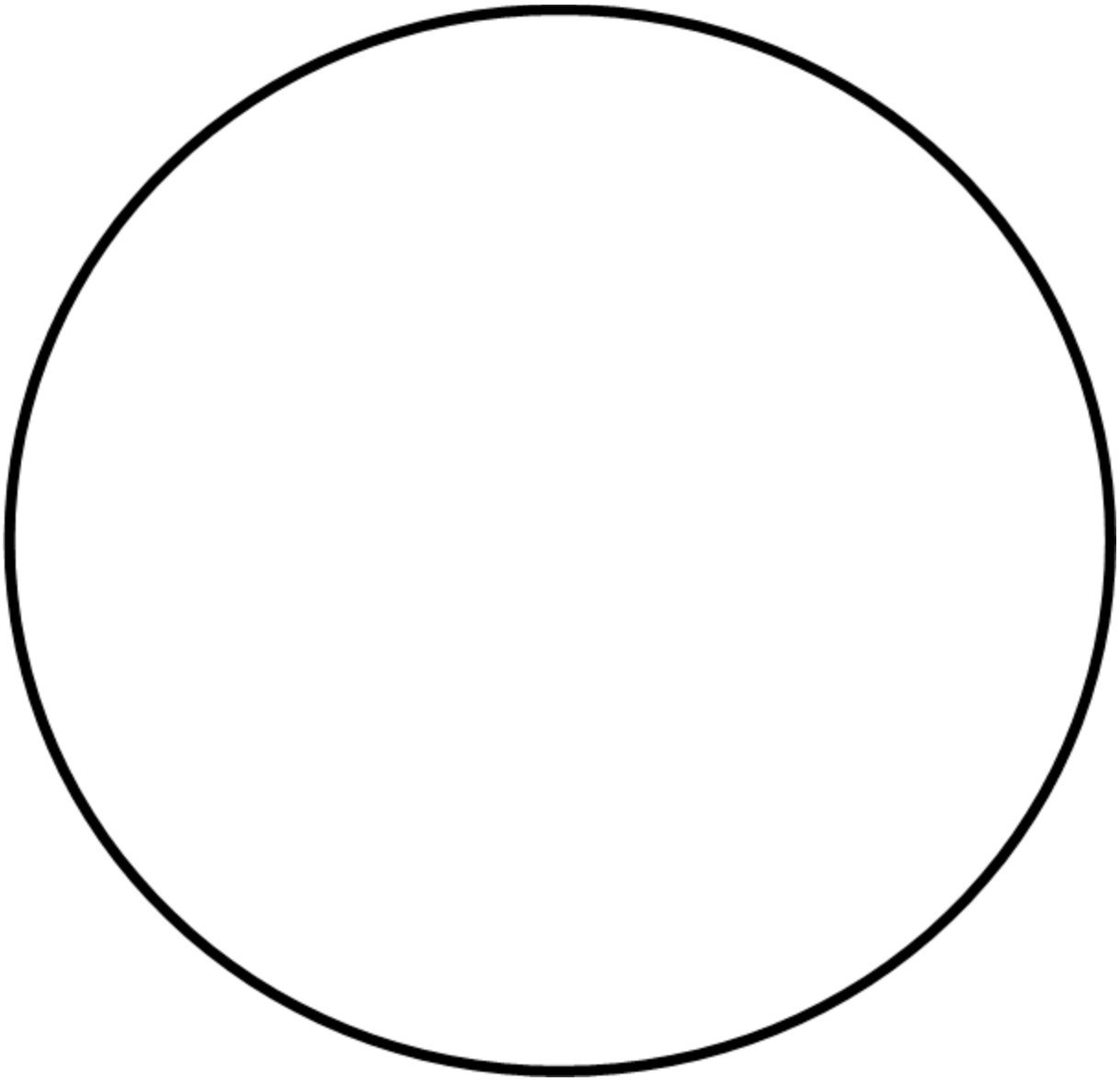
Logo Template



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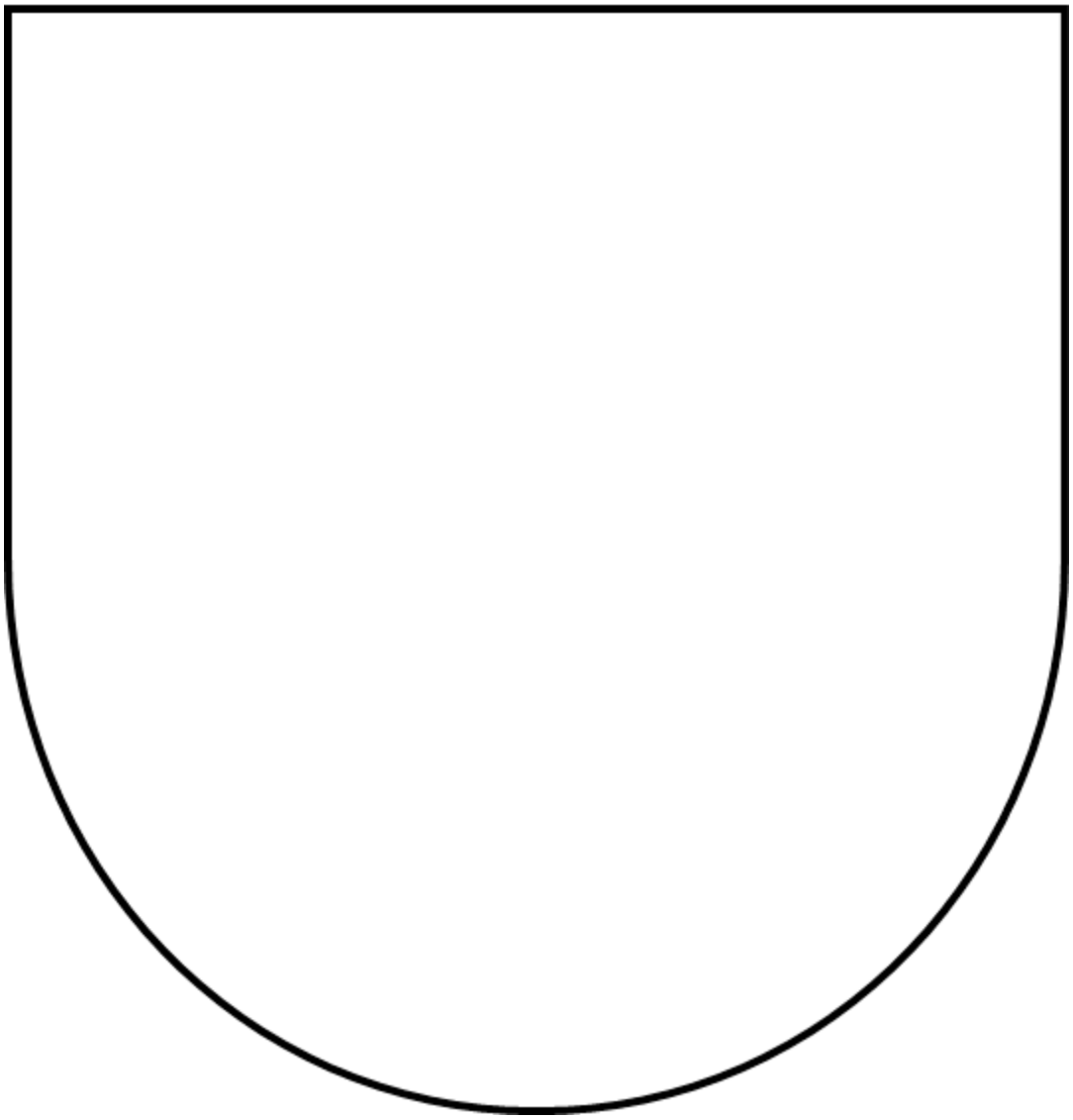
Logo Template



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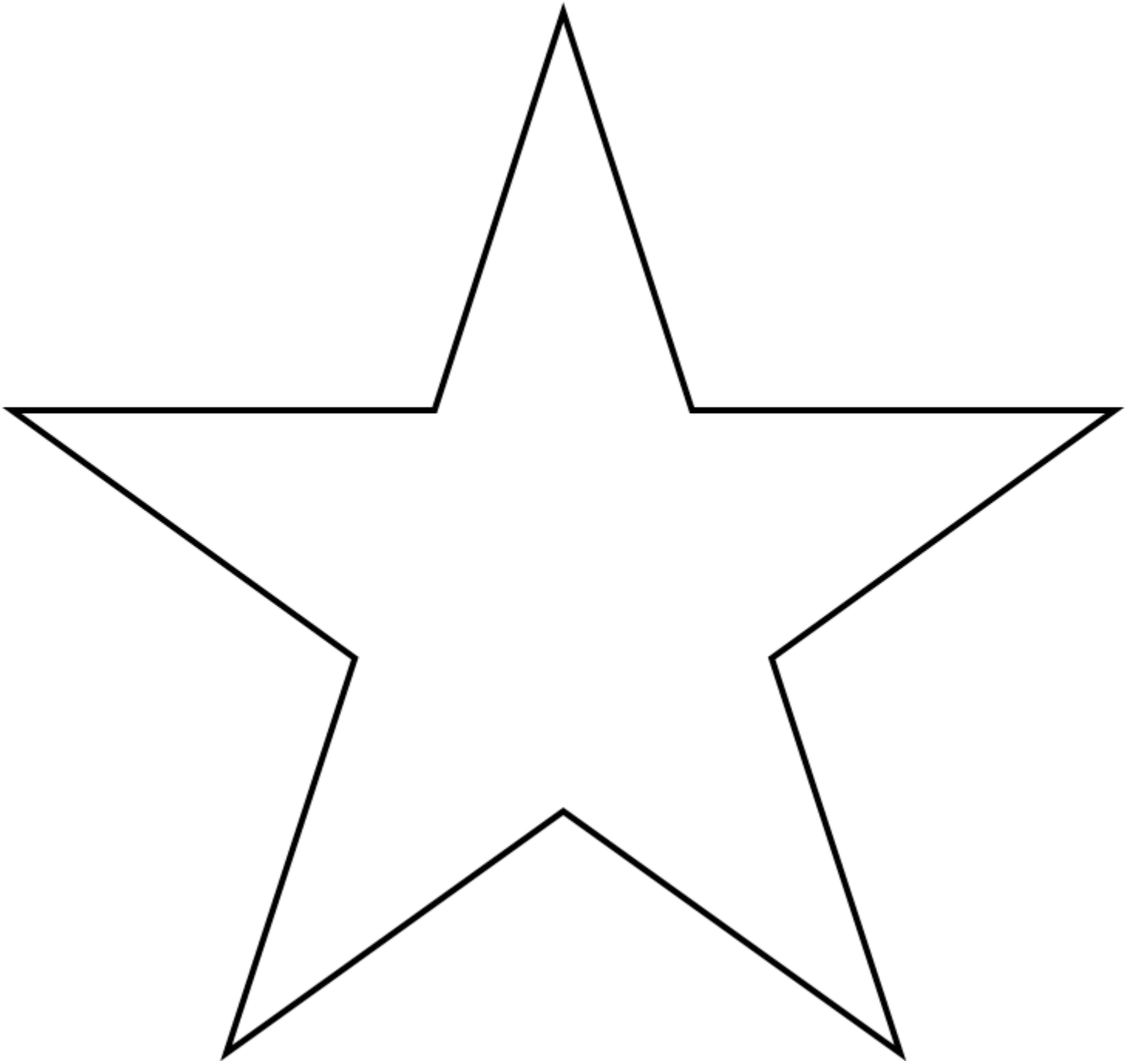
Logo Template



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Break
Time: 5 minutes

Workplace Wellness: Physical Fitness
Time: 10 minutes
Materials:

- May vary depending on what activity is selected

Take a minute to complete a short physical activity. You may find several ideas for short physical activities for students through a simple web search. Ideas could include simple exercises like jumping jacks or running in place. Many companies encourage physical activity during the workday.

Design a Journal
Time: 20 minutes
Materials:

- Student journals (see note in materials section)
- Markers
- Scissors
- Construction paper
- Other craft materials

Have students create a design journal to take notes, share wonderings, write reflections, and collect ideas. Ideas for types of journals can be found online.

Readings and Wonderings
Time: 20 minutes
Materials:

- Book or articles about Newton's Laws of Motion

Read a book or a kid friendly journal article about Newton's Laws of Motion and how they relate to moving a ball. Have students add notes about Newton's laws and give examples for each one. Have students write things they wonder about force and motion in their journals.

Lunch
Time: 30 minutes

Team Briefing 2
Time: 5 minutes
Materials: None
Say this:

> *Now that you have your team and have some background information about force and motion, you have a challenge. To be better prepared for the days ahead, you will need some basic training on the tools we will use this week. You mission this afternoon is to explore how Newton's Laws of Motion apply to moving a ball.*
>
> *Be sure to work together, take good notes and have fun!*

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Go over a few general guidelines for using the BricQ Motion Prime sets (what to do if you drop a piece on the floor, where do you put a piece you have found, what sharing looks like, etc.).

Show the Student Video of Soccer Players found in the lesson plan for Free Kick. https://education.lego.com/en-us/lessons/bricq-motion-prime/free-kick#engage

Ask the students:

- What did you observe? What can you infer from your observations?
- What happens when a soccer player kicks a ball? (Their kicking leg puts kinetic energy [i.e., movement] into the ball. The mass of the player's leg and the velocity ([i.e., speed] at which they kick determine how far the ball will move.)
- What enables soccer players to kick the ball in different directions? (The angle of the soccer player's foot as it hits the ball determines in which direction it'll go.)
- What makes the ball stop? (Friction from air resistance and from the surface the ball is rolling on, like the grass, will stop the ball.)

Tell students that they will be building a mechanical kicking foot, goalie and goal post.

Challenge 1 – Free Kick

Time: 40 minutes
Materials:

- BricQ Motion Prime sets
- Student Engineering Design Journals
- 1 Student worksheet per team

Ask students to

- Build the Free Kick model (take turns finding pieces and building). Building instruction pages 56-84.
- Take turns exploring the model. Notice the shoe is made with red bricks.
- Complete an experiment and write their findings in their journals.

Give each team one worksheet that they can cut apart. Each partner will have a worksheet.

Experiment 1:

- Ask the students to pull back the lever on their models and place the ball on the penalty spot. Release the lever.
- The ball should go straight into the bottom goal.
- Have each partner try this three times and write their findings in their journals.

Have students change the angle of the foot as shown in the student worksheet. Each partner should try each angle 3-5 times. Students write their findings for each angle in their journals.
After students have completed the experiment, discuss the findings as a class.
Ask students what law of motion is being applied.

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Have students complete the student worksheet. Have students explain how they work and why they would be used. Students should take notes in their student journals. They should be able to answer questions like:

Challenge 2 – Free Kick

Time: 20 minutes
Materials:

- BricQ Motion Prime sets
- Student Engineering Design Journals

Students will complete Experiment 2.
Experiment 2:
Ask students to:

- Remove the shoe made with red elements.
- Add the shoe made with yellow elements.
- Compare the red and yellow shoes.
- Write their comparison notes in their journals.
- Predict the angle at which the ball will travel.
- Write their predictions in their journals.
- Ask the students to pull back the lever on their models and place the ball on the penalty spot. Release the lever. Each partner should try this three times and write their findings in the journal. Compare the prediction with the actual movement.
- Next, have students change the angle of the foot as shown in the student worksheet. Each partner should try each angle 3-5 times. Students write their findings for each angle in their journals.

After students have completed the experiment, discuss the findings as a class.
Ask students what law of motion is being applied. Ask students what forces are being applied.

Break
Time: 5 minutes

Challenge 3 – Free Kick

Time: 20 minutes
Materials:

- BricQ Motion Prime sets
- Student Engineering Design Journals

Students will complete Experiment 3.
Experiment 3:
Ask students to:

- Remove the shoe made with yellow elements.
- Add the shoe made with purple elements.
- Compare the yellow and purple shoes.
- Write their comparison notes in their journals.
- Predict the angle at which the ball will travel.

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- Write their predictions in their journals.

Students should record the angle at which the ball will travel when the lever is pulled back and let go.

Ask students to compare their predictions to the actual angle the ball traveled. Students should write their findings in their journals.

Have students change the angle of the foot as shown in the student worksheet. Each partner should try each angle 3-5 times. Students write their findings for each angle in their journals.

Discuss
After students have completed the experiment, discuss the findings as a class. Ask students questions like:

- Why did the horizontal kicking mechanism shoot the ball upward when you replaced the red shoe with the yellow and purple shoes? *(These shoes have an inclined plane. When they collide with the ball, the force [i.e., the abnormal normal force] is always directed perpendicular [i.e., at a right angle] to the surface.)*
- What's the force called when the ball comes off the player's foot after it's kicked? *(This force is called a "force vector." It describes the amount of force that's applied in a specific direction.)*
- What law of motion is being applied?

Challenge 4 – Free Kick Math

Time: 25 minutes
Materials:

- BricQ Motion Prime sets
- Student Engineering Design Journals

Ask your students to measure how high the ball goes and how far it travels with the purple shoe. Each partner should try the shoe 3-5 times. Students write the height and the distance traveled in their journals. Ask students to suggest how to create a table that could hold the information gathered.

Show students how to calculate the ratio of height to distance traveled. Remind students to make sure their ratios are in lowest terms. This may require a quick review.

Ask students calculate the ratio of height to distance traveled for each trial. *(e.g., if the ball goes 4 inches high and travels 18 inches in [horizontal] distance, then 4/18 = a ratio of 2:9)*.
Ask students to add their calculations to the tables in their journals.

Disassemble and Inventory Check

Time: 10 minutes
Materials: BricQ Motion Prime set

Ask students to take apart the Free Kick model. Then, working with their partner, students will work to conduct an inventory check of the pieces in their kit to ensure all pieces are in the correct spots and no pieces are missing.

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Students should conduct an inventory of two sections that contain pieces used to build the Free Kick model. Students will not need to count pieces from all sections and it will be a quick check of their materials

> **Note:** For a full inventory: Have students place item from one compartment on the lid of the box. Then, using the paper insert in the kit (the one that is placed under the lid of the box) have students count and replace pieces into the compartment. Teams should be able to complete two compartments in five minutes. If pieces are missing, have students search other compartments, look to see if the piece is stuck in or on another piece, and/or check the LEGO lost and found area in your classroom.

Daily Debrief and Wrap Up
Time: 20 minutes
Materials:

- Sticky notes
- Student journals
- Chart paper
- Pencils
- Pens
- Markers

Label three pieces of chart paper with “Enjoyed” or “Learned” or “Wondering” so students can place their responses together.

Have students use sticky notes to write:

- One thing they enjoyed
- One thing they learned
- One thing they are wondering about

Place sticky notes in charts labeled.

Go through some of the responses on each chart.

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Learning through Sports Program Day 2

Pass the Ball

Big Question:
What types of motion can be caused gears? How do different size gears affect motion?

Materials needed for the day:

- BricQ Motion Prime sets
- Chart paper
- Student journals
- Measuring tapes
- Various craft materials
- Pens
- Pencils
- Markers

Day 2: Outline for the Day

Outline of Day	Tasks	Time	Materials
9:00 - 9:50	Welcome	5 min	• Student journals
	Team building activity	15 min	• BricQ Motion Prime Set Bricktionary Cards
	Review group rules and expectations and activities from yesterday.	5 min	• Group Rules Chart
	Team Briefing 1	5 min	• None
	Readings and Wonderings	20 min	• Book or journal article about gears used in machines
9:50 - 10:35	Challenge 1: Making a Ball Move	45 min	• BricQ Motion Prime sets • Building Instruction Booklet • Student journals
10:35 - 10:40	Break		

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10:40 – 11:40	Workplace Wellness (physical activity)	15 min	• Varies, based on the activity selected
	Team Briefing 2	5 min	• None
	Challenge 2: Gears and Gear Ratios	40 min	• BricQ Motion Prime sets • Building Instruction Booklet • Student journals
12:40 - 11:45	Get ready for lunch		
11:45 - 12:30	Lunch		
12:30 - 1:20	Team Briefing 3	5 min	• None
	Challenge 3: Complex Machines	40 min	• BricQ Motion Prime sets • Building Instruction Booklet • Student journals
	Break	5 min	
1:20 - 2:10	Team Briefing 4	5 min	
	Continue Challenge 4: Other Mechanisms	45 min	• BricQ Motion Prime sets • Building Instruction Booklet • Student journals
2:10 - 2:30	Clean up Daily debrief and wrap up	20 min	• Student journals

Welcome
Time: 5 minutes
Materials:

- Student journals

Welcome students back! Have students take a minute to read over the sticky notes placed on charts the previous day. Have students share their favorite moments from the previous day with a partner.

Team Building Activity
Time: 15 minutes

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Materials:

- BricQ Motion Prime Set
- Cards with objects to build

Place students in groups of 4-5 for team building activity- Bricktionary.

Bricktionary:

Have students play one round of Bricktionary. Students will draw a card from the stack without showing the word to their teammates. Then using bricks, students will build the object while teammates try to guess what it is. The game is over when everyone has had a turn. Below are some example cards you can use for the game.

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Bricktionary Cards

Truck	Place
Bridge	TV
Flower	Tree
Boat	House

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Review Group Rules Chart
Time: 5 minutes
Materials:

- Group Rules Chart (from Day 1)

Quickly review the group rules and expectations created on Day 1 by the students. Highlight positive moments from Day 1 (times when students helped each other, asking great questions, teamwork, helping to clean up…)

Team Briefing 1
Time: 5 minutes
Materials: BricQ Motion Prime set

Say to students:

> *Your task today is to work with different types of gears. Yesterday you worked with different feet to explore force and motion. Today you will work with gears to make balls move. Look in your sets and place one copy of all the gears you can find on the table. You should find 2 different black gears, one gray, and one tan gear. Keep just these four gears on your table. Put away the rest of the set.*

Readings and Wonderings
Time: 25 minutes
Materials:

- Internet research on different types of gears, types of movement gears have, and machines that use gears, driving and driven gears, gearing up and gearing down
- Videos on machines that use gears
- Student journals
- Building Instruction Booklet
- BricQ Motion Prime Set – look at gears available

Ask students to compare and contrast the gears. In their research, they should find what type of gears they are (double bevel). How are double bevel gears different from spur gears? Ask students to research gears, gear movement, and gear ratios. Students should write the information learned in their journals. They will use this information later.

Discuss different types of gears based on your research, readings, and videos. Ask students to think about how gears move or cause movement. Have students write in their journals the types of machines that use gears. Which of these machines are used, made, or sold in the local area? What games can they think of that use one or more gears?

Challenge 1: Making a Ball Move
Time: 45 minutes
Materials:

- BricQ Motion Prime sets
- Building Instruction Booklet

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- Student Design Journals
- Measuring tapes

Show students the video from Pass the Ball https://education.lego.com/en-us/lessons/bricq-motion-prime/pass-the-ball#prepare lesson. Review with the students the forces that make a ball move. Ask them so observe carefully the mechanisms at the end of the video. You may want to play the end more than once (from about 18 seconds to end).

Ask students to describe what they observed. Tell students they will be building mechanisms, but today they do not have instructions. They can look at the pictures on pages 2-3 in the building instructions booklet for ideas or they can create their own. The one requirement is that they use a gear to make a part of the mechanism hit the ball to cause movement.

Before starting to build, ask students which type of gear they are using. (double bevel) What is special about a double-bevel gear? (Double-bevel gears can mesh with two other gears or axles simultaneously and they can change the angle of motion up to 90 degrees.) Ask students to demonstrate how the gears can be meshed.

Ask students to build their models, reminding them they must use a gear to make a part of the mechanism that will hit the ball and cause it to move.

When the models are complete, have students test their models. Bring the class together and ask questions like:

- What did your model have to do in order to make the ball move?
- Which of the inspiration models helped you?
- How does your gear mechanism work?
- How did the gear mechanism push the ball?

Have teams trade models to test. Students should compare and contrast the two models, then write their findings in their journals.

Tell students they need to measure the distance the ball moves when using their model. Each student should use the mechanism 5 times and measure the distance the ball travels. Students should make a table in their journals. Write the distance traveled for each trial of both partners.

Which model causes the ball to go farthest? Ask the class to watch that model move the ball. What do students observe? What can they infer from their observation? Ask the team who built the model to explain in detail how it works.

Break
Time: 5 minutes

Workplace Wellness: Physical Fitness
Time: 15 minutes
Materials:

- May vary depending on what activity is selected

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Take a minute to complete a short physical activity. You may find several ideas for short physical activities for students through a simple web search. Ideas could include simple exercises like jumping jacks or running in place. Many companies encourage physical activity during the workday.

Team Briefing 2
5 minutes

Tell students:

> *You have created gear mechanisms. Now you will apply mathematics to your gear models. In your research, you learned about gear ratios. You will determine the gear ratios for all mechanisms in the current models and record them in your journals.*

Challenge 2: Gears and Gear Ratios
Time: 40 minutes
Materials:

- BricQ Motion Prime sets
- Building Instruction Booklets
- Student journals

Have students count the number of teeth on the:

- large black gear. (36 teeth on this double-bevel gear)
- gray gear (28 teeth on this double-bevel gear)
- tan gear (20 teeth on this double-bevel gear)
- small black gear (12 teeth on this double-bevel gear)

Students should write the number of teeth on each gear in their journals for quick reference.

Review with students how to determine a gear ratio (dividing the number of teeth of the driving gear by the number of teeth of the driven gear). First, have students identify the driving gears (the driving gear is the gear that is moved by the force of the student turning it). Next, have students identify the driven gears (the driven gear is the gear that is moved by the driving gear. The driving gear and the driven gear are meshed together).

Have students calculate the gear ratios for each of their mechanisms. Review with students how to write ratios. Remind them to make their ratios into lowest terms. For example, a 36-tooth driving gear to 28-tooth driven gear ratio would be written as 9:7.

Ask students:

- Which ratios make the turning mechanism move faster? (larger number : smaller number)
- Which ratios make the turning mechanism move slower? (smaller number : larger number)

Ask students to identify the gear ratios of each team's model and add the information to their journals. Which of the two models caused the ball to go farthest? What are the gear ratios of the mechanisms

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for the model that made the ball move the farthest? What are the gear ratios of the mechanisms for the other model? What can students infer from their data? Ask the teams to explain their thoughts.

Ask students to identify each gear mechanisms as gearing up or gearing down. (Gearing up has a gear ratio that is a larger number : smaller number. Gearing down has a gear ratio that is a smaller number : larger number.) Tell students that gearing up is used to increase speed and that gearing down is used to increase torque or driving power and it also reduces speed.

Ask students to identify which of the models they tested made a ball move the farthest and if it was created to gear up or gear down. Have students explain why they believe that the ball traveled farther using this type of gearing. Students should write their explanations in their journals.

Lunch
Time: 30 minutes

Team Briefing 3
Time: 5 minutes
Materials: None

Tell students:

> *Hello Engineers! Now you are ready to combine two mechanisms to make a more complicated ball moving model. You have seen several models built by your peers as well as the inspiration models in the building booklet. Think about how you can create a new model.*

Challenge 3: Complex Mechanisms
Time: 35 min
Materials:

- BricQ Motion Prime sets
- Student journals
- Tape measures

Ask students to brainstorm with their partner their ideas for a more complicated model that combines two gear mechanisms. If preferred, two teams can brainstorm ideas. All groups should designate one person to write all the ideas in the journal. Bring the students back together as a class after 5-7 minutes. Have the groups share their ideas with the class.

Ask students to work with their partners to build the machines. They can choose to take apart their previous model or add to it.

When the models are complete, have students test their models. Bring the class together and ask questions like:

- How do your gear mechanisms work?
- How do the gear mechanisms make the ball move?

Have students write in their journals an explanation (description) of how the gear mechanisms work and how the mechanisms make the ball move.

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Have teams trade models to test. Students should compare and contrast the two models, then write their findings in their journals.

Have students write a brief reflection on the activity in their design journals.

- What was easy about this challenge?
- What was difficult about this challenge?
- What did I learn from this challenge?

Have students take apart their models. They will be starting new models.

Team Briefing 4
5 minutes
Tell students:

> *You are now going to try to make a scissor mechanism to make the ball move or you can make a machine that will move the ball in a curve. You and your partner can determine which new model you want to create.*

Challenge 4: Other Machines
Time: 30 minutes
Materials:

- BricQ Motion Prime sets
- Student journals

Ask students to brainstorm ideas and then start building. They can use the building instruction booklet pictures on pages 2-3 as inspiration.

As students iterate the design, ask them how the force will act upon the ball. Ask them where on the ball the force will act to make the ball go straight and where is should act on the ball to make it move in a curved manner.

When the models are completed, have students move around the room to see the other team's models. Have half the teams share their models and then switch. All students should take notes in their journals about the models they observed and how they moved.

Cleanup, Daily Debrief and Wrap Up
Time: 15 minutes
Materials:

- Student journals
- Markers
- Colored pencils
- Crayons

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Have students take apart the models and put the pieces back into the correct locations in the bin trays.

Have students write three words in their journals that they feel reflect what they have learned today. Choose one of these words and draw a sketch that illustrates why they chose the word.

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Learning Through Sports Program Day 3

Propeller Car

Big Question:
How do Newton's Laws of Motion apply to a propeller car?

Materials needed for the day:

- BricQ Motion Prime sets
- Building Instruction Booklets
- Student journals
- Student worksheet for each team https://education.lego.com/v3/assets/blt293eea581807678a/blt4fc97ae3dd11333d/5eabfbf2d4b10d15d3e8d834/U3L6-worksheet.pdf
- Fan (large)
- Measuring tapes
- Chart paper
- Pens
- Pencils
- Markers

Day 3: Outline for the Day

Outline of Day	Tasks	Time	Materials
9:00 - 10:30	Welcome	10 min	• Student journals
	Team building activity	15 min	• BricQ Motion Prime Set
	Review Group Rules Chart	5 min	• Group Rules Chart
	Team Briefing 1	5 min	• None
	Readings and Wonderings	20 min	• Internet research • Student journals
	Inventory Check	5 min	• BricQ Motion Prime sets
	Challenge 1: Build a Propeller Car and Test It	45 min	• BricQ Motion Prime sets • Building Instruction Booklets • Student journals

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10:35 - 10:40	Break		
10:40 - 10:45	Team Briefing 2	5 min	• None
10:45 - 11:25	Challenge 2: Changing the Gear Assembly	40 min	• BricQ Motion Prime sets • Building Instruction Booklets • Student journals
11:25 - 11:30	Get ready for lunch		
11:30 - 12:00	Lunch		
12:00 - 1:15	Workplace Wellness (physical activity)	10 min	• Varies, based on the activity selected
	Team Briefing 3	5 min	• None
	Challenge 3: Additional Blades	60 min	• BricQ Motion Prime sets • Building Instruction Booklets • Student journals
1:15 - 1:20	Break	5 min	
1:20 - 2:10	Challenge 4: Changing the Blade Assembly	50 min	• BricQ Motion Prime sets • Building Instruction Booklets • Student journals
2:10 - 2:30	Cleanup Daily debrief and wrap up	20 min	• Student journals

Welcome
Time: 10 minutes
Materials:

- Student journals

Welcome students back. Have students take a minute to share the words they added to their journals with someone other than their partner. Compile a list of the words as a group on chart paper. Discuss what words were repeated, if any.

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Team Building Activity
Time: 15 minutes
Materials:

- BricQ Motion Prime Set

Build a Bridge
Challenge students to build a LEGO® bridge that spans two tables in pairs. You can determine the length. Allows students only 5 minutes to complete their bridge working together with their partner.

Extensions:

- Build the longest bridge
- Build the tallest bridge
- Build a bridge that can hold the most weight (use a bucket and some weights to test)

Review Group Rules Chart
Time: 5 minutes
Materials: Group Rules Chart (from Day 1)

Quickly review the group rules and expectations created on Day 1 by the students. Highlight positive moments from Day 2 (times when students helped each other, asking great questions, teamwork, helping to clean up…)

Team Briefing 1
Time: 5 minutes
Materials: None

> *This morning, your task is to investigate propellers and how they are forced to move by wind and how they can cause movement of an attached wheeled vehicle. Start be thinking about windmills and fan blades and how they are shaped.*

Research and Wonderings
Time: 20 minutes
Materials: None

Discussion and conduct Internet research on how windmills and fans work. Research different types of blades and shapes for both windmills and fans. Have students research propeller blades and propeller cars. How do they work? What seems to make a vehicle move toward the wind or away from the wind?

Lead a discuss on how propellers and blades. Have students compare and contrast propellors and blades. Have students explain how propellor cars seem to work.

Inventory Check
Time: 5 minutes
Materials:

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- BricQ Motion Prime sets

Ask students to find their partner from Day 1.

Have students check to see all items in the bin are in the proper trays. Ask students to inventory the red and blue trays compartments.

Challenge 1: Build a Propeller Car and Test It
Time: 45 minutes
Materials:

- BricQ Motion Prime sets
- Building Instruction Booklets
- Student worksheet – Propeller Car
- Student journals
- Large fans

Show students the video in the Engage section of the lesson. https://education.lego.com/en-us/lessons/bricq-motion-prime/propeller-car#engage

Ask students questions like:

- What makes a wind turbine move? (wind – generated by differences in atmospheric pressure)
- Which forces make a wind turbine move? (The shape of the blades affects the force vectors of the wind, which results in rotational motion. The blades are curved, not straight planks.)

Tell students they are going to build a propeller car and investigate how wind force can change the motion of the car. Have students work with their partners to build the Propeller Car model. The instructions begin on page 104 in the Building Instruction Booklet.

Remind students:

- To take turns gathering pieces and adding the bricks to the build
- That switching roles is part of being good team members.
- To help each other by being kind and considerate

When the models are complete, ask students to set their propeller cars on a starting line, facing toward the fan. Before turning on the fan, have students predict in their journals if the car will go forward or backward. Then, allow students to turn on the fan for the model. Have each team observe how the car moves. They should record their observations in their journals. Each team should try this experiment at least three times. Then, using the worksheet, indicate if the first model when facing the fan went slow or fast.

Next, have each team turn their model around, so it faces away from the fan. Have each team observe how the car moves. They should record their observations in their journals. Each team should try this experiment at least three times. Then, using the worksheet, indicate if the first model when facing away from the fan went slow or fast.

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Discuss what conclusions can they draw from this first experiment.

Break
Time: 5 minutes

Team Brief 2
5 minutes

Tell students:

> *You are going to change the model and explore what happens. You will write your findings in your journals using clear descriptions.*

Challenge 2: Changing the Gear Assembly
Time: 40 minutes
Materials:

- BricQ Motion Prime sets
- Building Instruction Booklets
- Student worksheet – Propeller Car
- Student journals
- Large fans
- Measuring tapes

Ask students to switch the position of the gear assembly so the gray gear is on top.

When the gear assembly flip is complete, ask students to set their propeller cars on a starting line , facing toward the fan. Before turning on the fan, have students predict in their journals if the car will go forward or backward and explain their prediction. Then, ask students to turn on the fan for the model. Have each team observe how the car moves. Each team should try this experiment at least three times. They should record their observations in their journals. Ask students to use the worksheet to indicate if the first model when facing the fan went slow or fast.

Have each team turn their model around, so it faces away from the fan. Have each team observe how the car moves. Discuss how far the car travels. They should record their observations in their journals. Each team should try this experiment at least three times. Ask students to use the worksheet to indicate if the first model when facing away from the fan went slow or fast.

Ask students:

- What conclusions can they draw from this experiment?
- What could you change to make your car switch from going toward the wind (upwind) to going away from the wind (downwind)? (The gearing or the direction of the propeller.)
- What causes the propeller car to move upwind (toward the fan)? (The sum of the force vectors acting on the vehicle push it upwind.)
- Can a wind-powered car travel faster than the wind is blowing? (Yes!. Some of the cars in the video you saw in the first Team Brief were moving a lot faster than the wind was blowing.)

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Lunch
Time: 30 minutes

Workplace Wellness: Physical Fitness
Time: 10 minutes
Materials:

- May vary depending on what activity is selected

Take a minute to complete a short physical activity. You may find several ideas for short physical activities for students through a simple web search. Ideas could include simple exercises like jumping jacks or running in place. Many companies encourage physical activity during the workday.

Team Briefing 3
Time: 5 minutes
Materials: None

You will add additional blades and run the experiments again. You will make predictions with rationales and then test and compare your results to your predictions.

Challenge 3: Additional Blades
Time: 60 minutes
Materials:

- BricQ Motion Prime sets
- Building Instruction Booklets
- Student worksheet – Propeller Car
- Student journals
- Large fans
- Measuring tapes

Part 1
Have students create a 4-bladed propeller for their car. Move the gear assembly to the original setting with the gray gear on the bottom.

When the models are complete, ask students to set their propeller cars on a starting line, facing toward the fan. Before turning on the fan, have students predict in their journals if the car will go forward faster or slower than the first experiment with two blades. Ask students to turn on the fan for the model. Have each team observe how the car moves. Each team should try this experiment at least three times and record their observations in their journals. Then, using the worksheet, indicate if the first model when facing the fan went slow or fast.

Next, have each team turn their model around, so it faces away from the fan. Predict if the car will travel farther – if so, how much farther. Have each team observe how the car moves. Each team should try this experiment at least three times. They should record their observations in their journals. Then, using the worksheet, indicate if the first model when facing away from the fan went slow or fast.

Ask students to switch the position of the gear assembly so the gray gear is on top.

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When the gear assembly flip is complete, ask students to set their propeller cars on a starting line , facing toward the fan. Before turning on the fan, have students predict in their journals if the car will go forward or backward and explain their prediction. Then, allow students to turn on the fan for the model. Have each team observe how the car moves. Each team should try this experiment at least three times. They should record their observations in their journals. Ask students to use the worksheet to indicate if the first model when facing the fan went slow or fast.

Have each team turn their model around, so it faces away from the fan. Ask each team to observe how the car moves. How far does the car travel? They should record their observations in their journals. Each team should try this experiment at least three times. Ask students to use the worksheet to indicate if the first model when facing away from the fan went slow or fast.

Discuss what conclusions can be drawn from these experiments.

Part 2

Have students create a 6-bladed propeller for their car. Move the gear assembly to the original setting with the gray gear on the bottom.

When the models are complete, ask students to set their propeller cars on a starting line, facing toward the fan. Before turning on the fan, have students predict in their journals if the car will go forward faster or slower than the first experiment with two blades. Ask students to turn on the fan for the model. Have each team observe how the car moves. Each team should try this experiment at least three times and record their observations in their journals. Ask students to use the worksheet to indicate if the first model when facing the fan went slow or fast.

Have each team turn their model around, so it faces away from the fan. Ask students to predict if the car will travel farther – if so, how much farther. Have each team observe how the car moves. Each team should try this experiment at least three times and record their observations in their journals. Ask students to use the worksheet to indicate if the first model when facing away from the fan went slow or fast.

Ask students to switch the position of the gear assembly so the gray gear is on top.

When the gear assembly flip is complete, ask students to set their propeller cars on a starting line , facing toward the fan. Before turning on the fan, have students predict in their journals if the car will go forward or backward and explain their prediction. Ask students to turn on the fan for the model. Have each team observe how the car moves. Each team should try this experiment at least three times and record their observations in their journals. Ask students to use the worksheet to indicate if the first model when facing the fan went slow or fast.

Have each team turn their model around, so it faces away from the fan. Have each team observe how the car moves. How far does the car travel? They should record their observations in their journals. Each team should try this experiment at least three times. Ask students to use the worksheet to indicate if the first model when facing away from the fan went slow or fast.

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Discuss what conclusions they can draw from these experiments.

Team Brief 4
Time: 5 minutes

Say to students:

> *You will continue to work with the propeller car. You will now change the position of the blade assembly.*

Challenge 4: Changing the Blade Assembly
Time: 50 minutes
Materials:

- BricQ Motion Prime sets
- Building Instruction Booklets
- Student worksheet – Propeller Car
- Student journals
- Large fans
- Measuring tapes

Ask students to change the blade assembly so it is at the back of the car. Remind students that they will have to move parts of the gear assembly as well. Have students predict in their journals if the car will go upwind or downwind. Students should write an explanation of their prediction.

Allow students to test their models and measure the distance traveled away from the fan when moving downwind. Ask students to compare the results of the propeller car with 6-blade assembly in front with the 6-blade assembly in the back of the car. Students should write their findings in their journals.

Ask students:

- To determine the gear ratio for their gear assembly.
- Explain how the gears mesh together and why bevel gears are needed.
- Describe the gear ratio relationship between the rate at which the propeller blades turn and the rate at which the wheels turn.

Have students add the information requested to their journals.

Discuss as a class after the students have had time to add the information to their journals. Have students explain their observations and given rationale for their conclusions. Ask students the cause of the movement and what the effect is within the propeller car system.

Have students disassemble their models and put away the elements into the correct locations.

Daily Debrief and Wrap Up
Time: 20 minutes
Materials:

- Student journals

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Have students write in their journals two things they learned today and if either of those things surprised them.

Ask students if any of them would be interested in working on full-scale models of propeller cars. Ask students what careers/jobs or career pathways would be important to the building of propeller cars?

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STEAM through Sports Day 4

Collision Course

Big Question:
How can one moving object cause an object at rest to move?

Materials needed for the day:

- BricQ Motion Prime sets
- Building Instruction Booklets
- Student journals
- Chart paper
- Various craft materials
- Old magazines that can be cut up (optional)
- Pens
- Pencils
- Markers
- Glue sticks

Day 4: Outline for the Day

Outline of Day	Tasks	Time	Materials
9:00 - 10:50	Welcome	5 min	• Student journals
	Team building activity	20 min	• BricQ Motion Prime Set
	Review group rules and expectations and activities from yesterday	5 min	• Group Rules Chart
	Team Briefing 1	5 min	• None
	Research and Wonderings	20 min	• Discussion • Internet research • Student journals
	Inventory Check	5 min	• BricQ Motion Prime sets • Building Instruction Booklets
	Challenge 1: Strike the Ball	50 min	• BricQ Motion Prime sets • Building Instruction Booklets

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			• Student journals
10:50 - 10:55	Break		
10:55 - 11:00	Team Briefing 2	5 min	• None
11:00 - 11:55	Challenge 2: Measuring Angles	40 min	• BricQ Motion Prime sets • Building Instruction Booklets • Student journals
11:55 - 12:00	Get ready for lunch		
12:00 - 12:30	Lunch		
12:30 - 2:00	Workplace Wellness (physical activity)	10	• Varies, based on the activity selected
	Break		
	Team Brief 3	5 min	
	Culminating Activity – Create a Game with Movement	55 minutes	• BricQ Motion Prime sets • Building Instruction Booklets • Student journals
	Showcase : Play My Game	30 min	• BricQ Motion Prime sets • Building Instruction Booklets • Student journals
2:00 - 2:30	Clean up Daily Debrief and Wrap Up Celebration	30 min	• BricQ Motion Prime sets • Building Instruction Booklets • Student journals

Welcome
Time: 5 minutes
Materials:

- Student journals

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Welcome students back! Have each student share their ideas on what activities Collision Course could entail. Have them write one sentence in their journals about an object colliding with another.

Team Building Activity
Time: 20 minutes
Materials:

- BricQ Motion Prime Set

Create a Creature
Have each student create a creature using LEGO® bricks. Have them give their creature a name and a special characteristic. Have students share their creature with their partner. Have the pair create a short story that includes both creatures. Ask students to write a paragraph in their journal about their creatures and the story.

Review group rules and expectations
Time: 5 minutes
Materials: Group Rules Chart

Quickly review the group rules and expectations. Highlight positive moments from Day 3 (times when students helped each other, asking great questions, teamwork, helping to clean up…)

Explain that they will have guests today and that they will be telling the guests about the cool new vehicle that they created.

Team Briefing 1
Time: 5 min
Materials: None

Say to students:

> *You will be working with objects that collide and trying to get the collision to cause exact movement. If you have ever played pool or billiards then you may have a head start on today's activities. Remember, you will be relating the movements to Newton's Laws of Motion. You may want to find your notes on those laws in your journals. Have fun today and keep your collisions limited to the LEGO balls in the sets!*

Research and Wonderings
Time: 20 minutes
Materials:

- Discussion and Internet research
- Student journals

Have students research objects in motion and the forces acting on them, such as friction and gravity. Students may wish to review Newton's Laws of Motion. They should research how colliding objects behave depending on how the objects collide, especially billiard balls.

Ask students to write their findings in their journals. Discuss the information they found.

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Inventory Check
Time: 5 minutes
Materials:

- BricQ Motion Prime sets

Ask students to find their partner from Day 1.

Have students confirm that all pieces in the bin are in the correct tray compartments.

Challenge 1: Strike the Ball
Time: 50 minutes
Materials:

- BricQ Motion Prime sets
- Building Instruction Booklets
- Student journals

Show students the Video in the Engage section of the Strike the Ball Lesson.
https://education.lego.com/en-us/lessons/bricq-motion-prime/strike-the-ball#engage

Facilitate a quick discussion about which forces help one ball to collide with another in tabletop ball games. Ask students how the resulting force vectors can impact movement. Ask students how players can use their understanding of forces, interactions and angles to score and win a game.

Ask students questions like:

- How are the ball games that you saw in the video different from others you've seen? *(One ball collides with another to hit it into a pocket to score.)*
- What happens when two balls collide at different angles, and why does this happen? *(Newton's third law: equal and opposite forces.)*
- What did you notice about the collisions you saw in the video? *(When the balls bump each other, it's called an "elastic collision." The rigid balls bounce off each other with no [significant] loss of kinetic energy/motion.)*
- Tell the students that they're going to design a mechanism that can strike one ball against another to score into a pocket from different angles.

Ask students to find the following:

- 2 large blue plates
- 2 green frames
- 2 white plates
- 2 yellow balls

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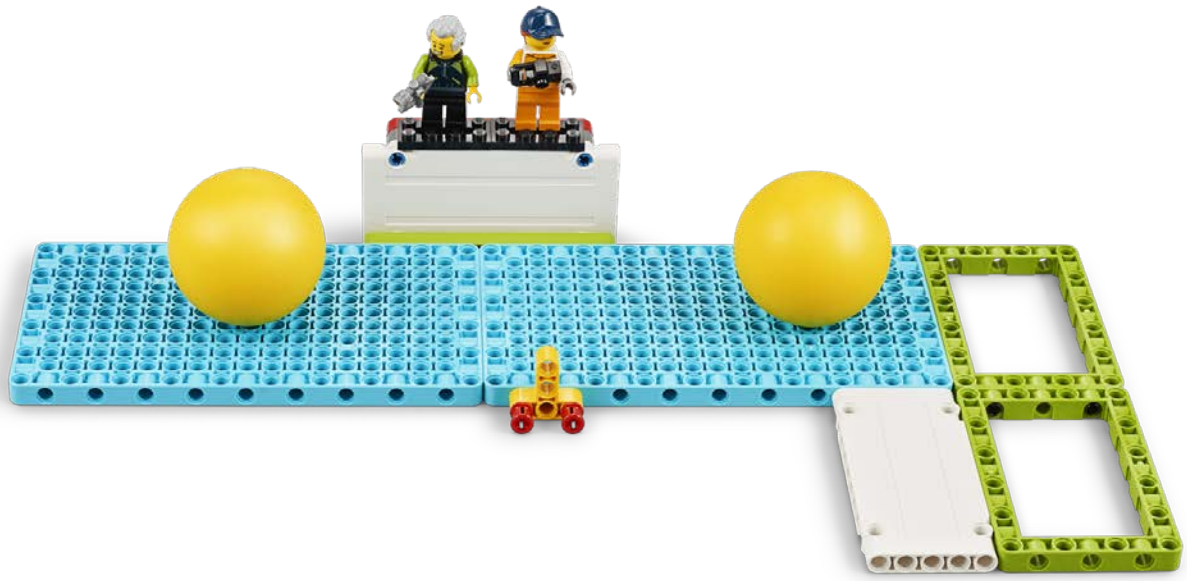
Tell students they must build the game area. Show students the picture on the student worksheet https://education.lego.com/en-us/lessons/bricq-motion-prime/strike-the-ball/student-worksheet or use the picture below.



Have students create a mechanism to move one ball into the other. Explain to students that they need to determine the exact location where each ball will start. They cannot add any materials to the game area except the mechanism to push the first ball. Tell students they must design a ball-striking mechanism for the game area that can score into either or both pockets. Have the students discuss the problems they need to solve, and then sketch and label some ideas before they start building.

Share with students the rules of the game:

- The ball-striking mechanism must be attached to the blue panel *(they can't just use a long cross axle as a mini pool cue)*, and it should have at least two moving parts.
- They're not allowed to touch either ball with their hands after they've placed it on the game area.

Before building begins have students share their sketches with the class.

Ask students the following questions:

- How will your model push the ball?

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- Which models from the building instructions book inspired you?
- What's the same as your sketch? What's different?

After all the students have share their ideas, ask the teams to discuss what they could change or add to their models to make them better. Have students write their ideas in their journals.

Allow students time to build and test and iterate. When teams have a working model, have two teams share their models with each other. They will compete using both models.

Note: If any of your students get stuck when generating ideas, coach them by:

- Asking if they've already built any models that could make a ball move
- Showing them the inspiration picture on page 1 of building instructions book to use as a good starting point
- Some students might have ideas that are too big to build within the available time. Encourage them to think about ways they could simplify their idea before the next class. Foster their creativity, explaining that many designers take time away from a project to rethink and revise their plans.
- This photo shows a sample solution taken from page 1 in the building instructions book. However, we don't recommend showing it to your students unless they're having trouble coming up with their own ideas because it tends to limit their creativity.

Tell students:

- Each person gets to have 10 tries on each model.
- To use a table or chart in the student journal to record the points scored.

Scoring Guide:

- One ball in Pocket 1 *(2 points)*
- One ball in Pocket 2 *(4 points)*
- One ball each pocket by striking ball “A” against ball “B” *(10 points)*
- No points are scored if either ball doesn't stay in any pocket *(green frame)*

After all teams have completed their first round of the game, ask students questions like:

- How well did your model work?

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- How were you able to make the first or second ball move at an angle?

Break
Time: 5 minutes

Team Briefing 2
Time: 5 min
Materials: None

Tell students:
You created a mechanism and played a game using the mechanism. Now, you will add the printed angle measurement elements to measure the angle from which the balls are being hit. This time when you play, you will record each angle and whether or not you scored. Then, you will analyze the data to determine which angle works best.

Challenge 2: Measuring Angles
Time: 40 minutes
Materials:
- BricQ Motion Prime sets
- Building Instruction Booklets
- Student journals

Have students add one or more of the printed angle measurement elements to their models so they can measure the angle of launch (the angle at which the mechanism hits the first ball) or the angle of collision (the angle at which the first ball hits the second ball.)

Tell students the rules are the same.

Tell students:
- Each person gets to have 10 tries on each model.
- To use a table or chart in the student journal to record the launch angle or collision angle or both and the points scored.

Ask students what conclusions that can draw from the data in their journals. Ask them if all the members of the group had the same data, roughly, or it there was a lot of variance in the data. Ask students to explain the variance – what other factors might be affecting the performance (force of the impact on the ball).

Lunch
Time: 30 minutes

Workplace Wellness
Time: 10 minutes
Materials:
- May vary depending on what activity is selected

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Take a minute to complete a short physical activity. You may find several ideas for short physical activities for students through a simple web search. Ideas could include simple exercises like jumping jacks or running in place. Many companies encourage physical activity during the workday.

Team Briefing 3
Time: 5 min
Materials: None

Tell students:

> *This afternoon, you will create your own game. You will need to create the models used, the rules, the scoring, and written directions on how to play. You will need to work quickly enough to have time to play all the created games.*

Culminating Project: Create a Game with Movement
Time: 55 minutes
Materials:

- BricQ Motion Prime sets
- Building Instruction Booklets
- Student journals
- Measuring tapes
- Tape
- Markers
- Chart Paper

Tell students that they will create a game. They must:

- Build the models to use in the game.
- At least one model must contain movement that causes something else to move. For example, gears, rack and pinion, scissored levers, etc. (They may use the building instruction booklet for inspiration.)
- Name the game.
- Write directions on how to play.
- Write an explanation of how to score points and the object of the game.

Explain that each team should play their own game once and make modifications as needed to improve the directions, the scoring, the models, etc.

When at least two teams have completed their games, ask teams to read through the written instructions and try to play the game. If questions arise, the team who created the game may make modifications to their instructions, models, and so forth. If another team gives them a good idea, the team receiving input should give them credit by making a note in their student journals.

Both teams should have played each other's games and they should be confident of the directions, models, and so forth for both games.

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Showcase: Play My Game
Time: 30 minutes
Materials:

- BricQ Motion Prime sets
- Building Instruction Booklets
- Student journals
- Measuring tapes
- Tape
- Markers
- Chart Paper

Explain that students will play all the games in the room. Allow students to work with each team until they have played all the games or until time is up. Have students write the name of the game they played and take a few notes on what they liked or disliked, how much fun they had, and the mechanisms involved in the models. Tell students they will need this information later.

Have students take apart the models and put them into the correct locations. Each team needs to do a complete inventory of the set.

Cleanup, Daily Debrief, Wrap Up, and Celebrate
Time: 30 minutes
Materials:

- Student journals
- Colorful paper
- Markers
- Sticky notes
- Glue sticks

Have students take apart the models and put them into the correct locations. Each team needs to do a complete inventory of the set. Have a location for students to bring extra pieces they find and to look for pieces that are missing.

Ask the student if they enjoyed the games and what they enjoyed most. Give each student 3 sticky notes. Have students use the notes in their journal as reference and write:

- The name of one game on the sticky note that they enjoyed and why
- The name of one game on the sticky note that they that was hard and why
- The name of their game on the sticky note and what they liked best about it

Collect the notes and organize them by game name. Have a member of each team come forward to get their notes.

Discuss some of the games that were really fun and why. Discuss some of the games that were hard and why.

Ask students what games they would like to try to create if they were doing this challenge again.

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Celebrate all the students and their games and all they have learned.

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